



TEKTRONIX®

committed to
technical excellence

TM 500

Modular test and
measurement
instruments

Counters

Digital Multimeters

Signal Sources

Power Supplies

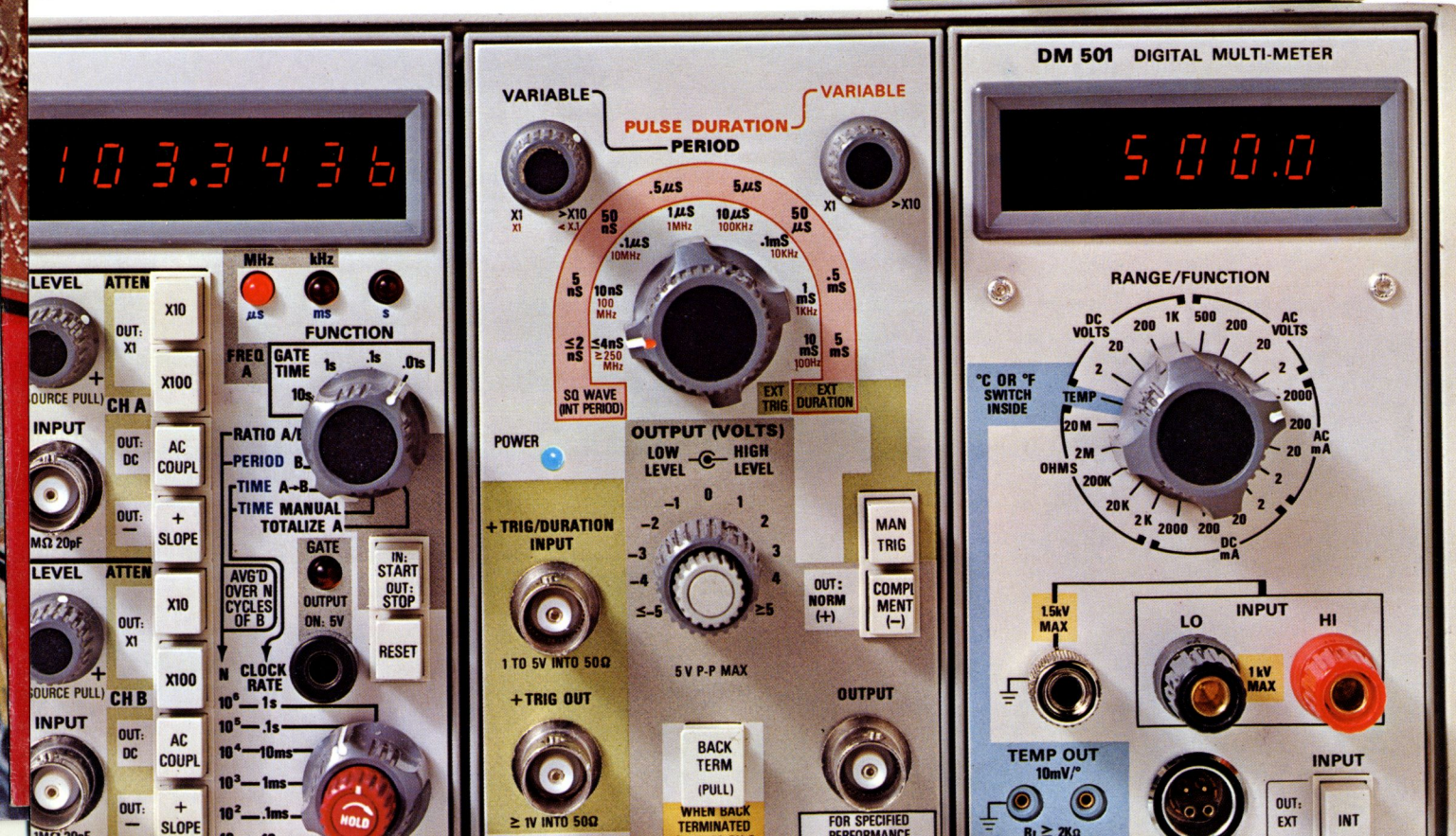
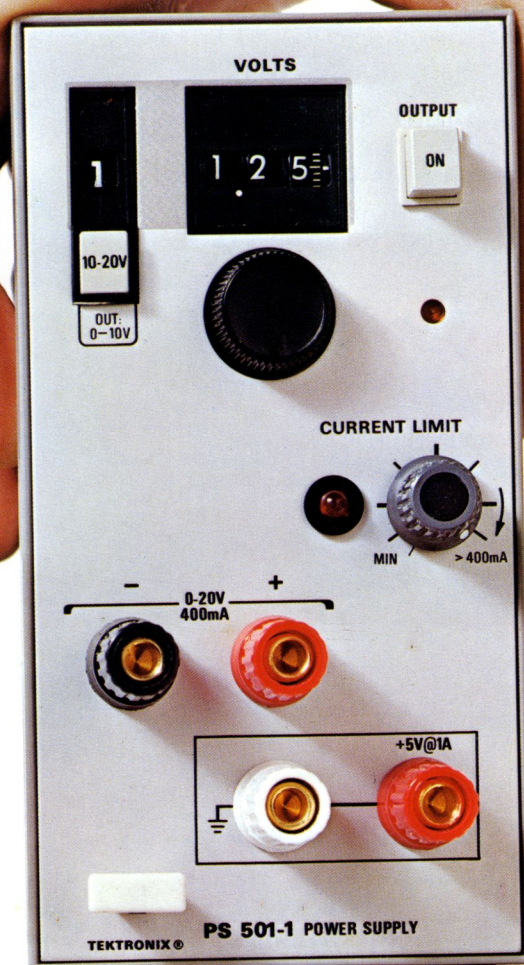
Signal Processors

Oscilloscopes



Actual Size!

Until you see TM 500-Series instrumentation, and discover its capabilities for yourself, you cannot fully appreciate how compact and easy to handle it is. These instruments offer the quality and multiplicity of functions needed in modern electronics—and all within reach of your fingertips.



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Section 1 TM 500 Modular Concepts and Features

Designed for Measurement Solutions

Over 30 compact plug-in test and measurement instruments which can work individually or be combined into powerful systems — that's TEKTRONIX TM 500.

TM 500 plug-in modular instruments range from general purpose devices like multi-meters and power supplies to specialized units like oscilloscope calibration units and a digital delay trigger generator. The mainframes come in benchtop, rackmount, SCOPE-MOBILE® cartmounted and portable traveler models, with spaces for one to six plug-ins.

TM 500 allows you to assemble a specialized package of instruments to meet your individual measurement needs, or you can pick one of the standard combinations suggested in this catalog. You can also select an assortment of mainframes and an inventory of plug-in instruments, and then have the freedom to make one kind of measurement today and an entirely different one tomorrow.

Modularity Means More Than Plug-Ins

Each TM 500 instrument is *designed* as a plug-in unit, with standard and special connections available at a rear connector as well as on the front panel. Any instrument can be plugged into any TM 500 mainframe slot, with a few providing extra performance in a special high-power compartment. Plug-ins can be rotated among mainframes or exchanged with supplementary units in seconds.

This add-on capability also means that your TM 500 system can keep up to date without the need to replace the complete investment. New TM 500 units can add the capability to keep up with new developments, while your existing units go on with day-to-day work. And both new and old units will work together, too.

Your TM 500 Can Be A Measurement System

By connecting to the signal and control lines brought out at the rear of each plug-in, the optional mainframe interface board turns a TM 500 package into an integrated measurement system. Both standard and user-defined lines are available, and simple or complex systems can be assembled as the need arises.

Signals and inputs available at the rear connector of each plug-in include most front-panel connections, many internal values and, on some units, BCD outputs. For automatic logging and calculating, you can connect a plug-in interface for TEKTRONIX Programmable Calculators. And, as the various industry interconnections standards develop, there will be TM 500 interfaces for many of these too.

Flexible TM 500 Works Anywhere

TM 500 is designed to serve a wide variety of uses. The mainframes come in benchtop, rackmount and a protected portable travel case-style unit. The three and four-compartment versions can be fitted to TEKTRONIX SCOPE-MOBILE® carts. With the variety of plug-ins available, this means that TM 500 is at home almost anywhere.

Since you can take TM 500 right to the problem, you can be sure that the measurement you make in the field is the same as the one on the bench. The measurement set-up you build in the lab can go into rackmounted TM 500 units on the production line. And, with your traveler mainframe, you can take your instruments along as carry-on luggage when the best choice is to carry your lab equipment right to the problem.

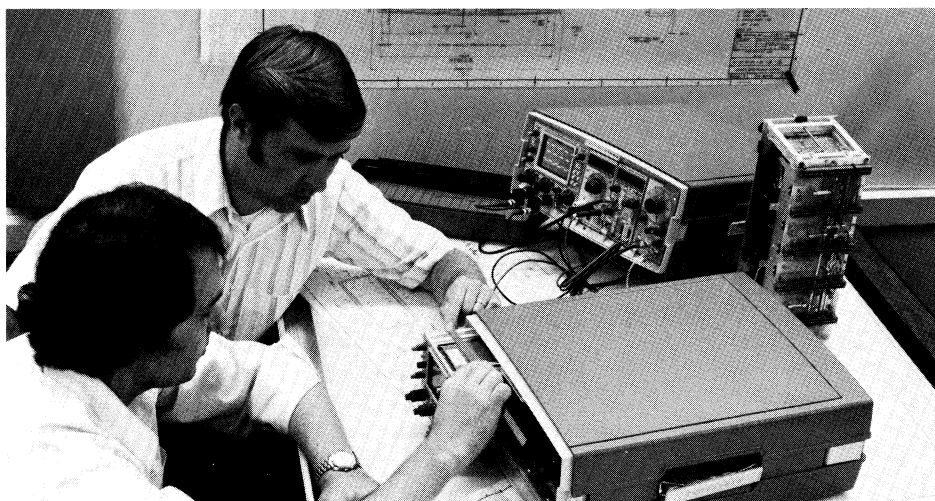
Quality, Value and Economy

TM 500 was designed to keep costs low and measurement value high. The mainframes include many of the more expensive components, such as the case and primary power supply, so they are shared by several plug-in instruments.

Extensive use has been made of the advanced technology and manufacturing techniques pioneered in TEKTRONIX Oscilloscopes — including the use of many Tektronix manufactured parts ranging from control knobs to integrated circuits.

Because of the wide selection of TM 500 instruments available, you can often tailor a TM 500 system to meet the needs of a special application at far less cost than that of a custom system or collection of the necessary separate instruments that would otherwise be required.

Since TM 500 is backed up by Tektronix, you save money in the long run as well. Worldwide customer assistance and service, quality engineering, and readily available parts are an important part of the value of TEKTRONIX TM 500 equipment.



Why You Should Buy TM 500

Production Engineers

Time savings are among the most important reasons to buy TM 500 for production line use. Time savings at the design stage, where the interconnection capability of the TM 500 system allows the quick construction of sophisticated measuring systems. Time savings at the training and measurement stage, where the easy-to-read digital outputs reduce operator error and fatigue, and where BCD output and a calculator interface make it possible to set up automatic testing and measurement logging. And time savings on repairs, where individual instruments can be unplugged for quick replacement to get the system back in operation immediately, eliminating possible production bottlenecks.

TM 500 rackmounting, portable, and mobile cart mounting options give you a whole range of configurations to choose from. Single-compartment and double-wide compartment circuit card plug-in kits with front panel and internal circuit board make it possible to construct compatible interfaces and custom circuits for further flexibility. And for complex systems and limited areas, the compact size of the TM 500 instruments is also an important factor to consider.

Design Engineers

If you're expected to produce advanced circuit designs, then you need test instrumentation that can match your measurement requirements. That's why TM 500 state-of-the-art capability is a key benefit for design engineering use.

Modularity allows you to add units to keep up with advances in circuitry, while the compact size means that a full complement of instruments can be kept on a crowded workbench. Interconnection capability makes over 30 input and output lines available, so you can build custom test systems for specialized design projects. And flexibility means that TM 500 will keep up with your imagination.

Maintenance Engineers

With portable, cartmounted, rackmount and desktop versions, TM 500 packages can do the work wherever it needs to be done. For specialized jobs, "solution" oriented instruments make those measurement problems easy to lick.

For example, the TG 501 Time Mark Generator not only provides exact pulses for calibration of oscilloscope and recorder time bases, but it also allows you to match a variable pulse with your existing calibration, and then read the error in percent on the TG 501 display. Since the TM 500 units can be brought to the job, oscilloscopes and recorders can be calibrated on site, eliminating the errors and added down time caused by moving them back to a calibration bench.

For general repair work, the flexibility of the TM 500 line means that any of the more than 30 units can be in place and running in seconds, covering far more of the possibilities than would be possible with a more limited system. You can set up your TM 500 instruments to have the ones you need at your fingertips, and still be able to switch to others in seconds when the problem requires an unexpected measurement.

Educational Use

With TM 500, you can build student lab stations with the full capability of a complete range of instruments, yet assemble them within the stringent limitations of budgets and space that so often apply. You can supply basic TM 500 units to each student, with more specialized instruments rotated among groups as the curriculum requires. This saves the cost of duplicate purchases without limiting vital access to the measurements students need to make.

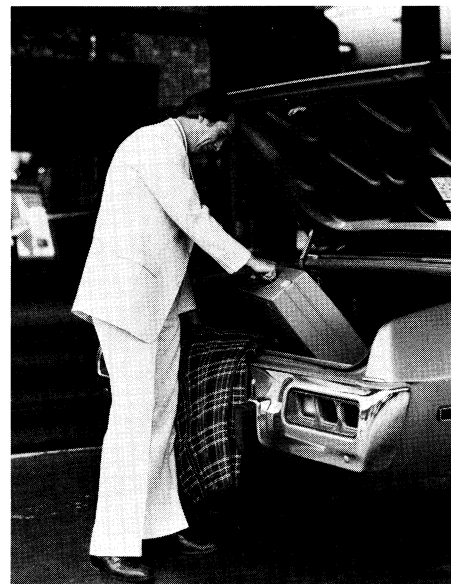
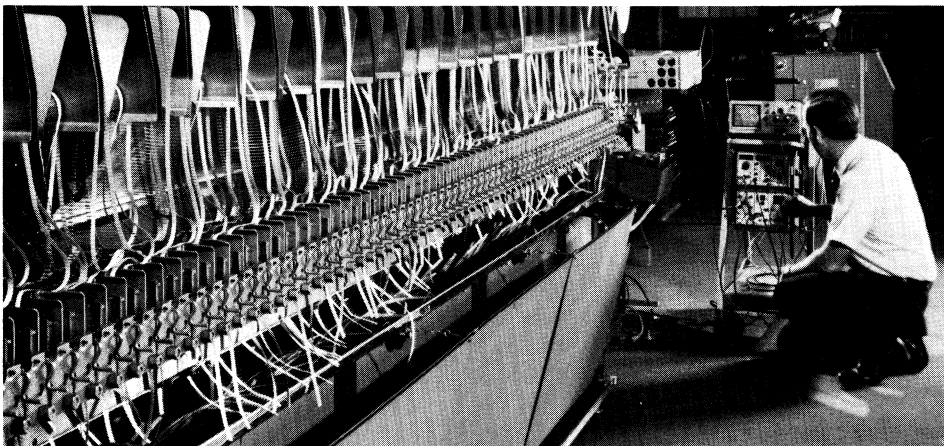
Although TM 500 equipment is quite sophisticated, it has been designed with human factors in mind. Color-coded front panels, standardization of connectors, and easy-to-read digital displays make TM 500 quite suitable for student use. In addition, the actual hands-on experience with commercial equipment is a valuable experience for students who will later be going on to further study or employment.

Service Engineers

With TM 500's extreme portability, you can concentrate on electronics instead of on the logistics of getting test equipment to where you need it. The traveler five-compartment mainframe will go just about anywhere you might have to go, and the measurement power of the TM 500 instruments it carries assures you that you'll rarely have to make a second call because you couldn't make a vital reading.

With a choice of two oscilloscopes, five counter/timers and close to a dozen signal generators, you can pick the level of performance you need. The systems capability of the TM 500 line means that you can also assemble a package for repetitive measurements, allowing you to make routine measurements quickly.

Special units, such as the DD 501 Digital Delay and temperature-measuring DM 502 Digital Multimeter make service work easier and more productive. And the custom interface capability means that you can build that adapter you need right in a blank plug-in, keeping your total measurement package neat and easy to handle.



Section 2 Special Configurations and Applications

One of the major benefits inherent in the TM 500 modular-design concept is the flexibility it offers the user in dealing with specific applications problems. With 30 modules and six power mainframes to choose from, an almost unlimited variety of combinations is available to meet the most difficult and exacting measurement requirements. Add to this the synergistic effect of intermodule connections, digital outputs, and a number of compatible TEKTRONIX Oscilloscopes, Calculators and Special Accessories, and the true extent of the TM 500 modules versatility becomes apparent.

Largely as a result of planning, but also because of customers' alertness to the full potential of the TM 500-Series, a number of identifiable special-purpose systems have appeared on the scene since the line's introduction. Common to all these systems is

functional economy; that is, the packaging of all functions necessary to a particular task or group of tasks in a single, portable or mobile unit results in appreciable savings in space, weight, labor and capital expenditures.

A number of application areas lend themselves especially well to the systems approach. Among these are electronic equipment maintenance, laboratory and industrial instrument calibration, industrial controls calibration and professional/vocational training. In each of these areas, large numbers of tests and measurements must be performed, each possibly requiring a different type of instrument.

By housing these instruments in a common power supply mainframe with an internal connection arrangement, the usual tangle of

power cords and interconnection cables is eliminated. Standardized front-panel markings and controls lead to a reduction in human error. Portability (or mobility in the case of the more sophisticated systems) is enhanced to a degree heretofore unobtainable. Finally, the TM 500 systems or package approach eliminates the necessity for dealing with a variety of suppliers, each with its own sales, service and support policies.

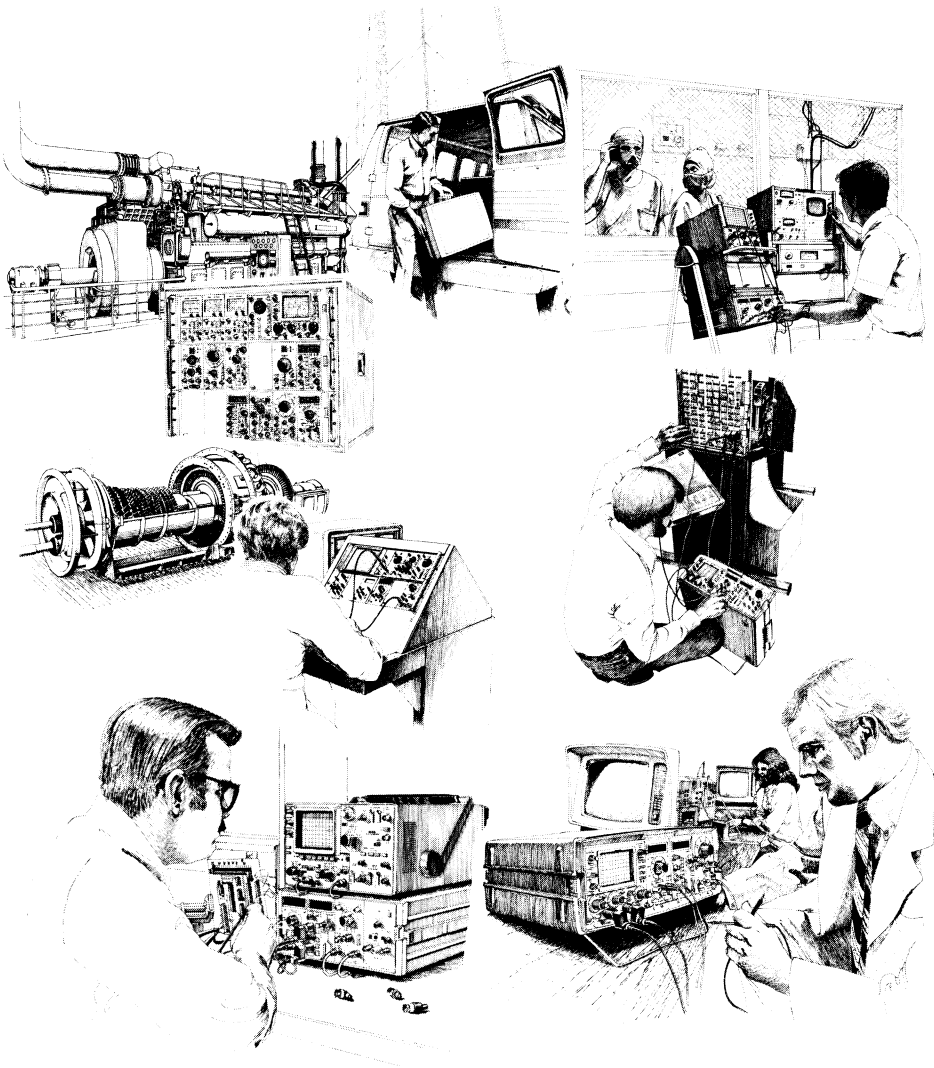
In the pages that follow, a few examples of typical field-tested TM 500 packages are presented. If none of these happens to fit your particular application, consult your local Tektronix field engineer listed on the back cover and he will assist you in analyzing your needs and picking out the most advantageous combination of instruments.

General Purpose Industrial

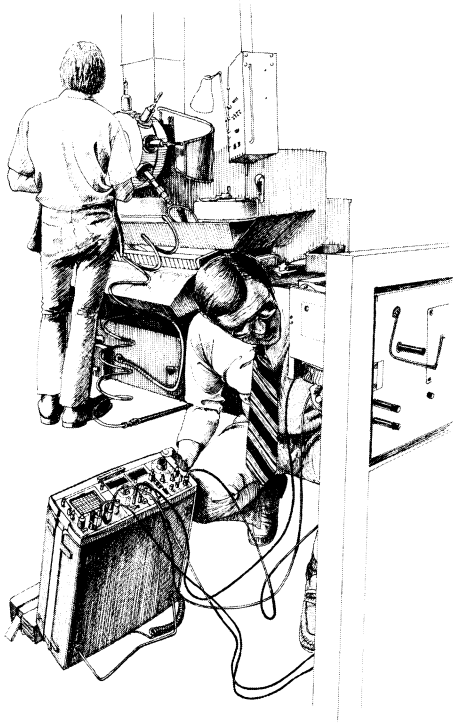
In recent years, electronic technology has rapidly spread into dozens of new applications areas, all requiring design, production, and service professions, all requiring new sophistication in electronic instrumentation. Tektronix recognizes that industry has special needs for test instruments. While *r & d* electronics is often the primary use consideration, TM 500 instrumentation is especially applicable for maintaining electronically controlled machines, and for production control procedures.

The TM 500 General Purpose Instrumentation Systems shown here offer a unique value to industry . . . continuity of instrumentation from *r & d* all the way through field service. Since the plug-in instruments incorporated in a TM 500 Traveler Mainframe for field service may be selected identical to those rackmounted for production control and to those on the lab bench in the design laboratory, identical standards can be readily maintained throughout the development and application of the project.

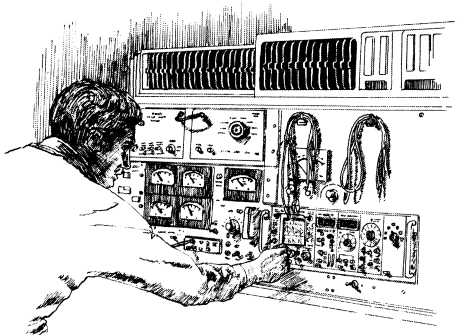
The TEKTRONIX TM 515 Traveler Mainframe is as attractive as fashionable flight luggage, compact enough to "carry on" and slide under an aircraft seat, yet in reality, it's a five-compartment power module/mainframe that provides power and interface connections for TM 500 plug-in modular instrumentation. Plug in the new (two-wide) SC 502 15-MHz dual-channel Oscilloscope, and you have the beginnings of a powerful go-anywhere instrumentation package.



With the TM 515 Traveler Mainframe and SC 502 Oscilloscope as a nucleus; select from DMMs, counters, generators, power supplies, signal processors, and even custom plug-ins with your "home-built" circuits. Intended applications include areas from digital field service to medical, from audio/communications to on-site industrial controls maintenance.



In a rackmounted configuration, TM 500 modular instrumentation offers your QC, production test, or built-in test equipment a highly compact, extensive line of test instruments, designed to work totally independently or as a system. Custom plug-in kits make it easier for you to build in your own testing circuits compatible with TM 500. The RTM 506 rackmounting power module/mainframe (only 5¼" high) provides six compartments to accommodate TM 500 plug-in modular instruments and the plug-in kits. It is available for benchtop or portable use (TM 506) as well as for rackmounting (RTM 506).



A common interface circuit board within the mainframe permits the intercommunication of inputs, output, and various parameters among the plug-ins. Tektronix will supply you with data on voltages, currents, and pin connection diagrams, so you can determine the feasibility of assembling your special circuits in blank TM 500 plug-in kits.

Industrial process control, computer-aided control, numerical control and automated production equipment all pose one major problem that was forgotten by many planners. When something breaks down, the machine cannot be taken to the local tv service shop. While circuit board cards may be unplugged for checkout or service, generally service equipment must be brought to the machine, and it must be the right equipment. The TM 500 mobile test lab allows you to roll an extensive laboratory of equipment throughout your plant. What's more, the modular nature of the TM 500-Series allows you to make up the system that best fits your needs. The pictured rollabout lab (pg. 46) used to service an automatic component insertion machine is typical of a user-made-up system. Some computer-controlled machines contain relatively complex digital circuitry requiring a storage oscilloscope, pulse generators, digital word recognizers, digital delay and even digital data storage. Machines using position servos often need very sensitive instruments with special analog circuits such as differential input amplifiers, filters, ramp generators, function generators, digital multimeters, power supplies and special purpose add point simulators. All of these are available as part of a rollabout lab from Tektronix.

Until recent years, ac power control was accomplished by relays. Malfunctioning relays could be observed visually. Now triacs and SCRs perform these functions, and an oscilloscope plus dc current and voltage measurement capabilities are necessary for design, test, and maintenance. The SC 501 and DM 502 perform these tests. Motor speed control, formerly done mechanically or with rheostats, now also uses triacs or SCRs and needs similar instrumentation. Business calculators were hand-cranked or motor-driven mechanical marvels. Now integrated circuits and light-emitting diode displays do everyone's calculations, and dc voltage and current, resistance, and waveforms must be measured for their design, test, or maintenance. A pulse source may be necessary to clock the logic, and a counter desirable for clock rate measurements. The DM 502, SC 501, FG 503, and DC 504 are all useful in these measurements. As electronic games replace pinball machines, solid-state timers replace motor driven cams in washing machines and traffic signal control boxes, electronic camera shutters and dark-room timers take over photography, and

electronic ignition moves under the hoods of most autos, the need for quality but reasonably priced instrumentation spreads.

The DM 502 Digital Multimeter, especially when equipped with the temperature measurement feature, is perhaps the most versatile basic measurement instrument available. It provides high accuracy, easy to interpret measurements of dc voltage, dc current, ac voltage, ac current, resistance, decibels, and temperature in °C or °F.

The FG 503 Function Generator provides square-wave outputs for use in amplifier transient response testing; by use of the adjustable dc offset and square waves, the FG 503 serves as a pulse generator for logic testing. The triangular waveform is useful for determining overload (clipping) point in amplifiers and as a linear symmetrical ramp for time base use or in testing comparators. In sine wave mode, the FG 503 is a capable audio oscillator and radio frequency generator through the medium frequency ranges to 3 MHz. By applying a ramp to the FG 503's VCF input, it can be made to function as a swept-frequency generator. A suitable ramp is available as a rear output from the SC 501 Oscilloscope.

The DC 504 Counter-Timer measures frequency to 80 MHz, measures period for high resolution measurements in a short time at low frequencies, totalizes events (pulses), and measures rpm from optical or magnetic transducers which provide one pulse per machine resolution. The SC 501 Oscilloscope has a 5 MHz bandwidth, triggered sweep and wide range control of vertical sensitivity and horizontal time per division. The sweep can be triggered from the signal or an external source; thus the SC 501 can make phase measurements and time delay measurements in addition to allowing visual analysis of complex waveforms, signal aberrations, etc.

These wide-ranging measurement capabilities, Tektronix quality and reputation for after-sales support, reasonable prices, and compactness, would be reason for specification of either of these systems even if they were unchangeable non-expandable "monolithic" instruments. When the future expandability via the TM 500 modular plug-in concept is considered, these systems become even more desirable for a myriad of applications.

Counter-DMM Combo

The digital counter and the digital multimeter, both powerful instruments by themselves, form a particularly useful combination when employed together. The interconnection capability of the TM 500 line allows the strengths of this pairing to be realized, while avoiding many of the limitations of either separate stand-alone units or integrated counter-DMM's with only a single display.

Turning a DC 505A Counter plus a DM 501 or DM 502 Multimeter into an integrated system requires only one simple operation. With a simple connection at the rear interface board of the mainframe, the dc trigger level output of the counter is routed to the rear input of the DMM. Now, at a touch of the INT button on the DMM, they become an integrated pair with the DMM displaying the counter trigger level setting.

Trigger-level readout makes measurement of time and frequency easier and more accurate. To make sure correct counter readings are obtained when measuring a signal of known amplitude, the counter triggering point shown on the DMM can be set to a level that you are certain the signal will pass through (for example, +1.4 volts if your measurements will be period, width, frequency, etc. from TTL logic). For unknown signals, the counter trigger level can be rotated through its range, and the extremes of triggered operation noted. Those trigger levels, as displayed on the DMM, will indicate the signal peaks. Set the trigger level to half the peak-to-peak difference for reliable triggering, and for width or interval measurements referred to the 50% amplitude point.

When high performance counter-timers like the DC 505A can provide resolution capability of 0.1 nanosecond (using averaging), even fast rise and fall times become significant. Full precision can be realized only by making time measurements at the desired amplitude on the signal. If the signal, for example, is a 50 nanosecond pulse with 10 nanosecond rise and fall, the counter could read the pulse duration as ranging from 40 to 60 nanoseconds, depending on where the trigger level is set. Only by knowing signal amplitude and setting the counter to trigger at 50% can the true 50 ns width be measured.

When the counter and DMM are not needed as a pair, the DMM switch can be pushed to EXT and the two instruments become electrically independent. Since they are separate, each with its own display, the DMM can make dc, ac, resistance, or (optionally) temperature measurements while the counter simultaneously measures frequency, time, or counts events. Single combination instruments with shared displays can only be counters or DVM's at any one time.

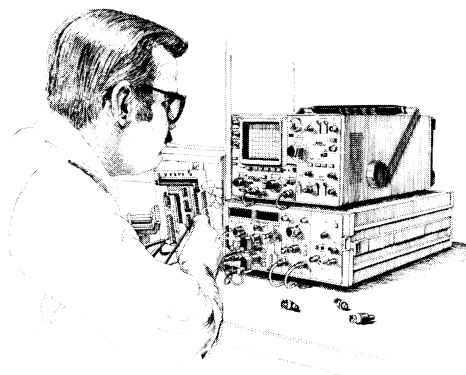
The TM 500 DMM's are full capability instruments—full floating inputs (many dual function instruments have one side grounded) and full functions including dc volts, ac volts, dc current, ac current, and resistance, rather than dc volts only. The DM 502 also offers dB measurement capability on the ac ranges. Both DM 501 and DM 502 have optional digital thermometer capability, with probes for measuring surface and ambient temperatures, and digital readout in °C or °F.

The DC 505A is a Universal Counter-Timer, with a 0 to 225 MHz range, dc and ac coupling, dual inputs, and 7 operating modes (frequency, ratio, period, time interval, width, gated events count, and totalize).

High-Speed Digital Logic Package

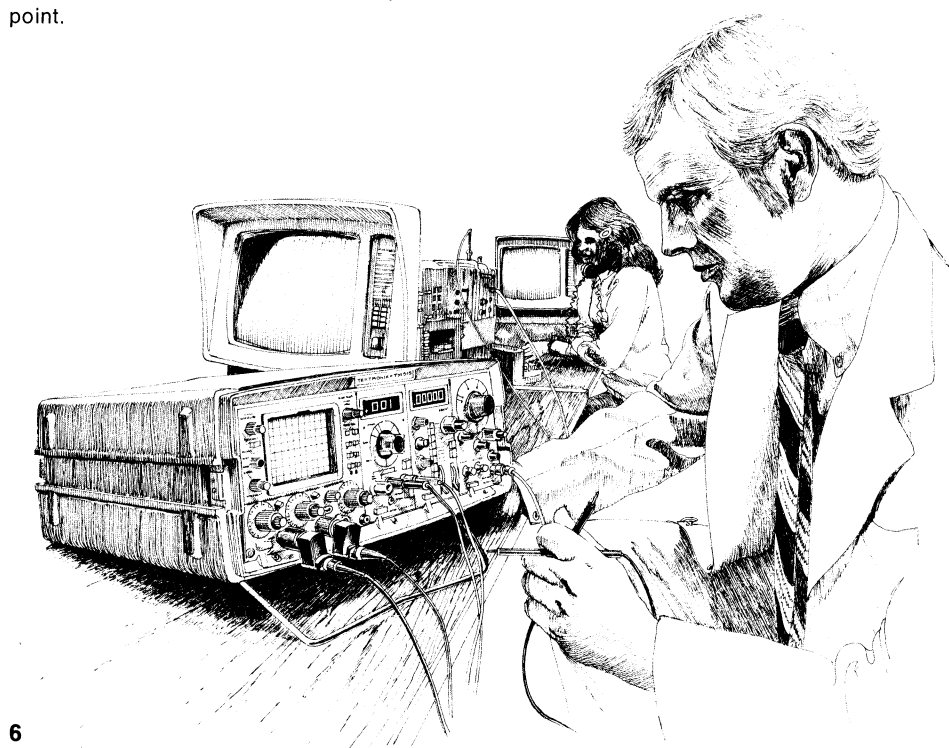
The TM 500 High Speed Digital Logic Package is a specialized selection of instruments with features ideally suited for design and testing of digital logic circuits, especially TTL and ECL.

The package consists of a TM 504 Mainframe, a PG 502 Pulse Generator, a DC 505A Universal Counter, a DM 501 Multimeter, and a PS 505 Power Supply. Each instrument offers features and performance useful in a digital-design environment.



The PS 505 Power Supply provides a floating 3.0 to 5.5 V dc high-current (4 A) output for powering TTL and ECL devices. The PG 502 is particularly suited to high speed logic design and testing, since its unique output circuitry allows independent control of both high and low pulse levels. This allows the design engineer to set the pulse-top-and-bottom levels instantly to the values specified for a particular logic family, or to vary the lower level independently of the upper level to determine noise rejection. This feature, together with the PG 502's state-of-the-art 1 ns rise time and 250 MHz repetition rate, will be especially appreciated by the logic designer.

The DC 505A Universal Counter/Timer features two input channels, direct counting capability to 225 MHz, 10 ns single-shot pulse-width resolution, or 100 ps interval resolution by averaging over repetitive signals, among other outstanding capabilities. It can prove invaluable in the design, development, and maintenance of high speed logic circuits.



The DM 501, in addition to providing all the functions of a conventional multimeter, offers the designer an additional capability—temperature measurement. Using the temperature probe, the designer can test relay drivers and other power devices for excessive temperatures, locate unpredicted hot spots in densely packed circuitry, verify operating temperatures of logic IC's, and monitor outputs for the effects of temperature variation.

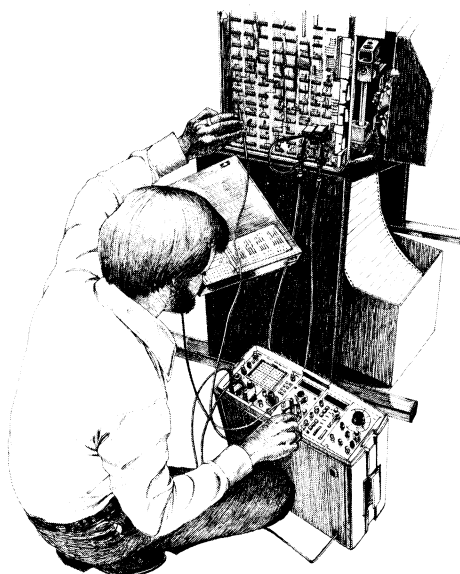
The High Speed Digital Logic Package also offers a strong price advantage over any combination of instruments available in the current market which is capable of delivering comparable performance, features, and accuracy. In addition, any grouping of competitive instruments with comparable performance would also occupy at least three times the space.

It is recommended that the package be used in conjunction with a TEKTRONIX 485 or 7904 high-performance Oscilloscope in order to take full advantage of its capabilities. The 485 Oscilloscope is a 350 MHz portable, dual-trace oscilloscope with a sweep rate of 1 ns/div, and a writing speed of 6.0 div/ns. Alternate switching between intensified and delayed sweeps is included, as is auto-focus, variable trigger holdoff, and automatic deflection factor readout. The auto-focus circuit makes it unnecessary to readjust the focus each time the intensity is changed. The focus will always be correct in single-shot photography. A beam current-limit circuit protects the crt phosphor from high intensity burns.

The 4-plug-in 7904 Oscilloscope is the widest-real-time-bandwidth general purpose oscilloscope available today. For example, with the 7A19 Amplifier, it can display a 500 MHz signal at 10 mV. A 7A19 variable delay option allows the matching of signal transit times of two plug-ins and their probes to better than 50 ps. The P6201 1-times FET probe brings you high impedance and wide bandwidth performance. In combination with the 7A19/7904, it provides a system BW of 450 MHz at 10 mV with 100 K Ω and 3.0 pF loading.

For more information concerning the 485 Oscilloscope or the 7904 Oscilloscope (and its many versatile plug-ins), circle the information card for TEKTRONIX 1975 Products Catalog.

For complete specifications on the individual TM 500 modules, see Section 3, Plug-in Modules.



Digital Service Travel Lab

The digital field service engineer for a modern computer-based system is faced with an ever increasing variety of equipment requiring maintenance, adjustment and repair. The TEKTRONIX Digital Field Service Travel Lab shown here supplies a wide range of measurement capability, yet it is easily carried in its compact, rugged, portable housing. Its luggage styling permits entrance by the front door. Instruments included are the SC 502 Dual-Trace Oscilloscope, DD 501 Digital Delay, DM 502 Digital Multimeter, and DC 505A Universal Counter/Timer.

Typical applications include inspection and repair of disc, tape, drum, and cassette memories, keyboard and graphic terminals, card and paper tape punches and readers, optical and magnetic ink readers, plotters, modems, and more. The utility of a general purpose oscilloscope for computer peripheral and digital system maintenance hardly needs to be reiterated here. The 15 MHz bandwidth of the dual-trace SC 502 Oscilloscope is adequate for nearly all signals in computer peripherals.

The high one-millivolt-per-division sensitivity allows signals to be observed directly at disc and tape heads. Verification of correct codes—section, address, control, etc.—and measurement and adjustment of pulse widths or timing relationships are among other highly useful applications of the SC 502.

When serial data is involved, the DD 501 Digital Delay vastly enhances the utility of the SC 502. The DD 501 provides an output trigger pulse to the SC 502 after N input pulses, with N selectable from 1 to 99,999 by the thumb-wheel switches on the panel. Thus the operator can "walk" down a train of

frame, sector, or sync pulses and examine the ensuing data on the scope with virtually zero jitter, even if the data comes from a motordriven disc or tape with its inherent short-term speed variations.

Modems, terminals, and most other peripherals with data present in bit-serial or byte-serial form can be more efficiently serviced with the DD 501.

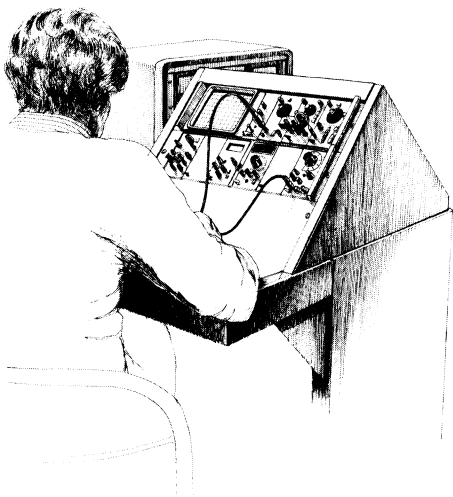
For full parallel or bit parallel, byte serial data, the TEKTRONIX 821 Word Recognizer can be used to generate trigger signals on any present bit pattern.

Available in 4-bit expandable units, the 821's are not TM 500 plug-ins, but their compact size allows them to be easily carried along with other accessories. See the Tektronix general catalog or contact your local engineer for information about the 821.

While the SC 502 Oscilloscope provides timing information along with amplitudes and waveforms, the DC 505A Universal Counter/Timer provides more accurate quantitative values, as well as several other measurements. DC 505A capabilities include 1.5 to 3 nanosecond absolute accuracy and 100 picosecond resolution in pulse width and time interval measurements from nanoseconds upwards. Thus the DC 505A can measure delay lines, clock periods, one-shot pulse widths, and propagation delays across boards. Its frequency measurement capabilities are useful for clock rates and modem and multiplex carrier frequency checks. Period or frequency modes may be used to determine motor or disc rpm in rotating memories. The number of pulses occurring during a gate pulse or between start and stop pulses can also be measured.

The DM 502 Digital Multimeter is a quality, full-function instrument with two important plusses. In addition to the high accuracy and easy readability of most digital meters for dc and ac voltage, dc and ac current, and resistance, the DM 502 features dB and temperature measurement capability. Many digital systems include either analog interfaces or communications links where dB measurements are significant. Direct surface temperature measurement with convenient probe can be a rapid way to locate malfunctioning integrated circuits and power transistors or overloaded motors.

As with most TM 500 systems shown in these pages, other specific combinations of TM 500 instruments may be more suited for a particular application. All TM 500 instruments are freely interchangeable to provide custom-tailored systems, and for dynamic systems which change and grow with changing needs. Your Tektronix field engineer can help you select the best system for your unique requirements.



Educational Instrument Package

The TM 500 Educational Instrument Package is a combination of instruments especially selected for use in the field of education. The instrumentation listed is one of a number of possible combinations suitable for this purpose, and offers many advantages to the electronics instructor.

The potentialities of the modern oscilloscope as a training aid in the teaching of physics, mathematics, mechanical engineering and other disciplines unfortunately have never been recognized universally. The combination of TM 500 modules, used in conjunction with one of Tektronix' broad lines of oscilloscopes, will considerably simplify the instructor's task; it will allow him to generate visual representations of abstract concepts such as differentiation and integration, simple harmonic motion, arithmetic and exponential progression, thermodynamic laws, behavior of gases, nuclear radiation, and others.

Economic benefits are also made possible by concept of the TM 500 group. Individual modules may be rotated among students, thus supplying more unusual instruments only when needed to supplement a smaller basic set provided for each student. This alone has led several prestigious educational institutions to develop training programs in which a carefully selected TM 500 package and a TEKTRONIX Oscilloscope play major roles. Although any of the TM 500 modules have capabilities that lend themselves to educational applications, some of the instruments most likely to be used are:

a. Function Generators

Provide a variety of waveforms over a wide frequency range.

FG 503 recommended for its low cost.

b. Digital Multimeters

Multipurpose instrument required in any electrical or electronics lab. DM 502 recommended for its low cost.

c. Power Supplies

For powering breadboarded projects, performing basic dc circuit analysis and other experiments requiring external power. Any of TM 500 power supplies is suitable.

d. Operational Amplifiers

Can be used as integrator, differentiator, high or low gain amplifier, etc. AM 501 recommended.

e. Pulse Generators

Essential in study of logic circuitry. PG 505 recommended for low cost.

In order to take full advantage of the TM 500 training potentialities, the instructors need not rely entirely on their own inventiveness. The services of their local field engineers and the cooperation of the entire Tektronix organization are at their disposal to help them find the most economical and effective solution to a particular educational application. Educators are encouraged to consult freely with these sources in selecting the configuration of TEKTRONIX products most suitable for their particular needs.

For complete details and specifications on the individual modules comprising the Educational Instrument Package, see Section 3, Plug-in Modules.

Medical Instrumentation Calibration System

The repair and calibration of electronic equipment for medical diagnosis, therapy and research increasingly call for a wide selection of test and measurement equipment ranging from the most basic to the highly sophisticated. The TEKTRONIX Medical Instrumentation Calibration System is a compact, modular, flexible and portable system of test and measurement instruments which can be individually tailored to meet the repair and calibration needs of each separate installation.

The basic configuration of the TEKTRONIX Medical Instrumentation Calibration System is a special SCOPE-MOBILE®, carrying an oscilloscope and two TEKTRONIX TM 503 mainframe power units (pg 45). The mainframes accommodate the modular plug-in instruments, which can be any of the more than 30 units in the expanding TM 500 line of test and measurement products. Typical plug-ins which might be selected are digital multimeters, function generators, frequency counters, amplifiers, and power supplies.

The compactness and mobility of the MICS is a significant advantage. For repair or calibration of permanently installed equipment, a full selection of instruments can easily be brought to the job site, and the convenient mounting eliminates the need to find accessible surfaces on which to put everything. Even when testing and repairs are performed in the lab at adjoining workbenches, it is easier to roll MICS into place than constantly move large, heavy, separate instruments.



Although both the specific requirements and the instruments selected vary at different locations, several examples of the uses of a fairly sophisticated system and the needed modules are given below.

A typical MICS System consists of:

- a. **Storage Oscilloscope** (i.e., TEKTRONIX 434 or equivalent), a dual-trace oscilloscope with bistable storage capabilities, portability, and 25 MHz bandwidth.
- b. **DC 503—Digital Counter**, capable of measuring frequency, period, frequency ratios, and time between electronic events. Also totalizes electronic counts.
- c. **DM 501—Digital Multimeter**, measures ac/dc volts, ac/dc current, ohms, temperature (Fahrenheit or Centigrade).
- d. **TG 501—Time Mark Generator**, providing time mark outputs at intervals from 5 seconds to one nanosecond.
- e. **AM 502—Differential Amplifier**, with variable gain and selectable high and low pass filters.
- f. **RG 501—Ramp Generator**, producing positive or negative ramps of duration from 10 microseconds to 10 seconds, amplitude from 50 mV to 10 V.
- g. **FG 501/FG 502—Function Generator**, producing sine, square, triangle, pulse and ramp waveforms, with voltage-controlled frequencies variable from 0.001 Hz to 1 MHz (FG 501) or 0.1 Hz to 11 MHz (FG 502).
- h. **TM 503 Power Mainframes** to support individual instruments.
- i. **203 SCOPE-MOBILE® Modified Cart** for mounting and powering items a-h.

Oscilloscope

The TEKTRONIX 434 Dual-trace Portable Storage Oscilloscope is often recommended for MICS use. With a bandwidth of 25 MHz and a deflection factor of 10 mV per division, it provides ample capability for most of the measurements likely to be required in medical electronics service and calibration.

Another commonly selected unit is the 5441. This unit provides the flexibility of a main-frame and plug-in configuration in a moderately priced system. It features variable persistence storage, provision for crt read-out of amplifier and time-base settings and bandwidths up to 60 MHz. Three slots are provided for plug-in units from the more than twenty available for the 5000-Series oscilloscope family.

Many other TEKTRONIX Oscilloscopes, from hand-held 200-Series units to the precision laboratory 7000-Series, can also be selected for more specialized systems. A Tektronix field engineer can provide information about the best selection for any particular circumstance.

One of Tektronix' line of SCOPE-MOBILE® carts serves as a mobile mounting for the MICS system. The SCOPE-MOBILE's® upper tray carries the oscilloscope while two TM 503's, each housing three modules, are located under the tray, thereby placing all the controls of the oscilloscope and six modules within easy reach.

The MICS system is so flexible and versatile, the tasks it can perform cannot be listed fully. However, some of its typical, field-proven capabilities are:

EEG's and ECG's

These systems amplify extremely small voltage differences and plot the results on a display screen or chart recorder. A differential amplifier module with high common mode rejection (AM 502 Differential Amplifier) is necessary to look at signals in the initial amplifiers, or to substitute for malfunctioning sections. Timing of the sweep or chart speed requires a pulse of a specified degree of accuracy (from an FG 501 or FG 502 Function Generator or TG 501 Time Mark Generator module).

General repair and calibration often call for a multimeter (the DM 501 or DM 502 Digital Multimeter), a dual-trace storage oscilloscope (TEKTRONIX 434, 5441, or similar unit), and function generator (FG 501 or FG 502 Function Generator).

Patient Monitors

In addition to ECG and EEG information, patient monitor units usually provide for additional channels for such body functions as blood pressure, peripheral pulse, respiration rate and temperature. Many of the same test and repair problems are encountered, and therefore the same instruments are used as with the EEG's and ECG's.

Needed are the AM 502 Differential Amplifier, FG 501 or FG 502 Function Generator, DM 501 or DM 502 Digital Multimeter, and the 434, 5441, or a similar TEKTRONIX Dual-trace Storage Oscilloscope.

Chart Recorders and Display Units

Linearity of the drive or sweep and amplifier fidelity are the critical factors for chart recorders and display units. A time mark generator (TG 501 Time Mark Generator) or a function generator (FG 501 or FG 502 Function Generator) provides a signal for the linearity check. The TEKTRONIX TG 501 Time Mark Generator will also display the existing timing error if desired.

For repair of the amplifiers in chart and display units, a wide selection of general test equipment is usually required. This includes a multimeter (DM 501 or DM 502 Digital Multimeter), function generator (FG 501 or FG 502 Function Generator), and dual-trace oscilloscope (TEKTRONIX 434, 5441, or similar unit). A known working amplifier (AM 502 Differential Amplifier) is often necessary for making comparisons with suspect sections of defective equipment.

X-Ray and Cardiac Unit Control Systems

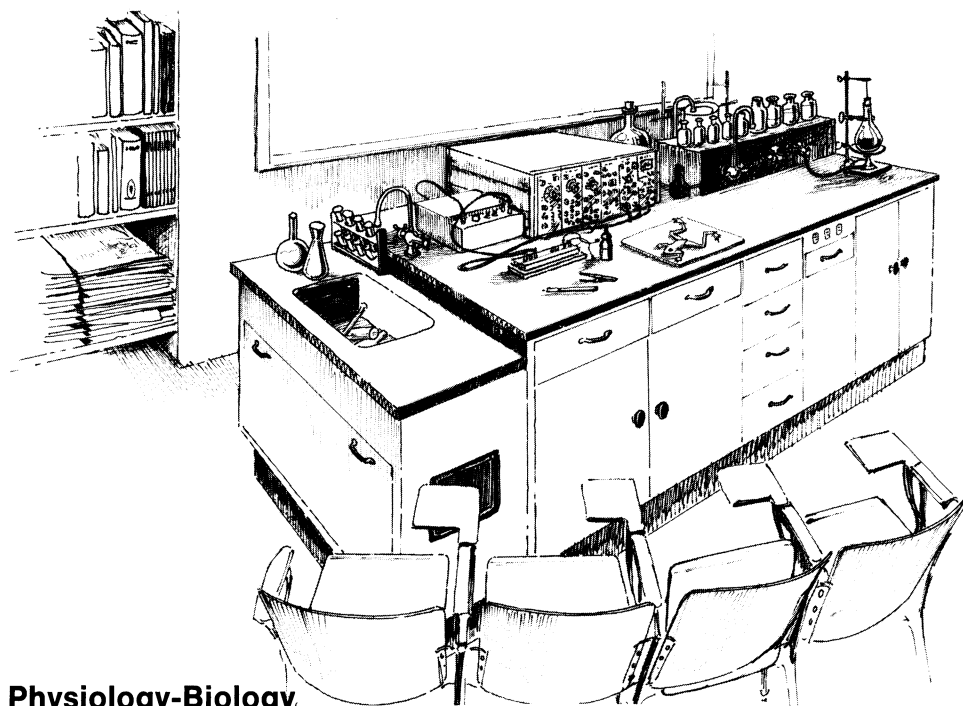
Most sophisticated medical electronic systems, from cardiac resuscitation (crash carts) units to x-ray facilities, depend on complex control and sequencing units. In addition to regulating order, amplitude and signal shape, these units often control precise timing and feedback functions. They may contain combinations of analog and digital circuits, with both low and high frequency components.

A complete range of equipment may be needed to calibrate or repair such a unit. Often called for are a multimeter (DM 501 or 502 Digital Multimeter), storage oscilloscope (the 434, 5441 or similar Tektronix unit), time mark generator (TG 501 Time Mark Generator), and counter/timer (DC 503 Universal Counter/Timer).

Other uses for the MICS System include:

1. Checking frequency and amplitude of radio-frequency equipment.
2. Testing pacemakers to detect incipient battery depletion.
3. Powering physiological transducers.
4. Testing ultra-sonic and echo-sounding equipment for frequency and pulse-echo intervals.

For a more complete description of the MICS System and its applications, circle the literature request card for the "Medical Instrumentation Calibration System" brochure (A-3152).



Physiology-Biology

TM 506/RG 501, PG 505, AM 501, AM 502, MR 501

Many physiological and biological experiments call for electrical stimuli, plus measurement of an evoked electrical response. The TM 500 line is well suited to these uses, since it includes both signal sources and measurement and display units.

This particular package provides a complex waveform plus selective amplification of the response, both of which can be displayed on the included monitor. Using TM 500's internal interconnection capability, all wiring between units can be done inside the main-frame minimizing front-panel clutter.

The RG 501 Ramp Generator provides a voltage signal which supplies timing information to two PG 505 Pulse Generators. It can be run in the repetitive mode, or in single sweeps if triggered by the appropriate input, such as the TEKTRONIX Manual Trigger Generator. Each PG 505 Pulse Generator can then be set independently for starting point on this ramp, amplitude, rise time, fall time, and polarity. The output pulses of the two pulse generators are summed by the AM 501 Operational Amplifier, permitting the construction of complex waveshapes such as paired stimuli, pulses or pedestal voltages, or waveforms triggered by independent inputs. The op amp can be set to yield a high or low output impedance, and will also drive a stimulus isolator if the experiment requires that additional degree of protection (pg 23).

While in the process of "building" the required waveform the MR 501 is used to display the output of the AM 501. The same

ramp signal out of the RG 501 that provides the delay reference for the pulse generators is also used to provide the sweep waveform to the MR 501. In this way time relationships are set so that each crt sweep shows one complete stimulus cycle.

The return data (the evoked response signal) is analyzed by using the AM 502 high gain Differential Amplifier as the signal conditioning amplifier and applying its output signal to the vertical input of the MR 501. The AM 502 is capable of selectable gain of 1 to 100,000 and features selectable high and low frequency filtering. The MR 501 with dc to 2 MHz response, provides full display capability for virtually all common biophysical signals.

Since laboratory work surface area is at such a premium in most institutions, the space saving properties of the TM 500 system will be of significant benefit to the user. In addition, elimination of the coils of multiple power cords running from the stacks of single instruments which this unit replaces is made possible by the TM 506's single shared primary power supply. If your application calls for a rack mounted installation, the rack mounted version (RTM 506) occupies only 5.25 inches vertically in a 19-inch rack.

For complete details and specifications on individual modules comprising the biological/physiological stimulation system see Section 3, Plug-in Modules.

Audio Instrumentation Package

The requirement to make tests and measurements on audio frequency equipment or components is spread throughout many industries. Telephone communications, audio-encoded data transmission, telemetry, command and control, broadcasting, recording, public address and sound reinforcement systems, and intercom systems are only a partial list. Most of these measurements must typically be made on location, and a compact, portable system that can also be used in the field or on a bench has obvious benefits.

The TM 500 Audio Instrumentation combination includes the SG 502 low distortion Audio Oscillator, DM 502 dB reading Digital Multimeter, DC 504 Counter with both frequency and period measurement ability, and SC 501 miniature Oscilloscope for waveform display and evaluation of dynamic peaks. Other TM 500 instruments may be added or substituted for particular applications.

The unique internal interconnection feature of TM 500 is especially useful in the audio package. Among the most common audio tasks are measuring gain, loss, and frequency response of amplifiers, attenuators, filters, and transmission lines. Using a main-frame with the jumper-connection option, you can conveniently connect the rear input of the DMM across the rear output of the audio oscillator.

Now, with the oscillator front-panel jack driving an external device and the output of the external device monitored by the DMM, you can make gain, loss, and response measurements without any cable transfers. With the DMM input switch in the INT position, you are monitoring oscillator output level. In the EXT position you are measuring output of the external device. Assuming that the DM 502 is in dB mode, the difference between the two readings is the gain or loss of the device. Audio oscillator frequency may be displayed on the DC 504 Counter.

Many individual TM 500 instruments are particularly suited to audio work. The SG 502 is a 600 ohm instrument with up to 70 dB of switched attenuation plus a variable control to provide outputs from volts to the sub-millivolt level. Distortion is an extremely low 0.035% over the audio range, and 0.3 dB flatness permits response checks without re-verifying generator level. The DM 502 dB mode can be referred to either 1 milliwatt in 600 ohms (dBm) or 1 volt (dBV) via internal switch; dynamic range in either case is from -60 dB to approximately +56

dB (500 volts rms). On any one setting of the range switch the instrument covers 40 dB dynamic range, and the 20 dB overlap of adjacent ranges allows selection of one switch setting which will cover the needs of most typical applications without frequent re-setting of the switch. Additionally, and quite unusual for dB-reading digital meters, the DM 502 is a full-function DMM with dc and ac volts, current, resistance, and temperature option for a multitude of other testing in equipment and systems.

The DC 504 features both frequency and period measurement modes. Counters which measure only frequency become quite limited in resolution and accuracy at low frequencies; for example, a 9 Hz tone can be displayed only as 9 Hz (± 1 Hz) in a reasonable one-second measurement interval. By switching to period mode, this same 9 Hz tone could be displayed as 111.11 milliseconds, ± 10 μ sec, in much less than a second. If necessary, this period could easily be converted to a frequency of 9.0000

by a quick $f = \frac{1}{T}$ calculation (made even easier with the now ubiquitous pocket calculator).

The SC 501 Oscilloscope features good sensitivity (10 mV/div), triggered sweep, and 5 MHz bandwidth. It permits visual analysis of waveforms for possible peak clipping, observation of peak-to-average ratios on actual voice or program material, and similar hard-to-qualify parameters.

Other TM 500 instruments which would prove useful in certain audio applications include the AM 502 Differential Amplifier for use as a pre-amp ahead of the DM 502 or SC 501; AF 501 Bandpass Filter, to function as a frequency-selective voltmeter with a scope or DMM; any of the FG 50X Function Generators, to supply triangular waveforms for easy measurement of amplifier clipping point plus square waveforms for transient analysis; and the FG 501 or FG 502 plus a PG 501 Pulse Generator for tone burst generation for loudspeaker and room reverberation testing.

Communications Service Travel Lab

Tektronix' unique Travel Lab concept provides a powerful tool for the communications field service engineer, installer, or maintenance technician. Modern electronics communications systems require a wide variety of measurements during installation, adjustment, alignment, and troubleshooting.

The Travel Lab, carrying five TM 500 instruments in a rugged attache-case styled mainframe, brings the full power and flexibility of the modular TM 500 line to service applications, whether the need is down the corridor, in a central office, or halfway across the country.

By the very nature of their objectives, most communications systems are geographically dispersed. Switching centers, satellite receivers, mountaintop repeaters, relay stations, remotely controlled transmitters in cow pastures, "antenna farms" atop tall buildings, and similarly located communications facilities are a way of life in the industry.



That's why the compact construction and rugged packaging of the TM 500 Communications Travel Lab is such an important advantage. The unitized mounting allows the easy handling of several needed instruments at once, yet the design of the TM 500 line permits the user to operate each instrument individually or, several together as a combination.

Typical measurements required in communications service that can be made with TM 500 instruments include high-accuracy measurements of rf carrier frequencies and sub-carrier frequencies; frequency response and bandwidth of voice links, telephone lines, amplifiers, and filters; audio tone level measurements; generation of test tones of precisely known level, frequency, and low

distortion; amplifier and system gain; filter or attenuator loss; examination of waveforms from microphones and other audio sources through preamps and mixers to modulators; audio phase shift measurements; sweep alignment of filters and discriminators; and dozens of other similar procedures. Typically, these measurements require several different types of test and measurement instruments.

Individual selections of TM 500 instruments for each application are possible, or even the selection of a varied stock out of which several instruments are chosen for each particular task. However, most applications can be covered by a basic configuration.

The particular Communications Service Travel Lab suggested includes the SC 502 Dual-Trace Oscilloscope, DM 502 Digital Multimeter with dB feature, SG 502 Audio Oscillator, and DC 502 550 MHz Frequency Counter, all enclosed in the rugged TM 515 Traveler Mainframe. The entire system is easily transported to the action spot — whether the transportation mode is commercial airline or pickup truck. The rugged design and moisture and dirt resistance of the Traveler Mainframe protects the instruments until needed, yet they can be placed "on the air" in seconds.

This particular combination allows fast and accurate measurements of most audio and rf carrier parameters. Subcarrier and carrier frequencies through VHF and into UHF (550 MHz) can be measured, covering most of the presently-used mobile communications, marine, aviation, and broadcast frequencies. Audio test tones can be generated with step attenuator control of levels down to sub-millivolt (< -60 dBm) levels. Audio tone level measurements, including modem and remote control system applications can be made in dBm or dB referred to one volt. In addition, all the basic dc and ac voltage and current plus resistance measurements are provided for times when circuit troubleshooting becomes necessary.

The specific system suggested is only one of dozens of practical variations that may be selected by the user, depending on the specific equipment and systems to be serviced. You might choose, for example, to substitute an FG 502 Function Generator for the SG 502 Audio Oscillator. This exchange trades the dB-calibrated step attenuators, sub-millivolt output, and 0.035% distortion of the RC type SG 502 for 0.5% distortion audio and rf signal generation from 0.1 Hz to 11 MHz; pulse generation for logic and data

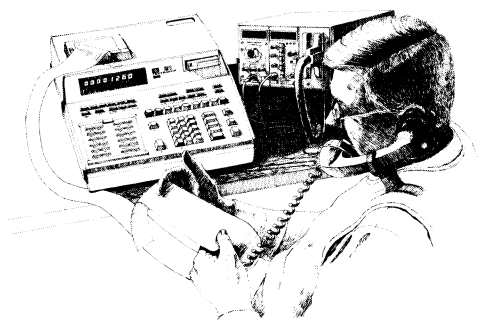
communications equipment; triangles for determining clipping points of amplifiers; and synchronous sweep capability to provide a complete filter alignment, discriminator alignment, and audio and video response measurement system (when driven by the ramp output of the SC 502 Oscilloscope). Another possible variation would be the use of a DC 505A Universal Counter-Timer rather than the DC 502 550 MHz Counter. While the 225 MHz limit of the DC 505A restricts its use to VHF-and-below rf carriers, it provides many other features of particular value in data communications, pulsed signals, time division multiplex, and other applications. The DC 505A's period mode and fast clock rate provide high-resolution measurements of pulsed tone frequencies and carrier bursts. Width and time interval modes are extremely useful in adjustment of data communication or time division multiplexing frame widths and critical timing relationships. Ratio mode is ideal for adjusting an oscillator to equality with another reference signal. A high-speed gated totalize mode allows verification of the number of pulses occurring during the presence of a gate signal.

Custom Selection and Interchangeability

Comparison of the user's needs and the TM 500 instrument specifications in this catalog can lead to custom-designed communications tests sets of many varieties. The quick plug-in interchangeability of TM 500 even makes it practical to stock a wide variety of instruments at the shop or in a van and to quickly outfit the TM 515 Traveler Mainframe only with those needed for a particular job right on the spot.

The 31/53 Calculator Instrumentation System

In the TM 500 Modular Test and Measurement Instruments, Tektronix has provided science and industry with some of the finest data acquisition instrumentation available in today's market. However, the acquisition of data is only the first step in the solution of a complex problem in many typical applications. Often data must be stored, perhaps converted to different units, and then mathematically operated upon to yield the desired results. It is almost a reflex reaction to turn to the minicomputer for a solution. However, minicomputers are expensive, and often not the best available choice.



Concurrently with the development of the TM 500 modular line, Tektronix has also developed the Tek 31 Programmable Calculator. This calculator has the memory and capability for processing up to 8192 program steps, 1000 data registers and a magnetic tape auxiliary memory.

Any counter, counter/timer, or multimeter signal acquired by the TM 500 instruments can be captured, measured, and fed to the calculator for processing. These include measurements of time, frequency, temperature, events, voltage, current, and resistance. Also, through the use of transducers, such physical quantities as pressure, displacement, motion, strain, force, sound, physical and chemical composition, and many others can be measured, converted to appropriate units, and operated upon mathematically. Statistical analyses like averaging, frequency distribution, grouping about the mean, curve fitting, etc. can be performed, with readout in whatever units are desired. Data conversion, data logging and permanent storage on tapes are also routine functions of this system.

The calculator is the computational center of the system. It is connected to the TM 500 modules by its 153 Instrumentation Interface. This unit transmits to the calculator all data displayed on the module's digital displays.

The other TM 500 mainframe compartments can be used to house any TM 500 unit with BCD interface. A common selection is one of the several possible combinations of the DM 501, DC 501 (Option 4), DC 502 (Option 4), and DC 503 (Option 4), or DC 505A (Option 4) as desired.

With 35 math functions available on the keyboard there is no need to work with abstract assembly languages. The natural math hierarchy makes programming an easy task. Full editing, subroutines, decision-making capability, magnetic tape control, trigonometric and hyperbolic functions, (and their inverse), logarithm, and exponential functions, plus many others are standard with the Tek 31. Furthermore, with the optional alphanumeric thermal printer, the Tek 31 will instruct the operator when to insert pertinent data from the keyboard, when to connect extra equipment or turn off other instruments.

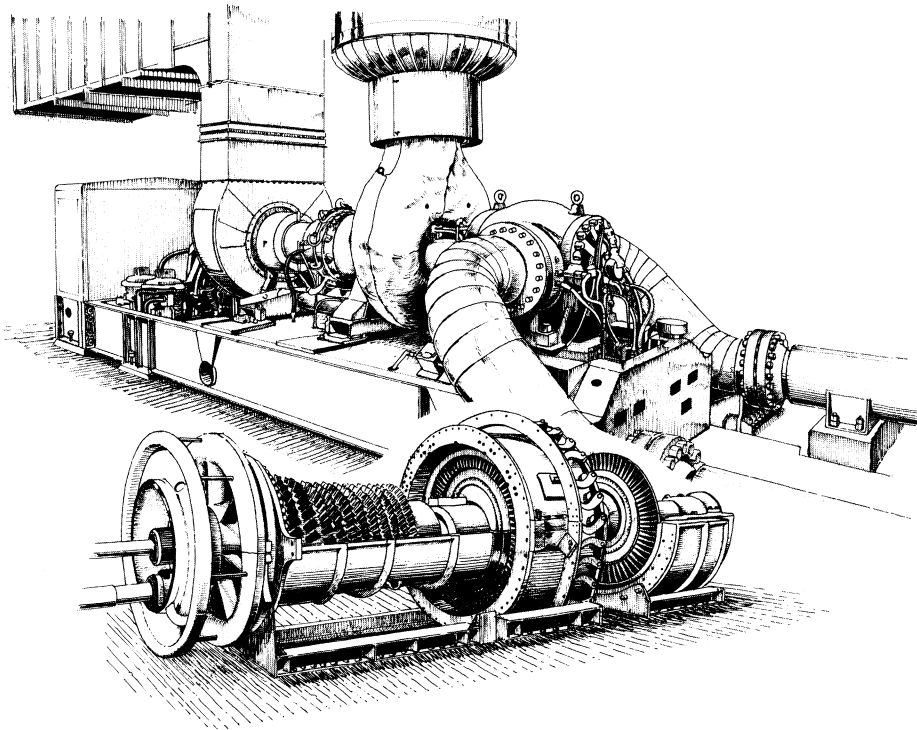
As an added attraction, when the TM 500 package and Tek 31 are not operating as a system, either can be used as separate units for the routine tasks for which they were designed. This capability naturally increases the cost effectiveness of the system.

Mechanical Measurements

Preventive maintenance is increasingly important as production processes become more closely linked into connected systems. Delivery times for even simple replacement parts often stretch to months and major sub-assemblies can take more than a year to produce; often the new parts cost five to ten times the cost of the original ones. Even where continuing operation is vital, redundant machinery is usually just too expensive or not available.

The way to avoid being surprised by sudden outages is to conduct periodic performance monitoring, examine the trends this data indicates, and perform preventive maintenance. Tektronix offers several TM 500 units as part of its wide range of electronic instrumentation equipment designed to measure, qualify, and diagnose mechanical systems. Some instruments may be used alone for jobs as simple as bearing monitoring, or several may be combined for in-place balancing equipment or sophisticated engine or turbine analysis systems. Some of the systems are enhanced by calculator and computer data reduction or control.

Mechanical measurement problems cover a wide range of parameters, and each situation may be very much different, making custom instruments for each application almost a must. The TM 500 family of modular test and measurement instruments is an almost ideal vehicle for this. Using TM 500's modularity, the right selection of instruments can be assembled for each job, with necessary changes for each new task made in seconds. Although the possibilities are virtually endless, the following paragraphs give



some short descriptions of a few of the many TM 500 combinations that can be put together for mechanical measurement applications.

Rotary Machine Balancing

A simple oscilloscope-based machinery balancing system utilizing the "Thearle" dynamic balancing technique can be assembled in the TM 515 Traveler Mainframe, using the SC 502 Oscilloscope, two AF 501 Band Pass filters and a DC 504 (rpm) Digital Counter. Signals from horizontal sensitive seismic transducers are filtered through the AF 501's and displayed on the two traces of the SC 502.

The shaft rotational angle or mechanical phase signal from a magnetic transducer is connected to the DC 504 for rpm measurement and to the "external sync" of the SC 502 sweep circuit to freeze the display independent of speed. The AF 501 filters eliminate unwanted background noise and higher order vibration signals from the balancing data display without introducing display data phase shifts which would contribute errors. With this system you can obtain the data right off the screen to make "Thearle's" calculations manually or if you desire, may use a simple automatic interactive program in the TEKTRONIX 31 Calculator. (A complete Balancing Rotating Machinery Application Note is available—contact your local Tektronix field engineer or write directly to Tektronix, att: Bill Vesser.)

Turbine Vibration and Performance Testing

TM 500 system modules may be combined into performance testing systems that may be used to make critical turbine monitoring and vibration tests. In addition, the TM 500 units may be used to calibrate the turbine's permanently-installed meters and monitors. A typical TM 500 Turbine analysis system for small turbines analysis could be made up from the following modules mounted in the portable TM 515 Traveler Mainframe:

AM 502 Differential Amplifier

AF 501 Band Pass Filter

DC 504 Digital Counter

DM 501 Mod 718D* Digital Voltmeter (high sensitivity)

PS 501-1 Mod 730E* Transducer Power Supply

The AM 502 has very high gain with wide bandwidth and separately controllable high and low pass filters. Dry frictionless bearing noises cover a wide range of frequencies which are masked by machinery ambient noises until it is too late. By setting up the filter on the AM 502 you can eliminate the lower frequency noises and "listen" only to the ultrasonic noises which give an early warning of trouble. The combination of a strain gage pressure transducer, the PS 501-1 Mod 730E* Transducer Power Supply

and the DM 501 allow a compressor inter-stage pressure measurement system of a very high resolution and good accuracy. When combined with the appropriate thermocouple compensation unit the DM 501 Mod 718D* allows a highly accurate temperature measurement unit for absolute and differential temperatures. The DC 504 is used to indicate the spool rpm and the AF 501 is used to band pass filter the "times one" vibration components to spot spool unbalance whether dynamic or load sensitive.

Many other forms of turbine analysis or turbine instrumentation calibration systems may be made of standard TM 500 modules to fit each turbine installation situation. In twin spool turbines, the DC 503 counter can be used to measure speed ratio of the two spools. In power turbine applications this also is desirable for load analysis.

Torsional Vibration Measurement

Similarly, a simple set up utilizing corresponding TM 500 modules, some component parts, and a machine tool shaft encoder can be used to measure the torsional vibration velocity and acceleration caused by misaligned shafts, U-joints, couplings, gear boxes, etc.

Gas Compressor Performance Analysis

The ability of the TM 500 modules to interface to both pressure and temperature transducers facilitates both static and dynamic compressor performance analysis. Automatic computation using a TEKTRONIX Programmable Calculator with a 153 Calculator Interface, or using a Digital Processing Oscilloscope, can also be employed instead of using manual computation methods for analysis.

Large Piston Engine Analysis

Various forms of engine analyzers for diesel, mixed fuel or pipeline gas-fueled engines can be made up from TM 500 modules and the appropriate TEKTRONIX Oscilloscope. The possible units range from a simple ignition and timing analyzer, or a vibration-timing analyzer up through complete computerized units. The TEKTRONIX Rotary Function Generator may be powered from a PS 501-1 Mod 730F* RFG Power Supply to form the basis of a system with timing mark displays, pressure-volume displays, shaft angle controlled axis display as well as the normal oscilloscope time based display.

*For price and delivery information on modified instruments, see your local Tektronix field engineer.

Multi-Channel Monitoring

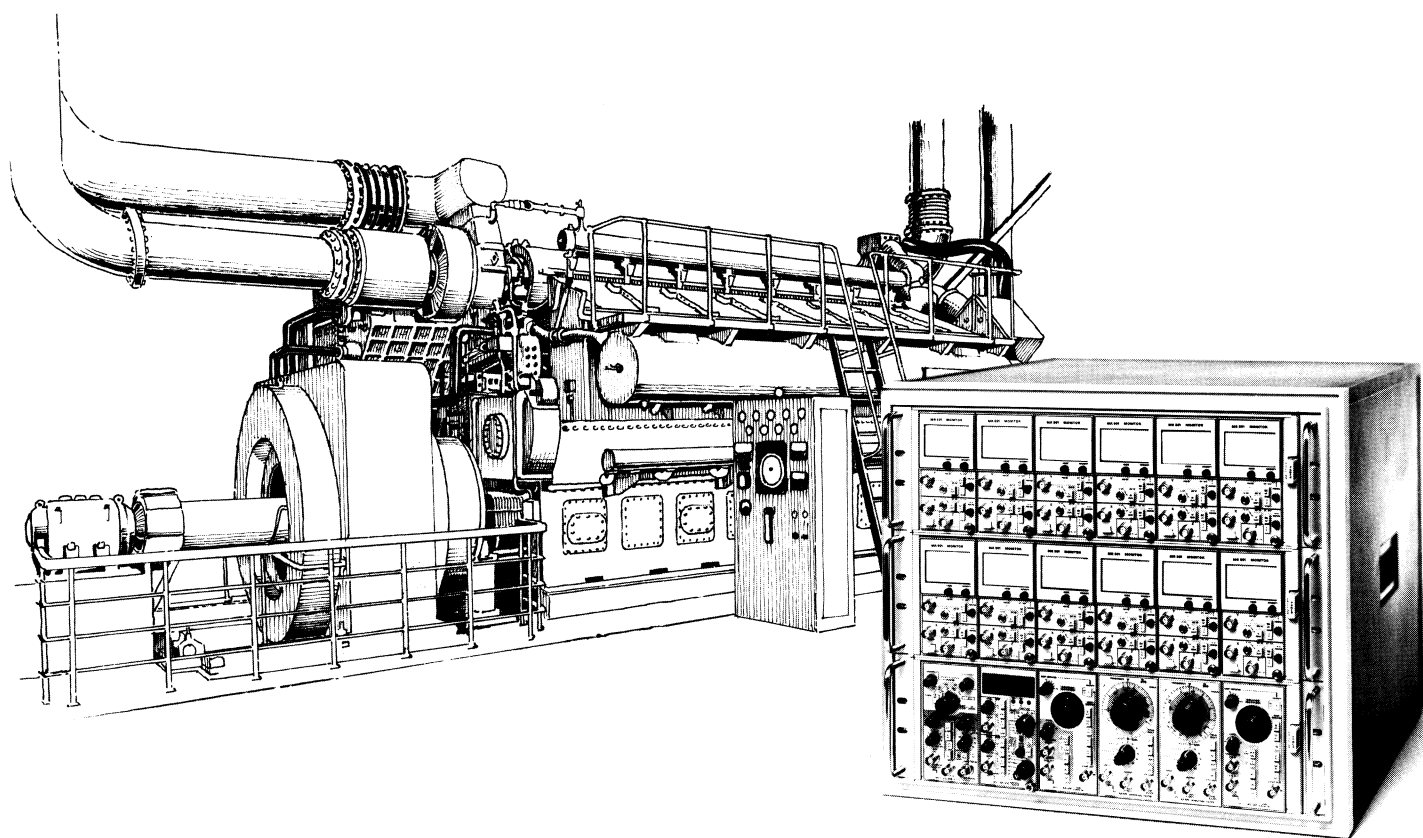
Dynamic testing of turbines, telemetry systems, multiple-track stereo recording, and sophisticated sound reinforcement systems all have one thing in common—the need for simultaneous monitoring of multiple signals to assure proper levels, absence of overload, and continuity of the system from transducers through cables, amplifiers, etc. When many channels of data or program material are involved, the monitors must be physically compact to permit one operator to simultaneously observe them. While analog meters may be sufficient for some types of signal monitoring, the cathode ray tube has the advantages of simultaneously indicating amplitude, frequency, waveshape, signal-to-noise ratio and instantaneous peak response.

A TM 500 system of rack-mounted MR 501 X-Y Monitors or SC 501 Oscilloscopes may be an ideal solution to many multi-channel signal monitoring applications, particularly when other TM 500 instruments may be included in the same system for purposes such as rpm indication, selective filtering of certain vibration components, continuity checks, or generation of test signals.

Engines, turbines, pumps, generators, and other large rotating machines must frequently undergo dynamic testing during their design stages or in qualification tests. Such a test is frequently instrumented with multiple transducers strategically located throughout the machine to monitor vibration, stress, temperature, and other important parameters. The analog data from these transducers is often recorded on multi-channel magnetic tape for later analysis, sometimes by computers. The expense of such testing makes it highly desirable to take precautionary steps to assure presence and quality of the analog data; one cable damaged during a last-minute inspection could destroy the value of the test if not observed and corrected in time. In this sort of machine testing application, the frequency of the signals from most transducers are related to the machine speed. A monitoring system consisting of a single time base (RG 501 Ramp Generator) driving the X-axis inputs of multiple X-Y monitors (MR 501s) is usually most appropriate.

When the signals are substantially independent, as might be true in an industrial telemetry situation, multiple SC 501 Oscilloscopes may be more desirable. Each oscilloscope time base may then be set independently to the optimum time per division and each will be independently triggered by the signal applied to it.

Other carefully selected TM 500 instrumentation can often be used to complete the measurement system, retaining the compact convenience and neat appearance of the system. In addition, units can be wired together through their rear interfaces, keeping cable clutter to a minimum while permitting various instruments to work together. Examples of instruments which might be added include a PG 506 Calibration Generator and TG 501 Time Mark Generator for time calibration; a DM 502 Digital Multimeter for dc level calibration, continuity checks, and audio frequency level measurements in decibels; a DC 504 Counter-Timer with direct rpm measurement capability; AM 502 Differential Amplifiers for use as transducer signal conditioning amplifiers, and an SG 502 Audio Oscillator or FG 501, FG 502, or FG 503 Function Generators as test signal sources. Special interfaces and functions required by the system can be mounted in physically compatible TM 500 Custom Plug-In Kits.



Oscilloscope Calibration Package

The cathode-ray oscilloscope is one of the most important electronic test instruments in use today. It provides more information on amplitude, time or frequency, waveform aberrations, interference, and signal-to-noise ratio at a glance than any other instrument. However, like any complex instrument, the oscilloscope requires periodic performance verification . . . and adjustment or repair, if the verification tests show performance is outside of specifications. Then, the virtues of the oscilloscope become added demands on proper maintenance and repair, since the instrument's extreme versatility requires a wide variety of types and magnitudes of calibration signals to fully check and reestablish its performance.

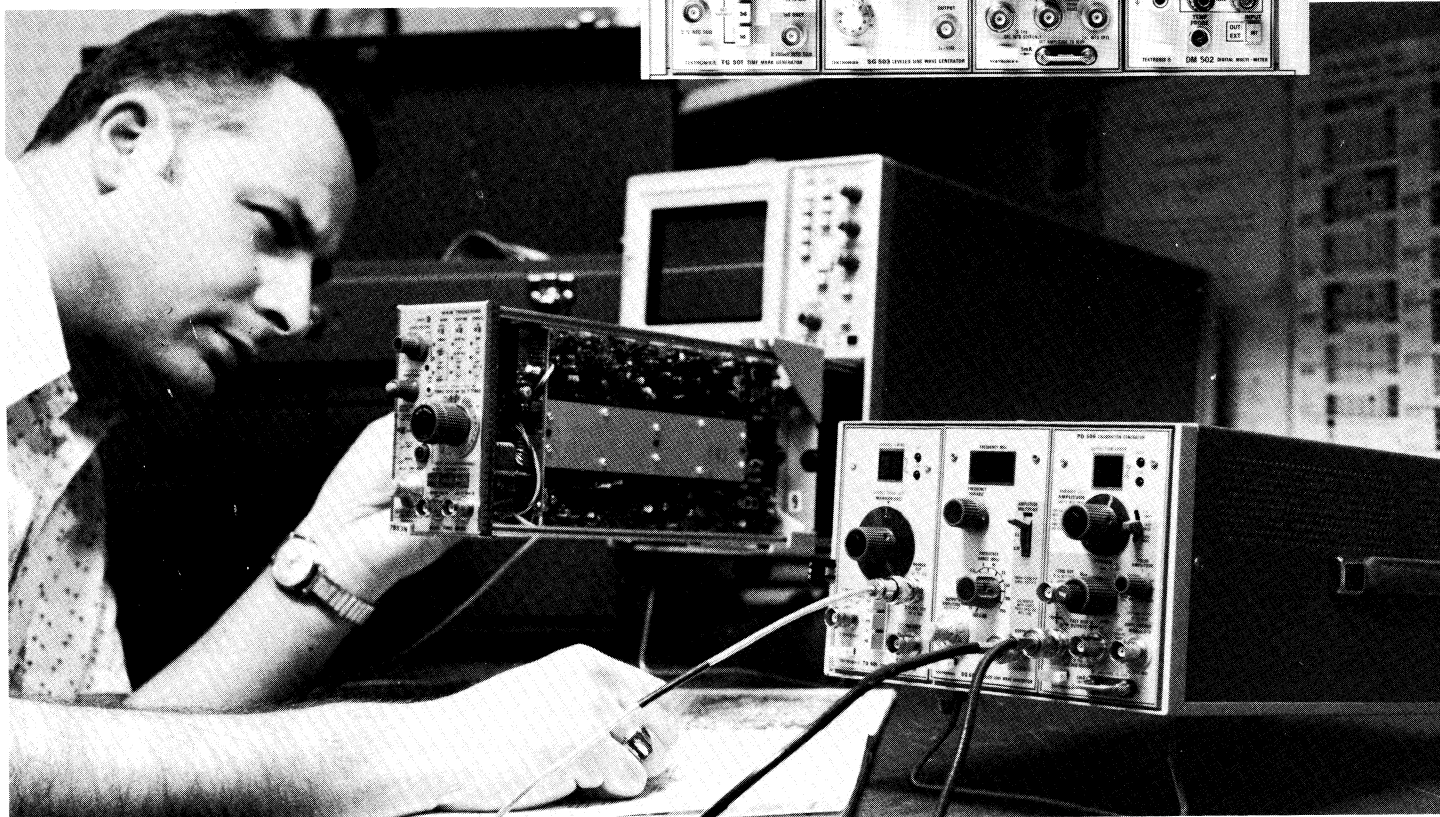
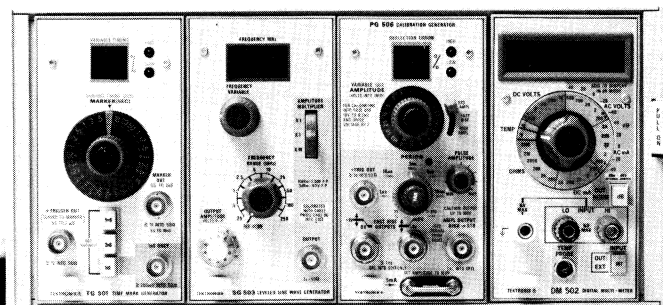
In the past, organizations with their own oscilloscope calibration facilities have been committed to heavy capital expenditures for a variety of high quality but general purpose instruments in order to satisfy all the requirements established by prescribed calibration procedures. Much of this equipment was heavy, bulky, and sometimes highly susceptible to shock, vibration, and extremes of temperature and humidity. This necessitated the establishment of a calibration lab, to which any instrument requiring a periodic check had to be delivered and subsequently returned to its working location.

With the advent of the TM 500 Oscilloscope Calibration Package, the situation is radically changed. The superior portability, accuracy and relative immunity to environmental influences of the calibrator package permit performance at the oscilloscope users' location, and in its normal working environment. This not only increases the effectiveness and accuracy of the calibration, but also saves the time normally consumed in transportation between users' site and calibration lab.

The calibration package consists of the PG 506 Calibration Generator, SG 503 Signal Generator, TG 501 Time Mark Generator, and DM 501 Digital Multimeter, all fitted into a TM 504 Power Mainframe. These instruments set the state-of-the-art in every respect in oscilloscope calibration. They provide the widest range of standard amplitude square waves, fastest rise times, lowest aberrations, fastest time marks, and widest frequency range of leveled sine waves available from any calibration equipment.

Time-saving, accurate procedures are enhanced by features such as direct display of the oscilloscope errors by the PG 506 and TG 501. The procedure is as follows: Either instrument can be placed in variable (rather than standard output) mode by the push button concentric with the range switch. The two-digit display then is lighted and the knob can be rotated until the amplitude of the square wave (PG 506) or spacing of the time marks (TG 501) is exactly aligned with the oscilloscope graticule divisions. The display shows the oscilloscope percentage error (up to $\pm 7.5\%$) under those conditions. If the indicated error is within instrument specifications, no further calibration need take place. Complete procedures are provided in Tektronix manuals.

For more details and specifications on the individual modules comprising the Oscilloscope Calibration Package, see Section 3, Plug-In Modules.



Counter/Timers

Digital integrated circuits and modern high-stability quartz crystals have combined to permit time and frequency measurements of a greater accuracy than for any other electrical parameters. The TEKTRONIX TM 500 line of digital counter/timers offers all the versatility, operating ease, compactness, and value available with present state-of-the-art techniques. Five models are available: the DC 501, DC 502, DC 503, DC 504 and DC 505A.

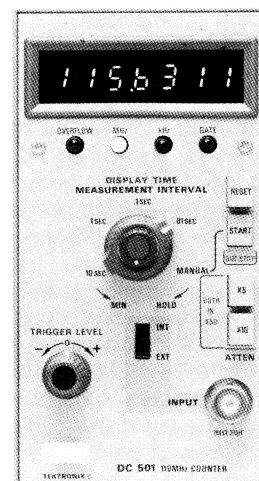
The counters, DC 501 and DC 502, measure frequencies and totalize events from low audio frequencies up through 110 or 550 MHz. The new low-cost DC 504 combines frequency counting and totalizing, plus an rpm capability, with the ability to measure period for higher resolution and accuracy at low frequencies. The DC 503 and DC 505A are fully Universal Counter/Timers which totalize and measure frequency, and also provide single period, period averaging, frequency ratio, and time interval capability. The DC 503 also includes a time-manual (electronic stopwatch) feature. The sophisticated DC 505A provides time-interval averaging, direct pulse width measurements, and a unique events-A-during-B mode.

Applications for the DC 501 and DC 502 frequency counters and the DC 504 period and frequency counter cover many measurements needed in communications work. Typical measurements include carrier and sub-carrier frequencies, modulation frequencies, pulse repetition rates in data communications, center frequency and corner

frequencies of tuned filters, frequency of signalling tones, and verification of discriminator linearity. The totalize (event-counting) mode is also useful in industrial control applications or research environments.

The second channel capabilities of the DC 503 and DC 505A Universal Counter/Timers permit measurement of frequency ratios and, more importantly, time intervals, in addition to the frequency and total events measures of single channel instruments. Time intervals are measured by counting the internal clock pulses which occur between a start event on channel A and a stop event on channel B. Resolution and accuracy are determined by the instrument's clock rate, and by whether time interval averaging is available.

The accuracy of counter/timer measurements is ultimately limited by the accuracy of the internal time base, although at some combinations of input frequency and counter operating controls, resolution may be the limiting factor. Two types of time base are available in the TM 500 family of counters. The standard time base is an uncompensated quartz crystal providing a monthly aging rate and temperature stability of 1 part in 10^5 (0.001%). The option 1 time base is a high stability temperature-compensated quartz crystal which provides a one-hundred-times improvement in aging rate and a twenty-times improvement in temperature stability. Temperature-compensated time bases have an inherent advantage over temperature-controlled (oven) time bases in that they do not require hours or days of warm-up to reach specified accuracy. This is particularly important in portable applications.



DC 501

Direct Counting to 110 MHz
7-Digit LED Display
Manual Start/Stop (Totalize)
Auto Range and Time Base Options

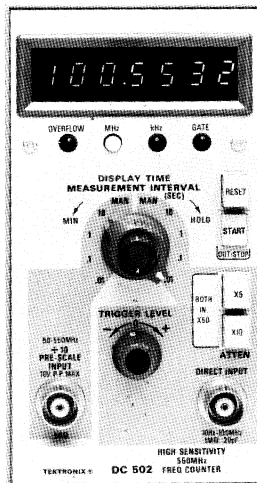
The DC 501 Digital Counter directly measures frequency from 10 Hz to 110 MHz and totalizes (counts number of events) from 0 to 9,999,999 at a maximum rate of 110 MHz. Measurement readout is provided by seven-segment LED's in a seven digit display. The decimal point is automatically positioned and leading zeros (to the left of the most significant digit or decimal point) are blanked. Register overflow is indicated by a front-panel LED. Signals to be counted can be applied via a front-panel BNC connector into an impedance of 1 M Ω and 20 pF or via the rear connector into an impedance of 50 Ω and 20 pF. Four gate times of .01s, 0.1s, 1s, and 10s are provided. A standard internal 1 MHz clock is provided with 1×10^{-5} accuracy (0° to 50° C) and an aging rate of 1×10^{-5} per month. An optional clock with 5×10^{-7} accuracy (0° to 50° C) and an aging of 1×10^{-7} per month is available at extra cost. Input sensitivity is approximately 300 mV peak-to-peak (100 mV rms sine wave) below 110 MHz. An automatic measurement interval option, also at extra cost, automatically selects the gate time (up to 10 seconds) to obtain maximum resolution with any input signal.

DC 501 Digital Counter
Option 1 (Time Base)
Option 2 (Auto Measurement)
Option 4 (Calculator)

DIGITAL COUNTERS — COMPARISON OF CHARACTERISTICS

The following is a comparison of the main characteristics of the DC 501 through the DC 505A. A complete list of specifications appears on the following pages.

	DC 501	DC 502	DC 503	DC 504	DC 505A
Number of Digits	7	7	7	5	7
Frequency Range	110 MHz	550 MHz	100 MHz	80 MHz	225 MHz
Totalize	Yes	Yes	Yes	Yes	Yes
Period	No	No	Yes	Yes	Yes
Period Average	No	No	Yes	No	Yes
Time Interval	No	No	Yes; 1 μ s maximum clock rate	No	Yes; 10 ns maximum clock rate
Time Interval Average	No	No	No	No	Yes
Ratio	No	No	Yes	No	Yes
Other	Option 1 FCC type Approved	Option 1 FCC Type Approved	Time Manual	Rpm	Events A During B, single-jack pulse width, dc trigger level out



DC 502

Counts to 550 MHz with $\div 10$ Prescale (50- Ω Input)

Direct Counting to 110 MHz

7-Digit LED Display

Manual Start/Stop (Totalize)

Time Base Option

The DC 502 Digital Counter measures frequencies from 10 Hz to 550 MHz or totalizes events up to the register capacity of 10^7-1 at the max rate of 550 MHz. Frequency measurements are accomplished using one of two inputs. The DIRECT INPUT has a frequency range of 10 Hz to 110 MHz, a 1 Megohm input impedance, 300 mV peak-to-peak sensitivity (100 mV rms sine wave) and an adjustable trigger level range. The $\div 10$ PRESCALE INPUT has a frequency range from 50 MHz to 550 MHz with a 500 mV peak-to-peak sensitivity (170 mV rms sine wave) and a 50- Ω input impedance. The manual totalizing mode with front-panel start-stop control is available at both inputs; from the pre-scale input, 1 displayed count per 10 input events will result. Measurement display is accomplished with seven-segment LED's in a seven-digit readout. The decimal point is automatically positioned by the measurement interval selected, and leading zeros (those to the left of the most significant digit or those to the left of the decimal point) are blanked. LED's indicate when the gate is armed, and whether displayed numbers are in kHz or MHz, and when register overflow occurs. Four gate times of 0.01s, 0.1s, 1.0s, and 10s are provided. A standard internal 1 MHz clock is provided with 1×10^{-5} accuracy (0° to 50°C) and aging rate of 1×10^{-5} per month. An optional clock with 5×10^{-7} accuracy (0° to 50°C) and aging rate of 1×10^{-7} per month is available at extra cost.

DC 502 Digital Counter

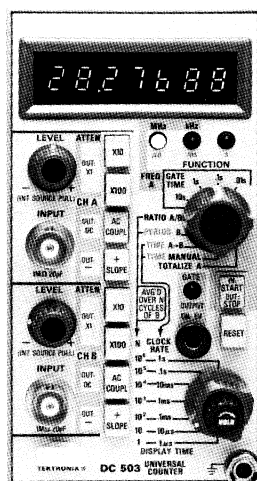
Option 1 (Time Base)

Option 4 (Calculator)

COMPARISON OF CHARACTERISTICS

	DC 501	DC 502
DISPLAY	7 digits (7-segment LED's) storage, leading zero blanked. Overflow, gate open and kHz or MHz indicators.	
DIRECT INPUT Frequency Range	10 Hz to 110 MHz	
Sensitivity	300 mV p-p (100 mV rms sine wave)	
Impedance	1 M Ω , paralleled by 20 pF	
Triggering Level	Adjustable, ± 2 V	
Max Safe Input	500 V (dc and peak ac, or p-p ac) at ≤ 1 kHz	
Attenuation	X1, X5, X10, or X50	
Resolution	0.1 Hz with 10 sec gate, 1 Hz with 1 sec gate, 10 Hz with 0.1 sec gate, 100 Hz with 0.01 sec gate	
$\div 10$ PRESCALE INPUT Frequency Range	Not Applicable	50 MHz to 550 MHz
Sensitivity		500 mV p-p (170 mV rms sine wave), or 1-2 mV rms (see special features below)
Impedance		50 ohms
Max Safe Input		10 V p-p
Resolution		1 Hz with 10 sec gate 10 Hz with 1 sec gate 100 Hz with 0.1 sec gate 1 kHz with 0.01 sec gate
STANDARD TIME BASE ACCURACY Temp. Stability, 0° to 50°C after Warm-up	Within 1 part in 10^5 (0.001%)	
Long Term Drift	Within 1 part in 10^5 per month (0.001%)	
Stability	Adjustable within 1 part in 10^7 (0.00001%)	
OPTION 1 TIME BASE ACCURACY Temp. Stability, 0° to 50°C after Warm-up	Within 5 parts in 10^7 (0.00005%)	
Long Term Drift	Within 1 part in 10^7 per month (0.00001%)	
Stability	Adjustable within 5 parts in 10^9 (0.0000005%)	
FCC Type Approval	Option 1 FCC Type Approved for frequency monitoring in AM and FM broadcast bands and on tv channels 2-6	Option 1 FCC Type Approved for frequency monitoring in AM and FM broadcast bands and on tv channels 2-6
Totalize	Counts events from 1 to 9,999,999 at a max rate 110 MHz. Start, stop and reset commands via front-panel push buttons.	Same as DC 501 plus $\div 10$ totalize which counts events to 99,999,990 at a max rate of 550 MHz. Display is 1/10 the number of input events
REAR INPUTS — For routing from other compartments or from rear-panel connectors on Power Modules	Direct count input (50 ohms impedance, resistor may be removed for 1 Megohm input), reset, external display scan clock, external time base	Reset, external display scan clock, external time base
REAR OUTPUTS — For routing from other compartments of Power Module or to rear-panel connectors on Power Modules	BCD serial-by-digit, plus lines for MHz light, decimal point, internal display scan clock, time base out, data ready, etc.	
SPECIAL FEATURES	Option 2—Automatically selects optimum measurement interval to fill the display, and displays appropriate kHz or MHz indication. Overflow is indicated for frequencies in excess of 9,999,999 MHz	A modification is available to provide 1-2 mV sensitivity from 50-550 MHz. See your Tektronix Field Engineer, Representative or Distributor for more information.
CALCULATOR INTERFACE	Option 4—Adds appropriate decimal point output data for compatibility with TEKTRONIX 31/53 Calculator Instrumentation System.	

DC 503 and New DC 505A Digital Counters



DC 503

Direct Counting to 100 MHz Six Measurement Functions Period and Ratio Averaging Interval Measurement Capability

The DC 503 Universal Counter offers counting to 100 MHz and provides the versatility of six measurement functions: frequency, period ratio, time A→B, time manual, and totalize. The two channels (A and B) have individual BNC inputs and separate trigger level, attenuator, and coupling mode controls. Seven-digit readout is via seven-segment light emitting diodes (LED's) with automatically positioned decimal point; leading zeros (to the left of the most significant digit or decimal point) are blanked. A flashing display indicates register overflow. The low cost DC 503 offers high performance in a variety of applications. Its interval measurement capability with selectable clock rates is useful for digital equipment design and maintenance, particularly digital control and data communications work. The A-channel frequency range of dc to 100 MHz serves in communication and rf use. High resolution measurements of low frequencies are available quickly in the period mode with averaging up to 1 million periods available. TIME MANUAL provides an electronic stop watch function with selectable clock rates. TOTALIZE counts and displays the total number of input events at rates from dc to 100 MHz.

DC 503

Option 1 (Time Base)

Option 4 (Calculator)

COMPARISON OF CHARACTERISTICS

	DC 503	DC 505A
DISPLAY	7 digits (7 segment LED's) Storage, leading zeros blanked	
FREQUENCY (A input) Range	0 to 100 MHz, dc coupled 10 Hz to 100 MHz, ac coupled	0 to 225 MHz, dc coupled 10 Hz to 225 MHz, ac coupled
Gate Times	0.01 sec, 0.1 sec, 1 sec, 10 sec	
Accuracy	±1 count ± time-base error	
TIME INTERVAL (A → B) Resolution, Single event	1 μs to 1 sec, selectable	10 ns to 1 ms, selectable
Resolution, averaging on repetitive events	Not Applicable	≤ 100 picoseconds with 10 ns clock and 10 ⁵ averaging. Clock rate selectable, 10 ns to 1 ms. Averaging factor independently selectable from 1 to 10 ⁵ . 5 ns minimum pulse width in either channel.
Accuracy	±1 count ± time-base error; other contributions negligible	±1 count ± time-base error ± trigger error CH A* ± trigger error CH B* ± channel delay match error of 2 ns max ± slew rate error*** ± 2 counts (10 ns clock rate only) Best absolute accuracy, 3 ns
WIDTH (B input) Resolution, single pulse	Use "tee" connector and Time Interval A→B mode; see specifications above	10 ns to 1 ms, selectable
Resolution, repetitive pulses	Not Applicable	≤ 100 picoseconds with 10 ns clock and 10 ⁵ avg. factor. Clock rate selectable 10 ns to 1 ms. Avg. factor independently selectable from 1 to 10 ⁵ . 2 ns minimum pulse width
Accuracy		±1 count ± time-base error + hysteresis error** ± slew rate error*** ± 2 counts (10 ns clock rate only). Best absolute accuracy, 1.5 ns.
PERIOD + PERIOD AVERAGING (B input) Resolution	From 1 μs for single period to 1 picosecond with 10 ⁶ averaging	From 10 ns to 1 ms for single period; to 0.1 picosecond max. with 10 ns clock and 10 ⁵ averaging
Accuracy	±1 count ± time-base error ± trigger error N	±1 count ± trigger error† ± 2 counts (10 ns clock rate only)
RATIO (A/B)	Averaged over 1 to 10 ⁶ cycles of signal at B.	Averaged over 1 to 10 ⁵ cycles of signal at B. Accuracy: ±1 count FREQ A ± trigger jitter chan B†
EVENTS A DURING B	Not Applicable	Averaged over 1 to 10 ⁵ occurrences of signal at B. Accuracy: ±1 count FREQ A + hysteresis error** ± slew rate error***
TOTALIZE (A)	1 to 9,999,999 at max rate of 100 MHz. Front-panel start, stop, reset control.	1 to 9,999,999 at max rate of 225 MHz. Front-panel start, stop, reset control
TIME MANUAL	Electronic stop watch; accumulates and displays time following activation of front-panel start button. Clock rates selectable from 1 μs to 1 sec.	Not Applicable
INPUT SPECIFICATIONS		
Freq. Range, A	0 to 100 MHz, dc coupled 10 Hz to 100 MHz, ac coupled	0 to 225 MHz, dc coupled 10 Hz to 225 MHz, ac coupled
Freq. Range, B	0 to 10 MHz, dc coupled 10 Hz to 10 MHz, ac coupled	0 to 225 MHz, dc coupled 10 Hz to 225 MHz, ac coupled
Sensitivity, A and B	300 mV p-p (100 mV rms sine wave)	150 mV p-p (50 mV rms sine wave) below 150 MHz. 300 mV p-p (100 mV rms sine wave) from 150 to 225 MHz
Impedance, A and B	1 MΩ paralleled by 20 pF.	1 MΩ paralleled by 24 pF.
Triggering Level, A and B	Adjustable ±1.5 V in X1 attenuator position.	Adjustable ±2.0 V in X1 attenuator position.
Max Safe Input, A and B	500 V (dc + peak ac, or p-p ac) ≤ 1 kHz	50 V (dc + peak ac, or p-p ac) in X1 attenuator position. 250 V (dc + peak ac, or p-p ac) ≤ 1 kHz in X20 attenuator position
Attenuation, A and B	X1, X10, X100	X1, X20
STANDARD AND OPTION 1 TIME BASE SPECIFICATIONS	Same as DC 501/DC 502 (Except, No FCC Type Approval)	
REAR INPUTS	Same as DC 501	
REAR OUTPUTS	Same as DC 501/DC 502	
CALCULATOR INTERFACE	Same as DC 501/DC 502	

NOTES:

$$* = \frac{0.01 \text{ V}}{(dv/dt \text{ of triggering edge})} / \sqrt{N}$$

$$** = \frac{0.1 \text{ V}}{(dv/dt \text{ stop edge})} \pm \frac{0.01 \text{ V}}{(dv/dt \text{ start edge})} / \sqrt{N}$$

***Input amplifier slew rate of 10 ns/volt will produce additional error in

(1) Time A → B mode if A and B level controls are not set for corresponding points on waveforms.

(2) Width B and Events A during B modes if B level control is not set at 50% of input pulse height.

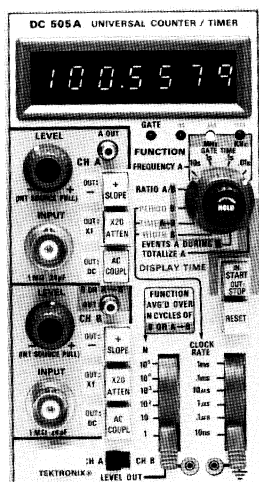
$$\dagger = \frac{0.01 \text{ V}}{(dv/dt \text{ triggering edge})} / N$$

NOTE 1: Accuracies with averaging are dependent on the laws of statistics in Time A → B, Width B, and Events A during B modes.

SPECIAL FEATURES

A Out: Shaped output, after LEVEL and SLOPE selection, of signal into CH A. This output represents what goes into the display of FREQ A, RATIO A/B, and TOTALIZE A. Propagation delay from CH A INPUT to A OUT is ≈ 15 ns.

B or A→B Out: Shaped output, after LEVEL and SLOPE selection, of either CH B signal or A→B signal. This output represents the continuous signal used in generating the display gating for RATIO A/B, PERIOD B, TIME A→B, Width B, and EVENTS A DURING B. Logic levels out are the same as for A OUT. Propagation delays from the channel INPUTS to B or A→B OUT are ≈ 15 ns.



DC 505A

NEW

Dc Trigger Level Output for Accurate setting with Companion DMM

Direct Counting to 225 MHz

10 Nanosecond Clock Rate

Time Interval Averaging with Resolution to 100 Picoseconds

Two Equal Bandwidth Channels for Time Measurements on Narrow Pulses
Events A During B

The DC 505A is a high-performance Universal Counter featuring direct counting to 225 MHz. Both channels, A and B, have equal response, for ratio, time interval and other measurements requiring two channels. This new "A" version provides dc trigger level output both at the front-panel jack and rear interface connector. Any TM 500 Digital Multimeter may be connected via the rear interface to read the DC 505A trigger level setting when the DMM input switch is pushed to the INT position. Alternately, an external voltmeter or oscilloscope may be connected to the front-panel jack to perform this function. The DC 505A can perform virtually any counting-timing function below 225 MHz.

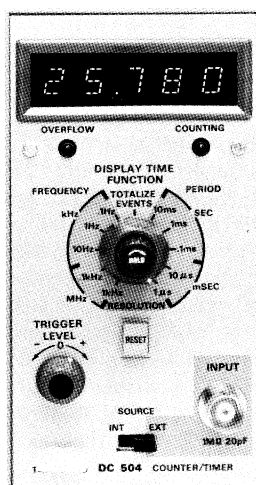
Various functions include conventional frequency operation on channel A, ratio of channel A to B frequency, period of signal B, time interval from channel A start to B stop, width B, events A during B, and totalize. An averaging feature allows measurements to be averaged from 1 to 10^5 times as selected

by front-panel controls with the resultant average displayed on the LED readout. Averaging factor and clock rate are independently selectable. Pulse width may be measured directly with single shot resolution to 10 ns. By use of maximum averaging on width or interval measurements of repetitive waveforms, resolution to better than 100 picoseconds is possible. Typical application of the DC 505A is in the design, development or maintenance of logic circuitry in high speed digital computers. It is a high-performance counter for state-of-the-art design and measurements up to 225 MHz.

DC 505A

Option 1 (Time Base)

Option 4 (Calculator Interface)



DC 504

Direct Frequency Counting to 80 MHz

Period Measurement for Resolution at Low Frequency

Rpm Counting

5-Digit LED Display

Low Cost

The DC 504 Counter/Timer measures frequency from 0 Hz (with 0.1 Hz resolution) to 80 MHz, period from 1 microsecond to 999.99 seconds, and totalizes events from 0 to 99,999 at a maximum rate of at least 80 MHz. A resolution of 0.1 Hz can be obtained by allowing the more significant figures of the counter to overflow. Five 7-segment light-emitting diodes (LED's) provide a visual numerical display. The decimal point is automatically positioned and leading zeros (to the left of the most significant digit or decimal point) are blanked. Digit overflow is indicated by a front-panel LED. Signals to be counted/timed can be applied to either a front-panel BNC connector or to the rear interface connector. Internal switches select frequency or rpm operation, internal time base or external standard, and override display storage.

Display — 5 digits, LED's.

Display Accuracy — ± 1 count \pm time-base accuracy (\pm trigger error in period mode only).

Frequency (or rpm) — Dc coupled: 0 Hz to at least 80 MHz. Ac coupled: 10 Hz to at least 80 MHz.

Frequency/rpm (max. resolution) — kHz Positions: 0.1 Hz, 1 Hz and 10 Hz (1 rpm, 10 rpm and 100 rpm).* MHz Positions: 0.1 kHz and 1 kHz (1000 rpm and 10 k rpm).*

Sensitivity — 20 mV rms (56.6 mV p-p) below 15 MHz, 35 mV rms (99 mV p-p) at or below 50 MHz derating to typically <175 mV rms (495 mV p-p) at 80 MHz.

Triggering Level — Adjustable over at least -1.5 V to $+1.5$ V.

Trigger Source — Internal (rear connector interface) or external (front-panel BNC).

Maximum Voltage — 250 V (dc and peak ac) at 500 kHz or less.

Impedance — 1 M Ω paralleled by approximately 20 pF.

Coupling — Dc or ac.

*Assuming transducer output is one pulse per revolution.

Internal Time Base

	Standard	Option 1
Crystal Frequency	1 MHz	5 MHz temperature compensated
Stability (0°C to 50°C) after ½ hour warm-up	Within 1 part 10^5	Within 5 parts in 10^7
Long-term Drift	1 part or less in 10^5 per month	1 part or less in 10^7 per month
Setability	Adjustable to within 1 part in 10^7	Adjustable to within 5 parts in 10^9

Totalize Events (resolution) — 1

Period (resolution) — m Sec Position: 1 μ s and 10 μ s. Sec Position: 0.1 ms, 1 ms and 10 ms.

Display Time — Variable from about 0.1 s to about 10 s. Detent position at cw position of DISPLAY TIME knob provides a HOLD mode.

Data Inputs and Outputs — Available at plug-in connector for intra-compartment routing in any TM 500 Power Module/Mainframe. BCD serial-by-digit (parallel data for one digit at a time) plus timing and control functions.

DC 504 Counter/Timer

Option 1 (Time Base)

DM 501, DM 502 Digital Multimeters

The digital multimeter, with the capability of measuring voltage, resistance, and current, is the most widely used electronic test instrument employed today, with the possible exception of the oscilloscope. Modern digital techniques have vastly improved the resolution and accuracy of the traditional volt-ohm-milliammeter, simplified instrument use, and reduced the possibilities of human error. The TM 500 Digital Multimeter line consists of two general purpose instruments, the DM 501 and DM 502 Digital Multimeters. In addition to the usual dc and ac voltage, resistance, and dc and ac current functions, both meters offer an optional temperature measurement function. Applying the tip of the optional temperature probe to a power transistor, integrated circuit, mechanical component, or any other surface provides an immediate digital readout of the surface temperature in degrees Centigrade or degrees Fahrenheit at the user's choice. The DM 502 further extends measurement capability by providing a standard decibel (dB) measurement feature across all ac ranges.

The DM 501 and 502 are similar instruments in many respects. Each measures dc voltage to 1,000 volts (extendable to 40,000 volts with the addition of the optional high-voltage accessory probe), ac voltage to 500 volts, both dc and ac current to 2 amps, and resistance to 20 megohms. Optionally, both provide probe measurement of surface temperatures from -55°C to $+150^{\circ}\text{C}$. The most significant differences lie in the dB capability of the DM 502, the $4\frac{1}{2}$ digits of the DM 501 versus $3\frac{1}{2}$ in the DM 502, and the float-

ing BCD output of the DM 501 (for compatibility with the TEKTRONIX 31/53 Calculator Instrumentation System and other digital readout systems).

Since the DM 501 is a $4\frac{1}{2}$ digit instrument, it can provide significantly more precise values than $3\frac{1}{2}$ digit instruments, including the DM 502. At a given signal level, the $4\frac{1}{2}$ digit instrument can supply 10X better resolution and conversely it can also measure 10X as large a signal at any given resolution level.

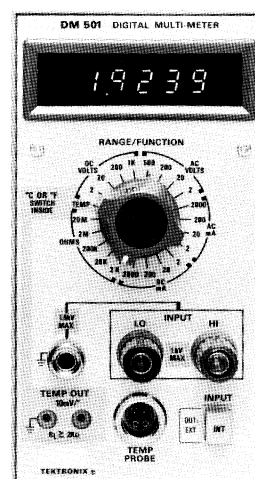
For example, an exact 2.000-volt signal must be measured on the 20-volt range on either instrument, since full scale on the nominal 2-volt range is actually 1.999 or 1.9999 volts. The specified possible error of the DM 502 (display 2.00) is $\pm 0.1\%$ of reading ± 1 count, equal to ± 12 millivolts, or 0.6% of reading. The same input is displayed on the DM 501 as 2.000, and the possible error of $\pm 0.1\%$ of reading ± 2 counts is 2.2 millivolts, or 0.11% — almost six times better.

The dB feature of the DM 502 is of great value in the general audio and communications industry: in mobile radio, microwave, telephone communication, computer time-sharing and other applications of data transmission via voice links, broadcasting, high-fidelity and recording industries, sonar, acoustics, audiometrics, and many other fields. The absolute reference of the DM 502 may be selected, by internal jumper, as dBm (0 dB = 0.775 V or 1 mW in 600 Ω) or dBV (0 dB = 1 V). With either reference, the dynamic range extends from -60 dB to approximately $+56$ dB.

DIGITAL MULTIMETERS DM 501 AND DM 502 COMPARISON OF CHARACTERISTICS

The following is a comparison of the major characteristics of the DM 501 and DM 502. A complete set of specifications may be found on the following pages.

	DM 501	DM 502
Number of Digits	$4\frac{1}{2}$	$3\frac{1}{2}$
Dc Volts — full scale	2 V to 1 kV	.2 V to 1 kV
Ac Volts — full scale	2 V to 500 V	.2 V to 500 V
Dc Current — full scale	2 mA to 2 A	200 μA to 2 A
Ac Current — full scale		
Resistance — full scale	2 k Ω to 20 M Ω	200 Ω to 20 M Ω
Temperature Probe	Optional	Optional
DB	No	-60 dB to $+56$ dB
BCD Output	Full Floating	Non-Floating
Input Impedance	10 Meg	10 Megs Normal; FET input on 0.2 and 2-volt scales by internal jumper



DM 501

0.1% Dc Voltage Accuracy

$4\frac{1}{2}$ -Digit LED Display

Auto Polarity

Measures Volts, Current, Resistance, Temperature

Fully Isolated Serial BCD Output

The DM 501 Digital Multimeter measures dc and ac voltage and current, resistance, and temperature. Dc voltage measurement accuracy is 0.1%. The ac functions are average responding and rms calibrated. A single front-panel control selects all functions and ranges. A push button selects front-panel input or optional rear interface connector input. Temperature measurements are made using a TEKTRONIX P6058 Probe or other suitable sensing devices. Front-panel pin jacks provide external temperature readout, at 10 mV per degree, regardless of the position of the function switch. An internal switch selects calibration in degrees Centigrade or Fahrenheit. Readout is a $4\frac{1}{2}$ -digit stored display using seven-segment LED's. The decimal point is automatically positioned by the RANGE/FUNCTION switch and leading zeros (those to the left of the decimal point or most significant digit) are blanked. Polarity indication is automatic. A blinking display indicates overrange. Serial BCD output is available at the rear interface connector.

DC VOLTAGE

Range — 2 V, 20 V, 200 V, and 1 kV full scale (19999 max reading), accurate within 0.1% of reading ± 2 counts.

Resolution — 100 μV .

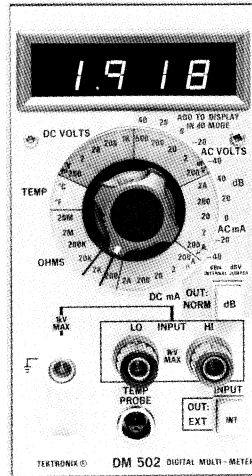
Common-Mode Rejection — ≥ 100 dB at dc, 80 dB at 60 Hz with 1 k Ω imbalance.

Step Response Time — < 1 s.

Normal-Mode Rejection — ≥ 30 dB at 60 Hz increasing 20 dB per decade.

Input R — 10 M Ω , constant.

DM 501, DM 502 Digital Multimeters



DM 502

AC VOLTAGE

Range — 2 V, 20 V, 200 V and 500 V full scale (19999 max reading), average responding, rms calibrated.

Accuracy — Within 0.5% of reading ± 2 counts from 40 Hz to 10 kHz; 1.0% of reading ± 2 counts, 20 Hz to 20 kHz. Usable to 100 kHz. Typically $< 5\%$ down between 0.4 V and 500 V at 100 kHz.

Resolution — 100 μ V.

Response Time — < 10 s.

Input R — 10 M Ω paralleled by < 100 pF.

AC & DC CURRENT

Range — 2 mA, 20 mA, 200 mA, 2 A full scale (19999 max reading), ac rms calibrated, average responding.

Resolution — 100 nA.

Accuracy — Dc amps, 0.2% of reading ± 2 counts; Ac amps, 0.6% of reading ± 2 counts from 40 Hz to 10 kHz $\pm 0.6\%$ of reading, ± 10 counts, 1 kHz to 10 kHz. Usable to 100 kHz.

Input R — $\frac{0.2 \text{ V}}{\text{Range Setting}} + 0.1 \Omega$

RESISTANCE

Range — 2 k Ω , 20 k Ω , 200 k Ω , 2 M Ω , 20 M Ω full scale (19999 max reading).

Accuracy — Within 0.3% ± 2 counts to 2 M Ω , 0.5% ± 2 counts on 20 M Ω scale.

Resolution — 0.1 Ω .

TEMPERATURE MEASUREMENT

Range — 55°C to +150°C (-67°F to $+302^\circ\text{F}$ selected by internal switch), using included temperature probe. The temperature probe functions regardless of the DM 501 mode and provides a front-panel analog signal output of 10 mV/ $^\circ$ (into 2 k Ω or greater); thus temperature may be measured simultaneously with any other function. If temperature probe is not desired, order Option 1. If temperature capability is not desired, order Option 2; note: capability cannot be restored at a later date.

Accuracy — With 1.5°C (2.7°F) from -55°C to $+125^\circ\text{C}$ and within 2.5°C (4.5°F) from -55°C to $+150^\circ\text{C}$.

Resolution — 0.1 $^\circ$.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display.

Measurement Rate — 5 measurements/second.

Maximum Input Voltage — 1 kV. The front-panel HI and LO connectors may be floated 1.5 kV maximum above ground, the rear inputs 350 V maximum. Current measuring functions are fused at 3 A. Ohms ranges are fused at 1/16 A.

Ambient Temperature — Performance characteristics are valid over a temperature range of $+15^\circ\text{C}$ to $+40^\circ\text{C}$.

Standard Accessories — 1 Pair Test Leads (003-0120-00), 1 P6058 Temp Probe (010-0259-00).

Optional Accessories — Deluxe test lead with accessories including push-on spring-loaded hook tip and special i.c. package tip, high flexibility wire, red, 4 ft. **Order (012-0426-00)**

As above except black.

Order (012-0426-01)

Test lead with alligator clip, 4 ft., black.

Order (012-0425-00)

ORDERING INFORMATION

DM 501 Digital Multimeter

Option 1 Without Temp Probe (P6058)

Option 2 Without Temp Capability and Probe

Optional Accessory — High Voltage Probe to 40 kV

Order 010-0277-00

Selectable DB Readout

Six Functions including Temperature and DB

0.1% Dc Voltage Accuracy

Auto Polarity

DB Readings from -60 DB to $+56$ DB

The DM 502 Digital Multimeter measures dc and ac voltage and current, dBm, dBV, resistance and temperature. The ac functions are average responding and rms calibrated. A single front-panel control selects all ranges. Front-panel push buttons select dB readout of ac functions in lieu of ac voltage or current and front-panel or rear interface connector input. DB is obtained by adding the selected dB scale value to the display reading. Readout in dBm or dBV is chosen by an internal jumper. An internal jumper also permits selection of FET input (> 1000 M Ω) or 10 M Ω input impedance on the two lowest dc voltage ranges.

The readout is a 3 1/2-digit display using seven-segment LED's. The decimal point is automatically positioned by the RANGE/FUNCTION switch. Polarity indication is automatic. Maximum display at stated accuracy is 1999.

Non-floating BCD output (referenced to the low input), is available at the rear interface connector if user wired.

DC VOLTAGE

Range — 0.2 V, 2 V, 20 V, 200 V, 1000 V.

Accuracy — Within $\pm 0.1\%$ of reading, ± 1 count.

Common-Mode Rejection — ≥ 100 dB at dc, ≥ 80 dB at 50 or 60 Hz with 1 k Ω imbalance.

Normal-Mode Rejection — ≥ 80 dB at 50 or 60 Hz.

Step Response Time — ≤ 0.5 sec.

Input R — 10 M Ω (jumper selectable for > 1000 M Ω on 0.2 V and 2 V ranges).

AC VOLTAGE

Voltage Range — 0.2 V, 2 V, 20 V, 200 V, 500 V.

Accuracy — Within $\pm 0.5\%$ of reading, ± 1 count, 40 Hz to 10 kHz. $\pm 1.0\%$ of reading, ± 1 count, 20 Hz to 20 kHz. Usable to 100 kHz. Typically $< 10\%$ down between 40 mV and 500 V at 100 kHz.

Response Time — ≤ 5 sec.

Common-Mode Rejection — ≥ 60 dB at 50 or 60 Hz.

Input R — 10 M Ω paralleled by less than 60 pF.

DB VOLTS AND CURRENT

Scales — $+40$, $+20$, 0, -20 , -40 dB. Reference is dBV (1 V) or dBm (1 mW dissipated in 600 Ω , 0.7746 V), selected by internal jumper.

Display — ± 19.99 dB on any scale, except that the total dynamic range is limited to the range -60 dB to approx. $+56$ dB by a 500 V max input specification.

Accuracy

Display Reading	Frequency Range	Maximum Error
0 to $+19.99$	20 H to 20 kHz	0.5 dB
0 to -10.00	20 Hz to 2 kHz 2 kHz to 20 kHz	0.5 dB 1.0 dB
-10.00 to -19.99	20 Hz to 2 kHz 2 kHz to 20 kHz 7.5 kHz to 20 kHz	0.5 dB 1.0 dB 2.0 dB

Response Time — ≤ 5 sec.

Common-Mode Rejection — ≥ 60 dB at 50 or 60 Hz.

RESISTANCE

Ranges — 200 Ω , 2 k Ω , 20 k Ω , 200 k Ω , 2 M Ω , 20 M Ω .

Accuracy — 200 Ω range, 0.5%, ± 1 count, ± 1 Ω ; 2 k Ω through 2 M Ω range, $\pm 0.5\%$, ± 1 count; 20 M Ω range, 1.0%, ± 1 count.

Response Time — ≤ 0.5 sec; 20 M Ω Range, ≤ 5 sec.

Maximum Output Current and Voltage — 1 mA maximum; approx. 12 V maximum.

AC & DC CURRENT

Ranges — 200 μ A, 2 mA, 20 mA, 200 mA, 2 A.

Accuracy — Dc current 0.2% of reading ± 1 count; ac current 0.6% of reading ± 1 count 40 Hz to 10 kHz.

Response Time — Dc ≤ 0.5 sec; ac ≤ 5 sec.

Input — $\frac{0.2 \text{ V}}{\text{Range Setting}} + 0.1 \Omega$ (< 2 k Ω with 200 μ A range)

TEMPERATURE MEASUREMENT

Ranges — Centigrade: -55°C to $+150^\circ\text{C}$. Fahrenheit: -67°F to $+200^\circ\text{F}$.

Accuracy — With probe shipped with instrument $\pm 2^\circ\text{C}$ ($\pm 3.6^\circ\text{F}$). With any P6430 probe prior to calibration with instrument, $\pm 8^\circ\text{C}$ ($\pm 14.4^\circ\text{F}$).

The temperature probe functions in all other modes in $^\circ\text{C}$ with analog signal out of 10 MV/ $^\circ$ at rear interconnect.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display.

Measurement Rate — 3.33 per second.

Inputs — The maximum input voltage is 1 kV. The front-panel HI and LO connectors may be floated 1 kV maximum above ground, the rear inputs 350 V. Current measuring functions are fused at 2.5 A. Ohms functions protected to 120 V rms indefinitely, 250 V rms 1/2 hour.

Ambient Temperature — Performance characteristics are valid over a temperature range of $+15^\circ\text{C}$ to $+40^\circ\text{C}$.

Standard Accessories — 1 Pair Test Leads (003-0120-00), 1 P6430 Temp Probe (010-6430-00).

Optional Accessories — Deluxe test lead with accessories including push-on spring-loaded hook tip and special i.c. package tip, high flexibility wire, red, 4 ft.

Order (012-0426-00)

As above except black.

Order (012-0426-01)

Test lead with alligator clip, 4 ft., black.

Order (012-0425-00)

ORDERING INFORMATION

DM 502 Digital Multimeter

Option 2 without Temp Capability and Probe

Optional Accessory — High Voltage Probe to 40 kV

Order (010-0277-00)

PG 501, PG 502, PG 505 Pulse Generators

During the recent dynamic growth of digital logic and computers, the pulse generator, long a valuable signal source, has acquired added importance. Pulse generators are especially useful for testing response of wide-band systems and for simulating signals from a variety of devices. Pulse generators are also used to provide stimulus to living tissue in physiological and biological research. In addition they are used to drive lasers, simulate data transmission signals, test switching speeds of active devices or memory elements, and for a wide variety of other functions.

The TM 500 line consists of three general purpose pulse generator modules and a specialized generator. The specialized generator, the PG 506, is intended primarily for oscilloscope calibration. The PG 501 and PG 502 are designed for the 50 ohm systems, and have repetition rates, amplitudes, and transition times compatible with the common digital integrated-circuit families such as TTL, DTL, and RTL. Furthermore, the PG 502, with 250 MHz repetition rate and inde-

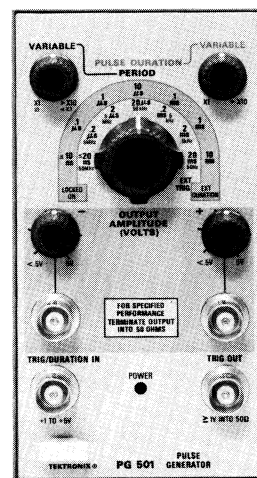
pendent control of the pulse top and bottom levels, is ideal for ECL design and testing. The PG 505 is a high amplitude, high impedance instrument ideal as a stimulus source for biological research. For the electronics instructor, the PG 505 can serve as a versatile, low-cost signal source. With a ramp input, it can provide delayed output pulses and has the wide variable rise and fall range which is valuable in the classroom for demonstrating circuits such as differentiators, and in the biological laboratory to more closely simulate the waveshapes of natural stimuli.

Both the PG 501 and PG 502 rank as outstanding values for their combinations of transition times and repetition rates. The PG 502 in particular sets new standards of value for an extremely high-performance pulse generator. Its independent controls for pulse top and bottom (Logic "1" and "0") levels permit variations in either level, without the annoying interaction of the more common amplitude and offset system.

PULSE GENERATORS—COMPARISON OF CHARACTERISTICS

The following is a comparison of the main characteristics of the PG 501, PG 502, and PG 505. A complete list of specifications appears on the following pages.

	PG 501	PG 502	PG 505
Rep Rate Range	5 Hz-to-50 MHz	10 Hz-to-250 MHz	1 Hz-to-100 kHz
Pulse Width Range	10 ns to 100 ms	2 ns to 50 ms	5 μ s to 0.5 s
$T_r + T_f$	Fixed, ≤ 3.5 ns	Fixed, ≤ 1.0 ns	Variable, ≤ 1 μ s to ≥ 20 ms
Maximum Amplitude	5 Volts across 50 Ω	5 Volts across 50 Ω	80 Volts behind 4 k Ω
Output Controls	Amplitude	Independent pulse top and pulse bottom, complement switch	Amplitude, inversion switch
Other	Simultaneous Pos. and neg. outputs	Manual trig., square-wave mode	Delay anywhere along 10-volt input ramp



PG 501

5 Hz-to-50 MHz plus Triggered Mode

Simultaneous Plus and Minus Outputs

5 V and 3.5 ns Into 50 Ω

Independent Period and Duration Controls

Trigger Out

Pulse Period — 20 ns or less to 20 ms (within 5% from 0.2 μ s to 2 ms and within 15% at 20 ms) in decade steps. Continuously variable between steps and to at least 0.2 s.

Pulse Duration — 10 ns or less to 10 ms (within 5% from 0.1 μ s to 10 ms) in decade steps. Continuously variable between steps and to at least 0.1 s.

Duty Factor — At least 70% for periods of 0.2 μ s or more. Duty factor decreases to 50% at 20 ns period. Minimum off time is 10 ns.

Pulse Rise Time and Fall Time — 3.5 ns or less.

Aberrations — With 3.5% at 5 V amplitude.

Pulse Amplitude — 0.5 V or less to at least 5 V into 50 Ω load.

Pulse Coincidence (+ and - outputs) — Leading edge of pulse outputs within 1 ns of each other (measured at 50% amplitude points).

Trigger Output — At least +1 V into 50- Ω load, occurring approx 8 ns prior to pulse output.

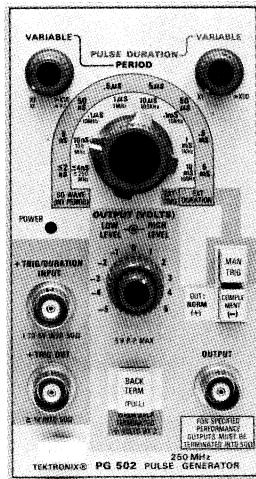
External Trigger/Duration Input — At least +1 not to exceed +5 V (dc + peak ac). Trigger/Duration recognition level, +1 V or less. Trigger/Duration reset level, +100 mV or less. Minimum on and off time is 10 ns.

PG 501 Pulse Generator

MANUAL (ONE-SHOT) TRIGGER GENERATOR

The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or complete train of events with instruments which do not have a manual trigger button or where a remote operation capability is desired, such as with some oscilloscopes and the PG 501, PG 505, and RG 501.

Order 016-0597-00



PG 502

10 Hz to 250 MHz

1 ns Rise Time

5 V Pulse Amplitude Into 50 Ω

Independent Pulse Top and Bottom Level Controls

Selectable Internal Reverse Termination

Short-Proof Output

Manual Trigger Button

The PG 502 (250-MHz Pulse Generator) features: fast rise and fall time; independent top and bottom pulse levels; and adjustable pulse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic circuits.

Pulse Period — 4 ns or less to 10 ms (within 5% in calibrated positions except 15% on 10 ms range) in decade steps. Continuously variable between steps and to at least 100 ms.

Pulse Duration — 2 ns or less to 5 ms (within 5% in calibrated positions except 15% on 5 ms range) in decade steps. Continuously variable between steps and to at least 50 ms. Square-wave mode approximately 50% duty factor.

Duty Factor — At least 50% in normal mode, approximately 100% in complement mode. Minimum off time is 2 ns.

Pulse Rise Time and Fall Time — Less than 1 ns.

Aberrations — Within $\pm 5\%$ at 5 V p-p amplitude, except negative transition aberrations may exceed 5% for durations less than 5 ns.

Pulse Top Flatness — Within 2%, beginning 10 ns after transition.

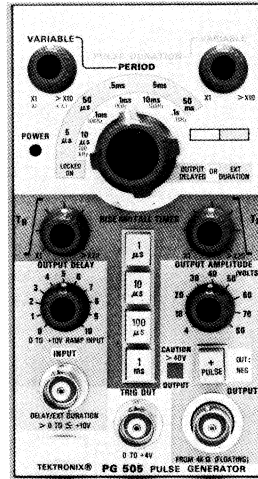
Pulse Amplitude — Pulse high and low levels independently adjustable over a -5 to $+5$ V range, with pulse amplitude limited between ≥ 0.5 V and ≤ 5 V. Complement switch inverts pulse between same two selected voltage levels. Front-panel selectable 50 Ω internal back termination divides output levels by two.

Offset — ± 5 V maximum, depends on amplitude setting.

Trigger Output — At least 1 V into 50 Ω , occurring approx 10 ns prior to pulse output.

External Trigger/Duration Input — Trigger threshold less than 1 V; reset threshold greater than 0.1 V; maximum input 5 V.

PG 502 Pulse Generator



PG 505

1 Hz-to-100 kHz

Independently Variable Duration and Period

80 V Output

Variable Rise Time and Fall Time

Delay Mode

The PG 505 Pulse Generator features: floating output; high output amplitude (80 volts); independently adjustable rise and fall times; independently variable pulse duration and period; external control of period or period and duration. The instrument is useful in the educational lab as a general-purpose pulse generator. A special position on the pulse period and pulse duration controls allows addition of an internal capacitor to custom-select pulse period and duration. When driven from an externally supplied 0 to 10 volt ramp, the delay control of the PG 505 permits the output pulse to occur at any selected voltage point on the ramp, thus providing controllable time delay to any set time along the ramp.

Pulse Period — 10 μ s or less to 100 ms (within 5%) in decade steps. Continuously variable between steps and to at least 1 s.

Pulse Duration — 5 μ s or less to 50 ms (5 μ s to 5 ms within 5%, 50 ms within 20%) in decade steps. Continuously variable between steps and to at least 0.5 s.

Duty Factor — (pulse duration/pulse period), 0 to 100%.

Pulse Rise Time and Fall Time — 1 μ s or less to 1 ms in decade steps with T_R or T_F controls set at (X1). T_R or T_F control extends time to at least 20 ms. Accurate within 5% with T_R or T_F set at (X1).

Aberrations — Within 5% peak to peak at maximum output into 4 k Ω , 20 pF load.

Residual Dc Offset — Less than 0.5% at maximum output.

Pulse Amplitude — 4 V or less to at least 80 V from a 4 k Ω source. Polarity selectable for + or - output.

Isolation of Pulse from Ground — 200 V dc.

Trigger Output — 0 to $+4$ V into 50 Ω .

External Trigger/Duration Input — Accepts TTL level signals.

Delay Mode — Delay range (with respect to delay signal) 0 to 10 V within 5%.

Delay Jitter — Less than 0.1% with a 10 V ramp input signal.

Custom Pulse Duration Range — 5 μ s and slower depending on internally installed capacitor.

Custom Pulse Period Range — 10 μ s and slower depending on internally installed capacitor.

PG 505 Pulse Generator

2620 STIMULUS ISOLATOR

The PG 505 Pulse Generator may be used to produce biophysical stimuli when used in conjunction with the 2620 Stimulus Isolator. Stimulus pulse polarity and timing are determined by the input to the 2620 (output of the PG 505). Stimulus pulse amplitude is controlled at the 2620. A high degree of isolation from the PG 505 and its common mode power source is achieved through use of optical coupling and battery power. The 2620 Stimulus Isolator permits true differential tissue stimulation.

INPUT

Required Current for + Output — $+10$ mA to $+20$ mA.

Required Current for - Output — -10 mA to -20 mA.

OUTPUT

Isolation, Output to Input — Impedance, $1 \times 10^{10} \Omega$ or greater, shunted by 10 pF or less. Voltage, 500 V maximum.

Ranges — 0 to $\pm 300 \mu$ A, 0 to ± 3 mA, or to ± 30 mA. + current and - current are independently variable and continuously calibrated.

Maximum voltage is 100 V. Output impedance is greater than 10 M Ω shunted by approximately 25 pF.

Rise Time, Fall Time — Less than 2 μ s when load resistance is 3.3 k Ω or less.

2620 Stimulus Isolator

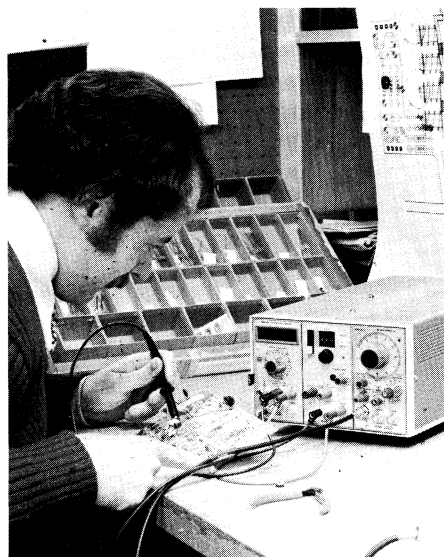
Extra Batteries — Nickel Cadmium.
Order 146-0005-00

MANUAL (ONE-SHOT) TRIGGER GENERATOR

The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or complete train of events with instruments which do not have a manual trigger button or where a remote operation capability is desired, such as with some oscilloscopes and the PG 501, PG 505, and RG 501.

Order 016-0597-00

FG 501, FG 502 and FG 503 Function Generators



The function generator is one of the most rapidly growing types of signal sources due to its extreme versatility and reasonable cost. They provide a variety of waveshapes, including triangular, square, sine and in some cases pulses and ramps. Triangular

waveforms, used in conjunction with oscilloscopes, determine the overload (clipping) point of amplifiers. Square waveforms simultaneously reveal low frequency response (by sag), high frequency response (by rise time), and transient response (by ringing and other aberrations) of amplifiers. Sine waves, universal in the electronics industry, show the full frequency response of various devices. Further, pulses and square waves are used as clock and signal sources in logic circuitry. Ramps and triangles provide time bases for oscilloscopes and paper recorders, and test signals for voltage comparators. The high frequency coverage of modern function generators extends into the audio, video, and radio spectra, and is useful in the telecommunications field as a modulation signal source. Their extreme low frequency range is useful in biological and geophysical simulations, servo systems, mechanical testing and simulations, and other applications. The VCF (voltage controlled frequency) feature permits a function generator plus externally supplied ramp to act as a sweep generator with up to a 1,000:1 sweep range for broad-band amplifier testing. The same VCF input, fed from a

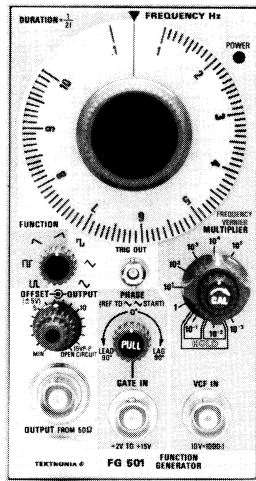
low-level modulating signal, provides a frequency-modulated carrier. The gate or burst feature is useful to test tone-controlled systems and loud-speaker transient response characteristics, and also provides half-sine pulses.

The three TM 500 function generators share many similar features. All provide the three basic waveforms (triangular, square, and sine), independent offset and amplitude controls, and a VCF capability with up to 1,000:1 range. The FG 501 provides $\pm 90^\circ$ control over the starting phase of the output waveform in burst mode while the FG 503 provides the highest output amplitude of the three instruments. Further, the FG 503 features a custom (c) position on the range switch. By installing the appropriate value of capacitor in the instrument, the user can make this "c" range cover any desired three-decade portion of the spectrum between 1 Hz and 3 MHz (fully specified), 0.01 Hz and 5 MHz (useable).

COMPARISON CHARACTERISTICS

	FG 501	FG 502	FG 503
Waveforms	Sine, Square, Triangle, Pulse, Ramp		Sine, Square, Triangle
Frequency Range	0.001 Hz to 1 MHz	0.1 Hz to 11 MHz (pulse, ramp 1.1 MHz max)	1.0 Hz to 3 MHz (usable 0.01 Hz to 5 MHz)
Amplitude Open Circuit	15 V p-p max, 0.5 V p-p min	10 V p-p max	20 V p-p max
Into 50 ohms	7.5 V p-p max, 0.25 V p-p min	5 V p-p max	10 V p-p max
Offset	± 5 V dc open circuit, ± 2.5 V dc into 50 Ω load		
Output Impedance	50 ohms		
Amplitude Flatness Sine Wave	± 1.5 dB, 0.001 Hz - 1 MHz ref. 10 kHz	± 1.5 dB, 0.1 Hz - 11 MHz ref. 10 kHz	± 2 dB, 0.1 Hz to 3 MHz ref. 10 kHz
Square, Triangle	± 1 dB ref. sine	± 3 dB ref. sine	± 1 dB ref. sine
Frequency Stability	$\leq 0.05\%$ for 10 min, $\leq 0.1\%$ for 1 hour, $\leq 0.5\%$ for 24 hours		
Sine Wave Distortion	$\leq 0.5\%$ 1 Hz to 20 kHz $\leq 1.0\%$ 20 kHz to 100 kHz $\leq 2.5\%$ (-32 dB) 100 kHz to 1 MHz	$\leq 0.5\%$ 10 Hz to 50 kHz ≤ -30 dB at all other frequencies	$\leq 0.5\%$ 1 Hz to 30 kHz $\leq 1.0\%$ 30 kHz to 300 kHz $\leq 2.5\%$ 300 kHz to 3 MHz
Square Wave Response	≤ 100 ns rise and fall $\leq 5\%$ total aberrations	≤ 20 ns rise and fall $\leq 3\%$ total aberrations	≤ 60 ns rise and fall $\leq 3\%$ total aberrations
Triangle Linearity	1% 0.001 Hz to 100 kHz 2% 100 kHz to 1 MHz	1% 0.1 Hz to 110 kHz 3% 100 kHz to 1.1 MHz 5% 1 MHz to 11 MHz	1% 1.0 Hz to 100 kHz 5% 100 kHz to 3.0 MHz
Voltage Controlled Frequency	1000:1 max with 0-10 V external signal Max input slew rate, ≥ 0.5 V/ μ s		
Burst/Gate	Input impedance, 1 k Ω . Control signal required $+2$ V; $+15$ V max. Bursts are synchronous with gate. Phase continuously variable from -90° to $+90^\circ$.	Control signal required, $+2$ V not to exceed $+15$ V. Bursts are synchronous with gate	Not Applicable
Trigger Output	TTL compatible; $+2.5$ V into 600 Ω	$+2.5$ V into 50 Ω	$+2.5$ V into 600 Ω

FG 501, FG 502 and FG 503 Function Generators



FG 501

Five Waveforms

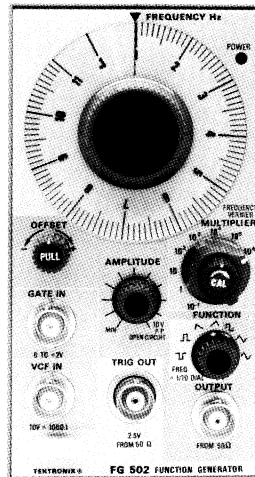
.001 Hz to 1 MHz

VCF and Gated Burst

Hold Mode

The FG 501 is a general-purpose, low frequency Function Generator producing low distortion sine, square, triangle, pulse, and ramp waveforms. Frequency is selectable from .001 Hz to 1 MHz (switched in decade steps). An external VCF input permits controlling the output frequency from an external voltage source. Frequency sweep up to 1,000:1 ratio may be accomplished by applying a voltage ramp to the VCF input. A hold control allows the operation of the generator to be halted instantaneously at any point in its cycle. Release of the hold will then allow the operation to continue normally. A gate input is provided to allow "burst" or single cycle operation, with the phase of the generator output at the start of the burst controllable over a $\pm 90^\circ$ range. Output signal voltage is adjustable to 7.5 V p-p into a 50-ohm load, with dc offset also adjustable up to ± 2.5 V.

FG 501 Function Generator



FG 502

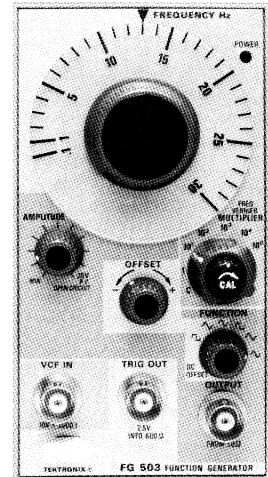
Five Waveforms

0.1 Hz to 11 MHz

VCF and Gated Burst

The FG 502 Function Generator provides low-distortion sine, square, and triangle waveforms, and positive or negative ramps and pulses. Output frequency is continuously variable from 0.1 Hz to 11 MHz and can be controlled either from the front panel or remotely over 3 decade ranges by an external voltage. The high frequency range from 1 to 11 MHz permits the versatility of the function generator to be extended into the medium radio frequency range. This higher frequency capability allows measuring bandwidth of filters or frequency response of video amplifiers, and simulating transmitted signals into broadcast band frequency receivers. Voltage controlled frequency input permits the FG 502 to be used as a sweep generator. The external gate input permits the FG 502 output in any of its modes to be controlled by an externally supplied pulse to generate bursts of various output waveforms. This feature has application in wireline or radio remote control equipment and in certain phases of the telephone industry.

FG 502 Function Generator



FG 503

Three Waveforms

1.0 Hz to 3 MHz

VCF

The FG 503 Function Generator provides high quality low distortion sine, square, and triangle waveforms. Six decade frequency multiplier steps, a custom position for user-determined frequency multiplication, a dial calibrated from 1.0 to 30 (uncalibrated from 0.1 to 1.0), and a frequency vernier control work together to select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency may be swept over a 1,000:1 ratio by an external voltage. Output amplitude and offset controls are provided. A trigger output is available for controlling external devices or equipment. Amplitude up to 10 V p-p can be developed across a 50-ohm load (20 V p-p open circuit). Selectable offset up to 2.5 V dc across 50 ohms (5 V dc open circuit) is also featured.

FG 503 Function Generator

Audio/Miscellaneous Generators

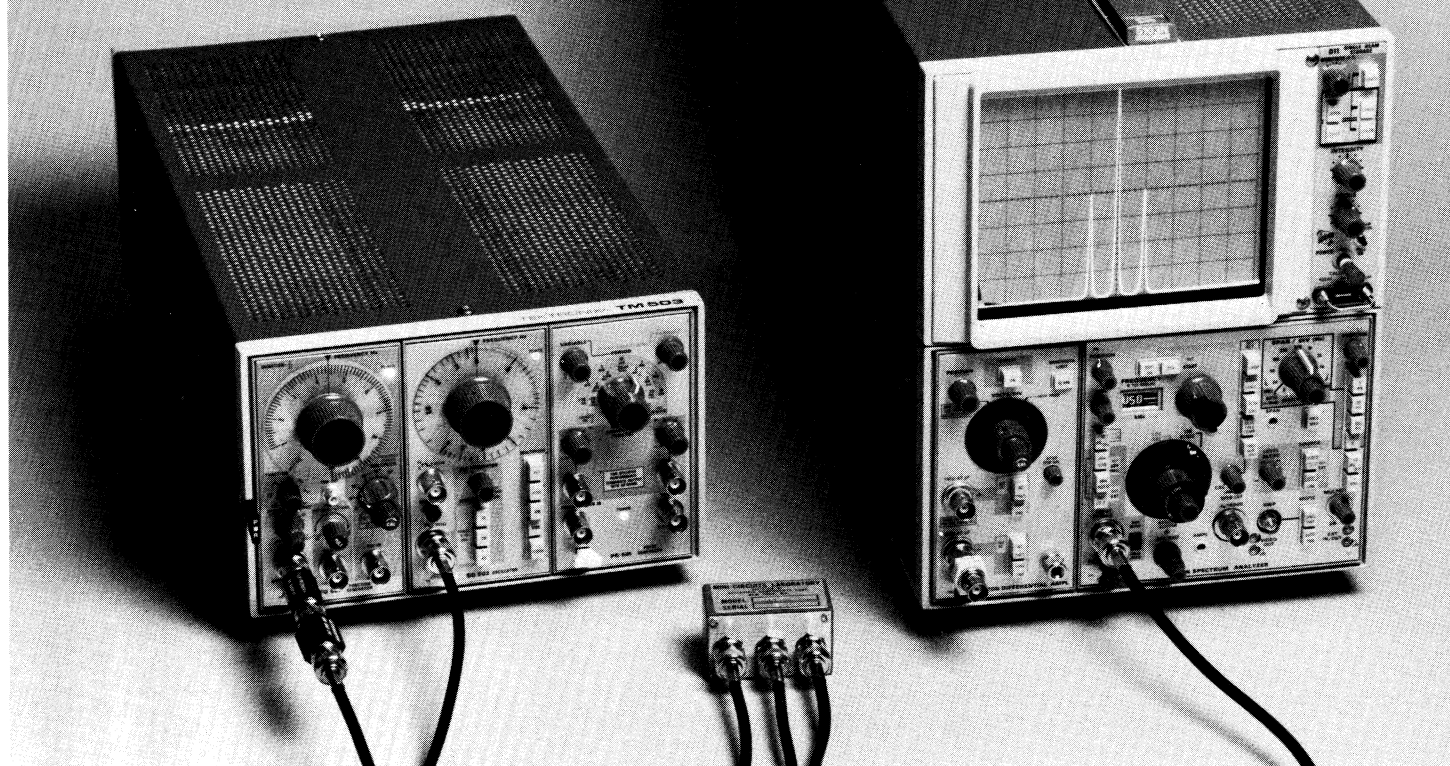
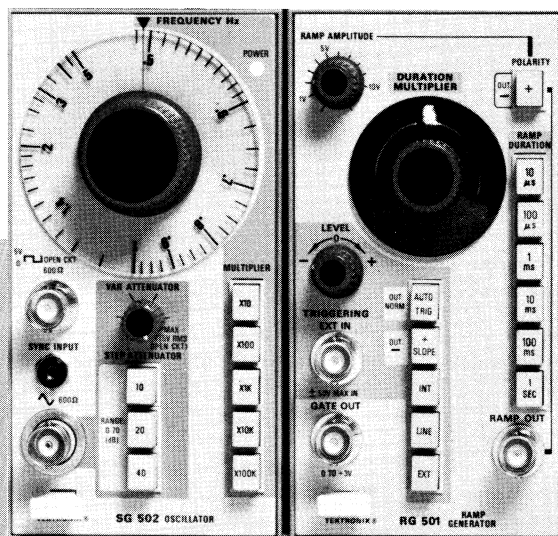
The Audio/Miscellaneous Generators include the SG 502 Audio Oscillator and the RG 501 Ramp Generator. The SG 502 Audio Oscillator features extremely low distortion and wide-range flat response for critical audio and communication systems and component testing. The RG 501 Ramp Generator provides single or repetitive ramps of controllable amplitude and duration, excellent linearity, and short retrace time.

The SG 502 Oscillator is an RC design featuring distortion less than 0.035% over the entire audio range of 20 Hz to 50 kHz. Distortion does not exceed 0.1% over the balance

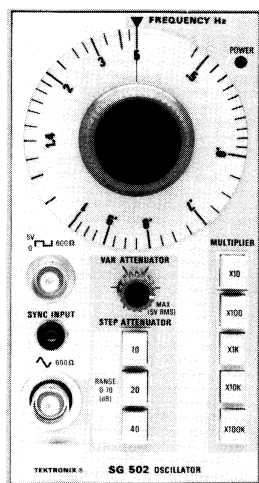
of its 5 Hz to 500 kHz coverage. Output amplitude is flat with ± 0.3 dB over the entire range. The output impedance is the 600 ohm audio industry standard. Amplitude control of over 70 dB is available in 10 dB steps plus a 40 dB variable attenuator. A fixed-amplitude square wave is present simultaneously. The SG 502 is used in various applications in conjunction with several other TM 500 instruments. One of these is the Audio Frequency Communications package, as discussed, where it and the DM 502 and DC 504 find ready application in telephonic communications, as well as in fields which use telephone lines for voice or low-speed data

transmission, like the broadcasting industry and computer time-sharing industry.

Frequently, the RG 501 Ramp Generator is used in conjunction with other TM 500 instruments; for instance, function generators, the PG 505 Pulse Generator, the MR 501 Monitor or other TEKTRONIX Crt Monitors, or an X-Y recorder. The ramp generator's output is an ideal time base for the monitor or recorder. Used with the PG 505 Pulse Generator, the RG 501 permits a pulse to be triggered at any selected point along a ramp: A single PG 505 and RG 501 can generate pulses delayed a controlled time following the RG 501 gate output and multiple PG 505's can be driven from one RG 501 to generate delayed pulse trains of almost any description. With any of the TM 500 function generators, where VCF (voltage controlled frequency) input is fed by the RG 501 output, a linear frequency sweep of up to 1,000:1 width may be generated.



SG 502 and RG 501 Audio/Miscellaneous Generators



SG 502

5 Hz to 500 kHz Sine and Square Waves

Extremely Low Distortion Sine-wave Shape

5 V Rms Open Circuit—600 Ω Source

0-40 dB Continuously Variable Plus 0-70 dB in 10 dB Steps

SINE WAVE

Frequency Range — 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to less than 50 kHz; within 10% of dial setting from 50 kHz to 500 kHz.

Amplitude Response — Flatness is 0.3 dB over entire range (1 kHz reference).

Attenuation — Selectable from 0 dB to 70 dB in 10, 20 and 40 dB steps with push buttons. Accurate within 2% for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to 40 dB.

Harmonic Distortion — Less than 0.035% from 20 Hz to 50 kHz. Less than 0.1% over the remaining frequency range.

Hum and Noise — Less than 0.1% of rated output.

Maximum Output Voltage — 5 V rms open circuit; 2.5 V rms into 600 Ω .

Output Impedance — 600 Ω , single ended.

SQUARE WAVE

Frequency Range — Same as sine wave. The square wave switches on at the 0° and 180° of sine out.

Rise and Fall Time — 50 ns or less.

Amplitude — +5 V, fixed, open circuit.

Output Impedance — 600 Ω , single ended.

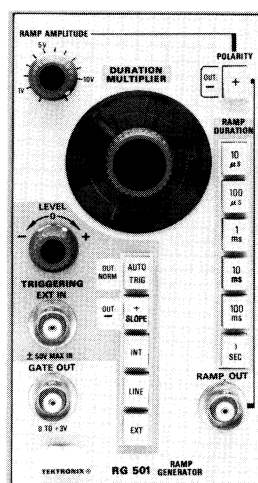
SYNC INPUT

Oscillator can be synchronized to external signal. Sync range, the difference between sync frequency and set frequency, is a linear function of sync voltage.

Input Impedance — 10 k Ω .

Measurements made at rated output and terminated in 600 Ω .

SG 502 Oscillator



RG 501

10 μ s to 10 s Ramp Duration

Plus or Minus Output

10-V Amplitude

Scope-type Trigger Functions

Gate Out, TTL Compatible

RAMP

Ramp Duration — Decade ranges of 10 μ s to 1 s, extends to 10 s with 1-10 duration multiplier. Accurate within 3% when multiplier is at X1 (multiplier not calibrated).

Ramp Amplitude — Continuously variable from 50 mV or less to at least 10 V, either polarity. Dc level between ramps, 0 V within 20 mV.

Gate — From a low state of 0 V, within 100 mV, the ramp gate rises to +3 V, within 0.6 V, in 100 ns or less. Fall time is 100 ns or less. Gate source impedance is 160 Ω , within 5%.

Ramp Output Characteristics — Minimum load resistance, 3 k Ω ; maximum load capacitance, 300 pF.

TRIGGERING

Auto Triggering — Provides free-running signal in absence of trigger. Locks automatically to trigger with a frequency above 20 Hz and at least 200 mV amplitude.

External Triggering — Sensitivity is at least 200 mV p-p, dc to 100 kHz. Input impedance approx 9.5 k Ω . 50 V (dc + peak ac) maximum input.

Internal Triggering — Same as external except that the trigger source is via the rear interface.

Line Trigger — Triggers at line frequency.

Trigger Level Range — ± 1 V.

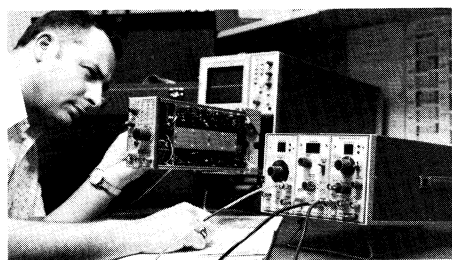
Optional Accessory — Manual (One-Shot) Trigger Generator

Order 016-0597-00

RG 501 Ramp Generator

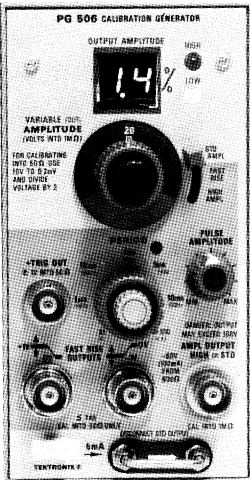


PG 506, SG 503 and TG 501 Oscilloscope Calibration Instruments



TEKTRONIX TM 500 Oscilloscope Calibration Instruments set the state-of-the-art in every respect in oscilloscope calibration. These instruments provide the widest range of standard amplitude square waves, fastest rise times, lowest aberrations, fastest time marks, and widest frequency range of leveled sine waves available from any calibration equipment.

Furthermore, the TM 500 Oscilloscope Calibration Instruments simplify and speed up verification procedures, assuring a high level of performance and minimum costs. For example, the TG 501 provides a variable mode in addition to its crystal-controlled mode. In the variable mode, the time mark spacing can be quickly adjusted to exactly align with the oscilloscope graticule marks. The resulting percentage timing error is then read directly off the TG 501 digital display. The superior multi-instrument portability of the TM 500 concept lets this rapid verification take place at the oscilloscope usage location, since the entire calibration facility now occupies one small package with a single handle. This on-site verification increases accuracy and time-savings still further.



PG 506
CALIBRATION GENERATOR

Three Square-Wave Output Modes

10 Hz to 1 MHz

Direct Readout of Oscilloscope Deflection Error

The PG 506 is a Calibration Generator for oscilloscopes with three modes of square-wave output, selectable dc outputs, and a variable-amplitude output with front-panel digital indication of oscilloscope deflection error. For checking attenuator performance and transient response of oscilloscopes, simultaneous plus and minus low-level, fast-rise (1.0 ns) square waves or high amplitude (60 volt) extremely clean square waves are available at frequencies from 10 Hz through 1 MHz. A 5-milliamp calibration current loop is useful for current probe calibration. In the amplitude calibration mode, a 1-kHz square wave is generated whose peak-to-peak amplitude is selectable in a 1-2-5 sequence from 200 microvolts to 100 volts. In this same mode, amplitude may be varied around the calibrated level until the square wave aligns with the oscilloscope vertical graticule divisions; scope deflection error is then read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance. An internal switch permits selection of continuous dc instead of the 1-kHz square wave at the 5-milliamp current loop and the amplitude calibration output.

OSCILLOSCOPE CALIBRATION INSTRUMENTS CHART

The following chart is a comparison of the three instruments making up the Oscilloscope Calibration Instruments.

A complete list of specifications appears on the following pages.

	PG 506 Calibration Generator	SG 503 Signal Generator	TG 501 Time Mark Generator
Primary functions	Amplitude calibration 200 μ V to 100 V	Bandwidth calibration 250 kHz to 250 MHz	Time-base calibration 1 ns to 5 sec
Secondary functions	Rise time and transient response testing, attenuator compensation testing	General leveled RF signal source	Testing oscilloscope nonlinearity
Accuracies	Amplitude $\pm 0.25\%$	Amplitude $\pm 1\%$ to 100 MHz, $\pm 3\%$ to 250 MHz; Frequency 0.01% ± 0.7 count (or least significant digit).	Time 0.001% / month standard, 0.00001% / month Option 1
Other	Dc available instead of square wave, 5 mA current loop, variable amplitude around standard voltage with digital display of oscilloscope deflection error when signal is aligned with graticule.	50 kHz reference. Built-in digital frequency readout. Amplitude range 5.5 V p-p to 5 mV p-p.	Variable time marks around standard values with digital display of oscilloscope timing error when signal is aligned with graticule.

PG 506, SG 503 and TG 501 Oscilloscope Calibration Instruments

AMPLITUDE CALIBRATOR MODE

Period — Fixed at approximately one millisecond.

Amplitude — From 100 V p-p to 200 microvolts p-p in 1-2-5 sequence, accurate within $\pm 0.25\%$ into 1 M Ω . 5 V p-p to 100 microvolts p-p into 50 Ω .

Error Readout Range — $\pm 7.5\%$.

Error Readout Resolution — 0.1%.

PULSE MODE

Period — One microsecond to 10 milliseconds (within 5%) in decade steps with the VARIABLE control on CAL position. VARIABLE extends period to at least 100 milliseconds.

Symmetry — Approximately 50% duty cycle.

HIGH AMPLITUDE OUTPUT

Rise Time — Underterminated: 100 ns or less. Terminated into 50 Ω . 10 ns or less.

Amplitude Range — Underterminated: 6 V or less to at least 60 V. Terminated into 50 Ω : 0.5 V or less to at least 5 V.

Leading Edge Aberrations — Within 2% or 50 mV p-p, whichever is greater, when terminated in 50 Ω .

Polarity — Positive going from a negative potential to ground.

Output Resistance Source — 600 Ω within 5%.

FAST RISE OUTPUTS

Rise Time (Terminated into 50 Ω) — 1.0 ns or less.

Amplitude Range (Terminated into 50 Ω) — 100 mV or less to at least 1.0 V.

Leading Edge Aberrations — 2% or 10 mV p-p, whichever is greater, during first 10 ns.

Flatness — Within 0.5% after first 10 ns.

Polarity — Simultaneous positive and negative going. Positive going is from a negative rest potential to ground. Negative going is from a positive rest potential to ground.

Output Resistance Source — 50 Ω within 3% at + and — output connectors.

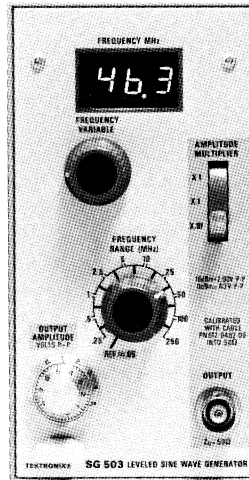
Trigger Output (Terminated into 50 Ω) — Positive-going signal of at least 1 V.

PG 506 Calibration Generator

TUNNEL DIODE PULSER

The Tunnel Diode Pulser (067-0681-01) provides a clean, fast-rise pulse for adjusting the transient response of high-frequency oscilloscopes and other instruments. The Tunnel Diode Pulser can be driven by the PG 506 Calibration Generator at repetition rates exceeding 50 Hz. Output amplitude of the pulse is approximately 250 mV into 50 ohms, while rise time is ≤ 125 ps; aberrations are $< 1\%$ in a 1-GHz system.

Order 067-0681-01



SG 503

SIGNAL GENERATOR

Leveled, Variable Output

250 kHz to 250 MHz

Digital Readout of Frequency

The SG 503 Signal Generator is a general-purpose leveled sine-wave oscillator. It provides a leveled output amplitude which is variable from 250 kHz to 250 MHz. The selected frequency is indicated by a built-in autoranging frequency counter with a three-digit LED read-out on the front panel. Accurately calibrated output voltage into 50 ohms is variable from 5 mV to 5.5 V peak-to-peak.

Frequency Range — 250 kHz to 250 MHz, plus 50 kHz reference frequency.

Accuracy — Within ± 0.7 of least significant digit of indicated frequency.

Amplitude Range — 5 mV to 5.5 V peak-to-peak into 50 Ω termination in three decade ranges.

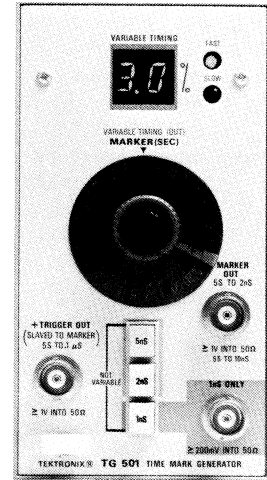
Amplitude Accuracy — (50 kHz reference) within 3% of indicated amplitude on (X1) range, 4% on (X.1) range and 5% on (X.01) range.

Flatness — (peak-to-peak). From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to $+1.5\%$, -1% variation may occur between 50 MHz and 100 MHz on amplitude multiplier X .1 and X .01 ranges only. From 100 MHz to 250 MHz, amplitude variation is within 3% of the value at 50 kHz.

Harmonic Content — Second harmonic at least 35 dB down. Third and all higher harmonics at least 40 dB down.

Other — Rear edge card connection available to address the leveling circuit.

SG 503 Signal Generator



TG 501

TIME MARK GENERATOR

Marker Outputs, 5 s to 1 ns

Direct Readout of Oscilloscope Timing Error

External Trigger Output

The TG 501 Time Mark Generator provides marker outputs from five seconds to one nanosecond. A unique feature on the TG 501 is a variable timing output with a front-panel two-digit LED display which indicates percentage of timing error between the normal time interval and a variable interval set to line up the marker pulse with graticule or division mark on the display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually estimating error from a display.

Markers — 1 ns through 5 s in a 1-2-5 sequence.

Marker Amplitude — ≥ 1 V peak into 50 Ω on 5 s through 10 ns markers. ≥ 750 mV peak-to-peak into 50 Ω on 5 ns and 2 ns markers. ≥ 200 mV peak-to-peak into 50 Ω on 1 ns markers.

Trigger Output Signal — Slaved to marker output from 5 s through 100 ns. Remains at 100 ns for all faster markers.

Internal Time Base	Standard	Option 1
Crystal Frequency	1 MHz	5 MHz
Stability (0° to 50° C) after $\frac{1}{2}$ hour warm-up	Within 1 part in 10^5	Within 5 parts in 10^7
Long-term Drift	1 part or less in 10^5 per month	1 part or less in 10^7 per month
Setability	Adjustable to within 1 part in 10^7	Adjustable to within 5 parts in 10^9

External Reference Input — Available with internal changes. Acceptable frequencies, 1 MHz, 5 MHz or 10 MHz. Input amplitude must be TTL compatible.

Timing Error Readout Range — to $\pm 7.5\%$. **Resolution** — to 0.1%.

TG 501 Time Mark Generator

Option 1, 5 MHz Time Base

PS 501, PS 501-1, PS 501-2, PS 503A, PS 505 Power Supplies

Direct current is almost invariably required for active devices, transducers, and many electromechanical components. Research, development, and design activities require supply voltages for the experimental or breadboard circuits and devices involved. Troubleshooting and maintenance, particularly when boards, modules, or sub-assemblies are removed for testing, also require versatile sources of direct current. Measurement systems often require dc for the basic transducers. While the possible combinations of voltage and current are infinite, modern semiconductors have decreased the typical maximum power requirements and have also produced some standardization of voltages. Most families of digital integrated circuits operate with a single 5-volt supply. Many operational amplifier IC's and other types of linear IC's operate with supply voltages in the 12- to 15-volt range, frequently requiring both positive and negative supplies. Complementary MOS (CMOS) logic typically can be powered by potentials ranging from a few volts to almost 20 volts.

The TM 500 line of power supplies features versatility and flexibility, with up to three independent voltages available from a single plug-in instrument. Four of the five power supplies feature a fixed 5-volt-at-1-amp supply for logic circuits or indicators plus one or two variable supplies. Three of these units—the PS 501, PS 501-1, and PS 501-2—are basically similar except for their means of voltage adjustment and indication. Each features a floating 0-to-20-volt output and adjustable current limiting from 0 to 400

milliamps with constant current operation above the limiting setting. The PS 501 uses a dual knob, coarse and fine control. The PS 501-1 precision supply uses a multi-turn potentiometer with a mechanical digital readout for precise setting and adjustment of the output voltage. The PS 503A provides a dual $-20-0+20$ volt variable supply plus a 5 volt 1 A independent supply. The $-20-0+20$ volt supply can be varied in a tracked mode, or each part set individually. The two variable outputs each provide up to 1 amp in the high-power compartment of a TM 504 or TM 506, or 400 mA maximum in all other compartments of any TM 500 mainframe.

In the tracking mode, the plus and minus supplies are varied by one knob in proportion to the voltage ratio set on their individual controls. In the non-tracking mode each can be set independently to any voltage from 0 to 20 V. Since all three of the variable supply terminals are floating, any one can be grounded or the two outside terminals used as a 0-to-40 volt supply. Both positive and negative variable supplies have their own current limiting. In the high power slot (the far right hand compartment) the PS 505 features a floating 3-to-5.5-volt output at up to 4 amperes with adjustable current limiting. In any other compartment, the maximum current available is 1 ampere and the output is non-floating (negative grounded). A front-panel indicator light shows whether the PS 505 is in a standard or a high-power compartment. The PS 505 is particularly useful for powering TTL and ECL circuitry.

CHARACTERISTICS COMMON TO PS 501, PS 501-1, PS 501-2, PS 503A

20 V FLOATING SUPPLY

Primary Power Input — Determined by power module (TM 501, TM 503, etc.).

Output — Floating, isolated from ground, 350 V dc + peak ac.

Stability — (0.1% \pm 5 mV) or less drift in 8 hours at constant line, load and temperature.

Indicator Lights — Voltage variation and current limit.

± 5 V GROUND-REFERENCED SUPPLY

Output — 4.8 to 5.2 V dc at 1 A (20°C to 30°C).

Load Regulation — Within 100 mV with a 1 A load change.

Line Regulation — Within 50 mV for a 10% line voltage change.

Ripple and Noise (1A) — 5 mV p-p or less; 100 μ V rms or less.

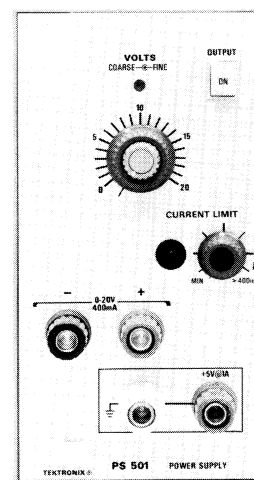
Stability — 0.5% or less drift.

Overload Protection — Automatic current limiting and over-temperature shutdown.

OPTIONAL ACCESSORY

Terminal Access Adapter Kit — For breadboarding and fixturing. Plugs directly onto front of PS 501 - PS 505. See accessory section for more details.

Order 013-0152-00



**PS 501
POWER SUPPLY**

**Floating Output, 0-20 V
0 to 400 mA**

Precise Regulation

Low Ripple and Noise

Fixed Output ± 5 V

Output — 0 V to 20 V dc.

Current Limit — 0 mA to 400 mA.

Minimum Resolution — 10 mV.

Line Regulation — Within 5 mV for a $\pm 10\%$ line voltage change.

Load Regulation — Within 1 mV with a 400 mV load change.

Ripple and Noise — 0.5 mV p-p or less; 0.1 mV rms or less.

Temperature Coefficient — 0.01%/°C or less.

Transient Recovery Time — 20 μ s or less for a constant voltage to recover within 20 mV of nominal output voltage after a 400 mA change in output current.

PS 501 Power Supply

POWER SUPPLIES—COMPARISON OF CHARACTERISTICS

The following is a comparison of the major characteristics of the power supplies.

A complete list of specifications may be found on the following pages.

	PS 501	PS 501-1	PS 501-2	PS 503A	PS 505
Voltage/Current #1	± 5 V @ 1 A	± 5 V @ 1 A	± 5 V @ 1 A	± 5 V @ 1 A	3 — 5.5 V @ 4 A*
Voltage/Current #2	0-20 V @ 400 mA	0-20 V @ 400 mA	0-20 V @ 400 mA	0 to $+20$ V @ 1 A*/400 mA**	No
Voltage/Current #3	No	No	No	0 to -20 V @ 1 A*/400 mA**	No
Current limit	0-400 mA	0-400 mA	0-400 mA	0-1 A*/400 mA**	0 — 4.0 A
Min. resolution	10 mV	1.6 mV	10 mV	10 mV	—
Foldback current	No	No	No	No	Yes > 4.0 * A foldback to < 1.5 and latches
Over voltage protection	No	No	No	Yes	Yes
Line regulation	< 5 mV††	< 5 mV††	< 5 mV††	< 5 mV†††	< 10 mV†
Ripple & noise p-p	0.5 mV††	0.5 mV††	0.5 mV††	0.5 mV†††	3 mV†
Others	Simple knob control	Multi-turn pot with digital readout	Meter for voltage or current	$+$ — outputs independent, or dual tracking at ratio set by individual knobs	

*In high-power (right-hand) compartment of TM 504 or TM 506.

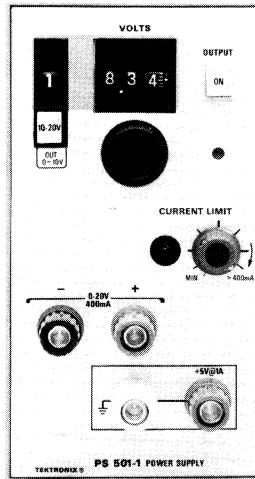
**In any standard mainframe compartment.

†Refers to output #1

††Refers to output #2

†††Refers to output #2 and #3

PS 501, PS 501-1, PS 501-2, PS 503A, PS 505 Power Supplies



**PS 501-1
POWER SUPPLY**

Features of PS 501 plus:

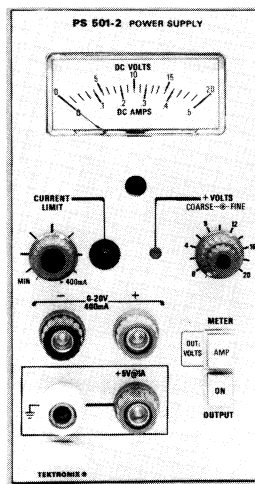
Precision Voltage Control

Easy to Read and Set

Minimum Resolution — 1.6 mV.

Voltage is selectable within 0.5% by a 10 turn potentiometer with a 3-digit in-line dial and range switch. Other specifications same as PS 501.

PS 501-1 Power Supply



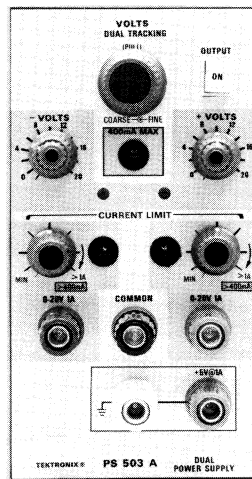
**PS 501-2
POWER SUPPLY**

Features of PS 501 plus:

Dual-Range Meter Readout

Meter — Dual range, 0 to 500 mA or 0 to 20 V dc. Accuracy, $\pm 2\%$ of full scale. Other specifications same as PS 501.

PS 501-2 Power Supply



**NEW PS 503A
TRIPLE POWER SUPPLY**

Independent + and — Controls

Dual Tracking Voltage Control

0 to ± 20 V at 1 A

Fixed 5 V at 1 A

Remote Resistance Programming

Over-voltage Protection Standard

The PS 503A features superior dual tracking performance, over-voltage protection, and remote resistance programming of voltage. When operated in the high-power compartment of a TM 504 or TM 506 mainframe, the PS 503A provides up to 1 amp from both + and —, 0-to-20 volt supplies.

± 20 V FLOATING SUPPLIES

Output — 0 to ± 20 V dc with respect to the common terminal or 0 to 40 V dc across the + and — terminals. Outputs can be varied independently or at a constant ratio.

Tracking Mode Offset Error — If the two supplies are set independently to any given voltage ratio and then varied by use of the VOLTS DUAL TRACKING control, the two supplies will maintain the same voltage ratio as initially set within ± 50 mV.

Current Limit — Adjustable 0 to 1 A (high-power compartment) or 0 to 400 mA (standard compartment) on each supply.

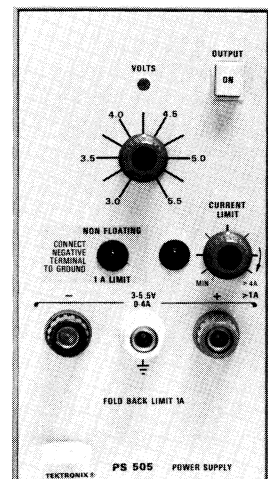
Load Regulation — Within 3 mV for 1 A change (high-power compartment) or 1 mV for 400 mA change (standard compartment).

Ripple and Noise — 3 mV p-p or less at 1 A load (high-power compartment). 0.5 mV p-p or less at 400 mA load (standard compartment).

Indicators — Individual voltage indicators and current limiting indicators for both + and — supplies. Non-high-power compartment (400 mA) indicator.

Other specifications same as PS 501.

PS 503A Power Supply



**PS 505
POWER SUPPLY**

Floating Output

3 to 5.5 V at 4 A

Overvoltage Protection Standard

Remote Resistance Programming of Voltage

The PS 505 is a variable, low voltage, high current, dc power supply. It is designed to operate in the high-power compartment of a TM 504 or TM 506 Power Module. In the high-power compartment, it provides a floating 3.0 to 5.5 V dc at 4.0 A. Operating in a standard compartment of TM 500-Series Power Module, the PS 505 will supply at least 1.0 A non-floating (negative ground).

Line Regulation — Within 10 mV for a $\pm 10\%$ line voltage change.

Load Regulation — Within 5 mV for 0.5 to 4.0 A load change.

Ripple and Noise — 3 mV peak-to-peak or less.

Temperature Coefficient — 0.01%/°C or less.

Stability — 0.1% ± 5 mV of drift in 8 hours.

Foldback Current — When output current exceeds 4.1 A, current folds back to less than 1.5 A and latches.

PS 505 Power Supply

AF 501, AM 501 and AM 502 Signal Processors

Signal processors are used to alter the characteristics of electrical signals in order to permit improved measurement and analysis. Typical examples include preamplification of low-level signals, addition or removal of dc offset, filtering to remove unwanted noise or signals outside the spectrum of interest, integration, differentiation, summing of multiple signals, impedance transformation, and post amplification to provide higher amplitude drive from low amplitude signal sources.

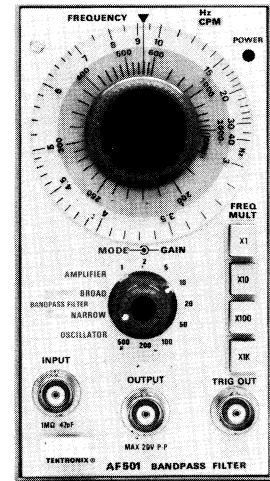
The TM 500 line of signal processors includes three versatile instruments, the AF 501 Bandpass Filter/Amplifier, the AM 501 Operational Amplifier and the AM 502 Differential Amplifier. Each is capable of being used in a variety of applications.

The AF 501 Bandpass Filter/Amplifier is an active filter whose center frequency is one-knob tunable over the entire audio range from 3 Hz to 35 kHz. Broad ($Q=5$) and narrow ($Q=15$) bandwidths are switch selectable. Flat amplification to 50 kHz is also available. In both filter and flat modes, amplification from 1 to 500 may be selected in a 1-2-5 sequence. The AF 501 also features an oscillator mode where the output frequency is the same as the center-tuned frequency in the filter modes. A signal output pulse, used for driving counters or oscilloscopes or for triggering stroboscopic lamps in study of mechanical systems, is also provided. The AF 501 selectivity permits individual analysis of the fundamental and harmonic compon-

ents of complex waveforms, such as signals from vibration transducers.

The AM 501 Operational Amplifier is a high-output unit with front-panel jacks for quick and easy change of configurations by selection of feedback components. The output power available (± 40 volts and ± 50 mA across loads of 800 ohms) is adequate for most electronic and many electro-mechanical applications. The AM 501 is ideal for classroom instruction and experimental use; it can be conveniently set up for various useful applications, such as differentiation, integration, summing, and impedance transformation. Where a more permanent use in a given configuration is desired, the feedback components may be hardwired inside the instrument.

The AM 502 Differential Amplifier is a highly flexible instrument giving control of gain, dc offset, low-frequency response, and high-frequency response. It may be used with single-ended input or in differential mode for maximum rejection of common-mode noise signals. High amplification may be used even with low-level signals having a dc component up to one volt, since the variable dc offset of the AM 502 can be used to cancel the signal's dc component. Full bandwidth of the amplifier is 1 MHz: switch-selectable high-pass and low-pass filters permit reducing the noise bandwidth when the full frequency range is not required.



**AF 501
BANDPASS FILTER**

- Tunable Bandpass Filtering to 35 kHz**
- Signal Amplification to 50 kHz**
- Sine-wave Generation to 35 kHz**
- Strobe Trigger Synced to Oscillator or Filter Output**
- Dial Readings in Hz or Cycles per Minute**

The AF 501 is a Bandpass Filter/Amplifier, ac-coupled amplifier and sine-wave generator combined in a single TM 500-Series module. Used alone or in conjunction with other TM 500-Series instruments, the AF 501 is a highly versatile and accurate signal analysis tool. Developed primarily for the mechanical

SIGNAL PROCESSORS — COMPARISON CHART

The following is a comparison of the main characteristics of the AF 501, AM 501 and AM 502.
A complete list of specifications appears on the following pages.

	AF 501 Tunable Bandpass Filter/Amplifier	AM 501 Operational Amplifier	AM 502 Differential Amplifier
Amplification range	1 to 500 in 1-2-5 steps	Depends on feedback components; open loop gain 10,000	1 to 100,000 in 1-2-5 steps
Input impedance	1 Meg	Depends on feedback components	1 Meg normal; FET input by internal jumper
Bandwidth control	Center frequency tunable 3 Hz to 35 kHz; $Q=5$ or 15	Depends on feedback components; max gain-bandwidth product 5 MHz	Independent switch-selected high-frequency and low-frequency filters
Maximum output	20 V p-p (Bandpass filter)	$\pm 40V$, ± 50 mA with 800 Ω load	± 5 V, ± 20 mA, output resistance 5 Ω or less
Other features	Functions as audio oscillator, narrow or wide bandwidth tunable filter and flat audio amplifier	Use as inverting or non-inverting amplifier, follower, summing amplifier, integrator, differentiator, etc., by appropriate feedback R and C	Coarse and fine control of up to ± 1 V of internal dc offset, ac or dc-coupling, single-ended or differential input, 25 μV equivalent input noise at full bandwidth

SC 501, MR 501, SC 502 Oscilloscope and Monitor

The ubiquitous cathode-ray oscilloscope is the world's most useful and versatile electronics test and measurement instrument. Tektronix, long identified with the oscilloscope, could hardly develop the TM 500 line of modular instrumentation without including crt display capability.

Three choices of performance level and display size are now available to add waveform display to the digital measurement capabilities of the TM 500 Multimeters and Counters.

The new SC 502 is a full-feature dual-trace 15 MHz Oscilloscope packaged as a double-width TM 500 plug-in. It features an exceptionally bright (12 KV) crt with an 8 x 10 division (0.25"/div.) graticule. A delay line allows observation of the full leading edge of waveforms. Vertical sensitivity is selectable from 1 mV/div to 20 V/div in 1-2-5 sequence, and sweep times can be chosen from 1.25 seconds/div to 20 nanoseconds/div. Sophisticated oscilloscope features include peak-to-peak auto trigger for hands-off operation with a wide variety of signals, selectable trigger hold-off for digital circuit applications, trigger view, and an A minus B vertical mode for differential viewing of signals.

The SC 501 is a complete triggered-sweep calibrated time base single-trace Oscilloscope. Y channel bandwidth is 5 MHz and sweep rates from 1 second per division to 200 nanoseconds per division are featured. In addition to display and measurement of external signals or waveforms generated by

TM 500 signal sources in the same power module, the SC 501 or SC 502 can also be integrated into more complex measurement packages. For example, the horizontal sweep on either oscilloscope also produces a ramp which is available on the rear interface connector, and this signal can be used to control other TM 500-Series instruments. The ramp can be used to sweep the function generator outputs of several TM 500 instruments, or as a delay source for the PG 505 Pulse Generator.

Both the MR 501 and SC 501 miniature 2.5 inch crt's with an internal 6 x 10 division

graticule of 0.203 inches per division. The MR 501 contains no time base and is optimized for X-Y displays. X and Y bandwidths are 2 MHz and the two channels are phase-matched. X, Y, and Z axis inputs all appear on the front panel.

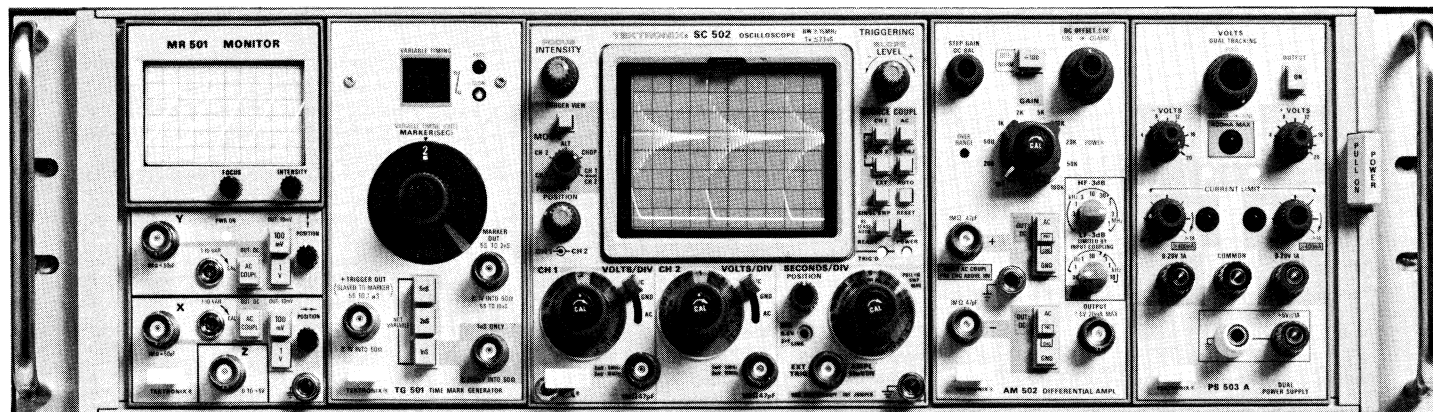
Where a time-calibrated display is required the RG 501 ramp output is compatible for use with the MR 501. Many useful functions, such as frequency sweeps, and delayed pulses or pulse trains, can be obtained by combining the MR 501 and RG 501 with a TM 500 Function Generator or the PG 505 Pulse Generator.

OSCILLOSCOPE AND MONITOR COMPARISON CHART

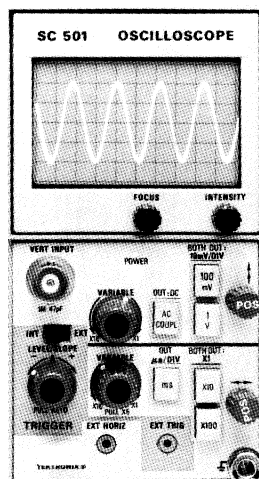
The following is a comparison of the main characteristics of the SC 501 and MR 501.

A complete list of specifications appears on the following pages.

	SC 502	SC 501	MR 501
Crt	8 x 10 divisions, 0.25"/div. P31 phosphor	6 x 10 divisions, 0.203"/div P31 phosphor	6 x 10 divisions, 0.203"/div P31 phosphor
Vertical (Y) axis	Dual-trace, 15 MHz, 1 mV to 20 V/div (5 and 10 MHz bandwidth at 1 and 2 mV) alt, chop, and ch 1 minus ch 2 modes	5 MHz bandwidth, 10 mV/div to 10 V/div	2 MHz bandwidth, 10 mV/div to 10 V/div
Horizontal (X) axis	Triggered sweep 200 ns/div to 0.5 sec/div with X10 magnifier, X2.5 variable, normal, p-p auto, ext/int trig, single sweep, external horizontal input, variable trigger hold off	Triggered sweep 1 μ s/div to 1 sec/div with X5 magnifier to 200 ns/div, normal/auto trigger, internal/external-trigger, external horizontal input	2 MHz bandwidth, 10 mV/div to 10 V/div, phase matched to Y axis within 1° from dc to 100 kHz.
Other features	Trigger view, 12 kV accelerating potential		



SC 501, MR 501, SC 502 Oscilloscope and Monitor



**SC 501
OSCILLOSCOPE**

5 MHz Bandwidth

Single Compartment Size

2½-inch Crt

Versatile Operating Features

The SC 501 is a single channel 5 MHz plug-in unit Oscilloscope with a 2.5 inch crt display which occupies a single TM 500-Series plug-in compartment. Oscilloscope capability significantly enhances the application range of the multifunctional TM 500-Series Test and Measurement Instruments.

With the SC 501 a multitude of versatile test systems may be structured from the TM 500-Series to suit specific needs for time and frequency response, modulating waveforms, power for devices under test, stimulus and response studies and voltage, current and temperature measurements. Since the SC 501 fits any TM 500 mainframe it can be used on the bench, in a rack, or on the road.

The single channel SC 501 has a calibrated vertical deflection range from 10 mV/div to 1 V/div, selectable in decade steps. A variable control extends this range to at least 10 V/div.

Calibrated sweep rates are selected by push-button logic in decade steps from 1 μ s/div to 100 μ s/div (microsecond), and from 1 ms/div to 100 ms/div (millisecond range). A variable control extends the slowest sweep rate to at least 1 sec/div and a fixed magnifier extends the fastest sweep rate to 200 ns/div.

A zero to 10 V ramp for all sweep rates (excluding the X5 magnification) is provided at a rear interface connector. This capability may be used for many auxiliary functions such as sweeping a Voltage Controlled Frequency Oscillator or obtaining variably delayed pulses from the PG 505 Pulse Generator.

The triggering circuits allow stable triggering from either internal or external sources. An AUTO triggering mode and manual LEVEL/SLOPE selection is combined in a single control. It is useful above 10 Hz and provides a bright baseline at all sweep rates.

An internal switch converts the horizontal deflection system of the SC 501 to an external horizontal amplifier which is internally calibrated for 100 mV/div deflection factor with a bandwidth of 100 kHz.

VERTICAL DEFLECTION

Bandwidth — Dc to >5 MHz.

Deflection Factors — 10 mV/div, 100 mV/div and 1 V/div. Accuracy, within 3%. Uncalibrated (variable) range, continuously variable between steps (10:1) and to at least 10 V/div.

Input Coupling — Ac or dc.

Input Impedance — 1 M Ω paralleled by 47 pF.

Maximum Safe Input Voltage — 350 V (dc + peak ac).

HORIZONTAL DEFLECTION

Time Base — Calibrated sweep rates: 1 μ s/div, 10 μ s/div, 100 μ s/div, 1 ms/div, 10 ms/div, 100 ms/div. Uncalibrated (variable) range: Extends slowest calibrated rate to ≥ 1 sec/div. X5 magnifier (fixed): Extends fastest calibrated sweep rate to 200 ns/div. Accuracy (over center 8 div): $\geq 5\%$ for all sweep rates. Linearity (any two division portion within center eight divisions): $\geq 5\%$.

External Horizontal Amplifier — Bandwidth: dc to 100 kHz. Input impedance: ≥ 100 k Ω paralleled by 25 pF. Maximum input voltage: ± 3 V.

TRIGGER

Normal Trigger Sensitivity (Trigger Level/Slope In) — Internal: dc coupled, 0.4 major division of deflection at dc; increasing to 1.0 major division of deflection at 5 MHz. External: dc coupled, 1 V minimum to 5 V maximum from dc to 5 MHz. External trigger input impedance: 22 k Ω paralleled by approximately 150 pF.

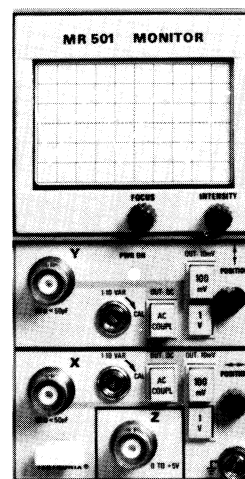
Auto Triggering (Trigger Level/Slope Out) — Sweep free-runs in absence of trigger signal or for trigger repetition rates below 10 Hz.

CRT

Crt Type — T2110.

Graticule — Type: Internal black lines, nonilluminated. Area: Six divisions vertical by 10 divisions horizontal. Each division equals 0.203 inch. Phosphor: P31 standard.

SC 501 Oscilloscope



**MR 501
MONITOR**

2 MHz X-Y Bandwidth

10 mV to 10 V Deflection Factors

Dc to 200 kHz Z-Axis Input

Compatible with RG 501

Small size, 2 MHz X-Y bandwidth and selectable sensitivity make the MR 501 a highly desirable monitor oscilloscope. It may be used with the RG 501 to form a complete oscilloscope having a wide range of sweep rates and full triggering facilities. Six MR 501's will fit in a single RTM 506 mainframe, allowing easy construction of large or small multiple displays.

VERTICAL and HORIZONTAL AMPLIFIERS

Bandwidth — Dc to at least 2 MHz.

Deflection Factor — 10 mV/div to 1 V/div in decade steps. Accurate within 3%, continuously variable between steps and to at least 10 V/div.

Input R and C — 1 M Ω paralleled by less than 50 pF.

Input Coupling — Ac or dc.

Maximum Safe Input Voltage — 350 V (dc + peak ac).

X-Y Phase Shift — Within 1° from dc to 100 kHz.

Z AXIS AMPLIFIER

Bandwidth — Dc to at least 200 kHz.

External Input Voltage — Plus 5 volts turns crt beam on from an off condition (compatible with RG 501 gate output).

Input Impedance — 10 k Ω paralleled by less than 50 pF.

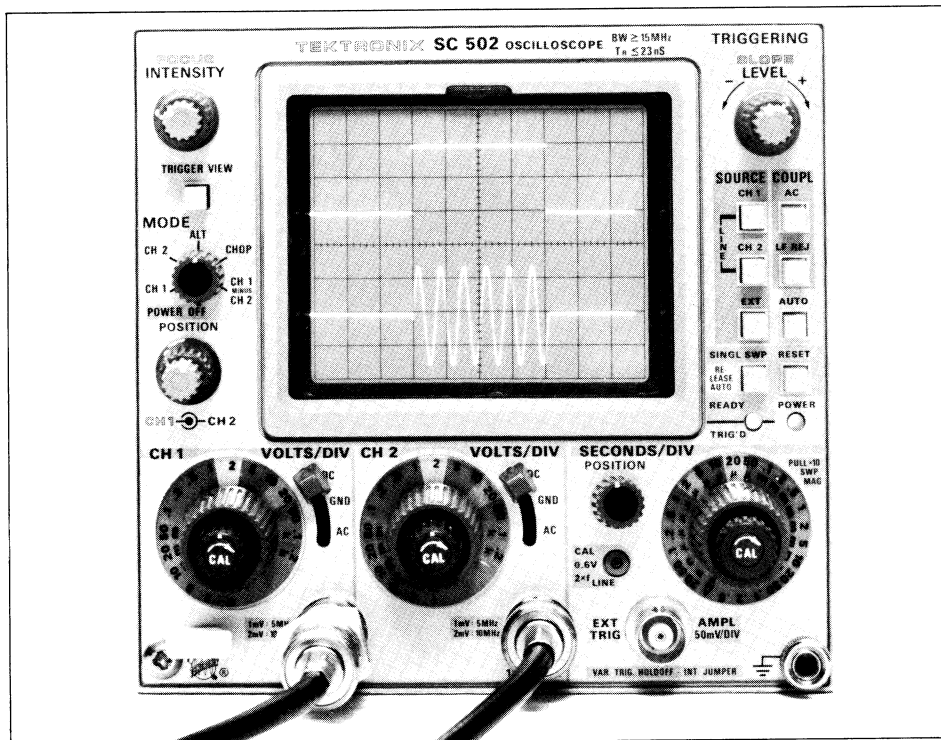
Input Coupling — Dc.

CRT

Graticule — Internal 6 x 10 divisions, 0.203 inch/div. **Phosphor** — P31.

MR 501 X-Y Monitor

SC 502 Oscilloscope



A Full-featured 15 MHz Dual-trace Oscilloscope in a Two-wide Plug-in

20 ns/div Max Calibrated Sweep Rate

1 mV/div Max Sensitivity

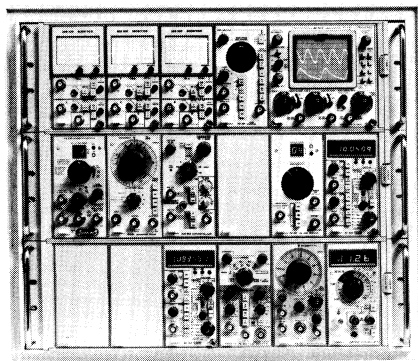
Delay Line

Trigger View

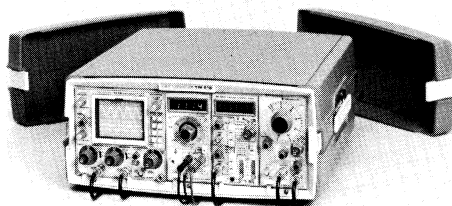
Variable Trigger Hold-off

Enhanced Automatic Triggering

The SC 502 is a general purpose, 15 MHz, dual-trace oscilloscope designed to operate in any two adjacent compartments of TM 500 Power Module/Mainframes. It has a high writing speed, a wide range of sweep rates, a wide range of deflection factors, and versatile triggering including trigger view and enhanced automatic triggering.

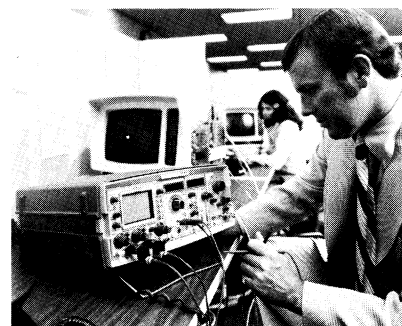


The SC 502 makes many new instrumentation systems feasible, especially in the areas of QA, production testing, maintenance, and field servicing. The rear interface feature of the SC 502 and all TM 500 instrumentation suggests exceptional applicability to systems of built-in test equipment or rack-mounted installations. And the TM 515 Traveler Mainframe with the SC 502 form a nucleus for sophisticated, compact field service "packages."



As with many TEKTRONIX products, the SC 502 features circuits, sub-circuits, and components designed and built by Tektronix to fulfill the special design capabilities of the instrument. Among its many recommended uses, the SC 502 is intended to be a power-

ful tool in the field servicing of digital equipment, where it would be used in association with disc memories, key-to-tape, printers, plotters, punches, readers, and terminals. The crt of the SC 502, for example, is of new design, offering a high writing speed as an advantage in the display of digital information, while stable, clean triggering is assured by incorporating well-proven circuits. Thus, the SC 502 offers the engineer a unique combination of performance, compactness and systems capability.



This instrument offers the features most often identified with more expensive monolithic or plug-in oscilloscopes, such as complete dual-trace modes, delay-line, trigger view, 1 mV sensitivity, sweep speeds from 0.5 s/div to 200 ns/div in 5-2-1 sequences plus X10 sweep magnifier for calibrated sweep speeds to 20 ns/div, single sweep, external horizontal input, probe calibrator, variable trigger holdoff, and an exceptionally bright crt trace as a special advantage in field servicing and production areas where high ambient light levels are often encountered.



The probe recommended for use with the SC 502 is the P6062A, which has selectable 1X and 10X attenuation.

Here is an oscilloscope that allows industry to apply the same measurement system from product research and development, through production, to field servicing.

VERTICAL DEFLECTION

Bandwidth at —3 dB points — 5 mV to 20 V/div, dc to at least 15 MHz; 2 mV/div, dc to at least 10 MHz; 1 mV/div, dc to at least 5 MHz.

Rise Time — 5 mV to 20 V/div, 23 ns or less.

Ac Low Frequency Response (Lower —3 dB point) — Without probe, 10 Hz; with probe (10X) 1 Hz.

Deflection Factors — Calibrated range: 1 mV to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) within 2%, (0° to +50°C) within 3%; 1 mV and 2 mV/div within 5%. Uncalibrated (variable) range. At least 2.5:1 range. Continuously variable between calibrated steps. Extends maximum attenuator step to at least 50 V/div.

Modes — CH 1, CH 2, Alt, Chop, CH 1 minus CH 2. Chop rate at least 250 kHz.

Input Impedance — 1 M Ω within 0.5% paralleled by approximately 47 pF.

Maximum Safe Input Voltage — 350 V (dc + peak ac) or 700 V peak-to-peak ac below 1 kHz.

Aberrations — Front corner $\pm 2\%$ or 3% p-p.

Common Mode Rejection ratios (CH 1 minus CH 2 mode) — At least 50:1 at 1 MHz when using same attenuator setting.

Channel Isolation — Input isolation: at least 80 dB up to 15 MHz; Display related: at least 50:1 up to 15 MHz.

Displayed Noise — 200 μ V or less of noise tangentially measured.

Position Range — ± 6 divisions.

Calibrator — Voltage, 0.6 V, $\pm 1\%$. Frequency, twice the power line frequency.

HORIZONTAL

Sweep Generator — Calibrated Sweep Rates: 0.5 s to .2 μ s/div 20 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 20 ns/div. Uncalibrated (variable) Range: The CAL (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 1.25 s/div.

Sweep Rate Accuracy — Within 3% unmagnified and within 5% magnified.

Trigger Holdoff — CAL (variable) control, if selected by an internal jumper, increases trigger holdoff time by a factor of at least 20.

External Horizontal Amplifier — Bandwidth: Dc Coupled, dc to at least 2 MHz; ac coupled less than 50 Hz to at least 2 MHz. Deflection Factor, 50 mV/div within 5%. X and Y Amplifier Phase Difference, less than 3° at 50 kHz or less. Input Impedance, 1 M with in 2% paralleled by approximately 47 pF. Maximum Safe Input Voltage, 350 V (dc + peak ac); 350 V peak to peak at 1 kHz or less.

Enhanced Automatic Triggering

In the automatic mode, the trigger circuit automatically adjusts to spread the peak-to-peak signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

TRIGGER

Trigger Modes — AUTO (enhanced), NORMAL (auto button out), SINGL SWP.

Trigger Sources — CH 1, CH 2, LINE, EXT.

Trigger Coupling — Dc, ac, ac low freq. reject.

Internal Trigger Sensitivity — Dc: 0.4 division of deflection, minimum, dc to 5 MHz; increasing to one division at 5 MHz to 15 MHz. Ac: 0.4 division of deflection minimum, 50 Hz to 5 MHz; increasing to one division at 5 MHz to 15 MHz. Will trigger below 50 Hz with increased deflection. LF REJ: 0.4 division of deflection, minimum, 5 kHz to 5 MHz; increasing to one division at 5 MHz to 15 MHz. Will trigger below 5 kHz with increased deflection.

External Trigger Sensitivity — Dc: 60 mV, minimum, dc to 5 MHz; increasing to 150 mV from 5 MHz to 15 MHz. Ac: 60 mV, minimum, 50 Hz to 5 MHz; increasing to 150 mV from 5 MHz to 15 MHz. Will trigger below 50 Hz with increased signal. LF REJ: 60 mV, minimum, 5 kHz to 5 MHz; increasing to 150 mV from 5 MHz to 15 MHz. Will trigger below 5 kHz with increased signal.

Triggering Level Range — Internal: at least + and —8 divisions. External: at least + and —1.2 V.

External Triggering Input — Input Impedance: 1 M Ω within 2% paralleled by approximately 47 pF. Maximum Safe Input Voltage: 350 V (dc + peak ac); 350 V peak to peak ac at 1 kHz or less.

Auto Mode — Sweep free-runs in the absence of a triggering signal. TRIGGER LEVEL range is reduced to approximately the peak-to-peak range of the triggering signal.

Single Sweep — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only. AUTO push button must be in the OUT position for operation and for setting triggering controls.

CRT

Phosphor — P31.

Deflection — Electrostatic.

Acceleration Potential — 12 kV.

Graticule — Scale, 8 x 10 divisions with 0.25 inch/div.

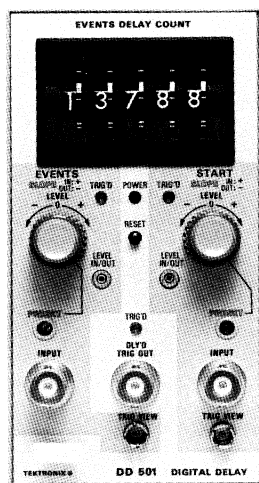
ENVIRONMENTAL CAPABILITIES

Temperature — Operating, 0°C to +50°C. Storage, —40°C to +75°C.

Altitude — Operating, to 15,000 feet. Storage, to 50,000 feet.

SC 502 Oscilloscope

DD 501 Digital Delay



Digital Events Delay for Oscilloscope Trigger

Delay to 99,999 events

Divide by N up to 40 MHz

Pulse Counting 65 MHz

Time Delay with Ext. Clock

Inputs Compatible With Most Attenuator Probes

The DD 501 is an Events Count plug-in unit. Separate external trigger signals connected to the EVENTS and START INPUT connectors allow up to 99,999 events to be counted. That is, the unit counts a predetermined number of Events, from 0 to 99,999, selected by the front-panel thumb-wheel switches. The last event counted generates a trigger pulse to the DLY'D TRIG OUT connector on the front panel. The DD 501 can also function as a frequency divider. A single external trigger signal, connected to both the EVENTS and START INPUT connectors, will be divided by the EVENTS DELAY COUNT switch setting plus one. The quotient output trigger pulse will appear at the DLY'D TRIG OUT connector on the front panel.

The DD 501 provides a digital events delay in a plug-in for the modular TM 500 line of test and measurement instruments.

Delay by event is particularly useful in troubleshooting asynchronous logic systems. It is very difficult for the observer to predict how much time will elapse prior to the pulse group he is interested in observing. The number of "clocking" events preceding the period of interest is, however, usually known and can be easily set on the thumb-wheel switches.

The DD 501 together with a TM 500 Power Module forms a low cost, easily portable means of providing an oscilloscope with delay-by-event capability for field servicing.

Almost anywhere long trains of serial data are handled, servicing can be made easier by the DD 501. Viewing selected information in data segments in disc, drum or tape memory systems, examining peripheral-to-central-processor data transfer, studying individual indexing pulses or data communication pulse trains, all are potential uses. Rotating memory systems are particularly excellent examples of where digital delay is useful, as the jitter caused by mechanical speed variations can thus be eliminated.

EVENTS DELAY

Count — 0 to 99,999 events.

Count Rate — Up to 65 MHz.

Throughput Time — 30 nsec or less.

Recycle Time — 25 nsec or less.

Start Pulse Lead Time — Simultaneous or ahead of the events pulse.

Reset — Resets start gate and events counter circuit.

TRIGGER

(All characteristics apply to both events and start triggers.)

Input Impedance — 1 M Ω , 20 pF.

Sensitivity — 85 mV peak-to-peak.

Trigger Level Range and Slope — ± 1 V.

Frequency Response — Up to 65 MHz.

Minimum Detectable Pulse Width — 5 nsec.

Trigger View Out — At least 0.5 V (200 Ω or less source impedance).

Triggered Light — Visual indication of events. Visual indication of start gate open.

OUTPUT

Width — Events pulse width plus 6 nsec or less.

Voltage — +0.8 V or less to at least +2.0 V into 50 Ω .

Light — Indicates output trigger.

Timing between EVENTS START and EVENTS — Lead time needed for EVENTS START to ensure recognition of next EVENTS pulse: 0 ns.

DD 501 Digital Delay



The Mainframes

One of the major elements in the wide appeal of TEKTRONIX TM 500 is its extreme flexibility and versatility of configuration. Most test instrument manufacturers by now have taken advantage of integrated circuits, LED displays, and other aspects of miniaturization technology to make more compact instruments. Tektronix, however, also combined advanced technology with a modular plug-in system to provide highly flexible test instruments configurations for use almost anywhere.

The "classical" benchtop environment is served by 1, 3, 4, and 6 compartment mainframes with tilt bails and handles. These same mainframes can be easily carried about for portable use. The new TM 515 luggage-styled 5 compartment travel mainframe was designed especially for portable applications where ruggedness and resistance against moisture and dust is necessary.

For mobility of an entire "bench full" of instruments, Tektronix offers a wide variety of SCOPE-MOBILE® Carts, from which you can configure your own rollabout test, maintenance, or calibration station. Among the various models are SCOPE-MOBILE® Carts to accept almost any of Tektronix' full line of oscilloscopes plus a 3-compartment, 4-compartment, or even two 3-compartment mainframes.

For rackmount applications, TM 500 fits up to six instruments into one standard rack width. Yet, the plug-in feature lets a rack installation be instantly re-configured or permits an instrument to be replaced to keep a critical test facility "on the air" even during maintenance or calibration of individual instruments.

In all configurations — bench, portable, rollabout, and rackmount — TM 500's internal interconnect feature lets commonly used connections between instruments be made only once and then stay hidden for simpler, uncluttered test setups. Then, at the touch of a switch, a counter can monitor the frequency of a signal source or a DMM can measure trigger level setting of a counter or voltage of a power supply.

Benchtop

The four TM 500 benchtop mainframes are the TM 501, TM 503, TM 504, and TM 506.

The TM 500 system concept provides significant benefits when multiple instruments are involved, but the TM 501 was provided for cases when only a single instrument is needed. The TM 503 is the most compact of the multi-compartment mainframes; it is only 15.3" deep, 6" high and 8.7" wide.

The TM 504 and TM 506 are both heavy-duty units. Each features a high power compartment at the right-hand end to also supply

greater current to TM 500 instruments that are designed for added performance or higher output power levels. The six compartment TM 506 also incorporates a quiet fan for optimum cooling. The TM 504 and TM 506 are slightly deeper than the TM 503.

All four benchtop models have feet, tilt bales, handles, and front-panel power switches. All operate from normal 110 or 220 V ac, 48 - 440 Hz.

Portable

All of the benchtop models can be used for portable operation as well. Carry handles and sturdy rear cord-wrap feet, plus optional accessory protective front covers (available for all but the TM 501) permit them to be used in many moderate applications. However, the new TM 515 was designed from the ground up for superior multi-instrument portability. In its carrying configuration it is a handsome piece of luggage with molded-in feet on the bottom and a comfortable luggage-type carrying handle. It is extremely moisture and dust resistant, and designed to withstand the rigors of transport in car trunks and pickup trucks. Once at the destination, the rear cover pops off to give access to the power cord, power switch, and allow air flow from the built-in fan. The front cover is removed to uncover up to five operating instruments from the broad TM 500 line. The result, a total electronics superlab disguised as a mild-mannered suitcase.

A wire bail stowed in the cover can be snapped into the front feet as a conventional tilt bail for benchtop use, or into the rear feet to support the TM 515 in a nearly vertical attitude on the floor with all instruments visible to a standing operator. Test lead storage is also provided inside the rear cover. The TM 515 operates from nominal

110 or 220 V, 48 - 60 Hz with the standard fan and 48 - 440 Hz with optional universal fan.

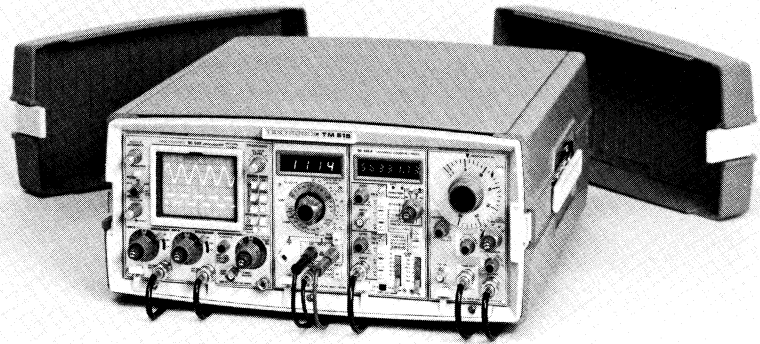
Rollabout

Rollabout test laboratories are combinations of TM 503 or TM 504 mainframes, TM 500 instruments, TEKTRONIX Plug-in or monolithic Portable Oscilloscopes, and SCOPE-MOBILE® Carts. The model 203 SCOPE-MOBILE® will hold a 5100, 5400, or three-plug-in model 7000-series oscilloscopes, or a portable such as the 434, 464, 465, 466, 475, and 485. The model 204 is designed for the four-plug-in members of the 7000 family. The Rollabout option permits mounting of TM 503 or TM 504 instead of the usual storage drawer. A specially modified 203 cart accepts two TM 503s. In each case, the result is a highly mobile lab on wheels which can be rolled out onto a production floor, over to large installations needing maintenance or calibration, into narrow quarters like x-ray control booths, or down laboratory aisles to aid in conserving bench space.

Rackmount

The new RTM 506 rackmounting mainframe is electrically identical to the TM 506 benchtop model but features a slide-out assembly and handles, plus a higher power fan than the bench version in recognition of the high ambient temperatures often found in enclosed racks and consoles.

It is also possible to convert two TM 503s into a rackmount assembly with a kit; this kit has the advantage of requiring four inches less depth than the RTM 506 for space-critical applications, but lacks the fan and high power compartment, and requires assembly by the user. Other kits are available to rackmount a single TM 503, or a TM 503 with a 603, 604, or 605 monitor.



TM 515 Traveler Mainframe

The TM 515 Traveler Mainframe accommodates five TM 500 plug-in modules, yet it is as attractive as quality, fashionable flight luggage. With a typical complement of TM 500 plug-in modules it weighs approximately 30 pounds. And it will go under the seat in most commercial aircraft. At last, the engineer on the go can take along a truly portable instrumentation package, one that goes as a unit, that is attractive, and that can be optimized for his instrumentation needs.

A typical application for the TM 515 could be digital field service, in which the likely plug-ins might be: an SC 502 dual-channel, 15 MHz (two-compartment wide) Oscilloscope, a DD 501 Digital Delay, and a DC 505A/DM 502 Combo, offering Universal Counter and full-function DMM capabilities plus readout of trigger level at the touch of the INT push button, once interface connections are made.

All plug-ins in the TM 515 mainframe can "talk" to each other and work together through a common interface circuit board. A factory-installed option (Option 5) allows TM 515 users to interconnect the plug-in instruments within the mainframe without making soldered junctions.

As in all TM 500 Power Module/Mainframes the power transformer of the TM 515 mainframe accommodates 100, 110, 120, 200, 220, and 240 V ac and 48 through 440 Hz. However, the range of line frequencies of

the TM 515 (and TM 506) is limited to 48-60 Hz by the electrical characteristics of the ventilating fan. Operating the TM 515 at the various line voltages is accomplished with quick-change line-selector blocks, but operating it at line frequencies outside the 48-60 Hz range requires the optional ventilating fan, since "forced air" is required. An optional 48-440 Hz fan is available.

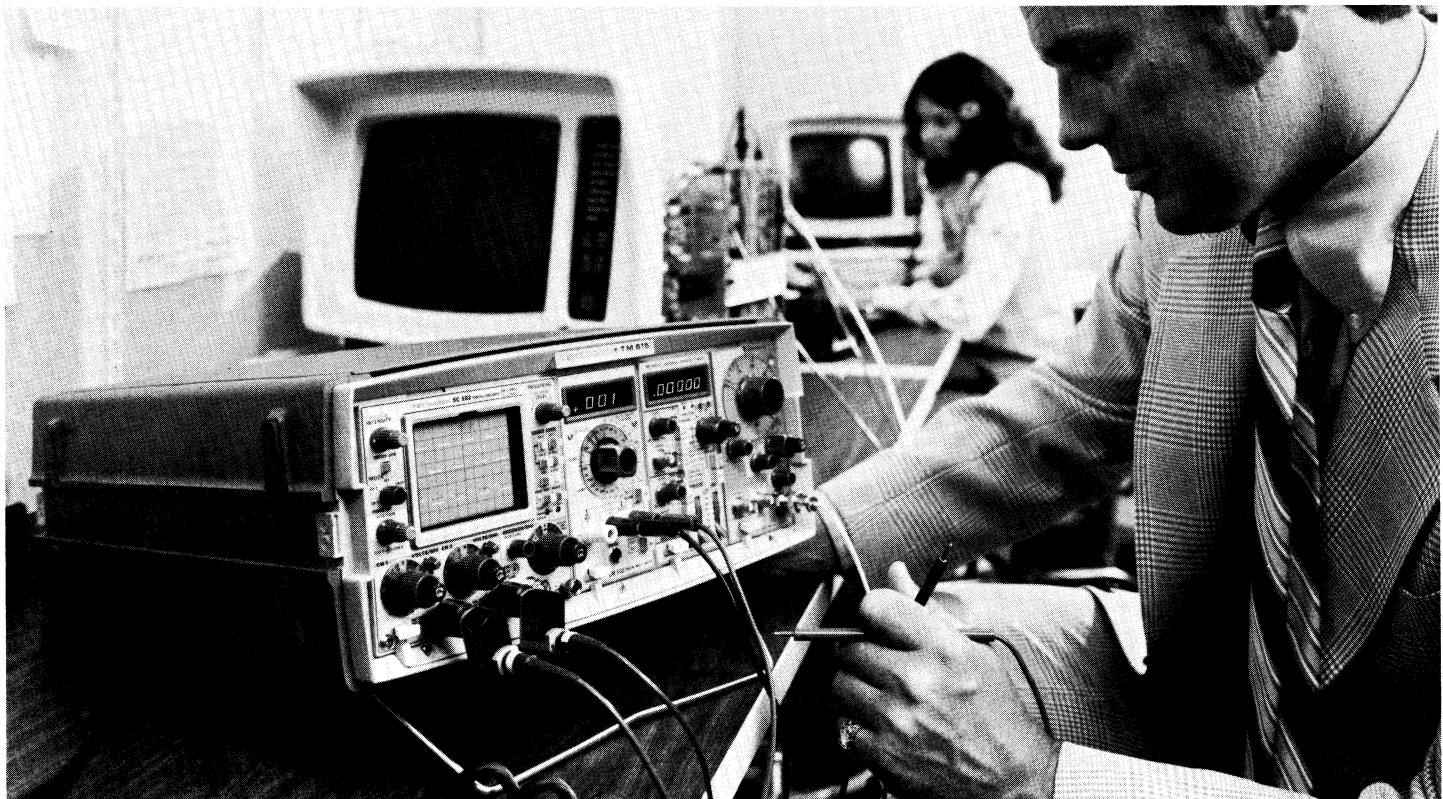
Significant cost savings are available through the use of TM 500 instrumentation systems in place of collections of monolithic instruments, mainly because TM 500 plug-in instruments share a common power supply and enclosure.

The TM 501 single-compartment, TM 503 three-compartment, TM 504 four-compartment, TM 515 five-compartment, and TM 506 six-compartment Power Module/Mainframes provide the necessary power supply components (transformer, rectifier, and filter) to operate any of the TM 500 modular plug-ins. Low-level regulator circuitry is included in each individual instrument, with high-dissipation power transistors mounted on heat sinks in the rear of the power module, so each instrument is supplied with the exact voltage necessary for optimum performance. All plug-ins are connected in the power unit by a common interface board. A matrix of signal interconnection possibilities produces extensive multifunction capabilities to reduce cabling clutter.

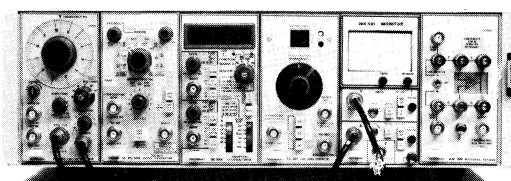
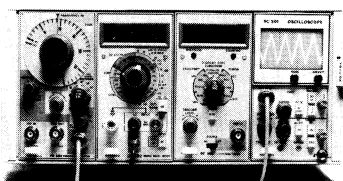
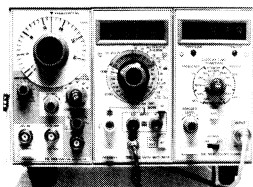
The TM 504 and TM 506 provide one high-power compartment, which is located on the



extreme right adjacent to the power switch. (Typically it is used to accommodate a power supply plug-in, such as the PS 503A, which can provide 1 amp 0 to 40 V dc in the high-power compartment.) The TM 506 is available either for bench use with a carrying handle for convenience, or in a rack-mounting version with mounting ears and slide-out tracks. Factory-installed options add 25-mil square-pin connectors on the rear of the interface circuit board and supply a kit of jumpers with mating square-pin connectors. These allow TM 500 users to easily inter-connect the plug-in instruments within the mainframe without making soldered junctions.



Specifications — TM 501, TM 503, TM 504, TM 506, TM 515



POWER REQUIREMENTS

Line Voltage Ranges — Universal Transformer: 100, 110, 120, 220, 240 V ac, all within 10%. Range changing for transformer accomplished with quick-change line-selector block.

Line Frequency Ranges — Universal Transformer: 48 Hz to 440 Hz.

NOTE: The ventilating fans on the TM 506 and TM 515 operate on 48-60 Hz only.

Power Consumption — Maximum primary power approximately: 35 W for TM 501, 120 W for TM 503, 200 W for TM 504, 320 W for TM 506 (and 240 W for TM 515). Actual power consumption depends on plug-in selection and operating modes.

SUPPLIES (UNREGULATED)

Shared by All Compartments — +33.5 V dc and -33.5 V dc. TM 501 — 500 mA maximum. TM 503 — 1 A maximum. TM 504 — 1.4 A maximum. TM 506 — 2.1 A maximum. TM 515 — 1.8 A maximum.

Low Power Compartments — Two 25 V ac windings, 500 mA each, supplied to each compartment, independently. 17.5 V ac and +11.5 V dc shared in any combination between these two supplies and among all low-power compartments. TM 501 — 1 A maximum. TM 503 and TM 504 — 3.6 A maximum. TM 506 — 6.5 A maximum. TM 515 — 6.5 A maximum.

High Power Compartments — (nearest to switch in TM 504 and TM 506): Two 25 V ac windings, 1 A each. 17.5 V ac and + 11.5 V dc, 4 A maximum, shared in any combination between these two supplies.

TEMPERATURE RANGE

Operating — 0°C to +50°C.

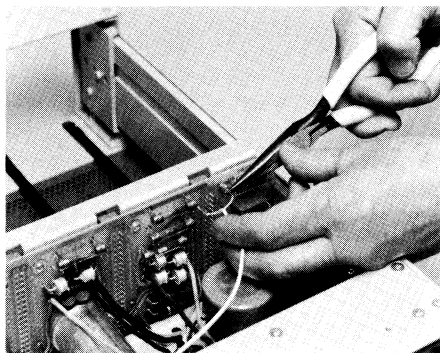
Nonoperating — -40°C to +75°C.

ALTITUDE RANGE

Operating — To 15,000 feet.

Nonoperating — To 50,000 feet.

OPTIONAL INTERFACE



The TM 500 line is designed so that connections between modules and/or external equipment can be made by the mainframe rear interface board and optional rear-panel connectors.

Each plug-in has selected lines brought to its interface, some parallel to front-panel connections, others present only at the interface. Normally, these lines are left open, but they may be connected by the user to reduce front-panel clutter or to perform functions not otherwise available. For example, digital counters have serial BCD outputs which may be brought out for data logging or processing.

LINEs AVAILABLE AT THE MODULE INTERFACE CONNECTOR

Digital Counters

BCD serial by digit	Reset
Range code (Except DC 502)	Time slot zero
Scan clock out	Data good
Scan clock in and internal scan disable	Signal in (selected by front-panel switch) (except DC 502)

These lines allow for external data logging and processing via the BCD output and associated signals. They also allow the external system to initiate the taking of a measurement, and control the rate at which the BCD data is scanned.

Digital Multimeters

Scan clock out	Most significant digit
Decimal point	Data transfer
BCD serial by digit	Polarity
Least significant digit	

Power Supplies

Supply output through rear connection
Remote sense
Remote analog voltage control
Remote analog current limit control

Amplifiers

Signal Out, Signal In

Monitor

X, Y, and Z inputs

Oscilloscope

Ramp out, Gate out

NOTE: If the power module is ordered with Option 2, it will be delivered with a rear-panel multi-pin connector, mating cable connector, and one BNC connector per plug-in compartment installed. The user may wire these to the interface board as desired. Option 2 (and option 5 of the TM 515) is also supplied with square-pin connectors on the rear interface board for connection between modules, using the supplied jumpers terminated with square-pin receptacles.

Pin assignments are common for each "family" of modules (DMMS, generators, counters, etc.). Each family has its own pattern of circuit board notches at the interface. Interface terminal barriers may be inserted in the mainframe so that it accepts only plug-ins of one family. A supply of barriers (and square-pin jumpers) is shipped with the power module if option 2 is ordered.

A typical example of interface connection between modules is to connect the ramp output of the RG 501 to the VCF input of the FG 502 for frequency sweep. The output of a power supply can be measured with the interface feature of the DM 501 for voltage monitoring.

POWER MODULE DIMENSIONS & WEIGHTS (Without Plug-ins)

CABINET

	TM 501		TM 503		TM 504		TM 506		TM 515	
Dimensions	in	cm	in	cm	in	cm	in	cm	in	cm
Height	6.0	15.2	6.0	15.2	6.0	15.2	6.0	15.2	6.8	17.3
Width	3.9	9.9	8.7	22.1	11.0	27.5	17.4	44.1	15.0	38.1
Length	15.3	38.8	15.3	38.8	20.0	50.0	20.0	50.0	20.0	50.2
Weight (approx) Net	lb 5.4	kg 2.4	lb 9.5	kg 4.3	lb 20.5	kg 9.3	lb 29.0	kg 13.2	lb 22.5	kg 10.2
Domestic Ship	13	5.9	17	7.7	26.0	11.8	41.0	18.7	30.0	13.6

ORDERING INFORMATION (Plug-ins Not Included)

TM 501 Power Module
with option 2 Interface

TM 503 Power Module
with option 2 Interface

TM 504 Power Module
with option 2 Interface

TM 506 Power Module
with option 2 Interface

RTM 506 Power Module
(rackmount version)

with option 2 Interface

TM 515 Traveler Mainframe

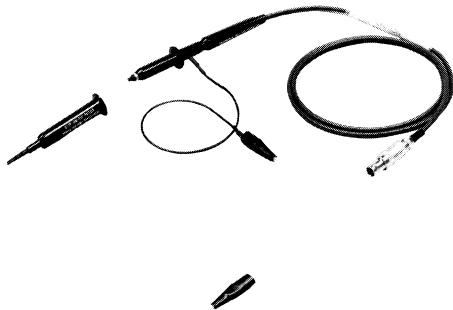
with option 5 Interface

with option 6 48-440 Hz fan

Accessories

This group of accessories adds to the versatility and performance of the TM 500 test and measurement system. Convenient cases and covers offer mobility and protection. The provision for user options with special purpose hardware adds flexibility. Adapters and blank panels can be supplied, as well as extender cables, coaxial cables, special probes, and devices designed to operate with various plug-ins for specific applications.

P6058 TEMPERATURE PROBE



The P6058 Temperature Probe is used with the DM 501 for sensing temperature from -55°C to $+150^{\circ}\text{C}$. The temperature sensing element consists of a transistor and is installed in the probe's nose tip. Temperature is measured by applying the flat surface of the probe's tip to the device being measured. P6058 probes are interchangeable among all DM 501s without requiring recalibration since probes and DM 501s are held to tight tolerances. Besides measuring temperature, the P6058 can function as an electrical probe for resistance, current, and voltage measurements to 500 V. To obtain the full probe kit with ground lead and push-on electrical contact tip, order 010-0260-00 below. A simple modification of the DM 501 is also required. For temperature-only measurements, order 010-0259-00.

The temperature probe consists of the temperature sensor, a four foot 4 wire coaxial cable, and a connector for attaching to the existing front-panel receptacle of the DM 501. The unit weighs approximately five ounces.

P6058 Temperature Probe,
Order 010-0259-00

P6058 Temperature Voltage Probe,
Order 010-0260-00

P6430 TEMPERATURE PROBE

The P6430 Temperature Probe is used with the DM 502 for sensing temperature from -55°C to $+150^{\circ}\text{C}$. The temperature sensing element consists of a transistor and is installed in the probe's nose tip. Temperature is measured by applying the flat surface of the probe's tip to the device being mea-



sured. The probe can be immersed vertically, approximately two inches in a liquid, for temperature sensing and still retain water tightness.

The temperature probe consists of the temperature sensor, a six foot, 2 wire coaxial cable, and a connector for attaching to the existing front-panel receptacle of the DM 502. The unit weighs approximately five ounces.

To meet full accuracy specifications a specific P6430 and DM 502 multimeter must be calibrated as a pair.

P6430 Temperature Probe,
Order 010-6430-00

HIGH VOLTAGE PROBE FOR USE WITH DMMs



The High Voltage Probe will measure voltages from 1 kV to 40,000 volts with an accuracy of 1% at 25,000 volts. The division ratio is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes.

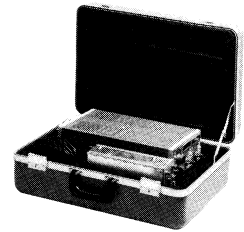
This probe plugs directly into the front end of either multimeter.

CHARACTERISTICS

Voltage range	1 kV to 40 kV
Input resistance	1000 M Ω
Division ratio	1000:1
Overall accuracy	20 kV to 30 kV 2%
Upper limit accuracy	Changes linear from 2% at 30 kV to 4% at 40 kV
Lower limit accuracy	Changes linear from 2% at 20 kV to 4% at 1 kV
Input Z at meter	10 M Ω required

Order Number: 010-0277-00

TM 500 CARRYING CASE



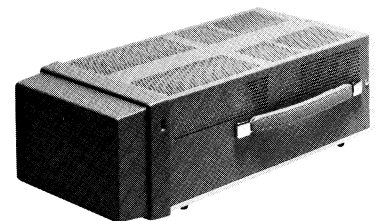
These luggage-type carrying cases for TM 500 equipment are molded of high strength glass-epoxy. The TM 503 model weighs 12 pounds empty and measures 23½" long by 8½" thick by 15½" high, including rubber feet, lockable latches, and handle. Inside, the resilient polyurethane foam insert is molded to accept a TM 503 (with or without the protective front cover) plus either a spare TM 500 family module or a 200-Series miniscope. A third compartment in the foam accepts miscellaneous cables, accessories, or small tools.

The TM 504 case has a molded foam insert which will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 24" long by 8½" thick by 17½" high and weighs approximately 14 pounds empty.

TM 503 Carrying Case,
Order 016-0565-00

TM 504 Carrying Case,
Order 016-0608-00

PROTECTIVE FRONT COVER



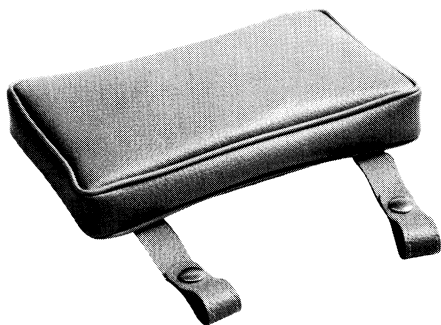
A snap-on front cover, molded of high impact plastic, is available for the TM 503 (shown above), TM 504, and TM 506 mainframes. While particularly valuable when the TM 503 or TM 504 (full of instruments) is carried into the field or in a vehicle, the cover is also good insurance against damage to instrument knobs and jacks during normal handling in the lab, or when a mainframe full of instruments is stored. The cover adds 1¾" to the length of the TM 503, TM 504, and TM 506 mainframes, and clears the longest knob projections on any of the instruments.

TM 503 Front Panel Cover,
Order 200-1566-00

TM 504 Front Panel Cover,
Order 200-1727-00

TM 506 Front Panel Cover,
Order 200-1728-00

ACCESSORY POUCH



While the TM 501, TM 503, TM 504, and TM 506 mainframes were optimized for bench use, they are frequently carried away for service elsewhere. Taking along the probes, cables, terminators, and other accessories usually required can then be a problem. The soft vinyl accessory pouch neatly solves this problem; sturdy snap-around straps let the pouch be secured to the carrying handle of any TM 500 Mainframe or TEKTRONIX Oscilloscope or the straps may be snapped together to form a carrying handle for the pouch to be used independently. A convenient side zipper lets accessory items be removed or stored without removing the pouch from the mainframe handle. Dimensions approximately 9 1/4" L x 5 3/4" W x 2" D.

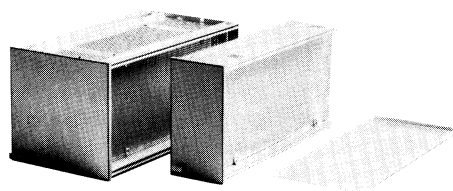
Order Number 016-0351-00

TM 500 BLANK PANEL

When operating the TM 500 instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

Blank Plug-in Panel,
Order 016-0195-01

TM 500 CUSTOM PLUG-IN KITS



Single and double compartment sizes

A complete test and measurement set-up for many typical jobs requires at least one non-standard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, and control; special processors or converters such as log amps, multipliers,

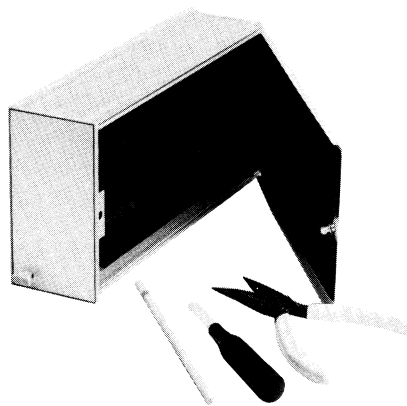
and analog-to-digital converters; and a variety of other system elements which are usually not available or economical as complete commercial instruments. The construction and packaging of these special items is always a problem, and the sheet metal work, and provision for necessary power supplies often far exceed the cost of the functional elements.

This is why the TM 500 line includes custom plug-in kits. The kits provide perforated main circuit boards which allow rapid construction and wiring of circuits using both discrete components and integrated circuits. Also included are top and bottom rails, side cover, front sub-panel, and a blank dress panel, and the latch mechanism. An instruction sheet details the voltages and currents available in the power module. Standard voltage regulator IC's can be used to provide exact voltages for most individual power supply requirements. The finished special-purpose circuitry or instrument is physically compatible with the other TM 500 instrumentation.

Custom Plug-in Kit (single compartment)
Order 040-0652-01

Custom-Plug-in Kit (double compartment)
Order 040-0754-00

PLUG-IN STORAGE COMPARTMENT

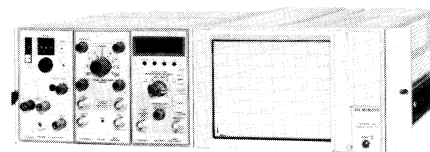


An electronics engineer or technician away from his bench seldom has enough storage space for probes, cables, "tees" and accessories, and small tools. The Plug-In Storage Compartment is a useful adjunct to many rollabout and Travel Lab configurations. If all five compartments in your TM 515 Traveler Mainframe are not used for a particular field application, stuff in a plug-in storage compartment for extra convenience. Put plug-in storage compartments in unused storage bins of your 203 or 204 SCOPE-MOBILE®. Even a rack-mount TM 500 installation might profit by readily-available terminators or attenuators in a presently-un-

used compartment. Compatible with all TM 500 Mainframes. 5000-Series Oscilloscope Mainframes, and 203 and 204 SCOPE-MOBILE® plug-in storage bins; inside dimensions 9 7/8" L x 2" W x 4 1/4" D.

Order Number 016-0362-00

CABINET-TO-RACKMOUNT CONVERSION KITS AND MONITORS



Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount two TM 503's side-by-side in a standard rack width.

Order 040-0616-01

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a single TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized.

Order 040-0617-01

Rackmount-to-cabinet conversion kit equipped to convert a rackmount TM 503 to a cabinet style.

Order 040-0618-01

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 and a 603, 604 or 605 in a standard rack width. For information about these monitors, including storage models, see your local Tektronix representative.

Order 040-0624-00

MONITOR ORDERING INFORMATION

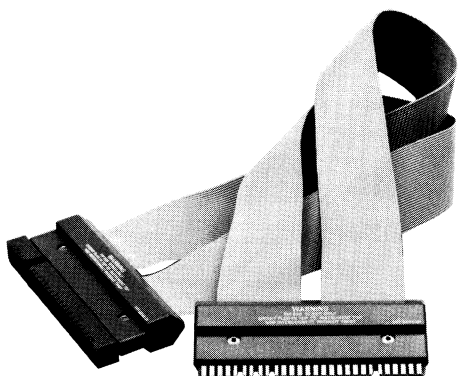
603 Storage Monitor
with option 4 Time Base

604 Monitor
with option 4 Time Base

605 Storage Monitor
with option 4 Time Base

Accessories

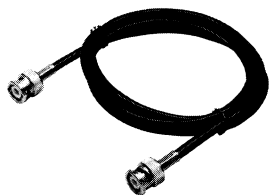
TM 500 FLEXIBLE EXTENDER CABLE



Designed to couple a TM 500 plug-in with the mainframe rear interface board connection. It provides a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

Extender Cable, Order 067-0645-01

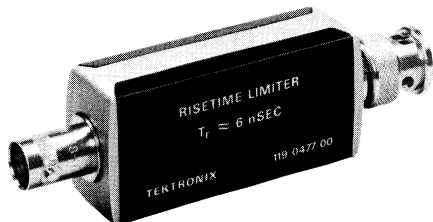
50 Ω PRECISION COAXIAL CABLE



For use with the PG 502, PG 506, and SG 503. These instruments are internally calibrated for use with this 3 ft. 50 Ω coaxial cable into a 50 Ω load.

50 Ω Cable, Order 012-0482-00

RISE-TIME LIMITER



For use with the PG 502 Pulse Generator which has a pulse rise and fall time of less than one nanosecond. In some applications such as TTL logic where slower rise time is needed, this fast pulse can be limited to six nanoseconds by using the rise-time limiter.

Rise-time Limiter, Order 015-0249-00

MANUAL (ONE-SHOT) TRIGGER GENERATOR

**RG 501,
PG 501
AND
PG 505**



The Manual (one-shot) Trigger Generator is a self-contained, battery-operated, hand held device for manually generating a single pulse. This adapter is used to start a pulse, ramp, sweep or complete sequence of events on instruments which do not have a manual trigger button or where a remote operation capability is desired, such as some oscilloscopes and the PG 501, PG 505, and RG 501.

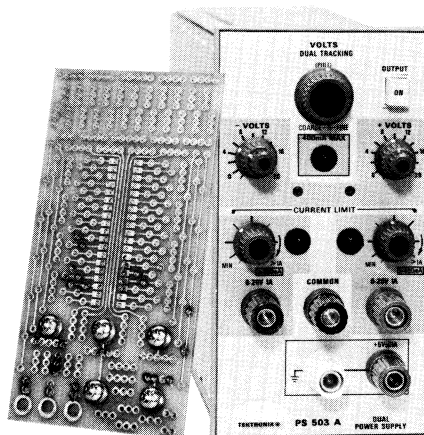
The internal trigger generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the push button.

The output pulse is nominally two milliseconds in width and three volts in amplitude with a rapid rise and fall. Output impedance is low (50 Ω); the pulse amplitude drops from about 3.8 to 1.5 volts when changed from a high impedance to a 50 Ω termination. The battery is a 5.4 V dry cell.

Applications for the trigger generator also include stepping or sequencing of digital systems, analog control systems, mechanical devices, as well as obtaining "single shot" operation from many types and brands of instruments. Biological and physical experiments, where manual triggering is required as a part of the stimuli, are also common applications.

Order Number 016-0597-00

FRONT-PANEL CIRCUIT BOARD ADAPTER KIT PS 501 AND PS 503A



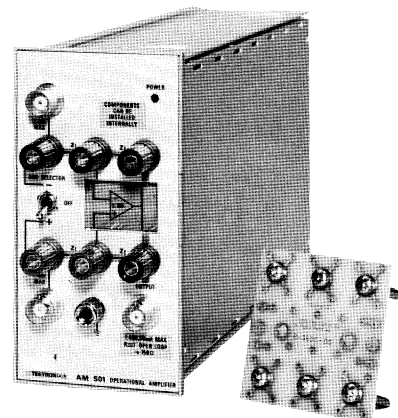
The front-panel circuit-board kit is a convenient way to mount small experimental circuits or fixtures right on the front of a TM 500 power supply.

Typical applications for the adapter are as a device tester (test fixture), educational demonstrator (especially IC's), and in temporary systems functions, e.g., OR'ing and AND'ing two signals. This adapter will supplement the blank plug-in kit for simple or temporary applications.

The adapter kit provides a convenient platform for building up circuits; its pin holes are pre-solder-flowed and some are inter-connected. Discrete devices can be readily attached to the adapter kit board, stored, and easily reattached to the "banana jack" plugs on the face of the PS 501 and PS 503A. Circuit clips for inter-connected pin holes are available from Tektronix. The adapter kit is 2 1/2 inches wide.

Order Number 013-0152-00

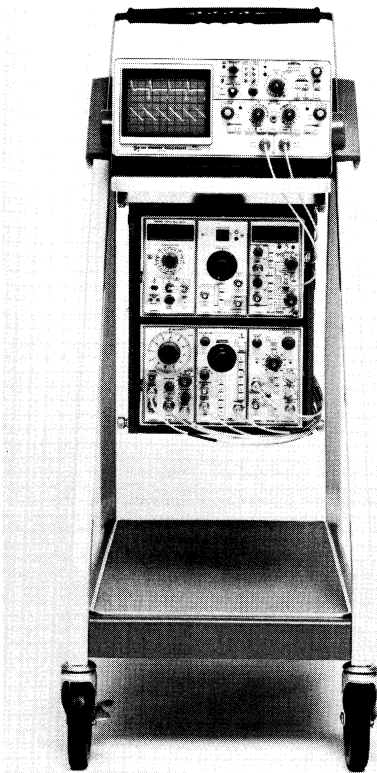
AM 501 AUXILIARY CIRCUIT BOARD KIT



The AM 501 Auxiliary Circuit Board Kit attaches to the input and output terminal plugs on the front of the AM 501 Operational Amplifier. The kit is approximately 2 1/2 inches square. The kit is a pc board which has six terminal studs for attachment to the amplifier's banana jacks. This permits the designer to build a circuit of resistors, capacitors, and other components for use in conjunction with the AM 501's input, output or feedback circuits. With several boards, the AM 501 Op Amp circuit can be changed instantly in configuration from integrator to differentiator to amplifier.

An additional advantage of the kit is that it does not interfere with the other connectors on the face of the AM 501.

Order Number 013-0146-00

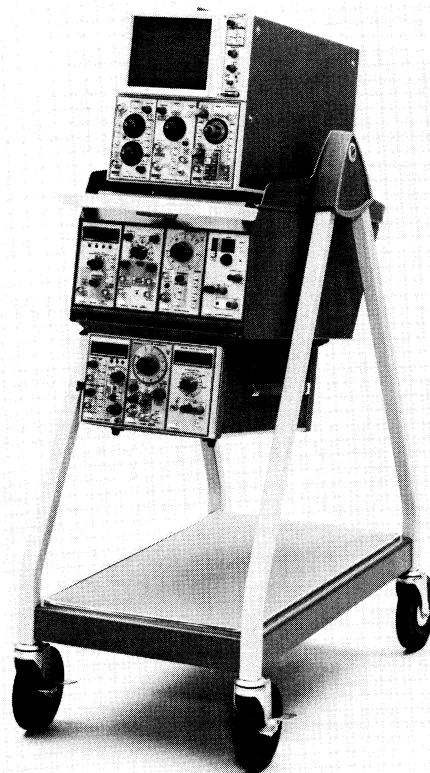


The **203 SCOPE-MOBILE® Modified Cart** is especially designed for the Medical Instrumentation Calibration System (MICS) or for the Rollabout Test and Measurement Laboratory. The cart has been modified to hold two TM 503 Power Modules in tandem. Its narrow width permits it to be easily moved into "tight" spots especially around hospitals, clinics, and other medical or manufacturing environments.

This product is available only on special request from the Tektronix modified products development department. Your Tektronix field engineer will assist you in ordering this modified cart and arranging pricing and delivery.

Adjustable tray tilt-locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis. Mechanical features include aluminum construction, 5-inch rubber wheels with front wheel brakes and linoleum-topped steel shelf at the bottom.

203 Modified Cart—Model 901R

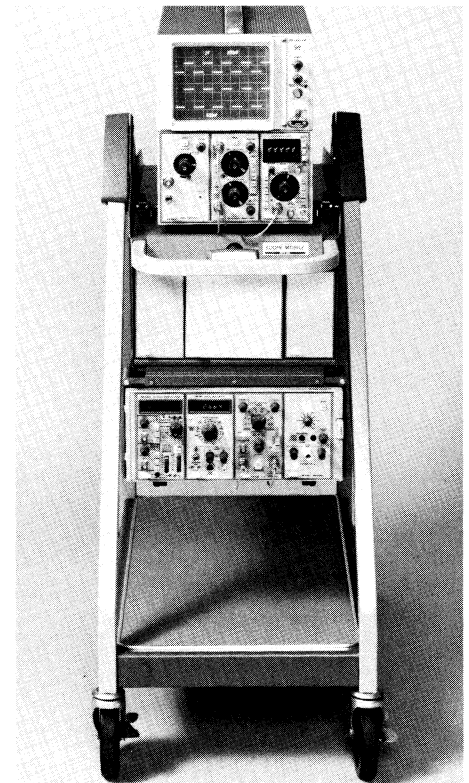


The **TEKTRONIX Model 203 SCOPE-MOBILE® Cart** holds any of the TEKTRONIX 5000-Series Oscilloscopes or any of the 7000-Series Oscilloscopes designed for three plug-ins (7403N, 7613, etc.). The Model 204 SCOPE-MOBILE® is required for the four plug-in models of the 7000-Series such as the 7704A, 7844, and 7904. Both models feature storage space for spare plug-ins and three ac receptacles located at the rear of the cart to supply power to the oscilloscope and associated instruments.

Both 203 and 204 SCOPE-MOBILE® Carts may be fitted with brackets to accept a TM 503 or TM 504 Power Module instead of the standard drawer below the storage bins. The combination of the cart plus a suitably chosen oscilloscope and group of TM 500 modular instruments becomes an extremely powerful and versatile rollabout test station.

The 203 and 204 SCOPE-MOBILE® Carts feature adjustable tilt trays with locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the level position. Mechanical features include aluminum construction, 5-inch rubber wheels with front wheel brakes and linoleum-topped steel shelf at the bottom.

For a new rollabout lab with capability for up to three operating TM 500 instruments, order a TM 503 and 203 Option 1 (center picture above) or a TM 503 and 204 Option 1 (not shown) for the wider oscilloscopes. For up to four operating TM 500 instruments, order a TM 504 plus a 203 and an 016-



0348-00 kit (right-hand picture above) or a TM 504 plus a 204 and an 016-0349-00 kit.

To retrofit a TM 503 to a standard 203 Cart which you may already own, order an 016-0583-00 kit. To retrofit a TM 503 to a standard 204 Cart, order an 016-0584-00 kit. TM 504's may also be retrofitted to 203 Carts with the 016-0348-00 kit and to 204 Carts with the 016-0349-00 kit.

SCOPE-MOBILE® Carts for TM 503's include mounting brackets for TM 503 Power Modules instead of a drawer. TM 503 must be ordered separately.

203 Option 1

204 Option 1

Standard SCOPE-MOBILE® Carts — to be used with adapter kits below which replace drawer.

203

204

TM 504 Adapter Kits—include hardware to attach TM 504 to 203 or 204 SCOPE-MOBILE®.

For 203, Order 016-0348-00

For 204, Order 016-0349-00

TM 503 Adapter Kits—include hardware to attach TM 503 to 203 or 204 SCOPE-MOBILE®. Note that this hardware is already included as part of 203 Option 1 or 204 Option 1.

For 203, Order 016-0583-00

For 204, Order 016-0584-00

SCOPE-MOBILE® Carts

SCOPE-MOBILE® USAGE CHART

Model No.	Tray Designed for Oscilloscope Type	Brackets Designed for TM 500 Mainframe/ Power Module Type	Storage Bin Capacity for Spare Plug-ins	Scope Lockdown	Top Tray Dimensions*	Bottom Shelf Dimensions**	Net Weight Approx.
203 Option 1	7403N, 7313, 7613, 7623, 7623A, 7633, 7603, 5100 & 5400-Series 400-Series	TM 503 (up to 3 TM 500 plug-in instruments)	Holds 4 5000, 7000 or TM 500-Series plug-ins (not powered)	Yes, for 5000 and 7000-Series	11.25 x 21 in.	14.75 x 26.75 in.	39 lb.
203 with 016-0348-00 kit	Same as above	TM 504 (up to 4 TM 500 plug-in instruments)	Same as above	Same as above	Same as above	Same as above	Same as above
203 (Modified)	Same as above	2 TM 503s (up to 6 TM 500 plug-in instruments)	None	Strap for 400-Series, Lockdown for 5000 and 7000-Series	11.25 x 21 in.	14.75 x 26.75 in.	48 lb.
204 Option 1	7704A, 7844, 7904	TM 503 (up to 3 TM 500 plug-in instruments)	Holds 5 7000-Series plug-ins (not powered)	Yes, for 7000-Series	14 x 21 in.	17.50 x 26.88 in.	39 lb.
204 with 016-0349-00 kit	Same as above	TM 504 (up to 4 TM 500 plug-in instruments)	Same as above	Same as above	Same as above	Same as above	Same as above

*Overall length of bottom of tray includes rear radius bend and front stops.

**Usable dimensions may be limited by height required.

***Contact your local Tektronix Field Engineering Office for price and delivery.



Tektronix, Inc.

Tektronix began with a handful of employees working in one small garage-like building. The original lone item they were producing was an oscilloscope, a model which even then was the best of its kind.

Today Tektronix has over 12,300 employees designing and manufacturing more than 200 products, including lines of oscilloscopes, information display products, automated measuring systems, television products, calculators, spectrum analyzers and test and measurement instruments.

The home office in Beaverton, Oregon, has surpassed its original one small building many times over. Today it is a 300-acre industrial park with over 2 million square feet dedicated to design and manufacturing. Field offices and service centers are in key locations all over the world.

Tektronix Field Engineers

Tektronix field engineers will help you select the product best suited for your present and future needs. Ask him about any instrument or product described in this booklet, or for other products described in our general catalog. You will find a listing of these Field Offices with resident engineers on the back cover.

Product Support

It is our intent to consistently provide unexcelled product service and support at competitive prices. Your field engineer is fully prepared to respond to your technical and business requirements. He has a strong technical background and extensive product and business training. Constant communication with Beaverton-based personnel enables him to remain current on new products and service. Call upon him for assistance any time you have questions about Tektronix, Inc., and its products.

Ordering

A field engineer will provide you with information on prices, terms of sale, shipping estimates and the best method of transportation for all instruments, accessories, and replacement parts.

If you require service, replacement parts, a warranty question resolved, or other help, please notify your Tektronix facility listed on the back cover.

For Customers Outside the United States

To provide you with personal assistance in ordering as well as servicing products, we have established Field Offices and technically qualified Tektronix distributors in many countries throughout the world. The Tektronix office or distributor in your country will be pleased to help you select the instruments that best suit your requirements in performance, and provide you with prompt ordering service.



Worldwide Support

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35000 Rennes
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 Telex TEKTOULS 53 243
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 8 Hiji-cho-2 Nakamura-ku
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Supplied and Supported by Tektronix Limited, P. O. Box 36, St. Peter Port, Guernsey, Channel Islands
 Telephone: Guernsey 26411 (eight lines), Telex: 41193

Tektronix Limited maintains a warehouse of United States-made instruments, accessories and parts on the island of Guernsey to quickly supply these distributors in filling customer orders. Technical support of customers and distributors is also available from this facility. In addition, Tektronix has manufacturing facilities within the European Economic Community and European Free Trade Association.

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TM 500 Modular Instruments

SIGNAL GENERATORS

FG 501 Function generator; 0.001 Hz to 1 MHz, five waveforms

FG 502 Function generator; 0.1 Hz to 11 MHz, 20 ns rise and fall, five waveforms

FG 503 Function generator, 3 waveforms, 1.0 Hz to 3 MHz

PG 501 Pulse generator; 5 Hz to 50 MHz, 3.5 ns rise and fall

PG 502 Pulse generator; 250 MHz, 1 ns rise and fall, independently controlled logic 1 and 0 levels

PG 505 Pulse generator; 100 kHz, 80-V floating output, independently variable rise and fall times

PG 506 Calibration generator; 1.0 ns rise time output, 60 V output, and voltage calibrated output for oscilloscope calibration (measures amplitude errors with 0.1% resolution over error range of $\pm 7.5\%$)

RG 501 Ramp generator; 10- μ s-to-10-s ramp, with four scope-type trigger controls

SG 502 RC oscillator; 5 Hz to 500 kHz, sine and squarewaves, 0.035% distortion

SG 503 Sinewave oscillator; 250 kHz to 250 MHz, 50-kHz reference output

TG 501 Time-mark generator; 1-ns-to-5-s markers, measures timing errors with resolution within 0.1% over timing error range of $\pm 7.5\%$

SIGNAL PROCESSORS

AF 501 Bandpass filter; tunable bandpass filter to 35 kHz, signal amplification to 50 kHz

AM 501 High-power, high-voltage op amp; 5-MHz bandwidth

AM 502 Dc-coupled, high-gain differential amplifier; 1 to 100,000 gain, dc-to-1-MHz bandwidth, selectable -3 dB points

OSCILLOSCOPE AND CRT MONITOR

SC 501 Oscilloscope, 5 MHz bandwidth

SC 502 Oscilloscope, 15 MHz, dual-channel

MR 501 X-Y monitor; 10 mV to 10 V per division, dc-to-2-MHz bandwidth

POWER SUPPLIES

(First four also provide + 5 volts, reference to ground)

PS 501 Floating output of 0 to 20 V, 0 to 400 mA

PS 501-1 PS 501 with 10-turn potentiometer readout

PS 501-2 PS 501 with dual-range meter readout

PS 503A Triple supply, 0 to ± 20 V or 0 to 40 V

PS 505 Variable, low voltage, high current dc supply (3.0 to 5.5 V dc at 4 A)

DIGITAL COUNTERS

DC 501 Seven-digit, 110-MHz counter and totalizer

DC 502 Similar to DC 501 with $\div 10$ pre-scaler for counting to 550 MHz

DC 503 Seven-digit, 100-MHz universal counter/timer with dual channels

DC 504 5 digit counter/timer; direct counting to 80 MHz

DC 505A Seven-digit universal counter/timer, 225 MHz on both channels

DIGITAL MULTIMETERS

DM 501 4½-digit multimeter with optional temperature-measuring capability

DM 502 3½-digit multimeter, auto polarity, dBm and dBv, optional temperature measuring

SPECIAL APPLICATION

DD 501 Digital events delay for oscilloscope trigger

MAINFRAMES

TM 501 Powers one module

TM 501 Option 2 Interface

TM 503 Powers three modules

TM 503 Option 2 Interface

TM 504 Powers four modules

TM 504 Option 2 Interface

TM 506 Powers six modules

TM 506 Option 2

RTM 506 Rackmount power module for six plug-ins

RTM 506 Option 2 Interface

TM 515 Traveler Mainframe

TM 515 Option 5 Interface

TM 515 Option 6 48-440 Hz Fan

Conversion Kit, cabinet to rackmount—
one TM 503 040-0617-01

Conversion Kit, cabinet to rackmount—
two TM 503's 040-0616-01

Conversion Kit, rackmount to cabinet—
TM 503 040-0618-01

Conversion Kit, cabinet to rackmount, to mount TM 503 with a 603, 604, or 605 monitor 040-0624-00

MOBILE TEST STATIONS

203 Option 1 SCOPE-MOBILE® Cart mounts one TM 503 mainframe and stores four modules

203 SCOPE-MOBILE® Modified Cart—Model 901R, mounts two stacked TM 503 mainframes

204 Option 1 SCOPE-MOBILE® Cart mounts TM 503, stores five modules

Power Module Adapter Kits

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