INSTRUCTION MANUAL

Serial Number ____________

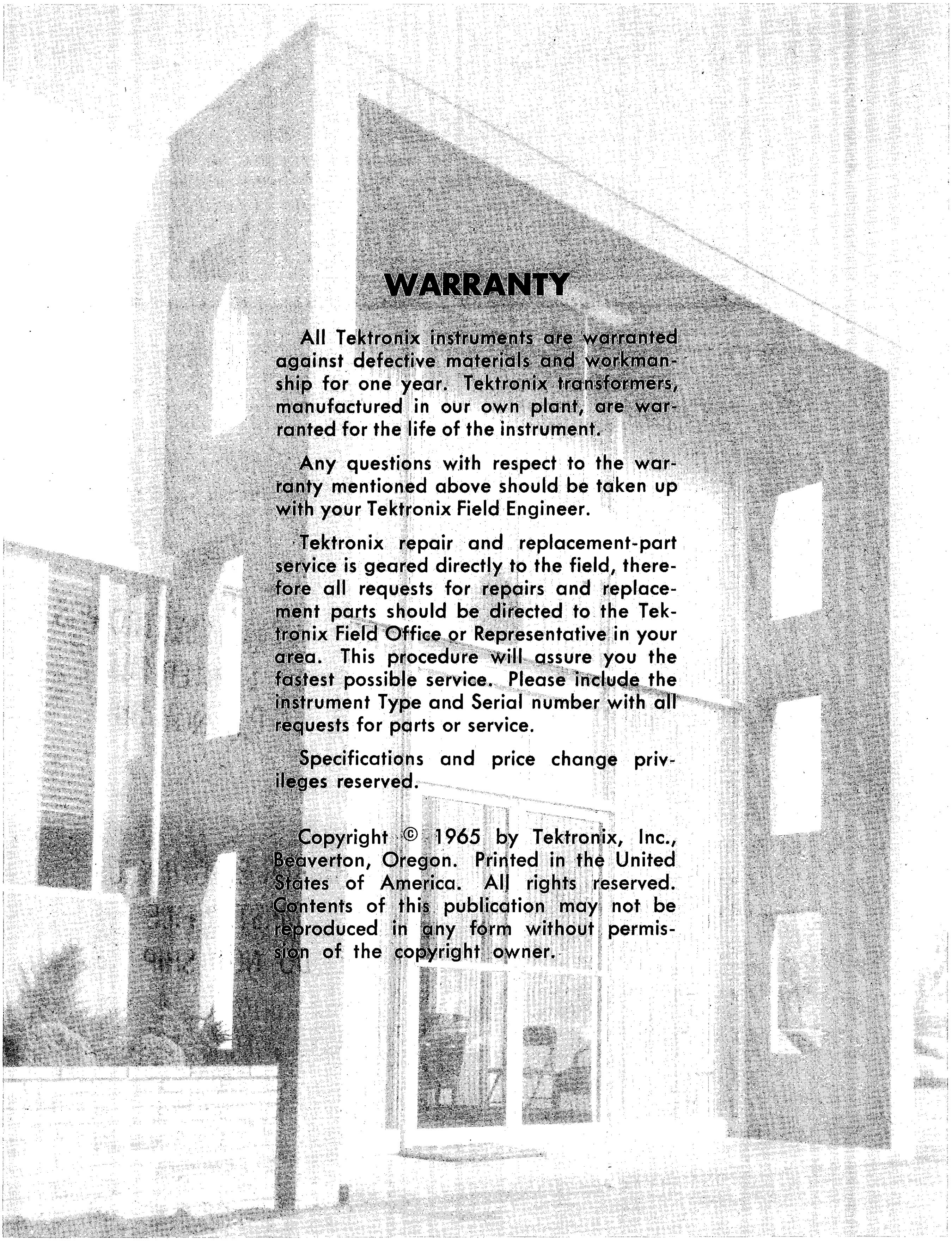
TYPE 3T4

Programmable Sampling Sweep
Plug-In Unit

Tektronix, Inc.

S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon ● Phone MI 4-0161 ● Cables: Tektronix

070-0439-00 665



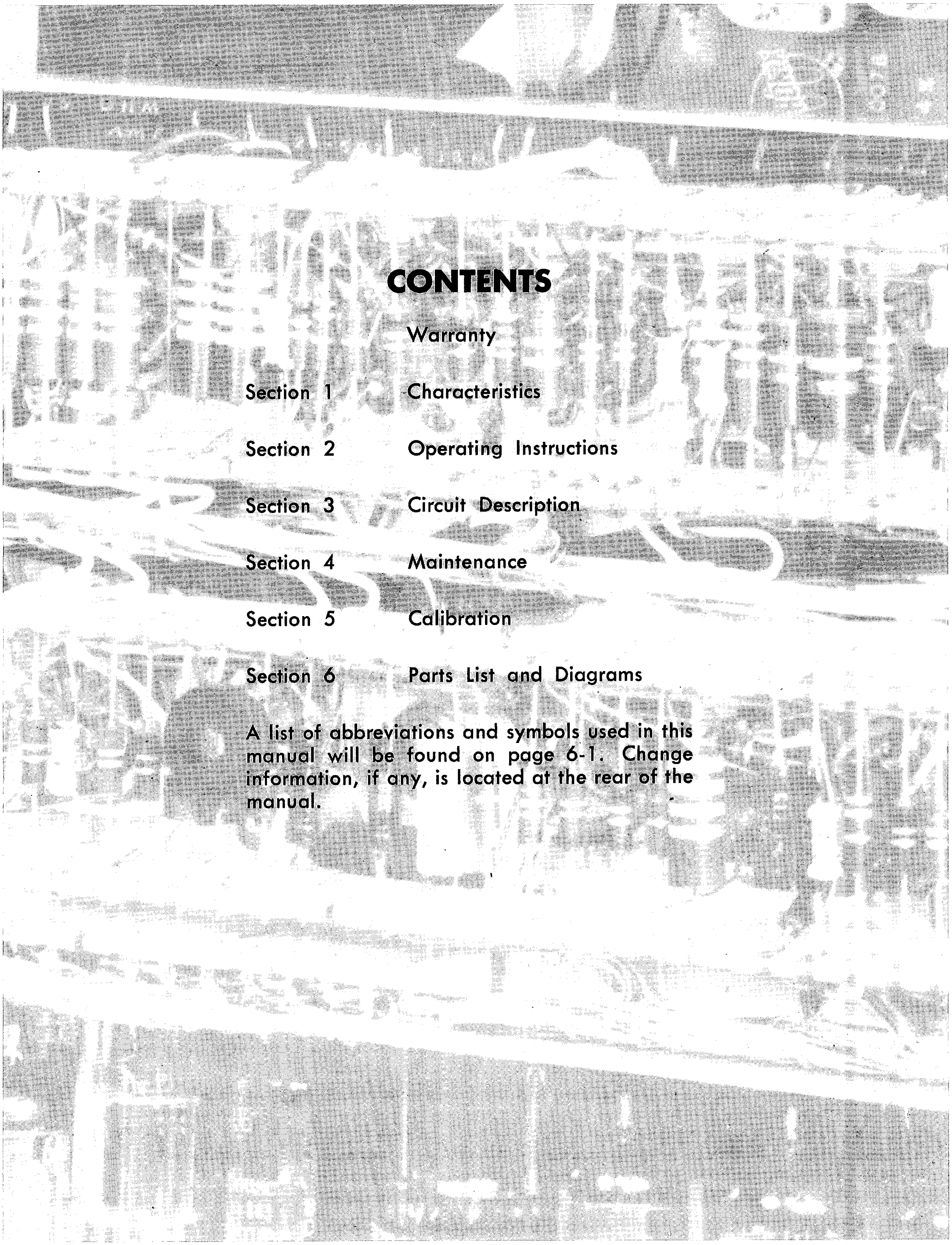
WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

Specifications and price change privileges reserved.



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A list of abbreviations and symbols used in this manual will be found on page 6-1. Change information, if any, is located at the rear of the manual.

Type 3T4 Programmable Sampling Sweep

SECTION 1
CHARACTERISTICS

Introduction

The Tektronix Type 3T4 Programmable Sampling Sweep plug-in unit is a wide range sampling time base designed particularly for the Tektronix Type 567 Readout Oscilloscope system. It may also be used to provide remote control of sweep functions in sampling systems using the Types 561A, RM561A, 564, or RM564 Oscilloscope main frames. The Type 3T4 provides all the information needed by the Type 6R1A Digital Unit (and some Type 6R1 Digital Units) to make accurate time measurements over a wide range of sweep rates.

The Type 3T4 is designed to operate within the Type 561A, RM561A, 564, RM564, 567, or RM567 Oscilloscope main frames and with the following Tektronix equipment:

Types 3S76, 3S3, or other 3-Series vertical sampling units.

Type 6R1A Digital Units, and some Type 6R1 Digital Units, (see below).

Type 262 Programmer for automatic control of the readout program.

Digital readout is available only when the Type 3T4 is operated in the Type 567 or RM567 Oscilloscope main frames.

ELECTRICAL CHARACTERISTICS

Digital Unit Compatibility

The Type 3T4 Programmable Sampling Sweep unit is compatible for operation with all Type 6R1A Digital Units, and Type 6R1 Digital Units S/N 695 and up. The Type 6R1 Digital Units S/N 101-694 (with exceptions beginning at S/N 391) require the installation of Tektronix Mod Kit 040-0342-00 when operated with a Type 3T4. See your Tektronix Field Engineer for details.

The Type 3T4 will perform within all specifications when operated with a Type 6R1A in a Type 567 S/N 300-up, or in a Type RM567 S/N 130-up. This applies only if the Type 3T4 is operated in a calibrated system. Prime requirement of the oscilloscope power supplies is that all adjustable supplies be within 1% of stated values. If using sampling, with the Type 567 and Type RM567, it is best to adjust low-voltage supplies to within 0.5%. If the Type 3T4 is to be operated in earlier 567 oscilloscopes, it is necessary to install Field Modification Kit 040-0319-00. Individually purchased Type 3T4 units (not calibrated in a system at the factory) require calibration in the system into which it is placed if operated with a Type 6R1, and/or in a Type 567 S/N 299 or below or a Type RM567 S/N 129 or below. Perform the following steps of the Calibration Procedure at the back of this manual: steps 8 through 12, 15 through 21.

Remotely Programmable Functions

The following functions may be remotely programmed by suitable connections made at the front-panel REMOTE PROGRAM connector.

1. Equivalent-time or real-time sweep rates.

2. Display time-window delay time, for equivalent-time sampling only.

3. Samples per sweep, either 100 or 1000.

4. Repetitive (normal) or single display modes.

5. Single display start.

6. Digital Unit decimal neons and units Nixies.

Sweep Rates

Seventeen calibrated equivalent-time sweep rates from 0.2 msec/div to 1 nsec/div in a 1, 2, 5 sequence. Crt display accuracy is within 3% of the indicated sweep rate after first 4% of Delay Range; see Table 2-1 and associated text. Each sweep rate can be increased approximately 3 times by turning the VARIABLE control clockwise from its CALIB position, providing continuous uncalibrated sweep rates between calibrated values. All sweep rates are programmable through the front-panel REMOTE PROGRAM connector when the TIME/DIV control is at the REMOTE PROGRAM position.

Real-time sampling with the Type 3T4 requires the use of an external clock and real-time trigger circuit. Sweep rates from 1 sec/div through 1 msec/div are available with this mode of operation. The Tektronix 013-0091-00 Real Time Adapter provides real-time sampling capability for the Type 3T4.

Delay Range

The start of the display time-window can be delayed by calibrated amounts of time, in relation to the initial trigger of each sweep. Table 1-1 shows the relationship between the full scale delay range (total amount of DELAY time) and the sweep rates as set by the TIME/DIV control.

TABLE 1-1

Delay Range Correlated To Sweep Rate

TIME/DIV Control	DELAY Range	Time/Minor DELAY Dial Div.
1 nSEC through .1 μSEC	1 μsec full scale	2 nsec
.2 μSEC through 10 μSEC	100 μsec full scale	0.2 μsec
20 μSEC through .1 mSEC	1 msec full scale	2 μsec
.2 mSEC	none	

Differential delay readings (measurements made between two DELAY dial points) can be made to an accuracy of $\leq \pm 0.75\%$ of Delay Range full scale (typically $\pm 0.4\%$ of full scale) using the front-panel DELAY control, providing, the first 4% of each Delay Range is not used. See Table 2-1 and associated text.

The delay function is programmable through the front-panel REMOTE PROGRAM connector by selection of an external resistor. See the Operating Instructions for details.

Samples per Sweep

Either 100 or 1000 samples per sweep may be selected, either by the front-panel SAMPLES/SWEEP control or through the REMOTE PROGRAM connector. Slow display rates can automatically be sped up (remotely programmed to 100 samples/div) during unused portions of the sweep, and slowed to 1000 samples/sweep during the time the Digital Unit memory circuits are being charged.

Digital Unit information is calibrated only when there are 1000 samples per sweep.

Sweep Modes

Four sweep operating modes can be selected from the front panel:

1. Normal; provides a conventional repetitive sweep.

2. External Input; an external signal does the scanning. The deflection factor is adjustable from 5 to 25 volts/div by the MANUAL SCAN OR EXT ATTEN control.

3. Manual Scan; the display is scanned at a manual rate by rotating the MANUAL SCAN OR EXT ATTEN control when the SWEEP MODE switch is at MAN.

4. Single Display; one sweep occurs each time the START button is pressed, provided that the sweep is either free run or properly triggered.

Either Normal or Single Display sweep modes can be selected through the REMOTE PROGRAM connector. When programmed for Single Display, the "start" command may be applied through the REMOTE PROGRAM connector.

Magnification of Crt Display

The DISPLAY MAG and SAMPLES/DIV controls are common, and permit selection of either ×1 or ×10 display magnification at 1000 SAMPLES/SWEEP. The display is magnified ten times when the control is at ×10. Information to the Digital Unit is not altered during display magnification.

Triggering

The Type 3T4 can be triggered either externally or internally from the vertical unit. Both trigger sources permit stable displays from either the positive or negative slope of the triggering signal. Signals are ac coupled for either external or internal operation. The external trigger connector is terminated in 50 ohms at all times.

External Triggering

Amplitude of the external trigger signal applied should not exceed 250 mv peak to peak for proper operation. Maximum overload permissible is ± 5 v. The maximum amount of jitter for each of four typical triggering signals is as follows:

1. $\leq$ 200 psec with a $\geq$ 5 mv pulse $\geq$ 2 nsec wide.

2. $\leq$ 200 psec with a 500 mc sinewave $\geq$ 20 mv peak to peak.

3. $\leq$ 200 psec with a 1000 mc sinewave $\geq$ 200 mv peak to peak.

4. $\leq$ 0.2 μsec with a 100 kc sinewave $\geq$ 5 mv peak to peak.

Internal Triggering

Dependent upon the vertical plug-in. For example, when used with a Type 3S76, the minimum amplitude of the vertical input signal must be greater than external trigger minimum requirements. The amount of jitter for two typical triggering signals is as follows:

1. $\leq$ 200 psec with a 500 mc sinewave $\geq$ 200 mv peak to peak.

2. $\leq$ 0.2 μsec with a 500 kc sinewave $\geq$ 25 mv peak to peak.

Trigger Output

The trigger output at the front-panel TRIG OUT connector is a negative pulse of approximately 500 mv.

Sweep Output

Staircase ramp, 1 volt per horizontal division of crt deflection.

Warm Up Time

Reaches rated accuracies after 20 minutes at 25° C, $\pm$5° C.

ENVIRONMENTAL CHARACTERISTICS

Storage

Temperature— −40° C to +50° C.

Altitude—to 50,000 feet.

Operating

Operating temperature—0° C to +50° C.

Operating altitude—10,000 feet maximum.

MECHANICAL CHARACTERISTICS

Dimensions—16½" x 4¼" x 6¼".

Weight—5¾ lbs.

Construction—Aluminum alloy chassis.

Finish—Photo-etched, anodized front panel.

Connectors—TRIGGER portion of front panel—EXT INPUT and TRIG OUT.

Lower left of front panel—SWEEP OUTPUT and EXT INPUT; all four BNC.

The REMOTE PROGRAM connector is a Microdot A43AP-2P.

ACCESSORIES

Standard Accessories

	Tektronix Part No.
2—Instruction manuals	070-0439-00

Optional Accessories

	Tektronix Part No.
Plug-in circuit card Extender Board, 56 pin. Use as servicing aid for etch-wired circuit cards.	012-0078-00
Flexible 560-Series Plug-In Extension, 30 inches long. For operating plug-in units outside 560-Series oscilloscopes.	012-0066-00
Rigid 560-Series Plug-In Extender. 10 inches long.	013-0034-00
Remote Program Cable, 10 feet long. With connectors. For use with Tektronix Type 262 Programmer, or the Real Time Adapter described below.	012-0101-00
Real Time Adapter. Permits remote operation of Type 3T4 for real-time sampling. Provides precision clock pulses for sweep rates of 1 msec/div through 1 sec/div in 1, 2, 5 sequence. Real-time trigger circuit included. Can be used as interface unit between Type 3T4 and Type 262 for automatic remote control of Type 3T4 and Type 262 for automatic remote control of Type 3T4 for full range of both equivalent-time and real-time sampling sweep rates.	013-0091-00
Remote Program Connector, male, 19-pin. Microdot A43AP-2P, unwired.	131-0388-00

NOTES

SECTION 2

OPERATING INSTRUCTIONS

Introduction

The Type 3T4 Programmable Sampling Sweep plug-in unit is an internally or remotely controlled sampling time-base for the Tektronix Types 561A, RM561A, 564, RM564, 567, and RM567 Readout Oscilloscope. Sweep rates and other functions can be controlled from Type 3T4 front-panel controls, or through the front-panel REMOTE PROGRAM connector. The Type 262 Programmer can be connected directly to the Type 3T4 to operate the equivalent-time sweep ranges, or it can be connected through the Tektronix 013-0091-00 Real Time Adapter to automatically program either equivalent-time or real-time sampling sweep rates.

Connection to the REMOTE PROGRAM connector is by a mating male Microdot A43AP-2P 19-pin connector, wired by the user, or by a special Tektronix 10-foot cable including both connectors for proper operation from either the Real Time Adapter or the Type 262 Programmer. See the accessories listed at the end of Section 1. Should the user build his own external control equipment, the oscilloscope —12.2-volt regulated supply can provide some current through the Type 3T4 J80 at pin 19. The amount of current available depends upon the plug-in units in use with the Type 3T4; 780 ma using a Type 3S76 without cathode follower probes; 420 ma using a Type 3S76 with cathode follower probes; and 790 ma using a Type 3S3.

Front Panel Type 3T4 vs Automatic REMOTE CONTROL (Type 262)

Manually setting the front-panel controls of the Type 3T4 and associated plug-in units is the normal form of programming time measurements. Each time you change the position of the front-panel controls you are programming another measurement. In a long series of measurements, changing controls is time consuming and may lead to errors. This problem is eliminated by operating the Type 3T4 remote control circuits from the Auxiliary Program section of a Tektronix Type 262 Programmer. Set the Type 3T4 TIME/DIV switch to REMOTE PROGRAM and external programming can begin.

One type of programming can be done automatically during remote operation that cannot be done by hand. That is to change the number of samples per division during a sweep. Low equivalent-time sweep rates, and most remote real-time sweep rates result in the sampling dot sweep rate being quite slow. Since the SAMPLES/SWEEP must be 1000 for correct Digital Unit readout, real-time sampling can require as long as 10 seconds per sweep. However, if the SAMPLES/SWEEP is remotely changed to 100 during that portion of the sweep when the Digital Unit is not making its measurement, much time can be saved. This feature of the Type 3T4 requires special modification of the Digital Unit, so is not described in detail here.

Delay of the display time window after initial trigger can be remotely programmed. A special Tektronix circuit card for the Auxiliary Program section of a Type 262 allows 999 digits of delay information for all but 0.2 msec/div sweep rate. The circuit employs 1-2-4-8 logic input. Available on special order as Trigger Delay Programming Card, Tektronix Part No. 039-0108-00. See your Tektronix Field Engineer for details of this and other support equipment for remote programming the Type 3T4.

The Type 3T4 Programmable Sampling Sweep unit can provide a variety of operating modes. Some decision should be reached regarding mode of operation in order to determine accessories needed. Internal control at the front panel requires the least amount of accessory equipment. Remote control by the Tektronix Real Time Adapter requires the unit and a special cable. Automatic remote control by the Tektronix Type 262 Programmer requires a Type 262 and a special cable.

This section of the manual will describe both equivalent- and real-time sampling operation of the Type 3T4.

Function of Front-Panel Controls and Connectors

POSITION Control	Positions the display horizontally.
SAMPLES/SWEEP DISPLAY MAG Switch	Selects either 100 samples per sweep or 1000 samples per sweep. The DISPLAY MAG function of this switch permits magnifying the center 1 division of the crt display by a factor of 10, at 1000 samples/sweep. However, only the crt display is affected, and the magnification feature does not affect the information sent to the Digital Unit.
SWEEP MODE Switch	NORM Position: Permits a normal repetitive sweep with sample-by-sample advancement through the oscilloscope display. SINGLE DISPLAY Position: Permits one display after the START button is pressed (useful for photographing the display). MAN Position: permits manual scanning of the sampling display by turning the MANUAL SCAN OR EXT ATTEN control. EXT INPUT Position: Permits an external sweep signal to control the sampling display scan.
MANUAL SCAN OR EXT ATTEN Control	Provides a hand-operated scan of the display when the SWEEP MODE switch is in the MAN position. Also serves as a variable attenuator for an external sweep scanning signal when the SWEEP MODE switch is in the EXT INPUT position.
EXT INPUT Connector (Sweep)	For applying an external positive-going scanning voltage. Sensitivity variable from 5 to 25 volts/div; input impedance vari-

	able from 20 to 100 kilohms. Maximum input voltage 250 volts, peak. Presents display at rate of external signal when Type 3T4 is triggered properly.
DELAY Control	Allows the start of the display time window to be positioned with respect to the initial trigger of each sweep.
TRIGGER LEVEL Control	Varies the trigger circuit sensitivity, allowing the operator to adjust for best display for various trigger signal levels. Also causes the sweep to free run when turned clockwise past about midrange. This latter operation allows synchronization of repetitive signals up to 500 mc internal or 1000 mc externally triggered.
RECOVERY TIME Control	Varies the holdoff time of the trigger circuit to ensure stable triggering when triggering signal frequency is equal to or harmonically related to the internal trigger repetition rate.
INT-EXT Switch	Selects either an internal trigger (INT position) from the vertical plug-in unit, or an external trigger (EXT position) from the trigger EXT INPUT connector, and determines whether triggering takes place on the positive (+) or negative (—) slope of the input signal.
EXT INPUT (Trigger) Connector	For applying a positive or negative external trigger of up to 250 mv peak for proper triggering. Overload occurs beyond ±5 v. Input impedance: 50 ohms shunted by 12 microhenries.
TIME/DIV Switch	Sets the equivalent-time sweep rate of the display and also serves to switch the unit to Remote Programming.
VARIABLE Control	Varies the sweep rate (uncalibrated) between TIME/DIV steps. The equivalent-time sweep rate at any given setting of the TIME/DIV switch can be increased about 3 times.
HORIZ GAIN (front-panel screwdriver adjustment)	Adjusts the horizontal amplifier gain to match oscilloscope crt deflection factor (this adjustment does not affect the digital information sent to the Digital Unit).
REMOTE PROGRAM Connector	Provides connections for externally programming the display mode: normal or single; time/div; delay time; single display start; and the samples per sweep. Provides —12.2 volts for operation of special remote control circuits.

Installing The Type 3T4 Into The Oscilloscope

CAUTION

Turn off oscilloscope power while inserting or removing plug-in-units.

The Type 3T4 is designed to provide timing information to the Digital Unit and horizontal deflection signals to the oscilloscope crt. It must be used in the horizontal plug-in compartment of the oscilloscope. When inserting the Type 3T4 into the plug-in compartment, make sure the interconnecting plugs are properly aligned. The Type 3T4 should slip easily into the compartment.

Once the plug-in has been properly seated, turn the knurled aluminum knob a few turns clockwise until it is hand-tight. To remove the plug-in unit, turn the knurled aluminum knob fully counterclockwise, then pull the plug-in unit straight out.

First-Time Operation

The following procedures cover first-time operation of the Type 3T4 in a Type 567 or Type RM567 Readout Oscilloscope. The discussion covers necessary steps to obtain a crt display and apply timing and delay information to the Digital Unit. Use this procedure in conjunction with the instructions for operating the units in the rest of the oscilloscope system.

1. Insert the Type 3T4 into the horizontal plug-in compartment of the oscilloscope. Set the trigger LEVEL control fully counterclockwise. Turn on the oscilloscope power and allow a few minutes for warm up.

2. Set the Type 3T4 front-panel controls as follows:

POSITION	Midrange
TIME/DIV	5 nSEC
VARIABLE	CALIB
DELAY	Fully counterclockwise
LEVEL	Fully counterclockwise
MAGNIFIER—SAMPLES/SWEEP	×1
SWEEP MODE	NORM
INT-EXT	+INT (Set to polarity of signal to be observed)
RECOVERY TIME	Fully counterclockwise

3. Apply the signal to be observed to the input connector of the vertical sampling plug-in unit.

NOTE

If using a Type 3S76, make sure the signal is greater than 40 mv peak-to-peak for proper internal triggering.

4. Slowly advance the Trigger LEVEL control for a stable display. The RECOVERY TIME control may also help stabilize the display if the signal frequency is near or harmonically related to 100 kc.

5. Set the TIME/DIV switch to the position where the displayed signal covers the desired number of horizontal graticule divisions.

6. With the POSITION control, move the display horizontally to the desired point on the graticule.

7. Turn the DELAY control and notice its effect on the display. The action of the DELAY control is most significant at faster sweep rates of each range given below and in Table 1-1. The DELAY control varies the position of the display with respect to the initial trigger of each sweep. The display position can be varied up to 1 μsec at sweep rates from 0.1 μsec/div through 1 nsec/div; up to 100 μsec at sweep rates from 10 μsec/div through 0.2 μsec/div; and up to 1 msec from 0.1 msec/div through 20 μsec/div. The DELAY control does not operate at 0.2 msec/div.

8. Set the SWEEP MODE switch to MAN and turn the MANUAL SCAN control. Check the intensity for proper brilliance. Note the horizontal scanning of the display at approximately the rate the control is turned. One full turn of the control scans the 10 divisions of the crt display.

9. Set the SWEEP MODE switch to SINGLE DISPLAY. Press the START button. After pressing the START button, the Type 3T4 allows one complete scan of the electron beam across the crt. This is particularly useful for photographing displays at slow pulse repetition rates. The START button can be used to arm the trigger circuits so a display is presented after triggers are received.

Horizontal Gain Adjustment

The basic oscilloscope crt deflection factor varies slightly from one oscilloscope to another. For this reason, the HORIZ GAIN (a front-panel screwdriver adjustment) should be checked and adjusted as necessary, should the Type 3T4 be moved from one oscilloscope to another.

Checking or setting the HORIZ GAIN control requires only one 50 Ω coax cable and a BNC to GR adapter when using the Type 3S76 vertical unit. The Type 567 Amplitude Calibrator 20-kc frequency is accurate within 0.1% and provides 500 mv peak-to-peak square waves into the sampling unit 50 Ω input. If using a Type 3S3 vertical unit, two 50 Ω cables are required, plus a 50 Ω termination and probe to cable adapter. Equipment is listed below for both procedures.

HORIZ GAIN adjust using Type 3S76 (Type 567 S/N 2060-up, or Type RM567 S/N 2030-up)

Equipment Required:

	Tektronix Part No.
1—50 Ω coax cable with BNC connectors.	012-0057-00
1—BNC female to GR Type 874 adapter.	017-0063-00

Procedure:

1. Install both the Type 3T4 and the Type 3S76 plug-in units into the Type 567 Oscilloscope. Turn on the power and let the system warm up for five or ten minutes.

2. Connect the 50 Ω cable directly to the Amplitude Calibrator 500 mv into 50 Ω connector, and the BNC to GR adapter on the other end.

3. Set the Type 3S76 Channel A MV/DIV switch to 200. Operate at A ONLY, and INTERNAL TRIGGER A.

4. Connect the BNC to GR adapter to the Type 3S76 Input A.

5. Set the Type 3T4 for internal triggering on the +slope, at a TIME/DIV setting of 10 μSEC. Set the DELAY control to 5.00.

6. Obtain a stable display with the LEVEL control. Position the display by both the POSITION and DELAY controls so two complete cycles of calibrator signal occupy 10 graticule divisions. Adjust the HORIZ GAIN control so the two calibrator cycles occupy exactly 10 divisions.

HORIZ GAIN adjust using Type 3S3

Equipment Required:

	Tektronix Part No.
1—50 Ω BNC termination.	011-0049-00
1—P6038 Probe to BNC adapter.	013-0084-00
1—50 Ω coax cable with BNC connectors.	012-0057-00

Procedure:

1. Install both the Type 3T4 and the Type 3S3 plug-in units into the Type 567 Oscilloscope. Turn on the power and let the system warm up for five or ten minutes.

2. Connect the 50 Ω termination directly to the Amplitude Calibrator 500 mv into 50 Ω connector, and the probe-to-BNC adapter to the termination.

3. Connect the 50 Ω coax cable from the Amplitude Calibrator +Pretrigger connector to the Type 3T4 trigger EXT INPUT connector.

4. Set the Type 3S3 Channel A Mv/Div switch to 200. Operate at A ONLY.

5. Connect the channel A P6038 Probe directly into the probe to BNC adapter.

6. Set the Type 3T4 for external triggering on the +slope, at a TIME/DIV of 10 μsec. Set the DELAY control to 6.30.

7. Obtain a stable display with the LEVEL control. Position of the display by both the POSITION and DELAY controls so two complete cycles of calibrator signal occupy 10 divisions. Adjust the HORIZ GAIN control so the two calibrator cycles occupy exactly 10 divisions.

HORIZ GAIN adjust in other systems

Procedure:

1. Insert the Type 3T4 and the associated vertical sampling plug-in unit into the oscilloscope, turn on the power and allow the instrument to warm up for five or ten minutes.

2. Set the front-panel controls of the Type 3T4 as follows:

POSITION	Midrange
SAMPLES/SWEEP—DISPLAY MAG	1000, ×1
TIME/DIV	10 μSEC
TRIGGER LEVEL	Fully clockwise
VARIABLE	CALIB
SWEEP MODE	NORMAL
INT-EXT	+INT
DELAY	Between 1.00 and 10.00

3. From an accurate frequency source such as Tektronix Type 180A, apply a 10 μsec (100 kc) signal to the Input connector of the vertical sampling plug-in unit and adjust for a vertical deflection of 2 to 6 divisions.

4. Determine the time duration of one cycle of the signal from the frequency source (time duration of one cycle is the reciprocal of the frequency).

5. Set the Trigger LEVEL and RECOVERY TIME controls for a stable display.

6. Check for the proper number of cycles per division. If the number of cycles per division does not exactly agree with the setting of the TIME/DIV switch, set the HORIZ GAIN for the proper timing. Use the POSITION and DELAY controls to align the display with the graticule markings.

Triggering The Type 3T4

The Type 3T4 can be triggered either internally or externally. Internal triggering requires no external connections to the Type 3T4 since the triggering signal is coupled internally from the vertical sampling plug-in unit.

However, external triggering permits stable displays from signals smaller than 40 mv peak to peak into the Type 3S76. External triggering is independent of the displayed waveform. Thus, when signals of equal or harmonically related frequency but different amplitudes are applied to the vertical plug-in unit, the triggering controls do not require resetting for a stable display. However, an external triggering signal must be related in time to the displayed signals to obtain a meaningful display.

The + and — positions of the INT-EXT switch determine whether initial triggering takes place on the positive- or negative-going slope of the triggering signal. The INT or EXT positions determine whether the triggering signal comes from the vertical sampling plug-in unit or from the EXT INPUT connector.

Sine-wave signals up to 1000 mc applied to the Trigger EXT INPUT can be used to obtain stable displays. Internal triggering produces stable displays up to only about 500 mc. In either case, the Trigger LEVEL control will be operated clockwise from the 12 o'clock point for synchronized operation. You may be able to obtain stable displays with higher frequency triggering signals (either internal or external) but the display will probably be noisy.

The ac coupling of the trigger signal sets a low-frequency sine-wave limit of about 50 kc for stable displays. Triggering from low-frequency sine waves requires careful adjustment of both the LEVEL and RECOVERY TIME controls. You may be able to obtain stable displays from triggering signals below 50 kc, but the display will probably be noisy. Slow rise pulses will produce stable displays when the rate of change is at least 150 mv/μsec. Use of either low-frequency sine waves, slow-rise pulses, or high-frequency sine waves will usually require signal amplitudes between 200 and 250 mv peak to peak.

Using the DELAY Control

The DELAY control allows the display time window to be positioned in relation to the initial trigger of each sweep. The start of the time window can be delayed calibrated amounts of time after the initial trigger of each sweep. The control is inoperative at 0.2 msec/div, and cannot be used for external real-time sampling.

The amount of full scale delay, and the incremental delay per minor dial division changes three times throughout the TIME/DIV switch. Full scale delay is 1 μsec for sweep rates of 1 nsec/div through 0.1 μsec/div; 100 μsec for sweep rates of 0.2 μsec/div through 10 μsec/div; and 1 msec for sweep rates of 20 μsec/div through 0.1 msec/div.

Sweep rate accuracy and the DELAY dial are related, in particular for DELAY dial settings at or near zero. With the DELAY dial set at 0.00, some sweep rates are non-linear (and inaccurate) for several divisions of the crt. With the DELAY dial set to 0.40, the first 4% of the Delay Range is moved off the left side of the crt and all display sweep rates are accurate to ±3%; timing information sent to the Digital Unit is accurate to ±2%. The first 4% of the Delay Range occupies different amounts of the display for each setting of the TIME/DIV switch. Table 2-1 lists the number of crt divisions the sweep must travel before the rate is accurate, and the equivalent-time each sweep rate is inaccurate, for each TIME/DIV switch position.

TABLE 2-1

Delay Range First 4% stated as crt divisions for each sweep rate. Set DELAY dial to be between 0.40 and 10.00 for accurate sweep rates.

TIME/DIV	Time Sweep is not accurate	Divisions sweep must travel before rate is accurate	Equivalent time per 1/10th turn of DELAY dial
1 nSEC	≤40 nsec	40	10 nsec
2 nSEC	≤40 nsec	20	10 nsec
5 nSEC	≤40 nsec	8	10 nsec
10 nSEC	≤40 nsec	4	10 nsec
20 nSEC	≤40 nsec	2	10 nsec
50 nSEC	≤40 nsec	0.8	10 nsec
.1 μSEC	≤40 nsec	0.4	10 nsec
.2 μSEC	≤4 μsec	20	1 μsec
.5 μSEC	≤4 μsec	8	1 μsec
1 μSEC	≤4 μsec	4	1 μsec
2 μSEC	≤4 μsec	2	1 μsec
5 μSEC	≤4 μsec	0.8	1 μsec
10 μSEC	≤4 μsec	0.4	1 μsec
20 μSEC	≤40 μsec	2	10 μsec
50 μSEC	≤40 μsec	0.8	10 μsec
.1 mSEC	≤40 μsec	0.4	10 μsec

In order to obtain valid sweep rates, it is always necessary to operate so that the inaccurate portion of the sweep is not included in the portion of the display where time measurements are made. For instance, at 50 nsec/div, the display is not accurate for the first 0.8 division. Since the

Digital Unit Dead Zone occupies about 0.6 division, the DELAY dial can be operated at 0.00 and accurate display and readout measurements made. However, at 1 nsec/div, the display is not accurate for the first 40 crt divisions. In order to obtain accurate display or readout time measurements, the DELAY dial must be operated between 0.40 and 10.00. This means the left side of the display is 4 time-windows from the initial trigger when the DELAY dial is at 0.40. The result is that external pretriggering must be provided at least 40 nsec earlier than the event to be viewed and measured. The Tektronix Type 111 Pretrigger Pulse Generator provides such a pretrigger.

The Type 111 was used when measuring the pulse duration shown in Fig. 2-1. The Type 3T4 controls were set as follows for Fig. 2-1a.

TIME/DIV	5 nSEC
LEVEL	About 10 o'clock for stable display
RECOVERY TIME	For stable display
INT EXT	+EXT
DISPLAY MAG	×1
SWEEP MODE	NORM
DELAY	1.00

The Type 111 controls were set:

REPETITION RATE	Near MAX
RANGE	10 KC
OUTPUT POLARITY	+
TRIGGER TO PULSE TIME DIFFERENCE VARIABLE	About 10 o'clock
FIXED INCREMENT	0

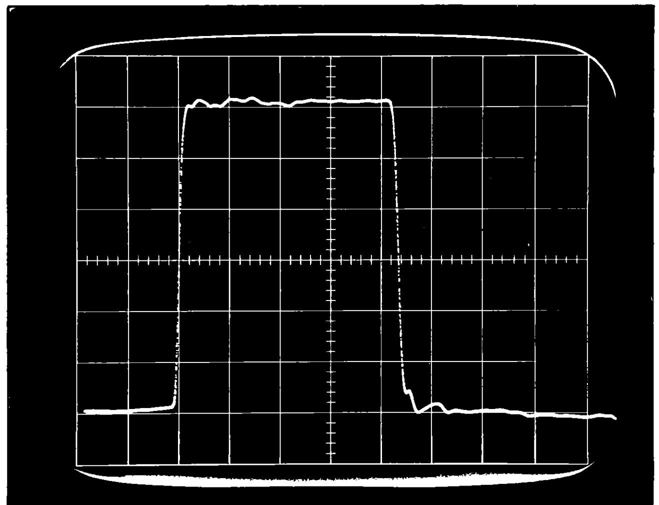
Connections included 10× attenuation in the 50 Ω cable to the Type 3S76 INPUT A, and 20× attenuation in the PRETRIGGER OUTPUT 50 Ω cable to the Type 3T4 Trigger EXT INPUT. The pulse duration of Fig. 2-1a appears from the display to be about 21.7 nsec.

Fig. 2-1b shows the display when the Type 3T4 TIME/DIV switch was set to 1 nSEC, and the Type 111 Pretrigger VARIABLE control was used to set the pulse rise to the graticule centerline. Type 3T4 DELAY dial still at 1.00.

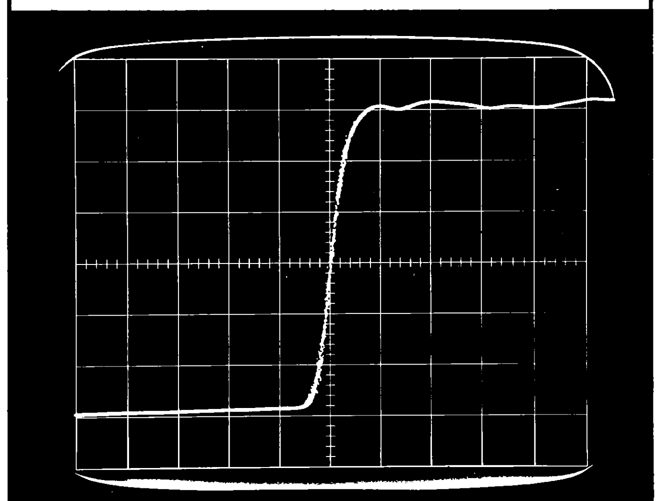
Fig. 2-1c shows the display after turning the Type 3T4 DELAY dial so the pulse fall rests at the graticule centerline. The DELAY dial was at 1.21. The equivalent time of the pulse is 1.21 — 1.00 = 0.21 dial divisions. 0.21 dial divisions × 100 nsec per dial turn = 21 nsec pulse duration, with a typical tolerance of ±4 nsec (±0.4% of full scale) with worst-case tolerance of ±7.5 nsec (≤±0.75% of full scale). This accurate incremental measurement would not be possible without the Type 111 (or equivalent) external pretrigger to the Type 3T4.

Selecting the Equivalent Sweep Rate from Front Panel

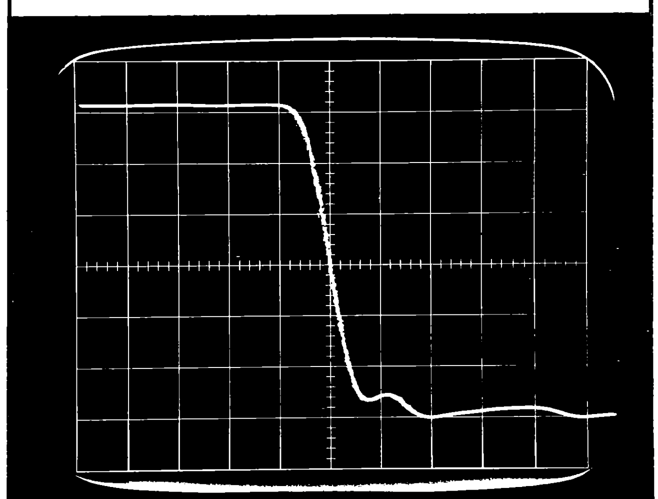
The Type 3T4 TIME/DIV switch selects calibrated equivalent sweep rates from 1.0 nanosecond per division to 0.2



(a) 5 nsec/div DELAY = 1.00.



(b) 1 nsec/div DELAY = 1.00.



(c) 1 nsec/div DELAY = 1.21.

Fig. 2-1. Three crt displays when using DELAY control to measure pulse duration.

millisecond per division. These rates, in turn, provide an equivalent 10-division display duration from 10 nanoseconds to 2 milliseconds. Setting the DISPLAY MAG switch to ×10 selects the crt center one division for expanded 10-division display, essentially increasing the equivalent sweep rate (on the crt only) to 10 times that of any setting of the TIME/DIV switch. The first and last 4.5 divisions of the unexpanded display are lost at the crt sides, causing the display rate to flicker at sweep rates 0.2 μSEC or slower when triggering rate is above 80 to 100 kc. The POSITION control and the DELAY control permit the whole display to be viewed in expanded form. The MAGNIFIER switch in no way affects the information being supplied to the Digital Unit.

The VARIABLE control increases the equivalent sweep rate at any setting of the TIME/DIV switch about 3 times (uncalibrated) when the control is fully clockwise.

Selection of sweep rate depends on the duration of the applied signal and the specific portion of the signal to be observed. The DELAY control aids in observing a specific portion of the applied signal.

The equivalent sweep rates of the Type 3T4 are accurate within 3% of the TIME/DIV switch setting when the VARIABLE control is set to CALIB and the DISPLAY MAG switch is set to ×1. This permits accurate time measurements directly from the oscilloscope display.

Selecting the Samples Per Sweep from Front Panel

In a sampling system, the applied signal is displayed as a series of samples or dots presented in sequence across the crt. With a great number of samples in the display, the trace appears to be continuous. With fewer samples in the display, the individual samples become apparent. The SAMPLES/SWEEP switch selects either 100 samples per sweep or 1000 samples per sweep. Proper setting of the SAMPLES/SWEEP switch is a choice between good trace continuity, flicker and display duration. Flicker becomes apparent with signals of low-repetition rate when the SAMPLES/SWEEP switch is set to 1000. (A trigger rate of 100 cps causes a 1000 samples/sweep display to take 1 sec/div at 20 μsec/div or slower.) By changing the setting of the SAMPLES/SWEEP switch to 100, flicker becomes less apparent. However, with 100 samples per sweep, make sure the loop gain, or dot transient response of the vertical sampling plug-in unit is set to unity; otherwise, the display may be distorted. Signals with high repetition rates cause less flicker; thus, in this case, the SAMPLES/SWEEP switch should be set to 1000 for best trace continuity.

The Digital Unit requires 1000 samples/sweep to make its measurements. Measurements are normally made by the Digital Unit. However, when making time measurements from the crt, the individual samples can serve as time markers. For example, suppose the Type 3T4 TIME/DIV switch is set to 1 nSEC and the SAMPLES/SWEEP switch is set to 100. In this case, each dot represents 0.1 nanosecond in equivalent time (1 nanosecond per division multiplied by 10 divisions and divided by 100 dots). In the example just given, the resolution of the Type 6R1A Digital Unit is also 0.1 nanosecond, but its accuracy is less than normal. Making time measurements from the face of the crt is easiest when the display contains 10 dots per division (i.e., the SAMPLES/SWEEP switch is set to 100 or the DISPLAY MAG switch is set to ×10).

Time Measurement

The Type 3T4 is accurately calibrated to indicate equivalent-time per division along the horizontal axis of the oscilloscope display. However, a superior method of time measurement is to use the Type 6R1A Digital Unit in a Type 567.

Single Display Operation from Front Panel

The Type 3T4 has a single display feature which is helpful when photographing low repetition-rate signals. To use the single display feature, first obtain a normal triggered display with the SWEEP MODE switch at NORM. Then set the SWEEP MODE switch to SINGLE DISPLAY. Press the START button, and the crt will produce a single display. To make a photographic recording of the single display, open the camera shutter, press the START button, and after allowing sufficient time for a complete display, close the camera shutter. Consult the camera instruction manual for further information on photographic recording.

EQUIVALENT-TIME REMOTE PROGRAMMING

The Type 3T4 Programmable Sampling Sweep unit has been specially designed to be used in high-speed automatic test systems. All functions except the POSITION, ×10 DISPLAY MAG and TRIGGER circuits are externally programmable. External programming on an automatic basis is normally done by the Tektronix Type 262 Programmer. The information to follow, and the circuit description, attempt to give sufficient information for the user to connect his own automatic programming facility to the Type 3T4.

External Control Circuit Ratings

Remote programming the Type 3T4 is done through the leads of the front-panel REMOTE PROGRAM connector, J80. External relay contacts or transistor gates connected to J80 pins 2 through 9 and pin 18, must be capable of switching an essentially resistive circuit current of up to 80 ma. The leads rest at a voltage of —12.2 volts and must be grounded to J80 pin 1. External contacts or gates connected to J80 pins 12 through 17 must carry up to 4 ma from a resistive circuit, grounding them to J80 pin 1. J80 pin 19 is the oscilloscope —12.2-volt regulated supply, available for external programming circuits. See page 2-1 for current limits from the —12.2-volt supply. J80 pins 10 and 11 permit external operation of the time-window delay feature of the Type 3T4.

If more than one remote program circuit operates pins 2 through 9, an isolation diode must be inserted in series with each lead to each parallel operated pin. As an example, Fig. 2-2 shows correct diode locations when alternately programming 0.2 msec/div and 10 μsec/div. J80 pin 8 is the parallel-operated pin in the example given. The diodes can be low-cost glass encapsulated silicon signal diodes. When inserting the isolation diode, place cathode on pin, anode to switch. Fig. 2-3 shows Type 262 Auxiliary Program circuit for programming the Type 3T4.

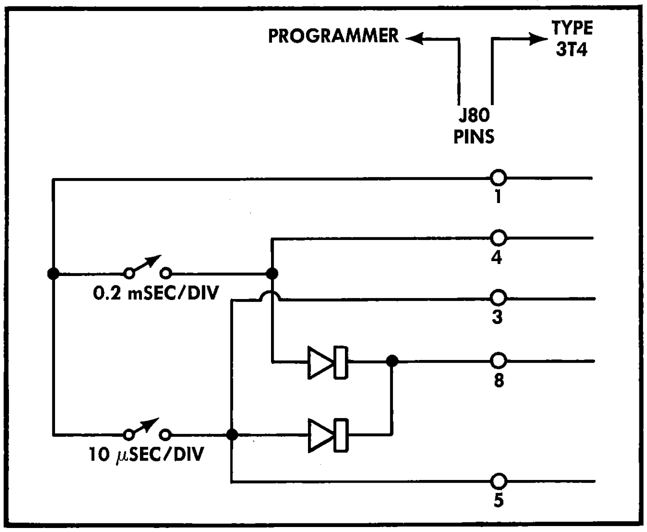


Fig. 2-2. Isolation diodes in leads switched more than once.

Sweep Rate Control Logic

Equivalent-time sampling sweep rates are remotely programmed by proper ground connections made through J80. Table 2-1 shows J80 leads that must be connected to pin 1 to obtain both the correct sweep rate and correct Digital Unit logic. An "X" in Table 2-2 means the pin numbered at the column top is to be connected to pin 1.

TABLE 2-2

Equivalent-Time Sweep Rate Control Logic

TIME/ DIVISION	J80 Pins To Be Connected To Pin 1							
	2	3	4	5	6	7	8	9
1 nsec/div			X	X				
2			X			X		X
5			X		X			X
10			X	X				X
20			X			X	X	
50			X		X		X	
0.1 μsec/div			X	X			X	
0.2		X				X		X
0.5		X			X			X
1		X		X				X
2		X				X	X	
5		X			X		X	
10		X		X			X	
20	X					X	X	
50	X				X		X	
0.1 msec/div	X			X			X	
0.2	X						X	

Triggering

Automatic remote programming of the Type 3T4 is normally done by the Type 262. The Type 262 also programs the Type 6R1A Digital Unit. Each measurement starts and ends on command from the Digital Unit. The Digital Unit cannot start a measurement unless the sweep has been triggered. Triggering the Type 3T4 is, thus, a prerequisite for a measurement. If the vertical unit is a Type 3S76, and if the vertical input is greater than 40 mv peak-to-peak, triggering can be internal. If operating with signals less than 40 mv peak-to-peak, or with a Type 3S3, the Type 3T4 must be triggered externally as described earlier in this section.

Delay

Remote programming of the Type 3T4 Delay feature is done by placing the correct value resistor between pins 10 and 11 of J80. The advantage of remote program Delay is the ability to position test displays for proper Digital Unit measurements. A Type 262 Auxiliary Program card can be wired to program both the display position (by Delay resistor) and the Digital Unit 0% and 100% Zones (by Offset resistor). This type of programming allows very versatile control of displays from various signal sources with differing cable propagation delays in relation to an externally triggered sweep. The resistors used can be either fixed or variable, to suit the application. Table 2-3 lists external Delay resistance as the correct number of ohms per unit of delay time for the three general fast ramp sections of the TIME/DIV range.

TABLE 2-3

Remote Delay Ranges and Resistance Across P80 Pins 10 and 11

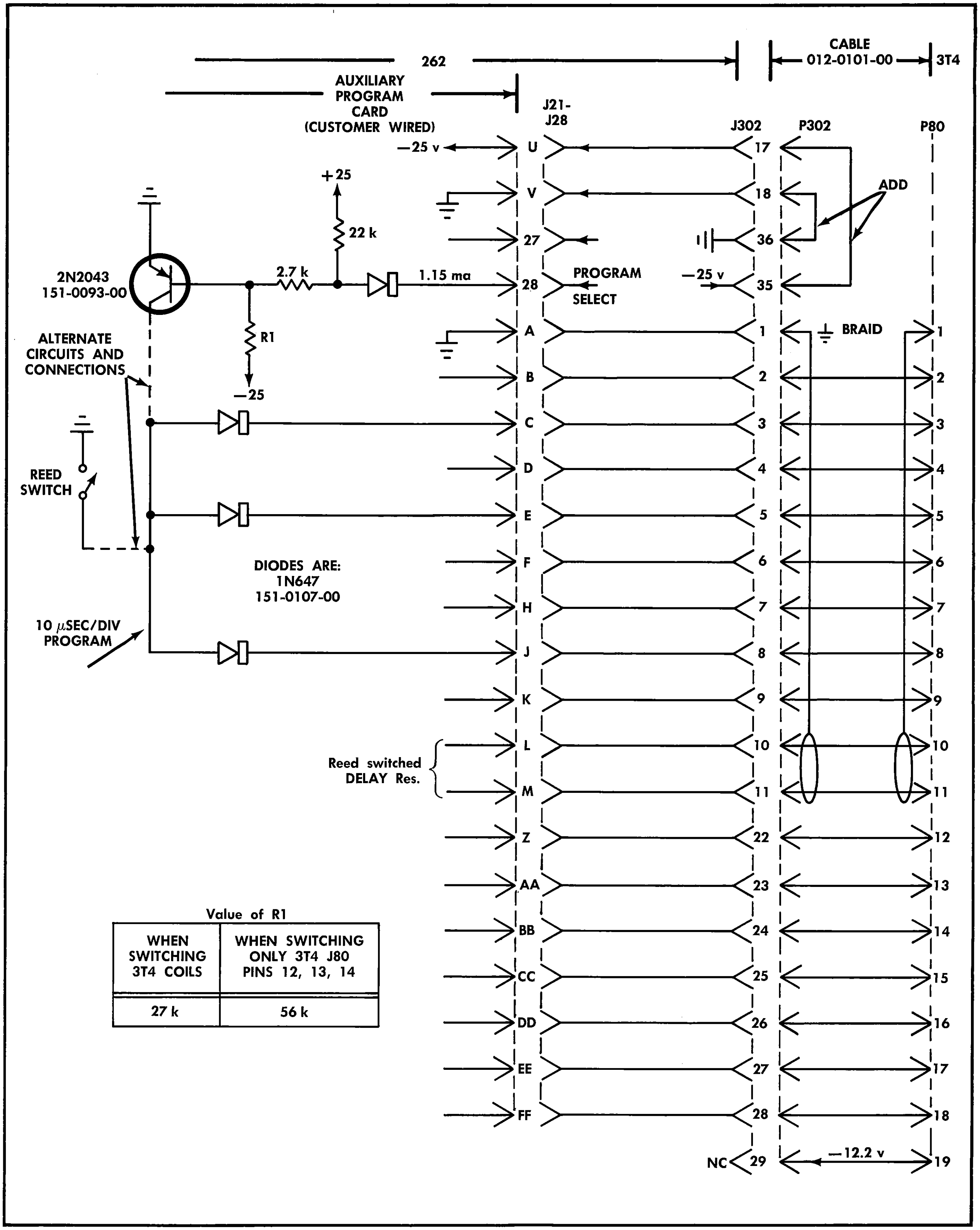
TIME/DIV RANGE	Full Scale Delay	Resistance per time-unit
0.1 msec through 20 μsec	1 msec	30 Ω/μsec
10 μsec through 0.2 μsec	100 μsec	300 Ω/μsec
0.1 μsec through 1 nsec	1 μsec	30 Ω/nsec

No Delay available at 0.2 msec/div; short pins 10 and 11 together.

To compute the value of resistance required between pins 10 and 11, multiply the delay time desired by the resistance/time.

Samples Per Sweep

The number of samples per sweep is externally programmable to allow automatic changes in display time. The Type 3T4 will normally be programmed to present 1000 Samples/Sweep. This number of samples gives proper Digital Unit resolution. The Type 6R1A Digital Unit requires one sweep to set its memories and start its display time, and a second sweep to end the display time. Time can be saved, then, by automatically switching to 100 Samples/Sweep ahead of the Digital Unit 0% Zone, back to 1000 Samples/Sweep during memory charging time and to 100 Samples/Sweep again after the 100% Zone. This type of operation requires that a special modification be made to the Type 6R1A. See your Tektronix Field Engineer for details.



Value of R1

WHEN SWITCHING 3T4 COILS	WHEN SWITCHING ONLY 3T4 J80 PINS 12, 13, 14
27 k	56 k

Fig. 2-3. Special transistor switch used on Type 262 Auxiliary Program card when all eleven reed switches are previously used. Use of a reed switch is recommended over the transistor, due to simplicity.

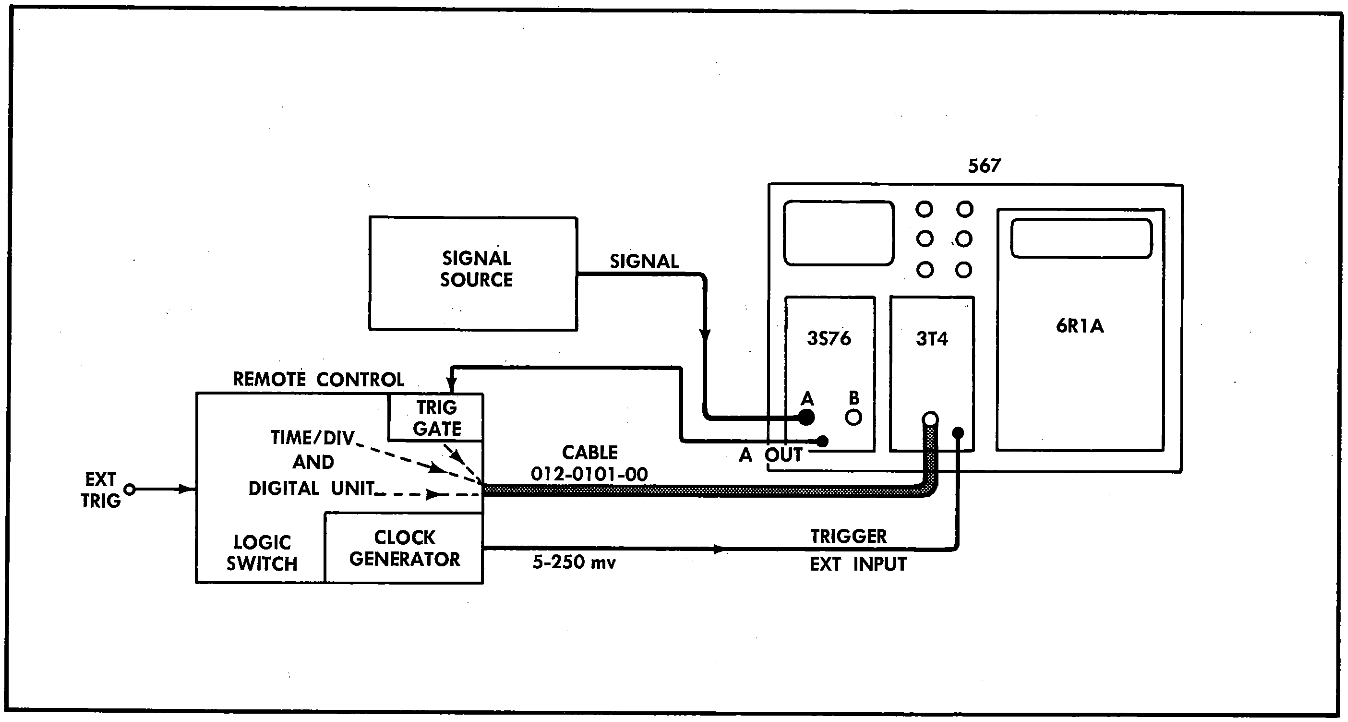


Fig. 2-4. Simplified real-time sampling equipment connections.

Single Display Mode

The Type 3T4 can be externally programmed for Single Sweep Display, and the Start command also externally given. Single Display operation during equivalent-time sampling may be valuable when setting up a new series of automatic programs. Operate the Type 262 Programmer manually to hold one program applied, while setting offset or other controls. Operating the Type 3T4 on a single display basis permits comparison between adjustments. It also allows the Type 6R1A display time to be extended until the next Start command is given.

Normal display operation is automatic in the Type 3T4 during remote programming. To stop normal repetitive sweeps and program Single Display, connect J80 pin 15 to pin 1. Then the Start command can be given either from the front-panel START button, or remotely by momentarily connecting J80 pin 16 to pin 1. (The primary advantage of remote Single Display programming is presented in the real-time sampling discussion to follow.)

Repetitive sweeps can be programmed in groups. Instead of permanently grounding J80 pin 15 and then starting each sweep at J80 pin 16, it may be to your advantage to electronically count the number of sweeps and automatically stop them after two or more have occurred. Grounding pin 15 a few microseconds after a sweep starts prevents another sweep, but allows the one started to be completed. The Digital Unit takes two sweeps to take and read out a measurement. External equipment can then be designed that will let the Type 3T4 run two sweeps, but stop it after two, until the Type 262 has changed programs. After the new program can operate, release pin 15 and a sweep can start; a sweep will start if triggering signals are being received by the Type 3T4.

J80 pin 16 can be treated two ways: 1) externally connect it to pin 1 to start a sweep, or 2) drive it with an ac coupled +15- to +20-volt pulse.

REAL-TIME SAMPLING REMOTE PROGRAMMING

Real-time sampling is possible with the Type 3T4 only when remotely controlled. Two special circuits in addition to logic closures are required: a precise clock pulse generator, and a trigger gate generator (real-time trigger circuit). The clock pulse is fed to the Trigger EXT INPUT terminal, and must be between 5 mv and 250 mv peak. Its repetition rate controls the real-time sweep rate. The trigger gate either applies a ground connection or a positive pulse to the remote Single Display START lead (J80-pin 16), or it removes the ground connection from the SINGLE DISPLAY lead (J80-pin 15). Either starts the sweep. The trigger gate is actuated by the vertical information, so in effect is used as a real-time trigger pulse to start the sweep. These circuits are included in the Tektronix 013-0091-00 Real Time Adapter.

Principle of Real-Time Operation

The clock pulses drive the trigger circuits to step the staircase generator and make the vertical unit take a sample. The Trigger LEVEL control is operated counterclockwise from its freerun position in a normal triggered-display manner. The sweep is operated at 1000 Samples/Sweep, so that 1000 clock pulses are needed to complete one sweep. Starting the sweep by a vertical trigger pulse permits a normal oscilloscope triggered display. See the Circuit Description for more details of the principles of real-time sampling.

Connections to J80

1. Connect pins 10 and 11 together to set the Delay circuit output voltage to the correct value. There is no time-window delay function during real-time sampling.

2. Connect pin 18 to pin 1 (Logic Decoder bypass) to connect the smallest fast ramp capacitor. This allows a strobe pulse to be sent to the vertical unit, and a staircase step to be taken, for each clock pulse.

3. Connect pin 15 to the trigger gate circuit. (Trigger gate circuit connects pin 15 to pin 1. Trigger gate pulse is positive by virtue of releasing pin 15 momentarily to start each sweep.)

4. Connect correct pins, 5, 6, or 7, to pin 1 according to Table 2-4. Pins 5, 6 and 7 provide correct "÷ by 1, 2, 5" connections to the Digital Unit Counters.

5. Connect the correct pins, 12, 13, or 14, to pin 1 according to Table 2-4. Pins 12, 13 and 14 energize the correct Digital Unit decimal neons and letter Nixie.

6. An alternate system for 3 above is to ground pin 15 to pin 1 during the entire time real-time sampling is programmed, then start each sweep at pin 16. Either ground pin 16 to pin 1 momentarily, or apply a +15- to +20-volt pulse to start each sweep.

Table 2-4 shows the pins of J80 to connect to pin 1, and the clock pulse period required for real-time sweep rates of 1 msec/div to 1 sec/div. An "×" means the pin numbered at the column top is to be connected to pin 1, ground. "Dec. 2" means Digital Unit second decimal neon will turn on. "Dec. 4" is automatically programmed in the absence of "Dec. 2" and "Dec. 3".

Fig. 2-4 is a simplified block diagram of real-time sampling circuits and connections to the Type 3T4.

TABLE 2-4

Real-Time Programming connections To J80, and Clock Pulse Period To Trigger EXT INPUT For 1000 Samples/Sweep

Time/Div*	Pin 5 ÷ 1	Pin 6 ÷ 2	Pin 7 ÷ 5	Pin 12 Dec. 2	Pin 13 Dec. 3	Pin 14 M Units	Clock Pulse Period
1 msec/div	×				×	×	10 μsec
2			×			×	20
5		×				×	50
10	×					×	100
20			×	×			200
50		×		×			500
0.1 sec/div	×			×			1 msec
0.2			×		×		2
0.5		×			×		5
1.0	×				×		10

*For other sweep rates (slower than 1 msec/div only) the sweep rate per div = clock pulse period X10^2.

SECTION 3
CIRCUIT DESCRIPTION

Introduction

The Type 3T4 is designed for use in an equivalent-time sampling system, but if externally generated real-time clock pulses are available, it may be used for real-time sampling also. This section of the manual presents a brief description of the basic sampling processes in equivalent- and real-time modes, then gives a detailed description of the various circuits in the Type 3T4.

BASIC SAMPLING TECHNIQUES

Sampling oscilloscopes are designed primarily to be used for viewing high-frequency or fast-rise repetitive waveforms. Most modern sampling systems accomplish this by taking samples from many different cycles of the input signal, then reconstructing the waveform in "equivalent time" on the crt screen. To recreate a repetitive signal using the sampling technique, samples must be taken over the portion of the signal that it is desired to measure or display. For example, when sampling a fixed point on a waveform, a trigger circuit opens the sampling gate in the vertical system and allows a sample of the incoming signal to pass through (see Fig. 3-1).

In actual practice, the system shown in Fig. 3-1 could not take a sample on the leading edge of the signal because of the finite time delay in the Trigger circuit. However, if a delay is introduced in the input circuit of the vertical system, the Trigger circuit will have time to open the sampling gate in the vertical system just as the leading edge of the incoming signal reaches the gate. Fig. 3-2 shows a sampling system block diagram with a delay line added to the vertical system.

Although the system represented in Fig. 3-2 could sample an incoming signal at one point on its leading edge, it could not sample the signal over its entire duration. Instead, it would consistently sample the same point on the signal each time it was triggered.

In order to sample over the entire duration of the signal, a stepping delay must be introduced so that samples can be taken at successively later and later points on the signal.

The delay circuit used in the Type 3T4 produces an electronic delay by a method called "trigger slewing". The Trigger circuit initiates a fast-falling voltage ramp when triggered by the incoming signal. This fast-ramp voltage must fall to the slewing voltage level of the comparator, then a new pulse (slewed trigger) is generated to operate the sampling gate. How long the slewed trigger is delayed depends upon the slope of the fast ramp and the level of the slewing voltage. The slewing voltage, and thus the time delay, is directly proportional to the horizontal deflection of the crt. Horizontal deflection voltage and slewing voltage may be obtained manually, but are normally obtained from the Staircase Generator, which automatically increases the voltage after each sample is taken. Thus, in a stepped fashion the sampling gate is opened at successively later instants with respect to each initiating trigger.

In the discussion of a sampling system the terms "equivalent time" and "real time" are often used. The basic difference between these two techniques is the number of input pulses required to present a single sweep or display on the face of the crt. In equivalent-time sampling only one sample is taken from each input pulse. In real-time sampling many samples may be taken of each input pulse. The fastest sweep rate which can be achieved with a practical real-

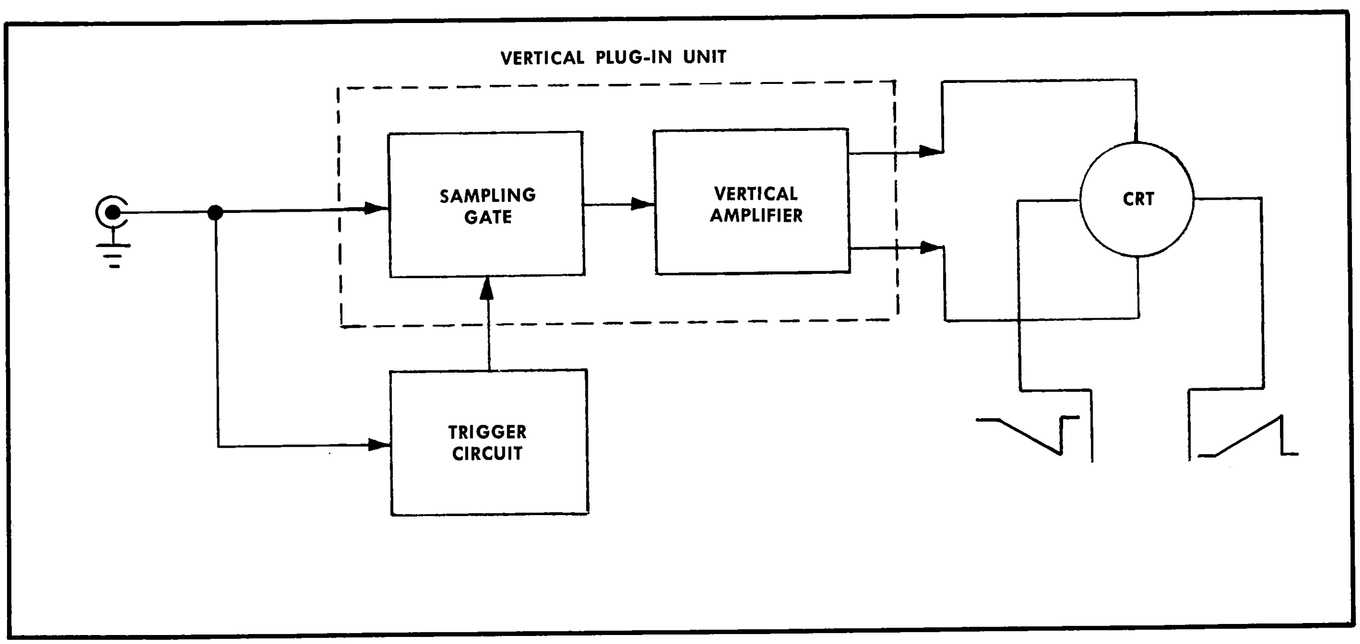


Fig. 3-1. Circuit required for sampling at a fixed point on an input signal.

time sampler is on the order of 1 msec/div. This is because the maximum repetition rate for taking samples is on the order of 10 μsec, and 1000 dots are usually desired for a single sweep. Fig. 3-3 illustrates the relationship between real-time, equivalent-time and an input signal.

Equivalent-Time Sampling

The equivalent-time portions of the sampling system are shown in Fig. 3-4. The vertical channel uses an input bridge that can take quick samples of the input signal, and a memory circuit that remembers the previous sample level until another sample is taken. The horizontal sweep is produced by a staircase voltage that advances one step each time a new sample is to be displayed. In triggered operation, one excursion of the input triggering signal actuates the trigger circuit, which then initiates one cycle of the sampling process to produce one dot of the crt display. Each displayed sample requires a separate triggering event.

The trigger circuit starts the operation of the fast ramp. When the fast ramp rundown voltage becomes equal to the existing staircase feedback voltage, the comparator triggers the slewed pulse generator. In turn, the slewed pulse generator pulses the sampling circuit and the staircase generator. The sampling circuit takes a quick sample of the signal level at the input, while the staircase generator advances one step. The sampling memory output is applied to the vertical amplifier and a new staircase output level is applied to the horizontal amplifier. As soon as the sample is taken, a dot is displayed on the crt screen at a level proportional to the input signal level at the moment it was sampled. The dot remains stationary on the screen until the next sample is taken.

Each subsequent triggering event initiates the same series of sampling events, but since the staircase feedback voltage moves down one step each time, the fast ramp has to run down slightly farther each time before a comparison pulse is produced. In this way, the sampling event is delayed by successively longer intervals and the samples are taken successively later along the waveform with respect to the triggering point. Each time a sample is taken, the dot position on the crt screen moves horizontally by one increment, and perhaps to a new vertical level. Since the sampling channel is an error-sensing circuit, the vertical position of the dot changes only if the input voltage level changes between sampling points.

The sampling operation is triggered each time at the same initial point on the triggering waveform, but the sample is taken progressively later on the waveform, due to the longer delay between the triggering event and each sampling event. In an equivalent-time display, no two samples are taken on the same cycle of the input waveform, though if the waveform is of a very high frequency, several cycles may occur between samples, due to the inherent recovery time (and resultant count-down) of the trigger circuit.

Real-Time Sampling

Fig. 3-5 shows the block diagram, and Fig. 3-3 (c) and (d) the waveforms of a typical real-time sampling system. The sampling operation performed by the sampling unit is identical to that performed in equivalent time, and some of the sweep and triggering functions remain the same. In real-time mode, however, the sampling process and the staircase advance are not initiated by the input signal, but rather by a real-time clock circuit (in the Type 3T4 the clock signal must be externally applied since the Type 3T4 contains no internal clock circuit).

In real-time sampling, sweep rates are generally quite slow (≥ 1 msec/div), and samples are taken at a rapid rate continuously along the waveform as contrasted with equivalent-time sampling where one sample is taken from each of a series of repetitive waveforms. The crt display is thus made up of a series of dots that actually follow the changes

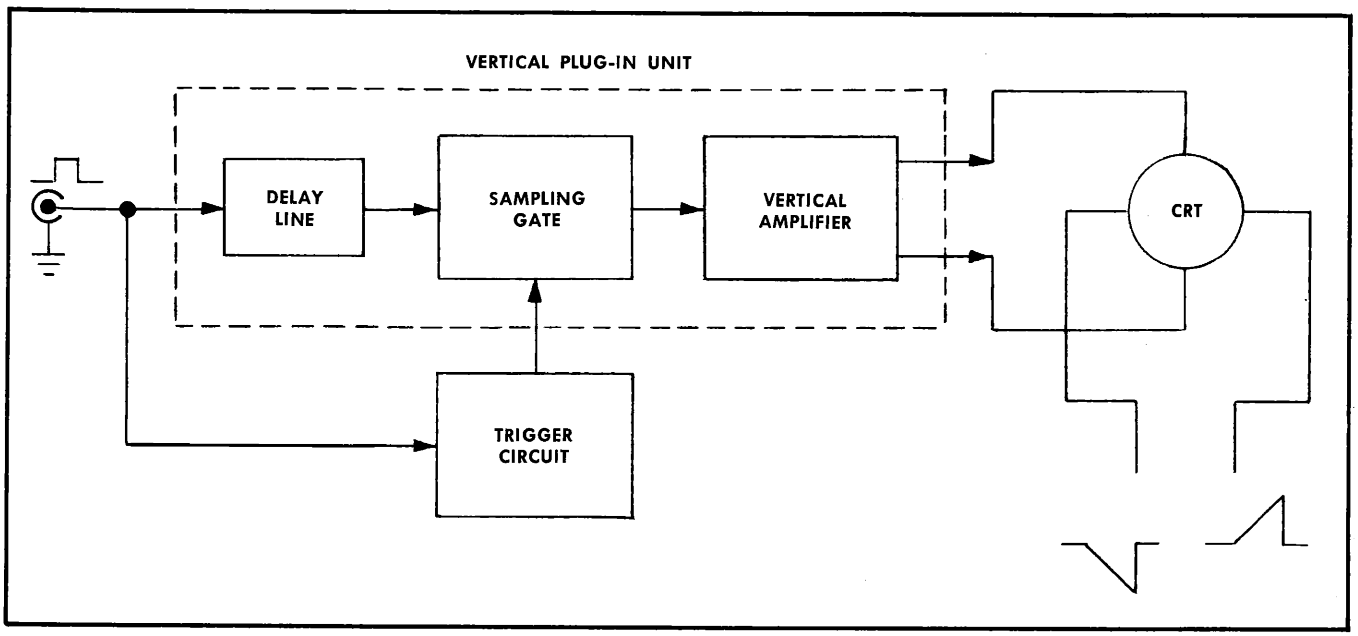


Fig. 3-2. Delay line added to the circuit of Fig. 3-1 so sampling takes place on the leading edge of the input signal.

Ⓐ

of the input waveform. Only one trigger is required per sweep (as in a conventional non-sampling oscilloscope), rather than one trigger per sample (as in equivalent-time sampling). Single events can be clearly displayed by real-time sampling, whereas a repetitive signal is required for equivalent-time sampling.

Whenever the system is set for real-time operation, a real-time clock signal must be applied. Each clock pulse advances the staircase generator one step and sends a strobe trigger to the vertical plug-in which samples the signal. The sweep rate is determined by the clock pulse period which governs the time per sample and thus the time per division. The clock pulse period must be externally controlled, as described in the operating instructions.

CIRCUIT ANALYSIS

For purposes of explanation, the Type 3T4 is divided into seven main diagrams: the Trigger and Holdoff circuit, the Fast Ramp circuit, the Staircase Attenuator and Inverter circuit, the Staircase Generator circuit, the Horizontal Amplifier, the Control Logic Decoder, and the +19- and —19-Volt Power Supplies.

The physical circuit layout is made in three general ways. All active elements of the Trigger and Holdoff and the Fast Ramp are mounted on the Timing Card. All active elements of the Staircase Generator (except the logic-controlled attenuator stage), the Horizontal Amplifier, and the +19- and —19-Volt Power Supplies are mounted on the chassis main frame. All active elements that relate to the control logic are mounted on the Logic Card. All controls are accessible either from the front panel or from the instrument right side (through the access made available by removing a portion of the Type 567 central bulkhead). No removable parts or controls are mounted on the instrument left side.

The circuit diagrams and interconnections are cross referenced by number 1 through 7 shown in diamonds on each

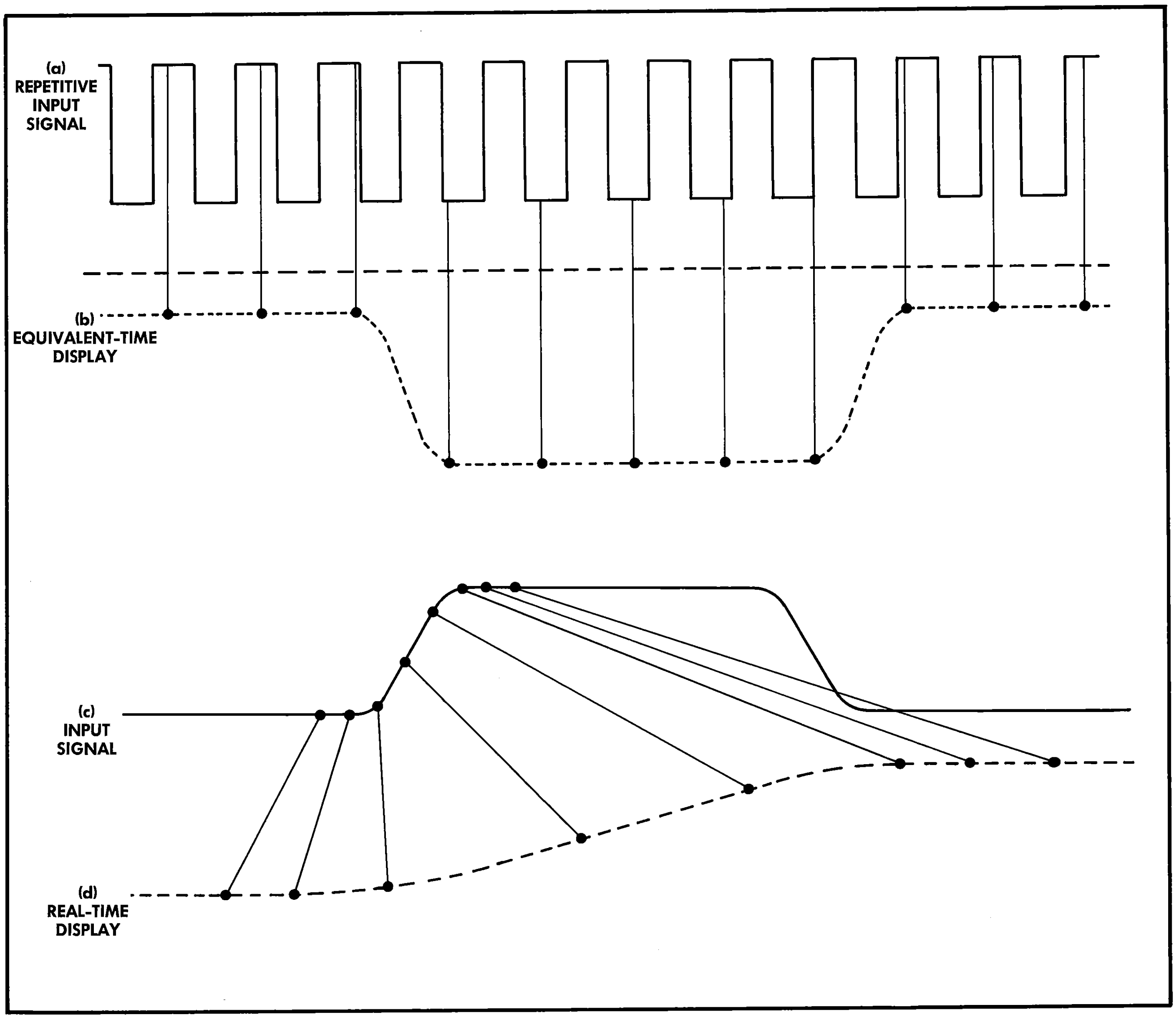


Fig. 3-3. Comparison between sampling equivalent-time and real-time displays.

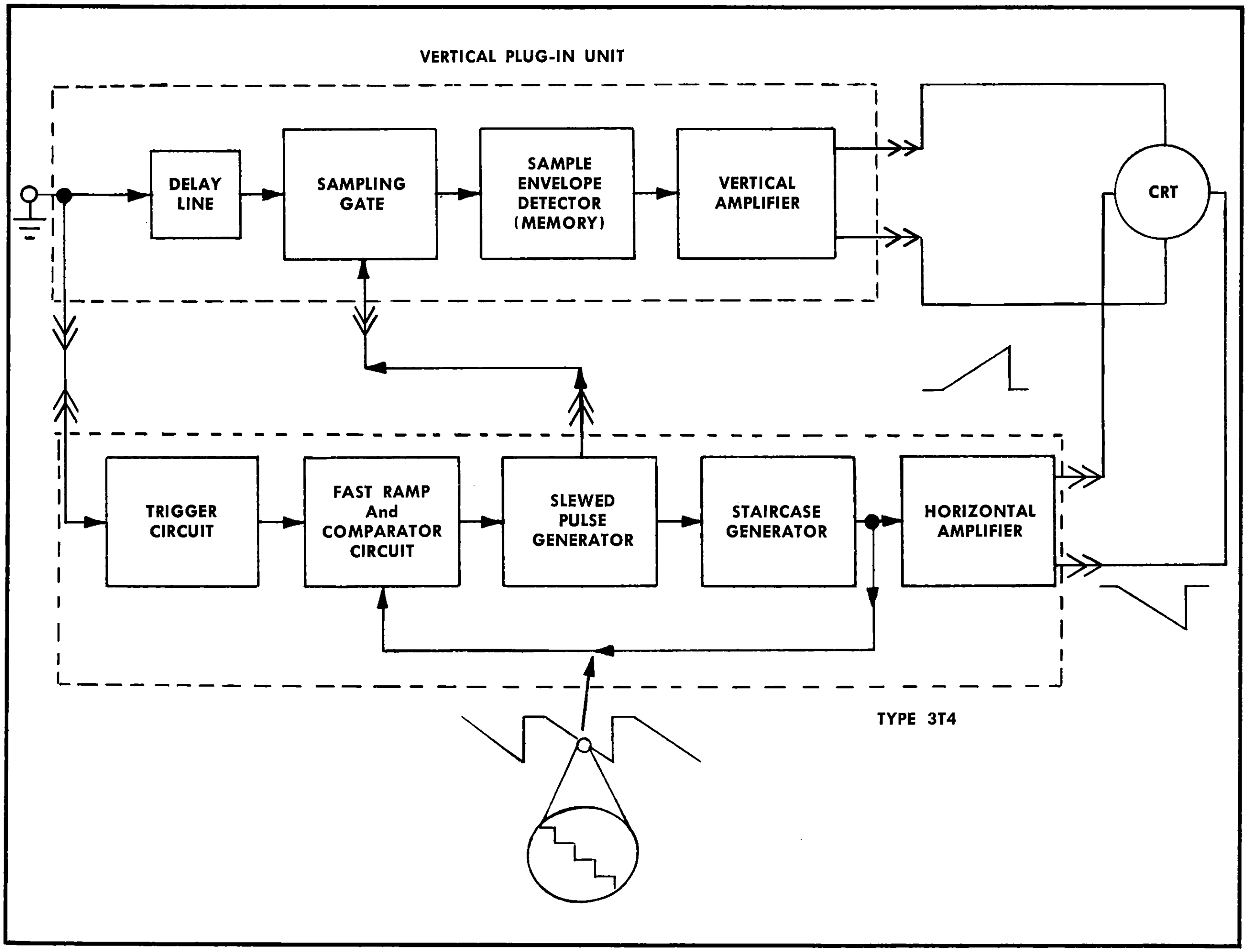


Fig. 3-4. Complete block diagram of the sampling system.

diagram. Circuits that are part of either etch-wired circuit card are outlined by blue lines and identified as to location. The Maintenance section contains illustrations with all circuit card components identified by circuit number. Diodes located in the main frame portion of the Type 3T4 are also illustrated in the Maintenance section.

The following circuit descriptions follow the same sequence as their associated circuit diagrams at the back of this manual. Each diagram is on a fold-out page, making comparison of text and diagram easier.

Trigger and Holdoff

The Trigger and Holdoff circuits consist of trigger input and selection circuitry, a Trigger Isolation Amplifier, a Trigger Recognizer, and a Holdoff Multivibrator.

Trigger Input Circuitry. Trigger source INT-EXT switch SW5 permits the trigger to be selected from the EXT INPUT connector J7, or from the vertical sampling unit via pin 3 of P21 interconnecting plug. The switch also terminates the unused trigger source (through R3 and R4 or through R6 and R7) and provides trigger signal inversion if desired. Assuming that SW5 is in the + INT position, the trigger signal from the trigger take-off circuit in the vertical sampling plug-in is terminated by the complementary reactances of L4 and C14 and the emitter resistance of Q14. When SW5 is at — INT, the negative triggering signal is applied to T8 which inverts it and applies it to the emitter circuit of Isolation Amplifier Q14. The Isolation Amplifier requires a positive input; therefore, SW5 switches inverting transformer T8 into the circuit whenever either of the — positions of the INT-EXT switch are selected. Capacitors C8 and C9 and resistors R8 and R9 form an RC network whose time constant complements the L/R time constant of T8, and thus keeps the impedance at the input of T8 nearly 50 Ω.

Trigger Isolation Amplifier. Transistor Q14 and associated circuitry comprise a grounded base amplifier which isolates the trigger input from the Trigger Recognizer circuit. (Q14 is soldered in place for effective high-frequency isolation.) The collector current of Q14 provides part of the bias current for trigger recognizer tunnel diode D15. Time correlated waveforms for the Trigger and Holdoff circuits are shown in Fig. 3-6.

Trigger Recognizer. The Trigger Recognizer circuit consists of D15, D22, L21, and the bias current setting resis-

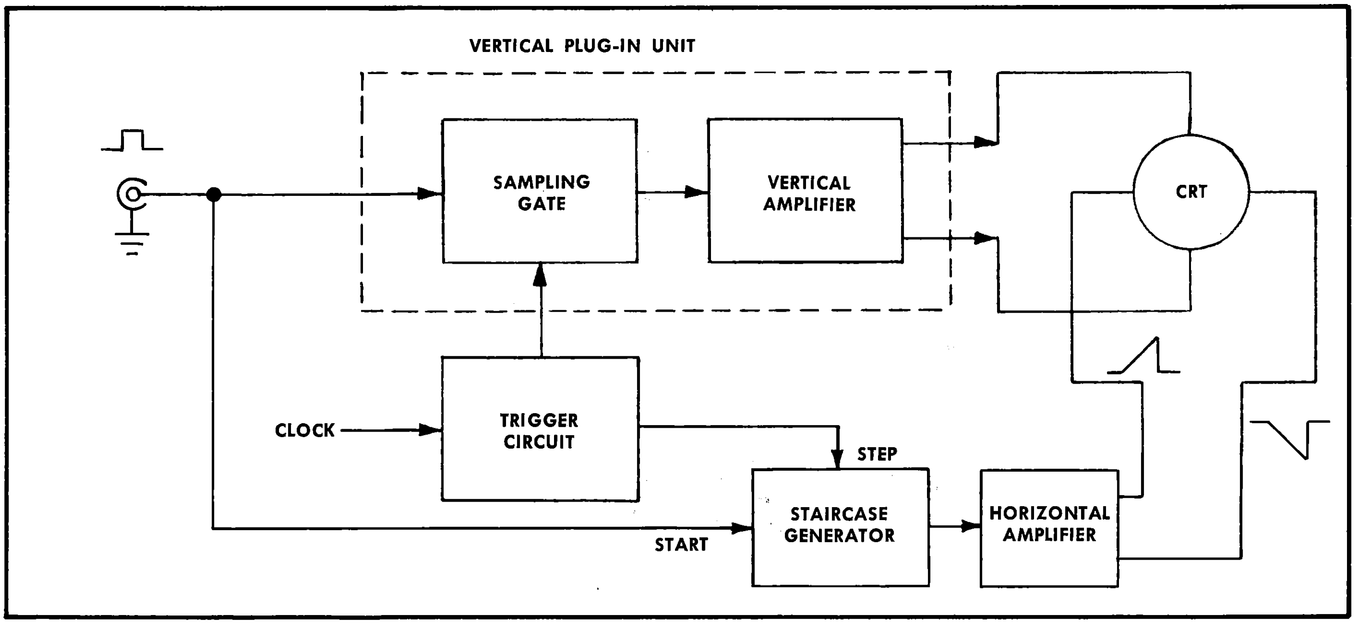


Fig. 3-5. Block diagram of typical real-time sampling system.

tors associated with the Trigger Sens Range and Trigger LEVEL controls. The Trigger Recognizer operates as a triggered one-shot when the Trigger LEVEL control is in the counterclockwise half of rotation and as a synchronized oscillator when the control is in the clockwise half of rotation.

When the Trigger LEVEL control is in its counterclockwise half of rotation, triggered operation is as follows: bias current is not sufficient for D15 to be in its high-voltage state and D25 (the Fast Ramp Driver TD) is in its low-voltage state (#1 of Fig. 3-6). As a positive trigger pulse of sufficient amplitude appears at Q14 emitter, Q14 current increases and the low-voltage peak current point of D15 is exceeded. D15 switches to its high-voltage state sending a sharp positive pulse through C21-R21 to D25 (#2 of Fig. 3-6). D25 also switches to its high-voltage state, triggering D105 (Fast Ramp diagram) and opening the fast-ramp clamp to start the fast-ramp circuit.

When D15 switches to its high-voltage state there is enough current to keep it there, except for the action of D22 and L21. Diode D22 is a back diode with a peak current of only 100 μamps. Its reverse I-V characteristic is similar to the characteristics of a forward biased germanium diode, except that the back diode starts conducting whenever its reverse voltage exceeds zero, rather than at 0.2 volts as with a normal germanium diode. At the time D15 switches to its high-voltage state, there is an instantaneous voltage drop across L21, which decays with an L/R time constant determined by the inductance of L21 and the reverse series resistance of D22 and D15. When the voltage drop across L21 has diminished sufficiently, D22 starts robbing current from D15. Since the voltage drop across D22 is less than that required to keep D15 in its high state, D15 then switches quickly back to its low-voltage state. As D15 switches back to its low-voltage state, the decreased voltage stops the current flow through D22 and the diodes remain in a low current condition as long as D15 is in its low-voltage state (#3 of Fig. 3-6).

D15 and D22 remain at a very low current condition (all triggers locked out) as long as the holdoff multivibrator (described below) holds them there, until the end of #3 in Fig. 3-6. The holdoff time shown in Fig. 3-6 is the shortest of three possible holdoff times. The holdoff time changes as the TIME/DIV switch is changed. Three sections of the TIME/DIV switch set the three possible holdoff times: from 1 nsec/div through 0.1 μsec/div, holdoff is about 8 μsec (#3 of Fig. 3-6); from 0.2 μsec/div through 10 μsec/div, holdoff is about 0.6 msec; and from 20 μsec/div through 0.2 msec/div, holdoff is about 5 msec. It is the holdoff time at the seven fastest sweep rates that limits the Type 3T4 dot repetition rate to between about 80 and 120 kc. (One dot can be triggered by vertical information after each holdoff interval.) The holdoff times, and therefore the maximum triggerable rate, is adjusted by the RECOVERY TIME control.

Holdoff Multivibrator. The holdoff multivibrator consists of transistors Q24, Q44, Q25 and Q35 and associated circuitry, with transistors Q25 and Q35 forming a complementary bistable. Capacitor C42 is one of three holdoff capacitors, and is wired permanently in the circuit. Capacitors C43 and C44 are auxiliary holdoff capacitors and are switched into the circuit at slower sweep rates. Transistors Q39 and Q49 perform holdoff capacitor switching in response to information from the TIME/DIV switch or the Remote Program connector. Transistor Q44 and Diode D41 form a non-saturating clamp circuit with diode D40 protecting Q44 against base-to-emitter voltage breakdown.

With the Trigger LEVEL control in the counterclockwise half of its rotation and no trigger signal applied, Q25 and Q35 in the bistable are both "on"; Q44 is "on" and Q24 is "off" (#4 of Fig. 3-6). With the application of a trigger to the emitter of Q14, D15 and D25 switch to their high-voltage states (#2 of Fig. 3-6). The sudden increase in voltage across D25 is coupled through R22 and R23 to the base of Q24, turning Q24 on. The conduction of Q24 robs current from D15 and D22 through R26 and D26, holding D15 in the low voltage state. C26 couples high-frequency energy from Q24 collector to D22 cathode, assuring D22 fast response back to its low-current state.

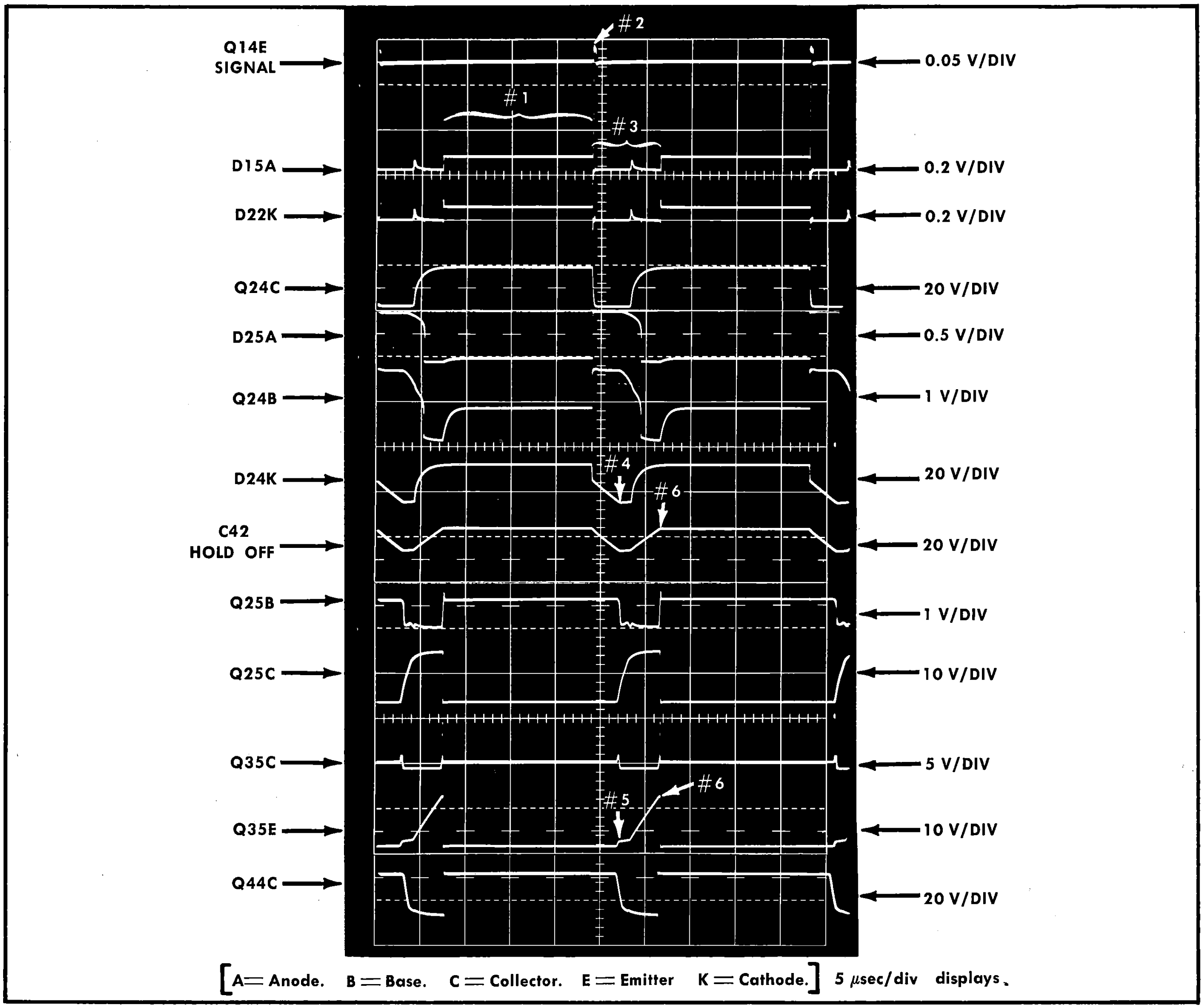


Fig. 3-6. Trigger and Holdoff waveforms during triggered operation. Type 3T4 controls: 5 nsec/div, Normal sweep, + EXT trigger at ≈40 kc, RECOVERY counterclockwise. Test oscilloscope/10X probe with short grounding clip and short flexible tip; 50 mc bandwidth. Probe ground at D45 anode. Sweep: 5 μsec/div + EXT trigger from Type 3T4 TRIG OUT connector.

Prior to the time that Q24 is turned on by the step from D25, the collector voltage of Q24 is high enough (about 13 volts) to reverse bias D46 and to forward bias D24, connecting R24 to R30 and R31. When Q24 conducts, its collector voltage drops to about ground level and turns D24 off. When D24 turns off, D46 turns on and the current through R30 and R31 switches to the path through D46, reducing the positive voltage across holdoff capacitor C42. The voltage across C42 decreases almost linearly to about +1 volt (#4 of Fig. 3-6). The time for this run-down accounts for approximately half the holdoff time.

As the voltage across the holdoff capacitor reaches +1 volt, the voltage at the junction of R30-R31 drops enough to forward bias D31 and turn Q25 off, which in turn cuts Q35 off (#5 of Fig. 3-6). Cutting Q25 off permits the voltage at the junction of R38-R39 to rise to about +19.4 volts and cut off Q44. Q44 then opens the current path for recovery tunnel diode D25 (which is through the rc delay network path of R41-C40) and resets D25 to its low-voltage state about 2 μseconds later. Q44 collector voltage drop causes Q24 collector to rise again to about +13 volts. This in turn switches the current through R30-R31 back again through R24-D24. Since Q35 is off, the current through R35 charges C42 positively again at a nearly linear rate. When the voltage across C42 reaches +12 volts, the emitter of Q35 becomes more positive than its base and turns on both Q35 and Q25 (#6 of Fig. 3-6). When both transistors turn on, the voltage at the emitter of Q35 drops to about +2.5 volts and reverse biases D35. Turning on Q25 also pulls down on the voltage at the junction of R38-R39 and turns Q44 on. The collector of Q44 rises swiftly to +19 volts, thus supplying bias through R25-R26 and L21 to D15, and also to D25 through the rc delay network of R41-C40. One cycle of the holdoff interval has been completed and the circuit is ready to receive another trigger and to operate again.

When the Trigger LEVEL control is set in the clockwise half of its range, D15 and D22 form a synchronizable oscillator. Operation is similar to the triggered one-shot mode except that when D15 switches back to its low-voltage state and current through D22 is reduced, the current that D22 gives up is applied to D15 and is sufficient to switch D15 back to its high-voltage state. The Trigger LEVEL control varies the current available in the circuit and thereby changes the frequency of the oscillation. The importance of the rc delay network (R41-C40) is evident only when the Trigger LEVEL control is in its clockwise half of rotation (i.e., in the synchronizing region). The resulting delay in the arming of D25 causes the multivibrator formed by D15-L21-D22 to go through several cycles of operation before finally combining its voltage with the triggering signal to switch D25 once more to its high-voltage state. This form of operation results in unusually stable synchronization of D25 by the input trigger signal.

Fig. 3-7 shows several waveforms that illustrate synchronized operation from a signal of approximately 65 mc. The Trigger LEVEL control was just clockwise from the free-run midrange position. The test oscilloscope was a Tektronix Type 547 with a Type 1A1 Dual-Trace Plug-In Unit and two P6006 10× Probes. The system bandpass is 50 mc. Fig. 3-7 (a) shows D15 anode (at 0.2 volts/div) at the top, and D25 anode (at 0.5 volts/div) at the bottom; sweep rate of 5 μsec/div. Fig. 3-7 (b) shows D15 anode at top and the junction between C21 and R21 at the bottom; sweep of 2 μsec/div. Note the R41-C40 rc rise just before D25 switches to its high state. Fig. 3-7 (c) shows D15 anode at the top and D25 anode at the bottom, both expanded by the delayed sweep at 0.1 μsec/div; note the 65-mc content along the more level portions of both waveforms and that D25 changes states at a positive peak of the 65-mc information, effectively synchronizing the sampling display.

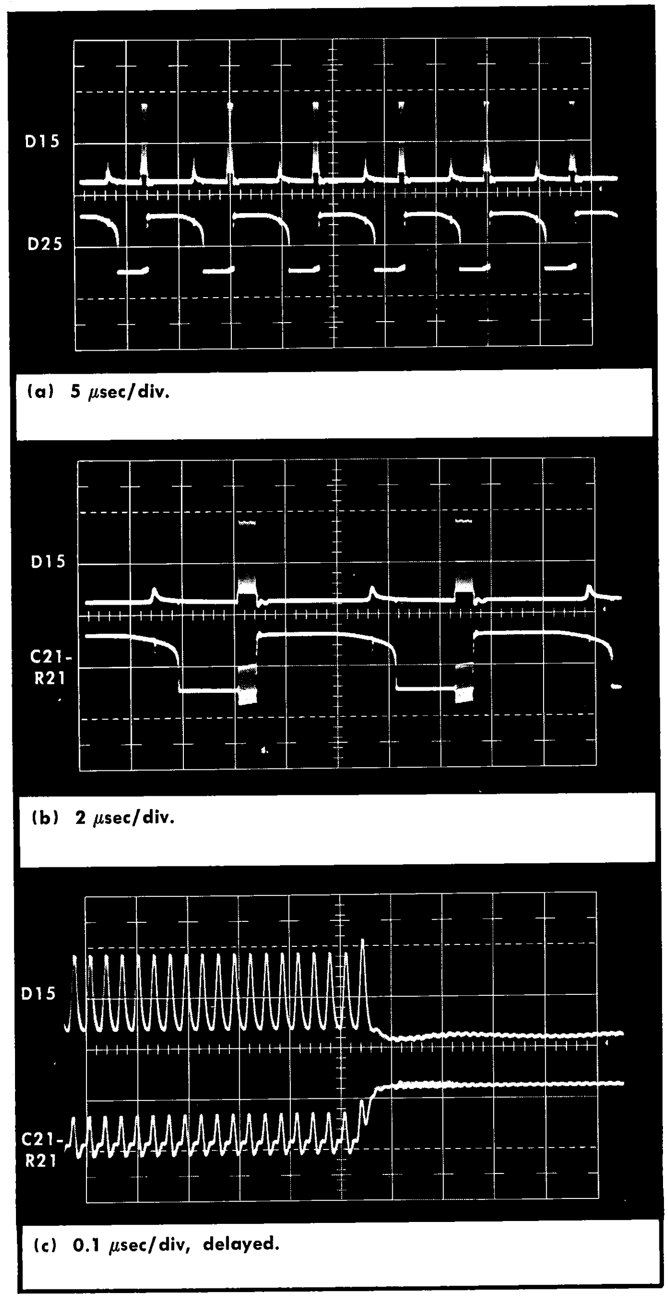


Fig. 3-7. Synchronized triggering.

Fast-Ramp Circuit

This circuit generates a fast-ramp waveform, compares it with an existing slow-ramp (staircase) waveform from the Staircase Generator, and produces a positive-polarity slewed pulse. The circuit consists of the Fast Ramp Clamp, the Fast Ramp comparator, and the Slewed Pulse Amplifier.

The time-voltage correlation of the display, the vertical signal, the trigger, the fast ramp, and the staircase generator follow.

1. The signals out of the trigger circuit that control the fast-ramp clamp, begin at the same point on the vertical information each time the signal reaches the trigger circuit. Compare waveforms number 1 and 2 of Fig. 3-8.

2. The fast-ramp clamp waveform starts and stops the fast-ramp rundown. Compare waveforms number 2 and 3 of Fig. 3-8.

3. The fast-ramp clamp and an inverted staircase signal are both required to trip the fast-ramp comparator D135. Compare waveforms 3 and 4 of Fig. 3-8.

4. The fast-ramp comparator D135 output pulse drives the slewed pulse generator that drives both the vertical plug-in unit and the Type 3T4 staircase generator. Compare waveforms number 3, 4, 5 and 6 of Fig. 3-8.

Thus, Fig. 3-8 shows the time-voltage relationship between the fast ramp and the inverted staircase. The Type 3T4 TIME/DIV switch changes the amplitude of the inverted staircase to change the equivalent time between display dots. The fast-ramp rundown slope remains the same over about 1/3 of the range of the TIME/DIV switch. The slope times are: about 2.2 μsec for rundown when the TIME/DIV switch is at 0.1 μsec through 1 nsec; about 0.22 msec for rundown when the TIME/DIV switch is at about 10 μsec through 0.2 μsec; and about 2.2 msec for rundown when the TIME/DIV switch is at 0.2 msec through 20 μsec.

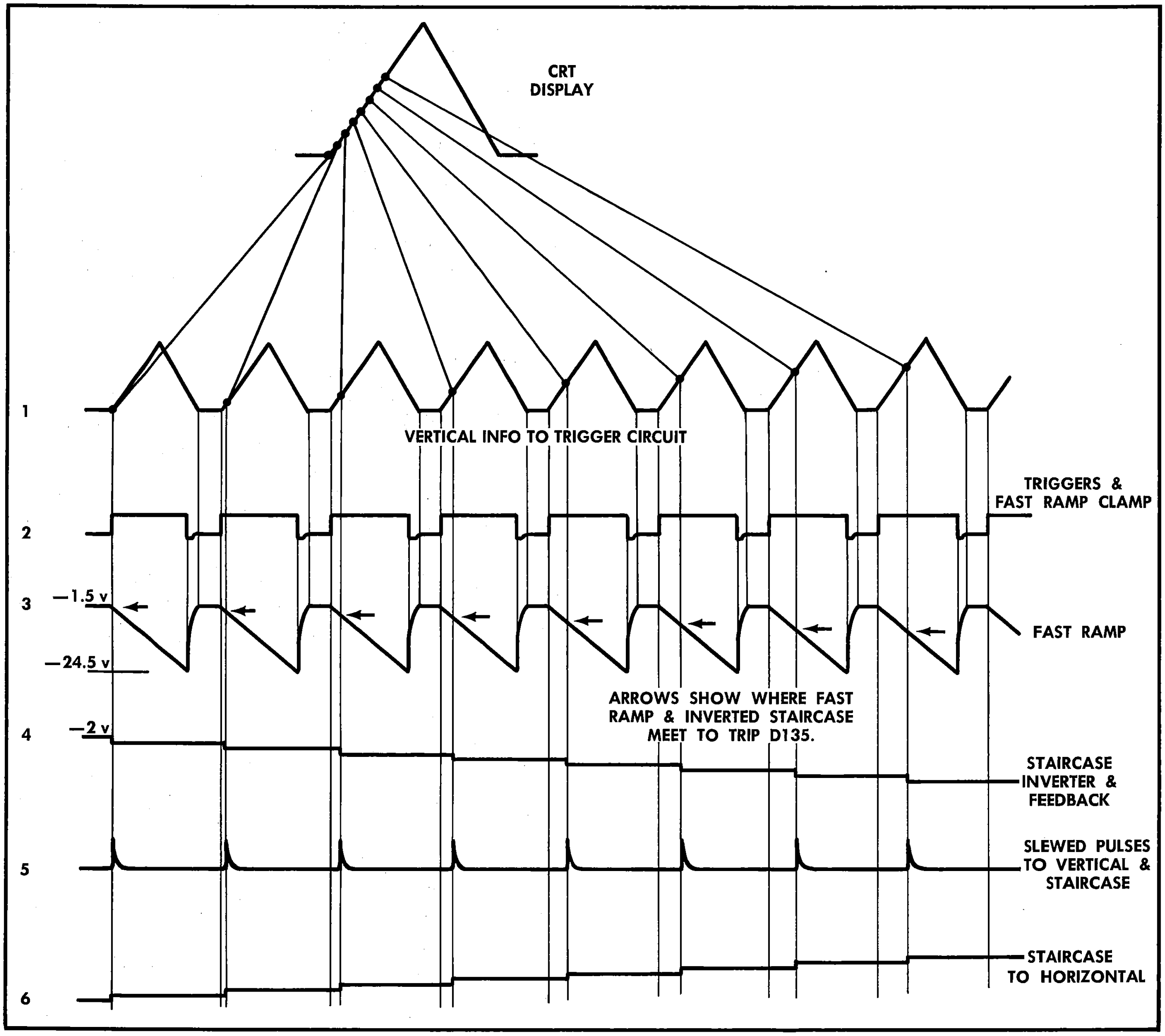
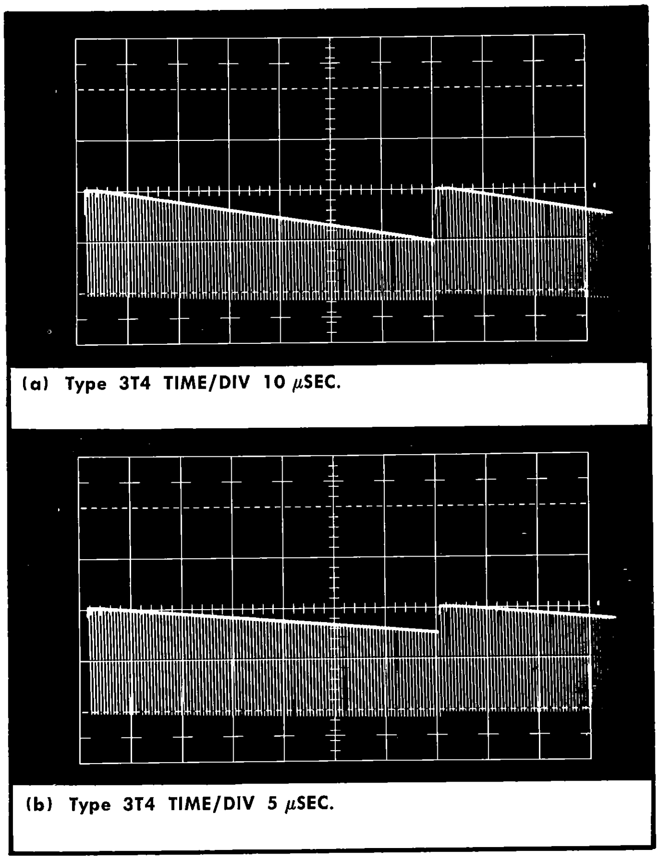


Fig. 3-8. Time correlation of display to fast ramp slewed pulses and staircase.

If less equivalent time is desired between dots, the TIME/DIV switch is set one step counterclockwise (within any one of the 3 fast-ramp ranges). This reduces the amplitude of the inverted staircase voltage sent to the fast-ramp comparator, (see Fig. 3-9) and makes the successding comparisons occur at shorter periods of time along the fast-ramp rundown than shown.

Fig. 3-9 shows two waveforms of the combined fast ramp and inverted staircase within the Type 3T4. The Type 3T4 was displaying 100 dots per sweep at equivalent sweep rates shown in Fig. 3-9. Note that the number of fast-ramp rundown pulses remained the same, and the display equivalent time was changed simply by changing the amplitude of the inverted staircase signal. The real time between dots, and the rate at which the display moved across the Type 3T4 crt remained the same in both cases. Thus, the larger the value of inverted staircase compared with the fast-ramp value of inverted staircase compared with the fast-ramp signals, the longer equivalent time between dots. This is caused by the fact that the fast ramp runs down a longer period of time before its voltage meets the staircase voltage and a slewed pulse is generated.

The fast-ramp waveform is developed across one of three selectable ramp-slope capacitors C121, C122, or C123. Comparison with the inverted staircase ramp voltage takes place at D135. The slewed pulse is generated when D135 switches from its low-voltage state to its high-voltage state. The slewed pulse is coupled to Q144 by T125, then amplified and inverted. The output of Q144 is applied through C144 and the interconnecting plug to the vertical sampling plug-in and also internally to the staircase generator.



(a) Type 3T4 TIME/DIV 10 μSEC.

(b) Type 3T4 TIME/DIV 5 μSEC.

Fig. 3-9. Waveform at fast ramp D132 anode. Test oscilloscope sweep rate: 10 msec/div.

Fast Ramp Clamp. This circuit consists of diodes D104 and D105, transistors Q103 and Q104, and associated circuit elements. Q104 is the clamp, while the other elements control it.

Transistor Q103 acts as a comparator when the fast-ramp clamp is in its quiescent state awaiting a trigger. Q103 compares the voltage at R101-R102 junction with the clamped fast ramp voltage level as follows: Q103 is conducting and has D105 set to its high-voltage state. The voltage across D105 is sufficient to bias Q104 into conduction, but not into saturation. Q104 conducts current primarily from Q114 (away from D135), but also from R103 and Q103 emitter, if the voltage at D105 cathode goes too far negative. The feed-back loop from Q104 collector to D105 cathode (through Q103) keeps the fast ramp voltage clamped to about —1.5 volts while in the clamped state. It also keeps D105 very near the trip level, so the trigger pulses can turn it off quickly when they arrive.

As a trigger pulse arrives from D25, the current of Q103 is switched from D105 to C22 long enough for D105 to drop back to its low-voltage state. By the time C22 is charged, D105 again conducts Q103 current, but this time at the low-voltage level. With D105 at its low-level, Q104 is cut off, releasing the current it had been taking from Q114. Q103 now acts as a constant current source for D105, with the current value set by R103 and the divider R101-R102. The collector circuit of Q103 is itself a very high impedance, so its current remains the same for either the high- or low-voltage state of D105.

With the fast ramp clamp removed, Q114 current now switches to the fast ramp capacitor. Before the clamp was removed, there was no current passing through R130-R131 or D135 because the cathode of D132 (at pin L, the inverted staircase input terminal), and therefore the anode of D131, was more negative than Q104 emitter. Current for R132 passes through D132 into the staircase inverter. Q114 current is held constant by its "long tail" emitter resistance and the fixed voltage at the anode of D107. With Q114 base held constant at —25 volts, the current through R111-R110 is fixed. The collector of Q114 is a very high impedance, so the voltage level can change without current change. Thus, Q114 is a constant current source for charging the ramp capacitor at a linear rate whenever the ramp clamp is removed by the arrival of a trigger pulse at D105. The fast ramp voltage can run from —1.5 volts to as low as about —23 volts. The slope of the fast ramp is set by Q114 current and whichever fast ramp capacitor is switched into operation. The fast ramp capacitors are C121, C122, C123, and C124, with C124 used only for fine adjustment of C123. Three fast ramp capacitors are used to cover all the equivalent-time sweep rates.

Fast Ramp Comparator. The Fast Ramp Comparator circuit consists of tunnel diode D135, diode D131, resistors R130 and R131, and associated elements. The comparator tunnel diode D135 obtains its arming bias from the fast ramp capacitor charging current. The arming bias is obtained by dividing the fast ramp capacitor charging current into two paths, one of which is R130 and R131, the other the resistance of D135.

In operation, the staircase voltage (#4 of Fig. 3-8) is applied to pin L of the Timing card, through D132 to the anode of D131. When the fast ramp clamp is removed, the voltage across the fast ramp capacitor starts negative. When the fast ramp rundown voltage is approximately equal to the staircase voltage, D131 conducts. More of Q114 current now passes through R131 and D135, and D135 switches to its high-voltage state. The resulting slewed pulse output from D135 is coupled through T125 to D145 which functions as a one-shot multi. D145 applies a negative pulse to Q144 and causes it to turn on. The fast-rising portion of the output pulse from Q144 (#5 of Fig. 3-8) is applied to the vertical sampling plug-in and triggers the strobe generator. The slower portion of the pulse (limited in risetime by L144) is coupled to the staircase generator causing it to advance one step.

The fast ramp continues to run down until D25 returns to its low-voltage state. As D105 receives the negative pulse from C22, it switches back to its high-voltage state, turning on Q104 and again clamping the fast ramp. Q104 passes a rather stiff pulse of current as it discharges the fast ramp capacitor. As soon as Q104 collector reaches —1.5 volts, Q103 again acts as a comparator and prevents Q104 from saturating (so it can turn off quickly at the arrival of the next trigger).

The two Gallium Arsenide diodes, D104 and D131, have a very fast turn-on or turn-off action and are essentially perfect switches at the times they either start or stop carrying current. Their action aids materially in keeping display jitter to a minimum.

The next time the fast ramp circuit is triggered, the inverted staircase voltage is more negative. This allows the ramp to run down a bit longer before a comparison is made, resulting in one more step of delay of the slewed pulse.

Staircase Generator

The Staircase Generator develops either a 0.5-volt-per-step or a 0.05-volt-per-step, positive-going staircase ramp signal of about 50 volts amplitude. The staircase is applied to the Horizontal Amplifier and to the Staircase Attenuator and Inverter circuit when the SWEEP MODE switch is at either NORM or SINGLE DISPLAY. The Staircase Generator also develops a +gate voltage, which is applied to the Digital Unit for the duration of each complete staircase ramp.

Included in the Staircase Generator are the following circuit elements:

1. An integrator-amplifier (Miller Integrator) made up of V263, Q261 and Q273, controlled by reset and gating circuits.

2. Timing capacitor C260 in the integrator circuit, operating in conjunction with C258 (A,B,C,D) as a bucket-and-ladle circuit to determine the voltage change of each staircase step.

3. Q254, which switches C258A and C258B in or out of the circuit, and provides a means of internally or externally changing the number of samples per sweep by grounding a lead.

4. Q235 and Q245, comprising a reset multivibrator which resets the integrator circuit output back to zero at the end of each sweep.

5. Q204, Q214 and Q224, providing the input circuitry necessary for the various modes of operation.

Normal Mode. For purposes of explanation, assume that the SWEEP MODE switch is in the NORM position, and the Staircase Generator is in its quiescent state with no staircase being generated. Under these conditions, both Q235 and Q245 are cut off. Disconnect diode D262 holds V263 grid positive enough so Q261 collector and Q273 emitter are pulled down. D261 is a feedback clamp which determines the output level of the staircase generator during its quiescent state (described below).

When the first positive-going slewed pulse from the Fast Ramp Generator is received at the base of Q204, Q204 collector produces a negative-going pulse of about 22 volts amplitude. The negative pulse out of Q204 is of somewhat longer duration than the slewed pulse due to base storage in Q204, and provides a current pulse to D225 with greater energy than is available from the slewed pulse. The output pulse from Q204 is differentiated by C209 and momentarily switches D225 to its high-voltage state, turning on common-base stage Q224. A negative output pulse from Q224 passes through C227 and R227 to turn on Q235 in the reset multi. Turning on Q235 also biases Q245 into conduction. The resulting current flow through R241 and R242 reverse biases disconnect diodes D261 and D262, releasing the Miller Integrator so timing capacitor C260 can be charged. Conduction of Q245 also keeps Q235 in conduction after the pulse from Q224 ends, so both transistors in the reset multi remain in conduction during the entire staircase.

When the positive-going slewed pulse is applied to the base of Q204, the resulting negative output pulse is also applied to C258. Diodes then transfer some of the charge from that capacitor to C260-R262, slowing the rate of charge of C260 to a rate to which the integrator-amplifier can respond.

During 1000 samples/sweep operation, Q254 is not conducting; thus, R258 reverse biases D258 and D260 to disconnect C258 A and B. As the collector of Q204 pulls down, current flows through C258 C and D, and D257 into C262-R262 and then C260. As Q204 collector rises positive at the end of the slewed pulse, C258 C and D are discharged by D256. D256 prevents C262 or C260 from "seeing" C258 C and D discharge.

During 100 samples/sweep operation, Q254 conducts so D258 and D260 are forward biased. As Q204 collector pulls down, current is pumped into C262-R262 and C260 by C258 A, B, C and D. As Q204 collector rises at the end of the slewed pulse, D256 and D259 discharge the four C258 capacitors.

Each time charge is transferred from C258 to C260, the output of the Miller Integrator is raised one step. The size of each step is determined by the value of C258 (selected by the SAMPLES/SWEEP switch) and the magnitude of the output voltage swing from Q204.

Transistor Q254 provides the means of changing from 1000 to 100 samples/sweep at any time. Very slow sweep rates can thus be sped up when the dot is outside the zone of interest. Note that C258C and C258D total about one-tenth the capacitance of C258A and C258B combined. This means that C258C and C258D can transfer only about a tenth as much charge as all four capacitors combined, therefore it takes ten times as many samples to charge C260. With all four capacitors in the circuit, the staircase steps are 0.5 volt each. By applying a positive voltage to the base of Q254 (accomplished by grounding the junction of R251-R252) C258A and C258B are switched into the ladle circuit by D258-D260 and also pass current to C260. The volts per step are thus changed from 0.05 to 0.5, changing the samples per sweep from 1000 to 100. Pin 17 of J80 provides access to the junction of R251-R252 for remotely programming the samples per sweep by the 0% and 100% zones of the Type 6R1A.

Each successive slewed pulse causes a uniform charge to transfer from C258 to C262 and then to C260, raising the Miller Integrator output in identical increments. The Miller Integrator operation starts with the release of current through the Disconnect Diodes D261-D262. A pulse of current arrives at C260 through C258-C262-R262, pulling the grid of cathode follower V263 a bit negative. V263 cathode follows the grid change and drives the base of the amplifier Q261. Q261 collector rises positively and drives the base of emitter follower Q273 so the voltage at the output lead rises. The output voltage rise pulls up on C260 and returns the grid of V263 to its original value, stopping the output rise as C260 receives its first step charge. Soon, a second step charge is sent through C258-C262-R262 to C260 and the grid of V263 and the process of Q273 charging C260 repeats.

The initial dc level of the output staircase is set to zero by adjusting the Staircase DC Level control R263. Adjusting R263 changes the current drive to Q261 base. The circuit operates to set the output to zero when D261-D262 are clamping the staircase. Q261 collector current is maximum at zero output, pulling its collector and the base of Q273 down near ground. This means Q261 base is fixed at about +0.6 volts. Q261 collector voltage is two diode junction voltage drops (Q273 base-emitter and D273) above zero volts, and also above its emitter voltage. Therefore Q261 is not saturated and can reduce its current quickly for the first staircase step. The grid voltage level of V263 sets its cathode voltage level. The cathode voltage level sets the base current to Q261. Since D261-D262 connect V263 grid to the output lead, adjusting the Staircase DC Level control shifts the dc level of V263 grid. This adjusts the base drive of Q261, which adjusts the output dc level; all within a tight feedback loop. A voltmeter check throughout the circuit would show that all voltage levels, except the base of Q261, change when the Staircase DC Level control is adjusted.

As the output voltage reaches 50 volts, D245 couples part of the voltage to the base of Q235 and turns off the reset multivibrator Q235-Q245. (Note that D236 prevents the base of Q235 from going positive more than about +0.6 volts.) The current through D245 flows through R246-R245-R244-R240 and to —19 volts through Q245. This voltage divider is adjustable by R245, the Sweep Length control, so Q235 flips the reset multi at the correct output voltage. The output of the Miller Integrator is a positive-going staircase that is applied to the Horizontal Amplifier, and to the Staircase Attenuator and Inverter circuit which drives the Fast Ramp Comparator.

When the staircase voltage reaches +50 volts and Q245 turns off, the voltage at the junction of R241-R242 goes positive, forward biasing disconnect diode D262. R241-D262 lift V263 grid positive, causing Q261 collector and Q273 emitter to pull down and linearly discharge C260. D272 conducts during rundown if Q273 emitter moves more slowly than its base. As C260 reaches its discharge state, D261 conducts and stops the rundown by passing more current through R241, so D262 takes V263 grid down to its quiescent level. D245 disconnects the base of Q235 from the rundown voltage, and C245 holds the base of Q235 positive long enough to allow complete recovery of the Miller Integrator. After C245 discharges, the reset multi is switched into conduction by the next negative pulse from Q224 as previously explained.

The crt unblanking signal and the +Gate signal to the Digital Unit are provided by V294A. The grid of V294A is driven below ground when the reset multi pulls down to permit a staircase to run. This cuts off the plate current of V294A. The 5-resistor divider in V294A plate circuit then sends +155 volts to the crt blanking plate, and +1.2 volts to the Digital Unit. The low-voltage values of the two gate output voltages are +25 volts to the crt and —2.2 volts to the Digital Unit.

Single Display Mode. With the SWEEP MODE switch set to SINGLE DISPLAY, one end of R212 is grounded and transistor Q214 is turned on by base current through R212. The conduction of Q214 biases D225 near its low voltage peak current point so it becomes a bistable multivibrator. The next time a slewed pulse is applied to Q204, the negative output of Q204 switches D225 to its high-voltage state. Switching D225 to its high-voltage state causes Q224 to conduct and deliver a start pulse to the base of Q235 in the reset multi. The transistors in the reset multi now conduct, reverse biasing the disconnect diodes and permitting the staircase to advance with each application of a slewed pulse. When the staircase reaches the point where D245 is forward biased, the reset multi resets, ending the sweep. However, tunnel diode D225 is still in its high-voltage state, preventing any additional slewed pulses from passing through Q224 to the reset multi. The Staircase Generator is thus locked up after one sweep.

It is now necessary to press the START button if another sweep is desired. When the START button is pressed, the current to D225 is momentarily interrupted by the positive pulse from C210, and D225 switches to its low-voltage state. With D225 in its low-voltage state, Q224 cuts off and C227 charges through D227 so it can deliver a pulse to the reset multi the next time that Q224 conducts.

At the end of the start pulse, the current through Q214 again biases D225 near its peak current point, but the voltage at the emitter of Q224 is not negative enough to bias Q224 into conduction. The Staircase Generator is now ready to start another sweep when a slewed pulse is received from the Fast Ramp Generator.

External Sweep and Manual Modes. In the EXT INPUT or MAN positions of the SWEEP MODE switch, the Staircase Generator is disabled by removing the —19 volts from the reset multi and from the emitter of Q204. In these positions, the Horizontal Amplifier is driven by the signal or voltage applied to MANUAL SCAN OR EXT ATTEN control R301 (diagrammed at the left side of the Horizontal Amplifier diagram). In the EXT INPUT position, the voltage or signal is applied through the EXT INPUT connector. In the MAN position, the voltage is taken from the +125-volt bus in the Type 3T4.

Staircase Attenuator and Inverter

The inverted staircase voltage (#4 in Fig. 3-8) applied to the comparator in the Fast Ramp Generator is derived from the staircase ramp by the Staircase Attenuator and Inverter circuit. This circuit consists of switchable attenuator networks, a transistor used as an impedance changer, a delay operational amplifier, and an inverting operational amplifier.

Staircase Attenuator. The equivalent time per division is determined by the magnitude of the steps in the staircase waveform applied to the Fast Ramp Comparator, and the slope of the fast ramp. The Staircase Attenuator provides for changing the magnitude of the steps in the staircase ramp voltage as the TIME/DIV switch is changed, or as certain leads (described in the Operating Instructions) of the REMOTE PROGRAM connector are grounded. Switching is done by magnetically operated reed switches mounted on the Logic card.

Transistor Q64 is a common-base isolation amplifier that allows the Staircase Generator and the VARIABLE control to always "see" essentially 100-k load. Signal current is applied to its emitter (about 2 Ω input resistance) as shown in Fig. 3-11 (b) through one of three resistors, R53, R54, or R56. These resistors meter the signal current into Q64 and allow the TIME/DIV switch 10-5-2 sequencing of the

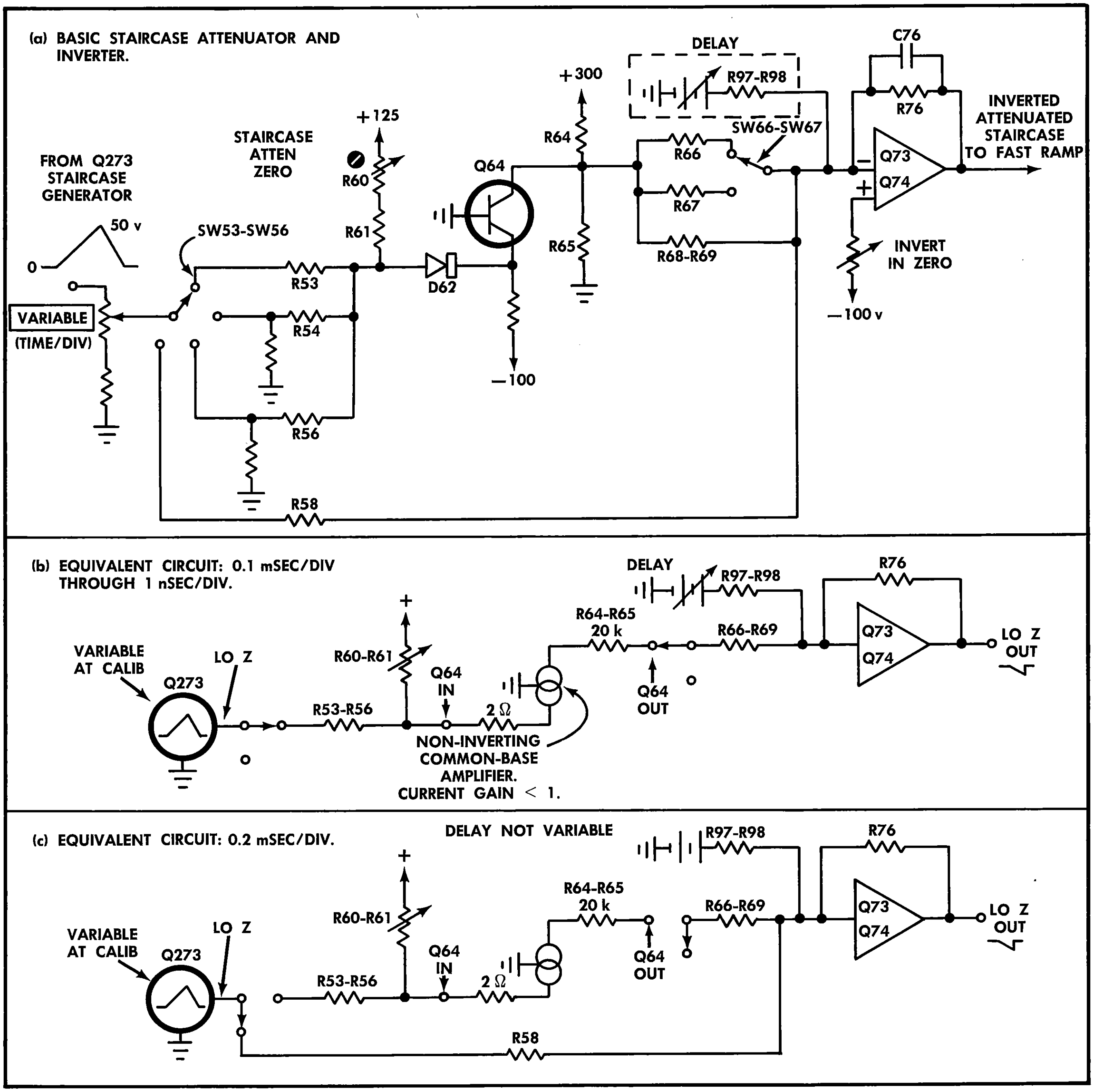


Fig. 3-10. Staircase and Inverter basic and equivalent circuits.

equivalent-time sweep rates. The particular resistor used is controlled by the position of the TIME/DIV switch (or through the REMOTE PROGRAM connector), which closes the appropriate reed switch SW53A, SW54A, or SW55A. Q64 emitter dc level is about —0.6 volts, which is offset by D62 back near zero, so there will be no input current when the staircase is at zero voltage. D62 also provides temperature compensation to the stage. The collector of Q64 is in itself a very high impedance; therefore, its output impedance is that of the parallel combination of R64-R65. R64-R65 parallel resistance of 20 k is the generator source resistance to the input resistors (R66, R67 and R68-R69) of the Inverter operational amplifier. These resistors allow ×0.1, ×1 and ×10 multiplication of the basic 10-5-2 sweep rate sequence, permitting all but 0.2 msec/div selection of sweep rates by switching Q64 input resistors and the input resistors to the Inverter amplifier. The combinations of three Q64 input attenuator resistors, three Inverter input resistors, and three fast ramp capacitors provide the 16 steps of the TIME/DIV switch 0.1 mSEC and

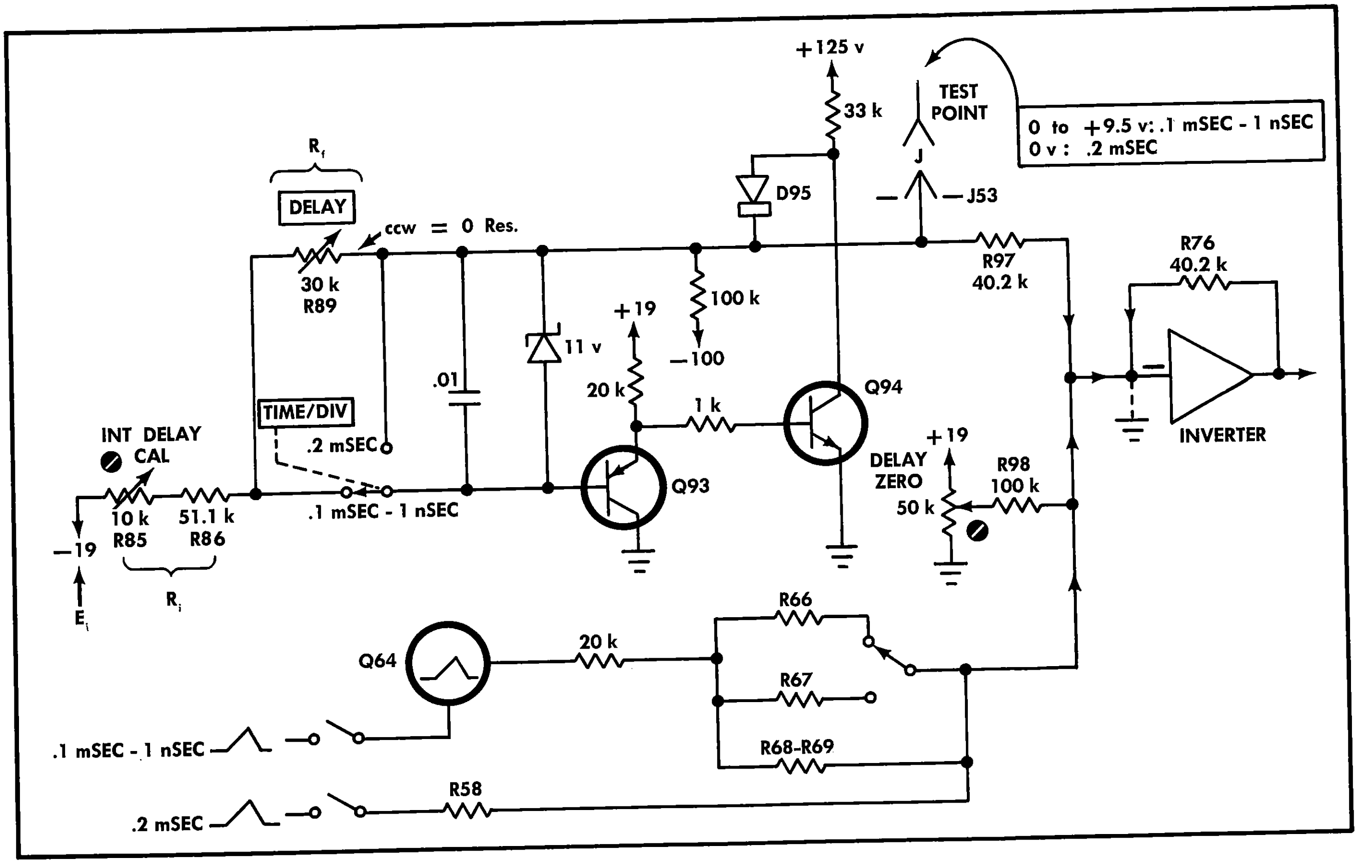


Fig. 3-11. DELAY operational amplifier circuit and four input paths to Inverter operational amplifier.

faster. R58 bypasses Q64 and feeds the Inverter directly (and the DELAY control is disabled) when the TIME/DIV switch is at .2 mSEC.

Delay Operational Amplifier. Delay of the time window is accomplished by allowing the fast ramp to run down farther before it reaches the comparison point on the staircase. In order to move the comparison point down, a dc offset voltage is added to the inverted staircase voltage sent to the fast ramp comparator. This dc offset voltage is derived by the injection of a dc current into the Inverter operational amplifier as controlled by the Delay operational amplifier.

In operation, DELAY control R89 varies the current feedback to the base of Q93. Transistors Q93 and Q94 form an operational amplifier whose adjustable dc output is

$$E_o = \frac{R_f\,E_i}{R_i}$$

where R_f is the feedback resistance, E_i is input voltage, and R_i is input resistance. It can be seen from the formula that the output voltage is directly proportional to R_f. Fig. 3-11 shows R85-R86 as R_i, —19 volts as E_i, and R89 as R_f. With the DELAY control (feedback resistance) set at maximum delay, the output voltage is maximum. When the DELAY control is set to zero delay, the output voltage is minimum with the collector of Q94 at approximately +0.6 volt, just above saturation. Q93 and Q94 do not saturate through the whole range of operation. Q93 is a current amplifier emitter follower that drives the base of Q94 through a 1-kc parasitic suppressor resistor. Q94 does not saturate because Q93 always draws current through R93. D95 offsets Q94 output voltage by about —0.6 volt so that the output voltage is close to zero for zero delay. R96 is a "keep alive" current source so D95 always provides its offset voltage, even when there is very little feedback current. The cathode of D95 is thus a low impedance voltage source adjustable by the DELAY control. The delay voltage range is set by adjusting (R_i) R85, the Internal Delay Cal control. R97 converts the voltage output to a current input (proportional to delay) to the Inverter operational amplifier.

Inverter Operational Amplifier. The Inverter operational amplifier consists of Q73 and Q74 and associated circuit elements. The feedback is frequency compensated by C76 so the amplifier can respond correctly to changes in staircase voltage. The amplifier is current driven at the base of emitter follower Q73. Q74 collector provides a voltage output to the fast ramp comparator.

Three sources provide current to the summing input to Q73; the Delay operational amplifier, the Delay Zero control, and the Staircase Attenuator circuit. The currents are summed at the input of the Inverter amplifier; thus the voltage output reflects the amount of delay and the setting of the TIME/CM switch.

As a typical operating situation, assume that the TIME/DIV switch is set to the .1 mSEC position, and that the DELAY control is set for maximum delay. Under these conditions, SW121 in the Fast Generator is closed, selecting the largest capacitor for the fast ramp, making available a fast ramp of approximately 2.2 msec. In the Staircase Attenuator SW53A and SW66 are closed, permitting the steps of the staircase applied to Q73 to be large. With the DELAY control set for maximum delay, the offset current through R97 is maximum. At the base of Q73, the large staircase steps are summed with the large offset current, giving an initial Inverter output of 10 volts for delay plus 10 volts of inverted staircase. When this voltage is applied to the Fast Ramp Comparator, the fast ramp must run down much farther than for faster sweeps because of the delay offset, and because the staircase steps are large. As a result, the first comparison of the fast ramp and the staircase takes place 1000 μsec after the sweep is triggered, at 10 volts down the fast ramp. Each succeeding comparison occurs 1000 μsec + (n) (1 μsec) later, where n = the number of previous comparisons at 1000 Samples/Sweep. The formula for determining the real time between samples is:

$$\frac{\text{equivalent time for 10 div sweep}}{\text{samples/sweep}}.$$

In this example: $\frac{1 \text{ msec}}{1000} = 1\ \mu\text{SEC/sample}.$

Horizontal Amplifier

The Horizontal Amplifier consists of a transistorized operational amplifier that drives a two-tube paraphase amplifier with cathode follower outputs to the crt horizontal deflection plates. With the SWEEP MODE switch set to NORM, the zero to 50-volt staircase from the Staircase Generator passes through R319 (R_i) to the base of Q334. Transistors Q334 and Q333 form an operational amplifier with R330 the feedback resistor (R_f). The output of the operational amplifier is coupled either directly (DISPLAY MAG at ×10) or through a 10× divider (DISPLAY MAG at ×1) to V364A in the paraphase stage of the vacuum-tube amplifier. The output of the paraphase amplifier is coupled through cathode followers V364B and V354B to the crt deflection plates via pins 17 and 21 of interconnecting plug P21. The amplifier is direct coupled, with D354 and D364 providing protection to V354B and V364B grids during warm up. Note that the staircase voltage and other input voltages are also sent to pin 20 of P22 for use in the Digital Unit such as the Type 6R1A.

Signals to the Horizontal Amplifier, the Digital Unit, the Staircase Attenuator and Fast Ramp, and the SWEEP OUTPUT, come from three different sources. The Signal source depends upon the method of display scan. The Normal or Single Display mode of display scan provides the Staircase Generator signal to all four circuits. Manual Scan provides an adjustable dc voltage (through the intergrating circuit R304-C304) to all four circuits (even though the Digital Unit can't recognize it). External Sweep provides an external sweep controlling voltage at all four circuits. The External Sweep signal can be greater than 50 volts peak, and then attenuated by the MANUAL SCAN OR EXT ATTEN 100-kc potentiometer, R301. The Manual Scan voltage of up to +125 volts available from R301 is attenuated by R304 in series with the following circuit inputs. D319 protects Q334 base-emitter junction from accidental damage by application of negative voltages during External Sweep operation.

The POSITION control and R323 provide a dc positioning current to the summing input of Q334. The Positioning signal produces slightly more than one crt diameter horizontal position control when the DISPLAY MAG switch is at ×1 (Q333-Q334 gain 0.025), and about 10 crt diameters of position control when the DISPLAY MAG switch is at ×10 (Q333-Q334 gain 0.25).

The Sweep Output circuit employs a cathode follower that receives an attenuated horizontal input signal. The output voltage swings from +10 to +20 volts for a Normal-Display sweep scan.

The Horizontal Amplifier provides for X—Y operation through the leads connected to pins 11 and 12 of P21. In the usual system, a positive voltage (+300 volts through 47 kΩ) sufficient to saturate Q334 is applied to pin 11, effectively removing the staircase and Position control signals from the paraphase amplifier. The vertical plug-in unit Channel B output signal is then applied to pin 12 of P21, and from there to V354A in the paraphase ampilifier. Q334 virtual ground input prevents the input circuits from "seeing" the X—Y staircase lockout signal.

Logic

The Logic circuits (see Control Logic diagram) are a series of magentically operated reed switches and logic gates which select the timing components and provide Units, Decimal, and Counter ÷ 1, 2, 5 control of the Digital Unit through connector P22. When operating in internal modes, the reed switches and gates are controlled by ground connections made by the TIME/DIV switch. When the TIME/DIV switch is in the REMOTE PROGRAM position, control of the switches and gates is transferred to the REMOTE PROGRAM connector on the front panel, and the system is controlled by externally connecting certain pins of P80 to pin 1 of P80.

The logic control used in the Type 3T4 is to either ground or not ground certain control leads. The information required to remotely program the Type 3T4 is included in the Operating Instructions of this manual. All internal control of sweep rate selection is accomplished by the TIME/DIV switch supplying particular reed switch coils and transistor gates with ground closures.

TIME/DIV switch sections 1F, 1R, 2F, and 2R control the reed switch coils which connect the proper fast ramp capacitors, transistor gates for trigger circuit hold-off capacitors, reed switches for staircase attenuator resistors for the selected sweep rates, and transistor gates for Digital Unit logic. Switch sections 4F and 4R transfer control of the Delay resistance from internal to remote, and also short the internal DELAY control when the TIME/DIV switch is set to .2 mSEC. Section 3F shifts control of the Normal and Single Display modes from internal to external program. Diodes are connected across all of the reed switch coils to clamp "inductive kick" voltages, when current through the coils is interrupted.

Most operations of the logic closures are multiple in nature. Several leads are grounded simultaneously, and each of the leads performs several operations. When the TIME/DIV switch grounds a lead, at least one reed switch is actuated, and the bias is changed on one or more logic gates simultaneously.

Operation of the 1F & R[1] section of the TIME/DIV switch provides an example of logic control. Assume TIME/DIV to be set to a sweep rate between 0.2 msec/div and 20 μsec/div. The lead grounded by switch section 1F & R grounds one end of R44 (Trigger and Holdoff Diagram). This forward biases Q44 and connects C44 holdoff capacitor into the trigger holdoff circuit; the same ground connection energizes L121 (Fast Ramp diagram) to connect C121 into the fast ramp rundown circuit. Pin 4 of J53 (Control Logic diagram) is grounded to turn on Q464. This turns on Q563 to light the Digital Unit 2nd decimal neon D2. Pin 4 also grounds the anode of D490, turning on Q513 to light the Digital Unit symbol "M". If the Digital Unit is programming a time measurement, with the Type 3T4 SWEEP MODE switch at NORM or SINGLE DISPLAY and the VARIABLE at CALIB, the Digital Unit symbol "S" is already lighted. As seen from the above description, reed switches and logic gates change the Type 3T4 internal circuits, and the Logic Card circuits operate the Digital Unit logic circuits.

Transistors diagrammed down the right side of the Control Logic diagram, Q513 through Q563, operate Digital Unit logic leads only if Logic Enable transistor Q504 is conducting. Q504 conducts when the Digital Unit programs a time measurement, with Type 3T4 SWEEP MODE at NORM or SINGLE DISPLAY, and VARIABLE at CALIB. Q504 conduction does not forward bias any of the Digital Readout Driver transistors, but brings their base bias resistor networks to a voltage very nearly turning them on. If Q504 is not conducting, all of the Digital Readout Driver transistors are biased into cutoff, and the biasing resistor networks prevent the rest of the logic circuits from turning them on.

Q513-Q523-Q533 conduct one at a time, to turn on the characters "M", "μ", or "N" in the Digital Unit letter Nixie. These three transistors are interlocked by prior Logic Card circuitry so that no more than one of them conducts for any given condition. Fig. 3-12 shows the conditions of Q504 and Q513 that allowed the previous example to light the Digital Unit "M" and "S" symbols in the letter Nixie. Driver transistors Q513 through Q563 have special operating characteristics. A forward bias of +0.4 volt will cause only a 20-nanoampere collector current with E_c +120 volts; yet these transistors conduct about 6-ma collector current with a forward bias of +0.68 volt. Fig. 3-12, Q513 bias is +0.6 volt at (a), +0.34 volt at (b), and —0.09 volt at (c); therefore, Q513 conducts at (a) only. Should the anode of D490 be grounded when conditions are as in Fig. 3-12 (c), Q513 total bias volts would be essentially +0.3 volt, and Q513 would not light the Digital Unit "M" symbol. D490 serves to disconnect L121 and its low-resistance path to —12.2 volts when the "M" lamp is not required, and to permit J53-6 to be grounded without turning on L121.

Q513 through Q563 all operate with the same bias conditions. None will turn on either a letter Nixie or a decimal neon in the Digital Unit unless Q504 is conducting. When the Digital Unit is programmed for a voltage measurement, Q504 is turned off by opening the ground connection in the Digital Unit. The "S" symbol in the letter Nixie is then turned off, and both the letter Nixie and the decimal neons are controlled by the vertical plug-in unit.

[1] **"IF & R Section" refers to both front and rear sides of the first TIME/DIV switch wafer back of the front panel. This section of the switch controls three contact groups for operating the trigger holdoff and the fast ramp capacitors.**

The letter Nixie Digital Readout drivers Q513-Q523-Q533 must each be programmed separately to operate. However, the "decimal" drivers Q543-Q553-Q563 require only two logic inputs. If Q553 and Q563 are both off, the D553-D554 OR gate lets R540-R541 turn on Q543, to automatically program the Digital Unit decimal neon (either D4 or D5, depending upon the position of the Type 3T4 DISPLAY MAG-SAMPLES/SWEEP switch).

The emitter circuit for each set of three driver transistors include a germanium diode (D533 and D563) that permits a driver transistor emitter to go positive momentarily when a transistor first turns on. This permits the 2.7-k emitter resistor (R533 or R563) to discharge decoupling capacitors such as C561 through C578 (at P22 and in the Digital Unit) without damaging the transistor—as would be the case if the emitter were solidly grounded. Another protective diode D504, limits the reverse bias seen by Q504 emitter-base junction when Q504 is not required to enable the Digital Unit Drivers.

Logic Decoder transistors and diodes form several logic gates. Starting at the top of the Control Logic diagram, Table 3-1 lists each logic circuit, its components, type ,and input leads referenced to J53. Table 3-1 is valuable in servicing, and checking for proper Type 3T4 operation.

A complete Logic Block diagram follows the schematic drawings at the back of this manual.

Examples of the logic gates are given here, using Table 3-1 for reference. Not all gates will be described, as several are similar in function.

1. Simple OR gates in the Logic Decoder are made up of diodes only. For instance: D494-D495 allow either pin J53-18 **or** Q473 (which operates by pins J53-8 and J53-15) to turn on Q523 and the Digital Unit "μ" Nixie.

2. A simple AND gate is Q473-D470. This AND gate turns on the Digital Unit D2 neon and the "μ" Nixie when P53-8 **and** P53-15 are both grounded. D470 assures that Q473 will not turn on (by base current through R471) whenever P53-15 is not grounded. When P53-15 is not grounded, D470 passes enough current through R471 and Q434 so Q473 cannot turn on, but at the same time Q434 does not conduct enough to turn on Q553.

3. A simple 3-in-NOR circuit is Q454-D450-D451-D452. Q454 will conduct when neither D450, **nor** D451, **nor** D452 conducts current from R450 to ground. When none of the diodes conduct, the biasing resistors R450-R451-R452 turn Q454 on.

4. A more complicated Anti-coincidence circuit is Q434-D434. Q434 will conduct when P53-15 is grounded and P53-8 and P53-9 are not grounded. D434 prevents Q434 from conducting and therefore turning on Q473 incorrectly, whenever Q443 is conducting (this is also described below as D434 preventing low-β reverse transistor operation of Q434).

5. There are four single diode gates in the Logic Decoder that are used primarily for externally controlled real-time sampling operation. P80-18 must be externally grounded for all sweep rates of real-time sampling; therefore, D120 prevents interfering control of the Logic Decoder through P53-15. The other diodes simply permit external circuits to operate the Digial Unit logic when the TIME/DIV switch is at REMOTE PROGRAM.

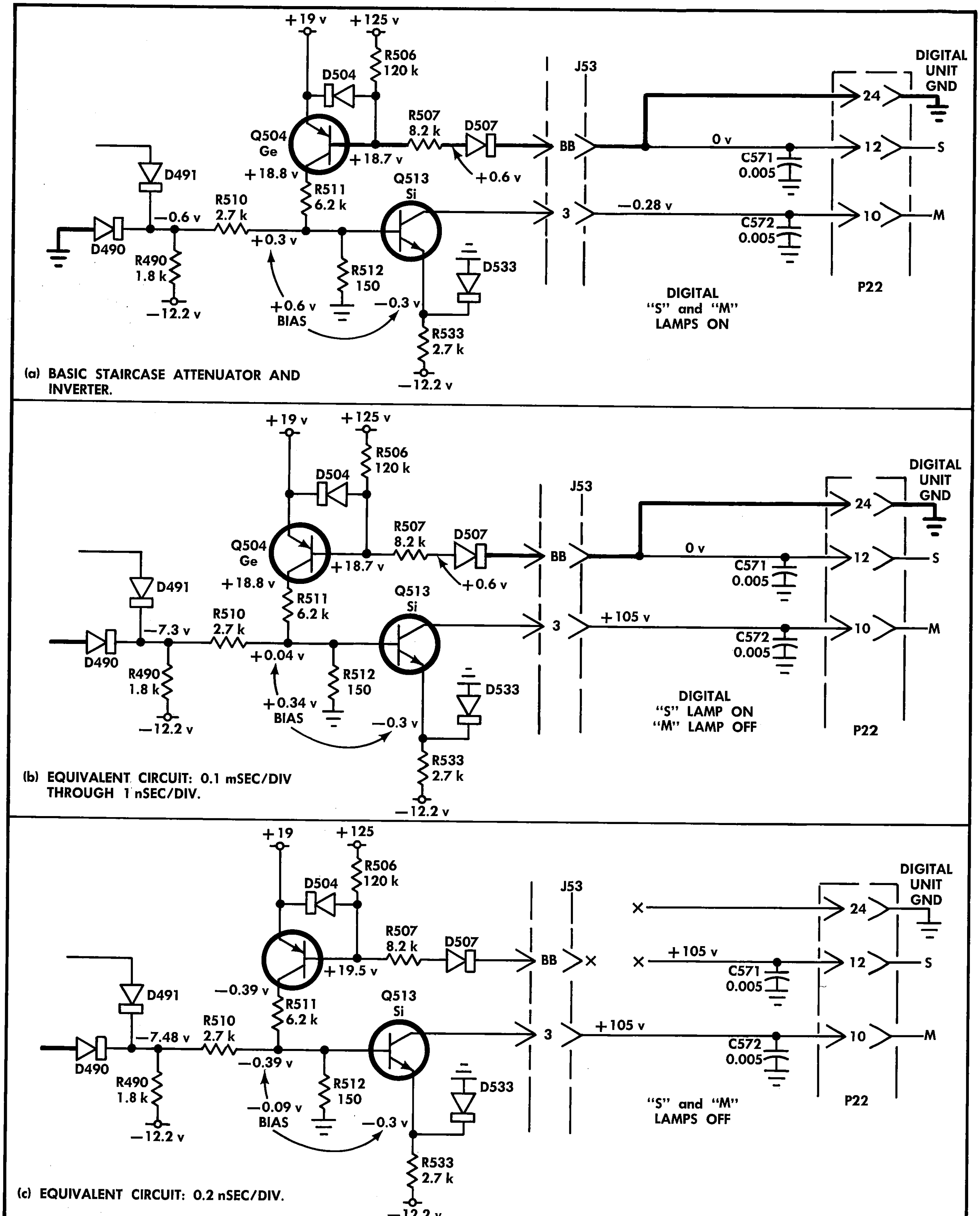


Fig. 3-12. Three possible conditions of Q504-Q513 and Digital Unit 'S' and 'M' units lamps.

TABLE 3-1

Control Logic Card Logic-Gates
with input leads referred to J53.

Components	Transfer Function (pins J53)	Gate Type	Output (At 1000 Samples/Sweep)
D490-D491	6+4	OR	Operates "M" units.
D494-D495	8•15+18	OR	Operates "μ" units.
Q484	15•$\overline{8}$	Anti-coincidence	Operates "N" units.
Q473, D470	8•15	AND	D2 and "μ" units.
D430-D431	8+9	OR	
Q434-D434	15•$\overline{(8+9)}$	Anti-coincidence	D3 & 0.1 μsec-20 nsec recognizer.
Q443-D440	18•9	AND	D3 & 1 μsec-2 μsec recognizer.
Q464-D464	4•(CC+24+25)	AND	D2 & 0.1 msec-20 μsec recognizer.
Q454-D450-D451-D452	$\overline{CC+24+25}$	3-in-NOR	D3 & 0.2 msec recognizer.
D553-D554	$\overline{(Q553+Q563)}$	OR	D4 in absence of D2 or D3.
D550	17 & P80-13		Real-time input for D3.
D465	5 & P80-12		Real-time input for D2.
D491	6 & P80-14		Real-time input for "M" units.
D120	P80-18+$\overline{15}$	Exclusive OR	Real-time: allows C123 remote connection without making input to Logic Decoder through J53-15.

Numerous silicon diodes are used throughout the Logic Decoder. Most are in active logic circuits, but some are not. One diode that is not part of an active logic circuit is D464 in the collector lead of Q464. Another diode, D434 in the collector of Q434, is part of an active logic circuit. Each diode prevents reverse transistor operation of Q434 and Q464 respectively. If these diodes were not in the circuit, reverse voltages would sometimes be applied to the transistors, which would then operate with low β in the reverse direction. The diodes assure that the two transistors will maintain high collector circuit impedance at times when reverse voltage is applied.

Several diodes are used for lead isolation. For instance, D450 (near pin J53-25) permits pins J53-24 or J53-CC to be grounded without also grounding J53-25 and turning L53 on.

The resistors R572 through R578, and the Zener diode D579 with R579, (diagrammed at the right side of the page) all act to prevent the Digital Unit "letter" and "decimal" lamps from flickering when they are not programmed. They also prevent the Digital Unit from applying excessive voltage to the digital driver transistor collectors.

Power Supplies

The Type 3T4 contains both a +19- and a —19-volt electronically regulated power supply. The +19-volt supply receives its unregulated dc from T702 and the associated fullwave bridge rectifier. The —19-volt supply receives its current from the oscilloscope —100-volt supply. Regulation and the output voltage of both supplies depends upon the oscilloscope —100-volt supply.

+19-Volt Supply. 6.3 vac entering the Type 3T4 through P21 pins 1 and 2 supplies power to the primary of T702. T702 secondary provides power to the fullwave bridge rectifier D722 A, B, C, and D, producing about +30 volts dc across C722. (C720 reduces high-frequency drive from T702 secondary.)

The regulator circuit consists of a single transistor comparator Q724, and a series regulator transistor Q727. Q724 compares a voltage very near ground (from D723) to the voltage at the center of precision divider R727-R728. The precision divider provides essentially ground level voltage to the base of Q724 when the regulator output voltage is +19. Q724 collector circuit supplies +19.6 volts at the correct base current drive level to Q727. D723 passes any current from R723 to ground that is not needed by Q724, and serves to temperature-compensate the supply. D723 also protects Q724 from damage should the base-collector junction of Q727 short circuit. D723 then reverse biases and lets Q724 emitter "see" the degeneration of R723. R723 is normally not degenerative to Q724 because of D723 conduction.

Assume the output voltage rises positively, caused by reduced load or by increase in the +30-volts. The precision divider R727-R728 will apply more forward bias to Q724 (aided at high frequencies by C726-R726) increasing Q724 collector current, which in turn robs base current from Q727. Q727 then increases its emitter output resistance and the output voltage drops to the correct value again. C729 helps to reduce the supply high-frequency output impedance.

—19-Volt Supply. Current for the —19-volt supply comes from the oscilloscope —100-volt supply, through R737 to both the output load and the emitter of shunt regulator

Q737. Q734 is a one-transistor comparator that compares a voltage near ground (from D734) to the voltage at the center of precision voltage divider R731-R732. The circuit operates in much the same way as the comparator of the +19-volt supply.

Assume the output voltage goes positive due to increased load (not due to a change in the regulated —100 volts). The precision divider will provide less current to the base of Q734, decreasing Q734 current drive to the base of Q737. Q737 then draws less current, letting R737 pull the output voltage back to normal. C733-R733 aid the supply correction for high frequencies. C730 helps to reduce the supply high-frequency output impedance.

Interconnections

Oscilloscope interconnections are made through two 24-pin connectors at the rear of the Type 3T4. The top horizontally mounted connector is used for normal oscilloscope operation, providing power to the Type 3T4 and trigger connections from the vertical unit. The vertically mounted connector handles information to the Type 567 and its Digital Unit.

All components identified on the Interconnections & Power Supply diagram are also included with the other drawings. Such duplication is done in an attempt to make the reading of diagrams easier.

SECTION 4
MAINTENANCE

Introduction

This section contains maintenance instructions for the Tektronix Type 3T4, and includes preventive maintenance, troubleshooting hints, and corrective maintenance.

Preventive Maintenance

Preventive maintenance consists of cleaning, visual inspection, lubrication, and, if needed, recalibration. Preventive maintenance is generally more economical than corrective maintenance, since preventive maintenance can usually be done during idle periods at a time convenient to the user. The preventive maintenance schedule established for the instrument should be based on the amount of use and the environment in which the instrument is used.

Cleaning. The Type 3T4 should be cleaned as often as operating conditions require. The Type 567 air filter provides nearly 100% protection against dust accumulating in the interior of the instrument, but a small amount of dust is brought in by circulating air. Operation without the side panels in place is never recommended for internal temperature control reasons.

Dirt on the circuit components prevents efficient heat dissipation and may cause component overheating. Clean the instrument by loosening the accumulated dust with a dry, soft paint brush. Remove the loosened dust by vacuum and/or dry, low-pressure compressed air (high-velocity air can damage some components). Hardened dirt and grease may be removed with a cotton-tipped swab or a soft cloth dampened with water and a mild detergent solution (such as Kelite or Spray White). Abrasive cleaners should not be used.

CAUTION

Do not permit water to get inside controls or shaft bushings. Store the instrument in a dust-tight covering when not in use.

Dirt in the Type 567 air filter chokes the flow of cooling air and leads to excessive Type 3T4 operating temperatures. Inspect and clean the air filter as often as operating conditions require.

Remove light dirt loads from the air filter by gently rapping the filter on a hard surface, dirty side down. Flush the remaining dirt and grease from the filter with a gentle stream of hot water; flush from the clean side. Heavy dirt loads that cannot be removed by the foregoing treatment are removed by agitating the filter up and down in a solution of hot water and soap or mild detergent.

After the filter is cleaned, rinse and let dry. Spray the filter with an adhesive such as "Filter Kote" (Tektronix Part No. 006-0580-00) or "Handi-Koter" (these products are normally available from air-conditioner suppliers). Let the filter dry from 2 hours to overnight before reinstalling in the instrument. Do not use lubricating oil or kerosene on the air filter.

Lubrication. The life of potentiometers, rotary switches and the fan motor is lengthened if these devices are kept properly lubricated. Use a cleaning type lubricant (such as Cramoline) on shaft bushings, plug-in connector contacts, and switch contacts. Lubricate the switch detents with a heavier grease (Beacon grease No. 325 or equivalent). Lubricate the fan motor bearings with a few drops of light machine oil (do not over-lubricate). The necessary materials and instructions for proper lubrication of Tektronix instruments are contained in a component lubrication kit which may be ordered from Tektronix. Order Tektronix Part No. 003-0342-00.

Visual Inspection. After cleaning, the instrument should be carefully inspected for such defects as poor connections, damaged parts, and improperly seated tubes or transistors. The remedy for most visible defects is obvious; however, if heat-damaged parts are discovered, determine the cause of overheating before the damaged parts are replaced. Otherwise, the damage may be repeated.

Tube and Transistor Checks. Periodic preventive maintenance checks consisting only of removing the tubes and transistors from the instrument and testing them in a tester are not recommended. The circuits within the instrument provide the only satisfactory means of checking tube and transistor performance. Defective tubes or transistors will usually be detected during recalibration of the instrument. Details of in-circuit tube and transistor checks are given in the troubleshooting procedures later in this section.

Recalibration. To ensure accurate measurements, the instrument calibration should be checked after each 500 hours of operation or every six months if the instrument is used intermittently. The calibration procedure is helpful in isolating major troubles in the instrument. Moreover, minor troubles not apparent during regular operation are frequently revealed and corrected during recalibration. Complete calibration instructions are contained in Section 5.

Corrective Maintenance—General

General Troubleshooting. If the instrument is not operating, attempt to isolate the trouble by a quick operational and visual check. Make sure that any apparent trouble is actually due to a malfunction within the Type 3T4 and not due to improper control settings or a fault in associated equipment.

Operate the controls to see what effect, if any, they have on the trouble symptoms. The normal or abnormal operation of each particular control helps in establishing the nature of the trouble. The normal function of each control is listed in Section 2 of this manual.

If the trouble cannot be located by means of front-panel checks, remove the oscilloscope side panel and check voltages and waveforms against those presented in the circuit descriptions and schematics, starting with the power-supply connections.

CAUTION

Be careful when making measurements on live circuits. The small size and high density of components used in this instrument result in close spacing. An inadvertent movement of the test probes, or the use of oversized probes may short between circuits.

Component Numbering. The circuit number of each electrical part is shown on the circuit diagrams. Note that a functional group of circuits (such as the power supply) is assigned a particular series of numbers. Table 4-1 lists the circuits or functional groups of circuits and the series of component numbers assigned to them.

TABLE 4-1

Component Numbering

Circuit	Component No. Series
Trigger and Holdoff	0-49
Staircase Attenuator and Inverter	50-99
Fast Ramp Generator	100-199
Staircase Generator	200-299
Horizontal Amplifier	300-399
Control Logic	400-599
Power Supply	700-799

Identification of Switch Wafers. Switch wafers shown on the circuit diagrams are numbered from the first wafer located behind the detent section of the switch to the last wafer. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function. For example, the designation 2R printed by a switch section on a schematic identifies the switch section as being on the rear side of the second wafer when counting back from the front panel.

Wiring Color Code. The wiring in the Type 3T4 is color coded to facilitate circuit tracing. In the case of power-supply leads, the color code indicates the voltage carried, with the widest stripe denoting the first significant figure. Table 4-2 lists the color combinations and the voltages indicated by the colors.

TABLE 4-2

Power Supply Color Coding

Supply	Color Code
+300	Orange/Black/Brown on White
+125	Brown/Red/Brown on White
+19	Red/Black on White
—19	Red/Black on Tan
—100	Brown/Brown/Black on Tan

Parts Replacement. All parts used in the Type 3T4 can be purchased directly through your Tektronix Field Engineer or Field Office. However, replacements for standard electronic items can generally be obtained locally in less time than is required to obtain them from Tektronix. Replacements for the special parts used in the assembly of the Type 3T4 should be ordered from Tektronix since these parts are manufactured, or selected, by Tektronix to satisfy a particular requirement. Before purchasing or ordering, consult the Parts List in Section 6 to determine the value, tolerance, and ratings required. See "Parts Ordering Information" and "Special Notes and Symbols" on Page 1 of Section 6.

NOTE

When selecting the replacement parts, it is important to remember that the physical size and shape of a component may affect its performance at high frequencies. Parts orientation and lead dress should duplicate those of the original part since many of the components are mounted in a particular way to reduce or control stray capacitance and inductance. After repair, portions of the instrument may require recalibration.

Replacing Components on Etch-Wired Circuit Cards. Use ordinary electronic grade 60/40 solder and a 35- to 40-watt pencil soldering iron with a ⅛" wide chisel tip. The tip of the iron should be clean and properly tinned for best heat transfer in a short time to a soldered connection. A higher wattage soldering iron, if used and applied for too long a time, ruins the bond between the etched wiring and base material by charring the glass epoxy laminate.

The step-by-step technique is as follows:

1. To remove a component, cut the leads near the body. This frees the leads for individual unsoldering.

2. Grip the lead with needle-nose pliers. Apply the tinned tip of the soldering iron to the lead between the pliers and the card; then pull gently.

3. When the solder first begins to melt, the lead will come out, leaving a clean hole. If the hole is not clean, use the soldering iron and a toothpick or a piece of enamel wire to open the terminal hole. Do not attempt to drill the solder out since the "through-hole" plating might be destroyed.

4. Clean the leads on the new component and bend them to the correct shape. Carefully insert the leads into the holes from which the defective component was removed.

5. Hold the leads of tunnel diodes such as D15 and D25 with tweezers or pliers to form a heat sink. Apply the iron for a short time at each connection on the side of the board opposite the component to properly seat the component.

6. Apply the iron and a little solder to the connections to finish the solder joint.

Replacing Components on Ceramic Terminal Strips. Special silver-bearing solder is used to establish a bond to the ceramic terminal strips used in Tektronix instruments. This bond may be broken by repeated use of ordinary tin-lead solder or by excessive heating. Solder containing about 3% silver is recommended. Silver-bearing solder is usually available locally or may be purchased in one-pound rolls through your Tektronix Field Engineer or Field Office. Order by Tektronix Part No. 251-0514-00.

Because of the shape of the ceramic strip terminals it is recommended that a soldering iron with a wedge-shaped tip be used. A wedge-shaped tip allows the heat to be concentrated on the solder in the terminals. It is important to use as little heat as possible while producing a full-flow joint.

The step-by-step technique is as follows:

1. Use long-nose pliers for a heat sink. Attach pliers between the component and the point where heat is applied.

2. Use a 50- to 75-watt soldering iron with a clean tip, properly tinned with solder containing about 3% silver.

3. Apply heat directly to the solder in the terminal without touching the ceramic. Do not twist the iron in the notch as this may chip or break the ceramic strip.

4. Apply only enough heat to make the solder flow freely.

5. Do not attempt to fill the notch with solder; instead apply only enough solder to cover the wires adequately and form a small fillet. Overfilling the notches may result in cracked terminal strips. If the lead extends beyond the solder joint, clip off the excess close to the joint.

6. Remove all wire clippings from the chassis.

Ceramic Strip Replacement. Unsolder all connections, then use a 3/8" diameter by 3" long plastic or hardwood dowel and a small (2 to 4 oz.) mallet to knock the stud pins out of the chassis. Place one end of the dowel on the end of the stud pin protruding through the chassis. Rap the opposite end of the dowel smartly with the mallet. When both studs of the strip to be removed have been loosened in this fashion, the strip is removed as a unit. The spacers will probably come out with the studs. If not, they can be pulled out separately. An alternative method of removing the terminal strip is to use diagonal cutters to cut off the sides of the studs. The ceramic strip is removed and the studs pulled from the chassis with a pair of pliers. Replacement ceramic strips are supplied with studs and spacers, so the old studs need not be salvaged. The ceramic strip and its parts are shown in Fig. 4-1.

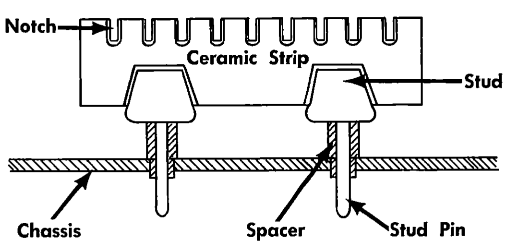


Fig. 4-1. The ceramic strip and its parts.

Transistor Replacement

Transistors should not be replaced unless they are actually defective. Transistor defects usually take the form of the transistor opening, shorting, or developing excessive leakage. To check a transistor for these and other defects, use a transistor curve display instrument such as a Tektronix Type 575. However, if a good transistor checker is not readily available, a defective transistor can be found by signal-tracing, by making in-circuit voltage checks, by measuring the transistor forward-to-back resistance using proper ohmmeter resistances, or by using the substitution method. The location of all transistors is silk-screened on the chassis next to each socket.

To check transistors using a voltmeter, measure the emitter-to-base and emitter-to-collector voltages and determine if the voltages are consistent with the normal resistances and currents in the circuit (see Fig. 4-2).

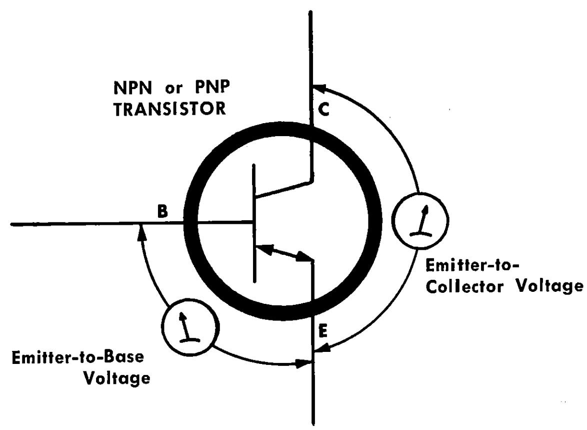


Fig. 4-2. In-circuit voltage checks NPN or PNP transistors.

To check a transistor using an ohmmeter, know your ohmmeter ranges, the currents they deliver, and the internal battery voltage(s). If your ohmmeter does not have sufficient resistance in series with its internal voltage source, excessive current will flow through the transistor under test. Excessive current and/or high internal source voltage may permanently damage the transistor.

NOTE

As a general rule, use the R × 1 k range where the current is usually limited to less than 2 ma and the internal voltage is usually 1½ volts. You can quickly check the current and voltage by inserting a multimeter between the ohmmeter leads and measuring the current and voltage for the range you intend to use.

When you know which ohmmeter ranges will not harm the transistor, then use those ranges to measure the resistance with the ohmmeter connected both ways as given in Table 4-3.

TABLE 4-3
Transistor Resistance Checks

Ohmmeter Connections*	Resistance Readings That Can Be Expected Using the R × 1 k Range
Emitter-Collector	High readings both ways (about 60 k to around 500 k).
Emitter-Base	High reading one way (about 200 k or more). Low reading the other way (about 400 Ω to 2.5 k).
Base-Collector	High reading one way (about 500 k or more). Low reading the other way (about 400 Ω to 2.5 k).

***Test prods from the ohmmeter are first connected one way to the transistor leads and then the test prods are reversed (connected the other way). Thus, the effects of the polarity reversal of the voltage applied from the ohmmeter to the transistor can be observed.**

If there is doubt about whether the transistor is good or not, substitute a new transistor; but first, be certain the circuit voltages applied to the transistor are correct before making the substitution.

When checking transistors by substitution, be sure that the voltages and leads on the transistor are normal before making the substitution. If a transistor is substituted without first checking out the circuit, the new transistor may immediately be damaged by some defect in the circuit.

Rotary Switches

Individual wafers or mechanical parts of rotary switches are normally not replaced. If a switch is defective, replace the entire assembly. The availability of replacement switches, either wired or unwired, is detailed in the Parts List.

Resistor Coding

The Type 3T4 uses a number of very stable metal film resistors identified by their gray background color and color coding.

If the resistor has three significant figures with a multiplier, the resistor will be EIA color coded. If it has four significant figures with a multiplier, the value will be printed on the resistor. For example, a 333 k resistor will be color coded, but a 333.5 k resistor will have its value printed on the resistor body.

The color-coding sequence is shown in Fig. 4-3 and Table 4-4.

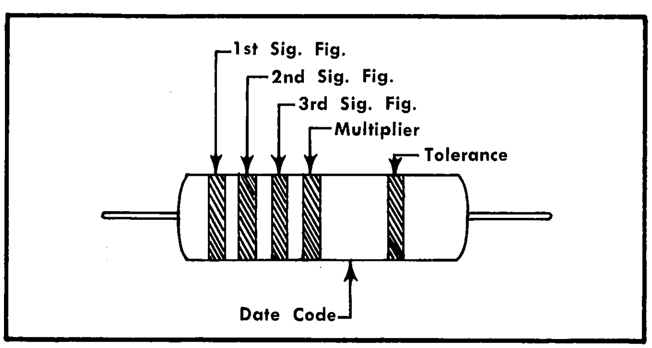


Fig. 4-3. Standard EIA color code for metal film resistors.

TABLE 4-4
Color-Code Sequence

Color	1st Sig. Fig.	2nd Sig. Fig.	3rd Sig. Fig.	Multiplier	(±) Tolerance
Black	0	0	0	1	—
Brown	1	1	1	10	1
Red	2	2	2	100	2
Orange	3	3	3	1,000	—
Yellow	4	4	4	10,000	—
Green	5	5	5	100,000	0.50
Blue	6	6	6	1,000,000	0.25
Violet	7	7	7	10,000,000	0.10
Gray	8	8	8	100,000,000	0.05
White	9	9	9	1,000,000,000	—
Gold				0.1	5
Silver				0.01	—
No Color					10

Parts Location

All parts on the etch-wired circuit cards are identified in Fig. 4-4, Fig. 4-5 and Fig. 4-6. All semiconductors on the left side of the main chassis are identified in Fig. 4-7. The components mounted underneath the two circuit card connectors are identified in Fig. 4-8.

Troubleshooting Resistance Checks

In the event of trouble, Table 4-5 may be of value when searching for the fault. The table lists the dc resistance to ground of each pin of P21, the horizontally mounted 24 pin rear-panel connector, when the Type 3T4 is disconnected from the oscilloscope.

TABLE 4-5
P21 DC Resistances To Ground

Pin	Approximate Resistance
1 and 2	60 k
3, 4 and 5	0
6	15 k
7 and 8	inf
9	0
10	14 k
11	50 k
12	2.8 k
13	18 k
14	inf
15	5.6 k
16	55 k
17	35 k
18	inf
19	0
20	5.6 k
21	34 k
22	0
23	4.6 k
24	inf

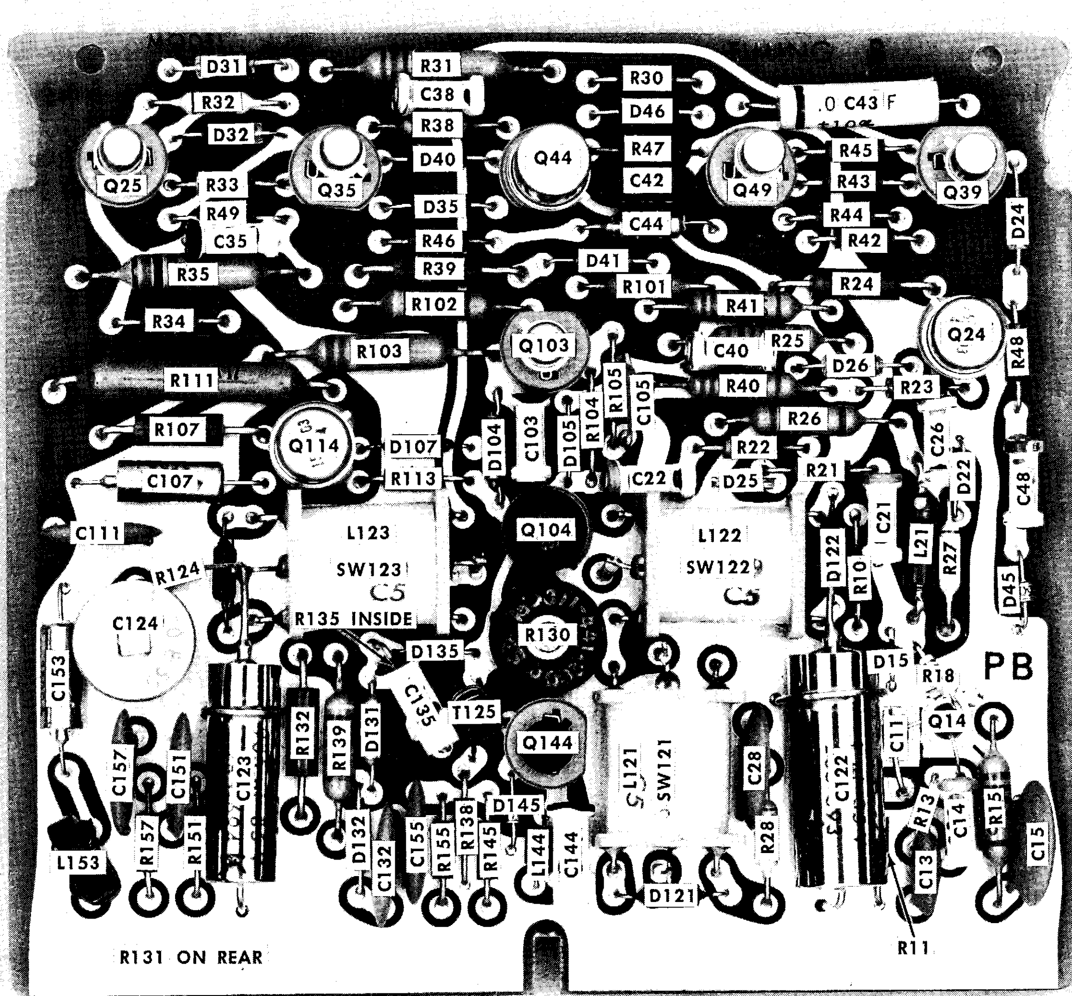


Fig. 4-4. Timing Card parts locations.

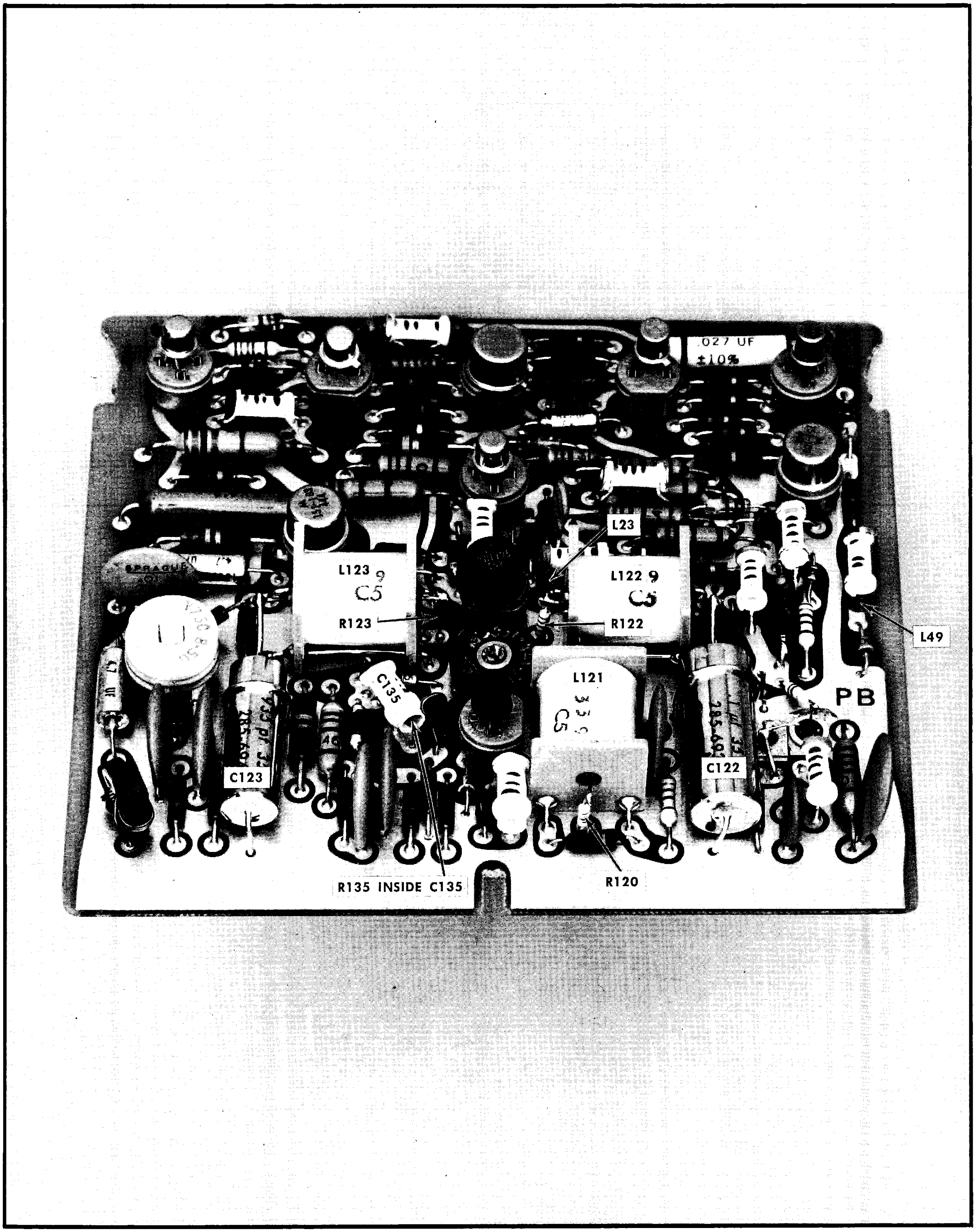


Fig. 4-5. Locations of difficult-to-find Timing Card parts.

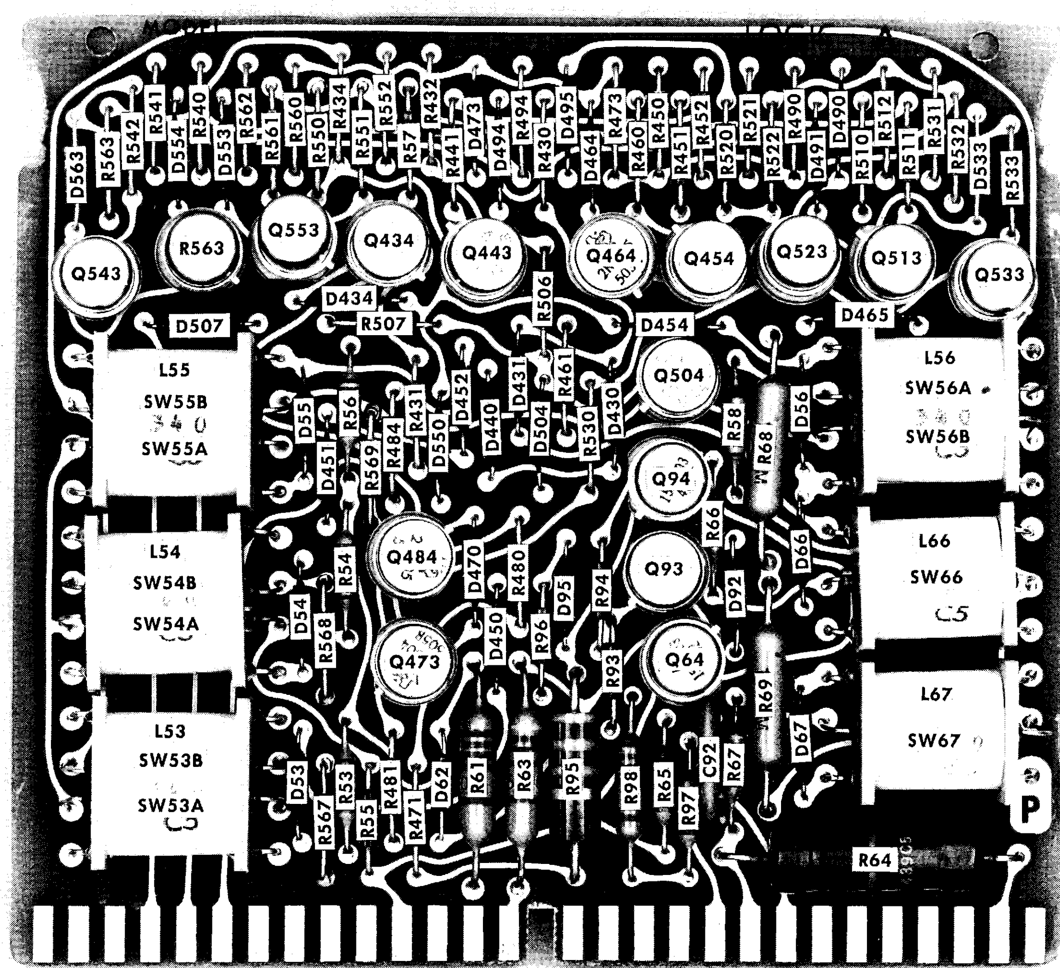


Fig. 4-6. Logic Card parts locations.

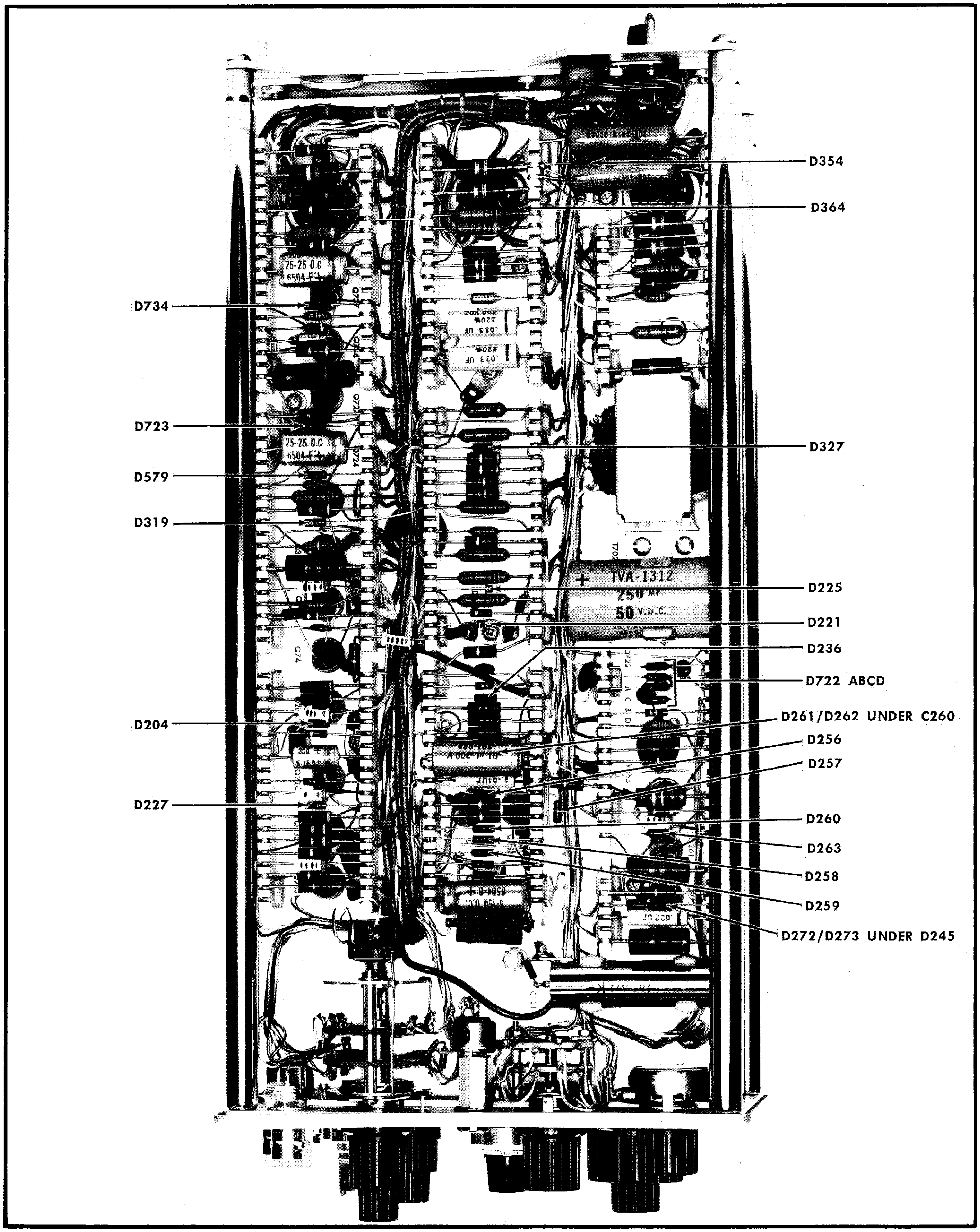


Fig. 4-7. Left side semiconductor locations.

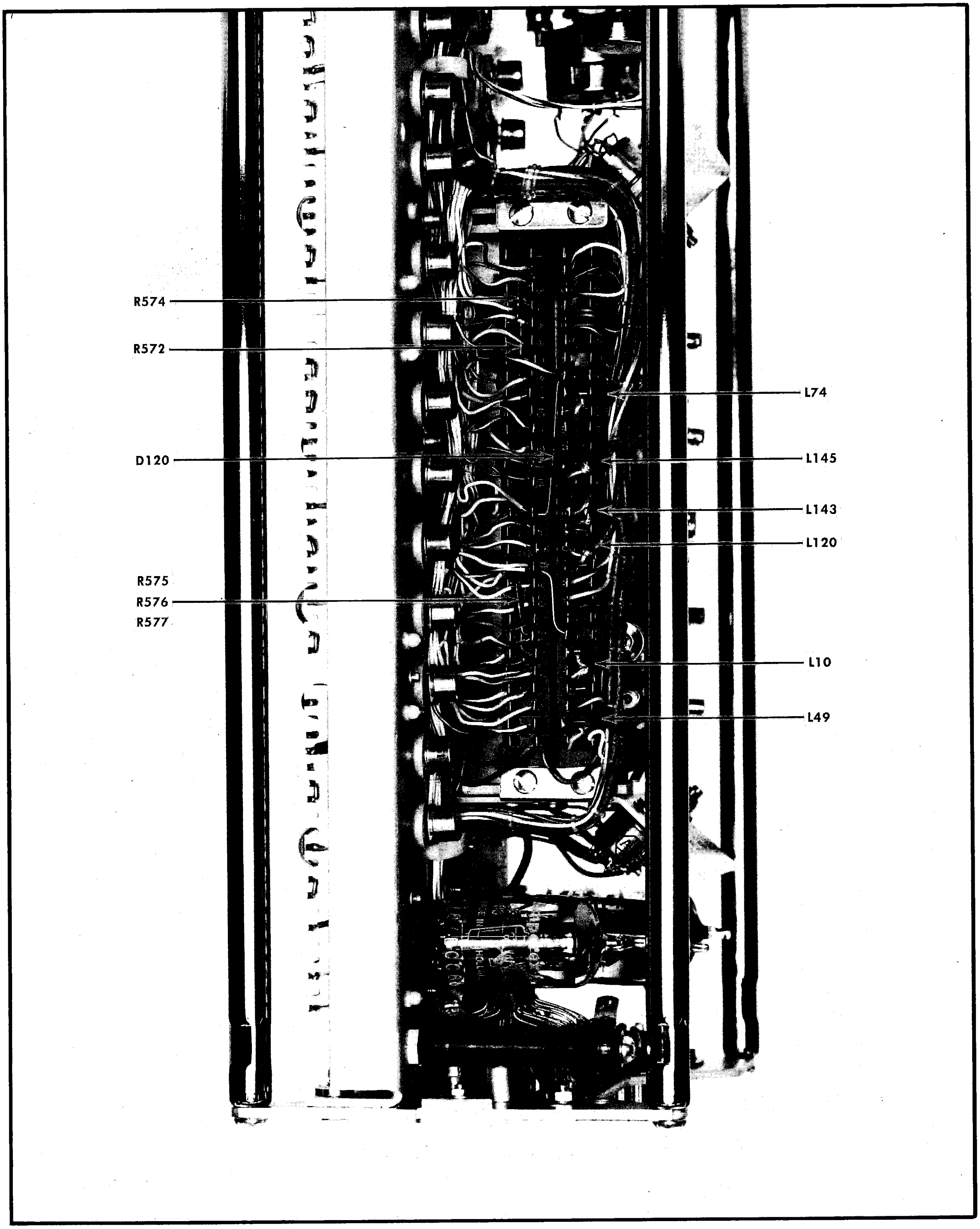


Fig. 4-8. Parts Location under circuit card connectors.

NOTES

SECTION 5
CALIBRATION

General

Recalibrate the Type 3T4 after each 500 hours of operation, or every six months if used intermittently. It may also be necessary to recalibrate certain sections of the instrument when tubes, transistors, or other components are replaced. Before recalibrating the instrument, clean it as outlined in Section 4.

NOTE

The performance standards described in this section of the manual are provided strictly as guides to calibration of the Type 3T4 and should not be construed as advertised performance specifications. However, if the Type 3T4 performs within the guide tolerances given in the calibration procedure, it will also perform as listed in the Characteristics section of this manual.

The following portion of this manual presents a step-by-step calibration and verification procedure. The title of each numbered step begins with "Adjust" or "Check", thereby identifying the step function as calibration or verification. The steps are identified in this manner because any or all groups of numbered "Checks" can be skipped without disrupting the adjustment continuity of the procedure. However, all adjustments must be completed in the order given and none should be skipped. Remember that proper overall operation is ensured when all steps in the procedure have been completed and all adjustments have been made as accurately as possible.

Do not set any internal adjustments to midrange as a preliminary to recalibration. Presetting internal adjustments to midrange makes it necessary to completely recalibrate the instrument.

Equipment Required

Equipment required for the complete calibration of the Type 3T4 is shown in Fig. 5-1 and Fig. 5-2, and listed below. Alternate equipment may be substituted for that listed, if the performance specifications of the substituted equipment meet the particular requirements of the test. All test equipment must be calibrated and in good working order.

System Components

1. A Tektronix Type 567 or Type RM567 Readout Oscilloscope in which the Type 3T4 will be normally operated. (Other Tektronix oscilloscopes listed in the Characteristics section of this manual may be used, if the Type 3T4 is normally to be operated in them.)

2. A Type 6R1A Digital Unit, or a Type 6R1 Digital Unit S/N 695-up.

3. A Type 3S76 Dual-Trace Sampling unit, or a Type 3S3 Sampling Probe unit.

Test Equipment

4. A 30 inch Flexible Extension, for operating the Type 3T4 outside the system oscilloscope; Tektronix Part No. 012-0066-00.

5. Two rigid 10 inch Plug-In Extensions; Tektronix Part No. 013-0034-00.

6. A Test Oscilloscope, such as the Tektronix Type 547 (shown), or other 540-Series Oscilloscope. Required bandpass, dc to 30 mc.

7. A Type W Plug-In Unit, for accurate voltage and waveform measurement. Permits measuring power-supply and dynamic voltages to within 0.2% with a variable dc comparison voltage. Minimum deflection factor required, 5 mv/cm. Required bandpass, dc to 23 mc at 50 mv/cm.

8. A Type 180A Time Mark Generator. For 0.2 msec through 1 μsec markers, and 5 mc, 10 mc and 50 mc sine-waves, all within 0.001%.

9. A Type 111 Pretrigger Pulse Generator. For pulses at approximate 100 kc rate, from 2 nsec to 20 nsec duration, $\leq$ 0.5 nsec risetime, and greater than 5-volt peak amplitude. Also for an approximate 10-volt pretrigger pulse that occurs $\leq$ 30 nsec to $\geq$ 250 nsec prior to fast-rise pulse.

10. A 10× Probe with BNC connector, Tektronix P6023 Probe.

11. A 1× Probe with BNC connector, Tektronix P6028 Probe.

12. A 50 Ω coax cable, RG-58A/U, with BNC connectors, approximately 43 inches long; Tektronix Part No. 012-0059-00.

13. A 50 Ω coax cable, RG-8A/U, with GR Type 874 connectors, 5 nsec signal delay; Tektronix Part No. 017-0502-00.

14. Two 50 Ω coax cables, RG-58A/U, with GR Type 874 connectors, 2 nsec signal delay, ±10%; Tektronix Part No. 017-0505-00. Only one required if you use the 1000 mc oscillator. See NOTE with item 21.

15. A 50 Ω coax Charge Line for the Type 111, with one GR Type 874 connector, 9 nsec signal delay; Tektronix Part No. 017-0506-00. (A 10 nsec signal delay 50 Ω coax with two GR Type 874 connectors may be substituted; Tektronix Part No. 017-0501-00.)

16. Two GR to BNC Female adapters; Tektronix Part No. 017-0063-00.

17. A GR to BNC Male adapter; Tektronix Part No. 017-0064-00.

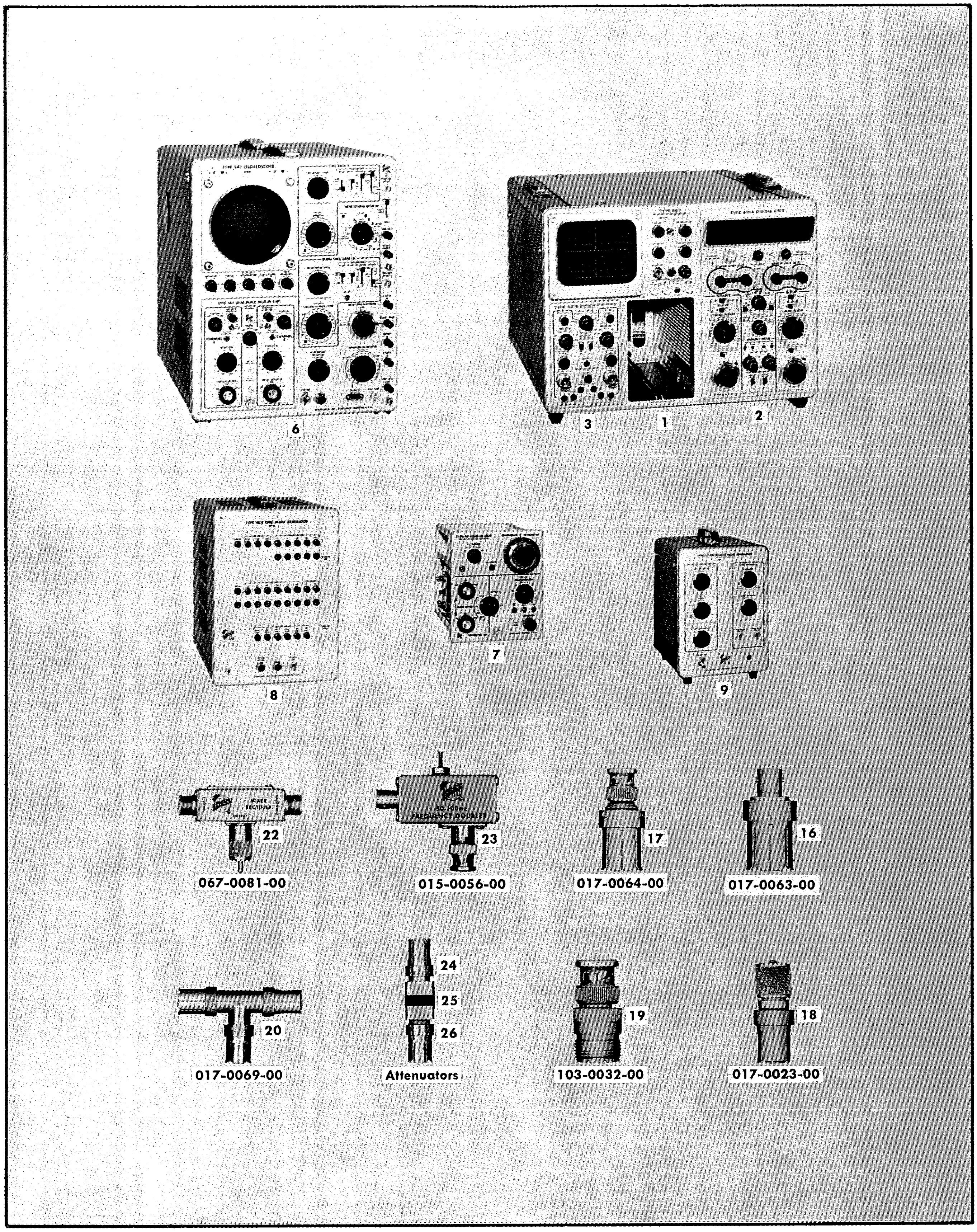


Fig. 5-1. Test equipment required for calibrating the Type 3T4.

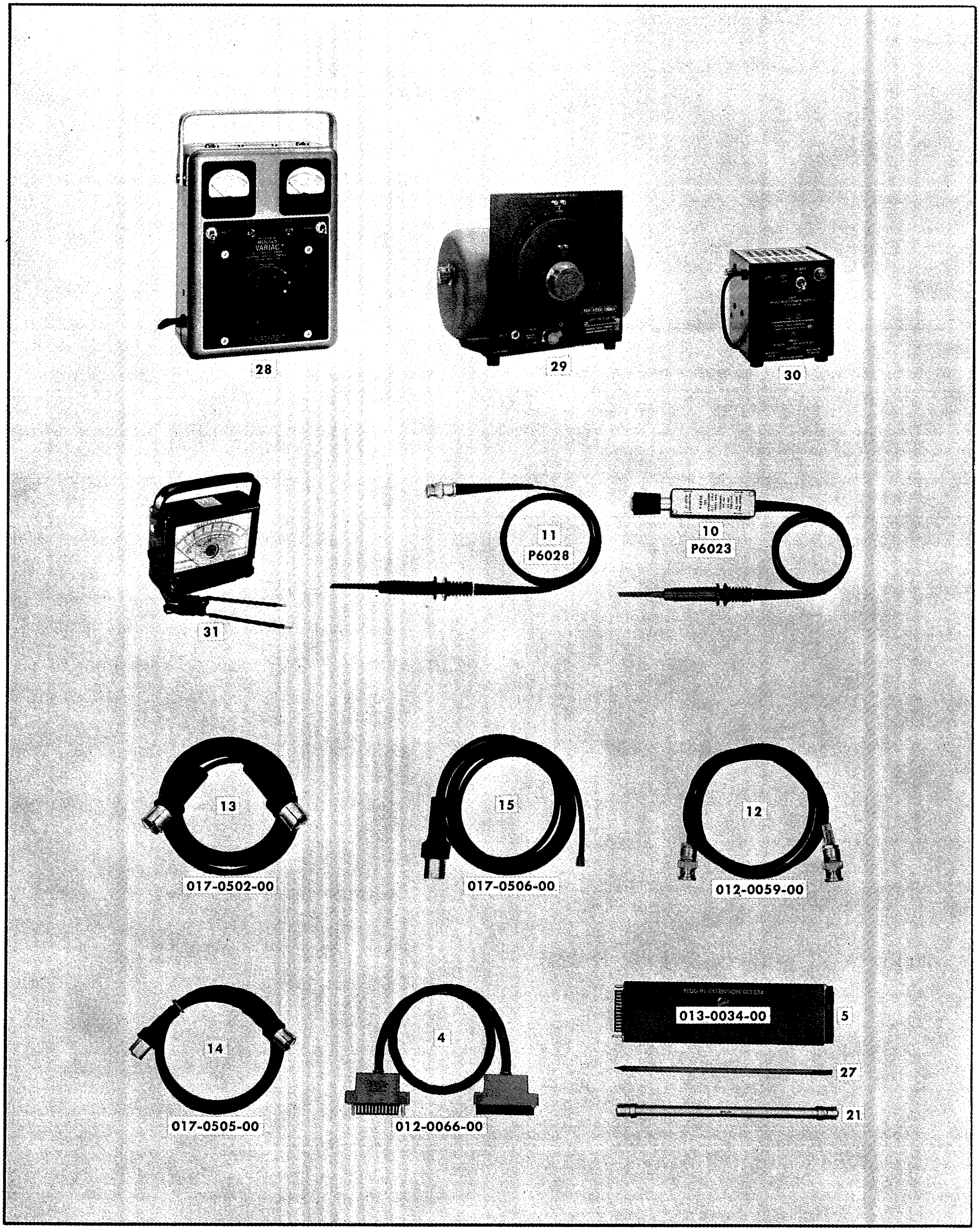


Fig. 5-2. Additional test equipment.

18. Two GR to UHF Male adapters; Tektronix Part No. 017-0064-00.[1]

19. A UHF Female to BNC Male adapter; Tektronix Part No. 103-0032-00.[1]

20. A GR Type 874 T; Tektronix Part No. 017-0069-00.

21. A 30 cm air line with GR Type 874 connectors. General Radio 874-L30.

NOTE

Item 21 is an alternate test item in case you do not use the 1000 mc oscillator called out below. See NOTE at Step 23 of the Calibration Procedure.

22. A Mixer-Rectifier, for calibrating 1000 mc oscillator; Tektronix Part No. 067-0081-00.[1]

23. A 50-100 mc Doubler, to double the Type 180A 50 mc sinewave output; Tektronix Part No. 015-0056-00, if your Type 180A has a BNC MARKER OUTPUT connector; Tektronix Part No. 015-0013-00, if your Type 180A has a UHF MARKER OUTPUT connector.

24. Two 10× 50 Ω in-line attenuators, with GR Type 874 connectors; Tektronix Part No. 017-0044-00.

25. A 5× 50 Ω in-line attenuator, with GR Type 874 connectors; Tektronix Part No. 017-0045-00.

26. Two 2× 50 Ω in-line attenuators, with GR Type 874 connectors; Tektronix Part No. 017-0046-00.

27. A non-conducting adjusting tool, such as an 8 inch soldering aid, 1/4 inch diameter; Tektronix Part No. 003-0209-00.

28. A Variable line-voltage autotransformer, such as the General Radio VARIAC, Type W10MT3W, metered, 600-watt rating.

29. A General Radio Unit Oscillator, Type 1218A, 900 to 2000 mc.

30. A General Radio Unit Power Supply, Type 1201B, for the 1000 mc oscillator.

31. A bench multimeter, for general servicing measurements. 20,000 Ω/V, such as Simpson 262.

32. A small insulated handle non-magnetic tool to short the crt horizontal deflection plate pins (not shown).

ABBREVIATED CALIBRATION PROCEDURE

___1. Check Control Indexing & Knob Positions. (Page 5-6)

___2. Check +19- and —19-Volt Power Supplies. (Page 5-7)
+18.73 to +19.27 v ______
—18.73 to —19.27 v ______
Ripple ≤ 7 mv p-p ______
Ripple ≤ 7 mv p-p ______

___3. Adjust TRIGGER SENS RANGE Control, R16. (Page 5-9)

___4. Check Signal At TRIG OUT Connector. Approx. 450 mv p-p ______ (Page 5-10)
RECOVERY TIME fully counterclockwise: 8 to 10 μsec period ______

___5. Prelim Adjust COMPARATOR LEVEL Control, R130. (Page 5-13)

___6. Adjust HORIZ GAIN Control, R301. 40 volts = 8 divisions. (Page 5-14)

___7. Check DISPLAY MAG X10 Horizontal Gain. 8 div ±2.4 minor div. (Page 5-15)

___8. Adjust INVERT IN ZERO Control, R70. Zero volts ±2 mv. (Page 5-15)

___9. Adjust STAIRCASE DC LEVEL Control, R263. Zero volts ±0.2 volts. (Page 5-15)

___10. Adjust STAIRCASE ATTEN ZERO Control, R60. ±85 mv of ground. (Page 5-16)

___11. Adjust Sweep MAG REGIS Control, R341. (Page 5-16)

___12. Adjust SWEEP LENGTH Control, R245. 10.5 div. (Page 5-17)

___13. Check Signal At SWEEP OUTPUT Connector. 1 volt/div ±10%. (Page 5-19)

___14. Check Staircase Holdoff Time. At least 2 msec. (Page 5-19)

___15. Final Adjust COMPARATOR LEVEL Control, R130. (Page 5-20)

___16. Adjust SWEEP CAL Control, R110. (Page 5-20)

___17. Prelim Adjust DELAY ZERO Control, R99. (Page 5-21)

___18. Adjust FAST RAMP Capacitor, C124. (Page 5-22)

___19. Adjust Staircase Samples/Sweep Capacitors, C258C & C258A. (Page 5-24)

___20. Adjust INTERNAL DELAY CAL Control, R85. (Page 5-25)

___21. Adjust Fast Ramp & Staircase Steps for Correct Digital Unit Readout. (Page 5-25)

___ Check Timing With Digital Unit.

___22. Final Adjust DELAY ZERO Control, R99. (Page 5-28)

___23 or 24. Check 1 nsec/div Sweep Rate. Air Line or 1000 mc. (Page 5-31 and 5-33)

___25. Check Fast Ramp Linearity. ±1.5%. (Page 5-35)

___26. Check High Frequency Sine Wave Triggering. (Page 5-35)
500 mc Internal ______
≤ 200 psec jitter. 1000 mc External ______
System test frequency if below that above ______

___27. Check Pulse Triggering. 2 nsec pulse, 25 mv EXT. ≤ 200 psec jitter. (Page 5-38)

___28. Adjust REMOTE DELAY CAL Control, R80. (Page 5-39)

___29. Check SINGLE DISPLAY Operation. (Page 5-40)

[1]These items are required only if a 1000 mc oscillator is used in calibrating the Type 3T4.

NOTES

CALIBRATION PROCEDURE

Preliminary

In the procedure that follows, test equipment setups are illustrated at important points, with control settings called out for the Type 3T4 and associated instruments. Control setting changes from the preceding step are always indicated in bold-face type.

Checks and Adjustments

1. Preliminary Control Check

Check all front-panel controls for proper indexing. Check the variable controls for smooth operation. Check that the DELAY dial reads 0.00 when fully counterclockwise. Correct any defects found.

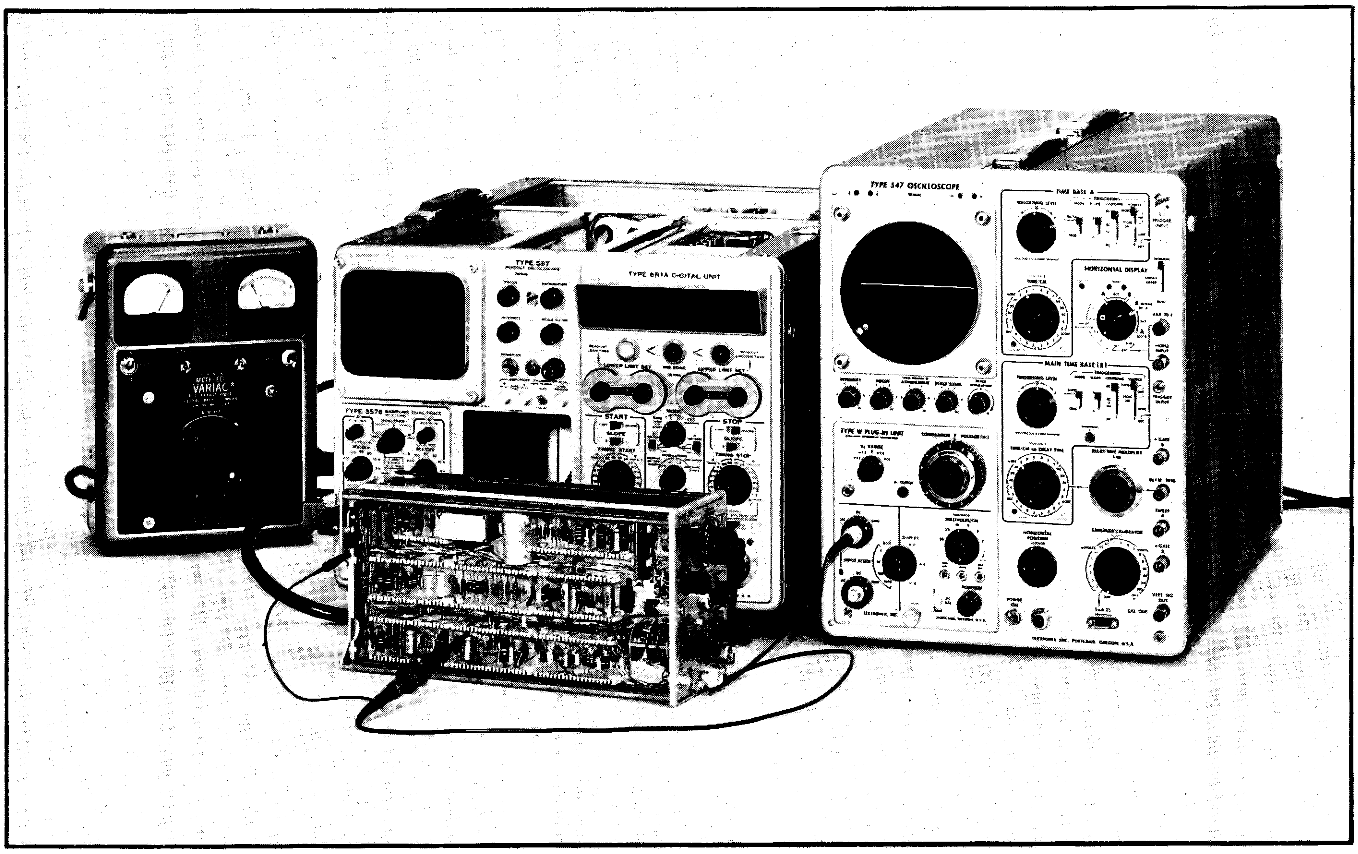


Fig. 5-3. Test setup for checking +19- and —19-volt supplies.

Control Settings

Type 3T4

POSITION	Midrange
TIME/DIV	10 nSEC
VARIABLE	CALIB
DISPLAY MAG	×1
SWEEP MODE	NORM
DELAY	0.00
MANUAL SCAN OR EXT ATTEN	Midrange
LEVEL	Clockwise
INT-EXT	+INT
RECOVERY TIME	Counterclockwise

Type 3S76

Mode	A ONLY
MV/DIV	200
SMOOTH-NORMAL	SMOOTH
POSITION	Midrange
DC OFFSET	Trace centered
NORM-INV	NORM
INTERNAL TRIGGER	A

Test Oscilloscope

TIME/CM	2 mSEC
Triggering MODE	Automatic
TRIGGERING LEVEL	0
SLOPE	+
SOURCE	INT-NORM

Type W

DISPLAY	A-B
Vc RANGE	+11
COMPARISON VOLTAGE (Vc)	1.900

Ⓐ

A Input Coupling	GND
INPUT ATTEN	10
MILLIVOLTS/CM	10

Connections

Connect the P6028 1× Probe to the Type W Unit Channel A input connector. Connect the probe ground clip to the Type 3T4 rear panel near V294, as shown in Fig. 5-3.

2. Check Internal Power Supply Voltage and Regulation

NOTE

Rapid air temperature changes due to drafts in the test area can cause minor voltage drift of either supply. Make the following voltage checks under constant or slowly changing temperature conditions.

a. Set up the equipment as shown in Fig. 5-3, using the plug-in extension cable to make connections between the Type 3T4 and the horizontally mounted J21 connector of the Type 567.

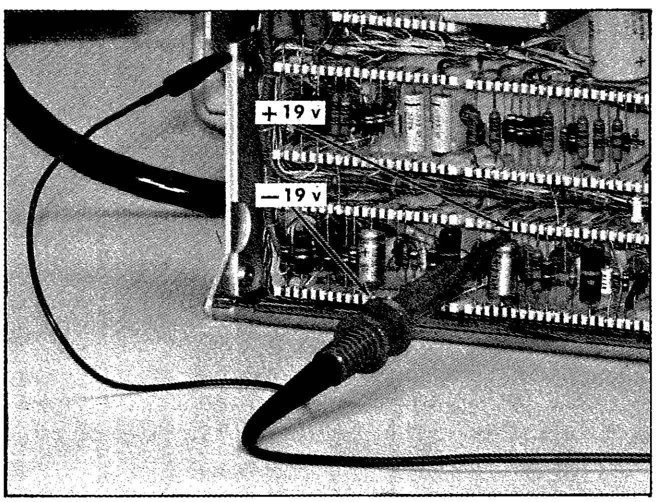


Fig. 5-4. Step 2 +19- and —19-volt power supply test points, left side of Type 3T4.

b. Connect the Type 567 to the variable line-voltage source and turn on all equipment. Set the Power-line voltage for the Type 567 at 117 volts (or 234 volts) and allow all equipment to warm up for 20 minutes before proceeding.

c. Adjust the Type W VAR BAL control so the test oscilloscope trace does not shift vertically as the MILLIVOLTS/CM switch is operated through its range of positions. Set the MILLIVOLTS/CM switch to 10. Position the trace to the crt graticule centerline.

d. Connect the 1× probe tip to the positive end of C729, the +19-Volt test point shown in Fig. 5-4.

e. Change the Type W switches simultaneously: change the DISPLAY switch and the Channel A input selector switches to A-Vc and DC, respectively. Re-center the trace with the COMPARISON VOLTAGE (Vc) control. The dial should be between the voltage values of +18.73 to +19.27 volts. 120 cps ripple voltage should be less than 7 millivolts, peak to peak. Disregard any trigger spikes that may be visible on the test oscilloscope display. If the supply voltage is outside the limits stated, check the Type 567 Oscilloscope —100-Volt supply, and then the Type 3T4, R727 and R728. Record the value of the +19-Volt supply in the space provided in the abbreviated procedure at the end of this section.

f. Operate the variable line-voltage autotransformer slowly through the range of 105 to 125 volts (210 to 250 volts if the Type 567 is wired for the higher line voltage). The Type 3T4 +19-Volt supply should stay within the limits stated in 2e. Switch the Type W DISPLAY and Channel A input switches back to A-B and GND simultaneously.

g. Set the Type W Vc RANGE switch to —11. Connect the 1× probe to the negative end of C730, the —19-Volts test point shown in Fig. 5-4. Set the Type W COMPARISON VOLTAGE (Vc) control to 1.900. Set the line voltage to 117 volts.

h. Simultaneously change the Type W DISPLAY and Channel A input selector switches to A-Vc and DC, respectively. Recenter the trace using the COMPARISON VOLTAGE (Vc) control. The dial should be between the voltage values of —18.73 to —19.27 volts. 120 cps ripple voltage should be less than 7 millivolts, peak to peak. Disregard any trigger spikes that may be visible on the test oscilloscope display. If the supply voltage is outside the limits stated, check the Type 567 Oscilloscope —100-Volt supply, and then the Type 3T4, R731 and R732. Record the value of the —19-Volt supply.

i. Operate the variable line-voltage autotransformer slowly through the range of 105 to 125 volts (210-250). The Type 3T4 —19-Volt supply should stay within the limits stated in 2h. Simultaneously switch the Type W DISPLAY and Channel A input selector switches to A-B and GND, respectively.

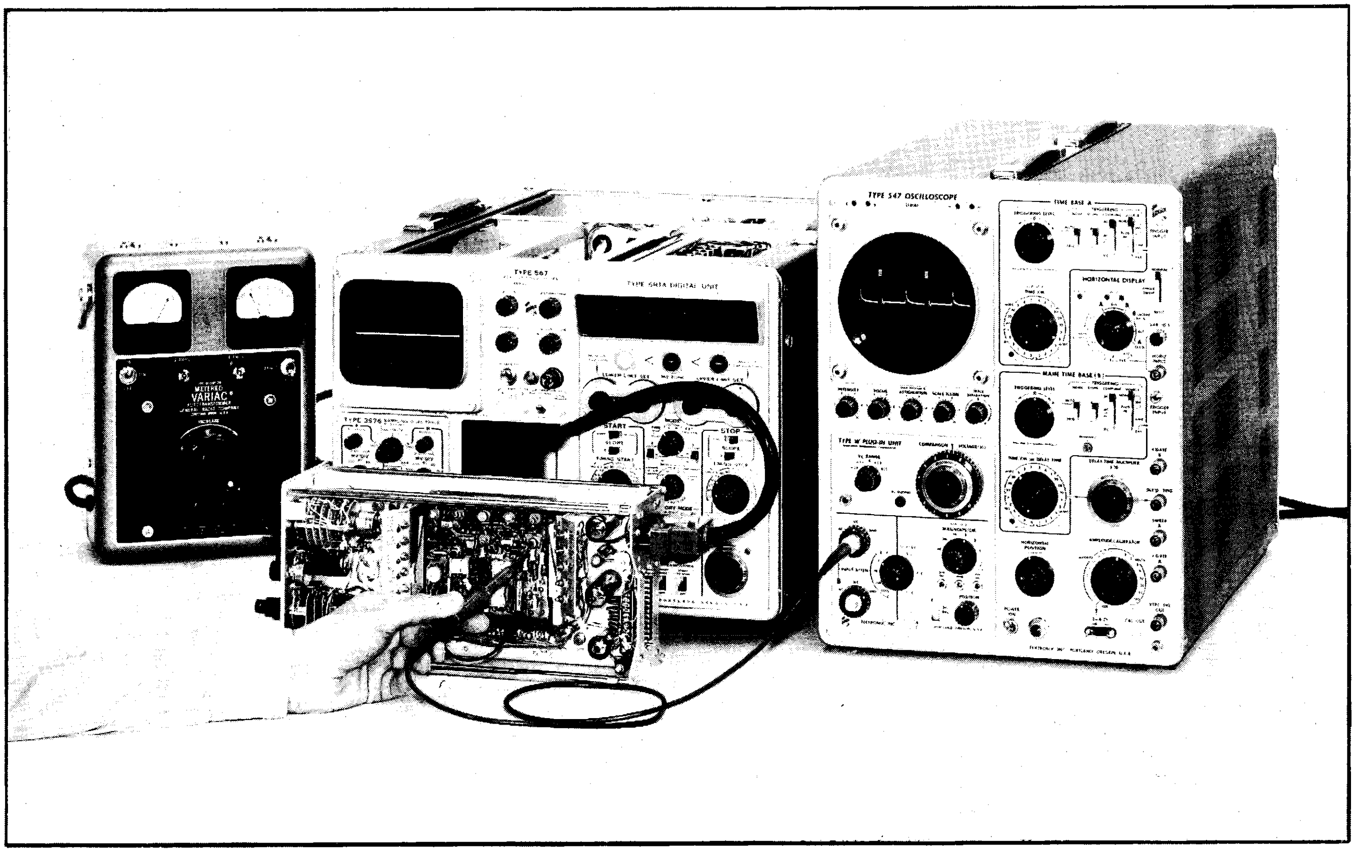


Fig. 5-5. Step 3 test setup for adjusting TRIGGER SENS RANGE control, R16.

Control Settings

Type 3T4

POSITION	Midrange
TIME/DIV	10 nSEC
VARIABLE	CALIB
DISPLAY MAG	×1
DELAY	0.00
SWEEP MODE	NORM
MANUAL SCAN OR EXT ATTEN	Midrange
LEVEL	**2 o'clock**
INT-EXT	+INT
RECOVERY TIME	Counterclockwise

Type 3S76

All Controls	As set

Type 6R1A

CRT INTENSIFICATION switches	OFF

Test Oscilloscope

TIME/CM	**2 μSEC**
Triggering MODE	Automatic
TRIGGERING LEVEL	0
SLOPE	+
SOURCE	INT

Type W

DISPLAY	A-B
Vc RANGE	**0**
A Input Coupling	**DC**
INPUT ATTEN	**1**
MILLIVOLTS/CM	**5**
POSITION	**Trace at —1 cm, no signal**

Connections

Remove the 1× probe from the Type W Channel A input. Install the 10× probe to the Type W Channel A input connector. Check the probe compensation. Reset the test oscil-

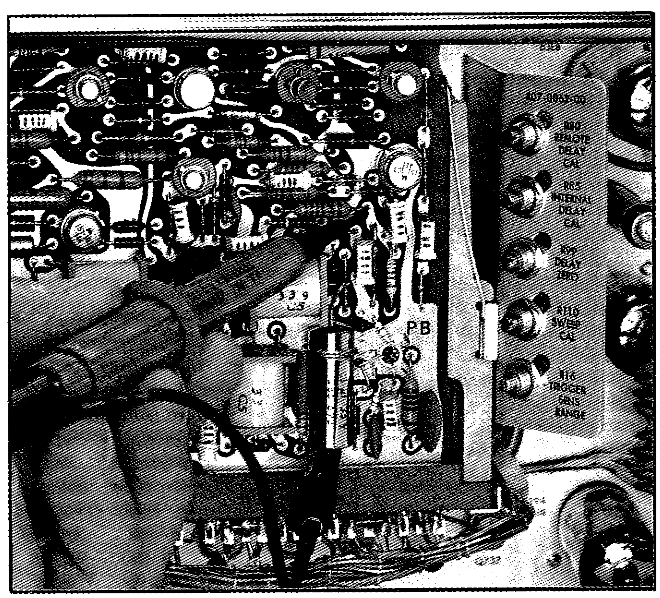


Fig. 5-6. Step 3 junction of L21-D22 and probe ground-clip location.

Ⓐ

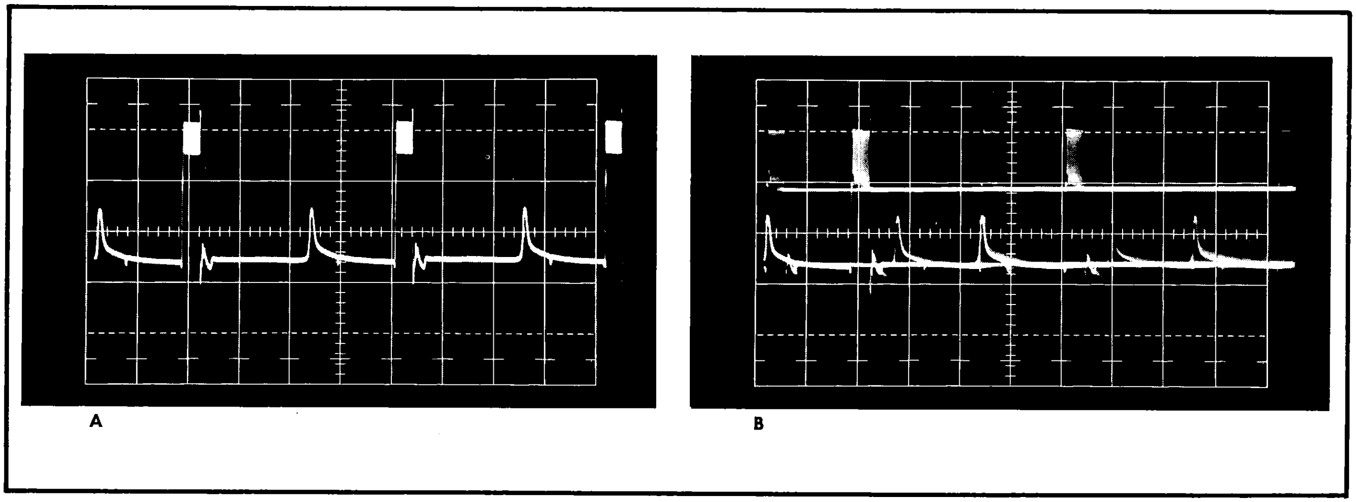


Fig. 5-7. Step 3 TRIGGER SENS RANGE R16, test oscilloscope waveforms.

loscope and Type W as above. Attach the probe ground clip to the ground lead of C122 (connection shown in Fig. 5-6).

3. Adjust TRIGGER SENS RANGE Control, R16 ❶

a. Set up the equipment and make the connections shown in Fig. 5-5. Set the test oscilloscope no-signal trace level one cm below the graticule centerline.

b. Touch the probe tip to the junction of D22-L21 (shown in Fig. 5-6) and obtain a stable display on the test oscilloscope similar to Fig. 5-7a.

c. Set the Type 3T4 LEVEL control carefully to 12 o'clock.

d. Adjust the TRIGGER SENS RANGE control, R16, until the Type 3T4 trigger circuit free runs part of the time, giving a test oscilloscope display similar to Fig. 5-7b.

e. Remove the probe tip from the junction of D22-L21.

NOTES

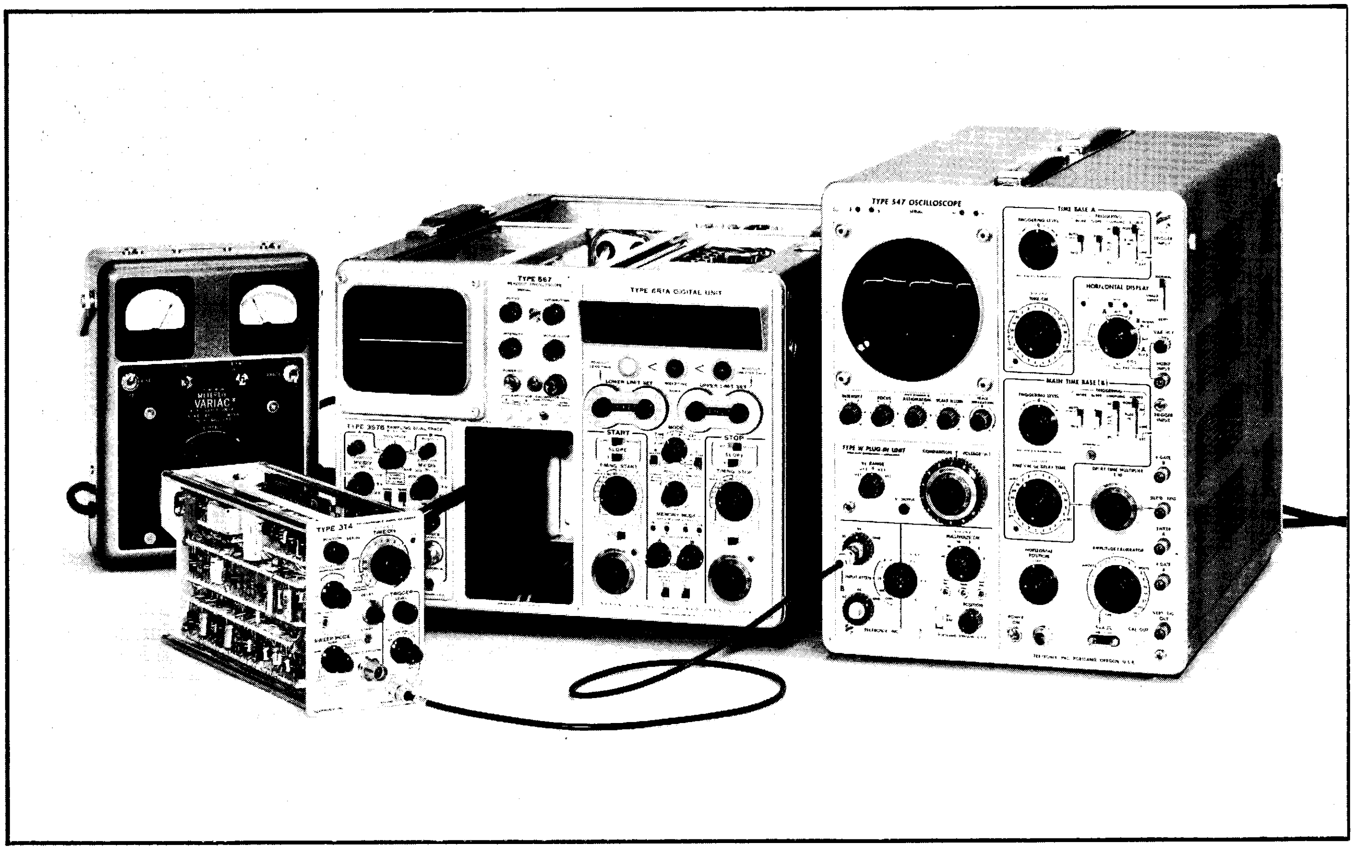


Fig. 5-8. Step 4 test setup to measure amplitude of signal at TRIG OUT connector.

Control Settings

Type 3T4

All controls except LEVEL and RECOVERY TIME same as in Step 3.

LEVEL	**Fully clockwise**
RECOVERY TIME	**Fully counterclockwise**

Type 3S76

No change

Test Oscilloscope

All controls except Triggering SLOPE same as in Step 3.

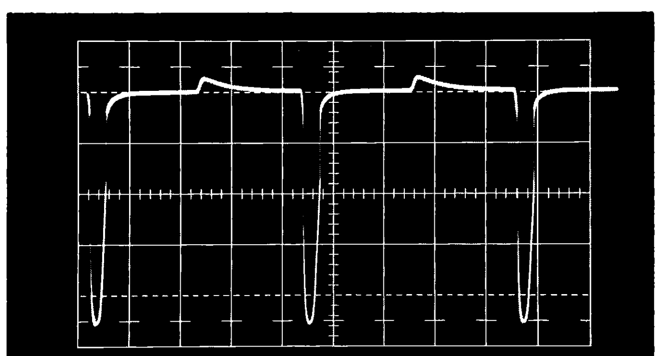
Triggering SLOPE	**—**

Type W

INPUT ATTEN	**10**
MILLIVOLTS/CM	**10**
POSITION	**Trace +2 cm, no signal**

Connections

Attach a 50 Ω termination to the Type W Channel A input. Connect a 50 Ω coax cable from the Type 3T4 TRIG OUT connector to the 50 Ω termination.



2 μsec/cm

Fig. 5-9. TRIG OUT connector waveform—Step 4 a.

Ⓐ

4. Check Signal at TRIG OUT Connector

a. Connect the setup shown in Fig. 5-8. The test oscilloscope display should be similar to Fig. 5-9, approximately 450 mv peak to peak, with a pulse period of between 8 and 10 μsec.

b. Turn the RECOVERY TIME control fully clockwise and note that the pulse period extends at least 1.5:1.

c. Check that the pulse period falls within the limits of Table 5-1 with the RECOVERY TIME control fully counterclockwise, for the three TIME/DIV control sections listed.

TABLE 5-1

TRIG OUT Signal Pulse Periods

TIME/DIV Section	Test Scope TIME/CM	Pulse Period
1 nSEC through .1 μSEC	2 μSEC	8 to 10 μsec
.2 μSEC through 10 μSEC	.1 mSEC	0.5 to 0.7 msec
20 μSEC through .2 mSEC	1 mSEC	5 to 7 msec

NOTES

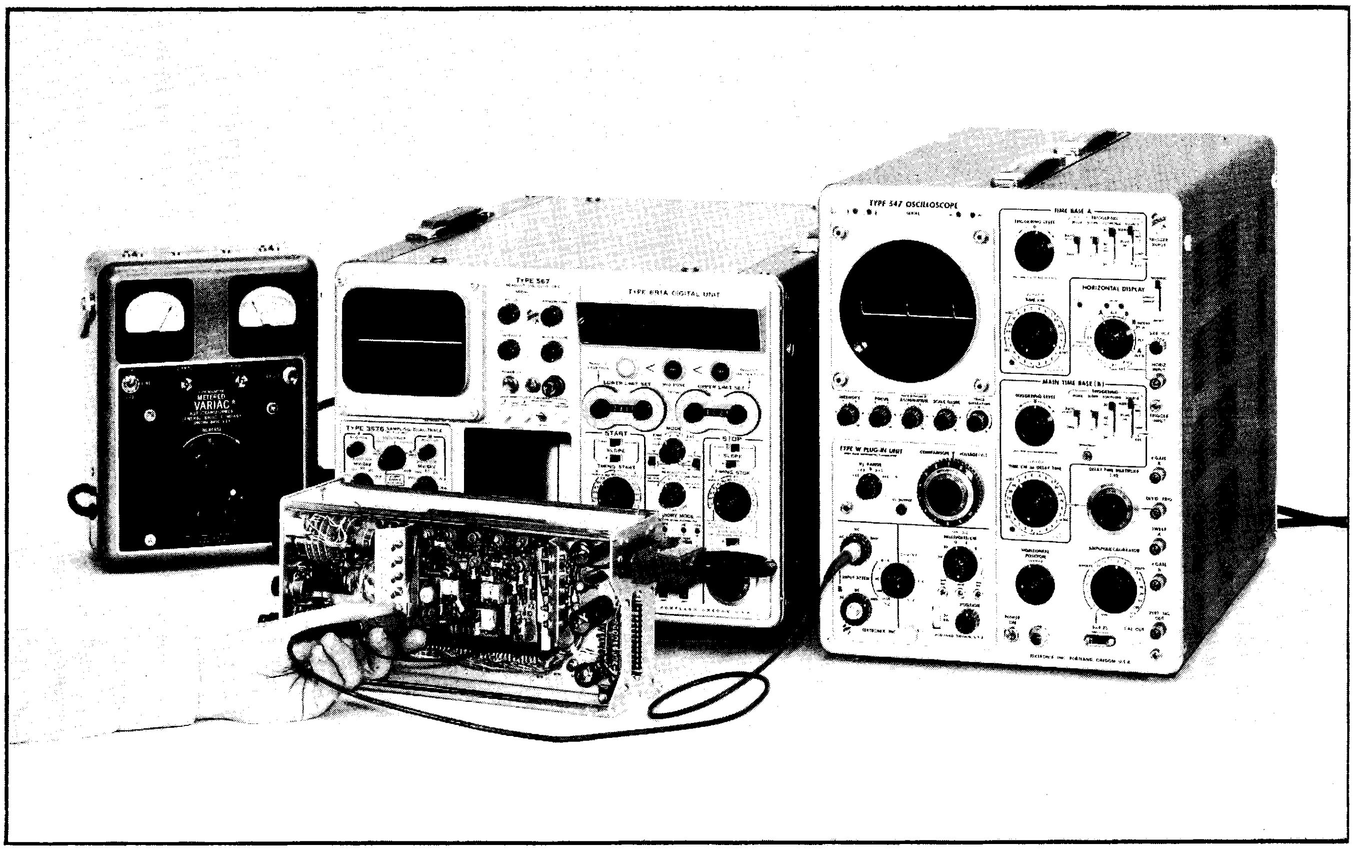


Fig. 5-10. Step 5 test setup for preliminary adjustment of COMPARATOR LEVEL control R130.

Control Settings

Type 3T4

POSITION	Midrange
TIME/DIV	10 nSEC
VARIABLE	CALIB
DISPLAY MAG	×1
DELAY	0.00
SWEEP MODE	NORM
MANUAL SCAN OR EXT ATTEN	Midrange
LEVEL	**2 o'clock**
INT-EXT	+INT
RECOVERY TIME	Counterclockwise

Type 3S76

All controls	As set

Test Oscilloscope

TIME/CM	2 μSEC
Triggering MODE	Automatic
TRIGGERING LEVEL	0
SLOPE	+
SOURCE	INT

Type W

DISPLAY	A-B
Vc RANGE	0
A Input Coupling	DC
INPUT ATTEN	**100**
MILLIVOLTS/CM	10
POSITION	**Trace +1 cm, no signal**

Connections

Connect the 10× probe to the Type W Channel A input connector. Connect the probe ground clip to the ground lead of C122 and touch the tip to the collector of Q144 as shown in Fig. 5-11.

5. Preliminary Adjust COMPARATOR LEVEL Control, R130 **0**

a. Turn R130 (see Fig. 5-11) fully counterclockwise using a non-conducting screwdriver (R130 metal screwdriver adjust slot is about —15 or —25 volts from ground). Slowly turn R130 clockwise until spikes appear on the test oscilloscope crt similar to Fig. 5-12.

b. Operate the Type 3T4 TIME/DIV control through all but the REMOTE PROGRAM position while observing the test oscilloscope display. If the spikes disappear at any TIME/DIV switch setting, turn R130 slightly farther clockwise to assure that the comparator operates correctly.

c. Lift the 10× probe tip and ground clip. Set the test oscilloscope trace to the graticule centerline. Use the same Type W control settings.

d. Connect the 10× probe ground clip to the ground lead shown, and the tip to 390 Ω R203 as shown in Fig. 5-13. The test oscilloscope display should be similar to Fig. 5-14, and the pulse amplitude greater than 8 mm, or 8 volts.

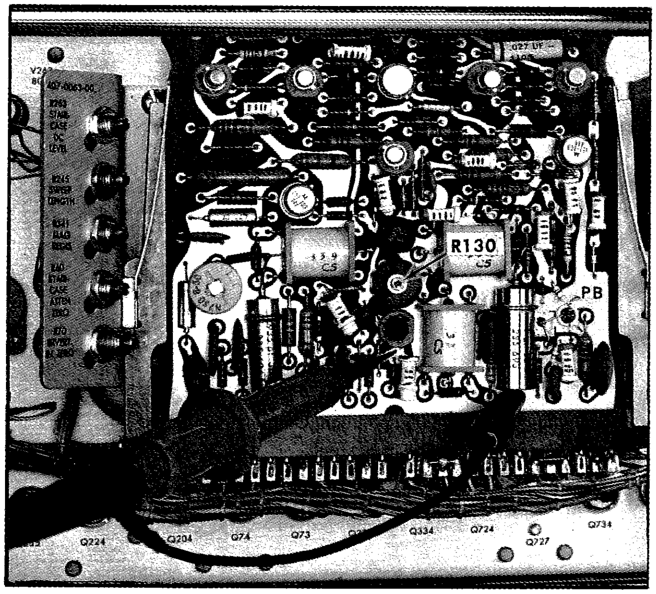


Fig. 5-11. Probe tip location for Q144 collector, and R130 location.

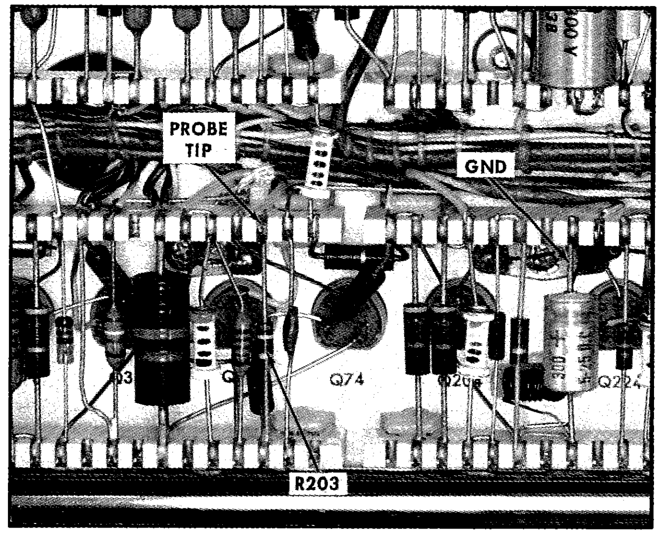


Fig. 5-13. Probe tip and ground clip locations for Step 5 d.

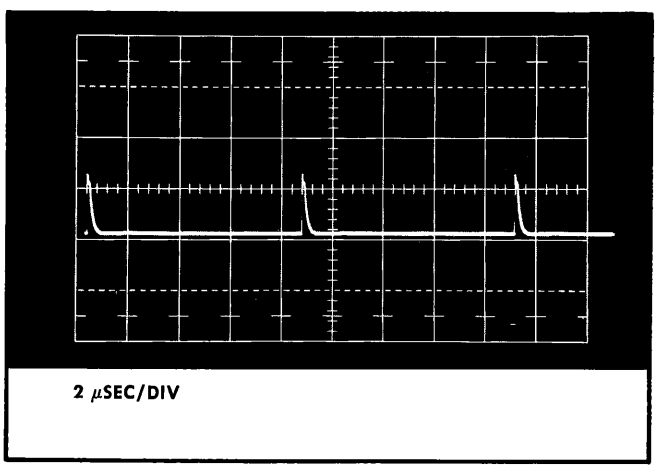


Fig. 5-12. Signal at Q144 collector—Step 5 a.

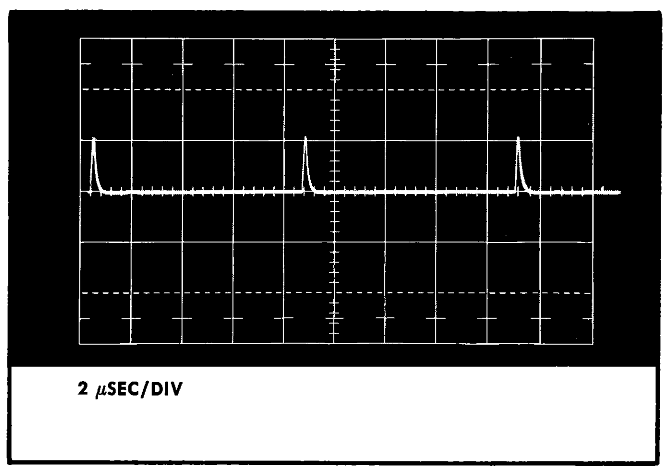


Fig. 5-14. Signal at R203, Step 5 d.

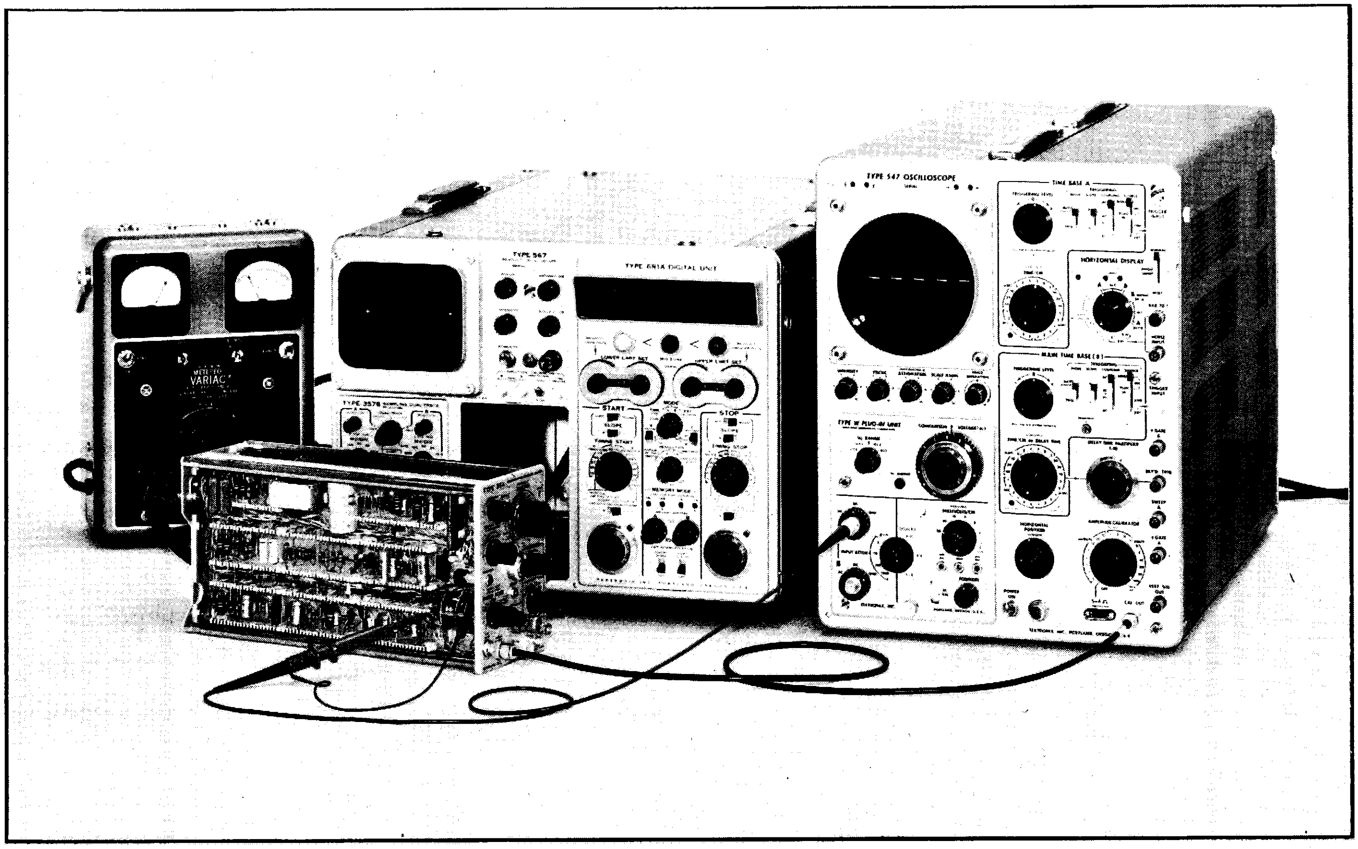


Fig. 5-15. Step 6 test setup for adjusting HORIZ GAIN control, R301.

Control Settings

Type 3T4

(Turn Type 567 INTENSITY control for dim trace first.)

SWEEP MODE	**EXT INPUT**
POSITION	**Dot 1 div from left edge of Type 567 graticule**
TIME/DIV	10 nSEC
VARIABLE	CALIB
DISPLAY MAG	×1
DELAY	0.00
MANUAL SCAN OR EXT ATTEN	**Fully counterclockwise**
LEVEL	2 o'clock

Type 3S76

All controls	For dot vertically centered

Test Oscilloscope

TIME/DIV	**.5 mSEC**
Triggering MODE	Automatic
TRIGGERING LEVEL	0
SLOPE	+
SOURCE	INT
AMPLITUDE CALIBRATOR	**100 VOLTS**

Type W

DISPLAY	A-B
Vc RANGE	**+1.1**
COMPARISON VOLTAGE (Vc)	**4.00**
A Input Coupling	DC
INPUT ATTEN	100
MILLIVOLTS/CM	**50**
POSITION	**Trace centered, no signal**

Connections

Connect a 50 Ω coax cable between the test oscilloscope CAL OUT connector and the Type 3T4 sweep EXT INPUT connector. Connect the 1× probe to the Type W Channel A input and to the arm of R301, MANUAL SCAN OR EXT ATTEN control, see Fig. 5-16.

6. Adjust HORIZ GAIN Control, R301 ➊

a. Set up the equipment shown in Fig. 5-15, with the 1× probe connected to the arm of R301 as shown in Fig. 5-16. Set the MANUAL SCAN OR EXT ATTEN control to about midrange. The test oscilloscope display should show just the ground level part of the Amplitude Calibrator signal. Adjust the Type W POSITION control so the signal rests on the graticule centerline.

b. Set the Type W DISPLAY switch to A-Vc and adjust the Type 3T4 MANUAL SCAN OR EXT ATTEN control so the Amplitude Calibrator positive peak display rests at the test oscilloscope graticule centerline. The voltage at the arm of R301 is now 40 volts peak to peak.

c. Leave the 1× probe attached to the arm of R301, and the Type W input selector at DC. Adjust the Type 3T4 front-panel HORIZ GAIN control for exactly 8 divisions between dots on the Type 567 crt. Use the Type 3T4 POSITION control to position the dots 1 division in from each end of the Type 567 graticule. Go directly to Step 7.

7. Check DISPLAY MAG X10 Horizontal Gain

a. Use the same setup as Step 6c. Set the test oscilloscope AMPLITUDE CALIBRATOR to 10 VOLTS. Adjust the Type 3T4 POSITION control so the two dots straddle the graticule centerline. Set the Type W INPUT ATTEN to 10, and the DISPLAY switch to A-B. Position the test oscilloscope display of the Amplitude Calibrator ground level signal to the graticule centerline.

b. Set the Type W DISPLAY switch to A-Vc and adjust the Type 3T4 MANUAL SCAN OR EXT ATTEN control so the Amplitude Calibrator positive peak display rests on the test oscilloscope graticule centerline. The signal at the arm of R301 is now 4 volts peak to peak.

c. Leave the 1× probe attached to the arm of R301. Set the Type 3T4 DISPLAY MAG switch to ×10. The Type 567 display should be two dots 8 divisions apart, ±2.4 minor divisions. If not, check the values of R335, R338 and R339 at the collector of Q333. The resistors are located on the Type 3T4 left side in the center line of ceramic strips near the chassis label for D225.

d. Remove the signal from the EXT INPUT, and disconnect the 1× probe. Set the MANUAL SCAN OR EXT ATTEN control fully counterclockwise. Leave the other controls as now set.

8. Adjust INVERT IN ZERO Control, R70 ①

a. Leave the 1× probe attached to the Type W Channel A input. Set the Type W controls:

INPUT ATTEN	10
MILLIVOLTS/CM	5
DISPLAY	A-B
Input Coupling	GND
POSITION	Trace centered

Leave the test oscilloscope controls as set.

b. Set the Type 3T4 Trigger LEVEL control fully counterclockwise.

CAUTION

J53-13 has +125 volts on it. Take care not to let the probe tip touch both pins 12 and 13 at the same time, or Q73, Q74, and Q64 may be damaged.

c. Carefully touch the probe tip to J53-12 (Logic Card connector pin 12 shown in Fig. 5-17). Set the Type W Input Selector to DC and adjust the INVERT IN ZERO control for zero volts—zero trace shift on the test oscilloscope.

9. Adjust STAIRCASE DC LEVEL Control, R263 ①

Steps 9 and 10 must be performed in sequence.

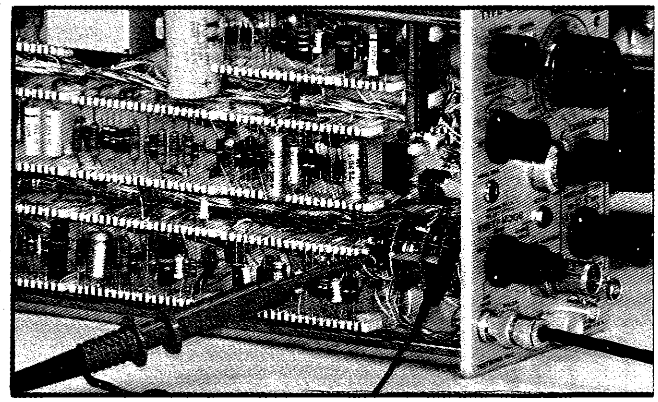


Fig. 5-16. Probe tip connection to arm of R301.

a. Leave all test oscilloscope controls as set. Set the Type W Input Selector to GND and position the trace 1 cm above the graticule centerline.

b. Set the Type 3T4 controls:

Trigger LEVEL	2 o'clock
SWEEP MODE	SINGLE DISPLAY

c. Connect the 1× probe tip to the "electrical top" end of the VARIABLE control, R51. The connection is at the opposite end of the pot from the 51 k, ½-watt resistor.

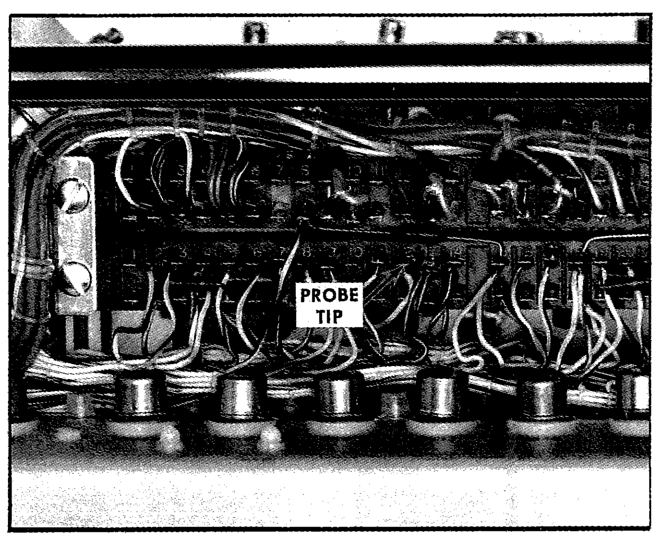


Fig. 5-17. Probe tip location at J53-12, Step 8 c.

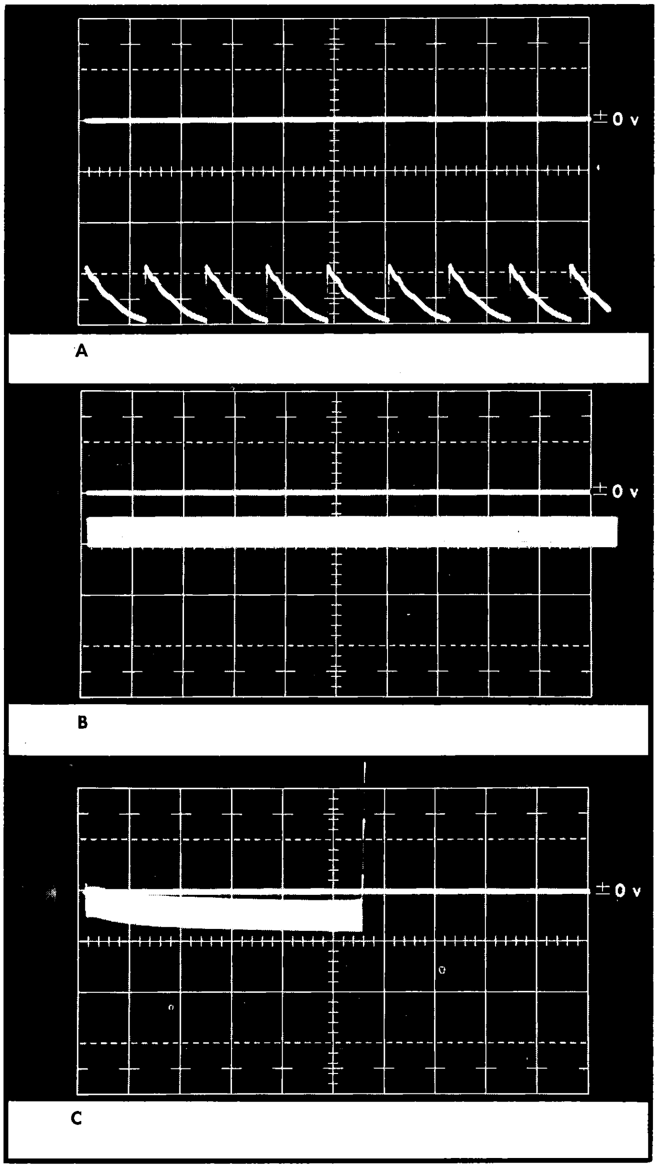


Fig. 5-18. Test oscilloscope waveforms for Step 9. Vertical deflection factor: 50 mv/div.

d. Set the Type W input coupling switch to DC. Set the Type 3T4 TIME/DIV switch to 1 μSEC and observe the test oscilloscope crt. The display will be similar to the lower waveform of Fig. 5-18a. If no display appears on the test oscilloscope, adjust R263 until a display appears. Set the Type 3T4 TIME/DIV switch to 10 nSEC. Adjust R263 so the display is about 1 division below the test oscilloscope zero reference line as shown in Fig. 5-18b.

e. Set the Type 3T4 SWEEP MODE switch to NORM (TIME/DIV still at 10 nSEC). Adjust R263 until the test oscilloscope display is similar to Fig. 5-18c; the top portion of the display "wide-band" should rest just under the zero reference line.

f. Set the Type 3T4 SWEEP MODE switch to SINGLE DISPLAY and operate the TIME/DIV switch through the range of 1 nSEC to 10 μSEC. Leave the switch at each position long enough for the test oscilloscope display to stabilize. If any position of the TIME/DIV switch causes any portion of the display to rise above zero volts, readjust R263 so all Type 3T4 sweep rates produce a staircase output voltage at zero volts or slightly negative.

NOTE

The procedure just outlined sets the Type 3T4 staircase zero voltage at ground, or slightly negative. This permits both the Type 6R1 and Type 6R1A Comparators to operate correctly. The actual tolerance for the staircase zero voltage is ±0.2 volts when using a Type 6R1A.

10. Adjust STAIRCASE ATTEN ZERO Control, R60 ⓘ

This step must not be adjusted out of sequence.

a. Set the Type W input coupling to GND and position the trace to the graticule centerline. Leave all test oscilloscope controls as set. Set the Type 3T4 TIME/DIV control to 10 nSEC.

b. Connect the 1× probe to test point terminal K of J53, the Logic Card connector. Adjust R60 until the top of the display rests about two graticule minor divisions below the graticule centerline. Operate the TIME/DIV switch slowly through the ranges from 1 nSEC through 10 mSEC and note the dc level at the top of each display. If the dc level changes more than 1.5 cm (75 mv), adjust R60 and repeat. It is possible in some instruments to adjust R60 so the dc level does not change more than about 40 mv. The instrument is within tolerance if the dc level is within 85 millivolts of ground at test point terminal K. Disconnect the 1× probe from the Type 3T4.

11. Adjust Sweep MAG REGIS Control, R341 ⓘ

a. Set the Type 3T4 controls:

TIME/DIV	10 μSEC
SWEEP MODE	NORM
DISPLAY MAG	×10
LEVEL	2 o'clock
POSITION	Trace begins at graticule centerline

b. Carefully short the crt horizontal deflection plates together (at the crt neck top) with a non-magnetic tool that has an insulated handle. Be careful not to ground either plate to the crt shield. The spot position is the crt electrical center. Remove the short and position the trace to start at the crt electrical center.

c. Set the DISPLAY MAG control to ×1 and adjust the MAG REGIS control, R341, so the trace again begins at the crt electrical center.

Ⓐ

d. Set the DISPLAY MAG control to ×10. Position the display to the crt electrical center. Set the DISPLAY MAG control to ×1 and adjust R341 so the trace again begins at the crt electrical center. Check that the trace start does not shift more than 1 minor division from the crt electrical center when the DISPLAY MAG switch is changed from ×1 to ×10 and back.

12. Adjust SWEEP LENGTH Control, R245 ⓘ

a. With the Type 3T4 controls as in Step 11 (DISPLAY MAG at ×1), position the trace beginning to the left edge of the graticule.

b. Adjust the SWEEP LENGTH control, R245, so the sweep length is 10.5 divisions.

NOTES

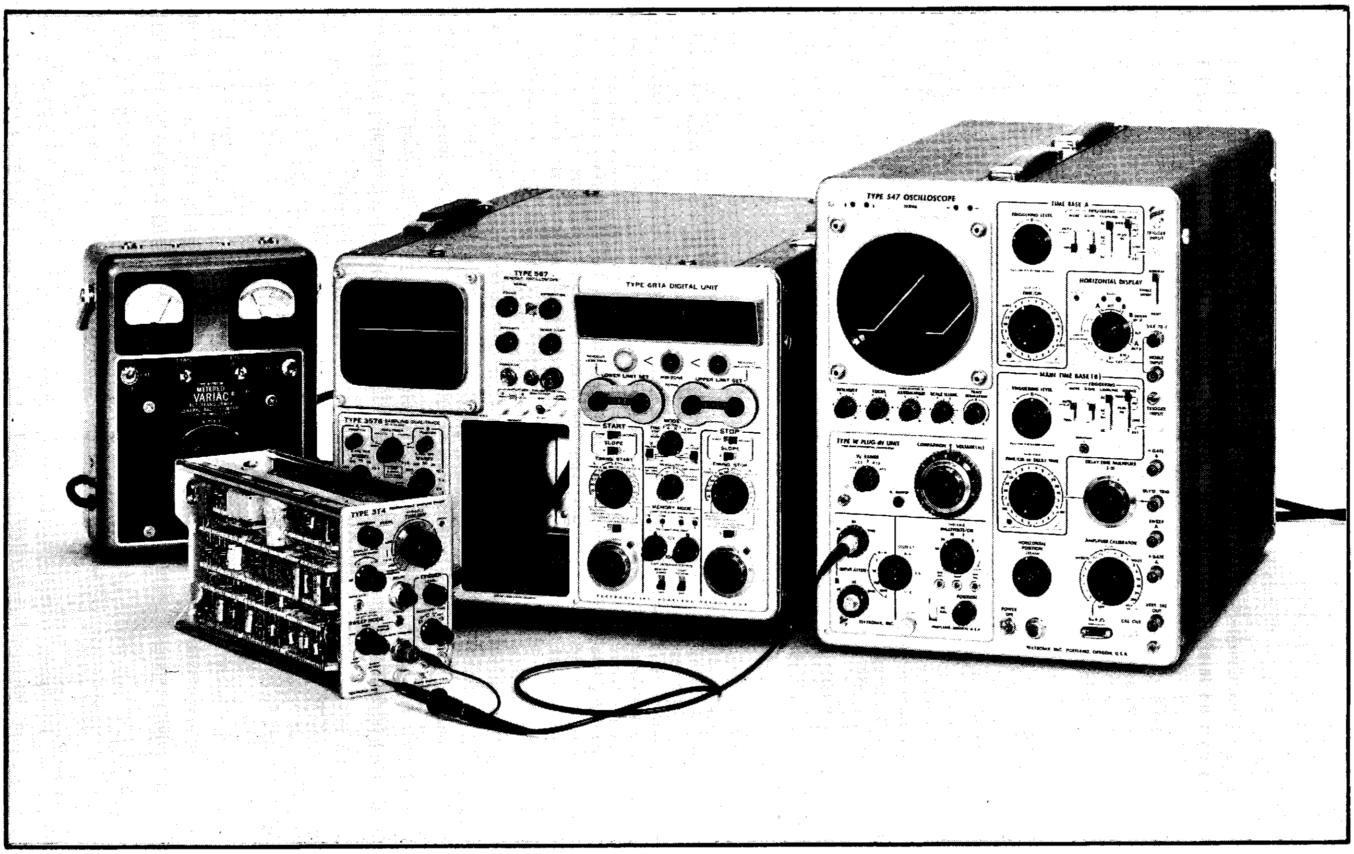


Fig. 5-19. Step 13 test setup to check signal amplitude at SWEEP OUTPUT connector.

Control Settings

Type 3T4

SWEEP MODE	NORM
POSITION	**Midrange**
TIME/DIV	**10 nSEC**
VARIABLE	CALIB
DISPLAY MAG	×1
DELAY	0.00
LEVEL	2 o'clock

Type 3S76

All controls	As set

Test Oscilloscope

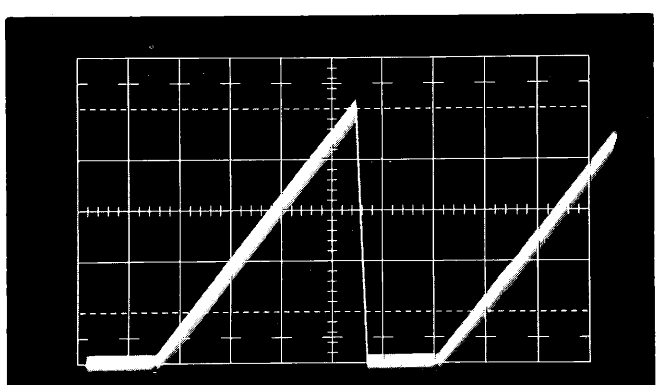
TIME/DIV	**2 mSEC**
Triggering MODE	**TRIG**
SLOPE	**—**
SOURCE	INT
TRIGGERING LEVEL	For stable display

Type W

DISPLAY	A-B
Vc RANGE	**0**
A Input Coupling	**AC**
INPUT ATTEN	10
MILLIVOLTS/CM	**20**

Connections

Connect the 10× Probe to the Type W Channel A input connector and the tip to the Type W SWEEP OUTPUT connector center pin.



2 msec/div. 2 volts/div

Fig. 5-20. SWEEP OUTPUT waveform—Step 13 b.

Ⓐ

13. Check Signal Amplitude at SWEEP OUTPUT Connector

a. Connect and set up the test oscilloscope as shown in Fig. 5-19.

b. The SWEEP OUTPUT signal should be similar to that shown in Fig. 5-20; 1 volt per division of sweep on the Type 567 crt, ±10%. Leave the connections and setup as is for step 14.

14. Check Staircase Holdoff Time

With the setup as just used in Step 13b, the time the staircase voltage remains at its most negative level must be at least 2 msec. Fig. 5-20 shows about 2.3 msec for holdoff time.

NOTES

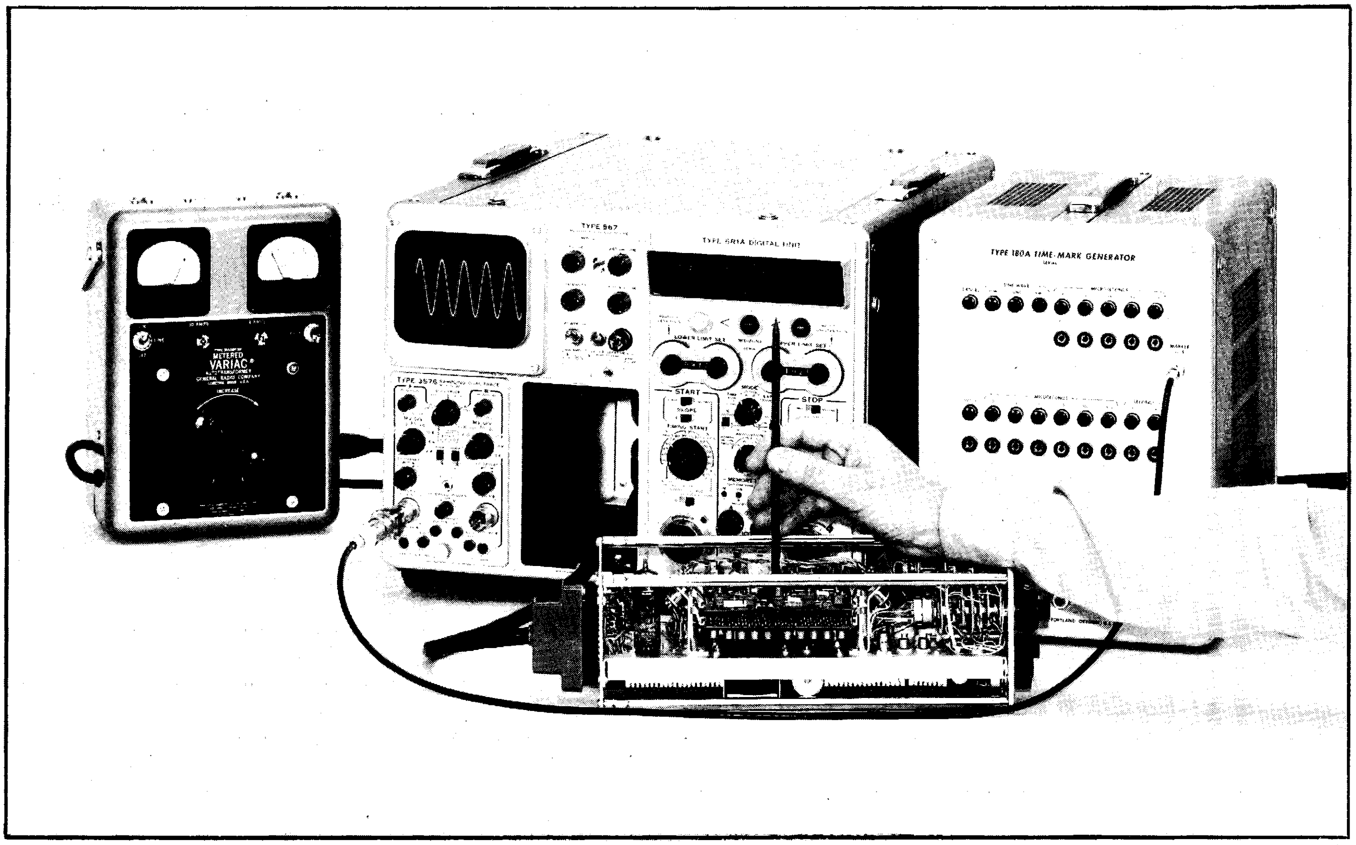


Fig. 5-21. Step 15 test setup for final adjustment of COMPARATOR LEVEL control R130.

Control Settings

Type 3T4

SWEEP MODE	NORM
TIME/DIV	**.1 μSEC**
VARIABLE	CALIB
DISPLAY MAG	×1
DELAY	**2.00**
RECOVERY TIME	**Stable display**
LEVEL	**Stable display**

Type 3S76

Channel A POSITION	Midrange
Mode	A ONLY
SMOOTH-NORMAL	**NORMAL**
Channel A MV/DIV	**200**
2-200 VAR.	**CALIB.**
DC OFFSET	**For centered display**
INTERNAL TRIGGER	A
NORM-INV	NORM

Type 180A

SINE WAVE	**5 MC**
No other buttons pushed	

Type 6R1A

CRT INTENSIFICATION switches	OFF

Connections

Connect a 5× attenuator to the Type 3S76 INPUT A connector. Attach a BNC to GR adapter to the 5× attenuator.

Connect a 50 Ω coax with BNC connectors between the Type 180A MARKER OUT connector and the BNC to GR adapter.

15. Final Adjust COMPARATOR LEVEL Control, R130

a. Connect the system shown in Fig. 5-21, and obtain a stable 5 mc sinewave display. Be certain that the Type 3T4 LEVEL control is counterclockwise of its 12 o'clock position.

b. Use a non-metallic screwdriver, for low-capacitance reasons, and adjust R130 (shown in Fig. 5-11) clockwise until the display becomes a straight line. Note the control position. Adjust R130 counterclockwise until the display disappears. Note the control position. Set R130 midway between the no-sweep and straight-line display positions.

Leave the system as connected.

16. Adjust SWEEP CAL Control, R110

a. Set the Type 3T4 controls:

TIME/DIV	10 μSEC
DELAY	2.50

Set the Type 3S76 Channel A MV/DIV control to 100.

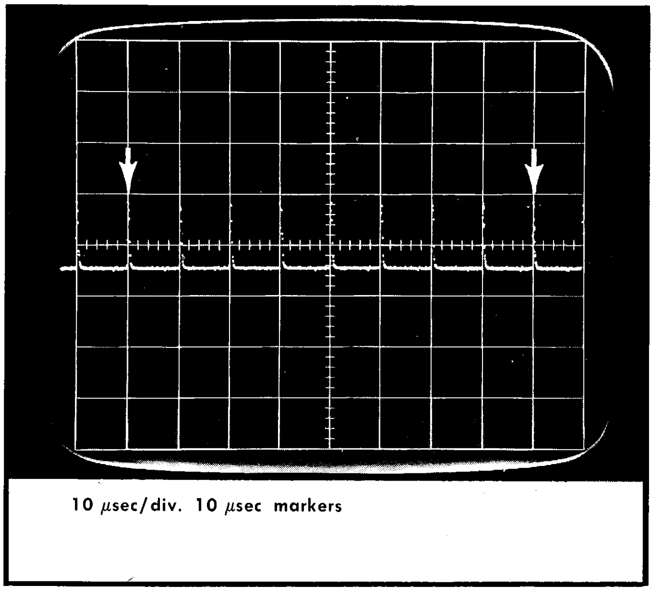


Fig. 5-22. Timing adjusted so that time-marks fall behind first and ninth graticule lines—Step 16.

b. Set the Type 180A buttons:

Cancel the SINE WAVE button.
Press the 10 MICROSECONDS button.

c. Adjust the Type 3T4 LEVEL control for a stable display and adjust the SWEEP CAL control, R110, for exactly one time mark per division within the middle 8 divisions of the Type 567 graticule. The display will be like Fig. 5-22.

d. The SWEEP CAL and COMPARATOR LEVEL controls interact, so repeat Steps 15 and 16.

Leave the system as connected for Step 17.

17. Preliminary Adjust DELAY ZERO Control, R99 ⓿

a. Set the Type 3T4 controls:

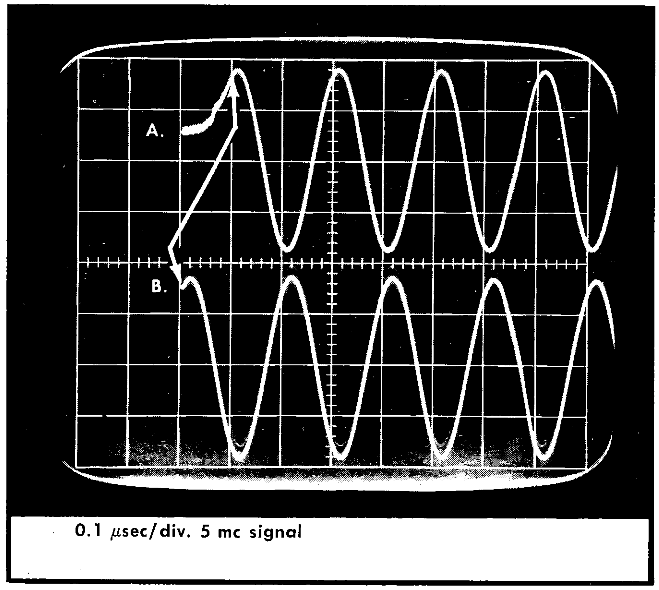


Fig. 5-23. Waveforms for Step 17.

TIME/DIV	.1 μSEC
DELAY	0.00

Set the Type 3S76 Channel A MV/DIV control to 200.

b. Set the Type 180A buttons:

Cancel the 10 MICROSECONDS button.
Press the 5 MC SINE WAVE button.

c. Adjust the Type 3T4 LEVEL and RECOVERY TIME controls for a stable display.

d. Adjust the DELAY ZERO control, R99, so the display first looks like Fig. 5-23a. Then adjust R99 slightly clockwise to obtain a display like Fig. 5-23b. Arrows in Fig. 5-23 indicate the same point of the time window on both waveforms.

NOTES

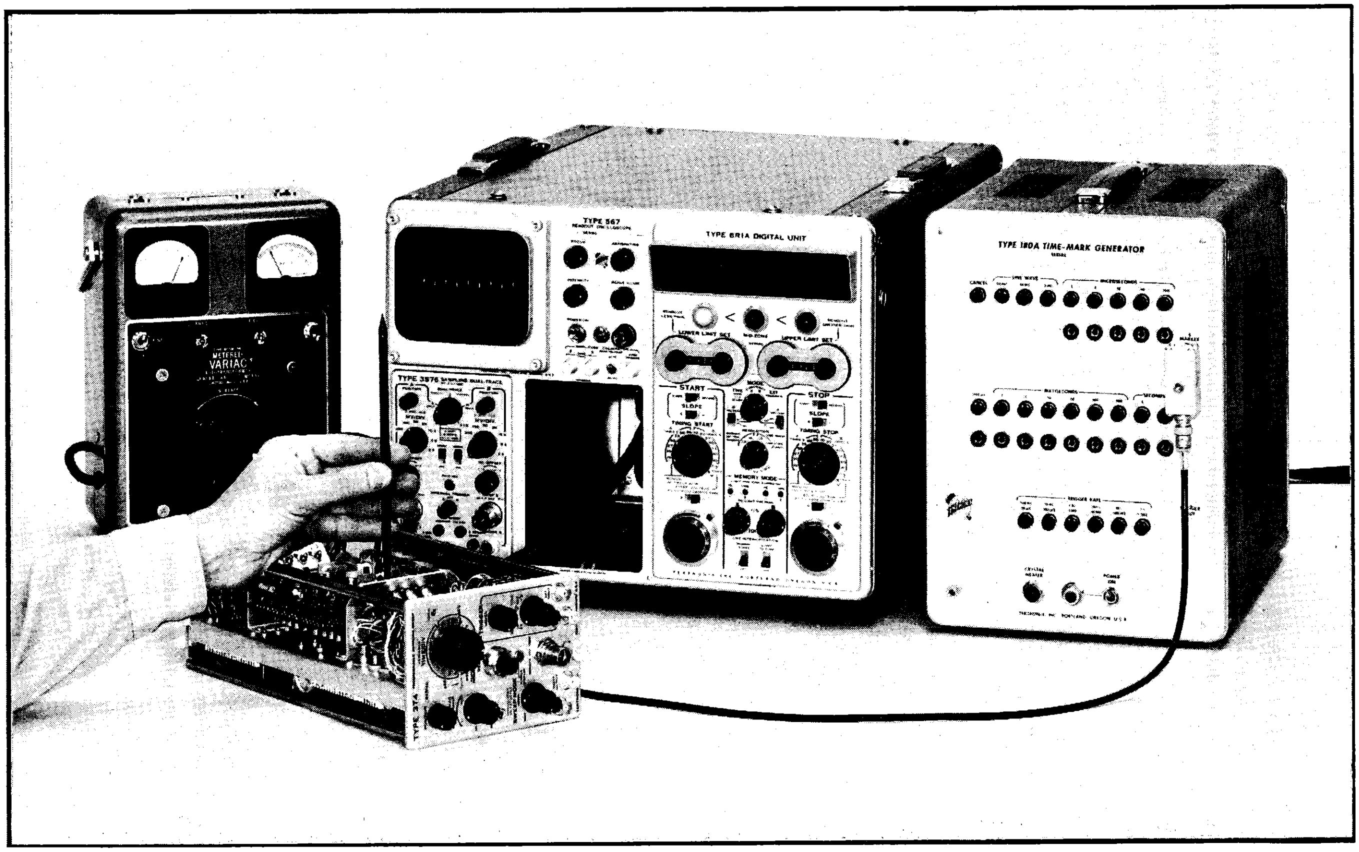


Fig. 5-24. Step 18 test setup for adjusting the Fast Ramp Capacitor, C124.

Control Settings

Type 3T4

TIME/DIV	**10 nSEC**
VARIABLE	CALIB
DISPLAY MAG	×1
SWEEP MODE	NORM
DELAY	**Between 9.00 and 10.00**
INT-EXT	**+INT**
LEVEL	Stable display
RECOVERY TIME	Stable display

Type 3S76

Mode	A ONLY
SMOOTH-NORMAL	**SMOOTH**
Channel A MV/DIV	**100**
INTERNAL TRIGGER	A

Type 180A

SINE WAVE	**50 MC**

Connections

Install the 50-100 mc doubler to the Type 180A MARKER OUT connector. Connect a 50 Ω coax between the Type 3S76 INPUT A connector and the doubler. Use a BNC to GR adapter.

18. Adjust FAST RAMP Capacitor, C124 ⓿

a. Obtain a stable triggered display of the 100 mc sinewaves similar to Fig. 5-25. It may be necessary to adjust the doubler tuning slug to obtain nearly equal amplitude peaks. Use the Type 3T4 DELAY control to position the peaks to coincide with vertical graticule lines. Keep the DELAY control between 9.00 and 10.00

b. Adjust C124 (Fig. 5-26) with a non-metallic tool until the 100 mc sinewave peaks fall directly behind the first and ninth graticule lines (marked in Fig. 5-25).

c. Remove the 100 mc doubler and replace it with the 5× attenuator.

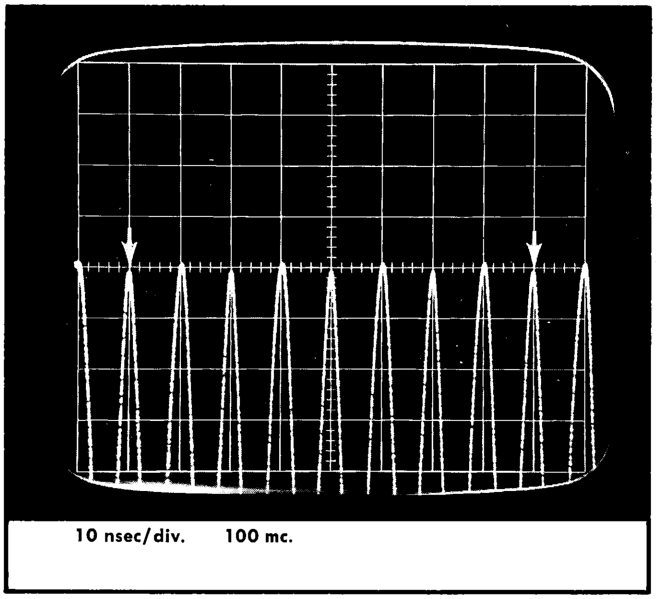


Fig. 5-25. Display when adjusting C124 in Step 18 b. Arrows indicate alignment points. (Doubler tuning adjusted so positive peaks are nearly equal.)

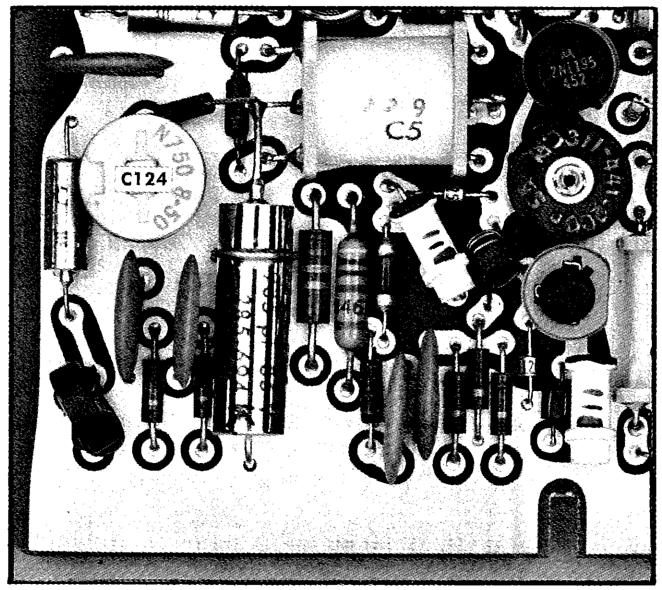


Fig. 5-26. Location of C124 on Timing card.

NOTES

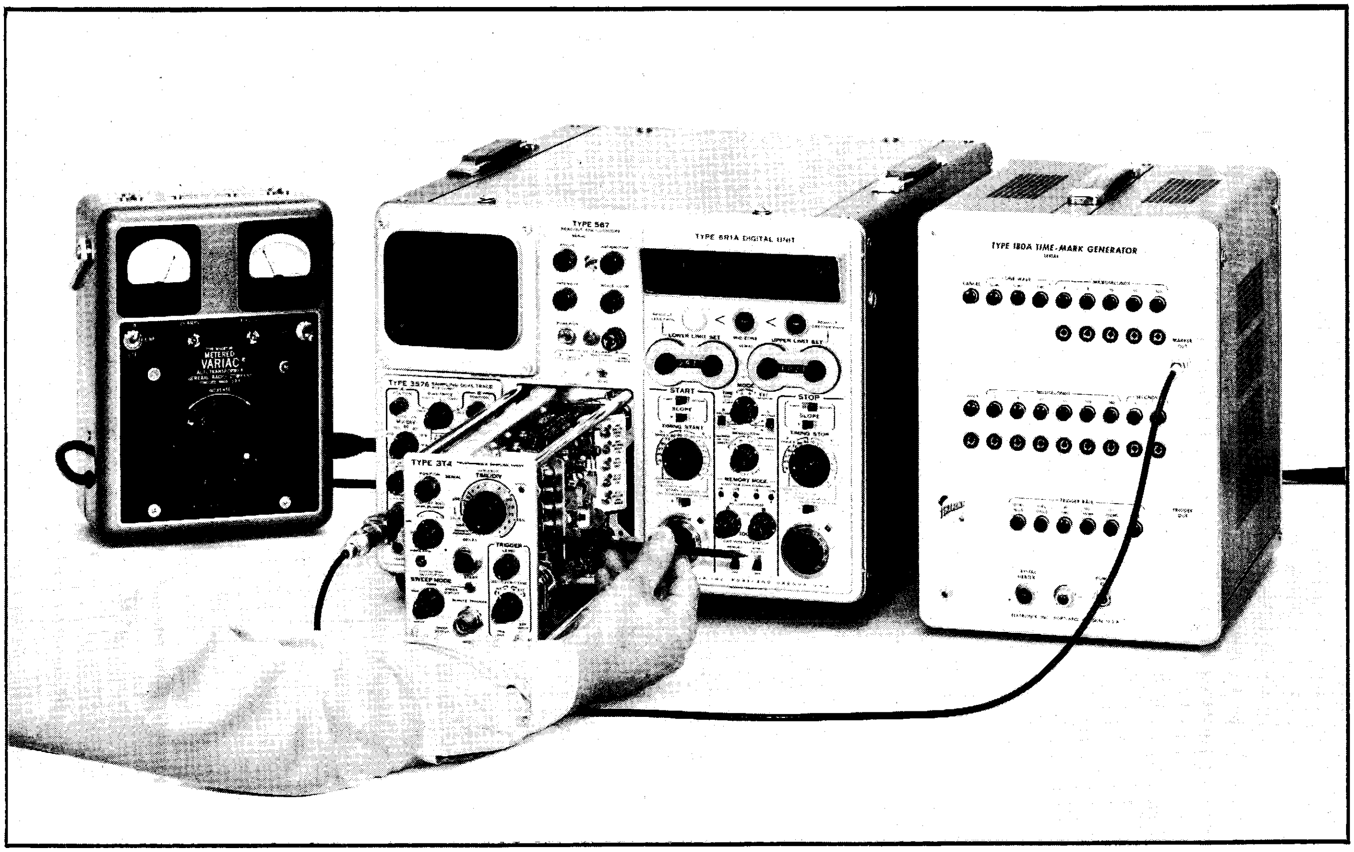


Fig. 5-27. Step 19 test setup for adjusting the Staircase Samples/Sweep capacitors C258C and C258A.

Control Settings

Type 3T4	
TIME/DIV	**.1 μSEC**
DELAY	**0.00**
DISPLAY MAG	×1
INT-EXT	+INT
Other	Stable display
Type 3S76	
MV/DIV	**200**
SMOOTH-NORMAL	SMOOTH
Type 6R1A	
MODE	**TIME**
START Switches	**SECOND + SLOPE**
TIMING START	**A TRACE 50%**
STOP Switches	**SECOND + SLOPE**
TIMING STOP	**A TRACE 50%**
RESOLUTION	**LO ONE SWEEP**
CRT INTENSIFICATION switches	**OFF**
Type 180A	
SINE WAVE	10 MC

Connections

Remove the flexible extension cable and install the Type 3T4 part way into the horizontal cell of the Type 567 using two 10 inch extensions. (This permits the Digital Unit Logic circuits to operate from the Type 3T4 Logic Card.) It is essential that the Type 6R1A be properly calibrated.

Connect a 50 Ω coax cable from the Type 180A MARKER OUT connector to the 5× attenuator (with proper adapter) to the Type 3S76 INPUT A connector.

19. Adjust Staircase Samples/Sweep Capacitors, C258C and C258A

a. Wait 10 minutes after reinstalling the Type 3T4 before proceeding. Obtain a stable display of 10 mc sinewaves.

b. Set the Type 3T4 TIME/DIV switch to 10 μSEC. The display will be a "chronograph" of the frequency difference between the Type 180A 10 mc and the Samples/Sweep frequency. The chronograph display is actually the heterodyne beat note between the two frequencies. Adjust C258C (location shown in Fig. 5-29) for minimum frequency difference for a display similar to Fig. 5-28a. If the two frequencies differ slightly, the display will be similar to Fig. 5-28b. Adjust C258C to present a nearly straight line display similar to Fig. 5-28a. C258C adjustment is very sensitive.

c. Set the Type 3T4 SAMPLES/SWEEP switch to 100. If the frequency of Samples/Sweep is nearly correct, the display will be similar to Fig. 5-30b. Adjust C258A (location shown in Fig. 5-29) very slowly until the display is similar to Fig. 5-30a. Since it is possible to get a display like Fig. 5-30a for 9 or 11 dots per division, set the Type 3T4 TIME/DIV switch to 5 nSEC and count the dots. The display should be similar to Fig. 5-30c, with exactly ten dots per division. If there are 9 or 11, readjust C258A until you are certain of the correct setting.

20. Adjust INTERNAL DELAY CAL Control, R85 ⓿

a. Set the Type 3T4 TIME/DIV control to 5 nSEC, and the DISPLAY MAG switch to ×1. Set the Type 3S76 MV/DIV switch to 50. Press the Type 180A SINE WAVE 50 MC button. Obtain a stable display similar to Fig. 5-31a. Horizontally position the 3rd peak to be directly behind the ninth graticule line. The 3rd peak is now number zero of 50 peaks. Do not touch the triggering or POSITION controls during Step 20b.

b. Slowly turn the DELAY dial away from zero and count the number of peaks that pass behind the ninth graticule line. Count 5 peaks per turn of the DELAY dial. Count 20 peaks, stop at 4.00 and adjust the INTERNAL DELAY CAL control so the 20th peak rests behind the ninth graticule line. Reset the DELAY dial to 0.00. Use the POSITION control to reposition the 3rd peak (number zero) behind the ninth graticule line. Count 5 peaks per turn and turn the DELAY dial slowly to 10.00. Count the peaks so the 50th peak appears behind the ninth graticule line at 10.00 (not at the end of DELAY dial rotation, but carefully at 10.00). Adjust the INTERNAL DELAY CAL control so the 50th peak rests accurately behind the ninth graticule line.

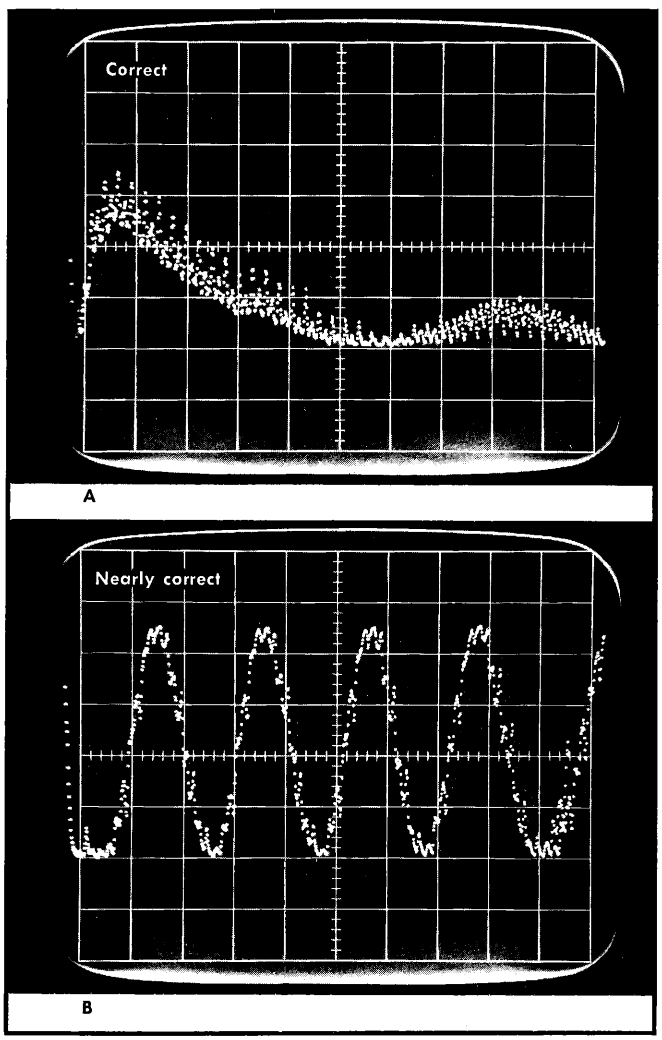


Fig. 5-28. Displays when adjusting C258C—Step 19 b.

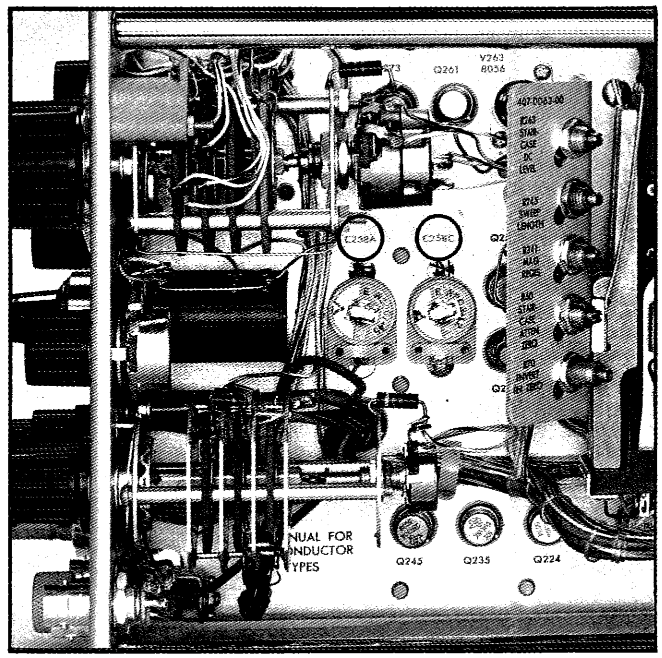


Fig. 5-29. Main chassis locations of C258C and C258A.

Recheck this step so you are certain just 50 peaks pass under the ninth graticule line between DELAY dial positions 0.00 and 10.00.

NOTE

Fig. 5-31a is a normal display with DELAY dial at 0.00, and shows the non-linearity at the start of the fast ramp. Note that the non-linearity disappears after the first 40 nsec, measurable by turning the DELAY dial less than one full turn. Fig. 5-31b shows the display when the DELAY dial is at 10.00, and the 50th peak rests behind the ninth graticule line.

21. Adjust Fast Ramp and Staircase Steps for Correct Digital Unit Readout ⓿

a. Set the Type 180A output for 10 MC. Set the Type 3S76 MV/DIV switch to 200. Set the Type 3T4 TIME/DIV switch to 50 nSEC, and the DELAY dial to between 9.00 and 10.00. Set the Type 6R1A CRT INTENSIFICATION switches up. Obtain a stable display.

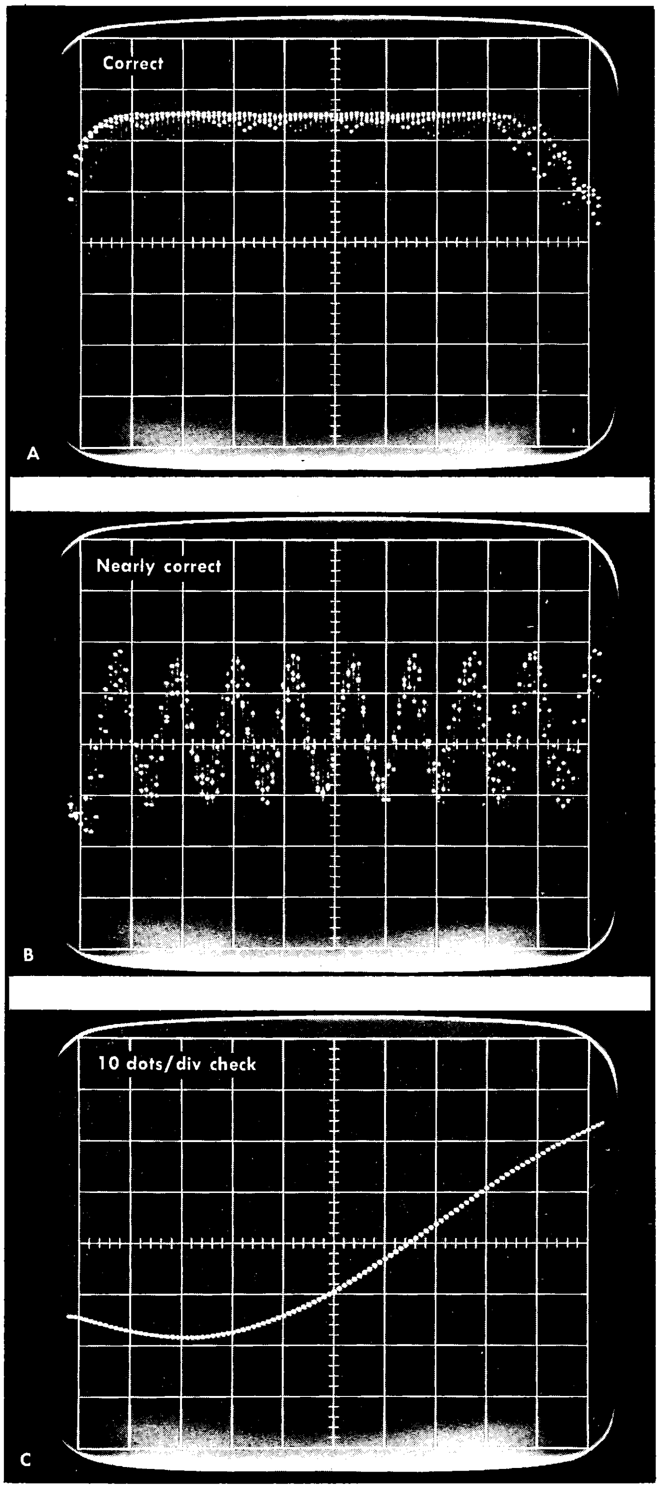


Fig. 5-30. Displays when adjusting C258A—Step 19 c.

b. Position the Type 6R1A 0% and 100% Intensified Zones as shown in Fig. 5-32. The Digital Unit readout should now be .100 μS. If it is not, set the Type 6R1A RESOLUTION switch to HI AVERAGE OF TEN SWEEPS and adjust the Type 3T4 Fast Ramp Capacitor, C124, until the readout is between .1005 and .0995 μS. Watch the readout for several counts before proceeding. Reset the Type 6R1A RESOLUTION switch to LO AVERAGE OF TEN SWEEPS.

c. Repeat Steps 19a and 19b.

d. Repeat all of Step 20.

e. Repeat Steps 21a and 21b.

f. Repeat Step 19c.

g. Set the Type 3T4 TIME/DIV to .1 μSEC and the DELAY dial to 1.00. Set the Type 180A for 10 MC sinewave output. Adjust the Type 3T4 HORIZ GAIN for exactly one cycle per major graticule division.

h. The Type 3T4 should now be properly calibrated to be within specifications for both the sweep rates and incremental delay measurements. To be certain that all sweep rates are accurate, perform the checks listed in Table 5-2. The Display column relates to the number of cycles or pips that will be visible, and is just a check that your display is proper. Display accuracies are not listed, but are ±3% in all cases.

The 100 mc doubler output signal is not exactly symmetrical. It is necessary to measure the 50% to 50% point of a

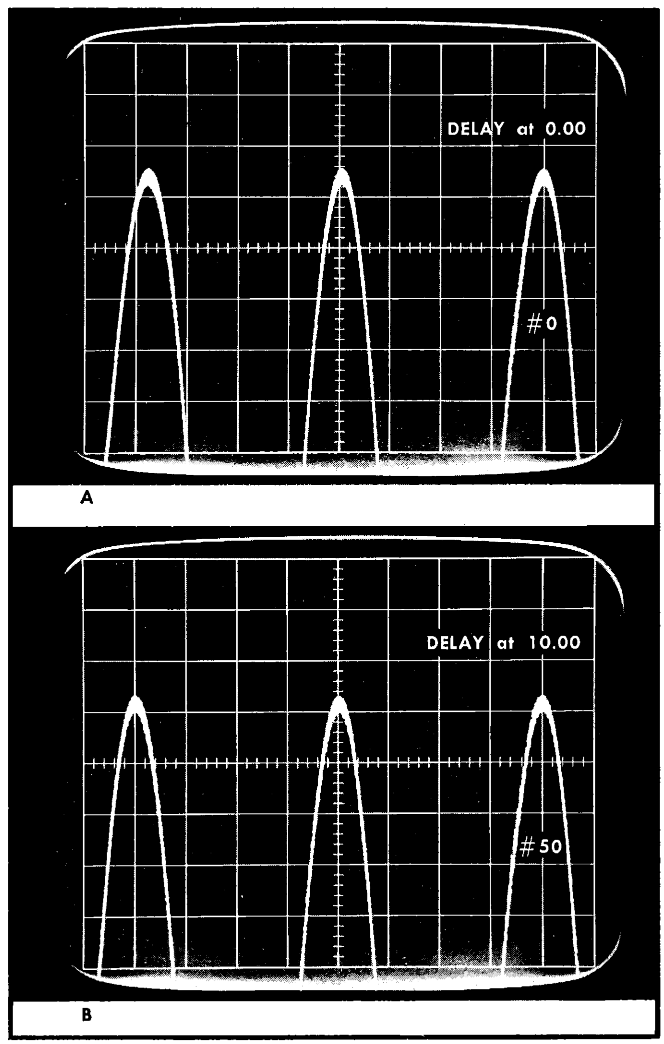


Fig. 5-31. Displays when adjusting R85—Steps 20 a and 20 b.

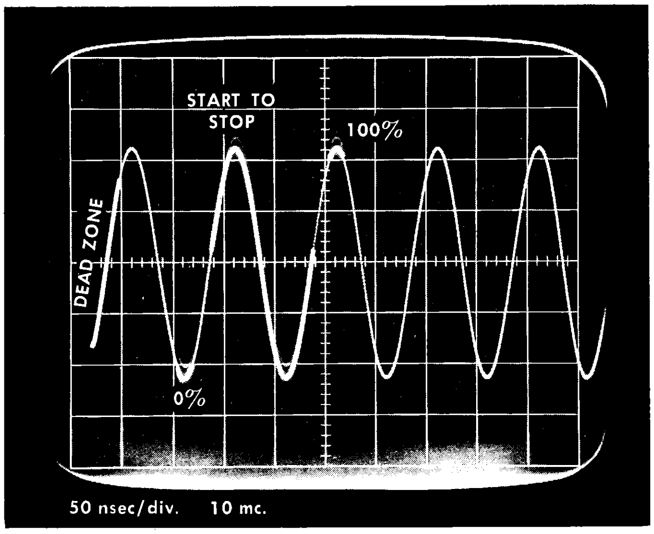


Fig. 5-32. Type 6R1A Intensified Zones when readjusting C124 in Step 21.

cycle, note the reading, then with the DELAY control, position the time window to measure the next cycle 50% to 50% points. Average the two readings to check that the timing accuracy is within the limits listed in Table 5-2.

When using time markers, adjust the Type 6R1A Memory Zones, and the Type 3T4 DELAY dial for a display similar to that in Fig. 5-33. Always adjust the controls so the 0% zone is on the base-line just in front of the first pip, and the 100% zone is "laid across" a positive peak following the intensified START TO STOP zone. These adjustments will permit an accurate Digital Unit readout.

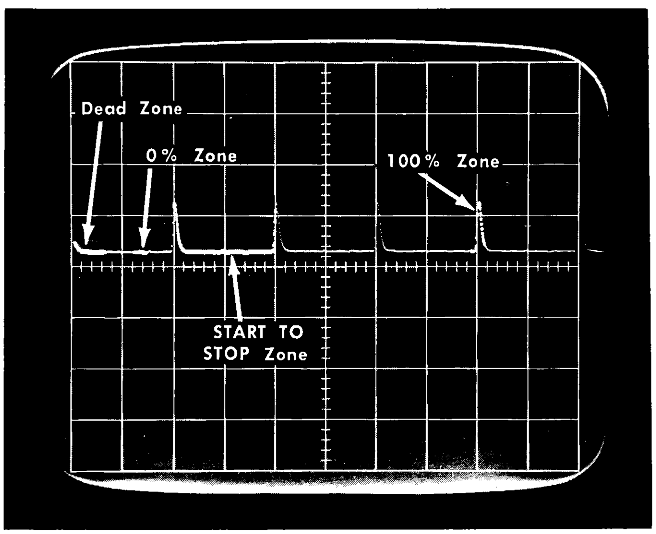


Fig. 5-33. Intensified Zones properly positioned for Digital Unit timing checks.

TABLE 5-2

Timing Checks

Signal	TIME/DIV	Display	Readout
100 MC	2 nSEC	2 cycles	09.7 to 10.3 NS
50 MC	5 nSEC	2.5 cycles	19.4 to 20.6 NS
50 MC	10 nSEC	5 cycles	19.4 to 20.6 NS
10 MC	20 nSEC	2 cycles	.097 to .103 μS
10 MC	50 nSEC	5 cycles	.097 to .103 μS
5 MC	.1 μSEC	5 cycles	.194 to .206 μS
5 MC	.2 μSEC	10 cycles	0.194 to 0.206 μS
MARKERS			
1 μS	.5 μSEC	5 pips	0.97 to 1.03 μS
5 μS	1 μSEC	2 pips	4.85 to 5.15 μS
5 μS	2 μSEC	4 pips	04.85 to 05.15 μS
10 μS	5 μSEC	5 pips	09.7 to 10.3 μS
50 μS	10 μSEC	2 pips	48.5 to 51.5 μS
50 μS	20 μSEC	4 pips	0.049 to 0.051 MS
100 μS	50 μSEC	5 pips	0.097 to 0.103 MS
500 μS	.1 MSEC	2 pips	0.485 to 0.515 MS
500 μS	.2 MSEC	5 pips	00.49 to 00.51 MS

If any readout listed in Table 5-2 is out of tolerance, it will probably appear cyclically. For example: if R67 (Staircase Attenuator & Inverter diagram) is out of tolerance, sweep rates of 1 μSEC, .5 μSEC, .2 μSEC, 10 nSEC, 5 nSEC and 2 nSEC will all be affected.

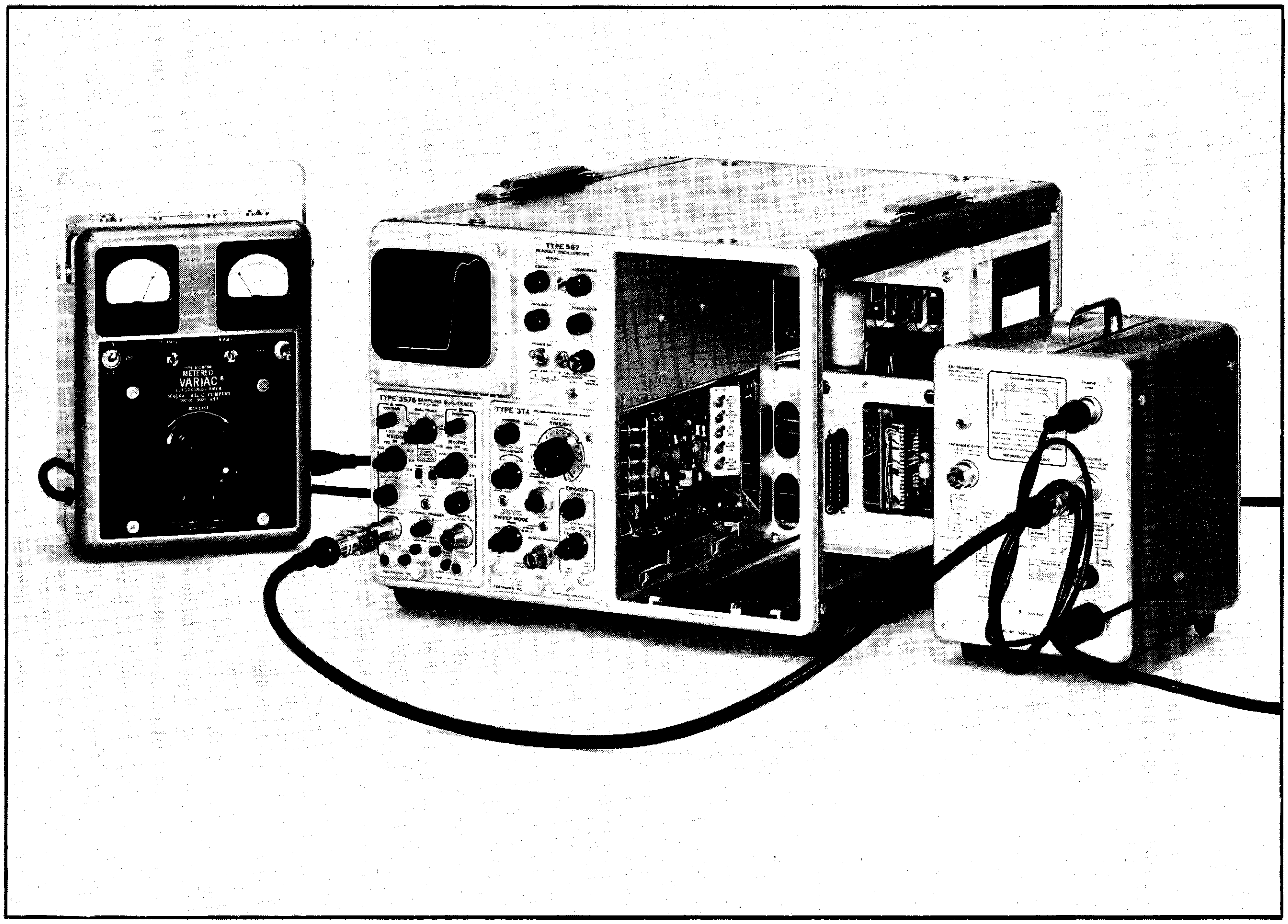


Fig. 5-34. Step 22 test setup for final adjustment of DELAY ZERO control R99.

Control Settings

Type 3T4

TIME/DIV	**1 nSEC**
VARIABLE	CALIB
LEVEL	**First point from fully counterclockwise for stable display**
RECOVERY TIME	Counterclockwise
POSITION	**Trace begins just at graticule left edge**
DISPLAY MAG	×1
SWEEP MODE	NORM
DELAY	0.00

Type 3S76

MV/DIV	**CH A, 200**
2-200 VAR.	CALIB.
Mode	**A ONLY**
SMOOTH-NORMAL	SMOOTH
INTERNAL TRIGGER	**A**
Other Controls	Display like Fig. 5-35

Type 111

REPETITION RATE	**Near MAX**
RANGE	**10 KC**
OUTPUT POLARITY	**+**
Other	**Optional**

Connections

Install a 5× attenuator to the Type 111 PULSE OUTPUT connector, and a 2× attenuator to the Type 3S76 INPUT A connector. Connect the two attenuators with a 50 Ω coax cable.

22. Final Adjust DELAY ZERO Control, R99 ⓿

a. Install the Type 3T4 inside the Type 567 horizontal plug-in cell without any extender. Remove the Type 6R1A from its cell and remove the central bulkhead partition exposing the Type 3T4 controls. Turn the power back on and wait five minutes for the temperature to stabilize.

b. Adjust the Type 3T4 LEVEL control just sufficiently clockwise to obtain a stable display. Do not turn the LEVEL control any further clockwise than necessary for a stable display.

c. Adjust the DELAY ZERO control until the pulse rise crosses the graticule centerline between 5.5 and 6.0 divisions from the start of the trace (see Fig. 5-35).

d. Repeat Step 20, and check that the INTERNAL DELAY CAL is still correctly adjusted. If it requires readjustment, do so and then recheck Step 22c and Step 20 again.

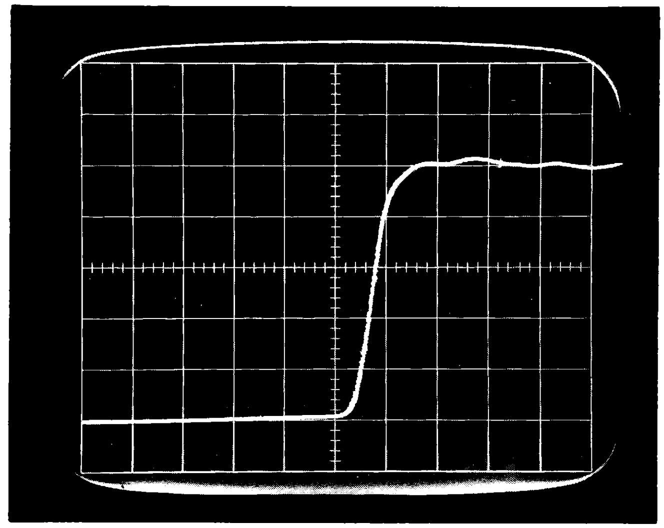


Fig. 5-35. Correct pulse rise position after adjusting DELAY ZERO control. Step 22.

NOTES

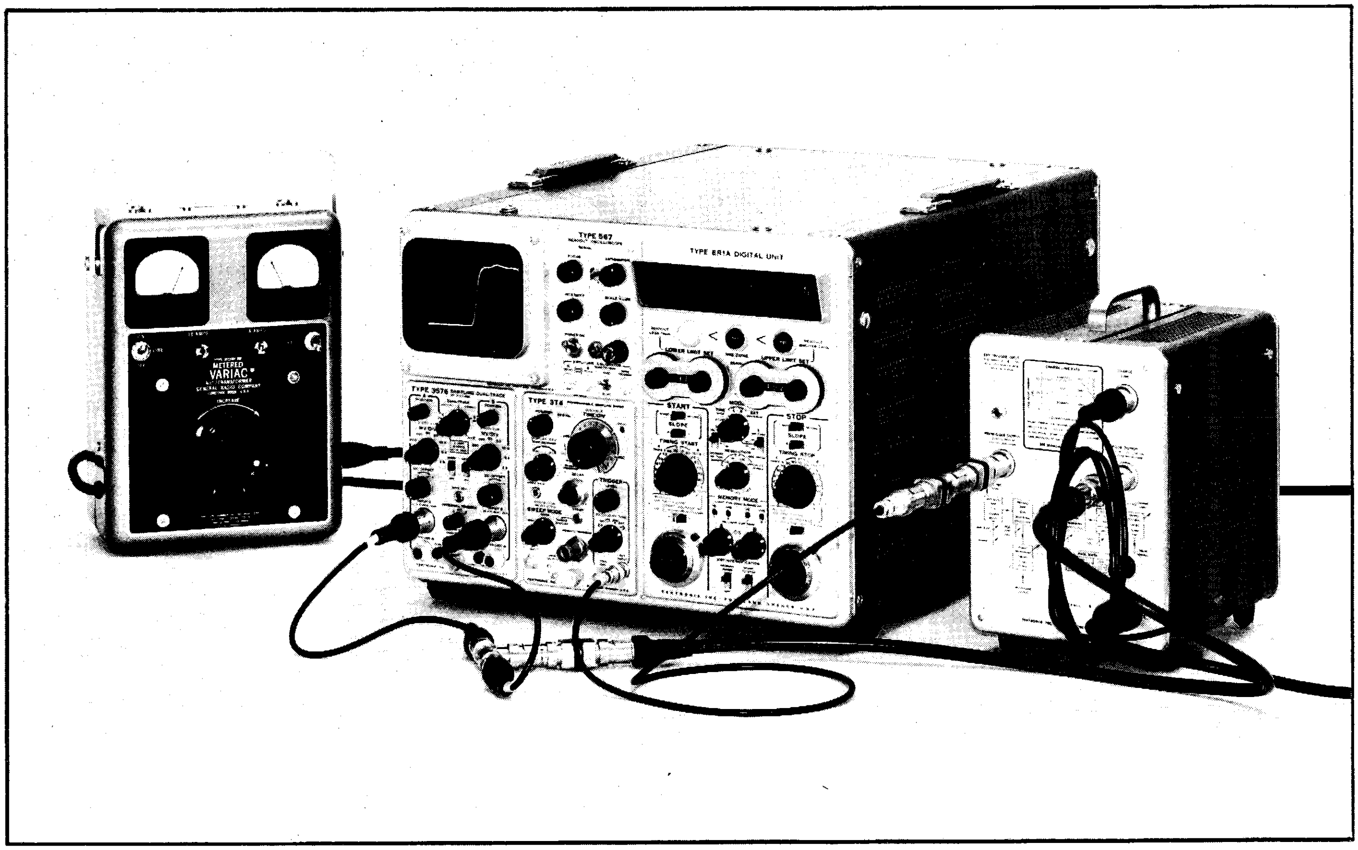


Fig. 5-36. Step 23 test setup for checking 1 nsec sweep rate with 30 nsec air line.

Control Settings

Type 3T4

TIME/DIV	**1 nSEC**
LEVEL	Stable display
RECOVERY TIME	Stable display
INT-EXT	**+EXT**
DISPLAY MAG	×1
SWEEP MODE	NORM
DELAY	**1.00**

Type 3S76

MV/DIV	**200 both channels**
2-200 VAR.	CALIB.
Mode	**DUAL-TRACE**
SMOOTH-NORMAL	SMOOTH
NORM-INV	**NORM both channels**
INTERNAL TRIGGER	OFF
POSITION and DC OFFSET	**Both channels display centered and overlapping (Fig. 5-37a)**

Type 111

REPETITION RATE	Near MAX
RANGE	10 KC
OUTPUT POLARITY	+
TRIGGER TO PULSE TIME DIFFERENCE	**Near 10 o'clock for centered pulse rise (Fig. 5-37a)**

Type 6R1A

START Switches	FIRST + SLOPE
TIMING START	50% A TRACE
STOP Switches	**FIRST + SLOPE**
TIMING STOP	**50% B TRACE**
RESOLUTION	**LO AVERAGE OF TEN SWEEPS**
A and B Zones	**As in Fig. 5-37a**

Connections

Install a 2 nsec 50 Ω cable to each Type 3S76 Input connector. Join the other ends of the cables with a GR coax T. Install a 2× attenuator to the branch arm of the coax T. Install a 5× attenuator to the Type 111 PULSE OUTPUT connector, and a 5 nsec 50 Ω cable with GR connectors between the 5× and the 2× attenuators.

Install two 10× attenuators in series onto the Type 111 PRETRIGGER OUTPUT connector. Place a GR to BNC female adapter on the second 10× attenuator. Join the adapter to the Type 3T4 Trigger EXT INPUT by a 50 Ω cable with BNC connectors. Install a 9 nsec charge line to the Type 111 CHARGE LINE connector (a 10 nsec coax can be substituted for the 9 nsec charge line).

NOTE

Steps 23 and 24 both perform the same function. Use Step 23 if no 1000 mc oscillator is at hand. Use Step 24 if a 1000 mc signal is available.

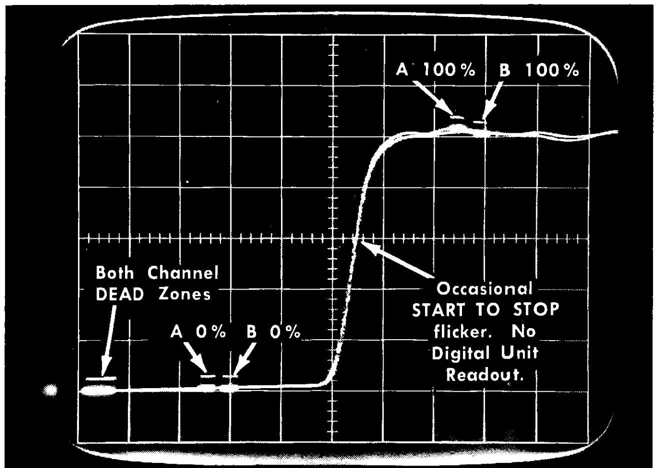
23. Check Sweep Rate at 1 nsec/div with 30 cm Air Line

a. Obtain a stable dual-trace display similar to Fig. 5-37a with both traces vertically positioned to look as if it were a single trace display at the Dead Zones.

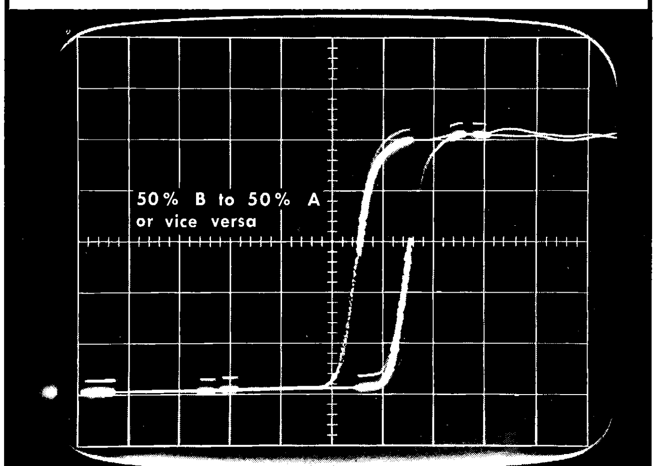
b. If the Type 6R1A shows no readout, but the display shows a minor time difference between pulses, set the TIMING START switch to 50% B TRACE and the TIMING STOP switch to 50% A TRACE. The START TO STOP intensified zone should now appear and the Digital Unit readout show the propagation time difference of the two 2 nsec cables. Slowly withdraw the 2 nsec cable attached to the INPUT B connector until the Digital Unit no longer shows a readout and the START TO STOP intensified zone just flickers occasionally (or pull out the other channel connector if this causes the time difference to increase). If there is still a time difference when the connector center conductors separate, push them together a bit until firm contact is made, and slowly withdraw the other end connector from the coax T. Thus, the propagation delay through the two cables can be made equal. Double check that the time through the two cables is equal by again setting the Type 6R1A TIMING START switch to 50% A TRACE and the TIMING STOP switch to 50% B TRACE. Whether or not the Type 6R1A starts its 50% to 50% measurement on the A or the B trace should make no difference, and the readout should remain zero.

c. Insert the 30 cm GR air line in series with the fully mated 2 nsec cable. The display should now show two pulse rises one division apart, and the Digital Unit readout should be between 0.97 and 1.03 NS. If the START TO STOP intensified zone does not appear as shown in Fig. 5-37b, change the Type 6R1A TIMING START and TIMING STOP switches to begin the measurement on the other trace.

If the sweep timing is out of tolerance, check resistors R68 and R69 on the Logic Card. Parts locations are identified in the Maintenance section of this manual. Change the out of tolerance resistor, let the system warm up for 20 minutes, then repeat Steps 9 and 10, and repeat the procedure beginning at Step 16 through this point.



A. 2 nsec cables set for equal delay.



B. 30 cm air line inserted in series with fully mated 2 nsec cable.

Fig. 5-37. Waveforms for Step 23. TIME/DIV 1 nSEC.

NOTES

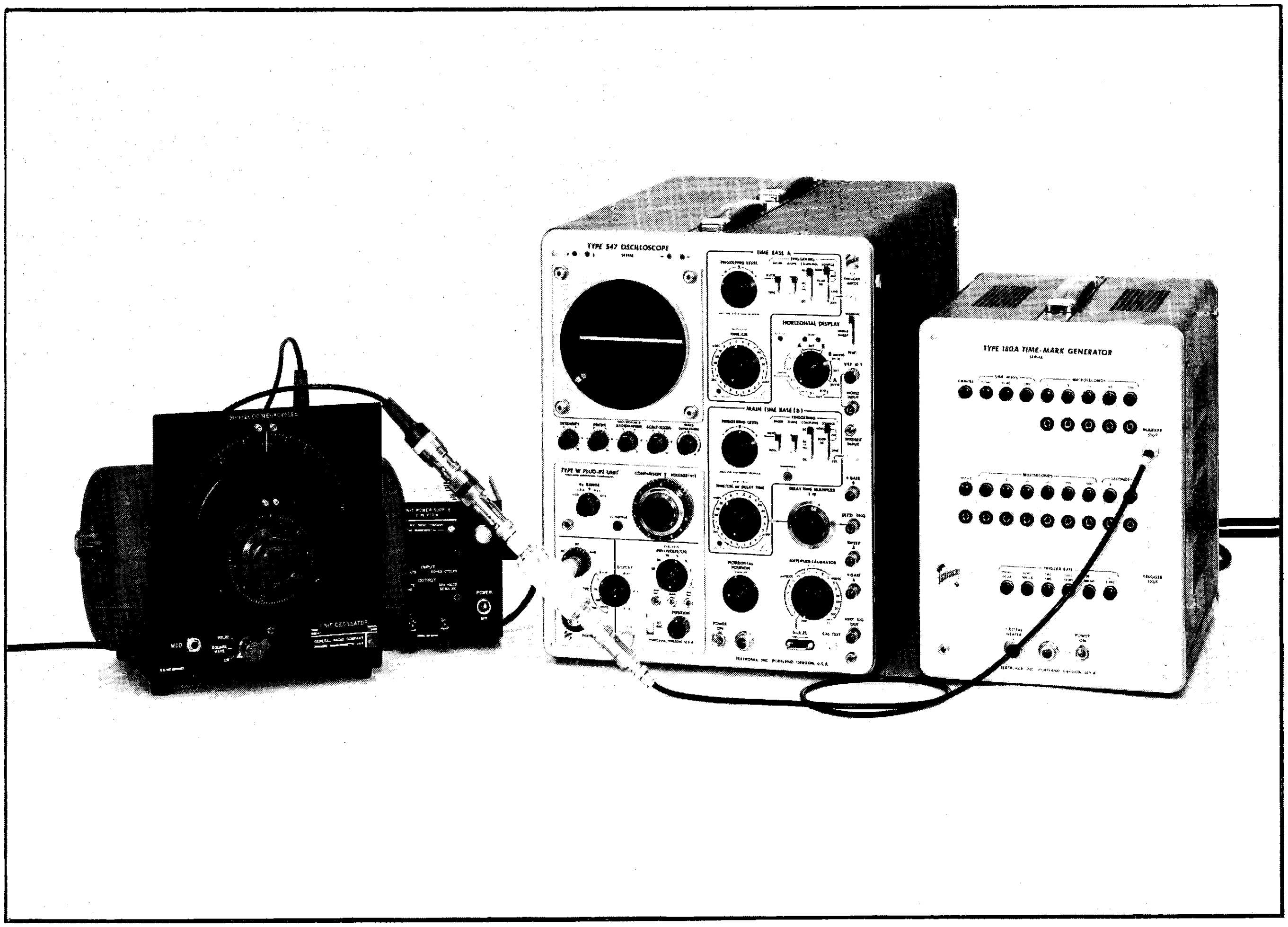


Fig. 5-38. Step 24 a. Test setup for calibrating 1000 mc oscillator.

Control Settings

General Radio Type 1218A Unit Oscillator

Dial	**1000**
Mode	**Clockwise**
Δf	**Midrange**
OUTPUT CONTROL	**Fully clockwise**

Type W

INPUT ATTEN	**1**
MILLIVOLTS/CM	**5**
DISPLAY	A-B
Input Coupling	AC

Test Oscilloscope

TIME/CM	**1 mSEC**
Triggering	**+EXT**

Type 180A

SINE WAVE	**50 MC**
TRIGGER RATE	**10 KC**

Connections

Install a 3 foot output cable to the GR oscillator output connector. Install a Tektronix 2× attenuator to the other end of the cable, and the 2× attenuator to the UNKNOWN input connector of the Mixer-Rectifier.

Install a 50 Ω coax cable from the Type 180A MARKER OUT connector to the KNOWN end of the Mixer-Rectifier unit. Use a suitable adapter.

Install a 50 Ω coax from the Type 180A TRIGGER OUT connector to the test oscilloscope TRIGGER INPUT connector.

Connect the OUTPUT of the Mixer-Rectifier to the Type W Channel A input, using a suitable UHF to BNC adapter.

24. Check 1 nsec/div Sweep Rate with 1000 MC Signal

a. Set up the equipment of Fig. 5-38 to adjust the 1000 mc oscillator to ±0.25% by comparison with Type 180A 50 MC.

The test oscilloscope display will be like Fig. 5-39a when the 1000 mc oscillator is not on frequency. The display will be like Fig. 5-39b when the oscillator frequency is correct. Fig. 5-39c is a single-sweep display of Fig. 5-39b, showing that the oscillator beats exactly with the 20th harmonic of 50 mc part of the time. The oscillator adjustment is very sensitive, so adjust the vernier dial to be nearly correct, and then bring the frequency on with the Δf control. About 15° rotation of the Δf control should make the display again like Fig. 5-39a. Leave it set for a display like Fig. 5-39b.

IMPORTANT

The 2× attenuator on the 3 foot oscillator coax standardizes the environment of the load seen by the oscillator, so the frequency will remain sufficiently accurate when the unit drives the Type 3T4-3S76. DO NOT REMOVE the attenuator or change the degree of connector mating of the cable between the attenuator and the oscillator.

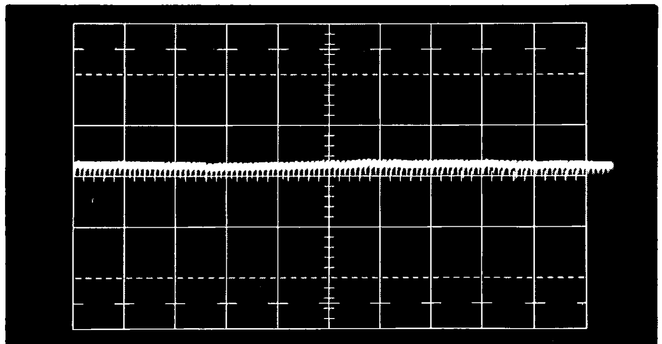
b. Adjust the Type 3T4 Trigger LEVEL control for a stable display, and position the display similar to Fig. 5-41a. Check that there are two cycles per division (a double check that the oscillator is truly at 1000 mc).

Set the Type 3T4 TIME/DIV switch to 1 nSEC and position the display like Fig. 5-41b. Check that the timing causes eight complete cycles to occupy the eight divisions between the first and ninth graticule marks. Tolerance is ±1.25 minor divisions, or ±3%.

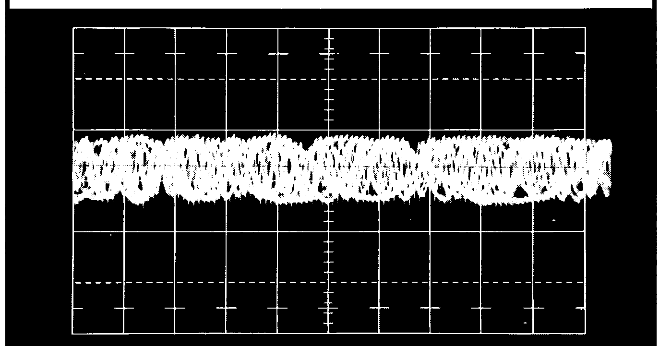
Double check the timing by turning on the Type 6R1A INTENSIFIED ZONES switches and adjust the zone positions for a display like Fig. 5-42. The Digital Unit readout should be between 0.97 and 1.03 ±1 count.

If the sweep timing is out of tolerance, check resistors R68 and R69 on the Logic Card. Parts locations are identified in the Maintenance section of this manual. Change the out of tolerance resistor, let the system warm up for 20 minutes, then repeat Steps 9 and 10, and repeat the procedure beginning at Step 16 through this point.

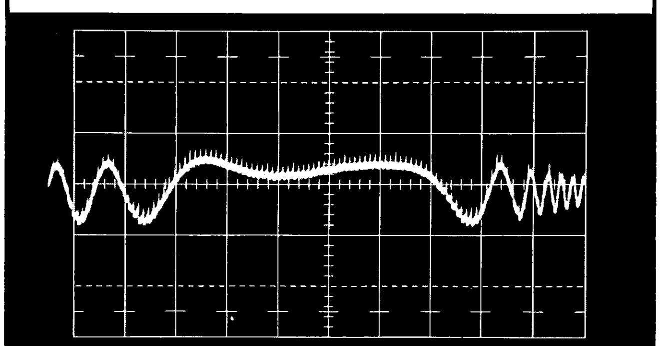
Leave the oscillator on for Step 26.



A. Unknown not 1000 mc.



B. Unknown is 1000 mc.



C. Single sweep display when unknown is 1000 mc

Fig. 5-39. Test oscilloscope displays when setting 1000 mc oscillator to correct frequency. Step 24 a.

NOTES

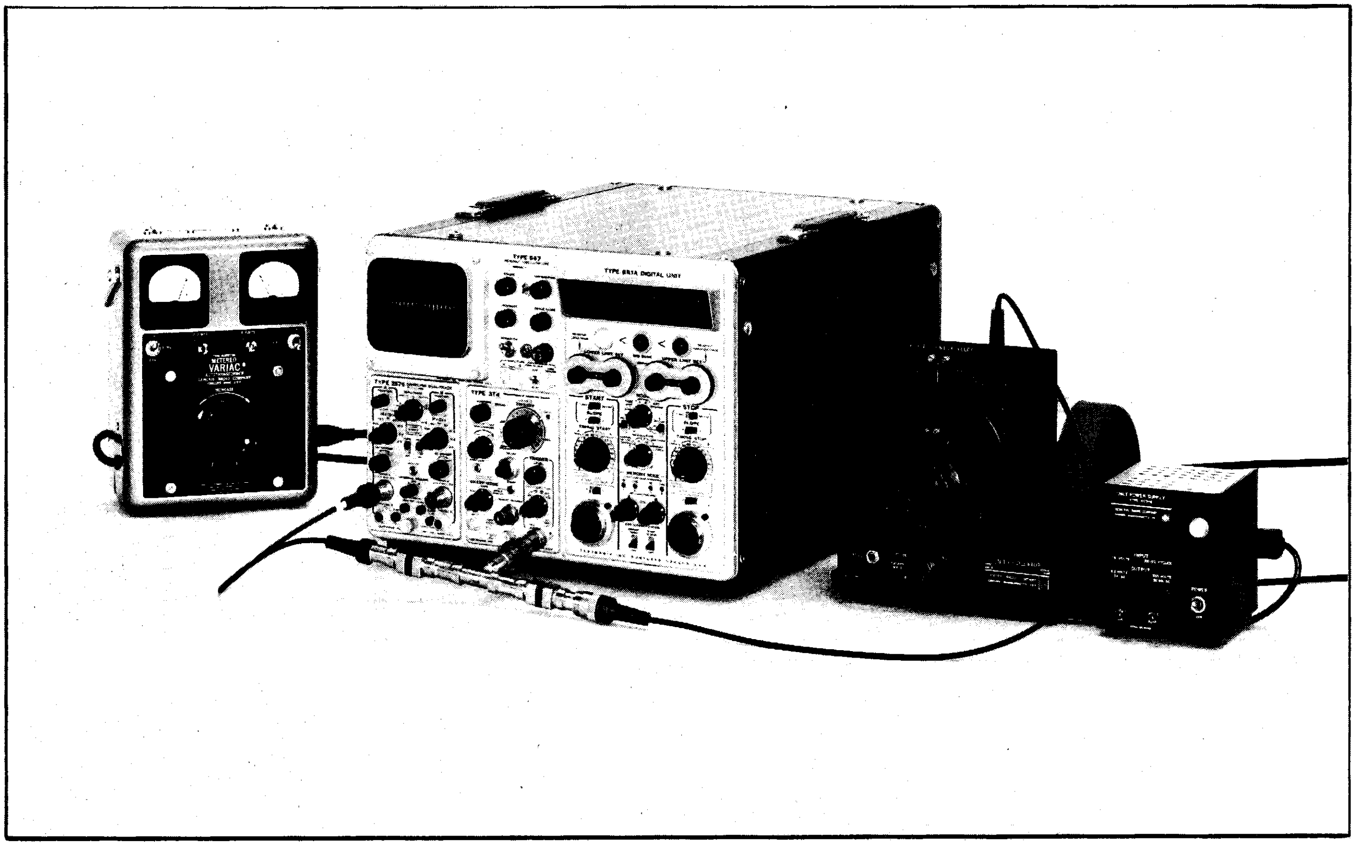


Fig. 5-40. Step 24 b. Test setup when using accurate 1000 mc sine wave to check 1 nsec/div sweep rate.

Control Settings

Type 3T4

TIME/DIV	**2 nSEC**
VARIABLE	CALIB
INT-EXT	+EXT
LEVEL	Stable display
RECOVERY TIME	**Fully counterclockwise**
DISPLAY MAG	×1
SWEEP MODE	NORM
DELAY	1.00

Type 3S76

Mode	**A ONLY**
MV/DIV	**50**
2-200 VAR.	CALIB.
INTERNAL TRIGGER	OFF
SMOOTH-NORMAL	SMOOTH

Type 6R1A

MODE	TIME
START Switches	FIRST + SLOPE
TIMING START	50% A TRACE
STOP Switches	**SECOND + SLOPE**
TIMING STOP	**50% A TRACE**
RESOLUTION	LO AVERAGE OF TEN SWEEPS
CRT INTENSIFICATION switches	**OFF**

Connections

Install a 10× attenuator to the branch arm connector of a GR Type 874 T. Join the 10× attenuator to the Type 3T4 Trigger EXT INPUT through a GR to BNC male adapter.

Connect the GR Oscillator (1000 mc adjusted in Step 24a) cable and 2× attenuator to one of the through connections of the GR T.

Install a 5× attenuator and 2 nsec 50 Ω cable to the third GR T connector. Install the other end of the 2 nsec cable to the Type 3S76 INPUT A connector.

25. Check Fast Ramp Linearity

a. Connect the Type 180A MARKER OUT connector to the Type 3S76 INPUT A through a 50 Ω cable and 5× attenuator. Press the Type 180A SINE WAVE 10 MC button in. Set the Type 3S76 MV/DIV switch to 200, and the SMOOTH-NORMAL switch to SMOOTH.

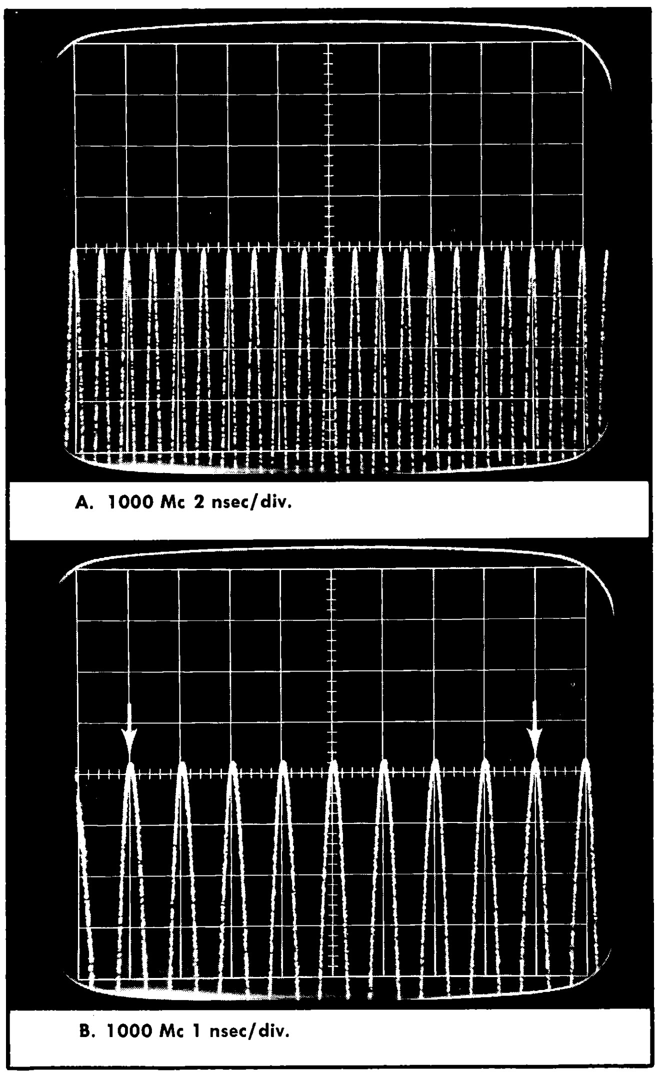
Set the Type 3T4 TIME/DIV to 20 nSEC and internally triggered for a stable display.

b. Set the Type 3T4 DELAY dial to a position between 0.05 and 1.00 to obtain a 10 mc sinewave display that is positioned as shown in Fig. 5-43a, with the sweep beginning as the signal slopes negative. The actual position of the DELAY dial is not important, so long as it rests between 0.50 and 1.00.

Leave the Type 6R1A controls set to measure time of one cycle as in Step 24b, except position the 0% and 100% zones as shown in Fig. 5-43a. The Digital Unit readout should be between 0.97 and 1.03. The display should be very stable with the controls as set, and the readout should repeat itself without changing more than one count. Record the readout.

c. Turn the DELAY dial clockwise one turn until the display is the same, only one cycle farther down the fast ramp. Record the readout. Repeat this step through each turn of the DELAY dial as far as possible. Record each readout.

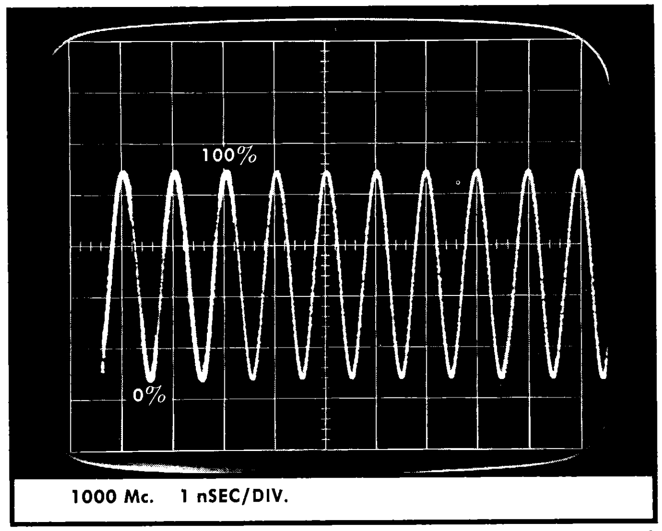
d. Set the DELAY dial to a position between 1.00 and 1.50 to obtain a 10 mc sinewave positioned as shown in Fig. 5-43b. Set the Digital Unit 0% and 100% zones as shown. Record the readout.



A. 1000 Mc 2 nsec/div.

B. 1000 Mc 1 nsec/div.

Fig. 5-41. Check of 1 nsec/div timing in Step 24 b. Timing is checked between the arrows.



1000 Mc. 1 nSEC/DIV.

Fig. 5-42. Displays using Digital Unit to check 1 nsec/div sweep rate. Step 24 b.

e. Turn the DELAY dial clockwise one turn until the display is the same, only one cycle farther down the fast ramp. Record the readout. Repeat this step through each turn of the DELAY dial as far as possible. Record each readout.

The readouts obtained are a record of the Fast Ramp linearity between the DELAY dial limits of 0.50 and 10.00. If the linearity produces readouts with greater than ±1.5% deviation (3% variation in readout) first check that all controls are correctly set, and that the display triggering is stable. Then, turn off the equipment and check that the leads at both ends of L123-SW123 are positioned physically as shown in Fig. 4-5 and that R123 and R124 are of the correct value. If all is correct, then check or change Q114 and turn on the equipment again. Wait 20 minutes for warm up, and repeat Steps 15 through 25. If still nonlinear, check the waveforms associated with the Fast Ramp Clamp, and the Fast Ramp, as shown in the Circuit Description.

NOTE

The maintenance suggestions given are not to suggest that problems are normal. The linearity of the Fast Ramp as checked with the Digital Unit RESOLUTION switch at HI AVERAGE OF TEN SWEEPS is typically within 0.03%.

26. Check High Frequency Sinewave Triggering

NOTE

This step is needed only if the intended use of Type 3T4 is for stable displays with external 1000 mc triggering. If your system uses pulses, or sinewaves below 1000 mc, check performance with your system signal. (Some Type 3T4 units will trigger in a stable manner at 2000 mc.)

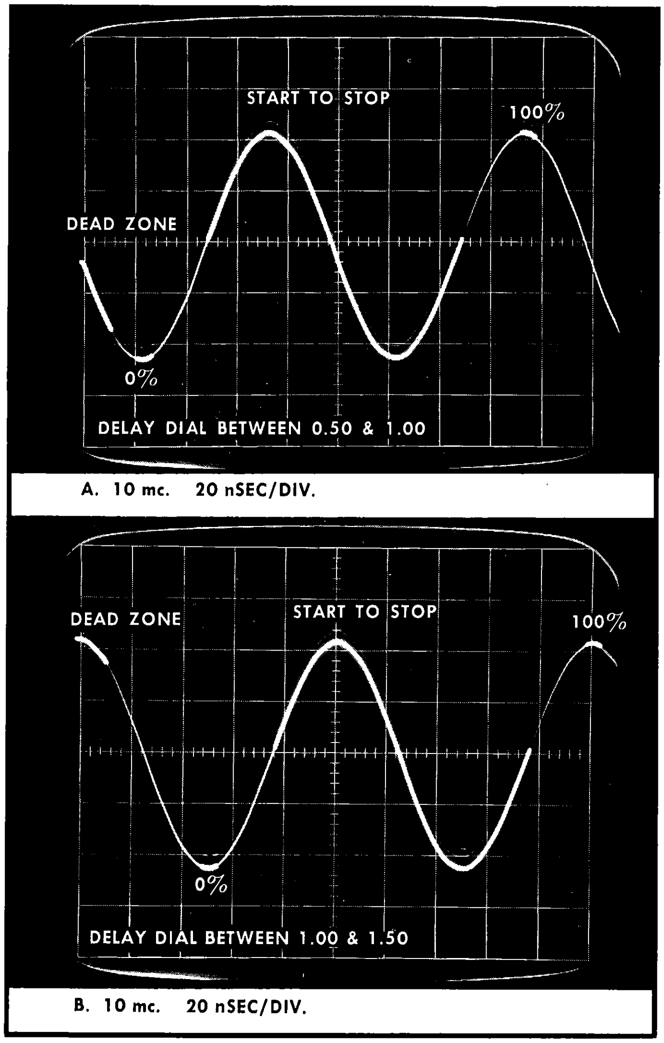


Fig. 5-43. Initial setting of Digital Unit 0% and 100% Zones when checking Fast Ramp linearity. Step 25.

a. If your equipment uses sinewaves of less than 1000 mc, set it up similarly to Fig. 5-40 and obtain a stable display. Be sure to deliver the correct amount of signal to the Trigger EXT INPUT connector. 200 mv peak to peak is delivered to the EXT INPUT in the setup of Fig. 5-40.

b. Disconnect the signal to the Type 3S76 INPUT A. Set the MV/DIV switch to 200 and position the trace to the graticule center. Set the MV/DIV switch to 10 and reposition the trace to the graticule center using the DC OFFSET control. The DC OFFSET control is correctly adjusted when the trace does not leave the graticule center as the MV/DIV switch is rotated from 200 to 10.

c. Reconnect the signal to the Type 3S76 INPUT A and set the SMOOTH-NORMAL switch to NORMAL. Obtain a stable display similar to Fig. 5-44a.

Set the Type 3T4 DISPLAY MAG switch to X10 for a display similar to Fig. 5-44b.

Set the Type 3S76 MV/DIV switch to 10 and obtain a display similar to Fig. 5-44c. The scribed lines on the waveform of Fig. 5-44c eliminate approximately 10% of the dots from the jitter reading. The display should not be greater than two horizontal divisions wide (200 picosec) when measured as shown in Fig. 5-44c.

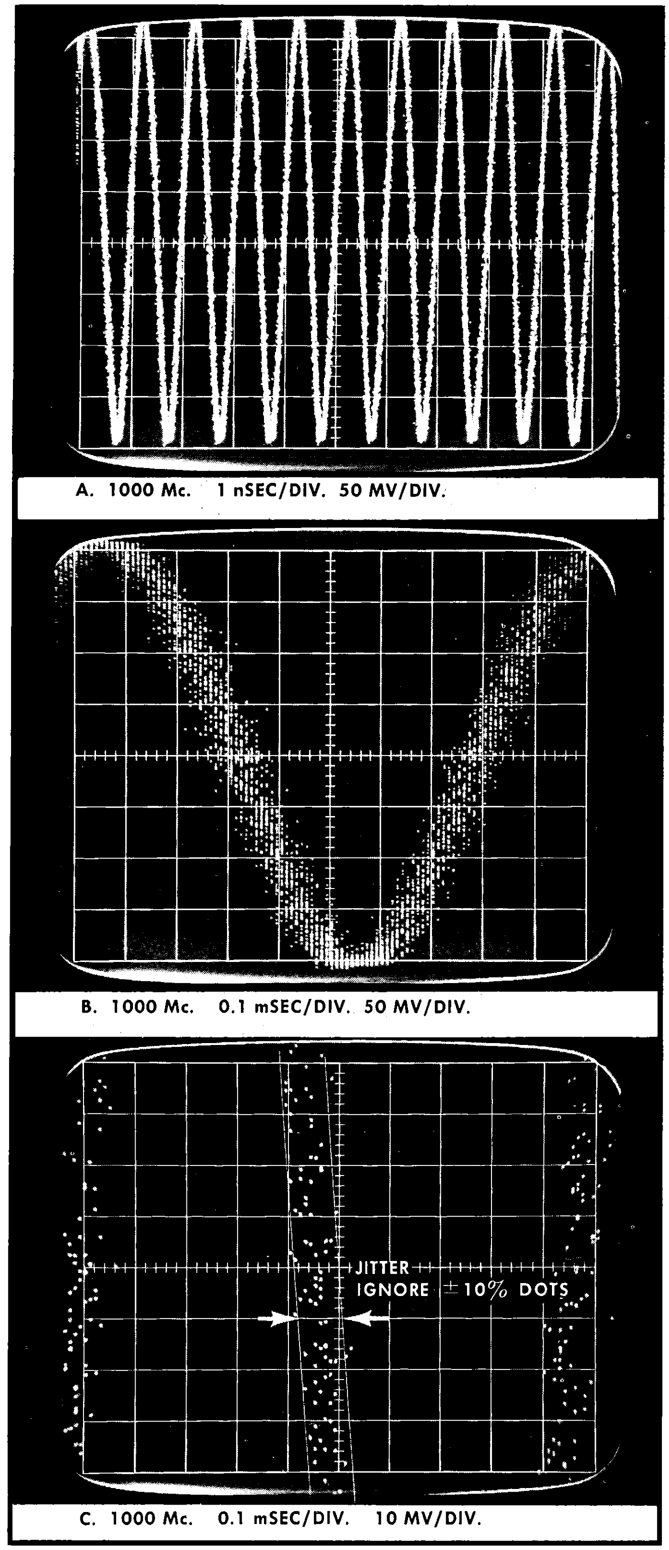


Fig. 5-44. Waveforms for Step 26.

If jitter is greater than 200 picosec, adjust the Fast Ramp COMPARATOR LEVEL control, R130, very slightly for a position of reduced jitter.

If jitter is still greater than 200 picosec, check —100- and +125-volt power-supply ripple; then change D135 and/or D105. All of these items should help you obtain approximately 100 picosec or less jitter as shown in Fig. 5-44c.

d. Repeat Step 22 and then Step 20 if you have adjusted R130 or changed any parts.

e. If you use signals near 500 mc for internal sinewave triggering, check the jitter with your 500 mc source in a manner similar to the above, but internally triggered. Apply at least 200 millivolts peak to peak of 500 mc signal to the Type 3S76 INPUT A connector when checking internal triggering jitter. If there is greater than 200 picosec jitter (and if there is less than 200 picosec jitter externally triggered at 1000 mc), check that the interconnecting plugs at the rear of each plug-in unit and in the Type 567 mainframe are clean and making good contact.

NOTES

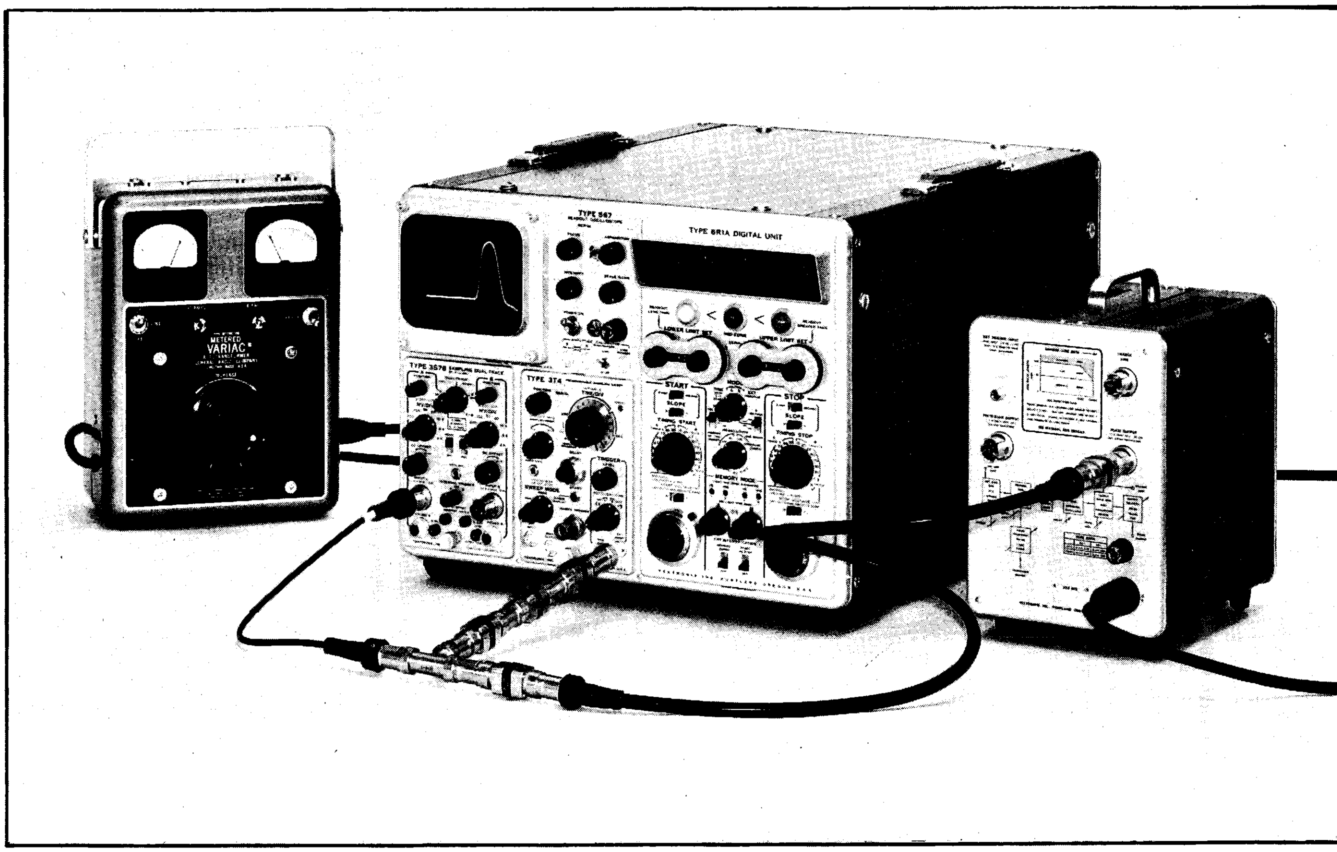


Fig. 5-45. Step 27 test setup for checking Type 3T4 ability to trigger properly on low-level short duration pulses.

Control Settings

Type 3T4

TIME/DIV	1 nSEC
DISPLAY MAG	×1
DELAY	**0.10 for pulse display as in Fig. 5-46b**
SWEEP MODE	NORM
LEVEL	Most stable display
RECOVERY TIME	Most stable display
INT-EXT	+EXT

Type 3S76

MV/DIV	**20**
SMOOTH-NORMAL	**NORMAL**
DC OFFSET	**No trace shift through MV/DIV switch**
INTERNAL TRIGGER	OFF

Type 111

REPETITION RATE	Near MAX
RANGE	10 KC
OUTPUT POLARITY	+

Connections

Install a 10× attenuator on the Type 111 PULSE OUTPUT connector; a 50 Ω cable to the 10× attenuator, and a second 10× attenuator on the cable output end; attach the second 10× to one of the through connectors of a GR T; a 2 nsec 50 Ω cable from the other through connector of the T to the Type 3S76 INPUT A; a 5×, and two 2× attenuators to the branch arm connector of the T, with GR to BNC adapter and connected to Type 3T4 Trigger EXT INPUT connector. All connections are shown in Fig. 5-45.

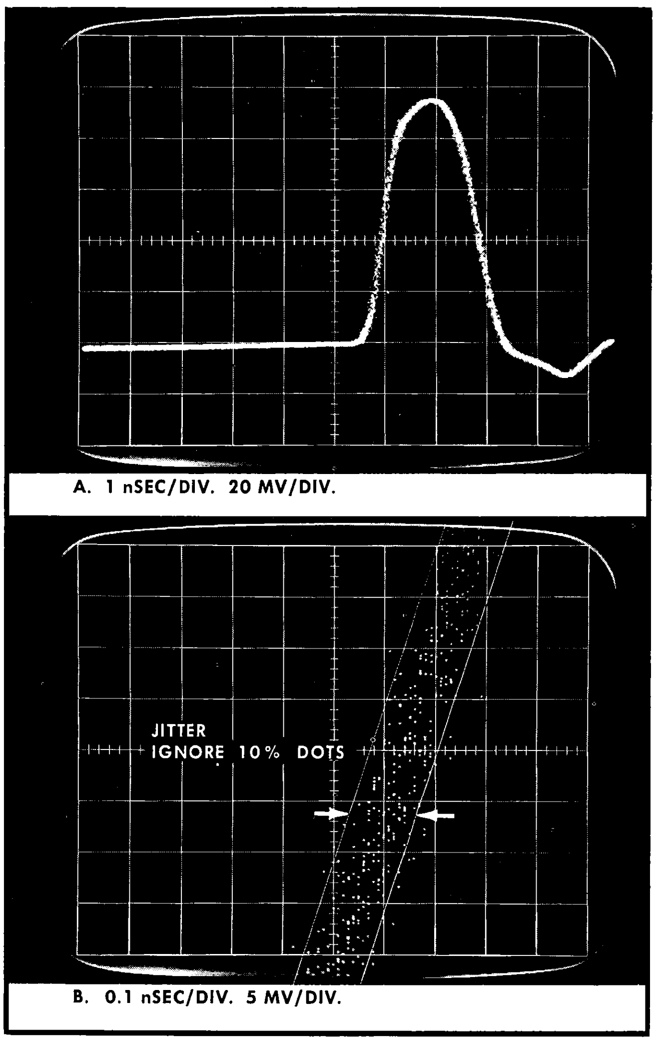
27. Check Pulse Triggering

a. Set up the equipment shown in Fig. 5-45 and obtain a display similar to Fig. 5-46a. Since the Type 111 output amplitude is not adjustable, measure the pulse amplitude on the crt. If it is near 100 mv peak (as in Fig. 5-46a) leave the attenuators as connected. If it is less, remove a 2× (or other) attenuator from the Trigger EXT INPUT line. The need is for at least 25 mv peak pulse to enter the EXT INPUT connector. As soon as you are certain the signal is approximately correct, proceed.

b. Set the Type 3S76 MV/DIV switch to 5, and position the display down so about the middle of the pulse rise crosses the crt centerline.

Set the Type 3T4 DISPLAY MAG to ×10 and, ignoring 10% of the dots, measure the display jitter as shown in Fig. 5-46b. If the jitter is greater than 200 picosec, carefully adjust the Type 3T4 LEVEL control, the RECOVERY TIME control, and the Type 111 REPETITION RATE control to try to obtain a cleaner triggered display. Next, check the signal amplitude into the Trigger EXT INPUT connector to be certain it is at least 25 mv. Normally, if Step 26 jitter was well within limits, you will not have any problem with this pulse jitter check.

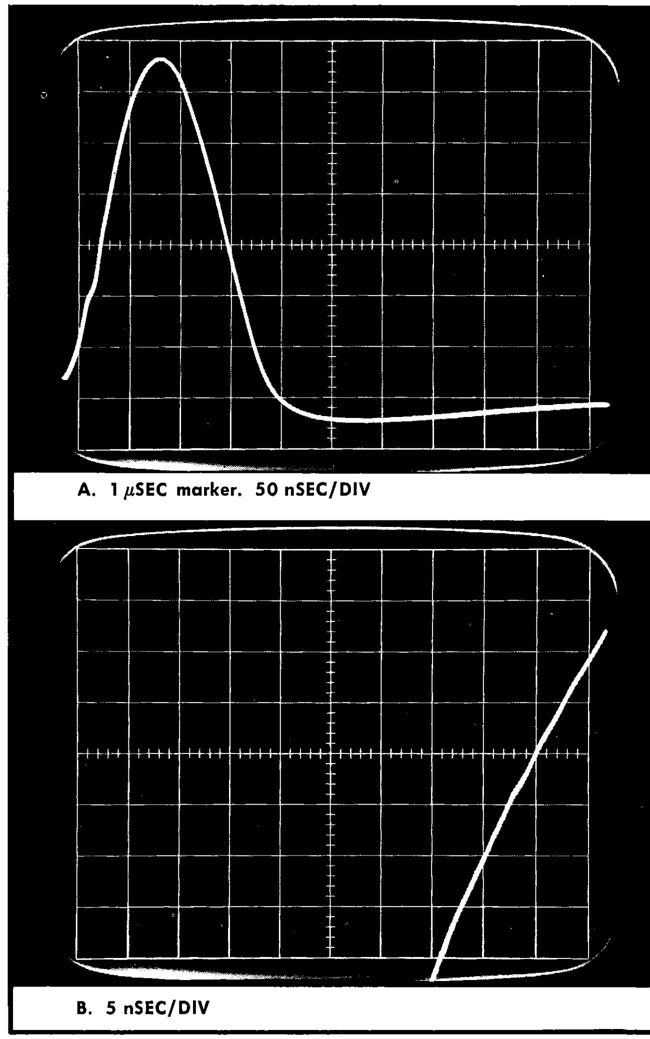
c. Set the Type 111 OUTPUT POLARITY to —, and the Type 3T4 INT-EXT switch to —EXT. Reposition the display, and check the jitter for a negative-going pulse; equal to or less than 200 picosec.



A. 1 nSEC/DIV. 20 MV/DIV.

B. 0.1 nSEC/DIV. 5 MV/DIV.

Fig. 5-46. Waveforms for Step 27.



A. 1 μSEC marker. 50 nSEC/DIV

B. 5 nSEC/DIV

Fig. 5-47. Remote Delay Cal waveforms—Step 28.

28. Adjust REMOTE DELAY CAL Control, R80 ⓘ

NOTE

This step is important only when the Type 3T4 is to be remotely controlled. External connection to the REMOTE PROGRAM connector is necessary. See the Operating Instructions section discussion of remote programming and remote delay resistance.

a. Set up your remote equipment so the two remote delay leads are accessible for connecting them together and/or placing a 1% 30 k resistor between them.

b. Connect the Type 180A MARKER OUT connector to the Type 3S76 INPUT A connector, without any attenuator. Set the Type 3S76 MV/DIV switch to 100, and the SMOOTH-NORMAL switch to SMOOTH. Press the Type 180A 1 MICROSECONDS button.

c. Set the Type 3T4 remote controls:

TIME/DIV	50 nSEC
DELAY	0 (leads shorted)
SWEEP MODE	NORMAL

d. Set the Type 3T4 front-panel controls:

TIME/DIV	REMOTE PROGRAM
INT-EXT	+INT
Trigger LEVEL	For stable display
RECOVERY TIME	For stable display

The display should now be similar to Fig. 5-47a.

e. Set the Type 3T4 Remote TIME/DIV to 5 nSEC, and the Type 3S76 MV/DIV to 20. Use both the Horizontal and Vertical POSITION controls to set the pulse rise so it crosses the crt centerline at the ninth graticule marking as shown in Fig. 5-47b.

f. Insert the 1% 30 k resistor between the remote delay leads. The display should now look the same as Fig. 5-47b. If it does not, adjust the REMOTE DELAY CAL control, R80, until the display duplicates Fig. 5-47b. Short the remote delay leads and check the zero display position again, then again insert the 30 k resistor and adjust the REMOTE DELAY CAL control until the display is like Fig. 5-47b. The remote DELAY circuit will now perform according to Table 2-2 in the Operating Instructions.

Leave the Type 180A as connected.

29. Check SINGLE DISPLAY Operation

a. Use the signal as set in Step 28.

b. Set the Type 3T4 TIME/DIV switch to 50 nSEC, the DELAY dial to 0.00, and the Type 3S76 MV/DIV switch to 100. The display should be like Fig. 5-47a.

c. Set the Type 3T4 SWEEP MODE switch to SINGLE DISPLAY. The trace should disappear. Press the START button and you should see one complete trace with a display like Fig. 5-47a. If not, read the Circuit Description and service the Single Display portion of the Staircase Generator circuit.

NOTES

SECTION 6
PARTS LIST and DIAGRAMS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix Field Office.

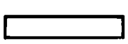
Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix Field Office will contact you concerning any change in part number.

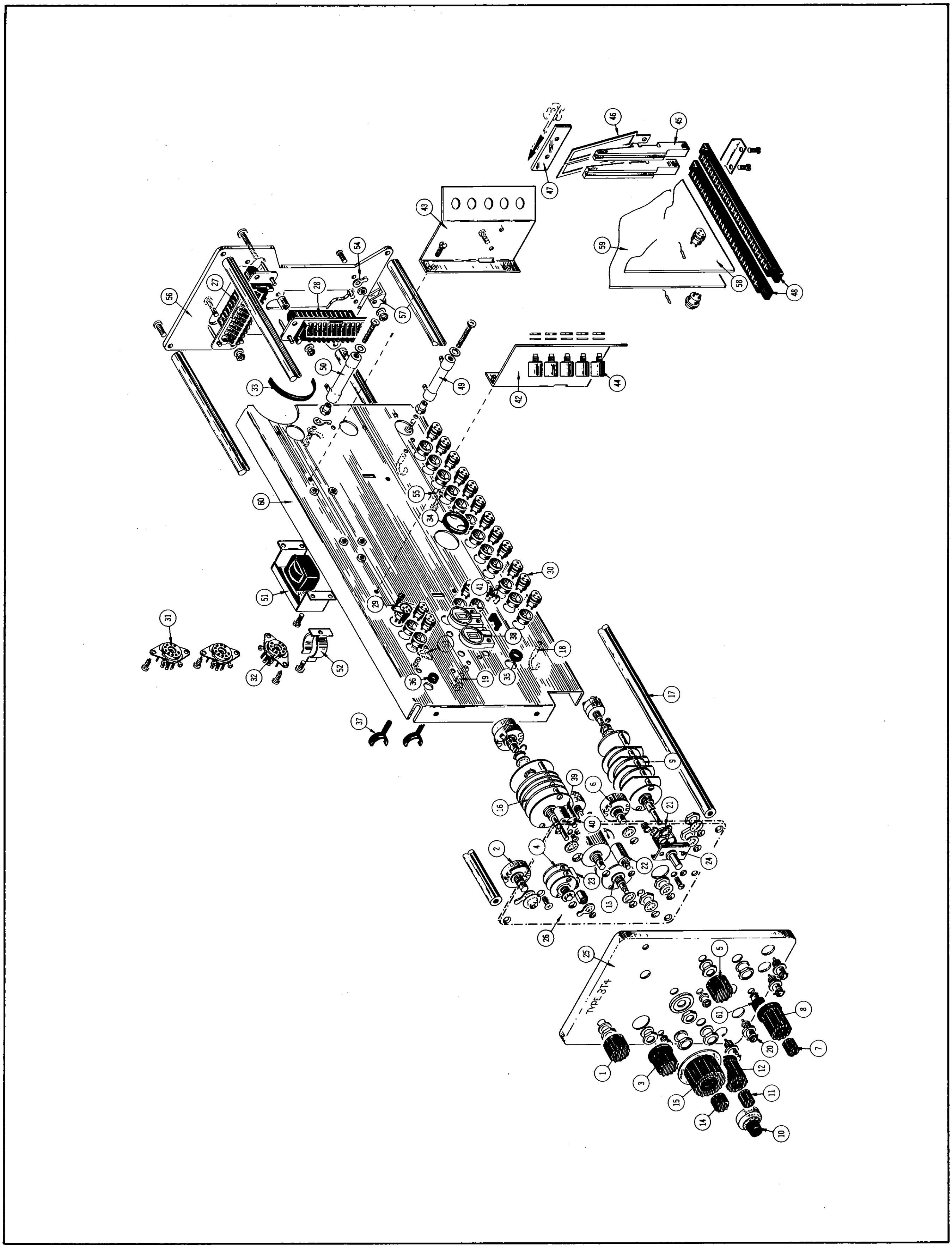
ABBREVIATIONS AND SYMBOLS

a or amp	amperes
BHS	binding head steel
C	carbon
cer	ceramic
cm	centimeter
comp	composition
cps	cycles per second
crt	cathode-ray tube
CSK	counter sunk
dia	diameter
div	division
EMC	electrolytic, metal cased
EMT	electroyltic, metal tubular
ext	external
f	farad
F & I	focus and intensity
FHS	flat head steel
Fil HS	fillister head steel
g or G	giga, or 10^9
Ge	germanium
GMV	guaranteed minimum value
h	henry
hex	hexagonal
HHS	hex head steel
HSS	hex socket steel
HV	high voltage
ID	inside diameter
incd	incandescent
int	internal
k or K	kilohms or kilo (10^3)
kc	kilocycle
m	milli, or 10^{-3}
mc	megacycle
mm	millimeter
meg or M	megohms or mega (10^6)
met.	metal
μ	micro, or 10^{-6}
n	nano, or 10^{-9}
Ω	ohm
OD	outside diameter
OHS	oval head steel
p	pico, or 10^{-12}
PHS	pan head steel
piv	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
Prec	precision
PT	paper tubular
PTM	paper or plastic, tubular, molded
RHS	round head steel
rms	root mean square
sec	second
Si	silicon
S/N	serial number
t or T	tera, or 10^{12}
TD	toroid
THS	truss head steel
tub.	tubular
v or V	volt
Var	variable
w	watt
w/	with
w/o	without
WW	wire-wound

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number.
000X	Part removed after this serial number.
*000-000	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

EXPLODED VIEW



EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	Q T Y.	DESCRIPTION
1	366-0148-00			1	KNOB, charcoal—POSITION
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
2	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0207-00			1	LUG, solder, pot 3/8 inch
	210-0013-00			1	LOCKWASHER, internal, 3/8 x 11/16 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
3	366-0173-00			1	KNOB, charcoal—SAMPLES/SWEEP-DISPLAY MAG
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
4	260-0682-00			1	SWITCH, unwired—SAMPLES/SWEEP-DISPLAY MAG
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
5	366-0148-00			1	KNOB, charcoal—TRIGGER LEVEL
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
6	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0013-00			1	LOCKWASHER, internal, 3/8 x 11/16 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
7	366-0140-00			1	KNOB, red—RECOVERY TIME
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
8	366-0250-00			1	KNOB, charcoal—INT-EXT
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
9	262-0715-00			1	SWITCH, wired—SOURCE
	- - - - - -			-	switch includes:
	260-0683-00			1	SWITCH, unwired
	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot alone)
	210-0046-00			1	LOCKWASHER, .400 OD x .261 inch ID
	210-0583-00			2	NUT, hex, 1/4-32 x 5/16 inch
	376-0014-00			1	COUPLING, wire
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
10	331-0096-00			1	DIAL, w/knob—DELAY

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	Q T Y.	DESCRIPTION
11	366-0140-00			1	KNOB, red—MANUAL SCAN OR EXT ATTEN
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
12	366-0250-00			1	KNOB, charcoal—SWEEP MODE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
13	262-0714-00			1	SWITCH, wired—SWEEP MODE
	- - - - - -			-	switch includes:
	260-0680-00			1	SWITCH, unwired
	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot alone)
	210-0046-00			1	LOCKWASHER, .400 OD x .261 inch ID
	210-0538-00			2	NUT, hex, 1/4-32 x 5/16 inch
	376-0014-00			1	COUPLING, wire
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0013-00			1	LOCKWASHER, internal, 3/8 x 11/16 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
14	366-0081-00			1	KNOB, red—VARIABLE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
15	366-0109-00			1	KNOB, charcoal—TIME/DIV
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
16	262-0713-00			1	SWITCH, wired—TIME/DIV
	- - - - - -			-	switch includes:
	260-0681-00			1	SWITCH, unwired
	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot alone)
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0413-00			2	NUT, hex, 3/8-32 x 1/2 inch
	376-0014-00			1	COUPLING, wire
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0013-00			1	LOCKWASHER, internal, 3/8 x 11/16 inch
	210-0840-00			1	WASHER, .390 ID x 9/16 inch OD
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
17	384-0615-00			4	ROD, frame
	- - - - - -			-	mounting hardware for each: (not included w/rod)
	212-0044-00			1	SCREW, 8-32 x 1/2 inch RHS, phillips
18	343-0089-00			2	CLAMP, cable, large
19	129-0069-00			1	POST, tie, delrin
	- - - - - -			-	mounting hardware: (not included w/post)
	361-0007-00			1	SPACER, nylon
20	131-0106-00			4	CONNECTOR, chassis mounted, coax

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
21	210-0255-00			2	LUG, solder, coax
22	260-0689-00			1	SWITCH, unwired—START
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0046-00			1	LOCKWASHER, .400 OD x .261 inch ID
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			2	NUT, hex, 1/4-32 x 5/16 inch
23	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0471-00			1	NUT, pot, hex, 1/4-32 x 19/32 inch
	210-0223-00			1	LUG, solder
	358-0054-00			1	BUSHING, banana jack
24	214-0052-00			1	FASTENER, w/stop
	- - - - - -			-	mounting hardware: (not included w/fastener)
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
25	333-0840-00			1	PANEL, front
26	387-0978-00			1	PLATE, front sub-panel
27	131-0149-00			1	CONNECTOR, chassis mounted, 24 contact
	- - - - - -			-	mounting hardware: (not included w/connector)
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS
28	131-0149-00			1	CONNECTOR, chassis mounted, 24 contact
	- - - - - -			-	mounting hardware: (not included w/connector)
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
	166-0032-00			2	TUBE, spacer
	211-0016-00			2	SCREW, 4-40 x 5/8 inch RHS
29	136-0101-00			1	SOCKET, 5 pin
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0055-00			2	SCREW, thread forming, 2-32 x 3/16 inch, PHS phillips
30	136-0181-00			16	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, mounting
31	136-0072-00			2	SOCKET, 7 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	213-0044-00			2	SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips
32	136-0015-00			1	SOCKET, STM9G
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0044-00			2	SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips
33	252-0564-00			1	GROMMET, strip
34	348-0050-00			1	GROMMET, plastic, 3/4 inch
35	348-0056-00			1	GROMMET, delrin, .406 OD x .353 ID x .140 inch high
36	348-0063-00			1	GROMMET, plastic, 1/2 inch

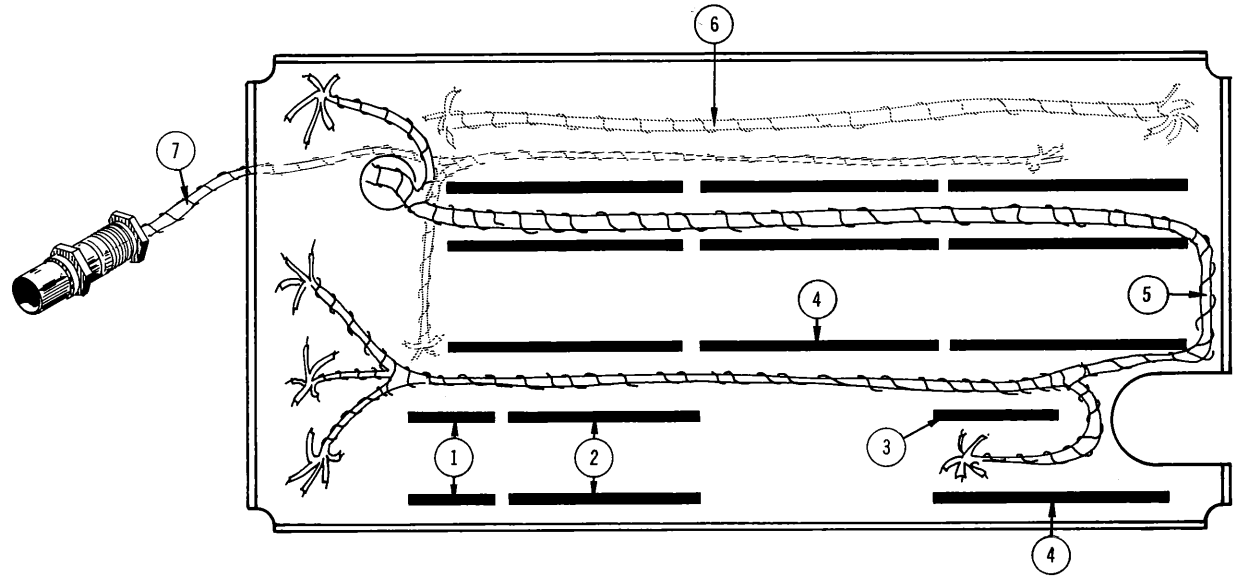
EXPLODED VIEW (Cont'd)

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
37	352-0068-00			2	HOLDER, delrin
38	- - - - - -			2	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
	214-0153-00			1	FASTENER, snap
39	352-0067-00			1	HOLDER, single, neon
	- - - - - -			-	mounting hardware: (not included w/holder)
	210-0406-00			1	NUT, hex, 4-40 x 3/16 inch
	211-0031-00			1	SCREW, 4-40 x 1 inch FHS
40	378-0541-00			1	FILTER, lens, neon
41	426-0121-00			1	MOUNT, toroid, nylon
	- - - - - -			-	mounting hardware: (not included w/mount)
	361-0007-00			1	SPACER, nylon
42	407-0063-00			1	BRACKET, pot
43	407-0062-00			1	BRACKET, pot
44	- - - - - -			10	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex, 1/4-32 x 5/16 inch
45	351-0059-00			4	GUIDE, board
46	344-0101-00			4	CLIP, retainer board
47	407-0061-00			2	BRACKET, connector
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
	211-0510-00			2	SCREW, 6-32 x 3/8 inch BHS
	210-0006-00			2	LOCKWASHER, internal, #6
48	131-0292-00			2	CONNECTOR, 56 pin
	- - - - - -			-	mounting hardware for both: (not included w/connectors)
	406-0676-00			2	BRACKET, grounding
	211-0014-00			4	SCREW, 4-40 x 1/2 inch BHS
49	- - - - - -			1	RESISTOR
	- - - - - -			-	mounting hardware: (not included w/resistor)
	211-0553-00			1	SCREW, 6-32 x 1 1/2 inches RHS, phillips
	210-0601-00			1	EYELET
	210-0478-00			1	NUT, hex, 5/16 x 21/32 inch
	211-0507-00			1	SCREW, 6-32 x 5/16 inch BHS
50	- - - - - -			1	RESISTOR
	- - - - - -			-	mounting hardware: (not included w/resistor)
	211-0553-00			1	SCREW, 6-32 x 1 1/2 inches RHS, phillips
	210-0601-00			1	EYELET
	210-0478-00			1	NUT, hex, 5/16 x 21/32 inch
	210-0203-00			1	LUG, solder
	211-0507-00			1	SCREW, 6-32 x 5/16 inch BHS

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
51	- - - - - -			1	TRANSFORMER
	- - - - - -			-	mounting hardware: (not included w/transformer)
	211-0008-00			4	SCREW, 4-40 x 1/4 inch BHS
52	344-0118-00			1	CLIP, capacitor mounting
	- - - - - -			-	mounting hardware: (not included w/clip)
	211-0507-00			1	SCREW, 6-32 x 5/16 inch BHS
53	210-0204-00			5	LUG, solder, DE #6
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	213-0044-00			1	SCREW, thread cutting, 5-32 x 3/16 inch PHS, phillips
54	210-0202-00			3	LUG, solder, SE #6
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	211-0504-00			1	SCREW, 6-32 x 1/4 inch BHS
	210-0407-00			1	NUT, hex, 6-32 x 1/4 inch
55	210-0201-00			5	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	213-0044-00			1	SCREW, thread cutting, 5-32 x 3/16 inch PHS, phillips
56	387-0595-00			1	PLATE, panel rear
57	351-0037-00			1	GUIDE, plug-in, delrin
	- - - - - -			-	mounting hardware: (not included w/guide)
	211-0013-00			1	SCREW, 4-40 x 3/8 inch RHS
	210-0004-00			1	LOCKWASHER, internal, #4
	210-0406-00			1	NUT, hex, 4-40 x 3/16 inch
58	670-0073-00			1	CARD, (TIMING CIRCUIT)
	- - - - - -			-	card includes:
	136-0183-00			10	SOCKET, transistor, 3 pin
	260-0552-00			3	SWITCH, reed, unwired
59	670-0074-00			1	CARD, (LOGIC CIRCUIT)
	- - - - - -			-	card includes:
	136-0183-00			16	SOCKET, transistor, 3 pin
	260-0552-00			6	SWITCH, reed, unwired
60	441-0582-00			1	CHASSIS, main
	- - - - - -			-	mounting hardware: (not included w/chassis)
	211-0507-00			2	SCREW, 6-32 x 5/16 inch BHS
	211-0559-00			3	SCREW, 6-32 x 3/8 inch, 100° CSK, FHS phillips
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
61	366-0109-00			1	KNOB, plug-in securing
	- - - - - -			-	knob includes:
	213-0005-00			1	SCREW, set, 8-32 x 1/8 inch, HSS
	210-0894-00			1	WASHER, polyethylene, .567 OD x .033 inch ID

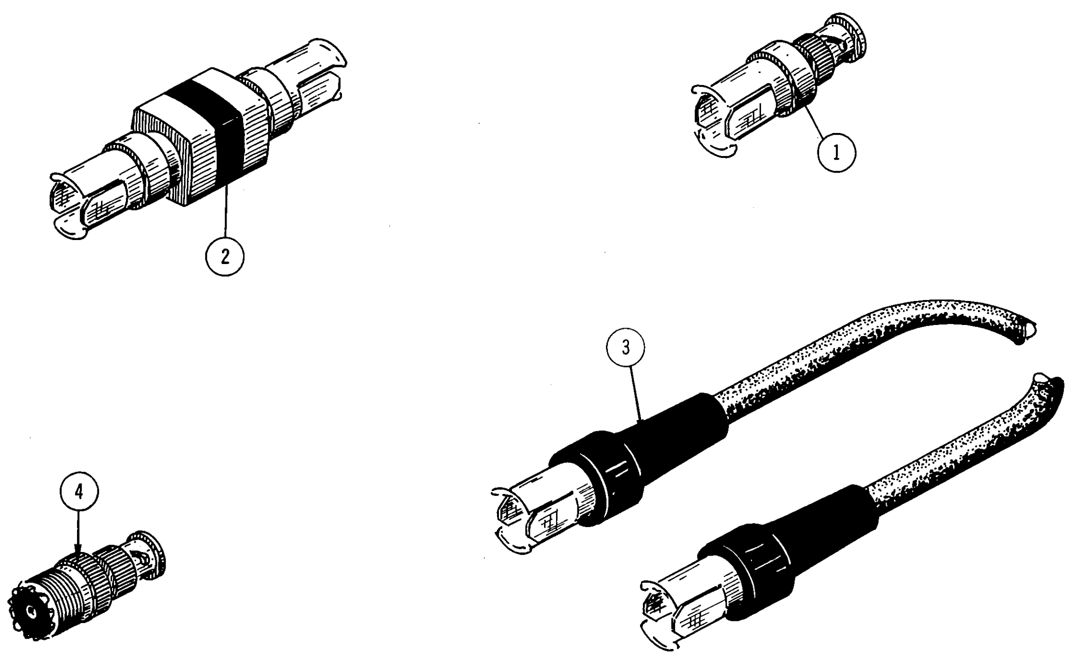
CABLE HARNESS & CERAMIC STRIPS



CABLE HARNESS & CERAMIC STRIPS

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
1	124-0149-00			2	STRIP, ceramic, 7 notches, 1 5/32 x 7/16 inch
	- - - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, nylon
2	124-0146-00			2	STRIP, ceramic, 16 notches, 2 7/16 x 7/16 inch
	- - - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, nylon
3	124-0147-00			1	STRIP, ceramic, 13 notches, 2 x 7/16 inch
	- - - - - - -			-	strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - - -			-	mounting hardware: (not included w/strip)
	361-0009-00			2	SPACER, nylon
4	124-0145-00			13	STRIP, ceramic, 20 notches, 3 x 7/16 inch
	- - - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, nylon
5	179-0927-00			1	CABLE HARNESS, chassis
6	179-0928-00			1	CABLE HARNESS, timing
7	179-0929-00			1	CABLE HARNESS, connector
	- - - - - - -			-	cable harness includes:
	131-0387-00			1	CONNECTOR

ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
1	017-0064-00			1	ADAPTER, BNC to GR
2	017-0044-00			2	ATTENUATOR, 50 Ω
3	017-0501-00			2	CABLE, 50 Ω
4	103-0032-00			1	ADAPTER, male BNC to female UHF

ELECTRICAL PARTS

Values are fixed unless marked Variable.

MAIN CHASSIS

Ckt. No.	Tektronix Part No.	Description					S/N Range
		Bulb					
B50	150-0025-00	Neon, NE-2E				UNCAL	
		Capacitors					

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Description					S/N Range
C8	283-0079-00	0.01 μf	Cer		250 v		
C9	283-0079-00	0.01 μf	Cer		250 v		
C76	281-0513-00	27 pf	Cer		500 v		
C121†		1 μf					
C201	281-0525-00	470 pf	Cer		500 v		
C202	283-0000-00	0.001 μf	Cer		500 v		
C204	290-0026-00	5 μf	EMT		25 v		
C209	281-0524-00	150 pf	Cer		500 v		
C210	283-0000-00	0.001 μf	Cer		500 v		
C227	281-0551-00	390 pf	Cer		500 v	10%	
C231	281-0523-00	100 pf	Cer				
C233	283-0079-00	0.01 μf	Cer		250 v		
C245	285-0624-00	0.027 μf	PTM		100 v	10%	
C258A	281-0012-00	7-45 pf	Cer	Var			
C258B	283-0552-00	200 pf	Mica		500 v	1%	
C258C	281-0007-00	3-12 pf	Cer	Var			
C258D	281-0577-00	14 pf	Cer		500 v	5%	
C260	*291-0038-00	0.01 μf	Plstc		300 v	5%	
C261	283-0081-00	0.01 μf	Cer		25 v		
C262	285-0569-00	0.01 μf	PTM		200 v		
C266	281-0523-00	100 pf	Cer		350 v		
C274	283-0000-00	0.001 μf	Cer		500 v		
C304	290-0149-00	5 μf	EMT		150 v		
C571	283-0001-00	0.005 μf	Cer		500 v		
C572	283-0001-00	0.005 μf	Cer		500 v		
C573	283-0001-00	0.005 μf	Cer		500 v		
C574	283-0001-00	0.005 μf	Cer		500 v		
C575	283-0001-00	0.005 μf	Cer		500 v		
C576	283-0001-00	0.005 μf	Cer		500 v		
C577	283-0001-00	0.005 μf	Cer		500 v		
C578	283-0001-00	0.005 μf	Cer		500 v		
C702	283-0079-00	0.01 μf	Cer		250 v		
C712	285-0628-00	0.033 μf	PTM		300 v		
C714	290-0267-00	1 μf	EMT		35 v		
C716	285-0628-00	0.033 μf	PTM		300 v		

† Part of Timing Capacitor located on Timing Circuit Card.

MAIN CHASSIS *(Cont'd)*
Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			S/N Range
C720	283-0001-00	0.005 μf	Cer	500 v	
C722	290-0165-00	250 μf	EMT	50 v	
C726	290-0267-00	1 μf	EMT	35 v	
C729	290-0107-00	25 μf	EMT	25 v	
C730	290-0107-00	25 μf	EMT	25 v	
C733	290-0267-00	1 μf	EMT	35 v	

Diodes

D120	*152-0107-00	Silicon	Replaceable by 1N647
D204	*152-0185-00	Silicon	Replaceable by 1N3605
D221	*152-0075-00	Germanium	Tek Spec
D225	152-0093-00	Tunnel	1N376 4.7 MA
D227	*152-0075-00	Germanium	Tek Spec
D236	*152-0185-00	Silicon	Replaceable by 1N3605
D245	*152-0061-00	Silicon	Tek Spec
D256	*152-0185-00	Silicon	Replaceable by 1N3605
D257	*152-0045-00	Silicon	Selected from 1N622A
D258	*152-0045-00	Silicon	Selected from 1N622A
D259	*152-0061-00	Silicon	Tek Spec
D260	*152-0165-00	Silicon	Selected from 1N3579
D261	*152-0061-00	Silicon	Tek Spec
D262	*152-0045-00	Silicon	Selected from 1N622A
D263	*152-0107-00	Silicon	Replaceable by 1N647
D272	*152-0107-00	Silicon	Replaceable by 1N647
D273	*152-0107-00	Silicon	Replaceable by 1N647
D319	152-0008-00	Germanium	
D327	*152-0107-00	Silicon	Replaceable by 1N647
D354	*152-0185-00	Silicon	Replaceable by 1N3605
D364	*152-0185-00	Silicon	Replaceable by 1N3605
D579	152-0032-00	Zener	¼M105Z10 105 v, ¼ w, 10%
D722A,B,C,D	*152-0107-00	Silicon	Replaceable by 1N647
D723	*152-0107-00	Silicon	Replaceable by 1N647
D734	*152-0107-00	Silicon	Replaceable by 1N647

Inductors

L4	108-0249-00	12 μh
L10	276-0541-00	Core, Ferrite
L49	276-0541-00	Core, Ferrite
L74	276-0541-00	Core, Ferrite
L120	276-0541-00	Core, Ferrite
L143	276-0541-00	Core, Ferrite
L145	276-0541-00	Core, Ferrite
L233	*120-0266-00	Toroid, 10T
L702	276-0517-00	Core, Powder Iron
L703	276-0517-00	Core, Powder Iron

MAIN CHASSIS *(Cont'd)*

Transistors

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q73	*151-0103-00	Replaceable by 2N2219	
Q74	*151-0087-00	Selected from 2N1131	
Q204	*151-0103-00	Replaceable by 2N2219	
Q214	*151-0151-00	Replaceable by 2N930	
Q224	151-0069-00	2N1304	
Q235	151-0071-00	2N1305	
Q245	151-0069-00	2N1304	
Q254	*151-0096-00	Selected from 2N2893	
Q261	*151-0096-00	Selected from 2N2893	
Q273	*151-0096-00	Selected from 2N2893	
Q333	151-0070-00	2N1377	
Q334	*151-0103-00	Replaceable by 2N2219	
Q724	*151-0103-00	Replaceable by 2N2219	
Q727	*151-0136-00	Replaceable by 2N3053	
Q734	*151-0087-00	Selected from 2N1131	
Q737	*151-0136-00	Replaceable by 2N3053	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R3	315-0101-00	100 Ω	¼ w			5%
R4	315-0101-00	100 Ω	¼ w			5%
R6	315-0101-00	100 Ω	¼ w			5%
R7	315-0101-00	100 Ω	¼ w			5%
R8	315-0101-00	100 Ω	¼ w			5%
R9	315-0101-00	100 Ω	¼ w			5%
R16	311-0387-00	5 k		Var		Trigger Sens Range
R29	311-0369-00	100 k		Var		LEVEL (Trigger)
R36	301-0243-00	24 k	½ w			5%
R37	311-0170-00	20 k		Var		RECOVERY TIME
R50	316-0124-00	120 k	¼ w			
R51†	311-0524-00	100 k		Var		VARIABLE (Time/Div)
R52	301-0513-00	51 k	½ w			5%
R60	311-0326-00	10 k		Var		Staircase Atten Zero
R70	311-0097-00	200 Ω		Var		Invert In Zero
R71	323-0357-00	51.1 k	½ w		Prec	1%
R73	321-0423-00	249 k	⅛ w		Prec	1%
R74	305-0223-00	22 k	2 w			5%
R76	321-0696-00	40.2 k	⅛ w		Prec	½%
R80	311-0326-00	10 k		Var		Demote Delay Cal
R81	321-0357-00	51.1 k	⅛ w		Prec	1%
R85	311-0326-00	10 k		Var		Internal Delay Cal
R86	321-0357-00	51.1 k	⅛ w		Prec	1%
R89	311-0318-00	30 k		Var		DELAY
R99	311-0329-00	50 k		Var		Delay Zero

† Ganged with SW51A. Furnished as a unit.

MAIN CHASSIS *(Cont'd)*
Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R110	311-0086-00	2.5 k		Var		Sweep Cal	
R121	315-0510-00	51 Ω	1/4 w			5%	
R201	301-0472-00	4.7 k	1/2 w			5%	
R202	302-0562-00	5.6 k	1/2 w				
R203	316-0391-00	390 Ω	1/4 w				
R204	316-0222-00	2.2 k	1/4 w				
R206	301-0472-00	4.7 k	1/2 w			5%	
R207	301-0102-00	1 k	1/2 w			5%	
R209	302-0222-00	2.2 k	1/2 w				
R210	315-0474-00	470 k	1/4 w			5%	
R211	302-0562-00	5.6 k	1/2 w				
R212	316-0682-00	6.8 k	1/4 w				
R213	316-0102-00	1 k	1/4 w				
R214	323-0242-00	3.24 k	1/2 w		Prec	1%	
R221	302-0222-00	2.2 k	1/2 w				
R223	316-0101-00	100 Ω	1/4 w				
R225	315-0103-00	10 k	1/4 w			5%	
R226	315-0512-00	5.1 k	1/4 w			5%	
R227	301-0472-00	4.7 k	1/2 w			5%	
R231	302-0103-00	10 k	1/2 w				
R232	302-0272-00	2.7 k	1/2 w				
R233	302-0101-00	100 Ω	1/2 w				
R235	302-0104-00	100 k	1/2 w				
R236	302-0393-00	39 k	1/2 w				
R240	301-0123-00	12 k	1/2 w			5%	
R241	301-0133-00	13 k	1/2 w			5%	
R242	301-0682-00	6.8 k	1/2 w			5%	
R244	302-0393-00	39 k	1/2 w				
R245	311-0448-00	20 k		Var		Sweep Length	
R246	302-0101-00	100 Ω	1/2 w				
R251	315-0302-00	3 k	1/4 w			5%	
R252	315-0222-00	2.2 k	1/4 w			5%	
R253	316-0103-00	10 k	1/4 w				
R254	315-0683-00	68 k	1/4 w			5%	
R256	302-0825-00	8.2 meg	1/2 w				
R258	302-0825-00	8.2 meg	1/2 w				
R259	315-0223-00	22 k	1/4 w			5%	
R260	316-0101-00	100 Ω	1/4 w				
R261	302-0101-00	100 Ω	1/2 w				
R262	302-0121-00	120 Ω	1/2 w				
R263	311-0328-00	1 k		Var		Staircase DC Level	
R264	301-0512-00	5.1 k	1/2 w			5%	
R266	316-0101-00	100 Ω	1/4 w				
R271	304-0334-00	330 k	1 w				
R273	305-0223-00	22 k	2 w			5%	

MAIN CHASSIS *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R274	305-0622-00	6.2 k	2 w			5%	
R293	302-0223-00	22 k	½ w				
R294	304-0823-00	82 k	1 w				
R296	302-0272-00	2.7 k	½ w				
R297	302-0822-00	8.2 k	½ w				
R298	302-0563-00	56 k	½ w				
R301	311-0525-00	100 k		Var		MANUAL SCAN OR EXT ATTEN	
R304	315-0363-00	36 k	¼ w			5%	
R311	323-0443-00	402 k	½ w		Prec	1%	
R312	323-0386-00	102 k	½ w		Prec	1%	
R313	302-0393-00	39 k	½ w				
R315	323-0288-00	9.76 k	½ w		Prec	1%	
R318	301-0101-00	100 Ω	½ w			5%	
R319	323-0385-00	100 k	½ w		Prec	1%	
R321	311-0206-00	250 k		Var		POSITION	
R323	301-0164-00	160 k	½ w			5%	
R324	301-0514-00	510 k	½ w			5%	
R327	302-0473-00	47 k	½ w				
R328	302-0473-00	47 k	½ w				
R330	321-0696-00	40.2 k	⅛ w		Prec	½%	
R332	302-0154-00	150 k	½ w				
R334	302-0563-00	56 k	½ w				
R335	323-0380-00	88.7 k	½ w		Prec	1%	
R338	323-0385-00	100 k	½ w		Prec	1%	
R339	321-0293-00	11 k	⅛ w		Prec	1%	
R341	311-0361-00	500 k		Var		Mag Regis	
R343	301-0105-00	1 meg	½ w			5%	
R344	323-0385-00	100 k	½ w		Prec	1%	
R345	321-0293-00	11 k	⅛ w		Prec	1%	
R346	323-0284-00	8.87 k	½ w		Prec	1%	
R347	323-0256-00	4.53 k	½ w		Prec	1%	
R350	302-0101-00	100 Ω	½ w				
R353	308-0105-00	30 k	8 w		WW	5%	
R355	304-0223-00	22 k	1 w				
R356	311-0095-00	500 Ω		Var		HORIZ GAIN	
R358	302-0101-00	100 Ω	½ w				
R359	304-0154-00	150 k	1 w				
R360	302-0101-00	100 Ω	½ w				
R363	308-0105-00	30 k	8 w		WW	5%	
R365	304-0223-00	22 k	1 w				
R368	302-0101-00	100 Ω	½ w				
R369	304-0154-00	150 k	1 w				
R572	315-0105-00	1 meg	¼ w			5%	
R573	315-0105-00	1 meg	¼ w			5%	
R574	315-0105-00	1 meg	¼ w			5%	

MAIN CHASSIS *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R575	315-0105-00	1 meg	¼ w		5%	
R576	315-0105-00	1 meg	¼ w		5%	
R577	315-0105-00	1 meg	¼ w		5%	
R578	315-0474-00	470 k	¼ w		5%	
R579	315-0103-00	10 k	¼ w		5%	
R701	302-0154-00	150 k	½ w			
R702	302-0104-00	100 k	½ w			
R704	308-0077-00	1 k	3 w	WW		
R706	308-0023-00	10 k	10 w	WW	5%	
R710	303-0510-00	51 Ω	1 w		5%	
R723	301-0182-00	1.8 k	½ w		5%	
R724	324-0315-00	18.7 k	1 w	Prec	1%	
R726	302-0471-00	470 Ω	½ w			
R727	321-0314-00	18.2 k	⅛ w	Prec	1%	
R728	323-0385-00	100 k	½ w	Prec	1%	
R731	321-0316-00	19.1 k	⅛ w	Prec	1%	
R732	321-0316-00	19.1 k	⅛ w	Prec	1%	
R733	302-0471-00	470 Ω	½ w			
R734	321-0275-00	7.15 k	⅛ w	Prec	1%	
R735	301-0104-00	100 k	½ w		5%	
R737	308-0018-00	2.5 k	10 w	WW	5%	

Switches

	Unwired	Wired		
SW5	260-0683-00	*262-0715-00	Rotary	TRIGGER SOURCE
SW51A†	311-0524-00			UNCAL
SW85	260-0681-00	*262-0713-00	Rotary	TIME/DIV
SW210	260-0689-00		Push-Button	START
SW245	260-0680-00	*262-0714-00	Rotary	SWEEP MODE
SW257	260-0682-00		Rotary	DISPLAY MAG SAMPLES/SWEEP

Transformers

T8	*120-0399-00	Toroid, 8T
T702	*120-0252-00	Power

Electron Tubes

V263	154-0417-00	8056
V294	154-0187-00	6DJ8
V354	154-0460-00	6JE8
V364	154-0460-00	6JE8

TIMING CIRCUIT CARD

Complete Card *670-0073-00

Capacitors

Ckt. No.	Tektronix Part No.		Description		Model No.
C11	283-0072-00	0.01 μf	Cer		
C13	283-0023-00	0.1 μf	Cer	10 v	
C14	281-0513-00	27 pf	Cer	500 v	
C15	283-0079-00	0.01 μf	Cer	250 v	
C21	281-0523-00	100 pf	Cer	350 v	

† Ganged with R51. Furnished as a unit.

TIMING CIRCUIT CARD *(Cont'd)*

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					Model No.
C22	281-0523-00	100 pf	Cer		350 v		
C26	281-0524-00	150 pf	Cer		500 v		
C28	283-0079-00	0.01 μf	Cer		250 v		
C35	281-0620-00	21 pf	Cer		500 v	1%	
C38	281-0524-00	150 pf	Cer		500 v		
C40	281-0536-00	1000 pf	Cer		500 v		
C42	283-0598-00	253 pf	Mica		300 v	5%	
C43	*285-0624-00	0.027 μf	PTM		100 v	10%	
C44	290-0288-00	0.27 μf	EMT		35 v		
C48	281-0580-00	470 pf	Cer		500 v	10%	
C103	281-0504-00	10 pf	Cer		500 v	10%	
C105	283-0000-00	0.001 μf	Cer		500 v		
C107	290-0187-00	4.7 μf	EMT		35 v		
C111	283-0079-00	0.01 μf	Cer		250 v		
C121† }		1 μf					
C122 }	*295-0088-00	0.1 μf	Timing Capacitor				
C123 }		935 pf					
C124	281-0022-00	8-50 pf	Cer	Var			
C132	283-0079-00	0.01 μf	Cer		250 v		
C135	281-0622-00	47 pf	Cer		500 v	1%	
C144	281-0622-00	47 pf	Cer		500 v	1%	
C151	283-0079-00	0.01 μf	Cer		250 v		
C153	290-0187-00	4.7 μf	EMT		35 v		
C155	283-0079-00	0.01 μf	Cer		250 v		
C157	283-0079-00	0.01 μf	Cer		250 v		

Diodes

Ckt. No.	Tektronix Part No.	Description	
D15	152-0177-00	Tunnel TD253B	10 MA 2 pf
D22	152-0070-00	Back BD4	0.1 MA 10 pf
D24	152-0008-00	Germanium	
D25	152-0154-00	Tunnel TD253	10 MA
D26	152-0008-00	Germanium	
D31	152-0008-00	Germanium	
D32	152-0071-00	Germanium	ED2007
D35	*152-0185-00	Silicon	Replaceable by 1N3605
D40	*152-0185-00	Silicon	Replaceable by 1N3605
D41	152-0005-00	Germanium	T13G
D45	152-0093-00	Tunnel	1N376 4.7 MA
D46	*152-0185-00	Silicon	Replaceable by 1N3605
D104	*152-0205-00	GaAs	
D105	*152-0125-00	Tunnel	Selected TD3A 4.7 MA
D107	152-0034-00	Zener	1N753 6.2 v, 0.4 w, 10%

† C121 located on Main Chassis.

TIMING CIRCUIT CARD *(Cont'd)*

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			Model No.
D121	*152-0107-00	Silicon	Replaceable by 1N647		
D122	*152-0107-00	Silicon	Replaceable by 1N647		
D123	*152-0107-00	Silicon	Replaceable by 1N647		
D131	*152-0205-00	GaAs			
D132	*152-0185-00	Silicon	Replaceable by 1N3605		
D135	*152-0125-00	Tunnel	Selected TD3A	4.7 MA	
D145	*152-0125-00	Tunnel	Selected TD3A	4.7 MA	

Inductors

L21	*108-0112-01	0.3 μh
L22	276-0532-00	Core, Shield Bead
L23	276-0532-00	Core, Shield Bead
L48	276-0532-00	Core, Shield Bead
L49	276-0532-00	Core, Shield Bead
L121	*108-0339-00	Coil, Reed
L122	*108-0339-00	Coil, Reed
L123	*108-0339-00	Coil, Reed
L144	*120-0304-00	Toroid, 3T
L153	*120-0312-00	Toroid, 15T

Transistors

Q14	*151-0142-00	Selected from 2N3546
Q24	*151-0103-00	Replaceable by 2N2219
Q25	*151-0108-00	Replaceable by 2N2501
Q35	151-0162-00	2N3324
Q39	*151-0151-00	Replaceable by 2N930
Q44	*151-0087-00	Selected from 2N1131
Q49	*151-0151-00	Replaceable by 2N930
Q103	*151-0108-00	Replaceable by 2N2501
Q104	*152-0532-00	2N1195, checked
Q114	*151-0103-00	Replaceable by 2N2219
Q144	*151-0083-00	Selected from 2N964

Resistors

R10	315-0153-00	15 k	¼ w		5%
R11	315-0512-00	5.1 k	¼ w		5%
R13	317-0390-00	39 Ω	⅛ w		5%
R15	322-0222-00	2 k	¼ w	Prec	1%
R18	317-0390-00	39 Ω	⅛ w		5%

Ⓐ

TIMING CIRCUIT CARD *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					Model No.
R21	315-0750-00	75 Ω	¼ w			5%	
R22	315-0390-00	39 Ω	¼ w			5%	
R23	315-0101-00	100 Ω	¼ w			5%	
R24	301-0102-00	1 k	½ w			5%	
R25	322-0201-00	1.2 k	¼ w		Prec	1%	
R26	322-0201-00	1.2 k	¼ w		Prec	1%	
R27	321-0218-00	1.82 k	⅛ w		Prec	1%	
R28	321-0218-00	1.82 k	⅛ w		Prec	1%	
R30	315-0102-00	1 k	¼ w			5%	
R31	323-0391-00	115 k	½ w		Prec	1%	
R32	321-0297-00	12.1 k	⅛ w		Prec	1%	
R33	315-0472-00	4.7 k	¼ w			5%	
R34	315-0222-00	2.2 k	¼ w			5%	
R35	323-0396-00	130 k	½ w		Prec	1%	
R38	321-0281-00	8.25 k	⅛ w		Prec	1%	
R39	301-0823-00	82 k	½ w			5%	
R40	322-0197-00	1.1 k	¼ w		Prec	1%	
R41	322-0197-00	1.1 k	¼ w		Prec	1%	
R42	315-0562-00	5.6 k	¼ w			5%	
R43	315-0102-00	1 k	¼ w			5%	
R44	315-0562-00	5.6 k	¼ w			5%	
R45	315-0102-00	1 k	¼ w			5%	
R46	316-0825-00	8.2 meg	¼ w				
R47	316-0126-00	12 meg	¼ w				
R48	315-0681-00	680 Ω	¼ w			5%	
R49	315-0103-00	10 k	¼ w			5%	
R101	321-0162-00	475 Ω	⅛ w		Prec	1%	
R102	322-0251-00	4.02 k	¼ w		Prec	1%	
R103	323-0344-00	37.4 k	½ w		Prec	1%	
R104	315-0471-00	470 Ω	¼ w			5%	
R105	315-0101-00	100 Ω	¼ w			5%	
R107	301-0683-00	68 k	½ w			5%	
R111	308-0273-00	6.5 k	5 w		WW	2%	
R113	315-0100-00	10 Ω	¼ w			5%	
R120	317-0510-00	51 Ω	⅛ w			5%	
R122	317-0101-00	100 Ω	⅛ w			5%	
R123	317-0111-00	110 Ω	⅛ w			5%	
R124	315-0100-00	10 Ω	¼ w			5%	
R130	311-0441-00	200 Ω		Var		Comparator Level	
R131	315-0101-00	100 Ω	¼ w			5%	

TIMING CIRCUIT CARD *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				Model No.
R132	301-0563-00	56 k	½ w		5%	
R135†	315-0102-00	1 k	¼ w		5%	
R138	315-0200-00	20 Ω	¼ w		5%	
R139	322-0251-00	4.02 k	¼ w	Prec	1%	
R145	315-0102-00	1 k	¼ w		5%	
R151	315-0101-00	100 Ω	¼ w		5%	
R155	315-0100-00	10 Ω	¼ w		5%	
R157	315-0101-00	100 Ω	¼ w		5%	

Switches

	Unwired	Wired	
SW121	260-0552-00		Reed
SW122	260-0552-00		Reed
SW123	260-0552-00		Reed

Transformer

T125	*120-0374-00	Toroid	2T-4T

LOGIC CIRCUIT CARD

Complete Card *670-0074-00

Ckt. No.	Tektronix Part No.	Description			Model No.
		Capacitor			
C92	283-0079-00	0.01 μf	Cer	250 v	

Diodes

D53	*152-0107-00	Silicon	Replaceable by 1N647
D54	*152-0107-00	Silicon	Replaceable by 1N647
D55	*152-0107-00	Silicon	Replaceable by 1N647
D56	*152-0107-00	Silicon	Replaceable by 1N647
D62	*152-0185-00	Silicon	Replaceable by 1N3605

† Located inside C135.

LOGIC CIRCUIT CARD *(Cont'd)*

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description		Model No.
D66	*152-0107-00	Silicon	Replaceable by 1N647	
D67	*152-0107-00	Silicon	Replaceable by 1N647	
D92	152-0055-00	Zener	1N962A 11 v, 0.4 w, 5%	
D95	*152-0107-00	Silicon	Replaceable by 1N647	
D430	*152-0107-00	Silicon	Replaceable by 1N647	
D431	*152-0107-00	Silicon	Replaceable by 1N647	
D434	*152-0107-00	Silicon	Replaceable by 1N647	
D440	*152-0107-00	Silicon	Replaceable by 1N647	
D450	*152-0107-00	Silicon	Replaceable by 1N647	
D451	*152-0107-00	Silicon	Replaceable by 1N647	
D452	*152-0107-00	Silicon	Replaceable by 1N647	
D454	*152-0107-00	Silicon	Replaceable by 1N647	
D464	*152-0107-00	Silicon	Replaceable by 1N647	
D465	*152-0107-00	Silicon	Replaceable by 1N647	
D470	*152-0107-00	Silicon	Replaceable by 1N647	
D473	*152-0107-00	Silicon	Replaceable by 1N647	
D490	*152-0107-00	Silicon	Replaceable by 1N647	
D491	*152-0107-00	Silicon	Replaceable by 1N647	
D494	*152-0107-00	Silicon	Replaceable by 1N647	
D495	*152-0107-00	Silicon	Replaceable by 1N647	
D504	*152-0107-00	Silicon	Replaceable by 1N647	
D507	*152-0107-00	Silicon	Replaceable by 1N647	
D533	152-0008-00	Germanium		
D550	*152-0107-00	Silicon	Replaceable by 1N647	
D553	*152-0107-00	Silicon	Replaceable by 1N647	
D554	*152-0107-00	Silicon	Replaceable by 1N647	
D563	152-0008-00	Germanium		

Inductors

L53	*108-0340-00	Coil, Reed
L54	*108-0340-00	Coil, Reed
L55	*108-0340-00	Coil, Reed
L56	*108-0340-00	Coil, Reed
L66	*108-0339-00	Coil, Reed
L67	*108-0339-00	Coil, Reed

Transistors

Q64	*151-0103-00	Replaceable by 2N2219
Q93	*151-0087-00	Selected from 2N1131
Q94	*151-0103-00	Replaceable by 2N2219
Q434	151-0071-00	2N1305
Q443	151-0069-00	2N1304

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	Model No.
Q454	151-0071-00	2N1305	
Q464	151-0071-00	2N1305	
Q473	151-0069-00	2N1304	
Q484	151-0071-00	2N1305	
Q504	151-0071-00	2N1305	
Q513	*151-0096-00	Selected from 2N1893	
Q523	*151-0096-00	Selected from 2N1893	
Q533	*151-0096-00	Selected from 2N1893	
Q543	*151-0096-00	Selected from 2N1893	
Q553	*151-0096-00	Selected from 2N1893	
Q563	*151-0096-00	Selected from 2N1893	

Resistors

Ckt. No.	Tektronix Part No.	Value	Wattage	Type	Tolerance
R53	321-0644-00	100 k	⅛ w	Prec	¼%
R54	321-0646-00	200 k	⅛ w	Prec	½%
R55	315-0204-00	200 k	¼ w		5%
R56	321-0648-00	500 k	⅛ w	Prec	½%
R57	315-0124-00	120 k	¼ w		5%
R58	321-0653-00	102 k	⅛ w	Prec	½%
R61	323-0393-00	121 k	½ w	Prec	1%
R63	323-0347-00	40.2 k	½ w	Prec	1%
R64	324-0415-00	205 k	1 w	Prec	1%
R65	321-0643-00	22.1 k	⅛ w	Prec	¼%
R66	321-0642-00	20.3 k	⅛ w	Prec	¼%
R67	321-0647-00	422 k	⅛ w	Prec	½%
R68	325-0005-00	1.985 meg	½ w	Prec	½%
R69	325-0005-00	1.985 meg	½ w	Prec	½%
R93	315-0203-00	20 k	¼ w		5%
R94	315-0102-00	1 k	¼ w		5%
R95	304-0333-00	33 k	1 w		
R96	315-0104-00	100 k	¼ w		5%
R97	321-0347-00	40.2 k	⅛ w	Prec	1%
R98	322-0385-00	100 k	¼ w	Prec	1%
R430	315-0392-00	3.9 k	¼ w		5%
R431	315-0562-00	5.6 k	¼ w		5%
R432	316-0274-00	270 k	¼ w		
R434	315-0182-00	1.8 k	¼ w		5%
R441	316-0274-00	270 k	¼ w		
R450	315-0392-00	3.9 k	¼ w		5%
R451	315-0562-00	5.6 k	¼ w		5%
R452	316-0274-00	270 k	¼ w		
R460	315-0103-00	10 k	¼ w		5%
R461	316-0274-00	270 k	¼ w		

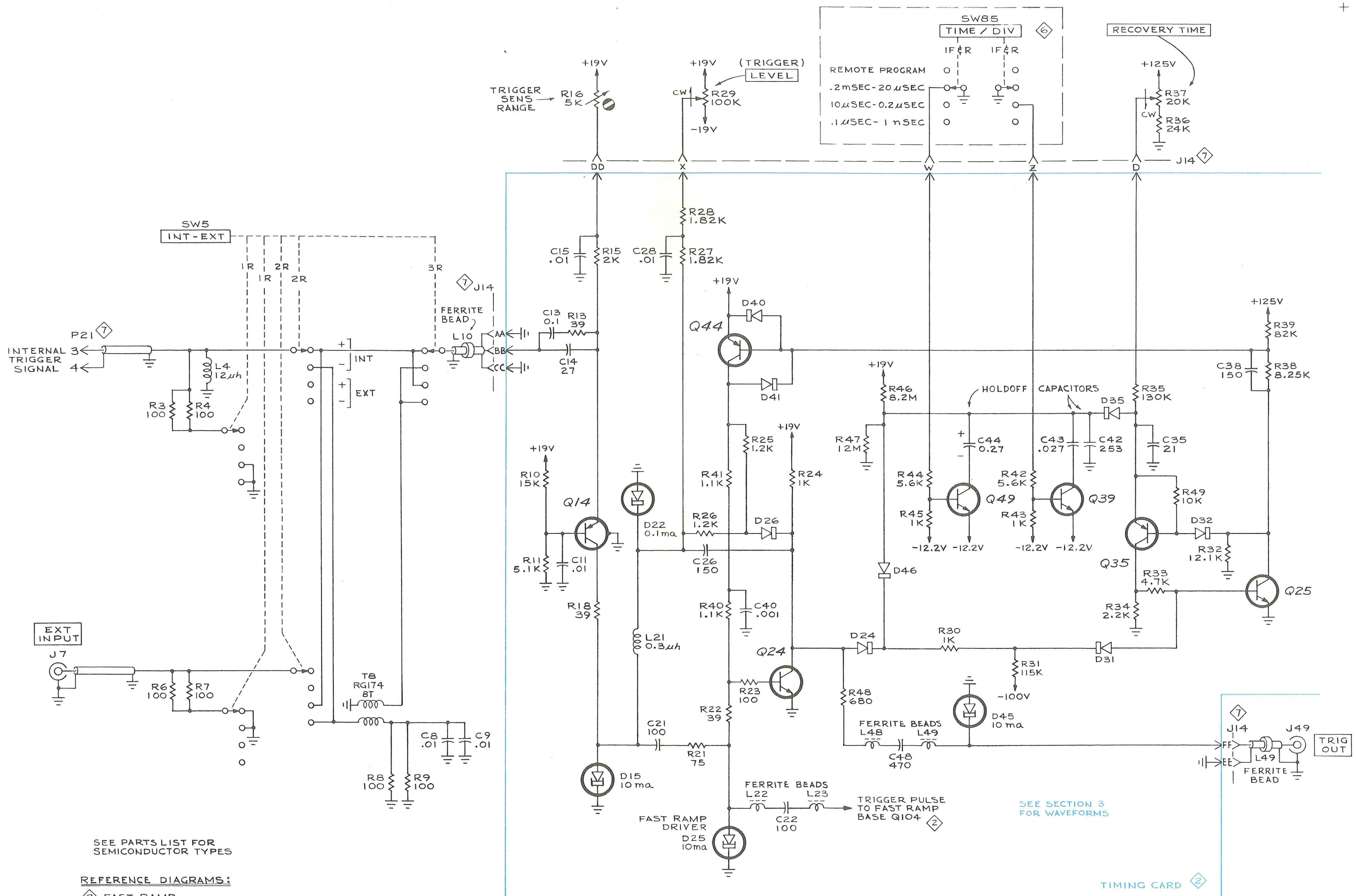
LOGIC CIRCUIT CARD *(Cont'd)*

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description		Model No.
R471	316-0274-00	270 k	¼ w		
R473	315-0182-00	1.8 k	¼ w	5%	
R480	315-0103-00	10 k	¼ w	5%	
R481	316-0274-00	270 k	¼ w		
R484	315-0182-00	1.8 k	¼ w	5%	
R490	315-0182-00	1.8 k	¼ w	5%	
R494	315-0182-00	1.8 k	¼ w	5%	
R506	315-0124-00	120 k	¼ w	5%	
R507	316-0822-00	8.2 k	¼ w		
R510	315-0272-00	2.7 k	¼ w	5%	
R511	315-0622-00	6.2 k	¼ w	5%	
R512	315-0151-00	150 Ω	¼ w	5%	
R520	315-0272-00	2.7 k	¼ w	5%	
R521	315-0622-00	6.2 k	¼ w	5%	
R522	315-0151-00	150 Ω	¼ w	5%	
R530	315-0272-00	2.7 k	¼ w	5%	
R531	315-0622-00	6.2 k	¼ w	5%	
R532	315-0151-00	150 Ω	¼ w	5%	
R533	315-0272-00	2.7 k	¼ w	5%	
R540	315-0682-00	6.8 k	¼ w	5%	
R541	315-0102-00	1 k	¼ w	5%	
R542	315-0151-00	150 Ω	¼ w	5%	
R550	315-0272-00	2.7 k	¼ w	5%	
R551	315-0622-00	6.2 k	¼ w	5%	
R552	315-0151-00	150 Ω	¼ w	5%	
R560	315-0272-00	2.7 k	¼ w	5%	
R561	315-0622-00	6.2 k	¼ w	5%	
R562	315-0151-00	150 Ω	¼ w	5%	
R563	315-0272-00	2.7 k	¼ w	5%	
R567	315-0182-00	1.8 k	¼ w	5%	
R568	315-0182-00	1.8 k	¼ w	5%	
R569	315-0182-00	1.8 k	¼ w	5%	

Switches

	Unwired	Wired	Description
SW53A	260-0552-00		Reed
SW54A	260-0552-00		Reed
SW55A	260-0552-00		Reed
SW56A	260-0552-00		Reed
SW66	260-0552-00		Reed
SW67	260-0552-00		Reed

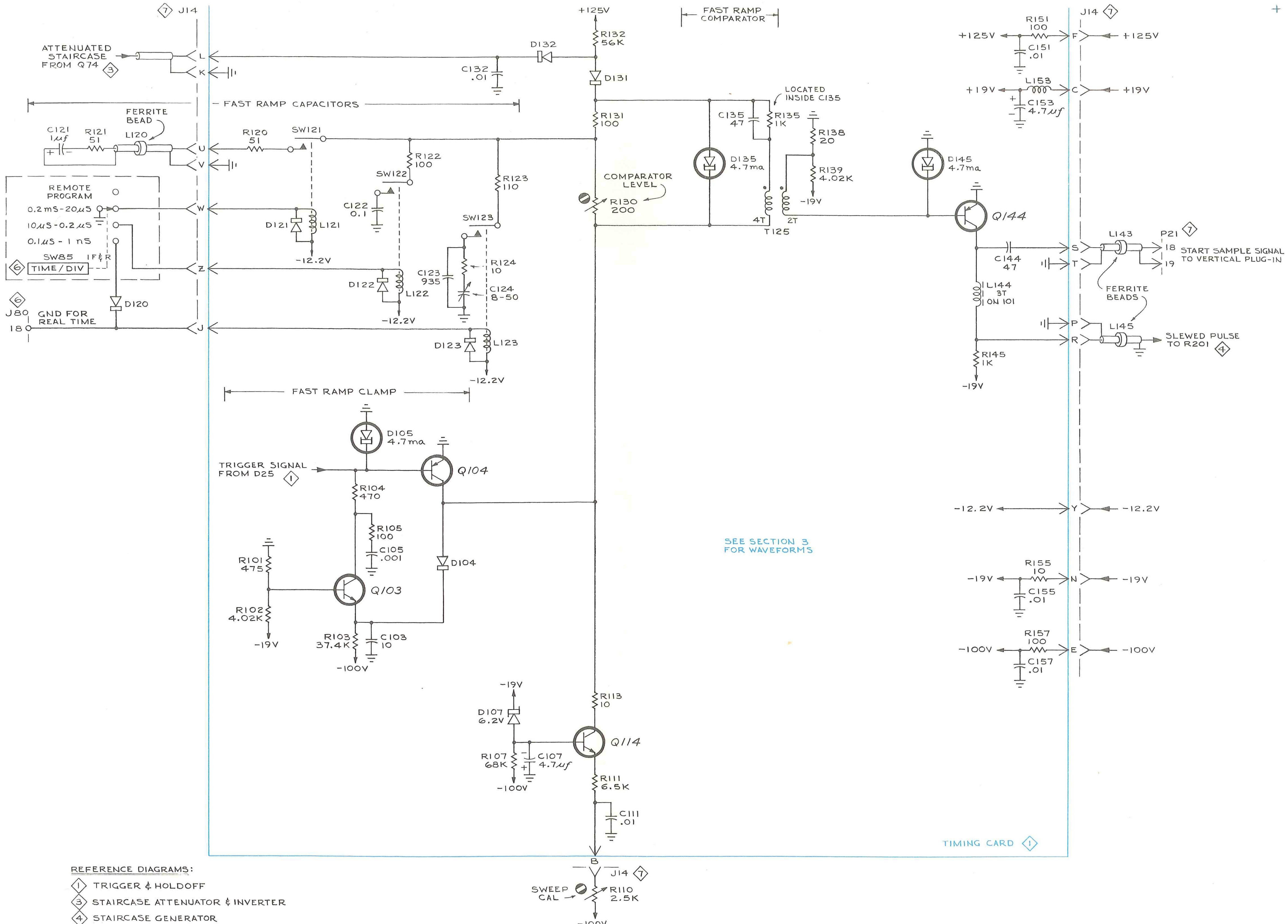


SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DIAGRAMS:

⟨2⟩ FAST RAMP
⟨6⟩ CONTROL LOGIC
⟨7⟩ INTERCONNECTIONS & POWER SUPPLY

MRH
365

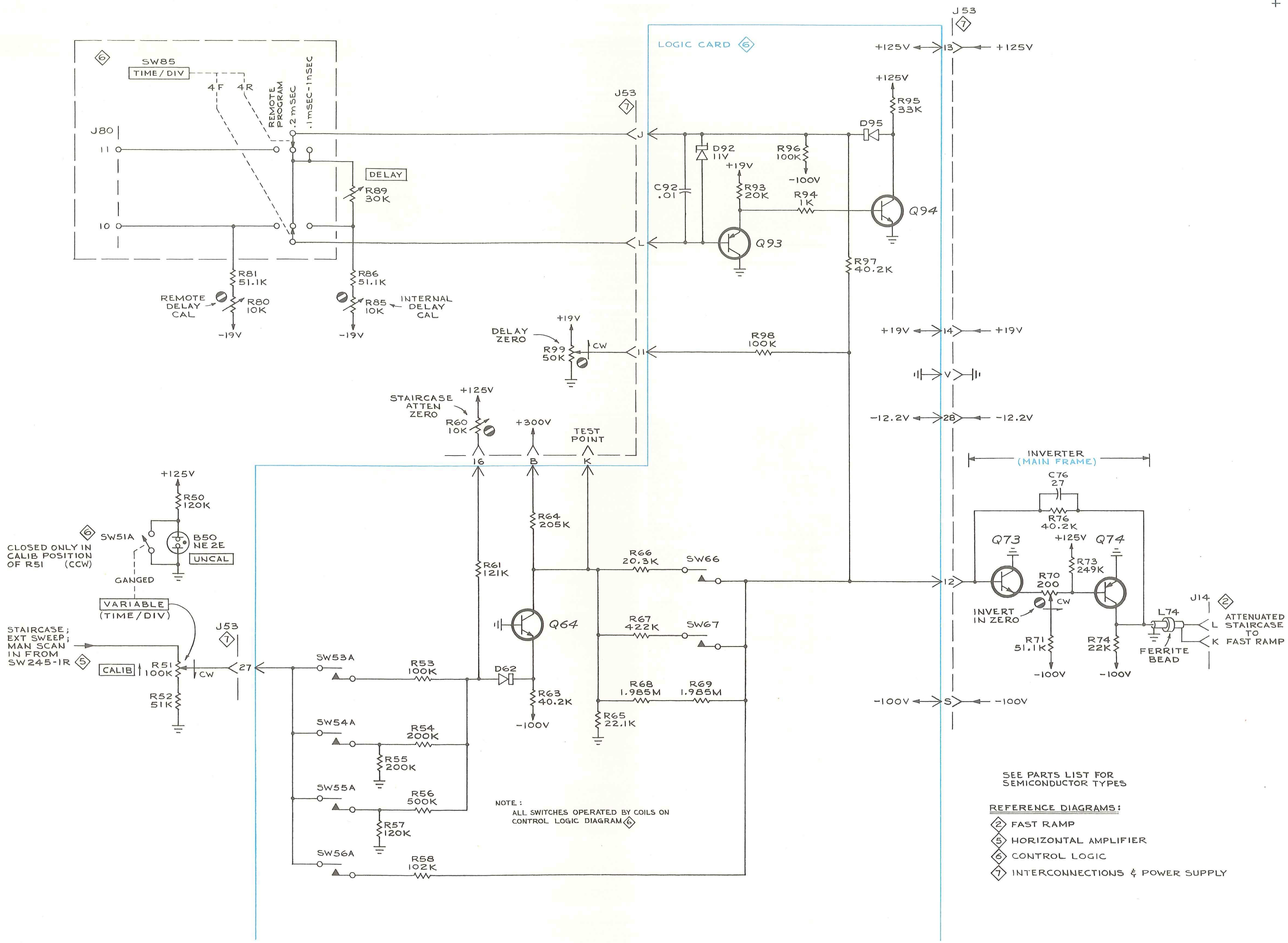


REFERENCE DIAGRAMS:

1. TRIGGER & HOLDOFF
3. STAIRCASE ATTENUATOR & INVERTER
4. STAIRCASE GENERATOR
6. CONTROL LOGIC
7. INTERCONNECTIONS & POWER SUPPLY

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

MRH
465

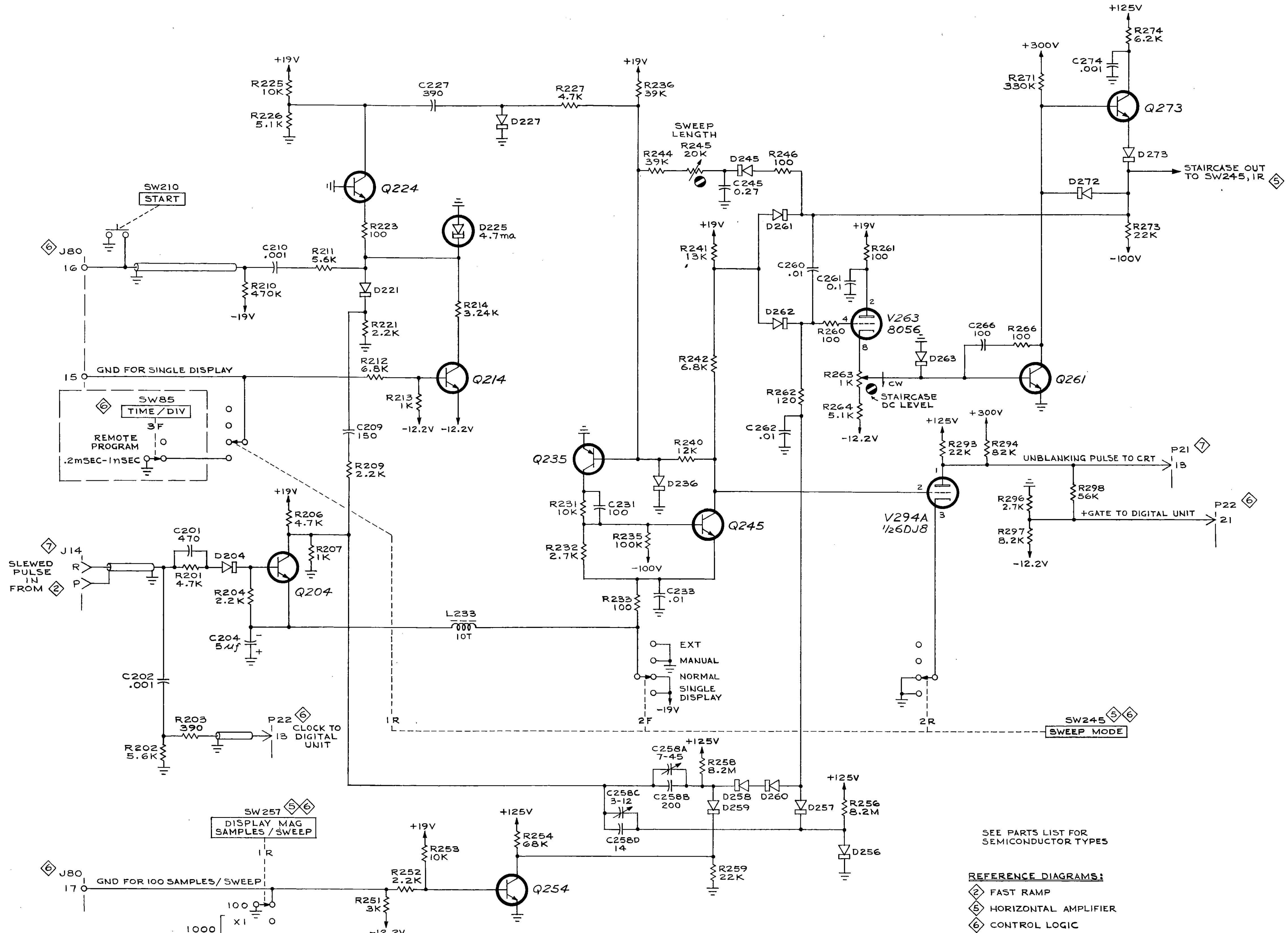


MRH 465

TYPE 3T4

A

STAIRCASE ATTENUATOR & INVERTER 3



SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DIAGRAMS:

- 2 FAST RAMP
- 5 HORIZONTAL AMPLIFIER
- 6 CONTROL LOGIC
- 7 INTERCONNECTIONS & POWER SUPPLY

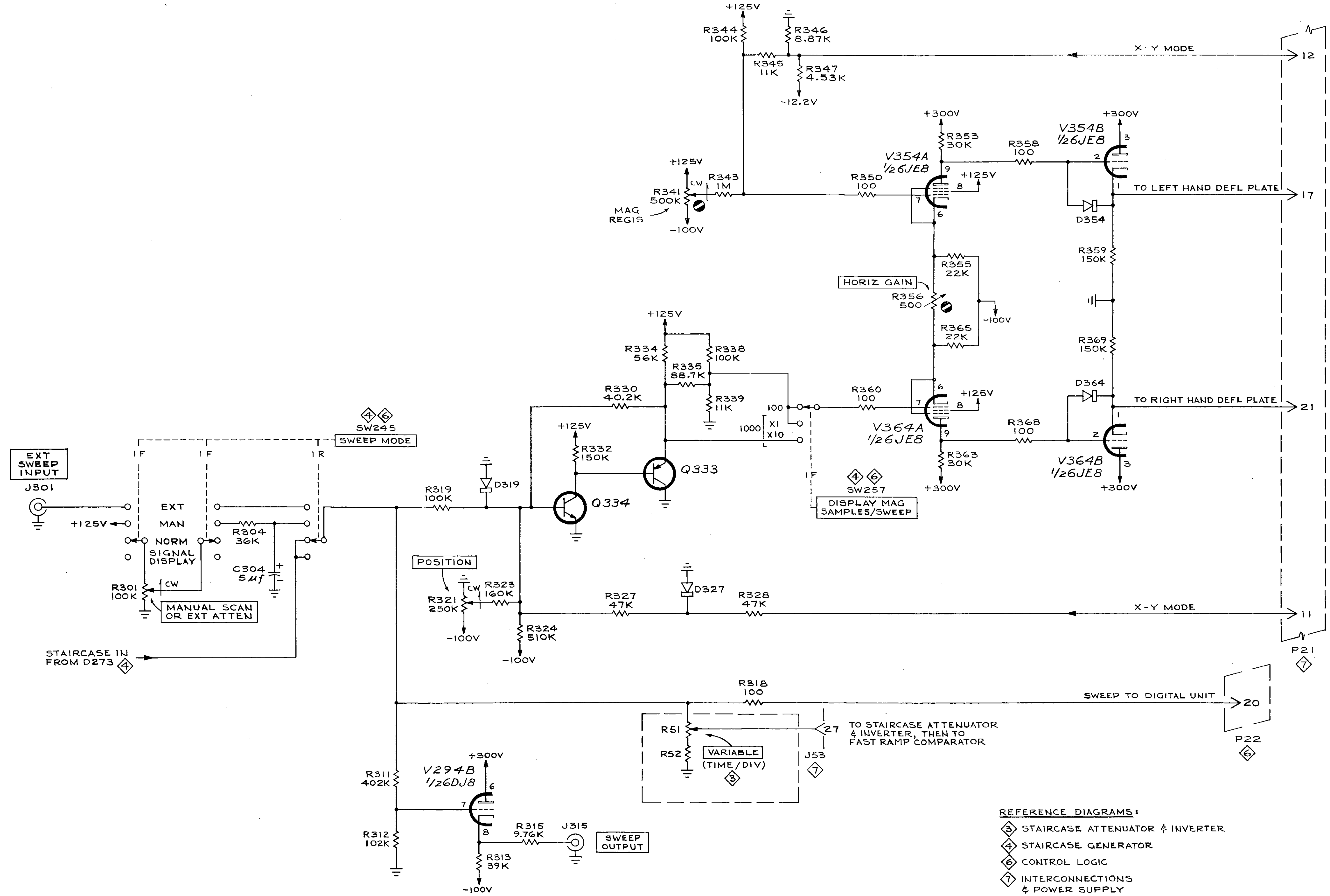
MRH
465

TYPE 3T4

A

STAIRCASE GENERATOR 4

4 STAIRCASE GENERATOR



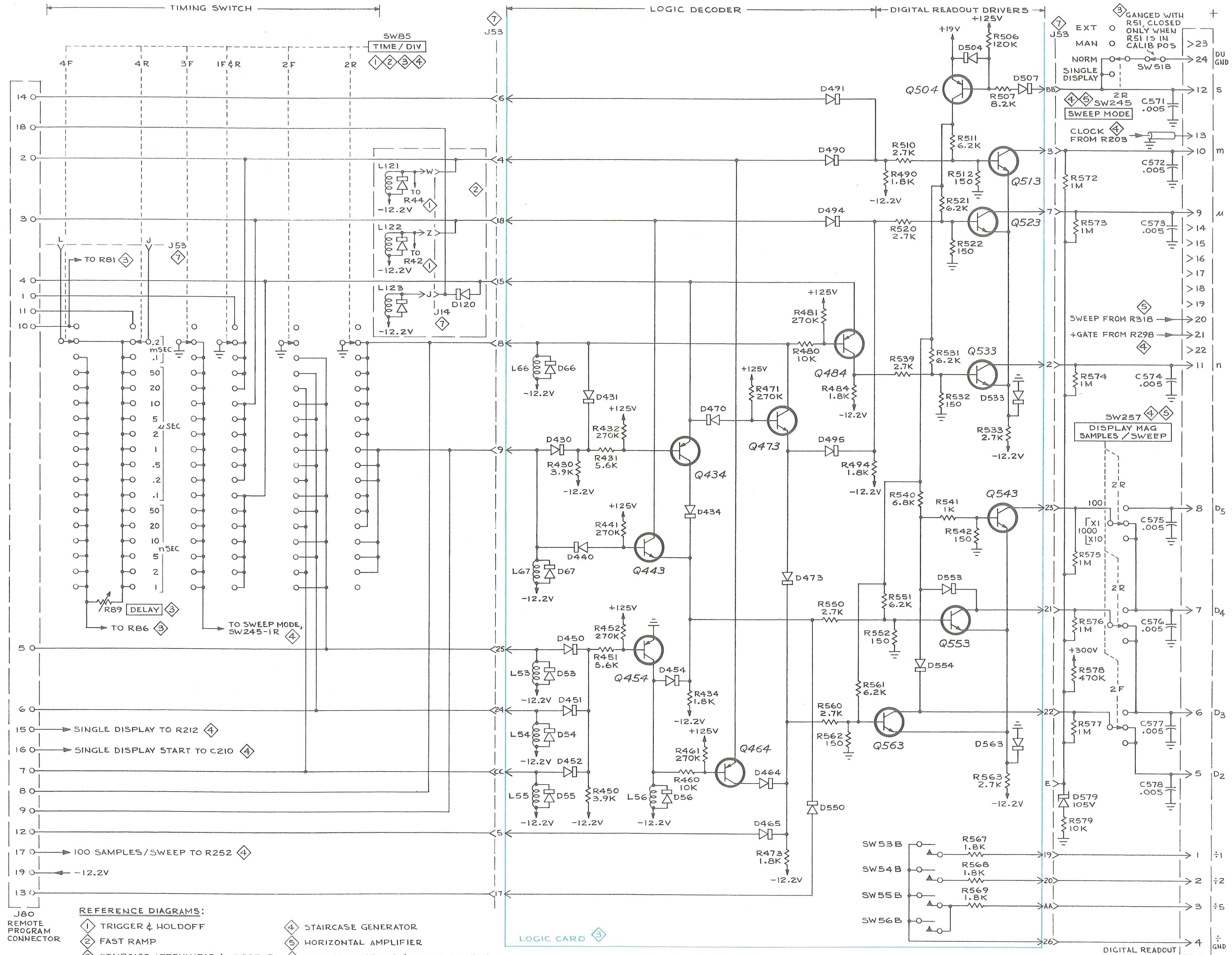
REFERENCE DIAGRAMS:

③ STAIRCASE ATTENUATOR & INVERTER
④ STAIRCASE GENERATOR
⑥ CONTROL LOGIC
⑦ INTERCONNECTIONS & POWER SUPPLY

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

MRH 365

NOTES:
1. L53 CONTROLS REED SWITCHES SW53A ③ AND SW53B ⑥
2. L54 CONTROLS REED SWITCHES SW54A ③ AND SW54B ⑥
3. L55 CONTROLS REED SWITCHES SW55A ③ AND SW55B ⑥
4. L56 CONTROLS REED SWITCHES SW56A ③ AND SW56B ⑥
5. L66 CONTROLS REED SWITCH SW66 ③
6. L67 CONTROLS REED SWITCH SW67 ③

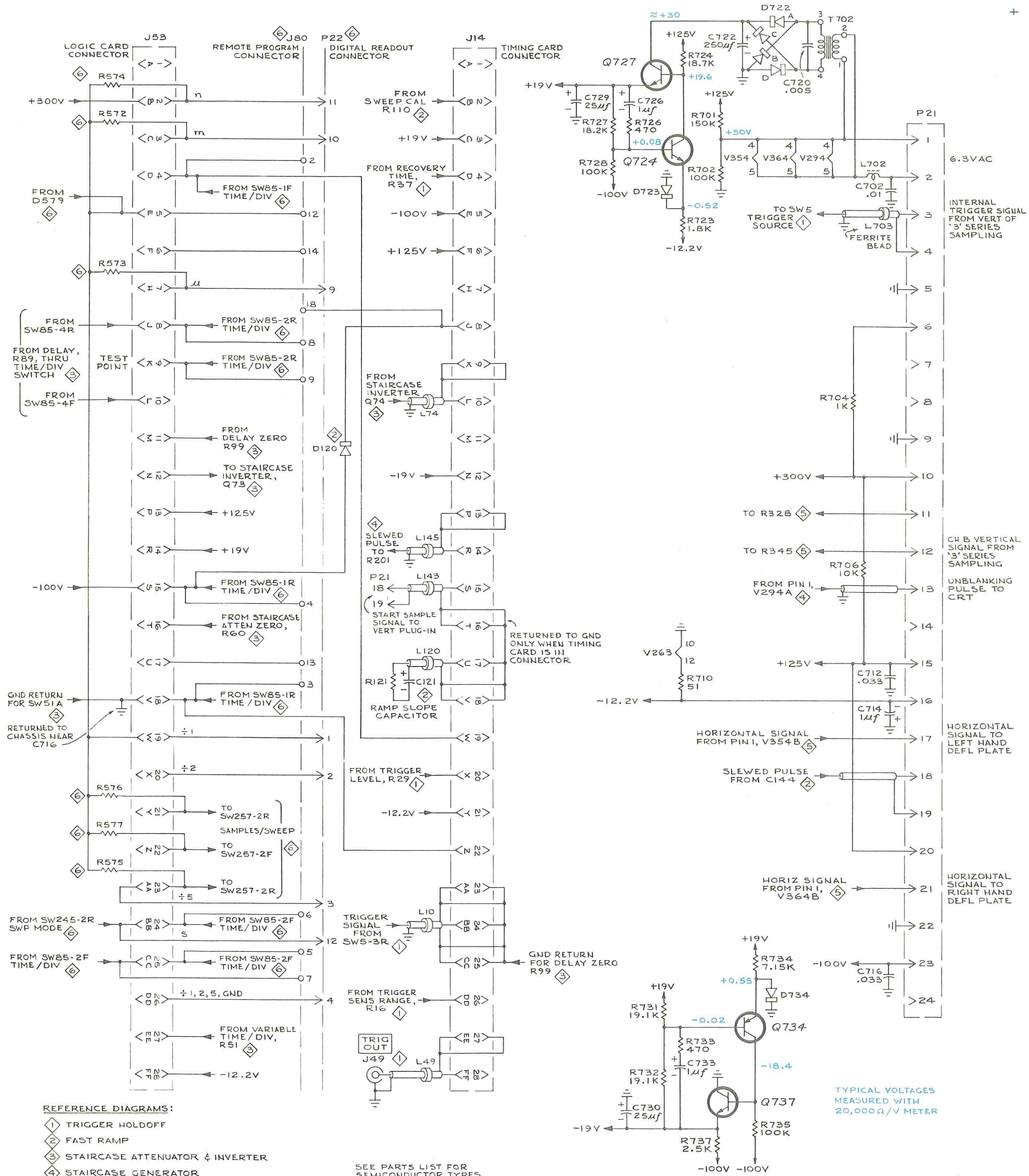


TYPE 3T4

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

CONTROL LOGIC ⑥

MRH 365



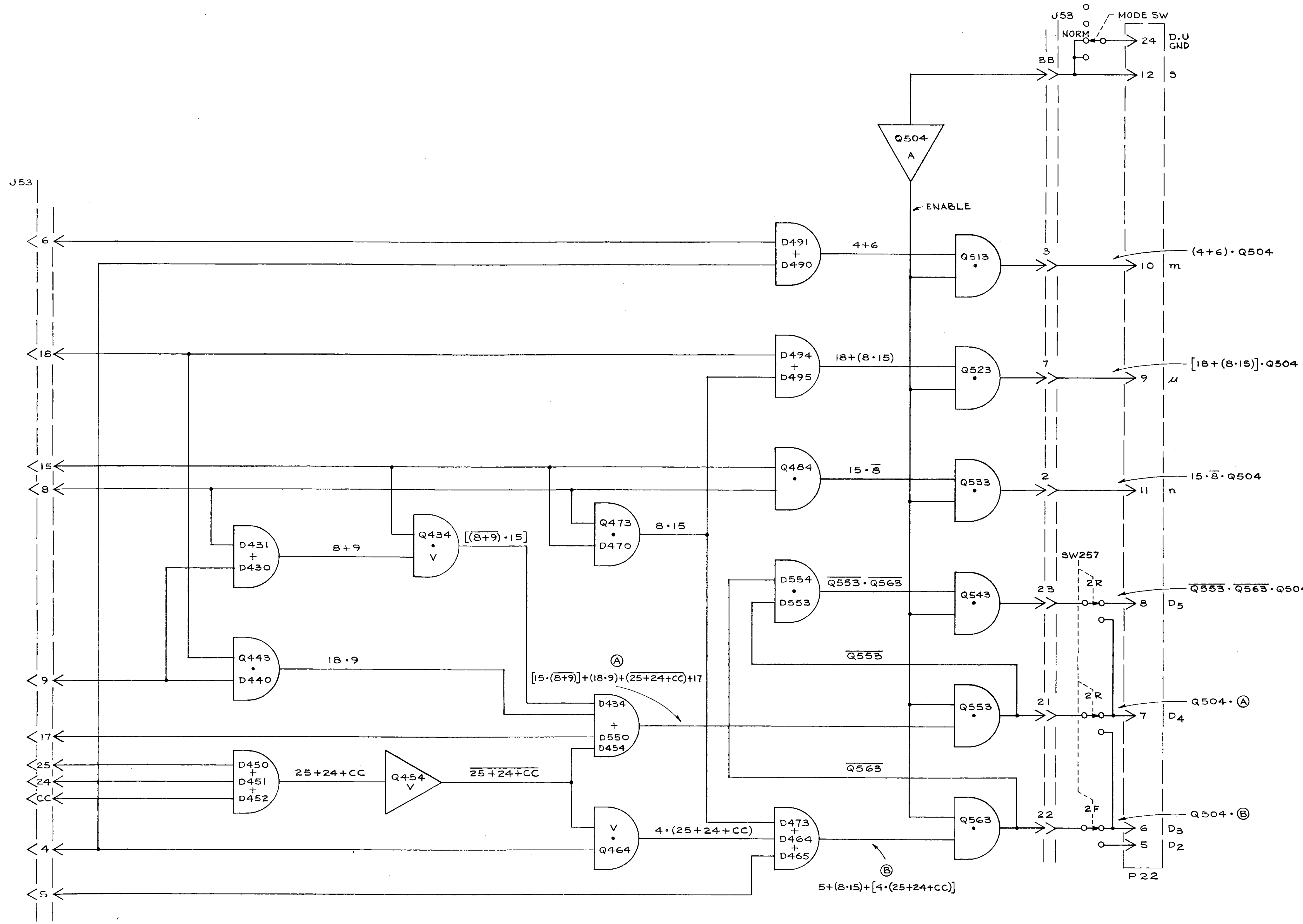
REFERENCE DIAGRAMS:

1. TRIGGER HOLDOFF
2. FAST RAMP
3. STAIRCASE ATTENUATOR & INVERTER
4. STAIRCASE GENERATOR
5. HORIZONTAL AMPLIFIER
6. CONTROL LOGIC

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

MR4
365

TYPE 3T4 A INTERCONNECTIONS & POWER SUPPLY 7



MRH
365

TYPE 3T4

A

LOGIC BLOCK DIAGRAM

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE 3T4 -- TENT. S/N 170

PARTS LIST CORRECTIONS

PARTS ADDED:

D255*	152-0165-00		6165

CHANGE TO:

D92	152-0031-00	Zener	1N962A
D262	152-0165-00		6165

*Add D255 in series with D257 (cathode of D255 to anode of D257).