SECTION 1

INTRODUCTION

The TEKTRONIX 7912AD Programmable Digitizer is a wide-bandwidth waveform acquisition instrument with both analog and digital outputs. Programming is accomplished over the bus specified in IEEE Standard 488-1975.

Two operating modes are provided. In the digital mode, the 7912AD digitizes either a single-shot or repetitive waveform and stores it for internal processing or for output on the IEEE 488 bus. Analog outputs are also provided to display the waveform data on an X-Y-Z monitor. In the TV mode, the 7912AD converts a waveform to a composite video output. This allows the input waveform to be displayed on a TV monitor such as the TEKTRONIX 634 Monitor, one of the 650- and 670-series of color Picture Monitors.

In either the TV or digital mode, the 7912AD can acquire waveforms with high bandwidths: up to 500 MHz with the TEKTRONIX 7A19 Amplifier plug-in, for instance, or 1 GHz with the TEKTRONIX 7A21N Direct Access plug-in. The time window can be selected between 10 milliseconds and 5 nanoseconds using a TEKTRONIX 7000-series time base plug-in. This is equivalent to sampling rates (in digital mode) from 50 kHz to 100 GHz.

Remote control and data output via the IEEE 488 bus is simplified by two microprocessor systems in the 7912AD. The firmware operating systems for these microprocessors is designed to let the programmer talk to the 7912AD in as simple and obvious a manner as possible.

Design of the firmware that controls the IEEE 488 interface is consistent with the IEEE 488-1975 standard. Extended addresses are used so that the 7912AD can act as a transparent interface for programmable plug-ins (if installed). These plug-ins include the 7A16P Programmable Amplifier and the 7B90P Programmable Time Base.

The 7912AD operates in many respects like an oscilloscope such as those in the TEKTRONIX 7000-series. The input signal is connected to a vertical plug-in to drive the vertical deflection amplifer. A number of 7000-series plug-ins are available to tailor the 7912AD for bandwidth, input impedance, differential or single-ended input, and input voltage. On most vertical plug-ins, a wide range of deflection factors (amplification) can be selected on the front panel. A number of 7000-series time base plug-ins are available to drive the horizontal deflection amplifier at calibrated sweep rates.

Although the vertical and horizontal deflection systems of the 7912AD are similar to those of an oscilloscope, the similarity ends there. In place of the oscilloscope CRT, there is a scan converter tube. Instead of displaying the input waveform as a trace on the phosphor-coated face of a CRT, the input waveform is written on a silicon diode matrix and read from this target as in a vidicon TV camera.

The Scan Converter

Because of the high writing rate of the scan converter, the 7912AD performs at high bandwidths and sampling rates not usually obtained with other digitizing techniques. The high writing rate stems from several factors that can be understood only by considering the design of the scan converter. The scan converter is an electron tube with dual electron guns, one at each end of the tube. Between the two guns is the target (Fig. 1-1).

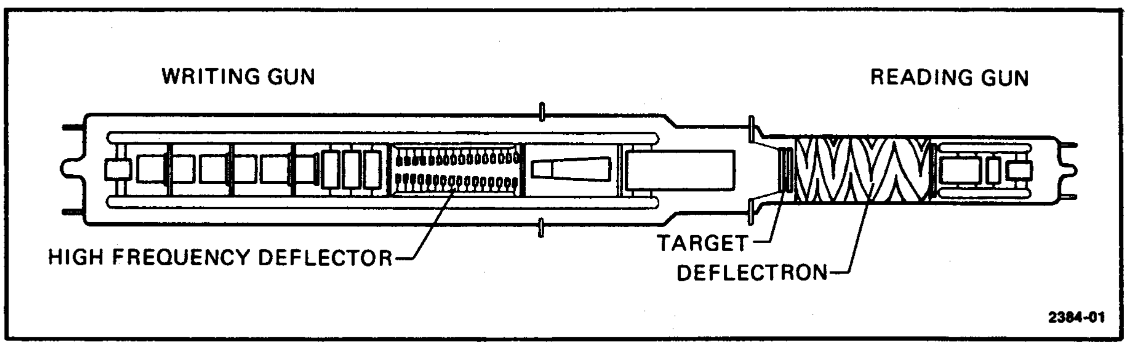


Fig. 1-1. The 7912AD scan converter tube.

The target is an array of diodes formed on an n-type silicon wafer by integrated circuit techniques (Fig. 1-2). In operation, the target substrate is held positive with respect to the reading gun cathode by the target lead. The target is scanned continuously by the reading beam, charging each diode toward the more negative cathode potential to reverse-bias it.

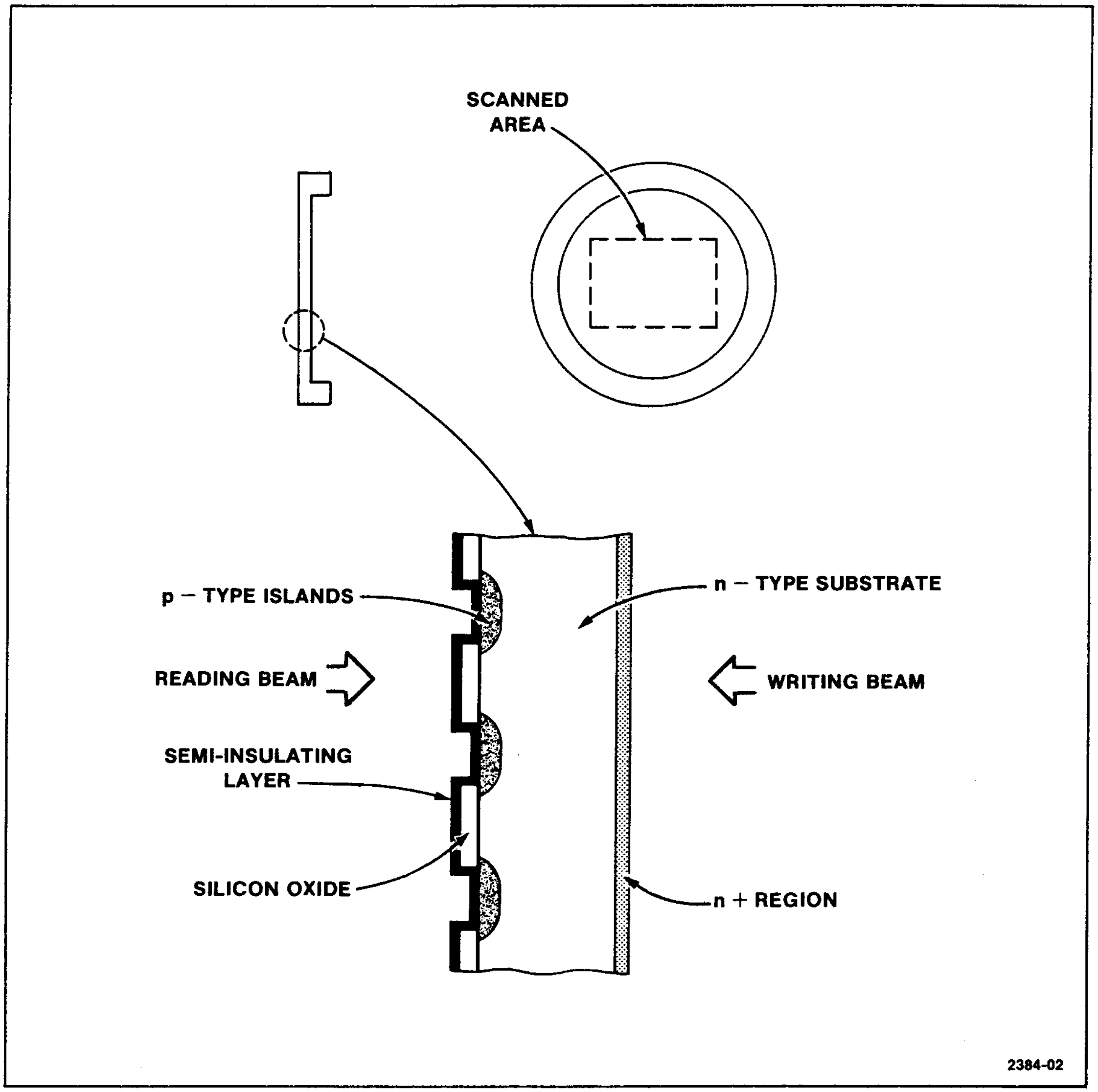


Fig. 1-2. The 7912AD scan converter target. The area scanned is approximately 1.3 X 0.95 centimeters with a diode density of about 800 per centimeter.

When the time base is triggered, it unblanks the writing gun and applies a ramp to the horizontal deflection plates of the writing gun to write a trace across the target. At the same time, the input signal is applied to the vertical deflection plates to vary the height of the trace according to the amplitude of the input signal.

The writing gun electrons, accelerated by the 10-kilovolt potential between the gun and target, bombard the target (Fig. 1-3). Each electron creates many electron-hole pairs near the surface. The holes diffuse through the target and drift across the depletion region at the p-n junction, causing the adjacent diodes to conduct and discharge. When the reading beam next scans the target, little or no current flows at points that were not written. Where the target was written, however, the diodes are recharged and a signal current can be detected in the target lead. This output signal is amplified for further processing.

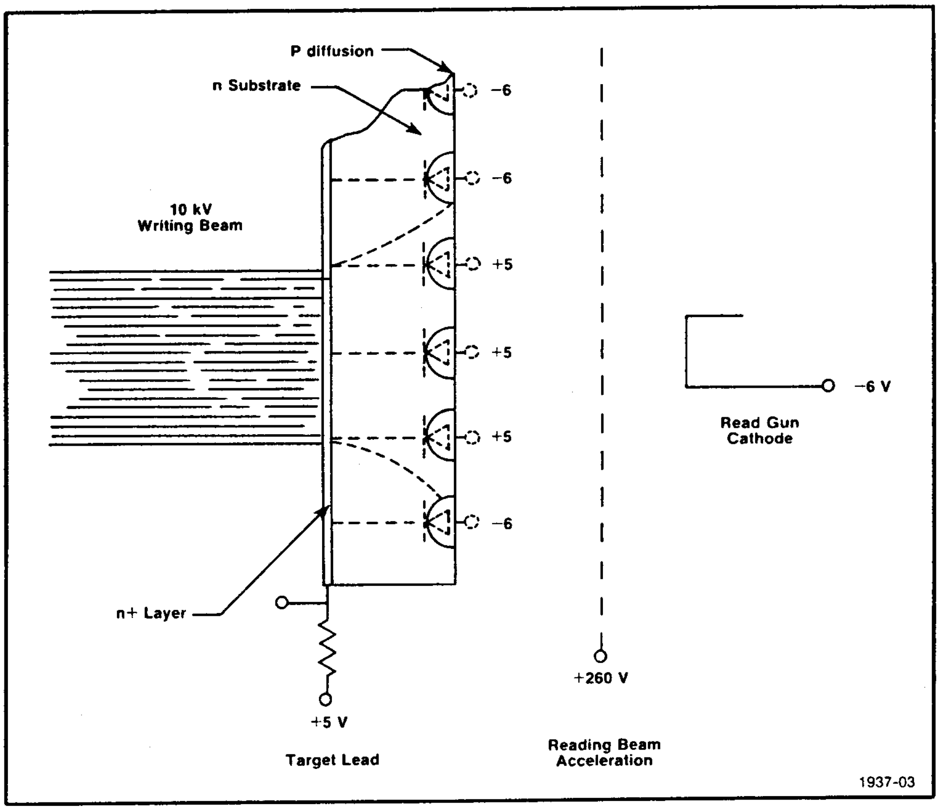


Fig. 1-3. The scan converter tube in operation showing the effect of the reading beam.

Since the energy required to create an electron-hole pair in silicon is about 3.6 electron volts, roughly 2,780 electron-hole pairs are created by each 10-kV electron that strikes the target. Accounting for certain losses, the effective charge gain in the target is about 2,000. This gain is responsible for the high-speed performance of the scan converter because few electrons need to strike the target to record a waveform, allowing the writing trace to be deflected at high speeds.

Other advantages stem from writing and reading the waveform on the target. Because the target is small, the writing beam need only be deflected over a small area (about 1.3 X 0.95 centimeters). Only the writing beam need be high-velocity; the reading beam can be scanned more slowly.

TV Mode

In TV mode, the target is scanned horizontally by the reading beam in a conventional television format with a 525-line (625 lines with option 13) raster. This scan mode is shown in Fig. 1-4. The output signal is amplified, a sync waveform is added, and the composite video signal is provided to two output connectors on the 7912AD rear panel.

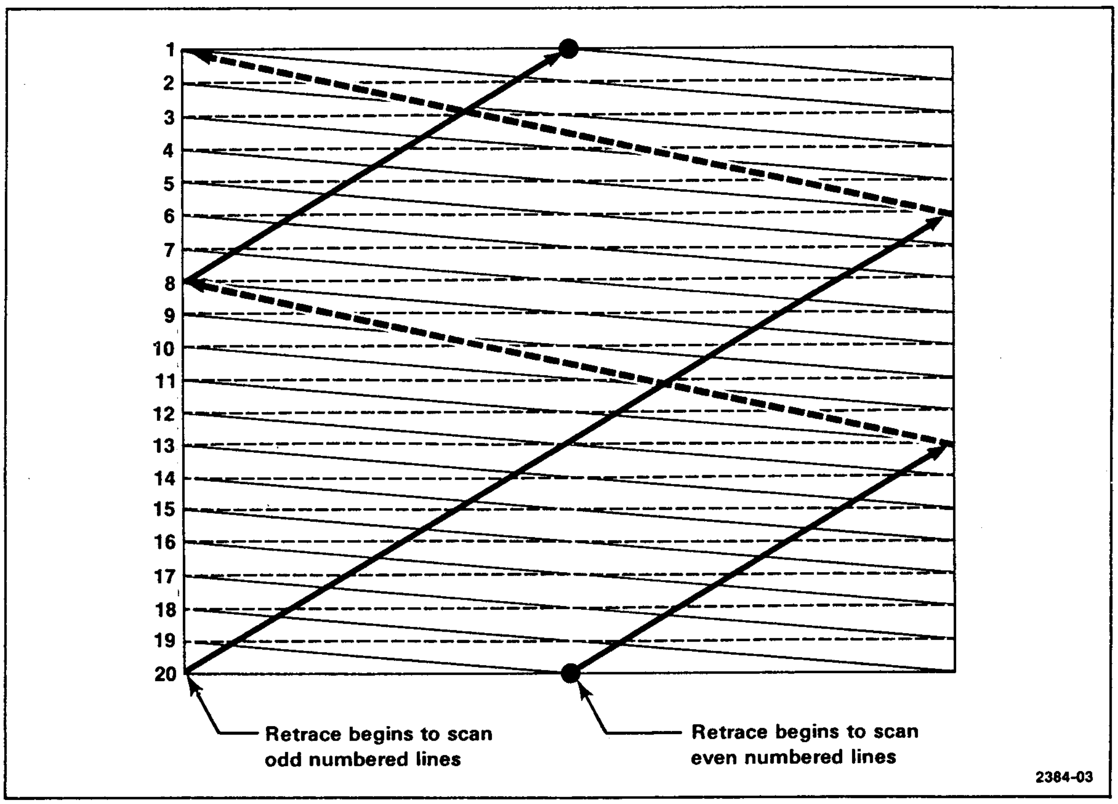


Fig. 1-4. A small-scale example of an interlaced horizontal scan such as is used in 7912AD TV mode.

One output, LINEAR, is a replica of the output of the target lead. The signal goes positive (white) whenever the reading beam crosses a portion of the target that is written; its amplitude varies with the intensity with which that portion of the target was written.

The other output, BINARY, is a two-level output derived from the LINEAR signal. A comparator sets the video level high when it detects that the writing beam crosses a portion of the target that is written. The comparator sets the video level low at all other times during the scan.

To provide the waveform scale factors as part of the monitor display, a character generator adds the readout from the plug-ins to the composite video outputs.

The TV mode provides several advantages over a conventional oscilloscope display. The monitor can be larger and it can be located some distance from the 7912AD. The TV monitor can be used to set up the 7912AD and plug-in controls for data acquisition. The effect of the intensity controls can be observed, for instance. If the BINARY output is used, the output of the comparators can be displayed to assure that all parts of the waveform will be digitized in the digital mode at a particular intensity setting.

Digital Mode

In the digital mode, the target is scanned vertically by the reading beam in a 512 X 512 point format (Fig. 1-5). The signal from the target lead is amplified and fed to a comparator. If the signal is above the comparator threshold, the comparator switches to a high state to indicate that the reading beam is crossing a portion of the target that is written. If the signal is below the threshold, the comparator switches low to indicate that no trace is detected.

The 7912AD begins to store data on the next time base trigger after either the DIGITAL button is pressed (local mode) or a digitize command is received (remote mode). Two counters are the source of the data. One counter is incremented from 0 to 511 as the reading sweeps down the target. Each time the counter is incremented, the output of the comparator is sampled. If the comparator has changed state since the last sample, the count is complemented and stored in memory in the Y (vertical) array.

As a result, two data values are usually stored during each vertical scan, one for the top of the trace and one for the bottom of the trace.

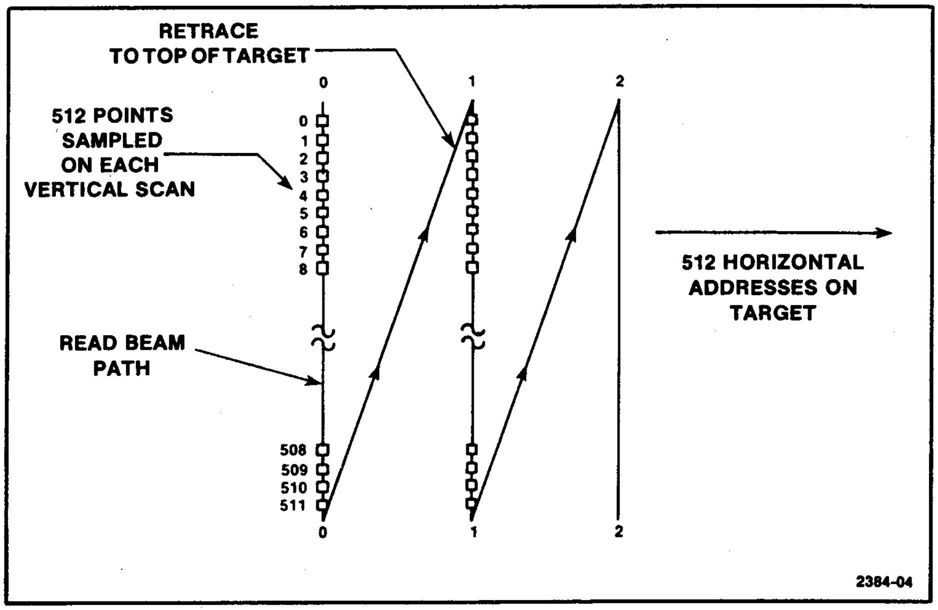


Fig. 1-5. In digital mode, the target is scanned along 512 vertical lines from left to right.

Data are always stored in pairs. If the top of a written portion of the target is detected, the bottom will be detected as well. Up to 30 data can be stored to handle graticule and dual traces. The data are complemented so 511 corresponds to the top of the target and zero to the bottom.

Meanwhile, another counter is incremented each time the reading beam begins another vertical scan. The value of the counter is used to address a location in an X (horizontal) array where the number of data points detected by that vertical scan is stored. When read, the X and Y arrays are used by 7912AD microprocessor routines or external data processing to recover the X and Y coordinates of all points detected as data on the target.

Block Drawing

The 7912AD block drawing (Fig. 1-6) indicates signal and data flow in the instrument. It also relates the scan converter to the other analog circuitry and the two microprocessor systems. The scan converter is shown in two pieces, the writing gun on the left-hand portion of the figure and the reading gun on the right-hand portion.

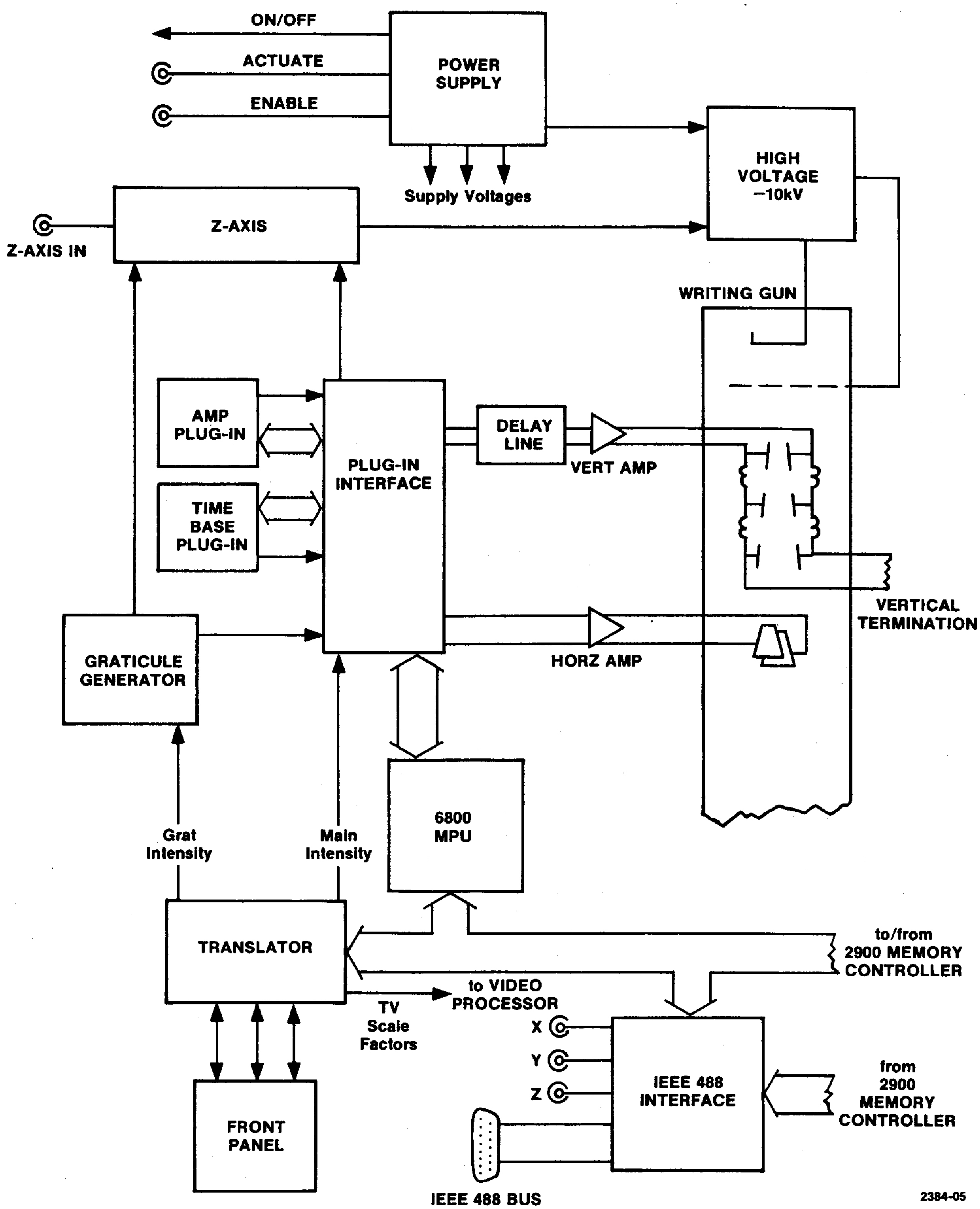
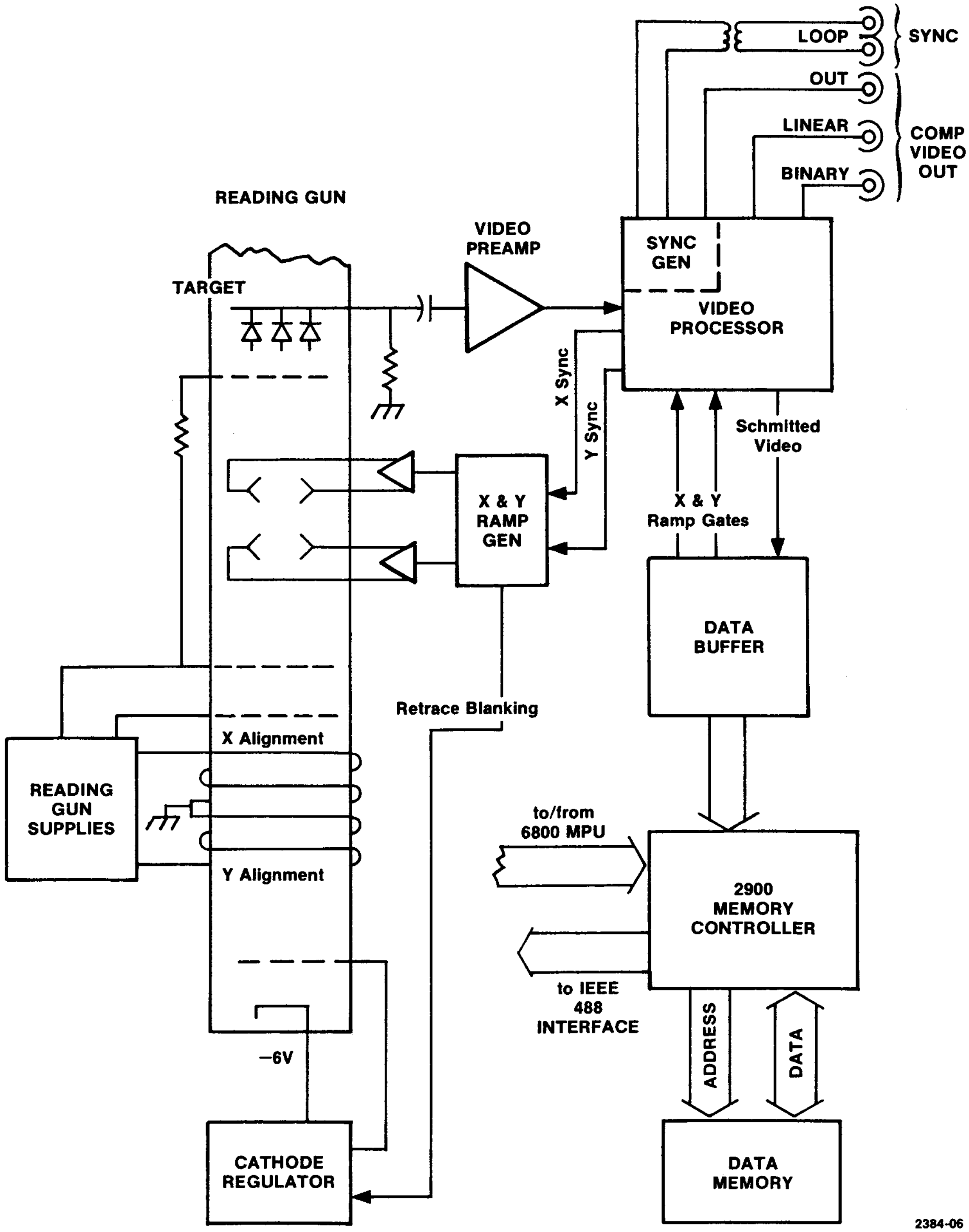


Fig. 1-6. A block drawing of the 7912AD with plug-ins showing the



relationship between the analog and microprocessor systems.

Power Supply. The power supply provides regulated voltages for the analog and digital circuitry as well as the plug-ins. It also supplies the drive to the writing gun high-voltage section. In addition to the ON/OFF switch, it can be turned on and off through the ACTUATE connector. The ENABLE output can, in turn, control another instrument's ACTUATE input.

Analog Signal Flow. Input signals to drive the writing gun come from either the amplifier (vertical) and time base (horizontal) plug-ins or from the graticule generator. The plug-in interface switches in the graticule generator as the signal source for a short period of time following each sweep from the plug-ins to write a dot matrix on the target. This provides a frame of reference for the waveform.

The vertical and horizontal amplifiers are driven by the outputs from the plug-in interface and, in turn, drive the vertical and horizontal deflection plates in the writing gun. The vertical signal is delayed so the leading edge of a fast pulse can be written on the target without a pretrigger. The delay allows time for triggering on the input signal and for the time base sweep to begin before the input signal reaches the vertical deflection plates. These plates are actually helical delay lines designed for high-frequency response. The deflecting field appears in the gap between the helices.

Separate intensity lines from the plug-in interface and from the graticule generator control the writing gun Z-axis. Two lines are needed because the writing gun intensity must be controlled independently during the times it writes the graticule and the waveform. The intensity control signals come from the translator rather than from the front panel (as discussed below).

The Z-axis drive goes to the high-voltage assembly to be translated to the very high negative voltage necessary on the writing gun grid. The writing gun is operated at a very high negative potential so the target and deflection amplifiers can be near ground potential. The monoaccelerator (single accelerating potential) design holds spot size of the writing beam to a minimum (0.001 inch).

When read from the target, the waveform and/or graticule is preamplified and then output as composite video for display or passed on to the data buffer. The clock that controls reading the target originates in the data buffer. X and Y ramp gates derived from the clock are used by the video processor to generate sync pulses for the X and Y ramp generators. The sync generator puts out a TV sync signal based on the ramp gate signals or can use an external signal applied to the LOOP input to override the X and Y ramp gates.

The X and Y ramp generators drive the reading gun deflection plates (through amplifiers) and send a signal to the cathode regulator to blank the reading beam during retrace. The deflection plates are part of the deflectron shown in Fig. 1-2 as is the magnetic yoke for focusing and aligning the beam. Accelerating voltages provided by the reading gun supplies are much lower for the low-velocity reading gun than that required for the writing gun.

Data Flow. In digital mode, data values are recovered by the data buffer. A Y counter keeps track of the vertical position of the reading beam as it scans the target. When the beam crosses the edge of a written portion of the target, the Schmitted video signal changes state. The transition causes the data buffer to latch the contents of the Y counter as a data point. Although the 2900 memory controller is fast, it could not keep up with the data without buffering. So all points detected during a single scan are stored temporarily in a high-speed cache memory to reduce the data rate out of the data buffer.

The 2900 stores the Y data from the cache memory along with the number of points stored for each vertical scan in the data memory. Once stored, the waveform data can be processed by the memory controller (averaged, for example). The processed data is also stored in the data memory.

The data memory can be read out over the IEEE 488 bus. The 2900 controls a high-speed data bus going to the IEEE 488 interface to enable fast data transfers over the bus. The data can also be converted to XYZ outputs for a refreshed display on a monitor.

Instrument Control. The 7912AD firmware operating system runs on the 6800 microprocessor (MPU). It controls instrument status and command input/output through either the front panel or the IEEE 488 interface.

Front panel controls for programmable functions do not set operating parameters directly. For instance, the intensity levels are controlled by lines from the translator labeled Grat Intensity and Main Intensity in Fig. 1-6. These control signals are set by the 6800 MPU through digital-to-analog (D/A) converters in the translator.

In remote mode, the 6800 sets the levels according to values programmed over the IEEE 488 bus. In local mode, the 6800 compares the intensity levels to levels selected through the front panel controls and adjusts the D/A outputs to match the front panel controls. Whether in local or remote mode, the 6800 monitors the writing beam duty cycle and automatically limits the intensity, if necessary, to prevent damage to the target.

Scale factors are also handled by the 6800, whether in TV or digital mode. The 6800 reads the scale factors from the plug-ins through the plug-in interface. In TV mode, it outputs the scale factors through a character generator on the translator as video to the video processor. There the scale factor video is added to the composite video display. In digital mode, the 6800 reads out the scale factors on request over the IEEE 488 bus.

The 6800 MPU performs several other tasks. It acts as a transparent interface for programmable plug-ins; command I/O for the plug-ins passes through the MPU onto a bus between the MPU and plug-in interface. This path continues via the bus shown in Fig. 1-6 going to each plug-in. The 6800 also initiates data storage or processing by the memory controller in response to commands over the IEEE 488 bus (remote mode) or data storage when the front panel DIGITAL button is pressed (local mode).

Waveform Storage

The 7912AD waveform data memory is divided between a raw data area of 10-bit words and a processed data area of 16-bit words as shown in Fig. 1-7. The memory is semiconductor, so data is lost when power is turned off.

Raw Arrays. Vertical data values are stored in the vertical array during a digitize operation. The values include all points detected on the target, whether the edge of a waveform trace, graticule dot, or a defect. Since the reading beam scans the target continuously and is not synchronized with the writing beam, it may be anywhere on the target when

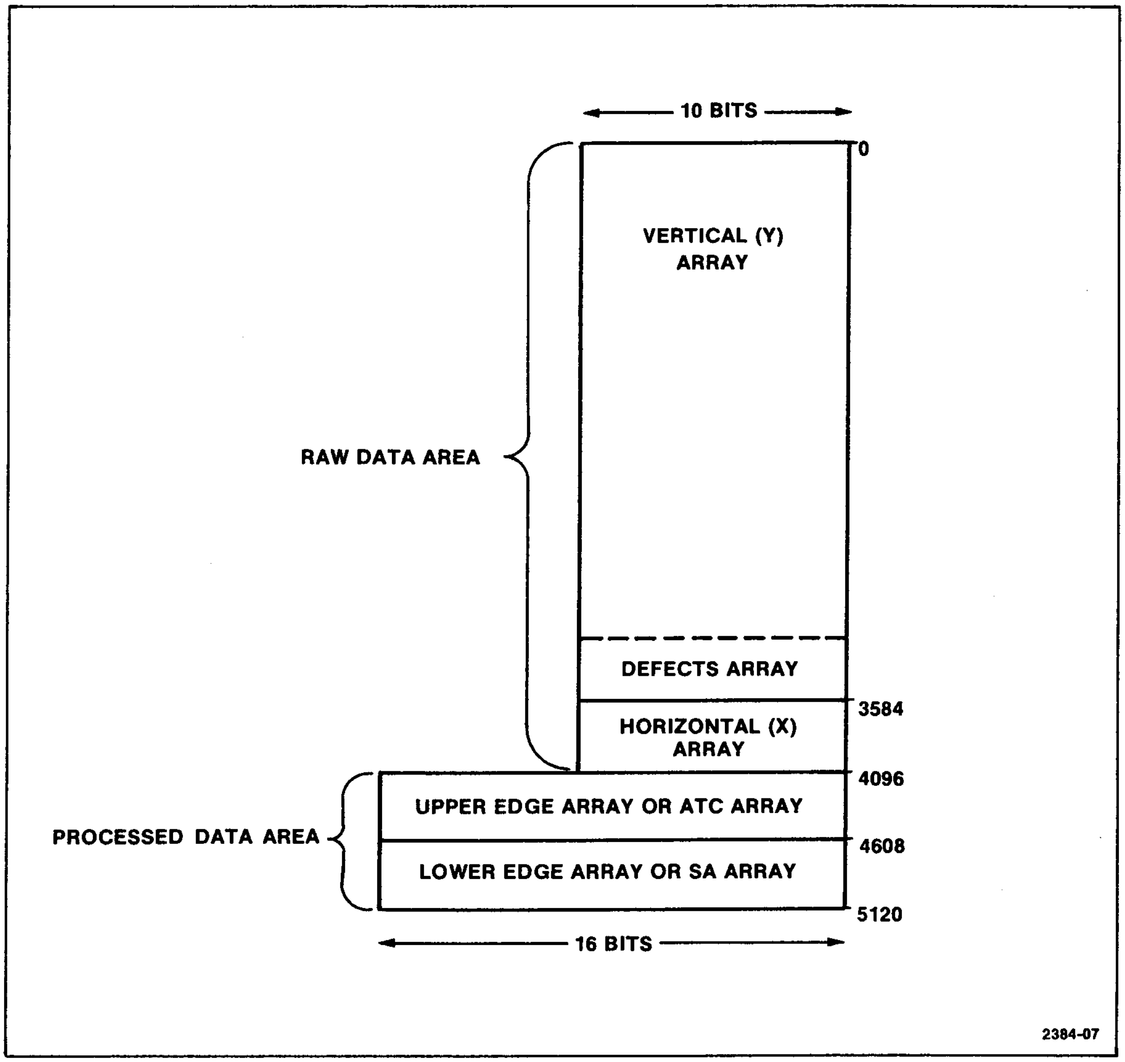


Fig. 1-7. 7912AD data memory map showing arrays used for raw and processed waveforms.

the 7912AD begins storing data. The data are stored starting at the top of the raw vertical array and are stored continuously until the reading beam returns to where storage began. Data are stored in the order they are detected from top to bottom of each of the 512 vertical scans of the target moving from left to right.

Because of the way data are stored, the raw vertical array may wrap around. That is, the data may start anywhere within the time window (where the target represents a time frame), continue in order to the end of the window, but then return to the beginning and continue until reaching the starting point. This is corrected by internal data processing so the data is output by the READ commands from left to right of trace. It is not corrected, however, if the raw area of the memory is DUMPed, as noted in Section 3, Programming.

The 7912AD keeps track of the number of vertical data values stored during each vertical scan (that is, for each horizontal location of the target) in an X (horizontal) counter array. The counts are stored so that the first X array location contains the number of data values stored during the left-most vertical scan, the next address contains the number of values for the next vertical scan to the right, and so on. When output by the READ command, this array is converted to a pointers array to be used to interpret the vertical array.

A defects array located just above the pointers array can identify target defects (points detected as data whether written or not). Defects are stored in reverse order, that is, the first defect value is written at the highest address in the array and the array is written upward. Values in the defect array between 512 and 1023 are horizontal locations on the target where 512 is the left-most vertical scan and 1023 is the right-most vertical scan. Each horizontal value is followed by values between 0 and 511 to represent defects at that horizontal position on the target.

Using the standard 7912AD's defects capability, vertical raw data that matches data in the defect array can be flagged by setting bit 10 of the word. Further internal processing can reject the defects.

Processed Array. The processed data area does double duty. It can be used either as a single 1K block for the two edge arrays, or split into two 512-word blocks for the average-to-center (ATC) array and the signal-averaged (SA) array. In either case, the arrays are single-valued functions processed by the memory controller. Each array contains 512 points, reordered so they represent the function from left to right of trace. The edge arrays define the top and bottom of the trace. The ATC array is the average of the top and bottom of the trace. The signal-averaged array is the average of a number of ATC arrays from a repetitive waveform.

Because they share the same memory space, it is not possible to store all four processed arrays at one time. Either the edge arrays or the average-to-center and signal-averaged arrays can exist at any time.

Options

The following options are available for the 7912AD. They are not field-installable; instructions are not provided in the 7912AD manuals to modify the 7912AD for these options. Changes to the replaceable parts lists are detailed in the service manual for the 7912AD.

Option 4. Change to fast digitize mode. The scan time to read a waveform from the target and into local memory is reduced by compressing the scan. The target is written on and read from a 256 X 256 point matrix with a maximum of 14 points stored per vertical scan. However, the data are normalized to a 512 by 512 point matrix before further processing or output. Vertical values are multiplied by two and the data are blown up to 512 points horizontally by treating every other point as if it is empty.

Graticule resolution is cut by one-half; every other major division is marked in digital mode, and every other major and minor division is marked in TV mode. Both the TV and XYZ displays are restored to the same size as the non-option 4 displays.

This option changes the minimum sweep rate to 200 microseconds/division. This is the lower limit on sweep rate for digitizing reliable data in fast-digitize mode.

Option 9. Set instrument for 230 VAC operation; substitute a 230 volt power cord.

Option 13. Change TV scan rate. The TV mode reading scan of the target is changed to 625 lines per frame with a 50 hertz field rate. The composite video outputs, sync input, and sync output are changed to match this scan rate.

Option 30. Delete cable. The IEEE 488 bus cable that is a standard accessory is deleted.

Specifications

Electrical characteristics of the 7912AD are listed in Table 1-1, Table 1-2, and Table 1-3. To be valid, the following conditions apply:

1) The 7912AD and plug-ins must be calibrated at an ambient temperature between +20 and +30 degrees C.

2) The 7912AD and plug-ins must be allowed to warm up for at least 20 minutes with all covers installed.

3) The calibration of the 7912AD must be checked according to the calibration procedure within each 1000 hours of operation or every six months if operated infrequently. Any adjustments that cause performance outside the limits allowed by the calibration procedure must be readjusted. The plug-ins must also be operated within their calibration intervals.

4) The 7912AD and plug-ins must be operated within their specified environmental limits (Table 1-4). In some cases, an electrical characteristic applies only to a limited temperature range or must be derated to apply to the entire temperature range. These cases are noted.

Statements in the Performance Requirements column are verified by the steps marked with a √ in the calibration procedure (7912AD Service Manual). Statements listed in the Supplemental Information column are not verified in the calibration procedure and are not to be construed as performance requirements of the 7912AD.

Physical characteristics are listed in Table 1-5.

TABLE 1-1

Electrical Specifications

Characteristics	**Performance Requirements**	**Supplemental Information**
VERTICAL DEFLECTION SYSTEM		
Deflection factor	Compatible with all 7000-Series amplifier plug-in units.	Full-scale deflection is ±4 divisions.
Relative accuracy	See Table 1-2.	
Centering	Zero-volt input can be centered by plug-in position control.	Within 0.5 division of electronic graticule center with no plug-in (1 division, option 4).
Low-frequency linearity	0.1 division or less compression or expansion of a centered, two-division waveform. This limit is not exceeded if the waveform is positioned anywhere within the electronic graticule area.	
Bandwidth	See Table 1-2.	
Rise time	See Table 1-2.	
Isolation, signal to graticule	At least 100:1 up to 250 MHz; at least 40:1 from 250 MHz to 500 MHz.	

TABLE 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
Delay line	Adds approximately 60-nanosecond delay in vertical signal path to permit viewing or digitizing of leading edge of triggering waveform.	
GRATICULE		
Format	8 vertical divisions X 10 horizontal divisions.	
TV mode	Both major and minor divisions marked, five minor divisions per major division.	
Digital mode	Only major divisions marked.	
TV mode, option 4	Only every other major and minor division marked.	
Digital mode, option 4	Only every other major division marked.	
Writing time		Requires 3 milliseconds, gated immediately after waveform is acquired. Locks out vertical signal and main sweep and disables Z-axis.

TABLE 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
Position		Adjustable horizontally and vertically ±5%.
Amplitude		Adjustable horizontally and vertically ±5%.
Intensity	Controlled from front panel or by programmed command separately from main intensity.	
Stability		
0 to +40 degrees C		0.5%.
+20 to +30 deg. C		0.1%.

HORIZONTAL DEFLECTION SYSTEM

Deflection factor	Compatible with all 7000-Series plug-in units. See Table 1-3 for recommended time base plug-ins.	Full scale deflection is ±5 divisions.
DC linearity	0.05 division or less error at each graticule line after adjusting for no error at the second and tenth graticule lines (0.1 division, option 4).	

TABLE 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
Fastest calibrated sweep rate (with 7B90P, 7B92A, or 7B80 MOD GB Time Base)	0.5 nanosecond/division.	
Slowest sweep rate	1 millisecond/division (200 microseconds/division, option 4).	
Centering	Center of sweep can be centered in graticule by time base Position control.	
Bandwidth, 10 division reference	DC to at least 1 megahertz.	
EXTERNAL Z-AXIS INPUT		
Polarity	Positive-going signal decreases trace intensity of writing gun; negative-going signal increases trace intensity. Zero-volt (approximate) input produces no intensity change.	
Sensitivity	Two volts peak-to-peak provides trace modulation over full intensity range.	

TABLE 1-1 (cont.)

Characteristics	**Performance Requirements**	**Supplemental Information**
Low-frequency limit		DC
DC input resistance		550 ohms, ±10%.
Maximum Input voltage		15 volts (DC + peak AC).

CRT TARGET AND WRITING GUN

Gun type	Mono accelerator.	
Light defects		
Distribution	No more than six points digitized or displayed other than those written by input waveform. No two light defects on same vertical line within ±3 degrees of deflection.	
Size	No light defects larger then four TV lines.	
Geometry	A straight-line input is read from the target as a straight line within 0.1 division.	

TABLE 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
Writing Rate (+10 to +40 degrees C)		
TV mode	Writes an 8-division sine wave of at least 500 MHz in a single sweep.	At least 12.5 divisions per nanosecond; 30 divisions per nanosecond, typical.
Digital mode	Writes a single 8-division pulse with a rise time of 1 nanosecond or less (2 nanoseconds or less from 0 to +10 degrees C).	At least 8 divisions per nanosecond, typical.
Option 4		
TV mode	Writes an 8-division sine wave of at least 1 GHz in a single sweep.	At least 25 divisions per nanosecond; 60 divisions per nanosecond, typical.
Digital mode	Writes a single 10-division pulse with a risetime of 0.5 nanosecond or less (1 nanosecond or less from 0 to +10 degrees C.)	At least 20 divisions per nanosecond, typical.

TABLE 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
READING GUN		
Type	Monoaccelerator	
RAMP GENERATOR AND SCAN AMPLIFIER		
Scan time, digital mode		Approximately 16.4 milliseconds per waveform to read waveform and store in memory (approximately 4.5 milliseconds, option 4).
VIDEO SYSTEM		
Resolution		
TV mode		At least 400 TV lines per picture width. Video signal is down less than 50% at linear output.
Ultimate resolution, TV mode		At least 500 TV lines when viewed on a TEKTRONIX 632 Monitor or equivalent.

TABLE 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
Digital mode		
Horizontal	Two signals, each including a step with a risetime of 10 nanoseconds, are digitized separately at a sweep speed of 50 nanoseconds/division if the steps are delayed 1.25 nanoseconds with respect to each other.	400 lines.
Vertical	A 50 milivolt square wave is resolved at 2 volts/division.	320 lines.

VIDEO OUTPUTS

Composite video		
Linear	1 volt into 75 ohms for full white signal. Conforms to EIA RS-170.	
Binary		
Low level	0 to +0.3 volts into 75 ohms.	
High level	+1 volt ±0.1 volt into 75 ohms.	

TABLE 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
Scan rate		
Standard		525 lines/frame, 60 Hz field rate (interlaced).
Option 13		625 lines/frame, 50 Hz field rate (interlaced).
Scale factor readout	Up to eight characters per channel.	
VERTICAL plug-in	Channel 1 appears in upper left corner of graticule, channel 2 in lower left corner of graticule.	
HORIZONTAL plug-in	Channel 1 appears in upper right corner of graticule, channel 2 in lower right corner.	
Return losses, sync loop		At least 40 dB to 4 megahertz.

IEEE 488 Interface

Data connector	Conforms to IEEE Standard 488-1975.	
Signal levels		Conform to IEEE Standard 488-1975.
Signal timing		Conforms to IEEE Standard 488-1975.

TABLE 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
Data transfer rate, max.		710 kilobytes/second.
Waveform transfer time, min.		9 milliseconds for 1024 vertical and 512 pointer data.
Waveform acquisition and transfer rate, max.		5-20 waveforms/second (Intensity dependant)
X-Y-Z analog display outputs of waveform data		
X and Y	1 volt peak-to-peak into 100 kilohms or greater; adjustable from 0.75 to 1.3 volts.	8-bit resolution
Z	Zero volts (blanked), 1 volt (unblanked) into 100 kilohms or greater. Blanked between data points.	
Z_{out}, X and Y		50 ohms, ±5%.

FEEDTHROUGH CONNECTORS

VERT IN, CAL IN, TRIG IN (rear-panel connectors)	Connect to front panel connectors through coaxial cable.	

TABLE 1-1 (cont.)

Characteristics	**Performance Requirements**	**Supplemental Information**
Z_0		50 ohms, ±2%.
Attenuation of VERT IN/OUT and CAL IN/OUT signal paths		0.33 dB at 400 MHz; 0.54 dB at 1 GHz.

POWER SUPPLY

Remote control		
ACTUATE	TTL low level (<0.8V) applied between center conductor and outer conductor turns on power supply. A return to a TTL high level (>2V) turns off power supply. Outer conductor is isolated from chassis by approximately 100 ohms.	
ENABLE	Provides TTL low level (<0.4V) between center conductor and outer conductor approximately 150 milliseconds after power-up. Maximum sink current is 16 milliamps. Goes to TTL high level after power supply is turned off.	

TABLE 1-1 (cont.)

Characteristics	Performance Requirements	Supplemental Information
POWER INPUT		
Line voltage		
115, nominal		90 to 132 volts AC.
230, nominal		180 to 250 volts AC.
Line frequency		48 to 440 Hz.
Power consumption		
Typical, not including plug-ins		250 watts
Maximum, including plug-ins		360 watts
Line current, max		5.2 amps (90 VAC)
SAFETY		
Power line fuse	6 amps, 250 volt, fast-blow.	

TABLE 1-2

7912AD SYSTEM ELECTRICAL CHARACTERISTICS

Plug-in Amplifier	**Performance Feature**	**Minimum Deflection Factor**	**Bandwidth**	**Rise Time (Calculated)**	**Relative Accuracy***
7A11	Low-capacitance FET probe built-in	5 mV/div	250 MHz (225 MHz, +30 to +40 degrees C)	1.4 ns (1.6 ns, +30 to +40 degrees C)	2%
7A13	Differential input; DC offset	1 mV/div	105 MHz	3.4 ns	1.5%
7A16A	1-megohm input	5 mV/div	225 MHz	1.6 ns	2%
7A16P	Programmable	10 mV/div	200 MHz	1.8 ns	2%
7A18	Dual-channel, 1-megohm input	5 mV/div	75 MHz	4.7 ns	2%
7A19	Wide bandwidth, 50-ohm input	10 mV/div	500 MHz (400 MHz, +30 to +40 degrees C)	0.8 ns (0.9 ns +30 to +40 degrees C)	3%
7A24	Dual-channel, wide bandwidth, 50-ohm input	5 mV/div	350 MHz (300 MHz, +30 to +40 degrees C)	1.0 ns (1.2 ns, +30 to +40 degrees C)	2%
7A21N	Direct access, 50-ohm input	Less than 4 V/div	1 GHz	0.35 ns	--
7A26	Dual-channel 1-megohm input	5 mV/div	200 MHz (160 MHz, +30 to +40 degrees C)	1.8 ns (2.2 ns, +30 to +40 degrees C)	2%

*Applies to all deflection factors when the plug-in gain is set at the deflection factor designated on each plug-in. The calibration signal must be supplied by an external calibrator whose accuracy is within 0.25%.

TABLE 1-3
RECOMMENDED TIME BASE PLUG-IN

Plug-in	**Maximum Sweep Rate**	**Triggering Frequency Range**	**Notes**
7B80	1 ns/div	400 MHz	
7B80GB	500 ps/div	400 MHz	Slowest sweep rate is 10 us/div
7B90P	500 ps/div	400 MHz	Programmable
7B92A	500 ps/div	500 MHz	Both normal and delayed sweep; set intensity carefully in alternate mode

TABLE 1-4

ENVIRONMENTAL CHARACTERISTICS

Characteristics	**Description**
Temperature	
Operating	0 to +40 degrees C.
Nonoperating	-55 to +75 degrees C.
Altitude	
Operating	Up to 4570 meters (15,000 feet).
Nonoperating	Up to 15,200 meters (50,000 feet).
Electromagnetic compatibility (EMC) with plug-ins or EMC-shielded blank plug-ins installed	Meets all applicable parts of MIL-STD-461A when tests are performed according to MIL-STD-462 for radiated and conducted electromagnetic emissions and susceptibility from 30 hertz to 1 gigahertz.

TABLE 1-5

PHYSICAL CHARACTERISTICS

Characteristics	Description
Size	Can be mounted in standard 19-inch rack. See Fig. 1-8.
Weight (no plug-ins)	Approximately 24.7 kilograms (54.6 pounds).
Air intake at fan	2.83 $meters^3$/min. (100 $feet^3$/min), max; typically 2.40 $meters^3$/min. (85 $feet^3$/min).

Accessories

The following accessories are supplied with the 7912AD; part numbers are given in the 7912AD Service Manual:

1 power cord, 2.4 meters (8 feet)

1 set of rack slides with hardware

1 IEEE 488 bus cable, 2 meters (6.6 feet)

1 operators manual

1 service manual

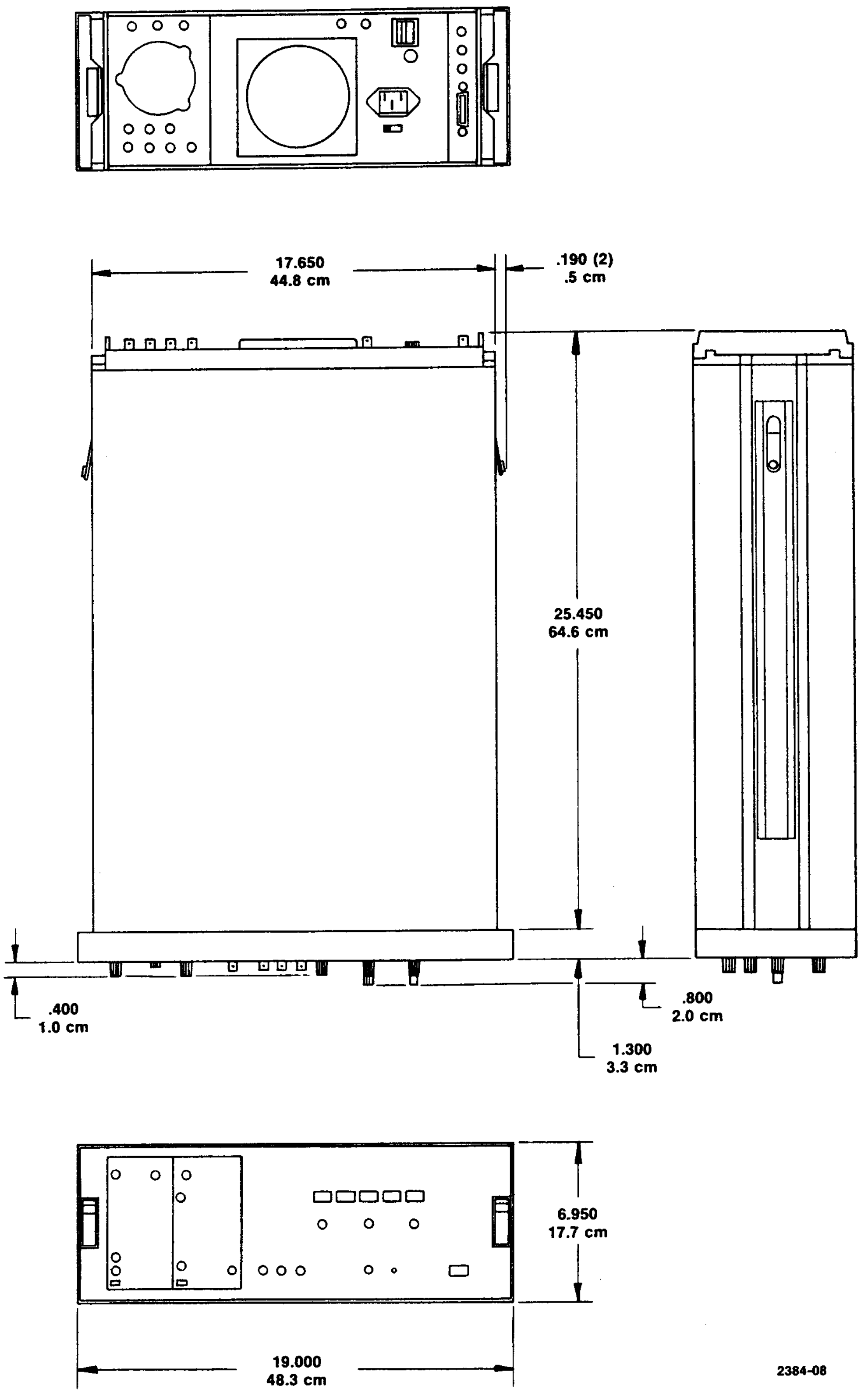


Fig. 1-8. 7912AD outside dimensions shown in both inches and centimeters.

SECTION 2

OPERATION

This section contains a description of 7912AD controls and connectors and instructions for local (operator) control of the instrument. Turn to Section 3 for instructions for remote (programmed) control. However, instructions for acquiring data whether under local or remote control are given in this section.

The 7912AD is based on the TEKTRONIX 7000-series plug-in concept. Signal-conditioning plug-ins are used. These have their own operating controls; see the plug-in operators manuals for a description of the controls and instructions for operating the plug-ins. Although some of the plug-in controls are referenced in this manual, they are not fully described, nor are full instructions for their use provided.

Controls and Connectors

Front Panel

The front panel controls and connectors are shown in Fig. 2-1. The numbers in the following descriptions refer to Fig. 2-1.

OPERATING MODE

(1) TV: Sets the 7912AD to TV mode. Lights when in TV mode. If, when the TV button is pressed, the 7912AD is performing a digitize operation, it waits until completed before switching to TV mode.

(2) DIGITAL: Sets the 7912AD to digital mode and initiates a digitize operation. Lights when in digital mode. There is a two-second delay for set-up when switching from TV to digital mode. Once DIGITAL is pressed, the 7912AD is readied to digitize but waits for a sweep gate from the time base to store data detected on the target. To be detected, the input waveform and/or graticule must have been written on the target with sufficient intensity (set by the INTENSITY controls).

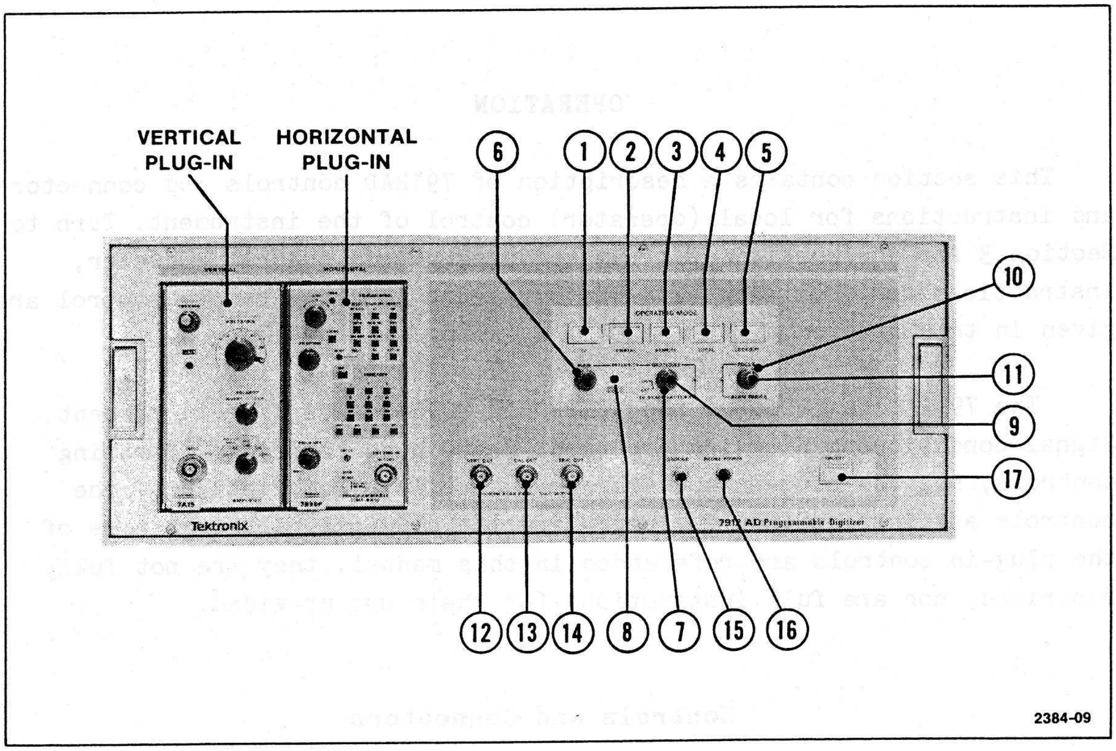


Fig. 2-1. Front panel controls and connectors. The numbers refer to descriptions in the text of the controls and connectors.

(3) REMOTE: Lights to indicate when the 7912AD is set to remote mode by the IEEE 488 bus system controller. When REMOTE is pressed, the 7912AD requests service from the IEEE 488 bus controller if the interrupt is enabled.

(4) LOCAL: Returns the 7912AD from remote mode to local control if not in remote with lockout state (see LOCKOUT). Lights when in local mode. If the instrument is executing a remote command or performing a digitize operation, it waits until finished to return to local.

(5) LOCKOUT: Lights to indicate the 7912AD is set to either local with lockout state or remote with lockout state by the IEEE 488 bus system controller. In remote with lockout state (both REMOTE and LOCKOUT are lighted), the LOCAL button does not return the instrument from remote to local control.

INTENSITY

(6) MAIN: Sets writing beam intensity to control input waveform definition on the converter tube target.

(7) GRATICULE: Sets writing beam intensity when the graticule is written on the converter tube target (outer knob). When set to minimum, the graticule is not written, so it is not displayed (TV mode) or digitized (digital mode).

DECREASE INTENSITY

(8) Lights to warn that the 6800 MPU is automatically limiting beam current because either or both intensity controls are set too high. Also lights if the 6800 MPU turns off the writing beam because it detects an invalid sweep rate or missing horizontal plug-in readout. Blinks when a hardware protection circuit becomes active; in this condition, the beam is automatically deflected outside the graticule area.

(9) TV SCALE FACTORS

Turns on or off the display of scale factors when in TV mode (inner knob).

(10) FOCUS

Sets focus of writing beam to affect trace definition (outer knob).

(11) BEAM FINDER

Compresses the input waveform into the graticule area, even if the waveform is overdriving the 7912AD input (inner button). Used to determine how the plug-in controls should be changed to match the input waveform. Can not be set under remote control.

(12) VERT OUT

Connects through 50-ohm coaxial cable to rear panel VERT IN.

(13) CAL OUT

Connects through 50-ohm coaxial cable to rear panel CAL IN.

(14) TRIG OUT

Connects through 50-ohm coaxial cable to rear panel TRIG IN.

(15) GROUND

Connects to chassis ground.

(16) PROBE POWER

Provides power for TEKTRONIX active probes.

(17) ON/OFF

Turns on/off the 7912AD power supply if the rear-panel PRINCIPAL POWER SWITCH is on (can be overridden by rear-panel ACTUATE connector). Lights when the power supply is turned on.

Rear Panel

The rear panel controls and connectors are shown in Fig. 2-2. The numbers in the following descriptions refer to Fig. 2-2.

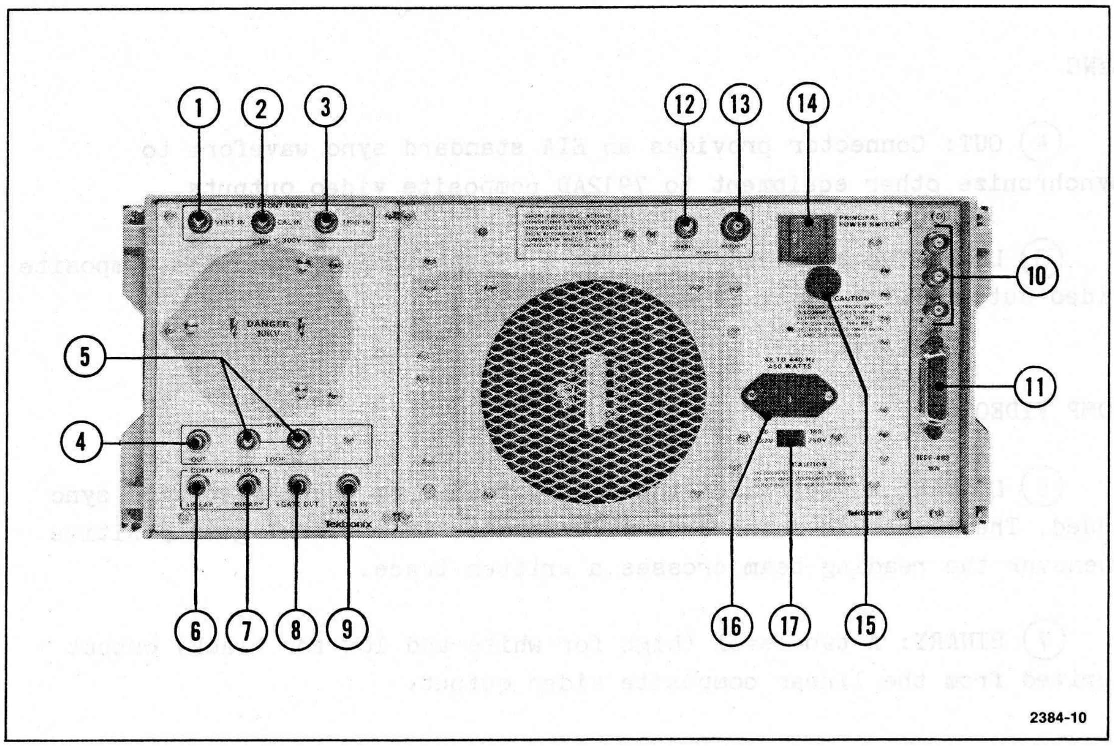


Fig. 2-2. Rear panel controls and connectors. The numbers refer to descriptions in the text of the controls and connectors.

(1) VERT IN

Connects through 50-ohm coaxial cable to front panel VERT OUT.

(2) CAL IN

Connects through 50-ohm coaxial cable to front panel CAL OUT.

(3) TRIG IN

Connects through 50-ohm coaxial cable to front panel TRIG OUT.

SYNC

(4) OUT: Connector provides an EIA standard sync waveform to synchronize other equipment to 7912AD composite video outputs.

(5) LOOP: Two connectors provide a 75-ohm loop to sync the composite video outputs with other TV equipment.

COMP VIDEO OUT

(6) LINEAR: A replica of the signal read from the target with sync added. The target is scanned in a TV format. This signal goes positive whenever the reading beam crosses a written trace.

(7) BINARY: A two-level (high for white and low for black) output derived from the linear composite video output.

(8) + GATE OUT

Provides a positive pulse with a duration equal to and coincident with the time base sweep. The amplitude is approximately 0.5 volts into 50 ohms and 10 volts into 1 megohm.

(9) Z-AXIS IN

$\pm$ 1 volt input modulates the writing gun intensity over its full range; a zero volt input causes no change in the intensity selected by the intensity controls. A positive signal reduces intensity; a negative signal increases intensity.

CAUTION

Signals connected to Z-AXIS IN control writing beam intensity independently of the 6800 MPU, bypassing the firmware intensity protection. The effect of this input depends on sweep speed and the input waveform; use it with caution to prevent damage to the scan converter target. Connect only low-amplitude signals (±100 millivolts) until the effect on writing beam intensity is monitored.

(10) X,Y,Z

Provide X-Y-Z analog equivalents of the waveform data stored in memory for a refreshed display on a monitor. The outputs are disabled if there is no valid data to display, also while the 7912AD is digitizing or busy with waveform data input or output on the IEEE 488 bus. Scale factors are not displayed. There is no local control of the XYZ display -- it is programmed by the XYZ command as described in Section 3.

(11) J13 IEEE 488-1975

Provides connection to the bus specified in IEEE Standard 488-1975.

(12) ENABLE

Applies a TTL low level between the center and outer conductors after the power supply is turned on; allows power-up of a system to be daisy-chained.

(13) ACTUATE

A TTL low level applied between the center and outer conductors turns on the 7912AD power supply. A return to a TTL high level turns off the 7912AD power supply.

(14) PRINCIPAL POWER SWITCH

Power line switch that turns on or off power input to power supply.

(15) FUSE

Replaceable power line fuse.

(16) Power Connector

CAE-22 three-prong power connector; IEC-coded.

(17) Line Voltage Selector

Selects either 115 VAC or 230 VAC operation.

Operating the 7912AD

Before operating the 7912AD, check the environmental and physical specifications at the end of Section 1; the operating temperature and airflow requirements of the instrument must be met. Be sure there is nothing blocking the fan intake (screen on rear panel) or the air exhaust holes on the sides of the instrument.

Plug-Ins

The 7912AD accepts two Tektronix 7000-series plug-ins. These can be selected to tailor the bandwidth, sweep speed, and other characteristics of the 7912AD for your application. See the specifications in Section 1 for recommended plug-ins and their performance in the 7912AD.

CAUTION

Always turn off the 7912AD power before removing or installing plug-ins to prevent damage to the circuitry.

Install an amplifier plug-in in the VERTICAL compartment and a time base plug-in in the HORIZONTAL compartment. Either programmable or non-programmable plug-ins may be used. The time base must provide readout for the 7912AD to determine that a valid sweep rate is selected. If the time base has no readout, the 7912AD main and graticule intensities are turned off.

CAUTION

Intensity and contrast controls of a dual time base plug-in bypass the firmware intensity protection, setting writing beam intensity independently of the 6800 MPU. Before installing the 7B92A Dual Time Base, reduce its Intensity and Contrast controls to minimum. Monitor the effect of these controls on writing beam intensity and use them carefully when operating the 7B92A in intensified or alternate sweep modes to avoid burning the scan converter target. Do not use other dual time base plug-ins such as the 7B52, 7B53A, or 7B92 in intensified or alternate (mixed) sweep modes because they lack a contrast control.

The 7912AD can display scale factor readout from the plug-ins in TV mode as shown in Fig. 2-3. Channel 1 of an amplifier in the VERTICAL compartment is displayed as vertical channel 1. If channel 2 of a dual amplifier is selected, it is displayed as vertical channel 2. Sweep rates of a time base in the HORIZONTAL compartment may be displayed in either horizontal channel 1 or 2, depending on the plug-in.

The readout display may differ from that obtained with a given plug-in in other 7000-series mainframes in two respects:

1) Only eight characters per channel can be displayed. This does not affect plug-ins recommended in the specifications in Section 1. It may, however, omit characters from some digital plug-ins. Also, special characters from such plug-ins may be garbled.

2) An amplifier operated in inverted mode is indicated by a minus sign in front of the scale factor, rather than a down arrow. Special characters used by 7000-series plug-ins to indicate uncalibrated readout are displayed by the 7912AD. Usually this is the greater-than sign (>) for amplifier and time base scale factors, although some plug-ins use the less-than sign (<) or X to indicate uncalibrated readout.

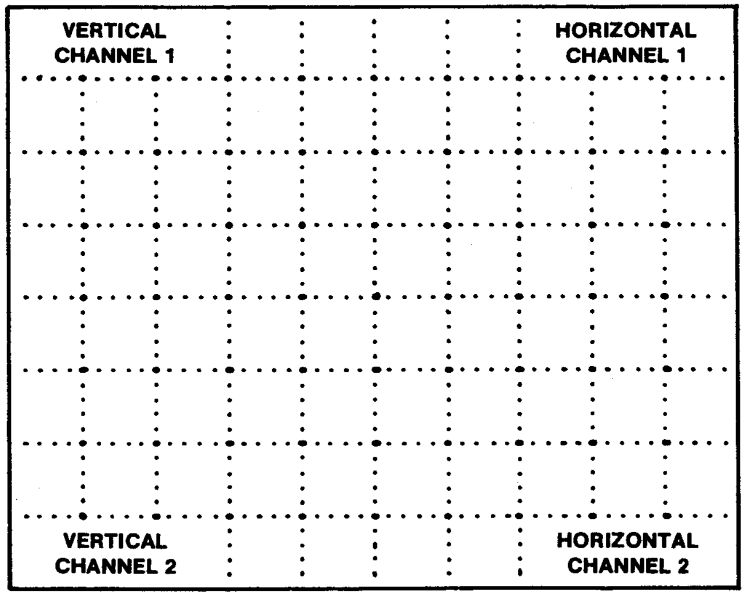


Fig. 2-3. Position of plug-in readout on the TV display.

NOTE

If a 7A21N Direct Access Plug-in is installed, no graticule information can be generated or displayed.

Supplying Power

The 7912AD power cord must be connected to an outlet with a securely grounded protective-ground contact and the correct single-phase voltage. To connect power to the 7912AD, follow the instructions in Section 4.

For either the front-panel ON/OFF switch or the rear-panel ACTUATE connector to power up the instrument, the PRINCIPAL POWER SWITCH must be turned on.

WARNING

To avoid electric shock, be sure that the protective-ground circuit is not interrupted. This can allow the chassis to float to hazardous potentials. Be sure that the power cord, plug, and outlet provide a secure path to earth (ground) for the protective-ground circuit of the 7912AD.

Waveform Monitors

Waveforms acquired by the 7912AD can be viewed on monitors. A TV monitor is used to display waveforms in real-time as they are acquired in TV mode. An XYZ monitor is used to display waveforms stored in memory. An example of each monitor is shown in use with a 7912AD in Fig. 2-4. Instructions to connect the monitors are given under Cabling in Section 4.

Getting a Picture (TV Mode)

1. Set the INTENSITY controls (MAIN and GRATICULE) to minimum (counterclockwise). Although the 7912AD has protection circuitry to prevent damage to the scan converter tube by high intensity levels, set the intensity controls to minimum before turning on power to be safe.

2. Check that the 7912AD is connected to a compatible video monitor. For instructions to connect a monitor, see Section 4.

3. Turn on the video monitor and set for normal brightness.

4. Set the TV SCALE FACTORS switch to ON.

5. Set the time base plug-in for an automatic sweep at 1 millisecond/division or faster.

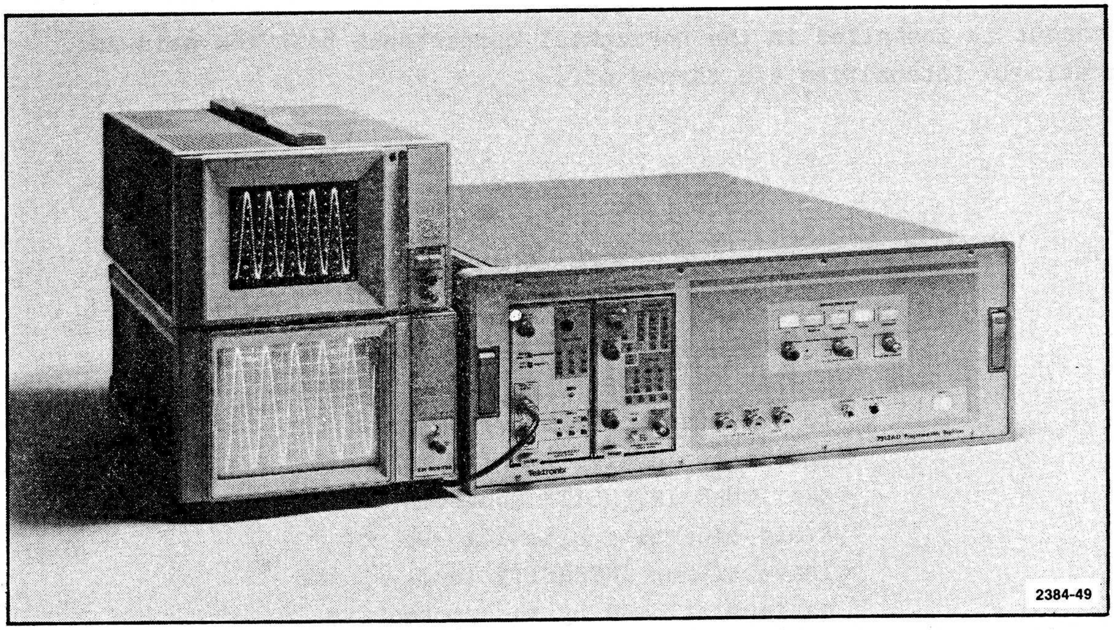


Fig. 2-4. The 7912AD is shown operating with an XYZ monitor (top) and a TV monitor (bottom).

6. Set the amplifier plug-in position control midrange.

7. Press the ON/OFF button or apply a TTL active low on the ACTUATE connector. The button should light and the fan should start. If not, check that the PRINCIPAL POWER SWITCH is ON. The 7912AD is automatically set to the local and TV modes following power-up. If not, check that the 7912AD is not under remote control. To prevent this, disconnect the instrument from the IEEE 488 bus. Scale factors set by the plug-in controls should be displayed on the monitor after a short warm-up. If not, check the monitor connections and operating controls and that the plug-ins have readout capability.

The 6800 MPU performs a self-test on power-up before setting the operating modes to local and TV. If the test fails, the 6800 does not light LOCAL and TV, but hangs at the 6800 bus address where the test failed as a clue for diagnosing the problem.

8. After a short wait to allow the scan converter tube to warm up, increase the GRATICULE INTENSITY slowly until the graticule appears on the monitor. The TV mode graticule is shown in Fig. 2-3. Check that the DECREASE INTENSITY light does not come on. Note: If a time base without

readout is installed in the horizontal compartment both the main and graticule intensities are turned off.

CAUTION

Although protective circuitry in the 7912AD is designed to prevent damage to the scan converter from high intensity levels, set the MAIN and GRATICULE INTENSITY controls carefully. Avoid excessive blooming. Do not leave either INTENSITY level at the maximum allowed by the protective circuitry for extended periods.

9. Increase the MAIN INTENSITY slowly and watch for a trace. Check that the DECREASE INTENSITY light does not come on. The trace should appear within one-half to one full turn of the MAIN INTENSITY control.

10. If the trace does not appear, press the BEAMFINDER control. This compresses the waveform within the viewing area to detect an over-scanned signal. Use the plug-in controls to bring the trace within the graticule.

11. If a trace still does not appear, recheck the instructions performed in the steps above.

12. Either or both intensity controls may need to be changed for different sweep speeds and input signals. If intensity is too high, blooming occurs. If intensity is too low, portions of the display are missing.

13. Set the FOCUS control for a well-defined trace.

14. Allow the 7912AD to warm up for 20 minutes for specified performance. During warm-up, the intensities must normally be increased slightly over their values shortly after turn-on.

Storing and Viewing Data (Digital Mode)--Repetitive Sweep

1. Check that the 7912AD is connected to a compatible display monitor. For instructions to connect a monitor, see Section 4.

2. Turn on the monitor and set for normal viewing level (erase the display if a storage monitor is used).

The following steps through 7 can be skipped if you have already turned on the 7912AD and gotten a picture in the TV mode.

3. Set the INTENSITY controls (MAIN and GRATICULE) to minimum (counterclockwise). Although the 7912AD has protection circuitry to prevent damage to the scan converter tube by high intensity levels, set the intensity controls to minimum before turning on power to be safe.

4. Set the time base plug-in for an automatic sweep of 1 millisecond/division or faster.

5. Set the amplifier plug-in position control to midrange.

6. Press the ON/OFF button or apply a TTL active low on the ACTUATE connector. The button should light and the fan should start. If not, check that the PRINCIPAL POWER SWITCH (rear-panel) is ON. The 7912AD should go to the local and TV modes when it powers up. If not, check that the 7912AD is not under remote control. To prevent this, disconnect the instrument from the IEEE 488 bus. There is normally no display on the monitor after power up because no valid data exists in memory. Allow the 7912AD and monitor a short warm up before going to the next step.

The 6800 MPU performs a self-test on power-up before setting the operating modes to local and TV. If the test fails, the 6800 does not light LOCAL and TV, but hangs at the 6800 bus address where the test failed as a clue for diagnosing the problem.

7. Increase the MAIN and GRATICULE INTENSITY controls a small amount from minimum.

8. Press the DIGITAL button. A waveform is digitized and stored in memory on the next time base sweep, following approximately two-seconds delay for set up if changing from the TV mode.

9. If the INTENSITY controls are set too low, no data is stored, so there is no display on the monitor. Increase the INTENSITY levels a small amount and repeat step 8. Check that the DECREASE INTENSITY light does not come on. Continue to repeat steps 8 and 9 until a trace and graticule are displayed. This should occur within one-half to one turn of the MAIN INTENSITY control and about a half-turn of the GRATICULE INTENSITY control. If not, check the monitor connections and controls.

CAUTION

> Although protective circuitry in the 7912AD is designed to prevent damage to the scan converter from high intensity levels, set the MAIN and GRATICULE INTENSITY controls carefully. Avoid excessive blooming. Do not leave either INTENSITY level at the maximum allowed by the protective circuitry for extended periods.

10. In digital mode, only the major divisions are marked on the graticule. If the graticule is displayed, but not the waveform, press DIGITAL while holding in the BEAMFINDER control. This compresses the waveform and the graticule to detect an overscanned signal. Use the plug-in controls to bring the waveform within the graticule. If no signal is applied, the waveform is only a baseline.

11. If no waveform is displayed, recheck the instructions above.

12. Either or both intensity controls may need to be changed for different sweep speeds and input signals. If intensity is too high, blooming occurs. If the intensity is too low, portions of the display are missing.

13. Set the FOCUS control for a well-defined trace. Each time the control is changed, a new waveform must be digitized to see the effect.

14. Allow the 7912AD to warm up for 20 minutes for specified performance. The intensities must normally be increased slightly as the instrument warms up.

Storing a Single-Sweep Waveform

Instructions already given for storing a waveform called for the time base to be set to automatic sweep mode. Although this is the easiest mode for set-up, it does not take advantage of the 7912AD's ability to capture very fast transient events with the time base in single-sweep mode. To use the single-sweep mode, however, further set-up of the triggering and intensity controls is necessary. If the 7912AD and plug-ins are already set to store a waveform with automatic sweep as discussed above, follow these instructions to acquire a waveform with a single sweep:

1) Change the time base triggering mode to normal and set the triggering level, slope, and coupling controls for a triggered sweep (triggered light on).

2) Step 1 works only if the signal to be acquired is repetitive. If not, set the time base trigger source to line and set the controls for a triggered sweep. Triggered on line, the display in step 4 or 5 may not show a stable waveform.

3) Set the time base to single-sweep mode.

4) If in TV mode using a TV monitor, watch the monitor while repeatedly pressing the time base single-sweep reset button. Increase the 7912AD MAIN INTENSITY and GRATICULE INTENSITY until the waveform and graticule are fully displayed.

5) If in digital mode using a display monitor, watch the monitor after pressing DIGITAL and then the time base single-sweep reset button. Increase the 7912AD MAIN INTENSITY and GRATICULE INTENSITY while repeatedly pressing DIGITAL and single-sweep reset in sequence until the waveform and graticule are displayed. Some graticule dots may be missing because the digitize operation begins before the graticule is written.

NOTE

Once DIGITAL is pressed, the 7912AD begins a digitize operation; it can not be reset to TV mode until finished. This requires that the time base sweep be gated. Therefore, if the time base plug-in is not in auto, but in normal or single-sweep modes, the trigger conditions (level, slope, etc.) must be met in order to digitize. The 7912AD operating modes can then be reset, if desired.

6) If the triggering source was set to line in step 2, set the time base triggering source, level, slope, and coupling controls to match the trigger expected to be acquired with the waveform.

7) To acquire the transient event, press DIGITAL, then single-sweep reset. This arms the 7912AD and time base to acquire a waveform when the time base sweep is triggered.

8) To store very fast transients at fastest sweep rates, very high MAIN INTENSITY levels are required. Try resetting FOCUS to achieve maximum writing rate so the trace is fully written.

Local Control in an IEEE 488 System

Some pointers are given here to operate the 7912AD locally when it is interfaced to an IEEE 488 system.

Taking Control. The 7912AD goes to local state automatically at power-up. All local operating controls are active, and the LOCAL button lights. An IEEE 488 bus controller can then set the instrument to remote state. In remote state, all front panel controls are inactive except ON/OFF, BEAMFINDER, LOCAL, and REMOTE; the REMOTE button is lighted. Local control can be restored by pressing LOCAL.

To prevent local control, the controller can set the 7912AD to remote with lockout state. All front panel controls are inactive except

BEAMFINDER, ON/OFF, and REMOTE; the REMOTE and LOCKOUT buttons are lighted. Pressing LOCAL does not restore local control.

The REMOTE button has another function besides indicating remote control. When this button is pressed, the 7912AD asserts SRQ on the IEEE 488 bus if the interrupt is enabled. The controller may be programmed to respond to this request as desired. For example, one use for the button could be to signal the controller to restore local control when the 7912AD is in the remote with lockout state.

If both LOCAL and LOCKOUT are lighted, the 7912AD is in the local with lockout state. To the operator, this state appears the same as the local state.

When the 7912AD returns from remote to local control, the current value of all local controls is assumed. However, several programmed operating modes, such as graticule-only and XYZ, are not controlled from the front panel and do not change from their condition under remote control.

CAUTION

Immediately check the settings of the MAIN and GRATICULE INTENSITY controls when the 7912AD is returned from remote to local control. Sweep rate or the input signal may be different than when the 7912AD was last operated under local control and the intensity levels may no longer be correct.

Graticule-Only Mode. The 7912AD can be switched to a graticule-only mode. This may be used to digitize the graticule in the absence of a triggered sweep. In this mode, the graticule is written at a repetition rate that simulates the graticule intensity written after a single-sweep; the waveform is not written on the target. This mode can only be selected through the IEEE 488 Interface by the GRAT ON command. Once selected, it can not be defeated from the front panel without turning off power. (The 7912AD powers up with the graticule-only mode cleared). The IEEE 488 bus controller should be programmed to reset the graticule-only mode when restoring local control for the operator to acquire waveforms.

XYZ Outputs. The 7912AD automatically switches the XYZ display to show the results of the last digitize operation or waveform processing operation. For instance, in local mode when the DIGITAL button is pressed, the XYZ display shows whatever is digitized as soon as the operation completes. Under remote control, waveform processing operations can be called. These include digitize and signal average, determine trace edges, and digitize defects. The display shows the results of the processing as soon as it is completed. If the digitize and signal average operation is called, for example, the signal-averaged waveform is displayed automatically.

The XYZ display mode can be changed under remote, but not local, control. For instance, the display can be changed from that of the last waveform digitized to show a signal-averaged waveform previously acquired if it is still in memory. Or the display can be turned off.

Whatever XYZ display was called under remote control, the XYZ display automatically changes to show the results of digitize or waveform processing operations that follow. So when the 7912AD is returned to local control and another waveform is digitized by pressing DIGITAL, the XYZ display automatically switches to show the waveform.

Acquiring Data

The 7912AD operates much like other 7000-series oscilloscopes when acquiring a waveform for viewing, either in TV or digital mode. Although this similarity carries over to acquiring data in digital mode, some further considerations apply.

Graticule. When acquired as data, the dot graticule may serve a different purpose than when it is viewed as a yardstick to measure a waveform displayed on a monitor. As data, the graticule may be used to correct inaccuracies in the 7912AD analog-to-digital conversion. These could be due to nonlinearities in the 7912AD amplifiers or the scan converter or due to variations in target geometry affecting the signal path shared by the input and the graticule.

To subtract out such subtle inaccuracies, the graticule can be compared to an ideal graticule and the difference used to correct the digitized waveform. To do this, however, the waveform and graticule should be acquired separately. Otherwise, the data would have to be sorted first to separate the graticule and waveform. This is also true of data acquired for internal processing by the 7912AD memory controller. If the graticule is mixed in data that is signal-averaged, for example, the graticule corrupts the results.

Defects. A portion of the scan converter target that is read as data whether or not it is struck by the writing beam is called a defect. While the ideal is no defects, a few may exist on the target (see the CRT target and writing gun specification in Section 1).

Defects can be caused by burns that result from too-high intensity levels for extended periods. Apparent defects can be caused by improper calibration. Refer calibration to qualified service personnel for adjustment of the instrument within the limits stated in the service manual. Attempts to enhance performance by adjusting the instrument outside these limits can instead degrade performance, causing such problems as apparent defects.

If possible, position the trace away from defects so later processing can more easily remove them from the data. The 7912AD contains firmware routines to flag defects for such processing. The programming commands to handle defects are explained in Section 3.

Sweep Speed and Intensity. The critical parameter in acquiring data with the scan converter is writing intensity. This is affected by the intensity and focus controls, sweep speed (set by the time base sweep rate), and trace slope (caused by changes in amplitude of the input signal).

A step transition can result in missing data during the transition or blooming before and after the transition (or both). If intensity is set too low, a portion of the trace is missing as shown in Fig. 2-5b. If intensity is set too high, the trace blooms where it travels more slowly, and the top and bottom portions of the waveform overlap. The solution is to increase the sweep rate, reducing the slope of the transition, and to increase the intensity enough to write the transition.

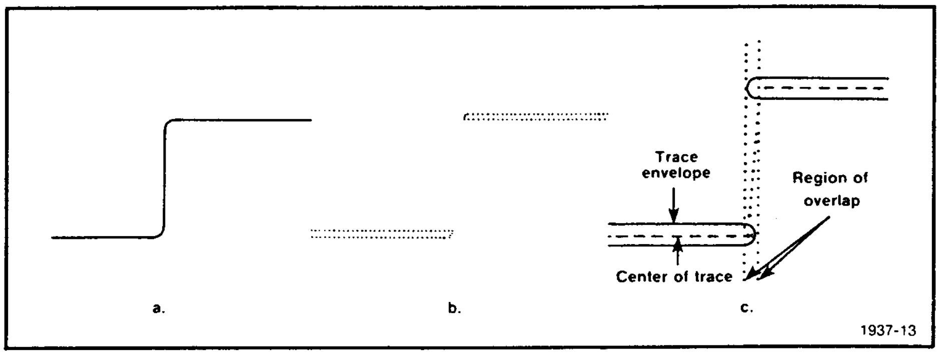


Fig. 2-5. Blooming on a step transition.

The MAIN INTENSITY control requires careful attention when digitizing a waveform with a fast transition. Although blooming on the slow portion (top and bottom) of the trace should be avoided, sufficient intensity should be achieved during the fast transition. A good compromise is shown in Fig. 2-6. Note, however, that the reading beam vertical scan through the transition (part c of the figure) may detect multiple data points. Because of lower intensity during the transition, the trace may be read as a collection of dots rather than as an envelope.

How the transition in Fig. 2-6 would be detected is shown in Fig. 2-7. Part a of the figure shows a typical signal read from a strongly written portion of the target. In part b, the signal from a fast transition is weaker, but still above the detection level. However, if this signal is degraded by noise, as in part c of the figure, multiple edges of the trace are detected. It may not be possible to correct this situation by increasing intensity and/or sweep speed, but a firmware routine is provided to determine the trace edge. Other routines allow missing data to be interpolated if intensity can not be increased to fully write fast transitions.

Another waveform that requires a careful balance between intensity and sweep speed is shown in Fig. 2-8. If the intensity is increased to capture the abrupt transition at the top and bottom of the waveform as

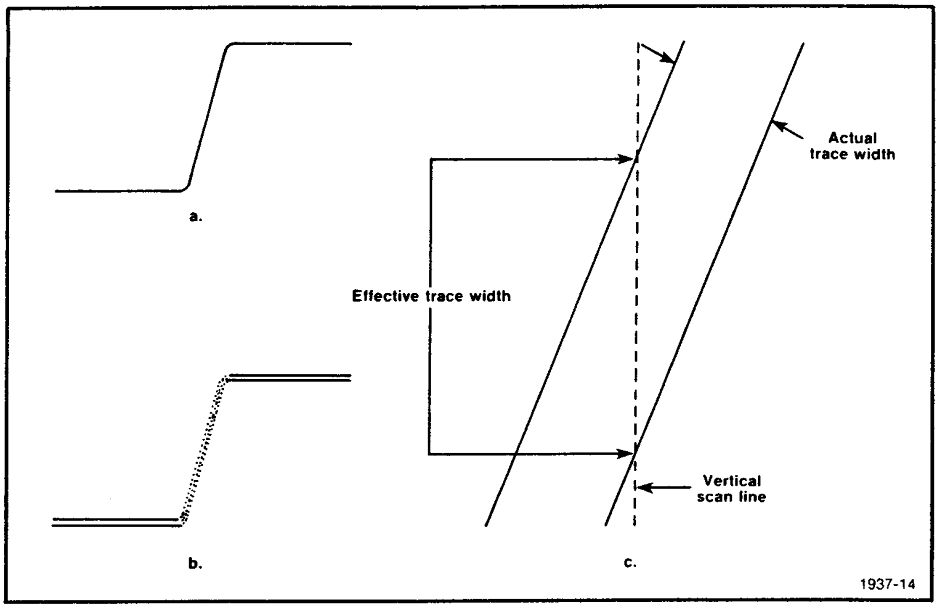


Fig. 2-6. A vertical scan through a fast transition.

shown in part b of the figure, bloom causes the peak value to be underestimated if the top and bottom of the trace are averaged. Increasing the sweep speed to reduce the number of cycles for less abrupt transitions would improve the data.

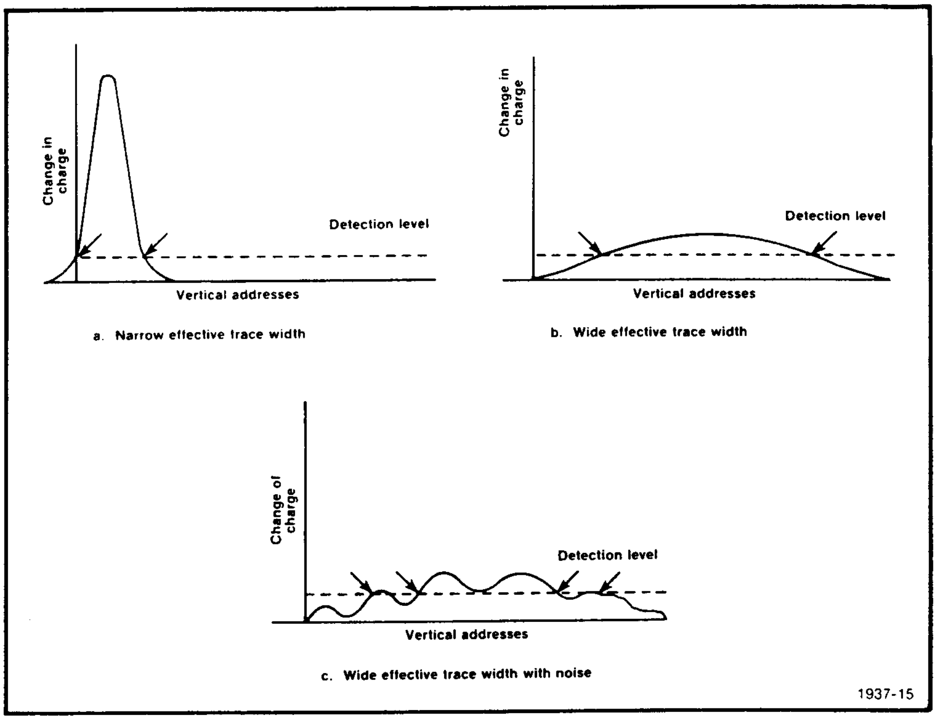


Fig. 2-7. The effect of noise on the signal detected from the target.

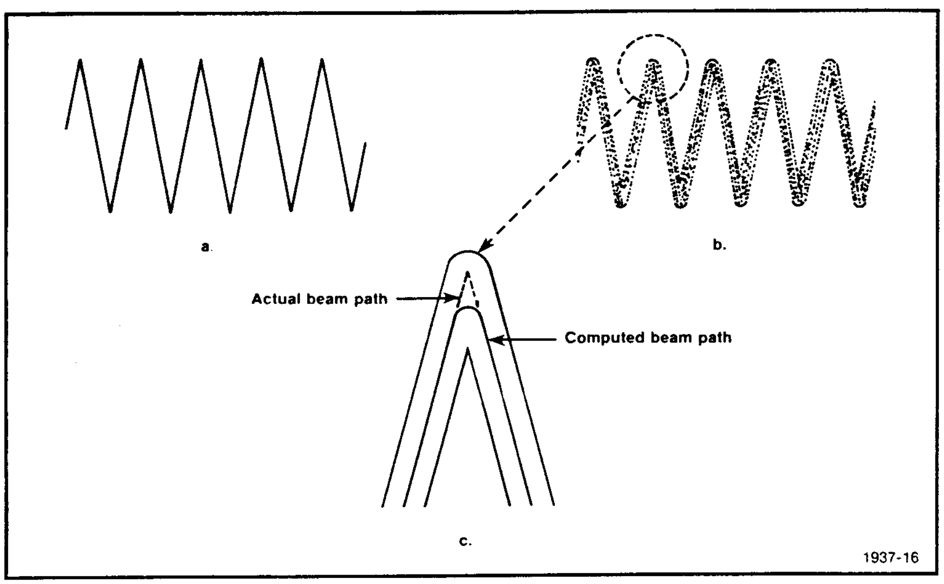


Fig. 2-8. Underestimation of trace peak due to blooming.