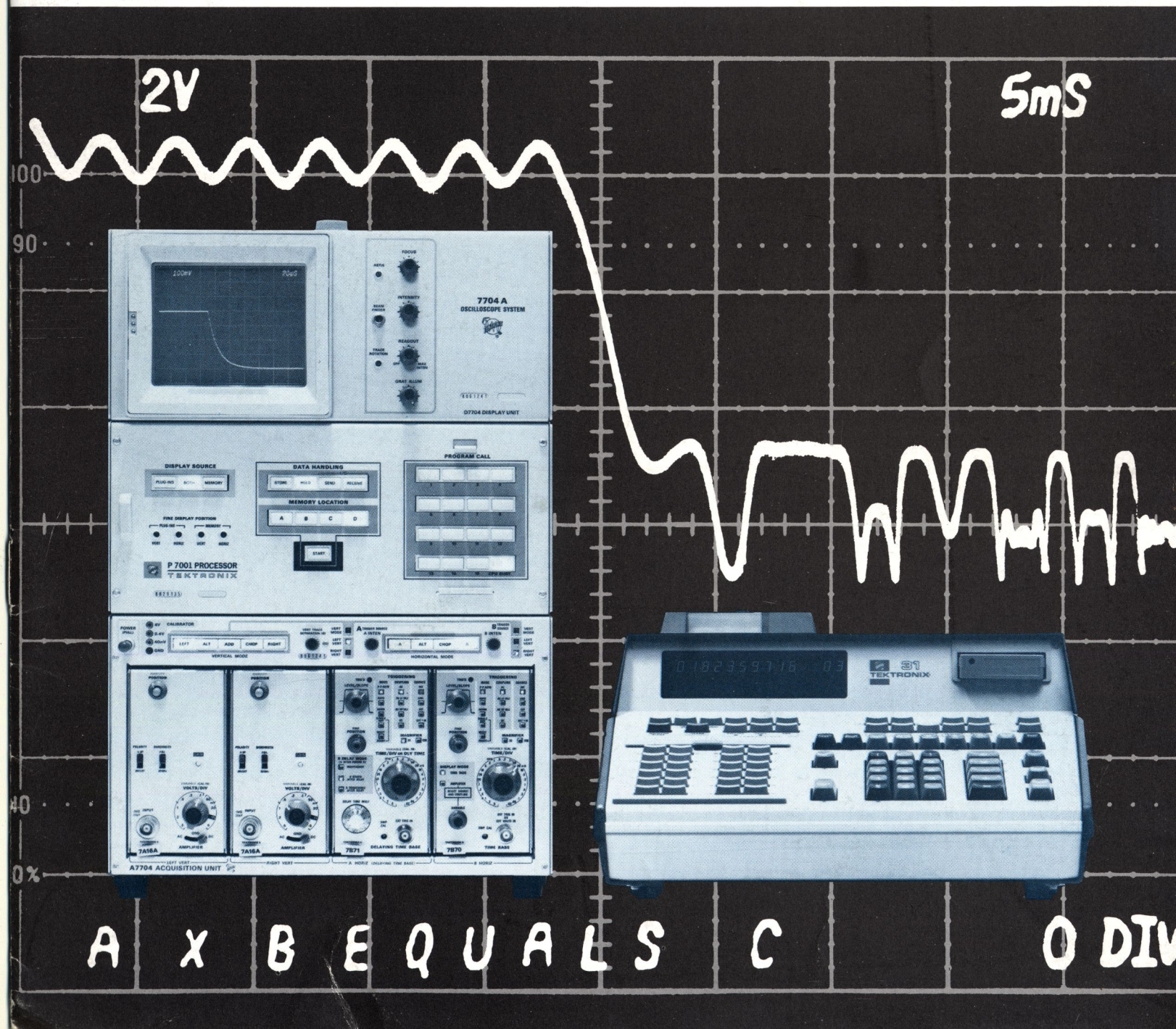
TEKTRONIX®
committed to
technical excellence

DIGITAL PROCESSING OSCILLOSCOPE

CALCULATOR AIDED MEASUREMENTS



Introduction

Today, it seems that we are all in a never-ending search for greater speeds. Saving time has gone from a fetish to becoming an economic necessity. At Tektronix we realize that often "time" is the critical obstacle that frustrates man's imagination and slows the pace of man's development.

Tektronix recently introduced two new time-saving products: The Digital Processing Oscilloscope; and the TEKTRONIX Type 31 Programmable Calculator. Each is a great step forward in simplifying complicated and involved calculations and measurements. Now, we have combined these units into one system, the Digital Processing Oscilloscope/31 Calculator (DPO 3100 Series).

How did we do it? First, from our 7000 Oscilloscope family we took the 7704A main frame, added a P7001 Processor to digitize waveforms, and interfaced it with our Type 31 Programmable Calculator. The complete assembly can be programmed to perform waveform calculations and measurements with the stroke of just a few keys.

Until now, programmable calculators and computers have been unable to remove completely the language barrier. Tektronix understands the problems this has created. That's why we have designed our calculators the other way around: from you and your mind back to the machine. Instead of you having to adapt to the machine, it has been adapted to you and the math language with which you grew up.

This natural language feature allows even the relatively inexperienced operator to use the machines, helping to free the engineer from the less productive tasks of collecting, processing and recording data. Information on programming the DPO 3100 Series can be found beginning on page 2.

Until the Digital Processing Oscilloscope (DPO) was developed, most oscilloscope waveform computation was accomplished by plotting each waveform and doing the math point by point. With this method, the engineer spent untold hours performing the same calculations on each individual point. Now, by using the TEKTRONIX 31 Programmable Calculator, you, the operator, simply tell the calculator to perform the desired math function. Your answer is plotted on the CRT. Examples of waveform calculations performed by the DPO 3100 Series appear on page 5.

It is not necessary to keep the components of the DPO 3100 Series coupled together. As a matter of fact, one of the great benefits in owning a DPO 3100

is that the TEKTRONIX Type 31 can be used as a stand-alone scientific programmable calculator; and the Digital Processing Oscilloscope can be used as a stand-alone unit to view, store, and play back waveforms, (or coupled to a computer for additional flexibility). Pages 6 and 7 discuss the features and capabilities of the calculator. Pages 8 through 11 discuss the features found in the Digital Processing Oscilloscope. To obtain more detailed information on these units, use the card attached to the Configuration and Price insert.

Briefly, the Digital Processing Oscilloscope acquires electrical events, or any phenomenon that can be represented as a waveform, processes that waveform and displays the result. In order to process the waveform, the processor converts the analog waveform to a digital array and memorizes that array. Then the digitized waveform is sent to a calculating device where any sort of mathematical or logical operation can be performed on it depending on the computer program. The processed waveform is sent back to the Digital Processing Oscilloscope where it can be graphically displayed.

The acquisition system with more than 25 plug-ins available, and more to come, is unparalleled in the industry and adds a new element of versatility. (See acquisition system on pages 8 and 9.) No other equipment of like nature offers so many plug-ins—and at such a comparatively low cost.

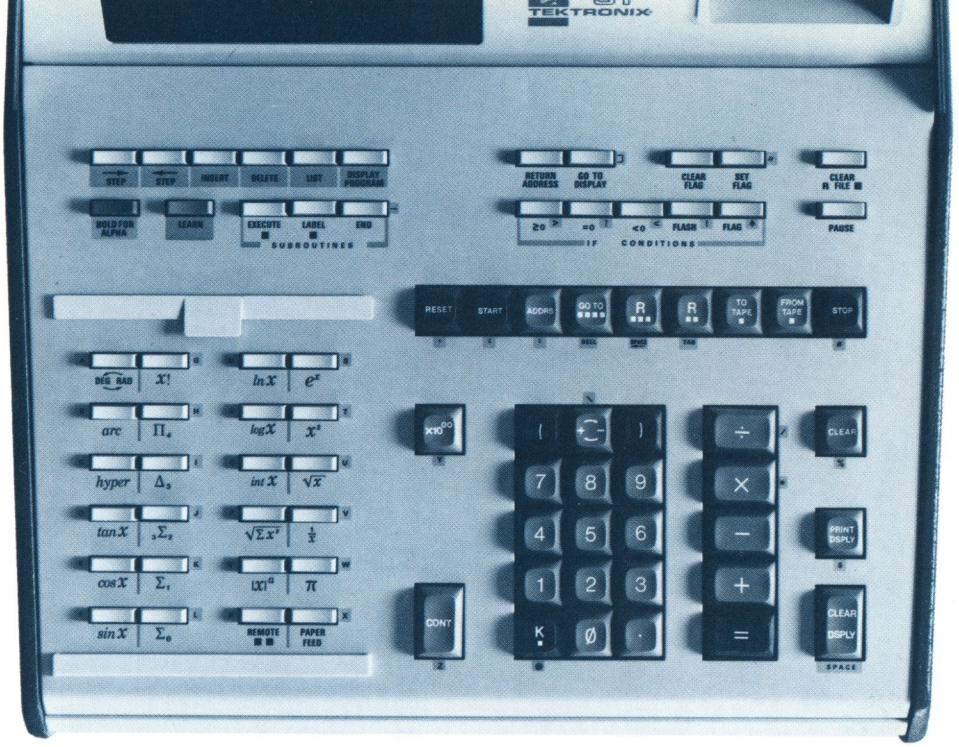
When you consider the versatility and power of the DPO 3100 Series, its price, compared with other systems, is very competitive.

At the present time, several configurations are available to meet your specialized requirements. These, however, are only the beginning. Tables have been provided in the Configuration and Price insert, making it easy and convenient to determine the cost of the various configurations.

Your Tektronix Digital Application Engineer can be of great assistance in helping select the options and accessories to meet your application requirements. His strong technical background, plus his extensive product training, make him a good source of reference when there is a question to be answered.

If, after reading this brochure, you wish to make a "hands on" inspection of the DPO 3100 Series, please let us know. Your Application Engineer will be happy to arrange a demonstration for your particular application—at your convenience.

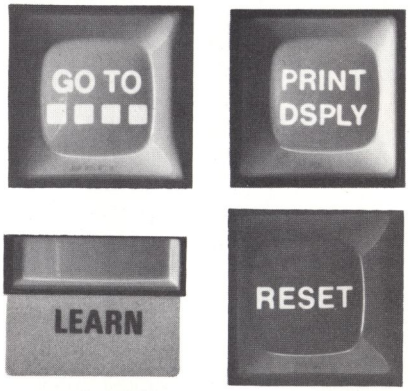
Programming



With the Type 31 Calculator, you have at your fingertips computer-like power in the math language you understand. This provides programming ease for the beginner and enough power to satisfy the experienced programmer. Consider these features:

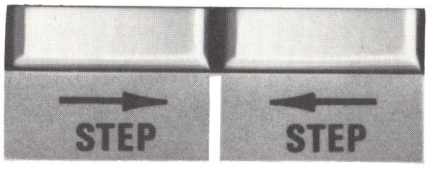
- Full editing capability.
- The ability to symbolically address and nest subroutines.
- CRT alphanumeric readout that is as simple as writing your name so messages from the calculator to the operator are in English.
- The ability of the calculator to communicate by writing instructions on the CRT, asking for input and labeling results.
- Full mathematical capability is retained while using customized programs.
- A single keystroke can call a custom program.

For example, to enter a program into the calculator program memory, simply tell the calculator the starting point of the program by pressing GO TO followed by the desired memory address. Then, to tell the calculator to remember the keystrokes of your program, press LEARN and enter your program. To print any results, simply press PRINT DISPLAY. To end the program and reset the calculator, press RESET. Exit the learn mode by pressing LEARN.



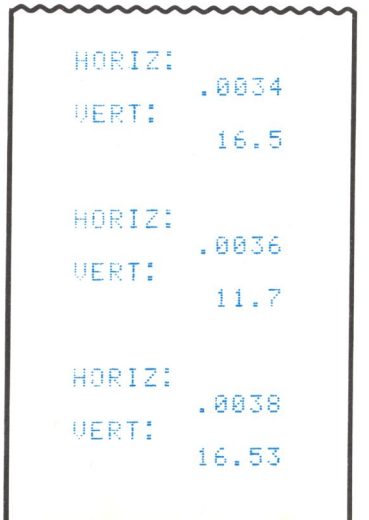
Decision making within your program is a simple matter with the "if" condition keys (conditional branching). The number in the display may be tested for less than zero, equal to zero, or greater than or equal to zero. In addition, you can test the condition of a programmable flag and test to see if the calculator has over-ranged or attempted an illegal math operation (indicated by a flashing display). If these conditions are not sequential, program execution is interrupted and program control branches to the appropriate point in the program. In addition to these conditional branches, four types of unconditional branches are available.

If there is an error in programming, it's easy to examine the program by pressing "step forward" or "step back"



to debug the program. The printer will list the program steps for you in English. Once you detect the error, you can insert, delete or overwrite a step. If necessary, the machine automatically re-numbers the subsequent program steps. Symbolically labelling a subroutine allows you to call a subroutine by its name rather by its location in memory. The calculator will remember the subroutine location. All you have to do is tell the calculator which subroutine you want. The calculator finds the subroutine, executes it and returns automatically to the return address. This return address may be sequentially stored and recalled to permit nesting of subroutines, or modified to alter the return address.

Reading the operations and results is easy due to the large, bright numeric display. Messages displayed tell you what mode you are in and if an error has been made. When hard copy is needed, there's the optional silent alphanumeric thermal printer.



The wide variety of input and output peripherals, you can interface to the calculator, provide more power. A graphic terminal combination is available which provides large screen graphics and optional data communications interfacing to the world of telecommunications.

In the DPO 3100 Series, your Type 31 Programmable Calculator has one continuous memory; and, you can branch to any step. The versatility of the calculator allows you to use an overlay to label 24 user-definable keys in your language, thus "customizing" the calculator to fit your requirements.

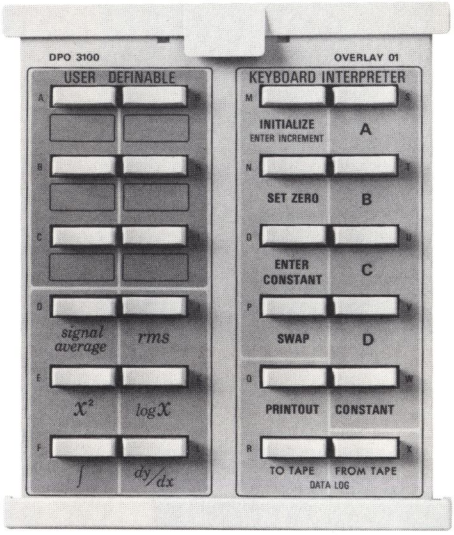
For example, if you're an electrical engineer dealing with complex variables, you may label keys "magnitude" and "phase". A single keystroke would give you any of these parameters. If you are dealing with statistics, you might choose to label some of the keys "mean," "variance," "standard deviation" or "linear regression." While you're using the overlay, you still maintain the full mathematical capability of the calculator. The magnetic tape cartridge can also be used to store your programs or data and load programs. It can also be used to expand the number of steps or data registers available to you.

"Customizing" the calculator's 24 user-definable keys is one of the building blocks on which the DPO/Calculator interface is based. By programming the user-definable keys to process waveforms, we now have the ability to make waveform computations with the stroke of a key.

Programs

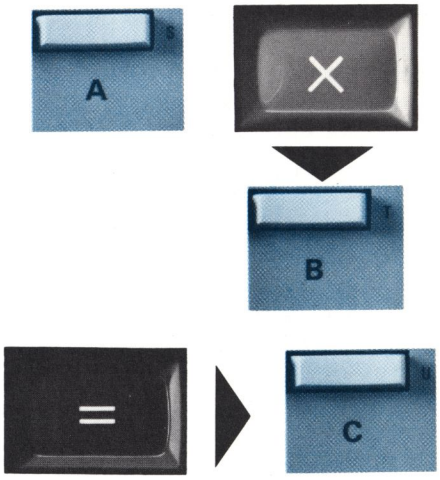
Keyboard Interpreter Programs

To familiarize you with the DPO 3100 Series, and to allow easily accessible waveform processing, Tektronix has developed the Keyboard Interpreter Program and a Program Keyboard Overlay to match. It contains programs to add, subtract, multiply, divide, log x, integrate, differentiate, x^2, signal average and determine RMS. In addition, there are four keys and corresponding space available for your user-defined functions.

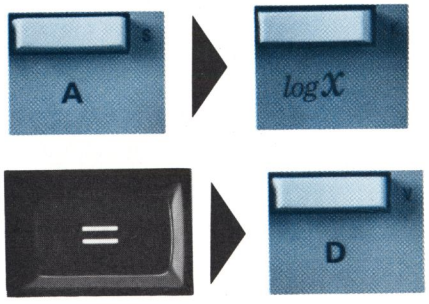


After loading a program, and placing the Program Overlay in place, you can now perform waveform computations. The Keyboard Interpreter Program will automatically scale waveforms, process scale factors from the plug-ins and will process waveform arrays just as the calculator normally processes a single variable.

For example, to multiply a waveform in memory location "A" by a waveform in memory location "B" and deposit the resulting waveform in memory location "C," simply press A × B = C on the calculator keyboard and the interpreter program will automatically multiply the waveforms using the appropriate scale factors, rescale the result to fit in the area of the CRT and place the result in memory location C along with the new scale factor.



To look at another example, suppose you wish to take a waveform in A and deposit its logarithm in memory location D. Simply press A log x = D. The logarithm of A is now in location D with its scale factor.



Special Programs

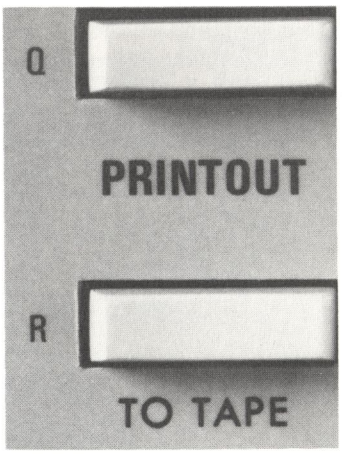
To further enhance your capabilities for waveform processing, Tektronix will offer a number of special purpose programs in the form of pre-recorded tape cartridges and printed program listings. Some of the specific programs to be available include: peak voltage, rise time, convolution, correlations and discrete Fourier transform.

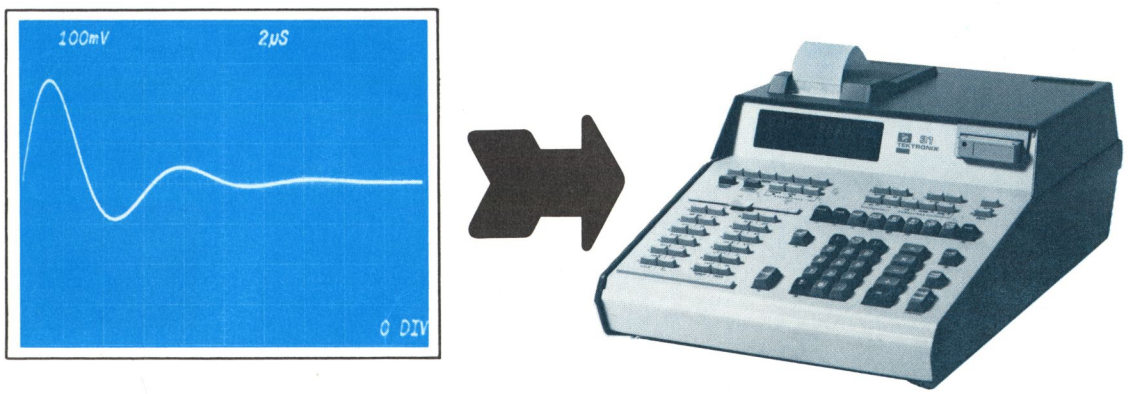
Software Development Manual

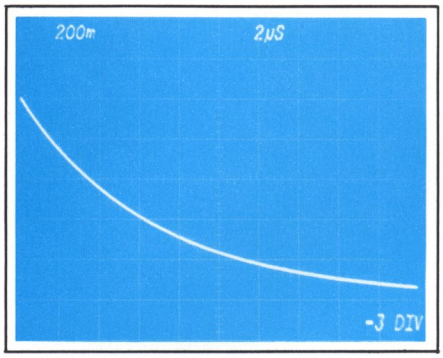
The Software Development Manual is a comprehensive easy-to-understand guide to enable you to create effective programs tailored exactly to your specific requirements. The manual contains a thorough discussion of the DPO, the interface and the calculator, plus a discussion of how they communicate and interact. You will also find detailed information on waveform processing, a library of subroutines, examples of many simple programs, a comprehensive discussion of programming techniques and methods, and finally, program checkout procedures. Scaling methods are also discussed along with scale factor acquisition and processing.

Data Logging

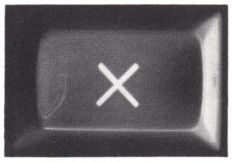
One very important feature of the DPO 3100 Series is its data logging capability. You can store entire waveforms on a magnetic tape cartridge at the push of a button (along with scaling and scale factor information and message text). These can be stored for any duration and played back at will. The alphanumeric thermal printer can be used to record each digital horizontal waveform element along with the appropriate scale factor.

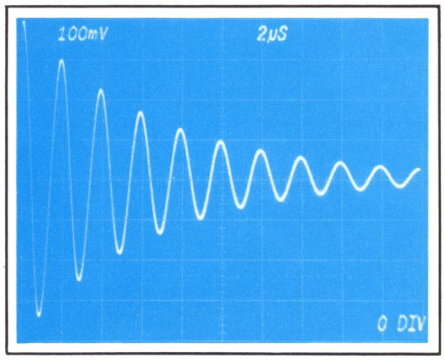




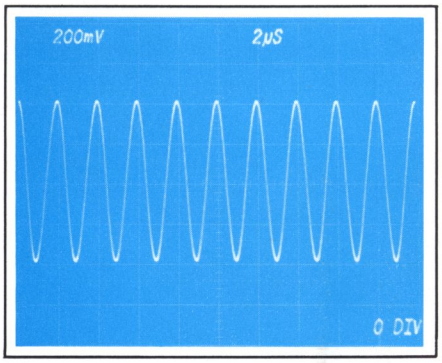


Store this derived expotential waveform in memory buffer A.

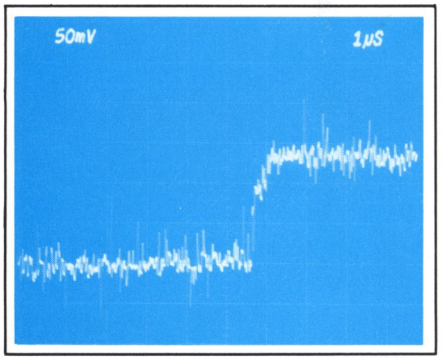




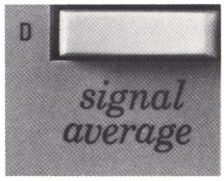
Press the five calculator keys A X B = C. This will call the program which multiplies buffer A by buffer B and deposits the result in buffer C. The product of the two waveforms is shown above. Note that the correct dimensions are preserved in the CRT readout.

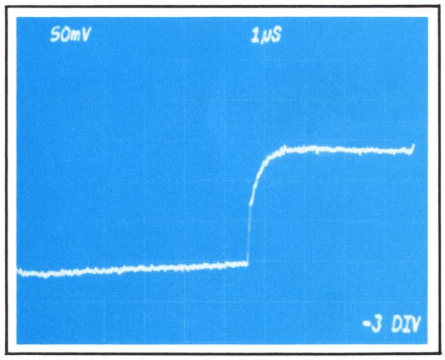


Store the above sinewave in memory buffer B.

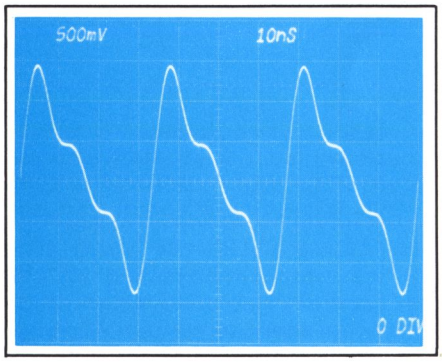


Above is a waveform with so much noise present it is difficult to make a useful measurement.

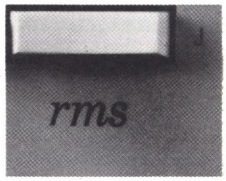


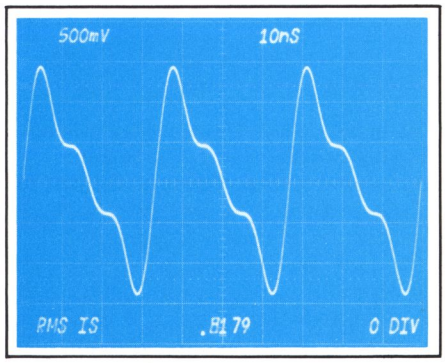


After pressing the *signal average* button the resultant waveform appears above. Note that this waveform has been rescaled by the user.

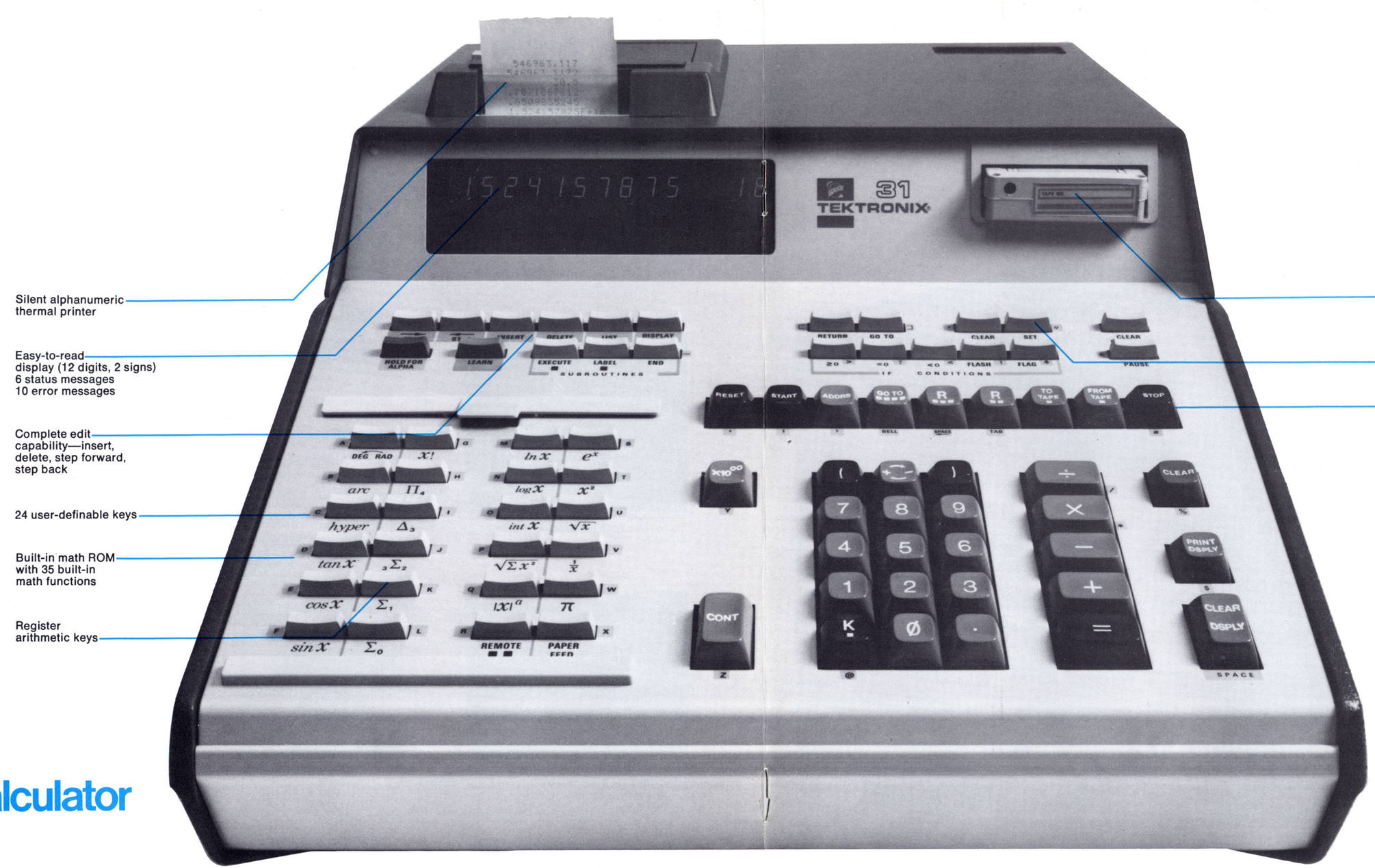


Above is a complex waveform.





Pressing the *rms* button calls the program to calculate root mean squared. As you see the calculated value is displayed on the bottom CRT readout line.



Calculator

As an individual unit—a self-contained entity—the TEKTRONIX Type 31 Programmable Calculator is a powerful tool. Up to 8191 program steps with 266 registers are available along with an internal switch enabling an increase in registers at the expense of the number of available program steps. It has been designed to be extremely versatile so that in addition to being a scientific instrument, it may also be used as a general purpose programmable calculator in almost any application.

One distinguishing feature that sets the Type 31 Programmable Calculator apart from all others in its field is its natural math language. Tektronix has successfully removed the machine language barrier; thus, there is no special machine language to learn. The English-like programming keys on a simply defined keyboard execute the math functions just as you would write them.

Within the Tektronix Type 31 Calculator there are over 30 built-in math functions. There are 24 keys which can be user defined to perform those special functions you use frequently. Loaded with a magnetic cartridge containing your special programs, the calculator is customized instantly to meet your own specific computation requirements.

This customizing capability expands the usefulness of the Tektronix Type 31 Calculator. As an example, its first function of the day could be performing business math by defining the keys for doing budgets, cost analysis and other non-waveform calculations. Then, by simply changing the magnetic cartridge, loading the program and changing the Program Overlay, the calculator can move easily into the field of optics, design engineering, dynamic stress analysis, physical measurements, vibration analysis, etc.

As a multi-purpose calculator, the Tektronix Type 31 Programmable Calculator is of significant value.

For more information on the Type 31 calculator stand alone capabilities, please refer to the Tektronix Programmable Calculator brochure. The brochure can be requested by mailing one of the "Business Reply Cards" contained on the Price Insert.

Digital Processing Oscilloscope

CRT Readout: displays measurement parameters on the CRT.

Large, Bright, Display: display area 8 cm x 10 cm; bright, fast writing CRT with a 24 kV accelerating potential.

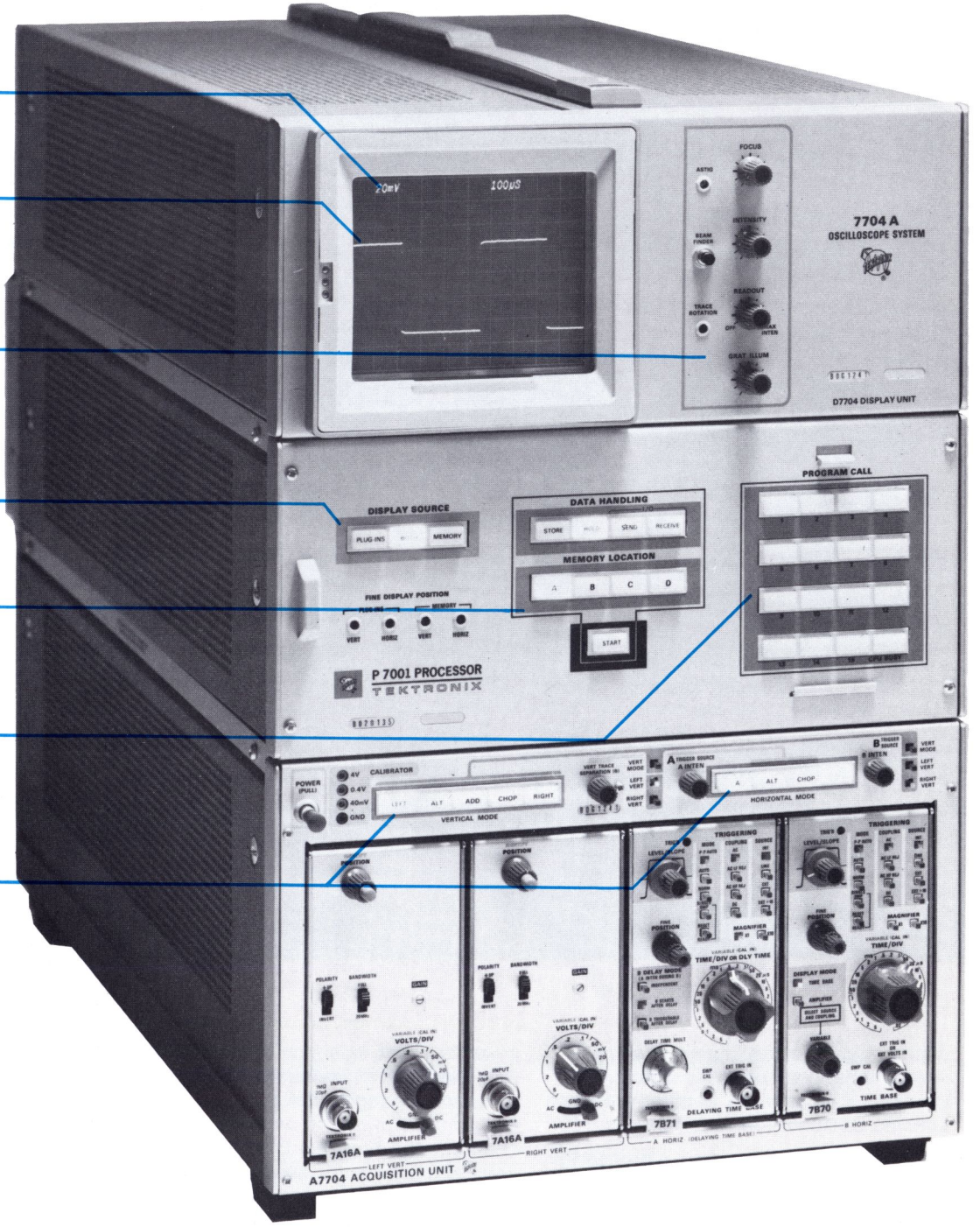
Independent Intensity Adjustments: allow independent brightness control of analog displays and CRT readouts.

Display Source Buttons: selects sources from which the CRT signals are taken.

Data Handling and Memory Location: permits operator to store wave forms and CRT readout values.

User Definable Program Buttons: allows remote control of user definable functions programmed by the calculator.

Vertical and Horizontal Mode Switching: allows easy display selection of vertical and horizontal signal sources.



The Digital Processing Oscilloscope (DPO) is a part of the TEKTRONIX 7000-Series of measurement equipment. The wide and flexible array of signal acquisition units and timebase (plug-ins) already available for the 7000-Series; plus, the ability to view, digitize, store and play back any or both waveform and readout information displayed on the CRT screen make it an important member of the measurement community.

Basically, a DPO is a combination of three major components: (1) the D7704 Display unit; (2) the P7001 Processor; and (3) the A7704 acquisition unit with compartments holding from one to four plug-ins.

Display

The D7704 Display unit is equipped with a bright fast-writing CRT with a 24kV accelerating potential. The internal 8 x 10 graticule is provided with a variable illumination feature.

CRT Readout takes the guess work out of visual oscilloscope measurements by displaying the measurement parameters on the CRT screen where they can be viewed, digitized, stored and played back.

The readout also provides the units of measure and coefficients (scale factors) necessary for an externally connected controller to assign the proper values to the absolute waveform obtained from the P7001 memory.

The CRT Readout can be addressed by a 7000-Series plug-in installed in the Acquisition unit or by an external controller such as a computer or calculator to place alphanumeric text on the CRT screen. The text may instruct an operator to change a control setting or perhaps provide wareform identity.

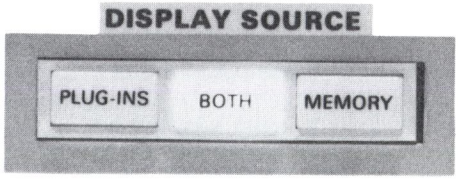
Processor

The P7001 Processor is designed to provide maximum flexibility as a signal interface for the calculator. It contains signal routing circuitry, analog to digital (A/D) circuitry, digital to analog (D/A) circuitry, and up to 4,000 words of 10 bit memory for storage of digitized waveforms and alphanumeric information for the D7704 CRT readout.

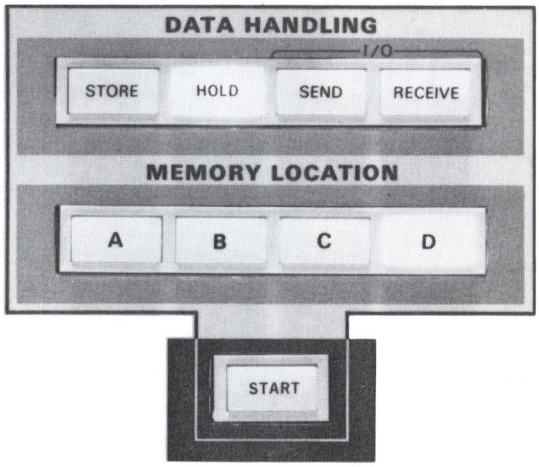
It also accepts external controller interface units. The processor unit by itself can perform simple digital storage and playback operations. When connected to a controller, complete digital processing is possible.

Digitizing is performed on a pseudo-random basis. The circuitry is capable of processing a new sample every 6.5 μs. Since both the vertical and time information is digitized, the vertical information will always be stored in the correct position within the 512 word storage array. (A waveform requires 512 words of storage.)

To make the storage operation more convenient, the operator may view the signal being stored in memory while at the same time up-dating or refreshing that location.



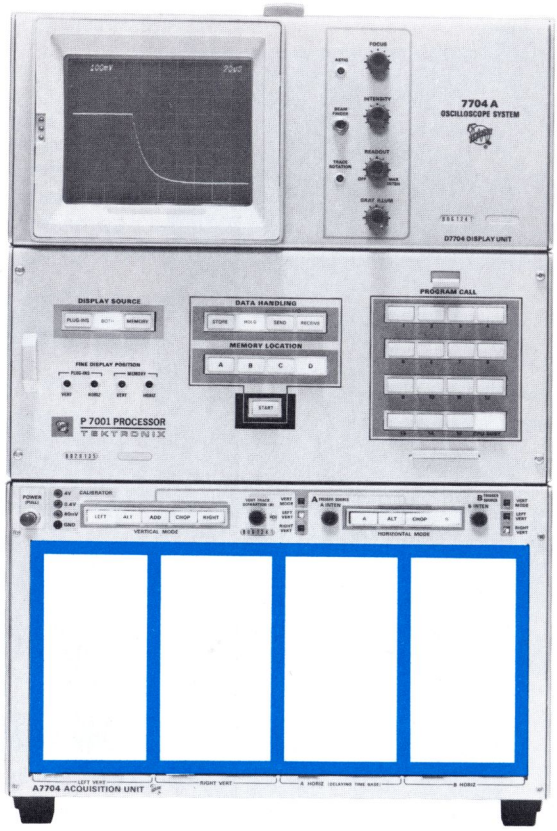
When the operator desires to display a signal from more than one memory location, he depresses from one to four of the MEMORY LOCATION buttons.



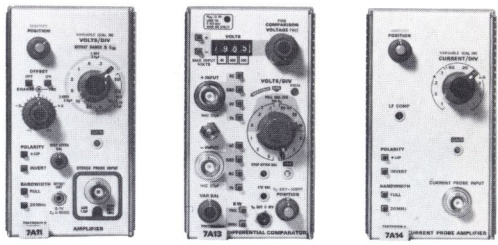
As a stand alone unit, the DPO contains full facilities to store and play back waveforms. These capabilities allow it to be used to compare waveforms against a standard. The operator may digitize, and store a standard (or signature) waveform, so that later he may recall and reconstruct it along with an incoming waveform and display them both on the CRT. By comparing, the operator can see at a glance where they differ.

The P7001 has plug-in memory to enable selection of the most appropriate memory size. Plug-in memories available are: 1K MOS, 2K MOS and 4k Core. The standard 4K core memory, unlike MOS memories, will retain stored information regardless of power interruptions.

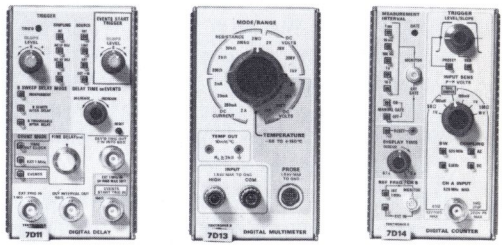
For more details on DPO-Computer systems, use the card attached to the Price Insert to obtain the Digital Processing Oscilloscope brochure.



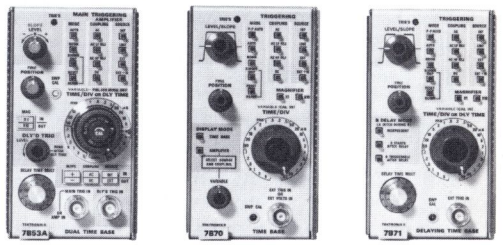
AMPLIFIERS



DIGITAL PLUG-INS



TIME BASES



Acquisition Units

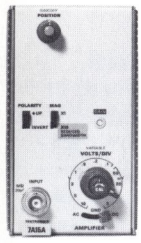
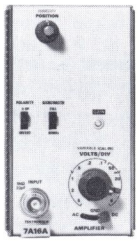
Tektronix is the undisputed leader in the field of laboratory oscilloscope plug-ins. In 1969 Tektronix introduced the 7000-Series plug-in family. Many instrument concepts were pioneered by the 7000-Series, giving the family a degree of flexibility, versatility and operating convenience far exceeding any other oscilloscope system on the market at the present time.

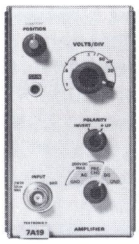
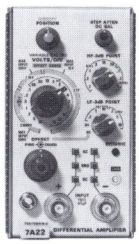
Today, there are more than 25 plug-in units available for the DPO with more being developed. An enormous range of signals can now be captured for digital processing. These plug-ins have sensitivities ranging from 10 microvolts per division to many kilovolts per division. Signal amplitudes up to 40 kV peak may be accessed using high voltage signal probes.

The wide range of acquisition units makes the Digital Processing Oscilloscope extremely useful for those doing research and development work in many fields of study. Optics, chemistry, physics, mechanical studies, fluidics and pressure studies, are only a few of the areas which present themselves as possibilities.

The use of suitable transducers ahead of a vertical amplifier plug-in unit permits quick, easy, calculator processing of information in many fields. A single Digital Processing Oscilloscope may serve in lieu of many different highly specialized and expensive measuring systems by reconfiguring software programs and using different signal acquisition units.

The A7704 Acquisition unit will operate with any combination of up to four of 7000-Series plug-in units. This flexibility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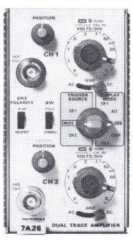
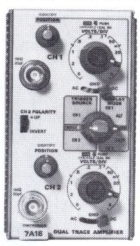
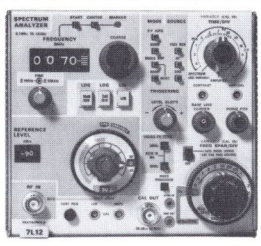
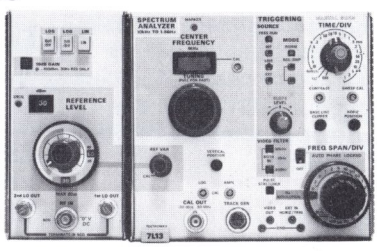
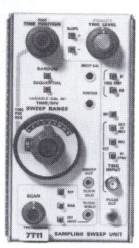



SPECTRUM ANALYZERS


SAMPLING PLUG-INS





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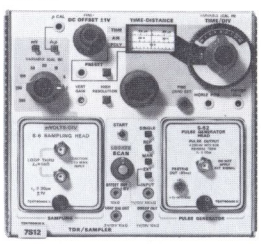
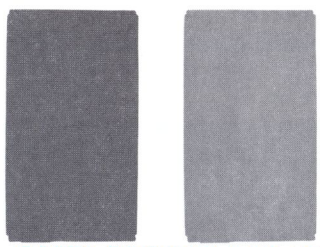


AND MORE TO COME . . .

will increase even further as new 7000-Series plug-ins are announced.

The ability to use different plug-ins to meet differing requirements provides extreme flexibility. For time based measurements a vertical amplifier unit and a time base may be paired. At the same time if one parameter is to be plotted as a function of another, a vertical plug-in unit may be installed in a horizontal position of the acquisition unit for an X-Y plot display. X-Y displays may be directly stored for processing provided that Y is a single valued function of X.

The Digital plug-in units offer a digital delay with a digital delay readout; a digital multi-meter that is capable of measuring DC volts, DC current, resistance and temperature; a 525 MHz digital counter and a universal counter timer which offers oscilloscope control of time and frequency measurements. While these units provide no analog signal on the display unit, the results of the digital measurements are visible on the CRT Readout.

All information visible on the CRT is accessible to the processing system; therefore, the digital measurements may be calculator processed either alone or in conjunction with the P7001 digitized waveform information.

To learn about the latest developments in the 7000-Series use the card attached to the Price Insert and ask for a 7000-Series catalog. Your TEKTRONIX Digital Applications Engineer and your Field Engineer can be of great assistance in providing you with the information you require. Call on them when you have questions.

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