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Edited by A.F. Denisov

Countries. Years. Oscilloscopes.

(History of Oscillography of the USSR)

Vilnius 2022

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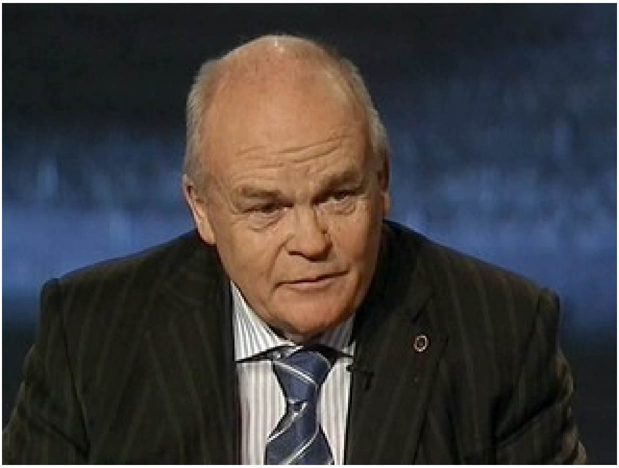
Summary

Detailed Content
(with references to all oscilloscope models)

Preface



Academician Evgeny Pavlovich Velikhov

Only experimentation can confirm or reject theoretical findings. At the heart of experiment is the measurement function. The function was born from the measurement of time, path (distance) and temperature.

With the development of civilization, the functions and methods of measurement have expanded. And it was radio measurement technology, its methods and tools that ensured the progress of all mankind.

One of the basic parameters of various phenomena is the waveform, which reflects the states of the measured phantom. The shape of the signal has different nature: whether it is a hammer blow on an anvil, a heartbeat or a sharp pain in the human brain, a flash on the Sun or the process of splitting an atom.

A signal can be electrical, optical, acoustic, a function of a gravitational or other field, but it is the signal, its form and parameters that carry the basic information essence.

In these circumstances, the role and importance of oscillography, its measurement methods and wide range of functionalities can hardly be underestimated.

A significant contribution to the development of oscillography in the USSR was made by the Ministry of Medium Machine Building and the Kurchatov Institute of Atomic Energy. I.V.Kurchatov Institute of Atomic Energy. Under the supervision of G.N.Sofiev, the curator of the IAE, the first domestic high-speed broadband oscilloscope was created in the Vilnius Design Bureau
"Hyacinth" (ISO-1, C1-11). Developments for the Serpukhov gas pedal were supervised by B.A. Utochkin. Developers of oscilloscopes in Lvov and Minsk met the needs of the Ministry of Defense. A large number of plants in different regions of the country provided serial production of a huge range of universal, high-speed, stroboscopic, and then digital oscilloscopes.

Many things in our lives determine the course of history, in science and industry, in love and in separation.

It is gratifying that despite the problems of the 1990s small teams of oscillographers in the countries of the former USSR have survived and are successfully working, using and developing the previously created scientific and technical background. Yes, forms and methods of measurements are changing, spheres of application are changing, functional capabilities have changed and considerably expanded, but oscillography, in comparison with other methods of radio-technical measurements, lives and successfully develops.

The great collected material with People and devices in various countries is a living history of a bygone era and a great credit to the compilers of this fascinating book.

Director of the Kurchatov IAE. I.V.Kurchatov
Academician of the Russian Academy of
Sciences E.P.Velikhov

From authors

We live in the era of rapid development of digital radio electronics, including electronic measurement technology, including oscillographic measurement methods.

The purpose of this book is to analyze the development of oscillography in the union republics of the former USSR (now independent states) during the last 50 years of the past XX century.

The authors have been the developers of many generations of oscillographic instruments in Belarus, Russia, Lithuania and Ukraine for dozens of years.

The leading, head organization for oscilloscope development in the USSR from 1960 to 1991 was the oscilloscope department of the Vilnius RESEARCH INSTITUTE radio measuring devices, where the head of the department from 1965 to 1991 was Dr. A.F. Denisov, who is the main co-author and editor of this book.

The other authors of this book were also leading specialists in the developing oscillographic departments of various research institutes:

- B.I.Prots - Lviv LNIRTI (Radio Engineering Research Institute), author of Chapter 2;
- N.A.Kukharenko - Minsk MNIPI (research instrument-building institute), author of Chapter 3;
- Y.A.Ryabinin - Gorky State Research Institute of Scientific and Technical Pedagogy, author of Chapter 4,
- V.B.Dvoretsky - Vilnius VNIIRIP, author of chapter 1, introduction, chapter 5, conclusion, as well as co-author of chapters 2, 3, 4 and editor of the book.

Having great experience and knowledge in this area of electronic measuring equipment, the authors have tried to generalize the activities of various research institute teams in the field of creating oscillographic devices, and show the results of their creative achievements. In our work we tried to involve veterans and young people as much as possible and to use their memories. The informational help of the Internet was not superfluous either.

Many interesting things have happened over the years. Electro-vacuum (lamp) devices appeared and disappeared and were rapidly replaced by semiconductor devices. And those, in their turn, were supplanted by devices based on integrated circuits of general and private application, and they were replaced by came digital instruments based on microprocessors, digital memory, analog-to-digital and digital-to-analog converters.

New methods of oscillography appeared - recording of single-shot signals on the basis of storage CRTs, stroboscopic and digital conversion, as well as new ways of measuring and displaying information. New types of instruments were created - for working in harsh operating conditions, for analyzing single signals, for adjusting television systems, for repairing electronics on the customer's side, etc.

We tried to trace the process of formation of enterprises, teams of developers, including leading specialists in various directions of oscillography.

The authors undertook a comprehensive generalization of these materials for the first time in the modern history of the former USSR, using the recollections mainly of oscilloscope developers, but also of their co-executors - employees of manufacturing plants in various cities of the country - in Gorky and Bryansk, Minsk and Makhchkala, Vilnius and Abovyan, Lvov and Mytishchi.

In the middle of 2012, in Vilnius, the presentation of the book "People, Years. Oscilloscopes" [1], dedicated to the employees of the oscilloscope department of only one research institute, the developer of oscilloscopes - VNIIRIP, their creativity, scientific research, development and introduction of devices into serial production.

The cover of the book "People, Years. Oscilloscopes," released in 2012.

Time has shown that experts have shown considerable interest in this book. And that is why in 2021, in Vilnius, after 9

The second book - "The Alma Mater of Vilnius Radio Electronics" was published, dedicated to the work and employees of a wider range of departments of VNIIRIP.

This book also aroused interest of a wide range of specialists also because it analyzed in detail and summarized the results of work of the oscillographic department. And now, finally, it is time to analyze the history of development and production of oscillographic devices not only in Vilnius, but also at other enterprises, on the scale of the whole former USSR.

We tried to diversify the textual material of the book with visual information in the form of photographs of devices, specific performers, group photos of teams of laboratories, departments and enterprises. The authors realize that searching and reviewing a large factual material for such a long period of time, inaccuracies, omissions and even mistakes are inevitable. Therefore, we apologize to our readers in advance. We are grateful to our assistants, reviewer and consultants, and express our deep appreciation to them. We will be delighted if this book arouses the keen interest of our readers.

Author's Collective.

Introduction.

How oscillography was born.

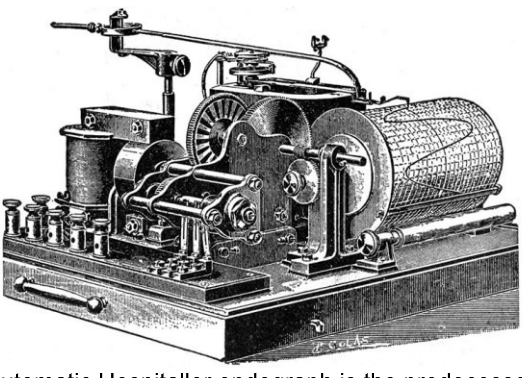
Oscillographic devices are designed to observe and record the shape of electrical and optical signals, (both various oscillations and pulsed, continuous, single and repetitive signals), as well as to measure their time a n d amplitude parameters.

The history of development of oscillography has more than 140 years [8, 9]. Initially, in the XIX century, the shape of electrical oscillations was recorded manually on paper.

In **1880, the** first attempts to automate the recording of this process were made by Jules François Joubert, who proposed a step-by-step semi-automatic method of recording the signal.

The widespread use of alternating currents has led to the need to have in some cases really accurate curve shapes, not only approximate signal values.

Hospitaller's ondograph, created in these years, gave a complete and continuous automatic recording of the curve of whole periods of alternating current in time. In the ondograph it was realized by memorizing individual values of the signal on the capacitor in the form of a constant voltage and using a commutator to measure these values with a galvanometer (voltmeter) and then construct the signal from these individual values.



The fully automatic Hospitaller ondograph is the predecessor of André Blondel's bifilar-suspended magnetoelectric oscilloscope

In **1885,** A.R. Kolli, a Russian physicist from Kazan University, created an oscillometer - the prototype of loop oscilloscopes. In **1893,** French physicist Andre *Blondel* created the first magnetoelectric oscilloscope with a bifilar (two-strand) suspension. This device could record the strength of alternating current. To do this, it had an ink pen attached to a coil through which current was passed. This pen would draw line on moving paper tape. The first oscilloscopes were almost purely The first oscilloscopes were almost purely mechanical devices, which made them not very accurate, and relatively slow. Their bandwidth rarely reached 20 kHz.

In **1895-96**, A.S. Popov, a Russian physicist and inventor of radio, demonstrated wireless transmission of information over a distance by transmitting the word "Hertz" by wireless telegraph.

In **1897,** *Karl Ferdinand Braun,* a German scientist, created the cathode ray tube, the prototype of the modern electron beam tube (CRT), to indicate the shape of an electromagnetic wave. On a fluorescent screen, a line between two points corresponding to the minimum and maximum values of the signal under study was illuminated. The illuminated line was cast on the external screen with the help of a W. König mirror, which allowed to observe the change of the signal in time, thus creating a sweep of the signal. The scanning speed of the mirror (sweep speed) transforming a pulsating vertical line into a two-dimensional visually observable picture of the current waveform was selected during setup.

In **1899,** Brown's assistant I. Cennec introduced an electromagnetic sweep based on a magnetic deflection coil to replace the Koenig mirror, which increased the system's speed.

In **1907,** another of his assistants, the Russian L. I. Mandelstam, developed a method and a scheme for obtaining a sawtooth current for linear sweep of an oscillogram along the time axis. The essence of the method was that only the beginning of the capacitor discharge process was used to generate the sweep voltage, when the current is practically a linear function of time.

In **1907,** Russian physicist B.L. Rozing applied for a patent "Method of electrical transmission of images over a distance" in which he proposed a television system with a transmitting and receiving tube Brown (kinescope), and with a electronic line-by-line scanning. That is, for the first time in the world he formulated the basic principle of the device and operation of television. In 1908-11 he received patents for it in Russia, England, Germany, and the USA.

In **1911,** B.L. Rozing realized the first TV transmission of simple images in his laboratory. His pupil V. Zworykin managed to bring this system in the USA to realization in mass production.

However, the kinescope deflection coils had low speed and high inertia of the beam movement due to their inductance, which hindered the observation (oscillography) of fast-flowing oscillations.

Therefore, already in **1911 the** first electron-beam tube (CRT) with electrostatic deflection, developed by D.A. Rozhansky in the company "**General Electric**", which had a higher speed than the kinescope, appeared, which allowed to start the development of oscillographic research installations for laboratory application in the field of fast-flowing processes.

However, the appearance of electronic oscilloscopes as instruments was delayed by World War 1, which began during this period.

The invention of the radio lamp in 1907, followed by the beginning of radio broadcasting in the USSR in 1924 (in the USA in 1920) and the beginning of radio receivers production, stimulated the beginning of radio measuring instruments industry, including the beginning of oscilloscopes production.

In **1918** in Russia was created Nizhny Novgorod Laboratory Bonch-Bruevich, with the purpose of research in the field of application of electronic tubes in the field of radio communication, radio broadcasting, which later and established the production of radio lamps.

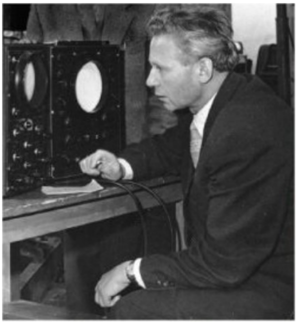
In **1930, the** Moscow Power Engineering Institute was founded by the outstanding scientist and statesman G.M.Krzhizhanovsky (who led the development of the USSR Electrification Plan, the GOELRO Plan). In it, during this period, the first laboratory oscillographic installations were developed under the direction of Prof. I.S.Stekolnikov.

In **1933-34, the** Central Military-Industrial Radio Laboratory (Central Military-Industrial Radio Laboratory, founded in 1928 in Gorky, now Nizhny Novgorod, on the basis of the Nizhny Novgorod Bonch-Bruevich Laboratory, see above, 1918) under the direction of

V.P.Kuryachyev and V.G.Dubenetsky created the **first models of Soviet oscilloscopes OKR-1, OKR-2, OKR-5.**

The OCD marking meant: O - oscilloscope; K - cathode oscilloscope (in contrast to the loop oscilloscope widely used at that time); P - sweeping, because before that all oscilloscope models were without time sweeping (only Lissajous figures were observed, by means of which frequencies, stability, modulation depths and even power levels were measured).

These oscilloscopes were necessary for the development of devices for measuring the depth of modulation type IM-1, (as well as IM-2, -5, -6, -7), for the production of radio transmitters. The "IM" devices consisted of a mechanical device, which was mounted on the oscilloscope screen, with pointers of zero line, signal minimum and maximum.



Ilya Samuilovich Stekolnikov

Vyacheslav Pavlovich Kuryachiev

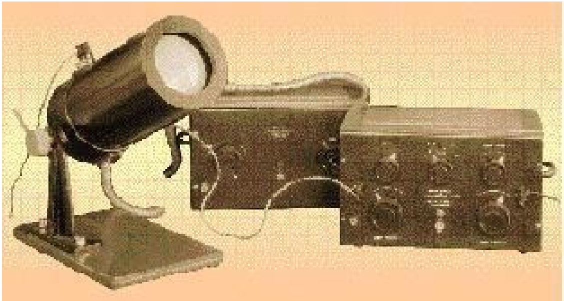
Valerian Georgievich Dubenetsky

In **1931-32,** the American company **General Radio (GR)** launched the world's 1st commercial oscilloscope, model 478-A, which could be used outside the laboratory for the first time [10, 11, 12].

General Radio oscilloscope model 478-A, consisted, as can be seen from the photograph, of 4 units [8,9] :

- electron-beam tube (CRT), model 478-A, priced at $95, (the CRT was manufactured in Germany by Manfred von Ardenne), - power supply, model 496-A, priced at $110,
- tube holder unit, model 497-A, priced at $75,
- Bedell 506-A reamer block, (from 1932), priced at $160,

Thus, the price of the world's first commercial oscilloscope was $440.



General Radio's first commercial oscilloscope, model 478-A, (30 MHz bandwidth) with unit Bedell 506-A reamers (right), (USA) 1932.

The first oscilloscope by C.A.Cossor (England) 1932.

Since it had no vertical deflection amplifier and the signal under study was fed directly to the CRT plates, the bandwidth reached a record 30 MHz. But in this case, the signal under study, in amplitude, had to be large, at least at the level of several tens of volts, or more, to be seen (sensitivity 75 volts/inch or 30 v/cm),

In **1932**, the British company A.C.Cossor also launched its 1st oscilloscope in the market.

In **1935**, **General Radio** markets the world's first mass-produced industrial oscilloscope as a complete monoblock in a single housing, the Model **687** (announced in 1934)

From this point on, the oscilloscope is transformed from a stationary research unit into a single independent portable measuring instrument.

This model contained the CRT, scanning circuitry, and power supply in a common housing, but, as before, did not have an amplifier for the signal under test, which was fed directly to the CRT plates, as in the previous case. With the new CRT (RCA 907) the bandwidth reached 130 MHz.

Parameters of oscilloscope GR 687 1935 year:

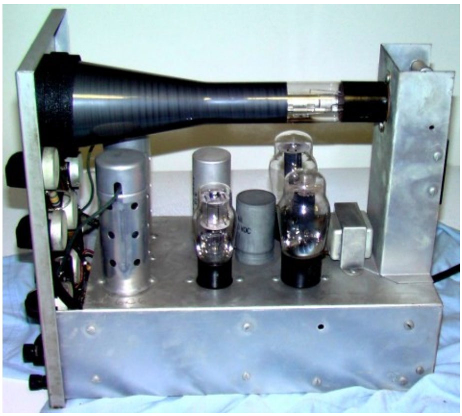
- 130 MHz bandwidth, (when the signal is applied to the CRT plates), MHz.
- sensitivity of 75 volts/inch (30 v/cm),
- sweep frequency from 30 Hz to 3 kHz,

- monitoring of signals up to 21 kHz (synchronization),
- weighing 17 pounds.

Oscilloscope GR 687 1935.Side view of oscilloscope GR 687 1935.

In **1939-40** in the United States, **DuMont** Labs, launched its first (and the world's first) mass-produced industrial oscilloscope, **model 164,** in a single housing with an amplifier of the signal under study, while significantly (by 2 orders of magnitude) increasing the sensitivity. From that moment on, for many decades, this oscilloscope structure became practically an industrial standard.

DuMont 164 Oscilloscope
(30 kHz band) 1940.



Design of the first DuMont
scilloscope, model 164

Parameters of a 1940 DuMont 164 oscilloscope:

- bandwidth from 15 Hz to 30 kHz,
- at a sensitivity of 0.48 volts/inch (0.21 v/cm),
- input resistance of 1 mOhm,
- built on five tubes,
- 11 pounds.

Allan Balcom Du Mont was born in 1901 in New York City, where he graduated from Polytechnic Institute in 1924 and became an electrical engineer. He then joined the Westinghouse Lamp Company, where he worked in CRT manufacturing.

In **1931**, he founded his own firm, DuMont Labs Allen B., Inc. which survived until 1960 and manufactured CRTs, oscilloscopes, televisions, and other instruments.

Du Mont developed an improved version of the electron beam tube that was cheaper to manufacture and lasted much longer than the German Brown tubes that were in use in the United States at the time. The German tubes had a life expectancy of 25 to 30 hours. Du Mont's invention of the first durable electron beam tube later made commercially viable television possible. He started his own company, Allen B. Du Mont Laboratories, in the basement of his Upper Montclair home in 1931, manufacturing long-life CRTs. That same year he sold the first two tubes to two college science labs for $35 each.

This company also marketed the first commercial, TV receiver. DuMont Labs conquered the oscilloscope market, and continued to dominate it until the early 1950s.

In **1940, the** USSR began production of pulse radar stations **(RUS-2), of** which **607 sets were produced** during the war of **1941-45**. Research in this field in the country began as early as **1933**. These events in their turn determined a great need in metrological support of radar development and production, in particular oscilloscopes, microwave generators and other devices, for which purpose after the war "Plant-555" was established in Vilnius.

Pulse radar station **RUS-2**. 1940.

RUS-2 radar parameters:
- carrier frequency **75 MHz**,
- pulse duration 12 µs,
- maximum range 150 kilometers,
- peak power 120 kW,
- range accuracy of 1.5 kilometers,
- 3 degrees azimuth accuracy.

In the USSR, oscillography was most massively developed after World War II, during the Cold War and the development of atomic weapons, as well as during the period of radarization.

In **1944** in Vilnius, on the basis of the former private enterprise "Elektrit", which produced radio receivers before the war, the state-owned "Plant-555" was established within the NKAP (People's Commissariat of Aviation Industry) in order to organize the production of measuring instruments for metrological support of production and development of aircraft radars. More details on the history of the enterprise
"Electrite", can be found in section 3.1. of this book or in the sources [1, 2, 3, 4], appendix 8.

In **1948** at "Zavod-555", S.N.Makeev developed the **first in the country (and in Vilnius) serial industrial oscilloscope EO-7 (C1-1)** with a bandwidth of 250 kHz [10].

Sergey Nikolaevich Makeev

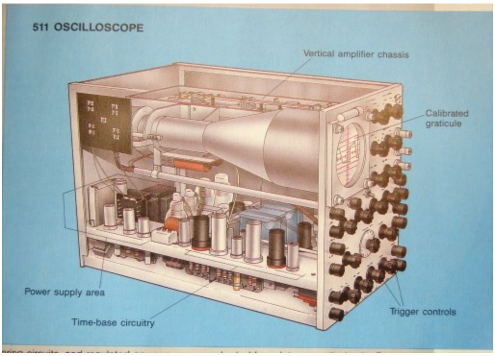
The first domestic oscilloscope **S1-1 (EO-7).** 1948 г.

In the same year, the Rybinsk Instrument Engineering Plant (now part of JSC "Concern Radio Engineering "Vega") started serial production of this oscilloscope.

Parameters of the first Soviet serial oscilloscope **S1-1:**
- 2 Hz - **250 (300) kHz** band,
- sensitivity of 0.25 cm/mV,
- input 1 Mohm/30pf,
- 2 Hz-50 kHz sweep,
- with 16 tubes,
-power consumption 120 W,
-weight 24 kilograms.

In **1946**, January 16, in Portland, Ore. In 1946, on January 16, 1946, in Portland, Oregon, USA, the company Tekrad was formed, which was renamed **Tektronix (Tek**) on February 2. From then on, Howard Vollum and Milt Bave, the founders of Tek, began the development of the first oscilloscope of the company, the model 511, which was completed within a year. Finally, **in May 1947, the 1st Tektronix oscilloscope, model 511,** with serial number 001, **was sold** at a price of $795**.**

Tektronix 511 Oscilloscope
1947 edition



Design of the first Tektronix oscilloscope, model 511

In this oscilloscope, for the first time in the world, a delay line was used to observe the edge of the pulse under study (G. Vollum borrowed this idea from radar technology) and a wait mode of the sweep. In a d d i t i o n , the strongest feature of the

This device had a 100 times wider bandwidth than the Du Mont devices (models 208 and 308) that dominated the market at the time.

Tek 511 Model Parameters:

- band 10 Hz - 10 MHz, rise time 40 ns,
- sensitivity of 0.27 V/cm,
- 1Mohm/40pf input impedance,
- Standby and automatic reamer operation modes,
- sweep coefficients of 0.01 s/cm-100 ns/cm, with stretching by a factor of 5.
- CRT size is 5 inches,
- weight 29.5 kilograms.

The founder of Tektronix, which later became the world leader in the production of oscilloscopes, **Howard Vollum was** born in 1913 in Portland, USA, In 1934, as a college student, he built his 1st homemade oscilloscope, in order to observe distortions in low-frequency amplifiers on the design it resembled the oscilloscope General Radio 478, released in 1931.

In 1936, at the age of 23, Howard Wollum began working in a radio repair store, attached to a radio store opened by his partner, Jack Murdoch, in Portland, USA.

In 1940-45, at the age of 27-32, Vollum was drafted into the U.S. Army, then sent to a unit that was engaged in radar development. There Vollum worked on a project of radar for mortar fire control, where he met Bill Hewlett, the founder of Hewlett-Packard.

Established on March 3, **1949 by** the order of Minaviaprom as part of plant No. 555 - OKB-555 (in 1966-1991 - VNIIRIP), became the **leading enterprise of the country (since 1961)** for the development of all classes of oscillographic devices - universal (including interchangeable units), wideband, service, storage, speed, special, stroboscopic, and digital.

Multifunctionality of measuring capabilities of oscilloscope served its wide use in various branches of national economy of the country.

The point is that a waveform contains countless parameters depending on the desired accuracy of its descriptions. And many of them can be observed and measured on an oscilloscope screen.

And if we add to this that through vision a person receives up to 90% of all information, and a simple graph can give a person more information than hundreds of pages of printed text, it becomes clear why the oscilloscope has become one of the most popular electronic measuring instruments for electronic technicians.

The most different types of oscilloscopes were in demand, both in terms of technical characteristics, methods of signal registration, and purpose (laboratory, field, service, special and others, up to 10 types in total).

To meet the needs, new enterprises are being established to develop and mass produce various types of oscillographic instruments.

In **1951** in Lviv, on the basis of aircraft repair "Zavod No. 797" of the NKAP, an enterprise "P/ya No. 125, Izmeritel" of the NKRP (People's Commissariat of Radio Industry) was established, which later became the second center for development and production of oscilloscopes.

In **1956** at the plant "P/ya 125" was created SKB (Special Design Bureau), later LKB and then on its basis and LNIRTI (Lviv Scientific Research Radio Technical Institute). The first device developed in the SKB was a television oscilloscope S1-9 (EO-58) with a bandwidth of 5 MHz. This oscilloscope was developed in **1958**, i.e. 10 years later than the first oscilloscope in Vilnius.

The main direction of oscillography in Lviv was the creation of portable devices for harsh operating conditions (field), mainly for the provision of military equipment and, also, for the provision of television measurements.

In **1949,** the Gorky Research Institute-11 was established - the progenitor of Soviet radio-measuring technology. This research institute had its origins in the Nizhny Novgorod radio laboratory (established in 1918 by order of V.I. Lenin).

Since **1956,** it was transformed into TsNII-11 and became the head in the field of radio-measuring instruments (RMI) within the 6th Main Directorate (MD) of the Ministry of Communications Industry (MCI) [5].

In the early 1960s, the Gorky Central Research Institute-11 began to create a new class of oscilloscopes using the effect of stroboscopic conversion of repetitive signals, and then to the creation of digital oscilloscopes.

The prototype of the first stroboscopic oscilloscope was created at the Leningrad Institute LITMO by V.A.Vol in the early 1950s.

The first device of this direction, developed in 1962-1963 in TsNII-11 in Gorky, was a stroboscopic attachment S1-21 to Lvov oscilloscope S1-19, which provided bandwidth extension from 1 to 200 MHz (200 times) for repetitive signals.

In 1940-50 years oscillographic recorders of special purpose series OK with photoregistration from the CRT screen began to be developed at the Moscow Institute of Physics of the Earth under the direction of K.Kamenetsky.

By the late 1960s, the need for oscillographic measuring instruments for scientific research in various fields of human endeavor had increased dramatically.

Therefore, in **1972, the** development of universal oscilloscopes began in Minsk at the MNIPI, established in 1971. This research institute was created on the basis of the SKTB (1954) at the Molotov Radio Plant (later named after Lenin), established in 1940 by employees of the same Vilnius private enterprise "Elektrit", on the basis of which the "Plant 555" was created. Molotov (later named after Lenin), created in 1940 by the employees of the same Vilnius private enterprise "Elektrit", on the basis of which "Plant 555", a manufacturer of oscilloscopes, was established. The first oscilloscope developed in 1976 in MNIPI was the portable C1-76 with a bandwidth of 1 MHz. This direction on creation of universal portable oscilloscopes for general purpose, along with digital oscilloscopes, became the main directions of MNIPI activity.

The following decades (1965-1985) became the "Golden Age" in oscillography, both domestic and world. In the 1980s the country produced up to 160 thousand oscilloscopes per year. In general, the volume of industrial output of oscillographic devices exceeded 25% of the total output of all types of radio measuring devices. Every fifth oscilloscope produced in the world was manufactured in the USSR.

Industrial production of oscilloscope devices in the country was carried out at nine enterprises: in Abovyan (plant of "Izmeritel), in Bryansk (Elektroapparat plant), in Vilnius (VZRIP plant), in Lviv (Izmeritel plant), in Makhachkala

(Makhachkala Instrument-Making Plant), in Minsk (Lenin Plant and Kalibr Plant), in Nizhny Novgorod (Frunze Plant), and in Mytishchi (Mytishchi Radio Equipment Plant).

A total of **246** models and modifications (including fractions) of oscilloscopes for serial production were developed in the USSR during the whole period **1948-1992.**

Most of them were developed **in Vilnius**, in the head oscillographic department - **140** models of oscilloscopes and their variants (as fractions), which amounted to about **56.9% of** all developments.

In **Lvov 52** such devices were developed, or **21.1% of** all developments. In Minsk - **30 devices,** or **12.2%,** and in Gorky - **24** devices, or **9.8% of** all oscilloscopes developed in the USSR.

After 1992, with the collapse of the USSR, 6 GU MPSS and MRP, which united 4 research institutes (VNIIRIP, MNIPI, GNIPI and LNIRTI) and 9

The oscillographic industry in the USSR was disbanded and ceased to exist.

The development of oscilloscopes continued in much smaller volumes at separate enterprises, which were already established in different countries - Lithuania, Ukraine, Belarus and Russia in private companies created on the basis of these research institutes.

Chapter 1.
Vilnius Research Institute of Radio Measuring Instruments (VNIIRIP)

1.1. Becoming an enterprise. 1944-1959 .

On October 13, 1944, NKAP (People's Commissariat of Aviation Industry) Order No. 605ss was issued. On the basis of this order, the Central Design Bureau-17 (Central Design Bureau-17) was given plants 278, 283, 287, 290, as well as the enterprise on the territory of the *Elektrit plant* in Vilnius, which had produced radio receivers before the war, which was named **"Allied State Plant 555"**.

Plant 555 was commissioned in the **fall of 1944** and was profiled as an enterprise for development and production of radio measuring equipment for metrological support of radar equipment production. The main production is oscilloscopes, pulse measuring devices and microwave devices.

From **1944** to **1992, the** ever-expanding territory of the former *Elektrit* factory was used under different names:

- c 1944 - Plant No. 555 and Central Plant Laboratory (CPL);
- since 1949 - Plant No. 555 and OKB No. 555;
- since 1960 - NII-555 with pilot plant P/y 6 (together P/y 50);
- since 1966 - VZRIP plant (p/y A-7859) and VNIIRIP Institute (p/y R-6856);
- since 1991 - *Elita* electronics institute and *Rimeda* plant
- since 1994 - many small private enterprises.

In the late 1940s, the Central Plant Laboratory (**CPL**) was established at Plant 555 (Director L.A. Chernyshev), headed by Sergei Nikolaevich Makeev, a graduate of the Warsaw Polytechnic Institute, who joined the plant on July 25, 1944 (Vilnius was liberated on July 13, 1944). The laboratory began to develop its own instruments, including oscilloscopes.

In **1948** S.N.Makeev developed the **first in the USSR (and in Vilnius) serial industrial oscilloscope EO-7 (C1-1)** with a bandwidth of 250 kHz at "Zavod-555". In the same

The Rybinsk Instrument Engineering Plant (now part of JSC "Concern Radio Engineering "Vega") started serial production of this oscilloscope. A photo of this device and its developer, as well as its parameters, are placed above in section
"Introduction." [10].

The list of all oscilloscopes developed at VNIIRIP is given in Appendix 1.

Later the laboratory was transformed into a department, then into the Radio Technical Service (RTS), which were successively headed by M.D.Rossosky and L.I.Dobrovolsky (deputy chief engineer of the plant). This service included two departments - the Department of Centimeter Technique (head of the department S.S.Fel) and the Department of Pulse Technique (head of the department Z.V.Magrachev), as well as a group of designers, headed by N.S.Broido, who before the war had been head of production at the Elektrit plant. The leading employees of the division were A.I.Naidenov, P.H.Drap, and B.V.Shapurov.

At the demonstration. From ***left to right:*** M.D.Rossosky, R.I.Berezina, S.S.Fel, E.Kravchun, M.M.Esipenko, T.I.Kaskievich, H.G.Zaidelson, R.S.Kulakova, O.F.Vasilieva, E.Shulzhenko, L.A.Tipenkova. Photo of the late 1950s

May Day demonstration. From *left to right:* A.Volkov, O.F.Vasilieva, R.S.Kulakova, M.M.Esipenko, T.I.Kaskiewicz, N.S.Broido, V.S.Flotsky.
Photo from the mid-1950s. This is the only surviving photo of N.S. Broido, who was the production manager of the *Elektrit* plant before the war.

Employees of the impulse department of the plant's RTS. From *left to right,* ***sitting:*** A.Saudargas, T.R.Antonovich, M.I.Yefimchik, G.D.Voronova (Zakharchuk), V.S.Dekhtyaruk;
stand: A.A.Kalamkarov, A.D.Semenyuk, L.B.Pavlovich, B.V.Shapurov, L.I.Dobrovolsky. Photo from the late 1950s.

On **March 3, 1949 by** order of Minaviaprom in the composition of the plant - 555 **is created OKB-555 - Separate Design Bureau No. 555,** later NII-555 and VNIIRIP (simultaneously with the establishment of NII-11/GNIPI in Gorky/N. Novgorod)**.** The plant director at that time was Viktor Nikolayevich Denisov.

Vladimir Petrovich Uftyuzhaninov, an employee of the Moscow Central Design Bureau-17 (NII-17), was appointed head of the Experimental Design Bureau-555, and Grigory Vasilyevich Sibilev, also an employee of the Central Design Bureau-17, became his deputy, chief engineer of the Experimental Design Bureau [6].

Natalia Uftyuzhaninova, granddaughter of Vladimir Petrovich, recalls:

"Grandfather was born in 1904 in Tomsk and received his higher education there. In the late 1950s, he was sent to Leningrad, to the Prof. Bonch-Bruevich Electrotechnical Institute, where he worked in research laboratories. He spent the whole war on the Karelian front, and in 1944 he was sent to the Central Design Bureau-17 of MAP, where he worked for 5 years. In 1949, together with five employees of the Central Design Bureau, he was sent to Vilnius with the task of creating a new Design Bureau on the basis of plant 555".

Vladimir Petrovich Uftyuzhaninov - Head of OKB-555

Grigory Vasilyevich Sibilev - Chief Engineer of OKB-555

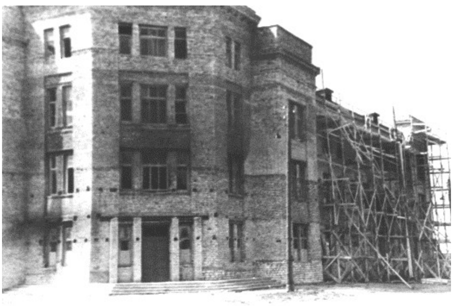
Together with them came three more employees of the same enterprise: Tamara Petrovna Kudryavtseva - a specialist in the field of microwave devices, Sergey Pavlovich Algin and Leonid Arkadyevich Lvov - designers.

At the same time, technical documentation and prototypes for a complex of new radio measuring devices developed at NII-17 under the common code "Vanadium". The complex included oscilloscope 25-I (later C1-2), signal generator 26-I, distance calibrator for radar stations 27-I, as well as a set of microwave devices on the topic "Magnezit".

Established in that distant wartime, on October 1, **1944,** the Moscow Central Design Bureau-17 was focused on the development of aircraft radar systems and facilities. Subsequently, the enterprise was called NII-17, the Moscow Research Institute of Instrument Engineering, and now it is the Vega Radio Engineering Concern [6].

Initially all OKB employees worked in one room, they were: M.Stolov, N.Aleksandrova (Malakhova), E.Pigarev, L.Auzin, M.Savinsky, V.Panasiuk, B.Kovarsky, L.Tsukerman, A.Vasiliev, P.Zaleckis, B.Yanovchik (Kazhe), Chekanauskas, V.Gulimov, E.Romanova, N.Mescheryakova and others.

The first subdivisions with a total number of no more than 30 people in 1950 in the OKB were two thematic departments: the department of No.2 (department of pulse devices), headed by G.V.Sibilev, and department No.3 (department of microwave devices), headed by T.P.Kudryavtseva; design bureau (S.P.Algin, L.A.Lvov, B.Yanovchik) and pilot shop (N.M.Prokofiev - head and foremen G.Charushin and A.Dapshis).



The building at the crossroads of Shevchenkos Street (before the war Sheptytskogo Street) and Shvidrigailos Street (before the war *E.Rydza-Smilgego Street*, after the war - *E.Rydza-Smilgego Street*).
Montvilos). This building housed the laboratories of OKB-555 in the 1950s and early 1960s, the main building of VZRIP in the 1970s and 1980s, and currently houses various commercial organizations, a hotel, and a bank.
On the left is a photo from 1945, on the right is a photo from 2010.

Since **1951**, all the services of the OKB were located in a corner building on Shevchenkos and Montvilos Streets (nowadays Švitrigailos). The same building housed one of the plant's workshops and a medical center.

The first subdivisions with a total number of no more than 30 people in 1950 in the OKB were two thematic departments: the department of No.2 (department of pulse devices), headed by G.V.Sibilev, and department No.3 (department of microwave devices), headed by T.P.Kudryavtseva; design bureau (S.P.Algin, L.A.Lvov, B.Yanovchik) and pilot shop (N.M.Prokofiev - head and foremen G.Charushin and A.Dapshis).

In the same years, close ties were maintained between the employees of the Design Bureau and the plant. Under A. Rozhnov's leadership, there were joint soccer and hockey teams, a unified scientific and technical library, a children's music school worked in the Zarya club.

Work in the Design Bureau began with the introduction at the plant of a set of devices developed in the Central Design Bureau-17 of the Ministry of Aviation Industry.

The kit included:

-devices of 3 centimeter range (measuring line, echo resonator and a number of others). Topics **"Magnesite", "Molybdenum", "Octave", "Radium-P"),**

-pulse-oscillographic devices under the general code **"Vanadium"** (oscilloscope 25I, or C1-2, pulse generator 26I, distance calibrator 27I) [12].

Oscilloscope 25-I (subsequently C1-2). 1950 г.

Pulse generator 26I. 1950 г.

The Design Bureau was entrusted with finalization of devices and design documentation. L.B.Tsukerman and V.F.Samorodsky were responsible for finalization of the power supply units. V.P.Uftyuzhaninov and G.V.Sibilev were in charge of general management of the work on introduction of the devices into serial production. The executors were T.P.Kudryavtseva, V.I.Gulimov, S.P.Algin, V.I.Beletsky and others.

Sergey Pavlovich Algin

L.A.Lvov

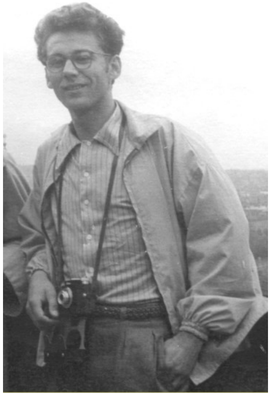
In **1951,** V.P.Uftyuzhaninov and G.V.Sibilev together with the chief engineer of the plant A.T.Denisenko became laureates of the Stalin (later State) Prize of the USSR of the third degree for finalization and introduction into production of new equipment on the topics "Magnesite", "Molybdenum", "Vanadium", "Octave", "Radium-P" (25I, 26I, etc.) [7].

The first development of the Design Bureau was a special device - a **defect-toscope (86I and 86IP). The** leading engineer was L.A.A.Auzin, the main executors were V.Chekanauskas, P.Gorev, N.Goreva, N.Malakhova.

In **1951, the** Design Bureau was joined by a large group of engineers and technicians - A.Kazhe, V.Isaev, G.Bessonov, A.Emelyanov, L.Krylov, Y.Senkevich, P.Urbanas, V.Samorodsky, I.Dagis, V.Flotsky, A.Kovbasyuk (Rumyantsev), A.Avizhen, Y.German, A.Vasiliev, A.Tsvetkov, R.Danchenko and others. A group of specialists including N.Murzin, N.Slobodskoy, N.Isaiko, S.Salivon, Ya.Stolovitsky moved from the plant.

With the arrival of newcomers to the OKB, structural reorganization began. Specialized, subject-specific departments were created, subdivisions and development begins, directly by local specialists.

The first oscilloscope developed at OKB-555 in 1954 was the ENO-1 oscilloscope (C1-4, see photo in Section 3.2., page 62), designed by A.P. Chyorny, later chief engineer of VNIIRIP.



Oscilloscope ENO-1 (C1-4). 1954.

Anatoly Pavlovich Cherny.
Photo from the late 1950s

During the first 5-7 years the Design Bureau was replenished with experienced specialists and young people, graduates of universities and technical schools from different republics of the country. And in 1956 the first reorganization of OKB subdivisions took place. By this time the number of the OKB reached 100 people.

After the reorganization the department No.2 was abolished and on its basis were created laboratories No.1, No.2 and No.3, which were respectively headed by L.A.Auzin (pulse technique), G.M.Lifanov (oscilloscopes), and T.P.Kudryavtseva (microwave devices).

Radio engineers were required for the development of the Experimental Design Bureau and Plant 555 and new radio engineering enterprises being established in Lithuania. Their training was started in the universities of the Republic. Specialists of the Experimental Design Bureau were involved in lecturing.

G.P.Vihrov was the first to give a course in radio engineering to the students of the Physics Department of Vilnius State University. Among his students was P.Fridberg, who worked at the company for many years and headed the theoretical research department at the research institute. G.P.Vikhrov also conducted classes with trainees from the People's Republic of China (PRC) interning at Plant 555.

Lev Avgustovich Auzin

Gennady Makarovich Lifanov

Tamara Petrovna Kudryavtseva

The Design Bureau specialists (G.Vikhrov, A.Denisov, A.Fedorenchiku and others) were repeatedly offered to move to newly established Lithuanian enterprises. Many of them did (I.Shatkus, V.Stalinkevicius, P.Urbanas, D.Eidukas and others) and continued their labor activity there quite successfully.

One of the first developments of NII, in the field of medical equipment, in the early 1960s, was an electrocardiograph with registration based on thermal paper (the main developers were A.Chernyi, G.Bessonov, V.Azarenkov, see Chapter 6).

Later on, **1960** became the year of profound changes, the year of defining transformations, the year of rapid assertion of the Design Bureau as the country's leading enterprise in the field of radio-measuring equipment.

1.2. Enterprise Development. 1960-1992

In early **1960**, the State Committee for Radio Electronics (SCRE) on the basis of Plant-555 and OKB-555 created the organization a/ya-50, consisting of NII-555 and pilot plant p/ya-6.

Alexander Mikhailovich Suchkov, who had previously worked as Chief Engineer of Kaunas Radio Plant, was appointed Director of the organization and simultaneously Director of the Research Institute. V.P. Uftyuzhaninov became chief engineer of the Research Institute. Vladimir Aleksandrovich Novopolsky was appointed Director of the pilot plant, and October Osipovich Burdenko, Head of Shop 7, was appointed Chief Engineer.

Alexander Mikhailovich Suchkov - Director VNIIRIP

Vladimir Alexandrovich Novopolsky - Chief Engineer of VZRIPa

October Osipovich Burdenko - Director of VZRIPa

The radio-technical service of the plant was reduced and its specialists were transferred to research institutes (M.I.Efimchik, A.A.Kalamkarov, A.D.Semenyuk, S.S.Fel, O.F.Vasilieva, E.Dagilite, T.I.Kaskevich, L.I.Dobrovolsky, B.M.Mukomel, P.M.Pereshivannyi and others).

The corresponding order of the Director of the organization changed the structure of NII subdivisions.

With the establishment of the Institute, the volume of work increased, the number of R&D and experimental work increased, new directions in development appeared, the number of personnel increased, the general services of the Institute increased. Laboratories turned into departments. Two departments of pulse technology were created, Department No.1 (Head L.A. Auzin) and Department No.4 (Head G . P. Vikhrov), oscillographic department (acting head of the department V.M. Levin) and department No.3 (head of the department T.P. Kudryavtseva), Each department consisted of 2-3 laboratories. Institute-wide services also turned into departments.

In **1961 the** Research Institute became the leading oscillography enterprise in the country, Departments No.1 and No.2 were united into one pulse-oscillography department (Head L.A.Auzin, Deputy Head V.M.Levin). When the departments were united, an independent laboratory of medical radioelectronics (Head A.P.Cherny) was allocated, which became the Department of Medical Radioelectronics in 1964.

In **1962, a** new separate building was constructed for the Research Institute on Naugarduko Street (former Partizanu Street), which housed all the departments of the Institute.

The 15th building of the Research Institute on Partizanu Street (now Naugarduco Street), built in 1962. Photo 2010.

as an engineer at Kaunas NIIRIT, a former branch of Vilnius NII-555.

Expansion of the subject matter (development of optoelectronic, picosecond and millimeter wave ranges), increase in the number of research institutes required changes in the structure of subdivisions. Departments were enlarged, departments were created, design bureaus of departments (DBS) were returned to the general design service, specialized co-executive divisions were created to solve general issues (theoretical calculations laboratory, power supply department, microelectronics department, etc.).

Viktor Dmitrievich Starikov - Director of VNIIRIP from 1968 to 1991.

The 5th building of the Research Institute on Vityanö Street, built in 1966. 2011 photo.

In **1966** for the needs of the Institute a new industrial building was built on Vityanö Street with a length of about 200 meters.

Увеличивается число предприятий-разработчиков элементной базы для радиоизмерительных приборов и, в первую очередь, разработчиков ЭЛТ, ЗЭЛТ, ЭЛТБВ (Московский электроламповый завод – нач. Лаборатории A.Khutilenok; Design Bureau of Lvov *Kinescope Plant* - head of the Design Bureau E. Martynova, head of the Department B. Kinakh, developer V. Malyshev; Fryazinsk Research Institute - developers V. Bogachenko and Y. Chaiko, V. Shkunov; Design Bureau of Novosibirsk Electro-Vacuum Devices Plant, head of the Department V.A. Yedin.

Leningrad association "*Svetlana*" develops fast-acting diodes and microcircuits, Vilnius enterprise - "*Svetlana*" develops fast-acting diodes and microcircuits.

he "*Venta"* company develops fast ADC and DAC microcircuits, Tomsk NIIPP develops Gunn diodes (chief designer V.Lukash) and arsenide-gallium mixing diodes (I.D.Romanova).

Kherson Production Association "Dnepr" creates fast-acting diodes with charge accumulation (chief designer F.V.Prodan). Leningrad Scientific Research Institute "Domen" (head of the laboratory V.K.Kunevich) develops microwave ferrite devices (valves, circulators), Scientific Research Institute "Istok" (Fryazino, chief designer A.A.Negirev) small-size LOVs - sources of microwave power of millimeter wave range.

Many other MEP enterprises are also developing electronics products required for the equipment created by the Research Institute.

In **1985 the** commissioning of the microelectronics building was completed.

The 31st building of the Research Institute (microelectronics) at the intersection of Vityaneo and Partizanu (Naugarduco) streets, built in 1984. Photo from 2011.

Ties are being strengthened with scientific centers of the country: with Lithuanian Academy of Sciences and KPI (Academician D.Eidukas, Prof. R.Zhilinskas), with VISI (Prof. Z.Vainoris and Prof. A.I.Naidenov), with Ryazan Radio Engineering Institute (Prof. A.Berkutov), with Kiev Institute of Radio Engineering (Prof. A.Vainoris and Prof. R.Zhilinskas).

Polytechnic Institute (Prof. S.V. Denbnovetsky, Associate Professor I.I. Orlov, Associate Professor A.A. Bokrinskaya, I.G. Sporevoy, etc.).

By this time the Vilnius plant could not master all the developments of NII, and the Ministry involved new plants. The following plants started to master the developments of NII:

- *Izmeritel* plant*,* Abovyan, Armenia - directors A. Kirakosyan and A. Torosyan, chief engineers V. Piloyan and D. Efremov, chief designer A. Kalantaryan);
- Minsk Lenin Plant, hereinafter "BELVAR" - Director V.Mumai, Chief Engineer I.Shut, Deputy Chief Designer S.Yurko,
- Minsk plant "Kalibr" - chief engineer P.Kovalev;
- Bryansk plant "*Elektroapparat*" - director Murashchenkov chief engineer V.Parfenov, chief designer B.Ovsyannikov;
- Makhachkala plant - directors A.Kolyvanov, Y.Berezutskiy, chief engineers Y.Berezutskiy, V Bulatinkov, S Huseynov;
- Moscow plant of measuring equipment - directors N.Grusha, A.Rosschupkin, chief engineer R.Kogan;
- Mytishchi Radio Equipment Plant - directors V.Panov, I.Khodyachikh, chief engineer P.Voronkov, chief designer V.Dudin.

Research and production and technical activities of thematic and design-technological subdivisions of the Research Institute, as well as microelectronics subdivisions and subdivisions related to design automation and use of computer technology, predetermined by the state plans, decisions and resolutions, were accompanied by the corresponding scientific and technical policy, which was formed to a large extent by the Scientific and Technical Council (STC) of VNIIRIP.

The NTS consisted of managers and leading specialists of the Institute. V.D. Starikov, Director of the Institute, was the Chairman of the NTS, A.P. Chernyi, Chief Engineer, was the Deputy Chairman, and Mikhail Semenovich Braver was the Secretary. In all main divisions of the Institute according to their areas of specialization the corresponding sections (parts) of the NTS of the Institute were created and actively worked.

At the beginning of the 1990s VNIIRIP was the country's leading enterprise for pulse-oscillographic devices. Headcount

The number of employees at the research institute was more than 2000 people, the number of employees at the plant exceeded 5000 people. The Institute employed over four dozen candidates and doctors of sciences, laureates of Union and republican prizes, Honored Inventors of the Republic of Lithuania, authors of scientific publications and books, dozens of certificates of authorship, holders of orders.

During the years of activity of the Design Bureau and Research Institute hundreds of radio measuring devices were developed and put into serial production, which influenced the technical and scientific level in such spheres as electronic equipment, communications, transport, aviation, shipbuilding, defense industry, energy (including nuclear), space research, medicine, consumer electronics. And these spheres determined at that time the authority of the USSR as a great world power.

After August 1991, VNIIRIP, which was a part of the Telecom Concern (formerly 6 GU MPSS of the USSR Ministry of Communications), which included 9 serial plants and was 90-95% financed by profits from the production of its devices, became the property of the Republic of Lithuania. Thus, VNIIRIP was separated from serial plants in other countries and, accordingly, from the sources of financing.

Due to these circumstances and the retirement of the Director of the Research Institute V.D.Starikov, the reorganization of the Research Institute began. In accordance with the new documents, the Director of the Research Institute was to be elected by the Scientific Council of the Institute, the Chairman of which was elected G.A.Sharov at the suggestion of V.D.Starikov. The Scientific Council of the Institute elected E.L.Pileckas, Doctor of Technical Sciences, a former employee of the Institute, as the new Director. The Institute was renamed as ELITA Research Institute and during 1992-93, due to the lack of centralized funding, practically ceased to exist.

On the basis of its subdivisions a number of state personal enterprises were created, after privatization transformed into CJSC, which continued the work on creation of radio measuring equipment of separate directions.

VNIIRIP recreation center, on the Baltic Sea, in Palanga, on Užkanaves str.

VNIIRIP recreation center near Lake Drabužis, in the village of Drabužininkai.

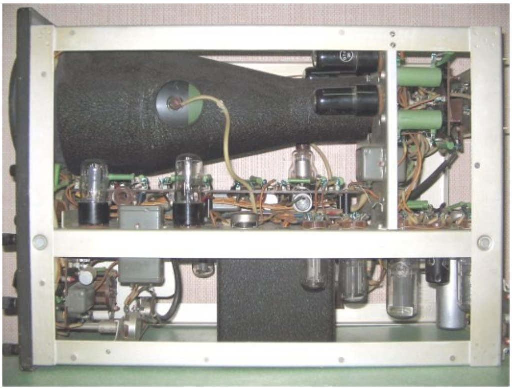
1.3. The rise of oscillography 1948-1959.

In **1948**, a year after the first sale of the Tek 511, the first Soviet serial industrial oscilloscope **S1-1,** renamed **EO-7 in** 1957, was developed in the Central Factory Laboratory (TsZL) of Plant-555 in Vilnius. It was created under the leadership of the head of the Central Laboratory of the Central Laboratory - Sergey Nikolaevich Makeev and was produced for a long time at the plant in Rybinsk. This oscilloscope was also developed by Pyotr Kharitonovich Drap [1, 13]

The analog of this device was the DuMont 208 oscilloscope, [14] 1943, which was supplied to the USSR under Lend-Lease. Since the first Soviet serial oscilloscope was produced 5 years after the DuMont 208 (this was influenced by World War II), its main parameter - bandwidth - was improved, in particular, the bandwidth was expanded **2.5** times from 100 to **250 kHz.**

The first domestic oscilloscope S1-1 (EO-7). 1948 г.

Sergey Nikolaevich Makeev - the first head of the CPF



Design of the first industrial serial Soviet oscilloscope S1-1

Front panel of oscilloscope C1-1 (EO-7)

Parameters of the first Soviet serial oscilloscope S1-1:

- 2 Hz - 250 (300) kHz band,
- sensitivity of 0.25 cm/mV,
- input 1 Mohm/30pf,
- 2 Hz-50 kHz sweep,
- with 16 tubes,

-power consumption 120 W,

-weight 24 kilograms.

DuMont 208 Oscilloscope 1943 (analog of C1-1)

DuMont oscilloscope design, model 208

In the USSR, the beginning of the development of industrial oscilloscopes is associated with the Moscow CKB (Research Institute) - 17, from the 17GU NKAP (MAP)
[6] which was founded on October 1, 1944. The founder of the Russian radiolocation took part in the foundation of this research institute
- Academician A.I. Berg. Despite the fact that the development of devices of this NII-17 was started earlier, the first (two years earlier) in serial production was the **C1-1, in 1948.**

It was the first developments of this research institute - oscilloscope **25-I (C1- 2),** pulse generators 26-I, 27-I and other types of devices began to be produced at Vilnius plant №555, starting in **1950** (its photo on page 33) [1,15]

It should be noted that the oscilloscope 25-I of 1950, had a bandwidth of 30 Hz - **5 MHz** at a weight of 25 kg, and on this parameter it was close to the oscilloscope Tek 511 produced in 1947.

G.V.Sibilev played a leading role in the introduction of the 25-I oscilloscope. It was necessary to adapt the technical documentation for serial production of the oscilloscope at the plant.

According to the system of appointments adopted in MAP, as a rule, top managers of enterprises were appointed as chief designers of developments, so the chief designers of OKB-555 were:

- V.P.Uftyuzhaninov - on microwave devices,
- G.V.Sibilev - on pulse-oscillographic devices.

In **1954, the** 1st oscilloscope was developed in OKB-555, established in 1949. It was created in department No. 2 and became the 2nd oscilloscope of the Fives. It was a low-frequency oscilloscope **ENO-1 (C1-4), which** had a bandwidth of **1 MHz.**

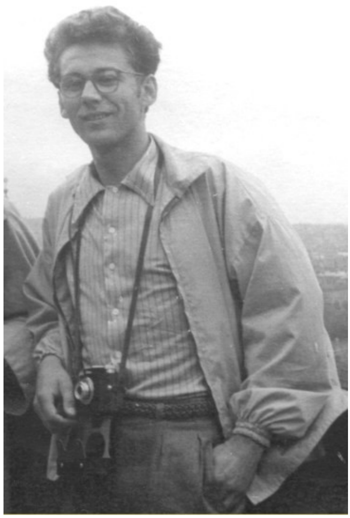
The chief designer of the device was G.V. Sibilev. Anatoly Pavlovich Cherny, a graduate of Lviv Polytechnic Institute, who later became the Chief Engineer of VNIIRIP and a laureate of the USSR Council of Ministers Prize, took an active part in the development.

The oscilloscope had a sensitivity of 3 to 300 mV/mm, with a bandwidth of 1 MHz, overall dimensions of 576x444x280 mm and a mass of 26 kg. Interestingly, the oscilloscope's input divider had a 1-3-10 step, the vertical path gain reached 1200, and the input impedance switched from 75 ohms to 0.51 Mohm. ENO-1 was the first domestic oscilloscope with a DC input of vertical deflection channels (the so-called "open input"). This made it an instrument for research of pulse signals, since only the preservation of the constant component of the pulse signal provides its complete and accurate reproduction. The sawtooth sweep voltage was formed by discharging the capacitance through the high output resistance of the pentode.

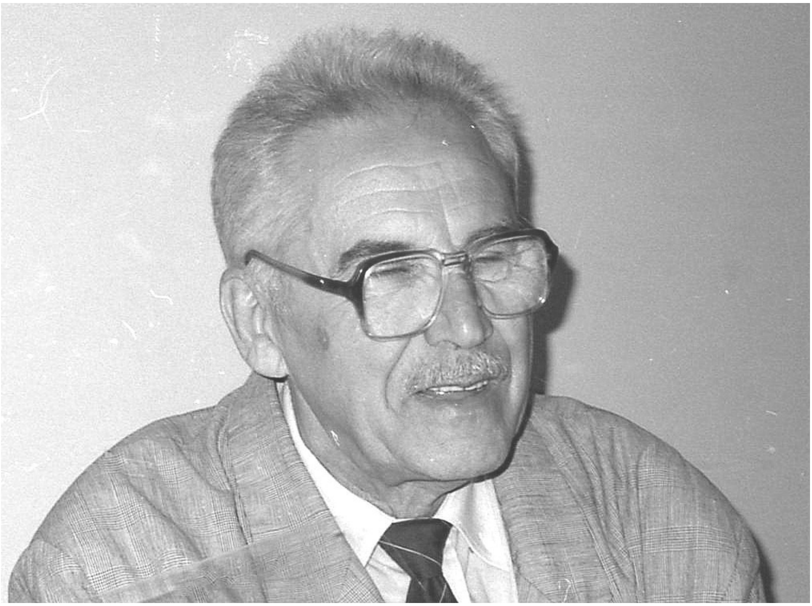
On what element base was the oscilloscope of the mid-1950s built? The input differential stage was made on a pair of 6N1P tubes, the output stage was made on a pair of 6P1P tubes with output to 13LO36V CRT plates, which had a long afterglow time, up to 5 seconds. The output of the horizontal deflection amplifier was a pair of 6P6C tubes, the sweep generator was a 6Zh8 pentode, and the whole circuit was dotted with gas stabilizers. The oscilloscope was mass-produced at the Vilnius plant for about 10 years.

Anatoly Pavlovich Cherny worked his way up to the position of a developer, head of the laboratory, head of the department, became the chief engineer of the research institute, chief designer of oscillography in the country. Together with A.F.Denisov, A.P.Cherny became a laureate of the USSR Council of Ministers Prize for the creation of a universal measuring and computing complex and implementation of the results of its development in the national economy (on a closed subject, April 28, 1984).

Oscilloscope ENO-1 (C1-4). 1954.



Anatoly Pavlovich Cherny.



Anatoly Pavlovich Cherny, Chief Engineer of VNIIRIP.
Photo from the late 1990s

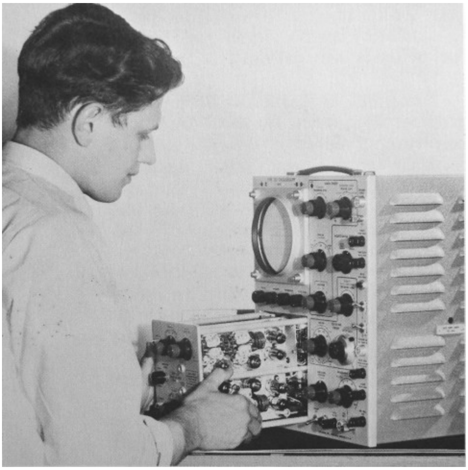
In **1954,** Tektronix introduced the world's 1st family of oscilloscopes with interchangeable units, the 530 series, consisting of 2 base units **531** and **535** for the 10 MHz band, and two interchangeable units "53C" and "53D" types. These devices opened a new, the most popular and high-volume oscilloscope market trend - laboratory oscilloscopes with interchangeable units.

The 531 basic oscilloscope unit had 1 sweep and cost $995, while the 535 had 2 sweeps - main and delayed - and cost $1300.

The interchangeable 2-channel "53C" unit had a bandwidth of 8.5 MHz, with a sensitivity of 50 mV/del.

The interchangeable 1-channel, "53D" unit, with differential inputs, had a bandwidth of 2 MHz at 50 mV/del and 0.3 MHz at 1 mv/del.

Thus, the 531/535/53C oscilloscopes had a bandwidth of only 8.5 MHz, and the 531/535/53D had a bandwidth of only 2 MHz.

Oscilloscope Tek 531 with block 53s Oscilloscope Tek 535 These

devices served as a prototype of the 1st domestic oscilloscope with interchangeable units S1-8A, developed in 1958, as well as the 1st domestic family of oscilloscopes with interchangeable units "Kulisa" S1-15/S1-17, developed in 1961-62.

From that moment oscilloscopes with interchangeable units became one of the main activities of Tektronix and later VNIIRIP/VZRIP.

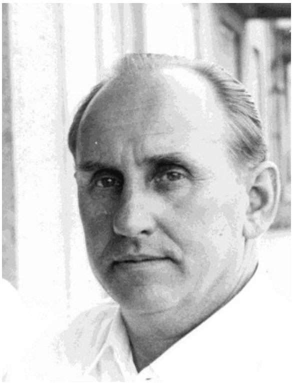
In **1956**, by order of MAP, in Department No. 2, OKB-555, the world's widest-bandwidth, at that time, two-beam oscilloscope **DESO-1 (C1-7, on the theme "Palm") was** developed for the band **60 MHz,** with a large screen diameter - 120 mm, on a tube 18LO47. The amplifier was made according to the traveling wave scheme. The chief designer was G.V.Sibilev, the leading developer was M.C.Stolov (who emigrated to Poland in 1957). S.P.Algin, V.D.Balalaev, V.F.Verzilova, P.I.Gorev, N.Y.Korovina, L.A.Lvov, V.F.Samorodsky and others took an active part in the development.

In **1956, the** most broadband oscilloscope made by Tek- tronics was the Model **517** introduced in 1950 with a 50 MHz bandwidth, which was less than that of the C1-7.

In the same year, Hewlett-Packard entered the oscilloscope market for the first time. The bandwidth of its widest-band oscilloscope.

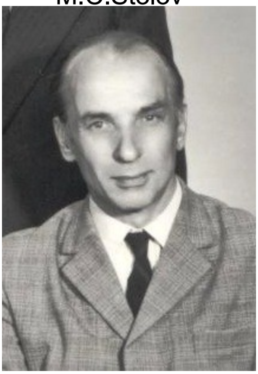
The HP150A, released in the same year, 1956, was even less, 10 MHz.[16]

M.C.Stolov



S.P.Algin,

V.F.Verzilova,



P.I.Gorev,

N.Y.Korovina,

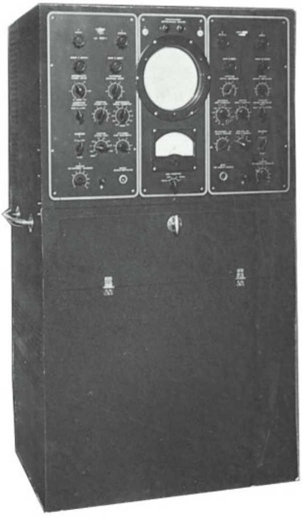
L.A.Lvov,

The C1-7 oscilloscope marked the beginning of an important direction of Russian oscillography - broadband oscilloscopes. This direction ranked second in terms of output (for VNIIRIP/VZRIP) in the 1980s, after oscilloscopes with interchangeable units - up to 25% of output.

This was an adequate response to the appearance of the Tek 517 in 1950 in the USA, which was surpassed both in the number of channels and bandwidth.

This record was not easy to achieve, the weight of the device was 270 kg and the power consumption was 1500 watt.

Oscilloscope S1-7 (DESO-1) was introduced and successfully produced at Rybinsk Instrument-Making Plant.



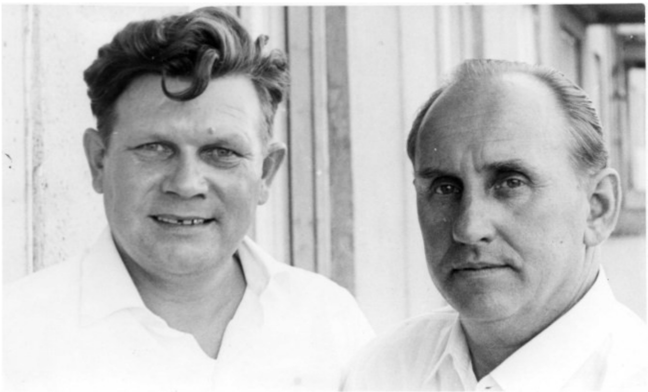
Double-beam oscilloscope
DESO-1 (C1-7). 1956 г.

Mikhail Tsezarevich Stolov (center).
Photo from the late 1950s.

Parameters C1-7:
- 30 Hz to 60 MHz bandwidth,
- CRT 18LO47,
- Number of beams (channels) - 2,
- Sensitivity 150 mV/cm, +/- 10%,
- Sweeps 0.3 μs/cm to 1 ms/cm, +/-10%,
- Weight 270 kg,
- Power consumption 1500 W.

The first specialized oscillographic subdivision - laboratory No. 2 in the Design Bureau was established in 1956 after reorganization of department No. 2. The laboratory was headed by an experienced specialist, a graduate of the Gorky Polytechnic Institute Gennady Makarovich Lifanov, who later became the head of the technical department of VNIIRIP.

Gennady Makarovich Lifanov was born in 1922 in Gorky (now Nizhny Novgorod). Graduated from the Gorky Polytechnic Institute. Participant of the Second World War, finished the war in Vienna, was awarded orders and medals. Worked at various enterprises in Gorky. In the early 1950s he was sent to Vilnius. He became the first head of the oscilloscope laboratory.



The first head of the oscillographic laboratory Gennady Makarovich Lifanov (left) and Sergei Pavlovich Algin, later head of the design department of the research institute. Photo from the 1960s

Under his direct supervision in 1956, the development of the country's first high-speed and the world's widest-band oscilloscope C1-11 ("Hyacinth") for 100 MHz (200 MHz) bandwidth was started.

From left to right: A.D.Semenyuk, ..., M.I.Efimchik, A.M.Vlaskin, A.F.Denisov. Photo of the 1950s

In **1956-1957** the laboratory was considerably replenished with young specialists, graduates of Kaunas and Lvov Polytechnic Institutes (D.Eidukas, J.Shatkus, G.Puodjunaite, V.Stalinkyavicius, A.Denisov, A.Semeniuk, V.Silvestruk, A.Fedorenchik), who later became the main executors of works, leading specialists, heads of departments.

In **1956,** engineers A. Emelyanov and A. Krasiy started working in the unit, V. Levin, an employee of the Novosibirsk Association "Svetlana", who graduated from the Bauman Moscow Higher Technical School in 1949, was hired. Bauman.

The Central Plant Laboratory (CPL) established at the plant in the late 1940s, which became the New Products Department (NPD) in 1956 and the Radio Technical Service (RTS) in 1958, made a significant contribution to the development of oscillography. The CPL was headed by the oldest worker of the enterprise S.N.Makeev, who came to the plant on July 25, 1944 (Vilnius was liberated on July 14, 1944).

After the organization of the Research Institute, Sergey Nikolaevich worked in the 2nd Department, where he worked until his retirement. Subsequently, he developed a broadband oscilloscope S1-20 "Kernel-B", which he later modernized into oscilloscope S1-54.

Sergey Nikolaevich Makeev - the first head of the CPF

Oscilloscope lab staff.
From left to right: M.C.Stolov, V.M.Levin, G.M.Lifanov, R.P.Kuznetsova, G.E.Bessonov, A.Tsvetkov. Photo from the end of 1950.

N.E. Kuzovkova recalls: "When I came to work at the Research Institute, my desk was next to Sergey Nikolaevich Makeev's desk. It was a surprisingly interesting person. He graduated from the Warsaw Polytechnic Institute, was brought up in Europe, had a very good technical background. He worked very carefully, without hurry, and he taught me a lot".

From the mid-1950s until the end of 1959, the department and then the Radio Technical Service (RTS) was headed by M.D.Rossosky, Deputy Chief Engineer of the plant. This service included two departments - the Department of Centimeter Technique (S.S.Fel) and the Department of Pulse Technique (Z.V.Magrachev). The RTS also included a group of designers headed by N.S.Broido, who before the war was the head of production at the Elektrit plant. Later, this group was headed by M.M.Esipenko, who came to the plant from Leningrad in 1950 and later worked as one of the heads of the design department of the research institute.

In **1957,** under the leadership of Z.V.Magrachev, one of the most popular oscilloscopes **SI-1 (C1-5) was** created, **which was** produced for many years by the Vilnius plant and also by the Mytishchi Pre-building Plant (hereinafter referred to as Mytishchi Plant). In 1958, Z.V.Magrachev was sent to Krasnodar to the newly established research institute, where he worked for a long and successful period as the head of the development department. He was succeeded by M.I. Efimchik as head of the pulse department.

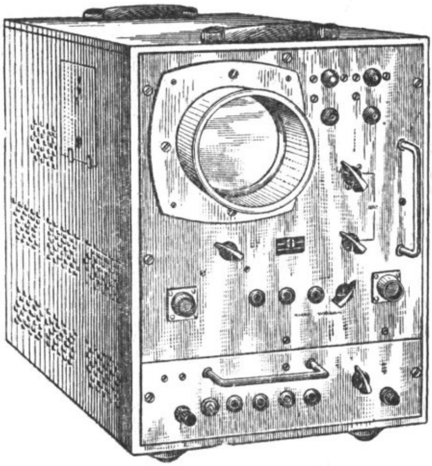
Oscilloscope SI-1 (C1-5).1957, white in color.

Oscilloscope SI-1 (C1-5) 1957. black.

Zinovy Magrachov. 1957 г

The C1-5 oscilloscope was the first portable, (handheld) instrument with the lowest weight in the country. It was a response to the Tektronix model 315 released in 1952, which weighed 16 kg and had a bandwidth of 5 MHz. It set the stage for a new direction in domestic oscillography - service oscilloscopes, which were designed to repair equipment on the customer's side. This oscilloscope was very popular with consumers. It is still in service and is sold on the Internet at a price of about 30 euros.

Parameters of oscilloscope C1-5:
- 10 MHz band,
- sensitivity 25 mm/0.3 mV,+/- 10%,
- 1 µs/cm, +/- 5%,
-power consumption 180 W.
-weight 18 kilograms.



The world's first high-speed oscilloscope, C1-10 (OS-4), 1957 г.

In **1957**, "OKB-555" developed the world's first high-speed ultra-wideband oscilloscope, the **S1-10 (OS-4),** for the 1 GHz band for photoregistration of single signals.

This device initiated the development of a new direction in world oscillography - high-speed ultra-wideband oscilloscopes.

Tektronix created a similar model only 4 years later in 1961, it was the Model 519 also for the 0-1 GHz band, with a with a power consumption of 650 watts.

Thus, at that time VNIIRIP was 4 years ahead of Tech.

And although this direction was very modest in terms of production volumes - only up to 3.5% of VNIIRIP oscilloscopes volumes, and occupied a low 6th place out of 8 by this indicator, nevertheless it was one of the most important directions, as these devices were used for nuclear research and determined both the defense capability of our country and its power armament.

The signal in these devices, for the first time in the country, was fed directly to the CRT plates, without an amplifier. For various reasons this device was not mass-produced. S.I. Pedan and A.G. Rusin developed this device on the topic "Nucleus".

Parameters of the world's 1st high-speed oscilloscope, the C1-10 (OS-4),:
- 1000 MHz band,
- sensitivity of 5 V/mm,
- 50 ohm input,
- sweep 10 ns/ecp, +/-5%,
- power consumption 500 W,
- 40 pounds.

In **1958, the** development of the world's most ultra-wideband oscilloscope with high sensitivity and high photographic recording speed for that time, the **C1-11 (ISO-1)** was completed on the theme **"Hyacinth"** for the **100 MHz band,** which became fundamental for that period.

The instrument was developed to support research conducted at the Kurchatov Institute of Atomic Energy of the Ministry of Medium Machine Building. The instrument was developed to support research conducted at the Kurchatov Institute of Atomic Energy of the Ministry of Medium Engineering. G.M.Lifanov, head of the oscilloscope laboratory organized in 1956, was responsible for the technical design stage.

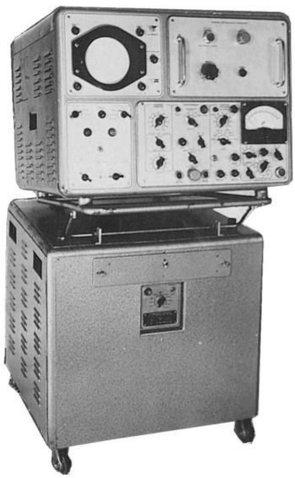
The main requirements for the development were large bandwidth and high recording speed for monitoring and recording of fast single and infrequent signals.

The recording speed was provided by the recommended CRT type.13LO104A, which was purposefully developed in Fryazino for this oscilloscope. To ensure high quality of focusing and high brightness of the beam, the CRT had a high accelerating voltage. At the same time, the sensitivity of the deflector plates was low, which made it very difficult for the oscilloscope to operate.

development of the output stage of a broadband amplifier, as well as a fast sweep generator with a large output amplitude.

The oscilloscope had to have a bandwidth with the amplifier of 200 MHz (according to the TOR), and even 400 MHz when the signal was fed directly to the CRT. To solve this dual task, a high-frequency switch was mounted on the board near the CRT.

The oscilloscope also had an input attenuator and was equipped with a probe. At that time there were no foreign analogs of oscilloscopes with similar technical characteristics in the world. The most broadband oscilloscopes at that time were oscilloscopes Tek 541/k and 545/k, from the 500 series, with a bandwidth of 30 MHz.



Parameters of oscilloscope C1-11:

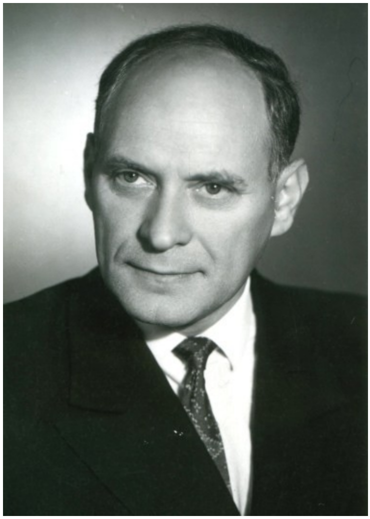
- ELT 13 LO 104A,
- 10 kHz to 100 MHz bandwidth,
- a write speed of 4,000 kilometers per second,
- sensitivity of 100 mV/cm,
- 25 ns/cm to 20 μs/cm sweep,
- power consumption 1200 VA,
- weight 165 kg.

Oscilloscope S1-11

The vertical deflection channel was developed by Viktor Markovich Levin. He finished this work as the project manager.

Having volunteered for the Great Patriotic War as a 3rd year student at Bauman Moscow Higher Technical School, he graduated there with honors after the end of the war in 1949. On assignment he was sent to Novosibirsk, to the factory of electro-vacuum devices, association "Svetlana" (evacuated during the war from Leningrad), where he was engaged in the development of instruments for testing the plant's products.

While working in Vilnius, Victor Markovich was the chief designer of developments, head of oscillographic laboratory, department, scientific head of the direction. He was awarded many orders and medals. Victor Markovich left the Institute in 1990 at the age of 70.



Victor Markovich Levin. Photos of the 1970s

The direct executors of the project were V.Stalinkevičius, a graduate of Kaunas Polytechnic Institute, and V.A.Silves-truk, a graduate of Lviv Polytechnic Institute.

The horizontal deflection channel, synchronizers, sweeps, calibrator, pulse generator, delay unit and voltmeter were developed by young graduates of Lviv Polytechnic Institute in 1957 A.F.Denisov, A.I.Fedorenchik and arrived in 1958 I.I.Pits, power supplies - Y.M.Yarmolenko and A.Krasiy.

The vertical deflection channel was built on the principle of a traveling wave amplifier. V.M.Levin developed the calculation methodology and design principle of the amplifier, and its realization in mock-ups and samples was performed by A.F.Denisov. Both the preliminary and terminal stages of the amplifier were made on dozens of 6Zh1P and 6P14P high-frequency tubes, respectively. The amplifier was not very stable, sometimes its excitation could be removed only by removing one of the lamps.

The sweep generator was developed by A. Emelyanov (at the initial stage) and A. Fedorenchik. The fast sweep generator was based on a GU50 pentode controlled by a 6V1P secondary emission lamp. The generator formed a sawtooth voltage with a duration of 25 nanoseconds at an amplitude of 600 V. It was possible to see such a "sawtooth" only directly on the deflection plates of the oscilloscope DESO-1 available in the laboratory.

The oscillographic laboratory was located in three small rooms of the corner building of the plant (like all OKBs) on Shevchenko St. and Montvilos St. (today Shvitrigailos St.).

The building at the crossroads of Shevchenko and Montvilos streets, which housed an oscillographic laboratory in the late 1950s and early 1960s. Photo 2010.

The windows of the laboratory (in which up to five Alexanders worked simultaneously) faced Montvilos Street and were only 200 meters away from the jammers, which created significant interference.

V.M.Levin recalls. "At that time A.I. Shokin, Deputy Minister of the Ministry of Industry and Trade (later Minister of Electronic Industry), visited the Design Bureau. He was thoroughly familiarized with the problems arising from the close proximity of "jammers". Shokin asked his escort about the price of the "jammers" and, having learned that it did not exceed 3 million rubles, recommended their demolition. His instruction, however, was not carried out, and the " jammers," which are in common use, were demolished.

called 'Statues of Liberty,' constantly pestered designers and manufacturers of highly sensitive instruments."

Employees of the first oscillographic laboratory of OKB-555 (including the developers of the Hyacinth (C1-11) ISO-1 theme):

From left to right:

-Bottom row: E.A.Fomin, V.Stalinkyavichyus, V.A.Silvestruk, M.S.Buslovitch, A.Tsvetkov.

-2nd row: A.Monastyrsky, V.T.Panasiuk, D.Eidukas, V.M.Levin, Y.M.Yarmolenko, V.A.Mukhin.

-3rd ***row:*** M.Yarmukhamedov, E.A.Shestakova, G.Puojunaite, R.P.Kuznetsova (Danchenko), N.Smirnova, N.Yu.Korovina, R.A.Lytkina, T.A.Dudashkina.

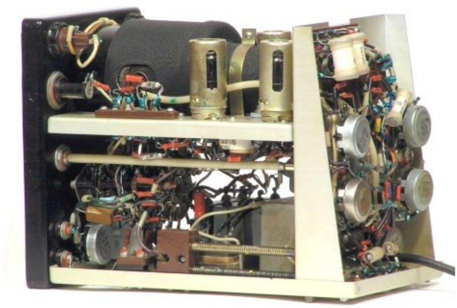
-Top ***row:*** J.Shatkus, A.F.Denisov, A.Krasii, Y.G.Guselnikov, I.I.Pits, A.I.Fedorenchik, A.Emelyanov. Photo 1958.

The work on the "Hyacinth" theme progressed with difficulty. Young people had no practical experience, there was no special literature and information about foreign analogs of similar range, as they were not available in nature. We had to move by trial and error. As some developers said, it was more difficult to create individual components of the device than it was to launch the first satellite. It was 1958.

Nevertheless, albeit with some deviations from the specification, (100 MHz bandwidth, instead of 200) in 1958 development of the instrument was completed, the instrument was assigned type ISO-1 (later C1-11), and serial production began at the Makhachkala Instrument-Making Plant (hereinafter referred to as the Makhachkala Plant), a new plant in the industry. At that time it was the first production of the plant. The creation of the device made it possible to close a large need in the study of elementary particle physics, after which the department stepped confidently into the field of nanosecond pulse technique.

The development became a good school for the formation of the main staff (backbone) of the developers for all subsequent years of the team's development and oscillography as a whole. **An important moment was the achievement of the 100 MHz bandwidth, a milestone that no one in the world had managed to conquer at that moment.**

In **1957,** under the leadership of Boris Vasilievich Shapurov, an RTS engineer of the plant, the 1st small-sized service oscilloscope **EMO-2 (C1-6)** was developed, with an extremely low weight of 4.5 kg.



EMO-2 (C1-6)EMO-2 (C1-6) oscilloscope inside.

The oscilloscope had a bandwidth of 1 MHz, 7-cm CRT and had amazing for those times mass - dimensional characteristics.

This device initiated the development and production of a new class of devices - service oscilloscopes designed for repair and maintenance of electronic equipment at the customer's site. This direction became one of the three most popular in the country in terms of production volumes. Such devices was produced up to 11.7% of VNIIRIP oscilloscopes production volumes for 1984-1992.

Parameters of EMO-2 (C1-6) device:

- 1 MHz bandwidth, amplitude from 2 to 200 V,
- deviation factor of 1.6 mm/V,
- sweep factor from 1.5 μs/ecp. to 0.2 ms/ecp.
- power consumption 35 W,
- weight 4.5 kilograms.

Employees of the pulse department of the plant's RTS. From *left to right, sitting:* A.Saudargas, T.R.Antonovich, M.I.Efimchik, G.D.Voronova (Zakharchuk), V.S.Dekhtyaruk; *standing: A.*A.Kalamkarov, A.D.Semenyuk, L.B.Pavlovich, B.V.Shapurov, L.I.Dobrovolsky. Photo of the late 1950s.

EMO-2" oscilloscope was produced by Rybinsk Instrument-Making Plant since 1957. Since 1960, the oscilloscope was produced under the name "S1-6". In the Internet even today you can find all schemes and descriptions of this device.

And finally, in **1958, a** fundamentally important device for "fives" appeared - **S1-8A (UO-1M),** for the band 25 MHz, developed on the theme **"Cathetus"** in OKB-555. This device opened

A new direction in VNIIRIP's activity, which later became the main one for many years - laboratory oscilloscopes with interchangeable units.

This direction in terms of production volumes became a record for VNIIRIP and took the 1st place in terms of oscilloscope production volumes of VNIIRIP in the 80s.

It was the first attempt to give a worthy answer to the oscilloscopes of Tektronix models 531/535 and 541/545 of 530/540 series, released in 1954-55, for the band 10 and 30 MHz, and the 1st attempt to establish the production of oscilloscopes with interchangeable units on "fives".

The device was produced at VZRIP and at the Bryansk Electroapparat plant (in the form of a device with a structurally designed replaceable unit, which could be changed during production at the plant, or during repair).

Jonas Shatkus. Photo 1958.

Oscilloscope UO-1M (S1-8A). 1958 г.

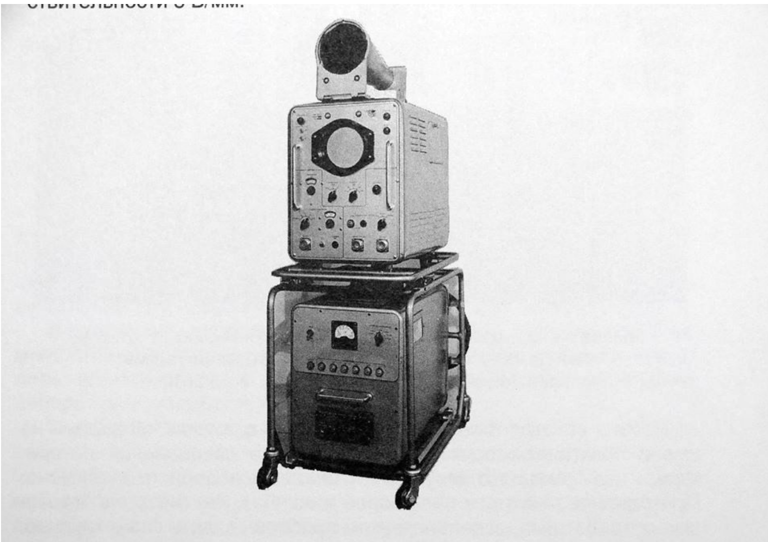
However, it was not possible to achieve full interchangeability of the units on the consumer side, during use, with stable parameters, as there was no idea about normalization of the base-block docking parameters. This development was led by Jonas Shatkus, later director of Vilnius Research Institute of Electrography. V. Stalinkevičius and A Šliavas. The development was carried out in of laboratory No.2, head Lifanov G.M. The method of measurements on calibrated scales was applied in the instrument for the first time in the country.

At the international exhibition in Budapest, this device won a gold medal.

Parameters of oscilloscope S1-8A (UO-1M):

- 0-25 MHz band,
- CRT 13LO3I,
- deviation coefficients of 50 mV/cm-50 V/cm,
- input 500 kOhm/40pf, 1 megohm/20pf, with 1 megohm/10pf divider,
- sweep coefficients of 25 ns/cm -1 ms/cm,
- measurement error +/-3% +1 mm of the scale,
- power consumption 650 W,
- weight 35 kilograms.

In **1959**, the OKB-555 developed the world's 1st industrial high-speed oscilloscope **S1-14** on ELTBV, for the band 1 GHz. on the topic **"Bamboo."**



Скоростной осциллограф С1-14. 1959 г.

This device initiated serial production of a new trend in world oscillography - high-speed ultra-wideband oscilloscopes for photo-registration of single signals.

Tektronix was 2 years behind OKB-555 in this market. It created a similar model only in 1961. It was model 519 also for the 0-1 GHz band.

The signal in these devices was fed directly to the ELTBW plates, (CRT with deflecting plates of the "traveling wave" type) without an amplifier.

This device was mass-produced and allowed to make photo-recording of single signals using a "Zorky" camera with a "Jupiter" lens.

This device was developed by chief designer A. Kovalsky, lead engineer A.G. Rusin, developer N. Ternovy.

Parameters of the device C1-14:

- Band 0 - 1000 (3000) MHz,
- CRT 13LO102M,
- photo-recording speed of 25 thousand kilometers per second,
- sensitivity 3.3 V/mm+/-10%., (5 V/mm for 3000 MHz),
- sweeps 10, 30, 100, 300, 500 ns per screen, +/-20%,
- power consumption 850 W,
- weighing 107 pounds.

Specialists of the radio engineering service of the plant also accompanied the serial production of special oscilloscopes of OK-series: OK-15 (C1-23), OK-17 (C1-24), OK-19 (C1-25), OK-21 (C1-26) and OK-25.

(C1-27) developed by the Moscow Institute of Physics of the Earth. E.E. Goller in his article "Nuclear Testing in the Arctic. Measurements at the Novaya Zemlya test site using the 2IV and CT methods" writes the following about the production of these oscilloscopes at the Vilnius plant: "Some oscilloscopes were produced at the Vilnius plant. The oscilloscopes OK-17, OK-21, OK-25 were produced in several thousand pieces (OK-17 - 7935 pieces, OK-21 - 4776 pieces, OK-25 - 2782 pieces). Part

oscilloscopes were developed by order of Arzamas-16. Many of the developed devices were used in atomic tests" [18]. [18].

A.A.Kalamkarov recalls: "There was certainly a certain competition between the Design Bureau and RTS of the plant. The plant had a very strong group of oscilloscope developers, as well as great experience and knowledge of the production base".

In **1959,** Tektronix introduced the 580 series of oscilloscopes with interchangeable units, models **581/585, for** 100 MHz bandwidth, thus catching up with the bandwidth achievements of the C1-11 a year later.

At that time oscilloscopes C1-11 and 581/585 became the most broadband oscilloscopes in the world for only 1 year. But in the following year **1960 the** HP company started production of stroboscopic oscilloscope oscilloscopes model **HP 185A** for the bandwidth of 500 MHz, which led to a revolution in expanding the bandwidth of oscilloscopes for repetitive signals (the bandwidth was expanded by 5 times).

In 1960, the OKB-555 underwent a reorganization, which was already in progress by the end of the 1950s. As a result of the reorganization, the Design **Bureau became the leading one in the industry in** several areas, including **oscillography**. Development of serial devices at the plant was discontinued, and many developers from the plant's RTS went to work at the newly established NII-555 in **1960.**

Centralization of management and development was primarily associated with the establishment of the 6th Main Directorate (6GU) of radio-measuring devices of the MRP, and serious changes were associated with the name of Valerian Georgievich Dubenetsky, Chief Engineer of the Directorate.

In **1959, a** thorough survey of enterprises - potential customers of oscilloscopes from many ministries was conducted and a multi-year plan for the development of oscillography in the country was formed.

In **1949-1959** (10 years), during the period of oscillography formation at the enterprises Zavod-555/OBB-555, Vilnius, **10 models of oscilloscopes were developed by a** team of 30 to 100 people, **9 of which were mass-produced**.

This resulted in **5 main directions of oscillography development:**

- **oscilloscopes with interchangeable units** (C1-8 type),
- **broadband oscilloscopes** (like C1-7, C1-11),
- **service oscilloscopes** (for example, as C1-6),
- **low-frequency oscilloscopes** (type C1-1, C1-2, C1-4, C1-5),
- **high-speed special oscilloscopes** (like C1-10, C1-14).

On the one hand, work began on the development of devices for general use, and first of all, universal oscilloscopes and oscilloscopes with interchangeable units (such as devices of the 530/540/580 series by *Tektronix)*.

On the other hand, a powerful stimulus for the development of oscillography was research in nuclear physics, and high-energy physics, which led to the appearance of devices for photo-registration of single broadband signals.

1.4. Development of oscillography directions 1960-1965.

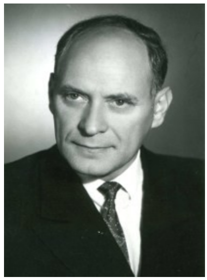
In the early 1960s, major changes took place in the structure of the enterprises. In **1960**, the enterprises **OKB-555** and **Zavod-555** were reorganized into **NII-555** (organization of PO Box 50) with a subordinate pilot plant PO Box 6. The establishment of NII put an end to parallel developments in the Experimental Design Bureau and at the plant. The leading employees of the plant's RTS, who participated in the development of new devices, were transferred to the Research Institute. Among those who were engaged in oscillography were M.I.Efimchik, A.A.Kalamkarov, A.D.Semenyuk, designers O.F.Vasilieva, E.Dagilite, T.I.Kaske-vich and others (see the order on pages 39-42).

Alexander Mikhailovich Suchkov was appointed Director of NII-555, and Vladimir Petrovich Uftyuzhaninov was appointed Chief Engineer. By Order No. 89 of July 19, 1960, in connection with the reorganization of the enterprise, V.M.Levin was appointed acting Head of Department No. 2.

The heads of laboratories are: №21 - J.Shatkus, №22 - A.P.Vasiliev, №23 - M.I.Efimchik.

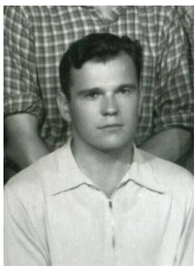

A.M.Suchkov


V.P.Uftyuzhaninov


V.M.Levin


Й. Shatkus


A.P.Vasiliev


M.I.Efimchik

In **1960** Vladimir Aleksandrovich Novopolsky (later in 1966-1990, chief engineer of Vilnius plant), who was the author of many remarkable books on oscillography, was appointed director of the experimental plant of unit 6. Every engineer of the Research Institute considered it his duty to have his books in his library. The book "Electron-beam Oscilloscope" [17], published in 1969, was especially popular. [17], published in 1969, and "Electron-beam Oscillographs" (jointly with A.I. Naidenov) [19], published in 1983.

It should be noted that V.A. Novopolsky translated and edited the book "Oscilloscopes in Measurement Technology" by I. Cheh, published in 1965, which at that time was the "Bible" of oscillographers [20]. Many years later, at the end of 1987, Vladimir translated and edited the book "Winning with people: The first 40 years of Tektronix", published in 1986 for the 40th anniversary of *Tektronix* [10].

In **1960,** Oktyabr Osipovich Burdenko, who had previously worked as the head of shop No. 7 of the plant, became the chief engineer of the plant (P. 6). Later, since 1966, he became the director of VZRIP and then the general director of the production association with branches in Lithuania, Belarus and Russia, numbering about 7 thousand people. Undoubtedly, O.O. Burdenko was a very bright personality. Without this deeply educated and enterprising person it is difficult to imagine the life of the "site". It was under O.O.Burdenko that the plant began to rumble all over the Soviet Union, and the Vilnius "Fives" were still famous thanks to their oscilloscopes.

October Osipovich Burdenko, general director of VZRIP. Photo of the mid-1980s

Vladimir Alexandrovich Novopolsky is the chief engineer of VZRIP.
Photo from the early 1980s

In the same year, **1960,** NII-555 completed the development of the 1st domestic high-precision special dual-beam oscilloscope **DEO-1** (**C1-12, "Nezabudka")** with a bandwidth of up to 15 MHz. The work was headed by A.I. Fedorenchik, the main executors were G. Puodjunaite and E. Dagelite.

Alexander Ivanovich Fedorenchik.
Photo from the mid-1960s

Double-beam oscilloscope S1-12
(DEO-1). 1960 г.

The customers of the oscilloscope were the enterprises of the Ministry of Medium Machine Building (I.V. Kurchatov IAE). The development was carried out in order to ensure the study of single and rarely repeating signals with increased measurement accuracy. Therefore the device was developed on CRT of 18LO1A type with a large screen and high brightness of the beam. The beam energy was such that a bright beam (without sweep) carelessly left in static position burned phosphor. The disadvantage of the CRT was the low sensitivity of the deflection system, which caused high power consumption and bulky oscilloscope.

Oscilloscope S1-12 was mass-produced at the Vilnius plant; more than 500 devices were produced. Starting with this device, many serial broadband oscilloscopes of VNIIRIP began to be equipped with photo attachments for recording of single signals, which expanded the scope of their application. By the way, the oscilloscopes of Tektronix were always equipped with attachments for photoregistration of single-shot signals.

Puojunaite G.IEuliana

Dagilite Photo from the end of 1960s

For the first time in domestic oscillography the accuracy of measurements on both axes amounted to 5% against the previously usually accepted 10%

Parameters of the device C1-12:

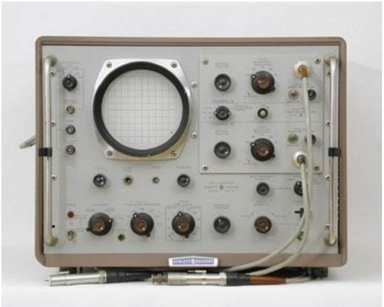
- 0-15 MHz band,
- CRT 18LO1A, write speed 200 km/s,
- deviation coefficients 100 mV/cm - 10 V/cm,
- 50 ns/cm - 2.5 s/cm sweep coefficients,
- measurement error +/-5%,
- power consumption 1700 W,
- weight 168 kg, oscillographic unit 50 kg.

In **1960-61** in the USA there were important events that seriously influenced the emergence and development of new directions in the world oscillography.

In **1961,** HP made a breakthrough in expanding the oscilloscope bandwidth for repetitive signals by developing the world's first stroboscopic oscilloscope**, HP 185A,** for a bandwidth of 500 MHz. Until then, the oscilloscope bandwidth record belonged to C1-11 (1958) and Tek 581/585 (1959) and was equal to 100 MHz, i.e. the bandwidth was expanded 5 times!

Almost simultaneously, Tektronix, in the same year, **1960,** gave its answer to this event by releasing an interchangeable stroboscopic

N" unit for oscilloscopes with interchangeable units of 500 series, models **581/585/531/535/541/545,** for the same 500 MHz band. In this case, it is very difficult to establish someone's priority, as both companies announced these devices, almost simultaneously.



HP 185A stroboscopic oscilloscope, for the 500 MHz band. 1960 г.

Replacement strobe unit Tek "N", per lane 500 MHz. 1960 г.

Bill Hewlett, in his 1983 book "The Possibilities of Invention", recalled that the principle of the stroboscope was borrowed from electrical engineering. When it was necessary to accurately measure the instantaneous voltages of 3-phase alternators at different points in time, capacitors were connected to them via a switch. When it was necessary to make a measurement, the commutator was disconnected from the generator and connected to a voltmeter, thus taking a sample from the alternating voltage and converting it into a slower or semi-constant voltage.

However, such oscilloscopes could not record single signals, as many samples taken from a large number of periods of the signal under study were required to form the final signal on the screen.

Since then, the bandwidth of conventional oscilloscopes has been called "real-time bandwidth", or single-signal bandwidth. And the band of stroboscopic oscilloscopes became known as the "strobe-mode band", or the band for repetitive signals.

1961 Tektronix marketed the first proprietary high-speed oscilloscope**, the** Model **519,** designed to examine primarily single-shot and infrequently-repeated signals in the field of nuclear and other research at the 1 GHz band. And despite the fact that it was 4 years behind the C1-10 model and 2 years behind the C1-14 model of similar purpose for the same band, still the market launch of this model emphasized the importance of this direction for the world oscillography.

In 1961, the department was enlarged and transformed into the pulse-oscillographic department consisting of three oscillographic and two pulse laboratories.

The department was headed by Lev Avgustovich Auzin. Victor Markovich Levin became Deputy Head of the Department and Scientific Supervisor of Oscillography. Soon G.M.Lifanov moved to the position of Head of the Technical Department. A.P.Vasiliev became Deputy Head of the Microwave Devices Department, and his laboratory was headed by A.F.Denisov in **1962.** The research institute received the status of the country's leading oscillography enterprise.

In **1961,** NII-555 developed the country's 1st oscilloscope with truly, (fully), interchangeable units - the **C1-15 on the "Kulisa"** theme, for the 25 MHz band (and 350 MHz in strobe mode since 1967).

After this development, oscilloscopes with interchangeable units became the main activity of "Pyatyorki". Their production in 1984-92 amounted to 43.0% of the production volume of all oscilloscopes developed in VNIIRIP (while broadband oscilloscopes were produced only 25.5%, service oscilloscopes 11.7%, and other categories even less). Till 1991 three families (generations) of oscilloscopes with interchangeable units were developed - lamp oscilloscopes "Kulisa" (C1-15), transistor oscilloscopes "Snaige" (C1-70) and oscilloscopes using microcircuits "Svet" (C1-91).

The prerequisites for this development were as follows. Since 1958, the C1-8 oscilloscope (25 MHz) was produced with a constructive interchangeable unit, and this design idea was successful and liked by consumers and manufacturers.

On the other hand, in 1955, Tektronix released oscilloscopes with interchangeable 541/545 model blocks, the 540 family, for the 30 MHz band, and it was obvious that this family became successful in the market. Therefore, the analog of the C1-15 was the Tek 541 with K,G,CA,D,D,E,N blocks.

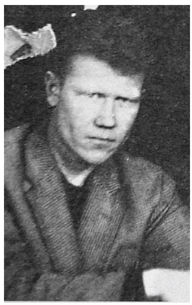
The C1-15 was mass-produced for many years in Vilnius and Bryansk, and was extremely popular. It had 1 compartment for an exchangeable unit in the vertical deflection channel, with exchangeable units

The user could change it independently, during operation, depending on the measurement tasks.

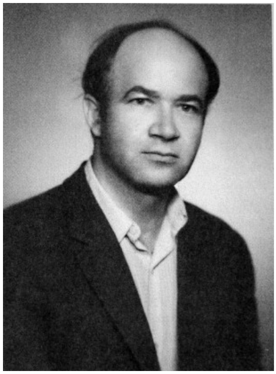
Jonas Shatkus. Photo from 1958.

1st oscilloscope with interchangeable blocks in the country
C1-15 ("Coolisa").1961.

C1-15 was developed in laboratory No. 21 of J. Shatkus. He was in charge of this development. The leading executors were Y.Y. Yarmolenko, N.Y. Korovina. The developers of the blocks were V.P. Redkin, G.I. Andreev, E.A. Fomin, V.A. Mukhin, A.D. Semenyuk, M.S. Buslovitch, and others.



N.Y. Korovina. V.P. RedkinG .I. AndreevE. A. Fomin,


V.A. Mukhin, A.D. Semenyuk, M.S. Buslovitch

Creation of oscilloscope C1-15 allowed to solve the problems of interchangeability of interchangeable units, as the emphasis was placed on improving the docking parameters of the unit - base. By its technical characteristics, the family of oscilloscopes with interchangeable units allowed to replace up to 22 different types of manufactured devices. If we take into account that the cost of interchangeable units at that time did not exceed 15% of the cost of the device as a whole, it becomes clear that this oscilloscope concept was the most promising from the economic point of view.

Single channel preamplifier U1

Differential preamplifier U2

Two-channel preamplifier U3

Differential preamplifier U4

Highly sensitive differential amplifier U5

Stroboscopic unit U8

Parameters of oscilloscope with interchangeable units C1-15, (analogs are given in brackets):
- CRT 13LO3I, the same as in C1-8,
- Stripe

C1-15/1, (Tek 541/K) with single-can. amplifier U1, 0 - 25 MHz, 50 mV/del., C1-15/2, (Tek 541/G) with diff. amplifier U2, 0 - 20 MHz, 50 mV/del., C1-15/3, (Tek 541/ÑA) with 2-can. ampl. U3, 0 - 20 MHz, 100 mV/del., C1-15/4, (Tek 541/D) with differential amplifier. U4, 0 - 1 MHz, 1 mV/del., C1-15/5, (Tek 541/E) high sensitivity, U5, 0.5 Hz - 60 kHz, 50 µV/del., C1-15/7, with 200 MHz strobe block, since 1965,
C1-15/8 (Tek 541/N) with 2-can. strobe unit U8, 0 - 350 MHz, 20 mV/del. since 1967,
- inputs 0.5 mOhm-1mOhm/40pf or 75Ohm-500kOhm/12pf,
- expansion factor. 20ns-1s/div. (2ns/del. to 50ns/del. in C1-15/8 var.)
- 5-10% error,
- Consumption. Power. 700 W,
- Weight 42 kg.

In 1962, thanks to the energy and persistence of A.M. Suchkov, Director of the Research **Institute, the Institute received a separate new large building** on Partizanu St. (nowadays Naugarduco St.), which housed all the thematic departments, design department, and experimental workshop. The pulse-oscillography department was located on the 4th floor, in the wing of the building adjacent to Montvilos Street. The windows of the laboratories faced Partizanu Street, as well as inside the territory.

15th building of the Research Institute on Partizanu Street (now Naugarduko Street),
built in 1962. Photo 2010.

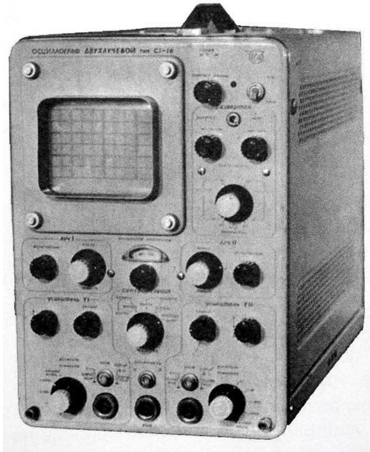
In **1962**, a family of oscilloscope with interchangeable units "Kulisa" was supplemented by another base unit of the two-beam oscilloscope **S1-17 "Bahroma-B"** (on CRT 16LO2I), which used the same interchangeable blocks as in the oscilloscope S1-15. The base unit of the S1-17 had a bandwidth of 10 MHz. Since the oscilloscope was a two-beam oscilloscope, it contained two compartments for interchangeable blocks. For the first time it was possible to observe 4 signals simultaneously on the screen of this device. The leading developer of the device was A.F.Denisov. V.A.Silvestruk and E.N.Sverchkov participated in the development. Oscilloscope C1-17 was also produced by Bryansk plant, as well as C1-8 and C1-15. The parameters are similar to C1-15, except for the following:

- band with units U1, U2 and U3: 0-10 MHz,
- sweep coefficients 100 ns/cm - 0.5 ms/cm,
- power consumption 800 W, weight 47 kg.

In **1962,** under the leadership of G.E. Bessonov, the development of a two-beam oscilloscope **S1-16 "Biser"** (on the same CRT 16LO2I as S1-17) for the band 0 - 5 MHz was completed. The oscilloscope consumed 350 W, weighed 25 kg and was mass-produced by the Makhachkala plant.

In **1962**, the development of a two-beam low-frequency high-sensitivity oscilloscope **S1-18 "Bahroma-M"** (on the same CRT 16LO2 as S1-17, only in modification B) with a bandwidth of up to 1 MHz/20 mV/cm, or 0.2 MHz/1 mV/cm, with a consumption of 300 W and a weight of 25 kg was completed. Customers of the oscilloscope were enterprises of the Ministry of Medium Machine Building.

Two-beam oscilloscope with interchangeable units C1-17 "Bahroma-B",.1961.



Dual beam oscilloscope C1-16 "Beads."

Alexander Fedorovich Denisov. Photo from the mid-1960s

Vladimir Silvestruk. Photo of the 1970s

Evgeny Nikolayevich Sverchkov Photo from the mid-1960s

German Bessonov. Photo of the mid-1960s

The leading developer of the device was A.I.Fedorenchik, the main executor was M.S.Buslovitch. A specific application of the device was its use for monitoring the operation of special communication devices with pulse-width coding, where a distinctive requirement was high synchronization of channel sweeps. For similar purposes previously used oscilloscopes by *Cossor*, built on CRT with beam splitting. Oscilloscope S1-18 was mass-produced by Bryansk plant.

Double beam oscilloscope S1-18
1962. ("Bahroma-M")

C1-18 dual-beam oscilloscope
1962 (inside view).

In **1962,** in NII-555 S.N. Makeev, the developer of the 1st Soviet oscilloscope S1-1 (EO-7), developed a tube oscilloscope **S1-20, on** the topic **"Nucleus-B",** with increased (for those times) accuracy of measurements for the band 20 MHz, on CRT 13LO03I (as in S1-8 and S1-15). The C1-20 was later modernized by him into the model **C1-54, a** tube-semiconductor device**.**

Parameters of **C1-20/C1-54:**

- 0-20 MHz band,
- sense. 100 mV/div. +/-5%,
- div. 25 ns/div. +/-5%,
- power consumption. 360/140 W,
- weight 23/25 kg

S.N. MakeevOscillologist . C1-20, 1962.

In **1962, the** seminal work of NII-555 **Research and Development** Institute **"Zeleny",** on calculation of errors and improvement of accuracy of oscilloscopes, was carried out at NII-555.

Scientific supervisor of the work - V.M. Levin, leading engineer Fedorenchik A.I. Yarmolenko Y.M., Dodin M. and Kulik G. also took part in the work.

At that time there were debates about the accuracy required for an oscilloscope. In NII-555, under the leadership of G.P. Vikhrov, pulse voltmeters of instantaneous signal values, precision time interval meters were developed and produced, and it was believed that accurate measurements should be made by them, but foreign experience showed that the accuracy of oscillographic measurements could be higher.

Typically, oscilloscopes of those years had an accuracy of 10% on both axes, while there was a need for more accurate instruments.

Within the framework of this work, variants of visual measurement error reduction were proposed with the help of electronic marks, excluding errors of alignment with the scale and geometric distortions of CRT. Also, for the first time, the requirements to the transient response parameters of a precision oscilloscope, such as rise time, spike, rise time, rise time, peak irregularity, which determine the dynamic errors of signal reproduction, were defined in detail.

As a result of this work were developed first in 1963 oscilloscope S1-32 "Taiga" for the band 40 MHz, with an accuracy of 3%, and then in 1966 - S1-40 "Svirel", for the band 25 MHz, with a voltage measurement accuracy of 2%, and time intervals of 1%. This work became the basis for the creation of the state standard GOST 9810-69 "Electron-beam oscilloscopes, nomenclature of parameters and general technical requirements."

In **1962,** HP and Tektronix continued to expand the bandwidth of their strobe oscilloscopes. Thus, HP released the **HP185B** model for the 1 GHz band, and Tektronix released the **Tek 661** model for the 3.5 GHz band.

In **1963-64,** HP introduced its 1st family of oscilloscopes with interchangeable units **HP140,** for 20 MHz and 18 GHz bandwidth in strobe mode in a new design.

This HP 140 family and the **HP 180 family** (1966, 50 MHz) served as the prototype for the 2nd all-transistor family (generations) of oscilloscopes with interchangeable units "Snaige", S1-70, VNIIRIP, developed in 1972-76, for 50 MHz band.

The family was based on 3 base units for the 20 MHz band:

- Regular 140 A/B, weighing 16 lbs, priced at $795 / $695,
- with adjustable afterglow 141 A/V, weighing 18 lbs, priced at $1,600 / $1,500,
- with a large screen 143 A, weight 28 kg, price 1500 dollars,

Prices of replacement units from 275 to several thousand dollars.

HP140A,1963

HP141B/A

HP143A

The last model HP 143 A, (see photo) is of interest because its constructive concept - 2 "Nadel" type cases, the upper of which is used for a large screen, and the lower for the measuring part of the device, was used in the development of a number of special, stroboscopic and digital oscilloscopes VNIIRIP, developed in the 70-80s, such as S9-6 (Stropilo), S9-9 (Sigma), S9-13 (Sonata), S9-20/26 (Sputnitsa), S7-20/21 (Snop/Sofia). Also this model is interesting in that it uses CRT TV (kinescope), with a large screen, as in C9-13.

By the early 1970s, this HP140 family included 5 basic and up to 22 interchangeable units with a wide range of function such as, broadband, high sensitivity, multichannel, stro-boscopic with OTDR, and spectrum analyzer units.

In the same **1963, the** same large TV CRT as in the HP143A was used to develop a demonstration oscilloscope **"Shkolnik"** model **OD-723,** developed at NII-555, under the supervision of V.A. Silvestruk for the 1 MHz band. The device was not mass-produced.

Oscilloscope "Shkolnik", OD-723, 1963.

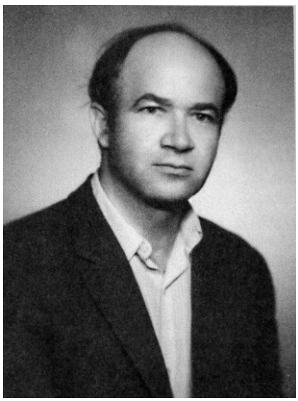
V.A. Silvestruk

In **1963,** in NII-555, an oscilloscope of increased accuracy **S1-32 ("Taiga")** was developed for a wider bandwidth of 40 MHz.

This development was one of the first attempts to realize the results of R&D "Zeleny" aimed at reducing the error of oscillographic measurements from 10% to 3%. The device was not mass-produced.

Main developer - E.A. Fomin, developers - A.D. Semenyuk and R.P. Kuznetsova.

Fomin E.A.



Semenyuk A.D.

Kuznetsova R.P.

Parameters of the device C1-32:

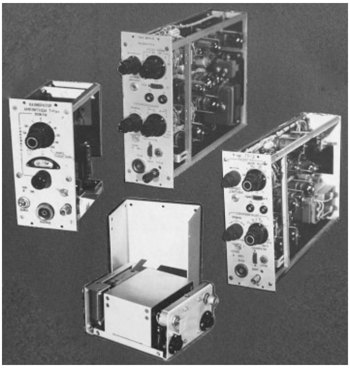
- 0-40 MHz band,
- the working field of the CRT screen is 50x70 mm,
- sensitivity 100 mV/cm **+/-3%,**
- 10 ns/cm - 0.5 s/cm **+/-3%,**
- power consumption 1300 W,
- 70 pounds.

C1-32, 1963.

The development of the development team was a consequence of new requirements of science and technology to study both fast flowing signals and slowly changing single and rarely repeating processes. These requirements led to the emergence of 2 new directions in oscillography - stroboscopic conversion of repetitive signals, and registration of one-time signals with the help of memory electron-beam tubes (MEBT).

The emergence of storage electron-beam tubes led to the creation of a new class of oscillographic devices that allow recording and then reproducing single pulse signals whose moments of occurrence are significantly different in time. In oscilloscopes of this class, the invisible (potential) image of the signal on the internal target is converted into a visible (light) image on the screen phosphor by means of a special reproducing projector.

In connection with the task of reducing the development time and serial production of devices, **in 1963, on the "Christmas tree" theme, a set of** unified, structurally complete **standard oscilloscope assemblies was created,** such as indicators (BI1-1 on 13LO3I and BI1-2 on 16LO2I), sweeps (BR1-1 on 50 ns/del and BR1-2 on 500 ns/del), amplifiers (BU5-1/3/4), calibrators (BK1-1/2), power supplies BP2-1/30), on the basis of which devices with a bandwidth of up to 10-15 MHz could be quickly assembled.



Units for oscilloscopes with bandwidth up to **15 MHz ("Christmas tree").** 1963 г.

V.M.Levin initiated the development of the blocks (the "Christmas Tree" theme) and became its chief designer. The leading developer was A.A.Zybin. V.M.Eremenko, M.S.Buslovitch, V.P.Redkin, L.M.Trub, N.M.Sarycheva, V.Rajyunayte participated in the development.

A.A.Zybin

L.M.TrubV

.Rajyunaite N

. M.Sarycheva

On the basis of the developed blocks, under the leadership of V.M.Levin, a new class of devices was created in a short period of time - memory oscilloscopes, or oscilloscopes on memory CRTs (ZELTs).

Since the end of **1963**, A.A.Kalamkarov headed the laboratory №24, where memory oscillographs based on ZELTs were developed.

In **1964**, the Vilnius Research Institute-555 completed the development of the country's 1st ZELT oscilloscope - **S8-9,** (**S1-29, "Duplet"),** made on a half-tone ZELT (PT ZELT) type 13LN5.

It had a bandwidth of 2 MHz, and allowed to study single signals at a recording speed of up to 100 km/sec; playback time 1 min, storage time 16 hours, power consumption 350 W, weight 25 kg. The chief designer of the C8-9 oscilloscope was G.E.Bessonov, the leading designer was E.Dagilite, and V.V.Malakhov and M.A.Cheryshnevy took part in the development.

The oscilloscope was mass-produced at the Vilnius plant.

In **1972** it was modernized under the leadership of A.A.Kalamkarov and already as **C8-9A** was mass-produced at the Abovyan plant.

1- The C8-9 (C1-29) storage oscilloscope. 1964 г.

German Bessonov. Photo of the mid-1960s

V.V.Malakhov

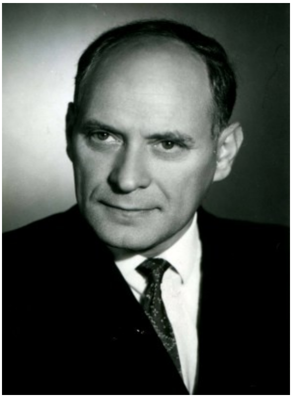
E.Dagilite

M.A.Cheryshnevyy

Following the C8-9 (C1-29) were the developments of low-hr.
In the case of bistable storage oscilloscopes with a bandwidth of 1 MHz, on bistable ZELTs (BS ZELTs) with a long time of reproduction of the visible image (up to 30 min.) and preservation of the image.

the image recorded on the target in the off state for several days.

In **1964,** on the basis of bistable ZELT type 13LN2, and from standard blocks on the theme "Christmas tree", was developed the country's first memory oscilloscope **S1-37** (**S8-1,** code **"Inza"),** for a band up to 1 MHz, with a long playback time of up to 30 minutes, with preservation of the image of the recorded signal after turning off the device. The recording speed was 4 km/s, consumption 450 W, mass 35 kg.



Viktor Markovich Levin. Photo from the early 1970s

Memory oscilloscope S8-1 (S1-37). 1964 г.

A.A. Kalamkarov.

P.I. Gorev.G.

I. Andreev.

A.O.Goncharenko

The leading developers of the devices were V.M.Levin, A.A.Kalamkarov and P.I.Gorev, the amplifier and calibrator were developed by G.I.Andreev, and the design by A.O.Goncharenko. At the technical design stage, the development of the C8-1 was supervised by Edmundas Ciape.

The C8-1 oscilloscope was mass-produced at the Vilnius plant, At the International Exhibition in Brno in 1969, the C8-1 oscilloscope was awarded a gold medal and was also given the State Quality Mark.

In **1964, the** country's first portable broadband (at that time) universal oscilloscope with a bandwidth of up to 100 MHz - **S1-31 ("Zlak"),** on a new CRT 13LO10T, weighing 40 kg, with a consumption of 750 VA was created.

And, although in 1958 OKB-555 already had experience in creating a 100 MHz oscilloscope (C1-11), this device could not become a mass-produced device, as it weighed 165 kg and was very bulky. It was necessary to create a more compact device to replace the C1-11.

Alexander Denisov. Photo from the mid-1960s

Universal oscilloscope S1-31, 100 MHz. 1964 г.

Vladimir Arkadyevich Mukhin. 1970s

Joseph Iosifovich Pietz. Photo from the 1980s

Galina Narkunene. 1970s.

Real-time mastering of the 0-100 MHz frequency range was fundamentally important, as this frequency range was one of the most demanded by consumers of broadband oscilloscopes in the country.

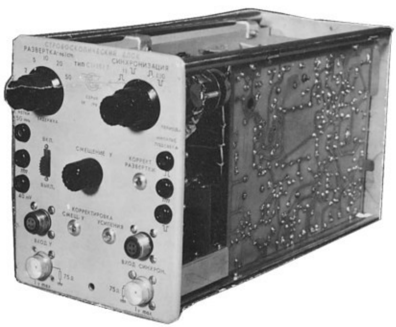
The chief designer of the development was A.F.Denisov, the leading engineer was I.I.Pits, the development group included V.A.Mukhin and designer G.A.Narkunene.

In the device, for the first time in the country, a delayed sweep was used. And, although it did not have interchangeable units, this device completed the series of tube oscilloscopes of the "Kulisa" type (C1-15), with interchangeable units, so its analog was the oscilloscope model 585 by *Tektronix,* 1959.

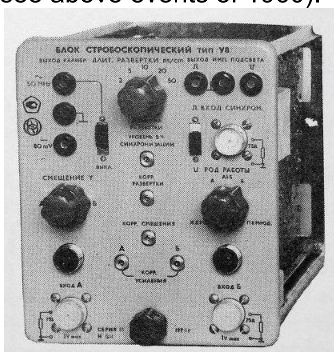
The oscilloscope was mass-produced at the Vilnius plant.

In **1965, an** important step was made both in the field of expanding the bandwidth of domestic oscilloscopes and in the development of the family of oscilloscopes with interchangeable units. The first in the country interchangeable stroboscopic single-channel unit was developed for oscilloscope **S1-15/7 on** the theme **"Viewer" for** the first time for the bandwidth of 200 MHz,

The 1st monoblock stroboscopic oscilloscope in the USSR - C1-39 (C7-5) was created in 64-65 in Gorky, GORIPI, by Gryaznov M.I. and Ryabinin Y.A., 5 years after similar developments at Tektronix - interchangeable strobe unit "N" for 530/540/580 series and HP 185A, for 500 MHz band, which appeared in 1960 (see above events of 1960).



Replaceable strobe unit U7 with bandwidth
200 MHz, for C1-15/17. 1965 г.



Replacement stroboscopic two-channel U8 unit with 350 MHz bandwidth. for C1- 15/17. 1967 г.

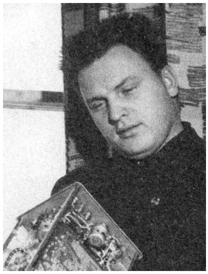
These events gave birth to a new direction in domestic oscillography - ultra-wideband (up to tens of GHz) stroboscopic oscilloscopes for observation of periodic signals.

The stroboscopic oscillography department at NII-555 started to deal with stroboscopic oscillography in **1964**. A.F. Denisov became a pioneer in the development of stroboscopic oscilloscopes in Vilnius NII-555. Under his direct supervision in 1965, first a single-channel interchangeable unit U7 to **S1-15/7 ("Viewer"),** and in 1967 a two-channel interchangeable unit U8 to **S1-15/8 ("Lead"),** as well as to the oscilloscope with interchangeable units S1-17 from the family "Kulisa" were created.

The group of block developers included V.A.Silvestruk, E.N.Sverchkov, E.I.Alekseev.

Alexander Fedorovich Denisov.

Vladimir Andreevich Silvestruk



Evgeny Nikolayevich Sverchkov

Evgeny Ivanovich Alekseev.

Both base units C1-15/17 and interchangeable strobe units U7 and U8 were mass-produced at the Bryansk plant.

E.N. Sverchkov recalls: "The first stroboscopic units developed in Vilnius contained single-diode mixers on an arsenide-gallium diode. This led to a significant "spanning" of the strobe pulse to the channel input and to distortion of the investigated signal. The situation came to the point that the signal front under certain conditions looked negative on the oscilloscope screen, which caused first bewilderment and then a smile from the developers".

Dual beam storage oscilloscope C8-2 (C1-41). 1965 г.

In **1965**, on the next halftone ZELT 13LN6, VNIIRIP developed a 2-beam storage oscilloscope **S8-2** (**S1-41**, on the theme **"Garden")** for the bandwidth of 7 MHz. It became the next device developed on the basis of blocks on the theme
"The recording speed was 500 km/s, which is 5 times higher than that of the C8-9 with 13LN5. The device was mass-produced by the Abovyan plant.

The leading performers were: E.Chyape, A.A.Kalamkarov, P.I.Gorev, G.I.Andreev, V.V.Malakhov, A.Goncharenko, V.Rubinen.

Parameters of the device C8-2:
- 0-7 MHz band,
- PT/ZELT - 13LN6,
- recording speed of 500 kilometers per second,
- playback time 1 min,
- retention time is 16 hours,
- sensitivity 25 mV/div. +/-10%
- 50 ns/del - 25 s/del. +/-10%,
- power consumption 900 W, weight 70 kg.

The high level of characteristics of the device, C8-2, relatively high reliability, allowed up to 2000 to operate this oscilloscope in the armed forces of the Russian Federation.

In **1965**, in VNIIRIP, 6 years after the development of C1-14, a new, third high-speed oscilloscope **C1-36 was** developed on the basis of ELTBV "Futer-2" on the theme **"Harmony":** for the band 1.2 GHz. The previous models S1-10/14 reached only **1 GHz.**

The C1-36 was mass-produced at the Vilnius plant. Weight and power consumption were halved compared to the previous model C1-14.

In 1961, the developer of the previous high-speed oscilloscope C1-14, developed in 1959 (see above), A.F. Kovalsky left for Kiev, and V.I. Vinogradov, at that time the youngest head of the subdivision, was appointed head of the corresponding laboratory, and eight months later he was replaced by A.F. Denisov.

C1-36 was developed by: A.G. Onishchenko - ELTBV, V. Kozlov and Z. Bigelis - unwinding, K. Burba - synchronization, V.M. Krestnikov and O.M. Chepilko. - high-voltage converter, unwinding.

Speed oscilloscope S1-36. Parameters

of the device S1-36:
- 1200 MHz band,
- ELTBW "Futer-2",
- photorecording speed of 10,000 kilometers per second,
- deviation coefficient. 1 mm/V+/-10%,
- expansion factor. 10 ns/ecp, +/-20%,
- power consumption. 400 W,
- weight 45 kilograms.

Onishchenko A.

GBigelis Z.

Burba

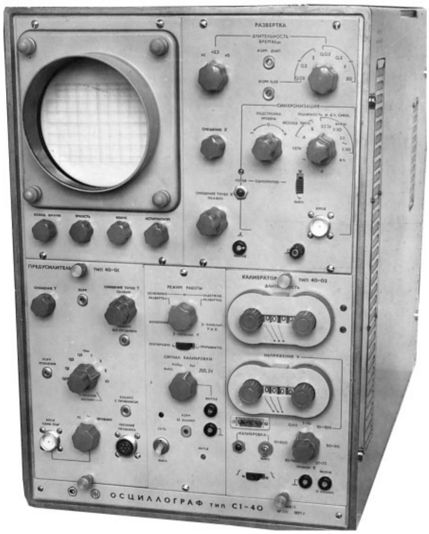
KChepilko O.

MKrestnikov V.M.

In **1966,** based on the results of research and development "Zeleny", the country's first precision measuring oscilloscope **S1-40 ("Whistle")** with a bandwidth of **0-25 MHz** at 50 mV/del. and accuracy characteristics of signal waveform reproduction and measurement of its parameters, previously unattainable, was created on a new CRT 13LO11U. For example, the emission at the top of the transient characteristic did not exceed 2%, and the peak irregularity did not exceed ±1%. The weight of the device amounted to 50 kg with the consumption of 830 W.

The oscilloscope used new methods of measuring signal parameters based on the use of precisi- nal marks. Thanks to this, for the first time oscilloscopes had a voltage measurement error of no more than ±2% and a time interval measurement error of no more than ±1%. Such accurate oscilloscopes were required, for example, for tuning the equipment of the Ostankino TV Center.

Alexander Ivanovich Fedorenchik.
Photo from the mid-1960s

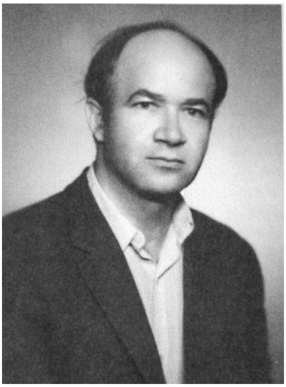


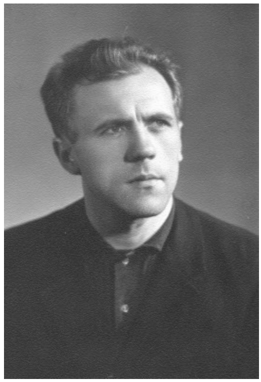
Measuring oscilloscope
C1-40. 1966 г.

The chief designer of the oscilloscope C1-40 was A.I.Fedorenchik. G.Puodzhyu-nayte (leading engineer), M.S.Cheprakova (leading designer) participated in its creation. A.D.Semenyuk (horizontal channel), G.N.Kulesh (calibrator), Oscilloscope S1-40 was mass-produced at the Bryansk plant.


Puodžiūnaitė Gražina


Margarita Stepanovna Cheprakova.
Photo from the 1970s


Alexander Demjanovich Semenyuk.
Photo from the 1970s

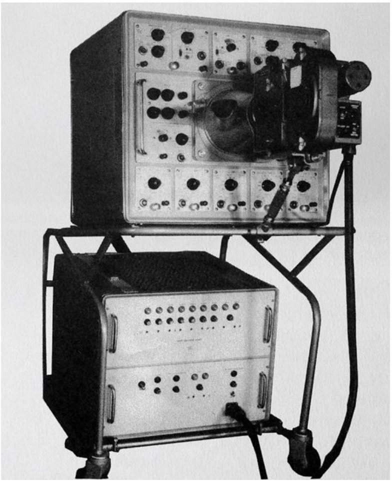

Grigory Nikolayevich Kulesh.

In **1969, the** first and the only five-beam oscilloscope **S1-33 ("Lena") in the** country was developed under the direction of M.I.Efimchik. The vertical channel and calibrator of the oscilloscope were developed by A.A.Saldin, the horizontal channel by V.E.Paskis.

A.A.Saldin recalls: "Apparently, C1-33 was the last oscilloscope made on tubes. The device had a five-beam CRT of 22LO1A type, four channels had a bandwidth of 5 MHz, and the fifth channel had a bandwidth of 600 kHz; two sweeps, one of which worked for three beams, and the other for the remaining two beams...."

The possibility of photographing single multiple processes with the help of the RFK-5 photo set-top box was envisaged. The development was initiated by the general customer. CRT 22LO1A was unique and was not used in other developments. Even for those times the oscilloscope was grandiose - its two units had a mass of 162 kg, with a consumption of 1200 VA.

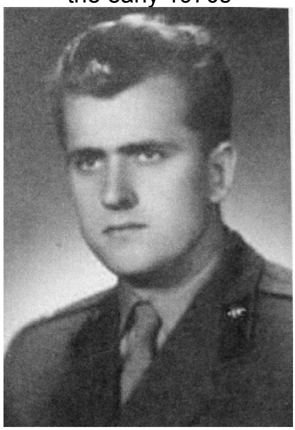
The device was mass-produced at the Vilnius plant.



C1-33 five-beam oscilloscope.
1969 г.

Mikhail Yefimchik. Photo of the early 1970s

Alexander Anisimovich Saldin.
Photo from 1967.



Vladimir Evaldovich Paskis.
Photo of the mid-1960s

During these years, radio electronics was rapidly developing in Lithuania, and both the Vilnius plant and the Design Bureau became suppliers of personnel for the newly established Lithuanian enterprises. J.Šatkus left for the Research Institute of Electrography, V.Stalinkevičius moved to the Radio Components Plant. D.Eidukas moved to the Kaunas branch of Vilnius Research Institute, which was transformed into an independent research institute KNIIRIT in 1966. Later he became the head of the department of Kaunas Polytechnic Institute, professor, academician of the Lithuanian Academy of Sciences.

It should be noted that before 1960 oscillographic developments were based on serial CRTs, customers of which were third-party enterprises, and often these CRTs did not satisfy the developers. Since the early 1960s, the department began to actively supervise CRT developments and, starting from 1964, almost all oscilloscope models were developed on tubes specially ordered by the VNIIRIP department for MEP enterprises.

The parameters of new CRTs during their development and production were tested using special stands developed and supplied to MEP enterprises by the oscillographic department of VNIIRIP. M.S. Buslovitch supervised the development of the stands.

A similar situation gradually developed with other electronic components. In the past, the oscilloscopes used components that were mass-produced or developed at the request of oscilloscope customers, but in the future the oscilloscope developers themselves developed requirements for the products that determined the progress in the development of oscillography and ordered them at the MEP enterprises.

Thus, new wideband CRTs with high sensitivity, including those with distributed deflection system, internal parallax-free scale, high speed of photorecording, as well as wideband transistors, high-speed pulse Schottky diodes, charge storage diodes, tunnel diodes, high-stability capacitors, etc. were ordered and developed.

In the mid-1960s, attempts were made, though unsuccessful, to create their own laboratory for CRT production and their serial production at the Panevezys "Ekranas" plant.

During the period of development of oscillographic devices development and production at NII-555 (formerly OKB-555)**, from 1960 to 1966 (for 6 years), the** developers of the oscillographic department, numbering up to 100-130 people, developed **23 models of** oscilloscopes and interchangeable units for them, of which 17 were mass-produced at the plants of the industry.

Including oscilloscopes and base units - 16, models C1-12, 15, 17, 16, 18, 20, OD-723, C1-32, C8-9, C8-9A, C8-1, C1-31, C8-2, C1-36, C1-40, 33, as well as exchangeable units - 7, models U1, 2, 3, 4, 5, 7, 8.

By the middle of the 60's **7 main directions of** development and production of oscillographic devices in VNIIRIP were finally formed (which influenced the change of the structure and number of sectors of the department in 1965):

1) oscilloscopes with interchangeable blocks, the main direction, (types C1-8, C1-15/1.../5, C1-17), about **43.0% of** production volumes;

2) broadband oscilloscopes, with bandwidth over 10 MHz, at that time, later over 100 MHz (such as C1-7, C1-11, C1-12, C1-20, C1-32, C1-31, C1-40), **25.5% of** volumes:

3) service oscilloscopes (like C1-6, weighing less than 5 kg), approx. **11.7%** volumes;

4) low-frequency oscilloscopes, 10 MHz and less, (type C1-1, C1-2, C1-4, C1-5, C1-16, C1-18), **8.5% of** volumes;

5) storage oscilloscopes, for the study of slow single signals on ZELTs (C8-1, C8-2, C8-9), **4.0%** volumes;

6) high-speed special oscilloscopes for photo-recording of fast single signals (like C1-10, C1-14, C1- 36), **3.5%** volumes;

7) stroboscopic oscilloscopes for investigation of ultra-wideband repetitive signals (type C1-15/7, C1- 15/8), **2.9%** volumes.

Later, in the 80s, the ZELT oscilloscopes began to be gradually replaced by digital ZELT oscilloscopes (with digital memory), which formed a new, eighth direction.

Production volumes of each area are calculated based on production data, industry implementation department
6 GU MPSS, (located on the territory of VNIIRIP, hands.

B.Z.Altshuller), for 1984-1992, published in the book "People. Years. Oscilloscopes" in 2012. [1].

The point is that NII-555, which in 1960-65 was a part of SCET, and later a part of MRP, and 6 GU MPSS, which included many serial plants, was **90-95%** financed at the expense of profits from the production of their own devices, so it was the volume of serial production of devices developed in the NII that was very important for financing the life and development of the Institute.

Therefore, the subsequent sections of this chapter describing the various directions in oscillography are arranged in that order, that is, according to volume production.

Tables showing the production volumes of 28 models of VNIIRIP oscilloscopes in 1984-1992 are given at the end of Appendix 1. There are also given the production volumes for 8 main directions of development (types) of VNIIRIP oscilloscopes, including in percentage of the total volume.

1.5. Golden era of oscillography development. 1965-1991.

In 1965, NII-555 (organization a/y 50) **was transformed into an** enterprise with an open name - Vilnius Scientific Research Institute of Radio Measuring Instruments - **VNIIRIP** (enterprise p/y R-6856), whose proud name this book bears. And the "Experimental Plant, P/y 6" was transformed into an independent Vilnius Radio Measuring Instruments Plant (VZRIP) - P/y A-7859. With the same names, the Institute and the plant would live the biggest and the most successful period of their existence - 26 years, and their heyday would also fall on the same period.

In the same year another change in the structure of the division took place. **A.F.Denisov was appointed Head of Oscillographic Department No.2.**

Alexander Fedorovich Denisov. Photo from the early 1970s

Alexander Fedorovich Denisov was born in Moscow in **1935.**

In **1957** he graduated from the Radio Engineering Department of the Lviv Polytechnic Institute and was assigned to work in the Design Bureau-555 of the Vilnius plant p/y 6.

In **1957**, having started working as a 3rd category engineer in the group of developers of a broadband oscilloscope on the theme "Hyacinth" (C1-11/ISO-1), under the supervision of G.M. Lifanov, by the end of the development (1958) A.F. Denisov became a leading engineer and implemented this device at the Vilnius and Makhachkala plants.

In **1962,** he became chief of Laboratory No. 42, and was appointed lead engineer of C1-17.

In **1964,** A.F. Denisov became the chief designer of the C1-31 oscilloscope.

In 1965, Alexander Fedorovich was appointed head of the oscillographic department No. 2, and became a pioneer in the development of stroboscopic oscilloscopes at VNIIRIP. He was the leading developer of stroboscopic devices, C1-15/7 (1965), C1- 15/8 (1967), and then the chief designer of the C7-8 stroboscope (1969),

In **1968** he was the first oscillographer to defend his Ph.D. thesis, followed by his doctoral thesis in **1984.**

In **1976,** Alexander Fedorovich was appointed deputy head of department No. 2, and head of department No. 22.

In **1984,** A.F. Denisov became deputy chief of department No. 4 and chief of department 42.

In **1986,** A.F. Denisov became the head of Department No. 4 of seven sectors.

A.F. Denisov, 1960s.

Alexander F. Denisov, 1980s.

Alexander Fyodorovich Denisov was the chief designer of developments in most scientific and technical areas of the department, such as oscilloscopes **with interchangeable units, special, high-speed and other oscilloscopes.** In terms of production volumes, the devices developed directly under the supervision of Alexander Fyodorovich **made up to 47% of** all oscilloscopes produced by VNIIRIP in 1984-1992.

By 1965, the oscillographic department No. 2 had become a powerful development unit consisting of five laboratory sectors (LS), design and construction sector (PCS-2), layout workshop and a group for technical documentation under the leadership of N.N.Goreva.

The number of the department exceeded 130 people. V.M. Levin became deputy head of the department, and since 1973 - V.A. Silvestruk.

Each laboratory sector had its own specialization according to the established trends in oscilloscopy by this time:

LS-21 - universal oscilloscopes with interchangeable units, Head A.A.Zybin.

LS-22 - stroboscopic oscilloscopes, chief V.A.Silvestruk.

LS-23 - high-speed oscilloscopes on ELTBV, chief V.I.Vinogradov.

LS-24 - memory oscilloscopes, chief A.A.Kalamkarov.

LS-25 - universal broadband oscilloscopes, chief A.I.Fedorenchik.

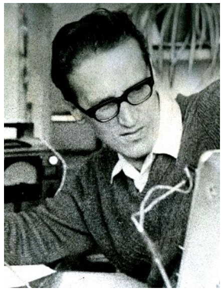
PCC-2 - Design and Construction Sector, Sector Head H.G. Zaidelson.

After A.A.Zybin's departure to Tallinn in the 70s, the laboratory sector LS-21 was headed by A.V.Mikhalev. Since 1971 the laboratory sector LS-22 was headed by M.I.Efimchik, the laboratory sector LS-23 - by V.A.Silvestruk. After A.A.Kalamkarov was appointed Deputy Chief Engineer of the Research Institute in 1971, the laboratory sector LS-24 was headed by V.M.Levin.

Since that time the transition to a new element base - semiconductor devices - began. The era of transistors was coming. The size of devices sharply decreased, their power consumption decreased, reliability increased. CRTs with rectangular screen and internal parallax-free scale appeared.

Branch chiefs of the oscillographic department in 1965:





LS-21. A.A.Zybin LS-22.V.A. SilvestrukLS-23
V.I.Vinogradov.



LS-24.A.A.Kalamkarov. LS-25 A.I.Fedorenchik. PKS-2 H.G.Zaidelson.

In the same years, international cooperation began to develop. In the Council for Mutual Economic Assistance (CMEA), the USSR was assigned specialization in electronic oscilloscopes, and the Vilnius Research Institute, as the leading enterprise of the country, represented these devices in CMEA countries and took part in the development of CMEA standards for this type of instrumentation.

During **1975-1985** VNIIRIP specialists (A.I.Fedorenchik, M.I.Efimchik, A.A.Kalamkarov) carried out work on coordination of special technical conditions with specialists from Hungary, GDR, Poland, Czechoslovakia and Bulgaria. The closest cooperation was with GDR. Annual meetings and demonstration of new developments were held until 1991.

NII specialists participated in the meetings of the working group of the International Electrotechnical Commission (IEC) on the development of IEC recommendations No. 488 on the definition of parameters and test methods of electronic oscilloscopes.

PKS-2 employees . *From left to right.*
Bottom row: L. Panova, O. Shanich, O. F. Vasilyeva, A. I. Solyankina, H. G. Seidelson, T. I. Kaskevich, V. F. Verzilova, V. Karnitskene.
Middle row: I.G. Nesterova, V. Belanova, T. Ilyukevich, last name not established, M.S.Cheprakova, A.Safronova, E.Dagilite, T. Volkova, V. Rajunaite, L. Mesyats, E. V. Baranova.
Top row: M.V. Orlov, V.M. Berezhnoy, K. Ishchuk, O. Leskiv, N. Fesenko, V. M. Makarskaya. Photo from the late 1970s.

In **1966 ,** an important event occurred. Mainly for the needs of the VNIIRIP Institute, as well as for some services of the VZRIP Design Bureau, a new, spacious industrial building was built on the street. Vityanyo is about 200 m long and has an area of about 15 thousand square meters. m.

The oscillography department moved from building 15 to the street. Naugarduko on the 4th floor of the new building

This is the most famous **photograph of oscilloscope employees**
Department No. 2, made in 1968. The year of arrival to work at the "site" at the Design Bureau/ Research Institute is indicated in brackets . ***From left to right.***

- ***Bottom row:*** A.A.Rotskina (1957), V.A.Mukhin (1955), T.I.Kaskevich (1950), V.D.Semenyuk (1957), N.Yu.Korovina (1954), A F. Denisov (1957), V. M. Makarskaya (1955), T. M. Kot (1958), V. A. Silvestruk (1957).
- ***Middle row:*** M.I. Efimchik (1957), A.V. Pushkareva (1955), L.A. Lvov (1949), G.A. Narkunene (1955), R.P. Kuznetsova (1956), V M. Levin (1956), V. K. Rubinene (1955), O. F. Vasilyeva (1951), A. I. Solyankina (1955), G. V. Karkotskaya (1955), A. O. Goncharenko (1955).
- ***Top row:*** O.T.Vereshchak (1955), V.P.Redkin (1957), P.I.Gorev (1950), O.M.Chepilko (1954), E.A.Shestakova (1956), M A. Chereshnevy (1954), G. Puodzhunaite (1957), A. I. Fedorenchik (1957), M. S. Buslovich (1956), N. N. Goreva (1950).

In the second half of the 1960s, there was a change in the leadership of VNIIRIP. **In 1965,** the head of the medical radio electronics department, A.P. Cherny, became the chief engineer of the institute .

The chief engineer of Kaunas NIIRIT **V.D. Starikov** became director of VNIIRIP **in 1968.**

In 1974, some time after this, reorganization began at the institute. On the basis of the oscillographic department No. 2, **the pulse-oscillographic department No. 2 was created, under the leadership of Ph.D. M.I. Efimchik,** S.I. Pedan was appointed his deputy. **The number of members of the department then numbered about 140 people.**

Victor Dmitrievich Starikov –
director of VNIIRIP from 1968 to 1991.

Chief engineer of VNIIRIP
Anatoly Pavlovich Cherny.
Photograph from the late 1990s

Department No. 2 consisted, as before (in 1965) of 5 divisions, but of a different type - 3 departments and 2 sectors:

- LS-200, early V.Latinis, test pulse generators,
- LS-211, beginning M.I. Efimchik, stroboscopic devices,
- department 22, beginning A.F. Denisov, oscilloscopes,
- department 23, beginning A.M.Vlaskin, pulse generators,
- department 24, head. G.P. Vikhrov, pulse meters.

In **1976 ,** the reorganization continued. LS-200 and LS-211 were combined into department 21, leaving the remaining departments unchanged. **S.I. was appointed head of the department. Pedan,** and A.F. Denisov became his deputy. The department includes 4 departments:

- department 21, beginning M.I. Efimchik, stroboscopic devices,
- department 22, beginning A.F. Denisov, oscilloscopes,
- department 23, beginning A.M.Vlaskin, pulse generators,
- department 24, head. G.P.Vikhrov. test pulse generators,

Section 21 consisted of:

- LS-211, beginning M.I. Efimchik, stroboscopic oscilloscopes,
- LS-212, beginning V.M.Levin, low-frequency oscilloscopes,
- LS-213, beginning Y. Rapalis, service oscilloscopes.

Employees of department No. 2: *From left to right,* ***bottom row:*** M.S. Buslovich, E.A. Shestakova, P.I. Gorev; ***top row:*** V.A.Mukhin, O.M.Chepilko, Photo from the mid-1970s

In **1976 ,** several development groups from other departments joined Department No. 21. The laboratory of service oscilloscopes under the leadership of Y. Rapalis was transferred from the medical department, and the group of A.V. Kozhukhov was transferred from the department of G.P. Vikhrov, the first at the institute to conduct research in the field of a new class of oscilloscopes - digital storage.

Department No. 22 included three laboratories: - LS-221, beginning. A.V.Mikhalev, oscilloscopes with replaceable units,

- LS-222, beginning A.I. Fedorenchik, broadband oscilloscopes,
- LS-223, beginning V.A. Silvestruk, and since 1978 A.G. Onishchenko, soon growth oscilloscopes and recorders of single-shot signals.

In **1981 ,** Department No. 21 was reorganized due to the emphasis on the development of digital oscilloscopes. Four laboratories were created in the department:

– LS-211, beginning Ya.M.Rossosky, stroboscopic oscilloscopes,

– LS-212, beginning M.I. Efimchik, microprocessor devices, – LS-213, beginning. A.V.Kozhukhov, digital oscilloscopes,

– LS-214, beginning A.A. Likhtinshain, universal and service oscillographs with a bandwidth of up to 100 MHz.

Heads of VNIIRIP departments. *From left to right:* I.A. Schmidt, A.F. Denisov, G.M. Lifanov, A.I. Fedorenchik, E.L. Piletskas, S.I. Pedan. Photo from the early 1980s

In **1984 ,** after the death of S.I. Pedan, pulse oscillography department No. 2 was divided into two departments:

- **department No. 4, oscillographic, beginning. A.I. Fedorenchik,**
- department No. 9, impulse, beginning. A.M.Vlaskin,

Oscillographic department No. 4 consisted of 3 departments:

- department 41, head. M.I.Efimchik, digital and strobe oscillators,
- department 42, head. A.F. Denisov, osc. from shifts bl. and specialist osc., - department 43, beginning. A.I. Fedorenchik. wideband oscilloscopes.

The national team of department No. 4 at a tourist rally, at the VNIIRIP recreation center near Lake Drabuzhis. Photos from the 1980s

Each of the three oscillographic departments had three research sector. In department No. 41 it is:
- NIS-411 (Ya.M. Rossosky), strobe oscilloscopes, -
NIS-412 (N.V. Radionov), microprocessor devices,
- NIS-413 (A.V. Kozhukhov), digital oscilloscopes.

In department
No. 42 - NIS-421 (A.V. Mikhalev), oscill. with shift blocks,
- NIS-422 (A.G. Onishchenko), high-speed oscilloscopes,
- NIS-423 (N.E.Isaenko), metrology for oscilloscopes.

In department No. 43:
- NIS431 (V.K. Shapiro), broadband oscilloscopes,
- NIS432 (A.A. Likhtenshain), service and low-frequency oscilloscopes,
- NIS433 (V.N. Kazimyants). software for oscilloscopes dept. 4.

At this time, the sector for the development of metrological instruments for oscilloscopes (N.E. Isaenko) was transferred from department No. 9 to oscillographic department No. 42.

In 1986, 21 years later, everything returns to the origins of the reorganization. **Oscillographic department No. 4 is being restored under the guidance of Doctor of Technical Sciences. A.F. Denisova.**

A.I. Fedorenchik becomes deputy head of the department.
Department No. 4 consists of seven research sectors:

- NIS-41 (M.I. Efimchik), strobe oscilloscopes,
- NIS-42 (A.V. Mihalev), oscill. with shift blocks,
- NIS-43 (A.G. Onishchenko), high-speed oscilloscopes,
- NIS-44 (A.A. Likhtenshain), service and low-frequency oscilloscopes,
- NIS-45 (A.V. Kozhukhov), digital oscilloscopes.
- NIS-46 (N.E.Isaenko), metrology for oscilloscopes.
- NIS-47 (Ya.M. Rossosky), added to them in **1988 ,** from the NIS-41.

In the late 1980s, in the oscillographic department No. 4 about 200 people worked.

The 1970s and 1980s of the last century, due to the absence of major military conflicts in the world, as well as due to the rapid development of radio electronics, communications, television and computer technology, **became the golden era of the development of oscillography in the USSR** and in the world . Oscilloscopes have always been the most widespread, and

largest, in terms of production volume, type of RIP, which is why **the oscilloscope at that time was called the "King" of measuring instruments.**

In 1986, 160 thousand oscilloscopes were produced in the country **for a total of 235 million rubles.** In the same year, oscilloscopes worth $1,270 million were produced abroad (with a total RIP output of $4,800 million). Taking into account the fact that the dollar then cost about 0.90 rubles, the analysis showed that **by the mid-1980s, every fifth oscilloscope produced in the world was manufactured in the USSR.**

In the 1970s, *Tektronix became the undisputed leader in world oscillography.* From the late 40s to the mid-80s, the number of employees at this enterprise grew to 25 thousand people. Six out of every ten oscilloscopes (60%) produced in the world were manufactured by *Tektronix.* Its constant competitor, *Hewlett Packard,* lagged behind in volume (10%) and technical characteristics. Due to the growing demand for oscillographic instruments in those years, development divisions engaged in oscillography began to develop in our country in the newly created instrument-making radio engineering research

institutes.

In Gorky in 1949, GNIPI was formed, which in 1956 became head in instrument making. And there, a little later, the oscillographic department of A.Z. Barzakh was founded. The specialization of this department of GNIPI was stroboscopic oscilloscopes, (such as S7-13, S7-16 and S7-17 for the band from 0.6 to 10 GHz), and digital oscilloscopes (for example, S9-8, S9-16), which were produced at the Minsk Kalibr plant.

Lvov Scientific Research Radiotechnical Institute.
LNIRTI.

In Lvov in 1956, the LNIRTI Institute was founded, in which V.A. Polushin's department also began developing oscillographs. The specialization of the Lvov NIRTI was the development of small-sized oscilloscopes for harsh operating conditions with a bandwidth of up to 50 MHz. The first development of LNIRTI in 1959 was

the fairly successful and widespread oscilloscope S1-13, developed under the leadership
V.G. Andrushchenko, who later became the head of the 6th Main Instrument-Making Directorate of the MPSS. Another fundamental

work of LNIRTI was the development of the mass-produced oscilloscope S1-35, developed under the leadership of Z.M. Bodnar in 1964-1965. An analogue of this device was a small-sized semiconductor oscilloscope model 321 from *Tektronix.* In 1972, LNIRTI also created the most popular portable

oscilloscope in the USSR, S1-65 at 35 MHz. It was unique in that its assembly and adjustment took place on the conveyor belt of the Minsk Production Association named after. Lenin. This was the first time in the production of oscilloscopes. Since then, LNIRTI has developed many large-scale models of portable universal oscilloscopes, which have been successfully produced for many years. One of the latest was the impressive wideband oscilloscope C1-

104 per 500 MHz band. The leading specialists of LNIRTI were V.A. Polushin, Z.M. Bodnar, G. Evtyukhin, B.I. Prots, A.N. Gonchar-Bysh and others.

Minsk Scientific Research Instrument-Making Institute. MNIPI

In 1954, the Minsk Research Institute - MNIPI was founded. By the 1970s, a department was created under the leadership of V.N. Vishnevsky (later headed by N.A. Kukharenko), who also took up oscillography. His specialization was close to LNIRTI - monoblock portable oscilloscopes up to 100 MHz, for harsh operating conditions.

This was the first attempt by the head of the 6th Main Directorate of the MPSS V.G. Andrushchenko (fellow student of A.P. Cherny) to create competition in the country among oscilloscope developers. The first developments of MNIPI

were the oscilloscopes S1-82 (chief designer V.B. Mochalin), S1-114 (chief designer V.M. Nemirovsky), and the modernization of the Lvov S1-65 at 35 MHz into S1-65A at 50 MHz. Later, digital oscilloscopes were also developed there (such as S9-28, S8-52). MNIPI has been developing and producing analog and digital oscilloscopes to date, its latest models are

S1-179, S8-54, for a bandwidth of up to 200 MHz, and with sampling up to 1 GHz.

Two developments of oscilloscopes were also carried out by V. Kaminsky at the Bryansk plant design bureau.

At the same time, factories in Abovyan and Makhachkala were connected to the factories producing oscilloscopes in Vilnius, Bryansk, Lvov, Minsk and Mytishchi.

Abovyan plant "Meter

Gorky Research Institute instrument-making Institute (GNIPI)

Kiev PO im. S.P.Koroleva

Makhachkala instrument-making plant

Minsk Scientific Research instrument-making institute (MNIPI)

Minsky instrument-making plant named after V.I.Lenin

Minsk plant “Caliber”

Moscow plant measuring equipment (MSIA)

Mytishchinsky Instrument-making plant

Logos of research institutes and manufacturing plants in the industry

A significant contribution to the creation of new oscilloscopes belongs to the general customer (USSR Ministry of Defense) and its representatives from the metrological service of the Moscow Region, Mytishchi, who were repeatedly the chairmen of state commissions for the acceptance of devices. Let's note the names here -

A.N.Stelmashenko and A.V.Boldina, as well as the names of employees of the customer’s representative office (PZ) VNIIRIP / VZRIP - V.M.Tsarkova and Yu.P.Spiridonova.

The creation of oscillographic equipment in the country was carried out on the basis of constantly developed and updated development programs, and was aimed both at updating the fleet of instruments and at creating fundamentally new measuring instruments.

The formation of such programs was based on the analysis of a large number of measurement tasks in various fields of science and technology, as well as on the basis of an analysis of trends in the development of foreign technology.

A significant role in the coordination and preparation of such programs belonged to the oscillographic department of VNIIRIP, as the leading division of the industry. The development of development programs was led by the chief engineer of the research institute, the chief designer of the oscillography industry A.P. Cherny and the head of the oscillographic department A.F. Denisov. The program was approved by the 6th Main Directorate of the MPSS.

As a rule, such a development program consisted of a development plan for new oscilloscopes, a plan for their metrological support, a plan for providing the element base, as well as a plan for basic research work. The program included the development of equipment for harsh operating conditions, laboratory, and service devices.

These are the goals, for example, set by the Development Program Oscillographs before 1990:

ÿ Universal oscilloscopes with bandwidth up to 2 GHz.

ÿ Stroboscopic oscilloscopes with bandwidth up to 60 GHz.

ÿ Digital oscilloscopes with sampling rates up to 1 GHz.

ÿ Storage oscilloscopes with digital memory on ZELT with a recording speed of up to 30 thousand km/s.

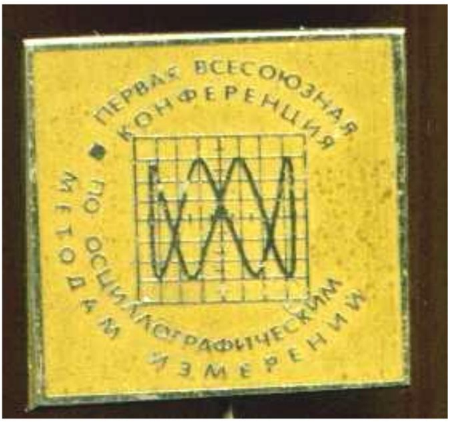
ÿ High-speed oscilloscopes based on ELTBV with bandwidth up to 10 GHz and recording speeds up to 300 thousand km/s.

At MEP, on the basis of the Oscillographic Industry Development Programs, a planned large-scale development of the element base for oscilloscopes was carried out, and, first of all, the development of CRTs. The work was carried out at the Design Bureau of the Moscow Electric Tube Plant in the laboratory of A. Khutilenka; at the Research Institute of Fryazino under the leadership of N. Tarasov, V. A. Bogachenko, V. A. Shkunov, Yu. V. Chaiko; in the OKB of the Lvov plant “Kinescope” (E. Martynova, B. Kinakh, V. Malyshev, L. O. Kobinets); in OKB

Novosibirsk Electric Vacuum Devices Plant, (E.A. Edin and E.A. Starykin).

The scientific and production base of oscillography was strengthened, and, as a result, **scientific and technical conferences on oscillographic measurement methods.**

In total, 6 such all-Union conferences were held **- in 1973, 1975, 1978, 1982, 1986 and 1990.** These conferences brought together leading experts from Lvov, Minsk, Gorky, Moscow and other cities. They gave reports on current and completed developments, on methods of oscillographic measurements, and on original circuit solutions. This was a good opportunity for developers from different cities, united by common goals, to communicate, get to know each other, and exchange experiences. During conferences, as a rule, programs and abstracts of reports by specialists were published. Photos of the covers of these publications are given in Appendix 6.



Badge of the First All-Union Oscillographic conference 1972

Badge of the Sixth All-Union oscillographic conference 1990 (last conference)

In 1977, for a set of works on the research and development of methods for calculating broadband pulse oscillographic devices and the introduction of the results into folklore farm, a group of employees of department No. 2 were awarded the title of laureates of the Republican Prize of the Lithuanian SSR.

In 1984, the head of the oscillographic department, Ph.D. A.F. Denisov. In 1991, Y.M. Rossosky became the laureate of the USSR Council of Ministers Prize, and in the same year A.F. Denisov was elected a foreign member of the Russian Metrological Academy of Sciences (Nizhny Novgorod).

Laureates of the Republican Prize of the Lithuanian SSR in the field of science for 1977 *From left to right,*
bottom row: V.Latinis, G.Puodzhunaite, A.F.Denisov; ***top row:***
A.I. Fedorenchik, M.I. Efimchik, A.G. Onishchenko

Based on the results of developments, employees of oscillographic departments, in addition to reports at conferences, also submitted many applications for copyright certificates for inventions.

Employees of the oscillographic department 21 (41) are the authors of the inventions. *From left to right,* ***bottom row:*** M.N. Dvoretsky, A.S. Minin, B.N. Levitas, O.M. Zaitsev; ***top row:*** Y.M.Rossosky, V.V.Ivanov, A.G.Kosakovsky, M.I. Efimchik, R.V. Bodnar. Photo from the mid-1980s

In this work they were assisted by the ONTIPI department (head of the department A.G. Andrienko) and patent expert G.I. Andreev, previously a highly qualified developer of the oscillography department. Sometimes the correspondence with the patent department was delayed, but still, from time to time it was possible to obtain the desired copyright certificate, which was encouraged, including financially.

In the early 70s, following A.F. Denisov, oscillographic department 2 was replenished with new candidates of technical sciences. Theses were defended by M.I. Efimchik, E.A. Fomin. Later, their ranks were replenished by A.G. Onishchenko, B.N. Levitas, V.N. Kazimyanets, A.G. Kosakovsky, I.A. Naydenova, and later by A.V. Kozhukhov. Thus, in the 2nd department, up to 8-9 candidates, and later doctors of science, worked simultaneously.

Employees of the oscillographic department 22 (42) are the authors of inventions.
From left to right: ... Tyurin. Vas.B.Dvoretsky, G.I.Andreev, Y.Stasiukinas, A.F. Denisov, O.A. Boytsov, A.G. Kosakovsky, R.V. Bodnar, against the background of the Sova/Svita-3 digital oscilloscope and the S1-115/9 logic analyzer. Photo from 1984.

At the end of 1982, Deputy Chief Engineer of the Research Institute **A.A. Kalamkarov,** a long-term employee of the oscillographic department, previously the head of the storage oscilloscope sector at ZELT, **was sent to Cuba** to serve as head of the CMEA joint laboratory for testing electronic equipment under the influence of tropical climate factors.

Anatoly Aikovich Kalamkarov was born in 1936 in Batumi. In 1960, he graduated from the radio engineering department of the Leningrad Institute of Aviation Instrumentation and was assigned to work in Vilnius, at the plant, post office box 6. He began his career at the plant's RTS as a radio engineer in a department headed by M.I. Efimchik. I started with modifications to the S1-4 (ENO-1) oscilloscope, developed by A.P. Cherny. In the same year, he was transferred from the plant to the newly organized research institute in the oscillographic department, which led by L.A. Auzin. Since 1965 - head of laboratory No. 24 (oscilloscopes on ZELT, instead of A.P. Cherny, who headed the new division - the department of medical equipment).

The main technical direction of the laboratory was the development of oscilloscopes based on CRT storage devices (group C8-), as well as test equipment for testing potentialoscopes.

VNIIRIP management team. The photo was taken in 1982 during A.A. Kalamkarov's farewell to Cuba. *From left to right,*
Bottom row: A.P. Cherny, A.G. Andrienko, V.D. Starikov, N.M. Bogatova, A.A. Kalamkarov, N.E. Kuzovkova, K.K. Pilalis, H.G. Seidelson , Y.P. Spiridonov.
Middle row: R. Shilas, V. M. Lapidus, A. F. Denisov, O. V. Kremnev, V. A. Abramov, N. K. Murzin, A. P. Pinchuk, B. Z. Altshuller, A. I. Romanenko, V. Ya. Snitko, V. A. German. ***Top row:*** S. N. Dubina, V. F. Samorodsky, G. M. Lifanov, A. P. Vasiliev, E. L. Pileckas, B. M. Mukomel, M. I. Yefimchik, A. I. Fedorenchik , M.M. Yesipenko.

From 1971 to 1982 and from 1987 to 1990, working as deputy chief engineer of the research institute, A.A. Kalamkarov oversaw the work of the design service, metrological department, standardization departments, technical documentation and technical information. A large amount of work involved constant process of approval and transfer of design documentation for new products to manufacturing plants (Abovyan, Bryansk, Vilnius, Makhachkala, Mytishchi). After 1990, A.A.

Kalamkarov returned to Cuba for position of head of the CMEA laboratory.

In 1981 and 1986, evenings of the oscillography department 2 were held, dedicated to the 25th and 30th anniversary of the founding of the oscillography laboratory at VNIIRIP.

Gala evening in honor of the 30th anniversary of oscillography at the Palace of Trade Unions in Vilnius, in 1986.

It should be noted that abroad there was constant interest in the technical level and “know-how” of Soviet oscillography. Leading foreign companies closely monitored the level of newly developed devices in the USSR. Thus, Marshall *M. Lee* in the book “Winning with People: 40 years of Tektronix”, which tells about the 40-year history of the company

Tektronix, very vividly describes the company's 1971 shareholders meeting [10]. Among other things, he reports

that Howard Vollum, newly elected chairman of the company after the death of Melvin Jack Murdock, has prepared a treatise on the technical level of the latest Soviet oscilloscopes. A copy of this treatise was kept on display throughout the meeting. Similar analyzes were carried out periodically at the company.

Of undoubted interest is the declassified report on the technical level of Soviet traveling wave tube oscilloscopes, prepared for the CIA by John *K.*

Boiciock) and dating back to 1975 [26]. Below is a copy of the original and a translation of this memorandum, as well as some comments.

CIA Released Documents

Documents Homepage > CIA Documents > Documents released in period: 1/1/1976-8/15/1975

Previous document: WEEKLY REVIEW: SELA CREATED Next document: CHILE AFTER TWO YEARS OF MILITARY RULE

SOVIET TRAVELING WAVE OSCILLOSCOPES (S-08910)

Created: 10/22/1975

OCR scan of the original document, errors are possible

cia historical review program release as9

S

MEMORANDUM TOR: Mr. John K. Boiciock

Chief, Electronic Branch Office of Export Administration Department, of Commerce

Travelling Wave Oscilloscopes

Attachedeport on Soviet travelling wave oscilloscopes which you requeued from of this office. Please address any questions to

“The Soviet Union has been producing traveling wave CRT oscilloscopes for approximately 12 years. The first such oscilloscope, the S1-14, originally called the SO-1, was announced in 1963...”

Here in the memorandum there was an error of several years. In fact, development of the C1-14 (CO-1), “Bamboo” oscilloscope was completed in 1959, and it went into production the following year.

Further: “...It had a bandwidth of 0-3 GHz directly on the tube, and 0-1 GHz when using a delay line. Its sensitivity was 50 V/cm at 3 GHz and 33 V/cm at 1 GHz...” Absolutely accurate data!

The following describes in detail all high-speed oscilloscopes developed in Vilnius until 1971, including S1-36, S7-10, S7-10A, S7-10B.

Such interest of Tektronics and the CIA in our developments suggests that these devices were strategically important for them during the Cold War.

After the end of the “golden” period, **in the 1990s, a crisis occurred in the oscilloscope industry in the world.** So from the 1990s to the 2000s, the number of, for example, Tektronix , decreased from 25 to 6 thousand people, and with minor fluctuations remains the same to this day.

Something similar happened with the oscillographic industry in the CIS countries in the 1990s and 2000s, and not only because of the collapse of the USSR and CMEA. The fact is that global changes have come in the world's rapidly developing electronic technology.

With the advent of microprocessors, ADCs and DACs in all types of electronic devices, the process of replacing analog parts of devices with digital ones, and standardizing the circuit solutions of digital and microprocessor parts of devices began. This has reduced the need for circuit engineers (who used oscilloscopes to design, manufacture, and service electronics), and with it, the need for programmers has increased dramatically. This has led to a reduction in the need for oscilloscope instruments. Instead, logic analyzers, protocol analyzers and other new types of devices appeared. Therefore, it was **the 1970s and 1980s that became the “golden” time in the development of the oscillographic industry both in the USSR and throughout the world.**

1.6. Oscilloscopes with replaceable units

Of course, in terms of sales volumes, laboratory oscilloscopes with replaceable units, due to their wide functionality and ease of use, **were the main activity of VNIIRIP (and VZRIP). Over the period 1984-1992, in terms of production volumes,** these devices, by a large margin, took 1st place among the other eight areas of development of VNIIRIP oscilloscopes. They were produced for **286 million rubles** (and with strobe options for about 300 million rubles), which amounted to about **43** (45) **%** of the production volumes of all VNIIRIP oscilloscopes over these years (see tables at the end of Appendix 1). However, the situation at Tektronics was exactly the same; its main series of oscilloscopes with replaceable units **-** 500, 7000 and 5000 **-** dominated both in the company's production volumes and in the number of models in catalogs.

1.6.1. Generation "Snaige" (50 MHz/3.5 GHz). 1972-1976.

In **1972 ,** one of the **most** successful and largest-scale oscilloscopes from VNIIRIP – **S1-70.** Due to inexhaustible demand, it was produced for about 14 years from 1972 to 1986. And the S1-74 oscilloscope (a two-beam version of the S1-70, from the same family) was produced for 18 years, until the liquidation of VZRIP in 1992. The previous device - S1-15 “Kulisa”, to replace which the S1-70 was developed, was also produced for a long time - 10 years.

Legendary universal oscilloscope C1-70 with interchangeable units with 1U11 amplifier and 1P11 scanning units. 1972

Over the last 3 years of production alone, in 1984-86, about 13 thousand such devices were produced at the Vilnius plant for the amount of 25 million rubles, on average 4000 pcs. per year, at a price (in -+average) about 1800 rubles.

This was the 1st, head model of the new, 2nd, semiconductor family (generation), oscilloscopes with replaceable units for a band up to **50 MHz,** and up to **3.5 GHz** in stroboscopic mode.

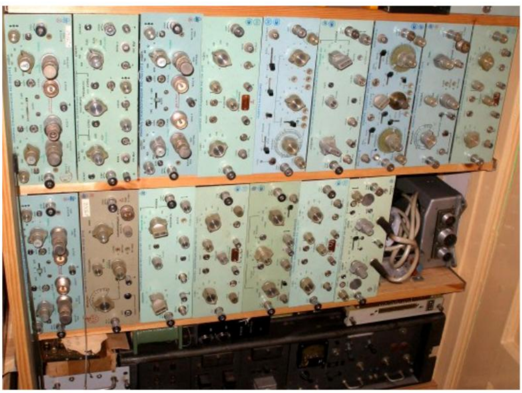
This family of oscilloscopes (“Snaige”) included the universal S1-70 (then S1-70A, with an enlarged screen), later the two-beam S1-74, as well as storage S8-12, S8-13, S8-14, 5 in total base and 11 replacement blocks. Note that the previous Kulis lamp family (C1-15/ C1-17) had only 2 base and 7 replacement units.

The prerequisites for this development were as follows. On the

one hand, created in 1961-62. years, the family of oscilloscopes with replaceable units "Kulisa" S1-15/17 for the 25/10 MHz band has shown high efficiency and demand among consumers. However, the oscilloscopes of this family were tube-based, quickly became outdated, and needed to be replaced with devices built on transistors. On the other hand, in 1963 HP released a new transistor-based series of oscilloscopes with replaceable units, HP 140, for a 20 MHz band, and already in 1966 released

the next series of oscilloscopes, HP 180, with replaceable units for a 50 MHz band.

The HP140 series was taken as a design analogue of this family, and in terms of electrical parameters the series was HP180, since the frequency parameters of the HP140 (20 MHz) were already covered in the C1-15 (25 MHz).



Replacement units for oscilloscopes of the S1-70, “Snaige” family, produced at

Vilnius and Bryansk factories

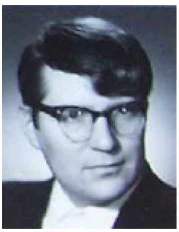
For the Vilnius plant, the S1-70, for the first time made entirely on transistors, became the hallmark of the enterprise for many years (until 1987).

The S1-70 used a CRT type 11LO2I “Cream” with a working part of the screen of 64x80 mm, but after modernization in **1976 , the S1-70A** device already had a CRT 13LO1I, with a much larger
screen 80x100mm. For the first time in this family, the base unit already had 2 compartments for replaceable units - one for vertical, the other for horizontal beam deflection. This was not the case in the previous generation of “Kulis”, where there was only one compartment for the vertical deflection of the beam.

This was key work for department 2, the head of which, and the chief designer of this topic, was Denisov A.F. The main work was carried out in LS-21, under the leadership of A.A. Zybin, and after his departure to Tallinn in 1972 under the leadership of A.V. Mikhaleva. Work on the development of 5 basic and 11 replacement units of the family took place in four of the five sectors of department 2. More than 50 people participated in the work.

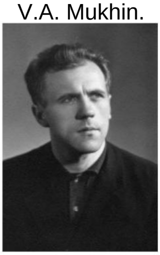
The leading engineer of S1-70 was V.A. Mukhin. V.P. took
part in the development of the family. Redkin, I.I. Pits, A.A. Plaksy, G.N. Kulesh, G.I. Andreev, I. Lantrat, V. Odnorog, A.I. Babichev, A.V. Mikhalev, A.I. Shemraev, Yu. Eremin, and others.


V.A. Mukhin.

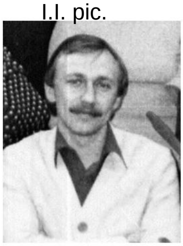

V.P. Redkin

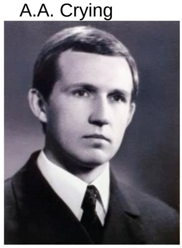

I.I. pic.


A.A. Crying

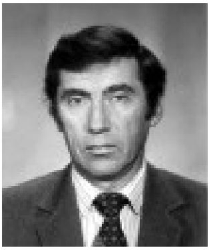

G.N. Kules.


G.I. Andreev.


I. Lantrat


A.I. Shemraev

The design of blocks and devices was carried out by specialists from the design sector: H.G. Zaidelson, V.F. Verzilova, T.I. Kaskevich, V.K. Rubinene. Power supplies were developed by S.Ya. Zablotskis, L. Bagdanavichus, N.S. Shabunina, M. Mikhaleva. Technological support was provided by V.A. Klimovich and A.V. Pushkareva.




A.V. Mikhalev H.G.Zaydelson T.I.Kaskevich V.F. Verzilova

Parameters of the **S1-70** device (in brackets for strobe blocks):
- Band, depending on blocks - **50, 10, 1, 0.1 MHz, (3.5 GHz),**
- CRT “Cream” 11LO2I, screen 64x80 mm (later 80x100 mm, for S1-70A).

- Sensitivity – 10 mV/div., 1 mV/div., 10 ÿV/div., 10 dB/div., (5 mV/div.),
- Input 1 MOm/30 pf, (50 ohm),
- Sweep 10 ns-5 s/div. (100 ps-5 µs),
- Error 5%,
- Power consumption 250 W,
- weight 24 kg.

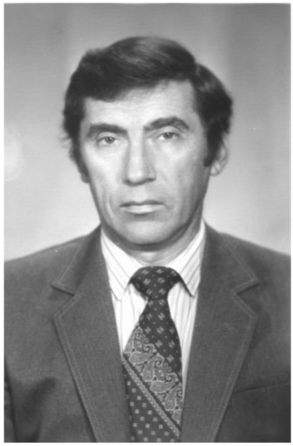
In terms of its parameters, the S1-70 completely replaced the S1-15.

In **1972 ,** a **1U11** differential amplifier unit was developed for oscilloscopes from the Snige family, for example, **S1-70/1** (Ya40-1100), per 50 MHz band with a sensitivity of 10 mV/div. and dual scanning unit **1P11** (Ya4S-2100), 10 ns/div.

Differential block amplifier Ya40-1100 (1U11). 1972

Dual scanner ÿ40-2100 (1ÿ11). 1972

The differential amplifier block was developed by V. Redkin, and scanner A.V. Mikhalev.



Vyacheslav Petrovich Redkin Alexander Vladimirovich Mikhalev.

In **1972 ,** the development of 2 stroboscopic units for the **S1-70/2 family of oscilloscopes was also completed.** This is a two-channel stroboscopic amplifier unit Ya40-1700 **(1U71)** with a bandwidth of 0-3.5 GHz and a stroboscopic scanning unit Ya40-2700 **(1P71).** More detailed information about them is in section 1.12.

In **1974 ,** on the topic **"Grid"** on a CRT 13LO16A, the 2nd basic unit of the family of oscilloscopes with replaceable units "Snaige" (S1-70) was developed - a two-beam **S1-74** at **35 MHz,** instead of a two-beam S1-17 (the "Kulisa" family ") at 10 MHz. This base unit expanded the capabilities of the Snige family, since it already had 3 compartments for replaceable units, two of them for vertical and one for horizontal deflection. Therefore, it made it possible to observe on the screen up to 2 signals with single-channel amplifier blocks, and up to 4 signals simultaneously with two 2-channel

replaceable blocks (1U12 since 1976). S1-74 also made it possible to simultaneously photograph two single signals at a high photo recording speed, thanks to the new 13LO16A double-beam CRT.

Over the last 8 years of production alone, in 1984-92, about 13 thousand such devices were produced worth 31 million rubles, in on average 1628 pcs. per year, at a price (on average) of about 2,400 rubles. At the same time, the S1-74 was produced for 18 years at the VZRIP plant.

Developed S1-74 Kulesh G.N. and Shemraev A.I.

Dual-beam oscilloscope with replaceable blocks S1-74. 1974

Photo of the base unit of the S1-74 oscilloscope without inserted replaceable units

G.N. Kulesh

A.I. Shemraev

Parameters S1-74:
- **35 MHz band,**
- CRT screen 60x100 mm,
- **2 beams, 3 compartments with / w,**
- **up to 4 channels,**
- power consumption 300 W,
- weight 30 kg.

In **1974 ,** for the Snige family **(S1-70/4),** a differential amplifier unit Ya40-1102 **(1U13)** was developed for a 10 MHz band, with an increased sensitivity of 0.5 mV/div. and a scanning unit with an adjustable number of starts (from 1 to 100) - **1ÿ91**

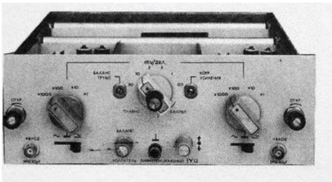
(Ya40-2900),

10 ns/div, for use in storage oscilloscopes.

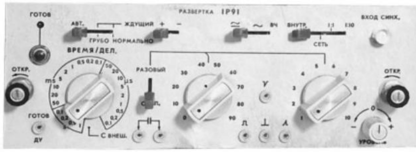
A.A. Likhtinshain recalls: "The development of block 1U13 was carried out by G.I. Andreev. A serious problem here was zero drift, due to the use of a pair of nuvistors in the input stage, which in no way

It was not possible to match them in pairs. Only replacing the nuvistors with a 2P304 field-effect transistor solved the problem. Already 8 years later, when the metrological support of stereo signals arose the task of measuring signals with very high coefficient of suppression of the common-mode component, the 1U13 block turned out to be the best of all oscillographic amplifiers produced by the domestic industry.”

The 1P91 scanner (Ya40-2900) was developed by A.I. Shemraev, for the development of which he was awarded a bronze medal from VDNKh.



Differential block amplifier Ya40-1102 (1U13). 1974



Scanner ÿ40-2900 (1ÿ91). 1974

In **1974 ,** the **S8-12** storage oscilloscope was developed **(“Seida”),** which became the 3rd base unit of the “Snaige” family. It was distinguished by a high recording speed and automatic brightness setting when switching the scan duration. It used a half-tone PT ZELT 13LN10 “Katyusha” with a photo recording speed **of 4000 km/s,** a storage time of 40 s, and a working part of the screen of 50x80 mm. The bandwidth of the oscilloscope with a plug-in unit was **50 MHz.** The image was erased both manually and automatically. With automatic erasing, the playback time was regulated from 1.5 to 5 s, and the recorded information could be stored for 7 hours when the device was turned off.

The leading developer of the oscilloscope was M.S. Buslovich. A. Grigorenko and A. A. Plaksiy took part in the development.

Storage oscilloscope with replaceable blocks C8-12. 1974

In **1974 ,** the 4th basic block of the **S8-13** storage oscilloscope from the Snige family (S1-70/74, S8-12) was developed on the **Svita-2 theme,** for a 1 MHz band **with a long playback and storage time .**

C8-13 was produced in large quantities at the Vilnius plant for 15 years. In 1984-87 alone, about 8 thousand of these devices were produced, worth about 16 million rubles, on average 2000 units per year, at a price of 1900 rubles. The device was built on a bistable memory BS ZELT 13LN2 with a recording speed of up to 20 km/s, with a playback time of 30 minutes, and with a working part of the screen 60x80 mm. The base unit bandwidth was 1 MHz. A feature of the oscilloscope was the multi-mode operation of the CRT - conventional oscillography, storing, enhancing image brightness, forcing and accumulation. The brightness

enhancement mode made it possible to observe signals with a repetition rate of one hertz. The device provided for automatic erasing of the image with subsequent preparation for launch and automatic brightness control when switching the sweep duration. With automatic erasing, the playback time was regulated within a few tens of seconds, and the recorded information could be stored for several days when the device was turned off. The work was carried out in the laboratory sector LS24, headed by V.M. Levin. The development manager was P.I. Gorev.

Parameters S8-13:
- **1 MHz band,**
- BSZELT 13LN2,
- **recording speed 20 km/s,**
- **playback 30 min.,**
- power consumption 180 W,
- weight 23 kg.

Storage oscilloscope S8-13:

S8-13 was developed by:
- chief designer Gorev P.I., - leading engineer Pleshkov V.A., - developers - Malakhov V., Shestakova E., and Sarycheva N.

Pavel Ivanovich Gorev

Vladislav Aleksandrovich Pleshkov

Vladimir Vasilievich Malakhov.

E.A. Shestakova

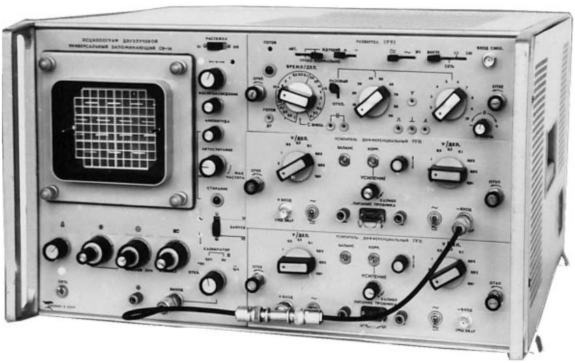
Lyudmila Volkova advertises the C8-13 oscilloscope for a German technical magazine. Photo from the early 1980s

In **1974 ,** the 5th basic block of **the S8-14** 2-beam storage oscilloscope from the Snige family was developed on the topic **“Speed-2”,** for a **50 MHz band.**

The device was built on a two-beam half-tone memory PTZELT 13LN11 with a recording speed of **3000 km/s** and with a working part of the screen of 40x80 mm, with playback time of 40 seconds, for each beam with a beam overlap of 20 mm. Depending on the removable units, the bandwidth reached **50 MHz.**

The device provided the possibility of simultaneous use of two replaceable amplifier blocks in the vertical deflection channels and one scanner in the horizontal deflection channel. The device made it possible to oscilloscope two single signals on each beam of a double-beam CRT.

The leading developer of the C8-14 base unit was M.A. Chereshnevy.



Mikhail Alekseevich Chereshnevy. Photo from the 1960s

Dual beam storage oscilloscope with replaceable blocks C8-14. 1974

The image was erased in the device both manually and automatically. With automatic erasing, the playback time was regulated from 1.5 to 5 s, and the recorded information could be stored for 7 hours when the device was turned off.

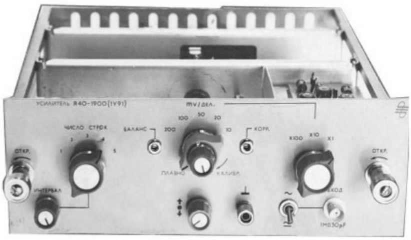
From 1979 to 1989, the S8-14 oscilloscope was mass-produced at the Abovyan plant for 10 years. In 1984-89, about 8 thousand of these devices were produced, worth about 25 million rubles, on average 1300 pieces each. per year, at a price of 3240 rubles.

In **1974 , a 1U72** stroboscopic amplifier unit was developed for the Snige family **(S1-70/3)** with an input 2-channel probe for the 0-700 MHz band. More detailed information about it is in section 1.12.

In **1975 ,** for the Snige family, a line-shift amplifier block **1U91** (for **S1-70/5)** and a logarithmic amplifier block **1U92** (for **S1-70/6) were developed.**

The Ya40-1900 (1U91) amplifier block was developed by V. Odnorog. A distinctive feature of this amplifier was its operation in the mode of shifting the zero position of the beam (line) after the next scan stroke. The bandwidth of oscilloscopes with this block was 10 MHz.

The logarithmic amplifier block Ya40-1901 (1U92) was developed by A.I. Babichev. The bandwidth of oscilloscopes with this block was 1 MHz, and the deviation coefficient was 10 dB/div.



Amplifier block
I40-1900 (1U91). 1975

Logarithmic block
amplifier Ya40-1901 (1U92). 1975

In **1976 ,** production of the 6th basic block of the S1-70A oscilloscope began , for a 50 MHz band, by upgrading the S1-70, while the size of the CRT was increased from 64 * 80 mm to 80 * 100 mm. Unfortunately, the 13LO1I CRT used in **the S1-70A** was produced in limited quantities, which reduced the production volume of this device. For this reason, the S1-70A was produced in parallel with the S1-70, until 1986. In 1984-86 The Vilnius plant produced 773 such

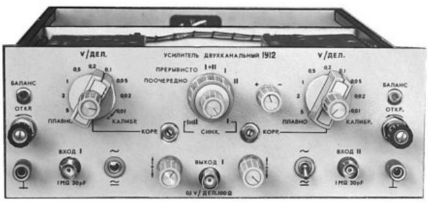
devices worth 2.04 million rubles, an average of 250 units per year at a price of 2,639 rubles.

Universal oscilloscope **C1-70A** on a CRT
with screen dimensions 80x100 mm. 1974

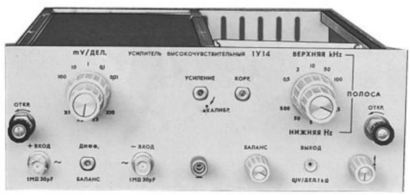
In **1976 ,** a fundamentally important block of 2-channel amplifier **1U12** was developed for **S1-70/7** from the (Snaige) family, for the entire 50 MHz band, at 10 mV/div., which converted S1-70, S1-
70A, S8-12 and S8-13 are 2-channel oscilloscopes, and S1-74 and S8-14 are 4-channel.

The Y40-1101 (1U12) two-channel amplifier-switch unit was developed by A.I. Babichev. The bandwidth of oscilloscopes with this block was 50 MHz. In this block, bandwidth was the most significant design issue. Because of this, its mass production began only in 1976.

In **1976 ,** I. Lantrat developed a highly sensitive amplifier unit **1U14** for **S1-70/8** from the (Snaige) family, for a bandwidth of 100 kHz, with a sensitivity of 10 ÿV/div.



Two-channel amplifier block
Ya40-1101 (1U12). 1976



High sensitivity unit
amplifier Ya40-1103 (1U14). 1976

1.6.2. Generation "Light" (100 MHz/18 GHz) 1977-1988

The emergence of a new element base (new CRTs with a much larger screen size, new integrated and hybrid private m/s, digital TTL, K-MOS and ESL m/s for general use, and later microprocessors) became the basis for the creation of the next generation of universal oscilloscopes with replaceable blocks. Since 1977, a large group of developers has been creating a new (microcircuit-based) third generation of wideband oscilloscopes with replaceable "Svet" units.

In **1977 ,** on the topic **"Svet-1"** on the CRT 17LO1I, the 1st oscilloscope **C1-91/1** was developed , a new, most multifunctional, with the largest number of replaceable units of the family of oscilloscopes with replaceable units of the 3rd generation, for a 100 MHz band , and 18 GHz in strobe mode.

Among 28 VNIIRIP oscilloscopes, this unique device, **S1-91, became an absolute record holder and took 1st PLACE in production volumes in 1984-89** In various versions, it was produced in large quantities at the Vilnius and Minsk factories, individual blocks were manufactured in Bryansk.

They were issued in the amount of about 86 million rubles. (22780 pieces), in on average almost 4 thousand pieces. per year, at an average price of 3,800 rubles.

Universal oscilloscope with replaceable blocks S1-91. 1977

Tek 7603 oscilloscope – analog S1-91.

The prerequisites for the development of **the "Light" series** were as follows. In 1969, Tectronics began production of a new family of oscilloscopes with interchangeable units, the 7000 series, with the TEK 7704 model, at 250 MHz, (replacing the TEK 580 family up to 100 MHz). This 7000 family was distinguished by a wider bandwidth, the presence of 3-4 compartments for replaceable units and the presence of a character generator for displaying measurement results on the screen. Then in 1970, TEK released a relatively inexpensive model - TEK 7603, at 100 MHz, with 3 bays for removable units.

On the other hand, in 1971, HP expanded its family of 50 MHz HP180 plug-in oscilloscopes, announced in 1966, with 100 MHz models.

S1-91 was developed to replace the main base unit S1-70 (S1-70A) of the Snige series. However, the S1-70 was so successful that its production continued even after the development of the S1-91, and only after the development of the S1-122 did the production of Snige begin to wind down.

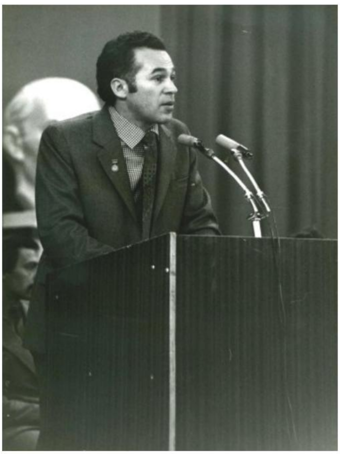
On the topic "Svet-1" samples of the first oscilloscope S1-91/1 of the "Svet" family of oscilloscopes with replaceable blocks were developed, consisting of: - base block **S1-91,** -

calibrator block of the

base block 2K11,

- amplifier unit YA4S-90 (2 pcs.),

- scanner Ya4S-91.



Chief designer of S1-91, beginning. department 22 - Denisov A.F.

S1-91. Sample technical design, with caliber block. 2K11 in the center.

In this oscilloscope, for the first time for oscilloscopes with plug-in
The following microcircuits were used in these blocks:

- private use, developed in the microelectronics department of VNIIRIP, active, hybrid M/S analog switches in the 150 MHz band,

- for private use, developed in the same place, passive, M/S dividing cells of attenuators, consisting of RC elements, made using thick film technology, with laser trimming,

- logical digital TTL microcircuits, general use, low and medium degree of integration, for control circuits and character generators,

Other innovative solutions should also be noted:

- the power supply, for the first time in Soviet oscillography, was made according to a transformerless circuit, which made it possible to significantly reduce weight and increase its power,
- for the first time in the country, the oscilloscope was equipped with a character generator for displaying deviation and sweep coefficients on the screen, as well as measurement results on the CRT screen, which worked on the basis of a micro-raster 7-segment method,

- specially for this family, unique multi-contact block-base connectors with zero joint force were developed, designed for multiple joints, and developed by E. Dagelite and M. M. Esipenko,

- for high-frequency switching circuits of attenuators and sweep coefficients, special drum-type switches with low parasitic contact capacitance were developed, developer N.Yu. Kurbatov,

Further development of replacement units for the Svet family continued for 10 years. A total of 15 replacement and 5 base units were developed in various departments of the institute, as well as outside it . **For this reason, the "Svet" family became the most significant family of oscilloscopes with replaceable units** of all three developed at VNIIRIP and in the country (the "Snaige" generation had only 11 replaceable units, and the "Kulisa" only 7).

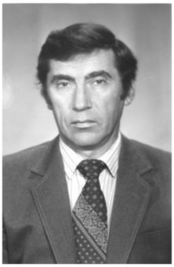
Chief designer, beginning department 22 - Denisov A.F. Deputy Ch. design, beginning LS-221 - Mikhalev A.V. Designer - Dagelite E. and Belanova V.

The S1-91 base unit was developed by:

- Ved. Eng. Mukhin V.A. - control and switching circuit of the base unit, as well as the 2K11 calibrator unit (which solved the problem of block replacement),

- final amplifiers X, Y, Z - Plaksiy A.A., - power supply - Orlov I.I.,
- character generator - Kostenko L.Ya., (Orlov I.I. from KPI), Mezenkov A.I., Dvoretsky V.B., (revision during implementation).

The Ya4S-90 amplifier block was developed by Lantrat I., and the Ya4S-91 scanner block was developed by B. Brazhalovich and A. Berlin.

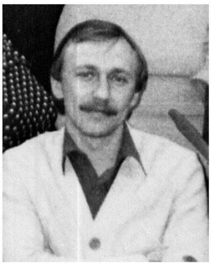

A.V. Mikhalev.


E. Dagelite


V. Belanova


V.A. Mukhin.


A.A. Crying


I. Lantrat


B. Brazalovic


A.G. Berlin


Leonid Yakovlevich Kostenko.


Anatoly Ivanovich Mezenkov


Vasily Borisovich Butler

Employees of the laboratory sector LS221 **are developers of universal oscilloscopes with replaceable units.**
From left to right, sitting: V.A. Mukhin, D. Makoseeva, A.G. Berlin, V.P. Redkin; ***standing:*** A.A.Plaksy, E.Kuznetsov, N.N.Alekseenko, A.Mezenkov, N.Fedorova, S.Filatov, E.M.Bubinas, N.Kravtsova, A.V.Mikhalev, Vas.B. Dvoretsky, B. Brazhelovich, G. Stankevichene, A. Chelnokova.
Photo from the mid-1980s.

Parameters **S1-91/1** (with blocks Y4S-90 - 2 pcs., and Y4S-91):

- 100 MHz band,

- ELT 17LO1I, **screen 100x120 mm,**

- number of compartments for replaceable blocks - 3,

- number of channels up to 4,

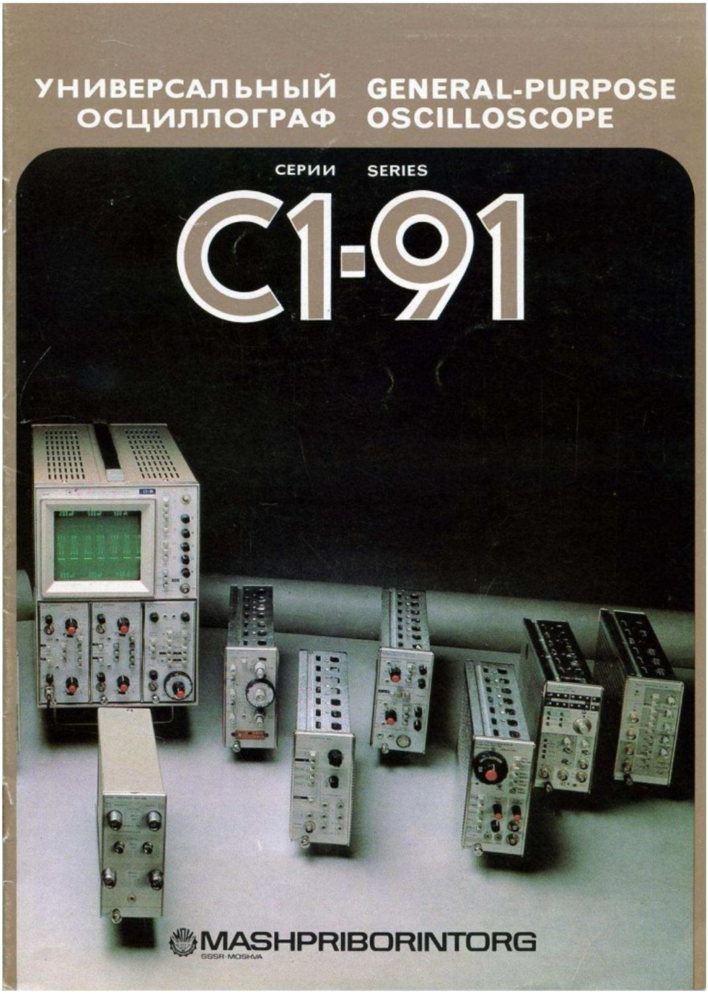
- number of sweeps - 2,

- Compatible with a family of 13 plug-in units, including multimeter, curve tracer, measurement unit, digital delay unit, sampling oscilloscope up to 18 GHz, etc.

- there is a character generator for indicating the deviation and sweep coefficients, as well as the results of measurements on the CRT,

- sensitivity 5 mV/div, with an error of 4%,
- sweep up to 5 ns/div, with an error of 4%, - power consumption 150 W,
- weight 15 kg.

The foreign analogue of the S1-91 is the oscilloscope 7603 from Tektronix. An analogue of the "Light" series is the 7000 TEK series.



Universal oscilloscope S1-91 with a family of replaceable units. Advertising V/O “Mashpriborintorg”.

In **1978 , a Ya4S-97** multimeter unit was developed for the **S1-91/2 oscilloscope,** on the topic **“Fiber-2”.** This block was developed by one of the oldest employees of the research institute, an employee of the department. 24, led. Eng. Isaev V.K., engineer O.F. Dombrovsky, L.N. Krylov after which it was produced in large quantities in Bryansk. The block was popular on the market and was also used in other oscilloscopes of the “Svet” series, such as S1-115/2 and S1-122/2.

In 1984-1986 3212 units were produced. oscilloscopes S1-91/2, on average more than 1000 pcs. per year, at a price of 3,700 rubles.

Universal block voltmeter Ya4S-97. 1978

Eng. Isaev V.K.,

Ya4S-97 parameters :
- voltage measurements 20 mV - 200 V - 20 kV, with error. 0.25-3%,
- resistance measurements 1 Ohm - 2 MOhm, with an error of 0.5-3%,
- current measurements 0-2 A, with an error of 0.6-3%,
- temperature measurements from -40 to +120 degrees, +/- 2 degrees.

In **1978 ,** a set of blocks for the **S1-91/3** stroboscopic oscilloscope was developed, consisting of Ya4S-95 and Ya4S-96 for the **12** GHz band, as well as a Ya4S-89 differential generator block for the same set. These blocks are described in more detail in section 1.12., (Stroboscopic oscilloscopes).

In **1979 ,** on the topic **“Fiber-4”,** in order to increase the accuracy of time measurements, a digital delay unit **YA4S-98** was developed for the **S1-91/5 oscilloscope,** which was mass-produced by the Vilnius plant. In 1984-86 887 such devices were produced, on average 300 devices per year, at a price of 3,800 rubles, for a total of 3.37 million rubles.

Digital delay unit Ya4S-98, for S1-91/5 was developed by employees of department 9 - Juozas Stasiukinas, Saulius Juska, Vitas Grigonis and Oleg Boytsov

Digital block
Ya4S-98 delays. 1979

Ya4S-98 parameters:
- provides an increase accuracy of time measurements up to fractions of a percent, for oscilloscopes S1-91/115/122 and S8-21, due to a digital quartz sweep start delay,

- shift error - +/- 0.5 ns, trigger range 0-60 MHz,




Juozas Stasyukinas

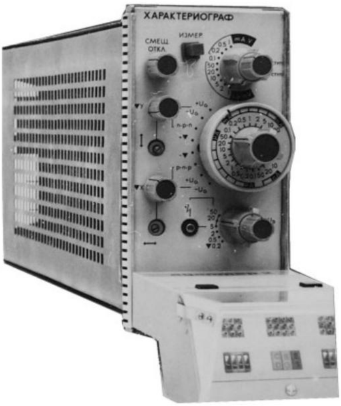
Saulius Yushka Vytas Grigonis

Oleg Boytsov

In **1979 ,** a **Ya4S-92** curve-character unit was developed for the **S1-91/6 oscilloscope,** which was mass-produced by the Vilnius plant.

In 1986-88 958 such devices were produced, on average 300 devices per year, at a price of 3,480 rubles, for a total of 3.33 million rubles.

The Ya4S-92 curve-character unit for S1-91/6 was developed in Kaunas at the KNIIRIT Institute.



Characteristic block
Ya4S-92. 1979

Ya4S-92 parameters:

- two-channel display of current-voltage characteristics (CV characteristics) of semiconductor devices, including transistors and diodes, with a power of up to 0.8 W,

- current range 30-160 mA, voltage 0.5-500 V,

- number of current-voltage curves - up to 10.

In 1980, the Minsk plant began production of C1-91, 1st model of the 3rd largest series of oscilloscopes with replaceable units "Light", for a 100 MHz band. Since **1982 ,** its production was mastered at the Vilnius plant.

The main modifications and basic blocks of oscilloscopes with replaceable blocks were developed mainly in the following departments:

- 1960-65, LS-21, early. J. Shatkus,
- 1965-72, LS-21, early. Zybin A.A.,
- 1972-1992, beginning Mikhalev A.V., LS-21 (1972-76), LS-221 (1976-84), NIS-421 (1984-86), NIS-42 (1986-92).

It is necessary to say a few words about the developers, who worked in these departments and the specifics of their work. Since this direction was the largest in terms of volume (43%

oscilloscopes VNIIRIP), then the specialists working in these departments had to bear a significant additional
the burden of fine-tuning these devices in large-scale production. And in parallel it was necessary to develop new devices.

These developers were often deprived of bonuses due to complaints from manufacturing plants, since during large-scale production of complex devices, problems that arose due to variations in the parameters of components occurred more often.

At the same time, developers of VNIIRIP divisions, whose developments were not implemented and were never mass-produced, received the full quarterly bonus. This was certainly unfair, and led to an outflow of personnel from the divisions developing oscilloscopes with replaceable units (only in the 80s

e years, developers S. Kondratyev and A.I. Mezenkov left the sector for the plant to become traffic controllers, where the salary was many times higher. and others). Although, objectively, salaries and bonuses in these divisions, due to the increased sales volume and workload, should have been higher than in other divisions. Due to the proximity of the developer, employees of the design bureau of the Vilnius
plant often distracted the sector developers from current work during the day with questions about the production of implemented devices. And only by staying in the evenings, after work, could the developers concentrate on new developments.

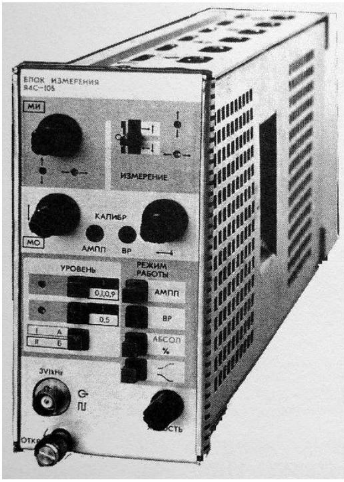
In a word, the volume of work and responsibility for errors, with such a huge production, were sometimes prohibitive. But on the other hand, it forced me to be more precise and professional in my decisions.

And if we add to this the responsibility of making the right strategic design decisions on the compatibility of blocks, which should not have become obsolete for 10-15 years (that’s how long one family of oscilloscopes with replaceable blocks lived and developed), then it becomes clear how difficult and interesting it was this job.

In **1981 , the Ya4S-105** measurement unit was developed from the **S1-91/7 composition,** which was mass-produced by the Vilnius plant. In 1984-88 1,025 such devices were produced, on average 200 devices per year, at a price of 3,908 rubles, amounting to 4.01 million rubles.

The block allowed partial automation of measurements and semi-automatic marker measurements amplitude-time parameters of the signal with increased accuracy, due to a special calibration procedure, during which correction coefficients for each deviation and sweep coefficient were entered into memory.

For the first time in the block, along with TTL microcircuits, for computing used a microcontroller from the calculator, and M/S PPZU.

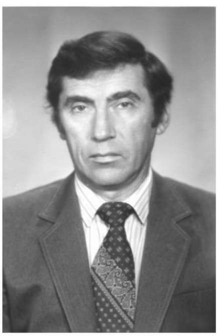


Measurement unit
Ya4S-105. 1981

Ya4S-105 parameters:

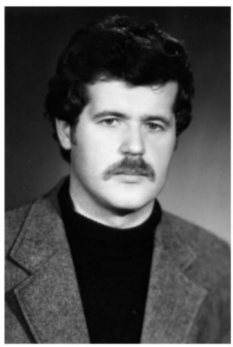
- semi-automatic marker measurements of voltage and time intervals for oscilloscopes C1-91/115/122/S8-21, with results displayed on the screen,
- **voltage measurements from 15 mV to 40 V, +/- 1.5-3%**
- **limits for measuring signal durations 40 ns-20 ms, +/-1.5-3%,**
- **automatic setting of amplitude levels 0.1, 0.5, 0.9 +/- 1%.**

The measurement unit was developed in LS-221, head and chief designer Mikhalev A.V., leading engineer Mezenkov A.I., development engineer Bubinas E.M.



Alexander Vladimirovich Mikhalev.

Anatoly Ivanovich Mezenkov



Evgeny Bubinas.

In **1981 ,** a set of stroboscopic units for the **S1-91/4** oscilloscope was developed , consisting of Ya4S-100, Ya4S-101, and Ya4S-102, for a band of **18** GHz. These blocks are described in more detail in section 1.12., (Stroboscopic oscilloscopes).

In **1983 ,** at VNIIRIP **(Sova Research Institute),** a prototype of the Svet series oscilloscope was first developed, with a microprocessor and digital memory, with a bandwidth of 250 MHz / 2 channels, or 100 MHz / 4 channels, or up to 18 GHz / 2 channels in strobe mode. At the same time, it accepted up to 12 types of replaceable blocks of the “Light” series.

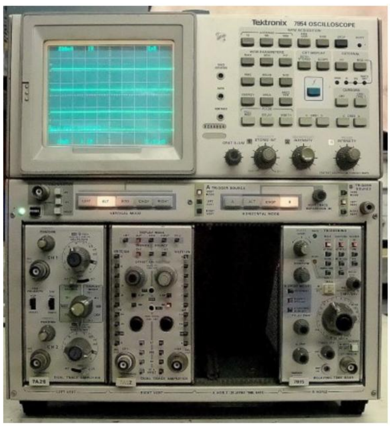
This work became key and decisive for further development of the direction of oscilloscopes with replaceable units.

The prerequisites for this development were as follows. In 1969 (see here Section 3.9, ZELT) the 1st automated oscilloscope S8-8 “Svaya” was developed at VNIIRIP, which allows partially automating the measurement process.

In 1974, Tektronix released a modification of the 7704 analog oscilloscope base unit in combination with the P7001 digital unit (see photo below). The P7001 unit was mounted between the CRT compartment and the removable unit compartment. It made it possible to sample (digitize) a signal in the 175 MHz band (up to 14 GHz

with strobe blocks) and output the results to an external computer of the PDP11 type via the GPIB interface, and then automate the measurement process using the external computer.


7704/P7001 only



Only 7854

In the early 80s, the microprocessor revolution began, and a new element base began to appear, such as m/s ADCs and DACs. Then devices built on these elements with automation control and measurement functions began to appear on the market. In 1980, Tektronix, instead of the Tek 7704/P7001 device, released its own, one of the best, top-end oscilloscopes in the 7000 series -

Tek 7854 in a standard design with a built-in microprocessor and digital memory in the base unit with a bandwidth of 400 MHz (14 GHz, in the gate). mode), with a single signal sampling frequency of 0.5 MHz. Its main developer and manager was Tom Rossi, who later headed the project of the next family of digital oscilloscopes with replaceable units - the Tek 11400 series (photo 7854 on the previous page).

This device automated the data collection process and measurements, for which he was equipped with a signal calculator. However, the management process remained manual and non-automated.

There was a need to develop such a device in the "Light" series. The task was not easy, because... No one had yet tried to make oscilloscopes with microprocessors and digital memory in department 22. There was no experience in developing microprocessor controllers, nor debugging tools for their development -

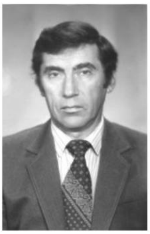
emulators. At the same time, it was necessary to immediately expand the band to 250 MHz, which in itself was not easy.

Model of an oscilloscope based on the research project “Sova”

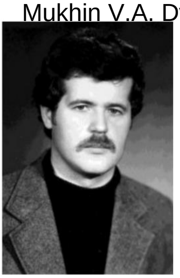
As a result of 2 years of work in 1981-83. a prototype of an oscilloscope was created (which was then demonstrated for some time at department instrument exhibitions) and the groundwork for the development of microprocessor systems, sampling and information display systems, which was then implemented in the "Svita-3" theme in the Ya4S-122 block in 1984-87 .G.

For the first time in oscilloscopes with plug-in units in the country, a microprocessor multiprocessor structure was used, in which each base and plug-in units had their own microprocessor systems based on 580IK80, which communicated with each other via a serial interface via 580BB51, thanks to which it was possible to automate not only measurements, but also control of the device, which was absent in the analogue of TEK 7854. The following took part in the development:

Deputy Ch. designer - Mikhalev A.V., Ved.
analogue engineer - Mukhin V.A.,
Ved. digital engineer - Dvoretsky V.B., Vertical tract -
Plaksiy A.A.,
ADC - Mezenkov A.I., Bubinas E.M.,
Microprocessor system - Dvoretsky V.B., Karpach E.A., Chairkin V.,
Software -
Navickas R., Yurka G.




Mikhalev A.V. Mukhin V.A. Dvoretsky V.B. Plaksiy A.A.

Mezenkov A.I. Bubinas E.M. Karpach E.A. Navickas R.

The oscilloscope was created jointly with the staff of the department of Professor Sigorsky, Kyiv Polytechnic Institute -
Ph.D. Orlov I.I., and Sporev I.G. Parameters of
the oscilloscope layout according to the SOVA research project::

- 250 MHz band,
- number of compartments of replaceable blocks - 3,
- number of compatible replaceable blocks of the "Light" series - 14 blocks,
- sampling frequency - 1 MHz,
- recording length up to 1 kb,
- number of memorized signals - up to 8,
- isolating a signal from noise, isolating an envelope, - mathematical and other operations on signals using a special separate removable calculation block,

- automatic measurements of up to 12 signal parameters,
- semi-automatic, marker measurements,
- full automatic, remote (RC) and manual control of the device, with special replaceable blocks.

In **1984 ,** at VNIIRIP, on a CRT 17LO4I, on the topic **“Svet-4” ,** the 2nd of the “Svet” family, the basic block of a two-beam oscilloscope **S1-115,** with a bandwidth of 50 MHz, was developed for the purpose of photo-recording 2 single-shot signals simultaneously. It was developed to replace the dual-beam S1-74 (at 35 MHz) from the Snige family, and was produced at the Vilnius plant.

Dual beam universal oscilloscope
with replaceable blocks C1-115. 1983

In 1990-92 they were issued in the amount of about 14.2675 million. rub. (2509 pieces), on average more than 800 pieces. per year, at a price of 5,750 rubles.

The basic block of the S1-115 dual-beam oscilloscope was compatible with all removable blocks of the Svet family from S1-91, plus the Ya4S-110 logic analyzer block and the Ya4S-122 signal analyzer block with digital memory (since 1986), up to 14 removable blocks in total .

The last two blocks were added to the C1-115 due to the fact that a new, more reliable power supply was developed for it, which provided greater power consumption for replaceable blocks and higher current limits than the C1-91 power supply.

For the first time in the "Light" family within the framework of the "Light-4" theme for C1-115 was developed completely new, on a new element base, a character generator operating on the basis of a new, more progressive method of functional stresses, which had more beautiful, readable characters. It was the first to use microcircuits of medium and high degree of integration - ROM and DAC (S1-91 had a simpler, microraster, 7-segment character generator).

Chief designer, beginning LS-221 - Mikhalev A.V.
Ved. engineer, amplifier circuits X,Y,Z, vertical path - Plaksiy A.A.

Control circuits - Skeiris K.
New power supply, with increased currents - Orlov I.I.
New generation character generator - Dvoretsky V.B.
Device design - Dagelite E. and Belanova V.,
Preparation of documentation - Makoseeva D.
Parameters **S1-115:**
- 50 MHz band,
- CRT 17LO4I, screen 100x120 mm,
- 2 independent beams,
- number of channels 4,
- compatibility with 15 replaceable blocks,
- photo registration of up to 2 single signals simultaneously at a speed of up to 200 km/s,
- power consumption 150 W,
- weight 15 kg.

In **1984 , the Ya4S-110** logic analyzer unit was developed from the **S1-115/9** and **S1-122/9** oscilloscopes (since 1986) with a logic analysis frequency of up to 100 MHz.

Logic analyzer block YA4S-110. 1984

Options:
- logical frequency
analysis up to 100 MHz,
- number of channels 4, 8, 16,
- memory capacity 4*1016, 8*508, 16*254,
- logical triggering from a combination of input signals

The S1-122/9 oscilloscope with the Ya4S-110 unit was mass-produced by the Vilnius plant. In 1990-91 177 such devices were produced, worth 1.39 million rubles, an average of 80 devices per year at a price of 7865 rubles. The Ya4S-110 logic

analyzer block was developed in the department. 9, under the leadership of Juozas Stasiukinas, Saulius Juska Vitas Grigonis and Oleg Boitsov.

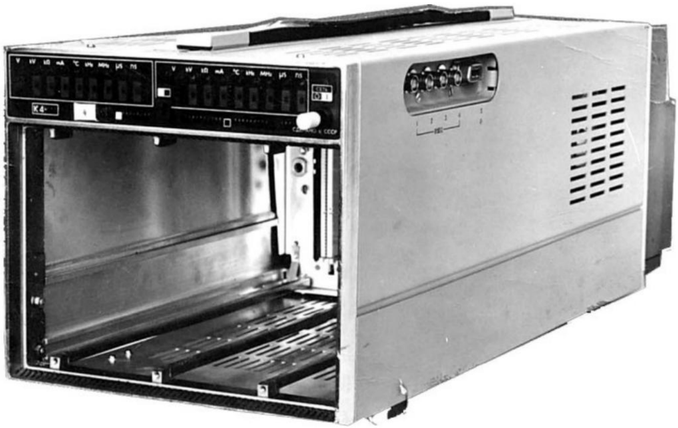
Juozas Stasyukinas

Saulius Yushka

Oleg Boytsov

Vitas Grigonis

In **1984 ,** VNIIRIP developed the basic power supply and display unit **Ya4S-111,** and on its basis, and on the basis of S1-91 and S1-115, measuring installations **K2-52** and **K2-53.** The Ya4S-111 power and display unit was designed to operate replaceable units of the "Svet" series without base units of oscilloscopes.



K2-52. 1984

Display and power supply unit YA4S-111. 1984

The complex measuring system, depending on the delivery option, could include various replaceable blocks of the “Svet” series, such as blocks of two-channel 100 MHz amplifiers, scanner blocks, a multimeter, a curve tracer, a precision measurement block, a logic analyzer and a digital oscilloscope.

The YA4S-111 unit and these installations were developed by Y. Stasiukinas, V.K. Isaev, S.A. Like Vyach. Butler.

Y. Stasyukinas V.K. Isaev

S.A. Say

Vyach. Butler

In **1986 ,** on the new CRT 17LO7I, within the framework of the **“Svita-3”** theme, a new base unit **S1-122 was developed,** for a 100 MHz band,
for the “Light” series, which replaced the main oscilloscope S1-91, which had been produced for a long time before it, in this series, and worked with all types of previously created replacement units.

The replacement of the S1-91, developed in 1977 and mass-produced since 1980, was necessary because in the family of replaceable blocks of the "Svet" series, units appeared with higher power consumption than the S1-91 could provide, for example Ya4S-110, Ya4S-122 (Svita-3), which were already accepted by the two-beam, more expensive S1-115, with a more powerful power supply with a smaller bandwidth (50 MHz).

In total, S1-122 was compatible with 14 replaceable units of the “Svet” series, which made it possible to produce 13 modifications of this oscilloscope from **S1-122/1** to S1-122/13, depending on the configuration of the replaceable units.

In the output amplifier Y, the base block S1-122, the first semiconductor microcircuits of wideband amplifiers for private use in VNIIRIP were used, developed in the 6th department (microelectronics) of VNIIRIP on the topic “Dance-V”, by Kulkov Yu.M., Zalogin M., Shemraev A.I., and others,

specifically for this device.

Microcircuits "Tanets-V" were the first to be manufactured in the new VNIIRIP microelectronics case, built specifically for the development and manufacture of sub-unit M/S for private use.

S1-122 used a new character generator, developed within the framework of the "Light-4" theme (S1-115), which had a better shape of characters and better stability of their position on the screen than in S1-91.

Universal digital oscilloscope **S1-122/8** (with signal analyzer unit YA4S-122) 1986

Parameters of the base unit **C1-122:**

- **100 MHz band,**
- ELT 17LO7I, screen **100x120 mm,**
- **number of compartments for replaceable blocks - 3,**
- **number of channels up to 4,**
- **new generation character generator,**
- **compatibility with the family of replaceable blocks of the "Light" series, up to 15 blocks,**
- power consumption 150 W,
- weight 17 kg.

S1-122 was mass-produced at the Vilnius plant and in various delivery options **took an honorable second place** (after S1-91/1- /7), among 28 VNIIRIP oscilloscopes by production volume. In 1987-91 they were produced in the amount of about 63.07 million rubles, in variants S1-122/1 - S1-122/12, in the amount of 11.092 thousand pieces, on average over 2 thousand pieces. per year, at a price of about 5-9 thousand rubles.

Chief designer, beginning department 22, - Denisov A.F., deputy chief designer, chief LS-221 - Mikhalev A.V.

Developers of the S1-122 base unit:

- Ved. engineering, amplifier circuits X, Y, Z, vertical. tract - Plaksiy A.A.,
- microcircuits “Dance-V” - Kulkov Yu.M., Zalogin M., Shemraev A.I.,
- compartment switching control circuits - Skeiris K.,
- power supply - Orlov I.I.,
- new generation character generator - Dvoretsky V.B.,
- design of the device - Dagelite E. and Belanova V.,
- documentation preparation - Makoseeva D.

In **1986 ,** within the framework of the **“Svita-3”** theme, a triple-width signal analyzer unit **Ya4S-122** was also developed , which is a 2-channel **digital storage oscilloscope,** without an indicator and a power supply, the role of which could be played by the base blocks **S1-122,** S1 -115, Ya4S-111 and, subsequently, S8-21.

The impetus for starting the development of this unit was the need to replace the C8-13 storage oscilloscope at the Vilnius plant, with a 1 MHz band, on a bistable storage CRT (Svita-2, see above section 3.5.1, 1974) with a large signal storage time, and a high-sensitivity amplifier block 1U13 (0.5 mV/div.).

Signal analyzer unit Ya4S-122.

Tek 7D20 sampler unit

On the other hand, in the early 1980s, Tectronics released a digital memory, microprocessor-controlled, triple-width, model 7D20, 70 MHz bandwidth, 5 mV/div sensitivity, 40 MHz sampling rate, for the 7000 series oscilloscopes. price 7750 dollars

Based on the groundwork for the development of microprocessor systems, ADCs, digital memory and display devices created within the framework of the Sova research project (see above 1983), the 1st signal analyzer unit in the "Light" series (essentially a digital oscilloscope) storing microprocessor-controlled Ya4S-122 to the base units S1-115, S1-122, Ya4S-111.

with

The Ya4S-122 unit, the first of the oscilloscopes at VNIIRIP, had automatic, as well as remote and manual microprocessor control. For the first time in the "Light" series, it became possible to isolate a signal from noise, perform automatic, cyclic measurements of up to 8 signal parameters (frequency, period, duration, amplitude, rise/fall time, etc.), perform mathematical operations on signals and transmit them to an external computer.

LS221 employees are the developers of S1-122 and Ya4S-122, theme "Svita-3".
From left to right, sitting: V. Belanova, A. V. Mikhalev, E. Dagilite, Vas. B. Dvoretsky;
standing: V. Chasovskikh, E. M. Bubinas, V. G. Chairkin, R. Navickas, A. Skeris, K. Shnipas, A. A. Plaksiy. Photo from the mid-1980s

In automatic mode, the device itself set all the device modes for observing 2 periods of signals on the screen, which was implemented for the first time in the country in serial oscilloscopes with replaceable units.

In a 10 MHz band, the device allowed recording 2 single signals with pre-recording and a sampling frequency of 20 MHz, or 1 signal with a frequency of 40 MHz. For repeating signals, a strobe mode was implemented with an equivalent sampling frequency of 5 GHz, at sweeps up to 20 ns/div.

In the Ya4S-122 unit, for the first time in the country, a single, non-contact handle was used for all smooth adjustments (pulse sensor), developed specifically for this device.

A programmable attenuator based on reed switches and small-sized delay lines based on flexible Teflon printed circuit boards were also specially developed for this device. The Ya4S-122 unit was mass-produced as part of the S1-
oscilloscope
122/8 at the Vilnius plant and became the 1st digital microprocessor oscilloscope introduced into production in Lithuania.

During **1990-1991 ,** 201 units **of S1-122/8** were produced. in the amount of 1.93362 million rubles, at a price of 9620 rubles. And according to this parameter, it entered the top three most expensive oscilloscopes from VNIIRIP, after S9-9, with a price of 27,000 rubles. and C9-4(A) with a price of 16,000 rubles.

Leading engineer of Ya4S-122 - Vas Dvoretsky. B.

For the creation of the S1-122/8 oscilloscope with the Ya4S-122 unit, Dvoretsky V.B. was awarded a silver medal from VDNKh.

Processor, RAM, ROM, signal and text display device -
Butler Vas. B. and Karpacz E.A.
Attenuator, amplifiers, delay lines, - Shnipas K. ADC, front
control panel, pulse sensor. - Bubinas E.M.
Synchronizer and sweep, - Chasovskikh V.
COP interface, - R. Navickas and G. Juska.
Software, - R. Navickas and G. Juska.
Device design - Dagelite E. and Belanova V.
Drawing up and coordination of documentation - Karpach E.A.

Parameters of the Ya4S-122 signal analyzer block:
- band 0-10 MHz,
- number of channels - 2,
- number of simultaneously displayed signals up to 8, -
recording length from 2048 to 256 t/channel,

- sensitivity 0.5 mV/div.,
- sweep up to 20 ns/div.,
- registration of single signals with a sampling frequency: one signal - up to 40 MHz, two simultaneously - up to 20 MHz,

- registration of repeating signals with an equivalent sampling frequency of up to 5 GHz,
- separation of periodic signals from random noise,
- automatic control of all modes of the device, for setting two periods of the signal under study on the screen, - remote control of the device via the COP interface, and output/reception of information about signals and their parameters,

- cyclic automatic measurements of up to 8 signal parameters (frequency, period, duration, amplitude, front, fall, etc.),

- marker semi-automatic signal measurements,
- mathematical operations with signals (+, -, *, /, exp., log., etc.),
- signal processing (for example - smoothing, exponential, etc.).

In **1987 ,** on the topic **"Light-3",** the development of an analog storage oscilloscope **S8-21** was completed , from the "Light" series with a bandwidth of **100 MHz,** and a recording speed of **10,000 km/sec.** This device was supposed to replace storage oscilloscopes on grayscale CRTs in the Saige series - S8-12/S8-14, with a 50 MHz band with a recording speed of 4000 km/sec. An analogue of this device was the Tek 7623 oscilloscope, at 100 MHz,

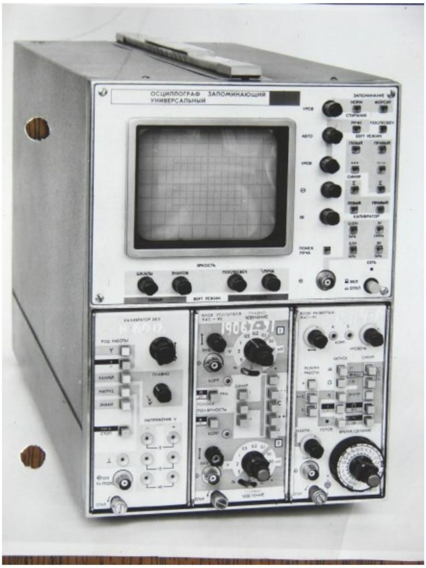
with a recording speed in forced mode of 10,000 km/s.

Especially for this oscilloscope, the developer V. Malyshev in Lvov created a multi-mode grayscale storage CRT 16LN14I with a recording speed of 10 thousand km/s in forced mode with a screen size of 40x50 mm and 2 km/s in normal mode with a working part size screen 80x100 mm. Playback time – at least 30 s.

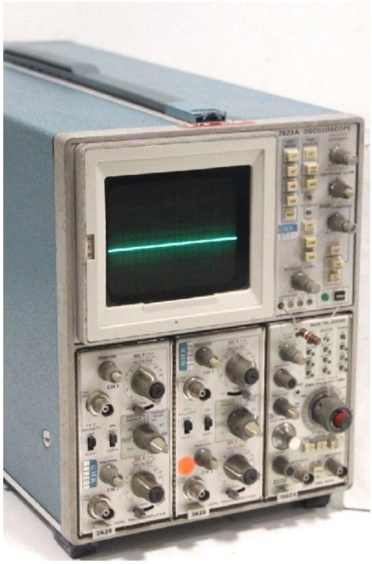
The oscilloscope was put into mass production at the Vilnius plant in 1989. It was produced: in 1991 - 35 pieces, in 1992 - 30 pieces.

S8-21 was developed by:
Chief designer, beginning LS-221 - Mikhalev A.V.
Ved. engineering, amplifier circuits X,Y,Z, vertical path - Plaksii A.A.,
Control circuits - Skeiris K.,

Power supply - Orlov I.I.,
Character generator - Dvoretsky V.B.,
Preparation of documentation - Makoseeva D.



Storage oscilloscope with replaceable blocks S8-21. 1987



Storage oscilloscope with replaceable blocks Tek 7623

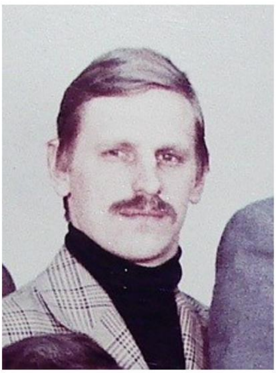
Parameters S8-21:
- 100 MHz band, -
halftone ZELT 16LN14I, - number
of channels 4,
- compatibility with 15 replaceable units, - photo
recording of a single signal at speeds up to 10,000 km/s, - power consumption 150
W, - weight 17 kg.

In **1988 ,** based on **S1-122/8, Ya4S-122, Ya4S-111, K2-52 and PC "Neuron IV 56-01"** (developed by KNIIRIA, Kiev), on the topic **"Svita-3/ Saratov",** an AIS (automatic measuring system) was developed to monitor the parameters of antenna arrays of aircraft radars. AIS was developed by order of the Saratov airline and was intended for recording and measuring single bursts of pulses.

A one-time delivery of several samples was carried out of this system to the customer - Saratov Aviation Enterprise.

Measuring system "Saratov" based on oscilloscope S1-122/8

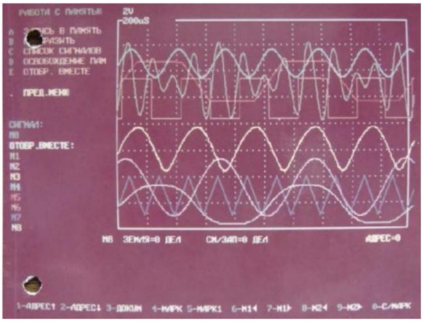
AIS "Svita-3/Saratov" was developed by Vladimir Chairkin, Romualdas Navickas, Gintaras Jurka and Alexandra Ponomareva.



V.G. Chairkin

R. You get used to it

A.N. Ponomareva.



User interface of the Saratov measuring system

AIS "Saratov", in the center K2-52 and S1-122/8

In conclusion, it should be noted that the direction of universal multifunctional laboratory oscilloscopes with replaceable units is technologically, organizationally and financially one of the most complex and capital-intensive areas of production of radio measuring instruments in the world.

Therefore , only the four most highly developed countries in the world in all respects - the USA (Tektronics and HP), **France** (Schlumberger), **Japan** (Iwatsu) **and the USSR** (VNIIRIP) - **were able to establish the production of oscilloscopes with replaceable** units.

At the same time, the most advanced and high-tech (in terms of the number of models and blocks, as well as functionality and parameters) families of oscilloscopes with replaceable blocks were produced
only in **the USA (Tek 7000)** and in **the USSR (Series “Light”),** because the Iwatsu and Schlumberger families had only a few basic and replacement units.

Over the 20 years of production of the 2nd and 3rd generations of oscilloscopes with removable units, a total of 36 basic and removable units were developed, including in the “Snaige” generation (C1-70) - 5 basic and 11 removable units, and in the “ Light" (C1-91) – 5 basic and 15 replaceable blocks.

1.7. Wideband oscilloscopes. 1974-1989

In terms of sales volumes, **the direction of universal wideband oscilloscopes** (for a band of 100 MHz and above) **took an honorable second place** among eight other areas of development of VNIIRIP oscilloscopes, after oscilloscopes with replaceable units.

For the period 1984-1992 the production volume of such devices amounted to about **170 million rubles,** which amounted to about **25%**
production volumes of all VNIIRIP oscilloscopes over these years (see tables at the end of Appendix 1).

Increasing the performance of microelectronics products required the introduction of measuring instruments, and primarily oscilloscopes, into industrial broadband products. New technologies have been developed for these instruments that record signals in real time.

wideband CRTs with a large screen, internal scale and high photographic recording speed.

The development of universal broadband oscilloscopes was carried out mainly in the laboratory of A.I. Fedorenchik. Also, one device each was developed in the laboratories of A.V. Mikhalev and V.M. Levin.

In **1974 ,** in the laboratory of A.I. Fedorenchik, the most broadband at that time, the universal oscilloscope **S1-75** was developed on the topic **"Boxwood",** for a band of 250 MHz (at 10 mV/d). It was the first universal device in the country with such a bandwidth.

TEK 475A oscilloscope, 1977.

Oscilloscope C1-75. 1974

S1-75 was produced in large quantities at the Bryansk plant for about 15 years from 1975 to 1990. **It took an honorable 3rd place among all VNIIRIP oscilloscopes** (out of 28), **in terms of production volume**
(at the same time it took 1st place among wideband oscilloscopes). In 1984-1990 23.308 thousand units were made. of such devices in the amount of 62.931600 million rubles, on average over 3000 pcs/year at a price of 2700 rubles.

In 1973, Tectronics announced the TEK 475 200 MHz portable oscilloscope, which was upgraded to the TEK 475A 250 MHz model in 1977.

S1-75 became the first universal oscilloscope in the country for a 250 MHz band (and the first wideband oscilloscope assembled entirely on transistors; at the same time, it set records for weight - 23 kg, and power consumption - 160 W.

Before this device, the most broadband (tube) oscilloscope was the S1-31, with a bandwidth of 100 MHz, it weighed 40 kg and consumed 600 W (see section 3.3, 1964).

Alexander Ivanovich Fedorenchik. Photo from the early 1980s

Grazyna Puodziunaitÿ at work with an oscilloscope S1-75.
Photo from the early 1970s

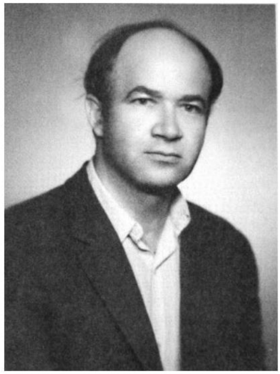
The oscilloscope contained two channels with a 50-ohm input. The vertical path was built on the most broadband transistors at that time. The input attenuator was based on a drum-type design developed in the laboratory of V. Latinis for high-frequency pulse generators. A wideband band has been specially developed for this oscilloscope.

13LO105M CRT with a working part of the screen 60x100 mm. Oscillograph was awarded a gold medal at the Leipzig Trade Fair.

Chief designer of S1-75 - Fedorenchik A.I.,
Leading Engineer - Puodžiÿnaitÿ G.,

Margarita Stepanovna Cheprakova.

Vitas Latinis.



Alexander Demyanovich Semenyuk

designer - Cheprakova M.S.,
attenuator – Latinis V.,
horizontal channel - Semenyuk A.D.,
calibrator, scan - Maksimenko E.E., Shemraev A.I.

Parameters of the **S1-75 device:**
- band 0-250 MHz,
- input impedance 50 Ohm,
- number of channels - 2,
- deviation coefficient 10 mV/div.+/-5%,
- sweep factor 2 ns/div.+/-5%,
- power consumption 160 W,
- weight 23 kg.

In **1977 ,** a two-channel portable oscilloscope was developed: **S1-92 ("Hundred")** with a bandwidth of 0-100 MHz (at 5 mV/d) on the same CRT 17LO1I as S1-91, with a large screen size of 100x120 mm.

S1-92 was produced in large quantities at the Vilnius plant.

Among VNIIRIP oscilloscopes, it took 13th place out of 28 in terms of production volumes in 1984-87, they were produced in the amount of about 20.622 million rubles. (6874 pieces, about 2000 pieces/year, at a price of 3000 rubles). When in 1977

a new, promising oscilloscope S1-91 was developed, at 100 MHz, with replaceable blocks, on a new element base, the head office was asked to develop a monoblock at 100 MHz, on the same technological basis, because there was a great need in the country for oscilloscopes with such a band.

And although the LS-221 sector specialized in oscilloscopes with replaceable units, and monoblocks were not its specialization, this development was carried out here.

For the first time in the country, this oscilloscope used microcircuits for private use, developed at VNIIRIP:

- active, hybrid MS of analog switches in the 150 MHz band,

- passive, MS dividing cells of attenuators, consisting of RC elements, made using thick film technology, with laser trimming.

It should also be noted that the power supply, for the first time for monoblock oscilloscopes, was made according to a transformerless circuit.

Universal oscilloscope C1-92. 1977

Parameters **S1-92:**

- Band 100 MHz,

- **number of channels - 2,**

- sensitivity 5 mV/div., +/-4%,

- **sweep - double,** up to 5 ns/div, +/-4%,

- ELT 17LO1i, **100x120 mm,**

- power consumption 160 W,

- weight 16 kg.

Main construction, beginning LS-221 - Mikhalev A.V.

Oscilloscope S1-92 was developed by:

- designer - Dagelite E.
- Ved. Eng. Redkin V.P.,
- final amplifiers X, Y, Z - Plaksiy A.A.
- power supply - Orlov I.I.

- pre-amplifier Lantrat I.,
- development Brazhalovich B. and Berlin A.G.

In **1979 ,** using a CRT 16LO101A with a larger screen than the S1-75, a universal broadband 2-channel oscilloscope **C1-97 ("Candle") was developed,** for the first time in the 350 MHz band.

S1-97 was produced in large quantities at the Bryansk plant and took an honorable 4th place among VNIIRIP oscilloscopes (out of 28) in terms of production volumes (at the same time it took 2nd place among broadband oscilloscopes).

In 1984-1991 16.578 thousand pieces were made. such devices worth 61.67 million rubles; on average, more than 2,000 such devices were made per year, at a price of 3,720 rubles. This device became the country's first 2-channel universal oscilloscope for a 350 MHz band with active probes developed by A. Kolesov.

The vertical path was built for the first time on microassemblies for private use, also used in the next device S1-108, developed in the microelectronics department of VNIIRIP.

Universal two-channel oscilloscope C1-97. 1979
The active probe is visible on the left.

The chief designer of the S1-97 was A.A. Lysenko,
Hungarian Yu. E., Semenyuk A.D., Chepilko O.M. took part in the development. and Petrova I.M.

Parameters of the **S1-97 device:**

- band 0-350 MHz,
- input impedance 50 Ohm,
- **number of channels - 2,**
- minimum deviation coefficient - 5 mV/div.+/-3%,
- minimum sweep ratio - 1 ns/div.+/-3%,
- power consumption 140 W,
- weight 17 kg.

In **1979 ,** a promising broadband oscilloscope was developed, with increased measurement accuracy, **S1-108,** on the same CRT 16LO101A as S1-97, on the topic **"Svir",** for a band of 350 MHz. He continued the line of precision oscilloscopes started by the S1-40 oscilloscope (see Chapter 3.3).

S1-108 was produced in large quantities at the Bryansk plant and ranked an honorable 5th place among VNIIRIP oscilloscopes (out of 28) in terms of production volumes (at the same time it took 3rd place among wideband oscilloscopes).

Device parameters **C1-108:**

- band **0-350 MHz,**
- ELT 16LO101A,
- input impedance 50 Ohm,
- number of channels - 1,
- sensitive 10 mV/div +/-2%,
- sweep 1 ns/div.+/-2%,
- power consumption 110 W,
- weight 17 kg.

Universal oscilloscope
C1-108. 1979

In 1984-1991 8.565 thousand pieces were made. such devices worth 38.97 million rubles; on average, more than 1,000 such devices were made per year, at a price of 4,550 rubles.

Increased accuracy of time measurements in this device was ensured by a built-in quartz digital delay.

The chief designer of the S1-108 was A.I. Fedorenchik,
Leading Engineer - Puodžiÿnaitÿ G.,
designer - Cheprakova M.S.,
horizontal channel - Semenyuk A.D.,
calibrator, scanner - Maksimenko E.E., Shemraev A.I.,
digital part - Shapiro V.

A.I. Fedorenchik recalls: “In the S1-97 and S1-108 oscilloscopes, to ensure high-quality photo recording of signals, the accelerating voltage of the CRT exceeded 20 kV. Therefore, in some operating modes of the oscilloscope, for example, at maximum brightness and low duty cycle, noticeable X-ray radiation appeared. This was determined at one of the enterprises in the GDR, where C1-oscilloscopes were supplied

108.

The head of the main department of the MPSS, T.M. Lotorev, urgently went to the plant, taking with him me, as the chief designer of the development, recognized as the main culprit of the scandal. We had to strengthen the CRT shielding and install a special protective glass in front of the screen.”

In **1983 ,** at VNIIRIP, on a CRT 16LO101a, a wideband oscilloscope **S1-116 (Samara) was developed, for the first time with**
microprocessor, and **an input impedance of 1 MOhm, at 250 MHz.**

SP Oscilloscope C1-116 at 250 MHz.

Parameters of the **S1-116 device:**
- band **0-250 MHz,**
- ELT 16LO101A,
- **input impedance 1 MOm,**
- number of channels - 2,
- feelings. 5 mV/div +/-3%,
- sweep 1 ns/div.+/-3%,
- **multimeter,**
- **digital delay,**
- power consumption 105 W,
- **weight 17 kg.**

In 1982-83 Tektronics began production of wideband portable analog oscilloscopes with microprocessor control in the Tek 2400 series, with a bandwidth of 200 MHz or more. S1-116 was mass-produced at the Bryansk plant and took 21st place among VNIIRIP oscilloscopes (out of 28) in

terms of production volume.

In 1987-1991 1.361 thousand pieces were made. such devices worth 6.61 million rubles; on average, more than 250 such devices were made per year, at a price of 4860 rubles.

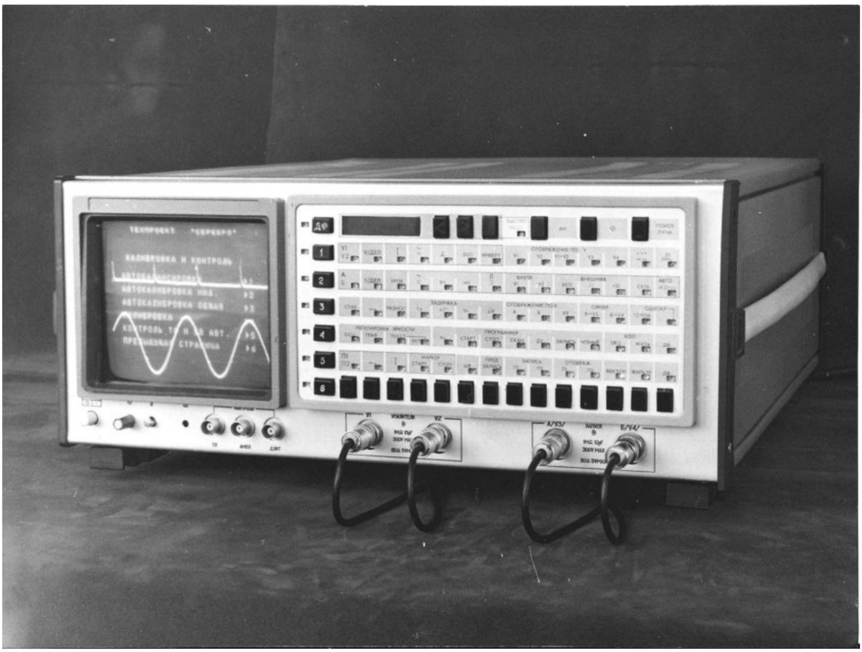
Employees of the laboratory sector **LS225** are developers of universal wideband oscilloscopes. ***From left to right, sitting:*** G. Puodzhyunaite, A.I. Fedorenchik, G.A. Fakeeva; ***standing:*** O.M. Chepilko, S. Usavichyute, T. Stelmakh, R. S. Kaplinskaya, Z. Volkova, E. E. Maksimenko, A. D. Semenyuk, V. K. Shapiro, T. Lavrinovich, R. Navickas, E. Miceika, A. Kopylov. Photo from the early 1980s. J. Bradzjus, This device became the first universal broadband oscilloscope in the country for a 250 MHz band, with an input impedance of 1 MOhm (previously there was only 50 Ohm, and only S1-91/S1-92 had 1 MOhm at 100 MHz), at the same time it became the 1st wideband analog oscilloscope with microprocessor control.

S1-116 had a digital delay for time measurements with increased accuracy and a built-in multimeter. Chief designer of

S1-116 - A.I. Fedorenchik, leading engineer - G. Puodzhunaite, designer - M.S. Cheprakova, horizontal channel - A.D. Semenyuk, digital microprocessor part - V. Shapiro, software – Navickas R., developers - Ambrazaitis K., Bernotas A.

In **1985 ,** VNIIRIP developed an analog oscilloscope with digital memory and a microprocessor, **C1-121 ("Silver"),** on a 100 MHz band, on a CRT 17LO1I.

S1-121, unfortunately, was never mass-produced.



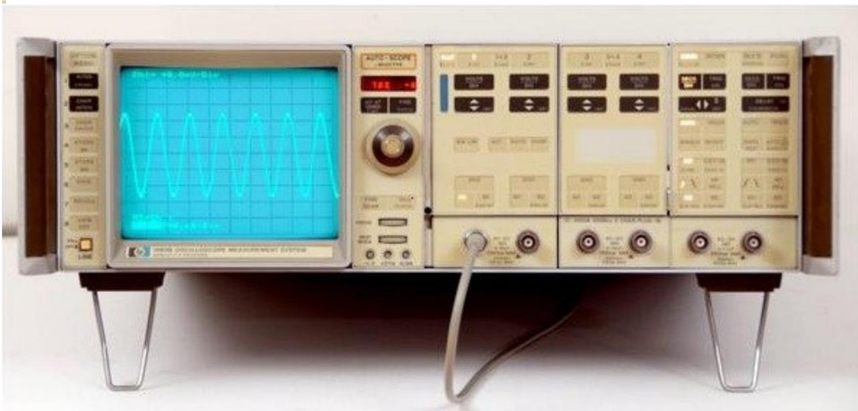
Universal oscilloscope S1-121. 1985

The history of its development is as follows.

In 1980, Tectronics, with the Model 7854, was the first to use a microprocessor for calculations in an analog oscilloscope with digital memory at 400 MHz. (see above 3.3.5 R&D “Owl”).

And after him, HP in 1982 introduced its new, revolutionary model HP1980 with a microprocessor, also designed for automatic control of an analog oscilloscope with digital memory, at a 100 MHz band.

It was a revolutionary model and was named after the year the project began - 1980. The project was led by Zvonko Fazarink, later recognized as an outstanding HP developer, and Bill Hewlett himself supervised this project.



Oscilloscope HP1980

This oscilloscope was the first in the world to implement:

- automatic control mode of the oscilloscope "Autoscope", in which all adjustments of the device were set to the optimal position for observing two periods of the signal under study,

- for smooth adjustments, a single electronic non-contact handle was used - a pulse sensor,
- “Menu” buttons were used to expand the functionality of the device,

- automatic calibration programs, and much more.

At this time, VNIIRIP had already created a backlog of microprocessors and it was possible to give a worthy response to the release of HP 1980.

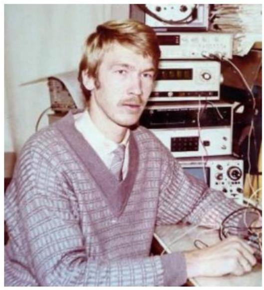
As part of the “Silver” theme, a four-channel analog oscilloscope with microprocessor control was created, which made it possible to work in both traditional analog mode and mode with digital memory. The oscilloscope bandwidth in both modes was 100 MHz, and the maximum real-time sampling rate was 20 MHz. In that

The oscilloscope used a 17LO1I CRT with a working part of the screen 100x120 mm.

The device contained a built-in out automatic control of functional checking metrological parameters, and carrying performance monitoring at the level of basic operating modes, self-diagnosis of analog oscilloscope components and auto-calibration of deviation and sweep coefficients. The oscilloscope used a matrix front control panel in the form of a removable remote control (control up to 1.5 m).

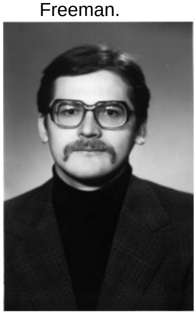
Alexander Arkadyevich Likhtinshain.

Joseph Aronovich Freeman.

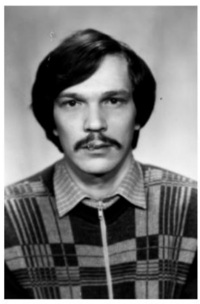


Alexander Vasilievich Volkov.

Anatoly Afanasyevich Lazukin.



Alexander Petrovich Galkin.



Vladimir Alekseevich Peryshkin.

S1-121 was developed by:
- chief designer, Likhtinshain A.A.,
- ved. engineer, Freeman I.A.,
- vertical channel, Volkov A.V.,
- horizontal channel, Lazukin A.A.,
- microprocessor system, Galkin A.P.,
- ADC, Peryshkin V.A.

Device parameters C1-121:
- 100 MHz band,
- ELT 17LO1I,
- number of channels - 4,
- sensitivity 2 mV/div,
- sweep up to 20 ns/div,
- number of simultaneously displayed signals up to 4 real time, and up to 2 from digital memory,
- signal adaptation mode (automatic control),
- recording length 1024 - 256 t/channel,
- sampling of single-shot signals, 20 MHz,
- power consumption 220 W,
- weight 25 kg.

In **1989 ,** VNIIRIP developed a unique ultra-wideband oscilloscope **S1-129 (“Capital”),** for a band of 0-1000 MHz.

A pilot batch of 10 S1-129 devices was manufactured at VNIIRIP and delivered to customers in Moscow and Novosibirsk. The technical documentation was transferred to the Bryansk plant.

This device became the first in the country, and the second in the world, a universal ultra-wideband oscilloscope for the 0-1000 MHz band, real time (without using strobe mode).

It made it possible to record single signals using the photo recording method at high speeds of up to 200 thousand km/sec.

The prerequisites for this development were as follows.

In 1978, Tectronics released the Tek 7104 oscilloscope in the 7000 series with replaceable units for a 1 GHz band, based on an ECTBV with microchannel plates. At this point, it became the most wideband real-time oscilloscope in the world.

And in 1986, he also released a portable monoblock oscilloscope Tek 2467, also based on ELTBV with microchannel plates, to a 350 MHz band, and then in the Tek 2467B variant it was upgraded to 400 MHz.

At VNIIRIP at that time, during the development of real-time devices, a bandwidth of only 350 MHz was achieved (in LNIRTI - **500 MHz,** in the **S1-104** model in **1981),** so the task was set to expand the bandwidth up to **1 GHz.**

Universal oscilloscope C1-129. 1989

Especially for this device, by order of VNIIRIP, a set of high-speed devices was developed at different enterprises of the country, providing the necessary wide-bandwidth of the device: - ELTBV for the first time with a

microchannel plate (brightness amplifier) was developed in Novosibirsk, in the Design Bureau of the Electric Vacuum Plant by Ediny V.A. and Starykin E.A., and microchannel plates for this ELTBV were developed at the enterprise in Ordzhonikidze,

- a set of broadband microcircuits “Tube” for vertical and horizontal paths was developed at the OKB of the semiconductor plant in Novosibirsk,

- a special cable for the delay line was developed in OKB cable industry in Mytishchi,

- input thin-film attenuators and a high-resistance active probe were created at VNIIRIP in the microelectronics department, head of department Guoga V.,

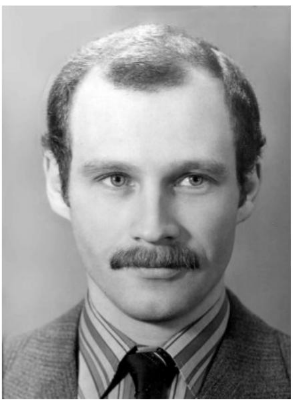
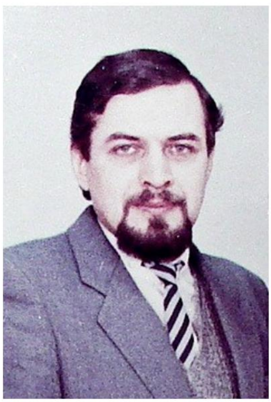
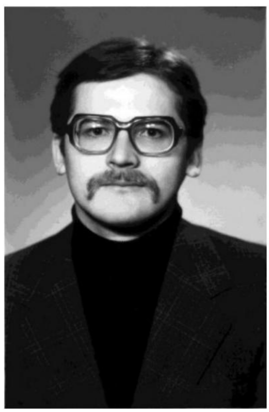
- elastomeric connectors for broadband “Tube” microcircuits were developed in the technology department of VNIIRIP, department head N.K. Murzin.

Such a volume of development of components for a device developed at VNIIRIP, made at other enterprises, was done for the first time in the history of VNIIRIP.

In any case, in every respect, this development was unique and revolutionary and provided a breakthrough in expanding the bandwidth of oscilloscopes in the country.

At that time, there were only two real-time oscilloscopes in the world for such a wide frequency band 0 - 1000 MHz, these were Tek 7104 and S1-129.

Chief designer of S1-129 - Fedorenchik A.I.,
Leading Engineer - Puodžiÿnaitÿ G.,
designer - Cheprakova M.S.,
horizontal channel - Semenyuk A.D.,
digital microprocessor part - Shapiro V.,
software - Navickas R., Galkin A.P.
developers - Ambrazaitis K., Bernotas A.

Vladimir.Shapiro. Romualdas Navickas Alexander Galkin.

Algis Bernotas.

Kyastutis Ambrazaitis.

Device parameters: - band
0-1000 MHz, - input
impedance 50 Ohm, - number of channels
- 2, - sensitivity 10 mV/
div.+/-3%, - minimum sweep 200 ps/div.+/-3%,

A.I. Fedorenchik presents oscilloscopes developed under his leadership.
On the stand from right to left: S1-129, S1-108, S1-97, S1-116,
S1-134 and S1-137. Photo 1994

For many years, **the leading developer of universal broadband oscilloscopes was A.I. Fedorenchik;** most of the developments on this topic were carried out in his laboratory sector.

Alexander Ivanovich Fedorenchik was born in 1934 in small Belarusian town of Cherven.

In **1957 ,** he graduated from the radio engineering department of the Lvov Polytechnic Institute and was assigned to work at OKB-555 of the Vilnius plant, post office box 6.

Together with his colleagues, he took part in the development of a high-speed oscilloscope **S1-11 (ISO-1), on the topic “Hyacinth”.** For this oscilloscope, Alexander Ivanovich developed a system of scan generators.

In **1962** A.I. Fedorenchik is a leading engineer **at the Zelen Research and Development Institute.** This work became the basis for the creation of the main state standard for oscillography - GOST 9810-69 "Cathode-ray oscilloscopes, nomenclature of parameters and general technical requirements."

In **1959-1964 ,** Alexander Ivanovich was the presenter developer of dual-beam oscilloscopes **S1-12** and **S1-18.**

From 1974 to 1989 A.I. Fedorenchik was the chief designer and leading specialist in the development of the most broadband universal oscilloscopes in the country at that time, **S1-75, S1-108, S1-116 and S1-129.**

In **1990-1991 ,** under the leadership of A.I. Fedorenchik there were service oscilloscopes **S1-134 and S1-137 were developed.**

From 1974 to 1991 , the bandwidth of wideband oscilloscopes developed under the leadership of A.I. Fedorenchik, **was expanded 4 times** - from 250 MHz (S1-75) to 1000 MHz (S1-129). In terms of production volumes, devices developed under the

leadership of A.I. Fedorenchik **(broadband oscilloscopes),**

accounted for up to **25%** of all production volumes of VNIIRIP oscilloscopes for 1984-1992.

Since 1965 A.I. Fedorenchik was the head of the LS-25 laboratory, since 1976 the head of LS-222, and since 1984 the head of department 4 and department 43.

A.I. Fedorenchik, 1970s

A.I. Fedorenchik, 1980s

All devices developed under his leadership, as well as the S1-97 oscilloscope, created in his laboratory sector, were produced at the Bryansk plant for many years in large batches. These devices were awarded medals from VDNKh and the Leipzig Fair, and A.I. Fedorenchik himself was awarded a government award - the Order of the Badge of Honor and became a laureate of the Republican Prize of the Lithuanian SSR in the field of science.

For 15 years (from 1974 to 1989), 7 models of wideband oscilloscopes (for a bandwidth of 100 MHz and higher) were developed in the oscillographic departments of VNIIRIP.
models S1-75, 92, 97, 108, 116, 121, 129.

1.8. Service oscilloscopes. 1976-92

By sales volume, **the direction of service oscilloscopes** (weighing less than 5 kg) **took an honorable third place** among eight other areas of development of VNIIRIP oscilloscopes.

For the period 1984-1992 the production volume of such devices amounted to about **78 million rubles,** which amounted to about **12%** of the production volume of all VNIIRIP oscilloscopes over these years (see tables at the end of Appendix 1).

The widespread introduction of radio electronics into various sectors of the national economy has set a new task for the radio measuring industry - the creation of devices for setting up, servicing and repairing household appliances - from TV to cars. The devices had to be cheap, small-sized, easy to use with relatively low technical characteristics. Thus a new direction emerged -

service radio measuring instruments, including service oscilloscopes. In section 1.3 we already mentioned

that the first attempt to create a service device at the Vilnius enterprise was made in the 1950s. In 1957, the plant's RTS created a small-sized oscilloscope EMO-2 (S1-6) with a bandwidth of 1 MHz and a weight of 4.5 kg.

A.A. Likhtinshain recalls: “When the Mytishchi plant, which for a long time produced the portable oscillograph S1-5 (SI-1), weighing 18 kg, which was its “workhorse” and brought foreign exchange profits to the country and the plant, turned to the Vilnius Research Institute with proposal to develop a replacement for C1-5, he did not meet with understanding. The oscillographic department at that time was focused on the development of completely different products, and therefore refused, citing being busy with more important problems.”

The initiative to develop the first service oscilloscope belonged to the chief engineer of the 6th Main Directorate of the MPSS V.G. Andrushchenko. As part of the technical project, three research institutes (Vilnius, Lvov and Gorky) presented their working models a year later. As a result, the device project developed in Vilnius under the leadership of J. Rapalis won, which outperformed competitors due to its simplicity and low cost.

The project became the basis for the development of a set of documentation for the S1-90 oscilloscope, which was created in the medical equipment department of VNIIRIP.

In **1976 ,** at the same place, the 2nd truly service oscilloscope **S1-90 was developed,** on a CRT 8LO7i on the topic **“Service-1”** weighing 3.5 kg, for a band of 0-1 MHz. The vertically oriented design of the S1-90, S1-94 and “Saga” oscilloscopes later became a well-recognized “brand” of service oscilloscopes from VNIIRIP.

The S1-90 oscilloscope was mass-produced for only a few years.
Mytishchi plant - it was quickly replaced by S1-94.

Parameters of the S1-90 device:
- band 0-1 MHz,
- CRT 8LO7i, 40x60 mm,
- sensitivity
  10 mV/div, +/-10%,
- sweep 1 µs/div. +/-10%,
- power consumption 20 W,
- weight 3.5 kg.

Service oscilloscope S1-90. 1976

Juozas Rapalis. Photo from the mid-1980s

Liliya Antonovna Chernysheva. Photo from the early 1980s

Chief designer of the development - Y. Rapalis,
Leading engineer - Chernysheva L., main
developers - Kostikov V., Gurin Yu., Rumyantseva L.

It was Y. Rapalis who became the founder of the development of mass-produced small-sized oscilloscopes for general use - service oscilloscopes.

In connection with the reorganizations carried out at the institute, since 1977, the development of service oscilloscopes was carried out in the oscillographic departments. At the same time, the Yu. Rapalis sector was transferred to department No. 21 of M.I. Efimchik.

In **1977 ,** the laboratory of Y. Rapalis created a new service oscilloscope **S1-94 “Service-2“,** on the same CRT 8LO7i with a bandwidth of 0–10 MHz, with the same weight of 3.5 kg, and the same overall dimensions as and C1-90. This device completely replaced the outdated S1-5 (SI-1) and began to
be produced at the Mytishchi plant in 1978. It became the most popular oscilloscope, widely exported, and became the calling card of the country's foreign trade association - Mashpriborintorg.

Service oscilloscope S1-94 with a bandwidth of 0 -10 MHz.
Advertising V/O “Mashpriborintorg”. 1977

Parameters of the S1-94 device:
- band 0 -10 MHz,
- CRT 8LO7i 40x60 mm,
- koéf. deflection. 10 mV/div +/- 6%,
- coefficient development 0.1 µs/div.+/-6%,
-power consumption 25 W,
- weight 3.5 kg.

Chief designer of the development - Y. Rapalis,
Leading engineer - Chernysheva L., main
developers - Kostikov V., Gurin Yu., Rumyantseva L.

This legendary oscilloscope became one of the winners among the oscilloscopes of the USSR in 1984-1991. by the number of devices produced, they were released during this period -
101.451 thousand pieces, approximately 12.6 thousand pieces/year, or 1 thousand pieces/month, at a price of 170 rubles.

This device is also one of the record holders for the longest time in production, because it was in production from 1978 to 1991, i.e. 13 years old. And although in terms of volume

production, it took only 16th place out of 28, due to the low price (170 rubles), but still it was one of the devices that was exported en masse and earned foreign currency, which was very important at that time.

The interest of radio amateurs in the S1-94 oscilloscope was genuine. It was so popular that its design was published in Radio magazine in January 1983.

In **1980 ,** VNIIRIP developed a mass service oscilloscope **S1-112 ("Servant"),** on an 8LO6i CRT, for the first time with a multimeter, weighing 3.5 kg, for a band of 0-10 MHz.

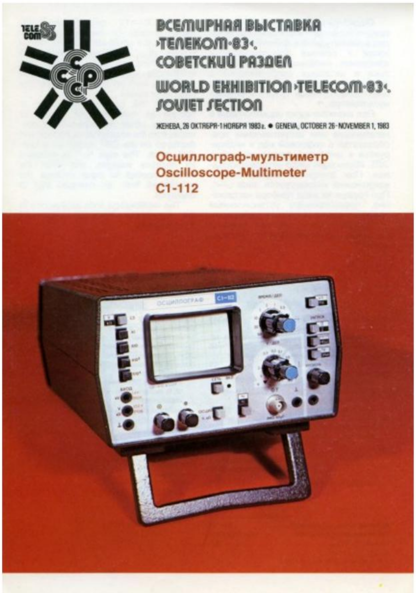
S1-112 was produced in large quantities at the Vilnius plant. This oscilloscope took 12th place out of 28 among VNIIRIP oscilloscopes in 1984-1991. in terms of production volumes, they were produced during this period - 52.637 thousand units, approximately 10 thousand units per year, or almost 1 thousand units per month, at a price of 430 rubles.

If we consider S1-112/S1-112A as one model, then this legendary oscilloscope became the champion among oscilloscopes of the USSR in 1984-1991. in terms of the number of pieces produced, they were produced during this period - 112.836 thousand pieces, approximately 14 thousand pieces/year, or 1.2 thousand pieces/month, at a price of 430/470 rubles.

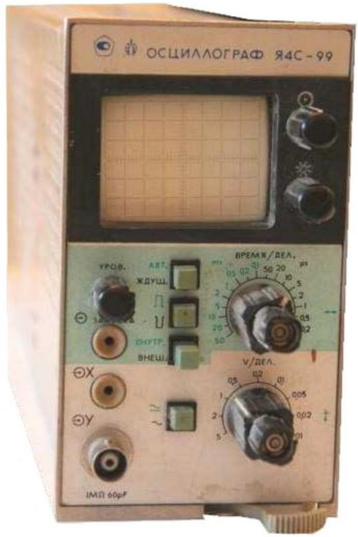
This was one of the devices that was exported en masse and earned foreign currency, thanks to which it, along with the S1-94, became the calling card of the foreign trade association "Mashpriborintorg".

It was a single-channel 10 MHz oscilloscope with a sensitivity of 5 mV/div. The device was already made in a plastic case with overall dimensions of 110x100x250 mm and weighing only 3.5 kg. The working part of the CRT screen was 40×60 mm, consumed power – 25 VA. The multimeter displayed measurement results directly on the CRT screen through a character generator in a seven-segment format and made it possible to measure DC voltage and resistance.

In 1988, the S1-112 was modernized. As a result, the S1-112A oscilloscope already had an extended bandwidth of up to 20 MHz.



Service oscilloscope with built-in multimeter S1-112. 1980



Oscillographic unit S1-109 (Ya4S-99). 1980

The chief designer of the development was Yu.G. Gurin.

Chernysheva L., Kostikov V., and Rapalis Yu also took part in the development.

Parameters of devices S1-112 (S1-112A):
- band 0-10 (0-20) MHz,
- ELT 40*60 mm,
- sensitivity 5 mV/div.+/-5%,
- sweep 50 ns/div.+/-5%,
- multimeter with character generator, for measuring voltage and resistance,

- consumption power. 25 W,
- weight 3.5

kg. In **1980 ,** the development of the oscillographic replacement unit **S1-109 (Ya4S-99)** on the topic **“Caliber-S”,** on a CRT 6LO3i, was completed. The device was designed to work with the base blocks BB1/1, BB1/3 and BB1/6, which are part of the modular small-sized measuring complexes K2-42 and K2-43, an analogue of which was the TM500/TM5000 system from Tektronix .

S1-109 was an oscilloscope in the form of a replaceable unit, without a power supply, the role of which was performed by the base units. 5 MHz bandwidth at 10 mV/div sensitivity. It used a CRT with a working part of the screen 30x40 mm. The main development is Y. Rapalis. designer Oscillographic units were mass-produced at the Minsk Kalibr plant.
was

In **1982 ,** in the sector of A.A. Likhtinshain, the development of the service oscilloscope **S1-118 “Service-4”** on a CRT 11LO9I was completed. This was the first domestic two-channel service oscilloscope. Its bandwidth was 10 MHz, sensitivity 5 mV/div. For the first time, a CRT with a working part of a 60x80 mm screen, type 11LO9I, was used. The device was made in a plastic case with overall dimensions of 210x120x300 mm and a weight of 4 kg. Power consumption was 28 VA.

Двухканальный сервисный осциллограф С1-118. 1982 г.

Two-channel service oscilloscope S1-118. 1982

Galina Dmitrievna Artamonova.

The main designer of the development was Y. Rapalis. V.A. Kostikov and G.D. Artamonova participated in the development. I.A. Chernysheva, The production of the S1-118 oscilloscope was proposed to the Abovyan plant. A.A.

Kalamkarov recalls: “The Institute offered serial production of the S1-118 oscilloscope to the Abovyan plant. He stubbornly refused, because, in the opinion of the plant management, it was much easier to produce one expensive storage oscilloscope, which has a higher price, than twenty cheap service ones. At the same time, the C1-94 thundered across the entire industry, on which the country earned more foreign currency than on all other oscilloscopes. This was the decisive factor -

The Abovyan plant agreed to implement the device and successfully coped with it.”

In 1987, the S1-118 oscilloscope was modernized, and the band
The bandwidth of the S1-118A was expanded to 20 MHz.

This oscilloscope took 22nd place out of 28 among VNIIRIP oscilloscopes in 1985-1988. in terms of production volumes, they were produced during this period - 14.453 thousand units, approximately 3613 units per year, or almost 301 units per month, at a price of 400 rubles. If we consider S1-118/S1-118A as one model, 22,590 thousand units were produced during this period, approximately 4518 units per year, or 376 units per month, at a price of 400/450 rubles.

In **1983 ,** the development of the **Saga** service oscilloscope on the 8LO7I CRT was completed. The appearance of the technical specifications for the development was preceded by the release of the Resolution of the Central Committee of the Communist Party of Lithuania on the production of consumer goods at Lithuanian enterprises included in the military-industrial complex of the USSR. A.A. Likhtinshain recalls: “We

discussed for a long time the question of what could be offered for sale in retail stores for radio amateurs. We decided that the most correct thing would be to develop an oscilloscope in the form of a simplified and cheaper S1-94. Subsequently, it was produced by the Vilnius plant, since the Decree concerned Lithuanian enterprises.”

Like the S1-94, the Saga oscilloscope had one channel and a bandwidth of 7 MHz and did not fall under the GOST requirements for oscilloscopes.

The chief designer of the development was Yu.G. Gurin. A significant part of it was carried out by Y. Rapalis.

Oscilloscope “Saga”. 1983 Service storage oscilloscope
S8-20. 1987

In **1987 ,** the development of the S8-20 “Trace” service storage oscilloscope was completed . This oscilloscope was developed based on the S1-118 oscilloscope. At the same time, the Lvov Lamp Plant developed an inexpensive half-tone storage CRT 11LN1I, which had a working part of the screen 56x70 mm, a recording speed of 100 km/s and a playback time of 20-180 s. This CRT was used in the S8-20 oscilloscope. The S8-20 oscilloscope had two channels with a bandwidth of 10 MHz and a sensitivity of 2 mV/div. The device was made in a plastic case similar to S1-118, with overall dimensions 210x120x300 mm, weight 4.5 kg and power consumption 28 VA. The main designer of the development was Y. Rapalis. L.A. Chernysheva and V.A. Kostikov participated in the development. A pilot batch of devices was produced by the Abovyan plant. The S8-20 oscilloscope was not produced serially due to the lack of serial production of the CRT 11LN1I.

In **1987 ,** the development of a progressive service analog oscilloscope with digital memory and a **S8-22 Soldi microprocessor was completed.** Initial work

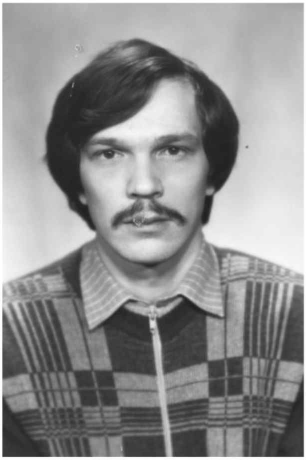
was carried out V sector of A.A. Likhtinshain, and since 1987 - in the sector of A.V. Mikhalev. It was a two-channel oscilloscope that allowed operation in both analog mode and digital memory mode.

The oscilloscope bandwidth was 20 MHz. The maximum real-time sampling rate was 1 MHz. On fast scans, a strobe mode was provided for data collection. The oscilloscope used a 12LO1I CRT with a working part of the screen of 60x80 mm. The device had a built-in character generator for displaying measurement information on the CRT screen. The device features pre-recording and signal averaging, marker measurements of voltage and time intervals, as well as output to a plotter. The oscilloscope was distinguished by its low weight of 6.5 kg and low power consumption of 40 VA, with small dimensions.

Combined oscilloscope C8-22. 1987

The chief designer of the device was V.A. Pleshkov (senior).
Participated in the development:
V.A. Peryshkin leading engineer of the topic, (horizontal channel and ADC), D.E. Petrov

(microprocessor system), B.M. Klimkovetsky and L.V. Volkova (vertical channel).



Vladimir Alekseevich Peryshkin.

Vladislav Aleksandrovich Pleshkov.

The foreign analogue of the S8-22 was the Tek 336 oscilloscope from *Sony/ Tektronix,* weighing 5 kg, with a bandwidth of 50 MHz.

Oscilloscope Tek 336, 50 MHz, sampling 1 MHz, weight 5 kg. A pilot batch of

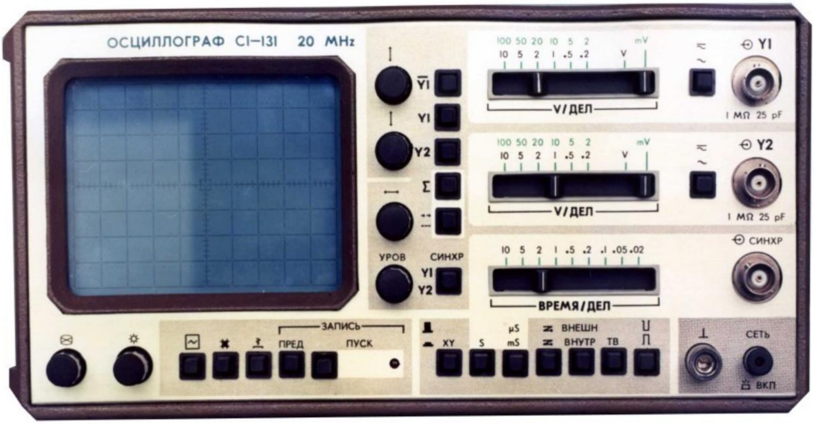
S8-22 oscilloscopes was produced by the Abovyan plant, however, due to the crisis of the 90s, the device was not mass-produced.

Employees of the LS214 laboratory sector are developers of service, low-frequency and storage oscilloscopes. ***From left to right, sitting:***

S.I. Pedan, V.A. Peryshkin, E.A. Shestakova,
B.M. Klimkovetsky, T.F. Orlova, I.M. Arbekova, A.A. Likhtinshain,
L.A. Chernysheva;
standing: V.Valyackas,
M. Grishko, A. A. Lazukin, V. V. Malakhov, I. A. Naidenova, N. G. Malakhova, I. A. Freeman, L. V. Volkova, Y. Labul, V. A. Pleshkov. Photo from the early 1980s.

At the end of the 1980s, the A.A. Likhtinshain sector was completely switched to developing service oscilloscopes. Was a promising program for creating new families has been developed service oscilloscopes.

In **1989 ,** the development of a service oscilloscope ends **S1-131 “Soda”.** with a bandwidth of 0-20 MHz and digital memory.

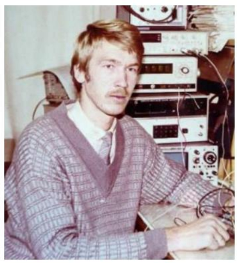


Service oscilloscope with digital memory S1-131. 1989

The device had two channels with a sensitivity of up to 2 mV/div, an ADC with a maximum sampling frequency of 1 MHz, and a memory of 1 kB. The oscilloscope used a CRT with a working part
screen 60x80 mm type 11LO9I, the same as in S1-118. The device was made in a new plastic case with overall dimensions 240x120x300 mm and weighing 4.5 kg. Power consumption was 40 VA.

The chief designer of the development was A.A. Likhtinshain. IN
The development team included A.A. Lazukin (lead engineer),
Y. Rapalis, A.V. Volkov, designer M. Martynenkova.



A.A. Likhtinshain A.A. Lazukin Y. Rapalis A.V.Volkov,

Oscilloscope S1-131 was successfully implemented at Vilnius
factory In 1990-1991 710 pieces were produced, approximately 350 pieces per year, at a price of 700 rubles.

In **1990,** the S1-131 oscilloscope became the head model of a family of 4 service oscilloscopes, developed on the **Sochi** theme by the same developers as S1-131, in the A.A. Likhtinshain sector for the Mytishchi plant.

The family included four oscilloscopes: **S1-139, SK1-140, SK1-144 and SK1-132.** The characteristics common to the entire family were a bandwidth of 0-20 MHz, sensitivity up to 2 mV/div, and the ability to synchronize with a television signal. The devices used a 11LO9I CRT with a working part of the screen 60x80 mm. The oscilloscope was made in a plastic case with overall dimensions of 243x133x330 mm, its weight was 4.5 kg.

The S1-139 oscilloscope was a simple service oscilloscope. The SK1-140 oscilloscope contained a multimeter. The SK1-144 oscilloscope contained a multimeter and a television signal line extraction unit. The SK1-132 oscilloscope contained a multimeter and a teletext generator.

In 1992, the oscilloscopes of the Sochi family were modernized; their bandwidth was expanded to 25 MHz, and the models were assigned numbers - S1-139A, S1-140A, SK1-144A, SK1-132A.

Documentation for the family of these oscilloscopes was transferred to the Moscow Measuring Equipment Plant (MZIA, hereinafter referred to as Moscow plant), where they were produced for more than 10 years.

Two-channel service oscilloscope with multimeter and teletext generator SK1-132. 1991

Two-channel service oscilloscope S1-139. 1991

In **1990 ,** under the leadership of A.I. Fedorenchik, a group of developers consisting of G. Puojunaite, K. Ambrazaitis and A. Bernotas created the **S1-134 oscilloscope.**

It was a two-channel service oscilloscope, the first to offer 0-35 MHz bandwidth and 2 mV/div sensitivity. It used a CRT with a parallax-free scale of type 12LO1I and with a working part of the screen of 60x80 mm. The device was made in a metal case with overall dimensions of 268x130x360 mm and a weight of 5 kg, the power consumption was 30 VA.

Service oscilloscope S1-134. 1990

For a long time, the oscilloscope was mass-produced by Bryansk factory,

In **1991 ,** the development of the service was completed oscilloscope **S1-137.**

The two-channel oscilloscope S1-137 with a bandwidth of 25 MHz was the basic model of a series of service oscilloscopes and was distinguished by its compact design and low weight. It had a sensitivity of up to 2 mV/div and the ability to synchronize with a TV signal. It also used a 12LO1I type CRT with a working part of the screen of 60x80 mm.

The device was made in a metal case with overall dimensions of 270x130x375 mm and a weight of 5 kg, the power consumption was 40 VA.

The oscilloscope was created under the leadership of A.I. Fedorenchik by a group of developers consisting of G. Puodžiÿnaite, K. Ambrazaitis, A. Bernotas and V. Valentukeviÿius.

Oscillograph S1-137. 1991

Subsequently, the same group developed two new modifications of the device – **S1-137/1 and S1-137/2.** Oscilloscope S1-137/1 could be used as a base for creating a small measuring laboratory for a radio technician. This combined device combined in one housing a two-channel oscilloscope and a 3.5-digit digital multimeter with indication of readings on an LCD indicator. The multimeter measured DC and AC voltage, DC current, and resistance.

The S1-137/2 oscilloscope additionally contained digital memory with a sampling frequency of up to 1 MHz and a memory capacity of 0.5 kB/channel. It also had a serial interface

RS-232. The digital part of the device was developed by A.P. Galkin. Oscilloscopes of the S1-137 series were mass-produced at the Minsk plant.

In just 16 years (from 1976 to 1992), VNIIRIP developed 17 models of service oscilloscopes, models C1-90, 94, 112, 112A, 118, "To You", C8-20, 22, C1-131, 139, 140, 144, 132, 134, 137, 137/1, 137/2.

1.9. Low frequency oscilloscopes. 1979

In terms of sales volumes, **the direction of universal low-frequency oscilloscopes** (for a band of 10-15 MHz or less, with a weight of more than 5 kg) **took fourth place** among eight other areas of VNIIRIP oscilloscope development. For the period 1984-1991 the production volume of such devices amounted to about **56 million**

rubles, which amounted to about **8.5%**

production volumes of all VNIIRIP oscilloscopes over these years (see tables at the end of Appendix 3).

In connection with the development of research in medicine, biology and mechanics, as well as in other areas of the national economy in the country in the 70s, a need arose for universal, relatively low-frequency (from 1 to 10 MHz), but with high sensitivity (from 50 ÿV / div up to 0.5 mV/div) oscilloscopes.

In 1979, VNIIRIP developed two universal dual-beam oscilloscopes with a bandwidth of up to 10 MHz:

- 2-channel **C1-102 ("Salad-4"),**
- 4-channel **C1-103 ("Salad-5").**

The devices were highly sensitive. With a bandwidth of 10 MHz it was 0.5 mV/div, and with a bandwidth of 1 MHz it was 50 ÿV/div. The oscilloscopes used a 17LO4I double-beam CRT with a screen size of 100x120 mm, the same one that was used later in the S1-115, in 1984 (see Section 3.5.).

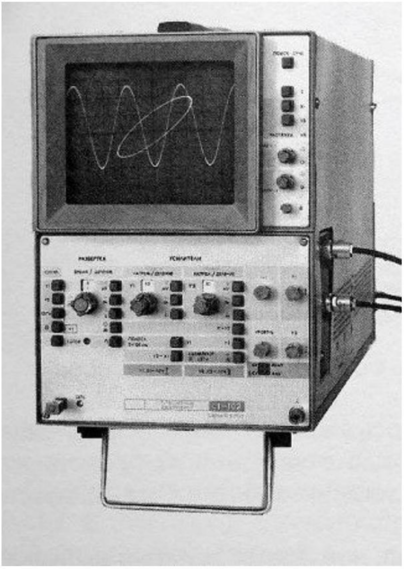
A special feature of the devices was electronic control of components, as well as the desire to completely abandon wired installation. The devices also had their own housing profile ordered.

S1-102 was produced in large quantities at the Bryansk plant and took 14th place among VNIIRIP oscilloscopes (out of 28) in terms of production volume.

In 1984-1988 6,564 thousand pieces were made. such devices worth 19.692 million rubles; on average, more than 1,300 such devices were made per year, at a price of 3,000 rubles.

S1-103 was produced in large quantities at the Bryansk plant and took 6th place among VNIIRIP oscilloscopes (out of 28) in terms of production volume.

In 1984-1991 9.685 thousand pieces were made. such devices worth 36.803 million rubles; on average, more than 1,200 such devices were made per year, at a price of 3,800 rubles.



Dual Beam Dual Channel oscilloscope C1-102. 1979

Dual beam four channel oscilloscope C1-103. 1979

Parameters of the S1-102 device:
- band 10/1 MHz,
- input impedance 1 mOhm,
- number of channels - 2,
- sensitivity - 0.5/0.05 mV/div. +/-4%,
- sweep 20 ns/div.+/-4%,
- power consumption 120 W,
- weight 15 kg.

Parameters of the S1-103 device:
- band 10/1 MHz,
- input impedance 1 mOhm,
- number of channels - 4,
- sensitivity - 0.5/0.05 mV/div. +/-4%,
- sweep 20 ns/div.+/-4%,
- power consumption 120 W,
- weight 15 kg.

Chief development designer, head of laboratory sector No. 24 - V.M. Levin,

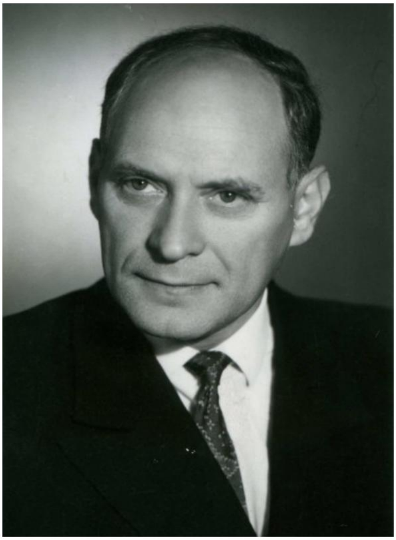
leading engineer - A.A. Likhtinshain,

amplification channel - I.A.Naidenova and G.I.Andreev,

indicator blocks - I.A.Freeman, switch - S.V.Gritsay, M.I.Grishko,

design - I.G. Nesterova and V. Karnitskene.

high-voltage power supplies - S.Ya. Zablotskis and M.R. Boreyko, low-voltage power supplies - N.S. Shabunina and M. Stolpner.



Victor Markovich Levin.
Photo from the early 1970s

Alexander Arkadyevich Likhtinshain.
Photo from the mid-1980s

Gennady Ivanovich Andreev.
Photo from the late 1970s

Irina Arkadyevna Naydenova.
Photo from the early 1980s

Joseph Aronovich Freeman.
Photo from the mid-1980s

1.10. Storage oscilloscopes on ZELT. 1966-1987

In terms of sales volumes, **the direction of storage oscilloscopes** (on storage - ZELT) **took fifth place** among eight other areas of development of oscilloscopes at VNIIRIP. For the period 1984-1992 the production volume of such devices amounted to about **27 million rubles,** or about **4.0%**

of the production volume of all VNIIRIP oscilloscopes over these years (see tables at the end of Appendix 1). It was already mentioned in section 1.4 that the appearance of storage cathode ray tubes, with a special spotlight for signal playback, in the country in the 1960s led to the creation of a

new class of oscillographic instruments that made it possible to record and then play back single pulse signals.

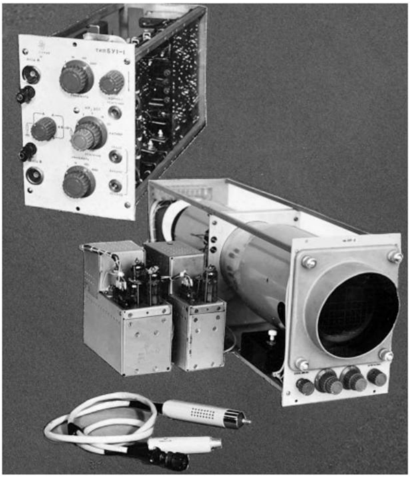
For a long time (from the mid-1960s to the 1990s) storage oscilloscopes were the most convenient and universal instruments for studying single-shot physical processes in biology, chemistry, medicine, geology, mechanics and other fields of science and technology.

In oscilloscopes of this class, the invisible (potential) image of the signal on the internal target is converted into a visible (light) image on the phosphor of the screen using a special reproducing spotlight.

The first storage oscilloscopes in the USSR (S8-9, S8-1, S8-2) were developed at VNIIRIP in 1964-1965 (see section 3.3).

The basis for the construction of VNIIRIP storage oscilloscopes was the development of a set of structural, functionally complete blocks (bricks) intended both for the construction of specific devices and for autonomous use by external consumers for their own special purposes. A.A. Zybin became the leading developer of blocks for storage oscilloscopes. V.M. took part in the development. Eremenko, M.S. Buslovich, V.P. Redkin, L.M. Trub (high-voltage power supply of CRT), N.M.

Sarycheva (scanning), V. Rajunaite (design).



In the period **from 1966 to 1967** year under the leadership of V.M. Levin carried out a series of works on the development of sets of blocks for building storage oscilloscopes: **– in 1966 “Sanction”, – in 1967 “Silicon-1,2”.**

Blocks for oscilloscopes with a bandwidth up to 15 MHz (“Silicon-2”). 1967

Alexey Alekseevich Zybin. Photo of the end

Mikhail Simkhovich Buslovich

Vyacheslav Petrovich Redkin

Lev Myronovich Trub

Nina Matveevna Sarycheva

Valentina Rajunaite

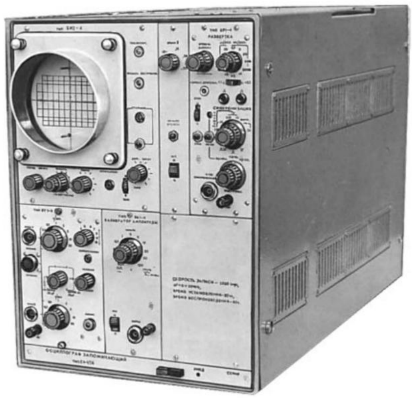
In 1967, based on a set of such blocks and on the basis of a half-tone ZELT 13LN7, a storage oscilloscope **S8-7 (S1-47 code "Gardener")** was developed with an increased recording speed of up to 1000 km/s, at a bandwidth of 20 MHz, and the same **S8-7A**
(C1-47A "Gardener-1"), only with acceptance by the customer.

The main designer of the development was A.A. Kalamkarov,
Leading engineer – P.I. Gorev.

The devices were mass-produced by the Abovyan plant. They are introduced

The research was conducted by I.I.Pits.

Storage oscilloscope
S8-7 (S1-47). 1967.



Storage oscilloscope
C8-7A (C1-47A). 1967

Anatoly Aikovich
Kalamkarov. Photo from
the 1970s

Pavel Ivanovich Gorev. Photo
from the early 1970s
years

Joseph Iosifovich Pits.

Photos from the 1980s

In 1968, on the bistable ZELT 13LN8, the first in the USSR, 2-beam storage oscilloscope **S8-11 (S1-51**

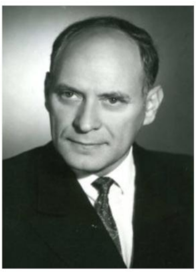
"Sad-1"), on a 1 MHz band, using standard blocks. For the first time, the device made it possible to register 2 simultaneously occurring single processes without photographic recording.

The leading developers of the devices were V.M. Levin, A.A. Kalamkarov and P.I. Gorev, the amplifier and calibrator were developed by G.I. Andreev, the design was by A.O. Goncharenko. S8-11 devices

were mass-produced by the Abovyan plant

Parameters of the S8-11 device:
- band 0-1 MHz,
- ZELT 13LN8,
- number of rays and channels - 2,
- recording speed 5 km/s,
- bistable SELT,
- playback up to 30 minutes,
- sensitivity 10 mV/div.
+/-10%,
- sweep 20 ns/div.+/-10%,
- consumption power 700 W,
- weight 50 kg.

Dual beam storage oscilloscope S8-11 (S1-51). 1968



Victor Markovich Levin.

Anatoly Aikovich Kalamkarov.

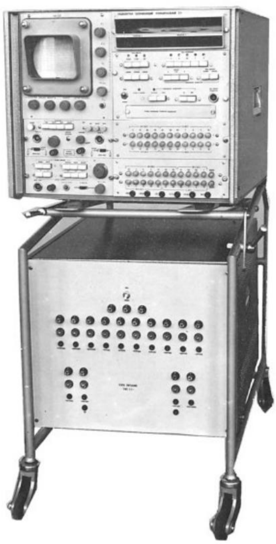
Gennady Ivanovich Andreev.

Pavel Ivanovich Gorev.

In 1969, on the bistable ZELT 13LN2, the first, in the history of VNIIRIP, automated oscilloscope **C8-8 (S1-58, “Svaya”),** with digital raster conversion, with a bandwidth of 1 MHz, was developed.

This was a fundamentally new automated device, with digital signal conversion, by internal raster reading of the potential signal relief from the screen of a bistable CELRT, which was later used in S9-6.

The development of such a device has opened up completely new possibilities for analyzing electrical signals. Firstly, almost all the main components of the oscilloscope have become automated - the vertical and horizontal channels, the indicator block. Secondly, many measuring tasks have been automated. For example, measuring the pulse power of a complex waveform at various loads, previously considered a rather difficult task, has become a routine procedure. For the first time, measurement results were displayed in digital form on alphanumeric indicators, and output was provided on an alphanumeric printing machine.



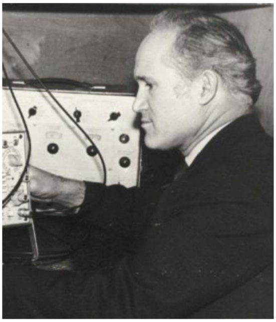
Automated storage oscilloscope S8-8 (S1-58).

Device parameters:
- band 0-1 MHz,
- bistable ZELT, 13LN2,
- number of rays and channels - 1,
- recording speed 10 km/s,
- sensitivity 5 mV/div.+/-10%,
- sweep 100 ns/div.+/-10%,
- power consumption 700 W,
- weight 115 kg.

The oscillograph was created jointly with the staff of the department of Professor Sigorsky, from the Kyiv Polytechnic Institute - Doctor of Technical Sciences. Debnovetsky S.V. and Ph.D. Orlov I.I.

The principle of constructing this device belongs to the leader of this project - V.M. Levin.

The development was carried out in the laboratory of A.A. Kalamkarov, leading engineer - V.M. Eremenko, developers - V.A. Pleshkov, T.S. Pleshkova, R.V. Bodnar, A.G. Berlin.


Vladislav Aleksandrovich Pleshkov


Roman Vyacheslavovich Bodnar. Photo from the early 1980s years


Alexander Grigorievich Berlin. Photo from the early 1980s years

S8-8 was mass-produced at the Makhachkala plant. The implementation was carried out by Roman Bodnar and Maria Grishko. The device was popular at the enterprises of the Ministry of Medium Machine Building.

In 1972, the S8-9 oscilloscope was modernized under the leadership of A.A. Kalamkarov and was already mass-produced as **the S8-9A** at the Abovyan plant.

In 1974, three memory oscilloscopes were developed on ZELT within the family of oscilloscopes with replaceable units of the **Snige** family - **S8-12, S8-13 and S8-14,** for a band of 50, 1 and 50 MHz, which are described in subsection 1.6. 1.

In subsequent years, due to the fundamental limitations of increasing the recording speed of SELTs with sufficient imaging of the playback time of recorded single signals, the main placed on relatively low-frequency, small-sized, emphasis was inexpensive oscilloscopes based on SELTs. A whole series of such devices was created: single-beam S8-15 (“Salad 1-2”), double-beam S8-17 (“Sad-1”) on a bistable CELRT instead of the S8-11 device and single-beam S8-18 (“Sevan”) on a grayscale CRT instead of the S8-9A device.

Development of storage oscilloscopes was carried out at LS24 (head of the laboratory V.M. Levin), and later in – LS214.

Employees of the LS214 laboratory sector are developers of service, low-frequency and storage oscilloscopes.

From left to right, sitting:

S.I. Pedan, V.A. Peryshkin, E.A. Shestakova, B.M. Klimkovetsky, T.F. Orlova, I.M. Arbekova, A.A. Lichtinshine, L.A. Chernysheva; ***stand:***

V. Valjackas, M. Grishko, A. A. Lazukin, V. V. Malakhov, I. A. Naidenova, N. G. Malakhova, I. A. Freeman, L. V. Volkova, Y. Labul, V. A. Pleshkov. Photo from the early 1980s.

In 1976, the development of the **S8-15 (“Salad 1-2”)** storage oscillograph was completed .

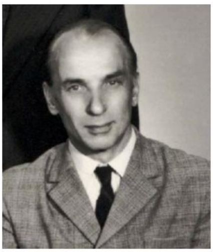
The chief designer was P.I. Gorev, leading engineer – V.A. Pleshkov,
V.V. took part in the work.
Malakhov, E.A. Shestakova.

It was a two-channel oscilloscope with a bandwidth of 0 - 10 MHz on a 16 cm halftone memory CRT with a playback time of 40 s, type 16LN1.

It was planned to launch the device into series at the Abovyan plant. However, ZELT was not accepted for serial production by the general customer. For this reason, the S8-15 oscilloscope was not mass-produced.

Storage oscilloscope S8-15. 1976

Parameters of the S8-15 device:
- band 0-10 MHz,
- halftone ZELT, 16LN1,
- recording speed 1000 km/s,
- time played. 40 sec.,
- storage time 16 hours,
- sensitive 2 mV/div +/-5%,
- sweep 50 ns/div.+/-5%,
- power consumption 65 W,
- weight 16 kg.



Pavel Ivanovich Gorev.

Vladislav Aleksandrovich Pleshkov

Vladimir Vasilievich Malakhov.

E.A. Shestakova

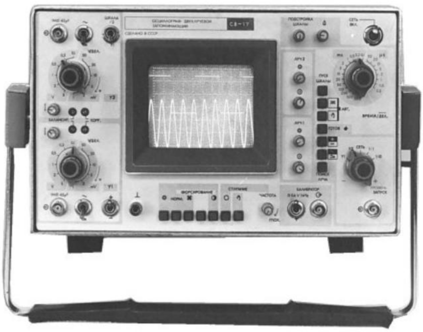
In 1979, a 2-beam memory device was developed oscilloscope **C8-17 ("Sad-1"),** for a 1 MHz band (instead of C8-11).

The device used a two-beam bistable SELT type 13LN8 with a working part of the screen 60x80 mm. The recording speed was 5 km/s, and in the forced mode - 40 km/s, playback time - 30 minutes, and storage time - 7 days.

S8-17 in 1981-89 It was produced in large quantities at the Abovyan plant and took 9th place among VNIIRIP oscilloscopes (out of 28) in terms of production volume. In 1984-1989 10.881 thousand pieces were made.

such devices worth 26.1144 million rubles; on average, more than 1,700 such devices were made per year, at a price of 2,400 rubles.

S8-17 was distinguished by high sensitivity (1 mV/div.) repeated signal recording, without erasing the previous signal and electronic
nary scale.



Parameters of the S8-17 device:
- band 0-1 MHz,
- bistable ZELT 13LN8,
- recording speed 40 km/s,
- playback time 30 min.,

- storage time 7 days,
- number of rays - 2
- sensitivity
  1 mV/div +/-3%,
- sweep 200 ns/div.+/-3%,
- power consumption 80 W,

- weight 16 kg.

Dual-beam storage oscilloscope
S8-17. 1979

Development was carried out in LS-24/LS-214, beginning. V.M. Levin.
Chief designer - Pleshkov V.A., developers -
Malakhov V.V., Shestakova E.A., Volkova L.V.

In 1979, the first state **standard for storage oscilloscopes GOST 23601-79 was released,** describing the range of parameters, technical requirements and test methods. The standard was developed by A.F. Denisov and M.S. Buslovich.

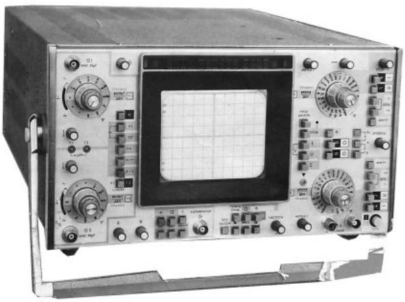
In 1983, to replace the C8-9A , **the C8-18 storage oscilloscope ("Sevan")** was developed for a 10 MHz band.

The oscilloscope was created on the basis of a half-tone ZELT 16LN3 with a working part of the screen 76x95 mm. The recording speed was 250 km/s, and the playback time was 30 minutes.

C8-18 in 1987-89 was mass-produced at the Abovyan plant and took 27th place among VNIIRIP oscilloscopes (out of 28) in terms of production volume.

In 1987-1989 341 pieces were made. such devices worth 818.4 thousand rubles; on average, more than 100 such devices were made per year, at a price of 2,400 rubles.

C8-18 was distinguished by high sensitivity, two channels, double sweep, electronic scale, and signal amplitude meter.

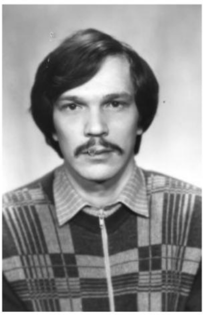


Storage oscilloscope S8-18. 1983

Parameters of the S8-18 device:
- band 0-10 MHz,
- halftone ZELT 16LN3,
- recording speed 250 km/s,
- playback time 30 min.,

- sensitivity 1 mV/div. +/-3%,
- sweep 50 ns/div.+/-3%,
- power consumption 85 W,

- weight 16 kg.



Vladimir Alexeyevich Peryshkin.

Development was carried out in LS-24/LS-214, beginning. V.M. Levin.

The main designer of the oscilloscope was V.A. Pleshkov, who also developed the amplification path. Leading engineer - V.A. Peryshkin, he developed a signal amplitude meter, a double delayed scan, and an electronic scale.

The project also involved B.M. Klimkovetsky (synchronizer and horizontal channel), V.V. Malakhov, E.A. Shestakova (memory control).

In the late 1980s, due to the advent of high-speed ADCs, microprocessors and digital memory, it became possible to create digital storage oscilloscopes based on them, allowing one-shot signals to be recorded, reproduced and stored without time restrictions. Therefore, further development of oscilloscopes based on CRTs was stopped. The penultimate storage oscilloscope on the ZELT was the S8-20 service oscilloscope, developed in **1987 ,** at 10 MHz, described in section 3.7.

The last storage oscilloscope on the ZELT was the oscilloscope with replaceable units **S8-21,** developed in **1987**
("Svet-3"), on a 100 MHz band, with a recording speed of 10,000 km/s, on a half-tone CRT (see Section 3.5).

For 11 years (from 1966 to 1987), VNIIRIP developed 8 monoblock storage oscilloscopes based on ZELT, models S8-7, 7A, 11, 8, 9A, 15, 17, 18.

1.11. High-speed and special oscilloscopes. 1968-1990

In terms of sales volumes, **the direction of special (C9) and high-speed (C7) oscilloscopes took sixth place** among eight other areas of development of VNIIRIP oscilloscopes. For the period 1984-1992 the production volume of such devices amounted to about **23 million rubles,** which amounted to about **3.5%**

production volumes of all VNIIRIP oscilloscopes over these years (see tables at the end of Appendix 3).

Oscilloscopes of this type, as well as storage oscilloscopes based on CRT, were intended mainly for recording, observing the shape, and measuring the parameters of single pulse signals. However, oscilloscopes based on bistable CRTs were relatively slow (bandwidth up to 1-2 MHz), and although oscilloscopes based on grayscale CRTs were much faster (bandwidth from 10-20 MHz to 50-100 MHz), their recording speeds were all the same equally insufficient for research in the field of nuclear physics. And only high-speed and special oscilloscopes had a significantly wider bandwidth - from 100 to 5000 MHz, and, accordingly, higher recording speeds, sufficient to solve these problems. Recording of single signals in these devices was carried out

either by photo-recording, or by quickly recording the signal on a blind CRT target, followed by digitizing the signal and storing it in digital memory.

These devices were expensive, unique, and were used mainly in nuclear research, in organizations of the Ministry of Medium Mechanical Engineering, including institutes such as IAE or FIAE named after. Kurchatova. Therefore, they were produced in smaller quantities than other oscilloscopes, but these instruments determined the scientific level of research in the field of nuclear physics and nuclear energy, and therefore their developments were of key importance for the defense and nuclear energy of the country.

The development of such devices began in **the 50-60s (C1-10,** “Core”,/1000 MHz,/1957; S1-14, / “Bamboo”, / 1000 MHz, / 1959; **C1-36,** “Harmony”,/1200 MHz,/1965), as described in section 1.3. and 1.4.

S1-14 and S1-36 were the first high-speed devices built on the basis of a traveling wave CRT (ELTBV), type 13LO102M and 10LO102M, respectively. The fact is that it was then impossible to build an amplifier for such a band, and a BV-type deflection system increased the sensitivity of the device, thereby fulfilling the role of an amplifier.

Employees of the radio equipment department of the Vilnius Civil Engineering Institute, professors A.I. Naidenov and Z. Vainoris, took an active part in the work of the oscillographic department on this topic. A.I. Naidenov dealt with the transformation of the time scale of single-shot signals, and Z. Vainoris and S. Shtaras studied spiral deflection systems in ELTBV.

Employees of the laboratory sector LS-23 are developers of high-speed oscilloscopes (photo from 1967).

From left to right, top row: R.V. Bodnar, Z. Bigelis, K. Burba, V.M. Krestnikov, V.I. Vinogradov, E.L. Livshits, A.G. Onishchenko, V.E. Paskis; ***bottom row:*** V.N. Pleago (Tymko), I. Kudziavychene, N.E. Kuzovkova

The development of special and high-speed oscilloscopes is carried out mainly:

- since 1965 in sector LS23, head V.I. Vinogradov,
- since 1976 in LS-223, beginning. V.A.Sylvestruk, since 1978 A.G.Onishchenko,
- since 1984 in NIS-422, beginning. A.G. Onishchenko,
- since 1986 in NIS-43, beginning. A.G. Onishchenko.

S1-36, completed in **1965,** developed by: Onishchenko A.G., - ELTBV; Kozlov V., Bigelis Z. – development; Burba K. - synchronization; Krestnikov V.M., Chepilko O.M. - high-voltage converter and scanner, Taskin L.A. - calibrator,. It was at this time that the main backbone of the team of developers of high-speed oscilloscopes began to take shape (see Section 1.4.)

During these same years, an employee of the Institute of High Energy Physics, Doctor of Technical Sciences, began to take an active part in the development of high-speed oscilloscopes and ELTBVs. Boris Utochkin. Using the experience of constructing elementary particle accelerators in nuclear physics, B.N. Utochkin proposed a very effective system for focusing the ELTBV beam to increase sensitivity using external quadrupole magnetic lenses.

In the small town of Protvino, near Serpukhov, among a birch grove on the rocky base of the Central Russian Upland, in order to avoid geological influences, a grandiose, second largest particle accelerator in the world - a synchrocyclotron - was built. The circumference of the acceleration channel reached 2.2 kilometers. For comparison: in Dubna, at the international center for nuclear research, the particle accelerator had a circumference of only a few tens of meters.

The focusing of a beam of elementary particles - protons - was carried out by a magnetic field, for which powerful electromagnets were placed along the entire circumference of the synchro-cyclotron. B.N. Utochkin proposed using this principle of beam focusing in ELTBV, which was later implemented in the 10LO102M model, used in the S7-10 oscilloscope.

In 1968, on the topic **"Plot",** a highly sensitive high-speed oscilloscope **S7-10** (S1-61) was developed for the 0-1 GHz band.

The S7-10 oscilloscope had working screen dimensions of 20x40 mm, a deviation coefficient of 100 mV/mm with a beam line width in the center of the screen of 100 ÿm, scan speeds from 0.25 ns/mm to 100 ns/mm, an input resistance of 75 Ohm and a weight of 106 kg . It used ELTBV type 10LO102M, which used principle of beam focusing proposed by B.N. Utochkin. His institute was the first customer of the oscilloscope.

ELTBV 10LO102M was developed at the Platan Research Institute in Fryazino by V.A. Shkunov and was distinguished by an extremely effective beam focusing system to increase sensitivity. In the new ELTBV, two coils were put on the neck of the tube, near its cathode, and direct current was supplied to them. It took a very long time to select the location of the coils and the current value to obtain the best result (this work was carried out by V.M. Krestnikov). We finally settled on the design when the poles of the electromagnets were placed near the ELTBV, and the coils were fixedly positioned outside. These were so-called quadrupole lenses; There were two of them, which is why they were called duplet.

Since the developers of the ELTBV (and B.N. Utochkin especially) believed that in order to ensure the best focusing of the beam in the device, all parts of the circuit, and even the filament of the lamps, should be powered by direct current, a powerful network transformer and powerful voltage stabilizers were used in it. The ELTBV was placed in a continuous screen made of treated permalloy.

High-speed oscilloscope S7-10. 1968

Parameters of S7-10 devices:
- 1000 MHz band,
- photo recording speed - 1000 km/sec,
- input 75 Ohm,
- sensitivity 100 mV/mm+/-10%.,
- sweep 0.25 ns/screen, +/-10%,
- screen 20x40 mm,
- beam 100 microns,
- power consumption 750 W,
- weight 106 kg.

A major challenge was creating fast sweeps. It was necessary to generate a sawtooth voltage with a swing of up to 200 V. A problem arose with the switch switching current of several amperes. At first, traditional high-power lamps were used. Then, in Novosibirsk, special high-voltage lamps were developed that operated with an anode voltage of 600 V. A sawtooth voltage of 200 V was “cut out” from this voltage.

Subsequently, electronic semiconductor devices were used in scans, which were a hybrid of an electric vacuum tube and a semiconductor device. Such devices were developed using Svetlana software. Among engineers they were called “lampistors”.

In 1971, on the topic **"Sonnet-2"** after the modernization of the high-speed oscilloscope S7-10, two new modifications of it, **S7-10A and S7-10B,** were created for the 0-1.2 GHz band.

At the same time, the bandwidth was expanded and the weight was reduced. For the S7-10B, the new ELTBV 10LO103M was also used, with higher sensitivity, a larger screen size and an order of magnitude higher recording speed. A faster sweep was also developed for the S7-10B.

High-speed oscilloscope S7-10A.
1971

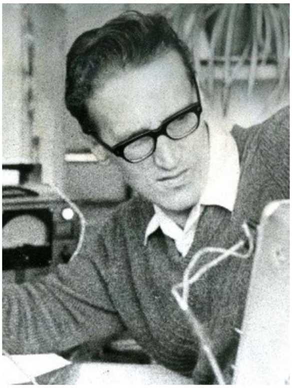
Parameters of S7-devices 10A/B:

- 1200 MHz band,
- photo recording speed - 1/10 thousand km/sec,
- input 75 Ohm,
- sensitivity. 100/75 mV/ mm+/-10%.,
- scan 0.25/0.125 ns/sec., +/-10%,
- screen 20x40/40x40 mm,
- beam 100 microns,
- power consumption 750 W,
- weight 75 kg.

S7-10/A/B was developed by:
- Onishchenko A.G. - ELTBV, chief designer,
- Bigelis Z. - scanner,

- Burba K. - synchronization,
- Krestnikov V.M., - high-voltage converter, scan,
- E.L. took part in the work. Simanson, L. Bogdanova and V.M. and Makarska – design.

Oscilloscopes S7-10 were mass-produced at Vilnius factory For the creation of the S7-10 oscilloscope, A.G. Onishchenko was awarded a bronze medal from VDNKh.



Viktor Ivanovich Vinogradov. Photo from the late 1960s

Anatoly Grigorievich Onishchenko with the new ELTBV. Photo 1975

Zigmas Bigelis. Photo from the early 1980s

Vladimir Mikhailovich Krestnikov

Kyastutis Burba.

From left to right: K. Burba, V. M. Makarskaya, V. M. Krestnikov (records signal), A.G. Onishchenko, L. Bogdanova, E.L. Simanson (focuses oscilloscope S7-10A). Photo from the late 1970s

The complexity of working on these devices was added by the fact that work on similar devices abroad, in the USA and in France, was strictly classified, and even obtaining information about the parameters of their devices was significantly difficult, and the acquisition of foreign analogues for study was completely excluded. The developers of these devices had to do almost everything on their own from scratch, while developers in other sectors had the opportunity to get acquainted with the operation of foreign devices not only from the documentation, but also by studying the oscilloscope samples purchased for this purpose.

On the other hand, the US CIA closely monitored all VNIIRIP developments in this area. Of undoubted interest is the declassified report on the technical level of Soviet traveling wave tube oscilloscopes, prepared for the CIA by John *K. Boiciock* and dating back to 1975 [31] (see section 3.4.). This report accurately describes our C1- devices.

14, C1-36, C7-10, C7-10A, C7-10B.

In 1975, high-speed trains were developed on the topic **"Signal".** oscilloscopes **S9-4/S9-4A,** for the 0-100/0-500 MHz band.

S9-4 (S9-4A) was mass-produced at the Vilnius plant and in terms of production volume it took 17th place out of 28 among VNIIRIP oscilloscopes.

The price of this device was almost a record - 16 thousand rubles, more than half of which was the price of a CRT. In terms of price, among the expensive oscilloscopes of VNIIRIP, it took second place and was second only to the 18 GHz strobe oscilloscope - S9-9 (Sigma),

In 1984-88 1019 pieces were produced. such devices in the amount 16.304 million rubles, on average 200 pcs. in year.

These devices were classic single-shot recorders. Further increases in the speed of high-speed recorders of single-shot signals were limited by the low speed of photo recording, which was limited by the current of the CRT beam, the brightness of the phosphor, as well as the aperture of the photographic lens and the sensitivity of the film. One of the ways to increase recording speed was the

creation of a fiber-optic CRT screen and a contact (without lens) method of direct photo recording, which was implemented in this development. The customer for this device was employees of the Moscow Research Institute of Pulse Technology,

one of the leading enterprises in the nuclear industry in the development of equipment for measuring the characteristics of various types of radiation.

Special oscilloscope S9-4. 1975

Special oscilloscope S9-4A. 1975

The S9-4 oscilloscope contained a vertical deviation amplifier with a bandwidth of 0-100 MHz. In the S9-4A oscilloscope, the signal under study was applied directly to the deflecting

CRT plates type 13LO106A; The bandwidth was 500 MHz. The signal was recorded using a contact photo attachment from a fiberglass CRT screen. The photo recording speed reached 20,000 km/s. Increased noise immunity of the device was noted.

Parameters of devices S9-4/S9-4A:
- C9-4 band with 100 MHz amplifier,
- band C9-4A when feeding a signal to a 500 MHz CRT,
- photo recording speed 1.5/20 thousand km/sec,
- sensitivity 10 mV/div.+/-10%.,
- sweep 2.5 ns/div., +/-10%,
- power consumption 150 W,
- weight 35

kg. For the creation of the S9-4/S9-4A oscilloscope, Zigmas Bigelis was awarded the Order of the Badge of Honor.

S9-4/S9-4A were developed by:
- Denisov A.F. - head design,
- Bigelis Z. - Ved. Eng.,
- Kudykin Yu.A., Sverchkov E.N., Taskin L.A., T. Pleshkova, - developers.




A.F. Denisov Zigmas Bigelis. Yu.A. Kudykin. E.N. Sverchkov

In 1976, based on the ELTBV 10LO104a, a high-speed oscilloscope **S7-15 ("Seven") was developed,** for the first time in the 5 GHz band.

S7-15 was mass-produced at the Vilnius plant. As in the high-speed oscilloscope S9-4 (see above 1975), one of the ways to increase recording speed was the creation of a fiber-optic CRT screen and a contact (without lens) method of direct photo recording, which was implemented in this development.

ELTBV for S7-15 contained a traveling wave signal system with a tape slowing spiral and a focusing doublet system based on magnetic quadrupole lenses, which made it possible to achieve photo recording speeds of up to 40 thousand km/sec.

Within the framework of this topic, a special camera was created for contact registration of a signal from a fiber-optic CRT screen.

Parameters of the S7-15 device:
- band 0-5000 MHz,
- ELTBV 10LO104a,
- input – 50 Ohm,
- beam width in the center 85 microns,
- working part of the screen 15x40 mm,
- RF-3 photographic film,
- photo recording speed - 40 thousand km/sec,
- sensitivity 1000 mV/ mm+/-10%.,
- sweep 0.1 ns/cm, +/-10%,
- power consumption 210 W,
- weight 50 kg.

S7-15 was developed by:
Head construct. - Onishchenko A.G.,
ved. Eng. - Burba K., synchronization, development,
Krestnikov V.M., - high-voltage unit, synchronizer,
developers - Vereshchak O.T., Wengersky Y.E., Taskin L.A.,
construction - Simanson E.L., Makarskaya V.M.

Collective LS-23:
Standing:
K. Burba, L. Bogdanova, Yu.A. Kudykin, Yu. Anisimov, V.M. Krestnikov;
sitting:
A.G. Onishchenko, V. I. Vinogradov, E. Rappoport, E. L. Simanson.

In 1980, a special digital storage oscilloscope **S9-6 ("Rafters")** was developed to record single-shot signals in the 0-100 MHz band **(the equivalent sampling frequency of a single signal is 10 GHz).**

S9-6 was mass-produced at the Vilnius plant and in terms of production volume it took 20th place out of 28 among VNIIRIP oscilloscopes. The price of this device is 7.3 thousand rubles. In 1984-60 966 units were produced. such devices worth 7.05 million rubles, an average of 160 pcs. in year. This important instrument was the first to discover a new, digital technology for

recording wideband single-shot signals with the output of signal data to an external computer, which significantly increased measurement productivity. Previously, the main method of recording such signals was photo registration, which was inconvenient and unproductive, since in order to observe the signal it was necessary to first develop the film. And now the signal immediately appeared on the indicator screen or computer display.

Special oscilloscope S9-6 with a bandwidth of 100 MHz. 1980

S9-6 parameters:
- 100 MHz band,
- gas-discharge indicator panel 100x100 points,
- marker measurements,
- recording speed 3000 km/sec.,
- sensitivity 5 mV/div.+/-3%.,
- sweep 2.5 ns/div., +/-3%,
- ADC resolution 256*256 lines (8 bits, 256 points/signal),
- equivalent sampling frequency of a single signal 10 GHz,

- interface with an external computer – cable up to 5 km, up to 64 channels,
- power consumption 560 W,
- weight 46 kg. (I9-2 / 30 kg + S9-6 / 16 kg)

This device was a development of the idea on the basis of which the C8-8 device was built (C1-58, “Pile”, see 1969, section 3.9). The S8-8 was the first to implement raster reading of a single signal from the SELT screen, but it did not provide data output to an external computer, and its bandwidth was too narrow - only 1 MHz.

A high-speed single-shot signal in the 0-100 MHz band in the S9-6 device was first recorded at high speed on a blind SELT target, and then read with a special raster, digitized using an ADC and recorded in digital memory. Then this signal was sent to the display unit and an external computer.

The device was an automated digital
a program-controlled system and consisted of two blocks:
- I9-2 recorder unit based on a blind CRT with a silicon target, type LN20, which was used as an analog storage device;

- indicator block C9-6 with control circuits and device
display based on the gas-discharge indicator IMG-1-01.

Oscilloscopes for organizing intended multi-channel (up to 64 channels) for measuring systems with digital data transmission over a distance of up to 5 km via two cable lines. Their digital part was built on TTL logic chips.

S9-6 was developed by:
- Denisov A.F. - head constructor,

- Avdeev V.A. - Ved. engineer, Ph.D., who arrived from Tomsk for a competition, especially for this project,
- Bodnar R.V. (research), Kudykin Yu.A. (amplifier), Pitz I.I., Taskin L.A., Didenko V.P., Dvoretsky Vyacheslav, (block indicator) - developers.

Avdeev V.A.

Bodnar R.V.

Kudykin Yu.A.

Pic I.I.,

Sverchkov E.N.,

Taskin L.A.,

Didenko V.P.,

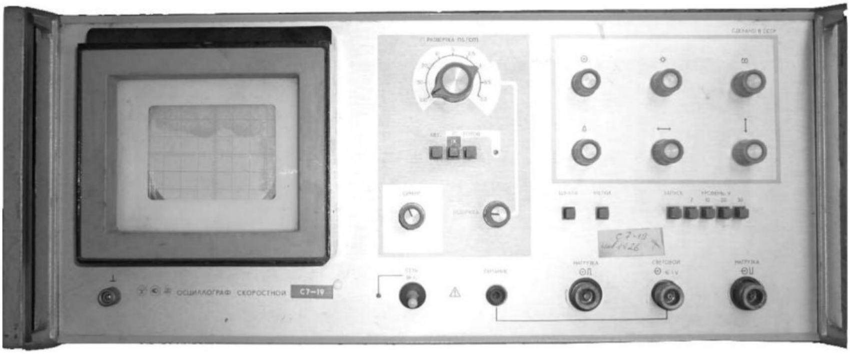
Dvoretsky Vyach.

In 1982, the high-speed oscilloscope S7-19 was developed , **("Shine"),** for the first time with a recording speed of 250 thousand km/sec., on the 5 GHz band.

S7-19 was mass-produced at the Vilnius plant.

The next fundamental way to increase recording speed (after S9-4, S7-15) was the creation of a CRT screen in the form of microchannel brightness amplifiers, which was implemented in ELTBV 10LO105A for S7-19.

This ELTBV contained a traveling wave signal system with a tape slowing spiral, a focusing doublet system based on magnetic quadrupole lenses, and a screen of microchannel plates - brightness amplifiers, which made it possible to achieve photo recording speeds of up to 250 thousand km/sec, and fully realize band 5 GHz.



High-speed oscilloscope S7-19. 1982

S7-19 was developed by:
Head construct. - Denisov A.F.,
deputy. Ch. design - Onishchenko A.G.,
Sverchkov E.N., - scan,
Taskin L A - calibrator,
developers - Didenko V.P., Pleshkova T.S.
Parameters of S7-19 devices:
- band 0-5000 MHz,
- photo recording speed - 250 thousand km/sec,
- deviation coefficient 170 mV/mm+/-10%.,
- sweep factor 0.2 ns/cm, +/-10%,
- time resolution 5.5 ps,
- power consumption 170 W,
- weight 30 kg.

In 1986, a special oscilloscope **S9-13** was developed (on the “Sonata” theme) for recording single-shot signals in the 0-350/1000 MHz band **(with an equivalent sampling frequency of a single signal - 40 GHz).**

The S9-13 was not mass-produced due to the demise of the VNIIRIP and VZRIP enterprises in the early 1990s.

It consisted of a converter block I9-3 and an indicator block S9-13.

This device was a development of the C9-6 device ("Rafters", see above here 1980), which for the first time implemented digital raster reading from a blind CRT target.

A high-speed single-shot signal in the 0-350/1000 MHz band in this device was first recorded at high speed on a blind CRT target, and then read by a special raster, digitized by an ADC and recorded in digital memory, and then sent to the display unit and an external computer.

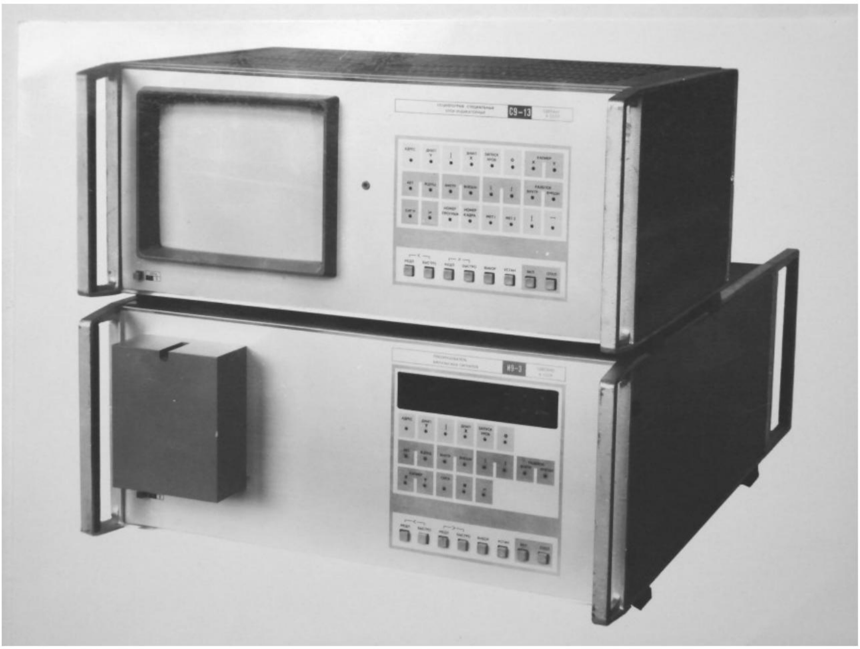
It was distinguished from

S9-6 by: - the use of a microprocessor to control the device,
- higher equivalent sampling frequency, 40 GHz
versus 10 GHz, -
wider bandwidth 350 MHz versus 100 MHz, when the signal is fed through an amplifier,

- ability to connect directly to a CRT with a 1000 MHz band,

- availability of a COP interface and full remote control of device modes,

- the ability to connect up to 32 converter blocks to one indicator block to organize a multi-channel AIS.



Special oscilloscope S9-13. Photo from 1986

S9-13 was developed by:
- Denisov A.F. - head design,
- Avdeev V.A. - Ved. Eng.,
- Bodnar R.V., Kudykin Yu.A., Pits I.I., Taskin L.A., Didenko V.P., Dvoretsky Vyacheslav., Danilkov, - developers.

Parameters S9-13:
- bandwidth when applying a signal to the deflection plates 1000 MHz,
- bandwidth when applying a signal through an attenuator and amplifier 350 MHz,
- large indicator based on a b/w kinescope,
- sensitivity 10 mV/div.+/-3%.,
- sweep factor 0.5 ns/div., +/-3%,
- ADC resolution 256*256 lines, (8 bits, 256 points/signal),
- equivalent sampling frequency of a single signal 40 GHz,

- type of interface with an external computer – LKP, KOP (HPIB),
- consumption power. 360 W,
- weight 46

kg. **In 1990,** in the NIS-46 sector, based on the S7-oscilloscope
19, an automated measuring system (AIS) was developed, later on the basis of which the AIS **K2-** was created
74) for recording single-shot signals, **over a 5 GHz band, with an equivalent sampling frequency of 400 GHz**

Several samples of this AIS were manufactured and supplied to Russia, China and other countries.

The system, using a domestic CCD matrix as a device, provided readout registration of single signals in the frequency band of the S7-19 oscilloscope with a time resolution of 4 ps/line, a deviation coefficient of 50 mV/line with an equivalent sampling frequency of 400 GHz with a readout raster of 512x512 lines. The software made it possible to automate the measurement of signal parameters. The system was developed by the head of NIS-46, N.E. Isaenko and leading engineer I.I. Zhilevich.

Over 18 years (from 1968 to 1986), VNIIRIP developed 10 models of special high-speed oscilloscopes for single-shot signals, namely S7-10, 10A, 10B, S9-4, 4A, S7-15, S9-6, S7-19 , S9-13, K2-74.

1.12. Stroboscopic oscilloscopes. 1969-1992

In terms of sales volumes, **the direction of stroboscopic** (C7), including stroboscopic-special (C9) **oscilloscopes, took seventh,** penultimate place, among eight other areas of development of VNIIRIP oscilloscopes. For the period 1984-1992 the production volume of such devices amounted to about **19.3 million rubles,** which amounted to about **2.9%**

production volumes of all VNIIRIP oscilloscopes over these years (see tables at the end of Appendix 1).

Stroboscopic oscilloscopes allow you to observe only repeating signals, which is why their range of application is narrower than other types of oscilloscopes, but they have a significant advantage - a significantly wider bandwidth up to tens of gigahertz, with high sensitivity at the level of units of millivolts. As mentioned above in section 1.4. The first single-channel stroboscopic oscilloscope of VNIIRIP was S1-15/7, ("Spectator", with U7 block, for a 200 MHz band), developed in 1965 under the direction of A.F. Denisova.

The group of block developers included V.A. Sylvestruk, E.N. Sverchkov, E.I. Alekseev.

Then, in 1967, the same group developed a two-channel replacement unit U8 for S1-15/8 ("Lead"), for the 350 MHz band. Both blocks U7 and U8 also worked in oscilloscopes S1-17/7 and S1-17/8. These devices were mass-produced by the Bryansk plant.

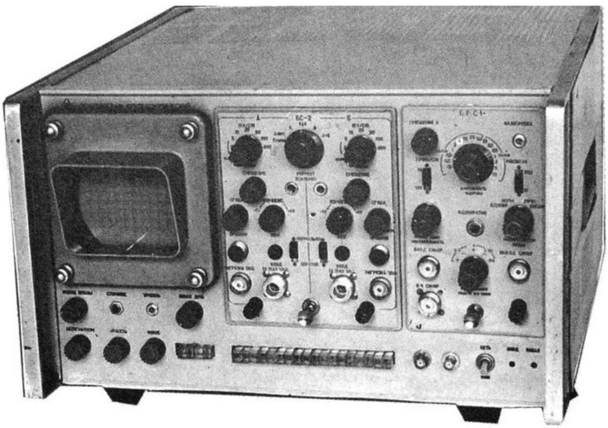
In 1969, the 3rd stroboscopic (and 1st monoblock stroboscopic) oscilloscope **S7-8 (S1-53, "Saccharin").** This was the next step in the direction of expanding the bandwidth of sampling oscilloscopes, the bandwidth was expanded by 4.3 times, from 350 MHz (S1-15/8) to 1.5 GHz. The C7-8 was mass-produced at the Vilnius plant. This was a response to the HP185B (1 GHz) and TEK661 (1/3.5 GHz) devices released in 1962.

It uses a bistable ZELT 13LN2, which made it possible to observe rarely repeating signals in a more comfortable mode.

V.A. remembers Sylvestruk: “The development of a stroboscopic mixer with the required transient response parameters caused many problems. This was our first 50-ohm mixer, since all mixers developed before were 75-ohm.

ohmic We managed to achieve the desired results only on the second attempt.”

A selection committee was unexpectedly appointed to Gorky. The commission resulted in a competition between the S7-8 oscilloscope and the S7-9 oscilloscope, developed by the Gorky GNIPI. As a result, the vertical path turned out to be better for the Gorky residents, and the horizontal one for the Vilnius residents. This was due to the fact that in the S7-8 oscilloscope, to ensure synchronization at frequencies above one gigahertz, gallium arsenide generator tunnel diodes 3A201, produced by the Tomsk Research Institute of Industrial Equipment, were used for the first time.



Stroboscopic oscilloscope S7-8 (S1-53). 1969

Parameters of the S7-8 device:

- 1500 MHz band,
- number of channels - 2,
- sensitivity 10 mV/div. +/-10%,
- sweep 100 ps/div. +/-10%,
- power consumption 300 W,
- weight 38 kg.

Glavk decided to launch both devices into series at different factories in the industry. Life put everything in its place: the C7-8 oscilloscope was successfully produced at the Vilnius plant for a long time, while the C7-9 could not be put into production for a long time at the Abovyan Izmeritel plant.

Chief designer - Denisov A.F., deputy chief Silvestruk V.A., developers - Saldin A.A., Alekseev E.I., Sverchkov E.N., Paskis V.E., Leshkova G.D., Voloshin A., Rogudeev.

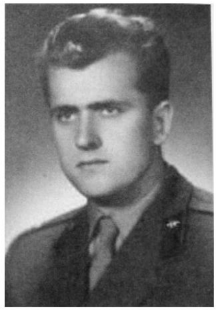
Alexander Fedorovich Denisov.

Vladimir Andreevich Silvestruk

Alexander Anisimovich Saldin.

Evgeniy Ivanovich Alekseev.

Evgeniy Nikolaevich Sverchkov



Vladimir Evaldovich Paskis

Starting from the late 1960s, stroboscopic oscilloscopes were developed in the laboratory, and then in the department of M.I. Efimchik. Developments were carried out both in the direction of creating monoblock devices and in the direction of creating replaceable units for universal oscilloscopes with replaceable units of new generations.

In 1971, on the 13LO2x CRT, the first stroboscopic oscilloscope was developed, according to the requirements of the general customer, **S7-11, (S1-66, "Sniper"),** for the 0-5 GHz band. In this case, the bandwidth of the stroboscopes was expanded by 3.3 times, after C7-8 (1.5 GHz). S7-11 was mass-produced at the Vilnius plant

The S7-11 oscilloscope was a two-channel device with the ability to connect high-resistance active probes, and also with a built-in high-frequency delay line to compensate for the initial sweep delay. The original design of the input path was a waveguide two-diode mixer, in which the duration of the strobe pulse was formed at the cutoff frequency of the rectangular waveguide.

B.N. Levitas recalls: “In 1973, I took part in the implementation of the device at the Vilnius plant. Then serious problems arose with the mixer - the VSWR of the device input was not provided. We had to modify the design and use high-frequency absorbing materials, after which the device began to be mass-produced by the plant.”

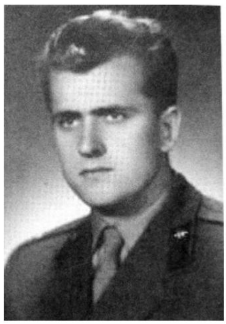
Device parameters S1-11:

- 5 GHz band,
- number of channels – 2,
- sensitivity 5 mV/div. +/-10%,
- sweep 50 ps/ div.+/-5%,
- power consumption 160 W,
- weight 33 kg.

Stroboscopic oscilloscope S7-11. 1971

The chief designer of the development was M.I. Efimchik, the leading engineer was V.E. Paskis (horizontal channel), the leading designer was T.I. Kaskevich, G.D. Leshkova participated in the work.

Mikhail Ivanovich Yefimchik. Photo from the early 1970s



Vladimir Evaldovich Paskis. Photo from the mid-1960s

In 1972, a new, second, transistor generation of oscilloscopes with replaceable units of the **S1-70 (“Snay-ge”) family appeared,** instead of the first, tube generation S1-15 (“Kulis”). In addition, in the same year, stroboscopic amplifier blocks **1U71 (Ya40-1700)** and scanning unit **1P71 (Ya40-2700)** were developed for the 3.5 GHz band (instead of U7 blocks from S1-15/7 and U/8 from S1-15/8).

Both units were mass-produced by the Vilnius plant and were included in one of the delivery kits (“fractions” - **S1-70/2)** of the S1-70 family oscilloscope.

The first two-channel pass-through mixer developed was distinguished by its simplicity and reliability. V.A. German took part in his calculations.

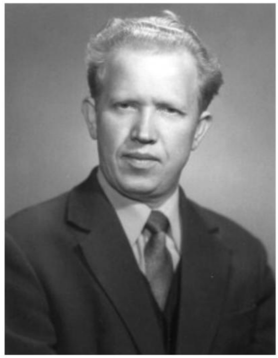
A.A. Saldin recalls: “I decided to calculate in detail the two-channel mixer using two methods - traditional and operator-based. Calculations showed that the mixer transmission coefficient should be 13%, which was an extremely good result. Based on this calculation, we made three mixer prototypes, and the test results of one of the prototypes showed a bandwidth of up to 7 GHz. This layout was taken as the basis for the development of design documentation.”

Stroboscopic version of the universal oscilloscope S1-70
with replaceable stroboscopic units 1U71 and 1R71. 1972

The 1U71 (Ya40-1700) stroboscopic amplifier unit was developed under the leadership of A.A. Saldin, and the 1P71 stroboscopic scanning unit was developed under the leadership of G.D. Artamonova.

Alexander Anisimovich Saldin. Photo 1967

Galina Dmitrievna Artamonova. Photo from the early 1970s.



Evgeny Ivanovich Alekseev. Photo from the late 1960s

In 1974 , E.I. Alekseev developed the **1U72 (Ya40-1701)** stroboscopic amplifier unit for the **S1-70** family **("Snaige")** with an input 2-channel probe with an input resistance of 100 kOhm, for a band of 0-700 MHz.

This unit was mass-produced by the Vilnius plant and was included in one of the delivery kits ("fractions" - **S1-70/3)** of the S1-70 family oscilloscope.

In 1977, a new third ("chip-based") generation of oscilloscopes with replaceable units of **the S1-91 ("Light") family appeared.**

Further expansion of the bandwidth in stroboscopy was associated, first of all, with the development of replaceable units for the family of oscilloscopes of the "Light" series: S1-91, S1-115, S1-122, and S8-21, Ya4S-111. This problem was solved by a group of developers of the LS211 laboratory under the leadership of M.I. Efimchik.

In 1978, within the framework of the **"Fiber-1" theme,** a set of blocks for the **S1-91/3** stroboscopic oscilloscope was developed with **Ya4S-95, Ya4S-96 and Ya4S-89** blocks for the first time in the 12 GHz band. This time the bandwidth of the stroboscopes was expanded 2.4 times, after S7-11 (5 GHz).

S1-91/3 was mass-produced by the Minsk plant.

Division 21 Stroboscopic Oscilloscope Development Team.
From left to right: O.M. Zaitsev, Ya.M. Rossosky, V.S. Royzentok, M.I. Efimchik, B.N. Levitas, A.S. Minin, V.I. Garkavy. Photo from the early 1980s

In 1984-88 1,452 such devices were produced, on average 300 devices per year, at a price of 5,000 rubles, worth 7.26 million. rubles

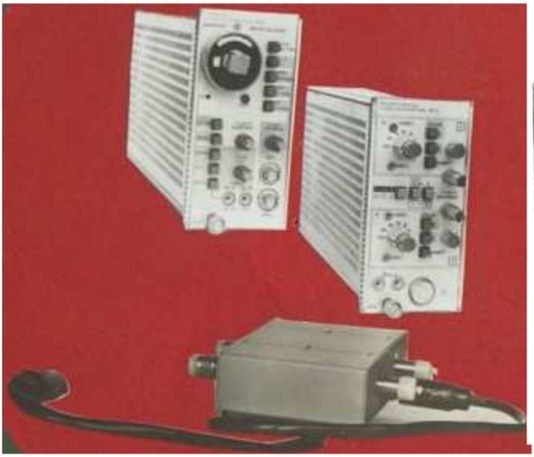
To carry out reflectometric measurements, an original remote pass-through mixer was developed (developed by B.N. Levitas, O.M. Zaitsev, lead designer V.A. Shlyakhtenko). The stroboscopic converter unit (leading engineer

of the unit V.I. Garkavy) with a mixer provided a record bandwidth of 0-12 GHz for that time.

Development (lead engineer of the block Ya.M. Rossosky). provided operation not only in stroboscopic mode, but also in real time.

All this was supplemented by the Ya4S-89 voltage differential generator unit (chief designer V.Latinis, developers A. Petrov, Vlasenko N.), containing a set of multi-polar voltage drop formers with a rise time of 50 or 70 ps.

The units were equipped with developed coaxial units (loads, voltage dividers, tees) with a bandwidth of up to 12 GHz, which greatly facilitated measurements. The design of the units was carried out by B.M. Ostrovsky, later the head of one of the oscillographic PKS.



Replaceable stroboscopic blocks YA4S-96, YA4S-95 and stroboscopic mixer. 1978

Differential generator block voltage Ya4S-89. 1978

Parameters of **the Ya4S-96 stroboscopic transducer unit** with mixer:

- 12 GHz band,
- number of channels 2,
- sensitivity 2-200 mV/div.+/- 3%,
- input 50 Ohm.

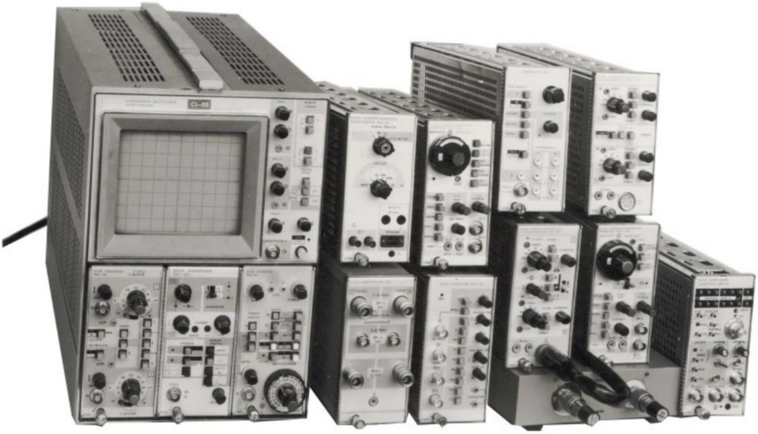
Parameters of the stroboscopic scanning unit

ÿ4ÿ-95:

- sweep 20 ps/div.-10 ÿs/div., +/- 4%,
- synchronization 0-5 GHz.

Parameters of **the Ya4S-89 voltage differential generator block :**

- band of tested devices - 5 GHz,
- rise time 50 ps,
- amplitude 200 mV, at a load of 50 Ohms,
- emission 5%,
- unevenness of the top 2-4%.



Dual-beam universal oscilloscope S1-115, with replaceable, including stroboscopic units /3, /4, and /13.

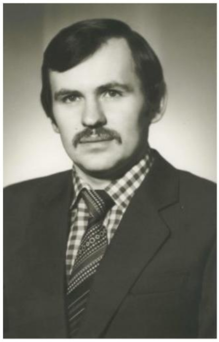
The Ya4S-95 and Ya4S-96 blocks were produced by the Minsk plant, and the Ya4S-89 block by the Vilnius plant. In the S1-91/3 version, the oscilloscope has been mass-produced at the Minsk plant since 1981. The chief designer of the "Fiber-1" theme is M.I. Efimchik.

Mikhail Ivanovich Yefimchik.

Yakov Moiseevich Rossosky.

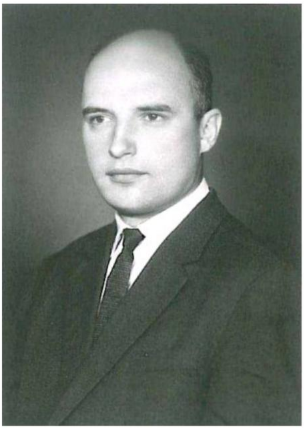
Vladimir Ivanovich Garkavyi

Boris Notelevich Levitas.

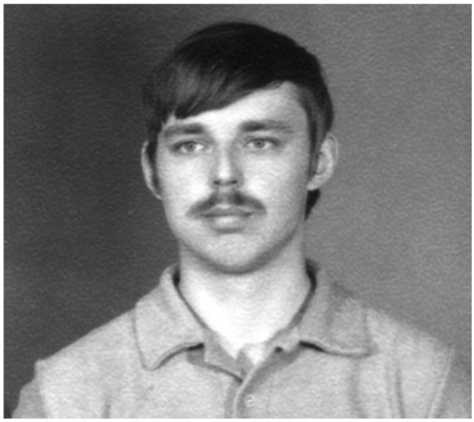


Oleg Mikhailovich Zaitsev.

Valentina Afanasyevna Nobleman



Vitas Latinis.



Anatoly Viktorovich Petrov

In 1981, within the framework of the **"Strobe-1"** theme , a set of stroboscopic units was developed for oscilloscopes of the "Svet" family, such as **S1-91/4, S1-122/4 and S1-122/13,** as part of **Ya4S-100, Ya4S-101, and Ya4S-102,** for the first time in the country on the 18 GHz band.

This was the next step in the direction of expanding the bandwidth of stroboscopic oscilloscopes by 1.5 times, after S1-91/3 (12 GHz).

Called among experts "The Fourth Fraction," the set of replaceable blocks "Strobe-1" for oscilloscopes S1-91/4 (and since 1984 for S1-122/4 and S1-122/13) was produced by the Minsk Plant for a long time. For 1985-1992 1486 such devices were produced, on average 212 devices per year, at a price of 3908 (for C1-

122/13) or 5580 rubles (for C1-91/4 and C1-122/4), in the amount of 7.078 mil. rubles The S1-91/4 and

S1-122/4 kits, in addition to the Ya4S-100 converter unit and the Ya4S-101 scanner unit, also included a Ya4S-89 differential generator unit, and the S1-122/13 kit included a Ya4S-102 delay unit instead .

It should be noted that for the first time in the USSR at this time, the bandwidth of a domestic oscilloscope in stroboscopic mode was equal to the same parameter of the world's best similar device of the HP 180 series, and exceeded the bandwidth of a similar device of the Tektronix 7000 series.

Ya4S-100 parameters:
- 18 GHz band,
- rise time 50 ps,
- number of channels -2,
- sensitivity 2 mV/div., +/-4%,

Ya4S-101 parameters:
- sweep 10 ps/div.-10 ÿs/div., +/-4%,
- synchronization 0-10 GHz.

Ya4S-102 parameters:
- 3 GHz bandwidth,

- rise time 150 ps,
- delay time 70 ns,

Oscilloscope S1-91/4 with replaceable strobe

blocks Ya4S-100, Ya4S-101 and Ya4S-89. 1981

Development was carried out in department 21, chief and chief designer Efimchik M.I., and in LS-211, beginning. Rossosky Ya.M.

The 2-channel stroboscopic converter unit Ya4S-100 was developed by V.I. Garkavy, and the remote mixer for it was developed by B.N. Levitas. and Zaitsev O.M.

The units performed digital measurements of voltage and time intervals using compensation and double delayed sweep methods. The two-channel analog delay unit Ya4S-102 provided a delay of 70 ns with a bandwidth of 2.3 GHz. The set of the device included developed by B.N. Levitas and V.S. Roisentok coaxial nodes, already with a bandwidth of up to 18 GHz.

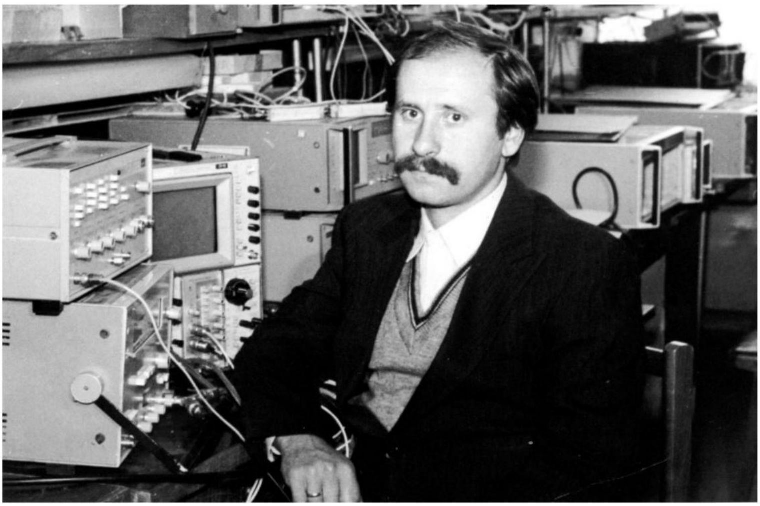
Such successes in the development of new frequency ranges would have been impossible without serious achievements in the field of creating new semiconductor devices at MEP enterprises, commissioned by developers from VNIIRIP, as well as our own technologies developed at VNIIRIP.

Thus, 3A538 pulse mixing diodes were developed at NIIPP, in Tomsk, under the leadership of department head I.D. Romanova. Fast-acting charge storage diodes

2D528 were developed at the Dnepr Production Association in Kherson, under the leadership of department head F.V. Prodan.

Picosecond tunnel diodes 1I308 were created at the Moscow Sapphire software. The microelectronics

department of VNIIRIP (department head V. Guoga) has developed a set of semiconductor wafers for coaxial units with a bandwidth of up to 18 GHz.



Victor Sergeevich Royzentok. Photo from the mid-1980s

In 1981, the first precision unique stroboscopic digital oscilloscope **S9-9 (“Sigma”) was developed,** with a microprocessor system for the 0-18 GHz band. C9-9 in 1985-91 was mass-produced

at the Minsk plant and took 23rd place among VNIIRIP oscilloscopes (out of 28) in terms of production volume.

In 1985-1991 181 pieces were made. such devices worth 4.9956 million rubles; on average, more than 20 such devices were made per year, at a price of 27.600 thousand rubles.

In terms of price, this device set an absolute record in the 80s. among other VNIIRIP oscilloscopes, as well as a weight record - 62 kg, since it became undoubtedly one of the most complex devices developed in the entire history of VNIIRIP.

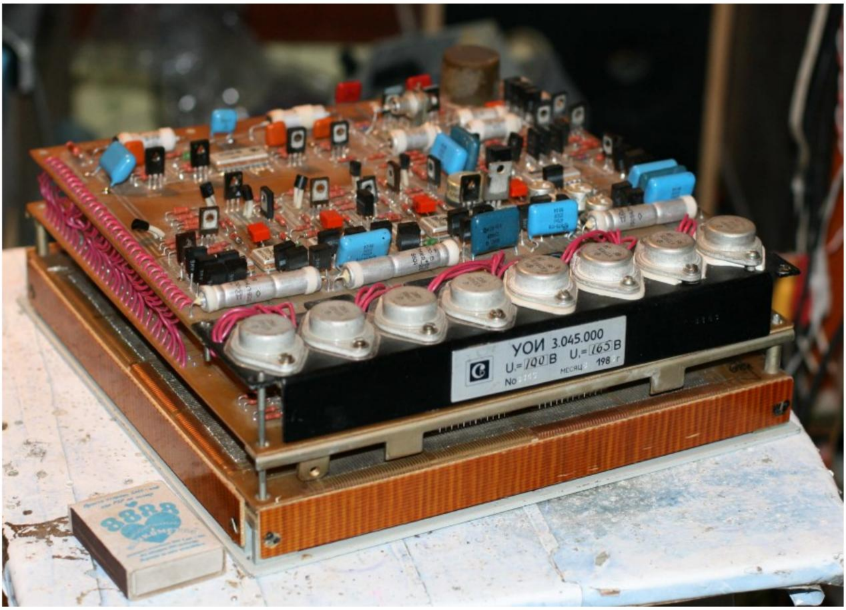
C9-9 precision sampling oscilloscope. 1981

This development can undoubtedly be called epochal and key, on the basis of which the team of digital oscilloscope developers grew under the leadership of Efimchik M.I.

In addition, this oscilloscope became the first VNIIIRIP oscilloscope to use microprocessor control.

Thanks to this development, the following appeared in the oscillography department for the first time:

- mini and micro-computers,
- programmers and programmers,
- debugging systems.



Gas-discharge matrix panel IGPV1-256x256 with control circuit, used as an indicator in the S9-9 oscilloscope

In the country by this time, the state standard and the general customer raised the question of metrological support for the production of generators with a rise time of 50 ps. To solve this problem, new methods for calibrating the device using frequency response and

Fourier transform were required, which required powerful hardware and software support. What was fundamentally new was, first of all, the approach to solving the main metrological problem, which is the reliable measurement of the amplitude-frequency response (AFC) of a stroboscopic oscilloscope

using precision power calibrators. Measurement data over the entire bandwidth up to 18 GHz were stored in the device's memory. Then the transitional characteristic

The statistics of the measured pulse generator were recorded in the oscilloscope memory, where it was transformed into the frequency domain using a direct Fourier transform. In the frequency domain, the signal shape was adjusted taking into account the data from the measured frequency response of the oscilloscope, after which the signal was returned to the time domain using the inverse Fourier transform.

Mathematical operations of direct and inverse Fourier transforms, performed in real time, were performed using a hardware-software method using a controller built into the display unit based on hard logic, developed in-house, which was carried out for the first time in oscillography. As a result, the S9-9 stroboscopic oscilloscope, created as part of the Sigma research and development project, was the first exemplary domestic oscilloscope, which became a means of first-class pulse measurements, intended for testing differential generators with a rise of 50 ps or more.

First of all, it ensured high accuracy and stability of the main metrological characteristics. Thus, when a pulse was applied with a rise time of 50 ps or more, the surge and unevenness of the transient response in the section up to 150 ps did not exceed ±2%, and in the section after 150 ps it did not exceed ±1%.

Employees of VNIIFTRI (the head institute of the USSR State Standard) also took part in the creation of the device - V.Z. Manevich, E.F. Hamadulin. A large team of

developers worked on this device:

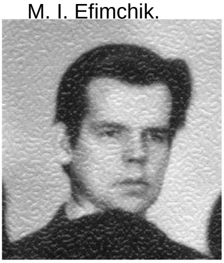
- Efimchik M.I., head. constructor,
- Radionov N.V., 1st deputy. Ch. Veda designer engineer,
- Levitas B.N., deputy. in microwave technology,
- German V.A., deputy. in metrology and computer technology,
- Ishchuk K., deputy. by design,
- Karpikhin S.A., processor unit,
- Rossosky Ya.M., horizontal channel,
- Savin V.K., software,
- Garkavy V.I., vertical channel,
- Zaitsev O.M., mixer, scan calibrator,
- Minin A.S., horizontal channel, deviation calibrator,
- Ivanov V.V., vertical channel,
- Shchava Yu.T., scan calibrator,
- Judge S.P., converter control,

- Galkin A.P., Fourier processor, interface with the SM-4 computer,
- Meriin M.B., Lomachenkov M.A., converter software,

- Karnitskene V., Shlyakhtenko V.A., design.




M. I. Efimchik. N.V.Radionov. B. N. Levitas V. A. German

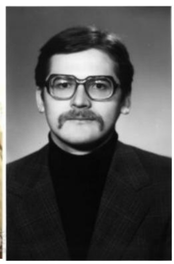
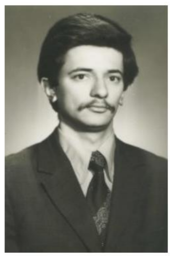



K. Ischuk S.A. Karpikhin. Y. M. Rossosky V. K. Savin




V. I. Garkavy O.M. Zaitsev A. S. Minin. V. V. Ivanov



Yu. T. Stava S.P. Judge A. P. Galkin M. B. Meriin

Employees played a major role in the implementation of the device Minsk plant - Yurko S.N., Kuznetsov O.N., Nikulin V.V.

Parameters C9-9: -
band 0-18 GHz, -
deviation coefficients 5-200 mV/div., - rise time 50
ps, overshoot 2%, unevenness 1%, - amplitude measurement error
1.5-3%, - coefficients sweep 10 ps-10 ÿs/div., -
synchronization band 0-10 GHz, instability 20 ps, -
time measurement error 1.5-4%, - test pulse 50 ps, 0.4 V, - weight
62 kg, - power consumption 400 W.

Leading developers of sampling oscilloscopes. V.V.Ivanov, A.S.Minin, M.I.Efimchik, Y.M.Rossosky, O.M.Zaitsev, B.N.Levitas

In the first half of the 80s, in department 41 under the leadership of M.I. Efimchik carried out a series of works on the creation of a large family of digital and stroboscopic oscilloscopes with replaceable units of the **“Sputnitsa/Sheaf”** family on a single design and technological basis.

As a result, **in 1986-88,** the development of **the S7-20 and S7-21 “Sheaf” stroboscopic oscilloscopes,** as well as **the Ya4S-125 “Sheaf-Chernik”** stroboscopic converter , was completed .

Computational stroboscopic oscilloscope C7-20 with replaceable mixers and voltage difference generators. 1987

Stroboscopic oscilloscope C7-21 with replaceable mixers and voltage differential generators. 1988

Precision stroboscopic transducer YA4S-125, consisting of a base unit YA4S-117, in which the calibrator unit YA4S-124 (left) and the stroboscopic transducer unit YA4S-123 (right) were located. The Sheaf-Blueberry version came with a 10 GHz mixer. 1986

The basis for constructing the devices were two replaceable blocks - stroboscopic converter YA4S-123 with a set of replaceable mixers and generators of picosecond voltage drops, as well as a calibrator unit YA4S-124.

Depending on the type of oscilloscope, the Ya4S-117 base unit, (for the Ya4S-125) the Ya9S-41 indication unit (for the S7-21), and the Ya9S-42 processing and display unit (processor) (for the S7-20) were used.

Three types of two-channel mixers were developed - with a bandwidth of 18 GHz, for the first time for a coaxial path with a cross-section of 3.5 mm, with a bandwidth of 10 GHz - for a coaxial path of 7 mm, as well as a high-impedance (100 kOhm) strobe probe with a bandwidth of 0-1 GHz and replaceable dividing nozzle 1:10. The kit also included three voltage differential generators: with a rise time of 20 ps, 70 ps and 500 ps, a microwave synchronizer, as well as a set of coaxial units of various sections of the coaxial path.

The main designer of the development was M.I. Efimchik. The devices were developed at NIS411; Deputy Chief Designer Ya.M. Rossosky (horizontal channel), B.N. Levitas (microwave units, metrology), O.M. Zaitsev (10 GHz mixer, 1 GHz stroboscopic probe, generator on tunnel diode), V.S. Royzentok (18-GHz mixer, generators on diodes with charge storage), V.V. Ivanov (vertical channel), A.S. Minin and A.A. Konakov (calibrator unit Ya4S-124). The block software was developed by M.B. Meriin.

The main customer of the Ya4S-125 Sheaf-Chernik stroboscopic transducer was the USSR Ministry of Defense. This 10-GHz device was used in the PLIT-A2 Chernika mobile metrological complexes, where, as part of the measurement laboratories, it provided automated verification, adjustment and maintenance of pulse generators and harmonic signal generators.

The documentation for the oscilloscopes was transferred to the Bryansk plant, but due to the crisis of the 90s, the devices were not mass-produced. The department supplied devices to customers in small quantities. From 1986 to 1989, up to 25 such devices were supplied to the customer to complete the mobile laboratories.

Mobile metrological complexes PLIT-A2 “Chernika”

Mikhail Ivanovich Efimchik with young engineers from department No. 21. ***From left to right:*** O.N.Florchuk A.M.Khazanov, M.I.Efimchik, A.Konakov, V.N.Pleshkov, A.A.Lazukin, A.V.Volkov. Photo from the mid-1980s

In 1990, under the leadership of M.I. Efimchik completed the development of a stroboscopic oscilloscope, **S7-20/4 (on the "Sofia" theme),** for the first time in the country on the 30 GHz band.

This oscilloscope continued the line of the family of devices with replaceable blocks "Sputnitsa"/"Sheaf". As part of the work, two new replaceable blocks were created - a stroboscopic converter with a 30 GHz mixer and a microwave synchronizer up to 18 GHz, as well as a calibrator block. The oscilloscope had a record low peak timing instability of 5 ps.

Stroboscopic oscilloscope C7-20/4 at 30 GHz, 1990

The work was carried out at NIS41. The leading engineer and developer of the horizontal channel was A.S. Minin, V.V. Ivanov, S. Efremov, V.S. Royzentok, I.M. Sklizkov took part in the work. The software was developed by M.B. Meriin.

The design documentation for the oscilloscope was transferred to the Bryansk plant, however, due to the crisis of the 90s, the devices were not mass-produced.

In 1991, a new edition of the State Standard for stroboscopic oscilloscopes, the nomenclature of their parameters, as well as technical requirements and test methods was developed to replace **GOST 23602-79.** In the new edition of the standard, significant space was devoted to issues related to digital stroboscopic oscilloscopes. The scientific director of the development was Ya.M. Rossosky

In 1992, under the leadership of the chief designer, head of the sector Ya.M. Rossosky completed the development of the **S7-23 stroboscopic oscilloscope (Sokolniki),** for the 18 GHz band. The background to its creation is as follows.

Portable stroboscopic oscilloscope S7-23. 1992

In 1988, the Moscow Radio Engineering Institute named after Academician A.L. Mints [23], one of the main enterprises of the MRP, was tasked with creating a stroboscopic oscilloscope that would allow precision phasing of extended antenna fields. The result of this was to be a broadband stroboscopic oscilloscope with

Unique even today, peak sweep instability is less than 1 ps.

The development on behalf of the customer was supervised by Igor Vsevolodovich Kaplun, head of one of the radar divisions of the Radio Engineering Institute, later General Director of the Russian company Satis-TL-94, which is a developer and manufacturer of equipment for satellite communication earth stations designed to operate with repeaters of artificial Earth satellites located in geostationary orbit.

The result was the first portable, smallest and lightest sampling oscilloscope in the history of VNIIRIP, with a bandwidth of 0 -18 GHz and a weight of only 8 kg. The remote oscilloscope unit included not only a two-channel pass-through mixer, but also a synchronizer, which was done for the first time. A CRT 12LO1I “Karat” with a working part of the screen 60x80 mm was used as an indicator.

The working project was financed by the Minsk Plant. The chief designer of the development is the head of the sector Ya.M. Rossosky, leading development engineer – O.M. Zaitsev, main developers – S.A. Karpikhin, S.P. Sharanda, the software was created by G.M. Shenderovich.

S. Efremov

I. Sklizkov

Sergey Petrovich Sharanda.

Georgy Shenderovich.

The design documentation for the oscilloscope was transferred to the Minsk plant in 1992, but due to the crisis of the 90s, the devices were not mass-produced.

From the late 1960s until 1991, the leading **developer of stroboscopic oscilloscopes was M.I. Efimchik.** The development of these devices was carried out in his laboratory sector and department.

Mikhail Ivanovich was born in 1932 in the Belarusian city of Slutsk. In **1957 ,**

he graduated from the radio engineering department of the Lviv Polytechnic Institute and was assigned to work at Vilnius plant No. 555. In **1959 ,** he was already acting as chief

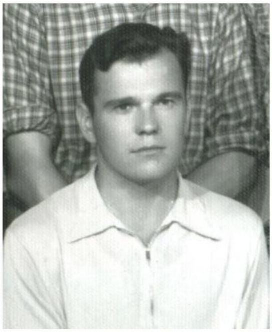
radio pulse department of the radio engineering service of the plant.

In **1960 ,** after the creation of NII-555 M.I. Efimchik was transferred to him to the position of head of laboratory No. 23, department No. 2.

From **1962** to **1970** he worked as a senior scientific employee and leading engineer of the oscillographic department.

Since **1971 ,** he has been the head of the stroboscopic laboratory of department

No. 2. Since **1974 ,** he headed the newly created pulse oscillographic department No. 2.


M.I. Efimchik 1963


M.I. Efimchik 1975


M.I. Efimchik 1985

From **1976** to **1986** - head of the research department, whose main specialization was the creation of digital and stroboscopic oscilloscopes. From **1987** to **1992** he was the head of scientific

research sector.

M.I. Efimchik was the chief designer of a large number of oscilloscopes - five-beam **S1-33,** stroboscopic **S7-11,**
S1-91/3 and C1-91/4, S9-9, S7-20, S7-21 and Ya4S-125, S7-20/4, digital storage **S9-20 - S9-26.**

Mikhail Ivanovich's long-term scientific specialization was the development of broadband stroboscopic mixers, as well as research in the field of asynchronous stroboscopic converters with serial readout.

From 1969 to 1991, the bandwidth of stroboscopic oscilloscopes, developed under the leadership of M.I. Efimchik, **increased 6 times** - from 5 GHz (S7-11) to 30 GHz (S7-20/4).

The devices developed under the leadership of M.I. Efimchik were mass-produced at the Vilnius, Minsk and Bryansk factories for many years. The devices were repeatedly awarded VDNKh medals. M.I. Efimchik is rightly considered the leader under whose leadership computational oscillography was born

and seriously developed. The first domestic oscilloscope to use a microprocessor was the S9-9 oscilloscope, developed under his leadership. In terms of production volumes, for 1984-1992, devices developed under the general leadership of M.I. Efimchik **(stroboscopic, digital, storage, low-frequency and service oscilloscopes)** accounted for up to **28%** of all production volumes of VNIIRIP oscilloscopes.

In **1973 ,** M.I. Efimchik defended his Ph.D. thesis. In 1977, he became a laureate of the State Prize of the Lithuanian SSR in the field of science.

Mikhail Ivanovich Efimchik with young specialists of the 41st department.

Over 23 years (from 1969 to 1992), VNIIRIP developed 10 models of stroboscopic oscilloscopes, models S7-8, 11, S1-91/3, S1-91/4, S9-9, S7-20, 21, Ya4S- 125, S7-20/4, S7-23.

1.13. Digital oscilloscopes. 1979-92

In terms of sales volumes , **the direction of digital storage oscilloscopes (C8-/C9-) took eighth and** last **place** among the eight directions of development of VNIIRIP oscilloscopes.

This is due to the fact that the time of intensive development of digital oscilloscopes coincided with the crisis of the late 1980s in the USSR and the cessation of the activities of the Ministry of Transport and Communications, which made their implementation at factories impossible.

For the period 1984-1992 the production volume of such devices amounted to about **5.564 million rubles** or about **0.8%** of the production volume of all VNIIRIP oscilloscopes over these years (see tables at the end of Appendix 1). This is a group of devices designed for recording single and repeating signals,

including digital storage oscilloscopes and recorders without a screen, which have become a fundamentally new direction in oscillography. The emergence of this direction was due to the successes of digital microelectronics, which made it possible to create microcircuits for high-speed comparators, ADCs, DACs, corresponding storage devices, control logic and microprocessor

controllers.

The background to the emergence of this trend is described above in subsection “1.6.2 Generation “Light”, 1983, research and development project “Owl”.

These devices opened a new 8th (and last) oscillographic direction in the activities of VNIIRIP -

digital storage oscilloscopes, which gradually began to replace analog storage oscilloscopes in production (see above in Chapter 3.9) with ZELT.

Work on the creation of digital storage oscilloscopes began as a result of close cooperation between Department 21 of VNIIRIP (headed by M.I. Efimchik) and the Ryazan Radio Engineering Institute, the department of Professor Berkutov. **In 1979,** the first classic, purely digital (as opposed to an analog oscilloscope with digital

memory, such as S8-22, or S1-121, see Section 1.8 or 1.7) storage oscilloscope **C9-5 was developed (" Sputnik-1"),** per 5 MHz band. C9-5 in 1984-90 was mass-produced at the Abovyan plant and took 26th place among VNIIRIP oscilloscopes (out of 28) in terms of production volume. In 1984-1990 553 pieces were made.

such devices worth 2.765 million rubles; on average, more than 80 such devices were made per year, at a price of 5,000 rubles.

The customer of the S9-5 was the Lytkarinsky Research Institute of Instrument Engineering, which dealt with the problems of radiation resistance of electronic equipment.

Mikhail Ivanovich Efimchik. Photo from the mid-1980s

For the first time, previously unattainable capabilities appeared in this device:

- practically unlimited storage time of the recorded signal,

- output of signal data to an external computer for processing and storage,

- absence of geometric distortion of the signal, due to the use of a flat matrix panel as an indicator.

For the first time, an oscilloscope used a flat matrix direct current panel of the IMG-1 (“Athlete”) type with a resolution of 100x100 elements and an element pitch of 1 mm to display the signal. The panel was developed by the Ryazan Research Institute of Gas Discharge Devices (department head A.B. Pokryvaylo). IN further laboratory A.V. Kozhukhova oversaw the development of new flat panels - AC, luminescent and liquid crystal.

Employees of the department of Professor Berkutov of the Ryazan Radio Engineering Institute, as well as employees of the Ryazan Research Institute of Gas Discharge Devices took part in the development.

The first digital oscilloscope S9-5. 1979

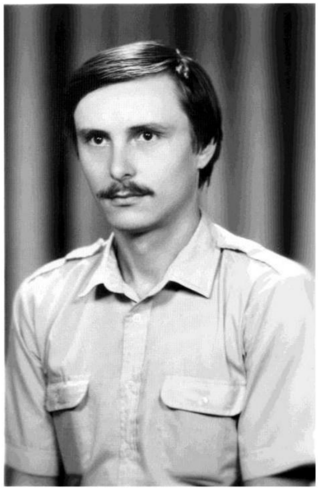
Parameters of the S9-5 device:
- 5 MHz band,
- input impedance 1 MOhm,
- number of channels - 2,
- deviation coefficients 1 mV/div.+/-2%,
- sampling frequency 5 MHz +/-2%, (later up to 20 MHz),
- number of ADC bits - 8,
- record length 1024 points,
- indicator resolution 100*100,
- power consumption 220 W,
- weight 18

kg. The analog-to-digital converters of this device, at the initial stage, were made in the form of a printed circuit board, based on microcircuits - comparators. Subsequently, already at the implementation stage at the Makhachkala plant, the device was modernized. It used new m/s ADCs developed by the Vilnius company Venta, which made it possible to increase the sampling frequency to 20 MHz.

For the first time, an interface for connecting to a computer, its architecture and software were developed for the S9-5 oscilloscope (developed by A.I. Mamaev).

Chief designer of S9-5 - Kozhukhov A.V.,
developers - Dvoretsky M.N., Kalev N.N., Abramov V., Chervyakov S., Mamaev A.I.

Anatoly Vladimirovich Kozhukhov.
Photo from the early 1980s



Mikhail Nikolaevich Dvoretsky.
Photo from the mid-1980s

N.N. Kalyov.

Chervyakov S.

Mamaev A.I.

In 1982, the second traditional purely digital oscilloscope **C9-10/1 ("Self-Analysis-20") was developed,** with a sampling frequency of 20 MHz, per 10 MHz bandwidth.

C9-10/1 in 1986-91 was mass-produced at the Makhachkala plant and took 25th place among VNIIRIP oscilloscopes (out of 28) in terms of production volume. 384

pieces were made. such devices worth 2.8896 million rubles; on average, more than 60 such devices were produced per year, at a price of 7525 rubles.

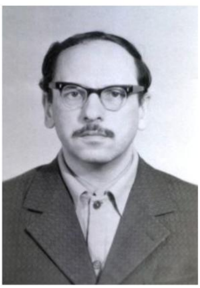
Device parameters S9-10/1:
- amplifier bandwidth 10 MHz,
- input impedance 1 MOhm,
- number of channels - 2,
- coéff. deflection. 5 mV/del.+/-2%,
- sampling frequency 20 MHz,
- number of ADC bits - 8,
- record length 1024 points,
- indicator resolution 100*100,

- weight 35 kg.

Digital oscilloscope S9-10/1. 1982

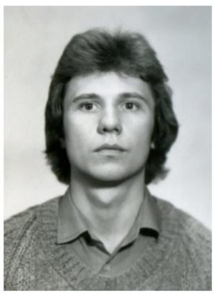
The customer for the S9-10/1 was the Ministry of Defense. The technical design model was made in the housing of the S9-5 oscilloscope. However, as it turned out during testing, its dimensions did not allow the device to be inserted into the hatch of a submarine. This led to the fact that at the stage of the detailed design the device was redesigned, it became a two-block one. The upper measuring block collected signals, and the lower interface block carried out the LCP interface and calibration.

Chief designer - Neugasimov V.V.,
Leading engineer - Ivanov E.A., developers - Artamonov A., Burlakov I.V., Kalev N.N., Andreev G.I.



Neugasimov.V.

Ivanov E.A.



Artamonov A.

Andreev G.I.

LS213 employees are developers of digital oscilloscopes. ***From left to right, sitting:*** V. Glushchenko, O. V. Kremnev, L. Ya. Kostenko, A. V. Kozhukhov, S. I. Pedan, V. A. Selivanov;
standing: N.N. Kalev, A. Artamonov, surname not established, M.N. Dvoretsky, M.Yu. Peryshkina (Gershpin), I. Trofimova, N.G. Malakhova, M. Kozhukhova, L. Gotovskaya, M I. Efimchik L. V. Volkova.
Photo from the early 1980s

N.N. Kalev recalls: “We always remember with deep respect and warmth Vasily Vasilyevich Neugasimov, the chief designer of the S9-10/1 oscilloscope. He was in every sense a very good and sincere person. You could always talk to him and consult on completely different problems. He had a wonderful atmosphere in the team."

In 1985-1986, in department No. 41, the development of a large family of purely digital and computing oscilloscopes (as well as recorders), with replaceable blocks, **(code “Sputnitsa”) was completed,** within which the topics “Sheaf”, “Sheaf-Blueberry” ” and “Sofia”, stroboscopic oscilloscopes were also developed, using blocks on the topic “Companion”.

The customer of “Sputnitsa” was VNIITRANSMASH - the leading institute for armored vehicles, a comprehensive scientific research, design, production and testing center for transport engineering, founded in 1949 on the basis of a pilot plant that created tanks and self-propelled artillery during the Second World War [22].

Devices and units included in the family of digital and stroboscopic oscilloscopes “Sputnitsa” / “Sheaf” / “Sofia”

The basis for constructing a system of digital oscilloscopes were 8-bit replaceable blocks of (analog-to-digital) converters, which consisted of attenuators, amplifiers, ADCs and buffer memory, models Ya4S-113, Ya4S-114, Ya4S-115, and Ya4S-116,

Replacement blocks for oscilloscopes of the “Sputnitsa” family. From left to right: synchronizer unit YA4S-112, converter unit YA4S-113, adaptation unit YA4S-115 and multiplexer unit YA4S-116

Structure of the family of recorders, digital (S9) and stroboscopic (S7) oscilloscopes with replaceable blocks “Sputnitsa” / “Sheaf” / “Sofia”

Replaceable blocks	**Registrars**	**Oscilloscopes**	**Computing oscilloscopes**
Ya4S-112 Synchronization.	**ÿ4ÿ-117** Basic block	**ÿ9ÿ-41** Display block	**ÿ9ÿ-42** Processor unit
Ya4S-113 10 MHz 1 channel Fd-100 MHz 2 channels FD-50 MHz digital	**ÿ4ÿ-118** 2/4 channel, 10 MHz 		**C9-20** 
Ya4S-114 5 MHz Fd-40 MHz digital	**ÿ4ÿ-119** 4 ch, 5 MHz 	**S9-24** 1 channel, 5 MHz 	**C9-21** 
ÿ4ÿ-115 1 MHz Fd-5 MHz (adapt.) digital	**Ya4S-120** 4 ch, 1 MHz 	**S9-25** 1 channel, 1 MHz 	**C9-22** 
Ya4S-116 0.25 MHz 2 channels Fd-0.5 MHz 4 channels Fd-0.25 MHz digital	**ÿ4ÿ-121** 8/16 ch, 0.25 MHz 	**S9-26** 2/4 channel, 0.25 MHz 	**C9-23** 
Ya4S-123, Ya4S-124 18; 10 and 1 GHz strobe.	**Ya4S-125** 2 channels, 18/10/1 GHz 	**S7-21** 2 channels, 18/10/1 GHz 	**S7-20** 
Ya4S-123/4, Ya4S-124/4 30 GHz strobe.			**S7-20/4** 

The Ya4S-113 converter block contained two channels with a bandwidth of 10 MHz and a maximum sampling frequency of 50 MHz/6 bits. In single-channel mode, a sampling frequency of 100 MHz/6 bits was provided.

The Ya4S-114 converter block contained one channel with a bandwidth of 5 MHz and a maximum sampling frequency of 40 MHz/8 bits.

Conversion unit (recorder) Ya4S-119 with 40 MHz sampling.

It consisted of four replaceable Ya4S-114 units and a Ya4S-112 synchronizer unit. In a similar configuration, conversion (recorder) units Ya4S-118, Ya4S-120 and Ya4S-121 were developed. 1986

The Ya4S-115 adaptation unit contained one channel with a bandwidth of 1 MHz and a maximum sampling frequency of 5 MHz. The bit depth varied from 8 to 12 bits.

The block used the principle of saving signal memory when provided that the measured signal did not change its gradient.

The Ya4S-116 multiplexer unit contained four channels with a bandwidth of 0.25 MHz and a maximum sampling frequency of 250 kHz. In dual-channel mode, a sampling frequency of 500 kHz was provided. The block contained switchable low-frequency 4-pole filters with a cutoff frequency from 10 kHz to 250 kHz, which ensured undistorted signal recording caused by an insufficiently high sampling frequency.

The time base and synchronization of the converters was provided by the Ya4S-112 synchronizer unit. It also performed synchronization according to various criteria, allowing you to register the most informative sections of the studied signals, complete pre-recording of signals, as well as external sampling.

Digital oscilloscope S9-26 with a four-channel multiplexer unit YA4S-116. In a similar configuration oscilloscopes S9-24 and S9-25 were developed. 1986

Depending on the type of device being formed, a Ya4S-117 base (power) unit, a Ya9S-41 indicator unit, a Ya9S-42 processor unit, as well as a different number of converter units were used. For example, the S9-20 oscilloscope provided up to 4 channels at a sampling frequency of 50 MHz, and the S9-23 oscilloscope provided up to 16 channels at a sampling frequency of 250 kHz.

The base (power) unit Ya4S-117 was intended for installing replaceable units into it, as well as for communication with the processor unit. The block contained six compartments for replaceable blocks. The Ya9S-41 display unit was a replaceable unit

with a 16LK2B television kinescope and provided display and measurement of signal parameters.

The Ya9S-42 processing and display unit (processor) carried out mathematical processing of registered signals (interpolation, digital filtering, differentiation and integration, direct and inverse Fourier transforms, calculation of correlation functions, signal modeling). The block contained an indicator on a gas-discharge matrix panel with memory and information capacity of 256x256 elements.

The devices were developed in three delivery options - conversion units (recorders without indicators, 4 models, Ya4S-118 - Ya4S-121), digital oscilloscopes (3 models, S9-24 - S9-26), as well as computational oscilloscopes (4 models, S9-20 – S9-23).

Computational oscilloscope S9-20 with a maximum sampling frequency of 100 MHz. The oscilloscopes S9-21, S9-22 and S9-23 were developed in a similar configuration. 1986

The conversion blocks (recorders) contained a Ya4S-117 base unit, a Ya4S-112 synchronizer unit and from two to four converter units (Ya4S-113 – Ya4S-116). The recorders made it possible to work as part of an AIS through a public channel or through a serial RS-232 interface.

Digital oscilloscopes contained a Ya4S-117 base unit, a Ya4S-112 synchronizer unit, one of the converter units (Ya4S-114 - Ya4S-116), as well as a Ya9S-41 display unit. This configuration was called the “minimum set” and ensured registration, display and measurement of the parameters of the signals under study on a television CRT. The computing oscilloscopes were conversion units Ya4S-118 –
Ya4S-121, equipped with a processing and display unit Ya9S-42. At such a “maximum

configurations" oscilloscopes were a modern computing system for measuring and processing single and repeating signals.

The foreign analogue of the Sputnitsa family of recorders was the family of samplers (recorders) of the 5180 series
from HP, models HP5180T (10 MHz /Fd-20 MHz /10 bit), HP5183 (Fd-4 MHz /12bit), HP5185 (Fd-250 MHz/8bit). However, this family did not contain stroboscopic recorder options.

HP 5180 sampler with XYZ monitor. 1983

HP5183 sampler with oscilloscope display.

The entire department of digital and stroboscopic oscilloscopes No. 41 worked on the development of the “Sputnitsa” / “Sheaf” family of oscilloscopes.

The list of participants in the Sputnitsa research and development project, published in the report on the technical project, included about 150 employees of the research institute, including about 50 employees of the oscillography department.

Digital recorders were developed in the NIS413 sector
under the leadership of the deputy chief designer and head of the sector A.V. Kozhukhov, the leading engineer for the set of conversion units was M.N. Dvoretsky. The Ya4S-113 converter unit was developed by: L.Ya. Kostenko, Yu.T.

Schava, A. Voskoboy, I. Burlakov, Y. Artamonov. The block used the latest developments of m/s ADC from the Vilnius company “Venta”.

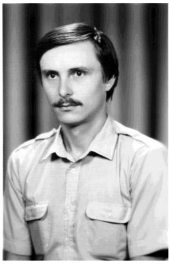
The Ya4S-114 converter unit was developed by Vyacheslav Pleshkov. The Ya4S-115 adaptation

unit was developed by V.V. Neugasimov and S.V. Kondratiev. The Ya4S-116 multiplexer unit was developed

by E.V. Pyatov.

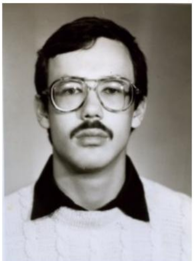
The Ya4S-112 synchronizer unit was developed by M.N. Dvoretsky, the unit software was developed by M.A. Lomachenkov and A. Sla-
Vinskaya


A.V. Kozhukhov

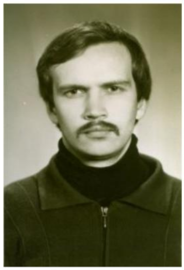

M.N. Butler.

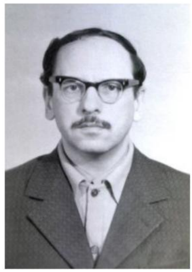

LA. Kostenko


Y.T. Stava


A. Voskoboy


Yu. Artamonov.


V.N. Pleshkov


V.V. Neugasimov


S.V. Kondratv


EV Pyatov.

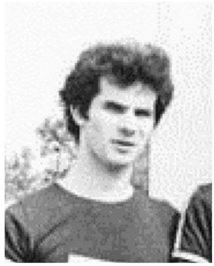

M.A. Lomachenkov


A.R. Slavinskaya

The Ya4S-117 base unit was developed by N.N. Kalev and I.A. Zago-nyaev, and power sources for it S. Veremyev. The base unit contained power supplies and an interface board for the Ya9S-42 processor unit.

N.N. Kalev

I.A. Zagonyaev



S. Veremyev

The Ya9S-42 processing and display unit (processor), as well as the Ya9S-41 display unit, were developed in the NIS412 sector under the leadership of Deputy Chief Designer and Sector Head N.V. Radionova.

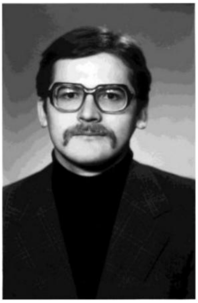
S.A. was the leading engineer of block ÿ9ÿ-42. Karpikhin, lead programmer - V.K. Savin. A.M. took part in the development. Khazanov, Yu.A. Staritsyn, A.P. Galkin, M.A. Lomachenkov, V. Valyatskas, V.A. Ostrikov, I.P. Pereshivannaya, I.A. Bosis, L.W. Charykova (Kondratieva), E.B. Tereshina (Savina), S.V. Florchuk.

N.V. Radionov S.A. Karpikhin,

VC. Savin.

M.A. Lomachenkov

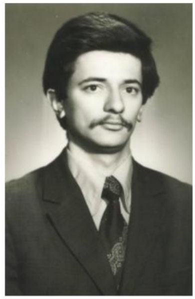
The leading engineer of the Ya9S-41 display unit was A.P. Galkin. The block was developed by Y. Rapalis (ELT), S.V. Florchuk, later R. Lomsargis, software was created by M.A. Lomachenkov and M.B. Meriin.



A.P. Galkin,

Y. Rapalis

S.V. Florchuk



M.B.Meriin.

The Ya9S-42 processor unit was created after the completion of the implementation of the S9-9 oscilloscope processor unit and absorbed the experience of its development and new achievements of domestic microelectronics. To significantly increase the computing power for processing measurement information, for the first time in instrument construction, the built-in micro-computer “Electronics-80” was used, which was mass-produced with acceptance by the general customer at the Voronezh Computer Plant and had a built-in operating system with an electronic disk.

Design and documentation group. *From left to right, sitting:* V.A. Shlyakhtenko, N.S. Pyatova, T.N. Suruda, N.N. Dvoretskaya; *standing:* O.I.Shagoiko, O.V.Shkul, N.P.Mikhantieva, L.Ya.Kostenko, E.D.Kaleva

A lot of work was done by the design and documentation group, which included: A.I. Yakimova, O.I. Shagoiko, T. Voronetskaya, G.G. Bazhko, Z.P. Stradalova, N.P. Mikhantieva, T.N. Suruda, L.S. Petrunina (Shchava), O.V. Shkul, S.M. Rublyuk.

Design documentation for the Sputnitsa family of oscilloscopes was transferred to the Bryansk plant. At the end of the 1980s, the plant produced a pilot batch of one of the devices - S9-23. Devices of the Sputnitsa family were not mass-produced due to the economic crisis of the late 80s.

From 1986 until the early 1990s, recorders and oscilloscopes of the “Sputnitsa” family were supplied in small quantities, under contracts, to various enterprises in the country, by employees of department 41 and VNIIRIP.

In 1991, the development of **the S8-24 “Tear”** digital storage oscilloscope began , which was completed in 1992.

Digital storage oscilloscope S8-24. 1992

The customer of the work was the Minsk plant. Main goal
The work was to create a wideband portable digital oscilloscope. With limited funding, an attempt was made in a short period to create a 250 MHz digital oscilloscope with new performance characteristics

As part of this topic, a portable (8 kg) two-channel wideband (250 MHz) oscilloscope with a high-impedance input and a sampling frequency of 1 MHz was created. A CRT 12LO1I “Karat” with a working part of the screen 60x80 mm was used as an indicator.

LS212 employees are developers of processor devices for digital storage and stroboscopic oscilloscopes.
From left to right, sitting: I.V. Karpikhina, T.N. Suruda, L.S. Petrunina (Shchava), A.I. Yakimova, M.I. Efimchik, surname not established, N.N. Dvoretskaya, O. I.Shagoiko;
standing: E.D.Kaleva, S.V.Florchuk, L.Ya.Kostenko, N.V.Radionov, V.A.German, S.A.Karpikhin, Yu.T.Shava, S.I.Pedan, N. Yakovleva, S. A. Shagoyko, L. Gotovskaya, M. B. Meriin.
Photo from the early 1980s

In 1993, a pilot batch of devices was manufactured. By
Due to the crisis of the 90s, the oscilloscope was not mass-produced.

The chief designer of the development was Y.M. Rossosky, the leading engineer was O.M. Zaitsev (vertical channel), S.A. Karpikhin (microprocessor units), G.M. Shenderovich (software), S.P. participated in the development. Sharanda (ADC), M.M. Levin (design). A.P. Galkin took part in the development of the oscilloscope.

Over 13 years (from 1979 to 1992), VNIIRIP developed 27 models of digital oscilloscopes, their basic and replacement units. Including 10 oscilloscope models: S9-5, S9-10, S9-
20, 24, 21, 25, 22, 26, 23, S8-24, as well as 17 models of replacement units for them: Ya4S-112, 117, 118, 113, 114, 119, 115, 120, 116, 121, 123 , 124, 125, 123/4, 124/4, Ya9S-41, 42.

1.14. Oscilloscopes in independent Lithuania

By Government Decree N491 of **November 26, 1991** of the Republic of Lithuania, the Vilnius Research Institute of Radio Measuring Instruments was transformed into the Vilnius Institute of Electronics “Elita”. Doctor of Technical Sciences was appointed director of the enterprise. Eugenius Pileckas.

E. Piletskas began his career in the 1950s at VZRIP as a mechanic in workshop No. 7. Then he worked in the quality control department, entered the Vilnius branch of the KPI, which he graduated in 1961 and began working at the Vilnius Research Institute-555 in the laboratory of medical electronics. Having worked at the research institute for more than a quarter of a century, E. Piletskas became the head of the medical electronics department, defended his master's and doctoral dissertations, and in 1987 became a laureate of the USSR Council of Ministers Prize for the development of CAD systems. From 1986 to 1991 he worked at Kaunas Polytechnic Institute.

In 1992 , perhaps the last reorganization in the history of the institute began. Thematic departments were abolished, and **in 1993** the privatization of the entire Elita Institute of Electronics began, ending **in 1994.** The creation of departments began, then state personal enterprises (SPE) with 100% state capital, then, after the first stage of privatization, closed joint-stock companies. The established enterprises were engaged in the development, supply and repair of various electronic equipment; they were led by young ambitious leaders

new generation.

Under these conditions, the director of the institute, E. Piletskas, managed to organize privatization in such a way that almost all newly organized enterprises were able to survive in the new conditions and continue their activities. The terms of privatization provided for preferential (closed) privatization of up to 50% of shares, which could be purchased by employees of the created enterprises. Upper level of privatization at the initial stage

was 60%, which did not allow third-party buyers of shares to purchase more than 10% of the shares. The remaining 40% of shares were owned by the state for a long time.

6 enterprises were created on the basis of the oscillographic department:

- *Eltesta,* director J. Rossosky.
- *Geozondas (Zondas),* director B. Levitas.
- *Inmatsis,* director N. Isaenko.
- *Kontestas,* director A. Likhtinshain.
- Oscilografijos centras, director D. Petrov.
- *Salpas,* director A. Mikhalev, later N. Kalev.

So all based on the oscilloscope department VNIIRIP established 6 different CJSCs. **For 2020,** according to the website “rekvizitai.vz.lt”, only 4 of them had employees and were actively working:

Name	Director	Number employees
1 *Electrical test*	Ya. Rossosky	16
2 *Geosondes*	B. Levitas	25
3 *Disputes*	A. Likhtinshain	4
4 *Oscillography Center*	N. Kalev	3

In total, in all CJSCs created on the basis of the oscillographic department of VNIIRIP **in 2020,** there were only 48 employees, or 2.4% of the total number of VNIIRIP (over 2000 people).

1.14.1. JSC Eltesta

JSC Eltesta was created **in 1993** by specialists from the former laboratory of stroboscopic oscilloscopes as part of the privatization of the Elita Electronics Institute. Initially it was a state-owned personal enterprise with 100% state share capital. **In 1995,** the company's employees bought out its controlling stake. **Since 2005**

the state is not the owner of the company's shares.

In 1996-2001 The company concentrated on a program to create subsurface radars to search for non-metallic objects. The main customer of the work was the Finnish company Impulse Technology Labs. As a result, a mine detector for non-metallic mines was created, which makes it possible to detect anti-personnel mines with a diameter of up to 8 cm at a depth of up to 30 cm and anti-tank mines with a diameter of up to 30 cm at a depth of up to 70 cm. The product was tested at the Finnish Army training ground. The first series of products was released.

Mine detector **ITL-231A**

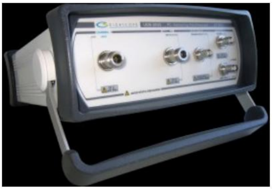
Subsurface Radar **ER2-02**

In 2000, the **ER2-02** radar was created to search for subjects illegally crossing the border in boxcars. The radar was installed above slowly moving cars and had a penetration depth of up to 2.5 m when searching for objects with physical properties close to the human body.

Since 2000, the company has returned to the market of radio measuring instruments. **In 2000-2006** was carried out a program for the development of the world's first USB stroboscopic oscilloscopes – attachments for personal computers.

4 models of oscilloscopes of **the UDS-2000** family were created bandwidth up to 30 GHz. The family also included a time domain reflectometer and an optical oscilloscope. The work was carried out by order of the Finnish company Unigraf, which for some time was a shareholder of JSC Eltesta.

In 2002, the company participated in a competition to become the developer of a stroboscopic oscilloscope for LeCroy, but lost to Picosecond Pulse Labs.



USB stroboscopic oscilloscope **UDS-2020** with 20 GHz bandwidth

USB stroboscopic oscilloscope-reflectometer **UDS-2214**

USB Strobe Oscilloscope **UDS-2128** with optical channel

PXI Bandwidth Sampling Oscilloscope **GFT-6202** 0-12 GHz.

In 2005-2006 The first 12 GHz PXI stroboscopic oscilloscope, **GFT-6202, was created by order of the French company Greenfield Technology.** This marked the beginning of the development of single-board oscilloscopes with microwave units mounted on them.

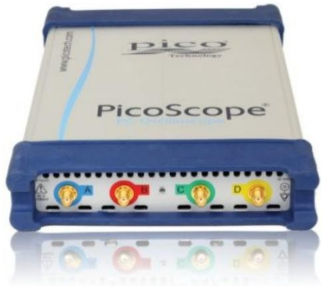
From 2007 to the present, JSC Eltesta has been working on joint programs with the British company Pico Technology, which is its shareholder. JSC Eltesta develops and manufactures the devices, and Pico Technology is responsible for their marketing and sales.

In 2007-2009 The **PS-9200** family of PC sampling oscilloscopes with a 12 GHz bandwidth was created. The family includes 3 models, including a time domain reflectometer and an optical oscilloscope. The devices were mass-produced until 2017. **In 2009,** the **PicoScope 9201** oscilloscope was one of six finalists in the Best In Test category for the world's best test instruments of the year. **In 2010, the PicoScope 9211** oscilloscope

was also among the finalists in the Best In Test nomination.

In 2010, a 4-channel signal sampler **PicoScope 6407** was developed with a bandwidth of up to 1 GHz and a sampling frequency of up to 5 GHz, which has been commercially produced to this day.

PicoScope 9200 family of PC sampling oscilloscopes with bandwidth up to 12 GHz



PicoScope 6407 signal sampler with up to 1 GHz bandwidth and up to 5 GHz sampling rates

In 2011-2013 The **PS-9300** family of PC sampling oscilloscopes with a bandwidth of up to 20 GHz was created. In 2017, the bandwidth was expanded to 25 GHz.

In 2020, this family already included 9 models, including those with a bandwidth of 15, 20 and 25 GHz, several types of pulse reflectometers with different resolutions, an optical oscilloscope with a bandwidth of up to 9 GHz, models with carrier frequency restoration of digital streams up to 11 Gb/s, as well as two four-channel models.

At the end of 2013, the PicoScope 9300 family of oscilloscopes was included in the top ten most popular radio measuring instruments by EDN magazine.

PicoScope 9300 family of PC sampling oscilloscopes
with bandwidth up to 25 GHz

Family of picosecond USB pulse generators

PisoSource **PG9000**

In 2014, the **PicoScope 9312** oscilloscope was one of four finalists in the Best In Test category for the best test instruments of the year.

In 2014, the PisoSource PG900 family of picosecond USB pulse generators was created . The generators generate multipolar pulses with an amplitude of 200 mV with a rise time of up to 35 ps, as well as an adjustable amplitude of up to 6 V with a rise time of no more than 60 ps. Their serial production began in 2015.

In 2012, JSC Eltesta financed the publication of the book
A.F. Denisov and Y.M. Rossosky "People. Years. Oscilloscopes."

In February 2014, EDN magazine published an article by A.F. Denisov and Y.M. Rossosky "A history of oscilloscope development in Vilnius." In EE Times magazine, in the preface to this article, the magazine's chief technical editor, Martin Rowe, called Vilnius the oscillography capital of Eastern Europe.

In December 2014, JSC Eltesta was named the best Lithuanian company in the category "Leader of Innovative Solutions". The award was presented by the Prime Minister of the Republic A. Butkevicius.

In 2016-2018 The company has developed a family of four-channel PC-digital oscilloscopes **PicoScope 9404** with a bandwidth of 5 GHz and 16 GHz, characterized by high metrological characteristics.

Four-channel PC-digital oscilloscope
PicoScope 9404.

FemtoScope 1000 and 2000
single and dual channel
USB digital oscilloscopes .

In 2018-2019 single- and dual-channel USB digital oscilloscopes of the **FemtoScope** family with a bandwidth of 5 GHz and 16 GHz were developed. Along with high metrological characteristics, the devices are characterized by low cost and dimensions; they can even fit in the palm of your hand.

Currently, the company employs 16 people, among whom there are many young engineers. The executive director is Yakov Rossosky, the technical director is
Oleg Zaitsev, scientific consultant - Doctor of Technical Sciences Alexander Fedorovich Denisov.

According to analysts, the company has 2.5% of the world market for stroboscopic oscilloscopes in terms of the number of devices sold per year and over 1% of the world market for stroboscopic oscilloscopes in terms of the volume of devices sold in monetary terms.

Eltesta JSC team. ***From left to right:*** Yakov Rossosky, Evgeniy Kononov, Oleg Zaitsev, Evgeniy Pyatov, Tamara Zrazhevskaya, Tatiana Potaptseva, Pavel Dubitsky, Laima Okunevichiute, Evgeniy Kostetskyi, Larisa Vologzhanina, Tomas Tankelun, Yanina Fedorovichene, Alexander Galkin, Natalia Zalesskaya, Marina Kolpachenko

1.14.2. ÿÿÿ Geosondes

The private enterprise (cooperative) “Zondas” was created in March 1988 from specialists from the 2nd, 8th and 9th oscillographic and generator departments of VNIIRIP and consisted of 15 people.
It was one of the first technical cooperatives.
Ph.D. was elected chairman of the cooperative. Evgeniy Bugaets,
his deputies: in science - Ph.D. Boris Levitas, on financial issues - Alexander Mamaev, on technical issues
Igor Pozamantir.

Initially, its employees combined work in cooperative with work at a research institute. At the beginning of 1989, the main employees left VNIIRIP, rented premises, entered into agreements for the development of measurement systems with several enterprises (but not with VNIIRIP), and with the advances they received, they bought equipment and began work. The main theme of the enterprise was the development of ultra-wideband (UWB) systems, the main components of which are pulse generators and stroboscopic oscilloscopes.

In 1990, Evgeniy Bugaets became a member of the innovative Council under the Council of Ministers of Russia. Director of the enterprise “Zondas” becomes Boris Levitas.

The first development of the cooperative was a measuring system based on the S1-91/4 stroboscopic oscilloscope, ADC and a computer for measuring the parameters of microwave microcircuits in frequency band up to 18 GHz (customer - enterprise in Saratov).

In the process of developing a radar system for measuring the effective scattering surface (ESR) (customer - enterprise in Moscow) the effect was accidentally discovered detecting a moving object (person) behind a wall, which gave development push of the direction for new
Boris Levitas became the immediate head of the department.

Also at this time, optoelectric and electro-optical converters up to 3 GHz were developed and manufactured (optical designer Igor Pozamantir).

A system for testing fiber cables has been manufactured based on this optics, which became the first foreign contract. Three such systems were delivered to Poland.

At that time, Zondas did not yet have a foreign currency account and the contract was concluded by barter. In exchange, the company received 7 computers

IBM PC, each of which at that time cost 5 times more than a Zhiguli car.

In 1995, ground penetrating radars began to be actively developed. First, in collaboration with the St. Petersburg enterprise “Spectrum”, and then with the University of Delft (Holland).

The university was supplied with several search systems objects, including plastic mines, underground . These systems were built using multi-channel (4, 6, 8) stroboscopic converters in the frequency band up to 20 GHz. For the first time, equipment for measuring antenna parameters was also developed and supplied to this university. in the near field. In 2002, the ground penetrating radar - mine detector was tested with positive results at the Night Vision test site in the USA.

Since 1992, the development and supply of systems for measuring antenna parameters based on measurements in the time domain began.

The first system (“Polygon”) for measuring parameters far field antennas, developed jointly with by the Russian company "Mera", was delivered to Gdansk, Poland. All measuring equipment was designed and manufactured in Zondas, and the rotating device and software provision by the company "Mera". Polygon bandwidth 1 – 18 GHz.

After this, systems for measuring antenna parameters became one of the company's main products. Further developed their own rotating devices and software software for antenna measurements. In subsequent years in Six more measurement systems were delivered to Poland parameters of antennas with a frequency band up to 40 GHz.

Antenna measurement site in Gdansk, Poland, 1992.

In 1995, the Zondas enterprise was transformed into Geozondas JSC. The director of the company remains Ph.D. Boris Levitas,
his deputies: Ph.D. Irina Naydenova, Alexander Minin, and later Sergey Kharchenko.

The conquest of the markets of the Far East and West began .
Together with the Russian company "Spectrum" it was delivered to
China is somewhat large (in terms of equipment volume)
measuring systems. The Geozondas antenna measurement site in the frequency range 0.1 - 20 GHz with a distance of 230 m was installed in Taiwan in 2003 at Da Yeh University.

Receiving part of the landfill

Transmitting part of the landfill

Antenna measurement site at Da Yeh University in Taiwan.

In 2002, a number of optical units with lasers were developed and supplied to Israel for 3 years.
emitters (chief designer Alexander Ktitorov).

B. Levitas

I. Naydenova

A. Minin

A. Ktitorov

In 2005, together with JSC Lifodas, a monitoring system for optical communication lines was developed. In 2013, the system was modernized.

In 2007, JSC Geozondas became a member Europroject (Framework-6 program) to detect hidden objects under clothing and behind the wall (RADIOTECT). In project 10 organizations from 7 countries participated and, according to its results, JSC "Geozondas" has developed a new direction in development of equipment for searching for living objects in ruins and behind a wall, detecting a person by movement or breathing, development of ISAR and SAR imaging systems. The scientific director of the department is Boris Levitas.

Subsequently, Geozondas became a participant in seven more different European projects.

Geozondas constantly cooperates with universities, accepts students for practical training, supervises theses works. The best students remain to work at the company. The young specialists got involved in the work perfectly.

Currently, the main activity of JSC Geozondas is the development and production of UWB pulse instruments and systems, mainly for antenna and radar measurements, as well as for radar imaging. Measuring systems are designed to measure antenna parameters, material parameters, S-parameters

UWB devices, as well as for radar measurements and detection of hidden objects (in walls, under clothes, underground), the presence of moving or stationary (according to breathing) of people behind a wall or in ruins, etc. A distinctive feature of most UWB systems "Geozondas" - the use of short pulses as test signals. When such systems are placed indoors, signals reflected from walls and other foreign objects

come with a delay and do not distort the measurement results. The frequency characteristics of the measured objects are calculated using the Fourier transform .

UWB pulse systems include: pulse generator (transmitter), oscilloscope (receiver), computer, and may also include antennas and a positioner that moves the antennas or the measured object.

JSC Geozondas has developed pulse generators with rise times from 25 ps to 5 ns, with amplitudes up to 300V

(Alexander Minin - work manager, Alexander Martyanov, Vyacheslav Dvoretsky). More than 40 types of generators have been developed.

Pulse generators

Pulse Generator
GZ1121ME-03/200V/1M

Pulse Generator Head
GZ1118ANE

Vyach. Butler

Y. Shchava

V. Ivanov

N. Radionov

S. Efremov

Digital Sampling
Converter
GZ6E
0-6 GHz

Digital Sampling
Converter
GZ10M2
0-10 GHz

Digital Sampling
Converter
SD-10820
0-20 GHz

Digital Sampling
Precision Converter
SD203TMS-26A
0-40 GHz

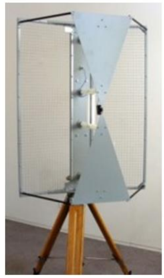
Picosecond stroboscopic transducers

JSC Geozondas has developed stroboscopic converters (oscilloscopes) and antennas for measuring systems with a bandwidth of up to 40 GHz (Boris Levitas, Alexander Minin, Vladimir Ivanov, Alexander Konakov, Yuri Schava, Nikolai Radionov, Sergei Efremov, Sergei Sharanda, Maria Savitskaya, Alexander Smirnov, Alexander Ktitorov, Vytautas Jozapaitis, Alexander Voskoboy).

Double-Ridged TEM Horn Antenna GZ0240DRH 2 ÷ 40 GHz

Shielded Loaded Bow-Tie Antenna GZ031ANL-4B 0.3 ÷ 1 GHz

Vivaldi Tapered Slot Antenna GZ0665TSA 0.6 ÷ 6.5 GHz

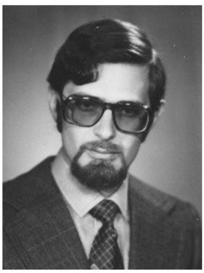


Loaded Bow-Tie Antenna GZ00803ANL 0.08 ÷ 0.3 GHz

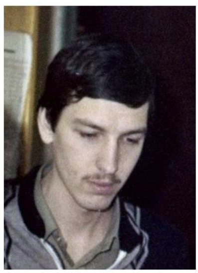
Antennas for measurement systems

The software for devices and systems was developed and improved by Sergey Kharchenko, Irina Shcherbak, Joseph Freeman, Jerzy Mordasevich, Dmitry Kudryavtsev, Natalya Levit, Alexander Prisyazhny, Jonas Matuzas, Mikhail Drozdov).

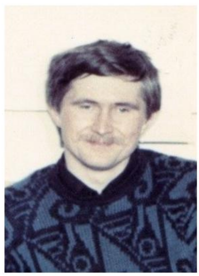
S. Sharanda



I. Freeman



A. Konakov



S. Kharchenko

Most of the equipment sold is non-standard, adapted to the Customer's tasks.

Installation section: Sergey Kosach, Vladimir Karpenko, Natalya Zaleskaya, Lyudmila Ukharova, Voldemar Aprub.

Based on these developed devices, components and software UWB measuring systems were created to ensure this.

Due to the need to paint manufactured equipment, a powder coating area was opened in 1996, which also supplied external customers. Head of the site – Ph.D. Victor Druzhinin. In 2007 the site was closed.

The novelty, technical level and quality of the supplied equipment made it possible to significantly expand sales markets. The equipment and its individual devices are supplied in many countries of the world, including such as: England, Belgium, Germany, Israel, Poland, Turkey, USA, France, Japan, China, South Korea and others, 35 countries in total.

Today "Geozondas" is one of the world leaders in the development of UWB measuring equipment and UWB radars, takes an active part in international symposia and conferences around the world.

Recognition of such merits was the right to conduct Vilnius at the 2010 international conference Microwave & Radar Week 2010. The main organizer is Geozondas. B. Levitas – Chairman of the Organizing Committee conference, I. Naydenova - executive secretary of the conference, A. Ktitorov - executive editor conference publications. About 500 people from 44 countries took part in the conference. The organization of the conference was recognized as the best in Europe in 2010. Organizers awarded diplomas of the Polish Academy of Sciences.

Confirmation of the success of the conference was the decision to hold the Microwave & Radar Week conference again 2020 in Vilnius. The company "Geozondas" was again appointed as the main organizer. The conference was prepared, but due to the COVID-19 pandemic, the conference was moved to Warsaw.

Currently, Geozondas has developed and supplies customers with measuring systems with instruments operating not only in the time domain, but also in the frequency domain.

The results of the company's work are regularly presented at major international conferences and symposia, and demonstrated at exhibitions where they receive recognition. For example, at the largest symposium - Asia Pacific Symposium of Electromagnetic Compatiblity in 2010 in China, they were awarded.

Participation in conferences brings benefits - receiving contracts and orders.

In 2021, Geozondas, together with Lime Microsystems, developed a portable UWB radar with a linearly modulated frequency in the 3.1 - 3.6 GHz band (FRED) for detecting objects behind a wall.

Work managers: from Geozondas - Boris Levitas, from Lime Microsystems" director Alexander Mamaev.

In 2021, Geozondas turned 33 years old. During this time, many specialists passed through Geozondas. Warm and
a friendly atmosphere is always present at the company, which promotes success at work. Veterans of the company - former VNIIRIP developers shared their development experience and instilled a spirit of cooperation and mutual assistance.

Team "Geozondas" 2016

"Geozondas" is not only instruments, UWB measuring systems - the main thing is the people who created all this. Many employees have been working since the company was founded.

Discussion of the FRED radar project, 2021. ***From left to right:***
A. Mamaev, B. Levitas, A. Voskoboy, Yu. Rafanavicius, D. Shchepanov,
A. Minin, Yu. Chava, S. Sharanda

It should be noted that one of the merits of the company is that during the difficult years of the crisis of the 90s, the collapse of VNIIRIP, it was possible to retain specialists and prevent them from getting lost in the vastness of commodity markets. The company lives, develops and produces products. The main types of products are presented on the website www.Geozondas.com (The site was created by A. Ktitorov and S. Dremlyuga. The site is supported by Svetlana Dremlyuga).

Recognition of the success of the company "Geozondas" was that in 1995 the heads of the company B. Levitas and I. Naydenova were entrusted with organizing a branch of the IEEE (Institute of Electrical and
Electronics Engineers) in Lithuania. The first head of the Lithuanian department of microwave technology was B. Levitas. In 2006, a separate Lithuanian section of IEEE was created. Head of the section

I. Naydenova was elected (2006 - 2012). Currently , I. Naidenova is the head of the microwave department of the Lithuanian section of the IEEE.

Management of the company "Geozondas", 2021. ***From left to right:*** S. Kharchenko, I. Naydenova, B. Levitas, A. Minin

1.14.3. JSC Contestas

In 1989 based on the NIS-44 (started by A. Likhtinshain) and the disbanded NIS-433 Kazimyanets) (beg. oscillographic department of VNIIRIP, a self-supporting sector of service oscilloscopes was created (headed by A. Likhtinshain). The main developments in this sector in the period 1989-91. are described in section 1.8.

A batch of S1-118A oscilloscopes was finalized. 200 pcs. to the Australian market to ensure barter supply of a batch of IBM PC 286 personal computers. As a result of this transaction, in 1990. the sector was equipped with 12 (!!) the most modern personal computers at that time. In the fall of 1991, there were changes in management and the transformation of VNIIRIP into the Elite Institute of Electronics, and VZRIP into the RIMEDA plant. Relations between the managers did not work out and funding for work for VZRIP completely stopped. Also, for various reasons, the implementation of the Sochi R&D project to develop a service oscilloscope stopped. As a result, the sector was left virtually without funding. The same situation was observed in other development divisions of VNIIRIP.

The institute began mass layoffs, sales of equipment, and employees leaving for permanent residence in the Russian Federation and other countries. By the fall of 1992, the situation became critical. In Lithuania, a policy was announced for the privatization of all industry. No one imagined or understood what it was and how to do it.

In the summer of 1992, a UN commission (headed by Diamond), which reviewed the electronics industry of the Baltic republics. In a report made at the end of 1992, IE ELITE (named enterprise 555) was especially noted, about which it was written that only this research institute with its technological base, modern by the most stringent standards, team of specialists and scientific and technical groundwork is capable of bringing great profits to Lithuania than all its industry and agriculture. Inspired by this conclusion, the management of the research institute sent a letter to the Lithuanian government with a request to give the institute the status of a budgetary organization and assistance in orders from Western countries. The letter was superimposed on the resolution of Deputy Prime Minister Plehavicius (who is also the Minister of Social Security) that we need to think about whether Lithuania needs *this is an enterprise in general. After this letter, it became absolutely clear that there would be no government assistance and it was impossible to maintain the institute in its previous form.*

Now, 20 years after these events, we must pay tribute to director E. Piletskas, who managed in this most difficult situation not only to formulate a plan for the gradual reform of the institute and create at least some conditions for the survival of the development departments, but also to implement it, consistently, step by step step by step, carrying out the organizational activities of this plan. It seems the plan was as follows:

- create, on the basis of the largest development units that show signs of independence, initiative and the ability to survive, enlarged self-supporting units, which in the future will be transformed into independent enterprises - subsidiaries of the research institute;

- liquidate auxiliary divisions of the institute (design and technological departments/divisions, maintenance, procurement department, partially microelectronics department, etc.) by partially reducing employees and partially transferring them and equipment to development departments;

- non-core and auxiliary assets that have a commercial perspective should also be transferred to an independent division-department, which will later be transformed into a subsidiary;

- after the formation of production departments, transform them into subsidiary (personal) enterprises of the research institute, transferring the main core assets to their balance sheet and immediately begin their privatization. Do the same “on the sly” with the department of non-core assets, and “bury” all the ballast and debts in a formally

existing research institute that remains on the balance sheet of the state (the Ministry of Industry and Trade, and then Education and Science).

Of course, everything did not happen so simply and primitively. There was a lot of improvisation, but the vector was just like that. Among the personal motives of the new director E. Piletskas, I will note only this - in my opinion, he perfectly understood that in order to implement his plan (vision of further development) he would need a complete change of the team on which he would rely in the implementation of this plan. Therefore, when creating departments, he completely deliberately replaced almost the entire top and middle management of the research institute with "chief labs" and managers personally invited by him from outside. The motives were apparently the following:

- it is difficult to count on recognition and assertion of your authority in the eyes of the "old guard", who were already in the ranks of department heads when you were still a leading engineer; - disbelief in the ability of the "old guard" to move away, or abandon the "Soviet" experience, and move to "capitalism"; - their lack of knowledge of the Lithuanian language even at an elementary level; - age. By replacing the team with "forty-year-old lab bosses," you can expect greater loyalty, initiative, enterprise, and inexperience in mercantile matters.

I will also note one important point during this period: E. Piletskas knew how to resolve issues, both at the top and prepare their solutions, in company with the heads of other similar research institutes. Therefore, their idea about personal enterprises at the research institute, and then the idea (the main one!!) about limiting the level of privatization of personal enterprises to 60%, implemented in the regulations of the Lithuanian government, are the most important in that some development divisions of VNIIRIP have survived and continue their activities to this day por.

These 60% made the created enterprises uninteresting for bandits and looters and gave them the opportunity to do, to the best of their ability and skill, what they knew how to do better than others.

Creation of the Department of Consumer and Industrial Electronics, DBPE 1992-93.

In September 1992, thematic departments were created at the Elite Institute of Electronics. At this moment Likhtinshain A.A. was director of commerce at IE ELITE while retaining the position of head of the service oscilloscopes department. He was asked to create a department of consumer and industrial electronics (DCPE) on the basis of the service oscilloscopes department and the commercial and technical department (headed by V.S. Kozlov), which was also part of his area of responsibility.

During the formation of the staff of this department to it

The head of broadband oscilloscopes, A. Fedorenko, addressed with a proposal to include his laboratory in the newly created department. The proposal was accepted in September 1992. DBiPE began its activities. With the advent of the laboratory of broadband oscilloscopes, the current topics of the department were supplemented by the introduction of the 1 GHz oscilloscope S1-129 (“Capital”) at the Bryansk plant “Electroapparat” and the completion of the development of the service oscilloscope S1-137 for the Minsk

software named after. Lenin. The number of the department at the initial stage was about 40 people, but over the next 4-5 months about 10 people quit.

Until the end of 1992, the funding situation continued to deteriorate. There were virtually no funds to pay employee salaries and utility bills. I recall that the salary (in coupons) was equivalent to 10-15 dollars and all employees of the department came to the city self-government for certificates to receive benefits.

At the end of 1992, losses on the department's balance sheet reached 60 thousand coupons. I managed to live through the entire fall due to the fact that
Using connections with the management of the Mytishchi plant “Contact”, we were able to buy from them and profitably resell a batch of S1-94 oscilloscopes, as well as receive small funding for the modernization of S1-94A, that is, increasing the bandwidth to 20 MHz, and introducing a second channel based on the external synchronization input . Naturally, the funding went past the research institute’s account, and what they received was barely enough for people to somehow feed themselves.

But the desire to break out of this vicious circle was great. At this moment, contacts between the leadership of the BPE department and the energetic entrepreneur from Germany Werner Fritsche began, which later grew not only into successful cooperation, but also into personal friendship. A range of tasks was formed that seemed interesting and promising to us - the problems of heat metering and energy saving in

the cities of Lithuania and, in the future, the development of heat metering devices. The plans were to create a joint venture on the basis of the department. In January 1993 I called Werner and shared my problems. A month later he arrived, and we agreed to submit an application to the European Commission for a grant under the COST program.

And to prepare the source materials for this work, Fritsche ordered a preliminary project "Organization of heat supply in Vilnius" and paid 5,000 marks for its implementation. At that time it was a lot of money. It was possible to pay salaries, buy a fax and go on business trips!

At about the same time, with the direct recommendations of Alexei Leontyevich Molchanov (Chief Engineer of the 6th Main Directorate of the MPSS) and the now living Gennady Petrovich Gubar
(supervisor of VNIIRIP at the 6th Main Directorate of MPSS), the director of the Moscow ZIA A.N. Rosshchupkin called me and expressed interest in purchasing documentation for the Sochi family of service oscilloscopes.

Since the documentation had already been transferred to Mytishchi, but had been lying there without any hint of implementation for more than a year, in order to avoid claims from the Kontakt plant , we agreed to upgrade the oscilloscopes to a 25 MHz band and obtain new types for all devices in the family. By the beginning of March we received an advance payment for the basic model and began to come to life.

The developers went about their usual business, and I and A.I. Fedorenchik traveled to factories and organizations in the CIS in search of new orders. At the same time, the IE "Elite" was separating departments into separate personal enterprises of the institute: separate balance sheets and staffing tables were being prepared, transferred premises and equipment were being redistributed.

Establishment of the Contestas enterprise in 1993

By July 1, 1993 DBPE became the state-owned enterprise Contestas.

A very wise saying: "water does not flow under a lying stone." Intensive searches for orders began to bear fruit until the end of 1993:

- A.I. Fedorenchik received orders in Minsk for the development of modifications of the S1-137 service oscilloscope with a multimeter (S1-137/1) and with digital memory (S1-137/2) and agreed in Bryansk for development from 1994. portable oscilloscope with a bandwidth of 100 MHz (S1-152);

- A.A. Likhtinshain, with the help of A.L. Molchanov and G.P. Gubar, "broke through" additional funding for the development of a family of service oscilloscopes for MZIA from the State Budget of the Russian Federation (through MNIIRIP), and agreed with Mytishchi "Contact" and the RF Ministry of Defense about developing for them since 1994. service field oscilloscope to replace the Lvov S1-101, - sold 2 pieces in company with Inmatsis

CJSC. installations for digital recording of single-shot broadband signals based on S1-129 oscilloscopes and video cameras with CCD recorders;

- based on the modernized S1-94A, we modernized the SAGA oscilloscope and then began its production under the KT-04 brand;

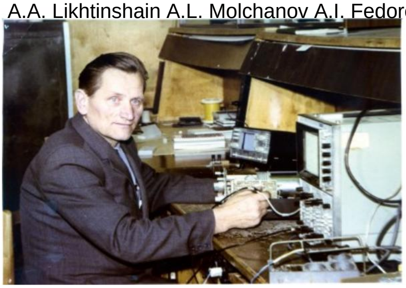
- in the summer of 1993, A.A. Likhtinshain met and established business contacts with the director of the Berlin branch of Mashpriborintorg V.M. Shmelkov (future trade representative of the Russian Federation in Germany) and immediately received from him an order for the supply of a batch of service oscilloscopes with digital memory C1-131 and KT-04;

- in parallel, we successfully began to manufacture and sell our service oscilloscopes to other European countries (mainly to Hungary).

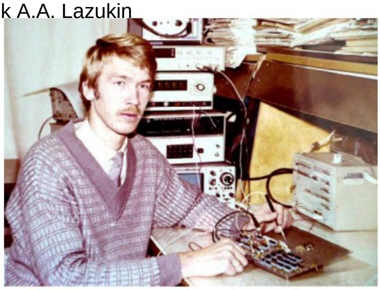
In Vilnius, the entire 2nd half of 1993 was spent forming Contestas into a normally functioning development enterprise. 2 development laboratories were formed: - A.A. Lazukina (developers Y. Rapalis, S. Kilas, A. Volkov, M. Grishko, M. Parshina, R. Grigalunene, L. Volkova);




A.A. Likhtinshain A.L. Molchanov A.I. Fedorenchik A.A. Lazukin



Y. Rapalis



A.Volkov

- A.I. Fedorenchik (developers G. Puodzhunaite, A. Bernotas, K. Ambrozaitis, Kotov, and others).


G.Puodziunaite


K. Ambrozaitis


A. Bernotas

The design and technological group of M. Cheprakova (R. Leonaviÿienÿ, R. Zeuger, T. Potaptseva, V. Melnikov) and a commercial division under the leadership of V.S. were created. Kozlova. The number of "Contestas" by the end of 1993. reached 30 people.


M. Cheprakova


R. Zeuger


M. Hryshko


L.Volkova

In Contestas, 1993 ended successfully: they not only covered losses of 60 thousand litas, but also earned a profit of about 20 thousand litas for the next year. (How useful they were for privatization!!)

Privatization of JSC Contestas, 1994

The entire first quarter of 1994 was devoted to preparations for the 1st stage of privatization. E. Piletskas conducted it with great energy and pressure. Constant meetings. Discussions, division of premises, equipment, people, debts, etc. By and large, no one understood

or understood this; most managers of personal enterprises acted on the principle that if a neighbor needs it, then it will be useful to me, and then they thought whether I might choke on what I bit off. As a result of this

In the division, “Contestas” “got” the “Greek hall” (VNIIRIP assembly hall), and the enterprise acquired complete geometric forms with an area of about 1000 m2, in contrast to the passage yard that existed before.

Contestas was lucky. For some reason, the director of Elitelma (an enterprise based on the microelectronics department) V. Kapalinskas did not work well with E. Piletskas and quit. He was asked to move to Contestas as deputy director and subsequently become the organizer of the production of heat meters, which Contestas and V. Fritzsche were going to develop and produce. He agreed.


V.Kapalinskas

V. Kapalinskas's first task was to manage the privatization process of Contestas (subscription of shares, constituent meeting of the team, purchase of checks, etc., etc.). This intelligent, energetic and exceptionally decent person quickly, independently and very skillfully solved the most complex and unexpected issues and problems.

At the end of March 1994, a constituent meeting was held and the Contestas enterprise received the status of a closed joint stock company. Constituent documents - charter, registration certificate and seal were received on July 15, 1994.

Development of "Contest", 1994-97.

During this period, oscilloscopes were developed for external orders:

- completion of work on modifications of the **S1-137** oscilloscope for Minsk (1994);
- modernization of the family of service oscilloscopes SK1-132A, **S1-139A,** SK1-140A and SK1-144A with a band of 0-25 MHz for MZIA (1994-95);

- development of a service field 20 MHz oscilloscope S1-161 for Contact software, Mytishchi (1994-96, implementation 1997);
- development of a portable 100 MHz oscilloscope S1-152 for the Elektroapparat plant, Bryansk (1994-96);

- technical project of a high-speed digital oscilloscope with a 250 MHz bandwidth (1997)

We carried out our own work on oscillography:
- creation of modifications of the digital service oscilloscope C1-
131 under the brands KT323 (4 memory zones) and KT328 (KT323 with a software package for working with the IBM PC personal computer) 1994;
- modernization of multimeter oscilloscope C1-112 (C1-112A);
- joint research with JSC Geozondas on the creation of an ultra-high-speed 4-channel digital recorder with a sampling frequency of 8 GHz (development of an 8 GHz ADC) in 1996.

In the direction of developing heat metering devices together with Werner Fritzsche's company "Ingenieurburo TEMPELWALD", Greiz, Germany - 1994-95. - Research work "HEATCONTROL" under a grant from the European Commission under the COST program. Project participants: - "Ingenieurburo
TEMPELWALD", Greiz,
Germany, project manager;

- JSC "Contestas", Lithuania; -
University of Marseille, France; - a company from
Budapest, Hungary.

The Contestas grant amounted to 41 thousand ecus (euro). "Contestas" also received another grant of 15 thousand litas from the Academic Council of the Lithuanian Academy of Sciences for its part of the project.

In 1995-96 meters were developed - sensors of heat consumed by a heating radiator (EHKV). Customer and co-executor - "Ingenieurburo TEMPELWALD", Greiz, Germany.

Manufacturing program:
- 1994-96, manufacturing (with the participation of JSC Tverme, created on the basis of the 11th assembly shop VZRIP) and supply of batches of service oscilloscopes KT-04, KT-323, KT-328, KT32 according to Shmelkov's orders, to Hungary and in the CIS; - in 1994, in parallel, Contestas began to develop the supply of
components and devices (mainly to India) on orders and through the mediation of Mashpriborintorg. Soon this activity became an independent and extremely profitable segment of the enterprise's activities and in some years reached sales volumes of 200 thousand dollars or more.

It was absolutely clear that in order to implement such an ambitious development and production program, changes in the structure of the enterprise and strengthening of personnel were necessary.

composition. Moreover, several key specialists quit (A. Volkov, Kilas, Valentukevichus).

In 1994, excellent specialists - Yu. Shchava, E. Pyatov, A. Voskoboy, B. Valyuk - came to Contestas from Eltesta JSC, which was experiencing great difficulties. They got involved in the development of a heat meter, where A. Lazukin was the technical director. B. Valyuk was especially energetic in the work, she headed the design and technology group and created there in one year, probably the strongest team of designers compared to other similar enterprises.

Y. Shchava

E. Pyatov

A. Voskoboy

B. Valyuk

She organized training for employees to work with AutoCAD, equipped herself with modern office equipment, and the group, with a small force, began developing design documentation for all simultaneously ongoing developments. At the same time, work was carried out there to create a corporate style for Contestas devices and to use standard housings from Western manufacturers for the developed RIPs.

To dispatch production tasks to Contestas, the former chief engineer of VZRIP, V.A.Novopolsky, was invited and we collaborated with him for almost 2 years.

Re-equipment of an enterprise, construction site, etc. required large expenses. We did not skimp on this and therefore could not boast of large salaries.

Termination of development activities, 1997-99.

There are many reasons for this: changes in the environment, force majeure, mistakes, but the main thing is people.

At the end of 1993, A.L. Molchanov unexpectedly died (since 1988, chief engineer of the 6th Main Directorate of the MPSS, previously an employee of VNIIRIP), and in 1995 he resigned

G.P. Gubar (previously curator of VNIIRIP at the 6th Main Directorate of the MPSS). And counting on support and assistance from Russian Telecom (formerly MPSS) and Russian factories has become much more difficult.

In March 1995, V. Kapalinskas went to ZAO Medelkom, where the salaries were higher, the prospects were clearer, and the manager was excellent.

And in April 1995 Suddenly he had a heart attack and 2 days later Contestas' partner Werner died. After his funeral, A.A. Likhtinshain, shocked, returned to Vilnius. At this time, there were many problems with the organization of public services in buildings and on the territory of enterprises (there was a lot of discussion, argument, and worry). After one of these discussions, A.A. Likhtinshain the next morning went by car to Palanga to V. Guoga (formerly head of the

microelectronics department of VNIIRIP), who helped Contestas a lot, organized a meeting there with one head physician to discuss the development of a special registrar

As a result, apparently near the city of Palanga A.A. Likhtinshain fell asleep and woke up barely alive in the Klaipeda hospital. Spent 3 months at home on crutches. Work "on heat" began to cool down at the end of 1996. have ended. Werner's young successors were afraid to develop this direction, which required special organizational skills. They probably did the right thing.

At the end of 1996 Shmelkov in Berlin resigned from the directors of Mashpriborintorg and became a trade representative. Supply orders were cut short immediately.

In 1997 the owner and management of the Kontakt PA in Mytishchi changed, which diligently forgot not only the "card debts" of the enterprise for the implementation of C1-161, but also openly ate 300 thousand rubles that came from the budget for payment to Contestas. Then the Chernomyrdinsky sequester of the Russian Federation budget came up and the MZIA did not pay the advance on

the technical project that had begun, feeding "Contestas" breakfasts and honest words for more than 6 months. And then a default occurred in the Russian Federation and all debts and other income in rubles turned into nothing.

Contestas went on downtime, each month costing approximately $10,000. Supplies soon ran out and people began to leave. A.A. Likhtinshain understood 2 years earlier that to survive you need your own reserve, your own unique know how, that the market for service oscilloscopes is very unstable and China will inevitably win. He counted on a foundation in the field of virtual high-speed digital oscilloscopes based on work for MZIA. But it was not possible to create it.

Activities of "Contestas" in 1999-2004.

In 1999, at the request of Mashpriborintorg, we successfully overhauled 4 RIP-4 radar testers. Much of the credit for this success certainly goes to V. Kozlov, formerly an employee of department No. 3, where RIP-4 was developed.

Inspired by the success in this new field, supported by a new order for spare parts for this device, I revived the design team, and we practically reproduced this device, which was once produced by the Kyiv Korolev Production Association. (Even some of the nodes were made better). They made good money, but there was no promised continuation. Trade only: parts, devices, customs, etc. It became boring and sad. But, in 2002 in

America, I first saw an electric scooter for the disabled. And this idea fascinated me. Both novelty for our market and its social usefulness.

"Contestas" in 2004-2013

Most of the employees are old and retired. Or quit for various reasons. Likhtinshain and A. Lazukin practically remained.

In 2004, we bought a small batch of scooters in China. We took part in exhibitions and advertised in newspapers. The result is practically zero. Our people want everything for free and at a discount. In 3 years we barely sold 10 pieces. But during the walk, they still left traces in the heads of the local leadership and some functionaries from the disabled community, who in 2007 asked for compensation of 3,500 litas for a scooter. And business started. By the end of 2007, 20 units were sold. In 2008 there were already 50 pieces.

We are practically a monopoly. But then the crisis came, the abolition of the preferential 5% VAT, the reduction of compensation to 1000 litas and all trade stopped. All that remains is the service of disabled equipment, and supplies, sometimes of devices, and sometimes of parts. This is how we live, trying to be useful.

1.15. Results of VNIIRIP's work in the field of oscillography.

In total, in all oscillographic divisions of VNIIRIP, for 43 years of its glorious history (from 1948 to 1991),
About 140 models of oscilloscopes, their modifications, and options for their delivery were developed, including the so-called "fractions" in the designation of models (including due to replaceable blocks). This number includes about 100 models of oscilloscopes, and about 50 replacement units for them, since some packages included more than 1-2 different replacement units.

To count the number of models, taking into account model numbers with "fractions" as individual models (for example, S1-91/2, and they were produced that way), made it possible to compare in this book the number of models of oscilloscopes with replaceable units, and the number of models of monoblock oscilloscopes , which were also assigned model numbers with "fractions" (for example, C1-166/1). On the other hand, this makes it possible to take into account the development of individual replacement units for oscilloscopes.

Modernized models were also taken into account as separate ones, for example, with the index "A" (C1-70A). These model accounting rules were applied to all oscilloscope development enterprises equally.

The list of oscilloscopes developed by the oscillographic divisions of VNIIRIP, as well as the names of the development topics, the years of their completion, the main characteristics and the name of the manufacturer, are given in Appendix 1, at the end of the book. There is also information about the production volumes of some models in 1984-1992.

Most of all USSR oscilloscopes were developed
It was in Vilnius, in the main oscillographic department, that there were 140 models of oscilloscopes and their variants out of 246 in the USSR, which amounted to about 56.9% of all developments of oscilloscopes in the USSR.

With this fact, Vilnius confirmed its leading position in oscillography in the USSR and in fact proved that it was not for nothing that it became the leader in oscillography in the country and took an honorable 1st place among research institutes developing oscilloscopes in the USSR, in terms of the number of developed models.

Therefore, it was here, in Vilnius, that all 6 All-Union Oscillographic Conferences were held, which brought together specialists from different cities and enterprises of the country.

So Thus, Vilnius really was the oscillographic capital not only of the USSR, but of all of Europe, since the production of oscilloscopes in Europe at that time was not very developed (Philips Test & Measurement D., Rohde & Schwarz, Schlumberger, a small branch of Tektronix on the island of Guernsey,

that's probably all that was in Europe at that time).

Vilnius' leadership is due to the fact that they began to develop and produce oscilloscopes there much earlier than other cities. The first oscilloscope was created in Vilnius in 1948, while in Lvov in 1957, in Gorky in 1962, and in Minsk only in 1975.

And this, in turn, is due to the fact that in Vilnius, on the territory of VNIIRIP/VZRIP, even before the war there was an advanced radio engineering enterprise for the production of radio receivers - "Electrit", which competed on equal terms with the Philips company in radio receivers, which produced a lot electronics specialists who subsequently created oscilloscopes (see section 3.1).

Almost all existing types of oscilloscopes were developed in Vilnius (9 out of 10 types, except for TV oscilloscopes, while in Lvov 6 out of 10, in Minsk 5 out of 10, and in Gorky 3 out of 10).

No. Oscilloscope type Vilna. Lvov Minsk Gork. 1 With shifts block. **38 (45)** 2 Low frequency						I am. %	
			4	-	4	46 (53) 18,7	
		11	**22**	7	-	40 16,3	
3 Stroboscopes 3 Service 5		17	-	-	**17**	34	13,8
Digital (and A/D) 7 Mid-		**23**	5	2	-	30	12,2
frequency. 6 Wideband 8 Special/		**15**	1	9	3	28	11,4
Speed 9 Memorable 10 TV Total		3	8	**8**	-	19	7,7
		9	4	4	-	17	6,9
		13	-	-	-	13	5,3
		11	-	-	-	11	4,5
		-	**8**	-	-	8	3,3
		140	52	30	24	**246**	100
	%	56,9	21,1	12,2	9,8	100	

As can be seen from the table above, in 6 types of oscilloscopes out of 10, Vilnius was the leader in the number of developments. These are such types as: oscilloscopes with replaceable units, service, digital, broadband, high-speed and storage. Lviv was in the lead

only in 2 types, and Minsk and Gorky have 1 type each. This table is also shown in Appendix 5.

Perhaps it is precisely for these reasons that the development traditions of oscillographic preserved in Vilnius today, although in a much smaller equipment are volume and scale than in Soviet times.

(Explanations regarding the terminology used in the table above:

1. Oscilloscopes with replaceable units (OSB, or SB) are universal devices that allow the replacement of their units during operation by the consumer, in order to expand functionality, without recalibration.

2. Low frequency (LF) oscilloscopes are universal oscilloscopes, with a bandwidth of up to 10 (15) MHz,

3. Service oscilloscopes are universal small-sized devices weighing less than 5 kg.

4. Stroboscopic oscilloscopes are special ultra-wideband devices designed only for repetitive signals.

5. Digital (and analog-to-digital) oscilloscopes are devices built on the basis of analog-to-digital signal conversion, followed by its storage on in

digital memory and display the waveform on the screen.

6. Wideband (WB) oscilloscopes are universal devices with a bandwidth of 100 MHz and higher.

7. Mid-frequency oscilloscopes (MF) are universal devices with a bandwidth in the range of 20-60 MHz.

8. Special, (high-speed) oscilloscopes are mainly broadband devices for registration (including photo registration) of single signals.

9. Storage oscilloscopes are devices for recording and observing single signals on the screen special storage CRTs.

10. Television oscilloscopes are instruments containing special blocks for observing details of the fine structure of TV signals, such as, for example, a line selection block, etc.).

Here is a list of legendary achievements in the field of oscillography VNIIRIP, with the mark **“Developed for the first time in the USSR”:**

- oscilloscope with replaceable blocks **S1-15, (1960)**
- semiconductor family of oscilloscopes with interchangeable blocks “Snaige” **(C1-70, since 1972,** etc.),
- the most multifunctional family of oscilloscopes with replaceable units based on microcircuits - “Svet” **(S1-91, since 1977,** etc.), consisting of the largest number - **5 basic and 15 replaceable blocks,**

- the largest number - **3** families of oscilloscopes with replaceable units: “Kulisa” (S1-15, 1960), “Snaige” (S1-70, 1972), “Light” (C1-91, 1977).
- 1st oscilloscope in the USSR, **S1-1, 1948,**
- service oscilloscope **S1-6, 4.5 kg, 1957,**
- service oscilloscope with a minimum weight of 3.5 kg - **S1-90, 1976,**

- the most broadband, stroboscopic oscilloscope on **12 GGc, S1-94/3, 1978,**
- the most broadband stroboscopic oscilloscope on **30 GHz, S7-20/4, 1990,**
- digital oscilloscope **S9-5, 1979,**
- digital oscilloscope with sampling rate **100 MHz, S9-20, 1986,**
- 1st digital oscilloscope made of OSB, mass-produced, with automatic measurements and control - **S1-122/8, 1986,**
- SP oscillograph at **100 MHz, S1-11, 1958,**
- ShP oscilloscope at **100 MHz** with a weight of 16 kg, **S1-92, 1977,**
- SP oscillograph at **250 MGc, S1-75, 1974,**
- SP oscillograph at **350 MGc, S1-97, 1979,**
- SP oscillograph at **1000 MGc, S1-129, 1989,**
- MF oscilloscope at **60 MHz, S1-7, 1956,**
- the largest-scale oscilloscope, production - **12.6** thousand devices per year, **S1-94, 1977,**

- **storage oscilloscopes** for a band of **1-100 MHz,** with a recording speed of 0.004-10 thousand km/s, a total of 15 models **1964-1987 m.g.,**

- **special high-speed oscilloscopes** for the **100-5000 MHz band,** with a recording speed of 1-250 thousand km/s, 12 in total models **1957-1986,**

- the most expensive, most broadband, and without a doubt the most complex, precision oscilloscope for testing picosecond differential generators in the USSR, priced at 27.6 thousand rubles. - **S9-9, 18 GHz, 1981**

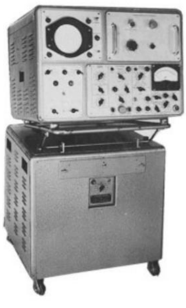
The total achievements of VNIIRIP in the field of oscillography, over 43 years, with the mark “Developed for the first time in the USSR” are: twenty two (22).

Outstanding oscilloscopes developed at VNIIRIP, and having the status **“Developed for the first time in the USSR”:**

S1-1, 250 kGc, 1948.

S1-7, 60 MGc, 1956

S1-6, 4.5 kg, 1957,



S1-11, 100 MGc, 1958

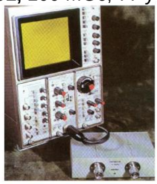
S1-15, 25 MGc, 1960

S1-70, 50 MGc, 1972



S1-75, 250 MGc, 1974. **S1-90,** 3.5 kg, 1976 **S1-91,** 100 MGc, 77 years.





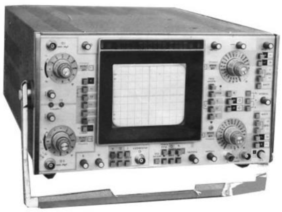
S1-92, 100 MGc, 1977 **S1-94,** 10 MGc, 1977, **S1-94/3,** 12 GGc, 78 years.



S9-5, 5 MHz, 1979 **S1-97,** 350 MGc, 1979 **S1-122/8,** 10 MGc, 86g.



S9-20, 20/100 MHz, 86 **S1-129,** 1 GHz, 1989, **S7-20/4,** 30 GHz, 90 g.



C8-18, ZELT, 1983. **C9-6,** 0.1/10 GHz, 1980 **C9-9,** 18 GHz, 1981

Thus, VNIIRIP was the largest center in the USSR for the development of oscilloscopes. It not only developed the largest number of oscilloscope models (56.9%), but also developed the most unique, technically complex and extreme ones.

Along with this, here, in the head department for oscillography in the USSR, VNIIRIP, a detailed analysis of the world oscilloscope market was regularly carried out, and a technical policy in the field of oscillography in the country was formed. Standards for oscillography and programs for the development of this industry were developed, as well as programs for the development of the element base in MEP for the needs of oscillography. As a result of such a technical policy in the USSR, under the leadership of the 6th GU MPSS, an instrument-making corporation was organized from 3

research institutes and 9 factories, which, in terms of its number, range of instruments, and technical level of products, corresponded to the best instrument-making companies in the world, such as Hewlett Packard and Tektronics.

In turn, thanks also to this, the USSR managed to create some of the best branches of technology in the world, such as nuclear, aviation, space and defense, which established the USSR in the world as one of the most powerful powers in the world.

Currently, there is only one company left in Vilnius - Eltesta JSC, with only 15 people, which continues to develop and produce USB-type digital and stroboscopic oscilloscopes (that is, without a screen, like set-top boxes for computers), its activities are described in section 1.14.1. Since 1992, this company has developed about 30 oscilloscope models.

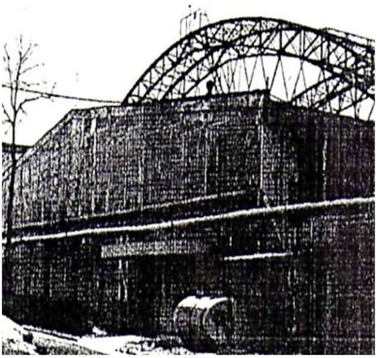
Chapter 2.

Lviv Scientific Research Radio Engineering Institute (LNIRTI)

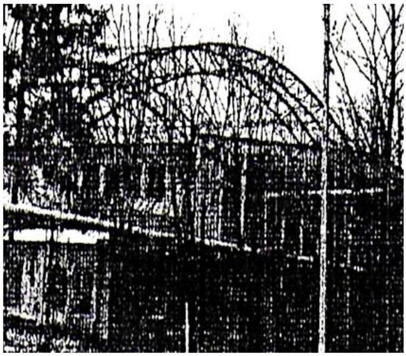
2.1. History of the creation of the Lvov Special Design Bureau. 1951-1958

2.1.1. At the origins

The origins of Lvov oscillography lead to the end of 1944 to two hangars at the Sknilovsky airfield, on the site of pre-war aircraft repair shops, where on December 13, 1944, by Decree of the State Defense Committee, plant No. 797 was founded.



Hangar No. 1 of Plant No. 797



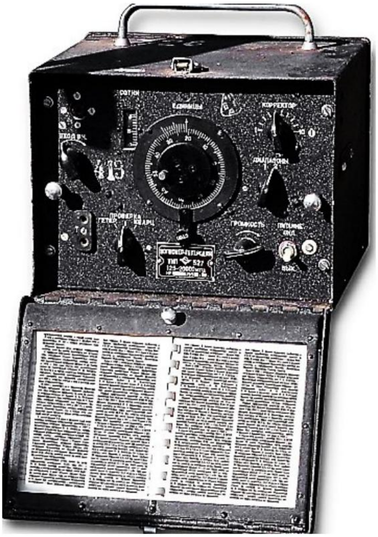
Hangar No. 2 of Plant No. 797

Until 1951, Plant No. 797 was subordinate to the Ministry. Aircraft were repaired here, and later, after a radical restructuring of the enterprise aviation industry, the creation of new at first workshops, they began to manufacture landing gear for aircraft and installations for checking and regulating aircraft hydraulic systems.

In 1951, the enterprise was transferred from the Ministry of Aviation Industry to the Ministry of Radio Industry under the name "PO Box No. 125" ("Measurer"), which later received the name "Production Association named after V.I. Lenin", and in 1999 - "Lviv Association of Radio Engineering equipment" (LORTA).

Since 1951, the enterprise began repurposing from the production of aviation equipment to the development and production of radio equipment for defense and general purposes.

Technical re-equipment of production is being carried out. There are qualitative changes and updates to its economic system and organizational structure, technologies and labor organization are being improved in all structural divisions. Shops are being reconstructed, workers and plant engineering personnel are being retrained, new production units are being created, which are being replenished with new engineering personnel, and the like [1].



Serial production of radio equipment for air defense troops begins: short and medium wave autonomous field radio stations and ship autonomous radio stations. Until 1956, the company began to produce the first radio-electronic measuring instruments -

heterodyne wavemeters VG-526, VG-526U, VG-527, VG-528 and resonant wavemeters of the decimeter wave range under the code names “Fly” and “Bee”.

Heterodyne wavemeter VG-527

On January 4, 1956 (7 years after the creation of OKB-555 in Vilnius), by order of the Ministry of Radio Industry of the USSR, a special design bureau (SKB) was created at the Lvov plant, post office box No. 125, later called the Lvov Design Bureau (LKB), and by order no. 237 of the same

Ministry on April 22, 1969, created the Lvov Scientific Research Radio-Technical Institute (LNIRTI).

In 1956-1957, several areas of development of radio measuring instruments were formed at SKB: television measuring equipment, oscillography, frequency measuring equipment and digital voltmeters.

The main direction in the development of radio measuring instruments became oscillography.

There are 5 directions in the oscillography of the Lvov SKB development of oscilloscopes (including for harsh operating conditions);

• low-frequency (LF) oscilloscopes, for a bandwidth of up to 10 MHz; • television (TV) oscilloscopes (with a TV line extraction unit and other TV measurements) for a band from 10 – 20 MHz;
• mid-frequency (MF) oscilloscopes, for a band of 20 - 50 MHz; • wideband oscilloscopes with a bandwidth of 100 MHz and higher,
• small-sized service oscilloscopes, weighing less than 5 kg.

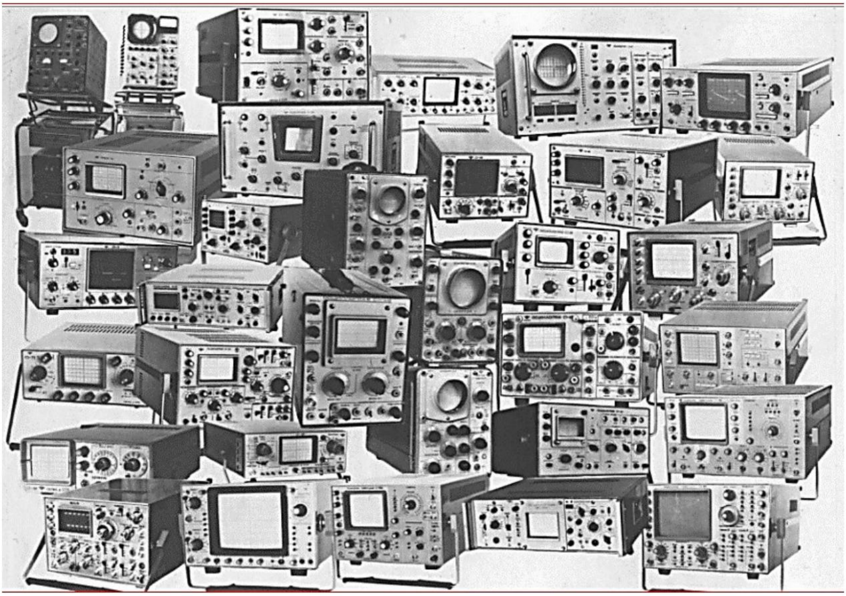
During the period from 1956 to 1991, LNIRTI employees developed and put into production at the Lvov Association of Radio Engineering Equipment (LORTA), the Zolochiv Radio Plant (ZRZ), the Novorozdilsk Signal plant, at two plants in Minsk (Belarus) - the plant named after V.I. Lenin and the Kalibr plant and at the Bryansk plant

"Electroapparat" (Russia) **51 models of oscilloscopes.**

These are the following models: S1-9 (EO-58), S1-13 (EO-60), S1-13A, S1-19, S1-19B, S1-22, S1-30, S1-30A, S1-34, S1-35, S1-43, S1-48, S1-48B, S1-49, S1-52 (S9-52), S1-55, S1-57 (S9-57), S1-59, S1-63, S1-64, S1-64A, S1-65, S1-67, IS-67, S1-68, S1-69, S1-71, S9-1, S1-73, S1-77, S1-78, S1-79, S1-80, S1-80/1, S1-80/2, S1-80/3, S1-81 (S9-2), S1-83, S1-93, S1-98, S1-99, S1-100, S1-101, S1-104, S1-107, S1-113, SK1-119, S1-123, S1-124, S1-130, S1-135 (1101).

After the collapse of the USSR, during the period from 1991 to 1998, LNIRTI employees developed **11 more oscilloscope models:** - 1101A, 1102 (S1-136), 1102A, 1201, 1202, 1203, 1204, 1301, 1301A, 2201, 2201A.

In addition, on a CRT with a screen size of 100x120 mm, the following have been developed, but not put into production: a 4-channel analog oscilloscope with a bandwidth of 0-100 MHz on the topic “Structure-1”, 4-channel digital oscilloscopes with a bandwidth of 0-100 MHz 100 MHz “Stroke-3” and “Stroke -3M”.

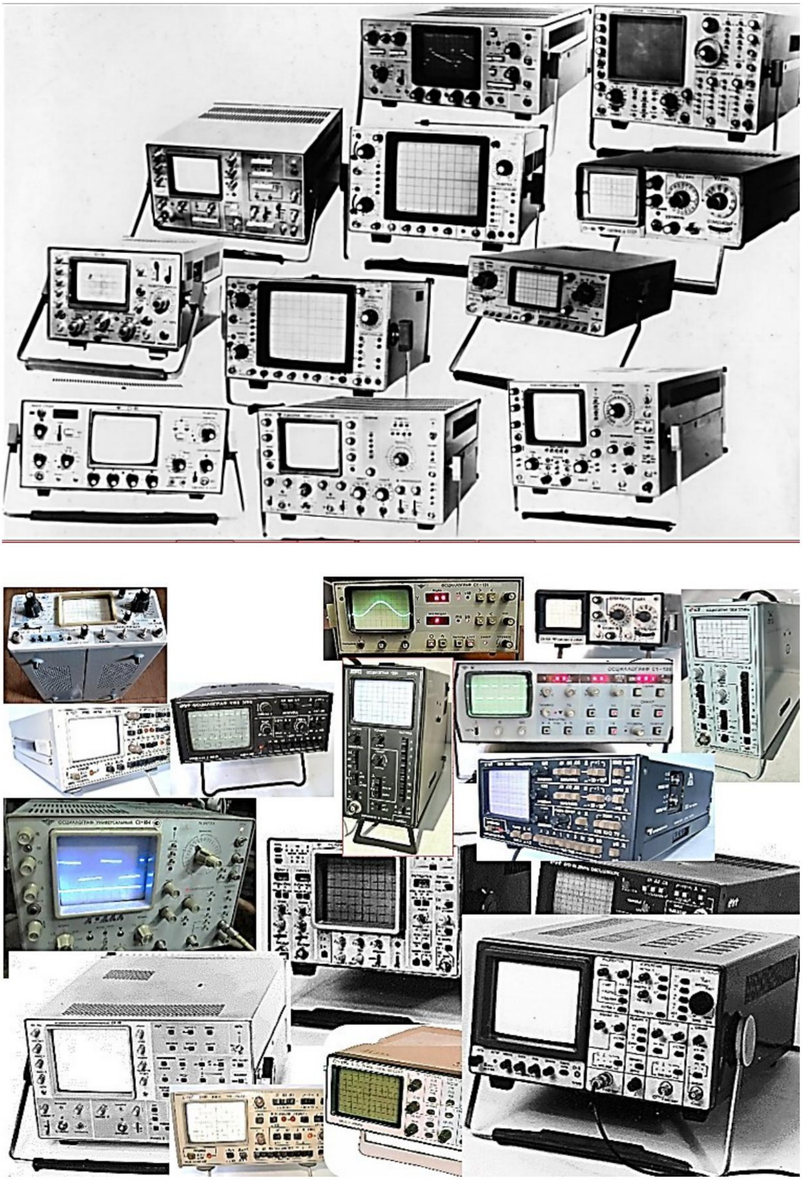


Photos of oscilloscopes developed at LNIRTI.

Oscilloscopes developed at LNIRTI were used in various sectors of the national economy, the military-industrial complex, and the armed forces, were sold on the international market and exported to over 40 countries. The scientific achievements of LNIRTI workers in the creation and implementation

of oscilloscopes in production include 204 inventions protected by copyright certificates and patents, 236 scientific articles, one monograph, 4 dissertations, the state standard of Ukraine DSTU 3238-95 "Electronic-promene oscillography".

LNIRTI employees also received VDNKh medals for successes in the national economy of the country: gold - 16, silver - 53, bronze - 185, two employees became laureates of state prizes, dozens of employees were awarded diplomas of the Presidium of the Verkhovna Rada and the Ministries for high professional excellence and significant contribution to the development of the scientific and technical potential of the country.



Photos of oscilloscopes developed at LNIRTI (continued).

2.1.2. SKB at the plant, post office box No. 125

The main task of SKB, created in 1956 at the enterprise, post office box No. 125, was the modernization of products produced by the plant and the development of new radio measuring and special equipment. The production area occupied by SKB in the first year of its existence was 35 m2 .

The first head of SKB was the chief engineer of the plant, post office box No. 125, Lev Vyacheslavovich Zeland (1956-1959), later the general director of the Lviv production association "Polaron" (1959-1986), largest which was the Ukraine manufacturer of electronic products in Western

Lev Vyacheslavovich Zeland - first head of SKB

During the period from 1956 to 1959, Zealand carried out significant work at SKB regarding the creation of the SKB team. He invited experienced and young specialists from the radio engineering department of the Lvov Polytechnic Institute to work at SKB.

In the 50s, in engineering practice and in the practice of radio amateurs, visual methods for monitoring the characteristics of radio engineering devices began to be widely used, based on the use of panoramic indicators, which made it possible to automate the process of measuring the characteristics of electronic devices as much as possible.

In particular, with the help of devices for tuning televisions (PNT), meters of amplitude-frequency, phase-frequency and transient characteristics, it is possible to perform measurements in a few minutes that would take from tens of minutes to hours using traditional devices of generators, voltmeters, etc. .

The introduction of such devices into mass production, their modernization and the development of new devices was undertaken by SKB at the plant, post office box No. 125.

2.1.3. Oscillographic division of SKB

From the very first days, SKB created an oscillographic division within its structure. In 1956, a group of specialists modernized radio measuring instruments made on cathode ray tubes. Within 2 into a laboratory that which was studying years, this group grew developed a number of instruments for use in television technology.

The year 1956 can be considered the year of the birth in Lvov of an amazing creation of science and technology - oscillography, which rightfully appeared in the city of Lvov - an important cultural and scientific center of the Ukrainian SSR.

It was in 1956 that the plant, PO Box No. 125, began the development of serial production of the first oscilloscope of oscillographic type devices in the Soviet Union: the frequency response meter television ICH-1, the transient response EO-53 meter IPH-1, devices for tuning TVs PNT-2 and PNT-3.

The EO-53 oscilloscope was intended for operational monitoring of the performance of television paths and its individual links in television systems. The design documentation for EO-53, PNT-2 and PNT-3 was developed by the All-Union Scientific Research Institute of Television (Leningrad) and in 1956 transferred the documentation to the Lvov plant, post office box No. 125, to organize serial production. It is interesting to note that the first tube frequency response meter, ICHH-1, was too bulky, weighing 200 kg. The meter made it possible to “remove”

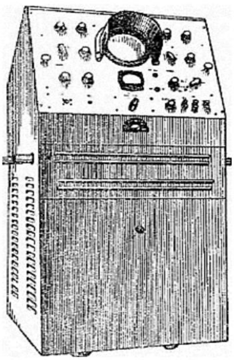
amplitude-frequency characteristics in the frequency range from 0.1 to 20 MHz with frequency deviation up to 4 MHz.

It is during the development of the above-mentioned devices in mass production - acceptance of design documentation for products; organizing jobs and training for equipment adjusters; regulating products and submitting them to the technical control department; prompt resolution of issues that arose in the process of their production and regulation were born and future highly qualified specialists and scientists gained experience, who became the pride of the enterprise and gained fame far beyond its borders.

In the same 1956, graduates of the radio engineering department of the Lvov Polytechnic Institute came to work at SKB, in the department of the Chief Designer, the department of the Chief Technologist and the assembly shop of the plant, post office box No. 125: V.A. Adashchik (later director of LORTA), A. V. Zhidachevsky, K. G. Bas, E. K. Blyudin, V. A. Polushin, V.P. Kravchenko, O.M. Klishch, V.D. Maslakovets, M.G. Mazo, E.T. Udovichenko (later director of the Sistema Research Institute, Dr. Yu.A. Tsarevsky, V.A. Rymsha, V.V. Cherlenevsky, V.V. Yablonsky, V.I. Mikhalevsky, Plaksyuk,
economic sciences),

I.G. Ivanov (later chief engineer of the Polaron production association), G.V. Podoshik, L. Pelensky and others.

Already in the second half of 1956, at the plant PO Box No. 125, serial production of a new range of radio measuring instruments began: meters of amplitude-frequency and transient characteristics ICHH-1 and IPH-1, devices for tuning televisions PNT-2 and PNT-3, electronic beam oscilloscope EO-53 on a CRT 31LO33V with a long afterglow of the CRT screen.

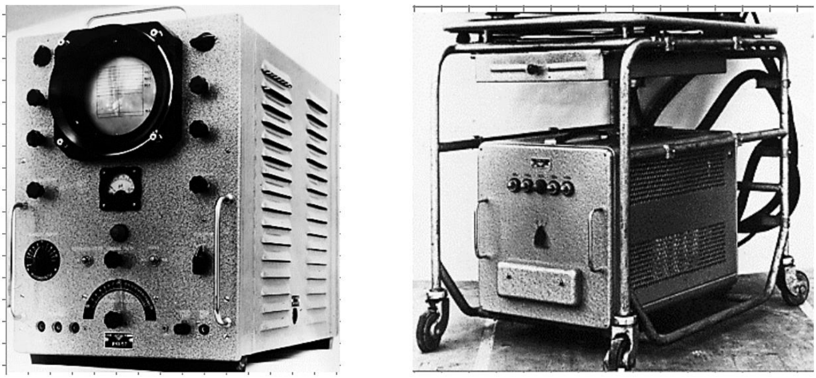


Oscilloscope EO-53 Devices for tuning TVs PNT-3 and PNT-3m

In 1957, SKB began work on modernizing mass-produced devices for visual tuning of PNT-2 and PNT-3 televisions, as well as the development of new models of amplitude-frequency and transient characteristics meters ICHH-57 and IPH-57 with improved technical characteristics.

The modernized model PNT-2 and PNT-3 was named PNT-3m. Their modernization was carried out by V.G. Andrushchenko, Z.M. Bodnar, B.M. Gorelov, V.A. Polushin, V.D. Maslakovets, A.V. Zhidachevsky, V.P. Kravchenko.

In 1958, instead of the ICHH-1 amplitude-frequency characteristics meter and the IPH-1 transient characteristics meter, ICHH-57 and IPH-57 devices were developed and put into production.



ICHH-57 meter and power supply for it

The developers of ICHH-57 and IPH-57 were V.G. Andrushchenko, Z.M. Bodnar, V.A. Polushin, B.M. Gorelov, V.P. Kravchenko, A.V. Zhidachevsky, V.D. Maslakovets , design engineers
A.I. Kukhlevsky, G.O. Evtyukhin, V.M. Shpytko.

Vladimir Hryhorovych Andrushchenko (right)

The first technical manager of the developers of devices for tuning televisions, meters of amplitude-frequency and transient characteristics, and the first oscilloscopes at SKB was Vladimir Grigorievich Andrushchenko, Vladimir Grigorievich Andrushchenko subsequently became the chief engineer of the 6th State Administration (Main Directorate) of radio measuring equipment of the Ministry of Communications Industry (MPSS), under whose subordination was VNIIRIP and its head oscillography department. Subsequently, V.G. Andrushchenko became Deputy Minister of the MPSU.

From the memoirs of MPSS workers [2]: “I, and many others, consider Vladimir Grigorievich Andrushchenko to be one of the leading specialists in our field. This man, who appeared on the horizon of the radio industry in a sailor's vest, possessed, and still probably has, a phenomenal memory and organizational abilities and, despite the fact that he never defended master's and doctoral dissertations, he is on an equal footing, and more often than not, as the most experienced radio operator, discussed problems with the main specialists.

Vladimir Grigorievich began his activities as head of the main department by establishing order. And this means: down with diversity, forward to specialization. As a result of establishing this order, noise generators went to Kaunas, power supplies to GNIPI, and power meters to Mytishchi."

2.1.4. SKB structuring

In 1957-1958, the structuring of SKB began. Laboratories were created, each of which included 2-3 groups of instrument developers - engineering and technical workers.

The development team primarily consisted of 3-5 employees. The engineering and technical development team was headed by a leading engineer. The leading engineer was the direct scientific and technical leader and labor organizer in the group. His functions included: development

and coordination of technical tasks on research or development work (research and development work); development of individual technical specifications for the component parts of the device and issuance of them to specialized divisions of SKB and co-executing enterprises; personal participation in the development and calculations of the most complex circuits, functional units, parts, systems, devices and all necessary development documentation.

Mostly each of these groups developed one device, sometimes two devices at the same time. The development period for the device lasted on average 2-3 years. With the increase in the volume of development of design documentation, separate design design of the divisions, who developed device, divisions for the development of power supplies for devices, technological division and other support services.

In the first years of the creation of laboratories, along with the development of oscillographic equipment, work began on the development television measuring equipment. Worked in the direction of developing television measuring equipment Z.M.Bodnar, V.A.Rymsha, A.V.Zhidachevsky, V.I.Mikhalevsky, G.V.Podoshik.

Z.M. Bodnar, V.A. Rymsha and G.V. Podoshik developed a group propagation time meter F4-1, designed for panoramic measurement of the physical time characteristics of message transmission along a transmission channel. A wideband signal passing along a communication line is distorted, that is, its shape at the output of the line does not coincide with the shape at its input. This distortion occurs due to the fact that different frequency components of the signal, propagating at different speeds,

reach the end of the communication line at different times.

The F4-1 meter made it possible to isolate one of the components of signals propagating along a communication line and display the measurement result distortion broadband

V.I. Mikhalevsky, G.V. Podoshik, Plaksyuk developed a generator of television measuring signals, which was intended for use in a complex of equipment for monitoring and measuring the main indicators of television equipment and image transmission channels of long-distance cable and radio relay communication lines.

2.1.5. Chief engineer of SKB

In 1958, the position of chief SKB engineer, which was taken by senior lecturer of the Department of Radio Receiving Devices of the Lviv Polytechnic Institute (LPI) Konstantin Vladimirovich Kravchenko.

Konstantin Vladimirovich Kravchenko

Trudova the Konstantin next Vladimirovich in the path passed following way:

1949-1954 – senior researcher at LPI.
1954-1958 – senior lecturer at LPI. 1957-1958 – senior lecturer at LPI and part-time engineer-consultant at SKB, post office box No. 125.

1958-1966 – chief engineer of SKB, post office box No. 125.
1966-1969 – chief engineer of LKB. 1969-1980 – head of department, deputy head of department of LNIRTI.

This man’s personality combined high professionalism, the broadest erudition, organizational talent, strong business acumen and life wisdom. Having become the first deputy head of SKB, he took responsibility for the results and efficiency of SKB's production activities, for its scientific and technical policy and prospects for technical development.

2.2. Tube oscilloscopes 1957-1965

A special place among SKB's developments was occupied by universal real-time cathode-ray oscilloscopes, that is, oscilloscopes in which the signal image on the CRT screen appears almost simultaneously with the action of the signal at the input of the device, in contrast to stroboscopic oscilloscopes.

Universal oscilloscopes have become the most popular type of instrument among other types of oscilloscopes.

The universal oscilloscopes with wide functionality developed at SKB were intended for use in a wide variety of areas of the national economy, the armed forces, the military-industrial complex and

for sale on the international market.

The development of oscilloscopes was headed by V.A. Polushin. His career path went as follows:

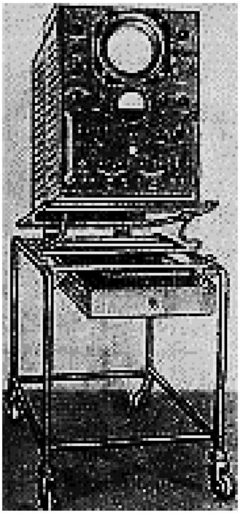
Vadim Andreevich Polushin

1956 – control engineer of workshop No. 5 of the plant, post office box No. 125, engineer at SKB.
1958-1959 – senior, leading engineer at SKB. 1961 – Head of the
SKB laboratory. 1966 – beginning laboratory department.
1971 – head of department laboratory – Deputy Chief Engineer.
1976 – head of department.
1977 – head of department.
1987 – Head of Department – Chief Metrologist of LNIRTI.

1991 – dismissed due to exit to pension.

2.2.1. 1st oscilloscope S1-9 (12 MHz) developed at SKB

In **1957 ,** the development of the first television oscilloscope EO-58 (S1-9) was started at SKB, and in **1958** it was completed, which was put into production at the plant, post office box No. 125 in 1959, and which eventually replaced the oscilloscope EO-53 in production. .



The EO-58 (S1-9) oscilloscope was a high-class universal instrument and was intended for measuring and monitoring a television signal, which contains information about television image and sound, as well as for studying and measuring the amplitude and time parameters of periodic signals.

Oscilloscope S1-9 parameters:

- 12 MHz band,
- CRT 13LO37, diameter 125 mm,
- sensitivity 40 mV/cm,
- sweep 1000 ÿs/screen,
- power consumption 550 VA,
- weight 65 kg.

EO-58 (C1-9)

The device made it possible to study the television signal in detail from the whole half-frame to part of the half-frame and any line.

The oscilloscope was used for setting up television and pulse equipment during their development, for setting up during the operation of long-distance television channels of cable and radio relay communication lines. television centers,

2.2.2. Change of head of SKB

The increase in the volume of development of radio measuring equipment and the new tasks assigned to SKB required a radical transformation of technology for the development of measuring instruments.

In 1959, Aron Abramovich Yavich became the head of the design bureau of the plant, post office box No. 125. A decisive, strong-willed person, empowered to carry out management functions, he took the initiative and responsibility for the results and immediately took on the assigned work.

Yavich was more of an administrative leader than an innovative leader, an authoritarian type of leader, but a master leader who cared about the development of the enterprise and the well-being of workers. He had friendly communications with both local authorities and the leadership of the Ministry. His role as a leader was multifaceted. As a leader, he had a monopoly on decision-making and control over their implementation, gave instructions and orders

subordinates, monitored the progress of their implementation and demanded their implementation.

Took responsibility for creating conditions for solving assigned tasks. At the same time, he showed his organizational, professional, and communication qualities; he was a good organizer who knows how to organize work. During his management, a small design bureau at the plant, post office box No. 125, grew into an independent LNIRTI team of many thousands (about 4.5 thousand employees). Under it, new production buildings, auxiliary structures and housing for workers were built.

Aron Abramovich Yavic

The career path of Aron Abramovich Yavich is as follows:

1949-1952 – plant post office box No. 1, Krasnoyarsk.

1952-1957 – head of the central laboratory, senior engineer of the OGK, head of the design bureau of the OGK plant, post office box No. 125.

1959-1966 – head of the design bureau of the plant, post office box

No. 125. 1966-1969 – head of the design bureau.

1969-1987 – director of LNIRTI.

2.2.3. TV tuning device PNT-59

In **1960 ,** instead of a device for tuning televisions, PNT-3m

a model of the device PNT-59 (X1-7 and X1-7B) was developed. The new model of the device provided configuration and visual viewing of the frequency characteristics of radio and television devices and was a combination of a four-band oscillatory frequency generator and a marker generator of an oscillographic device.

and

The sweep frequency generator covered the frequency range from 0.1 to 232 MHz and had four sub-ranges.

The frequency tag generator generated tags at intervals of 1 MHz and 10 MHz. Output voltage was regulated
smoothly and in steps from a maximum level of 0.1 V ± 50%.

Using an oscilloscope - the PNT-59 oscillographic device, it became possible to study signals in the frequency range 0.1-15; 27-60; 55-102 and 174-232 MHz depending on the selected frequency range.

TV tuning device PNT-59 (X1-7)

The sensitivity of the vertical deflection amplifier in oscilloscope mode was no less than 0.4 mm/mV, and from the input of the detector head - no less than 150 mm/V. The input capacitance did not exceed 6 pF.

With the first developments came the first success: the PNT-59 device was awarded a gold medal and an exhibition diploma at the international exhibition in Brussels in 1961.

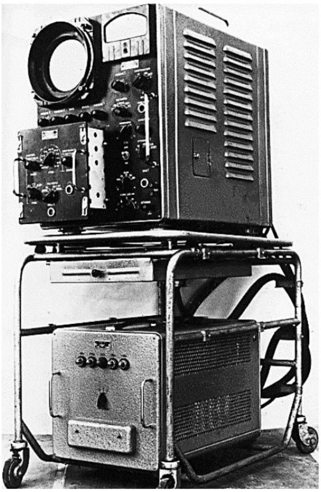
The developers of the device were: V.G. Andrushchenko, Z.M. Bodnar, B.M. Gorelov, V.A. Polushin, V.D. Maslakovets, A.V. Zhidachevsky, V.P. Kravchenko.

2.2.4 TV oscilloscopes with replaceable units S1-13 (A)

In **1959-1961 ,** multifunctional oscilloscopes S1-13 and S1-13A (EO-60) with bandwidth from 20 Hz to 15 MHz, which combined the functions of a universal and television oscilloscope.

The oscilloscopes had three replaceable units: RB-1 – time base generator; RB-II is a television line extraction block and RB-III is a frequency response meter block.

The oscilloscopes were intended to study the shape and measure the parameters of periodic signals, a detailed study of television raster signals with an indication of the area under study on a remote control device. Along with this, the devices made it possible to study and configure video amplifiers and passive quadripoles based on the amplitude-frequency characteristics observed on the screen of the cathode ray tube.



Parameters of the S1-13 (A) oscilloscope with replaceable units:

- 15 MHz band,
- CRT screen 40x80 mm,
- sensitivity 100 mV/cm,
- scan 600 ns/sec.,
- power consumption 600 VA,
- weight 84 kg.

Replaceable blocks with C1-13 (A):
- RB-1, scanner,
- RB-2, line selection block,
- RB-3, frequency response meter.

Oscillograph S1-13 (A)

The developers of the EO-60 (S1-13) oscilloscope were: E.K.Blyudin, V.I.Gudyk, Ya.S.Kurylyak, B.A.Molnar, V.A.Polushin,
M. Gnatyshin. At the initial stage, the development was headed by leading engineer V.A. Polushin, and subsequently by leading engineer E.K. Blyudin.

E.K. Blyudin is co-author of the book “Portable Oscilloscopes”, M., 1978. and co-author of the State Standard of Ukraine "Electronic-promenetic oscillography".

requirements and test methods. (DSTU 3238-95), State Standard of Ukraine, Kyiv.

Evgeny Konstantinovich Blyudin

The career path of E.K. Blyudin looked like in the following way:

1956 - graduated from the radio-technical faculty of LPI. 1956 – TsZL engineer at the plant, post office box No. 125.

1956 – senior engineer of the laboratory department of the civil engineering department of the plant, post office box No. 125.

1959 - senior engineer of SKB at the plant, post office box No. 125.

1961–1967 - leading engineer at SKB and LKB.

1967-1984 - head of the laboratory of the LKB and LNIRTI.

1984 – Head of the LNIRTI department.

1991 – dismissed from LNIRTI due to retirement due to age.

1992 – leading engineer of LNIRTI.

2007 – dismissed from LNIRTI due to staff reduction.

Eugene Konstantinovich belongs to real intellectuals with a high internal culture, filled with self-esteem and deep respect for other people. He remains like this under any circumstances, having firm convictions, does not yield under material pressure.

difficulties, nor under the influence of life's temptations.

In particular, holding the position of head of the department from 1984 to 1989, in 1989 he voluntarily wrote a letter of resignation in favor of another, and he himself moved to a lower position. Evgeniy Konstantinovich was firmly convinced that the department should be headed by the one who developed and approved the program for the development of radio measuring equipment at the institute. No amount of persuasion to remain in his position helped. Evgeniy Konstantinovich is an excellent specialist, balanced, friendly and simply a good person.

2.2.5. Oscilloscopes S1-19 and S1-19B with long afterglow of the CRT screen

In **1962 ,** SKB developed laboratory and field oscilloscopes S1-19 and S1-19B, highly sensitive to input signals (2 mV/cm - 5 V/cm), with a range of studied signals extended to low frequencies (maximum time base duration 2 s/ cm). Oscilloscopes were intended to study periodic and single processes in the millisecond range.

Oscilloscopes S1-19 and S1-19B replaced the outdated one oscilloscope ENO-1 (S1-4), developed at VNIIRIP in 1954. In comparison with S1-4, the S1-19 and

S1-19B oscilloscopes had better sensitivity to input signals, two identical amplifiers in the vertical and horizontal beam deflection channels, which made it possible to study Lissajous figures and current-voltage characteristics.

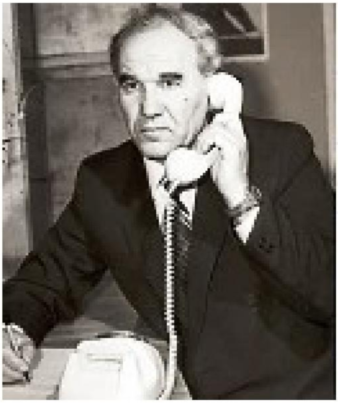
The oscilloscopes had two variable plug-in blocks - BPU-1 and BPU-2. The bandwidth with the BPU-1 block was 0 - 1 MHz, and with the BPU block - 2 Hz - 1 MHz.

Another feature of the S1-19 and S1-19B oscilloscopes was the operating temperature at which the technical characteristics of the devices were guaranteed. Unlike S1-4, which could only operate in room conditions, oscilloscopes S1-19 and S1-19B provided their characteristics at ambient temperatures from minus 10ºÿ to plus 40ºÿ and humidity up to 90% at a temperature of 25ºÿ. The weight of the devices in comparison with the S1-13 oscilloscope decreased by almost 5 times and amounted to 21 kg.

Parameters of the S1-19 (B) oscilloscope with replaceable blocks BPU-1/2:

- band with BPU-1: 0-1 MHz,
- band with BPU-2: 2 Hz-1 MHz,
- CRT screen 50x80 mm,
- sensitivity 2 mV/cm,
- sweep 10 ÿs/d,
- power consumption 250 VA,
- weight 21 kg.

The development of the S1-19 and S1-19B oscilloscopes, as well as all subsequent oscilloscopes with a long CRT screen afterglow, was led by the leading engineer, and subsequently the head of the sector, Yosif Petrovich Lazor.



Yosif Petrovich was wonderful a qualified specialist, high a principled, even categorical, but sensitive, caring person, demanding of himself and others. This energetic attentive and and businesslike man was able to rally around himself all employees of the department and work to create oscillographic technology, which was not inferior to the best world standards.

Yosif Petrovych Lazor

The main developers of oscilloscopes S1-19 and S1-19B were E.K.Blyudin, B.A.Molnar, V.I.Gudyk and Z.M.Bodnar.

2.2.6. Small LF oscilloscope C1-22 (5 MHz)

In **1965 ,** SKB developed a small-sized S1-22 oscilloscope, wideband for that time (0-5 MHz), for harsh operating conditions. Operating temperature from minus 30ºÿ to plus 50ºÿ, humidity 95% at 25ºÿ.

The features of the S1-22 oscilloscope were a large dynamic range of amplitudes of the input signals under study from 0.5 V to 1500 V, small overall dimensions of 460x275x190 mm and a weight of 12.5 kg. To make it possible to observe the leading edges of short pulses, there was a delay line in the vertical deflection path.

Developers of oscilloscope S1-22: leading engineer R.K. Sharykin, A.M. Zadorozhny, L.N. Minenko, O. Klish, B.G. Taradas.

Oscillograph S1-22

Oscilloscope S1-22 parameters:

- 5 MHz band,
- CRT screen 50x80 mm,
- number of channels - 1,
- sensitivity 100 mV/cm,
- sweep 100 ns/cm,
- power consumption 200 VA,
- weight 13 kg.

2.2.7. Low-frequency oscilloscope S1-30 (1 MHz)

In **1962 ,** the S1-30 oscilloscope was developed in two versions - desktop and rackmount. The device was intended to study electrical signals in the frequency range from direct current to 1 MHz by visual observation, photography and measurement of their parameters.

The deflection coefficient of the vertical beam deflection channels is set stepwise from 0.02 to 5 V/cm with an overlap of 2.5 and multiplication by 1 and 10.

The presence of identical amplifiers in the vertical and horizontal beam deflection channels made it possible to observe Lissajous figures, current-voltage characteristics, and carry out a number of other measurements.

An internal calibrated voltage source generated symmetrical square wave voltage with a frequency of 1000 Hz, set in 18 steps from 0.2 mV to 100 V with an error of no more than ± 3%.

Oscilloscope S1-30:
- 1 MHz band,
- CRT screen 50x80 mm,
- number of channels - 1,
- sensitive 20 mV/cm,
- sweep 2 µs/cm,
- consumption power 520 VA,
- weight 36 kg.

The main developers of the oscilloscope were: lead engineer I.P. Lazor, B.A. Molnar, V.I. Gudyk and Z.M. Bodnar.

2.3. Semiconductor oscilloscopes 1965-1969

Despite the rapid development of oscilloscopes based on tube technology, with the expansion of the functionality of devices and, as a consequence, their complication, low reliability and durability of devices are beginning to be felt. The electronic lamp has insurmountable disadvantages: large dimensions,

high energy consumption, long time to enter the operating mode, low reliability. As a result, after 2-3 decades of existence, tube electronics in many applications have reached the limit of their capabilities.

The vacuum tube needed a more compact, economical and reliable replacement. And it was found in the form of a semiconductor transistor. Its creation is rightly considered one of the greatest achievements of scientific and technical thought of the twentieth

century.

2.3.1. 1st semiconductor oscilloscope S1-35 (5 MHz)

In **1963 ,** SKB began and in **1965** completed the development of the first laboratory-field oscilloscope in the USSR, S1-35, made on semiconductors.

The device was intended to study pulsed and periodic processes of milli- and microsecond duration with amplitudes up to 300 V through visual observation in field conditions.

Options oscilloscope S1-35:

- 5 MHz band,
- feelings. 10 mV/d,
- unfold. 2 μs/d,
- consumption Power. 30 VA,
- weight 8 kg.

The oscilloscope bandwidth was 0-5 MHz. A special feature of the oscilloscope was its low power consumption - only 30 VA, as well as its small overall dimensions of 174x220x421 mm and weight of 8 kg. Harsh operating conditions included: temperature from minus 30ºÿ to plus 50ºÿ and humidity up to 95% at plus 25ºÿ.

The development of the S1-35 oscilloscope was headed by leading engineer Zinovy Mikhailovich Bodnar. The main developers were: B. Kazantsev, B. Kuyumchan, E.I. Lagun, Melikhov.

Zinovy Bodnar is a wonderful person, a well-known specialist in the field of oscillography. His career path is as follows:

Zinovy Mykhailovych Bodnar

1957 – engineer at SKB plant, post office box No. 125.
1959 - senior engineer at SKB. 1960 – leading engineer of the SKB laboratory.
1966 – leading engineer, head of the LKB laboratory.

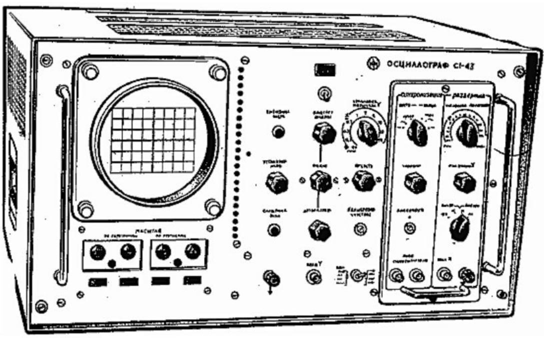
1969 - head of the laboratory of LNIRTI.
1970 - head of the sector. 1972 - head of the laboratory. 1978 – deputy head of the department.
1983 – deputy head of the department.
1984 – Head of Department.
1989 – leading engineer.
1993 – leading design engineer.
2005 – dismissed from LNIRTI due to withdrawal on retire.

2.3.2. 1st automated LF oscilloscope S1-43 (10 MGc)

In **1966 ,** the Special Design Bureau at the mailbox plant No. 125 was renamed Lvov Design Bureau (LKB).

The next development at SKB-LKB was the S1-43 oscilloscope with bandwidth 0-10 MHz, developed in **1965-1967 .**

The device provided for automatic setting of scales with digital display. The image size is automatically set within 2-6 cm vertically, and horizontally within 2-6 signal repetition periods.



Options
oscilloscope S1-43:

- 10 MHz band,
- CRT screen 60x80 mm,
- feelings. 50 mV/d,
- unfold. 500 ns/d,
- auto. ex. scale,
- consumption Power. 150 VA,
- weight 40 kg.

Automated oscilloscope S1-43

Constant component is compensated signal automatically or manually by calibrated steps within ±11 cm. The oscilloscope allows any combination

manual and automatic control. It is used in laboratory and production conditions.

The development team included: E.K. Blyudin (see photo at the S1-13 oscilloscope), D.I. Grytsak, B.A. Mandziy, N.F. Storozhenko. I.I.Halavka.

2.3.3. LF oscilloscope C1-48 and C1-48B (1 MHz)

In **1968 ,** the S1-48 desktop oscilloscope was developed, and in 1970, the S1-48B rackmount oscilloscope
execution.

The features of oscilloscopes include: high
sensitivity to input signals (2 mV/cm), operation in X-Y mode. The presence of identical amplifiers in the

channels of vertical and horizontal beam deflections makes it possible to observe the current-voltage characteristics and Lissajous figures.

Developers of the S1-48 and S1-48B oscilloscopes: leading engineer J.P. Lazor (see photo in section 2.2.5, near the S1-19 oscilloscope), I.M. Sydor, Ya.B. Pentsak.

Parameters of the S1-48 oscilloscope: - 1 MHz band, - CRT screen 60x80 mm, - sensitivity. 2 mV/d, - sweep. 2 ÿs/ d, - consumption power 75 VA, - weight 20 kg.

Oscillograph S1-48

2.3.4. LF small-sized scillograph S1-49 (5 MHz)

Oscilloscope S1-49 parameters:

- 5 MHz band, - CRT screen 36x60 mm, - sensor. 10 mV/d, - sweep. 0.2 μs/d, - consumption power 38 VA, - weight 8.5 kg.

Small-sized semiconductor oscilloscope S1-49

In **1968 ,** a small-sized oscilloscope S1-49 was developed. The range of measured voltages is 20 mV - 200 V; range of measured intervals 8 ÿs – 0.5 s; power consumption 38VA, weight 9 kg. Portability, small dimensions and weight of the device, universal power supply: mains 220 V, 50 Hz; 115 V, 400 Hz and from a 24 V DC source made the oscilloscope indispensable for the maintenance and repair of radio devices, in laboratory, production and field conditions.

Operating conditions: operating temperature from minus 30ºÿ to plus 50ºÿ, operating humidity 95% at 25ºÿ.

Alexander Nikolayevich Gonchar-Bysh

The development of the S1-49 oscilloscope was led by leading engineer A.N. Gonchar-Bysh. Oscilloscope developers: B. Kazantsev, Yu. Kos, A. Titarov, Melikhov.

Being a competent and excellent specialist, Alexander Nikolaevich Gonchar-Bysh was a decent person with a gentle character. Alexander Nikolaevich is an inventor, author of more than a dozen patents and copyright

certificates.

2.3.5. Television oscilloscope S1-52 (S9-52)

In **1969 ,** the S1-52 TV oscilloscope with a bandwidth of 0-12 MHz was developed, designed for periodic and operational monitoring of the video signal and its components in black-and-white and color television systems.

Oscillograph S1-52

TV settings
oscilloscope S1-49:

- 12 MHz band,
- CRT screen 60x80 mm,
- feelings. 100 mV/d,
- unfold. 0.1 µs/d,
- TV line selection block,
- consumption power. 70 VA,
- weight 25 kg.

The device uses a phase-accounting device, which allows you to examine any part of the television raster with high temporal stability, in particular, to highlight a television line or part of it in each of the half-frames.

A special feature of the S1-52 oscilloscope is the guarantee of its technical parameters during continuous operation for 22 hours.

Developers of the S1-52 oscilloscope: L.V. Shtoiko, V.I. Sukonko, N.P. Matushek, V.I. Gromov, S. Bolyak.

2.3.6. LF dual-beam oscilloscope S1-55 (10 MHz)

In **1968 ,** to replace the two-beam tube oscilloscope S1-34 with a bandwidth of 0-5 MHz, LKB developed universal dual-beam oscilloscope based on semiconductor elements S1-55 on with a bandwidth of 0 - 10 MHz.

Dual-beam oscilloscope S1-55

Parameters of 2-beam oscilloscope S1-55:

- 10 MHz band,
- ELT 9LO2I,
- feelings. 10 mV/d,
- unfold. 20 ns/d,
- consumption power. 75 VA,
- weight 15 kg.

The oscilloscope uses a dual-beam cathode-ray tube, two independent amplifiers in the vertical path to deflect each beam, and an amplifier in the Z channel to modulate the brightness of the beam with signals from external sources. The device has a universal power supply from an alternating current network of 220 V with a frequency of 50 Hz,

as well as from a network of 115 V and 220 V with a frequency of 400 Hz, and power supply from a DC source of 24 V. Power consumption is 75 VA. Overall dimensions 205x 355x 470 mm, weight 15 kg.

The device has the ability to operate in harsh climatic conditions from minus 30ºÿ to plus 60ºÿ, humidity up to 98% at plus

35ºÿ. This allows the device to be used in field conditions during search and reconnaissance expeditions.

The development team of the S1-55 oscilloscope included: leading engineer Ya.S. Kurylyak, B.I. Prots (2.7.1.), P.F. Tolmachov, B.D. Kovpak.

2.3.7. Special television oscilloscope S1-57 (15 MGc)

Developed in the late 60s, the special television oscilloscope S1-57 (S9-57) with a bandwidth of 0-15 MHz is intended for studying television signals with indication of a section of the television raster on a video control device.

The device contains a television line selection block, which allows you to examine the oscillogram of any line of a television raster with the exact setting of the number of the line being examined; a circuit for recording a video signal based on the level of synchronization pulses, which made it possible to fix the position of the oscillogram on the screen of the cathode ray tube during video signal transmission.

TV settings
oscilloscope S1-49:
- 12 MHz band,
- CRT screen 60x80 mm,
- feelings. 100 mV/d,
- unfold. 0.1 μs/d,
- TV block BVS,
- consumption power. 70 VA,
- weight 25 kg.

Special television oscilloscope S1-57 (S9-57)

Oscilloscope developers: leading engineer L.V. Shtoiko, V.I. Sukonko, N.P. Matushek, V.I. Gromov, O. Levina.

2.4. Lviv Scientific Research Radio Engineering Institute (LNIRTI)

In 1969, by order of the Ministry of Radio Industry dated April 22, 1969 No. 237, the Lviv Scientific Research Radio Engineering Institute (LNIRTI) was formed on the basis of the LKB. This happened 3 years after the formation of VNIIRIP.

The increase in the development of radio-measuring and special equipment, the creation of complex radio-electronic systems for the needs of defense and the national economy required a radical improvement in the scientific and technical potential of the institute, its production and technical resources. There has become an urgent need to change all factors affecting working conditions, including the construction of buildings, and a radical renovation of production and equipment.

LNIRTI began construction of a large economic complex, which consisted of a 4-story research and production building with an area of 12,850 m2 and an adjacent 6-story administrative building with an area of 5,100 m2 .

Administrative, research and production building of LNIRTI: on the left is a 6-story administrative building, on the right is a 4-story research and production building.

The research and production building primarily housed comfortable laboratories for equipment developers and, at first, on the ground floor -

production capacity.

The administrative building housed auxiliary services and a branch of the clinic, which served not only employees of the institute, but also employees who previously worked at LNIRTI.

2.4.1 Production building

Subsequently, for pilot production, LNIRTI were with
a four-story building 7B with an area of 10,492 m2 was built
adjacent six-story administrative building 7G with an area of 4658 m2 .

The structure of LNIRTI also included the unfinished semiconductor chip plant "Integral", a unique facility in Vinniki (near Lvov) - two soundproof chambers and the experimental plant "Volna".

Pilot production housing and view - inside the housing

In 1985, construction began on the huge Integral semiconductor device plant. According to the project, the construction of 17 buildings was provided. During the period from 1985 to 1991, 5 buildings were partially built and 2 buildings were put into operation: a procurement and a chemical warehouse.

Soundproofing chambers are built on special “floating foundations” and are designed for testing

radio equipment with minimal influences
external physical factors: noise and vibrations, including Earth vibrations.

The Volna pilot plant was intended for serial production in small batches of measuring and special electronic equipment, which were developed at LNIRTI.

Experimental plant "Volna"

2.4.2 Laboratory and production building

In 1985, the period of the so-called “Gorbachev perestroika” began. These changes in economics and politics also affected LNIRTI. In parallel with the development of special equipment, a research institute for the development of household radio electronics is being created at LNIRTI. A 10-story building was built.

To the left of the 10-story building is a 4-story production building 7G, to the right is a conference room, and behind the 10-story building is another 6-story production building 7D.

At the end of the 80s, LNIRTI began construction of a 10-story administrative building. A skeleton was built

Houses. Later, the unfinished house passed to another owner, who modified and completed it.

Laboratory and production 10-storey building

Photo of the building, the construction of which began at LNIRTI.

"Winter Garden" conference hall

Residential buildings for LNIRTI workers on the street. Scientific

2.5. Oscilloscopes for special purposes. 1971

Oscilloscopes that were developed at SKB, LKB and LNIRTI were exported to over 40 countries and used in different climatic zones, the temperature in which could vary from very cold minus 50ºÿ to tropical dry over 60ºÿ and tropical marine climates. Climatic factors that affect devices and limit their performance include: ambient temperature and humidity, heat stroke, atmospheric pressure, the presence of aggressive substances and ozone in the

environment, solar radiation, fungal formations (mold), the presence of microorganisms, insects and rodents, danger of explosion and flaring of the atmosphere, water influences in the form of splashes or

rain.

Particularly harmful for devices is the humid tropical zone, in which, in addition to high humidity, there is also an increased concentration of salts near the seas and oceans, which make the atmosphere of this zone especially corrosive and aggressive. The development and serial production of oscilloscopes that would meet the above requirements is too expensive.

Therefore, to supply oscilloscopes in climatic zones with very harsh climates, special development of such devices was carried out or the development of the device was carried out in two versions: for use in temperate climatic zones, and with the modification of such devices for use in tropical or subtropical climates.

Special oscilloscopes developed at LNIRTI have shown trouble-free operation in aggressive tropical conditions of the marine climate.

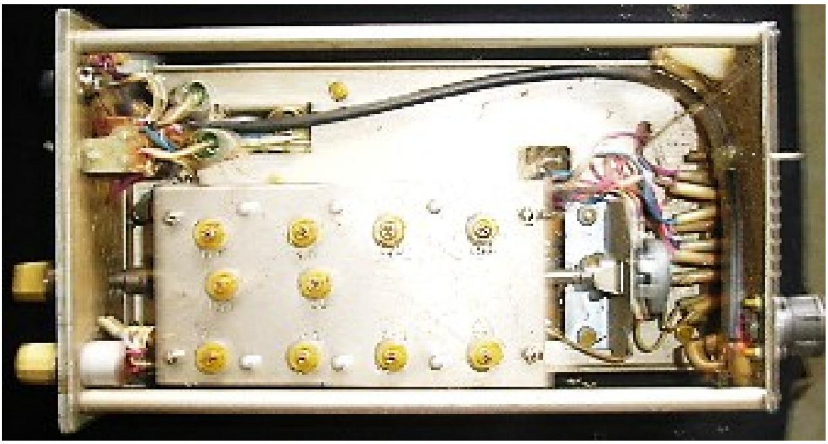
2.5.1 Special TV oscilloscope for monitoring audio channel S1-59 (1 MHz)

In **1971 ,** the S1-59 oscilloscope was developed. It was a special development and, as part of a set of equipment, served to check the quality indicators of amplitude-modulated signals of transmitting devices, control and measure the parameters of equipment and sound transmission channels in television.

The device was made in two versions: tropical and
non-tropical implementation.

Oscilloscope S1-59 in tropical design

The oscilloscope provides a logarithmic scale of the vertical deflection of the cathode ray tube beam, and within two divisions of the screen scale, the sensitivity to input signals is linear - 2 mV/div.



Plug-in unit (as opposed to a replaceable) oscilloscope S1-59

The device allows you to set a zero potential at the oscilloscope input in the range of ± 100 V without switching the attenuator.

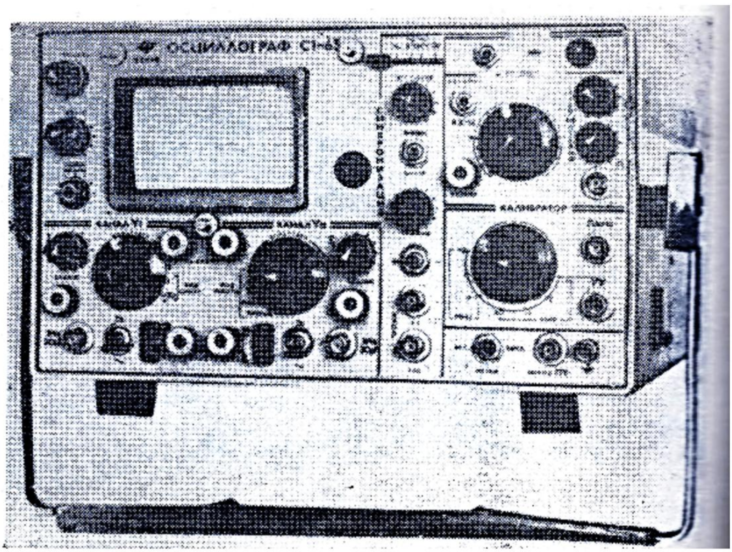
Oscilloscope developers: L.V. Shtoiko, V.I. Sukonko V.F. Yakimiv.

2.5.2. Two-channel onboard oscilloscope S1-63 (25 MHz)

In 1971, the S1-63 oscilloscope was also developed with a bandwidth from DC to 25 MHz, which
was intended for use on board airplanes and helicopters and provided for studying the shape and measuring the parameters of electrical signals on the screen of a cathode ray tube, as well as photo recording of images from the CRT screen.

The oscilloscope is subject to special requirements regarding the ability to withstand the action of reduced atmospheric pressure not only during transportation in unsealed cabins and compartments of aircraft when the oscilloscope is turned off, but also to maintain its technical parameters when the operating mode is turned on, and even in

wide range of temperature changes.



Oscilloscope C1-63

The S1-63 oscilloscope also has the ability to store its appearance and parameters during and after exposure to solar radiation.

Developers of the S1-63 oscilloscope: V.I. Gudyk, D.I. Gritsak, I.I. Khalavka, M.V. Yushyna, V. Koshulenko.

2.6. Universal oscilloscopes 1971-1979

2.6.1. Dual-channel oscilloscopes S1-64 and S1-64A (50 MGc)

In **1971 ,** oscilloscopes S1-64 and S1-64A were developed and are designed to study one or two electrical
signals in the frequency range from DC to 50 MHz. Five operating modes of the switch in the vertical deflection path, main and delayed scans, small overall dimensions and weight make the device most suitable for repairing and setting up radio equipment for various purposes in laboratory and workshop conditions.

Parameters of the two-channel midrange oscilloscope S1-64:

- 50 MHz band,
- CRT screen 48x80 mm,
- number of channels - 2,
- feelings. 1 mV/d,
- number of sweeps - 2,
- unfold. 0.1 µs/d,
- consumption power. 150 VA,
- weight 19 kg.

Oscilloscope C1-64

Oscilloscope C1-64A is different from oscilloscope S1-64 only with a larger working field of the cathode ray tube screen, 64x80 mm, versus 48x80 mm, the overall dimensions of which are in both devices are the same.

Oscilloscope C1-64A

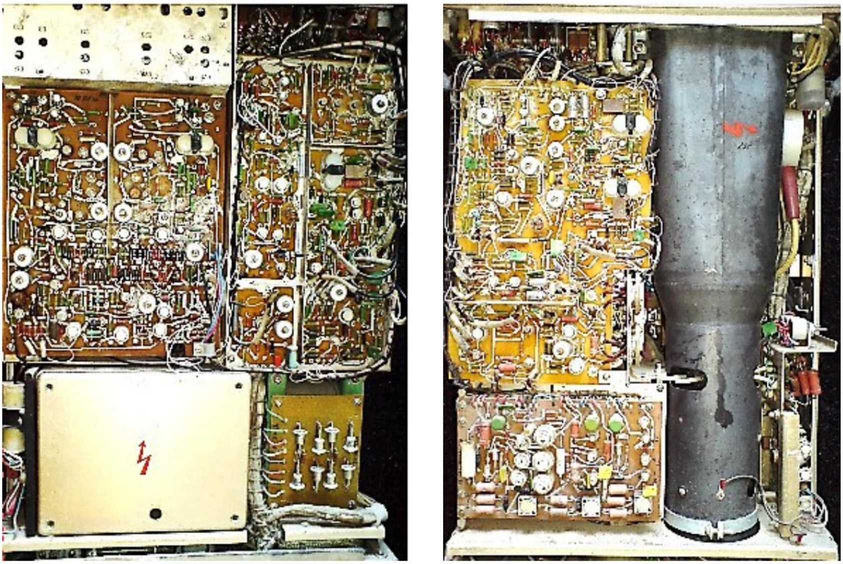
Oscilloscopes use a cathode ray tube with internal scale, which made it possible to reduce by half the error in measuring the amplitude and time intervals of the signals being studied by oscilloscopes.

The device provides an increase in the deflection coefficient (sensitivity to input signals) up to 1 mV/div when vertical deflection channels are connected in series.

In S1-64 and S1-64A, for the first time in universal oscilloscopes, two time sweeps of the studied signals were used: main and delayed.

For a more detailed study of part of the signal under study, including those remote for a significant time from the beginning scan, the scan is stretched - it is enlarged several times. Delayed sweep allows you to select a small area

on the signal image and stretch it hundreds, thousands of times.



Photos of the opened oscilloscope S1-64A

Oscilloscopes S1-64 and S1-64A met the most modern requirements for the key characteristics of devices. They are distinguished by their versatility and ease of use.

With a wide range of functions, operating the device has not become more difficult. These devices are intuitive and simple to operate, allowing you to quickly understand all the intricacies associated with oscilloscopes.

Developers of oscilloscopes C1-64 and C1-64A: leading engineer A.N. Gonchar-Bysh (see section 2.3.4.), BA Kazantsev, L.Y. Lysiak, L. Martynuk, Yu. Cos, A.R. Levin, J.O. Knysh, V.O. Don't worry.

2.6.2. Legendary midrange oscilloscopes S1-65 and S1-65A (35/50 MHz)

In **1971 ,** the legendary S1-65 and later S1-65A oscilloscopes with bandwidths of 35 MHz and 50 MHz were developed to work in laboratory and very harsh field conditions.
respectively.

These devices are unique in that they have become one of the most popular among universal oscilloscopes of the USSR.

S1-65A was produced simultaneously at 2 factories in Minsk - named after. Lenin and “Caliber” of the Ministry of the Moscow Union of Soviet Socialist Republics. From 1980 to 1990, its annual production amounted to more than 11 thousand devices per year.

In terms of serial number, the mid-frequency portable S1-65A was second only to the 2nd service, cheaper low-frequency devices S1-112A (20 MHz) and S1-94 (10 MHz), developed by VNIIRIP, the serial number of which was just over 12 thousand units. in year.

At the same time, it became the most popular and large-scale mid-frequency oscilloscope of the USSR in the 35-50 MHz band.

Oscillograph S1-65

Options
single-channel midrange
oscilloscope S1-64:

- 35 MHz band,
- CRT screen 64x80 mm,
- number of channels - 1,
- feelings. 5 mV/d,
- number of scans - 1,
- unfold. 10 ns/d,
- consumption power. 125 VA,
- weight 16 kg.

Due to production stock on key parameters, high reliability, manufacturability, maintainability and low price of this device, the demand for S1-65A was so high that at the plant named after. Lenin, for the first time in the history of oscillography of the USSR, the adjustment of these devices on a conveyor was organized. In the future, this method of adjustment

was not used for any of the other models of oscilloscopes in the USSR.

Oscilloscope S1-65 (35 MHz) was developed in Lvov in **1971** year under the leadership of leading engineer R.K. Sharykin by a group of developers - A.M. Zadorozhny, L.N. Minenko, V. Koshulenko, A.G. Khurmanets.

After the development of the S1-65 device in production at 2 factories in Minsk in the 70s, the Minsk MNIPI set up and successfully solved the problem of expanding the bandwidth of this device to 50 MHz, and expanding the working part of the CRT screen.

Oscilloscope C1-65A

Chief designer of modernization work in Minsk, MNIPI

in the oscilloscope S1-65A was Ph.D. Nemirovsky V.M., developers - Petrovich A.G., Mironov E.S.

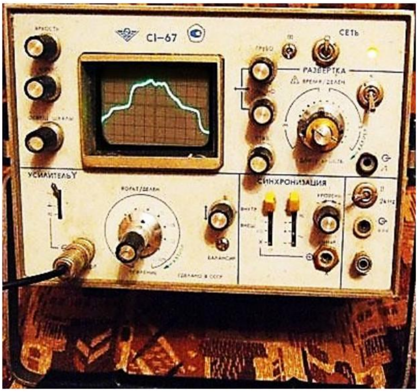
main

These oscilloscopes are small in size and weight and can used for work at temperatures from minus 30ºÿ to plus 60ºÿ, humidity up to 98% at a temperature of 40 ºÿ.

2.6.3. LF oscilloscope S1-67 (10 MHz) and special IS-67

In **1972 ,** the S1-67 oscilloscope was created with a bandwidth of 0-10 MHz, is distinguished by its small overall dimensions and weight, and is used for research and measurement of parameters in laboratory, workshop and harsh field conditions.

The S1-67 oscilloscope uses a cathode ray tube with an internal parallax-free scale. The device has universal power supply: from a network of 220 V with a frequency of 50 Hz, 115 V - 220 V with a frequency of 400 Hz and from a DC source of 24 V.



Parameters of the single-channel low-frequency oscilloscope S1-67:

- 10 MHz band,
- CRT screen 42x60 mm,
- number of channels - 1,
- feelings. 10 mV/d,
- number of scans - 1,
- unfold. 100 ns/d,
- consumption power. 45 VA,
- weight 10 kg.

Oscillograph S1-67

Subsequently, the task was set to finalize oscilloscope S1-67 for use on horse-drawn and tracked vehicles in conditions of bad roads and off-road conditions.

The device had to be able to withstand the destructive effects and

mechanical shocks

vibration, provide impact strength and impact resistance, save your settings after they have been applied.

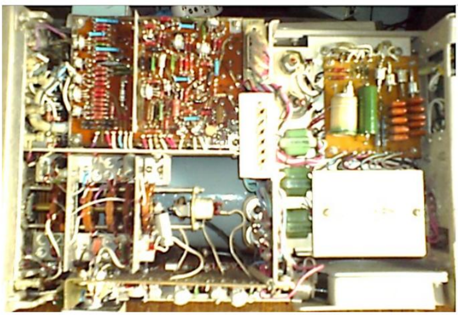


Photo of the opened oscilloscope S1-67

Emergence shocks is associated with a sharp and rapid movement of the vehicle on which the oscilloscope was installed. Action

mechanical shocks are accompanied by the excitation of damped oscillations at the natural frequencies of vibrations of the elements and the structure parts of the oscilloscope, when the structural elements resonate at the frequencies of disturbances, the impact.

caused by

When refining the design of the device, special attention was paid to the effect of mechanical factors, of which the shock with the shortest duration of its increase is particularly dangerous. The S1-67 was developed specifically for the oscilloscope

a shock absorber on which the device was installed, and which mainly ensured the stability of the device during the action of mechanical factors. Oscilloscope S1-67 in this design was called "oscilloscope IS-67".

The operating temperature range of the IS-67 oscilloscope has been expanded from minus 40ºÿ to plus 60ºÿ.

Developers of oscilloscopes S1-67 and IS-67: leading engineer Ya.S. Kurylyak, B.I. Prots (see section 2.7.1.), R.V. Lavrukh, R.D. Stetsiv.

2.6.4. LF oscilloscope S1-68 (1 MHz)

The goal of the development of the S1-68 oscilloscope, developed in **1968 ,** was to create a device highly sensitive to input signals (2 mV/D) with universal power supply from an alternating current network and a direct current source.

Oscillograph S1-68

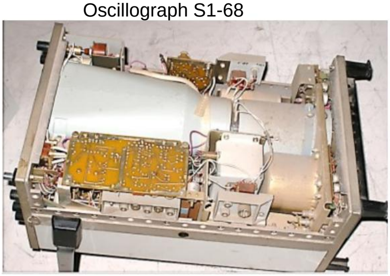


Photo of the opened oscilloscope S1-68

Parameters of the single-channel low-frequency oscilloscope S1-68:

- 1 MHz band,
- CRT screen 60x80 mm,
- number of channels - 1,
- feelings. 2 mV/d,
- number of scans - 1,
- unfold. 2 µs/d,
- consumption power. 40 VA,
- weight 10 kg.

S1-68 is designed for mass shape research low frequency signals and measurements of their amplitude and time parameters.

Oscilloscope developers: leading engineer J.P. Lazor (see section 2.2.5), I.M. Sydor, Ya.B. Pentsak, V. Lemishevsky.

2.6.5. The first semiconductor broadband oscilloscope in the USSR S1-71 at 100 MHz

In **1973 ,** the country's first universal semiconductor oscilloscope with a bandwidth of 0-100 MHz was developed. Using an oscilloscope, you can examine periodic and pulsed signals with amplitudes from 15 mV to 100 V and durations from 10 ns to 1 s by visual observation on the screen of a cathode ray tube or by photographing. The oscilloscope is characterized by low error, high sensitivity, universal power supply and low power consumption.

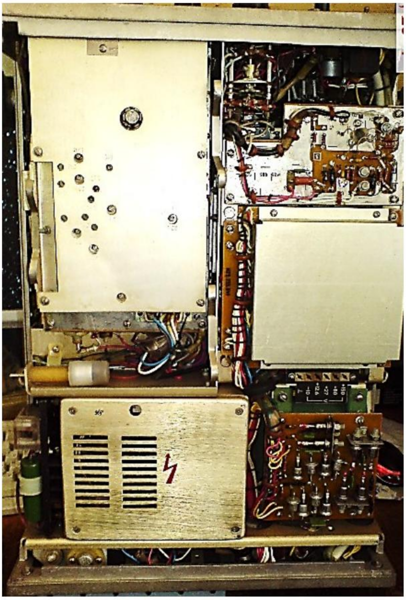
The error in measuring amplitude and time intervals is no more than 5%. The built-in calibrator has a square wave output voltage with amplitudes: 0.03; 0.06; 0.12; 0.3; 0.6 and 6 V with a frequency of 2 kHz and an error of 1.5%.

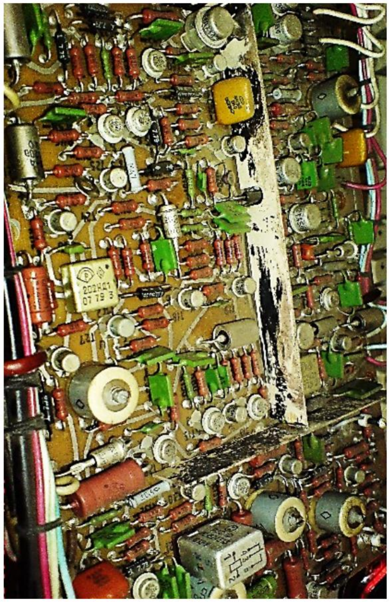
Power supply of the oscilloscope: from a network of 220 V with a frequency of 50 Hz; from a DC source of 24 V, 0.75 A. Power consumption is only 35 VA, weight 8 kg.

The device can also be used in countries with tropical climate, in air-conditioned rooms.

Oscillograph S1-71

Reviews from users of the S1-71 oscilloscope: using the S1-71 oscilloscope you can test and repair a variety of devices. control and measuring oscilloscope S1-71 quickly solves the problem of identifying equipment problems. The presence of many functions does not complicate device control. Therefore, working with an oscilloscope is simple and convenient.





Photos of the opened oscilloscope S1-71

The development of the S1-71 oscilloscope was led by leading engineer Vasily Ivanovich Gudyk. Main developers of the device: D.I. Grytsak, M. Boychuk, Berezovskaya.

2.6.6. 1st service small-sized oscilloscope in the USSR - S1-73 (5 MHz), weighing 4.5 kg.

In **1974 ,** at the request of aviators, an S1-73 oscilloscope with a bandwidth of 0-5 MHz was developed to study signals with amplitudes from 10 mV to 350 V and durations from 200 ns to 0.5 s.
The working part of the CRT screen is 36x60 mm, sensitivity 10 mV/d, scan rate 50 ns/d, power consumption 30 VA. The weight of this device was
only 4.5 kg (which is less than 5 kg - the norm for service oscilloscopes) and for this parameter it set a weight record and became the 1st service oscilloscope in the USSR.

The ability to operate the oscilloscope in a chest position makes working with the device convenient in hard-to-reach places.

places: cabinets, racks, intermediate stations of communication lines and other objects.

The device has a built-in delay line, which provides measurement of the rise time of pulses on fast sweeps.

The S1-73 oscilloscope is one of the most common devices in its class and is popular among specialists and radio amateurs. It was a relatively inexpensive, small-sized and lightweight device with a universal

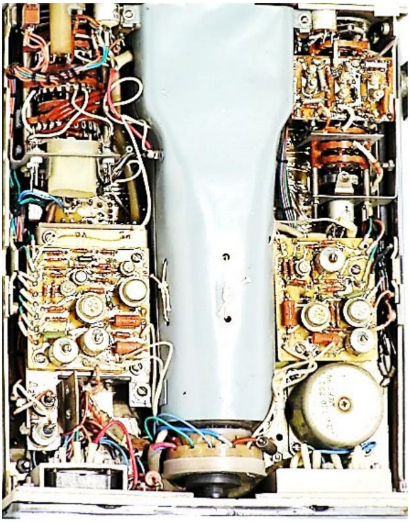
powered from a 220 V network, frequency 50 Hz-60 Hz, and from a DC source with a voltage of 20 V-30 V.

Oscillograph S1-73

The device provides technical parameters under extremely harsh operating conditions: operating temperature range from minus 30ºÿ to plus 50ºÿ, humidity 98% at 40ºÿ.

The development was led by leading engineer I.M. Sydor.

The main developers of the S1-73 oscilloscope: Yu.V. Berezovsky, Ya.B. Pentsak, V. Lemishovsky.

Opened oscilloscope S1-73

Ivan Mikhailovich Sydor

1954-1957 – military service.
1958-1964 – student at LPI.
1964-1967 – Eng. OGK of the EMZ institute Izhevsk (Russia).
1967-1969 **-** Eng. LKB laboratories.
1970-1977 - st. Eng. LNIRTI.
1977-1998 – leading engineer. LNIRTI.
1998 – dismissed from LNIRTI due to staff reduction.

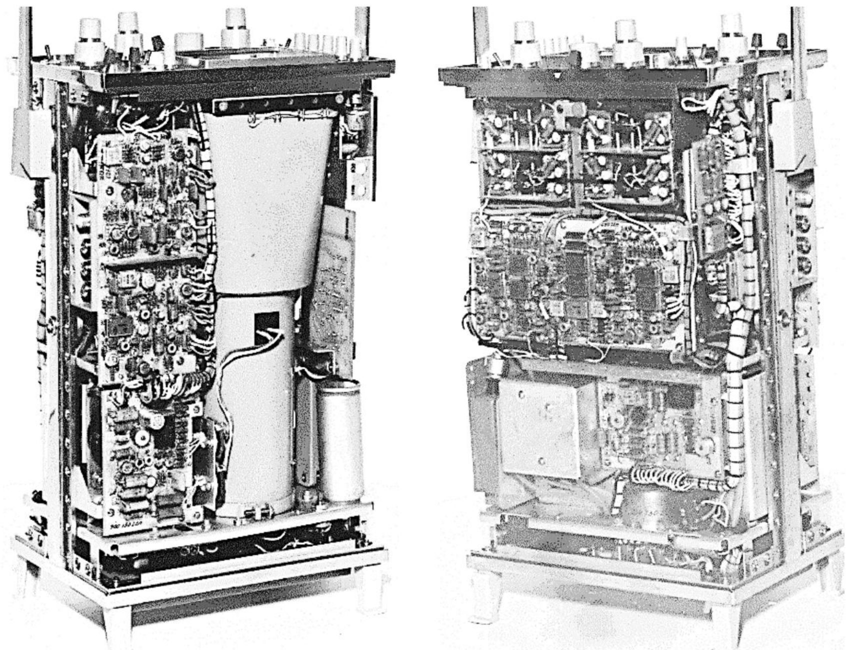
2.6.7. LF two-channel oscilloscope S1-77 (10 MHz)

In **1975 ,** the S1-77 oscilloscope was developed designed to study signal shapes by visual observation in the frequency range from 0 to 10 MHz, to measure amplitude and instantaneous values in the range from 10 mV to 200 V and time intervals from 100 ns to 0.4 With. Availability two channels of vertical deflection ensures simultaneous examination of two signals on one scan.

Oscillograph S1-77

Parameters of the two-channel low-frequency oscilloscope S1-77:

- 1 MHz band, - CRT screen 60x80 mm, - number of channels - 2, - senses. 5 mV/d, - number of sweeps - 1, - sweep. 100 ns/d, - cons. power 50 VA,
- weight 10 kg.



Opened oscilloscope S1-77

Supply voltage: from AC mains (220±22) V with frequency (50 - 60) Hz and harmonic content up to 5%, from AC mains (115±5.75) and (220±11) V with frequency (400±12) Hz and harmonic content up to 5%, from a direct current source (24 ± 2.4) V. Operating conditions: air temperature from minus 30ºÿ to plus 50ºÿ; relative humidity 98% at a

temperature of 35ºÿ.

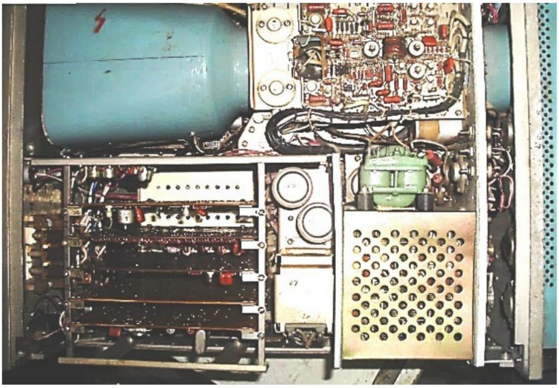
Developers: Y.S. Kurylyak, I.M. Gyzha, R.V. Lavrukh.

2.6.8. MF automated oscilloscope S1-78 (35 MHz)

In **1976 ,** an automated oscilloscope was developed
S1-78 is designed for studying signals in the frequency range 0-35 MHz with amplitudes from 15 mV to 200 V.

Automated oscilloscope S1-78

The oscilloscope provides automatic setting of scales with the following display on the screen of electronic beam tube of numbers and symbols of the dimension of deviation coefficients and sweep coefficients, as well as automatic control of the brightness of the beam when switching the sweep duration.



Automatic parameters midrange oscilloscope S1-78:

- 35 MHz band,
- CRT screen 80x100 mm,
- number of channels - 1,
- feelings. 5 mV/d,
- number of scans - 1,
- unfold. 10 ns/d,
- automatic selection of coefficients deviation and sweeps,
- consumption power. 130 VA,
- weight 19 kg.

Oscilloscope S1-78 from the inside

The vertical image size is set automatically within the range of 2.2 cm - 7.7 cm and 2.2 cm - 8 cm horizontally. The DC component of the signal is compensated in the range from 2.5 V to 200 V depending on the coefficients

deviations.

Any combination of manual and automatic control is allowed. It is possible to remotely control vertical and horizontal scales.

Main developers: Chief designer A.M. Gonchar-Bysh (see section 2.3.4.), leading engineer A.R. Levin, A. Titarov, V. A. Zhuk, O. Savich, N.L. Slotenko, L.V. Zabudaeva.

2.6.9. ShP two-channel oscilloscope S1-79 at 100 MHz.

In **1975 ,** the S1-79 oscilloscope was developed (to replace the S1-71) designed to study one or two signals in the frequency range from DC to 100 MHz with amplitudes from 2 mV to 200 V, measurement error less than 5%. Delayed sweep 0.05 s/div - 0.5 s/div with 10x stretch and continuous adjustment.

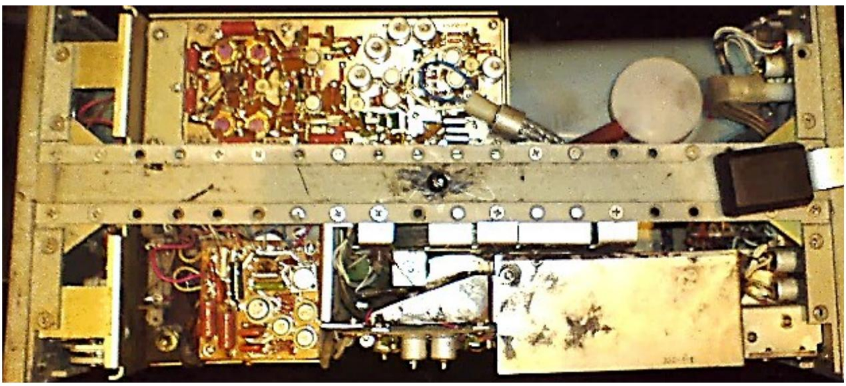
In the S1-79 oscilloscope, in comparison with the S1-71 oscilloscope, the functionality is significantly expanded: five operating modes of the vertical deflection channel switch make it possible to select any of the two input signals, their algebraic sum, and display both signals on the screen in alternating or intermittent mode; presence of main and delayed time bases; X-Y mode; The sensitivity of the oscilloscope to the input signals under study has been increased by 2.5 times.

Parameter SP 2 blood.
oscilloscope S1-79:

- 100 MHz band,
- CRT screen 48x80 mm,

- number of channels - 2,
- feelings. 5 mV/d,
- number of sweeps - 2,
- unfold. 5 ns/d,
- consumption power. 160 VA,
- weight 19 kg.

Oscillograph S1-79



View of the opened oscilloscope S1-79

The development was led by leading engineer Leon Iosifovich Lysyak. The main developers of the S1-79 oscilloscope: M.V. Yushina, N.I. Kuris, R.D. Stetsiv, E.Y. Lagun, D. Gresko.

Leon Yosifovich Lysiak
1964 – graduated from the radio-technical faculty of LPI.

1965 – engineer, senior engineer. Research Institute No. 2 of the Ministry of Defense.
1968-1969 – Engineer LKB
1969-1973 – senior engineer. LNIRTI.
1973-1979 – leading engineer of LNIRTI.
1978 - awarded the degree of Ph.D. tech. Sci.
1979-1980 – senior scientific. co-workers LNIRTI.
1985 – dismissed from LNIRTI on his own desire.

2.6.10. Oscilloscope with replaceable blocks S1-80

In **1979 ,** LNIRTI completed an attempt to create new generation of oscilloscopes with replaceable units (OSB) (theme "Snow"). Replacement blocks significantly expand the functionality of this type of oscilloscope.

It should be noted that for LNIRTI this was the 2nd attempt to create a family of oscilloscopes with replaceable units (OSB). The first attempt was in 1959 and 1962. when creating tube oscilloscopes S1-13 and S1-19. True, it was not possible to create a family then, since the blocks RB-1, RB-2 and RB-3 from S1-13 were not suitable for S1-19, which had its own blocks BPU-1 and BPU-2, which did not fit S1 -13.

It should be noted that OSB is strong and has the advantage in the form of broad functionality, precisely in the case of creating a family of several basic and a sufficient number of replaceable blocks, provided that they are all compatible. And this is not at all easy to do, since the element base of electronics, changes very quickly (they say that it changes completely in 5 years). And the OSB family has been alive and developed, as a rule, for more than 10 years.

So, for example, by this time VNIIRIP already had experience development and serial production at the 6GU MPSS factories of 2 families of OSB - lamp "Kulis" and transistor "Snaige", and the 3rd family of the "Light" series (on m/s) of models from S1-91/1 to S1 was developed -91/6.

So the 1st family of OSB, developed by VNIIRIP, - “Kulisa”, consisted of 2 basic (C1-15 and C1-17) and 7 replaceable blocks (fully compatible), lived for 12 years (from 1960 to 1972).

The 2nd family of OSB - “Snaige”, consisted of 5 basic (S1-70, S1-74, S8-12, S8-13, S8-14) and 11 replaceable blocks and lived for 14 years (S1-70, with 1972 to 1986), up to 17 years (C1-74, from 1974 to 1991). The next 3rd generation OSB

"Svet" also had 5 basic but there are already 15 replacement units and it has lived for 14 years (from 1977 to 1991).

By changing blocks, you can get an oscilloscope with different characteristics: highly sensitive, 2 or 4 channels, with single or differential inputs. Available

also spectrum analyzer, logic state analyzer, digital multimeter, signal generator, frequency counter and the like.

This S1-80 oscilloscope (OSB type), unfortunately, was not mass-produced, since the developers of LNIRTI, experienced specialists in monoblock oscillography, did not have enough experience in the successful development and production of OSB, especially in terms of the block base, to achieve

connecting parameters interchangeability.

At the first stage, a base unit with a bandwidth of 0-150 MHz, two scanners, and a wideband amplifier 0-35 MHz with a minimum deviation coefficient of 10 mV/div, highly sensitive amplifier - 1 mV/div, current amplifier (unit for observing the shape of electric current), current probe, multimeter unit. The multimeter unit allowed digital measurements of: DC voltage from 2 mV to 1000 V; DC current from 2 µA to 2 A; resistances from 2 Ohms to 2 MOhms; temperatures from minus 60ºÿ to plus 100ºÿ.

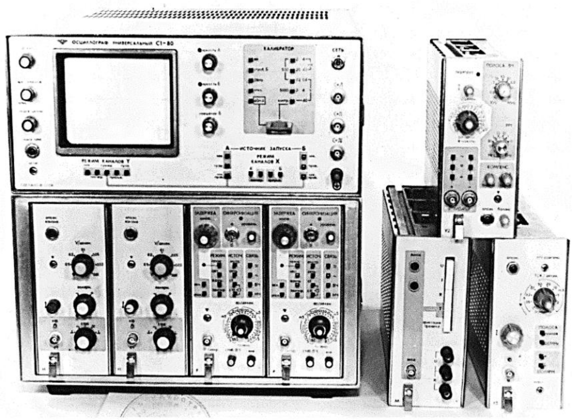
At that time (in 1977-1979) in the USA, at the Tektronics company A very important and multifunctional OSB family, the 7000 series, the most advanced in the world at that time, was successfully developed.

In this regard, in the USSR it was decided to urgently begin similar developments at 3 enterprises at once, in order to select the best development for mass production:

- within the framework of the MCI, at LNIRTI - the topic “Snow” (C1-80),

- within the framework of the MPSS at VNIIRIP - “Svet-1” (S1-91), and at GNIPI – “Scorpio” (SK1-95/110/111).

But since LNIRTI and GNIPI, at that time, had no experience in the development and production of OSB families, and VNIIRIP already had successful, 17 years of experience in the development and production of 2 such families (including 7 basic and 18 replacement blocks) then the choice of the developer of the new generation of OSB was a foregone conclusion, it became
VNIIRIP. It was there that the developers had significant experience, both in the compatibility of blocks and approaches to the reserves of block-base connecting parameters, and in the strategic planning of such developments over the course of decades.



Parameters
of the S1-80 oscilloscope
(OSB type):

-OSB band, 30 MHz,
- BB band 150 MHz,
- SB band 35 MHz,
-number of channels - 2,
-feelings 10/1 mV/d,
- number of sweeps - 2,
- unfold 5 ns/d,
-SB multimeter,
-SB current amplifier.

Oscilloscope with replaceable blocks S1-80

Dmitry Ilkovich Grytsak

A block for observing the shape of the electric current and measuring its parameters, together with a current probe developed for it, provided measurement of the shape of the current without breaking the controlled circuits.

The development was headed by leading engineer Dmitry Ilkovich Grytsak.

Oscilloscope developers: I.M. Adyakina, B. Kovpak, A. Zadorozhny, Ya.A. Knysh, I.M. Gizha, E.I. Mikhailov, B.I. Prots, V. Spirin, S. Shary.

2.6.11. Special television oscilloscope S1-81 (C9-2) – for the Moscow Olympics 1980 (20 MHz)

Parameters of TV oscilloscope S1-81:

- 20 MHz band,
- screen ELT 80x100 mm,
- number of channels - 1,
- feelings. 10 mV/d,
- number of scans - 1,
- unfold. 20 ns/d,
- TV block BVS,
- consumption power. 120 VA,
- weight 18 kg.

Television oscilloscope S1-81 (S9-2)

In **1976 ,** the S1-81 oscilloscope was created, developed by intended purpose for the Olympic television and radio complex, as an integral part of a set of equipment for monitoring and measuring the parameters of television equipment, which ensured high quality television broadcasts of the Olympic Games in Moscow in 1980.

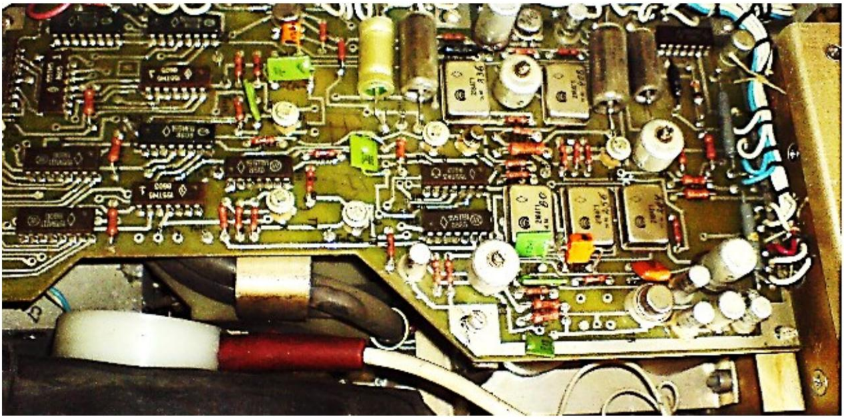
The S1-81 oscilloscope is intended for use both as a television and as a universal device. As a television oscilloscope, it is designed to study a television signal with an indication on a video monitoring device in black-and-white and color television systems through visual observation.

Two methods of TV line selection were used: smooth and discrete using decade dividers, which significantly increased the efficiency of the line selection unit (LSU).

The oscilloscope uses a 15LO1I cathode ray tube with increased brightness.

The design of the device is desktop-rack-mount, there are low-impedance and high-impedance inputs. An input impedance of 75 Ohms allows you to study signals without distortion when they are supplied by cable.

Developers oscilloscope S1-81: V.I. Sukonko, L.V. Shtoiko, S. M.P. Matushyk, V.I. Gromov, V.F. Yakymyv, Bolyak.



Inside view of the S1-81 oscilloscope

During the Olympics-80, LNIRTI workers L.V. Shtoiko and V.F. Yakymiv were sent to Moscow to promptly ensure the normal functioning of the oscilloscopes.

2.6.12. LF oscilloscopes, two-channel S1-83 (5 MHz) and S1-93 (15 MHz).

Universal two-channel oscilloscopes S1-83 and S1-93 with a large working field of the cathode ray tube screen (100x120 mm) with small dimensions (300x200x430 mm) and a weight of 10 kg, ease of handling, intended for a wide range of applications.

use in the development, adjustment and configuration of electrical circuits, for checking and repairing instrumentation and various automation devices in laboratory, workshop and field operating conditions.

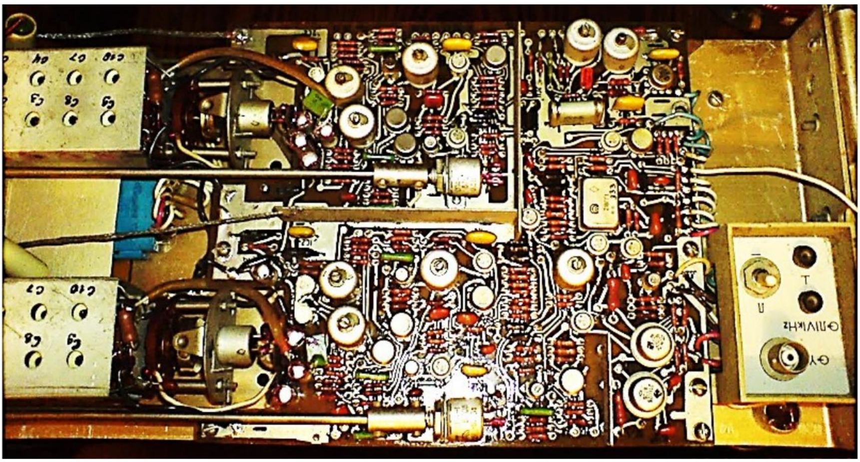
The S1-83 oscilloscope, developed in **1986 ,** provides display on the CRT screen of signals with a swing of 800 microvolts in the oscilloscope bandwidth of 0-5 MHz and signals with a swing of 80 microvolts - with a sequential connection of vertical deflection channels and a decrease in bandwidth.

It is possible to use the S1-83 oscilloscope as a video control device for graphic displays. The main developers of the S1-83 oscilloscope: V.D. Tkachuk,
Yu.V.Berezovsky, J.P. Lazor, I.M. Sydor.

Parameters of TV oscilloscope S1-83:

- 5 MHz band, - CRT screen 100x120 mm, - number of channels - 2, - senses. 0.1 mV/d, - number of sweeps - 1, - sweep. 100 ns/ d, - cons. power 50 VA,
- weight 10 kg.

2 channel LF oscilloscope S1-83



Inside view of the S1-83 oscilloscope.

In the S1-93 oscilloscope, developed in **1977** in comparison with the S1-83 oscilloscope by reducing sensitivity to input signals, the bandwidth has been tripled to 15 MHz.

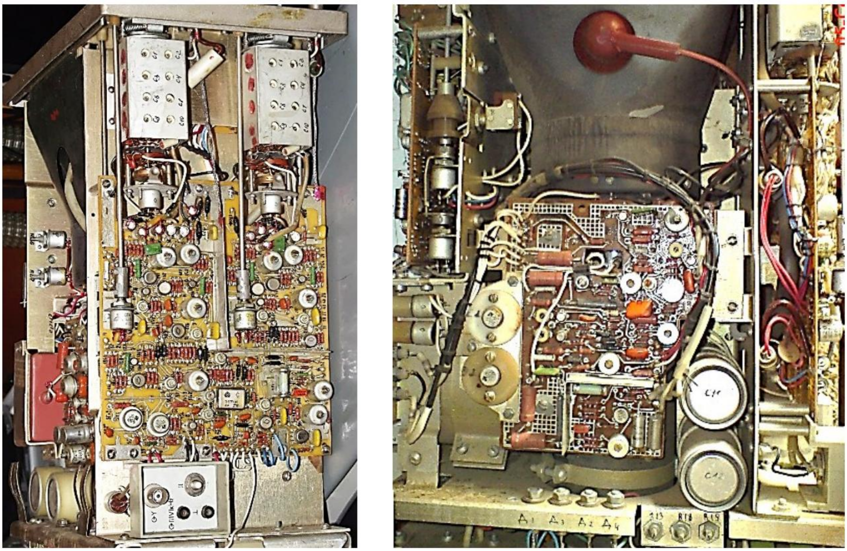
The S1-93 oscilloscope also provides automatic synchronization of the signals under study throughout the entire bandwidth of the oscilloscope. Main developers of the S1-93 oscilloscope:

leading engineer
I'M WITH. Kurylyak, I.M. Gizha, R.V. Lavrukh.

TV settings
oscilloscope S1-93:

- 15 MHz band,
- screen ELT 100x120 mm,
- number of channels - 2,
- feelings. 5 mV/d,
- number of scans - 1,
- unfold. 20 ns/d,
- consumption power. 50 VA,
- weight 10 kg.

Oscillograph S1-93



Oscilloscope S1-93 inside

Both oscilloscopes S1-83 and S1-93 provide operation from 220 V AC at 50 Hz, 115 V and 220 V at 400 Hz, from a 24 V DC source. The oscilloscopes can operate in the field and provide their performance over a range of

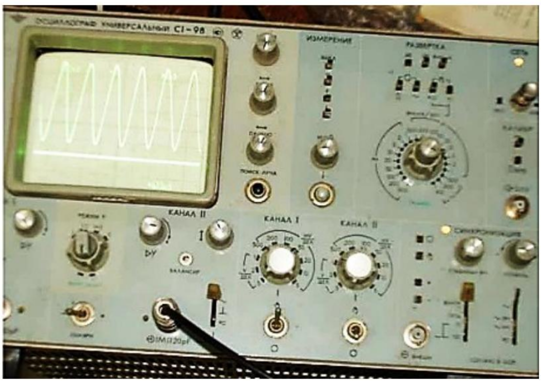
temperatures from minus 30ºÿ to plus 50ºÿ, humidity 98% at 35ºÿ for the S1-83 oscilloscope and 95% at 40ºÿ for the S1-93 oscilloscope for 16 hours of continuous operation.

Oscilloscopes S1-83 and S1-93 are distinguished by reliable measurements and ease of use. Due to this, they are popular both among specialists in various branches of industry, science and technology, and among radio amateurs.

The advantages of both oscilloscopes include a large production reserve for almost all characteristics of the devices. As one of the users of the S1-83 oscilloscope notes: “the frequency response according to the passport is 5 MHz, but in reality when measured at a level of 3 decibels it reaches up to 12 MHz - the manufacturer clearly did not fully appreciate their product!”

2.6.13. MF automated 2-channel oscilloscope S1-98 at 50 MHz

In **1979 ,** the S1-98 oscilloscope was developed with improved technical and operational characteristics to replace the S1-78 automated oscilloscope at 35 MHz.

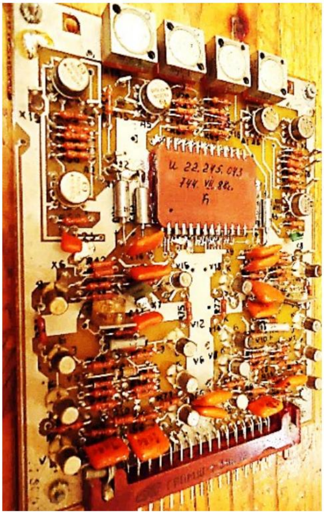


Automatic parameters midrange oscilloscope **S1-98:**

- **50 MHz** band ,
- CRT screen 80x100 mm,
- number of channels - 2,
- feelings. 5 mV/d,
- number of scans - 1,
- unfold. 10 ns/d,
- **author scale signal**
- **author measurements,**
- **character generator,**
- consumption power. 140 VA,
- weight 18 kg.

MF automated oscilloscope S1-98

Band transmission in S1-98, compared to S1-78, expanded to 50 MHz, the number of channels increased to 2, the error in measuring amplitudes and time intervals using the digital method was reduced by 2.5 times and amounted to 2%. Provided automatic setting of image scales.

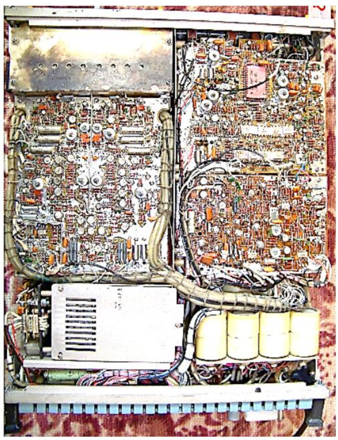


The image size along the vertical axis is set automatically within 2.2 - 7.7 cm and 2.2 - 8 cm along the horizontal axis

with subsequent display of numbers and signs of the dimensions of the deviation coefficients and sweep coefficients on the cathode-ray screen of the tube, since the generator. oscilloscope has a character

The device allows any combination of manual and automatic control of the installation of scale selection.

Automated oscilloscope S1-98 from the inside



Automated oscilloscope S1-98 from the inside

The chief designer of the development is Alexander Nikolaevich Gonchar-Bysh (see section 2.3.4.). The main developers of the device: leading engineer A.R. Levin, V.O. Zhuk, Ya.A. Knysh, O. Savich, L.V. Zabudaeva, N.L. Slovotenko, E.I. Lagoon, D. Gresko.

2.6.14. Wideband 2-channel oscilloscope S1-99 (100 MGc)

In **1979 ,** a two-channel oscilloscope S1-99 was developed with a wide bandwidth of 0-100 MHz, intended to replace the oscilloscope S1-79.

Parameter SP 2 blood. oscilloscope C1-79:

- 100 MHz band,
- screen ELT 100x120 mm,
- number of channels - 2,
- feelings. 2 mV/d,
- number of sweeps - 2,
- unfold. 5 ns/d,
- consumption power. 150 VA,
- weight 17 kg.

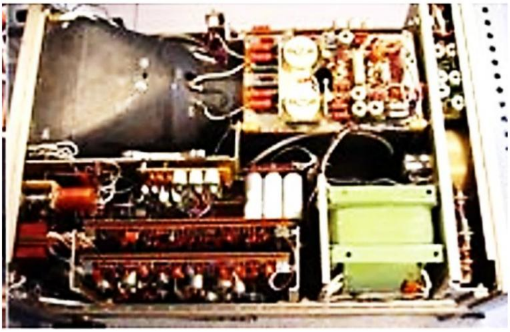
Oscillograph S1-99

The S1-99 oscilloscope provides simultaneous detailed study of the signal and its parts in different amplitude-time scales from 8 mV to 150 V and durations from 10 ns to 0.5 using delayed sweep.

Accuracy of deviation coefficients and coefficients sweep does not exceed 4%.

In comparison with the 100 MHz oscilloscope S1-79, the size of the working field of the cathode ray tube screen is increased by 2.5 times, the dimensions and weight of the device are reduced.

The operating temperature range of the S1-99 oscilloscope has been expanded to the region of sub-zero temperatures - down to minus 30ºÿ, humidity has been increased to 98% at a temperature of plus 35ºÿ.



The development of the device was led by a senior researcher, Ph.D. tech. sciences
Leon Yosifovich Lysiak.

The main developers of the S1-99 oscilloscope: V.I. Kiselev, M.V. Yushina, N.I. Kuris, R.V. Stetsiv, E.I. Lagun.

Oscilloscope S1-99 from the inside

2.6.15. Television oscilloscope S1-100 (20 MHz)

In **1979 ,** the S1-100 oscilloscope was developed to replace the S1-81 oscilloscope and was designed to study the shape
and measurements of amplitude and time parameters of periodic electrical signals, as well as for operational control
quality indicators of the television path, its individual links and components.

Parameters of TV oscilloscope S1-100:

- 20 MHz band,
- CRT screen 80x100 mm,
- number of channels - 1,
- feelings. 10 mV/d,
- number of scans - 1,
- unfold. 20 ns/d,
- TV block BVS,
- consumption power. 120 VA,
- weight 18 kg.

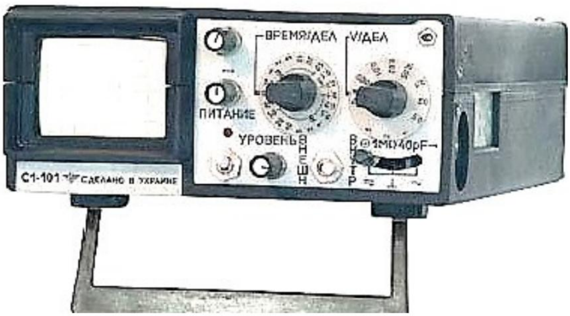
Television oscilloscope S1-100

The device allows you to examine any part of a television raster with high temporal stability, in particular, to select any line or part of it with an accurate setting of the number of the line being examined. A video signal recording circuit based on the level of recording the synchronization pulses of the oscillogram on the screen of a cathode ray tube during video signal transmission.
allows situation

The developers of the oscilloscope L.V. Shtoiko, V.I. Sukonko, N.P. Matushik, V.I. Gromov, V.F. Yakimiv.

2.6.16 Service, the lightest and smallest in the USSR oscilloscope S1-101 (5 MHz), weighing 2.3 kg.

In **1979 ,** a unique, lightest, and smallest oscilloscope in the USSR was developed - S1-101. It is a universal tool for studying the shape and measuring the parameters of periodic electrical signals in the amplitude range from 10 mV to 300 V and time intervals from 0.3 ÿs to 0.4 s in the frequency range from 0 to 5 MHz.



Service parameters oscilloscope S1-101:
- 5 MHz band,
- CRT screen 30x40 mm,
- number of channels - 1,
- feelings. 5 mV/d,
- number of scans - 1,
- unfold. 0.1 µs/d,
- consumption power. 18 VA,
- weight 2.3 kg.

Miniature service oscilloscope S1-101

The S1-101 oscilloscope has the smallest overall dimensions of 69x155x281 mm and a weight of 2.3 kg among universal ones,
service oscilloscopes based on cathode ray tubes, which were produced in the country.

Main developers of the S1-101 oscilloscope: lead engineer I.M. Gizha, V. Spirin, D. Gresko.

Oscilloscope S1-101 from the inside

A unique, smallest oscilloscope S1-101 in your hands.

2.7. 1st oscilloscope in the USSR and 3rd in the world 500 MHz band, 1981.

At the end of the 70s, the expansion of the frequency range into the upper region using discrete semiconductor elements came to its limit. The most broadband universal oscilloscopes

in the country there were oscilloscopes S1-75 **(1974)** with a bandwidth of **0-250 MHz,** developed on the most broadband transistors at that time, as well as S1-97 and S1-108 **(1979)** with a bandwidth of **0-350 MHz,** developed by Vilnius VNIIRIP, based on hybrid microcircuits within the framework of thin and thick film technology.

On the global market of broadband universal oscilloscopes, in **1971** OSB Tek 7904 with a bandwidth of **500 MHz was offered,** and in **1978** OSB Tek 7104 with a bandwidth

1000 MHz, developed by Tektronix, USA - the world leader in oscillography.

Tektronix has achieved such success thanks to its special technology for manufacturing its own semiconductor chips for these oscilloscopes -

amplifiers with a bandwidth of 0-3000 MHz.

Oscilloscope developers at LNIRTI decided to challenge VNIIRIP and Tektronics at the same time.

Work on creating an oscilloscope with a band of 0-500 MHz began with research work (R&D) on the topic "Boxwood". Since there were no enterprises in the country with experience in building

broadband amplifiers from DC to units

gigahertz, and there was also no integrated (semiconductor) technology for constructing such amplifiers, then within the framework of the research work the possibility of constructing broadband amplifiers using thin and thick film technologies, which at that time were already available in LNIRTI and VNIIRIP, was considered.

Based on the same technology, private m/s were built at VNIIRIP for oscilloscopes S1-75, S1-97, S1-108, S1-91 and S1-
92, for the 100-350 MHz band.

As shown by the first experiments in constructing individual amplifiers, achieving the cascades of broadband results will not desired
be possible using thin film technology alone. Therefore, the main focus in the process

The research work was aimed at developing a theory for optimizing the parameters of such amplifiers.

In the process of carrying out research work, a number of important theoretical and practical problems were solved. Was
the theory of optimization of broadband amplifiers has been developed, developed by the author of this section of the book, Bogdan Prots, in collaboration with other LNIRTI workers and published
in articles, many of which were published in collections of articles “Oscillographic measurement methods.” 4 copyright certificates on this topic were received.

As a result of the research work carried out, there was practically
The possibility of creating a vertical deflection path highly sensitive to input signals for an oscilloscope with a bandwidth of 0-500 MHz has been confirmed. However, no less complex problems of creating high-speed: a time-sweeping device

(oscilloscope scan unit), an image illumination channel (Z amplifier) on the screen of a cathode ray tube, and the most complex scan unit - a synchronizer, remained unsolved.

These unsolved problems had to be solved already in the process development work.

The scientific supervisor of this research work (theme "Boxwood"): was the author of this section - Bogdan Prots.

Main developers: P.I Oliynyk, I.N. Adyakina, A.I. Gadzevich, V.G. Makarevich, L.M. Smerklo, S.G. Polushina, G.I. Carrion.

2.7.1. Universal two-channel oscilloscope S1-104

Based on the results of the research work "Boxwood" in **1981 ,** at LNIRTI, it was developed and in the early 80s introduced into mass production in Lvov, the most broadband in the USSR at that time, and the third in the world (after Tek 7904 and Tek 7104) universal oscilloscope **S1-104** with a bandwidth of 0 - 500 MHz, with a deviation coefficient of 10 mV/d.

It is necessary to point out that in **1981** there were only 3 models of real-time oscilloscopes in the world (without strobe conversion) for a bandwidth of 500 MHz or more, these are Tek 7904, Tek 7104 and S1-104.

The **500-1000 MHz** band was the world record at that time, because... There were no oscilloscopes with greater real bandwidth.
The most advanced oscilloscope manufacturers such as
Hewlett Packard and Philips reached only a band of 275 at that time.
350 MHz.

Silk parameters
2 channel
oscilloscope C1-104:

- 500 MHz band,
- CRT screen 80x100 mm,

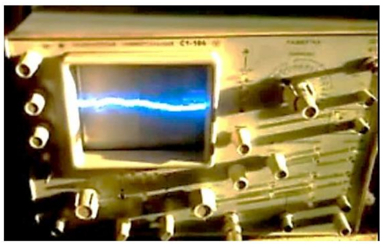
- number of channels - 2,
- feelings. 10 mV/d,
- number of scans - 1,
- unfold. 1 ns/d,
- consumption power. 170 VA,
- weight 16 kg.

Two-channel oscilloscope S1-104 at 500 MHz.

Use of rigid cables with a metal sheath,
ensured the unevenness of the transient response of the amplifiers was less than 1.5%.

The design of the attenuators and special miniature connectors, which connect the attenuators and the amplifier board with a rigid cable, were developed by highly professional leaders Vladimir Mikhailovich Shpytko and Valentin Antonovich Plebanovich.
design engineers

Attenuators S1-104



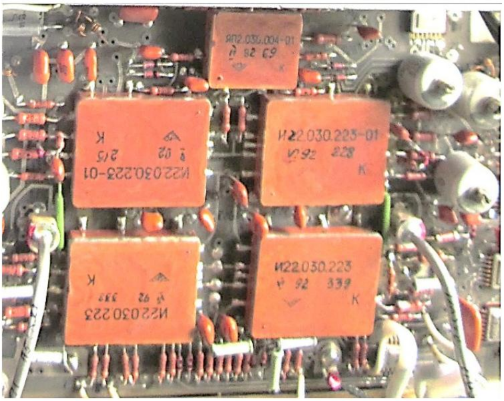
Oscillograph S1-104

High-precision 50-Ohm resistors for attenuators, manufactured in the microelectronics department of LNIRTI, represented
a thin film of resistive material on the surface
heat-conducting dielectric pad.

Particular difficulties in the manufacture of such resistors arose when cutting dielectric pads, applying metal contact films to their ends, and adjusting resistor values. All these processes had to be mastered during

development of an oscilloscope.

It is necessary to give credit for the significant and labor-intensive work done, first of all, to the head of the design department
microelectronics sector of LNIRTI Svetlana Gennadievna Polushina, Ya.S. Senyshyn. G.I. Padalke, B.V. Karpiv, A.F. Lasaev.



2-channel amplifier S1-104 on m/s of our own production

The use of unpackaged ultra-high-frequency transistors in microcircuits with thin- and thick film technology has led to particularly noticeable distortions of the subjects low frequency signals spectrum - slowly changing signals.

When such signals are amplified, fluctuations in the power dissipated in the transistors under the influence of these signals cause alternating thermal processes in the transistors, which in turn lead to changes in temperature-sensitive

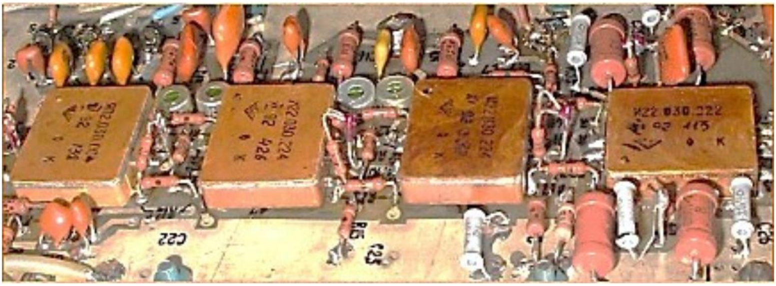
parameters of the transistor and the formation of electrical signals that are superimposed on the ones being studied and distort their shape. These distortions lead to the fact that the measurement error of amplitudes and time intervals in the low frequency region can be

more than 10%.

Known methods for reducing such distortion consisted of compensating the electrical signals generated by changing parameters of the transistor, and were carried out by introducing RC correction units, mainly into the emitters of transistors, or the so-called “lateral coupling”, which

complicated the design of the amplifier, making it difficult to configure and integrate. In the process of the Samshit research

project and the development of the S1-104 oscilloscope, a theory was developed and circuits, protected by copyright certificates, were proposed to reduce the distortion of low-frequency signals in broadband amplifiers, which consisted of eliminating the root cause of their occurrence - stabilizing the power dissipated in transistors when there is a signal at its input .



Oscilloscope output amplifier board S1-104

Already in the process of developing the oscilloscope, it was developed theory of improving the quality of the image of high-frequency signals on the screen of a cathode ray tube, due to the inertia of the oscilloscope components.

The talented and highly professional specialist Pavel Ivanovich Oliynyk discovered the cause of the blur (jitter in English terminology) of the image of high-frequency signals on the screen of a cathode ray tube

(ELT).

Subsequently, together with the author of this section of the book, a theory was developed for synchronizing the operation of scan generators, which ensured the elimination of blurring of the image of high-frequency signals on the CRT screen.

To study signals in unmatched high-impedance circuits, an active probe with attenuator attachments has been developed in a micro version. Probe bandwidth 0-700

MHz, input impedance 100 ±2 kÿ and input capacitance <3.5 pF.

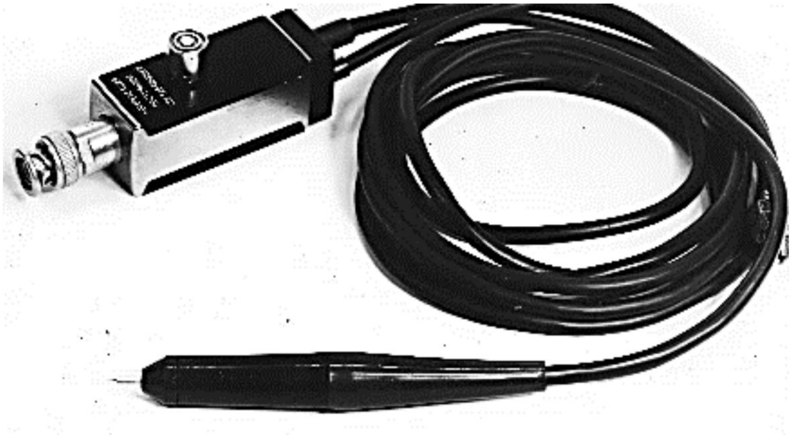
The developers of the S1-104 oscilloscope, having developed the probe circuit and drawn up the technical specifications for the development of the probe design, did not send them to a specialized design department
division that developed passive probes, and into the microelectronics design division.

Active probe with attenuator attachments.

The decision to transfer the development of the probe design to the microelectronics department was extremely successful, which was confirmed by the final result - an excellent small-sized active probe was developed.

And the probe developers had to solve a number of complex technical problems: ensure minimal dimensions, especially of the probe; configuration cutting of a dielectric pad board for heads the manufacture of active and passive components of an electrical circuit on it and at the same time ensuring its serial suitability; the input part of the head must provide connection of the attenuators-nozzles, while the probe head must be sealed.

The team of microelectronics designers from LNIRT successfully coped with this difficult task. Of particular note is G.I. Padalku, B.V. Karpiva, P.K. Fatueva.



High Resistance Active Probe

When developing the S1-104 oscilloscope, a special technology was also developed for sputtering gold onto individual sections of the printed circuit board and special contact tips for the spring carriers of cam switches for switching high-frequency signals.

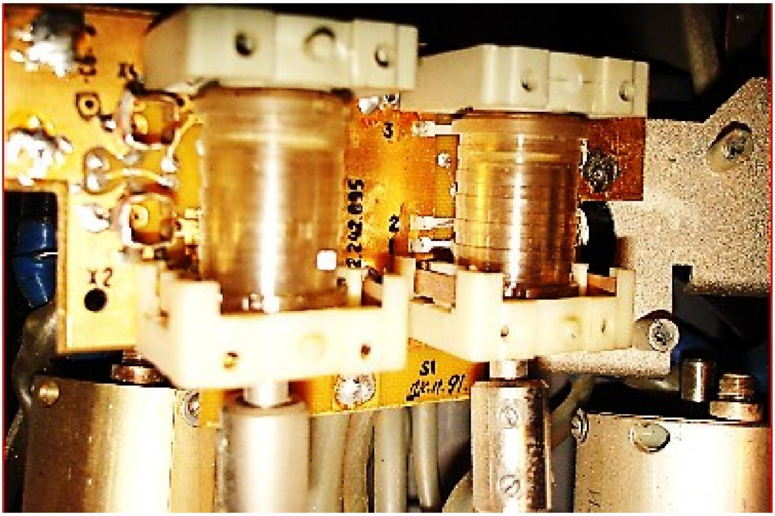
As part of the creation of the S1-104 oscilloscope, under contracts with other enterprises, the following were developed: a high-speed cathode ray tube, a two-wire cable delay line, a high-frequency pnp transistor and others

radioelements.

The key to success in creating the S1-104 oscilloscope was a number of factors. The first of them is the highly intellectual and hard work of the development team, the second is the development of the theory of constructing high-frequency oscilloscope units, the third is development at the level of inventions of all main components and the device as a whole, fourth - the use of new design and technological solutions. Serial production of the S1-104 oscilloscope was mastered at LORTA in the early 80s.

It should be noted that oscilloscopes with a bandwidth of 0-500 MHz and higher appeared on the world market after 6 years (except for Tek 7904/7104 oscilloscopes), and in the Soviet Union - 8 years after the development of the S1-104 oscilloscope.

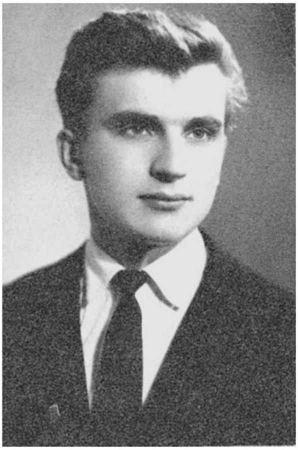
In 1989, the Vilnius Institute of Radio Measuring Instruments developed the **S1-129** oscilloscope with a bandwidth
0-1000 MHz - foreign analogue **-** Tek 7104 oscilloscope from Tektronix USA. As the authors of the book “People. Years. Oscilloscopes" [4]: the S1-129 oscilloscope was the final development of Alexander Ivanovich Fedorenchik. It is a pity that this work of Alexander Fedorenchik **-** a sincere friend of Lvov oscillography **-** ended so quickly in the world of oscillography with the advent of the 1990s.



External signal source switch board.

The development manager and direct implementer of the S1-104 oscilloscope is leading engineer B.I. Proc. The main developers of the S1-104 oscilloscope: P.I. Oliynyk, V.G. Makarevich, S.O. Shary, I.M. Adyakina, M. Bagan, E.I. Lagun, D. Gresko, G.N. Snigura.

A significant contribution to the development of the S1-104 oscilloscope was made by microelectronics workers from LNIRTI: Doctor of Technical Sciences L.M. Smerklo, G.I. Padalka, S.G. Polushina, P.K. Fatuev, B.V. Karpiv, G.F. Mikhailov, O. Flint, L.A. Vladimirtseva, V. Seketa.



Bogdan Ivanovich Prots

1959-1962 – Lvov Electrical Technical College of Communications, specialty – “television technology and radio relay communications"
1961-1962 – Donetsk television and radio center.
1962-1965 – military service.
1965-1966 – LPI student, radio engineering faculty,
1966-1972 - evening faculty of the LPI.
1966 - LKB laboratory technician
1967– Art. LKB technician
1968 – Eng. lab. LKB.
1969-1977 - st. Eng. LNIRTI laboratories.
1977-1985 – leading Eng. LNIRTI laboratories.
1985-1987 – Art. Researcher at LNIRTI

1987-1988 – chief designer of the Ministry of Radio Industry (technical area C1) – head of the LNIRTI sector. 1989-1991 – chief designer of the Ministry of Radio Industry – head of the LNIRTI department.

1991-1994 – head of the LNIRTI department.

1995-2007 – chief designer of the Ministry of Mechanical Engineering, Military-Industrial Complex and Conversion of Ukraine (Ministry of Mashprom) - head of the LNIRTI department.

2007-2012 – chief designer of the Ministry of Machine Industry, head LNIRTI laboratories.

2012 – dismissed from LNIRTI at his own request. He was directly involved in the development and introduction into serial production of oscilloscopes S1-55, S1-67, IS-67, S1-104, S1-123, 1101, 1201, 1202 and 1204.

2.8. Compact Low Frequency Oscilloscopes

2.8.1. Service oscilloscope-multimeter S1-107 (5 MHz)

In **1981 ,** almost simultaneously with the release of an oscilloscope-multimeter at VNIIRIP, with a cogenerator on the screen - S1-112, in Lvov, its own oscilloscope-multimeter - S1-107 was developed.

The device provided: studies of the shape of electrical signals in the frequency range from 0 to 5 MHz (10 mV/d) by visual observation, measurement of their amplitudes in the range from 20 mV to 350 V and time intervals from 400 ns to 1.0 s in oscilloscope mode ; measuring DC voltage from 1 mV to 1000 V, AC voltage from 1 mV to 300 V,

DC current from 1 μA to 1.999 A, active resistance from 1 Ohm to 1999 kOhm in multimeter mode.

It was inferior to the S1-122 in bandwidth (5 instead of 10 MHz) and in weight (4 instead of 3.5 kg), but it surpassed the severity of operating conditions.

Small-sized oscilloscope-multimeter S1-107 has been developed to replace the obsolete oscilloscope S1-73.

A special feature of the oscilloscope is the minimum power consumption - 30 VA, small dimensions and weight 4 kg, operating conditions: temperature from minus 30ºÿ to plus 50ºÿ, humidity up to 95% at plus 30ºÿ.

Oscilloscope-multimeter C1-107

As Ivan Mikhailovich Sydor recalls: when launching a pilot batch of S1-107 at the Zolochiv radio plant, they did not adhere to the requirements of the design documentation and replaced the fluoroplastic board of high-resistance (10 MOhm) resistive dividers in the digital multimeter with a fiberglass one. As a result, the device failed the test during acceptance tests for resistance to climatic influences.

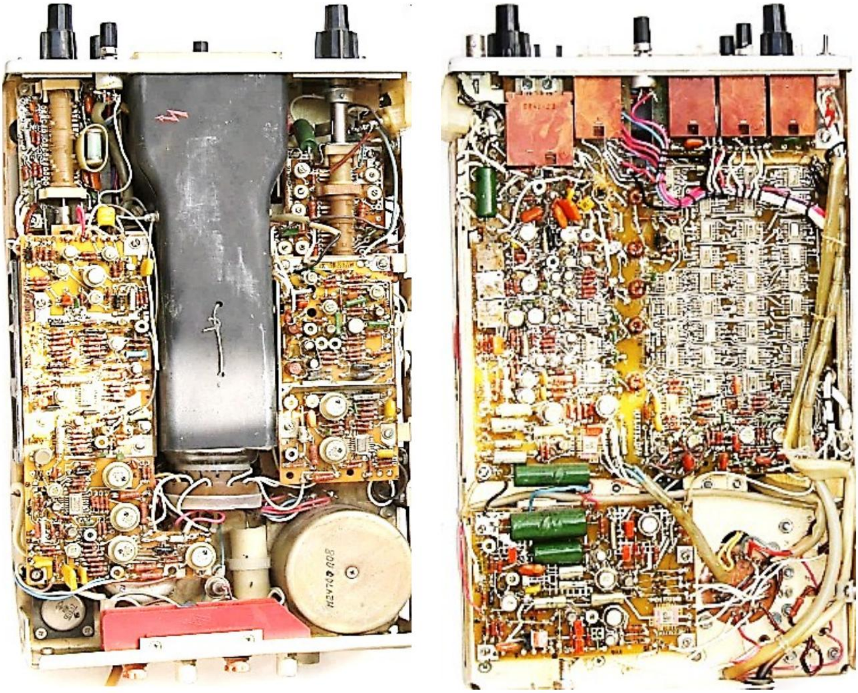


Photo of an oscilloscope-multimeter in open form

It should be noted that the values of What external operating factors for general-purpose oscilloscopes were very strict, for example, high humidity for C1-

107 is 98% at a temperature of plus 30ºÿ.

During testing, the device maintained under V conditions for 10 days.

The main developers of the device: I.M. Sydor, V.D. Tkachuk, Yu.V. Berezovsky, E.I. Lagoon, D. Greece.

The oscilloscope is equipped with a special chest bag for using the device in hard-to-reach places, both laboratory and in workshop and field operating conditions.

2.8.2. Vertical LF oscilloscope S1-113 (5 MHz)

The design of the device plays an important role in the development of oscilloscopes for harsh operating conditions. The need to regulate, monitor and repair oscilloscopes in the field and directly on site eliminates the possibility of using bulky instruments. Light, compact, easy-to-use devices that can operate under harsh operating conditions are needed.

The oscilloscopes developed at LNIRTI predominantly have a horizontal placement of the device housing and are based on the standard Narva housing or its modification - no

side ties.

In **1984 ,** the compact oscilloscope S1-113 was developed.

Oscilloscope C1-113

The S1-113 oscilloscope is one of the few designed in a vertical position, which has certain advantages and takes up less space on the desktop.

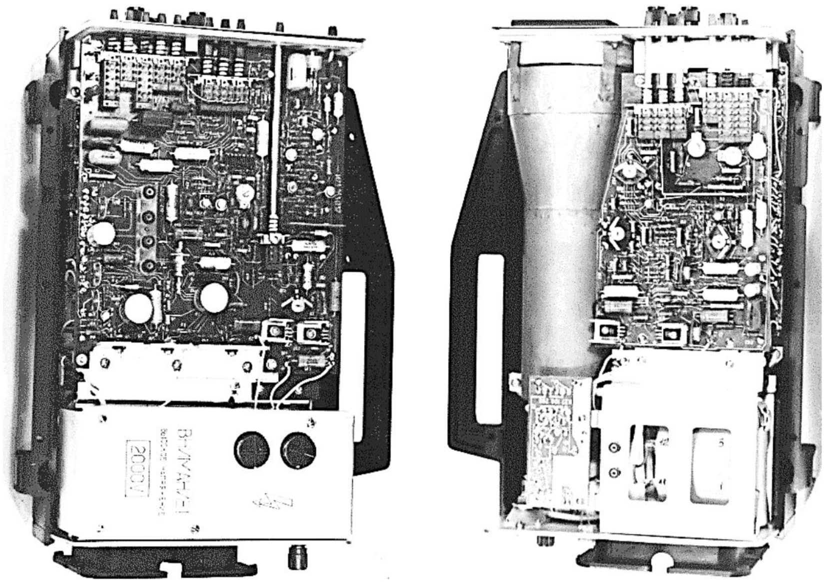
Single-channel oscilloscope S1-113, 5 MHz band,
(10 mV/d) is intended for studying electrical signals with amplitudes from 20 mV to 500 V and durations from 0.2 ÿs to 0.5 s.

The device can be used in laboratory, workshop and field conditions under limited operating conditions: operating temperature from 10ºÿ to 35ºÿ (non-operating temperature from minus 30ºÿ to plus 50ºÿ) and humidity up to 80% at 25ºÿ.

The device is powered from a 220 V network with a frequency of 50 Hz, power consumption 50 VA. A special

feature of the S1-113 oscilloscope is its high reliability and low price. The main purpose of the oscilloscope is for its use by a wide range of consumers.

Led the development of the oscilloscope - leading engineer Yaroslav Stepanovich Kurylyak. The main developers of the oscilloscope: V.F. Yakymiv, E.T. Berezovskaya, D. Gresko.



Photos of the opened oscilloscope S1-113

2.8.3. LF analog-digital oscilloscope S1-123 (10 MHz)

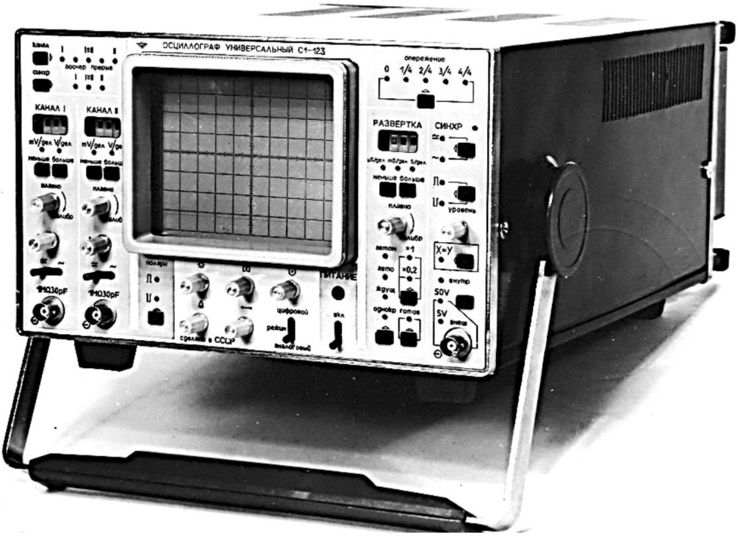
In **1986 ,** the first analog-to-digital oscilloscope was developed at LNIRTI, which provided display of signals discretely converted using digital devices on the screen of a cathode ray tube. analog and

The number of discrete conversion points along the Y axis is 225 (that is, the ADC is 8 bits/256 points, and 31 points are the margin at the edges of the screen) along the X axis is 1024 points. The goal of developing the S1-123 oscilloscope is to create a device that is highly sensitive to input signals over the entire range of the device's bandwidth from DC to 10 MHz

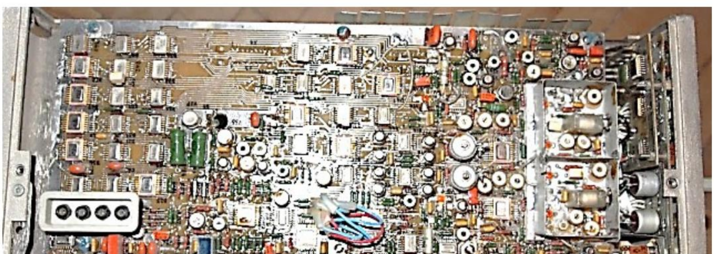
(1 mV/d) and provide the study of signal shapes and measurements of their parameters in an extremely low frequency range.

The functions of the oscilloscope are controlled and the selection of deviation and sweep coefficients is carried out by electronic switches by pressing buttons without mechanical locking. The number of channels in the vertical deflection path is 2. The oscilloscope allows you to examine signals with amplitudes from 1 mV to 400 V and durations from 90.0 ns to 500.0 s (8.33 minutes). Sensitivity to input signals of each channel 1 mV/d –

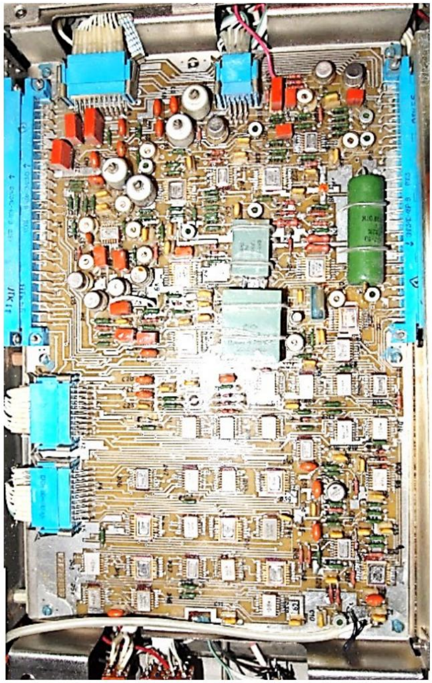
5 V/cm. The error of the deflection and sweep coefficients is ± 3%.



Universal oscilloscope S1-123



Photos of the opened oscilloscope S1-123

Photos of the opened oscilloscope S1-123

In digital conversion mode, the S1-123 oscilloscope provides: - continuous signal conversion and its

storage in digital memory, continuous display of the image of the converted signal on the tube screen from channels I or II, or simultaneously from both channels in intermittent mode, fixation

images at the moment of synchronization failure (signal reconstruction and storage mode, or digital oscilloscope):

- storing signals in advance relative to the start of the sweep, the discreteness of setting the advance of the sweep start is 0, 1/4, 2/4, 3/4, 4/4 of the entire sweep length.

The horizontal deflection path provides the following modes of operation of the scan generator: wait – WAIT; non-synchronous – NON-SYNCHR; one-time – ODNKR. The recording mode in standby mode is indicated by the SYNC indicator lighting up. In non-synchronous mode, the oscilloscope constantly is in recording mode. In one-shot mode, recording occurs after pressing the READY button.

The S1-123 oscilloscope allows continuous operation for 16 hours while maintaining its technical characteristics within the limits established by the technical specifications, when working in laboratory, workshop and field conditions in the temperature range from minus 30ºÿ to plus 50ºÿ and humidity up to 98% at 25ºÿ.

Headed the development - Ph.D. tech. Sciences, Art. scientific co-workers B.I. Proc. Oscilloscope developers: P.I. Oliynyk, I.Yu. Budaretskaya, E.I. Mikhailov, N.V. Khovalko, A.I. Gadzevich, T.P. Pirozhenko,

2.9. Zolochiv branch of LNIRTI

In **1969 ,** LNIRTI created a separate division in the city of Zolochiv to develop non-standard equipment, as well as to improve the scientific, technical and material support of production at the Zolochiv Radio Plant in the production of radio measuring and other electronic equipment developed at LNIRTI.

The first head of the newly created division was LNIRTI senior engineer Petr Fomich Tolmachev, with whom the author of this section of the book worked in the development group of a four-channel oscilloscope on a cathode ray tube storage device.

Pyotr Fomich always called himself a Siberian and was a person with special "Siberian" character traits. He had his own views on events in the country.

In 1972, Pyotr Fomich moved to the Zolochiv Radio Plant to the position of plant director, and subsequently went to his homeland - Siberia.

To quickly organize the production of radio-electronic equipment in the Zolochiv division of LNIRTI,
recruitment of specialists to move to permanent residence in Zolochiv. Everyone who went to work in Zolochiv was provided with separate housing. So, very quickly a division of LNIRTI was formed in Zolochiv, consisting of highly professional specialists.

Subsequently, a group of laboratory engineers and a group of design engineers were organized in the branch. The group of laboratory engineers was headed by Yosif Petrovich Ralko. The group included: M.M. Kozlyuk, B. Verkhola, M.Y. Tokar, P.S. Manchulenko, L.I. Kozak, L. Tyatin, V.I. Starovyna, L. Domeretskaya,

V. Seredyuk. Later, the group was supplemented by engineers B. Bodnarchuk and S. Morshchikhin.

The group of design engineers was headed by E. Zhovnovsky. The group included: V. Marchenko, I. Guzandrov, N. Zayarnyuk, A. Kozlyuk. Design engineer Yu. Yurchuk joined the group.

The branch's first order was installation, assembly and regulation of power supplies for the needs of LNIRTI.

Later, the branch developed stands for measuring the electrical and light characteristics of cathode ray tubes for oscilloscopes and picture tubes.

From 1975 to 1984, a separate Zolochiv division of LNIRTI No. 130 was led by: in 1975 - M. M. Kozlyuk, from 1975 to 1984 by I. Guzandrov.

During this period, there was a significant reduction in the volume of development of oscillographic equipment at LNIRTI, due to the repurposing of its developers to solve problems in the development of special equipment. **The development of oscilloscopes was entrusted to the Zolochiv division of LNIRTI.**

Since 1984, unit No. 130 was headed by Mikhail Mikhailovich Oleynikov, and his deputy was Anatoly Vladislavovich Khodakovsky. Unit No. 130 included unit No. 131, which was led by

Lev Yurievich Polishchuk, and unit No. 132, led by Yuri Feodosievich Yurchuk.

Division No. 130 expanded the range of developments. In addition to development, develop stands and radio measuring equipment. The first development of the division were television oscilloscopes Start **S9-29 and S9-29A,** which, unfortunately, were not introduced. Subsequently developed

oscillographs **SK1-119, S1-124 and S1-130.**

2.9.1. LF 2-channel oscilloscope-multimeter SC1-119 (10 MHz)

In **1985 ,** a 2-channel oscilloscope-multimeter SK1-119 was developed, designed to study the shape and measure the parameters of electrical signals in the frequency range 0-10 MHz and measure DC and AC voltage, DC current and active resistance using a built-in multimeter with digital indication of measurement results.

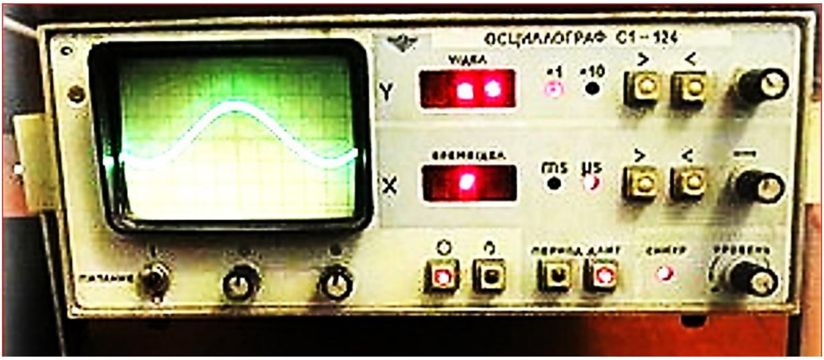
2-channel oscilloscope-multimeter SK1-119

The development of the SK1-119 oscilloscope was led by leading engineer Lev Yuryevich Polishchuk. Device developers: V.S. Mats, N.V. Zayarnyuk, B.D. Bodnarchuk, V.P. Seredyuk.

2.9.2 Service automated oscilloscope

S1-124 (10 MGc)

Universal automated service oscilloscope
S1-124 is designed to study the shape of periodic electrical signals in the frequency range 0-10 MHz and measure their amplitude and time parameters.



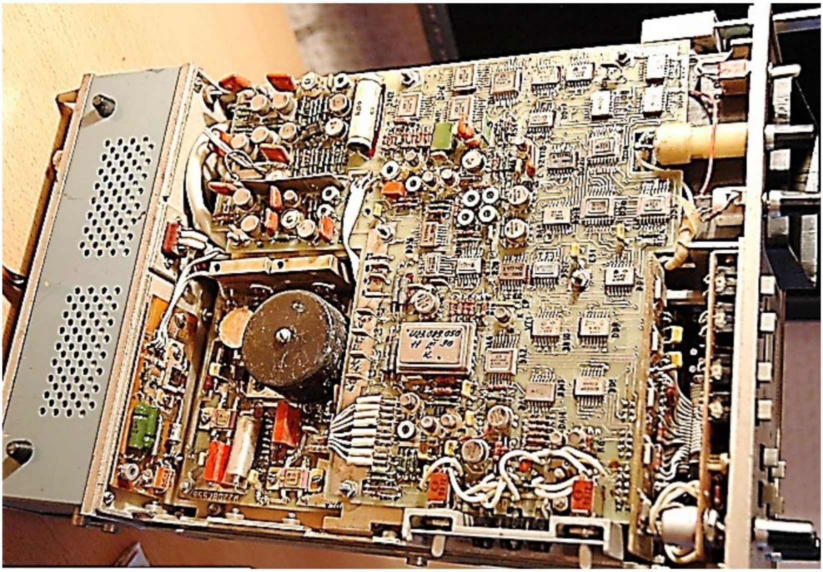
Universal oscilloscope S1-124

The oscilloscope provides the ability to manually
semi-automatic or automatic selection of scales of deviation coefficients and sweep coefficients with their indication on a digital display. In automatic operating mode, the oscilloscope provides automatic setting of signal image sizes within the working field of the CRT screen. Using an oscilloscope, you can examine signals in a wide range of amplitudes from 8 mV to 600 V. The oscilloscope is universal and easy to maintain, can be used in the development of radio equipment, for diagnosing radio-electronic equipment during operation in the field, workshop and laboratory conditions. The device can

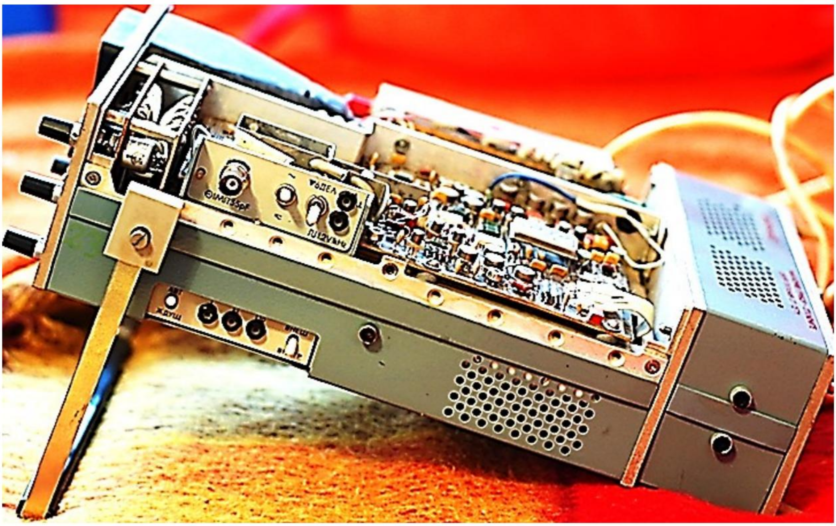
be used in automated control systems. The small dimensions of the oscilloscope, lightness and ease of use make it indispensable for measurements in hard-to-reach places.

Universal power supply: from AC mains voltage 220 V with a frequency of 50 Hz and 60 Hz, voltage 115 V or 220 V with a frequency of 400 Hz; from a 27 V DC source.

The main developers of the oscilloscope: L.Yu. Polishchuk, V.V Mats N.V. Zayarnyuk, S.V. Morshchykhin.



Oscilloscope S1-124, bottom view.



Opened oscilloscope S1-124

2.9.3 Service analog-to-digital oscilloscope for TV S1-130 (15 MGc)

The universal television oscilloscope S1-130 is designed for studying the shape and measuring the amplitude and time parameters of periodic signals in the frequency range from direct current to 15 MHz (10 mV/d), as well as for measuring and monitoring the parameters of a color television signal and its components. The device has a CRT screen 40x60 mm, 1 channel, scan rate 50 ns/d, power consumption 28 VA and weight 4.5 kg.

The S1-130 oscilloscope has a wide range of functions, has a TV line selection block that is easy to use operation, which allows you to quickly solve assigned problems.

The device provides automatic setting of the signal image size on the cathode ray tube screen, digital measurement of amplitude and time parameters of signals with an error of no more than ± 3%.

The device provides self-diagnosis, measurements and digital storage of low-frequency harmonic signals with a frequency of up to 1 kHz and pulsed signals with a duration of 0.5 ms and higher.

Oscillograph S1-130

Oscilloscope developers: L.Yu. Polishchuk, V.V. Mats, Yu.F. Yurchuk, M.I. Mandelberg.

2.10. Oscilloscope Design

An oscilloscope is a complex device and consists of many components and parts connected to each other in a certain sequence.

When developing an oscilloscope design, a design engineer must take into account the availability of manufacturing the device, the quantity and nature of the required materials, their cost, manufacturability of parts, assembly and installation. In this case, the design of the oscilloscope must provide: protection of the electrical circuit from the influence of electromagnetic and electric fields; thermal regime; location of controls that meets ergonomic requirements; minimum dimensions and weight; high reliability and maintainability.

LNIRTI developed a unified body design, which consists of a frame, upper and lower covers, shock absorbers and a U-shaped transfer handle.

Participation design engineers V designing aesthetically oscilloscopes contributed to the creation of advanced instruments that meet high technical and economic requirements.

Designers involved in the development of oscilloscopes: G.A. Yevtyukhin, A.I. Kuhlevsky, I.I. Gut, V.B. Rogovsky, V.A. Zalizko, G.N. Snigura, E.K. Volynets, R.D. Stetsiv, I.I. Mizyuk, Z.V. Pasternak, A.P. Kolesnik, V.M. Shpytko, V.A. Plebanovich, N.Yu. Oleshko, V.F. Dyachina, V.E. Zaikina, L.I. Gasyuk, A.A. Polukhtovych, E. Jovnovsky, V. Marchenko, I. Guzandrov, N. Zayarnyuk, A. Kozlyuk, Yu. Yurchuk.

2.11. Reforming oscillography at LNIRTI 1984-1991

Beginning in the mid-70s, the oscilloscope development departments at LNIRTI began to shrink and be repurposed to develop special-purpose equipment.

At the end of 1984, the management of LNIRTI left two workers to work on oscillography in Lvov: B.I. Protsya and P.I. Oliynyk, who at that time at the Zolochiv Radio Plant were introducing into serial production the analog-digital oscilloscope S1-123.

The course of events in LNIRTI and fundamental changes in the development of Lvov oscillography were influenced by the Decision of the Party Control Committee under the CPSU Central Committee of July 10, 1987 No. 167.

2.11.1. A turning point in the history of development Lviv oscilloscopes

Why a turning point has come in the development of Lviv oscillography will become clear from the order of the Ministry of Radio Industry dated November 9, 1987. No. 1097 on eliminating deficiencies in work and on the creation and use of measuring, testing and control instruments.

The order was issued based on the results of the work of the party control commission under the CPSU Central Committee and the decisions of the board of the USSR Ministry of Radio Industry, held on September 24, 1987.

The order noted shortcomings in the work of LNIRTI, regarding the creation of measuring, control and testing instruments:

- technical level of products developed and produced by the Lviv Production Association named after. IN AND. Lenin radio measuring instruments (oscilloscopes, etc.) are lower than those of similar devices produced by the Ministry of Industry and Communications (MPSS, 6GU), and are significantly inferior to foreign levels;

- there is a tendency to reduce the volume of production and development of radio measuring equipment (RIA) and the capacity for its production;

- the divisions of RIA developers available at the Lvov NIRTI are currently significantly reduced and do not correspond to the tasks facing the industry.

This order decided:

- to restore in the structure of the Lvov NIRTI design development divisions focused on equipment for the needs of the industry; on radio measuring

- allocate additional staff to LNIRTI in the number of 25 people with the corresponding payroll;
- ensure the development of design documentation for large-scale integrated circuits (LSI) and special large-scale integrated circuits (VLSI) for private use.

2.11.2. Change of head of LNIRTI

In 1987, Candidate of Technical Sciences, senior researcher Rostislav Vasilievich Obukhanich became the director of LNIRTI.

Rostislav Vasilievich Obukhanich

Rostislav Obukhanich is an extremely tolerant, patient and balanced person. traits characterize the line of his behavior as the head of the enterprise. He knew how to These support a person in both joy and sorrow, respect people, listen to other thoughts and views. He was V able to perceive without aggression the actions and thoughts of others that he did not share, and the ability to discover the understanding of the interlocutor in the process of communication. He had the inherent ability to listen and understand, hear and help.

2.11.3. Creation of oscilloscope sector No. 122

To fulfill the order of the Ministry of Radio Industry No. 1097 dated November 9, 1987, Sector No. 122 for the development of oscilloscopes is being created at LNIRTI. B.I. was appointed head of the sector. Proc.

The primary task that arose before the head of the sector was not staffing the sector specialists, and the formation and coordination of proposals for the industry program “Development and production of RIA by enterprises of the organization - 1 GU MRP for 1988-1995.” Such a program was developed in the shortest possible time and approved by the heads of the 1st State Institution of the Ministry of Radio Industry, 6th State Institution of the Ministry of Industry and Communications (MPSS) and the customer (representative of the Ministry of Defense) 12/29/1987.

This program included one research work “Search” - “Research on ways to create oscilloscopes of the IV and V generations” and 7 R&D projects that should be carried out at LNIRTI. The program noted: the name of the development, brief technical characteristics, the beginning and end of the development, the deadline for the transfer of design documentation to the manufacturer, the time of production of a pilot batch of devices and the start of mass production.

At the beginning of 1988, sector workers began completing development work, started and unfinished back in 1983: R&D "Slitok-2" - a television oscilloscope, and R&D Saklya-1 - a four-channel oscilloscope.

To improve the work to ensure management of the development of radio measuring instruments, the introduction into production of competitive types of products, by order of the Minister of the Ministry of Radio Industry dated June 17, 1988 No. 704, the chief designer of the Ministry for Development

oscillographs was appointed Prots Bogdan Ivanovich, head of the LNIRTI sector.

To quickly and efficiently solve the problems and achieve the goals of reviving Lviv oscillography, it was necessary to create a team of like-minded people, select appropriately qualified personnel who can creatively and effectively solve assigned tasks, create normal working conditions and fair pay. The emphasis was placed on a combination of highly qualified specialists and young specialists - graduates of Ukrainian universities: Lviv and Kyiv Polytechnic Institutes, Lviv University. Ivan Franko and other universities.

The main criterion in the selection of personnel was efficient work and the ability to complete assigned tasks. Author of this chapter took full responsibility for completing the assigned tasks and personally began to form a team of like-minded people.

Difficulties in forming a team were due to the fact that the decrease in the volume of development of oscillographic equipment and

a significant reduction in the developers of this technology has led to a gradual loss of our qualifications in this area
technology.

The subject of special attention in creating the team was the selection of young specialists capable of solving innovative tasks. Having taught part-time for a long time at the departments of the Lviv Polytechnic, the author of this chapter had the opportunity to directly get acquainted with university graduates.

Significant assistance in the selection of personnel was provided by the head of the Department of Radio Engineering Devices and Systems of LPI, Professor Doctor of Technical Sciences Zenon Dmitrievich Grytskiv and the Dean of the Faculty of Radio Engineering, Professor Doctor of Technical Sciences Ivan Nikiforovich Prudius. Additional training was widely provided to 5th year students during their practical training, providing them with real projects for constructing individual oscilloscope components for their graduation projects.

Graduates were invited to work not only in the specialty of radio engineering, but also in other specialties -
information and measuring technology, computer science and radiophysics, technology, electronics, computing
instrumentation and design of integrated circuits.

The basis of the personnel policy was the strategy of continuous self-training and retraining of employees in new design technologies. Each employee was required to prepare and give a lecture in the area of his choice. This approach contributed to the optimal combination of veterans' experience –

leading specialists of the team - and the energy, knowledge and skills of talented young graduates of higher educational institutions.

2.11.4 Meeting of the Minister of the Ministry of Radio Industry at LNIRTI

On July 08, 1988, a meeting was held at LNIRTI with the Minister of Radio Industry Vladimir Ivanovich Shimko on the progress in implementing the decisions of the Party and the Government on the creation and use of measuring, control and testing instruments.

At the meeting, the draft "Industry program for the development and production of oscilloscopes by enterprises of the Ministry of Radio Industry for the period 1988-2000" was also reviewed and approved.

As a result of the meeting, it was decided:

“- earmark state budget allocations for the development of oscilloscopes for 1989 in the amount of 2.062 million rubles to the Lvov NIRTI;

- Lvov NIRTI to entrust work on the development and manufacturing analog LSIs for oscillography software;
- to the director of the Lvov NIRTI, Comrade Obukhanich, to organize in the 2nd quarter. 1989 structural divisions, intended for the development of analog LSIs and oscilloscopes in accordance with the industry program;

- to the director of the Lvov NIRTI, Comrade Obukhanich, starting from the 2nd quarter. 1989 to issue, and to the General Director of NICFT, Comrade Savotin, to agree on the task and conclude agreements for the development of digital LSIs and VLSIs for private use for the production program for the production of oscilloscopes by LORTA;
- earmark funds for the Lvov NIRTI for 1990 for special technical equipment (STO), which is not enough for the development of analog LSIs, for the purpose of acquisition through inter-industry cooperation.

Minister V.I. Shimko."

2.11.5 Creation of oscillographic department No. 140

In connection with the growing volume of development of oscillographic equipment, the element base for it and the significant replenishment of sector 122 with new employees, in order to specialize scientific and labor activities, intensify work in promising areas and accelerate the implementation of scientific achievements in life, it was decided to form sector 122 on the basis of research department 140 consisting of 3 research laboratory sectors: No. 141, No. 142 and No. 143 (LNIRTI Order No. 199 dated June 14, 1989). Subsequently, 3 more laboratory sectors were formed in the department: No. 144, No. 145 and No. 146.

The functions of the head of department 140 are entrusted to B.I Protsya. Helped the head of the department to cope with the assigned tasks: Roman Vyacheslavovich Bodnar - deputy head of the department (former employee of VNIIRIP), Evgeniy Konstantinovich Blyudin, Yosif Petrovich Ralko, as well as Sofia Stepanovna Zvizlo and Natalia Vladimirovna Sushko - economists.

The department is entrusted with carrying out R&D to develop:

- universal oscilloscopes;
- automated tools for setting up and checking units devices being developed;
- specialized microelectronic analog and digital products for oscilloscopes;
- control and measuring equipment for checking parameters and testing special microelectronic products.

2.11.6. Laboratory sector No. 141

At the initial stage, the functions of the head of sector 141 were assigned to the head of department 140, and over time, leading engineer Ivan Mikhailovich Moskvitin was appointed head of sector 141.

Sector 141 included the following employees of sector 122: V.I. Gudyk, I.M. Sydor, Yu.V. Berezovsky, M.G. Boychuk, O.T. Berezovskaya, G.A. Legoyda, S.A. Vashchenko, I.O. Kuchma, V.V. Dolgikh, M.I. Krehovetsky, V.R. Vilyura.

Subsequently, the sector was replenished by: Y.S. Kurylyak, S.P. Evtukh, V.F. Yakymiv, I.M. Paslavskaya, A.E. Chudyak, E.G. Levchuk, N.M. Khodireva, N.V. Khovalko, M.V. Rooster, A.Ya. Kurnitsky.

Sector 141 is entrusted with the development of small-sized (miniature) special-purpose oscilloscopes for work in laboratory, workshop and field conditions.

2.11.7. Portable 2-channel midrange oscilloscopes with character generator S1-135 (20 MHz) and S1-135A (50 MHz)

Portable, small-size two-channel oscilloscopes S1-135 with a bandwidth of 0 – 20 MHz and S135A with a bandwidth of 0 – 50 MHz, with a sensitivity of 5 mV/d, subsequently, according to the Ukrainian classification of oscilloscopes developed by the staff of the department, they were named “Oscilloscope 1101” and “Oscilloscope 1101A”.

To create a competitive device, it was necessary first of all to develop a special element base for its construction. This process requires a significant amount of time and large financial investments. To reduce the costs of development, preparation of production and development of electronic equipment, it is necessary was to ensure compatibility and continuity of hardware solutions while simultaneously improving the quality of devices. Therefore, the development of a new element base and new technological processes was carried out based on their use not only in the S1-135 (1101) oscilloscope, but also in subsequent developments.

In within the development of the S1-135 (1101) oscilloscope, LNIRTI entered into an agreement with the Lvov Scientific Research Institute "Erotron" for the development of a unique cathode ray tube (CRT) for small-sized oscilloscopes under harsh operating was conditions, which successfully developed.

with

Cathode ray tube 8LO9I

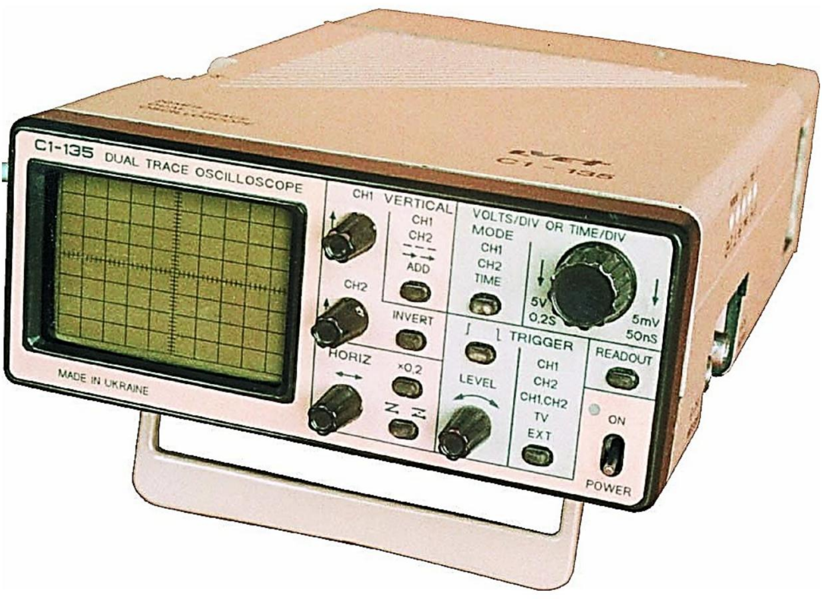
The technical characteristics of the 8LO9I CRT exceeded the similar characteristics of foreign CRTs. There are no domestic analogues. To increase the brightness of the beam on the tube screen, the inside of the conical flask is coated with a special

conductive layer. Research Institute "Erotron" had a scientific and production base and carried out the development, introduction into production and production of cathode ray tubes in small batches.

Engineers of laboratory sector 141 in a very short time mastered the construction of original circuit solutions **for digital technology** for their implementation using a software-technological method based on basic matrix crystals (BMCs) in the form of large integrated circuits (programmable logic matrices PLM).

BMKs are universal semiconductor crystals, all placed on photomasks for the manufacture of such crystals, with the exception plates of the switching layers are constant and do not depend on the implementation circuit. Close cooperation with employees of NICFT (Moscow) made it possible to obtain samples of manufactured microcircuits over the course of several weeks.

In parallel with the development of the oscilloscope and special element base, new technological processes were widely introduced. The design of the oscilloscope and its body are made entirely of insulating material (using plastics), which is covered in the right places with a layer of metallization. At the same time, the design of the oscilloscope ensured high requirements for mechanical strength and had double insulation from parts that are under dangerous voltage.

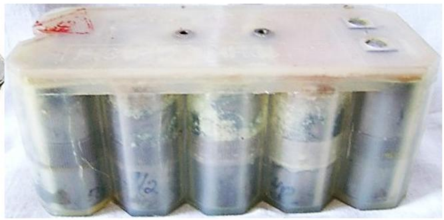


Oscillograph S1-135 (1101)

The oscilloscope power supply is made in two independent and interchangeable versions, which were separate complete units, each of which connects electrically and mechanically to the oscilloscope to form a single unit.

One power supply was intended to operate the oscilloscope from an AC voltage of 220 V with a frequency of 50-60 Hz, or a voltage of 220 V and 115 V with a frequency of 400 Hz. Another power supply was intended to operate the oscilloscope from batteries with a voltage of 12 V - 27 V and ensured operation of the device in field conditions in the absence of alternating current sources. The oscilloscope's power supply used batteries 10NKGTs-1D and 10NKGTs-1.8-1, the first with a nominal capacity of 1 A/h, the second with a nominal capacity of 1.8 A/h, ensuring operation of the oscilloscope in the long-term battery discharge mode.


Battery 10NKGTs-1D


Battery 10NKGTs-1.8-1

Oscilloscope 1101 successfully passed the State acceptance tests, was recommended for serial production and entered into the State Register of Measuring Equipment.

Simultaneously with the development of the 1101 oscilloscope, in sector 141 the development of a small-sized oscilloscope-multimeter (the "Sphere-5" theme) and a four-channel highly sensitive to input signals oscilloscope with a bandwidth of 0-25 MHz was underway under the "Sinilga-4" theme.

2.11.8. Integral technology at LNIRTI

The most difficult task in the development of oscilloscopes was the lack of analog microcircuits of wideband amplifiers with differential inputs and outputs, a bandwidth from direct current to hundreds of megahertz and several gigahertz, and source signal amplitudes from tens of miles to tens of volts. LNIRTI had no experience in developing such integrated amplifiers at that time.

As noted earlier, LNIRTI has fully mastered thick-film and thin-film, as well as partially - semiconductor technology.

To ensure a high level of development of new generation oscilloscopes, the Ministry of Radio Industry made significant investments to provide LNIRTI with special technological equipment for the creation of powerful semiconductor technology for the production of analog LSIs and VLSIs. It was envisaged that LNIRTI should become one of the leading enterprises in the country in the development and manufacture of analog large-scale integrated circuits that operate in a wide range of frequencies from direct current to several gigahertz.

The list of the necessary special technological equipment for carrying out R&D at LNIRTI to create analog LSIs for new generation oscilloscopes, which was supplied by the Ministry of Radio Industry, amounted to 18 items: - from magnetron sputtering installations, low-dose ion doping, deposition of layers at reduced pressure to installation of lead welding and sealing microcircuits, a diamond grinding machine, an electron scanning microscope with microanalysis capabilities and a machine design system, and many other necessary equipment.

LNIRTI widely introduced acoustoelectronics and magnetoelectronics, which made it possible to carry out R&D using complex microminiaturization methods.

Here we must pay tribute to the incredibly hard work to complete the implementation of the technological cycle for manufacturing analog semiconductor chips at LNIRTI, done by the head of the department, Doctor of Technical Sciences Lyubomir Mikhailovich Smerklo.

Lyubomir Mikhailovich Smerklo made a significant contribution to the development and implementation of new technologies at LNIRTI.

Smerklo was the initiator and organizer of the introduction into LNIRTI of the technology of thick and thin films, acoustoelectronics and magnetoelectronics, and subsequently the technology of integrated circuits.

Lubomyr Mykhailovych Smerklo

Lyubomir Smerklo deeply understood himself and convinced others that microelectronics is the foundation on which the modern radio-electronic industry should be built, which determines the technical level of industrial, household and military products, their competitiveness. all

2.12. Oscillography in independent Ukraine

On August 24, 1991, the Verkhovna Rada of Ukraine adopted the Act declaration of independence of Ukraine. After proclamation independence In Ukraine, the Ministry of Defense of Ukraine took over the financing of the development of oscilloscopes, which were already carried out at LNIRTI.

In 1992, the oscillographic department 140 developed and approved at the Ministry of Mechanical Engineering, Military-Industrial Complex and Conversion of Ukraine ("Minmashprom of Ukraine") a program for the development of radio measuring instruments in the interests of the national economy of Ukraine. Then, this program became an integral part of the comprehensive program "Measurements of electrical non-electrical quantities". The total volume of LNIRTI work for 1992-1996, according to the approved program, amounted to 266.7 million rubles.

To coordinate the development of radio measuring instruments and the element base for them, and their introduction into mass production, the chief designer of the Ministry of Mechanical Engineering, Military-Industrial Complex and Conversion of Ukraine, B.I., was appointed. Proc.

2.12.1. Laboratory sector 142, broadband oscilloscopes

Leading engineer Pavel Ivanovich Oliynyk was appointed head of sector 142. Sector 142 included the following employees:

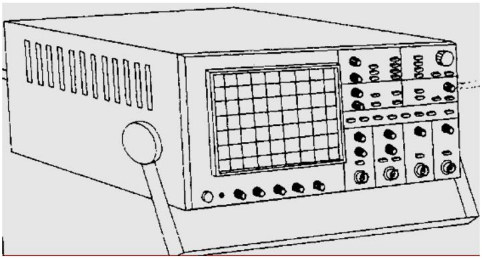
I.V. Kopachevsky, V.M. Salabay, I.V. Boguta, A.I. Gadzevich, N.V. Khovalko, S.V. Bartoshchuk, S.S. Muravsky, I. Muravskaya, O.R. Kozogon, V.V. Prokip, O.N. Oliynyk.

Subsequently, the sector was replenished by: Z. Kolodiy, I. Romaniv, I. Decyk, I. Shlyapa, Y. Tunsky, Y. Kutyuk, R. Pukhtaevich.

Laboratory Sector 142 is entrusted with the development of wideband, high-frequency analog and digital oscilloscopes with a bandwidth of 100 MHz and higher: a four-channel 100 MHz analog oscilloscope (topic "Structure-1"), a four-channel 100 MHz digital oscilloscope (topic "Line-3") and a two-channel analog oscilloscope with a bandwidth of 0 -1000 MHz.

2.12.2. Oscilloscopes "Structure-1", "Stroke-3/3m"

To develop oscilloscopes on the topics "Structure-1", "Stroke-3" and "Stroke-3M", LNIRTI entered into an agreement with the Lvov Scientific Research Institute "Erotron" for the development of a highly sensitive, large-screen 100x120 mm cathode ray tube.



The 1107PV2 microcircuit with a maximum sampling frequency of 20 MHz/8 bits, developed by the Venta enterprise, Vilnius, was used as an analog-to-digital converter (ADC).

Digital oscilloscope “Strova-3M”

Oscilloscopes on the topics “Structure-1”, “Stroke-3” and “Stroke-3M”, developed in **1996 ,** had microcontroller control.

In the oscilloscope "Stroke-3" and "Stroke-3M" the "General Use Channel" (GPIB) interface is used for data exchange as part of information-measurable systems. Starting from a scan rate of 2 ÿs/cm and higher, the device operated in an equivalent time mode, for which the classical stroboscopic method was used.

2.12.3. Oscilloscope 1301 for 0-1000 MHz band

A particular achievement of sector 142 was the development in **1992** 1301 analog two-channel high-sensitivity real-time oscilloscope with 0-bandwidth

1000 MHz, which successfully passed state admissions tests.

The oscilloscope has full electronic control of the functions and operating modes of the device, digital measurements of signal parameters using marker lines (cursors) and display measurement results in digital form on the screen of a cathode ray tube (character generator).

Cursors are used as measuring samples, with the help of which the parameters of the studied signals are measured along the vertical and horizontal axes of the CRT screen.

The use of measuring properties of cursors in the device ensures comfortable performance of main tasks
measurements: absolute voltage value (reference cursor at 0 V - ground); stress ratio; temporary difference; frequency measurement; phase shift.

Oscilloscope 1301, 0-1000 MHz band.

When developing the 1301 oscilloscope, samples of a fundamentally new CRT with a microchannel plate were used to enhance the brightness of the beam on the tube screen, previously used in the S1-129 oscilloscope. It used distributed

broadband "traveling wave" deflection system.

This CRT was developed by the Novosibirsk plant, specifically for the S1-129 oscilloscope at 1000 MHz, developed at VNIIRIP in 1989. The CRT provided ultra-high photographic and visual signal recording speeds: 200,000 km/s.

To construct the vertical deflection channel of the oscilloscope, prototypes of the M4204, M4204-1, M4204-2 and M4204-3 broadband amplifier microcircuits were used, which were developed on the “Tube” theme by the Novosibirsk Semiconductor Device Plant together with the experimental design bureau, also developed specifically for the S1-129 oscilloscope .

Broadband amplifier chips for a band up to 2-4 GHz

The amplifier bandwidth is from DC to 2-4 GHz.

A design feature of the amplifier microcircuits was that they provided a consistent electrical connection to the printed circuit board using special elastic clamps developed at LNIRTI.

Top and bottom sides of the chip

To ensure reliable electrical contact between the microcircuit and the board, the strip pins of the microcircuit are coated with a layer of gold. The strip contacts of the elastic clamps and the corresponding contacts of the printed circuit board were also coated with a gold layer.

The back side of the microcircuits is coated with a layer of gold to remove heat during their operation. The work of many LNIRTI employees was invested in the creation of the 1301 oscilloscope, but leading engineer Vladimir Mikhailovich Salabay

put especially a lot of work into the development of the oscilloscope. Vladimir Mikhailovich came to Lvov at our invitation from Zolochiv to develop oscilloscopes as a systems engineer with scientific and practical experience in this field. He was not afraid of difficulties and temporary failures in creating the device. He proceeded from the principle expressed by Henry Ford: "If something doesn't work out for you, then this is a wonderful opportunity to start over, but in a different way." Several years of persistent, exhausting work and the device

won recognition from the State Admissions Committee.

At the time of development of the 1301 oscilloscope, only 2 models of real-time oscilloscopes for the 0-1000 MHz band were created in the world:

- Tek 7104 (Tektronix, USA, mid-1980s);
- S1-129 (VNIIRIP, USSR, Vilnius, 1989).

Thus, the Lviv oscilloscope 1301 became the third to achieve such a record breaking mark and entered the top three leaders in world oscillography.

2.12.4. Laboratory sector 143

Sector 143 was entrusted with the development of automated tools for setting up and testing the components of the oscilloscopes being developed; support for the manufacture and verification of specialized analog and digital semiconductor microcircuits.

Laboratory sector 143 was headed by Petr Semenovich Manchulenko, and later Pyotr Nikolaevich Kritsky.

Sector 143 included employees: Z.M. Bodnar, L.Ya. Kupchak, I.M. Moskvitin, I.O. Muravskaya, L.I. Ivanova, V.Ya. Tunsky, G.Ch. Rybka, I.R. Kucher, O.M. Shostak, V.V. Weaver.

Subsequently, the sector was replenished by: V. Shuvaryk, Z. Pryimak, L.E. Myskiv, G.D. Chobit, M.V. Yoshina, N.T. Klos, Y.O. A leprosy.

The early days of the sector were a difficult period. There was no experience in designing electrical circuits for semiconductor chip manufacturing.

A new stage in the activities of the laboratory sector began with the appointment of Peter Kritsky as the head of the sector, who introduced a new breath into the work of the team entrusted to him.

Peter Nikolayevich Kritsky

Petr Nikolaevich headed the sector, having significant experience in the development of oscillographic instruments. He developed the vertical deflection path of the computational

oscilloscope C9-17.

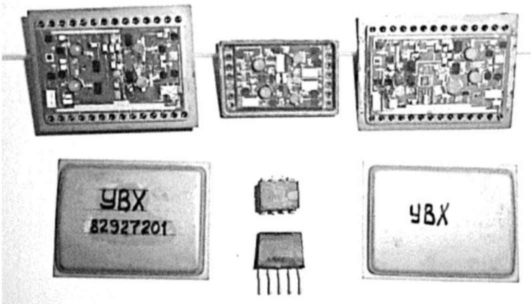
He had the gift of an organizer and performer, an obsession with work and uncompromising demands on himself and his work colleagues.

He knew how to organize the work so that the performers felt their participation in the matter and learned the joys of victory. His task was to teach workers to independently understand complex scientific and production tasks, and his requirement was that any well-done job should at the same time be done beautifully and in full accordance with the assigned tasks.

2.12.5. Chip design

A group of specialists from laboratory sector 143, headed by leading engineer Z.M. Bodnar, was engaged in the development of functional electronic components of the oscilloscope for their further implementation in the form of hybrid, integrated and combined hybrid-integrated circuits.

After preliminary calculation of the active and passive elements of the microcircuit, taking into account the circuit requirements and technological capabilities, calculation of the thermal regime of the microcircuit, a technical assignment for the development of the microcircuit was issued to the microelectronics department of LNIRTI for its final design and manufacture



At the beginning

the data of the future microcircuit were evaluated on the basis of the electrical circuit diagram on discrete elements transmitted by the developers of the device

Tah.

Hybrid microcircuits manufactured at LNIRTI

2.12.6. Chip testing equipment

A group of specialists led by P.S. Manchulenko carried out the design of non-standard hardware for diagnostics of printed circuit boards and microcircuits in the conditions of their development and mass production.

Needle mechanical adapter

The custom hardware kit also included elastic
a needle mechanical adapter, special connectors and the like, which
ensured that information was collected and transferred for processing to a computer.

2.12.7. Expansion of the oscilloscope department

IN communications with With the increase in the development of oscillographic equipment and the widespread introduction of computer technology into the instruments, new laboratory sectors 144, 145 and 146 are being formed in the structure of department 140.

Laboratory sector 144 is entrusted with the development of: small-sized digital oscilloscopes, analog-to-digital input/output devices for personal computers, microcontroller devices included in oscilloscopes.

management V

Vasily Stepanovich Kalatalyuk was appointed head of the sector.
The sector included: Roman Stepanovych Grabar; Vladimir Nykolyshyn; Andrey Yaroslavovich Zhukovsky; Mikhail Yaroslavovich Kozhan; Zenovy Yavorivskyi; Halyna Prokip.

Laboratory sector 145 developed software for microcontroller controls for oscilloscope functions and measurement information systems, software for digital signal processing.

Sector 145 was headed by Evgeniy Iosifovich Demchuk. Composition of the sector: Vladimir Ilkiv – senior researcher, candidate of physical and mathematical sciences, subsequently doctor of physical and mathematical sciences, LPI; Tatiana Tsios; Albina Tolstova; Natalia Gamiwka; Vladimir Fartushok; Ivan Zinko; Yuri Kulyna; Galina Khomulyak; Nadezhda Pashko; Nadezhda Music.

Division 146 of printed circuit board design was headed by as the head of the sector Roman Bozhyk.
Members of the unit: Lyuba Romanyshin; Oksana Garbuz; Andrey Manko; Andrey Zhilych; Evgeny Snitsky, Natalia Godovskaya, Elena Polstvina.

2.12.8 State standard of Ukraine: DSTU 3238–95

The intention to create an oscillographic state standard arose immediately after the Verkhovna Rada of Ukraine adopted the Act of Declaration of Independence of Ukraine. The development of the standard was initiated by the author of this section, who managed to effortlessly convince leading LNIRTI specialists of the need for such a standard and involve them in the development process itself.

We understood that increasing the scientific and technical level of standards has an active impact on improving the quality of products that are developed and manufactured. The high standards laid down in the standard must be fulfilled.

The purpose of creating the standard was to develop a concept that provided not only for bringing the general technical requirements for oscilloscope parameters closer to world standards, but also for device developers. This standard applies to military

provided to surpass opportunity
them. oscilloscopes for
industrial and technical purposes. The standard or its individual parts and
may be extended to stroboscopic, storage, digital, television oscilloscopes, as well as electronic oscilloscopes with other types of indicators, with the exception of specific parameters and specific technical requirements of these devices.

As a result, the standard "Electron-beam oscilloscopes" was created. General technical requirements and test methods. State Standard of Ukraine, Kyiv. - 233 p.

A feature of the developed standard is that all requirements for the parameters of oscilloscopes, as well as methods and conditions for testing devices, are described in such a way that the user of the standard does not need to refer to other regulatory documents.

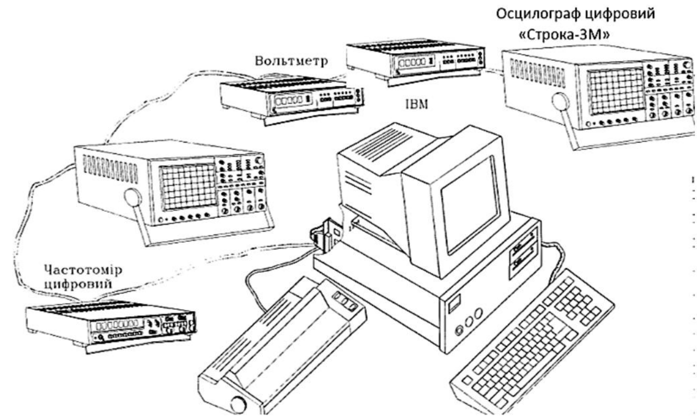
2.12.9 Automated measuring system (AIS)

Oscillographic technology occupied a special place in the program of the Ministry of Machine Industry of Ukraine, since it was precisely this technology, due to its versatility, that claimed the role of the basic structure on the basis of which measurement information systems equipped with the latest achievements of electronic computing technology are formed.

Main development The author of this section of the book was appointed as the designer of the measurement and information system. The development of the system was carried out by two departments - oscillographic department 140 and department 324 of digital signal processing, which was headed by Doctor of Technical Sciences, later professor, head of the department of electronic computers of the National University "Lviv Polytechnic" Anatoly Alekseevich Melnik.

Significant contributions to the creation of such a system were made by: Pavel Ivanovich Oliynyk, Andrey Yaroslavovich Zhukovsky, Mikhail Kozhan, Igor Detsyk, Anatoly Georgievich Larin, Candidate of Technical Sciences, later Doctor of Technical Sciences, Professor, Head of the Department of Automated Control Systems of the National University "Lviv Polytechnic" Ivan Grigorievich Tsmots , Roman Stepanovich Labyak, Yuri Mikhailovich Zakharko.

Through the joint efforts of oscillography and digital signal processing specialists, a unique measuring information system was created, the core of which was a computer and the digital oscilloscope “Strokka-3M” developed by department 140.



Measurement information system

The developed measuring information system provided:

- remote control of a set of devices – up to 31 devices;

- mathematical signal processing – 40 functions;
- data transfer speed – 1 MB/s;
- software: operating system MS DOS 3.3 and higher; application programs - Turbo Pascal, Turbo Assembler. Signal processing software:

- reception/transmission of control and measurement information IBM PC <---> measuring device;
- display on the IBM PC screen of the input and processed signals;
- signal accumulation mode on the IBM PC screen;
- recording measured information to disk, processing it and printing the parameters of the signals under study;
- automatic measurement: period, frequency, maximum, minimum, middle, peak-to-peak, rise time (front), fall time, energy, power, correlation, and so on;

- mathematical operations on signals: summation, subtraction, multiplication, division, root extraction, decimal logarithm, natural logarithm, absolute value and sign, averaging, smoothing, interpolation, differentiation, integration, wrapper and others.

2.12.10. From Heaven to Earth

It was necessary to descend from Heaven to Earth and develop devices, the serial production of which could be mastered by factories that are in a crisis situation that arose in connection with the new political situation and new

economic relations.

We realized the political and economic situation, the changes that were taking place in value orientations, rethought the capabilities of our factories, and quickly descended from Heaven to the sinful Earth.

We decided to develop a series of portable, inexpensive oscilloscopes for general consumption.

ELT 8LO10I

For this purpose, by order of LNIRTI Research Institute "Erotron", on the basis of the previously developed cathode ray tube 8LO9I, developed the 8LO10I tube, the cost of which was reduced by 30% compared to the 8LO9I tube.

2.12.11. SC oscilloscope 1201

The 1201 is a portable, single-channel, all-in-one oscilloscope that can be used to design, configure, and control electronic circuits. The device provides high accuracy in measuring the parameters of the signals under study.

The circuitry and design solutions in the 1201 oscilloscope are made in such a way that up to 80% of the components and parts of the 1201 oscilloscope were used in the development of the next universal two-channel oscilloscope 1202.

TV синхронізація
Низька ціна

TV Sync
Low Price

Основні технічні характеристики

Смуга пропускання	0-20 МГц
Діапазон амплітуд	10 мV-300 V
Похибка вимірювання	< 3%
Мережа	220 В (50-60) Гц
Споживана потужність	20 ВА
Розміри екрану ЕПТ	(40×60) мм
Габаритні розміри (Ш×В×Г)	(182×85×280) мм
Маса	< 3кг
Орієнтовна ціна	240 $

General Specification

Bandpass	0 to 20 MHz
Amplitude Range	10 mV to 300 V
Accuracy	< 3%
Power Supply	220 V (50-60) Hz
Consumption Power	20 VA
CRT Display	(40×60) mm
Overal Dimensions (W×H×D)	(182×85×280) mm
Weigth	< 3 kg
Approximate Price	240 $

Україна, 290060, м. Львів
вул.Наукова, 7, ЛНДРТІ
телетайп 234213 "ВОЛЬТ"

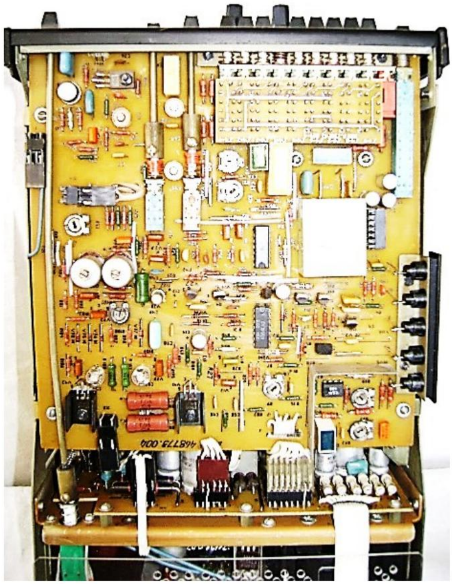
ПРОЦЬ
БОГДАН ІВАНОВИЧ
Телефон: (0322) 63-50-52

Oscilloscope 1201 for 20 MHz band

The high-frequency components of the device are mainly built on silicon high-frequency low-power bipolar transistors KT315 p-p-n type conductivity and a complementary bipolar transistor KT361 p-p-p type conductivity.

Leading engineer Vasily Fedorovich Yakymiv, Sergey Petrovich Evtukh, Alexander Chudyak, Irina Paslavskaya, Dmitry Gresko made a significant contribution to accelerating the development of oscilloscopes 1201 and 1202 and their introduction into mass production.

Vasily Fedorovich Yakymiv



Photos of the 1201 oscilloscope unfolded

2.12.12. Oscilloscope 1202

The 1202 oscilloscope differs from the 1201 oscilloscope only
the presence of a second channel in the vertical beam deflection path

The power supply, boards for the vertical and horizontal beam deflection channels were used from the 1201 oscilloscope, in which the possibility of electrically connecting to them circuits from the newly developed board of the second vertical beam deflection channel was provided in advance.

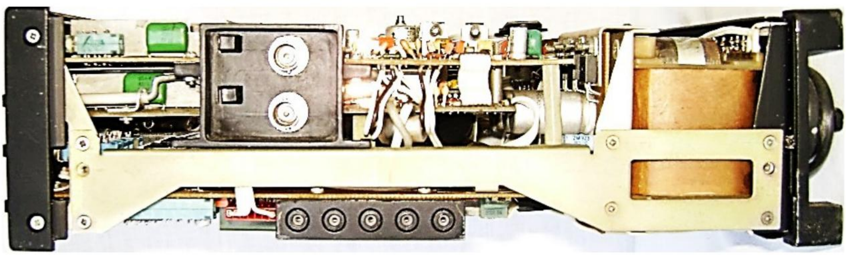


Photo of the 1202 oscilloscope opened

Oscilloscope 1202

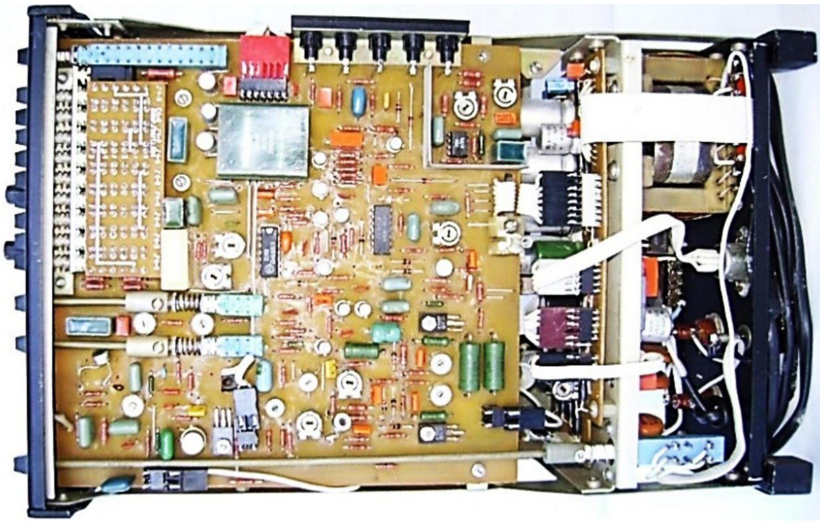


Photo of the 1202 oscilloscope opened

Only the front panel of the 1201 oscilloscope has undergone structural redesign; the connectors for the input signals under study are installed on the side panel. Separately provided structural fastening of the additional board of the second vertical deflection channel.

2.12.13. Digital oscilloscopes 2201 and 2201A

Digital oscilloscopes 2201 and 2201A with a bandwidth from DC to 20 MHz and 50 MHz, respectively, provide CRT display of signals discretely converted using digital devices and measurement of their parameters.

Digital oscilloscope 2201 (A) for 20 (50) MHz band.

Oscilloscope 2201 and 2201A allow you to study signals with amplitudes from 7 mV to 400 V and duration: oscilloscope 2201 - from 40 ns to 5000 s = 83, 333... minutes; oscilloscope 2201A - from 25 ns to 2000 s.

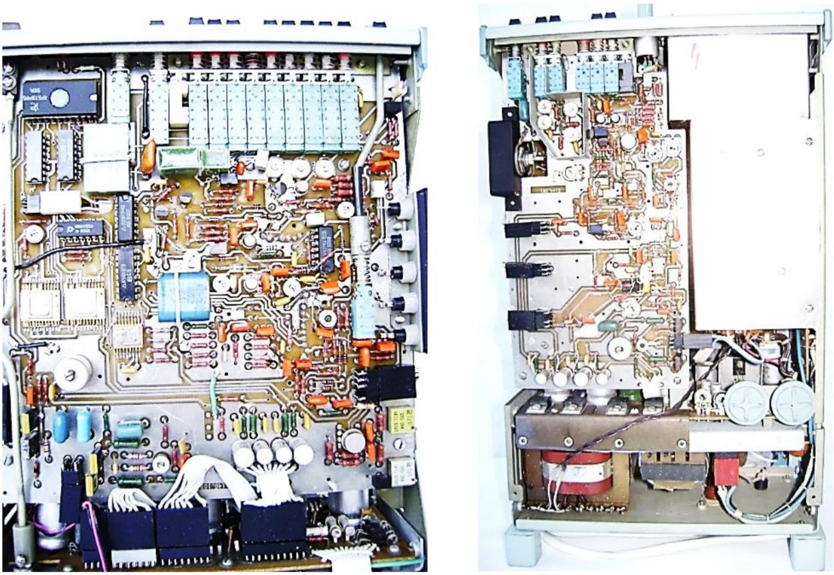
The 2201 and 2201A oscilloscopes provide:

- continuous conversion of analog signals into discrete signals and continuous display of the image of the converted signal on the screen of the cathode ray tube, fixing the image on the screen of the tube at the moment of synchronization failure;

- storing signals ahead of the start of the scan. The resolution of setting the sweep start advance is 0, 1/4, 2/4, 3/4, 4/4 of the entire sweep length;

- in non-synchronous mode, oscilloscopes are constantly in recording mode. In one-shot mode, recording occurs only when the READY button is pressed.

The 2201 and 2201A oscilloscopes are based on the design 1201 analog oscilloscope.



Photos of the 2201 oscilloscope opened

The development of oscilloscopes 2201 and 2201A was led by Andrey Yaroslavovich Zhukovsky. The main developers of the devices: V. Kalatalyuk, R. Grabar, V. Nikolyshyn, G. Prokip.

Andrey Zhukovsky is a gifted and talented engineer who made a significant contribution to the development of digital technology at LNIRTI. Under his leadership and with direct participation, the following were developed:

- oscilloscopes 2201 and 2201A; - within

the framework of the “Signal” research project - a prototype of a small-sized digital oscilloscope on a liquid crystal signal display device, the external design of which is similar to the design of a hand-held multimeter; - a series of analog-digital input/output devices for a personal computer

(PC-based digital oscilloscopes).

Structurally, analog-to-digital input/output devices were designed in the form of cells that were placed in expansion slots with an ISA bus. A device with an input signal switch and a 10-bit ADC K1113PV1A was used to input a cardiogram into a personal computer using an analog cardiograph (software development -

Anatoly Larin).

The device with the K1108PV1A ADC had a buffer memory and was similar in architecture to the data acquisition device of a digital oscilloscope. To operate in an equivalent time mode, the classic

stroboscopic method was used, but the comparator for generating samples was not analog, but digital, and accordingly, the inputs of the comparator received not sawtooth voltage signals, but samples from digital outputs

counters.

From the memoirs of Andrei Zhukovsky. “Physics was the subject that was most interesting to me and in which I could best express myself.

In my senior year I wanted to be a military pilot. The military commissar held a simple and successful conversation with us - he bribed us with romance, independence and social guarantees. But the doctors had other ideas about my suitability to become a military pilot. I endured such a refusal very difficult, but again my thoughts returned to physics. After graduating from school in 1983, he entered the physics department of Ivan Franko Lviv State University, majoring in

radiophysics and electronics.

In 1984, as a second-year student at the university, he was called up for military service in the anti-aircraft missile forces of the air defense (in those days, students were called up for military service for 2 years, all others served for 3 years - note from the author of the section).

In 1990, he completed his studies at the university and began working in department 140 of the LNIRTI as an engineer. Worked on digital oscilloscopes and input/output devices for personal computers. Then the development of oscilloscopes at LNIRTI quickly ceased. And the wanderings began in search of earnings for their daily bread.

In 1999-2001 he worked on integrated control systems for armored vehicles. In 2001-2003, he was involved in modernization at Ukrtelecom serial equipment for monitoring data transmission systems.

In 2003-2011, he carried out work on the design of a station for passive location of objects of radio frequency radiation and a homing head.

Andrey Yaroslavovich Zhukovsky

Since 2011 I have worked at a private enterprise as a leading engineer and am engaged in development of control devices for simulators of standard instruments located in the cockpit of vehicles.

2.12.14. "Research Center LORTA-TNP"

Since the second half of the 90s, the development of oscilloscopes at LNIRTI has sharply declined. We were looking for a way out the current situation.

The first step in this direction there was an oral agreement between the author of this section and the director of the State "LORTA-TNV" Igor Vasilyevich Moisyn on the creation, on the terms of self-financing and self-sufficiency, of a separate division in the structure of the state enterprise LORTA-TNV - the "research center "LORTA-TNV" ("SRC LORTA-TNV").

"SIC LORTA-TNV" had to have its own fixed assets and working capital, a hryvnia and foreign currency account in a banking institution, its own round seal, stamps, forms, trademark, could independently conclude agreements with residents and non-residents, and the like.

The SIC was created with the aim of intensifying the development of infrastructure radio electronics, scientific and technical improvement material support for production in the field of and production of radio-electro-communication measuring and other electronic equipment, provision of services in the fields of electronic equipment, industrial products, needs to satisfy enterprises, institutions, organizations and the population in goods and services. The Research Center was supposed to primarily consider the proposals of the enterprise LORTA-TNV and assist the development and implementation of the latest radio-electronic equipment into production.

As the first step in establishing connections between the developers of oscilloscopes at LNIRTI and the management of LORTA-TNV, we pledged to develop technical documentation for the widely used oscilloscope 1204 as quickly as possible and transfer it to the enterprise for development. LORTA-TNV, for its part, undertook to manufacture oscilloscope samples and conduct state acceptance tests at its own expense.

We must pay tribute to the director of LORTA-TNV, Igor Vasilievich Moisyn, who not only fulfilled our agreements on time and in full, but did more. He allocated two laboratory and production rooms for the employees of the Research Center and carried out their renovation.

02/07/2001r. Director of LORTA-TNV I.V. Moisyn approved the REGULATIONS on the "Research Center of the State Enterprise LORTA-TNV", and by order of the director of LORTA-TNV dated February 19, 2001. No. 09, "NDC DP LORTA-TNV" was created.

2.12.15. Oscilloscope 1204 for 20 MHz band

Over the course of 2 months, documentation for the vertical version of the 1204 oscilloscope was developed and sent to LORTA - TNV. Over the course of another 4 months, LORTA-TNV manufactured and assembled 5 oscilloscope samples, which together adjusted and prepared for State tests. The oscilloscopes successfully passed the state tests and LORTA-

TNV began preparing and testing a pilot batch of devices together with the developer. Having successfully passed the qualification tests, LORTA-TNV began serial production of the 1204 oscilloscope.

Oscilloscope 1204

B.I. Prots developed the circuit diagrams of the 1204 oscilloscope, including sweeps, with the exception of the power supply. The power supply for the 1204 oscilloscope was developed by D. Gresko.

2.12.16. Service oscilloscopes 1102/1102A (5/20) MHz

To replace the S1-101 oscilloscope with a bandwidth of 0-5 MHz and a cathode ray tube screen area of 12 cm2
1102 and 1102A oscilloscopes with bandwidths were developed

0-5 MHz and 0-20 MHz respectively on a CRT area size
tube screen 24 cm2 .

Oscilloscope 1102 (A) for 5 (20) MHz band

Compared to the S1-101 oscilloscope, the 1102 and 1102A oscilloscopes reduce the error in measuring amplitudes and time intervals by 2 times to ±5%, and also reduce the weight of the device to 2.1 kg.

The device is intended for use in laboratory, workshop and field conditions at temperatures from minus 30ºÿ to plus 50ºÿ.

By the time the development of the device was completed, the enterprise disappeared LORTA-TNV, and, consequently, “SIC LORTA-TNV”.

2.13. Results of LNIRTI in the field of oscillography

In just 33 years (from **1958** to **1991) of its glorious history**
At LNIRTI in the USSR, within the framework of the MRP, **about 52 models of oscilloscopes,** their modifications, and their supply options were developed, including the so-called "fractions" in the model designation (including through replaceable units). This number includes about 48 models of oscilloscopes, and about 10 replacement units for them, since some packages included more than 1-2 different replacement units (see table in section 1.15).

In terms of the number of oscilloscope models developed, during this period of time, LNIRTI oscilloscopes took an honorable 2nd place, after VNIIRIP oscilloscopes - 52 models out of 246, or 21.2% of models, against 56.9% of VNIIRIP models. This is partly due, apparently, to the fact that LNIRTI began developing oscilloscopes 9 years later than VNIIRIP. developed by the List of oscilloscopes, oscillographic divisions of LNIRTI, as well as the years of their creation, main characteristics and name of the
Appendix 2, at the end of the book. everyone manufacturer, are given in V

Produced by manufacturing plants, these oscilloscopes were very popular and sought-after products, successfully competing with analogues from other domestic and foreign companies. It should also be noted that the strength of LNIRTI oscilloscopes was their resistance to harsh and particularly harsh operating conditions of the devices, as well as their compactness and portability.

Quite a lot of types were developed in Lviv oscilloscopes - 6 types out of 10 (in Minsk 5 out of 10, and in Gorky only 3 out of 10, see table in Appendix 5), these are OSB, LF, service, ShP, MF and TV oscilloscopes. In 2 types of devices out of 10, LNIRTI was the leader in the USSR in terms of the number of developments. This - low-frequency and television oscilloscopes.

It is also necessary to note the achievements of LNIRTI in the field oscillography marked **"Developed for the first time in the USSR":**

- 1st transistor oscilloscope in the USSR **- S1-35, (1965),**
- 1st automated low-frequency oscilloscope - **S1-43, (1967),**
- the lightest and smallest service vehicle in the USSR oscilloscope, weighing **2.3 kg, - S1-101 (1979),**
- 1st transistor oscilloscope for **100 MHz band - S1-71, (1965),**
- 1st WB oscilloscope for **500 MHz band – S1-104 (1981),**

- 1st MF oscilloscope for **50 MHz band – S1-64 (1971),**

- the most popular and large-scale midrange oscilloscope - **S1-65,** production capacity up to **11 thousand devices per year,**

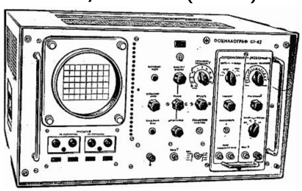
- TV oscilloscopes for the 12-20 MHz band, with a selection block lines, a total of 5 models C1-52/57/81/10 and C9-1 **1969-1980,**

The total achievements of LNIRTI in the field of oscillography, over 33 years, with the mark “Developed for the first time in the USSR” are **-** eight **(8).**

Legendary oscilloscopes developed at MNIPI and having the status **“Developed for the first time in the USSR”:**

S1-35, 5 MGc (1965)

S1-71, 100 MGc (1965)

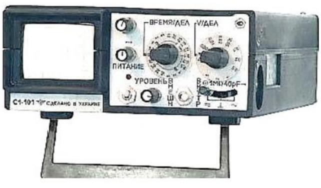


S1-43, auto, 10 MHz (1967)

TV oscillation **S1-57,** 15 MHz (1970)

S1-64, 50 MGc (1971)

S1-65, 35 MGc (1971)



S1-101/5 MGc/2.3 kg/(1979)

S1-104, 500 MGc (1981)

Of course, LNIRTI made an outstanding contribution to the development of the oscillographic industry in the USSR. But due to the policies of the Ministry of Radio Industry (MRI), within which LNIRTI worked, in the 80s, during the "Golden Era of Oscillography," when oscilloscopes were most in demand in the world and in the USSR, the development of oscilloscopes at LNIRTI was significantly reduced. The reason is the transfer of oscilloscope developers to departments with other, more important topics. This certainly slowed down the development of oscillography at LNIRTI.

If in the 70s LORTA, Zolochivsky and Novorozdilsky plants produced 80-90 thousand oscilloscopes per year, then in the 80s these enterprises jointly sold only thousands per year, and the number of devices in the 90s amounted to hundreds of pieces.

Political and economic transformations in the USSR and Ukraine led to the fact that in the early 90s, oscillography at LNIRTI entered a critical phase of its development, when the processes of curtailing the production of oscilloscopes by manufacturing plants, as well as their development at LNIRTI-LORTA, increased like an avalanche. Despite this, the development of oscilloscopes continued in the 90s in Lviv. During the times of independent Ukraine, these developments continued to decline, and at the moment

development of oscilloscopes at LNIRTI was completely stopped.

Unfortunately, in independent Ukraine, in the period after 1992, only 12 models of oscilloscopes and one oscillographic AIS were developed at LNIRTI. This is approximately 4 times less than in Soviet times (51 models). But even they, as a rule, were not introduced into mass production.

But, despite this, LNIRTI took its rightful place in the history of oscillography of the USSR, especially in the 60s and 70s, and has outstanding achievements both in terms of the number of developments of low-frequency and TV oscilloscopes, as well as in the field of service, broadband, and high-volume mid-frequency oscilloscopes.

Chapter 3.

Minsk Research Instrument-Making Institute (MNIPI)

3.1 History of the emergence and development of MNIPI 1925-2021

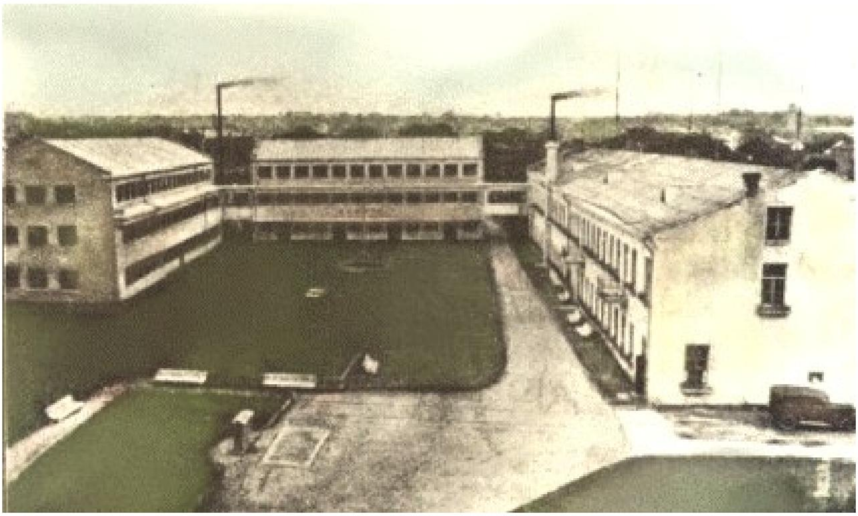
The history of the creation of the Minsk Research Instrument-Making Institute (currently JSC MNIPI) takes us back to 1925 in Vilnius.

In **1925 ,** in Vilna (Vilnius), at that time one of the provincial capitals of Poland, engineers, brothers Samuel Chvoles *and* Hirsh Chvoles , as well as Nachman Levin , created the radio engineering partnership *Elektrit.* Initially, on the street. Vilenska, 24 (currently Vilniaus St., 25), a store and workshop for the repair and sale of radio receivers and imported radio parts were created [2].

House at st. Vilenska, 24 (currently Vilniaus St., 25), where the store and motherhouse of the radio engineering partnership *Elektrit* were located

Thanks to the purchase of a license from the Viennese company Minerva, large investments and modern technologies *Elektrit* headed the production of radio receivers in Poland. In 1927, the company received official permission to build a plant, and since then it has been known as a manufacturer of radio receivers.

C **1934** to **1936** hours at ul. Sheptytskogo 16a *(ul. Generaÿa Szeptyckiego,* this is the street today. Shevchenkos, 16a) the construction of a modern production facility with a total area of over 10 thousand square meters was completed, which included three three-story buildings with its own power plant, carpentry shop, department for the production of parts and components, laboratory and warehouses. The plant employed 1,100 workers, including a large number of engineers and technicians, making the plant one of the largest employers in Vilna. There was an assembly line with six production lines, there was an assembly hall, and there was a trade union organization.



View of the production buildings of the *Elektrit* plant from the street. Sheptytskogo (Then now Shevchenko street). Photo from the late 1930s.

The production of radio receivers in 1936 amounted to 54 thousand units with a total cost of the equivalent of 1.2 million dollars. Completely new types were developed for each season devices that differed significantly from the models of the previous season.

Veniamin Pumpyansky (at that time an engineer at the Electrit plant, and later the chief engineer at the Minsk Gorizont plant) recalls [3,4]:

"Philips had a big radio factory in Warsaw, and we competed with them, but then our business went so well that we began to come out ahead. Our receivers had a very beautiful design. And the sound was perhaps the best in Poland, in any case, better than that of Philips.

With the outbreak of World War II in **1939 ,** immediately before the transfer of Vilna to the Lithuanian state, Red Army units were introduced into Vilnius. The enterprise was nationalized. The equipment was dismantled and transported to the USSR, to Minsk (Belarusian SSR), where on the

basis of the sawmill and furniture plant "Derevoobdelochnik", founded in 1907 (near the present Y. Kolas Square), a new enterprise called "Radio Plant" was built named after Molotov", in 1958 renamed the Minsk Instrument-Making Plant named after. V.I. Lenin, and since 1992 - to the BelVAR enterprise (hereinafter -

Minsk plant). Since

the autumn of **1940 ,** when some of the workers and specialists of the *Elektrit* plant moved from Vilnius to Minsk. The Minsk plant began producing models of radios previously produced

by the Elektrit plant , already under the new names "KIM" and "Pioneer". This is where the history of radio electronics in Belarus began.

After the war, from **1946 ,** the Minsk Plant produced radio receivers of its own design (Partizan, Minsk-53, Druzhba, etc.) until the early 1960s.

Minsk plant named after. Lenin, later "Belvar" and "Belvar-Amkodor"

Subsequently, since **1950 ,** the plant has been profiled as a manufacturer of wide-profile radio measuring equipment, including devices developed at VNIIRIP at the former site of the Electrit plant. And the production of radio receivers is transferred to the street. Krasnaya, where the new enterprise “Horizon” was founded.

This story is described in detail in the article by Viktor Korbut “From “Electrite” to “Horizon”“ [3, 4] based on the story of Veniamin Pumpyansky, chief engineer of the Horizon enterprise, before the war, a former engineer of the Electrit company.

In 1954, at the plant named after. Molotov in Minsk, SKTB (Special Design and Technology Bureau, predecessor of MNIPI) was created with the aim of developing various radio measuring equipment.

In 1971, on the basis of this SKTB, the MNIPI Institute was created, where the development of oscilloscopes began in 1972. Based on MNIPI and the plant named after. Lenin, the Minsk Production Association (MPO) named after. Lenin.

Minsk Scientific Research Instrument-Making Institute
(MNIPI, building in Minsk, on Yakub Kolas street 73).

The development of oscilloscopes at MNIPI in the 1970s was most likely started due to the fact that in Lvov, at LNIRTI, towards the end

In the 1970s and early 1980s, the development of oscillographic instruments began to wind down due to the repurposing of oscillographic units for military purposes. And at MNIPI at this time, they began to develop exactly those types of oscilloscopes that were abbreviated at LNIRTI - these are low-frequency (LF), mid-frequency (MF) monoblock oscilloscopes for harsh operating conditions.

MNIPI also received the code name PO Box G-4493.

V.A. became the director of MNIPI. Nosenko.

The development of oscillographic equipment was carried out at MNIPI almost 50 years, almost until now. At first - from 1972 to 1992 within the framework of the 6th State Administration of the USSR MPSS, then from 1992 independently, in the independent Republic of Belarus.

Since 1995, N.A. became the director of MNIPI. Kukharenko, formerly head of the oscillographic department and developer of the S9-18 oscilloscope.

In 1997, the institute was transformed into an open joint-stock company OJSC MNIPI as part of the State Military-Industrial Committee of the Republic of Belarus. V.A. Gomolko, who previously worked at the plant named after. V.I. Lenin (later “Belvar”) and carried out the introduction of oscillographic equipment into mass production.

In 2018, there was a change in the management of MNIPI. S.A. was appointed General Director. Popinako, an economist by profession, and the chief designer is a specialist in the field of voltmetry A.A. Volodkevich. Former director of MNIPI N.A. Kukharenko became assistant director, after which the development and production of oscilloscopes at MNIPI began to decline.

Until now, MNIPI remained the only operating multidisciplinary enterprise in the post-Soviet space for the development of RIP (oscilloscopes, voltmeters, signal generators, frequency meters, etc.), but here, unfortunately, starting from 2020, the development of oscilloscopes and other RIP was practically stopped.

Over many years of active activity, the enterprise has developed and put into serial production at various enterprises hundreds of types of radio measuring instruments, dosimetric equipment, communications equipment, control and measuring systems, etc.

Enterprise site www.mnipi.by.

Over 20 years at MNIPI, during the USSR, within the framework of the 6th Main Directorate of the Moscow Scientific and Practical System (from **1972** to **1992),** about **30** models and modifications (delivery options) of oscilloscopes were developed, including 1 type of replaceable oscilloscope unit.

These are the oscilloscope models:

- universal: S1-76, S1-65A, S1-82, S1-85, S1-114, S1-114/1, S1-117, S1-117/1, S1-117/2, S1-120, S1 -125, C1-126, C1-127, C1-128, S1-133, S1-133/1, S1-133/2, S1-142, RS1-01, RS1-02;
- digital: S8-19, S8-19/1, S8-23, S8-23/1,
- special: S9-7, S9-14, S9-18, S9-19, S9-28;
- as well as a replacement unit for the Ya4S-109 oscilloscope.

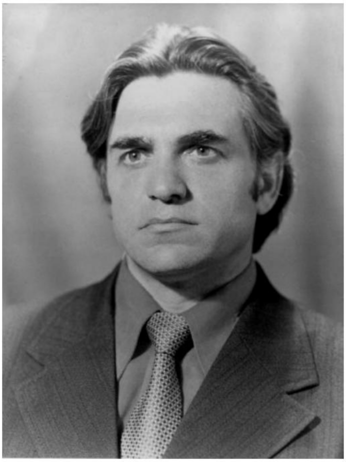
Over 29 years , MNIPI (and then JSC MNIPI) in independent Belarus (from **1992** to **2020)** developed **38** models and modifications of oscilloscopes:

- universal, (after 1992): S1-127/1, S1-127(ZhKI), S1-127(ŽKI)M, S1-127E, S1-148, S1-149, S1-150, S1-151, S1-157, S1-157/1, C1-157/2, C1-157/4, C1-157/5, C1-157/6, C1-164, C1-166, C1-166/1, S1-167, S1-167/1, S1-167/2, S1-170, S1-170/1, S1-170/2, S1-176, S1-176/1;
- digital (after 1992): S8-28, S8-33, S8-36, S8-38, S8-39, S8-41, S8-43, S8-52, S8-52/1, S8-53, S8-53/1, S8-54, S8-57.

3.2. The first oscilloscopes of MNIPI 1975-1982.

In **1972 ,** MNIPI began the first work on
oscillographic topics under the title of Research and Development Institute "Progress".

With the arrival in **1973** of Candidate of Technical Sciences Vitaly Nikolaevich Vishnevsky, the first
oscillographic division - oscillography sector. The first oscilloscopes developed at MNIPI are associated with his name.



In **1975 ,** an oscillography department was created at MNIPI, which Ph.D. Vishnevsky Vitaly Nikolaevich. He remained its boss until 1982. headed

In **1975 ,** the team's first development was completed -
LF oscilloscope **S1-76** for 1 MHz band . It was a low-frequency analog oscilloscope for the needs of the Ministry of Defense, with increased sensitivity of **100 ÿV/d.** and with

Vitaly Nikolaevich Vishnevsky

1st parameters
LF oscilloscope MNIPI
C1-76:

- 1 MHz band,
- CRT screen 60x100 mm,
- number of channels - 1,
- feelings. **100 µV/d,**
- number of scans - 1,
- unfold. 1 µs/d,
- consumption power. 55 VA,
- weight 13 kg.

Highly sensitive low-frequency oscilloscope **S1-76 (1 MHz/100 ÿV/d).**

The improved oscilloscope S1-76 was distinguished by high sensitivity and stable synchronization.

Vadim Ivanovich Ostapuk

The device was the first to use a scanning scheme based on digital integrated circuits, which later

used v

subsequent developments of oscillographic equipment. The oscilloscope was produced by the Kalibr plant from 1976 to 1985. Frequency band 1 MHz, sensitivity 100 µV/div. Chief designer - Ostapuk V.I.

In **1979 ,** work was completed on upgrading the legendary Lviv midrange oscilloscope **S1-65** to model **S1-65A,** which since the mid-1970s was produced at the plant named after. Lenin in Minsk.

The main objectives of the **S1-65** modernization were the following: expanding the bandwidth from **35** to **50 MHz,** replacing the electron tubes used in the oscilloscope with semiconductor devices and switching to a CRT with increased screen sizes.

1st parameters
Sÿ oscillograph MNIPI
S1-65A:

- **50 MHz** band ,
- CRT screen 64x80 mm,
- number of channels - 1,
- feelings. 5 mV/d,
- number of scans - 1,
- unfold. 10 ns/d,
- consumption power. 125 VA,
- weight 16 kg.

Legendary midrange oscilloscope **S1-65A** (50 MHz)

This device is unique in that it has become one of the most popular and large-scale oscilloscopes of the USSR.

S1-65A was produced simultaneously at 2 factories in Minsk - named after. Lenin and "Caliber" of the Ministry of the Moscow Union of Soviet Socialist Republics. From 1980 to 1990, its annual production amounted to more than **11 thousand devices per year.**

According to serial number, in the USSR, mid-frequency portable midrange The S1-65A oscilloscope was inferior only to the 2nd service, cheaper low-frequency devices S1-112A (20 MHz) and S1-94 (10 MHz), developed by VNIIRIP, the serial number of which was just over 12 thousand units. in year.

At the same time, **it became the most popular and high-volume oscilloscope of the USSR** in the 35-50 MHz band and **the most high-volume oscilloscope developed at MNIPI.**

Due to the production reserve for the main parameters, high reliability, manufacturability, maintainability and low price of this device, the demand for S1-65A was so high that at the plant named after. Lenin, for the first time in the history of oscillography of the USSR, the adjustment of these devices on a conveyor was organized. Subsequently, this adjustment method was not used for any of the other models of oscilloscopes in the USSR.

Vladimir Moiseevich Nemirovsky

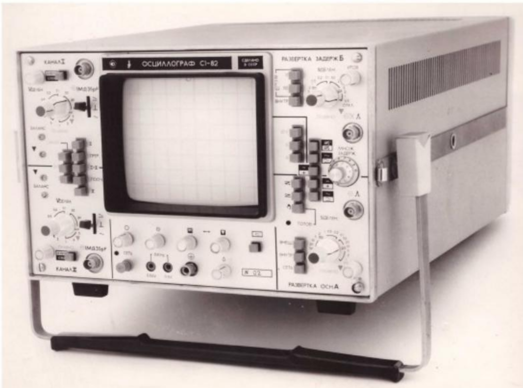
The main designer of the developed S1-65A oscilloscope was Ph.D. Nemirovsky V.M., developers - Petrovich A.G., Mironov E.S. main

Oscilloscope C1-65A was produced en masse, the total production volume was 110,935 units.

Nemirovsky V.M. is the author of more than a hundred inventions, most of which were used in the development of oscillographic equipment.

Since **1975 ,** the development of more technically complex, two-channel oscilloscopes with double delayed sweep.

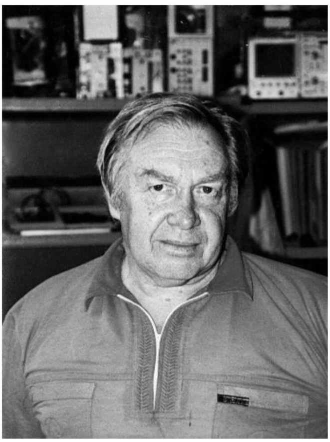
The first device with two channels and delayed scan , developed in **1978 ,** was the **S1-82** low-frequency oscilloscope.
per **10 MHz** band , with an increased size of the working field of the CRT screen - **100x120 mm** and increased sensitivity - **1 mV/d.**



2-channel oscilloscope **S1-82** (10 MHz)

Parameters of 2 channels.
LF oscilloscope MNIPI
C1-82:

- **10 MHz** band ,
- screen ELT **100x120 mm,**
- number of channels - 2,
- feelings. **1 mV/d,**
- number of sweeps - 2,
- unfold. 50 ns/d,
- consumption power. 55 VA,
- weight 13 kg.



Mochalin Viktor Borisovich

It should be noted that the developers of MNIPI oscilloscopes have always set ambitious goals tasks, and increased technical characteristics their devices.

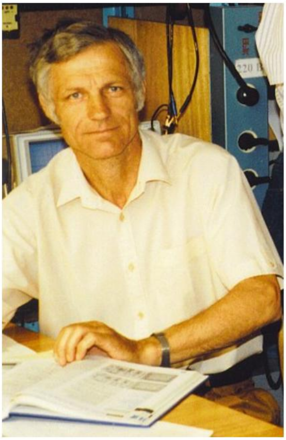
The chief designer of the S1-82 was V.B. Mochalin. This device was produced by the Caliber plant from 1979 to 2000. The production volume was 840 pcs., or 40 pcs./month.

With the organization of the oscillographic department in 1975, MNIPI began to conduct research to improve the accuracy of oscillographic measurements and their automation.

The results of the research work carried out were implemented in the development of oscilloscopes with digital measurements **S1-85** and oscilloscopes special purpose **S9-7** and **S9-14,** developed later.

The first broadband developed in **1980** oscilloscope MNIPI, with digital semi-automatic marker measurements of voltage and time, and a bandwidth of **100 MHz** - the **S1-85** oscilloscope became the main

the designer of which was Mataras L.I.



Leonid Ivanovich Mataras

It should be noted that mastering the 100 MHz band, at that time, in itself was not an easy task for the MNIPI team of oscilloscopes, and it was also necessary to introduce a character generator, marker measurements, and

V

improve their accuracy.

In VNIIRIP-e a similar oscilloscope appeared only a year later, in 1981. It was an oscilloscope S1-91/7 at 100 MHz, 2 channels, 5 mV/d and with a Ya4S-105 unit for marker semi-automatic measurements of parameters

matic

signal.

2-channel, ShP oscilloscope **S1-85** (100 MHz)

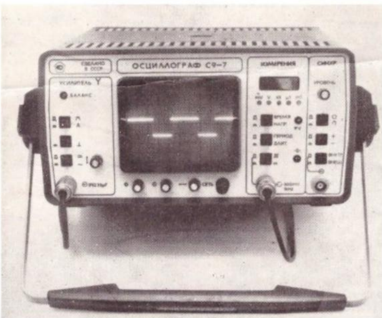
Parameters of 2 channels.
SP oscillograph MNIPI
S1-85:

- **100 MHz** band ,
- screen ELT **100x120 mm,**
- number of channels **- 2,**
- feelings. **5 mV/d,**
- number of sweeps - 2,
- unfold. 5 ns/d,
- marked measurements. U/T
- consumption power. 200 VA,
- weight 18 kg.

The device used original circuit solutions, protected by 4 copyright certificates, the authors of which were V.N. Vishnevsky, V.M. Nemirovsky. and Klepcha V.V. Start of serial production of the device in 1980.

The device was produced from 1981 to 1988. The production volume was 1289 units, or 184 units/month.

In **1982 ,** the first MNIPI oscilloscope was developed with automatic setting of the vertical and horizontal dimensions of the signal image, as well as with automatic measurements of 3 signal parameters. It was the low-frequency oscilloscope **S9-7 (10 MHz).**



Submachine gun. oscilloscope C9-7

Parameters of the low-frequency oscilloscope MNIPI **S9-7:**

- **10 MHz** band ,
- CRT screen 60x80 mm,
- number of channels - 1,
- feelings. 20 mV – 200 V,
- frequency sign. 20 Gc – 10 MGc,
- **author scaled signal**
- **author measured amplitude +/-3%,**
- **author change period/duration +/-2%,**
- consumption power. 65 VA,
- weight 7.5 kg.

And, although LNIRTI had already developed a similar automated oscilloscope S1-78 (35 MHz) in 1976, it did not have automatic measurements and it weighed a lot - 19 kg. Therefore, for the maintenance and repair of electronic equipment, a more compact device with a weight of at least half as much was required.

Ostapuk V.I.

According to the customer's definition, it was a “fool-proof” device intended for operation by an operator with a low level of training. The chief designer of this device was Ostapuk V.I., previously the developer of the S1-oscilloscope

76. C9-7 was produced from 1983 to 1993. The production volume was 6631 units, or 663 units/month. According to this indicator, S9-7 entered the top five most large-scale devices of MNIPI

Teams of employees of the oscillographic department of MNIPI.

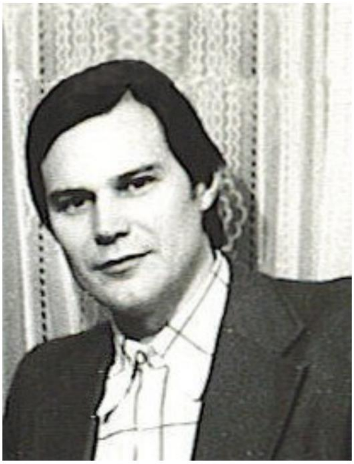
In **1980 ,** the development of the first digital oscilloscope with microprocessor control was completed in the USSR (and at MNIPI), and one of the first devices with automatic measurements of several signal parameters - the **S9-14** digital oscilloscope with a **100 MHz bandwidth.**

Parameters of the S9-14 digital oscilloscope : - bandwidth **100 MHz,** - CRT screen 100x120 mm, - number of channels - 1, - sensitivity 5 mV/d, - sweep 2 ns/d, **- digital memory,** - **marker measurements,** - **author. measured param. signal,**

- **interface KOP,** - user power. 300 VA, Digital

oscilloscope **C9-14 (100 MHz)** - weight 24 kg.

S9-14 provided the highest measurement accuracy signal parameters, in the frequency range up to 100 MHz.



Klepcha Vladimir Vasilievich

High metrological performance in this device was achieved through the use of original technical solutions and an integrated stroboscopic transducer microcircuit developed using gallium arsenide technology, developed jointly with MIET, (Moscow). Its production was carried out by input the microelectronics division of MNIPI for a number of years.

Chief development designer – Klepcha V.V. The S9-14 oscilloscope was produced from 1986 to 1991. The production volume was 713 units, or 143 units/month.

Thus, this instrument could only examine repeating signals. At the same time, he had the opportunity to isolate a signal from random noise by averaging and accumulating information about the signal.

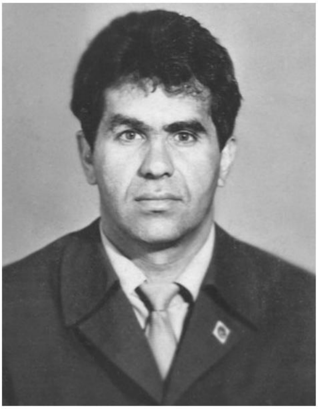
In **1981 ,** the development of a family of 2-channel LF of oscilloscopes **S1-117,** S1-117/1, S1-117/2, to the 10-15 MHz band, which replaced the oscilloscope S1-76.

2-channel low-frequency oscilloscope **S1-117/1** (15 MHz)

Parameters of 2 channels. LF oscilloscope **C1-117:**

- number of channels - 2,
- CRT screen 60x80 mm,
- **10 MHz band,** with feelings. **1 mV/d,**
- band **0.1 MHz,** with feelings. **0.1 mV/d,**
- number of scans - 1,
- unfold. 50 ns/d,
- consumption power. 60 VA,
- weight 10 kg.

Oscilloscopes S1-117/1 and S1-117/2 differ from S1-117, with a bandwidth of 15 MHz (at 1 mV/d), instead of 10 MHz.
In addition, the S1-117/1 also has a digital, semi-automatic meter of amplitude-time parameters, and synchronization with TV signals.



This family was one of the most popular due to its built-in, semi-automatic measurements, high sensitivity, low weight and small dimensions.

These oscilloscopes were produced from 1983 to 1996. The production volume was 21,740 units, or 1,972 units/year, and according to this indicator they took 3rd place among MNIPI oscilloscopes in terms of serial production.

The main designer of this family of oscilloscopes was V.S. Pahuta.

Valery Stanislavovich Pahuta

In **1982 ,** based on the design of the S1-117 oscilloscope, a replacement unit for the 2-channel **Ya4S-109 oscilloscope was developed,** for a 35 MHz band, (1 mV/d), without a unit

nutrition.

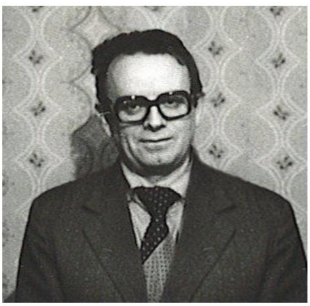
The role of the power supply in

In this case, the basic blocks BB1/4 were performed from the K2-50 measuring system, which included this replaceable block.

3.3. Oscilloscope MNIPI 1982-1992.

From 1982 to 1994, oscillographic department of MNIPI was headed by Nikolai Anatolyevich Kukharenko, who since 1995 became the general director of OJSC MNIPI.

Nikolay Anatolyevich Kuharenko



In **1984 ,** the development of the first oscilloscope for MNIPI with a built-in multimeter, **C1-114,** for a **50 MHz band,** and its version without a multimeter, S1-114/1, was completed . The main designer of this device was Nemirovsky V.M., who had previously developed the large-scale oscilloscope S1-65A at 50 MHz.

Nemirovsky V.M.

This midrange, 2-channel device, was produced in large quantities from 1986 to 1993. The total volume of its production was 50,337 units, or 7,191 units/year, and according to this indicator it took 2nd place , among MNIPI oscilloscopes in terms of serial number, after S1-65A.

It entered the top five most large-scale oscilloscopes in the USSR (not counting the Lvov ones, since there is no data on their serial production)
after service S1-94 and S1-112A (12 thousand pieces/year), S1-65A (11 thousand pieces/year), and S1-112 (8-9 thousand pieces/year). Average annual release C1-114 and S1-114/1 amounted to over 7 thousand units/year.

Parameter 2-x blood. SC oscilloscope **S1-114:**

- number of channels **- 2,**
- CRT screen 96x120 mm,
- **50 MHz band,** with feelings. 5 mV/d,
- number of scans - 1,
- sweep 5 ns/d,
- **multimeter U/I/R,**
- **logic probe,**
- consumption power. 90 VA,
- weight 14 kg.

2-channel oscilloscope S1-114 with a multimeter at 50 MHz.

In 1985, the ShP, 2-channel oscilloscope was developed
S1-120 for a 100 MHz band, with main and delayed sweep. This was the 2nd analog oscilloscope of MNIPI for such a band, after S1-85, developed in 1980.

Parameter 2-x blood. SP Oscilloscope **C1-120:**

- number of channels **- 2,**
- CRT screen 80x100 mm,
- **100 MHz band,** with feelings. 5 mV/d,
- number of sweeps **- 2,**
- sweep 2 ns/d,
- **digital delay (DZ),**
- consumption power. 120 VA,
- **weight 13 kg.**

2-channel oscilloscope C1-120 at 100 MHz with MP and CZ.

This device was distinguished by the fact that it was the first to use control of the device, measurements of signals implemented microprocessor-based time digital with increased accuracy due to digital delay, as well as automated channel balancing and self-diagnosis

main nodes.

Evgeniy Sergeevich Mironov

The S1-120 also had a low weight for a 2-channel 100 MHz oscilloscope - 13 kg, instead of 18 kg for S1-85 (MNIPI, 1980), or instead of 16 kg for S1-92 (VNIIRIP, 1977). True, the last two devices had a large CRT screen -

100x120 mm, and, accordingly, a heavier CRT.

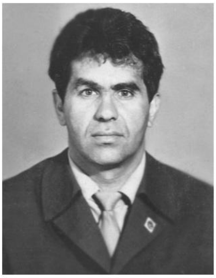
For the development of the device Ch. designer Mironov E.S. received the main prize of the USSR Exhibition of Economic Achievements - the Moskvich car. The oscilloscope was produced from 1986 to 1993. A total of 3009 devices were produced, or 430 units/month.

In 1986, the development of the 1st service 2-channel small-sized oscilloscope MNIPI - S1-125, for a 10 MHz band, for the Bryansk Radio Plant, for the first time for MNIPI with a weight of less than 5 kg. In addition to its small dimensions and weight, it was distinguished by a convenient, beautiful and ergonomic front panel.

Parameters of the service oscilloscope **S1-125:**

- number of channels **- 2,**
- CRT screen 60x80 mm,
- **10 MHz band,** with feelings. **1 mV/d,**
- number of scans - 1,
- sweep 20 ns/d,
- consumption power. 35 VA,
- **weight 4.9 kg.**

Service, small-sized oscilloscope S1-125 at 10 MHz, 4.9 kg.



Valery Stanislavovich Pahuta

The small-sized, lightweight and convenient service oscilloscope S1-125 has become - one popular from the most "long-livers" of the Bryansk plant, it was produced there from 1988 to 2013. The chief designer of this device

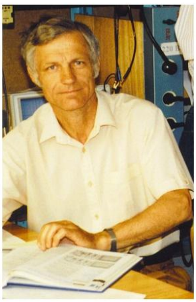
was V.S. Pahuta, who had previously developed the S1-117 family of low-frequency oscilloscopes, also for a 10 MHz band.

In **1986 ,** one of the best PN oscilloscopes was developed at MNIPI and in the USSR for a **100 MHz band.** It was the **S1-126 oscilloscope.** It was the first monoblock device with four vertical deflection channels and 2 scans.

Parameters of 4-channel SB oscilloscope **S1-126:**

- number of channels – 2+2,
- CRT screen 80x100 mm,
- **100 MHz band,** with
feelings. 5 mV-5 V/d, 2 channels,
and heard 0.1-0.5 V/d, +2 channels,
- number of sweeps **- 2,**
- sweep 2 ns/d,
- consumption power. 100 VA,
- weight 8.5 kg.

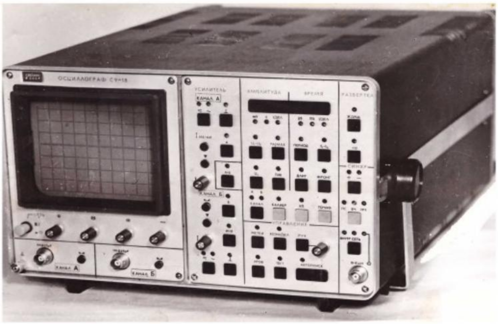
1st monoblock 4-channel oscilloscope in the USSR - S1-126



Leonid Ivanovich Mataras

Main the designer of the this outstanding device was L.I. Mataras. This was his 2nd 100 MHz oscilloscope, after S1-85 (1980). This device was produced from 1989 to 1994. The production volume was 1428 units, or 286 units/month. At the same time, it had a record weight for a 100 MHz oscilloscope at that time **- 8.5 kg.** At the time of development in 1986, it was among the world's best designs.

In **1986 ,** the midrange, two-channel
automated analog oscilloscope **S9-18 for a 50 MHz band, which became the first analog oscilloscope in the USSR, with full automation of control, automatic signal search and automatic measurements of signal parameters,** for such a band.



Oscilloscope C9-18

MF oscilloscope
S9-18 parameters:
- **50 MHz** band ,
- CRT screen 80x100 mm,
- number of channels - 2,
- feelings. 10 mV – 100 V,
- dlit. sign. 40 ns-50 ms,
- **author signal search,**
- **author change amplitudes,**
- **author change period/duration,**
- consumption power. 110 VA,
- **weight 14 kg, IF-KOP.**

In Lviv, 2-channel automated oscilloscope C1-
98 per 50 MHz band, was developed in 1979, albeit with more weight than C9-18.

This device became a continuation and development of the ideology embedded in the S9-7 device (1982), an analog automated oscilloscope, the 1st MNIPI device with automatic

signal scaling and auto. measurements of 3 of its parameters
per 10 MHz band (amplitude, period and duration).

Kuharenko N.A.

The chief designer of this oscilloscope was the head of the oscillographic department of MNIPI - Kukharenko N.A. The device was produced from 1988 to 1993. The

production volume was 3961 units, or 792 units/month. According to this parameter, it entered the top four most large-scale oscilloscopes of MNIPI.

S9-18 is designed to study periodic electrical signals by visual observation and automatic measurement of their main amplitude and time parameters, with the measurement results presented in digital form on an LED display.

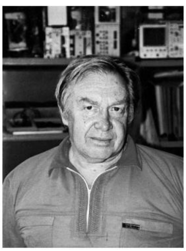
It provides high accuracy measurements in the frequency band up to 50 MHz when operating in harsh operating conditions.

Compared to S1-78 and S9-7, the S9-18 oscilloscope had full automatic control of the device (S1-78 and S9-7 only had signal scaling). This was done through the use of microprocessor control of the entire device, including remote control, via IF-KOP. At the same time, its weight was reduced to 14 kg, versus 18 kg for the S1-78. That's why he was so popular.

In **1987 ,** the SCH, small-sized, almost serviceable (weighing 5.5 kg), oscilloscope **S1-127** for a **50 MHz band was developed,** for work in harsh operating conditions. (from -30 to +50 degrees Celsius).

Oscillograph S1-127

Parameters of the service oscilloscope **S1-125:**
- number of channels - 2,
- CRT screen 60x80 mm,
- **50 MHz band,** with feelings. **1 mV/d,**
- number of scans - 1,
- sweep 5 ns/d,
- consumption power. 60 VA,
- **weight 5.5 kg.**



Mochalin Viktor Borisovich

S1-127 was produced from 1988 to 2013. The production volume was 7711 units, or 308 units/year.

The main designer of this device was V.B. Mochalin, who had previously developed a low-frequency 2-channel oscilloscope S1-82 for a 10 MHz band in 1978.

This device was developed on the basis of a single design with oscilloscope MNIPI - S1-125, 1986.

A version C1-127/1 was also produced for normal conditions (from +5 up to +40 degrees. Celsius).

The device was one of the smallest and lightest (5.5 kg) devices of this type with a 50 MHz band, which weighed in the range of 14-18 kg (like S1-64A, S1-98, S1-114, S9-18).

In **1988 ,** the 2nd was developed at MNIPI (after S9-14), ShP 2-x channel digital oscilloscope **S9-28,** 100 MHz bandwidth. (Before this, its previous similar version was developed -
S9-19, which was not subsequently mass-produced).

It was a purely digital, revolutionary, next-generation oscilloscope built for the first time on new digital and microprocessor technology principles, including a menu-based front panel.

For the first time in MNIPI, a mode was implemented in it displaying signals from digital memory based on television CRT - kinescope.

For the first time, all smooth, step-by-step adjustments are available in this device. carried out from a single contactless rotary knob control via a microprocessor system and a multi-channel DAC.

This device carried out analog-to-digital conversion and storage of 2 periodic signals into digital memory, with constant updating, in a frequency band from 0 to 100 MHz, or 2 single signals with a maximum sampling frequency of up to 20 MHz.

ShP digital oscilloscope S9-28 at 100 MHz - weight 12 kg.

Parameters of the digital oscilloscope **S9-28:**
- **100 MHz** band ,
- CRT screen 80x100 mm,
- number of channels - 2,
- sensitivity 5 mV/d,

- discretizer. 20 MGc,
- digital memory 512x8 bits per channel,
- **marker measurements,**
- **author measured parameter.,**
- **auto signal search,**
- **interface KOP,**
- consumption power. 210 VA,

The oscilloscope's functionality, implemented using a built-in microprocessor controller, includes:

- automatic signal search, automatic installation of image dimensions vertically and horizontally for observation of 1 or 2 periodic signals, - automatic calibration of device channels, - cyclic measurements of amplitude and time parameters

signals,

- marker signal measurements,
- a wide range of processing functions registered in memory signal.
- control of the operation of the device remotely in the AIS via the KOP interface,
- interactive mode of operation with the issuance of messages about the order operation and incorrect actions of the operator on the device screen,
- an additional set of functions available through the “Menu”.

Chief designer of the development Kolosov K.A. This oscilloscope was produced from 1990 to 1994. The production volume was 656 units, or 164 units/month. Another thing is that the start of its serial production occurred during a difficult crisis period, when the economy and the entire electronics industry were in decline. Maybe that's why it wasn't released for so long.

One of the first devices with an LCD display was the service digital oscilloscope **S8-19, 10 MHz band,** created in **1989** at MNIPI.

Due to the light weight of the LCD display and its small size, the dimensions of the oscilloscope have decreased compared to a conventional oscilloscope by 6-10 times, and the weight of this oscilloscope - 2.1 kg, has set a new record among digital and service

oscilloscopes and became the lightest oscilloscope in the USSR, overtaking the lightest oscilloscope in the USSR - S1-101, (LNIRTI, 1979), weighing 2.3 kg at half 5 MHz.

The relatively wide frequency range of the oscilloscope (10 MHz) is achieved by combining the traditional mode of operation of a digital oscilloscope in real time

(ADC - 6 bits/1 MHz) with an operating mode in a transformed time scale, which is used in stroboscopic oscilloscopes. High accuracy of measurement of signal amplitude parameters when used in a vertical

The deviation of the oscilloscope of the 6-bit ADC was achieved thanks to an original method of calibrating the oscilloscope, based on combining the boundaries between the corresponding quantization intervals with the levels of the calibration signal of the “square” type.

Oscilloscope C8-19

Parameters of the **S8-19 service oscilloscope:**

- number of channels - 1,
- screen 40x100 mm,
- resolution 62x160 t.,
- **10 MHz band,** with feelings. 10 mV/d,
- ADC, 1 MHz/6 bits,
- number of scans - 1,
- sweep 50 ns/d,
- consumption power. 23 W,
- **weight 2.1 kg.**

Valentin Mykhailovych Synkevich

To facilitate operation, the oscilloscope has implemented a mode that “prompts the operator” about incorrectly setting the sweep factor (the so-called “Aliaising Effect,” an envelope effect typical of digital oscilloscopes).

or

Being the first in its class, this device is still used by repairmen and developers. The chief designer of this development is Sinkevich V.M.

Later, a two-channel version of this device, S8-19/1, was also produced, which, in addition to the 2nd channel, had a single-signal sampling frequency increased to 2.5 MHz.

In **1990 ,** for particularly harsh operating conditions, especially in terms of mechanical influences, the oscillography department MNIPI developed two models of oscilloscopes.

Oscilloscope – multimeter **RS1-01** with a bandwidth **of 25 MHz** and oscilloscope **RS1-02** with a bandwidth of **100 MHz.** These devices are designed to operate at ambient temperatures from minus 30°C to plus 50°C and ensure operability after immersion in water and throwing onto a concrete floor from a height of 1 m. The main designers of these developments were - Poleshchuk V.A. and Matyushonok L.V.

Oscillograph RS1-02

Parameters 2 channel

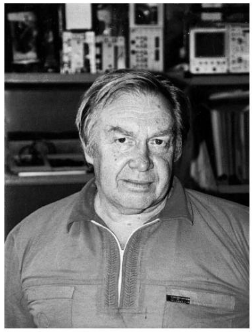
Oscilloscope **RS1-02:**
- number of channels – 2,
- CRT screen 60x80 mm,
- **100 MHz band,** with feelings. **10** mV-5 V/d,
- number of scans - 1,
- sweep 5 ns/d,
- consumption power. 90 VA,
- **weight 12 kg.**


Leonid Vladimirovich Matyushonok

RS1-01 oscilloscope parameters :
- number of channels – 1,
- CRT screen 60x80 mm,
- **25 MHz band,** with feelings. **2** mV-10 V/d, - number of sweeps - 1,
- sweep 0.1 ÿs/d,
- **multimeter U, I, R,**
- consumption power. 70 VA,
- **weight 9 kg.**

In **1991 ,** the development of the midrange, 2-channel oscilloscope **S1-142,** with a bandwidth of **50 MHz,** a sensitivity of 1 mV/d, and a sweep of 5 ns/d. It was the first to use an imported CRT (Holland). Power consumption 55 VA, weight 6.5 kg. Chief designer of the development - Mochalin V.B. The oscilloscope was produced from 1992 to 2011 by the Kalibr plant. The production volume was 190 pieces, or 10 pieces/year.

Oscillograph S1-142



Mochalin Viktor Borisovich

In Minsk, in the period 1990-1992, a family of analog-digital oscilloscopes was also developed - S1-128, S1-133, S1-133/1, S1-133/2 and S8-23. These oscilloscopes had similar front panel, dimensions, weight and parameters.

In **1990 ,** a midrange, two-channel, analog-digital oscilloscope **S1-128** at **25 MHz was developed,** with an automatic control mode for the entire device and automatic signal scaling **- "Autosearch".**

MF, A/D parameters of
the **S1-128 oscilloscope:**
- number of channels - 2,
- CRT screen 60x80 mm,
- **25 MHz band,** with
feelings. 2 mV-10 V/d,
- number of scans - 1,
- sweep 10 ns/d,
- auto signal search,
- sampling 200 kHz,
- digital memory 512x8 bits,

- marker measurements, -
consumption. power 65 VA,
- weight 6 kg.

2-channel, midrange, analog-digital oscilloscope S1-128 (25 MHz).

In **1992 ,** a family of 3 midrange oscilloscopes S1-133/3.5kg, **S1-133/1/3.7kg,** and **S1-133/2/4.7kg was developed,** also with a bandwidth **of 25 MHz,** 1 mV/d , 20ns/d. All devices were 2-channel, with less
screen - 40x80 mm, so they were a little lighter. **S1-133/1** had
A 1 kHz ADC and digital memory, and **S1-133** had a multimeter and a TV signal generator, but they were not implemented.

In **1992 ,** analog-to-digital, 2-channel, midrange oscilloscopes **S8-23 and S8-23/1** were developed for a **20 MHz** band and weighing **6.5 kg.** S8-23/1 differs from S8-23 only in the absence of a COP interface.

MF, A/D parameters of the **S8-23 oscilloscope:**
- number of channels - 2,
- CRT screen 60x80 mm,
- **20 MHz band,** with feelings. 1 mV-10 V/d,
- number of scans - 1,
- sweep 10 ns/d,
- **auto signal search,**
- **sampling 1 MHz,**
- **digital memory 1024x8 bit/channel,**
- **marker measurements,** - consumption. power 65 VA,
- **weight 7 kg, (ÿ8-23/1, 6.5 kg)**

2-channel, midrange, analog-digital oscilloscope S1-23 (20 MHz).

3.4. Oscilloscopes in independent Belarus. 1992-2016

In the post-perestroika period, in independent Belarus since 1992 to 2019, when many enterprises in Belarus and Russia reduced their capacity and even closed, and, accordingly, The demand for MNIPI's developments fell sharply, and a decision was made to organize its own serial production of devices at the institute. Currently, MNIPI produces more than seventy

types of instruments, including 9 oscilloscopes. The organization of serial production was headed by the Deputy General

production director Vladimir Alekseevich Gomolko, who previously worked at the instrument-building plant named after. V.I. Lenin (Belvar) as deputy chief designer.

In **1996 ,** a digital service was developed small-sized oscilloscope **S8-28, with a 20 MHz band, weighing 3 kg, with an LCD indicator,** which was a development of the concept of the S8-19 oscilloscope from 1989.

What changed? Much. The bandwidth for repeating signals has been expanded by 2 times from 10 to 20 MHz, and the sampling frequency of single signals has been increased from 1 to 2.5 MHz. The functionality has been seriously expanded - a new additional LCD indicator of the states of the controls has been introduced. The device is controlled by a microcontroller from a keyboard without fixing. Previously, these were mechanical controls.

There is storage of up to 8 signals (previously only 1). Automatic measurements have been introduced - frequency, period, pulse duration, signal swing. There is an indication of the “Aliaising” effect of an incorrect, too low, setting of the sampling frequency (sweep). There is a mode for recording “Glitches” of short noise pulses with a duration of 25 ns or more that occur between sampling moments.

S8-28 was mass-produced.

Parameters of the **S8-28 service oscilloscope:**
- **20 MHz band,** with feelings. 10 mV/d,
- number of channels - 1,
- ŽKI 40x100 mm,
- allowed. 62x160 t.,
- ADC, 2.5 MHz/6 bits,
- number of scans - 1,
- sweep 10 ns/d,
- **discrete. 2.5 MHz,**
- **author measured param.,**
- consumption power. 23 W,
- **weight 3 kg.**

Digital service oscilloscope **S8-28,** 20 **MHz, weight 3 kg.**

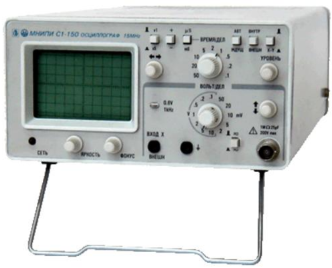
One of the first oscilloscopes independently developed at MNIPI after the collapse of the USSR and the 6th GU MPSS (later 1992) was the **S1-148** 150 **MHz** ShP oscilloscope developed in **1996 .** It was an analog 2-channel oscilloscope, with a sensitivity of 1 mV-5 V/d and a weight of 8 kg. Due to the difficult time period in which it was born, it was not brought into mass production.

In **1997,** a midrange, 2-channel analog-to-digital oscilloscope **S1-149 was developed,** with a bandwidth of **50 MHz,**
unified on the front panel with the S1-128 oscilloscope, developed in 1990 at 25 MHz.

MF, **A/D** parameters oscilloscope **S1-149:**
- number of channels - 2,
- CRT screen 60x80 mm,
- **50 MHz band,** with feelings. 2 mV-10 V/d,
- number of scans - 1,
- sweep 5 ns/d,
- **auto signal search,**
- **sampling 200 kHz,**
- **digital memory 512x8 bits,**
- **marker measurements,** - consumption. power 70 VA,
- **weight 6.5 kg, character generator.**

2-channel, midrange, analog-digital oscilloscope **S1-149 (50 MHz).**

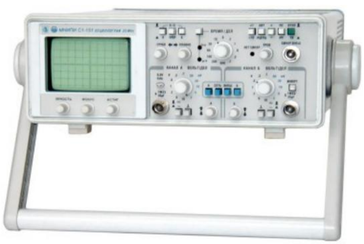
The first oscilloscopes developed in **1997** especially for the new serial production of JSC MNIPI, service, small-sized oscilloscopes appeared - single-channel **C1-150,** at **15 MHz,** weighing **2.8 kg,** and two-channel **S1-151** at **35 MHz,** weighing **3.7 kg.**



Parameters of the **S1-150 service oscilloscope:**

- number of channels - 1,
- CRT screen 40x60 mm,
- **15 MHz band,** with feelings. 2 mV/d,
- number of scans - 1,
- sweep 10 ns/d,
- consumption power. 25 VA,
- **weight 2.8 kg.**

Service, small-sized oscilloscope **S1-150** (15 MHz, 1 channel)



Parameters of the service oscilloscope **S1-151:**

- **number of channels - 2,**
- CRT screen 40x60 mm,
- **35 MHz band,** with feelings. 2 mV/d,
- number of scans - 1,
- sweep 10 ns/d,
- consumption power. 40 VA,
- **weight 3.7 kg.**

Service, small-sized oscilloscope **S1-151** (35 MHz, 2 channels)

Vadim Ivanovich Ostapuk

These service devices were small in size, weight and low cost. They were produced for 10 years, from 2007 to 2018. Their total production volume was 2970 units, 297 units per year. The chief designer of these devices was V.I. Ostapuk, who previously developed the first MNIPI S1-76 oscilloscope at 1 MHz, and the automated S9-7 at 10 MHz.

In **2000-2003 ,** OJSC MNIPI developed a family of 3, purely digital, progressive, 2-channel
oscilloscopes **S8-33, S8-36, S8-38** for a band of **20-50-100 MHz,** with sampling frequencies of 20 or 100 MHz.

These devices are equipped with a microcontroller, a progressive front panel, based on a “menu”, automatic signal search and automatic measurements of its parameters. They use an indicator based on a TV-CRT 16LK6B (kinescope), as well as a signal and text display device based on a standard VGA type computer video card (display controller). The weight of the devices was in the range of 8-9 kg.

The dimensions of these oscilloscopes were significantly reduced and the functionality was expanded. They
They are made in a single design and are lightweight. and wide functionality.

The **S8-33** oscilloscope was the first to release in **2000** at **20 MHz.**

Parameters of the digital oscilloscope **S8-33:**
- number of channels - 2,
- TV screen 80x100 mm,
- **20 MHz band,** with feelings. 5 mV-2 V/d,
- number of scans - 1,
- **eq. frequent disk. 5 GHz,**
- **sampling 20 MHz,**
- **numbers memorial 32Kx8 bits,**
- **auto signal search,**
- **author measured parameter.,**
- **marker measurements,** - consumption. power 160 VA,
- **weight 8 kg.**

2-channel, midrange, digital oscilloscope **S8-33** (20 MHz, 20 mV/s).

To collect data on repeating signals at fast sweeps over the entire bandwidth, a stroboscopic method is used, the resolution of which is characterized by the equivalent sampling rate of the repeating signal.

Wide functionality includes: auto-search for periodic signals in the range from 100 Hz to 10-40-90 MHz, depending on the model, memory storage of up to 4 signals, display simultaneously up to 4 waveforms (2 signals in real time and 2 signals recorded in digital memory).

The device has a pre-launch (viewing events up to the moment of launch) and post-launch (digital launch delay), an averaging mode and the separation of signals from noise,

Digital oscilloscopes **S8-36** and **S8-38** have exactly the same appearance, front panel and functionality as the S8-33. Only the following parameters differ:

	S8-33	**S8-36**	**S8-38**
Bandwidth, MHz, Sampling	20	50	100
frequency, MHz, Equivalent. sampling	20	20	100
frequency GHz, Power consumption, VA,		10	10
Weight, kg,	5	160	180
	160 8	8.5	8,5

Yuri Dmitrievich Shutov

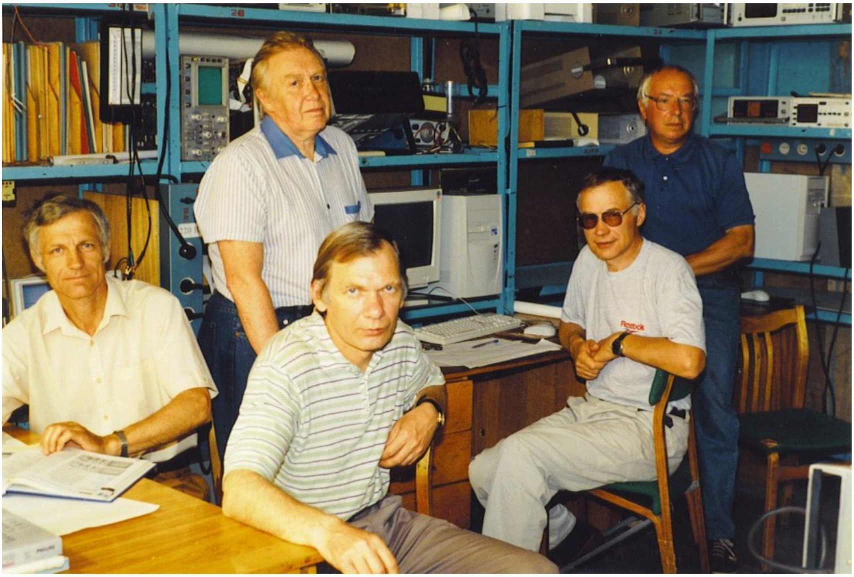
The devices also have a mode for recording short-term “glitches” lasting up to 50 ns, and also have a selection mode a given line from a standard TV signal. Chief designer of the development Shutov Yu.D. Oscilloscopes were produced from 2000 to 2014, previously by the Kalibr plant, and currently it is produced by MNIPI OJSC. The production volume of devices at MNIPI was set at 321 units.

In **2003 ,** a 2-channel ShP oscilloscope **S1-** was developed **164** per **150 MHz** band with MP control (PIC controller).

Parameter 2-x blood. SP Oscilloscope **C1-164:**

- number of channels - 2,
- CRT screen 80x100 mm,
- **150 MHz band,** with feelings. 5 mV-5 V/d,
- number of scans - 1,
- sweep 2 ns/d,
- **marker measurements,**
- **component tester,**
- consumption power. 90 VA,
- **weight 8 kg.**

2-channel ShP oscilloscope **S1-164** for **150 MHz** band with characteristic curve.



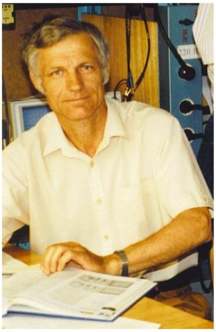
Oscilloscope development team, 2000s.

In **2003 ,** a family of 2-channel, midrange, (almost service - 5.5 kg in weight), oscilloscopes **S1-166 at 50 MHz,** and its version **S1-166/1** at **25 MHz, was developed.**

Parameter 2-x blood. SC oscilloscopes **C1-166 and C1-166/1:**

- number of channels
- 2, - CRT screen 60x80 mm, - **50 MHz band for S1-166,**
- 25 MHz band **for S1-166/1,**
- sensitive. 2 mV-5 V/d, - number of sweeps - 1, - sweep 10 ns/d, - consumption. power 60 VA, **- weight 5.5 kg.**

2-channel, SC, oscilloscope **C1-166 at 50 MHz,** and **166/1** at **25 MHz.**



Leonid Ivanovich Mataras

Oscilloscopes **S1-166 and S1-166/1** are designed for repair and maintenance of various equipment.

They have low cost and dimensions and were produced from 2003 to 2007. The main designer of the

development was L.I. Mataras, these

In **2004 ,** based on the design, structure, technology and ideology of the S8-33/36/38 family of oscilloscopes (see above in 2000), a midrange, 1-channel television (TV) was developed
digital oscilloscope **S8-41** for a **20 MHz band.**

S8-41 allows you to synchronize with a signal of a given television line, by vertical damping pulses, by field sync pulses, by horizontal sync pulses, by sync pulses of even and odd lines, to isolate the components of television signals using filters (0-

2) MHz; (3-5) MHz; 4.43 MHz. It was produced from 2004 to 2010.

Parameters of the digital oscilloscope **S8-41:**
- number of channels - 1,
- TV screen 80x100 mm,
- **20 MHz band,** with
feelings. 10 mV-1 V/d,
- number of scans - 1,
- **eq. frequent disk. 5 GHz,**
- sampling 50 MHz,
- numbers memorial 4x8 bits,
- marker measurements, -
consumption. power 120 VA,
- weight 6.5 kg.

1 channel, midrange, digital TV oscilloscope **S8-41** (20 MHz, 50 MV/s).

In **2005 ,** a family of wideband (WB), 2-channel oscilloscopes **S1-157, S1-157/1, S1-157/2,**

one of the most popular modern families of devices with frequency band up to **100 MHz,** with various additional functions, depending on delivery options (/1, /2).

Based on the basic model, oscilloscopes were produced: - with a semiconductor tester, (curve graph) S1-157, - with a curve graph and digital memory S1-157/1, Fd = 50 MHz, - with a curve graph and multimeter

S1-157/2.

2 channel parameters ShP oscilloscope **S1-157:** - number of channels - 2, - CRT screen 80x100 mm, - **100 MHz bandwidth,** with sensitivity. 5 mV-5 V/d, - number of scans - 1, - scan 2 ns/d, **- component tester (characteristic recorder),** - consumption. power 80 VA, **- weight 8 kg.**

ShP, 2 channels. oscilloscope **S1-157** at **100 MHz, with curve tracer**

Parameters of SB, **A/D** oscilloscope **S1-157/1:** - number of channels - 2, - CRT screen 80x100 mm, - bandwidth **100 MHz,** with sensitivity. 5 mV-5 V/d, - number of sweeps - 1, - sweep 2 ns/d, **- sampling 50 MHz, - digital memory 512x8 bits, characterization, - marker measurements,** - consumption. power 80 VA, **- weight 8 kg,** character generator.

2 channel oscilloscope **S1-157/1 at 100 MHz, digital. memory and character.**

Family of oscilloscopes C1-157, C1-157/1 and S1-157/2 was produced from 2005 to 2010.

The chief designer of this device was L.V. Matyushonok. The production volume was 1125 pieces.

In **2005 ,** a small-sized service digital storage oscilloscope **S8-39** was developed designed for studying periodic signals in the frequency range **0-50 MHz** and single-shot electrical signals by recording them in digital memory with a sampling frequency of up to **50 MHz.**

It allows you to observe the shape of signals on a liquid crystal display **(LCD),** on as well as produce automatic and marker measurements of amplitude and time parameters of the signal under study. The device has non-volatile memory for storing set operating modes, and calibration under processor control. The chief designer of the device is V.N. Cheley. The production volume was 125 pieces, **the price was 1150 euros.**

Parameters of the **S8-39 service oscilloscope:**

- **50 MHz band,** with feelings. 5 mV-2V/d,
- number of channels - 2,
- LCD 320x240 pixels,
- number of scans - 1,
- sweep 10 ns/d,
- **eq.frequency disk. 5 GHz,**
- **discrete. 50 MHz,**
- **author measured param.,**
- **marker measurements,**
- consumption power. 15 W,
- **weight 3 kg.**

2-k., digital service oscilloscope **S8-39, (50 MHz,** weight **3 kg)**

In **2006 ,** a family of midrange, 2-channel oscilloscopes **S1-167, S1-167/1 and S1-167/2** for a **25 MHz band.**

This family in its composition repeats the ideology of building a successful, more expensive family of C1- devices
157, S1-157/1 and S1-157/2 at 100 MHz (see above, in 2005), only in a more simplified version - up to 25 MHz:

- with a semiconductor tester, (characteristic recorder) **S1-167,**
- with digital memory **S1-167/1,** sampling up to 100 MHz,
- with multimeter **S1-167/2.**

Parameter 2-x blood. SC oscilloscope **S1-167:**

- number of channels - 2,
- CRT screen 80x100 mm,
- **25 MHz band,** with feelings. **2 mV-10 V/d,**
- number of scans - 1,
- sweep 10 ns/d,
- **component tester (characteristic graph),**
- consumption power. 80 VA,
- **weight 8 kg.**
- **price 1,445 euros.**

MF, 2-channel oscilloscope **S1-167** at **25 MHz** with characteristic curve.

The analog-to-digital oscilloscope S1-167/1 differs from the S1-167 in the absence of a curve tracer and the presence instead of a digital memory block in an analog device. It can record single and periodic signals over a 10 MHz bandwidth at 100 megasamples per second (100 MV/s or 100 MHz sampling rate). There is no strobe mode for fast scans. Memory capacity 64 kb. The device also has marker measurements and a character generator. Price 1558 euros.

All devices in the family have a standardized front panel and appearance.

The chief designer of the developments of the S1-167 family was Mataras L.I.,

In **2007 ,** a purely digital 2-channel, midrange oscilloscope **S8-43 was developed,** with a bandwidth of **50 MHz,** with a sampling rate of **100 MHz,** and equivalent sampling of **10 GHz** (in strobe mode).

In this case, the recording length of each channel could be selected from the range **1-4-16-64 kb,** while changing the resolution when measuring time.

The device has marker measurements and separate adjusting the brightness of the signal and the brightness of markers and text.

MF parameters of the **S8-43 digital oscilloscope:**
- number of channels - 2,
- CRT screen 80x100 mm,
- **50 MHz band,** with feelings. **2 mV-10 V/d,**
- number of scans - 1,
- sweep 10 ns/d,
- **sampling 100 MHz,**
- **equivalent sampling frequency 10 GHz,**
- **numbers memory 64Kx8 bit,**
- **marker measurements,** - consumption. power 160 VA,
- **weight 7 kg,**
- **price 1662 euros.**

Digital 2-channel, midrange oscilloscope **S8-43,** 50 **MHz**

In **2008 ,** a family of midrange, 2-channel oscilloscopes **S1-170, S1-170/1 and S1-170/2** for a **50 MHz band.**

This family in its composition repeats the ideology of building a successful, more expensive oscilloscope family S1-157, at 100 MHz (see above, in 2005), as well as a simpler family S1-167 at 25 MHz (see above in 2006), only in the version - up to 50 MHz:

- with semiconductor tester, (characteristic recorder) **S1-170,**
- with digital memory **S1-170/1,** sampling up to **100 MHz,**
- with multimeter **S1-170/2.**

The analog-digital oscilloscope S1-170/1 differs from the S1-170 in the absence of a curve tracer and the presence instead of a digital memory unit in an analog device that allows you to record single and periodic signals in a 10 MHz band at a speed of 100 mega samples per second (100 MV/ with or with a sampling rate of 100 MHz). There is no strobe mode. The device also has marker measurements and a character generator.

All devices in the family have a standardized front panel and appearance.

Parameter 2-x blood. SP
Oscilloscope **C1-170:**

- number of channels - 2,
- CRT screen 80x100 mm,
- **50 MHz band,** with
  feelings. 2 mV-10 V/d,
- number of scans - 1,
- sweep 10 ns/d,
- component tester
(characteristic graph),
- consumption power. 80 VA,
- weight 7 kg.

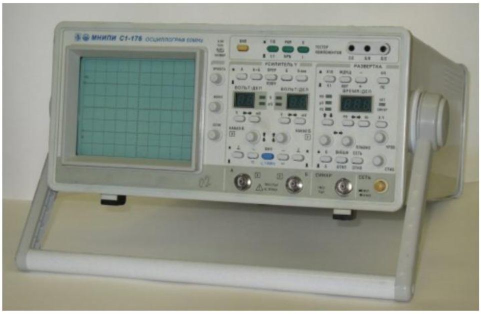
MF, 2-channel oscilloscope **S1-170** at **25 MHz** with characteristic curve.

Oscilloscopes of the **S1-170** family had low cost and dimensions; the chief designer of this development was L.V. Matyushonok. The total production volume of devices was 575 units.

In **2011 ,** the **C1-** family of oscilloscopes was developed
176 at 50 MHz and S1-176/1 at 25 MHz to replace discontinued oscilloscopes S1-65A, S1-114/1, S1-127. These devices are designed to operate in operating conditions with stringent mechanical requirements. Chief designer Matyushonok L.V.

This family differed from the S1-170 family at 50 MHz and S1-
167 at 25 MHz with the absence of a character generator and indication of deviation and sweep coefficients on 7-segment LED indicators located at the corresponding switches.

Price 3289 and 2373 euros respectively.
Both devices have a component tester - a curve tracer.



Oscillograph S1-176

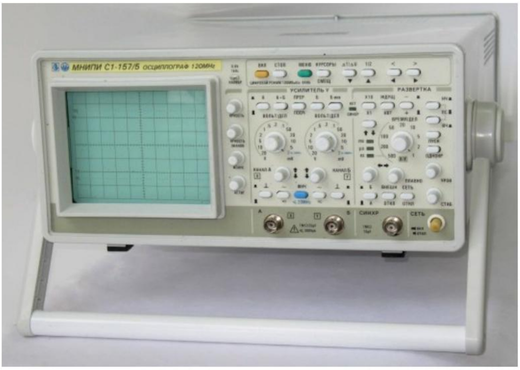
Parameter 2-x blood. SC oscilloscopes **C1-176 and C1-176/1:**
- number of channels - 2,
- CRT screen 80x100 mm,
- **50 MHz band for S1-176,**
- **25 MHz band for S1-176/1,**
- sensitive 2 mV-20 V/d,
- number of scans - 1,
- sweep 50 ns/d,
- **characterograph,**
- consumption power. 90 VA,
- **weight 6.8 kg.**

In **2013 ,** the S1-157/1/2 family of oscilloscopes was upgraded to a **100 MHz band.** In the modernized family of models **S1-157/4/5/6,** the band was expanded to **120 MHz,** and oscilloscopes were produced on its basis:
- with a semiconductor tester, (curvemeter) S1-157/4,

- with digital memory S1-157/5 (without curve graph), in in which the sampling frequency was increased from 50 to 100 MHz,
- with a curve graph and a multimeter S1-157/6. The devices were produced from 2013 to 2018. Total volume The production of modernized devices amounted to 1200 units.

Parameter 2-x blood. SP oscilloscope **C1-157/4:**
- number of channels - 2,
- CRT screen 80x100 mm,
- **120 MHz** band , with feelings. 2 mV-20 V/d,
- number of scans - 1,
- sweep 2 ns/d,
- **component tester (characterist),**
- consumption power. 90 VA,
- **weight 7.3 kg.**

ShP, 2 channels. oscilloscope **S1-157/4** at **120 MHz, with curve tracer**



Parameters ShP, **A/D** oscilloscope **S1-157/5:**
- number of channels - 2,
- CRT screen 80x100 mm,
- **120 MHz** band , with feelings. 2 mV-20 V/d,
- number of scans - 1,
- sweep 2 ns/d,
- discretizer. 100 MGc,
- digital memory from 512x8 bits, up to 64 kbits,
- marker measurements, - consumption. power 90 VA,
- weight 7.3 kg, character generator.

2 channel oscilloscope **S1-157/5 at 120 MHz,** with digital memory 100 MV/s

In **2014 ,** the service department was modernized, popular, promising, small-sized, lightweight **(5.5 - 6** kg), more broadband than other service ones **(50 MHz),** 2-channel, **S1-127 oscilloscope,** developed in **1987 .**

As a result, two versions of this device appeared: **C1-127/1** and **S1-127(ZhKI)** for the **50 MHz band.**

Version **S1-127/1** differed from S1-127 only in the front panel. Instead of rotary (up/down) switches with 3 positions modes, P2K type buttons appeared there.

Version **S1-127 (ZhKI)** was radically different **from S1-127 .** All that remains from the analog oscilloscope S1-127 are attenuators, part of the vertical deflection channel, synchronizer and block nutrition.

All other blocks have been replaced with digital ones. Heavy The glass CRT was replaced with a lightweight LCD indicator, which is why the high-voltage power supply for the CRT was no longer needed, and as a result, the weight of the device dropped by 2 kg from 6 kg to 4 kg. Digital processing units and a control unit were also introduced.

As a result, the weight of S1-127(ZhKI) decreased significantly, by 30%, which is quite important for service devices. But, unfortunately, that main additional functionality, such as auto-search for a signal and automatic measurements of its parameters, which usually accompanies the implementation of artificial intelligence in an oscilloscope, was not implemented in this case, although its implementation did not require large expenses.

As a result of such digitalization of S1-127 (LCD) in terms of parameters and the functionality did not differ from S1-127, and S1-127/1, except for weight.

Service **S1-127/1** at 50 MHz Digital S1-127(LCD) 50 MHz

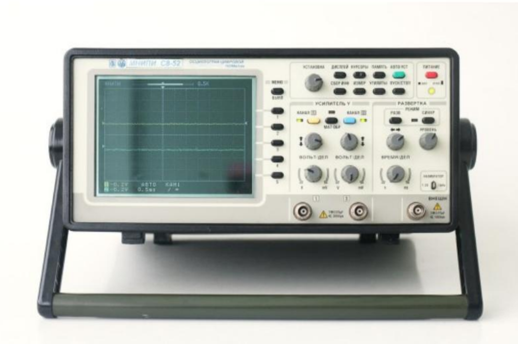
In **2016-2019 ,** MNIPI developed a new family of modern digital wideband oscilloscopes with improved parameters with a wider bandwidth and higher sampling frequency, as well as family of oscilloscopes and a weight **from 3.5 to 7 kg.** It was the **C8-52/53/54.**

These devices had:

- automatic search and scaling of signals,
- automatic measurement of up to 22 signal parameters,
- marker digital measurements,
- signal separation from noise and peak detection,
- automatic calibration of the device,
- calculation of the signal spectrum (FFT), - automatic storage in non-volatile memory up to 128 latest signal versions,
- display based on a color or b/w LCD TFT panel, - high metrological characteristics, - modern front panel based on “Menu” and rotary control knobs,
- LAN and USB interfaces,
- small dimensions, light weight, built-in battery,

The chief designer of the development was L.V. Matyushonok.

In **2016 ,** the development of broadband digital storage oscilloscopes **S8-52** at **120 MHz,** and **S8-52/1,** at **200 MHz** (1 Mÿ/50 ÿ input impedance) with upsampling to **250 MHz. Price 2362 euros.**



PN parameters of digital oscilloscopes **S8-52(/1):**
- number of channels - 2,
- color screen LCD 72x108 mm, or 240x320 pixels,
- band **120 (200) MHz,**
- feels. 2 mV-20 V/d,
- number of scans - 1,
- sweep 1 ns/d,
- auto signal search,
- sampling 250 MHz,
- equivalent sampling frequency 10 GHz,
- digital memory 16Kx8 bits,
- author and brand dimensions,
- use power. 90 VA,
- weight 7 kg, LAN, USB.

ShP digital oscilloscope **S8-52 (/1),** for a bandwidth of **120 (200) MHz** and **250 MV/s**

In **2016 ,** the development of wideband digital storage oscilloscopes **S8-53 and S8-53/1** at **100 MHz,** with a sampling frequency of up to **200 MHz, also ended. Price 1912 euros.**

These devices also have a display based on a black-and-white (for S8-53) and color (for S8-53/1) LCD TFT panel.

PN parameters of digital oscilloscopes **S8-53(/1):**
- number of channels - 2,
- LCD screen 72x108 mm, or 240x320 pixels,
- **100 MHz** band ,
- feels. 2 mV-20 V/d,
- number of scans - 1,
- sweep 2 ns/d,
- auto signal search,
- sampling 200 MHz,
- equivalent sampling frequency 10 GHz,
- digital memory 1Kx8 bits,
- author and brand dimensions,
- use power. 40 VA,
- weight 3.5 kg, LAN, USB.

ShP digital oscilloscope **S8-53 (/1),** with a bandwidth of **100 MHz** and **200 MV/s**

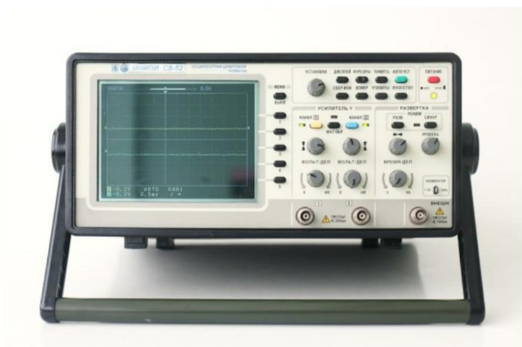
In **2016-2019 ,** the S1-127 (ZhKI) oscilloscope was modernized. As a result of this, its bandwidth was expanded, and two new versions of this long-lived device appeared in the MNIPI family of oscilloscopes - **S1-127(ZhKI)M,** and **S1-127E,** both with a **70 MHz** band .

In the S1-127(LCD) device, only the bandwidth is expanded,
and in the C1-127E the front panel was additionally redesigned.

Service **S1-127(ZhKI)M,** 70 MHz

Service **S1-127E** at 70 MHz

And finally, in **2019 ,** the development of the top-of-the-line digital broadband oscilloscope **S8-54** for OJSC MNIPI was completed with an input impedance a bandwidth of **200 MHz,** memorizing of 1 MOhm/50 Ohm, with an increased sampling frequency of up to **400 MHz. Price 2107 euros.**



Parameters of the S8-54 digital oscilloscope :
- number of channels - 2,
- LCD screen 72x108 mm,
or 240x320 pixels,
- **200 MHz** band ,
- feels. 2 mV-20 V/d,
- number of scans - 1,
- sweep 1 ns/d,
- auto signal search,
- sampling 400 MHz,
- equivalent sampling frequency 20 GHz,
- digital memory 32Kx8 bits,
- author and brand dimensions,
- use power. 40 VA,
- weight 3.8 kg, LAN, USB.

ShP digital oscilloscope **S8-54,** for a bandwidth of **200 MHz** and **400 MV/s**

This device, like the previous one, also has small dimensions and very light weight - only **3.8 kg,** according to which (less than 5 kg) it can be classified as a service oscilloscope.

Record length can vary from 256 points to 32K points
to the signal. The device uses a color LCD indicator.

And finally, in **2020 ,** the development of the latest, for OJSC MNIPI, broadband digital service was completed
storage oscilloscope-multimeter **S8-57** for a **150 MHz band.** However, this development was not introduced into the State Register of Measuring Instruments (in Russia), which indicates that mass production of this device was never launched.

Oscilloscope-multimeter, S8-57, as an oscilloscope
provides registration, memorization, marker and
automatic measurements of up to 22 signal parameters, in the amplitude range from 2 mV to 300 V (with a divider of 1:10) and time intervals from 2 ns to 100 s using two vertical deflection channels. There is an external synchronization input.

It also, like a multimeter, provides measurement of voltage and direct current, root mean square values of voltage and sinusoidal alternating current, and electrical resistance to direct current.

Parameters of the S8-57 digital oscilloscope :

- number of channels - 2,
- LCD screen 5.7", or 240x320 pixels, color,
- **150 MHz** band ,
- feels. 2 mV-20 V/d,
- number of scans - 1,
- sweep 2 ns/d,
- pre-launch – 50 divisions,
- delay launch – 500 cases,
- author change 22 signal parameters,
- marker measurements,
- digital multimeter,
- interface USB.
- consumption power. 50 VA,
- weight 3.5 kg,

ShP digital oscilloscope-multimeter **S8-57** at **150 MHz.**

The S8-57 also has additional functions for measuring frequency, period and spectral analysis of the input signal (FFT), recorder modes and tester of electrical circuit components.

3.5. Results of MNIPI in the field of oscillography.

Over 20 years at MNIPI, during the USSR, within the framework of the 6th Main Directorate of the Moscow Scientific and Practical System (from **1972** to **1992),** about **30** models and modifications (delivery options) of oscilloscopes were developed, including 1 type of replaceable oscilloscope unit.

According to the number of models developed during this period of time, MNIPI took 3rd place among 4 research institutes (overtaking GNIPI) that developed oscilloscopes in the USSR (see table in Appendix 5), having developed 12.2% of the models.

And this is a good result, considering that MNIPI started developing oscilloscopes later than everyone else, the last one, only in 1972.

The following oscilloscope models were developed here:

- universal: S1-76, S1-65A, S1-82, S1-85, S1-114, S1-114/1, S1-117, S1-117/1, S1-117/2, S1-120, S1 -125, C1-126, C1-127, C1-128, S1-133, S1-133/1, S1-133/2, S1-142, RS1-01, RS1-02;
- digital: S8-19, S8-19/1, S8-23, S8-23/1,
- special: S9-7, S9-14, S9-18, S9-19, S9-28;
- as well as a replacement unit for the Ya4S-109 oscilloscope.

A list of oscilloscopes everyone developed by the oscillographic divisions of MNIPI, as well V as the years of their creation, main characteristics and the name of the manufacturer, are given in Appendix 3, at the end of the book.

It should be noted that the strengths of MNIPI oscilloscopes were both resistance to harsh and especially harsh operating conditions, as well as high values of device parameters with developed functionality.

Here at MNIPI, they began to master and develop digital and microprocessor technologies in oscillography quite early. This can be explained, on the one hand, by the younger composition of the employees (since the team of oscillographers here was formed in the 70s and 80s, while in VNIIRIP and LNIRTI in the 50-60s), and on the other hand, by the presence in the city of Minsk, one of the best radio engineering institutes in the USSR -

MRTI, which trained highly qualified specialists for MNIPI.

Quite a lot of types of oscilloscopes were developed in Minsk - 5 types out of 10 (in Lvov 6 out of 10, and in Gorky only 3 out of 10, see table in Appendix 5), these are LF, service, digital, ShP and MF oscilloscopes.

In one type of oscilloscopes out of 10 types, MNIPI was the leader in the USSR in terms of the number of developments. These are mid-frequency (MF) oscilloscopes. And, although the same number (8 models) of midrange devices were developed in Lvov, the leader here was still Minsk, since its devices had better parameters (see Appendix 5.6), in particular, lower weight and consumption. power.

It is also necessary to note the achievements of MNIPI in the field oscillography marked **“Developed for the first time in the USSR”:**

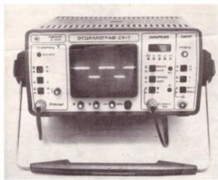
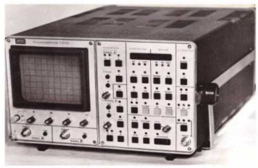
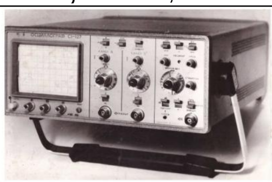
- the most highly sensitive **(100 μV/d) low frequency (1 MHz)** monoblock oscilloscope - **S1-76,** (for **1976),**
- the lightest **(7.5 kg) low-frequency** oscilloscope for a **10 MHz band,** and it also became the first low-frequency oscilloscope with automatic digital measurements of 3 signal parameters (amplitude, period, duration) and automatic scaling of signal sizes on the screen - **S9-7** (as of **1982),**

- the most broadband, serviceable, small-sized 2-channel oscilloscope for a **50 MHz band,** weighing only **5.5 kg** – **S1-127** (as of **1989),**
- the most broadband **digital** oscilloscope in the USSR for general use, (for a **100 MHz band),** for repeating signals, weighing 24 kg, and the first with microprocessor control, automatic measurements of parameters, with increased measurement accuracy and IF-KOP - **S9-14** (on **1980),**

- the lightest **(2.5 kg) digital** service oscilloscope on 10 MHz band, with LCD indicator – **S8-19** (for **1987),**
- the lightest **(6.5 kg)** midrange **analog-digital** oscilloscope at **20 MHz,** for the first time with automatic signal search, digital memory and marker measurements - **S8-23** (for **1992),**
- the lightest of the monoblock PN oscilloscopes for a **100 MHz band,** weighing **13 kg,** and the first of them with microprocessor control, dual sweep and digital delay - **S1-120** (for **1985),**
- the lightest of the monoblock oscilloscopes for a **100 MHz band,** weighing only **8.5 kg,** and the first of them, for **4 channels,** with double sweep - **S1-126** (for **1988),**
- the lightest, weighing **14 kg,** and broadband, **50 MHz,** from the midrange devices, oscilloscope-multimeter – **S1-114,** (for **1982),**
- MF **(50 MHz),** oscilloscope with auto-search for signal and automatic measurements of signal parameters – **S9-18,** (on **1986).**

The total achievements of MNIPI in the field of oscillography over 20 years, with the mark “Developed for the first time in the USSR,” are ten **(10).** This is more than in LNIRTI (8) over 33 years.

Outstanding oscilloscopes developed at MNIPI, and having the status **“Developed for the first time in the USSR”:**

	
S1-76, 1 MGc, 1976	**S9-14,** 100 MHz, 1980
	
S1-114, 50 MGc, 1982	**S9-7,** 10 MHz, 1982
	
S1-120, 100 MGc, 1985.	**S9-18,** 50 MHz, 1986
	
S8-19, 50 MHz, 1987	**S1-126,** 100 MGc, 1988
	
S1-127, 50 MGc, 1989	**S8-23,** 20 MHz, 1992

After the collapse of the USSR, **for 28 years** in independent Belarus (from **1992** to **2020),** at MNIPI, and then at JSC MNIPI (since 1997), **38** models and modifications of oscilloscopes were developed , which is even more than during the years of existence in the USSR - 30 models. This is more than in Lviv (12 models), since in Lviv oscillography ended earlier, by the end of the 1990s. And this is more than in Vilnius. (30 models of USB oscilloscopes from "Eltesta").

During this time, the following quite promising and competitive oscilloscope models were developed at MNIPI:

- universal, (after 1992): S1-127/1, S1-127(ZhKI), S1-127 (ZhKI)M, S1-127E, S1-148, S1-149, S1-150, S1-151 , S1-157, S1-157/1, C1-157/2, C1-157/4, C1-157/5, C1-157/6, C1-164, C1-166, C1-166/1, S1-167, S1-167/1, S1-167/2, S1-170, S1-170/1, S1-170/2, S1-176, S1-176/1;
- digital (after 1992): S8-28, S8-33, S8-36, S8-38, S8-39, S8-41, S8-43, S8-52, S8-52/1, S8-53, S8-53/1, S8-54, S8-57.

Such a high level of development and production of oscilloscopes is explained by a more successful privatization strategy and a more optimal economic course that was chosen by independent Belarus in these years.

If in Lithuania, in Vilnius, (in VNIIRIP), or in Ukraine, in Lvov, (in LNIRTI), before the privatization of enterprises, they previously dependent were dismembered on small parts, which themselves were not able to either develop or produce a complex and knowledge-intensive final product (for example, an oscilloscope), then in Belarus there was no hurry with this type of privatization. As indeed, at one time, in China.

For example, MNIPI, during the period of privatization in Belarus, from 1991 to 1997, remained undivided into parts, a single enterprise, in state ownership. He continued to work without breaking economic ties both with his factories and with traditional consumers in Russia and other countries. And only 6 years later, in 1997, it was privatized and transformed into OJSC MNIPI.

At the same time, the MNIPI institute itself was not divided into small parts, but was privatized entirely, and was preserved as a single whole, which provided good conditions for survival and adaptation to new market conditions, with its products.

As a result, many new, innovative, competitive devices were developed and produced at JSC MNIPI, much more than at VNIIRIP and LNIRTI after 1992. And this despite the fact that production at JSC MNIPI had to be created anew, since the Kalibr and Belvar plants, which previously produced MNIPI oscilloscopes, went into free operation

swimming.

During the time of independent Belarus, JSC MNIPI developed many advanced, promising modern universal, automated, analog oscilloscopes, such as S1-149, 150, 151, 157, 166, 167, 170, the bandwidth of which reached **150 MHz,** with such important additional functions such as auto signal search, marker measurements, component tester (characteristic graph), multimeter and additional digital memory.

With the development of microprocessor technology and new technologies signal sampling, great success has certainly been achieved also developers of digital oscilloscopes of JSC MNIPI. They have developed many models of purely digital oscilloscopes - C8-28, 33, 36, 38, 39, 41, 43, 52, 53, 54, 57. The bandwidth of such devices has reached **200 MHz,** and the sampling frequency is **400 MHz** (equivalent **to 20 GHz).** At the same time, the devices now have an automatic signal search mode and automatic measurement of dozens of its parameters, as well as many other modern functions.

Thus, the developers of MNIPI oscilloscopes, after 1992 achieved significant, the greatest successes among the 4 research institutes in the USSR, compared with oscilloscopes from VNIIRIP, LNIRTI and GNIPI. But as the crises of 1998, 2008, and the recent COVID-19 crisis—2020-21—developed and the production of oscilloscopes at JSC MNIPI began to decrease, and by 2021 have almost stopped. For sale, and apparently in production on the website of OJSC MNIPI for 2021, there are only 9 models of oscilloscopes, priced from 1100 to 3300 euros.

Of course, MNIPI made a large, significant contribution to the development of the oscillographic industry, and took its rightful place in the history of oscillography of the USSR, not only in the 70s and 80s, but also in the period after 1992. He has outstanding achievements both in the number of developments of mid-frequency oscilloscopes, and in the field of service, digital, wideband, and low-frequency

oscilloscopes.

Chapter 4. Gorky Research Instrument-Making Institute (GNIPI)

4.1. History of GNIPI

Gorky Research Instrument-Making Institute (GNIPI) “Quartz” (currently the Federal Research and Production Center “Nizhny Novgorod Research Instrument-Making Institute “Quartz” named after A.P. Gorshkov) - was the leading enterprise in the industry

radio measuring equipment in the USSR, and paid considerable attention to the development of oscillographic equipment. Currently, NNIPI is the largest enterprise in Russia for the development and production of radio-electronic measuring equipment [5].

From **1918** to **2017** in the city of Gorky (Nizhny Novgorod) under there were different names:

- since 1918 - Nizhny Novgorod Radio Laboratory (Bonch-Bruevich NRL, created by decree of V.I. Lenin), created with the aim of creating a radio broadcasting network in Russia;
- since 1928, NRL was transformed into TsVIRL (Central Military-Industrial Radio Laboratory) with the aim of creating army radio stations;

- since 1939 - TsVIRL was transformed into a research institute and pilot plant No. 326 named after. Frunze, with the aim of developing and producing radio stations for the army;
- since 1941, plant No. 326 named after. Frunze was converted into a plant, post office box 429 for the production of radio stations;
- since 1946, TsKB-326 was created on the basis of OGK plant No. 326;
- since 1949, NII-11 was created from TsKB-326, with a pilot plant, with the aim of developing research in the field of metrological support for radar and radio communications,
- since 1954, plant No. 326 was renamed to plant named after. Frunze,
- since 1956 - NII-11 was transformed into TsNII-11 (Central NII-11) and became the leader in the instrument making industry in the country,
- since 1967 - TsNII-11 was transformed into GNIPI (Gorky Scientific Research Instrument-Making Institute).

In 1969, the superconductor electronics sector was organized at GNIPI, which was engaged in the creation of devices based on

Josephson effect for quantum metrology and precision measurement technology.

In 1970, construction began on a new building of the GNIPI.

In 1971-1973 GNIPI is already under the jurisdiction of 6GU MCI, and received name of mailbox G-4367. It included departments: 8, 10, 2100; departments: 9, 1000, 3000, 4000, 6000, 7000.

At the institute's plant, serial production of devices of its own design was carried out. In 1971, 20 types of devices were produced.

By the end of the 1980s, GNIPI, as the lead institute, carried out 33% of the sub-industry's R&D and supplied design documentation to 11 serial plants in 27 areas of measuring technology.

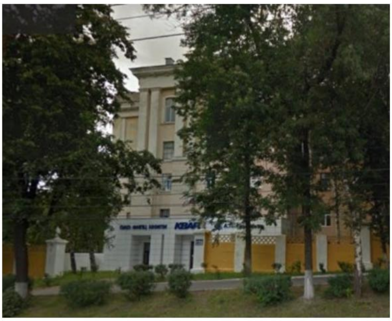
Since 1990, GNIPI was renamed NNIPI (Nizhny Novgorod) "Kvarts";

- since 1998 – transformed into a state unitary enterprise "Kvarts".

In 2004, the enterprise became one of the strategic defense enterprises. In the same year, the institute was awarded the status of a state basic scientific center in the field of "Radio-electronic measurement technology", and in 2006 - Federal Research and Production Center.

Since 2008, the enterprise became part of the defense Rostec enterprises;

Since 2011, the company has become a joint-stock company - OJSC "NNIPI Quartz named after. Gorshkova";



GNIPI building on Gagarin Avenue 176 in Nizhny Novgorod

Since 2017, the plant named after. Frunze and JSC NNIPI "Kvarts" named after. Gorshkova. As a result, it was formed

Joint Stock Company "Nizhny Novgorod Research and Production Association named after M.V. Frunze".

From the moment of its formation, the institute began to carry out research and development work to create new devices and new directions in the field of radio measuring technology. The first standard signal generators, spectrum analyzers, and tube voltmeters were developed here.

The oscillography department specialized in the development of wideband sampling and digital computing oscilloscopes. Currently, the main products of

the enterprise are: hydrogen frequency and time standards with the highest frequency stability, rubidium frequency standards, reference quartz oscillators; microwave and mm wavelength range products –

signal generators, frequency synthesizers, microwave units; receiving and analyzing equipment in the frequency range from units of hertz to hundreds of gigahertz; optoelectronic measuring devices for fiber-optic communication systems; automated measuring systems, incl. based on the VXI information highway, which corresponds to world standards and is actively exported to countries near and far abroad.

The institute continues work on the creation of a new generation of radio measuring equipment, including. in the frequency range up to 178 GHz. Much attention is paid to the further development of the research and production base. The program of technical re-equipment and reconstruction of the enterprise provides for the development of a number of high technologies. Today the enterprise is a team of highly qualified specialists, among them 5 doctors and 21 candidates of science. For

decades, company managers

were:

1956-1974 Gorshkov Alexander Porfirievich

1976-1983 Gashin Vladimir Mikhailovich
1983-1987 Kolchin Viktor Pavlovich
1988-1998 ? Ulyanov Adolf Alekseevich
1999-2005 Kudryavtsev Alexander Mikhailovich
2007-2012 Chernogubov Alexander Vladimirovich
2012-2014 Menshov Vladimir Pavlovich
2014-2016 Voronov Nikolay Anatolyevich

4.2. The origin of osillography in Gorky

The first cathode oscilloscopes **OKR-1, OKR-2, OKR-5** were created at TsVIRL in 1936-1939 with the participation of V.P. in the developments. Kuryachev and V.G. Dubenetsky. The marking meant: O - oscilloscope; K - cathode (in contrast to the then widely used loop oscilloscope); R - unfolding, since before Therefore, all oscilloscope designs were without time sweep (only Lissajous figures were observed, with the help of which frequencies, stability, modulation depths, and even power levels were measured).

These oscilloscopes were needed for the development of instruments for measuring the modulation depth of the IM-1 type (as well as IM-2, -5, -6, -7), which were necessary for the production of radio transmitters. “IM” devices were a mechanical device that was mounted on the oscilloscope screen, with indicators of the zero line, minimum and maximum of the signal.

Subsequently, Valerian Georgievich Dubenetsky, the developer of oscilloscopes of the OKR type, became the chief engineer of the State Committee for Energy Reconstruction and the Union Ministries, and made an outstanding contribution to the development of the radio measuring instruments industry.

Vyacheslav Pavlovich Kuryachev. Photo from the late 1930s

Valerian Georgievich Dubenetsky. Photo from the late 1930s

Brilliant erudition, high intellectual level, business trip to the world center of radio measuring technology -

Hewlett-Packard, USA, formed him as a major organizational specialist. Under his leadership, sections of the Main Directorate of the Ministry were held every two years to review five, ten and even twenty-year plans for the development of the industry. Dubenetsky created several new design bureaus and research institutes, attracted new manufacturing plants to the production of radio
measuring instruments, and introduced a system of leading institutes in various areas of technology.

A special place in the oscillographic technology of GNIPI is occupied by ultra-wideband oscilloscopes on traveling wave tubes, which provide studies of signals in a frequency band of up to 10 GHz and more. Oscilloscopes developed at GNIPI in the fifties of the last century, **OS-1, OS-2, OS-3** with a bandwidth of more than 1 GHz and sensitivity of the order of tenths of a volt, determined by the scan line width (tenths of a millimeter), played a certain role in the initial stages of development of nanosecond pulse technology (chief designer of the development A.E. Vuzkiy).

A high-speed oscilloscope of the OS-4 type, developed by the oscillographic laboratory of the institute under the team leadership of an outstanding scientist and inventor, Doctor of Technical Sciences, received great attention. M.I. Gryaznov, later the head of the oscillographic department of GNIPI.

They proposed a new vertical deflection system
CRT. The essence of the invention of M.I. Gryaznova was that the CRT deflection plates constituted a matched element of the signal transmission path: the capacitance of the plates and the inductance of the leads were calculated as elements of an LCL low-pass filter with a characteristic impedance equal to the characteristic impedance of the supply cables.

The oscilloscope was demonstrated at an international exhibition in New York in 1959 and was highly praised by experts.

Subsequently, oscilloscopes in this direction were called “high-speed” and were developed at the Vilnius VNIIRIP, from 1959 to 1982, for the needs of the nuclear research industry.

Subsequently, in the 60-70-80s in the city of Gorky, at GNIPI, the developers of the oscillographic department worked mainly with stroboscopic and digital oscilloscopes, as well as oscilloscopes with replaceable units.

4.3. Oscilloscopes with replaceable units.

In **1980 ,** at GNIPI, an attempt was made to create a family of oscilloscopes with replaceable units (OSB), on the theme **“Scorpio”,** models **SK1-95, SK1-110 and SK1-111** (chief designer V.N. Bobin) on the strip **100 MHz.**

This happened following the creation of a family of universal oscilloscopes with replaceable units of the “Svet” series, in VNIIRIP for the 100 MHz band, models from S1-91/1 to S1-91/6, developed in 1977-1979. At that time, in the

USA, the Tektronics company successfully developed a very important top-end and multifunctional OSB family, 7000 series, the most advanced in the world at that time.

In this regard, in the USSR it was decided to urgently begin similar developments at 3 enterprises at once, in order to select the best development from them for mass production: - within the framework of the MRP, in LNIRTI

- the theme “Snow” (C1-80),
- and within the framework of the 6GU MPSS in GNIPI - “Scorpion” (SK1-95/110/111),
- within the framework of the 6th State Institution of MPSS in VNIIRIP - “Svet-1” (C1-91).

Unlike the Vilnius family of oscilloscope S1-91 (Svet series), oscillographs based on the **Scorpio theme,** had four rather than three compartments for replaceable blocks, however, the blocks themselves were technological (i.e., replaceable only from the manufacturer) and did not provide the necessary parameters of the oscilloscopes in case of their replacement on the consumer side. This was due to the

fact that the developers of GNIPI did not have enough experience in the successful development and production of OSB, especially in terms of creating the necessary reserves of connecting block-base parameters to achieve their complete interchangeability.

The base unit had a model number - Ya9S-31 and a screen of 100x120 mm.

The Ya4S-80 amplifier block had deviation coefficients from 5 mV/div to 10 V/div, and the Ya4S-83 scan unit had sweep coefficients from 2 ns/div to 1 s/div.

In addition to standard oscillographic replaceable blocks, the Ya4S-84 amplitude measurement block, as well as Ya4S-87 multimeter blocks and digital delay block.

Thus, relatively few blocks were developed in this family - only 1 basic, and only 5 replaceable blocks. And besides the fact that these blocks were hardly replaceable. For comparison, the families developed at VNIIRIP - S1-70 (“Snaige”) had 5 basic and 11 replaceable blocks, and the S1-91 (“Light”) family, as a result, had 5 base and 15 replaceable blocks.

Oscilloscope **SK1-95** at **100 MHz,** with amplifier Ya4S-80, scanner Ya4S-83, multimeter Ya4S-87 and measurements Ya4S-84.

Models **SK1-95, SK1-110** and **SK1-111** differed from each other only in the set of replaceable units in the same base unit.

Base unit Ya9S-31

oscilloscopes

SC1-95, SC1-110, SC1-111:

- **100 MHz** band ,
- screen ELT 100x120 mm,
- number of compartments – 4,
- number of vertical channels - 2,
- number horizon. channels - 2,
- consumption power. 300 VA,
- weight 32 kg.

Replacement blocks:

1. Amplifier **YA4S-80**

- coefficient deviations. 5mV-5V/d,

2. Scanner **Ya4S-83**

- coefficient sweep 10 ns-1 s/d,

3. Amplitude measurement block

- **Ya4S-83,**

4.Ya4S-87 multimeter block ,

5. Block of digital delay and time measurements.

At that time, LNIRTI and GNIPI had no experience in the development and production of OSB families, while VNIIRIP had undeniable advantages in this regard.

By this time, there was already a successful 20-year experience in the development and production of 2 families of OSB (tube “Kulis” S1-15/17 and transistor “Snaige” S1-70/74, S8-12/13/14). This meant that the choice of the developer of the new 3rd generation OSB was practically a foregone conclusion, it became VNIIRIP.

It was there that the developers had significant experience, both in the compatibility of blocks and approaches to the reserves of block-base connecting parameters, and in the strategic planning of such developments over the course of decades.

It should be noted that OSB is strong and has an advantage over monoblocks in terms of wide functionality, only if a family is created from several basic and a sufficient number of replaceable blocks, provided that they are all compatible and interchangeable. And this is not at all easy to do, since the element base of electronics changes very quickly (it is believed that it changes completely in 5 years), while the OSB family lives and is developed, as a rule, for more than 10 years.

In addition, the devices of the “Svet” series had one and a half times less weight (about 20 kg, versus 32) and dimensions, since they had with only 3 compartments and a vertical layout, which meant they took up much less desk space. At the same time, these devices had the same 100 MHz band as the Scorpion family, with much wider functionality due to a much larger number of replaceable and base units in the family.

The **Scorpion** family , models **SK1-95, SK1-110 and SK1-111,** in terms of functionality, manufacturability and interchangeability of units, unfortunately, could not withstand competition with oscilloscopes of the Svet series (S1-91), developed in Vilnius. Therefore , **the Scorpion** devices were discontinued after several years of production at the Minsk Caliber plant.

Blocks included in the oscilloscopes SK1-95, SK1-110 and SK1-111

4.4. Digital oscilloscopes

The beginning of the eighties of the last century dates back to the emergence and development in the USSR of a new promising direction of oscillographic technology - digital oscillography.

The Nizhny Novgorod enterprise GNIPI was at the origins of this direction, which was the third to join the development of digital oscilloscopes, after VNIIRIP (S9-5, 1979) and MNIPI (S9-14, 1980). Here in **1981** it was developed
The first digital oscilloscope in GNIPI, **S9-8,** for a **2.5 MHz** band (20 MV/s).

Digital storage two-channel oscilloscope **S9-8 "Collection"** (chief designer I.D. Bolshagin) contained an analog-to-digital converter made according to the original circuit, and providing a record sampling frequency in the USSR at that time of up to 20 MHz (with a bandwidth of 2.5 MHz).

Previously, the record for sampling frequency was 5 MHz. belonged VNIIRIP, and was implemented in the S9-5 oscilloscope in 1979.

It should be noted that this device used a microprocessor system and IF-KOP, only for the 2nd time, for oscilloscopes in the USSR. This sectional, 12-bit, based on 589 series microcircuits, MP system was used to control the operating modes of the device and for marker measurements.

The first in the USSR to use a microprocessor system and IF-KOP for oscilloscopes were at MNIPI in 1980, in the S9-14 digital oscilloscope model.

Parameters of the digital oscilloscope **S9-8:**

- **2.5 MHz band,**
- CRT screen 85x107 mm,
- number of channels - 2,
- sensitive. 50 mV-50 V,
- **discretizer. 20 MGc,**
- digital memory 2048x8 bits, -

marker measurements,

- **interface KOP,**
- consumption power. 250 VA,
- weight 29 kg.

2-channel digital oscilloscope **S9-8 (2.5 MHz, 20 MV/s)**

For the first time in the USSR in oscillography, the S9-8 device used a 16LK1B kinescope with high resolution and increased brightness, which dramatically increased the quality of the image on the oscilloscope screen. The kinescope provided
indication of signals without flickering or loss of brightness, regardless of their repetition frequency.

Therefore, on the front panel of the oscilloscope C9-8
the need for traditional Focus and Brightness knobs.

In VNIIRIP, in devices S9-24/25/26, and in MNIPI in S9-19/28.
CRTs for digital oscilloscopes were used
much later, only 7 years later, in 1988.

Since the S9-8 was controlled by a microprocessor (MP), in addition to local manual control, it also implemented remote control and data exchange through the public channel interface (IF-KOP), which allowed it to work in AIS.

Thanks to this, during the production of C9-8, at the Kalibr plant,
its complete final verification was carried out on a special test AIS, without the participation of an operator, which was implemented for the first time in oscillography in the USSR (which one of the authors of this book was personally convinced of).

Oscilloscope S9-8 was produced at the Minsk plant “Caliber”
many years. It was a successful development by GNIPI, with the necessary technological reserves in terms of parameters, and an ergonomic front panel, which, among other things, ensured its success.

One of the disadvantages of the S9-8 oscilloscope can be considered the lack of software for automatic measurements of signal parameters and signal processing. This is explained by the individual, unique type of MP system, for which, due to the lack of universal software, a high-level language for debugging and translation, software for the device had to be written in a low-level language. And this was very labor-intensive, so the programs
It was decided to abandon automatic measurements.

But this drawback was partially eliminated in the next digital oscilloscope GNIPI - **S9-16,** developed in **1985**
year for the **5 MHz band.**

Digital storage two-channel oscilloscope S9-16 “Series” (chief designer A.A. Tereshenkov) at the same frequency
sampling up to 20 MHz provided a bandwidth of 5 MHz.

This oscilloscope had a remote keyboard that
contained signal processing functions and automatic

calculation of some of its parameters, and there was also the possibility of composing small programs from this keyboard, without an external computer.

These functions were fully implemented in the Tektronics top-end oscilloscope, model Tek 7854, which appeared in 1980. It also had a remote keyboard

a signal calculator with similar functions (see section 1.6.2 in this book, description of the research project “Owl”). So the oscilloscope C9-16, taking into account this remote keyboard, looked very modern and attractive.

The device provided measurement of voltages (effective and average values) in any part of the signal, signal swing, voltages between arbitrary points of the signal, time interval between signal points, finding local maximum and minimum signal values, processing and analysis of signals using special algorithms and formulas without the use of symbolic programming languages.

Parameters of the digital oscilloscope **S9-16:**
- **5 MHz band,**
- CRT screen 85x107 mm,
- number of channels - 2,
- sensitive. 100 mV-50 V,
- **discretizer. 20 MGc,**
- digital memory 4096x8 bits, -

marker measurements,
- **external keyboard**
signal processing,
- **interface KOP,**
- consumption power. 350 VA,
- weight 30 kg.

2-channel digital oscilloscope **S9-16 (5 MHz, 20 MV/s)**

The S8-16 oscilloscope had the same front panel and the same kinescope-based indicator as the S9-8, but it already had an ADC based on the m/s 1107PV2 - an 8-bit, 20 MHz ADC. And the MP system was already built on the basis of the standard 8-bit family of m/s series 580 (Intel 8080), which made it possible to quickly create more complex and multifunctional software for this device, designed for signal processing and calculation their parameters, based on languages of a higher level than was the case with the S9-8. The S9-16 oscilloscope was also mass-produced at the Kalibr plant in Minsk.

And finally, the 3rd and last digital oscilloscope created at GNIPI was **the S9-27,** created in **1988** for a **17 MHz** band (at 100 MV/s).

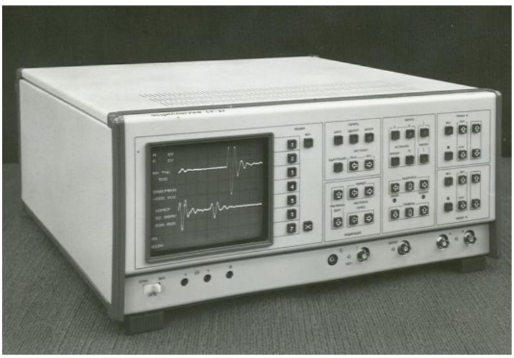
The digital storage two-channel oscilloscope S9-27 ("Sputnitsa", chief designer A.A. Abramovich) was the fastest mass-produced digital oscilloscope in the USSR. At a sampling frequency of up to **100 MHz,** the device had a bandwidth of **17.5 MHz.** Two microprocessors provided

high frequency of information changes on the indicator screen based on an oscillographic CRT 17LO6I with a 100x120 mm screen.

The device also includes the following features:

- adaptation of the device modes to the periodic period under study signal (auto-search for signal),
- signal averaging, signal extraction from random noise,
- automatic measurement of seven amplitude-time signal parameters,
- self-diagnosis of the device, including analog components,
- use of "Menu" buttons to increase the number of functions,
- remote control and data exchange via IF-KOP,

to ensure work in AIS,



Parameters of the digital oscilloscope **S9-27:**

- **17 MHz** band ,
- screen ELT 100x120 mm,
- number of channels - 2,
- feels. 20mV-100V,
- **discretizer. 100 MGc,**
- digital memory 2048x8 bits, **-**

signal search (adaptive),

- **author change 7 pairs signal,**
- **marker measurements,**
- **interface KOP,**
- consumption power. 440 VA,
- weight 30 kg.

2-channel digital oscilloscope **S9-27 (17 MHz, 100 MV/s)**

The S9-27 oscilloscope was also mass-produced at the Minsk Kalibr plant.

The advantages of digital oscilloscopes from Gorky include the fact that they were all originally designed with microprocessor, electronic and remote control

through IF-KOP, which made it possible to check them after production automatically, without operator participation, in special AIS designed to check them. And then, later, at the consumer, it was also possible to use these devices in custom AIS. The ideology of constructing the front panels of these devices also makes a very pleasant impression

and respect, with its thoughtfulness, rigor, order, and a certain conservatism, as well as continuity from model to model.

They feel a fairly smooth transition from the front panels of previous generations of oscilloscopes with mechanical controls to programmable devices, with non-latching buttons, in order not to strain the operators of these devices.

To the disadvantages of digital oscilloscopes from GNIPI, firstly First of all, it is necessary to attribute the narrow bandwidth (from 2.5 to 17.5 MHz), according to which they can only be classified, unfortunately, as low-frequency oscilloscopes, the typical weight of which at that time in the USSR was about 10 kg, and these devices weighed 3 times more, about 30 kg. As an analysis of the demand for oscilloscopes

in the USSR showed, at that time, consumers most needed mid-frequency ones, with a bandwidth of 20-50 MHz, and broadband ones at 100 MHz

oscilloscopes, which is confirmed by the large number of models for this band that were developed at this time, while the weight of such devices rarely exceeded 20 kg.

And devices with such a bandwidth, being developed at VNIIRIP, LNIRTI and MNIPI, are mainly were produced at industry factories, since they were larger than others are in demand in the national economy by consumers.

Secondly, the GNIPI instruments did not have a stroboscopic mode for collecting data at the fastest scans. This mode A digital oscilloscope is usually called the “equivalent” sampling mode, and it is used to increase the resolution of the device for time measurements of short time intervals, as was previously possible in conventional analog oscilloscopes.

The absence of such a mode significantly narrowed the scope of application of GNIPI digital devices, limiting it to only single signals. And as the analysis of user needs showed, at that time, only about 10% of them explored
single signals, while 90% of specialists needed instruments to study repeating signals.

The lack of an “equivalent” sampling rate does not allow for the necessary “resolution” in time
explore even that small bandwidth,
amplification paths, which was necessary for GNIPI oscilloscopes to record single-shot signals.

Due to the lack of an “equivalent” sampling mode, it was even difficult to certify the transient response (TR) of the amplifiers of these oscilloscopes.

The fact is that for the period of time of growth of the PH (time between 10% and 90% of the amplitude of the PH pulse), there was only only 2-3 points (ADC samples) of the signal. For example, for S9-8, PH-150 ns, and the time between samples is 50 ns (20 MHz), which can lead to a 50% error in measuring the PH rise time and, accordingly bandwidth.

For more or less reliable measurements on such a front it would be necessary to have at least 20-25 points (for accuracy time measurements, for example - 5% or less). This means that you need to have at least 8 ns/point, or at least a 125 MHz equivalent sampling rate.

Therefore, in the 80s, almost all digital oscilloscope manufacturers in the world had an equivalent sampling mode, for example Tek - 7854, Tek 7D20, HP1980 and many others. At this time, for example, since 1980, MNIPI had been producing a digital oscilloscope S9-14, for a 100

MHz band with an equivalent (stroboscopic) mode for collecting repeating signal data.

Other MNIPI oscilloscopes – S8-19 – had the same mode. at 10 MHz, since 1987 and S9-28 at 100 MHz, since 1988.

VNIIRIP did not lag behind, where in 1986 a digital oscilloscope S1-122/8 was released for a 10 MHz band, with an equivalent sampling frequency of 5 GHz.

It is difficult to explain the absence of such a mode in the digital oscilloscopes of GNIPI, especially since there, for the first time in the USSR, a stroboscopic oscilloscope was developed.

Subsequently, the stroboscopic devices of GNIPI became the main direction of his activity in oscillography, and set the tone in this direction in the USSR, as they were among the best. Head of Digital Oscillography in

GNIPI was Ph.D., the head of the sector, and then the department, A.G. Milekhin.

4.5. Sampling oscilloscopes

GNIPI, historically, became the founder stroboscopic oscillography in the USSR, having developed in **1962** the country's first stroboscopic attachment **S1-21** for the Lvov oscilloscopes S1-19 and S1-30 for a 1 MHz band, on the “Delta” theme, which provided a record expansion of the band of these devices to **200 MHz .**

This event was a breakthrough in expanding the bandwidth of oscilloscopes in the country, since until that moment the most broadband device in the country was the S1-11 with a bandwidth of 100 MHz
and the problem of expanding the bandwidth of oscilloscopes was acute.

This attachment could also be used with other low-frequency oscilloscopes that had scan generator outputs and beam modulator inputs (Z input), and was mass-produced by the Makhachkala Instrument-Making Plant.

Parameters of strobe attachment **S1-21:**

- **200 MHz** band ,
- number of channels - 1,
- sensitive 50 mV/cm,
- entrance. resistance 75 Ohm,
- scan rate - 30 ns/sec.,
- consumption power. 200 VA,
- weight 25 kg.

Stroboscopic attachment **S1-21,** for oscillator. S1-19 and S1-30 **(200 MHz)**

A similar device appeared at VNIIRIP a little later in 1965, it was an oscilloscope S1-15/7, also with a 200 MHz band.

In **1965 ,** GNIPI developed a new, first in the USSR monoblock stroboscopic oscilloscope **S1-39** (hereinafter **S7-5),** which immediately set **2** bandwidth records in the country.

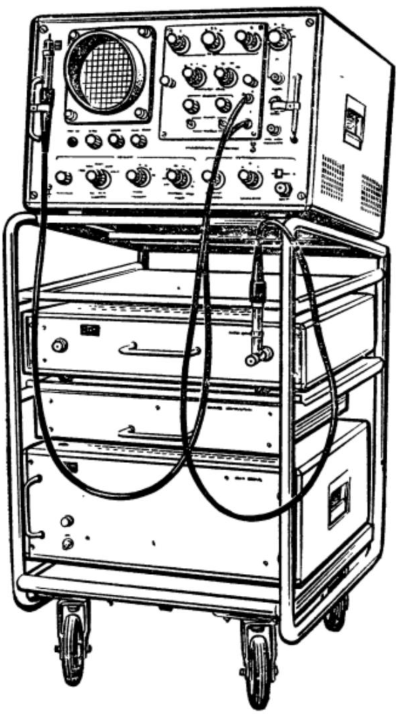
This oscilloscope included two units - 5PS-1, on
700 MHz band , and 5PS-2 for the **2 GHz band.**

The 5PS-1 block was a replaceable block with a stroboscopic probe, with a bandwidth of **700 MHz,**
sensitivity 20 mV/div and input impedance 100 kOhm. The 5PS-2 block used a pass-through stroboscopic mixer with a 50-ohm characteristic impedance and a band

transmission of **2 GHz,** with a sensitivity of 20 mV/div. This made it possible to carry out reflectometric measurements of transmission lines and various components.

Developed there, the C7-5A later corresponded to the C7-5 in purpose, but differed from it in the ability to program (remotely) control the sweep coefficients and the signal reading step. It was intended to work in systems and semi-automatic measuring complexes.

The device was introduced and mass-produced at Makhachkala instrument-making plant.



Parameters of **the S7-5 (A)** stroboscopic oscilloscope :

- CRT screen 60x80 mm,
- number of channels - 2,
- band with **5PS-1** - **700 MHz** with a sensitivity of 20 mV/d and noise of 2 mV,
- band with **5PS-2** - **2 GHz** with a sensitivity of 10 mV/d and noise of 1 mV,
- sweep 0.1 ns-10 ÿs/d,
- synchronization up to 700 MHz,
- jitter 0.2 ns,
- **version C7-5A with remote control for AIS,**
- consumption power. 300 VA,
- weight 80 kg.

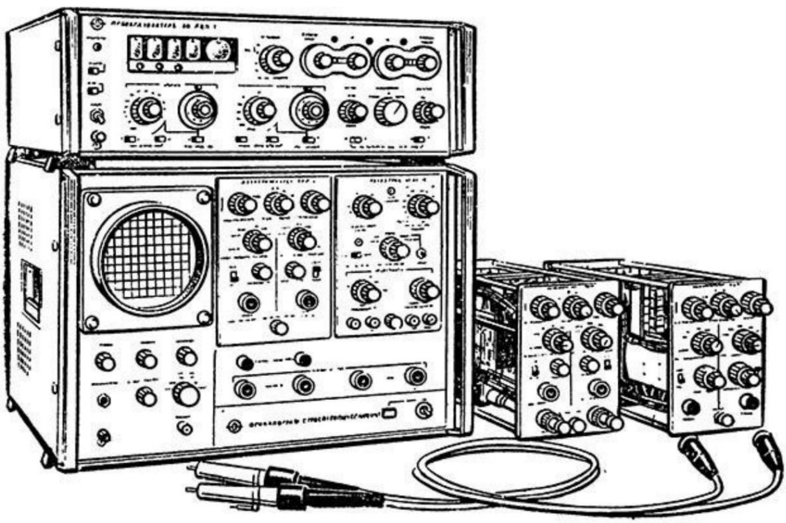
The chief designer of this device was V.I. Trenev, and M.I. Gryaznov took part in the development. and Ryabinin Yu.A.

Stroboscopic oscilloscope **S7-5 (2 GHz, 700 MHz)**

Subsequent developments of GNIPI - stroboscopic oscilloscopes S7-7 and **S7-9 (1970)** - represented a new level of development in this area, meeting the requirements of the time and the level of foreign technology, and therefore set a new record for bandwidth - **5 GHz.**

Chief designer of the development, Doctor of Technical Sciences M.I. Gryaznov presented for wide use a set of **S7-9** stroboscopic oscilloscopes with replaceable units with a bandwidth of **700 MHz, 2 GHz** and **5 GHz,** with program control and automated control of the parameters of the measured signals. The device kit included three replaceable transducer blocks, 7PS-1, 7PS-2, 7PS-3, a replaceable scanner,

7RS-1, delay line, as well as an analog-to-digital converter unit 9ADSP-1.



Stroboscopic oscilloscope **S7-9, (5 GHz, 2 GHz, 700 MHz)**

The **7PS-1** block was a stroboscopic probe with a bandwidth of **700 MHz** and an input impedance of **100 kOhm,**
which made it possible to conveniently connect it to any point of the device under study.

Block **7PS-2** had a pass-through type input mixer with 50-ohm characteristic impedance and **2 GHz** bandwidth . This mixer was especially effective for measuring distributed circuits using pulse reflectometry.

The most broadband unit was **7PS-3.** Its bandwidth reached **5 GHz,** the loads were placed inside the unit. It was used to measure the shortest pulses signals and microwave oscillations.

The **7RS-1** scanning unit provided a maximum scanning speed of 100 ps/division, synchronization up to 1 GHz with an instability of 50 ps.

Mikhail Ivanovich Gryaznov

The oscilloscope can allowed control operating main modes directly from the front panel or How remotely from the control panel, and if you had a programmer, it was possible to control the modes according to a specific specified program.

Chief designer of the development of S7-7 and S7-9 Doctor of Technical Sciences M.I. Gryaznov.

Scope of application - automatic and semi-automatic measuring complexes and systems for measuring the dynamic parameters of high-speed electronic devices.

Parameters of the S7-9 stroboscopic oscilloscope :

- CRT screen 60x80 mm,
- number of channels - 2,
- band with 7PS-1 - **700 MHz,** PH-0.5 ns, Rin-100 kOhm,
- band with 7PS-2 - **2 GHz,** PH-0.15 ns, Rin-50 Ohm,
- band with 7PS-3 - **5 GHz,** PH-0.07 ns, Rin-50 Ohm,
- noise 1.5 mV, harmony. 1 mV,
- sensitive. 10 mV-200 mV/d,
- sweep 0.1 ns-10 ÿs/d,
- synchronization up to 1 GHz,
- consumption power. 400 VA,
- weight 58 kg.

Thanks to the use of **the 9ADSP-1** analog-to-digital converter , which was essentially a specialized computing unit, the oscilloscope provided measurement of signal parameters, output of measurement results to the built-in digital display and to peripheral devices (perforator, digital digital processor) in a standard code, as well as tolerance control . The devices were demonstrated at an international exhibition in

Leipzig in 1965 and were awarded medals.

The next stage in the development of this direction was the creation in **1973** of **the S7-12** stroboscopic oscilloscope with replaceable units for the **5** and **0.7 GHz band.** A special feature of this oscilloscope is the ability to use it to study signals that repeat at a low frequency (from 50 Hz).

The chief designer of the development, V.V. Tsal, proposed gating signals not with single pulses, but with repeating ones with a frequency much higher than the repetition frequency ("comb" of strobe pulses), which made it possible to reduce the signal processing time by T/ÿt times (T is the signal repetition period , ÿt –

repetition period of strobe pulses in the "comb"). Among specialists, the "comb" was often called a "pack," and the regime itself was
combined.

The device kit included two replaceable transducer blocks and a replaceable scanner.

The 12PS-1 unit had a switchable bandwidth of 700 MHz or 120 MHz. In the second case, the sensitivity of the oscilloscope could be 0.5 mV/division with an rms noise level of 0.3 mV.

The 12PS-2 unit had a bandwidth of 5 GHz and made it possible to study transient processes with a rise time of 0.1 ns or more.

A special feature of the 12RS-1 scanning unit was its very wide range of scanning coefficients - from nanosecond to second duration ranges. In those years, such a sweep range could only be covered by the combined use of stroboscopic and conventional oscilloscopes.

The scan worked in both traditional stroboscopic mode, combined mode, and also in real time. A characteristic difference from other stroboscopic oscilloscopes was the "Time Magnifier", in which part

The signal under study could be stretched in time by 2, 5 or 10 times. In this case, the entire signal could be observed simultaneously on another scan line.

Stroboscopic oscilloscope **S7-12 (5 GHz, 700 MHz)**

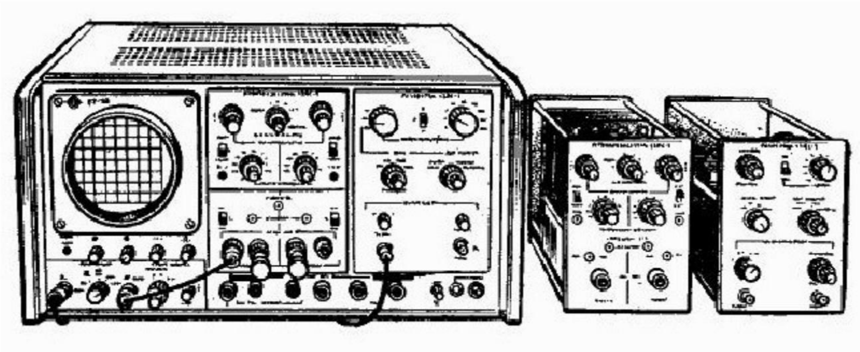
Parameters of the S7-12 stroboscopic oscilloscope :
- CRT screen 60x80 mm,
- number of channels - 2,
- band with 12PS-1 - **700 MHz,** PH-0.5 ns, Rin-100 kOhm,
- band from 12PS-2 - **5 GHz,** PH-0 0.07 ns, Rvh-50 Ohm,
- noise 1.5 mV, harmony. 1 mV,
- sensitive. 5 mV-200 mV/d,
- feelings 0.5-200 mV/d, (120 MHz)
- sweep 0.2 ns-0.5 s/d,
- synchronization 50 Hz-0.3 GHz,
- consumption power. 185 VA,
- weight 31 kg.

An important stage in the development of broadband stroboscopic oscillography was the development in **1975** and then serial production of the **S7-13 oscilloscope,** with a bandwidth of **10 GHz,** which set a new record in the USSR for the bandwidth of an oscilloscope.

Oscilloscopes **S7-13** consist of a base unit of the oscilloscope S7-13 with a set of spare and auxiliary equipment and replaceable units: **12PS-1, 13PS-1** (converter) and **12RS-1, 13RS-1** (sweep).

The oscilloscope was built on the basis of the S7-12 device with the replacement of conversion and scanning units. This was the first domestic stroboscopic oscilloscope that made it possible to observe and measure the parameters of picosecond signals (from 35 ps or more) in a band up to **10 GHz.**

A significant role in the development was played by the use of an original stroboscopic mixer, which allowed two times to expand the bandwidth and improve the manufacturability of its production compared to foreign analogues. Author inventions – Ph.D. V.M. Goryachev.



Stroboscopic oscilloscope **S7-13, (10 GHz, 700 MHz)**

It was also significant that thanks to the joint efforts of the oscilloscope developers and specialists from the development institutes of the Ministry of Electronic Industry, they were created and mass-produced

ultra-fast semiconductor diodes used in the stroboscopic mixer.

Parameters of the S7-13 stroboscopic oscilloscope :
- CRT screen 60x80 mm,
- number of channels - 2,
- band with 12PS-1 - **700 MHz,** PH-0.5 ns, Rin-1 MOhm/50 Ohm,
- band with 13PS-1 - **10 GHz,** PH-35 ps, Rin-50 Ohm, noise 3.3 mV,
- sensitive. 5 mV-200 mV/d,
- unfold. 12RS-1: 0.2 ns-0.5 s/d, at sync. up to 300 MHz,
- sync. With Ya4S-20A - 6 GHz,
- unfold. 13RS-1: 0.02 ns-0.5 µs/d, with synchronization. up to 500 MHz,
- consumption power. 185 VA,
- weight 31 kg.

Oscilloscopes S7-12 and S7-13 were mass-produced at the Minsk Kalibr plant. Plant workers V.G. Kats, V.E. Aleksandrov, B.A. Brilevsky actively participated in the development of documentation and, as a result, ensured stable production of devices for a number of years. Both oscilloscopes were widely used both in the USSR and abroad.

The main designer of this development was Doctor of Technical Sciences. Yu.A. Ryabinin. The chief designer

of the S7-13 oscilloscope, Yuri Aleksandrovich Ryabinin, was born in 1932 in Gorky. In 1956 he graduated from the Gorky Polytechnic Institute named after. A.A. Zhdanov, majoring in radio engineering.

His master's thesis “Study of stationary self-oscillations in pulse generators with delayed feedback” was defended by him in 1963 at the Gorky Polytechnic Institute, scientific advisor - Professor L.A. Morugin.

Yuri Alexandrovich Ryabinin

Doctoral dissertation “Theory and practice of constructing picosecond measuring devices with argument conversion”

temporarily

defended in 1983 at Kaunas Polytechnic

Institute, scientific consultant - academician of the Lithuanian Academy of Sciences D.Yu. Eidukas.

A student of the scientific school of Professor L.A. Morugin and Professor G.V. Glebovich. Main directions of scientific activity: nano- and picosecond pulse technology; oscillographic ultra-wideband pulse signals; stroboscopic conversion of picosecond signals; the use of nano- and picosecond pulses in measuring technology study, industry and national defense (antenna measurements, geolocation, medical research). Yuri Aleksandrovich Ryabinin developed the scientific direction -

stroboscopic oscillography of picosecond pulse signals (design theory, development of ultra-wideband pulse

oscilloscopes and

measuring instruments, application of developed methods and equipment). In the 60s and 70s, under the

direct supervision of Yu.A. Ryabinin, a number of research projects were carried out, which laid the foundation for the development of domestic stroboscopic oscilloscopes. He is the author of more than 100 published scientific works, including 4 monographs, one of them is

“Stroboscopic Oscillography” (1972). Two doctoral and two candidate

dissertations were defended under the scientific supervision of Yu.A. Ryabinin. Corresponding member of the Metrological Academy, in the 1990s - member of the International Working Group of the Technical Committee TK-85 of the International Electrotechnical Commission (IEC) to develop a standard for electromagnetic compatibility of technical equipment.

In **1985 , the S7-16** was developed - a computing oscilloscope with a bandwidth of **800 MHz,** with high measurement accuracy (chief designer V.V. Tsal).

Parameters of the **S7-16 oscilloscope:**
- screen ELT 100x120 mm,
- number of channels - 2,
- polosa **800 MGc,** PH-0.45 ns, Rvh-50 Ohm,
- heard 2 mV-200 mV/d,
- development 0.1 ns-50 µs/d, **- block of computational parameters,**
- **error correction 2-4%,**
- delay block,
- consumption power. 250 VA,
- weight 30+30=60 kg.

Computational stroboscopic oscilloscope **S7-16** (800 MHz)

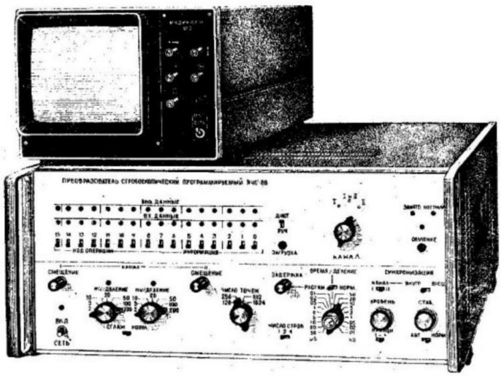
An important trend in the development of stroboscopic oscilloscopes has been the automation of measurements, a wide choice of conversion methods, signal separation from noise, and sorting of elements according to groups of parameters.

The oscilloscope turned into a complex measuring and computing device to satisfy
complex capable

researcher of the highest level:

- carry out measurements of inhomogeneities in transmission lines,
- perform the functions of a spectrum analyzer, - a meter of parameters of microwave nodes, - noise measurements with determination of their statistical characteristics.

In **1986 , S7-17** was developed - a computing programmable stroboscopic oscilloscope with a bandwidth of **600 MHz,** with automatic measurements of signal parameters (chief designer V.V. Shcherbakov).



Parameters of the **S7-16 oscilloscope:**

- screen ELT 100x120 mm,
- number of channels - 2,
- half **600 MGc,** PH-0.5 ns, Rvh-50 Ohm,
- feelings. 2 mV-200 mV/d,
- development 0.1 ns-50 µs/ d, **- IF with SM-1, M-6000,**
- measurement error. 1-2%,
- consumption power. 330 VA,
- weight 27+13=40 kg.

Computational stroboscopic oscilloscope **S7-16** (800 MHz)

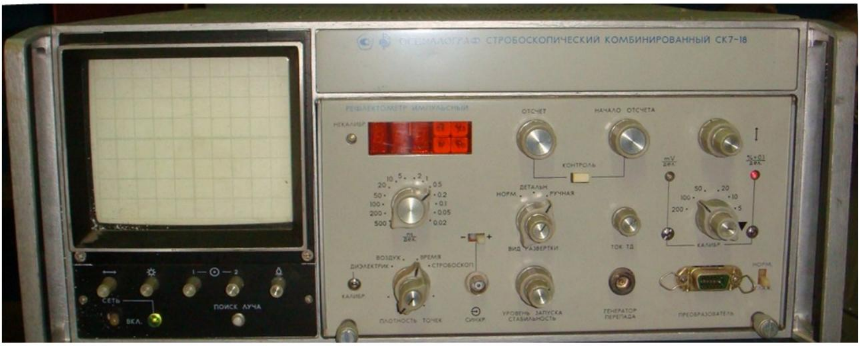
S7-17 provides the issuance of signal codes in TTL levels, through the IF to an external computer such as SM-1 or M6000 for processing the signal and calculating its parameters.

In **1986 ,** the stroboscopic oscilloscope was developed **SK7-18,** for the **10 GHz band.** This device had two operating modes - oscillographic and reflectometric.

It contained a voltage drop with a probe pulse rise time of less than 70 ps. In pulse reflectometer mode , the device made it possible to determine the reflection coefficient of a pulse from a given inhomogeneity, the distance to it and the nature of the inhomogeneity with high resolution (1 cm in the distance between two adjacent inhomogeneities in lines with an air dielectric).

The signals reflected from line inhomogeneities are observed on the oscilloscope screen. Digital readout made it possible to quickly and with large accuracy determine location heterogeneities.

The main designer of this complex was Doctor of Technical Sciences. M.I. Gryaznov.



Stroboscopic oscilloscope-reflectometer **SK7-18, (10 GHz)**

Parameters of the **SK7-18 stroboscopic oscilloscope:**
- screen ELT 100x120 mm,
- number of channels - 1,
- **10 GHz band,** PH-35 ps,
- Rvh-50 Ohm,
- sensitive. 5 mV-200 mV/d,
- sweep 0.2 ns-0.5 ÿs/d,
- **maximum distance 750 m,**
- **permission capacity 1 cm,**
- consumption power. 165 VA,
- weight 28 kg.

The apotheosis of the development of the direction of automation of measurements and expansion of bandwidth was the creation in **1983** of the S9-11 high-precision stroboscopic oscilloscope , per band **26 GHz,** which was a combination of an ultra-wideband oscilloscope and a microprocessor-based computing device (chief designer of the complex, Doctor of Technical Sciences A.V. Andriyanov).

This multifunctional two-channel oscilloscope-reflectometer set a new record for bandwidth in the USSR, and allowed additional measurements wave impedance of microwave transmission lines, VSWR, attenuation and S-parameters of microwave circuits. It was truly an outstanding, advanced device that met the most stringent modern requirements at that time.

Stroboscopic oscilloscope-reflectometer **S9-11, (26 GHz)**

Parameters of the S9-11 stroboscopic oscilloscope :
- screen ELT 100x120 mm,
- number of channels - 2,
- band with PS-1 – **1 GHz,** Rin-100 kOhm, noise – 1 mV,
- band with PS-18 - **18 GHz,** Rin-50 Ohm, noise 3.5 mV,
- band with PS-26 - **26 GHz,** Rin-50 Ohm, noise 5 mV,
- sensitive. 2 mV-200 mV/d,
- sweep: 10 ps-0.1 s/d,
- **error by time 0.3%,**
- **error by voltage 0.5%,**
- averaging up to 1024 signals,
- resolution of the reflectometer 5 mm,
- front probe. pulse 25 ps,
- spectral analysis,
- wave measurements. resistance, VSWR, osbl., modul. param.,
- **ADC 10 bit, memory 512 min.,**
- **microprocessor, IF-KOP,**
- consumption Power. 400 VA,
- weight 32 kg.

The chief designer of this complex, multifunctional complex and high-precision instrument was Doctor of Technical Sciences. A.V. Andriyanov.

Andriyanov, Alexander Vladimirovich - Doctor of Technical Sciences, Professor, born in 1951 in Gorky.

1973 - Candidate of Technical Sciences (at 22 years old),

1976 - Doctor of Technical Sciences, (at 25 years old),

1973-1976 — senior researcher at GNIPI, (22-25 years old),

1976 - senior lecturer at NSTU,

1976-1980 - boss sector GNIPI, (25-29 years old),

1980-1989 - Head of the Nizhny Novgorod Research Department of the Instrument-Making Institute "Kvarts", (29-38 years old),

1989-1998 - Professor of the Department of Radio Communications and Television Engineering, Nizhny Novgorod State Technical University, (38-47 years old),

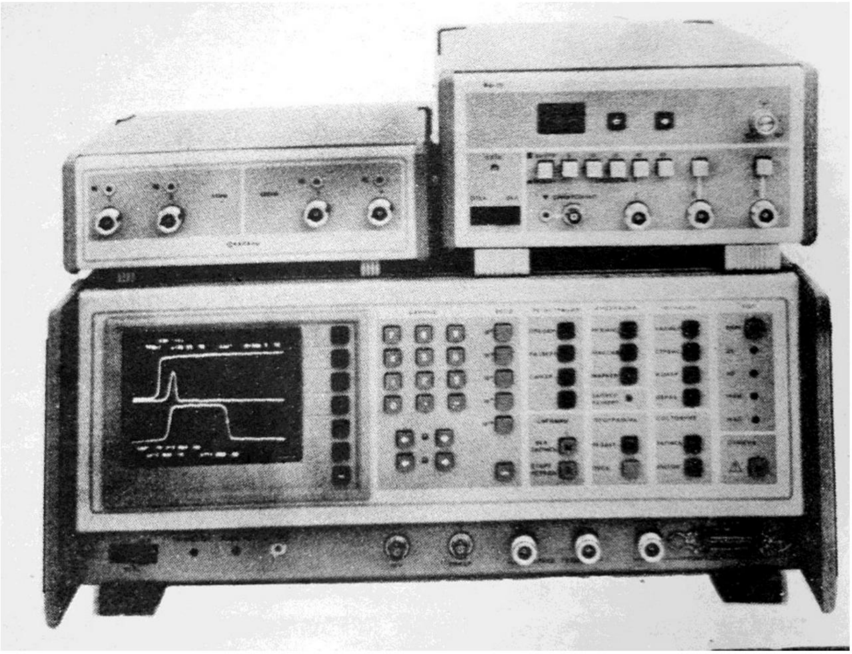
1998 - Head of the department of the special design bureau of radio measuring equipment.

Chief designer of the S9-11 stroboscopic oscilloscope

1999 - Professor of the Department of Information Radio Systems of NSTU,

1994-2005 - General Director of Scientific and Technical Enterprise Tensor LLC, Nizhny Novgorod (Russia), (43-54 years old).

The successful use of stroboscopic oscilloscopes in conjunction with picosecond pulse generators has found its place in measuring antenna parameters, as well as circuit parameters. The conducted studies showed the need to create a precision time sweep of oscillographic instruments in order to reduce the error in measuring frequency parameters. In **1990 ,** as part of the Corvette research and development work at NNIPI "Kvarts", a specialized oscillographic unit **K2-63** was developed for the **12 GHz band,** consisting of a stroboscopic oscilloscope and a pulse generator that generates differences voltages with an amplitude of up to 30 V with a rise time of 50 ps, as well as video pulses with a duration of 100 and 250 ps with an amplitude of 40 V. The main emphasis in development is on creating a highly stable time base and generators with extremely low time instability.



Oscillographic stroboscopic AIS **K2-63** (12 GHz)

Parameters of stroboscopic AIS **K2-63:**

- CRT screen 80x100 mm,
- number of channels - 4,

- 1 and 2 inputs, band – **12 GHz,**
Rvh-50 Ohm, noise – 1 mV,
- 3 and 4 input, band - **6 GHz,**
Rvh-50 Ohm, noise 0.5 mV,

- sensitive. 2 mV-200 mV/d,

- pulse generator:
30-40 V, duration. 100 ns,
pulse 1 – 30 V/80 ps,
pulse 2 – 40 V/250 ps,
pulse 3 – 50 ps.
- MP, IF- IEC-625,
- weight:
binder 35 kg,
converter 5 kg,
generator 10 kg,
total 50 kg.

The K2-63 installation contained a 4-channel stroboscopic converter with a bandwidth of 12 GHz and a time base that made it possible to maintain extremely low long-term (delay) and short-term (jitter) temporal stability of the recorded pulse. Jitter and signal drift did not exceed 1 ps, and the sweep error did not exceed 0.1%. The installation was produced at NNIPI “Kvarts” for customers related to measurements of antenna parameters, microwave components and dielectric spectroscopy.

The chief designer of the development was A.V. Andriyanov.

Notable publishing activity should be noted oscilloscope development managers – institute employees GNIPI.

So, in 1972, the Soviet Radio publishing house published Yu. Ryabinin’s monograph “Stroboscopic Oscillography”, and in 1979 the three-volume “Handbook of Radio Measuring Instruments” edited by V.S. Nasonova.

Subsequently, the results of the developments of the authors M.I. were summarized and published. Gryaznova, M.L. Gurevich and Yu.A. Ryabinin in the monograph “Measurement of Pulse Parameters”, and numerous articles in technical journals of the industry.

4.6. Oscilloscopes of independent Russia since 1994

4.6.1. Research and production company "Promribor NN"

In November 1994, on the basis of the digital oscillography department Nizhny Novgorod NNIPI “Quartz” A.A. Tereshenkov A.G. Milekhin and created the research and production company “Promribor”. The core of the team of the new enterprise

was made up of employees of the digital oscilloscopes department of NNIPI - a close-knit team of professionals. Behind the shoulders of this team is the creation of digital

oscilloscopes C9-8 (chief designer I.D. Bolshagin), C9-16 (chief designer A.A. Tereshenkov) and C9-27 (chief designer A.A. Abramovich), as well as the development of a digital oscilloscope with a strip 400 MHz on the topic “Soliton” (chief designer A.A. Gushchin) and the creation of many other devices, as well as dozens of scientific works. A team of developers led by A.G. Milekhin was invited to Yugoslavia to work with the goal of creating a promising digital oscilloscope.

For the creation of measuring instruments, many employees were awarded VDNKh medals of various denominations: A.A. Tereshenkov - 4 medals, A.G. Milekhin - 4 medals, I.A. Zalesskaya - 2 medals, N.V. Vetelev - 2 medals. A.G. Milekhin and A.A. Gushchin had degrees of candidates of technical sciences.

The basis of the company's activities since **1995** has been the development of the latest portable digital oscilloscopes **S1-154, S1-155** for that time . A.G. Milekhin, A.A. Tereshenkov, A.A. Gushchin, M.N. Perlmutter, G.N. Pribilova, A.V. Kravchenko, N.V. Vetelev took part in the development.

By the end of **1997 ,** the work was completed with the transfer of documentation for development to the plant named after. Frunze in Nizhny Novgorod, and the Moscow Measuring Equipment Plant (MZIA). It should be noted that these devices were produced before the present war and are used by the Ministry of Defense at their facilities, which

imposed additional requirements on the reliability and maintainability of devices, as well as on the conditions of their operation.

The **S1-154** oscilloscope had two channels and made it possible to record periodic signals in the range from 10 mV to 200 V in a bandwidth of up to **100 MHz.** One-time registration

signals in the same dynamic range were determined by a sampling frequency of 20 MHz, and the bandwidth
single signals was 2 MHz.

The S1-155 oscilloscope was different in that it was a single-channel device, its bandwidth was 50 MHz, but it had a built-in multimeter.

It should be noted that in these devices, the equivalent sampling frequency mode at fast sweeps was finally implemented, unlike previous devices.

Digital oscilloscopes **S1-154/S1-155** (100/50 MHz)

Parameters of the digital oscilloscope **S1-154:**
- CRT screen 53x70 mm,
- number of channels - 2,
- signal strip: repeating/ /single **100 MHz/2 MHz,**
- sensitive. 10 mV-5 V/d, +/-2%,
- signal delay/pre-recording,
- sweep 0.1 ms-2 s/d, +/-0.3% at sampling up to 20 MHz,
- sweep 10 ns-50 μs/d, +/-2% at equivalent. sampling up to 10 GHz,
- digital memory 2048x8 bits, **- signal search (adaptation),**
- author measurements 5 parameters signal
- **marker measurements,**
- **interface RS-232,**
- consumption power. 60 VA,
- weight 9 kg.

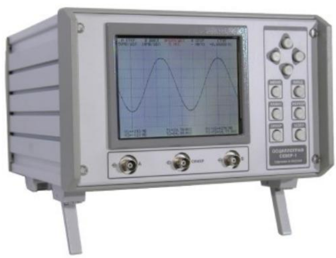
Parameters of the digital oscilloscope **S1-155:**
- CRT screen 53x70 mm,
- number of channels - 1,
- signal bandwidth: repeat//single **50 MHz/2 MHz,**
- sensitive. 10 mV-5 V/d, +/-2%,
- signal delay/pre-recording,
- sweep 0.1 ms-2 s/d, +/-0.3% at sampling up to 20 MHz,
- sweep 20 ns-50 µs/d, +/-2% at equivalent. sampling up to 10 GHz,
- digital memory 2048x8 bits, **- signal search (adaptation),**
- **author measurements 5 parameters signal**
- **marker measurements,**
- **interface RS-232,**
- **multimeter for measurements. U,I,R,**
- consumption power. 50 VA,
- weight 8 kg.

In these devices, as in the previous S9-8 and S9-16,

kinescope.

In **1996 ,** the development and production of a pilot batch of **S8-30 oscilloscopes was completed.** Due to the fall in funding in the field of science and industry, the serial production of these oscilloscopes was not mastered.

However, the level and quality of the developed oscilloscope is confirmed by the fact that its metrological characteristics and developed synchronization system allow this device to be used for modern developments even many years after its creation.



Digital oscilloscope **Sever-1** Digital oscilloscope **S8-30**

A significant event **in 2003** was the resumption of work on digital oscillography, for the first time after the completion of work on the S1-154 and S1-155 oscilloscopes.

According to the contract with MZIA, work on the creation of a new digital oscilloscope **"Sever-1" was started.** A. A. Tereshenkov, I. A. Zalesskaya, A. A. Gushchin, M. N. Perlmutter, V. B. Ilyin, N. A. Nikolaev took part in the project.

The developers were tasked with creating in the shortest possible time an inexpensive, modern, portable oscilloscope with a color LCD display in a unified housing used for the S4-Saturn spectrum analyzer. The design experience and professionalism of the employees made it possible to achieve the task, and certification tests of the device were successfully completed by mid-2004.

Parameters of the digital oscilloscope **Sever-1:**
- number of channels - 2,
- signal bandwidth : repeat//single **50 MHz/2 MHz,**
- sensitive. 10 mV-5 V/d, +/-2%,
- signal delay/pre-recording,
- sweep 0.1 ms-2 s/d, +/-0.3% at sampling up to 20 MHz,
- sweep 20 ns-50 µs/d, +/-2% at equivalent. sampling up to 10 GHz,
- digital memory 2048x8 bits, **- signal search (adaptation),**
- author measurements 5 parameters signal
- **marker measurements,**
- **interface RS-232,**
- consumption power. 10 VA,

For a long time, NPF "Prompribor" was a modern, dynamically developing company specializing in the development and production of high-tech, knowledge-intensive measuring equipment, as well as in the field of thermal power engineering, electrical power engineering and radio engineering. However, in October 2012 the organization was

liquidated due to merger with another enterprise.

4.6.2. Scientific and technical enterprise "Tensor"

The scientific and technical enterprise "Tensor" was founded in 1994 and is located in Nizhny Novgorod.

General Director of the enterprise - Doctor of Technical Sciences, Prof. Alexander Andriyanov, in the recent past, head of the department of stroboscopic oscilloscopes at GNIPI.

The company specializes in the development and manufacture of devices using ultra-wideband measuring signals of nano- and picosecond duration.

The company supports the following areas of activity:
- formation, emission and reception of nano- and picosecond duration;
- sensors and radars that use ultra-wideband measuring signals and are used in road construction, security systems, medicine and other fields of science and technology, - measurements of parameters of signals, microwave components and paths

in the time domain, - digital communication systems, - antenna measurements,
- radio measuring instrument making.

In 2005, the universal pulse generator G5-100 was developed and began to be mass-produced, and then the pulse generator G5-102 with improved characteristics, which largely filled the need for pulse generators.

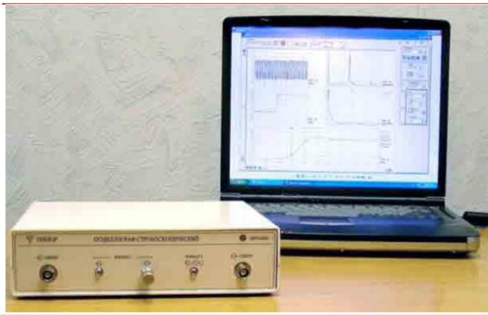
Since 2008, the production of selective voltmeters V6-17 and V6-18 with a frequency range up to 2 GHz.

In 2010, a group of low-frequency signal generators G3-135 - G3-137 was developed, characterized by a low level of harmonic distortion (G3-136) and an increased level of output power (G3-137).

The company has created and produces a multifunctional small-sized measuring unit for the microwave range **K2-92,** including a PC, a stroboscopic recorder with four independent scans, a pulse reflectometer with a resolution of 1 cm, a spectral signal analyzer based on the fast Fourier transform algorithm; as well as a VSWR, attenuation and impedance meter.

The stroboscopic transducer included in the system can have a bandwidth of **12 GHz, 18 GHz** and **37 GHz.**

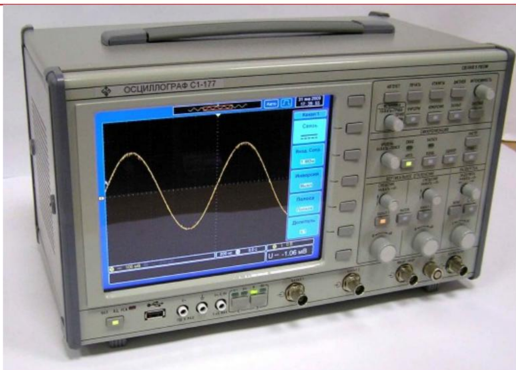
The built-in voltage differential generator has a rise time of less than 50 ps. The device works with a computer via USB 2.0 interface. Additionally, pulse shapers with various additional parameters can be supplied.



Parameters of **the K2-92 measuring setup:**
- band **12, 18, 37 GHz,**
- number of channels -2,
- sensitive 2 mV-200 mV/d, - sweep 10 ps-10 µs/d,
- error by time 0.3%,
- error by voltage 1-2%,
- memory from 256 to 2048 points,
- synchronization up to 2 GHz,
- weight 3 kg.

Oscillographic installation **K2-92** of the Tensor company

In **2014 ,** the Tensor enterprise developed a universal digital oscilloscope S1-177 with a built-in multimeter, a sampling frequency of 2 GHz and a bandwidth of 350 MHz.



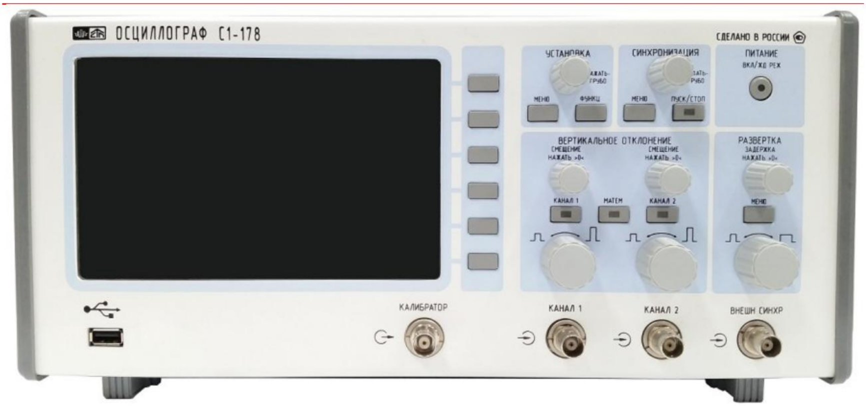
Parameters of the digital oscilloscope **S1-177:**
- **350 MHz band,**
- number of channels - 2,
- sampling up to **2 GHz,**
- sensitive. 5 mV-5 V/d,
- sweep 1 ns-0.5 s/d,
- error 2.5%,
- multimeter for measured. U,I,R, +/-2%,
- **auto signal search,**
- **author change parameters,**
- weight 7.5 kg, IF-USB.

Digital oscilloscope **S1-177** (350 MHz, 2000 Mv/s)

Despite the harsh operating conditions, the oscilloscope uses a hard drive and a built-in operating system

Windows. In many ways, high technical characteristics were achieved due to the original program for digital correction of the transient response of the oscilloscope, which allows the reduction of the real transient response to the required one.

The need for a cheaper oscilloscope for the needs of ordinary consumers for harsh operating conditions led to the development and start of production in **2019** of the **C1-178** digital oscilloscope with a sampling frequency of **1 GHz** and a bandwidth of up to **200 MHz.**



Digital oscilloscope **S1-178** (200 MHz, 1000 Mv/s)

The S1-178 oscilloscope allows you to automatically measure all the main parameters of signals and compare them with a template. At the same time, it has low power consumption, the ability to be powered from a direct voltage source of 10 - 15 V and an alternating voltage source of 100 -264 V with a frequency of 47 - 440 Hz.

The chief designer of Supertechpribor CJSC, Ivan Antonovich Shaiko, who served from 1997 to 2008 as the head of the Metrological Service of the Armed Forces of the Russian Federation, took an active part in shaping the appearance, development, and also in mastering the production of oscilloscopes S1-177 and S1-178.

4.7. Results of GNIPI in the field of oscillography.

Over **30 years** at GNIPI, during the USSR, within the framework of the 6th Main Directorate of the Moscow State Scientific-Industrial System, (from **1962** to **1992),** about **23** models and modifications (delivery options) of oscilloscopes were developed , including 15 types of replacement units for oscilloscopes. This accounting takes into account all modifications, including stroboscopic oscilloscope converter units.

with various replaceable

This number did not include the experimental devices-installations OKR-1, OKR-2 and OKR-5, developed in 1936-39 at the Nizhny Novgorod Radio Laboratory (NRL), and OS-1, OS-2, OS-3 developed at the Research Institute -11/TsNII-11, since they are not serial industrial devices.

In terms of the number of models developed in the period 1962-1992, GNIPI took the last 4th place among the 4 research institutes that developed oscilloscopes in the USSR (see table in section 1.15), having developed 9.8% of the models.

But, despite this, the developers of GNIPI oscilloscopes made a very important contribution to the development of oscillography in the USSR, especially in terms of stroboscopic and digital oscilloscopes.

The following oscilloscope models were developed here:

- universal, with replaceable blocks: SK1-95, SK1-110, SK1-111;
- digital: S9-8, S9-16, S9-27;
- stroboscopic: S1-21, S7-5/5ps-1, S7-5/5ps-2, S7-7, S7-9/7ps-1, S7-9/7ps-2, S7-9/7ps-3 , S7-12/12ps-1, S7-12/12ps-2, S7-13/12ps-1, S7-13/13ps-1, S9-11/ps-1, S9-11/ps-18, S9-11/ps-26, S7-16, S7-17, SK7-18.

Scroll everyone oscilloscopes developed by the oscillographic V divisions of GNIPI, as well as the years of their creation, main characteristics and the name of the manufacturer are given in Appendix 4, at the end of the book.

It should be noted that the most broadband stroboscopic oscilloscopes in the USSR were developed here.
GNIPI owns 5 out of 7 records for bandwidth
transmission of stroboscopic oscilloscopes. An important part

oscillographs from GNIPI are also digital oscilloscopes that were in demand and were mass-produced.

In Gorky, 3 types of oscilloscopes out of 10 were developed (in Minsk 5 out of 10, in Lvov 6 out of 10, and in Vilnius 9 out of 10, see table in section 1.15), these are oscilloscopes with replaceable units (OSB), digital and stroboscopic oscilloscopes.

In one type of oscilloscope out of 10, GNIPI was the leader in the USSR in terms of the number of developments. These are stroboscopic oscilloscopes. 17 models were developed.

It is necessary to note the achievements of GNIPI in the field oscillography marked **"Developed for the first time in the USSR":**

- the first and most broadband stroboscopic oscilloscope in the USSR **S1-21** for a **200 MHz band,** in the form of an attachment to S1-19 or S1-30 (1962),
- strobe - oscilloscope at **2 GHz, S7-5/5ps-2,** 1965,
- strobe - **5 GHz oscilloscope, S7-9/7ps-3,** 1970,
- strobe oscilloscope at **10 GHz, S7-13/13ps-1,** 1975,
- strobe - oscilloscope at **26 GHz, S9-11/ps-26,** 1983,
- digital oscilloscope, with sampling **20 MHz, S9-8,** 1981,

- digital oscilloscope, in serial production with sampling **100 MHz, S9-27,** 1988,

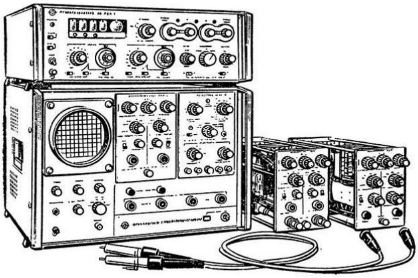
The total achievements of GNIPI in the field of oscillography over 30 years, marked "Developed for the first time in the USSR," are six **(6).**

After 1992, developers of digital and oscillographic instruments formed two private enterprises, which developed 7 oscillographic instruments. Today, only one of them really works.

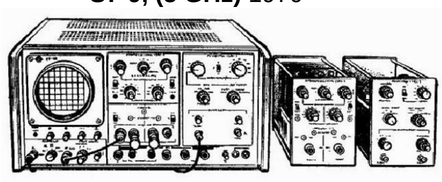
Of course, GNIPI made a significant contribution to the development of the oscillographic industry, and took its rightful place in the history of oscillography of the USSR. He has outstanding achievements both in the number of developments of stroboscopic oscilloscopes and in the number of records for the bandwidth of these devices. The achievements of GNIPI in the field of digital oscilloscopes are also important.

Outstanding oscilloscopes developed at GNIPI, and having the status **"Developed for the first time in the USSR":**

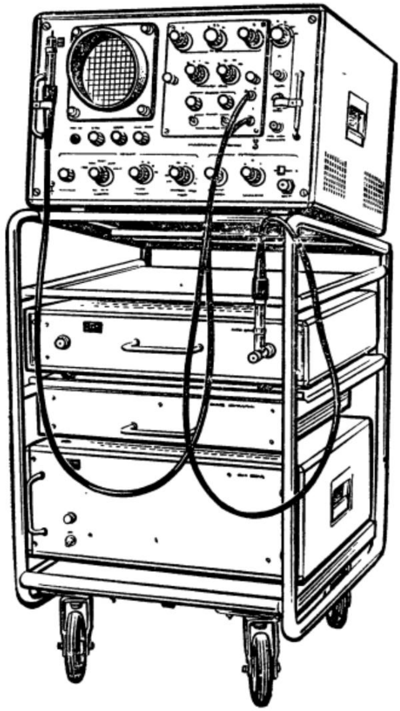
S1-21, (200 MHz) 1962



S7-9, (5 GHz) 1970

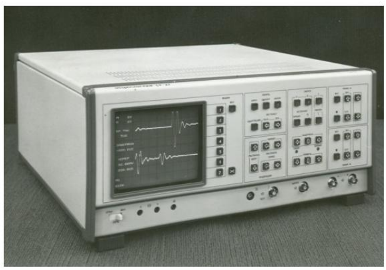


S7-13, (10 GHz) 1975



S7-5 (2 GHz) 1965

S9-8 (2.5 MHz, 20 MV/s) 1981



S9-27 (17 MHz, 100 MV/s) 1988

Chapter 5. Summary and comparison of results activities of VNIIRIP, LNIRTI, MNIPI and GNIPI.

For comparison, it is advisable to consider devices of only one type (species), and, if possible, developments from the same time period, provided that they were developed in different research institutes.
Memory, special and TV devices cannot be compared, since they were not developed in different research institutes.

5.1. Oscilloscopes with replaceable units (OSB)

The most common type of oscilloscopes in the USSR, in terms of the number of models developed, were oscilloscopes with replaceable blocks (OSB).

However, judging by production volumes in monetary terms, OSB also took first place among the other 10 types of oscilloscopes. Their share accounted for, for example, up to 43% of the production volumes of VNIIRIP oscilloscopes in 1984-1992, as can be seen from the corresponding tables in Appendix 1.

Our American colleagues had exactly the same picture; most of the Tektronics catalogs were occupied by OSB models of the 7000 and 5000 series, and it was clear that this was their main product. Top devices with extreme characteristics were also released only in the main series OSB Tek 7000, (later Tek 11000).

The development of these devices was carried out by three developing research institutes - GNIPI, LNIRTI and VNIIRIP.

All 53 OSB models, their developer, and their main parameters are given in a single table in Appendix 5.1.

Three generations of OSB were developed at VNIIRIP:

- the first, lamp-based - “Backstage”, S1-15 and S1-17, described in section 1.4., (there was also a not entirely successful attempt to create such a family before, based on OSB S1-8A, described in section 1.3);

- second, transistor - “Snaige”, S1-70 (A), S1-74, S8-12, S8-13, C8-14, described in section 1.6.1;
- third, using m/s - “Light”, S1-91, S1-115, S1-122, S8-21, Ya4S-111, described in section 1.6.2.

The OSB family, SK1-95/110/111, developed at GNIPI on the topic “Scorpio” is described in detail in section 4.3.

OSB family developed at LNIRTI - S1-80/1/2/3 on the topic "Snow", described in detail in section 2.6.10.

As already mentioned in the above sections, the OSB families of GNIPI and LNIRTI, for various reasons, could not be mastered in mass production, and they were not mass-produced. These families belonged to the third generation of OSB. While all three families (generations) of OSB developed by VNIIRIP were mass-produced for many years at

various factories in the industry and became their main products.

For this reason, a direct comparison of the OSB families developed by GNIPI and LNIRTI with the VNIIRIP families is not possible.

In this type of oscilloscopes, VNIIRIP, as a developer, took in the USSR the main and, practically, monopoly position.

It is possible to compare only different generations of OSB, VNIIRIP developments, which were mass-produced, to trace the development trends of OSB type oscillography.

From Appendix Table 5.1 it can be seen that when moving from generation to generation, the average bandwidth of OSB families always doubled. So in the 1st generation it was **25 MHz,** in the 2nd - **50 MHz,** and in the 3rd - already **100 MHz.**

At the same time, the average sensitivity of the devices increased steadily, first **50** mV/div., then **10** mV/div., and then **5** mV/div. The size of the CRT screen also increased. At the same time I was falling average power consumption **700, 250, 200** VA, and weight **42, 28** and **22** kg.

A sharp jump in the level of parameters is noticeable when moving from tube (1st) generation to transistor (2nd) generation. It should be noted that at the same time, both the measurement accuracy and the functionality were expanded. During the transition from one generation to another, also in these

families, the number of both basic (BB) and replaceable units increased (SB):

1st generation, 2 BB, 7 SB, total 9 blocks,

2nd generation, 5 BB, 11 SB, total 16 blocks,

3rd generation, 5 BB, 15 SB. only 20 blocks.

Thus, in this type of oscilloscopes, such as OSB, the main direction of oscillography in the USSR, VNIIRIP was the undisputed and uncontested leader, having developed 45 out of 53 instruments, the vast majority of which were produced in large quantities. While 4 such devices developed in LNIRTI and GNIPI, respectively, unfortunately, they were not mastered in production and were not mass-produced.

5.2. Low frequency oscilloscopes (LFOS)

Low frequency (LF) oscilloscopes are versatile oscilloscopes, with a bandwidth of up to 10 (15) MHz.

All 40 NMO models, their developer, and main parameters are given in a single table in Appendix 5.2. From this table and the table in Appendix 5, it is clear that devices of this type were developed in Lvov, Vilnius and Minsk. Moreover, the clear leader in this type of devices was Lvov (LNIRTI), 22 NMOs were developed there, 11 in Vilnius, and

only 7 such devices in Minsk. This is due to the specialization of these research institutes in oscillographic topics on the scale of the USSR.

At first, in the 50s, when only VNIIRIP was engaged in oscillography, and specialization in different types of oscilloscopes there were no research institutes; Vilnius was working on these devices. But already in the 60s, 70s and 80s, this topic was transferred first to Lvov, and then to Minsk.

In Vilnius, work on the development of NMOs began earlier than anyone else, in the late 40s. In the 70s, VNIIRIP developed only 2 such devices - S1-102/103, (as an exception, with particularly high sensitivity), since such work had already been carried out in Lvov and Minsk to a sufficient extent.

In Lviv, work on the development of such devices began in the early 60s. This direction developed successfully there in the 60s and 70s. However, in the 80s, due to the transfer of LNIRTI developers to other topics, these works began to decline.

However, in the second half of the 70s, this very important and popular topic on the market was picked up by the Minsk Research Institute, and developments in this direction were successfully continued in Minsk.

The parameters of lamp NFOs from the 50s and 60s, developed in Lviv and Vilnius, are identical, taking into account the development time and functionality.

Over the 10 years from 1965 to 1975, LNIRTI switched to the development of semiconductor NMOs, which led to a 10-fold increase in increase in average sensitivity from 50 to 5 mV/div., 5-fold decrease in average power consumption (from 300 to

60 VA) and a 2-fold reduction in average weight (from 25 to 13 kg). During this period, 11 models of such devices were developed.

Over the next 10 years, from 1976 to 1986, a total of 11 NMO models were also developed at LNIRTI and MNIPI. During this period, their average sensitivity doubled, and their average weight decreased by 1/5. At the same time, functionality has expanded, including in the area of automation.

Another advantage of NMOs was their portability and resistance to harsh climatic influences, which meant the possibility of their use in field conditions, in contrast to OSB, which were intended only for laboratory use. In this regard, the developers of LNIRTI and MNIPI have achieved great success, creating additional opportunities

for NMO consumers.

5.3. Sampling Oscilloscopes (Page)

Stroboscopic oscilloscopes (Str/O) are special ultra-wideband instruments designed for observing, and measuring only repeating recording

signals, due to time scale conversion, by gating (taking samples from a repeating signal).

All 34 Str/O models, their developer, and main parameters are given in a single table in Appendix 5.3. From this table and the table in Appendix 5, it is clear that type devices were developed in Vilnius and Gorky.

At the same time, there is no clear leader in this type (type) of oscilloscopes, since VNIIRIP and GNIPI each developed 17 models of such devices.

It should be noted that Str/O were the most What broadband oscilloscopes in the world (and in the USSR). GNIPI holds 5 out of 7 records for the bandwidth of stroboscopic oscilloscopes, while VNIIRIP holds only 2 of the same records (see Section 3.5 and 1.15).

Therefore, with an equal number of developments by VNIIRP / GNIPI - 17:17, taking into account the number of records 2:5, GNIPI wins, which is the leader in this area of oscillography, since it began working on it a little earlier than VNIIRIP (by 3 years, in 1962 versus 1965, see table Applications 5.3).

According to the table of oscilloscope production volumes VNIIRIP of various types, in 1984-1992, (see table in Appendix 1) production volumes of stroboscopes are only 2.9% of total oscilloscope production. These are very small volumes, but still these devices were very important for the development and development of the elemental base of high-speed radio electronics, such as, for example, microwave transistors, diodes and microcircuits. Without these devices it is impossible to imagine increasing the capacity of communication channels and mastering new

frequency ranges. Perhaps this is why stroboscopic oscilloscopes are among the three most numerous in terms of the number of developments (34), with relatively small production volumes.

Due to the peculiarity of the technology for obtaining an image of a signal - gating technology, or taking samples from the signal under study, stroboscopic devices were closest to digital oscilloscopes, which also took samples from the signal (for subsequent AD conversion).

Therefore, in stroboscopy in the 80s, when the elemental base was ripe for this, digital technologies began to actively develop - AD conversion and storage of the signal in digital memory (CPU). Therefore, both developers of stroboscopes and VNIIRIP and GNIPI

simultaneously developed both stroboscopic and digital oscilloscopes and made significant progress in these areas.

With the advent of microprocessor technology, steel
the possibility of signal processing appears, including isolating the signal from noise, which was especially important for stroboscopes, due to the data collection technology of these devices.

Then the possibilities of automatic
calculation of signal parameters and calculation of the signal spectrum based on fast Fourier transform (FFT) algorithms, as well as other measurements and signal processing.

All this in the 80s and early 90s led to the fact that stroboscopic devices at that time became one of the most complex and expensive types of oscilloscopes.

An example is a precision special oscilloscope (an exemplary tool for testing picosecond voltage differential generators), developed at VNIIRIP - S9-9, weighing 62 kg, for the 18 GHz band, developed on the “Sigma” theme.

This device set an absolute record for the price among all
oscilloscopes of the USSR - 27,000 rubles. It consisted of 2 separate buildings, one of which collected data, and the other displayed and processed it, including separating the signal from noise and calculating the spectrum using the FFT algorithm, as well as other types of signal processing.

5.4. Service oscilloscopes (Serv)

Service oscilloscopes (Serv) are universal small-sized devices weighing less than 5 kg, designed for servicing and repairing electronic equipment on the customer's side. Hence the increased requirements for portability, minimum dimensions and weight of such devices. All 30 models of Servo/ O USSR, their developer, and main

the parameters are given in a single table in Appendix 5.4.

From this table and the table in Appendix 5, it is clear that devices of this type were developed in Vilnius, Lvov and Minsk. Moreover, the clear leader in this type of devices is Vilnius (VNIIRIP), 23 Serv/O were developed there, 5 in Lvov, and only 2 such devices in Minsk. In Vilnius, work on the development of Serv/O began earlier than anyone else, back in 1957, having developed the tube C1-6, weighing 4.5 kg. Then after a 20-year break, this work was continued in the 70s and 80s, as well as in the early 90s. This topic was assigned to VNIIRIP, as the leading organization for oscillography, within the framework of the all-Union specialization, since it was quite in demand not only in the domestic, but also in the foreign market. Service instruments were also the most popular type of oscilloscope in production. The record holder for annual production among all oscilloscopes in the USSR was the C1- device.

94, (developed by VNIRIP) with serial production - 12,681 devices per year.

These devices became one of the main sources of foreign currency for the 6th State Administration of the Moscow Postal Service, which was necessary, including to purchase modern technologies abroad.

In Lvov and Minsk, work on this topic was not widely developed, but still, within the framework of the general direction of work on miniaturization and weight reduction universal oscilloscopes, they managed to develop 7 such devices.

At first, in the 70s and early 80s, it was believed that stripes were 1-10 MHz was enough for such devices, however, as the speed of electronic technology increased, later service devices began to appear in the 20-50 MHz band.

In Lvov in 1979, a unique service oscilloscope S1-101 was developed with a minimum weight, a record in the USSR - 2.3 kg.

Over time, it became clear that in order to repair and maintain electronic equipment, in addition to an oscilloscope, you need at least a multimeter, and in some cases other devices, such as a TV signal generator, and others. And the developers began to embed such devices in Serv/O.

In general, all Serv/O developments from different research institutes have similar or similar parameters and functionality.

Service devices LNIRTI and MNIPI are more resistant to harsh operating conditions, but they also had a higher cost.

5.5. Digital and analog-to-digital oscillographs (CO/AC)

Digital (DC and AD analog-to-digital) oscilloscopes are devices built on the basis of analog-to-digital signal conversion, followed by storing it in digital memory, and outputting the signal from memory to the screen for observation and measurement, as well as its output to other devices .

This type of oscilloscope was the last to appear and began to be actively developed only in the 80s. All 28 AC/DC models, their developer, and main parameters are given in a single table in Appendix 5.5. From this table and the table in Appendix 5, it is clear that devices of this type were developed in all 4 research institutes - in Vilnius, Minsk, Gorky and Lvov.

Moreover, the clear leader in this type of devices was Vilnius (VNIIRIP), 15 AC/DCs were developed there, 9 in Minsk, 3 in Gorky, and only 1 such device in Lvov.

The topic of development of digital oscilloscopes was not assigned to any specific research institute. It was new, revolutionary, progressive and very promising, like any other digital and microprocessor technology in those years.

Therefore, all research institutes sought to master this area before others, although at that time it was not at all easy to develop AC/DC, since the element base for building such devices was just starting to appear.

It was a little easier in this regard for those research institutes that were already developing stroboscopic oscilloscopes, which were closer to discrete technologies (these are VNIIRIP and GNIPI).

However, Minsk NIPI, having a younger team of developers, was also very actively involved in this topic and came in 2nd place in terms of the number of developments.

But in terms of the number of devices introduced into production, MNIPI confidently took 1st place, since all 9 of its devices were introduced and mass-produced.

In terms of implemented devices, VNIIRIP and GNIPI share 2nd place with 3 implemented devices each. For VNIIRIP these are S9-5, S9-10/1, S1-122/8, and for GNIPI - S9-8, S9-16, S9-27.

And, if GNIPI implemented all 3 of its monoblock central heating centers, then VNIIRIP implemented only 3 of its 15 devices.

The fact is that the development of the Sputnitsa family of central heating equipment, consisting of 11 devices, ended in VNIIRIP in 1986-88. And if we add to this that this family consisted of extremely complex and expensive, including computational oscilloscopes, weighing from 33 to 66 kg, consisting of two housings for some models, then it becomes clear how difficult and costly the task of implementing such a family was . Due to the crisis of the 90s, the introduction of such a large, complex and very expensive family became almost impossible.

It is also a pity that another analog oscilloscope with digital memory, developed by VNIIRIP - S8-22, small, inexpensive, compact, weighing only 6.5 kg, with a microprocessor, was also not implemented in Yerevan, since it was completed in 1987 year, at the height of the crisis.

Lviv LNIRTI, due to the reduction in development in the 80s
Over the years, he developed only one model of the AC device - S1-123.

In this category of devices, it is still necessary to note the first digital oscilloscope in the USSR, S9-5, developed by VNIIRIP, which was developed in 1979, successfully implemented, and was mass-produced for a number of years. And although it was developed in the pre-microprocessor era, this device was important because it was the first.

In 1986, VNIIRIP developed and then implemented the CO S1-122/8, one of the first microprocessor devices in this direction with increased sensitivity, real and equivalent sampling, full automation, including auto-search for signals, cyclic measurements of 8 parameters

signals, their processing and output to IF-KOP.

All 3 developments of GNIPI - S9-8, S9-16 and S9-27, were also microprocessor, modern devices with IF-KOP.

Among the MNINI devices, it is necessary to note the first, and only in the USSR, broadband central centers for the 100 MHz band, with microprocessor and high degree of automation - C9-14 and C9-28. Unfortunately, neither VNIIRIP nor GNIPI have made a design center for such a strip.

Original and extreme in weight - only 2.5 kg, there was also a MNIPI CO, with an LCD indicator - S8-19 (/1). The AC devices of MNIPI – S1-128, S1-133 (/1), S8-23 (/1) were also light in weight - only 6-7 kg.

5.6. Mid-frequency oscilloscopes (MF)

Mid-frequency (MF) oscilloscopes are universal oscilloscopes, with a bandwidth from 20 to 60 MHz.

All 19 SChO models, their developer, and main parameters are given in a single table in Appendix 5.6. From this table and the table in Appendix 5, it is clear that devices of this type were developed in Lvov, Vilnius and Minsk. Moreover, there was no clear leader in this type of device. In

Lvov (LNIRTI) and Minsk (MNIPI) each developed 8 SChO, and in Vilnius only 3. This is due to the specialization of these research institutes on oscillographic topics on the scale of the USSR.

At first, in the 50s, when only VNIIRIP was engaged in oscillography, and there was no specialization in different types of oscilloscopes among research institutes, Vilnius began to develop midrange frequencies devices. But already in the 70s and 80s this topic was completely transferred first to Lvov, and then to Minsk.

In the 50s and 60s, VNIIRIP developed only 3 midrange tube accessories – S1-7, S1-32, S1-40.

In Lviv, work on the development of such devices began in the early 70s. This direction developed successfully there in the 60s and 70s. However, in the 80s, due to the transfer of LNIRTI developers to other topics, the number of such developments decreased.

However, in the second half of the 70s, this topic, important and in demand on the market, was picked up by the Minsk Research Institute, and developments in this direction were successfully continued in the 80s in Minsk, which, as a result, became the leader in this direction, at least by the weight of these devices

The parameters of the SChO of the 70-80s, the developments of Lvov and Minsk, are basically identical, taking into account the time of development and their functionality.

Over the next 21 years, from 1976 to 1986, in LNIRTI and MNIPI, in In total, 16 models of semiconductor SSCs were developed. During this period, their sensitivity grew, and by the 90s, more than their average weight decreased by half from 14-19 to 6-7 kg. At the same time, the functionality has expanded, including in the direction of automation (auto-scaling of the signal).

Another advantage of SSCs was their portability and resistance to harsh climatic influences, which meant the possibility of their use in field conditions, in contrast to universal OSBs, which were intended only for laboratory use.

5.7. Wideband Oscilloscopes (WO)

Since electronics has constantly evolved towards increasing speed, this trend has required the emergence and continuous improvement of wideband oscilloscopes.

Wideband oscilloscopes (WBO) are universal instruments with a bandwidth of 100 MHz and higher, operating in real time (without time scale conversion, unlike stroboscopic instruments).

All 17 SHPO models, their developer, and main parameters are given in a single table in Appendix 5.7. From this table and the table in Appendix 5, it is clear that devices of this type were developed in Vilnius, Minsk, and Lvov.

Leadership in this type of devices was very important, since expanding the bandwidth was one of the main and sought-after tasks in oscillography, and it was usually not easy to achieve. This task, when developing devices, often required changing the element base to a new one, which still had to be mastered. A change in technology for the development and production of devices was also often required. That is, the development of SHPO

contained a large share of novelty, and therefore an appropriate share of risk, so these developments were often carried out at the level of inventions.

The undisputed leader in this direction, taking into account the specialization in the subject in the USSR, was Vilnius, 9 such devices were developed there, for the band from 100 to 1000 MHz, there were 4 bandwidth records were set, and during development, 8 “First in the USSR” events occurred.

Lvov took second place - 4 devices per band from 100 to 500 MHz, 1 record for bandwidth and 3 events “For the first time in the USSR”.

Minsk took third place - 4 devices per 100 MHz band, and 2 events “For the first time in the USSR”.

In the 50-60s, the first 2 tube SHPO - S1-11 and S1-31 at 100 MHz, weighing 165 and 40 kg. These were breakthrough unique developments that laid the foundation for the ShPO direction in the USSR.

In the 70s, in Vilnius and Lvov they began to develop SHPO based on semiconductors for the 100-250-350 MHz band, and already having

This work experience, in the same place, in the 80s they began to develop SHPO for the 500-1000 MHz band.

In Minsk, in connection with the departure of LNIRTI from this topic, in the 80s they began to develop SHPO at 100 MHz, including 4 channels and using microprocessors.

Here it is necessary to note the unique devices of VNIIRIP, such
How:

- S1-75 and S1-116 (with MP, multimeter, and 1 MOhm input) at 250 MHz,
- S1-97 and S1-108 (with digital delay) at 350 MHz,
- S1-129 with MP, and ELTBV on MCP, at 1000 MHz. For this development, a new CRT was specially developed, a new

element base of semiconductor microcircuits, and new printed circuit technology. In the entire history of oscillography, only two real-time devices have been developed for such a record band in the world: Tek 7104 and S1-129.

Also unique is the S1-104 at 500 MHz, developed by LNIRTI, which at one time was one of the three most broadband oscilloscopes in the world, after Tek 7904 (500 MHz) and Tek 7104.

The 500-1000 MHz bandwidth for universal real-time analog oscilloscopes is a record, since devices with a larger real-time bandwidth in history

world oscillography does not exist.

And today, there are only four devices with such a band in the history of world oscillography. Two of them were developed in the USA - Tek 7904 and Tek 7104, and two in the USSR - S1-104 and S1-129, so the score is 2:2.

Universal WB oscilloscope
C1-129 at 1000 MHz. 1989

Universal WB oscilloscope
C1-104 at 500 MHz. 1981

5.8 All 246 models of USSR oscilloscopes, sorted by model number (C1, C7, C8, C9, Ya4S, K2)

All **246** oscilloscope models, with their main parameters, developed in the USSR, and sorted by model number, are located in the table in Appendix 5.8.

During the period from 1948 to 1992 in the USSR, according to the GOST classification, the following was developed:

- 158 models of universal oscilloscopes **S1-,** which included OSB, LF, MF, ShP, Service, Special, TV and AC oscilloscopes,

- **27** models of high-speed oscilloscopes **S7-,** which included only stroboscopic and special devices,

- **21** models of storage oscilloscopes **S8-,** which included oscilloscopes based on ZELT, OSB, TsO, AC and Service oscilloscopes,

- **26** models of special oscilloscopes **S9-,** which included TV, Special, Strobe, CO, LF and MF oscilloscopes, **- 7** blocks of type **YA4S-,** of which 5 devices are recorders CO type and strobe type, oscilloscope unit (without power supply) and power supply for oscilloscope SBs,

- **3** oscillographic measuring systems type **K2-.**

4 models of different, different types were also developed devices developed not according to GOST classification.

Conclusion

In the USSR, in the period after the 2nd World War and until 1992, within the framework of the instrument engineering industry, the oscillographic branch of the economy successfully existed and developed. During this period, the oscillographic industry belonged to various ministries and departments, but basically, it was subordinate to the 6th Main Directorate of the Moscow State Transport System (except for LNIRTI and LORTA, which were subordinate to the MRP).

The development of oscilloscopes was carried out by 4 research institutes - VNIIRIP, LNIRTI, MNIPI and GNIPI, and the production of 11 factories -
Vilnius VZRIP, Minsk “Caliber”, Minsk “Belvar-Lenina”, Bryansk “Izmeritel”, Abovyansky, Makhachkala, Mytishchi, Moscow “MZIA”, Lviv association LORTA., Zlochiv plant.

In the main oscillography department in the USSR, VNIIRIP, regularly carried out a detailed analysis of the global and domestic oscilloscope market, and formed a technical policy in the field of oscillography in the country. Standards for oscillography and programs for the development of this industry were developed, as well as programs for the development of the element base in MEP for the needs of oscillography. In Vilnius, All-Union Oscillographic Conferences were held regularly, which brought together specialists from different cities and enterprises of the country.

IN

As a result of such a technical policy in the USSR, under the leadership of the 6th GU MPSS, an instrument-making corporation was organized, which, in terms of its numbers, range of instruments, and technical level of products, corresponded to the best instrument-making companies in the world, such as Hewlett-Packard and Tektronics. In terms of production volume, range, and technical parameters of oscilloscopes, the USSR was in 2nd place in the world, after the USA,

producing up to 20% of the world's oscilloscopes, and ahead of countries such as Japan, Germany and France.

In turn, thanks also to this, the USSR managed to create some of the best branches of technology in the world, such as nuclear, aviation, space and defense, which established the USSR in the world as one of the most powerful powers. Therefore, the history of oscillography in the USSR can and should be proud.

Application 1

Oscilloscopes VNIIRIP, Vilnius
1948-1992

(Arranged in order of chapters and information in the book)

Year	Model. Topic	Basic technical characteristics	Institute-manufacturer
1.3. The formation of oscillography in Vilnius, 1948-1959.			
1948	**C1-1 (EO-7)**	**LF, 250 kHz** band , 1 channel, 4 mV/cm, 16 lamps, 120 W, 24 kg.	Vilnius
1950	**S1-2 (25-I)**	**LF,** Sync., - **1 MHz,** Bandwidth 30 Hz **-5 MHz,** Rin=0.5 MOhm/75 Ohm, 25 kg. **LF,**	Vilnius
1954	**C1-4 (ENO-1)**	band 0-1 **MHz, 1** channel, 30 mV/cm, 1 ÿs/e, 250 VA, 26 kg.	Vilnius
1956	**S1-7 (DESO-1), "Palm"**	**ShP, 60 MHz** band , 2 beams, 150 mV/cm, CRT-18LO47, 0.3 ÿs/cm, 1500 W, 270 kg.	Rybinsk
1957	**C1-5 (SI-1)**	**LF,** portable, **10 MHz** band , 40 mV/cm, 180 W, **18 kg.**	Vilnius Mytishchi
1957	**S1-10 (OS-4) "Core"**	**Special,** high-speed, **1 GHz** band , 5 V/mm, 50 Ohm, 10 ns/e, 500 W, 40 kg.	**Not serially released.**
1957	**C1-6 (EMO-2)**	**Serv.,** Band **1 MHz,** 1.6 mm/V, 1.5 ÿs/e, CRT-7LO55, 35 W, **4.5 kg.**	Rybinsk
1958	**C1-8A, (UO-1M) "Katet"**	**SB, 25 MHz** band , 13LO3I, 50 mV/cm, 1 MOhm, 650 W, 35 kg.	Vilnius Bryansk
1958	**S1-11 (ISO-1), "Hyacinth"**	**ShP,** Band **100 (200) MHz,** 100 mV/cm 25 ns/cm, 4000 km/s, 1200 VA, weight 165 kg.	Makhachkala
1959	**C1-14 (CO-1), "Bamboo"**	**Special,** high-speed, band **1 (3) GHz,** 13LO/ ELTBV, 25 t.km/s, 3.3 V/mm, 10 ns/e, 850 W, 107 kg.	Vilnius
3.3 Development of trends in oscillography, 1960-1969			
1960 Vilnius	**C1-12 (DEO-1), "Forgetfulness"**	**LF,** 2 beams. **15 MHz** band , precise, (5%, instead of 10%), CRT 18ÿÿ1ÿ, 100 mV/cm, 1700 W, 50 kg.	
1961	**S1-15 (UO-2), "Scenery"**	**SB, 25 MHz** band , 1 vertical compartment for s/b, 13LO3I, 20 ns/d, 5-10%, 700 W, **42 kg.**	Vilnius Bryansk
Replacement blocks for C1-15 and C1-17 (U1-U8)			

1961	**U1** (S1-15/1)	**SB,** Amplifier. 25 MHz band , **50 mV/d.**	Vilnius Bryansk
1961	**AT 2** (S1-15/2)	**SB,** Differential amplifier. Bandwidth **20 MHz, 50 mV/d.**	Vilnius Bryansk
1961	**U3** (S1-15/3)	**SB,** Amplifier, 2 channels, Bandwidth **20 MHz, 100 mV/d.**	Vilnius Bryansk
1961	**U4** (S1-15/4)	**SB,** Differential amplifier. Bandwidth **1 MHz, 1 mV/d**	Vilnius Bryansk
1961	**U5** (S1-15/5)	**SB,** differential amplifier, **60 kHz bandwidth, 50 µV/d**	Vilnius Bryansk
1965	**U7** "Viewer"	**SB,** Stroboscopic unit, **200 MHz band,** Rin=75 Ohm.	Bryansk
1967	**U8** "Lead"	**SB,** Stroboscopic unit band **350 MHz, 20 mV/d,** 75 Ohm.	Bryansk
1962	**S1-16, "Pearl"**	**LF,** 2 beams, 16LO2I, strip **5 MGc,** 20 mV/d, 395 VA, 25 kg.	Makhachkala
1962	**C1-17, "Fringe-B"**	**Sat,** 2 ots. for s/b, 2 beams, CRT 16LO2I, **10 MHz band,** 7 s/b from S1-15, 100 ns/d, 800 W, 47 kg.	Bryansk
1962	**C1-18, "Fringe-M"**	**LF,** 2 beams, 16LO2V band **1 MHz,** 20 mV/cm, or 0.2 MHz, 1 mV/cm, 300 W, 25 kg.	Bryansk institution
1962	**C1-20, "Core-B"**	**LF, precise, 10 MHz** bandwidth , 100 mV/d, +/-5%, 400 W, 24 kg.	Vilnius
1963	**C1-32, "Taiga"**	**MF, precise, 40 MHz** band , CRT 50x70 mm, 100 mV/cm+/-3%, 10 ns/cm+/-3%, 1300 W, 70 kg.	**Not serially released.**
1963	**OD-723, "Schoolboy"**	**LF,** demo **1 MHz**	**Not serially released.**
1964	**C1-31, "Zlak"**	**SP,** bandwidth **100 MHz,** 13LO10T, 0.1 V/cm, 750 VA, 40 kg.	Vilnius
1964	**S8-9 (S1-29), "doublet"**	**SELT, 2 MHz** band , PT/SELT 13LN5, 100 km/s, 1 min./16 hours, 100 mV/cm, 1 ÿs/d, 450 VA, 25 kg.	Vilnius
1964	**C8-1 (S1-37), "Inza"**	**ZELT, 1 MHz** band , BS/ZELT 13LN2, 4 km/s, 30 min./170 hours, 10 mV/cm, 450 W, 35 kg.	Vilnius
1965	**C1-36, "Harmony"**	**Special,** high-speed, **1.2 GHz** band , ELTBV "Futer-2", 10 t.km/s, 1 mm/V, 10 ns/e, 400 W, 45 kg.	Vilnius
1965	**C8-2 (S1-41), "USA"**	**ZELT,** band **7 MHz,** PT/ZELT 13LN6, 500 km/h, 1 min./16 h., 25	Abovyan

		mV/d, 900 W, 70 kg.	
1966	**S1-40, "Svirel"**	**MF,** precise, **25 MHz bandwidth,** 50 mV/ cm, 830 W, 50 kg.	Bryansk
1969	**S1-33, "Lena"**	**LF,** 5 beams, **5 MHz bandwidth,** 10 mV/d, 600 VA, **160 kg.**	Vilnius
3.5. Oscilloscopes with replaceable units 3.5.1. Generation "Snaige", 1972-1976			
1972	**C1-70, “Snaige”**	**SB, 50 MHz** band , 2 compartments: vert. and horizontal, CRT 11LO2I 64x80 mm, 250 W, 24 kg.	Vilnius
1974	**C1-74, "Network"**	**SB,** 2 beams, **35 MHz band,** 3 bays: 2 vert. and 1 horizontal, 13LO16A, 4 channels, 300 W, 30 kg.	Vilnius
1974	**S8-12, "Seida"**	**SB,** 50 MHz band , **PT/ZELT,** 2 compartments, 13LN10, 4000 km/s, 40 sec./7 hours, 300 VA, 27 kg.	Abovyan
1974	**S8-13, "Entourage-2"**	**SB,** 1 MHz band , **BS/ZELT,** 2 compartments, 13LN2, 20 km/s, 30 min., 180 VA, 23 kg.	Vilnius
1974	**S8-14, “Speed-2”**	**SB,** 2 beams, **50 MHz band, PT/ZELT,** 3 compartments, 13Lÿ11, 3000 km/h, 40 sec./7h., 300 VA, 34 kg.	Vilnius
1976	**C1-70A, "Snaige-M"**	**SB, 50 MHz** band , 2 compartments: vert. and horizontal, **CRT 13LO1I 80x100 mm,** 250 W, 24 kg.	Vilnius
Replacement blocks for S1-70, S1-70A, S1-74, S8-12, S8-13, S8-14			
1972	**1U11, C1-70/1 (ÿ40-1100), "Snaige"**	**SB,** Differential amplifier.. Bandwidth **50 MHz, 10 mV/d.**	Vilnius
1972	**1R11, S1-70/1 (ÿ40-2100), "Snaige"**	**SB,** Dual sweep **10 ns/d.,** main and delayed.	Vilnius
1972	**1U71, C1-70/2 (ÿ40-1700), "Snaige"**	**SB,** Stroboscopic amplifier. Bandwidth **3.5 GHz, 2 channels, 5 mV/d, 50 ohms.**	Vilnius
1972	**1ÿ71, ÿ1-70/2 (ÿ40-2700)**	**SB,** Stroboscopic scanning. Synchronization frequency **1 GHz**	Vilnius
1974	**1U13, C1-70/4 (ÿ40-1102)**	**SB,** Differential amplifier Bandwidth **10 MHz, 0.5 mV/div.**	Vilnius
1974	**1P91, C1-70/5 (ÿ40-2900)**	**SB,** Dual sweep **10 ns/d.** Starts: 1-100, for ZELT.	Vilnius
1974	**1U72, C1-70/3 (ÿ40-1701)**	**SB,** Stroboscopic amplifier (with active probe). Band **700 MHz**	Vilnius

1975	**1U91, C1-70/5 (Ya40-1900)**	**SB,** Line Shift Amplifier. **10 MHz** band	Vilnius
1975	**1U92, C1-70/6 (ÿ40-1901)**	**SB,** Logarithmic amplifier. Bandwidth **1 MHz, 10 db/d.**	Vilnius
1976	**1U12, S1-70/7 (ÿ40-1104)**	**SB,** Two-channel amplifier. Bandwidth **50 MHz, 10 mV/d.**	Vilnius
1976	**1U14, S1-70/8 (ÿ40-1103)**	**SB,** High-sensitivity amplifier. Bandwidth **100 kHz, 10 μV/d.**	Vilnius
3.5. Oscilloscopes with replaceable units 3.5.2. Generation "Light", 1977-1988			
1977	**C1-91, "Light-1"**	**SB, 100 MHz** band , 3 compartments: 2 vert. and 1 horizontal, **ZG,** CRT 17LO1I **100x120 mm,** 150 W, 17/20 kg.	Vilnius Minsk B
1984	**S1-115, "World-4"**	**SB, 2 beams, 50 MHz** band , 3 compartments, **ZG,** 17LO4A, **100x120 mm,** 200 km/s, 150 W, 15/20 kg.	Vilnius
1984	**Ya4S-111, "World-41"**	**SB,** Basic bl. indication (LED) and power supply (without CRT), for replaceable units, 3 compartments, outputs signals	Vilnius
1984	**K2-52, K2-53 "World-41"**	**IS,** Complex measuring installations (with S1-91 and S1-115)	Vilnius
1986	**S1-122, "Entourage-3"**	**SB, 100 MHz** band , 3 bays: 2 vert. and 1 horizontal, **ZG,** CRT **17LO7I 100x120 mm,** 150 W, 17/20 kg.	Vilnius
1987	**S8-21, "Light-3"**	**SB,** 100 MHz band , **PT/ZELT,** 3 compartment, **ZG,** 13LN14I, 10000 km/s, 30 sec./7 hours, 150 VA, 17/20 kg.	**Not serially released.**
1988	**AIS "Svita-AIS** for **(S1-122/8)**	measuring parameters **3/Saratov"** antenna arrays based on **C1-122/Ya4S-122** and PC "Neuron".	VNIIRIP Supplies
Replacement blocks for S1-91, S1-115, S1-122, S8-21 and Ya4S-111			
1977	**Ya4C-90, C1-91/1,**	**SB,** Two-channel amplifier. Band **100 MHz, 5 mV/d, ("Light-1")**	Vilnius Minsk B
1977	**Ya4C-91, S1-91/1**	**SB,** Sweep up to **5 ns/div,** Vilnius double, **("Svet-1")**	Minsk B
1977	**2K-11, "World-1"**	**SB,** Basic calibrator block Vilnius blocks of the "Light" series **(PH, ZG)**	Minsk B
1978	**Ya4S-89, S1-91/3**	**SB,** Differential generator with front **50 ps, "Fiber-6"**	Vilnius
1978	**Ya4S-96, S1-91/3**	**SB,** Strobe converter, **12 GHz band, 2 mV/d, "Fiber-1"**	Minsk
1978	**Ya4S-95, S1-91/3**	**SB,** Strobe, **20 ps/div.** Sync. **5 GHz, "Fiber-1"**	Minsk

1978	**Ya4S-97, S1-91/2**	**SB, multimeter** =/~U, I, R, t, +/- 0.25-3%, **"Svetovod-2"**	Bryansk
1979	**Ya4S-92, S1-91/6**	**SB, Characterograph** of current-voltage characteristics of transistors, up to 0.8 W, **“Svetovod-2“**	Bryansk
1979	**Ya4S-98, S1-91/5**	**SB, Digital delay,** accuracy 0.01%, +/- 0.5 ns, **“Fiber-4“**	Bryansk
1981	**Ya4S-100, S1-91/4**	**SB,** Strobe converter, **18 GHz band, 2 mV/d, “Strobe-1“**	Minsk
1981	**ÿ4ÿ-101, S1-91/4**	**SB,** Strobe, **10 ps/d,** synchro **10 GHz, "Strobosc.-1"**	Minsk
1981	**ÿ4ÿ-102, ÿ1-91/4**	**SB,** Delay block **70 ns, PH-150 ps, “Strobe-1“**	Minsk
1981	**ÿ4ÿ-105, S1-91/7**	**SB, Measurement block, U and T,** accuracy 1.5%-3%, **"Spartak-1"**	Vilnius
1984	**Ya4S-110, S1-122/9**	**SB, Logic analyzer block,** 100 MHz/16 channel, **“Svet-44“**	Vilnius
1986	**ÿ4ÿ-122 S1-122/8 "Entourage-3"**	**SB, digital, auto oscilloscope,** Bandwidth 10 MHz/2ch, 0.5 mV/div. Sampling **20 MHz/5 GHz equivalent.**	Vilnius
	3.6. Wideband Oscilloscopes, 1974-1989		
1974	**C1-75, "Boxwood"**	**SP,** 2 channels. Band **250 MHz, 10** Bryansk **mV/d.,** 50 Ohm, ELT-13LO105M, 60x100 mm, 160 W, 23 kg.	
1977	**S1-92, "Hundred"**	**ShP,** 2 channels, **100 MHz band, 5 mV/ d.,** 1 MOhm, CRT 17LO1I, 100x120 mm, 2 div., 5 ns/d, 160 W, 16 kg.	Vilnius
1979	**S1-97, "Candle"**	**ShP,** 2 channels. band **350 MHz, 10 mV/d.,** 50 Ohm, CRT-16LO101A, 80x100 mm, 140 W, 17 kg.	Bryansk
1979	**S1-108, “Svir”**	**ShP,** precise, 1 channel. band **350 MHz, 5 mV/d.,** 50 Ohm, 19LO101M, 80x100 mm, **central locking,** 110 W, 17 kg.	Bryansk
1983	**S1-116, "Samara"**	**ShP,** 2 channels. band **250 MHz, 5 mV/ d., 1 MOhm,** 16LO101A, **MP, TsZ, MT,** 80x100 mm, 105 W, 15 kg.	Bryansk
1985	**S1-121, "Silver"**	**A/D,** 4 channels. **100 MHz band, 2 mV/d., 1 MOhm,** 17LO01I, **MP, ADC,** discr. 20 MHz, 250 W, 25 kg.	**Not serially released.**
1989	**C1-129, "Capital"**	**ShP,** 2 channels, **1000 MHz band, 10 mV/ div.,** 50 Ohm, CRT 60x80 mm, **MP,** 150 VA, 21 kg.	**VNIIRIP supplies**
	3.7. Service oscilloscopes, 1976-1992		
1976	**S1-90, “Service-1“**	**Serv.,** floor **1 MHz,** 1 channel, 10 mV/d, CRT-8LO7I, 40x60 mm, 25 W, **3.5 kg.**	Mytishchi

1977	**S1-94, "Service-2"**	**Ser., 10 MHz** band , 10 mV/d, 1 channel, CRT-8LO7I, 25 W, weight **3.5 kg.**	Mytishchi
1980	**S1-112, "Servant"**	**Server,** 1 channel, **with multimeter,** Band **10 MHz,** 25 W, **3.5 kg.**	Vilnius
1980	**ÿ4ÿ-99 (S1-109), "Caliber-S"**	**Serv.,** Oscillograph-shift. block, band **10 MHz,** 1 channel, ELT 6LO3I, without BP, for K2-42 (Only TM5000)	Minsk K
1982	**S1-118, "Service-4"**	**Server, 2 channels,** 10 MHz band , **5 mV/d,** CRT 11LO9I-60x80 mm, 28 VA, weight **4 kg.**	Abovyan
1983	**"To you"**	**Serv.** band **7 MHz,** 5 mV/d, 1 channel, ELT 40x60 mm, 30 VA, **3.2 kg**	Vilnius
1987	**S8-20, "after"**	**Server, ZELT, 2 channels,** 10 MHz band , **5 mV/d,** CRT 11LN1I-56x70 mm, 30 VA, weight **4.6 kg.**	**Not serially produced.**
1988	**S1-112A, "Servant"**	**Server,** 1 channel, **with multimeter,** Band **20 MHz,** 25 W, **3.5 kg.**	Vilnius
1988	**C1-118A**	**Server, 2 channels,** 20 MHz band , **5 mV/d,** CRT 11LO9I-60x80 mm, 28 VA, weight **4 kg.**	Abovyan
1989	**S1-131, "Soda"**	**Server, 2 channels, 20 MHz** band , 2 **mV/d, ADC - 1 MHz,** 11LO9I-60x80 mm, 40 VA, **4.5 kg.**	Vilnius
1990	**SK1-132, "Kochi"**	**Serv., +multimeter, +generator.T/T,** band **20 MHz, 2 mV/d,** 2 channels, 11LO9I-60x80 mm, **4.5 kg.**	Mytishchi
1990	**S1-139, "Sochi"**	**Server,** 20 MHz band , **2 mV/d,** 2 channels, 11LO9I-60x80 mm, **4.5 kg.**	Mytishchi
1990	**SK1-140, "Sochi"**	**Server, + multimeter,** 20 MHz band , **2 mV/d,** 2 channels, 11LO9I-60x80 mm, **4.5 kg.**	Mytishchi
1990	**SK1-144, "Sochi"**	**Server, +multimeter, +BVS/TV,** band **20 MHz, 2 mV/d,** 2 channels, 11LO9I-60x80 mm, **4.5 kg.**	Mytishchi
1990	**S1-134**	**Ser.,** 35 MHz band , **2 mV/d,** 2 channels, CRT 12LO1I-60x80 mm, 20 ns/d, 35 VA, **5 kg.**	Bryansk
1991	**S1-137**	**Ser.,** 25 MHz band , **2 mV/d,** 2 channels, 11LO9I-60x80 mm, 40 VA, **5 kg.**	Minsk
1992	**S1-137/1**	**Serv., +Multimeter,** band **25 MHz, 2 mV/d,** 2 channels, 11LO9I-60x80 mm, 40 VA, **5.3 kg.**	Minsk
1992	**S1-137/2**	**Serv., ADC-1 MHz,** bandwidth **25 MHz, 2 mV/d,** 2 channels, 11LO9I-60x80 mm, 40 VA, **5.5 kg.**	Minsk

1992	**SK1-132A Serv.,**	**+multitim., +T/T generator,** band **25 MHz, 2 mV/d,** 2 channels, 11LO9I-60x80 mm, **4.5 kg**	Moscow
1992	**C1-139A**	**Server,** 25 MHz band , **2 mV/d,** 2 channels, 11LO9I-60x80 mm, **4.5 kg.**	Moscow
1992	**SK1-140A Server,**	**+ multimeter,** band **25 MHz, 2 mV/d,** 2 channels, 11LO9I-60x80 mm, **4.5 kg.**	Moscow
1992	**SK1-144A Server,**	**+ multimeter,** band **25 MHz, 2 mV/d,** 2 channels, 11LO9I-60x80 mm, **4.5 kg.**	Moscow
3.8. Low Frequency Oscilloscopes, 1979			
1979	**S1-102, "Salat-4"**	**LF,** 2 channels. band **10/1 MHz, 0.5/0.05 mV/d.,** 1 MOhm, 17LO4I, 80x100 mm, 120 W, 15 kg.	Bryansk
1979	**S1-103, "Salat-5"**	**LF, 4 channels.** band **10/1 MHz, 0.5/0.05 mV/d.,** 1 MOhm, 17LO4I, 80x100 mm, 120 W, 15 kg.	Bryansk
3.9. Storage oscilloscopes on ZELT, 1967-1983.			
1967 Abovyan	**C8-7 (S1-47), "Gardener"**	**ZELT,** band **20 MHz, 50 mV/d,** 1 channel, PT/ZELT 13Lÿ7, 1000 km/c, playback 1 min., 750 W, 30 kg.	
1967	**C8-7A (C1-47A), "Gardener-1"**	**ZELT,** band **20 MHz, 50 mV/d,** 1 channel, PT/ZELT 13Lÿ7, 1000 km/c, 750 W, 30 kg. ÿÿÿ ÿÿÿÿÿ. condition ex.	Abovyan
1968	**C8-11 (S1-51), "Sad-1"**	**ZELT,** band **1 MHz, 10 mV/d,** 1 channel, BS/ZELT 13LN8, 5 km/h, 30 min., 700 W, 50 kg	Abovyan
1969	**C8-8 (S1-58), "own"**	**ZELT,** band **1 MHz, 5 mV/d,** 1 channel, BS/ZELT 13LH2, 10 km/h, 30 min., **Digital. Indication,** 700 W, 115 kg	Mahach-kala
1972	**C8-9A "Duplet-M"**	**SELT, 2 MHz** band , PT/SELT 13LN5, 100 km/s, 1 min./16 hours, 100 mV/cm, 1 ÿs/d, 450 VA, 25 kg.	Abovyan
1976	**S8-15, "Salad 1-2"**	**ZELT,** bandwidth **10 MHz, 2 mV/cm, 2 channels,** PT/ZELT 16LH1, 1000 km/h, 40 h/16 h, 65 VA, 16 kg.	**Not serially released.**
1979	**S8-17, "Sad-1"**	**ZELT,** band **1 MHz, 1 mV/cm, 2 channels,** BS/ZELT-16Lÿ8-40 km/h, 30 min./7 h., 80 VA, 16 kg.	Abovyan
1983	**S8-18, "Sevan"**	**ZELT,** band **10 MHz, 1 mV/cm, 2 channels,** PT/ZELT 16LN3, 250 km/h, 30 min., **izmer. amp.,** 85 VA, 16 kg.	Abovyan
3.10. Specialty oscilloscopes, 1968-1990			

1968	C7-10 (S1-61), "Plot"	**Special,** high-speed, **1 GHz** band , ELTBV-10LO102M-20x40 mm, **1000 km/s,** 100 mV/mm, 0.25 ns/e, beam-100 microns, 750 W, 106 kg.	Vilnius
1971	C7-10A(B), "Sonnet-2"	**Special,** high-speed, **1.2 GHz** band , **ÿÿÿÿÿ-10ÿÿ103ÿ-40x40** mm, **10 pcs. km/s,** 75 mV/mm, 0.125 ns/e, beam-100 µm, 750 W, 75 kg.	Vilnius
1975	C9-4, "Signal"	**Special, contact FR..,** band **100 MHz, 10 mV/d,** OV/E-13LO106A **1.5 t.km/s,** 2.5 ns/d, 150 W, 35 kg.	Vilnius
1975	C9-4A, "Signal"	**Special,** high-speed, **contact PR, 500 MHz** band , OV/E-13LO106A- **20 t. km/s,** 2.5 ns/d, 150 W, 35 kg, **Special,** high-speed	Vilnius
1976	S7-15, "Seven"	**contact PR, 5 GHz** band , OV/ELT-10LO104A - **40 t. km/s,** 0.1 ns/d, 210 W, 50 kg.	Vilnius
1980	C9-6, "Rafter"	**Special,** 100 MHz band , **5 mV/d,** ZELT-LN20-3 **v. km/s,** 2.5 ns/d, 256x256 pixels, Discr . **10 GHz, computer output,** 560 W, 46 kg.	Vilnius
1982	S7-19, "Shine"	**Special,** high-speed, **5 GHz** band , MKP/ELTBV-10LO105A-250 **t. km/s, 170 mV/mm,** 0.2 ns/cm, 5.5 ps/point, 170 W, 30 kg.	Vilnius
1986	C9-13 "Sonata"	**Special,** band **350/(1000) MHz, 10 mV/d,** 0.5 ns/d, 256x256 pixels, **Disc.40 GHz, MP, IF/KOP,** 360 W, 46 kg	**Not serially released.**
1990	AIS/K2-74/ /S7-19/	**Special, 5 GHz** band , AIS/S7-19, **discrete 400 GHz,** CCD matrix, 512x512 lines, 50 mV/L, 4 ps/L.	**VNIIRIP supplies**
3.11. Sampling oscilloscopes, 1969-1992			
1969	S7-8 (C1-53), "saccharin"	**Page,** band **1.5 GHz, 10 mV/d,** 2 channels, Rin=50 Ohm, ZELT-13LN2, 100 ps/d, 300 W, 38 kg.	Vilnius
1971	S7-11 (C1-66), "Sniper"	**Page, 5 GHz** band , 5 mV/d, 2 channels, CRT-13LO2, 50 ps/d, 160 W, 33 kg, harsh conditions, Noise-3.5 mV.	Vilnius
1972	S1-70/2 /1U-71/1ÿ71/ /"Snaige"	**Page,** 3.5 GHz band , **5 mV/d,** 2 channel, Rin=50 Ohm, 10 ps/d, sync. 1 GHz, 250 W, 24 kg.	Vilnius
1974	S1-70/3 "Snaige" 1U-72/1ÿ71/	**Page,** 3.5 GHz band , **5 mV/d,** 2 channel, Rin=100 kOhm, 10 ps/d, sync. 1 GHz, 250 W, 24 kg.	Vilnius

1978	**S1-91/3 "World Guide" ÿ4ÿ-95/96/89**	**Page,** 12 GHz band , **5 mV/d,** 2 channel, Rin=50 Ohm, 20 ps/d, sync. 5 GHz, Pulse generator 50 ps, 200 mV.	Minsk
1981 C1-91/4	**J4C-100/101/102 "World Guide"**	**Page, 18 GHz** band , 2 mV/d, 2 channel, Rin=50 Ohm, 10 ps/d, sync. 10 GHz, 70 ns delay line.	Minsk
1981	**C9-9, "Sigma"**	**Page, precise, 18 GHz** band , 5 **mV/d,** 2 ch, Rin=50 Ohm, 10 ps/d, sync. 10 GHz, gener. impulses. 50 ps, **error. 1.5-4%,** 400 W, 62 kg, Fourier transform.	Minsk
1986	**Ya4S-125, "Sheaf-Blueberry"**	**Page,** digital band **18/10/1 GHz,** noise-5/2/2 mV, Rin = 50 Ohm/100 kOhm, 300 VA, 30 kg, without indicator.	**VNIIRIP supplies**
1987	**S7-20, "bundle"**	**Page,** digital, strip **18/10/1 GHz,** noise - 5/2/2 mV, Rin = 50 Ohm / 100 kOhm, 450 VA, 60 kg.	**VNIIRIP supplies**
1988	**S7-21, S1/S2/S3 "bundle"**	**Page,** digital, strip **18/10/1 GHz,** noise - 5/2/2 mV, Rin = 50 Ohm / 100 kOhm, 300 VA, 30 kg.	**VNIIRIP supplies**
1990	**S7-20/4, "Sofia"**	**Page,** computing, **30 GHz band,** unstable. synchronization - 5 ps, 450 VA, 60 kg.	**Not serialized.**
1992	**S7-23, "Sokolniki"**	**Page, 18 GHz** band , CRT-12LO1I-60x80, 8 kg.	**Not serially released.**
3.12. Digital oscilloscopes, 1979-1992			
1979	**C9-5, "Sputnik-1"**	**TSO,** band **5 MHz, 1 mV/d,** 1 channel, **disc. 5 (20) MHz,** 8 bits/1k. points, burial 0.2-5%, IF-computer, 220 W, 18 kg.	Mahach-kala
1982	**C9-10/1, "Samoana-liz-20"**	**TSO,** band **10 MHz, 5 mV/d,** 2 channels, **disc. 20 MHz,** 8 bits/1k dots, wrong 0.2-2%, IF with EVM CM-1, 250 VA, 35 kg (oscil.25 kg+IF)	Mahach-kala
1986	**S9-20, "Companion"**	**CO,** Comput., **20 MHz band, 2/4 ch. disc. 100/50 MHz, 6 bit.,** error 0.2-1.2%, **MP, IF KOP /** RS-232, 900 VA, 64 kg, Fourier pr.	**Not serially release**
1986	**C9-21, "Companion"**	**CO,** Comput., **5 MHz band, 4 channels. disc. 40 MHz, 8 bits,** error 0.2-0.8%, **MP, IF KOP /** RS-232, 800 VA, 71 kg, Fourier pr.	**Not serially released.**
1986	**C9-22, "Companion"**	**CO,** Comput., **1 MHz band, 4 channels. disc. 5 MHz, 8-12 bit.,** error.0.5-1.4%, **MP, IF KOP /** RS-	**Not serially released.**

		232, 900 VA, 64 kg, Fourier Ave.	
1986	**C9-23, “Companion”**	**CO,** Comput., **0.25 MHz band, 16/8 ch. disc. 0.25/0.5 MHz, 8 resolution,** error 0.2-2%, **MP, IF KOP** / RS-232, 650 VA, 64 kg, Fourier Ave.	**Not serially released.**
1986	**ÿ4ÿ-118, “Companion”**	**CR,** Digital. register, no screen 20 MHz band , **2/4 ch. disc. 100/50 MGc, 6 levels,** error 0.2-1.2%, **MP, IF KOP,** 32 kg.	**Not serially released.**
1986	**ÿ4ÿ-119, “Companion”**	**CR,** Digital. register, no screen **5 MHz** band , 4 ch. **disc. 40 MGc, 8 levels,** error 0.2-0.8%, **MP, IF KOP /** RS-232, 32 kg.	**Not serially released.**
1986	**Ya4S-120, “Companion”**	**CR,** Digital. register, no screen 1 MHz band , **4 channels. disc. 5 MHz, 8-12 bits,** error 0.5-1.4%, **MP, IF KOP** 32 kg.	**Not serially released.**
1986	**ÿ4ÿ-121, “Companion”**	**CR,** Digital. register, no screen band **0.25 MHz, 16/8 ch. disc. 0.250/0.5 MGc,** error 0.2-2%, **MP, IF KOP,** 32 kg.	**Not serially released.**
1987	**S8-22, "Soldi"**	**A/D, 2 channels,** 20 MHz band , **1 mV/d, Discrete 1 MHz/5 GHz, MP, ZG, Auto.,** 12LO1I, 40 VA, **6.5 kg.**	**Not serially released.**
1988	**S9-24, “Companion”**	**CO,** 5 MHz band , **1 channel. disc. 40 MGc, 8 levels,** error 0.2-0.8%, **MP, IF KOP /** RS-232, 350 VA, 33.5 kg..	**Not serially released.**
1988	**C9-25, “Companion”**	**CO,** 1 MHz band , **4 channels. disc. 5 MGc, 8-12 grade,** error 0.5-1.4%, **MP, IF KOP /** RS-232, 200 VA, 33 kg	**Not serially released.**
1988	**C9-26, “Companion”**	**CO,** band **0.25 MHz, 16/8 ch. disc. 0.25/0.5 MHz, 8 bits,** error 0.2-2%, **MP, IF KOP /** RS-232, 200 VA, 33 kg	**Not serially released.**
1992	**S8-24, "A tear"**	**CO.,** band **250 MHz, Disc. 1 MHz, MP,** CRT-12LO1I-60x80, 8 kg.	**Not serially released.**

List of abbreviations adopted in this and other tables of all applications:

N min/MS hour – playback/storage time for ZELT, **Auto. Change** – automatic

measurements of signal parameters **Auto/ search** – auto search for **AP signal –** auto search for signal **A/D** – analog-to-digital, **AIS** – automatic IC, **Amp./Iz.** – amplitude measurements, **B/Bl., (BB)** – base unit, **Base. bl.** – base unit, **BVS** – line selection unit, **BP** – power supply, **BS** – bistable, **BS/ZELT** – bistable ZELT, **V/mm –** volts per millimeter, **VA** – volt-amperes, **VCO** – computing CO, **Gen.imp.** – pulse generator, **Disc.** – sampling, **F/US/Exp.** – harsh operating conditions, **ZG** – character generator, **ZELT** – memory CRT, **Ind.** – indicator, **IS** – measuring system, **IF-KOP** – KOP interface, **channel.** – channel, **KOP** – general channel

plates, **ÿs/e** - microseconds per screen, **MP** - microprocessor, **MT** - multimeter, **LF** - low-frequency, **OV** - fiber optic, **OV/E** - fiber optic screen, **Optical. (opt.)** – optical, **OSB** – oscilloscope with SB, **Ots.** – compartment, **p/aut.iz. - semi auto meas., CCD** – charge-coupled device, **PT** – half-tone, **PT/ ZELT** – half-tone ZELT, **PH** – transient response, **Reflect. (reflect.)-**

reflectometer SB, s/b – replaceable unit, **Serv.** – service, **synchronization -** synchronization, **Offset** – offset, **special -** special, **Page** – stroboscopic, **MF** – mid-frequency, **Accurate. (t.)** – point, **FR** – photo-recording, **DZ** – digital delay, **TsO** – digital oscilloscope, **CPU** – digital memory, **TsR** – digital recorder, **ShP** – broadband, **ED –** equivalent sampling., **Equiv. –** equivalent. **ELTBV** - traveling wave CRT,

use,
L. –
beam, **LZ** – delay line,
Mar.Meas. – marker measurements
mV/d – millivolts per division, **MCP**
– micro-channel

All VNIIRIP oscilloscopes 1948-1992.

(Sorted by device types and years of development)

No. Year Model Pol. **Type** MHz 25 SB	Peculiarities	**ELT** mm	**K.**	**Chuvs.** mV/div	**Disc.** MHz	**Resolve Power.**	**Weight Dev.** VA **to** **Mr**
1 **1958 C1-8A**	**ELT-13LO37,** D-Diameter Diam125 1 25 SB Basic Block, 1 vert. compartment, **13LO3I**			50			650 **35** VNIIRIP
2 **1960 S1-15**	Diam125 1 25 SB C block U1, **13LO3I** Diam125 1 20 SB C block U2-diff. Entrance, **13LO3I**			·		20 ns/d 700	**42** VNIIRIP
3 **1960 S1-15/1**	Diam125 1 10 SB Baz. Bl., **16LO2I** 2 beams, s/b ot C1-15 2l 20 SB C block U3-2 can.,			50		20 ns/d 700	**42** VNIIRIP
4 **1961 S1-15/2**	**13LO3I** Diam125 2k Diam125 1 Diam125 1 Diam125 1 Diam125 2k 64x80 1 64x80 1			50		20 ns/d 700	**42** VNIIRIP
5 **1962 C1-17** 6				·		20 ns/d 700	**42** VNIIRIP
1962 C1-15/3				100		20 ns/d 700	**42** VNIIRIP
7 **1963 S1-15/4**	1 SB With U4-differential block. entrance. **13LO3I** 0.06 SB			1		20 ns/d 700	**42** VNIIRIP
8 **1964 S1-15/5**	With U5-differential block. entrance. **13LO3I** 200 SB U7-strobe.			0,05		20 ns/d 700	**42** VNIIRIP
9 **1965** S1-15/7	converter -75 ohm. **13LO3I** 350 SB U8-strobe. converter -75			·		·	700 **42** VNIIRIP
10 **1967 S1-15/8**	ohm. **13LO3I** 50 SB Base unit, CRT - 2 compartments, **11LO2I,**			20		2 ns/d	700 **42** VNIIRIP
11 **1972 C1-70,** 12	50 SB With blocks 1U11/1R11, **11LO2I,** 3 500 SB With			·		-	250 **24** VNIIRIP
1972 C1-70/1 13	blocks 1U71/1R71-strobe, 50 Ohm			10		10 ns/d 250	**28** VNIIRIP
1972 C1-70/2		64x80	2k	5		0.1 ns/d 250	**28** VNIIRIP
14 **1974 C1-74**	35 SB B/Bl.2 L/4 k., 3 from. s/b S1-70, **13LO16** 700 SB	60x100 2 l		·		-	250 **30** VNIIRIP
15 **1974 S1-70/3**	1U72/1R71-strobe kit, 100 kOhm 10 SB 1U13/1R11-differential.	64x80	2k	5		0.1 ns/d 250	**28** VNIIRIP
16 **1974 S1-70/4**	high amplification 50 SB PT-ZELT, s/b S1-70, 2 **ots., 13LN10**	64x80	1	0,5		10 ns/d 250	**28** VNIIRIP
17 **1974 S8-12** 18		48x80	1	·		-	300 **27** VNIIRIP
1974 S8-13 19	1 SB BS-ZELT, s/b ot C1-70, 2 ots., **13ÿÿ2** 50 SB PT-ZELT, 2l/	60x80 1 40x80		·		-	180 **23** VNIIRIP
1974 S8-14	3ots. s/b C1-70, **13ÿÿ11** 10 SB 1U91/1ÿ91-us.so smesh.str. for	2l		·		-	320 **34** VNIIRIP
20 **1975 S1-70/5**	C8-XX 1 SB 1U92/1ÿ11 - logar. Usil. 10 db/del.	64x80	1	10		10 ns/d 250	**28** VNIIRIP
21 **1975 S1-70/6**		64x80	1	10		10 ns/d 250	**28** VNIIRIP
22 **of 1976 C1-70A**	50 SB Base Block, **15LO1I,** 2 outputs, 50 SB	80x100 1		·		-	250 **24** VNIIRIP
23 **1976 S1-70/7**	1U12/1R11 - 2-channel amplifier 0.1 SB 1U14/1R11-diff. high	64x80	2k	10		10 ns/d 250	**28** VNIIRIP
24 **1976 S1-70/8**	altitude ass. 100 SB Base Block, **ELT-17LO1I,** ZG, 3	64x80 1		0,01		10 ns/d 250	**28** VNIIRIP
25 **1977 C1-91**	compartments 100 SB YA4S-90/91, 4 channels, 2 scanners 100	100x120 2		·		-	150 **17** VNIIRIP
26 **1977 C1-91/1**	SB YA4S-90/91/97, 2 channels + multimeter, U/I/R 12 000	100x120 4k		5		5 ns/d 150	**20** VNIIRIP
27 **1978 C1-91/2**	SB Y4C-95/96/89-strobe.bl.+gen.imp., 2 k. 100 SB ÿ4ÿ-90/91/98-	100x120 2k		5		5 ns/d 220	**21** VNIIRIP
28 **1978 C1-91/3**	digital zader. development 100 SB ÿ4ÿ-90/91/92-characteristic tr-rov	100x120 2k		2		20 ps/d 220	**22** VNIIRIP
29 **1979 C1-91/5**		100x120 2k		5		5 ns/d 220	**21** VNIIRIP
30 **1979 C1-91/6**		100x120 2k		5		5 ns/d 220	**21** VNIIRIP
31 **1981 C1-91/4**	18,000 SB Ya4S-100/101/102-strobe-2 channels, +LZ 100 SB	100x120 2k		2		10 ps/d 220	**22** VNIIRIP
32 **1981 C1-91/7**	Ya4S-90/91/105-marker. measured U/T 100 SB Meas.	100x120 2k		5		5 ns/d 220	**21** VNIIRIP
33 **of 1984** K2-52/53	System S1-91/115 +Ya4S-111+sb 50 SB Base. Bl., 2 beams/4k.,	100x120 4k		5		5 ns/d 500	**60** VNIIRIP
34 **1984 ÿ1-115,** 35	**17LO4I,** ZG, 3 from. 100 SB BB, indicator-LED, 3 off., s/b from	100x120 2 l		·		-	150 **20** VNIIRIP
1984 ÿ4ÿ-111	S1-122 100 SB Base.Bl., **CRT-17LO7I,** ZG, 3 off. 37 **1986**	·	·	·		-	105 **8** VNIIRIP
36 **1986 S1-122**	**S1-122/1** 100 SB Ya4S-90/91, 4 channels, 2 scans 38	100x120 2		·		-	150 **17** VNIIRIP
1986 S1-122/2 100 SB	Ya4S-90/91/97.2 channels + multimetal. 39 **1986 S1-122/4** 18 000	100x120 4k		5		5 ns/d 150	**20** VNIIRIP
SB Ya4S-100/101/102-	strobe-2 channels, +LZ 100 SB Ya4S-90/91/98-digit delay.	100x120 2k		5		5 ns/d 220	**21** VNIIRIP
development 100 SB Ya4S-90/91/92-	characteristic recorder 100 SB Ya4S-90/91/105-marker.	100x120 2k		2		10 ps/d 220	**22** VNIIRIP
40 **1986 S1-122/5**	measured U/T 10 SB/C Ya4S-122, central heating, Digital	100x120 2k		5		5 ns/d 220	**21** VNIIRIP
41 **1986 S1-122/6**	Os., automatic control/change. - SB/C Ya4S-110, Logical	100x120 2k		5		5 ns/d 220	**21** VNIIRIP
42 **1986 S1-122/7**	analog.-100 MHz/16 k. 100 SB B.Bl., **CRT-13LN14,** 10t.km/	100x120 2k		5		5 ns/d 220	**21** VNIIRIP
43 **1986 S1-122/8**	s, ZG, 3 from.	100x120 2k		0,5	20/5000 -	20 ns/d 220	**21** VNIIRIP
44 **1986 S1-122/9** 45		100x120 16			100	-	220 **21** VNIIRIP
1987 S8-21		80x100 2		·		-	150 **17** VNIIRIP
46 **1958 S1-11** 47	100 ShP **ELT-13LO104A,** 4000 km/s, tube 100 ShP	D-130	1	100		25 ns/cm 1200	**165** VNIIRIP
1964 S1-31 48	**ELT-13LO10T,** 2 scans, lamps. 250 ShP **ELT-13LO105M,**	40x80 1		100			600 **40** VNIIRIP
1974 S1-75 49 **1977**	Rin-50 Ohm, 1500 km/s 100 ShP **ELT-17LO1I,** 1 MOhm, 2 scans	60x100 2		10		2 ns/d 160	**23** VNIIRIP
S1-92	350 ShP **ELT-16LO101A,** 50 Ohm, Digital. Zader. 350 ShP	100x120 2		5		5 ns/d 160	**16** VNIIRIP
50 **1979 S1-108**	**CRT-16LO101A,** 50Ohm/100kOhm/1MOhm 250 ShP **16LO101A,**	80x100 1		5		1 ns/d 110	**17** VNIIRIP
51 **1979 S1-97**	1 MOhm, MP, Digital Z, Multi. 100 ShP **CRT-17LO1I,** MP, IF-	80x100 2		10		1 ns/d 140	**18** VNIIRIP
52 **1983 S1-116**	EVM. 1,000 ShP MP. 50ÿ/100kÿ/1MOhm. 2 times.	80x100 2		5		1 ns/d 105	**15** VNIIRIP
53 **1985** S1-121		100x120 4		2	20 10	2 ns/d 250	**25** VNIIRIP
54 **1989** C1-129		60x80 2				0.2 ns/d 150	**21** VNIIRIP

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55 1957 C1-6	1 !5@2 -"-755, <0;>3. 1,6 </ 1 !	-60	1			1,5 <:A/M 35 4,5
56 1976 !1-90	5@2 -"-87	40E60	1	10		1 <:A/4, 20 3,5
57 1977 !1-94 58	10 !5@2 -"-87	40E60	1	10		100 =A/4, 32 3,5
1980 !1-109	5 !5@2 -"-63 (/4!-99)	30E40	1	10		100 =A/4, 30 1,8
59 1980 !1-112	10 5@2 -"-86, <C;LB8<., 87<. U/I/R 10 !	40E60	1	5		50 =A/4 25 3,5
60 1982 !1-118	5@2 -"-119, 2 :0=0;0	60E80 2:		5		50 =A/4 28 4
61 1983 !030	7 !5@2 -"-87	40E60	1	5		50 =A/4 30 3,2
62 1987 !8-20	10 5@2 "/-"-111, 100 :</A, 20 A.	56E70 2:		2		50 =A/4 30 4,6
63 1988 !1-112 64	20 5@2 -"-86, <C;LB8<., 87<. U/I/R 20 !	40E60	1	5		50 =A/4 25 3,5
1988 !1-118	5@2 -"-119, 2 :0=0;0 20 !5@2	60E80 2:		5		50 =A/4 28 4
65 1989 !1-131	&, -"-119,+F8D.?0<.-1 :1/8@. 35 !5@2	60E80 2:		2	1	50 =A/4 40 4,5
66 1990 !1-134	-"-121	60E80 2:		2		10 =A/4 35 5
67 1990 !1-139	20 5@2 -"-119	60E80 2:		2		20 =A/4 35 4,5
68 1990 !K1-132	20 5@2 -"-119, +<C;LB.,+5=."/".	60E80 2:		2		20 =A/4 35 4,5
69 1990 !1-140 70	20 5@2 -"-119, +<C;LB.	60E80 2:		2		20 =A/4 35 4,5
1990 !1-144	20 5@2 -"-119, +<C;LB.,+"/!.	60E80 2:		2		20 =A/4 35 4,5
71 1991 !1-137	25 5@2 -"-121	60E80 2:		2		20 =A/4 40 5
72 1992 !1-137/1	25 5@2 -"-121, +C;LB8<5B@ 25 !	60E80 2:		2		20 =A/4 40 5,3
73 1992 !1-137/2	5@2 &, -"-121,+F8D.?0<.-1 :1/8@. 25 !	60E80 2:		2	1	20 =A/4 40 5,5
74 1992 !1-139	5@2 -"-119	60E80 2:		2		20 =A/4 35 4,5
75 1992 !K1-132 76	25 5@2 -"-119, +<C;LB.,+5=."/".	60E80 2:		2		20 =A/4 35 4,5
1992 !1-140 77 1992 !	25 5@2 -"-119, +<C;LB.	60E80 2:		2		20 =A/4 35 4,5
1-144	25 5@2 -"-119, +<C;LB.,+"/!.	60E80 2:		2		20 =A/4 35 4,5
78 1948 !1-1	0.25 ' 1337 5 '	1337	1	4		120 24
79 1950 !1-2	R2E=0.5 </75<, 1337 1 ' 80<.	1337	1	30		25
80 1954 C1-4	--"-125<, 1337 10 '	133	1	30		250 26 180
81 1957 C1-5			1	40		18 1700 50
82 1960 C1-12	15 2 ;CG0, 181 1 '	181 2;		100		
83 1962 C1-18,	2 ;CG0, 162 10 ' 133	40E100 2; 133 1:		20		300 27
84 1962 C1-20				100		360 23
85 1962 !1-16	5 2 ;CG0, 162 5 '	40E100 2; 221 5;		20		395 25
86 1969 !1-33 87	5 ;CG59, ;0<?>2K9, 221 10 ' 1 F/			10		600 160 120
1979 !1-102 88 1979 !	0,05 </4, 2 ;CG0, 174 10 ' 1 F/0,05 </	100E120 2;		0,5		15 120 15
1-103	4, 2 ;CG0, 4 :., 174	100E120 4:		0,5		
89 1964 C8-1	1 -" !-4 :</A, 30<8=./170 G0A., 132 2	60E80	1	10		450 36
90 1964 !8-9	-" "-100 :</A, 1 <8=./16 G0A., 135 7 -"	40E80	1	100		1 <:A/4, 450 25
91 1965 C8-2	"-500 :</A, 1 <8=./16 G0A., 136 20 -"	48E80	1	25		900 70
92 1967 C8-7	"-1000 :</A, 1 <8=., 137, 1;>:8 20 -"	40E80	1	50		750 30 750
93 1967 C8-7A	"-1000 :</A, 1 <8=., 4;O /#A/-:A?.	40E80	1	50		30
94 1968 C8-11	1 -" !-5 :</A, 30 <8=., 138 1	40E80	1	10		700 50
95 1969 C8-8	-"!-10 :</A, 30 <8=., &8D@. 7<5@5=.	50E80	1	5		700 115
96 1972 !8-9	2 -" "-100 :</A, 1 <8=./16 G0A., 135 10	40E80	1	100		1 <:A/4, 450 25
97 1976 !8-15	-" "-1000 :</A, 40 A5:/16 G0A,161/2;	80E100 2;		2		65 16
98 1979 !8-17 99	1 -" !-40 :</A, 30 <8=./7 ACB., 168,2 ;.	60E80 2;		1		80 16
1983 !8-18	10 -" "-250 :</A,30<./16G.,163,<?./7.	76E95 2:		1		50 =A/4 85 16
100 1957 !1-10	1 000 !?5F !:>@., -"-13101, 75 <, 1		1	5000		10 =A/M 500 45
101 1959 C1-14	000 !?5F !:>@., -"-13102, 25 B.:</A, 1		1	3300		10 =A/M 850 107
102 1965 C1-36	200 !?5F !:>@., -"-«$CB5@-2», 10 B.:</A,		1	10000		10 =A/M 400 45
103 1968 C7-10	1 000 !?5F. !:>@., -"-10102 1B.:</A, 1	40E40	1	1000		125 ?A/M 750 106 250?A/<
104 1971 C7-10	200 !?5F. !:>@., 10102, 1 B. :</A,	20E40	1	1000		750 75 2,5 =A/4 150 35 0,1
105 1975 !9-4	100 !?5F. !:>@., 13106, 1,5 B.:</A, 5	60E100	1	10		=A/4 210 50 250?A/< 750
106 1976 !7-15	000 !?5F. !:>@., 10104, 40 B. :</A, 1	15E40	1	1000		75
107 1978 C7-10	200 !?5F. !:>@., 10103, 10 B. :</A, 500 !?	40E40	1	75		
108 1980 !9-4	5F. !:>@., 13106, 20 B. :</A, 100 !?	60E100	1	2000		2,5 =A/4 150 35 5 10 000M
109 1980 !9-6 110	5F. &, 20, 3 B. :</A, $--, 5 000 !?	100E100	1		2,5 =A/4 560 46 170 0,2 =A/4 170 30 10 40 000M	
1982 !7-19	5F. !:>@., 10105, 250 B.:</A, 5,5 ?A/B.	40E60	1	0,5 =A/4 360 46 50 400000M 4 ?A/;8=.		
111 1986 !9-13	350 !?5F. &, 162/20, 256E256 B>G.		1			
112 1990 2-74	5 000 !?5F. ! <0B@., !7-19, + . 512E512B.	40E60	1			
113 1969 !7-8	1 500 !B@. 50</10:<, -"-132, H-1,5 2 5 000 !	60E80	2	10		100 ?A/4 300 38
114 1971 !7-11 115	B@. -"-132, (C<-3,5 <, 6QAB .CA;.	64E80	2	5		50 ?A/4 160 33 10 ?A/4
1981 !9-9 116 1986 /	18 000 !B@. ">G=.-1,5-4%, $--,02B.87<, & 150E150 18 000 !B@. 57		2	5		400 62 10 ?A/4 300 30
4!-125	-", (C<-2-5 <, $--, & 18 000 !B@. HC<-5 <,		2	5		
117 1987 !7-20/!1	R2E = 50 <, &, 1 10 000 !B@. HC<-2 <, R2E	150E150	2	5		10 ?A/4 450 60
118 1987 !7-20/!2	= 50 <, &, 1 1 000 !B@. HC<-2 <,	150E150	2	5		10 ?A/4 450 60
119 1987 !7-20/!3	R2E=100 :<,&,1 18 000 !B@. HC<-5 <, R2E	150E150	2	5		10 ?A/4 450 60
120 1988 !7-21/!1 121	= 50 <, &, 162 10 000 !B@. HC<-2 <, R2E = 50 <,		2	5		10 ?A/4 300 30 10 ?A/4
1988 !7-21/!2 122 1988 !	&, 162 1 000 !B@. HC<-2 <, R2E=100 :<,&, 162		2	5		300 30 10 ?A/4 300 30
7-21/!3			2	5		
123 1990 !7-20/4	30 000 !B@. (C<-2,5 <, 468B.-5 ?A, &	150E150	2	10		5 ?A/4 450 60

124 1956 !1-7			60 !' -"-1847, 2 ;CG0, 40 !'				2	150			1500 270		
125 1963 C1-32, 126 1966 !			">G=>ABL 3%		50E70		1	100		10 =A/A< 1300 70			
1-40,			25 !' -"-1311#, ">G=>ABL 2%		60E80		1	50		20 =A/A<	950 55		
127 1979 !9-5 128			5 & =4.--1, $--, B>G=.0,2-5%, 10 & =4.--1,		100E100				1 5(20) 5 20		220 18 250 35		
1982 !9-10/1			$--, B>G=.0,2-2%, 20 & &, =4.--1, $-, 5 & &,		100E100		1 2		100(50) 40				
129 1986 !9-20			=4.--1, $-, 1 & &, =4.--1, $-,		256E256		2/4				900 64		
130 1986 !9-21			0,25 & &, =4.--1, $-, 20 &		256E256		4				800 64		
131 1986 !9-22			538AB@0B>@ 157 -", $-,		256E256		4		5		900 64 900 64		
132 1986 !9-23 133 1986 /			5 & 538AB@0B>@ 157 -", $-, 1		256E256		16/8		0,5/0,25				
4!-118 134 1986 /4!-119			& 538AB@0B>@ 157 -", $-, 0,25 &				2/4		100(50) 40		350 33 300 33		
			538AB@0B>@ 157 -", $-, 20 & &,				4						
135 1986 /4!-120			-"-121, 5 & &, -"-162, $-, 1 & &, -"-162,				4		5		250 33		
136 1986 /4!-121			$-, 0,25 & &, -"-162, $-,				16/8		0,5/0,25		200 33		
137 1987 !8-22					1 </4		2	1	1/5000	20 =A/4	40 6,5 350 33		
138 1988 !9-24 139 1988 !					162		1		40		250 33 200 33		
9-25 140 1988 !9-26					162				5				
					162		1 2/4		0,5/0,25				

A5 >AF8;;>3@0DK -;B5AB0 2

=57028A8<>9 8B25 2000-2019 3.3.

(BA>@B8@>20=K ?> 3>40< @07@01>B:8)

1 2000 UDS-2030 30 000 !B@>1 1,6%, 14 18B, A8=E. 1/12 F, HC<-3< 2 2000 UDS-2020 20 000 !B@>1 1,6%,							2	1	10"F/M	10 ?A/4	60 5,5 -;B5AB0		
14 18B, A8=E. 1/12 F, HC<-2< 3 2000 UDS-2020 12 000 !B@>1 1,6%, 14 18B, A8=E. 1/12 F, HC<-1< 4 2006							2	1	10"F/M	10 ?A/4	60 5,5 -;B5AB0		
UDS-2128 20 000 !B@>1 ?B8G. E. 3/8 F, 0,75-1,65 <:<, 5 2006 UDS-2113 12 000 !B@>1 ?B8G. E. 3/8 F,							2	1	10"F/M	10 ?A/4	60 5,5 -;B5AB0		
0,75-1,65 <:< 6 2002 UDS-2022 20 000 !B@>1 5D;5:B., 8<?C;LA 100 ?A/400 <, 7 2002 UDS-2021							2	1	10"F/M	10 ?A/4	60 5,5 -;B5AB0		
12 000 !B@>1 5D;5:B., 8<?C;LA 100 ?A/400 <, 8 2006 UDS-2214 14 000 !B@>1 8D. @5D;., 8<?							2	1	10"F/M	10 ?A/4	60 5,5 -;B5AB0		
C;LA 100 ?A/400 <, 9 2006 GFT-6202 12 000 !B@>1 ;>: PXI-AB@>1->AF8;;>3@0D							2	1	10"F/M	10 ?A/4	60 5,5 -;B5AB0		
							2	1	10"F/M	10 ?A/4	60 5,5 -;B5AB0		
							2	1	10"F/M	10 ?A/4	60 5,5 -;B5AB0		
							2						-;B5AB0
10 2007 PS-9201			12 000 !B@>1 2%, 16 18B, A8=E. 1/10 F, HC<-2 < 12 000 !B@>1				2	2	0,2	50 ?A/4	15	1,1 -;B5AB0	
11 2009 PS-9211			5D;5:B., 8<?C;LA 100 ?A/400 <, 12 000 !B@>1 ?B8G. E. 3/8 F,				2	2	0,2	10 ?A/4	15	1,1 -;B5AB0	
12 2009 PS-9231 13 2010			0,75-1,65 <<, 1 000 & &-8 18B,				2	2	0,2	10 ?A/4	15	1,1 -;B5AB0	
PS-6407 14 2011 P-9301-15							2		5 000 200 F/M			-;B5AB0	
15 000 !B@>1 (C<-2 <, &-16 18B, 2%, 15 2011 P-9301-25 25 000 !B@>1 (C<-2,5 <, &-16							2	1		5 ?A/4		1,3 -;B5AB0	
18B, 2%, 16 2011 P-9302-15 15 000 !B@>1 (C<-2 <, &-16 18B, 2%, 17 2012 P-9302-25 25							2	1		5 ?A/4		1,3 -;B5AB0	
000 !B@>1 (C<-2,5 <, &-16 18B, 2%, 18 2012 P-9311-15 15 000 !B@>1 5D;., 8<?C;. 60 ?							2	1		5 ?A/4		1,3 -;B5AB0	
A/6 (C<-1,6 < 19 2012 P-9311-20 20 000 !B@>1 5D;5:B., 8<?C. 60 ?A/6 16 18B, 20 2013							2	1		5 ?A/4		1,3 -;B5AB0	
P-9321-20 20 000 !B@>1 ?B. E. 9,5 F, &-16 18B, 2%, 21 2013 P-9341-20 20 000 !B@>1 (C<-2 <, &-16							2	1		5 ?A/4		1,3 -;B5AB0	
18B, 2%, 22 2013 P-9341-25 25 000 !B@>1 (C<-2,5 <, &-16 18B, 2%, 23 2016 P-9404-05 5 000 & &-12							2	1		5 ?A/4		1,3 -;B5AB0	
18B, 3,5%, HC<-1,8 <, 24 2016 P-9404-16 16 000 & &-12 18B,HC<-1,8 < 25 2019 FS-1051 5 000 &							2	1		5 ?A/4		1,3 -;B5AB0	
(C<-1,8 <, &-12 18B, 5 000 & (C<-1,8 <, &-12 18B, 5 000 & (C<-1,8 <, &-12 18B, 16 000							4	1		5 ?A/4		1,3 -;B5AB0	
& (C<-1,8 <, &-12 18B, 16 000 & (C<-1,8 <, &-12 18B, 16 000 & (C<-1,8 <, &-12 18B,							4	1		5 ?A/4		1,3 -;B5AB0	
							2	10 500		50 ?A/4		1,4 -;B5AB0	
							2	10 500 10 500		50 ?A/4		1,4 -;B5AB0	
							1			50 ?A/4		0,37 -;B5AB0	
26 2019 FS-2052							2	10 500		50 ?A/4		0,79 -;B5AB0	
27 2019 FS-3054							4	10 500		50 ?A/4		1,52 -;B5AB0	
28 2019 FS-1161							1	10 500		50 ?A/4		0,37 -;B5AB0	
29 2019 FS-2162							2	10 500 10 500		50 ?A/4		0,79 -;B5AB0	
30 2019 FS-3164							4			50 ?A/4		1,52 -;B5AB0	

Объёмы производства осциллографов ВНИИРИП на заводах отрасли за 1984-1992 г.г.

(по моделям согласно данным книги "Люди. Годы. Осциллографы" А.Ф. Денисов, Я.М. Россоский, по ценам 1984 г.)

Модель	Тема	Год	МГц	К	Особенн.	Цена	Завод	84 год	85 год	86 год	87 год	88 год	89 год	90 год	91 год	92 год	Всего шт.	Сумма руб.	Тыс.шт.	Мил.руб.
С1-122/1	Свита-3	86	100	4	Базовый	5570	Вильнюс				25	725	2878	2223	167		6018	33520260		
С1-122/2	Свита-3	86	100	2	Мультим.	5800	Вильнюс					223	1012	504	24		1763	10225400		
С1-122/5	Свита-3	86	100	2	Циф./Зад	5825	Вильнюс					111	406	237	17		771	4491075		
С1-122/6	Свита-3	86	100	2	Характер.	5570	Вильнюс					65	444	281			790	4400300		
С1-122/7	Свита-3	86	100	2	Измерен.	6210	Вильнюс						87	305	47		439	2726190		
С1-122/8	Свита-3	86	10	2	Циф./Пам	9620	Вильнюс							3	198		201	1933620		
С1-122/9	Свита-3	86	-	8	Лог./Анал	7865	Вильнюс							41	136		177	1392105		
С1-122/10	Свита-3	86	100	2	М/ЦЗ/Изм	7700	Вильнюс						30	93			123	947100		
С1-122/11	Свита-3	86	100	2	Измерен.	7200	Вильнюс							55			55	396000		
С1-122/12	Свита-3	86	100	2	М/ЦЗ/Изм	7075	Вильнюс							29			29	205175		
Всего С1-122/115 (шт/мил.руб)					12,875		74,663975													
Свет (только реальное время)					40,317		170,030115													
Свет всего (со стробоскопами)					43,255		184,368123													
Всего (со смен. блоками)																			89,832	286,416932
Запоминающие на ЗЭЛТ																				
С8-17	Сад-1	79	1	2	1мв/40км	2400	Абовян	1484	1850	1928	1957	1745	1917				10881	26114400		
С8-18	Сад-2	83	10	2	250км/с	2400	Абовян				175	132	34				341	818400		
Всего																			11,222	26,932800
Цифровые запоминающие																				
С9-5	Спутник-1	79	5	1	Fд=5мГц	5000	Махачкала	73	30	100	150	50	125	25			553	2765000		
С9-10/1	Самоан.-20	82	10		Fд=20мГц	7525	Махачкала			11	24	72	132	76	69		384	2889600		
Всего																			0,937	5,654600
Стробоскопы																				
С1-91/3	Свет-1	77	12000	2	Генер.ПХ	5000	Минск	257	345	325	211	314					1452	7260000		
С1-91/4	Свет-1	77	18000	2	Бл.Задер.	5580	Минск		53	244	170	149	144				760	4240800		
С1-122/4	Свита-3	86	18000	2	Бл.Задер.	3908	Минск							263	127		390	1524120		
С1-122/13	Свита-3	87	18000	2	Генер.ПХ	3908	Минск							267	69		336	1313088		
Свет всего (шт/мил.руб)					2,938		14,338008													
С9-9	Сигма	85	18000	2	Прециз.	27600	Минск		5	10	16	25	32	40	53		181	4995600		
Всего																			3,119	19,333608

Объёмы производства осциллографов ВНИИРИП на заводах отрасли за 1984-1992 г.г.

(по моделям согласно данным книги "Люди. Годы. Осциллографы" А.Ф. Денисов, Я.М. Россоский, по ценам 1984 г.)

Модель	Тема	Год	МГц	К	Особенн.	Цена	Завод	84 год	85 год	86 год	87 год	88 год	89 год	90 год	91 год	92 год	Всего шт.	Сумма руб.	Тыс.шт.	Мил.руб.
Специальные регистраторы																				
С9-4А	Сигнал	75	500	1	20т.км/с	16000	Вильнюс	150	219	258	250	142					1019	16304000		
С9-6	Стропило	80	100	1	Fд=10ГГц	7300	Вильнюс	87	100	150	150	151	150	178			966	7051800		
Всего																			1,985	23,355800
Сервисные																				
С1-94	Сервис-2	77	10	1	3,5 кг	170	Мытищи	9065	11598	10978	11485	12545	16329	14540	14911		101451	17246670		
С1-112	Сервант	80	10	1	Мультим.	430	Вильнюс	3750	8892	10289	15121	14508	77				52637	22633910		
С1-112А	Сервант	88	20	1	Мультим.	470	Вильнюс					507	14795	16728	27469	700	60199	28293530		
С1-118	Сервис-4	82	10	2	4 кг	400	Абовян		703	2604	5163	5983					14453	5781200		
С1-118А	Сервис-5	87	20	2		450	Абовян					15	8122				8137	3661650		
С1-131	Сода	89	20	2	Цифр.П.	700	Вильнюс							10	700		710	497000		
Всего																			237,587	78,113960
Осциллографы Всего																	410,743	666,489670	410,743	666,489670
Метрология для осциллографов																				
И1-9		75	100		Котк/Краз.	1000	Махачкала	1214	2048	1448	1443	1549	1422	850	243		10217	10217000		
И1-11	Газолин-1А	78	10		Пер. Хар.	1360	Вильнюс	516	534	404	443	392	257				2546	3462560		
И1-12	Газ-2	78	5000		Пер. Хар.	550	Вильнюс	1500	200	190	280	150	166	147			2633	1448150		
И1-14	Газолин-1Б	78	100		Пер. Хар.	1300	Вильнюс	508	500	405	1063	750	217				3443	4475900		
И1-15	Газолин-1Б	78	350		Пер. Хар.	1700	Вильнюс	306	351	300	537	300	323	255			2372	4032400		
И1-17	Газават-1	86	10		ПХ, КОП	3480	Махачкала					12	191	382	51		636	2213280		
И1-18	Газават-1	86	100		ПХ, КОП	3250	Махачкала					2	207	384	470		1063	3454750		
Всего																			22,910	29,304040

Объёмы производства осциллографов ВНИИРИП на заводах отрасли за 1984-1992 г.г.

(Итоги по категориям согласно данным книги "Люди. Годы. Осциллографы" А.Ф. Денисов, Я.М. Россоский, по ценам 1984 г., 1 долл.=0,9 руб.)

	Категория	Модели	% руб.	За 8 лет Мил. руб.	В год мил.руб.	% шт.	За 8 лет Тыс.шт.	В год тыс.шт.	В мес. штук	Цен.Осц. Тыс.руб.	Цен.Осц. Тыс.долл.
1	**Со сменными блоками**	**С1-70, С8-12/13/14, С1-91/115/122**	**43,0**	286,416932	35,802117	**21,9**	89,832	**11,229**	**936**	**3,188**	**3,543**
2	**Широкополосные**	**С1-75/97/108/116**	**25,5**	170,186970	21,273371	**12,1**	49,812	**6,227**	**519**	**3,417**	**3,796**
3	**Сервисные**	**С1-94/112/118/131**	**11,7**	78,113960	9,764245	**57,8**	237,587	**29,698**	**2475**	**0,329**	**0,365**
4	Низкочастотные	С1-102/103	8,5	56,495000	7,061875	4,0	16,249	2,031	169	3,477	3,863
5	Запоминающие на ЗЭЛТ	С8-17/18	4,0	26,932800	3,366600	2,7	11,222	1,403	117	2,400	2,667
6	Специальные регистраторы	С9-4А, С9-6	3,5	23,355800	2,919475	0,5	1,985	0,248	21	11,766	13,073
7	Стробоскопы	С1-91(/3/4), С1-122(/4/13), С9-9	2,9	19,333608	2,416701	0,8	3,119	0,390	32	6,199	6,887
8	Цифровые запоминающие	С9-5, С9-10/1	0,8	5,654600	0,706825	0,2	0,937	0,117	10	6,035	6,705
	Осциллографы Всего		**100,0**	666,489670	83,311209	**100,0**	410,743	**51,343**	**4279**	**1,623**	**1,803**
	Метрол. для Осциллографов	И1-9/11/12/14/15/17/18	4,4	29,304040	3,663005	5,6	22,910	2,864	239	1,279	1,421

@8;>65=85 2

AF8;;>3@0DK", 3. L2>2
1958-1991 3.3.

(BA>@B8@> 20=K ?> 3>4C 2K?CA:0)

>4	>45;L («"5<0»)	A=>2=K5 B5E=8G5A:85 E0@0:B5@8AB8:8	02>4 - 73>B>2.
1958	!1-9 (--58)	!, ?>;>A0 12 (5) F, 40 </A<, ", 13037, 1 <A/M, 550 65 :3.	L2>2
1959	!1-13 (--60)	" !, ?>;>A0 12 F, 100 </A<, -" -40%80 <, 600 =A/M, 3 A/1, 600 84 :3	8=A:
1961	!1-13	" !, ?>;>A0 12 F, 100 </A<, -" -40%80 <, 600 =A/M, 3 A/1, 600 84 :3.	8=A:
1962	!1-19	' (!), ?>;>A0 1 F, A/1, 2 </ A<, 2 250 21 :3, 270<5= !1-4.	L2>2
1962	!1-22	?>;>A0 5 F, 100 </ A<, ', =A/4, 200 13 :3. 100	L2>2
1962	!1-30	', ?>;>A0 1 F, 20 </A<, -" - 50E80 <, 520 ' (!), ? 36 :3.	L2>2
1963	!1-19	>;>A0 1 F, A/1, 250 2 </ A<, 2 21 :3, 270<5= !1-4.	L2>2
1964	!1-34	', 2 ;CG0, ?>;>A0 5 F, -" -91, 200 170 </A<, =A/A<, 150 !B>5G=K9 20@80=B ! 19 :3.	L2>2
1964	!1-30	1-30	L2>2
1965	!1-35	', , 1-9 =0 B@-@0E, 30 ?>;>A0 5 F, 10 </4, ', 8 :3.	L2>2
1967	!1-43	2B><., ?>;>A0 10 F, -" -60E80 <, 50 50 </4, =A/4, 150 ?>;>A0 1 F, 2 </4, ', <, 75 ', , ? 40 :3.	@O=A:
1968	!1-48	>;>A0 5 F, 36E60 <, 38 , 8,5 :3 ', -" -60E80 2 ;CG0, ? 20 :3.	L2>2
1968	!1-49	>;>A0 10 F, -" 10 </4, -" - -92, 20 =A/4, 75 15 :3.	L2>2
1968	!1-55	10 </4,	@O=A:
1969	!1-52 (! 9-52) !	", !, 12 F, 100 </A<, 60E80 -" - <, 70 25 :3.	>;>G52
1970	1-48	!B>5G=K9 20@80=B !1-48	L2>2
1970	!1-57 (! 9-57) !-67	", !, 15 F, 100 </A<, 60E80 -" - <, 110 25 :3.	>;>G52
1971		@>B82>C40@=K9 !1-67	L2>2

1971	!1- 59	", ' 4;O =0AB@>9:8 72C:0, !B>5G=K9, 1 F, 2 </4.	C5@89=> =5 2K?CA.
1971	!1-63	!', >@B>2>9, 25 F.	=5 2K?CA.
1971	!1-64	!', 2 :0=., ?>;>A0 50 F, 1 </4, -" 48E80, 2 @072. 10 =A/4, 150 :3. 19	L2>2
1971	!1-64	!', 2 :0=., ?>;>A0 50 F, -"-64E80, 1 </4, 2 @072. :3. 10 =A/4, 125 16	L2>2
1971	!1-65	!', ?>;>A0 35 F, 5 </4, -64E80 <, 10 =A/4, -" - 112 125 16 :3.	8=A:
1971	!1-67	', ?>;>A0 10 F, 10 </4, -" - 42E60 <, 45 10 :3 ?	L2>2
1972	!1-68	>;>A0 1 2 </4, -" -60E80 F, ', <, 40 10	L2>2
1973	!1-69	:3 ', 2 ;CG0, ?>;>A0 5 F, 1 </4, -" -40E100 <, 20 =A/4, 135 (, ? 17 :3.	L2>2
1973	!1-71	>;>A0 100 F, 5 </4, 48E80 <, 150 19 :3 -" - ", 20 F, 10 </4, 20 =A/4,	L2>2
1973	!9-1	130 26 :3. !5@2., ?>;>A0 5 F, 10 </ 4,	>;>G82
1974	!1-73	36E60<, 50 =A/4, 30 , 4,5 :3, -" - <0;>3010@8B=K9	>;>G52
1975	!1-77	', 2 :0=., ?>;>A0 10 F, -" -60E80, 100 5 </4, =A/4, 50 (, 2 :0=., ?>;>A0 100 F, -" 10 :3.	>;>G82
1975	!1-79	-48E80, 5 =A/4, 160 !', 2B., ?>;>A0 35 5 </4, F, 80E100 <, 10 =A/4, 130 270<5= ! 19 :3.	L2>2
1976	!1-78	1-43. 5 </4, -" - 19 :3	>;>G82
1976	!1-81 (! 9-2)	", 20 F, 10 </4, 20 =A/4, 120 18 :3.	>;>G82
1977	!1-93	', 2 :0=., ?>;>A0 15 F, 5 </4, -" -100E120, 20 =A/4, 160 10 :3	>;>G82
1979	!1-100	", "5;52878>==K9, 70<5=0 !1 -81	C5@89=> =5 2K?CA.
1979	!1-101	!5@2., ? > ; > A 0 5 -" -30E40 <, 18 , 2,3 F, 5 </4, :3 !	>74>;
1979	!1-80	-(, 5 A/1, 2 :0=., CA8;8B5;L 35/10 (100) F, 10/1 </4, CA8;.B>:0, <C;LB8 5B@. !', 2B./#., , ?>;>A0 50 F, </4, -" -80E100 <, 10 =A/4, 140	C5@89=> =5 2K?CA.
1979	!1-98	5	>;>G82

		18 :3, 270<5= !1-78.	
1979	!1-99	(, 2 :0=., ?>;>A0 100 F, 5 </4, -" -100E120, 2 @072., 5 =A/4, 150 17 :3. 270<5= ! 1-78	L2>2
1981	!1-104	(, 2 :0=., ?>;>A0 500 F, -" 10 </4, -80E100, 1 =A/4, 170 !5@2., , 16 :3.	L2>2
1981	!1-107	+C;LB8<5B@, ?>;>A0 5 10 </4, -" -40E60 <, 25 4 F, :3, 270<5= !1-73.	>;>G82
1982	!1-124	!5@2., 2B ., , ?>;. 10 F, 10 </4, -" -40E60 <, 50 =A/4, 25 4 :3	>;>G82
1984	!1-113	5@B8:0;L=K9 ?>;>A0 5 F	C5@89=> =5 2K?CA.
1986	!1-119	' - A <C;LB8<5B@><, 0-10 F	C5@89=> =5 2K?CA.
1986	!1-83	?>;>A0 5 2 </4, -" -60E80 F, ', <, 40 10 :3	L2>2
1987	!1-123	+&, ', 2 :0=., </4, ? ?>;>A0 10 F, 1 -" -80E100, 8A:@. 50 :F, >;>A0 -5 :F, 65 9 :3.	>;>G82
1989	!1-130	& +&, !5@2., "/!, ?>;>A0 15 F, 10 </4, -" -80E100, 8A:@. 10 :F, ?>;>A0 & -1 :F, 28 , 4,5 :3.	>;>G82
1991	!1-135 (1101) !	!', 2 :0=., ?>;>A0 20 F, -" -40E60, 50 =A/ 5 </4 4 . !', 2 :0=., ?>;>A0 -" -40E60,	L2>2
1991	1-135 (1101)	50 =A/4 . 50 F, 5 </4	L2>2

AF8;;>3@0MIN "- " 1992-1996 3.3. 2 =57028A8<>9#:@08=5.

(BA>@B8@>20=K ?> 3>40< @07@01>B:8)

! >4 >45;L >;. "8?				A>15==>AB8						07@01.			
			F (84)										
1 1992 1201			20!' 1:0=. 20!' 2:0=.,										
2 1992 1202			50!' #=825@A0;L=K9,										
3 1993 1203 7 1994			1000 (#=825@A0;L=K9, 700										
1301 8 1994 1301			(#=825@A0;L=K9, 20 !'										
			#=825@A0;L=K9, 20 !'										
4 1994 1204			AF8;;>3@0D - <C;LB8<5B@										
5 1994 1102			50 !' 8=80BN@=K9, 20 !' &8D@>2>9,										
6 1994 1102			50 !'										
9 1995 2201 10 1995													
2201													
11 1995			100 (		4-E :0;L=K9 0=0;>3>2K9, ?> B5<5 «! B@C:BC@0»-1								
12 1996			100 &		"!B@>:0-3" $-, &-20 F, 8 AB@>1. @568<.								
13 1996 !			100 ! & "!B@>:0-3" + :><?LNB5@										

A5 >AF8;;>3@0DK " 1958-1987 3.3.

(BA>@B8@>20=K ?> B8?0< ?@81>@2 8 3>40< @07@01>B:8)

! >4 >45;L >;. "8?	A>15==>AB8 -" 'C2AB. 8A:@. 07Q@. >I. 5A 07@01.								
	F (84) <	</45;F				3			
1 1979 !1-80	100! 5 A<5==THE 1;>;>2		2	10					-
2 1979 !1-80/1	35 ! 2 :0=., 2 @072Q@B:8,		2	10					-
3 1979 !1-80/2	10 ! 2 :0=., 2 @072Q@B:8, 2KA>:>GC2AB2.		2	1					-
4 1979 !1-80/3	35 ! A 1;. <C;LB8<., 1-2 :0=., 2-1 @072.		2	10					-
5 1973 !1-71 6 1975 !	100 (15 <-100 100 (2 10 =A-1A. 48E80			5		50 =A/4 150 19 "			
1-79	:0=.2 @. 2<-200, 50=A-0,5A 100 (<. 1-79, 8<-150, 48E80		1 2	5		5 =A/4 160 19 "			
7 1979 !1-99	10=A-0,5A! 500 (#=825@A0;L=K9 100E120		2	2		5 =A/4 150 17 "			
8 1981 !1-104	80E100		2	10		1 =A/4 170 16 "			
9 1974 !1-73	5 !5@2 <0;>3., 10 <-350 5 ! 200 =A-0,5 A 36E60		1	10		50 =A/4 30 4,5 >;>G82			
10 1979 !1-101 11 1981 !	5@2 0;>301., 10<3002, 0,3<:A-0,4A 5 !5@2 30E40		1	5		0,1 <:A/4 18 2,3 "			
1-107	C;LB</3,2<.!1-73, 20<-3502, 40E60		1	10		100 =A/4 25 4 >;>G82			
12 1982 !1-124	10 !5@2 2B><0B., <0;>3. 40E60		1	10		50 =A/4 25 4 >;>G82			
13 1989 !1-130	15 !5@2 +&, ", ! 40E60		1	10 1 :F 50 =A/4 28 4,5 >;>G82					
14 1962 !1-19	1 ' #=82., A/1: #-1,2 50E80		1	2		10 <:A/4 250 21 "			
15 1962 !1-22	5 ' #=82.,>@B0B82=K9 1 '		1	100		100=A/A< 200 13 "			
16 1962 !1-30 17 1963 !	0AB>;L=K9 1 ' #=82., 50E80		1	20		2 <:A/A< 520 36 "			
1-19 18 1964 !1-30 19	A/1: #-1,2 1 ' !B>5G=K9 5 ' 50E80		1	2		10 <:A/4 250 21 "			
1964 !1-34 20 1965 !	2CE;CG52>9, 91 50E80		1	20		2 <:A/A< 520 28 "			
1-35	5 ' </3., 1-9 =0 ?>;C/?		2	170		200=A/A< 150 19 "			
			1	10		200<:A/4 30 8 "			
21 1967 !1-43	10 ' 2B><0B878@>20=., 1 ' ', 60E80		1	50		500 =A/4 150 40 "			
22 1968 !1-48 23 1968 !	=0AB>;L=K9 5 ' 60E80		1	2		2 <:A/4 75 20 "			
1-49 24 1968 !1-55	0;>3010@8B., 20<2-2002, 8 <:A 10 ' 2-E ;CG., 36E60 92		1	10		0,2<:A/4 38 8,5 "			
	2<. !1-34		2	10		20 =A/4 75 15 "			
25 1970 !1-48	1 ' ', AB>5G=K9 60E80		1	2		2 <:A/4 75 20 "			
26 1971 !-67	10 ' @>B82>C40@=K9 42E60		1	10		100 =A/4 45 10 "			
27 1971 !1-59	1 ' !B>5G.,;>3.,"/.		1	2					-
28 1972 !1-67	10 ' #=825@A0;L=K9 1 ' 42E60		1	10		100 =A/4 45 10 "			
29 1972 !1-68	#=825@A0;L=K9 5 ' 2- 60E80		1	2		2 <:A/4 40 10 "			
30 1973 !1-69 31 1975 !	E ;CG52>9, 162 10 ' 2-E :0=., 10 40E100		2			200 =A/4 135 17 "			
1-77 32 1977 !1-93 33	<-200 15 ' #=825@A0;L=K9 5 ' 100 =A-0,4 A 60E80		2	1		100=A/4 50 10 >;>G82			
1984 !1-113	5@B81, 20<-500, 0,2<:A-0,5 100E120		2	5		20 =A/4 50 10 >;>G82			
	A		1	5 10					-
34 1986 !1-83	5' #=825@A0;L=K9 100E120		2	0,1		100 =A/4 50 10 "			
35 1986 !1-119	10 ' AF8;- <C;LB.,						>;>G82		
36 1971 !1-63	25 !' >@B>2>9, 2-E :0=.		2						-
37 1971 !1-64() 38 1971 !	50 !' 2-E :0=., 2 @072Q@B. 48E80		2	1		100 =A/4 150 19 "			
1-65 39 1976 !1-78	35 !' #=825@A0;L=K9, 112 35 !' 2B.. 64E80		1	5		10 =A/4 125 16 "			
	2<. !1-43, 15<-200, 80E100		1	5		10 =A/4 130 19 "			
40 1979 !1-98	50 !' 2E.+, <.!1-78 80E100		2	5		10 =A/4 140 18 >;>G82			
41 1991 !1-135	20 !' , =0:>35=5@0B>@, , <0;>301. 40E60		2	5		10 =A/4			-
42 1991 !1-135	50 !' , =0:>35=5@0B>@, , <0;>301. 40E60		2	5		10 =A/4			-
43 1958 !1-9 44 1959 !	12 " 12 " ", K45; !B@>:./:04@0, 13037 !: 125 <		1	40		1 <A/M 550 65 "			
1-13 45 1961 !1-13 46	12 " -1, @072., -2, !, -3 !, !, '%, 40E80		1	100		600 =A/M 600 84 "			
1969 !1-52	-1, 2, 3 40E80		1	100		600 =A/M 600 84 "			
	12 " !, !, -1,2,3 AB>5G. 60E80		1	100		0,1<:A/A 70 25 >;>G82			
47 1970 !1-57	15 " !?5F80;L=K9, ! 48E80		1	10		100<:A/4 110 25 >;>G82			
48 1973 !9-1	20 "		1	10		20 =A/4 130 25 >;>G82			
49 1976 !1-81	20 " 80E100		1	10		20 =A/4 120 18 >;>G82			
50 1979 !1-100	20 " 70<5= !1-81		1						>;>G82
51 1987 !1-123	10 & @5470?CA:, 6QAB. ;>3. 1024E256 80E100		2	1			50	-	

AF8;;>3@0DK3. 8=A:

1975-1990 3.3. (BA>@B8@>20=K?>3>4C 2K?CA:0)

>4	>45;L («"5<0»)	A=>2=K5 B5E=8G5A:85 E0@0:B5@8AB8:8	02>4 K?CA: (HB/3>4)
1975	C1-76	', 1 F, 0,1 </4, -" 1318, 55 13 :3 .	8=A:
1978	!1-65	!', 50 F, 5 </4, -" -112 64E80 <, 10 =A/4, 125 16 :3	8=A: 11000 HB./3>4
1978	!1-82	2 :0=., 10 F, 1 </4, ', 100E120, 171, 2 -" - @072., 50 =A/4, 100 15 :3.	8=A: 40 HB./3>4
1980	!1-85	(, 2 :0=., 100 F, 5 </4, 100E120, 171, 5 =A/4, 200 18 -" - :3.	8=A: 184 HB./3>4
1980	!9-14	(, 100 F, 02B. 8 <0@:. &, 87<., 5 </4, -" -100E120, 2 =A/4, 300 24 :3, $-	8=A: 143 HB./3>4
1981	!1-117	', 10 F 2 :0=., 0@:. 7<., </4, 8;8 0,1 &/0,1</4, 60E80, 1 -" 119, 60 10 :3.	8=A: 1672 HB./3>4
1981	!1-117/1	', 10 (0,1) F 2 :0=., 0@:. 7<., (0,1) </4, -" 1 -60E80-119, " A8=E@., 60 10 :3.	8=A:
1981	!1-117/2	', 15 F, 2 :0=., </4, 8;8 0@:. 7<., 1 -" 0,1 &/0,1</4, 60E80, 119, 60 10 :3.	8=A:
1982	!9-7	', 10 F ;8B., 2B. #?@. 8 7<. (<?;., 5 </ 5@8>4), 119, 65 , 4, -" 60E80, 7,5 :3.	8=A: 663 HB./3>4
1984	!1-114	!', 50 F, 2 :0=., 5 </4, 100E120-171, 5 =A/4, 90 14 -" - :3, + C;LB8<5B@.	8=A: 7191 HB./3>4
1984	/4!-109	',A<5=.1;>: >AF8;.4;O !, 10 F, 2 :0=., -" -30E40, 5 </4, 20 =A/4 !', 50 F, 2 :0=., 5 </4,	8=A:
1984	!1-114/1	100E120-171, 5 =A/4, 90 14 :3, 157 C;LB8<5B@0. -" -	8=A:
1985	!1-120	(, 100 F, 2 :0=., , 7<5@5=. &8D@. @5<. 045@6. (0,1%), 5	8=A: 403

		</4, -" -80E100, 2 @072.2 =A/4, 120 13 :3.	HB./3>4
1986	!1-125	!5@2., 10 F 2 :0=., 1 </4, 60E80-119, 20 =A/ 4, 35 , 4,9 :3. -" -	@O=A:
1986	!1-126	(, 100 F, 2+2 :0=., 5 </4, 80E100 <, 2 @072., 2 =A/4, 100 , 8,5 :3. -" -	8=A: 286 HB./3>4
1986	!9-18	!', 50 F, 2 :0=., , 2B. #?@. 8 7<. 0@0<5B@>2, 10 </4, -" 80E100, 110 ! 14 :3.	8=A: 792 HB./3>4
1987	!1-127	5@2., 50 F 60E80, 2 :0=., 1 </4, , 5,5 5 =A/4, 60 :3, 20@80=B /1 4;O 6QAB:8E CA;>289. -" -	8=A: 308 HB./3>4
1988	!9-19	&, (, 100 F, 2 :0=., , 2B. #?@. 8 7<., 2 </4, 8A:@. 20 F, -" -80E100, 2 =A/4, 250 21 :3.	C5@89=> =5 2K?CA.
1988	!9-28	&, (, 100 F, 2 :0=., 2B. #?@. 8 7<., 5 </4, 8A:@. 20 F, -" -80E100, 2 =A/4, 210 12 :3.	8=A: 164 HB./3>4
1989	!8-19/1	&, ', 10 F, 8A:@. 2,5 10 </4, F, M:2. 48A:@. 1 F, -40E100<, 62E100B>G., 50 =A/4, 23 , 2,5 :3.	8=A:
1989	!8-19	10 F, 10 </4, 8A:@. 1 &, ' F, -40E100<, 62E100B>G., 50 =A/4, 23 , 2,5 :3.	8=A:
1990	!1-128	!', 25 F 60E80, 2 :0=., 2 </4, 6 :3. 10 =A/4, 65 !', 25 F , -" -	8=A:
1990	!1-01	C;LB8<. , QA .#A;.- !', 100 F , C;LB8<., : A? .	8=A:
1990	!1-02	QA.#A;.-:A.	8=A:
1991	!1-142	!', 50 F 2 :0=., 1 </4, 80E100, 5 =A/4, 55 , 6,6 :3. -" -	8=A:
1992	!1-133	', 25 F 2 :0=., 1 </4, 80E100, 20 =A/4, 55 , 7,2 :3. -" -	C5@89=> =5 2K?CA.
1992	!1-133/1	25 F 2 :0=., 1 </4, &, 80E100, 20 =A/4, 55 , 7,2 :3. -" -	C5@89=> =5 2K?CA.
1992	!1-133/2	', 25 F 2 :0=., 1 </4, 80E100, <C;LB., 35=." A83. ,55 , 7 :3. -" -	C5@89=> =5 2K?CA.
1992	!8-23	&, ', 20 F, 2 :0=., 0@:. 7<., 1 </4, 8A:@. 1 F, 60E80, 10 =A/4, 75 , 6,5 :3, $- &, ', 20 F, 2 :0=., 7<., 1 </4, 8A:@. 1 F, -" -	8=A:
1992	!8-23/1	60E80, 10 =A/4, 75 , 6,5 :3, 157 0@:. -" -	8=A:

A5>AF8;;>3@0DK 1975-1992 3.3.

(BA>@B8@>20=K ?> B8?0< ?@81>@2 8 3>40< @07@01>B:8)

! >4 >45;L >;. "8?				A>15==>AB8	-" . 'C2AB. 8A:@. 072Q@.	>I. 5A 07@01.							
			F (84)		<	</45; F 2 2				:3			
4 1980 !1-85 13			100 (5AB@0=D.., ?5G0B., ,2 @072 100 (c ,		100E120			5		5 =A/4 200 18			
1985 !1-120			<0@:.87<., 2 @072., &, ?/0 87<. 100 (2+2 :0=., 57		80E100			5		2 =A/4 120 13			
15 1986 !1-126			100 (C;LB8<., 4;O 6QAB. CA;. 2 @072.		80E100		4	5		2 =A/4 100 8,5			
23 1990 !1-02			M:A?;C0B.		60E80		2	10		5 =A/4 90 12			
14 1986 !1-125 17 1987 !			10 !5@2 57		60E80		2	1		20 =A/4 35 4,9			
1-127			50 !5@2 >B -30 4> +50 3@.&.		60E80		2	1		5 =A/4 60 5,5			
1 1975 !1-76			1 ' ?5@2K9 >OF. -"-1318				1	0,1		1 <:A/4 55 13			
3 1978 !1-82 6 1981 !			10 ' 2 @072.-A=. 704., -"-171 10 ' (!		100E120		2			50 =A/4 100 15			
1-117			1-76)119, 0.1 F/0 1-05</4, 15 ' ?/02B.87<. t/V,		60E80		2	1 1		50 =A/4 60 10			
7 1981 !1-117/1			" A8=E@> =87.		60E80		3	1		50 =A/4 60 10			
8 1981 !1-117/2 9 1982 !			15 ' (!1-76)119, 0,1 F/0,1-05</4, 10 ' 2B./?>8A:,		60E80		4	1		50 =A/4 60 10 - 65 7,5			
9-7 10 1984 /			02B.87<., 119		60E80		1						
4!-109			10 ' >AF8;;>3. :0:A<5==. 1;>: 4;O !		30E40		2	5		20 =A/4			
2 1978 !1-65 11			50 !' #=825@A0;L=K9, -"-112 50 !'		64E80			5		10 =A/4 125 16			
1984 !1-114			C;LB8<5B@ 50 !' 57		96E120		1 2	5		5 =A/4 90 14			
12 1984 !1-114/1			C;LB8<5B@0 50 !'		100E120		2	5		5 =A/4 90 14			
16 1986 !9-18 22 1990 !			02B. 8 <0@:5@ .87<., $-		80E100		2	10		40 =A 110 14			
1-01			25 !' C;LB8<5B@, 4;O 6QAB. CA;. M:A?;.		60E80		1	2		0,1<:A/4 70 9			
25 1991 !1-142			50 !' 57		80E100		2	1		5 =A/4 55 6,5			
26 1992 !1-133			25 !' 57		40E80		2	1		20 =A/4 55 3,5			
28 1992 !1-133/2			25 !' 57 + <C;LB., +35=. 10 " A83=.		40E80		2	1		20 =A/4 55 4,7			
5 1980 !9-14			100 & , &, 02B.8 <0@:. 87<., $- 100		100E120		1	5		2 =A/4 300 24			
18 1988 !9-19 19 1988 !			& ,,02B.<0@.87<.,-"-161 100 & , ,		80E100		3	2 20 F 20=A/4			21		
9-28 20 1989 !8-19			02B.<0@.87<., $- 10 & 40E100		80E100		2	5 20 F 100 =A 210 12					
			<, 62E160 B>G5: 40E100 10 & 40E100 <, M:282.48A:@5B. 1 F 40E100 25 /				1	10 1 F 50 =A/4 23 2B 2,5					
21 1989 !8-19/1			& , , &-512E8, <0@:. 7<5@5=8O 60E80 25 /& 57 ,+ &, 4> 20 <A/45;.				2	10 2,5 F 50 =A/4 23 2B 2,5					
24 1990 !1-128 27 1992 !			20 & , &-1E818B, , <0@:. 7<., 20 & , &-1E818B, ,<0@.7.,157				2	2 0,2 F 10 =A/4 65 6					
1-133/1 29 1992 !8-23 30					40E80		2	1	1 :F 20 =A/4 55 3,7				
1992 !8-23/1					60E80		2	1	1 F 10 =A/4 75 7				
					60E80		2	1	1 F 10 =A/4 75 6,5				

AF8;;>3@0MIN 8 1996-2020 3.3.

2 =57028A8<>9 5;0@CA8.

(BA>@B8@>20=K ?> 3>40< @07@01>B:8)

! >4 >45;L >;. "8?	A>15==>AB8 -"	'C2AB. 8A:@. 072Q@. >I. 5A 07@01.			
	F (84) <	</45; F 2			:3
3 1997 !1-149 4	50 & , &-512E8, , <0@:.87<5@. 60E80		1	2 0,2 F 5 =A/4 70 6,5 2 -	
1997 !1-150 5 1997 !	15 !5@ 57 40E60				10 =A/4 25 2,8 2 -
1-151 6 2000 !8-33	35 !5@ 57 40E60		2		10 =A/4 40 3,7
	20 & , , 2B.,0@. 7<., VGA-166 80E100		2	5 20 F M4 5 & 160 8	
7 2002 !8-36	50 & , , 2B.,0@. 7<., VGA-166 80E100		2	5 20 F M410 & 160 8,5 5 -	
8 2003 !1-164 9	150 (, <0@:. 7<., B5AB5@ :><?>=5=B>2 80E100 50 !'		2		2 =A/4 90 8
2003 !1-166 10	57 60E80		2	2 -	10 =A/4 60 5,5 2 -
2003 !1-166/1 11 2003 !	25 !' 57 60E80		2		10 =A/4 60 5,5
8-38 12 2004 !8-41	100 & , , 2B.,0@. 7<., VGA-166 80E100 0@:.		2	5 100F M410 F 160 8,5	
13 2005 !1-157 14	20 & ", !, 7<.,VGA-166 80E100			10 50 F 5 & 120 6,5	
2005 !1-157/1 15	100 (57 , B5AB5@ ?/? 80E100		1	5 -	2 =A/4 80 8
2005 !1-157/2 16 2005 !	100 & &-8E512, <0@:.87<5@.,B5AB5@-?/? 80E100		2	5 50 <F 8 5 -	2 =A/4 80
8-39 17 2006 !1-167 18	100 (57 , C;LB8<5B@ 80E100 50 & , -48A?., </3,02B. 8 <0@:.		2		2 =A/4 80 8
2006 !1-167/1 19	7<5@. 320E240 25 !' 57		2	5 50 F 5 & 15 3 2 -	
2006 !1-167/2 20	B5AB5@ ?/? 80E100		2		10 =A/4 80 8
2007 !8-43 21 2008 !	25 & &-8E64 :, , <0@:. 7<5@. 80E100		2	2 100<F 10 =A/4 90 7,5 2 -	
1-170 22 2008 !1-170/1	25 !' 57 , C;LB8<. 50 & , 80E100		2		10 =A/4 90 7,5
23 2008 !1-170/2	&-8E64:0@:..7<., 50 !' 57 80E100		2	2 100 3F 10 & 160 7 2 -	
24 2011 !1-176 25	50 & , B5AB5@ ?/? 80E100		2		10 =A/4 80 7
2011 !1-176/1 26 2013 !	&-8E512, <0@:87<5@.,B5AB5@-?/? 80E100 50 !' A		2	2 100<F 10 =A/4 80 7 2 -	
1-157/4 27 2013 !	<C;LB8<5B@>< 80E100 50 !' 57		2		10 =A/4 80 7 2 -
1-157/5 28 2013 !	!-7 A53., "5AB5@ ?/? 80E100		2		10 =A/4 90 6,8 2 -
1-157/6 29 2014	25 !' 57 80E100 100 ("5AB5@ :><?>=5=B>2 80E100 100		2		10 =A/4 90 6,8 2
C1-127/1 30 2014	& , &-8E64:, <0@:.87<5@., 80E100 100 (! <C;LB8<5B@><		2		2 =A/4 90 7,3
C1-127	80E100 50 !5@ B> 65 GB> !1-127, => +5 4> +40 3@.&.,		2	2 100F 2 =A/4 90 7,3 2	
	64E80 50 & , -8=48:0B>@, F8D@>2>9.		2		2 =A/4 90 7,3 1
			2		5 =A/4 65 6 1
	8E16:, /		2 2		5 =A/4 50 4
31 2016 !8-52 32	120 & 7<, 6:8, $, USB/LAN 72E108 200 /1 6:8, USB/		2	2 250 3F M410 F 90	7
2016 !8-52/1 33 2016 !	LAN 72E108 100 & , 8E16:, /7<, F25B=.6:8, USB/LAN		2	2 250 3F M410 F 90	7
8-53 34 2016 !	72E108 - 70 F, >AB0;L=. !1-1276 53E77 200 & 32 :1, ,		2	2 200 3F M410 F 40 3,5	
8-53/1 35 2016 !	320E240 B>G5:,4803.14,5 72E108 70 & , /0=.-:=>?:8, 50E73		2	2 200 3F M410 F 40 3,5 1	
1-1276< 70 & 36 2019 !8-54 37 2019 !	150 & , >AF.-<C;LB. ,02B./<0@:./87<.,USB		2		5 =A/4 50 4
1-127 38 2020			2	2 400F M420 F 50 4 1 2 -	
C8-57			2		5 =A/4 50 4
		5,7"	2		2 =A/4 50 3,5

@8;>65=85 4

AF8;;>3@0DK , 3.

>@L:89 1962-1988 3.3.

>4	>45;L («"5<0»)	A=>2=K5 B5E=8G5A:85 E0@0:B5@8AB8:8 !	02>4
1962	!7-5/1	B@>1., 0,7 F, A 1;. 5?A 10 </ -1, R2E=100 4, (C< -2 <, :<, <, 300 79 :3. -" -60E80	0E0G - :0;0
1962	!7-5/2	!B@>1., 2 F, A 1;. 5?A 10 </4, -2, R2E=50 (C< -1 <, <, <, 300 79 :3. -" -60E80	0E0G - :0;0
1965	!7-7	!B@>1., 1 F.	C5@89=> =5 2K?CA.
1970	!7-9/1	!B@>1., 0,7 F, A 1;. 7?A </ -1, R2E= 50 1 :<, 60E80 10 </4, (C< -1,5 <, -" 58 :3. <, 400 !B@>1., 2 F, A	>AB02:8
1970	!7-9/2	1;. 7?A -2, R2E = 50 </1 :<, 0 </4, (C< -1,5 <, -" 60E80 <, 400 58 :3.	>AB02:8
1970	!7-9/3	!B@>1., 6 F, A 1;. 7?A </1 -3, R2E = 50 <, 10 </4, (C< -1.5 <, -" 58 :3. 60E80 <, 400 !	>AB02:8
1973	!7-12/1	B@>1., 0,7 F, A 1;. 12?A </1 -1, R2E = 50 <, 2 :0=., 5 </4, <, 185 31 :3. -" -80E100	8=A:
1973	!7-12/2	!B@>1., 5 F, A 1;. 12?A </ -2, R2E = 50 2 :., 5 </ 1 :<, -" 4, (C< -1.5 <, 31 :3. - 80E100<, 185 !B@>1., 0,7 F, A 1;.	8=A:
1975	!7-13/1	12?A </1 <, 2 :0=., 5 </4,, <, -1, R2E = 50 - 60E80 -" 185 44 :3.	8=A:
1975	!7-13/2	!B@>1., 10 F, A 1;. 1 3?A-1, R2E = 50 2 :0=., 5 </4, (C< -3,3 <, -" < 60E80 <, 185 ! B@>1., 0,8 F, -" 44 :3.	8=A:
1985	!7-16	-80E100 <, R2E = 50 < 2 </4, 2KG8A;8B. 1;>: 250 ! ?>;C -02B. 7<., 60 :3. B@>1., 0,8 F, 50 <, 2 </ 4	8=A:
1986	!7-17	80E100 <, 330 40 :3, 1;. $ 901 -" - A - ! -1, ?@5>1.$C@L5.	8=A:
1986	!7-18	!B@>1., 10 F, R2E = 50 <, 5 </4, @5D;5:B./@07@5H. 1 A<, 48AB. -750 <, 20	8=A:

		=A/4, 165 ! . 28 :3.	
1980	!9-11/1	B@>1., 1 F, A ?A :0=., 2 -1, R=100 :<, 2 HC<-1 <, -" </4 <, 10 ?A/4, ,, -100E120 42 :3. 400 !B@>1., 18 F, A ? .	8=A:
1980	!9-11/2	A -18, R = 50 <, 2 :., 2 </4,, HC< -1 <, -" -100E120 <, 10 ? A/4, 400 42 :3. .	8=A:
1980	!9-11/3	!B@>1., 26 F, A ?A -26, R = 50 <, 2 :., 2 </4,, HC< -1 < -" -100E120 <, 10 ?A/ 4, 400 42 :3. . .	8=A:
1979	!1-95	!, 2 :0=., 5 </4, -" -100E120 <, 2 =A/4, 300 32 :3. !, 1 :0=., +1;.	C5@89=> =5 2K?CA.
1979	!1-110	87<. <?;., 5 </4, -" -100E120 <, 2 =A/4, 300 !, 1 :0=., +1;. <C;LB8<5B@0 -" -100E120 <, 2 =A/4, 300 &, 2 . 32 :3. 5 </	C5@89=> =5 2K?CA.
1979	!1-111	:0=., 2 F, 50 < -50 20 F/8 18B, -589 A5@ 7<., . 4, 32 :3. -" -161, 29 :3. .	C5@89=> =5 2K?CA.
1981	!9-8	. 8A:@. ., 0@:. 250 .	8=A:
1985	!9-16	&, 2 :0=., 5 F 20 F/8 . 100 < -50 . 8A:@. 18B, -" -161, 350 &, -580 A5@., $,. 2 :0=., 17 F 8A:@. 100 F/8 18B, . 30:3. 20 < -100	8=A:
1988	!9-27	2B.#?@. 8 7<. 0@0<. 440 . -580 A5@., . $,. . -" -176 30 :3 +:;0280BC@0 :0;L:C;OB>@0 A83=0;>2. .	8=A:

AF8;;>3@0MIN «@><?@81>@ » 8 «"5=7>@»

1997-2019 3.3. 2 =57028A8<>9 >A88.

(BA>@B8@>20=K ?> 3>40< @07@01>B:8)

! >4 >45;L >;. "8?				A>15==>AB8	-" 'C2AB. 8A:@. 072Q@. >I 5A 07@01.								
			F (84)		<	</45; F			:3				
1 1997 C1-154 100 &				, , 2B. 8 <0@:.87<., $-RS232	53E70		2	10	20 F M410F 60 9				@>< ?@81>@
2 1997 C1-155 50 & , , 2B..87<.,RS232, <C;LB8<5B.					53E70		1	10	20 F M410F 50 8				@>< ?@81>@
3 1996 C8-30				&									@>< ?@81>@
4 2003 !525@-1 50 &				, , 2B. 8 <0@:.87<., $-RS-232			2	10	20 F M410F 10				@>< ?@81>@
5 2010 2-92 37000 !B@. @8AB02:0, 157 -", &-2, $-USB							2	2		10 ?A/4		3 "5=7>@	
6 2014 !1-177 350 & , &, , 2B.7<.?0@0<., $-USB				7 2019 !1-178 200 & , &, 2B.7<.?			2	5	2 F	1 =A/4	7,5 "5=7>@		
0@0<5B@>2, $							2		1 F			"5=7>@	

A5>AF8;;>3@0DK 1962-1988 3.3.

(BA>@B8@>20=K ?> B8?0< ?@81>@2 8 3>40< @07@01>B:8)

! >4 >45;L >;. "8?	A>15==>AB8 -" 'C2AB. 8A:@. 072Q@. >I 5A 07@01.								
F (84)	<	</45; F 1 1				:3			
1 1979 !1-110 100 ! 1 A/1 CA., 1 - 87<.0<.	100E120			5		2 =A/4	300 32		
2 1979 !1-111 100 ! 1 A/1 CA., 1 - <C;LB.	100E120			5		2 =A/4	300 32 300 32		
3 1979 !1-95 100 ! 2 A/1 CA8;8B5;O	100E120		2	5		2 =A/4			
4 1962 !1-21 200 !B@ @8AB02:0 : >AF. !1-19 8 !1-30 5 1962 !7-5/1 700 !B@ (!1-39) 5?			1	50		3 =A/4	200 25		
A-1, 100 :<, HC<-2 <, 6 1965 !7-5/2 2000 !B@ (!1-39) 5?A-2, 50 <, HC<-1 <	60E80		1	10			300 79		
	60E80		1	10			300 79		
7 1965 !7-7 1000 !B@			1						
8 1970 !7-9/1 700 !B@ 7?A-1, 1 :<, HC<-1,5 <, 9 1970 !7-9/2 2000 !B@ 7?A-2, 50 <,	60E80		1	10		0,1 =A/4 400 58 0,1 =A/4 400 58			
HC<-1,5 <, 10 1970 !7-9/3 6000 !B@ 7?A-3, 50 <, HC<-1,5 <, 11 1973 !7-12/1 700 !	60E80		1	10		0,1 =A/4 400 58 0,2 =A/4 0,2 =A/			
B@ 12?A-1, 50 <, HC<-1/0,3 < 12 1973 !7-12/2 5000 !B@ 1312,12?A-2,50<,HC<-1 <	60E80		1	10		4 20 ?A/4 20 ?A/4 10?A/4 10?A/4			
13 1975 !7-13/1 700 !B@ 1312, 12?A-1, (C<-1 < 14 1975 !7-13/2 10000 !B@ 1312, 13?A-1,	80E100		2	5		10?A/4 400	185 31		
(C<-3,3 < 15 1983 !9-11/1 1000 !B@ ?A-1, 100 :<, (C<-1 <, CA@.	80E100		2	5		42 0,1 =A/	185 31 185 44		
	60E80		2	5		4 250 60	185 44 400 42		
	60E80		2	5		0,1 =A/4	400 42		
	100E120		2	2		330 40			
16 1983 !9-11/2 18000 !B@ ?A-18, 50 <, (C<-3,5 <, CA@.	100E120		2	2		20 =A/4			
17 1983 !9-11/3 26000 !B@ ?A-26, 50 <, (C<-5 <, CA@54=., 18 1985 !7-16 800 !B@ R2E	100E120		2	2					
= 50 <, /2B. 87<., 2KG.1;>: 19 1986 !7-17 600 !B@ KE. " 8=D., ;.=.813 20 1986 !7-18 10000 !	100E120		2	2					
B@ 5D;. 1 A</750 <	100E120		2	2					
	100E120		1	5			165 28		
21 1981 !9-8 2,5 & -589 A5@., &-2E8, <0@:.87<.	161		2	5	20 F		250 29		
22 1985 !9-16 5 & -580 A5@., &-4E8, <0@:.87<. 161 17 & CA@54., 02B.C?			2		20 F		350 30		
23 1988 !9-27 @./87<., 580 A.	176		2		100F	440 30			

@8;>65=85 5

A5>AF8;;>3@0DK!

"01;8F0 G8A;0 @07@01>B>: >AF8;;>3@0D8G5A:8E ?@81>@2 :064>3> 87 4-E

>BA>@B8@>20==KE ?> B8?0< (2840<) 8 ;845@K 2 :064>< B8?5 >AF8;;>3@0D>2.

! "8?	8;L= L2>2 8=A: >@L: A53> % 845@							
1	!	38	4		4	46 18,7	8;L=	
2 '		11	22	7		40 16,3	L2>2	
3		17			17	34 13,8	>@L:	
B@>1		23	5	2		30 12,2	8;L=	
4	5@2 5 &/&	15 1	9	3	28	11,4 8;L=		
6!'	7	3	8	8		19 7,7	8=A:	
(8	!?	9	4	4		17 6,9	8;L=	
5F	13 9 -" 11					13 5,3	8;L=	
						11 4,5 8;	L=	
10 '			8			8 3,3	L2>2	
	A53>140 52%			30	24 246 100,0			
		56,9 21,1 12,2 9,8 100						
		8	4	5 @	6		2	1

1 10

!>:@0I5=8O, ?@8<5=O5<K5 2 MB>9 B01;8F5:

1. AF8;;>3@0DK A> A<5==K<8 1;>:0<8 (!, 8;8 MB> C=825@A0;L=K5 , 1;>:0<8 0=0;>3>2K5 ?@81>@K, (A 0=0;>3>2K<8 2E>40<8 % 8 #) ?>72>;ONI85 70<5=C 157 ? A2>8E 1;>:>2 87 A2>53>A5<59AB20 2 ?@>F5A5 M:A?;C0B0F88 ?>B@518B5;5< A53> ! 2 ! 1K;> 5@5:0;81@>2:8.

@07@01>B0=> 53 <>45;8 :0: MB> ?>:070=> 2 @8;>65=88 5.1, (0 =5 46 :0: 2 MB>9 B01;8F5) B0: :0: 8;L=NA:8E 87 =8E 1K;> 45 (0 =5 38, :0: 2 B01;8F5). 7 MB8E 7 =54>AB0NI8E <>45;59 8;L=NA:8E !

6 - 1K;8 AB@>1>A:>?8G5A:8<8 ! , 8, ?>MB><C, >B=5A5=K BCB : AB@>1>A:>?0< (17 2<5AB> 11) 0 1 F8D@>2K<!. -B> A45;0=> 4;O 871560=8O 42>9=>3> CGQB0 <>45;59 (1 <>45;L BCB <>65B 1KBL >B=5A5=0 B>;L: > : 1 B8?C).

2. 87:>G0AB>B=K5 (') >AF8;;>3@0DK (15) F, MB> C=825@A0;L=K5 >AF8;;>3@0DK, A ?>;>A9 ?@>?CA:0=8O 4> 10 3. !

5@28A=K5 >AF8;;>3@0DK (5@2) MB> C=825@A0;L=K5 <0;>3010@8B=K5 ?@81>@KA 25A>< <5=55 5 :3 ?@54=07=0G5==K5 4;O >1A; C6820=8O 8 @5<>=B0 M;5:B@>==>9 B5E=8:8 =0 AB>@=5 C 70:07G8:0.

4. !B@>1>A:>?8G5A:85 >AF8;;>3@0DK ? (!B@>1) MB> A?5F80;L=K5 H8@>:>?>;>A=K5 ?@81>@K, B>;L:> ? @54=07=0G5==K5 4;O =01;N45=8O, @538AB@0F88 8 87< 5@5=89 >2B>@ONI8EAO A83=0;>2.

5. &8D@>2K5 (&8 & 0=0;>3> -F8D@>2K5) >AF8;;>3@0DK MB> ?@81>@K, ?>AB@>5==K5 =0 >A=>25 0=0;>3> F8D@>2>3> ?@5>1@07>20=8O A83=0;0, A ?>A;54CNI8< 53> 70?><8=0=85< 2 F8D@>2>9 ?0<OB8 8 2K2>40 D>@<K A83=0;0 =0 M:@0= 8 4@C385 CAB@>9AB20.

6. (8@>:>?>;>A=K5 (() >AF8;;>3@0DK MB> C=825@A0;L=K5 ?@81>@KA ?>;>A9 ?@>?CA:0=8O 100 F 8 2KH5.

7. !@54=5G0AB>B=K5 >AF8;;>3@0DK (!') MB> C=825@A0;L=K5 ?@81>@KA ?>;>A9 ?@>?CA:0=8O 2 480?07>=5 20-60 F.

8. !?5F80;L=K5 (!?5F @538AB@0F88) 8 A:>@AB=K5 >AF8;;>3@0DK -@538AB@0F88) MB>, 2 >A=>2=><, H8@>:>?>;>A=K5 ?@81>@K 4;O (2 B>< G8A;5 D>B> 9. 0?><8=0NI85 >4=>:@0B=KE A83=0;>2.

>AF8;;>3@0DK ?0@0 <5B@>2 (-") MB> ?@81>@K 4;O @538AB@0F88, =01;N45=8O 8 87<5@5=8O >4=>:@0B=KE A83=0;>2 =0 M:@0=5 A?5F80;L=KE 70?><8=0NI8E -"

@8;>65=85 5.1

A5 53 >AF8;;>3@0D0 A> A<5==K<8

1;>:0<8 (!), @07@01>B0==K5 2 ! 2 1958-1987 3.3.

! >4 >45;L >;. "8?				A>1===>AB8	-" :/; 'C2AB. 8A:. 072Q@ >I 5A 07@01.								
			F	(84)		<<		</45;	F		:3		
1 1958 !1-8			25 ! -"-1337, -80<5B@ 25 ! 07.;,1		-125<		1	50			650 35		
2 1960 !1-15 3 1960 !			25@B. >BA5:, 133 25 ! ! 1;>:>< #1 20 ! !		-125<		1	·		20 =A/4 700 42			
1-15/1 4 1961 !1-15/2			1;>:><		133		1	50		20 =A/4 700 42			
5 1962 C1-17			#2-48DD5@5=F. 2E>4.		133		1	50		20 =A/4 700 42			
			10 ! 07. ;., 162 2 ;CG0,A/1 >B !1-15 162 2; 20 ! ! 1;>:>< #3-2 :0=.					·		20 =A/4 700 42			
6 1962 !1-15/3					133 2:			100		20 =A/4 700 42			
7 1963 !1-15/4 8 1964 !			1 ! ! 1;>:>< #4-48DD5@5=F. 2E>4.		133		1			20 =A/4 700 42			
1-15/5 9 1965 !1-15/7			0,06 ! ! 1;>:>< #5-48DD5@5=F. 2E>4.		133		1	1 50		20 =A/4 700 42 700 42			
10 1967 !1-15/8 A@54.			200 ! #7-AB@>1. ?@5>1@07>2.-75 ><		133		1	·		·			
25			350 ! #8-AB@>1. ?@5>1@07>2-75 ><		133 2:			20		2 =A/4 700 42			
				2 1/1., 7 A/1, 1-2 25@B. >BA5:	48E80		1/2 50			20 =A/4 700 42			
11 1972 C1-70			50 ! 07.;>:, -"- 112, 2 >BA5:0 12 1972 !		64E80		1	·		·	250 24		
1-70/1 50 !! 1;>:0<8		1#11/1 11 64E80 13 1972 !1-70/2 3500 ! 1;>:0<8 1#71/1 71-AB@>1., 50 < 64E80 2: 14					1	10		10 =A/4 250 28			
1974 C1-74 15 1974 !1-70/3								5		0,1 =A/4 250 28 250 30			
			35 ! /;.2 ;./4 :., 3 >B. A/1 !1-70, 1316 60E100 2;					·		·			
			700 ! 1#72/1 71-AB@>1 :><?;5:B, 100 :< 64E80 2: 10 ! 1#13/1 11-48DD5@.					5		0,1 =A/4 250 28			
16 1974 !1-70/4			2KA>:>G. CA8;.		64E80		1	0,5		10 =A/4 250 28			
17 1974 !8-12			50 ! "--", A/1 !1-70, 2 >BA.,1310 1 ! !--", A/		48E80		1	·		·	300 27		
18 1974 !8-13 19			1 >B !1-70, 2 >BA., 132 60E80 50 ! "--", 2;/3>BA. A/1 !				1	·		·	180 23 320		
1974 !8-14 20 1975 !			1-70, 1311 40E80 2; 10 ! 1#91/1 91-CA.A> A<5I.AB@. 4;O !8-%%					·		·	34		
1-70/5 21 1975 !1-70/6			64E80 1 ! 1#92/1 11 - ;>30@8D. CA8;., 10 41/4				1	10		10 =A/4 250 28			
					64E80		1	·		10 =A/4 250 28			
22 1976 C1-70			50 ! 07;>:, 151, 2 >BA, 50 !		80E100		1	·		·	250 24		
23 1976 !1-70/7 24 1976 !			1#12/1 11 - 2-E :0=0;L=K9 CA8;8B5;L 64E80 2: 0,1 ! 1#14/1 11-48DD5@. 2KA>:>G.					10		10 =A/4 250 28			
1-70/8 A@54.			CA8;.		64E80 50			0,01		10 =A/4 250 28			
			5 1/1., 11 A/1, 2-3 >BA5:0		60E100		1 1/4	10		10 =A/4 250 28			
25 1977 C1-91			100 ! 07.;>:, -"-171, , 3 >BA5:0 100E120 26 1977 C1-91/1				2	·		·	150 17		
100 ! /4!-90/91		4 :0=0;0, 2 @072Q@B:8 100E120 4: 27 1978 C1-91/2 100 ! /4!-90/91/97,2 :0=.+<C;LB8<5B. U/I/R 100E120						5		5 =A/4 150 20 5 =A/4 220 21			
2: 28 1978 C1-91/3 12000 ! /			4!-95/96/89-AB@>1.1;.+35=.8<?., 2 :. 100E120 2: 29 1979 C1-91/5					5		20 ?A/4 220 22 5 =A/4 220			
								2		21			
			100 ! /4!-90/91/98-F8D@>20O 7045@. @072. 100E120 2:					5					
30 1979 C1-91/6			100 ! /4!-90/91/92-E0@0:B5@8>3@0D B@-@>2 100E120 2:					5		5 =A/4	220 21		
31 1981 C1-91/4 18000 ! /4!-100/101/102-AB@>1-2 10=., + 32 1981 C1-91/7 33 1984					100E120 2:			2		10 ?A/4 220 22 5 =A/4 220			
2-52/53 100 ! 7<5@. !8AB.!			100 ! /4!-90/91/105-<0@:5@. 87<5@. U/T		100E120 2:			5		21 5 =A/4 500 60 150 20 105			
1-91/115 +/4!-111+A1 100E120 4: 34 1984 !1-115, 50 ! 07. ;., 2 ;CG./4:., 174, , 3 >B. 100E120 2; 35 1984 /4!-111								5		8			
100 !								·		·			
				, 8=48:-, 3 >BA., A/1 >B !1-122 100 !		·	·	·		·			
36 1986 !1-122			07.;., -"-177, , 3 >BA.		100E120		2	·		·	150 17		
37 1986 !1-122/1 38 1986 !			100 ! /4!-90/91, 4 :0=0;0, 2 @072Q@B:8 100 ! /		100E120 4: 100E120			5		5 =A/4 150 20 5 =A/4 220 21			
1-122/2			4!-90/91/97,2 :0=.+<C;LB8<5B.		2: 100E120 2: 100 ! /			5		10 ?A/4 220 22 5 =A/4 220			
39 1986 !1-122/4 18000 ! /4!-100/101/102-AB@>1-2 10=., + 40 1986 !1-122/5					4!-90/91/98-			2		21			
			F8D@>20O 7045@. @072. 100E120 2: 100 ! /4!-90/91/92-E0@0:B5@8>3@0D					5					
41 1986 !1-122/6			B@-@>2 100E120 2:					5		5 =A/4	220 21		
42 1986 !1-122/7			100 ! /4!-90/91/105-<0@:5@. 87<5@. U/T		100E120 2:			5		5 =A/4	220 21		
43 1986 !1-122/8 44 1986 !			10 ! /4!-122, & &8D@.A., 02B.C?@./87<. 100E120 2: ! /4!-110,					0,5 20/5000 20 =A/4 220 21 - 100 - 220 21 150 17					
1-122/9 45 1987 !8-21				>38G.0=0;.-100 F/16 :.	100E120		16						
A@54.			100 ! ;., -"-1314, 10B.:</A,, 3 >B. 80E100 100 5 1/1., 15 A/1, 3				2	·		·			
		>BA5:0 100 ! 07.;>:, 4 >BA5:0, =5 2K?CA:0;AO			100E120 4		5		5 =A/4 200 22				
46 1979 !1-80			35 ! 2 :0=., 2 @072Q@B:8, =5 2K?CA:0;AO 10 !				2	·		·	·	·	·
47 1979 !1-80/1 48 1979 !			2 :0=., 2 @072., 2KA>:>G., =5 2K?CA:.				2	10		·	·	·	·
1-80/2 49 1979 !1-80/3							2			·	·	·	·
A@54. 50 1979 /9!-31			35 ! A 1;. <C;LB8<5B@0, =5 2K?CA:0;AO 35 1				2	1 10		·	·	·	·
			1/1., 4 A/1, 4 >BA5:0 100 ! 07.;>:, 4 >BA., ,			2	10		5 =A/4				
			=5 2K?CA 0;AO 100E120 100 ! A/1: 2 CA8;.-/4!-80, 2 @072.-/				2	·		·	300 32		
51 1979 !1-95			4!-83 100 ! A/1: CA8;.-/4!-80; 87<5@8B.-/4!-84 100E120		100E120		2	5		2 =A/4 300 32			
52 1979 !1-110 53 1979 !			100 ! A/1: CA8;.-/4!-80; 1;.<C;LB.-/4!-87 100E120 100 1 1/1., 4 A/1, 4				1	5		2 =A/4 300 32			
1-111 A@54.			>BA5:0 100E120 2				1	5		2 =A/4 300 32			
							5		2 =A/4 300 32				

A5 40 =87:>G0AB>B=KE (')

>AF8;;>3@0D>2, @07@01>B0==KE 2 ! 2 1948-1987 3.3.

	>4 >4.		>; "87 A>15==>AB8 F		-"	'C2A. 8A:. 072Q@. >I. 5A 07@01.							
			(84) 0,25 '			<<		</	F		:3		
1 1948 !1-1 2					1337		45; 1 4				120 24 25		
1950 !1-2 3 1954			5 R2E=0.5 </75<, 1 '		1337		1	30				-17	
C1-4 4 1957 C1-5			80<. --"-125< 10 '				1	30			250 26 180		
5 1960 C1-12 6							1	40			18 1700 50		
1962 C1-18 7 1962			15 2 ;CG0 1 '		181 2;			100			300 25 360		
C1-20 8 1962 !1-16			2 ;CG0, 162		40E100 2;			20			23 395 25		
9 1969 !1-38 A@54.			10 '		138		1 100 20				600 160 488		
10 1979 !1-102 11			5 2 ;CG0, 162 5 '		40E100 2;						42		
1979 !1-103			5 CG59, :0<?>2K9, A?5F80;L=K9		221 5;								
		6						43					
A@54. 12 1962 !1-19			10 ' 1 F/0,05 </4, 2 ;CG0, 174 100E120 2; 10 ' 1 F/0,05 </4,					0,5			120 15 120		
13 1962 !1-22 14			2 ;CG0, 4 :., 174 100E120 4:					0,5			15		
		10					0,5			120 15			
1962 !1-30 15 1963 !			1' #=82., A/1: #-1,2, <5A. !1-4 5 '		50E80		1 2 1 100			10 <:A/4	250 21 "		
1-19 16 1964 !1-30			#=82.,>@B0B82=K9 1 '				1 20			100=A/A<	200 13 "		
17 1964 !1-34 18			0AB>;L=K9 1 '		50E80				- 2 <:A/A<		520 36 "		
1967 !1-43			#=82., A/1: #-1,2		50E80		1 2			10 <:A/4	250 21 "		
			1 ' !B>5G=K9		50E80		1	20	- 2 <:A/A<		520 28 "		
			5 ' 2CE;CG52>9 10		91		2 170 1 50			200=A/A<	150 19 "		
			' 2B><0B878@>20=.,		60E80					500 =A/4 150 40 "			
		A@54. 3					52			291 25			
19 1965 !1-36 20			5 ' <3., 1-9 =0 ?>;C/?				1	10		200<:A/4	30 8 75 20		-
1968 !1-48 21 1968 !			1 ' ', =0AB>;L=K9		60E80		1 2			2 <:A/4	"		
1-49 22 1968 !1-55			5 ' 0>3010@8B=K9		36E60		1	10		0,2<:A/4	38 8,5 "		
23 1970 !1-48 24			10 ' 2-E ;CG., 2<. !1-34 1 ' ',		92 2;			10		20 =A/4 75 15 "			
1971 !-67 25 1971 !			AB>5G=K9 10		60E80		1 2			2 <:A/4	75 20 "		
1-59 26 1972 !			' @>B82>C40@=K9		42E60			10		100 =A/4 45 10 "			
1-67 27 1972 ! 1-68			1 ' !B>5G.,;>3.,"/.				1 1 2 1 10						-
28 1973 !1-69 29			10 ' #=825@A0;L=K9		42E60		1 2 1 5 6			100 =A/4 45 10 "			
1975 !1-77 A@54.			1 ' #=825@A0;L=K9		60E80		5			2 <:A/4 40 10 "			
30 1977 !1-93 15 '			5 ' 2-E ;CG52>9, 162 10 '		40E100 2;					200 =A/4 135 17 "			
#=825@A0;L=K9			2-E :0=.		60E80 2:					100=A/4 50 10 "			
		31 5									61 13		
1984 !1-113 5 ' 5@B8:0;L=K9 32 1986 !1-83 5 '					100E120 2:					20 =A/4 50 10 "			
#=825@A0;L= K9 33 1986 !1-119 10 'AF8;.- <C;LB.,											-		
					100E120		2 0,1			100 =A/4 50 10 "			
											-		
		9						3			50 10		
A@54. 34 1976 !			1 ' ?5@2K9 >DF.		1318		1 0,1 2 1			1 <:A/4 55 13			
1-76 35 1979 !1-82			10 ' 2 @072.-A=. 704. 171 10 ' ?/0 87<. t/V, 0,1 F/0,1 </4, (!				2 1 3 1 4			50 =A/4 100 15			
36 1981 !1-117 37			1-76) 60E80 60E80 60E80 60E80 30E40				1 1 2 5 2			50 =A/4 60 10			
1981 !1-117/1 15 ' ?/02B.87<. t/V. " A8=E@>=87.										50 =A/4 60 10			
38 1981 !1-117/2 15 ' (!1-76) 119, 0,1 F/0,1-05</4, 39 1982 !9-7 10 ' !.										50 =A/4 60 10			
2B.#?@.+7<., 119 40 1984 !4!-109 10 ' >AF8;;>3. :0:											65 7,5		
A<5==. 1;>: 4;O !										20 =A/4			
		A@54. 10									57 11		

A5 34 AB@>1>A:>?8G5A:8E (!B@)

>AF8;;>3@0D0, @07@01>B0==KE 2 ! 2 1962-1990 3.3.

(6 87 =8E MB> !)

! >4 >45;L >;. '8? A>15==>AB8 . 'C2A. (C< 072. 1 1965 !1-15/7 200 ! #7-AB@>1. ?@5>1@07>2.-75 >< 133 2	>I 5A	07@01.		
1967 !1-15/8 350 ! #8-AB@>1. ?@5>1@07>2-75 >< 133 2: 3 1969 !7-8 1500 !B@. 50</		1 -		700 42 700
10:<, -"-132, H-1,5 2 60E80 4 1971 !7-11 5000 !B@. -"-132, (C<-3,5 <, 6QAB .CA;. 64E80 5			20 2 =A/4	42 300 38
1972 !1-70/2 3500 ! ! 1;>:0<8 1#71/1 71-AB@>1., 50 < 64E80 2: 6 1974 !1-70/3 700 !		2	10 1,5 100?A/4 5 3,5	160 33 250
1#72/1 71-AB@>1 :><?;5:B, 100 :< 64E80 2: 7 1978 C1-91/3 12000 ! /4!-95/96/89-		2	50 ?A/4 0,1 =A/4	28 250 28
AB@>1.1;.+35=.8<?., 2 :. 100E120 2: 8 1981 C1-91/4 18000 ! /4!-100/101/102-AB@>1-2 :0=., +			5 0,1 =A/4	220 22 220
100E120 2: 9 1981 !9-9 10 1986 /4!-125 18000 !B@. 57 -", (C<-2-5 <, $--, & 11 1987 !7-20/!1 18000 !			5 20 ?A/4	22 400 62
B@. HC<-5 <, R2E = 50 <, &, 1 150E150 12 1987 !7-20/!2 10000 !B@. HC<-2 <, R2E = 50 <, &, 1 150E150 13			2 10 ?A/4	300 30 450
1987 !7-20/!3 1000 !B@. HC<-2 <, R2E=100 :<,& 1 150E150 14 1988 !7-21/!1 18000 !B@. HC<-5 <, R2E = 50			2	60 450 60
<, & 162 15 1988 ! 18000 !B@. ">G=.-1,5-4%, $--,02B.87<, & 150E150		2	5 10 ?A/4	450 60 300
7-21/!2 10000 !B@. HC<-2 <, R2E = 50 <, &, 162 16 1988 !7-21/!		2	5 2,5 10 ?A/4 5 5	30 300 30
3 1000 !B@. HC<-2 <, R2E=100 :<,&, 162 17 1990 !7-20/4 30000 !B@. (C<-2,5 <,		2	10 ?A/4 5 2 10 ?A/	300 30 450
468B.-5 ?A, &		2	4 5 2 10 ?A/4 5 5	60
		2	10 ?A/4 5 2 10 ?A/	
		2	4	
		2		
		2	5 2 10 ?A/4	
	150E150	2	10 2,5 5 ?A/4	
A@54=. 9721			6 3 365 40	
18 1962 C1-21 19 200 !B@ @8AB2:0 : !1-19/30		1	50 30 =A/M	200 25 300
1962 !7-5/1 2000 !B@ (!1-39), 5?A-2, 50 <, HC<-1 < 20 1962 !7-5/2 700 !B@ (!	60E80	1	10 1 - 20 2 -	79 300 79
1-39), 5?A-1, 100 :<, HC<-2 <, 21 1965 !7-7 1000 !B@ 22 1970 !7-9/1 700 !B@ 7?	60E80	1		
A-1, 1 :<, HC<-1,5 <, 60E80 23 1970 !7-9/2		1		
2000 !B@ 7?A-2, 50 <, HC<-1,5 <, 60E80 24 1970 !7-9/3 5000 !B@ 7?A-3, 50 <, HC<-1,5 <, 60E80		2	10 1,5 0,1 =A/4 400 58	
25 1973 !7-12/1 700 !B@ 12?A-1,50 <,HC<-1,(0,3 </100 F) 60E80 26 1973 !7-12/2 5000 !B@ 12?		2	10 1,5 0,1 =A/4 400 58	
A-2,50 <,HC<-1/0,3 <, 1312 60E80		2	10 1,5 0,1 =A/4 400 58	
		2	5 1 0,2 =A/4 185 31	
		2	5 1 0,2 =A/4 185 31	
27 1975 !7-13/1 700 !B@ 12?A-1, (C<-1 <, 1312	60E80	2	5 1 20 ?A/4	185 44
28 1975 !7-13/2 10000 !B@ 13?A-1, (C<-3,3 <, 1312 29 1980 !9-11	60E80	2	5 3,3 20 ?A/4 2 5	185 44 400
26000 !B@ ?A-26, 50 <, (C<-5 <, CA@54=., 30 1980 !9-11 18000 !B@ ?	100E120	2	10?A/4 2 3,5 10?A/	42 400 42
A-18, 50 <, (C<-3,5 <, CA@. 31 1980 !9-11 1000 !B@ ?A-1, 100 :<, (C<-1	100E120	2	4 2 1 10?A/4 2 -	400 42
<, CA@.	100E120	2	0,1 =A/4 250 60 2	
32 1985 !7-16 800 !B@ R2E = 50 <, /2B. 87<., 2KG.1;>: 600 !	80E100	2	- 0,1 =A/4 330 40 5 - 20 =A/4 165 28 9	
33 1986 !7-17 34 B@ KE. "8=D., ;.= 813	100E120	2	2 293 48	
1986 !7-18 10000 !B@ 5D;. 1 A</750 < A@54=. 5263	80E100	1		

A5 30 A5@28A=KE (!5@2)
>AF8;;>3@0D>2, @07@01>B0==KE 2 ! 2 1957-1992 3.3.

! >4 >45;L >; "8?				A>15==>AB8	-" 'C2A. 8A:.	072Q@. >I 5A 07@01							
			F	(84)		<<		</45;				3	
1	1957 C1-6		1 !5@2 -"-755, <0;>301., 1,6 </		-60		1			1,5 <:A/M	35 4,5	20 3,5	
2	1976 !1-90		1 !5@2 -"-87		40E60		1	10		1 <:A/4,	32 3,5	30 1,8	
3	1977 !1-94		10 !5@2 -"-87		40E60		1	10		0,1<:A/4,	3,5 4		
4	1980 !1-109		5 !5@2 -"-63		30E40		1	10		0,1<:A/4,			
5	1980 !1-112 6		10 !5@2 -"-86, , <C;LB8<., 87<. U/I/R 10 !		40E60		1	5		50 =A/4 25			
1982 !1-118			5@2 -"-119, 2 :0=0;0		60E80 2:			5		50 =A/4 28			
7	1983 !030		7 !5@2 -"-87		40E60		1	5		50 =A/4 30	3,2		
8	1987 !8-20 9		10 !5@2 "/-"-111, 100 :</A, 20 A.		56E70 2:			2		50 =A/4 30	4,6		
1988 !1-112		10 1988 !	20 !5@2 -"-86, , <C;LB8<., 87<. U/I/R 20 !		40E60		1	5		50 =A/4 25	3,5		
1-118 11 1989		!1-131	5@2 -"-119, 2 :0=0;0		60E80 2:			5		50 =A/4 28	40 4,5	4	
			20 !5@2 &, -"-119,+F8D.?0<.-1 :1/8@. 60E80 2:					2	1 F 50 =A/4				
12	1990 !1-134		35 !5@2 -"-121		60E80 2:			2		10 =A/4 35		5	
13	1990 !1-139		20 !5@2 -"-119		60E80 2:			2		20 =A/4 35	4,5		
14	1990 !K1-132		20 !5@2 -"-119, +<C;LB.,+5=."/".		60E80 2:			2		20 =A/4 35	4,5		
15	1990 !1-140 16		20 !5@2 -"-119, +<C;LB.		60E80 2:			2		20 =A/4 35	4,5		
1990 !1-144			20 !5@2 -"-119, +<C;LB.,+"/!.		60E80 2:			2		20 =A/4 35	4,5		
17	1991 !1-137		25 !5@2 -"-121		60E80 2:			2		20 =A/4 40		5	
18	1992 !1-137/1		25 !5@2 -"-121, +C;LB8<5B@ 25 !		60E80 2:			2		20 =A/4 40	5,3 40 5,5		
19	1992 !1-137/2		5@2 &, -"-121,+F8D.?0<.-1 :1/8@. 60E80 2: 25 !5@2 -"-119 60E80					2	1 F 20 =A/4				
20	1992 !1-139		2:					2		20 =A/4 35	4,5		
21	1992 !K1-132	25 !5@2 -"-119, +<C;LB.,+5=."/".			60E80 2:			2		20 =A/4 35	4,5		
22	1992 !K1-140	25 !5@2 -"-119, +<C;LB.			60E80 2:			2		20 =A/4 35	4,5		
23	1992 !K1-144	25 !5@2 -"-119, +<C;LB.,+"/!.			60E80 2:			2		20 =A/4 35	4,5 33 4,2		
			18					4					
24	1974 !1-73		5 !5@2 #=825@A0;L=K9, <0;>3010@8B=K9		36E60		1	10		50 =A/4 30	4,5		
25	1979 !1-101		5 !5@2 0;>3010@8B=K9		30E40		1	5		0,1<:A/4 18 2,3			
26	1981 !1-107		5 !5@2 C;LB8<5B@, 2<5AB> !1-73		40E60		1	10		100 =A/4 25		4	
27	1982 !1-124		10 !5@2 2B><0B., <0;>3.		40E60		1	10		50 =A/4 25		4	
28	1989 !1-130		15 !5@2 +&, ", !		40E60		1	10 1 :F 50 =A/4 28 4,5					
			8					9			25 3,9		
29	1987 !1-125		10 !5@2 57		60E80		2	1		20 =A/4 35	4,9		8=A:
30	1989 !1-127		50 !5@2 >B -30 4> +50 3@.&.		60E80		2	1		5 =A/4 60 5,5 48 5,2			8=A:
			30					1					

@8;>65=85 5.5

A5 28 F8D>2KE 8 0=0;>3>-F8D@>2KE (&/&)

>AF8;;>3@0D>2, @07@01>B0==KE 2 ! 2 1979-1992 3.3.

! >4 >45;L >;. '78?	-" 'C2A. 8A:.		072. >I 5A 07@01.				
1 1979 !9-5	A>15==>AB8 5 & =4.--1, $--,	100E100		1	1 5		220 18 250 35
2 1982 !9-10/1 3	B>G= 0,2-5%, 10 & =4.--1, $--,	100E100		2	5 20		220 21 900 64
1986 !1-122/8 4 1986 !	B>G= 0,2-2%, 10 /& /4!-122,&,&8D@.A.,02B.C?	100E120 2:			0,5 20/5000 20 =A/4		800 64
9-20 5 1986 !9-21	@./87<. 20 & &, =4.--1,	256E256		2/4	- 100		
	$-, 5 & &, =4.--1, $-, 1	256E256		4	40		
6 1986 !9-22	& &, =4.--1, $-, 0,25 &	256E256		4	- 5		900 64
7 1986 !9-23 8	&, =4.--1, $-, 20 &	256E256		16/8	0,5		900 64
1986 /4!-118	538AB@0B>@ 157 -", $-, 5 &			2/4	- 100		350 33
9 1986 /4!-119	538AB@0B>@ 157 -", $-, 1 &			4	40		300 33
10 1986 /4!-120	538AB@0B>@ 157 -", $-, 0,25 &			4	- 5 0,5		250 33
11 1986 /4!-121	538AB@0B>@ 157 -", $-, 20 & &,			16/8			200 33
12 1987 !8-22	-"-121, 5 & &, -"-162,	1 </4		2	1 1/5000 20 =A/4		40 6,5 350 33
13 1988 !9-24	$-, 1 & &, -"-162, $-,	162		1	40		
14 1988 !9-25	0,25 & &, -"-162, $-,	162		1	- 5		250 33
15 1988 !9-26 A@54.		162		2/4	0,5		200 33 422 39
16	7				30		
1980 !9-14 17 1987 !	100 & , &, 02B.8 <0@:. 87<., $- 10 &	100E120			5 :2.48A 2 =A/4 10 10		300 24 23 2,5
8-19 18 1987 !8-19/1	40E100 <, 62E160 B>G5: 10 & 40E100 <,	40E1006:			1	50 =A/4	23 2,5
19 1988 !9-19	M:282 48A:@5B. 1 F 40E1006: 100 & ,,02B.<0@.87<.,-"-161			1	2,5/1000 50 =A/4 2 20/5000		
		80E100		1 2 3	20=A/4 5 20/5000 100 =A/M		21
20 1988 !9-28	100 & , 02B.<0@.87<., $- 25 /	80E100		2	210 12 2 0,2 10 =A/4 65 0,1 1		
22 1990 !1-128	& , , &-512E8, <0@:. 7<5@5=8O 25 &	60E80		2			6
21 1992 !1-133/1	57 ,+ &, 4> 20 <A/45;. 20 & ,	40E80		2	1	20 =A/4	55 7,2 7
23 1992 !8-23 24	&-1E818B, , <0@:. 7<.,	60E80		2	1	10 =A/4	75
1992 !8-23/1	20 & , &-1E818B, ,<0@.7.,157	60E80		2	1 1	10 =A/4	75 6,5
A@54. 49					1	107 10	
25 1981 !9-8 26	2 & -589 A5@., &-2E8, <0@:.87<.	161		2	5 20 10 20		250 29 350 30
1985 !9-16	5 & -580 A5@., &-4E8, <0@:.87<.	161		2			
27 1988 !9-27	17 & CA@54., 02B.C?@./87<., 580 A. 8	176		2	2 100		440 30
					47	347 30	
A@54. 28 1987 !1-123	10 & @5470?CA:, 6QAB.;>38:0, &-1E8 18B	80E100		2	1		50

A5 19 A@54=5G0AB>B=KE (!')
>AF8;;>3@0D>2, @07@01>B0==KE 2 ! 2 1956-1992 3.3.

! >4 >45;L >; "8?			A>15==>AB8	-" . 'C2AB2.	8A:. 072Q@. ./>I. 5A 07@01.						
		F	(84)		<<		</45;				:3
1 1971 !1-63		25 !' >@B>2>9, 2-E :0=.				2					
2 1971 !1-64		50 !' 2-E :0=., 2 @072Q@B.		48E80		2	1		100 =A/4	150	19 "
3 1971 !1-65		35!' #=825@A0;L=K9, 112		64E80		1	5		10 =A/4	125	16 "
4 1976 !1-78		35 !' 2B.. 2<. !1-43		80E100		1	5		10 =A/4	130	19 "
5 1979 !1-98	6 1986 !	50 !' 2B.+, <.!1-78		80E100		2	5	5 -	10 =A/4	140	18 "
1-64		50 !' 2-E :0=., 2 @072., C25;8G5=0 -"		64E80		2			100 =A/4	125	16 "
7 1991 !1-135		20 !'	, <0;>3010@8B=K9	40E60		2	5		10 =A/4		
8 1991 !1-135 50 !'			, , <0;>3010@8B=K9				10 =A/4				
	A@54=.	39					4			134 18	
9 1978 !1-65		50 !' #=825@A0;L=K9, -"-112 50 !'		64E80		1	5		10 =A/4	125	16
10 1982 !1-114		C;LB8<5B@ 50 !' 57		100E120		2	5		5 =A/4	90	14
11 1984 !1-114/1		C;LB8<5B@0 50 !'		100E120		2	5		5 =A/4	90	14
12 1986 !9-18			, 2B>?>8A:, 02B. 8 <0@:.87<.	80E100		2	10		40 =A 110		14
13 1990 !1-01	14 1991 !	25 !' C;LB8<5B@, 4;O 6QAB. CA;. M:A?;. 50 !' 57		60E80		1	2		0,1<:A/4 70		9
1-142 15 1992 !1-133		25 !' 57		80E100		2	1		5 =A/4 55		6,5
				40E80		2	1		20 =A/4	55	7,2
16 1992 !1-133/2 25 !' 57			+ <C;LB., +35=. 10 " A83=.	40E80		2	1		20 =A/4	55	7,2
	A@54=.	39					4			81 11	
17 1956 !1-7		60 !' -"-1847, 2 ;CG0, 40 !'		80<.-18		2	150			1500	270
18 1963 C1-32	, 19 1966 !	">G=>ABL 3% 25 !'		50E70		1	100		10 =A/A<	1300	70
1-40, A@54=.		-"-1311#, ">G=>ABL 2% 42		60E80		1	50		20 =A/A<	950	55
							100			1250 132	

@8;>65=85 5.7

A5 17 H8@>:>?>;>A=KE (()

>AF8;;>3@0D>2, @07@01>B0==KE 2 ! 2 1958-1991 3.3.

! >4 >45;L >;. "8?				A>15==>AB8	-" . 'C2A. 8A:. 072. >I. 5A 07@01.								
			F	(84)		<<		</45;				3	
1 1958 !1-11 2 1964 !			100 (-"-13104, 4000 :</A, ;0<?>2K9 100		13 A<		1	100		25 1200 165 600 40			
1-31 A@54= 3			(-"-1310", 2 @072Q@B:8, ;0<?>2, 100 250		40E80		1	100			900 103		
		1974 !						100					
1-75 4 1977 !1-92 5			(-"-13105, R2E-50 <,1500:</A 60E100 100 (-"-171, 1 <, 2 @072Q@B:8				2	10		2 160 23 5 160 16 17			
1979 !1-108			350 (-"-16101, 50 <, &8D@. 045@. 350		100E120		2	5					
			(-"-16101, 50</100</1< 250 (16101, 1 <, ,		80E100		1	5		1 110			
6 1979 !1-97 7 1983 !			&8D., C;LB. 100 & -"-171, , $--, 1000 (,		80E100		2	10		1 140 1		18	
1-116 8 1985 !1-121 9			50</100:</1<, 2 @072., 2 :. 343 100		80E100		2	5		105 15 2 250 25 0,2			
1989 C1-129			(5AB@., ?5G., , 2 @072.		100E120		4	2 20		150 21 154 19			
			100 (, <0@:.87<., 2 @072 100 (2+2 :0=., 57		60E80		2	10					
		A@54=.	100					7					
10 1980 !1-85 11 1985 !			(C;LB8<., 4;O # 100 100 (1 :0=., 1		100E120		2	5		5 200 2		18	
1-120 12 1988 !1-126			@072. 100 (#=., 2 :0=. 2 @072.		80E100		2	5		120 13 2 100 3,5 5			
13 1991 !1-02			100 (#=32. (<. !1-79), 2 :0=. 2		2 @072. 80E100 4			5		90 12 127,5 13			
			@072.				2	10 - 6,25					
								5					
A@54=. 14 1973 !1-71					48E80		1			50 150 19 "			
15 1975 !1-79 16 1979 !					48E80		2	5		5 160 5		19 "	
1-99					100E120		2	2		150		17 "	
17 1981 !1-104 A@54=.			500 (#=825@A0;L=K9, 2:0=. 1 @072. 200		80E100		2	10 - 6		1 170 16 "			
											158 18		

@8;>65=85 5.8 (1)

A5 246 >AF8;;>3@0D>2, @07@01>B0==KE

2 ! 2 1948-1992 3.3., 8 <BA>@B8@>20==KE ?> =><5@C

<>45;8 (!1-, !7-, !8-, !9).

! >4 >45;L >;. "8?	A>15==>AB8	-" 'C2AB. 8A:.		072Q@. >I. 5A 07@01.				
	F (84) 0,25	<		</45; F 1		:3		
1 1948 !1-1	' 1337 5 ' R2E=0,5 </75<,	1337			4		120 24	
2 1950 !1-2	1337 1 ' 80<. -"-125<, 1337 10 ' !5@2 -"-755,	1337		1	30			25
3 1954 !1-4 4 1957 !	<0;>3. 1,6 </ !' -"-1847, 2 ;CG0, !	133		1	30		250 26 180 18	
1-5	-"-1337,			1	40		35 4,5 1500	
5 1957 !1-6	1 -80<5B@ " ", K45;. !B@>:./:04@0,	-60		1		1,5 <:A/M	270	
6 1956 !1-7	60 13037 1 000 !?5F !:>@.,			2	150			
7 1958 !1-8	25 -"-13101, 75 < 100	80<125		1	50		650 35	
8 1958 !1-9	12 (-"-13104, 4000 :</A, ;0<?>2K9 15 '	125 <		1	40	1 <A/M 550 65 "		
9 1957 !1-10 10 1958 !	2 ;CG0, 181			1	5000	10 =A/M 500 45		
1-11		-130		1	100	25 =A/A< 1200 165		
11 1960 !1-12		181 2;			100		1700 50	
12 1959 !1-13	12 " !: -1, @072., -2, !, -3 !, !, '%, -1,	40E80		1	100	600 =A/M 600 84 "		
13 1961 !1-13	12 2, 3 1 000 !?	40E80		1	100	600 =A/M 600 84 "		
14 1959 !1-14	5F !:>@., -"-13102, 25 B.:</A, ! 07>2K9 ;>:,1			1	3300	10 =A/M 850 107		
15 1960 !1-15 16 1960 !	25 25@B. >BA5:, 133 ! ! 1;>:>< #1, 133 !	80<125		1		20 =A/4	700 42 700 42	
1-15/1 17 1961 !1-15/2	25	80<125		1	50	20 =A/4	700 42	
	20 ! 1;>:>< #2-48DD5@. E>4, 133 !	80<125		1	50	20 =A/4		
18 1962 !1-15/3	20 1;>:>< #3-2 :0=., 133 !	80<125 2:			100	20 =A/4	700 42	
19 1963 !1-15/4	1 1;>:>< #4-48DD5@. 2E>4. 133 !	80<125		1	1	20 =A/4	700 42	
20 1964 !1-15/5	0,06 ! 200 ! 1;>:>< #5-48DD5@. 2E>4. 133 #7-	80<125		1	0,05	20 =A/4	700 42	
21 1965 !1-15/7	AB@>1. ?@5>1@07.-75 ><, 133	80<125		1			700 42	
22 1967 !1-15/8 23 1962 !	350 #8-AB@>1. ?@5>1@07.-75 ><, 133 5 ' 2 ;CG0,	80<125 2:			20	2 =A/4	700 42 395 25	
1-16	162 ! 07. ;, 162 2 ;CG0 A/1 >B !	40E100 2;			20			
24 1962 !1-17	10 1-15 ' 2 ;CG0, 162 ' #=82., A/1: #-1,2	2;				20 =A/4	700 42	
25 1962 !1-18, 26 1962 !	1	40E100 2;			20		300 27	
1-19	1	50E80		1	2	10 <:A/4 250 21		
27 1963 !1-19	1 ' #=82., A/1: #1,2 10 '	50E80		1	2	10 <:A/4 250 21		
28 1962 !1-20 29 1962 !	133 200 !B@	133 1:			100		360 23	
1-21	@8AB02:0 :>OF. !1-19 8 !1-30			1	50	3 =A/4 200 25		
30 1962 !1-22	5 ' #=82.,>@B0B82=K9			1	100	100=A/A< 200 13 "		
31 1962 !1-30	1 ' 0AB>;L=K9 ' !	50E80		1	20	2 <:A/A< 520 36 "		
32 1964 !1-30	1 B>5G=K9	50E80		1	20	2 <:A/A< 520 28 "		
33 1964 !1-31	100 (-"-1310", 2 @072Q@B:8, ;0<?>2. 40 !'	40E80		1	100		600 40	
34 1963 !1-32, 35 1969 !	">G=>ABL 3% 5 ' 5 ;CG59,	50E70		1	100	10 =A/A< 1300 70 600 160		
1-33 36 1964 !1-34	;0<?>2K9, 221 5 ' 2CE;CG52>9, 91 ' </3.,	221 5;			10			
	1-9 =0 ?>;C/?			2	170	200=A/A< 150 19		
37 1965 !1-35	5			1	10	200<:A/4 30 8		
38 1965 !1-36	1 200 !?5F !:>@., -"-«$CB5@-2», 10 B.:</A,			1	10000	10 =A/M 400 45		
39 1966 !1-40, 40 1967 !	25 !' -"-1311#, ">G=>ABL 2%	60E80		1	50	20 =A/A< 950 55		
1-43	10 ' 2B><0B878@>20=., 1 ' ',	60E80		1	50	500 =A/4 150 40 "		
41 1968 !1-48 42 1970 !	=0AB>;L=K9 1 ' ', AB>5G=K9	60E80		1	2	2 <:A/4 75 20		
1-48	5 ' 0;>3010@8B.,	60E80		1	2	2 <:A/4 75 20		
43 1968 !1-49	20<2-2002, 8 <:A 12 " !, !, -1,2,3 AB>5G.	36E60		1	10	0,2<:A/4 38 8,5 "		
44 1969 !1-52		60E80		1	100	0,1<:A/A 70 25 >;>G82		
45 1968 !1-55 46 1970 !	10 ' 15 2-E ;CG., 2<. !1-34		92	2	10	20 =A/4 75 15 "		
1-57	" !?5F80;L=K9, !	48E80		1	10	100<:A/4 110 25 >;>G82		
47 1971 !1-59	1 ' !B>5G.,;>3.,"/.			1	2			
48 1971 !1-63	25 !' >@B>2>9, 2-E :0=.			2				
49 1971 !1-64	50 !' 2-E :0=., 2 @072Q@B.	48E80		2	1	100 =A/4 150 19 "		
50 1971 !1-64	50 !' 2-E :0=., 2 @072Q@B. 35 !'	64E80		2	1	100 =A/4 150 19 "		
51 1971 !1-65 52 1978 !	#=825@A0;L=K9, 112 50 !'	64E80		1	5	10 =A/4 125 16 "		
1-65	#=825@A0;L=K9, -"-112 10 ' #=825@A0;L=K9	64E80		1	5	10 =A/4 125 16		
53 1972 !1-67	' #=825@A0;L=K9 5 ' 2-E ;CG52>9,	42E60		1	10	100 =A/4 45 10 "		
54 1972 !1-68	1 162 50 ! 07;>:, -"- 2	60E80		1	2	2 <:A/4 40 10		
55 1973 !1-69	>BA5:0, 112,	40E100		2	1	200 =A/4 135 17 "		
56 1972 !1-70, 57 1976 !		64E80		1		- 250 24		
1-70 58 1972 !1-70/1	50 ! 07>2K9 1;>:, 151, 2 >BA5:0 !	80E100		1		- 250 24		
59 1972 !1-70/2	50 1;>:0<8 1#11/1 11, 112, !	64E80		1	10	10 =A/4 250 28		
	3 500 ! 1;>:0<8 1#71/1 71-AB@>1., 50 < !	64E80 2:			5	0,1 =A/4 250 28		
60 1974 !1-70/3	700 1#72/1 71-AB@>1 :><?;5:B, 100 :<	64E80 2:			5	0,1 =A/4 250 28		

@8;>65=85 5.8 (2)

! >4 >45;L >;. "8?	A>15==>AB8 -" 'C2AB. 8A:.		072Q@. >I. 5A 07@01.				
	F (84) 10 !	<	</45; F 1			:3	
61 1974 !1-70/4	1#13/1 11-48DD5@. 2KA>:>G. CA8;8B.	64E80		0,5		10 =A/4 250 28	
62 1975 !1-70/5	10 ! 1#91/1 91-CA.A> A<5I.AB@>:. 4;O !	64E80	1	10		10 =A/4 250 28	
63 1975 !1-70/6 64 1976 !	8- ! 1#92/1 11 - ;>30@. CA8;. 10 41/45;.	64E80 !	1	10		10 =A/4 250 28	
1-70/7 65 1976 !1-70/8	1 1#12/1 11 - 2-E :0=0;L=K9 CA8;8B5;L 64E80 2: ! 1#14/1 11-48DD5@. 2KA>:>GC2A.			10		10 =A/4 250 28	
	50 CA8;.	64E80	1	0,01		10 =A/4 250 28	
66 1973 !1-71	0,1 100 (15 <-100 5 !5@2 10 =A-1A.	48E80	1	5	·	50 =A/4 150 19 "	
67 1974 !1-73	<0;>3., 10 <-350 35 ! /;2 ;./4 :., 3 200 =A-0,5 A	36E60	1	10	·	50 =A/4 30 4,5 >;>G82	
68 1974 !1-74	>B. A/1 !1-70, 1316 250 (-"-13105, R2E-50 <,1500:</A ' ?	60E100 2;		·		- 250 30	
69 1974 !1-75	5@2K9 >AF. -"-1318	60E100	2	10		2 =A/4 160 23	
70 1975 !1-76	1		1	0,1	·	1 <:A/4 55 13	
71 1975 !1-77 72	10 ' 2-E :0=., 10 <-200 35 !' 2B..2<. 2: 0=., 100 =A-0,4 A	60E80	2	5	·	100=A/4 50 10 >;>G82	
1976 !1-78 73 1975 !	2 @072Q@B:8, !2 :0=., 2 @072Q@B:8,	80E100		5	·	10 =A/4 130 19 "	
1-79	2KA>:>GC2AB2.	48E80	1 2	5	·	5 =A/4 160 19 "	
74 1979 !1-80	100		2	10	·	· · ·	"
75 1979 !1-80/1	35		2	10			"
76 1979 !1-80/2	10		2	1			"
77 1979 !1-80/3	35 ! A 1;. <C;LB8<., 1-2 :0=., 2-1 @072. " !		2	10			"
78 1976 !1-81	20	80E100	1	10	·	20 =A/4 120 18 >;>G82	
79 1978 !1-82 80	10 ' 2 @072.-A=. 704., -"-171 5 ' #=825@A0;L=K9	100E120	2		·	50 =A/4 100 15	
1986 !1-83	100 (5AB@0=D.., ?5G0B., ,2	100E120	2	1 0,1	·	100 =A/4 50 10 "	
81 1980 !1-85	@072	100E120	2	5	·	5 =A/4 200 18	
82 1976 !1-90	1 5@2 -"-87	40E60	1	10		1 <:A/4, 20 3,5 - 150	
83 1977 !1-91	100 ! 07.;>:, -"-171, , 3 >BA5:0 ! /	100E120	2	·		17	
84 1977 !1-91/1	100 4!-90/91, 4 :0=0;0, 2 @072Q@B:8 ! /	100E120 4:		5		5 =A/4 150 20	
85 1978 !1-91/2	100 4!-90/91/97,2 :0=.+<C;LB8<5B. U/I/R 12 000 ! /	100E120 2:		5		5 =A/4 220 21	
86 1978 !1-91/3 87 1981 !	4!-95/96/89-AB@>1.1;.+35=.8<?., 2 :.	100E120 2:		2		20 ?A/4 220 22	
1-91/4 88 1979 !1-91/5	18 000 ! /4!-100/101/102-AB@>1-2 :0=., + ! /4!-90/91/98-	100E120 2:		2		10 ?A/4 220 22 5 =A/4 220	
89 1979 !1-91/6	100 F8D@>200 7045@. @072.	100E120 2:		5		21 5 =A/4 220 21	
	100 ! /4!-90/91/92-E0@0:B5@8>3@0D B@-@>2	100E120 2:		5			
90 1981 !1-91/7	100 ! /4!-90/91/105-<0@:5@. 87<5@. U/T	100E120 2:		5		5 =A/4 220 21	
91 1977 !1-92	100 (-"-171, 1 <, 2 @072Q@B:8 15 '	100E120	2	5		5 =A/4 160 16	
92 1977 !1-93	#=825@A0;L=K9 10 !5@2 -"-87	100E120	2	5	·	20 =A/4 50 10 >;>G82	
93 1977 !1-94		40E60	1	10		100 =A/4, 32 3,5	
94 1979 !1-95 95	100 ! 2 A/1 CA8;8B5;O 350 (-"-16101,	100E120	2	5	·	2 =A/4 300 32	
1979 !1-97 96 1979 !	50</100:</1< 50 !' 2B.+, <.!1-78 100 (<. !1-79,	80E100	2	10		1 =A/4 140 18	
1-98	8<-150, 10=A-0,5A 20 " 70<5= !	80E100	2	5	·	10 =A/4 140 18 >;>G82	
97 1979 !1-99	1-81	100E120	2	2	·	5 =A/4 150 17 "	
98 1979 !1-100			1				>;>G82
99 1979 !1-101	5 !5@2 0;>301., 10<-3002, 0,3<:A-0,4A 10 ' 1 F/0,05 </	30E40	1	5	·	0,1 <:A/4 18 2,3 "	
100 1979 !1-102	4, 2 ;CG0, 174 10 ' 1 F/0,05 </4, 2 ;CG0, 4 :.,	100E120 2;		0,5		120 15	
101 1979 !1-103	174 500 (#=825@A0;L=K9 5 !5@2 C;LB,</3,2<.!1-73,	100E120 4:		0,5		120 15	
102 1981 !1-104 103	20<-3502, 350 (-"-16101, 50 <,	80E100	2	10	·	1 =A/4 170 16 "	
1981 !1-107 104 1979 !	&8D@. 045@.	40E60	1	10	·	100 =A/4 25 4	>;>G82
1-108		80E100 5 !	1	5		1 =A/4 110 17	
105 1980 !1-109	5@2 -"-63 (/4!-99), A<5=, 1;>: >AF. 30E40 100 1 A/1 CA., 1 -		1	10		100 =A/4, 30 1,8	
106 1979 !1-110	87<.0<.	100E120	1	5	·	2 =A/4 300 32	
107 1979 !1-111	100 1 A/1 CA., 1 - <C;LB.	100E120	1	5	·	2 =A/4 300 32	
108 1980 !1-112	10 !5@2 -"-86, , <C;LB8<., 87<. U/I/R 20 !5@2	40E60	1	5		50 =A/4 25 3,5 25 3,5	
109 1988 !1-112	-"-86, , <C;LB8<., 87<. U/I/R 5 ' 5@B8:., 20<-500,	40E60	1	5		50 =A/4	
110 1984 !1-113 111	0,2<:A-0,5 A 50 !' C;LB8<5B@ 50 !' 57 C;LB8<5B@0 !			10			"
1984 !1-114 112 1984 !	07. ;., 2 ;CG./4:., 174, , 3 >B.	96E120	1	5	·	5 =A/4 90 14	
1-114/1 113 1984 !1-115,		100E120	2 2	5	·	5 =A/4 90 14	
114 1983 !1-116	50	100E120 2;		·		- 150 20	
	250 (16101, 1 <, , &8D., C;LB.	80E100	2	5		1 =A/4 105 15	
115 1981 !1-117	10 ' (!1-76) 119, 0.1 F/0.1-05</4, 15 ' ?/02B.87<. t/V,	60E80	2	1	·	50 =A/4 60 10	
116 1981 !1-117/1	" A8=E@>=87.	60E80	3	1	·	50 =A/4 60 10	
117 1981 !1-117/2	15 ' (!1-76) 119, 0,1 F/0,1-05</4, 10 !5@2 -"-119, 2	60E80	4	1	·	50 =A/4 60 10	
118 1982 !1-118 119	:0=0;0 20 !5@2 -"-119, 2 :0=0;0 10 '	60E80 2:		5		50 =A/4 28 4	
1988 !1-118 120 1986 !	AF8;.- <C;LB., (c , <0@:.87<., 2	60E80 2:		5		50 =A/4 28 4	
1-119	@072., &, ?/0 87<. 100					>;>G82	
121 1985 !1-120	100 (-"-171, , $-, 100E120 100 ! 07.;., -"-177, ,	80E100	2	5	·	2 =A/4 120 13	
122 1985 !1-121	3 >BA.		4	2	20	2 =A/4 250 25	
123 1986 !1-122		100E120	2	·		- 150 17	
124 1986 !1-122/1	100 ! /4!-90/91, 4 :0=0;0, 2 @072Q@B:8 ! /	100E120 4:		5		5 =A/4 150 20	
125 1986 !1-122/2	100 4!-90/91/97,2 :0=.+<C;LB8<5B.	100E120 2:		5		5 =A/4 220 21	
126 1986 !1-122/4 18 000 ! /4!-100/101/102-AB@>1-2 :0=., + 127 1986 !1-122/5 ! /4!-90/91/98-		100E120 2:		2		10 ?A/4 220 22 5 =A/4 220	
F8D@>O 7045@. @072. 128 1986 !1-122/6 ! /4!-90/91/92-E0@0:B5@8>3@0D B@-@>2	100	100E120 2:		5		21 5 =A/4 220 21	
	100	100E120 2:		5			
129 1986 !1-122/7	100 ! /4!-90/91/105-<0@:5@. 87<5@. U/T	100E120 2:		5		5 =A/4 220 21	
130 1986 !1-122/8	10 !/& /4!-122, &, &8D@.A., 02B.C?@./87<.	100E120 2:		0,5 20/5000		20 =A/4 220 21	

! >4 >45;L >;. "8?	A>15==>AB8 -" 'C2AB. 8A:.		072Q@. >I 5A 07@01.					
F (84)	<		</45; F			:3		
131 1986 !1-122/9	!/& /4!-110, >38G.0=0;.-100 F/16 :.	100E120	16	- 100			- 220 21	
132 1987 !1-123	10 & @5470?CA:, 6QAB.;>38:0, &-1E8 18B 10 !	80E100	2	₁			50	
133 1982 !1-124	5@2 2B><0B., <0;>3. 10 !5@2	40E60	₁	10		50 =A/4 25 4		>;>G82
134 1986 !1-125	57	60E80	2	₁		20 =A/4 35 4,9		
135 1986 !1-126 136	100 2 @072(2+2 :0=., 57	80E100	4	5		2 =A/4 100 8,5		
1987 !1-127	50 !5@2 >3 -30 4> +50 3@.&. 25 /& , ,	60E80	2	1		5 =A/4 60 5,5		
137 1990 !1-128	&-512E8, <0@:. 7<5@5=8O 1 000 (, 50</	60E80	2	2	0,2	10 =A/4 65 6		
138 1989 !1-129	100:</1<, 2 @07. 15 !5@2 +&, ", !	60E80	2	10		0,2 =A/4 150 21		
139 1989 !1-130		40E60	₁	10	1 :F	50 =A/4 28 4,5 >;>G82		
140 1989 !1-131	20 !5@2 & -"-119,+F8D.?0<.-1 :1/8@.	60E80 2:		2	₁	50 =A/4 40 4,5 35 4,5 35 4,5		
141 1990 !1-132	20 !5@2 -"-119, +<C;LB.,+5=."/". 25 !5@2	60E80 2:		2		20 =A/4		
142 1992 !1-132	-"-119, +<C;LB.,+5=."/".	60E80 2:		2		20 =A/4		
143 1992 !1-133	25 !' 57	40E80	2	₁		20 =A/4 55 3,5		
144 1992 !1-133/1	25 /& 57 ,+ &, 4> 20 <A/45;.	40E80	2	₁	0,1	20 =A/4 55 3,7		
145 1992 !1-133/2	25 !' 57 + <C;LB., +35=. 10 " A83=.	40E80	2	₁		20 =A/4 55 4,7		
146 1990 !1-134	35 !5@2 -"-121	60E80 2:		2		10 =A/4	35	5
147 1991 !1-135 148	20 !' , =0:>35=5@0B>@, , <0;>301.	40E60	2	5		10 =A/4		
1991 !1-135 149 1991 !	50 !' , =0:>35=5@0B>@, ,	40E60	2	5		10 =A/4		
1-137 150 1992 !1-137/1	<0;>301. 25 !5@2	60E80 2:		2		20 =A/4	40 5 40 5,3	
151 1992 !1-137/2	-"-121 25 !5@2 -"-121, +C;LB8<5B@ 25 !	60E80 2:		2		20 =A/4	40 5,5 35 4,5	
	5@2 &, -"-121,+F8D.?0<.-1 :1/8@.	60E80 2:		2	₁	20 =A/4	35 4,5	
152 1990 !1-139	20 !5@2 -"-119	60E80 2:		2		20 =A/4		
153 1992 !1-139	25 !5@2 -"-119	60E80 2:		2		20 =A/4		
154 1990 !1-140	20 !5@2 -"-119, +<C;LB. 25 !5@2	60E80 2:		2		20 =A/4	35 4,5	
155 1992 !1-140	-"-119, +<C;LB.	60E80 2:		2		20 =A/4	35 4,5	
156 1991 !1-142	50 !' 57	80E100	2	₁		5 =A/4 55 6,5		
157 1990 !1-144	20 !5@2 -"-119, +<C;LB.,+"/!.	60E80 2:		2		20 =A/4	35 4,5	
158 1992 !1-144	25 !5@2 -"-119, +<C;LB.,+"/!.	60E80 2:		2		20 =A/4	35 4,5	
159 1962 !7-5/1 160	700 !B@ (!1-39) 5?A-1, 100 :<, HC<-2 <, 2000 !B@ (!	60E80	₁	10			300 79	
1965 !7-5/2	1-39) 5?A-2, 50 <, HC<-1 <	60E80	₁	10			300 79	
161 1965 !7-7	1000 !B@		₁					
162 1969 !7-8	1 500 !B@. 50</10:<, -"-132, H-1,5 2 700 !B@ 7?	60E80	2	10		100 ?A/4 300 38 0,1 =A/4 400		
163 1970 !7-9/1	A-1, 1 :<, HC<-1,5 <, 2000 !B@ 7?A-2, 50 <,	60E80	₁	10		58 0,1 =A/4 400 58 0,1 =A/4		
164 1970 !7-9/2	HC<-1,5 <, 6000 !B@ 7?A-3, 50 <, HC<-1,5 <, 1	60E80	₁	10		400 58		
165 1970 !7-9/3	000 !?5F. !:>@., -"-10102 1B.:</A,	60E80	₁	10				
166 1968 !7-10		40E40	₁	1000		125 ?A/M 750 106		
167 1971 !7-10	1 200 !?5F. !:>@., 10102, 1 B. :</A, 1 200 !?	20E40	₁	1000		250?A/<	750 75	
168 1978 !7-10	5F. !:>@., 10103, 10 B. :</A,	40E40	₁	75		250?A/<	750 75	
169 1971 !7-11	5 000 !B@. -"-132, (C<-3,5 <, 6QAB .CA;.	64E80	2	5		50 ?A/4 160 33		
170 1973 !7-12/1	700 !B@ 12?A-1, 50 <, HC<-1/0,3 < 5000 !B@	80E100	2	5		0,2 =A/4	185 31	
171 1973 !7-12/2	1312,12?A-2,50<,HC<-1 < 700 !B@ 1312, 12?A-1,	80E100	2	5		0,2 =A/4	185 31	
172 1975 !7-13/1	(C<-1 < 10000 !B@ 1312, 13?A-1, (C<-3,3 < 5	60E80	2	5		20 ?A/4 185 44		
173 1975 !7-13/2	000 !?5F. !:>@., 10104, 40 B. :</A,	60E80	2	5		20 ?A/4 185 44		
174 1976 !7-15		15E40	₁	1000		0,1 =A/4 210 50		
175 1985 !7-16	800 !B@ R2E = 50 <, /2B. 87<., 2KG.1;>: 600 !B@ KE.	100E120	2	2		0,1 =A/4 250 60		
176 1986 !7-17	"8=D., ;.=.813	100E120	2	2		0,1 =A/4 330 40		
177 1986 !7-18	10000 !B@ 5D;. 1 A</750 < 5 000 !?	100E120	₁	5		20 =A/4 165 28		
178 1982 !7-19	5F. !:>@., 10105, 250 B.:</A, 5,5 ?A/B.	40E60	₁	170		0,2 =A/4 170 30		
179 1987 !7-20/!1 18 000 !B@. HC<-5 <, R2E = 50 <, &, 1 180 1987 !7-20/!2 10		150E150	2	5		10 ?A/4 450 60		
000 !B@. HC<-2 <, R2E = 50 <, &, 1 181 1987 !7-20/!3 1 000 !B@. HC<-2 <,		150E150	2	5		10 ?A/4 450 60 10 ?A/4 450		
R2E=100 :<,&,1		150E150	2	5		60		
182 1988 !7-21/!1 18 000 !B@. HC<-5 <, R2E = 50 <, &, 162 183 1988 !7-21/!2 10 000 !			2	5		10 ?A/4 300 30		
B@. HC<-2 <, R2E = 50 <, &, 162 1 000 !B@. HC<-2 <, R2E=100 :<,&, 162 30 000 !			2	5		10 ?A/4 300 30		
184 1988 !7-21/!3	B@. (C<-2,5 <, 468B.-5 ?A, &		2	5		10 ?A/4 300 30		
185 1990 !7-20/4		150E150	2	10		5 ?A/4 450 60		
186 1964 !8-1	₁ -" !-4 :</A, 30<8=./170 G0A., 132 7	60E80	₁	10			450 36	
187 1965 !8-2	-" "-500 :</A, 1 <8=./16 G0A., 136 20 -"	48E80	₁	25			900 70	
188 1967 !8-7	"-1000 :</A, 1 <8=., 137, 1;>:8	40E80	₁	50			750 30	
189 1967 8-7A! 190	20 -" "-1000 :</A, 1 <8=., 4;O /#A/-:A?.	40E80	₁	50			750 30 700	
1969 !8-8!	₁ -" !-10 :</A, 30 <8=., &8D@. 7<5@5=.	50E80	₁	5			115	

@8;>65=85 5.8 (4)

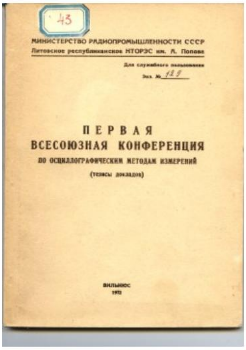
! >4 >45;L		>;. "8?		A>15==>AB8	-" 'C2AB. 8A:.	072Q@. >I. 5A 07@01.							
			F (84)		<	</45; F				:3			
191 1964 !8-9 192			2	-" "-100 :</A, 1 <8=./16 G0A., 135	40E80		1	100		1 <:A/4,	450 25 450 25		
1972 !8-9 193 1968 !			2	-" "-100 :</A, 1 <8=./16 G0A., 135 -" !-5 :</	40E80		1	100		1 <:A/4,	700 50 - 300		
8-11 194 1974 !8-12 195				A, 30 <8=., 138 ! "--", A/1 !	40E80		1	10			27 - 180 23		
1974 !8-13			1 50	1-70, 2 >BA.,1310 !	48E80		1						
			1	!--", A/1 >B !1-70, 2 >BA., 132 !	60E80		1						
196 1974 !8-14			50	"--", 2;/3>BA. A/1 !1-70, 1311 10 -"	40E80 2;					- 320 34			
197 1976 !8-15 198 1979 !			"-1000 : </A, 40 A5:/16 G0A,161/2;		80E100 2;			2			65	16	
8-17			1	-" !-40 :</A, 30 <8=./7 ACB., 168,2 ;.	60E80 2;			1			80	16	
199 1983 !8-18			10 -" "-250 :</A,30<./16G.,163,<?./7.		76E95 2:			1		50 =A/4	85	16	
200 1987 !8-19			10	& 40E100 <, 62E160 B>G5: & 40E100	40E100		1	10	1	50 =A/4 23 2B 2,5			
201 1987 !8-19/1			10	<, M:282.48A:@5B. 1 F 40E100 10 !5@2 "/-"-111, 100 :</A, 20 A.			2	10 2,5/1000 2		50 =A/4 23 2B 2,5			
202 1987 !8-20 203 1987 !					56E70 2: 100!					50 =A/4 30 4,6 - 150 17 40 6,5			
8-21				.;., -"-1314, 10B.:</A,, 3 >B.	80E100 &		2						
204 1987 !8-22			20	&, -"-121, ,	1 </4		2	1	1/5000 20 =A/4				
205 1992 !8-23			20	& &-1E818B, , <0@:. 7<., ,	60E80		2	1	1	10 =A/4 75 7			
206 1992 !8-23/1			20	& &-1E818B, ,<0@.7.,157	60E80		2	1	1	10 =A/4 75 6,5			
207 1973 !9-1 208			20				1	10		20 =A/4 130 25 >;>G82			
1975 !9-4			100 !?5F. !:>@., 13106, 115 B.:</A,		60E100		1	10		2,5 =A/4 150 85			
209 1980 !9-4			500 !?5F. !:>@., 13106, 20 B. :</A,		60E100		1	2000		2,5 =A/4 150 85 220 18			
210 1979 !9-5			5 & =4.--1, $--, B>G=.0,2-5%, 100 !?5F. &, 20, 3		100E100		1	1 5(20)					
211 1980 !9-6 212			B. :</A, $--, 10 ' 2B./?>8A., 02B.87<.,		100E100		1	5 10 000M 2,5 =A/4 560 46 - 65 7,5					
1982 !9-7			119 2,5 & -589 A5@., &-2E8, <0@:.87<.		60E80		1						
213 1981 !9-8					161		2	5	20 F		250 29		
214 1981 !9-9			18 000 !B@. ">G=.-1,5-4%, $--,02B.87<, & 150E150 100E100 100E120				2	5		10 ?A/4 400 62			
215 1982 !9-10/1 216 1983 !			10 & =4.--1, $--, B>G=.0,2-2%, 1000 !B@ ?A-1,				2	5	20		250 35 400 42		
9-11/1			100 :<, (C<-1 <, CA@.				2	2		10?A/4			
217 1983 !9-11/2			18000 !B@ ?A-18, 50 <, (C<-3,5 <, CA@.		100E120		2	2		10?A/4	400 42		
218 1983 !9-11/3			26000 !B@ ?A-26, 50 <, (C<-5 <, CA@54=., 350 !?5F. &,		100E120		2	2		10?A/4	400 42		
219 1986 !9-13			162/20, 256E256 B>G. 100 , &, 02B.8 <0@:. 87<., $-				1	10 40 000M 0,5 =A/4 360 46					
220 1980 !9-14			5 & -580 A5@&, &-4E8, <0@:.87<. 50 02B. 8		100E120		1	5		2 =A/4 300 24			
221 1985 !9-16 222 1986 !			<0@:5@ .87<., $-		161		2	10 20 F 10			350 30		
9-18				!'	80E100		2			40 =A 110 14			
223 1988 !9-19			100	& ,,02B.<0@.87<.,-"-161 &	80E100		3	2 20/5000		20=A/4		21	
224 1986 !9-20			20	&, =4.--1, $-, 5 & &,	256E256		2/4		100(50) 40		900 64		
225 1986 !9-21			=4.--1, $-, 1 & &, =4.--1, $-,		256E256		4		5		800 64 900 64		
226 1986 !9-22			0,25 & &, =4.--1, $-, 5 & &,		256E256		4				900 64 350 33		
227 1986 !9-23 228 1988 !			-"-162, $-, & &, -"-162, $-, 0,25 &		256E256 162		16/8 1		0,5/0,25 40				
9-24			&, -"-162, $-, & CA@54.,										
229 1988 !9-25			1	02B.C?@./87<.,	162		1		5		250 33		
230 1988 !9-26			580 A.		162		2/4		0,5/0,25		200 33		
231 1988 !9-27			17		176		2	2	100F	440 30			
232 1988 !9-28			100	& , 02B.<0@.87<., $-	80E100		2	5 20/5000		100 =A 210 12			
233 1984 /4!-109			10	>AF8;;>3. :0A<5==. 1;>: 4;O ! !	30E40		2	5		20 =A/4			
234 1984 /4!-111			100	, 8=48:.-, 3 >BA., A/1 >B !1-122 &						- 105		8	
235 1986 /4!-118			20	538AB@0B>@ 157 -", $-, &			2/4		100(50) 40		350 33		
236 1986 /4!-119 237 1986 /			5	538AB@0B>@ 157 -", $-, &			4				300 33 250 33		
4!-120				538AB@0B>@ 157 -", $-, &			4		5				
238 1986 /4!-121			10,25	538AB@0B>@ 157 -", $-,			16/8		0,5/0,25		200 33		
239 1986 /4!-125 18 000 !B@. 57 -", (C<-2-5 <, $--, &							2	5		10 ?A/4 300 30			
240 1983 !030			7 !5@2 -"-87 '		40E60		1	5		50 =A/4 30 3,2			
241 1971 !-67			10	@>B82>C40@=K9	42E60		1	10		100 =A/4 45 10 "			
242 1984 2-52			100	! 7<5@. !8AB.!1-91 +/4!-111+A1	100E120 4:			5		5 =A/4 500 60			
243 1984 2-53			50	! 7<5@. !8AB.!1-115 +/4!-111+A1	100E120 4:			5		5 =A/4 500 60			
244 1990 2-74			5 000 !?5F. ! <0B@., !7-19, + 25 100 -.	512E512B. 40E60		1	50 400000M 4 ?A/;8=.					
245 1990 !1-01 246 1990 !				!' C;LB8<5B@, 4;O 6QAB. CA;. M:A?;.	60E80			2		0,1<:A/4 70 9			
1-02				(C;LB8<., 4;O 6QAB. CA;. M:A?;C0B.	60E80		1 2	10		5 =A/4 90 12			

@8;>65=85 6

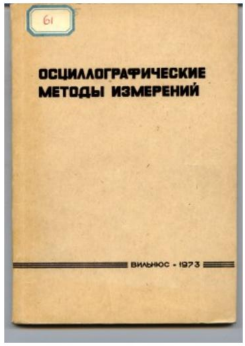
"8BC;L=K5 ;8ABK <0B5@80;>2

I VI >AF8;;>3@0D8G5A:8E :>=D5@5=F89

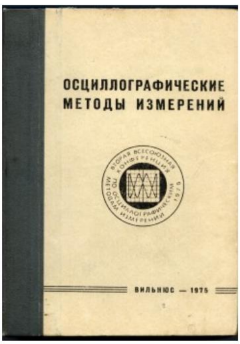
8;L=NA. 1972 -1990 33.



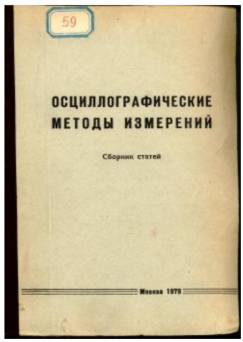
5@20O A5A>N7=0O :>=D5@5=F8O ?
> >AF8;;>3@0D8G5A:8< <5B>40<
87<5@5=89. "578AK 4>:;04>2.
8;L=NA. 1972 3.



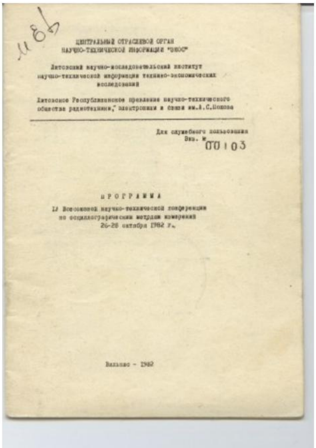
!1>@=8: AB0B59 ?> 4>:;040<, ?
@>G8B0==K< =0 5@2>9
A5A>N7=>9 :>=D5@5=F88 ?
> >AF8 ;;>3@0D8G5A:8< <5B>40<
87<5@5=89. 8;L=NA. 1973 3.



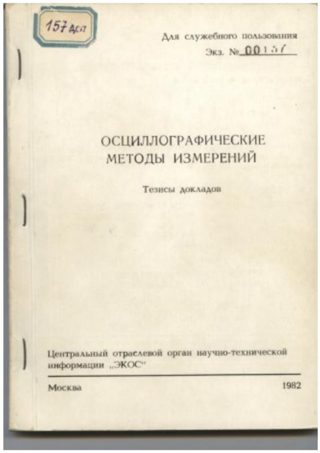
0B5@80;K II
A5A>N7=>9 :>=D5@5=F88 ?
> >AF8;;>3@0 D8G5A:8< <5B>40< 87<5@5=89.
8;L=NA. 19 -20 =>O1@O 1975 3.



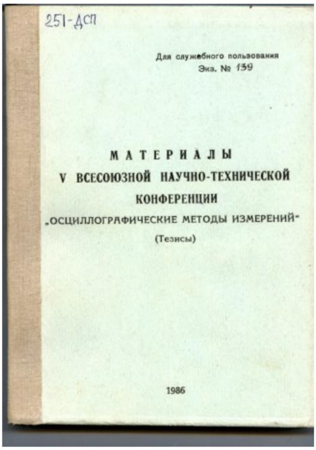
0B5@80;K III
A5A>N7=>9 :>=D5@5=F88 ?
> >AF8;;>3@0 D8G5A:8< <5B>40< 87<5@5=89.
8;L=NA. 1978 3.



@>3@0<0 IV A5A>N7=>9 =0CG=>
B5E=8G5A:>9 :>=D5@5=F88 ?>
>AF8;;>3@0D8G5A:8<
<5B>40< 87<5@5=89.
8; L=NA. 26 -28 >:BO1@O 1982 3.



"578AK4>:;04>2 IV A5A>N7=>9
=0CG=> -B5E=8G5A:>9 :>=D5@5=F88
?> >AF8;;>3@0D8G5A:8<
<5B>40< 87<5@5=89.
8;L=NA. 1982 3.



"578AK4>:;04>2 V A5A>N7=>9
=0CG=> -B5E=8G5A:>9 :>=D5@5=F88
?> >AF8;;>3@0D8G5A:8<
<5B>40< 87<5@5=89.
8; L=NA. N=L 1986 3.

@>3@0<0 VI A5A>N7=>9 =0CG=>
B5E=8G5A:>9 :>=D5@5=F88 ?>
>AF8;;>3@0D8G5A:8< <5B>40< 87<5@5=89.
8;L=NA. 18 -20 0?@5;O1990 3.

=0G>: 5@2>9 A5A>N7=>9

>AF8;;>3@0D8G5A:>9 :>=D5@5=F88 1972 3.

=0G>: (5AB>9 A5A>N7=>9

>AF8;;>3@0D8G5A:>9 :>=D5@5=F88 1990 3. (?>A;54=59 :>=D5@5=F88)

@8;>65=85 7

"8BC;L=K5 ;8ABK 3>AC40@AB25==KE AB0=40@B>2 2 >1;0AB8 >AF8;;>3@0D88, @07@01>B0==KE 2> 5

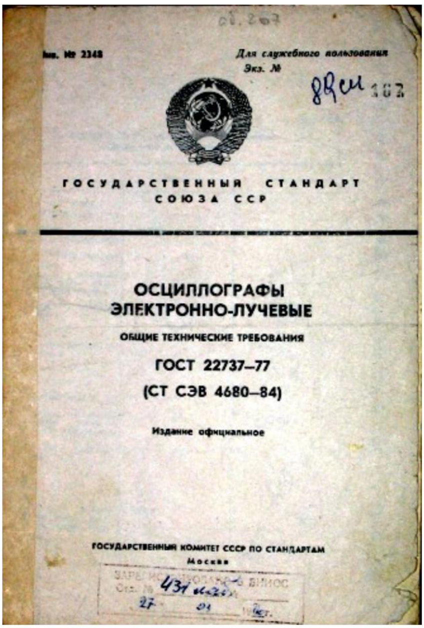
!" 9810-69

AF8;;>3@0DK M;5:B@>==> -;CG52K5, =><5=:;0BC@0 ?0@0<5B@>2 8 >1I85 B5E=8G5A:85 B@51>20=8O .

07@01>BG8:8: ..528= 8 ..$54>@5=G8:, .../@<>;5=:>

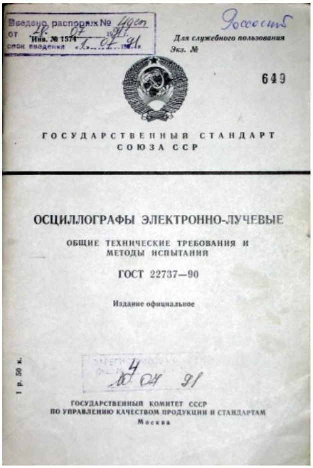
!" 22737-77

AF8;;>3@0DK M;5:B@>==> -;CG52K5. 1I85 B5E=8G5A:85 B@51>20=8O . 07@01>BG8:8: ..$54>@5=G8: ..!5<5=N:



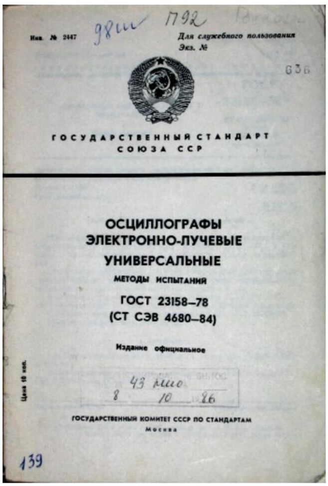
!" 22737-90

AF8;;>3@0DK M;5:B@>==> -;CG52K5. 1I85 B5E=8G5A:85 07@01>BG8:8: .. B@51>20=8O 8 <5B>4K 8A?KB0=89 . $54>@5=G8: ..!5<5=N:



!" 23158-78

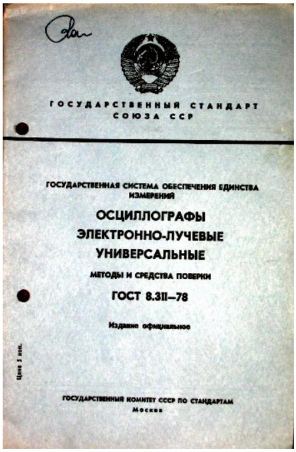
AF8;;>3@0DK M;5:B@>==> -;CG52K5 C=825@A0;L=K5. 5B>4K 8A?KB0=89 . 07@01>BG8:8: ..$54>@5=G8:, ..!5< 5=N:



!" 8.311-78

AF8;;>3@0DK M;5:B@>==> -;CG52K5 C=825@A0;L=K5. 5B>4K 8 !5<5=N:

A@54AB20 ?>25@:8 . 07@01>BG8:8: ..$54>@5=G8:, ..

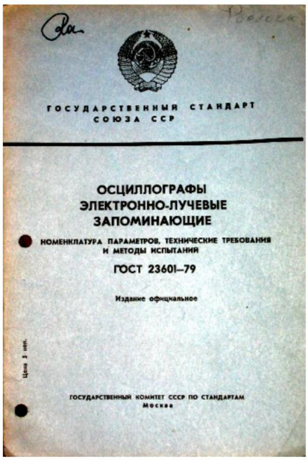


!" 23601-79

AF8;;>3@0DK M;5:B@>==> -;CG52K5 70?><8=0NI85. ><5=:;0 BC@0 ?0@0<5B@>2.

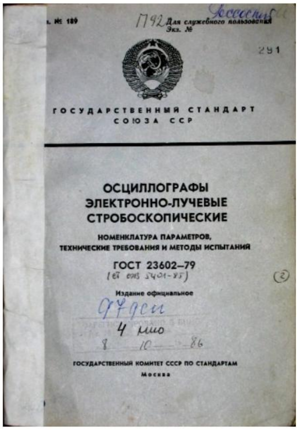
"5E=8G5A:85 B@51>20=8O 8 <5B>4K 8A?KB0=89 .

07@01>BG8:8: .$.5=8A>2, .!.CA;>28G



!" 23602-79

AF8;;>3@0DK M;5:B@>==> -;CG52K5 AB@>1>A:>?8G5A:85. ><5= :;0BC@0 ?0@0<5B@>2. "5E=8G5A:85 B@51>20=8O 8 <5B>4K 8A?KB0=89 .
540:F8O 1991 3. 07@01>BG8:: /.. >A:89


ГОСУДАРСТВЕННЫЙ СТАНДАРТ СОЮЗА ССР

ОСЦИЛЛОГРАФЫ ЭЛЕКТРОННО-ЛУЧЕВЫЕ СТРОБОСКОПИЧЕСКИЕ

НОМЕНКЛАТУРА ПАРАМЕТРОВ, ТЕХНИЧЕСКИЕ ТРЕБОВАНИЯ И МЕТОДЫ ИСПЫТАНИЙ

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ГОСУДАРСТВЕННЫЙ КОМИТЕТ СССР ПО СТАНДАРТАМ

Москва

0 ?>A;54=85 45AOBL ;5B =0G0;>AL <0A>2>5 ?@>872>4AB2> F8D@>2KE >AF8;;>3@0D>2 H8@>:>3> 480?07>=0 G0AB>B 8 =0?@O65=89. &8D@>2K5 >AF8;;>3@0DK ?> A2>8< ?0@0<5B@0< ?@81;878;8AL : A?5F80;878@>20==K< ?@81 >@0<, B0:8< :0: 2>;LB<5B@K 8 G0AB>B><5@K, 87<5@8B5;8 2@5<5==KE 8=B5@20 ;>2 8 0=0;870B>@KA?5:B@0.

564C=0@>4=K< AB0=40@B><, @53;0<5=B8@CNI8< B5@<8=>;>38N 8 <5B>4K ?@>25@:8 @538AB@0B>@2 A83=0;>2, : :>B>@K< >B=>AOBAO 8 >AF8;;>3@0DK, O2;O5BAO AB0=40@B *IEEE Std 1057-2007, IEEE Standard for Digitizing Waveform Recorders.*

@8;>65=85 8

8B5@0BC@0

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N48. >4K. AF8;;>3@0DK.
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C@L5@, 2013 11 14.

4. *Victor KORBUT.* B "-;5:B@8B0" 4> ">@87>=B0" . :>=G0=85.
8B>2A:89 C@L5@, 2013 11 21.

5. >@L:>2A:89 =0CG=> -8A;54>20B5;LA:89 ?@81>@AB@>8B5;L=K9
8=AB8BCB (-11, & -11, , 2 =0AB>OI55 2@5<O 20@F) $#
http://www.kvarz.com/general/spravka.html

6. AB>@8O :>=F5@=0 «530» (& -17, http://www.vega.su/ -17,)
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9. Type 497 Tube Mount. The 497 was part of the first GR oscilloscope, https://
www.ietlabs.com/
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10. -;5:B@>==K9 >AF8;;>3@0D "!
1-1" http://www.rw6ase.narod.ru/00/prib/eo7.html

11.AF8;;>3@0D DuMont 208

https://www.oscilloscopemuseum.com/oscilloscope-dumont-208-s5636.html

12. -;5:B@>==K9 >AF8;;>3@0D (A8=E@>A:>?) 25 - (!1 -2)
http://museum.radioscanner.ru/pribori/oscilografi/25i/25i.html

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