TEKTRONIX®

DIGITAL PROCESSING OSCILLOSCOPE

OPERATORS

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Serial Number _____

First Printing SEPT 1974

070-1599-00

WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the TEKTRONIX Field Office or representative in your area. This will assure you the fastest possible service. Please include the instrument Type Number or Part Number and Serial Number with all requests for parts or service.

Specifications and price change privileges reserved.

U.S.A. and foreign TEKTRONIX products covered by U.S. and foreign patents and/or patents pending.

TABLE OF CONTENTS

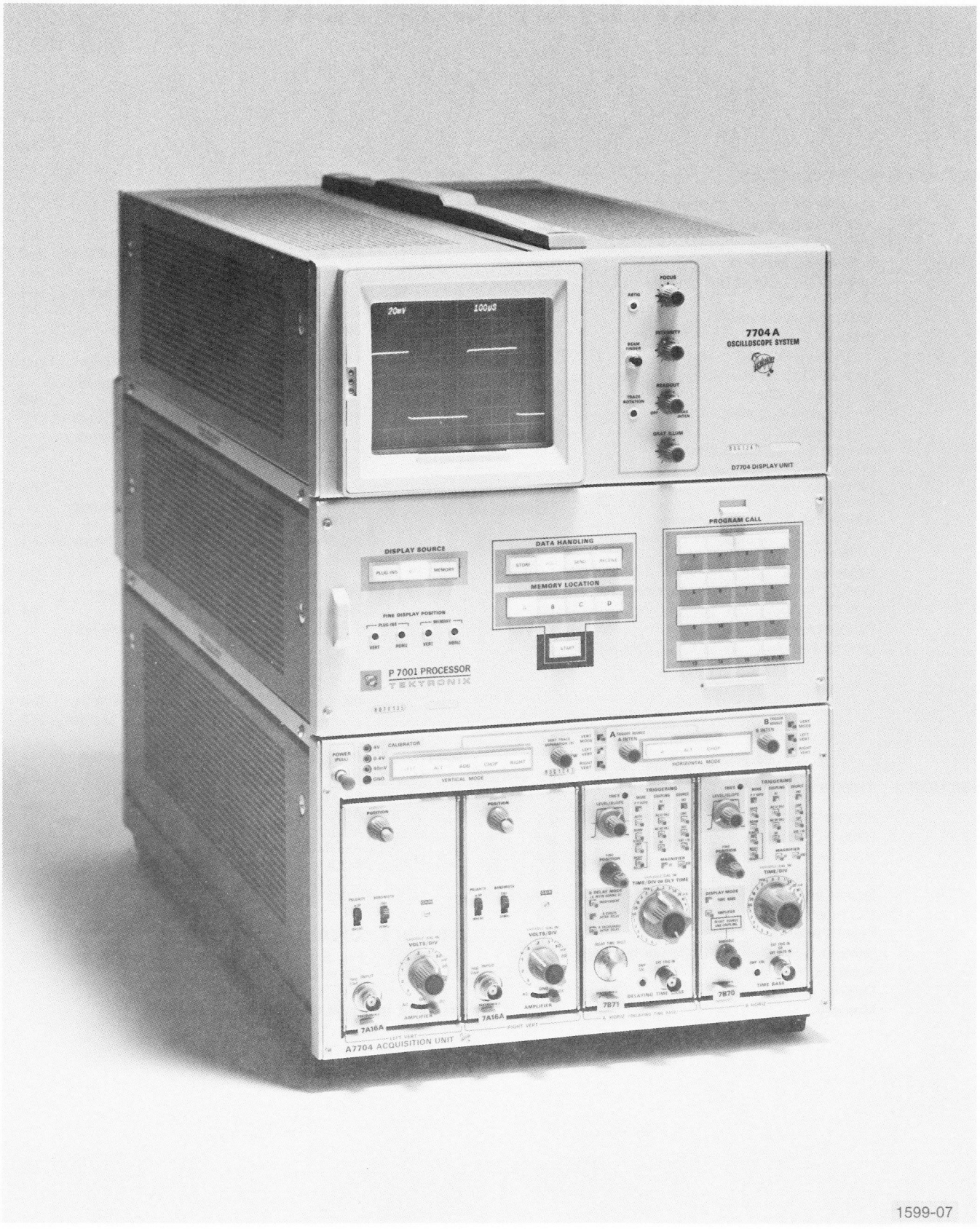


Fig. 1-1. Digital Processing Oscilloscope.

DPO OPERATION

NOTE

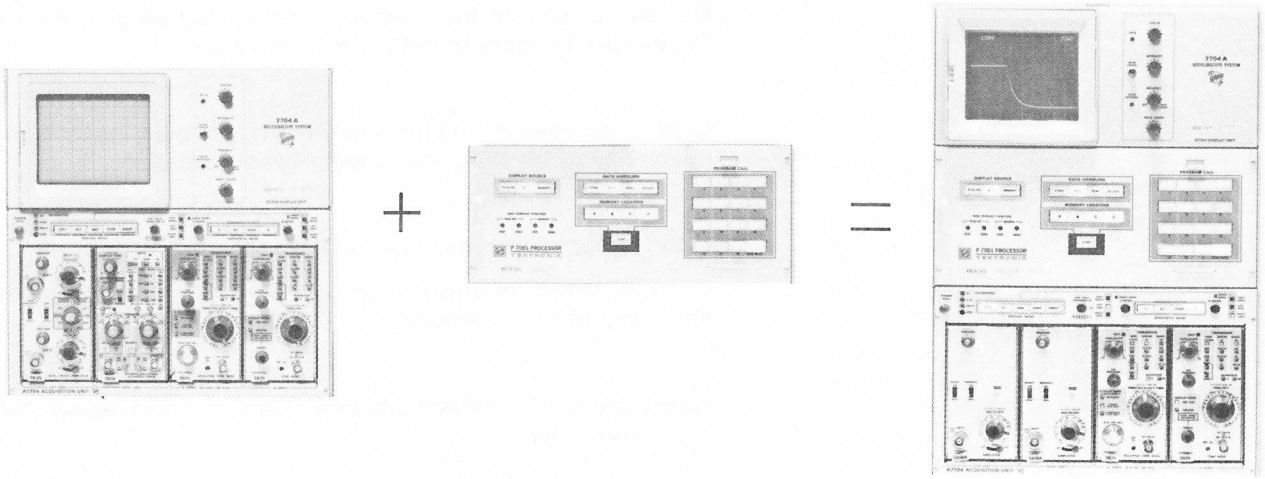
Before plugging the DPO into a power source, read Section 5 of this manual.

The DPO (Digital Processing Oscilloscope) is a computer compatible oscilloscope. It lets you make oscilloscope measurements in the normal manner or store the digitized waveforms in the processor's memory. The processor then provides an interface to a controller (minicomputer) and allows selection of waveform processing programs with pushbutton ease and simplicity. The results appear on the DPO display in familiar oscilloscope format, together with quantitative answers to computations if desired.

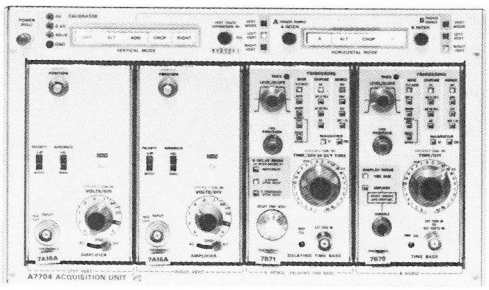
In short, the DPO gives you answers to your oscilloscope measurement problems when and where you need them, at the oscilloscope.

1599-01

MAJOR PARTS OF THE DPO



1599-02

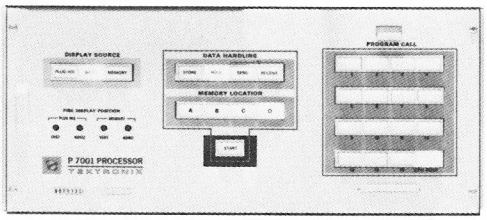


1599-03

A7704 Acquisition Unit

The first step in signal processing or measurement is signal acquisition. This is done by the A7704 Acquisition Unit.

The A7704 is one half of the 7704A, a dc-to-200-MHz oscilloscope that has the measurement flexibility allowed by a wide choice of available 7000-series plug-in—Vertical Amplifiers, Time Bases, and various Specialized Plug-ins. Refer to the DPO Specifications and Calibration Manual for a list of the plug-ins and their features.



1599-04

P7001 Processor

The P7001 Processor is the computer link that places signal processing power at your fingertips. Through its front-panel pushbuttons, you may select operating modes ranging from duplicating an oscilloscope waveform, or when interfaced with a computer, to automatic processing of acquired waveforms.

There are 28 pushbuttons located on the processor's front panel: three for selecting display sources, nine associated with data handling, and 16 related to processing data. For your convenience, these pushbuttons are grouped, labeled, and color coded according to their functions. As a further operating aid, each group and the buttons within each group are arranged for a natural sequence of selection. Color coding of the front panel controls is as follows:

BLUE—Identifies the controls affecting the crt display mode.

GREEN—Identifies all trigger controls.

Other colors such as gray, orange, yellow, etc., have no functional assignments, but are used as needed to indicate the relationship between the appropriate controls and connectors.

Briefly, the processor pushbuttons allow you to:

Display waveforms from the Acquisition Unit plug-in, from the Processor's memory or both simultaneously.

Digitize waveforms from the Acquisition Units plug-ins for storage in any one of the Processor's four memory locations.

And when interfaced with a controller, they allow you to:

Transfer waveform information between the Processor memory and the controller memory.

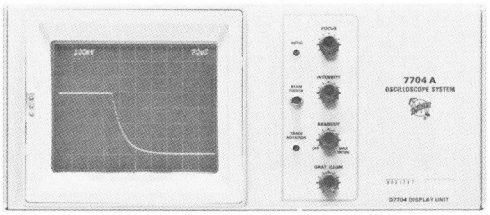
Select any of 13 waveform processing programs previously stored in the controller.

Exactly how to use the Processor pushbuttons will be explained later.

@

D7704 Display Unit

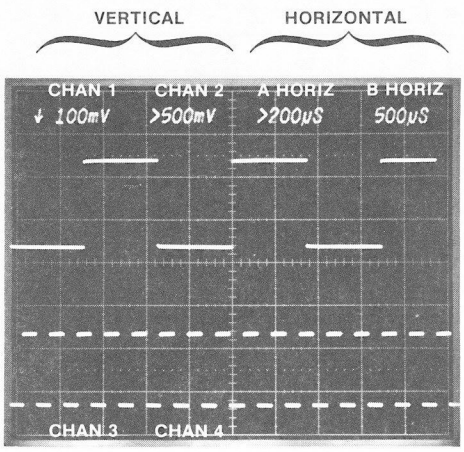
The results of signal acquisition and processing must be conveyed to the DPO user. This is done by the display section of the 7704A.



1599-05

The D7704 Display Unit provides a visual interface with the DPO in a familiar oscilloscope format. Up to four real time waveforms from the A7704 Acquisition Unit and four stored waveforms from the P7001 Processor may be displayed simultaneously on the D7704 Display Unit. Additionally, crt readout, a feature of Tektronix 7000-series oscilloscope, is carried over into the DPO and expanded to provide appropriate scaling and message displays.

Before going any further, it might be helpful to point out some crt readout features that are designed to aid you in interpreting displays.



1599-08

All vertical scale factors appear on the left half of the crt and all horizontal scale factors appear on the right half. A > symbol preceding a scale factor indicates that the plug-in or channel associated with that scale factor is in the uncalibrated mode—the true scale factor is different from that displayed. A ↓ symbol preceding a scale factor indicates that the plug-in associated with that scale factor has been placed in INVERT and the display from that plug-in is an inverted image of the original waveform.

The D7704 Display Unit is compatible with established photographic techniques and equipment. This compatibility allows ease of obtaining photographs of displayed information.

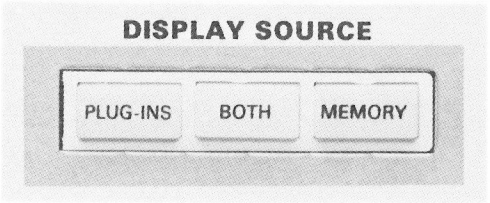
BECOMING FAMILIAR WITH DPO OPERATION

Whether you are an "old hand" at making oscilloscope measurements or have had only a little experience with oscilloscopes, you will find that DPO operation is basically oscilloscope operation with a few more steps added.

For DPO operation, you will need to be familiar with acquiring and storing waveforms.

Acquiring a waveform is nothing more than operation of a 7704A oscilloscope and will only be covered briefly. See the 7704A Operator's manual for operating procedures. Storing sequences will be covered in detail later.

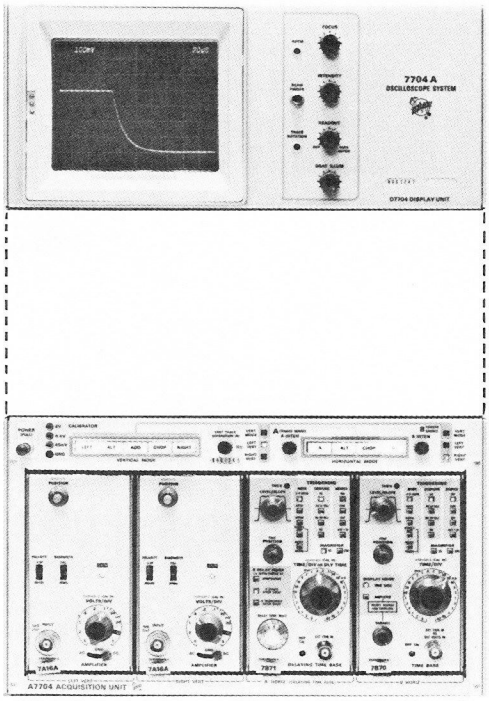
Acquiring a Waveform



1599-09

Waveform acquisition is the first step in DPO operation.

In acquiring waveforms, the DPO is operated in a mode that duplicates normal 7704A oscilloscope operation. To place the DPO in this mode of operation, press PLUG-INS in the DISPLAY SOURCE group of P7001 Processor pushbuttons.



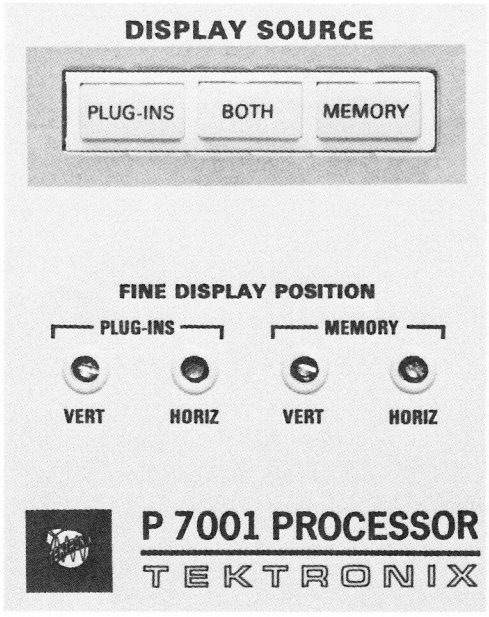
1599-10

Now you are ready to acquire waveforms in the same manner as you would when using a 7704A oscilloscope by itself.

You will find all front panel controls pertinent to normal oscilloscope operation located on the D7704 Display Unit, the A7704 Acquisition Unit, and the associated plug-ins. It is suggested that at this point you connect a signal from the A7704 CALIBRATOR to the left and right vertical channel inputs and manipulate the various D7704, A7704, and plug-in controls to determine their effect. With a small amount of experimentation, you should become familiar with both the location and effect of these controls.

PROCESSOR CONTROLS

The following paragraphs contain a short description of each processor pushbutton. This will acquaint you with them prior to going into the storing procedures. Similar descriptions for the 7704A and plug-in controls can by found in the applicable manuals.



1599-11

DISPLAY SOURCE

PLUG-INS—Only real time waveforms from the A7704 Acquisition Unit are displayed.

BOTH—Allows simultaneous display of waveforms from both the A7704 Acquisition Unit and the P7001 Processor memory.

MEMORY—The P7001 memory is the sole source of displayed waveforms.

FINE DISPLAY POSITION

PLUG-INS and MEMORY (VERT and HORIZ). These screwdriver adjustments are part of a front-panel adjustment procedure related to real time and stored waveform coincidence. Please refer to the section titled "Fine Display Position Adjustment" for correct procedures.

@

DATA HANDLING

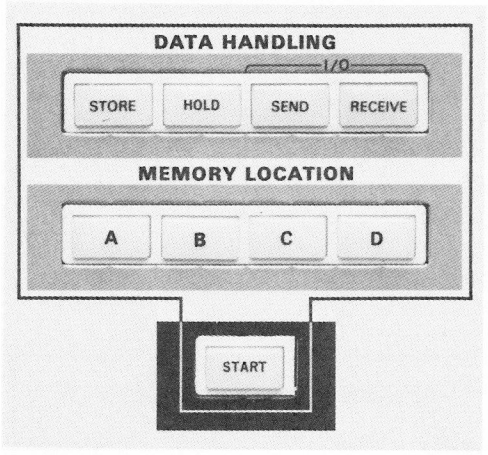
STORE—Prepares the processor for the store mode. Storing does not begin until the START button is pressed.

HOLD—When illuminated, indicates a P7001 Processor idle condition. HOLD locks signals in memory and stops the storing process. Used to cancel STORE, SEND, or RECEIVE prior to pressing START.

SEND—Prepares the P7001 Processor for transferring stored waveforms to a controller.

RECEIVE—Prepares the P7001 Processor for storing waveform information transferred from the controller.

START—Starts execution of STORE, SEND, or RECEIVE functions. For example, pressing START destroys the previously stored information as it stores the new. Updating of stored information is repeated with each sweep. HOLD terminates the storing and locks the signal in Memory.



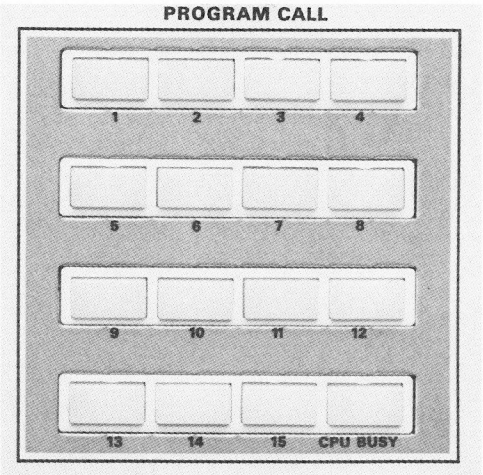
1599-12

MEMORY LOCATION

A, B, C, and D—Used to select processor memory locations for displaying, storing, sending, or receiving waveform information. Can be selected for individual operation or combination.

PROGRAM CALL

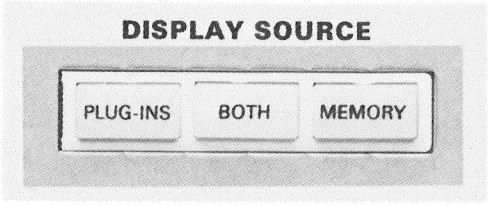
The PROGRAM CALL pushbuttons do nothing unless used in conjunction with an external controller and the appropriate software and user program. By pressing any of the first 13 PROGRAM CALL buttons, you can select and execute a wide choice of waveform processing programs. The remaining three buttons (14, 15, and CPU Busy) provide a means of controlling and monitoring program execution. Refer to the appropriate software manual for programming procedures.



1599-13

STORING SINGLE TRACE DISPLAYS

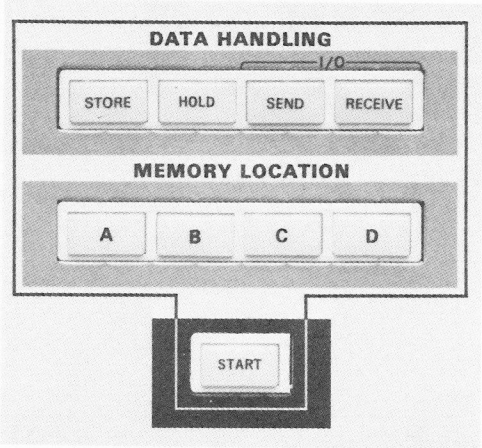
Now that you have had a chance to look over the P7001 Processor pushbuttons and to find out a little about them, you are ready to store a waveform. To begin, place the DPO in the acquisition mode of operation by pressing PLUG-INS. You will find the PLUG-INS pushbutton located in the group of processor buttons labeled DISPLAY SOURCE.



1599-09

Pressing PLUG-INS places the DPO in an operational mode duplicating that of a standard Oscilloscope system. Note that when you press PLUG-INS, it becomes illuminated. This illumination indicates the status of the DISPLAY SOURCE group of pushbuttons and tells you that the DPO displays are being derived entirely from the A7704 Acquisition Unit.

After pressing PLUG-INS, acquire and display a single waveform. A simple example of waveform acquisition consists of feeding one of the CALIBRATOR outputs into a vertical-amplifier plug-in such as a 7A16A Single-Trace Amplifier (in conjunction with the 7A16A, you will need to use a horizontal plug-in such as a 7B70 or 7B71 Time Base Unit). If you are using a dual trace plug-in, place its display mode switch in channel 1 or 2 (multiple trace storage will be covered later). Adjustment of vertical and horizontal plug-in, A7704, and D7704 controls will allow you to obtain the crt display centered on the graticule.



1599-12

Once the crt display has been obtained, the acquired waveform may be stored in any one of the processor's four memory locations. Briefly, storing is accomplished by pressing processor pushbuttons in the following sequence:

1) STORE

2) Select any one of the four memory locations.

3) START

4) HOLD

The waveform is now stored in the P7001 Processor memory at the selected location.

NOTE

When using 10X probes, the stored readout will be 1/10 the actual signal level unless a readout-coded 10X probe is used.

During each step of the storing process, the DPO provides visual status indications and gives you maximum opportunity for procedural changes.

To observe and understand these status indications, let us go through the storing sequence one step at a time and discuss the results of each step after it has been performed.

1) After acquiring a waveform, press STORE. You should see the following:

STORE—illuminated, indicating that the STORE function has been selected.

HOLD—illuminated, indicating that, although the STORE function has been selected, storing has not started.

BOTH—illuminated, indicating that the display source is simultaneously plug-ins and memory.

@

The crt displays two waveforms, one from the plug-ins and one from the processor memory.

A, B, C, or D—illuminated, indicating the display waveform memory location.

2) Press A, B, C, or D.

At this point you have the option of replacing the stored waveform with the acquired waveform or placing the acquired waveform in another memory location. When another memory location is selected, its contents will be displayed on the crt for consideration prior to replacement.

Should you choose not to store the acquired waveform, the STORE command may be canceled by pressing the HOLD pushbutton, if the START button has not been pressed.

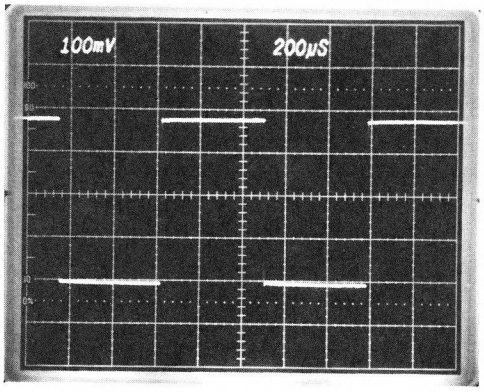
3) To continue the storing procedure, press

START—You should see the following:

STORE, BOTH, and the selected memory location are still illuminated.

HOLD—has extinguished, indicating that the processor is actively engaged in carrying out the selected function, in this case STORE.

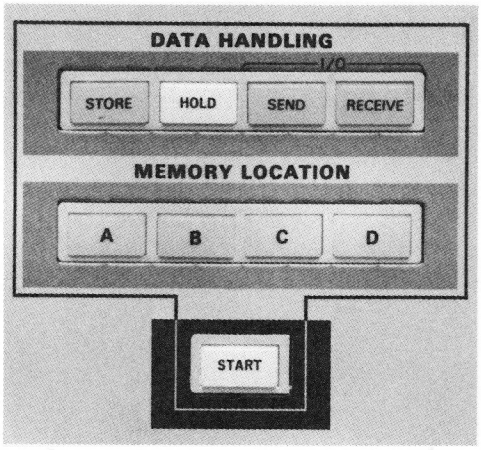
The crt displays the waveform—actually two waveforms are displayed; that from the plug-ins and its stored components from the processor memory. Due to their coincidence, they appear as one waveform.



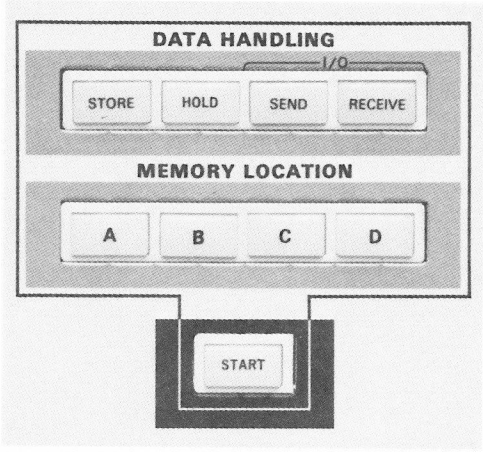
1599-14

Pressing START **causes the selected memory location to be cleared** and the acquired waveform to be digitized and placed in that memory location. Hold will stop the Storing process.

If you need to make waveform display adjustments, you may still do so while storing is in process. Display adjustment, or even acquiring a different waveform is still possible since the Processor memory is being continuously refreshed.



1599-15



1599-12

4) To complete the storing sequence, press

HOLD—You should see the following:

BOTH and the selected memory location still illuminated.

STORE—extinguishes and HOLD illuminates, indicating that storing has been accomplished and that the P7001 Processor has returned to the idle state.

The crt displays a waveform—the displayed waveform will be the one just stored.

Pressing the HOLD pushbutton causes the waveform to be fixed in the processor memory. The stored waveform is no longer subject to positioning by the plug-in controls.

The waveforms stored in the P7001 Processor memory may be displayed individually or simultaneously at any time by pressing BOTH or MEMORY in the DISPLAY SOURCE group and the appropriate MEMORY LOCATION pushbutton. BOTH allows display of the stored waveform along with waveforms present at the A7704 plug-ins. MEMORY allows display of stored waveforms only.

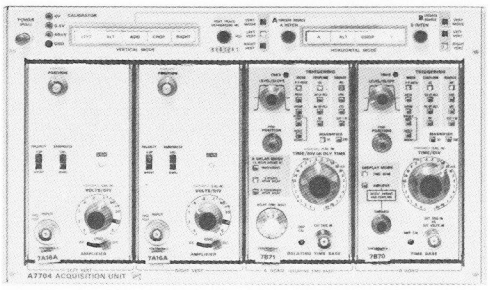
Simultaneous viewing of the contents in more than one memory location is accomplished by simultaneously pressing the desired MEMORY LOCATION pushbuttons (DISPLAY SOURCE must be in BOTH or MEMORY mode). When this is done, the readout appearing on the crt will be that associated with memory location A, if A is selected, or the selected memory location closest to A, if A is not among those selected.

By pressing all four memory location pushbuttons, the contents of all four memory locations may be displayed simultaneously.

SIMULTANEOUS STORAGE OF A SINGLE WAVEFORM IN MORE THAN ONE MEMORY LOCATION

The sequence for simultaneous storage of a single waveform in more than one memory location is: press STORE, simultaneously press two MEMORY LOCATION pushbuttons (A and B if the waveform is from left vertical or C and D if the waveform is from right vertical), press START, and finally press HOLD. However, when two MEMORY LOCATION buttons are pressed simultaneously, a waveform from the A7704 left vertical may be stored only in locations A and B and a waveform from the A7704 right vertical may be stored only in locations C and D. This applies to single waveform storage because the Acquisition Unit's channel-to-memory location assignment logic is designed to store multiple waveforms (Refer to Table 1-1 for multiple storage information).

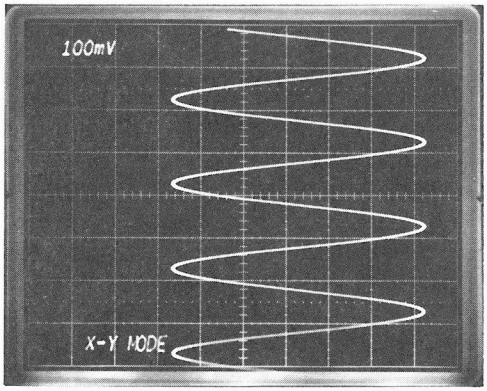
STORING MULTI-TRACE DISPLAYS



1599-03

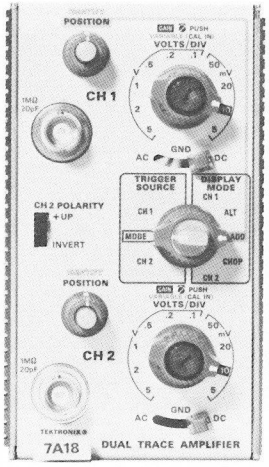
The A7704 Acquisition Unit, incorporating 7000 series plug-in flexibility, is capable of presenting various waveform combinations for display and processing (single trace, dual trace, three trace, four trace, and X-Y operation). For X-Y operation refer to the 7704A Operators Manual. This multiple acquisition and display capability is attainable via the choice of appropriate plug-ins and by using both plug-in and mainframe mode switching (ALTernate or CHOPped). There are limitations to mode selection in relation to waveform processing, which will be explained later in this section.

Storing a multi-trace display is slightly more complex than storing a single-trace display. The complexity of multi-trace storage can be reduced greatly by following a few general rules.



1599-16

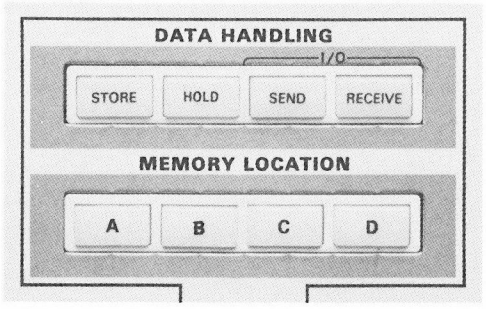
As with storing a single trace display, acquisition is the first step in storing a multi-trace display. In acquiring multi-trace displays, it is recommended that mode switching for the mainframe be confined to ALTernate. For dual channel plug-ins, mode switching on each vertical plug-in must be confined to CHOPped. These mode switching selections will provide the best results when storing multi-trace displays in the P7001 memory.



1599-17

To begin learning multi-trace storage, acquire a multi-trace display while using the allowable switching modes. A dual-trace display will suffice; however, if you feel adventurous and have two dual channel plug-ins available, you may choose to obtain a four-trace display. Whatever you choose, dual trace, three traces, or four traces, it is suggested that waveforms be acquired such that each trace is easily distinguishable from the others. This will aid in following the path of each trace during the storing procedure.

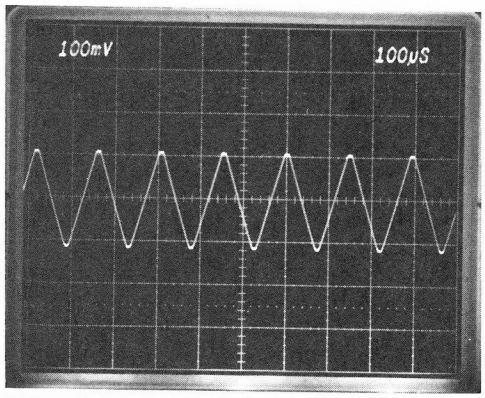
After obtaining a multi-trace display, press the STORE pushbutton.



1599-18

Next, press the appropriate MEMORY LOCATION pushbuttons. The number of memory locations selected and exactly which ones are selected — A, B, C, or D — depends upon the particular acquisition mode of the DPO — specifically, the number of traces being displayed and the selected combination of mainframe and plug-in mode switching.

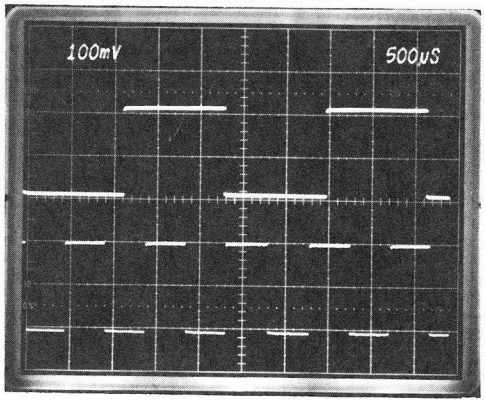
The number of memory locations selected should correspond to the number of waveforms displayed. If the number of selected memory locations is less than the number of displayed waveforms, noise from the Processor trying to switch between too many waveforms will appear.



1599-19

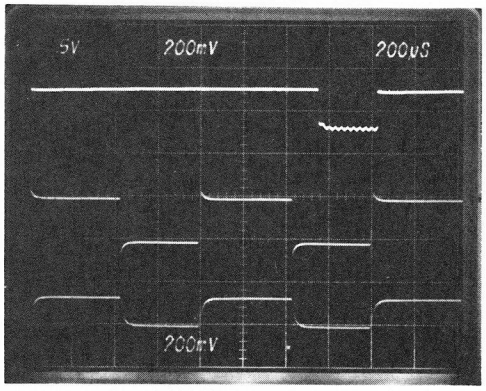
Whenever more than one memory location is selected, each memory location is assigned by hardware to a particular Acquisition Unit input. Exactly which memory location is assigned to what input depends upon the mainframe and plug-in mode switching selection. You are encouraged to learn by experimenting with multi-trace storage while operating in various modes. As a guide, the following general rules are offered:

Single Trace—A single trace may be stored in any one memory location; may be stored simultaneously in A and B for a left vertical source or in C and D for a right vertical source.



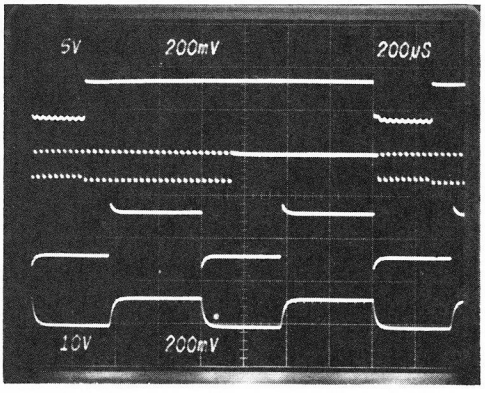
1599-20

Dual Trace—Dual traces may be stored by selecting A or B for left vertical and C or D for right vertical.



1599-21

Three Traces—Three traces may be stored by selecting both memory locations corresponding to the dual channel plug-in position, i.e., A and B for left vertical or C and D for right vertical, and either memory location corresponding to the single trace source.



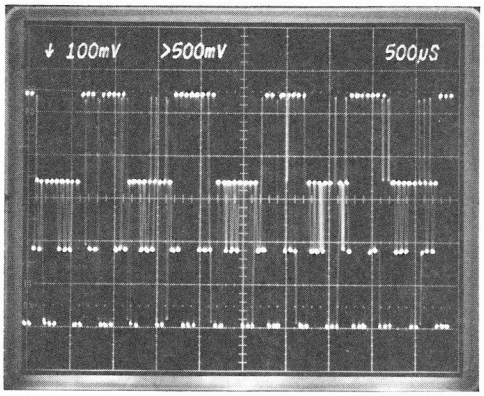
1599-06

Four Traces—Four traces may be stored by selecting all memory locations simultaneously. Left vertical CH 1 will go to A and CH 2 to B. Right vertical CH 1 will go to C and CH 2 to D.

@

After you have selected memory locations appropriate to your multi-trace display, press START.

You should now see the real time waveforms coincident with their stored duplicates.

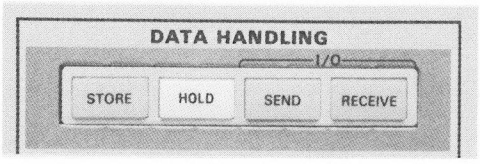


1599-22

If, instead, your display is chopped, you probably have selected a combination of mainframe and plug-in mode switching that is not compatible with DPO storing.

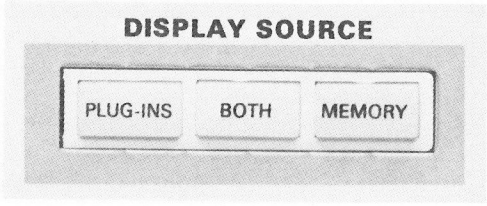
To correct this situation, you should check for proper memory location selection, or, if the proper locations have been selected, begin storing again with a different combination of mode switching.

To finalize storing, press HOLD.

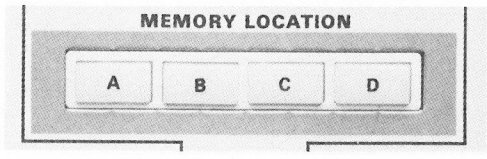


1599-23

You should now see the real time waveforms and their stored duplicates. Place the DISPLAY SOURCE in MEMORY. Now reselect your previous memory location selections, one at a time, and note the stored waveforms. Each location should contain one waveform from your multi-trace display. If a memory location is blank, except for scale factor readout, you have tried to store in a memory location that was not hardware assigned to the acquisition channels used. For example, displays from a dual trace plug-in located in the mainframe left vertical slot can only be stored in memory locations A and B. Attempting to store in locations C and D would result in those locations containing only the scale factor readout and no waveforms.



1599-09



1599-24

Table 1-1 is a summary of the available combinations of mode selection on the 7704A Acquisition Unit to waveform processing by the P7001.

TABLE 1-1

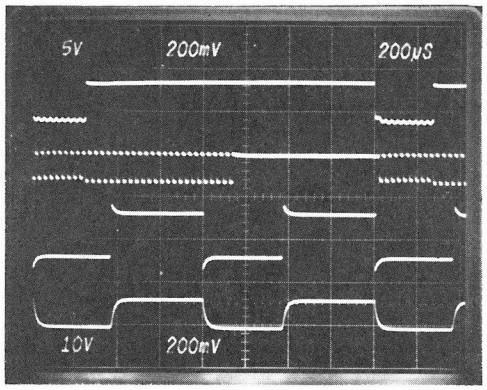
Single Time Base (Mainframe Horizontal Mode "A" or "B")				
			SELECT MEMORY LOCATION:	
SINGLE WAVEFORM (any source)				
Single Storage			A or B	or C or D
Simultaneous Storage				
from Left Vertical			A & B	
from Right Vertical				C & D
MULTIPLE WAVEFORM				
Mainframe Vertical Mode LEFT				
Left Plug-in Mode CHOP			A & B	
Mainframe Vertical Mode RIGHT				
Right Plug-in Mode CHOP				C & D
Mainframe Vertical Mode ALT				
(CHOP-not recommended)				
Left Plug-in Mode ---	If CH 1		A or B	
	If CH 2		A or B	
	If ADD		A or B	
	If CHOP		A & B	
	ALT (do not use)			
Mainframe Vertical Mode ADD				
Left and/or Right Plug-in Mode CHOP			A & B	

Dual Time Base (Mainframe Horizontal Mode "CHOP" or "ALT")			
		SELECT MEMORY LOCATION:	
Mainframe Vertical Mode ALT			
Left Plug-in Mode ---	If CH 1	A or B	
	If CH 2	A or B	
	If ADD	A or B	
	If CHOP	A & B	
	ALT (do not use)		
Right Plug-in Mode ---	If CH 1		C or D
	If CH 2		C or D
	If ADD		C or D
	If CHOP		C & D
	ALT (do not use)		

1599-57

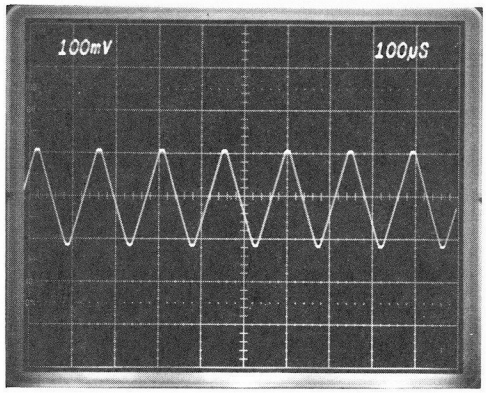
SCALE FACTORS AND HOW THEY ARE HANDLED

After storing a multi-trace display and observing the contents of each memory location individually, you may notice that each memory location contains scale factor readout pertaining not only to the waveform in that location, but also for all of the other waveforms in the original multi-trace display. In multi-trace storage, DPO hardware makes no distinction between scale factors for each waveform; thus the complete readout, as it appears in multi-trace acquisition, will be stored in each selected memory location.



1599-06

Naturally, when you are looking at a single memory location, you desire only the scale factors pertaining to that memory location. Software (TEK BASIC) is available that will remove extraneous scale factor information and assign each waveform with its proper scale factors.



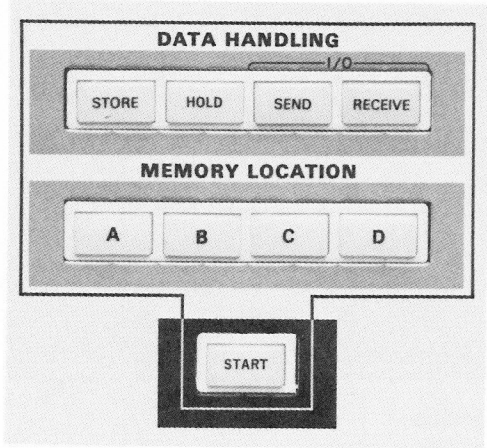
1599-19

USING THE DPO WITH A CONTROLLER

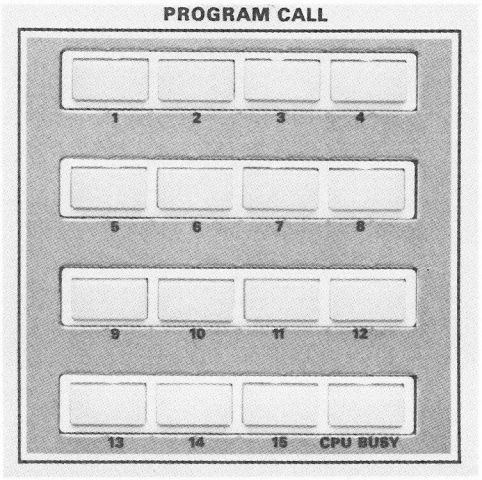
The full capabilities of the DPO can only be fully realized after it is interfaced with a controller (minicomputer). With the proper software, operations can be performed with waveforms under program control. You can acquire, store, and manipulate (e.g., add, subtract, or multiply two waveforms to obtain a third). You can also perform operations (average, integrate, differentiate, etc.) on a single waveform. Stored waveforms can be shifted to or interchanged between DPO memory locations. You can also write messages on the DPO Display screen, directly or under program control.

SEND and RECEIVE BUTTONS

The SEND and RECEIVE buttons on the Front Panel are used with a controller and its proper Software to send and receive waveforms between the DPO and a Controller.



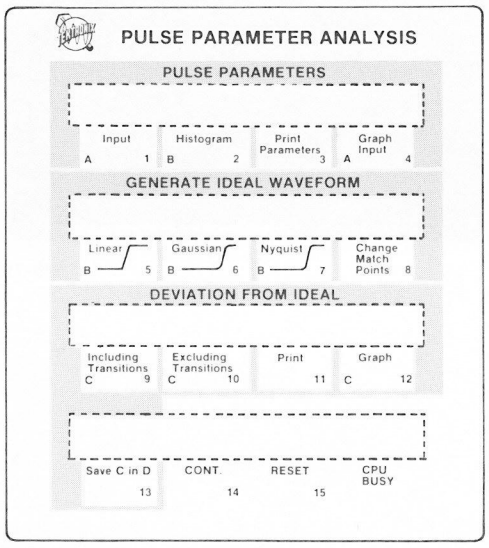
1599-12



1599-13

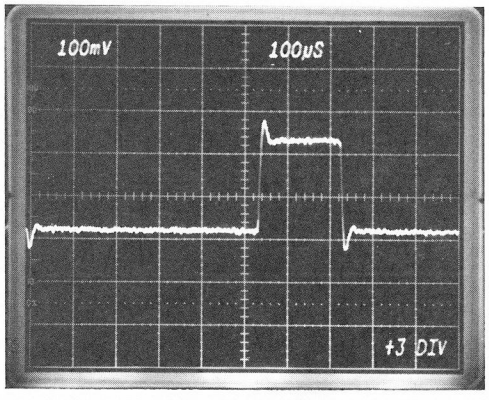
PROGRAM CALL BUTTONS

The PROGRAM CALL buttons are used to call up and start the appropriate user program sequence, provided that the proper software is loaded. For example, if TEK BASIC software is loaded in the controller and a user program is loaded with line numbers from 1ØØ to 199, then pressing button #1 on the DPO Front Panel will start the program at the first line between 1ØØ and 199. This is the same as typing "GOTO 1ØØ" on the terminal. Button #2 is line 2ØØ to 299 and so on through button #13 being line 13ØØ to 1399. A program call overlay can be used to label the appropriate call button assignment.



1599-25

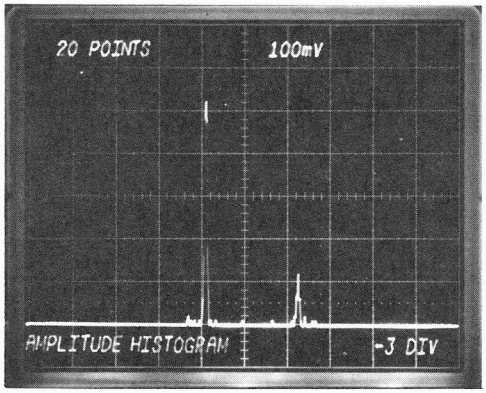
An example of a user program is the Pulse Parameter Analysis software available from Tektronix. This program provides the DPO user with a thorough analysis capability of any type of pulse that can be stored with the DPO. The overlay shown is for this program.



1599-26

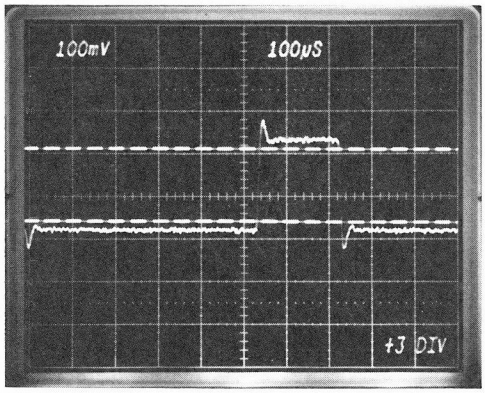
Pressing button #1 averaged an acquired pulse and stored it in the DPO's memory.

By pressing button #2 the controller provided a histogram on the pulse. It determined the number of points on the base line and the top of the pulse.



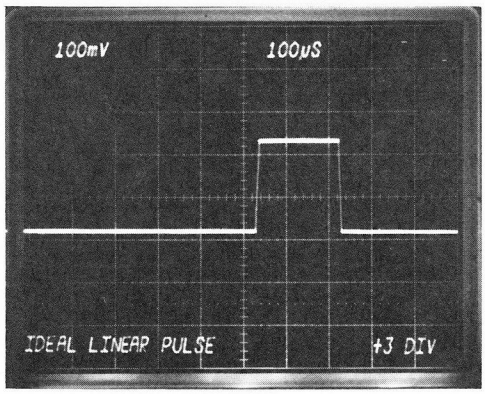
1599-27

The controller determined the Proximal and Distal points on the pulse and drew lines through them.



1599-28

By pressing button #5 the controller matched the input pulse to an Ideal Linear Pulse.



1599-29

PULSE PARAMETERS
JULY 29, 1974

VOLTAGE MEASUREMENTS

MEAN = -344MV
RMS = 354MV

PEAK TO PEAK = 300MV
AMPLITUDE = 211MV

0 % VALUE = -384MV
10 % VALUE = -363MV
50 % VALUE = -279MV
90 % VALUE = -194MV
100 % VALUE = -173MV

TIME MEASUREMENTS

RISETIME = 6US
DELAY = 538US
DURATION = 188US
FALLTIME = 6US

PROXIMAL-DISTAL TIMES

TIME, P-P = 194US
TIME, D-D = 182US
TIME P-D = 188US
TIME, D-P = 188US

LINEAR PULSE
10% & 90% MATCH

TOTAL DEVIATIONS
FLAT WITHIN 21.9%
AND -20.5%
TOTAL OF 42.4%

EXCLUDING TRANSITIONS
FLAT WITHIN 21.9%
AND -20.5%
TOTAL OF 42.4%

GAUSSIAN PULSE
10% & 90% MATCH

TOTAL DEVIATIONS
FLAT WITHIN 21.9%
AND -20.5%
TOTAL OF 42.4%

EXCLUDING TRANSITIONS
FLAT WITHIN 21.9%
AND -20.5%
TOTAL OF 42.4%

NYQUIST PULSE
10% & 90% MATCH

TOTAL DEVIATIONS
FLAT WITHIN 21.9%
AND -20.5%
TOTAL OF 42.4%

EXCLUDING TRANSITIONS
FLAT WITHIN 21.9%
AND -20.5%
TOTAL OF 42.4%

1599-30

Pressing buttons #6, 7, 9, 10 and 11 in their proper sequence will cause the above parameters to be printed on the terminal.

1599-31

USING THE DPO WITH A CALCULATOR

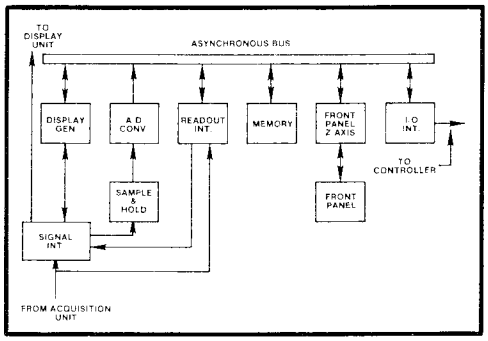
If you take the DPO and a DPO/TEK-31 Interface and load the proper software in the TEK 31, you can perform operations with waveforms under program control much the same as you can with a controller. All of the functions such as acquire, store, manipulate are available. So are addition, subtraction, and multiplication of two waveforms to obtain a third.

Refer to the DPO 3100 System manual and the Keyboard Interpreter software manual for detailed procedures.

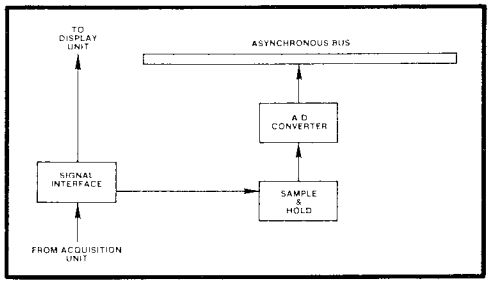
THEORY OF OPERATION

The P7001 Processor, which makes the 7704A oscilloscope a DPO, consists of six circuit cards along an asynchronous bus as shown in the block diagram, 1599-32. The bus operates on a first-come, first-served basis, with some priority determining logic in case two cards request the bus at the same time. The bus provides all cards with parallel access to power, address lines, control lines, and data lines.

Except for both Memory positions and the front Panel/Z-Axis position, all other blank card positions in the P7001 must contain a Data Channel Grant jumper card to enable the P7001 to operate properly. A detailed circuit description is contained in the P7001 Service Manual.



1599-32



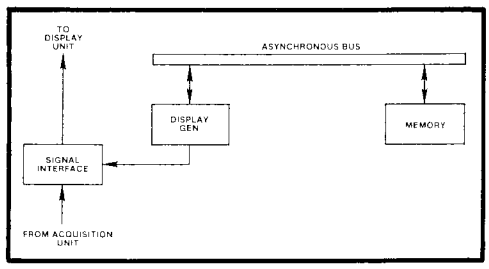
1599-33

OPERATING MODES

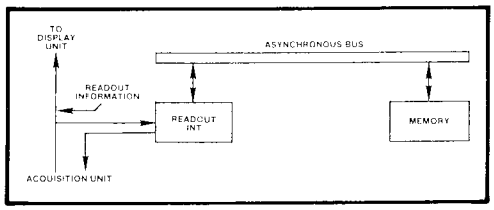
P7001—IDLE STATE (HOLD Mode)

When the P7001 is in the idle state — that is when the DATA HANDLING group of buttons has only the HOLD button lit — several continuous actions are taking place:

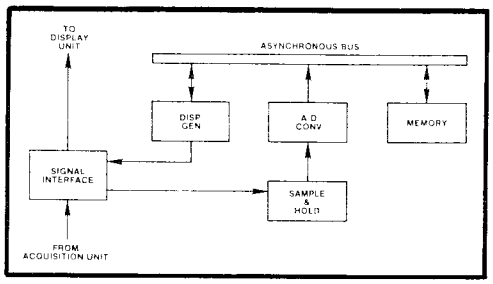
The Sample & Hold card takes waveform information from the Acquisition Unit and sends it to the A-D Converter (1599-33). The A-D Converter digitizes the waveform, but discards it until the STORE mode is selected. The Display Generator reads information from Memory, converts the digitized waveforms into analog information and sends it to the Signal Interface for selection by the DISPLAY SOURCE—MEMORY button on the front panel (1599-34). The Readout Interface card continuously monitors readout information from the Acquisition Unit and has it available for possible later storage (1599-35). When the MEMORY button is pressed, the Readout Interface card takes the readout information from the selected memory location and sends it to the Readout board in the Acquisition Unit.



1599-34



1599-35



1599-36

P7001 — STORE Mode

After the STORE and the START buttons are pressed, the P7001 begins new actions (1599-36).

The digitized waveform information, previously being discarded by the A-D Converter, is now placed in the selected memory location. With each successive trace of the horizontal sweep, new vertical information is entered. This updating is continuous until the HOLD button is pressed.

While storage is taking place, the Display Generator is receiving digitized waveform information from memory, converting it to analog information and sending it to the Display Unit through the Signal Interface. After HOLD is pressed, the Display Generator continues this function as long as the MEMORY button is pressed.

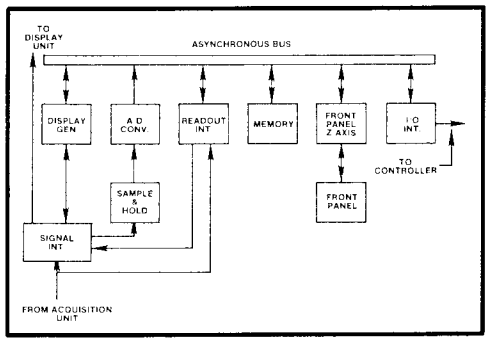
WHAT THE CARDS DO

SIGNAL INTERFACE

The Signal Interface, which is located on the Sample & Hold card, coordinates signal flow between the Display Unit (D7704), the Acquisition Unit (A7704), and the Processor (P7001).

I/O INTERFACE

The I/O Interface card functions as a bilateral link between the P7001 and a controller or calculator depending upon the interface card installed. Presently, there are two interface cards available; the DPO/CP Bus Interface and the DPO/TEK-31 Calculator Interface. Refer to the individual manuals for operating information.



1599-32

FRONT PANEL

The Front Panel card allows control of the P7001 from the front panel. It contains the status word generating circuitry, data bus interface and control logic, Z-Axis valid sensing, Z-Axis switching circuits, and bus termination.

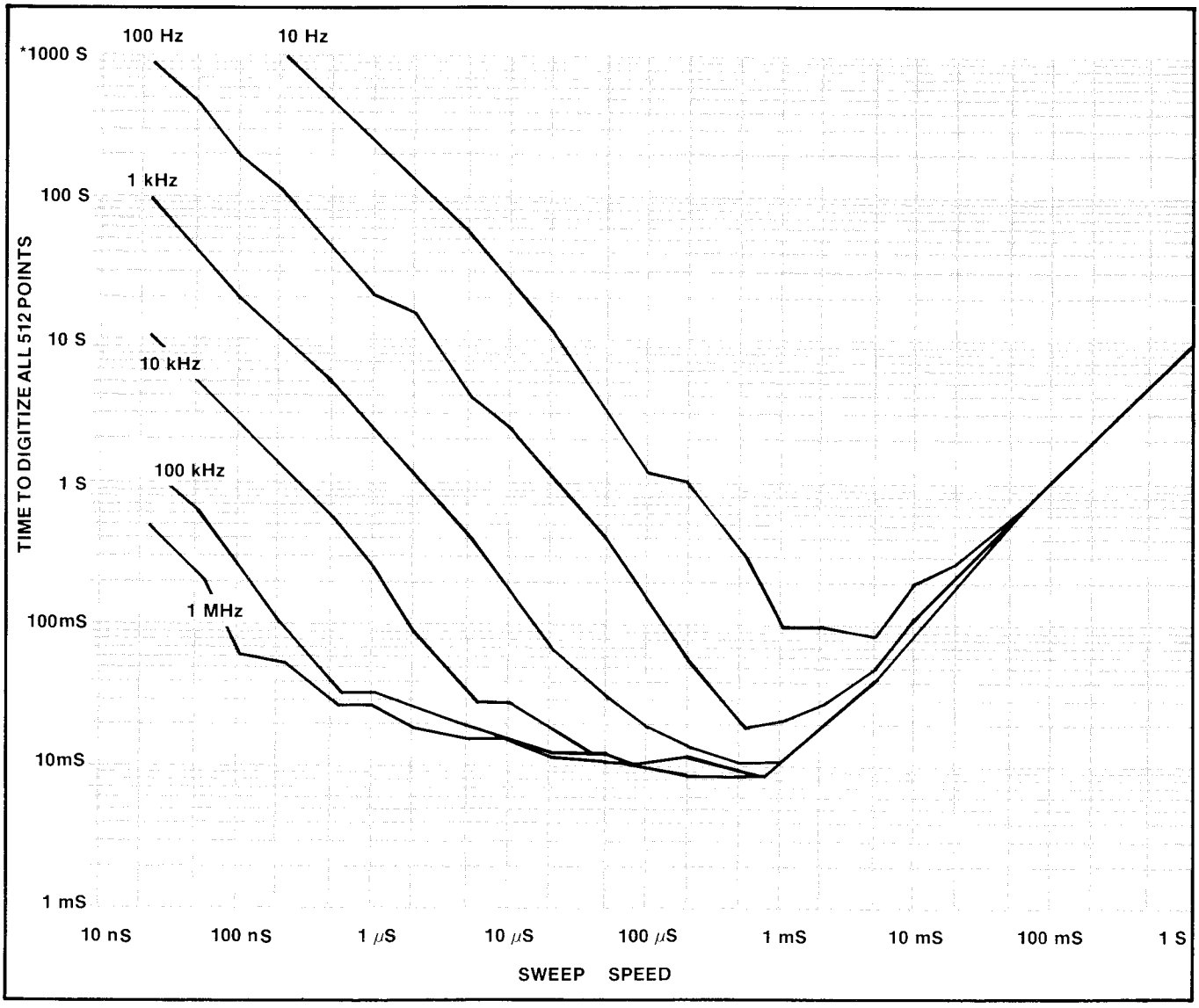
SAMPLE & HOLD and A-D CONVERTER

The Sample & Hold card obtains samples of waveforms generated by the Acquisition Unit. The A-D Converter converts the horizontal sample to a binary word of 9 bits (512 points), and the vertical to a binary word of 10 bits (1024 points). The horizontal sample determines the address in memory at which the vertical sample is stored.

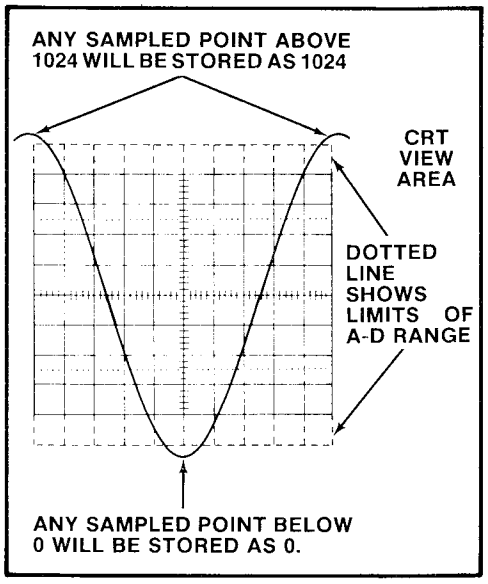
The Sample & Hold card takes a horizontal and vertical sample every 6.5 microseconds, regardless of sweep speed. For sweeps slower than 0.5 milliseconds/division, all 512 locations are filled in one sweep. Sampling of repetitive waveforms at sweep speeds faster than 0.5 milliseconds/division is thus done on an equivalent basis. That is, when repetitive waveforms are sampled, subsequent sweeps provide new and/or updated samples until the A-D Converter is commanded into the HOLD mode. The combination of new and old samples in memory provides a complete waveform.

For single-shot sweeps faster than 0.5 milliseconds/division, not all 512 memory locations will be filled, and horizontal resolution of the stored waveform may be reduced.

The graph shows the time required to fill the memory for various sweep speeds and various signal repetition rates. The horizontal axis of the graph indicates the sweep speed of the Horizontal Time Base plug-in. The vertical axis indicates the time required to fill the memory. The six lines on the graph indicates the repetition rate of the waveform to be stored.

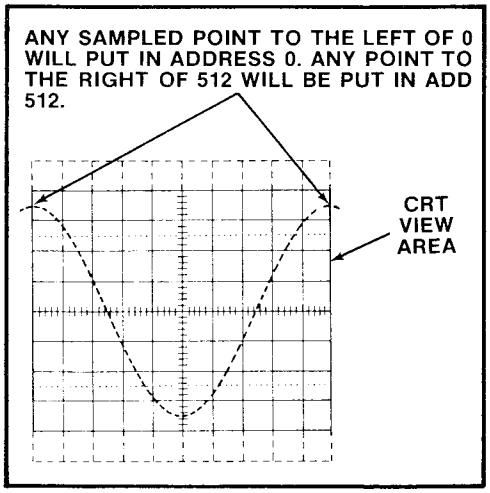


1599-37



1599-38

As previously stated, the acquired vertical sample is converted to a 10-bit vertical binary word, which corresponds to one of 1024 possible vertical positions. These positions are divided among 10 vertical divisions to provide approximately 102 positions per division. Only eight of the vertical divisions are displayed on the Display Unit's crt. The undisplayed divisions are above and below the displayed area. If the real time signal amplitude from the vertical plug-in is within these ten divisions, the vertical data in memory will correspond to the vertical data of the sampled waveform. If the amplitude of the real time signal (because of an incorrect setting of the VOLTS/DIV switch and/or incorrect vertical positioning) is outside these 10 divisions, it exceeds the dynamic range of the A-D Converter, and the sample is stored in memory as Ø or 1024 (1599-38).



1599-39

The horizontal sample acquired by the Sample & Hold circuit is converted to a binary word of 9 bits, which determines the address of the vertical sample in memory. Since the dynamic range of the sampled waveform is greater than the converted output of the A-D Converter, the first and last points of the converted waveform may not correspond to the end points of the sampled waveform (1599-39). The end points (Ø and 511) should be considered valid for measurement purposes.

READOUT INTERFACE

The Readout Interface converts readout information, from the Acquisition Unit, into ASCII code to be stored in the P7001 Memory. It reconverts the ASCII code, taken from the Memory, into readout information usable by the Display Unit.

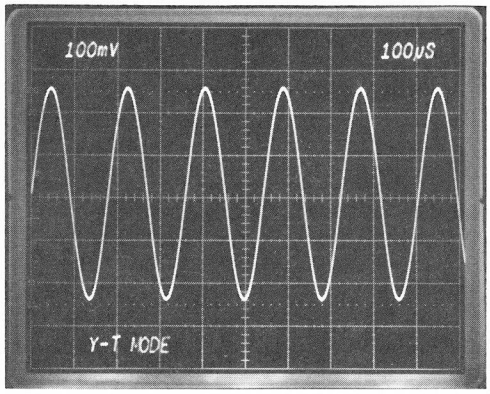
The source of the readout displayed on the crt is determined by the front panel DISPLAY SOURCE and DATA HANDLING pushbuttons. The figure depicts the source (PLUG-IN or MEMORY) of the readout for the various Acquisition Unit modes and Display Source.

DISPLAY SOURCE	MODE:	
	STORE	HOLD SEND OR RECEIVE
PLUG-IN	PLUG-IN	PLUG-IN
BOTH	PLUG-IN	MEMORY
MEMORY	PLUG-IN	MEMORY

1599-40

DISPLAY GENERATOR

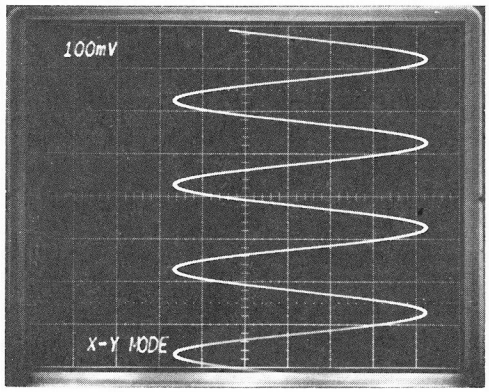
Two modes of Display Generator operation are available, Y-T and X-Y. Y-T (Y=Vertical vs T=Time) is the mode used to display waveform data that has been placed in memory by the A-D Converter or the controller/calculator. This is the mode associated with using the DPO with PLUG-INS button pressed. X-Y, on the other hand, is a display of the plotting of two variables (X coordinate and Y coordinate). The information displayed on the crt during the X-Y mode is not placed in Memory, as more than one Y coordinate cannot simultaneously occupy any given address in Memory. The X-Y mode may be used for simple operations, such as: drawing circles, elipses, spirals, etc., or more complex multi-valued functions.



1599-41

The Display Generator will display data on the crt in either mode. In the Y-T mode, which operates in conjunction with the P7001 Memory, the Display Generator may display an already-stored waveform, or it may clear the selected Memory Location and display new waveform data as the Memory is being updated. In the X-Y mode, which is operated by software only, the Display Generator displays each given point (or pair of X and Y coordinates) as it is sent from the computer or calculator.

In both the X-Y and Y-T modes, the Display Generator connects all adjacent points with vectors, through the linear interpolation feature. In the Y-T mode, zero is not recognized as a point, so that vectors are drawn between all adjacent nonzero points, In the X-Y mode, zero is recognized as a point, so vectors are drawn between adjacent points. A strappable option is available to eliminate the vectors and thus obtain a dot display only (refer to the Strap Options section of this manual).



1599-16

MEMORY

The Memory section stores acquired waveforms and their associated scale factors for display. Memory also stores information from a computer or calculator for display on the crt. Several types of memory are available, depending on your requirements: 4 k Core Memory, 1 k Semiconductor Memory, 2 k Semiconductor Memory, 3 k Semiconductor Memory, and 4 k Semiconductor Memory.

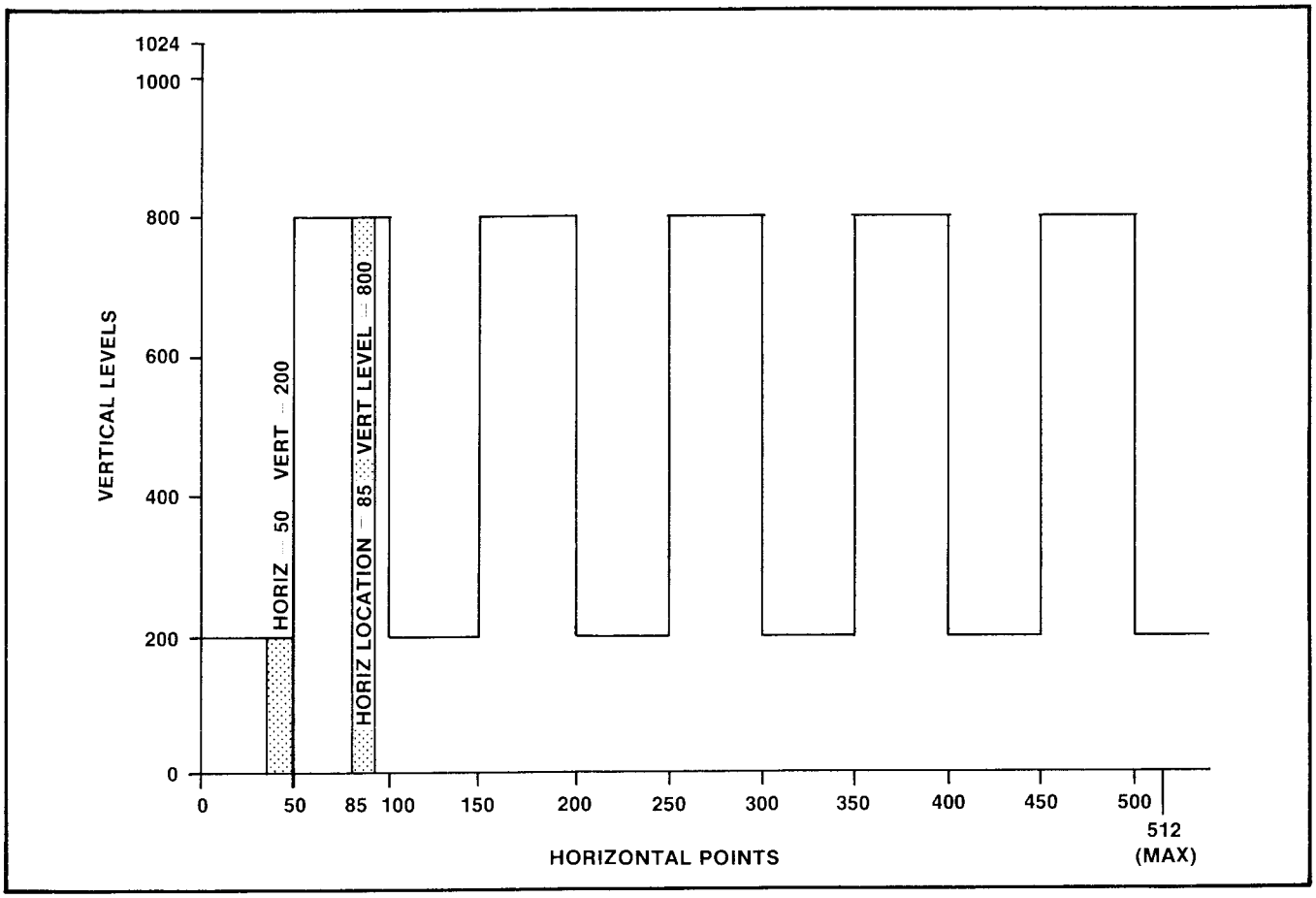
A 4k Memory consists of 4096 words divided into eight distinct sections of 512 words each (1599-42). Four sections are reserved for storage of digitized waveforms (A,B,C, & D). Each section has four fields associated with it (FØ, F1, F2, & F3). For example: Waveform A field Ø (FØ) contains scale factor information for waveform A. F1, F2, and F3 near waveform A are reserved for computer or calculator generated messages for display along with waveform A. Each word in each of the eight field sections contains 10 bits. Storage time for each word is 1.2 microseconds.

WAVEFORM A	F0	F1	F2	F3
WAVEFORM B	F0	F1	F2	F3
WAVEFORM C	F0	F1	F2	F3
WAVEFORM D	F0	F1	F2	F3

1599-42

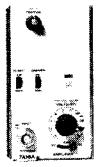
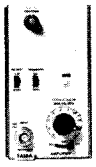
After conversion from analog to digital data, each waveform is stored in the selected Memory as 512 horizontal points (9 bits) with 1024 possible levels of vertical resolution (10 bits) at each point. The converted horizontal sample is the address at which the converted vertical sample is placed in Memory. Each of the 512 horizontal locations contains sequential samples of the vertical value of the waveform. Each horizontal location is single-valued, in that only one vertical sample may be stored at any given horizontal location.

The figure shows a typical squarewave that has been stored in a Memory location. Note that each of the 512 horizontal points contains only one vertical sample. For example: Horizontal location 50 contains level 200; Horizontal location 85 contains level 800. These levels are displayed as voltage, amperes, etc., depending upon the scale factor and plug-in information.



1599-43

Waveform information from the plug-ins can be stored in any one selected Memory location. If all Memory locations are selected, with the left vertical mode selected, then the waveform will go into Memory locations A & B only. Nothing will be stored in locations C & D. If the plug-in mode is changed to right vertical then the waveform will be stored in locations C & D. Nothing will be stored in locations A & B. Some examples of operating in the various modes of the 7704A and the P7001 Memory locations are shown in 1599-44. Also see Section 1, Table 1-1.

	STORAGE INTO:	STORAGE INTO:
MEMORY LOCATIONS SELECTED	A & B & C & D	
	A & B	
	A &	C
	A &	D
	B &	C
	B &	D
		C & D
	FROM LEFT VERTICAL	FROM RIGHT VERTICAL
PLUG-INS	 OR	

1599-44

STRAP OPTIONS

Introduction

Several circuit cards in the P7001 have strap options which allow you to determine their operating mode. This section describes the options available with each card.

The DPO/CP Bus Interface and the CP1100/CP Bus Interface strap options are not covered here. They can be found in the individual service manuals. Using these options, several DPO's can be connected to a controller at the same time; however, the software must be able to handle multiple units. The manual for the multiple unit software contains the required information to accomplish the desired connections.

Card Location

Each card for the P7001 has a specific location in the P7001. This position determines the priority that each card has in the use of the address and data buses. Fig. 3-1 shows this priority. Priority is not important unless two or more cards request the use of the bus at the same time. Otherwise, use of the bus is on a first-come first-served basis.

Fig. 3-2 shows the locations of the cards in the P7001. Spare locations J-3 and J-4, must contain a Data Channel Grant jumper card when the DPO is interfaced with a controller or calculator.

If only one semiconductor memory card is used, it can be located in either J-8 or J-9. A Data Channel Grant card is not required in the empty slot.

A-D Converter Straps

The strap for the A-D Converter is located on the top rear of the A-D Converter card (see Fig. 3-3). There are three positions for this strap. Position 2 is free-running trigger signal for the A-D Converter, and is the normal position. The other two positions are designed as aids in troubleshooting the instrument. The instructions are contained in the A-D Converter Service Manual.

Display Generator Straps

The strap options are located on the front third of the Display Generator card (see Fig. 3-4). These straps are located in three groups of two. The straps in all groups must be strapped the same. That is, all must be strapped to V or all to D. When the strap in each group is set to V, then the Display Generator will produce a vector between points on the crt. This is the normal pattern for the DPO. When the straps are set to D, the Display Generator will produce a dot pattern on the crt. This eliminates the vector line between points. If only a limited number of sample points of a waveform are available, the dot pattern might be preferred for scientific interpretation of the resulting display.

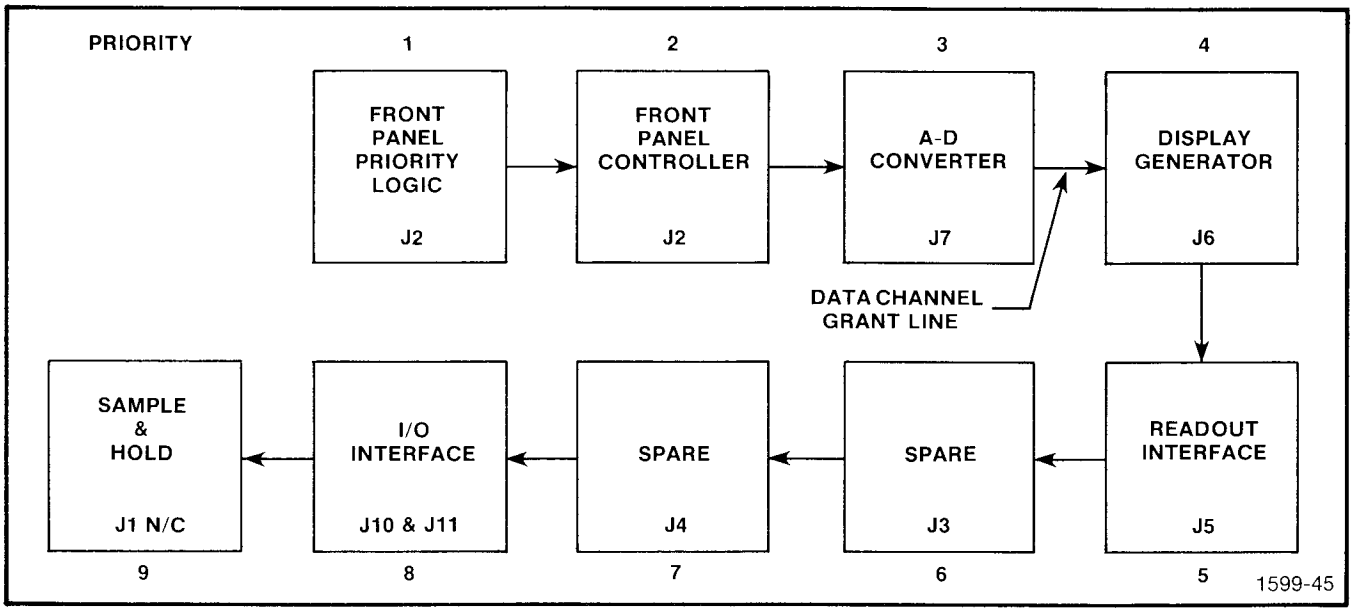


Fig. 3-1. Bus Priority.

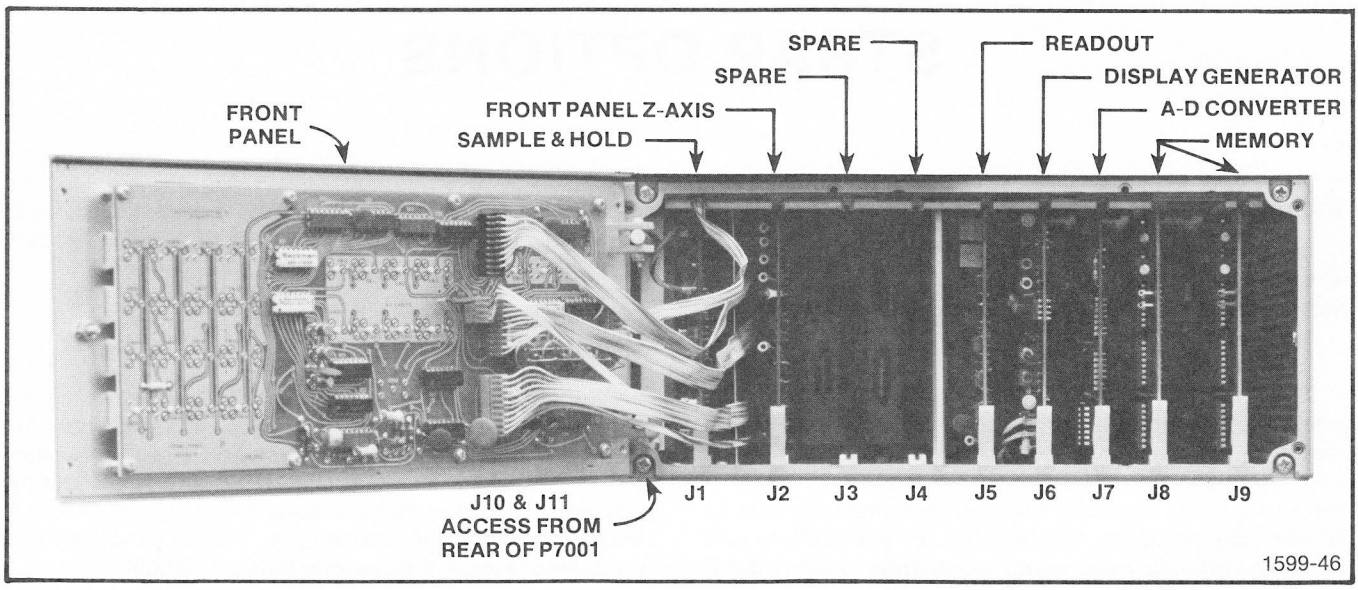


Fig. 3-2. P7001 Circuit Board Locations.

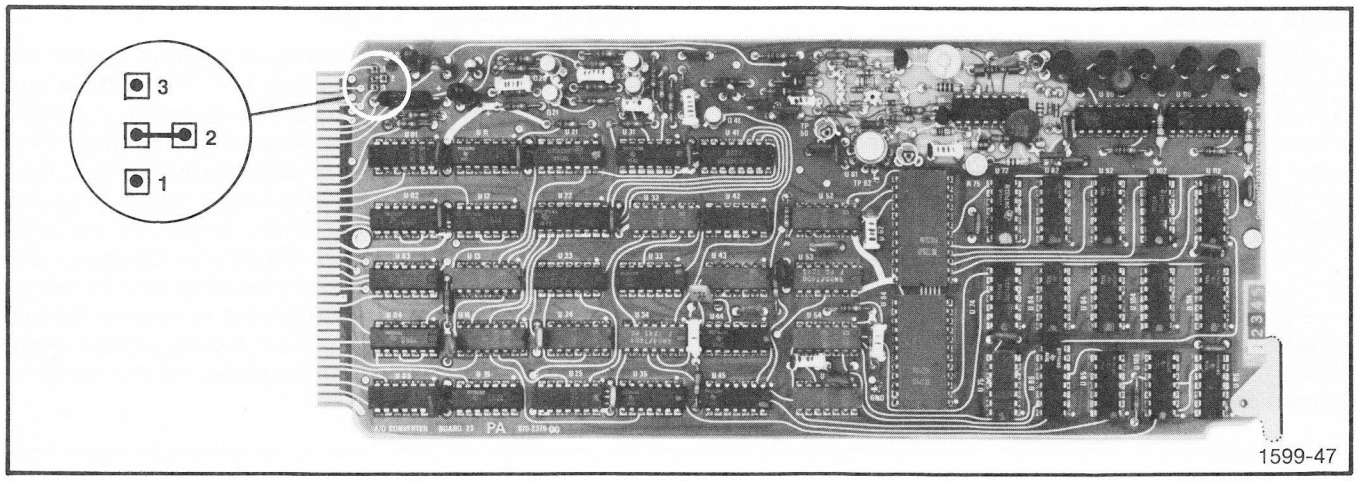


Fig. 3-3. A-D Converter Strap Location.

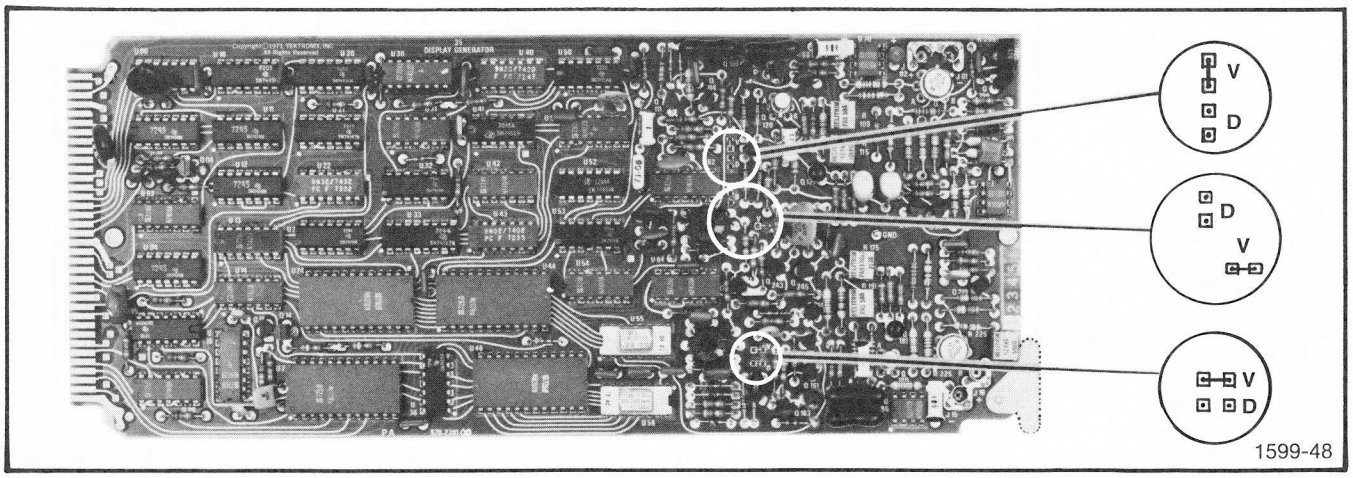


Fig. 3-4. Display Generator Strap Location.

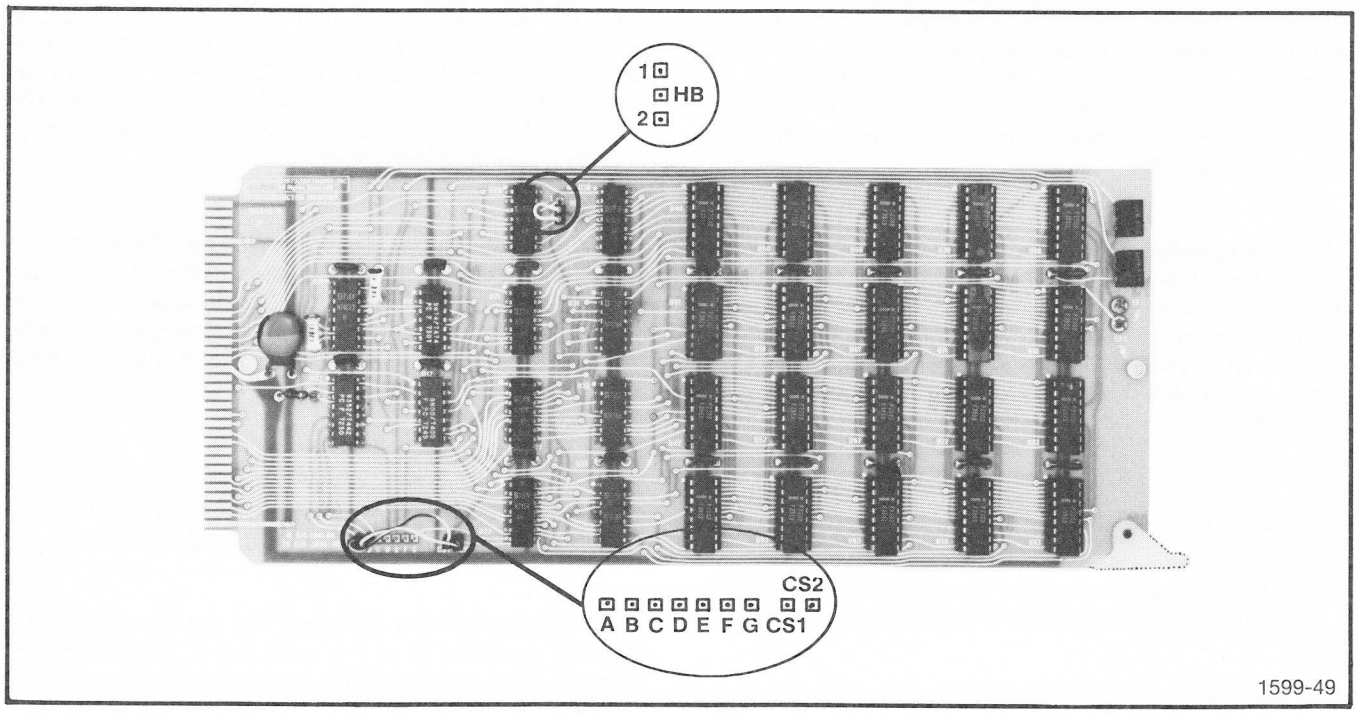


Fig. 3-5. 1 k and 2 k Semiconductor Memory Strap Location.

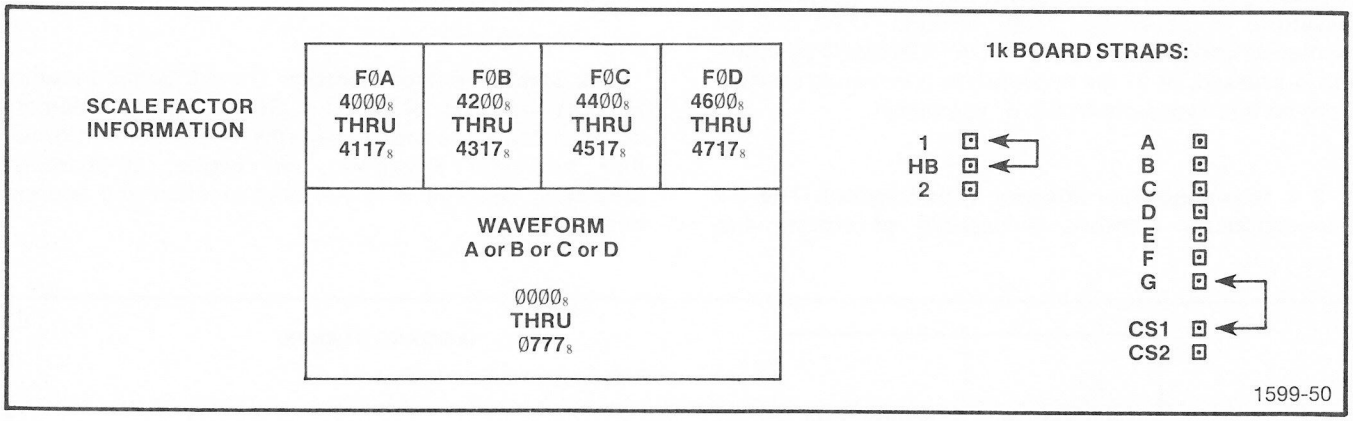


Fig. 3-6. 1 k Semiconductor Memory with Readout.

Semiconductor Memory Straps

Strap options are used in the Semiconductor Memory to establish the memory size and to select storage options. The strap options are shown in Fig. 3-5. The nine pins of the strap options are found in the lower rear portion of the card, while two are located above near the top edge of the card. Location is the same for 1 k and 2 k cards.

1 k Semiconductor Memory With Readout. The 1 k Semiconductor Memory is capable of storing one waveform with its associated readout plus three 80-character messages.

As shown in Fig. 3-6, addresses 0000_8 through 0777_8 are used for storing either waveform A, B, C, or D. The associated readout for the waveform will be stored in its corresponding location in Field Zero (FØ). The three unused locations in Field Zero may be used for computer generated messages.

For example: A waveform is stored in location B. The waveform data will be stored in addresses 0000_8 through 0777_8, the readout information for the waveform will be stored in addresses 4200_8 through 4317_8. If a message was put in location D, it would occupy the addresses 4600_8 through 4714_8. When the message is displayed, the

waveform (less readout) will also be displayed. Either the readout or the message can be displayed by pressing the appropriate Memory Location pushbutton on the Front Panel of the P7001 or, when Interfaced with a controller/calculator, set under program control. The waveform will be displayed regardless of which Memory Location is selected.

1 k Semiconductor Memory Without Readout. Another option allows the 1 k Semiconductor Memory to be able to store two waveforms (see Fig. 3-7). The memory is divided into two sections, one section for storing waveform A or C and the other section for storing waveform B or D. This option eliminates the readout and message storing capability.

NOTE

Make sure the Readout Interface card inside the P7001 is removed and a Data Channel Grant jumper card is installed into its place when using this option.

The waveform stored at addresses 0000_8 through 0777_8 will be displayed when: 1) MEMORY LOCATION A or C pushbutton is pressed, or 2) the appropriate commands are sent from an interfaced controller or calculator. The waveform at addresses 1000_8 through 1777_8 will be displayed when: 1) MEMORY LOCATION B or D pushbutton is pressed, or 2) the appropriate commands are sent from an interfaced controller or calculator.

2 k Semiconductor Memory With Readout. The 2 k Semiconductor Memory is capable of storing two waveforms with their associated readout and four 80-character messages (see Fig. 3-8). Addresses 0000_8 through 0777_8 are used for storing waveforms A or C and addresses 1000_8 through 1777_8 are used for storing waveforms B or D. Readout for each waveform is stored in the corresponding location of Field Zero. Field One may be used for storing messages.

2 k Semiconductor Memory Without Readout. This option allows the 2 k Semiconductor Memory to store four waveforms, but eliminates the readout and message storing capability. The waveforms occupy the same addresses as in the 4 k memory. Fig. 3-9 shows strap location and address allocation.

NOTE

Remove the Readout Interface card and install a Data Channel Grant card when using this option.

3 k Semiconductor Memory. The 3 k Semiconductor Memory consists of a 1 k and a 2 k Semiconductor Memory. This configuration will store four waveforms; however, there is only one message field for storing readout data and only one field for storing four, 80-character messages. Refer to Fig. 3-10 for strap location and address allocation.

4 k Semiconductor Memory. The 4 k Semiconductor Memory consists of two 2 k Semiconductor Memory cards. It can store four waveforms, scale factor information for each waveform, and twelve, 80-character messages. See Fig. 3-11 for strap location and address allocation.

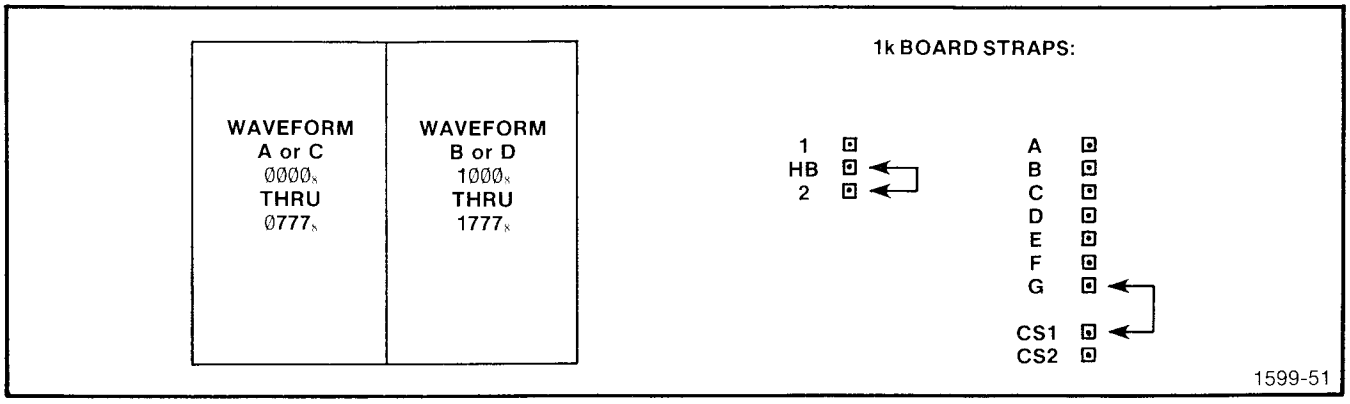


Fig. 3-7. 1 k Semiconductor Memory without Readout.

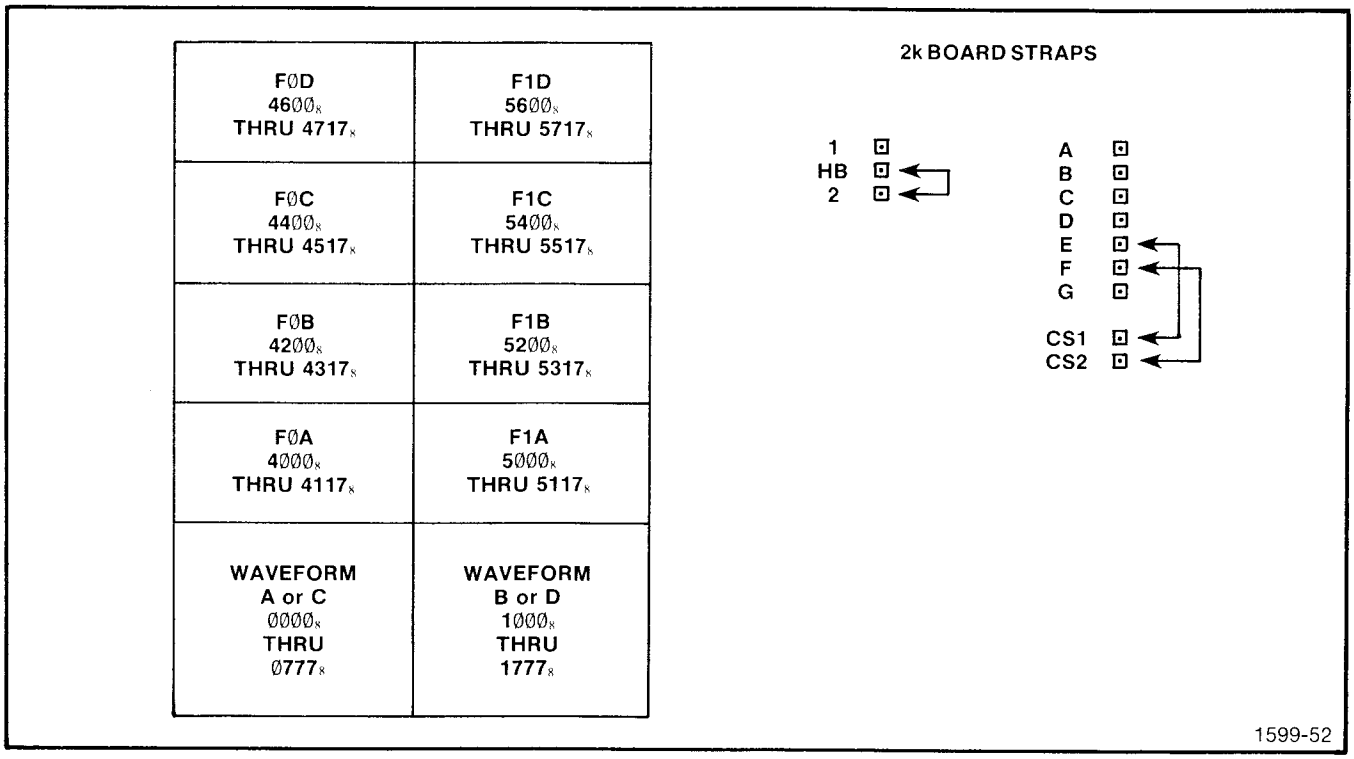


Fig. 3-8. 2 k Semiconductor Memory with Readout.

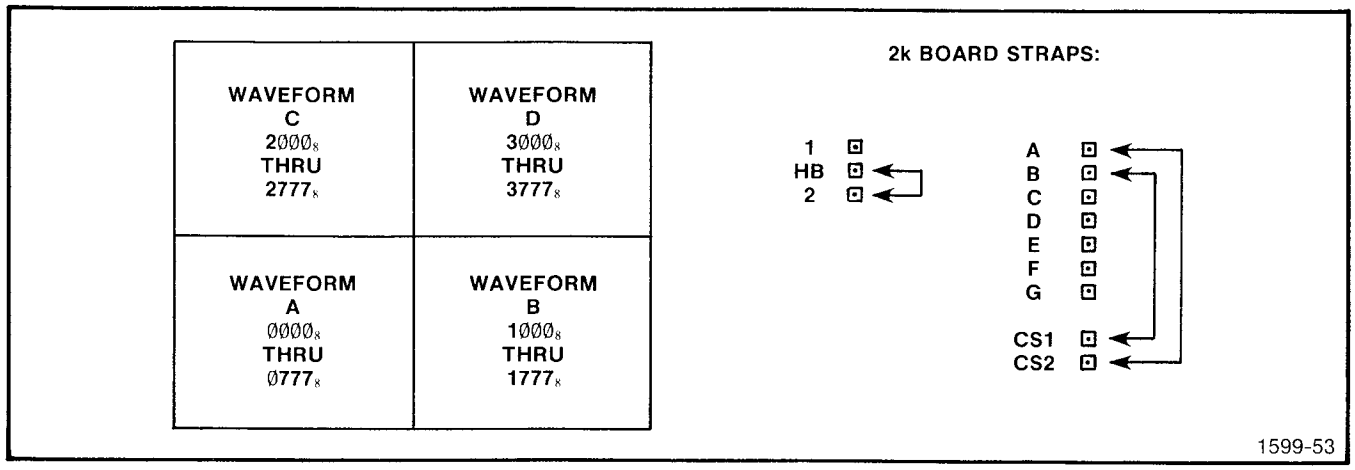


Fig. 3-9. 2 k Semiconductor Memory without Readout.

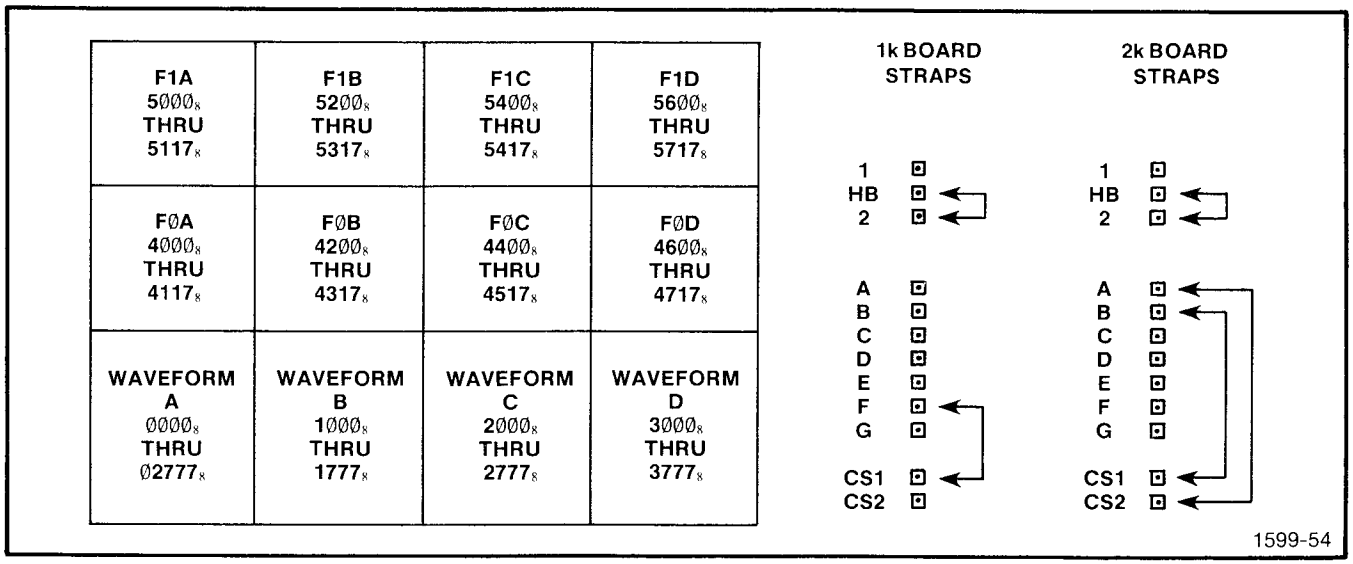


Fig. 3-10. 3 k Semiconductor Memory.

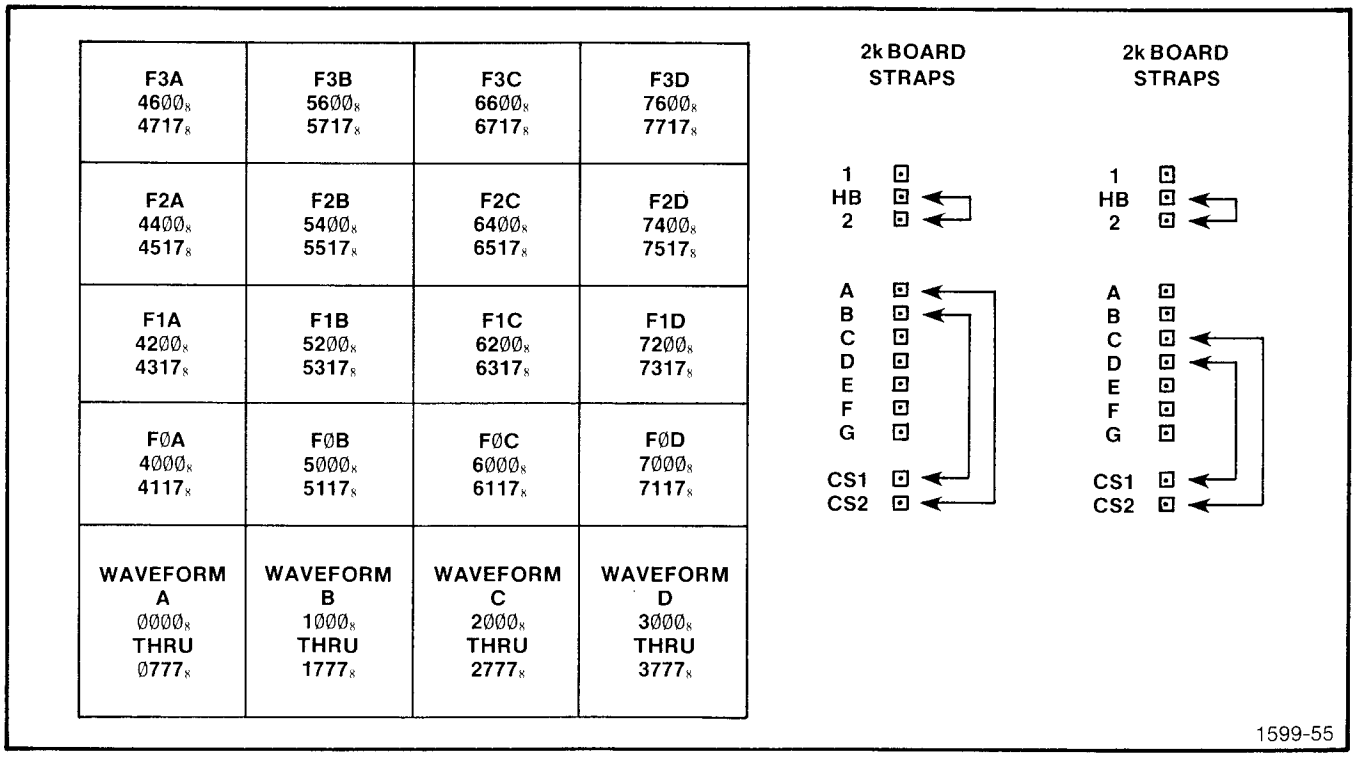


Fig. 3-11. 4 k Semiconductor Memory.

FINE DISPLAY POSITION ADJUSTMENT

Introduction

The FINE DISPLAY POSITION screwdriver adjustments on the front panel of the P7001 Processor are used to adjust the vertical and horizontal positioning of waveforms displayed from the plug-in units and the P7001 memory (see Fig. 4-1). The FINE DISPLAY POSITION, MEMORY, adjustments are made so that digital 512 in the P7001 memory is equal to the vertical center screen on the crt, and 256 is equal to the horizontal center screen. The PLUG-INS adjustments are made so the waveform being stored in memory and the real time waveform are superimposed on the crt.

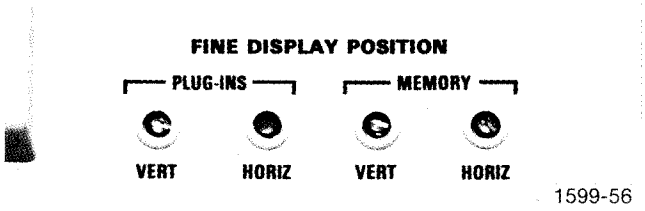


Fig. 4-1. Fine Display Position Adjustment Location.

Because of the environment in which the DPO is used, thermal drift may cause the waveforms to be incorrectly positioned. If this occurs, the FINE DISPLAY POSITION should be adjusted to compensate for the thermal drift. The following procedures are recommended.

Adjustment Procedure, DPO alone:

1. With power applied to the DPO, allow sufficient time for the equipment to reach operating temperature (approximately 20 minutes).

2. Install a Time Base unit in the A horizontal Plug-in position and select the A HORIZONTAL MODE. Set the Time Base unit for 0.5 milliseconds per division sweep rate, and P-P Auto-Triggering. Center the trace horizontally on the screen while in the PLUG-IN mode.

3. Select MEMORY as the DISPLAY SOURCE, A as the MEMORY LOCATION, and STORE as the DATA HANDLING mode. Press the START pushbutton.

4. Remove all other Plug-ins.

5. Using the FINE DISPLAY POSITION — MEMORY controls (VERT and HORIZ), match the horizontal line horizontally and vertically to the center line of the graticule (within two millimeters).

6. Install a vertical amplifier in the left vertical Plug-in position. Select the LEFT VERTICAL mode. With the amplifier set to 0.1 V/Division, connect the 0.4 V calibrator output to the amplifier.

7. Press BOTH, STORE, and START.

8. The waveform in Memory and the real time waveform should appear superimposed on the crt (within two millimeters). If the two waveforms do not coincide, adjust PLUG-INS (VERT and HORIZ) controls until both waveforms are superimposed on the crt.

Adjustment Procedure, Controller or Calculator with DPO:

If a controller or calculator is interfaced with the DPO, a generated, calibration waveform can be used for accurate positioning.

1. Store a controller/calculator generated waveform in MEMORY LOCATION D.

NOTE

If P7001 Checkout Software is available for use with the CP1100 Controller, the calibration waveform in it may be used.

2. Select MEMORY as the DISPLAY SOURCE, D as the MEMORY LOCATION, and HOLD as the DATA HANDLING mode.

3. Adjust FINE DISPLAY POSITION—MEMORY (VERT and HORIZ) controls until the waveform is centered properly on the crt graticule.

4. Connect a signal from the calibrator output of the Acquisition Unit to a Vertical Plug-in amplifier and obtain a display on the crt.

5. Press BOTH, STORE, then START.

6. The waveform in memory and the real time waveform should appear superimposed on the crt (within

two millimeters). If the two waveforms do not coincide, adjust PLUG-INS (VERT and HORIZ) controls until both waveforms are superimposed on the crt. Adjustment of the A INTEN (A-Intensity) control on the Acquisition Unit will aid in locating the PLUG-INS signal.

NOTE

If accurate positioning cannot be obtained with these procedures, re-alignment of the DPO is required. Refer to the service manual titled "DPO Specifications and Calibration".

@

OPERATING VOLTAGE

The DPO can be operated from either a 115-volt or a 230-volt nominal line voltage source. The Line Selector assemblies on the rear panel of the A7704 Acquisition Unit and the P7001 Processor converts this instrument from one operating voltage to the other. These assemblies also include line fuses. Use the following procedure to obtain correct instrument operation from the line voltage available.

CAUTION

This instrument is designed for operation from a power source with its neutral at or near earth (ground) potential with a separate safety-earth conductor. It is not intended for operation from two phases of a multi-phase system or across the legs of a single-phase, three-wire system.

1. Disconnect the instrument from the power source.

2. Loosen the two captive screws which hold the cover onto the selector assembly; then pull to remove the cover.

3. To convert from 115-volts to 230-volts nominal line voltage, or vice-versa, pull out the Selector switch bar (see Fig. 5-1) and plug it back into the remaining hole. Change the line-cord power plug to match the power-source receptacle or use a 115 to 230-volt adapter.

NOTE

Color-coding of the cord conductors is as follows (in accordance with National Electrical Code):

Line	*Black*
Neutral	*White*
Safety earth (ground)	*Green*

4. Re-install the cover and tighten the captive screws.

5. Be sure that both the A7704 Acquisition Unit and the P7001 Processor are set for the same voltage.

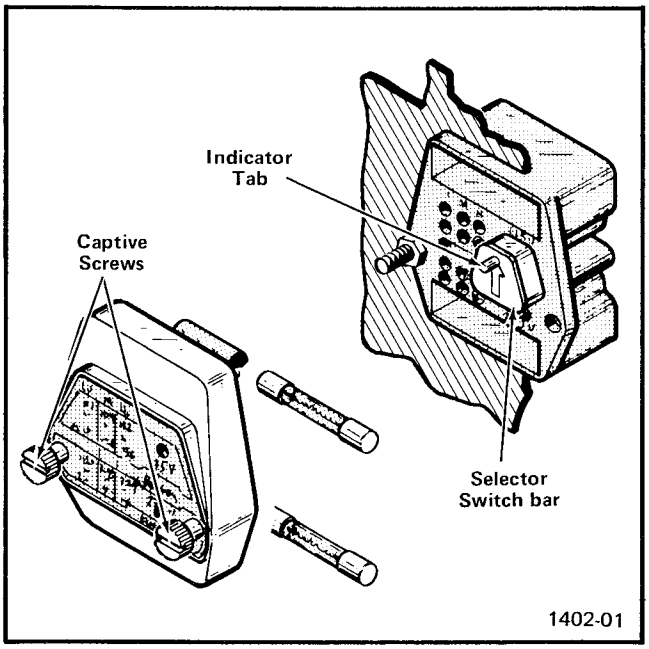


Fig. 5-1. Line Selector assembly on rear panel (shown with cover and fuses removed).

6. Before applying power to the instrument, check that the indicator tabs on the switch bars are protruding throught their correct hole for the desired line voltage range.

CAUTION

This instrument may be damaged if operated with the Line Selector assembly set to incorrect positions for the line voltage applied.

The DPO is designed to be used with a three-wire, ac power system. If the three- to two-wire adapter is used to connect this instrument to a two-wire ac power system, be sure to connect the ground lead of the adapter to earth (ground). Failure to complete the ground system may allow the chassis of this instrument to be elevated above ground potential and pose a shock hazard.