INSTRUCTION MANUAL

Serial Number _____

Sampling Heads

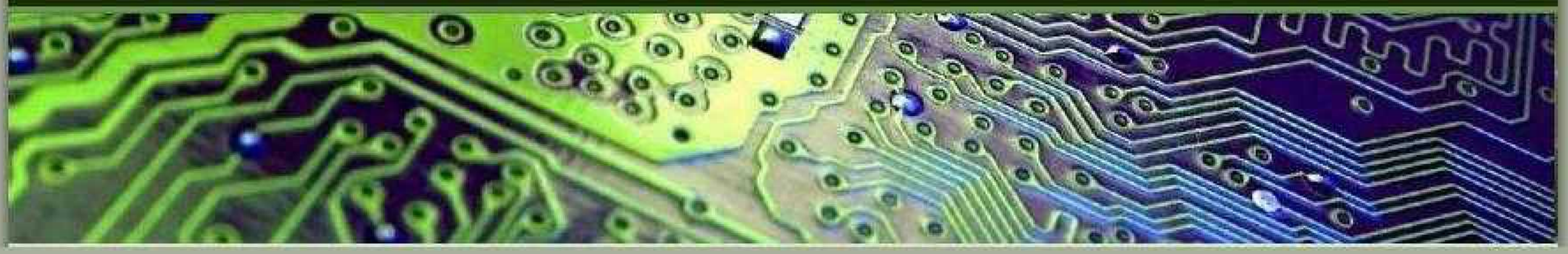
and Related Devices

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0927-00

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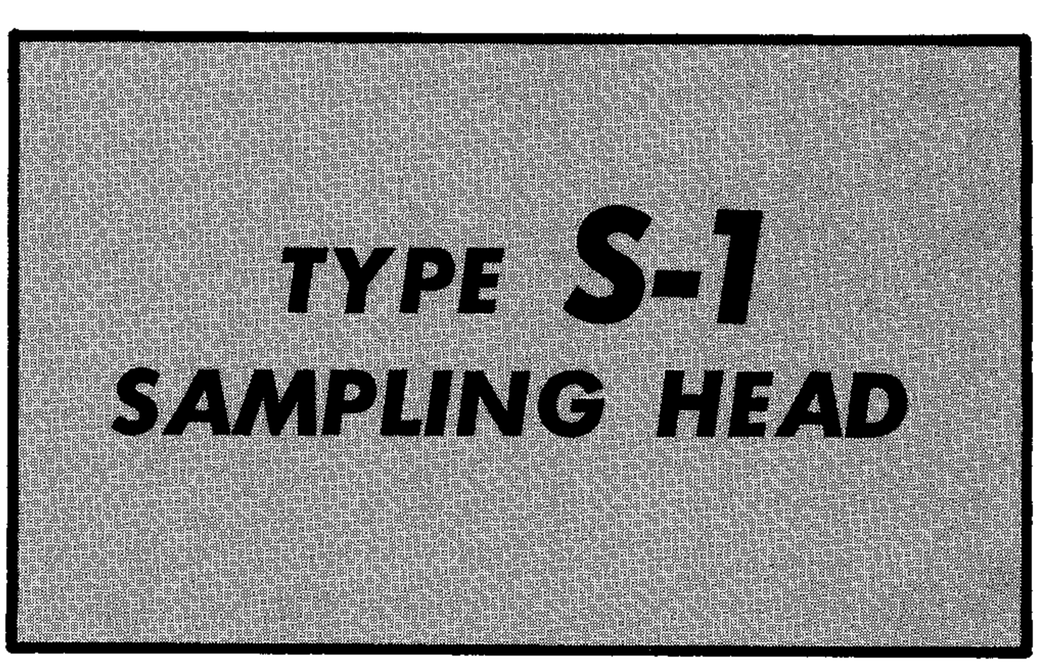
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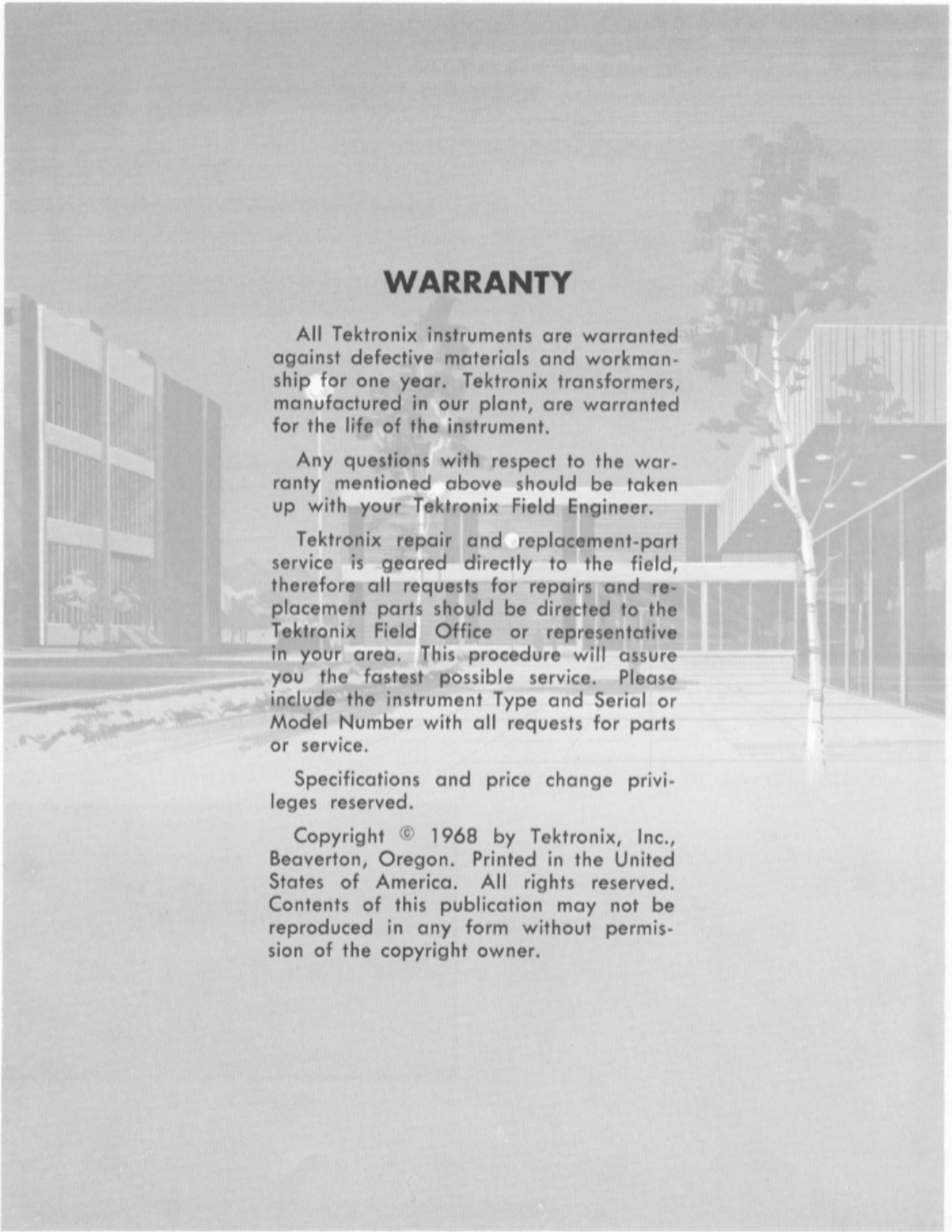
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070-0763-00



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All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our 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.

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Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.



Fig. 1-1. Type S-1 Sampling Head.

SECTION 1
TYPE S-1 SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

The Type S-1 Sampling Head is a 50 Ω input, 350 ps rise-time, plug-in preamplifier for use in some Tektronix 3S-series sampling units, such as the Type 3S2 Sampling Unit. Input characteristics of the sampling system are controlled by the type of sampling head in use.

The Type S-1 can be installed directly into the Type 3S2, or used remotely on an optional 3 foot or 6 foot extender cable. Vertical deflection factor of the sampling system is labeled at the top of the Type S-1 as mVOLTS/DIV; the label refers to the sampling unit Units/Div switch that is directly above the head.

A portion of the input signal is provided to the Type 3S2 Sampling Unit for externally triggering a Type 3T2 Random Sampling Sweep. The Type 3S2 allows selection of the trigger pickoff signal from the Channel A or Channel B sampling head. The selected trigger pickoff signal is returned to the Type 3S2 front panel at the Trig Out connector. The trigger pickoff signal is useful with any sampling sweep unit for repetitive signals where the triggering event does not have to be displayed. (Only the Type 3T2 random process sampling allows the triggering event to be displayed using the sampling head trigger pickoff signal.)

Digital Unit Program Connections

The Type S-1 contains connections at its rear that program both the decimal and the units lamps of a Type 230 Digital Unit. The S-1 digital control connections pass through the Units/Div switch of either the Type 3S5 or Type 3S6 Programmable Sampling Unit, and through the Type 568 Oscilloscope to the Type 230 Digital Unit.

ELECTRICAL CHARACTERISTICS

The following characteristics apply over an ambient temperature range of 0°C to +50°C. These characteristics apply only after the Type S-1 has been properly mated to the sampling unit and indicator oscilloscope, and after sufficient warmup time. For the particular system warmup requirements, refer to the related amplifier and indicator oscilloscope instruction manual. (A 5 minute warmup time is required for Type 3S2-3T2). A procedure for mating the Type S-1 to the vertical amplifier can be found in the Operating Instructions section of this manual.

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirement	Supplemental Information
Input Resistance	50 Ω within 1%	Measured at DC
Dot Response	Adjustable in the sampling unit to unity for signals up to 500 mV P-P; when the plus dot response is adjusted to unity, the minus dot response will be within 5% of unity, and vice versa.	
Operating Input Voltage Range	+1 V to −1 V, with ≤ 1 V P-P signals. Step signals greater than 500 mV require more than one dot to display 100% of the step transition.	
Maximum Input Voltage	±5 VDC or sine wave of 10 V P-P up to 10 MHz.	
Transient Response		
Risetime	350 ps or less, 10% to 90%.	Applies when the step pulse is Tektronix Type 284 Pulse Output signal through a 20 cm airline.
Pulse Flatness Deviation	≤ + 0.5 and − 3% in the first 5 ns after the step pulse reaches 50%.	
	≤ + and − 0.5% after the first 5 ns.	
Displayed Noise	2 mV or less, tangential noise.	
Trace Baseline Vertical Shift with Trigger Repetition Rate Change.	10 mV or less for trigger rate change from 30 Hz to 50 kHz.	

NOTES

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

This section provides the basic information required for operation of the Type S-1 Sampling Head, including installation and First Time Operation.

The Type S-1 completes the circuitry of some Tektronix sampling units, and controls the input characteristics of the vertical channel by providing the Strobe Generator, Sampling Bridge, and Preamplifier circuits. Such a sampling unit is the Type 3S2, using one or two S-series sampling heads. A Type 3S2 and a sampling sweep unit plugged into an indicator oscilloscope completes the sampling system. A choice of real or equivalent time sampling is provided by the type of sweep unit used.

A 50 Ω input resistance allows the use of 50 Ω attenuators and probes for operation over a wide range of signal voltages.

A portion of the input signal is provided to the sampling unit. In the Type 3S2, this signal is selected from Channel A or B, and returned to the front panel Trig Out connector for external triggering of sampling sweep units.

Installing the Type S-1 Sampling Head

Fig. 2-1 shows the Type S-1 partially installed into a Type 3S2 Sampling Unit with Type 561A Oscilloscope and Type 3T2 Random Sampling Sweep. The sampling head (or heads) can be plugged into the sampling unit as shown, or used remotely on a special extender cable. Three and six foot extender cables are available. Order the three foot extender cable by Tektronix Part No. 012-0124-00, or the six foot extender cable by Tektronix Part No. 012-0125-00. Contact your local Tektronix Field Engineer or Representative for price and availability of these optional accessories.

To insert the Type S-1 into the right or left hand compartments of the sampling unit, proceed as follows:

1. Pull the latch knob (Fig. 2-1) outward from the front panel (the latch knob will push out normally when the unit is inserted if the knob is left free to move).

2. Insert the Type S-1 slowly into the compartment, so the two plastic guides in the compartment engage the S-1.

3. Push the Type S-1 completely into the compartment.

4. Push the latch knob to lock the S-1 in place.

To remove the Type S-1 from the compartment, pull the latch knob away from the front panel, then pull the unit from the compartment.

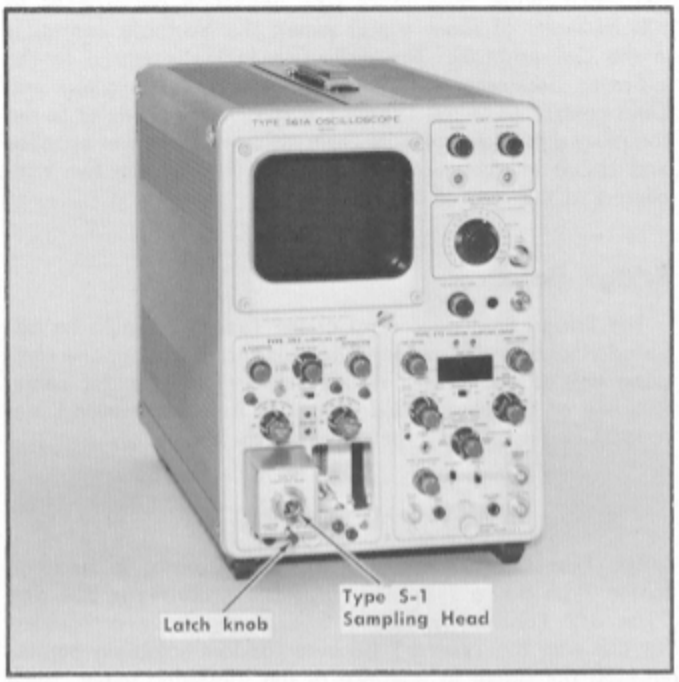


Fig. 2-1. Installation information.

To use the Type S-1 on an extender cable, install as follows:

1. Pull the latch knob located on the head end of the extender cable outward from the panel (the latch knob will push out normally when the extender is inserted if the knob is free to move).

2. Insert the extender cable head end slowly into the desired compartment in the sampling unit so the two plastic guides in the compartment engage the unit.

3. Push the head completely into the compartment.

4. Push the latch knob to lock the extender cable head end in place.

5. Connect the Type S-1 to the other end of the extender cable in a similar manner, and set the latch knob to hold it in place.

6. To remove the Type S-1 from the extender cable, pull the latch knob on the front panel of the Type S-1, and remove the unit from the extender cable.

7. To remove the extender cable head from the sampling unit compartment, pull the latch knob outward from the front panel, then pull the unit free.

Mating

The vertical deflection factor labeled by the Type S-1, and the sampling system loop balance (adjusted by the Bridge Bal control) must be considered when mating a Type S-1 with a sampling unit.

The mVOLTS/DIV label on the Type S-1 names the deflection factor units of the sampling unit Units/Div switch located directly above the label. For example, with the Type S-1 installed in a Type 3S2 and the Units/Div switch set at 100, each major division of CRT deflection corresponds to 100 millivolts of input signal (when the Variable control is in the Cal position). The deflection factor is mated to the indicator oscilloscope CRT by adjusting the sampling unit Gain control while the Type S-1 is in Channel B. Refer to the sampling unit manual for its Gain adjustment. Power supplies and circuit interconnections are made through the two connectors at the rear of the Type S-1.

Bridge Balance

The Bridge Balance control of the Type S-1 should be adjusted whenever the sampling head is changed from one sampling unit to another, or is operated on an extender cable. Location of the control and details of its adjustment are described in First Time Operation which follows.

FIRST TIME OPERATION

The First Time Operation procedure utilizes, in addition to the Type S-1, a Type 3S2, Type 561A, and Type 284. The Type 3T2 Random Sampling Sweep unit is recommended for use with the Type S-1 because random sampling permits viewing the signal in advance of the triggering event. Such trigger lead-time is required by the Type S-1 with the Type 3S2 to view fast pulses without a pretrigger. The Type 284 is used as a signal source.

Setup Information

1. With the Type 561A Power switch off, insert a Tektronix Type 3S2 Sampling Unit into the vertical compartment (left) and a Tektronix Type 3T2 Random Sampling Sweep into the horizontal plug-in compartment (right).

2. Insert the Type S-1 Sampling Head into Channel A compartment (left) in the Type 3S2 leaving the latch knob free to move. Once the S-1 is seated, push the latch to lock it in place.

3. Set the Intensity control on the Type 561A fully counterclockwise.

4. Connect the Type 561A to a power source which meets its voltage and frequency requirements.

5. Set the Power switch to On. Allow about 5 minutes warm-up so the units reach operating temperature before proceeding.

6. For single-trace operation, set the controls as follows:

Type 3S2

Display Mode	CH A
Normal-Smooth	Normal
A and B Position	Midrange
DC offset (both channels)	Midrange (5 turns from one end)
Units/Div (both Channels)	200
Variable (both Channels)	Cal
Invert (both Channels)	Push in
Dot Response (both Channels)	Midrange
B Delay	Midrange

Type 3T2

Horiz Position	Midrange
Samples/Div	9 o'clock position
Display Mode	Normal
Start Point	With Trigger
Sweep Rate	200 ns/Div
Range	10 μs
Display Mag	$\times$1
Time Magnifier	$\times$5
Variable	Cal
Time Position	Both fully clockwise
Trig Sensitivity	Fully clockwise
Recovery Time	Optional
Trigger Polarity	+
Trigger Source	Ext

Type 284

Square Wave Amplitude	1.0 V[1]
Period	1 μs
Mode	Square Wave Output
Lead Time	Optional

7. Connect the square wave output signal from the Type 284 to the input connector of the Type S-1 through a 50 Ω coaxial cable and a $\times$2 attenuator. Connect the trigger output signal from the Type 284 through a coaxial cable to the External Input 50 Ω connector on the Type 3T2.

8. Advance the Type 561A Intensity control until the free running trace brilliance is at the desired viewing level.

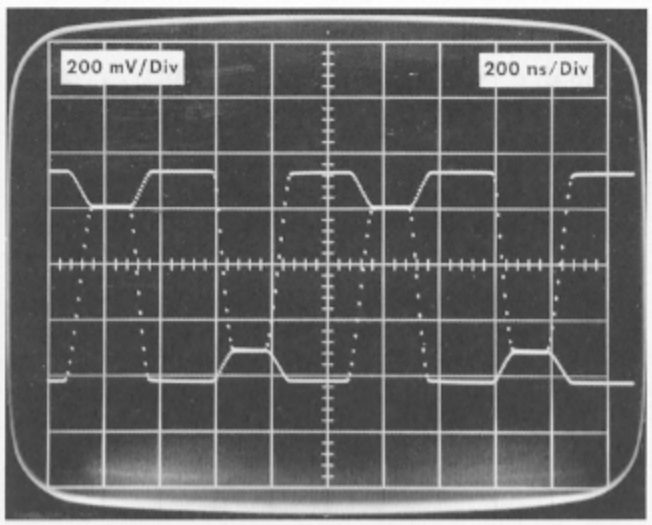
9. Center the trace on the graticule with the Type 3S2 A Position control and/or the DC Offset control. Adjust the Type 3T2 Trig Sensitivity control for a stable triggered display of a two-cycle square wave with an amplitude of about 2.5 divisions.

Adjusting Dot Response Sequential Sampling

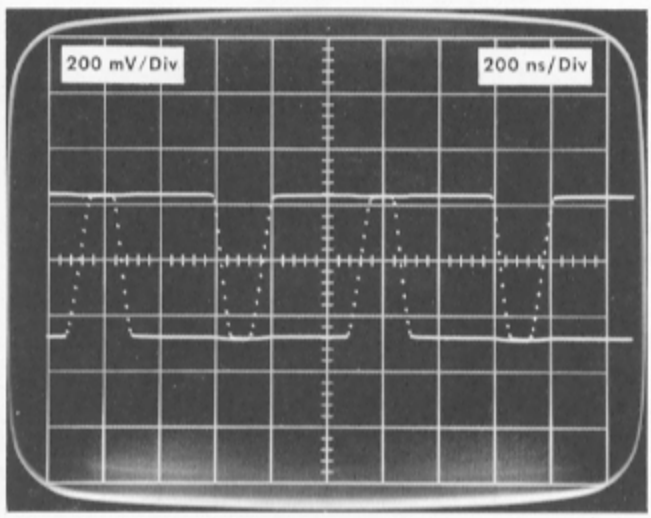
One method of adjusting the dot response to unity is to use a double or multiple-triggered sweep. This causes each sample to respond to the full signal amplitude and produce a display similar to Fig. 2-2A or B.

10. To obtain a display similar to that of Fig. 2-2A or B, turn the Type 3T2 Trig Sensitivity control clockwise into the

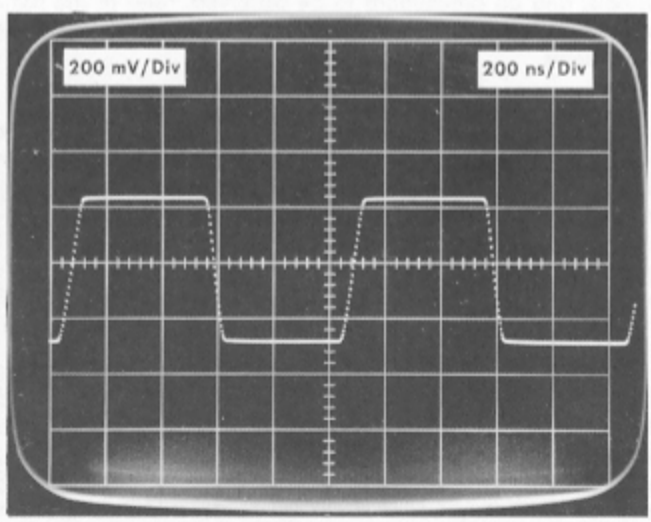
[1]**Used through X2 attenuator for 0.5 V into the Type S-1.**



(A) Double-triggered, > unity dot response



(B) Double-Triggered, unity dot response



(C) Properly triggered

Fig. 2-2. Typical display for unity dot response adjustment in normal sequential sampling.

free run region. Then adjust the Recovery Time control until the desired display appears.

11. Turn the Channel A Dot Response control to obtain a display showing unity dot response (see Fig. 2-2B). Fig 2-2A shows greater than unity dot response. This requires counterclockwise rotation of the Dot Response control to obtain unity dot response. The double triggering shown in Fig. 2-2A and B is useful to adjust the dot response to unity, but should not be used in making measurements.

12. After the dot response is adjusted to unity, turn the Trig Sensitivity control counterclockwise into the triggered region for a stable trace of a properly triggered display similar to Fig. 2-2C.

Random Sampling

13. Another convenient method of adjusting the dot response to unity can be shown with random process sampling. Change the following controls:

Type 3T2

Start Point	Before Trigger
Time Magnifier	×50

Type 284

Period	100 ns

14. A dot response greater than unity will produce a display similar to Fig. 2-3A. Dot response deviations from unity are best observed when the Type 3T2 Time Magnifier is set at ×20 or ×50. Adjust the Type 3S2 Dot Response control for a unity dot response display similar to Fig. 2-3B.

Bridge Balance Adjustment

15. Connect a bench multimeter set for ≈ 30 V full scale between ground and the Type 3S2 Channel A Offset jack. Adjust the Type 3S2 DC Offset control until the multimeter reads 0 Volts. Increase the meter sensitivity and repeat the adjustment for greater accuracy.

16. Disconnect the coaxial cable from the Type 284, leaving the other end of the cable connected to the Type S-1 input connector. Turn the Type 3S2 Trig Sensitivity control clockwise to free run the trace.

NOTE

Operating the sampling head without the input connector terminated by a 50 Ω resistor or coaxial cable will cause a vertical shift of the zero signal baseline by a few millivolts. This is caused by the strobe kickout signal being reflected from the open input connector, and arriving back at the sampling bridge while the bridge is conducting. Because of this phenomena, set the display zero reference point with the input between the Type S-1 input between the Type S-1 input and any tunnel-diode pulse generator or circuit that is sensitive to signals centering its output circuit.

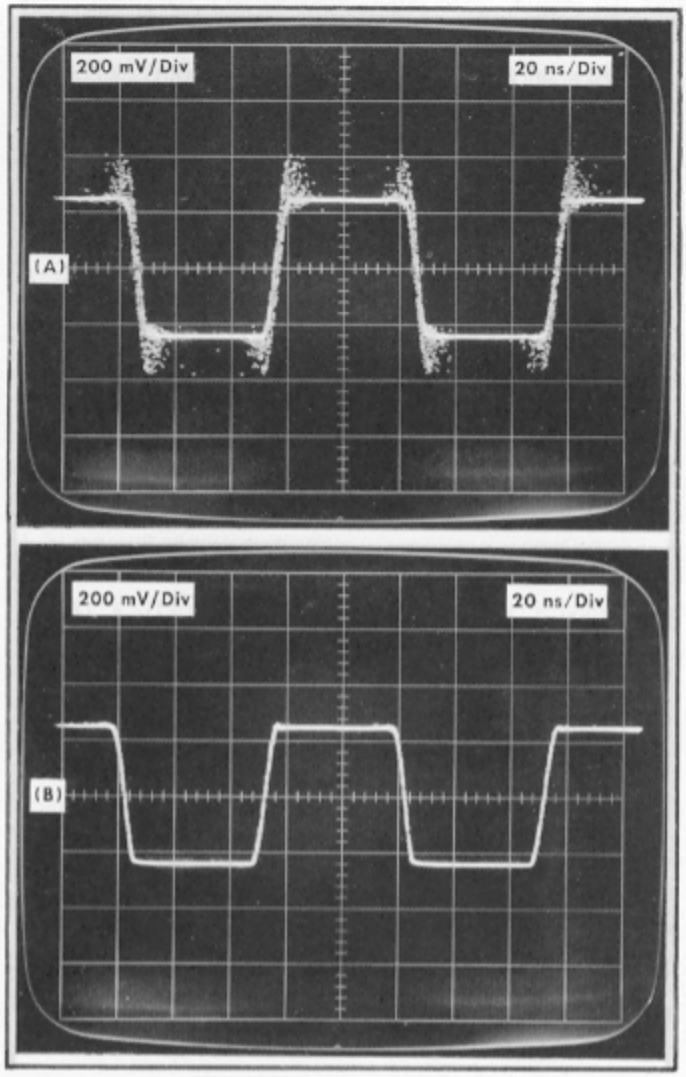


Fig. 2-3. Typical display for unity dot response adjustment in random sampling operation.

17. Switch the Type 3S2 Units/Div control throughout its range, adjusting the Type S-1 Bridge Bal control for a trace shift of not over one division as the Units/Div control is switched from one end to the other. See Fig. 2-4 for the location of the Bridge Bal control. This adjustment must be made whenever the Type S-1 is shifted from one sampling unit to another, or operated on a sampling head extender cable.

GENERAL OPERATING INFORMATION

Input Signal Connection Precautions

Accurate displays of signals containing very fast transitions or very high frequencies are possible only when the coupling circuit does not distort the signal. The Type S-1 input resistance is 50 Ω requiring the use of high quality 50 Ω coaxial cables and attenuators between the signal source and the sampling head input connector. Tektronix, Inc. offers several special probes that permit the signal source loading to be less than caused by the 50 Ω input

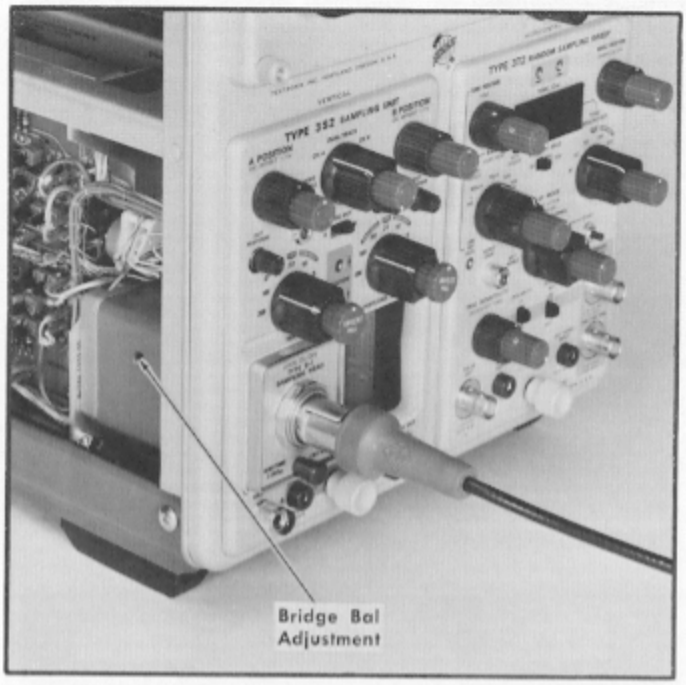


Fig. 2-4. Bridge Bal Location.

resistance. See your Tektronix Field Engineer or Representative about such special input coupling devices.

Input Voltage Considerations

Proper displays of various signal amplitudes require special attention to the type of time base generation in use. There are also input voltage limits that must be observed to prevent either display distortion or damage to the Type S-1.

For greater details on coupling of high frequency input signals, and on precautions to be observed, refer to the sampling unit Instruction Manual supplied with your sampling instruments.

Maximum input signal voltage is an important consideration in any sampling system. Signals greater than +1 or —1 volt generally will not permit a valid display. Thus any signals of greater amplitude should be attenuated in some manner before being applied to the Type S-1 input connector. Maximum input voltage without damage to the input termination resistor is +5 or —5 volts DC, or 10 volts peak to peak sine wave signals in the frequency domain of 10 MHz or below.

Where unity dot response is required, accurate displays are possible to achieve only when the input amplitude and the time base generator mode are both considered. The two time base generation modes are (1) normal process sampling, where each dot is displayed in sequence across the CRT, and (2) random process sampling where the dots are not necessarily displayed in a sequence that progresses uniformly across the CRT. (The Type 3T2 Random Sampling Sweep unit presents random process sampling displays in a controlled sequence very similar to normal process sampling when the Time Magnifier switch is at ×1 or ×2 and the trigger signal repetition rate is uniform.) The random process dot se-

quence is definitely not sequential when the Time Magnifier switch is anywhere between ×5 and ×50, with the dot presentation completely random at ×50. The Type 3T2 can be operated in a normal process mode, and all other Tektronix sampling sweep units generate only a normal process sequential dot display.

Unity dot response displays are not usually required when the signal rate of rise and the sweep rate selected provide a large number of dots for any vertical display change. Unity dot response is required for some random process sampling displays, and for normal process displays where there are either no samples, or less than about 6 samples in a step transition. Many dots in any verical change permits valid random process displays without unity dot response when the Type 3T2 Time Magnifier is at ×1 or ×2).

In summary, unity dot response exists when the vertical channel (sampling head and sampling unit) will accurately shift a sample dot 100% of the signal amplitude. The Specification Section lists the dot response linearity limits as ±5% for certain limited signal amplitudes discussed below. A 5% dot response linearity means that the vertical channel will shift a dot in the positive direction 100% of the full signal amplitude, but minus transitions may shift a dot between —95% and —105% of the full signal amplitude, and vice versa. (The sampling unit Dot Response control thus allows either the display top or bottom to be adjusted to unity dot response for close examination of signal detail.) Unity dot response is obtained by proper adjustment of the sampling unit Dot Response control as described in First Time operation.

Input signal amplitude limits for unity dot response within the 5% linearity tolerance are listed in Table 2-1. The input voltage columns are for signal amplitudes of 0.5 V peak to peak and 1.0 V peak to peak anywhere between +1 V and —1 V DC.

TABLE 2-1

Input Signal Amplitude Limits Allowing Unity Dot Response Vs Sampling Units mVOLTS/DIV Deflection Factor.

Sampling Unit Units/Div Switch	Input Voltage	
	0.5 V P-P	1.0 V P-P
All positions 200 to 2	yes	no
	Either Normal or Random Process	
Limited to positions of 20 to 2	yes	yes
	Either Normal or Random Process	
All positions 200 to 2	yes	yes
	Normal Process only with >6 dots in a 100% vertical transition.	

Triggering from the Signal

The Type S-1 provides a trigger pickoff signal to the sampling unit. This signal is a portion of the input signal.

In the Type 3S2, the signal is selected from the Channel A or Channel B sampling head and returned to the front panel Trig Out connector by the trigger circuit. The amplitude is about 10% of the input signal into 50 Ω. A small amount of the sampling bridge strobe signal is present with the trigger signal.

A Type 3S2 standard accessory trigger coupling cable can be used between the Type 3S2 and Type 3T2 for triggering the sampling sweep unit from the sampling head pickoff signal. Connect the cable between the Type 3S2 Trig Out connector and the Type 3T2 50 Ω Trigger Input connector. Operate the Type 3T2 as if externally triggered. Repetitive sine or square wave displays are best viewed when operating the Type 3T2 Start Point switch at With Trigger (normal process sequential dot sampling).

Fast pulse signals require random process sampling with the Type 3T2 Start Point switch at Before Trigger. This mode of operation will permit the sampling bridge strobe signal portion of the trigger pickoff signal to sometime trigger the timing unit. When this occurs, it is impossible to obtain a meaningful display. Signal amplitude to the Type S-1 must be greater than about 300 mV peak to peak in order to obtain valid displays of fast pulses during random process sampling. It is usually more satisfactory to obtain some other form of pretriggering for the sampling sweep unit when it is necessary to view fast signals.

Measuring Risetime

The Type S-1 is useful to show risetime and detect aberrations of signals in circuits that are properly coupled to the Type S-1. The risetime of both the generator (or source), and the Type S-1 must be taken into consideration.

Signals with risetimes as fast as about 0.8 ns (800 picoseconds) can be measured using the Type S-1 without any special considerations. Read the 10% to 90% risetime directly from the CRT (or digital unit) to know the risetime of the signal.

Signals with risetime faster than about 0.8 ns can be best be measured using a Tektronix Type S-2 Sampling Head. However, fair approximations of risetime can be made using the Type S-1 and calculating the signal risetime by formula (1) below. Formula (1) is based upon both the signal and the sampler having Gaussian risetime characteristics. The Type S-1 risetime is actually trape-zoidal, with a very linear rise and sharp corners. Signals with risetimes in the order of 50 ps will cause the sharp corners on the Type S-1 display to be quite obvious and signals with risetimes in the order of 80 to 100 ps will only modify the risetime display corners. Thus, it is recommended that displays with risetimes faster than 0.8 ns not be used to accurately measure the signal 10% to 90% rate of rise. The Performance Check and Recalibration Procedure gives equipment, procedure and displays of Type S-1 and Type S-2 risetime when driven by a 50 ps risetime tunnel diode pulser signal.

Formula (1)

$$T_r \text{ (Displayed)} = \sqrt{(\text{Signal } T_r)^2 + (\text{Type S-1 } T_r)^2}$$

transposing:

$$\text{Signal } T_r = \sqrt{(\text{Display } T_r)^2 + (\text{Type S-1 } T_r)^2}$$

NOTES

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

This section of the manual contains a block diagram analysis of the Type S-1 Sampling Head followed by a detailed circuit description. The Type S-1 Sampling Head is designed to be the signal input section of the sampling system. The reader may find it helpful to refer to the associated sampling unit manual for information on sampling principles if the purpose of a particular circuit is not clear. For example, Type 3S2 manual, Section 4, "Basic Sampling Principles". The sampling unit manual also shows interconnections and circuits referred to in this section. Schematic and block diagrams of the Type S-1 are located at the rear of this manual.

BLOCK DIAGRAM

Strobe Generator

The Strobe Generator develops fast-rise short-duration push-pull pulses that drive the Sampling Bridge into balanced conduction. Output occurs at the time of each sample when a command pulse arrives from the Delay and Strobe Driver circuit of the associated sampling unit. Shape and amplitude of the output strobe pulses is set by the Avalanche Volts and Snap-off Current controls. Strobe pulse duration is fixed by the two shorted clipping lines.

Sampling Bridge

The Sampling Bridge allows no connection other than the normal stray capacitance of the bridge between the input connector and the Preamplifier input except when driven into conduction by the Strobe Generator. When the Strobe Generator drives the Sampling Bridge into conduction, a portion of the signal across the Sampling Bridge is applied to the Preamplifier input.

Reverse bias is applied to the Sampling Bridge diodes by the Bridge Volts and Bridge Bal circuit. The sampling system feedback signal and DC Offset voltage is applied to the Sampling Bridge output side and the Preamplifier input through the biasing network.

Blow-by and Trigger Pickoff

The primary function of the Blow-by and Trigger Pickoff circuit is to cancel capacitively-coupled unwanted signals that normally bypass the Sampling Bridge. Very high frequencies pass to the Preamplifier input by the normal stray capacitances of the Sampling Bridge. These unwanted signals are called "blow-by".

The Blow-by circuit receives an attenuated portion of the input signal, amplifies and inverts the signal, and applies it, as a blow-by correction signal, through a capacitor to the output terminal of the Sampling Bridge. Magnitude of the blow-by correction signal is adjusted by the Transient Response control to effectively cancel the capacitively-coupled blow-by signal.

The trigger pickoff function of the Blow-by and Trigger circuitry provides a signal source for externally triggering the sampling sweep unit. The trigger pickoff circuit output signal drives an additional amplifier and channel selector circuit in the sampling unit.

Preamplifier

The Preamplifier circuit both amplifies and time-stretches the signal it receives from the Sampling Bridge. The signal received is a portion of the difference between the Feedback with the DC Offset voltage and the input signal. This "error signal" is amplified and AC coupled to the Post Amplifier in the sampling unit. The Preamplifier gain is adjustable to aid in setting the overall sampling head and sampling unit "loop" gain for proper unity dot response.

CIRCUIT DESCRIPTION

The Type S-1 Sampling Head uses the power supplies of the indicator oscilloscope and associated sampling unit. Interconnections to some of the circuits in the sampling unit are by two connectors at the rear of the sampling head. This Circuit Description covers the circuits of the Type S-1, and refers to circuits within the sampling unit. Reference to the sampling unit instruction manual diagrams and circuit description may be useful to fully understand the circuit relationships.

Strobe Generator

The Strobe Generator circuits are located on the Strobe board. The generator contains two basic circuits, the Avalanche circuit and the Snap-off diode circuit. Both circuits work together to produce the push-pull strobe pulses that drive the Sampling Bridge through two equal transmission lines. See Fig. 3-1.

Avalanche circuit. The Avalanche circuit converts the Strobe Drive pulse from the sampling unit to very fast push-pull pulses to drive the Snap-off diode to non-conduction.

The Strobe Drive pulse is transformer-coupled by T75 to the base and emitter of the Avalanche transistor Q69. Two outputs are AC-coupled from Q69, one from the collector

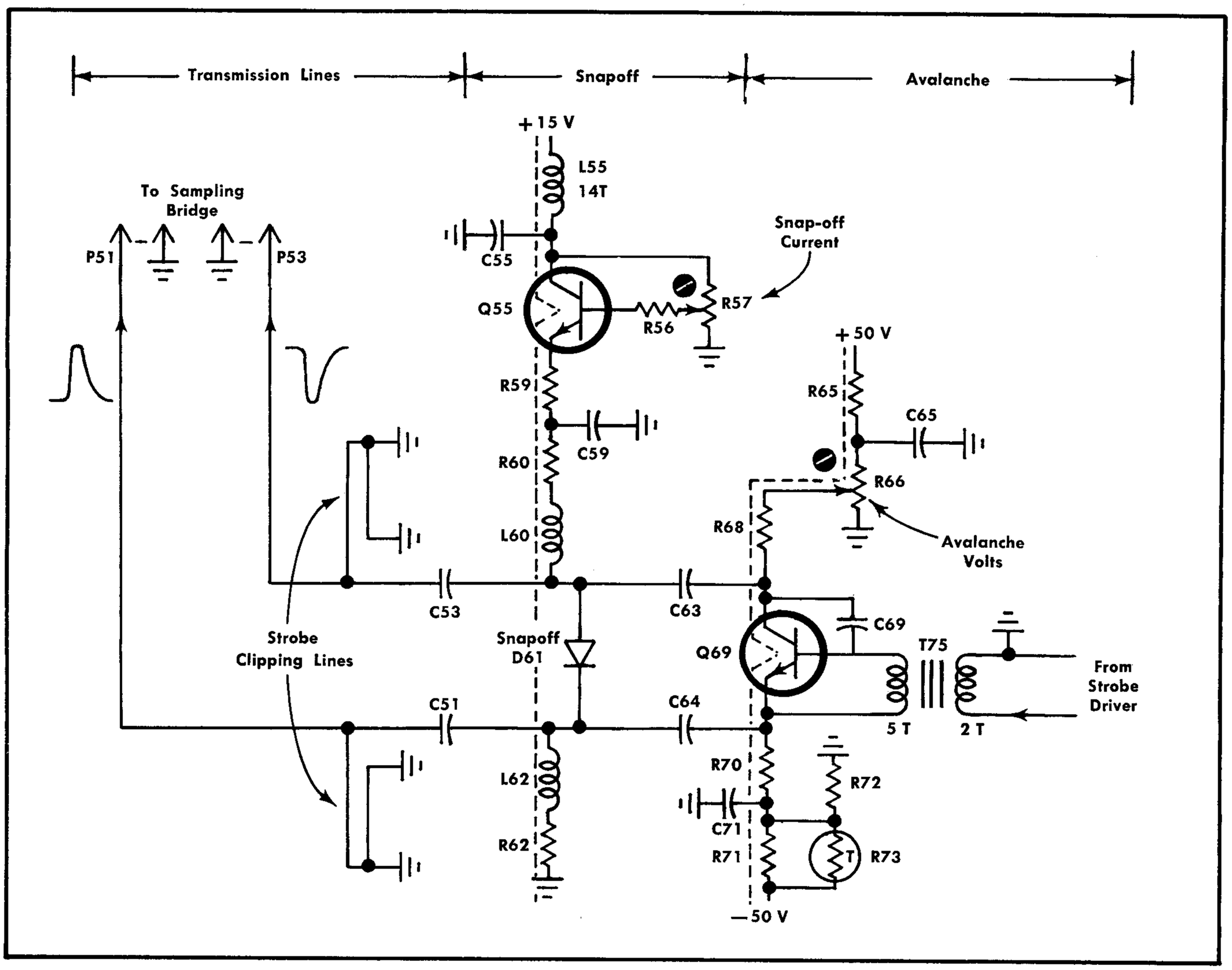


Fig. 3-1. Strobe Generator circuits.

and the other from the emitter. The Avalanche Volts control adjusts the collector voltage of the avalanche transistor Q69. The typical quiescent voltage at Q69 collector is about +15 volts. This voltage sets the amplitude of the signals that drive the Snap-off diode circuit, and assures the normal avalanche action of Q69 when driven by the Strobe Drive signal. Q69 current path is shown by a dashed line in Fig. 3-1. Before Avalanche conduction, there is a potential of about 60 volts between collector and emitter.

The negative Strobe Drive pulse is transformer-coupled by T75 to the emitter and the base of Q69, forward biasing Q69. Normal avalanche action follows with the collector going negative and the emitter going positive. This fast-rise push-pull signal is capacitively coupled to the Snap-off Diode circuit.

Snap-off circuit. The Snap-off circuit operates as a current switching circuit to apply some of the push-pull Avalanche signals at snap-off time to the Sampling Bridge.

The circuit consists of a Snap-off Current control R57, emitter follower Q55, Snap-off diode D61, two clipping lines, and associated components. Between drive pulses from the Avalanche circuit, the Snap-off diode D61 is forward-biased by the current in Q55. The current value is set by the Snap-off Current control R57. The current in D61 is typically 20 mA, and the current path is shown as a dashed line in Fig. 3-1. This heavy forward current assures that D61 has many carriers within its junction region.

The push-pull signals from the Avalanche circuit cause D61 junction carriers to reverse direction as a heavy reverse current. This heavy reverse current stops suddenly as all the carriers clear out of the junction. As the reverse current "snaps" to a stop, the push-pull avalanche signals are suddenly coupled toward the clipping lines and the Sampling Bridge by C53 and C51. The fast-rise step which appears at each clipping line input is propagated down the line. A finite period of time later the steps reach the short circuit ends of each clipping line. The step is then reflected, equal in amplitude and opposite in polarity, back to the transmission line. This cancels the signals moving toward the Sampling Bridge. This action results in a positive Strobe pulse being delivered to P51, and a negative Strobe pulse being delivered to P53.

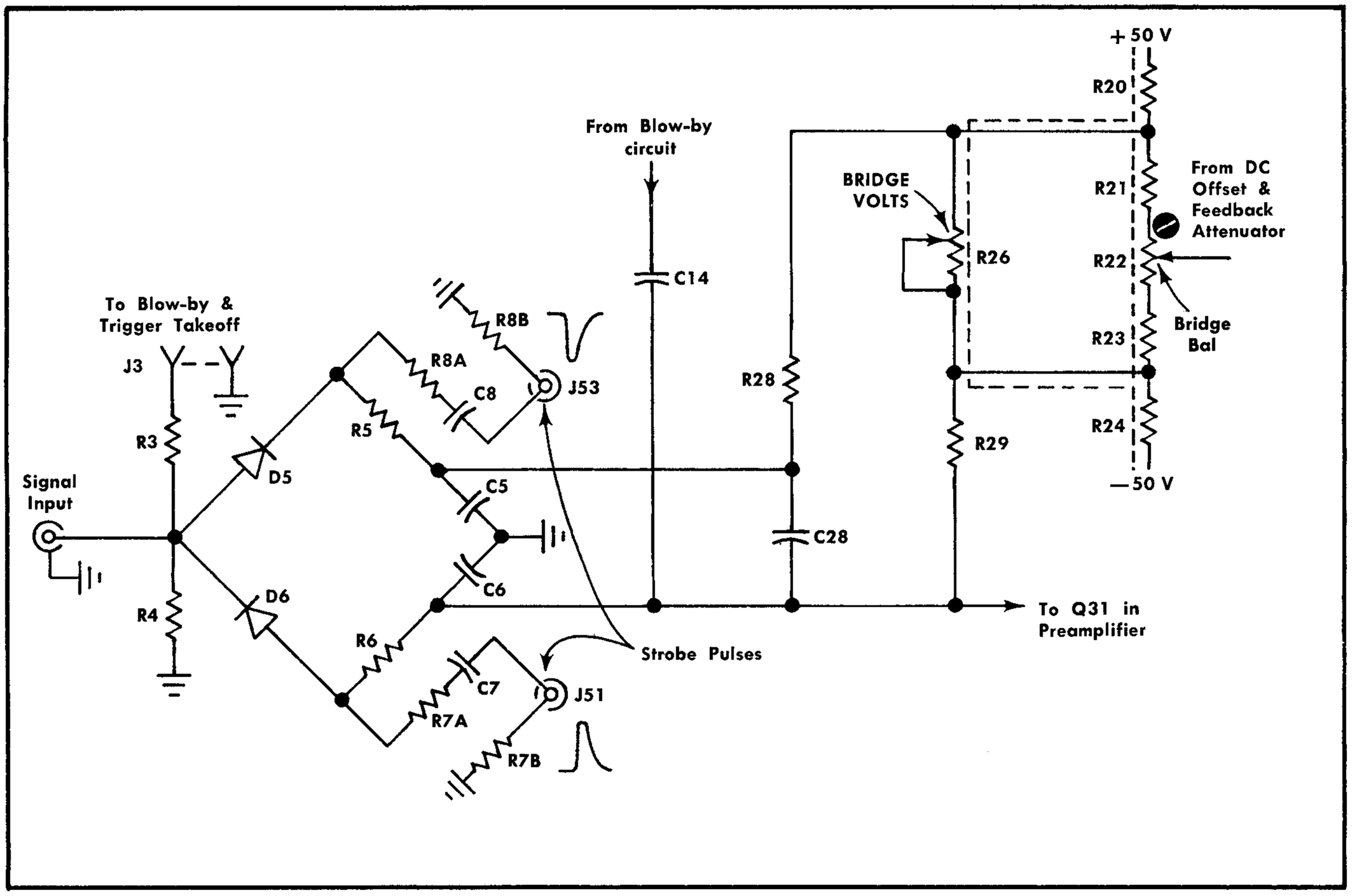


Fig. 3-2. Sampling Bridge circuit with Bridge Volts and Bridge Bal circuits.

Sampling Bridge

The Sampling Bridge consists of D5, D6, R5, R6, R7A, R8A, C5, C6, C7, C8, and C28. See Fig. 3-2. The Sampling diodes allow no connection between the input connector and the Preamplifier input (other than the normal stray capacitance of the bridge) except when driven into conduction by the strobe pulses from the Strobe Generator. During D5 and D6 conduction time of about 350 ps, the bridge delivers a portion of the voltage difference between the input signal and the bridge output signal to the Preamplifier input.

The bridge input circuit is terminated in 50 Ω. The 50 Ω consists of R4 with the series value of R3 and R10 in parallel. (R10 is shown in Fig. 3-3). R3 delivers a small portion of the input signal to the Blow-by and Trigger Pickoff circuit. The bridge output drives the high input impedance of Q31 gate in the Preamplifier.

Reverse-bias voltage for the sampling bridge diodes is developed across R21-R22-R23 in parallel with R26, the Bridge Volts control. R26 allows the reverse-bias voltage adjustment. A higher reverse voltage allows D5 and D6 to be turned on for a shorter period of time. A lower voltage gives a longer conduction time. During calibration the voltage is usually set nearly to maximum.

The Bridge Bal potentiometer is adjusted to compensate for diode, strobe, and other system unbalance signals. The combined memory feedback and DC Offset voltage from the sampling unit is fed through the bridge volts circuit to the output of the Sampling Bridge.

During the sampling time, the strobe pulses forward bias D5 and D6. By normal bridge function, the conduction of D5 and D6 charges or discharges C5, C6, C7 and C8. The voltage charge on these capacitors changes about 2½% of the difference between the Feedback and DC Offset voltage and the incoming signal voltage. This voltage change, called the error signal, is amplified in the Preamplifier.

Preamplifier

The Preamplifier circuit (see Fig. 3-3) amplifies and time-stretches the error signal pulse from the Sampling Bridge, and AC couples it to the Post Amplifier in the sampling unit.

The input transistor Q31 operates as a very high input impedance high-gain inverting amplifier. Temperature compensation for Q31 is accomplished by thermister R33 in parallel with R34. The 4 mA current path is from the +50 volt supply through R31, Q31, the parallel combination of R33-R34 and R35 to the —50 volt supply. C34 assures that Q31 AC gain is high, while its DC gain is less than 1.

Q41 and Q45 are connected as an operational amplifier with a very low output impedance at Q45 emitter. The output is coupled by C49 and L49 to the 90 Ω input resistance Post Amplifier in the sampling unit. Q45 current

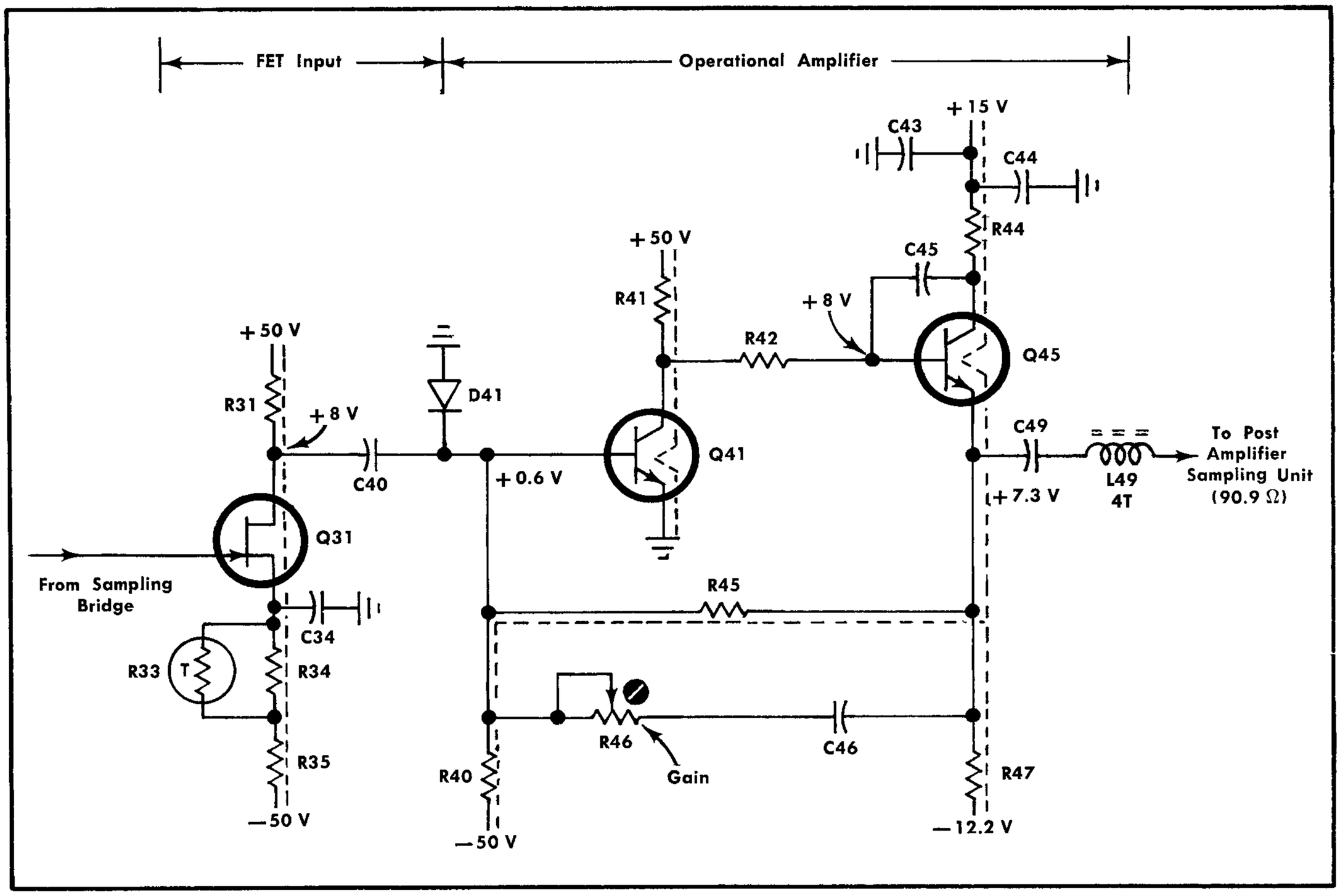


Fig. 3-3. Preamplifier circuit.

paths are shown by dashed lines in Fig. 3-3. D41 protects Q41 base from high negative voltage if Q45 is removed from its socket.

Current in R40 with DC negative feedback by R45 sets the output DC voltage level of the amplifier at about 7.3 volts. Negative AC feedback from the emitter of Q45 through C46 and Gain control R46 to Q41 base controls the AC gain of the Preamplifier. The Gain control R46 allows the AC feedback to be adjusted, thereby adjusting the gain. The AC gain of the Preamplifier is usually adjusted to be about 16 depending upon the sampling efficiency. For example: For an input signal into the Type S-1 input connector of 500 mV, if the display dot change is 100% of the signal, Q45 output signal will be about 200 mV. A positive 500 mV input signal will produce a +12.5 mV signal at Q31 gate (for a 2.5% sampling efficiency), and a positive 200 mV output signal. Likewise a negative input signal will produce a negative output signal.

Blow-by and Trigger Pickoff

The Blow-by and Trigger Pickoff circuits consists of Q13, Q17 and associated components connected as a common-emitter paraphase amplifier. See Fig. 3-4. The primary purpose of the circuit is to cancel unwanted high frequency capacitively-coupled signals that bypass the Sampling Bridge. The secondary purpose is to provide a trigger pick-off signal to the sampling unit for external triggering of the sampling sweep unit.

Input signal to the Blow-by and Trigger Pickoff circuit is a portion of the Type S-1 input signal. The signal is fed to the base of Q13 through R3. R10 terminates the 50 Ω impedance of J3-P3 coaxial connector and assures no reflections back into the input circuit. The output from Q13 collector feeds an AC coupled signal to the output side of the Sampling Bridge, cancelling the blow-by signal. The output from Q17 collector feeds a DC coupled trigger take-off signal to the sampling unit trigger amplifier.

To trace the Blow-by signal path, a portion of the Type S-1 input signal is coupled to the base of Q13 and inverted at the collector of Q13. The inverted signal amplitude is adjusted by R13, the Transient Response control, and fed through R14 and C14 to the output side of the Sampling Bridge. This signal is out of phase with the input signal, cancelling the induced displacement current of the capacitance shunting the Sampling Bridge.

The trigger pickoff signal path starts with a portion of the input signal coupled from Q13 emitter to Q17 emitter to provide an in-phase signal at Q17 collector to the Trigger Amplifier and selector circuits in the sampling unit. Q17 collector load is provided in the sampling unit.

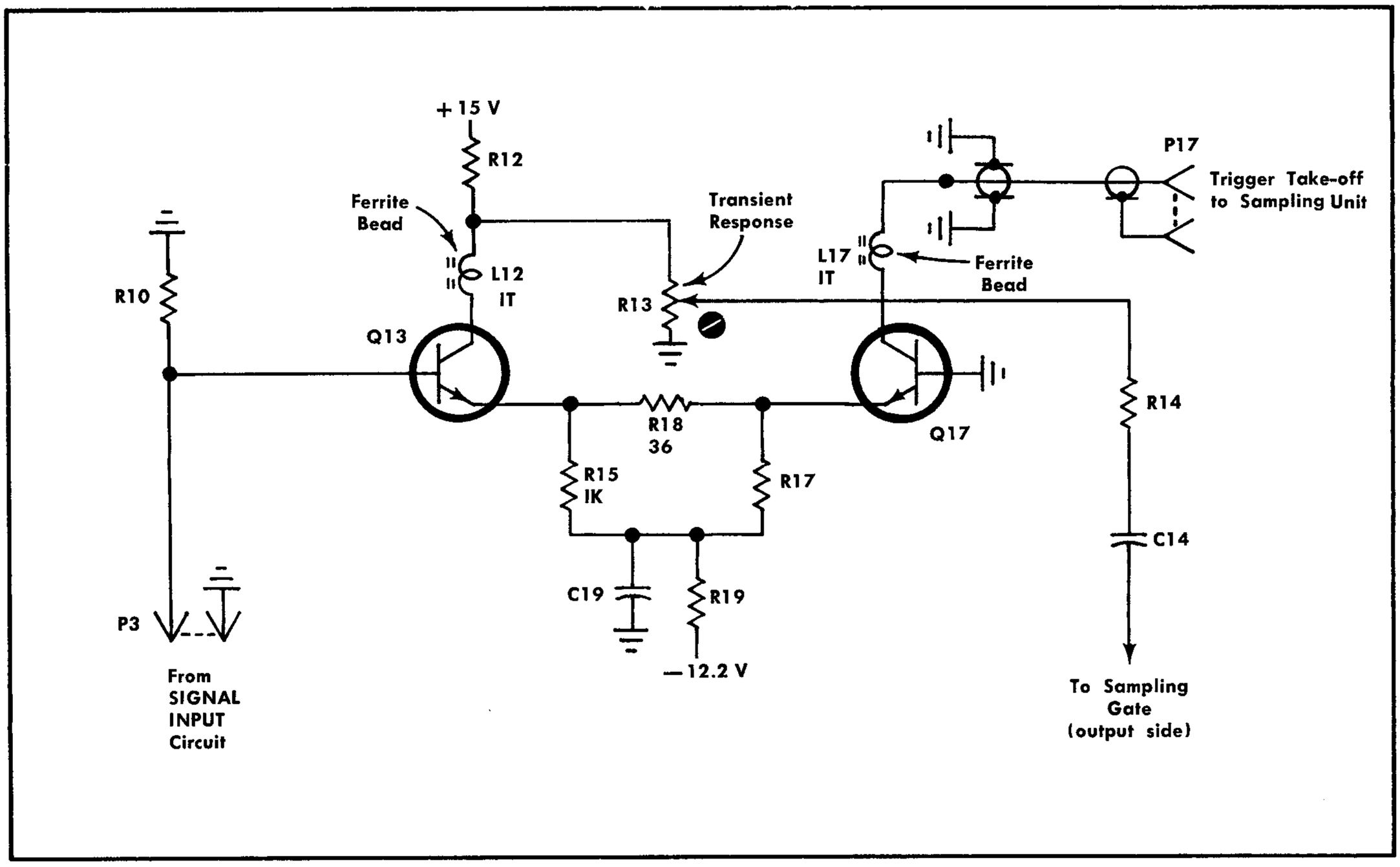


Fig. 3-4. Blow-by and Trigger Pickoff circuits.

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains information for use in corrective maintenance or troubleshooting of the Type S-1.

To remove the Type S-1 from its case, loosen the four retaining screws on the back. Then slide the back off, and remove the body by sliding it to the rear. Directions for replacing the case on the sampling head will be found at the end of this section.

Parts Replacement

All parts used in the Type S-1 can be purchased directly through your Tektronix Field Office or Representative. 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 S-1 should be ordered from Tektronix since these parts are either manufactured or selected by Tektronix to satisfy a particular requirement. Before purchasing or ordering, consult the Electrical or Mechanical Parts List to determine the value, tolerance and ratings required.

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, the sampling head may require recalibration.

Transistor Replacement. Cut the leads of a replacement transistor to the same length as the transistor removed and bend the leads as necessary. The lead configurations of the transistors used in the Type S-1 are shown in Fig. 4-1. Two transistors, Q13 and Q17, have soldered leads and are soldered to the circuit board. The field-effect transistor mounting has an arrow at the top position.

Leadless Capacitors. There are leadless ceramic capacitors soldered directly to the circuit boards. Care must be taken when replacing these capacitors as they are easy to crack. The type of solder used must be high quality, with good cold-flow characteristics. Thus, do not use 50/50 solder, but 60/40 or 62/38 solder when replacing the leadless capacitors.

Best results will be obtained by applying heat from the soldering iron directly under the leadless capacitor on the opposite side of the board. Usually a plated-through hole is under the leadless capacitor, allowing solder to conduct heat through the board. Without plated-through holes, the

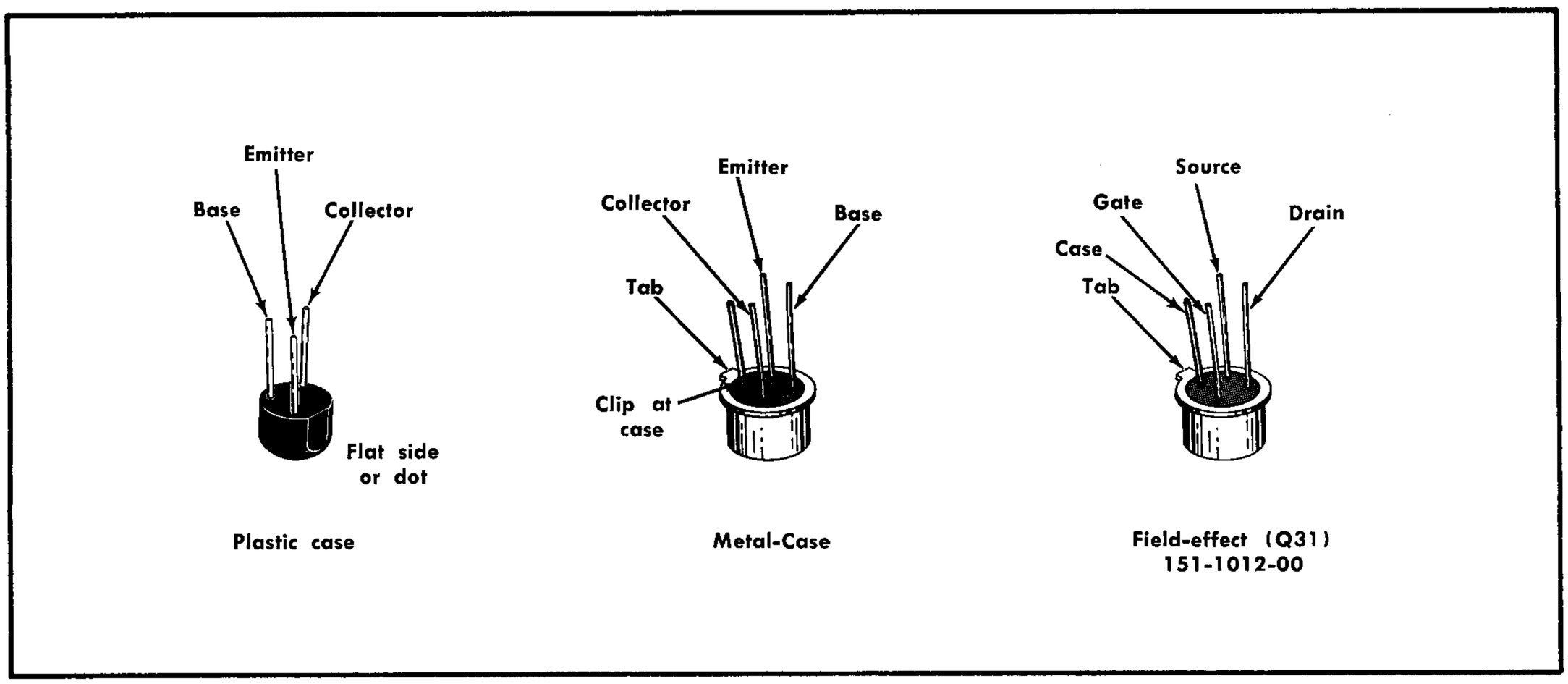


Fig. 4-1. Lead configuration for board-mounted transistors.

capacitor may be soldered into place by positioning the part, then applying heat to the adjacent plated area.

Use only enough solder to obtain a good full-flow joint. Excess solder on either side of the capacitor can lead to a shorted circuit.

Removal and Replacement of Snap-off Diode. The Snap-off diode is mounted in small metal clips, as shown on the circuit board illustration. The diode is best removed or replaced with a pair of shaped plastic tweezers, such as Tektronix Part No. 006-0765-00, or equivalent.

Replacement of Sampling Bridge Diodes. The Sampling Bridge diodes may be removed or replaced on the Sampler Board through the top of the unit. Fig. 4-2 shows a method for the removal or replacement of the white plastic holder in which the diodes are mounted.

CAUTION

The diodes are very fragile and it is possible to break one or both if the white plastic holder is removed or replaced too rapidly. Damage is caused when the holder ends snap together as they are moved from the circuit board.

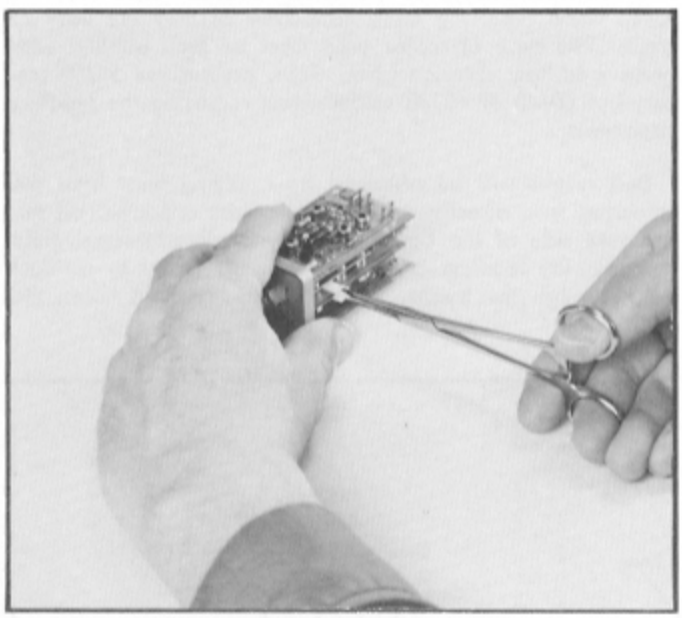


Fig. 4-2. Removal or replacement of sampling bridge diodes.

The position of the plastic diode holder assembly is shown in Fig. 4-3 with the shields removed; it is not necessary to remove these shields to replace the sampling diode assembly. For removal or replacement use Xcelite Forceps 42H, Tektronix Part No. 003-0347-00, or similar tool.

The hook-like ends of the diode holder normally rest in a circuit board hole and firmly hold the diodes to the plated area. Cautious removal, especially just as the holder clears the circuit board, is necessary to minimize the physical shock and possible damage to the diodes, as the hook-like ends may snap or spring together. Replacement of the holder should also be by slow, cautious movement; first as the hook-like ends reach the plated area which increases the thickness and second as they reach the hole where the possibility of physical shock exists as in the removal. A metal shield prevents the holder being inserted too far.

Circuit Board Replacement. If a circuit board is damaged and cannot be repaired, the entire assembly including all soldered-on components should be replaced. The part number given in the Mechancial Parts List is for the completely wired board.

The Preamp Board and the Strobe Board are removed by gently pulling outward from the Sampler Board. To replace the boards, align the connectors and pin contacts and ease the boards into position. Pin connectors should not protrude beyond the clamps.

The Sampler Board is removed as follows:

1. Remove both the Preamp Board and the Strobe Board.

2. Remove the 12 sided nut (nutdriver, special, Tektronix Part No. 003-0459-00) which secures the GR connector to the front panel.

3. Slide the Sampler Board and the GR connector away from the front panel.

To remove the Shields and Input Connector:

1. Loosen the threaded nut by turning it counterclockwise with the special Tektronix tool, Part No. 003-0607-00. Do not remove the threaded nut, but back it off just enough to free the notched plate (see Fig. 4-4).

2. Rotate the notched plate 90° and slide the Input Connector assembly away from the circuit board.

3. Loosen, but do not remove, the seven nuts holding the shields.

4. Remove the 7 nuts and bolts, freeing the shields.

TROUBLESHOOTING

The design of this sampling head is such that printed circuit boards are interchangeable from one unit to another. Since the outer boards are easily removed and replaced, it is possible to quickly troubleshoot a faulty sampling head by interchanging boards with an operating one. Thus, removal of the preamp board from the operating unit and replacement with one from the defective unit quickly checks the faulty units' preamp circuits.

The sampler board may be checked for defective parts without disassembly by the following procedure:

1. Remove the sampling diode plastic holder.

2. Remove the Preamp board. Leave the Strobe board in place.

3. With an ohmmeter, check the DC resistance to ground from the preamp input pins H and I. If a direct short is found, C5 or C6 is shorted; if a 350 Ω connection to ground is found, then C7 or C8 is shorted.

4. To check C5, C6, C7 and C8 for opens, (with Preamp board removed), use a Tektronix Type 130 Direct-Reading L-C

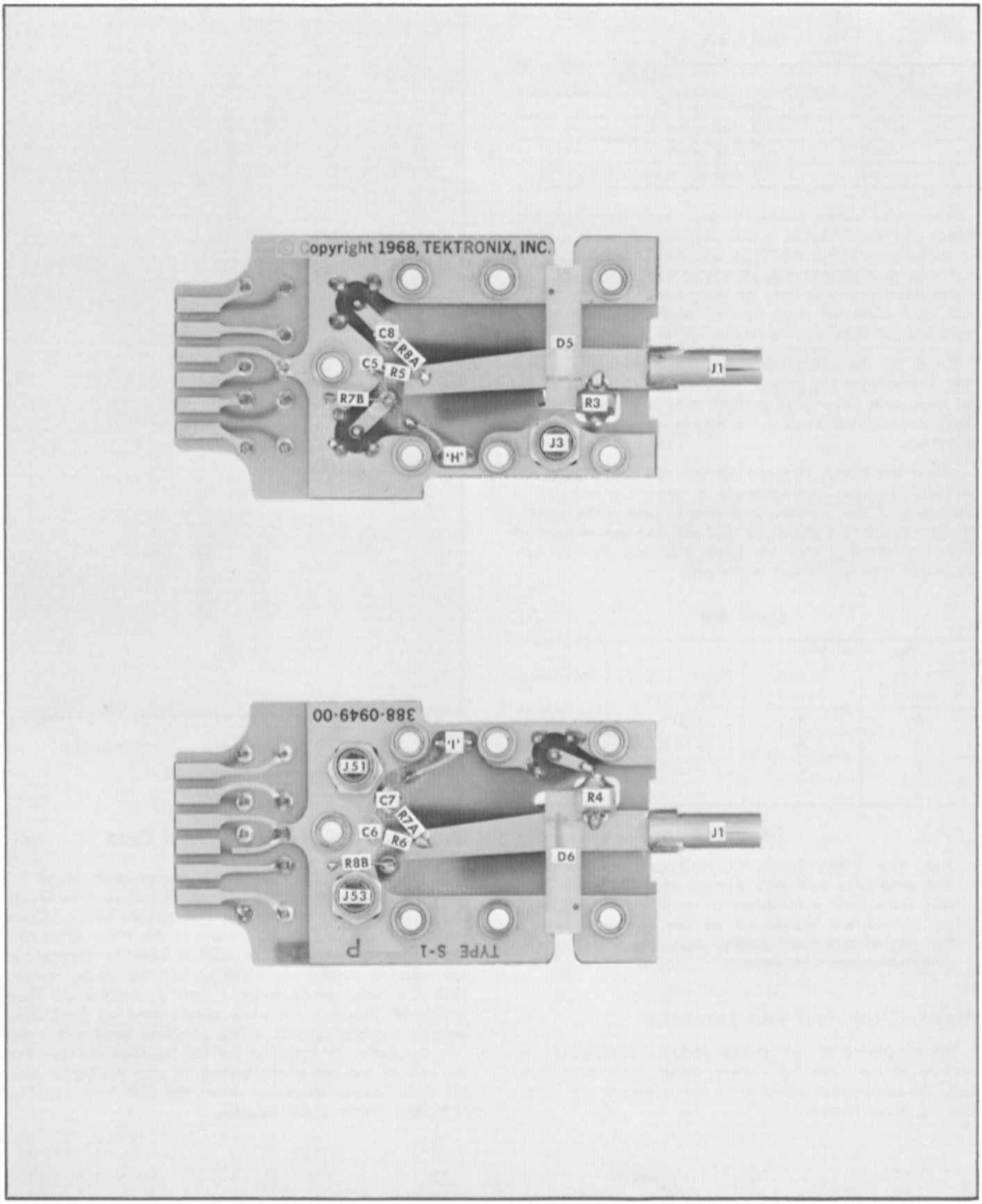


Fig. 4-3. Sampler circuit board, shields removed.

Meter (or equivalent) and refer to Table 4-1 for the values of capacitance from either pin H or I to ground.

TABLE 4-1

Input C	Problem
25 pF	Capacitors OK
20 pF	C5 (C6) open
10 pF	C7 (C8) open
5 pF	C5 and C7 open (C6 and C8)

Attempt to isolate trouble to one circuit through operational and visual checks. Verify that the trouble is actually a malfunction within the Type S-1, and not improper adjustments or malfunctioning associated equipment. Note the effect the adjustments have on the trouble symptoms. Normal and abnormal operation of each adjustment helps establish the location and nature of the trouble.

Check the instrument calibration procedure given in Section 5, and note the position of each adjustment so it can be returned to its original position after the check. This will facilitate recalibration after the trouble has been found and corrected.

Check the Circuit Diagram for voltages and waveforms. A block diagram and schematic diagram are included in Section 8 of this manual. It is usually best, if the trouble is not isolated to a circuit, to start with the power supplied from the sampling unit; see Table 4-2, then proceed consecutively from one circuit to the next.

TABLE 4-2

Test Point Pin		Power Supply (Decoupled)	Tolerance
Preamp Board	Strobe Board		
G	B	+50 V	±1 V
A	A	+15 V	±0.15 V
F	C	−50 V	±0.5 V
B	—	−12.2 V	±0.37 V

CAUTION

Use care when measuring voltages or signals. The small size and high density of components in this instrument establishes a condition such that an inadvertent movement of the test probe or the use of oversized probes may cause a short-circuit between components.

Major Circuit and Part Locations

The remainder of this section includes photographs of sections of the Type S-1. Major circuit areas are identified. All components mounted on circuit boards are identified by circuit numbers.

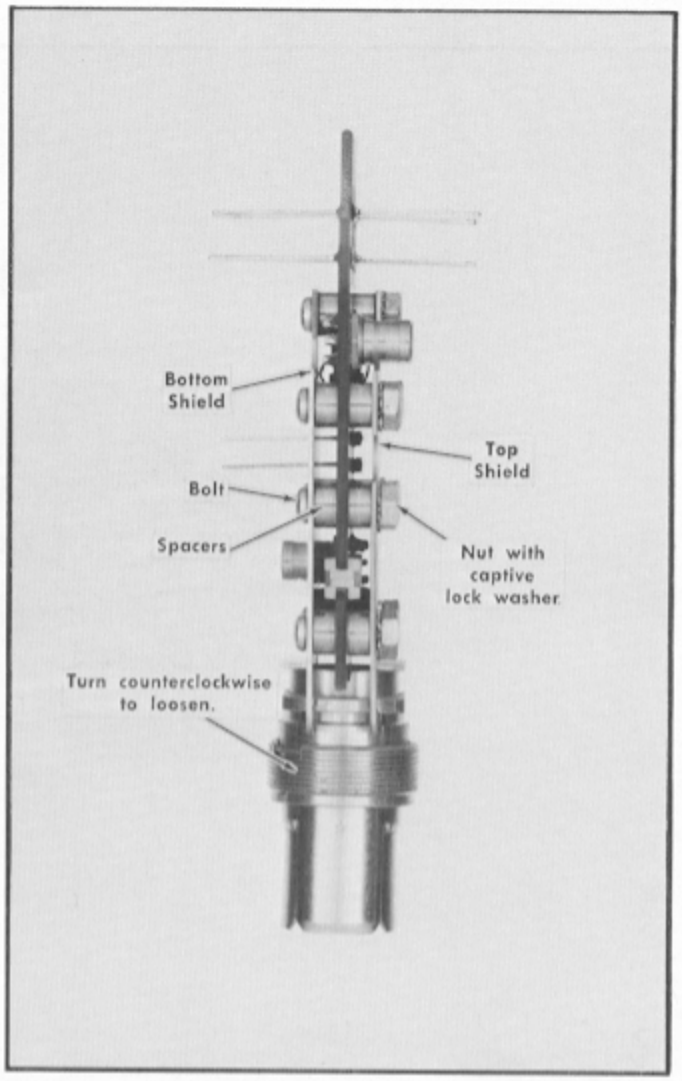


Fig. 4-4. Assembly of Sampler Circuit board.

Replacing the Sampling Head Case

To replace the case on the sampling head, align the body so that the hole in the side will appear over the Bridge Bal control at the rear of the Preamplifier board. Check that the upper and lower corners of the Preamplifier and Gate Generator boards are aligned with the channels in the sampling head body which contain the zigzag springs. Push the body gently forward until it contacts the front panel. Be sure that the white plastic pawl on the locking knob is properly aligned as the sampling head unit is slid into the body. In attaching the rear castings, be sure that the hole at one side of the casting fits over the trigger pick-off signal output connector. Insert the four long mounting bolts and tighten them securely.

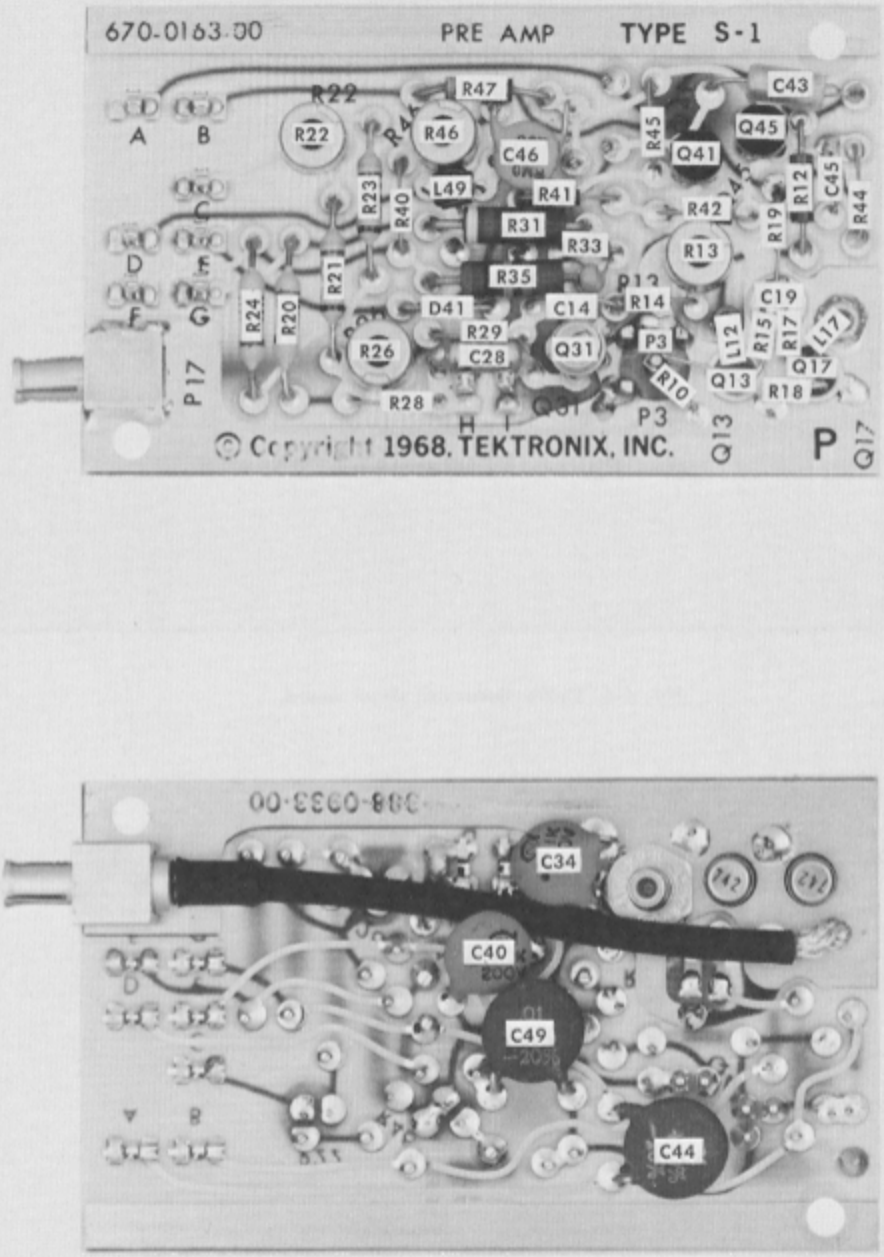


Fig. 4-5. Preamp circuit board.

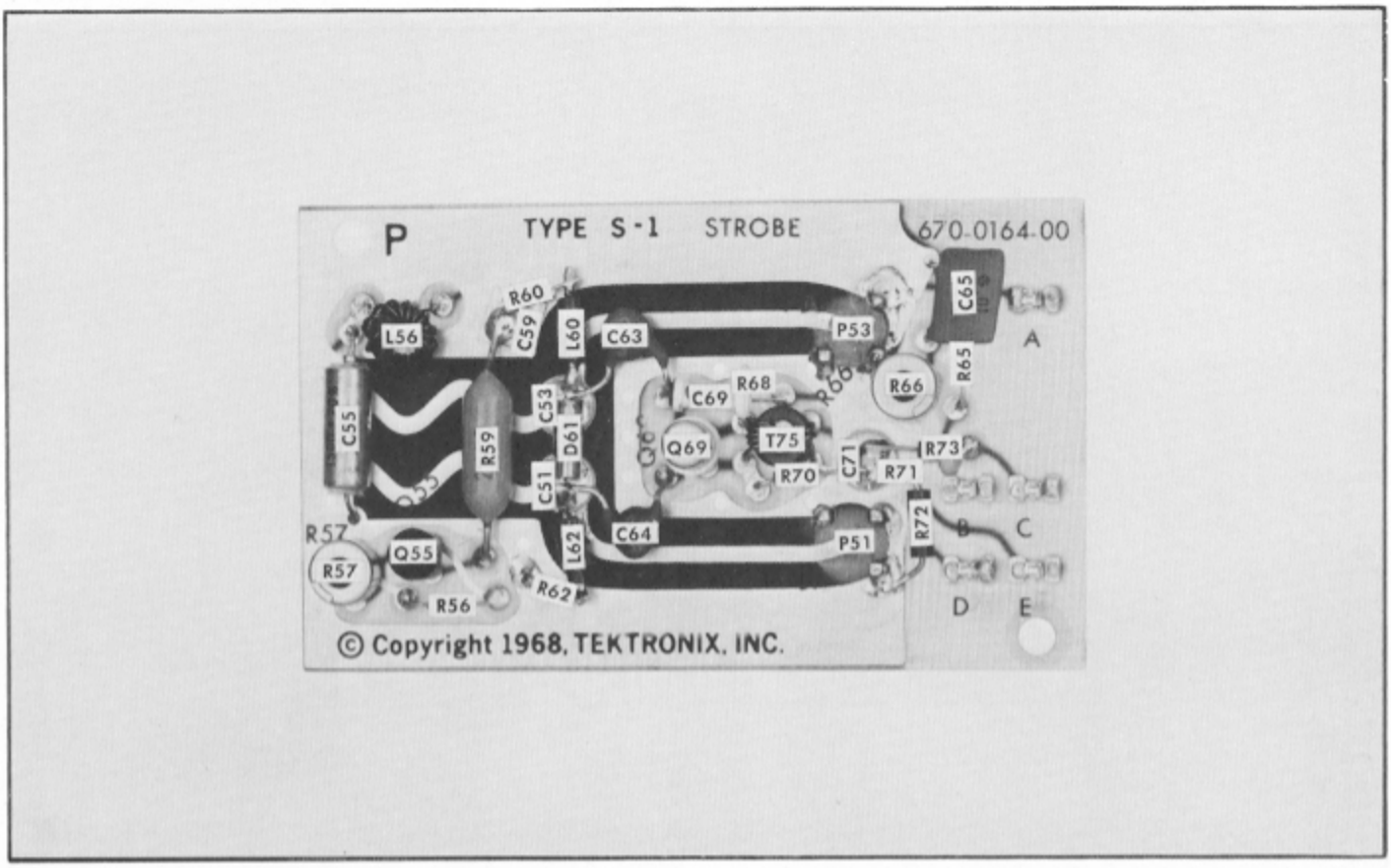


Fig. 4-6. Strobe Generator circuit board.

SECTION 5
PERFORMANCE CHECK / RECALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

Performance of the sampling head can be checked without making internal adjustments by using the steps of this procedure whose headings are set in the type face used in step 1 page 5-5). Failure to meet the requirements given in any check indicates the need for recalibration. Recalibration steps are headed by the type face shown in step 2.

The sampling head performance can be restored to the limits stated in Section 1 by performing the recalibration steps of this procedure. Any needed maintenance should be performed before proceeding with recalibration.

Since the sampling head functions as a part of the associated sampling unit, it is recommended that the performance checks for the sampling unit be performed just before these performance checks are made. Then, if the sampling unit requires recalibration, that procedure should be performed before starting this procedure.

NOTE

This procedure applies to both the Type S-1 and the Type S-2 Sampling Heads. Their controls are identical; thus, differences between the two are in performance and electrical characteristics. For example, Step 3 which checks the sampling head risetime, uses an identical procedure and the same equipment set-up for both sampling heads, with performance limits shown in separate photographs of proper CRT displays.

EQUIPMENT REQUIRED

The equipment listed below or its equivalent is required for a complete check and recalibration of either the Type S-1 or the Type S-2 Sampling Head; see Fig. 5-1. The equipment listed is used in the following procedure. Equipment specifications given are the minimum necessary for the particular use of each item. All test equipment must be correctly calibrated. If other equipment is substituted, it must meet or exceed the limits stated below. If a pulse generator other than the Type 284 is used, fast pulse display characteristics may vary from those shown in this manual.

All equipment items listed, except items 12, 13 and 14, can be obtained by ordering through your local Tektronix Field Engineer or Representative.

1. Test Oscilloscope. Bandwidth, DC to at least 50 MHz. Minimum deflection factor of 20 mV/div. For example, a Tektronix Type 585 with Type 82 Plug-In Unit.

2. 10× Probe for use with test oscilloscope. Tektronix P6008 Probe recommended with the Type 82 Plug-In Unit. Tektronix Part No. 010-0129-00.

3. Indicator Oscilloscope, with proper sampling plug-in units, such as a Type 561A or Type 564 Oscilloscope with Type 3S2 Sampling Unit and Type 3T2 Random Sampling Sweep. Or, a Type 568 Oscilloscope with the same vertical and horizontal plug-ins, and Type 230 Digital Unit if the sampling system is used with digital readout.

4. Special 3 foot flexible extender cable for operating the sampling head outside the sampling unit. Tektronix Part No. 012-0124-00 required.

5. Signal Generator-Pulse Generator, such as the Tektronix Type 284 Pulse Generator used in this procedure. pulse risetime $\leq$ 70 ps, at approximately 200 mV amplitude into 50 Ω, with a trigger signal available at least 75 ps in advance of the fast pulse. Square wave signals of 1 μs period (1 MHz) and 100 ns period (10 MHz) at 1-volt amplitude into 50 Ω. (If your Type 284 Lead time switch is labeled 5 ns-50 ns, order modification kit, Tektronix Part No. 040-0487-00.)

6. 50 Ω coaxial cable, RG 58/U, 5 ns signal delay, with GR 874 connectors. Tektronix Part No. 017-0512-00.

7. 50 Ω coaxial cable, 5 ns signal delay, approximately 40 inches long, with BNC connectors. Tektronix Part No. 012-0057-00.

8. 50 Ω coaxial air line, 20 cm long, with GR 874 connectors. GR 874-L20. Tektronix Part No. 017-0084-00.

9. One 50 Ω 5× Coaxial Attenuator, such as GR 874-G14. Tektronix Part No. 017-0079-00.

10. One 50 Ω 2× Coaxial Attenuator, such as GR 874-G6. Tektronix Part No. 017-0080-00.

11. A special Variable Attenuator with GR 874 connectors. It consists of a 100 Ω potentiometer across the 50 Ω line, and does not have a guaranteed response. Tektronix Part No. 067-0511-00.

12. DC Bridge for measuring 50 Ω. Plus or minus 2 volts DC maximum across 50 Ω resistor. Accuracy, ± 0.2% required (not shown).

13. Small insulated handle, 3/32 inch bit screwdriver for adjusting screwdriver-adjust controls. (Not shown.)

14. An RMS reading line voltage meter, with a ± 3% accuracy at the line voltage to which the indicator oscilloscope is connected. (Not shown.)

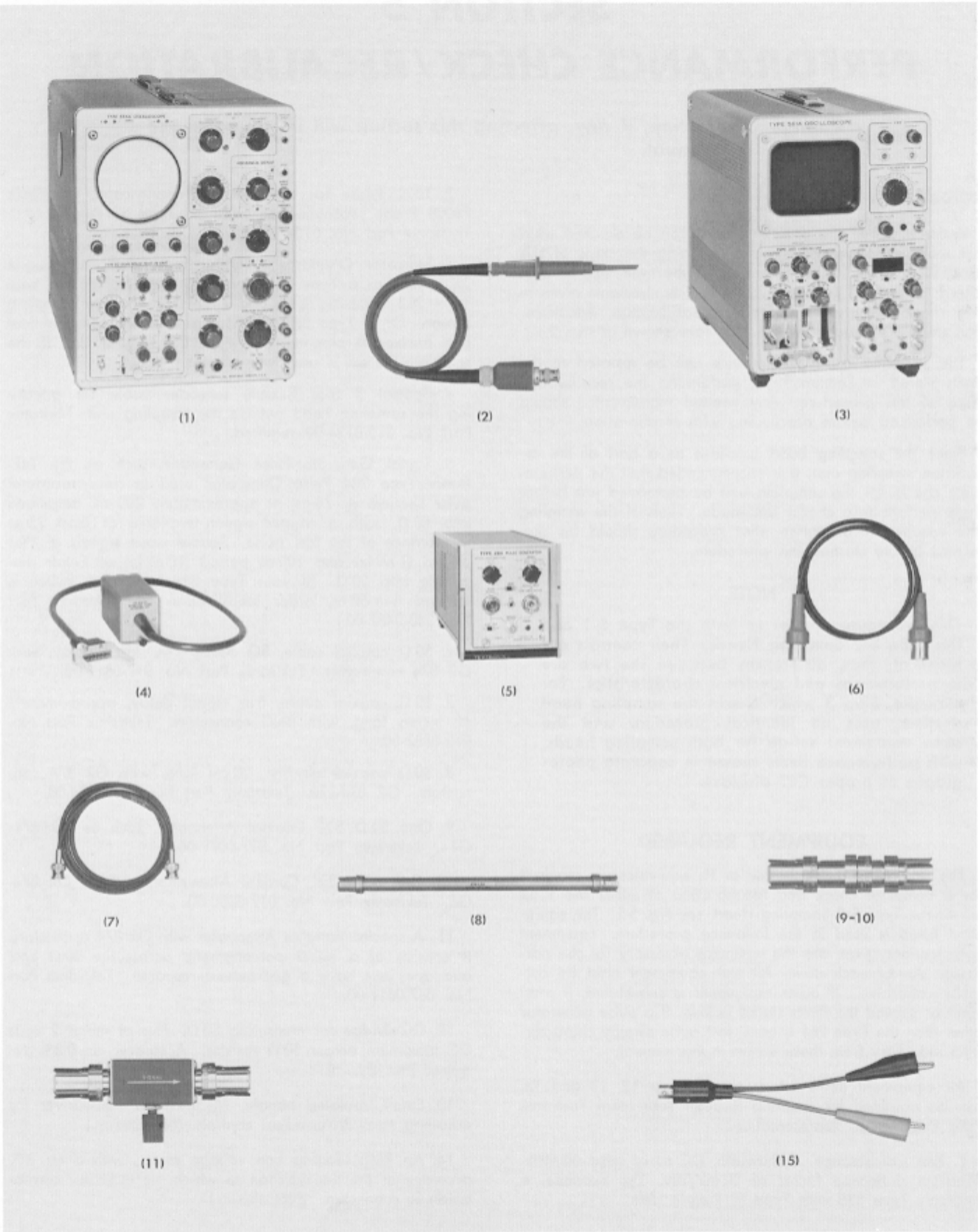


Fig. 5-1. Calibration Equipment.

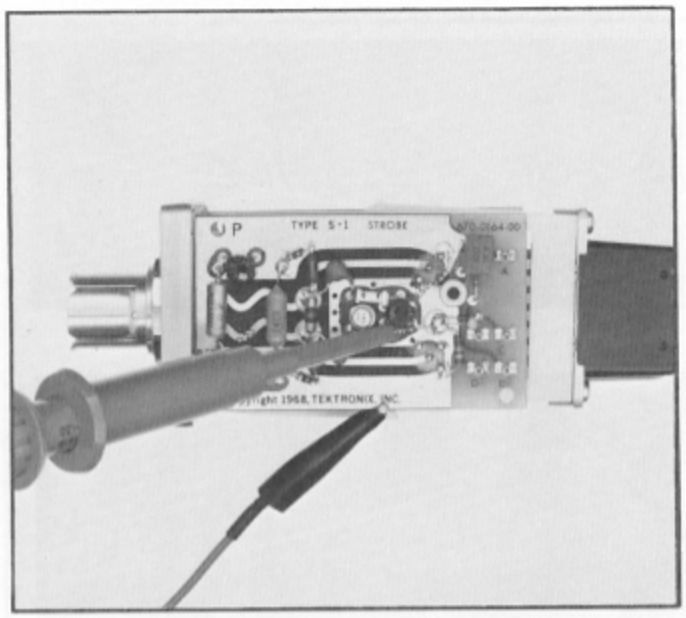


Fig. 5-2. Test oscilloscope 10× probe connected to Q69 emitter.

15. A clip lead to BNC adapter. Tektronix Part No. 013-0076-00.

PERFORMANCE CHECK AND RECALIBRATION RECORD AND INDEX

The following abridged procedure may be used as a guide by the experienced technician for checking and/or recalibrating either the Type S-1 or the Type S-2 Sampling Head. The abridged procedure can be used as a maintenance record (the procedure may be reproduced without special permission of Tektronix, Inc.). The step numbers and titles are identical to those in the complete procedure.

Sampling Head Type S-_____ Serial No. _____

Calibration Date _____

Calibrated By _____

Checked By _____

☐ 1. Check for Operation and Ability To Produce a CRT Display — Page 5-5

☐ 2. Check For Q69 (Avalanche) Operation — Page 5-5

☐ 3. Check 10% to 90% Risetime — Page 5-6

☐ 4. Adjust Risetime — Page 5-9

☐ 5. Check Dot Response Linearity — Page 5-11

☐ 6. Preliminary Bridge Bal Adjust — Page 5-13

☐ 7. Adjust Transient Response (Blow-by) — Page 5-13

☐ 8. Check Pulse Flatness Deviation — Page 5-13

☐ 9. Check Trace Shift From 30 Hz to 50 kHz — Page 5-15

☐ 10. Final Bridge Bal Adjust — Page 5-15

☐ 11. Check Tangential Noise — Page 5-15

PRELIMINARY PROCEDURE

1. Check the sampling head 50 Ω DC input resistance. With the sampling head separated from the sampling unit, use a DC Resistance Bridge and measure the DC input resistance. Connect one lead to the input connector outer conductor, and the other lead to the center conductor. Be sure the bridge does not apply more than ± 2 volts to the input terminals.

The sampling head input resistance must be 50 Ω, ± 1%.

If the input resistance is high, examine the trigger pick-off resistance divider with an ohmmeter. R3 can be measured by removing the Preamplifier board from the head and measuring between the center pin of J3 and the center pin of J1. R10 can be measured from the center pin of P3 to ground. If either of these resistors is open, the sampling head DC input resistance will be out of tolerance on the high side.

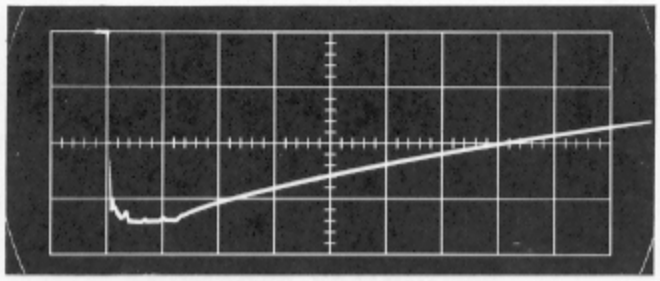
If the input resistance is low, and if the voltage applied by the bridge exceeds 0.6 volt, check for a shorted capacitor among C5, C6, C7 and C8. If changing the input polarity from the DC bridge produces a proper resistance reading, the conduction path can be traced through the one sampling diode that does conduct, to help locate the defective part.

If the termination resistor is itself out of tolerance, it is recommended that the sampler board be returned to Tektronix for repairs. The resistor assembly (R4, R3 and the ground clip) is available for making repairs at the time of recalibration. If replacement is attempted, it is very important that no solder be permitted to flow onto the area of sampling diode contact.

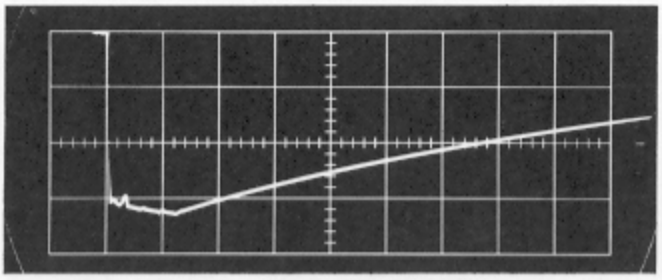
Complete any needed repairs to the sampling head before proceeding.

2. Connect the sampling head and oscilloscope system. This step discusses the assemblying of testing equipment, 5-minute warmup period, and setting of the vertical and horizontal plug-in unit Gain controls.

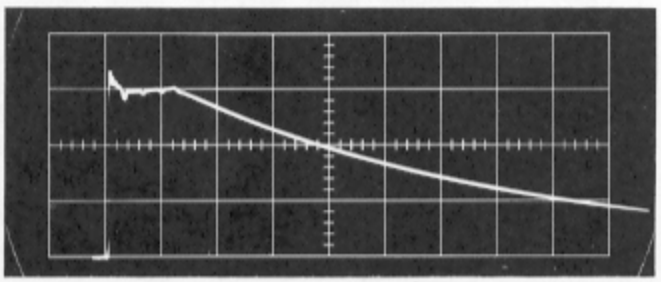
a. Assemble the indicator oscilloscope system. Place the Type 3S2 (or other Sampling Unit) into the left compartment of the indicator oscilloscope, and the Type 3T2 (or other Sampling Sweep Unit) into the right compartment. Install an operating sampling head into the Type 3S2 Channel B compartment. Leave the Channel A compartment vacant. (If using a Digital Readout unit, make the interconnections to the indicator.)



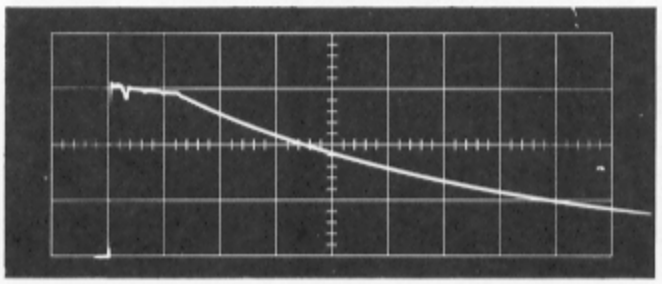
A. S-1, Q69 Collector.



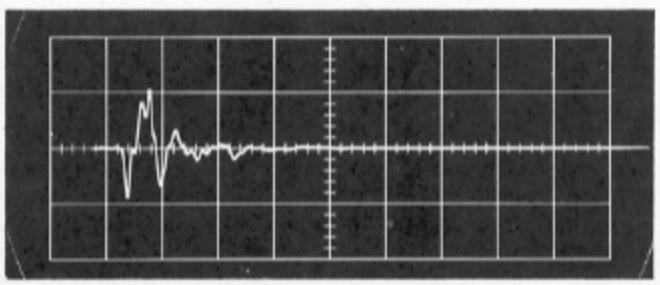
D. S-2, Q69 Collector.



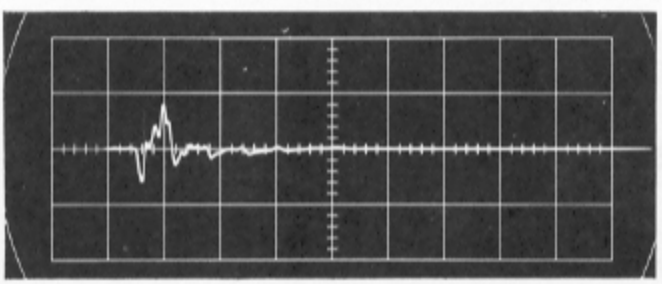
B. S-1, Q69 Emitter.



E. S-2, Q69 Emitter.



C. S-1, T75 Primary.



F. S-2, T75 Primary.

85 MHz test oscilloscope, P6008 10X Probe with 4 inch ground lead.

A, B, D and E: 0.2 μs/div and 10 V/div.

C and F: 0.1 μs/div and 5 V/div.

Fig. 5-3. Checking Avalanche drive and output.

b. Connect the RMS line-voltage meter to the power mains. Determine that the oscilloscope (and other equipment) power supply is set for the correct value of line voltage. Connect all the equipment to the proper power outlet and turn on the power. Obtain a free-running trace and let the equipment warm up for five minutes.

c. After the warm-up period, adjust the indicator oscilloscope Trace Alignment control so the free-run trace is parallel to the graticule lines.

NOTE

It is recommended that the recalibration procedure in the sampling unit instruction manual be completed before proceeding.

d. Connect the Type 284 Square Wave Output connector to the Channel B sampling head input. Use a 5 ns signal delay 50 Ω coaxial cable with GR 874 connectors (item 6 of equipment required). Connect the Type 284 Trigger Output connector to the sampling sweep unit External Trigger input (50 Ω) connector. Use a 5 ns signal delay 50 Ω coaxial cable with BNC connectors (item 7 of equipment required).

Adjust both the vertical and the horizontal unit Gain controls for proper deflection factor of each unit. Use the Type 284 100 ns period square wave as both a time and amplitude reference.

e. Install the sampling head to be recalibrated onto the special three foot extender cable (item 4 of equipment required). Connect the other end of the cable into the Type 3S2 Channel A sampling head compartment. (The sampling head should be in its case.) Allow a five minute warm up of the system.

CHECK AND RECAL PROCEDURE

1. Check For Operation and Ability to Produce a CRT Display

a. Connect the Type 284 Square Wave Output signal to the head to be calibrated. Then set the Type 3S2 controls for a Channel A display. If there is a square wave display, proceed to Step 3. If there is no square wave display, do Step 2.

2. Check For Q69 (Avalanche) Operation

a. Remove the extender cable from the sampling head (the indicator oscilloscope power may be left on).

b. Remove the sampling head case. First, remove the four round-head screws visible at the back of the unit; then slide the cover off by gently pulling it away from the front casting and input connector.

c. Reconnect the extender cable to the rear of the sampling head, being certain that the trigger pickoff coaxial connector mates with the coaxial connector of the extender cable. Use the signal set-up of step 1.

d. Use the test oscilloscope with 10× Probe to check for proper operation of Q69. The probe connections are shown in Fig. 5-2, and the general nature of the signals is shown in Fig. 5-3. Fig. 5-3A and B show the general amplitude for Q69 collector and emitter signals in a Type S-1 Sampling Head. Fig. 5-3D and E show the Q69 signals in a Type S-2 Sampling Head. Fig. 5-3C and F show the S-1 and S-2 typical drive signals at T75 primary (square terminal E) while the head is on the extender cable.

If T75 is receiving drive, but there is no signal out of Q69, change Q69 (changing Q69 may significantly increase the displayed noise, so it is best to have several transistors of this type on hand and grade them for low noise using step 11). If all signals of Fig. 5-3 are present, check the Preamplifier output (square terminal D). If there is no signal at the Preamplifier output, check the sampling diodes and Q31 in the following manner.

(1) Pull Q41 from its socket. Set the Type 3S2 DC Offset control for zero volts at the front panel Offset jack. Free run the time base unit. Use the test oscilloscope, with 10× probe, and monitor the drain lead of Q31.

(2) Q31 will have a pulse signal at each strobe time if the transistor is operating. If there is no pulse signal, change Q31, reinstall Q41 and try to obtain a trace.

(3) If Q31 is operating, and if there is a pulse of either polarity at its drain lead (with Q41 out), operate the BRIDGE BAL control (R22) through its range. As R22 is changed, the pulse signal should reduce to zero and change to the opposite polarity. If the pulse signals does not change polarity, one of the sampling diodes is open.

NOTE

The sampling diodes are very fragile and replace ments are expensive. The white plastic clip should not be disturbed nor withdrawn unless you are certain that a diode is defective. If a diode is to be changed, reinsert the clip very carefully so that the diodes do not receive any physical shock as the clip ends drop into place. With extreme caution, it is possible to remove and replace a set of sampling diodes without damage.

(4) Restore Q41 to its socket. Once a display is obtained, go on to Step 4.

NOTES

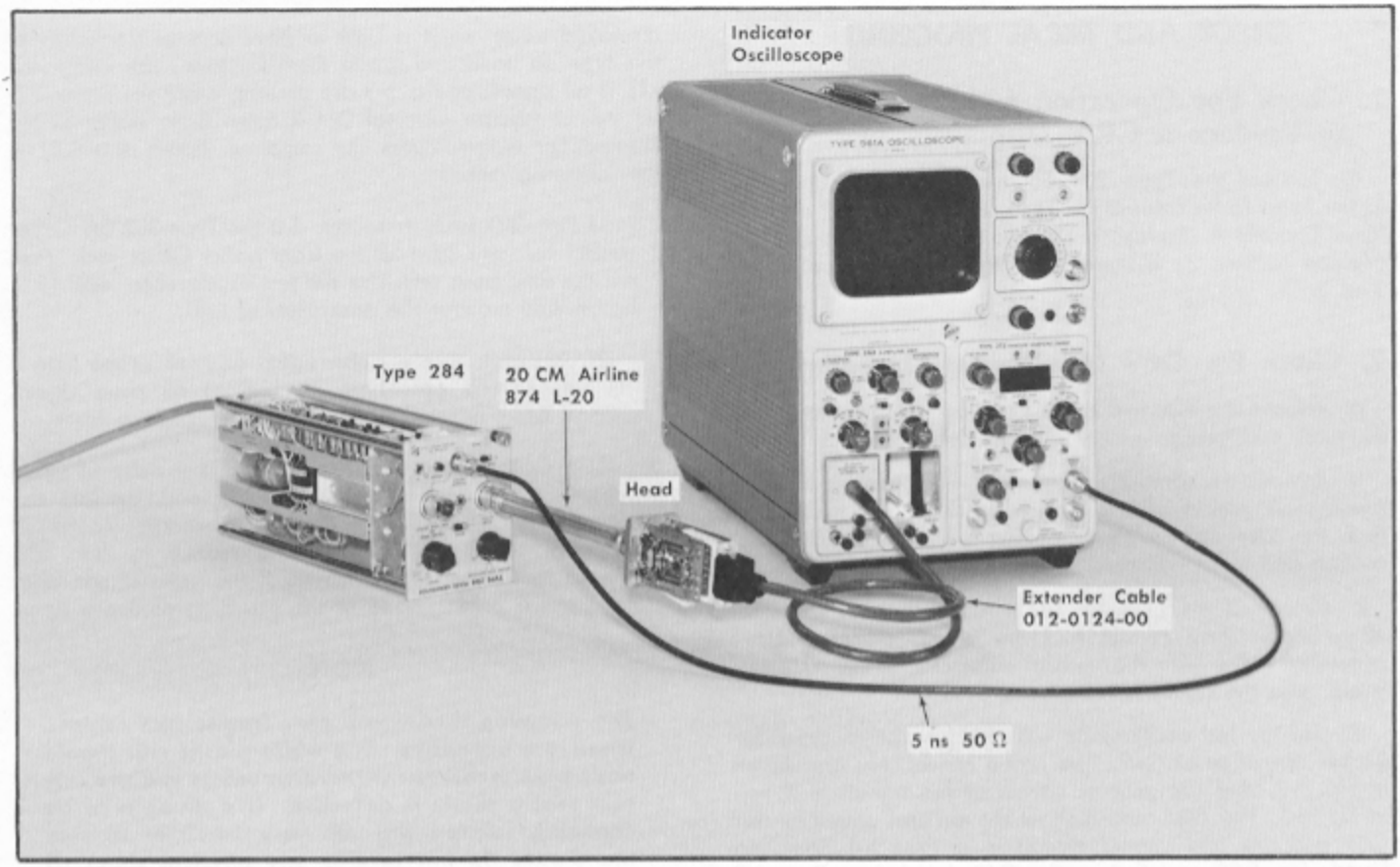


Fig. 5-4. Risetime check test equipment set-up.

3. Check 10% to 90% Risetime

NOTE

This step follows Step 1, and is to be performed with the case on the sampling head. If Step 2 was performed, ignore this step and proceed to step 4.

Requirement—The Type S-1 10% to 90% risetime is equal to or less than 350 ps.

The Type S-2 10% to 90% risetime is equal to or less than 50 ps, displayed as 86 ps or faster using the equipment set-up shown in Fig. 5-4.

a. Connect the equipment shown in Fig. 5-4 A or B, depending upon equipment in use. The extender cable is recommended, although not required. The cable permits easy access to the Type 284 TD Bias screwdriver control which is adjusted as part of this step.

Connections in Fig. 5-4 are:

(1) 20 cm 50 Ω air line between Type 284 Pulse Output connector and sampling head input connector. (No substitute signal cable is acceptable.)

(2) 5 ns signal delay 50 Ω coaxial cable (RG-58/CU, with BNC connectors between Type 284 Trigger Output jack and the sampling sweep unit External Trigger (50 Ω) input connector.

(3) Special 3 foot sampling head extender cable between the head and the Type 3S2 left side compartment connectors.

(4) If using digital readout, the proper cable between the oscilloscope and the digital unit, supplied with the Type 230.

NOTE

Instrument risetime can be checked either by visual measurement of the CRT display, or by a digital readout unit. Digital measurement of risetime requires that the Type 3T2 be operated in the With Trigger mode. With Trigger operation requires that the Type 284 trigger pulse have a leadtime of at least 73 ns before the fast Pulse Output signal. (Type 284 instruments with only 5 ns-50 ns Lead Time required the installation of Field Modification Kit, Tektronix Part No. 040-0487-00.)

CRT risetime measurement permits the Type 3T2 to operate in the Before Trigger (Random) mode, in which the trigger leadtime does not have to be 73 ns.

The 73 ns stated here is required for the With Trigger mode when the sampling head is operating on a 3 foot extender cable and the trigger cable has a 5 ns signal delay. Less leadtime (about has a 5 ns signal delay.. Less leadtime (about 70 ns) is required when the sampling head is installed in the Type 3S2 and the trigger cable signal delay is only 2 ns.

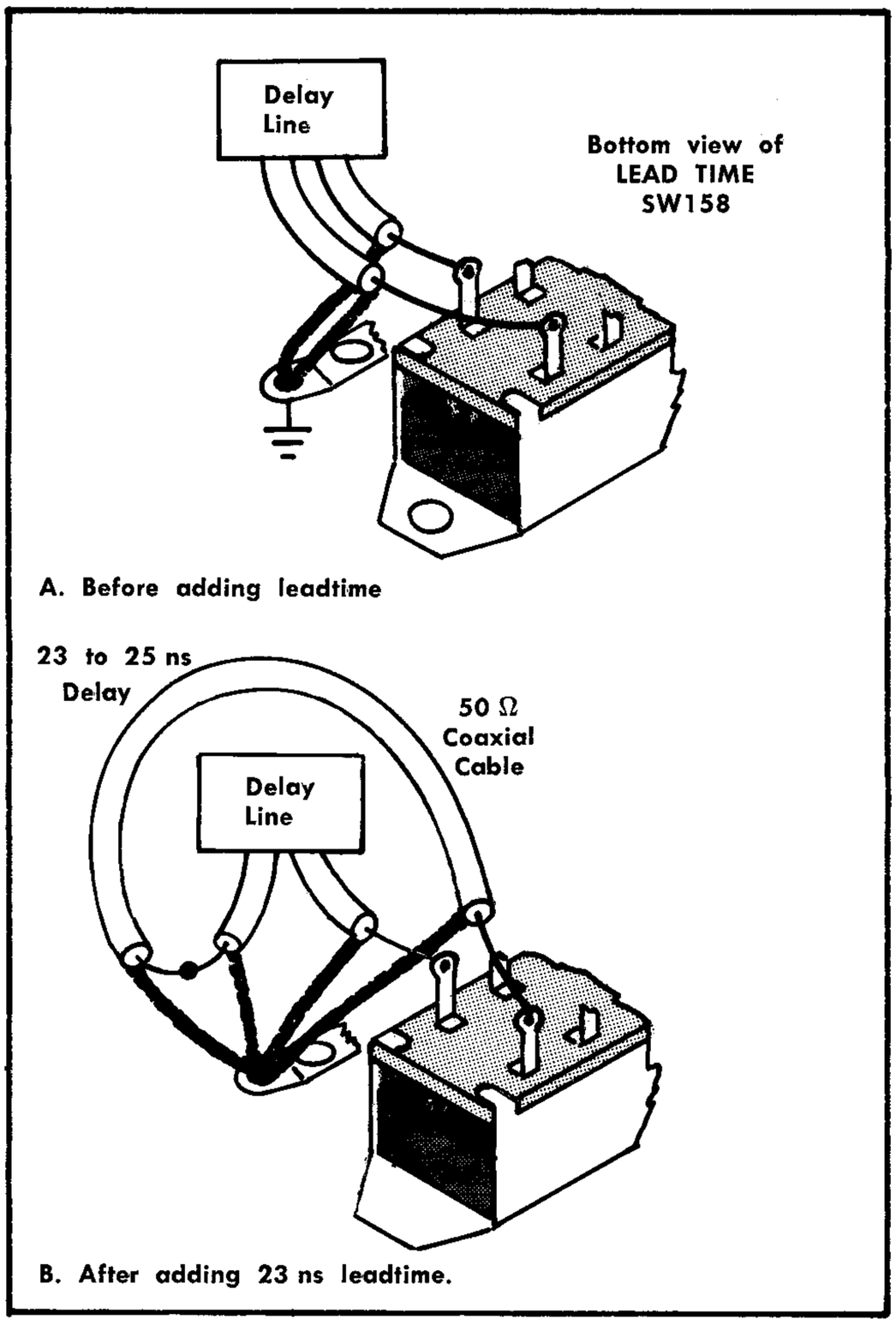


Fig. 5-5. Adding leadtime to a Tektronix Type 284 Pulse Generator.

Fig. 5-5 shows a substitute method of obtaining 73 ns trigger leadtime in an early model Type 284. If you install the recommended 23 ns signal delay cable shown in Fig. 5-5, operate the Type 284 with the case removed and adjust it as described **in the following portions of this step. Most Type 284 Puse Generators include 75 ns trigger signal lead time.**

Digital Readout of Risetime

Set the controls as follows:

Type 284

Mode	Pulse Output
Leadtime	75 ns
Other controls	Optional

Type 3S2

Normal-Smooth	Normal
Units/div	50
Variable	CAL
Mode	Channel A
Trig Out	Optional

Dot Response	Midrange
Other Controls	Optional

Type 3T2

Time Position	Fully clockwise
Fine	Midrange for centered display
Range	100 ns } 200 ps/div
Time Magnifier	X50 }
Variable	Cal
Display Mag	X1
Start Point	With Trigger
Display Mode	Normal
Trigger Source	Ext
Trigger Polarity	+
Trigger Sensitivity	10 o'clock
Recovery Time	Optional
Internal Samples/Div	100

Indicator Oscilloscope

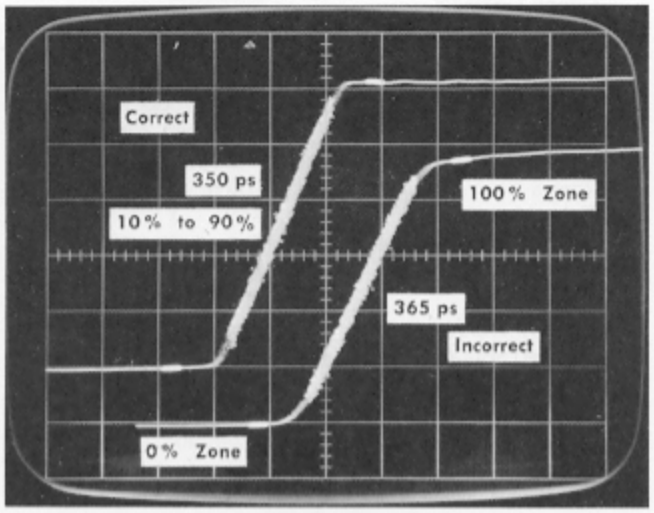
Intensity	Normal display
Scale Illum	As desired

Type 230

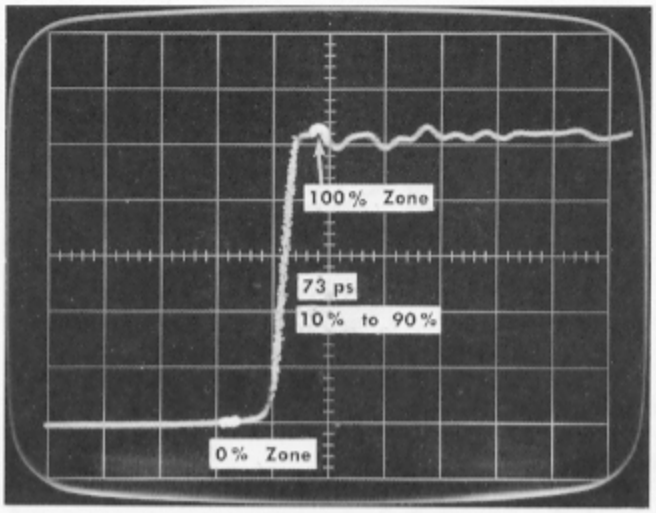
Measurement Averaging	8
CRT Intensification	Both Ref Zones and Time Measurement on
Measurement Mode	Time
CH A Reference Zones	Both at Average
Channel switches	Both at A
Time Measurement Start Point	10% Between Zones
Time Measurement Stop Point	90% Between Zones
Slope	Both at +1st
Display Time	Midrange
Triggered Measurement	Off
Limits	Optional

b. Use the Type 3T2 Fine Time Position control to position the pulse rise as in Fig. 5-6A or C.

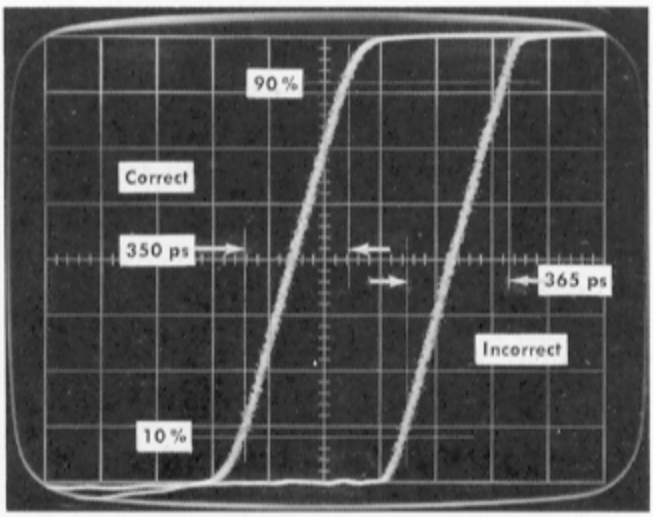
If a pulse display cannot be positioned into view, turn the Time Position to midrange (pulse display is off the CRT to the left) and adjust the Type 284 TD Bias control. Start by turning the TD Bias control fully counterclockwise. This assures that there is no pulse output and the indicator oscilloscope trace should be positioned two divisions up from the lower edge of the graticule. Slowly turn the Type 284 TD Bias control clockwise to a midrange position that causes the indicator oscilloscope trace to jump up about 5 divisions. (Repeat, so the control is at a position that just causes the trace to be up.) Set the Type 3T2 Time Position controls fully clockwise. If the indicator oscilloscope trace remains up 5 divisions without displaying a positive pulse, there is not sufficient leadtime in the triggering signal path. Shorten the 5 ns signal delay cable to the Type 3T2 Ext Trig 50 Ω input connector to 2 ns signal delay, and try again. Or operate in Channel B and use the B Delay control to gain more display leadtime. (An additional 2 ns trigger leadtime can be obtained by clockwise rotation of the Type 284 Snap Current control, R174, but at a cost of slowing the rate of rise of the fast Pulse Output signal. The recommended setting of R174 is about 30° from the counter-



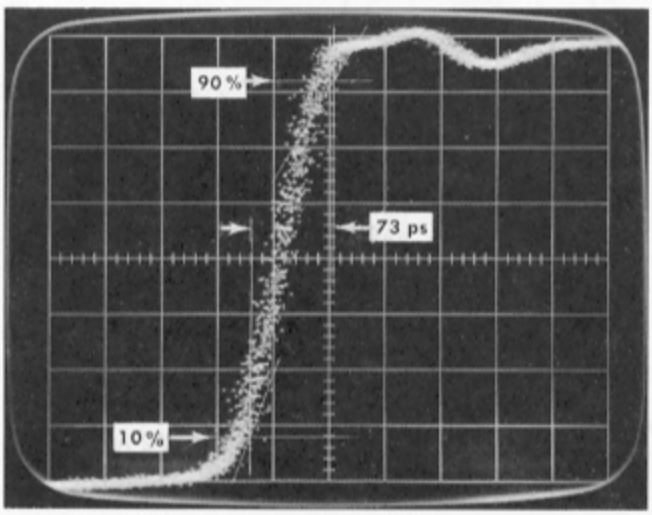
A. S-1. Digital risetime checks.



C. S-2, Digital risetime check.



B. S-1, CRT-measured risetime checks.



D. S-2, CRT-measured risetime checks.

A and C taken using Type 568 and Type 230 Digital Unit.
B and D taken using a Type 561A.

A and C: Type 3T2 internal Samples/Div switch at 100.
B and D: Type 3T2 internal Samples/Div switch at Variable.

A, B and C: 200 ps/div, Type 3T2 in With Trigger mode.
D: 50 ps/div, Type 3T2 500 ps/div and X10 Display Mag in With Trigger mode.

Fig. 5-6. Sampling Head risetime check displays. Left is correct. Right is slow due to clockwise rotation of Avalanche Volts control.

clockwise stop, and at a position where the displayed pulse time jitter is the least. Adjusting R174 for least trigger jitter (near its counterclockwise end) usually speeds the fast Pulse Output so the pulse risetime is about 45 to 50 ps.)

c. Once a pulse display is obtained, position it and the digital 0% and 100% zones as shown in Fig. 5-6A or C. Read the risetime from the Digital Unit. With the Type 3T2 Time Magnifier at X50 for 200 ps sweep rate, 350 ps will be read as +0.350 ns, and 75 ps will be read as +0.075 ns.

If the Type S-1 risetime is 350 ps or less, proceed to Step 5.

If the Type S-2 risetime is 86 ps or less, proceed to Step 5.

If the risetime of the sampling head is too slow, perform Step 4.

CRT Measurement of Risetime

Set the Type 3T2 controls:

Internal Samples/Div	Variable
Front Panel Samples/Div	9 o'clock
Start Point	Before Trigger

Trig Sensitivity	Clockwise to free run until a trace appears (several seconds), then back to 10 o'clock area for least trigger jitter.
Time Position	Counterclockwise until step pulse appears.

The Type S-1 risetime can be measured at 200 ps/div sweep rate with the Type 3T2 Range and Time Magnifier controls as set in the digital readout setup.

The Type S-2 risetime can best be measured at 50 ps/div sweep rate. Set the Type 3T2 controls:

Range	100 ns
Time Magnifier	X20
Display Mag	X10

For either type head, use the Type 3S2 Units/Div Variable control to obtain an 8 division vertical display.

Most accurate risetime measurement from the CRT is made by taking a photograph. Scribe the photo in a manner similar to that done in Fig. 5-6B or D.

If the Type S-1 risetime is 350 ps or less, proceed to Step 5.

If the Type S-2 risetime is 86 ps or less, proceed to Step 5.

If the risetime of the sampling head is too slow, perform Step 4.

4. Adjust Risetime ◑

Adjusting the risetime of either type sampling head uses basically the same procedure. The displays are different due to the difference in risetime and noise limits.

a. Each internal control has its particular effect upon sampling head operation. The list below gives the general effect of each control.

Control	Function
Avalanche Volts, R66	Alters strobe pulse amplitude and risetime, which affects the display risetime and dot response. Clockwise rotation makes risetime slower.
Snap-Off Current, R57	Alters dot response and display noise. Must be adjusted any time Avalanche Volts is changed.
Gain, R46	Alters dot response (by changing the feedback loop gain).
Bridge Volts, R26	Sets sampling diodes reverse voltage. Decreasing the bridge volts (counterclockwise rotation) slows display risetime by permitting a longer diode conduction time due to fixed amplitude strobe pulses. Keeping the Bridge Volts near maximum (clockwise allows better sampling dot response linearity as well as a larger input signal dynamic range.
Bridge Bal, R22	Introduces an internal offset voltage to the feedback loop to cancel normal error signals in the sampling loop, including normal unbalance in the sampling bridge. R22 is adjusted (with DC Offset at zero) to cancel most of the trace vertical shift as the Units/Div switch position is changed.
Transient Response, R13	Adjusts the magnitude of blow-by correction signal. (Not important when setting risetime.)

NOTE

It is usually possible to achieve a risetime value less than that quoted in Section 1 for both the Type S-1 and the Type S-2. The faster risetime is possible while also meeting the other specifications of noise and pulse flatness deviation. A single CRT measurement of risetime is usually adequate to check for proper sampling operation. An exact figure of the system (pulser, coaxial cable, and sampling head system) risetime can be more easily obtained by use of a digital readout unit. The digital readout figure can be accepted as the risetime of the Type S-1 itself if the Pulser used is as fast as the Type 284. However, the digital readout of a Type S-2 system risetime is that of the system and not just the S-2 alone. The procedure below is not specifically limited to use with either form of risetime measurement; therefore, if you use a digital system, set the digital unit controls as listed in Step 3. Risetime adjustment is given as the first recalibration step, because any time the Avalanche Volts control setting is changed, it is necessary to also adjust R57, R46 and R22 in that order.

b. Remove the sampling head cover. The head must be on an extender cable for access to all controls. Make the connections shown in Fig. 5-4. Set the controls as in Step 3. Preset the sampling head internal controls (see Fig. 5-7):

Type S-1

BRIDGE VOLTS	Fully Clockwise
GAIN	30° from clockwise end

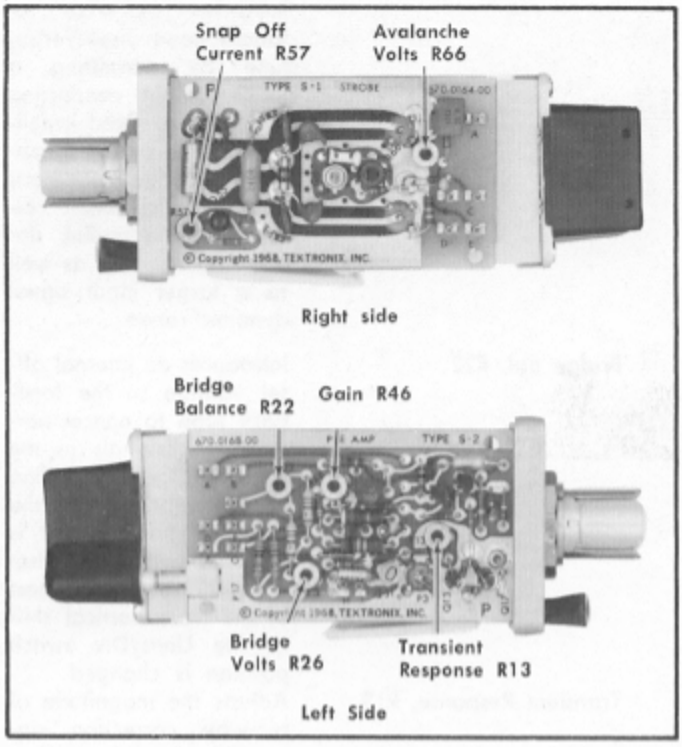


Fig. 5-7. Sampling head control locations.

Type S-2

BRIDGE VOLTS	Fully Clockwise
GAIN	Fully Clockwise

Leave the other head controls as previously adjusted.

Type S-1 Procedure

c. Operate the Type 3T2 with the Start Point switch at With Trigger. Obtain a display of the pulse rise.

Assuming that the risetime is slow, adjust the Avalanche Volts control about 5° counterclockwise. Fig. 5-8B shows a triple exposure of the effects of changing the setting of the AVALANCHE VOLTS control. Both the vertical and horizontal changes were caused by the AVALANCHE VOLTS control only; the vertical and horizontal Position controls were not touched.

Check the risetime, and do (d.) below. Then continue to adjust the AVALANCHE VOLTS control until the risetime is 350 ps or less, 10% to 90%. Repeat (d.) again.

d. Operate the Type 3T2 with the Start Point switch at Before Trigger. Obtain a display of the pulse rise.

Adjust the SNAP-OFF CURRENT control to minimize loop gain. This is done by first using the Type 3S2 Dot Response control to determine whether the display dot response is more than or less than unity. If it is less than unity, adjust the SNAP-OFF CURRENT control to reduce the trace vertical spread. If the dot response is more than unity, adjust the SNAP-OFF CURRENT control to increase the trace vertical spread. (See Fig. 5-8A.)

NOTE

The Type S-1 will in some cases have less display noise when adjusted for a risetime faster than 350 ps. The practical adjustment limit lies with the range of both the SNAP-OFF CURRENT and the GAIN controls. If the AVALANCHE VOLTS control is adjusted for too fast a risetime, one or both of the other controls will reach the end of its adjustment range and prevent proper calibration.

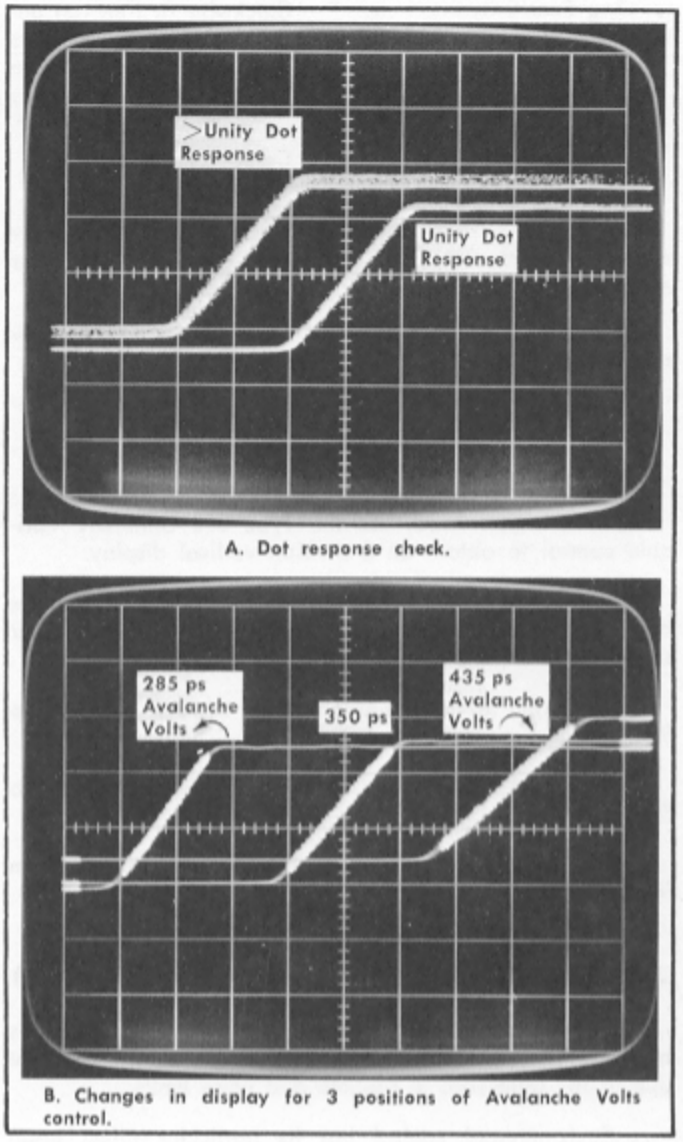


Fig. 5-8. Type S-1 displays for step 4. Sweep rate: 200 ps/div.

As the SNAP-OFF CURRENT control is turned, the display will move. The display shift is in the form of a rising or a dipping arc. The vertical component of the display movement is a result of a change in SNAP-OFF CURRENT, rather than any signal input change. The peak of the arc in either the positive or the negative direction occurs very near the point at which maximum loop gain occurs. Set the SNAP-OFF CURRENT control to the point where the display is at the peak of the arc, rather than precisely at maximum loop gain. This produces minimum display noise with proper risetime.

e. Set the Type 3S2 Dot Response control to its electrical midpoint. The electrical midpoint is found by watching the changes in trace spread through the total range of ad-

justment of the control. Set the dot response for a trace spread half-way between maximum loop gain and minimum loop gain.

Now adjust the Type S-1 GAIN control for unity dot response as indicated at the right of Fig. 5-8A.

Type S-2 Procedure

f. Operate the Type 3T2 with the Start Point switch at With Trigger. Obtain a display of the pulse rise.

Adjustment of the Type S-2 AVALANCHE VOLTS and SNAP-OFF CURRENT controls is made with the GAIN control at maximum and the Type 3S2 Dot Response control set to its electrical midpoint (see e. above).

NOTE

Before touching the AVALANCHE VOLTS control, check that the Type 284 Pulse Generator control (R174) is adjusted near the counterclockwise end of rotation. R174 is correctly adjusted when the displayed pulse horizontal time jitter is at a minimum. Minimum displayed time jitter is also obtained by careful adjustment of the Type 3T2 Trig Sensitivity control. After setting both the Pulse Generator Snap Current and the Type 3T2 Trig Sensitivity control, adjust the Type 284 TD Bias control for additional reduction in time jitter.

g. Adjust the Type S-2 AVALANCHE VOLTS control and then the SNAP-OFF CURRENT control for unity dot response. (See Fig. 5-9.) The procedure is to set the dot response to unity (at the pulse top) with the AVALANCHE VOLTS control, and then to adjust the (head) SNAP-OFF CURRENT control to maximize loop gain. If this causes the dot response to be greater than unity, reduce it with the AVALANCHE VOLTS control and again maximize loop gain with the SNAP-OFF CURRENT control.

If the Avalanche Transistor, the Snap-Off diode, and the two Sampling Bridge diodes are good, the system risetime will be on the order of 73 to 75 ps 10% to 90%.

As the Type S-2 SNAP-OFF CURRENT control is turned, a continuous vertical shift of the display occurs with a slight slowing of the rate near maximum loop gain. The final setting of the SNAP-OFF CURRENT control is at the slowed rate of vertical shift, almost coincident with maximum loop gain.

h. Check the risetime (as shown in Fig. 5-6C or D). It must be $\leq$ 86 ps 10% to 90%, and will probably be closer to 75 ps. (The 86 ps limit is calculated for the conditions of a 70 ps risetime Type 284 pulse, and a 50 ps risetime Type S-2.)

NOTE

If in the previous risetime adjusting step the sampling sweep unit is not a Type 3T2, random sampling is not available to show dot response. In this case, each time the dot response is to be checked, the signal and sweep rate and triggering must each be changed. The proper procedure for checking dot response using a Type 3T4 or Type 3T77A sampling sweep unit follows:

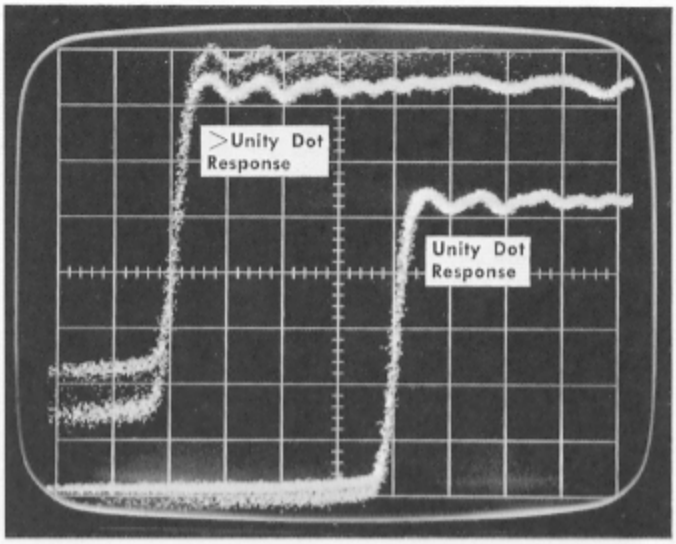


Fig. 5-9. Double exposure of Type S-2 Dot Response. (Type 3T2 operating at Before Trigger.)

1. Set the Type 284 Period switch to 1 μs, the Mode switch for a square wave output and the Square Wave Amplitude control for 1.0 V output. Install the variable attenuator between the Type 284 and the sampling head input.

2. Set the sweep rate to 0.2 μs/Div. Remove the trigger cable from the Ext Trigger input connector and set the Trigger Sensitivity control clockwise for a free run trace. It may then be necessary to adjust the Recovery Time control for a proper display.

3. A proper Type S-1 dot response display is shown in Fig. 5-10C and D. Note that the amplitude is the same as the square wave signal of Fig. 5-10A when the Type S-1 dot response linearity is checked in the next step.

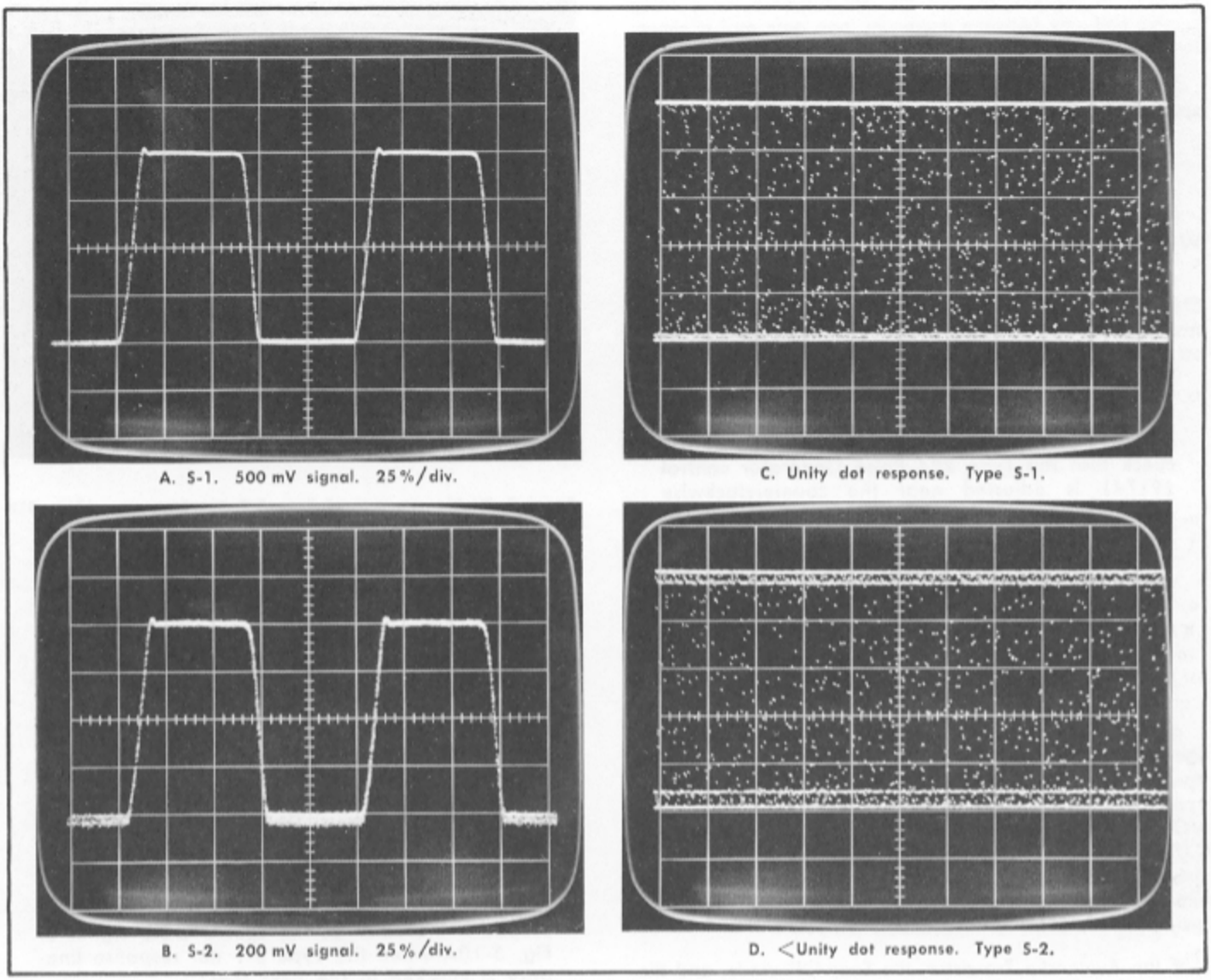
4. A proper Type S-2 display is four divisions, instead of the five shown. The photographs of Fig. 5-10C and D are time exposures of four sweeps, making the photos look similar to the CRT display as viewed by the calibrating technician.

5. Thus, the preceding risetime adjustment step requires that the sampling head signal source be changed from the Type 284 fast Pulse Output to the Square Wave Output for checking dot response, when the sampling sweep unit is not a Type 3T2.

5. Check Dot Response Linearity

Requirement—Type S-1. Dot will move full amplitude $\pm$5%, of any signal up to 500 mV peak to peak when sampling sweep unit is either double triggered or free run.

Type S-2: Dot will move full amplitude $\pm$5%, of any signal up to 200 mV peak to peak when sampling sweep unit is either double triggered or free run.



A. S-1. 500 mV signal. 25%/div.

C. Unity dot response. Type S-1.

B. S-2. 200 mV signal. 25%/div.

D. <Unity dot response. Type S-2.

Fig. 5-10. A and B obtained with Type 3T2 in random mode. C and D with Type 3T4 or Type 3T77A at 0.2 μs/div, free run. No external trigger signal applied.

The connections between the Type 284 and the sampling head are changed in this step. The head can be either on the extender cable with or without the case installed, or it can be in the Type 3S2 with the case in place.

Connections between the Type 284 Square Wave Output connector and the sampling head input connector includes attenuation. The attenuation can be attained either by fixed 50 Ω GR-874 type attenuators, or the special variable attenuator, item 11 of the equipment required list.

Attenuation is 2× for the Type S-1, and 5× for the Type S-2, when the Square Wave Amplitude is 1.0 volt.

a. Install the correct attenuator to the Type 284 Square Wave Output connector. Connect the output side of the attenuator to the sampling head input connector.

b. Set the Type 284 Period switch to 100 ns (set it to 1 μs when the sampling sweep unit is other than a Type 3T2). Set the Type 3T2 Range switch to 10 μs, the Time Magnifier to ×50 and the Start Point Switch to With Trigger.

c. Set the Type 3S2 Units/Div switch to 100 when checking a Type S-1, and to 50 when checking a Type S-2. Obtain a triggered square wave display.

Type S-1: Set the With Trigger display amplitude to exactly 5 divisions (500 mV input). Then adjust the Type 3S2 units/div Variable control counter clockwise until the display is 4 divisions peak to peak. This sets the display at 25% per major graticule division.

Type S-2: Set the With Trigger display amplitude to exactly 4 divisions (200 mV input), or 25% per major graticule division.

d. Set the Type 3T2 Start Point switch to Before Trigger (or free run the time base unit at 0.5 μs/div if not a Type 3T2). Obtain a triggered display.

Set the Type 3S2 Dot Response so the top of the square wave is at unity loop gain (one trace). The bottom of the square wave can show two traces, but the dot response overshoot or undershoot must not be greater than 5%, or

1 minor graticule division. (5% of Fig. 5-10C or D is 1.25 minor graticule divisions.)

If the dot response overshoots or undershoots more than 5%, the problem is either unbalanced sampling bridge diodes, or unbalanced strobe pulses to the bridge. If no components on either the strobe generator board or the sampler board are broken (or unsoldered), change the sampling diodes after reading the Note in Step 2d. Damage to leadless capacitors is about the only way the strobe pulse amplitudes can be unbalanced, and this is unlikely with normal care of the instrument.)

6. Preliminary Bridge Bal Adjust ◐

a. Place the 20 cm air line on the sampling head input connector. Leave the other end of the line open.

Free run the sampling sweep unit to obtain a no-signal trace.

b. Set the Type 3S2 DC Offset control for zero volts at the front panel Offset jack. Use either the test oscilloscope or a bench multimeter to determine zero volts.

c. As the Type 3S2 Units/Div switch is operated through its ranges, adjust the sampling head BRIDGE BAL control (R22) for no more than one division of vertical shift in the trace. (This control adjustment varies with the case on or off the sampling head, and varies with changes in extender cable.)

7. Adjust Transient Response Control, R13 ◐

a. Connect the Type 284 Square Wave Output connector to the sampling head input. Use proper attenuation (or the variable attenuator) for 0.5 volt to the Type S-1, or 0.2 volt to the Type S-2.

Set the Type 284 Period switch to 1 μs. Set the sweep rate to 1 μs/div and obtain a triggered display.

b. The display should be one cycle per division with the square wave top and bottom flat (parallel to a graticule line). Fig. 5-11 is a double exposure showing a correct adjustment of the TRANSIENT RESPONSE control, and an incorrect adjustment. The tilt of the square wave can be either rising or falling when R13 is not correctly adjusted.

c. Adjust R13 so the square wave display is flat.

8. Check Pulse Flatness Deviation

Requirement—Type S-1: Pulse will not deviate from flat more than +½% to −3% for first 5 ns after pulse reaches 50% amplitude, nor will it deviate more han +½% to −½% (total of 1%) thereafter.

Type S-2: Pulse will not deviate from flat more than +5% to −5% for first 2.5 ns after pulse reaches 50% amplitude, nor will it deviate more han +2% to −2% (total of 4%) thereafter.

a. Connect the 20 cm air line to the Type 284 Pulse Output connector and the Sampling Head to the other end of the air line.

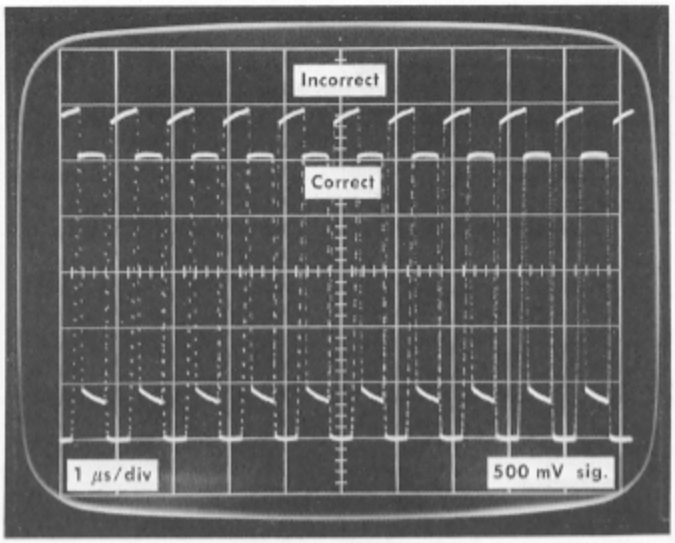


Fig. 5-11. Double exposure while adjusting R13, Transient Response control.

Type S-1

Set the sweep rate to 2 ns/Div, and the vertical for a 5 div display at 100 mV/Div (use the Variable if needed). Then change the mV/Div control (without moving the Variable) to 5 mV/Div or 1% per division. Bring the pulse top into view with the DC Offset control. See Fig. 5-12A.

Type S-2

Set the sweep rate to 1 ns/div, and the vertical for a 5 div display at 100 mV/Div (use the Variable if needed). Then change the mV/Div control (without moving the Variable) to 10 mV/Div, or 2% per division. Bring the pulse top into view with the DC Offset control. See Fig. 5-13A.

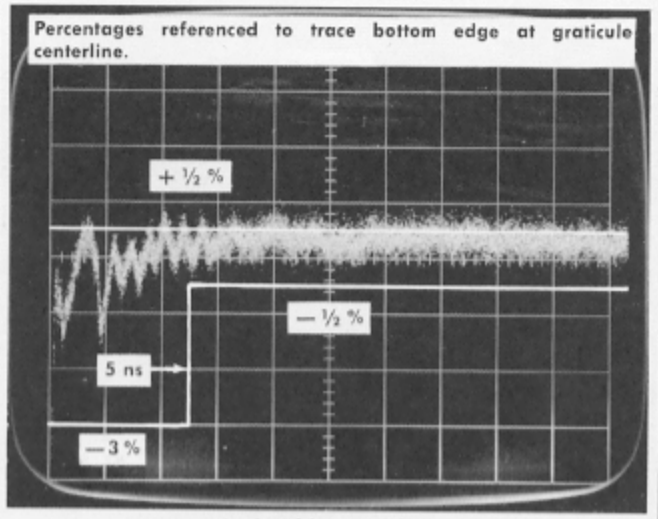
b. Time-position the display so the pulse rise is about a trace width inside the graticule edge. Check along the trace bottom for deviations as listed in the requirements, and as shown in Fig. 5-12 and Fig. 5-13.

Change the sweep rate as listed under the three parts of Fig. 5-12 and Fig. 5-13, and check for deviations as shown.

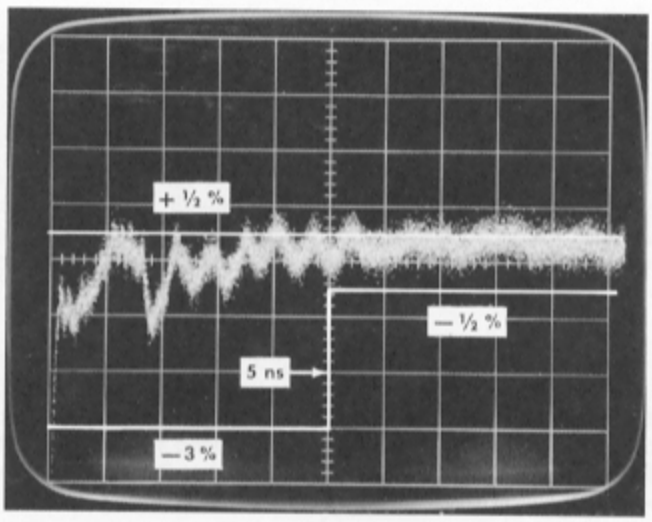
NOTE

The major dip 1.7 ns after the pulse rise is due to the Type 284 Pulse Generator reverse termination. Some other minor aberrations are also due to the Type 284. The requirement limits include deviations that are part of the Type 284. Therefore, the limits apply only when testing with the Type 284, and with a 20 cm air line between the pulser and the sampling head.

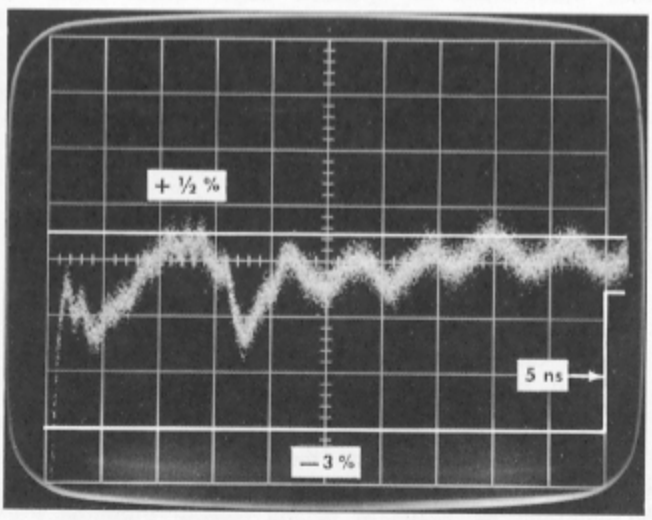
c. If either unit exceeds the pulse flatness deviation limits above, check the mechanical fit of the input connector. An improper (or loose) fit of the coaxial transition from round to flat at the Sampler Board input causes excessive aberrations when viewing a fast pulse. Also, check the solder connections between the round center conducter and the Sampler Board. See the Maintenance section of this manual.



A. 2 ns/div. 1 % /div.

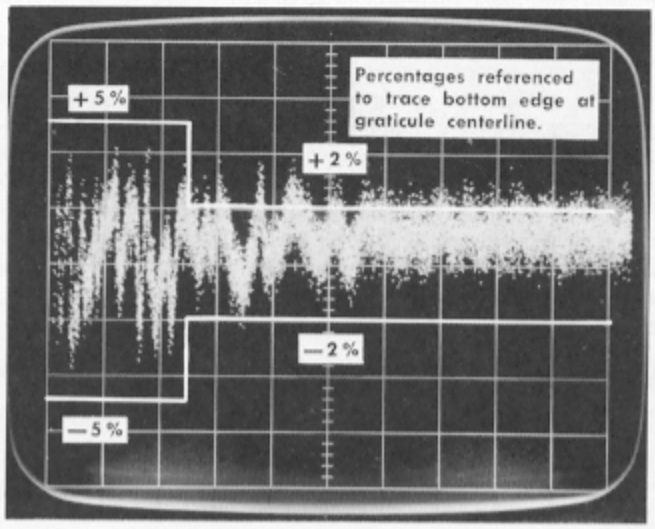


B. 1 ns/div. 1 % /div.

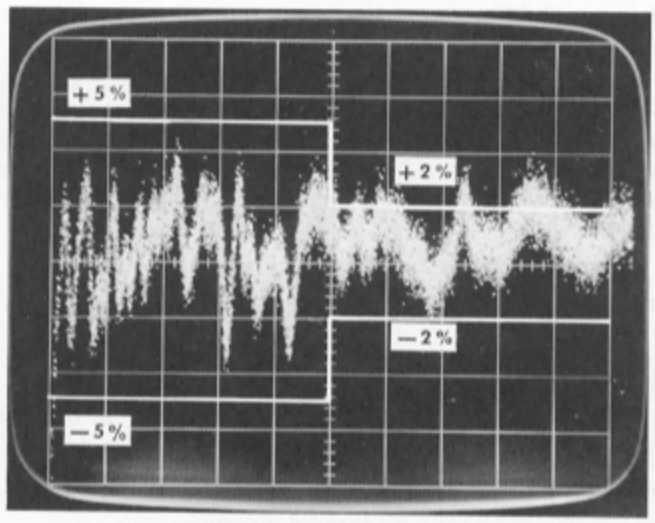


C. 500 ps/div. 1 % /div.

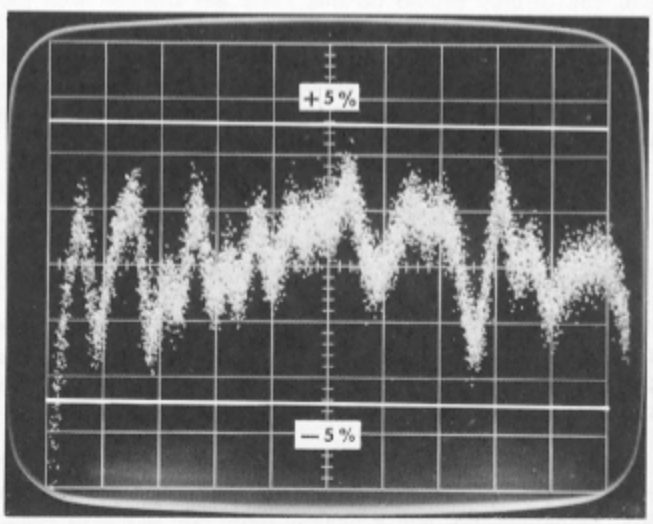
Fig. 5-12. Check of Type S-1 pulse flatness deviation. Step 8.



A. 1 ns/div. 5 mV/div = 2 % /div.



B. 500 ps/div. 5 mV/div = 2 % /div.



C. 200 ps/div. 5 mV/div = 2 % /div.

Fig. 5-13. Check of Type S-2 pulse flatness deviation. Step 8.

9. Check Trace Shift With Trigger Rate Change From 30 Hz to 50 kHz

Requirement—A no-signal trace will not shift vertically more than 10 mV when the sampling sweep unit external trigger rate is changed from 30 Hz to 50 kHz.

a. Use the test oscilloscope as a trigger rate generator. Use the front panel + Gate signal (+20 volts peak) to drive the sampling sweep unit external trigger input. Feed the + Gate directly to the Type 3T2 1 MΩ/UHF Sync connector and trigger on the — Polarity of the signal. (If the time base unit is a Type 3T4 or 3T77A, place a 10 kΩ, ½ watt resistor between the test oscilloscope + Gate terminal and the time base external 50 Ω trigger input connector to provide 100 mV of triggering signal.)

Set the test oscilloscope A sweep controls for a free run sweep. To obtain a 30 Hz trigger signal, set the Time/Div switch to 0.5 ms and the Variable time/div control to a position about 45° left of the top center. To obtain a 50 kHz trigger signal, set the Time/Div switch to 20 μs and the Variable time/div to a position 45° clockwise from bottom center.

b. Place either the 20 cm air line or a 50 Ω termination on the sampling head input connector. Set the sampling sweep unit for an external triggered sweep rate of 50 ns/Div (to assure the shortest trigger circuit holdoff period, and that the triggering rate can actually follow the external triggering signal repetition rate).

c. Set the Type 3S2 Units/Div control to 10. Connect the external trigger rate generator signal to the sampling sweep unit and obtain a triggered sweep at either 30 Hz or 50 kHz repetition rate. Set the Type 3S2 DC Offset control to place the trace at one of the graticule lines.

d. Switch the trigger rate generator through its ranges to the other frequency limit and check that the CRT trace does not move up or down farther than a total of one division.

e. If the trace moves too far, change either the head avalanche transistor (Q69) or the sampling bridge diodes. Changing either of these parts require starting this procedure again at Step 1.

10. Final Bridge Bal Adjust ❶

a. Place the sampling head case on the head, securing the four mounting bolts at the rear.

Fig. 5-14 shows the correct orientation of the sampling head case when reinstalling it. Note that the Preamplifier and Strobe Generator boards slide between part of the case and the zig-zag spring that runs from the front to the back. Correct case orientation places the one hole in the case over the Bridge Bal control. In sliding the case on, the white plastic locking latch must be fitted into part if the casting.

The rear casting cannot be mounted incorrectly because the trigger pickoff output coaxial connector fits through a hole in the casting. Place the rear casting in place before inserting the four long mounting bolts. Fit the rear casting and case in place by hand so there is no space between either end casting and the case before tightening the bolts.

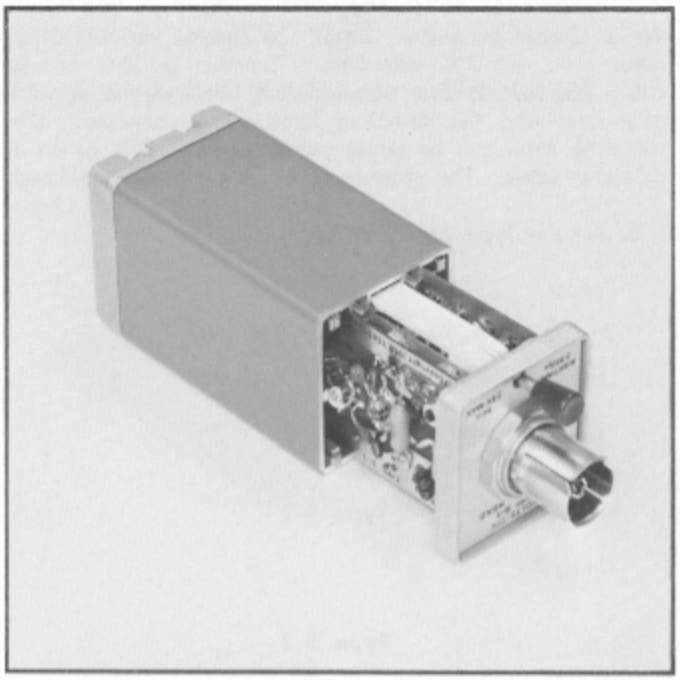


Fig. 5-14. Correct board and latch positions when reinstalling the Sampling Head case.

Place the 20 cm air line on the head input connector.

b. Place the head either inside the Type 3S2 Channel A compartment, or upon the extender cable with which it is normally used. If the head is not normally used on an extender cable, adjust the Bridge Bal control with the head inside the Type 3S2.

c. Free run the Type 3T2 with a 50 ns sweep rate (a 3T4 or 3T77A at .5 μs/div). Set the Channel A DC Offset control for zero volts at the front panel Offset connector. Center the trace with the Position control.

d. Operate the Type 3S2 Units/Div switch through its ranges and adjust the BRIDGE BAL control (through the hole in the left side of the case) for not more than one division of vertical shift.

11. Check Tangential Display Noise

NOTE

When making a visual noise reading from a sampling display, the eye interprets a noise value which is neither the RMS nor the peak to peak value. Since most observers agree that the displayed noise value is approximately 3 times the RMS value, the Tangential Noise here defined is 3 times the RMS value. (The mensurement technique given produces acceptable agreement between various operators as to the instrument's noise value.)

Requirement—Type S-1: Tangential noise will be not greater than 2 mV, with the case on the sampling head.

Type S-2: Tangential noise will be not greater than 10 mV, with the case on the sampling head.

a. Install a 5× 50 Ω attenuator on the Type 284 Square Wave Output connector. Install the special variable attenuator onto the 5× attenuator. Connect a 50 Ω coaxial cable (RG-58/CU, 5 ns signal delay) between the variable attenuator and the sampling head input connector. (The sampling head can be either inside the Type 3S2, or on an extender cable. The case must be in place on the head.)

b. Set the Type 284 controls:

Period	1 μs
Square Wave Amplitude	100 mV
Lead Time	Optional

c. Set the Type 3S2 controls:

Type S-1

Units/Div	5

Type S-2

Units/Div	20

d. Set the sampling sweep unit controls:

Trig Sensitivity	Clockwise - free run
Sweep rate	1 μs/div

Remove any external trigger cable from the sampling sweep unit external trigger input connector.

e. Refer to Fig. 5-15 during the following noise measurement procedure.

(1) Obtain a display (1) of two traces. Adjust the variable attenuator until the two traces blend together just to the point (2) at which they appear as one trace.

(2) **Type S-1**

Set the Type 284 Square Wave Amplitude control to 1.0 V (×10 signal amplitude). The display (3) now has a tangential deflection factor of 0.75 mV/div. ($E_{tangential}$ per division is equal to the Type 3S2 units/div setting of 5 mV divided by 2, times 3 divided by 10 = 0.75 mV/div.). Therefore, the 2 mV tangential noise limit includes 2.66 graticule divisions (3) of Fig. 5-15A. Check that the bottom edges of the two traces are not more than 2.66 divisions apart. Waveform (3) of Fig. 5-15A measure as 1.1 mV tangential noise.

Type S-2

Set the Type 284 Square Wave Amplitude control to 1.0 V (×10 signal amplitude). The display (3) now has a tangential deflection factor of 3 mV/div. ($E_{tangential}$ per division is equal to the Type 3S2 units/div setting of 20 mV divided by 2, times 3 divided by 10 = 3 mV/div.) Therefore, the 10 mV tangential noise limit includes 3.33 graticule divisions (3) of Fig. 5-15B. Check that the two traces bottom edges are not more than 3.33 divisions apart. Waveform (3) of Fig. 5-15B measures at about 8.8 mV tangential noise.

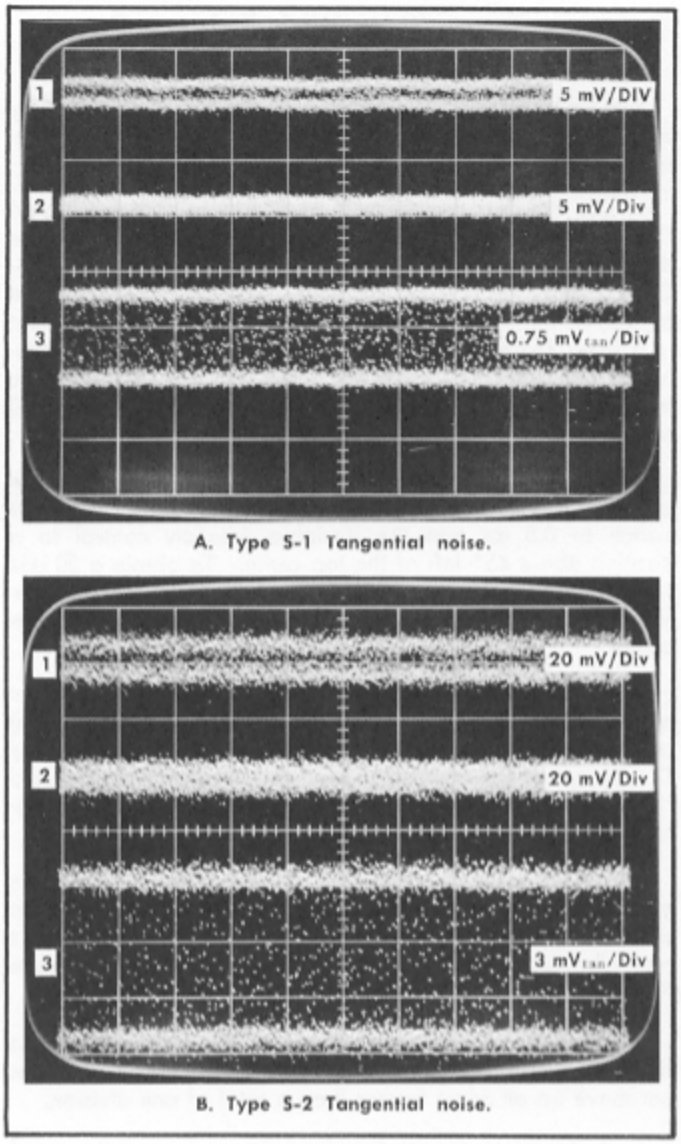


Fig. 5-15. Triple exposures of Tangential noise measurements, Step 11.

Determining Tangential Noise Deflection Factor

The noise displays (3 of Fig. 5-15A and B) have a noise deflection factor based upon the signal amplitude, the Type 3S2 Units/Div switch setting, the fact that the final trace separation is twice the RMS noise, and that the tangential noise is then 3 times the RMS noise. The square wave signal amplitude that makes two traces appear as one sets the trace separation to twice the RMS noise. The procedure used here then permits a noise deflection factor to be determined by dividing the input mV/div deflection factor by 2 (trace separation is 2× the RMS noise), multiplying by 3 (tangential noise is 3× the RMS noise) and then dividing by 10 (the signal amplitude change complement).

f. If the tangential noise is outside the required limits, return to Step 4. In a Type S-1 choose an Avalanche Volts setting that produces minimum noise right after the pulse rise (in With Trigger sweep mode). If it is impossible to obtain a sufficiently low noise figure, replace Q69 and repeat the rest of the procedure again.

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
°	degrees
°C	degrees Celsius (degrees centigrade)
°F	degrees Fahrenheit
°K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geqslant$	equal to or greater than
$\leqslant$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigahertz
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz
L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
+	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
Q	figure of merit
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference (see EMI)
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
$\ll$	small compared with
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub.	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xmfr	transformer

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Capacitors		
Tolerance ±20% unless otherwise indicated.						
C5	283-0133-00			5 pF	Cer	50 V 5%
C6	283-0133-00			5 pF	Cer	50 V 5%
C7	283-0093-00			15 pF	Cer	50 V
C8	283-0093-00			15 pF	Cer	50 V
C14	283-0136-00			10 pF	Cer	50 V 5%
C19	283-0121-00			0.001 μF	Cer	200 V
C28	290-0188-00			0.1 μF	Elect.	35 V 10%
C34	283-0067-00			0.001 μF	Cer	200 V 10%
C40	283-0067-00			0.001 μF	Cer	200 V 10%
C43	290-0246-00			3.3 μF	Elect.	15 V 10%
C44	283-0003-00			0.01 μF	Cer	150 V
C45	283-0066-00			2.5 pF	Cer	200 V
C46	283-0000-00			0.001 μF	Cer	500 V
C49	283-0003-00			0.01 μF	Cer	150 V
C51	283-0121-00			0.001 μF	Cer	200 V
C53	283-0121-00			0.001 μF	Cer	200 V
C55	290-0134-00			22 μF	Elect.	15 V
C59	283-0072-01			0.01 μF	Cer	
C63	283-0103-00			180 pF	Cer	500 V 5%
C64	283-0103-00			180 pF	Cer	500 V 5%
C65	283-0005-00			0.01 μF	Cer	250 V
C69	281-0612-00			5.6 pF	Cer	200 V ±0.5 pF
C71	283-0121-00			0.001 μF	Cer	200 V
				Semiconductor Device, Diodes		
D5, D6	*152-0360-00			GaAs, matched pair		
D41	*152-0185-01			Silicon		Replaceable by 1N4152
D61	*152-0335-00			Silicon		Snap-Off
				Inductors		
L12	276-0543-00			Core, Ferrite		
L17	276-0543-00			Core, Ferrite		
L49	*108-0440-00			Toroid, 4 turns		
L55	*120-0382-00			Toroid, 14 turns		
L60	*108-0170-00			0.5 μH		
L62	*108-0170-00			0.5 μH		

Connectors

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
P17	*175-0481-00			Cable Assembly, 3⅝ inches

Transistors

Q13	*151-0212-00		Silicon	Tek Spec
Q17	*151-0212-00		Silicon	Tek Spec
Q31	151-1012-00		Silicon	FET
Q41	151-0224-00		Silicon	2N3692
Q45	151-0224-00		Silicon	2N3692
Q55	151-0224-00		Silicon	2N3692
Q69	*153-0556-00		Silicon	Tek Spec

Resistors

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

R3	317-0391-00	390 Ω	⅛ W		5%
R4	307-0098-00	56.4 Ω			½%
R5	317-0201-00	200 Ω	⅛ W		5%
R6	317-0201-00	200 Ω	⅛ W		5%
R7A	317-0151-00	150 Ω	⅛ W		5%
R7B	317-0101-00	100 Ω	⅛ W		5%
R8A	317-0151-00	150 Ω	⅛ W		5%
R8B	317-0101-00	100 Ω	⅛ W		5%
R10	317-0510-00	51 Ω	⅛ W		5%
R12	315-0152-00	1.5 kΩ	¼ W		5%
R13	311-0643-00	50 Ω, Var			
R14	317-0271-00	270 Ω	⅛ W		5%
R15	317-0102-00	1 kΩ	⅛ W		5%
R17	317-0102-00	1 kΩ	⅛ W		5%
R18	317-0360-00	36 Ω	⅛ W		5%
R19	317-0511-00	510 Ω	⅛ W		5%
R20	321-0385-00	100 kΩ	⅛ W	Prec	1%
R21	321-0253-00	4.22 kΩ	⅛ W	Prec	1%
R22	311-0609-00	2 kΩ, Var			
R23	321-0253-00	4.22 kΩ	⅛ W	Prec	1%
R24	321-0385-00	100 kΩ	⅛ W	Prec	1%
R26	311-0613-00	100 kΩ, Var			
R28	317-0473-00	47 kΩ	⅛ W		5%
R29	317-0473-00	47 kΩ	⅛ W		5%
R31	301-0912-00	9.1 kΩ	½ W		5%
R33	307-0124-00	5 kΩ	Thermal		
R34	317-0202-00	2 kΩ	⅛ W		5%
R35	301-0103-00	10 kΩ	½ W		5%
R40	317-0224-00	220 kΩ	⅛ W		5%
R41	317-0223-00	22 kΩ	⅛ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
R42	317-0122-00			1.2 kΩ	1/8 W	5%
R44	317-0391-00			390 Ω	1/8 W	5%
R45	317-0303-00			30 kΩ	1/8 W	5%
R46	311-0633-00			5 kΩ, Var		
R47	315-0472-00			4.7 kΩ	1/4 W	5%
R56	317-0271-00			270 Ω	1/8 W	5%
R57	311-0607-00			10 kΩ, Var		
R59	308-0243-00			240 Ω	3 W WW	5%
R60	317-0390-00			39 Ω	1/8 W	5%
R62	317-0390-00			39 Ω	1/8 W	5%
R65	317-0101-00			100 Ω	1/8 W	5%
R66	311-0644-00			20 kΩ, Var		
R68	317-0332-00			3.3 kΩ	1/8 W	5%
R70	317-0332-00			3.3 kΩ	1/8 W	5%
R71	317-0202-00			2 kΩ	1/8 W	5%
R72	315-0203-00			20 kΩ	1/4 W	5%
R73	307-0124-00			5 kΩ	Thermal	

Transformers

T75	*120-0544-00	Toroid, 2 turns - 5 turns, bifilar

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

FIG. 1 EXPLODED

FIG. 2 STANDARD ACCESSORIES

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

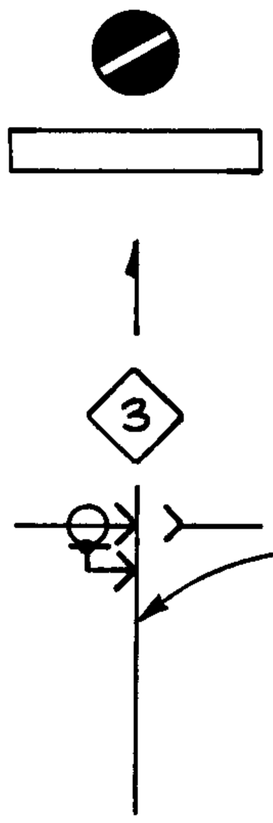
SECTION 7
MECHANICAL PARTS LIST

FIG. 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description
1-1	333-1040-00			1		PANEL, front
-2	386-1338-01			1		SUB-PANEL, front
-3	384-0687-00			1		SHAFT, extension, latch
-4	105-0066-00			1		STRIKE, latch
-5	131-0553-00			1		ADAPTER, contact to contact
-6	103-0076-00			1		ADAPTER, connector
	354-0322-00			1		RING, retaining (not shown)
	377-0196-00			1		INSERT, screw thread
-7	205-0091-00			1		SHELL, electrical connection
-8	132-0007-00			1		RING, snap
-9	103-0055-00			1		ADAPTER, contact to contact
-10	132-0028-00			1		INSULATOR, plastic
-11	132-0029-00			1		INNER CONDUCTOR
-12	132-0133-00			1		OUTER CONDUCTOR, sleeve
-13	220-0459-00			1		NUT, dodecagon, $\frac{7}{8}$-32 x 1 inch
-14	670-0165-00			1		ASSEMBLY, circuit board—GATE
	- - - - - -			-		assembly includes:
	388-0949-00			1		BOARD, circuit
-15	- - - - - -			1		CLIP, plastic, w/diode
-16	131-0582-00			3		CONNECTOR, stand-off, female
-17	131-0586-00			11		CONNECTOR, terminal, feed-thru
-18	- - - - - -			14		SPACER, sleeve
	- - - - - -			-		mounting hardware: (not included w/assembly)
-19	211-0014-00			7		SCREW, 4-40 x $\frac{1}{2}$ inch, PHS
-20	210-0586-00			7		NUT, keps, 4-40 x $\frac{1}{4}$ inch
-21	119-0145-00			2		PLATE, line section
-22	670-0164-00			1		ASSEMBLY, circuit board—STROBE
	- - - - - -			-		assembly includes:
	388-0948-00			1		BOARD, circuit
-23	131-0391-00			2		CONNECTOR, stand-off, male
-24	136-0252-00			6		SOCKET, pin connector
-25	136-0263-00			5		SOCKET, pin connector
-26	344-0061-00			2		CLIP, diode
-27	670-0163-00			1		ASSEMBLY, circuit board—PRE AMP
	- - - - - -			-		assembly includes:
	388-0947-00			1		BOARD, circuit
-28	131-0391-00			1		CONNECTOR, stand-off, male
-29	136-0252-00			10		SOCKET, pin connection
-30	136-0263-00			9		SOCKET, pin connection
	210-0707-00			1		EYELET, gold plated (not shown)
-31	380-0125-00			1		HOUSING, wrap-around
-32	386-1337-01			1		PANEL, rear
	- - - - - -			-		mounting hardware: (not included w/panel)
-33	211-0141-00			4		SCREW, 4-40 x 3$\frac{1}{4}$ inches, PHS

SECTION 8
DIAGRAMS

The following symbols are used on the diagrams:



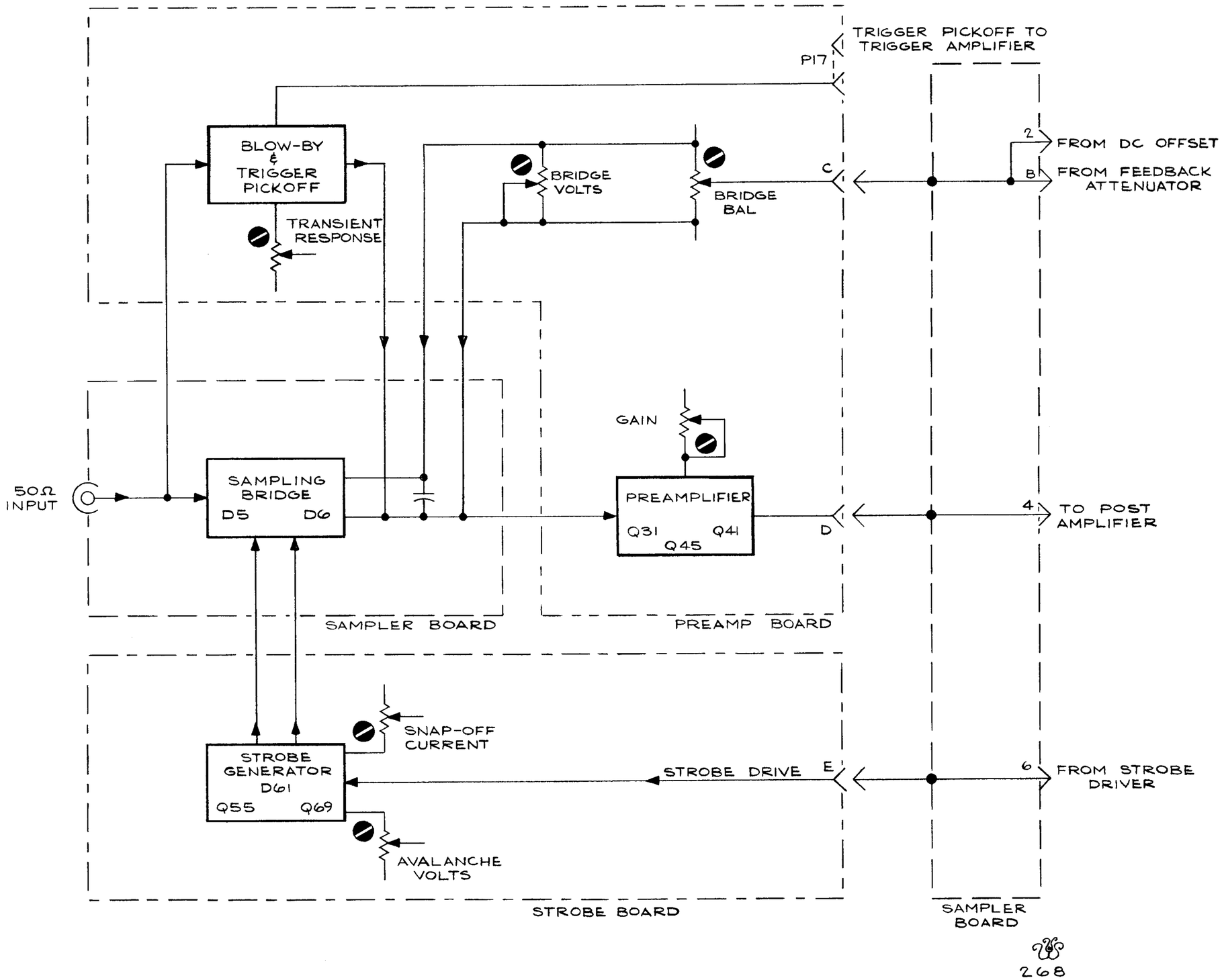
Screwdriver adjustment

Front panel control or connector

Clockwise control rotation in direction of arrow

Refer to indicated diagram

Blue line encloses components located on circuit board



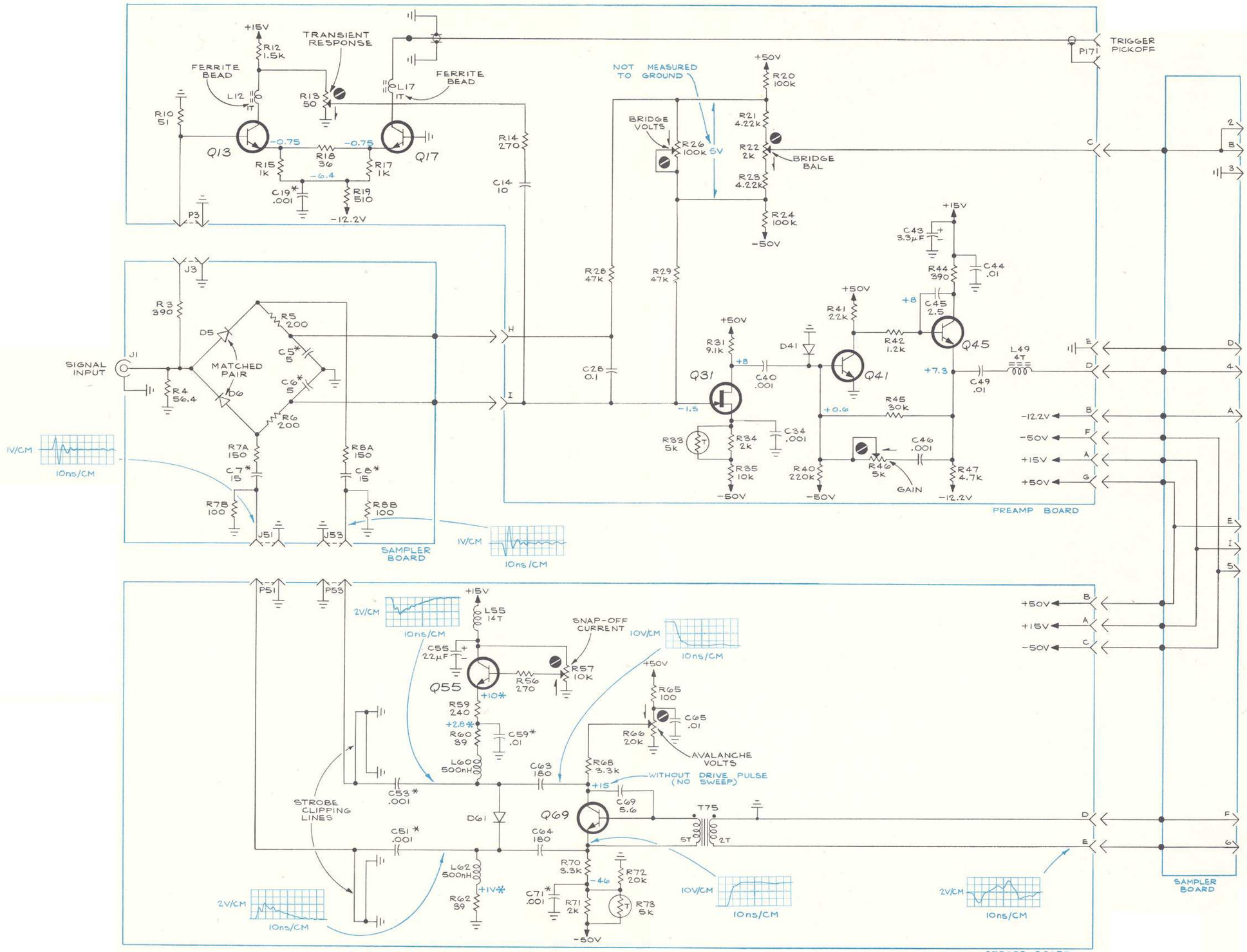
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TYPE S-1 SAMPLING HEAD A BLOCK DIAGRAM

VOLTAGE AND WAVEFORM TEST CONDITIONS

Typical voltage measurements and waveform photographs (shown in blue) were obtained under the following conditions unless noted on the individual diagrams:

Test Oscilloscope	
Bandwidth	DC to at least 50 MHz
Probe Input	10 Megohms, 7 picofarads
Probe Ground lead	Clipped to Type S-1 chassis
Triggering	External via 1 X probe to Sampling Unit CH A Memory Gate transformer primary Test Point.
DC Voltmeter	
Type	Volt-Ohmmeter 20,000 Ω/volt
Type S-1 conditions	Connected on a 3 foot extender cable. Case removed for access to circuits.
Vertical input signal	50 Ω Termination or Coaxial cable connected. No signal.
Sampling Unit	
Vertical Position	Centered
DC Offset	Midrange. Zero volts at Offset Out jack.
Sampling Sweep Unit	
	Type 3T2: use any convenient sweep rate and free run the sweep with Trigger Sensitivity control fully clockwise. Type 3T4 or Type 3T77A: Set Time/Div switch to .5 μs and free run the sweep with the Trigger Level control fully clockwise.



* DENOTES READINGS THAT VARY WITH D61 CHARACTERISTICS.

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

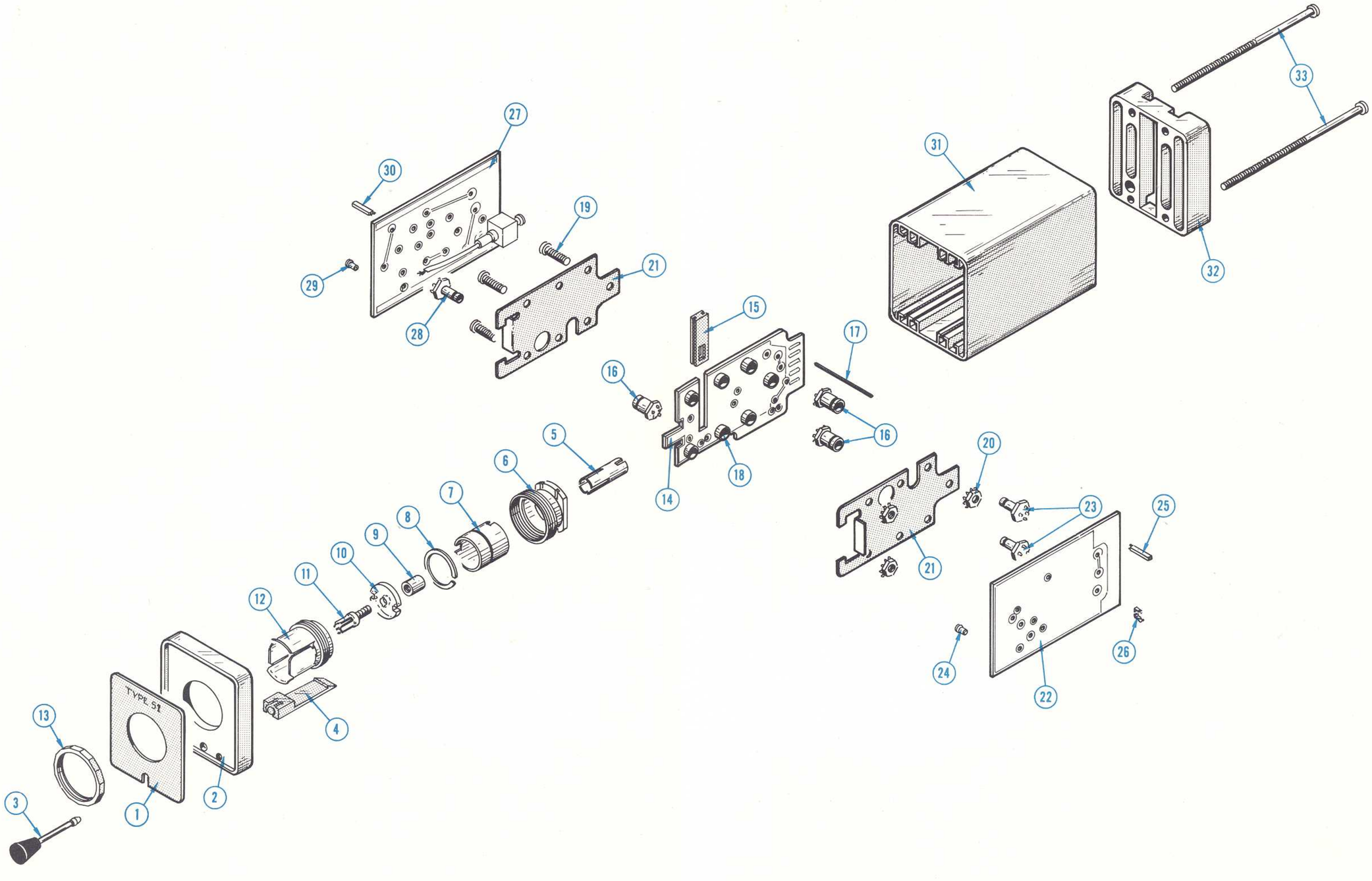
* DENOTES LEADLESS CAPACITORS

TYPE S-1 SAMPLING HEAD

A1

1168

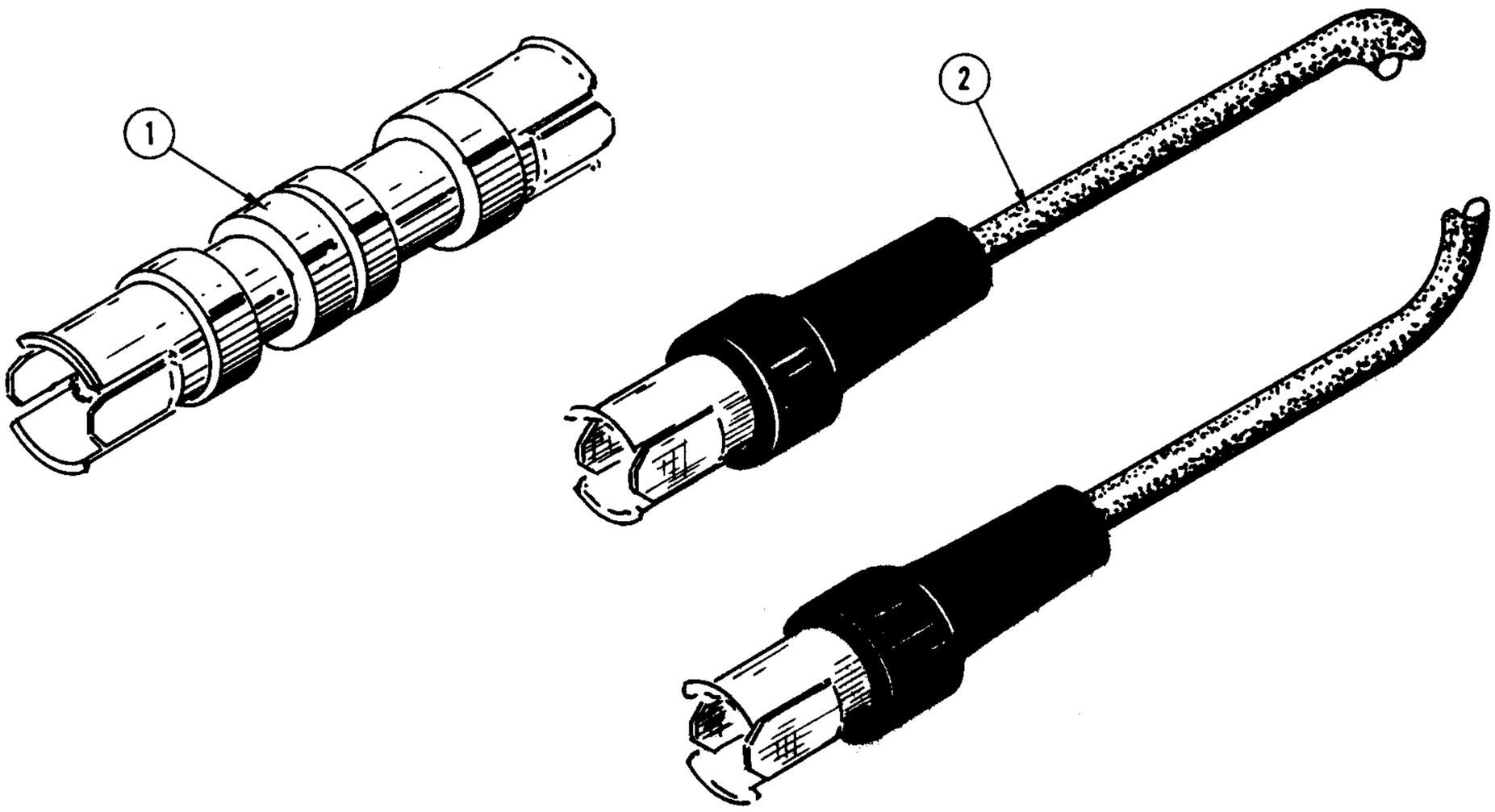
FIG. 1 EXPLODED



OPTIONAL ACCESSORIES (NOT SHOWN)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
	012-0124-00			1		CABLE, extender, 3 feet
	012-0125-00			1		CABLE, extender, 6 feet

FIG. 2 STANDARD ACCESSORIES



A

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
2-1	017-0078-00			1		ATTENUATOR, 10X 50 Ω
-2	017-0512-00			1		CABLE, 5 ns delay w/GR connectors
	070-0763-00			2		MANUAL, instruction (not shown)

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.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

INSTRUCTION MANUAL

Serial Number _____

TYPE S-2 SAMPLING HEAD

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0764-00

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our 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 or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

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	Parts Ordering Information
Section 6	Electrical Parts List
	Mechanical Parts List Information
Section 7	Mechanical Parts List
Section 8	Diagrams
	Mechanical Parts List Illustrations
	Accessories

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.



Fig. 1-1. Type S-2 Sampling Head.

SECTION 1
TYPE S-2 SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

The Type S-2 Sampling Head is a 50 Ω input, 50 ps rise-time, plug-in preamplifier for use in some Tektronix 3S-series sampling units, usch as the Type 3S2 Sampling Unit. Input characteristics of the sampling system are controlled by the type of sampling head in use.

The Type S-2 can be installed directly into the Type 3S2, or used remotely on an optional 3 foot or 6 foot extender cable. Vertical deflection factor of the sampling system is labeled at the top of the Type S-2 as mVOLTS/DIV; the label refers to the sampling unit Units/Div switch that is directly above the head.

A portion of the input signal is provided to the Type 3S2 Sampling Unit for externally triggering a Type 3T2 Random Sampling Sweep. The Type 3S2 allows selection of the trigger pickoff signal from the Channel A or Channel B sampling head. The selected trigger pickoff signal is returned to the Type 3S2 front panel at the Trig Out connector. The trigger pickoff signal is useful with any sampling sweep unit for repetitive signals where the triggering event does not have to be displayed. (Only the Type 3T2 random process sampling allows the triggering event to be displayed when using the sampling head trigger pickoff signal.

Digital Unit Program Connections

The Type S-2 contains connections at its rear that program both the decimal and the units lamps of a Type 230 Digital Unit. The S-1 digital control connections pass through the Units/Div switch of either the Type 3S5 or Type 3S6 Programmable Sampling Unit, and through the Type 568 Oscilloscope to the Type 230 Digital Unit.

ELECTRICAL CHARACTERISTICS

The following characteristics apply over an ambient temperature range of 0° C to +50° C. These characteristics apply only after the Type S-2 has been properly mated to the sampling unit and indicator oscilloscope, and after sufficient warmup time. For the particular system warmup requirements, refer to the related amplifier and indicator oscilloscope instruction manual. (A 5 minute warmup time is required for Type 3S2 — 3T2). A procedure for mating the Type S-2 to the vertical amplifier can be found in the Operating Instructions section of this manual.

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirement	Supplemental Information
Input Resistance	50 Ω within 1%	Measured at DC
Dot Response	Adjustable in the sampling unit to unity for signals up to 200 mV P-P; when the plus dot response is adjusted to unity, the minus dot response will be within 5% of unity and vice versa.	
Operating Input Voltage Range	+1 V to −1 V with ≤1 V P-P signals. Step signals greater than 200 mV require more than one dot to display 100% of the step transition.	
Maximum Input Voltage	±5 VDC or sine wave of 10 V P-P up to 10 MHz.	
Transient Response		
Risetime	50 ps or less, 10% to 90%.	
Pulse Flatness Deviation	≤ +5% and −5% in the first 2.5 ns after the step pulse reaches 50%.	Applies when the step pulse is Tektronix Type 284 Pulse Output signal through a 20 cm airline.
	≤ + and −2% after the first 2.5 ns.	
Displayed Noise	10 mV or less, tangential noise.	
Trace Baseline Vertical Shift with Trigger Repetition Rate Change.	10 mV or less for trigger rate change from 30 Hz to 50 kHz.	

NOTES

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

This section provides the basic information required for operation of the Type S-2 Sampling Head, including installation and First Time Operation.

The Type S-2 completes the circuitry of some Tektronix sampling units, and controls the input characteristics of the vertical channel by providing the Strobe Generator, Sampling Bridge, and Preamplifier circuits. Such a sampling unit is the Type 3S2, using one or two S-series sampling heads. A Type 3S2 and a sampling sweep unit plugged into an indicator oscilloscope completes the sampling system. A choice of real or equivalent time sampling is provided by the type of the sweep unit used.

A 50 Ω input resistance allows the use of 50 Ω attenuators and probes for operation over a wide range of signal voltages.

A portion of the input signal is provided to the sampling unit. In the Type 3S2, this signal is selected from Channel A or B, and returned to the front panel Trig Out connector for external triggering or sampling sweep units.

Installing the Type S-2 Sampling Head

Fig. 2-1 shows the Type S-2 partially installed into a Type 3S2 Sampling Unit with Type 561A Oscilloscope and Type 3T2 Random Sampling Sweep. The sampling head (or heads) can be plugged into the sampling unit as shown, or used remotely on a special extender cable. Three and six foot extender cables are available. Order the three foot extender cable by Tektronix Part No. 012-0124-00, or the six foot extender cable by Tektronix Part No. 012-0125-00. Contact your local Tektronix Field Engineer or Representative for price and availability of these optional accessories.

To insert the Type S-2 into the right or left hand compartments of the sampling unit, proceed as follows:

1. Pull the latch knob (Fig. 2-1) outward from the front panel (the latch knob will push out normally when the unit is inserted if the knob is left free to move).

2. Insert the Type S-2 slowly into the compartment, so the two plastic guides in the compartment engage the S-2.

3. Push the Type S-2 completely into the compartment.

4. Push the latch knob to lock the S-2 in place.

To remove the Type S-2 from the compartment, pull the latch knob away from the front panel, then pull the unit from the compartment.



Fig. 2-1. Installation information.

To use the Type S-2 on an extender cable, install as follows:

1. Pull the latch knob located on the head end of the extender cable outward from the panel (the latch knob will push out normally when the extender is inserted if the knob is free to move).

2. Insert the extender cable head end slowly into the desired compartment in the sampling unit so the two plastic guides in the compartment engage the unit.

3. Push the head completely into the compartment.

4. Push the latch knob to lock the extender cable head end in place.

5. Connect the Type S-2 to the other end of the extender cable in a similar manner, and set the latch knob to hold it in place.

6. To remove the Type S-2 from the extender cable, pull the latch knob on the front panel of the Type S-2, and remove the unit from the extender cable.

7. To remove the extender cable head from the sampling unit compartment, pull the latch knob outward from the front of the panel, then pull the unit free.

Mating

The vertical deflection factor labeled by the Type S-2, and the sampling system loop balance (adjusted by the Bridge Bal control) must be considered when mating a Type S-2 with a sampling unit.

The mVOLTS/DIV label on the Type S-2 names the deflection factor units of the sampling unit Units/Div switch located directly above the label. For example, with the Type S-1 installed in a Type 3S2 and the Units/Div switch set at 100, each major division of CRT deflection corresponds to 100 millivolts of input signal (when the Variable control is in the Cal position). The deflection factor is mated to the indicator oscilloscope CRT by adjusting the sampling unit Gain control while the Type S-2 is in Channel B. Refer to the sampling unit manual for its Gain adjustment. Power supplies and circuit interconnections are made through the two connectors at the rear of the Type S-2.

Bridge Balance

The Bridge Balance control of the Type S-2 should be adjusted whenever the sampling head is changed from one sampling unit to another, or is operated on an extender cable. Location of the control and details of its adjustment are described in First Time Operation which follows.

FIRST TIME OPERATION

This First Time Operation procedure utilizes, in addition to the Type S-2, a Type 3S2, Type 561A, and Type 284. The Type 3T2 Random Sampling Sweep unit is recommended for use with the Type S-2 because random sampling permits viewing the signal in advance of the triggering event. Such trigger lead-time is required by the Type S-2 with the Type 3S2 to view fast pulses without a pre-trigger. The Type 284 is used as a signal source.

Setup Information

1. With the Type 561A Power switch off, insert a Tektronix Type 3S2 Sampling Unit into the vertical compartment (left) and a Tektronix Type 3T2 Random Sampling Sweep into the horizontal plug-in compartment (right).

2. Insert the Type S-2 Sampling Head into Channel A compartment (left) in the Type 3S2 leaving the latch knob free to move. Once the S-1 is seated, push the latch to lock it in place.

3. Set the Intensity control on the Type 561A fully counterclockwise.

4. Connect the Type 561A to a power source which meets its voltage and frequency requirements.

5. Set the Power switch to on. Allow about 5 minutes warm-up so the units reach operating temperature before proceeding.

6. For single-trace operation, set the controls as follows:

Type 3S2

Display Mode	CH A
Normal-Smooth	Normal
A and B Position	Midrange
DC Offset (both Channels)	Midrange (5 turns from one end)
Units/Div (both Channels)	100
Variable (both channels)	Cal
Invert (both Channels)	Push in
Dot Response (both Channels)	Midrange
B Delay	Midrange

Type 3T2

Horiz Position	Midrange
Samples/Div	9 o'clock position
Display Mode	Normal
Start Point	With Trigger
Sweep Rate	200 ns/Div
Range	10 μs
Display Mag	$\times$1
Time Magnifier	$\times$5
Variable	Cal
Time Position	Both fully clockwise
Trig Sensitivity	Fully clockwise
Recovery Time	Optional
Trigger Polarity	+
Trigger Source	Ext

Type 284

Square Wave Amplitude	1.0 V[1]
Period	1 μs
Mode	Square Wave Output
Lead Time	Optional

7. Connect the square wave output signal from the Type 284 to the input connector of the Type S-2 through a 50 Ω coaxial cable and a $\times$5 attenuator. Connect the trigger output signal from the Type 284 through a coaxial cable to the External Input 50 Ω connector on the Type 3T2.

8. Advance the Type 561A Intensity control until the free running trace brilliance is at the desired viewing level.

9. Center the trace on the graticule with the Type 3S2 A Position control and/or the DC Offset control. Adjust the Type 3T2 Trig Sensitivity control for a stable triggered display of a two-cycle square wave with an amplitude of about 2 divisions.

[1]**Used through $\times$5 attenuator for 0.2 V into the Type S-2.**

Adjusting Dot Response Sequential Sampling

One method of adjusting the Dot Response to unity is to use a double or multiple-triggered sweep. This causes each sample to respond to the full signal amplitude and produce a display similar to Fig. 2-2A or B.

10. To obtain a display similar to that of Fig. 2-2A or B, turn the Type 3T2 Trig Sensitivity control clockwise into the free run region. Then adjust the Recovery Time control until the desired display appears.

11. Turn the Channel A Dot Response control to obtain a display showing unity dot response (see Fig. 2-2B). Fig. 2-2A shows greater than unity dot response. This requires counter-clockwise rotation of the Dot Response control to obtain unity dot response. The double triggering shown in Fig. 2-2A and B is useful to adjust the dot response to unity, but should not be used in making measurements.

12. After the dot response is adjusted to unity, turn the Trig Sensitivity control counterclockwise into the triggered region for a stable trace of a properly triggered display similar to Fig. 2-2C.

Random Sampling

13. Another convenient method of adjusting the dot response to unity can be shown with random process sampling. Change the following controls:

Type 3T2

Start Point	Before Trigger
Time Magnifier	×50

Type 284

Period	100 ns

14. A dot response greater than unity will produce a display similar to Fig. 2-3A. Dot response deviations from unity are best observed when the Type 3T2 Time Magnifier is set at ×20 or ×50. Adjust the Type 3S2 Dot Response control for a unity dot response display similar to Fig. 2-3B.

Bridge Balance Adjustment

15. Connect a bench multimeter set for ≈ 30 V full scale between ground and the Type 3S2 Channel A Offset jack. Adjust the Type 3S2 DC Offset control until the multimeter reads 0 Volts. Increase the meter sensitvity and repeat the adjustment for greater accuracy.

16. Disconnect the coaxial cable from the Type 284, leaving the other end of the cable connected to the Type S-2 input connector. Turn the Type 3S2 Trig Sensitivity control clockwise to free run the trace.

NOTE

Operating the sampling head without the input connector terminated by a 50 Ω resistor or coaxial cable will cause a vertical shift of the zero signal baseline by a few millivolts. This is caused by the

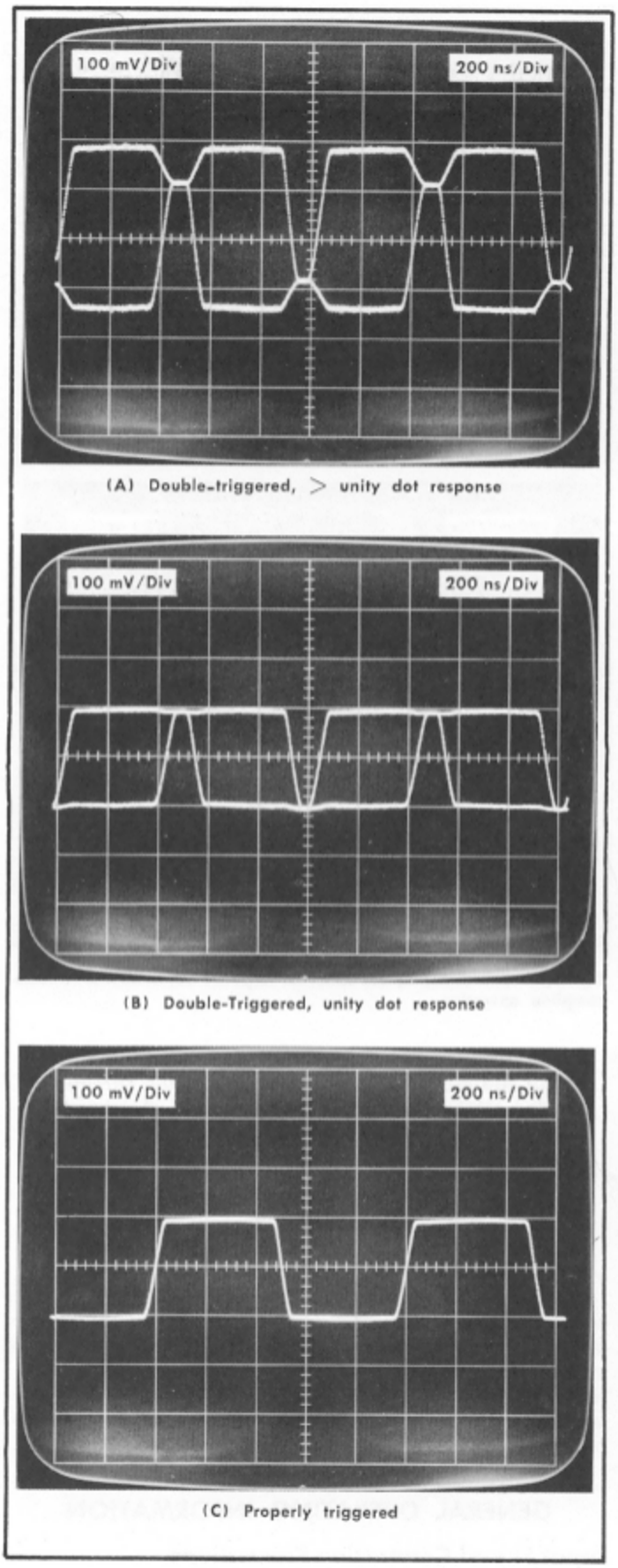


Fig. 2-2. Typical display for unity dot response adjustment in normal sequential sampling.

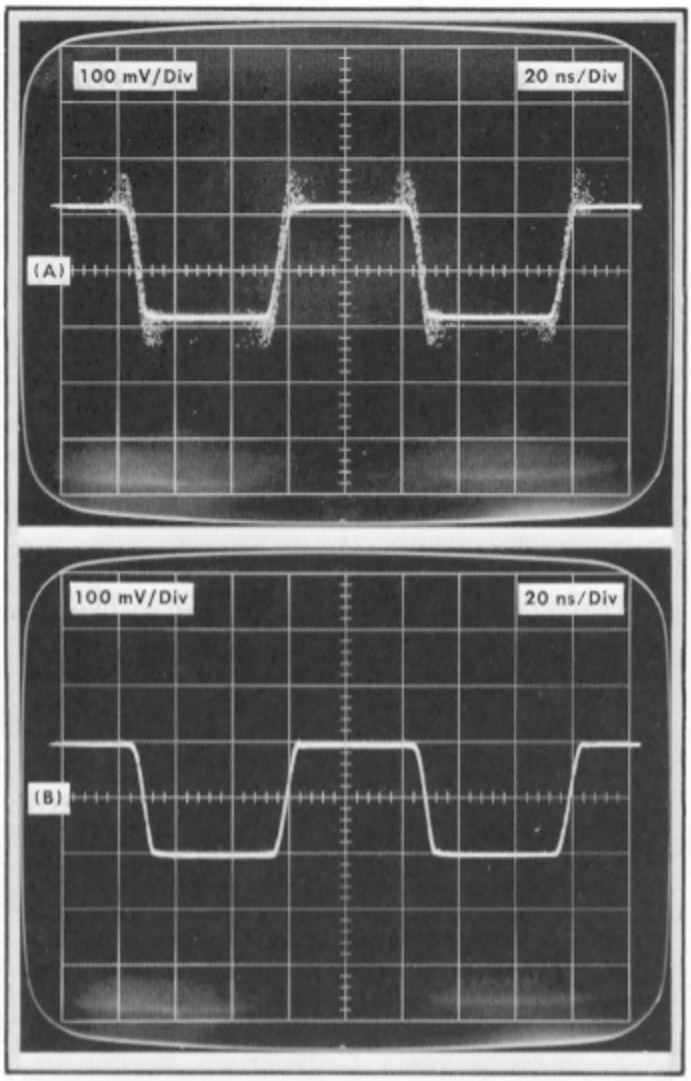


Fig. 2-3. Typical display for unity dot response adjustment in random sampling operation.

strobe kickout signal being reflected from the open input connector, and arriving back at the sampling bridge while the bridge is conducting. Because of this phenomena, set the display zero reference point with the input circuit terminated. Also use at least 20 cm airline between the Type S-2 input and any tunnel-diode pulse generator or circuit that is sensitive to signals entering its output circuit.

17. Switch the Type 3S2 Units/Div control throughout its range, adjusting the Type S-2 Bridge Bal control for a trace shift of not over one division as the Units/Div control is switched from one end to the other. See Fig. 2-4 for the location of the Bridge Bal control. This adjustment must be made whenever the Type S-2 is shifted from one sampling unit to another, or operated on a sampling head extender cable.

GENERAL OPERATING INFORMATION

Input Signal Connection Precautions

Accurate displays of signals containing very fast transitions or very high frequencies are possible only when the coupling circuit does not distort the signal. The Type S-2 input resistance is 50 Ω requiring the use of high quality 50 Ω coaxial cables and attenuators between the signal source and the sampling head input connector. Tektronix, Inc. offers several special probes that permit the signal source loading to be less than that caused by the 50 Ω input resistance. See your Tektronix Field Engineer or Representative about such special coupling devices.

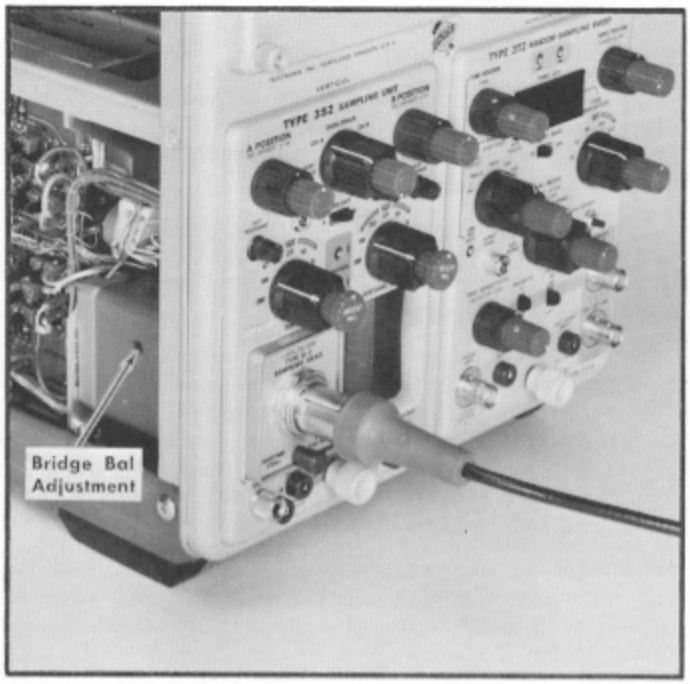


Fig. 2-4. Bridge Bal Location.

Input Voltage Considerations

Proper displays of various signal amplitudes require special attention to the type of time base generation in use. There are also input voltage limits that must be observed to prevent either display distortion or damage to the Type S-2.

For greater details on coupling of high frequency input signals, and on precautions to be observed, refer to the sampling unit Instruction Manual supplied with your sampling instruments.

Maximum input signal voltage is an important consideraion in any sampling system. Signals greater than +1 or —1 volt generally will not permit a valid display. Thus any signals of greater amplitude should be attenuated in some manner before being applied to the Type S-2 input connector. Maximum input voltage without damage to the input termination resistor is +5 or —5 volts DC, or 10 volts peak to peak sine wave signals in the frequency domain of 10 MHz or below.

Where unity dot response is required, accurate displays are possible to achieve only when the input amplitude and the time base generation mode are both considered. The two time base generation modes are: (1) normal process sampling, where each dot is displayed in sequence across the CRT, and (2) random process sampling where the dots are not necessarily displayed in a sequence that progresses uniformly across the CRT. (The Type 3T2 Random Sampling Sweep

unit presents random process sampling displays in a controlled sequence very similar to normal process sampling when the Time Magnifier switch is at ×1 or ×2 and the trigger signal repetition rate is uniform.) The random process dot sequence is definitely not sequential when the Time Magnifier switch is anywhere between ×5 and ×50, with the dot presentation completely random at ×50. The Type 3T2 can be operated in a normal process mode, and all other Tektronix sampling sweep units generate only a normal process sequenial dot display.

Unity dot response displays are not usually required when the signal rate of rise and the sweep rate selected provide a large number of dots for any vertical display change. Unity dot response is required for some random process ampling displays, and for normal process displays where there are either no samples, or less than about 6 samples in a step dot response is required for some random process sampling transition. (Many dots in any vertical change permits valid random process displays without unity dot response when the Type 3T2 Time Magnifier is at ×1 or ×2.)

In summary, unity dot response exists when the vertical channel (sampling head and sampling unit) will accurately shift a sample dot 100% of the signal amplitude. The Specification Section lists the dot response linearity limits as ±5% for certain limited signal amplitudes discussed below. A 5% dot response linearity means that the vertical channel will shift a dot in the positive direction 100% of the full signal amplitude, but minus transitions may shift a dot between —95% and —105% of the full signal amplitude, and vice versa. (The Dot Response control thus allows either the display top or bottom to be adjusted to unity dot response for close examination of signal detail.) Unity dot response is obtained by proper adjustment of the sampling unit Dot Response control as described in First Time Operation.

Input signal amplitude limits for unity dot response within the 5% linearity tolerance are listed in Table 2-1. The input voltage columns are for signal amplitudes of 0.2 V peak to peak and 1.0 V peak to peak anywhere between +1 V and —1 V DC.

TABLE 2-1

Input Signal Amplitude Limits Allowing Unity Dot Response Vs Sampling Unit mVOLTS/DIV Deflection Factor.

Sampling Unit Units/Div Switch	Input Voltage	
	0.2 V P-P	1.0 V P-P
All positions 200 to 2	yes	no
	Either Normal or Random Process	
Limited to positions of 20 to 2	yes	yes
	Either Normal or Random Process	
All positions 200 to 2	yes	yes
	Normal Process only with >6 dots in a 100% vertical transition.	

Triggering from the Signal

The Type S-2 provides a Trigger pickoff signal to the sampling unit. This signal is a portion of the input signal. In the Type 3S2, the signal is selected from the Channel A or Channel B sampling head and returned to the front panel Trig Out connector by the trigger circuit. The amplitude is about 10% of the input signal into 50 Ω. A small amount of the sampling bridge strobe signal is present with the trigger signal.

A Type 3S2 standard accessory trigger coupling cable can be used between the Type 3S2 and Type 3T2 for triggering the sampling sweep unit from the sampling head pickoff signal. Connect the cable between the Type 3S2 Trig Out connector and the Type 3T2 50 Ω Trigger Input connector. Operate the Type 3T2 as if externally triggered. Repetitive sine or square wave displays are best viewed when oeprating the Type 3T2 Start Point switch at With Trigger (normal process sequential dot sampling).

Fast pulse signals require random process sampling with the Type 3T2 Start Point switch at Before Trigger. This mode of operation will permit the sampling bridge strobe signal portion of the trigger pickoff signal to sometimes trigger the timing unit. When this occurs, it is impossible to obtain a meaningful display. Signal amplitude to the Type S-2 must be greater than about 300 mV peak to peak in order to obtain valid displays of fast pulses during random process sampling. It is usually more satisfactory to obtain some other form of pretriggering for the sampling sweep unit when it is necessary to view fast signals.

Measuring Risetime

The Type S-2 is useful to show 10% to 90% risetime of signals in circuits that are properly coupled to the input. The risetime of both the generator (of source), and the Type S-2 must be taken into consideration.

Signals with risetimes (at the input connector) as fast as about 150 picoseconds can be measured using the Type S-2 without any special considerations. Read the 10% to 90% risetime directly from the CRT (or digital unit) to know the risetime of the signal.

Signals with risetimes faster than about 150 ps can still be measured using the Tektronix Type S-2 Sampling Head. However, only approximations of risetime can be made by calculating the signal risetime using formula (1) below. Formula (1) is based upon both the signal and the sampler having Gaussian risetime characteristics. The Type S-2 risetime is not Gaussian. Signals with risetimes in the order of 45 ps will cause the Type S-2 display to show a composit risetime in the order of 73 ps. Thus, it is recommended that displays with risetimes faster than about 150 ps not be used to accurately measure the signal 10% to 90% rate of rise. The Performance Check and Recalibration Procedure gives equipment, procedure and displays of Type S-1 and Type S-2 risetime when driven by a 50 ps risetime tunnel diode pulser signal.

Formula (1) $T_r \text{ (Displayed)} = \sqrt{(\text{Signal } T_r)^2 + \text{Type S-2 } T_r)^2}$

transposing:

$$\text{Signal } T_r = \sqrt{(\text{Signal } T_r)^2 + \text{Type S-2 } T_r)^2}$$

NOTES

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

This section of the manual contains a block diagram analysis of the Type S-2 Sampling Head followed by a detailed circuit description. The Type S-2 Sampling Head is designed to be the signal input section of the sampling system, and determines the input characteristics of the sampling system. The reader may find it helpful to refer to the associated sampling unit manual for information on sampling principles if the purpose of a particular circuit is not clear. For example Type 3S2 manual, Section 4, "Basic Sampling Principles". The sampling unit manual also shows interconnections and circuits referred to in this section. Schematic and block diagrams of the Type S-2 are located at the rear of this manual.

BLOCK DIAGRAM

Strobe Generator

The Strobe Generator develops fast-rise short-duration push-pull pulses that drive the Sampling Bridge into balanced conduction. Output occurs at the time of each sample when a command pulse arrives from the Delay and Strobe Driver circuit of the associated ampling unit. Shape and amplitude of the output strobe pulses is set by the Avalanche Volts and Snap-off Current controls. Strobe pulse duration is fixed by the two shorted clipping lines.

Sampling Bridge

The Sampling Bridge allows no connection other than the normal stray capacitance of the bridge between the input connector and the Preamplifier input except when driven into conduction by the Strobe Generator. When the Strobe Generator drives the Sampling Bridge into conduction, a portion of the signal across the Sampling Bridge is applied to the Preamplifier input.

Reverse bias is applied to the Sampling Bridge diodes by the Bridge Volts and Bridge Bal circuit. The sampling system feedback signal and DC Offset voltage is applied to the Sampling Bridge output side and the Preamplifier input through the biasing network.

Blow-by and Trigger Pickoff

The primary function of the Blow-by and Trigger Pickkoff circuit is to cancel capacitively-coupled unwanted signals that normally bypass the Sampling Bridge. Very high frequencies pass to the Preamplifier input by the normal stray capacitances of the Sampling Bridge. These unwanted signals are called "blow-by".

The Blow-by circuit receives an attenuated portion of the input signal, amplifies and inverts the signal, and applies it, as a blow-by correction signal, through a capacitor to the output terminal of the Sampling Bridge. Magnitude of the blow-by correction signal is adjusted by the Transient Response control to effectively cancel the capacitively-coupled blow-by signal.

The trigger pickoff function of the Blow-by and Trigger circuitry provides a signal source for externally triggering the sampling sweep unit. The trigger pickoff circuit output signal drives an additional amplifier and channel selector circuit in the sampling unit.

Preamplifier

The Preamplifier circuit both amplifies and time-stretches the signal it receives from the Sampling Bridge. The signal received is a portion of the difference between the Feedback with the DC Offset voltage and the input signal. This "error signal" is amplified and AC coupled to the Post Amplifier in the sampling unit. The Preamplifier gain is adjustable to aid in setting the overall sampling head and sampling unit "loop" gain for proper unity dot response.

CIRCUIT DESCRIPTION

The Type S-2 Sampling Head uses the power supplies of the indicator oscilloscope and associated sampling unit. Interconnections to some of the circuits in the sampling unit are by two connectors at the rear of the sampling head. This Circuit Description covers the circuits in the Type S-2, and refers to circuits within the sampling unit. Reference to the sampling unit instruction manual diagrams and circuit description may be useful to fully understand the circuit relationships.

Strobe Generator

The Strobe Generator circuits are located on the Strobe board. The generator contains two basic circuits, the Avalanche circuit and the Snap-off diode circuit. Both circuits work together to produce the push-pull strobe pulses that drive the Sampling Bridge through two equal transmission lines. See Fig. 3-1.

Avalanche circuit. The Avalanche circuit converts the Strobe Drive pulse from the sampling unit to very fast push-pull pulses to drive the Snap-off diode to non-conduction.

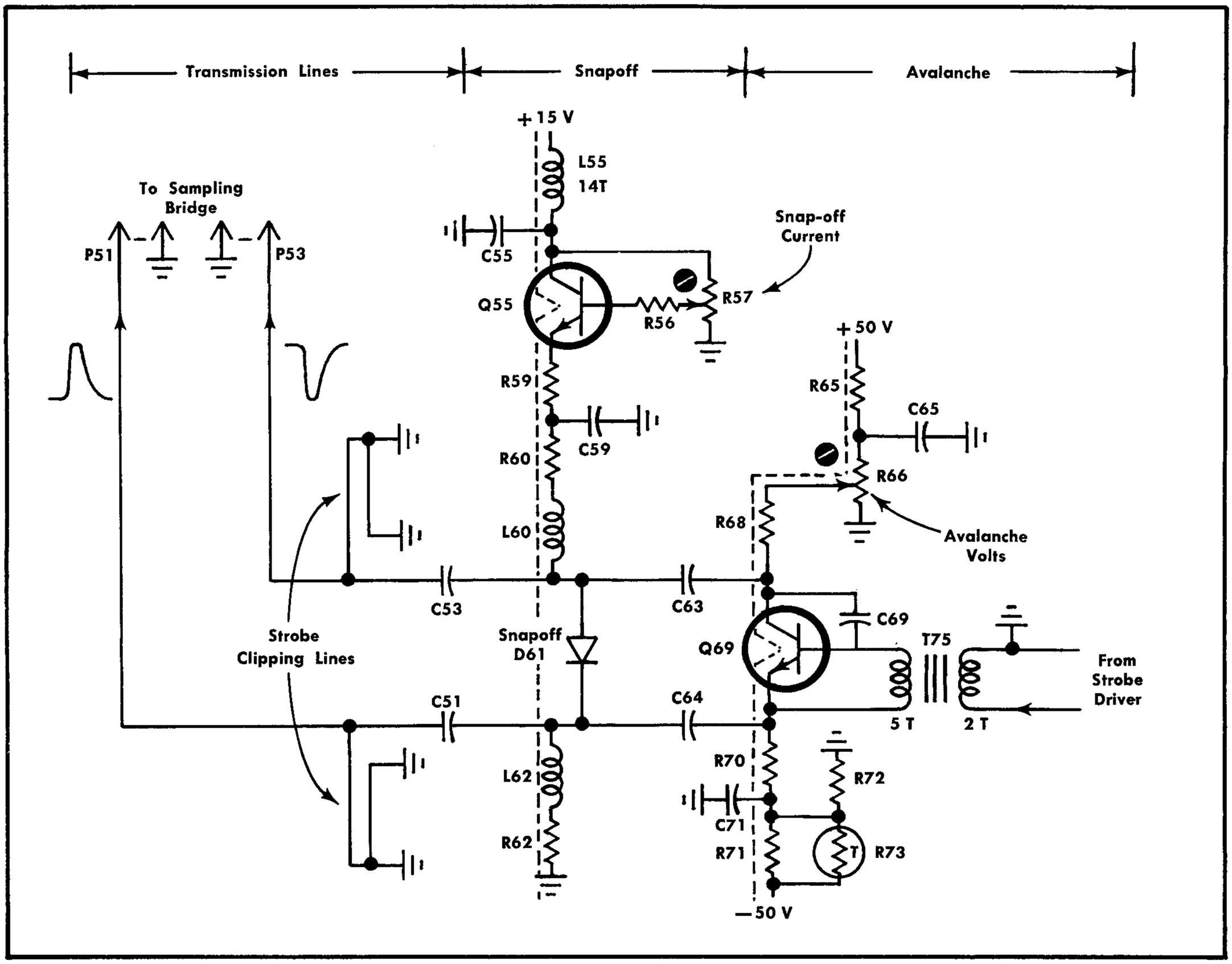


Fig. 3-1. Strobe Generator circuits.

The Strobe Drive pulse is transformer-coupled by T75 to the base and emitter of the Avanlanche transistor Q69. Two outputs are AC-coupled from Q69, one from the collector and the other from the emitter. The Avalanche Volts control adjusts the collector voltage of the avalanche transistor Q69. The typical quiescent voltage at Q69 collector is about +15 volts. This voltage sets the amplitude of the signals, that drive the Snap-off diode circuit, and assures the normal avalanche action of Q69 when driven by the Strobe Drive signal. Q69 current path is shown by a dashed line in Fig. 3-1. Before Avalanche conduction, there is a potential of about 60 volts between collector and emitter.

The negative Strobe Drive pulse is transformer-coupled by T75 to the emitter and the base of Q69, forward biasing Q69. Normal avalanche action follows with the collector going negative and the emitter going positive. This fast-rise push-pull signal is capacitively coupled to the Snap-off Diode circuit.

Snap-off circuit. The Snap-off circuit operates as a current switching circuit to apply some of the push-pull Avalanche signals at snap-off time to the Sampling Bridge.

The circuit consists of a Snap-off Current control R57, Q55, Snap-off diode D61, two clipping lines and associated components. Between drive pulses from the Avalanche circuit, the Snap-off diode D61 is forward-biased by the current in Q55. The current value is set by the Snap-off Current control R57. The current in D61 is typically 20 mA, and the current path is shown as a dashed line in Fig. 3-1. This heavy forward current assures that D61 has many carriers within its junction region.

The push-pull signals from the Avalanche circuit cause D61 junction carriers to reverse direction as a heavy reverse current. This heavy reverse current stops suddenly as all the carriers clear out of the junction. As the reverse current "snaps" to a stop, the push-pull avalanche signals are suddenly coupled toward the clipping lines and the Sampling Bridge by C53 and C51. The fast-rise step which appears at each clipping line input is propagated down the line. A finite period of time later the steps reach the short circuit ends of each clipping line. The step is then reflected, equal in amplitude and opposite in polarity, back to the transmission line. This cancels the signals moving toward the Sampling

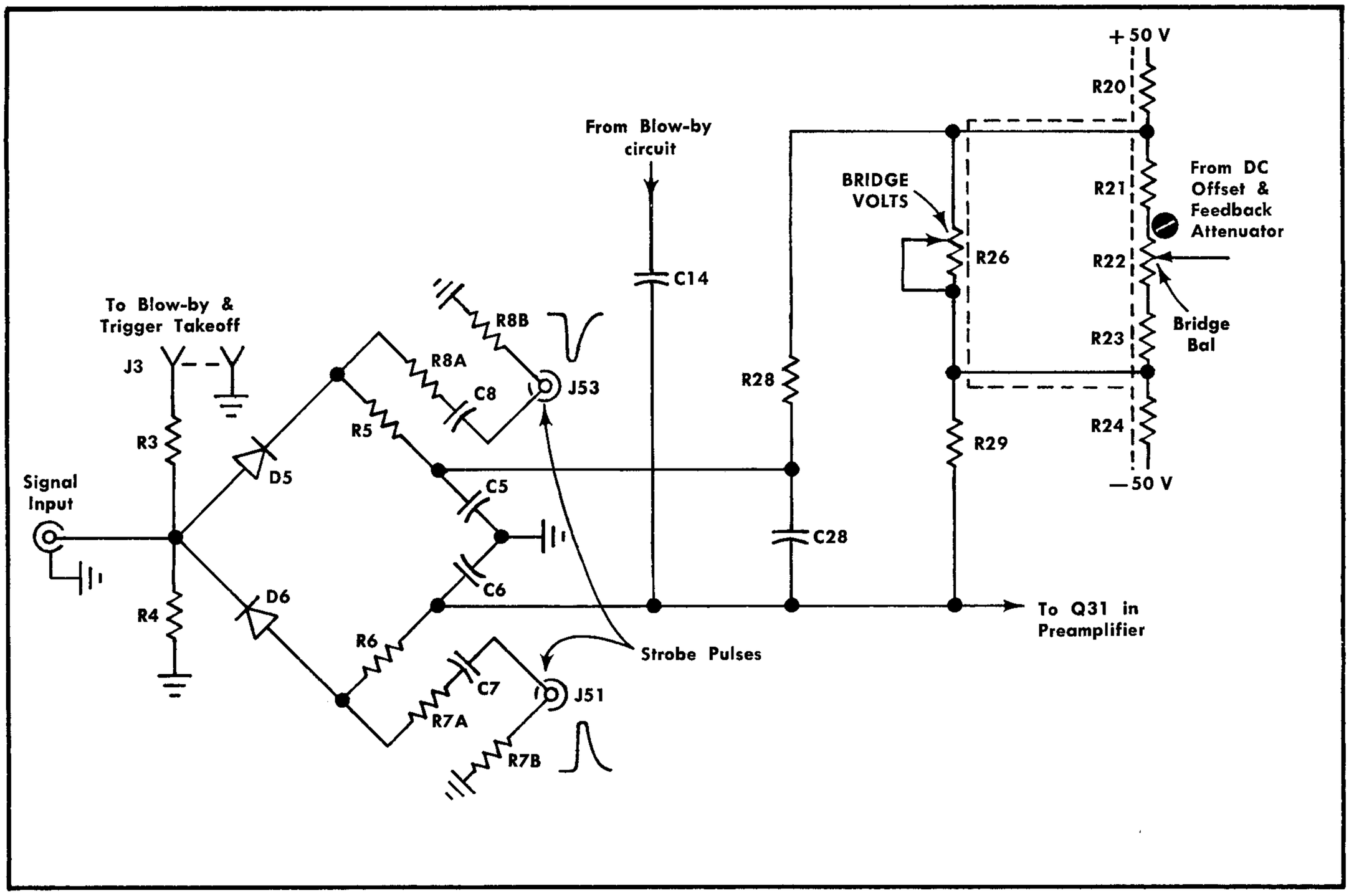


Fig. 3-2. Sampling Bridge circuit and Bridge Volts and Bridge Bal circuits.

Bridge. This action results in a positive Strobe pulse being delivered to P51, and a negative Strobe pulse being delivered to P53.

Sampling Bridge

The Sampling Bridge consists of D5, D6, R5, R6, R7A, R8A, C5, C6, C7, C8, and C28. See Fig. 3-2. The Sampling diodes allow no connection between the input connector and the Preamplifier input (other than the normal stray capacitance of the bridge) except when driven into conduction by the Strobe pulses from the Strobe Generator. During D5 and D6 conduction time of about 45 to 50 ps the bridge delivers a portion of the voltage difference between the input signal and the bridge output signal to the Preamplifier input.

The bridge input circuit is terminated in 50 Ω. The 50 Ω consists of R4 with the series value of R3 and R10 in parallel. (R10 is shown in Fig. 3-3). R3 delivers a small portion of the input signal to the Blow-by and Trigger Pickoff circuit.

The bridge output drives the high input impedance Q31 gate in the Preamplifier.

Reverse-bias voltage for the sampling bridge diodes is developed across R21-R22-R23 in parallel with R26, the Bridge Volts control. R26 allows the reverse-bias voltage adjustment. A higher reverse voltage allows D5 and D6 to be turned on for a shorter period of time. A lower voltage gives a longer conduction time. During calibration the voltage is usually set nearly to maximum.

The Bridge Bal potentiometer is adjusted to compensate for diode, strobe, and other system unbalance signals. The combined memory feedback and DC Offset voltage from the sampling unit is fed through the bridge volts circuit to the output of the Sampling Bridge.

During the sampling time, the strobe pulses forward bias D5 and D6. By normal bridge function, the conduction of D5 and D6 charges or discharges C5, C6, C7 and C8. The voltage charge on these capacitors changes about 2½% of the difference between the Feedback and DC offset voltage and the incoming signal voltage. This voltage change, called the error signal, is amplified in the Preamplifier.

Preamplifier

The Preamplifier circuit (see Fig. 3-3 amplifies and time-stretches the error signal pulse from the Sampling Bridge, and AC couples it to the Post Amplifier in the associated plug-in unit.

The input transistor Q31 operates as a very high input impedance high-gain inverting amplifier. Temperature compensation for Q31 is accomplished by thermistor R33 in parallel with R34. The 4 mA current path is from the +50

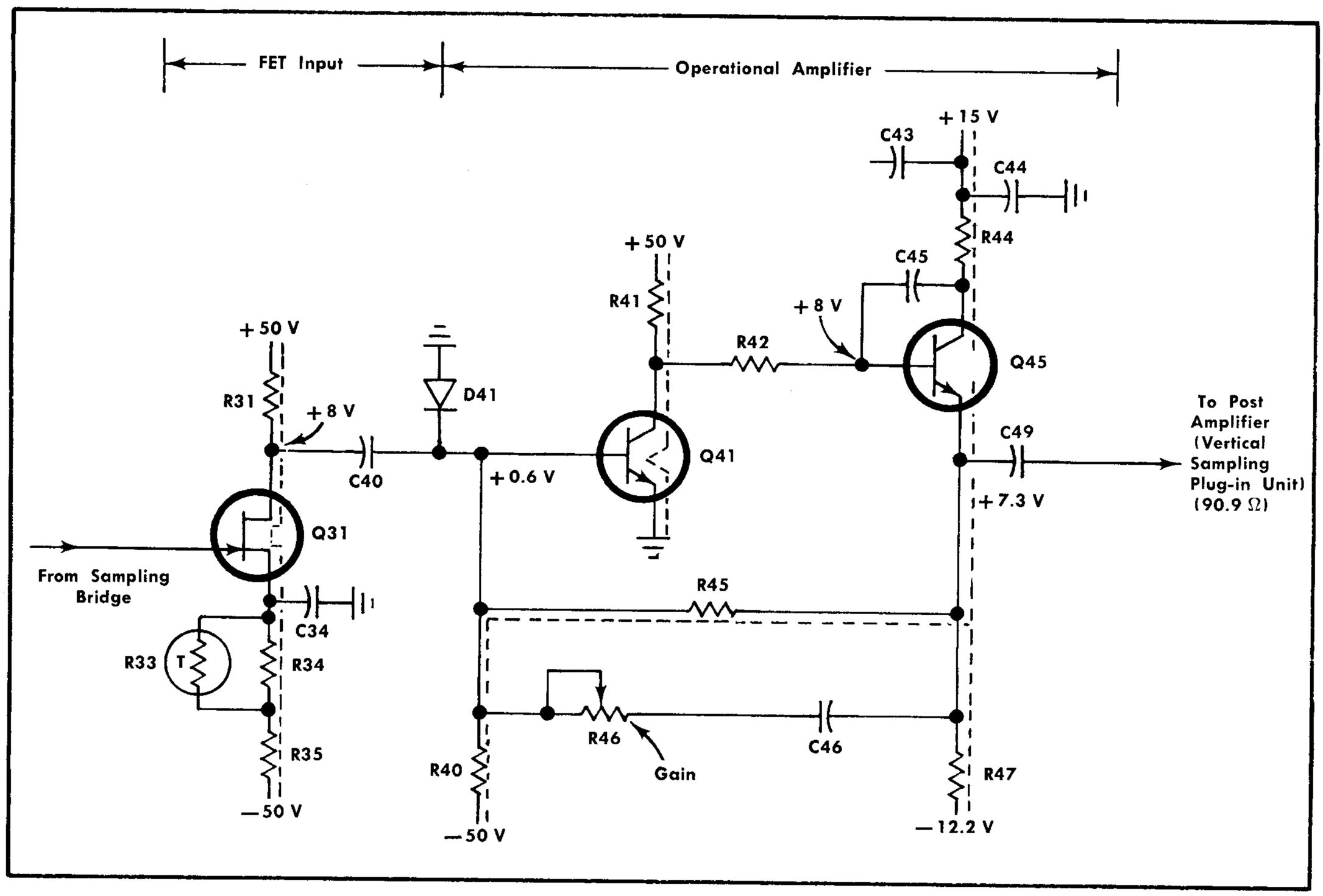


Fig. 3-3. Preamplifier circuit.

volt supply through R31, Q31, the parallel combination of R33-R34 and R35 to the —50 volt supply. C34 assures that Q31 AC gain is high, while its DC gain is less than 1.

Q41 and Q45 are connected as an operational amplifier with a very low output impedance at Q45 emitter. The output is coupled by C49 to the 90 Ω input resistance Post Amplifier in the sampling unit. Q45 current paths are shown by dashed lines in Fig. 3-3. D41 protects Q41 base from high negative voltage if Q45 is removed from its socket.

Current in R40 with DC negative feedback by R45 sets the output DC voltage level of the amplifier at about 7.3 volts. Negative AC feedback from the emitter of Q45 through C46 and Gain control R46 to Q41 base controls the AC gain of the Preamplifier. The Gain control R46 allows the AC feedback to be adjusted, thereby adjusting the gain. The AC gain of the Preamplifier is usually adjusted to about 16 depending upon the sampling efficiency. For example: For an input signal into the Type S-2 input connector of 200 mV, if the display dot change is 100% of the signal, Q45 output signal will be about 80 mV. A positive 200 mV input signal will produce a +5 mV signal at Q31 gate (or a 2.5% sampling efficiency), and a positive 80mV output signal. Likewise a negative input signal will produce a negative output signal.

Blow-by and Trigger Pickoff

The Blow-by and Trigger Pickoff circuits consist of Q13, Q17 and associated components connected as a common-emitter paraphase amplifier. See Fig. 3-4. The primary purpose of the circuit is to cancel unwanted high frequency capacitively-coupled signals that bypass the Sampling Bridge. The secondary purpose is to provide a trigger pickoff signal to the sampling unit for external triggering of the sampling sweep unit.

Input signal to the Blow-by and Trigger Pickoff circuit is a portion of the Type S-2 input signal. The signal is fed to the base of Q13 through R3. R10 terminates the 50 Ω impedance of J3-P3 coaxial connector and assures no reflections back into the input circuit. The output from Q13 collector feeds an AC coupled signal to the output side of the Sampling Bridge, cancelling the blow-by signal. The output from Q17 collector feeds a DC coupled trigger pickoff signal to the sampling unit trigger amplifier.

To trace the Blow-by signal path, a portion of the Type S-2 input signal is coupled to the base of Q13 and inverted at the collector of Q13. The inverted signal amplitude is adjusted by R13, the Transient Response control, and fed through R14 and C14 to the output side of the Sampling Bridge. This signal is out of phase with the input signal, cancelling the

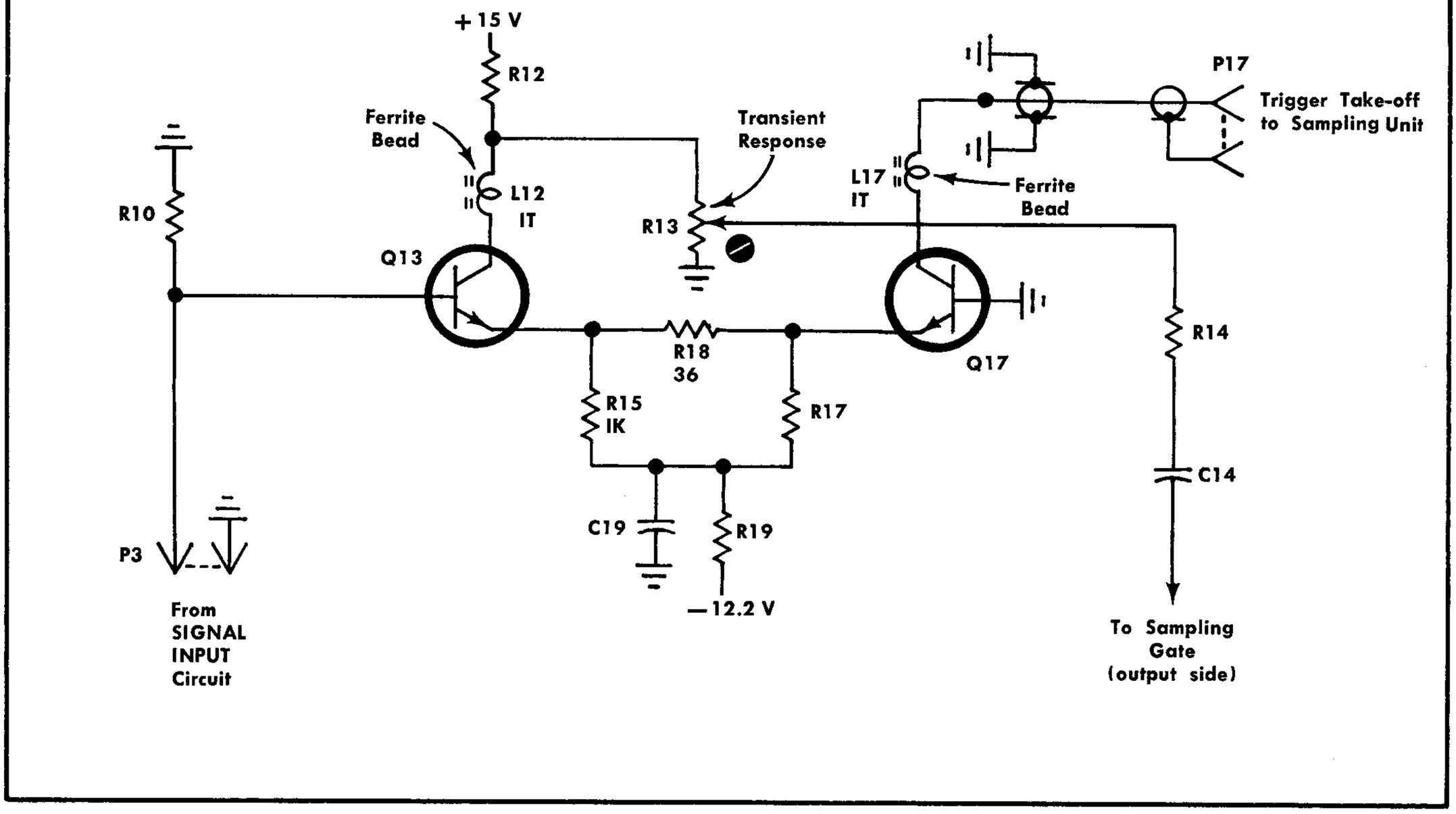


Fig. 3-4. Blow-by and Trigger Take-off circuits.

induced displacement current of the capacitance shunting the Sampling Bridge.

The trigger pickoff signal path starts with a portion of the input signal coupled from Q13 emitter to Q17 emitter to provide an in-phase signal at Q17 collector to the Trigger Amplifier and selector circuits in the sampling unit. Q17 collector load is provided in the sampling unit.

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains information for use in corrective maintenance or troubleshooting of the Type S-2.

To remove the Type S-2 from its case, loosen the four retaining screws on the back. Then slide the back off, and remove the body by sliding it to the rear. Directions for replacing the case on the sampling head will be found at the end of this section.

Parts Replacement

All parts used in the Type S-2 can be purchased directly through your Tektronix Field Office or Representative. 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 S-2 should be ordered from Tektronix since these parts are either manufactured or selected by Tektronix to satisfy a particular requirement. Before purchasing or ordering, consult the Electrical or Mechanical Parts List to determine the value, tolerance and rating required.

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, the sampling head may require recalibration.

Transistor Replacement. Cut the leads of a replacement transistor to the same length as the transistor removed and bend the leads as necessary. The dead configuration of the transistors used in the Type S-2 are shown in Fig. 4-1. Two transistors, Q13 and Q17, have soldered leads and are soldered to the circuit board. The field-effect transistor mounting has an arrow at the top position.

Leadless Capacitors. There are leadless ceramic capacitors soldered directly to the circuit boards. Care must be taken when replacing these capacitors as they are easy to crack. The Type of solder used must be quality, with good cold-flow characteristics. Thus, do not use 50/50 solder, but 60/40 or 62/38 solder when replacing the leadless capacitors.

Best results will be obained by applying heat from the soldering iron directly under the leadless capacitor on the opposite side of the board. Usually a plated-through hole is under the leadless capacitor, allowing solder to conduct heat through the board. Without plated-through holes, the capacitor may be soldered into place by positioning the part, then applying heat to the adjacent plated area.

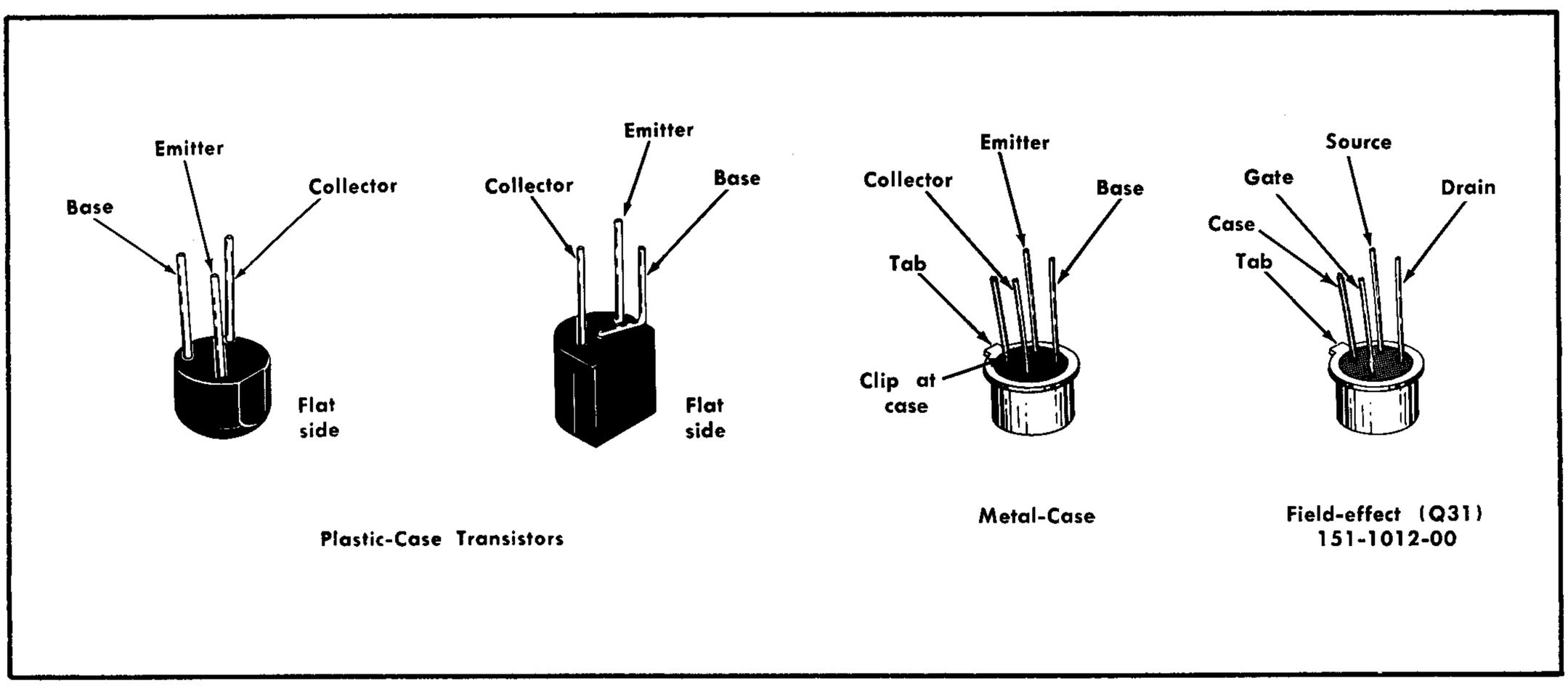


Fig. 4-1. Lead configuration for board-mounted transistors.

Use only enough solder to obtain a good full-flow joint. Excess solder on either side of the capacitor can lead to a shorted circuit.

Removal and Replacement of Snap-off Diodes. The Snap-off diode is mounted in small metal clips, as shown on the circuit board illustration. The diode is best removed or replaced with a pair of shaped plastic tweezers, such as Tektronix Part No. 006-0765-00, or equivalent.

Replacement of Sampling Bridge Diodes. The Sampling Bridge diodes may be removed or replaced on the Sampler Board through the top of the unit. Fig. 4-2 shows a method for the removal or replacement of the white plastic holder in which the diodes are mounted.

CAUTION

The diodes are very fragile and it is possible to break one or both if the white plastic holder is removed or replaced too rapidly. Damage is caused when the holder ends snap together as they are moved from the circuit board.

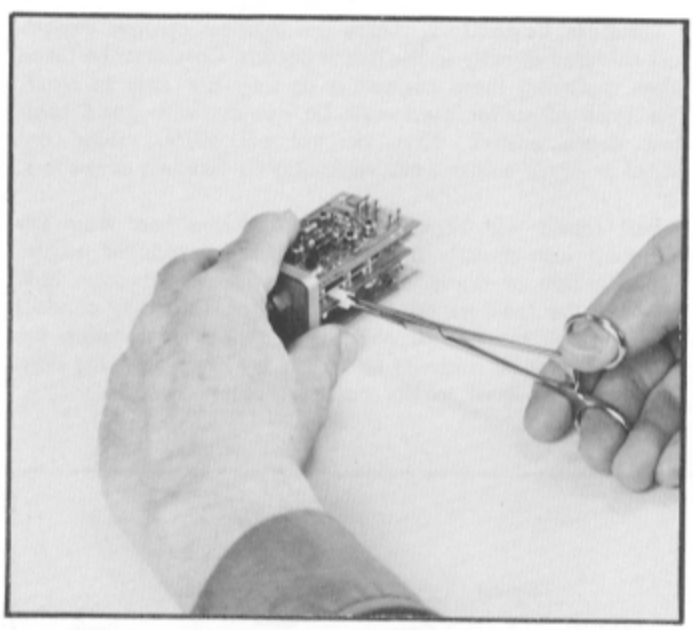


Fig. 4-2. Removal or replacement of sampling bridge diodes.

The position of the plastic diode holder assembly is shown in Fig. 4-4 with the shields removed; it is not necessary to remove these shields to replace the sampling diode assembly. For removal or replacement use Xcelite Forceps 42H, Tektronix Part No. 003-0347-00, or similar tool.

The hook-like ends of the diode holaer normally rest in a circuit board hole and firmly hold the diodes to the plated area. Cautious removal, especially just as the holder clears the circuit board, is necessary to minimize the physical shock and possible damage to the diodes, as the hook-like ends may snap or spring together. Replacement of the holder should also be by slow, cautious movement; first as the hook-like ends reach the plated area which increases the thickness and second as hey reach the hole where he possibility of physical shock exists as in the removal. A metal shield prevents the holder being inserted too far.

Circuit Board Replacement. If a circuit board is damaged and cannot be repaired, the entire assembly including all soldered-on-components should be replaced. The part number given in the Mechanical Parts List is for the completely wired board.

The Preamp Board and the Strobe Board are removed by gently pulling outward from the Sampler Board. To replace the boards, align the connectors and pin contacts and ease the boards into position. Pin connectors should not protrude beyond the clamps.

The Sampler Board is removed as follows:

1. Remove both the Preamp and the Strobe Board.

2. Remove the 12 sided nut (nutdriver, special, Tektronix Part No. 003-0459-00) which secures the GR connector to the front panel.

3. Slide the Sampler Board and the GR connector away from the front panel.

To remove the Shields and Input Connector:

1. Loosen the threaded nut by turning it counterclockwise with the special Tektronix tool, Part No. 003-0607-00. Do not remove the threaded nut, but back it off just enough to free the notched plate (see Fig. 4-3).

2. Rotate the notched plate 90° and slide the Input Connector assembly away from the circuit board.

3. Loosen, but do not remove, the seven nuts holding the shields.

4. Remove the 7 nuts and bolts, freeing the shields.

TROUBLESHOOTING

The design of this sampling head is such that printed circuit boards are interchangeable from one unit to another. Since the outer boards are easily removed and replaced, it is possible to quickly troubleshoot a faulty sampling head by interchanging boards with an operating one. Thus, removal of the preamp board from the operating unit and replacement with one from the defective unit quickly checks the faulty units preamp circuits.

The sampler board may be checked for defective parts without disassembly by the following procedure:

1. Remove the sampling diode plastic holder.

2. Remove the Preamp board. Leave the Strobe board in place.

3. With an ohmmeter, check the DC resistance to ground from the preamp input pins H and I. If a direct short is found, C5 or C6 is shorted; if a 350 Ω connection to ground is found, then C7 or C8 is shorted.

4. To check C5, C6, C7 and C8 for opens (with Preamp board removed), use a Tektronix Type 130 Direct-Reading L-C Meter (or equivalent) and refer to Table 4-1 for the values of capacitance from either pin H or I to ground.

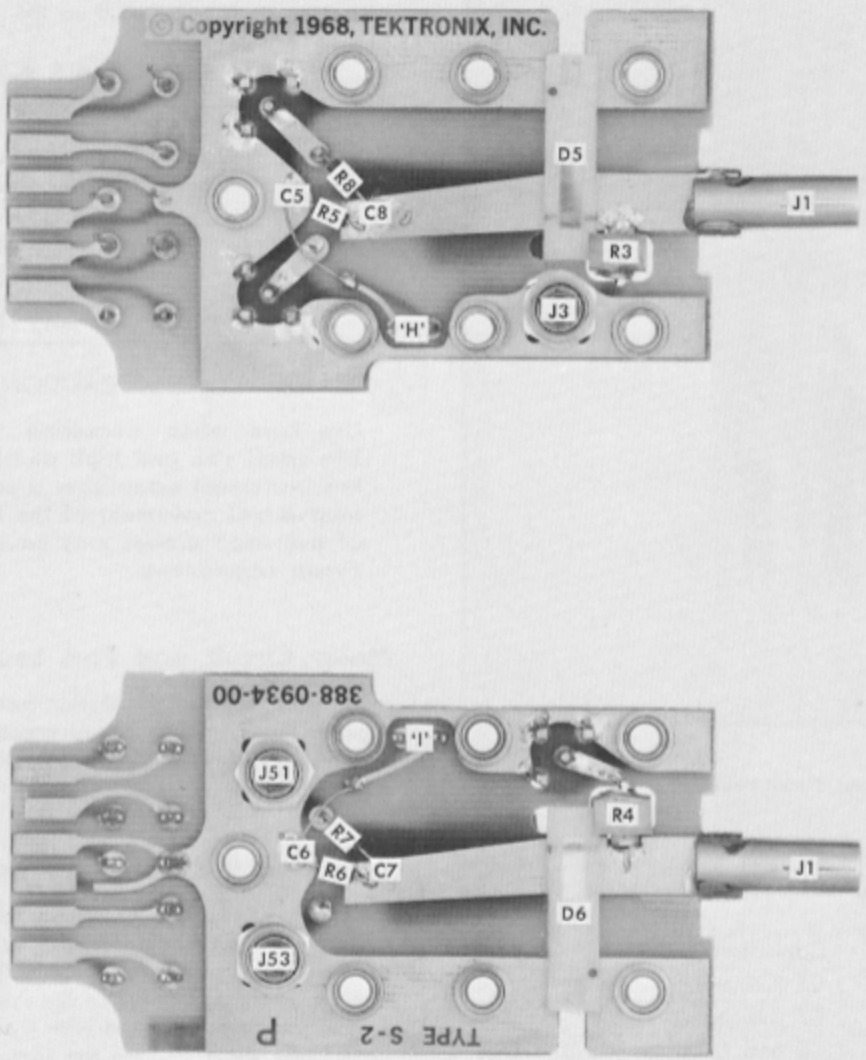


Fig. 4-3. Sampler circuit board, shields removed.

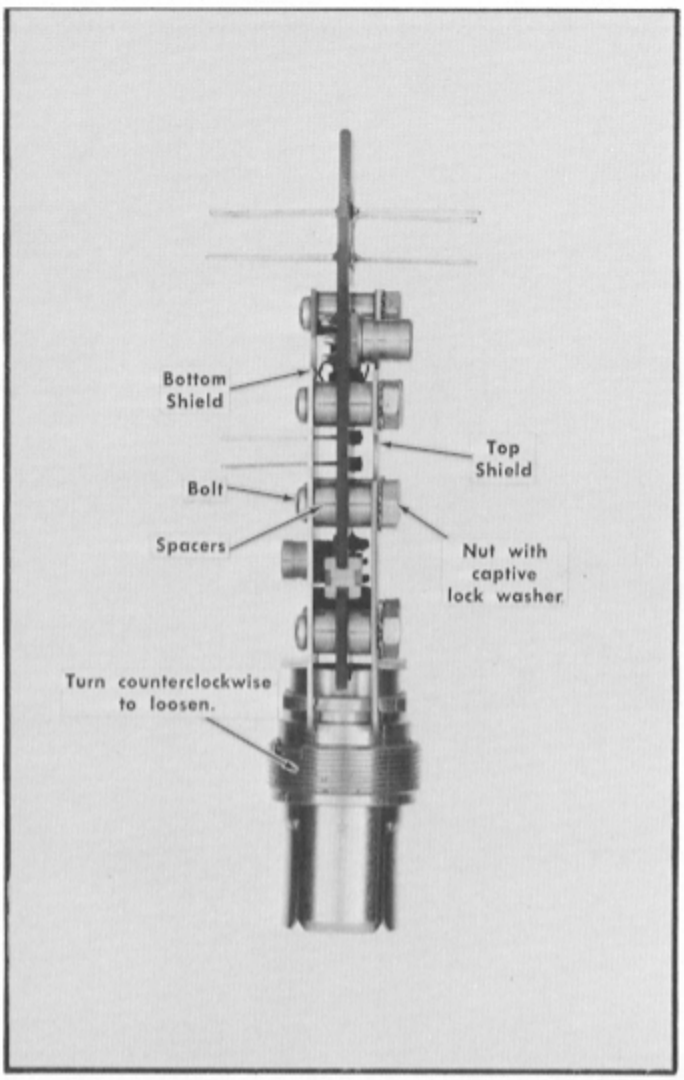


Fig. 4-4. Assembly of Sampler Circuit board.

TABLE 4-1

Input C	Problem
17 pF	Capacitors OK
12 pF	C5 (C6) open
10 pF	C7 (C8) open
5 pF	C5 and C7 open (C6 and C8)

Attemp to isolate trouble to one circuit through operational and visual checks. Verify that the trouble is actually a malfunction within the Type S-2, and not improper adjustments or malfunctioning associated equipment. Note the effect the adjustments have on the trouble symptoms. Normal and abnormal operation of each adjustment helps establish the location and nature of the trouble.

Check the instrument calibration procedure given in Section 5, and note the position of each adjustment so it can be returned to its original position after the check. This will facilitate recalibration after the trouble has been found and corrected.

Check the Circuit Diagram for voltages and waveforms. A block diagram and schematic diagram are included in Section 8 of this manual. It is usually best, if the trouble from the sampling unit; see Table 4-2, then proceed consecutively from one circuit to the next.

TABLE 4-2

Test Point Pin		Power Supply (Decoupled)	Tolerance
Preamp Board	Strobe Board		
G	B	+50 V	±1 V
A	A	+15 V	±0.15 V
F	C	−50 V	±0.5 V
B	- - -	−12.2 V	±0.37 V

CAUTION

Use care when measuring voltages or signals. The small size and high density of components in this instrument establishes a condition such that an inadvertent movement of the test probe or the use of oversized probes may cause a short-circuit between components.

Major Circuit and Part Locations

The remainder of this section includes photographs of sections of the Type S-2. Major areas are identified. All components mounted on circuit boards are identified by circuit numbers.

Replacing the Sampling Head Case

To replace the case on the sampling head, align the body so that the hole in the side will appear over the Bridge Bal control at the rear of the Preamplifier board. Check that the upper and lower corners of the Preamplifier and Gate Generator boards are aligned with the channels in the sampling head body which contain the zigzag springs. Push the body gently forward until it contacts the front panel. Be sure the white plastic pawl on the locking knob is properly aligned as the sampling head unit is slid into the body. In attaching the rear castings, be sure that the hole at one side of the casting fits over the Trigger Pickoff output connector. Insert the four long mounting bolts and tighten them securely.

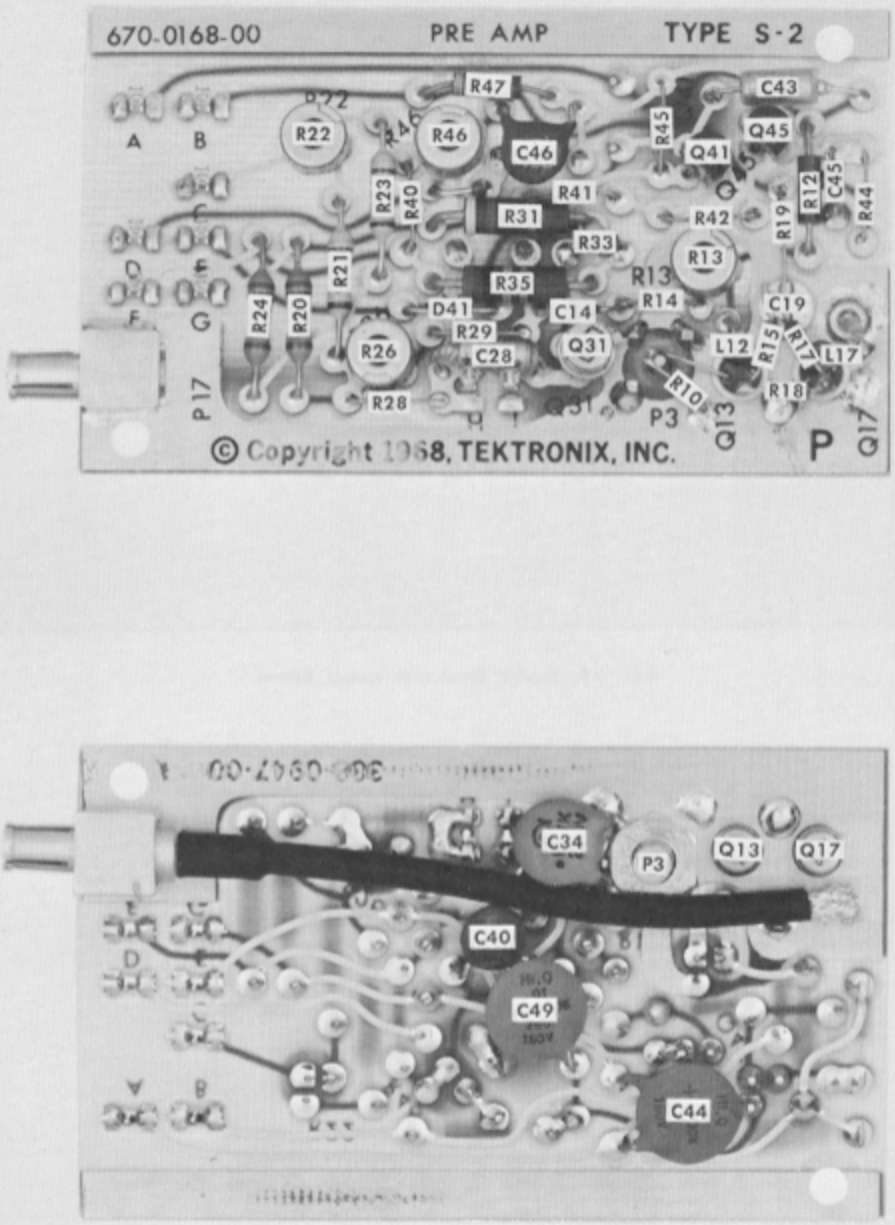


Fig. 4-5. Preamp circuit board.

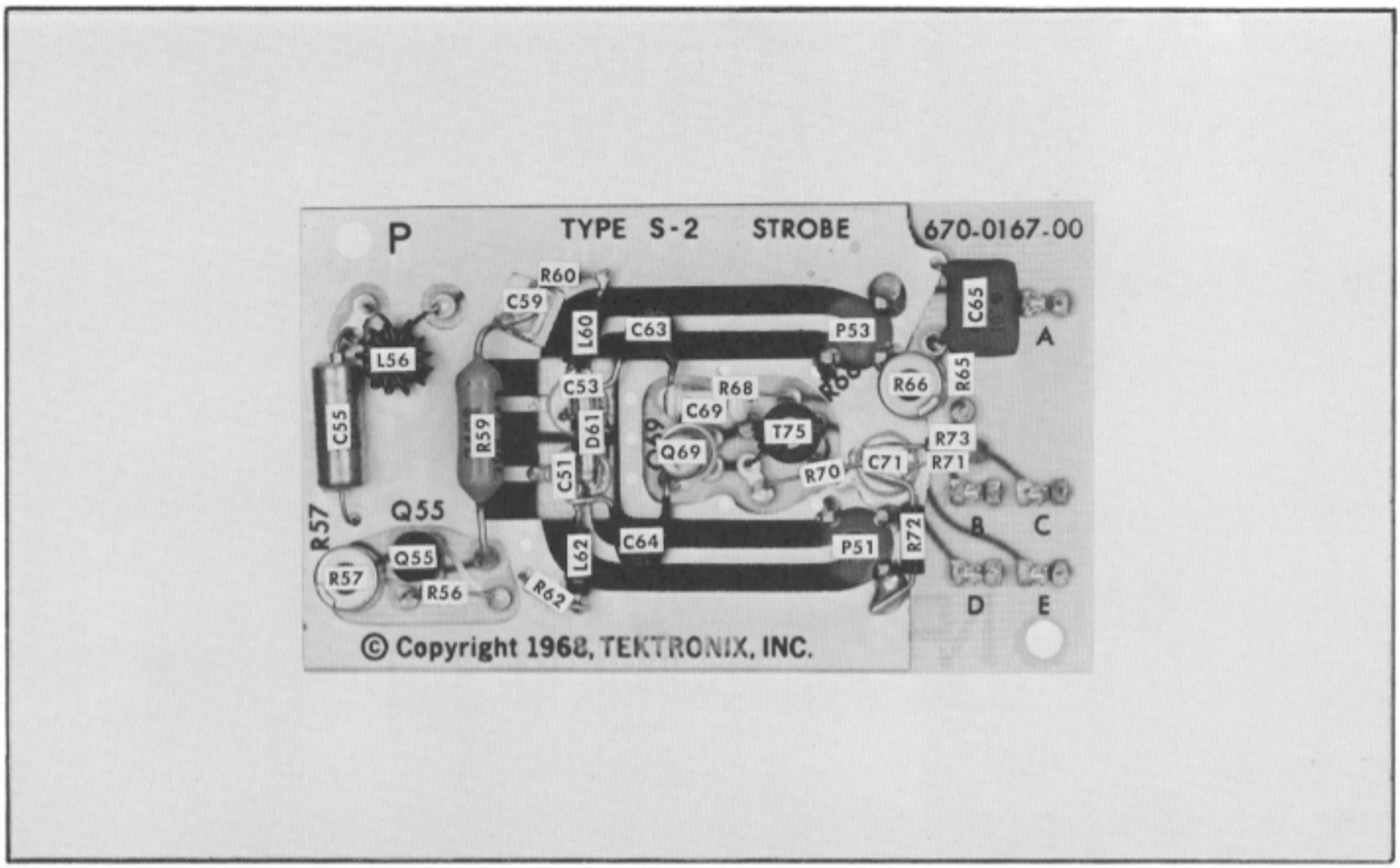


Fig. 4-6. Strobe Generator circuit board.

SECTION 5
PERFORMANCE CHECK / RECALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

Performance of the sampling head can be checked without making internal adjustments by using the steps of this procedure whose headings are set in the type face used on step 1 (page 5-5). Failure to meet the requirements given in any check indicates the need for recalibration. Recalibration steps are headed by the type face shown in step 2.

The sampling head performance can be restored to the limits stated in Section 1 by performing the recalibration steps of this procedure. Any needed maintenance should be performed before proceeding with recailbration.

Since the sampling head functions as a part of the associated sampling unit, it is recommended that the performance checks for the sampling unit be performed just before these performance checks are made. Then, if the sampling unit requires recalibration, that procedure should be performed before starting this procedure.

NOTE

This procedure applies to both the Type S-1 and the Type S-2 Sampling Heads. Their controls are identical; thus, differences between the two are in performance and electrical characteristics. For example, Step 3 which checks the sampling head risetime, uses an identical procedure and the same equipment set-up for both sampling heads, with performance limits shown in separate photographs of proper CRT displays.

EQUIPMENT REQUIRED

The equipment listed below or its equivalent is required for a complete check and recalibration of either the Type S-1 or the Type S-2 Sampling Head; see Fig. 5-1. The equipment listed is used in the following procedure. Equipment specifications given are the minimum necessary for the particular use of each item. All test equipment must be correctly calibrated. If other equipment is substituted, it must meet or exceed the limits stated below. If a pulse generator other than the Type 284 is used, fast pulse display characteristics may vary from those shown in this manual.

All equipment items listed, except items 12, 13 and 14, can be obtained by ordering through your local Tektronix Field Engineer or Representative.

1. Test Oscilloscope. Bandwidth, DC to at least 50 MHz. Minimum deflection factor of 20 mV/div. For example, a Tektronix Type 585 with Type 82 Plug-In Unit.

2. 10× Probe for use with test oscilloscope. Tektronix P6008 Probe recommended with the Type 82 Plug-In Unit. Tektronix Part No. 010-0129-00.

3. Indicator Oscilloscope, with proper sampling plug-in units, such as a Type 561A or Type 564 Oscilloscope with Type 3S2 Sampling Unit and Type 3T2 Random Sampling Sweep. Or, a Type 568 Oscilloscope with the same vertical and horizontal plug-ins, and Type 230 Digital Unit if the sampling system is used with digital readout.

4. Special 3 foot flexible extender cable for operating the sampling head outside the Sampling Unit. Tektronix Part No. 012-0124-00 required.

5. Signal Generator—Pulse Generator, such as the Tektronix Type 284 Pulse Generator used in this procedure. Pulse risetime $\leq$70 ps, at approximately 200 mV amplitude into 50 Ω, with a trigger signal available at least 75 ps in advance of the fast pulse. Square wave signals of 1 ms period (1 MHz) and 100 ns period (10 MHz) at 1-volt amplitude into 50 Ω. (If your Type 284 Leadtime switch is labeled 5 ns—50 ns, order modification kit, Tektronix Part No. 040-0487-00.)

6. 50 Ω coaxial cable, RG 58C/U, 5 ns signal delay, with GR 874 connectors. Tektronix Part No. 017-0512-00.

7. 50 Ω coaxial cable, 5 ns signal delay, approximately 40 inches long, with BNC connectors. Tektronix Part No. 012-0057-00.

8. 50 Ω coaxial air line, 20 cm long, with GR 874 connectors. GR 874-L20. Tektronix Part No. 017-0084-00.

9. One 50 Ω 5× Coaxial Attenuator, such as GR 874-G14. Tektronix Part No. 017-0079-00.

10. One 50 Ω 2× Coaxial Attenuator, such as GR 874-G6. Tektronix Part No. 017-0080-00.

11. A special Variable Attenuator with GR 874 connectors. It consists of a 100 Ω potentiometer across the 50 Ω line, and does not have a guaranteed response. Tektronix Part No. 067-0511-00.

12. DC Bridge for measuring 50 Ω. Plus or minus 2 volts DC maximum across 50 Ω resistor. Accuracy, ±0.2% required. (Not shown.)

13. Small insulated handle, $^3/_{32}$ inch bit screwdriver for adjusting screwdriver-adjust controls. (Not shown.)

14. An RMS reading line voltage meter, with a ±3% accuracy at the line voltage to which the indicator oscilloscope is connected. (Not shown.)

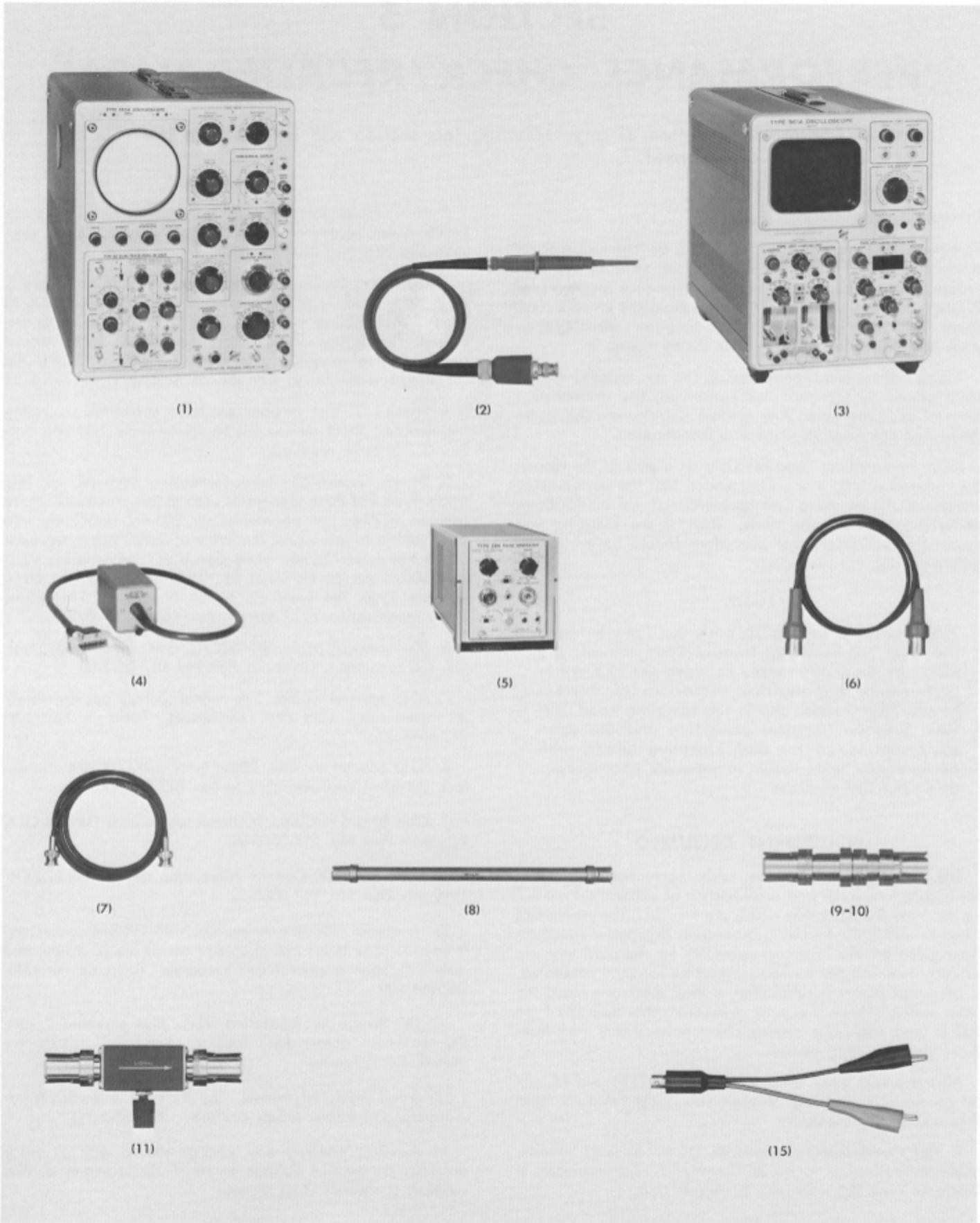


Fig. 5-1. Calibration Equipment.

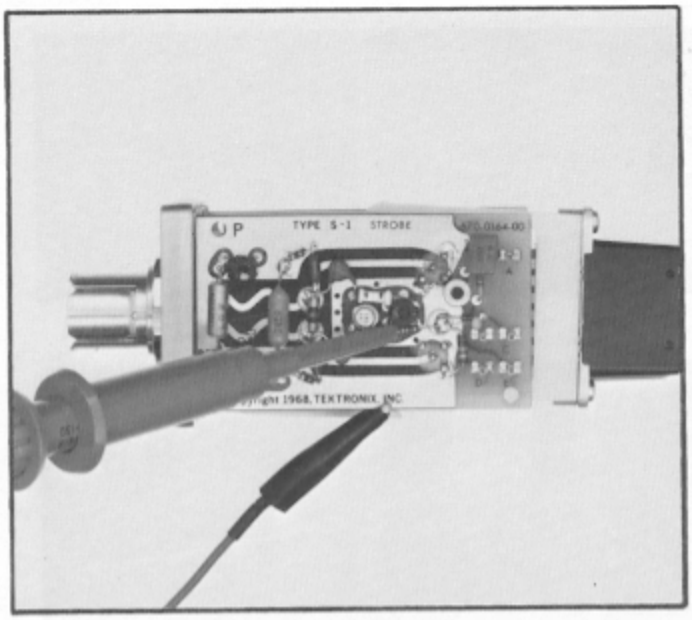


Fig. 5-2. Test oscilloscope 10× probe connected to Q69 emitter.

15. A clip lead to BNC adapter. Tektronix Part No. 013-0076-00.

PERFORMANCE CHECK AND RECALIBRATION RECORD AND INDEX

The following abridged procedure may be used as a guide by the experienced technician for checking and/or recalibrating either the Type S-1 or the Type S-2 Sampling Head. The abridged procedure can be used as a maintenance record (the procedure may be reproduced without special permission of Tektronix, Inc.). The step numbers and titles are identical to those in the complete procedure.

Sampling Head Type S-_____ Serial No. _____

Calibration Date _____

Calibrated By _____

Checked By _____

☐ 1. Check for Operation and Ability To Produce a CRT Display — Page 5-5

☐ 2. Check For Q69 (Avalanche) Operation — Page 5-5

☐ 3. Check 10% to 90% Risetime — Page 5-6

☐ 4. Adjust Risetime — Page 5-9

☐ 5. Check Dot Response Linearity — Page 5-11

☐ 6. Preliminary Bridge Bal Adjust — Page 5-13

☐ 7. Adjust Transient Response (Blow-By) — Page 5-13

☐ 8. Check Pulse Flatness Deviation — Page 5-13

☐ 9. Check Trace Shift From 30 Hz to 50 kHz — Page 5-15

☐ 10. Final Bridge Bal Adjust — Page 5-15

☐ 11. Check Tangential Noise — Page 5-15

PRELIMINARY PROCEDURE

1. Check the sampling head 50 Ω DC input resistance. With the sampling head separated from the sampling unit, use a DC Resistance Bridge and measure the DC input resistance. Connect one lead to the input connector outer conductor, and the other lead to the center conductor. Be sure the bridge does not apply more than ±2 volts to the input terminals.

The sampling head input resistance must be 50 Ω, ±1%.

If the input resistance is high, examine the trigger pickoff resistance divider with an ohmmeter. R3 can be measured by removing the Preamplifier board from the head and measuring between the center pin of J3 and the center pin of J1. R10 can be measured from the center pin of P3 to ground. If either of these resistors is open, the sampling head DC input resistance will be out of tolerance on the high side.

If the input resistance is low, and if the voltage applied by the bridge exceeds 0.6 volt, check for a shorted capacitor among C5, C6, C7 and C8. If changing the input polarity from the DC bridge produces a proper resistance reading, the conduction path can be traced through the one sampling diode that does conduct, to help locate the defective part.

If the termination resistor is itself out of tolerance, it is recommended that the sampler board be returned to Tektronix for repairs. The resistor assembly (R4, R3 and the ground clip) is available for making repairs at the time of recalibration. If replacement is attempted, it is very important that no solder be permitted to flow onto the area of sampling diode contact.

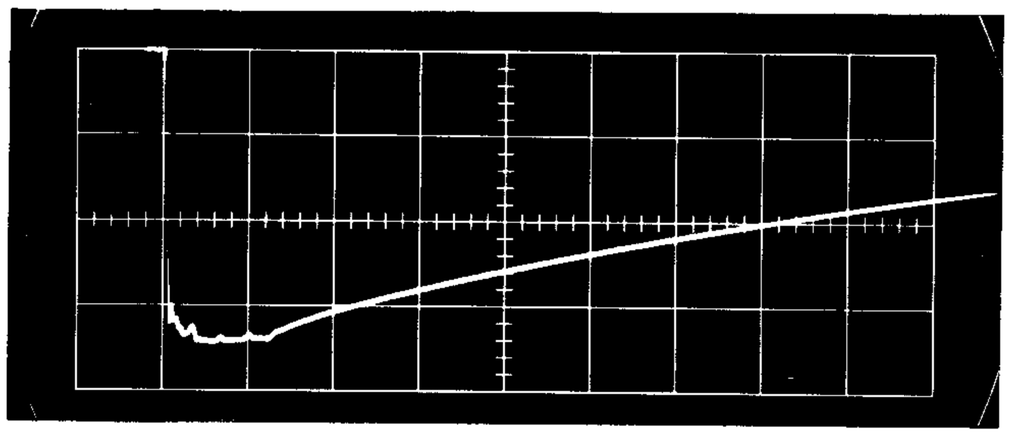
Complete any needed repairs to the sampling head before proceeding.

2. Connect the sampling head and oscilloscope system. This step discusses the assembling of testing equipment, 5-minute warmup period, and setting of the vertical and horizontal plug-in unit Gain controls.

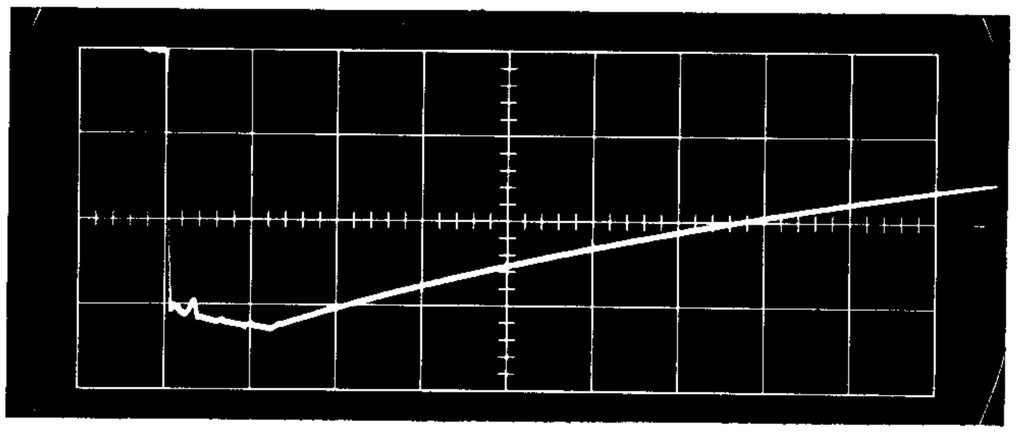
a. Assemble the indicator oscilloscope system. Place the Type 3S2 (or other Sampling Unit) into the left compartment of the indicator oscilloscope, and the Type 3T2 (or other Sampling Sweep Unit) into the right compartment. Install an operating sampling head into the Type 3S2 Channel B compartment. Leave the Channel A compartment vacant. (If using a Digital Readout unit, make the interconnections to the indicator.)

b. Connect the RMS line-voltage meter to the power mains. Determine that the oscilloscope (and other equipment) power supply is set for the correct value of line voltage. Connect all the equipment to the proper power outlet and turn on the power. Obtain a free-running trace and let the equipment warm up for five minutes.

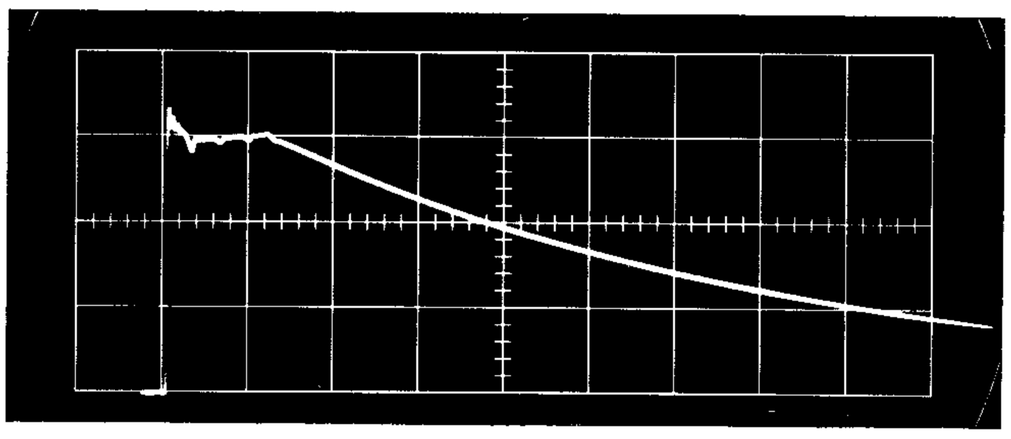
c. After the warm-up period, adjust the indicator oscilloscope Trace Alignment control so the free-run trace is parallel to the graticule lines.



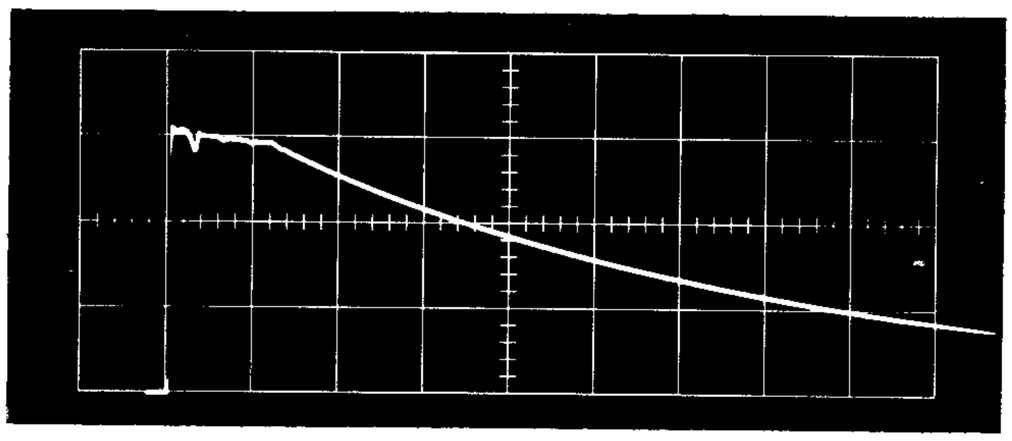
A. S-1, Q69 Collector.



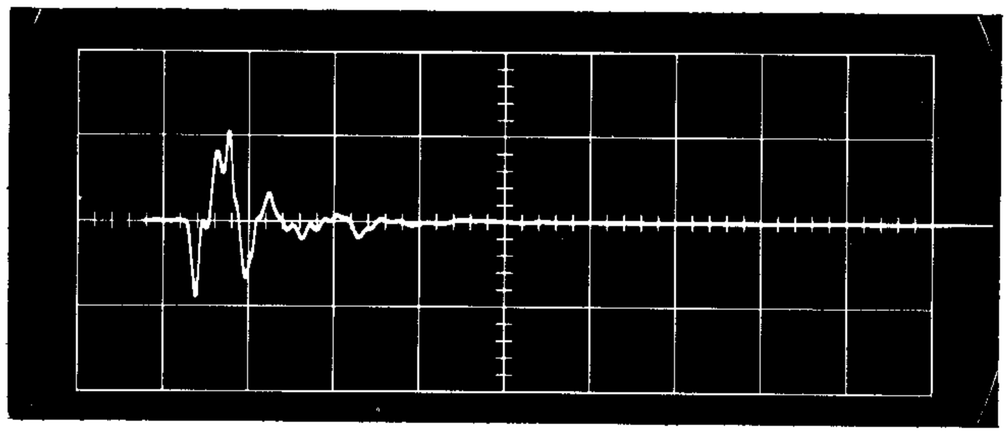
D. S-2, Q69 Collector.



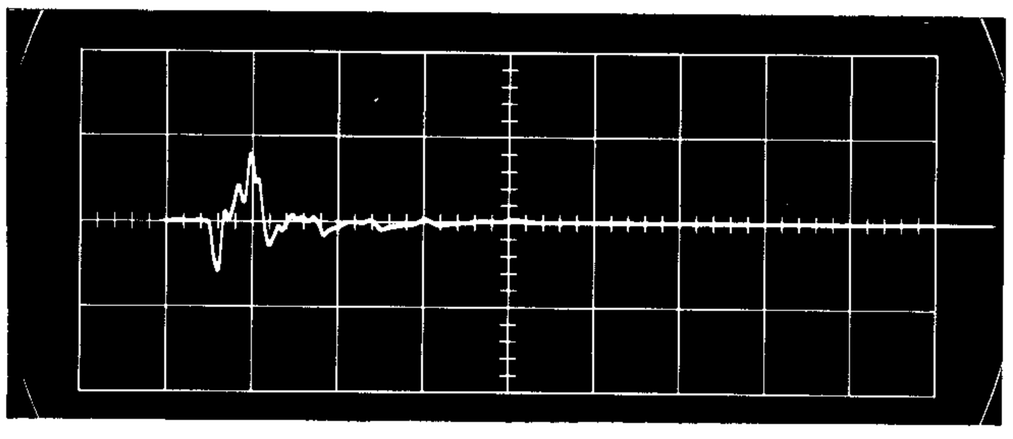
B. S-1, Q69 Emitter.



E. S-2, Q69 Emitter.



C. S-1, T75 Primary.



F. S-2, T75 Primary.

85 MHz test oscilloscope, P6008 10X Probe with 4 inch ground lead.

A, B, D and E: 0.2 μs/div and 10 V/div.

C and F: 0.1 μs/div and 5 V/div.

Fig. 5-3. Checking Avalanche drive and output.

NOTE

It is recommended that the recalibration procedure in the sampling unit instruction manual be completed before proceeding.

d. Connect the Type 284 Square Wave Output connector to the Channel B sampling head input. Use a 5 ns signal delay 50 Ω coaxial cable with GR 874 connectors (item 6 of equipment required). Connect the Type 284 Trigger Output connector to the sampling sweep unit External Trigger input (50 Ω) connector. Use a 5 ns signal delay 50 Ω coaxial cable with BNC connectors (item 7 of equipment required).

Adjust both the vertical and the horizontal unit Gain controls for proper deflection factor of each unit. Use the Type 284 100 ns period square wave as both a time and amplitude reference.

e. Install the sampling head to be recalibrated onto the special three foot extender cable (item 4 of equipment required). Connect the other end of the cable into the Type 3S2 Channel A sampling head compartment. (The sampling head should be in its case.) Allow a five minute warm up of the system.

CHECK AND RECAL PROCEDURE

1. Check For Operation and Ability to Produce a CRT Display

a. Connect the Type 284 Square Wave Output signal to the head to be calibrated. Then set the Type 3S2 controls for a Channel A display. If there is a square wave display, proceed to Step 3. If there is no square wave display or trace, do Step 2.

2. Check For Q69 (Avalanche) Operation

a. Remove the extender cable from the sampling head (the indicator oscilloscope power may be left on).

b. Remove the sampling head case. First, remove the four round-head screws visible at the back of the unit; then, slide the cover off by gently pulling it away from the front casting and input connector.

c. Reconnect the extender cable to the rear of the sampling head, being certain that the trigger pickoff coaxial connector mates with the coaxial connector of the extender cable. Use the signal set-up of step 1.

d. Use the test oscilloscope with 10× Probe, to check for proper operation of Q69. The probe connections are shown in Fig. 5-2, and the general nature of the signals is shown in Fig. 5-3. Fig. 5-3A and B show the general amplitude for Q69 collector and emitter signals in a Type S-1 Sampling Head. Fig. 5-3D and E show Q69 signals in a Type S-2 Sampling Head. Fig. 5-3C and F show the S-1 and S-2 typical drive signals at T75 primary (square terminal E) while the head is on the extender cable.

If T75 is receiving drive, but there is no signal out of Q69, change Q69 (changing Q69 may significantly increase the displayed noise, so it is best to have several transistors of this type on hand and grade them for low noise using step 11). If all signals of Fig. 5-3 are present, check the Preamplifier output (square terminal D). If there is not signal at the Preamplifier output, check the sampling diodes and Q31 in the following manner.

(1) Pull Q41 from its socket. Set the Type 3S2 DC Offset control for zero volts at the front panel Offset jack. Free run the time base unit. Use the test oscilloscope, with 10× probe, and monitor the drain lead of Q31.

(2) Q31 will have a pulse signal at each strobe time if the transistor is operating. If there is no pulse signal, change Q31, reinstall Q41 and try to obtain a trace.

(3) If Q31 is operating, and if there is a pulse of either polarity at its drain lead (with Q41 out), operate the BRIDGE BAL control (R22) through its range. As R22 is changed, the pulse signal should reduce to zero and change to the opposite polarity. If the pulse signal does not change polarity, one of the sampling diodes is open.

NOTE

The sampling diodes are very fragile and replacements are expensive. The white plastic clip should not be distrurbed nor withdrawn unless you are certain that a diode is defective. If a diode is to be changed, reinsert the clip very carefully so that the diodes do not receive any physical shock as the clip ends drop into place. With extreme caution, it is possible to remove and replace a set of sampling diodes without damage.

(4) Restore Q41 to its socket. Once a display is obtained, go on to Step 4.

NOTES

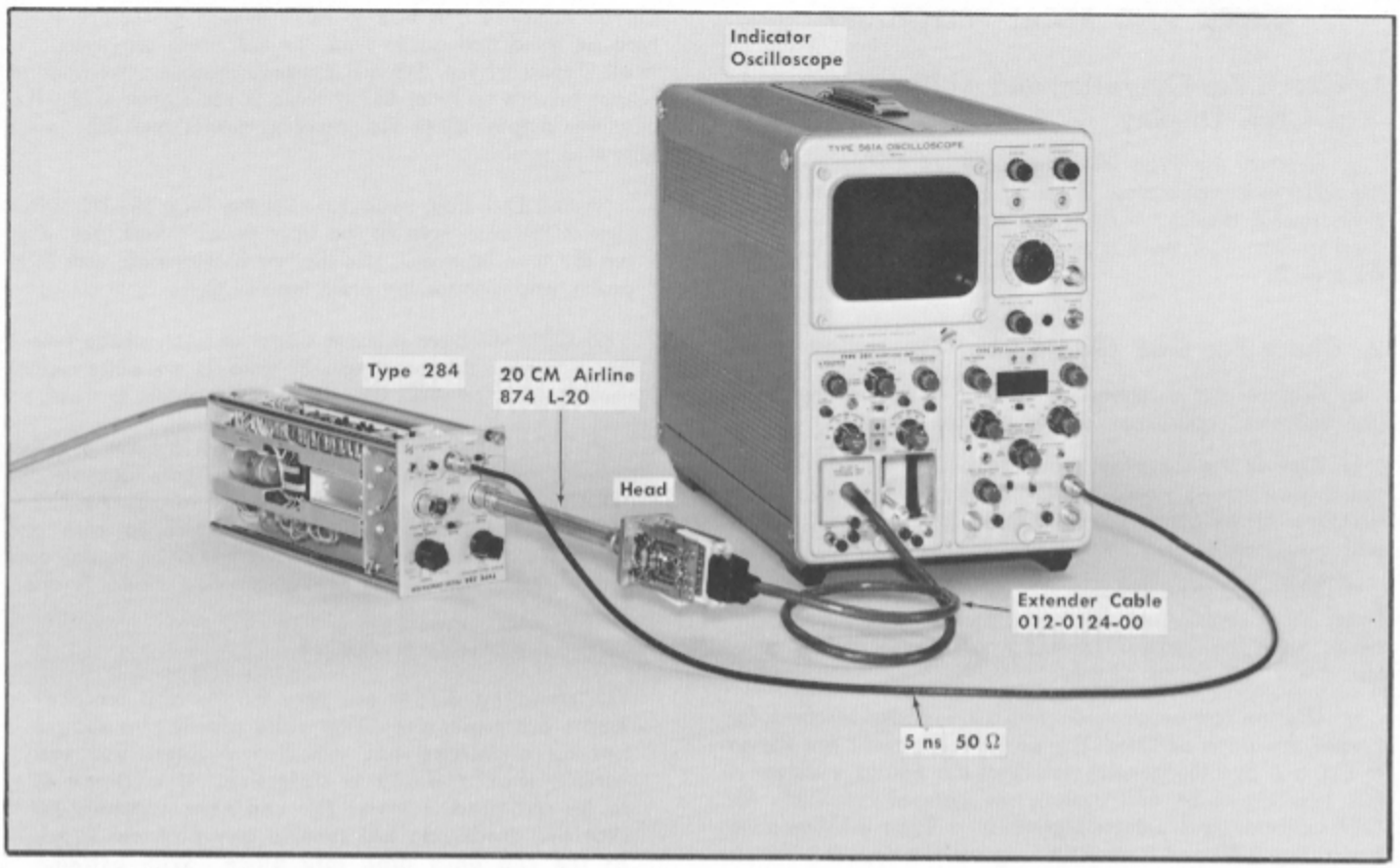


Fig. 5-4. Risetime check test equipment set-up.

3. Check 10% to 90% Risetime

NOTE

This step follows Step 1, and is to be performed with the case on the sampling head. If Step 2 was performed, ignore this step and proceed to step 4.

Requirement—The Type S-1 10% to 90% risetime is equal to or less than 350 ps.

The Type S-2 10% to 90% risetime is equal to or less than 50 ps, displayed as 86 ps or faster using the equipment setup shown in Fig. 5-4.

a. Connect the equipment shown in Fig. 5-4A or B, depending upon equipment in use. The extender cable is recommended, although not required. The cable permits easy access to the Type 284 TD Bias screwdriver control which is adjusted as part of this step.

Connections in Fig. 5-4 are:

(1) 20 cm 50 Ω air line between Type 284 Pulse Output connector and sampling head input connector. (No substitute signal cable is acceptable.)

(2) 5 ns signal delay 50 Ω coaxial cable (RG-58/CU, with BNC connectors) between Type 284 Trigger Output Jack and the sampling sweep unit External Trigger (50 Ω) input connector.

(3) Special 3 foot sampling head extender cable between the head and the Type 3S2 left side compartment connectors.

(4) If using digital readout, the proper cable between the oscilloscope and the digital unit, supplied with the Type 230.

NOTE

Instrument risetime can be checked either by visual measurement of the CRT display, or by a digital readout unit. Digital measurement of risetime requires that the Type 3T2 be operated in the With Trigger mode. With Trigger operation requires that the Type 284 trigger pulse have a leadtime of at least 73 ns before the fast Pulse Output signal. (Type 284 instruments with only 5 ns-50 ns Lead Time require the installation of Field Modification Kit, Tektronix Part No. 040-0487-00.)

CRT risetime measurement permits the Type 3T2 to operate in the Before Trigger (Random) mode, in which the trigger leadtime does not have to be 73 ns.

The 73 ns stated here is required for the With Trigger mode when the sampling head is operating on a 3 foot extender cable and the trigger cable has a 5 ns signal delay. Less leadtime (about 70 ns) is required when the sampling head is installed in the Type 3S2 and the trigger cable signal delay is only 2 ns.

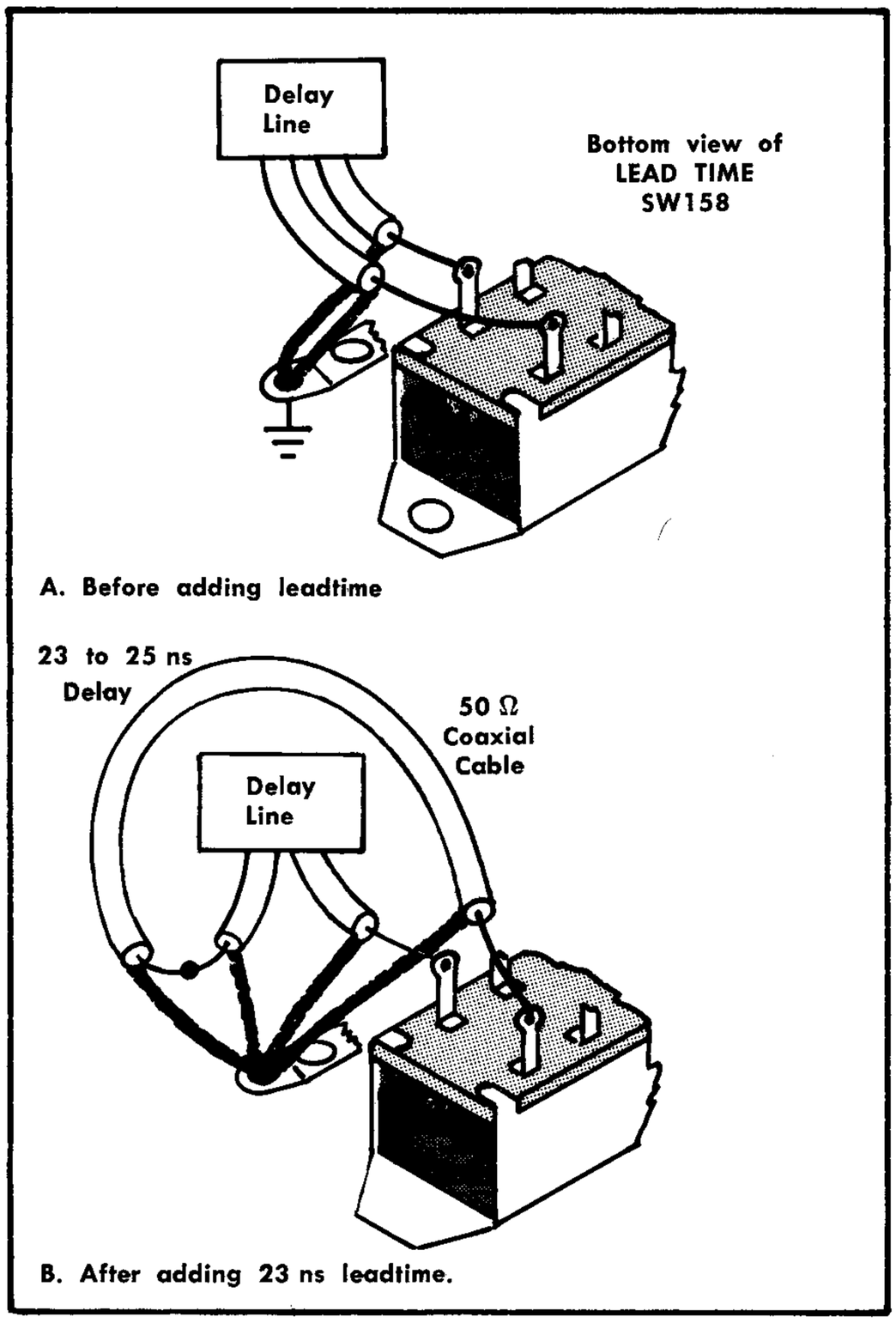


Fig. 5-5. Adding leadtime to an early model Tektronix Type 284 Pulse Generator.

Fig. 5-5 shows a substitute method of obtaining 73 ns trigger leadtime in an early model Type 284. If you install the recommended 23 ns signal delay cable shown in Fig. 5-5, operate the Type 284 with the case removed and adjust it as described in the following portions of this step.

Digital Readout of Risetime

Set the controls as follows:

Type 284

Mode	Pulse Output
Leadtime	75 ns
Other controls	Optional

Type 3S2

Normal-Smooth	Normal
Units/div	50
Variable	Cal
Mode	Channel A
Trig Out	Optional
Dot Response	Midrange
Other Controls	Optional

Type 3T2

Time Position	Fully clockwise
Fine	Midrange for centered display
Range	100 ns } 200 ps/div
Time Magnifier	×50 }
Variable	Cal
Display Mag	×1
Start Point	With Trigger
Display Mode	Normal
Trigger Source	Ext
Trigger Polarity	+
Trigger Sensitivity	10 o'clock
Recovery Time	Optional
Internal Samples/Div	100

Indicator Oscilloscope

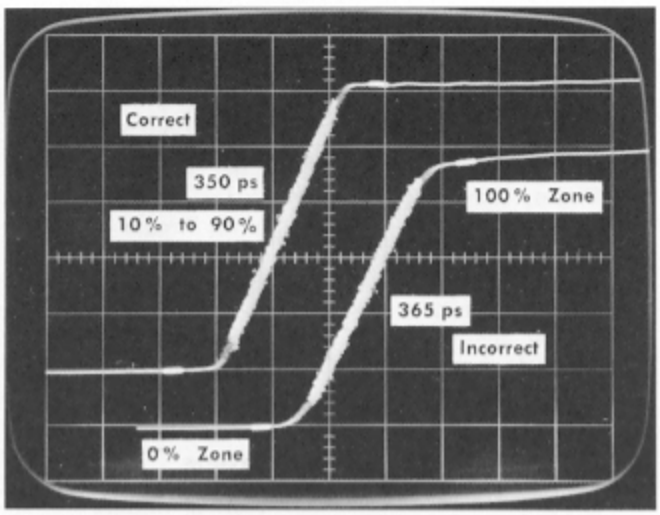
Intensity	Normal display
Scale Illum	As desired

Type 230

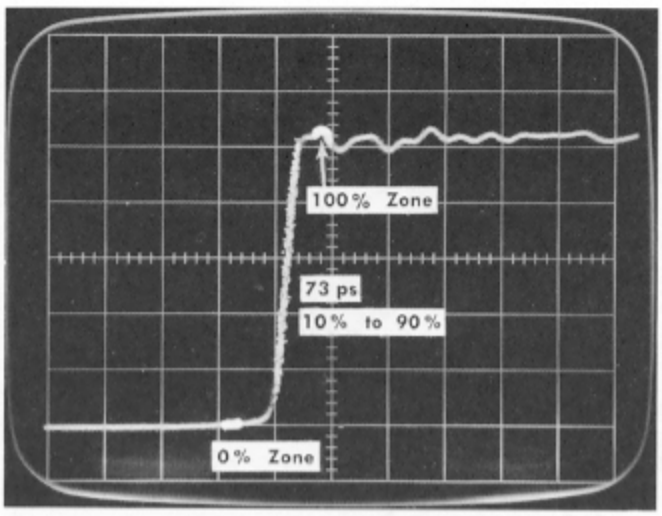
Measurement Averaging	8
CRT Intensification	Both Ref Zones and Time Measurement on
Measurement Mode	Time
CH A Reference Zones	Both at Average
Channel switches	Both at A
Time Measurement Start Point	10% Between Zones
Time Measurement Stop Point	90% Between Zones
Slope	Both at +1st
Display Time	Midrange
Triggered Measurement	Off
Limits	Optional

b. Use the Type 3T2 Fine Time Position control to position the pulse rise as in Fig. 5-6A or C.

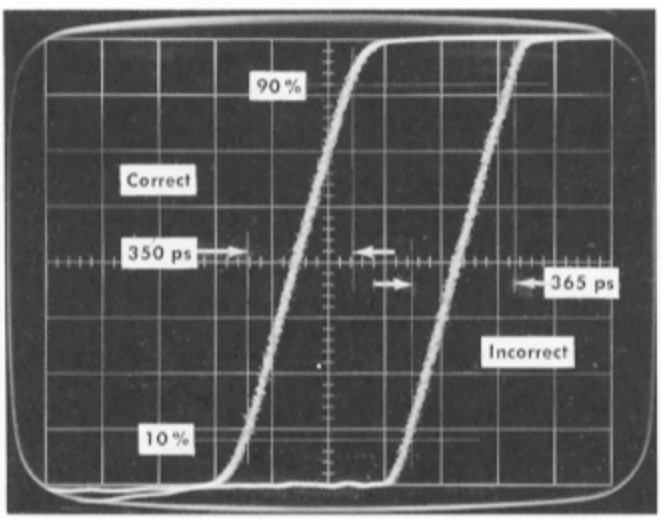
If a pulse display cannot be positioned into view, turn the Time Position to midrange (pulse display is off the CRT to the left) and adjust the Type 284 TD Bias control. Start by turning the TD Bias control fully counterclockwise. This assures that there is no pulse output and the indicator oscilloscope trace should be positioned two divisions up from the lower edge of the graticule. Slowly turn the Type 284 TD Bias control clockwise to a midrange position that causes the indicator oscilloscope trace to jump up about 5 divisions. (Repeat, so the control is at a position that just causes the trace to be up.) Set the Type 3T2 Time Position controls fully clockwise. If the indicator oscilloscope trace remains up 5 divisions without displaying a positive pulse, there is not sufficient leadtime in the triggering signal path. Shorten the 5 ns signal delay cable to the Type 3T2 Ext Trig 50 Ω input connector to 2 ns signal delay, and try again. Or operate in Channel B and use the B Delay control to gain more display leadtime. (An additional 2 ns trigger leadtime can be obtained by clockwise rotation of the Type 284 Snap Current control, R174, but at a cost of slowing the rate of rise of the fast Pulse Output signal. The recommended setting of R174 is about 30° from the counterclockwise stop, and at a



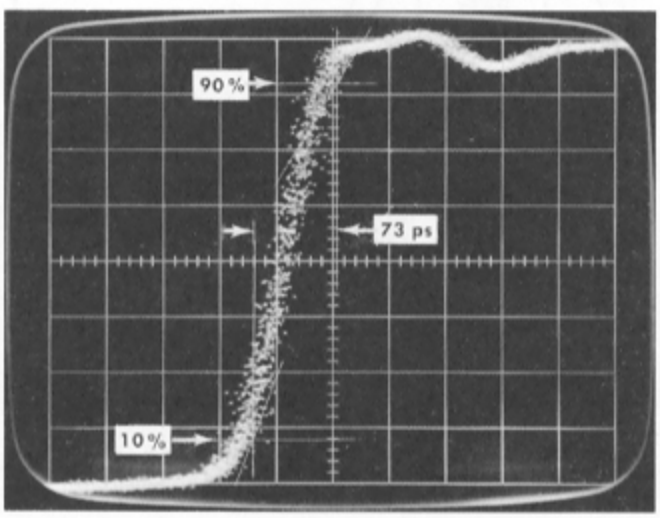
A. S-1. Digital risetime checks.



C. S-2, Digital risetime check.



B. S-1, CRT-measured risetime checks.



D. S-2, CRT-measured risetime checks.

A and C taken using Type 568 and Type 230 Digital Unit.
B and D taken using a Type 561A.

A and C: Type 3T2 internal Samples/Div switch at 100.
B and D: Type 3T2 internal Samples/Div switch at Variable.

A, B and C: 200 ps/div, Type 3T2 in With Trigger mode.
D: 50 ps/div, Type 3T2 500 ps/div and X10 Display Mag in With Trigger mode.

Fig. 5-6. Sampling Head risetime check displays. Left is correct. Right is slow due to clockwise rotation of Avalanche Volts control.

position where the displayed pulse time jitter is the least. Adjusting R174 for least trigger jitter (near its counterclockwise end) usually speeds the fast Pulse Output so the pulse risetime is about 45 or 50 ps.)

c. Once a pulse display is obtained, position it and the digital 0% and 100% zones as shown in Fig. 5-6A or C. Read the risetime from the Digital Unit. With the Type 3T2 Time Magnifier at ×50 for 200 ps sweep rate, 350 ps will be read as +0.350 NS, and 75 ps will be read as +0.075 NS.

If the Type S-1 risetime is 350 ps or less, proceed to Step 5.

If the Type S-2 risetime is 86 ps or less, proceed to Step 5.

If the risetime of the sampling head is too slow, perform Step 4.

CRT Measurement of Risetime

Set the Type 3T2 controls.

Internal Samples/Div	Variable
Front Panel Samples/Div	9 o'clock
Start Point	Before Trigger

Trig Sensitivity	Clockwise to free run until a trace appears (several seconds), then back to 10 o'clock area for least trigger jitter.
Time Position	Counterclockwise until step pulse appears.

The Type S-1 risetime can be measured at 200 ps/div sweep rate with the Type 3T2 Range and Time Magnifier controls as set in the digital readout step.

The Type S-2 risetime can best be measured at 50 ps/div sweep rate. Set the Type 3T2 controls:

Range	100 ns
Time Magnifier	×20
Display Mag	×10

For either type head, use the Type 3S2 Units/Div Variable control to obtain an 8 division vertical display.

Most accurate risetime measurement from the CRT is made by taking a photograph. Scribe the photo in a manner similar to that done in Fig. 5-6B or D.

If the Type S-1 risetime is 350 ps or less, proceed to Step 5.

If the Type S-2 risetime is 86 ps or less, proceed to Step 5.

If the risetime of the sampling head is too slow, perform Step 4.

4. Adjust Risetime ❶

Adjusting the risetime of either type sampling head uses basically the same procedure. The displays are different due to the difference in risetime and noise limits.

a. Each internal control has its particular effect upon sampling head operation. The list below gives the general effect of each control.

Control	Function
Avalanche Volts, R66	Alters strobe pulse amplitude and risetime, which effects the display risetime and dot response. Clockwise rotation makes risetime slower.
Snap-Off Current, R57	Alters dot response and display noise. Must be adjusted any time Avalanche Volts is changed.
Gain, R46	Alters dot response (by changing the feedback loop gain).
Bridge Volts, R26	Sets sampling diodes reverse voltage. Decreasing the bridge volts (counterclockwise rotation) slows display risetime by permitting a longer diode conduction time due to fixed amplitude strobe pulses. Keeping the Bridge Volts near maximum (clockwise) allows better sampling dot response linearity as well as a larger input signal dynamic range.
Bridge Bal, R22	Introduces an internal offset voltage to the feedback loop to cancel normal error signals in the sampling loop, including normal unbalance in the sampling bridge. R22 is adjusted (with DC Offset at zero) to cancel most of the trace vertical shift as the Units/Div switch position is changed.
Transient Response, R13	Adjusts the magnitude of blow-by correction signal. (Not important when setting risetime.)

NOTE

It is usually possible to achieve a risetime value less than that quoted in Section 1 for both the Type S-1 and the Type S-2. The faster risetime is possible while also meeting the other specifications of noise and pulse flatness deviation. A single CRT measurement of risetime is usually adequate to check for proper sampling operation. An exact figure of the system (pulser, coaxial cable, and sampling head system) risetime can be more easily obtained by use of a digital readout unit. The digital readout figure can be accepted as the risetime of the Type S-1 itself if the Pulser used is as fast as the Type 284. However, the digital readout of a Type S-2 system risetime is that of the system and not just the S-2 alone. The procedure below is not specifically limited to use with either form of risetime measurement; therefore, if you use a digital system, set the digital unit controls as listed in Step 3. Risetime adjustment is given as the first recalibration step, because any time the Avalanche Volts control setting is changed, it is necessary to also adjust R57, R46 and R22 in that order.

b. Remove the sampling head cover. The head must be on an extender cable for access to all controls. Make the connections shown in Fig. 5-4. Set the controls as in Step 3. Preset the sampling head internal controls (see Fig. 5-7):

Type S-1

BRIDGE VOLTS	Fully Clockwise
GAIN	30° from clockwise end

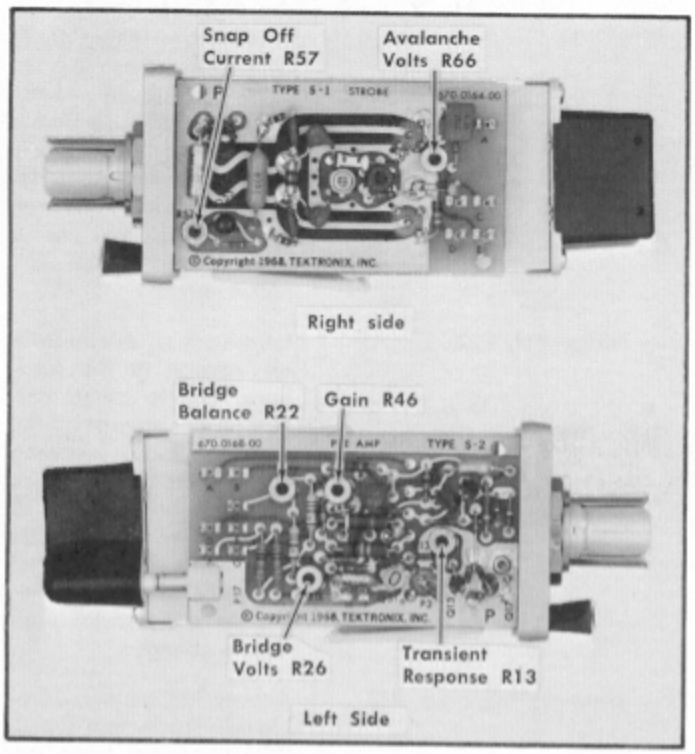


Fig. 5-7. Sampling head control locations.

Type S-2

BRIDGE VOLTS	Fully Clockwise
GAIN	Fully Clockwise

Leave the other head controls as perviously adjusted.

Type S-1 Procedure

c. Operate the Type 3T2 with the Start Point switch at With Trigger. Obtain a display of the pulse rise.

Assuming that the risetime is slow, adjust the Avalanche Volts control about 5° counterclockwise. Fig. 5-8B shows a triple exposure of the effects of changing the setting of the AVALANCHE VOLTS control. Both the vertical and horizontal changes were caused by the AVALANCHE VOLTS control only; the vertical and horizontal Position controls were not touched.

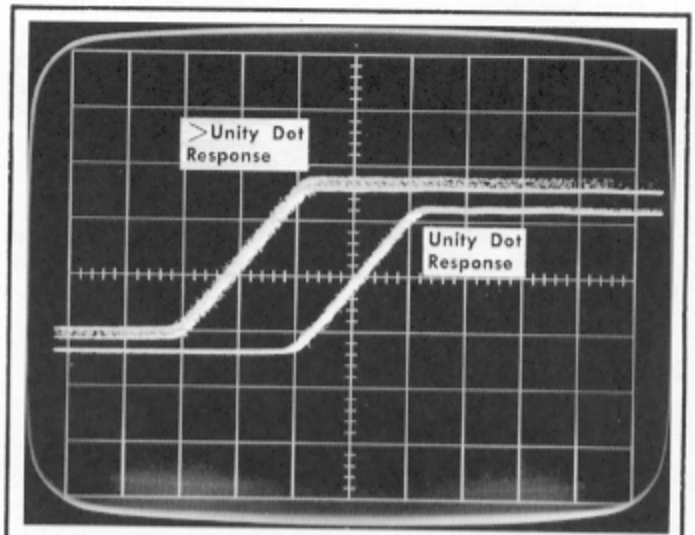
Check the risetime and do (d.) below. Then continue to adjust the AVALANCHE VOLTS control until the risetime is 350 ps or less, 10% to 90%. Repeat (d) again.

d. Operate the Type 3T2 with the Start Point switch at Before Trigger. Obtain a display of the pulse rise.

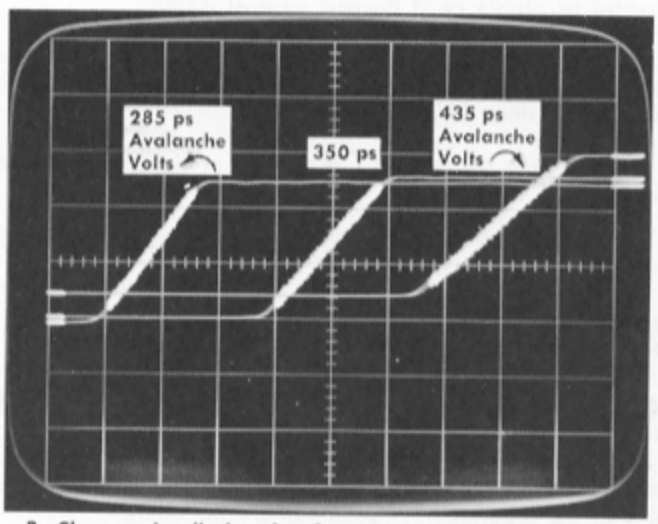
Adjust the SNAP-OFF CURRENT control to minimize loop gain. This is done by first using the Type 3S2 Dot Response control to determine whether the display dot response is more than or less than unity. If it is less than unity, adjust the SNAP-OFF CURRENT control to reduce the trace vertical spread. If the dot response is more than unity, adjust the SNAP-OFF CURRENT control to increase the trace vertical spread. (See Fig. 5-8A)

NOTE

The Type S-1 will in some cases have less display noise when adjusted for a risetime faster than 350 ps. The practical adjustment limit lies with the range of both the SNAP-OFF CURRENT and the GAIN controls. If the AVALANCHE VOLTS control is adjusted for too fast a risetime, one or both of the other controls will reach the end of its adjustment range and prevent proper calibration.



A. Dot response check.



B. Changes in display for 3 positions of Avalanche Volts control.

Fig. 5-8. Type S-1 displays for step 4. Sweep rate: 200 ps/div.

As the SNAP-OFF CURRENT control is turned, the display will move. The display shift is in the form of a rising or a dipping arc. The vertical component of the display movement is a result of a change in SNAP-OFF CURRENT, rather than any signal input change. The peak of the arc in either the positive or the negative direction occurs very near the point at which maximum loop gain occurs. Set the SNAP-OFF CURRENT control to the point where the display is at the peak of the arc, rather than precisely at maximum loop gain. This produces minimum display noise with proper risetime.

e. Set the Type 3S2 Dot Response control to its electrical midpoint. The electrical midpoint is found by watching the

changes in trace spread through the total range of adjustment of the control. Set the dot response for a trace spread halfway between maximum loop gain and minimum loop gain.

Now adjust the Type S-1 GAIN control for unity dot response as indicated at the right of Fig. 5-8A.

Type S-2 Procedure

f. Operate the Type 3T2 with the Start Point switch at With Trigger. Obtain a display of the pulse rise.

Adjustment of the Type S-2 AVALANCHE VOLTS and SNAP-OFF CURRENT controls is made with the GAIN control at maximum and the Type 3S2 Dot Response control set to its electrical midpoint (see e. above).

NOTE

Before touching the AVALANCHE VOLTS control, check that the Type 284 Pulse Generator Snap Current control (R174) is adjusted near the counterclockwise end of rotation. R174 is correctly adjusted when the displayed pulse horizontal time jitter is at a minimum. Minimum displayed time jitter is also obtained by careful adjustment of the Type 3T2 Trig Sensitivity control. After setting both the Pulse Generator Snap Current and the Type 3T2 Trig Sensitivity control, adjust the Type 284 TD Bias control for additional reduction in time jitter.

g. Adjust the Type S-2 AVALANCHE VOLTS control and then the SNAP-OFF CURRENT control for unity dot response. (See Fig. 5-9.) The procedure is to set the dot response to unity (at the pulse top) with the AVALANCHE VOLTS control to maximize loop gain. If this causes the dot response to be greater than unity, reduce it with the AVALANCHE VOLTS control and again miximize loop gain with the SNAP-OFF CURRENT control.

If the Avalanche Transistor, the Snap-off diode, and the two Sampling Bridge diodes are good, the system risetime will be on the order of 73 to 75 ps 10% to 90%.

As the Type S-2 SNAP-OFF CURRENT control is turned a continuous vertical shift of the display occurs with a slight slowing of the rate near maximum loop gain. The final setting of the SNAP-OFF CURRENT conrol is at the slowed rate of vertical shift, almost coincident with maximum loop gain.

h. Check the risetime (as shown in Fig. 5-6C or D). It must be $\leq$ 86 ps 10% to 90%, and will probably be closer to 75 ps. (The 86 ps limit is calculated for the conditions of a 70 ps risetime Type 284 pulse, and a 50 ps risetime Type S-2.)

NOTE

If in the previous risetime adjusting step the sampling sweep unit is not a Type 3T2, random sampling is not available to show dot response. In this case, each time the dot response is to be checked, the signal and sweep rate and triggering must each be changed. The proper procedure for checking dot response using a Type 3T4 or Type 3T77A sampling sweep unit follows.

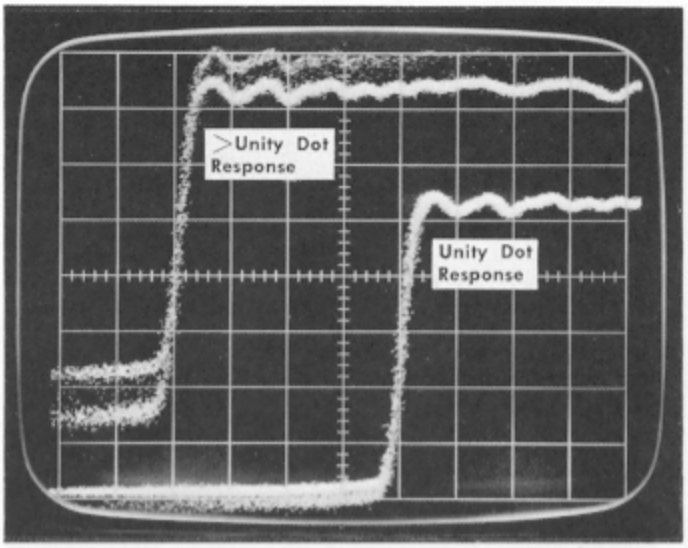


Fig. 5-9. Double exposure of Type S-2 Dot Response. (Type 3T2 operating at Before Trigger.)

1. Set the Type 284 Period switch to 1 μs, the Mode switch for a square wave output and the Square Wave Amplitude control for 1.0 V output. Install the variable attenuator between the Type 284 and the sampling head input.

2. Set the sweep rate to 0.2 μs/Div. Remove the trigger cable from the Ext Trigger input connector and set the Trigger Sensitivity control clockwise for a free run trace. It then may be necessary to adjust the Recovery Time control for a proper display.

3. A proper Type S-1 dot response display is shown in Fig. 5-10C and D. Note that the amplitude is the same as the square wave signal of Fig. 5-10A when the Type S-1 dot response linearity is checked in the next step.

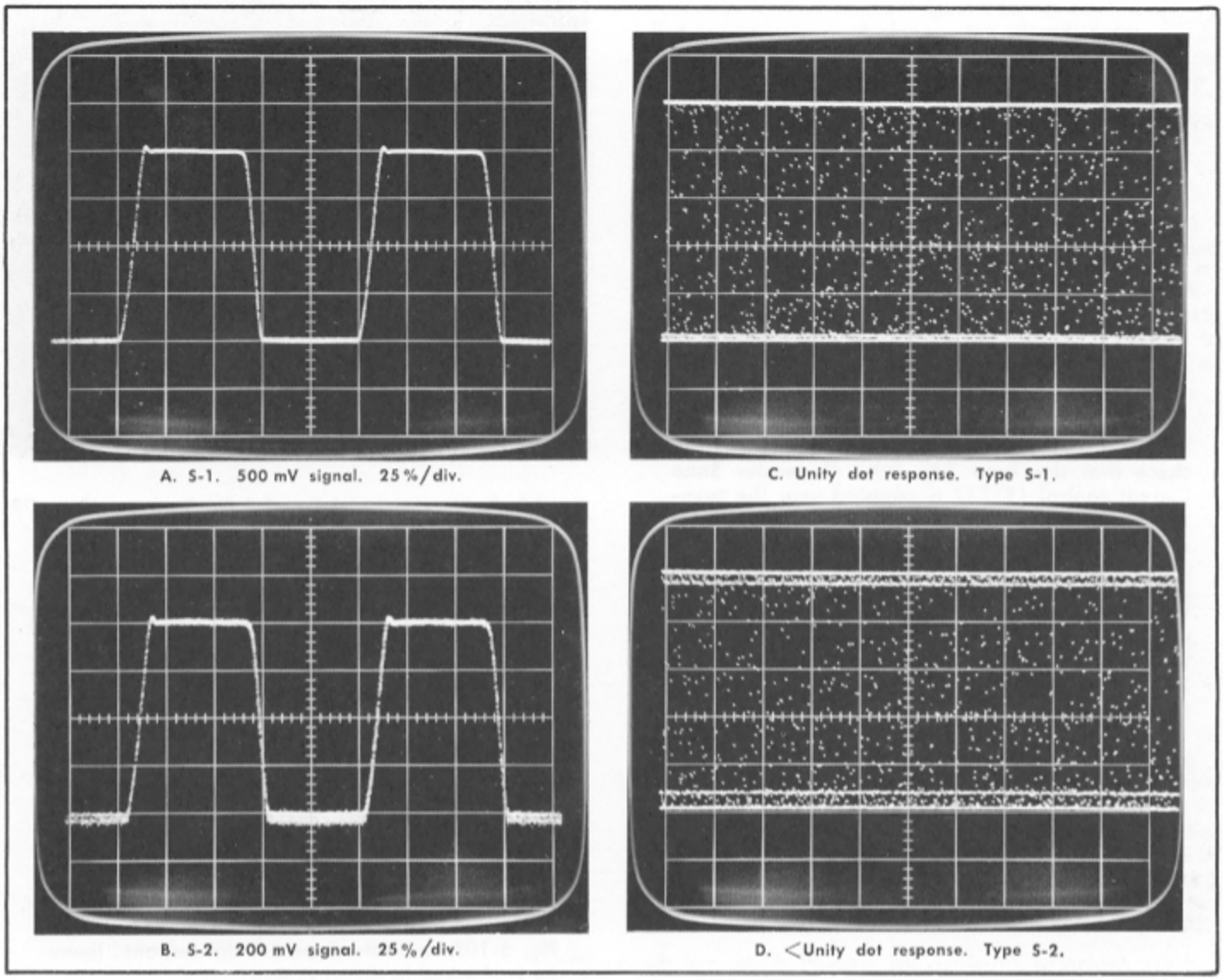
4. A proper Type S-2 display is four divisions, instead of the five shown. The photographs of Fig. 5-10C and D are time exposures of four sweeps, making the photos look similiar to the CRT display as viewed by the calibrating technician.

5. Thus, the preceding risetime adjustment step requires that the sampling head signal source be changed from the Type 284 fast Pulse Output to the Square Wave Output for checking dot response, when the sampling sweep unit is not a Type 3T2.

5. Check Dot Response Linearity

Requirement—Type S-1: Dot will move full amplitude ±5%, of any signal up to 500 mV peak to peak when sampling sweep unit is either double triggered or free run.

Type S-2: Dot will move full amplitude ±5%, of any signal up to 200 mV peak to peak when time base unit is either double triggered or free run.



A. S-1. 500 mV signal. 25%/div.

C. Unity dot response. Type S-1.

B. S-2. 200 mV signal. 25%/div.

D. <Unity dot response. Type S-2.

Fig. 5-10. A and B obtained with Type 3T2 in random mode. C and D with Type 3T4 or Type 3T77A at 0.2 μs/div, free run. No external trigger signal applied.

The connections between the Type 284 and the sampling head are changed in this step. The head can be either on the extender cable with or without the case installed, or it can be in the Type 3S2 with the case in place.

Connections between the Type 284 Square Wave Output connector and the sampling head input connector include attenuation. The attenuation can be attained either by fixed 50 Ω GR-874 type attenuators, or the special variable attenuator, item 11 of the equipment required list.

Attenuation is 2× for the Type S-1, and 5× for the Type S-2, when the Square Wave Amplitude is 1.0 volts.

a. Install the correct attenuator to the Type 284 Square Wave Output connector. Connect the output side of the attenuator to the sampling head input connector.

b. Set the Type 284 Period switch to 100 ns (set it to 1 μs when the sampling sweep unit is other than a Type 3T2). Set the Type 3T2 Range switch to 10 μs, the Time Magnifier to ×50 and the Start Point switch to With Trigger.

c. Set the Type 3S2 Units/Div switch to 100 when checking a Type S-1, and a 50 when checking a Type S-2. Obtain a triggered square wave display.

Type S-1: Set the With Trigger display amplitude to exactly 5 divisions (500 mV input). Then adjust the Type 3S2 units/div Variable control counter clockwise until the display is 4 divisions peak to peak. This sets the display at 25% per major graticule division.

Type S-2: Set the With Trigger display amplitude to exactly 4 divisions (200 mV input), or 25% per major graticule division.

d. Set the Type 3T2 Start Point switch to Before Trigger (or free run sampling sweep unit at 0.5 μs/div if not a Type 3T2). Obtain a triggered display.

Set the Type 3S2 Dot Response control so the top of the square wave is at unity loop gain (one trace). The bottom of the square wave can show two traces, but the dot response overshoot or undershoot must not be grater than 5%, or 1

minor graticule division. (5% of Fig. 5-10C or D is 1.25 minor graticule divisions.)

If the dot response overshoots or undershoots more than 5%, the problem is either unbalanced sampling bridge diodes, or unbalanced strobe pulses to the bridge. If no components on either the strobe generator board or the sampler board are broken (or unsoldered), change the sampling diodes after reading the Note in Step 2d. Damage to leadless ca-acitors is about the only way the strobe pulse amplitudes can be unbalanced, and this is unlikely with normal care of the instrument.)

6. Preliminary Bridge Bal Adjust ◐

a. Place the 20 cm air line on the sampling head input connector. Leave the other end of the line open.

Free run the sampling sweep to obtain a no-signal trace.

b. Set the Type 3S2 Offset control for zero volts at the front panel Offset jack. Use either the test oscilloscope or a bench multimeter to determine zero volts.

c. As the Type 3S2 Units/Div switch is operated through its ranges, adjust the sampling head BRIDGE BAL control (R22) for no more than one division of vertical shift in the trace. (This conirol adjustment varies with the case on or off the sampling head, and varies with changes in extender cable.)

7. Adjust Transient Response Control, R13 ◐

a. Connect the Type 284 Square Wave Output connector to the sampling head input. Use proper attenuation (or the variable attenuator) for 0.5 volt to the Type S-1, or 0.2 volt to the Type S-2.

Set the Type 284 Period switch to 1 μs. Set the sweep rate to 1 μs/div and obtain a triggered display.

b. The display should be one cycle per division with the square wave top and bottom flat (parallel to a graticule line). Fig. 5-11 is a double exposure showing a correct adjustment of the TRANSIENT RESPONSE control, and an incorrect adjustment. The tilt of the square wave can be either rising or falling when R13 is not correctly adjusted.

c. Adjust R13 so the square wave display is flat.

8. Check Pulse Flatness Deviation

Requirement—Type S-1: Pulse will not deviate from flat more than +½% to −3% for first 5 ns after pulse reaches 50% amplitude, nor will it deviate more than +½% to −½% (total of 1%) thereafter.

Type S-2: Pulse will not deviate from flat more than +5% to −5% for first 2.5 ns after pulse reaches 50% amplitude, nor will it deviate more than +2% to −2% (total of 4%) thereafter.

a. Connect the 20 cm air line to the Type 284 Pulse Output connector and the Sampling Head to the other end of the air line.

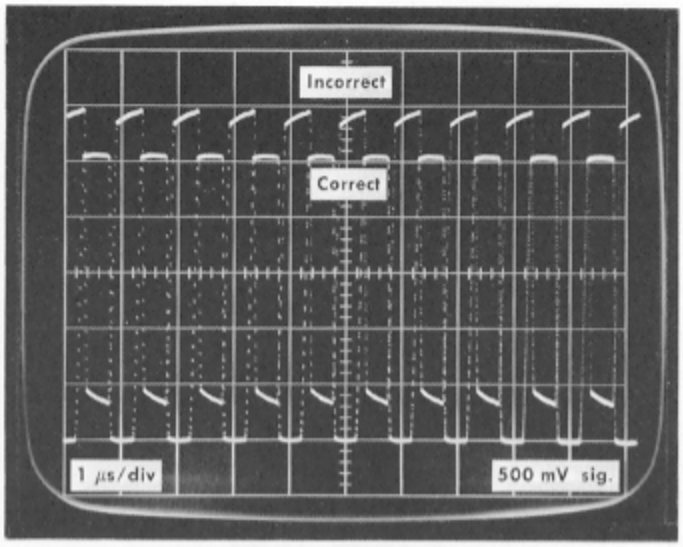


Fig. 5-11. Double exposure while adjusting R13, Transient Response control.

Type S-1

Set the sweep rate to 2 ns/div, and the vertical for a 5 div display at 100 mV/div (use the Variable if needed). Then change the mV/div control (without moving the Variable) to 5 mV/div or 1% per division. Bring the pulse top into view with the DC Offset control. See Fig. 5-12A.

Type S-2

Set the sweep rate to 1 ns/div, and the vertical for a 5 div display at 100 mV/div (use the Variable if needed). Then change the mV/div control (without moving the Variable) to 10 mV/div, or 2% per division. Bring the pulse top into view with the DC Offset control. See Fig. 5-13A.

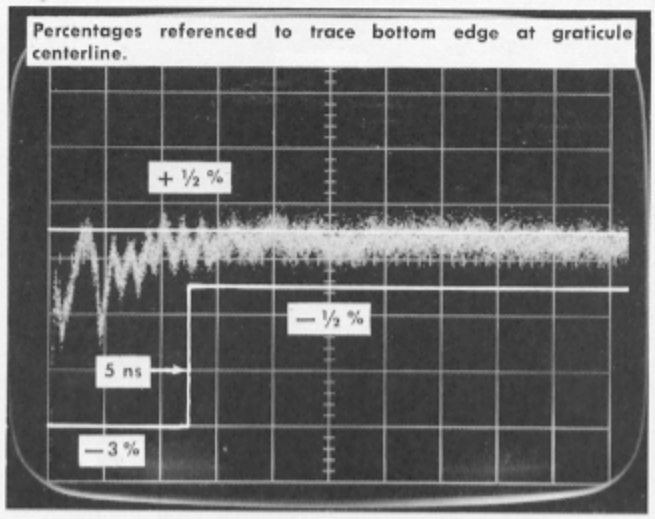
b. Time-position the display so the pulse rise is about a trace width inside the graticule edge. Check along the trace bottom for deviations as listed in the requirements, and as shown in Fig. 5-12 and Fig. 5-13.

Change the sweep rate as listed under the three parts of Fig. 5-12 and Fig. 5-13, and check for deviations as shown.

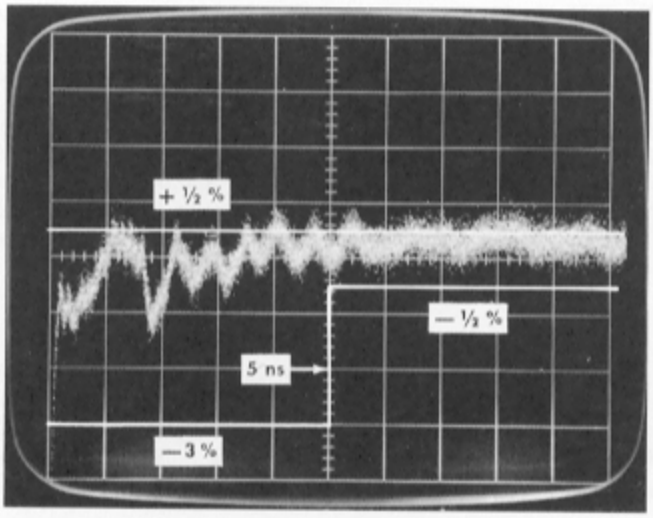
NOTE

The major dip 1.7 ns after the pulse rise is due to Type 284 Pulse Generator reverse termination. Some other minor aberrations are also due to the Type 284. The requirement limits include deviations that are part of the Type 284. Therefore, the limits apply only when testing with the Type 284, and with a 20 cm air line between the pulser and the sampling head.

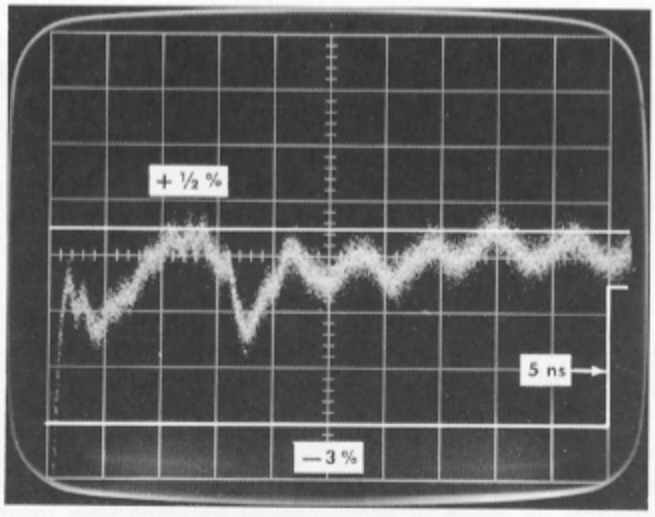
c. If either unit exceeds the pulse flatness deviation limits above, check the mechanical fit of the input connector. An improper (or loose) fit of the coaxial transition from round to flat at the Sampler Board input causes excessive aberrations when viewing a fast pulse. Also, check the solder connections between the round center conductor and the Sampler Board. See the Maintenance section of this manual.



A. 2 ns/div. 1 % /div.

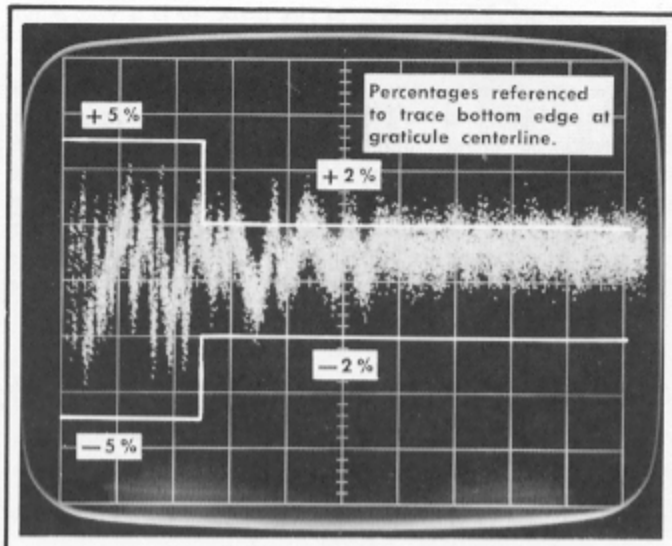


B. 1 ns/div. 1 % /div.

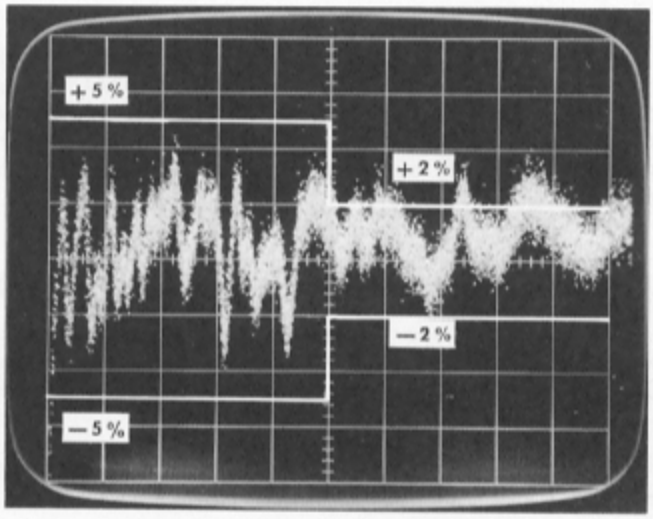


C. 500 ps/div. 1 % /div.

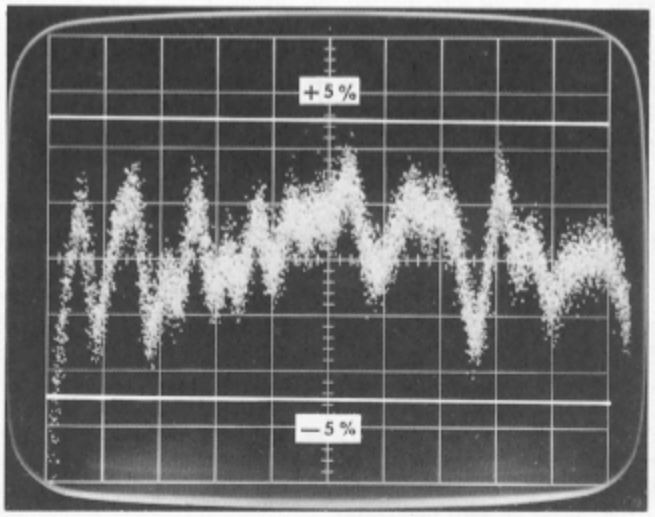
Fig. 5-12. Check of Type S-1 pulse flatness deviation. Step 8.



A. 1 ns/div. 5 mV/div = 2 % /div.



B. 500 ps/div. 5 mV/div = 2 % /div.



C. 200 ps/div. 5 mV/div = 2 % /div.

Fig. 5-13. Check of Type S-2 pulse flatness deviation. Step 8.

9. Check Trace Shift With Trigger Rate Change From 30 Hz to 50 kHz

Requirement—A no-signal trace will not shift vertically more than 10 mV when the time base external trigger rate is changed from 30 Hz to 50 kHz.

a. Use the test oscilloscope as a trigger rate generator. Use the front panel + Gate signal (+20 volts peak) to drive the time base external trigger input. Feed the + Gate directly to the Type 3T2 1 MΩ/UHF Sync connector and trigger on the — Polarity of the signal. (If the sampling sweep unit is a Type 3T4 or 3T77A, place a 10 kΩ ½ watt resistor between the test oscilloscope + Gate terminal and the time base external 50 Ω trigger input connector to provide 100 mV of triggering signal.)

Set the test oscilloscope A sweep controls for a free run sweep. To obtain a 30 Hz trigger signal, set the Time/Div switch to 0.5 ms and the Variable time/div control to a position about 45° left of top center. To obtain a 50 kHz trigger signal, set the Time/Div switch to 20 μs and the Variable time/div to a position 45° clockwise from bottom center.

b. Place either the 20 cm air line or a 50 Ω termination on the sampling head input connector. Set the sampling sweep unit for an external triggered sweep rate of 50 ns/div (to assure the shortest trigger circuit holdoff period, and that the triggering rate can actually follow the external triggering signal repetition rate.

c. Set the Type 3S2 Units/Div control to 10. Connect the external trigger rate generator signal to the sampling sweep unit and obtain a triggered sweep at either 30 Hz or 50 kHz repetition rate. Set the Type 3S2 DC Offset control to place the trace at one of the graticule lines.

d. Switch the trigger rate generator through its ranges to the other frequency limit and check that the CRT trace does not move up or down farther than a total of one division.

e. If the trace moves too far, change either the head avalanche transistor (Q69) or the sampling bridge diodes. Changing either of these parts requires starting this procedure again at Sep 1.

10. Final Bridge Bal Adjust

a. Place the sampling head case on the head, securing the four mounting bolts at the rear.

Fig. 5-14 shows the correct orientation of the sampling head case when reinstalling it. Note that the Preamplifier and Strobe Generator boards slide between part of the case and the zig-zag spring that runs from the front to the back. Correct case orientation places the one hole in the case over the Bridge Bal control. In sliding the case on, the white plastic locking latch must be fitted into part of the casting.

The rear casting cannot be mounted incorrectly because the trigger pickoff output coaxial connector fits through a hole in the casting. Place the rear casting in place before inserting the four long mounting bolts. Fit the rear casting and case in place by hand so there is no space between either end casting and the case before tightening the bolts.

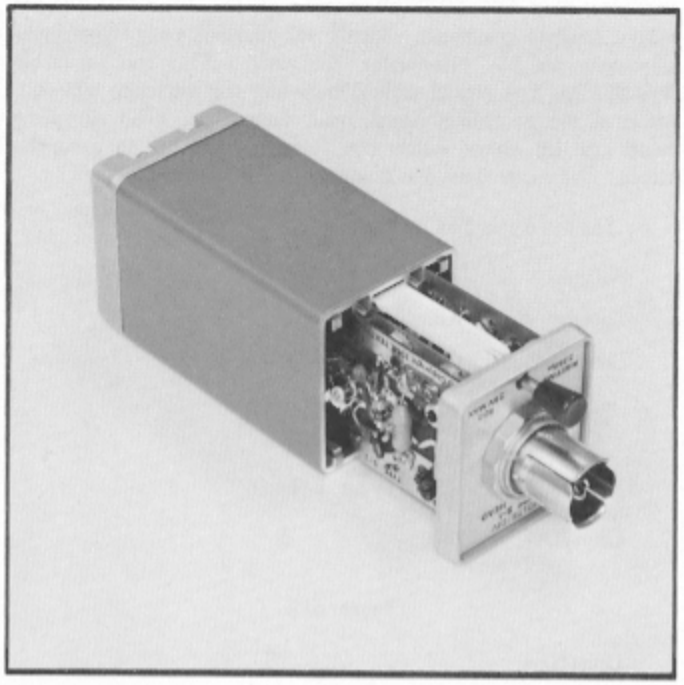


Fig. 5-14. Correct board and latch positions when reinstalling the Sampling Head case.

Place the 20 cm air line on the head input connector.

b. Place the head either inside the Type 3S2 Channel A compartment, or upon the extender cable with which it is normally used. If the head is not normally used on an extender cable, adjust the Bridge Bal control with the head inside the Type 3S2.

c. Free run the sampling sweep unit with a 50 ns sweep rate (a 3T4 or 3T77A at .5 μs/div). Set the Channel A DC Offset control for zero volts at the front panel Offset connector. Center the trace with the Position control.

d. Operate the Type 3S2 Units/Div switch through its ranges and adjust the BRIDGE BAL control (through the hole in the left side of the case) for not more than one division of vertical shift.

11. Check Tangential Display Noise

NOTE

When making a visual noise reading from a sampling display, the eye interprets a noise value which is neither the RMS nor the peak to peak value. Since most observers agree that the displayed noise value is approximately 3 times the RMS value, the Tangential Noise here defined is 3 times the RMS value. (The measurement technique given produces acceptable agreement between various operators as to the instrument's noise value.)

Requirement—Type S-1: Tangential noise will be not greater than 2 mV, with the case on the sampling head.

Type S-2: Tangential noise will be not greater than 10 mV, with the case on the sampling head.

a. Install a 5× 50 Ω attenuator on the Type 284 Square Wave Output connector. Install the special variable attenuator onto the 5× attenuator. Connect a 50 Ω coaxial cable (RG-58/CU, 5 ns signal delay) between the variable attenuator and the sampling head input connector. (The sampling head can be either inside the Type 3S2, or on an extender cable. The case must be in place on the head.)

b. Set the Type 284 controls:

Period	1 μs
Square Wave Amplitude	100 mV
Lead Time	Optional

c. Set the Type 3S2 controls:

Type S-1

Units/Div	5

Type S-2

Units/Div	20

d. Set the sampling sweep unit controls:

Trig Sensitivity	Clockwise - free run
Sweep rate	1 μs/div

Remove any external cable from the sampling sweep unit external trigger input connector.

e. Refer to Fig. 5-15 during the following noise measurement procedure.

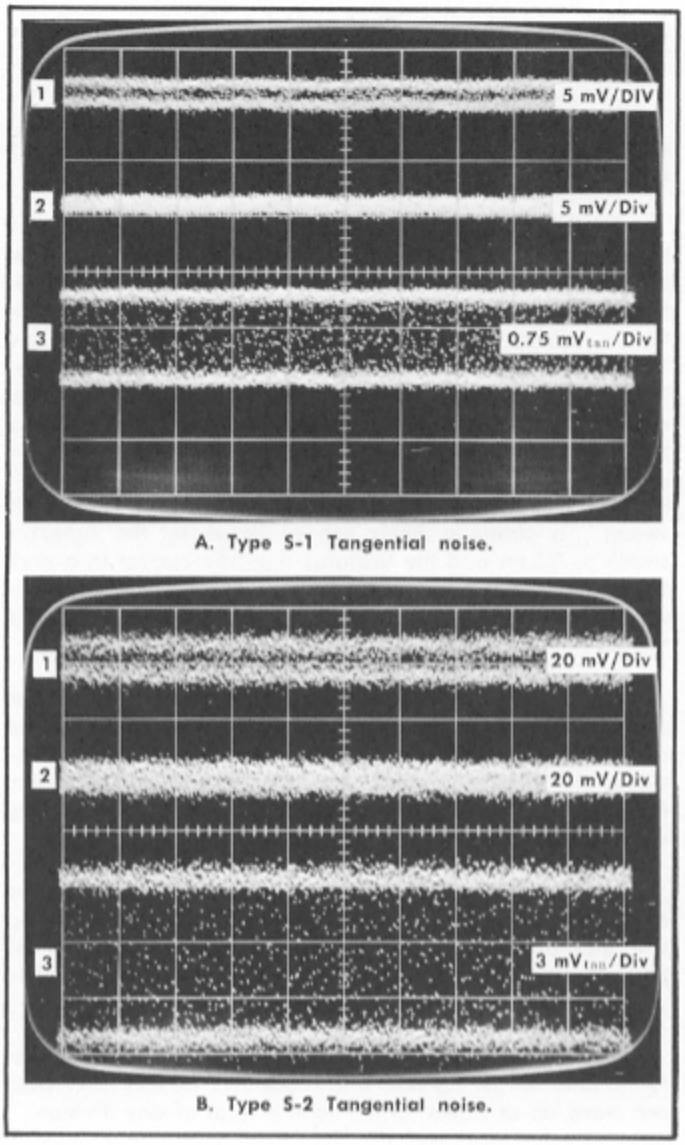
(1) Obtain a display (1) of two traces. Adjust the variable attenuator until the two traces blend together just to the point (2) at which they appear as one trace.

(2) **Type S-1**

Set the Type 284 Square Wave Amplitude control to 1.0 V (×10 signal amplitude). The display (3) now has a tangential deflection factor of 0.75 mV/div. ($E_{tangential}$ per division is equal to the Type 3S2 units/div setting of 5 mV divided by 2, times 3 divided by 10 = 0.75 mV/div.) Therefore, the 2 mV tangential noise limit includes 2.66 graticule divisions (3) of Fig. 5-15A. Check that the bottom edges of the two traces are not more than 2.66 divisions apart. Waveform (3) Fig. 5-15A measures as 1.1 mV tangential noise.

Type S-2

Set the Type 284 Square Wave Amplitude control to 1.0 V (×10 signal amplitude). The display (3) now has a tangential deflection factor of 3 mV/div. ($E_{tangential}$ per division is equal to the Type 3S2 units/div setting of 20 mV divided by 2, times 3 divided by 10 = 3 mV/div). Therefore, the 10 mV tangential noise limit includes 3.33 graticule divisions (3) of Fig. 5-15B. Check that the two traces bottom edges are not more than 3.33 divisions apart. Waveform (3) of Fig. 5-15B measures as about 8.8 mV tangential noise.



A. Type S-1 Tangential noise.

B. Type S-2 Tangential noise.

Fig. 5-15. Triple exposures of Tangential noise measurements, Step 11.

Determining Tangential Noise Deflection Factor

The noise displays (3 of Fig. 5-15A and B) have a noise deflection factor based upon the signal amplitude, the Type 3S2 Units/Div switch setting, the fact that the final trace separation is twice the RMS noise, and that the tangential noise is then 3 times the RMS noise. The square wave signal amplitude that makes two traces appear as one sets the trace separation to twice the RMS noise. The procedure used here then permits a noise deflection factor to be determined by dividing the input mV/div deflection factor by 2 (trace separation is 2 × the RMS noise), multipling by 3 (tangential noise is 3 × the RMS noise) and then dividing by 10 (the signal amplitude change complement).

f. If the tangential noise is outside the required limits, return to Step 4. In a Type S-1 choose an Avalanche Volts setting that produces minimum noise right after the pulse rise (in With Trigger sweep model). If it is impossible to obtain a sufficiently low noise figure, replace Q69 and repeat the rest of the procedure again.

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
◐	Screwdriver adjustment.
▭	Control, adjustment or connector.

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
°	degrees
°C	degrees Celsius (degrees centigrade)
°F	degrees Fahrenheit
°K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geqslant$	equal to or greater than
$\leqslant$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigahertz
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz
L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
+	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
Q	figure of merit
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference (see EMI)
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
$\ll$	small compared with
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub.	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xmfr	transformer

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Capacitors		
Tolerance ±20% unless otherwise indicated.						
C5	283-0133-00			5 pF	Cer	50 V	5%
C6	283-0133-00			5 pF	Cer	50 V	5%
C7	283-0137-00			7 pF	Cer		
C8	283-0137-00			7 pF	Cer		
C14	283-0136-00			10 pF	Cer	50 V	5%
C19	283-0121-00			0.001 μF	Cer	200 V	
C28	290-0188-00			0.1 μF	Elect.	35 V	10%
C34	283-0067-00			0.001 μF	Cer	200 V	10%
C40	283-0067-00			0.001 μF	Cer	200 V	10%
C43	290-0246-00			3.3 μF	Elect.	15 V	10%
C44	283-0003-00			0.01 μF	Cer	150 V	
C45	283-0066-00			2.5 pF	Cer	200 V	
C46	283-0000-00			0.001 μF	Cer	500 V	
C49	283-0003-00			0.01 μF	Cer	150 V	
C51	283-0121-00			0.001 μF	Cer	200 V	
C53	283-0121-00			0.001 μF	Cer	200 V	
C55	290-0134-00			22 μF	Elect.	15 V	
C59	283-0072-01			0.01 μF	Cer		
C63	283-0103-00			180 pF	Cer	500 V	5%
C64	283-0103-00			180 pF	Cer	500 V	5%
C65	283-0005-00			0.01 μF	Cer	250 V	
C69	281-0612-00			5.6 pF	Cer	200 V	±0.5 pF
C71	283-0121-00			0.001 μF	Cer	200 V	
				Semiconductor Device, Diodes		
D5, D6	*152-0361-00			GaAs, matched pair		
D41	*152-0185-01			Silicon	Replaceable by 1N4152	
D61	*152-0335-00			Silicon	Snap-Off	
				Inductors		
L12	276-0543-00			Core, Ferrite		
L17	276-0543-00			Core, Ferrite		
L55	*120-0382-00			Toroid, 14 turns		
L60	*108-0170-00			0.5 μF		
L62	*108-0170-00			0.5 μF		

Connectors

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
P17	*175-0481-00			Cable Assembly, 3⅝ inches

Transistors

Q13	*151-0212-00	Silicon		Tek Spec
Q17	*151-0212-00	Silicon		Tek Spec
Q31	151-1012-00	Silicon		FET
Q41	*151-0192-00	Silicon		Replaceable by MPS - 6521
Q45	*151-0192-00	Silicon		Replaceable by MPS - 6521
Q55	151-0224-00	Silicon		2N3692
Q69	*153-0556-00	Silicon		Tek Spec

Resistors

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

R3	317-0391-00	390 Ω	⅛ W		5%
R4	307-0098-00	56.4 Ω			½%
R5	317-0201-00	200 Ω	⅛ W		5%
R6	317-0201-00	200 Ω	⅛ W		5%
R7	317-0151-00	150 Ω	⅛ W		5%
R8	317-0151-00	150 Ω	⅛ W		5%
R10	317-0510-00	51 Ω	⅛ W		5%
R12	315-0152-00	1.5 kΩ	¼ W		5%
R13	311-0643-00	50 Ω, Var			
R14	317-0271-00	270 Ω	⅛ W		5%
R15	317-0102-00	1 kΩ	⅛ W		5%
R17	317-0102-00	1 kΩ	⅛ W		5%
R18	317-0360-00	36 Ω	⅛ W		5%
R19	317-0511-00	510 Ω	⅛ W		5%
R20	321-0385-00	100 kΩ	⅛ W	Prec	1%
R21	321-0253-00	4.22 kΩ	⅛ W	Prec	1%
R22	311-0609-00	2 kΩ, Var			
R23	321-0253-00	4.22 kΩ	⅛ W	Prec	1%
R24	321-0385-00	100 kΩ	⅛ W	Prec	1%
R26	311-0613-00	100 kΩ, Var			
R28	317-0473-00	47 kΩ	⅛ W		5%
R29	317-0473-00	47 kΩ	⅛ W		5%
R31	301-0912-00	9.1 kΩ	½ W		5%
R33	307-0124-00	5 kΩ	Thermal		
R34	317-0202-00	2 kΩ	⅛ W		5%
R35	301-0103-00	10 kΩ	½ W		5%
R40	317-0224-00	220 kΩ	⅛ W		5%
R41	317-0223-00	22 kΩ	⅛ W		5%
R42	317-0122-00	1.2 kΩ	⅛ W		5%
R44	317-0391-00	390 Ω	⅛ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Description		
R45	317-0303-00			30 kΩ	1/8 W	5%
R46	311-0614-00			30 kΩ, Var		
R47	315-0472-00			4.7 kΩ	1/4 W	5%
R56	317-0271-00			270 Ω	1/8 W	5%
R57	311-0607-00			10 kΩ, Var		
R59	308-0243-00			240 Ω	3 W WW	5%
R60	317-0390-00			39 Ω	1/8 W	5%
R62	317-0390-00			39 Ω	1/8 W	5%
R65	317-0101-00			100 Ω	1/8 W	5%
R66	311-0644-00			20 kΩ, Var		
R68	317-0332-00			3.3 kΩ	1/8 W	5%
R70	317-0332-00			3.3 kΩ	1/8 W	5%
R71	317-0202-00			2 kΩ	1/8 W	5%
R72	315-0203-00			20 kΩ	1/4 W	5%
R73	307-0124-00			5 kΩ	Thermal	

Transformers

T75	*120-0544-00	Toroid, 2 turns - 5 turns, bifilar

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

FIG. 1 EXPLODED VIEW

FIG. 2 STANDARD ACCESSORIES

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

SECTION 7
MECHANICAL PARTS LIST

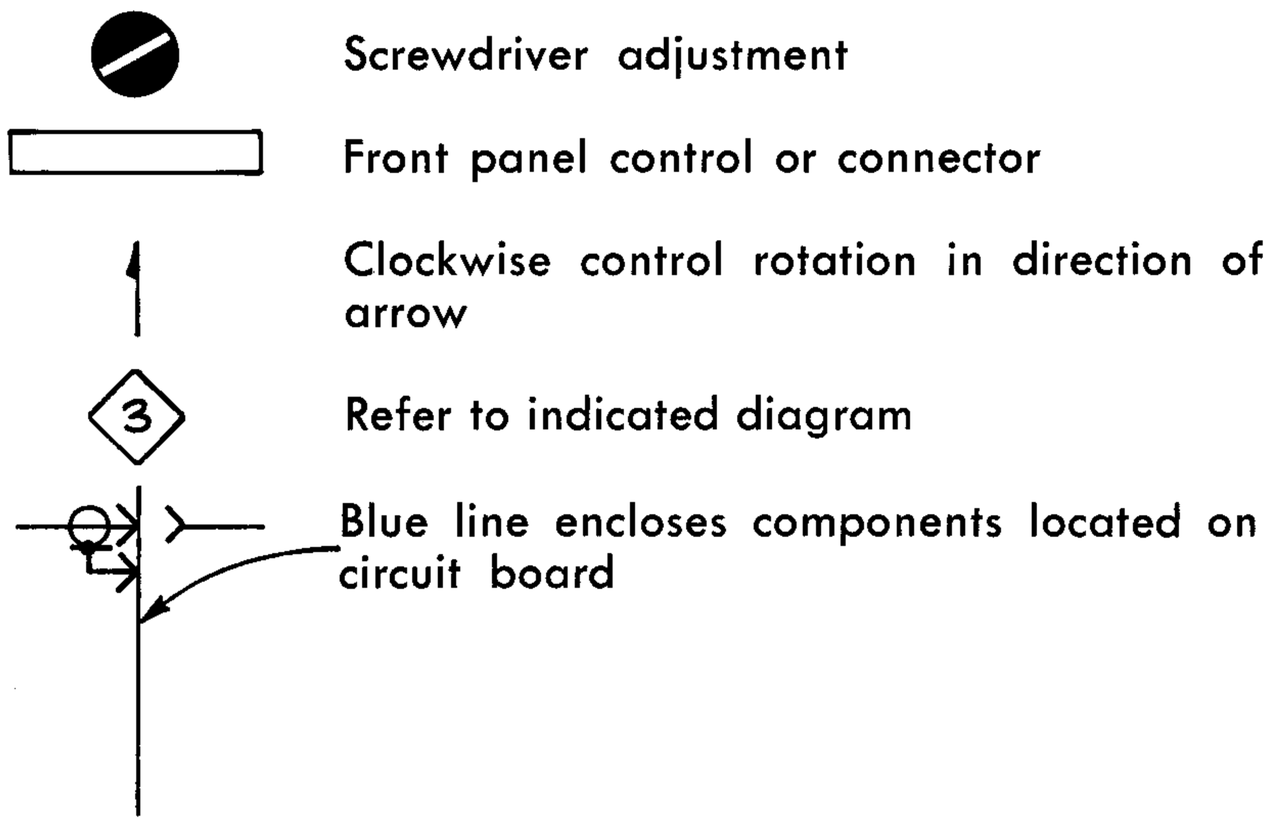
FIG. 1 EXPLODED VIEW

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-1	333-1035-00			1	PANEL, front
-2	386-1338-01			1	SUB-PANEL, front
-3	384-0687-00			1	SHAFT, extension, latch
-4	105-0066-00			1	STRIKE, latch
-5	131-0553-00			1	ADAPTER, contact to contact
-6	103-0076-00			1	ADAPTER, connector
	354-0322-00			1	RING, retaining (not shown)
	377-0196-00			1	INSERT, screw thread
-7	205-0091-00			1	SHELL, electrical connection
-8	132-0007-00			1	RING, snap
-9	103-0055-00			1	ADAPTER, contact to contact
-10	132-0028-00			1	INSULATOR, plastic
-11	132-0029-00			1	INNER CONDUCTOR
-12	132-0133-00			1	OUTER CONDUCTOR, sleeve
-13	220-0459-00			1	NUT, dodecagon, $\frac{7}{8}$-32 x 1 inch
-14	670-0169-00			1	ASSEMBLY, circuit board—GATE
	- - - - - -			-	assembly includes:
	388-0934-00			1	BOARD, circuit
-15	- - - - - -			1	CLIP, plastic, w/diode
-16	131-0582-00			3	CONNECTOR, stand-off, female
-17	131-0586-00			11	CONNECTOR, terminal, feed-thru
-18	- - - - - -			14	SPACER, sleeve
	- - - - - -			-	mounting hardware: (not included w/assembly)
-19	211-0014-00			7	SCREW, 4-40 x $\frac{1}{2}$ inch, PHS
-20	210-0586-00			7	NUT, keps, 4-40 x $\frac{1}{4}$ inch
-21	119-0145-00			2	PLATE, line section
-22	670-0167-00			1	ASSEMBLY, circuit board—STROBE
	- - - - - -			-	assembly includes:
	388-0932-00			1	BOARD, circuit
-23	131-0391-00			2	CONNECTOR, stand-off, male
-24	136-0252-00			6	SOCKET, pin connector
-25	136-0263-00			5	SOCKET, pin connector
-26	344-0061-00			2	CLIP, diode
-27	670-0168-00			1	ASSEMBLY, circuit board—PRE AMP
	- - - - - -			-	assembly includes:
	388-0933-00			1	BOARD, circuit
-28	131-0391-00			1	CONNECTOR, stand-off, male
-29	131-0252-00			10	SOCKET, pin connector
-30	136-0263-00			9	SOCKET, pin connector
	210-0707-00			1	EYELET, gold plated (not shown)
-31	380-0125-00			1	HOUSING, wrap around
-32	386-1337-01			1	PANEL, rear
	- - - - - -			-	mounting hardware: (not included w/panel)
-33	211-0141-00			4	SCREW, 4-40 x 3$\frac{1}{4}$ inches, PHS

Ⓐ

SECTION 8
DIAGRAMS

The following symbols are used on the diagrams:



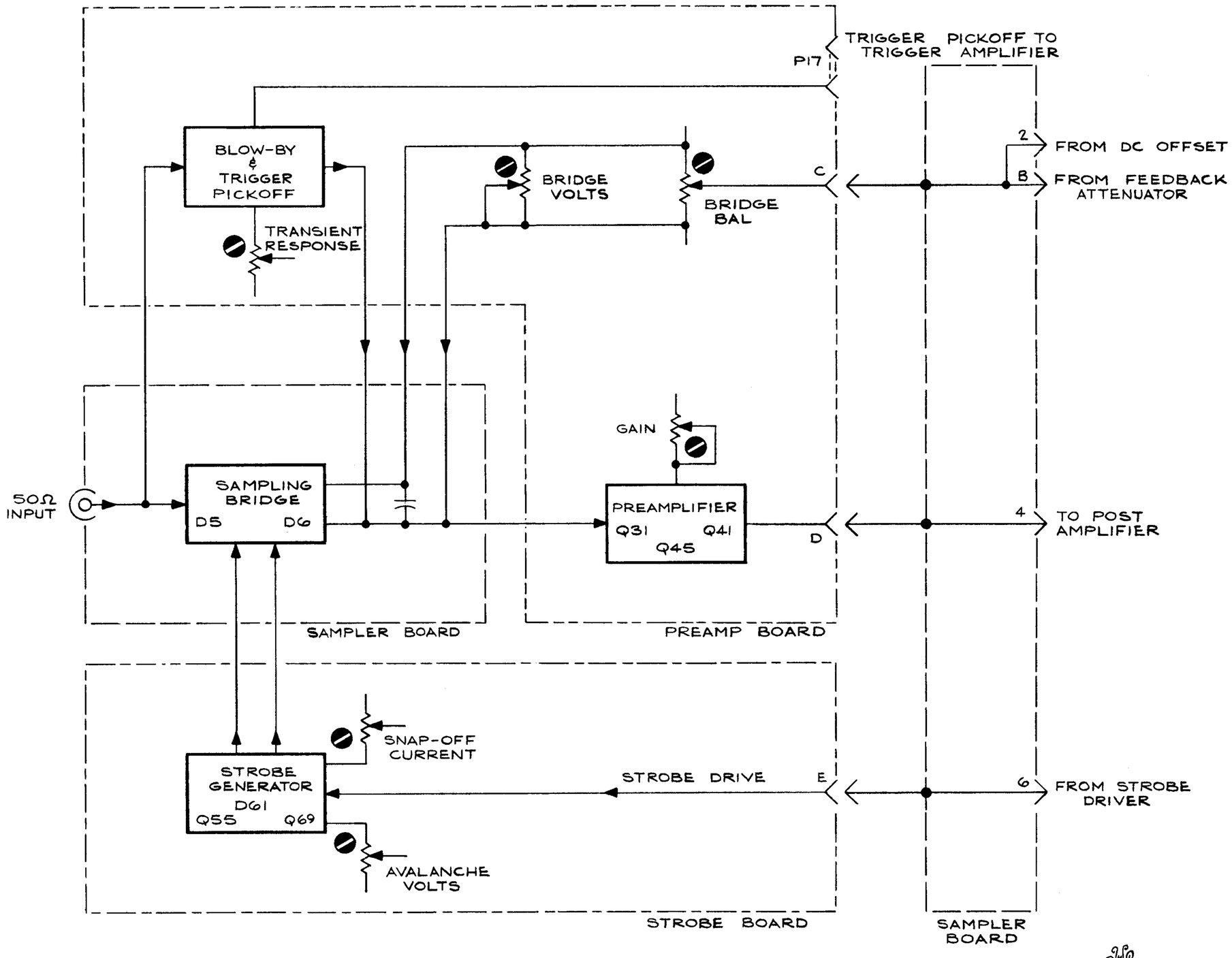
Screwdriver adjustment

Front panel control or connector

Clockwise control rotation in direction of arrow

Refer to indicated diagram

Blue line encloses components located on circuit board



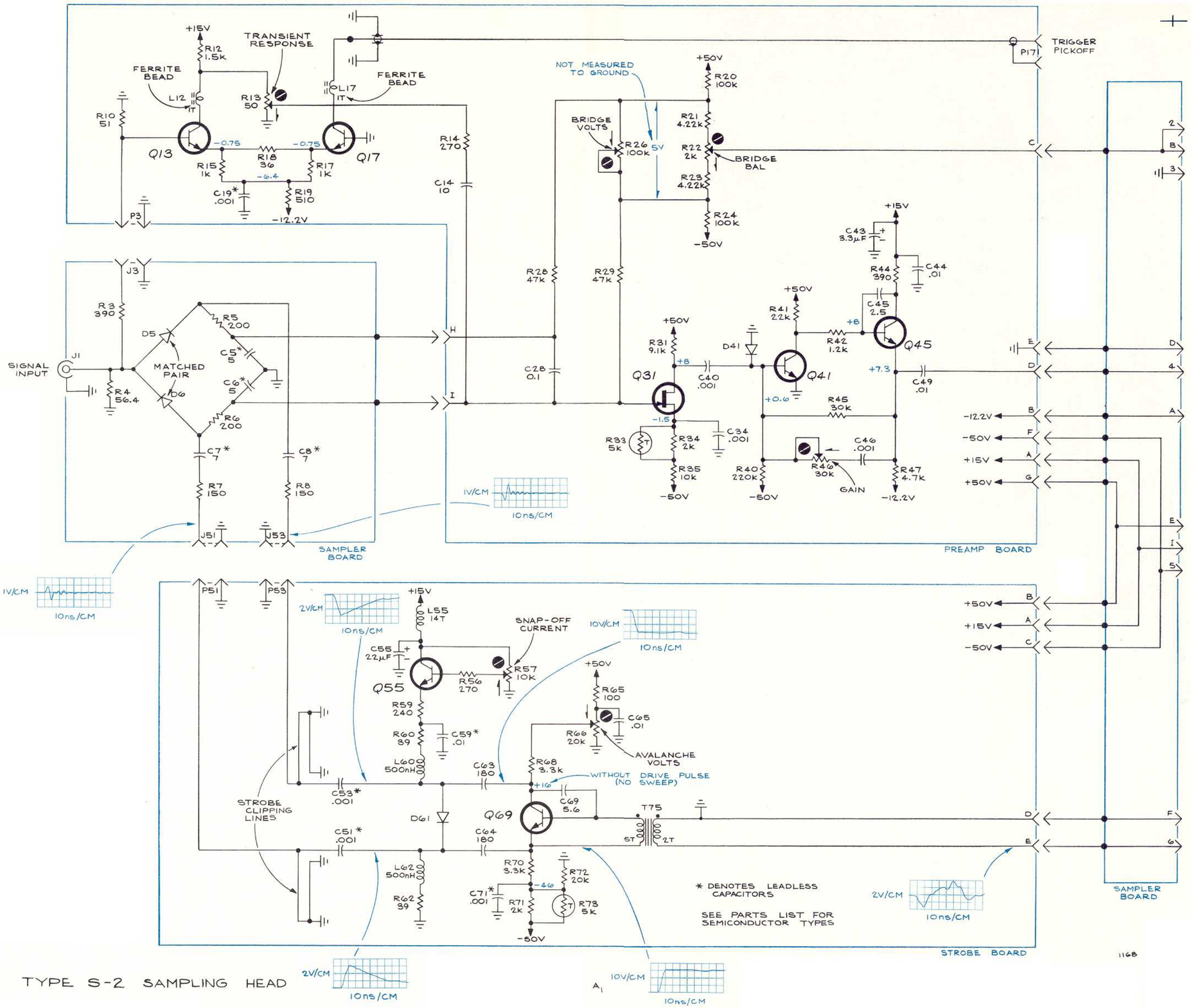
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TYPE S-2 SAMPLING HEAD A BLOCK DIAGRAM

VOLTAGE AND WAVEFORM TEST CONDITIONS

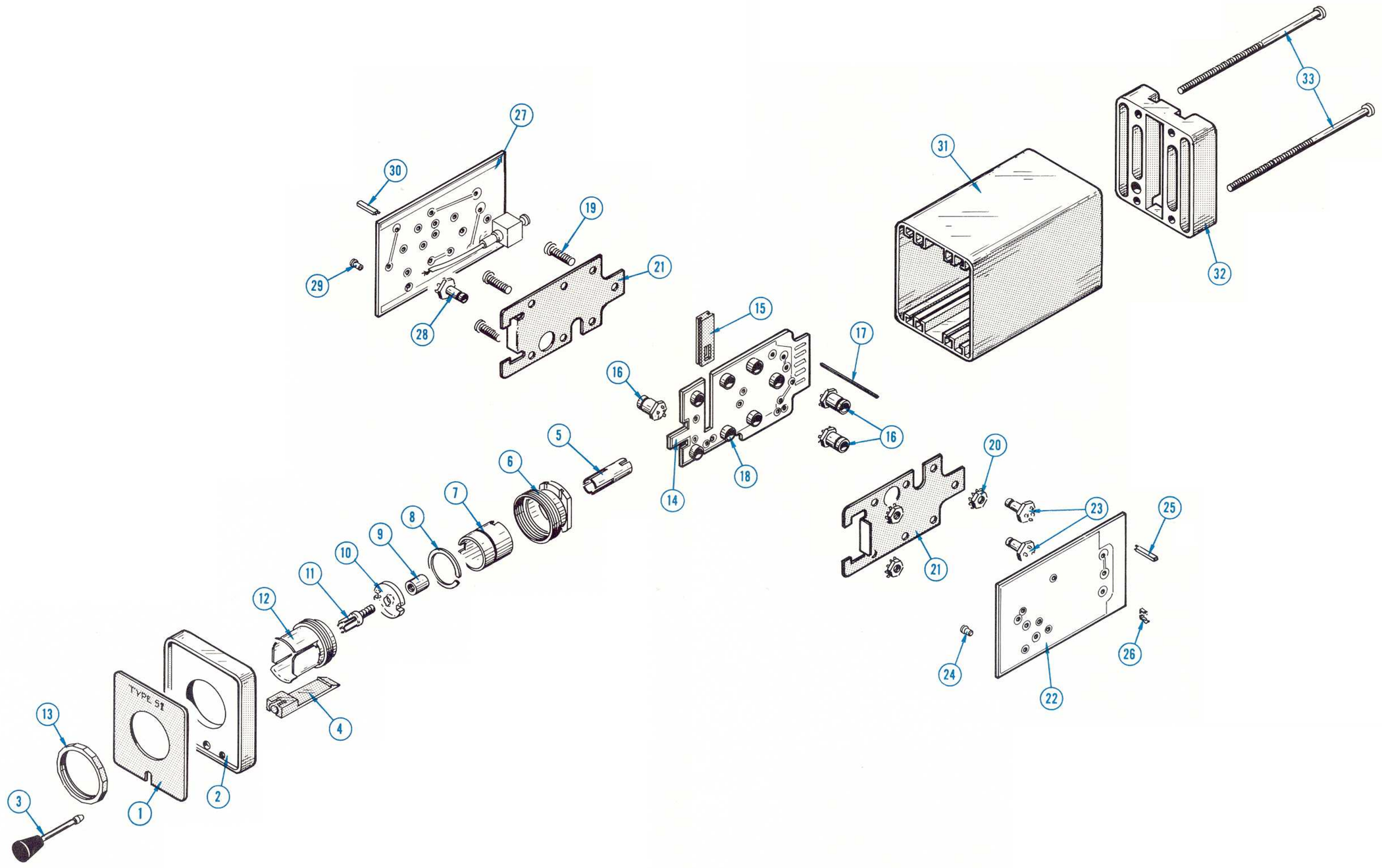
Typical voltage measurements and waveform photographs (shown in blue) were obtained under the following conditions unless noted on the individual diagrams:

Test Oscilloscope	
Bandwidth	DC to at least 50 MHz
Probe Input	10 Megohms, 7 picofarads
Probe Ground lead	Clipped to Type S-2 chassis
Triggering	External via 1 X probe to Sampling Unit CH A Memory Gate transformer primary Test Point.
DC Voltmeter	
Type	Volt-Ohmmeter 20,000 Ω/volt
Type S-2 conditions	Connected on a 3-foot extender cable. Case removed for access to circuits.
Vertical input signal	Termination or Coaxial cable connected. No signal.
Sampling Unit	
Vertical Position	Centered
DC Offset	Midrange. Zero volts at offset Out jack.
Sampling Sweep Unit	
	Type 3T2: use any convenient sweep rate and free run the sweep with Trigger Sensitivity control fully clockwise. Type 3T4 or Type 3T77A: Set Time/Div switch to .5 μs and free run the sweep with the Trigger Level control fully clockwise.



TYPE S-2 SAMPLING HEAD

FIG. 1 EXPLODED

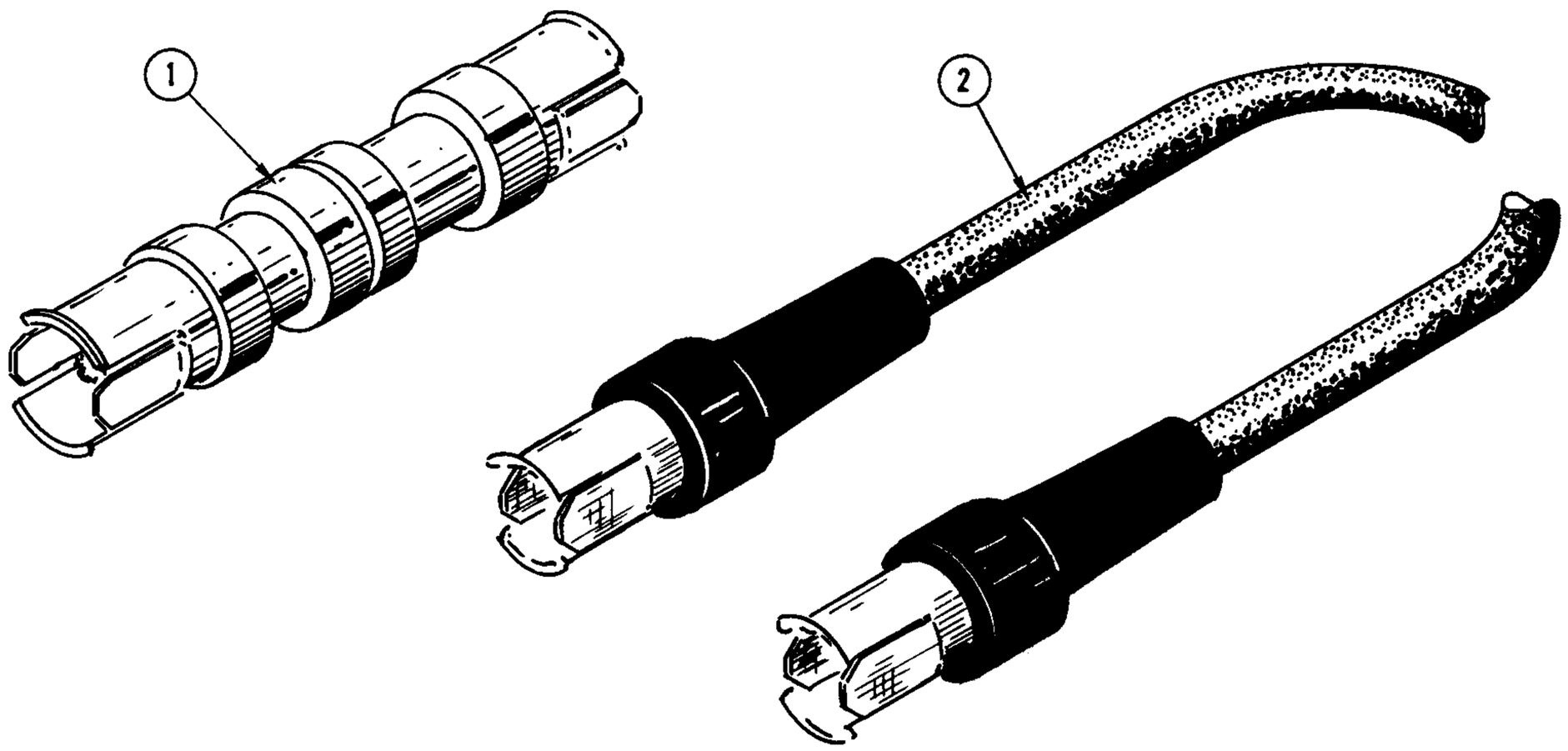


TYPE S-2 SAMPLING HEAD

OPTIONAL ACCESSORIES (NOT SHOWN)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
	012-0124-00			1		CABLE, extender, 3 feet
	012-0125-00			1		CABLE, extender, 6 feet

FIG. 2 STANDARD ACCESSORIES



A

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
				1 2 3 4 5	
2-1	017-0078-00			1	ATTENUATOR, 10X 50 Ω
-2	017-0502-00			1	CABLE, 5 ns delay, w/GR connectors
	070-0763-00			2	MANUAL, instruction (not shown)

MANUAL CHANGE INFORMATION

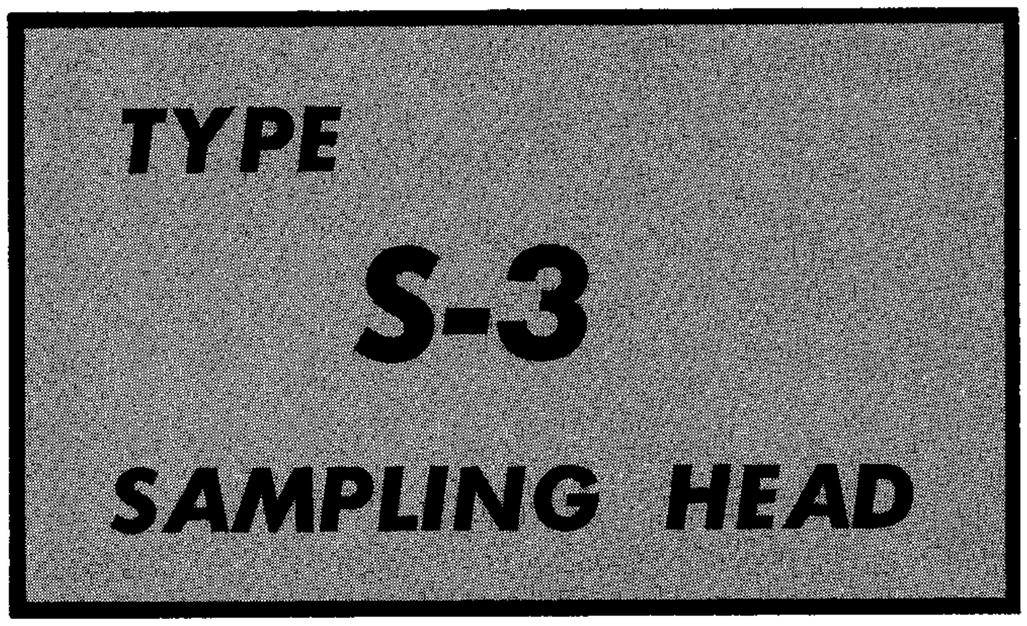
At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

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.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

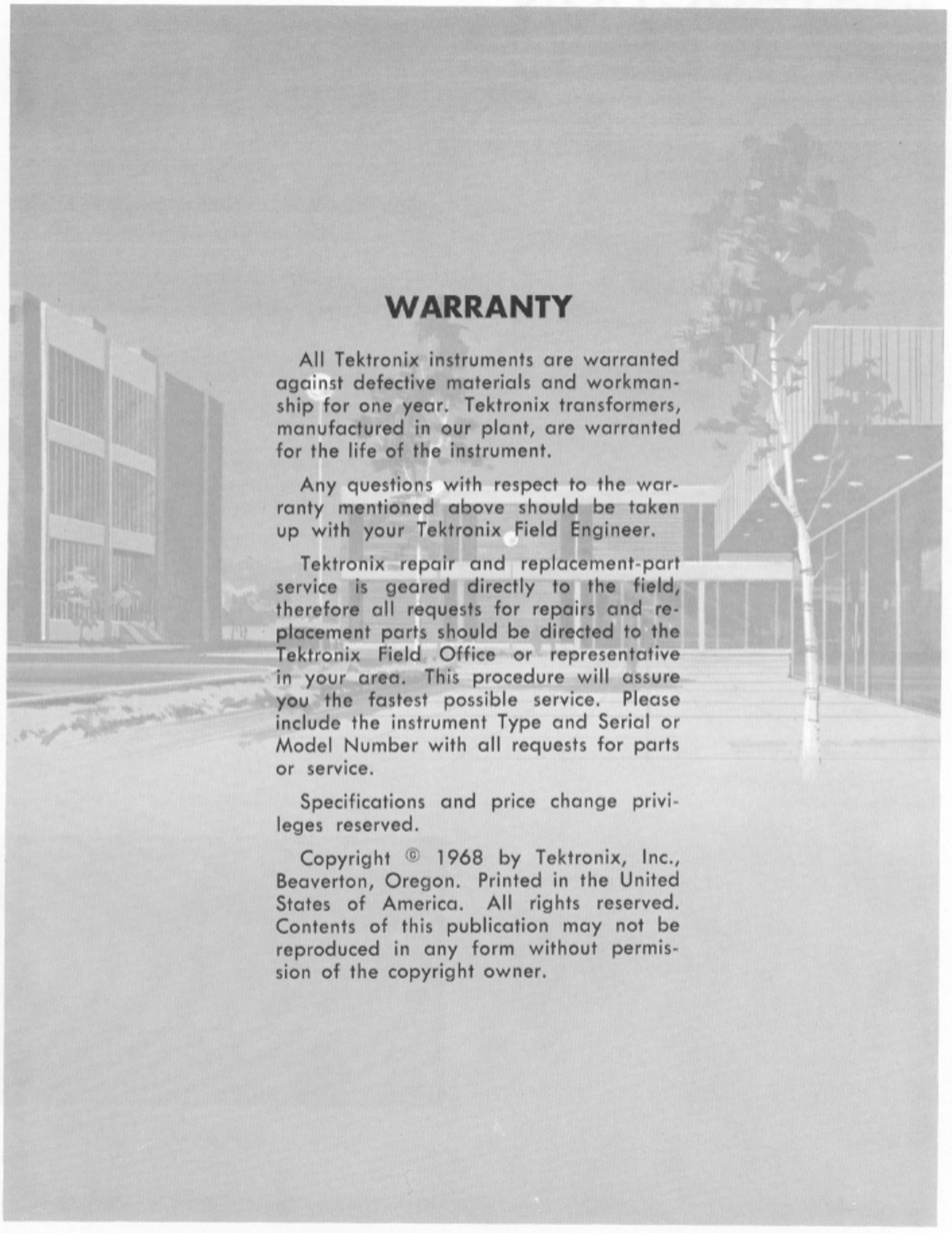
INSTRUCTION MANUAL

Serial Number _____



Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0765-00



WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our 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 or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

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	Abbreviations and Symbols
	Parts Ordering Information
Section 6	Electrical Parts List
	Mechanical Parts List Information
Section 7	Mechanical Parts List
Section 8	Diagrams
	Mechanical Parts List Illustrations
	Accessories

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

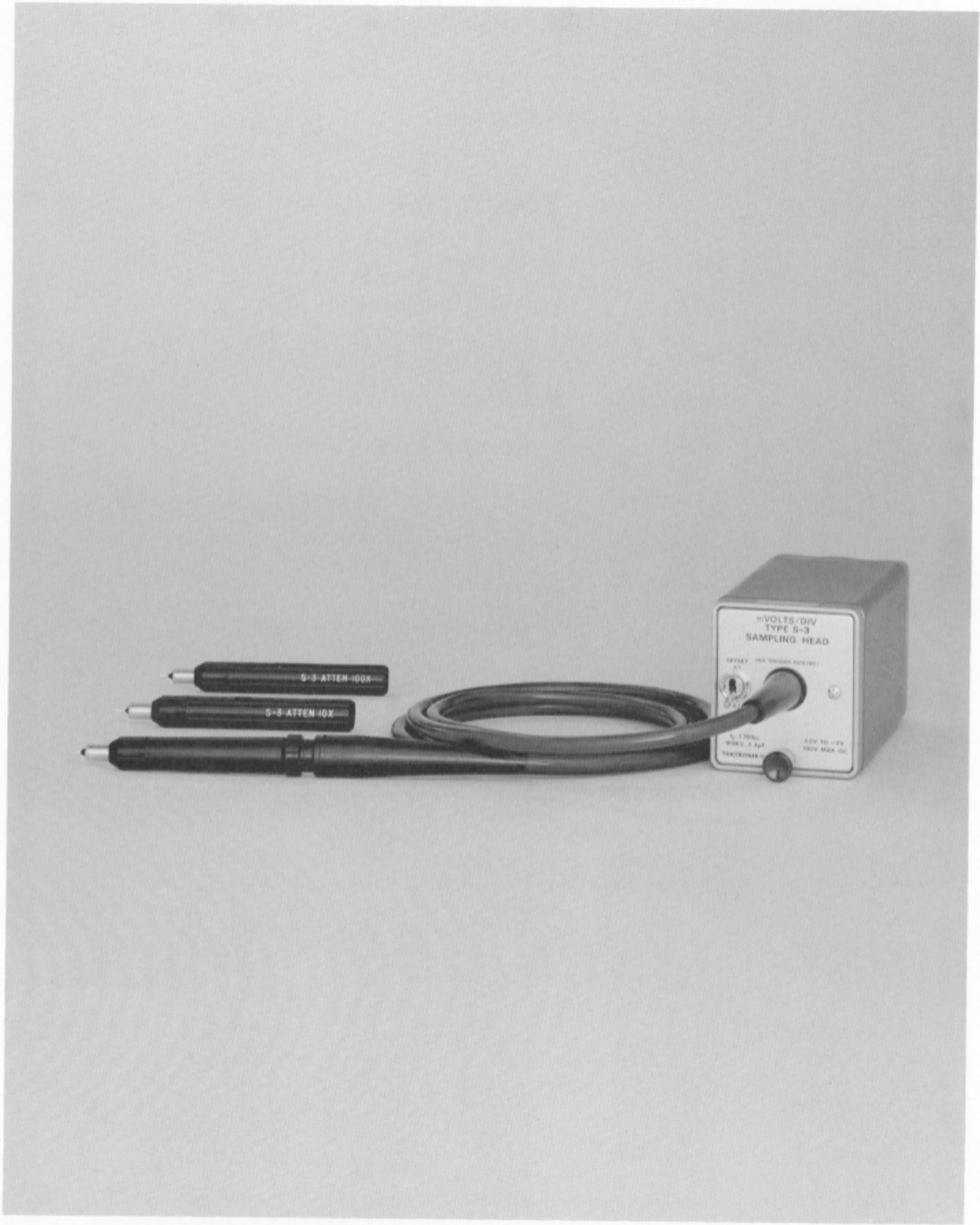


Fig. 1-1. Type S-3 Sampling Head and Probe.

SECTION 1

TYPE S-3 SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

The Type S-3 Sampling Head is used with Tektronix 3S-series units such as the Type 3S2, 3S5, and 3S6. The Type S-3 consists of a plug-in head with a permanently attached, miniature 1× probe containing the sampling bridge. See Fig. 1-1.

The Type S-3 can be installed directly into sampling units such as the Type 3S2 or Type 3S5. It can also be used remotely with the Type 3S2 or Type 3S5, on an optional 3 foot or 6 foot extender cable. When used with a Type 3S6 Sampling Unit, the Type S-3 is plugged into the dual-input interconnecting cable provided with the sampling unit.

Input characteristics of the sampling systems are determined by the Type S-3. The probe tip has a low-frequency input resistance of 100 kΩ paralleled by about 2.3 pF of capacitance. Input resistance and capacitance with plug-in accessories (coupling capacitor, 10× or 100× attenuators) attached to the probe tip can be found later in this section as well as in the Operating Instructions. Other input characteristics, both with and without the plug-on accessories, are also given in this section.

An offset voltage of either ±1 volt or ±2 volts may be selected with a toggle switch (OFFSET) located on the sampling head front panel. The ×1 position of the OFFSET switch provides an offset voltage range of ±1 V while the ×2 position provides a range of ±2 V to the probe sampling bridge. The Type S-3 does not provide a trigger pickoff from the input signal for internal triggering of the associated sampling unit. Vertical deflection factor of the sampling system is labeled at the top of the Type S-3 as mVOLTS/DIV; the label refers to the sampling unit Units/Div switch of the corresponding channel.

Digital Unit Programming Connections

The Type S-3 has two contacts at its rear connector that program the decimal and units-of-measure lamps of the Type 6R1A or Type 230 Digital Unit. These connections are not needed when using a Type 3S2 Sampling Unit. When using a Type 3S5 or Type 3S6 Sampling Unit, one contact notifies the digital readout unit, through the sampling unit digital control circuits, that the Type S-3 is a voltage-measuring head. This causes the Volts lamp to light. The other sampling head contact notifies the digital readout unit, through the sampling unit digital control circuits, that the Type S-3 sensitivity requires no decimal shift of the numbers around the sampling unit Units/Div switch.

ELECTRICAL CHARACTERISTICS

Characteristics

The following characteristics apply over an ambient temperature range of 0° C to +50° C and after a five minute warmup, providing the instrument was calibrated at a temperature between +20° C and +30° C.

Characteristics listed below apply only after the Type S-3 has been properly mated to the sampling unit and indicator oscilloscope, and after these units have been given sufficient warmup time. To determine the particular system warmup requirements, refer to the related amplifier and indicator oscilloscope instruction manual. A procedure for mating the Type S-3 to the sampling unit can be found in the Operating Instructions.

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement		
DC Input Resistance			
Probe Only	100 kΩ within ¼%		
With 10× Attenuator	1 MΩ within 1%		
With 100× Attenuator	1 MΩ within 1%		
Input Capacitance			
Probe Only	≈2.3 pF		
With 10× Attenuator	≈2 pF		
With 100× Attenuator	≈1.7 pF		
With Coupling Capacitor	≈4.5 pF		
Coupling Time Constant (probe and coupling capacitor only)	≥100 μs		
Deflection Factors	mV/Div, (1 times the numbers around the sampling unit Units/Div switch).		
Accuracy[1]			
Probe Only	Within 1.0%		
With 10× Attenuator	Within 2.25%		
With 100× Attenuator	Within 3.0%		
Signal Offset Range	With probe only	Into 10× attenuator	Into 100× attenuator
OFFSET switch at ×1	±1 V	±10 V	±100 V
OFFSET switch at ×2	±2 V	±20 V	±200 V
Offset Accuracy[1]	Probe only	With probe and 10× attenuator	With probe and 100× attenuator
OFFSET switch at ×1	±1.6%	±3.1%	±3.85%
OFFSET switch at ×2	±1.35%	±2.85%	±3.6%

[1]**Add these tolerances to sampling unit accuracy to determine system accuracy.**

Specification—Type S-3

Characteristic	Performance Requirement
Response to Step Signals Risetime (10% to 90%) Probe Only	350 ps or less
With 10× Attenuator	400 ps or less
With 100× Attenuator	500 ps or less
Pulse Flatness Deviation Probe Only	+8%, −2% or less, total of 10% or less P-P within 2 ns after step reaches 100%; +1%, −1% or less, total of 2% or less P-P thereafter.
With 10× Attenuator	+2%, −5% or less, total of 7% or less P-P within 5 ns after step reaches 100%; +1%, −1% or less, total of 2% or less P-P thereafter.
With 100× Attenuator	+5%, −8% or less, total of 13% or less P-P within 5 ns after step reaches 100%; +2%, −5% or less, total of 7% or less P-P from 5 ns to 30 ns after step; +1%, −1% or less, total of 2% or less P-P thereafter.
Maximum Operating Signal Voltage Probe Only	2 V P-P
With 10× Attenuator	20 V P-P
With 100× Attenuator	200 V P-P
Safe Overload Signal Voltage Probe Only	Do not exceed + or − 100 V (peak) limits. Maximum sine wave input is 20 V P-P.
With 10× Attenuator	Do not exceed + or − 350 V (peak) limits. Maximum sine wave input is 200 V P-P.
With 100× Attenuator	Do not exceed + or − 350 V (peak) limits. Maximum sine wave input is 200 V P-P.
Loop Gain Probe Only	Adjustable to unity on the sampling unit front panel for signals up to 1 V P-P; when the loop gain is adjusted to unity with positive input signals, the loop gain will be within 5% of unity with negative input signals and vice versa.
With 10× Attenuator	Adjustable on the sampling unit front panel to unity for signals up to 10 V P-P; when the loop gain is adjusted to unity with positive input signals, the loop gain will be within 5% of unity with negative input signals and vice versa.
With 100× Attenuator	Adjustable on the sampling unit front panel to unity for signals up to 100 V P-P; when the loop gain is adjusted to unity with positive input signals, the loop gain will be within 5% of unity with negative input signals and vice versa.
Displayed Noise (no accessories connected to probe tip)	3 mV or less, measured tangentially.

ENVIRONMENTAL CHARACTERISTICS

Storage	Operating
Temperature— −40°C to +65°C.	Temperature — As stated preceding Electrical Characteristics table.
Altitude—To 50,000 feet.	Altitude—To 15,000 feet.

MECHANICAL CHARACTERISTICS

Dimensions— (head)	Height ≈ 2 inches Width ≈ 1¾ inches Length ≈ 4½ inches
Probe cable length	≈ 3 feet 6 inches
Construction—	Epoxy laminated circuit boards. Aluminum wrap-around cabinet with aluminum casting at front and rear. Anodized aluminum front panel.
Accessories—	An illustrated list of the accessories supplied with the Type S-3 is at the end of the Mechancial Parts List pullout pages.

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

This section provides the basic information required for operation of the Type S-3 Sampling Head, including installation and First Time Operation.

The Type S-3 is used with some Tektronix sampling units such as Types 3S2, 3S5 and 3S6 using one or two S-series sampling heads. One of these sampling units and a sweep unit plugged into an indicator oscilloscope completes the sampling system. The choice of real or equivalent time sampling is a function of the sweep unit used.

The Type S-3 consists of a plug-in head with a permanently attached miniature 1× probe containing the sampling bridge circuit. Accessories supplied include a coupling capacitor, a 10× and a 100× attenuator which provide for operation over a wide range of input signal voltages.

An Offset switch on the sampling head panel allows selection of an Offset voltage range of either +1 Volt to −1 Volt or +2 Volts to −2 Volts as set by either ×1 or ×2 switch position. The DC Offset control of the sampling unit sets the DC Offset voltage within the above ranges. This voltage effectively offsets an equal amount of the input signal at the tip of the probe without attenuators, and 10 or 100 times with 10× or 100× attenuators.

Installing the Type S-3 Sampling Head

Fig. 2-1 shows the Type S-3 partially installed into a Type 3S2 Sampling Unit with Type 561A Oscilloscope and Type 3T2 Random Sampling Sweep. The sampling head (or heads) can be plugged into the sampling unit as shown, or used remotely on a special extender cable. Three and six foot extender cables are available. Order the three foot extender cable by Tektronix Part No. 012-0124-00, or the six foot extender cable by Tektronix Part No. 012-0125-00. Contact your local Tektronix Field Engineer or Representative for price and availability of these optional accessories.

To insert the Type S-3 into the right or left hand compartments of the sampling unit, proceed as follows:

1. Pull the latch knob (Fig. 2-1) outward from the front panel (the latch knob will push out normally when the unit is inserted if the knob is left free to move).

2. Insert the Type S-3 slowly into the compartment, so the two plastic guides in the compartment engage the S-3.

3. Push the Type S-3 completely into the compartment.

4. Push the latch knob to lock the S-3 in place.

To remove the Type S-3 from the compartment, pull the latch knob away from the front panel, then pull the unit from the compartment.

To use the Type S-3 on an extender cable, install as follows:

1. Pull the latch knob located on the head end of the extender outward from the panel (the latch knob will push out normally when the extender is inserted if the knob is free to move).

2. Insert the extender cable head end slowly into the desired compartment in the sampling unit so the two plastic guides in the compartment engage the unit.

3. Push the head completely into the compartment.

4. Push the latch knob to lock the extender cable head end in place.

5. Connect the Type S-3 to the other end of the extender cable in a similar manner, and set the latch knob to hold it in place.

6. To remove the Type S-3 from the extender cable, pull the latch knob on the front panel of the Type S-3, and remove the unit from the extender cable.

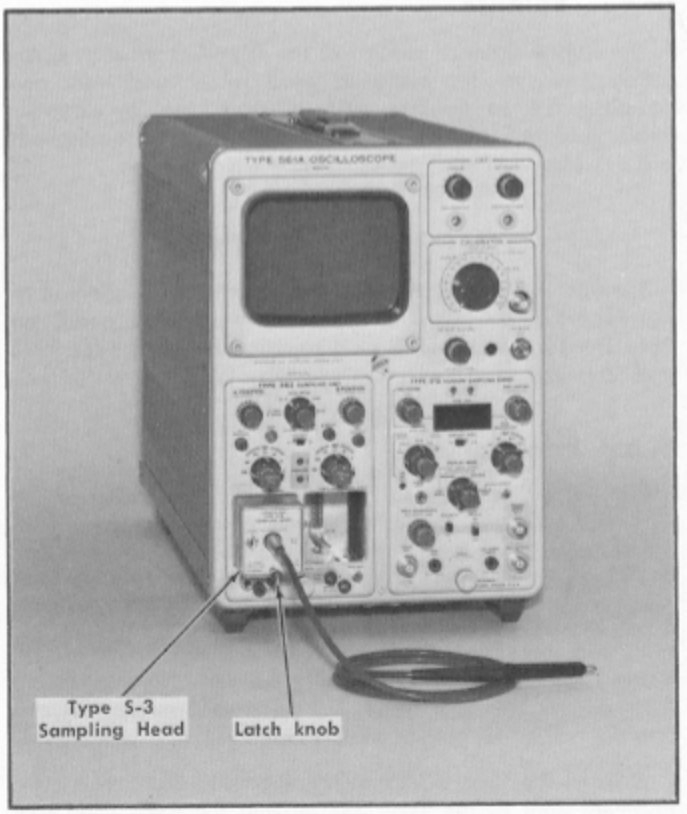


Fig. 2-1. Installation Information.

7. To remove the extender cable head from the sampling unit compartment, pull the latch knob outward from the front of the panel, then pull the unit free.

Mating

The vertical deflection factor labeled as mVOLTS/DIV by the Type S-3, and the sampling system loop balance (adjusted by the Bridge Bal control) must be considered when mating a Type S-3 with a sampling unit. If the sampling unit is a Type 3S2, the system loop gain (as adjusted by the sampling unit Memory feedback capacitor) must be checked. A check of the loop gain linearity at 1-V peak to peak input to the probe tip will determine if the sampling unit loop gain is correctly adjusted. See the Type 3S2 Sampling Unit instruction manual Calibration Procedure for proper adjustment of the system loop gain.

The mVOLTS/DIV label on the Type S-3 names the deflection factor units of the sampling unit Units/Div switch located directly above the label. For example, with the Type S-3 installed in a Type 3S2 and the Units/Div switch set at 100, each major division of CRT deflection corresponds to 100 millivolts of input signal (when the Variable control is in the Cal position). Additionally, the deflection factor is changed by adding an accessory attenuator of either 10× or 100× attenuation to the S-3 probe input.

The deflection factor is mated to the indicator oscilloscope CRT by adjusting the samping unit Gain control. Refer to the sampling unit manual for its Gain adjustment. Power supplies and circuit interconnections are made through the two connectors at the rear of the Type S-3.

Bridge Balance

The Bridge Balance control of the Type S-3 should be adjusted whenever the sampling head is changed from one sampling unit to another, or is operated on an extender cable. Location of the control and details of its adjustment are described in First Time Operation which follows.

FIRST TIME OPERATION

The First Time Operating procedure utilizes, in addition to the Type S-3, a Type 3S2, Type 3T2, Type 561A, and Type 284. The Type 284 is used as a signal source with Type VP-2 and 50 Ω end-line termination. See Fig. 2-2.

Setup Information

Make sure that the Horiz Plug-in Compatibility switch on the Type 3S2 bulkhead immediately behind the front panel is in the Sampling 3T-series position. Also make sure the Samples/Div switch SW450 on the Type 3T2 bulkhead behind the front panel is set to the Variable (Front Panel) position.

1. With the Type 561A Power switch off, insert a Tektronix Type 3S2 Sampling Unit into the vertical compartment (left) and a Tektronix Type 3T2 Random Sampling Sweep into the horizontal plug-in compartment (right).

2. Insert the Type S-3 Sampling Head into Channel A compartment (left) of the Type 3S2 leaving the latch knob free to move. Once the S-3 is seated, push the latch to lock it in place.

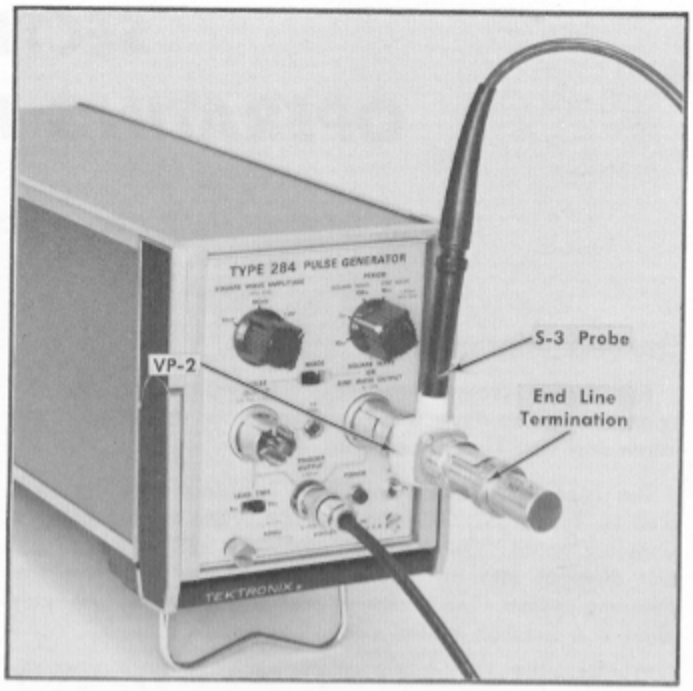


Fig. 2-2. S-3 probe - VP-2 connections.

3. Set the Intensity control on the Type 561A fully counterclockwise.

4. Connect the Type 561A to a power source which meets its voltage and frequency requirements.

5. Set the Power switch to on. Allow about 5 minutes warm-up so the units reach operating temperature before proceeding. (The Type S-3 can be installed or removed while the power is on.)

6. For single-trace operation, set the controls as follows:

Type S-3

OFFSET	×1

Type 3S2

Display Mode	CH A
Normal-Smooth	Normal
A and B Position	Midrange
DC Offset (both Channels)	Midrange (5 turns from one end)
Units/div (both Channels)	200
Variable (both Channels)	Cal
Invert (both Channels)	Push in
Dot Response (both Channels)	Midrange
B Delay	Midrange

Type 3T2

Horiz Position	Midrange
Samples/Div	9 o'clock position

Display Mode	Normal
Start Point	With Trigger
Range	10 μs } Sweep
Display Mag	×1 } Rate
Time Magnifier	×2 } 500 ns/Div
Variable	Cal
Time Position	Both fully clockwise
Trig Sensitivity	Fully Clockwise
Recovery Time	Optional
Trigger Polarity	+
Trigger Source	Ext

Type 284

Square Wave Amplitude	1.0 V[1]
Period	1 μs
Mode	Square Wave Output
Lead Time	Optional

7. Place the probe tip into the Type VP-2 as shown in Fig. 2-2. (Remove the insulating sleeve from the probe tip to fit it into an early model Type VP-2.) Terminate the VP-2 with GR874-W50B 50 Ω end-line termination (Tektronix Part No. 017-0081-00). Connect the Trigger output signal from the Type 284 through a 5 ns coaxial cable with BNC connectors to the External Input 50 Ω connector of the Type 3T2.

8. Advance the Type 561A Intensity control until the free running trace brilliance is at the desired viewing level.

9. Center the trace on the graticule with the Type 3S2 A Position control and/or the DC Offset control. Adjust the Type 3T2 Trig Sensitivity control for a stable triggered display of a five-cycle square wave with an amplitude of about 5 divisions.

Probe Compensation

The 1 μs square wave signal is the correct frequency to use to compensate the probe.

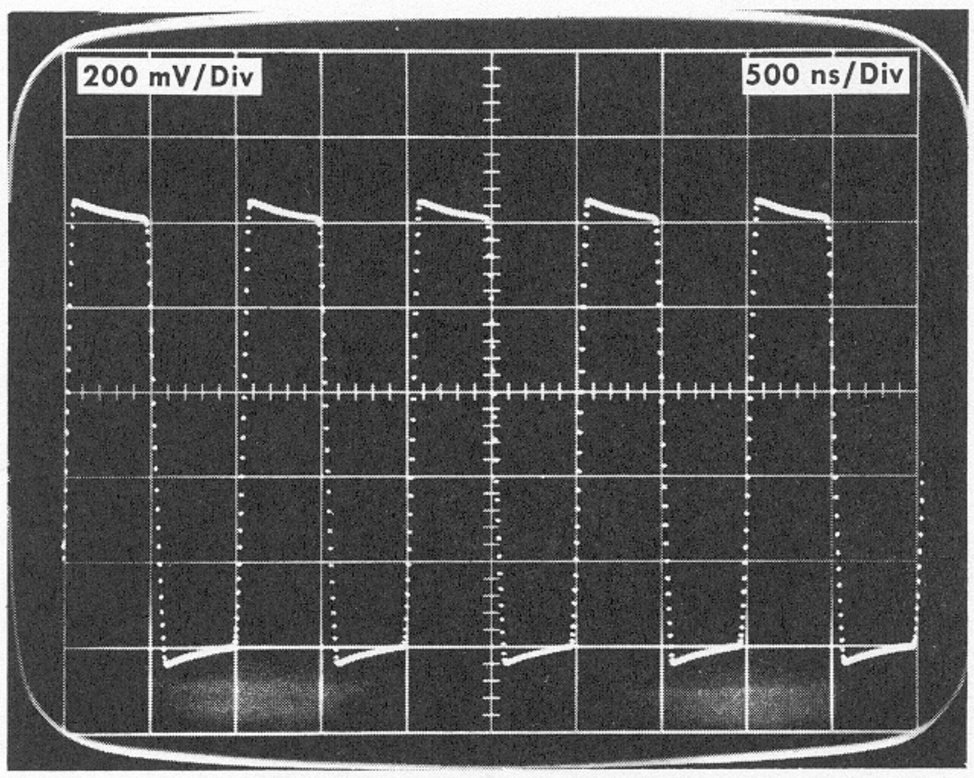
10. If the display (step 9) top and bottom portions are flat as shown in Fig. 2-3C, the probe is properly compensated and no adjustment is required. The 10× and 100× attenuators must be compensated after the probe is compensated. (The adjustment information is given in the attenuator compensation paragraph later in this section.)

11. The probe will require compensation only if the display shows over- or under-compensation as in Fig. 2-3A or B.

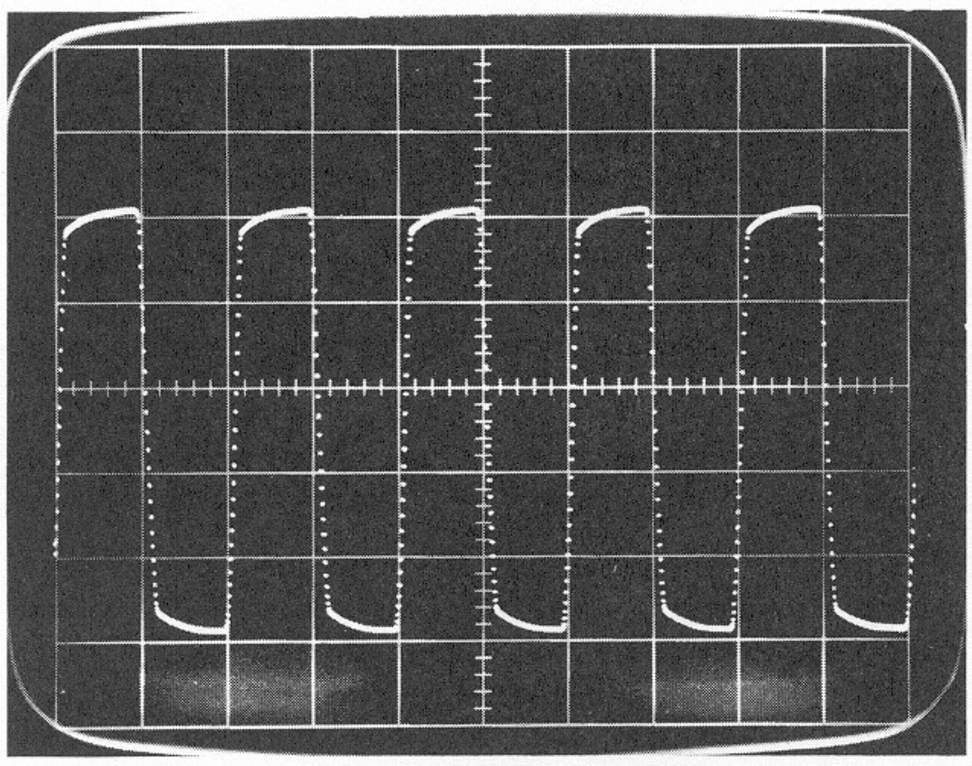
12. To adjust the probe compensation, loosen the probe body and tip (shown in Fig. 2-4) by turning the locking nut counterclockwise.

13. Slowly turn the probe body and tip assembly until the 1 μs square wave top and bottom are flat as shown in Fig. 2-3C. Then turn the locking nut counterclockwise to tighten the probe and tip assembly in place. Readjust if necessary to assure a flat display after the locking nut is tight.

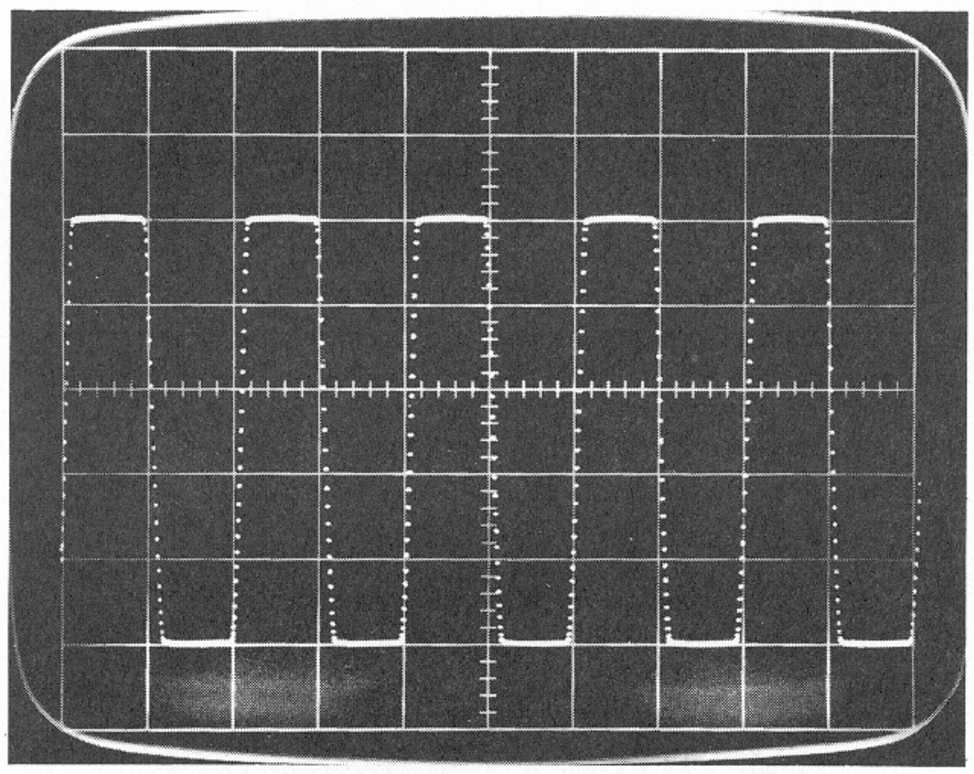
[1]VP-2 with 50 Ω end-line termination.



(A) Over Compensated



(B) Under Compensated



(C) Correctly Compensated

Fig. 2-3. Probe compensation displays.

Adjusting Dot Response (Loop Gain) Control

Sequential Sampling. One method of adjusting the Dot Response control for unity loop gain is to use a double or multiple-triggered sweep. This causes each sample to respond to the full signal amplitude and produce a display similar to Fig. 2-5A or B.

14. To obtain a display similar to that of Fig. 2-5A or B, change the Time Magnifier to ×5 (200 ns/Div) and turn the Trig Sensitivity control into the free-run region. Then adjust the Recovery Time control until the desired display appears.

15. Turn the Channel A Dot Response control to obtain a display showing unity loop gain (see Fig. 2-5B). Either the upper or the lower portion of the display may be adjusted to level. In Fig. 2-5B the upper portion of the double triggered display is adjusted showing the lower portion at near level within 5% of the full signal amplitude. Fig. 2-5A shows less than unity loop gain. This requires clockwise rotation of the Dot Response control to obtain unity loop gain.

The double triggering shown in Fig. 2-5A and B is not useful when making amplitude measurements.

16. After the Dot Response control is adjusted for unity loop gain, turn the Trig Sensitivity control counterclockwise into the triggered region for a stable trace of a properly triggered display similar to Fig. 2-5C.

Random Sampling. Another convenient method of adjusting the Dot Response control for unity loop gain uses random process sampling.

17. Change the following controls:

Type 3T2

Start Point	Before Trigger
Time Magnifier	×50

Type 284

Period	10 ns

18. Loop gain greater than unity will produce a display similar to Fig. 2-6A. Variations from the display shown can be caused by different settings of the Recovery Time, Samples/Div and Trigger Sensitivity controls on the Type 3T2. Loop gain deviations from unity are best observed when the Type 3T2 Time Magnifier is set at ×20 or ×50. Adjust the Type 3S2 Dot Response control for unity loop gain as shown in Fig. 2-6B.

Bridge Balance Adjustment

Connect a bench multimeter set for ≈30 V full scale between ground and the Type 3S2 Channel A Offset jack. Adjust the Type 3S2 DC Offset control until the multimeter reads 0 Volts. Increase the meter sensitivity and repeat the adjustment for greater accuracy.

19. Disconnect the Type VP-2 from the Type 284, leaving the Type S-3 probe in the Type VP-2 terminated by the end-line termination. This avoids pickup from the probe tip. Turn the Type 3T2 Trig Sensitivity control clockwise to free run the sweep.

20. Switch the Type 3S2 Units/Div control from 200 to 20, adjusting the Type S-3 Bridge Bal control for the minimum trace shift. See Fig. 2-7 for the location of the Bridge Bal control. This adjustment must be made whenever the Type S-3 is shifted from one sampling unit to another, or operated on a sampling head extender cable.

NOTE

Physical movement of the Type S-3 probe cable will shift the trace vertically a few millivolts after the Bridge Bal control is adjusted. For correct low level DC voltage measurements, carefully adjust the Bridge Bal control with the probe in the same physical location as it will be used (or connected to the test point where it will be used before the signal is present).

Attenuator Compensation

The 10× and the 100× attenuator probe attachments can be compensated only after the probe has been compensated. See steps 10 to 13. A fast-rise square wave signal with an amplitude of about 1 V (for 10× attenuator) and about 10 V (for 100× attenuator) at a frequency of about 50 kHz is required to properly compensate the attenuators. A Tektronix Type 106 Square Wave generator is used in the following procedure.

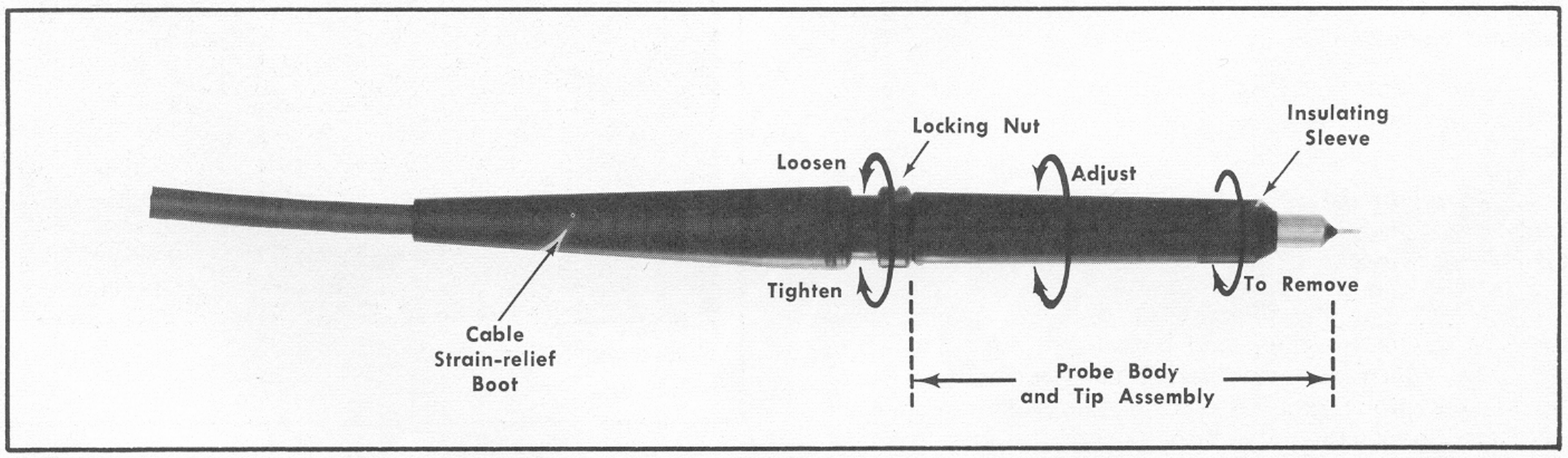
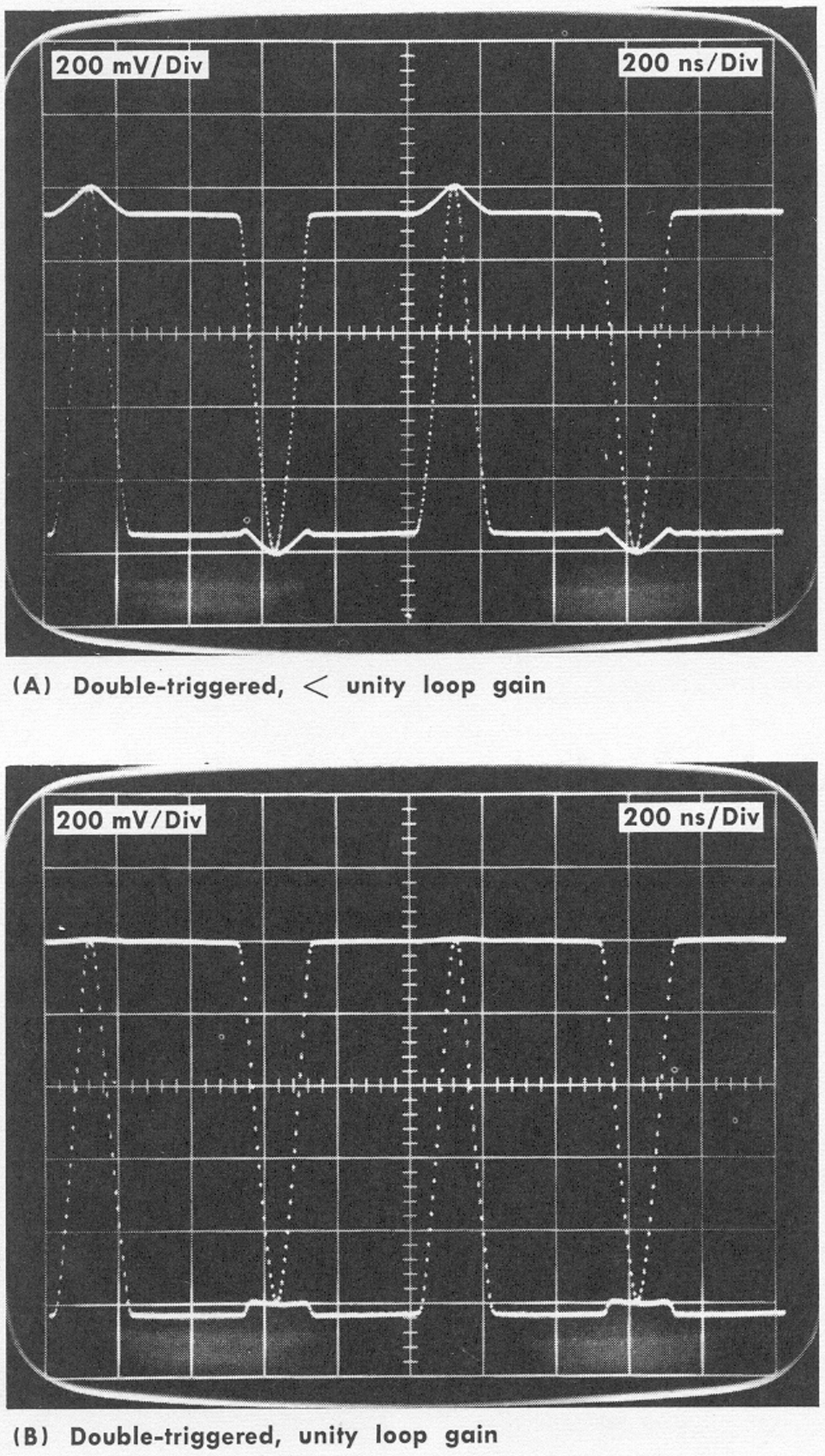
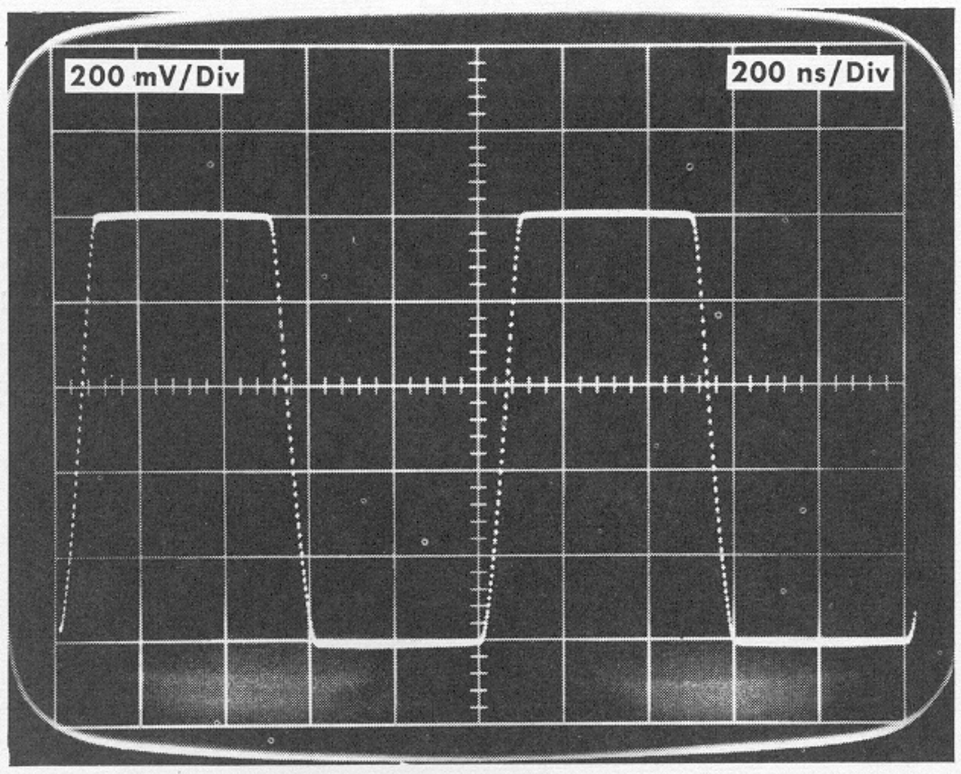


Fig. 2-4. Probe composation procedure.



(A) Double-triggered, < unity loop gain

(B) Double-triggered, unity loop gain



(C) Properly triggered

Fig. 2-5. Typical display of unity loop gain adjustment in normal sequential sampling.

21. Connect the Type 106 Hi Amplitude Output to the VP-2 voltage pickoff with the 50 Ω termination installed. Remove the insulating sleeve on the 10× attenuator, attach the attenuator (by the threaded connection) to the Type S-3 probe, and place the attenuator tip in the VP-2. Connect the Type 106 Trigger Output through a coaxial cable to the Type 3T2 Ext Trig Input 50 Ω connector. Set the Type 106 Square Wave Repetition Rate to 50 kHz.

22. Change the following controls:

Type 3T2

Range	100 μs	Sweep Rate
Time Magnifier	×5	2 μs/Div

Type 3S2

Units/Div	100

23. Adjust the Type 106 Amplitude control for a 5-division display.

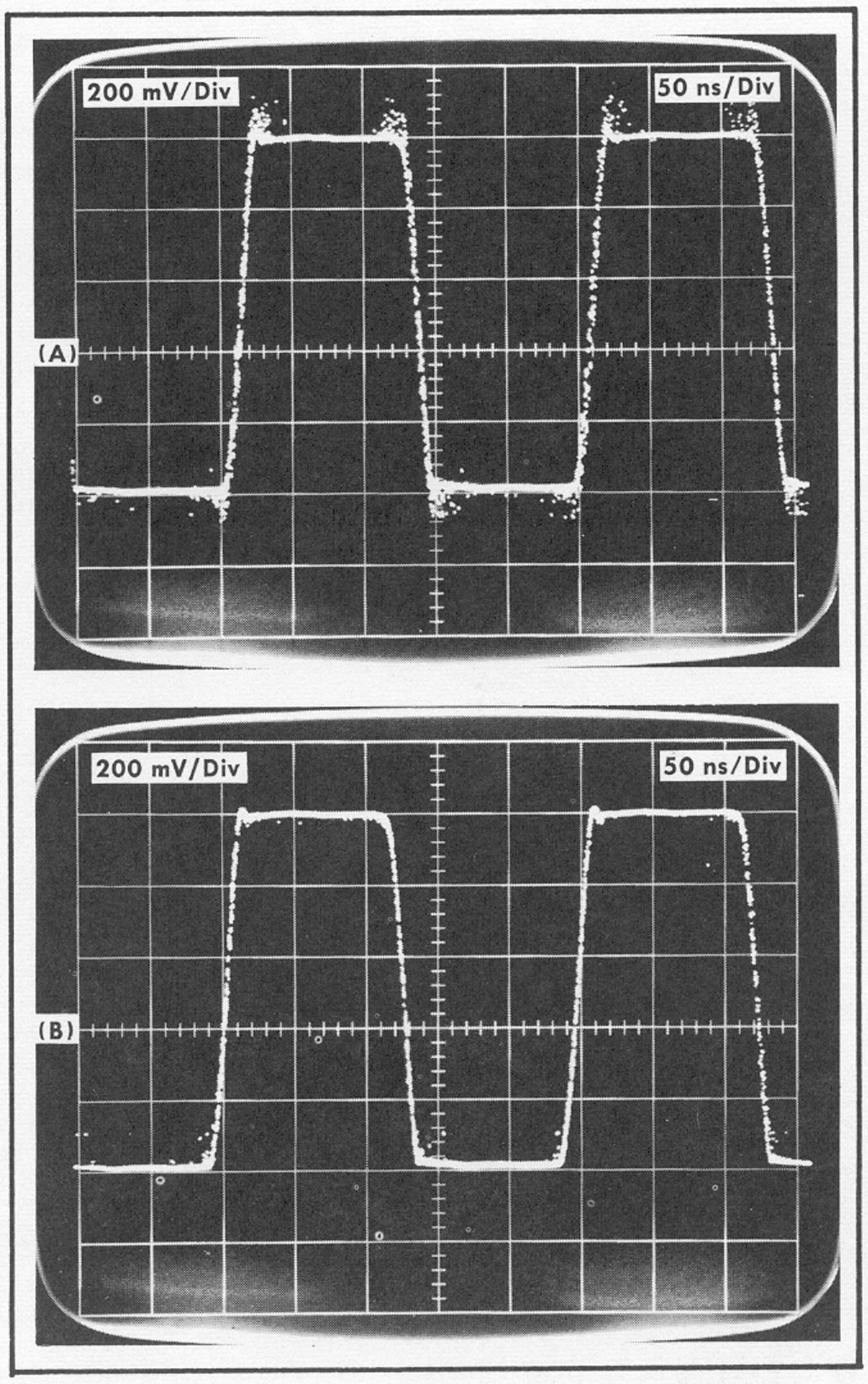


Fig. 2-6. Typical display for unity loop gain adjustment in random sampling operation.

TABLE 2-1

Type S-3 Input System

System	Source Loading	Time Constant	Maximum Input Signal	Safe Overload
Probe Only	100 kΩ, ≈2.3 pF	DC Coupling	2 V P-P	±100 V DC or 20 V P-P Sine wave
Probe & AC Coupling Capacitor	100 kΩ, ≈4.5 pF	100 μs	2 V P-P	Note 2
Probe & 10× Attenuator	1 MΩ, ≈2.0 pF	DC Coupling	20 V P-P	±350 V DC or 200 V P-P Sine wave
Probe & 10× Attenuator & AC Coupling Capacitor	1 MΩ, ≈4.0 pF	1000 μs	20 V P-P	Note 2
Probe & 100× Attenuator	1 MΩ, ≈1.7 pF	DC Coupling	200 V P-P	±350 V DC or 200 V P-P Sine wave
Probe & 100× Attenuator & AC Coupling Capacitor	1 MΩ, ≈3.8 pF	1000 μs	200 V P-P	Note 2

[2]**Maximum input voltage with AC Coupling Capacitor is 200 V combined DC and AC peak.**

24. Adjust the Type 3T2 Trig Sensitivity control for a stable triggered display. Use the Time Position control to center the top of the square wave. If the top of the square wave is level, the attenuator is properly compensated and no adjusment is required.

25. If the square wave top display is not level, compensate the 10× attenuator by carefully adjusting the capacitor in the attenuator with a small screwdriver.

26. Remove the 10× attenuator and install the 100× attenuator. Set the Type 106 Amplitude control fully clockwise (maximum amplitude). Set the Type 3S2 Units/Div switch to 50 and the Variable control for a 5 division display. If the top of the square wave is level, the attenuator is properly compensated and no adjustment is required.

27. If the square wave top display is not level, compensate the 100× attenuator by carefully adjusting the capacitor in the attenuator with a small screwdriver.

Coupling Capacitor

The coupling capacitor attachment for the Type S-3 is a 1000 pF (200 volt) capacitor. The capacitor can be used at the Type S-3 probe tip with or without an attenuator to AC couple the input signal. The capacitor adds some additional shunt capacitance at the probe tip. The input capacitance and the time constant with the coupling capacitor attached are shown in Table 2-1.

DC OFFSET Range Switch

The DC Offset switch allows selection of an offset voltage range of either +1 Volt to —1 Volt or +2 Volts to —2 Volts as set by either the ×1 or ×2 switch position. The sampling unit DC Offset control selects the offset voltage within the above ranges. The offset voltage can be used to cancel the effect of a DC input voltage of up to ±2 volts at the S-3 probe (without attenuators), up to ±200 volts using the 100× attenuator. For further DC offset voltage information, see the Operating Instruction section of the manual for the sampling unit in use.

GENERAL OPERATING INFORMATION

Input Voltage Considerations

Proper displays of various signal amplitudes require special attention to the type of time base generation in use. There are also input voltage limits that must be observed to prevent either display distortion or damage to the Type S-3.

The input voltage limits depend upon whether the probe is used alone or in combination with an accessory attenuator and/or capacitor. Table 2-1 shows the maximum input signal and the safe overload voltage for each system combination.

Where unity loop gain is required, accurate displays are possible to achieve only when the input amplitude and the time base generation mode are both considered. The two time base generation modes are: (1) normal process sampling, where each dot is displayed in sequence across the CRT, and (2) random process sampling where the dots are not necessarily displayed in a sequence that progresses uniformly across the CRT. The Type 3T2 Random Sampling Sweep unit presents random process sampling displays in a controlled sequence very similar to normal process sampling when the Time Magnifier switch is at ×1 or ×2 and the trigger signal repetition rate is uniform. The random process dot sequence

is definitely not sequential when the Time Magnifier switch is anywhere between ×5 and ×50, with the dot presentation completely random at ×50. The Type 3T2 can be operated in a normal process mode, and all other Tektronix sampling sweep units generate only a normal process sequential dot display.

Unity loop gain displays are not usually required when the signal rate of rise and the sweep rate selected provide a large number of dots for any vertical display change. Unity loop gain is required for some random process sampling displays, and for normal process displays where there are either no samples, or less than about 6 samples in a step transition. (Many dots in any vertical change permits valid random process displays without unity loop gain when the Type 3T2 Time Magnifier is at ×1 or ×2.)

In summary, unity loop gain exists when the vertical channel (sampling head and sampling unit) will accurately shift a sample dot 100% of the signal amplitude. The Specification Section lists the loop gain linearity limits as ±5% for certain limited signal amplitudes discussed below. A 5% loop gain linearity means that the vertical channel will shift a dot in the positive direction 100% of the full signal amplitude, but minus transitions may shift a dot between —95% and —105% of the full signal amplitude, and vice versa. (The Dot Response control thus allows either the display top or bottom to be adjusted to unity loop gain for close examination of signal detail.) Unity loop gain is obtained by proper adjustment of the sampling unit Dot Response control as described in First Time Operation.

Input signal amplitude limits for unity loop gain within the 5% linearity tolerance are listed in Table 2-2. The input voltage columns are for signal amplitudes of 1.0 V peak to peak and 2.0 V peak to peak anywhere between +2 V and —2 V DC.

TABLE 2-2

Input Signal Amplitude Limits Allowing Unity Loop Gain Vs Sampling Unit mVOLTS/DIV Deflection Factor. (Probe without attenuators)

Sampling Unit Units/Div Switch	Input Voltage	
	1.0 V P-P	2.0 V P-P
All positions 200 to 2	yes	no
	Either Normal or Random Process	
Limited to positions of 20 to 2	yes	yes
	Either Normal or Random Process	
All positions 200 to 2	yes	yes
	Normal Process only with >6 dots in a 100% vertical transition.	

Input Signal Connection Precautions

Accurate displays of signals containing very fast transitions or very high frequencies are possible only when short ground connections are made at the probe tip. The Type S-3 probe shunt resistance and capacitance are shown in Table 2-1 for each combination of probe, attenuator and coupling capacitor. For example, the table shows that the probe only has a loading of 100 kΩ paralleled by ≈2.3 pF. The signal source impedance must be low when measuring pulses with fast rise times near the system limit. A ground wire lead adds series inductance to the probe tip ground, which will decrease the rise time or cause ringing under fastrise conditions. Use the shortest ground lead possible or use special adapters for mating the Type S-3 probe to coaxial systems.

Each time a sample is taken, a small amount of strobe kickout signal is present at the probe tip. Some fast generator circuits, such as the Type 284 Pulse Output circuit, are sensitive to the strobe kickout signal. When using the Type 284 Pulse Generator Output signal to drive the probe, use a coaxial line of at least 8 cm length between the Type 284 Pulse Output connector and the Type S-3 Probe.

Probe Adapters

Voltage Pick-off Adapter. The Tektronix Voltage Pick-off Adapter VP-2 (Tektronix Part No. 017-0077-01) permits using the Type S-3 probe within a closed 50 ohm system with negligible effect on the signal. A VP-2, terminated in 50 Ω at each end GR874 connector, presents a 62.5 Ω source resistance to the Type S-3 probe tip.

Probe Tip to GR Adapter. (Tektronix Part No. 017-0076-00.) Allows the probe to be connected directly to GR874 coaxial connectors. If the probe and adapter are connected to an unterminated 50 Ω cable, the source resistance to the probe tip is 50 Ω. The signal amplitude from a 50 Ω source is 2× its terminated value, and signal reflections back to the signal source must be considered. Re-reflections from signal sources other than 50 Ω may be included as part of the display. The Probe Tip to GR Adapter should be used at the end of 50 Ω coaxial cables whose signal source impedance is also 50 Ω. Use of a good reverse termination will absorb the reflected signal returned to the source by the probe tip mismatch and prevent display confusion.

Probe Tip to BNC Adapter. (Tektronix Part No. 013-0084-00.) This adapter is identical in function to the Probe Tip to GR Adapter, but is fitted with BNC connectors.

Bayonet Ground Assembly. (Tektronix Part No. 013-0085-00. The Bayonet ground assembly (a probe accessory supplied with the Type S-3) provides a very short ground connection at the probe tip. The bayonet tip is convenient when the ground plane is adjacent to the signal source.

Chassis Mount Test Jack. (Tektronix Part No. 131-0258-00.) Can be mounted directly into the test circuit so that the Type S-3 probe can be conveniently connected. This allows a good signal ground connection but adds about 2 pF capacitance over the normal probe tip value.

Other accessories including ground leads are shown on the accessories pull-out page at the rear of this manual.

Measuring Risetime

The Type S-3 is useful to show risetime and detect aberrations of signals in circuits that are properly coupled to the Type S-3. The risetime of both the generator (or source), and the Type S-3 must be taken into consideration. The Type S-3 risetime is slowed with the addition of an attenuator. See Section 1 for risetime specifications.

Signals with risetimes as fast as about 0.8 ns (800 picoseconds) can be measured using the Type S-3 without any special considerations. Read the 10% to 90% risetime directly

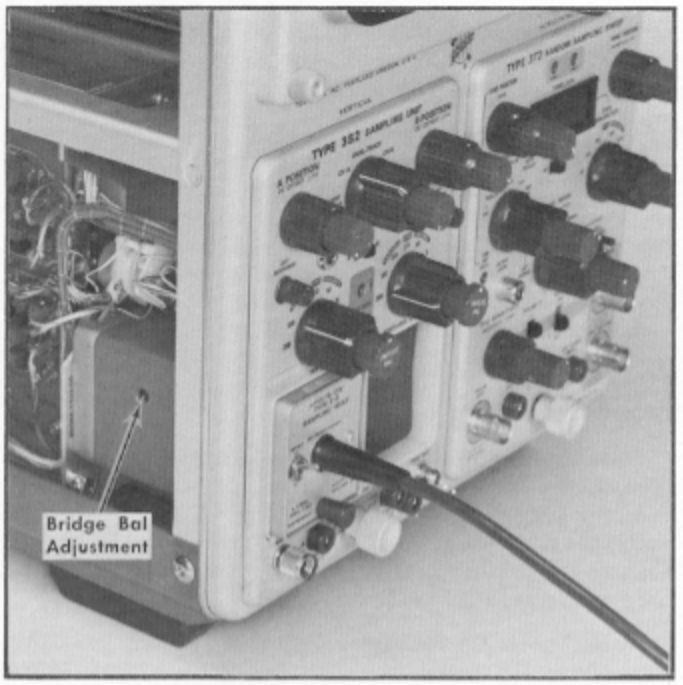


Fig. 2-7. Bridge Bal Location.

from the CRT (or digital unit) to know the risetime of the signal.

Signals with risetime faster than about 0.8 ns can best be measured using a Tektronix Type S-2 Sampling Head. However, fair approximations of risetime can be made using the Type S-3 and calculating the signal risetime by formula (1) below. Formula (1) is based upon both the signal and the sampler having Gaussian risetime characteristics. The Performance Check and Calibration Procedure gives equipment, procedure and typical displays of the Type S-3 risetime when driven by a 70 ps risetime signal.

Formula (1)

$$T_r \text{ (Displayed)} = \sqrt{(\text{Signal } T_r)^2 + (\text{Type S-3 } T_r)^2}$$

$$\text{Signal } T_r = \sqrt{(\text{Display } T_r)^2 - (\text{Type S-3 } T_r)^2}$$

Triggering the Sampling System

The Type S-3 has no internal trigger pickoff system. Therefore, an external trigger signal must be supplied to the sampling sweep unit. If the signal being measured is a repetitive sine or square wave, a pretrigger is not required. Viewing the leading edge of a fast pulse signal does require a pretrigger, or use of the random process sampling possible with the Type 3T2. Two trigger pickoff devices for 50 Ω source impedance are described.

CT-3 Signal Pickoff. (Tektronix Part No. 017-0061-00.) A convenient method of picking off a signal in a 50 Ω system. Sensitivity is 10% of the voltage under test into a 50 Ω load.

50 Ω Power Divider. (GR874-TPD. Tektronix Part No. 017-0082-00.) Can be used to supply 50% of the input signal as a trigger signal and 50% of the input signal to a 50 Ω load. Requires the use of the Type VP-2 and a 50 Ω termination. Its primary advantage is for use with sine waves of low amplitude (less than 0.1 volt) if CT-3 10% trigger amplitude is so low the sampling sweep unit doesn't trigger properly.

Connect the trigger signal from either trigger pickoff unit to the sampling sweep unit. Use a 2× attenuator to reduce trigger circuit reflections when using the GR874-TPD. Operate the sweep unit externally triggered. Random process sampling of the Type 3T2 constructs a display of a repetitive signal so that no delay line or pretrigger is required to view the leading edge of a fast pulse. Normal sequential process sampling requires a pretrigger signal to view the leading edge of a fast pulse signal. This can be obtained from some pulse generators with a pretrigger output signal, such as the Tektronix Type 284. Another method is to use a trigger pickoff device at the signal source ahead of a high fidelity delay line. The delay line provides a signal delay necessary to observe the leading edge of a fast pulse. The delay line method is described in the Performance and Calibration Section of this manual.

SECTION 3

CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

This section of the manual contains a block diagram analysis of the Type S-3 Sampling Head followed by a detailed circuit description. The Type S-3 is the signal input section of the sampling system, and determines the input characteristics of the sampling system. You may find it helpful to refer to the associated sampling unit manual for information on sampling principles if the purpose of a particular circuit is not clear. For example Type 3S2 manual, Section 3, "Basic Sampling Principles". The sampling unit manual also shows interconnections and circuits referred to in this section. Schematic and block diagrams of the Type S-3 are located at the rear of this manual.

BLOCK DIAGRAM

Strobe Generator

The Strobe Generator develops fast-rise short-duration push-pull pulses that drive the Sampling Bridge into balanced conduction. Output occurs at the time of each sample when a command pulse arrives from the Delay and Strobe Driver circuit of the associated sampling unit. Shape and amplitude of the output strobe pulses is set by the Avalanche Volts and Snap-off Current controls. Strobe pulse duration is fixed by the two shorted clipping lines.

Sampling Bridge

The Sampling Bridge allows no connection other than the normal stray capacitance of the bridge between the input connector and the Preamplifier input except when driven into conduction by the Strobe Generator. When the Strobe Generator drives the Sampling Bridge into conduction, a portion of the signal across the Sampling Bridge is applied to the Preamplifier input.

Reverse bias is applied to the Sampling Bridge diodes by the Bridge Volts and Bridge Balance circuit. The sampling system feedback signal and DC Offset voltage is applied to the output side of the Sampling Bridge and the Preamplifier input.

Preamplifier

The Preamplifier circuit both amplifies and time-stretches the signal it receives from the Sampling Bridge. The signal applied to the preamplifier is a portion of the difference between the combined feedback and DC offset voltage, and the input signal. The error signal is amplified and AC coupled to the post amplifier in the sampling unit. The Preamplifier gain is adjustable to aid in setting the overall sampling head and sampling unit loop gain to unity for proper dot response displays.

CIRCUIT DESCRIPTION

The Type S-3 Sampling Head uses the power supplies of the indicator oscilloscope and associated sampling unit. Interconnections to some of the circuits in the sampling unit are by a connector at the rear of the sampling head. This Circuit Description covers the circuits in the Type S-3, and refers to circuits within the sampling unit. Reference to the sampling unit instruction manual diagrams and circuit description may be useful to fully understand the circuit relationships.

Strobe Generator

The Strobe Generator circuits are located on the Strobe board. The generator contains two basic circuits, the Avalanche circuit and the Snap-off diode circuit. Both circuits work together to produce the push-pull strobe pulses that drive the Sampling Bridge through two equal transmission lines. See Fig. 3-1.

Avalanche circuit. The Avalanche circuit converts the Strobe Drive pulse from the sampling unit to very fast push-pull pulses to drive the Snap-off diode to non-conduction.

The Strobe Drive pulse is transformer-coupled by T75 to the base and emitter of the Avalanche transistor Q69. Two outputs are AC-coupled from Q69, one from the collector and the other from the emitter. The Avalanche Volts control adjusts the collector voltage of the avalanche transistor Q69. The typical quiescent voltage at Q69 collector is about +15 volts. This voltage sets the amplitude of the signals that drive the Snap-off diode circuit, and assures the normal avalanche action of Q69 when driven by the Strobe Drive signal. Q69 current path is shown by a dashed line in Fig. 3-1. Before Avalanche conduction, there is a potential of about 60 volts between collector and emitter.

The negative Strobe Drive pulse is transformer-coupled by T75 to the emitter and the base of Q69, forward biasing Q69. Normal avalanche action follows with the collector going negative and the emitter going positive. This fast-rise push-pull signal is capacitively coupled to the Snap-off Diode circuit.

Snap-off circuit. The Snap-off circuit operates as a current switching circuit to apply some of the push-pull Avalanche signals at snap-off time to the Sampling Bridge.

The circuit consists of a Snap-off Current control R57, Q55, Snap-off diode D61, two clipping lines and associated components. Between drive pulses from the Avalanche circuit,

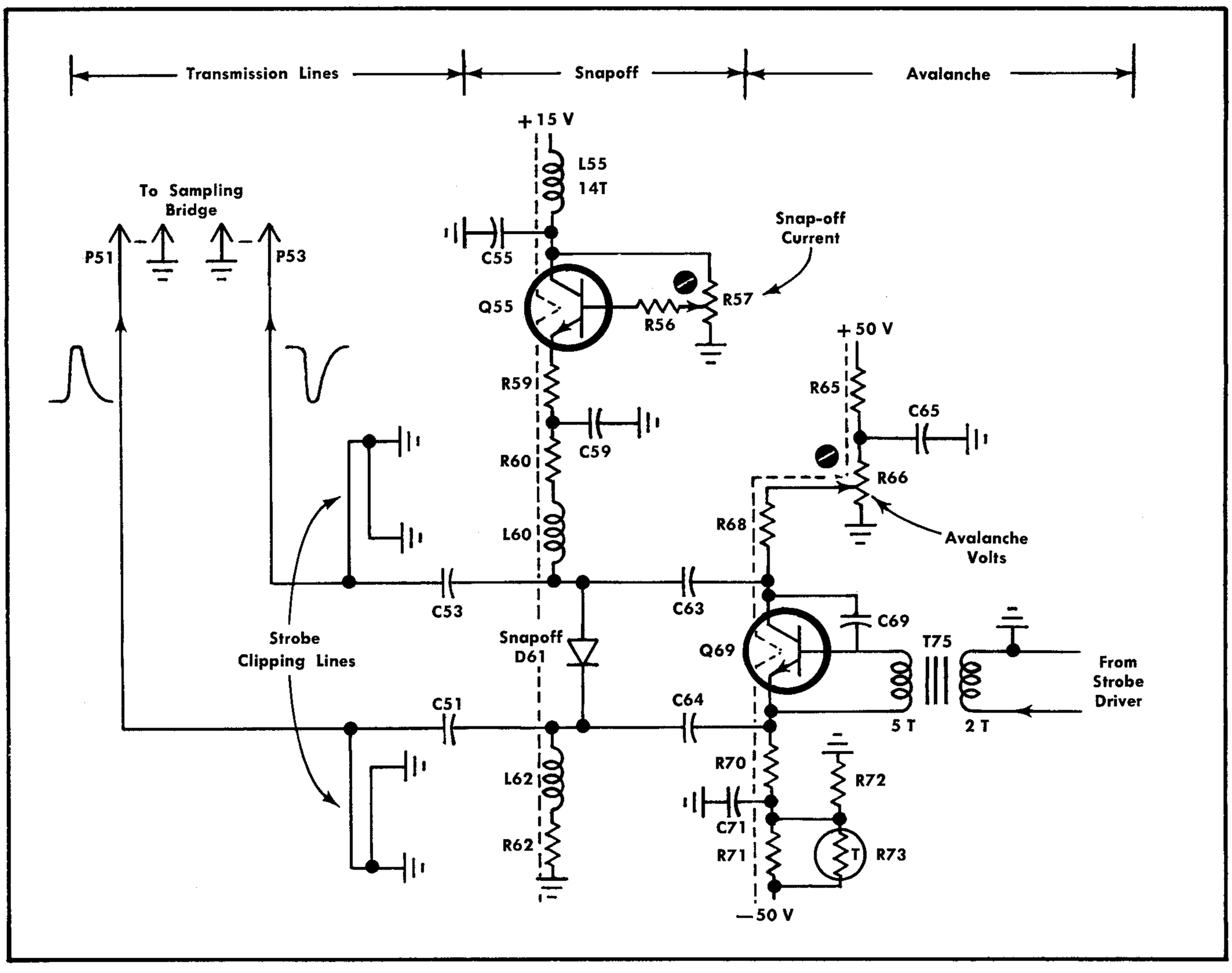


Fig. 3-1. Strobe Generator circuits.

the Snap-off diode D61 is forward biased by the current in Q55. The current value is set by the Snap-off Current control R57. The current in D61 is typically 20 mA, and the current path is shown as a dashed line in Fig. 3-1. This heavy forward current assures that D61 has many carriers within its junction region.

The push-pull signals from the Avalanche circuit cause D61 junction carriers to reverse direction as a heavy reverse current. This heavy reverse current stops suddenly as all the carriers clear out of the junction. As the reverse current "snaps" to a stop, the push-pull avalanche signals are suddenly coupled toward the clipping lines and the Sampling Bridge by C53 and C51. The fast-rise step which appears at each clipping line input is propagated down the line. A finite period of time later the steps reach the short circuit ends of each clipping line. The step is then reflected, equal in amplitude and opposite in polarity, back to the transmission line. This cancels the signals moving toward the Sampling Bridge. This action results in a positive Strobe pulse being delivered to P51, and a negative Strobe pulse being delivered to P53.

Sampling Bridge

The Sampling Bridge diodes A, B, C, and D are encapsulated as a single unit and shown as D4 in Fig. 3-2. These diodes are located within the body of the probe. The input signal, appearing at the probe tip, is applied across the series combination of R1 and R4. This 100 kΩ resistance together with the low value of input capacitance provide the Type S-3 with a relatively high input impedance. Capacitor C1 is in series with the stray capacitance at the input of the Sampling Bridge. The capacitance of C1 can be varied by rotating the body of the probe (See Operating Instructions, Section 2). Correct adjustment of C1 provides the proper division of high-frequency signal components across C1 and the stray capacitance in parallel with R4.

The Sampling Bridge is kept reverse biased except for short intervals (during sampling time) when it is driven into conduction by pulses from the Strobe Generator. During the conduction time of about 350 ps, current through the bridge increases or decreases the voltage on capacitor C30 at the gate of Q31. The voltage on C30 changes only a small percentage of the difference between the combined feedback

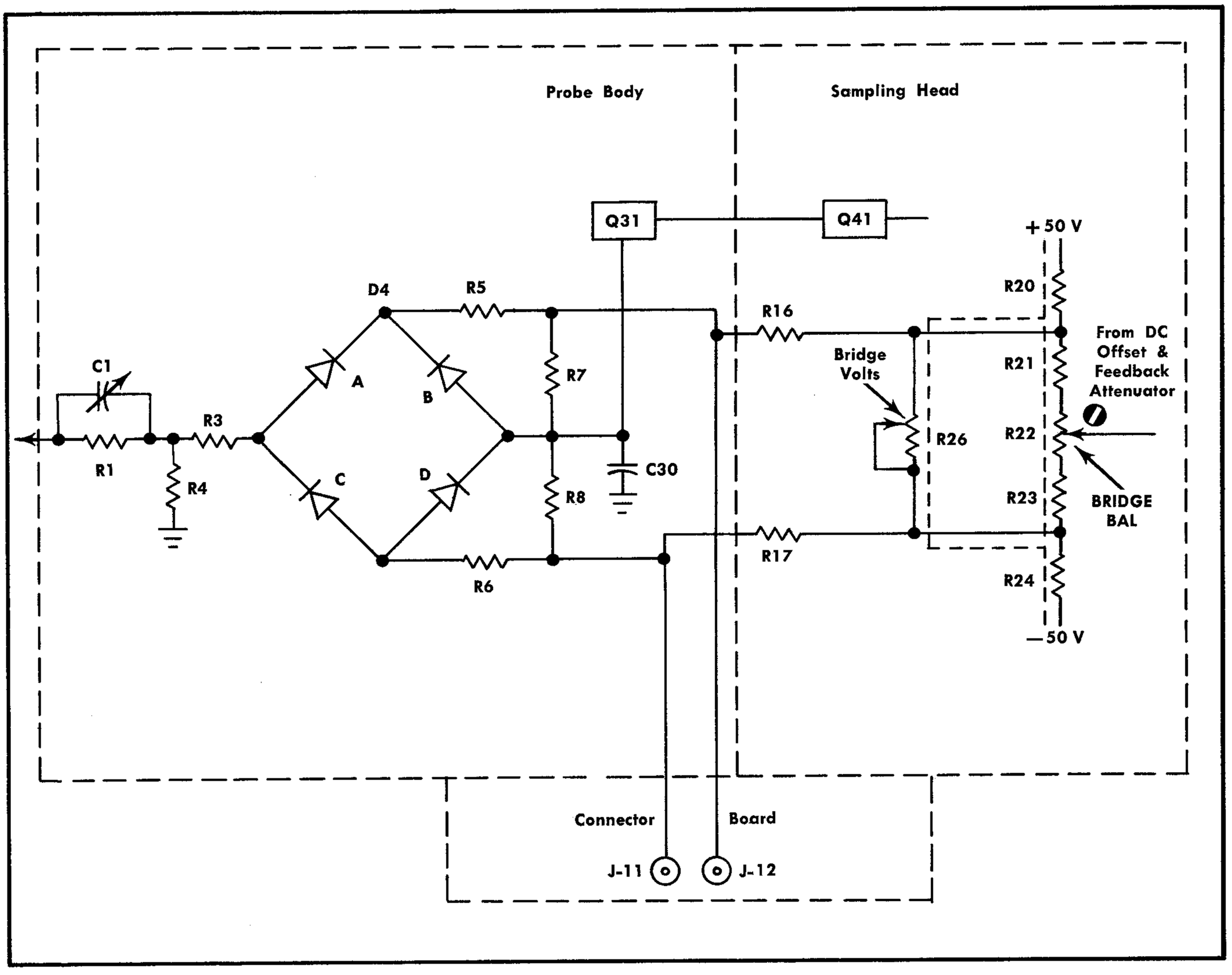


Fig. 3-2. Sampling Bridge circuit and Bridge Volts and Bridge Balance circuits.

and DC offset voltage and the incoming signal voltage due to the short bridge conduction time. This voltage change, called the error signal, is amplified by Q31 and the remainder of the preamplifier bringing the voltage on C30 up to the proper value, through the feedback circuit, prior to unblanking of the CRT.

Reverse-bias voltage for the sampling bridge diodes is developed across R21, R22, and R23 paralleled by R26, the Bridge Volts control. R26 allows adjustment of the reverse bias. A higher reverse voltage allows bridge conduction for a shorter time. A lower voltage provides a longer conduction time.

The Bridge Bal potentiometer is adjusted to compensate for diode, strobe, and other system unbalance signals. The combined memory feedback and DC offset voltage from the sampling unit is fed through the bridge volts circuit to the output of the Sampling Bridge.

Feedback and offset voltages are applied from the associated sampling unit to the movable contact of the Bridge Bal control R22. A switch on the front panel of the Type S-3 Sampling Head permits selection of either of two ranges of offset voltage. See Fig. 3-3. With the OFFSET switch at the ×2 position, up to 2 volts of offset voltage of either polarity is available for application to the sampling bridge. With the switch set to the ×1 position up to 1 volt of either polarity can be applied.

Preamplifier

The Preamplifier circuit (see Fig. 3-4) amplifies and time-stretches the error signal pulse from the Sampling Bridge, and AC couples it to the Post Amplifier in the associated plug-in unit.

Transistor Q31 operates as a very high impedance high-gain inverting amplifier. C34 assures that Q31 has a high AC gain, while the DC gain is less than 1.

Q41 and Q45 are connected as an operational amplifier with a very low output impedance at Q45 emitter. The output is coupled by C49 to the 90 Ω input resistance Post Amplifier in the sampling unit. Q45 current paths are shown by

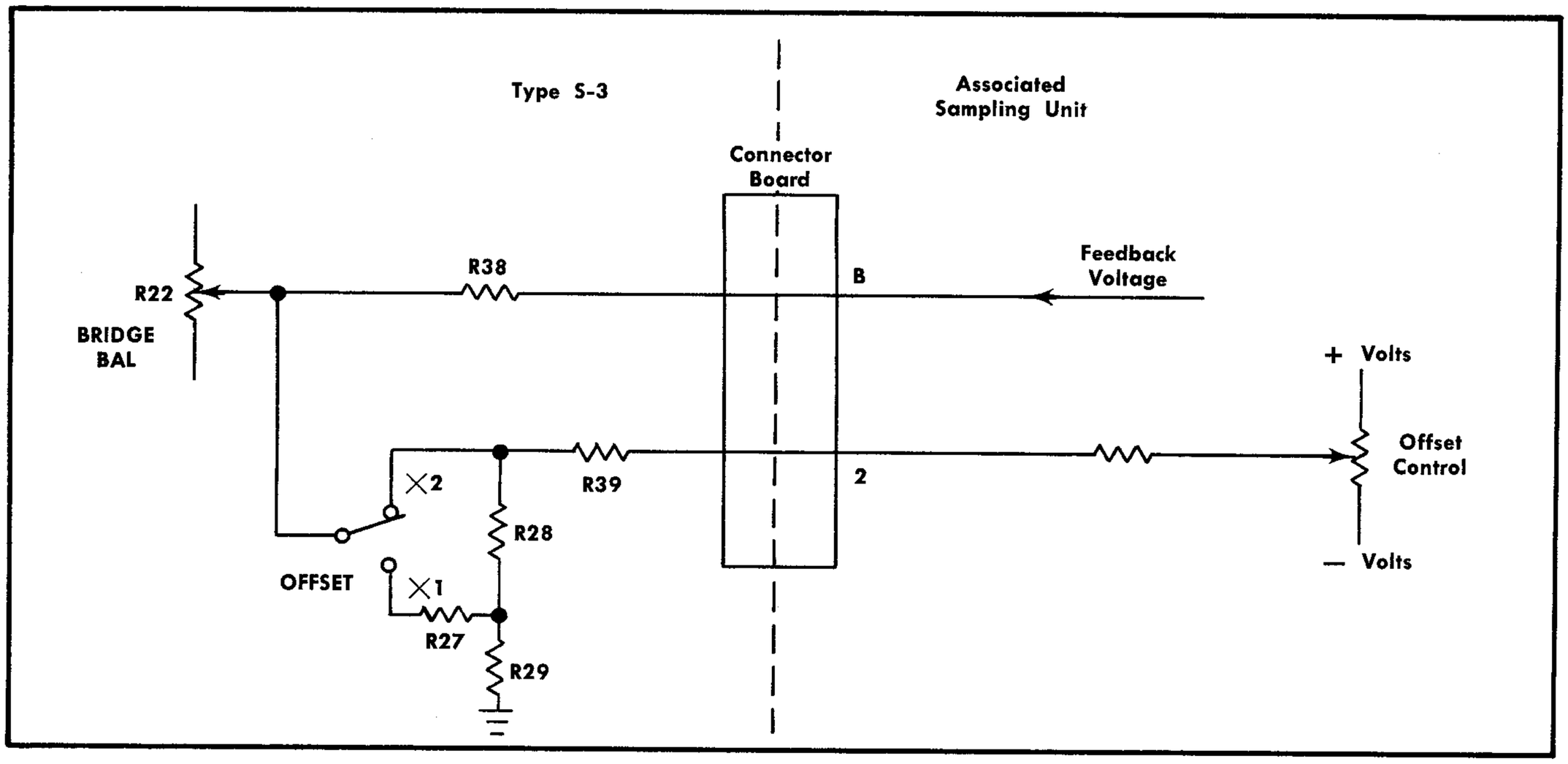


Fig. 3-3. OFFSET range switch and associated circuit.

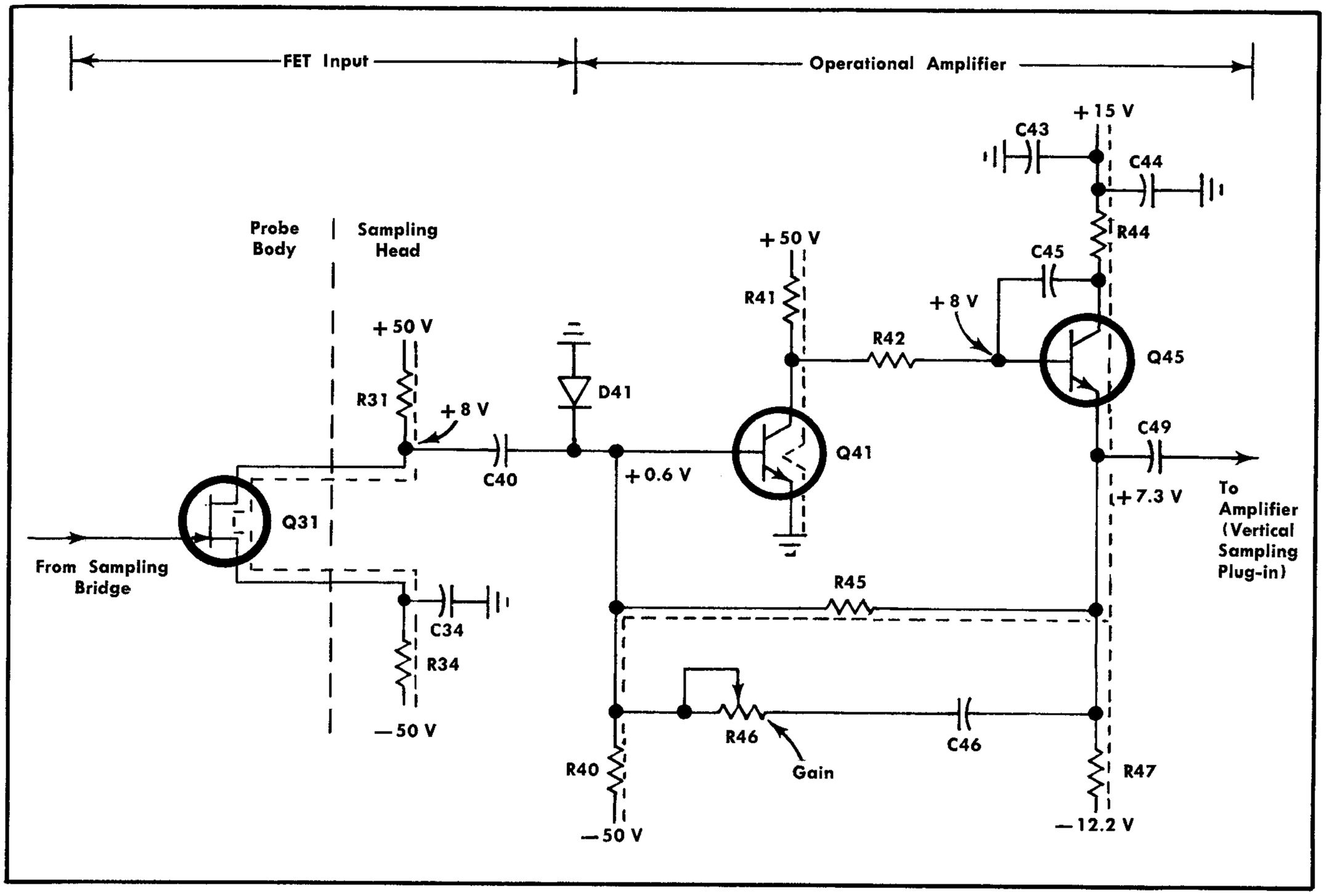


Fig. 3-4. Preamplifier circuit.

dashed lines in Fig. 3-3. D41 protects Q41 base from high negative voltage if Q45 is removed from its socket while the power is on.

Current in R40 with DC negative feedback by R45 sets the output DC voltage level of the amplifier at about +7.3 volts. Negative AC feedback from the emitter of Q45 through C46 and Gain control R46 to Q41 base controls the AC gain of the Preamplifier. The Gain control R46 allows the AC feedback to be adjusted, thereby adjusting the gain.

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains information for use in corrective maintenance or troubleshooting of the Type S-3.

To remove the Type S-3 from its case, loosen the four retaining screws on the back. Then slide the back off, and remove the case by sliding it to the rear. Directions for replacing the case on the sampling head will be found at the end of this section.

Parts Replacement

All parts used in the Type S-3 can be purchased directly through your Tektronix Field Office or Representative. 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 S-3 should be ordered from Tektronix since these parts are either manufactured or selected by Tektronix to satisfy a particular requirement. Before purchasing or ordering, consult the Electrical or Mechanical Parts List to determine the value, tolerance and ratings required.

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, the sampling head may require recalibration.

Transistor Replacement. Cut the leads of a replacement transistor to the same length as the transistor removed and bend the leads as necessary. The lead configurations of the transistors used in the Type S-3 are shown in Fig. 4-1. The field-effect transistor, Q31, which is located in the probe body, has leads soldered to the circuit board.

Leadless Capacitors. There are leadless ceramic capacitors soldered directly to the circuit boards. Care must be taken when replacing these capacitors as they are easy to crack. The type of solder used must be high quality, with good cold-flow characteristics. Thus, do not use 50/50 solder, but 60/40 or 62/38 solder when replacing the leadless capacitors.

Best results will be obtained by applying heat from the soldering iron directly under the leadless capacitor on the opposite side of the board. Usually a plated-through hole is under the leadless capacitor, allowing solder to conduct heat through the board. Without plated-through holes, the capacitor may be soldered into place by positioning the part, then applying heat to the adjacent plated area.

Use only enough solder to obtain a good full-flow joint. Excess solder on either side of the capacitor can lead to a shorted circuit.

Removal and Replacement of Snap-off Diode. The Snap-off diode is mounted in small metal clips, as shown on the circuit board illustration. The diode is best removed or replaced with a pair of shaped plastic tweezers, such as Tektronix Part No. 006-0765-00, or equivalent.

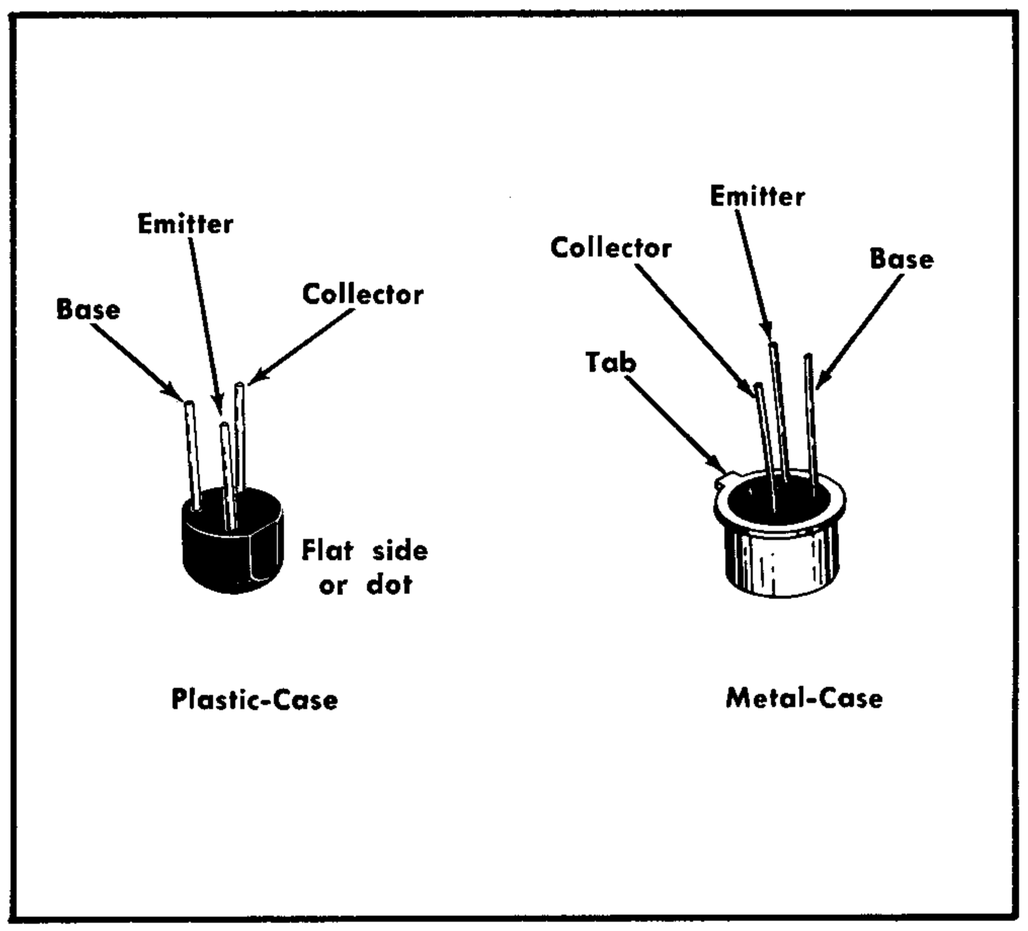


Fig. 4-1. Lead configuration for board-mounted transistors.

Circuit Board Replacement. If a circuit board is damaged and cannot be repaired, the entire assembly including all soldered-on components should be replaced. The part number given in the Mechanical Parts List is for the completely wired board.

The Preamp Board and the Strobe Board are removed by gently pulling outward from the Terminal Board. To replace the boards, align the connectors and pin contacts and ease the boards into position. Pin connectors should not protrude beyond the clamps. Solder the three leads to the Preamp Board.

The Terminal Board is removed as follows:

1. Remove both the Preamp Board and the Strobe Board.

2. Remove the front panel by removing the locking nut on the OFFSET switch ($10^{5}/_{16}$" nutdriver) and the phillips head screw.

3. Keep the white plastic circuit board holders straight while loosening the screws at the front of the sampling head.

4. Disconnect and unsolder leads from the probe cable and the Terminal Board is free.

Probe Care

The probe should be inspected before further use any time it has been dropped or damaged. To inspect the inside of the probe, grasp the cable strain-relief boot about 3/4 inch from the probe body, then turn the coupling nut clockwise about three turns and the probe body counterclockwise about six complete turns. This frees the securing threads and allows the body to be removed from the tip end.

The cable strain-relief boot can be moved back from its normal position by turning clockwise when the probe body is installed.

If any parts require replacement, it is recommended that you send the probe to the nearest Tektronix Field Repair Center.

CAUTION

Use extreme care in soldering on the probe circuit board. Ground the metal on the probe body to the same potential as the soldering iron to avoid electrical shock to the sampling diodes (D4.) Use heat sinks to avoid heat damage. Careful handling is needed to prevent physical damage to the small part. Use 60/40 or 62/38 solder and a miniature soldering iron (Tektronix Part No. 003-0338-00) with tweezers as a heat sink. Excessive heat may expand the epoxy coating on the diodes and cause damage to internal connections within the device.

Replacing the Cable Assembly

If the coaxial cable between the probe body and sampling head should fail a replacement cable assembly (with attached new probe) is available. Replace the cable as follows:

1. Remove the case by unscrewing the four rear Phillips head screws. Slide the case off the back of the unit.

2. Remove the small screw at the right center of the front panel and the nut from the toggle switch at left center of the front panel (use a 5/16" open end wrench) and remove the front panel.

3. Carefully remove the two outer circuit boards taking note of how the OFFSET switch is placed. Do not lose the black plastic spacer that is now loose on the threaded portion of the switch.

4. Remove the two flat-head Phillips screws holding the center circuit board to the front panel casting.

5. Withdraw the two strobe cable coaxial connectors and unsolder the two leads and grounding braid from the center board.

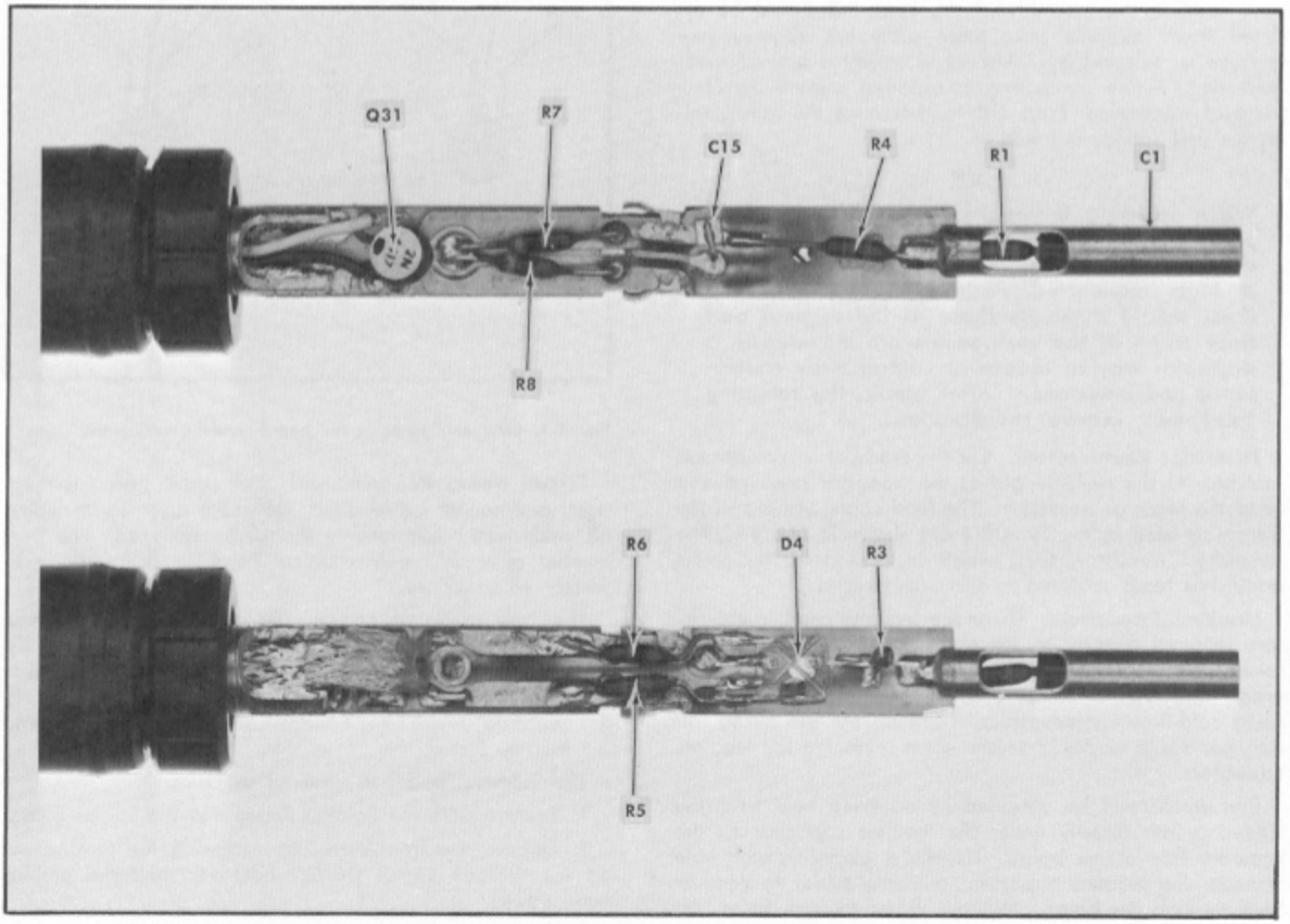


Fig. 4-2. Type S-3.

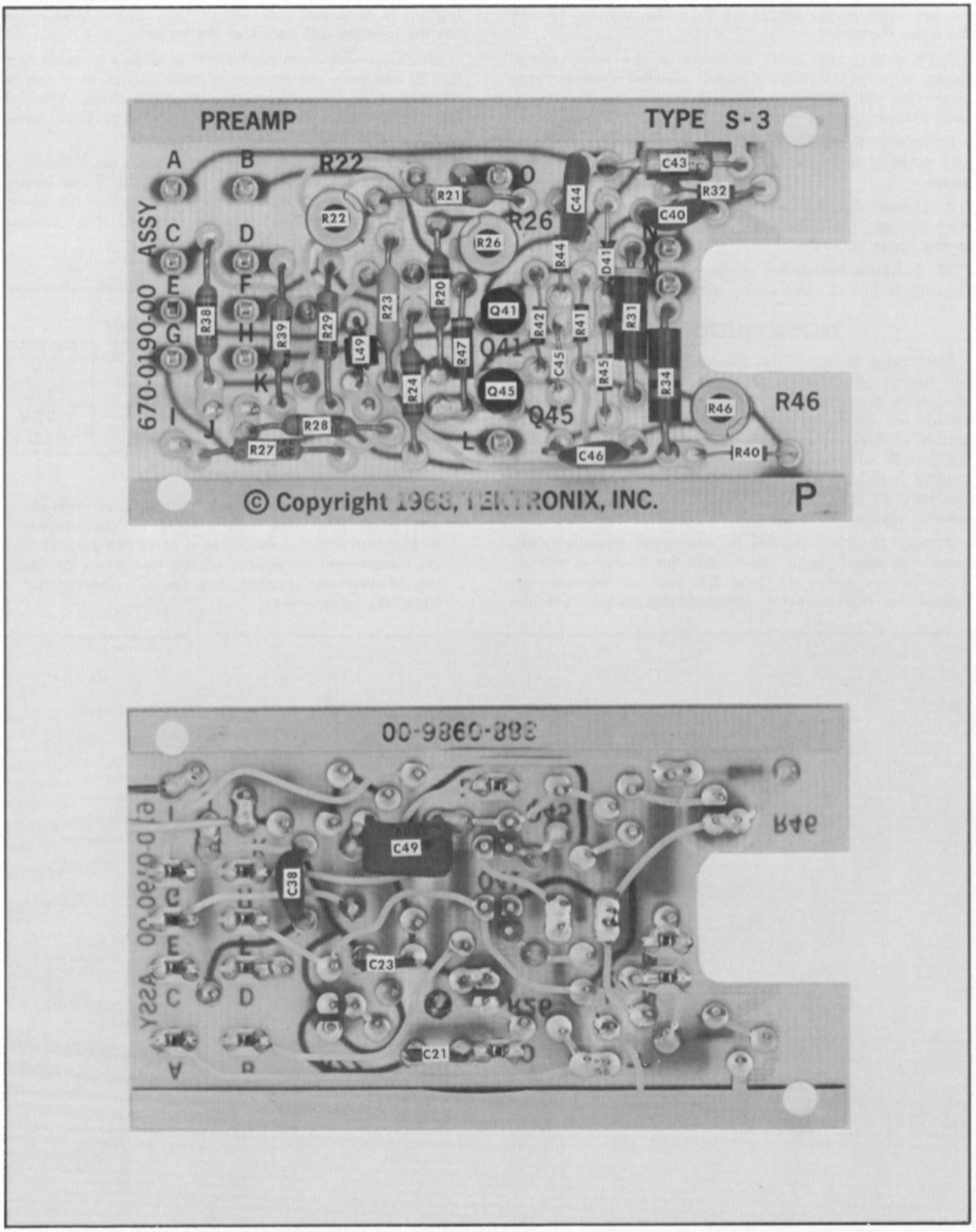


Fig. 4-3. Preamp circuit board.

6. Loosen the two round-head Phillips screws that hold the two white plastic clamps on the cable end and remove the cable assembly.

7. Place the new cable assembly in the white plastic clamp with the clear (transparent) covered coaxial cable above the red covered cable and tighten the two round-head Phillips screws.

8. Connect the white wire to upper, black wire to center and shield to the lower terminals at the front of the circuit board.

9. Connect the red covered coaxial cable to the lower connector and the clear (transparent) covered coaxial cable to the upper connector.

10. Complete reassembly of the unit by using procedure the reverse of that used during disassembly.

TROUBLESHOOTING

Mechanical design of this sampling head is such that circuit boards are interchangeable from one unit to another (the probe circuit board is not replaceable). Since the outer boards are easily removed and replaced, it is possible to quickly troubleshoot a faulty sampling head by interchanging boards with an operating one. Thus, removal of the preamp board from a defective unit and replacement with one from an operating unit quickly checks the faulty units' preamp circuits.

Attempt to isolate trouble to one circuit through operational and visual checks. Verify that the trouble is actually a malfunction within the Type S-3, and not improper adjustments or malfunctioning associated equipment. Note the effect control adjustments have on the trouble symptoms. Normal or abnormal operation of each control helps establish the location and nature of the trouble.

Check the instrument calibration procedure given in Section 5, and note the position of each control so it can be returned to its original position after the check. This will facilitate recalibration after the trouble has been found and corrected.

A block diagram and schematic diagram are included in Section 8 of this manual. It is usually best, if the trouble is not isolated to a circuit, to start by checking the power supplies of the sampling unit; see Table 4-1, then proceed consecutively from one circuit to the next.

TABLE 4-1

Test Point Pin		Power Supply (Decoupled)	Tolerance
Preamp Board	Strobe Board		
G	B	+50 V	±1 V
A	A	+15 V	±0.15 V
F	C	−50 V	±0.5 V
B	—	−12.2 V	±0.37 V

CAUTION

Use care when measuring voltages or signals. The small size and high density of components in this instrument establishes a condition such that an inadvertent movement of the test probe or the use of oversized probes may cause a short-circuit between components.

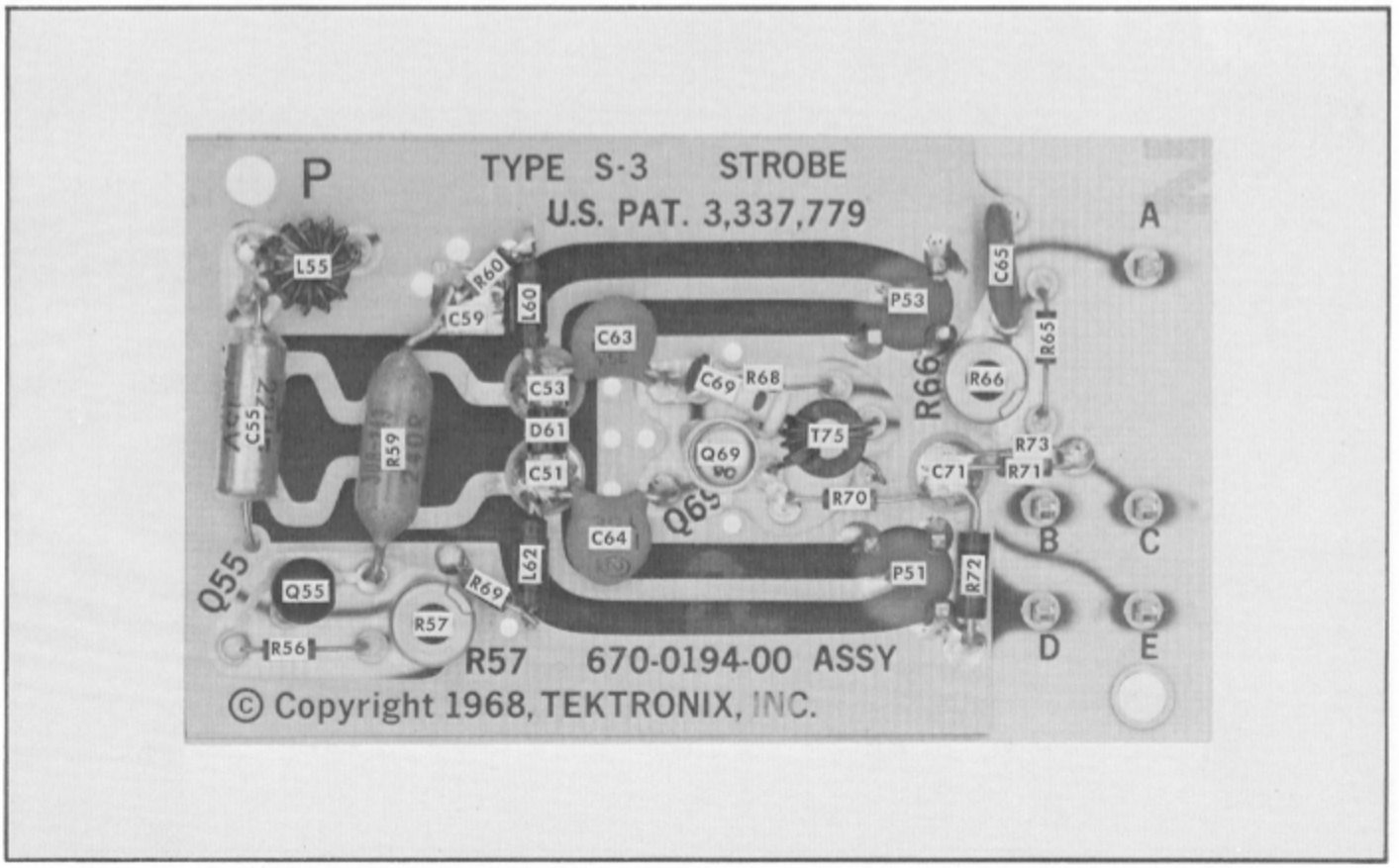


Fig. 4-4. Strobe circuit board.

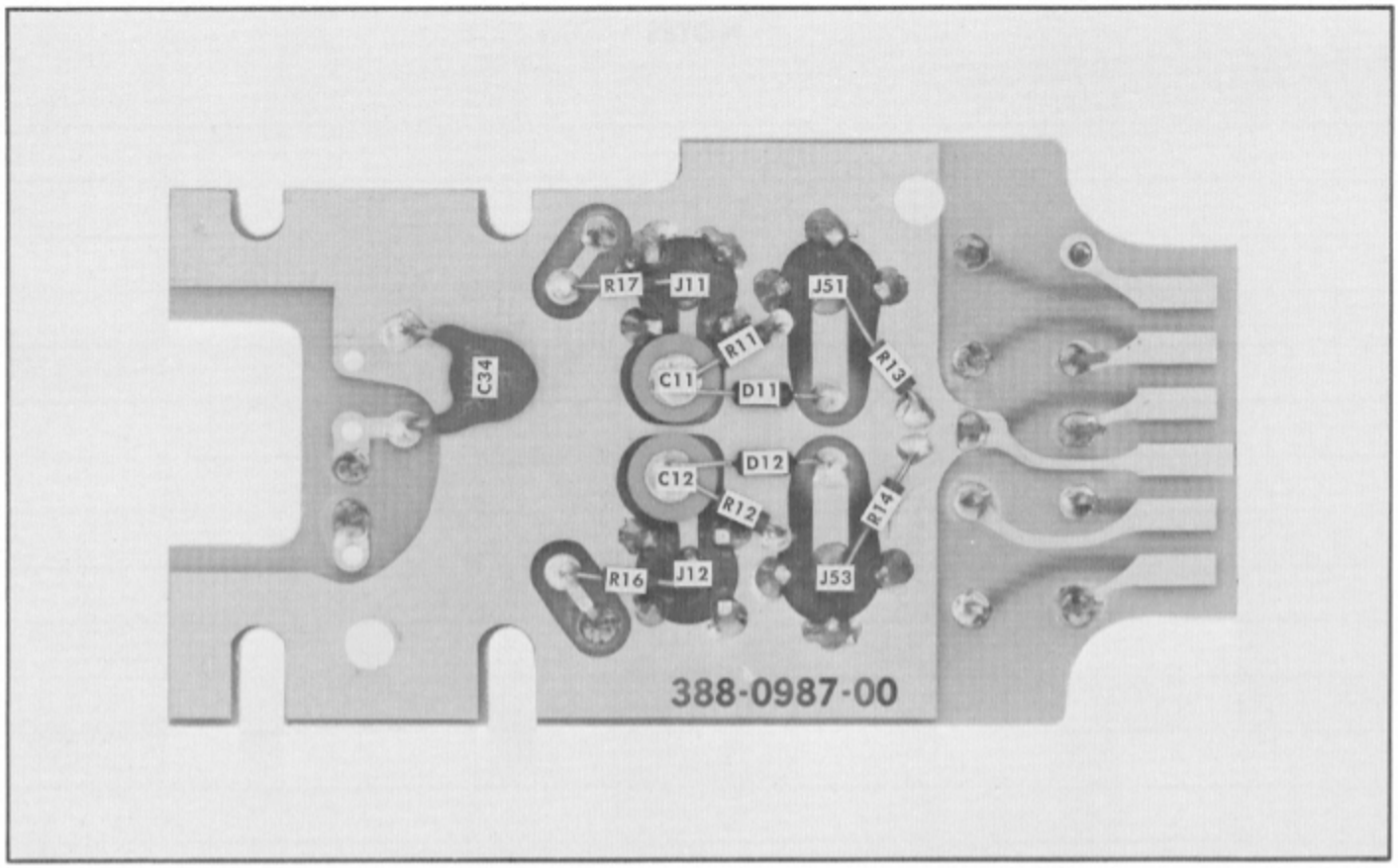


Fig. 4-5. Terminal circuit board.

Major Circuit and Parts Locations

The remainder of this section includes photographs of sections of the Type S-3. Major circuit areas are identified. All components mounted on circuit boards are identified by circuit number.

Replacing the Sampling Head Case

To replace the case on the sampling head, align the body so that the hole in the side will appear over the Bridge Bal control (R22 located on the left side). Check that the upper and lower corners of the Preamplifier and Gate Generator boards are aligned with the channels in the sampling head body which contain the zigzag springs. Push the body gently forward until it contacts the front panel. Be sure that the white plastic pawl on the locking knob is properly aligned as the sampling head unit is slid into the case. In attaching the rear casting, be sure that the hole at one side of the casting is at the bottom of the Type S-3. Insert the four long mounting bolts and tighten them securely. Check that the center board is centered in the rear casting opening so the head can be properly inserted into the sampling unit.

NOTES

SECTION 5
PERFORMANCE CHECK / CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The following procedure may be used as a check of the sampling head performance, or as a complete calibration procedure. When only the Performance Check steps are done, the sampling head is checked to the "Performance" information given in Section 1 of this manual. When the calibration steps are also done, limits, tolerances, and waveforms are added as calibration guides for these steps, and not as sampling head specifications.

Since the sampling head functions as a part of the associated sampling unit, it is recommended that the performance checks for the sampling unit be performed just before these performance checks are made. Then, if the sampling unit requires calibration, that procedure should be performed before starting this procedure. It is recommended that the Type S-3 be calibrated in the sampling unit in which it will be used. Even though the following procedure is written using a Type 3S2, it can be easily adapted to use with either a Type 3S5 or Type 3S6.

The two procedures are identified by the type style used in the headings of each step. Performance Check steps are those identified in the type style used in the Introduction subheading. Calibration steps are headlined in the type style of Step 2 and the next sub-heading, Equipment Required.

EQUIPMENT REQUIRED

The equipment listed below or its equivalent is required for a complete check and calibration of the Type S-3 Sampling Head; see Fig. 5-1. The equipment listed is used in the following procedure. Equipment specifications given are the minimum necessary for the particular use of each item. All test equipment must be correctly calibrated. If other equipment is substituted, it must meet or exceed the limits stated below. If a pulse generator other than the Type 284 is used, fast pulse display characteristics may vary from those shown in this manual.

All equipment items listed, except items 20, 21 and 22 can be obtained by ordering through your local Tektronix Field Engineer or Representative.

1. Test oscilloscope. Bandwidth, DC to at least 20 MHz. Minimum deflection factor of 20 mV/div. Comparison Voltage for measurements. For example, a Tektronix Type 545B with Type W Plug-In Unit.

2. 1X Probe for use with test oscilloscope. Tektronix P6011 Probe recommended with the Type W Plug-In Unit. Tektronix Part No. 010-0190-00.

3. Indicator oscilloscope, such as a Type 561A or Type 564 Oscilloscope with proper sampling plug-in units such as the Type 3S2 Sampling Unit and Type 3T2 Random Sampling Sweep. Or, a Type 568 Oscilloscope with the same vertical and horizontal plug-ins, and Type 230 Digital Unit if the sampling system is used with digital readout.

4. Special 3 foot flexible extender cable for operating the sampling head outside the sampling unit. Tektronix Part No. 012-0124-00 required except when using a Type 3S6 Programmable Sampling Unit.

5. Signal generator—pulse generator, such as the Tektronix Type 284 Pulse Generator used in this procedure. Pulse risetime $\leq$70 ps, at approximately 200 mV amplitude into 50 Ω, with a trigger signal available at least 75 ns in advance of the fast pulse. Square wave signals of 1 μs period (1 MHz with 1-V amplitude accuracy of ±0.5%) and 100 ns period (10 MHz) at 1 volt amplitude into 50 μs. (If your Type 284 Leadtime switch is labeled 5 ns—50 ns, order modification kit, Tektronix Part No. 040-0487-00.)

6. Pulse generator. Amplitude into 50 Ω, 5 V and 50 V, risetime 250 ps, pulse duration about 20 ns or more. For example, Tektronix Type 109 Pulse Generator.

7. Square wave generator. Amplitude at least 12 V into 50 Ω. Repetition rate of 50 kHz. Risetime 12 ns or less. Tektronix Type 106 Square Wave Generator recommended.

8. Signal delay coaxial cable. Impedance 50 Ω; delay: 80 ns; connectors, GR874. Tektronix Type 113 Delay Cable (60 ns) with a 20 ns RG213/U coaxial cable, Tektronix Part No. 017-0504-00, or four 5 ns coaxial cables, type RG213/U, GR874 connectors, Tektronix Part No. 017-0502-00.

9. 50 Ω amplitude calibrator. Output impedance 50 Ω; voltage range 0.06 to 2.0 volts square wave; accuracy within ±0.25%. Tektronix Calibration Fixture 067-0508-00. (If the repetition rate is 20 kHz, change C25 from a .005 μF discap to a .0033 μF discap.)

10. One 50 Ω 10X attenuator with BNC connectors, Tektronix Part No. 011-0059-00.

11. One 50 Ω 5X coaxial attenuator, such as GR874-G14. Tektronix Part No. 017-0079-00. Two 50 Ω 10X coaxial attenuators, such as GR874-G20. Tektronix Part No. 017-0078-00.

12. A special variable attenuator with GR874 connectors. It consists of a 100 Ω potentiometer across the 50 Ω line, and does not have a guaranteed response. Tektronix Part No. 067-0511-00.

13. 50 Ω voltage pickoff, Type VP-2. Tektronix Part No. 017-0077-01, supplied with the Type S-3.

14. Signal pickoff, Type CT-3. Trigger source output, 50 Ω. Risetime less than 0.4 ns. Tektronix Part No. 017-0061-00.

15. Two 50 Ω GR874 end-line terminations, Type GR874-W50B. Tektronix Part No. 017-0081-00.

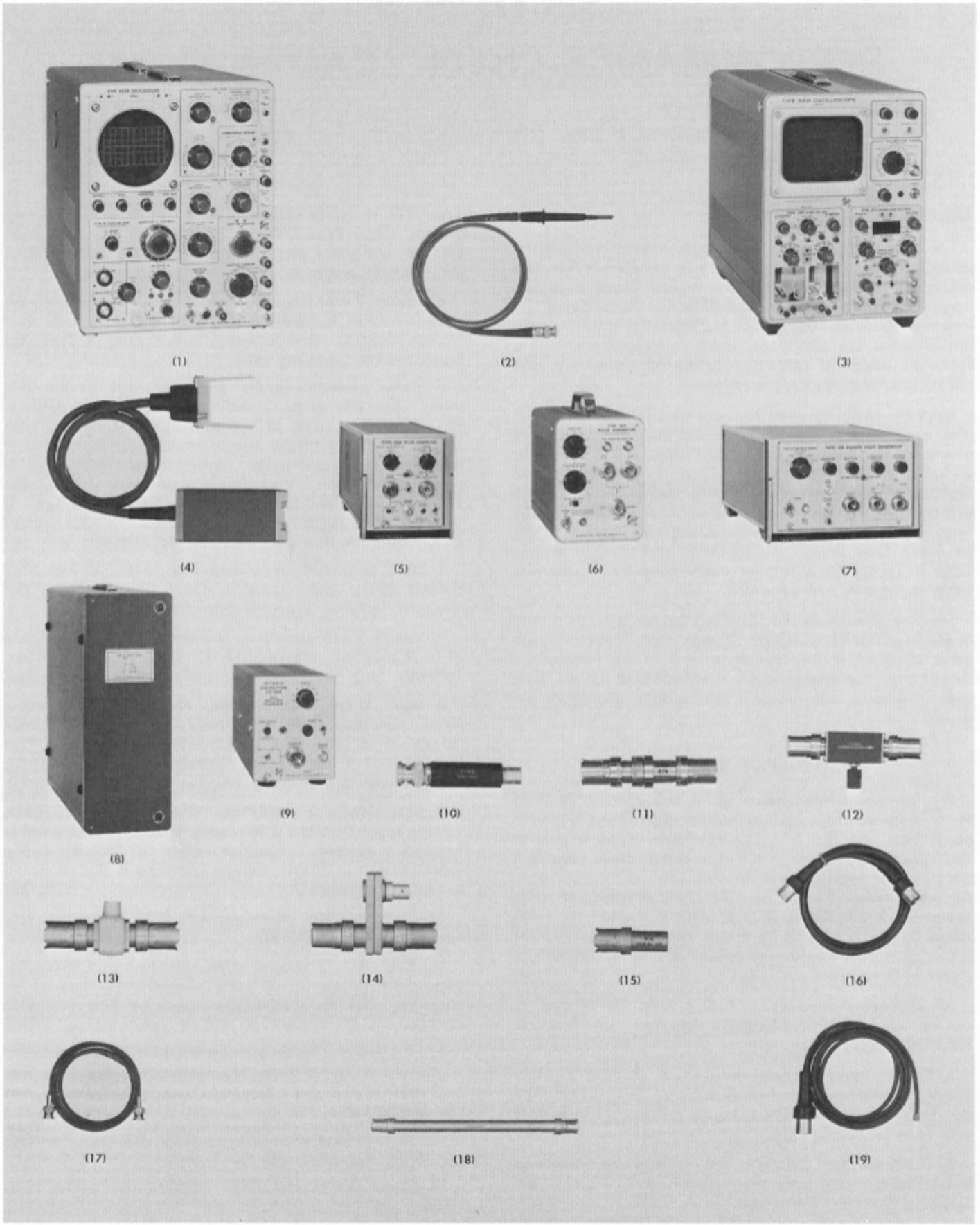


Fig. 5-1. Calibration Equipment.

16. 50 Ω coaxial cable, RG 58C/U, 5 ns signal delay, with GR874 connectors. Tektronix Part No. 017-0512-00.

17. 50 Ω coaxial cable, 5 ns signal delay, approximately 40 inches long, with BNC connectors. Tektronix Part No. 012-0057-01.

18. 50 Ω coaxial air line, 20 cm long, with GR874 connectors. GR874-L20. Tektronix Part No. 017-0084-00.

19. Charge line, 50 Ω 9 ns coaxial cable, checked, GR874 connector. Tektronix Part No. 017-0506-00.

20. DC bridge for measuring 100 kΩ and 1 MΩ. Plus or minus 100 volts DC maximum across 100 kΩ resistor. Accuracy, ±0.025% required. (Not shown.)

21. Small insulated handle, 3/32 inch bit screwdriver for adjusting screwdriver-adjust controls. (Not shown.)

22. An RMS reading line voltage meter, with a ±3% accuracy at the line voltage to which the indicator oscilloscope is connected. (Not shown.)

23. Bench multimeter, 20,000 ohm/volt, such as Simpson 262 or Triplett 630-NA. (Not shown.)

24. Type S-1 Sampling Head (not shown).

PERFORMANCE CHECK AND CALIBRATION RECORD AND INDEX

The following abridged procedure may be used as a guide by the experienced technician for checking and/or calibrating the Type S-3 Sampling Head. The abridged procedure can be used as a maintenance record (the procedure may be reproduced without special permission of Tektronix, Inc.). The step numbers and titles are identical to those in the complete procedure.

Sampling Head Type S-3, Serial No. _____

Calibration Date _____

Calibrated By _____

Checked By _____

☐ 1. Check for Operation and Ability To Produce a CRT Display (Page 5-4)

☐ 2. Check For Q69 (Avalanche) Operation (Page 5-4)

☐ 3. Check Probe Compensation (Page 5-5)

☐ 4. Check Risetime (Page 5-8)

☐ 5. Adjust Risetime (Page 5-10)

☐ 6. Check Loop Gain Linearity (Page 5-11)

☐ 7. Preliminary Bridge Bal Adjust (Page 5-12)

☐ 8. Check Pulse Flatness Deviation (Page 5-12)

☐ 9. Final Bridge Bal Adjust (Page 5-15)

☐ 10. Check Tangential Noise (Page 5-15)

☐ 11. Check Offset Accuracy (Page 5-16)

☐ 12. Check Deflection Factor Accuracy (Page 5-17)

PRELIMINARY PROCEDURE

1. Check the Type S-3 probe DC input resistance. Remove the sampling head from the sampling unit, remove the case and the Preamp circuit board. Use a DC resistance bridge and measure the DC input resistance across the probe tip (without attenuator). Be sure the bridge does not apply more than 100 V DC to the probe tip.

The probe input resistance must be 100 kΩ, ±0.25%.

Install the 10× attenuator on the probe and measure the input resistance across the attenuator tip. The 10× attenuator input resistance (when mounted on the probe) must be 1 MΩ, ±1%.

Remove the 10× attenuator tip and install the 100× attenuator on the probe. Measure the input resistance across the tip. Input resistance must be 1 MΩ, ±1%.

If any parts within the probe body or attenuation require replacement, it is recommended that you send your probe to your nearest Tektronix Field Repair Center.

Complete any needed repairs to the sampling head before proceeding. Replace the Preamp circuit board. The case should remain off for the Calibration procedure.

2. Connect the Type S-3 Sampling Head and oscilloscope system. This step discusses the assembling of test equipment, 5-minute warmup period, and setting of the sampling unit Gain and the sampling sweep Horiz Gain controls.

a. Assemble the indicator oscilloscope system. Place the sampling unit into the left compartment of the indicator oscilloscope, and the sampling sweep unit into the right compartment. Install an **operating** sampling head into the sampling unit Channel B compartment. Leave the Channel A compartment vacant. (If using a digital unit, make the interconnections to the indicator.)

b. Connect the RMS line-voltage meter to the power mains. Determine that the oscilloscope (and other equipment) power supply is set for the correct value of line voltage. Connect all the equipment to the proper power outlet and turn on the power. Obtain a free-running trace and let the equipment warm up for five minutes.

c. After the warmup period, adjust the indicator oscilloscope Trace Alignment control so the free-run trace is parallel to the graticule lines.

d. Connect the Type 284 Pulse Generator Square Wave Output to the operating Channel B sampling head input. Connect the Trigger Output to the sampling sweep unit Trigger Ext Input (50 Ω) through a BNC 50 Ω coaxial cable.

Adjust both the vertical and the horizontal unit Gain controls for proper deflection factor of each unit. Use the Type 284 100 ns period square wave as both time and amplitude reference.

e. Install the sampling head to be calibrated onto the special three foot extender cable and the extender into the Channel A compartment of the sampling unit. Set the OFF-SET switch to ×1. Allow a five minute warmup of the system. For a Performance Check, install the sampling head into the Channel A compartment without the extender.

PERFORMANCE CHECK AND CALIBRATION PROCEDURE

1. Check Operation and Ability to Produce a CRT Display

a. Connect the Type 284 Square Wave Output signal through a VP-2 voltage pickoff with a GR874-W50B 50 Ω termination to the Type S-3 probe.

b. Set the sampling unit controls for a Channel A display. Perform calibration step 2 if there is no display.

2. Check For Q69 (Avalanche) Operation

a. Remove the extender cable from the sampling head (the indicator oscilloscope power may be left on).

b. Remove the sampling head case. First, remove the four round-head screws visible at the back of the unit; then, slide the cover off by gently pulling it away from the front casting and probe.

c. Reconnect the extender cable to the rear of the sampling head. Use the signal set-up of step 1.

d. Use the test oscilloscope with 1× Probe, to check for proper operation of Q69. The probe connections are shown in Fig. 5-2, and the general nature of the signals is shown in Fig. 5-3. Fig. 5-3A and B show the general amplitude for Q69 collector and emitter signals. Fig. 5-3C shows the typical drive signals at T75 primary (square terminal E of Strobe board) while the head is on the extender cable.

If T75 is receiving drive, but there is no signal out of Q69, change Q69 (changing Q69 may significantly increase

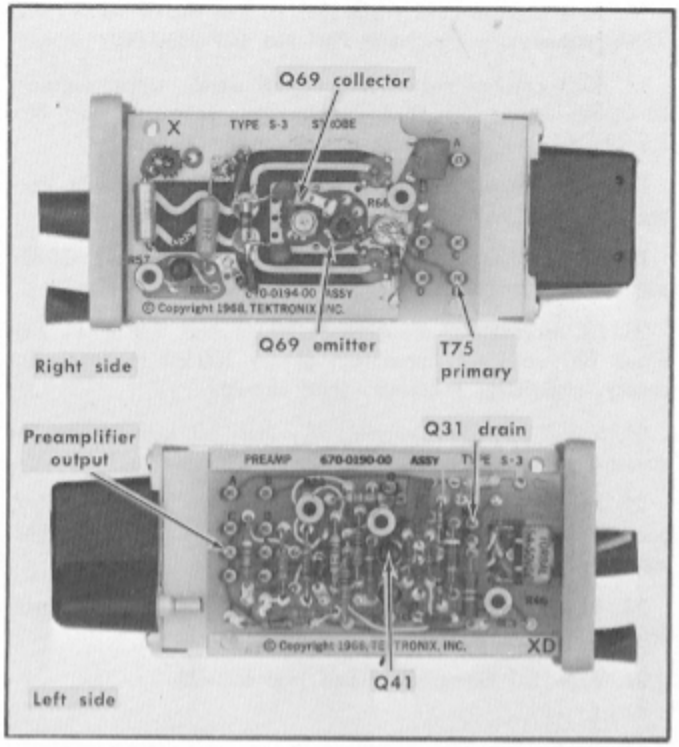
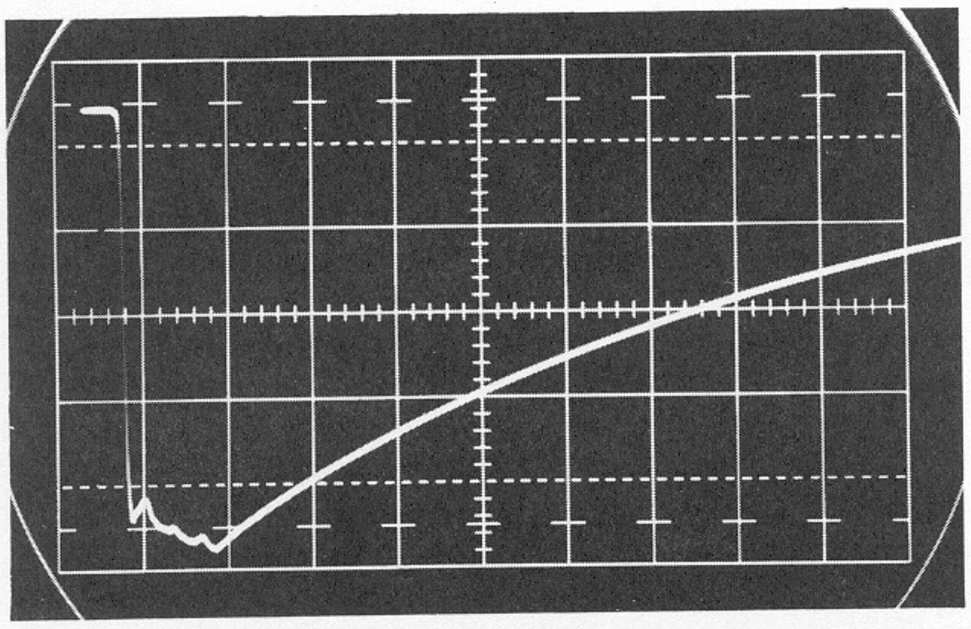


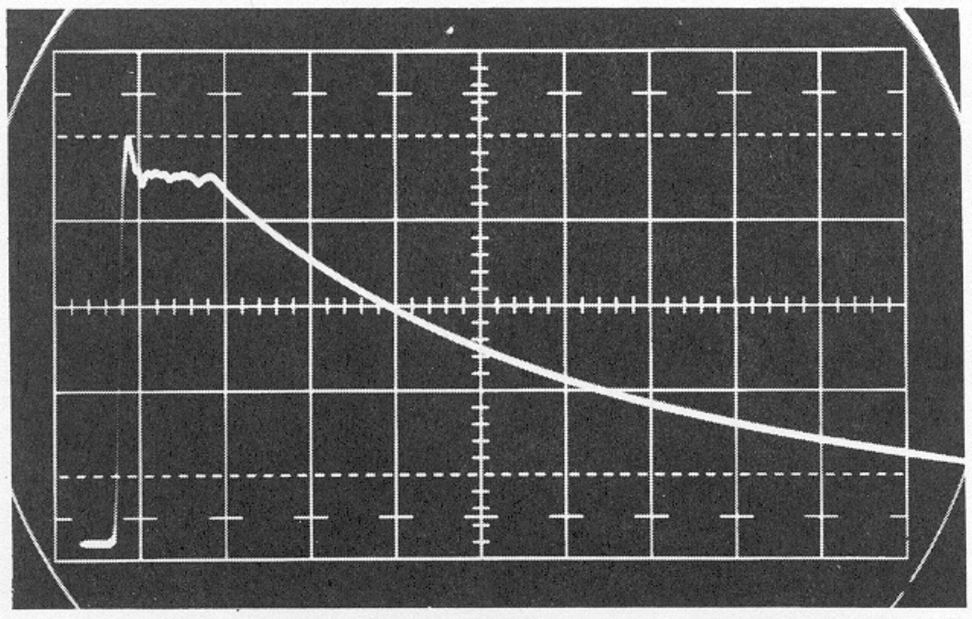
Fig. 5-2. Test point locations for step 2.

the displayed noise, so it is best to have several transistors of this type on hand and grade them for low noise using step 10). If all signals of Fig. 5-3 are present, check the Preamplifier output (square terminal E of Preamp board). If there is no signal at the Preamplifier output, check the sampling diodes and Q31 in the following manner.

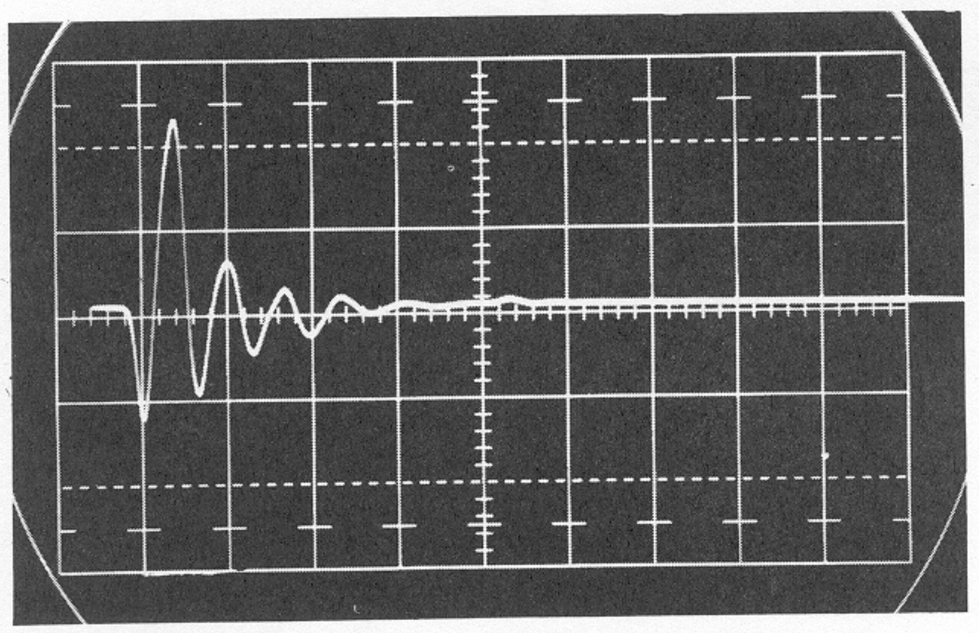
(1) Pull Q41 from its socket. Set the Type 3S2 DC Offset control for zero volts measured at the front panel Offset jack. Free run the sampling sweep unit. Use the test oscilloscope, with 10× probe, and monitor the drain lead of Q31 (square terminal N).



(A) Q69 Collector; 0.2 μs/div, 5 V/div.



(B) Q69 Emitter; 0.2 μs/div, 5 V/div.



(C) T75 Primary; 0.1 μs/div, 1 V/div.

Fig. 5-3. Checking Avalanche drive and output.

(2) Q31 will have a pulse signal at each strobe time if the transistor is operating. If there is no pulse signal, change Q31, re-install Q41 and try to obtain a trace.

NOTE

Q31 is located on the probe body circuit board. Use extreme caution in removal and replacement; use only a small, low-wattage soldering iron and a heat sink. Use tweezers to avoid physically damaging the transistor.

(3) If Q31 is operating, and if there is a pulse of either polarity at its drain lead (with Q41 out), operate the Bridge Bal control (R22) through its range. As R22 is changed, the pulse signal should reduce to zero and change to the opposite polarity. If the pulse signal does not change polarity, one of the sampling diodes is open.

CAUTION

Since the sampling diodes are very delicate, extreme care is required in soldering them. Use proper heat sinks, and avoid the possibility of electric shock to the diodes.

(4) Restore Q41 to its socket. Once a display is obtained, go on to Step 5.

3. Check or Adjust Probe Compensation

Requirement—Optimum flat top of a 1 μs period square wave.

Probe Only

a. Connect the Type 284 Square Wave output to the VP-2 voltage pickoff with the GR874-W50B 50 Ω termination installed. Connect the Type S-3 probe to the VP-2. Connect the Trigger Output to the sampling sweep unit Ext Trig Input (50 Ω).

b. Set the Type 284 Square Wave Amplitude to 1 V and the Period switch to 1 μs.

c. Set the sampling sweep unit for 500 ns/div (0.5 μsμdiv). Obtain a stable display.

d. Check for a level top of the square wave; see Fig. 5-4. To compensate the Probe for a flat top on the square wave display loosen the coupling (locking) nut, and rotate the probe body as necessary. When the correct display is obtained, finger-tighten the locking nut.

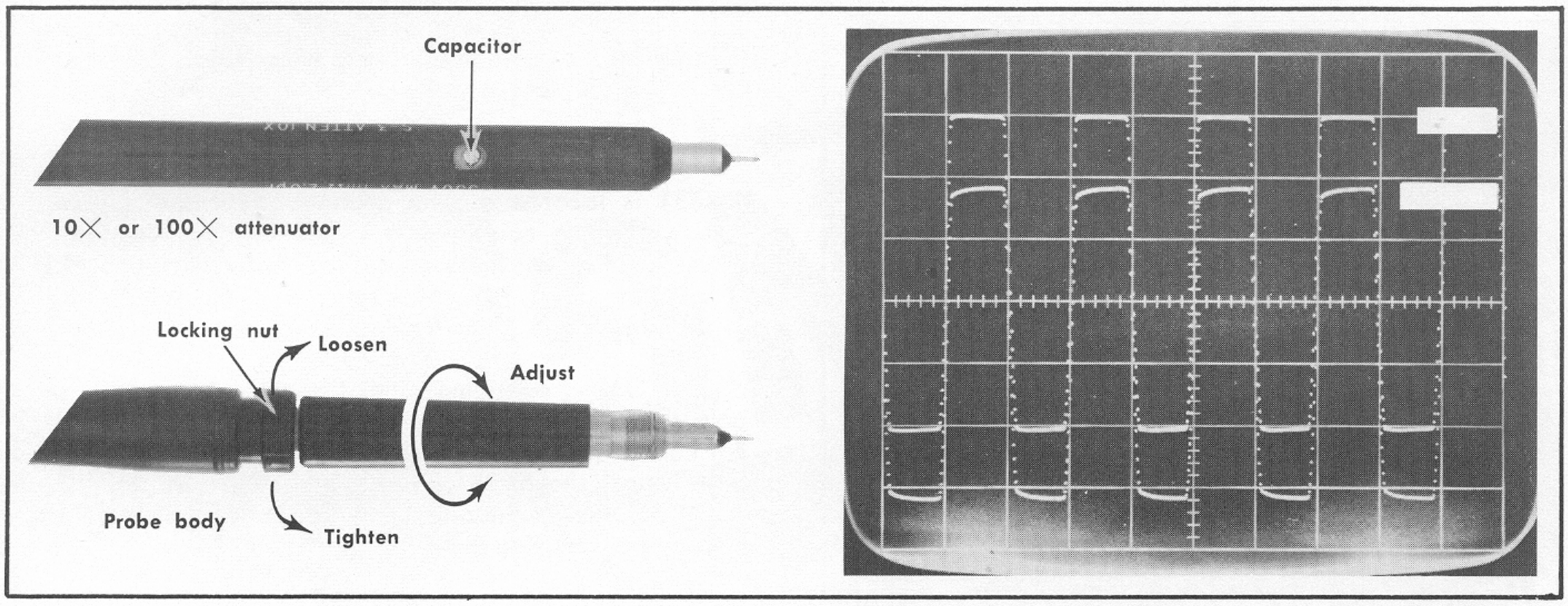


Fig. 5-4. Probe compensation.

10× Attenuator on Probe

e. Connect the Type 106 Hi Amplitude Output to the VP-2 voltage pickoff with the GR874-W50B 50 Ω termination installed. Attach the 10× attenuator to the Type S-3 probe and connect it to the VP-2. Connect the Type 106 Trigger Output to the sampling sweep unit Ext Trig Input (50 Ω) connector. Set the square wave repetition rate to 50 kHz.

f. Set the sampling sweep unit for a 2 μs/div sweep rate. Set the sampling unit Units/Div switch to 100 and adjust the Type 106 Amplitude control for a 5 division display. Use the sampling sweep unit Time Position controls to bring the square wave top into view.

g. Check for a level top on the square wave. If not level, compensate the 10× attenuator by carefully setting the capacitor (see Fig. 5-4), for a level top.

100× Attenuator on Probe

h. Remove the 10× attenuator and install the 100× attenuator.

i. Change the sampling unit Units/Div switch to 50 and set the Type 106 Amplitude control fully clockwise (maximum amplitude). Set the sampling unit Variable control for a 5 division display.

j. Check for a level top on the square wave. If not level, compensate the 100× attenuator by carefully setting the capacitor for a level top on the square wave.

k. Set the Type 106 Amplitude control fully counterclockwise and remove the probe from the VP-2.

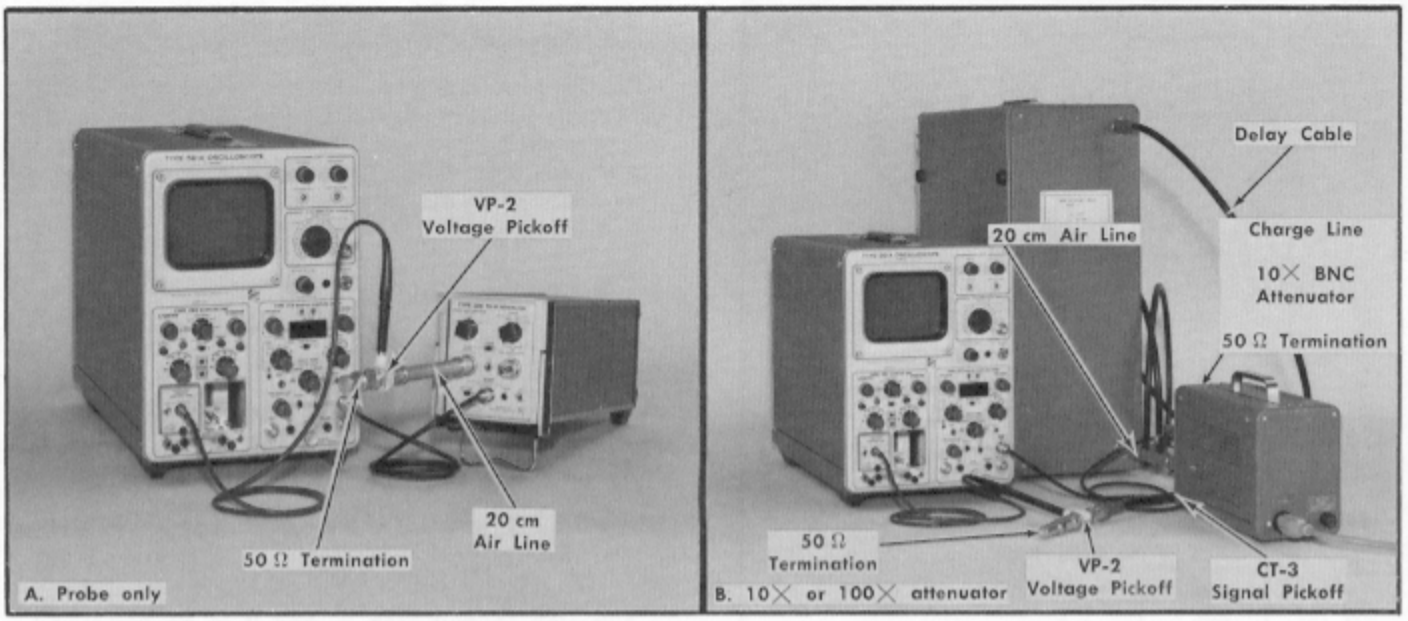


Fig. 5-5. Equipment setups to check risetime and pulse flatness deviation.

Control Settings

Type 3S2

Normal-Smooth	Normal
Units/div	100
Variable	Cal
Mode	Channel A
Trig Out	Optional
Dot Response	Midrange
Other Controls	Optional

Type 3T2

Time Position	Fully clockwise
Fine	Midrange for centered display
Range	100 ns,
Time Magnifier	×50 } 200 ps/div
Variable	Cal
Display Mag	×1
Start Point	With Trigger
Display Mode	Normal
Trigger Source	Ext
Trigger Polarity	+
Trigger Sensitivity	10 o'clock
Recovery Time	Optional
Internal Samples/Div	100

Indicator Oscilloscope

Intensity	Normal display
Scale Illum	As desired

Type 284

Mode	Pulse Output
Other controls	Optional

Type 109

Amplitude	Fully clockwise
Voltage Range	5.0
Pulse Polarity	+

If a digital unit is used to measure risetime, set the controls as follows:

Type 230

Measurement Averaging	8
CRT Intensification	Both Ref Zones and Time Measurement on
Measurement Mode	Time
CH A Reference Zones	Both at Average
Channel switches	Both at A
Time Measurement Start Point Sw	10% Between Zones
Time Measurement Stop Point Sw	90% Between Zones
Slope	Both at +1st
Display Time	Midrange
Triggered Measurement	Off
Limits	Optional

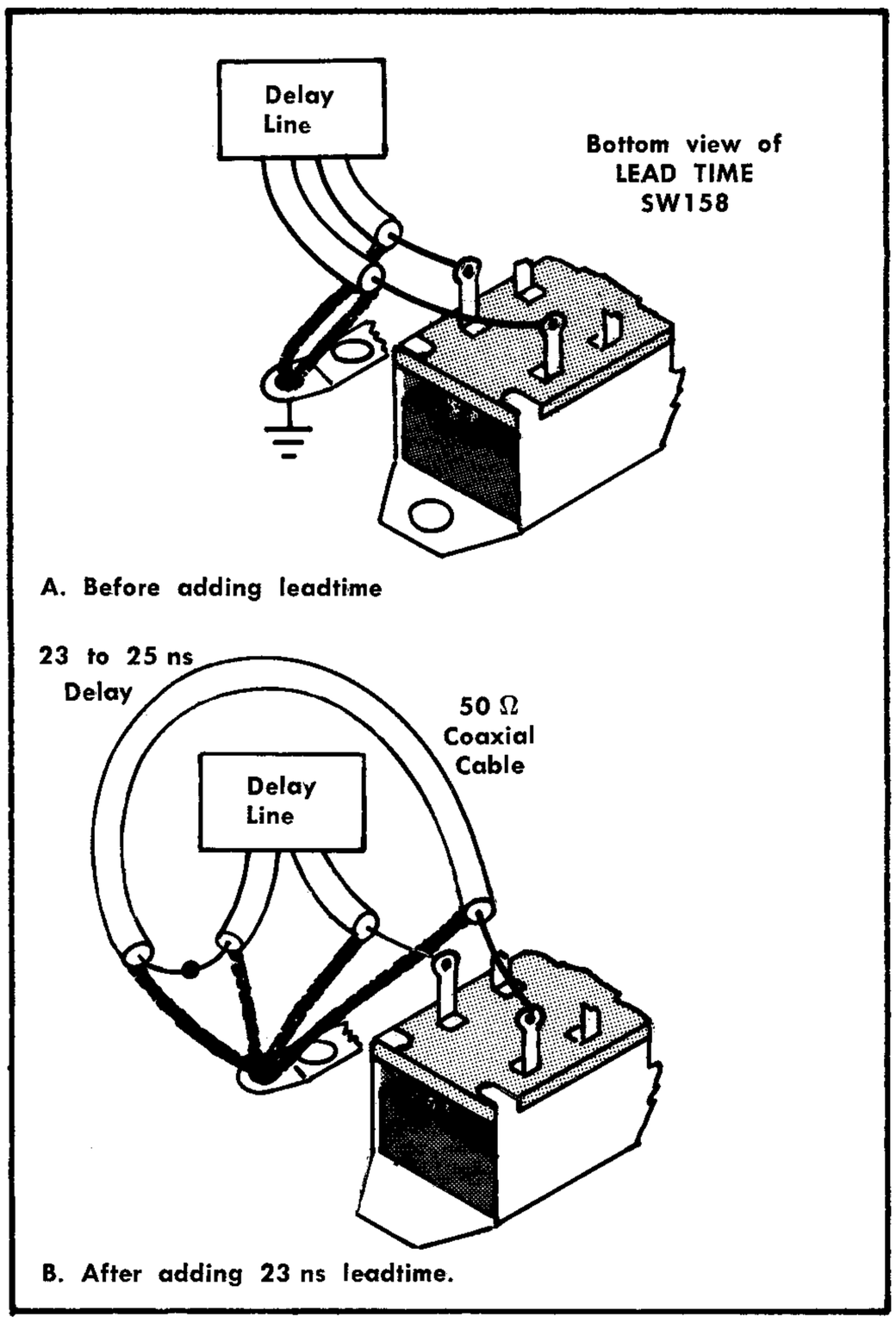


Fig. 5-6. Adding leadtime to an early model Tektronix Type 284 Pulse Generator.

NOTE

Instrument risetime can be checked either by visual measurement of the CRT display, or by a digital readout unit. Digital measurement of risetime requires that the Type 3T2 be operated in the With Trigger mode. With Trigger operation requires that the Type 284 trigger pulse have a leadtime of at least 73 ns before the fast Pulse Output signal. (Type 284 instruments with only 5 ns-50 ns Lead Time require the installation of Field Modification Kit, Tektronix Part No. 040-0487-00.)

CRT risetime measurement permits the Type 3T2 to operate in the Before Trigger (Random) mode, in which the trigger leadtime does not have to be 73 ns. The 73 ns stated here is required for the With Trigger mode when the sampling head is operating on a 3 foot extender cable and the trigger cable has a 5 ns signal delay. Less leadtime (about 70 ns) is required when the sampling head is installed in the Type 3S2 and the trigger cable signal delay is only 2 ns.

Fig. 5-6 shows a substitute method of obtaining 73 ns trigger leadtime in an early model Type 284. If you install the reconmmended 23 ns signal delay cable shown in Fig. 5-6, operate the Type 284 with the case removed and adjust it as described in the following step.

4. Check Risetime

Requirement—Probe only: 10% to 90% risetime is equal to or less than 350 ps.

10× attenuator: 10% to 90% risetime is equal to or less than 400 ps.

100×attenuator: 10% to 90% risetime is equal to or less than 500 ps.

NOTE

This step follows Step 3, and is to be performed with the case on the sampling head. If Step 2 was performed, ignore this step and proceed to Step 5.

The portions of this step that check the attenuators risetime need not be performed unless there is a question about the individual attenuator. If one has been dropped, or electrically damaged, a check of its risetime can reveal whether it needs to be replaced. There is no adjustment in either attenuator that affects risetime. If an attenuator does not meet is risetime requirements, replace it with a new attenuator.

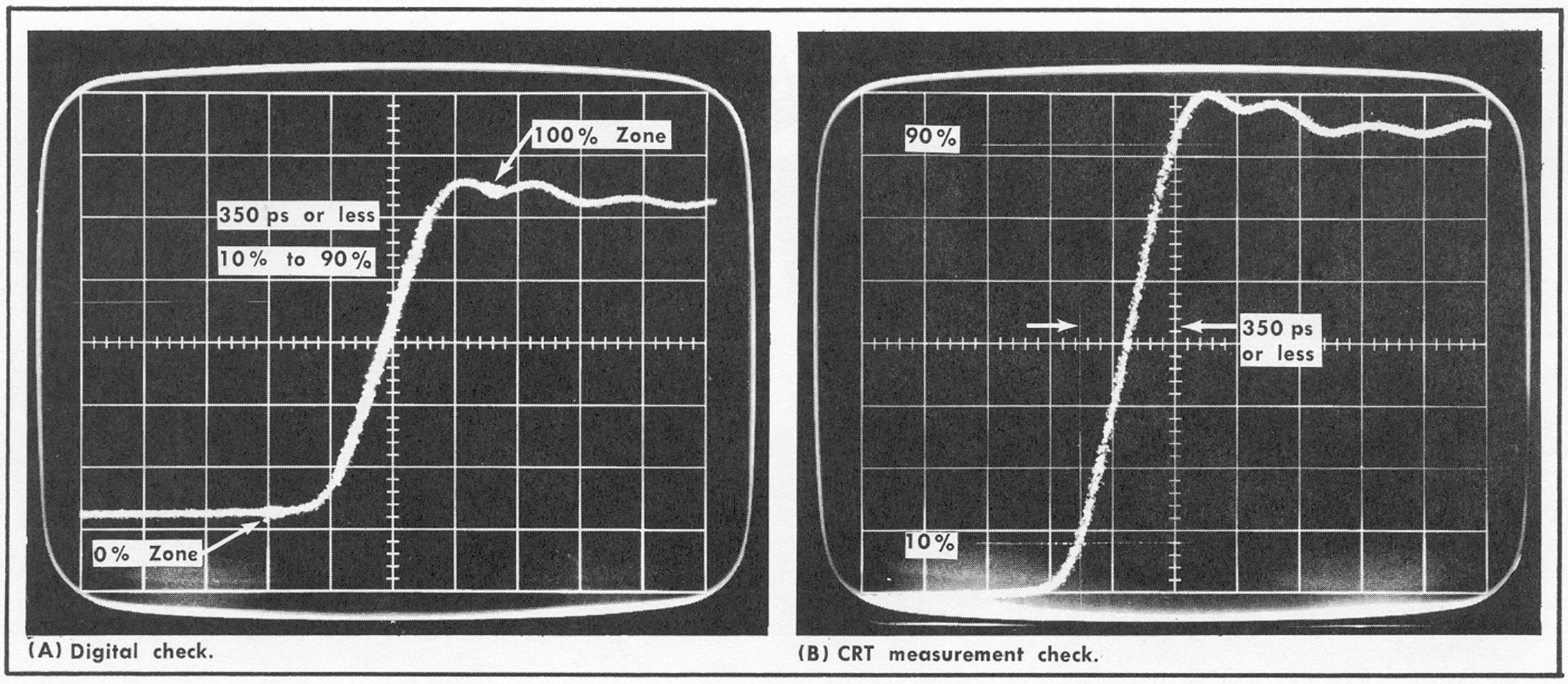
a. Use the equipment setup shown in Fig. 5-5A. The connections are as follows:

(1) Connect a BNC coaxial cable from the Type 284 Trigger Out to the sampling sweep unit Trigger Input (50 Ω).

(2) Connect the Type 284 Pulse Output to the 20 cm Air Line, the VP-2 voltage pickoff, then the GR874-W50B 50 Ω termination. Connect the Type S-3 probe to the VP-2.

b. Use the Type 3T2 Fine Time Position control to position the pulse rise as in Fig. 5-7A.

If a display cannot be positioned into view, turn the Time Position to midrange (pulse display is off the CRT to the left) and adjust the Type 284 TD Bias control. Start by turning the TD Bias control fully counterclockwise. This assures that there is no pulse output and the indicator oscilloscope trace should be positioned two divisions up from the lower edge of the graticule. Slowly turn the Type 284 TD Bias control clockwise to a midrange position that causes the indicator oscilloscope trace to jump about 5 divisions. (Repeat, so the control is at a position that just causes the trace to be up.) Set the Type 3T2 Time Position controls fully clockwise. If the indicator oscilloscope trace remains up 5 divisions without displaying a positive pulse, there is not sufficient



(A) Digital check.

(B) CRT measurement check.

Fig. 5-7. Risetime measurement displays.

leadtime in the triggering signal path. Shorten the 5 ns signal delay cable to the Type 3T2 Ext Trig 50 Ω input connector to 2 ns signal delay, and try again. Or operate the Type S-3 in Channel B and use the B Delay control to gain more display leadtime. (An additional 2 ns trigger leadtime can be obtained by clockwise rotation of the Type 284 Snap Current control, R174, but at a cost of slowing the rate of rise of the fast Pulse Output signal.) The recommended setting of R174 is about 30° from the counterclockwise stop, and at a position where the displayed pulse time jitter is the least. Adjusting R174 for least trigger jitter (near its counterclockwise end) usually speeds the fast Pulse Output so the pulse risetime is about 45 or 50 ps.)

c. Once a pulse display is obtained, position it and the digital unit 0% and 100% zones as shown in Fig. 5-7. Read the risetime from the digital unit. With the Type 3T2 Time Magnifier at ×50 for 200 ps sweep rate, 350 ps will be read as +0.350 NS.

If the risetime of the sampling head is too slow, perform Step 5.

CRT Measurement of Risetime

Set the Type 3T2 controls:

Internal Samples/Div	Variable
Front Panel Samples/ Div	9 o'clock
Start Point	Before Trigger
Trig Sensitivity	Clockwise to free run until a trace appears (several seconds), then back to 10 o'clock area for least trigger jitter.

The risetime can be measured at 200 ps/div sweep rate with the Type 3T2 Range and Time Magnifier controls set in the digital readout step. Use the Type 3S2 Units/Div Variable control to obtain an 8 division vertical display.

Most accurate risetime measurement from the CRT is made by taking a photograph. Scribe the photo in a manner similar to that done in Fig. 5-7B.

d. Check that the risetime is not more than 350 ps. If the risetime is slower than 350 ps, perform step 5.

NOTE

The remainder of this step checks the risetime of the two attenuators. Checking their risetime requires a pulser and signal delay coaxial cable that includes significant cable losses. Fig. 5-11, part B shows the losses in which the pulse appears to dribble up after the fast step portion is completed. Use only the fast step portion when checking attenuator risetime, ignoring the dribble up portions of the display. Fig. 5-11B shows the 100% point for Step 4 part (g) and (k) below.

e. 10× attenuator test equipment setup is shown in Fig. 5-5B. Connections are as follows:

(1) Install the 50 Ω termination onto the Type 109 Charge Line 1 connector, connect the charge line (item 19 of equipment required) to the Type 109 Charge Line 2 connector and the Output connector to a CT-3 Signal Pickoff.

(2) Connect a 20 cm airline from the CT-3 to the input of a Type 113 Delay Cable and connect 20 ns of RG213/U coaxial cable to the Type 113 Output.

(3) Connect a 10× BNC attenuator to the CT-3 and a BNC coaxial cable from the attenuator to the sampling sweep Trigger Input (50 Ω) connector.

(4) Connect a VP-2 voltage pickoff with a GR874—W50B 50 Ω termination to the delay cable output.

(5) Attach the 10× attenuator to the Type S-3 probe and connect the 10× attenuator to the VP-2 voltage pickoff. Obtain a display.

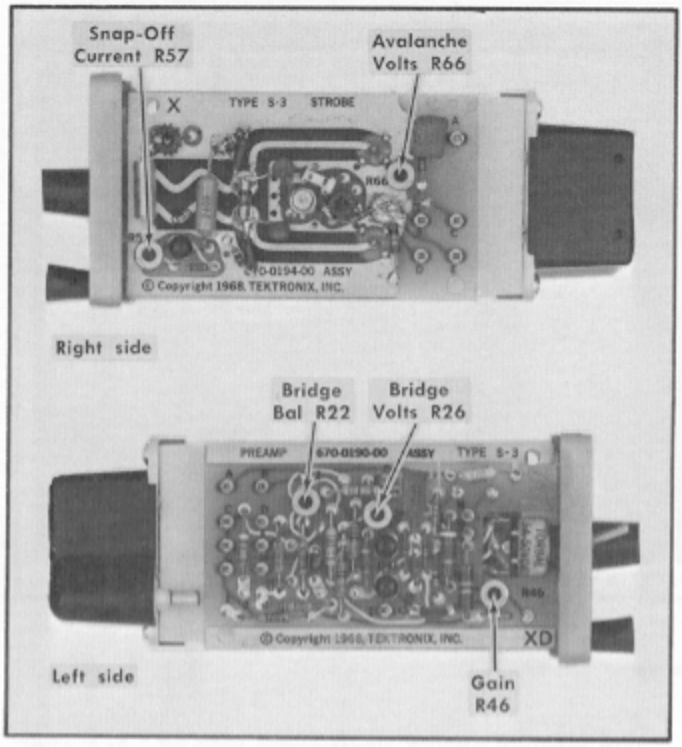


Fig. 5-8. Sampling head internal controls.

f. Set the sampling unit Units/Div switch to 100 and adjust the Variable control for a display amplitude of 8 divisions, along the fast rise portion.

g. Check that the 10% to 90% risetime is 400 ps or less.

h. Remove the 10× attenuator head and attach the 100× attenuator head. Use the equipment setup as shown in Fig. 5-5B with connections as given in step e (1) through (4) and connect the 100× attenuator to the VP-2 voltage pickoff.

i. Set the Type 109 Voltage Range switch to 50, and the Amplitude control fully clockwise (maximum).

j. Set the sampling unit Units/Div Variable control for an 8 division display amplitude and horizontally center the rising portion of the display with the sampling sweep unit Time Position control.

k. Check that the 10% to 90% risetime is 500 ps or less.

CAUTION

Be certain the outputs of the Type 109 and Type 106 are set to minimum before changing the attenuator heads, or changing to probe only operation.

5. Adjust Risetime

a. Each internal control has its particular effect upon sampling head operation.

(1) Avalanche Volts, R66, alters strobe pulse amplitude and risetime, which affects the display risetime and loop gain. Clockwise rotation makes risetime slower.

(2) Snap-Off Current, R57, alters loop gain, strobe amplitude and display noise, and must be slightly readjusted any time the Avalanche Volts control setting is changed.

(3) Gain, R46, alters loop gain by changing the Preamplifier gain.

(4) Bridge Volts, R26, sets the reverse voltage of the sampling diodes. Decreasing the bridge volts (countercolckwise rotation) slows the displayed risetime by permitting a longer diode conduction time due to fixed amplitude strobe pulses. Keeping the Bridge Volts control near maximum (clockwise) allows better sampling loop gain linearity as well as a larger input signal dynamic range.

(5) Bridge Bal, R22, introduces an internal offset voltage to the feedback loop to cancel normal error signals in the sampling loop, including normal unbalance in the sampling bridge. R22 is adjusted (with DC Offset at zero) to cancel most of the trace vertical shift as the Units/Div switch position is changed.

NOTE

It is usually possible to achieve a risetime value less than that quoted in Section 1. The faster risetime is possible while also meeting the other specifications of noise and pulse flatness deviation. A simple CRT measurement of risetime is usually adequate to check for proper sampling operation. An exact figure of the system (pulser, coaxial cable, and sampling head system) risetime can be more easily obtained by use of a digital readout unit. The digital readout figure can be accepted as the risetime of the Type S-3 itself if the pulser used is as fast as the Type 284. The procedure below is not specifically limted to use with either form of risetime measurement; therefore, if you use a digital system, set the digital unit controls as listed in Step 4. Risetime adjustment is given as the first calibration step, because any time the Avalanche Volts control setting is changed, it is necessary to also adjust R57, R46 and R22 in that order.

b. Remove the sampling head cover. The head must be on an extender cable for access to all controls. Make the connections shown in Fig. 5-5A. Set the controls as in Step 4. Preset the sampling head internal controls (see Fig. 5-8):

Bridge Volts	Fully Clockwise
Gain	40° from clockwise end

Leave the other head controls as adjusted.

c. Operate the Type 3T2 with the Start Point switch at With Trigger. Obtain a display of the pulse rise.

Assuming that the risetime is slow, adjust the Avalanche Volts control about 5° counterclockwise.

Check the risetime and do (d) below. Then continue to adjust the Avalanche Volts control until the risetime is 350 ps or less, 10% to 90%. Repeat (d) again.

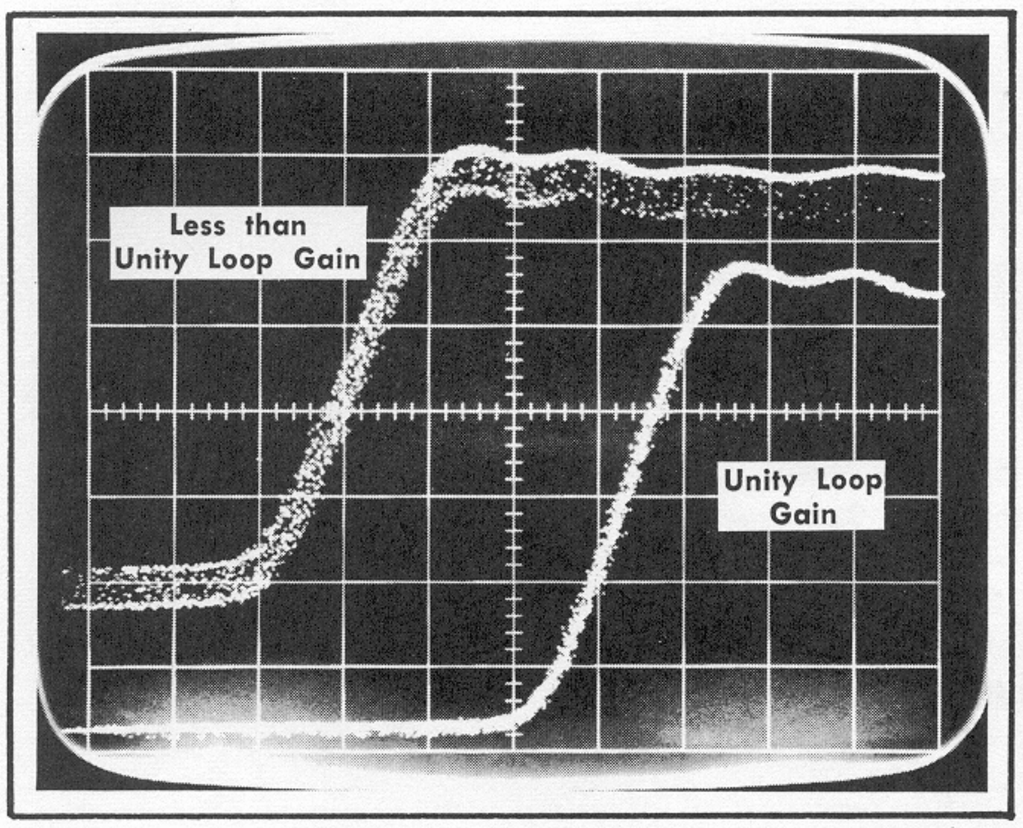


Fig. 5-9. Loop gain check in random sampling, before Trigger operation of the Type 3T2.

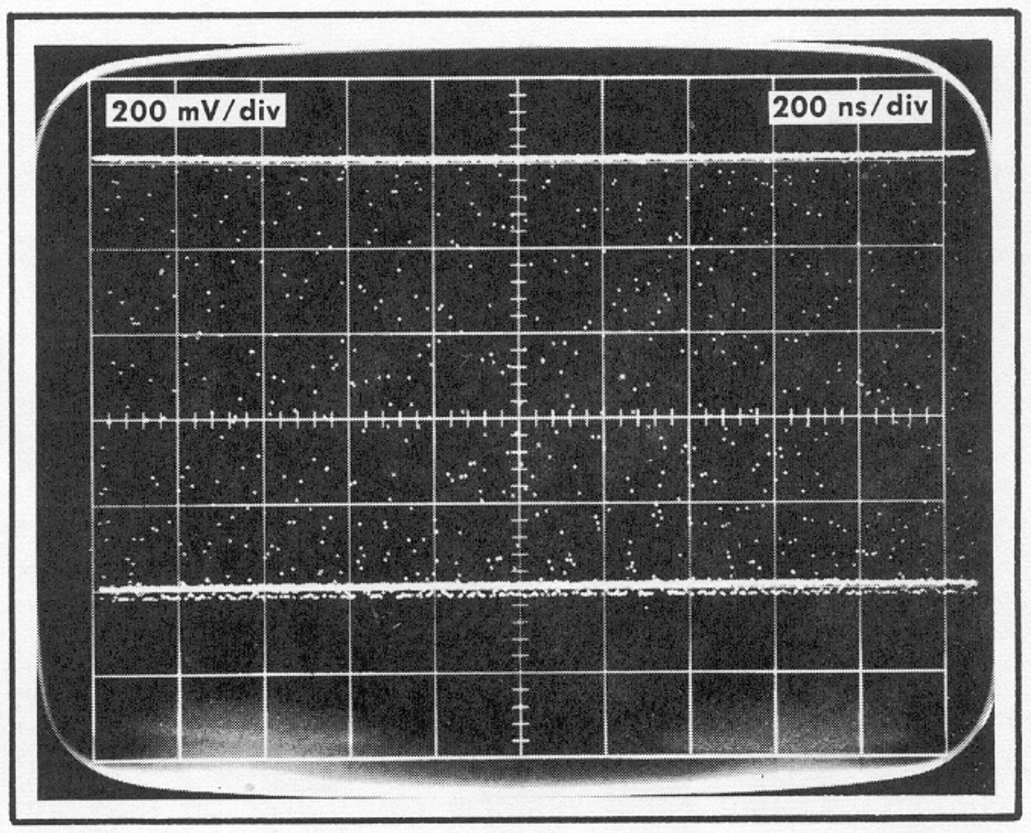


Fig. 5-10. Unity loop gain set at top of display.

d. Operate the Type 3T2 with the Start Point switch at Before Trigger. Obtain a display of the pulse rise.

Adjust the Snap-Off Current control to minimize loop gain. This is done by first using the Type 3S2 Dot Response control to determine whether the display loop gain is more than or less than unity. If it is less than unity, adjust the Snap-Off Current control to reduce the trace vertical spread. If the loop gain is more than unity, adjust the Snap-Off Current control to increase the trace vertical spread. (See Fig. 5-9).

NOTE

The Type S-3 will in some cases have less display noise when adjusted for a risetime faster than 350 ps. The practical adjustment limit lies with the range of both the Snap-Off Current and the Gain controls. If the Avalanche Volts controls is adjusted for too fast a risetime, one or both of the other controls will reach the end of its adjustment range and prevent proper calibration.

As the Snap-Off Current control is turned, the display will move. The display shift is in the form of a rising or a dipping arc. The vertical component of the display movement is a result of a change in Snap-Off Current, rather than any signal input change. The peak of the arc in either the positive or the negative direction occurs very near the point at which maximum loop gain occurs. Set the Snap-Off Current control to the point where the display is at the peak of the arc, rather than precisely at maximum loop gain. This produces minimum display noise with proper risetime.

e. Set the Type 3S2 Dot Response control to its electrical midpoint. The electrical midpoint is found by watching the change in trace spread through the total range of adjustment of the control. Set the control for a trace spread halfway between maximum loop gain and minimum loop gain.

Now adjust the Type S-3 Gain control for unity loop gain as indicated at the right of Fig. 5-9A.

6. Check Loop Gain Linearity

Requirement—Dot will move full amplitude ±5% of any signal up to 1 V peak to peak (valuable with random process sampling); signal to 10× attenuator, 10 V peak to peak; signal to 100× attenuator, 100 V peak to peak.

NOTE

Correct adjustment of the Bridge Balance control (not more than 1 division trace movement with rotation of the Units/Div switch from 200 to 20) and the sampling unit Smoothing Balance, R247/R457 in the Type 3S2 (no trace movement as the Normal-Smooth switch is changed from Normal to Smooth) is necessary for correct operation.

The connections between the Type 284 and the sampling head are changed in this step. The head can be either on the extender cable with or without the case installed, or it can be in the Type 3S2 with the case in place.

a. Connect the Type 284 Square Wave Output connector to the sampling head probe through a VP-2 voltage pickoff with 50 Ω termination attached.

b. Set the Type 284 Period switch to 1 μs. Set the Type 3T2 Range switch to 10 μs, the Time Magnifier to ×5 (200 ns/div) and the Start Point switch to With Trigger.

c. Set the Type 3S2 Units/Div switch to 20 and obtain a triggered square wave display. Use the Type 3S2 Variable Units/Div control to obtain 5 divisions of amplitude.

d. Disconnect the trigger signal. Turn the sampling sweep Trigger Sensitivity and Recovery Time controls for a free run display as in Fig. 5-10.

e. Set the sampling unit Dot Response control so the top of the square wave is at unity loop gain (one trace). The bottom of the square wave can show two traces, the separation (loop gain overshoot or undershoot) must not be greater than 5%, or 1.25 minor divisions.

7. Preliminary Bridge Bal Adjust

a. Free run the sampling sweep to obtain a no-signal trace.

b. Set the Type 3S2 Offset control for zero volts at the front panel Offset jack. Use either the test oscilloscope or a bench multimeter to determine zero volts.

c. As the Type 3S2 Units/Div switch as operated from 200 to 20, adjust the sampling head Bridge Bal control (R22) for no more than one division of vertical shift in the trace. (This control adjustment varies with the case on or off the sampling head, and varies with changes in extender cable. Movement of the probe cable can also cause the trace to shift position.)

8. Check Pulse Flatness Deviation

Requirement—Probe only; Pulse will not deviate from flat more than +8% to —2% (total 10%) for first 2 ns after step, nor more than +1% to —1% (total 2%) thereafter.

10× attenuator: Pulse will not deviate from flat more than +2% to —5% (total 7%) for first 5 ns after step, nor more than +1% to —1% (total 2%) thereafter.

100× attenuator: Pulse will not deviate from flat more than +5% to —8% (total 13%) for first 5 ns after step, +2% to —5% (total 7%) from 5 ns to 30 ns after step, +1% to —1% (total 2%) thereafter.

NOTE

Some minor aberrations are due to the Type 284. The requirement limits include deviations that are part of the Type 284. Therefore, the limits apply only when testing with the Type 284, and with a 20 cm air line between the pulser and the VP-2 and probe.

a. Use the equipment setup shown in Fig. 5-5A. The connections are as follows:

(1) Connect a BNC coaxial cable from the Type 284 Trigger Out to the sampling sweep unit Trigger Input (50 Ω).

(2) Connect the Type 284 Pulse Output to the 20 cm air line, the VP-2 voltage pickoff, then the GR874-W50B 50 Ω termination. Connect the Type S-3 probe to the VP-2.

b. Set the sampling sweep unit Range switch to 100 ns and the Time Magnifier switch to ×10 (1 ns/div).

c. Set the sampling unit Units/Div switch to 100 and adjust the Variable control for 5 divisions from the baseline to the flat top of the display.

d. Set the sampling unit Units/Div switch to 10 without disturbing the Variable control, and center the top of the display with the DC Offset control; see Fig. 5-11.

e. Check that the pulse flatness deviation during the first 2 ns (2 divisions) does not exceed +8% (each vertical division represents 2% of the total display height) nor—2% for a total of 10% (Fig. 5-11A).

f. Change the sampling sweep unit Time Magnifier to ×2 (5 ns/div) and check the pulse flatness deviation following the first 2 ns through 20 ns, for not more than +1% nor —1% for a total of 2%. (2 ns through 10 ns, see Fig. 5-11A. 10 ns through 1.8 μs, see Fig. 5-11E; equipment set-up described in part t below.)

NOTE

The portions of this step that check attenuator pulse flatness deviation need not be performed unless there is a question about an individual attenuator. If one has been dropped, or electrically damaged, a check of its pulse flatness characteristics can reveal if it needs replacement. There is no adjustment in either attenuator to compensate for an out of tolerance pulse flatness deviation.

The double exposure pictures of Fig. 5-11 are provided to show a comparison of the pulse flatness deviation characteristics of the probe and of the 10× attenuator with the same generator source. Pulse flatness deviations of the attenuator are seen as changes in separation between the "Probe/Gr-10×" waveform and the "10× Attenuator" waveform. One of the two numbered point is at minimum separation, and the other numbered point is at the maximum separation (points 1 and 2 in Fig. 5-11C through F). This method requires either a camera for double exposures, or a storage oscilloscope in order to make valid comparisons.

Attenuators

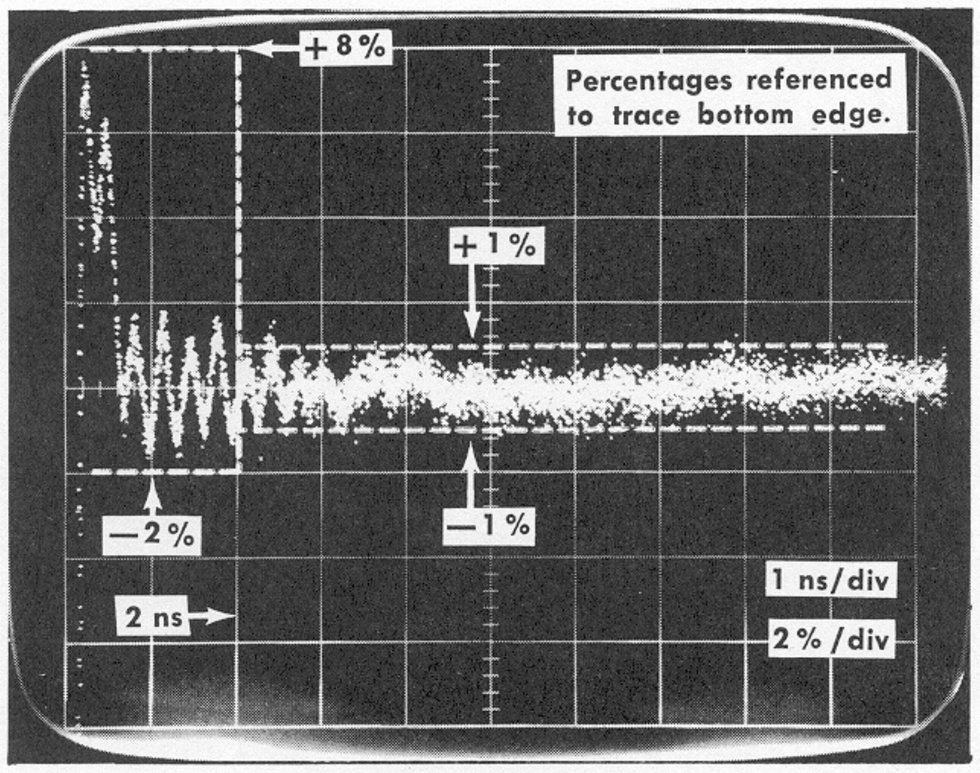
g. Set the sampling unit Units/Div switch to 100 and the Variable to CAL.

h. Initial equipment setup.

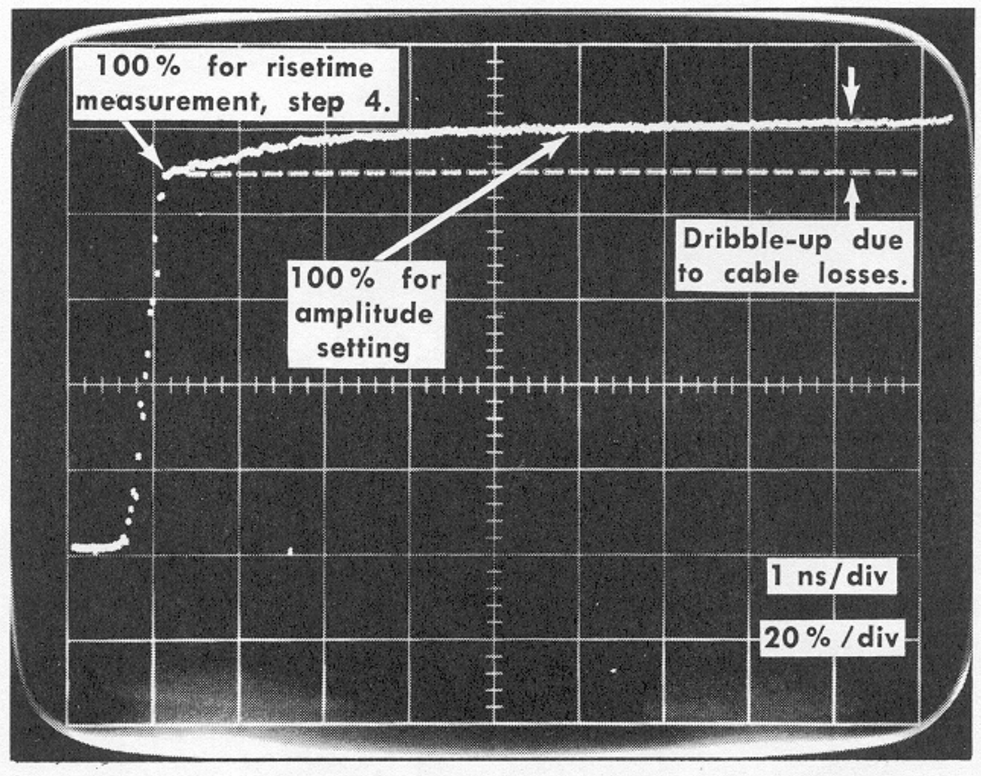
(1) Place the 50 Ω termination onto the Type 109 Charge Line 1 connector, the charge line (item 19) to the Charge Line 2 connector and a CT-3 Signal Pickoff onto the Output connector.

(2) Connect a 20 cm air line from the CT-3 to the input of a Type 113 Delay Cable, with 20 ns of RG213/U coaxial cable added to the output of the Type 113.

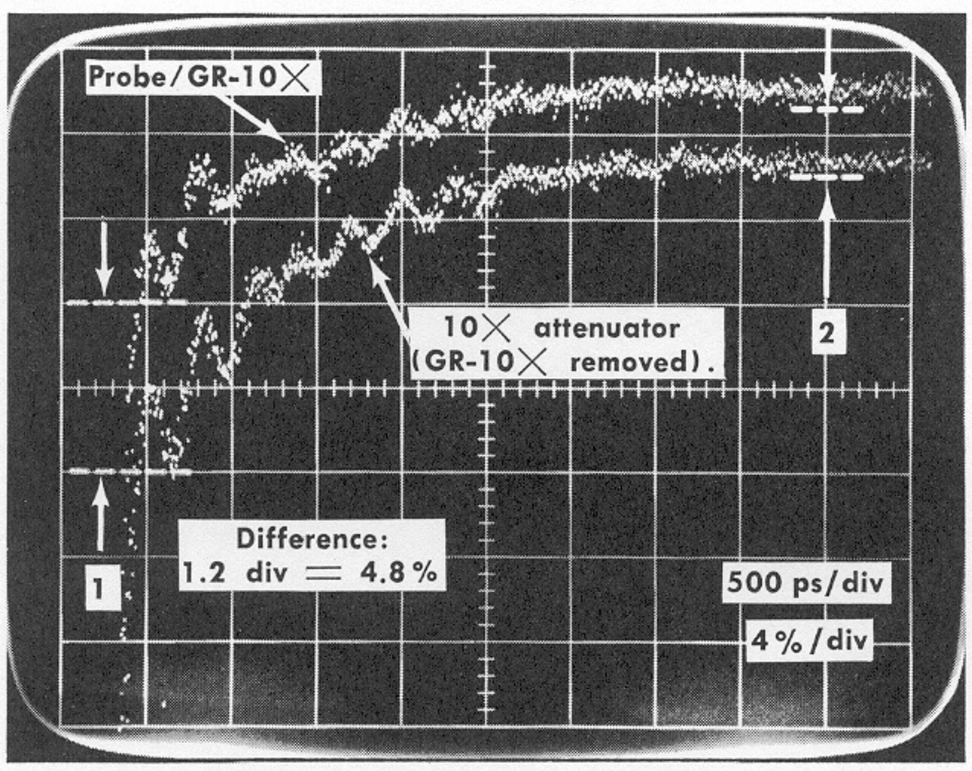
(3) Connect a 10× BNC attenuator to the CT-3 trigger pickoff output connector and a BNC coaxial cable from the attenuator to the sampling sweep unit Trigger Input (50 Ω) connector.



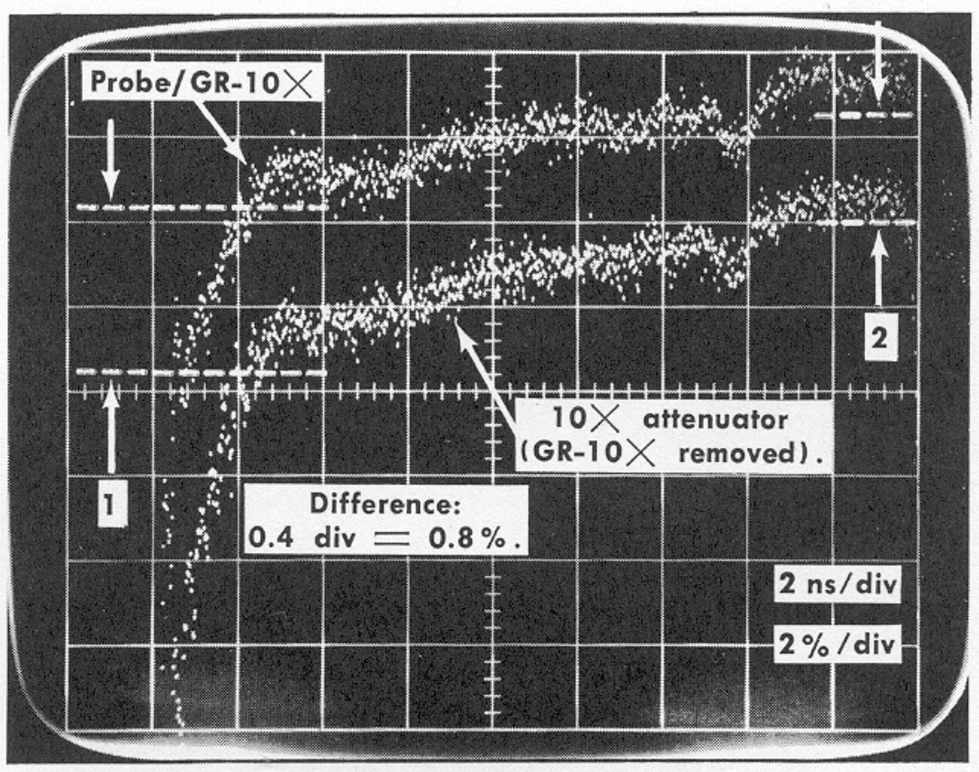
(A) Type 284, pulse—Type S-3 Probe.



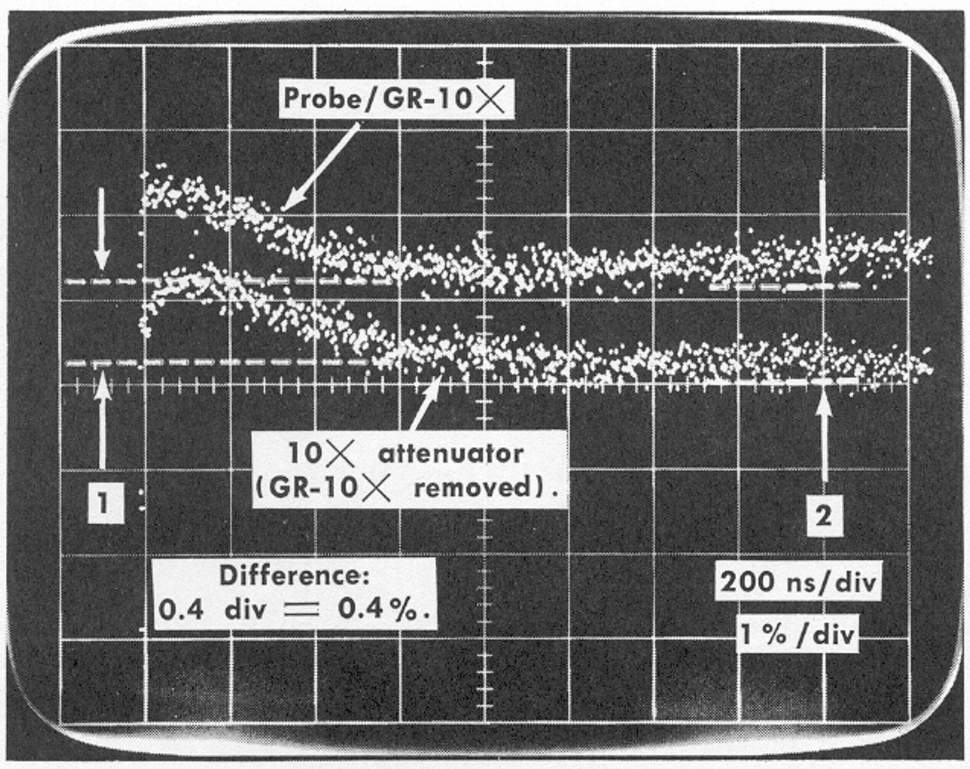
(B) Type 109—10× attenuator attached.



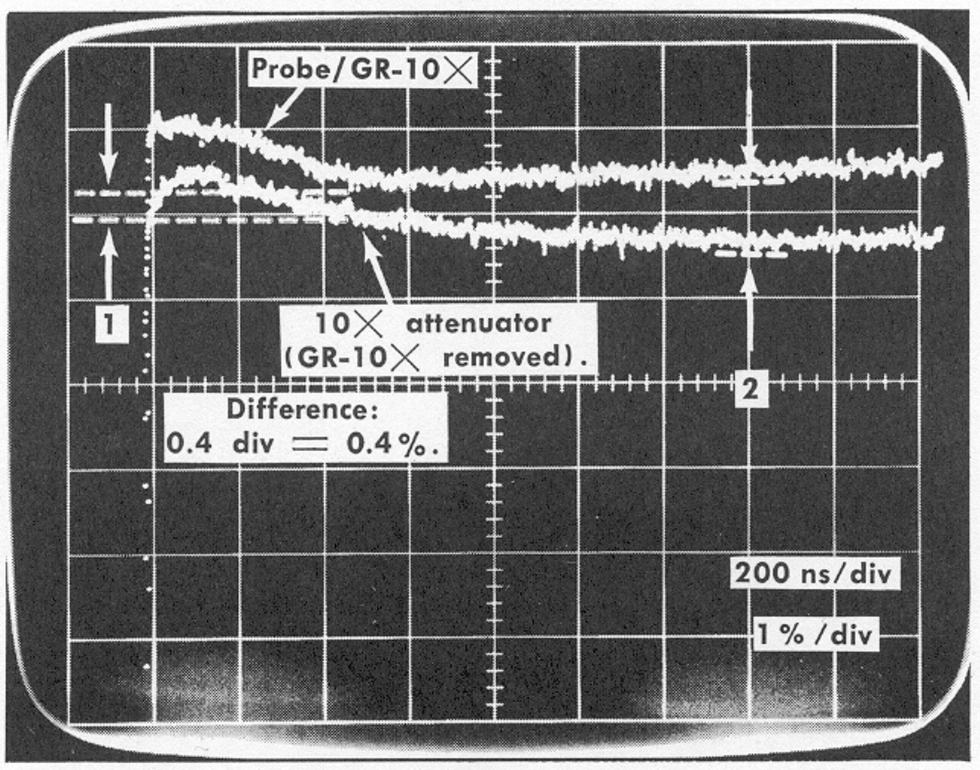
(C) Type 109.



(D) Type 109.



(E) Long term, using Type 106.



(F) Type 106, smoothed display.

Fig. 5-11. Pulse flatness deviation, step 8.

(4) Connect a GR-10× attenuator to the delay cable output and a VP-2 voltage pickoff with a GR874-W50B 50 Ω termination to the GR-10× attenuator.

(5) Connect the probe tip into the VP-2 voltage pickoff.

i. Set the Type 109 Voltage Range switch to 5 and the Amplitude control fully clockwise. Adjust the sampling unit Variable Units/Div control for a 5 division display.

j. Set the sampling sweep unit for a 1 ns/div sweep rate (Range switch to 100 ns and the Time Magnifier switch to ×10).

k. Refer to Fig. 5-11C. Change the Type 3S2 Units/Div switch to 10 and use the DC Offset control to vertically place the pulse at a reference on the graticule and the sampling sweep unit Time Position controls for horizontal placement. (This display must be retained for reference either by storage on a storage oscilloscope, or by photograph which is not developed until a second waveform is also exposed. Remember the location on the graticule.) Fig. 5-11C and D are examples of the two exposures and desired measurement of the separation. The percentage per vertical division is dependent on the Units/Div switch setting, a 5 division display at 100 Units/Div is 20%/div and will be 4%/div at 20 Unit/Div or 2%/div at 10 Units/Div. (This completes obtaining the "Probe/GR-10×" waveform.)

l. Checking a 10× probe attenuator. Remove the probe and install the 10× attenuator onto its tip. Remove the Gr-10× attenuator at the delay cable output and VP-2. Connect the VP-2 to the delay cable output and the 10× attenuator to VP-2. Do not change the generator output amplitude. This setup is shown in Fig. 5-5B.

m. Place the display near the stored "Probe/Gr-10×" display, using only the DC Offset and Time Position controls. Expose the waveform and develop the photograph. Determine the separation difference(s) between the two waveforms. This is the percentage of pulse flatness deviation for the 10× attenuator, and should not exceed a total of 7% in the first 5 ns of the pulse.

n. Checking a 100× probe attenuator. Remove the 10× attenuator from the probe. Install 2 GR-10× attenuators between the delay cable output and the VP-2.

o. Connect the probe to the VP-2. Set the Type 109 Voltage Range switch to 50.

p. Set the sampling unit Units/Div switch to 100 and adjust the Variable control for 5 divisions of display amplitude. Leave the sampling sweep unit sweep rate at 1 ns/div.

q. Set the sampling unit Units/Div switch to 10 and position the waveform as in part k for storage or photograph.

r. Install the 100× attenuator to the probe tip. Remove both GR-10× attenuators between the delay cable and the VP-2. Connect the VP-2 to the delay cable output and the 100× attenuator into the VP-2.

s. Position the display near the stored "Probe/2 GR-10×" display as in part m for comparison with the stored display or the second exposure. Determine the separation difference(s) between the waveforms. For the 100× attenuator, the difference should not exceed a total of 13% during the first 5 ns of the pulse, nor more than a total of 7% during the 5 ns through 20 ns time interval, which is checked at 5 ns/div (Time Magnifier switch at ×2).

t. Long-term pulse flatness deviations are checked as follows for the probe, 10× attenuator and 100× attenuator:

(1) Connect a GR-10× attenuator and the VP-2 voltage pickoff with the 50 Ω termination GR874-W50B attached to the Type 106 Hi Amplitude Output.

(2) Connect a BNC coaxial cable from the Trigger Output to the sampling sweep unit 50 Ω Trigger Input.

(3) Set the sampling sweep unit for a 200 ns/div sweep rate (Range switch to 100 μs and Time Magnifier to ×50).

u. Set the sampling unit Units/Div switch to 100 and connect the Type S-3 probe only to the VP-2.

v. Set the Type 106 Repetition Rate at 50 kHz and obtain a stable display. Set the Type 106 Amplitude control for a 5 division display and position the top portion of the pulse into the graticule area.

w. Set the sampling unit Units/Div switch to 5 and check that the pulse flatness deviations are not more than +1% or —1% (total 2%) with each vertical division representing 1% of the display height following the first 2 ns.

x. To check the 10× attenuator, the displayed waveform of the pulse in part w must be stored or photographed as before.

y. Remove the probe and install the 10× attenuator. Remove the GR-10× attenuator and connect the VP-2 to the Type 106 Output connector. Install the probe 10× attenator in the VP-2.

z. Position the display and compare it to the stored display, note the separation at 2 points, determine the difference and check that the percentage is not greater than a total of 2% following the first 5 ns.

aa. Remove the 10× attenuator from the VP-2. Install two GR-10× attenuators between the Type 106 Output and the VP-2.

Set the Type 106 Amplitude control fully clockwise.

ab. Connect the probe to the VP-2. Set the sampling unit Units/Div switch to 50 and adjust the Variable control for a 5 division display amplitude. Set the Units/Div switch to 5 and store the display as before.

ac. Remove the two GR-10× attenuators, connect the VP-2 to the Output connector and attach the 100× attenuator to the probe and to the VP-2.

ad. Compare the display with the stored waveform as in part z. Check that the pulse flatness deviations are not more than a total of 7% from 20 ns to 30 ns and not more than a total of 2% following the first 30 ns.

Set the Type 106 Amplitude control fully counterclockwise.

9. Final Bridge Bal Adjust

a. Place the case on the sampling head, securing the four mounting bolts at the rear.

Fig. 5-12 shows the correct orientation of the sampling head case when re-installing it. Note that the Preamplifier and Strobe Generator boards slide between part of the case and the zig-zag springs that run from the front to the back. Correct case orientation places the one hole in the case over the Bridge Bal control. In sliding the case on, the white plastic locking latch must be fitted into part of the casting.

The rear casting is mounted so the hole in the casting is at the bottom. Place the rear casting in place before inserting the four long mounting bolts. Fit the rear casting and case in place by hand so there is no space between either end casting and the case before tightening the bolts.

b. Place the head either inside the Type 3S2 Channel A compartment, or upon the extender cable with which it is normally used. If the head is not normally used on an extender cable, adjust the Bridge Bal control with the head inside the Type 3S2.

c. Free run the sampling sweep unit with a 50 ns sweep rate (3T4 or 3T77A, use .5 μs/div). Set the Channel A DC Offset control for zero volts at the front panel Offset connector. Center the trace with the Position control.

d. Operate the Type 3S2 Units/Div switch from 200 to 20 and adjust the Bridge Bal control (through the hole in the left side of the case) for not more than one division of vertical shift.

10. Check Tangential Display Noise

NOTE

When making a visual noise reading from a sampling display, the eye interprets a noise value which is neither the RMS nor the peak to peak value. Since most observers agree that the displayed noise value is approximately 3 times the RMS value, the Tangential Noise here defined is 3 times the RMS value. (The measurement technique given produces acceptable agreement between various operators as to the instrument's noise value.)

Requirement—Tangential noise will be not greater than 3 mV, with the case on the sampling head; 10× attenuator tangential noise will not be greater than 30 mV; 100× attenuator tangential noise will not be greater than 300 mV.

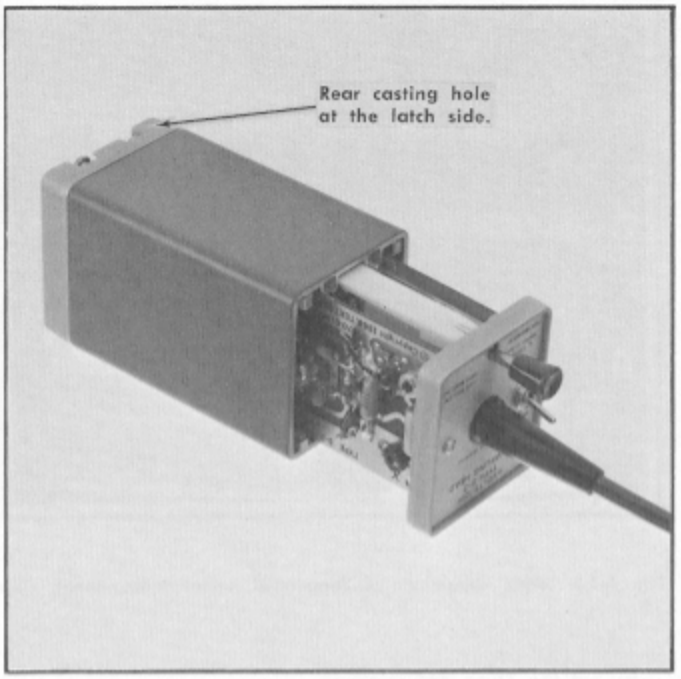


Fig. 5-12. Correct board and latch positions when re-installing the Sampling Head case.

NOTE

System noise does not change with the addition of an attenuator to the probe tip. The noise values stated in the requirement above are referred to the input and the ×10 and ×100 change in attenuator tip input deflection factor. It is therefore not necessary to check the noise with an attenuator attached to the probe tip.

a. Intall a GR 5× 50 Ω attenuator on the Type 284 Square Wave Output connector. Install the special variable attenuator (item 12) onto the 5× attenuator. Connect the VP-2 voltage pickoff (with 50 Ω termination attached) beween the variable attenuator and the tip. (The sampling head can be either inside the Type 3S2, or on an extender cable. The case must be in place on the head.)

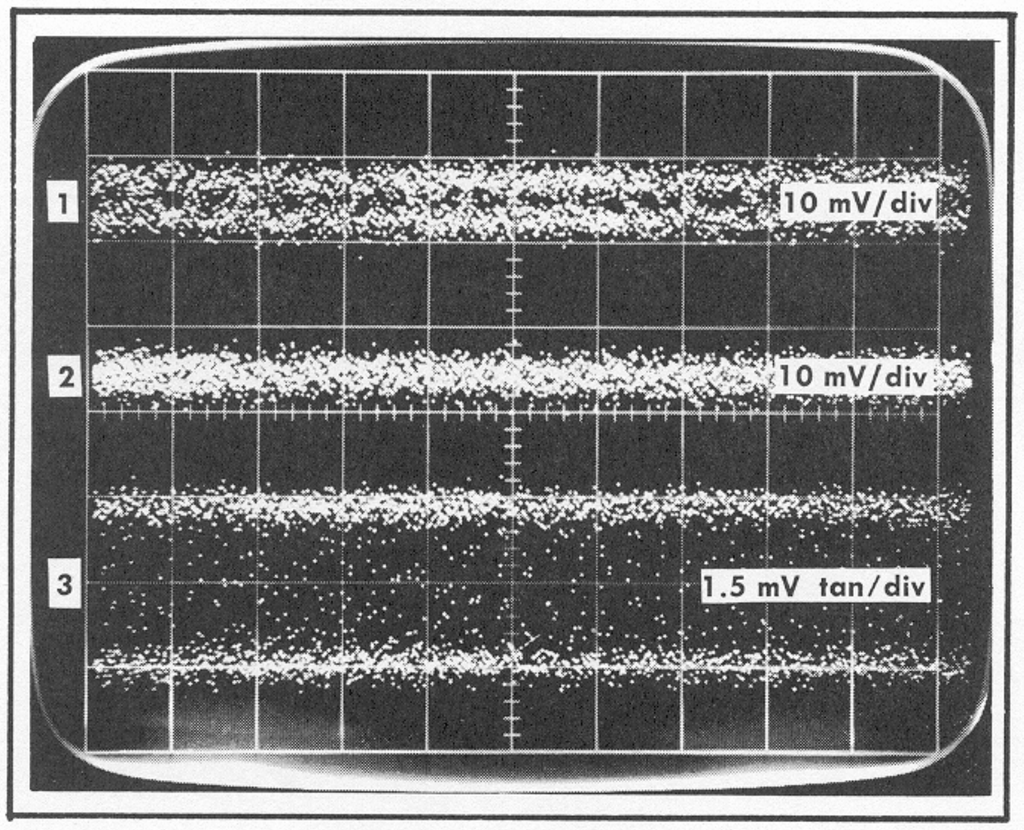


Fig. 5-13. Triple exposures of Tangential noise measurement, step 10.

b. Set the Type 284 controls:

Period	1 μs
Square Wave Amplitude	100 mV
Lead Time	Optional

c. Set the sampling unit Units/Div switch to 10.

d. Set the sampling sweep unit controls:

Trig Sensitivity	Clockwise - free run
Sweep rate	1 μs/div

Remove any external cable from the sampling sweep unit external trigger input connector.

e. Refer to Fig. 5-13 during the following noise measurement procedure.

(1) Obtain a display of two traces as shown at point (1) of Fig. 5-13. Adjust the variable attenuator until the two traces blend together just to the point (2) at which they appear as one trace.

(2) Set the Type 284 Square Wave Amplitude control to 1.0 V (×10 signal amplitude). The display (3) now has a tangential deflection factor of 1.5 mV/div. ($E_{tangential}$ per division is equal to the Type 3S2 Units/Div setting of 10 mV divided by 2, times 3 divided by 10 = 1.5 mV/div.) Therefore, the 3 mV tangential noise limit includes 2 graticule divisions (3) of Fig. 5-13. Check that the bottom edges of the two traces are not more than 2 divisions apart. Waveform (3) Fig. 5-13 measures as 3 mV tangential noise.

Determining Tangential Noise Deflection Factor

The noise display (3 of Fig. 5-13) has a noise deflection factor based upon the signal amplitude, the Type 3S2 Units/Div switch setting, the fact that the final trace separation is twice the RMS noise, and that the tangential noise is then 3 times the RMS noise. The square wave signal amplitude that makes two traces appear as one sets the trace separation to twice the RMS noise. The procedure used here then permits a noise deflection factor to be determined by dividing the input mV/div deflection factor by 2 (trace separation is 2× the RMS noise), multiplying by 3 (tangential noise is 3× the RMS noise) and then dividing by 10 (the signal amplitude change complement).

f. If the tangential noise is outside the required limits, return to Step 5. Choose an Avalanche Volts setting that produces minimum noise right after the pulse rise (in With Trigger sweep mode). If it is impossible to obtain a sufficiently low noise figure, replace Q69 and repeat the rest of the procedure again.

11. Check Offset Accuracy

Requirement—Accuracy with probe only is ±0.75% at ×1 offset, or ±0.5%, at ×2 offset.

10× attenuator accuracy is ±2%, at ×1 offset, or ±1.75%, at ×2 offset.

100× attenuator accuracy is ±2.75%, at ×1 offset or ±2.5%, at ×2 offset.

Tolerances do not include errors within the sampling unit or the VP-2 50 Ω termination. (Tolerance in the Type 3S2 is ±2% at the Offset jack and the 50 Ω GR874-W50B termination is ±0.5%.

a. Connect the VP-2 voltage pickoff with the GR874-W50B 50 Ω termination installed to the Output connector of the 50 Ω Amplitude Calibrator (item 19). Connect a BNC coaxial cable from the Trigger Output connector to the sampling sweep unit Trigger Input 50 Ω connector.

b. Set the sampling sweep unit for 2 μs/div (Range switch to 100 μs and Time Magnifier switch to ×5).

c. Set the sampling unit Units/Div switch to 100.

d. Set the 50 Ω Amplitude Calibrator Volts switch to .6 and the Test-Operate switch to Operate. Set the S-3 OFFSET switch to ×1.

e. Connect the Type S-3 probe to the VP-2 and obtain a stable 6 division display.

f. Connect the 1× probe from the Type W (test oscilloscope) to the Offset Out jack on the sampling unit. Type 3S6: TP663 CH A TP763 CH B, of Offset circuit card.) Set the Type W controls as follows:

Vc Range	+11
Comparison Voltage	000
Display	A-Vc
Input Atten	R = ∞

g. Position the indicator oscilloscope display bottom to the graticule centerline using the DC Offset control. Use the test oscilloscope (Type W) and measure the sampling unit DC Offset voltage (Type 3S2 and 3S5 measured at the front panel Offset jack; Type 3S6 measured at TP 663 CH A, or TP 763 CH B, of the Offset circuit card, with a center card extender and rigid plug-in extender in use). The voltage will be at or very near zero.

Change the sampling unit Units/Div switch to 50 and reset the display bottom of the graticule centerline with the DC Offset control. Now measure and record the DC Offset voltage with the test oscilloscope.

Change the sampling unit Units/Div switch to 50 and reset the display bottom of the graticule centerline with the DC Offset control. Now measure and record the DC Offset voltage with the test oscilloscope.

g. Set the Type W Comparison Voltage outer dial to 6, so the comparison voltage is now 6.00 volts different from the measurement in part f.

With the sampling unit DC Offset control, position the display downward so the top is at the graticule centerline. Make certain that the displayed square wave line is in the exact relationship to the centerline as when positioning the display bottom in part f.

Measure the DC Offset voltage with the test oscilloscope, using the same test oscilloscope graticule line used in part f.

The accuracy of the sampling unit is the difference of offset measurements and correct voltage expressed as a percentage of the total. Note the sampling unit offset accuracy.

h. Install the Type S-3 in the Channel A compartment and allow 5 minutes warm-up. Connect the VP-2 and tested 50 Ω termination to the Amplitude calibrator. Install the S-3 probe into the VP-2.

i. Measure the Offset voltage as parts f and g. Check that the difference between the Type S-3—sampling unit accuracy and the Type S-1—sampling unit accuracy, which is the Type S-3 offset error, is within the tolerance listed in the requirement.

Repeat the above procedure of parts g and h. The total difference betwen the two Comparison Voltage readings must be between 5820 (5.820 V) and 6180 (6.180 V), which includes the following tolerances: probe, ±0.5% at ×2 OFFSET; termination, ±0.5%; and sampling unit, ±2%.

12. Check Deflection Factor Accuracy

NOTE

Deflection factor accuracy of the sampling unit must be known. This step, as a preliminary method, uses a Type S-1 Sampling Head as a standard for checking or setting the output of the sampling unit. No other method is acceptable.

a. Measure the input resistance of the Type S-1 Sampling Head with a resistance bridge and note any variation from 50 Ω.

b. Install the Type S-1 in the sampling unit and connect the 50 Ω Amplitude Calibrator Output to the Type S-1 input through a 5 ns coaxial cable. Set the 50 Ω Amplitude Calibrator Volts switch for 0.6 volts.

c. Set the Type 3S2 Sampling Unit Units/Div switch to 100 and the sampling sweep for 2 μs/div (Range switch to 100 μs and Time Magnifier switch to ×5). Obtain a stable 6 division display and position it at the center of the graticule area.

d. Set the Type W controls as follows:

Millivolts/cm	10
Variable	Cal
Input Atten	10
Display	A-Vc
Input Coupling	DC

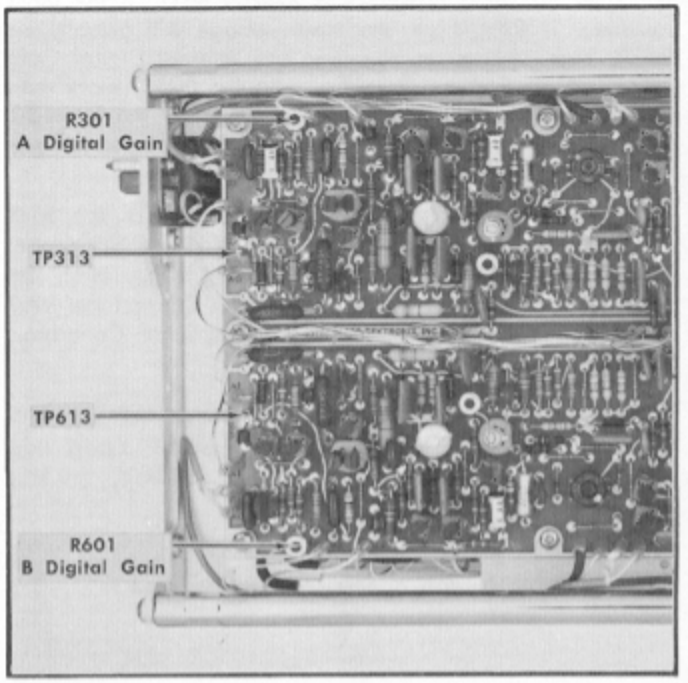


Fig. 5-14. Locations of Digital Outputs in the Type 3S2.

e. Connect the 1× probe from the Type W A Input to the sampling unit Digital Output. In the Type 3S2, connect to TP313 for Channel A operation or TP613 for Channel B operation (Pin 1 or Pin 3 on the vertically mounted interconnecting plug). See Fig. 5-14 for locations. (Type 3S5 or 3S6, TP 418 CH A, or TP 438 CH B, located on the Output board.)

f. This step describes how to eliminate the contribution to deflection factor accuracy of the vertical channel of the sampling system. An adjustment is made within the sampling unit that removes any error of the measurement that might otherwise come from the signal source, the sampling feedback loop, the Type S-1 input resistance and the Type W signal voltage measurements. The only remaining system error is due to the accuracy (error) of the 50 Ω GR874W-50B termination used with the VP-2 and S-3 probe. It must also be measured.

The signal measured by the Type W and test oscilloscope is the output of the Channel Amplifier. That 6 V peak to peak signal must have its peak to peak limits beween 0 V and +20 V. Set the Channel Amplifier output signal within that range with the sampling unit DC Offset control. Make the measurement as follows:

Set the Type W Vc Range switch to +11 and the Comparison Voltage outer dial to 1. Set the test oscilloscope square wave display bottom to the graticule centerline using the Type W Position control, the sampling unit DC Offset control, and the Comparison Voltage inner dial. (The outer dial may have to be a 0.) Record the dial reading, and do not disturb the Type W Position control or the sampling unit DC Offset control.

Increase the Type W Comparison Voltage dial readings until the test oscilloscope display top is at the graticule centerline. Record the dial readings. The difference between the two sets of dial readings must equal 6.00 volts if

the Type S-1 input resistance is exactly 50 Ω. If the input resistance is 0.5% high, the input voltage will actually be 0.25% high. Adjust the sampling unit internal Digital Gain control so the Channel Amplifier output is 0.25% more than 6.00 volts, or to 6.015 volts peak to peak. If the Type S-1 input resistance is low, adjust the Digital Gain for a lower amplitude output signal.

g. Measure and record the DC resistance of the 50 Ω termination to be used with the VP-2 and the S-3 probe. Remove the Type S-1 from the sampling unit. Install the Type S-3 and allow 5 minutes warm-up. Connect the VP-2 and tested 50 Ω termination to the Amplitude Calibrator. Install the S-3 probe into the VP-2.

h. Measure the Channel Amplifier output voltage with the Type W Comparison Voltage as in part f. Check that the signal voltage is 6 V peak to peak ±30 mV, ±0.5%, plus the error caused by the GR874-W50B termination.

i. Install the 10× attenuator on the Type S-3 probe and set the 50 Ω Amplitude Calibrator for 2 volts. Center the 2 division display.

j. Measure the Channel Amplifier output voltage as before in part f. Check that the signal voltage is 2 V peak to peak, ±35 mV, ±1.75%, plus the error caused by the GR874-W50B termination.

k. Remove the 10× attenuator. Install the 100× attenuator on the Type S-3 probe. Set the sampling unit Units/Div switch to 10 and center the 2 division display.

l. Measure the Channel Amplifier output voltage as in part f. Check that the signal voltage is 2 V peak to peak, ±50 mV, ±2.5%, plus the error caused by the GR874-W50B termination.

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
incd	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Capacitors		
Tolerance ±20% unless otherwise indicated.						
C1	- - - - - -			(See Mech. Parts, Body-Tip Assembly)		
C11	283-0165-00			50 pF	Cer 1000 V	5%
C12	283-0165-00			50 pF	Cer 1000 V	5%
C21	283-0051-00			0.0033 μF	Cer 100 V	5%
C23	283-0051-00			0.0033 μF	Cer 100 V	5%
C30	281-0679-00			15 pF	Cer 50 V	10%
C34	283-0119-00			0.0022 μF	Cer 200 V	10%
C38	283-0032-00			470 pF	Cer 500 V	5%
C40	283-0067-00			0.001 μF	Cer 200 V	10%
C43	290-0246-00			3.3 μF	Elect. 15 V	10%
C44	283-0005-00			0.01 μF	Cer 250 V	
C45	283-0066-00			2.5 pF	Cer 200 V	
C46	283-0067-00			0.001 μF	Cer 200 V	1%
C49	283-0005-00			0.01 μF	Cer 250 V	
C51	283-0121-00			0.001 μF	Cer 200 V	
C53	283-0121-00			0.001 μF	Cer 200 V	
C55	290-0134-00			22 μF	Elect. 15 V	
C59	*283-0072-01			0.01 μF	Cer	
C63	283-0103-00			180 pF	Cer 500 V	5%
C64	283-0103-00			180 pF	Cer 500 V	5%
C65	283-0005-00			0.01 μF	Cer 250 V	
C69	281-0612-00			5.6 pF	Cer 200 V	±0.5 pF
C71	283-0121-00			0.001 μF	Cer 200 V	
C80[1]						
C81[1]						
C84[1]						
C90[2]						
C91[2]						
C94[2]						
C96[2]						
				Semiconductor Device, Diodes		
D4	152-0368-00			Silicon	Bridge	
D11	*152-0322-00			Silicon	Tek Spec	
D12	*152-0322-00			Silicon	Tek Spec	
D41	*152-0185-00			Silicon	Replaceable by 1N4152	
D61	*152-0335-00			Silicon	Snap-Off	

[1]Furnished as a unit with 10X Attenuator Head (010-0364-00)

[2]Furnished as a unit with 100X Attenuator Head (010-0365-00)

Connectors

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
J11	131-0265-00			Coaxial right-angle
J12	131-0265-00			Coaxial right-angle
J51	131-0582-00			Coaxial female
J53	131-0582-00			Coaxial female
P11	- - - - - -			(See Mech. Parts, Probe & Cable Assembly)
P12	- - - - - -			(See Mech. Parts, Probe & Cable Assembly)
P51	131-0391-00			Coaxial male
P53	131-0391-00			Coaxial male

Inductors

L40	276-0507-00	Core, ferramic suppressor	
L55	*120-0382-00	Toroid	14 turns, single
L60	*108-0170-01	0.5 μH	
L62	*108-0170-01	0.5 μH	

Transistors

Q31	151-1023-00	Silicon	FET
Q41	151-0224-00	Silicon	2N3692
Q45	151-0224-00	Silicon	2N3692
Q55	151-0224-00	Silicon	2N3692
Q69	*153-0556-00	Silicon	Selected

Resistors

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

R1	325-0033-00	50 kΩ	1/10 W	Prec	¼%
R3	307-0150-00	75 Ω	0.075 W		5%
R4	325-0033-00	50 kΩ	1/10 W	Prec	¼%
R5	325-0037-00	100 Ω	1/20 W	Prec	1%
R6	325-0037-00	100 Ω	1/20 W	Prec	1%
R7	325-0001-00	100 kΩ	1/20 W	Prec	1%
R8	325-0001-00	100 kΩ	1/20 W	Prec	1%
R11	317-0151-00	150 Ω	⅛ W		5%
R12	317-0151-00	150 Ω	⅛ W		5%
R13	317-0510-00	51 Ω	⅛ W		5%
R14	317-0510-00	51 Ω	⅛ W		5%
R16	317-0102-00	1 kΩ	⅛ W		5%
R17	317-0102-00	1 kΩ	⅛ W		5%
R20	321-0385-00	100 kΩ	⅛ W	Prec	1%
R21	321-0253-00	4.22 kΩ	⅛ W	Prec	1%
R22	311-0609-00	2 kΩ, Var	½ W		30%
R23	321-0253-00	4.22 kΩ	⅛ W	Prec	1%
R24	321-0385-00	100 kΩ	⅛ W	Prec	1%
R26	311-0613-00	100 kΩ, Var	½ W		30%
R27	321-0776-03	3.501 kΩ	⅛ W	Prec	¼%

Resistors (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
R28	321-0777-03			5.14 kΩ	1/8 W	Prec 1/4%
R29	321-0778-03			5.148 kΩ	1/8 W	Prec 1/4%
R30	307-0150-00	XB020000		75 Ω	0.075 W	5%
R31	301-0912-00			9.1 kΩ	1/2 W	5%
R32	317-0221-00			220 Ω	1/8 W	5%
R34	301-0123-00			12 kΩ	1/2 W	5%
R38	321-0779-03			7.02 kΩ	1/8 W	Prec 1/4%
R39	321-0780-03			18.96 kΩ	1/8 W	Prec 1/4%
R40	317-0224-00			220 kΩ	1/8 W	5%
R41	317-0223-00			22 kΩ	1/8 W	5%
R42	317-0122-00			1.2 kΩ	1/8 W	5%
R44	317-0101-00			100 Ω	1/8 W	5%
R45	317-0303-00			30 kΩ	1/8 W	5%
R46	311-0607-00			10 kΩ, Var	1/2 W	30%
R47	315-0242-00			2.4 kΩ	1/4 W	5%
R56	317-0271-00			270 Ω	1/8 W	5%
R57	311-0607-00			10 kΩ, Var	1/2 W	30%
R59	308-0243-00			240 Ω	3 W	WW 5%
R60	317-0390-00			39 Ω	1/8 W	5%
R62	317-0390-00			39 Ω	1/8 W	5%
R65	317-0101-00			100 Ω	1/8 W	5%
R66	311-0644-00			20 kΩ, Var	1/2 W	30%
R68	317-0332-00			3.3 kΩ	1/8 W	5%
R70	317-0332-00			3.3 kΩ	1/8 W	5%
R71	317-0202-00			2 kΩ	1/8 W	5%
R72	315-0203-00			20 kΩ	1/4 W	5%
R73	307-0124-00			5 kΩ	Thermal	
R80[3]						
R81[3]						
R84[3]						
R86[3]						
R90[4]						
R91[4]						
R93[4]						
R94[4]						
R96[4]						
R98[4]						

Switch

SW27	260-0643-00	Toggle	OFFSET

Transformer

T75	*120-0544-00	Toroid, 2 windings

[3]Furnished as a unit with 10X Attenuator Head (010-0364-00)

[4]Furnished as a unit with 100X Attenutor Head (010-0365-00)

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

FIG. 1 EXPLODED

FIG. 2 STANDARD ACCESSORIES

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specificed.

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

SECTION 7
MECHANICAL PARTS LIST

FIG. 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-	015-0120-00			1		SAMPLING HEAD, w/o probe
	- - - - - -			-		sampling head includes:
-1	333-1059-00			1		PANEL, front
	- - - - - -			-		mounting hardware: (not included w/panel)
-2	211-0022-00			1		SCREW, 2-56 x 3/16 inch, RHS
-3	386-1338-03			1		PLATE, sub-panel, front
-4	260-0643-00			1		SWITCH, toggle-OFFSET RANGE
	- - - - - -			-		mounting hardware: (not included w/switch)
-5	361-0184-00			1		SPACER, ring
-6	210-0940-00			1		WASHER, flat, 1/4 ID x 3/8 inch OD
-7	210-0562-00			1		NUT, hex., 1/4-40 x 5/16 inch
-8	105-0066-00			1		STRIKE, latch
-9	384-0687-00			1		SHAFT, latch
-10	352-0139-00			2		HOLDER, circuit board
	- - - - - -			-		mounting hardware for each: (not included w/holder)
-11	213-0012-00			1		SCREW, thread cutting, 4-40 x 3/8 inch
-12	670-0190-00			1		ASSEMBLY, circuit board—PREAMP
	- - - - - -			-		assembly includes:
	388-0986-00			1		BOARD, circuit
-13	136-0252-01			6		SOCKET, pin connector
-14	136-0263-01			12		SOCKET, connector pin
-15	670-0191-00			1		ASSEMBLY, circuit board—TERMINAL
	- - - - - -			-		assembly includes:
	388-0987-00			1		BOARD, circuit
-16	131-0265-00			2		CONNECTOR, coaxial, female
-17	131-0582-00			2		CONNECTOR, receptacle
-18	131-0591-00			11		TERMINAL, pin, 0.89 inch long
-19	131-0594-00			3		TERMINAL, pin, 1.485 inches long
-20	670-0194-00			1		ASSEMBLY, circuit board—STROBE
	- - - - - -			-		assembly includes:
	388-1017-00			1		BOARD, circuit
-21	131-0391-00			2		CONNECTOR, coaxial, male
-22	136-0252-01			6		SOCKET, pin connector
-23	136-0263-01			5		SOCKET, connector pin
-24	344-0061-00			2		CLIP, diode
-25	380-0125-00			1		HOUSING
	- - - - - -			-		housing includes:
-26	131-0555-00			4		CONTACT
-27	386-1337-01	B010100	B010149	1		PANEL, rear
	386-1337-04	B010150		1		PANEL, rear
	- - - - - -			-		mounting hardware: (not included w/panel)
-28	211-0141-00			4		SCREW, machine, 4-40 x 3 1/4 inch, PHS

FIG. 1 EXPLODED *(cont)*

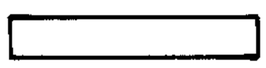
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-29	010-0236-00			1	ASSEMBLY, PROBE & CABLE
	- - - - - -			-	assembly includes:
-30	200-0372-00			1	CAP, protective
-31	204-0351-00			1	ASSEMBLY, body-tip
-32	343-0165-00			1	CLAMP, half, strain relief
-33	343-0164-00			1	CLAMP, half, strain relief
	- - - - - -			-	mounting hardware: (not included w/clamp
-34	211-0100-00			2	SCREW, 2-56 x 3/4 inch, RHS
-35	210-0405-00			2	NUT, hex., 2-56 x 3/16 inch

SECTION 8
DIAGRAMS

The following symbols are used on the diagrams:

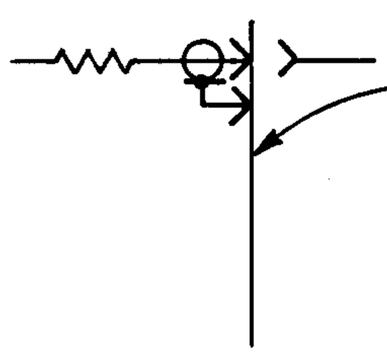


Screwdriver adjustment

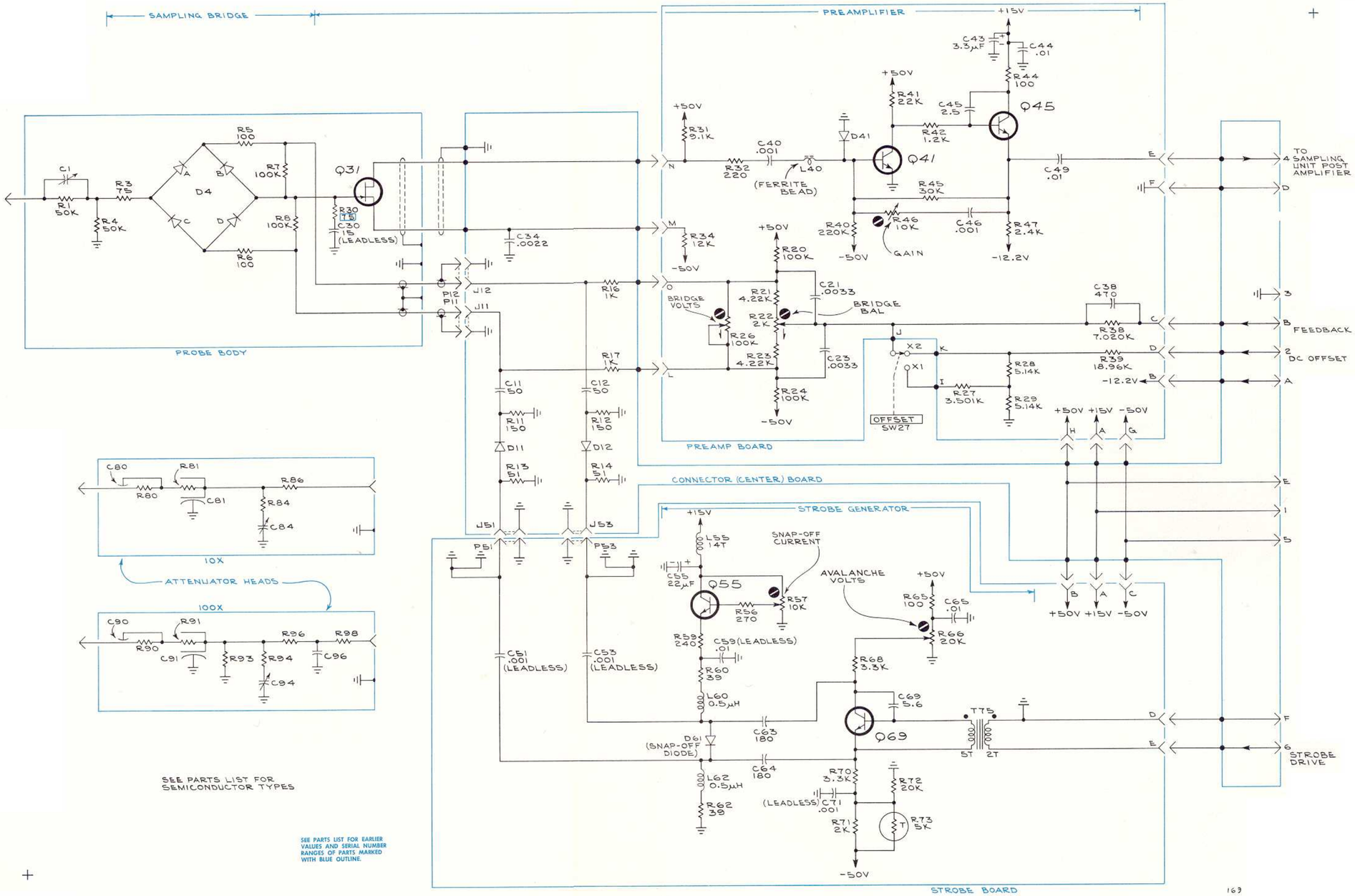


Front panel control or connector

Clockwise control rotation in direction of arrow



Blue line encloses components located on circuit board

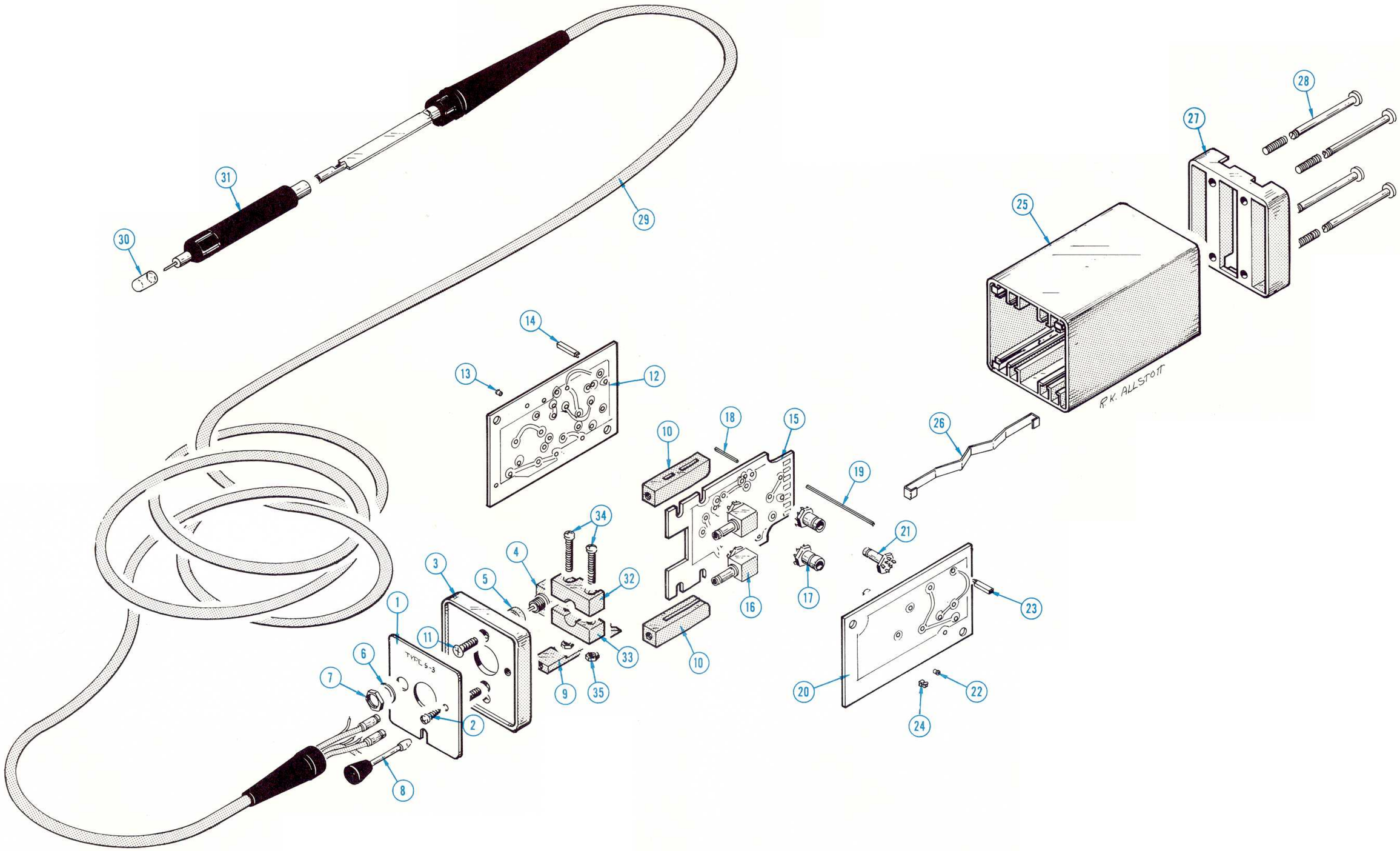


SEE PARTS LIST FOR SEMICONDUCTOR TYPES

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

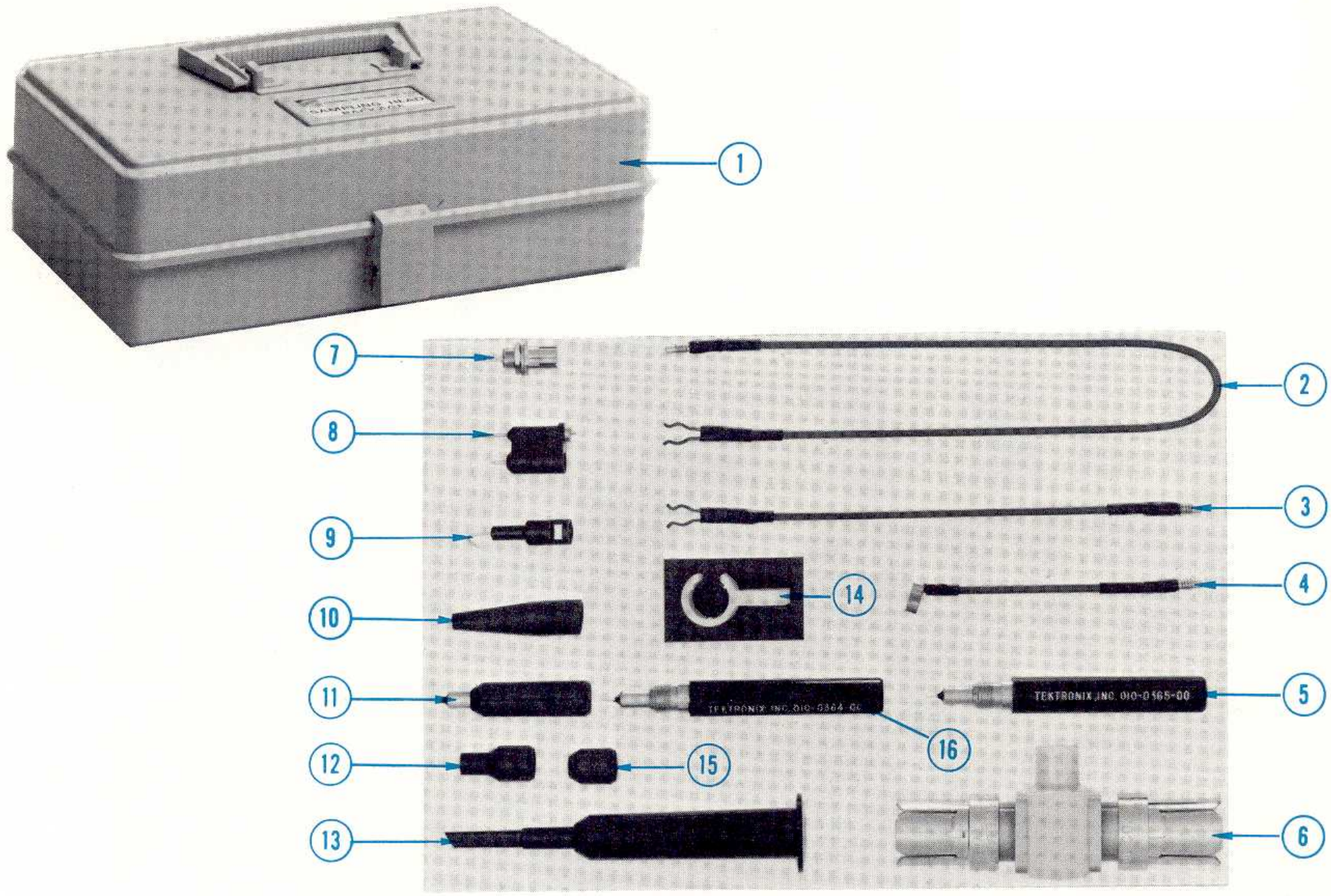
TYPE S-3 SAMPLING HEAD

FIG. 1 EXPLODED



TYPE S-3 SAMPLING HEAD

FIG. 2 STANDARD ACCESSORIES



A

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
2-1	016-0121-00			1	CARRYING CASE
-2	175-1018-00			1	LEAD, electrical, 12.5 inches long
-3	175-1017-00			1	LEAD, electrical, 5.5 inches long
-4	175-0249-00			1	CABLE ASSEMBLY, 3 inches long
-5	010-0365-00			1	ATTENUATOR HEAD, 100X
-6	017-0077-01			1	VOLTAGE PICKOFF
-7	131-0258-00			2	CONNECTOR, test point jack
-8	013-0085-00			1	ADAPTER, bayonet ground
-9	206-0114-00			1	TIP, probe (hooked)
-10	344-0046-00			3	CLIP, probe
-11	011-0098-00			1	CAPACITOR, coupling
-12	200-0834-00			1	CAP, end
-13	013-0097-00			1	TIP, probe, retractable hook
-14	352-0090-00			1	HOLDER, probe
-15	200-0835-00			2	CAP, end
-16	010-0364-00			1	ATTENUATOR HEAD, 10X
	070-0765-00			1	MANUAL, instruction (not shown)

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.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

TYPE S-3

TEXT CORRECTION

Section 1 TYPE S-3 SPECIFICATION

Page 1-1 ELECTRICAL CHARACTERISTICS Table

CHANGE: to read as follows:

Deflection Factors	mV/Div, (1 times the numbers around the sampling unit Units/ Div switch).
Accuracy[1]	
Probe Only	Within 1.0%
With 10X Attenuator	Within 2.25%
With 100X Attenuator	Within 3.0%

Section 5 PERFORMANCE CHECK/CALIBRATION

Page 5-3 Performance Check and Calibration Record and Index

CHANGE: Step 12 to read as follows:

☐ 12. Check Deflection Factor Accuracy (Page 5-17)

Page 5-6 Fig. 5-4

ADD: to the label on the upper waveform "Correct", and add to the label on the lower waveform "Incorrect".

TEXT CORRECTION

Section 1 Type S-3 Specification

Page 1-1 Electrical Characteristics Table

CHANGE: to read as follows:

Offset Accuracy[1]	Probe only	With probe and 10X attenuator	With probe and 100X attenuator
OFFSET switch at X1	±1.6%	±3.1%	±3.85%
OFFSET switch at X2	±1.35%	±2.85%	±3.6%

Section 5 Performance Check/Calibration

Page 5-16 Step 11. Check Offset Accuracy

CHANGE: as follows:

Requirement--Accuracy with probe only is ±1.6% at X1 offset, or ±1.35%, at X2 offset.

10 X attenuator accuracy is ±3.1% at X1 offset, or ±2.85% at X2 offset.

100X attenuator accuracy is ±3.85% at X1 offset, or ±3.6% at X2 offset.

NOTE

The offset accuracy of the sampling unit must be known. This step, as a preliminary method, uses a Type S-1 as a standard for checking the offset accuracy of the sampling unit.

a. Set the sampling sweep unit for 2 μs/div (Range switch to 100 μs and Time Magnifier switch to X5).

b. Set the sampling unit Units/Div switch to 100.

c. Set the 50 Ω Amplitude Calibrator Volts switch to .6 and the Test-Operate switch to Operate.

d. Install the Type S-1 in the sampling unit and connect the 50 Ω Amplitude Calibrator Output to the Type S-1 input through a 5 ns coaxial cable. Connect a BNC coaxial cable from the Trigger Output connector to the sampling sweep unit Trigger Input 50 Ω connector.

e. Connect the 1X probe from the Type W (test oscilloscope) to the Offset Out jack on the sampling unit. (Type 3S6: TP663 CH A TP763 CH B, of Offset circuit card.) Set the Type W controls as follows:

Vc Range	+11
Comparison Voltage	000
Display	A-Vc
Input Atten	R = ∞

f. Position the indicator oscilloscope display bottom to the graticule centerline using the DC Offset control. Use the Test oscilloscope (Type W) and measure the sampling unit DC Offset voltage (Type 3S2 and 3S5 measured at the front panel Offset jack; Type 3S6 measured at TP 663 CH A, or TP763 CH B, of the Offset circuit card, with a center card extender and rigid plug-in extender in use). The voltage will be at or very near zero.

Change the sampling unit Units/Div switch to 50 and reset the display bottom of the graticule centerline with the DC Offset control. Now measure and record the DC Offset voltage with the test oscilloscope.

g. Set the Type W Comparison Voltage outer dial to 6, so the comparison voltage is now 6.00 volts different from the measurement in part f.

With the sampling unit DC Offset control, position the display downward so the top is at the graticule centerline. Make certain that the displayed square wave line is in the exact relationship to the centerline as when positioning the display bottom in part f.

Measure the DC Offset voltage with the test oscilloscope, using the same test oscilloscope graticule line used in part f.

The accuracy of the sampling unit is the difference of offset measurements and correct voltage expressed as a percentage of the total. Note the sampling unit offset accuracy.

h. Install the Type S-3 in the Channel A compartment and allow 5 minutes warm-up. Connect the VP-2 and tested 50 Ω termination to the Amplitude calibrator. Install the S-3 probe into the VP-2.

i. Measure the Offset voltage as parts f and g. Check that the difference between the Type S-3 -- sampling unit accuracy and the Type S-1-- sampling unit accuracy, which is the Type S-3 offset error, is within the tolerance listed in the requirement.

TYPE S-3

TEXT CORRECTION

Section 1 Specification

Page 1-1 Electrical Characteristics Table

CHANGE: the Coupling Time Constant to read:

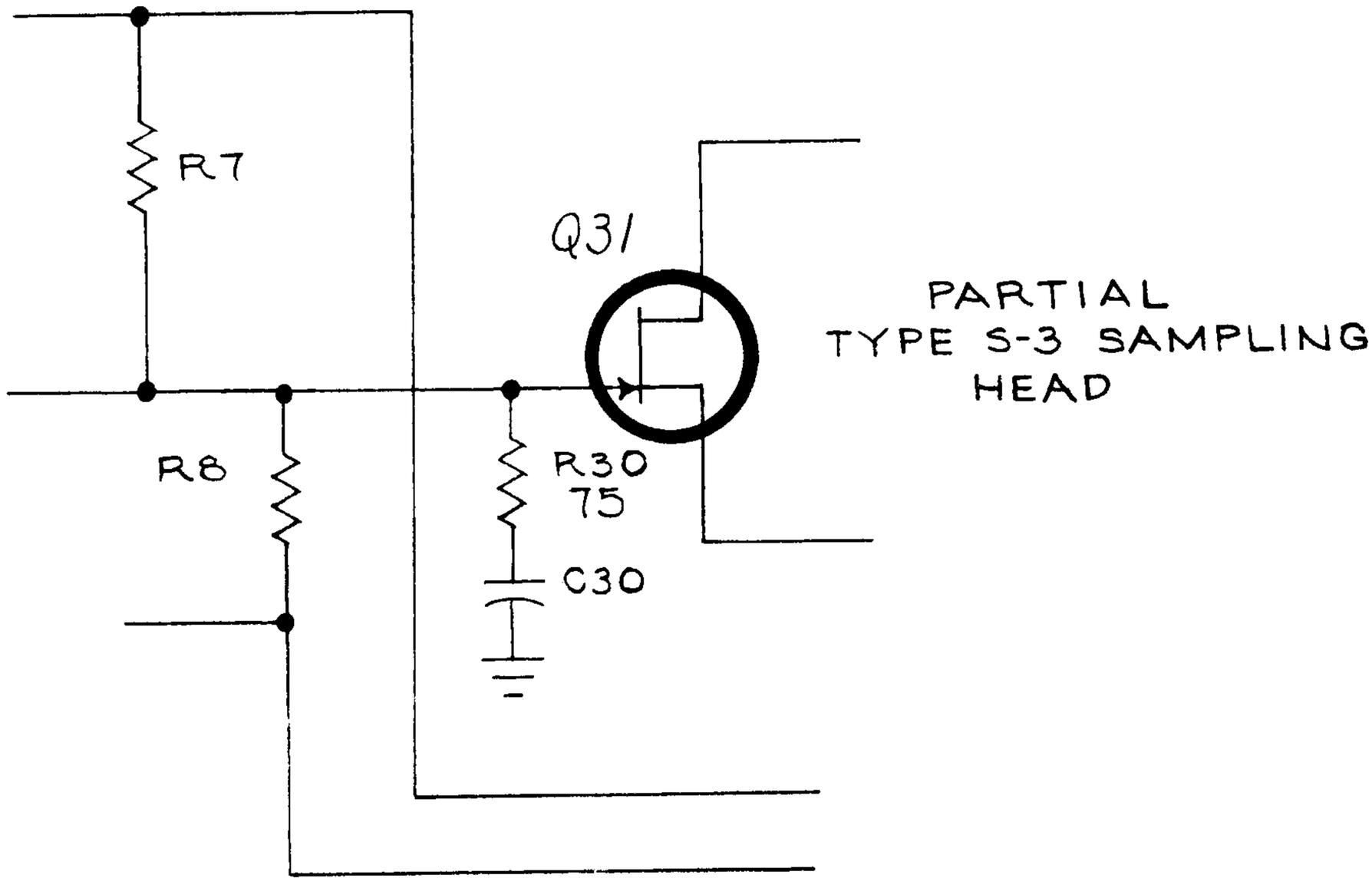
Coupling Time Constant (probe and coupling capacitor only)	≥ 100 μs

TYPE S-3 EFF SN B020120

ELECTRICAL PARTS LIST AND SCHEMATIC ADDITION

ADD:

R30	307-0150-00	75 Ω	.075 W	±5%

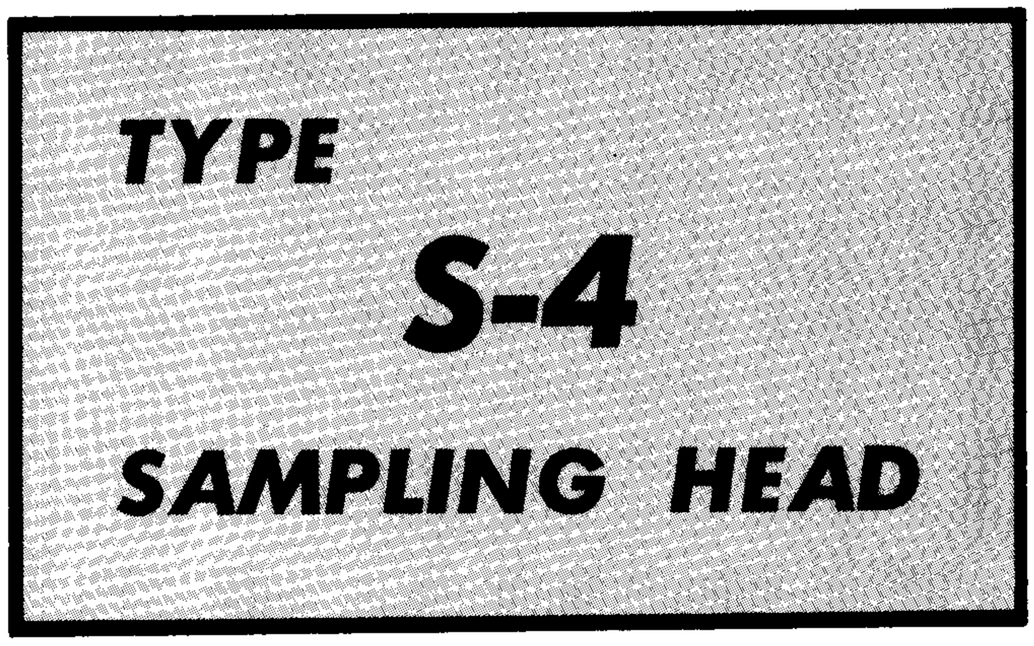


PARTIAL---SAMPLING HEAD CIRCUIT

M14,627/1268

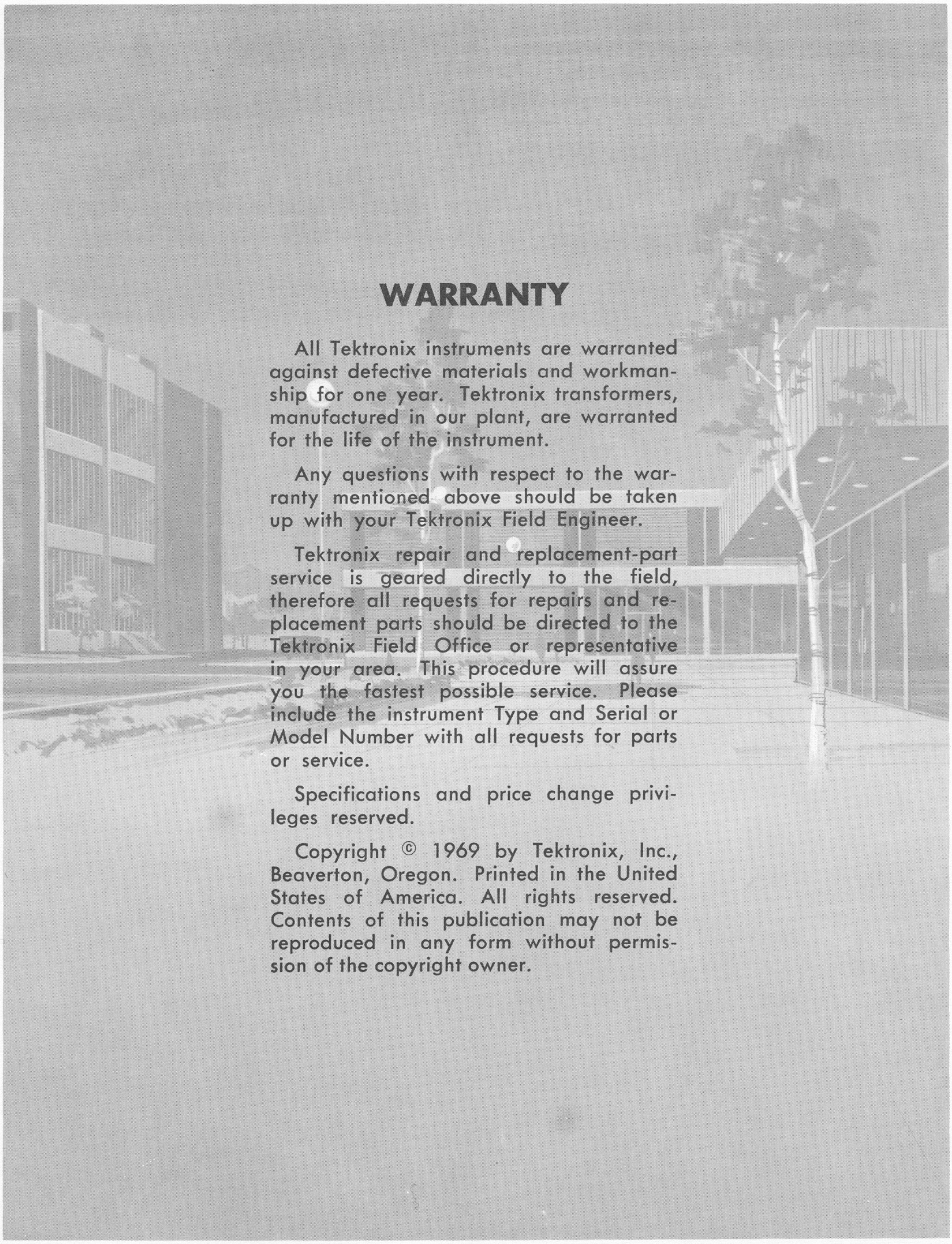
INSTRUCTION MANUAL

Serial Number _____



Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0896-00



WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our 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 or Model Number with all requests for parts or service.

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Section 2 Operating Instructions

Section 3 Circuit Description

Section 4 Maintenance

Section 5 Performance Check/Calibration

Abbreviations and Symbols

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Section 6 Electrical Parts List

Mechanical Parts List Information

Section 7 Mechanical Parts List

Section 8 Diagrams

Mechanical Parts List Illustrations

Accessories

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units," MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of the manual.



Fig. 1-1. Type S-4 Sampling Head.

SECTION 1
TYPE S-4 SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

The Type S-4 Sampling Head is an input signal processing unit for Tektronix sampling units such as the Type 3S2, 3S5, and 3S6. Input characteristics of the sampling system are determined by the Type S-4. The Type S-4 has an input impedance of 50 Ω and a risetime of 25 ps or less.

The Type S-4 can be installed directly into a sampling unit or used remotely (with the Type 3S2 or Type 3S5) on an optional 3 foot or 6 foot extender cable. When used with a Type 3S6 Sampling Unit the Type S-4 is plugged into the dual-input extender cable supplied with the Type 3S6.

A portion of the signal delivered to the sampling head input is coaxially coupled to the sampling unit for use as an internal trigger signal. The Type 3S2 allows selection of the trigger pickoff signal from the Channel A or Channel B sampling head. Type 3S5 and 3S6 Sampling Units permit use of the trigger pickoff signal only from Channel A. Use of this trigger pickoff signal is dependent upon the type of sampling unit and sampling sweep unit used in the system. See the instruction manual for your sampling unit and sampling sweep unit for further information.

Vertical deflection factor of the sampling system is labeled at the top of the Type S-4 as mVOLTS/DIV; the label refers to the sampling unit Units/Div switch of the corresponding channel.

Digital Unit Programming Connections

The Type S-4 has two contacts at its rear connector that program the decimal and units-of-measure lamps of a Tektronix Type 6R1A or Type 230 Digital Unit. These connections are not used with a Type 3S2 Sampling Unit. When using a Type 3S5 or Type 3S6, one of the sampling head contacts notifies the digital readout unit, through the sampling unit digital control circuits, that the Type S-4 is a voltage measuring head. This causes the Volts lamp of the digital readout unit to light. The other sampling head contact notifies the digital readout unit, through the sampling unit digital control circuits, that the Type S-4 sensitivity requires no decimal shift of the numbers around the sampling unit Units/Div switch.

ELECTRICAL CHARACTERISTICS

Characteristics

The following characteristics apply over an ambient temperature range of 0°C to +50°C and after a five minute warmup providing the instrument was calibrated at a temperature between +20°C and +30°C.

Characteristics listed below apply only after the Type S-4 has been properly mated to the sampling unit and indicator oscilloscope and after these units have been given sufficient warmup time. To determine the particular system warmup requirements, refer to the related amplifier and indicator oscilloscope instruction manual. A procedure for mating the Type S-4 to the sampling unit can be found in the Operating Instructions section of this manual

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
Input Resistance	50 Ω within 5%
Response to Step Signals Risetime (10% to 90%)	25 ps or less (Verify using step 9, Section 5.)
Pulse Flatness Deviation (after 90% point on display) 0 ps to 400 ps	−10% to +10% with a total of 20% or less. (Verify using step 10, Section 5).
400 ps to 25 ns	0% to +10% with a total of 10% or less. (Verify using step 10, Section 5).
25 ns or more	−2% to +2% with a total of 4% or less. (Verify using step 10, Section 5).
Maximum Operating Signal Voltage	1 V P-P
Safe Overload Signal Voltage	Not to exceed + or −5 V (DC plus AC peak)
Loop Gain	Adjustable in the sampling unit to unity for signals up to 500 mV P-P; when the loop gain is adjusted to unity with positive input signals, the loop gain will be within 5% of unity with negative input signals and vice versa.
Baseline Shift (with change in repetition rate)	10 mV or less, 30 Hz to 50 kHz
Displayed Noise	5 mV or less, measured tangentially

ENVIRONMENTAL CHARACTERISTICS

Storage	Operating
Temperature— −40°C to +65°C	Temperature—As stated above Electrical Characteristics table
Altitude—To 50,000 feet	Altitude—To 15,000 feet

MECHANICAL CHARACTERISTICS

Dimensions— Height ≈ 2 inches
Width ≈ 1 7/8 inches
Length ≈ 4 1/8 inches

Construction— Epoxy laminated circuit boards. Aluminum wrap around cabinet with aluminum casting at front and rear. Anodized aluminum front panel.

Accessories— An illustrated list of the accessories supplied with the Type S-4 is at the end of the Mechanical Parts List pullout pages.

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

This section provides the basic information required for operation of the Type S-4 Sampling Head, including installation and First Time Operation.

The Type S-4 can be used on an extender cable without compromising the response of the measurement system. Signals are applied to the 50 Ω input of the sampling head through a 3 mm, 50 Ω coaxial connector located at the center of the front panel.

Unity loop gain can be obtained with input signals of up to 0.5 volt (peak-to-peak). Unity loop gain ensures the most accurate displays, of particular importance during fast changes in input signal amplitude. See the Basic Sampling Principals Section of your sampling unit manual for further information.

The Type S-4 may be used with input signals up to 1 volt (peak-to-peak). Specifications for the Type S-4 Sampling Head are given in Section 1 of this manual.

NOTE

Attenuators, with threaded 3 mm connectors, are available as optional accessories. These attenuators are useful in reducing the amplitude of large signals. Other optional accessories with 3 mm connectors include coaxial cables, a 50 Ω termination, and adapters for interconnecting various types of connectors. Refer to your Tektronix catalog or contact your local Tektronix Field Engineer or Representative for further information about optional accessories.

Installing the Type S-4 Sampling Head

Fig. 2-1 shows the Type S-4 partially installed in a Type 3S2 Sampling Unit with a Type 564 Oscilloscope and a Type 3T2 Random Sampling Sweep unit. The sampling head (or heads) can be plugged into the sampling unit as shown, or used remotely on a special extender cable. Three and six foot extender cables are available. Order the three foot extender cable by Tektronix Part No. 012-0124-00, or the six foot extender cable by Tektronix Part No. 012-0125-00. Contact your local Tektronix Field Engineer or Representative for price and availability of these optional accessories.

To insert the Type S-4 into a compartment of the sampling unit, proceed as follows:

1. Pull the latch knob (Fig. 2-1) outward from the front panel (the latch knob will push out normally when the unit is inserted if the knob is left free to move).

2. Insert the Type S-4 slowly into the compartment, so the two plastic guides in the compartment engage the S-4.

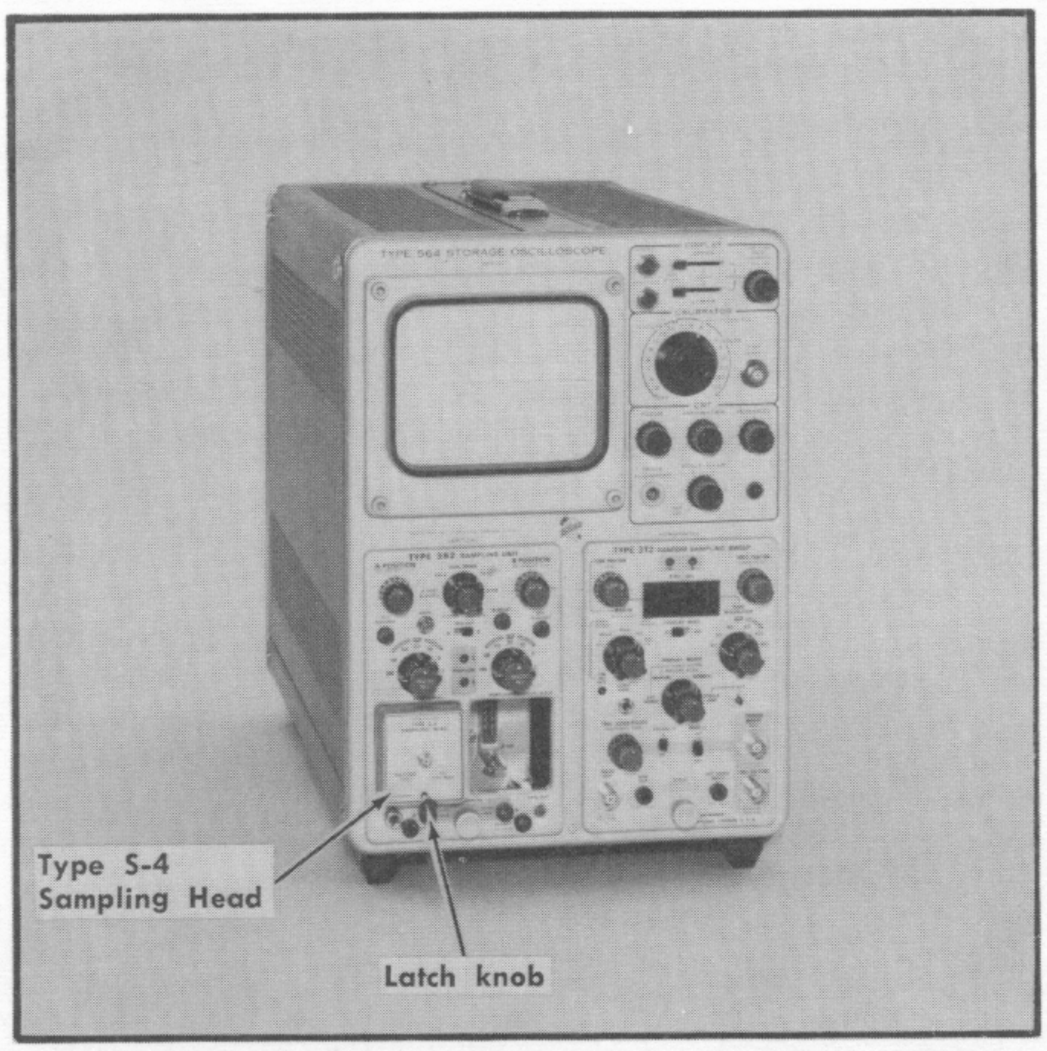


Fig. 2-1. Inserting the Type S-4 Sampling Head in the sampling unit.

3. Push the Type S-4 completely into the compartment.

4. Push the latch knob to lock the Type S-4 in place.

To remove the Type S-4 from the compartment, pull the latch knob away from the front panel, then pull the unit from the compartment.

To use the Type S-4 on an extender cable, install as follows:

1. Pull the latch knob located on the head end of the extender cable outward from the panel (the latch knob will push out normally when the extender is inserted if the knob is free to move).

2. Insert the extender cable head end slowly into the desired compartment in the sampling unit so the two plastic guides in the compartment engage the unit.

3. Push the head completely into the compartment.

4. Push the latch knob to lock the extender cable head end in place.

5. Connect the Type S-4 to the other end of the extender cable in a similar manner, and set the latch knob to hold it in place.

6. To remove the Type S-4 from the extender cable, pull the latch knob on the front panel of the Type S-4, and remove the unit from the extender cable.

7. To remove the extender cable head from the sampling unit compartment, pull the latch knob otuward from the front of the panel, then pull the unit free.

Mating

The vertical deflection factor and the sampling system loop balance (adjusted by the Gate Bal control) should be adjusted when mating a Type S-4 to a sampling unit.

The mVOLTS/DIV label on the Type S-4 names the deflection factor units of the sampling unit Units/Div switch. For example, with the Type S-4 installed in a Type 3S2 and the Units/Div switch set at 100, each major division of CRT deflection corresponds to 100 millivolts of input signal (when the Variable control is in the Cal position). The deflection factor is mated to the indicator oscilloscope CRT by adjusting the sampling unit Gain control. Refer to the sampling unit manual for its Gain adjustment.

The Gate Balance adjustment of the Type S-4 is not greatly affected when the sampling head is changed from one sampling unit to another, or is operated on an extender cable. However, for precise offset measurements, the Gate Balance control must be readjusted whenever such a relocation is made. Location of the control and details of its adjustment are given below under the heading First Time Operation.

FIRST TIME OPERATION

In addition to the Type S-4, this procedure utilizes a Type S-50 Pulse Generator, Type 3S2 Dual-Trace Sampling Unit, Type 3T2 Random Sampling Sweep, and a Type 564 Storage Oscilloscope. See Fig. 2-2. The Type 3T2 Random Sampling Sweep permits viewing the signal in advance of the triggering event. Such sampling sweep trigger lead-time is required when using the Type S-4 with the Type 3S2 for viewing fast pulses without a pretrigger. The built-in pretrigger circuit of the Type S-50 permits sequential sampling units, such as the Type 3T5 or Type 3T6, to operate at their faster sweep rates.

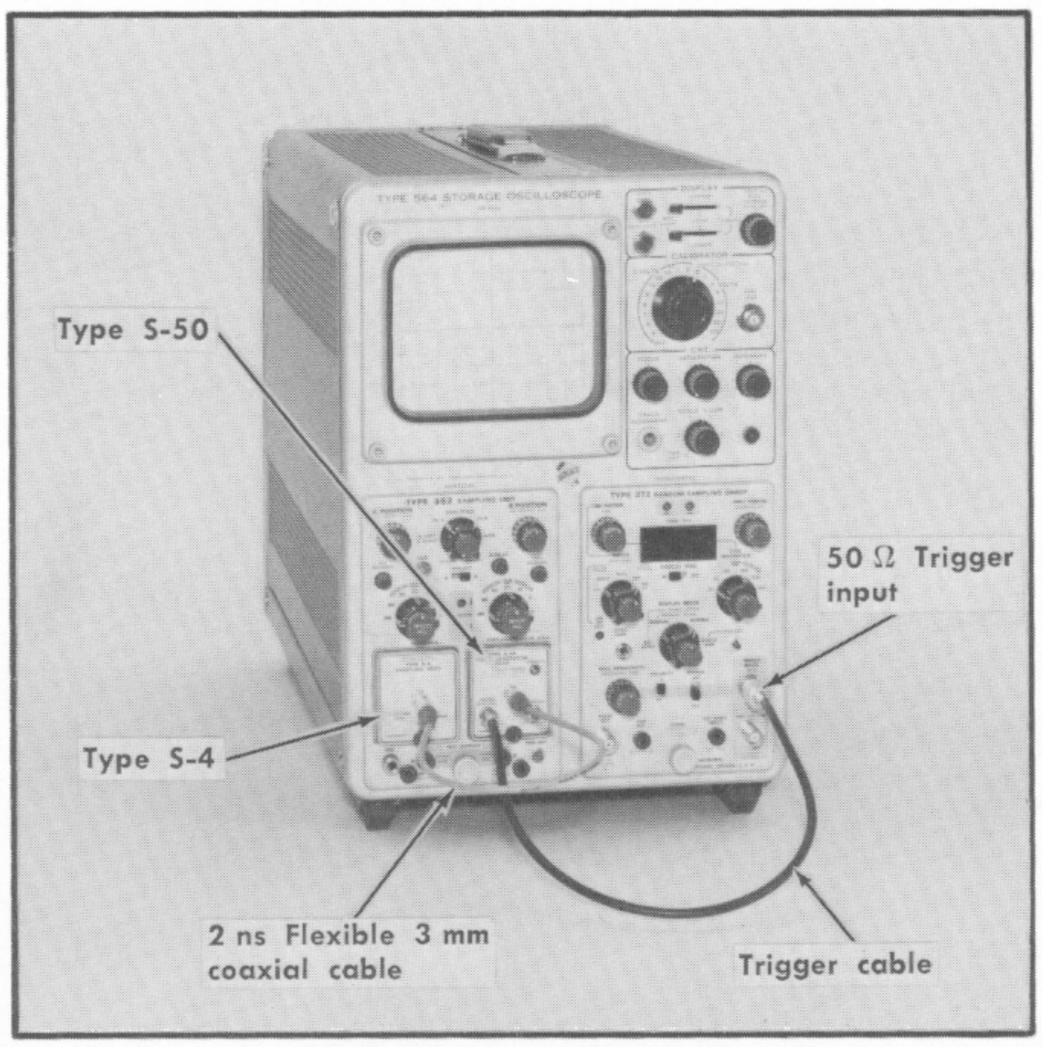


Fig. 2-2. Equipment setup used during First-Time Operation.

Setup Information

1. With the Type 564 Power switch off, insert a Tektronix Type 3S2 Sampling Unit into the vertical channel compartment (left) and a Tektronix Type 3T2 Random Sampling Sweep unit into the horizontal channel compartment.

2. Insert the Type S-4 into the Channel A compartment (left) of the Type 3S2 leaving the latch knob free to move. Once the S-4 is seated, push the latch to lock it in place.

3. Insert the Type S-50 into the Channel B compartment (right) of the Type 3S2 leaving the latch knob free to move. Once the S-50 is seated, push the latch to lock it in place.

4. Connect the Type S-50 output connector to the Type S-4 input connector using a 2 ns section of flexible coaxial line. See cable bending limits discussed under Cable and accessory Considerations later in this section.

NOTE

Connectors at both ends of the coaxial cable should be firmly connected to mating connectors or accessories. Tighten slightly more than finger tight using a $^{5}/_{16}$ inch wrench. A good connection is necessary to minimize reflections at the junction of connectors.

5. Connect Pretrigger Out of the Type S-50 to the 50 Ω Trigger Input of the Type 3T2.

6. Set the Intensity control on the Type 564 fully counterclockwise.

7. Connect the Type 564 to the power line and set the Power switch to On.

8. Allow about 5 minutes warmup so the units reach operating temperature before proceeding.

9. Set instrument controls as follows:

TYPE 3S2

Display Mode	CH A
Normal-Smooth	Normal
Horiz Compatibility Sw.	Sampling
Channel A controls	
Position	Midrange
DC Offset	Midrange (5 turns from one end)
Units/Div	200
Variable	Cal
Invert	Push in
Dot Response	Midrange

TYPE 3T2

Time Position	Midrange
Horiz Position	Midrange
Samples/Div	9 o'clock position
Samples/Div Sw	Variable
Display Mode	Normal
Start Point	Before Trigger
Sweep Rate	100 ns/Div
Range	1 μs
Dsiplay Mag	×1
Time Magnifier	×1
Variable	Cal
Trigger Source	Ext
Trig. Sensitivity	Fully clockwise

TYPE 564

Astigmatism	Midrange
Focus	Midrange
Intensity	Fully counterclockwise
Upper and Lower Screen	Non-Store

10. Advance the Type 564 Intensity control until the trace brilliance (free running sweep) is at the desired viewing level. Adjust Astigmatism and Focus controls.

11. Center the trace on the graticule with the Type 3S2 "A" Position control and/or the DC Offset control.

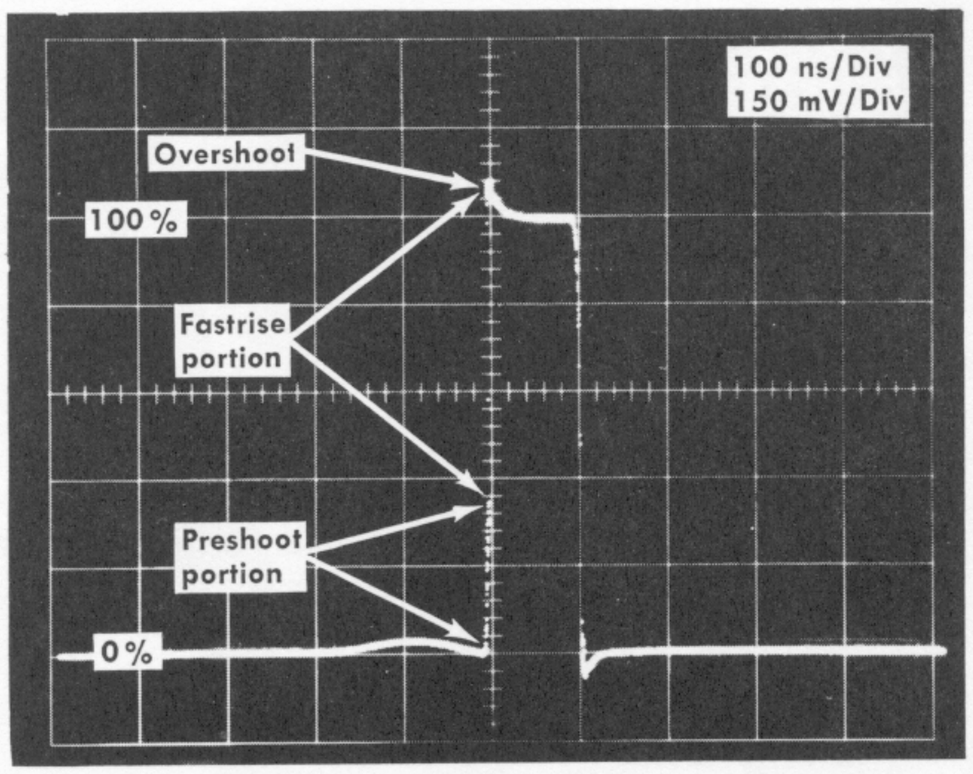
12. Adjust the Type 3T2 Trigger Sensitivity and Time Position controls for a stable triggered display of the Type S-50 output pulse. See Fig. 2-3A (displayed signal amplitude has been adjusted to 5 divisions by turning the Type 3S2 Channel A Variable control).

Display Characteristics of Fastrise Input Pulses

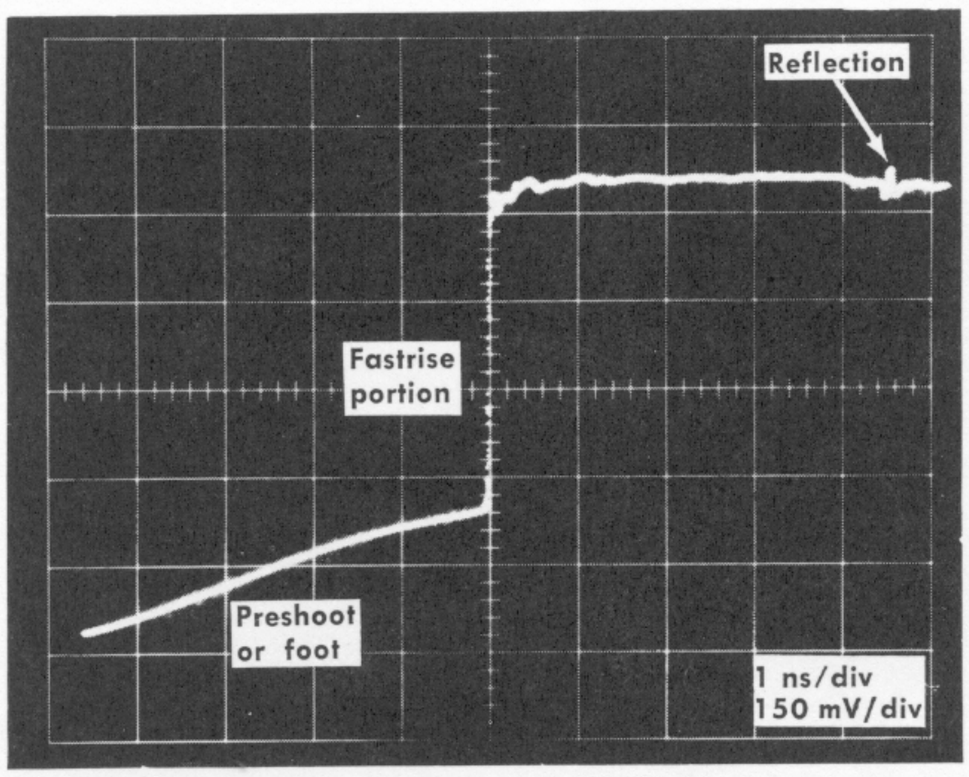
In Fig. 2-3A the displayed pulse shows overshoot at the end of the fastrise portion of the pulse. This overshoot is normal when using the Type S-4 together with a fastrise pulse generator such as the Type S-50. Since the 0% to 100% amplitude of the pulse is 5 divisions, each division represents 20%. In Fig. 2-3A the overshoot appears to have an amplitude of approximately 0.4 divisions or 8%.

The preshoot portion of the Type S-50 output pulse is the relatively slow rise signal driving the Type S-50 output tunnel diode. The fastrise portion occurs as the output tunnel diode switches. Thus, the region labeled as the preshoot portion of the pulse in Fig. 2-3A is apparently much slower than the fastrise portion. The presence of several dots indicates samples taken during the preshoot, and the absence of samples during the fastrise portion indicates the difference in risetime. The appearance of these portions of the Type S-50 output pulse at a faster sweep rate is shown in Fig. 2-3B.

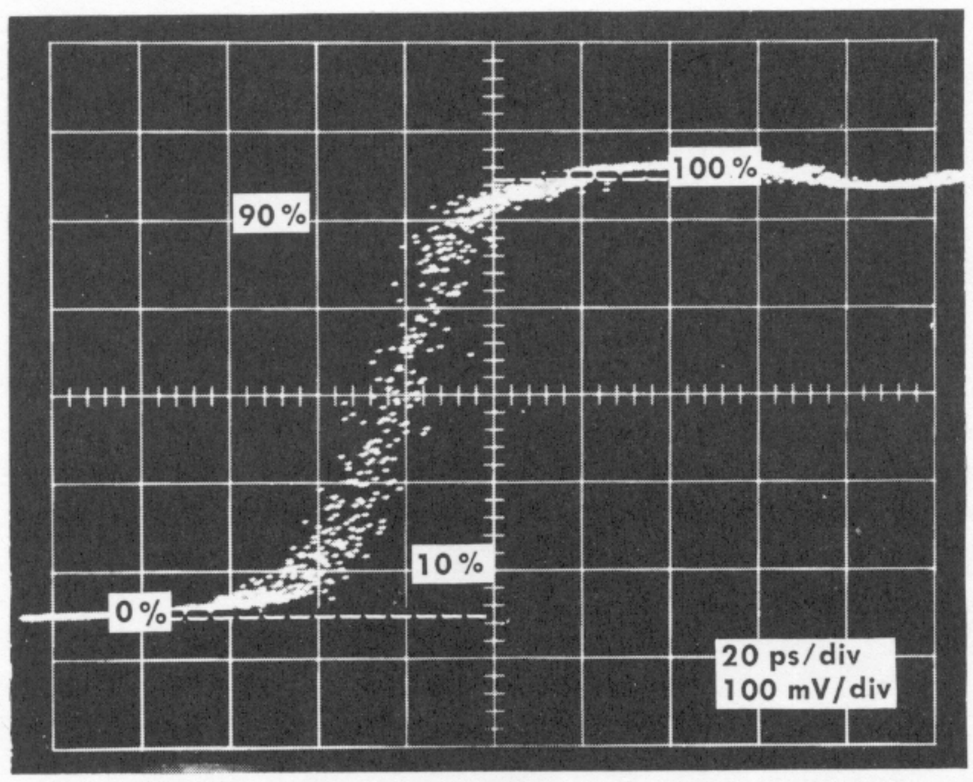
Set Type 3T2 Range switch at 100 ns and Time Magnifier to X10. Set the Type 3T2 Start Point switch to With Trigger. Turn the Type 3T2 Time Position control until a display similar to that of Fig. 2-3B is visible. This waveform shows that after a rather gradual rise requiring about 5 ns (5 divisions)



(A) Overshoot of displayed fastrise signal.



(B) Preshoot and fastrise portions of an input signal.



(C) Determining displayed risetime.

Fig. 2-3. Fastrise pulse displays.

the signal amplitude suddenly increases by approximately 500 mV. The displayed pulse of Fig. 2-3B is typical of the Type S-50 and Type S-4 combination.

In Fig. 2-3B the aberration occurring approximately 4.5 ns after the fastrise portion of the pulse is a result of a reflection at the input gate of the Type S-4. A portion of the fastrise part of the pulse traveling from the Type S-50, through the 2 ns length of coax and through the Type S-4 input connector to the input gate, is reflected back to the Type S-50. This round trip requires approximately 4.5 ns when the Type S-50 and Type S-4 are interconnected with a 2 ns section of coaxial line. Adding a second 2 ns section of line in series with the first would result in the reflection being displayed 4 ns (2 X 2 ns) later, or 8.5 ns after the fastrise portion of the pulse.

Determining Displayed Risetime

1. Set the fastrise portion of the displayed pulse to graticule center, as shown in Fig. 2-3B, using the Time Position control of the Type 3T2.

2. Change the Type 3S2 deflection factor to 100 mV/Div (Variable at CAL).

3. Vertically center the fastrise portion of the displayed pulse using the Type 3S2 Channel A Offset control.

4. Set the Type 3T2 Time Magnifier at X50 and readjust the triggering for minimum jitter using the Type 3T2 Sensitivity control.

5. Set the Type 3T2 Display Mag at X10 and carefully adjust the Time Position control for a display similar to that of Fig. 2-3C.

In order to accurately determine the displayed risetime the display should be photographed or stored (on a Storage Oscilloscope CRT) to permit careful analysis. To store the display, set the Type 3T2 Display Mode to Single Swp., the Type 564 upper and lower screen for storage, and push the Type 3T2 Single Sweep Start pushbutton.

The pulse risetime is found by determining the horizontal distance between the 10% and 90% amplitude points and multiplying this distance by the Time/Div setting of the sampling sweep unit. It is recommended that the 0% to 100% amplitude be adjusted to exactly 5 divisions using the Type 3S2 Variable control, and the display vertically centered using the Type 3S2 DC Offset control. This will position the 0% point 2.5 divisions below graticule center and the 100% point 2.5 divisions above graticule center. The 10% amplitude will then appear 2 divisions below graticule center and the 90% point 2 divisions above graticule center. More information on locating the 0% and the 100% points of the displayed waveform is given later in this section.

Gate Balance Adjustment

The Type S-4 Gate Balance may occasionally require readjustment. The location of the control is shown in Fig. 2-4. Channel A sampling head can be adjusted while on an extender cable or when inserted in the sampling unit. In order to adjust the Gate Balance of a Type S-4 located in the Channel B compartment of the sampling unit, it is necessary to remove the oscilloscope side panel and any sampling head plugged into the Channel A compartment.

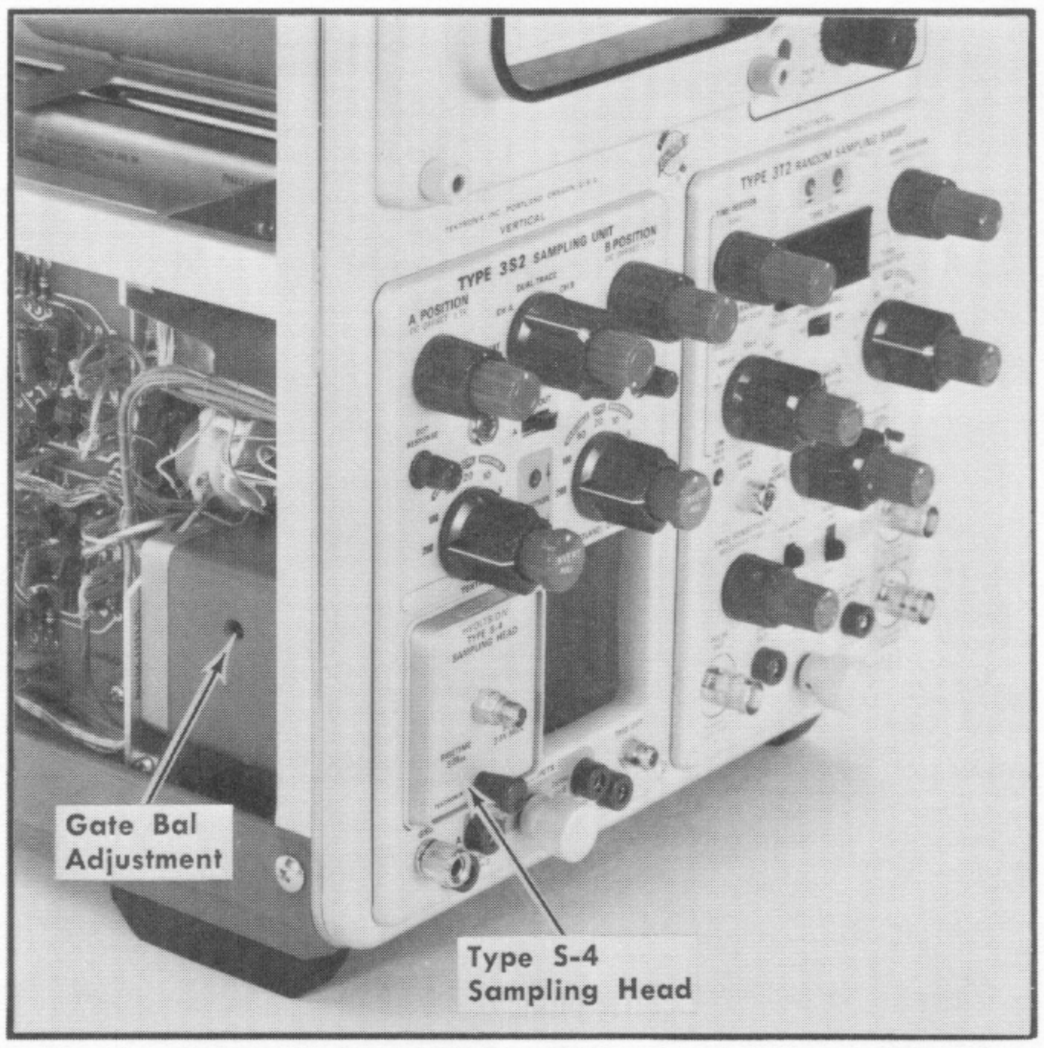


Fig. 2-4. Gate Balance location.

1. Connect a bench multimeter set for approximately 30 V full scale between ground and the Type 3S2 Channel A Offset jack.

2. Adjust the Type 3S2 DC Offset control until the multimeter reads 0 volts.

3. Increase the meter sensitivity and repeat the adjustment for greater accuracy.

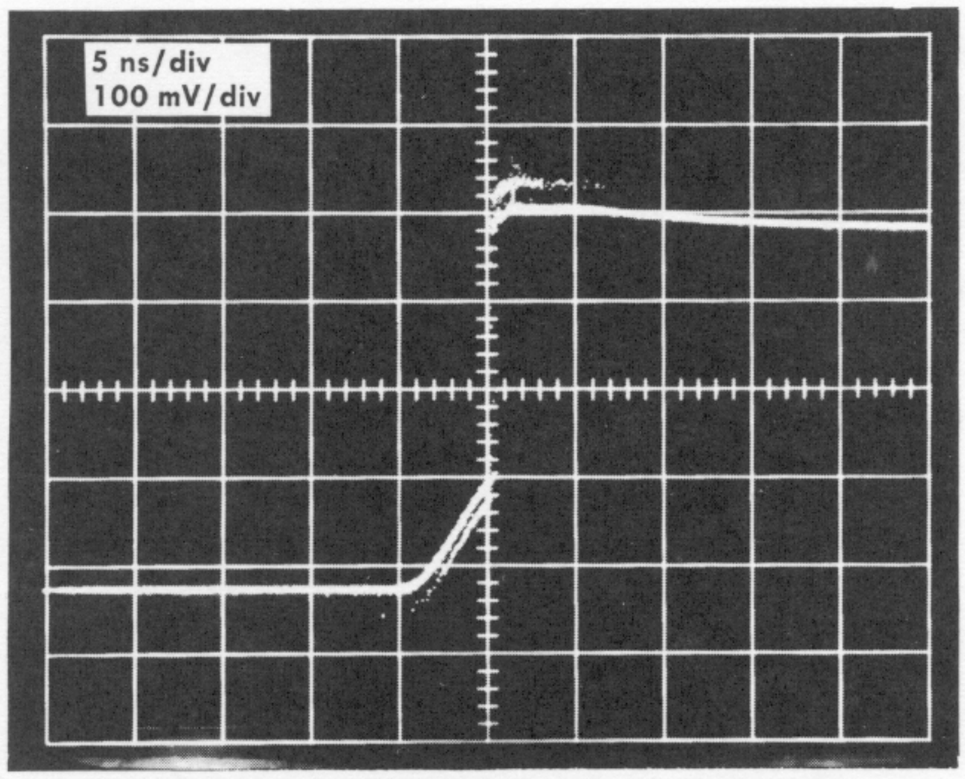
4. Disconnect the semi-rigid cable from the Type S-50, leaving the other end of the cable connected to the Type S-4 input connector.

5. Turn the Type 3T2 Trigger Sensitivity control clockwise to free-run the trace.

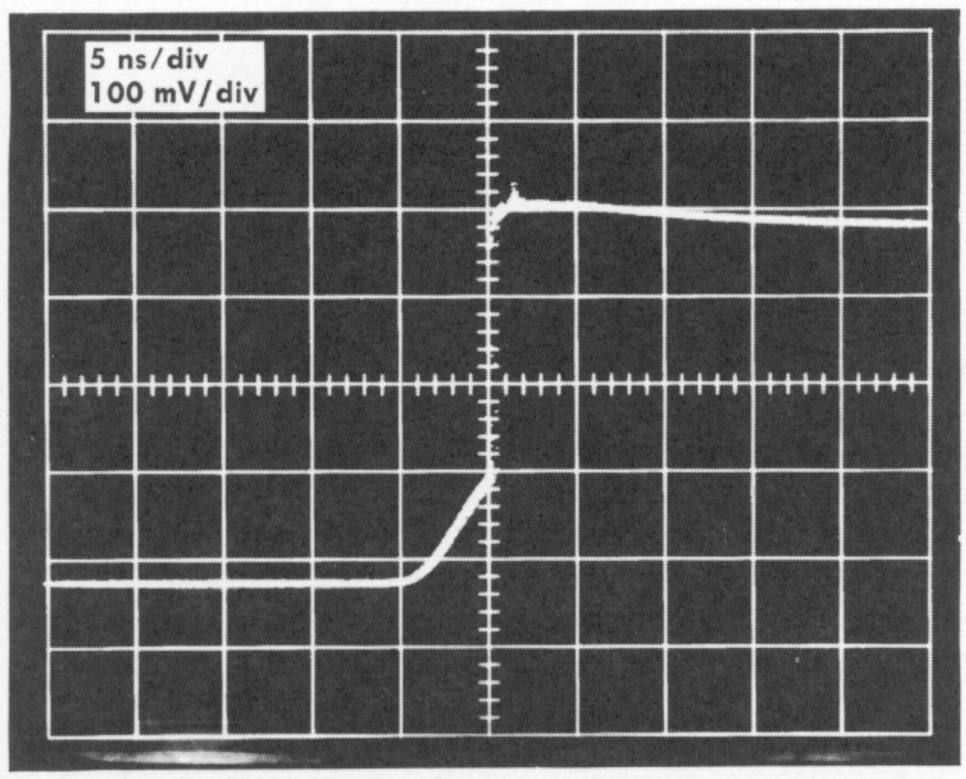
NOTE

Operating the sampling head without the input connector terminated by a 50 Ω resistor or coaxial cable may cause a vertical shift of the zero signal baseline by a few millivolts. This is caused by the strobe kickout signal being reflected from the open input connector, and arriving back at the sampling gate while it is conducting. Because of this, terminate the input circuit when setting the display zero reference point. Also use a 15 cm airline, or a cable providing at least 500 ps of delay, between the Type S-4 input and any tunnel-diode generator or circuit that is sensitive to signals entering its output circuit.

6. Switch the Type 3S2 Units/Div control throughout its range, adjusting the Type S-4 Gate Balance control for a trace shift of not over one division as the Units/Div control is switched from one end to the other.



(A) Dot response set for more than unity loop gain.



(B) Dot response set for unity loop gain.

Fig. 2-5. Typical display changes with dot response adjustment when using random sampling operation.

OPERATING INFORMATION

Dot Response

Dot response of the sampling unit must be adjusted for unity loop gain to minimize waveform distortion and dot splattering. With unity loop gain the system will track the input signal closely.

An example of the appearance of a displayed waveform with the dot response adjusted for a gain greater than unity is shown in Fig. 2-5A. In Fig. 2-5A the Type 3T2 is set for random sampling (Before Trigger) and the Time Magnifier is set at 20. The output signal of the Type S-50 Pulse Generator is being applied to the Type S-4 input through a 2X attenuator. Fig 2-5B shows the effect on the displayed waveform of setting the dot response for a loop gain of unity.

Although proper adjustment of the dot response control is particularly necessary during random sampling, improper adjustment of dot response (loop gain) will also result in a distorted waveform display during sequential sampling. Consult the Basic Sampling Principals and the Operating Instructions Section of your sampling unit instruction manual for further information about dot response and loop gain.

Smoothing

Setting the Normal-Smooth switch of your sampling unit to Smooth will result in a reduction of displayed noise. Since switching to Smooth reduces loop gain to approximately 0.3, transient response problems caused by low loop gain may show up. Smoothing should not be used when the Type 3T2 is used as a random sampler.

A loop gain of less than unity can be useful, if the resulting compromise is understood and the system is operated properly. Random noise in the display is reduced when loop gain is less than unity, since several consecutive samples are averaged. The averaging may also slow down the fastest risetime capability, depending upon the number of dots contained in the step transition. By increasing the number of dots (Samples/Sweep or Samples/Div) in a step transition, the display will follow the actual step transition more closely. If the number of samples (dots) in the step transition is reduced below 12 the true waveshape may not be displayed in Smooth.

Effect of Excessive Input Voltage

A maximum operating signal voltage of 1 volt (peak-to-peak) is specified for the Type S-4 in Section 1 of this manual. Signals having an amplitude of more than 1 volt (P-P) at the Type S-4 input may be distorted by the sampling head. Large signals must be reduced in amplitude to not more than 1 volt (P-P) at the Type S-4 input.

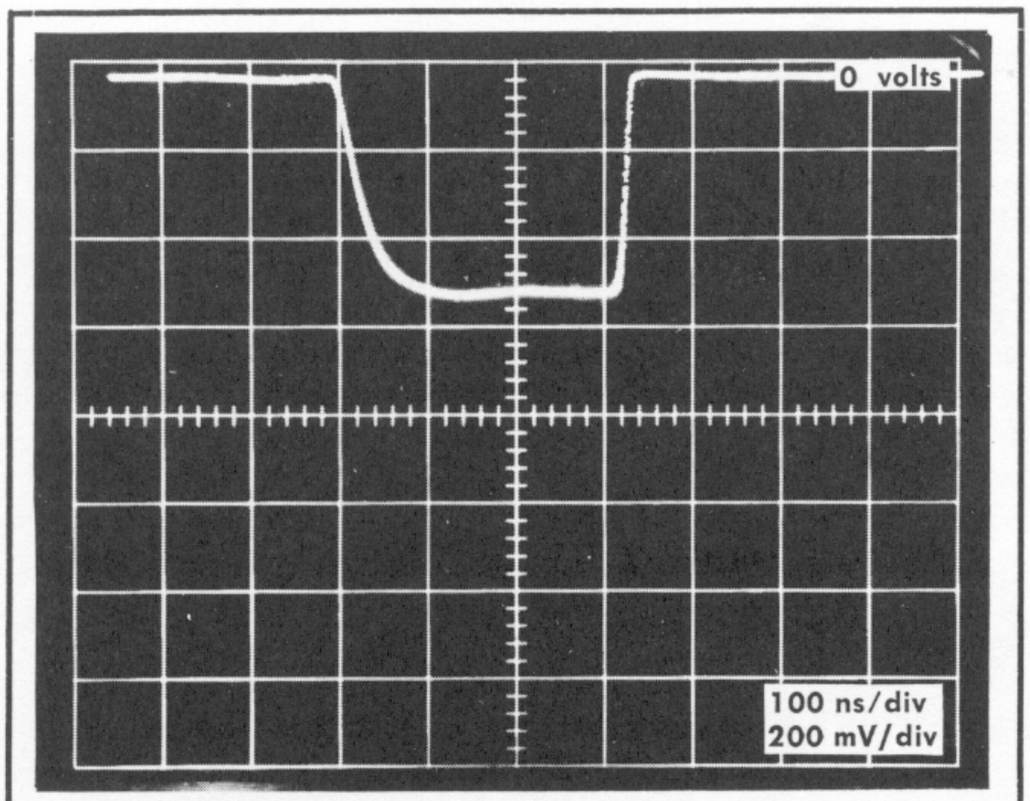
A 15 volt (P-P) signal can be reduced to a suitable amplitude at the Type S-4 input by inserting a series combination of 10X and 2X attenuators in the coaxial line delivering the signal. A series combination of 10X and 5X attenuators would also be satisfactory.

Displayed waveforms with several values of signal voltage applied to the Type S-4 input are shown in Fig. 2-6. Fig. 2-6A shows the displayed waveform with an input signal of 0.5 volt (P-P). In Fig. 2-6B the input signal has been increased to 0.9 volt. Fig. 2-6C shows the distorted display resulting from applying a signal of 1.1 volts (P-P) to the Type S-4 input.

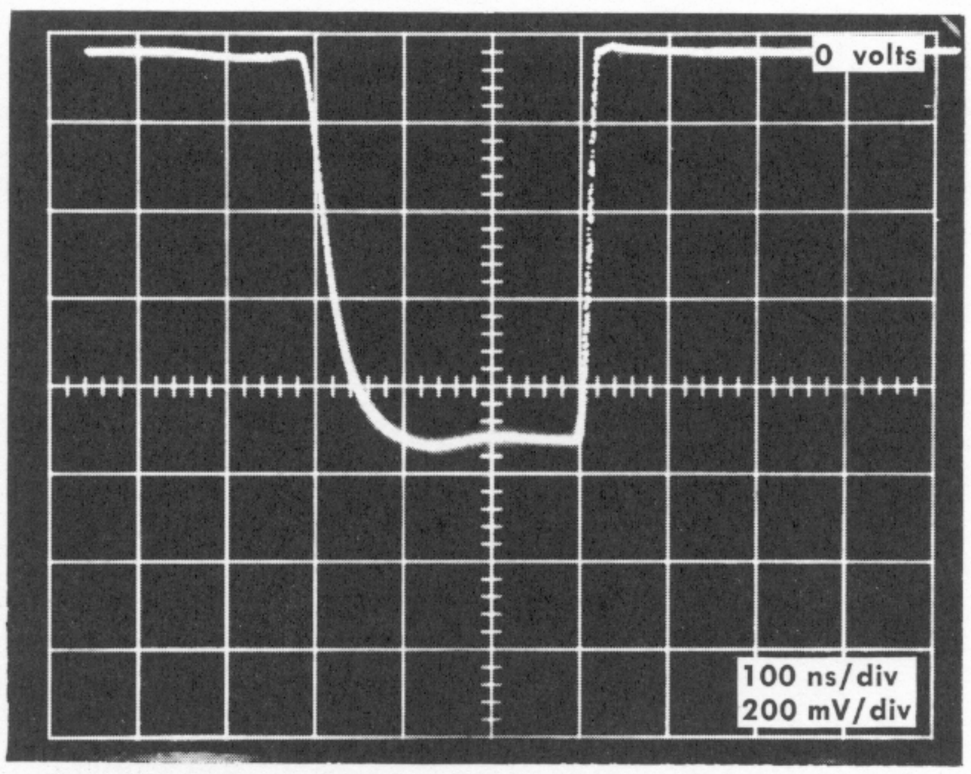
See the discussion on Sine Wave Signal Measurements later in this section for information on signal amplitude affect upon display amplitude accuracy.

Risetime Measurements

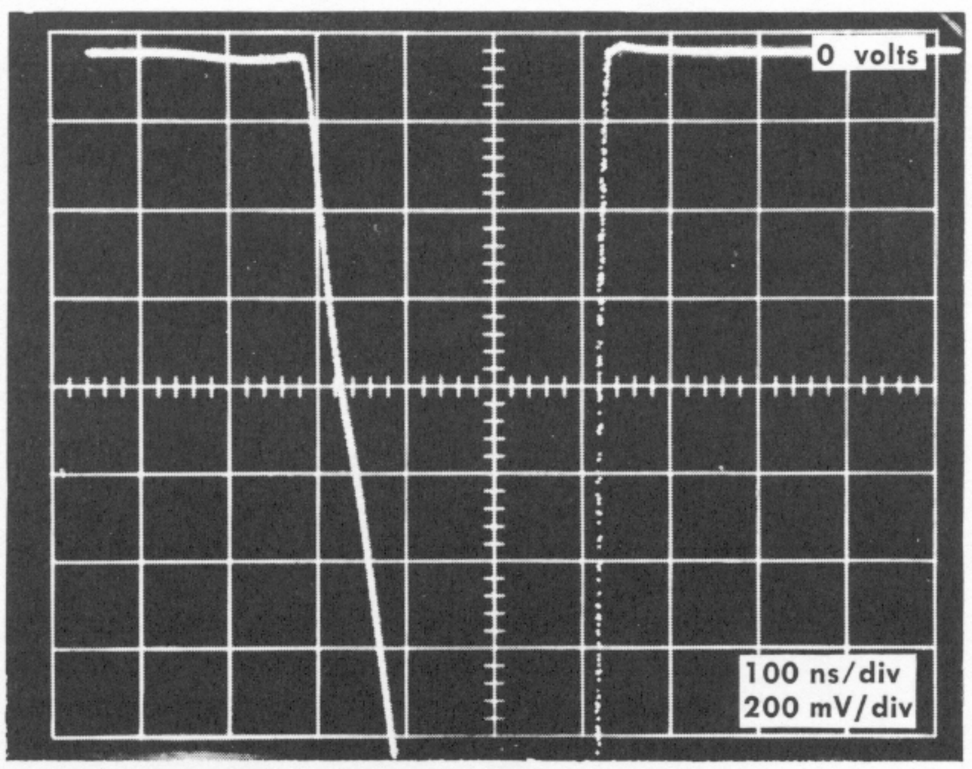
Accurately determining risetime from an observed display requires that the position of the 10% and 90% points be accurately known and that the horizontal distance between these points be accurately measured. The timing accuracy of the sampling sweep unit must also be known. Switching the sampling sweep unit from one oscilloscope to another requires readjustment of the horizontal gain control on the sampling sweep front panel. See your sampling sweep unit



(A) —500 mV input signal.



(B) —900 mV input signal



(C) —1.1 V input signal

Fig. 2-6. Effect of input signal amplitude on display amplitude.

instruction manual for timing accuracy specifications and complete instructions for checking timing.

During First Time Operation earlier in this section a storage oscilloscope was used to display risetime. Ability to store a display is an advantage when determining risetime from the CRT display, especially when using a high dot density and a low signal repetition rate. An alternate method of determining risetime when a storage oscilloscope is not available and the display rate is slow is to photograph the display.

0% and 100% Levels with the Type S-4/S-50 Combination

When using the Type S-4/S-50 combination a special technique is used in locating the 0% and 100% amplitude levels of the displayed waveform. In Fig. 2-7 two reference position are shown. Reference point 1 is at the corner preceeding the fastrise portion of the display. Reference point 2 is at the corner following the fastrise portion of the display. Both reference points are located where the rate of change of slope is maximum (where the radius of curvature is least). The 0% zone is centered 35 ps before the first reference point and the 100% zone is centered 35 ps after the second reference point. Each zone is 35 ps in width. The 0% and 100% levels are the average amplitude of the zones.

Follow the procedure below in determining the displayed risetime:

1. Locate reference point 1 and 0% zone.

2. Locate reference point 2 and the 100% zone.

3. Using the sampling unit DC Offset and Variable controls, set the 0% level 2.5 divisions below graticule center and the 100% level 2.5 divisions above graticule center. Remember the level is the average value within the zone.

4. Locate the 10% point on the fastrise portion of the displayed waveform (the point where the trace crosses the horizontal graticule line located two divisions below the graticule center).

5. Locate the 90% point on the fastrise portion of the displayed waveform (the point where the trace crosses the the horizontal gratucule located two divisions above graticule center).

6. Multiply the horizontal separation, in divisions, between the 10% and 90% points by the Time/Div setting of the sampling sweep unit to determine the displayed risetime. The specified combined risetime of the Type S-4/S-50 combination is 35 ps.

Displayed Risetime and Actual Risetime

Differences in displayed and actual signal risetime will result unless the risetime of the sampling system is about four times faster than the risetime of the signal to be measured. As used in this discussion, the sampling system is considered to be made up of the sampling head and any coaxial line, connectors or accessories between the signal source (the Type S-50) and the sampling head. Displayed risetime is dependent upon the risetime of the sampling head, the risetime of the pulse generator, and the risetime of the cable and connecting components between the gener-

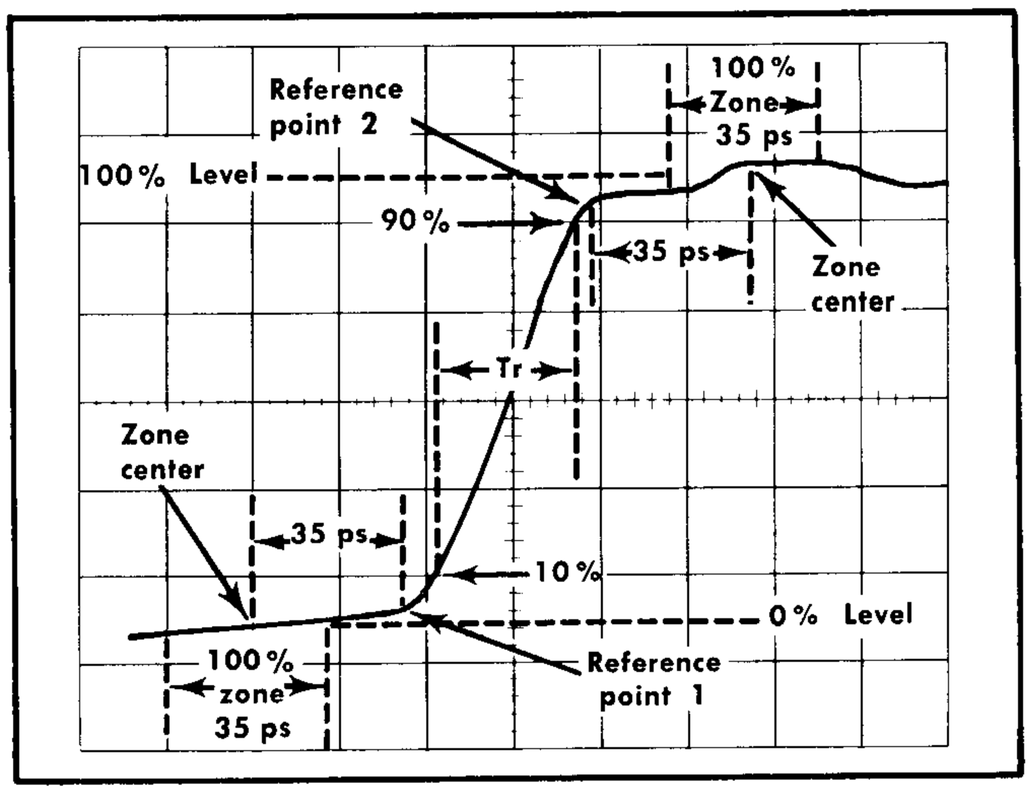


Fig. 2-7. Special S-4/S-50 system risetime measurement technique.

ator and sampling head. With signals as fast as about 100 ps arriving at the Type S-4 input, the displayed risetime will be very close to the actual signal risetime.

Since the risetime of the Type S-50 Pulse Generator output signal is much faster than 100 ps, the displayed risetime (with this pulse applied to the Type S-4 input) will not be the actual signal risetime.

The risetime of signals that are faster than 100 ps can still be determined using the Tektronix Type S-4 Sampling Head. However, the signal risetime is calculated using formula (2-2) below. Signal risetime calculated using formula (2-2) will provide a close approximation of the actual signal risetime.

The relationship between displayed risetime, signal risetime, signal path risetime, and sampling head risetime is shown by formula (2-1) below. What was referred to as system risetime has been broken down into T_r of signal path, and T_r of Type S-4 in formula (2-1). T_r of signal path includes the combined risetime of all coaxial cables, connectors, or accessories between the signal source and the Type S-4 input. If the signal path consists of a coaxial cable having a risetime of 8 ps and connectors and accessories having a risetime of 6 ps, the combined signal path risetime is

$$(8)^2 + (6)^2 \approx 10 \text{ ps.}$$

$$T_r \text{ (displayed)} \approx \sqrt{(T_r \text{ signal})^2 + (T_r \text{ of sig. path})^2 + (T_r \text{ of Type S-4})^2} \quad (2\text{-}1)$$

For example, assuming an input signal having a risetime of 25 ps; connecting cable, accessories, an dconnectors having a risetime of 10 ps; and a sampling head with a risetime of 25 ps gives:

$$T_r \text{ (displayed)} \approx \sqrt{(25)^2 + (10)^2 + (25)^2}$$

$$T_r \text{ (displayed)} \approx \sqrt{625 + 100 + 625}$$

$$T_r \text{ (displayed)} \approx 37 \text{ ps}$$

Transposing formula 2-1 to permit calculation of signal risetime when the dispalyed risetime, signal path risetime, and sampling head risetime is known gives:

$$T_r \text{ (signal)} \approx \sqrt{(T_r \text{ displayed})^2 - (T_r \text{ of Type S-4})^2 - (T_r \text{ of sig. path})^2} \quad (2\text{-}2)$$

Additional information concerning the effect of connecting cables on the displayed signal risetime may be found under Cable and Accessory Considerations later in this section.

Sine Wave Signal Measurements

The parameters of the Type S-4 are specified using pulse or time domain parameters and nomenclature. The frequency response characteristics of the unit, while not specified, are such that it may be used for relative sine wave measurements through its calculated upper 3 dB rolloff point of 14 GHz.

Because of the traveling wave gate used in the Type S-4, it is capable of handling very large signals as compared to other microwave samplers. Even so, the peak to peak signal amplitude should be held to as low a level as possible consistent with good signal to noise ratio when making checks in the 5 to 15 GHz region to avoid compression effects.

Cable and Accessory Considerations

When connecting a signal to the Type S-4 it is important that the signal coupling cable, connectors, attenuators and any other devices between the signal source and sampling head have the correct characteristic impedance, be capable of handling the signal frequency without causing excessive loss or distortion, and be of high quality. Care must be taken to firmly tighten all connectors, or unwanted reflections may result.

Accurate displays of signals containing very fast transitions or very high frequencies are possible only if the cables carrying the signal to the sampling head do not distort the signal. The Type S-4 input resistance is 50 Ω and requires the use of high quality, low loss, 50 Ω coaxial cables and attenuators between the signal source and the sampling head input connector. Using an adapter to change from 3 mm to a larger diamter coaxial cable will resutl in a loss of system bandwidth.

The Type S-4 sampling head is useful from DC up to at least 14 GHz. Standard and optional 3 mm accessories available from Tektronix are intended for use at frequencies to 18 GHz and are generally useful at frequencies to 25 GHz. Since any accessories in the path between the signal source and the Type S-4 input will increase the displayed signal risetime, use only high quality accessories of adequate high frequency capability. Accessories (3mm) supplied with the Type S-4, or available as optional equipment, include flexible and semi-rigid coaxial cable, attenuators, adapters to change from 3 mm to larger size coaxial cable, and a power divider. See your Tektronix Field Engineer or Representative for price and availability of optional accessories.

The physical and electrical characteristics of the cable determine the characteristic impedance, velocity of propagation and nature of signal losses.

It is important to use cables or airlines, in the signal-handling side of the system, that are as short as possible. Use of the optional 3 foot or 6 foot head extender cable perits locating the Type S-4 near the signal source and thereby keeps the input coaxial cable short and signal losses to a minimum. Signal losses along a coaxial line, due to skin effect or dielectric loss, result in a loss of high-frequency signal amplitude as the signal travels along the line. Dielectric loss along the coaxial line also results in an increase in the displayed risetime of fast step pulses. Dielectric and skin effect losses increase with signal frequency and the length of the coaxial cable. Fig. 3-8A shows the displayed waveform when the 25 ps output pulse of the Type S-50 is fed to the Type S-4 input through a semi-rigid 3 mm coaxial line available as an optional accessory. In Fig. 2-8B the 25 ps pulse is fed to the S-4 input through a 5 ns length of flexible 3 mm coaxial cable, Tektronix Part No. 015-1005-00. Fig. 2-8C shows the risetime of the displayed signal when the same 25 ps pulse is sent through a 5 ns length of good quality coaxial cable similar to Type RG-58/U. The importance of using a short length of the proper type coaxial between the signal source and the Type S-4 input is apparent from comparison of the waveforms of Fig. 2-8.

Another factor that can result in loss of signal in a coaxial cable is use of coaxial cable having a diameter that is large compared to the wavelength of the highest frequency components of the signal. The Type S-4 input connector is intended for use with Teflon dielectric coaxial cable having an outer conductor with an outside diameter of 0.141 inches.

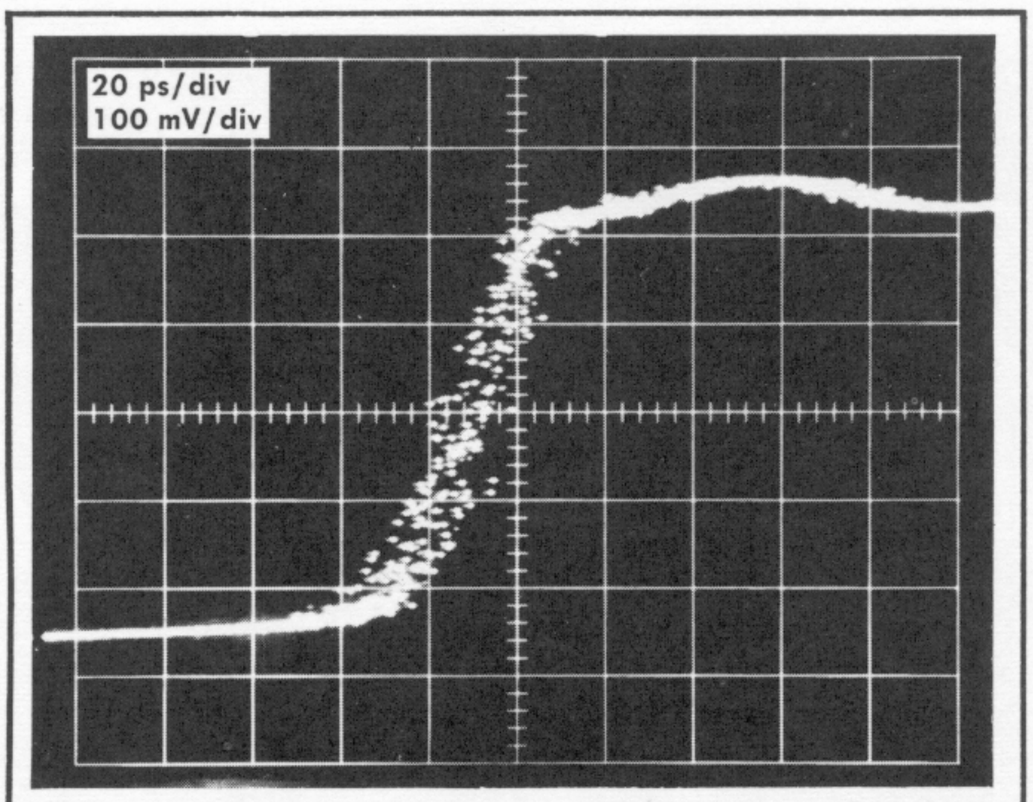
Resistive losses in large diameter coaxial cable is less than in smaller diameter cable for frequencies below the critical value.

CAUTION

The two lines listed under part numbers 015-1015-00 and 015-1005-00 must be treated with care to obtain maximum life and least signal distortion. The semirigid line may have its shape changed just twice in its lifetime, providing the minimum bend radius is no less than 10 times its OD, or approximately 1½ inches. The flexible (2 ns delay) cable must not be given a bend radius less than 10 times its OD, or approximately 2¼ inches. (The same applies to a 5 ns signal delay flexible cable, Tektronix Part No. 015-1006-00.) The two flexible cables may have their outer conductor damaged by tighter bending. Few flexures assure longer life.

Use of Probes

A Tektronix P6034 or P6035 probe may be used with the Type S-4 Sampling Head. Connecting either of these probes to the Type S-4 input requires using a GR to 3 mm adapter. It should be kept in mind that the high frequency capability of the Type S-4 will be limited to that of the probe.



(A) 500 ps length of 3 mm semi-rigid coaxial cable.

(B) 5 ns length of 3 mm flexible cable.

(C) 5 ns length of cable similar to RG 58/U.

Fig. 2-8. Effect of cable length, diameter, and quality on displayed risetime.

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

General

This section of the manual contains a block diagram description of the Type S-4 Sampling Head followed by a detailed circuit description. Read the section on Basic Tektronix Sampling Principles, located in the associated sampling unit manual, if the function of a particular Type S-4 circuit is not clear. Both the block and schematic diagrams are located at the rear of this manual.

The Type S-4 is the signal input section of a sampling system, and determines the vertical channel input characteristics. The special traveling-wave gate at the input differs from the sampling bridge described in the Basic Sampling Principles section of the sampling unit manual.

BLOCK DIAGRAM

Both the Block Diagram and the circuit schematic show the Type S-4 circuits outlined by dashes, indicating the individual circuit boards within the unit. One circuit board is devoted to the generation of the sampling gate strobe pulses, one to the sampling gate, one to the blow-by and trigger pickoff amplifier and one to the preamplifier.

Strobe Generator

The Strobe Generator develops heavy-current (several mA), short-duration, push-pull pulses that drive the Sampling Gate into balanced conduction. Output occurs at the time of each sample when a command pulse arrives from the Strobe Driver circuit of the associated sampling unit. The pulse lasts for a period of about 125 ps, turning on the Sampling Gate diodes. At the end of the pulse, the diodes turn off very quickly, retaining a portion of the input signal. Strobe pulse duration and fall time are fixed by the Snap-Off diode D61, and the two clipping lines. The Strobe Generator parts layout and circuit board construction are carefully controlled during manufacture to ensure proper strobe pulses being sent to the Sampling Gate.

Sampling Gate

The Sampling Gate (called the Sampling Bridge in other Tektronix sampling circuitry) connects the input signal to the Preamplifier only during the short time when each sample is taken. The six diodes, D2A through D2F, form what is technically termed a traveling wave gate. It is the way the end of the Strobe Drive pulse travels through the gate that determines the step response of the sampler. In other Tektronix sampling bridges, the step response risetime is controlled by the strobe pulse duration. In the Type S-4, the step response risetime is controlled instead by the length of time it takes the strobe pulse end to travel through part of the Sampling Gate.

At the end of each Strobe pulse, part of the input signal is stored temporarily between Sampling Gate diodes and is then fed to the Preamplifier input at a rate much slower than the step response risetime. It is only the special traveling wave gate that has its electrical environment controlled for minimum reflections of fast pulse signals. All circuit parts that pass the sampled error signal (see the sampling unit manual section on Basic Sampling Principles for definition of error signal) to the Preamplifier handle only moderate rate-of-rise signals. A special 10 X (20 db) 50 Ω attenuator helps serve as a high-quality, high-frequency termination to the input connector and the 50 Ω environment of the traveling wave gate.

Part of the input signal is continuously passed to the Trigger Amplifier Board and the Blow-by compensating and Trigger Pickoff circuit. The signal passes through the 10 X attenuator directly to the Trigger Amplifier Board and is terminated in 50 ohms there.

Gate Bias

Reverse bias is applied to the Sampling Gate diodes by the Gate Bias circuit. The average voltage of the gate bias is controlled by the Gate Balance circuit and the associated sampling unit DC Offset and Feedback signals. The Sampling Gate output is DC coupled to the Preamplifier input through a portion of the Gate Bias circuit.

Blow-by and Trigger Pickoff

The primary function of the Blow-by and Trigger Pickoff circuit is to cancel capacitively-coupled unwanted signals that normally bypass the Sampling Gate. These unwanted signals are called "blow-by" signals.

The Type S-4 special traveling wave Sampling Gate contains two blow-by reducing diodes that minimize the capacitively-coupled unwanted signals. The special Sampling Gate construction and the blow-by circuit cancel essentially all of the unwanted signals that would otherwise distort the oscilloscope sampling display.

The Blow-by and Trigger Pickoff circuit receives an attenuated portion of the input signal and terminates the 10 X attenuator that is located between the Sampling Gate and the Trigger Amplifier Board. The circuit amplifies and inverts the signal and applies it, as a blow-by correction signal, through a small capacitor to the output side of the Sampling Gate blow-by limiting diodes. Magnitude of the blow-by correction signal is adjusted during calibration by the Transient Response control.

The trigger pickoff function of the Blow-by and Trigger circuit provides an in-phase signal source for internally triggering the sampling sweep unit. Not all channels of all sampling units (in which the S-4 operates) couple the trigger pickoff signal to the sampling sweep unit. If the signal is not used, the sampling unit terminates the output in 50 Ω, allowing the circuit to remain functional for blow-by correction.

Preamplifier

The Preamplifier circuit both amplifies and time-stretches the signal it receives from the Sampling Gate. The signal received is a portion of the difference between the Feedback combined with the DC Offset voltage and the input signal. This "error signal" is amplified and AC coupled to the Post Amplifier in the sampling unit. The Preamplifier gain is adjustable to aid in setting the overall sampling head and sampling unit "loop" gain to unity for proper dot response.

CIRCUIT DESCRIPTION

Refer to the main schematic diagram during the following descriptions. The Type S-4 Sampling Head uses the power supplies of the indicator oscilloscope and associated sampling unit. Interconnections to the sampling unit circuits are by two connectors at the sampling head rear. The following description includes references to circuits in the sampling unit and sampling sweep unit, all units forming one sampling system. Reference to diagrams and circuit descriptions in the instruction manuals for the other sampling units will help in gaining a full understanding of the circuit relationships.

Strobe Generator

The Strobe Generator circuits are all located on the (right side) Strobe circuit board. The generator contains two basic circuits, an Avalanche circuit that delivers fast push-pull pulses, and the Snap-off diode and clipping lines circuit. Both circuits work together to produce the push-pull strobe pulses that drive the special traveling-wave Sampling Gate through two equal transmission lines. Both sets of circuitry are physically arranged over separate ground planes that are identified on the main schematic diagram. The two ground planes are connected together by R52 and R54, to damp out ringing between the two circuit areas at sample time.

The Avalanche Circuit converts the Strobe Drive pulses from the sampling unit to very fast push-pull pulses that drive the Snap-off diode to non-conduction.

The Strobe Drive pulse is transformer-coupled by T75 to the base and emitter of Avalanche transistor Q69. Two outputs are AC-coupled from Q69, one from the collector and the other from the emitter. The Avalanche Volts control adjusts the collector voltage of avalanche transistor Q69. The typical quiescent voltage at Q69 collector is about +15 volts. This voltage sets the amplitude of the signals that drive the Snap-off diode circuit and assures the normal avalanche action of Q69 when driven by the Strobe Drive signal. Before Avalanche conduction, there is a potential of about 60 volts between Q69 collector and emitter.

The negative Strobe Drive pulse is transformed into a hard forward bias signal to Q69. Normal avalanche action follows with the collector going negative and the emitter going positive. This fast-rise, push-pull signal is capacitively coupled to the Snap-off circuit.

The Snap-off Circuit operates as a current switching circuit to apply some of the push-pull Avalanche current signal at snap-off time to the Sampling Gate. The circuit consists of a Snap-off Current control R57, Q55, Snap-off diode D61, two clipping lines and associated components. Between drive pulses from the Avalanche circuit, the Snap-off diode D61 is forward-biased by the current in Q55. The current value is set by the Snap-off Current control R57. The current in D61 is typically 20 mA. This forward current assures that D61 has many carriers within its junction region.

The push-pull signals from the Avalanche circuit cause D61 junction carriers to reverse direction as a heavy reverse current. This heavy reverse current stops suddenly as all the carriers clean out of the junction. As the reverse current "snaps" to a stop, the push-pull avalanche signals are suddenly coupled into the clipping lines by C52 and C54 and toward the Sampling Gate by R51-C51 and R53-C53. The fast-rise step which appears at each clipping line input is propagated down the line. About 50 ps later the steps reach the short circuited ends of each clipping line. The step is then reflected, equal in amplitude and opposite in polarity, back to the input end of each clipping line. This cancels the signals moving toward the Sampling Gate. This action results in a positive Strobe pulse being delivered to P53, and a negative Strobe pulse being delivered to P51.

The clipping lines have a surge impedance of approximately 10 Ω with a very good short circuit at the shorted ends. The high quality of the short, and the line low impedance causes the reflected signal to stop the Strobe pulses very rapidly. Such rapid ending of the Strobe pulse and the characteristics of the traveling wave Sampling Gate causes each sampling diode to turn off in approximately 10 ps. The fast diode turn-off is discussed below in the Sampling Gate description.

Ringing of the Snap-off diode and the clipping lines is very rapidly. Such rapid ending of the Strobe pulse and the the lines ends. Ringing is also limited to some degree by the two equal resistors R60 and R62 that are in DC series connection with the Snap-off diode D61. The primary function of R60-R62, however, is to provide a DC path for D61 forward conduction while at the same time allowing the Avalanche signals to pass on into the clipping lines and Sampling Gate. As the Avalanche pulses end and as both the Avalanche and Snap-off circuits recover for another sample, R60-R62 re-establish the correct quiescent charges on C63 and C64. C59 assures a very low impedance AC path for the ground side of R60 so that R60 and R62 will both have the same affect upon the circuit.

Another technique for minimizing Strobe ringing is that of R51 and R53 being in series with the output lines to the Sampling Gate. The output connectors that connect the Strobe board to the Sampler board have a 50 Ω characteristic impedance. R51 and R53 raise the Clipping lines 10 Ω impedance drive to 50 Ω to properly match the connections. Thus, at the end of the Strobe pulse, reflections back from the Sampling Gate are reverse terminated. These resistors and the resistors discussed in the preceeding paragraph all

assure that there is no possibility of double strobing of the Sampling Gate due to ringing of the Strobe Generator circuits.

Two separate ground planes are identified on the main schematic diagram between the Avalanche and Snap-off circuits. Two resistors connect the two ground plane ends together to damp any natural ringing when the case is off. Ringing can occur without R52 and R54 because the two ground planes are connected together at the instrument front and rear through the Sampler board. Rake-type ground symbols (USA Standard ASA Y 32.2, 1967) on the diagram identify chassis ground return circuits connected to the front panel or case. Triangle-type ground symbols are used throughout the Sampling Gate area, Strobe Generator and Trigger board areas to indicate these circuits all share a common grounding system with the signal input connector, J1. Component layout is organized so the strobe signal ground currents balance to zero at the center of the Sampling Gate, and thus do not contribute unwanted currents to the input signal. Q69 circuit is capacitively isolated from both ground planes as much as possible, with its primary signal output path being through C63-C64 and C52-C54. There is a small third terminal capacitance to ground between the two windings of T75, but it is not large enough to disturb the balanced drive from Q69 to D61.

Sampling Gate and Gate Bias Circuits

The Sampling Gate consists of six series diodes, D2 A through F, and four resistors all mounted on a ceramic substrate inside the input circuit holder. See Fig. 3-1 during the following dicussion.

The signal that arrives at J1 travels right on through the Sampling Gate area to a 3 mm 50 Ω 10X (20 db) attenuator. Ouput of the attenuator feeds the Trigger and Blow-by Compensation circuit where it is terminated in 50 Ω. When not being strobed, D2C and D2D present a very small value of capacitance to the input signal. When the diodes conduct due to Strobe current, the input line is coupled to the traveling wave gate.

Gate Biasing

Quiescent condition of the Sampling Gate diodes is controlled by the Gate Bias circuit. D2A, D2B, D2E and D2F are each reverse biased about 0.5 volts by D20, D23, D25 and D28. D2C and D2D are reverse biased about 1.2 volts each, a total of about 2.45 V is developed across the parallel combination of R24-C25 of the Gate Bias circuit. The Gate Bias circuit receives its current from the two 50-V supplies and R30-R31-R32-R33 and R34 of the Gate Balance control circuit. The diodes of the Gate Bias circuit are used as 0.5-volt Zener diodes. R2A-R2F with C24 and R2B-R2E with C25 isolate the traveling wave gate segments from the Preamp and Bias circuits R21-R26 conduct DC bias potentials to the gate but allow a sampled error signal to drive C24 and the Preamplifier input.

Except for the very short strobed conduction time (about 125 ps), the Sampling Gate diodes do not conduct. A portion of the input signal is coupled through stray capacitances to the Preamplifier input, and disturbs the normal sampling display. This effect is known as "blow-by".

Blow-by Correction

The basic risetime of the traveling wave Sampling Gate is 25 ps. In this extremely short interval of time, only a very small amount of charge can be collected in one sample. What small charge is collected, is called the error signal and is amplified by the Preamplifier and the sampling unit circuits. The Preamplifier has a shaped frequency response best suited to amplifying each samples small charge and delivering a proper error signal to the sampling unit.

It is impossible to build a sampling gate without a path for blow-by displacement currents that cause the Preamplifier to respond to a part of some input signals and thus distort the display. The Type S-4 Preamplifier responds to signals in the 0.5 to 3 MHz bandpass region. Signals much higher or lower in frequency are not amplified. Those blow-by signals in the Preamplifier bandpass region that do get through the Sampling Gate are virtually eliminated by the Blow-By correction amplifier Q10. The traveling wave gate is constructed by double differentiate signals in the Preamplifier response domain while not affecting the small sampled charge quantities obtained during each sample interval.

Blow-by rejection in the Sampling Gate is assured by the double differentiation networks that have very fast RC times. They are located between the signal input and the Preamplifier. The first differentiation network is formed by reverse biased diodes D2C and D2D and their respective resistors to ground (see Fig. 3-1), R2B and R2E. The second network is formed by diodes and resistors D2B, D2E and R21, R26, respectively. All the Sampling Gate diodes are normally non-conducting and are therefore very small capacitors. The differentiating networks eliminate all but about 5% of the possible blow-by effects. The Blow-By correction amplifier feeds an inverted replica of the input signal into the Sampling Gate output, a small quantity of charge passes through C19 to cancel most of the remaining blow-by signal.

Traveling Wave Sampling Gate

Push-pull strobe pulses from the Strobe Generator cause the six Sampling Gate diodes to conduct for about 125 ps. While the diodes are conducting, the signal at the input connector propagates down the diode transmission paths as well as toward the 10X attenuator, R3. As the fast falling strobe pulse end begins to propagate into the diode transmission paths, the diodes are quickly switched off (into reverse bias), one set after another. First, diodes D2A and D2F turn off, then D2B and D2E, and finally D2C and D2D. Turn off time of the diode sets is controlled by the mechanical spacing and thereby the propagation time between sets. The Sampling Gate risetime is determined by these propagation times, and is thus not heavily influenced by the strobe pulse amplitude or duration. The sampling process is thus one of trapping signal charge between sets of diodes, in particular, between set D2A-D2F and the set D2B and D2E. The risetime is very close to the double transit time between sets.

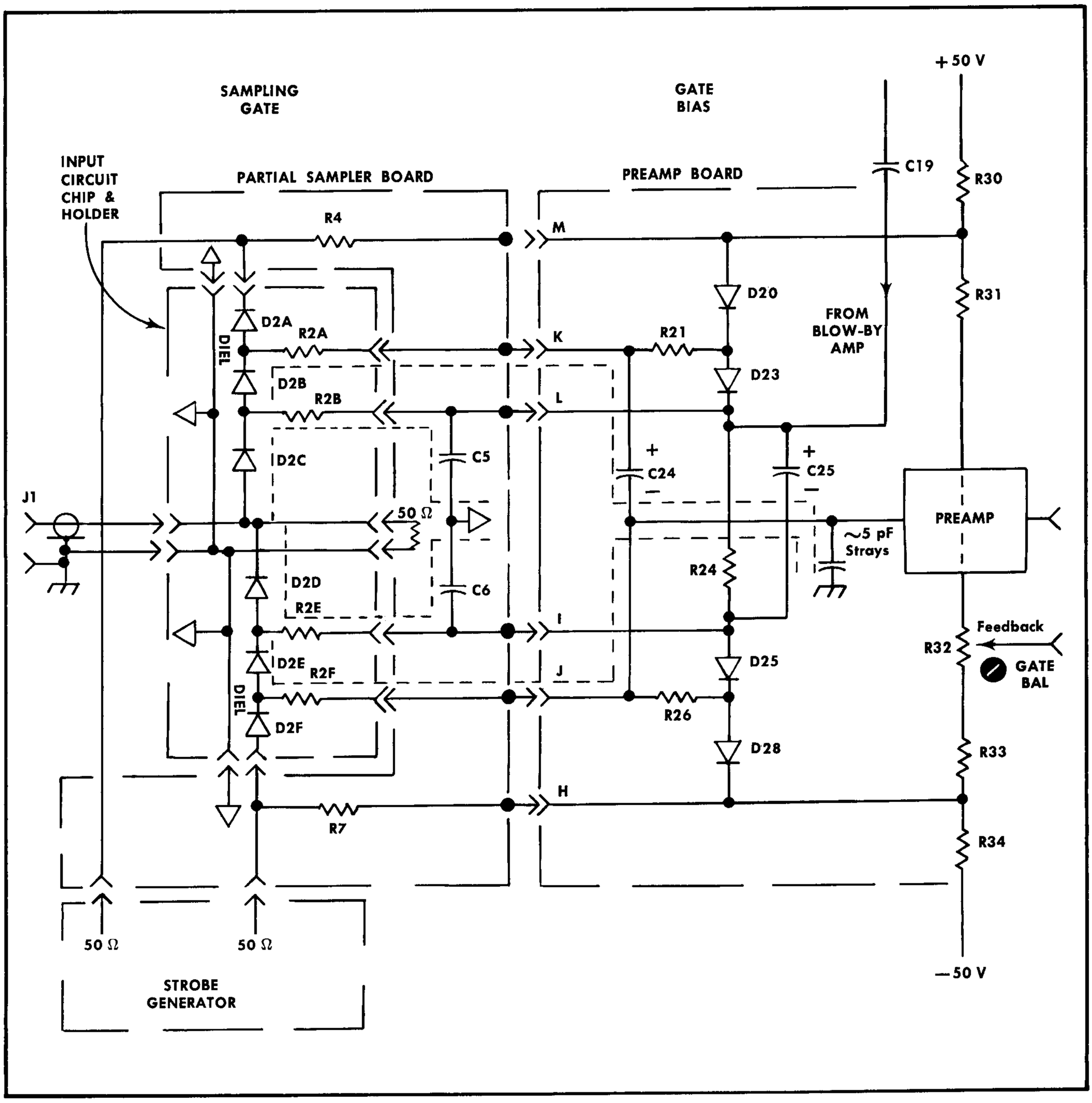


Fig. 3-1. Traveling wave Sampling Gate and Gate Bias circuit components, with input signal blow-by differentiating paths shown by dotted lines.

Once the signal charge trapping process has taken place (at the strobe pulse end), the Preamplifier begins to receive the trapped charge by conduction through resistors R2A and R2F (See Fig. 3-2). The Preamplifier input capacitance is much larger than the capacitance of the transmission line segments between the diode sets, causing practically all of the trapped charge to finally transfer to the Preamplifier input. The transfer time constant is approximately 10 nanoseconds.

Because of the carefully adjusted balance of the plus and minus strobe signals (set by the physical position of R51 and R53 in the Strobe Generator), the Preamplifier receives only the trapped signal charge and nothing from the Strobe Generator.

Preamplifier

The Preamplifier circuit amplifies and time-stretches the error signal pulse from the Sampling Gate, and AC couples it to the Post Amplifier in the associated plug-in unit.

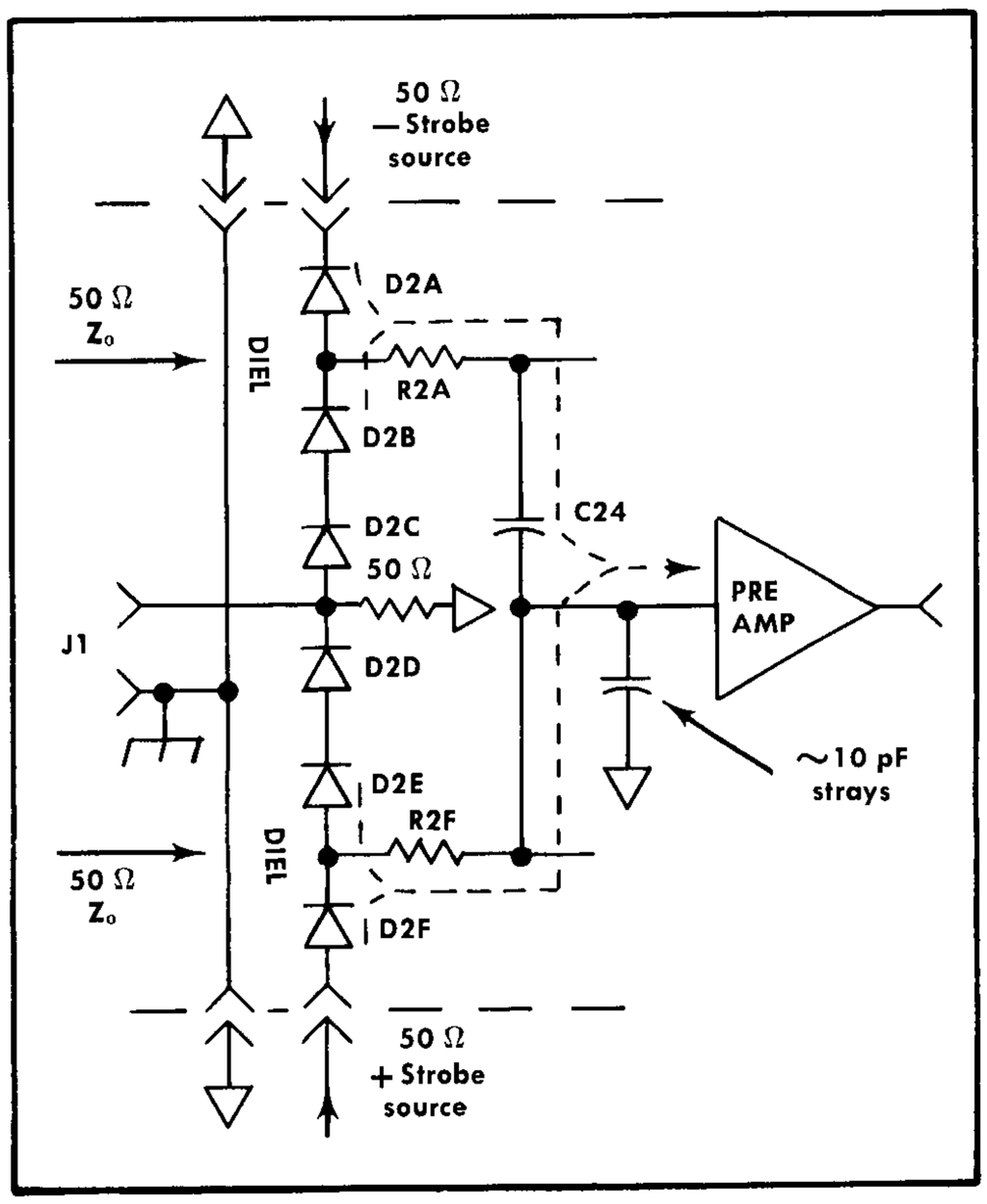


Fig. 3-2. Error-signal source and path to Preamp shown by dotted lines.

Input transistor Q36 operates as a very high input impedance, high-gain inverting amplifier. Temperature compensation for Q36 is accomplished by thermistor R33 in parallel with R39. A total of 4.4 mA channel current passes from the +50 volt supply through R36, Q36, the parallel combination of R33-R39 and R40 to the —50 volt supply. C39 assures that Q36 AC gain is high, while its DC gain is less than 1.

Q43 and Q46 are connected as an operational amplifier with a very low output impedance at Q46 emitter. The output is coupled by C50 to the 90 Ω input resistance Post Amplifier in the sampling unit. D41 protects Q43 base from high negative voltage if Q46 is removed from its socket.

Current in R40 with DC negative feedback by R48 sets the output DC voltage level of the amplifier at about 7.3 volts. Negative AC feedback from the emitter of Q46 through C49 and Gain control R49 to Q43 base controls the AC gain of the Preamplifier. Gain control R49 allows the AC feedback to be adjusted, thereby adjusting the gain. The AC gain is adjusted during calibration so that the sampling head has the correct amplitude output signal to the sampling unit Post Amplifier.

The Type S-4 sampling efficiency is less than 2%. (See the sampling unit instruction manual Basic Sampling Principles for sampling efficiency definition.) With a low samplng efficiency, the Preamplifier positive and negative signal output impedance must both be low. Q46 assures a low output impedance for positive-going output pulses, and D43 assures a low output impedance for negative-going output pulses. D43 conducts only for large negative output signals that fall at a rate faster than Q46 emitter can follow. Q46 emitter remains a low output impedance for small negative output signals.

Components not already mentioned above include: C47 and R46 that both prevent parasitic oscillations of Q46, and C45-C46 that decouple the +15-volt supply for both low and high frequency current pulses of Q46.

Blow-by and Trigger Pickoff

The Blow-by and Trigger Pickoff circuits consist of Q10, Q14 and associated components connected as a common-emitter paraphase amplifier. The primary purpose of the circuit is to cancel unwanted high frequency capacitively-coupled signals that bypass the Sampling Gate. The secondary purpose is to provide a trigger pickoff signal to the sampling unit for internal triggering of the sampling sweep unit.

Input signal to the Blow-by and Trigger Pickoff circuit is a portion of the Type S-4 input signal. The signal is fed to the base of Q10 through R3. R10 terminates the 50 Ω impedance of the input and assures no reflections back into the input circuit. The output from Q10 collector feeds an AC coupled signal to the output side of the Sampling Gate, cancelling the blow-by signal. The output from Q14 collector feeds a DC coupled trigger pickoff signal to the sampling unit for use by the sampling sweep unit.

Feedback Limiting

The Preamplifier input is the input terminal of an integrating pulse amplifier that includes the sampling unit Post Amplifier, AC Amplifier, Memory Gate and Memory Amplifier. Feedback from the Memory Amplfier output is DC coupled to the Type S-4 Preamplifier input through the sampling unit Feedback Attenuator and the Type S-4 Gate Bal control.

As a sample is taken, the error signal is amplified and converted to a DC signal for both the CRT and the feedback that arrives through pins 2 and B of the sampler board. The maximum feedback is limited to approximately ±1.2 volts by two resistive dividers and D80 and D82. The limiting is to prevent excessive feedback voltage from reaching the Sampling Gate when the sampling unit Units/Div switch is changed between positions. In certain conditions of operation, the excessive feedback can cause the Sampling Gate to go into a mode of conduction that holds the CRT beam off screen. By limiting the feedback amplitude, overdriven displays will leave the CRT screen but will return just as soon as the overdrive is removed. Without the limiting, an overdrive signal could cause the display to disappear.

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section is a maintenance guide for the Type S-4 Sampling Head. Some circuit testing and repair suggestions are included. See the Circuit Description for additional circuit details if a problem exists that is not covered here. Parts ordering, disassembly and reassembly information is also included.

To remove the Type S-4 Sampling Head from its case, loosen the four retaining screws on the back. Then slide the back off and remove the case by sliding it to the rear. Directions for replacing the case will be found at the end of this section.

Parts Removal and Replacement

All parts used in the Type S-4 can be purchased directly through your Tektronix Field Office or Representative, although standard electronic items may be obtained locally. Replacements for the special parts used in the Type S-4 should be ordered from Tektronix since these parts are either manufactured or selected by Tektronix to satisfy a particular requirement. Before purchasing or ordering, consult the Electrical or Mechnical Parts List to determine the value, tolerance and ratings required.

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, the sampling head may require calibration.

Transistor Replacement. Cut the leads of a replacement transistor to the same length as the transistor removed and bend the leads as necessary. The lead configurations of the transistors used in the Type S-4 are shown in Fig. 4-1. Two transistors on the Trigger Amp circuit board (Q10 and Q14) have soldered leads. Field-effect transistor Q36 mounting has an arrow at the tab position.

Leadless Capacitors. There are leadless ceramic capacitors soldered directly to the circuit board. Care must be taken when replacing these capacitors as they crack easily. The type of solder used must be electronic grade 60/40 or 62/38 solder with good cold-flow characteristics.

Solder the leadless capacitor into place by positioning the part and applying heat to the adjacent plated area.

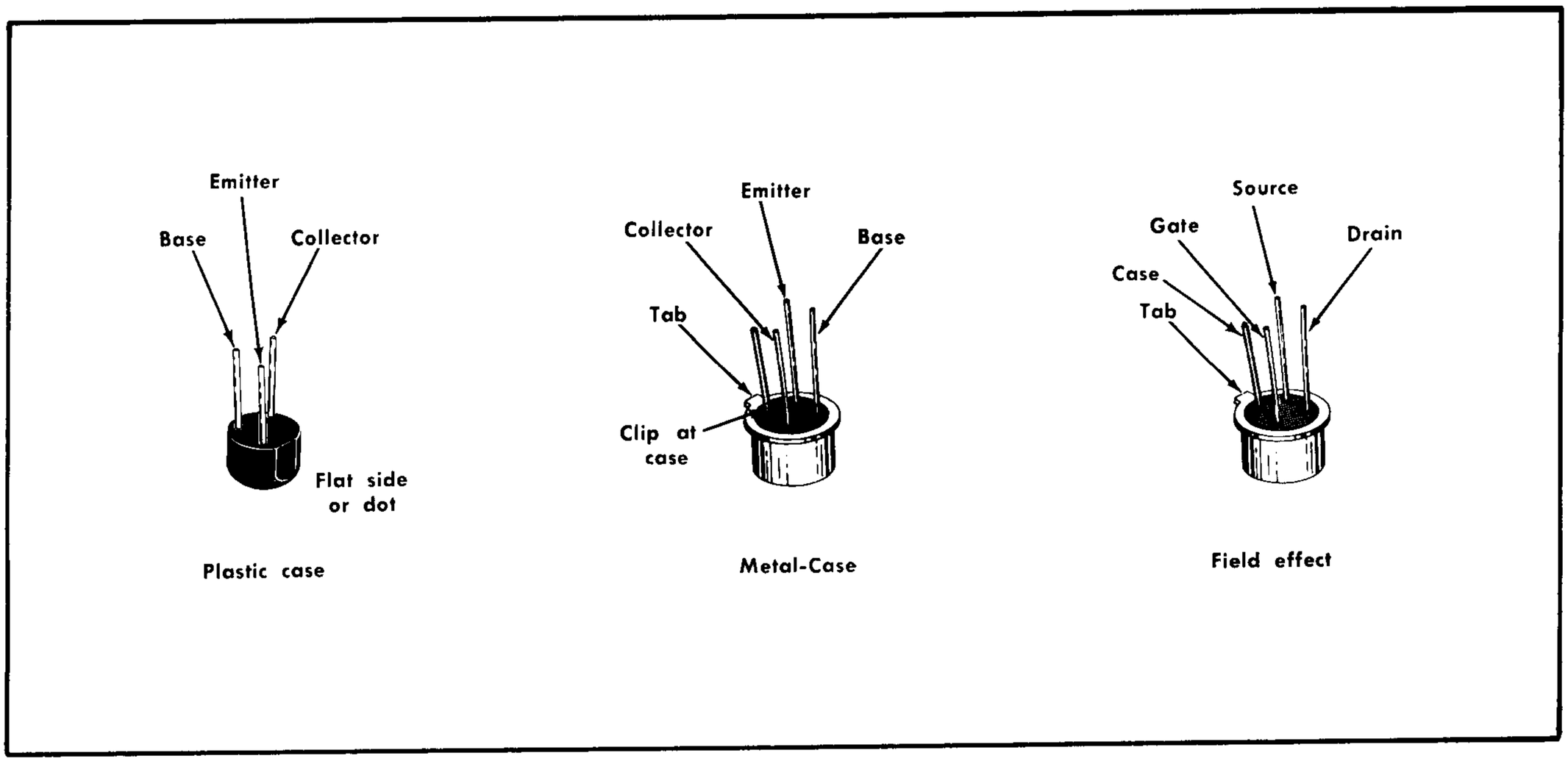
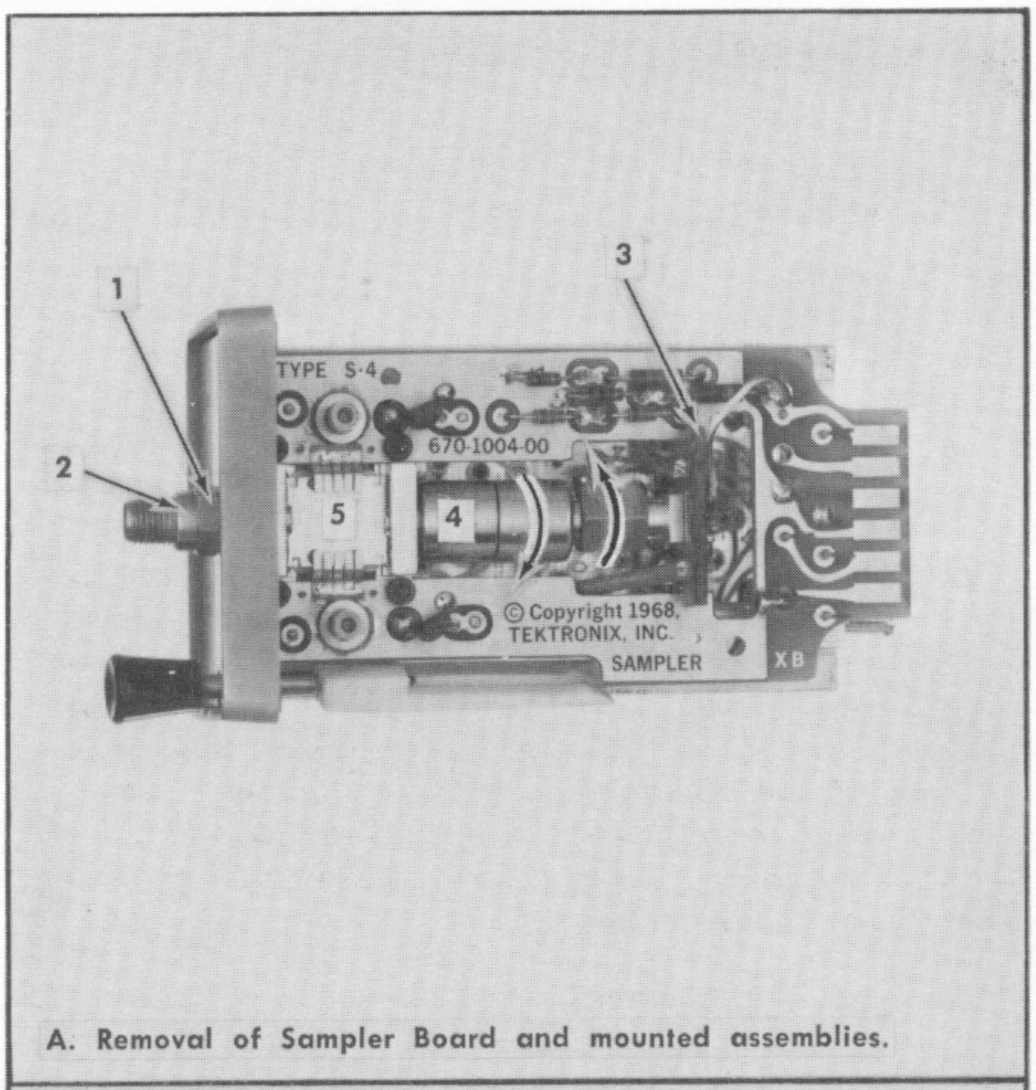
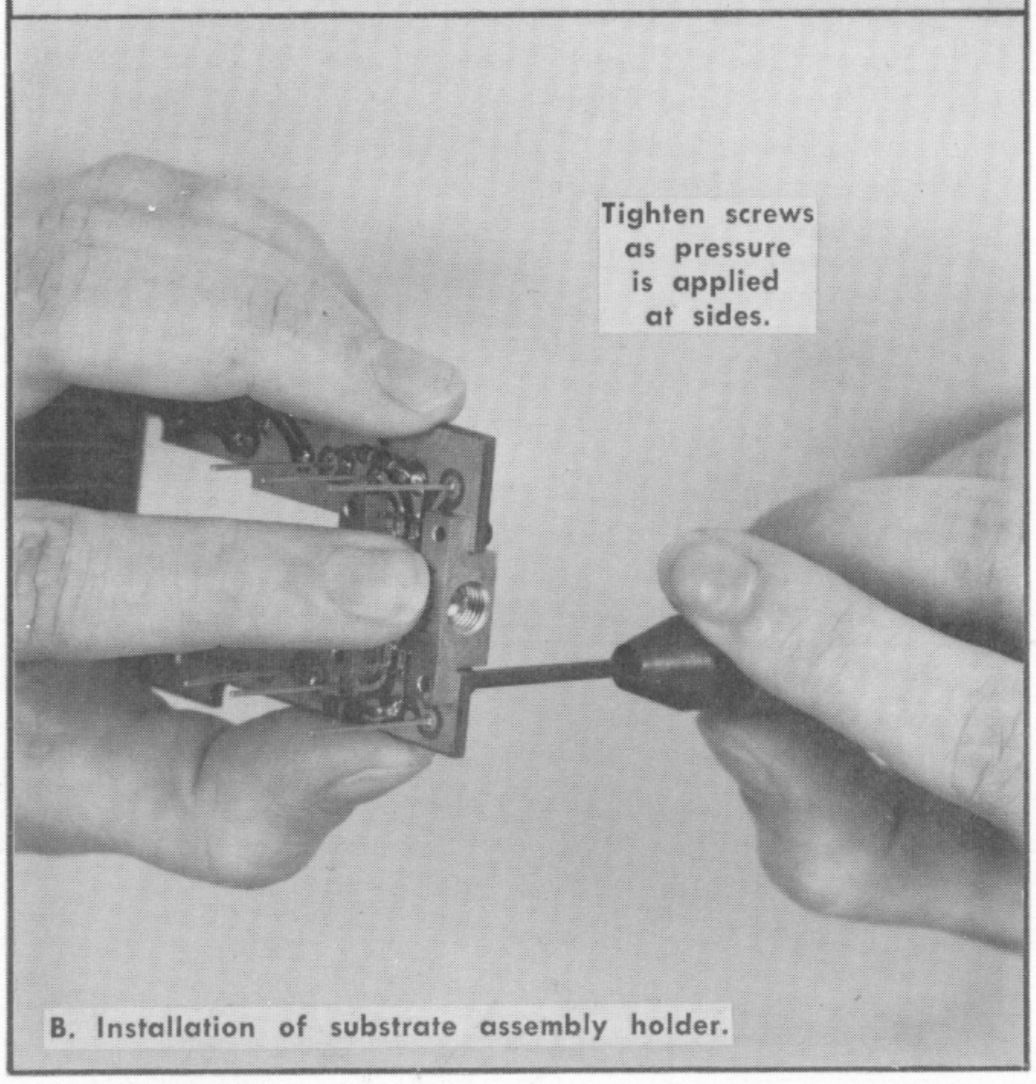


Fig. 4-1. Lead configuration of transistors in the Type S-4.

Ⓐ



A. Removal of Sampler Board and mounted assemblies.



B. Installation of substrate assembly holder.

Fig. 4-2. Sampler Board removal and reassembly.

Solder leads to the leadless capacitor by applying heat to the leads. Excess solder on either side of the capacitor can lead to a shorted circuit.

Removal and Replacement of Snap-off Diodes. The Snap-off diode is mounted in small metal clips, as shown on the circuit board illustration. The diode is best removed or replaced with a pair of shaped plastic tweezers, such as Tektronix Part No. 006-0765-00, or its equivalent.

Circuit Board Replacement. If a circuit board is damaged and cannot be repaired, the entire assembly including all soldered-on components should be replaced. The part number given in the Mechanical Parts List is for the completely wired board.

The Strobe Board and the Preamp Board are removed by gently pulling outward from the Sampler Board. The Preamp Board holds the pretrigger output connector, P17, and a coaxial cable from the Trigger Amp Board soldered to the junction of R17 and R18. For replacement, align the connectors and pin contacts and ease the boards into position. Pin connectors should not protrude beyond the clamps.

Remove the Sampler Board as in Fig. 4-2 and as follows:

1. Loosen, but do not remove, the threaded nut on the Input connector with a $^5/_{16}$ inch wrench.

2. Loosen the Input connector with a $^7/_{32}$ inch wrench. Remove the Input connector with the fingers.

3. Unsolder the —12.2 volt lead to the Trigger Amp Board.

4. Loosen, but do not remove, the $^5/_{16}$ nut holding the Trigger Amp Board. The Trigger Amp Board is wired to the Sampler Board and to the Preamp Board.

5. Remove the attenuator by unscrewing it from the substrate assembly (right hand thread) and then slide both the attenuator and the Trigger Amp Board to the rear.

6. Remove the substrate assembly, bracing it with a finger as in Fig. 4-2B, by removing the hexagonal screws with a $^3/_{64}$ inch Allen wrench. Lift the substrate assembly away from the Sampler Board.

NOTE

Do not touch the gold plated areas on the substrate which are visible at the sides, due to the possibility of contamination from natural body oils.

Replacement of the mounted assemblies and the Sampler Board follows:

1. Place the substrate assembly on the Sampler Board between the pins, which prevent forward or backward movement, and brace the substrate assembly as the hexagonal screws are screwed in approximately half a turn. Apply pressure at the Sampler Board sides, see Fig.4-2B, and tighten the front screws. The substrate should orient itself for best electrical contact. Then tighten the rear screws and release the pressure.

2. Install the attenuator and Trigger Amp Board.

3. Tighten the coupling nut. Solder the —12.2 volt lead to the board. The Preamp Board may be placed into position at this time.

4. Place the front panel so the Input connector will align with the substrate assembly. Make sure the plastic locking pawl is positioned with the flat surface facing downward. Finger tighten the connector. Tighten the Input connector with a $^7/_{32}$ inch wrench to 10 in-lbs, estimated, if no torque wrench is available. Tighten the locking nut with a $^5/_{16}$ inch wrench to 15 in-lbs.

Replacement of the Sampling Gate substrate assembly or of the Strobe Board may cause a system unbalance, resulting in strobe kickout from the Input connector. This con-

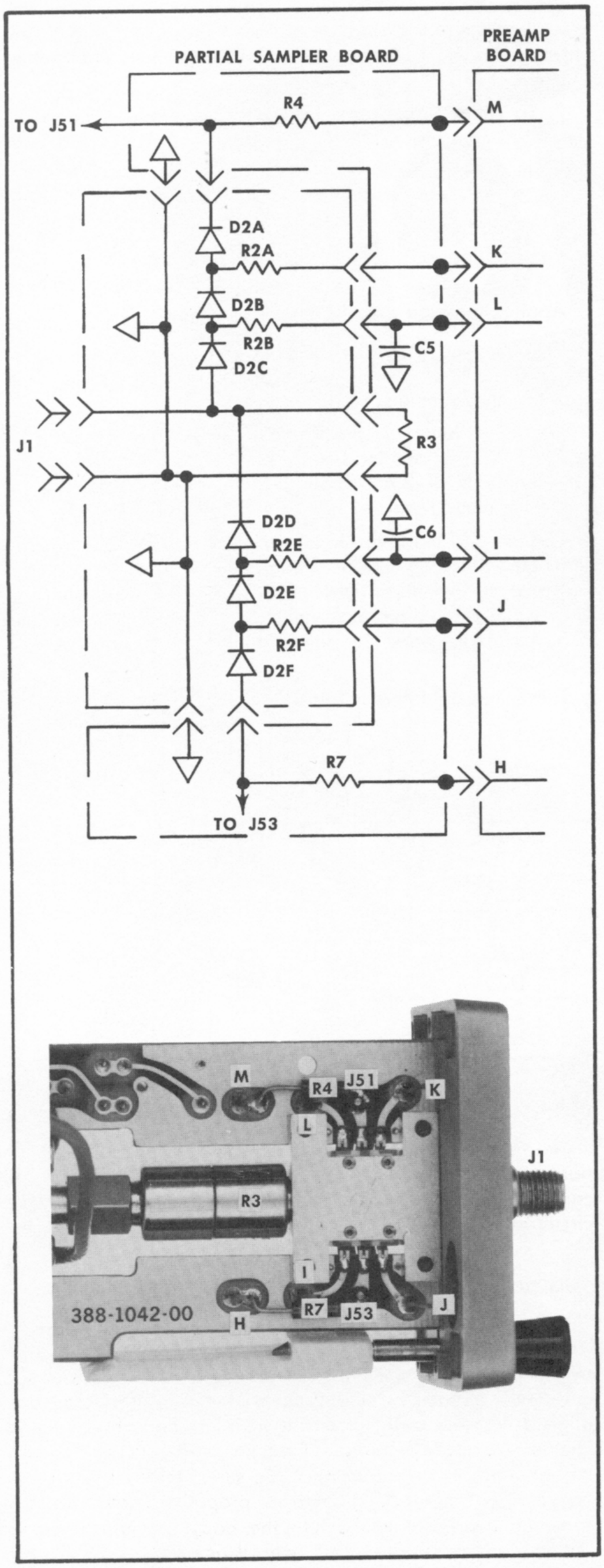


Fig. 4-3. Sampling Gate circuit and test points for checking the diodes.

dition is corrected by resoldering R51 or R53 (possibly both) to a different point on the clipping lines. See step 13 in the Performance Check/Calibration Procedure.

Checking Sampling Gate Diodes

A dynamic check of the condition of the forward characteristics of the sampling gate diodes can be quickly made by following the procedure outlined in Section 5, step 13f, of this manual. In this check, the diodes are checked for both + and — strobe pulse conduction. If either the + or the — strobe pulse is not found in this dynamic check, then further static checks can be performed on the gate, as outlined below. If both strobe polarities are observed, the other circuits of the sampling head should be checked for problems, leaving the sampling gate till last.

The Sampling Gate diodes can be specially checked by the use of a transistor characteristic curve tracer, such as the Tektronix Type 575. DO NOT USE AN OHMMETER TO CHECK THE SAMPLING GATE DIODES.

Once it has been decided to check the Sampling Gate diodes, refer to Fig. 4-3 for both the Sampling Gate circuit and test points used in the procedure listed below. The procedure outlines a method of checking forward conduction in groups of three, and reverse leakage on an individual basis.

1. Remove the sampling head case and the Preamplifier board. Leave the attenuator and Strobe Board in place.

2. Refer to Fig. 4-3 for testpoints that must be used for checking D2A, D2B and D2C in one group or D2D, D2E and D2F in a second group. For the first group, the curve tracer positive lead is to be attached to ground and for the second group the positive lead is to be attached to J53. Attach the negative lead of the first group to J51. When checking the second group ground the negative lead. These polarity connections test each group of three diodes for their forward conduction in the curve tracer first quadrant as shown in Fig. 4-4.

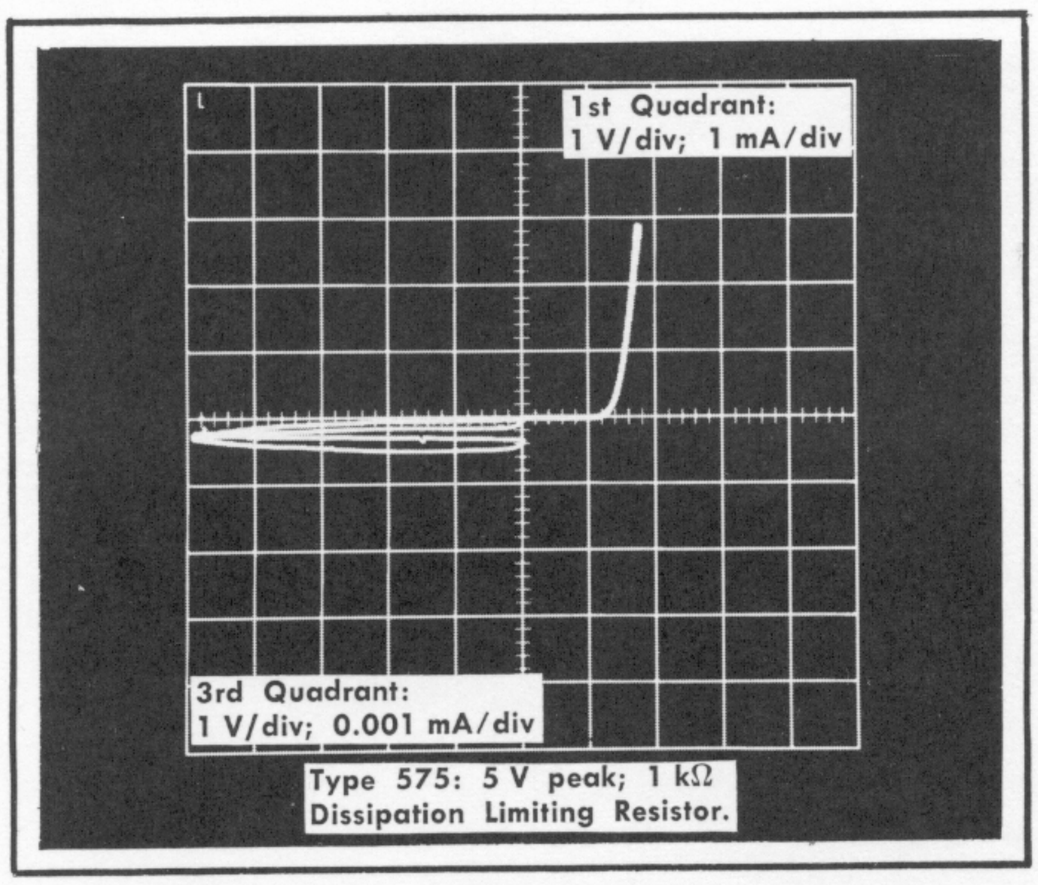


Fig. 4-4. Type 575 Characteristic curves of forward and reverse voltage conduction of D2A, D2B and D2C. Do not use more than 5 volts peak.

Ⓐ

3. Set the Type 575 controls:

Vertical Current	
Collector mA	1 mA/Div
Horizontal Volts/Div	
Collector Volts	1
Peak Volts Range	20
Polarity	+
Peak Volts	For no-load 5 divisions horizontal trace display.
Dissipation Limiting Resistor	100 Ω
Base Step Generator Controls	Optional, not used.
Sloping Panel Controls	
Grounding Sw	Emitter Grounded
Selector Sw	A or B, whichever side has had clip leads attached for the test.
Both Position Controls	Dot at Graticule center.

4. Attach two leads to terminals of the Type 575 sloping front panel. Small clip leads or meter leads with banana tips on one end and prongs on the other end will do. Attach one lead to an E binding post and the other to the C binding post above the E post. Place the selector switch so it points toward the side where the test leads are connected.

5. Connect the E lead to the Sampling Gate terminal J51 and the C lead to ground. The Type 575 display should now be like the first quadrant display of Fig. 4-4. If the display shows slightly more than 1.2 volts flat display and then a rising portion like Fig. 4-4, the three diodes D2A, D2B and D2C are operating correctly in the forward direction. Check the other three diodes forward conduction before measuring either set reverse leakage.

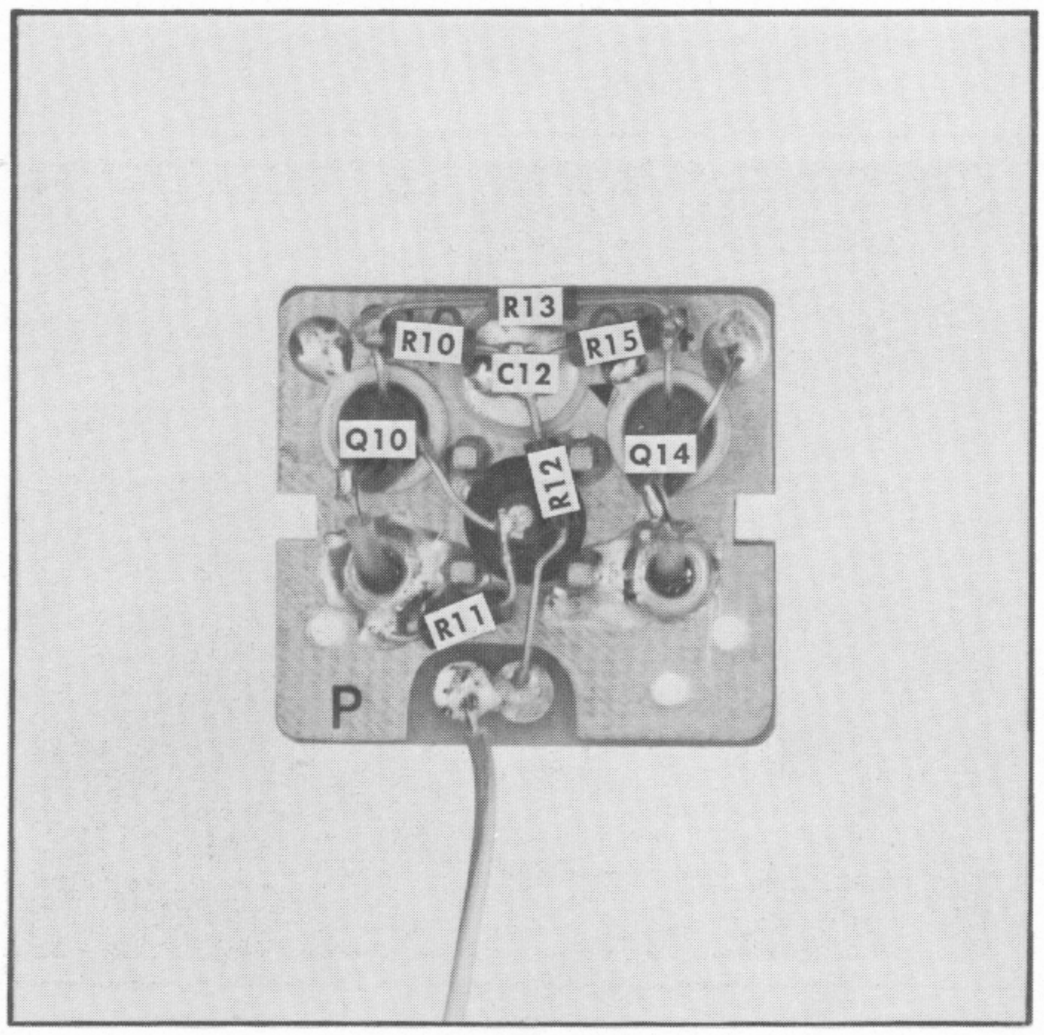


Fig. 4-5. Trigger Amp circuit board.

6. Move the test leads so the E lead is touching the sampling head ground and the C lead is touching J53. The display should be the same as that in the first quadrant of Fig. 4-4.

7. To check the reverse leakage of a diode, change the Type 575 controls:

Vertical Current	
Collector mA	0.01
0.1× button	Pressed in
Vertical Position	No-load trace at graticule centerline.
Applied Voltage Polarity	—

8. The set-up of part 7 gives a vertical deflection factor of 0.001 mA/Div, and will probably include some hum loops as shown in the third quadrant of Fig. 4-4.

The 0.1× button in the Vertical Current block can be released while the test leads are being attached to the correct test terminals of the Sampling Gate, and then pressed to make the measurement.

Connect the leads to check each individual diode reverse leakage. Checking reverse leakage of three in series might not give an indication that one is bad. Any one diode that shows any discernible leakage (negative movement of Type 575 trace) is cause to reject a whole Sampling Gate assembly.

Test points are listed in Table 4-1 for all six diodes.

TABLE 4-1

Individual Sampling Gate diode test terminals for reverse leakage checking.

Diode	Terminals	
	+	—
D2A	J51	K
D2B	K	L
D2C	L	Ground
D2D	Ground	I
D2E	I	J
D2F	J	J53

Major Circuits and Parts Locations

The remainder of this section includes photographs of sections of the Type S-4. Major circuit areas are identified. All components mounted on circuit boards are identified by circuit numbers.

Replacing the Sampling Head Case

To replace the case on the sampling head, align the body so that the hole in the side appears over the Gate Bal control at the rear of the Preamp Board. Check that the upper and lower corners of the Preamp and Strobe boards are aligned with the channels in the sampling head body which contain the zigzag springs. Push the body gently forward until it contacts the front panel. Be sure that the white plastic pawl on the locking knob is properly aligned as the sampling head unit is slid into the body. In attaching the rear casting, be sure that the hole at one side of the casting fits over the trigger pickoff signal output connector. Insert the four long mounting bolts and tighten them securely.

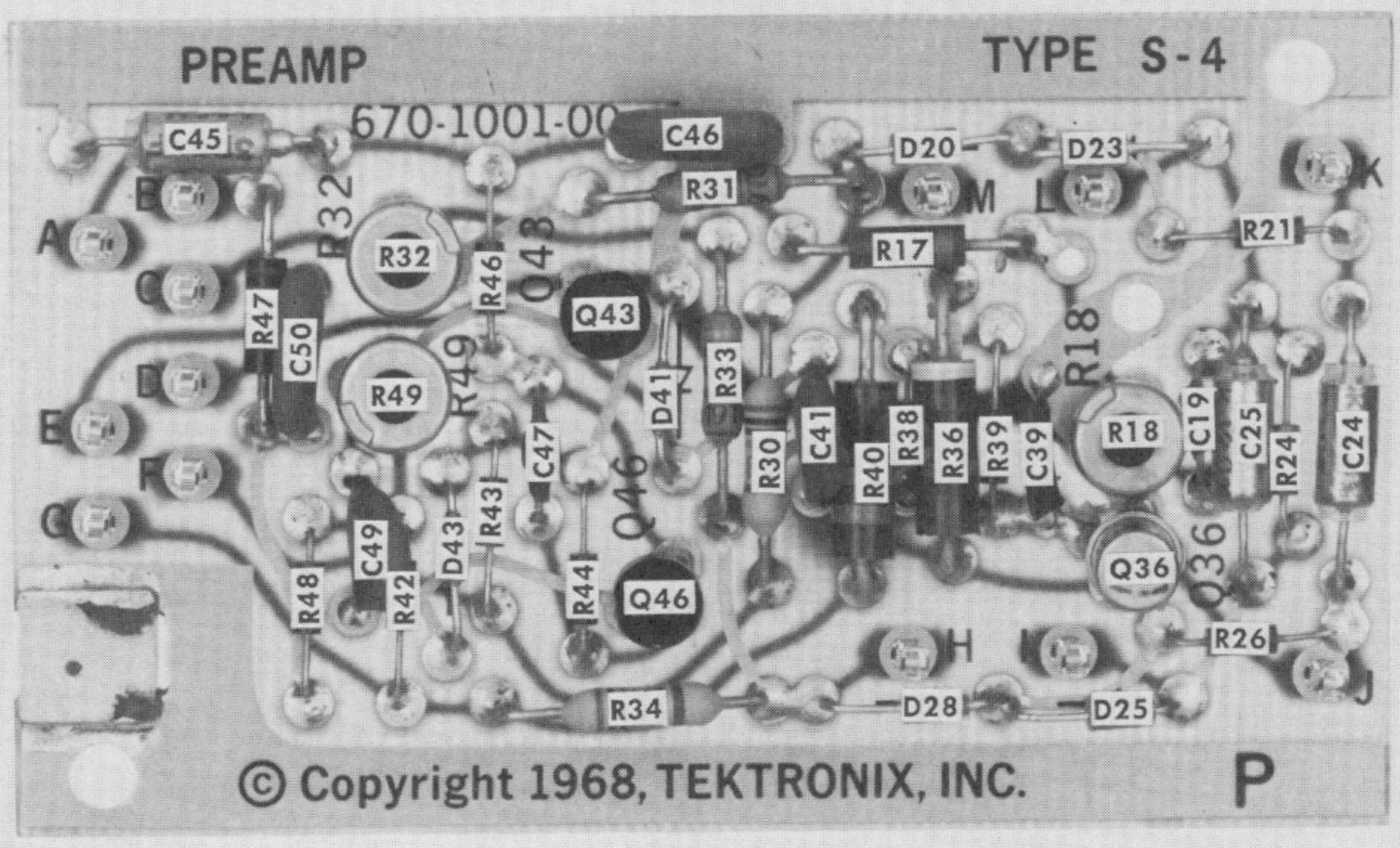
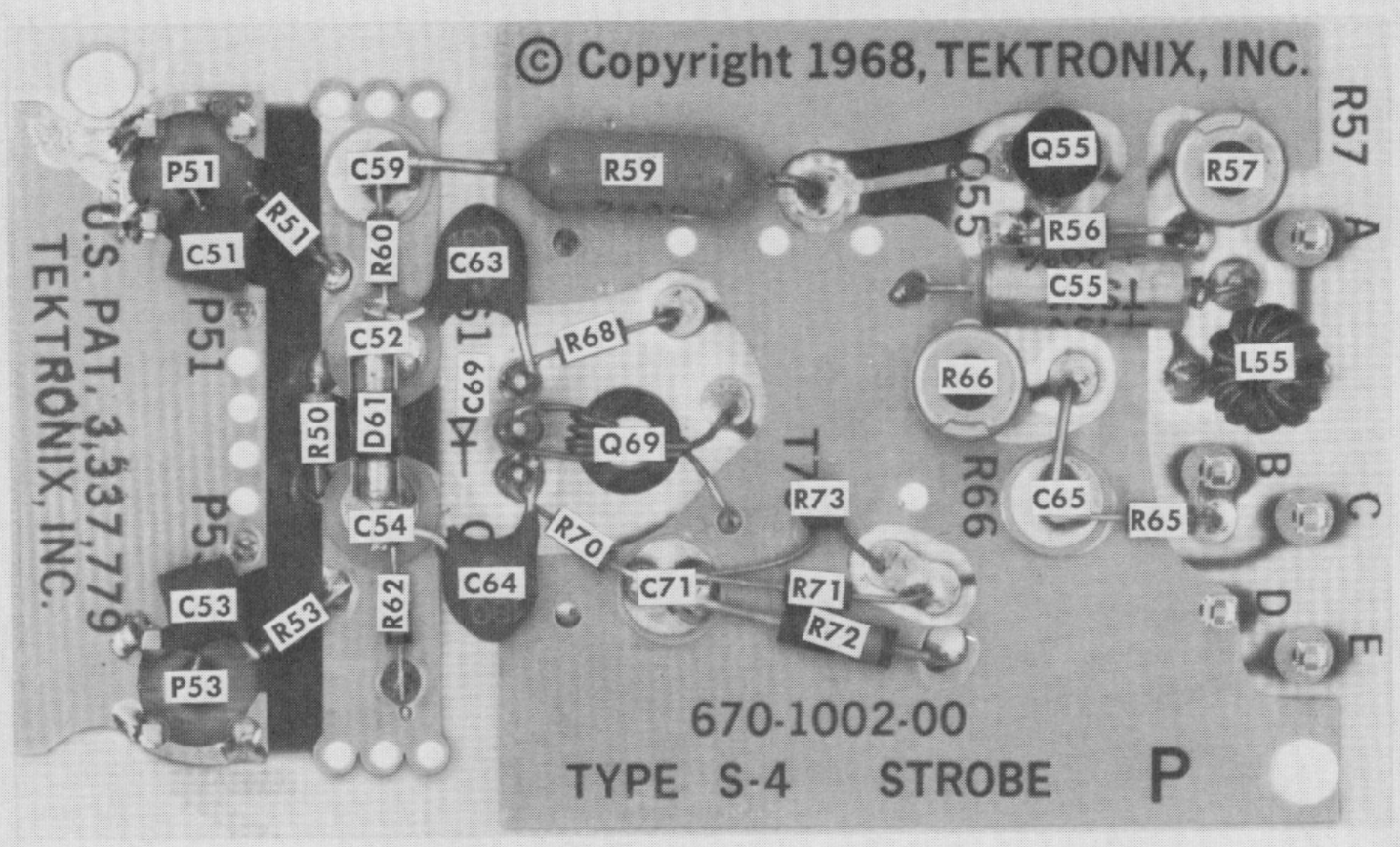
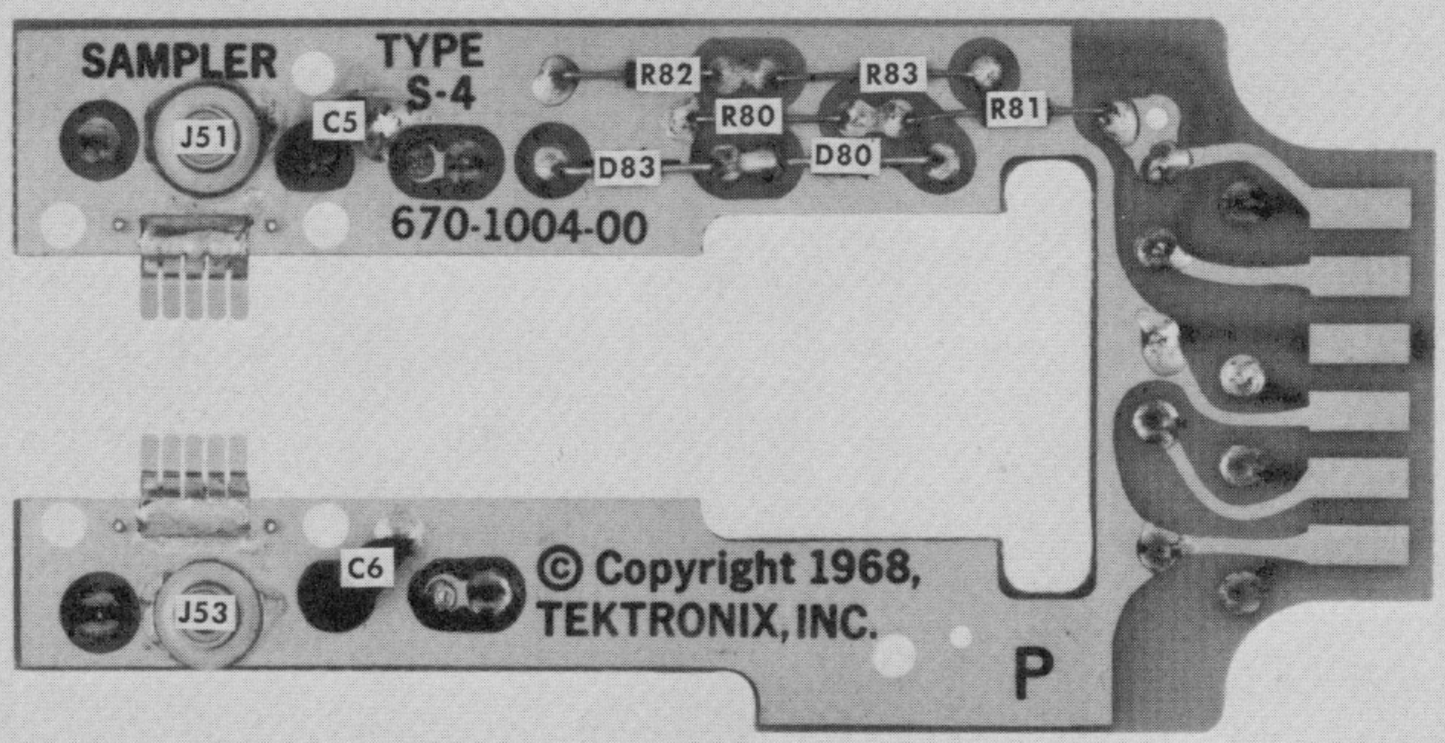


Fig. 4-6. Preamp circuit board.



R52, R54, and Q69 mounted on underside.

Fig. 4-7. Strobe circuit board.



R4 and R7 mounted on underside.

Fig. 4-8. Sampler circuit board.

SECTION 5
PERFORMANCE CHECK / CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

Performance of the Type S-4 can be checked without making internal adjustments by using the steps of this procedure whose headings are set in the type face used in step 1. Failure to meet the requirements given in any check indicates the need for calibration and/or repair.

The sampling head performance can be restored to the limits stated in Section 1 by performing the calibration steps of this procedure. Calibration steps are headed by the type face shown in step 2. Any needed maintenance should be performed before proceeding with calibration.

Since the sampling head functions as a part of the associated sampling unit, the sampling unit calibration must be correct before starting this procedure. It is recommended that the performance checks for the sampling unit be performed and any faults corrected just before the Type S-4 performance checks are made.

EQUIPMENT REQUIRED

This performance check and calibration procedure for the Type S-4 Sampling Head requires the use of the test equipment listed below and shown in Fig. 5-1. The test equipment specifications given are the minimum acceptable for the particular use of each item. If other test equipment is substituted, it must meet or exceed the requirements stated. All test equipment must be correctly calibrated.

All equipment items listed, except items 15, 16 and 17 can be obtained by ordering through your local Tektronix Field Engineer or Representative.

1. Indicator Oscilloscope, with proper sampling plug-in units, such as a Type 561A or Type 561B Oscilloscope with Type 3S2 Sampling Unit and Type 3T2 Random Sampling Sweep.

2. Test Oscilloscope. Requirements: bandwidth DC to at least 30 MHz, minimum deflection factor of 0.5 V/div. For example, a Tektronix Type 545B with Type 1A2 Dual-Trace Plug-In Unit.

3. 10× Probe for use with test oscilloscope. Tektronix P6012 Probe recommended with the Type 1A2 Dual-Trace Plug-In Unit. Tektronix Part No. 010-0203-00.

4. Signal Generator-Pulse Generator, such as the Tektronix Type 284 Pulse Generator used in this procedure. Requirements: Pulse risetime 70 ps or less, amplitude approximately 20 mV into 50 Ω, with a 180 mV positive-going trigger signal available at least 75 ns in advance of the pulse. Trigger signal risetime must be ≤400 ps. The generator must supply square wave signal outputs of 1 μs period (1MHz) and 100 ns (10 MHz) at 100 mV and 1.0 V amplitudes into 50 Ω. (If your Type 284 Lead Time switch is labeled 5 ns-50 ns, order modification kit, Tektronix Part No. 040-0487-00.)

5. Pulse Generator with risetime 25 ps or less, such as the Tektronix Type S-50 Pulse Generator Head. Requirements: Risetime ≤25 ps, amplitude ≤+400 mV into 50 Ω, with a 180 mV positive-going trigger signal available at least 75 ns in advance of the fast pulse. Trigger signal risetime must ≤400.

6. Solid coaxial line with 3 mm connectors, Tektronix Part No. 015-1015-00.

7. GR 874 to 3 mm adapter plug, Tektronix Part No. 015-1007-00.

8. GR 874 to 3 mm adapter jack, Tektronix Part No. 015-1008-00.

9. 50 Ω 2× coaxial attenuator, GR 874 connectors, such as GR 874-G6. Tektronix Part No. 017-0080-00.

10. A special variable attenuator with GR 874 connectors. It consists of a 100 Ω potentiometer across the 50 Ω line, and does not have a guaranteed response. Tektronix Part No. 067-0511-00.

11. 50 Ω coaxial cable with BNC connectors, approximately 40 inches long. Tektronix Part No. 012-0057-01.

12. Coaxial cable, BSM to BNC connectors, type RG58 cable, 18 inch length. Tektronix Part No. 012-0127-00.

13. Special 3 foot flexible extender cable for operating the sampling head outside the sampling unit. Tektronix Part No. 012-0124-00 required.

14. A clip lead to BNC adapter. Tektronix Part No. 013-0076-00.

15. DC Bridge for measuring 50 Ω. Requirements: plus or minus 5 volts maximum across 50 Ω resistor. Accurate within ±0.5%. (Not shown).

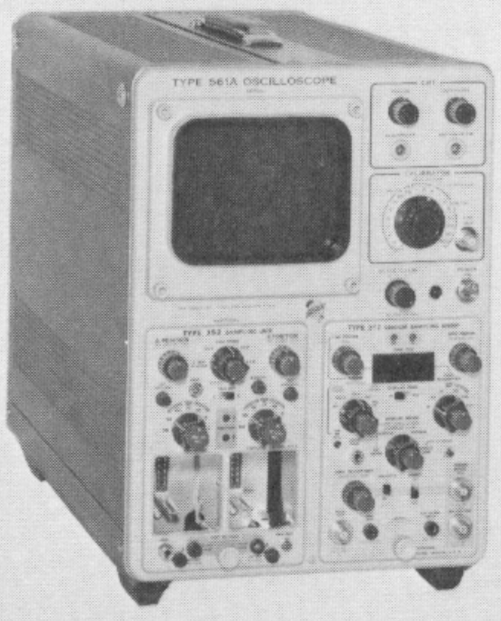
16. Small screwdriver, with insulated handle, 3/32 inch bit, for adjusting screwdriver-adjust controls. (Not shown.)

17. An RMS reading line voltage meter, accurate within ± 3% at the line voltage to which the indicator oscilloscope is connected. (Not shown.)

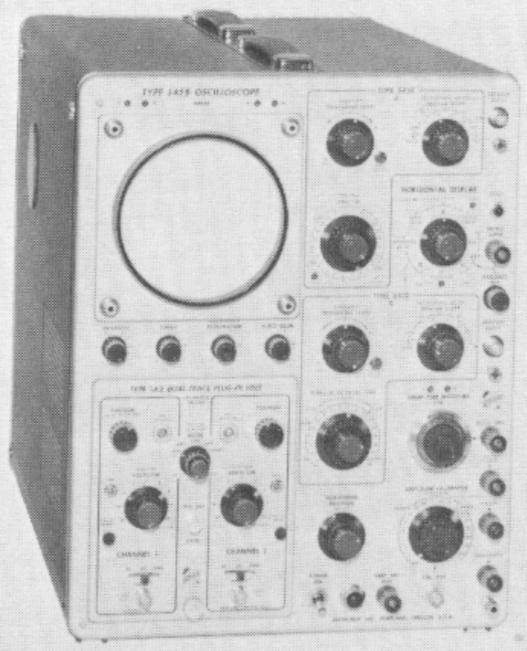
18. A sampling test oscilloscope, required to check strobe kickout, Step 13, such as a Type 561A Oscilloscope, Type 3T2 Random Sampling Sweep Unit, Type 3S2 Dual-Trace Sampling Unit and Type S-2 Sampling Head. (Not shown.) A second 50 Ω coaxial cable with BNC connectors, item 11, is also required.

PERFORMANCE CHECK AND CALIBRATION RECORD AND INDEX

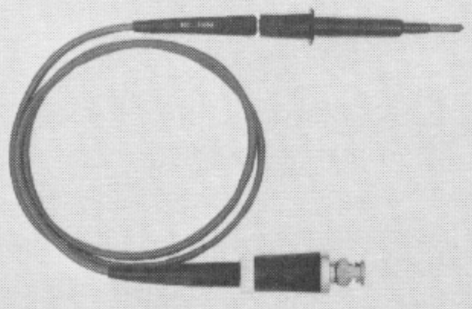
The following abridged procedure may be used as a guide by the experienced technician for checking and/or calibrating the Type S-4 Sampling Head. The step numbers and titles are identical to those in the complete procedure.



(1)



(2)



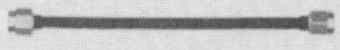
(3)



(4)



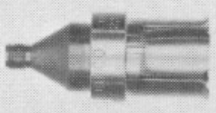
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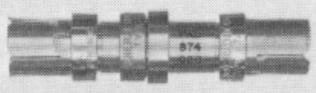
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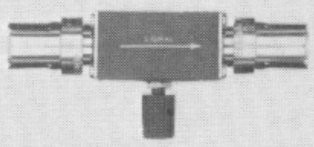
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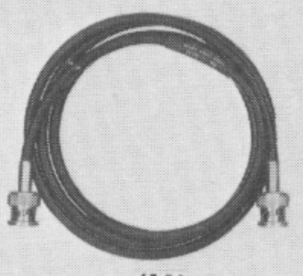
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(9)



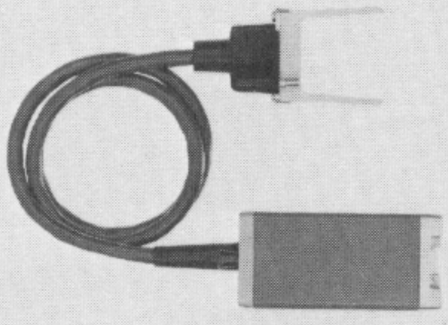
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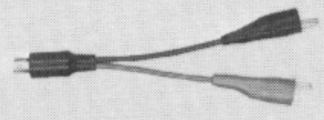
(11)



(12)



(13)



(14)

Fig. 5-1. Equipment required for calibration of the Type S-4.

The abridged procedure can be used as a maintenance record (the procedure may be reproduced without special permission of Tektronix, Inc.).

Type S-4 Sampling Head Serial No. _____

Calibration Date _____

Calibrated By _____

Checked By _____

- ☐ 1. Check Ability to Produce a CRT Display (Page 5-4)
- ☐ 2. Check Strobe Operation (Page 5-5)
- ☐ 3. Adjust Avalanche Volts and Snap-Off Current (Page 5-5)
- ☐ 4. Adjust Gate Bal (Page 5-6)
- ☐ 5. Check Dot Transient Response (Page 5-6)
- ☐ 6. Adjust Gain (Page 5-7)
- ☐ 7. Check Maximum Operating Signal Voltage (Page 5-7)
- ☐ 8. Check Displayed Noise (Tangential) (Page 5-7)
- ☐ 9. Check Risetime (Page 5-8)
- ☐ 10. Check Pulse Flatness Deviation (Page 5-9)
- ☐ 11. Adjust Transient Response (Page 5-10)
- ☐ 12. Check Baseline Shift With Repetition Rate Change (Page 5-10)
- ☐ 13. Check or Adjust Strobe Kickout (Page 5-10)

PRELIMINARY PROCEDURE

1. Check the 50 Ω DC Input Resistance. With the sampling head separated from the sampling unit, use a DC Resistance Bridge and measure the DC input resistance. Connect one lead to the input connector outer conductor, and the other lead to the center conductor. Be sure the bridge does not apply more than ±5 volts to the input terminals.

The Type S-4 input resistance must be 50 Ω, ±5%, for a resistance reading of 47.5 Ω to 52.5 Ω.

Complete any needed repairs to the sampling head before proceeding.

2. Setting up the equipment.

a. Assemble the indicator oscilloscope system. Place the Type 3S2 (or other sampling unit) into the left compartment of the indicator oscilloscope, and the Type 3T2 (or other sampling sweep unit) into the right compartment. Install an operating sampling head into the Type 3S2 Channel B compartment. Leave the Channel A compartment vacant.

b. Connect the RMS line-voltage meter to the power mains. Determine that the oscilloscope (and other equipment) input voltage selector is set for the correct value of line voltage. Connect all the equipment to the proper power outlet and turn on the power.

c. Obtain a free-running trace on the indicator oscilloscope and let the equipment warm up for five minutes. After the warm-up period, adjust the Trace Alignment control so the free-run trace is parallel to the graticule lines.

d. Connect the Type 284 Square Wave Output connector to the Channel B sampling head input. Use a 5 ns signal delay 50 Ω coaxial cable with GR 874 connectors. Connect the Type 284 Trigger Output connector to the sampling sweep unit External Trigger input (50 Ω) connector, using a BNC 50 Ω coaxial cable.

Set the Type 284 Period at 100 ns Square Wave and the Amplitude at 1 volt. Using the Type 284 as both a time and amplitude reference adjust both the vertical and the horizontal unit screwdriver adjustable Gain controls for proper deflection factor of each unit.

e. Install the Type S-4 onto the special three foot extender cable. Connect the other end of the cable into the Type 3S2 Channel A sampling head compartment. Allow a five minute warm up of the system.

NOTE

The case should be in place unless access to internal controls is necessary.

f. Set the controls as listed following Fig. 5-2.

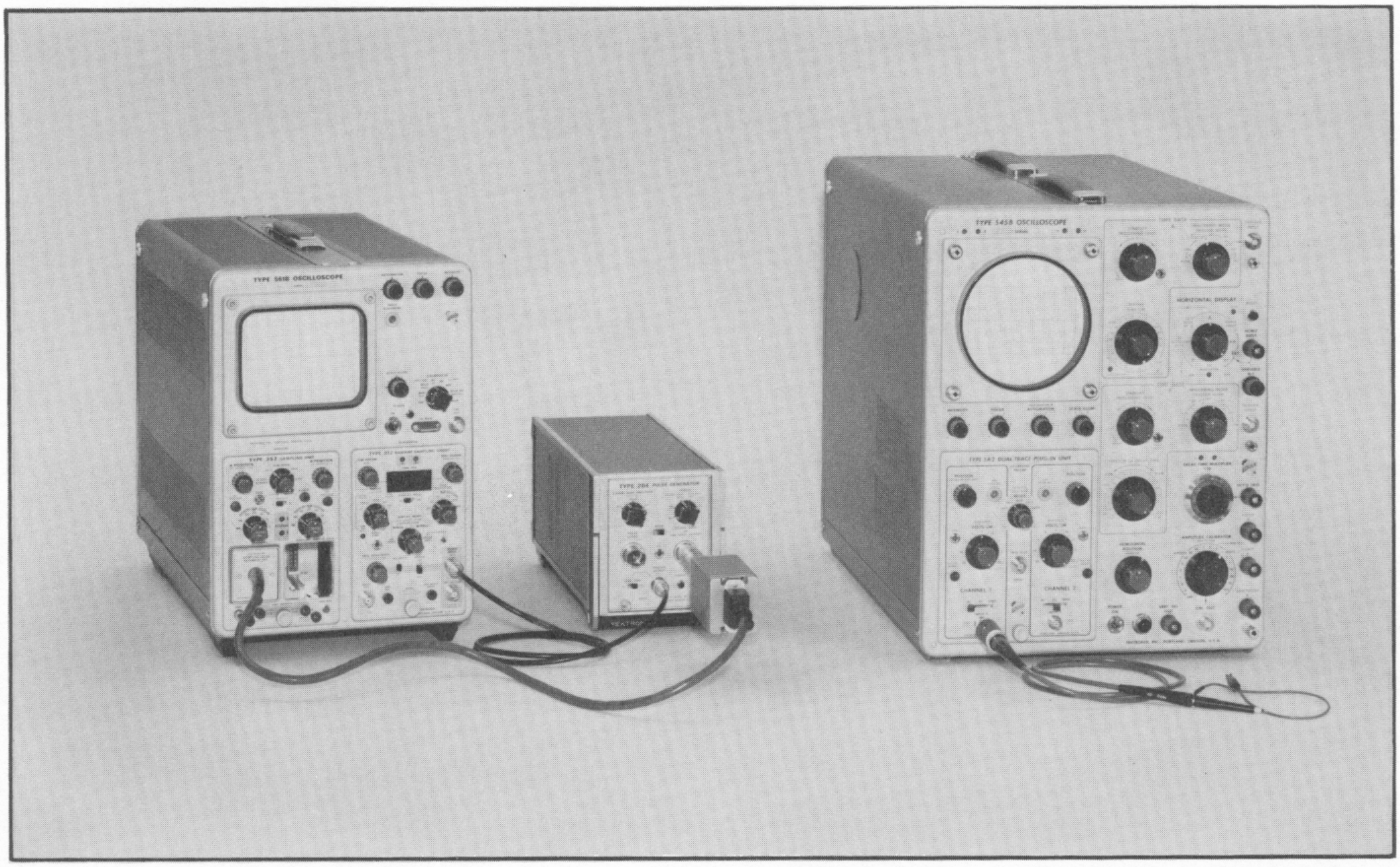


Fig. 5-2. Initial equipment setup.

Sampling Unit (Both channels)

Mode Switch	CH A
Dot Response	Midrange
Units/Div	100
Variable	Cal
Invert	Pushed in
Position	Midrange
DC Offset	0 volts at Offset Out
Horiz Plug-in Compatibility (Internal)	Sampling

Sampling Sweep Unit

Display Mode	Normal
Start Point	With Trigger
Time/Div	50 ns
Range	1 μs
Time Magnifier	×2
Variable	Cal
Display Mag	×1
Time Position controls	Fully clockwise
Horiz Position	Midrange
Trig Sensitivity	Stable Display
Recovery Time	Optional
Trigger Polarity	+
Trigger Source	Ext
Samples/Div	100, Dot at 9 o'clock

Type 284

Mode	Square Wave
Period	100 ns
Square Wave Amplitude	1.0 V
Lead Time	75 ns

Test Oscilloscope

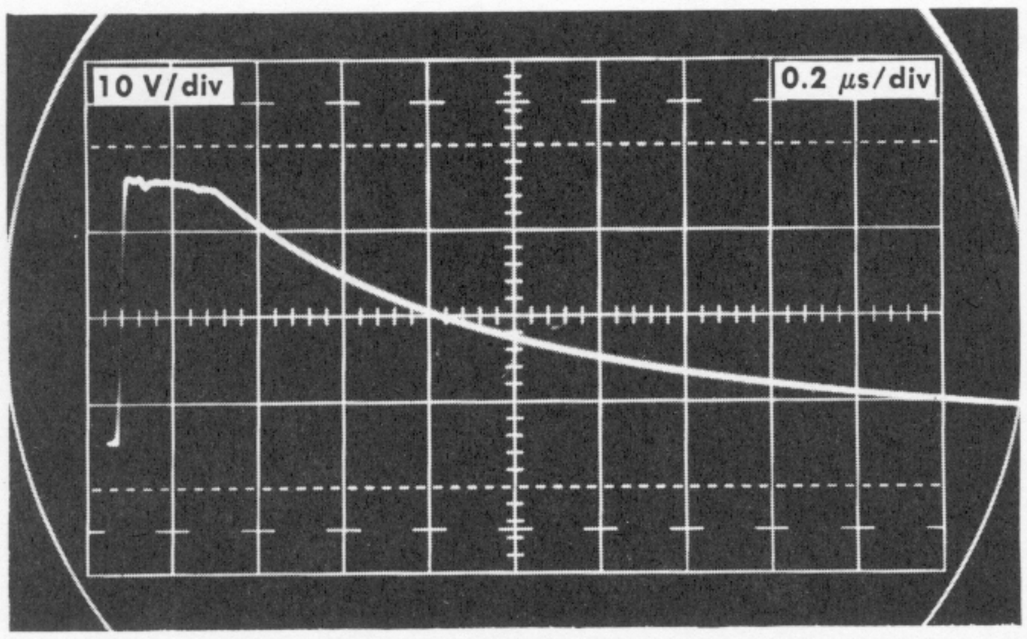
Triggering	+ Int, AC
Time/Div	0.2 μs
Vertical	
With 10× Probe	1.0 V/Div, AC

PERFORMANCE CHECK AND CALIBRATION PROCEDURE

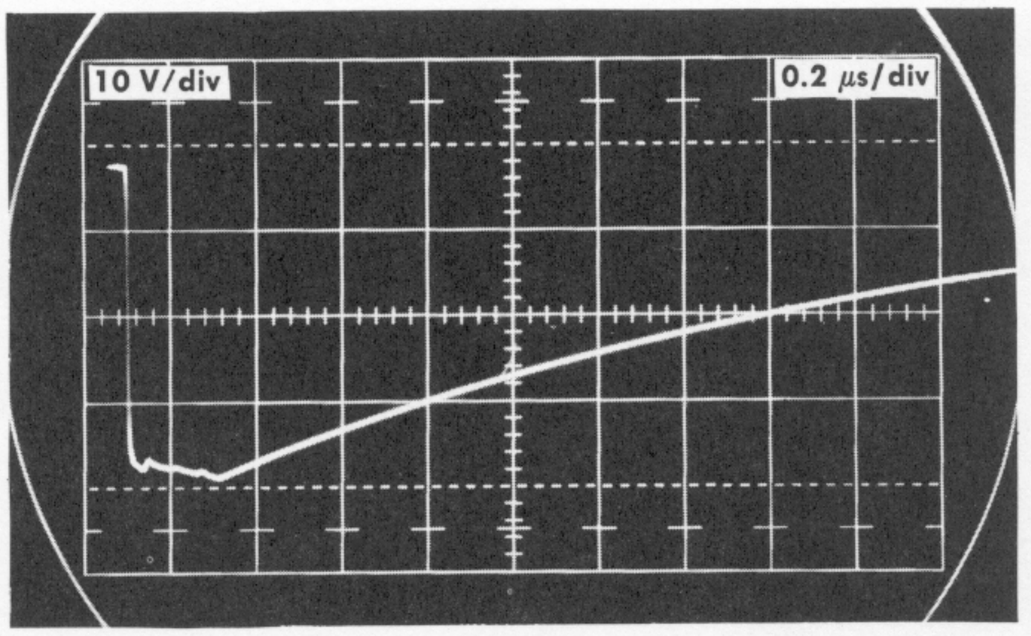
1. Check Ability to Produce a CRT Display

a. Connect the Type 284 Square Wave Output signal to the Type S-4 as shown in Fig. 5-2. Use a 2× GR attenuator at the Type 284 Output connector and a GR to 3 mm adapter to the Type S-4 Input connector.

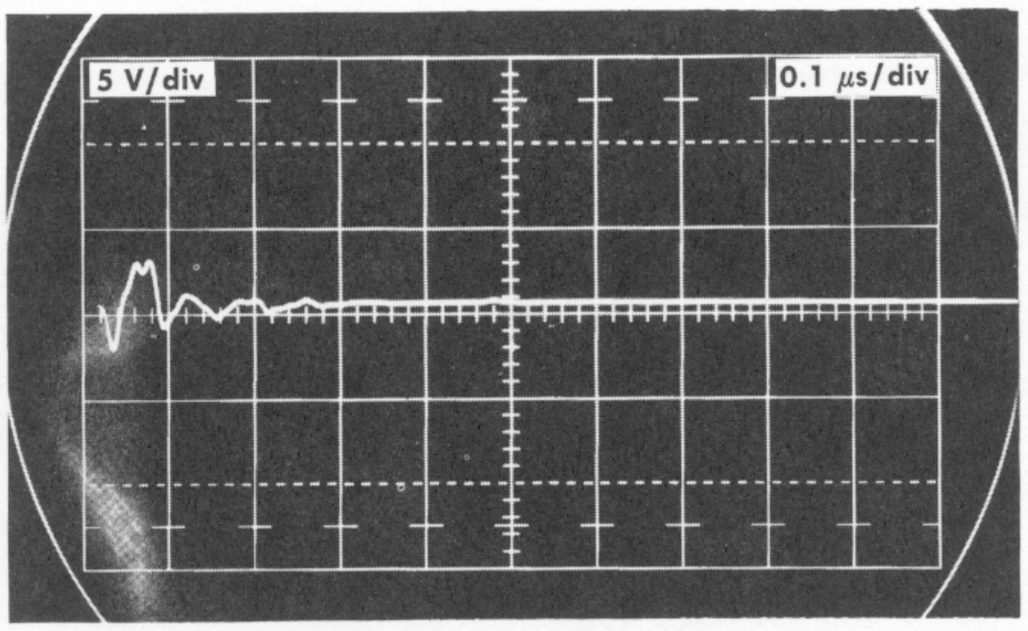
b. Check the CRT for a normal square wave display. If the display is normal, proceed to step 3. If there is no display, perform step 2.



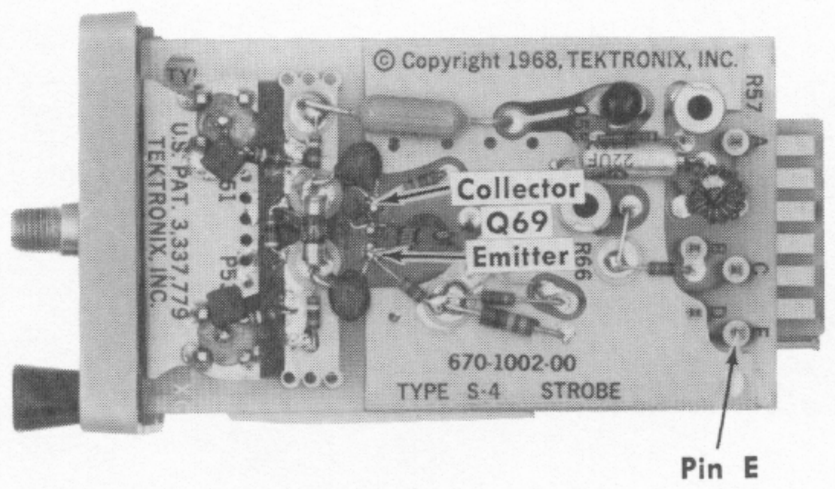
A. Q69 Emitter.



B. Q69 Collector.



C. T75 Primary, Pin E.



D. Test point locations.

Fig. 5-3. Typical displays for Q69 operation.

2. Check Strobe Operation

a. Remove the extender cable from the sampling head (the indicator oscilloscope power may be left on).

b. Remove the Type S-4 case. First, remove the four round-head screws visible at the back casting, then slide the cover off by gently pulling it away from the front casting and input connector.

c. Reconnect the extender cable to the Type S-4. Use care to properly align the Trigger Pickoff connector.

d. Check for proper strobe operation by connecting a 10× probe from the test oscilloscope to the emitter of Avalanche transistor Q69. Amplitude of the waveforms is affected by adjustment of Avalanche Volts control R66. Check the waveforms at the collector of Q69 and at the Primary of T75 (Pin E of the Strobe Board). Typical displays are shown in Fig. 5-3.

If T75 is receiving drive, but there is no signal out of Q69, change Q69. Turn the power off before removing the Strobe Board.

3. Adjust Avalanche Volts and Snap-Off Current

Avalanche Volts control R66 alters the strobe pulse amplitude and risetime. These in turn affect the display noise, balance, and dot transient response. Snap-Off control R57 affects display noise, balance, and strobe kick-out.

a. Disconnect the 2× GR attenuator from the Type 284. Leave the attenuator and adapter attached to the Type S-4.

b. Set the Type 3T2 Trigger Sensitivity control for a free-running trace.

c. Set Avalanche Volts control R66 (see Fig. 5-4) and Snap-Off Current control R57 to midrange.

d. Turn the Avalanche Volts control R66 clockwise into the free-run position. The trace will become very noisy. Turn R66 counterclockwise about 30 degrees or more from the free-run position.

e. Set Snap-Off Current control R57 for the minimum amount of current to center the trace on the CRT. This will appear as the first nulling as the trace moves on the CRT with clockwise rotation of R57.

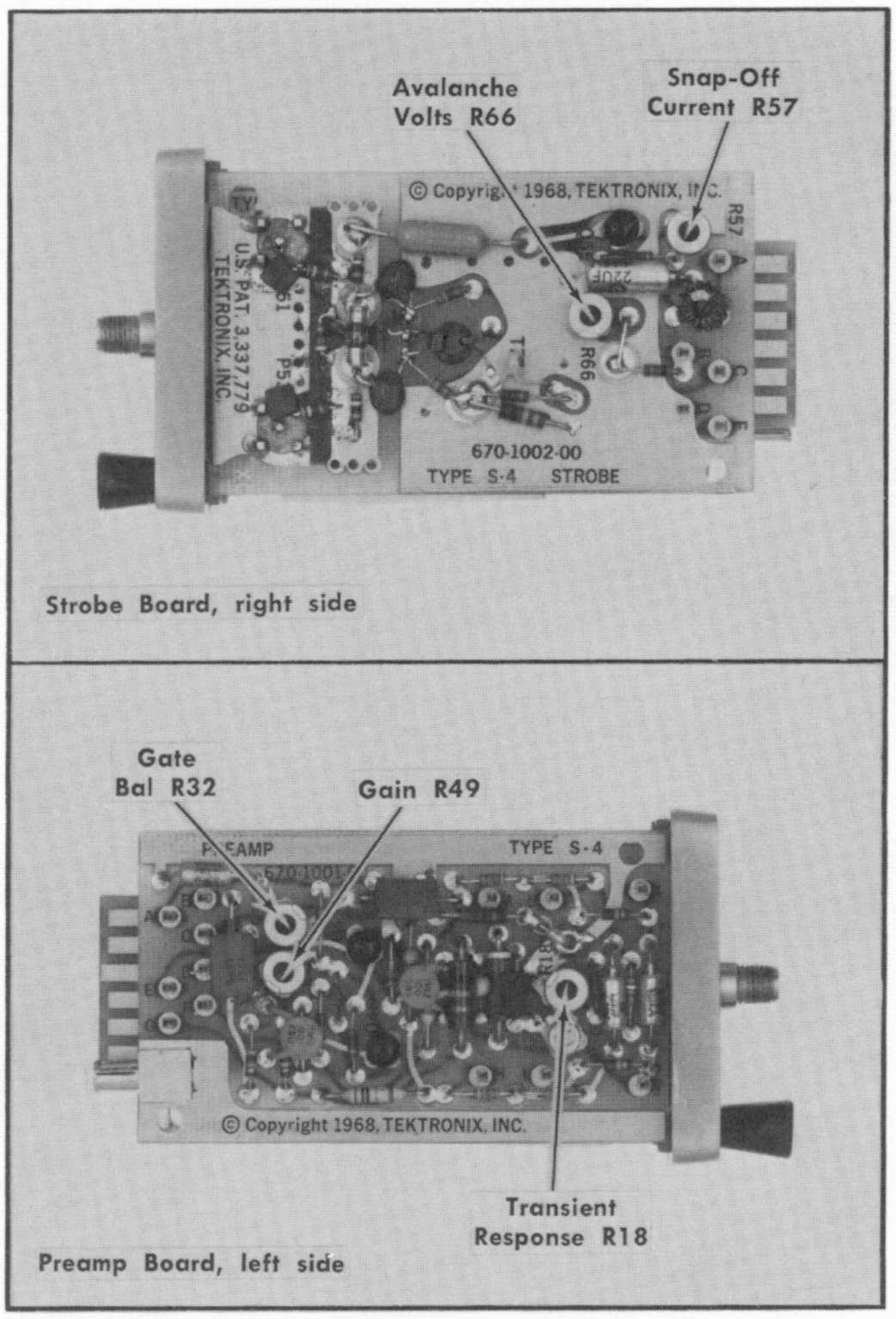


Fig. 5-4. Type S-4 internal control locations.

f. Fine adjustment of the controls is made for maximum loop gain and best dot transient response linearity. Connect the Type 284 Square Wave Output to the Type S-4 Input connector through the 2× attenuator and 3 mm to GR adapter.

g. Set the sampling sweep unit Start Point switch to Before Trigger, the sweep rate to 20 ns/div (Time Magnifier switch to ×5) and obtain a triggered display. The display may show greater than unity loop gain as a double trace. See Fig. 5-5.

h. Set the Avalanche Volts, R66, and the Snap-Off Current, R57, controls for maximum loop gain (two traces on the square wave) and linearity (difference at upper and lower trace separations should be equal).

i. Disconnect the 2× attenuator from the Type 284. Leave the attenuator and adapter attached to the Type S-4.

4. Adjust Gate Bal

Gate Bal control R32 introduces an internal offset voltage to the feedback loop to cancel normal error signals in the sampling loop, including normal unbalance in the traveling wave gate. R32 is adjusted (with DC Offset at zero) to

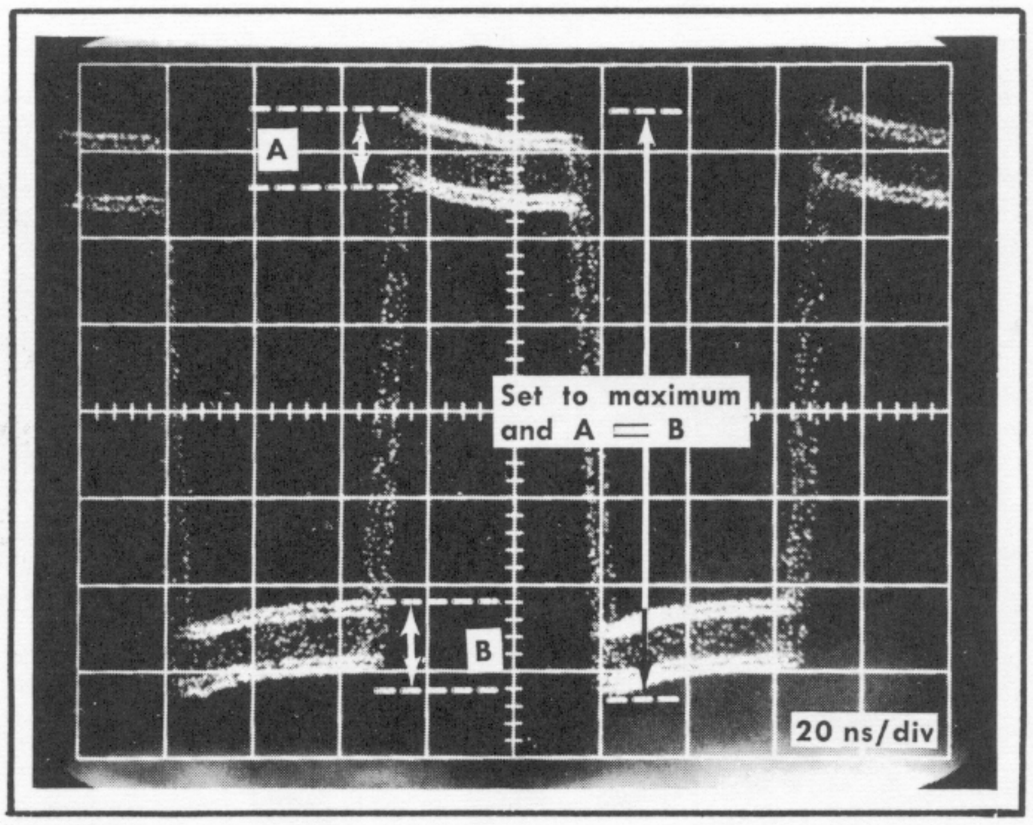


Fig. 5-5. Fine adjustment of Avalanche Volts and Snap-Off Current, step 3.

cancel most of the vertical trace shift as the Units/Div switch setting is changed.

a. Set the sampling unit DC Offset control for zero volts at the Offset Out jack.

b. Observe the trace as the sampling unit Units/Div switch is operated through its ranges and adjust Gate Bal control R32 for no more than one division of vertical shift of the trace. This adjustment varies with changes in the extender cable and when the Type S-4 case is removed or replaced. The Gate Bal control should be readjusted each time the equipment configuration is changed (cable moved or Type S-4 cover removed or replaced).

c. Set the sampling unit Units/Div switch to 100.

5. Check Dot Transient Response

Requirement—Dot will move full amplitude ±5%, of any signal up to 500 mV peak to peak when sampling sweep unit is either double triggered or free run.

a. Connect the Type 284 Square Wave Output connector to the Type S-4 Input connector with the 2× GR attenuator or variable attenuator and 3 mm to GR adapter.

b. Connect the coaxial cable from the Type 284 Trigger Output to the sampling sweep Trigger Input connector.

c. Set the Type 284 Period switch to 100 ns (set it to 1 μs when the sampling sweep unit is other than a Type 3T2). Set the Type 3T2 Range switch to 10 μs, the Time Magnifier to ×50 and the Start Point switch to With Trigger.

d. Set the sampling unit Units/Div switch to 100 and obtain a triggered square wave display.

e. Set the Type 3T2 Start Point switch to Before Trigger (or free run the sampling sweep unit at 0.5 μs/div if not a Type 3T2). Obtain a triggered display.

f. Set the sampling unit Dot Response so the top of the square wave is at unity loop gain (one trace). The bottom

of the square wave can show two traces, but the dot response overshoot or undershoot must not be greater than 5%, or 0.25 major division on the graticule (see Fig. 5-6).

If the dot response overshoots or undershoots more than 5%, perform step 6.

6. Adjust Gain

Gain control R49 changes the feedback loop gain.

a. Use the same setup as the preceding steps. Set the sampling unit Dot Response control to its electrical midpoint. The electrical midpoint is found by watching the changes in the display with greater or less than unity loop gain and setting the Dot Response control half-way between maximum loop gain and minimum loop gain.

b. Adjust Gain control R49 for unity loop gain as shown in Fig. 5-6.

Fine adjustment of Avalanche Volts control R66 and Snap-Off Current control R57 for the best dot transient response with minimum noise may correct a dot response overshoot or undershoot in excess of the 5% tolerance. Sampling gate replacement may cause unbalanced response. See step 13 for adjustment of strobe pickoff resistors R51 and R53.

7. Check Maximum Operating Signal Voltage

Requirement—Signal amplitude up to 1 V peak to peak must be displayed without distortion.

a. Connect the Type 284 Square Wave Output to the Type S-4 through a 3 mm to GR adapter and the solid coaxial 3 mm line.

b. Connect the Type 284 Trigger Output to the sampling sweep Trigger Input.

c. Set the sampling unit Units/Div switch to 20. Set the Type 284 Period switch to 1 μs and the Amplitude switch to 100 mV.

d. Set the sampling sweep unit for a 200 ns/div sweep, the Trigger Mode switch to With Trigger and obtain a stable display. Observe the top and bottom portions of the display.

e. Change the Units/Div switch to 200 and the Type 284 Amplitude switch to 1.0 V.

f. Check that the square wave display is not distorted at the top or bottom portions as observed in part d.

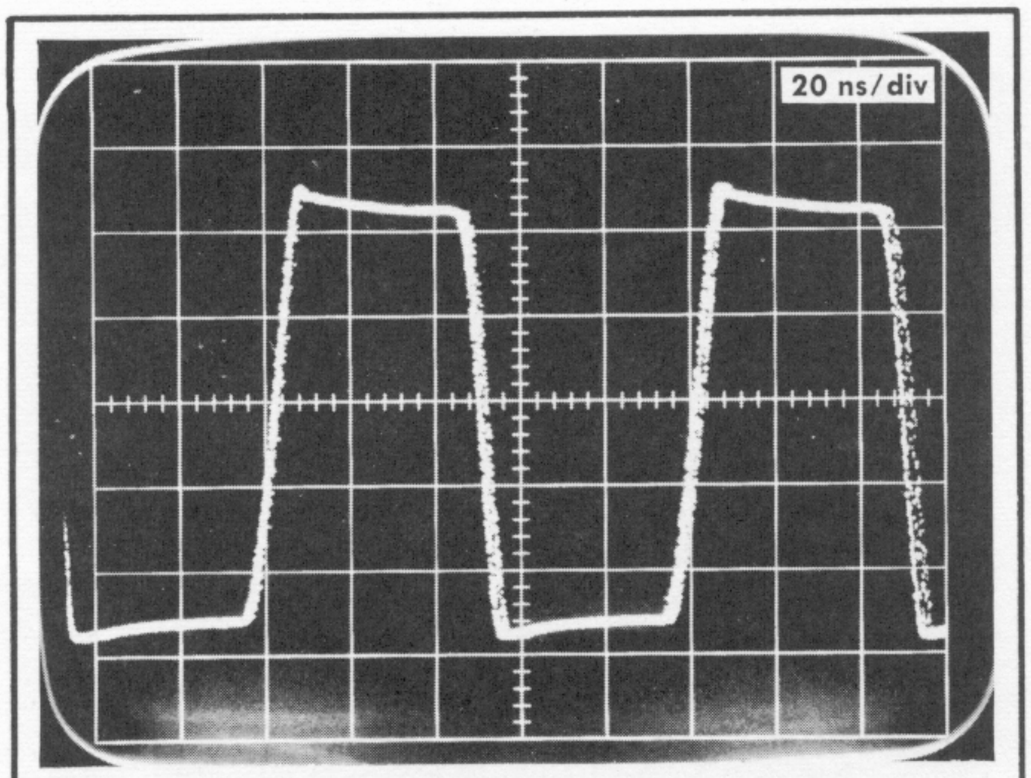
A distorted Square Wave display may be caused by Gate unbalance. Check step 4, Adjust Gate Bal, or replace the substrate assembly, see the Maintenance section.

g. Remove the 3 mm GR adapter and the solid coaxial 3 mm line.

8. Check Displayed Noise (Tangential)

NOTE

When making a visual noise reading from a sampling display, the eye interprets a noise value which is neither the RMS nor the peak-to-peak value. Since most observers agree that the displayed noise value is approximately 3 times the RMS value, the Tangential Noise here defined is 3 times the RMS value. (The measurement technique given produces acceptable agreement between various operators as to the instrument's noise value.)



A. Before Trigger mode.

B. Free run trace.

Fig. 5-6. Dot Transient Response check.

Requirement—Tangential noise will be not greater than 5 mV, with the case on the Type S-4.

a. Connect the Type 284 Square Wave Output to the Type S-4 Input connector with the 2× GR attenuator, variable attenuator, and the 3 mm to GR adapter.

b. Set the sampling unit Units/Div switch to 10 and the Variable control to Cal.

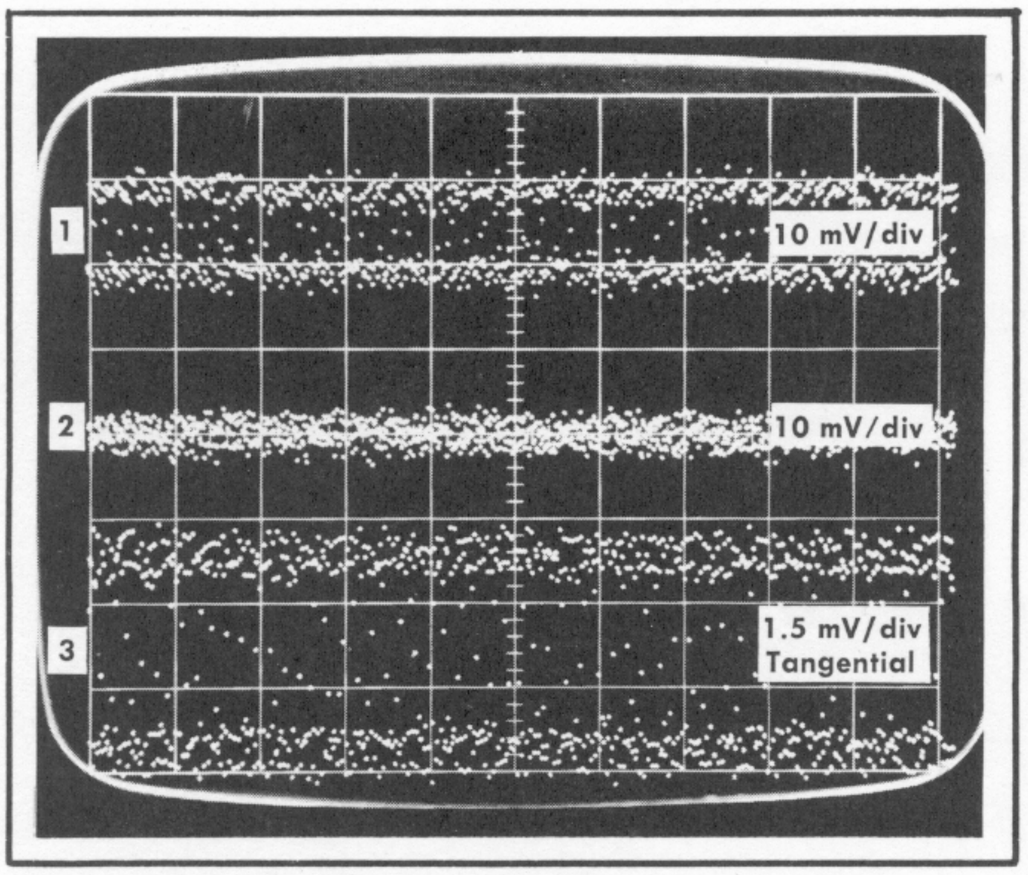


Fig. 5-7. Triple exposure of Tangential noise measurement.

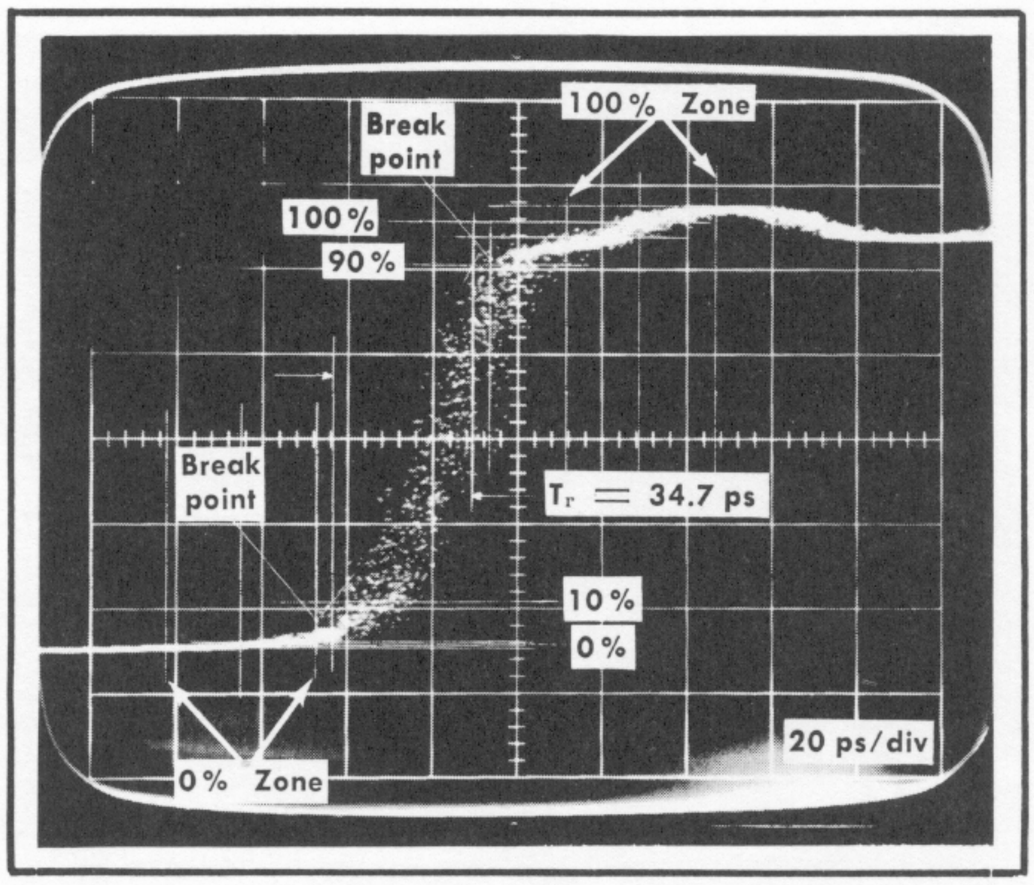


Fig. 5-8. Combination of Type S-4 and Type S-50 risetime measurement.

c. Set the sampling sweep unit for a 1 μs/div sweep and the Trigger Sensitivity control clockwise for free run operation. Disconnect the coaxial cable to the Trigger Input connector.

d. Refer to Fig. 5-7 for displays of the following noise measurement procedure.

(1) Obtain a display of two traces.

(2) Adjust the variable attenuator until the two traces blend together just to the point at which they appear as one trace.

(3) Change the Type 284 Amplitude switch to 1.0 V, 10 times the signal amplitude. The display now has tangential deflection factor of 1.5 mV/div.

Tangential deflection factor per division is equal to the Units/Div setting of 10 mV divided by 2, times 3 divided by 10 = 1.5 mV/div.

The 5 mV tangential display noise limit includes 3.33 graticule divisions (3) of Fig. 5-7. Check that the bottom edges of the two traces are not more than 3.33 divisions apart. Waveform (3) measures as 3.6 mV tangential noise.

Determining Tangential Noise Deflection Factor.

The noise displays of Fig. 5-7 have a noise deflection factor based upon the signal amplitude, the sampling unit Units/Div setting, the fact that the final trace separation is twice the RMS noise, and that the tangential noise is 3 times the RMS noise. The square wave signal amplitude that makes two traces appear as one sets the trace separation to twice the RMS noise. The procedure used here then permits a noise deflection factor to be determined by dividing the input mV/div deflection factor by 2 (trace separation is 2 times the RMS noise), multiplying by 3 (tangential noise is 3 times the RMS noise) and then dividing by 10 (the signal amplitude change factor).

e. Disconnect the Type S-4 from the Type 284.

9. Check Risetime

Requirement—The 10% to 90% risetime is equal to or less than 25 ps, displayed as 35 ps or less using the Type S-50 Pulse Generator Head.

Risetime measurement requires either a camera or a storage oscilloscope because the dot density must be increased for an accurate display and the sweep becomes too slow for visual interpretation.

a. Install the Type S-4 in the sampling unit left compartment without the extender.

b. Set the sampling unit Units/Div switch to 100.

c. Connect the Type S-50 on the extender in the right compartment of the sampling unit. Connect the Pulse Output to the solid coaxial line and to the Type S-4 Input connector. Connect the BSM to BNC cable from the Type S-50 Pretrig Out connector to the sampling sweep unit 50 Ω Trigger Input connector.

d. Set the sampling sweep unit for a 20 ps/div sweep rate (Range switch to 100 ns, Time Magnifier switch to ×50 and the Display Mag switch to ×10). Center the rising portion of the pulse on the graticule and obtain at least 100 dots per division. Photograph or store the display.

e. Measure the risetime as follows:

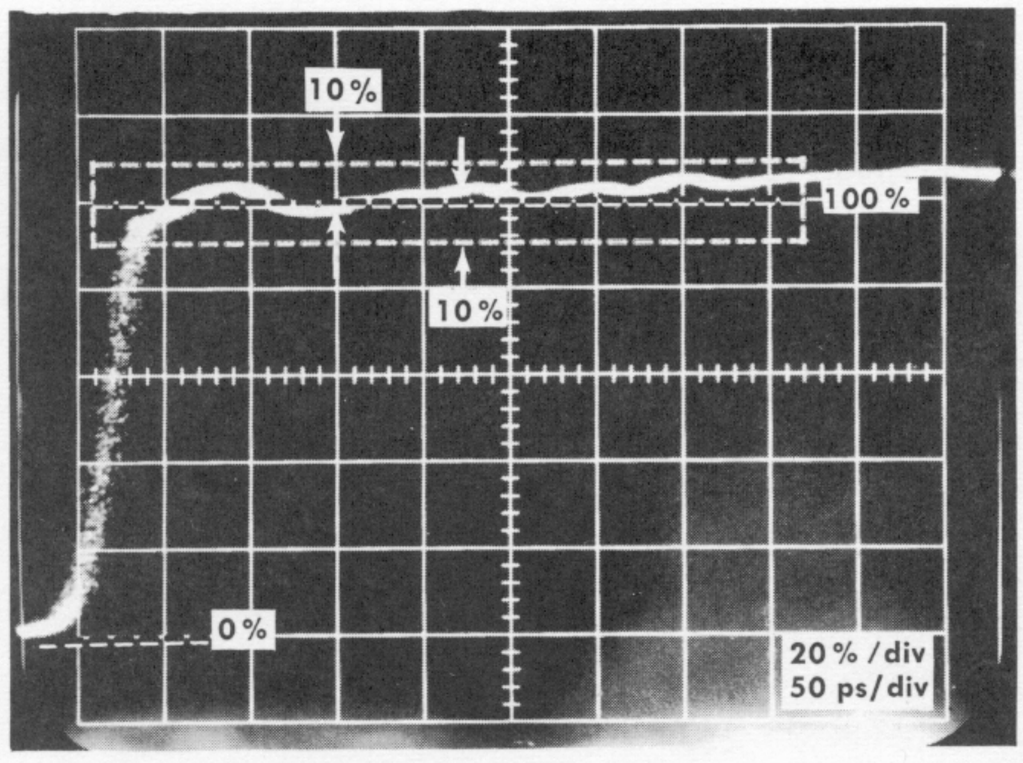
(1) Mark reference points at maximum rate of change, the break points shown in Fig. 5-8.

(2) Mark the centers of the 0% zone and 100% zone (the specified system risetime wide, 35 ps), 35 ps from the reference break points, shown in Fig. 5-8.

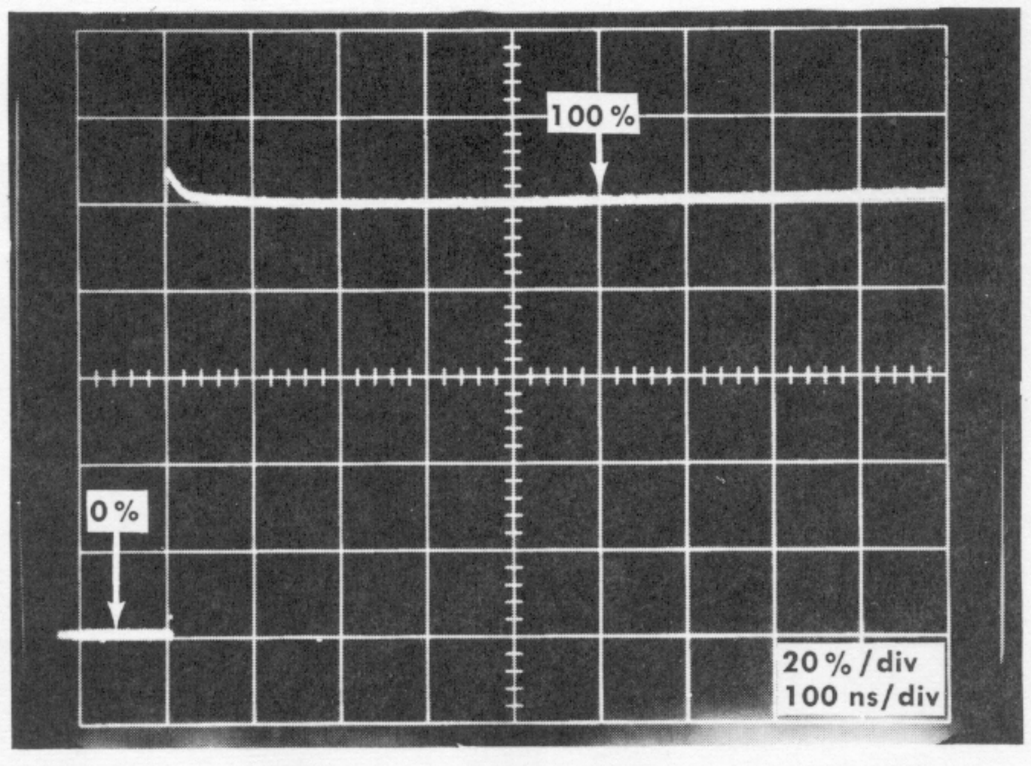
(3) Mark the average level of the 0% and 100% zones through the centers of the zones.

(4) Mark the 10% and 90% points in relation to the 0% and 100% average levels.

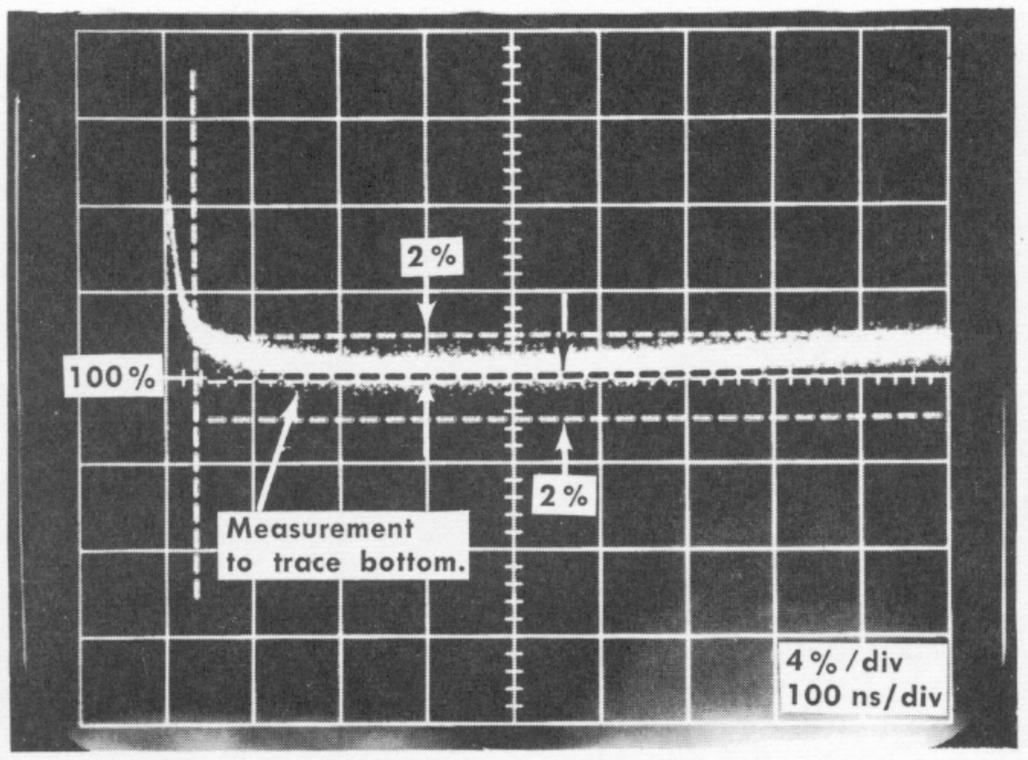
(5) Measure the risetime between the 10% and 90% points.



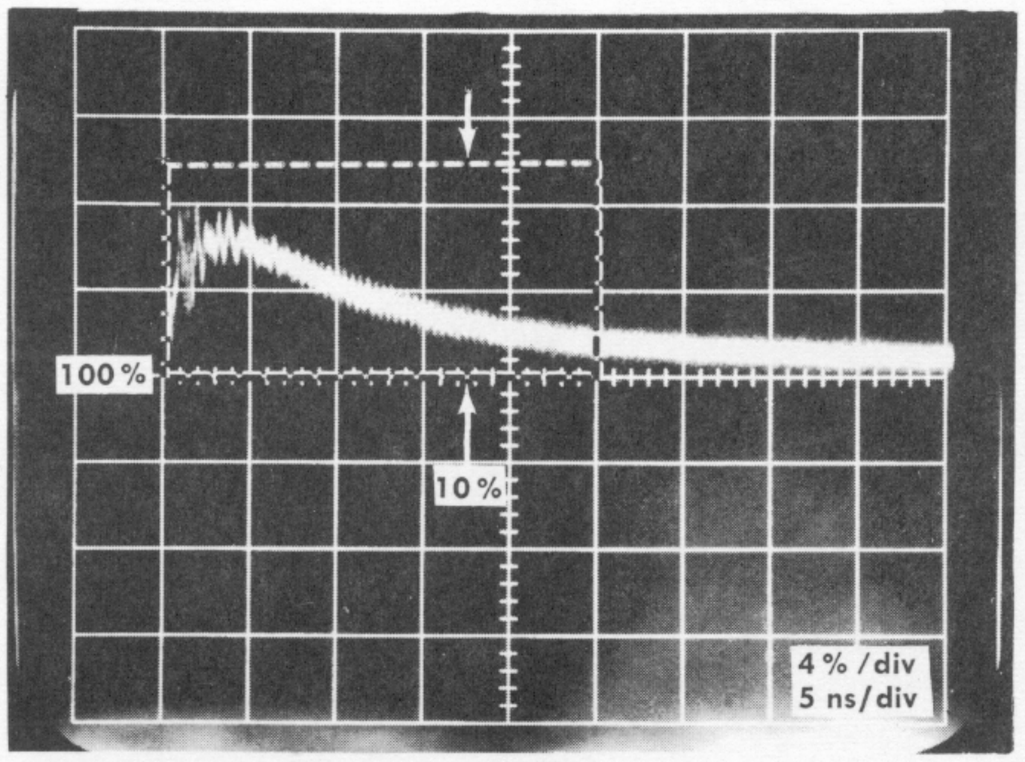
A. Type S-50 for 90% amplitude through 400 ps time interval.



B. Initial amplitude of Type 284 Pulse Output. Before Trigger operation.



C. 25 ns and thereafter time interval.



D. 400 ps through 25 ns time interval.

Fig. 5-9. Check of pulse flatness deviation, step 10.

f. Check that the risetime is 35 ps or less.

g. Use the same display and setup for the pulse flatness deviation check, step 10.

10. Check Pulse Flatness Deviation

Requirement—Pulse will deviate from the flat;

First 400 ps after step, —10%, +10% or less, total less than 20% peak to peak;

Between 400 ps and 25 ns after step, 0%, +10% or less, total less than 10% peak to peak;

After 25 ns, +2%, —2% or less, total less than 4% peak to peak.

The Type S-50 is used to determine pulse flatness deviation during the first 400 ps and the Type 284 is used after the first 400 ps.

Measurement of the pulse flatness deviation during the first 400 ps requires either a camera or a storage oscilloscope because the dot density must be increased for an accurate display and the sweep becomes too slow for visual interpretation, as in the check of risetime.

a. Use the same setup as in step 9 and set the 100% zone on a graticule line. Change the sampling sweep unit sweep rate to 50 ps/div (Time Magnifier switch to ×20) and Time Position the display so the 90% amplitude point is near the first division on the graticule.

b. Check that the pulse does not deviate from the 100% level more than +10% or —10% (total of 20% peak to peak) during the first 400 ps, see Fig. 5-9A. 10% is about a half division.

c. Disconnect the Type S-50 from the solid coaxial line.

d. Connect the Type 284 Pulse Output connector to the Type S-4 Input connector through a 3 mm to GR adapter and the 3 mm solid coaxial line. Set the Type 284 Mode switch to Pulse Output. Connect the Type 284 Trigger Output to the sampling sweep unit 50 Ω Trigger Input connector through a BNC coaxial cable.

e. Set the sampling sweep unit sweep rate to 100 ns/div (Range switch to 1 μs, Display Mag switch to ×1 and the Time Magnifier switch to ×1). Set the Start Point switch to Before Trigger and obtain a stable display.

f. Use the sampling sweep unit Time Position control to place the rising portion of the pulse one division from the left edge of the graticule. Set the sampling unit Variable Units/Div control for 5 divisions between the 0% amplitude and the 100% amplitude level. See Fig. 5-9B. Use the point 50 ns before the pulse as 0% and the point 500 ns after the pulse as 100%.

g. Change the Units/Div switch (without moving the Variable control) to 20 or a signal amplitude now 4% per division.

h. Position the trace bottom at the 100% (500 ns after pulse rise) amplitude point on the center graticule line.

i. Check the pulse flatness deviation from 25 ns after pulse rise through end of the pulse. (The Time Position control may be used.) See Fig. 5-9C.

j. Check that the pulse flatness deviation is not more than +2%, —2% (total of 4% peak to peak). If the deviation is more than specified, perform step 11, Adjust Transient Response.

k. Set the sampling sweep unit sweep rate to 5 ns (Range switch to 100 ns and Time Magnifier switch to ×2) and set the Start Point switch to With Trigger.

l. Reposition the rising portion of the pulse one division from the left edge of the graticule. Check the pulse flatness deviation from 400 ps to 25 ns after the pulse rise. See Fig. 5-9D.

m. Check that the pulse flatness deviation is not more than 0%, +10% or total 10% peak to peak.

n. Use the same setup to perform the Transient Response adjustment. Disconnect the Type 284 with the solid coaxial line from the Type S-4 and remove the BNC coaxial cable from the sampling sweep Trigger Input. Proceed to step 12.

11. Adjust Transient Response ◑

Transient Response control R18 adjusts the magnitude of the blow-by correction signal; it does not change risetime.

a. Use the same setup as the pulse flatness deviation check, parts d through j.

b. Adjust Transient Response R18 so the pulse flatness does not deviate more than +2% or —2%, total 4% peak to peak, in the interval following 25 ns after the pulse rise. See Fig. 5-9C.

c. Disconnect the Type 284 with the solid coaxial line from the Type S-4 Input and remove the BNC coaxial cable to the sampling sweep unit Trigger Input connector.

12. Check Baseline Shift With Repetition Rate Change

Requirement—A no-signal trace will not shift vertically more than 10 mV when the sampling sweep unit external trigger rate is changed from 30 Hz to 50 kHz.

a. Use the test oscilloscope as a trigger rate generator. Drive the sampling sweep unit external trigger input with the front panel +Gate signal (+20 volts peak). Connect the +Gate to the clip lead adapter and to the Type 3T2 1 MΩ/UHF SYNC connector and trigger on the — polarity of the signal. (If the sampling sweep is other than a Type 3T2, place a 10 kΩ, ½ watt resistor between the test oscilloscope +Gate terminal and the sampling sweep external 50 Ω Trigger Input connector to provide 100 mV of triggering signal.)

Set the test oscilloscope sweep controls for a free run sweep. To obtain a 30 Hz trigger signal, set the Time/Div switch to 0.5 ms and the Variable time/div control to a position about 45° left of the top center. To obtain a 50 kHz trigger signal, set the Time/Div switch to 20 μs and the Variable time/div control to a position 45° clockwise from bottom center.

b. Connect the 3 mm to GR adapter and 2× GR attenuator on the Type S-4 Input connector.

c. Set the sampling sweep unit for an external triggered sweep rate of 50 ns/div (to ensure that the shortest trigger circuit holdoff period is obtained and that the triggering rate can actually follow the external triggering signal repetition rate).

d. Set the sampling unit Units/Div switch to 10. Connect the external trigger rate generator signal to the sampling sweep unit and obtain a triggered sweep at either 30 Hz or 50 kHz repetition rate. Set the sampling unit DC Offset control to place the trace at one of the graticule lines.

e. Change the trigger rate generator through its ranges to the other frequency limit and check that the CRT trace does not move up or down farther than a total of one division.

f. If the trace moves too far, check the avalanche transistor, Q69. This requires starting the procedure at step 1.

g. Disconnect the Trigger Input cable from the test oscilloscope.

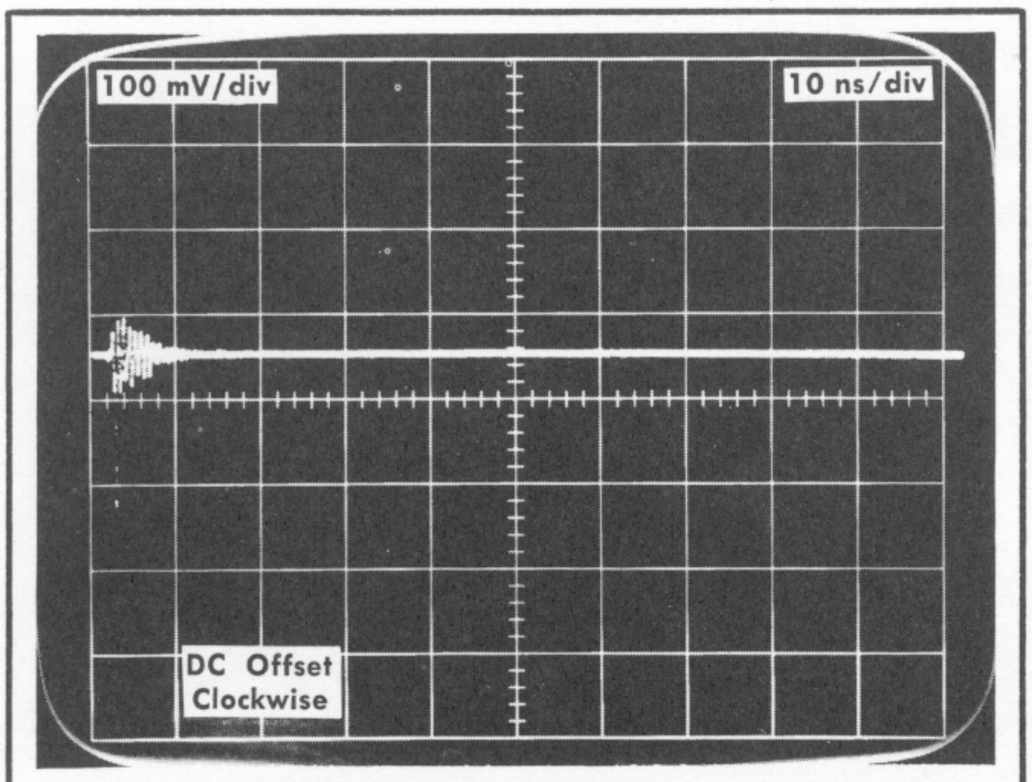
13. Check or Adjust Strobe Kickout

NOTE

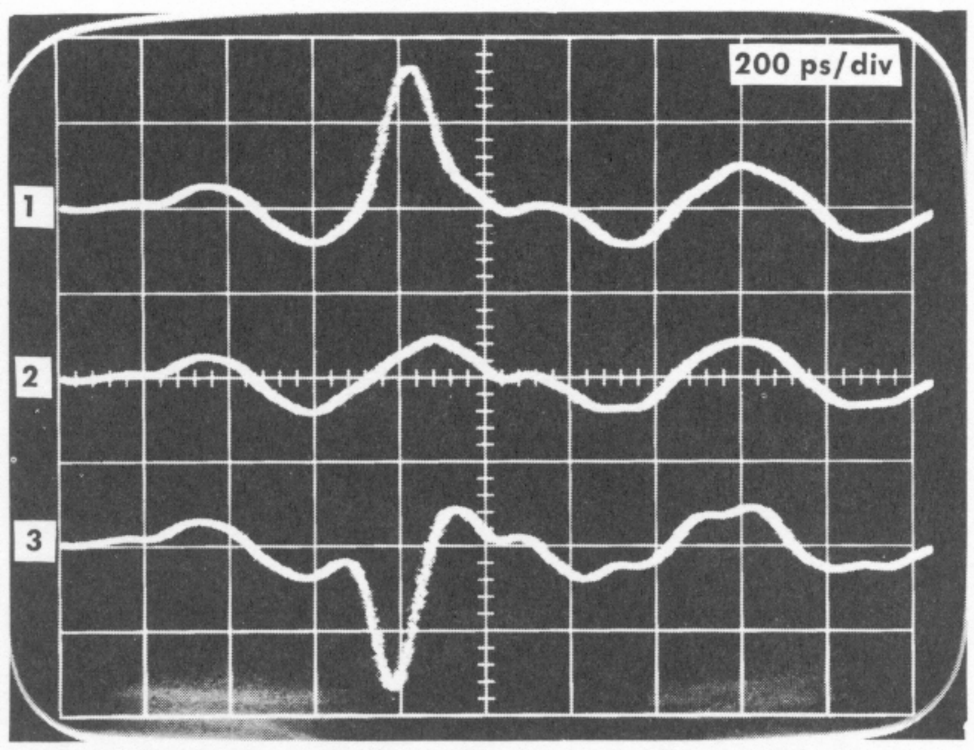
Strobe kickout need to be checked only if the Sampling Gate substrate assembly or Strobe Board have been replaced.

a. Install the extender in Channel A and attach the Type S-4. Connect the Type S-4 Input connector through a 3 mm to GR adapter to the sampling test oscilloscope.

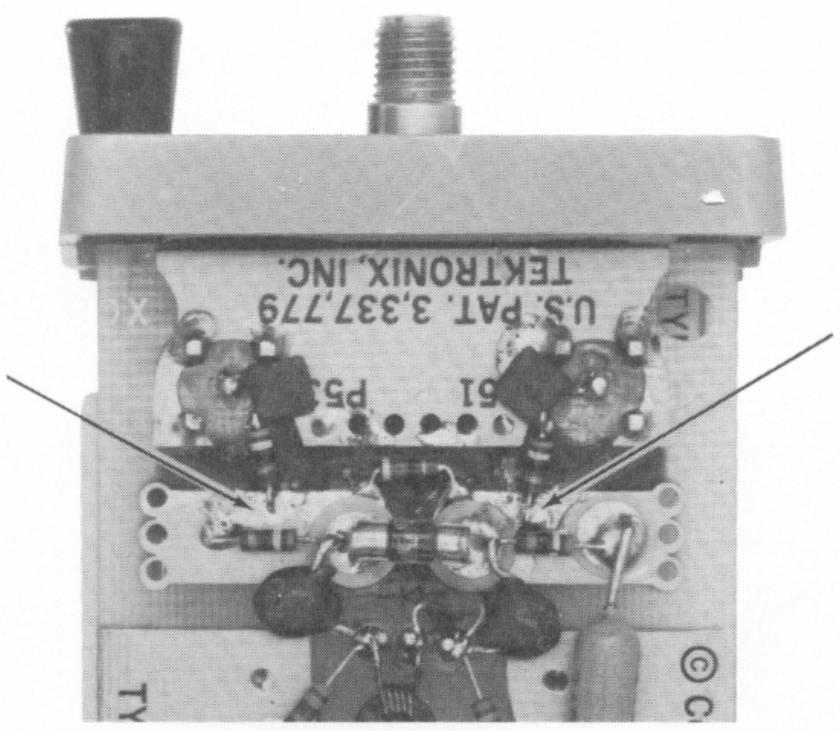
b. Connect the Type 284 Trigger Output to the indicator oscilloscope sampling sweep unit Trigger Input 50 Ω connector with a BNC cable. Set the Type 284 Mode switch to Pulse Output.



A. Locating the ringing portion.



B. DC Offset control for Strobe kickout location.



C. Location of the solder points.

Fig. 5-10. Strobe kickout from the Type S-4 Input connector.

c. Connect the Type 3T2 Pulse Out connector through a BNC cable to the External Trigger Input 50 Ω connector on the sampling test oscilloscope.

d. Set the indicator oscilloscope sampling sweep unit controls as follows:

Time Position	Midrange
Samples/Div	Any position
Time/Div	10 ns
Range	100 ns
Display Mode	Manual
Manual Scan	Midrange
Trigger Sensitivity	Fully counterclockwise
Recovery Time	Fully counterclockwise
Polarity	+
Source	Ext

e. Set the sampling test oscilloscope as follows:

Sampling Sweep Unit

Time/Div	10 ns
Samples/Div	100
Time Position	Midrange
Trigger Source	Ext
Slope	—
Sweep Mode	Normal
Trigger Sensitivity	10 o'clock

Sampling Unit

Millivolts/Div	100
DC Offset	Centered display
Other controls	Optional

f. Set the indicator oscilloscope sampling unit Units/Div switch to 2 and rotate the DC Offset control. The sampling test oscilloscope CRT display should show a spike in the ringing portion, positive for counterclockwise rotation and negative for clockwise rotation. This identifies the Strobe kickout. Place the ringing portion in the first division with the Time Position control, see Fig. 5-10.

g. Change the sampling test oscilloscope sweep rate to 200 ps/div. Fig. 5-10B shows the sampling unit (1) DC Offset control counterclockwise, (2) DC Offset control set for minimum of both strobes, and (3) DC Offset control set clockwise. Set the sampling unit DC Offset control for minimum amplitude of both strobes.

h. Set the sampling unit Units/Div switch to 100 and check the kickout. Amplitude up to a 50 mV peak is acceptable.

i. Reduce the kickout amplitude by moving the solder point on the clipping lines of R51 or R53. Since the solder points are at ground potential, the CRT display is observed

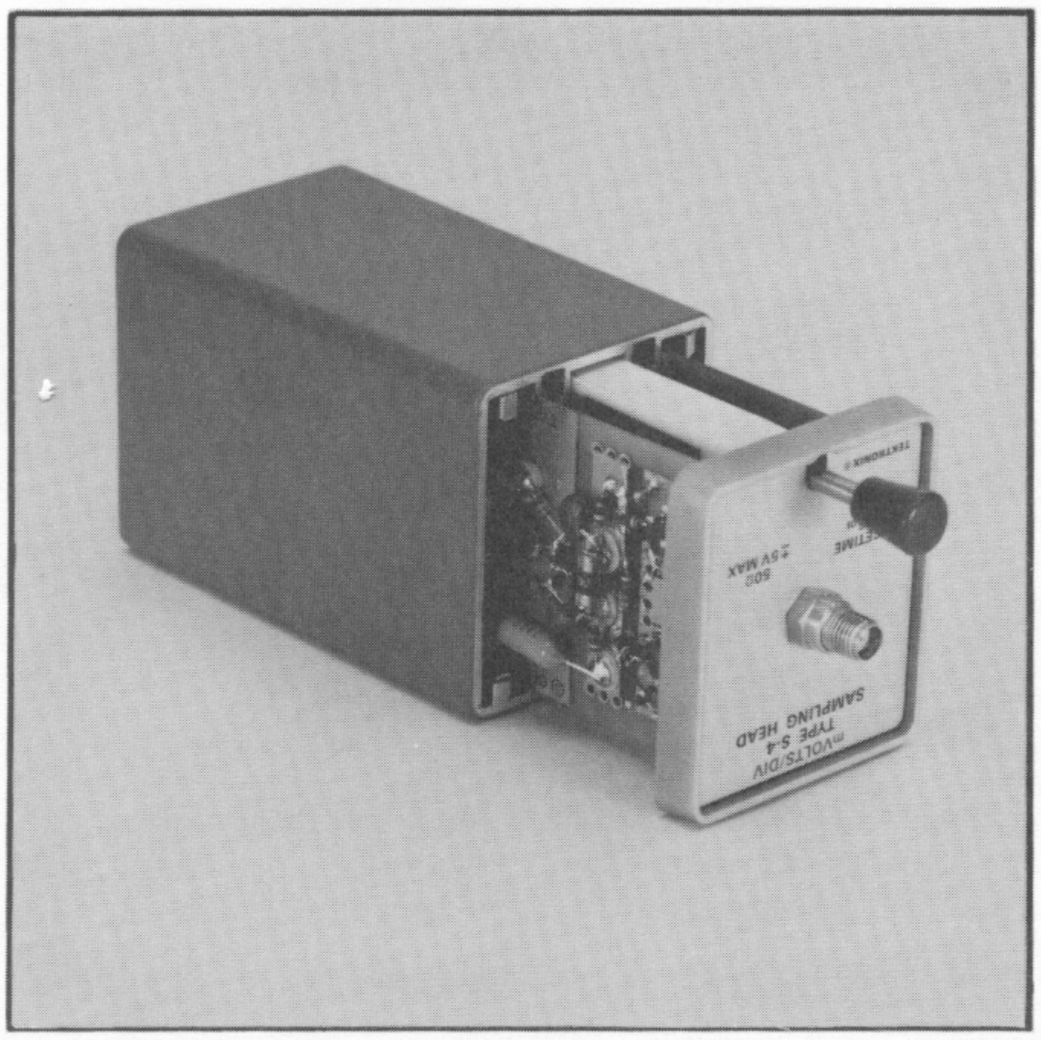


Fig. 5-11. Correct board and latch positions when re-installing the Sampling Head case.

as the lead is heated with a small soldering iron and moved with a soldering tool. Keep the solder points as close to R50 as possible. Fig. 5-10C shows the solder points on the clipping lines.

j. Set the sampling test oscilloscope at 1 ns/div (Time Magnifier at ×10).

k. Set the indicator oscilloscope sampling unit Units/Div switch to 2 and the DC Offset control fully clockwise.

l. Check that the kickout occurs within 1.2 ns of the beginning of the ringing portion. If not, readjust the Snap-Off Current control (see Step 3 Adjust Avalanche Volts and Snap-Off Current).

The case on the Type S-4 may change the kickout amplitude from that observed with the case off. Desired minimum is with the case on the Type S-4 and several attempts should be made. Risetime should be checked after any solder point change.

Fig. 5-11 shows the correct board and latch position for re-installation of the case.

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
incd	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
◐	Screwdriver adjustment.
▭	Control, adjustment or connector.

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Capacitors		
Tolerance ±20% unless otherwise indicated.						
C5	283-0047-00			270 pF	Cer	500 V 5%
C6	283-0047-00			270 pF	Cer	500 V 5%
C12	283-0121-00			0.001 μF	Cer	200 V
C19	283-0136-00			10 pF	Cer	50 V 5%
C24	290-0188-00			0.1 μF	Elect.	35 V 10%
C25	290-0267-00			1 μF	Elect.	35 V
C39	283-0051-00			0.0033 μF	Cer	100 V 5%
C41	283-0000-00			0.001 μF	Cer	500 V
C45	290-0246-00			3.3 μF	Elect.	15 V 10%
C46	283-0005-00			0.01 μF	Cer	250 V
C47	283-0066-00			2.5 pF	Cer	200 V
C49	283-0000-00			0.001 μF	Cer	500 V
C50	283-0005-00			0.01 μF	Cer	250 V
C51	283-0154-00			22 pF	Cer	50 V 5%
C52	283-0135-00			100 pF	Cer	
C53	283-0154-00			22 pF	Cer	50 V 5%
C54	283-0135-00			100 pF	Cer	
C55	290-0134-00			22 μF	Elect.	15 V
C59	283-0121-00			0.001 μF	Cer	200 V
C63	283-0103-00			180 pF	Cer	500 V 5%
C64	283-0103-00			180 pF	Cer	500 V 5%
C65	283-0121-00			0.001 μF	Cer	200 V
C69	283-0140-00			4.7 pF	Cer	50 V 5%
C71	283-0121-00			0.001 μF	Cer	200 V
				Semiconductor Device, Diodes		
D2A[1]						
D2B[1]						
D2C[1]						
D2D[1]						
D2E[1]						
D2F[1]						
D20	152-0333-00			Silicon		High speed and conductance
D23	152-0333-00			Silicon		High speed and conductance
D25	152-0333-00			Silicon		High speed and conductance
D28	152-0333-00			Silicon		High speed and conductance

[1]Furnshed as a unit with Hybrid Osc. Assembly (*155-0001-00).

Semiconductor Device, Diodes *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Description
D41	*152-0185-00		Silicon	Replaceable by 1N4152
D43	*152-0185-00		Silicon	Replaceable by 1N4152
D61	*152-0335-00		Silicon	Snap-off
D80	*152-0185-00		Silicon	Replaceable by 1N4152
D83	*152-0185-00		Silicon	Replaceable by 1N4152

Connectors

J1	131-0631-00		Receptacle, electrical
J3[2]			
J51	131-0391-01		Receptacle, electrical
J53	131-0391-01		Receptacle, electrical
P3	131-0663-00		Receptacle, electrical
P17	131-0565-00		Receptacle, electrical, male
P51	131-0582-00		Receptacle, electrical
P53	131-0582-00		Receptacle, electrical

Inductors

L10	276-0543-00		Core, ferrite
L14	276-0543-00		Core, ferrite
L55	*120-0382-00		Toroid, 14 turns single

Transistors

Q10	*151-0212-00		Silicon	Tek Spec
Q14	*151-0212-00		Silicon	Tek Spec
Q36	151-1012-00		Silicon	FET
Q43	151-0224-00		Silicon	2N3692
Q46	151-0224-00		Silicon	2N3692
Q55	151-0224-00		Silicon	2N3692
Q69	*153-0556-00		Silicon	Tek Spec

Resistors

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

R2A[3]				
R2B[3]				
R2E[3]				
R2F[3]				
R4	315-0103-00	10 kΩ	¼ W	5%

[2]**Furnished as a unit with 10X Atten. (119-0178-00).**

[3]**Furnished as a unit with Hybrid Osc. Assembly (*155-0001-00).**

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
R7	315-0103-00			10 kΩ	¼ W	5%
R10	317-0102-00			1 kΩ	⅛ W	5%
R11	317-0510-00			51 Ω	⅛ W	5%
R12	317-0511-00			510 Ω	⅛ W	5%
R13	317-0360-00			36 Ω	⅛ W	5%
R15	317-0102-00			1 kΩ	⅛ W	5%
R17	315-0152-00			1.5 kΩ	¼ W	5%
R18	311-0643-00			50 Ω, Var		
R21	317-0224-00			220 kΩ	⅛ W	5%
R24	317-0393-00			39 kΩ	⅛ W	5%
R26	317-0224-00			220 kΩ	⅛ W	5%
R30	321-0385-00			100 kΩ	⅛ W Prec	1%
R31	321-0253-00			4.22 kΩ	⅛ W Prec	1%
R32	311-0609-00			2 kΩ, Var		
R33	321-0253-00			4.22 kΩ	⅛ W Prec	1%
R34	321-0385-00			100 kΩ	⅛ W Prec	1%
R36	301-0912-00			9.1 kΩ	½ W	5%
R38	307-0124-00			5 kΩ	Thermal	
R39	317-0202-00			2 kΩ	⅛ W	5%
R40	301-0103-00			10 kΩ	½ W	5%
R42	317-0224-00			220 kΩ	⅛ W	5%
R43	317-0223-00			22 kΩ	⅛ W	5%
R44	317-0122-00			1.2 kΩ	⅛ W	5%
R46	317-0101-00			100 Ω	⅛ W	5%
R47	315-0272-00			2.7 kΩ	¼ W	5%
R48	317-0303-00			30 kΩ	⅛ W	5%
R49	311-0607-00			10 kΩ, Var		
R50	317-0470-00			47 Ω	⅛ W	5%
R51	317-0390-00			39 Ω	⅛ W	5%
R52	317-0101-00			100 Ω	⅛ W	5%
R53	317-0390-00			39 Ω	⅛ W	5%
R54	317-0101-00			100 kΩ	⅛ W	5%
R56	317-0271-00			270 Ω	⅛ W	5%
R57	311-0607-00			10 kΩ, Var		
R59	308-0243-00			240 Ω	3 W WW	5%
R60	317-0390-00			39 Ω	⅛ W	5%
R62	317-0390-00			39 Ω	⅛ W	5%
R65	317-0101-00			100 Ω	⅛ W	5%
R66	311-0644-00			20 kΩ, Var		
R68	317-0332-00			3.3 kΩ	⅛ W	5%
R70	317-0332-00			3.3 kΩ	⅛ W	5%
R71	317-0202-00			2 kΩ	⅛ W	5%
R72	315-0203-00			20 kΩ	¼ W	5%
R73	307-0124-00			5 kΩ	Thermal	
R80	317-0101-00			100 Ω	⅛ W	5%

Ⓐ

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
R81	317-0152-00			1.5 kΩ	⅛ W 5%
R82	317-0101-00			100 Ω	⅛ W 5%
R83	317-0182-00			1.8 kΩ	⅛ W 5%

Transformer

T75	*120-0544-00	Toroid, 2 windings

Integrated Circuit

*155-0001-00	Hybrid Gate Assembly

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

FIG. 1 EXPLODED

SECTION 7
MECHANICAL PARTS LIST

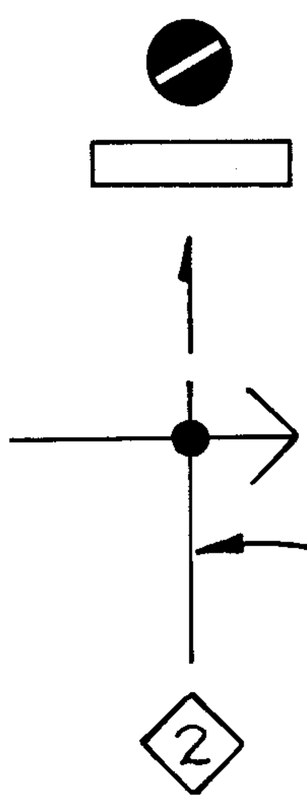
FIG. 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-1	333-1097-00			1		PANEL, front
-2	386-1338-09			1		SUB-PANEL, front
	670-1001-00			1		ASSEMBLY, circuit board—PREAMP
	- - - - - -			-		assembly includes:
-3	388-1039-00			1		BOARD, circuit
-4	136-0263-01			13		SOCKET, pin connector
-5	136-0252-01			10		SOCKET, receptacle (eyelet)
-6	210-0707-00			1		EYELET, metallic
-7	175-1042-01			1		ASSEMBLY, cable, w/connector & holder
-8	155-0001-00			1		ASSEMBLY, hybrid Gate (U1)
	- - - - - -			-		mounting hardware: (not included w/assembly)
-9	211-0092-00			4		SCREW, 2-56 x 3/16 inch, HSS
-10	119-0178-00			1		TERMINATION, coaxial (R3, J3)
-11	131-0632-00			2		CONNECTOR, electrical, contact
-12	214-1072-00			2		SPRING, helical compression
-13	131-0631-00			1		CONNECTOR, OSM
	- - - - - -			-		mounting hardware: (not included w/connector)
-14	220-0531-00			1		NUT, hex., 1/4-32 x 0.375 inch
-15	670-1003-00			1		ASSEMBLY, circuit board—TRIGGER TAKE OFF
	- - - - - -			-		assembly includes:
	388-1041-00			1		BOARD, circuit
-16	131-0663-00			1		CONNECTOR
-17	210-0707-00			2		EYELET, metallic
-18	670-1004-00			1		ASSEMBLY, circuit board—SAMPLER
	- - - - - -			-		assembly includes:
	388-1042-00			1		BOARD, circuit
-19	214-1081-00			4		PIN, spiral
-20	131-0391-01			2		CONNECTOR, male
-21	131-0591-00			12		TERMINAL, pin, 0.025 square x 0.84 inch long
-22	131-0594-00			3		TERMINAL, pin, 0.025 square x 1.485 inches long
-23	670-1002-00			1		ASSEMBLY, circuit board—STROBE
	- - - - - -			-		assembly includes:
	388-1040-00			1		BOARD, circuit
-24	136-0263-01			5		SOCKET, pin terminal
-25	136-0252-01			6		SOCKET, pin connector
-26	344-0061-00			2		CLIP, diode
-27	131-0582-00			2		CONNECTOR, female
-28	384-0687-00			1		SHAFT, latch
-29	105-0066-00			1		STRIKE, latch
-30	380-0125-00			1		HOUSING
	- - - - - -			-		housing includes:
-31	131-0555-00			4		CONTACT
-32	386-1337-04			1		PANEL, rear
	- - - - - -			-		mounting hardware: (not included w/panel)
-33	211-0141-00			4		SCREW, 4-40 x 3 1/4 inches, PHS

SECTION 8
DIAGRAMS

Schematic Symbols

The following special symbols are used on the schematics:



Screwdriver adjustment

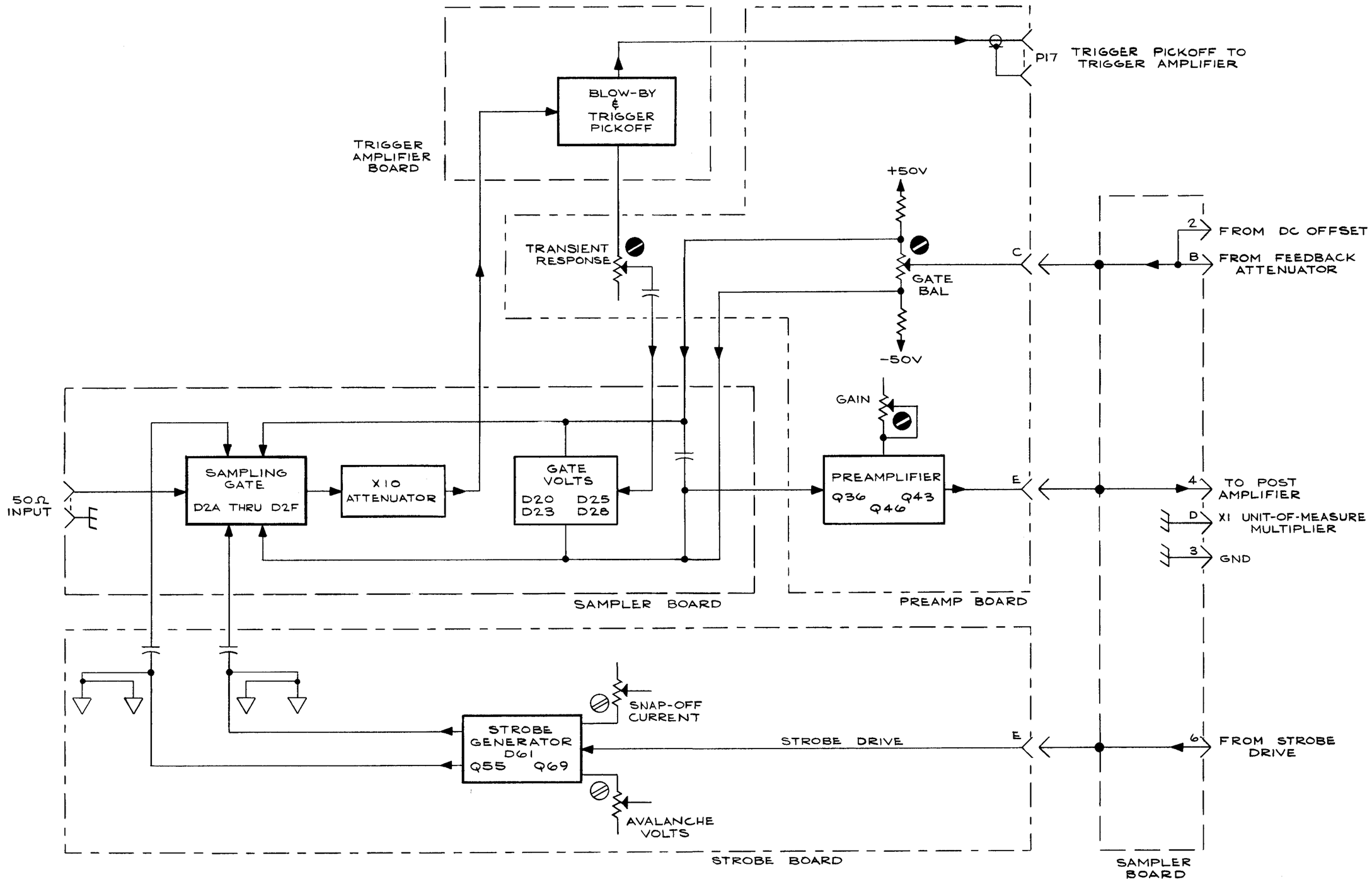
Front-panel control or connector

Clockwise control rotation in direction of arrow

Connection soldered to etched-wiring board

Blue line encloses components located on etched-wiring board

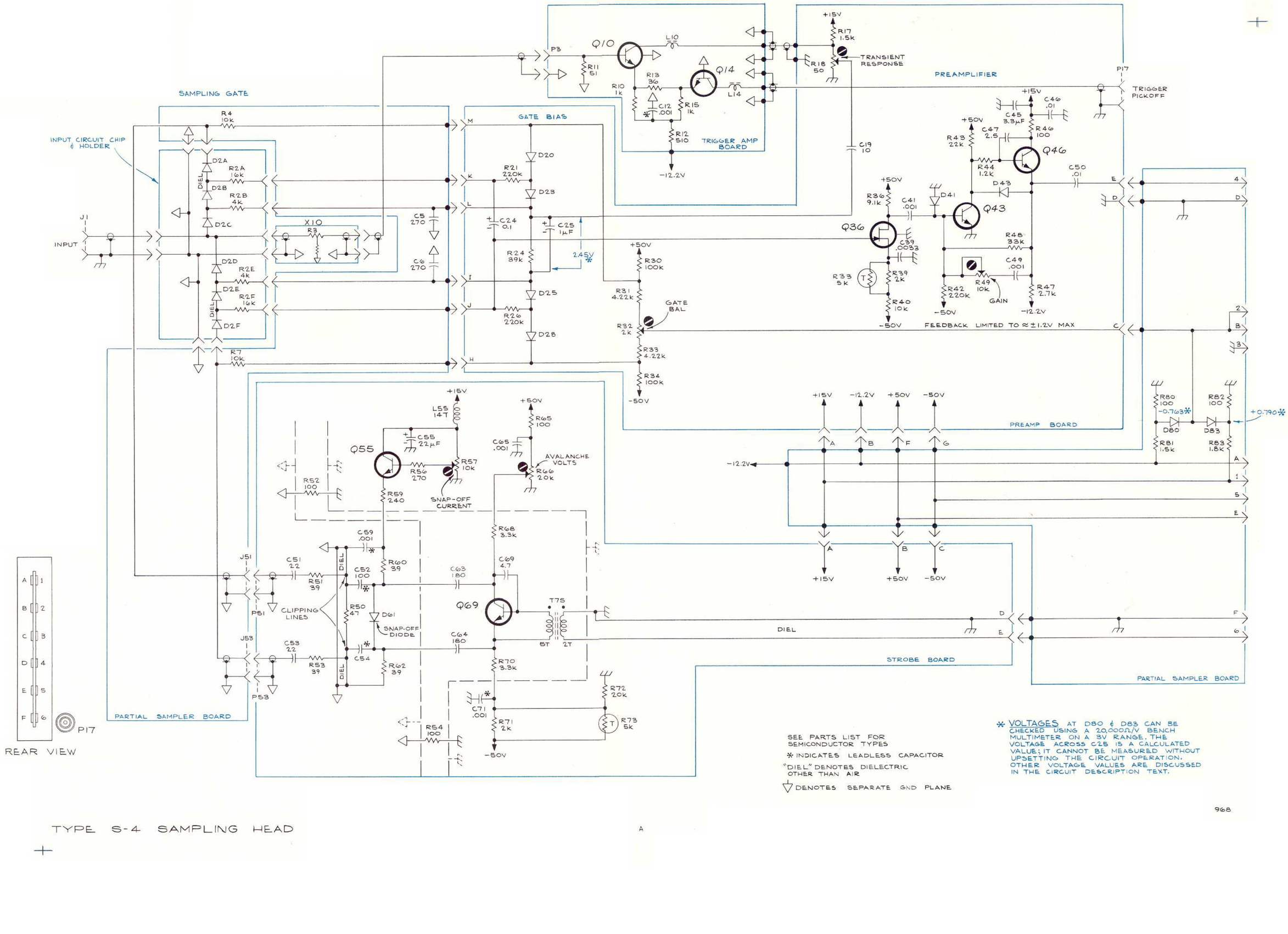
Input from, or output to indicated schematic



TYPE S-4 SAMPLING HEAD

A

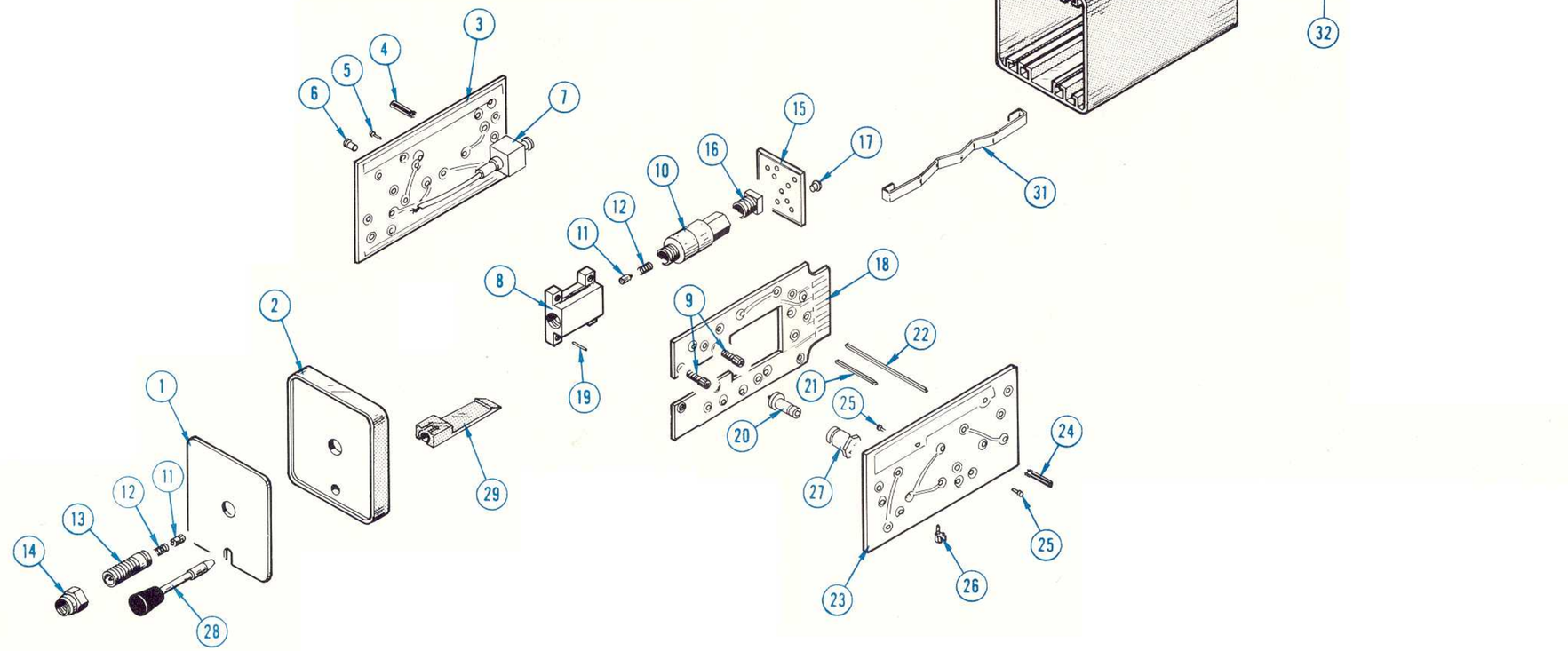
BLOCK DIAGRAM



TYPE S-4 SAMPLING HEAD

A

FIG 1 EXPLODED



OPTIONAL ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
	015-1001-00			1		ATTENUATOR, 2X, 3 mm male to female
	015-1002-00			1		ATTENUATOR, 5X, 3 mm male to female
	015-1004-00			1		TERMINATION, 50 Ω 3 mm female
	015-1006-00			1		CABLE, signal, 5 ns, 3 mm male to female
	015-1008-00			1		ADAPTER, GR874 to 3 mm female
	015-1009-00			1		ADAPTER, "N" type female to 3 mm male
	015-1010-00			1		ADAPTER, 7 mm to 3 mm male
	015-1012-00			1		ADAPTER, 3 mm female to female
	015-1013-00			1		COUPLING CAP, 3 mm female
	015-1014-00			1		POWER DIVIDER, "T", 3 mm male
	015-1015-00			1		CABLE ASSEMBLY, RF, 3 mm, 5 ns
	015-1016-00			1		ADAPTER, "T", female, male, female

FIG 2 ACCESSORIES

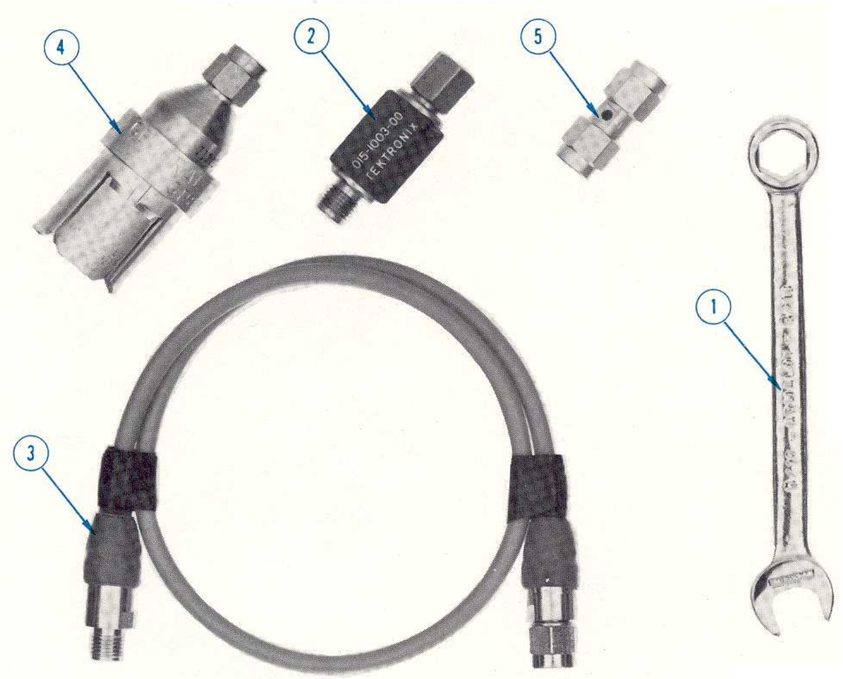


FIG. 2 ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
2-1	003-0247-00			1		WRENCH, combination, $^5/_{16}$ inch
-2	015-1003-00			1		ATTENUATOR, 10X, 3 mm male to female
-3	015-1005-00			1		CABLE, signal, 2 ns, 3 mm male to female
-4	015-1007-00			1		ADAPTER, GR874 to 3 mm male
-5	015-1011-00			1		ADAPTER, 3 mm male to male
	070-0896-00			1		MANUAL, instruction (not shown)

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.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

TYPE S-4

TEXT CORRECTION

Section 3 Circuit Description

Page 3-2 right column

CHANGE: the first two sentences of the next to the last paragraph to read as follows:

Ringing of the Snap-off diode and the clipping lines is prevented mainly by R50 which is directly across the lines ends.

TEXT CORRECTION

Section 2 Operating Instructions

Any time the rigid coaxial cable is identified as semi-rigid, remove the word "semi" from the text.

Page 2-8 CAUTION

REPLACE: the present CAUTION text with the following:

CAUTION

The two coaxial lines listed under part numbers 015-1015-00 and 015-1005-00 must be treated with care to obtain maximum life and least signal distortion. The rigid line may not have its shape changed and still have the propagation delay and Z_o guaranteed. In cases where the line is not used at its maximum performance limits, small amounts of bending can be made providing mating connectors are on each end before bending. If bent to a curve radius of 1-1/2 inches, the line may be made totally inoperative. The flexible cable must not be given a bend radius less than 10 times its OD, or approximately 2-1/4 inches. Flexible cables may suffer outer conductor breakage by tighter bending. Few Flexures assure longer life.

Section 3 Circuit Description

Page 3-5 Column 1

DELETE: put a period after R38 in second sentence and delete remainder of the second sentence.

CHANGE: the third sentence to read:

A total of 4.4 mA channel current passes from the +50 volt supply through R36, Q36, R38 and R40 to the -50 volt supply.

Page 3-5 Column 2

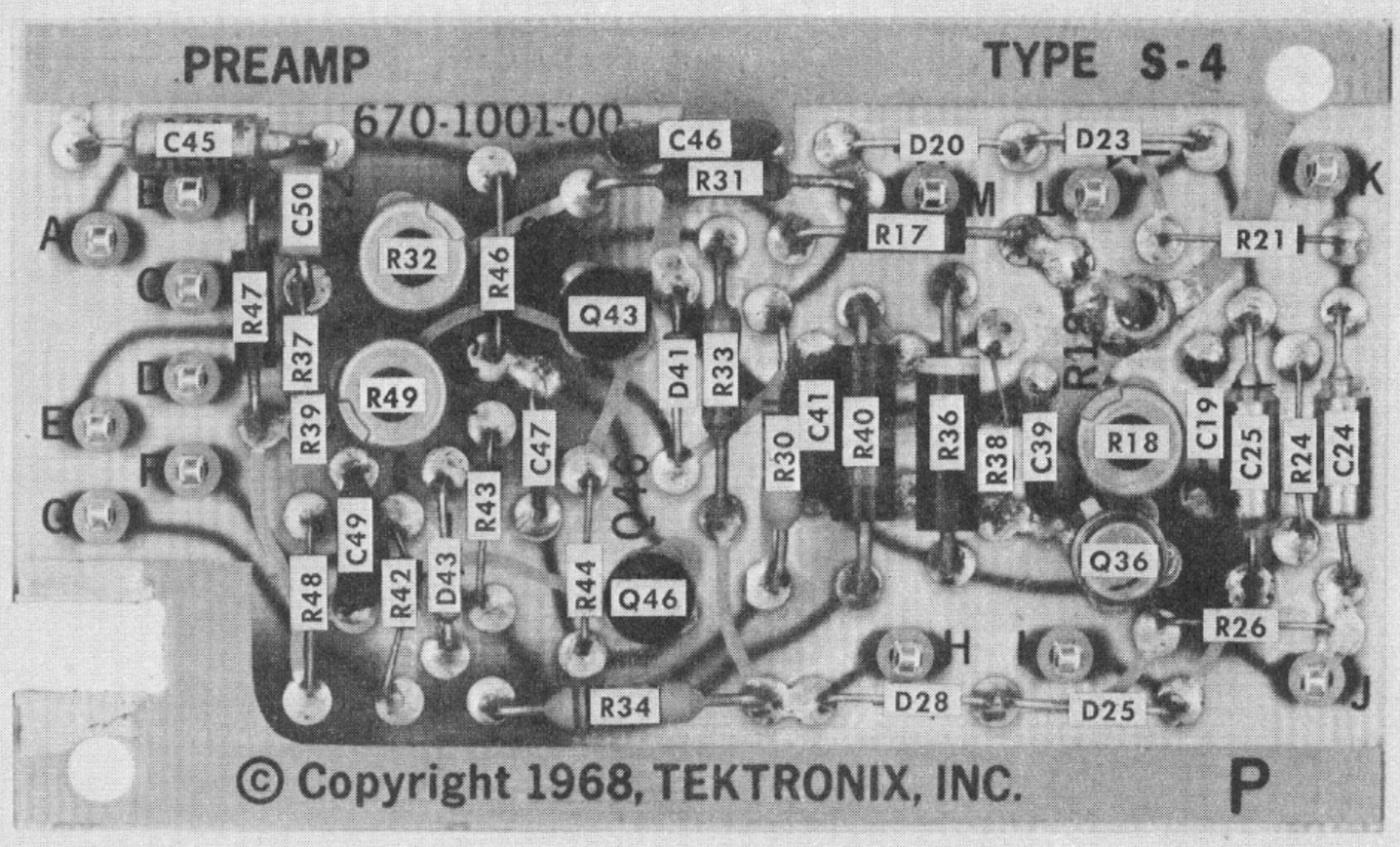
INSERT: the following sentence between the second and third sentences in paragraph two:

> R37 and R39 provide temperature compensation to stabilize loop gain.

Section 4 Maintenance

Page 4-5 Fig. 4-6

REPLACE: the present Fig. 4-6 with the one below:



Section 5 Performance Check/Calibration

CHANGE: all references to solid coaxial cable to rigid coaxial cable.

C2/369

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

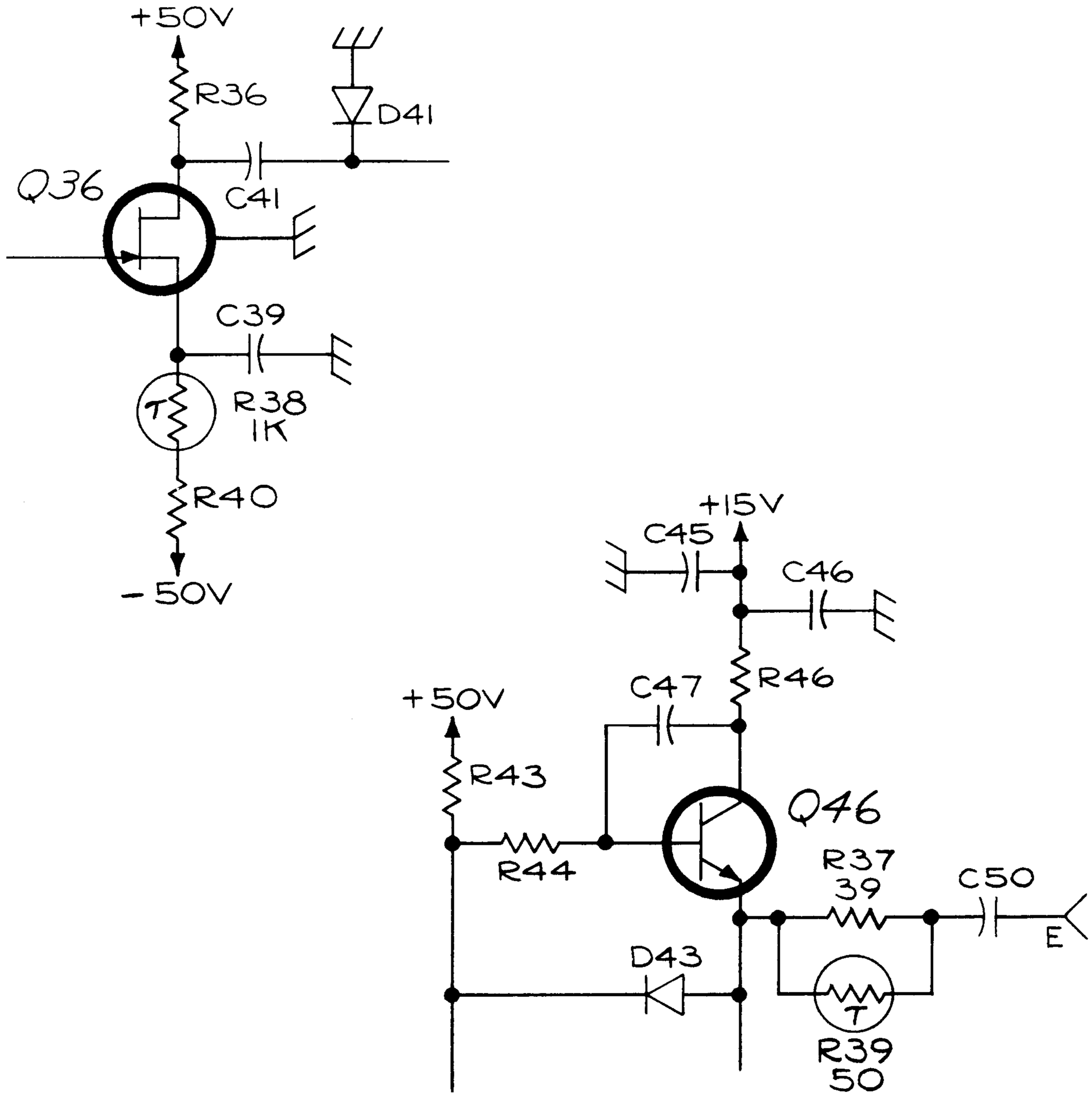
C50	283-0155-00	0.01 μF	Cer	100 V
R38	307-0127-00	1 kΩ	Thermal	
R39	307-0122-00	50 Ω	Thermal	
R72	315-0124-00	120 kΩ	1/4 W	5%

ADD:

R37	317-0390-00	39 Ω	1/8 W	5%

TYPE S-4

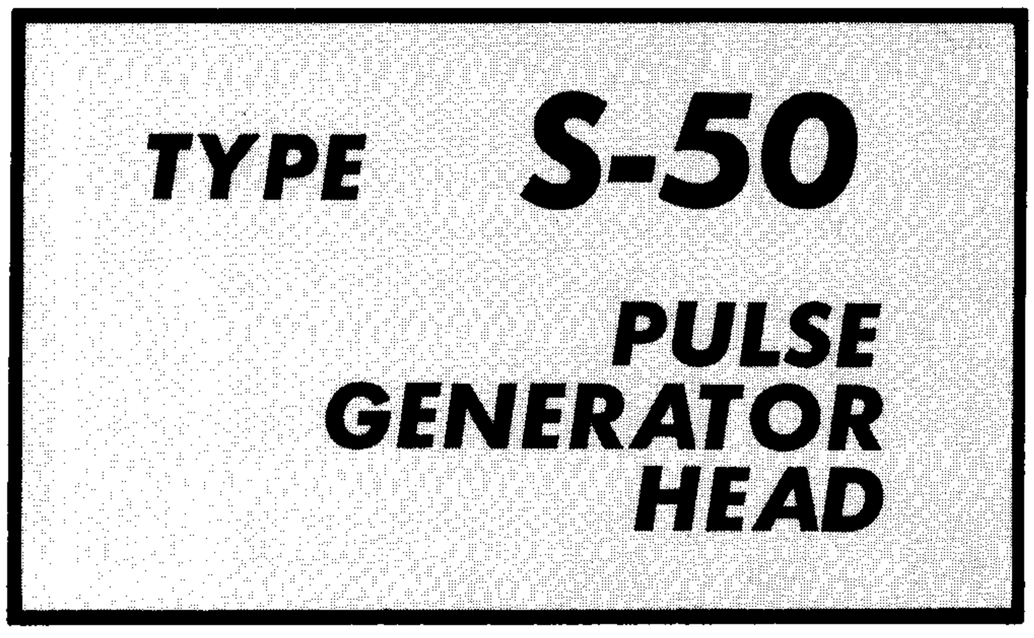
SCHEMATIC CORRECTION



PARTIAL SAMPLING HEAD

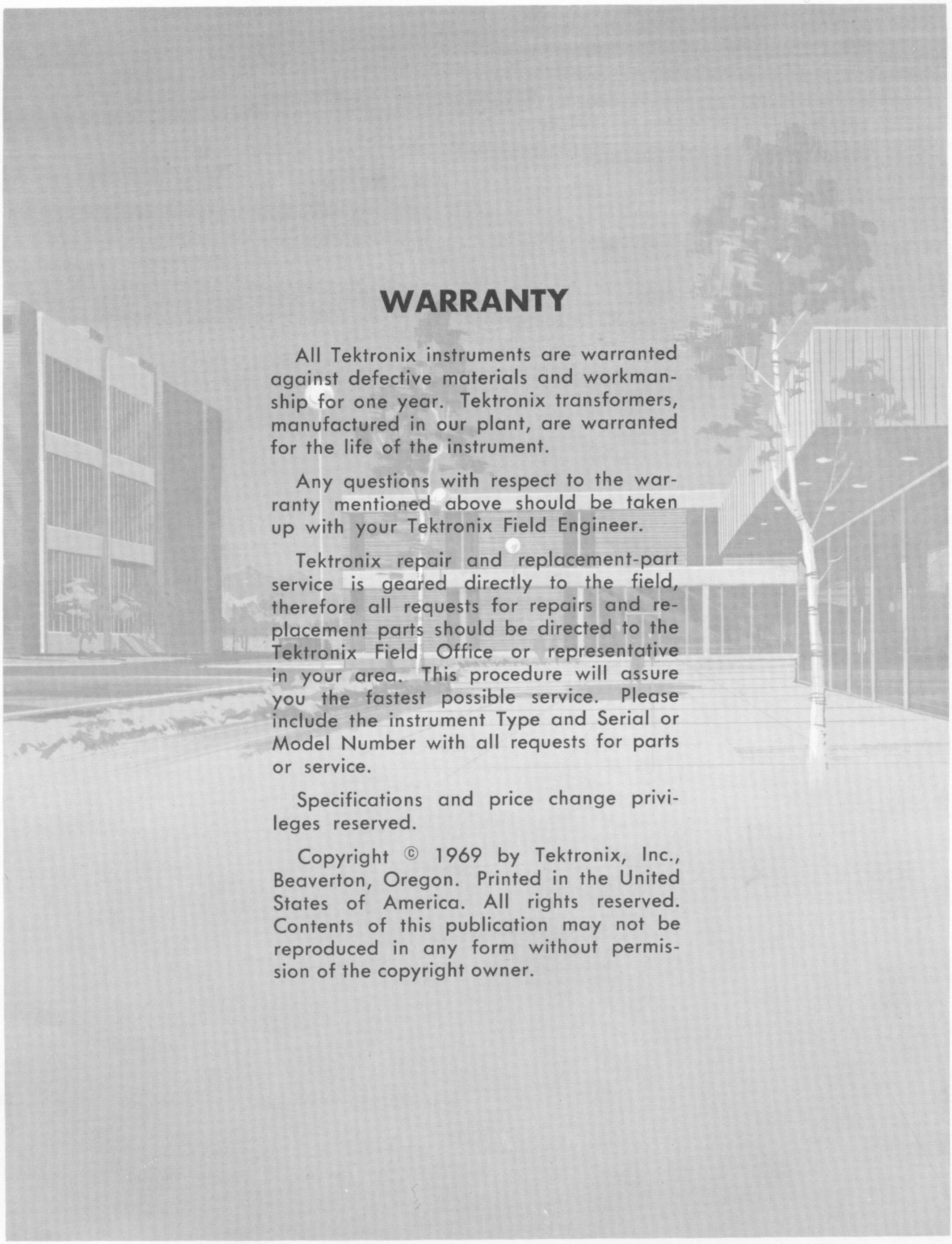
INSTRUCTION MANUAL

Serial Number _____



Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0897-00



WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our 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 or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

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Section 2 Operating Instructions

Section 3 Circuit Description

Section 4 Maintenance

Section 5 Performance Check/Calibration

Abbreviations and Symbols

Parts Ordering Information

Section 6 Electrical Parts List

Mechanical Parts List Information

Section 7 Mechanical Parts List

Section 8 Diagrams

Mechanical Parts List Illustrations

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.



Fig. 1-1. Type S-50 Pulse Generator Head.

SECTION 1
TYPE S-50 SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

The Type S-50 Pulse Generator Head provides a fastrise pulse that is useful in determining the risetime of a sampling system. The less than 25 ps risetime output pulse of the Type S-50, when combined with a fastrise sampling system, also provides high resolution TDR displays. The positive-going output pulse of the Type S-50 has an amplitude of at least 400 mV into 50 Ω and a duration of approximately 100 ns. Repetition rate of the output pulse is approximately 25 kHz.

A pretrigger pulse is available at the Type S-50 front and rear panels. The pretrigger pulse occurs approximately 75 ns before the output pulse. The pretrigger pulse is useful for internal or external triggering of non-random sampling sweep units.

A trigger pulse, occurring at the same time as the fastrise output pulse, is available at the TRIG OUT connector on the Type S-50 front panel.

The operating power required by the Type S-50 is obtained from the Tektronix Type 285 Power Supply or from Tektronix Type 3S2, 3S5, or 3S6 Sampling Units.

ELECTRICAL CHARACTERISTICS

Characteristics

The following characteristics apply over an ambient temperature range of 0° C to +50° C after a five minute warm-up for an instrument that was calibrated at a temperature between +20° C and +30° C. Operating voltages applied to the Type S-50 must be within the limits stated in Section 2 of this manual.

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirement
PULSE OUTPUT	
Risetime (10% to 90%)	25 ps or less (Verify using step 7, Section 5).
Pulse Flatness Deviation (after 90% point on display)	
0 ps to 400 ps	—10% to +10% with a total of 20% or less. (Verify using step 8, Section 5).
400 ps to 5 ns	—5% to +5% with a total of 5% or less. (Verify using step 8, Section 5).
5 ns or more	—2% to +2% with a total of 4% or less. (Verify using step 8, Section 5).
Amplitude into 50 Ω	At least 400 mV, positive going.
Pulse Duration	100 ns to 120 ns
Repetition Rate	25 kHz, within 10%
PRETRIG OUT	
Risetime (10% to 90%)	400 ps or less
Amplitude into 50 Ω	At least 180 mV, positive going.
Pulse Duration	3 ns to 5 ns
Pretrigger to Pulse Time Interval	70 ns to 80 ns
Pretrigger to Pulse Output Jitter	15 ps or less
Pretrig Out (Rear Panel)	
Risetime (10% to 90%)	400 ps or less
Amplitude into 50 Ω	At least 70 mV, positive-going
Pulse Duration	4 ns to 8 ns
TRIG OUT	
Risetime (10% to 90%)	250 ps or less
Amplitude into 50 Ω	At least 200 mV, positive-going
Pulse Duration	100 ns to 120 ns
Time Coincidence with PULSE OUTPUT	Within 5 ns

ENVIRONMENTAL CHARACTERISTICS

Storage	Operating
Temperature— —40° to +65° C	Temperature— As stated above Electrical Characteristics table
Altitude— To 50,000 feet	Altitude— To 15,000 feet

MECHANICAL CHARACTERISTICS

Dimensions— Height ≈2 inches
Width ≈1⅞ inches
Length ≈4 inches

Construction— Epoxy laminated circuit boards. Aluminum wrap-around cabinet with aluminum casting at front and rear. Anodized aluminum front panel.

Accessories— An illustrated list of the accessories supplied with the Type S-50 is at the end of the Mechanical Parts List pullout pages.

NOTES

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

This section provides the basic information required for operation of the Type S-50 Pulse Generator Head, and includes installation and First Time Operation instructions.

The Type S-50 may be powered by the Type 3S2, 3S5, or 3S6 Sampling Unit in place of a sampling head, at the sacrifice of one sampling channel. Or the unit may be powered separately by a Tektronix Type 285 Power Supply for S-Series Heads. The Type S-50 may also be operated on one of two accessory extender cables for semi-portable use permitting short-length coaxial cables to be used between the PULSE OUTPUT connector and the load.

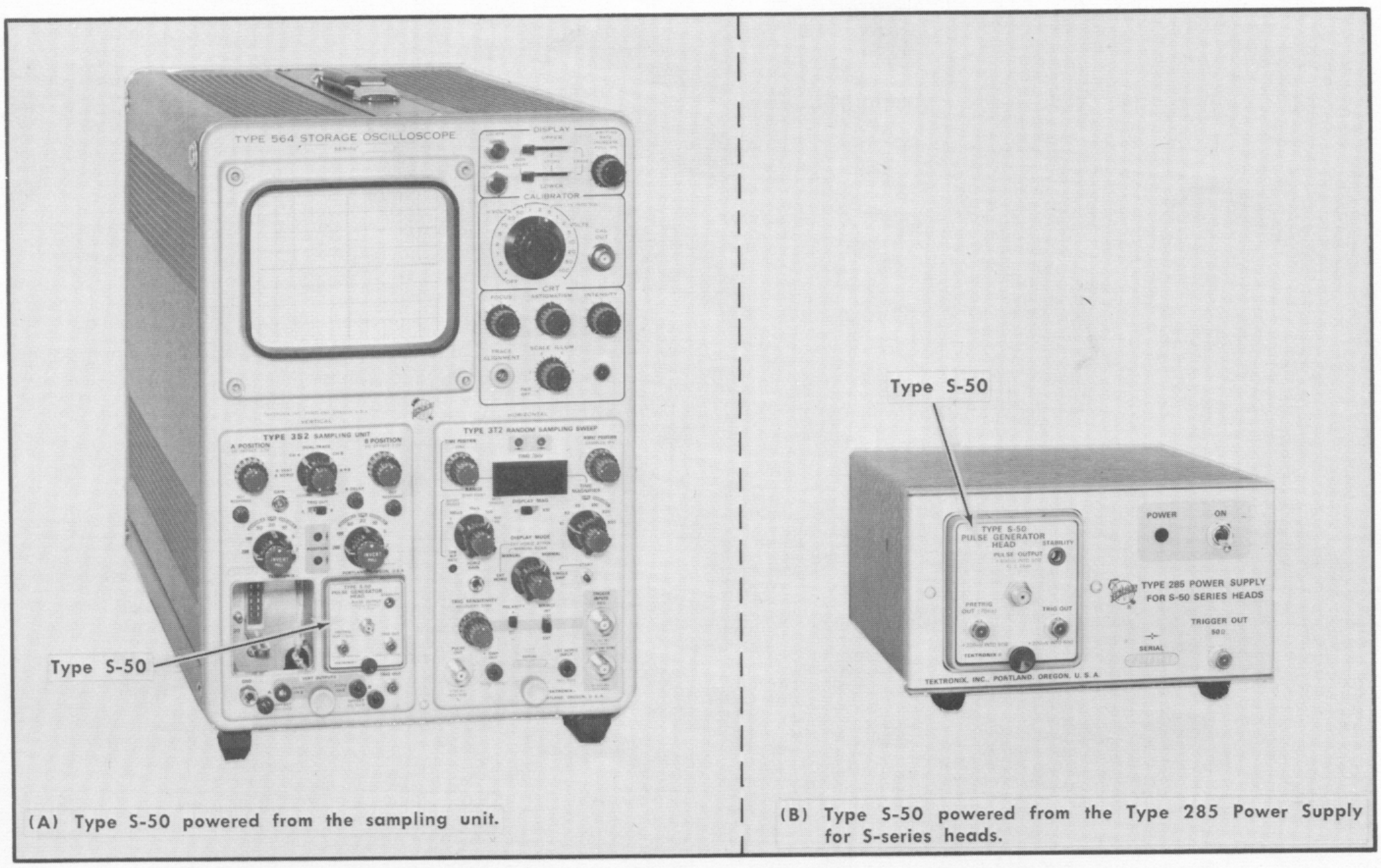
High resolution TDR measurements of coaxial cable discontinuities can be made using the Type S-50 and a Type S-4 Sampling Head. The fastrise output pulse also is valuable for checking the 10% to 90% risetime of amplifiers, or of a fast rise sampling system.

A pretrigger output pulse allows a sequential sampling system to display the main pulse without using a delay line in the signal path. This pretrigger pulse is also available at the rear for internal triggering of a sampling sweep unit. Another front panel connector provides a trigger pulse that is time coincident with the fastrise output pulse. The PRETRIG OUT and TRIG OUT connectors are BSM type, while the PULSE OUTPUT connector is a threaded 3 mm type.

Minimum time jitter between the main fastrise output pulse and both trigger pulses is maintained by occasional operator adjustment of the front panel STABILITY control (a screwdriver control). A procedure for adjusting the STABILITY control is given in the First Time Operation description later in this section.

Installing the Type S-50 Pulse Generator Head

Fig. 2-1A shows the Type S-50 installed in the Channel B compartment of a Type 3S2 Sampling Unit. Operating the



(A) Type S-50 powered from the sampling unit.

(B) Type S-50 powered from the Type 285 Power Supply for S-series heads.

Fig. 2-1. Obtaining operating power for the Type S-50.

Ⓐ

Type S-50 in this manner leaves only Channel A of the sampling unit available to operate a sampling head. The Type S-50 can be plugged into the sampling unit as shown, or used remotely on a special extender cable. Three and six foot extender cables are available. Order the three foot extender cable by Tektronix Part No. 012-0124-00, or the six foot extender cable by Tektronix Part No. 012-0125-00. Contact your local Tektronix Field Engineer or Representative for price and availability of these optional accessories.

To insert the Type S-50 into a compartment of the sampling unit, proceed as follows:

1. Pull the latch knob (Fig. 2-1A) outward from the front panel (the latch knob will push out normally when the unit is inserted if the knob is left free to move).

2. Insert the unit slowly into the compartment, so the two plastic guides enter the rear connector opening.

3. Push the Type S-50 completely into the compartment.

4. Push the latch knob to lock the unit in place.

To remove the Type S-50 from the compartment, pull the latch knob away from the front panel, then pull the unit from the compartment.

To use the Type S-50 on an extender cable, install as follows:

1. Pull the latch knob located on the head end of the extender cable outward from its panel (the latch knob will push out normally when the extender is inserted if the knob is free to move).

2. Insert the extender cable head end slowly into the desired compartment in the sampling unit so the two plastic guides engage the unit.

3. Push the head completely into the compartment.

4. Push the latch knob to lock the extender cable head end in place.

5. Connect the Type S-50 to the other end of the extender cable in a similar manner, and set the latch knob to hold it in place.

6. To remove the Type S-50 from the extender cable, pull the latch knob on the front panel of the Type S-50, and remove the unit from the extender cable.

7. To remove the extender cable head from the sampling unit compartment, pull the latch knob outward from the front of the panel, then pull the unit free.

The Type S-50 may also be operated in a Type 285 Power Supply for S-Series Heads as shown in Fig. 2-1B. Powering the Type S-50 from the Type 285 permits both sampling unit channels to be used for sampling heads. The Type S-50 is installed in the Type 285 in the manner discussed above for insertion into a sampling unit.

FIRST-TIME OPERATION

In addition to the Type S-50, this procedure uses a Type S-4 Sampling Head, Type 3S2 Dual-Trace Sampling Unit, Type 3T2 Random Sampling Sweep, and a Type 564 Storage Oscilloscope. See Fig. 2-2. The Type 3T2 Random Sampling Sweep permits viewing the signal in advance of the triggering event

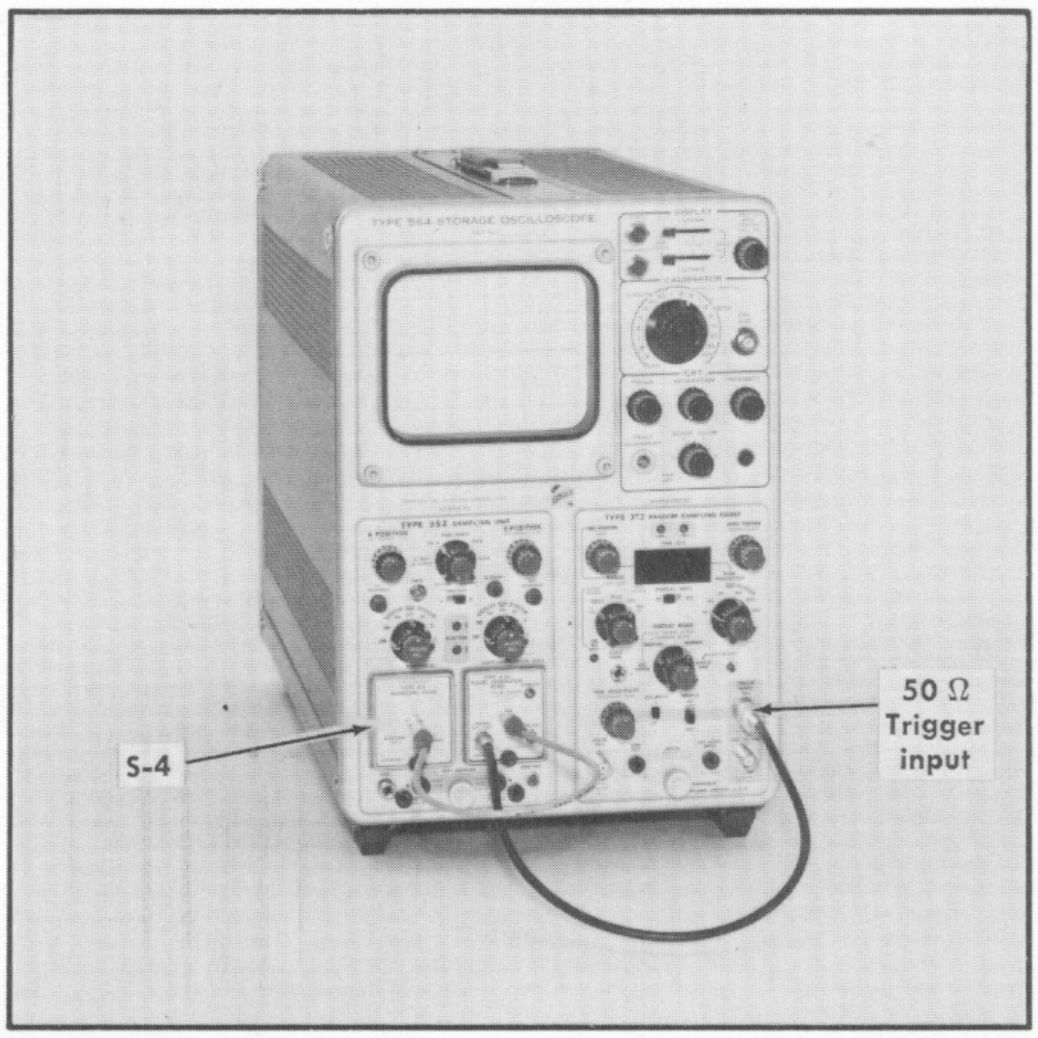


Fig. 2-2. Equipment setup used during First-Time Operation.

without a pretrigger. Since the Type S-50 has a pretrigger output, the fastrise pulse output may also be viewed using a sequential sampling sweep unit (this function is also available in the Type 3T2).

Setup Information

1. With the Type 564 Power switch off, insert a Tektronix Type 3S2 Sampling Unit into the vertical compartment (left) and a Tektronix Type 3T2 Random Sampling Sweep Unit into the horizontal plug-in compartment.

2. Insert the Type S-4 into Channel A (left) of the Type 3S2, leaving the latch knob free to move. Once the S-4 is seated, push the latch to lock it in place.

3. Insert the Type S-50 into Channel B (right) of the Type 3S2, leaving the latch knob free to move. Once the Type S-50 is seated, push the latch to lock it in place.

4. Connect the Type S-50 PULSE OUTPUT connector to the Type S-4 input connector using a 2 ns signal delay section of 3 mm flexible coaxial line.

NOTE

Connectors at both ends of all signal coaxial cable should be tightened firmly to mating connectors or adapters. Tighten slightly more than finger tight using a $^{5}/_{16}$ inch end wrench. A good connection is necessary to minimize reflections at the connector junctions.

5. Connect the Pretrigger Out connector to the 50 Ω Trigger Input of the Type 3T2. Use trigger cable such as Tektronix Part No. 012-0128-00 (7 inch) or Tektronix Part No. 012-0127-00 (18 inch).

6. Set the Type 564 Intensity control fully counterclockwise.

7. Connect the Type 564 to the power line and set the Power switch to On.

8. Allow about 5 minutes warm-up so the units reach operating temperature before proceeding.

9. Set instrument controls as follows:

Type 3S2

Display Mode	CH A
Normal-Smooth	Normal
Horiz Plug-In Compatibility SW	Sampling, 3T-Series
Channel A controls	
Position	Midrange
DC Offset	Midrange (5 turns from one end)
Units/Div	200
Variable	Cal
Invert	Pushed In
Dot Response	Midrange
Channel B controls	Optional

Type 3T2

Time Position	Midrange
Horiz Position	Midrange
Samples/Div	9 o'clock position
Samples/Div SW	Variable
Display Mode	Normal
Start Point	Before Trigger
Sweep Rate	100 ns/Div
Range	1 μs
Display Mag	×1
Time Magnifier	×1
Variable	Cal
Trigger Source	Ext
Trig Sensitivity	Fully clockwise
Trig Polarity	(+)

Type 564

Astigmatism	Midrange
Focus	Midrange
Intensity	Fully counterclockwise
Upper and Lower Screen	Non-store

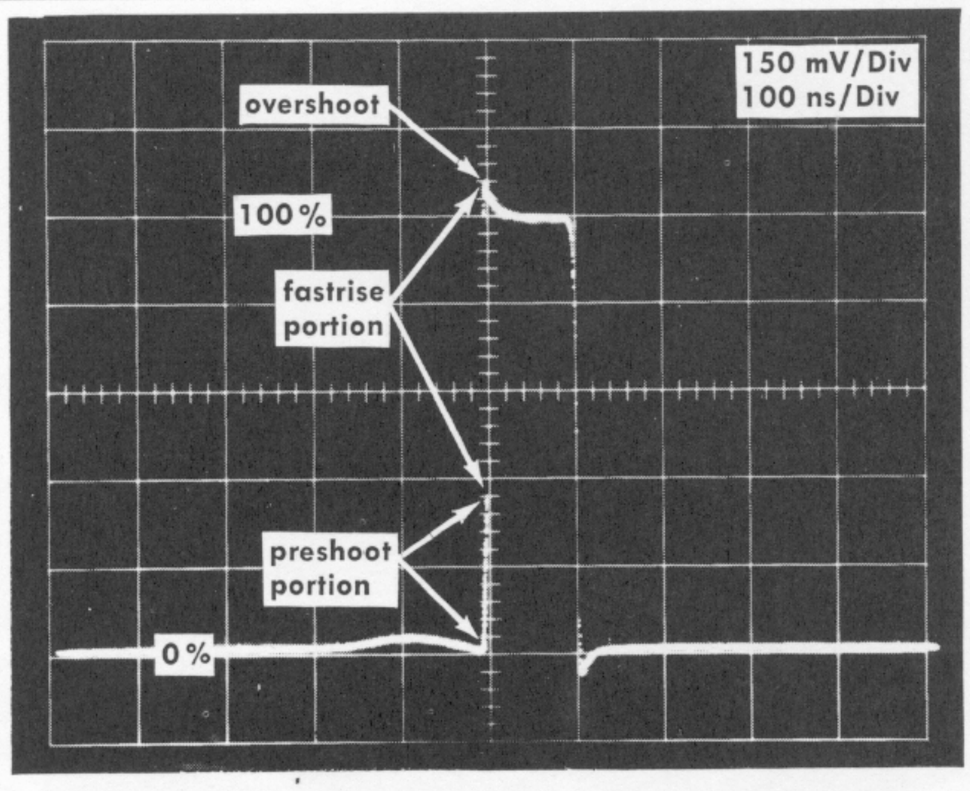
11. Set the Type 564 Intensity control so the trace brillance is correct. Adjust Astigmatism and Focus controls for best focus.

12. Center the trace on the graticule with the Type 3S2 DC Offset control.

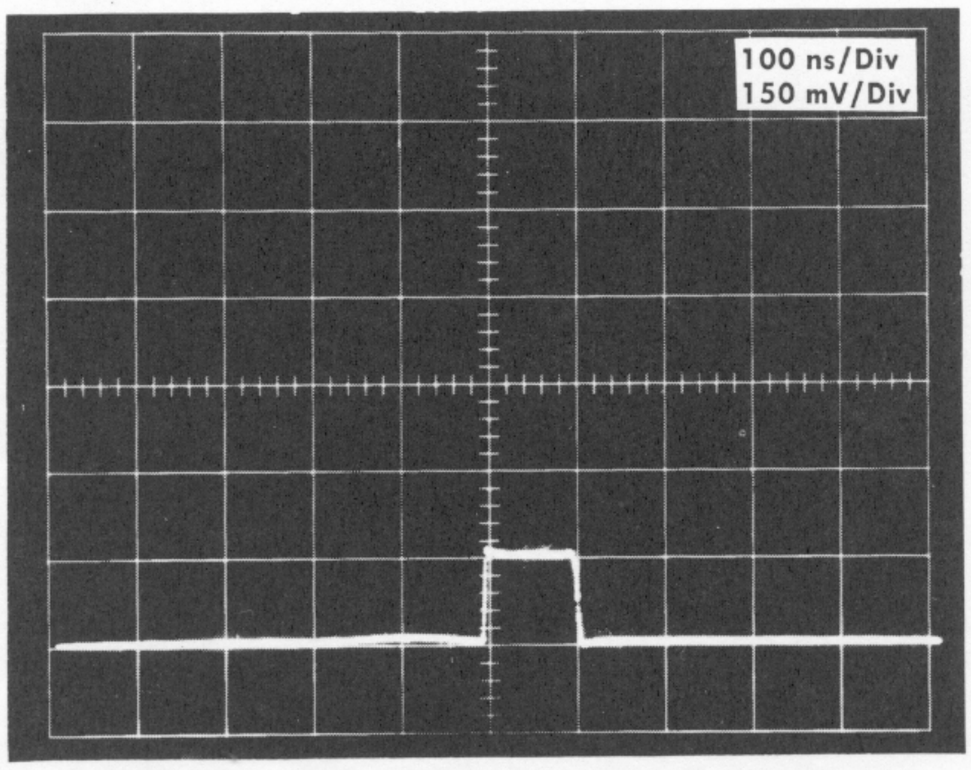
13. Adjust the Type 3T2 Trigger Sensitivity and Time Position controls for a stable triggered display of the Type S-50 output pulse. See Fig. 2-3A (display amplitude is approximately 5 divisions set by the Type 3S2 A Variable control).

Characteristics of the Output Pulse

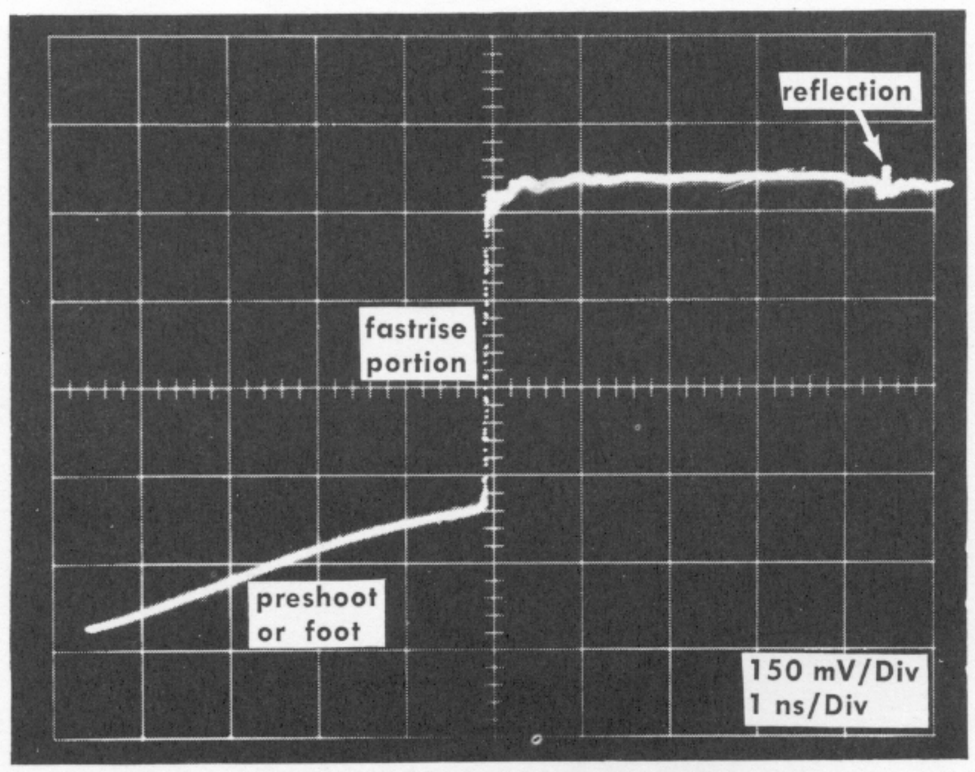
The pulse appearing at the Type S-50 PULSE OUTPUT connector has both a preshoot and a fastrise portion. Fig. 2-3A



(A) Typical display with the Type S-50/Type S-4 combination.



(B) Typical display with STABILITY fully counterclockwise.



(C) Display at faster sweep rate with STABILITY properly adjusted.

Fig. 2-3. Displays of Type S-50 output pulse.

shows both parts with the preshoot portion starting upward 5 divisions from the graticule left edge and 3 divisions below graticule center. The preshoot region ends approximately 1.2 divisions below graticule center.

In most Type S-50 applications the preshoot portion of the output pulse is not useful and is of no interest. The preshoot can be considered to be an unavoidable delay in starting of the fastrise pulse output. The preshoot amplitude is affected by adjustment of the STABILITY control. See the Circuit Description Section of this manual for further information.

In Fig. 2-3A the fastrise portion starts 1.2 divisions below graticule center and rises vertically to a point 2.2 divisions above graticule center. No samples or at most one, are visible during the fastrise portion due to the relatively slow sweep rate. The trace therefore has a gap in this region. In order to measure risetime, a much faster sweep rate must be used.

Stability Control

A STABILITY control is provided on the Type S-50 front panel. This control must be adjusted to obtain minimum time jitter between the main output pulse and both trigger pulses.

Fig. 2-3A shows the appearance of a normal output pulse.

To learn how the STABILITY control affects the display, turn it fully counterclockwise.

This will stop the fastrise output pulse and produce a display as shown in Fig. 2-3B. Slowly rotate the STABILITY control clockwise until the output pulse fastrise portion reappears at the preshoot region as shown in Fig. 2-3A.

Change the sweep rate to 1 ns/Div by changing the Type 3T2 Range switch top 100 ns, and the Time Magnifier to ×10. Set the Type 3T2 Start Point Switch to With Trigger. Adjust the Type 3T2 Time Position control for a display similar to that shown in Fig. 2-3C. After a rather gradual rise requiring about 5 ns (5 divisions), the amplitude of the signal shown increases by about 500 mV. The preshoot or foot (the gradual rise) occupies the portion of the graticule to the left of graticule center. The fastrise leading edge of the output pulse is approximately at graticule center.

Slowly rotate the Type S-50 STABILITY control counterclockwise and observe that the fastrise pulse moves to the right and away from the preshoot region or disappears from view. Now slowly turn the Type S-50 STABILITY control clockwise until the fastrise portion just reaches the preshoot region of the display. See Fig. 2-3C. Note the horizontal position of the fastrise portion of the display or set the fastrise portion to graticule center using the Type 3T2 Time Position control. Turn the Type S-50 STABILITY control carefully clockwise until the fastrise portion moves 0.5 to 1.0 ns to the left of the position previously noted. The Type S-50 STABILITY control is now correctly adjusted.

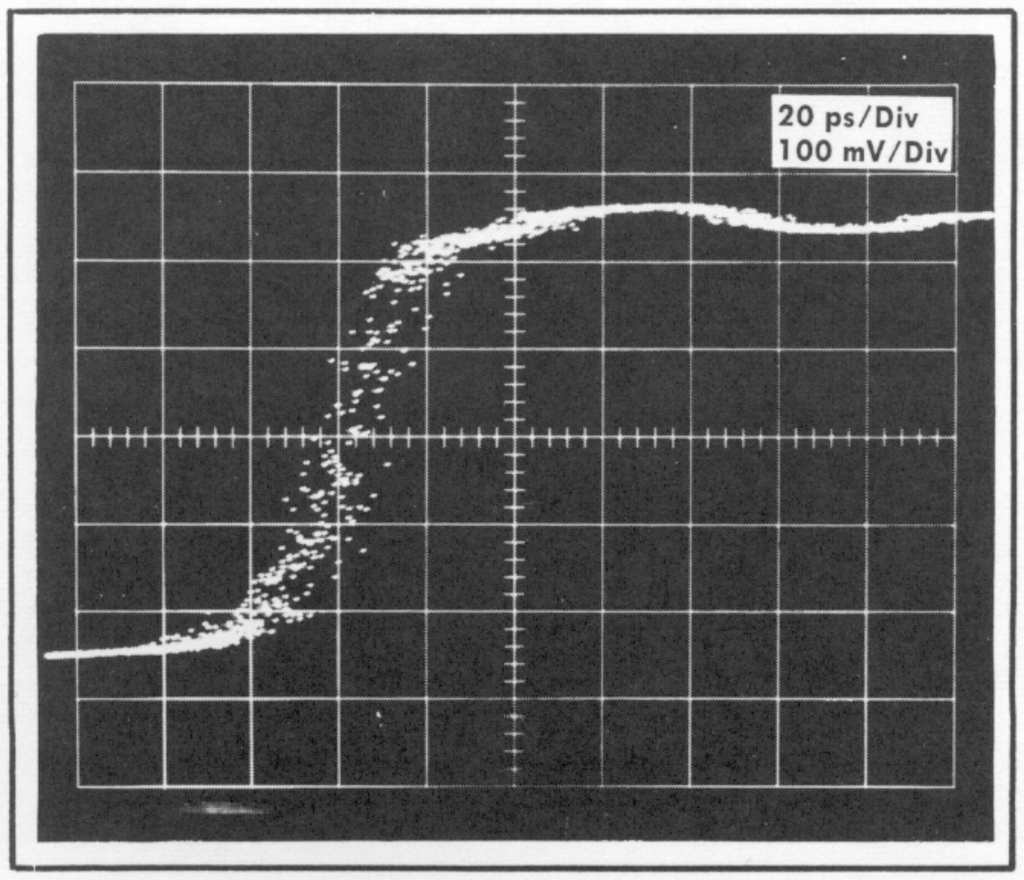


Fig. 2-4. Fastrise portion of Type S-50 output pulse at 20 ps/Div sweep rate (equipment: 2 n signal delay 3 mm flexible coaxial cable and Type S-4 Sampling Head).

Making Risetime Measurements

In order to measure the risetime of very fast step signal displays, a sweep rate considerably faster than 1 ns/Div is necessary.

1. Change the Type 3S2 deflection factor to 100 mV/Div and set the Variable control to Cal.

2. Vertically center the fastrise part of the step using the Type 3S2 DC Offset control.

3. Set the Type 3T2 Time Magnifier at ×50 (200 ps/Div sweep rate) and readjust the triggering for minimum jitter using the Type 3T2 Sensitivity control.

4. Set the Type 3T2 Display Mag at ×10 (20 ps/Div sweep rate) and carefully adjust the Time Position control for a display similar to that of Fig. 2-4.

In order to accurately measure the step 10% to 90% risetime, the display should be photographed or stored on a Storage oscilloscope CRT to permit careful analysis. To store the display, set the Type 3T2 Display Mode to Single Sweep and the Type 564 upper and lower screen switch for storage; then push the Type 3T2 Single Sweep Start pushbutton.

NOTE

A detailed discussion is given later in this section for properly positioning the display when using the Type S-50 for verification of a Type S-4 risetime.

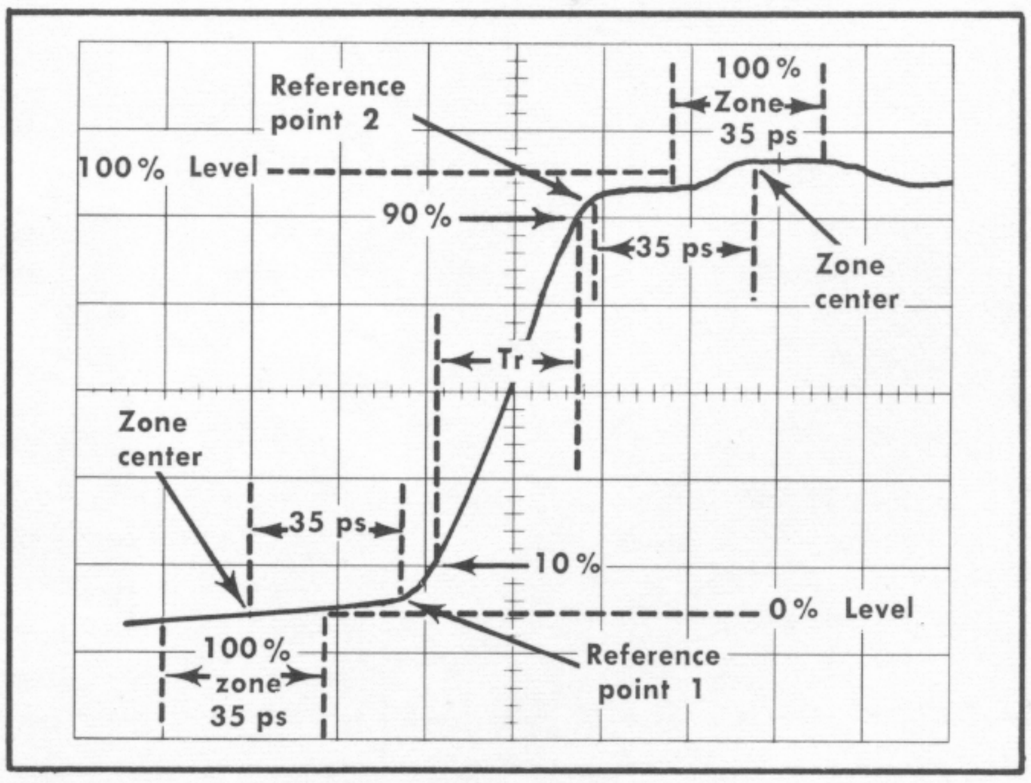


Fig. 2-5. Special S-50/S-4 system risetime measurement technique.

If the sampling unit is operated with a low loop gain (smoothed), the displayed risetime may be longer than the actual risetime unless there are a large number of samples during the step rise. Switching to Normal loop gain (while resulting in a noisier display) will permit this effect to be checked. The Pulse generator risetime may also have considerable effect on the displayed risetime. The effects of the pulse generator on displayed risetime is discussed later in this section.

OPERATING INFORMATION

Measuring Step Signal Risetime

In the First Time Operation example given earlier in this section a storage oscilloscope was used to hold a fastrise display for careful measurement of risetime. Ability to store a display gives an operator an accuracy advantage at a low signal repetition rate. An alternate method of holding a fastrise display for careful measurements is to use a Tektronix trace-recording camera to photograph a single sweep display.

Accurate risetime measurements from a CRT display require that the 10% and 90% points be located accurately and that the horizontal distance between these points be carefully measured. The sampling sweep unit timing accuracy must be known. Changing the sampling sweep unit from operation in one oscilloscope to operation in another requires readjustment of the front panel horizontal gain control. See your sampling sweep unit instruction manual for timing accuracy specifications and complete instructions for checking timing.

A displayed pulse risetime is found by multiplying the horizontal distance (in divisions) between the 10% and 90% amplitude points by the sweep rate. It is recommended that the display amplitude be adjusted so the 0% and 100% points are exactly 5 divisions apart (using the sampling unit Variable control). Vertically center the display (using the DC Offset control) to place the 0% and 100% points 2.5 divisions from the graticule center. The 10% and 90% amplitude points are 2 divisions from the graticule center. A special method is used to locate the 0% and 100% points when the equipment is the Type S-50/Type S-4 combination; it is discussed below.

Special S-50/S-4 system risetime measurement. Refer to Fig. 2-5 during the following description.

Reference point 1 is at the corner that preceeds the display step. Reference point 2 is at the corner following the fast-rise portion of the step. Both reference points are located where the slope rate of change is maximum (where the radius or curvature is least). Special zones are used to locate the 0% and 100% amplitude points. The 0% zone center is 35 ps before the first reference point and the 100% zone center is 35 ps after the second reference point. Each zone is 35 ps wide. The 0% and 100% amplitude points are then placed at the average amplitude of their respective zones.

Follow the procedure below for measurement of the displayed S-50/S-4 system risetime:

1. Locate reference point 1 and the 0% zone.
2. Locate reference point 2 and the 100% zone.
3. Use the sampling unit DC Offset and Variable controls and place 0% zone average value 2.5 divisions below graticule center and the 100% zone average value 2.5 divisions above graticule center.
4. Locate the step 10% point where the trace crosses the −2 division horizontal graticule line.
5. Locate the step 90% point where the trace crosses the +2 division horizontal graticule line.
6. Multiply the horizontal separation, in divisions, between the 10% and 90% points by the sampling sweep unit sweep rate to find the system risetime. The specified combined risetime of the Type S-50/S-4 system is 35 ps.

Effect of System Components on Displayed Risetime

The displayed risetime of a pulse generator and sampling oscilloscope system is affected by the pulse generator rise-

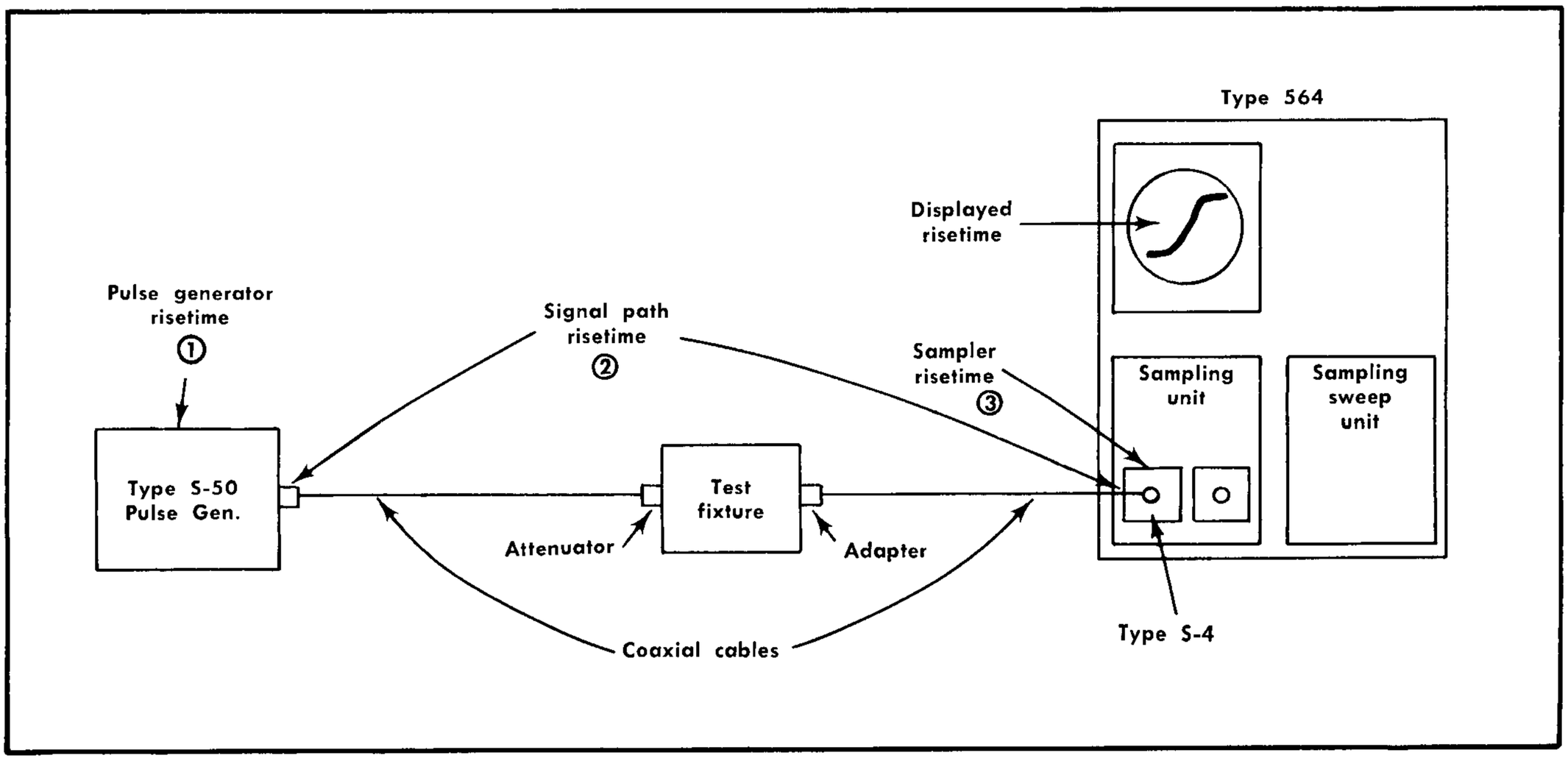


Fig. 2-6. Parts of a pulse generator and sampling oscilloscope system that affect displayed risetime.

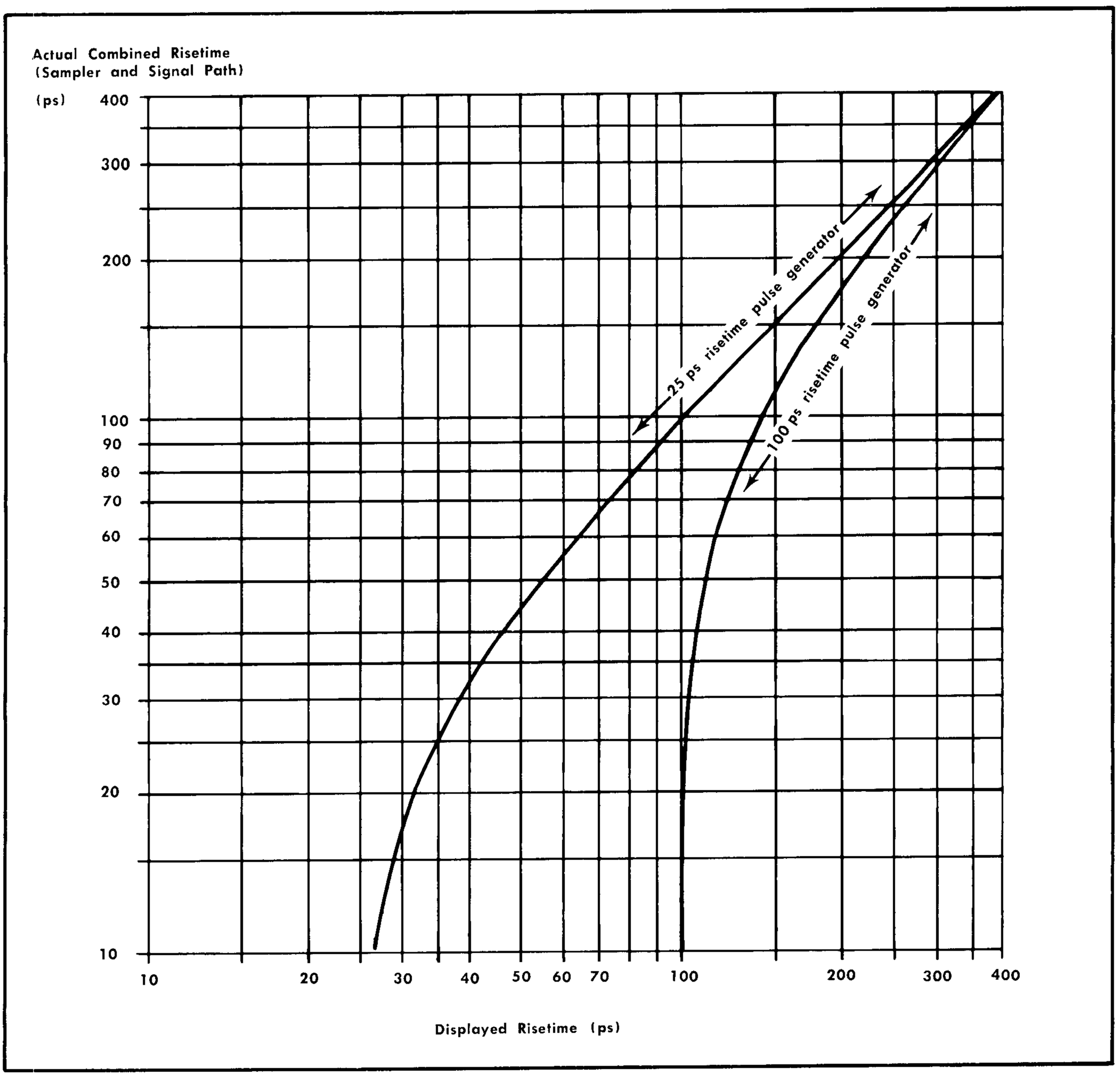


Fig. 2-7. Displayed risetime versus actual combined risetime of sampler and signal path (approximate values).

time, the signal path risetime, and the sampler risetime. Fig. 2-6 shows these three contributors to overall displayed risetime. The signal path risetime is considered to be the combined risetime of everything in the signal path between the pulse generator output and the sampler input. The effect on displayed risetime of any one of the three parts shown in Fig. 2-6 is insignificant if the risetime of the part is at least four times faster than the remainder of the system. Therefore, a 25 ps risetime pulse generator (part 1 of Fig. 2-6) will have very little effect on the overall system risetime if the combined risetime of the remainder of the system (parts 2 and 3 of Fig. 2-6) is more than 100 ps. Formula (2-1) shows the approximate relationship between the displayed or overall system risetime and the parts contributing to this risetime.

$$\text{Tr (displayed)} \approx \sqrt{(\text{Tr pulse gen})^2 + (\text{Tr signal path})^2 + (\text{Tr sampler})^2} \quad (2\text{-}1)$$

Formula (2-1) may be put into a different form by transposing one or more of the terms under the square root sign. An example is shown in Formula (2-2).

$$\text{Tr (signal path and sampler combined)} \approx \sqrt{(\text{TR displayed})^2 - (\text{Tr pulse gen})^2} \quad (2\text{-}2)$$

Fig. 2-7 is a graph showing the effect of pulse generator risetime on the displayed or overall system risetime. The values shown in Fig. 2-7 are approximate since the graph is based on approximations using Formula (2-1).

Effect of Sampling Head on Displayed Type S-50 Output Pulse

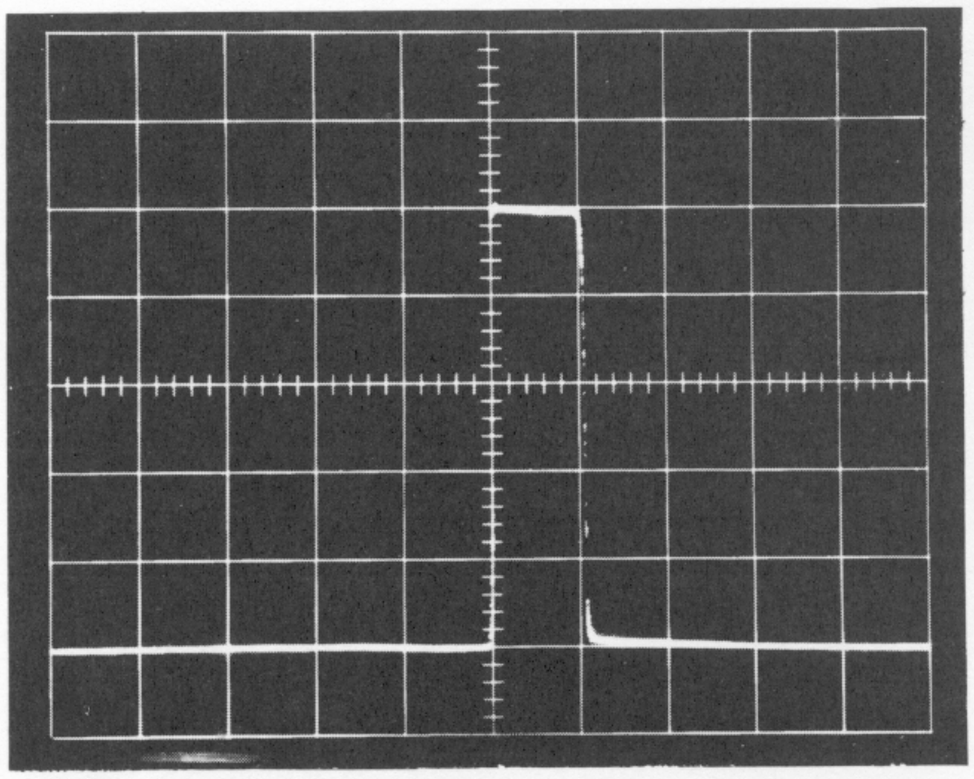
The Type S-50 may be used with S-series sampling heads other than the Type S-4. Typical Type S-50 output pulse displays with Type S-1, S-2, and S-4 Sampling Heads are shown in Figures 2-8, 2-9 and 2-10.

Coaxial Cables and Accessories

The Type S-50 output connector (threaded 3 mm) is intended for use with Teflon dielectric coaxial cable having an outer conductor with an outside diameter of 0.141 inches. Standard and optional 3 mm accessories available from Tektronix operate to frequencies above 18 GHz, and are generally useful up to 25 GHz. Accessories (3 mm) include flexible and semi-rigid coaxial cables, attenuators, adapters to change from 3 mm to other connector types, and a power divider tee. See your Tektronix Field Engineer or Representative for price and avaliability of optional accessories.

CAUTION

The two coaxial lines listed under part numbers 015-1015-00 (500 ps semi-rigid 3 mm coax) and 015-1005-00 (2 ns flexible 3 mm coax) must be treated with care to obtain maximum life and least signal distortion. The semi-rigid line may have its shape changed just twice in its lifetime, providing the minimum bend radius is no less than 10 times its outside diameter or approximately 1½ inches. The flexible (2 ns delay) cable must not be given a bend radius less than 10 times its outside diameter, or approximately 2¼ inches. (The same applies to the 5 ns signal delay flexible cable, Tektronix Part No. 015-1006-00.) The two flexible cables may have their outer conductor damaged by tighter bending. Few flexures assure longer life.

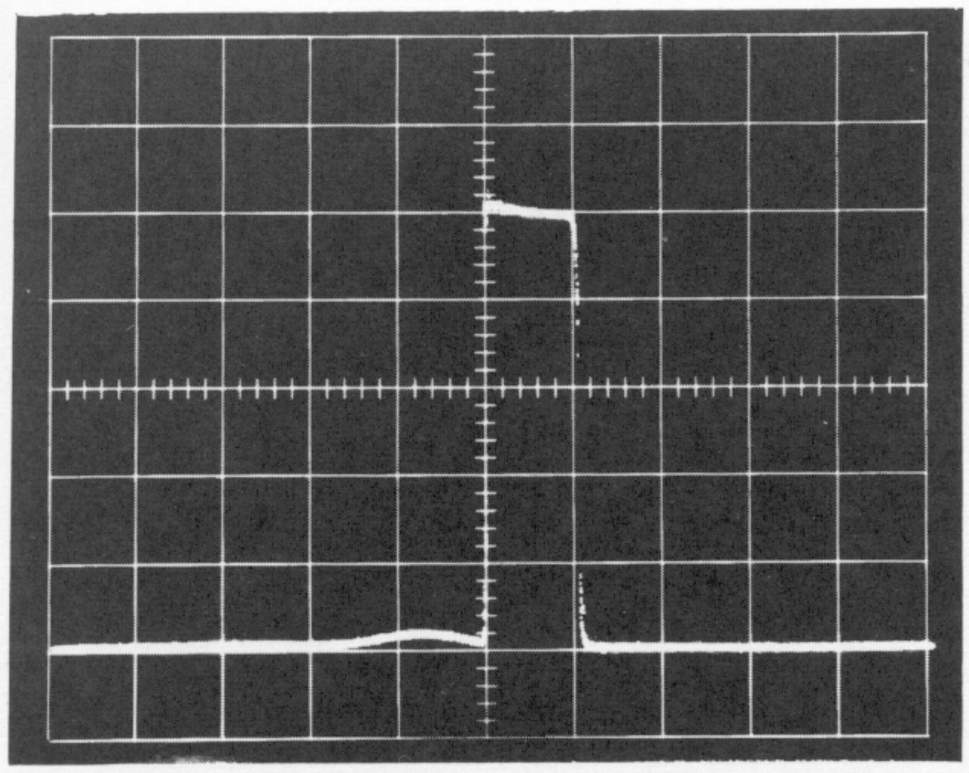


(A) At sweep rate of 100 ns/div.

(B) At sweep rate of 1 ns/div.

(C) At sweep rate of 100 ps/div.

Fig. 2-8. Type S-50 output pulse displays using the Type S-1 Sampling Head.

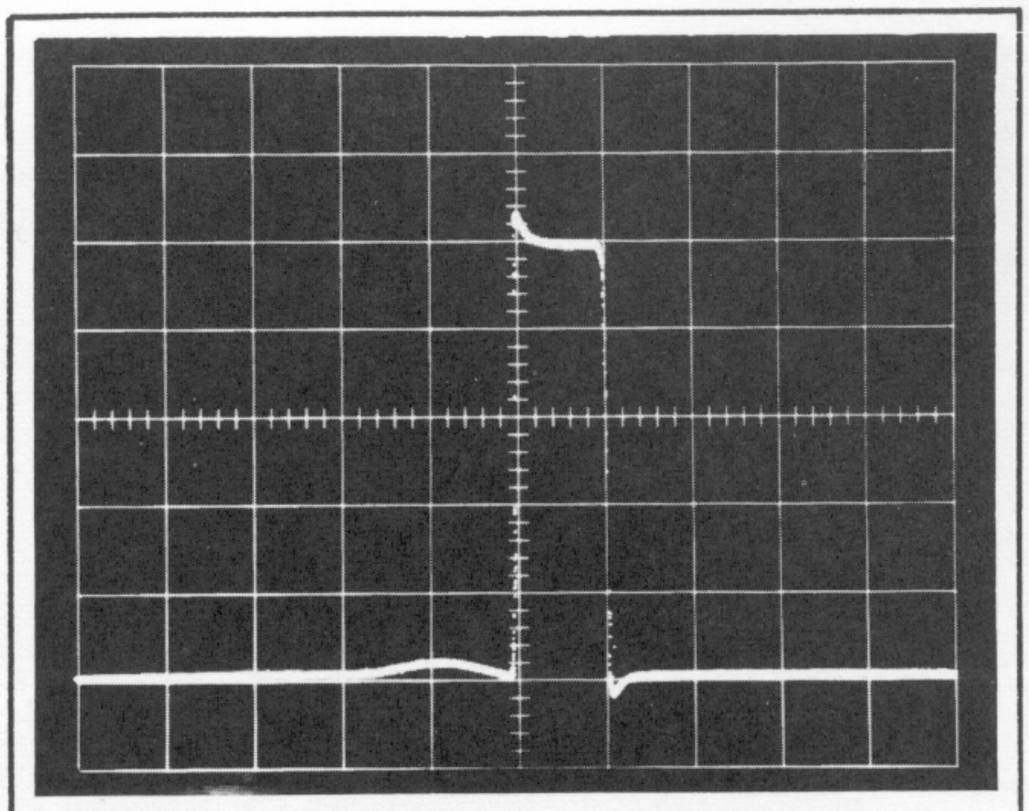


(A) At sweep rate of 100 ns/div.

(B) At sweep rate of 1 ns/div.

(C) At sweep rate of 100 ps/div.

Fig. 2-9. Type S-50 output pulse displays using the Type S-2 Sampling Head.



(A) At sweep rate of 100 ns/div.

(B) At sweep rate of 1 ns/div.

(C) At sweep rate of 100 ps/div.

Fig. 2-10. Type S-50 output pulse displays using the Type S-4 Sampling Head.

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

General

The Type S-50 Pulse Generator Head circuits are contained on two circuit boards. Except for the output tunnel diode assembly, all the circuits use standard etched wiring and discrete components. Properly oriented transistor sockets are fabricated as part of the circuit boards.

The Type S-50 requires +15 V and —12.2 V input power. The input power is normally obtained from either a Type 285 Power Supply For S-50 Series Heads or from one of the dual-channel sampling units that accept S-series heads. When the S-50 is operated in such a sampling unit, another S-series head can be plugged into the other channel.

BLOCK DIAGRAM

The major circuits of the Type S-50 (see Fig. 3-1) consist of the 25 kHz Multivibrator, the Pretrigger Generator, the Leadtime Control circuit, the Trigger Delay Generator, the Stability and TD (tunnel diode) Drive circuit, the Pulse Output circuit, and the Trigger Output TD circuit. The 25 kHz pulse output repetition rate is controlled by the 25 kHz Multivibrator. The Multivibrator drives the Pretrigger Generator, which in turn drives the two PRETRIG OUT connectors (one on the front panel, the other internal) and the Leadtime Control circuit. The Leadtime Control circuit drives the Trigger Delay Generator. Jitter-free leadtime trigger-pulse to output-pulse timing and uniform output pulse duration is ensured by the Trigger Delay Generator (the circuit is of a differential design that ignores power supply ripple and noise). The Trigger Delay Generator output is applied to the Stability and TD Drive circuit. The Stability and TD Drive circuit drives both the (time coincident) Trigger Output TD, and (through an emitter follower) the Pulse Output TD. The STABILITY control permits the operator to adjust the Output TD current to compensate for aging and temperature variations (see Operating Instructions section).

CIRCUIT DESCRIPTION

25 kHz Multivibrator

The 25 kHz multi (see circuit diagram) is a low-component circuit that operates with transistors Q1 and Q5 conducting alternately. For purposes of explanation, assume that Q1 has just turned off and Q5 has turned on. Under these conditions, the operation is as follows:

Transistor Q5 base voltage is set by voltage divider resistors R1 and R4 at —1.11 V. Q5 emitter is at about —1.7 V with a total instantaneous emitter current (through R3-C7 and R7) of 4.3 mA. The 4.3 mA value is based upon current in R7 paralleled by current in R3-C7. Capacitor C7 has a charge on it that places Q1 emitter instantaneously about +0.5 V more positive than Q5 emitter. The voltage starts to change as R3 pulls current out of C7 and drives Q1 emitter in a negative direction. As soon as Q1 emitter voltage reaches about —6.5 V, the multi switches; Q1 becomes the conducting transistor and Q5 turns off.

At the instant Q1 starts to conduct, the voltage of the charge on C7 is about 4.8 V. Q1 collector drops to about —6.5 V, reverse biasing Q5 by about 5.4 V (and stopping the drive to Q9). Current through R7 drains charge from C7 until the voltage across R7 drops to about 0.5 V and Q5 emitter voltage reaches about —7 V. At this point the multi again switches with Q5 becoming the conducting transistor and Q1 turning off.

It is the AC coupling by C7 between Q1 and Q5 emitters and the DC coupling between Q1 collector and Q5 base that provides the regenerative switching path which ensures that the multi changes state rapidly in either direction. Almost all of Q5 collector current (4 mA) is taken from Q9 base, ensuring that Q9 is driven into saturation each time Q5 in the 25 kHz multi conducts. (R5 is an I_{CBO} leakage path to ensure that Q9 remains cut off when Q5 is not conducting; it is not the collector load for Q5).

Pretrigger Generator

The Pretrigger Generator consists of transistor Q9, tunnel diode D10 and associated circuit elements. Q9 drives D10 so it delivers a fast, positive step to the two PRETRIG OUT connectors and to the Leadtime Control circuit once each 25 kHz multi cycle. Drive from the multi is sufficient to saturate Q9, effectively connecting R9 to ground. Current in R9 and D10 is then about 25 mA, more than enough to trip tunnel diode D10 from its low-voltage state to its high-voltage state. Caacitor C10 at D10 cathode ensures that the fast change in state delivers a positive step from D10 anode, and that the signal is decoupled from the power supply.

The positive output step from D10 is RC coupled to both the Type S-50 front-panel PRETRIG OUT connector and rear-panel (internal) pretrigger output connector P21. The 2- to 3 Ω conduction resistance of D10 is raised to 50 Ω by R23 in series with the lead to the front-panel PRETRIG OUT connector. The PRETRIG OUT signal is $\geq$ +200 mV into 50 Ω due to R23 forming an approximate 2:1 voltage divider with the output load resistance (50 Ω). The internal pretrigger signal amplitude is $\geq$ +70 mV into 50 Ω due to the approximate 4:1 voltage divider of R20 and the parallel value of R21 and the 50 Ω at the sampling sweep unit internal trigger input circuit.

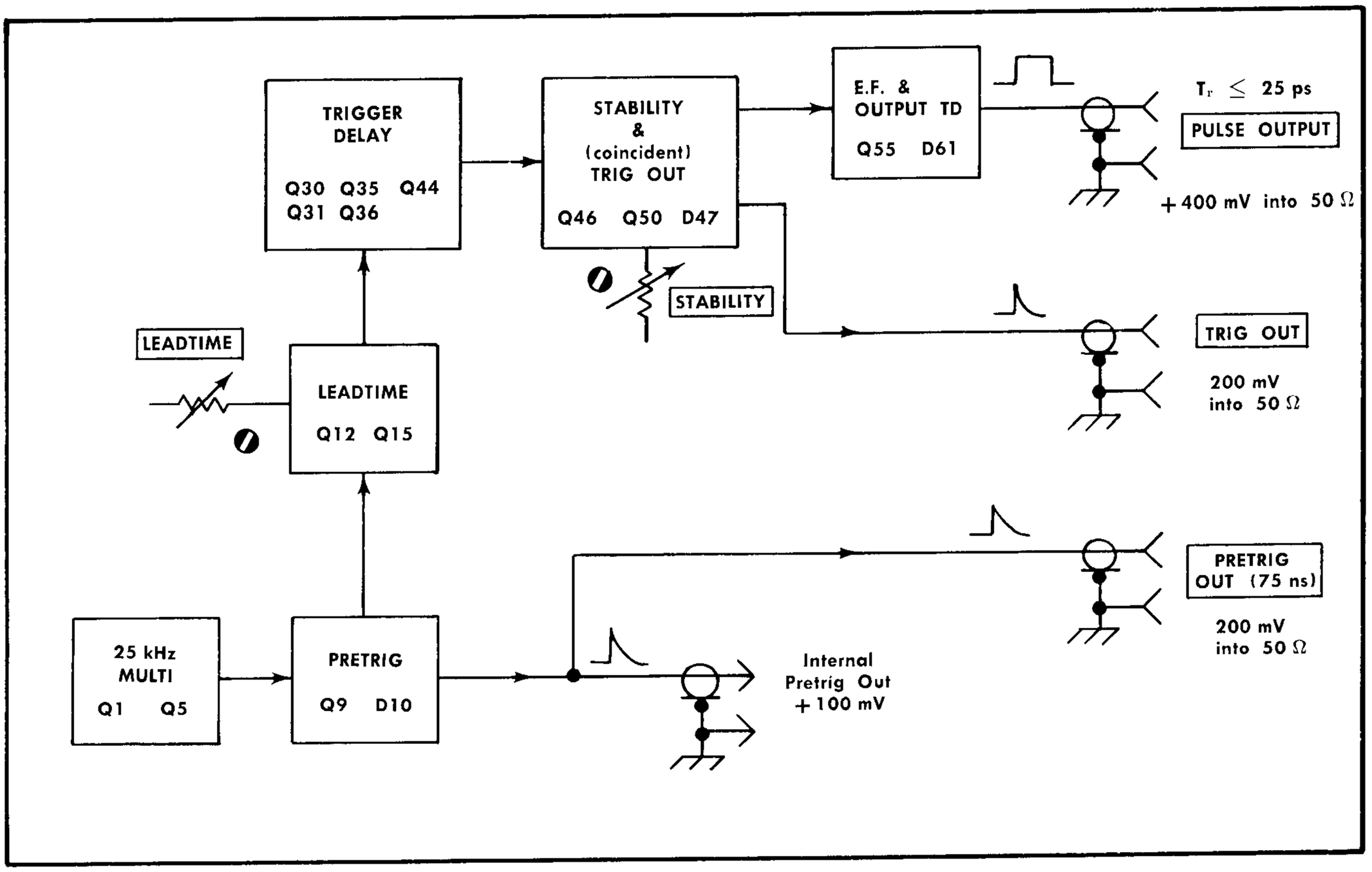


Fig. 3-1. Type S-50 Block Diagram.

Leadtime Control Circuit

The positive step from the Pretrigger Generator also drives the Leadtime Control circuit (transistors Q12 and Q15 and associated circuit elements) via resistor R11 to Q12 base. The Leadtime Control circuit functions as an adjustable current switch and is used to drive the Trigger Delay Generator.

When D10 is at its low-voltage state, Q12 is cut off and Q15 conducts all the current of R13 and R14. Transistor Q15 base is biased about 0.3 V positive from the —6 V supply to ensure that Q12 base-emitter bias (the base is only +0.3 V in respect to the emitter) prevents Q12 from conducting. Leadtime Control R14 permits adjustment of the current through R13 from approximately 6.4 mA to 8.0 mA. The actual value is set during calibration to obtain a pretrigger leadtime (in relation to the Pulse Output) of 75 ns.

When the conduction of Q5 saturates Q9 and drives D10 to its high-voltage state, Q12 suddenly conducts all the current of R13 and R14. The current path switches from Q15-R15 to Q12-R33-R34. The resulting sudden voltage step developed across resistors R33 and R34 initiates the 75 ns delay between the pretrigger event and the pulse output event. When the 25 kHz multi again switches state, Q9, D10 and Q12 are once more cut off. Q15 picks up the current of R13 and R14 and shunts it to ground through R15. Output pulse duration is independent of the length of time Q12 conducts.

Trigger Delay Generator

The Trigger Delay Generator, consisting of transistors Q30-Q31, Q35-Q36 and Q44, generates the 75 ns delay between the Pretrigger Pulse and the Output Pulse. After a delay of 75 ns from the time that Q12 conducts, Q35 applies a turn-on signal to the Stability circuit (Q46) and the Pulse Output steps positive. When an additional 100 ns has elapsed, Q30 turns on Q44 which removes the drive to Q46 and stops the Output Pulse.

For purposes of explanation, assume that Q12 is cut off. There is no current in R33 so the bases of Q30 and Q35 are at ground potential. Both these transistors conduct current as controlled by Q31 and Q36. Transistor Q30 conducts about 2.9 mA, most of which is base current from Q44, driving that transistor into saturation. The low saturation resistance of Q44, is connected across the base-emitter junction of Q46. The saturation of Q44 provides about 7.3 mA to Q35 and ensures that Q46 remains at cutoff. The total 10.2 mA comes from the +15 V supply through R43.

When D10 drives Q12 into conduction, the base voltage of both Q30 and Q35 drops to about —3.5 or —4 volts, the value depending upon the resistance of Leadtime control R14. Since the base voltages of Q30 and Q35 are now more negative than the voltage of their emitters (held at about —0.6 V by capacitors C31 and C36) both transistors stop conducting. Q44 is released from saturation, but with Q35 cut off, Q46 is also left at cut off. (R45 provides on I_{CBO} leakage path that ensures that Q46 remains cut off.) Current in Q31 (2.9 mA) now comes from C31 and the current in Q36 (7.3 mA) now comes from C36. Since both C31 and C36 are the same value (within 1%), C36 changes its charge about 2.5 times faster than C31 changes its charge.

Q31 and Q36 charge C31 (and Q30 emitter) and C36 (and Q35 emitter) in a negative direction. At the end of 75 ns, the voltage on C36 is enough negative to turn on Q35. With Q30 and Q44 still cut off, the full 7.3 mA of Q36 is applied to the base of Q46 through Q35. Q46 is biased into conduction turning on Q55 and switching tunnel diode D45 to its high-voltage state. The conduction of Q55 switches Pulse Output tunnel diode D61 to its high-voltage state, generating the output pulse in time coincidence (±5 ns) with the trigger output from D47. Capacitor C43 holds Q44 and Q46 emitter voltage constant as the circuit current changes from 10.2 mA to 0 mA, then to 7.3 mA and back again to 10.2 mA.

About 100 ns after Q35 is returned to conduction as explained above, the charge on C31 becomes negative enough to turn on Q30. The conduction of Q30 drives Q44 into saturation, which shunts Q46 base-emitter junction with a low resistance, turning Q46 off. With Q46 now cut off, both the time-coincident trigger output and pulse tunnel diodes return to their low-voltage state.

Stability and TD Drive Circuits

The Stability circuit is an adjustable current switch with Q50 normally conducting. When the 75 ns trigger delay period ends and the output pulse is to occur, Q46 conducts. Q46 conduction switches D47 to its high voltage state and also drives the current amplifier Q55 which then drives the Pulse Output tunnel diode.

Adjustment of the STABILITY control alters the steady state voltage charge of C43 by changing the current in R43. Adjusting the control clockwise makes Q50 base voltage more positive, causing the emitter current through R43 to decrease. This makes C43 voltage more positive so that when Q46 conducts to saturation (for its short 100 ns period) its collector voltage goes more positive than for a counterclockwise control setting. Thus the STABILITY control adjusts Q46 collector saturation current by changing the voltage at Q46 emitter. Another way of saying the same thing is to consider Q46 collector saturation voltage as a variable and the current then set by Ohms Law and the value of R48. Very little current is required of Q46 collector by the base of Q55, however, the current to D61 is altered in the same way because Q46 collector saturation voltage sets Q55 emitter voltage. The current through Q55 and the resistors in series with its emitter and D61 is controlled by Ohms Law and the total circuit series resistance.

Trigger Out and Pulse Output Circuits

Both Trig Out tunnel diode D47 and Pulse Output tunnel diode D61 operate without prebias between pulses. Their low-output state is set with no current through either diode. As Q46 goes into conduction, R48 couples the signal to D47 and the Trig Out signal is developed as D47 switches to its high-voltage state. At the same time, Q55 emitter voltage follows Q46 collector voltage and provides the 62 mA required to switch D61 to its high voltage-state and drive the 50 Ω load. Since both diodes start without prebias, both signals contain a rising ramp signal that is obvious just before the tunnel diodes switch from their low-voltage current peak to their high-voltage state.

Minimum time jitter between the Pretrigger output pulse and the main Pulse Output signal is obtained by careful adjustment of the STABILITY control. See the Operating Instructions section for proper setting of the STABILITY control.

Special Components

Special components not mentioned in any of the previous description include the following:

Resistor R8 limits Q9 base current and prevents parasitic oscillations. Capacitor C33 slows the rate of change at Q30 and Q35 base leads so that when Q12 cuts off there is no difference in Q30 or Q33 collector current. C33 slows the base signals well below the F_t frequency of either transistor, forcing both collector circuits to change at the same rate and thus prevent an output pulse when Q12 cuts off. R36 and R41 prevent parasitic oscillations. R50 and R55 limit collector dissipation and prevent parasitic oscillations.

Special output circuit components that aid impedance matching and critically damp stray capacitances include R57, R58 and R61. Resistor R59 and capacitor C59 add a small capacitive load to Q55 to compensate for the inherent inductance of Q55 emitter lead. Resistor R47 (in the Trig Out line) raises the dynamic resistance of D47 from about 2- or 3 Ω to 50 Ω, making the trigger circuit have a 50 Ω source impedance.

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section is a maintenance guide for the Type S-50 Pulse Generator Head. Information for parts ordering, disassembly, component checks and reassembly is included.

To remove the Type S-50 Pulse Generator Head from its case, loosen the four retaining screws on the back. Then slide the back off and remove the case by sliding it to the rear. Directions for replacing the case will be found at the end of this section.

Obtaining Replacement Parts

All parts used in the Type S-50 can be purchased directly through your Tektronix Field Office or Representative, however, it is suggested that standard electronic items be obtained locally. Replacements for the special parts used in the Type S-50 should be ordered from Tektronix since these parts are either manufactured or selected by Tektronix to satisfy a particular requirement. Before purchasing or ordering, consult the Electrical or Mechanical Parts List to determine the value, tolerance and rating required.

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 Removal and Replacement

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 making in-circuit voltage checks, or by substitution. Transistor circuit numbers are screened on the circuit board next to the pin sockets which are fabricated as part of the circuit board.

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. 4-1). Note the lead configuration in Fig. 4-2.

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. If a transistor is substituted without first checking out the circuit, the new transisor may immediately be damaged by some defect in the circuit.

Parts Replacement. To replace parts soldered to the circuit board, clip the leads of the component, remove the component and then remove the clipped leads individually.

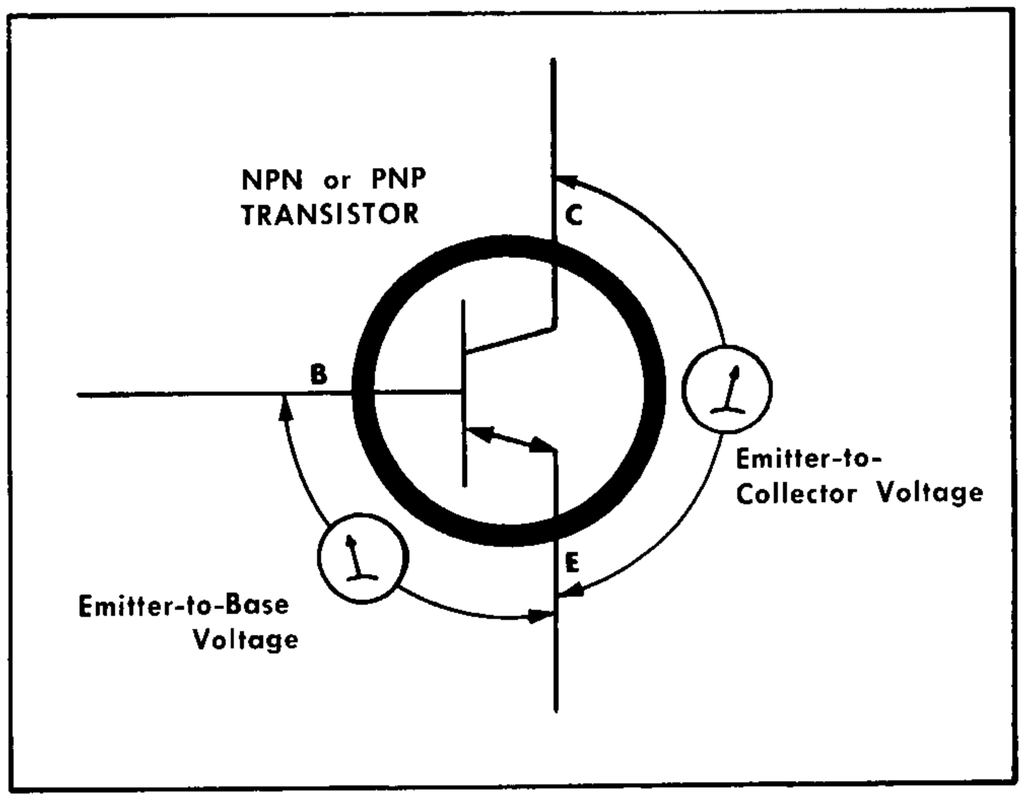


Fig. 4-1. In-circuit voltage checks NPN or PNP transistors.

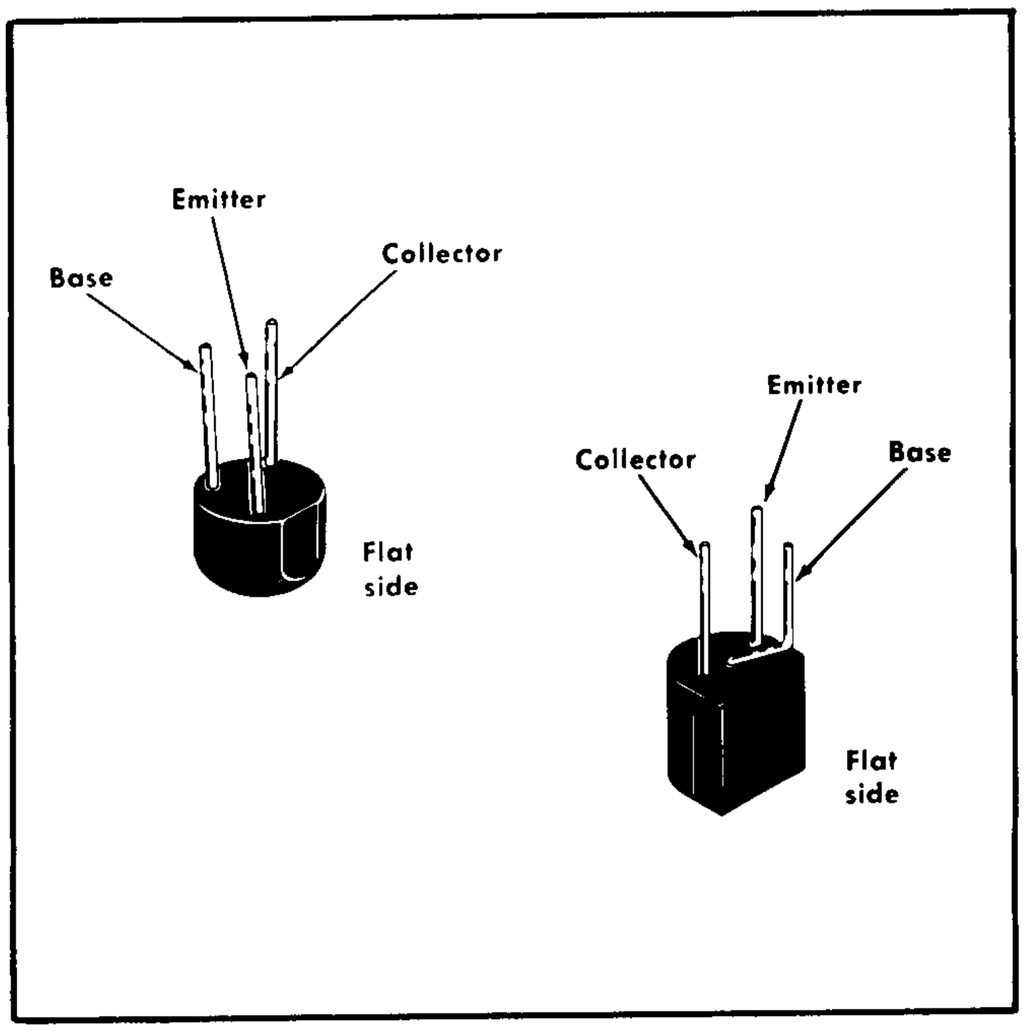
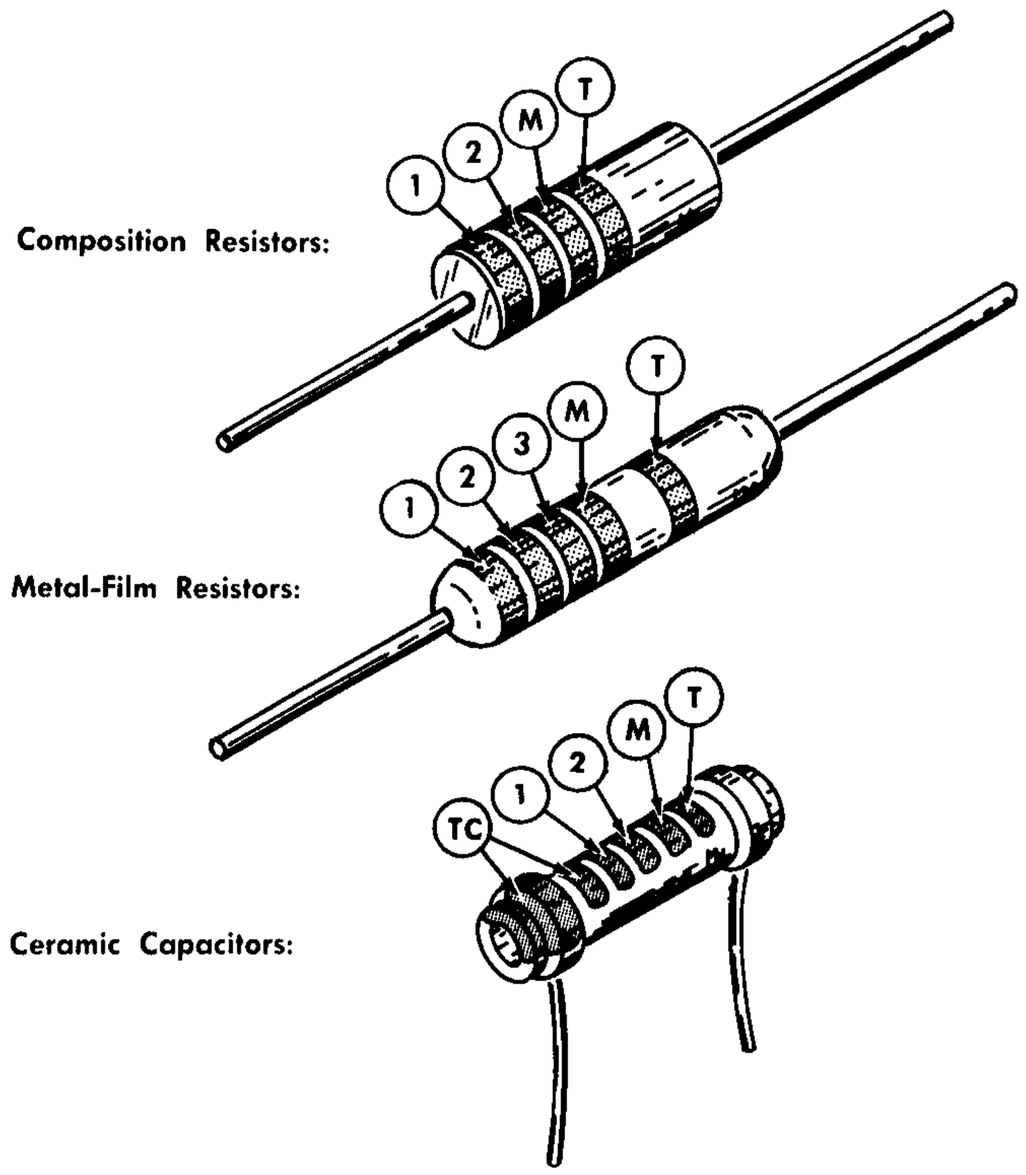


Fig. 4-2. Lead configuration of transistors in the Type S-50.

Ⓐ



(1) (2) and (3) —1st, 2nd and 3rd significant figures;

(M) —multiplier; (T) —tolerance;

(TC) —temperature coefficient.

Resistor and Capacitor Color Code

Color	Significant Figures	Multiplier		Tolerance	
		Resistors	Capacitors	Resistors	Capacitors
Silver	---	10^{-2}	---	±10%	---
Gold	---	10^{-1}	---	±5%	---
Black	0	1	1	---	±20% or 2 pF*
Brown	1	10	10	±1%	±1% or 0.1 pF*
Red	2	10^{2}	10^{2}	±2%	±2%
Orange	3	10^{3}	10^{3}	±3%	±3%
Yellow	4	10^{4}	10^{4}	±4%	+100% −0%
Green	5	10^{5}	10^{5}	±0.5%	±5% or 0.5 pF*
Blue	6	10^{6}	10^{6}	---	---
Violet	7	---	---	---	---
Gray	8	---	10^{-2}	---	+80% −20% or 0.25 pF*
White	9	---	10^{-1}	---	±10% or 1 pF*
(none)	---	---	---	±20%	±10% or 1 pF*

*For capacitance of 10 pF or less.

NOTE: (T) and/or (TC) color code for capacitors depends upon manufacturer and capacitor type. May not be present in some cases.

Fig. 4-3. Resistors and ceramic capacitor color-code.

NOTE

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.

Install the new part, with leads bent to fit the holes and clipped so they will just protrude through the board; apply heat and solder for a firm solder joint.

The soldering iron tip should be of copper with a chisel or bevel shape. To obtain a low working-tip temperature, consider the following:

1. At slow soldering speeds, a 25-watt iron and 1/8 inch tip.

2. At medium soldering speeds, a 40-watt iron and a 3/16 inch tip.

3. At fast soldering speeds, a 50- or 60-watt iron and a 1/4 inch tip.

The best type of solder for use on the Tektronix circuit boards is a eutectic type cored wire solder of size #20 AWG, composed of 63% tin and 37% lead with a central core of activated resin flux.

Replacing Leadless capacitors. Use a small soldering iron with low heat to tin the capacitor. A silver coin at the edge will hold it in place. Tin the circuit board placement area.

Place the capacitor on the desired location and apply heat to the adjacent area, not to the capacitor directly. Apply light pressure with a toothpick or small wooden stick until the capacitor settles, indicating that the solder has melted underneath. Remove the heat and allow the area to cool.

Bend the wire(s) over the top of the capacitor, within approximately one lead diameter. Heat the wire and apply solder until the solder wicks down onto the top of the capacitor. Remove the soldering iron and allow the lead to settle.

Resistor Coding and Capacitor Marking

Fig. 4-3 shows the color-coding sequence of the resistors and ceramic capacitors used in the Type S-50.

Circuit Board Replacement

If a circuit board is damaged and cannot be repaired, the entire assembly including all soldered-on components should be replaced. The part number given in the Mechanical Parts List is for the completely wired board.

The Driver Board is removed by gently pulling outward from the Pulser Board. For replacement, align the connector and the pin contacts and ease the board into position. The pin connectors should not protrude beyond the clamps.

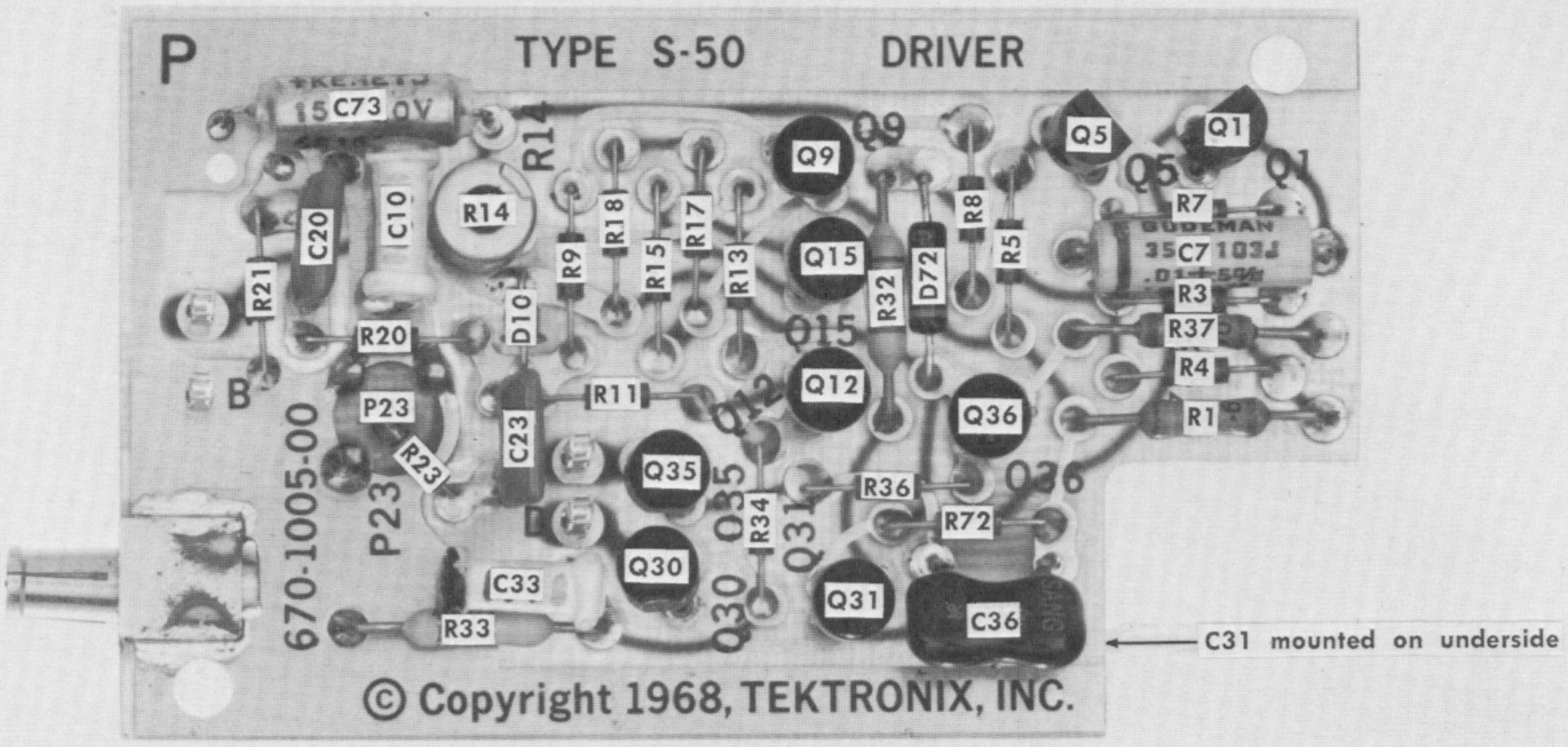


Fig. 4-4. Driver circuit board.

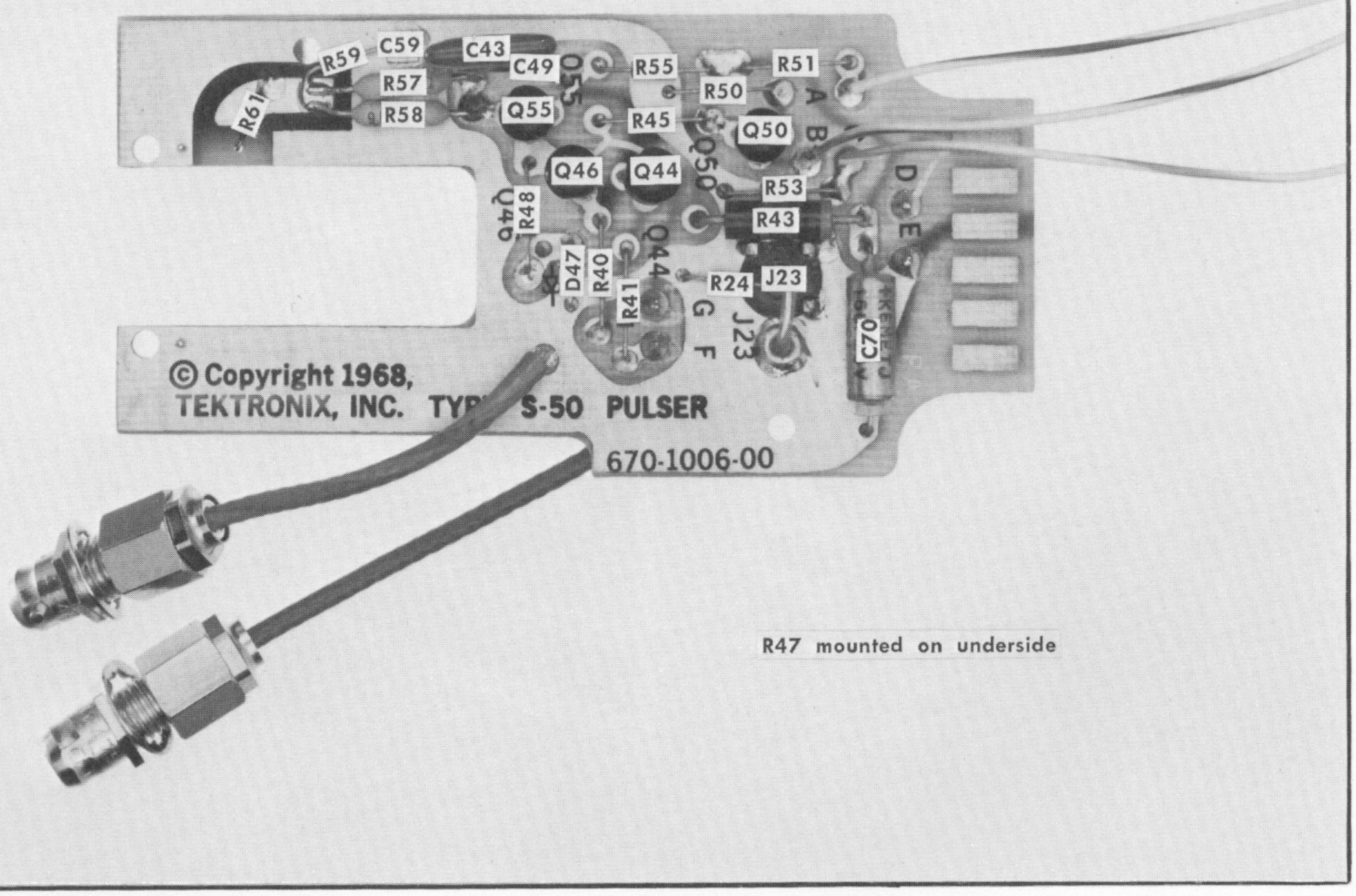


Fig. 4-5. Pulser circuit board.

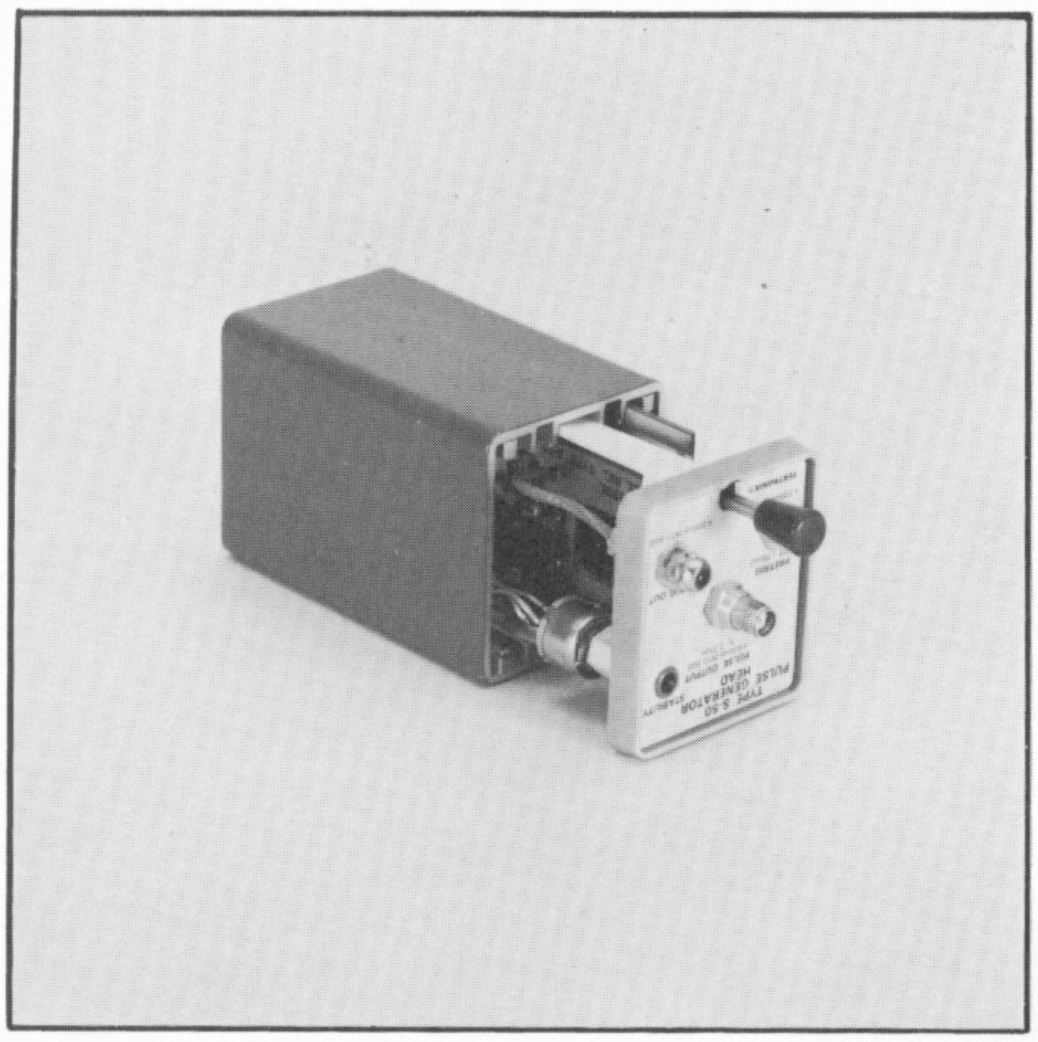


Fig. 4-6. Correct board and latch positions when re-installing the Type S-50 case.

Remove the Pulser Board as follows:

1. Remove the nut on the Pulse Output connector with a $^5/_{16}$ inch wrench. DO NOT LOOSEN THE PULSE OUTPUT CONNECTOR. The Pulser board is now held by wires connected to the trigger connectors and the stability control.

2. Unsolder the wires to the potentiometer and remove the trigger output connectors with a $^9/_{32}$ inch wrench.

3. Remove the Pulser board with the tunnel diode holder mounting attached.

4. Remove the tunnel diode holder mounting by first unsoldering the fine wire at the end of R61 and removing the Allen head screws with a $^3/_{64}$ inch Allen wrench.

5. Lift the mounting away from the Pulser board with the Pulse Output connector attached.

The tunnel diode, D61, is removable with only the Driver Board removed. Unscrew the knurled knob, which holds a spring and the tunnel diode D61, and lift it from the mounting.

NOTE

The tunnel diode, D61, is very small and expensive. Hold the assembly over the work area, preferably a light background, to minimize the possibility of loss or damage by accidental dropping of the holder. Always set the Stability control fully counterclockwise before operation of a new tunnel diode.

Place the mounting on the Pulser Board so the hexagonal nuts can be properly installed. Place the front panel slot on the Pulser Board with correct alignment of the Pulse Output connector with the tunnel diode holder mounting. Tighten the threaded nut on the Pulse Output connector with a $^5/_{16}$ inch wrench to approximately 15 inch-pounds. Replace the Driver Board.

Parts Locations

All components mounted on circuit boards are identified by circuit numbers as shown in Fig. 4-4 and Fig. 4-5.

Case Replacement

Align the case body so the hole in the side will appear over the Leadtime control, R14, located on the left side. Check that the upper and lower corners of the Driver Board is aligned with the channel containing the zigzag spring. Push the case body forward until it contacts the front panel. Be sure that the white plastic pawl on the locking knob is properly aligned as the Head is slid into the case. Attach the rear casting so the hole is over the Trigger Takeoff connector. Insert the four long mounting bolts and tighten them securely. Check that the Pulser Board is centered in the rear casting opening so the Type S-50 can be properly inserted into the sampling unit or Type 285 Power Supply.

SECTION 5
PERFORMANCE CHECK / CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

Performance of the Type S-50 Pulse Generator Head can be checked using the steps of this procedure which are headed in the type face used in step 2. Failure to meet the requirement given in any check indicates the need for adjustment or repair. Calibration is headed by the type face in step 1.

EQUIPMENT REQUIRED

The equipment listed below or its equivalent is required for a complete performance check and calibration of the Type S-50 Pulse Generator Head, see Fig. 5-1. Equipment specifications given are the minimum necessary for the particular use of each item. All test equipment must meet or exceed the limits stated below.

All equipment items listed can be obtained by ordering through your local Tektronix Field Engineer or Representative.

1. Oscilloscope, with proper sampling plug-in units, such as a Type 561B Oscilloscope with Type 3S2 Sampling Unit and Type 3T2 Random Sampling Sweep.

2. Sampling Head; Type S-4 with 25 ps risetime is recommended.

3. Pulse generator for pulse flatness deviation reference; Tektronix Type 284 Pulse Generator with pulse output of a 70 ps risetime and maximum 3% pulse flatness deviation is recommended.

4. Signal delay coaxial cable, impedance, 50 Ω; delay, 60 ns; connectors, GR874. Tektronix Type 113 Delay Cable is recommended.

5. Flexible extender cable for operating either the Type S-50 or Type S-4 outside the sampling unit; Tektronix Part No. 012-0124-00.

6. Power supply, with access to rear panel Pretrigger Out connector. Tektronix Type 285 Power Supply recommended.

7. One 42-inch coaxial cable with BNC connectors; characteristic impedance approximately 50 ohms. Tektronix Part No. 012-0057-01.

8. One 3 mm coaxial cable, 2 ns delay. Tektronix Part No. 015-1005-00.

9. Solid coaxial line with 3 mm connectors, Tektronix Part No. 015-1005-00.

10. One 7-inch coaxial cable, type RG58, with BNC to BSM connectors. Tektronix Part No. 012-0128-00.

11. One 18-inch coaxial cable, type RG58, with BNC to BSM connectors. Tektronix Part No. 012-0127-00.

12. Adapter, 3 mm male to GR874, Tektronix Part No. 015-1007-00.

13. Adapter, 3 mm female to GR874, Tektronix Part No. 015-1008-00.

14. Adapter, BNC female to GR874, Tektronix Part No. 017-0063-00.

15. Two adapters, BNC female to 3 mm male, Omni Spectra No. O/S 21190.

16. Adapter, BNC female to BSM male, Tektronix Part No. 103-0036-00.

17. Pocket screwdriver with shank at least 2 inches long and a blade width of approximately $^3/_{32}$ inch. Tektronix Part No. 003-0192-00.

PERFORMANCE CHECK AND CALIBRATION RECORD AND INDEX

The following abridged procedure may be used as a guide by the experienced technician for checking the performance of the Type S-50 Pulse Generator Head. The abridged procedure can be used as a maintenance record (the procedure may be reproduced without special permission of Tektronix, Inc.). The step numbers and titles are identical to those in the complete procedure.

Type S-50, Serial No. _____

Performance Check Date _____

Performed By _____

☐ 1. Adjust Stability, R52. (Page 5-4)

☐ 2. Check Pretrigger to Pulse Time Interval. (Page 5-5)

☐ 3. Adjust Leadtime, R14. (Page 5-5)

☐ 4. Check Pulse Duration. (Page 5-5)

☐ 5. Check Pulse Repetition Rate. (Page 5-5)

☐ 6. Check Pulse Amplitude into 50 Ω. (Page 5-6)

☐ 7. Check Pulse Risetime. (Page 5-6)

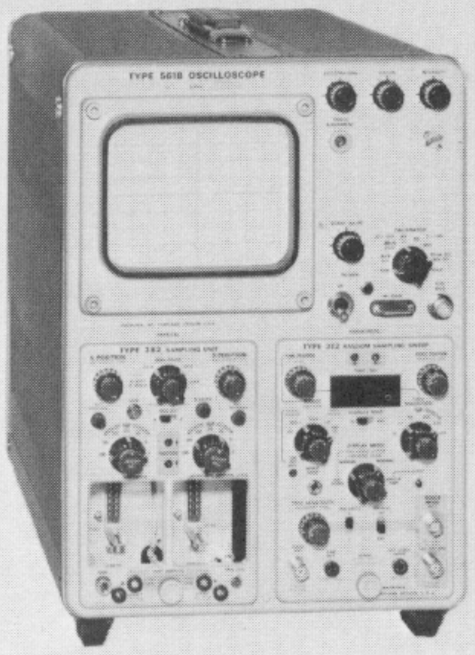
☐ 8. Check Pulse Flatness Deviation. (Page 5-7)

☐ 9. Check Pretrigger Pulse Duration. (Page 5-7)

☐ 10. Check Pretrigger Pulse Amplitude. (Page 5-8)

☐ 11. Check Pretrigger Pulse Risetime. (Page 5-8)

☐ 12. Check Pretrigger to Pulse Jitter. (Page 5-9)



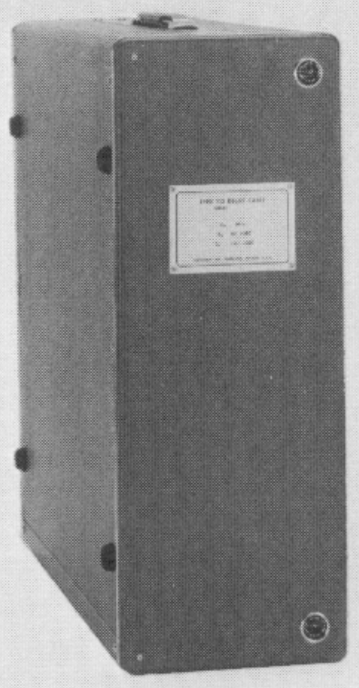
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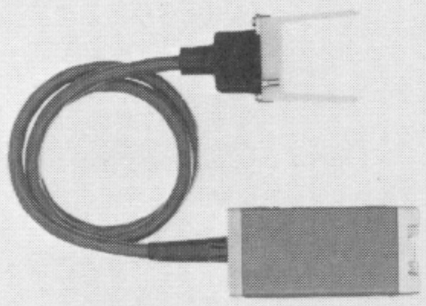
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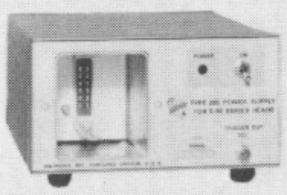
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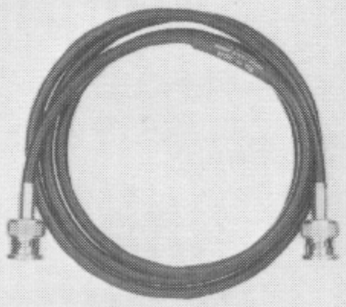
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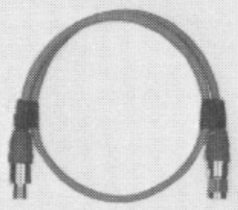
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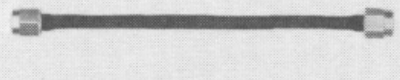
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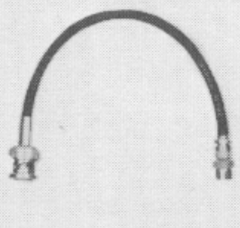
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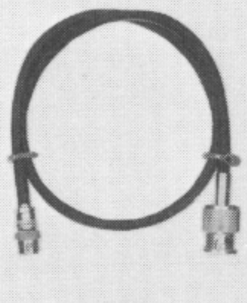
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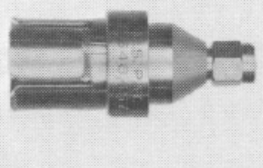
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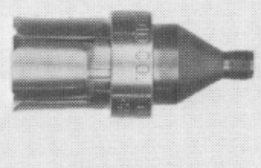
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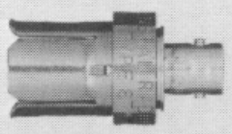
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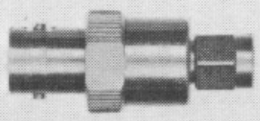
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(13)



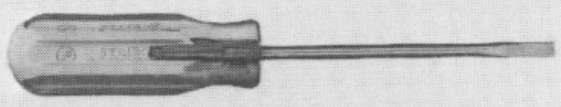
(14)



(15)



(16)



(17)

Fig. 5-1. Equipment required for performance check and calibration.

☐ 13. Check Pretrigger Pulse Duration (Rear Panel). (Page 5-9)

☐ 14. Check Pretrigger Pulse Amplitude (Rear Panel). (Page 5-10)

☐ 15. Check Pretrigger Pulse Risetime (Rear Panel). (Page 5-10)

☐ 16. Check Trigger Pulse Amplitude into 50 Ω. (Page 5-10)

☐ 17. Check Trigger Pulse Risetime. (Page 5-10)

☐ 18. Check Trigger Pulse Duration. (Page 5-10)

☐ 19. Check Pulse Output to Trigger Output Time Interval. (Page 5-10)

PRELIMINARY PROCEDURE

Install the sampling unit into the left compartment of the oscilloscope and the sampling sweep unit into the right compartment. Place the Type S-4 Sampling Head in the Channel A compartment of the sampling unit and place the extender in the Channel B compartment. Connect the Type S-50 to the extender.

Set the controls as listed following Fig. 5-2. Adjustments are accessible without removing the case.

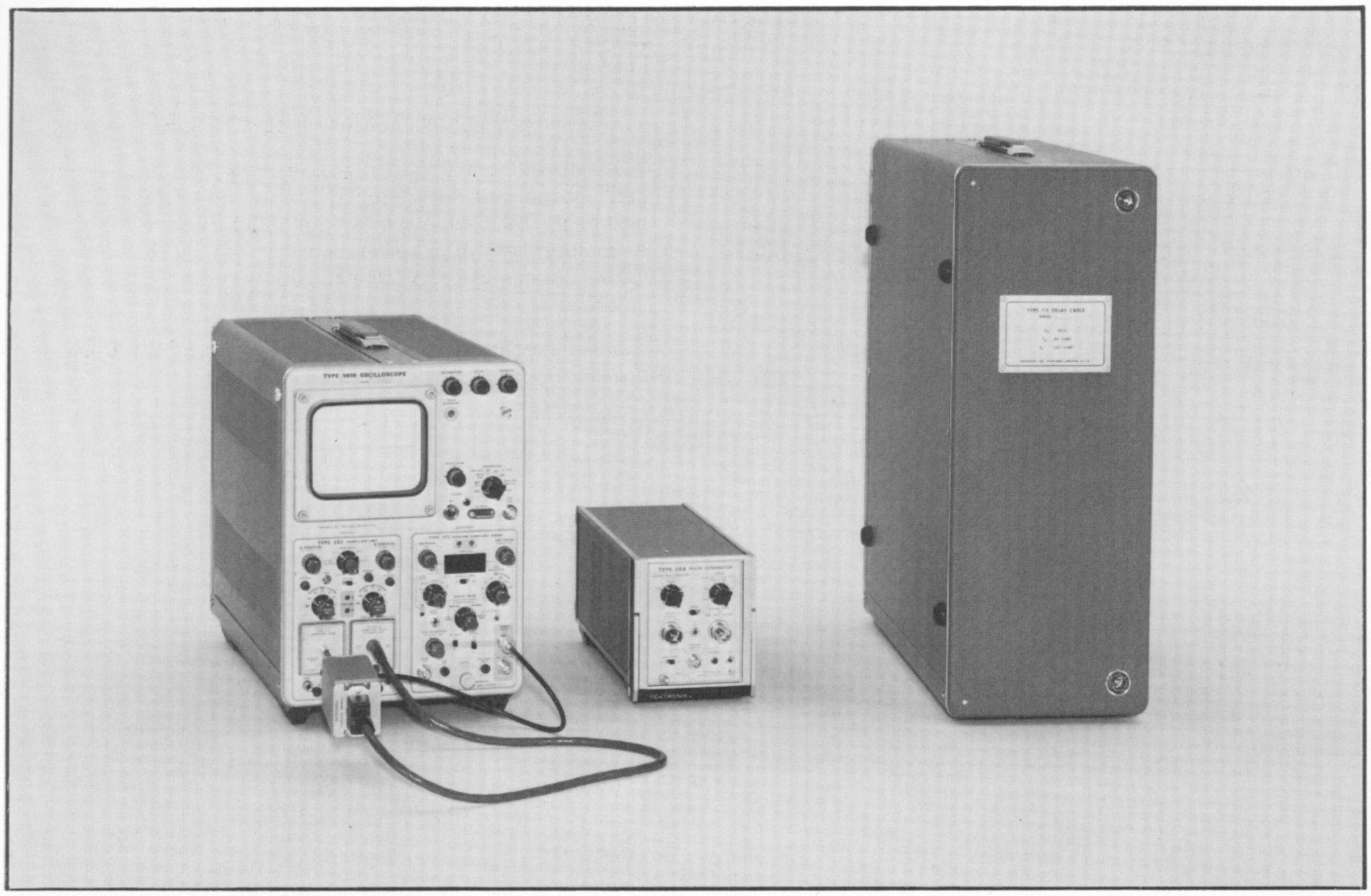


Fig. 5-2. Initial equipment setup.

Sampling Unit (Both Channels)

Mode Switch	CH A
Dot Response	Midrange
Units/Div	100
Trig Out	B
Variable	Cal
Invert	Pushed in
Position	Midrange
DC Offset	0 volts at Offset Out
Internal Horiz Plug-In Compatibility	Sampling

Sampling Sweep Unit

Display Mode	Normal
Start Point	With Trigger
Time/Div	1 ns
Range	100 ns
Time Magnifier	×10
Variable	Cal
Display Mag	×1
Time Position controls	Fully clockwise
Horiz Position	Midrange
Trig Sensitivity	Stable Display
Recovery Time	Optional
Trigger Polarity	+
Trigger Source	Ext
Samples/Div	100, Dot at 9 o'clock

Type 284

Mode	Pulse
Lead Time	75 ns
Other controls	Optional

PERFORMANCE CHECK AND CALIBRATION PROCEDURE

1. Adjust Stability Control, R14

a. Connect the Pulse Output connector to the solid coaxial line with 3 mm connectors and to the Type S-4 Input connector. Connect the Pretrig Out connector to a BNC to BSM coaxial and to the sampling sweep unit 50 Ω Trigger Input connector. The equipment setup is shown in Fig. 5-2.

b. Initially set the STABILITY control fully counterclockwise and observe that the fast rise portion of the pulse is absent.

c. Turn the STABILITY control clockwise through the following displays;

(1) Appearance of the fast rise portion with a less than tolerance pulse width,

(2) Fast rise portion moves to the left to position at the top of the slow rising portion, note this position,

(3) Continue clockwise rotation to move the fast rise portion ½ to 1 ns to the left of the position noted in (2).

d. Disconnect the Type S-50 from the Type S-4. Remove the extender and install the Type S-50 into the sampling unit.

2. Check Pretrigger to Pulse Time Interval

Requirement—Pretrigger must lead the pulse by 75 ns within 5 ns.

a. Connect the 3 mm to BNC female adapter to the Pulse Output connector and the BSM to BNC adapter to the Pretrig Out connector.

b. Connect a BNC coaxial cable from the Pretrig Out adapter to a BNC to 3 mm adapter and the Type S-4 Input connector. Connect a BSM to BNC cable from the sampling unit Trig Out connector to the sampling sweep unit 50 Ω Trigger Input connector.

c. Set the sampling sweep unit for a sweep rate of 10 ns/div (Time Multiplier switch to ×1) and the Start Point switch to Before Trigger. Use the Time Position controls to position the rising portion of the pulse at the left edge of the graticule.

d. Move the BNC coaxial cable from the Pretrig Out adapter to the Pulse Output adapter.

e. Check that the position of the rising portion of the Pulse Output is between 7 and 8 divisions from the left edge of the graticule, 75 ns within 5 ns. Fig. 5-3 is a double exposure for this measurement.

f. If the leadtime is not between 70 and 80 ns, perform step 3.

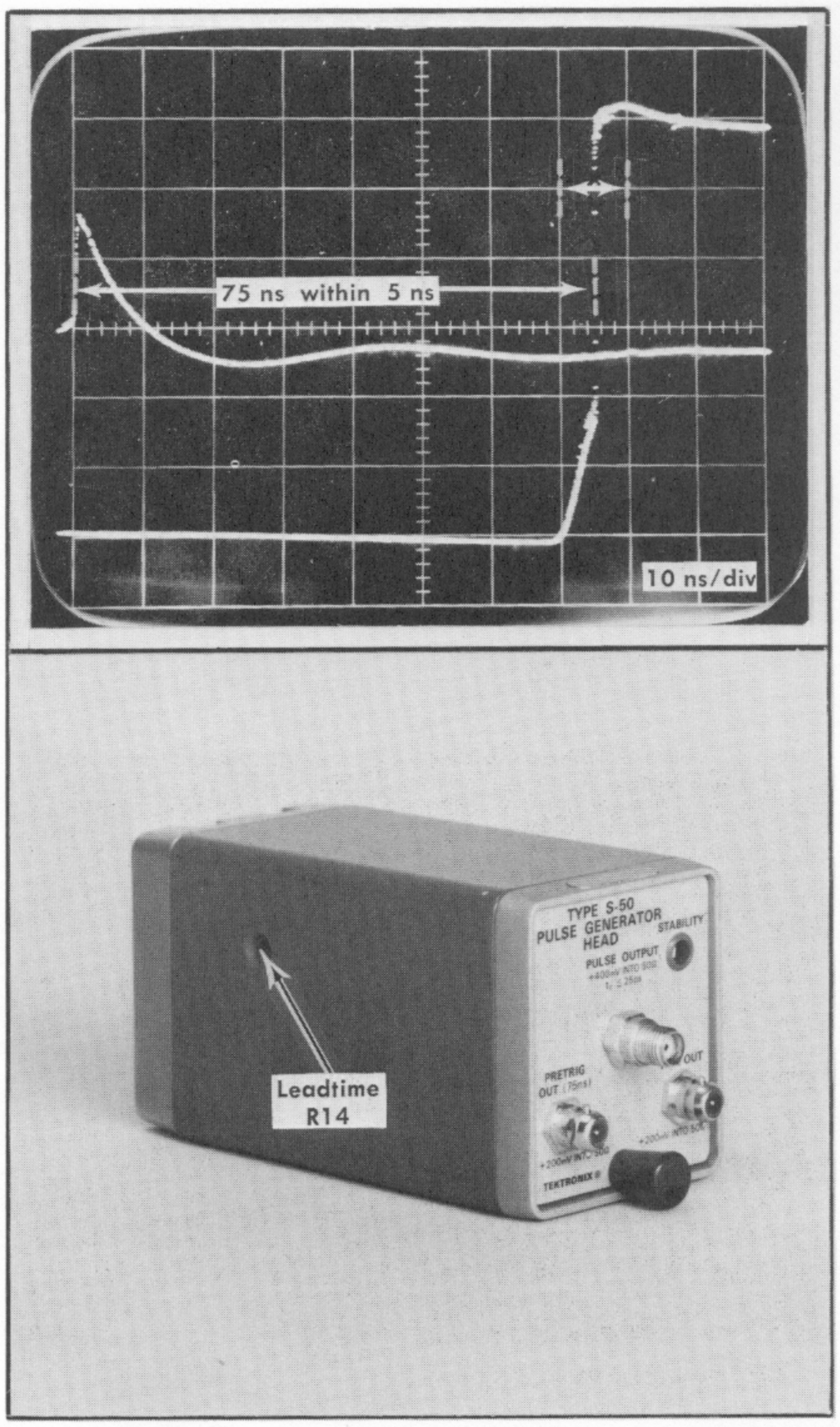


Fig. 5-3. Pretrigger to Pulse time interval and adjustment.

3. Adjust Leadtime, R14

a. Remove the Type S-50 from the sampling unit and install the extender. Connect the Type S-50 onto the extender.

b. Use the method described in step 2. If the position of the Pulse Output is not between 7 and 8 divisions from the reference Pretrigger Out pulse at the left edge of the graticule, adjust Leadtime, R14, located under the case hole on the left side, to position the Pulse Output pulse 75 ns from the Pretrigger Out pulse.

4. Check Pulse Duration

Requirement—Pulse duration at 50% amplitude point must be 100 ns, —0%, +20%.

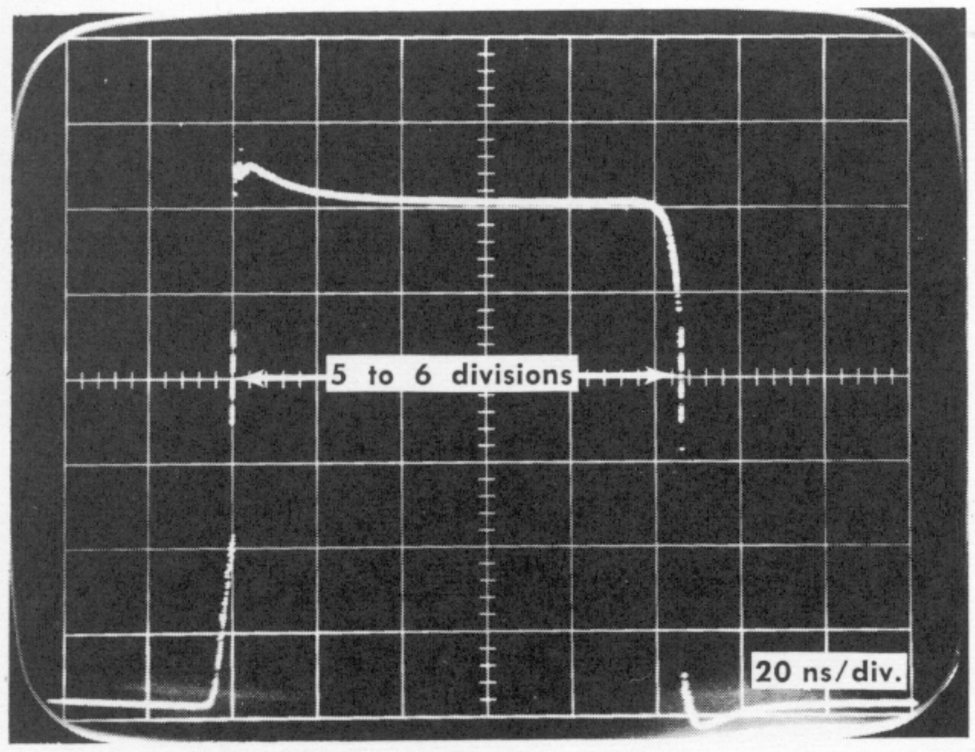
a. Connect the Pulse Output connector to the solid coaxial line with 3 mm connectors and to the Type S-4 Input connector. Connect the Pretrig Out connector to a BNC to BSM coaxial cable and to the sampling sweep unit 50 Ω Trigger Input connector. The equipment setup is shown in Fig. 5-2.

b. Set the sampling sweep unit sweep rate to 20 ns/div (Range switch to 1 μs and Time Multiplier to ×5).

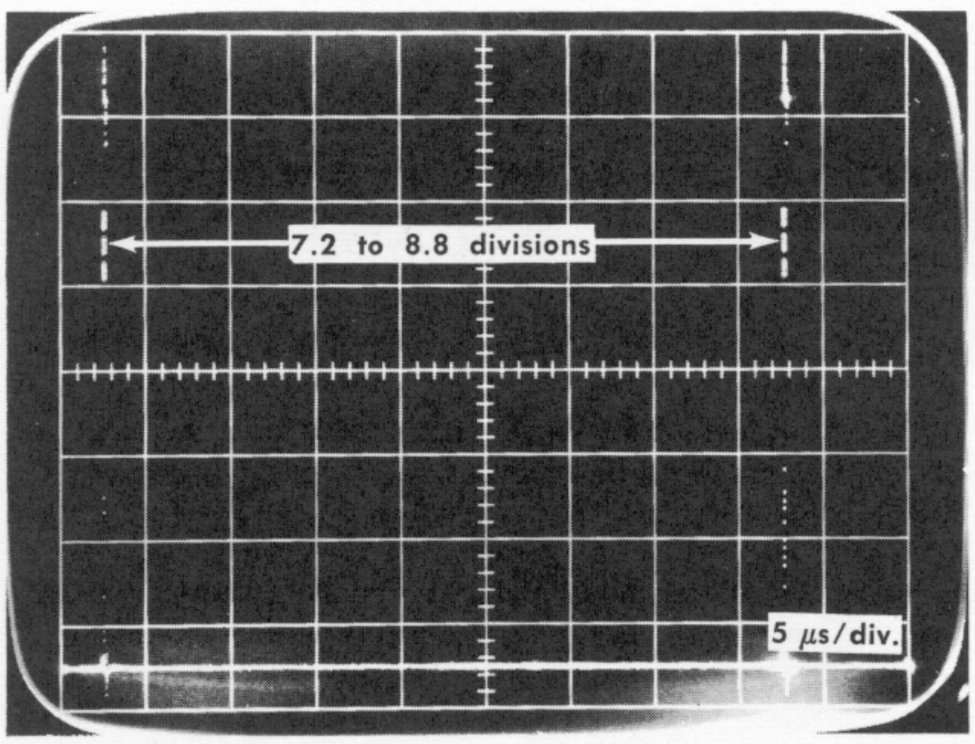
c. Center the display with the sampling unit Position control and check that the pulse duration at the 50% amplitude point is between 5 and 6 divisions (100 ns, —0%, +20%). See Fig. 5-4A.

5. Check Pulse Repetition Rate

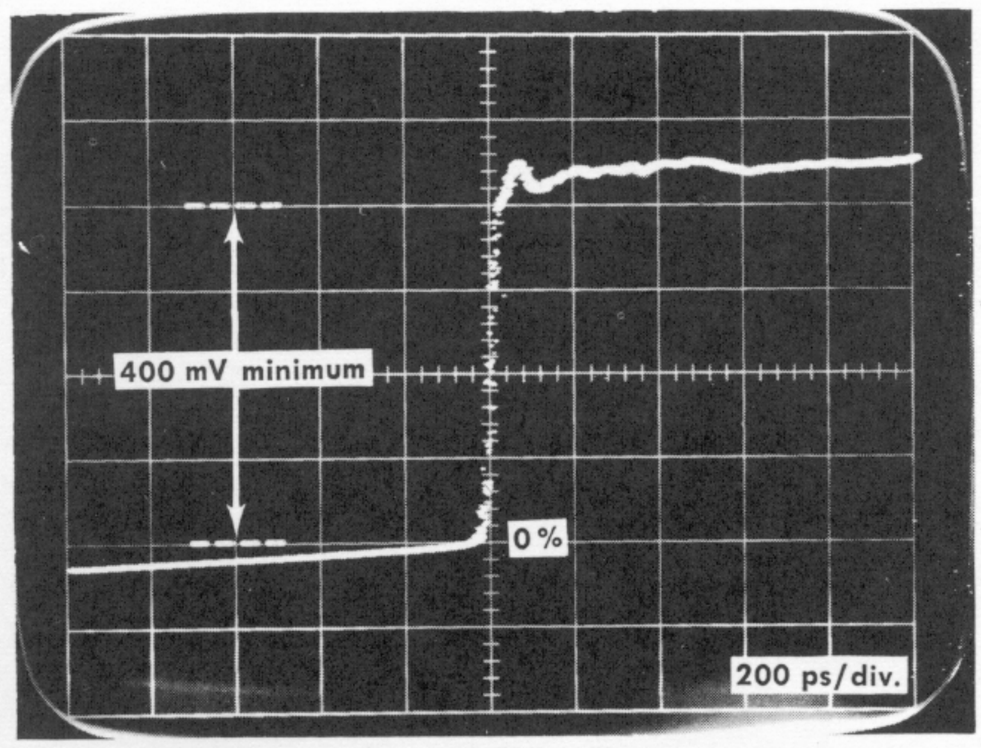
Requirement—Repetition rate must be 25 kHz within 10%.



(A) Pulse duration.



(B) Pulse repetition rate.



(C) Pulse amplitude.

Fig. 5-4. Typical displays for checking Pulse Output.

a. Set the sampling sweep unit sweep rate to 5 μs/div (Range switch to 100 μs and Time Magnifier to ×2). Set the Display Mode switch to Manual and use the Manual Scan control to measure the time between positive going pulses.

b. Check that time between pulses is between 36 μs and 44 μs (7.2 and 8.8 divisions) or 25 kHz within 10%. See Fig. 5-4B.

c. Set the sampling sweep unit Display Mode switch to Normal.

6. Check Pulse Amplitude into 50 Ω

Requirement—Amplitude must be 400 mV or more, positive going, into 50 Ω.

a. Set the sampling sweep unit Start Point to With Trigger and the sweep rate to 200 ps (Range switch to 100 ns and Time Magnifier switch to ×50).

b. Measure the amplitude of the pulse from the 0% level to the 100% level.

c. Check that the amplitude is 400 mV or more (at least 4 divisions). See Fig. 5-4C.

7. Check Pulse Risetime

Requirement—The 10% to 90% risetime is equal to or less than 25 ps, displayed as 35 ps or less using the Type S-4 Sampling Head.

Risetime measurement requires either a camera or a storage oscilloscope because the dot density must be increased for an accurate display and the sweep becomes too slow for visual interpretation.

a. Set the sampling sweep unit for a 20 ps/div sweep rate (Range switch to 100 ns, Time Magnifier switch to ×50 and the Display Mag switch to ×10). Center the rising portion of the pulse on the graticule and obtain at least 100 dots per division. Photograph or store the display.

b. Measure the risetime as follows:

(1) Mark reference points at maximum rate of change, the break points shown in Fig. 5-5.

(2) Mark the centers of the 0% zone and 100% zone, 35 ps wide (the specified system risetime) and 35 ps from reference break points, shown in Fig. 5-5.

(3) Mark the average level of the 0% and 100% zones through the centers of the zones.

(4) Mark the 10% and 90% points in relation to the 0% and 100% average levels.

(5) Measure the risetime between the 10% and 90% points.

c. Check that the risetime is 35 ps or less.

d. Use the same setup for the pulse flatness deviation check.

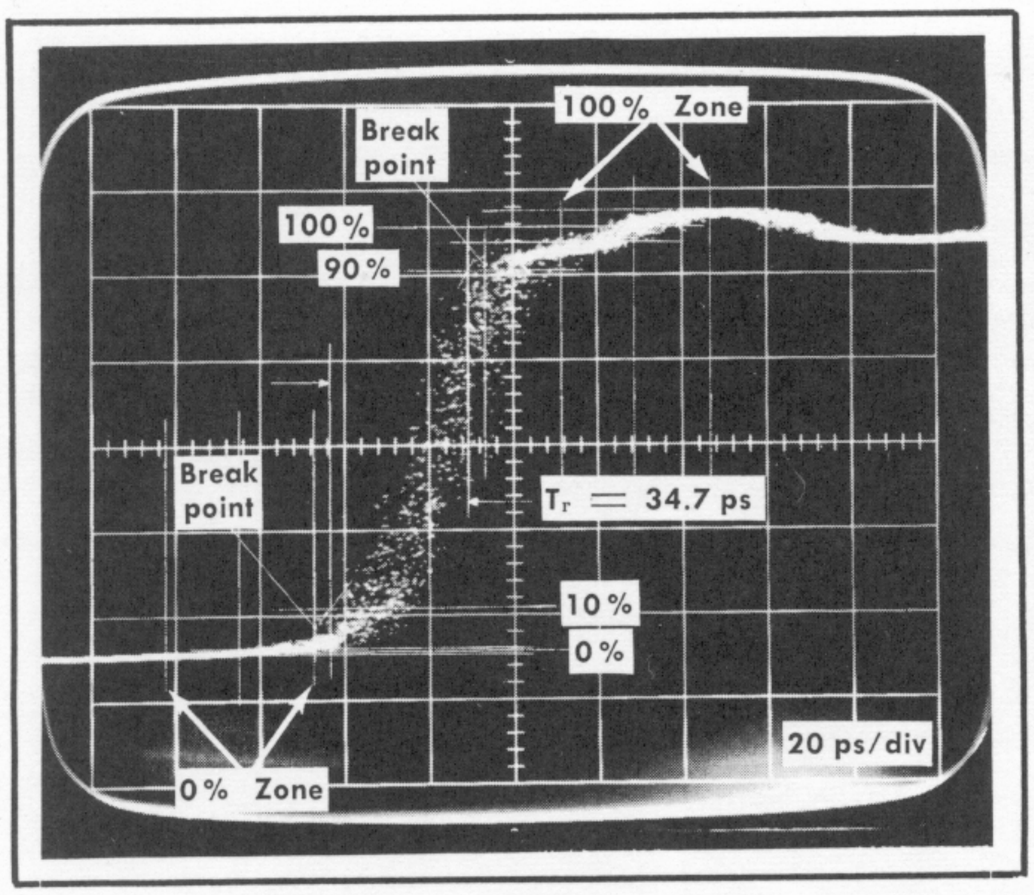


Fig. 5-5. Combination of Type S-50 and Type S-4 risetime measurement.

8. Check Pulse Flatness Deviation

Requirement—Pulse will deviate from the flat;

First 400 ps after step, +10%, —10% or less, total of 20% peak to peak;

Between 400 ps and 5 ns after step, +5%, —5% or less, total of 5% peak to peak;

Between 5 ns and 100 ns after step, +2%, —2% or less, total of 4% peak to peak.

The Type 284 is used to determine pulse flatness deviation present in the Type S-4 Sampling Head from 400 ps to 100 ns.

The double exposure pictures of Fig. 5-6 are provided to show a comparison of the pulse flatness deviation characteristics of the Type S-50 and the Type 284 with the same sampling unit. Pulse flatness deviations of the Type S-50 are seen as changes in separation between the Type 284 waveform and the Type S-50 waveform. This method requires either a camera for double exposures, or a storage oscilloscope in order to make valid comparisons.

a. Use the same setup as in step 7 and set the 100% zone on a graticule line. Change the sampling sweep unit sweep rate to 50 ps/div (Time Magnifier switch to ×20) and Time Position the display so the 90% amplitude point is near the first division on the graticule.

b. Check that the pulse does not deviate from the 100% level more than +10% or —10% or a total of 20% (10% is about a half division) during the first 400 ps, see Fig. 5-6A.

c. Set the sampling sweep unit for a 10 ns/div sweep rate (Display Mag switch to ×1 and the Time Magnifier switch to ×1) and obtain a stable display.

d. Set the sampling unit Variable Units/Div control so the 0% to 100% levels of the pulse are 5 divisions apart, *20% per division*, (the 100% level is about 80 ns from the rising portion of the pulse).

e. Change the Units/Div switch (without moving the Variable control) to 20. Each vertical division represents 4% of the total display height. Set the sampling sweep unit sweep rate to 500 ps/div (Time Magnifier switch to ×20).

Use the DC Offset control to vertically place the pulse at a reference on the graticule and the sampling sweep unit Time Position controls for horizontal placement. (This display must be retained for reference either by storage on a storage oscilloscope, or by photograph which is not developed until a second waveform is also exposed. Remember the location on the graticule). This completes obtaining the Type S-50 waveform for the 400 ps through 5 ns interval.

f. Remove the Type S-50 and the BNC to BSM cable. Connect the Type 284 Pulse Output connector to the Type S-4 Input connector through a 3 mm to GR adapter and the solid coaxial 3 mm line.

g. Connect the Type 284 Trigger Output to the sampling sweep unit 50 Ω Trigger Input connector with a BNC coaxial cable.

h. Set the sampling unit Units/Div switch at 50, the sampling sweep unit for a 10 ns/div sweep (Time Magnifier switch to ×1) and obtain a stable display. Set the sampling unit Variable Units/Div control for a display amplitude equal to the Type S-50 pulse amplitude including the step preceeding the fast pulse, see Fig. 5-6B.

i. Change the Units/Div switch (without moving the Variable control) to 10 and place the display near the stored Type S-50 display, using only the DC Offset control. Change the sweep rate to 500 ps (Time Magnifier switch to ×20) and Time Position the display at the same horizontal placement as the Type S-50. Expose the waveform and develop the photograph. Determine the separation differences between the two waveforms. This is the percentage of pulse flatness deviation for the Type S-50 Pulse Generator Head and should not exceed +5%, —5% or total 5% peak to peak.

j. Change the sampling sweep unit for a sweep rate of 10 ns/div (Time Magnifier switch to ×1) and repeat the procedure to determine the pulse flatness deviation from 5 ns through 100 ns, for a deviation not more than +2%, —2%, or a total 4% peak to peak. Maintain the 10 ns/div sweep rate.

k. Disconnect the Type 284 from the Type S-4 and the sampling sweep unit.

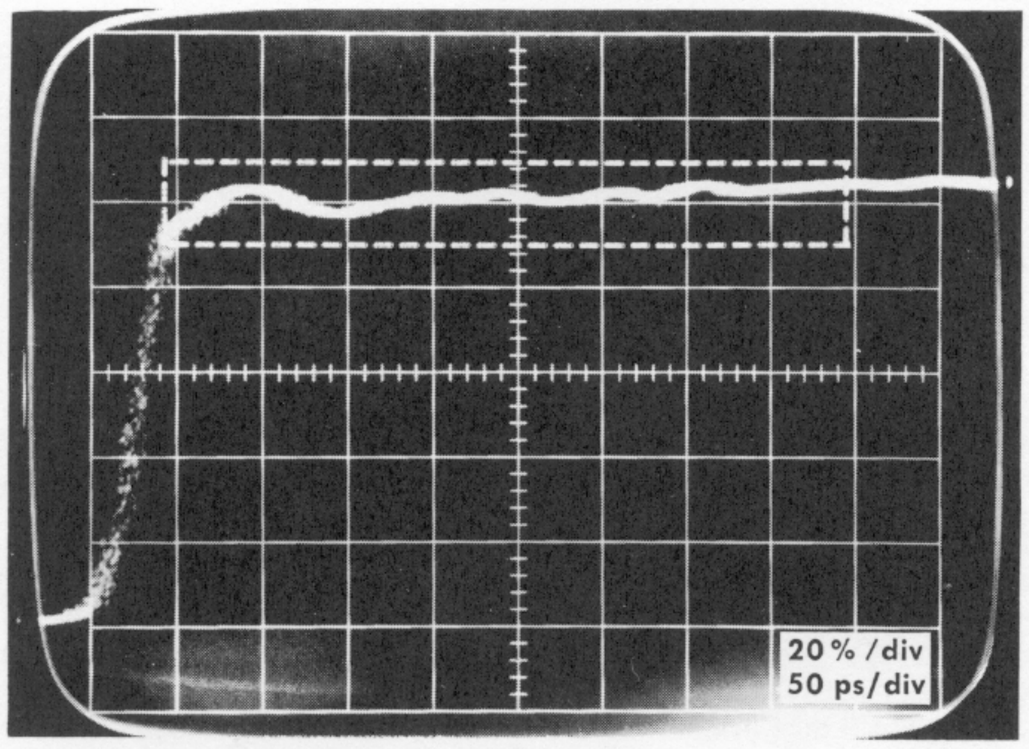
9. Check Pretrigger Pulse Duration

Requirement—Pulse duration must be 4 ns within 1 ns.

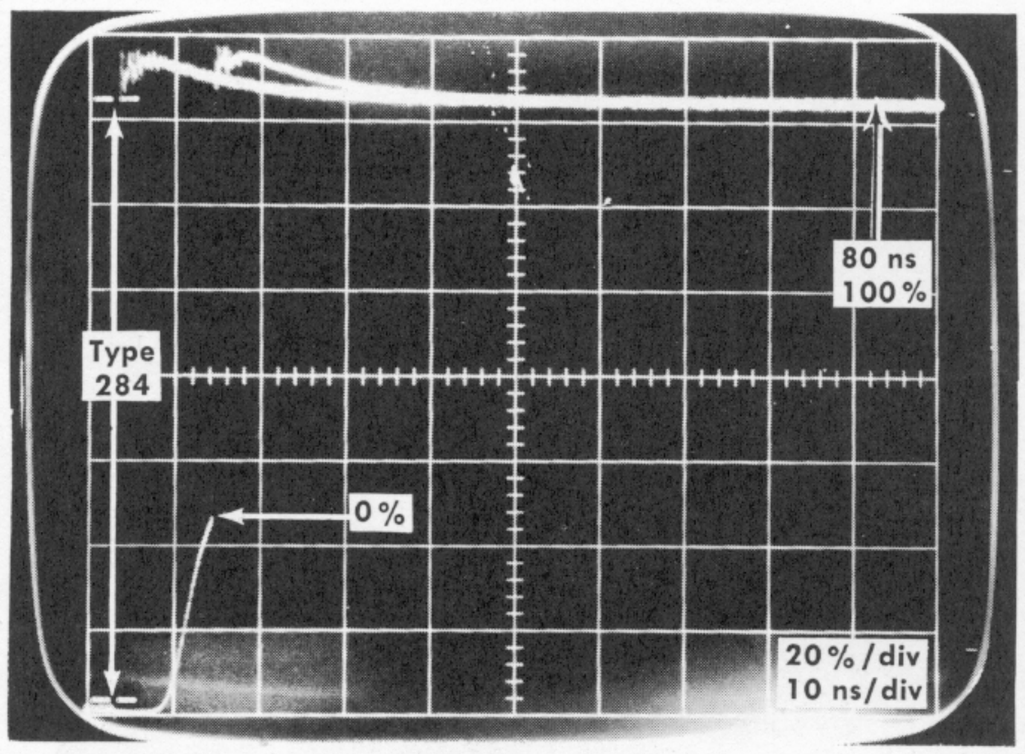
a. Remove the sampling head extender and install the Type S-50 in the Channel B compartment of the sampling unit.

b. Connect the Pretrig Out connector to a BNC to BSM cable, a BNC to 3 mm adapter and to the Type S-4 Input connector.

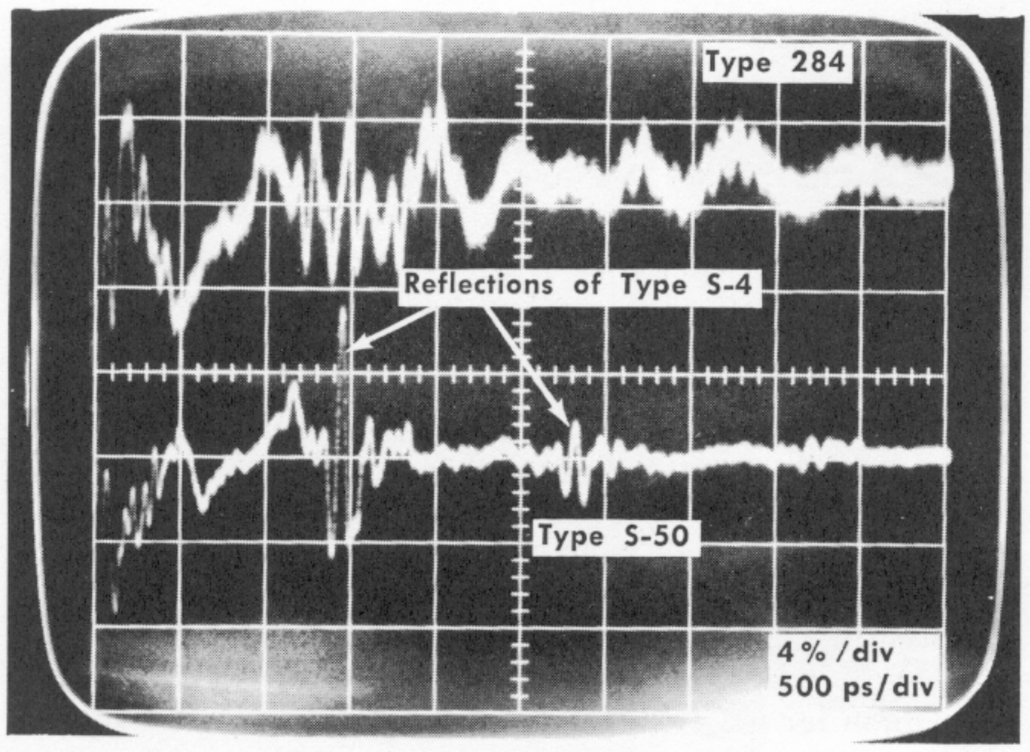
c. Connect a BNC to BSM cable from the sampling unit Trig Out connector to the sampling sweep unit 50 Ω Trigger Input connector.



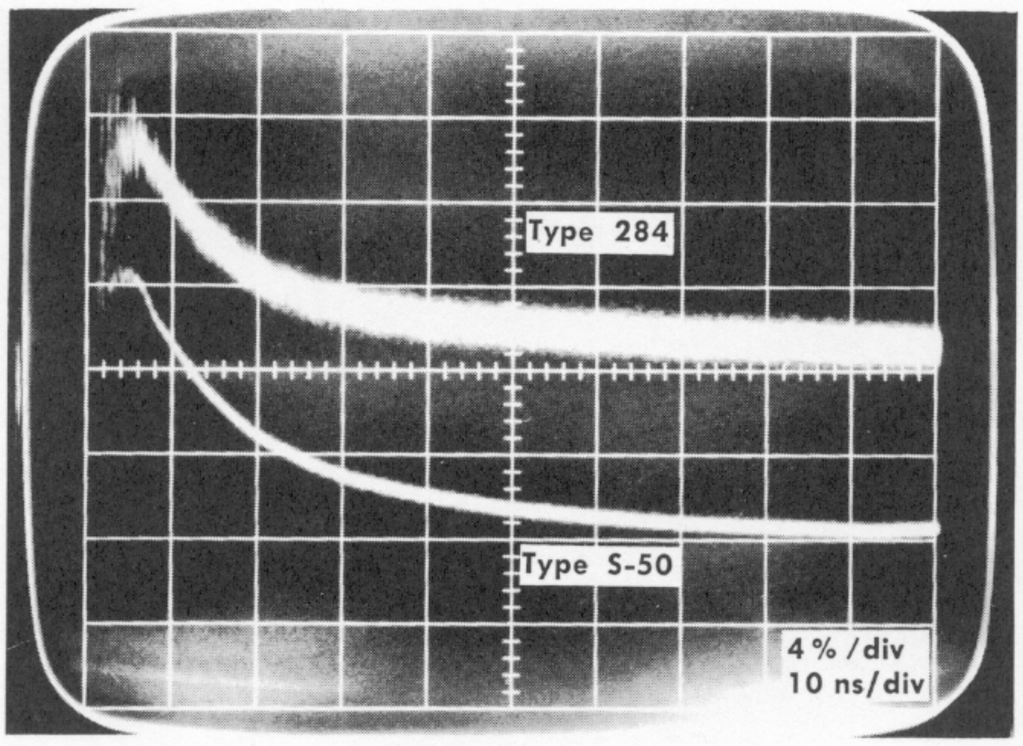
(A) First 400 ps interval.



(B) Amplitudes for comparisons.



(C) 400 ps through 5 ns interval.



(D) 5 ns through 100 ns interval.

Fig. 5-6. Pulse flatness deviation check.

d. Set the sampling unit Units/Div switch to 50 and the Variable control to Cal.

e. Set the sampling sweep unit for a sweep rate of 2 ns/div (Range switch to 100 ns and Time Magnifier switch to ×5). Set the Start Point switch to Before Trigger and the Display Mag switch to ×1. Obtain a stable display.

f. Check that the pulse duration at the 50% amplitude points is between 3 and 5 ns. See Fig. 5-7.

10. Check Pretrigger Pulse Amplitude

Requirement—Amplitude must be 180 mV or more.

a. Measure the amplitude on the positive going portion from the preshoot to the maximum amplitude level, see Fig. 5-7.

b. Check that the amplitude is at least 180 mV.

11. Check Pretrigger Pulse Risetime

Requirement—Risetime must be 400 ps or less.

a. Set the sampling sweep unit sweep rate to 200 ps/div (Time Magnifier switch to ×50). Center the rising portion of the pulse with the Time Position controls.

b. Set the sampling unit Variable Units/Div control for an amplitude convenient to measure the risetime from the 10% to 90% levels.

c. Check that the 10% to 90% risetime is not more than 400 ps.

d. Set the Variable Units/Div control to Cal.

e. Disconnect the cable from the Pretrig Out connector to the Type S-4 Input connector.

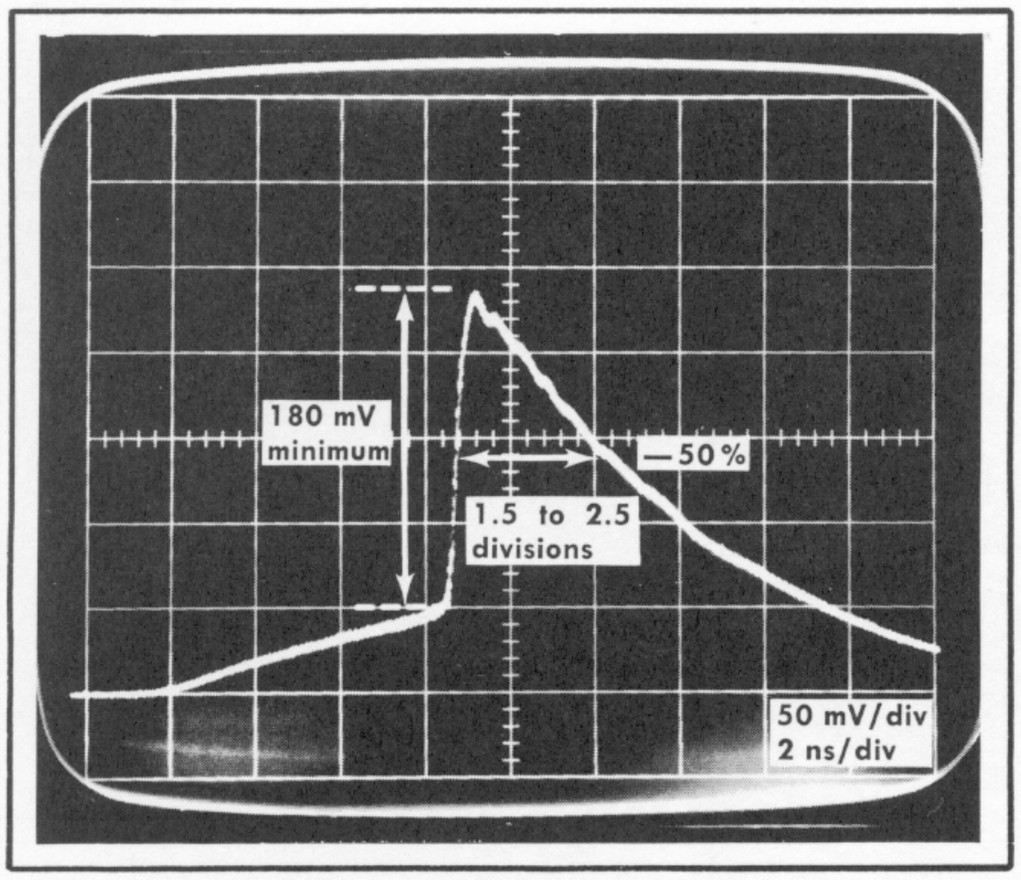


Fig. 5-7. Typical display for checking Pretrigger pulse duration and amplitude.

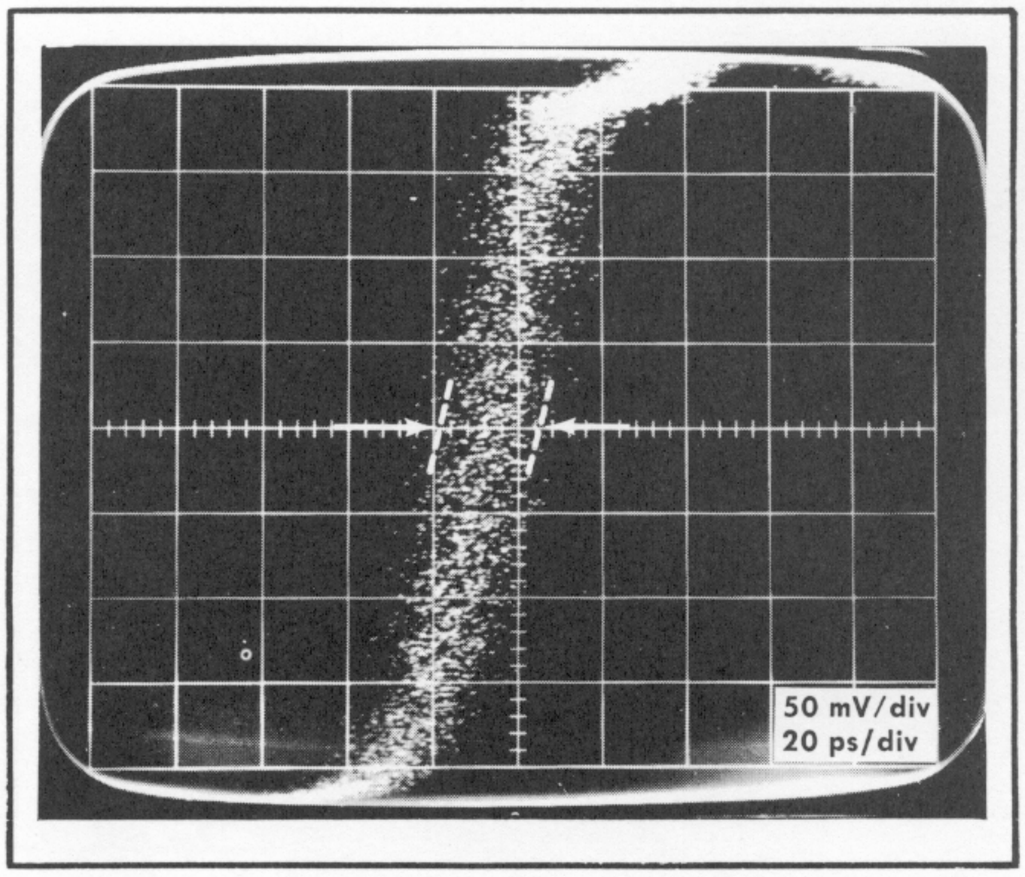


Fig. 5-8. Jitter measurement.

12. Check Pretrigger to Pulse Jitter

Requirement—Jitter must be 15 ps or less; will be 20 ps or less with the Type 3T2.

a. Remove the Type S-50 from the sampling unit and install the extender. Connect the Type S-50 to the extender.

b. Connect a BNC to BSM coaxial cable from the Type S-50 Pretrig Out connector to the sampling sweep unit 50 Ω Trigger Input connector. Connect the solid coaxial line with 3 mm connectors from the Pulse Output connector to the Type S-4 Input connector.

c. Set the Start Point switch to With Trigger and set the Trigger controls for a stable display. Set the Samples/Div control for the maximum number of dots and the Display Mag switch to ×10.

d. Determine the jitter by measuring 90% of the dot density on the rising portion, see Fig. 5-8.

e. Check that the jitter is not more than 20 ps as displayed with the Type 3T2 Random Sampling Sweep. Proceed to step 13.

If the jitter measurement is greater than 20 ps, note the measurement and determine the Type 3T2 jitter by the following method.

f. Disconnect the solid coaxial line and remove the Type S-50 from the extender. Do not distrub the sampling sweep unit trigger connection or controls.

g. Install the Type S-50 into the Type 285 Power Supply. Connect the Type 285 Triger Out to the Type S-4 Input connector through a BNC to BSM coaxial cable, a BNC to GR adapter, the 60 ns Delay Cable, a GR to 3 mm adapter and the 3 mm cable.

h. Set the sampling unit Units/Div switch to 5 and adjust the Variable Units/Div control to align the leading edge of the pulse on a 45° angle with the graticule lines.

i. Measure 90% of the horizontal dot density in terms of graticule divisions. Note this measurement (A).

j. Disconnect the cable from the Type 285 Trigger Out connector. Position the trace at the graticule center and measure 90% of the vertical dot density in graticule divisions. Note this measurement (B).

k. Calculate the Type 3T2 jitter with the following formula:

$$\text{Type 3T2 jitter} = \sqrt{A^2 - B^2} \times 20\text{ ps}$$

l. Calculate the Type S-50 jitter by the following formula:

$$\text{Type S-50 jitter} = \sqrt{\left(\frac{\text{observed jitter}}{\text{part e}}\right)^2 - \left(\frac{\text{Type 3T2 jitter}}{\text{part k}}\right)^2}$$

13. Check Pretrigger Pulse Duration (Rear Panel)

Requirement—Pulse duration must be 6 ns within 2 ns.

a. Disconnect the solid coaxial line and remove the Type S-50 from the extender. Install the Type S-50 into the Type 285 Power Supply.

b. Connect the Type 285 Trigger Out to the Type S-4 Input connector through a BNC to BSM coaxial cable and a BNC to 3 mm adapter.

c. Set the sampling unit Units/Div switch to 20 and the Variable Units/Div control to Cal.

d. Set the sampling sweep unit for a sweep rate of 2 ns/div (Range switch to 100 ns and Time Magnifier switch to ×5). Set the Samples/Div control to 9 o'clock, 100 dots per division. Set the Start Point switch to Before Trigger and the Display Mag switch to ×1. Obtain a stable display.

e. Check that the pulse duration at the 50% amplitude points is between 4 and 8 ns, 2 to 4 divisions.

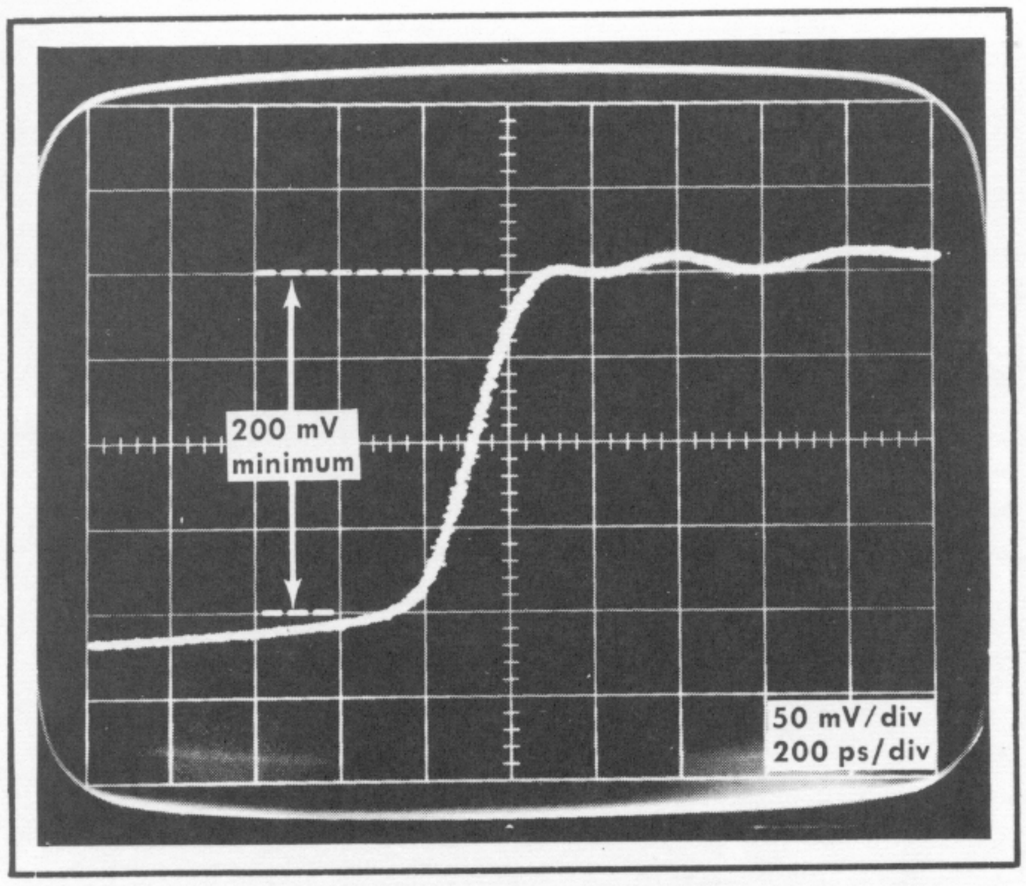


Fig. 5-9. Typical display for measuring Trigger pulse amplitude.

14. Check Pretrigger Pulse Amplitude (Rear Panel)

Requirement—Amplitude must be 70 mV or more.

a. Measure the amplitude on the positive going portion from the top of the preshoot to the maximum amplitude level.

b. Check that the amplitude is at least 70 mV.

15. Check Pretrigger Pulse Risetime (Rear Panel)

Requirement—Risetime must be 400 ps or less.

a. Set the sampling sweep unit sweep rate to 200 ps/div (Time Magnifier switch to ×50). Center the rising portion of the pulse with the Time Position controls.

b. Set the sampling unit Variable Units/Div control for an amplitude convenient to measure the risetime from the 10% to 90% levels.

c. Check that the 10% to 90% risetime is not more than 400 ps.

d. Set the Variable Units/Div control to Cal.

e. Disconnect the cables to the Type S-50 and remove it from the Type 285 Power Supply. Remove the extender and install the Type S-50 into the sampling unit.

16. Check Trigger Pulse Amplitude into 50 Ω

Requirement—Amplitude must be 200 mV or more.

a. Connect the Type S-50 Trig Out connector to a BNC to BSM coaxial cable and BNC to 3 mm adapter to the Type S-4 Input connector. Connect the Pretrig Out connector to the sampling sweep unit 50 Ω Trigger Input connector through a BNC to BSM coaxial cable.

b. Set the sampling unit Units/Div switch to 50 and the sampling sweep unit Start Point switch to With Trigger.

c. Measure the amplitude on the positive going portion, see Fig. 5-9.

d. Check that the amplitude is at least 200 mV.

17. Check Trigger Pulse Risetime

Requirement—Risetime must be 250 ps or less.

a. Set the sampling unit Variable Units/Div control for an amplitude convenient to measure the risetime from the 10% to 90% levels.

b. Check that the 10% to 90% risetime is not more than 250 ps.

c. Set the Variable Units/Div to Cal.

18. Check Trigger Pulse Duration

Requirement—Trigger pulse duration at 50% amplitude point must be 100 ns, —0%, +20%.

a. Set the sampling sweep unit sweep rate to 20 ns/div (Range switch to 1 μs and the Time Magnifier switch to ×5).

b. Set the Start Point switch to Before Trigger. Obtain a stable display.

c. Center the display and check that the pulse duration at the 50% amplitude point is between 5 and 6 divisions, 100 ns, —0%, +20%. See Fig. 5-4A.

d. Disconnect the cables from the Type S-4 and the sampling sweep unit.

19. Check Pulse Output to Trigger Out Time Interval

Requirement—Trigger Out pulse will coincide with the Pulse Output pulse within 5 ns.

a. Set the sampling sweep unit sweep rate to 2 ns/div (Range switch to 100 ns).

b. Connect the Type S-50 Pulse Output to the Type S-4 Input connector through a 3 mm to BNC female adapter, BNC coaxial cable, and 3 mm to BNC female adapter. Connect the sampling unit Trigger Out to the sampling sweep unit 50 Ω Trigger Input connector through a BSM to BNC cable.

c. Obtain a stable display and set the rising portion of the display at the center of the graticule.

d. Connect the BSM to BNC adapter to the Trig Out connector and move the BNC coaxial cable from the Pulse Output to the Trig Out adapter.

e. Check that the leading edge of the Trigger Out pulse is within 5 ns (2.5 divisions) of the center graticule setting of the Pulse Output pulse.

f. Disconnect the cables from the Type S-4 and the sampling unit.

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
incd	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Capacitors		
Tolerance ±20% unless otherwise indicated.						
C7	285-0598-00			0.01 μF	PTM	100 V 5%
C10	281-0536-00			1000 pF	Cer	500 V 10%
C20	283-0107-00			51 pF	Cer	200 V 5%
C23	283-0107-00			51 pF	Cer	200 V 5%
C31	283-0644-00			150 pF	Mica	1%
C33	281-0504-00			10 pF	Cer	500 V 1%
C36	283-0644-00			150 pF	Mica	1%
C43	283-0059-00			1 μF	Cer	25 V +80%—20%
C59	283-0132-00			10 pF	Cer	50 V 5%
C70	290-0135-00			15 μF	Elect.	20 V
C73	290-0135-00			15 μF	Elect.	20 V
				Semi-conductor Device, Diodes		
D10	152-0379-00			Tunnel	20 mA 10 pF	
D47	152-0379-00			Tunnel	20 mA 10 pF	
D61	*153-0040-00			Tunnel	Diode Assembly, selected	
D72	152-0227-00			Zener	1N753A 400 mW, 6.2 V, 5%	
				Connectors		
J23	131-0582-00			Receptacle, electrical		
J25	131-0579-00			Receptacle, electrical, male		
J48	131-0579-00			Receptacle, electrical, male		
J62	131-0631-00			Receptacle, electrical		
P21	131-0565-00			Receptacle, electrical, male		
P23	131-0391-00			Coax, 50 Ω, male		
				Transistors		
Q1	*151-0192-00			Silicon	Replaceable by MPS 6521	
Q5	*151-0192-00			Silicon	Replaceable by MPS 6521	
Q9	151-0221-00			Silicon	2N4258	
Q12	151-0225-00			Silicon	2N3563	
Q15	151-0225-00			Silicon	2N3563	

Transistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Description
Q30	151-0223-00		Silicon	2N4275
Q31	151-0225-00		Silicon	2N3563
Q35	151-0223-00		Silicon	2N4275
Q36	151-0225-00		Silicon	2N3563
Q44	151-0221-00		Silicon	2N4258
Q46	151-0221-00		Silicon	2N4258
Q50	151-0221-00		Silicon	2N4258
Q55	151-0223-00		Silicon	2N4275

Resistors

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

R1	321-0209-00	1.47 kΩ	1/8 W	Prec	1%
R3	317-0512-00	5.1 kΩ	1/8 W		5%
R4	317-0153-00	15 kΩ	1/8 W		5%
R5	317-0103-00	10 kΩ	1/8 W		5%
R7	317-0103-00	10 kΩ	1/8 W		5%
R8	317-0101-00	100 Ω	1/8 W		5%
R9	317-0241-00	240 Ω	1/8 W		5%
R11	317-0201-00	200 Ω	1/8 W		5%
R13	317-0751-00	750 Ω	1/8 W		5%
R14	311-0605-00	200 Ω, Var			
R15	317-0101-00	100 Ω	1/8 W		5%
R17	317-0122-00	1.2 kΩ	1/8 W		5%
R18	317-0560-00	56 Ω	1/8 W		5%
R20	317-0151-00	150 Ω	1/8 W		5%
R21	317-0331-00	330 Ω	1/8 W		5%
R23	317-0470-00	47 Ω	1/8 W		5%
R24	317-0103-00	10 kΩ	1/8 W		5%
R32	321-0220-00	1.91 kΩ	1/8 W	Prec	1%
R33	321-0155-00	402 Ω	1/8 W	Prec	1%
R34	317-0101-00	100 Ω	1/8 W		5%
R36	317-0101-00	100 Ω	1/8 W		5%
R37	321-0182-00	768 Ω	1/8 W	Prec	1%
R40	317-0431-00	430 Ω	1/8 W		5%
R41	317-0101-00	100 Ω	1/8 W		5%
R43	301-0301-00	300 Ω	1/2 W		5%
R45	317-0103-00	10 kΩ	1/8 W		5%
R47	317-0470-00	47 Ω	1/8 W		5%
R48	317-0331-00	330 Ω	1/8 W		5%
R50	317-0331-00	330 Ω	1/8 W		5%
R51	317-0122-00	1.2 kΩ	1/8 W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Description			
R52	311-0486-00			500 Ω, Var			
R53	317-0152-00			1.5 kΩ	1/8 W		5%
R55	317-0750-00			75 Ω	1/8 W		5%
R57	321-0093-00			90.9 Ω	1/8 W	Prec	1%
R58	321-0093-00			90.9 Ω	1/8 W	Prec	1%
R59	317-0470-00			47 Ω	1/8 W		5%
R61	325-0037-00			100 Ω	1/20 W	Prec	1%
R72	317-0102-00			1 kΩ	1/8 W		5%

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

FIG. 1 EXPLODED

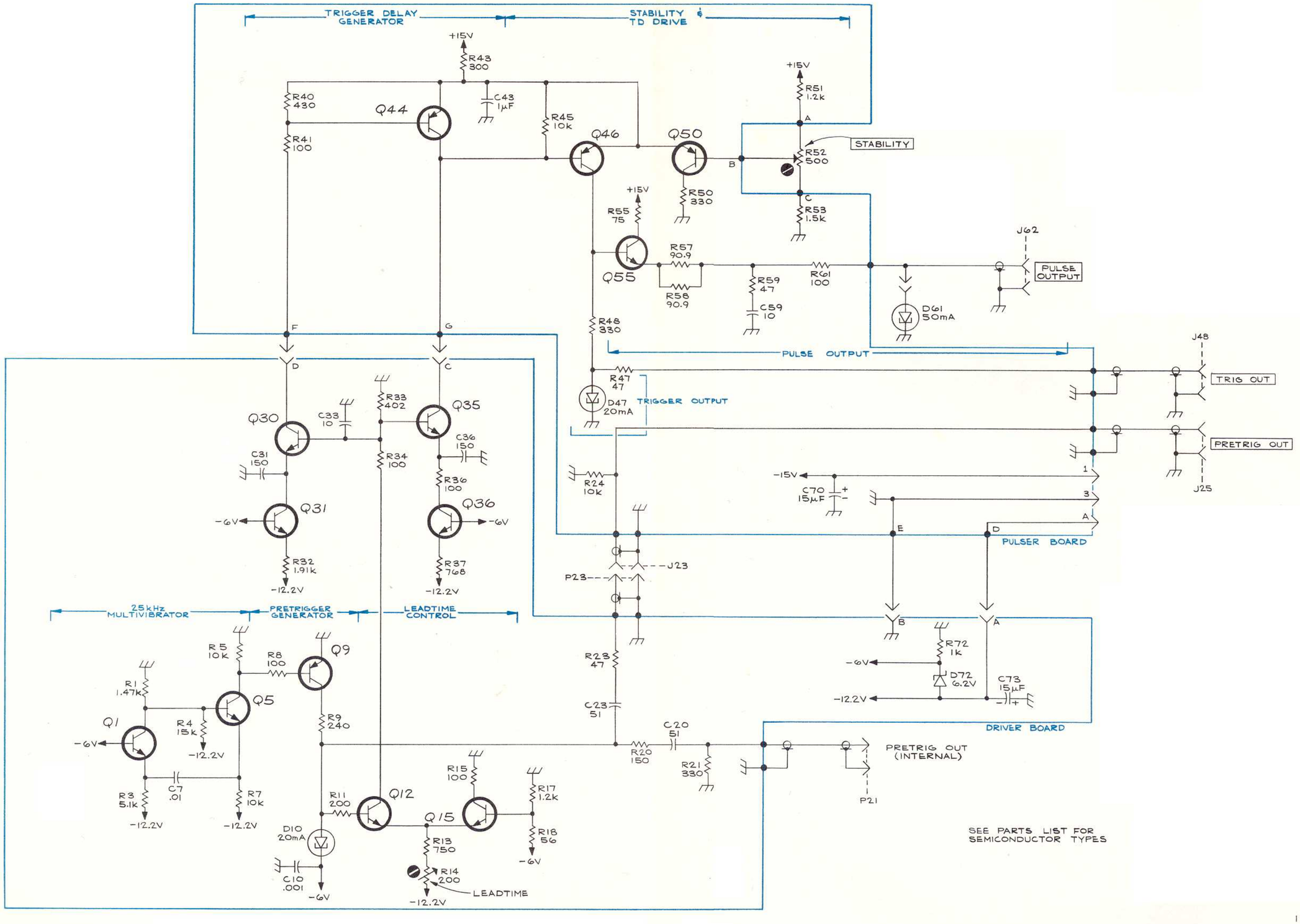
SECTION 7
MECHANICAL PARTS LIST

FIG. 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-1	333-1096-00			1	PANEL, front
-2	386-1338-09			1	SUBPANEL, front
	670-1005-00			1	ASSEMBLY, circuit board—DRIVER
	- - - - - -			-	assembly includes:
-3	388-1043-00			1	BOARD, circuit
-4	136-0252-01			27	SOCKET, pin connection
-5	136-0263-01			4	SOCKET, connector pin
-6	131-0391-00			1	CONNECTOR, standoff male
-7	175-1036-01			1	ASSEMBLY, cable, w/connector and holder
	670-1006-00			1	ASSEMBLY, circuit board—PULSER
	- - - - - -			-	assembly includes:
-8	388-1044-00			1	BOARD, circuit
-9	136-0252-01			12	SOCKET, pin connection
-10	131-0582-00			1	CONNECTOR, standoff female
-11	131-0591-00			4	TERMINAL, pin, 0.835 inch long
-12	214-1081-00			2	PIN, spiral
-13	210-0707-00			2	EYELET, metalic
-14	131-0631-00			1	CONNECTOR, single contact
-15	131-0742-01			1	CONTACT, electrical
-16	384-0687-00			1	SHAFT, latch
-17	105-0066-00			1	STRIKE, latch
-18	175-1038-00			1	CABLE, w/connector
	- - - - - -			-	cable includes:
-19	131-0579-00			1	CONNECTOR, coaxial, miniature bayonet w/hardware
-20	175-1039-00			1	CABLE, w/connector
	- - - - - -			-	cable includes:
-21	131-0579-00			1	CONNECTOR, coaxial, miniature bayonet w/hardware
-22	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-23	358-0301-01			1	BUSHING, sleeve, gray plastic
-24	358-0343-00			1	BUSHING, machine thread, 1/4-32 x 2.06 inches
-25	210-0046-00			1	WASHER, internal, 0.261 ID x 0.400 inch OD
-26	220-0510-00			1	NUT, hex., 1/4-32 x 0.312 inch x 0.40 inch long
-27	153-0040-00			1	HOLDER, diode assembly (D61)
-28	131-0741-00			1	CONNECTOR, block
	- - - - - -			-	mounting hardware: (not included w/connector)
-29	211-0092-00			2	SCREW, 2-56 x 3/16 inch, socket cap, black
-30	220-0531-00			1	NUT, hex., 1/4-32 x 0.375 inch
-31	380-0125-00			1	HOUSING
	- - - - - -			-	housing includes:
-32	131-0555-00			4	CONTACT
-33	386-1337-01			1	PANEL, rear
	- - - - - -			-	mounting hardware: (not included w/panel)
-34	211-0141-00			4	SCREW, machine, 4-40 x 3 1/4 inches, PHS

FIG. 1 *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty 1 2 3 4 5	Description
					STANDARD ACCESSORIES
1-	070-0897-00			1	MANUAL, instruction (not shown)
-35	015-1015-00			1	CABLE ASSEMBLY, rf, 50 ohm
					OPTIONAL ACCESSORIES
	015-1001-00			1	ATTENUATOR, fixed, 2X, 3 mm male to female
	015-1002-00			1	ATTENUATOR, fixed, 5X, 3 mm male to female
	015-1003-00			1	ATTENUATOR, fixed, 10X 3 mm male to female
	015-1004-00			1	TERMINATION, coaxial, 50 ohm, 3 mm male to female
	015-1005-00			1	CABLE ASSEMBLY, rf, 2 nsec, 3 mm male to female
	015-1006-00			1	CABLE ASSEMBLY, rf, 5 nsec, 3 mm male to female
	015-1007-00			1	ADAPTER, connector, 3 mm male to GR
	015-1008-00			1	ADAPTER, connector, 3 mm female to GR
	015-1009-00			1	ADAPTER, connector, 3 mm male to N
	015-1010-00			1	ADAPTER, connector, 3 mm to 7 mm
	015-1011-00			1	ADAPTER, connector, 3 mm male to male
	015-1012-00			1	ADAPTER, connector, 3 mm female to female



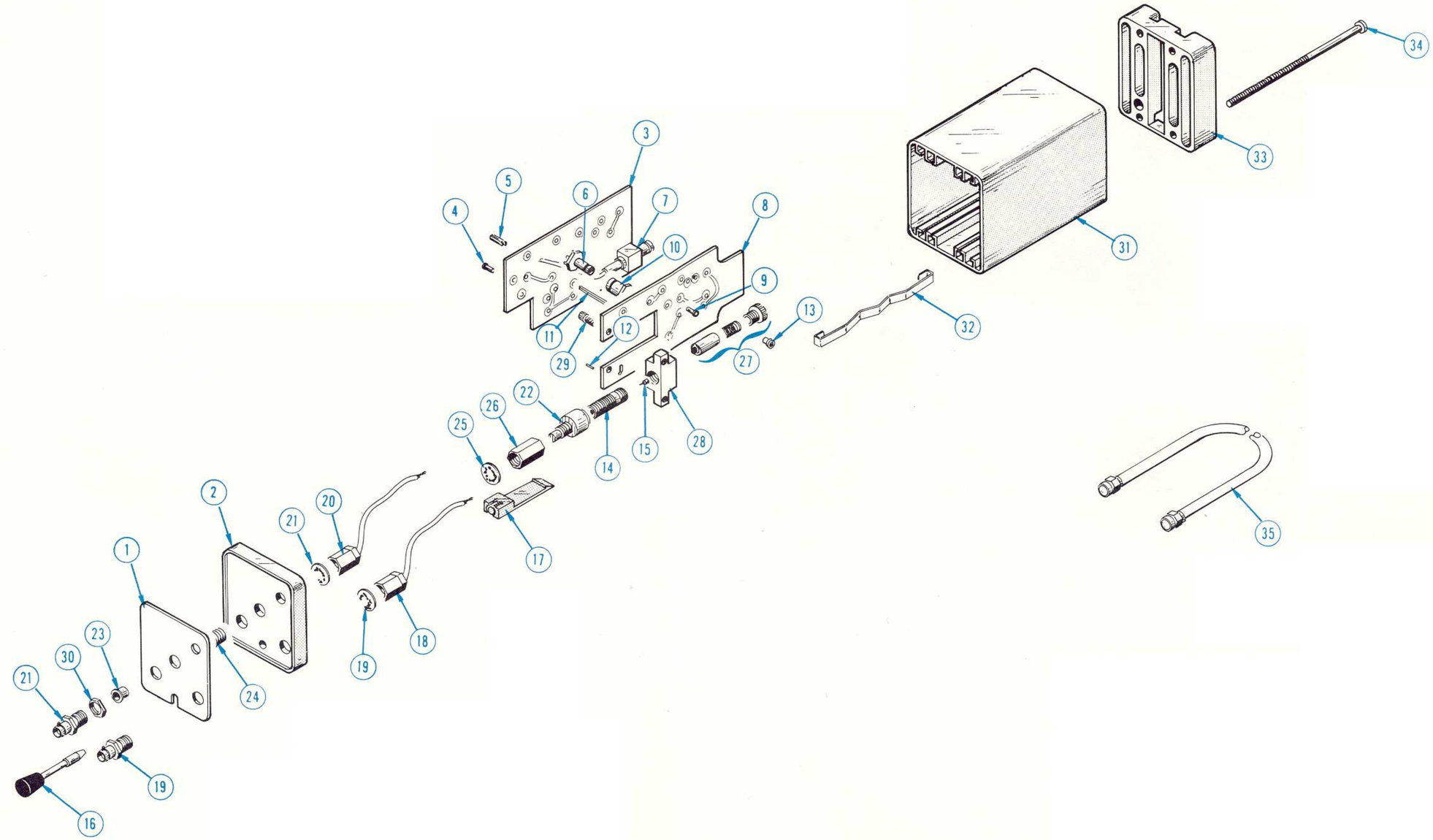
1168

TYPE S-50

A

PULSE GENERATOR HEAD

FIG 1 EXPLODED



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.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

TEXT CORRECTIONS

Section 4 Maintenance

Page 4-4 left column

CHANGE: Fig. 4-6 to Fig. 4-7.

ADD: the following after number 1:

CAUTION

Turning the Pulse Output connector may move the fine wire connected to a contact in the mounting. The movement may ground or break the fine wire, part of item 15 in the Mechanical Parts List.

ADD: the following after number 5:

Tunnel Diode, D61. Performance of D61 should be checked only by observing the normal operation of the Type S-50.

CAUTION

Do not check D61 with an ohmmeter or curve tracer.

Fig. 2-3A and B show normal displays with operation of the Type S-50 Stability control. Failure to obtain a fast rise pulse may indicate failure of D61.

ADD: the following after the NOTE:

Fig. 4-6 shows the physical placement of the fine wire as it makes contact with the Pulse Output connector and as it is soldered to R61.

To replace the connector, remove the tunnel diode holder and fine wire contact from the mounting. Place a small drop of Loctite (screw-lock)®, catalogue number 59-21, on the connector threads and tighten the connector securely. Install and center the fine wire contact, then replace the tunnel diode holder and be certain that the fine wire does not touch the holder.

ADD: the following new Figure 4-6:

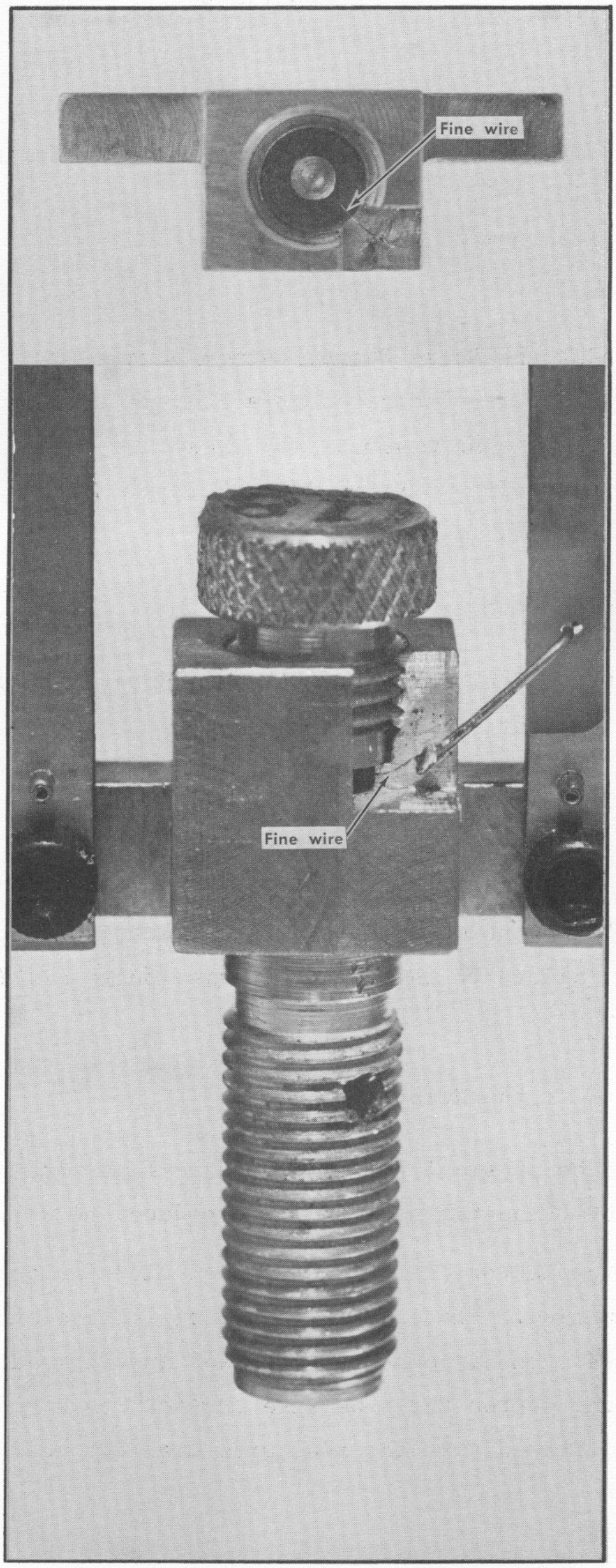


Fig. 4-6. Electrical contact of fine wire at mounting and R61.

Section 5 Performance Check/Calibration

Page 5-7 Step 8 (d)

ADD: to the last sentence:

, see Fig. 5-6B. Note the total display amplitude including the step preceding the 0% level.

Page 5-7 Step 8 (h)

ADD: the following paragraph to part h:

Sampler blowby, if present, would be sentitive to the step as well as the fast rise pulse of the Type S-50. Therefore, the Type 284 display amplitude is set to the Type S-50 total display amplitude for the most accurate comparison.

Page 5-7 Step 8 (i)

CHANGE: line 6 to read:

as the Type S-50 display. Expose the waveform and develop the

TEXT CORRECTION

Section 1 Specification

Page 1-1 Table of ELECTRICAL CHARACTERISTICS

CHANGE: the Performance Requirement of Pulse Flatness Deviation as noted below:

400 ps to 5 ns	-5% to +5% with a total of 8% or .....
5 ns or more	-4% to +1% with a total of 5% or.....

Section 2 Operating Instructions

In Section 2 any time the rigid cable is identified as semi-rigid, remove the word "semi" from the text.

Page 2-7 CAUTION

REPLACE: the present CAUTION text with the following:

CAUTION

The two coaxial lines listed under part numbers 015-1015-00 and 015-1005-00 must be treated with care to obtain maximum life and least signal distortion. The rigid line may not have its shape changed and still have the propagation delay and Z_o guaranteed. In cases where the line is not used at its maximum performance limits, small amounts of bending can be made providing mating connectors are on each end before bending. If bent to a curve radius of 1-1/2 inches, the line may be made totally inoperative. The flexible cable must not be given a bend radius less than 10 times its OD, or approximately 2-1/4 inches. Flexible cables may suffer outer conductor breakage by tighter bending. Few flexures assure longer life.

Section 3 Circuit Description

Page 3-3 first column, first paragraph

REPLACE: the last three lines of the first paragraph with the following:

output from D47. Capacitors C43 and C46 hold Q44 and Q46 emitter voltage constant as the circuit current changes from 10.2 mA to 0 mA, then to 7.3 mA and back again to 10.2 mA. C43 is located near Q44. Inductance of the wire connecting Q46 to C43 reduces the effectiveness of C43 in maintaining Q46 collector voltage constant. Therefore, C46 is connected directly to the emitter of Q46.

Page 3-3 Special Components

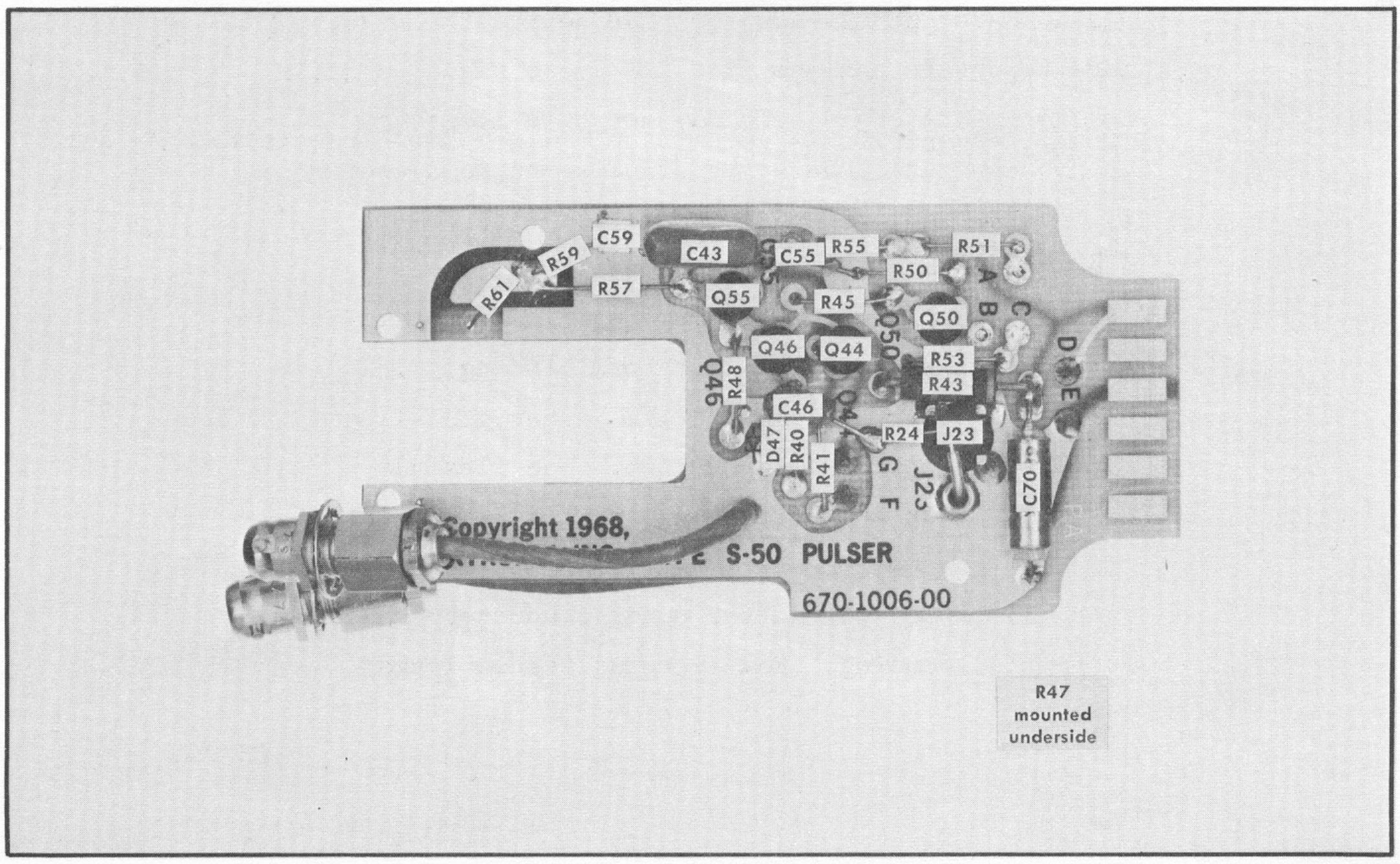
ADD: the following sentence to the end of the second paragraph:

C55 together with R55 provide power supply decoupling.

Section 4 Maintenance

Page 4-3 Fig. 4-5

REPLACE: the present Fig. 4-5 with the one below:



Section 5 Performance Check/Calibration

In Section 5 when reference to solid coaxial line is made change designation to rigid coaxial line.

Page 5-1 EQUIPMENT REQUIRED

CHANGE: Item 9 to read:

9. Rigid coaxial line with 3 mm connectors, Tektronix Part No. 015-1015-00.

Page 5-4 PERFORMANCE CHECK AND CALIBRATION PROCEDURE

CHANGE: the Step 1 heading and part a to read:

1. Adjust Stability Control, R52

a. Connect the Pulse Output connector to the rigid coaxial line.....

Page 5-7 8. Check Pulse Flatness Deviation

CHANGE: specified percentages as shown:

.....

Between 400 ps and 4 ns after step, +5%, -5% or less, total of 8% peak to peak;

Between 5 ns and 100 ns after step, +1%, -4% or less, total of 5% peak to peak.

Page 5-7 Step 8(i)

CHANGE: the last line of part i to read as follows:

not exceed +5%, -5% or total 8% peak to peak.

Page 5-7 Step 8 (j)

CHANGE: the third and fourth line to read:

through 100 ns, for a deviation not more than +1%, -4% or a total 5% peak to peak. .....

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

C43	283-0164-00	2.2 µF	Cer	25 V	
C46	283-0177-00	1 µF	Cer	25 V	+80%-20%
C55	283-0178-00	0.1 µF	Cer	100 V	+80%-20%
C59	283-0093-00	15 pF	Cer	50 V	
R57	317-0430-00	43 Ω	1/8 W	Fixed	5%

REMOVE:

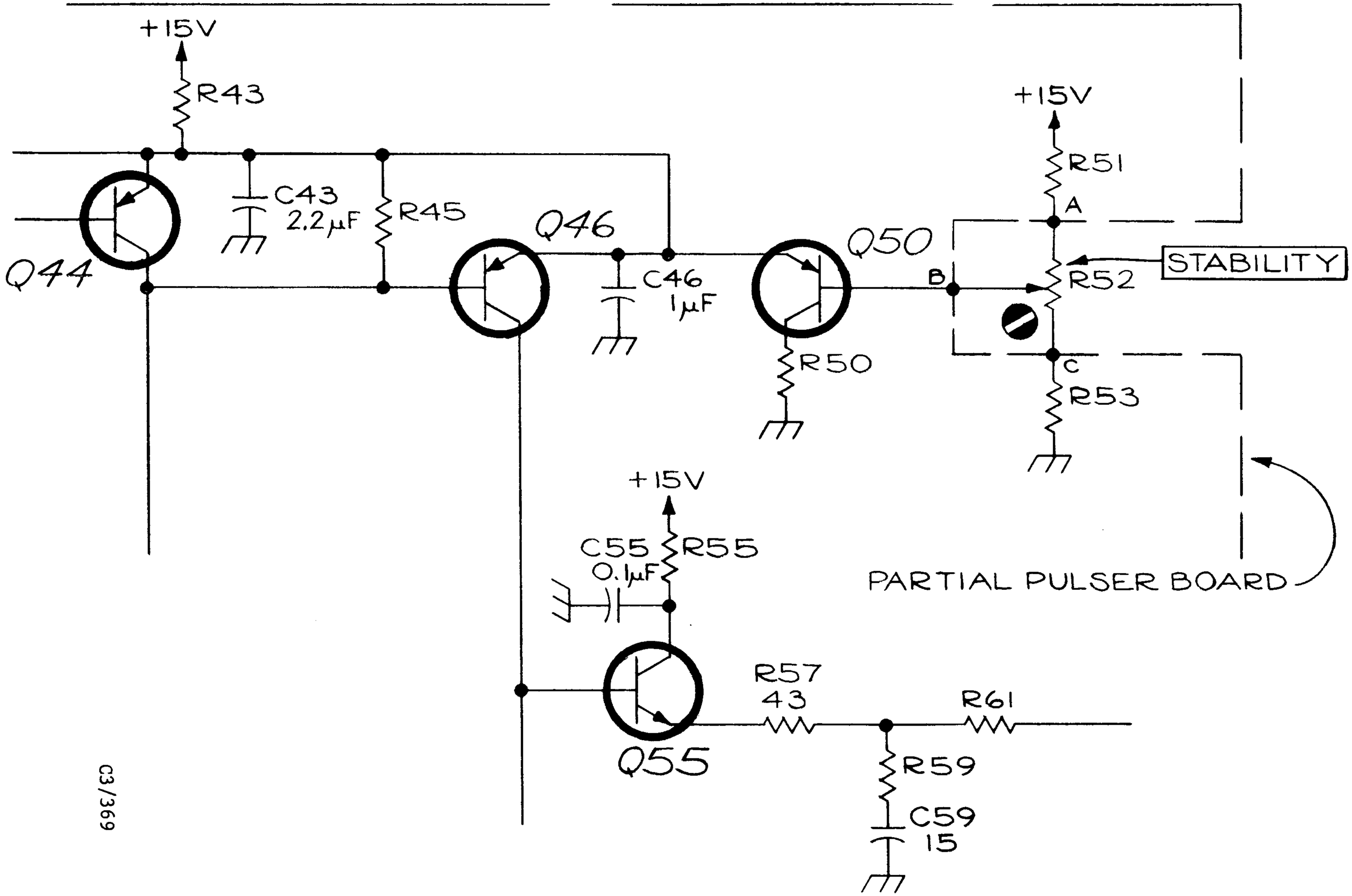
R58	321-0093-00	90.0 Ω	1/8 W	Prec	1%

MECHANICAL PARTS LIST CORRECTION

Page 7-1

CHANGE: Fig. and Index No. 1-29 to read:

-29	211-0162-00	2 SCREW, 2-56 x 3/16 inch, socket cap, stainless steel



PARTIAL PULSE GENERATOR HEAD

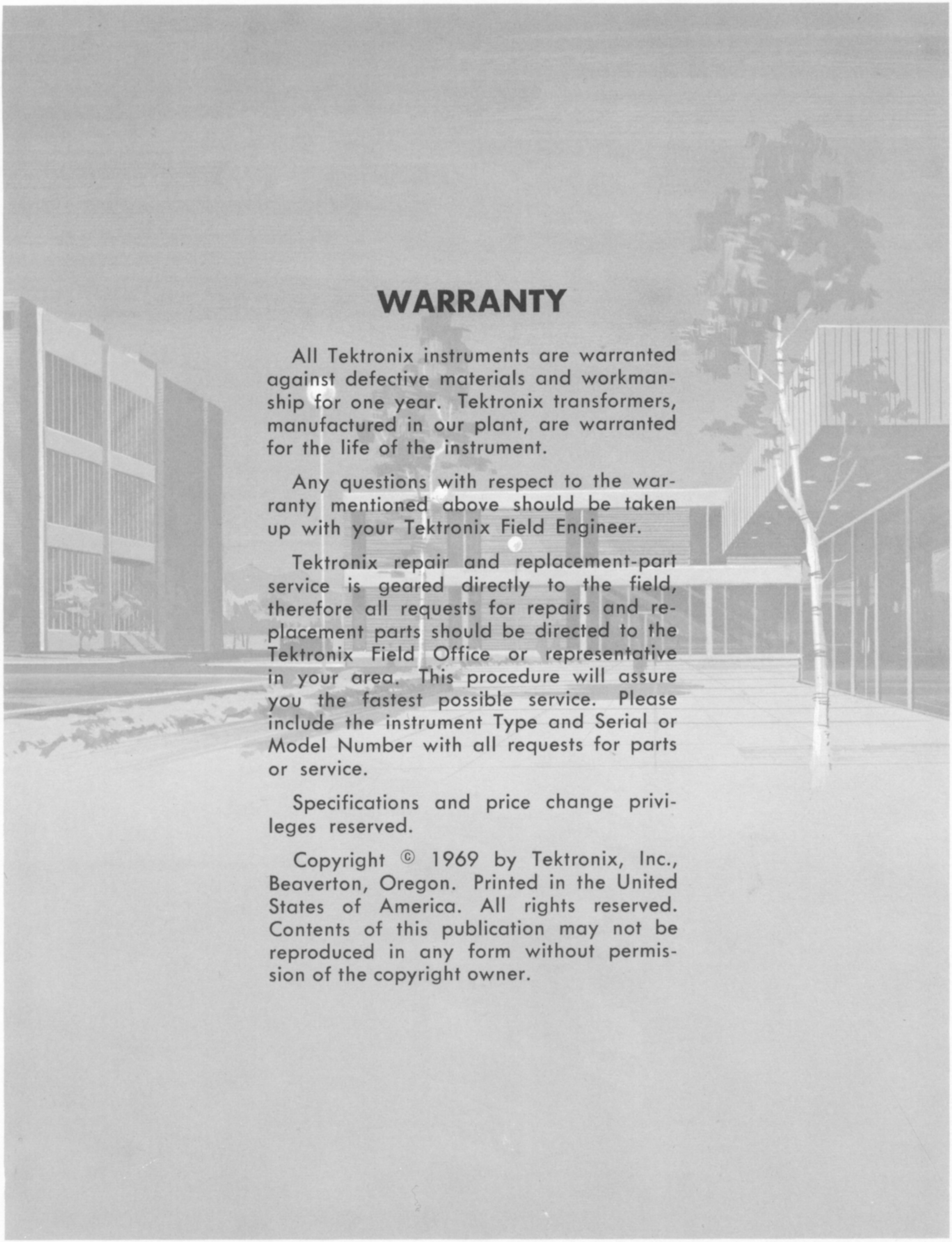
INSTRUCTION MANUAL

Serial Number _____



Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0898-00



WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our 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 or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

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Section 8 Diagrams

Mechanical Parts List Illustrations

Accessories

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.



Fig. 1-1. Type S-51 Trigger Countdown Head.

SECTION 1
TYPE S-51 SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

The Type S-51 Trigger Countdown Head produces stable, low repetition rate trigger signals from 1 GHz to 18 GHz sine waves. The Type S-51 may be operated in one channel of a Type 3S2, 3S5 or 3S6 Sampling Unit in place of one of the sampling heads, or it may be operated separately in the Type 285 Power Supply. The front-panel SYNC control allows the operator to synchornize a 200 MHz oscillator to a subharmonic of the input signal. Output from the Type S-51 is available at both a front-panel TRIG OUT connector and through a rear-panel connector. The output signal is a direct countdown from the input and permits proper triggering of a Tektronix Type 3T2 Sampling Sweep Unit.

ELECTRICAL CHARACTERISTICS

The following characteristics apply over an ambier temperature range of 0°C to +50°C. These characteristic apply only when the Type S-51 is powered by either a Tek tronix sampling unit or a Type 285 Power Supply. All equip ment used in checking these characteristics must be give. sufficient warmup time. Warmup time for each item is give in its own instruction manual. Minimum warmup time for th Type S-51 is 5 minutes.

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
Input Signal Frequency Range	1 GHz to 18 GHz (To verify, use steps 8 and 10, Section 5.)
Sensitivity	A signal value that will give 100 mV P-P into 50 Ω, 200 mV P-P into an open circuit. A maximum amplitude of 5 V P-P.
Input Impedance Impedance	50 Ω line, unterminated.
Capacitance	1 pF, ±20%
Trigger Output Front Panel and Internal	≥200 mV into 50 Ω
Trigger Pulse Duration	≥1 ns
Trigger Pulse Period	15 μs ±3 μs
Oscillator Period	3.5 to 6 ns
Variable Range	1 to 2 ns
Jitter with ≥ 100 mV P-P input signal	5 to 18 GHz: ≤10 ps (To verify, use step 11, Section 5.)
	1 to 5 GHz: ≤15 ps (To verify, use step 9, Section 5.)
Kickout at signal INPUT connector	≤400 mV; pulses cease ≤30 ns after the start of the TRIG OUT pulse.

ENVIRONMENTAL CHARACTERISTICS

Characteristic	Performance Requirement
Temperature	Operating: 0° C to +50° C
	Non-operating: −45° C to +65° C
Altitude	Operating: To 15,000 feet
	Non-operating: To 50,000 feet
Vibration, Operating	15 minutes along each axis at 0.015 inch. Vary the frequency from 10 to 50 to 10 c/s in 1 minute sweeps. Three minutes at any resonant point or at 50 c/s.
Shock, Non-operating	500 g's, 2 ms duration, 2 shocks/axis 750 g's, 1 ms duration, 2 shocks/axis 1,000 g's, 0.5 ms duration, 2 shocks/axis
Transportation	Qualified under National Safe Transit Committee Test Procedure 1A.

PHYSICAL CHARACTERISTICS

Characteristic	Description
Finish	Anodized aluminum front panel, blue-vinyl painted, wrap-around aluminum cabinet.
Dimensions	Height: ≈2 inches Width: ≈1 7/8 inches Length: ≈4 1/16 inches including knobs and connector.

NOTES

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section provides the basic information required for the operation of the Type S-51 Trigger Countdown Head. It includes installation, first time operation and general operating instructions.

The Type S-51 is designed to provide stable trigger pulses in the approximate range of 55 kHz to 83 kHz to Tektronix Type 3T2 Sampling Sweep Unit. The operator synchronizes the Type S-51 to a subharmonic of the 1 GHz to 18 GHz input signal with the SYNC control.

The Type S-51 is intended to be inserted into one of the channels of a Type 3S2, 3S5 or 3S6 sampling unit or powered separately in a Type 285 Power Supply.

Installing the Type S-51 Trigger Countdown Head

Fig. 2-1 shows the Type S-51 partially installed into a Type 3S2 Sampling Unit with a Type 561B Oscilloscope, a Type S-4 Sampling Head and a Type 3T2 Random Sampling Sweep. The S-51 can be plugged into the sampling unit as shown, or used remotely on a special extender cable. Three and six foot extender cables are available. Order the three foot extender cable by Tektronix Part No. 012-0124-00, or the six foot extender cable by Tektronix Part No. 012-0125-00. Contact your local Tektronix Field Engineer or Representative for price and availability of these optional accessories.

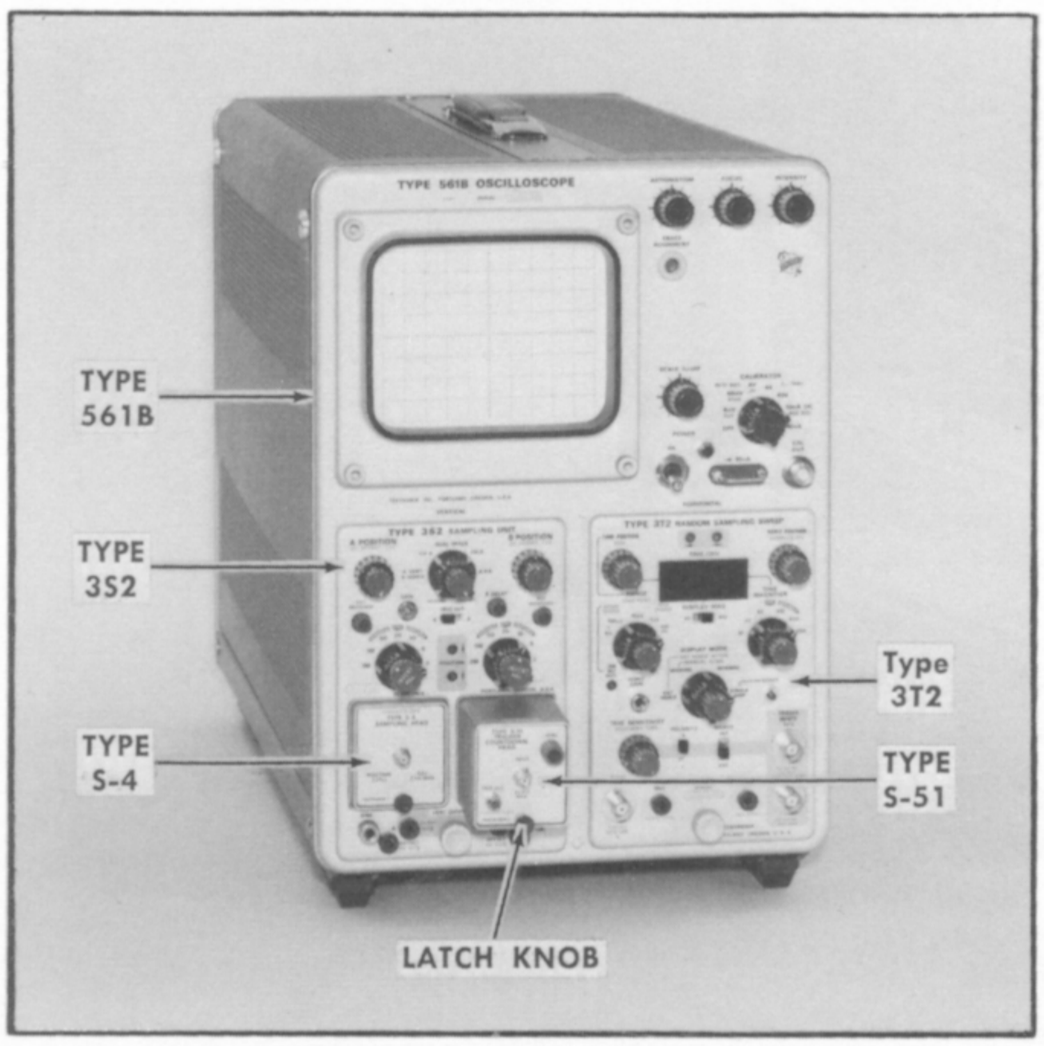


Fig. 2-1. Installation information.

To insert the Type S-51 into the right or left hand compartments of the sampling unit, proceed as follows:

1. Pull the latch knob (Fig. 2-1) outward from the front panel (the latch knob will push out normally when the unit is inserted if the knob is left free to move).

2. Insert the Type S-51 slowly into the compartment, so the two plastic guides in the compartment engage the S-51.

3. Push the Type S-51 completely into the compartment.

4. Push the latch knob to lock the S-51 in place.

To remove the Type S-51 from the compartment, pull the latch knob away from the front panel, then pull the unit from the compartment.

The procedure for installing the Type S-51 into the Type 285 Power Supply is similar to the above procedure.

To use the Type S-51 on an extender cable, install as follows:

1. Pull the latch knob located on the head end of the extender cable outward from the panel (the latch knob will push out normally when the extender is inserted if the knob is free to move).

2. Insert the extender cable head end slowly into the desired compartment in the sampling unit so the two plastic guides in the compartment engage the unit.

3. Push the head completely into the compartment.

4. Push the latch knob to lock the extender cable head end in place.

5. Connect the Type S-51 to the other end of the extender cable in a similar manner, and set the latch knob to hold it in place.

6. To remove the Type S-51 from the extender cable, pull the latch knob on the front panel of the Type S-51 and remove the unit from the extender cable.

7. To remove the extender cable head from the sampling unit compartment, pull the latch knob outward from the front of the panel, then pull the unit free.

FIRST TIME OPERATION

The First Time Operation procedure uses the Type S-51, a Type 3S2, a Type 561B a Type 3T2 and a Type S-4. Other Sampling Heads with other input characteristics may be used.

Setup Information

1. With the Type 561B Power switch off, insert a Tektronix Type 3S2 Sampling Unit into the vertical plug-in compartment (left) and a Tektronix Type 3T2 Random Sampling Sweep unit into the horizontal plug-in compartment (right).

2. Inset the Type S-4 Sampling Head into the Channel A compartment (left side) in the Type 3S2.

3. Insert the Type S-51 Trigger Countdown Head into Channel B compartment (right side) in the Type 3S2.

4. Set the Intensity control on the Type 561B for a proper intensity display.

5. Connect the Type 561B to a power source which meets its voltage and frequency requirements.

6. Set the Power switch to on. Allow about 5 minutes warm-up so that the units reach operating temperature before proceeding.

NOTE

In the steps that follow (and whenever making new connections) tighten the outer section of each 3 mm connector to a torque value of 9 inch-pounds using a standard 5/16 inch open-end wrench.

7. Connect an 18-inch coaxial cable (RG 58 C/U) with one BNC and one BSM connector, Tektronix Part No. 012-0127-00, from the Type 3T2 50 Ω Trigger Input to the Type S-51 TRIG OUT connector.

8. Connect a 2 ns signal delay 3-mm coaxial cable, Tektronix Part No. 015-1005-00, between a power divider tee, Tektronix Part No. 015-1014-00, and the Type S-4 Input.

9. Connect a 2 ns signal delay 3-mm coaxial cable and a 10X (20 dB) attenuator, Tektronix Part No. 015-1003-00, between the power divider tee and the Type S-51 INPUT.



Fig. 2-2. Setup when performing the first time operation procedure.

10. Connect a 1 GHz signal generator to the power divider tee (using suitable connectors and attenuators if attenuation of the signal is needed). See Fig. 2-2. Turn the generator on.

11. For single-trace operation, set the controls as follows:

Type 3S2	
Display Mode	CH A
Normal-Smooth	Normal
A Position	Midrange
DC Offset	Midrange
Units/Div	200
Variable	Cal
Invert	Push in
Dot Response	Midrange
Horiz Plug-in Compatibility SW	Sampling—3T Series
Type 3T2	
Horiz Position	Midrange
Samples/Div	9 o'clock position
Samples/Div SW	Variable
Display Mode	Normal
Start Point	With Trigger
Sweep Rate	
Range	100 ns
Display Mag	X1
Time Magnifier	X10
Variable	Cal
	= 1 ns/div
Time Position	Both fully clockwise
Trig Sensitivity	Fully counterclockwise
Recovery Time	Fully counterclockwise
Trigger Polarity	+
Trigger Source	Ext
Time/Div Readout	1 ns
Type S-51	
SYNC	Adjust for most stable display

NOTE

After the Sync control is adjusted, the Type 3T2 Trig Sensitivity and Recovery Time controls should be readjusted for improved triggering and a display with the least jitter.

Fig. 5-7 is the waveform of a 1 GHz signal.

General Operating Instructions

The Type S-51 places a frequency dependent impedance across the end of the INPUT coaxial transmission line. C1 is the primary element of the impedance; other components include L1, R8, R9, R10, R11 and tunnel-diode D2. Tunnel-diode D2 presents ≈2 Ω impedance to ground to the input capacitor C1, but the parallel resistors reduce the impedance to less than 2 Ω. The input impedance is computed by

the formula $Z = \sqrt{X_c^2 + R^2}$ and it is ≈160 Ω at 1 GHz and ≈10 Ω at 18 GHz.

The signal source may be affected by reflections from the Type S-51 input and kickout pulses from the Oscillator tunnel-diode. Both may be reduced by using an attenuator at the input of the Type S-51. In cases where a 10X attenuation of the input signal can be tolerated, a 10X (20 dB) attenuator will attenuate the reflected signal a total of 100X (40 dB). The reflected signal is then reduced to 1% of its non-attenuated case value. Attenuation of the reflected signal is also increased by the use of a power divider tee.

The use of attenuators attached to the Type S-51 INPUT connector is necessary when: 1. The signal to the INPUT connector is 5 V P-P or greater. 2. The 200 MHz Oscillator kickout disturbs the signal source. 3. Signal reflections back to the signal source distort the CRT display.

All 3-mm connectors should be tightened to a torque of 9-inch-pounds with a $^5/_{16}$ inch open end wrench to guarantee proper connections.

Contact your Tektronix field engineer for other 3-mm coaxial cable accessories.

NOTES

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

This section of the manual contains a block diagram description of the Type S-51 Trigger Countdown Head followed by a detailed circuit description.

The Trigger Countdown Head contains two etched circuit boards, the Trigger board and the Control board. The Trigger board contains the Oscillator, the Arming Tunnel Diode and the Output Tunnel Diode. The Control board contains the circuits that control the repetition rate of the output trigger pulses.

BLOCK DIAGRAM

Oscillator Block

The Oscillator circuit (see block diagram at the rear of the manual) is caused to free run for short periods of time by the Control Circuits. During the period of free run, the Oscillator can be adjusted so it synchronizes with an incoming signal. Each period of oscillation causes an output trigger pulse with or without the oscillator being synchronized. Very soon after an output trigger pulse, the Control Circuit shuts the Oscillator off for about 15 μs. The Oscillator frequency of approximately 200 MHz can be altered over a small range by the front panel SYNC control to cause solid synchronization with an input signal. Pulses from the Oscillator are applied to Arming Tunnel Diode D17 and to Output Tunnel Diode D23. When the oscillator is properly synchronized with the input signal, each TRIG OUT output pulse is harmonically related to the input signal.

Control Circuits

The Control circuits turn on the Oscillator, start an arming bias to the Arming Tunnel Diode D17, and supply a partial enabling bias to the Output Tunnel Diode D23. After the Oscillator starts, one of its output pulses trips the Arming Tunnel Diode which in turn arms the Output Tunnel Diode. The next Oscillator output pulse drives the Output Tunnel Diode to deliver a Trigger Output signal.

As the Output Tunnel Diode delivers its output signal, the Control circuits shut off the Oscillator (preventing any more than about 5 or 6 more Oscillator cycles) and removes the arming bias from both the Arming and Output Tunnel Diodes. The quick turn-off is necessary to prevent additional kickout pulses from the Oscillator into the INPUT connector and to limit the power dissipation in the Oscillator tunnel diode.

It is the Control Circuits that cause the unit to deliver regular Trigger Output pulses to the TRIG OUT connector(s) with a repetition rate of about 67 kHz even though there may be no input signal for the Oscillator to synchornize with. The continuous trigger output pulses (without an input signal) allow the sampling system to display a trace to show the condition of synchronization, or lack of synchronization.

The Control Circuits shown in the main block diagram contain a fast turn-off and a slower Oscillator hold-off control system. The fast turn-off portion includes both halves of Q35 and Q52. The hold-off portion includes Q35B, Q39 and the Timing Multivibrator Q42, Q43, and Q47. Each of these circuits is described in detail later in the Circuit Description.

Arming Tunnel Diode Block

The purpose of the Arming Tunnel Diode is to arm the Output Tunnel Diode. The Arming Tunnel Diode is slowly armed by a current ramp that is provided by the Control Circuits a short time after the Oscillator starts; after arming, it is triggered by a pulse from the Oscillator. When the Arming Tunnel Diode steps to its high voltage state, the Output Tunnel Diode is fully armed so it can be driven by the next Oscillator output pulse. Thus two successive Oscillator pulses are used to generate each output trigger pulse.

Output Tunnel Diode Block

After the Output Tunnel Diode is fully armed by the Arming Tunnel Diode, it is triggered to its high voltage state by the next pulse from the Oscillator. The Output Tunnel Diode voltage step is presented as a differentiated trigger pulse to the TRIG OUT connectors. The output pulse can thus be synchronized with an input signal but when not synchronized it occurs at a repetition rate set by the Control circuits.

CIRCUIT DESCRIPTION

Oscillator

The Oscillator is composed of tunnel diode D2, L1 and load resistors R8, R9, R10 and R11. Q47 with R48, R49, R50 (of the Control Circuits) and Q5 with R6 (of the SYNC circuit) are both current sources for tunnel diode D2. The Oscillator frequency is altered slightly by changing the current supplied to D2. R4 and SYNC control R3 form a variable bias network for Q5 which allows adjustment of the current to D2 to alter the Oscillator frequency for proper synchronization with the input signal.

The input to the Trigger Countdown Head, connector J1, feeds the input signal into an assembly containing a ceramic wafer on which is a 50 Ω transmission line that is connected to tunnel diode D2 through coupling capacitor C1. The

tunnel diode is inserted into the end of the assembly in a hollow-head knurled screw. Output pulses from D2 are coupled through R13 to Arming Tunnel Diode D17 and the Output Tunnel Diode D23.

Each input signal cycle (within the operating frequency range) is from five to ninety times the Oscillator nominal frequency of 200 MHz. The SYNC control varies the Oscillator frequency just enough so that the Oscillator is easily synchronized on positive excursions of the input signal. If the Oscillator is right at 200 MHz and the input signal is right at 1000 MHz, each output pulse of the Oscillator occurs at exactly every fifth input signal cycle. This type of harmonic relationship exists for all input frequencies and Oscillator output pulses.

Arming Tunnel Diode

The Arming Tunnel Diode, D17, receives the Oscillator output signal through a short length of 50 Ω transmission line that is formed by part of the etched circuit board. The transmission line is terminated in approximately 50 Ω at both ends. R13 raises the very low Oscillator output resistance to 50 Ω, and the short length of line drives 50 Ω. The transmission line load consists of R15, L15, C16, R16 and the low resistance of D23. Frequencies near or higher than 200 MHz are coupled through C16 to both the Arming TD and the Output TD. L15 and C16 are self resonant at 200 MHz. C16 therefore allows R16 to be the major load from about 200 MHz up, while L15 allows R15 to be the major load from about 200 MHz down. Thus the network provides both a DC isolation between the Oscillator and the two tunnel diodes, and a good transmission line match to prevent reflections back and forth that would disturb the units normal mode of operation.

The total biasing current for Tunnel Diode D17 comes from both the Timing Multivibrator and the Oscillator. R19 and C19 delay the Timing Multivibrator drive so that the Arming Tunnel Diode is slowly armed. Part of D17 arming current is supplied through R17, which limits D23 from being fully armed. D17 triggers when the sum of the slowly rising arming current from the Timing Multivibrator and a positive current pulse from the Oscillator is sufficient to trigger it. When D17 is driven to its high voltage state, the current in R17 is reversed, adding to D23 current and causing it to be fully armed. The next Oscillator output pulse then causes D23 to deliver an output Trigger Pulse.

Output Tunnel Diode

The Output Tunnel Diode circuit is composed of tunnel diode D23 and its biasing network R21, R22 and R23. The Output Tunnel Diode triggers as the result of three input currents. It is enabled (partially armed) by the Timing Multivibrator through the bias network and it receives final arming when D17 switches to its high voltage state. The next positive Oscillator pulse following D17 being armed triggers the Output Tunnel Diode to its high state. Its output pulse goes through C24 to the front panel TRIG OUT connector J31. The pulse is also applied to the base of Q35B to start the Oscillator turn-off process.

Control Circuits

The Control Circuits consist of the paraphase amplifier Q35, pulse amplifier Q52, Inverter Amplifier Q39, and the Astable Timing Multivibrator Q42, Q43 and Q47.

Paraphase amplifier Q35 provides both an in-phase and an out of phase output signal when the Output Tunnel Diode is driven to its high voltage state. The in-phase output to Q52 is used to pulse Q52 into saturation, causing R51 to take most of the Timing Multivibrator current away from the Oscillator. This action stops the oscillator within 5 or 6 Oscillator cycles after the Trigger Output signal occurs. The out-of-phase Q35 output drives Q39 into saturation which turns off Q47 and the Timing Multivibrator a few nanoseconds after Q52 turns off the Oscillator. As the Timing Multivibrator turns off, arming bias is removed from both the Arming and Output tunnel diodes and they both drop back to their low voltage state. (All three tunnel diodes rest for more than 90% of the time the unit is operating.) As the Output Tunnel Diode D23 drops to its low voltage state, the drive to both Q52 and Q39 is stopped. Between that time and the time the Timing Multivibrator starts another cycle, Q35B, Q52, Q39, Q42 and Q47 are all at cut-off. Three transistors still conduct: Q5, Q35A and Q43.

Q35A base is biased at about +0.2 volt by the resistive divider R37-R38 and the +15-V supply. Thus Q35A conducts the major current of R35 when the Output Tunnel Diode D23 is at any point along its current curve while at the low voltage state. When D23 switches to its high state, Q35B base will be biased as much as +0.6 volt and Q35B then conducts the major current of Q35. As Q35B begins to conduct, its collector forward biases Q39 and the reduced conduction of Q35A sends a positive pulse through C54 to Q52. Both Q39 and Q52 conduct to saturation. As previously described, Q52 turns off the Oscillator and Q39 turns off the Timing Multivibrator.

The Timing Multivibrator is described as just having been driven into non-conduction by Q39. The instantaneous conditions then are:

1. No current passes in R41 because Q39 is saturated.

2. Q47 cuts off; its collector voltage and Q42 base voltage drop to about +0.4 volt due to current flow in R46, R48-R49, R50 and the Oscillator circuit. (It is not significant to the understanding of the Timing Multivibrator whether Q52 is still conducting or not, because C54 charges rapidly and Q52 turns off very soon anyway.)

3. Q43 base is biased at about —3.7 V, setting its emitter at about —4.3 V and the collector current (by Ohms Law and R43) is held at a constant 3.3 mA.

4. Just before Q42 was cut off by Q47 collector negative signal, it was conducting all of Q43 collector current (3.3 mA) and C42 was charged only about 1.2 volt (+15 minus +13.8 at D42 cathode = 1.2 volt). Now with Q42 off and D42 reverse biased, all of Q43 current comes from C42. Q43 collector voltage is changing in a negative direction, headed toward a condition where all of the current comes from Q42.

5. Very shortly after Q47 is cut off, the Output Tunnel Diode D23 drops to its low voltage state stopping Q35B and Q39 conduction. This condition prevails until the multivibrator resets.

The Timing Multivibrator automatically resets as soon as D42 cathode reaches —1 V (as C42 charges negatively). At this point D42 is forward biased allowing Q42 to take all of Q43 current. Before Q42 begins to conduct, and after Q39 stops conducting, there is about a 0.4 volt drop across R41 by current from +15 V through R46, R48-R49, R50 and the Oscillator 2.5 Ω. The 0.4 volt is a forward bias to Q47, but not enough to cause it to conduct. Then, when Q43 finally becomes the current source for Q42, that 3.3 mA is added to the 4 mA of the resistance divider applying a possible 0.73 volt forward bias to Q47. It is important that both currents add in R41, because the 3.3 mA of Q43 alone is not enough to forward bias Q47 into conduction.

As Q42-Q43 current add to R41 resistive load curent, Q47 is forward biased causing its collector to raise positive and greatly increase the drive to Q42 base. There is now a regenerative turn-on of both transistors that takes a period of time controlled by the saturation resistance of Q42 in series with the resistor R42 and C42. R41 doesn't have a lot to do with C42 discharge time because most of the current comes from +15 volts through Q47 emitter-base junction. Thus the regenerative turn-on also causes a ramp signal to be developed at Q42 emitter that is very fast compared to the earlier charge of C42. The heavy discharge current of C42 passing through Q47 emitter-base junction turns Q47 on very hard which in turn starts the Oscillator quickly and applies a current to the Arming Tunnel Diode circuit. (D17 is armed slowly because of the RC delay of R19 and C19, to delay D17 being triggered until the Oscillator has completed a few cycles, either synchronized, or not synchronized.) D17 always triggers at approximately the same time of each cycle regardless of whether an input signal is present or not.

As soon as C42 is fully charged, the total current in R41 drops to the 3.3 mA controlled by Q43. The 4 mA of the resistive divider is not there because Q47 has Q42 base almost all the way up to +15 volts. There is not enough current in R41 to keep Q47 conducting, and the multivibrator automatically shuts off. This becomes a fail-safe feature that protects the Oscillator tunnel diode from over dissipation in the event D17, D23, Q35 or Q39 fail. Thus the Oscillator low operating duty factor is maintained even if other components should fail. The time constant of C42-R42 and Q42 saturation resistance is slightly longer than the natural occurrence of each output trigger.

A number of components were not mentioned in the discussion. R53 assures that Q52 remains off when not driven by Q35A. R30 provides the necessary DC load resistance for use in a Sampling Unit. C28, L26 and C26 provide power supply filtering which is needed when the unit is operated in a Sampling Unit. R21, R22 and R23 set the arming bias for the Output Tunnel Diode D23. R32 is a parasitic suppressor.

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains information for use in corrective maintenance or troubleshooting of the Type S-51.

To remove the Type S-51 from its case, loosen the four retaining screws on the back. Then slide the back off, and remove the case by sliding it to the rear.

Parts Replacement

All parts used in the Type S-51 can be purchased directly through your Tektronix Field Office or Representative. 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 S-51 should be ordered from Tektronix since these parts are either manufactured or selected by Tektronix to satisfy a particular requirement. Before purchasing or ordering, consult the Electrical or Mechanical Parts List to determine the value, tolerance and rating required.

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 frequences.

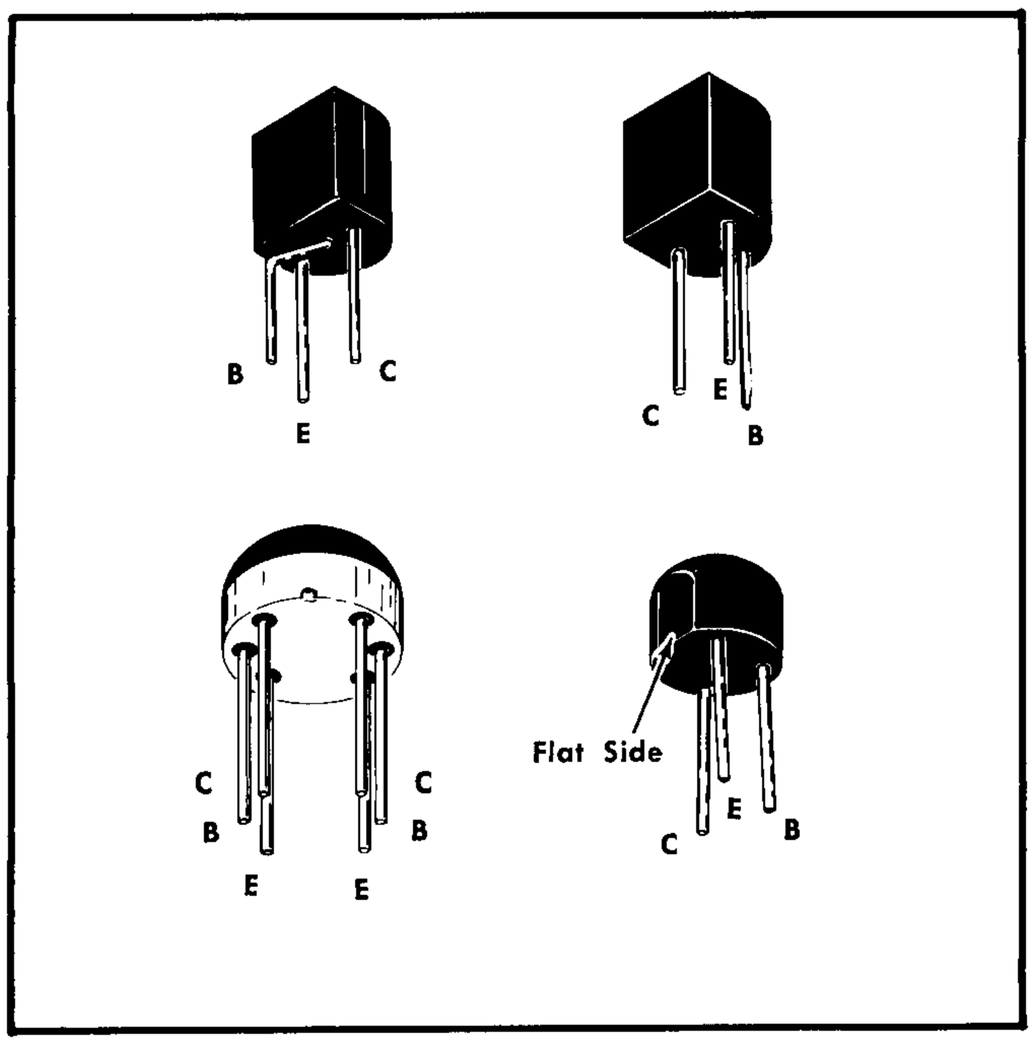


Fig. 4-1. Lead configuration for circuit board mounted transistors.

Transistor Replacement. Cut the leads of a replacement transistor to the same length as the transistor removed and bend the leads as necessary. The lead configuration of the transistors used in the Type S-51 is shown in Fig. 4-1.

Replacement of soldered-in components. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection. Do not lay the iron directly on the board, as it may damage the board. Refer to Fig. 4-2.

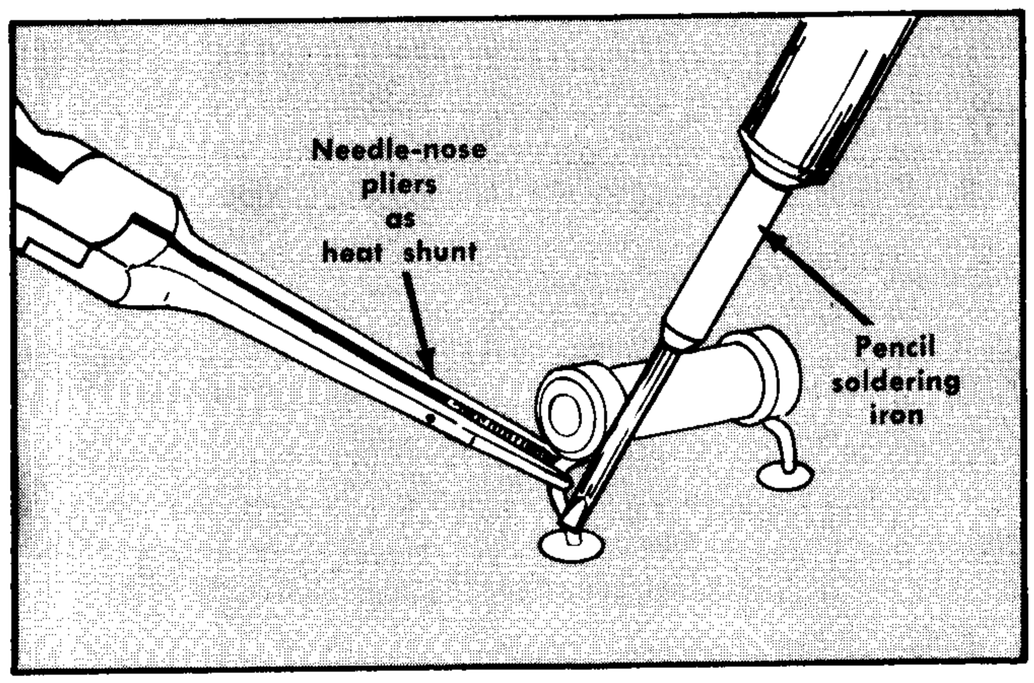


Fig. 4-2. Apply the soldering iron to the heat-shunted lead when removing a component from a circuit card.

When the solder begins to melt, pull the lead out gently. This should leave a clean hole in the board. If not, the hole can be cleaned by reheating the solder and placing a sharp object such as a toothpick or pointed tool into the hole to clean it out.

Bend the leads of the new component to fit the holes in the board. If the component is replaced while the board is mounted in the instrument, cut the leads so they will just protrude through the board.

Pre-tin the leads of the component by appling the soldering iron and a small amount of solder to each (heat-shunted) lead. Insert the leads into the board until the component is firmly seated against the board. If it does not seat properly, heat the solder and gently press the component into place.

NOTE

Parts orientation and lead dress should duplicate those of the orginal part since many of the com-

ponents are mounted in a partcular way to reduce or control stray capacitance and inductance. After repair, the Trigger Countdown Head may require recalibration.

Use ordinary 60/40 solder and a 35- to 40-watt pencil type soldering iron on the circuit boards. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the etched wiring from the base material.

Apply the iron and a small amount of solder to the connection to make a firm solder joint. To protect heat-sensitive components, hold the lead between the component body and the solder joint with a pair of long-nose pliers or other heat sink.

Clean the area around the soldered connection with a flux-remover solvent to maintain good environmental characteristics. Be careful not to remove information printed on the board.

S-51 MAINTENANCE

Circuit Board Replacement

If a circuit board is damaged and cannot be repaired, the entire assembly including all soldered-on components should be replaced. The part number given in the Mechanical Parts List is for the completely wired board.

Control Board Replacement

1. Gently pull the Control Board away from the Trigger Board to remove the Control Board from the coaxial and pin connections that support the Control Board.

2. The new Control Board is installed by aligning the coaxial and pin connections and then pressing the two boards together so that the coaxial connector is properly seated.

Trigger Board Replacement

1. Remove the Control Board.

2. Remove the front side of the TRIG OUT connector by using a $^5/_{16}$-inch box-wrench. This disassembles the connector.

3. Unsolder the three wires on the body of the SYNC control.

4. Remove the $^5/_{16}$-inch nut on the front panel INPUT connector.

5. Separate the Trigger Board and the front panel.

6. To separate the substrate assembly from the Trigger Board, remove the four $^5/_{64}$-inch Allen-head screws that fasten the Substrate Assembly into which is inserted the tunnel-diode D2 and the INPUT connector.

7. Mount the Substrate Assembly on the new Trigger Board. If the INPUT connector is loose in the Substrate Assembly, it should be tightened to 15 inch-pounds.

8. Assemble the Trigger Board and the front panel. The nut on the INPUT connector should be tightened to 10 inch-pounds.

9. Solder the three wires to the SYNC control.

10. Mount the TRIG OUT connector with its wire lead onto the front panel.

11. Install the Control Board.

Replacing Tunnel-Diode D2

Do this replacement in a clean, flat work area since the tunnel-diode is easily lost due to its small size. Keep foreign material away from the diode when it is exposed.

1. Gently pull the Control Board away from the Trigger Board to remove the Control Board from the coaxial and pin connections that support the Control Board.

2. Remove the screw from the back of the Substrate Assembly while the screw is pointed upward to prevent the loss of the tunnel-diode or the spring underneath the tunnel-diode. The tunnel-diode and the spring are contained in the hollow screw and they will separate from the screw. Fig. 4-3 shows an exploded view of this assembly.

3. Insert the new tunnel-diode assembly, which contains the tunnel-diode, spring, and hollow screw, into the Substrate Assembly while the screw is pointed upward.

4. Replace the Control Board, being careful to align the pins and the coaxial connectors.

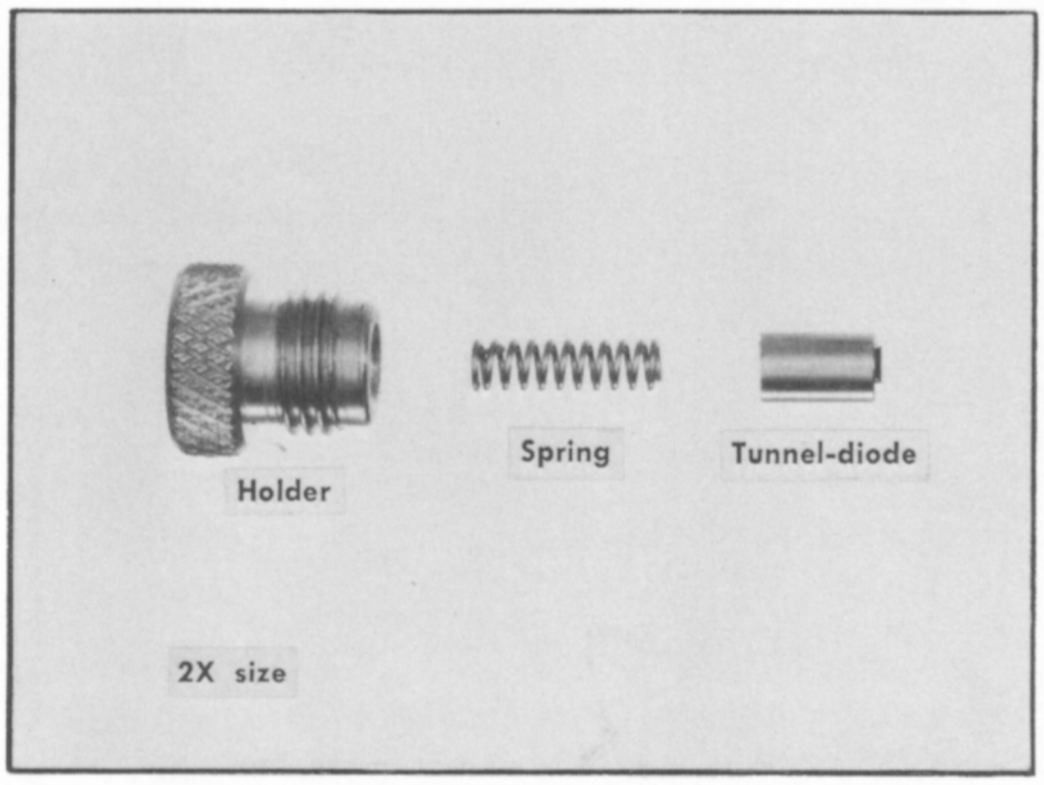


Fig. 4-3. Exploded view of tunnel diode D2 assembly.

Substrate Assembly Replacement

Replace the Substrate Assembly if the contacts on the edge of the substrate are damaged or the components on the substrate are faulty. See Fig. 4-4 for a picture of the Substrate Assembly.

1. Gently pull the Control Board away from the Trigger Board to remove the Control Board from the coaxial and pin connections that support the Control Board.

2. Remove the nut on the INPUT connector with a $^5/_{16}$-inch box wrench.

3. Remove the INPUT connector with a $^7/_{32}$-inch open-end wrench.

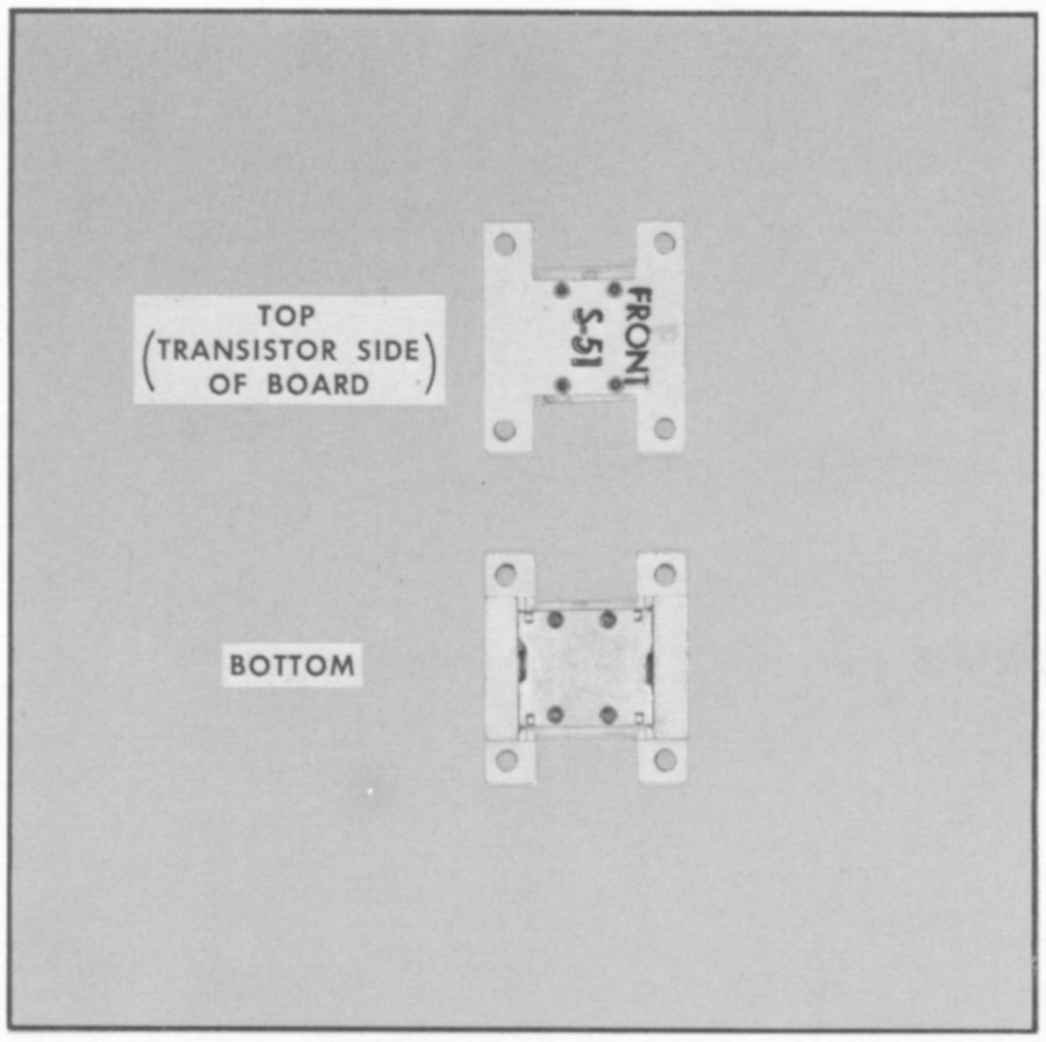


Fig. 4-4. Substrate assembly.

4. Pull the Trigger Board away from the panel and note, on the component side of the board, the word FRONT printed next to the INPUT connector.

5. Remove the four $^{5}/_{16}$-inch Allen head screws which hold the Substrate Assembly to the Trigger Board.

6. Separate the Substrate Assembly from the Trigger Board.

7. Over a clean, flat work area, remove the knurled-head screw from the Substrate Assembly while pointing the screw upwards. Be careful not to lose the tunnel-diode which is inside the screw.

8. Insert the knurled-head screw containing the tunnel-diode into the back end of the new Substrate Assembly.

9. Remount the Substrate Assembly onto the Trigger Board.

10. Insert the INPUT connector through the front panel and into the Substrate Assembly and tighten to 15 inch-pounds.

11. Restore the nut to the INPUT connector and tighten to 10 inch-pounds.

12. Remount the Control Board onto the Trigger Board.

Internal Trig Out Connector Replacement

1. Remove the Control Board from the Type S-51.

2. Mount the Control Board transistor-side-down in a vise and unsolder the shield and center conductor from the Control Board.

3. Unsolder the connector mount from the Control Board. Apply a high wattage iron to the mount only. Do not use more heat than necessary.

4. Mount the Control Board transistor-side-up in a vise and solder in the new connector with the chamferred hole away from the edge of the board. The mount must be flush with the edge of the board and pressed down with the soldering iron while soldering.

5. Insert the new connector after the mount has cooled. Check that the metal ring on the connector prevents the connector from being pushed out of its mount.

6. Solder the shield and center conductor to their proper positions on the Control Board.

7. Mount the Control Board in the Type S-51.

Semiconductor Checks

The operation of a semiconductor device may be checked with a Type 575 Transistor-Curve Tracer. *Semiconductor Device Measurements,* a Tektronix publication (Tektronix Part No. 062-1009-00), discusses curve-tracer measurement techniques of semiconductor devices. Transistor current gain is discussed on pages 1 through 24. Signal diodes are discussed on pages 99 through 106. Tunnel-diodes are discussed on pages 125 through 134.

Transistor Checks. 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 ranges, or by using the substitution method. The location of all transistors is shown in the parts location figures later in this section.

To check a transistor using a voltmeter, measure the emitter to-base and emitter-to-collector voltages and determine whether the voltages are constant with the normal resistances and currents in the circuit (see Fig. 4-5). Note the electrode configuration in Fig. 4-1.

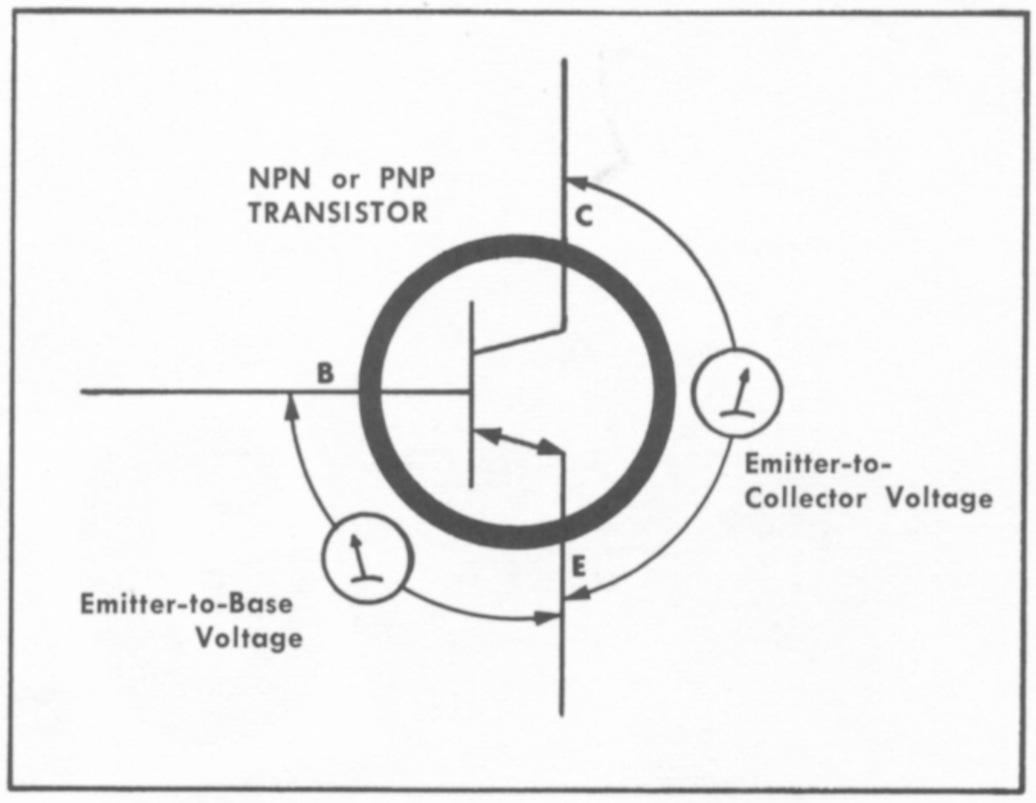


Fig. 4-5. In-circuit checks NPN or PNP transistors.

Checking Tunnel Diode D2. Performance of tunnel-diode D2 should be checked only by its in-circuit operation. Use the Kickout at Input step of the Performance Check/Calibration procedure to check the operation of the tunnel-diode D2.

CAUTION

Do not check D2 with an ohmmeter or a curve tracer. Performance of D17 and D23 may be checked with a curve tracer such as the Tektronix Type 575. Do not use an ohmmeter.

Diode Checks. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of about 1.5 volts, the resistance should be very high in one direction and very low when the leads are reversed.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High currents may damage the diode.

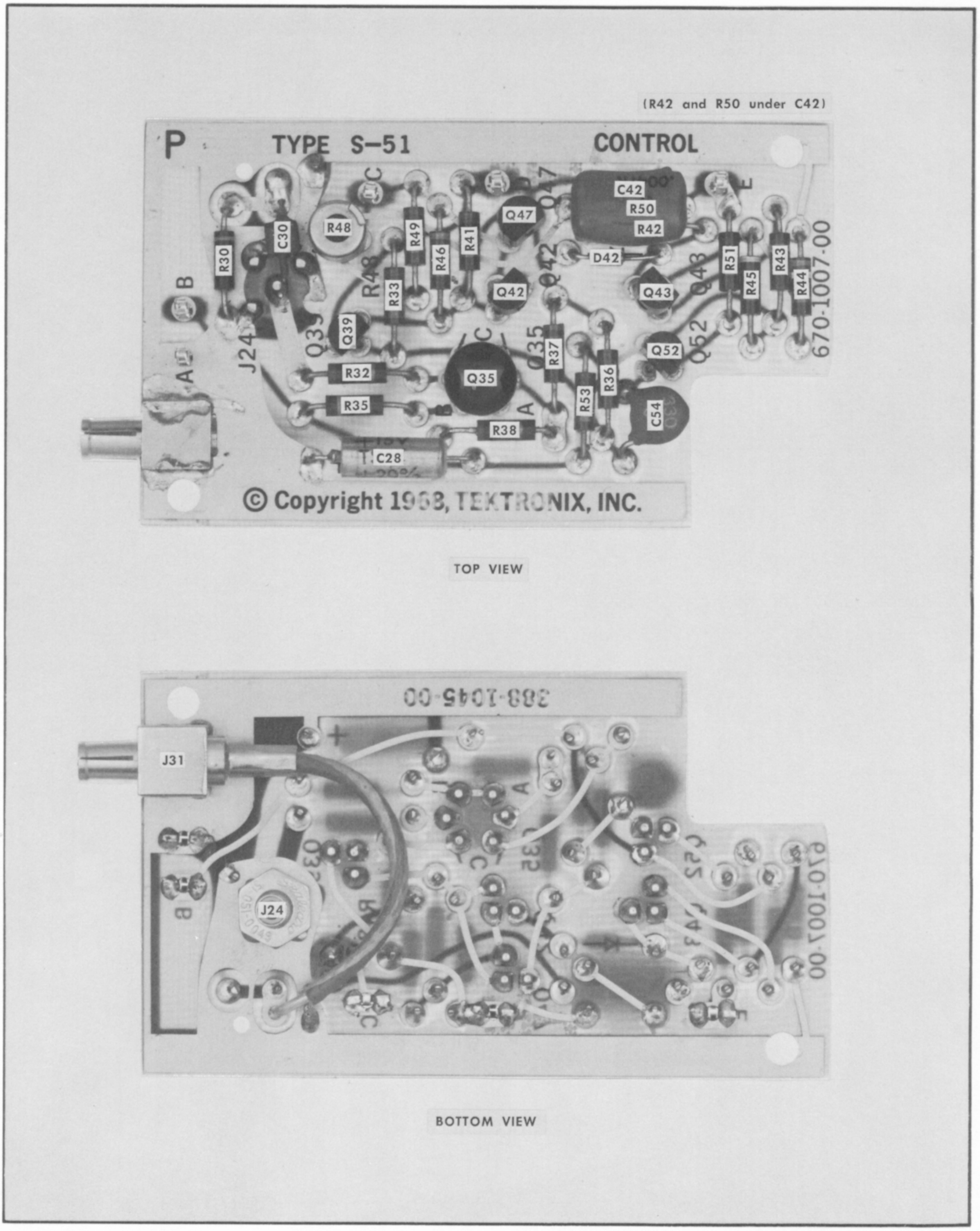


Fig. 4-6. Control board.

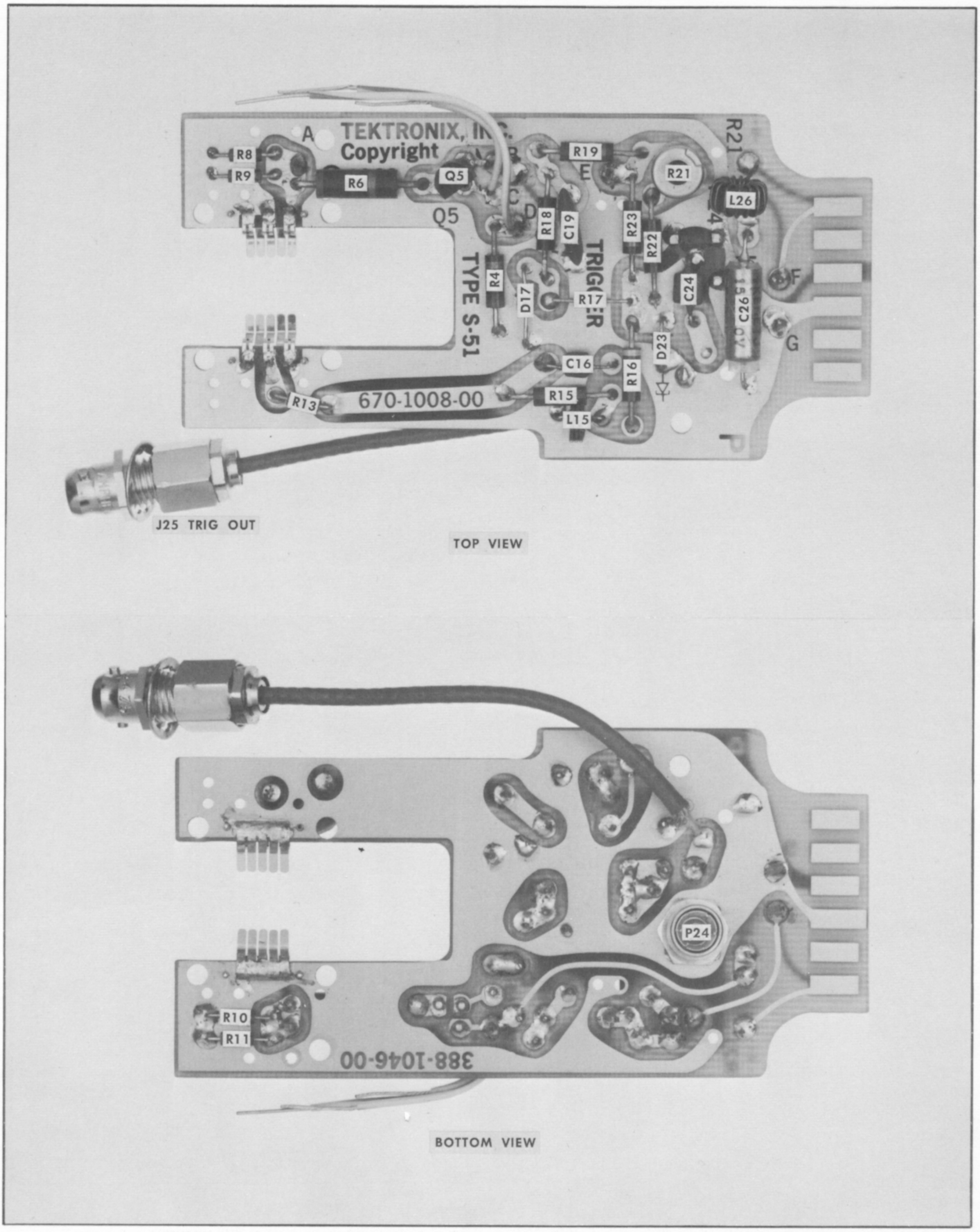


Fig. 4-7. Trigger board.

SECTION 5
PERFORMANCE CHECK / CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The following procedure may be used as a front-panel check of the instrument's performance, or as a complete calibration procedure. When only the Performance Check steps are done, the instrument is checked to the "Performance Requirements" given in Section 1. When the calibration steps are also done, the limits, tolerances, and waveforms given are added as calibration guides for these steps, and are not instrument specifications.

The Performance Check procedure is steps 2 through 11. The Calibration procedure is step 1 and step 2.

EQUIPMENT REQUIRED

The equipment listed below or its equivalent is required for a complete check and calibration of the Type S-51 Trigger Countdown Head. Equipment specifications given are the minimum necessary for the particular use of each item. All test equipment must be correctly calibrated. If other equipment is substituted, it must meet or exceed the limits stated below.

1. Type 561B Oscilloscope.

2. Type 3T2 Random Sampling Sweep.

3. Type 3S2 Sampling Unit.

4. Type 285 Power Supply.

5. 5 ns signal delay 3-mm flexible coaxial 50 Ω cable, Tektronix Part No. 015-1006-00.

6. 2 ns signal delay 3-mm flexible coaxial 50 Ω cable, two required. Tektronix Part No. 015-1005-00.

7. 5X (14 dB) 50 Ω attenuator with 3-mm connectors. Tektronix Part No. 015-1002-00.

8. Male to male 3-mm coaxial adapter. Tektronix Part No. 015-1011-00.

9. BNC jack to 3-mm plug adapter. Omni Spectra Model 21190.

10. Sampling Head Extender, 3 ft. Tektronix Part No. 012-0124-00.

11. Type S-4 Sampling Head.

12. 10 inch 50 Ω coaxial cable with BNC/BSM connectors. Tektronix Part No. 012-0128-00.

13. 18 inch 50 Ω coaxial cable with BNC/BSM connectors. Tektronix Part No. 012-0127-00.

14. Test oscilloscope such as a Type 545B with a Type 1A1 Dual-trace Plug-in Unit.

15. Power divider tee with 3-mm connectors. Tektronix Part No. 015-1014-00.

16. Adapter, GR to BNC female. Tektronix Part No. 017-0063-00.

17. Adapter, GR to 3-mm female. Tektronix Part No. 015-1008-00.

18. Type 113 Delay Cable, 60 ns signal delay and 50 Ω characteristic impedance.

19. Adapter, GR to 3-mm male. Tektronix Part No. 015-1007-00.

The following items are not shown:

20. 1 GHz signal generator with >500 mV output into 50 Ω, such as General Radio UHF Unit Oscillator Type 1361-A.

21. 18 GHz signal generator with >500 mV output into 50 Ω, such as Hewlett Packard SHF Signal Generator Model 628A.

22. Special waveguide to 3-mm female coaxial adapter for the above generator; Omni Spectra Model 20188J.

23. Power meter capable of measuring >25 μW (.1 V across 50 Ω), such as Hewlett Packard Model 431C Power Meter with Hewlett Packard Thermistor Mount, Model 8478B.

24. Adapter, N Jack/3-mm Jack, such as Omni Spectra Model 21010.

PERFORMANCE CHECK AND CALIBRATION RECORD INDEX

The following abridged procedure may be used as a performance check or calibration procedure guide by the experienced calibrator, or it may be used as a record. (Tektronix, Inc. authorizes reproduction of the abridged procedure by any user of the equipment). The step numbers and titles are identical to those used in the complete procedure. When the instrument meets the requirements in the Performance Check steps, the Type S-51 will meet all Characteristics listed in Section 1.

☐ 1. Adjust D23 Enabling Current, R21 (Page 5-4)

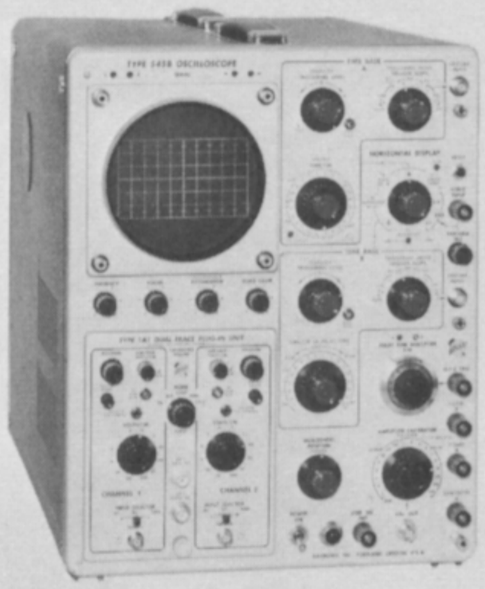
Set R21 at the mid-point between the trace turn on and turn off points.

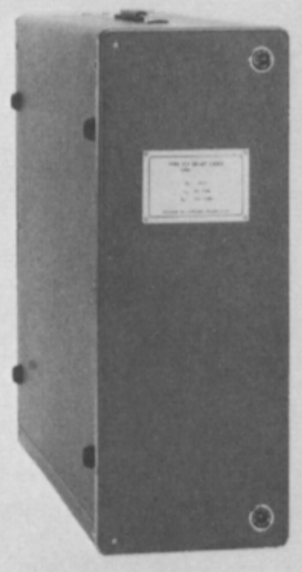
☐ 2. Check and Adjust the Oscillator SYNC TD (Page 5-4)
Bias control, R48

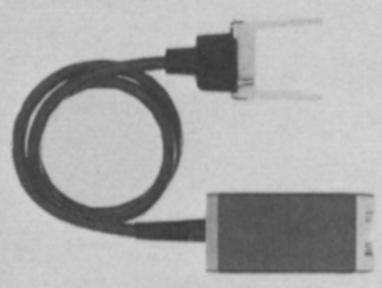
Range of change of the Oscillator period by the SYNC control is 1 ns to 2 ns.

Ⓐ


(1-2-3)

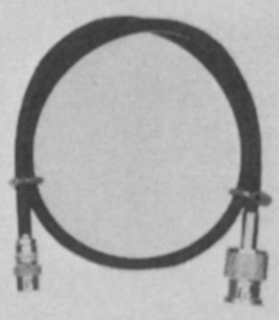

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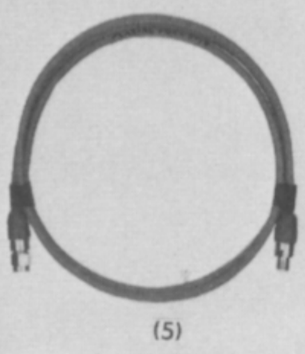

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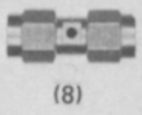

(10)

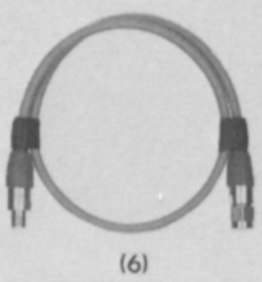

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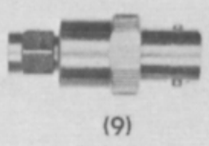

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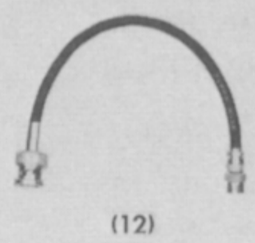

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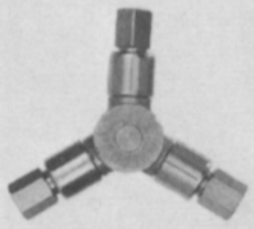

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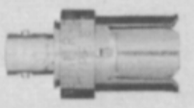

(16)

Fig. 5-1. Equipment required for Performance Check and Calibration.

☐ 3. Oscillator Kickout Check (Page 5-4)

Positive Oscillator kickout pulses are 400 mV into 50 Ω.

☐ 4. Check Oscillator Cutoff (Page 5-5)

Oscillator cutoff within 30 ns after the start of the trigger pulse.

☐ 5. Check TRIG OUT (External) Pulse Amplitude and Duration (Page 5-5)

Pulse amplitude is ≥200 mV into 50 Ω.

Pulse duration ≥1 ns at the 50% amplitude points.

☐ 6. Check (Internal) TRIG OUT Pulse Amplitude and Duration (Page 5-6)

Same as Step 6.

☐ 7. Check TRIG OUT Pulse Period (Page 5-6)

Pulse period is 15 μs ±3 μs.

☐ 8. Check for Proper Triggering at 1 GHz (Page 5-6)

A triggered display is obtained of a 1 GHz, 100 mV input signal into the Type S-51.

☐ 9. Check 1 GHz to 5 GHz Trigger Jitter (Page 5-6)

The Type S-51 jitter is ≤15 ps or the combined jitter of the Type S-51 with the Type 3T2 is ≤22 ps.

☐ 10. Check for Proper Triggering at 18 GHz (Page 5-7)

A trigger display is obtained of an 18 GHz, 100 mV input signal into the Type S-51.

☐ 11. Check 5 GHz to 18 GHz Trigger Jitter (Page 5-7)

The Type S-51 jitter is ≤10 ps or the combined jitter of the Type S-51 with the Type 3T2 is ≤20 ps.

Preliminary Procedure

a. Connect the Type 561B Oscilloscope and the Type 285 Power Supply to the proper AC power source.

b. Set the Type 3S2 internal Horiz Plug-in Compatibility switch to Sampling and insert the unit into the left compartment of the Type 561B.

c. Set the Type 3T2 internal Samples/Div switch to Variable and insert the unit into the right compartment of the Type 561B

d. Remove the case from the Type S-51 (See Maintenance Section) and connect the Type S-51 to the Type 285 Power Supply with a sampling head extender.

e. Insert a Type S-4 into Ch A of the Type 3S2.

f. Turn the equipment on and allow a 5 minute warmup period.

g. Connect the Type S-51 INPUT connector to the Type S-4 input connector using a 5X (14 dB) attenuator, a 5 ns signal delay 3-mm coaxial cable, and a male-to-male 3-mm coaxial adapter.

h. Connect an 18-inch coaxial cable with BNC and BSM connectors between the Type S-51 TRIG OUT connector and the Type 3T2 50 Ω Trigger Input connector.

i. Make the following control settings:

Type 3T2

Time Position (both)	Fully clockwise
Start Point	Before Trigger
Trig Sensitivity	Fully counterclockwise
Recovery Time	Fully counterclockwise
Display Mode	Normal
Manual Scan	Optional
Polarity	+
Source	Ext
Horiz Position	Centered
Samples/Div	10 o'clock
Time/Div	
Range	100 ns
Display Mag	X1
Time Magnifier	X10
Variable	Cal

1 ns

Type 3S2 (Channel A)

Mode Switch	Ch. A
Dot Response	Adjust for unity loop gain
Units/Div	50
Variable	Cal
Invert	Pushed in
A Position	Midrange
DC Offset	Adjust to display trace

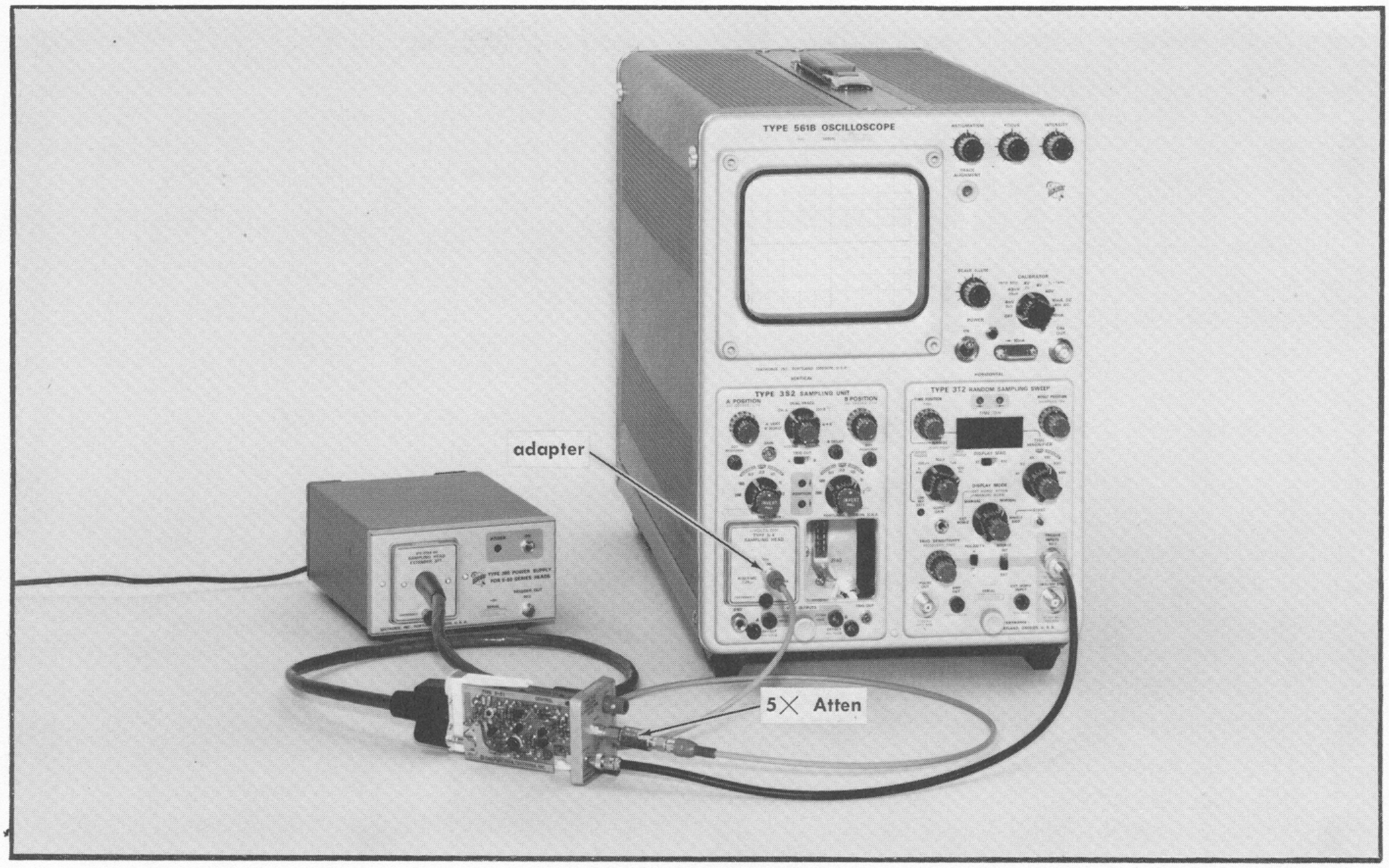


Fig. 5-2. Equipment setup for step 1.

1. Adjust D23 Enabling Current, R21

a. Turn R48 fully counterclockwise.

b. Turn R21 fully counterclockwise.

c. Turn R21 slowly clockwise to obtain a trace and mark this setting of R21. Both horizontal position indicator lights turn on when the trace starts to sweep.

d. Turn R48 clockwise to obtain an indicator oscilloscope display of the Oscillator pulses similar to Fig. 5-3.

e. Turn R21 counterclockwise to stop the display. One of the horizontal position indicator lights turns off at the same time. Mark this setting of R21 and then turn R21 clockwise to the midpoint between the two marks and leave it there.

f. If no trouble-shooting is to be performed, remove the sampling head extender. Install the Type S-51 into its case and insert the unit into the Type 285 Power Supply.

2. Check and Adjust Oscillator Sync TD Bias control R48

Requirement—The Oscillator period is between 3.5 ns and 6.0 ns. The SYNC control will change the Oscillator period an amount between 1 ns and 2 ns.

a. Obtain a stable display of oscillator pulse, similar to that shown in Fig. 5-3.

b. Turn the Type 3T2 Time Position control and find the right end of the pulse train. Find a positive pulse that does not move when the S-51 SYNC control is turned through its complete range. This pulse is usually the third pulse from the right end of the pulse train.

c. Turn the Type 3T2 Time Position control to position the stable pulse to the last graticule line at the CRT right side.

d. Turn the 10 turn SYNC control through its whole range. The positive pulse that is to the left of the stable reference pulse should move $\geq$1 ns, but $\leq$2 ns. The period between the pulses must stay between 3.5 ns and 6.0 ns over the full range of the SYNC control. If these requirements are met, then R48 is set correctly; if not, do part e below.

e. Insert the screwdriver through the hole in the left side of the Type 285 Power Supply case to adjust R48. If the moving pulse moves less than 1 ns, or the period is less than 3.5 ns, turn R48 counter-clockwise to increase these values. If the moving pulse moves more than 2 ns, or the period is greater than 6.0 ns, turn R48 clockwise to decrease these values.

3. Oscillator Kickout Check

Requirement—Amplitude of positive Oscillator kickout pulses: $\leq$ 400 mV into 50 Ω.

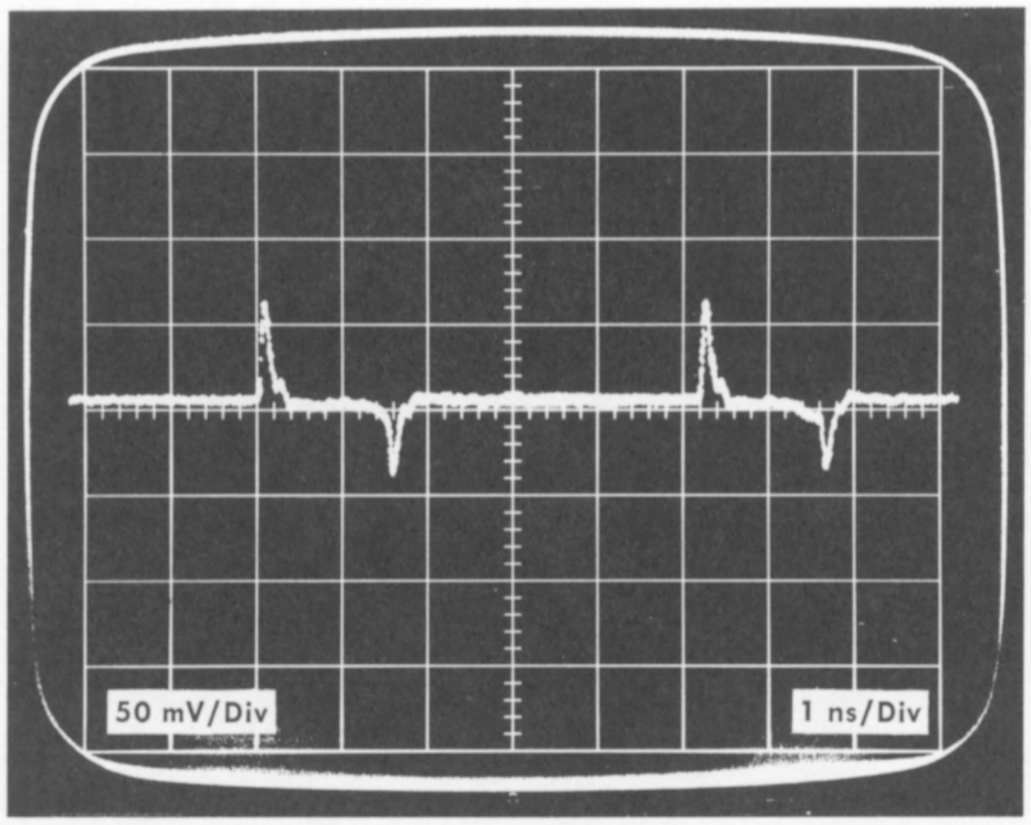


Fig. 5-3. Oscillator pulses at Type S-51 INPUT connector.

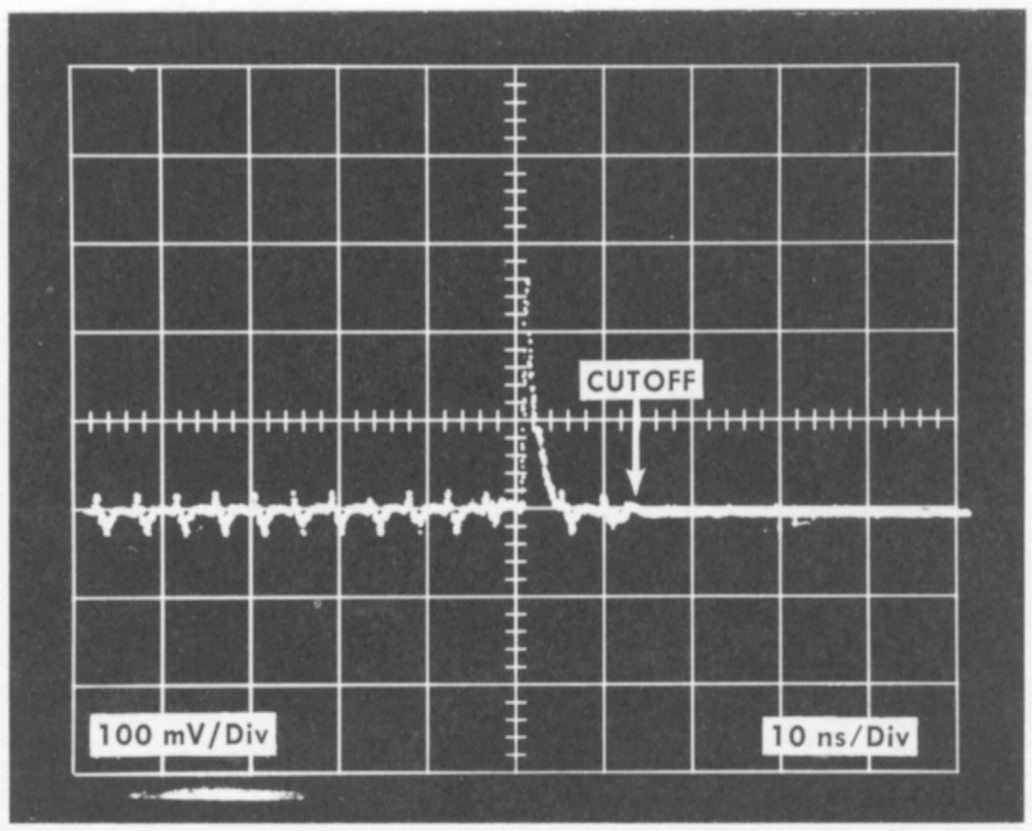


Fig. 5-4. Oscillator cutoff after trigger pulse.

a. Remove the 5X (14 dB) attenuator from the 3-mm coaxial line that is between the Type S-51 and the Type S-4 INPUT connectors. Reconnect the line.

b. Set the Type 3S2 Ch. A Units/Div switch to 100.

c. Obtain a stable display and measure the positive pulse amplitude.

If the amplitude is $>$400 mV, check C1. C1 is checked with an ohmmeter (X100 Ω scale). Turn off the power and remove the case. Place one probe on the INPUT connector center conductor and the other probe at the junction of R13 and the contact to the substrate. Check that the meter reads an open circuit. Replace the case and re-install the S-51 back into its operating position. Turn on the power and allow 5 minutes warm-up time.

4. Check Oscillator Cutoff

Requirement—Oscillator pulses cease within 30 ns after the start of the TRIG OUT pulse.

a. Remove the 3-mm coaxial cable and adapter from the Type S-4 and the Type S-51.

b. Disconnect the coaxial cable from the Type S-51 TRIG OUT connector and connect the same cable to the Type 285 Trigger Out connector.

c. Connect a 10-inch coaxial cable with BNC and BSM connectors and a male 3-mm to female BNC adapter between the Type S-51 TRIG OUT and the Type S-4 Input.

d. Set the Type 3T2 Sweep Rate to 10 ns/Div (Range to 1 μs).

e. Time position the Trigger Output pulse to the center of the graticule and check that the Oscillator pulses cease within 30 ns after the start of the TRIG OUT pulse. See Fig. 5-4 for a similar display. Q52, Q39 and Q35 control the Oscillator cutoff.

5. Check TRIG OUT Pulse Amplitude and Duration (External)

Requirement—Pulse amplitude is $\geq$ 200 mV into 50 Ω and pulse duration is $\geq$1 ns at the 50% amplitude points.

a. Set the Type 3T2 Sweep Rate to 1 ns/Div (Range to 100 ns).

b. Set the Type 3S2 Ch A Units/Div switch to 50.

c. Obtain a display similar to Fig. 5-5. Check for a pulse amplitude $\geq$200 mV.

d. Check for a pulse duration $\geq$1 ns at the 50% amplitude points. If the pulse duration is less than 1 ns, check C24 and D23.

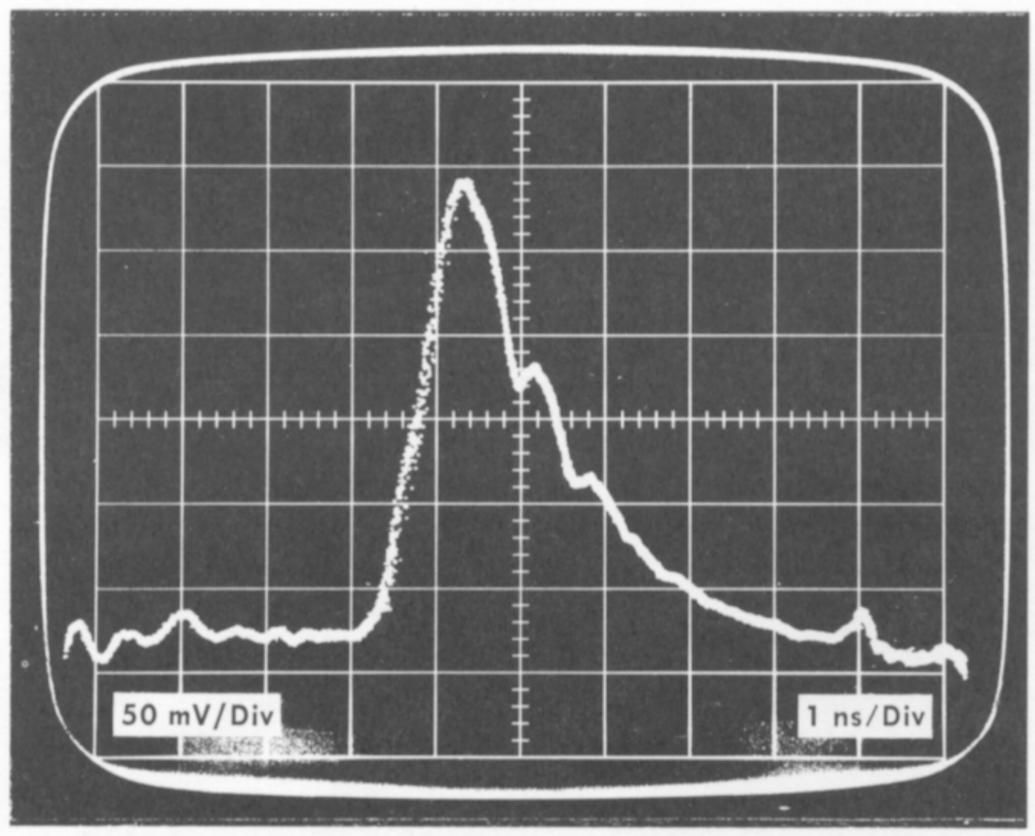


Fig. 5-5. Trigger output pulse.

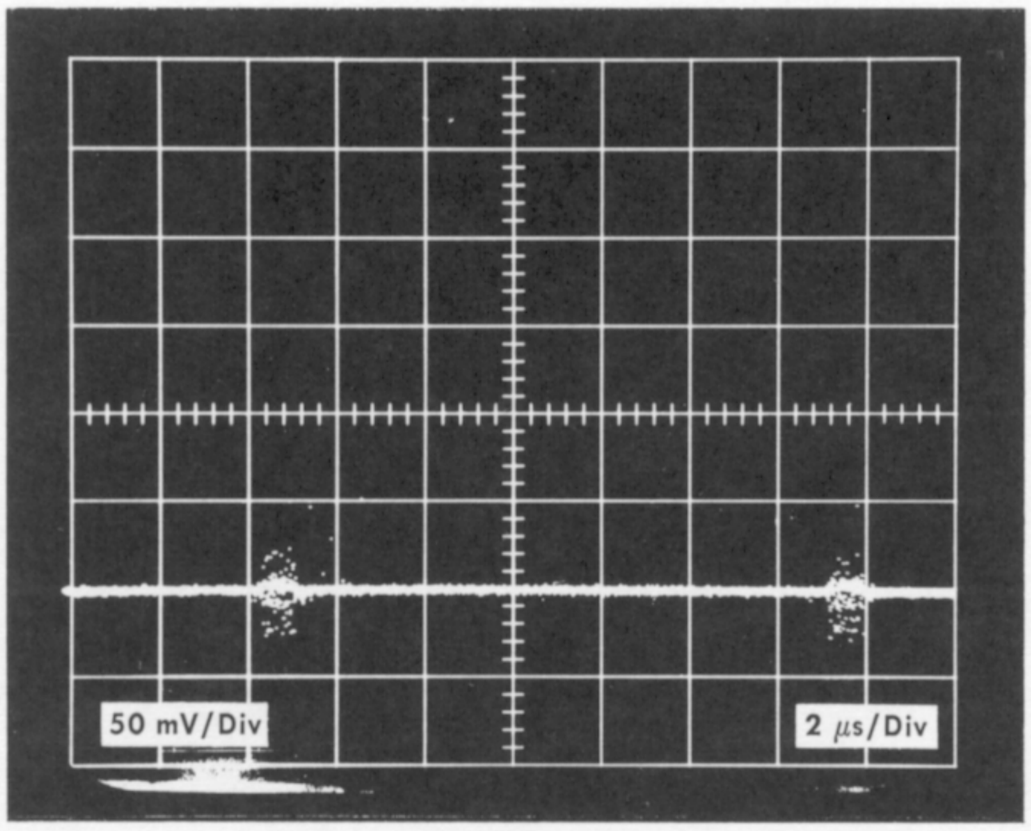


Fig. 5-6. TRIG OUT pulse period check showing only the dot clusters at the base of each pulse.

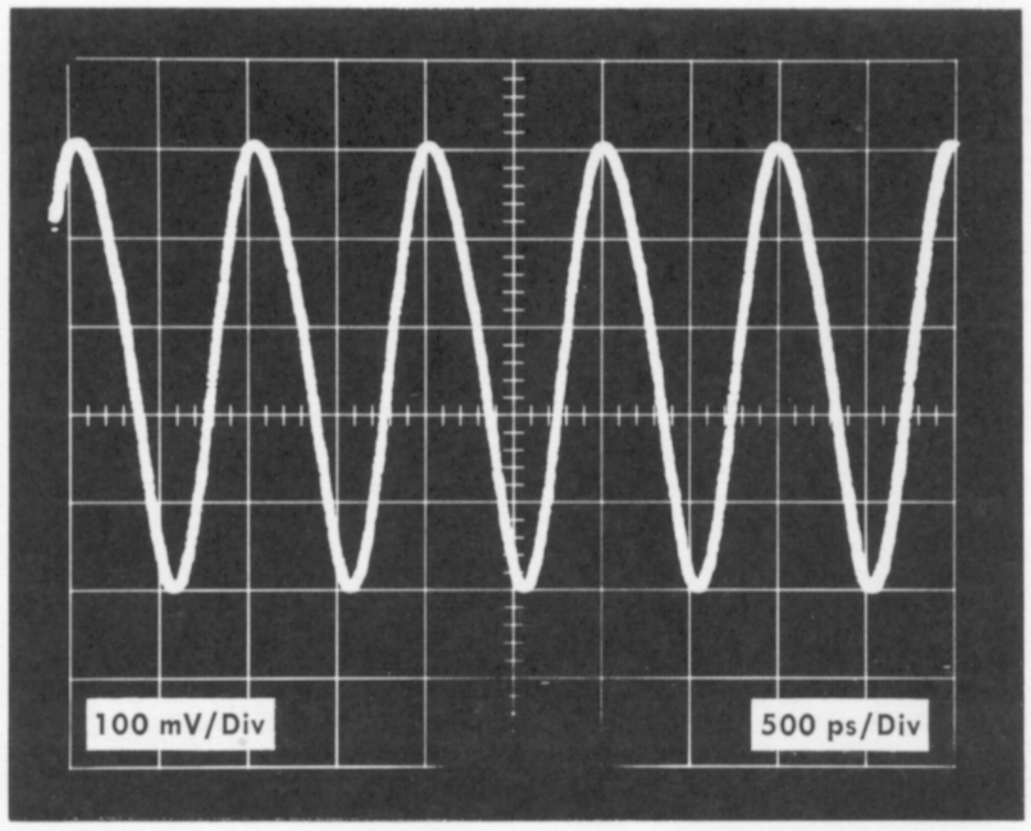


Fig. 5-7. 1 GHz sine wave display, step 8.

6. Check TRIG OUT Pulse Amplitude and Duration (Internal)

Requirement—Pulse amplitude is $\geq$ 200 mV into 50 Ω and pulse duration is $\geq$1 ns at the 50% amplitude points.

a. Interchange the two cables at the Type S-51 TRIG OUT connector and the Type 285 Trig Out connector.

b. Check for a pulse amplitude $\geq$ 200 mV.

c. Check for a pulse duration $\geq$1 ns at the 50% amplitude points. If the pulse is less than 1 ns, check C30.

d. Return the cables to their original connections.

7. Check TRIG OUT Pulse Period

Requirement—TRIG OUT pulse period is 15 μs ± 3 μs.

a. Set the Type 3T2 Sweep Rate to 2 μs/Div (Range to 100 μs and Time Magnifier to X5).

b. Adjust the Type 3T2 Time Position control to locate two positive pulses. The pulses have a cluster of dots at their bases; see Fig. 5-6. The dot cluster is a confused and noisy display because there is less than one dot per oscillator cycle. After locating the pulses, place the Type 3T2 Display Mode switch to Manual and manually scan the trace where the dot clusters are located. A vertical line of dots will appear above each cluster, thus locating the TRIG OUT pulse. The TRIG OUT pulse period (the distance between the two lines) must be 6.5 major graticule divisions ±1.5 div, which is 15 μs ± 3 μs.

c. Return the Display Mode switch to Normal.

8. Check for Proper Triggering at 1 GHz

Requirement—A triggered display is obtained of a 1 GHz signal when the Type S-51 input signal is 100 mV pk-pk.

a. Connect an 18-inch coaxial cable with BNC and BSM connectors from the Type S-51 TRIG OUT to the Type 3T2 50 Ω Trigger Input.

b. Connect a 5X (14 dB) attenuator and a 2 ns signal delay 3-mm coaxial cable between the Type S-51 INPUT and a power divider tee.

c. Connect a 2 ns signal delay 3-mm coaxial cable between the Type S-4 and the power divider tee.

d. Connect the power divider tee to a 1 GHz signal source such as a General Radio Type 1361-A UHF Unit Oscillator by using a GR to 3-mm female adapter.

e. Set the Type 3T2 Sweep Rate to 500 ps/Div (Range to 100 ns and Time Magnifier to X20).

f. Set the Type 3S2 Units/Div switch to 100.

g. Set the Type 3T2 Start Point switch to With Trigger.

h. Adjust the Type S-51 SYNC control and the Type 3T2 Sensitivity control for a triggered display.

i. Set the Type 3T2 Samples/Div control at ≈9 o'clock.

j. Set the signal generator amplitude to obtain a 500 mV P-P display. This gives a 100 mV P-P signal (after being attenuated by the 5X attenuator) to the Type S-51 INPUT.

k. The display should now be a clean, triggered 1 GHz sine wave such as shown in Fig. 5-7.

9. Check 1 GHz to 5 GHz Trigger Jitter

NOTE

A Type 564 Storage Oscilloscope or a Tektronix trace-recordng camera photograph can make the reading of this check easier than when viewing an active CRT display.

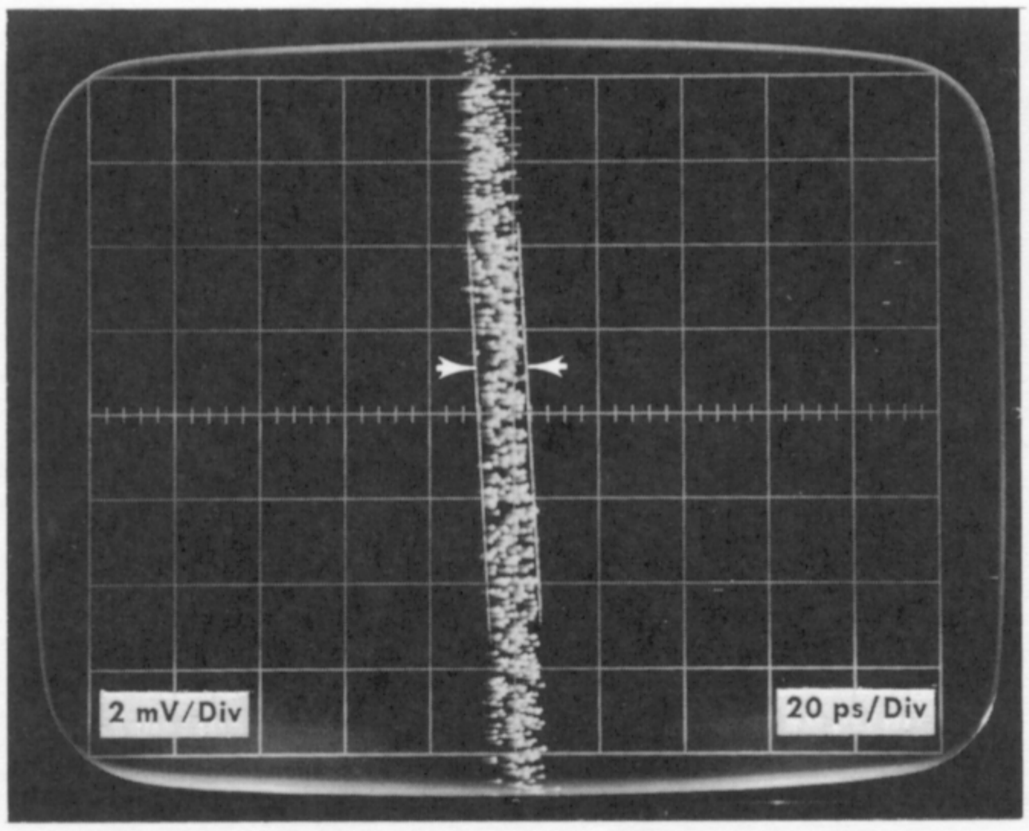


Fig. 5-8. Typical 1 GHz trigger jitter of the Type S-51 when the sampling sweep unit is a Type 3T2.

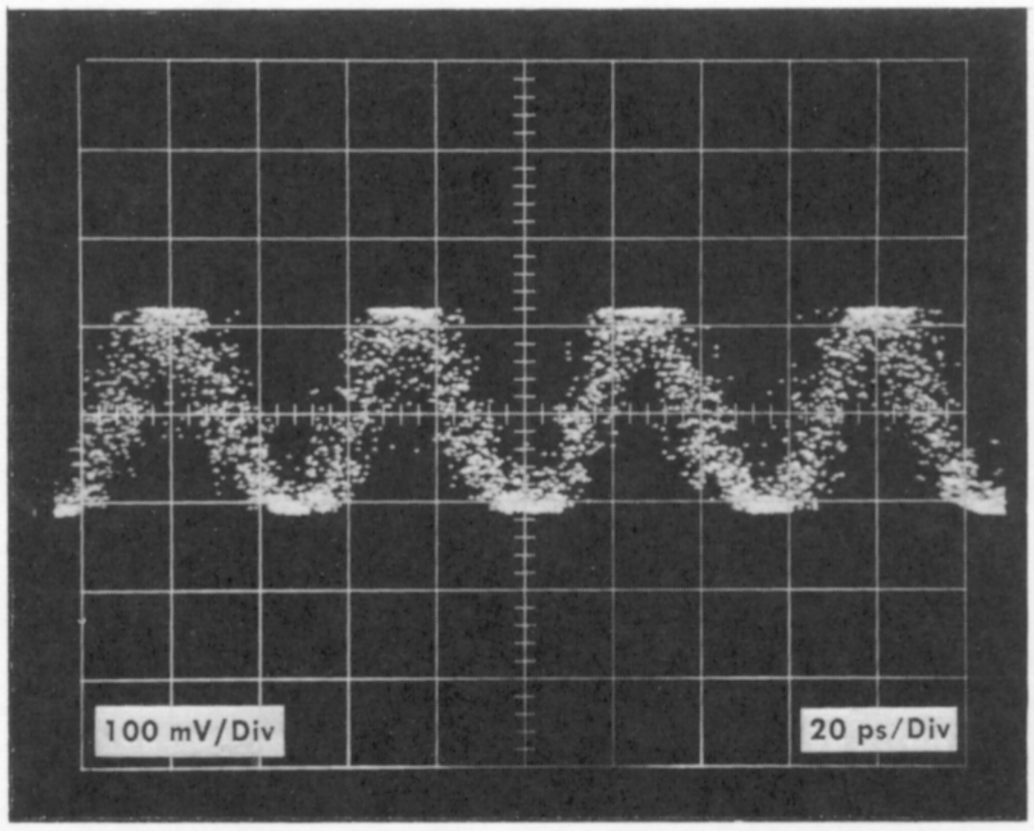


Fig. 5-9. Typical 18 GHz sine wave display.

Requirement—Time jitter between a 1 GHz sine wave and the Type S-51 TRIG OUT pulse will be $\leq$ 15 ps, or the displayed jitter (which includes the Type 3T2 jitter) will be $\leq$22 ps.

a. Set the Type 3S2 Dot Response control for a unity loop gain display.

b. Set the Type 3T2 Time/Div to 20 ps (Display Mag to X10 and Time Magnifier to X50).

c. Set the Type 3S2 Units/Div switch to 2.

d. Adjust the Type 3T2 Time Position control and the Type 3S2 A Position control to position a center portion (maximum rate of change) of the sine wave to the graticule center and measure the trace width that includes 90% of the dots. See Fig. 5-8 for a typical display. Check that the combined jitter of the Type S-51 and the Type 3T2 is $\leq$ 22 ps.

If the combined jitter is $>$ 22 ps, the jitter of the Type S-51 is computed by the formula: Jitter (S-51) $= \sqrt{A^2 - B^2}$ where A is the combined jitter of the Type S-51 and the Type 3T2 and B is the Type 3T2 jitter. The procedure for determining the Type 3T2 jitter is given at the end of this procedure.

10. Check for Proper Triggering at 18 GHz

Requirement—A trigger display is obtained of an 18 GHz signal, when the Type S-51 input signal is 100 mV pk-pk.

a. Make the connections given in step 8a, b and c.

b. Connect the power divider tee to an 18 GHz signal source such as a Hewlett Packard SHF Signal Generator Model 628A with an Omni Spectra adapter Model 20188J.

c. Temporarily replace the Type S-51 with a power meter such as a Hewlett Packard Model 431C Power Meter with its Thermister Mount (Model 8478B). The Thermister Mount requires an N jack to 3-mm female coaxial adapter to connect the 3-mm coaxial line.

d. Set the signal generator 18 GHz signal amplitude to 25 μwatts as measured by the 50 Ω input power meter. This is the 100 mV P-P reference signal amplitude for the 50 Ω Type S-51 INPUT. Disconnect the power meter.

e. Reconnect the signal cable to the Type S-51. The Type S-4 responds with less than full amplitude and the display is not 100 mV P-P, even though the signal amplitude to the S-51 is correct for this check.

f. Set the Type 3T2 Sweep Rate to 20 ps/Div (Range to 100 ns, Display Mag to X10 and Time Magnifier to X50).

g. Set the Type 3S2 Units/Div switch to 100.

h. Adjust the Type S-51 SYNC control for a stable display.

i. Check for a triggered display such as is shown in Fig. 5-9.

11. Check 5 GHz to 18 GHz Trigger Jitter

See the NOTE in step 9.

Requirement—Time jitter between the 18 GHz sine wave and the Type S-51 TRIG OUT pulse will be $\leq$10 ps, or the displayed jitter (which includes the Type 3T2 jitter) will be $\leq$20 ps.

a. Set the Type 3S2 Units/Div switch to 2.

b. Position a center portion (maximum rate of change) of the sine wave to the graticule center and measure the 90% trace width. Check that the combined jitter of the Type S-51 and the Type 3T2 is $\leq$20 ps.

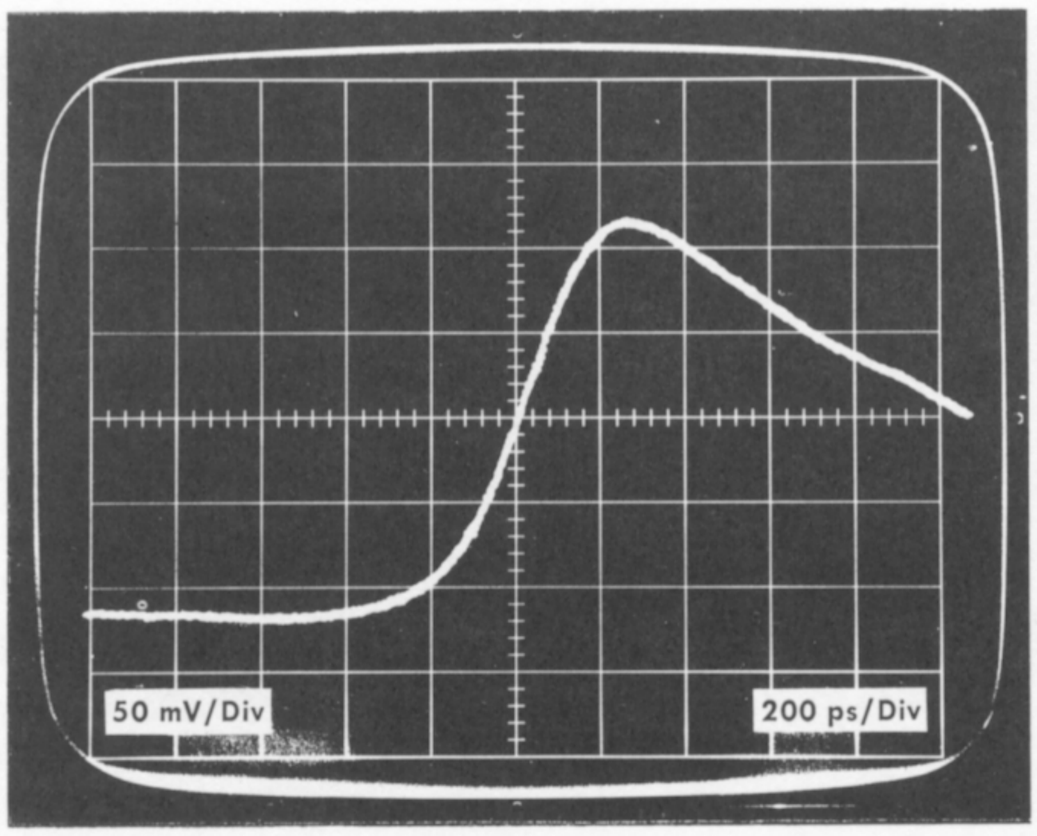


Fig. 5-10. Typical trigger output display using the Type 113 Delay Cable.

If the combined jitter is >20 ps, the jitter of the Type S-51 is computed by the formula given in step 9c.

Measuring the Type 3T2 Jitter:

a. Install the Type S-51 into a Type 285 Power Supply.

b. Install a Type S-4 into Ch A of the Type 3S2 Sampling Unit.

c. Connect, in order, between the Type 285 Trigger Out connector and the Type S-4 Input connector the following items: 18-inch coaxial cable with BSM and BNC connectors, BNC-to-GR ADAPTER, Type 113 Delay line, GR-to-male 3-mm adapter, and a 5 ns signal delay 3-mm coaxial cable.

d. Connect a 10-inch coaxial cable with BSM and BNC connectors between the Type S-51 TRIG OUT connector and the Type 3T2 50 Ω Trig Input connector.

e. Set the Type 3S2 Units/Div control to 50.

f. Set the Type 3T2 Sweep Rate to 200 ps (Range to 100 μs, Display Mag to X1 and Time Magnifier to X50), the Start Point switch to With Trigger, the Samples/Div control to ≈ 9 o'clock and the Trig Sensitivity and Recovery Time controls fully counterclockwise.

g. Position the 50% amplitude point of the pulse leading edge at graticule center. See Fig. 5-10 for a similar display.

h. Set the Type 3S2 Units/Div control to 10.

i. Set the Type 3T2 Sweep Rate to 20 ps/Div (Display Mag to X10).

Adjust the Type 3T2 Trig Sensitivity control for minimum trace width.

Re-center the trace and adjust the Type 3S2 Ch A Units/Div Variable control to position the waveform at a 45 degree angle to the graticule lines.

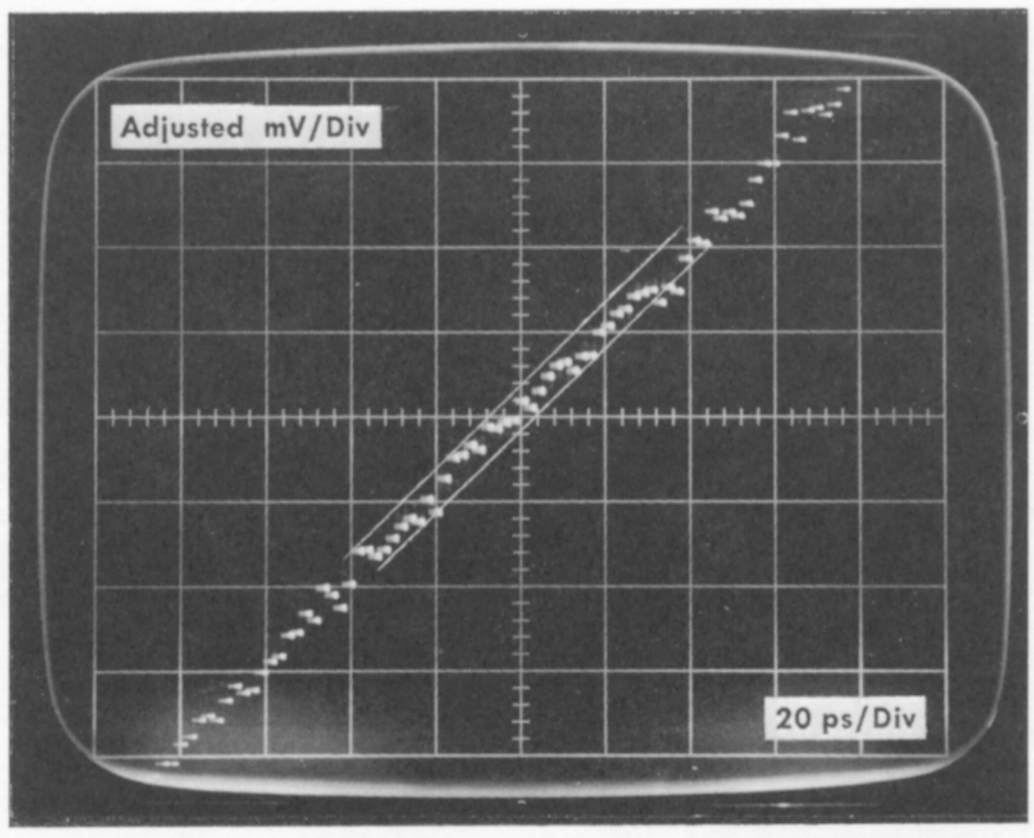


Fig. 5-11. Combined jitter of the Type 3T2 and noise of the Type S-4.

j. Measure 90% of the horizontal trace width in graticule divisions (measurement C in part n below). This is a special CRT measurement of the Type 3T2 jitter and the Type S-4 noise combined. See Fig. 5-11 for a typical display.

k. Disconnect the coaxial cables from the Type 285 Trigger Out connector and the Type S-51 TRIG OUT connector.

l. Advance the Type 3T2 Trig Sensitivity control to free-run the trace.

m. Position the trace no signal near graticule center and measure the Type S-4 vertical noise (90% of the trace width) in graticule divisions (measurement D in part n below). See Fig. 5-12 for a typical display.

n. Compute the Type 3T2 jitter with the following formula: Jitter (3T2) = $\sqrt{(C^2 - D^2)}$ (20 ps).

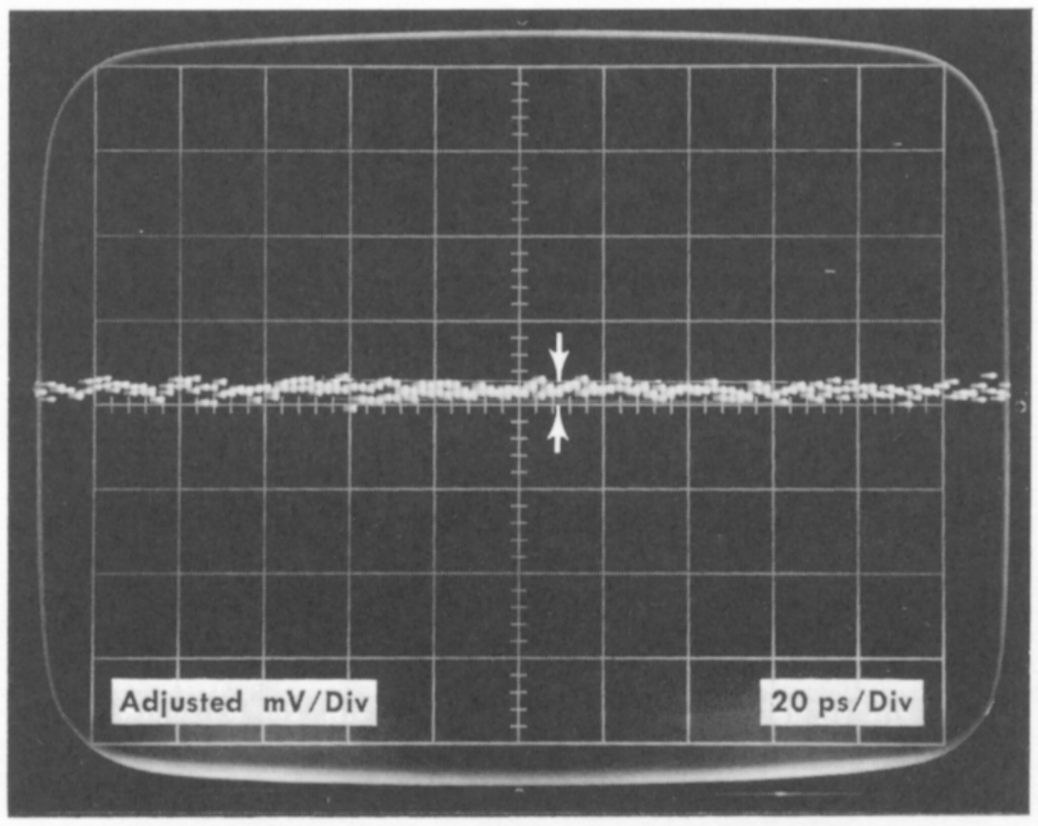


Fig. 5-12. Noise due to the Type S-4 only.

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
incd	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
◐	Screwdriver adjustment.
▭	Control, adjustment or connector.

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Capacitors		
Tolerance ±20% unless otherwise indicated.						
C1[1]						
C16	283-0136-00			10 pF	Cer	50 V 5%
C19	283-0119-00			2200 pF	Cer	200 V 5%
C24	283-0159-00			18 pF	Cer	50 V 5%
C26	290-0135-00			15 μF	Elect.	20 V
C28	290-0134-00			22 μF	Elect.	15 V
C30	283-0159-00			18 pF	Cer	50 V 5%
C42	283-0100-00			4700 pF	Cer	200 V 10%
C54	283-0077-00			330 pF	Cer	500 V 5%
				Semi-Conductor Device, Diodes		
D2	*153-0041-00			Tunnel	Diode Assembly, selected	
D17	152-0140-01			Tunnel	10 mA 8 pF	
D23	152-0387-00			Tunnel	20 mA 4 pF	
D42	*152-0185-00			Silicon	Replaceable by 1N4152	
				Connectors		
J1	131-0631-00			Receptacle, electrical		
J24	131-0391-00			Coax, 50 Ω male		
J25	131-0579-00			Receptacle, electrical, male		
P17	131-0565-00			Receptacle, electrical, male		
P24	131-0582-00			Receptacle, electrical		
				Inductors		
L1[1]						
L15	*108-0420-00			60 nH		
L26	*120-0382-00			14 turns, single		

[1]**Furnished as a unit with Hybrid Osc. Assembly (*155-0003-00).**

Ⓐ

Transistors

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Q5	151-0190-00			Silicon 2N3904
Q35	151-0249-00			Silicon Dual
Q39	151-0188-00			Silicon 2N3906
Q42	151-0190-00			Silicon 2N3904
Q43	151-0190-00			Silicon 2N3904
Q47	151-0164-00			Silicon 2N3702
Q52	151-0190-00			Silicon 2N3904

Resistors

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

R3	311-0668-00	2 kΩ, Var		
R4	315-0102-00	1 kΩ	1/4 W	5%
R6	301-0621-00	620 Ω	1/2 W	5%
R8	317-0082-00	8.2 Ω	1/8 W	5%
R9	317-0100-00	10 Ω	1/8 W	5%
R10	317-0100-00	10 Ω	1/8 W	5%
R11	317-0100-00	10 Ω	1/8 W	5%
R13	317-0510-00	51 Ω	1/8 W	5%
R15	315-0510-00	51 Ω	1/4 W	5%
R16	315-0470-00	47 Ω	1/4 W	5%
R17	317-0101-00	100 Ω	1/8 W	5%
R18	315-0241-00	240 Ω	1/4 W	5%
R19	315-0102-00	1 kΩ	1/4 W	5%
R21	311-0644-00	20 kΩ, Var		
R22	315-0242-00	2.4 kΩ	1/4 W	5%
R23	315-0102-00	1 kΩ	1/4 W	5%
R30	315-0331-00	330 Ω	1/4 W	5%
R32	315-0101-00	100 Ω	1/4 W	5%
R33	315-0103-00	10 kΩ	1/4 W	5%
R35	315-0242-00	2.4 kΩ	1/4 W	5%
R36	315-0122-00	1.2 kΩ	1/4 W	5%
R37	315-0682-00	6.8 kΩ	1/4 W	5%
R38	315-0101-00	100 Ω	1/4 W	5%
R41	315-0101-00	100 Ω	1/4 W	5%
R42	315-0201-00	200 Ω	1/4 W	5%
R43	315-0242-00	2.4 kΩ	1/4 W	5%
R44	315-0392-00	3.9 kΩ	1/4 W	5%
R45	315-0912-00	9.1 kΩ	1/4 W	5%
R46	315-0332-00	3.3 kΩ	1/4 W	5%
R48	311-0622-00	100 Ω, Var		

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
R49	315-0101-00		100 Ω	1/4 W	5%
R50	315-0240-00		24 Ω	1/4 W	5%
R51	315-0221-00		220 Ω	1/4 W	5%
R53	315-0103-00		10 kΩ	1/4 W	5%

Integrated Circuit

	*155-0003-00	Hybrid Osc. Assembly

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

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

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, instrument type or number, serial or model number, and modification number if applicable.

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

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

FIG. 1 EXPLODED

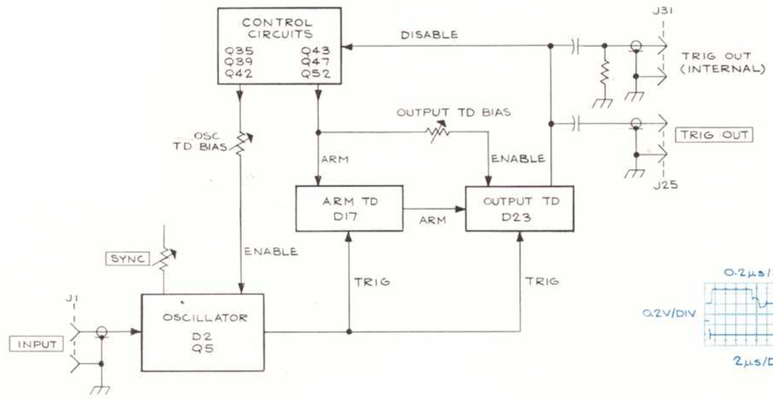
SECTION 7
MECHANICAL PARTS LIST

FIG. 1 EXPLODED

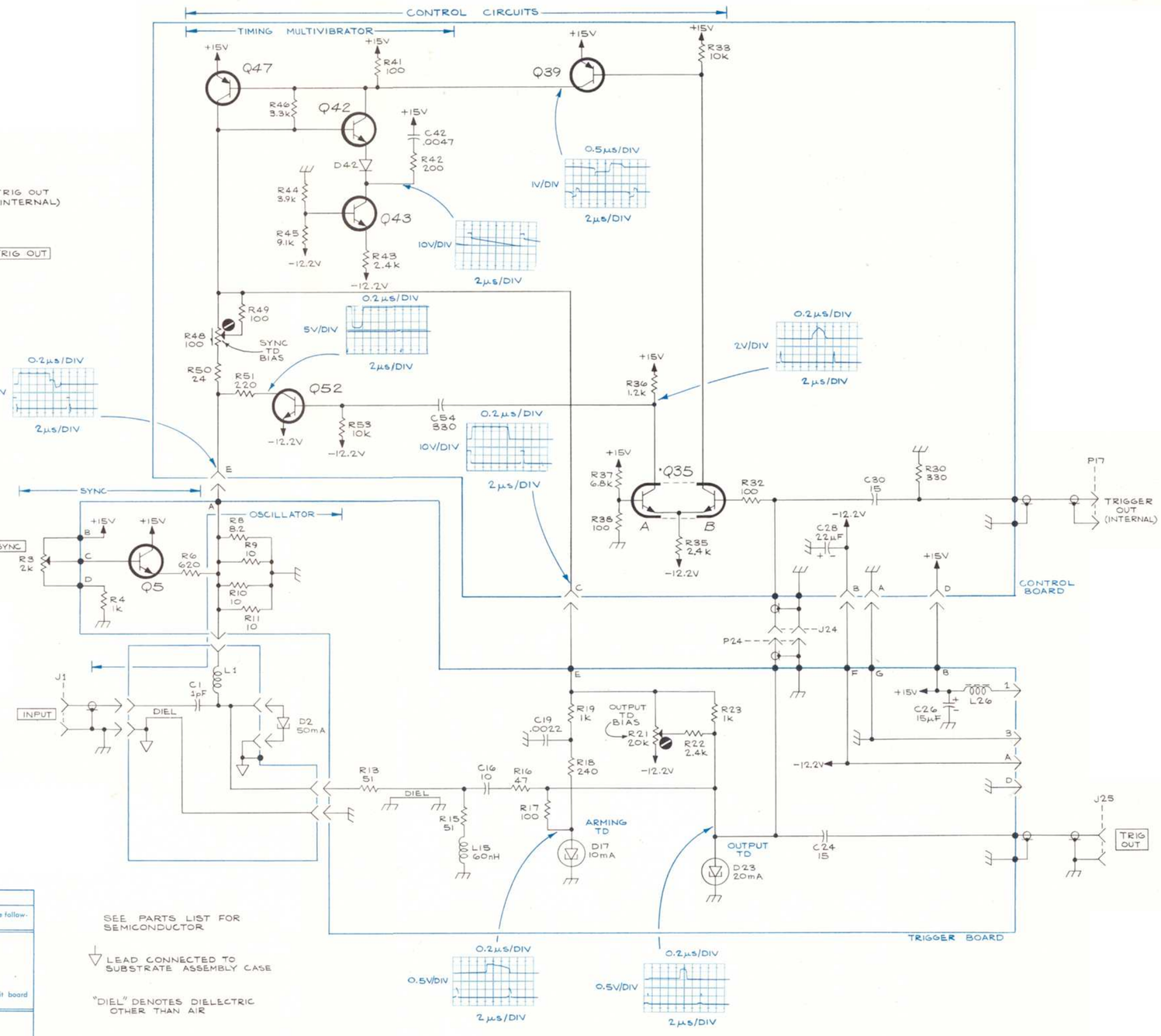
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-1	333-1098-00			1		PANEL, front
-2	386-1338-09			1		SUBPANEL, front
	670-1008-00			1		ASSEMBLY, circuit board—TRIGGER
	- - - - - -			-		assembly includes:
-3	388-1046-00			1		BOARD, circuit
-4	136-0252-01			3		SOCKET, pin connection
-5	214-1081-00			4		PIN, spiral
-6	131-0591-00			5		TERMINAL, pin, 0.835 inch long
-7	131-0582-00			1		CONNECTOR, standoff female
-8	220-0531-00			1		NUT, hex., 1/4-36 x 0.375 inch
-9	131-0631-00			1		CONNECTOR, single contact
-10	214-1072-00			1		SPRING, helical compression, 0.031 OD x 0.094 inch
-11	131-0632-00			1		CONTACT, electrical
-12	155-0003-00			1		ASSEMBLY, hybrid osc. (U1)
	- - - - - -			-		mounting hardware: (not included w/assembly)
	211-0092-00			4		SCREW, 2-56 x 3/16 inch, socket cap, black
-13	152-0041-00			1		HOLDER, diode assembly (D2)
-14	384-0687-00			1		SHAFT, extension, latch
-15	105-0066-00			1		STRIKE, latch
-16	175-1037-00			1		CABLE, w/connector
	- - - - - -			-		cable includes:
	131-0579-00			1		CONNECTOR, coaxial, miniature bayonet w/hardware
-17	366-1064-00			1		KNOB, gray—SYNC
-18	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-19	210-0046-00			1		LOCKWASHER, internal, 0.261 ID x 0.400 inch OD
-20	210-0583-00			2		NUT, hex., 1/4-32 x 5/16 inch
	670-1007-00			1		ASSEMBLY, circuit board—CONTROL
	- - - - - -			-		assembly includes:
-21	388-1045-00			1		BOARD, circuit
-22	131-0391-00			1		CONNECTOR, standoff male
-23	136-0252-01			21		SOCKET, pin connection
-24	136-0263-01			5		SOCKET, connector pin
-25	175-1036-01			1		ASSEMBLY, cable, w/connector and holder
-26	380-0125-00			1		HOUSING
	- - - - - -			-		housing includes:
-27	131-0555-00			4		CONTACT
-28	386-1337-05			1		PANEL, rear
	- - - - - -			-		mounting hardware: (not included w/panel)
-29	211-0141-00			4		SCREW, machine, 4-40 x 3 1/4 inch, PHS

FIG. 1 EXPLODED *(cont)*

Fig. & Index No.	Part No. Tektronix	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description
						STANDARD ACCESSORIES
	070-0898-00			1		MANUAL, instruction (not shown)
						OPTIONAL ACCESSORIES
	015-1001-00			1		ATTENUATOR, fixed, 2X, 3 mm male to female
	015-1002-00			1		ATTENUATOR, fixed, 5X 3 mm male to female
	015-1003-00			1		ATTENUATOR, fixed, 10X, 3 mm male to female
	015-1004-00			1		TERMINATION, coaxial, 50 ohm, 3 mm male to female
	015-1005-00			1		CABLE ASSEMBLY, rf, 2 nsec, 3 mm male to female
	015-1006-00			1		CABLE ASSEMBLY, rf, 5 nsec, 3 mm male to female
	015-1007-00			1		ADAPTER, connector, 3 mm male to GR
	015-1008-00			1		ADAPTER, connector, 3 mm female to GR
	015-1009-00			1		ADAPTER, connector, 3 mm male to N
	015-1010-00			1		ADAPTER, connector, 3 mm to 7 mm
	015-1011-00			1		ADAPTER, connector, 3 mm male to male
	015-1012-00			1		ADAPTER, connector, 3 mm female to female



BLOCK DIAGRAM



WAVEFORM TEST CONDITIONS	
Waveform photographs (shown in blue) were obtained under the following conditions:	
Test Oscilloscope	
Type	545B
Bandwidth with Type 1A1 Vertical Plug-In Unit	DC to 33 MHz
Probe Input R and C	10 MΩ, 10 pF
Probe Ground Lead	Clipped to etched circuit board ground
Type S-51	
SYNC Control Position	Midrange
External Connections	Sampling Head Extender only (for power).

SEE PARTS LIST FOR SEMICONDUCTOR

▽ LEAD CONNECTED TO SUBSTRATE ASSEMBLY CASE

"DIEL" DENOTES DIELECTRIC OTHER THAN AIR

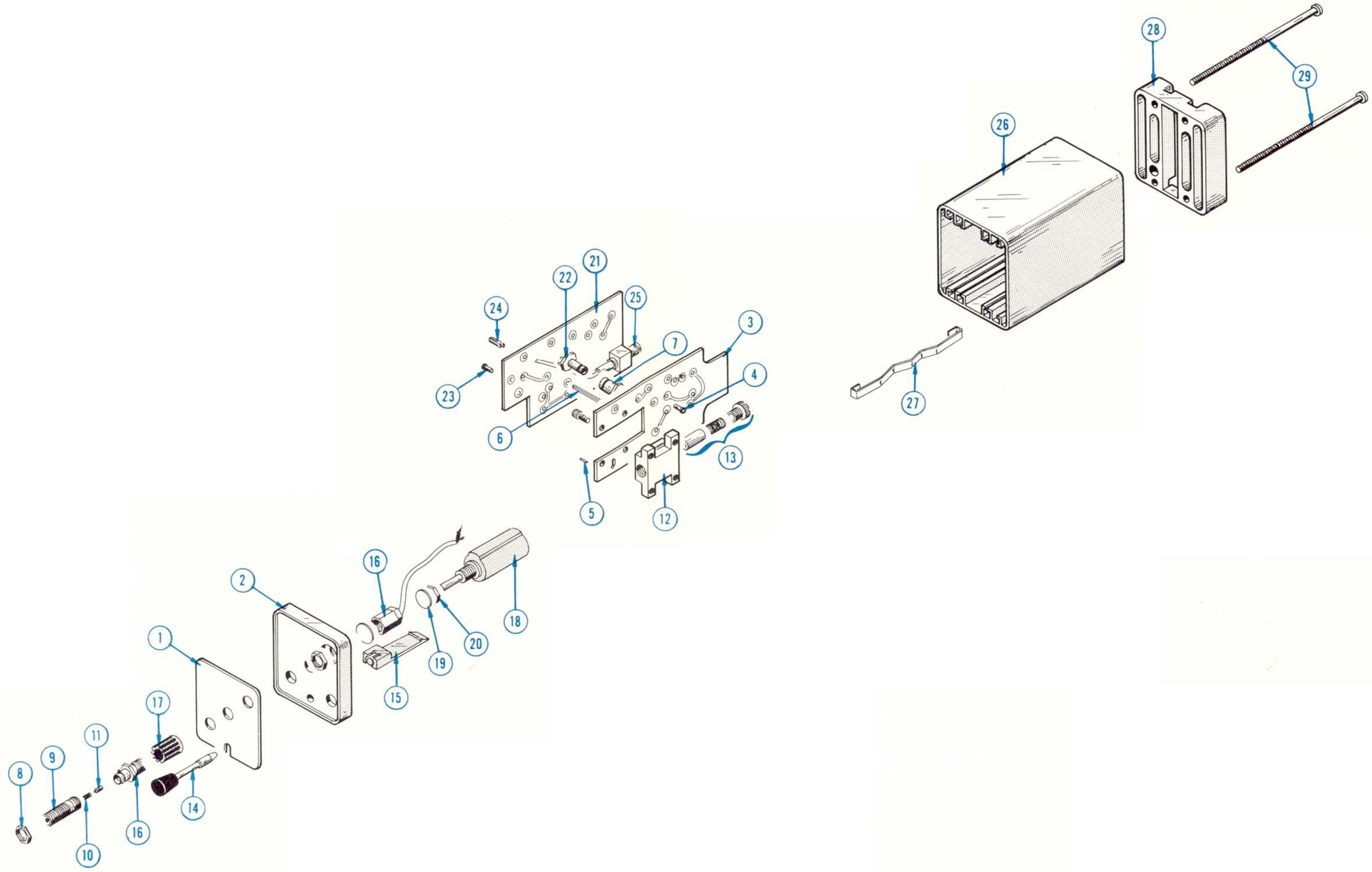
TYPE S-51

A

1168

TRIGGER COUNTDOWN HEAD

FIG. 1 EXPLODED



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.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

TYPE S-51

General Information

This insert describes a change to the specification of the TRIG OUT (Internal and External) Pulse.

TEXT CORRECTION

Section 1

Page 1-1 second column

CHANGE: line 1 to read: Trigger Pulse Duration ≥ 1 ns <u>at +100 mV</u>.

Section 5

Page 5-3 first column

CHANGE: last line of step 5 to read: Pulse duration <u>is ≥ 1 ns at +100 mV</u>.

Page 5-5 second column

CHANGE: second line of step 5 Requirement to read:

pulse duration is ≥ 1 ns at <u>+100 mV</u>.

CHANGE: first sentence of part d to read:

Check for a pulse duration ≥ 1 ns at <u>+100 mV, as shown in Fig. 5-5</u>.

Page 5-6 first column

CHANGE: second line of step 6 Requirement to read:

pulse duration is ≥ 1 ns at <u>+100 mV</u>.

CHANGE: first sentence of step 6(c) to read:

Check for a pulse duration ≥ 1 ns at <u>+100 mV</u>. <u>If the pulse duration is less than 1 ns, check C30</u>.

Page 5-5 Fig.5-5

REPLACE: the existing Fig. 5-5 with the Figure below:

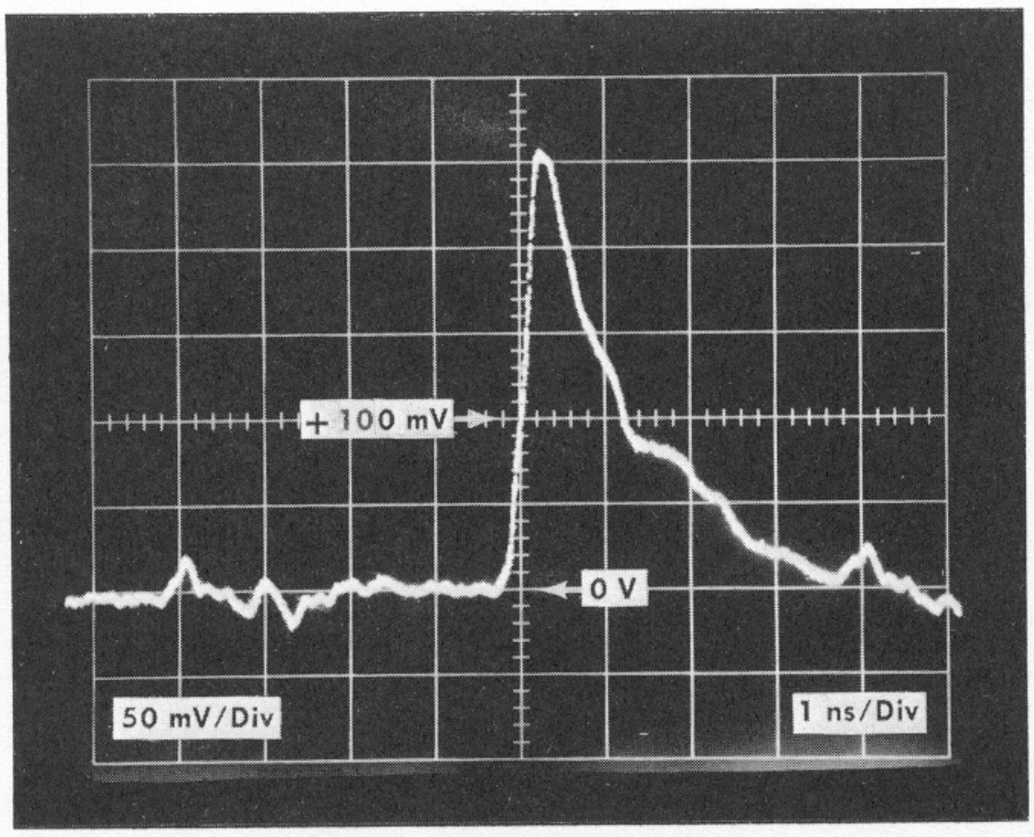


Fig. 5-5. Trigger output pulse amplitude and duration measurement.

INSTRUCTION MANUAL

Serial Number _____

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TYPE 285 POWER SUPPLY

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0903-00

1168

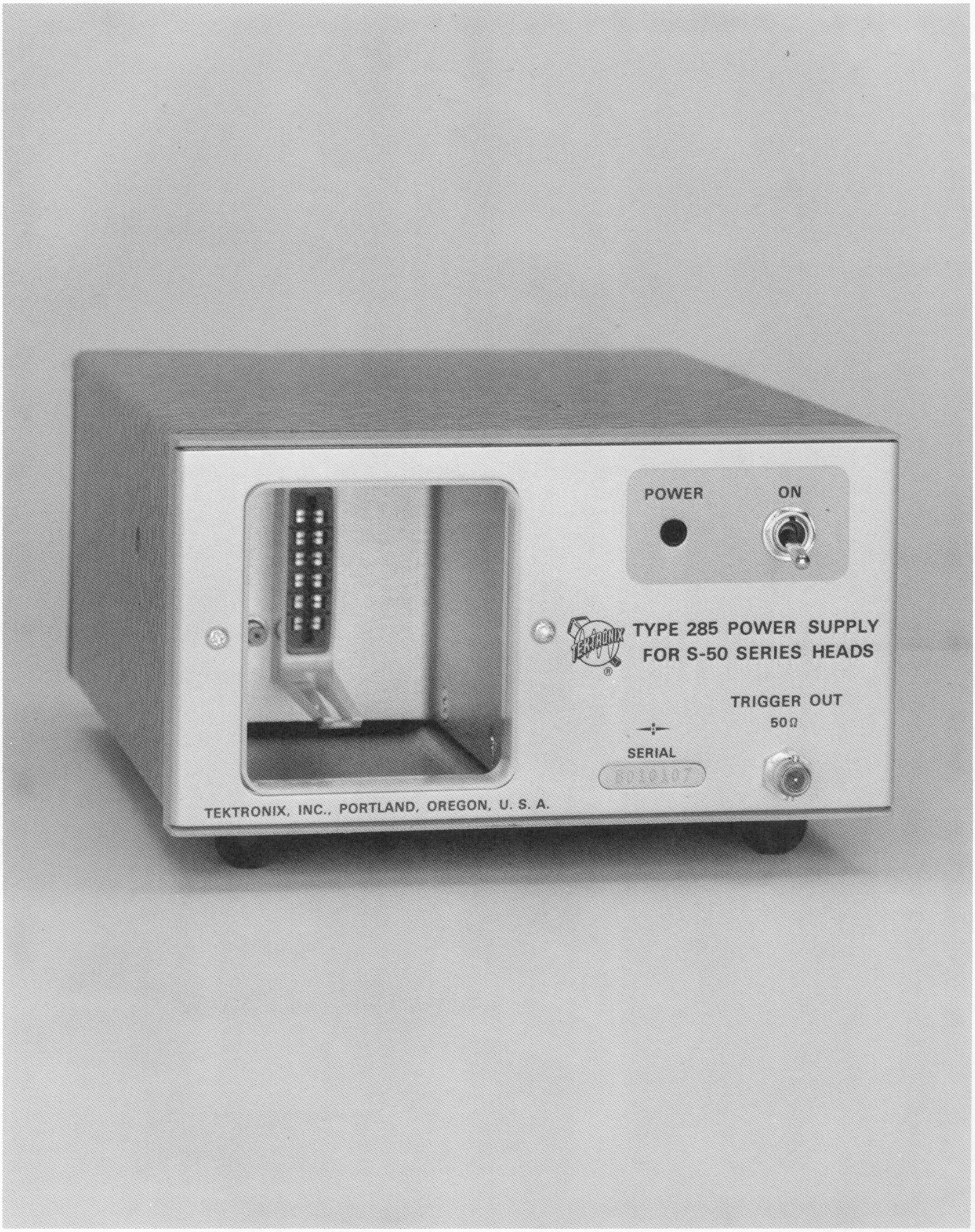


Fig. 1-1. Type 285 Power Supply for S-50 Series Heads.

SECTION 1
TYPE 285 SPECIFICATION

General Information

The Type 285 Power Supply for S-50 Series Heads contains the regulated power supplies for operation of either the Type S-50 Pulse Generator Head or the Type S-51 Trigger Countdown Head. It provides a front panel trigger output jack for the internal trigger pulse of any S-50 series head.

Characteristics

The following characteristics apply over an ambient temperature range of 0° C to +50° C and after a five-minute warmup, provided the instrument has been calibrated at a temperature between +20° C and +30° C.

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement
Output Voltage	+15 V within 1% and -12.2 V within 2%
Maximum Output Current	100 mA from each supply
Ripple	1 mV or less
Line Voltage Range 115 V 230 V	Grounded Neutral Distribution System 90 VAC to 136 VAC 180 VAC to 272 VAC
Line Frequency	50 Hz to 400 Hz

Fuse Data

115 V	1/8 A Slo Blow
230 V	1/16 A Slo Blow

ENVIRONMENTAL CHARACTERISTICS

Storage	Operating
Temperature-- -40° C to +65°C	Temperature-- As stated above in the Electrical Characteristics table.
Altitude-- To 50,000 feet	Altitude-- to 15,000 feet

MECHANICAL CHARACTERISTICS

Dimensions-- Height 3 1/8 inches
Width 5 inches
Length 8 inches

Approximate dimensions include switch and cord holders.

Construction-- Aluminum allow chassis with epoxy laminated circuit boards. Both circuit boards are removable without using a soldering iron. The front panel is anodized aluminum. The textured aluminum cover has blue vinyl paint.

Accessories--- Standard accessories supplied with the Type 285 are listed in the Mechanical Parts List.

SECTION 2
OPERATING INSTRUCTIONS

General Information

The Type 285 Power Supply for S-50 Series Heads is intended for use with special heads such as the Type S-50 Pulse Generator Head or the Type S-51 Trigger Countdown Head. The Type 285 provides the regulated supply voltage requirements of one Type S-50 series head.

Regulated voltages are delivered to the S-50 series head through connector J40 at the rear of the plug-in compartment. A coaxial connector, J17, is also located at the rear of the plug-in compartment. A coaxial cable within the Type 285 connects J17 to the TRIGGER OUT connector (J45), on the Type 285 front panel. The signal available at the TRIGGER OUT connector depends on the type of S-50 series head plugged into the Type 285. See the instruction manual for your S-50 series head for further information.

Operating Information

A line voltage Selector switch on the Type 285 rear panel permits operation from 115 VAC or 230 VAC. Be sure the switch is set to the position corresponding to the line voltage to be utilized, and connect the Type 285 power cord to the AC line.

The S-50 series head is plugged into the compartment provided in the Type 285 front panel. To insert a S-50 series head, slide the unit completely into the compartment in the Type 285, leaving the latch at the bottom of the unit free to move. Push the latch knob to lock the S-50 series head in place. To remove the head, pull the latch knob away from the panel. See Fig. 2-1.

A toggle switch on the front panel of the Type 285 turns the instrument on or off. A POWER indicator lights when the POWER switch is on and the instrument is connected to the line voltage.

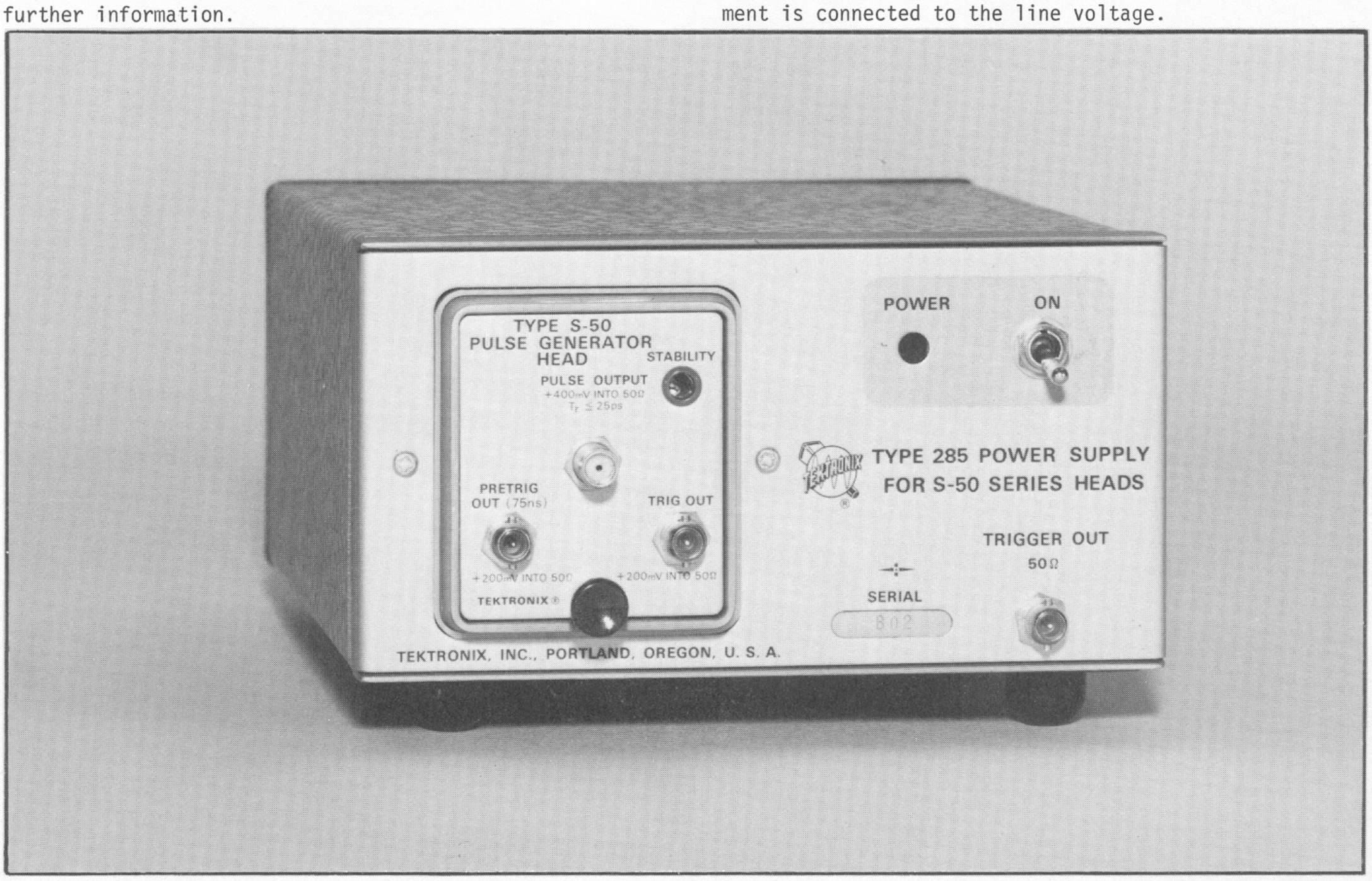


Fig. 2-1. S-50 series head installed in the Type 285.

SECTION 3
CIRCUIT DESCRIPTION

The Type 285 Power Supply develops regulated voltages of -12.2 V and +15 V for the Type S-50 series head. The Type 285 Power Supply operates from a 115 VAC or 230 VAC power source. Switch SW2 must be placed in the 115 V position if the power source is 115 VAC. The primary windings of transformer T2 are connected in parallel and fuse F1 protects the Type 285 Power Supply in case of overload. If the power source is 230 VAC, place switch SW2 in the 230 V position. The primary windings of transformer T2 are connected in series. Fuse F2 is connected in series with F1, and F2 is the controlling fuse. A POWER indicator light is connected across the secondary winding of the -12.2 V Power Supply. POWER switch SW1 connects both sides of the power line to the Type 285 Power Supply.

The +15 V Power Supply is composed of transformer T2 secondary winding (terminals 5 and 6 on the transformer), full wave bridge rectifier D20, filter capacitor C20, error signal amplifier Q24, inverter amplifier Q33 and series regulator Q35.

The regulator action is as follows: (Assuming a positive-going change in output voltage.) Q24A is biased at +9 V by Zener diode D22. Q24B base is biased by the voltage divider network R29, R30 and R31. R30 sets the Power Supply output to +15 V. The error signal is applied to Q24B base through the voltage divider R29, R30, and R31. (C29 couples fast-rise signals to Q24B base for greater output from Q24B.) Emitter follower Q24B drives Q24A emitter. The in-phase error output signal at the junction of R26 and R27 drives Q33 base. Q33 inverts and amplifies the signal to drive Q35, which serves as a variable resistor in series with the load. The signal to Q35 reverse biases the transistor to decrease the current through it and the load. The decreased current through the load lowers the load voltage to the desired value.

Turning on the Type 285 with the load connected, at first most of the supply voltage appears across Q35 which is cut off (it has very high resistance); Therefore, the output voltage is about zero volts. Q16 in the -12.2 V Power Supply is also turned off since that supply does not have the +15 V necessary for proper operation. Network R36, R37, R38 and D37 applies forward bias and turns on Q35. With about zero volts feeding R37, (instead of the normal operating voltage of -12.2 V), approximately -27 volts at the junction of R37-R38, D37 is biased into conduction. The resulting voltage drop across R36 forward biases Q35 into conduction and the +15 volt Power Supply output rises to +15 V at which time the -12.2 V Power Supply operates properly and D37 is reversed biased (cut off).

Components not described above provide the following functions: C22 helps to stabilize Q24A base voltage for high frequency signals and to reduce the noise generated by D22. R26 is a parasitic suppressor. D33 provides temperature compensation for Q33. C39 reduces the high frequency output impedance of the supply.

The -12.2 V Power Supply is composed of transformer T2 secondary winding (terminals 7 and 8 on the transformer), full wave bridge rectifier D4, filter capacitor C4, error signal amplifier Q6, emitter follower Q12 and series regulator Q16.

The regulator action is as follows: (Assume a negative change in output voltage). Q6B base is biased by the voltage divider R10 and R11. R10 is connected to the +15 V reference voltage. The error signal is applied to Q6B by voltage divider R10 and R11. (C11 couples fast rise signals to Q6B base for greater output from Q6B.) Emitter follower Q6B drives Q6A emitter. The in-phase error output signal at the collector of Q6A drives emitter follower Q12. In-phase output from Q12 emitter drives Q16, which serves as a variable resistor in series with the load. The negative-going signal at Q16 base reverse biases the transistor to decrease the current through it and the load. The decreased current through the load raises the voltage back to -12.2 V.

R12 is transistor Q12's dissipation limiting resistor. C18 reduces the high frequency output impedance of the supply.

SECTION 4
MAINTENANCE

Removal of the Case

Remove the screws holding the power cord holders and the case will slide off at the rear of the Type 285.

Parts Removal and Replacement

Whenever a part is replaced, check and adjust the power supplies as necessary; see the Calibration section. Most parts in the Type 285 can be replaced without detailed instructions. Parts ordering information is included immediately preceding the Electrical Parts List section.

CAUTION

Disconnect the power cord before removing fuses or other components.

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 may be found by making in-circuit voltage checks, or by substitution. The location of all transistors is silk-screened on the circuit board next to the socket or on the chassis for the rear-panel mounted power transistors.

To check transistors using a voltmeter, measure the emitter-to-base and emitter-to-collector voltages and determine whether the voltages are consistent with the normal resistances and currents in the circuit (see Fig. 4-1). Note the lead configuration in Fig. 4-2.

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. If a transistor is substituted without first checking out the circuit, the new transistor may immediately be damaged by some defect in the circuit.

Parts Replacement. The replacement of parts soldered to the circuit boards is as follows:

1. Clip the leads of the component to be replaced.
2. Remove the component from the circuit board.
3. Remove the clipped leads individually from the circuit board.

The tip of the soldering iron should be of copper with a chisel or bevel shape. To obtain a low working-tip temperature, consider the following:

1. At slow soldering speeds, a 25-watt iron and 1/8 inch tip.
2. At medium soldering speeds, a 4-watt iron and a 3/16 inch tip.
3. At fast soldering speeds, a 50- or 60-watt iron and a 1/4 inch tip.

Install the new part, with leads bent to fit the holes and clipped so they will just protrude through the board, and apply heat and solder for a firm solder joint.

The best type of solder for use on the Tektronix circuit boards is a "eutectic"-type cored-wire solder of size #20 AWG, composed of 63% tin and 37% lead with a central core of activated rosin flux.

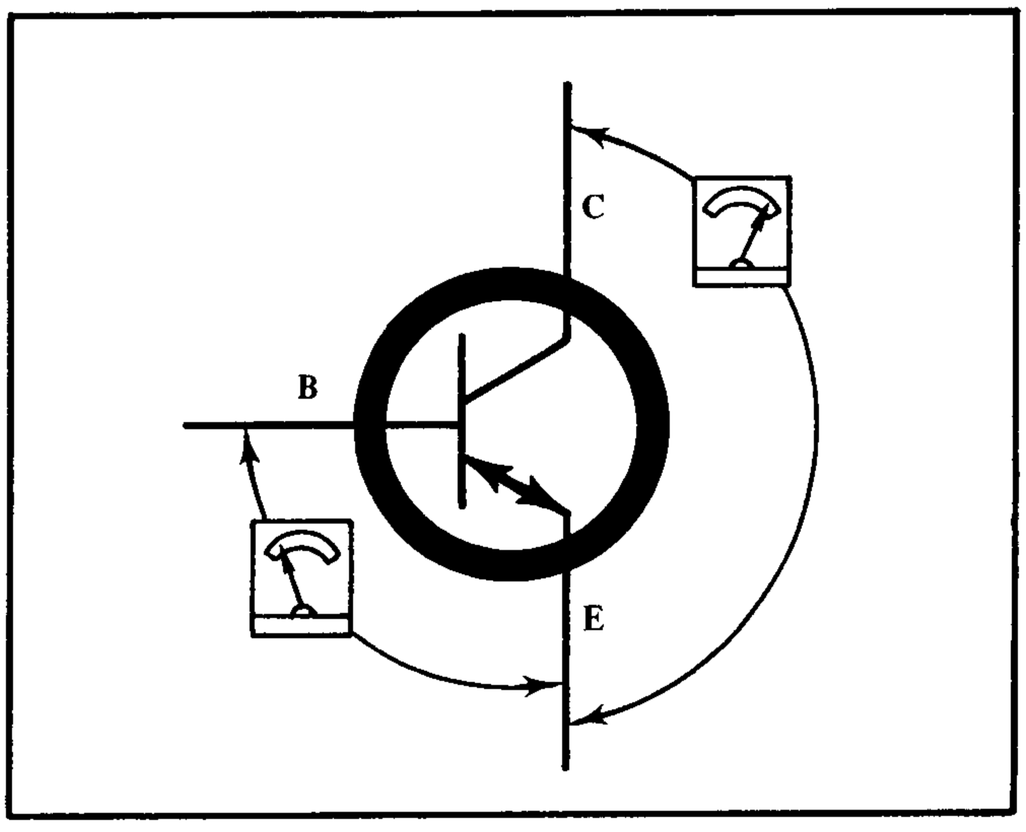


Fig. 4-1. In-circuit voltage checks NPN or PNP transistors.

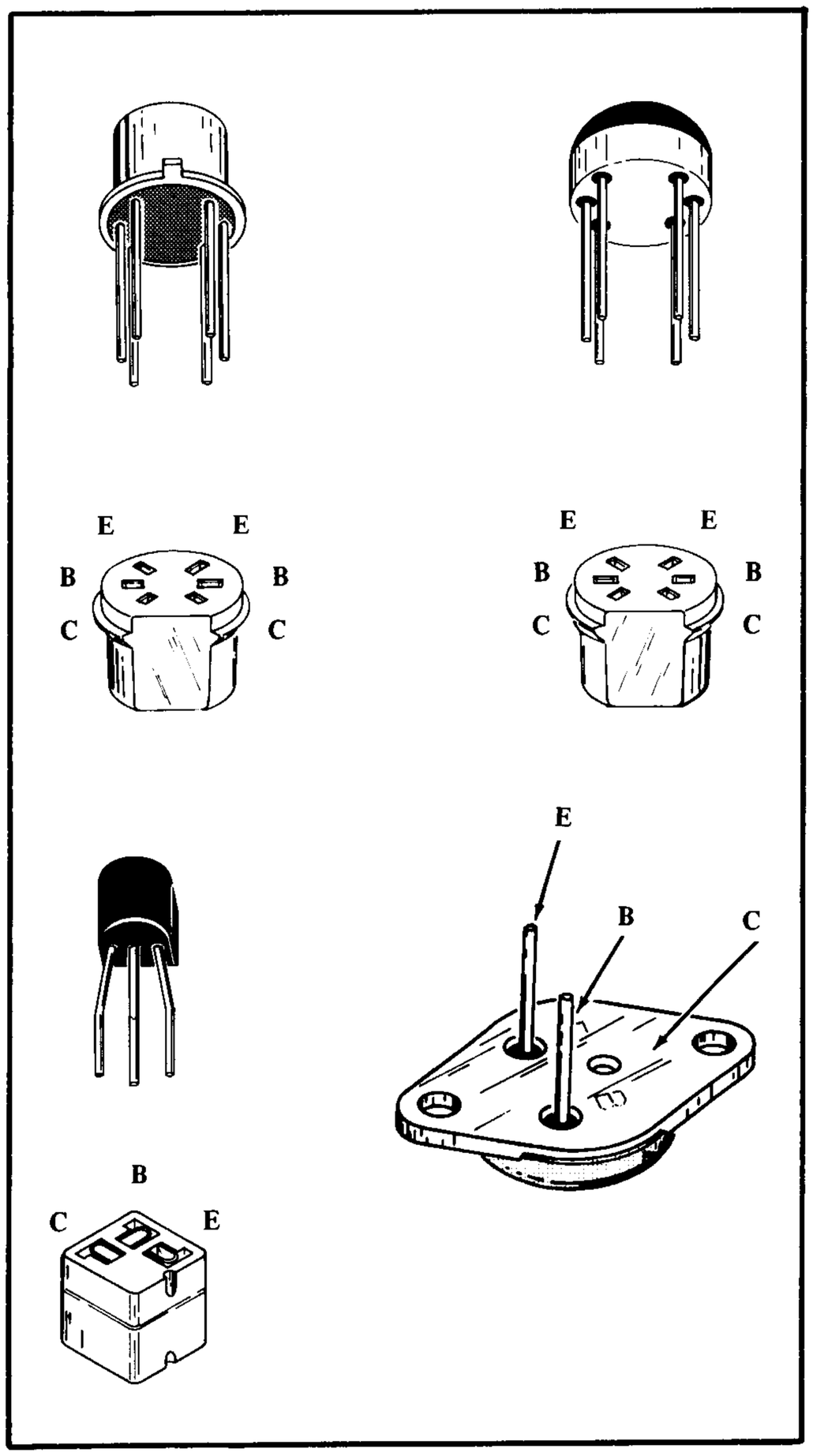


Fig. 4-2. Lead configuration of transistors in the Type 285.

Circuit Board Replacement. If a circuit board is damaged and cannot be repaired, the entire board, including all soldered-on components, should be replaced. The part number given in the Mechanical Parts List is for the completely wired board.

Both circuit boards, which are mounted back to back with plastic spacer separation, are secured by 2 chassis mounting screws. Loosen the mounting screws and lift both circuit boards from the chassis. Separate the boards by gently pulling the +15 V Regulator board upward from the -12.2 V Regulator board. Color-coded wires are removed from the pins by pulling straight off with long-nosed pliers. The sequence of wires on the -12.2 V Regulator board is listed in Table 4-1.

Table 4-1

Pin A	Red on White
Pin B	Green on White
Pin C	Blue on White
Pin D	Grey on White (2)
Pin E	Violet on White (2)
Pin F	White
Pin G	Yellow on White
Pin H	Orange on White
Pin I	Black on White
Pin J	Brown, Red, Black on White
Pin K	Green, Green, Black on White

To attach the +15 V Regulator board to the -12.2 V Regulator board, align the pins and the mounting screws before easing the board into position. Install the circuit boards and tighten the mounting screws.

Parts Locations

All components mounted on circuit boards are identified by circuit numbers and shown in the photographs included in the remainder of this section.

Case Replacement

Align the case so the side adjustment hole will be on the left of the 285, by the head opening, and the feet on the bottom. Slide the case on the Type 285 and attach the cord holders with the mounting screws.

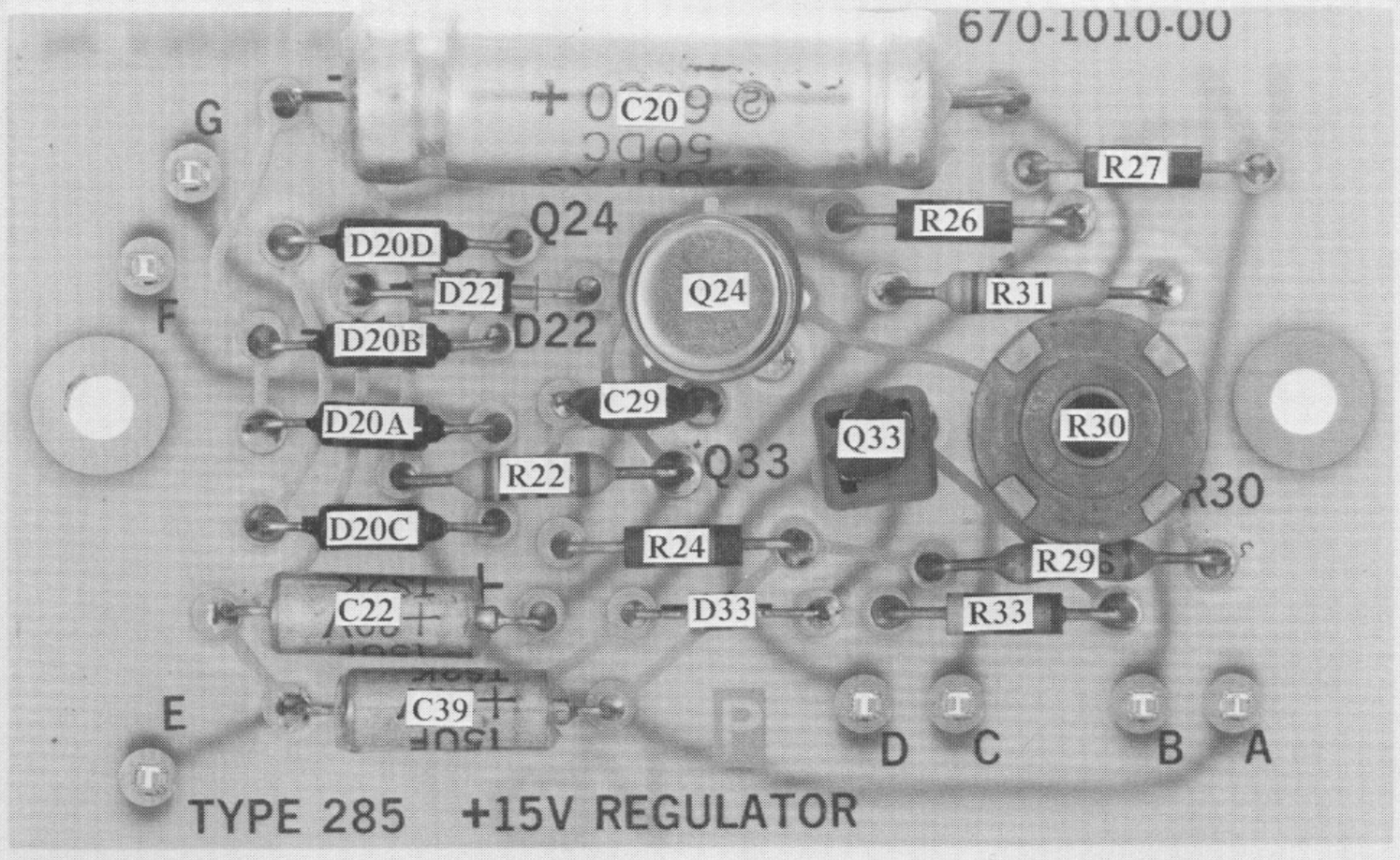


Fig. 4-3. +15 V Regulator circuit board.

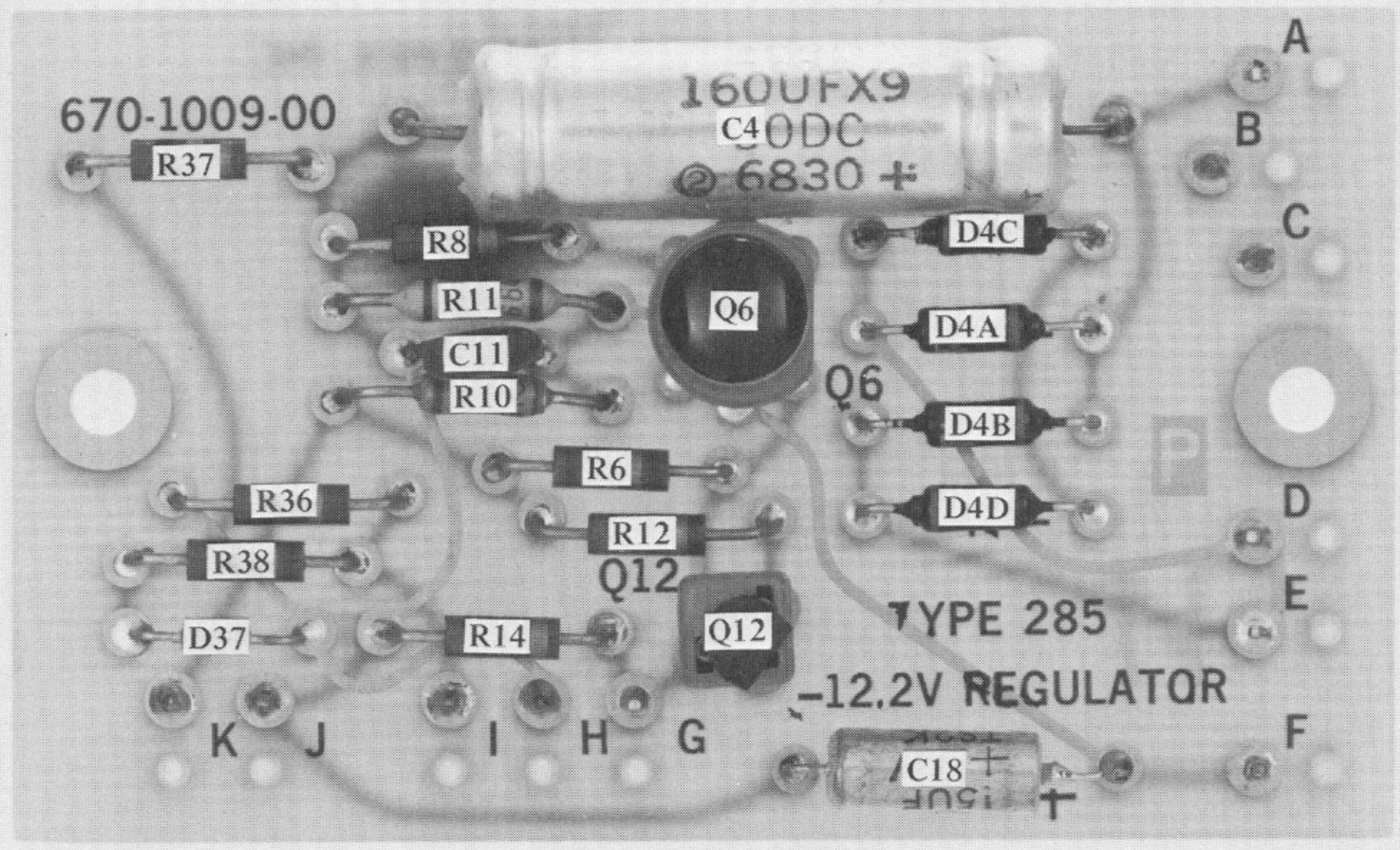


Fig. 4-4. −12.2 V Regulator circuit board.

SECTION 5
PERFORMANCE CHECK/CALIBRATION

Introduction

This section of the manual contains a procedure for checking and calibrating the power supplies of the Type 285. The instrument will not require frequent calibration, but occasional adjustments will be necessary as components age or are replaced.

Equipment Required

The following equipment or its equivalent is required for calibration of the Type 285.

1. Autotransformer with output voltage variable between 90 and 136 VAC (or 180 to 272 VAC) and a minimum rating of 25 watts. If the autotransformer does not have an AC voltmeter to indicate output voltege, monitor its output with an RMS reading voltmeter with a range of at least 150 (300) volts. For example, General Radio W10MT3W Metered Variac Autotransformer.

2. Oscilloscope, maximum deflection factor of 1 mV/div and comparison voltage for measurement of +15 V and -12.2 V within 0.2%. Tektronix Type W Plug-In Unit with Type 545B Oscilloscope (540 series) or Tektronix Type 3A7 Differential Comparator with Type 3B4 Time Base Unit and Type 561A Oscilloscope (560-Series) meet these requirements.

3. 1X probe, Tektronix P6028. Tektronix Part No. 010-0074-00.

4. If a Type W plug-In Unit is not available, a precision voltmeter is needed that can measure up to +15 or -12.2 V with an accuracy of ±0.2%. John Fluke Model 801B meets the requirements.

5. Test loads for power supplies:

+15 V supply; a 150 Ω, 2 watt, composition resistor, 10% tolerance, Tektronix Part No. 306-0151-00.

-12.2 V supply; a 120 Ω, 2 watt, composition resistor, 10% tolerance, Tektronix Part No. 306-0121-00.

6. Four clips, Mueller #30 miniature, to be attached to the test load resistors. Tektronix Part No. 344-0024-00.

PRELIMINARY INSTRUCTIONS

1. Disconnect the power cord. Remove the case of the Type 285 by removing the power cord holder screws and sliding the case off to the rear.

2. Connect the 120 Ω resistor between pin A of J40 and ground. Connect the 150 Ω resistor between pin 1, opposite pin A, and ground.

3. Connect the Type 285 power cord to the output of the variable autotransformer.

4. Turn on the instrument power and adjust the autotransformer for an output of 115 volts as determined by the LINE VOLTAGE SELECTOR, located on the rear panel.

5. Turn on the oscilloscope. Allow 15 minutes for warmup and stabilization.

6. Set the oscilloscope and Type W controls as follows:

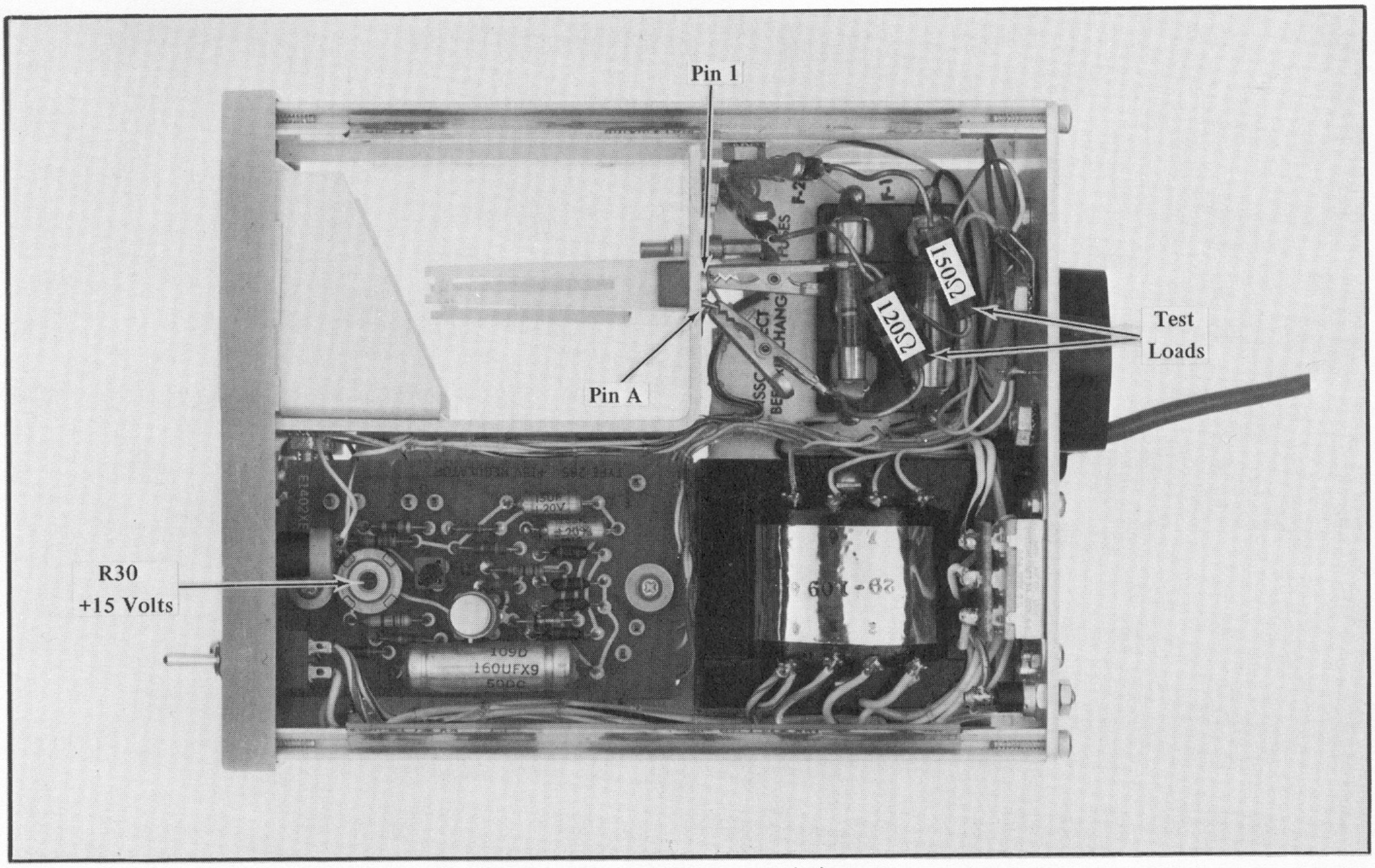


Fig. 5-1. Locations of test points and adjustment.

Oscilloscope	
Triggering	Int, +, AC
Stability	Fully clockwise
Time/cm	1 ms

Type W	
Vc Range	0
Comparison Voltage	1500
AC DC GND	GND
Input Atten	10
Display	A-Vc
Millivolts/cm	5
Variable	Calib

PROCEDURE

1. Check or Adjust Power Supplies

a. Set the oscilloscope trace at the graticule center line. Connect the 1X probe to pin 1 at the 150 Ω resistor in the Type 285. Fig. 5-1 shows the locations of test points and the adjustment.

b. Set the AC DC GND switch to DC and the Vc Range switch to +11.

c. Check that the trace is at the center line with a comparison Voltage setting between 1515 and 1485 (15 volts ±1%).

d. If the Comparison Voltage is not between 1515 and 1485, adjust R30, the +15 volts control, until the trace is at the graticule center line with Comparison Voltage set at 1500.

e. Change the autotransformer output voltage from 90 volts to 136 volts and check that the +15 V supply remains within the 1% tolerance.

f. Set the autotransformer output voltage to 115 volts. Set the Vc Range switch to 0 and the AC DC GND switch to GND. Connect the 1X probe to pin A at the 120 Ω resistor. Set the trace at the center line.

g. Set the Comparison voltage to 1220. Change the AC DC GND switch to DC and the Vc Range switch to -11.

h. Check that the trace is at the center line with a comparison Voltage setting between 124B and 1196 (12.2 volts ±2%).

i. Change the autotransformer output voltage from 90 volts to 136 volts and check that the -12.2 volt supply remains within the 2% tolerance.

2. Check Ripple

a. Set the Vc Range switch to 0 and the AC DC GND switch to AC. Set the Input Atten switch to 1 and the Millivolts/cm switch to 1.

b. Set the oscilloscope Time/cm switch to 5, the Triggering switch to Auto and the Trigger Slope switch to + line.

c. Change the autotransformer output voltage from 90 volts to 136 volts and check that the ripple as observed on the oscilloscope does not exceed 1 mV (1 division); see Fig. 5-2. Measure from trace bottom at a low point to trace bottom at a high point.

d. Connect the 1X probe to pin 1 at the 150 Ω resistor.

e. Change the autotransformer output voltage from 90 volts to 136 volts and check that the ripple does not exceed 1 mV (1 division).

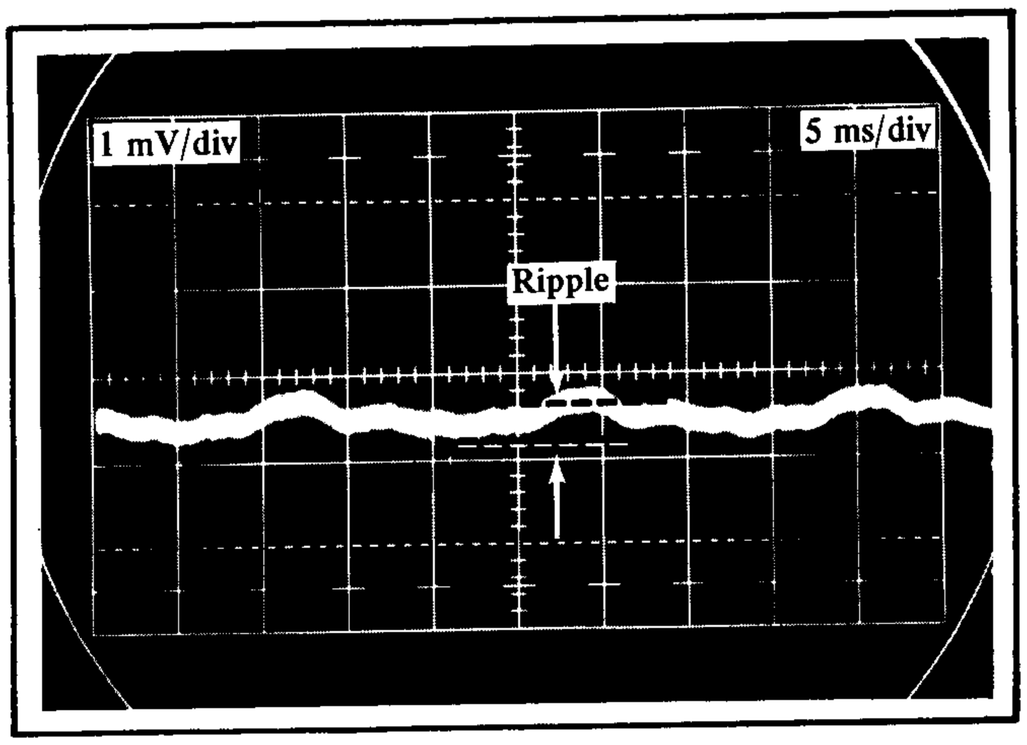


Fig. 5-2. Typical display of ripple.

f. Turn the Type 285 Power Off and disconnect the power cord from the autotransformer.

3. Check 230—Volt Operation

a. Set the LINE VOLTAGE SELECTOR switch on the rear panel to 230 V.

b. Connect the Type 285 power cord to a 230 V source and set the Type 285 Power On.

c. Check the +15 volt and -12.2 volt supplies, pin 1, and pin A of J40, as described in step 1. Tolerance on the +15 volt supply is 1% and on the -12.2 volt supply tolerance is 2%. The autotransformer range for checking the regulation is 180 through 272 volts.

NOTES

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
			Bulb			
B3	150-0088-00			Incandescent 2187D		
			Capacitors			
Tolerance ±20% unless otherwise indicated.						
C4	290-0394-00			160 µF	Elect.	50 V 10%
C11	283-0032-00			470 pF	Cer	500 V 5%
C18	290-0135-00			15 µF	Elect.	20 V
C20	290-0394-00			160 µF	Elect.	50 V 10%
C22	290-0135-00			15 µF	Elect.	20 V
C29	283-0065-00			0.001 µF	Cer	100 V 5%
C39	290-0135-00			15 µF	Elect.	20 V
			Semiconductor Device, Diodes			
D4 A,B,C,D (4)	*152-0107-00			Silicon	Replaceable by 1N647	
D20 A,B,C,D (4)	*152-0107-00			Silicon	Replaceable by 1N647	
D22	152-0212-00			Zener	1N936 9 V, 5%, TC	
D33	152-0141-02			Silicon	1N4152	
D37	152-0141-02			Silicon	1N4152	
			Fuses			
F1	159-0063-00			1/8 A	3AG Slo-Blo	
F2	159-0051-00			1/16 A	Slo-Blo	
			Connectors			
J17[1]						
J40	131-0581-00			12 Pin, Female		
J45[1]						
			Transistors			
Q6	151-0249-00			Silicon	Dual	
Q12	*151-0192-00			Silicon	Replaceable by MPS-6521	
Q16	*151-0148-00			Silicon	Selected from 40250 (RCA)	
Q24	151-0261-00			Silicon	Dual	
Q33	151-0188-00			Silicon	2N3906	
Q35	*151-0148-00			Silicon	Selected from 40250 (RCA)	

[1] See Mechanical Parts List (*175-1012-00)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
				Resistors		
Resistors are fixed, composition, ±10% unless otherwise indicated.						
R6	315-0183-00	18 kΩ		1/4 W		5%
R8	315-0752-00	7.5 kΩ		1/4 W		5%
R9	315-0224-00	220 kΩ		1/4 W		5%
R10	321-0230-00	2.43 kΩ		1/8 W	Prec	1%
R11	321-0221-00	1.96 kΩ		1/8 W	Prec	1%
R12	315-0182-00	1.8 kΩ		1/4 W		5%
R14	315-0752-00	7.5 kΩ		1/4 W		5%
R22	321-0184-00	806 Ω		1/8 W	Prec	1%
R24	315-0132-00	1.3 kΩ		1/4 W		5%
R26	315-0101-00	100 Ω		1/4 W		5%
R27	315-0622-00	6.2 kΩ		1/4 W		5%
R29	321-0163-00	487 Ω		1/8 W	Prec	1%
R30	311-0442-00	250 Ω, Var				
R31	321-0183-00	787 Ω		1/8 W	Prec	1%
R33	315-0432-00	4.3 kΩ		1/4 W		5%
R36	315-0102-00	1 kΩ		1/4 W		5%
R37	315-0103-00	10 kΩ		1/4 W		5%
R38	315-0102-00	1 kΩ		1/4 W		5%
				Switches		
Wired or Unwired						
SW1	260-0834-00	Toggle		POWER		
SW2	260-0675-00	Slide		115/ V 230 V		
				Transformer		
T2	*120-0581-00	Power				

SECTION 7
MECHANICAL PARTS LIST

FIG. 1 EXPLODED VIEW

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-1	175-1012-00			1	CABLE ASSEMBLY, RF: 50 Ω coaxial, 8.5 inches
	- - - - - -			-	w/snap-on connector 1 end, male BNC opposite
-2	260-0834-00			1	SWITCH, toggle (w/hardware)--ON
	- - - - - -			-	mounting hardware: (not included w/switch)
-3	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
-4	333-1102-01			1	PANEL, front
	- - - - - -			-	mounting hardware: (not included w/panel)
-5	213-0055-00			2	SCREW, 2-32 x 3/16 inch, thread forming, PHS
-6	352-0084-00			1	HOLDER, neon
-7	378-0541-01			1	FILTER, lens, neon
-8	200-0609-00			1	CAP, lamp holder
-9	200-0895-00			1	BEZEL, 2.344 x 1.995 x 0.46 inch, plastic
-10	386-1516-01			1	SUB-PANEL, front
	- - - - - -			-	mounting hardware: (not included w/sub-panel)
-11	213-0192-00			4	SCREW, 6-32 x 1/2 inch, Fil HS
-12	343-0189-00			2	CLAMP, rim clenching
-13	426-0440-00			2	FRAME, side, left & right
-14	255-0249-00			4	CHANNEL, extrusion, 4 1/2 inches, Black Plastic
-15	407-0546-00			1	BRACKET, connector
	- - - - - -			-	mounting hardware: (not included w/bracket)
-16	211-0538-00			4	SCREW, 6-32 x 5/16 inch, 100° csk, FHS
-17	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
-18	407-0545-00			1	BRACKET, support
	- - - - - -			-	mounting hardware: (not included w/bracket)
-19	211-0538-00			2	SCREW, 6-32 x 5/16 inch, 100° csk, FHS
-20	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-21	210-0457-00			3	NUT, keps, 6-32 x 5/16 inch
-22	131-0581-00			1	CONNECTOR, chassis mounting, 12 contact, male
-23	351-0132-00			1	GUIDE, clip
	- - - - - -			-	mounting hardware: (not included w/guide)
-24	213-0082-00			2	SCREW, 4-40 x 1/2 inch, thread forming, PHS

FIG. 1 EXPLODED VIEW (CONT)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
1-25	352-0025-00			1	HOLDER, fuse,dual
	- - - - - -			-	mounting hardware: (not included w/holder)
-26	211-0510-00			2	SCREW, 6-32 x 3/8 inch, PHS
-27	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-28	- - - - - -			1	TRANSFORMER
	- - - - - -			-	mounting hardware: (not included w/transformer)
-29	211-0021-00			2	SCREW, 4-40 x 1 1/4 inches, RHS
-30	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
-31	343-0088-00			1	CLAMP, cable, plastic
-32	441-0808-00			1	CHASSIS, main
	- - - - - -			-	mounting hardware: (not included w/chassis)
-33	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
-34	211-0538-00			2	SCREW, 6-32 x 5/16 inch, 100° csk, FHS
-35	211-0514-00			2	SCREW, 6-32 x 3/4 inch, PHS
-36	386-1457-00			1	PANEL, rear
	- - - - - -			-	mounting hardware: (not included w/panel)
-37	213-0192-00			4	SCREW, 6-32 x 1/2 inch, Fil HS
-38	129-0006-00			1	POST, connecting, insulated
	- - - - - -			-	mounting hardware: (not included w/post)
-39	210-0006-00			1	LOCKWASHER, internal, #6
-40	210-0407-00			1	NUT, hex., 6-32 x 1/4 inch
-41	337-1036-00			1	SHIELD, switch, fiber board
-42	260-0675-00			1	SWITCH, slide--LINE VOLTAGE SELECTOR
	- - - - - -			-	mounting hardware: (not included w/switch)
-43	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-44	211-0097-00			2	SCREW, 4-40 x 5/16 inch, PHS
-45	200-0669-00			1	COVER, transistor
-46	- - - - - -			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)
-47	386-0143-00			1	PLATE, insulator
-48	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
-49	211-0511-00			1	SCREW, 6-32 x 1/2 inch, PHS
-50	210-0811-00			2	WASHER, fiber, #6
-51	210-0202-00			1	LUG, solder, #6
-52	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-53	200-0669-00			1	COVER, transistor
-54	- - - - - -			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)

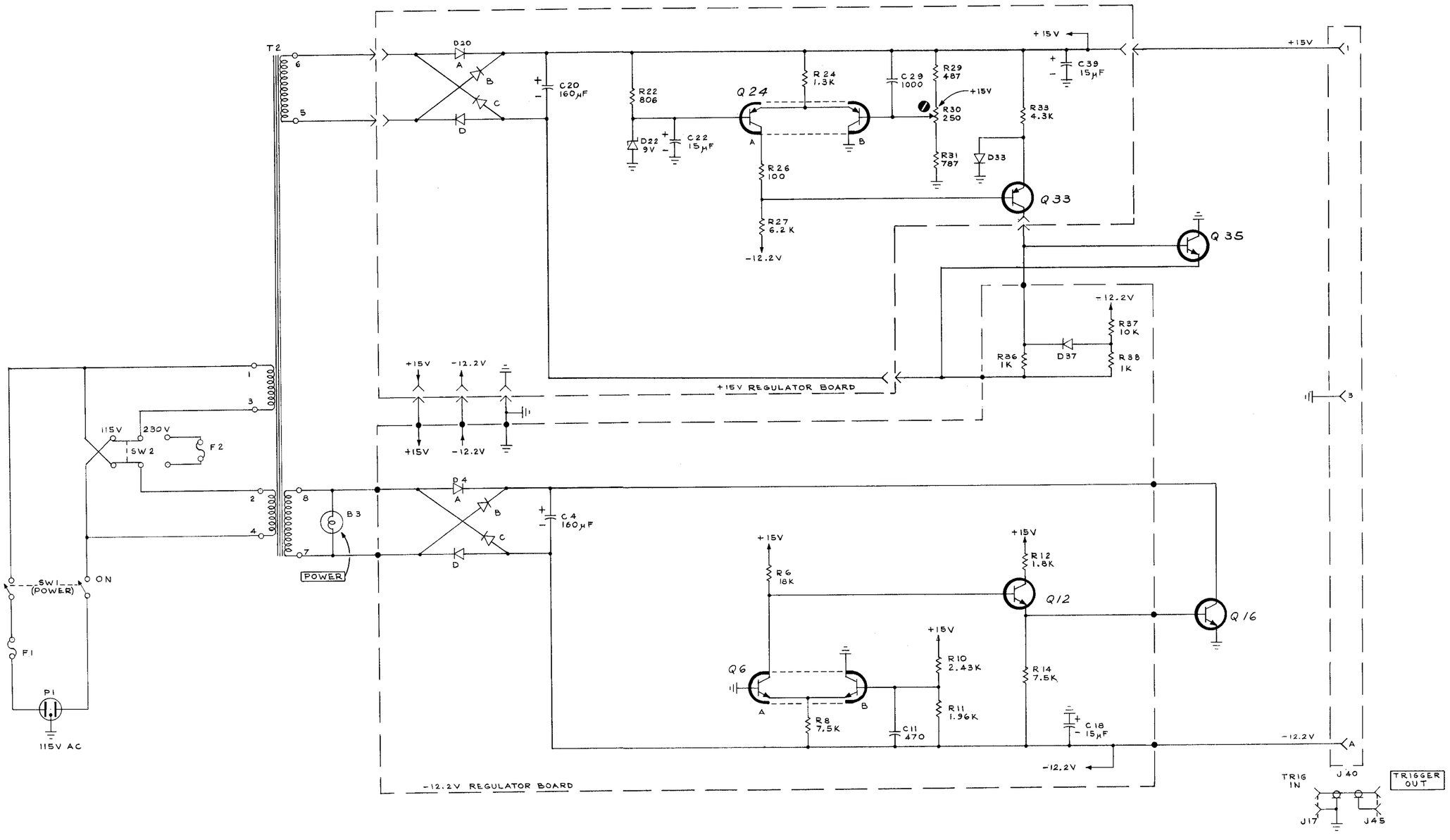
FIG. 1 EXPLODED VIEW (CONT)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
-55	211-0511-00			1	SCREW, 6-32 x 1/2 inch, PHS
-56	210-0202-00			1	LUG, solder, #6
-57	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-58	358-0091-00			1	BUSHING, strain relief
-59	161-0052-00			1	CORD, power, 3 conductor, 8 feet long
	- - - - - -			-	cord includes:
-60	334-1205-00			1	SLEEVE, marker, cable
-61	179-0318-00			1	CABLE HARNESS
	- - - - - -			-	cable harness includes:
-62	131-0512-00			13	CONNECTOR, cable
-63	179-1317-00			1	CABLE HARNESS, power
-64	670-1010-00			1	ASSEMBLY circuit board--+15 V REGULATOR
	- - - - - -			-	assembly includes:
	388-1086-00			1	BOARD, circuit
	- - - - - -			-	board includes:
-65	136-0263-01			7	SOCKET, connector pin
-66	136-0220-00			1	SOCKET, transistor, 3 pin
-67	136-0235-00			1	SOCKET, transistor, 6 pin
-68	670-1009-00			1	ASSEMBLY, circuit board--12.5 V REGULATOR
	- - - - - -			-	assembly includes:
	388-1085-00			1	BOARD, circuit
-69	136-0220-00			1	SOCKET, transistor, 3 pin
-70	136-0235-00			1	SOCKET, transistor, 6 pin
-71	131-0590-00			7	PIN, circuit board terminal
-72	131-0608-00			4	PIN, circuit board terminal
-73	351-0155-00			11	GUIDE, terminal lead
	- - - - - -			-	mounting hardware: (not included w/assembly)
-74	211-0152-00			2	SCREW, 4-40 x 5/8 inch, PHS
-75	361-0212-00			2	SPACER, sleeve, plastic
-76	390-0055-00			1	CABINET, wraparound
-77	348-0138-00			4	FOOT, rubber
	- - - - - -			-	mounting hardware for each: (not included w/foot)
-78	210-0006-00			4	LOCKWASHER, internal, #6
-79	211-0503-00			4	SCREW, 6-32 x 3/16 inch, PHS
-80	386-1458-00			1	PANEL, cabinet, rear
-81	348-0172-00			2	FOOT, cabinet, blue
	- - - - - -			-	mounting hardware for each: (not included w/foot)
-82	211-0514-00			2	SCREW, 6-32 x 3/4 inch, PHS

STANDARD ACCESSORIES

-83	103-0013-00	1	ADAPTER, power cord, 3 to 2 wire
-84	012-0127-00	1	CABLE ASSEMBLY, RF, 18.5 inches long
---	070-0903-00	2	MANUAL, instruction (not shown)

NOTES



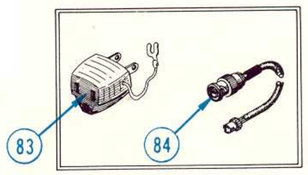
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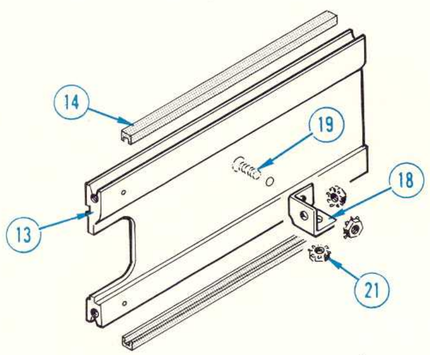
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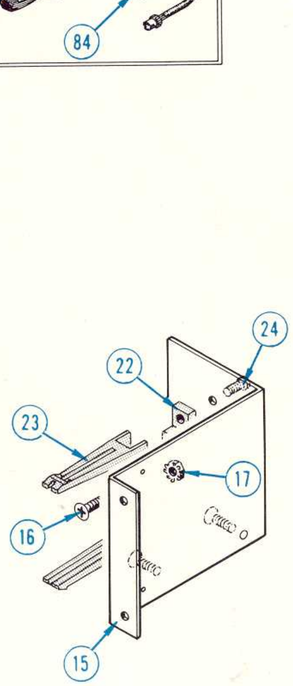
SAMPLING HEAD POWER SUPPLY

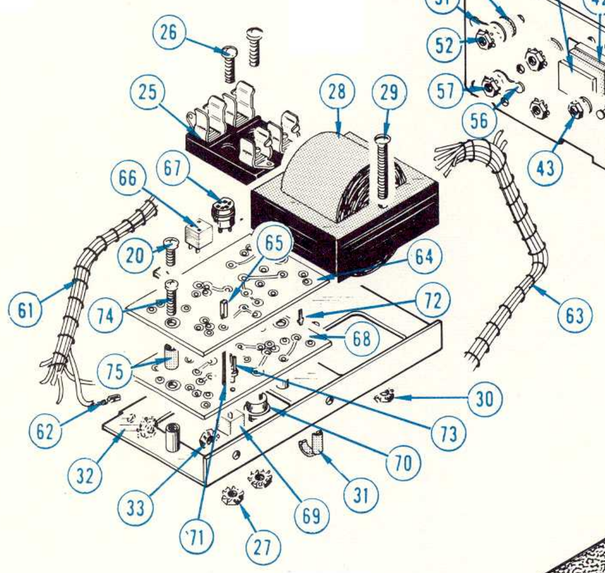
1068

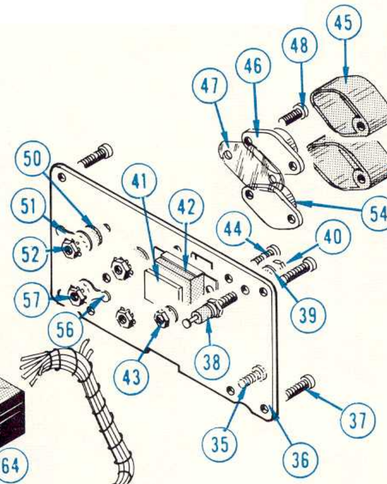
FIG. 1 EXPLODED

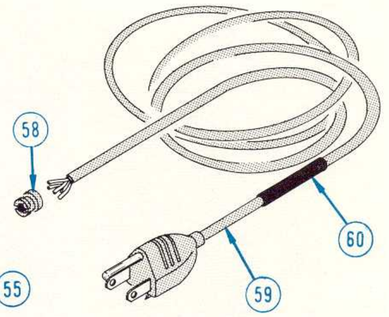


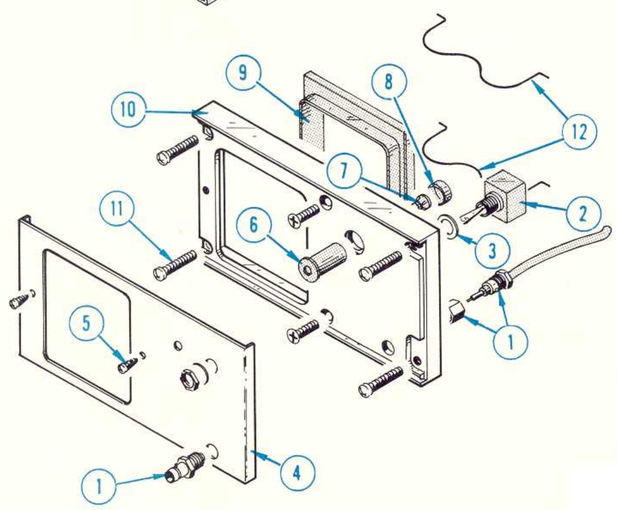


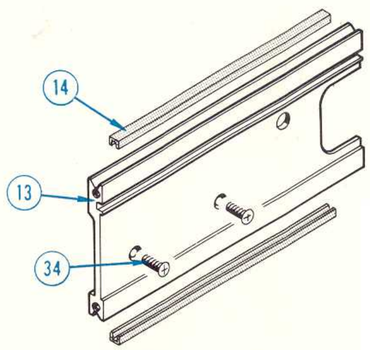


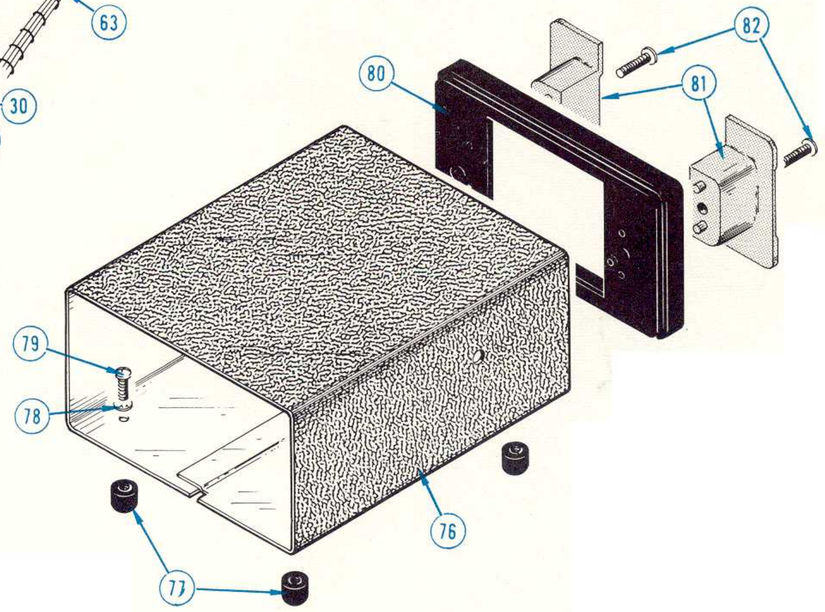












MANUAL CHANGE INFORMATION

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.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

TYPE 285

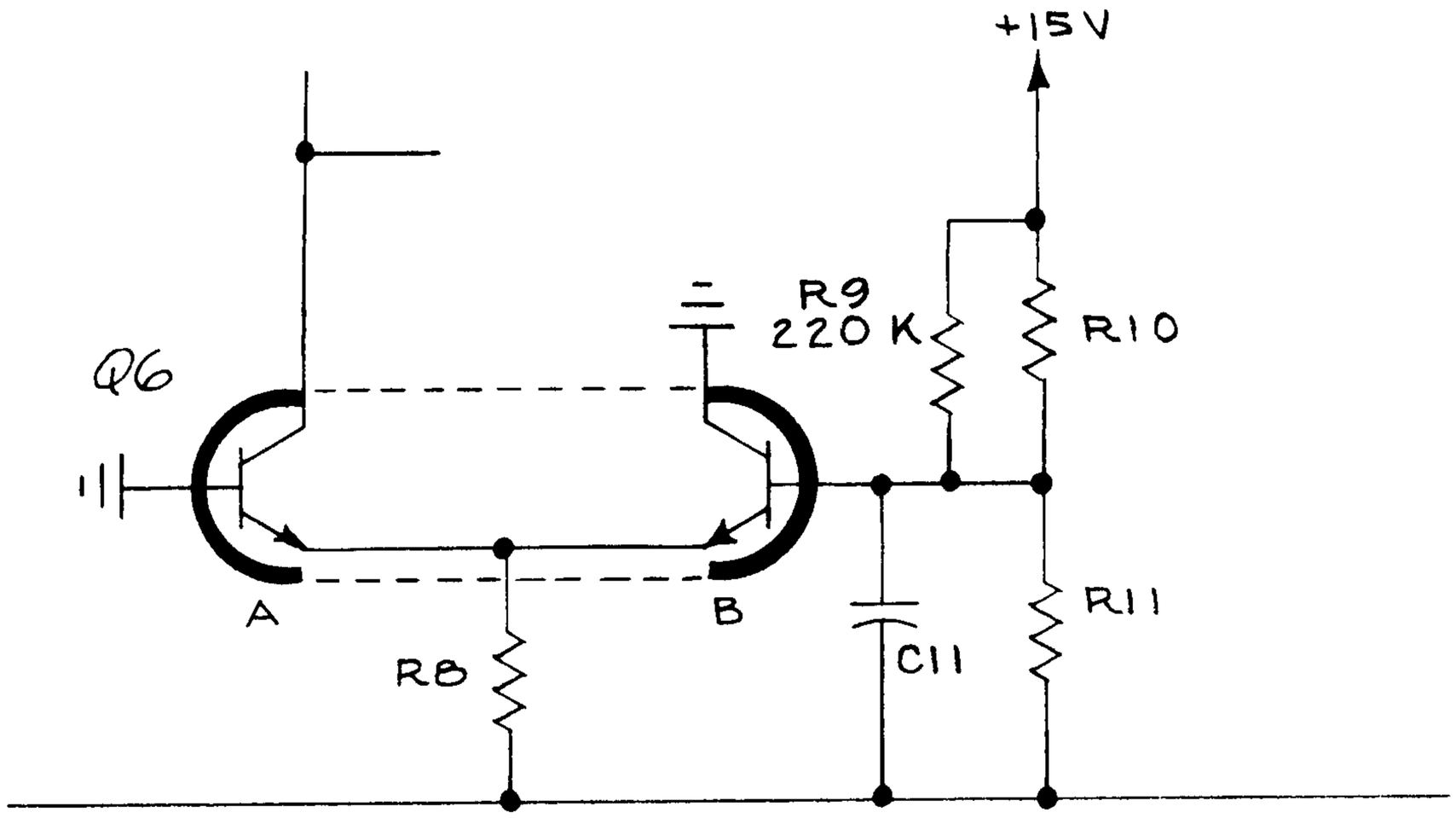
ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

R9	315-0224-00	220 kΩ	1/4 W	5%

SCHEMATIC CORRECTION

PARTIAL
-12.2 V REGULATOR



M14,721/1268