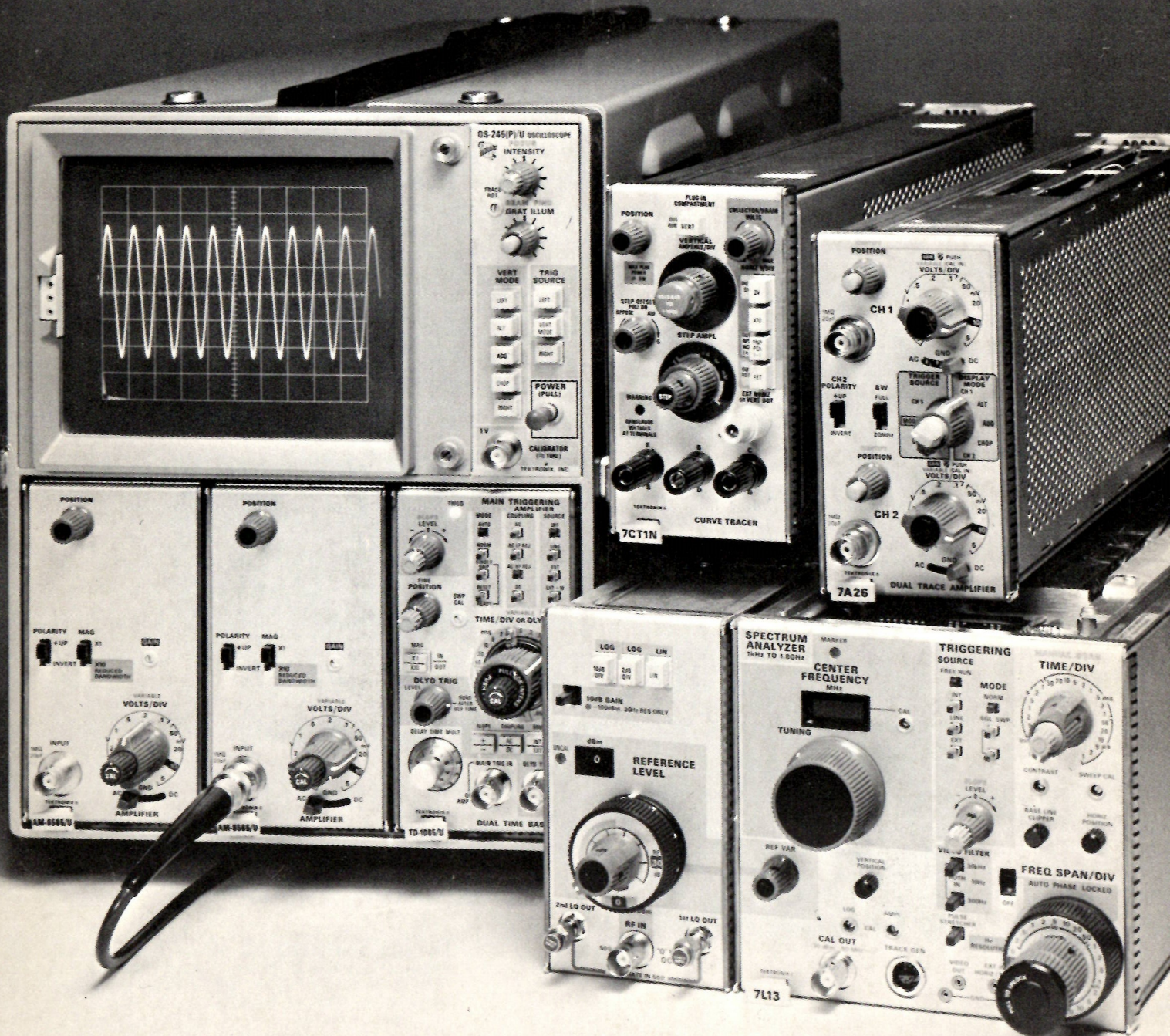TEKTRONIX®
committed to
technical excellence

7000 Series Instrumentation To Complement AN/USM-281C

...more than an oscilloscope

WP1100-SERIES DIGITAL PROCESSING OSCILLOSCOPES

The WP1100-Series DPO is a calculator aided instrumentation system that offers the computational capabilities to solve a variety of data acquisition and analysis problems. With this system, the full signal acquisition capabilities of the TEKTRONIX 7000-Series laboratory oscilloscope have been maintained and have been reinforced with the data processing capabilities of the TEKTRONIX 31 Programmable Calculator.

A key feature of the WP1100-Series is that it enables operations with waveforms to be performed under program control. Waveforms digitized by the DPO are acted upon by programs stored in the calculator.

A stored waveform can be operated on by another waveform; the two can be multiplied, subtracted, etc., to obtain a third waveform. It is also possible to perform operations (calculate integrals, differentials, etc.) on a single waveform to obtain a second. Resulant waveforms are displayed with appropriate scale factors.

The WP1100 also allows alphanumeric messages to be sent from the calculator to the DPO.

The TEKTRONIX 31 features over 30 built-in math functions. There are 24 keys that can be defined to perform special, frequently used functions. In the WP1100 DPO there are 256 memory registers and 2048 program steps. The WP1101 DPO contains 256 memory registers and 8192 program steps. There is also a special memory partition switch that increases the number of memory registers by decreasing the number of program steps. The switch gives a choice of memory register and program step allocations as follows: 256/8192, 640/5128, or 2048/1000.

To provide useful and powerful software that simplifies waveform processing, Tektronix has developed the KEYBOARD INTERPRETER Program, and a Program Keyboard Overlay to match, for the WP1101. It contains programs to add, subtract, multiply, divide, log X, integrate, differentiate, X^2, signal average, and determine rms, min, max, and mean values of stored waveforms.

The Keyboard Overlay also has six keys reserved for user-definable functions. With those keys, custom programs and subroutines may be called.

After loading a program, and placing the overlay in place, waveform computations may be easily performed. The KEYBOARD INTERPRETER program will automatically scale waveforms, process scale factors from the plug-ins, and process waveform arrays just as the calculator normally processes a single variable.

One of the unique advantages of the WP1100-Series DPO is the value that each sub-unit has when used independently. Even without the calculator to process data, the DPO retains the full acquisition capabilities of a laboratory scope. Indeed, there are applications where the DPO is significantly more versatile than the general-purpose scope from which it was built. Go/no-go testing is a good example. Once calculator determined waveform parameters are stored in the P7001 Processor, an operator can visually compare those with the output of a device under test. While the DPO is used for go/no-go testing, the TEKTRONIX 31 Calculator can be disconnected and used elsewhere as a stand-alone programmable calculator for any number of applications, from circuit design to cost accounting. Software support for stand-alone operation includes mathematical, statistical, and electronic engineering packages.

For graphic and alphanumeric representations of measurements and computations, the TEKTRONIX 4661 Digital Plotter is plug-in compatible with the WP1100-Series. With the 4661, full or half scale graphs may be drawn on paper up to 11 x 17 inches. The full scale mode provides 10 inches of y data and 15 inches of x data. In the half scale mode, the plotter accepts 20 inches of y data and 30 inches of x data.

WP1200-SERIES DIGITAL PROCESSING OSCILLOSCOPES

The WP1200-Series DPO, with I/O options, memory options, and a variety of labor-saving peripherals, represents a comprehensive, powerful, and flexible data acquisition and analysis system. This system may be used for many applications in such fields as physics, optics, chemistry, mechanics, biology, and electronics.

Superior performance has been achieved by incorporating DPO TEK BASIC software, CP1100-Series controllers, graphic terminals, cassette or paper tape input/output units, and an optional hard copy unit into standard DPO configurations. These WP1200-Series DPO configurations deliver unmatched performance while the options ensure flexibility to meet individual requirements.

Because of its simplicity and power, the BASIC software language, developed at Dartmouth, is now widely used in business, industry, and science. It is easy to learn and can be applied to most problems quickly and easily. An outstanding feature of BASIC is that it interacts with the user at the terminal in a conversational way. This gives users direct control.

To support the DPO, Tektronix has developed DPO TEK BASIC as an extension of the Dartmouth BASIC software. Many of the original BASIC commands that have been retained have been expanded. New commands have been added to speed waveform processing and to provide interaction between all DPO configuration components and the user.

Important features of the TEKTRONIX GP1100-Series Controllers used in Digital Processing Oscilloscopes include: memory capacity of 16k, 24k, or 28k of byte-addressable 16-bit words; power fail/restart; automatic priority interrupt, an asynchronous serial interface to the graphics terminal; and parallel synchronous interfaces to the P7001 Processor and the paper tape reader/punch or tape cassette. These CP1100 characteristics enable the user to take full advantage of the powerful software features of both DPO TEK BASIC and the optional WDI TEK BASIC software packages.

To assist in writing and editing programs quickly and easily, the WP1200-Series DPO's use TEKTRONIX graphic terminals. In addition to convenient program writing and editing, the terminals allow viewing analyzed data quickly, in a variety of tabular and graphic formats.

For permanent hard copies of graphic terminal displays, the optional TEKTRONIX 4610 Hard Copy Unit may be used. In just seconds, graphs of waveforms, data, and program listings are available. These copies, in an 8 x 10 inch dry copy format, are ideal for records and reports, and are suitable for reproduction.

Both paper tape and cassette DPO configurations are available. In addition to providing fast and easy program loading, entire waveforms can be stored for records or transferred to another computer.

For more information on Digital Processing Oscilloscopes, contact your nearest Tektronix Digital Applications Engineer or write to Tektronix, Inc., P.O. Box 500A, Beaverton, OR 97077.

Waveform Digitizing Instruments (WDI) using the R7912 Transient Digitizer

Transient Analysis and Digital Storage at 8,000 div/μs

Analog Bandwidth:
1 GHz at 4 V/div (direct access)
500 MHz at 10 mV/div

Writing Rate
8,000 div/μs DIGITAL mode
30,000 div/μs NON-STORE (tv) mode

Sampling Rate (Effective):
10 psec (100 GHz) or slower

In advancing the technologies of physics, chemistry, and electronics, researchers have learned to use a variety of instruments to solve measurement problems associated with acquiring fast transient events. The problems are compounded when, the events must not only be acquired, but must also be analyzed.

The Waveform Digitizing Instrument (WDI) configurations have been designed to give users the information they need quickly and economically by capturing and processing both transients and repetitive, short duration events. These configurations can be divided into two categories: viewing configurations —the fastest oscilloscopes available—and software assisted configurations for complete waveform analyses.

For Viewing
The **WDI** viewing configurations (WP2001, WP2002, WP2003, and WP2004) may be used either as ultrafast oscilloscopes or as storage media for brief events. Bright, clearly visible displays of the events are shown in realistic time. Depending on the configura-

tion, events may be recorded as hard copies or by other photographic methods. Some features are:

- **Large, Bright Tv Displays,** VTR data logging possible
- **High Writing Rates,** DIGITAL mode 8,000 div/µs, NONSTORE (tv) mode 30,000 div/µs
- **Crt Storage Capability** provides optimum performance at lowest cost
- **Digital Storage Capability** provides memory refreshed displays with nonstorage monitors
- **Hard Copies in Seconds** from a TEKTRONIX hard copy unit and a 613 Storage Display Unit

For Software Assisted Analysis

With WDI software assisted configurations, (WP2221, WP2222, WP2321, WP2322), complete measurement and analytical procedures may be performed. The enhancement and editing routines of the software, WDI TEK BASIC, also aid in the task. For future use, program libraries may be generated for particlar classes of events. Capabilities include:

Software Waveform Analyses

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

Software Control

- DIGITAL mode
- NONSTORE (tv) mode
- Graticule
- Scale factor information
- Signal channel selection
- Sweep arming
- Memory lock

Dual Digital Cassette

- Program storage
- Waveform storage (data logging)
- Very convenient operation

Paper Tape Reader Punch (optional)

Graphics Display Terminal

- Large, easy to view display
- Graphic display capability
- Keyboard for system control and program writing
- 8¼ x 11-in hard copies in seconds (from a TEKTRONIX hard copy unit)

Tv Monitor

For signal viewing and acquisition unit setup

Multichannel Capability

Up to 32 acquisition units may be incorporated in one configuration

Controllers

- CP1151 with 28k of core memory (16k optional), 16-bit words, and a cycle time of 2.7 µs
- CP1160 with 28k of core memory, 16-bit words, and a cycle time of 0.9 µs

The case for the R7912 Transient Digitizer. Converting analog events to digital information and meeting the requirements of machine data processing techniques can cause errors because of the resolution and time uncertainty in the digitizing process. These errors become increasingly evident as bandwidth requirements are extended. These errors limit the validity of the data, especially in waveform analysis where the results of frequency and phase calculations may be affected.

When scan conversion is not used, the instantaneous amplitude of a continuously varying waveform may be digitally identified only if the digitizing process occurs at the same instant. Hence, the conversion of high speed waveforms requires the use of very high sample rates. If the Nyquist criterion is not observed, however, some instantaneous values will be lost, and interpolation will leave doubt about the values between the digitized steps. Also, time uncertainty (sometimes called "aperture error") and signal slew rate will contribute to amplitude inaccuracy. This type of error is substantially reduced in the R7912 because it is the stored image of the event rather than the event itself that is digitized.

Tailored Performance

A comprehensive range of TEKTRONIX 7000-Series plug-in amplifiers provides R7912 input characteristics to suit most applications. Many bandwidth, sensitivity, and input impedance combinations provide versatility.

Vertical Amplifiers. Plug-in amplifiers such as the 7A16A, 7A19, 7A21N, and 7A24 may be used in the left-hand compartment of the R7912.

Time Bases Units. Plug-in time bases such as the 7B70 and 7B92A may be used in the right-hand compartment of the R7912.

R7912 Performance Characteristics

The R7912 Scan Converter Crt — Double-ended, dual-gun type.

Resolution of digital data, stored in the R7912 on a 512-point by 512-point matrix, is rated, best case, at 1 part in 320 for vertical values and 1 part in 400 for horizontal values.

Distortion because of beam velocity modulation may occur but, in the worst case, the amplitude of any instrument generated harmonics will be more than 30 db down from the fundamental for a sinusoid of 20 cycles at 90 percent of full screen amplitude. Transients with an amplitude of 90% of full screen and a beam intensity/velocity ratio of up to 10:1 may be digitized. In either case, the results are repeatable; therefore, software enhancement techniques may be used to advantage.

Writing Rate — NONSTORE mode: visual writing rate —30,000 div/µs (when viewed on a TEKTRONIX 632 Picture Monitor). DIGITAL mode: digital storage writing rate—8,000 div/µs (equivalent to a digitizing rate of 100 points/ns).

Memory:

Type — Static semiconductor memory, nondestructive readout.

Size — 4096 words by 10 bits.

Cycle Time — 1.6 µs per word or slower.

Output — Bit parallel; word serial; 9 data bits plus 10th-bit flag.

Vertical System:

Channels — Left-hand plug-in compartment—compatible with 7000-Series plug-ins. Bandwidth determined by plug-in unit.

Chopped Mode — Chop rate determined by vertical plug-in selected.

Delay Line — Permits viewing leading edge of displayed waveform.

Horizontal System:

Channels — Right-hand plug-in compartment—compatible with time bases of the 7B70 and 7B90 Series.

Calibrated Sweep Speed — To 500 ps/div with 7B92A.