TEKTRONIX® PRODUCTS 1976

Quality electronic products to help you test, measure, display, record and calculate:

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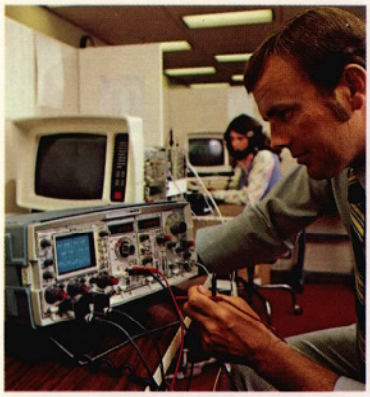
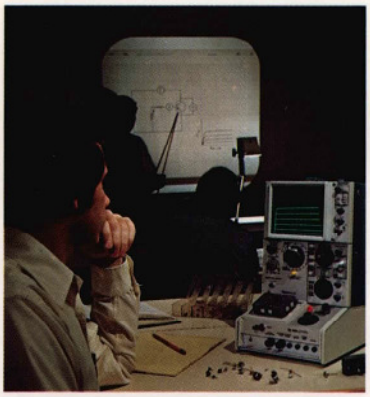
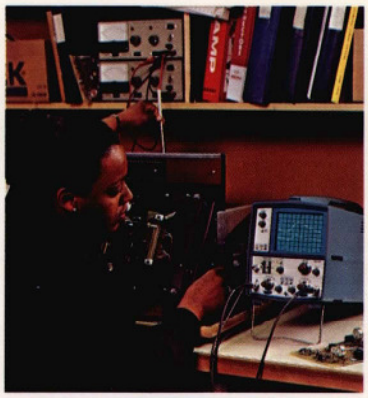
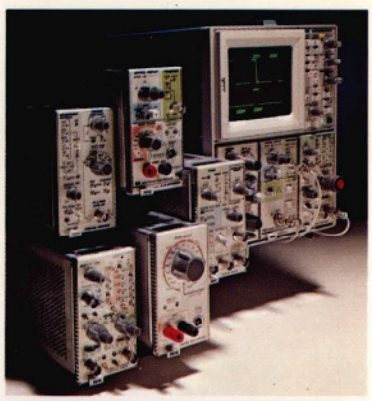
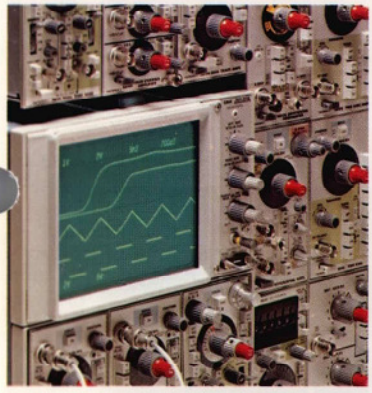
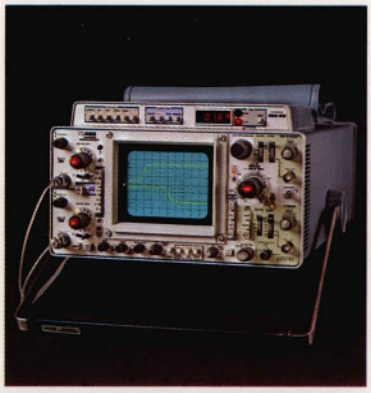
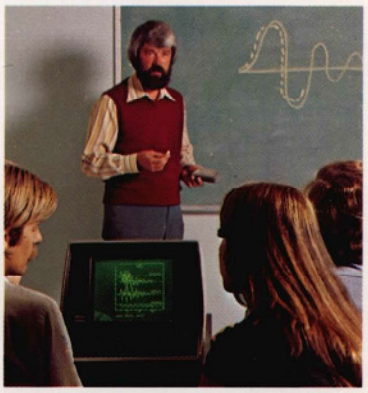
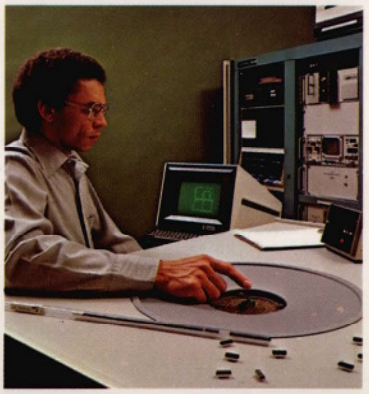
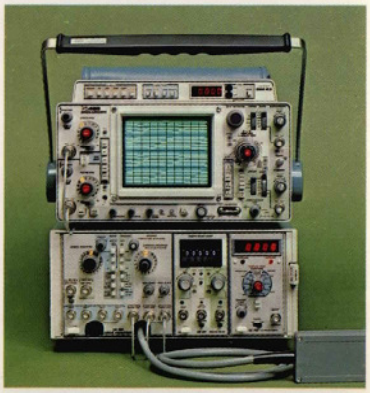
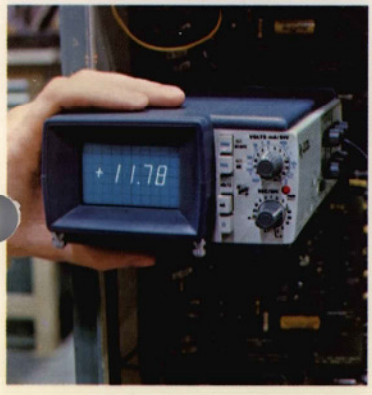
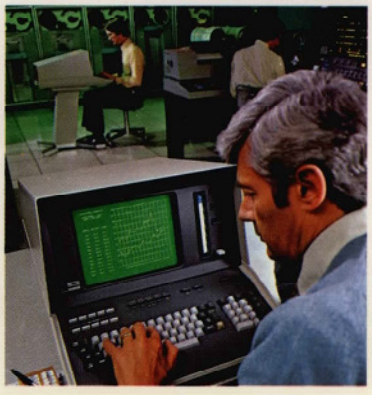










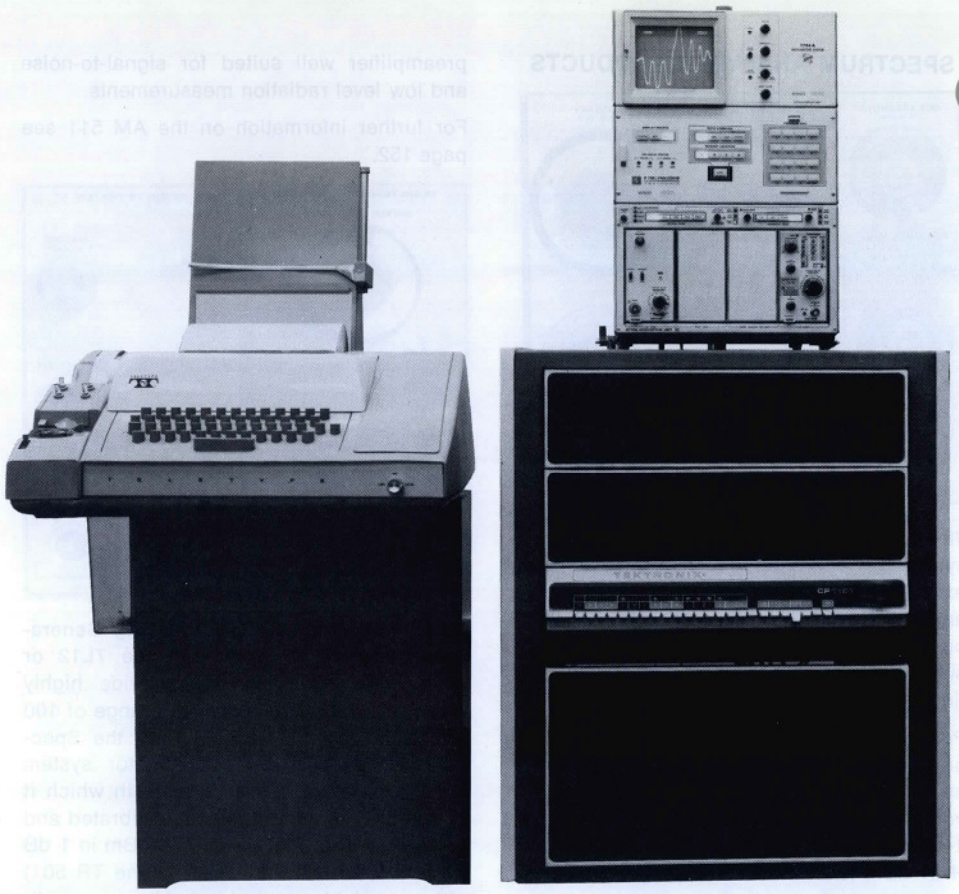


DIGITAL PROCESSING OSCILLOSCOPES

The WP 1205 DPO is a low-priced starting package for customers with a restricted budget. The package includes one 7A16 vertical plug-in, one 7B70 time base plug-in, a CP1151 controller with a 16 k memory, a modified ASR-33 teletype, and paper tape DPO TEK BASIC software.

The WP 1205 has an internal 1 k memory, adequate to acquire and display one waveform with scale factors. To store four waveforms, a 4 k DPO memory option is available. The software, DPO TEK BASIC, is written to allow specific routines to be selected at loading. This provides the CP1151 controller (16 k) with adequate program space for most user applications.

For further information on the WP 1200 Series see page 31.



COMPUTER TERMINAL PRODUCTS

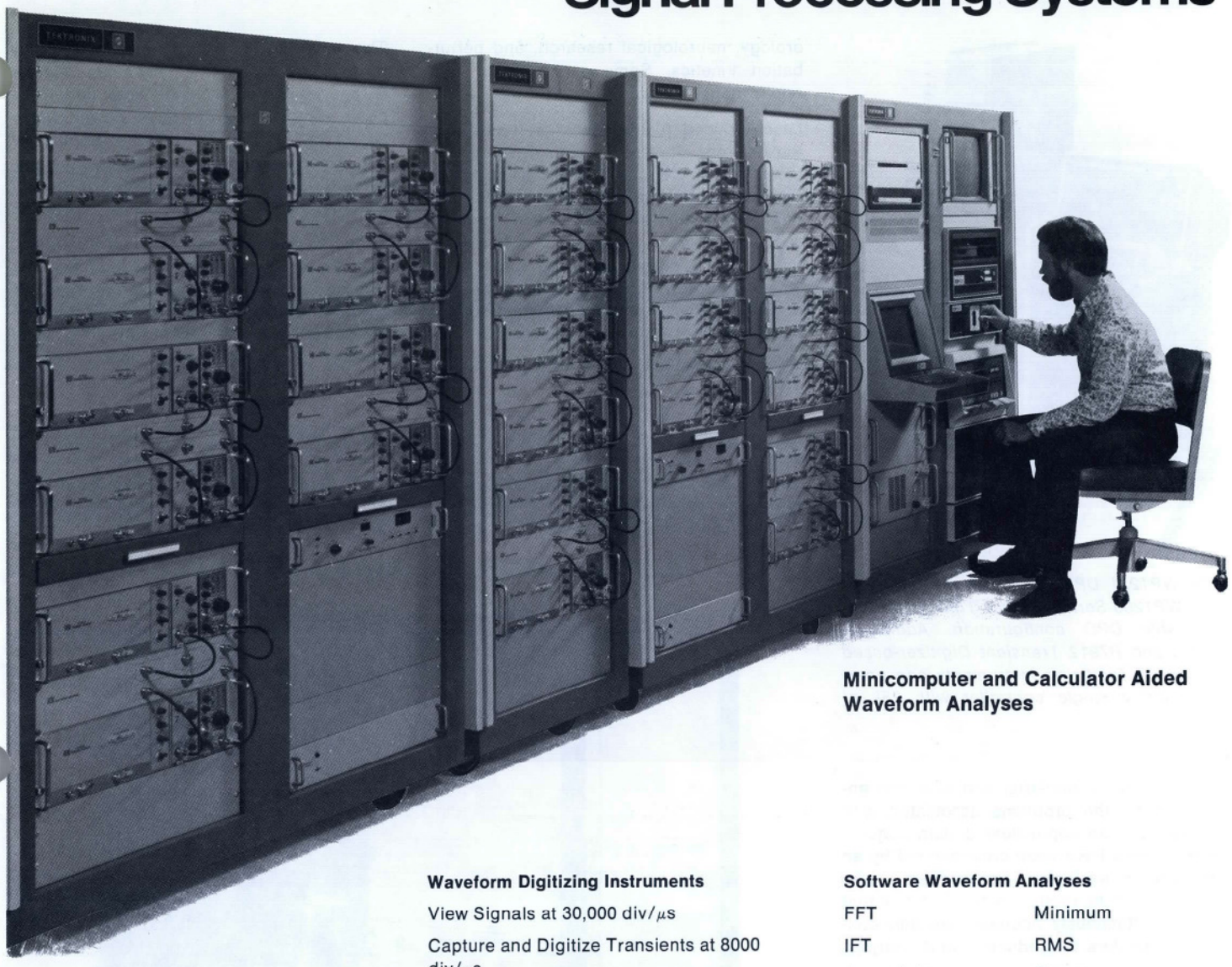
The 4051 BASIC Graphic Computing System is a compact data system that combines high-level BASIC-language interaction, built-in computing, local tape memory, and the unique graphic capability of the Tektronix storage display.

The standard 4051 includes a firmware implementation of BASIC with 8 k bytes of working space. Options include 8 k, 16 k, and 24 k of add-on memory. A built-in 3M mag tape unit adds 300 k bytes of local storage.

The 4051 is designed to control the operation of other instruments through the new standardized, general purpose, interfacing system (GPIB) called IEEE Std 488-1975. An optional data communications interface provides for coupling to host computers, and other RS-232-C compatible peripherals such as line-printers and keyboard terminals.

For further information on the 4051 see page 202.

Signal Processing Systems



Minicomputer and Calculator Aided Waveform Analyses

Waveform Digitizing Instruments

View Signals at 30,000 div/μs

Capture and Digitize Transients at 8000 div/μs

As many as 32 Acquisition Channels in One Configuration

Single-Shot Sampling Rates to 100 GHz

Digital Processing Oscilloscopes

Digitize, Store, and Process any Displayed Repetitive Waveform

Compare Stored Waveforms with Real-Time Waveforms

Acquisition Plug-ins with Diverse Capabilities

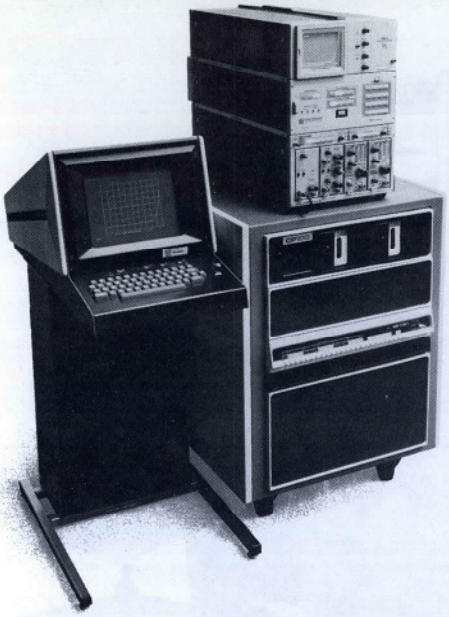
Signal Averaging from dc-14GHz

Software Waveform Analyses

FFT	Minimum
IFT	RMS
Convolution	Cross
Correlation	Addition
Differentiation	Subtraction
Integration	Multiplication
Maximum	Division

Plug-Ins Available

Amplifiers	Counters
Time Bases	Multimeters
Spectrum Analyzers	Samplers



The WP1221 DPO shown above is one of the WP1200-Series DPOs. This is an expandable DPO configuration. Additional DPOs and R7912 Transient Digitizer-based Waveform Digitizing Instruments can operate from a single controller with 28k of memory.

In a variety of industrial and research environments, the problems associated with providing more sophisticated data acquisition systems have been compounded by an information explosion. Researchers, inundated with data, require instrumentation that can simultaneously acquire data and convert these data for reduction and analysis.

The Tektronix Signal Processing Systems (SPS) group provides complete solutions to many of these measurement and analysis problems. Integrated SPS systems offer performance unattainable by individual products. A review of SPS product nomenclature reflects the growth in experience and market leadership that has resulted from years of experience. Today, SPS is used to describe Digital Processing Oscilloscope (DPO) systems, Waveform Digitizing Instrument (WDI) systems, and combined DPO/WDI systems.

SPS hardware is designed to the limits of technology. The software, TEK BASIC, leads the industry in waveform processing capability. The commitment to technological progress in automated measurements represented by this hardware and software has resulted in systems that provide the maximum possible long term value to systems users.

These systems are installed in applications as diverse as aerospace, component testing, computers, foundries, laser research, meterology, neurological research, and perturbation kinetics. Some examples of SPS applications include:

Laser-induced fusion research, to achieve the desired, efficient burning of thermonuclear fuel. To do this, it is necessary to develop lasers that generate extreme amounts of energy in pulses lasting a nanosecond or less. In addition, researchers believe that these lasers pulses must be shaped, or "manufactured," to deliver the maximum power (at exactly the right instant) to the deuterium and tritium fuel pellets.

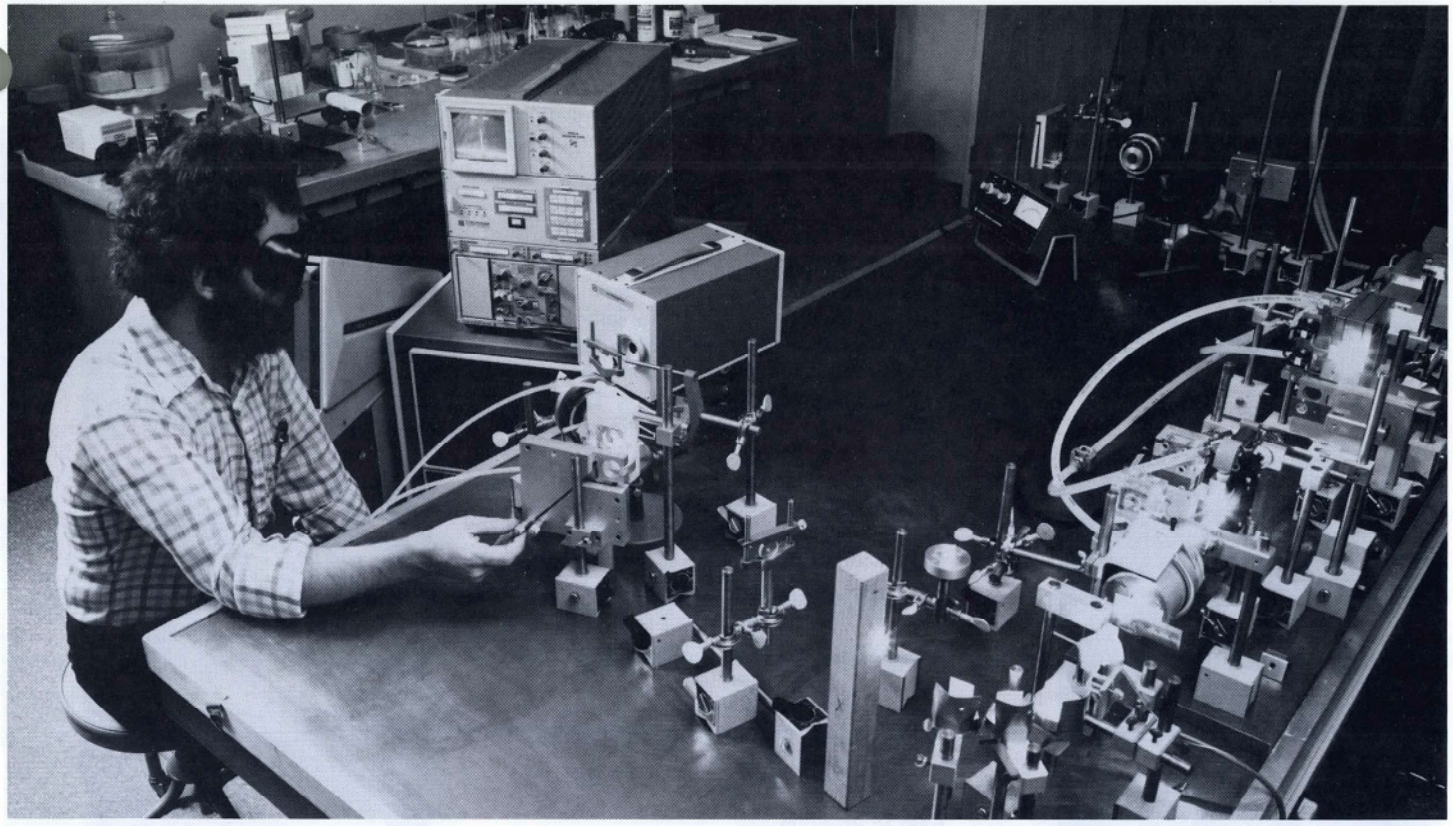
Several parameters in a typical laser fusion experiment may be monitored with SPS instrumentation. For example, the oscillator pulse purity may be checked by using either fiber optics and a photo diode, or a pellicle at the output of the laser to obtain pulse information for analysis. Similar techniques may be used to check the purity of pulses at several stages.

The power levels of these laser pulses may be measured by integrating each detector output waveform, with the area under the curve representing the pulse power. Other detectors that provide suitable outputs for the SPS configurations include Faraday cups, cylindrical analyzers, and secondary electron multipliers.

Dynamic laser trimming of active circuits, or devices, by applying power from the laser to do a cutting sequence that will bring the circuit closer to a specified performance level. SPS instrumentation may be used to monitor the circuit single-shot response characteristics and thus avoid circuit thermal effects.

Laser Interferometry, a technique that uses the Doppler shift effect of laser beams (an example is to examine an explosion front and detect its motion as well as the size of material within the shock front).

The WP2000-Series WDI analysis configurations are designed to acquire waveforms of transient phenomena and immediately perform full analyses. Other WDI analysis configurations include from 1 to 32 R7912 acquisition units, a controller (for waveform processing), a graphics terminal, a TV video or other monitor, a magnetic tape cassette, a disk or paper tape, and WDI TEK BASIC software.



Raman Scattering, a technique that looks at shifts in frequencies scattered or returned from a laser pulse hitting a gas cloud or target, and re-radiating at a frequency other than the frequency going into the sample.

Materials testing in industry, where lasers are used as a means for strengthening materials (shock hardening steel, aluminum, and titanium alloys by focusing a high-energy laser beam onto the surface of the metal) and for welding by using a high-energy laser beam instead of a flame. Here, SPS instrumentation may be used to monitor the lasers (the amount of energy used) and the materials (the effect of that energy on the material).

Time of flight (TOF) mass spectrometry, a method of materials analysis whereby atoms may be separated and identified, the SPS WDI configurations fit an instrumentation gap. In TOF mass spectrometry, materials are heated to cause emission of ions. These ions are accelerated, focused into an ion beam, and detected in a TOF tube. The mass-to-charge ratio (m/e) of each ion type determines its velocity in the TOF tube. Ion species identification is accomplished as a function of time, since each species in the sample travels at a different velocity and arrives at the detector at a different time. With the time data, the m/e may be calculated and each species identified.

Electro magnetic pulses, EMP and the associated rapidly changing electromagnetic fields can interfere with or damage a variety of electronic circuits. These EMP signals can be large amplitude pulses, with high frequency oscillations.

Sources of EMP can include lightning arc discharges. Because EMP can damage circuits, vulnerability studies, often requiring a transfer function analysis, must be made, and protection techniques must be developed. The SPS capabilities offer some solutions to the problems encountered in studying the transient nature and high-frequency components of EMP.

The list of SPS applications is growing, and includes:

Perturbation Kinetics — Stopped flow, T-jump, fluorescence decay.

Computers — Power supply design, bus transient analysis, propagation delay studies.

Communications — Transfer function analysis.

Electronic Warfare — ECM, radar signature analysis.

Component Testing — IC parameters, pc boards, filters.

Ordnance — Shock and acoustic testing.

Power Supply Design — Switching transient analysis.

Power Lines — Transient monitoring and analysis.

Security Systems — Transfer function analyses, ciphonics.

Navigational Systems—Pulse code modulation (pcm), timing information.

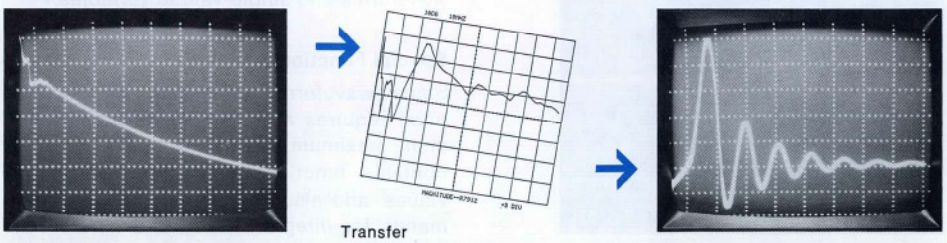
Nuclear Magnetic Resonance — Observing flip resonance.

Meteorology — Cloud pollution content studies using radar and pulsed lasers.

Optics — Determining laser-related optical characteristics.

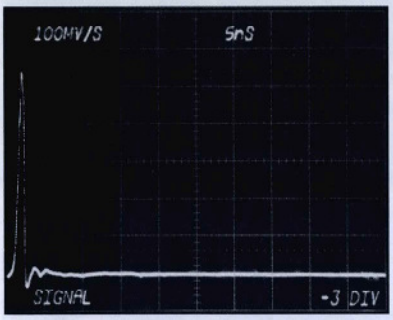
For complete SPS product and application information, use the catalog reply card to send for the DPO and WDI brochures, or contact the nearest Tektronix Field Office.

Transfer Function Analyses

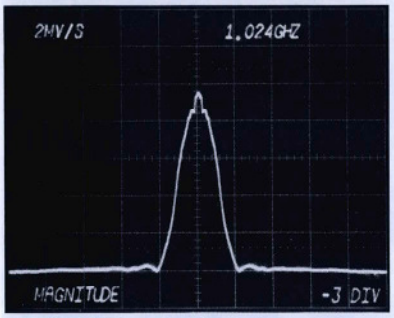


Input — Transfer Function Magnitude — Output

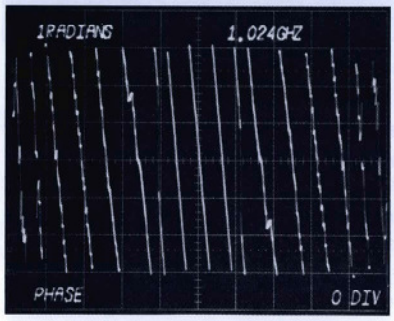
FAST FOURIER TRANSFORMS



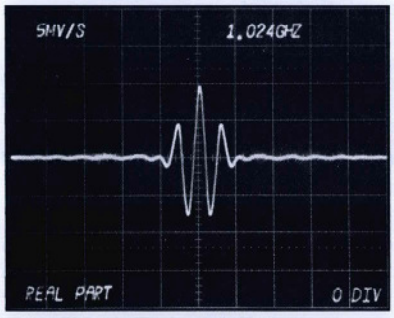
From time-domain data,



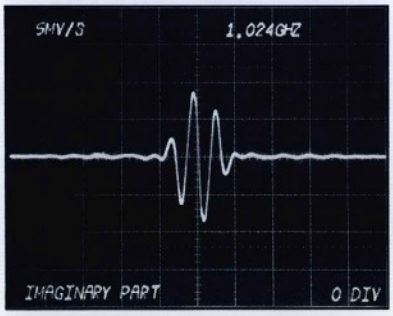
the DPO gives you magnitude vs frequency,



phase vs frequency,



real, and



imaginary vectorial values.

Programming, The TEK BASIC Approach

Because detailed signal analyses involve more than simply estimating a few waveform parameters, software is as important as hardware when considering a measurement system.

SPS waveform analysis configurations use TEK BASIC software, which is an extended version of the BASIC programming language. It is written in assembly (marco) language for maximum speed of program execution and minimum use of controller memory. Tektronix developed TEK BASIC *to facilitate array data manipulations associated with waveform processing.* With it, users can perform analyses of acquired waveforms that are either beyond the scope of BASIC, or are not attainable with standard BASIC programming statements.

Versions of TEK BASIC have been optimized for various DPO and WDI configurations. These are referred to as DPO TEK BASIC and WDI TEK BASIC, respectively. However, the comments here will be generalized to encompass features of both software packages.

Easy to Program

TEK BASIC is *interactive.* Programming via the graphics terminal enables users, even those without formal computer programming experience, to quickly develop measurement and analysis routines. To assist operators, system commands are provided to edit, store, and retrieve programs easily. In addition, *TEK BASIC responds with an error message on the terminal when statements are entered incorrectly.*

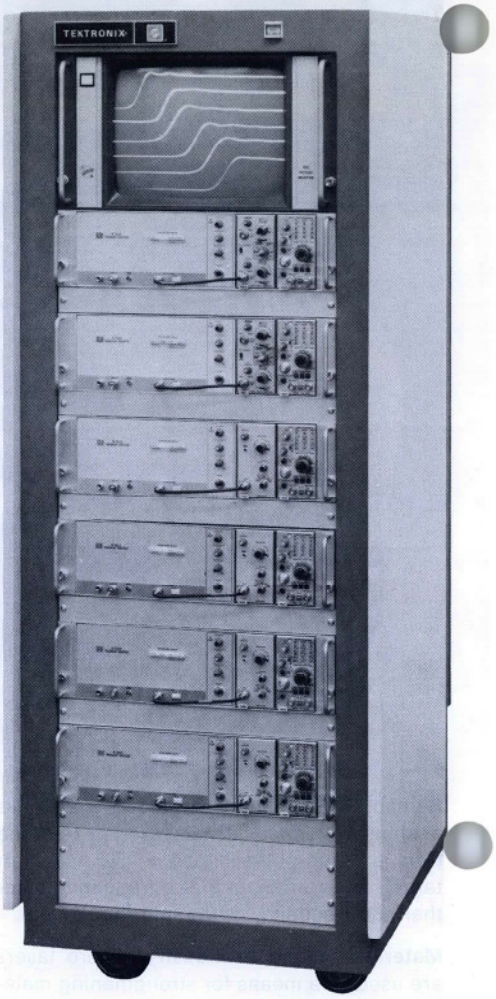
Powerful Through Expanded Capability

Many of the standard BASIC operators, functions, and commands have been retained. With the operators, you can add, subtract, multiply, divide, and exponentiate. Mathematical functions include: square root, power of e, natural log, absolute value, truncate, random number, sign (+ or —), sine, cosine, and arctangent.

These operators and functions have been extended to *process entire waveforms (512-point arrays) as though they were single-valued variables.* This means that you can write algebraic expressions involving both waveforms and single-valued variables.

Special Functions

Since waveform processing for analysis often requires a knowledge of mean, minimum, maximum, and rms values, TEK BASIC contains functions for determining those values, and also contains single-word commands for *integrate (INT)* and *differentiate (DIF).* These functions save a great deal of programming time. There is also a special function, *cross (CRS),* that can be used for determining the point at which array values cross a specified level.



The WP2052 CAMAC Compatible WDI configuration is one of a series of SPS products designed for labs that use the CAMAC interface standard.

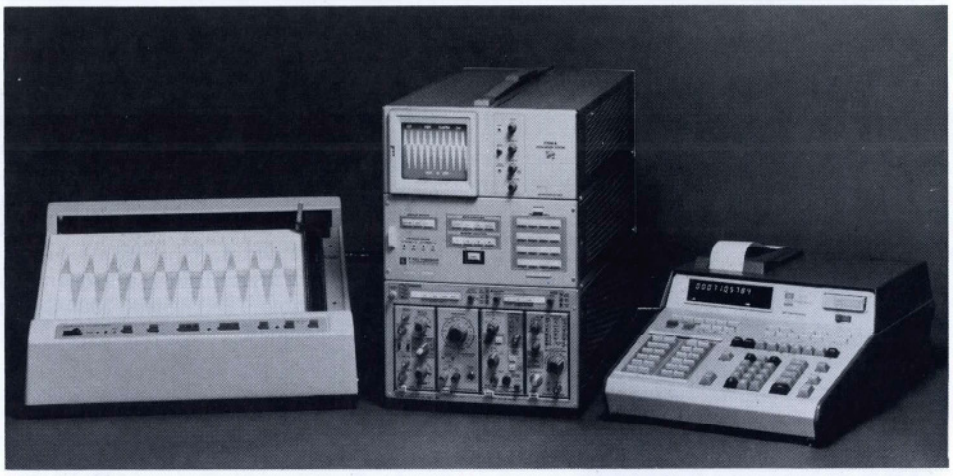
Fast Fourier Transform

Analysis of waveforms and transients often includes determining the frequency components of acquired time domain data. This can be accomplished with the fast Fourier transform. The inverse Fourier transform is also provided to reconstruct time domain information from frequency domain data. In TEK BASIC, these are simple commands, *FFT* and *IFT,* that do not require tedious programming. Both can be executed by single-word commands, or incorporated easily into longer user programs.

Transfer Function Analysis

A transfer function mathematically describes the response characteristics of a circuit or a system. By measuring and analyzing both the input and output signals, one can develop the signal transfer characteristics of a circuit or system under test. When cw techniques are inappropriate, the transient analysis capabilities of our WDI configurations are required. This is often the case in "real life" environments, and it is in these cases that the SPS WDI waveform analyzers are most useful.

TEK BASIC allows the user to write his own transfer function algorithms. While the transfer function analysis is a complex measurement to perform, it is probably one of the most useful measurement tools available to the experimenter today.



Calculator aided SPS instrumentation such as the WP1101 DPO above deliver versatile, low-cost signal acquisition and processing capabilities.

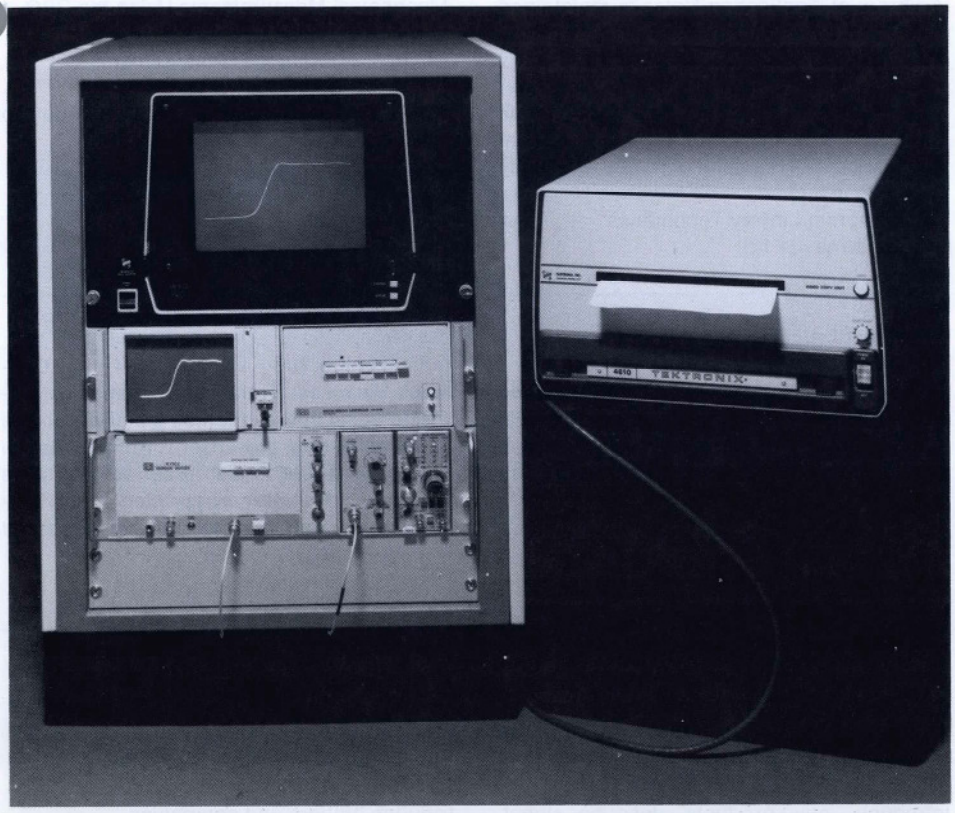
Signals and Noise

Software techniques useful for viewing signals in the presence of noise include signal averaging and correlation. For repetitive signals, averaging can be used to remove uncorrelated noise. In other applications, such as locating an echo following a stimulus pulse (echo ranging with lidar, radar, and sonar), cross correlation can be used. Auto correlation is also provided, and can be used to detect extremely weak signals accompanied by noise, or to detect the presence of unknown periodic signals interspersed among seemingly nonperiodic signals.

Software Digital Filtering

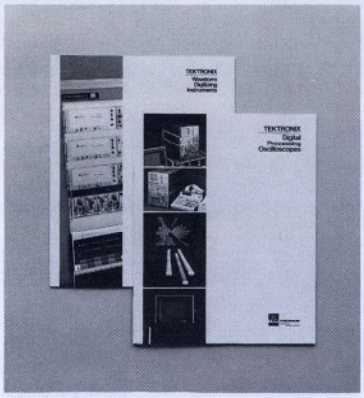
When it is required that a signal be filtered, and it is prohibitively expensive, or not practical to build the desired filters from electronic components, digital filtering often provides a solution. The ability of TEK BASIC to simulate desired circuit effects, through operations such as integration, Fourier transform, etc., enables users to synthesize the required filter.

For more on TEK BASIC software and SPS products, use the catalog reply card to send for the latest DPO and WDI brochures, application notes, and technical article reprints. If your needs are immediate, phone the nearest Tektronix Field Office.



The WP2004 Waveform Digitizing Instrument shown above is one of the WP2000-Series WDI viewing configurations — effectively the world's fastest oscilloscopes. For convenience, a variety of displays is available. Television video monitors can be used for viewing from a distance. Storage monitors and hard copy units can be used to generate permanent copies.

Literature Available

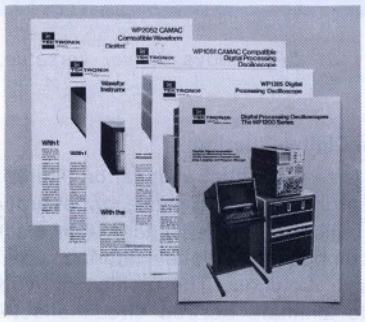


Digital Processing Oscilloscope (DPO) Brochure

This 24-page, color brochure discusses the concept of Digital Processing Oscilloscopes. Specifications and characteristics are included with a description of the relevant features of the calculator-aided WP1100-Series DPOs and the minicomputer-aided WP1200-Series DPOs. To illustrate the acquisition versatility of DPOs, a section outlining compatible TEKTRONIX 7000-Series Plug-ins is included.

Waveform Digitizing Instruments (WDI) Brochure

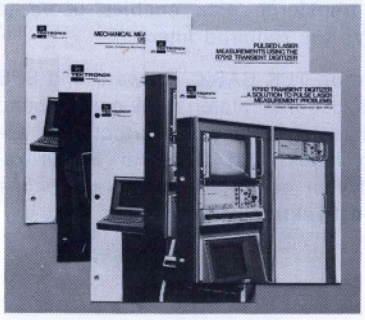
A discussion of some waveforms analysis problems together with the solutions provided by WDI configurations is presented in this 16-page, color brochure. Both the WDI viewing and software assisted configurations are presented together with discussions of waveform processing and WDI TEK BASIC software. Because the WDI configurations feature TEKTRONIX R7912 Transient Digitizers as signal acquisition units, the performance characteristics of the double-ended scan converter tube used in R7912s are included.



Data Sheets

With versatility as an underlying approach to solving measurement problems, the number and variety of Signal Processing Systems is increasing. As new SPS instrumentation applications emerge, data sheets to accompany the product line brochures are generated.

Presently there are DPO and WDI data sheets documenting individual configurations as well as configuration families such as the WP1200-Series DPOs. Also, there are special capabilities data sheets including the series on CAMAC compatible SPS products.



Application Notes

A library of Application Notes is maintained to disseminate technical information about the uses of SPS instrumentation. This library contains notes on specific techniques used in operating SPS instrumentation as well as descriptions of market oriented instrument applications. A sample of notes presently available includes:

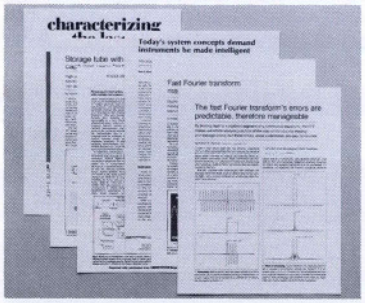
DPO Program Library Techniques
(DPO Note 45F1.0)

Mechanical Measurements Using the DPO
(DPO Note 45A1.0)

Engine Performance Measurements
(DPO Note 45A1.1)

R7912 Transient Digitizer . . . A Solution to Pulse Laser Measurement Problems
(WDI Note 47N1.0)

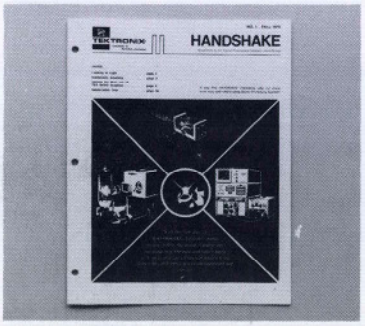
Pulsed Laser Measurements Using the R7912 Transient Digitizer.
(WDI Note 47N1.1)



Technical Article Reprints

Because of the newsworthy nature of many SPS applications, as well as the advanced instrumentation techniques used in SPS products, several technical articles have appeared in the media. Reprints are available.

Topics of these technical articles range from the high technology, instrument-oriented "Storage Tube with Silicon Target Captures Very Fast Transients," from *Electronics*, to applications-oriented material such as "Characterizing the Laser," from *Industrial Research*. There is also a series of articles on Fourier transforms reprinted from *Electronics*, as well as material that appeared in *EDN* and *Laser Focus*.



Handshake, a User's Newsletter

In 1975, Tektronix began publishing "Handshake", a quarterly newsletter addressed to users of digital signal processing techniques. Articles contained in "Handshake" introduce new products, describe signal processing applications, and provide operating and programming hints to SPS product users.

Since "Handshake" is a user's newsletter readers are invited to contribute articles. Submitted articles that have been selected for publication carry full credit to the contributing authors and companies.