

INSTRUCTION MANUAL

Serial Number _____

TYPE S-1
SAMPLING HEAD

Tektronix, Inc.

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070-0763-00

mVOLTS/DIV
TYPE S-1
SAMPLING HEAD



RISETIME
 $\leq 350\text{ps}$

50 Ω
 $\pm 5\text{V MAX}$



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 $50\ \Omega$ 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 $+50^{\circ}\text{C}$. 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	$50\ \Omega$ 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 $\leq 1\ \text{V}$ P-P signals. Step signals greater than 500 mV require more than one dot to display 100% of the step transition.	
Maximum Input Voltage	$\pm 5\ \text{VDC}$ 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	$\leq +0.5$ and -3% in the first 5 ns after the step pulse reaches 50%.	
	$\leq +$ 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.	

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 Pick-off 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

Circuit Description—Type S-1

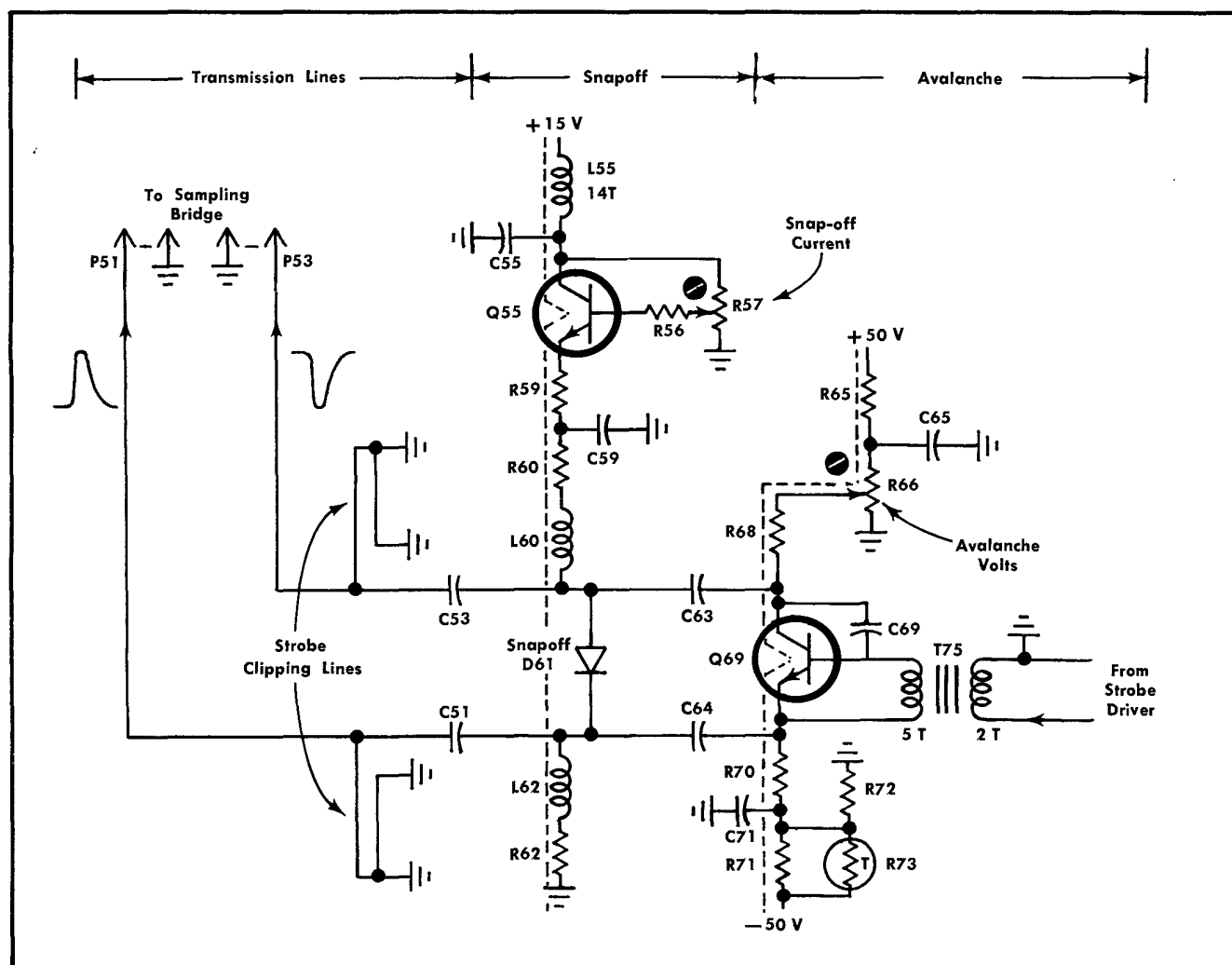


Fig. 3-1. Strobe Generator circuits.

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.

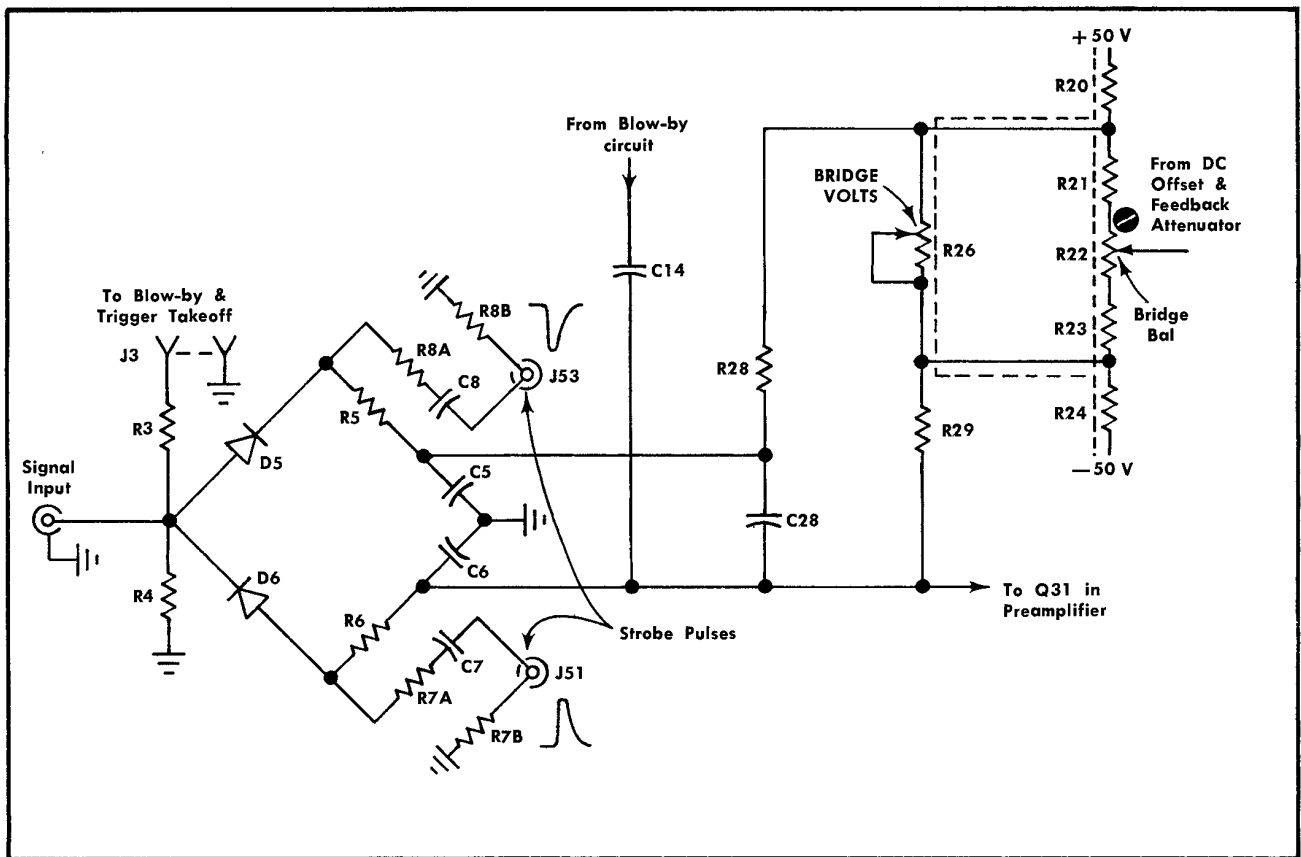


Fig. 3-2. Sampling Bridge circuit with Bridge Volts and Bridge Bal circuits.

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 Preamplicifier 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 Preamplicifier 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 Pick-off circuit. The bridge output drives the high input impedance of Q31 gate in the Preamplicifier.

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 Preamplicifier.

Preamplicifier

The Preamplicifier 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 thermistor 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

Circuit Description—Type S-1

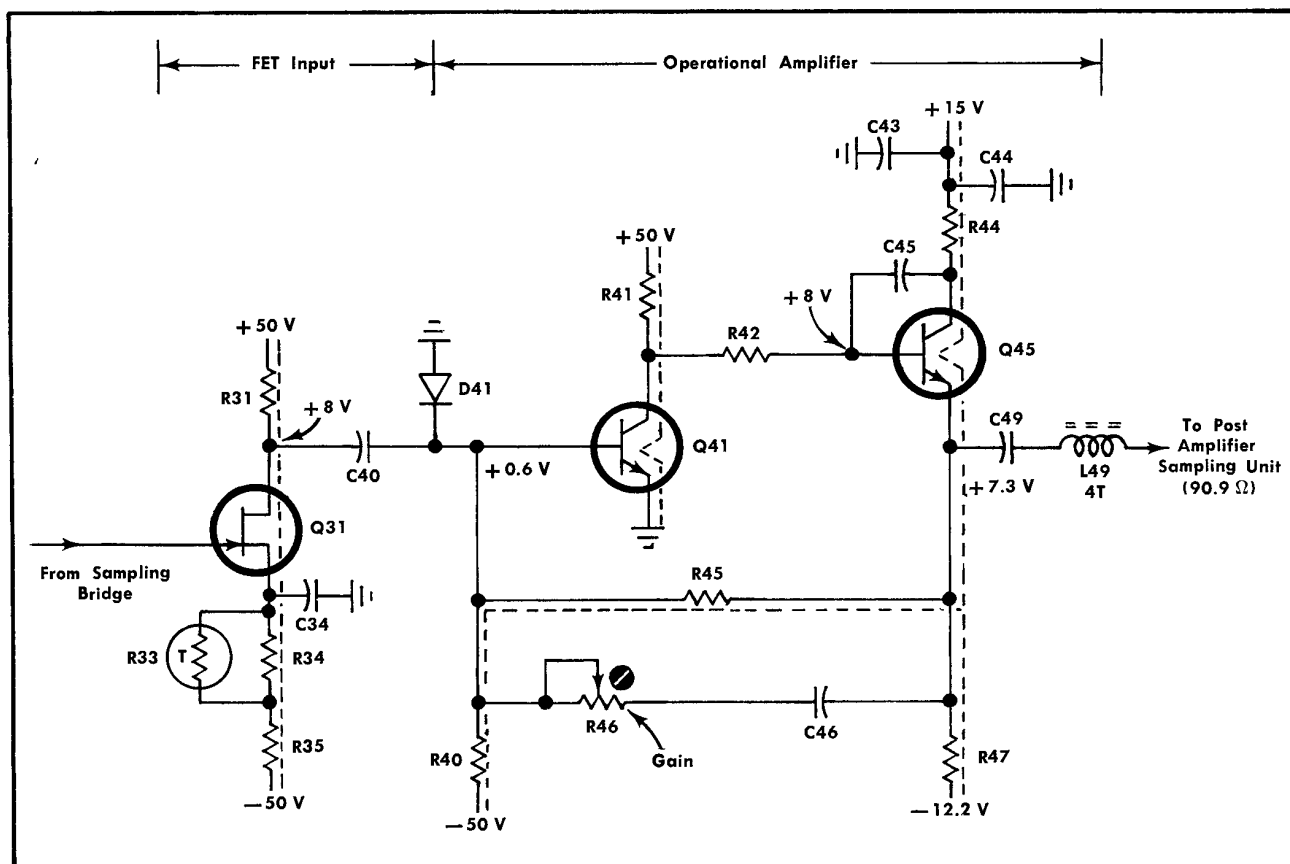


Fig. 3-3. Preamplifier circuit.

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 circuit 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.

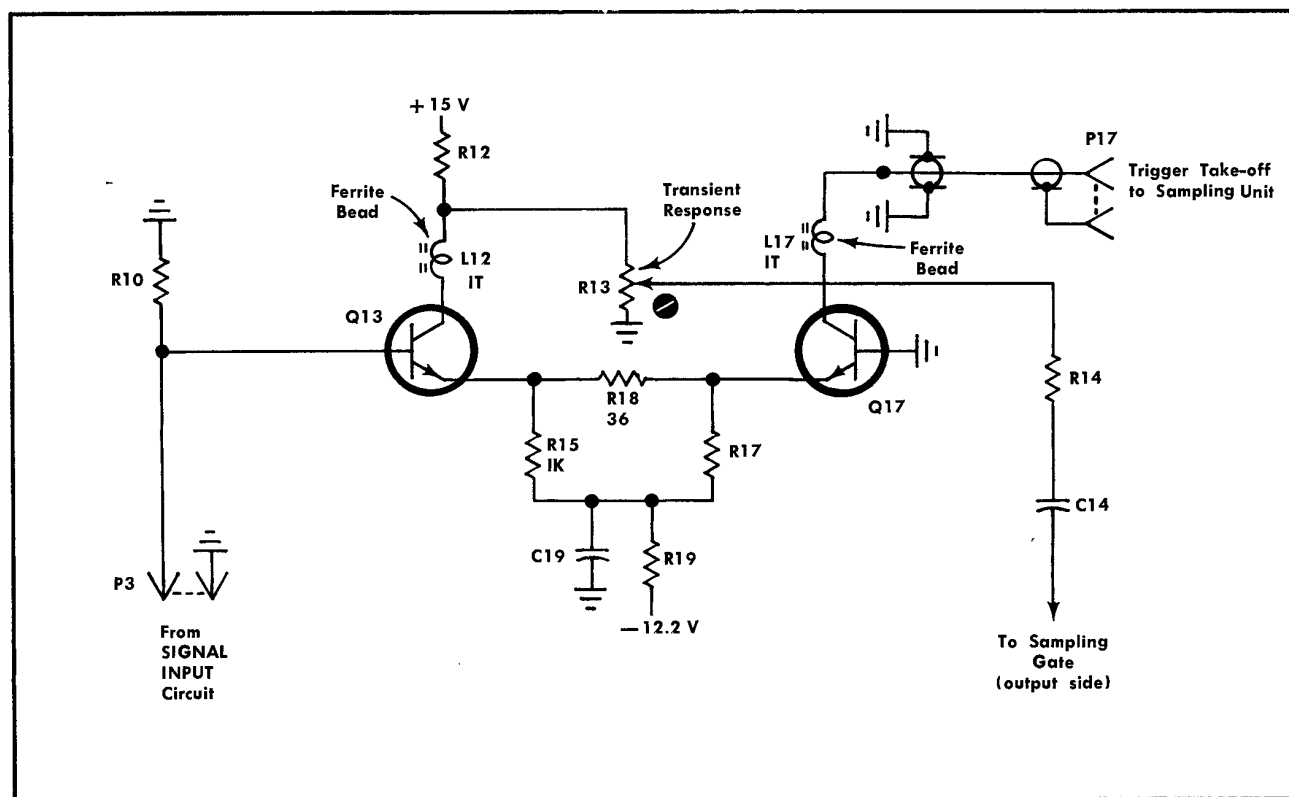


Fig. 3-4. Blow-by and Trigger Pickoff circuits.

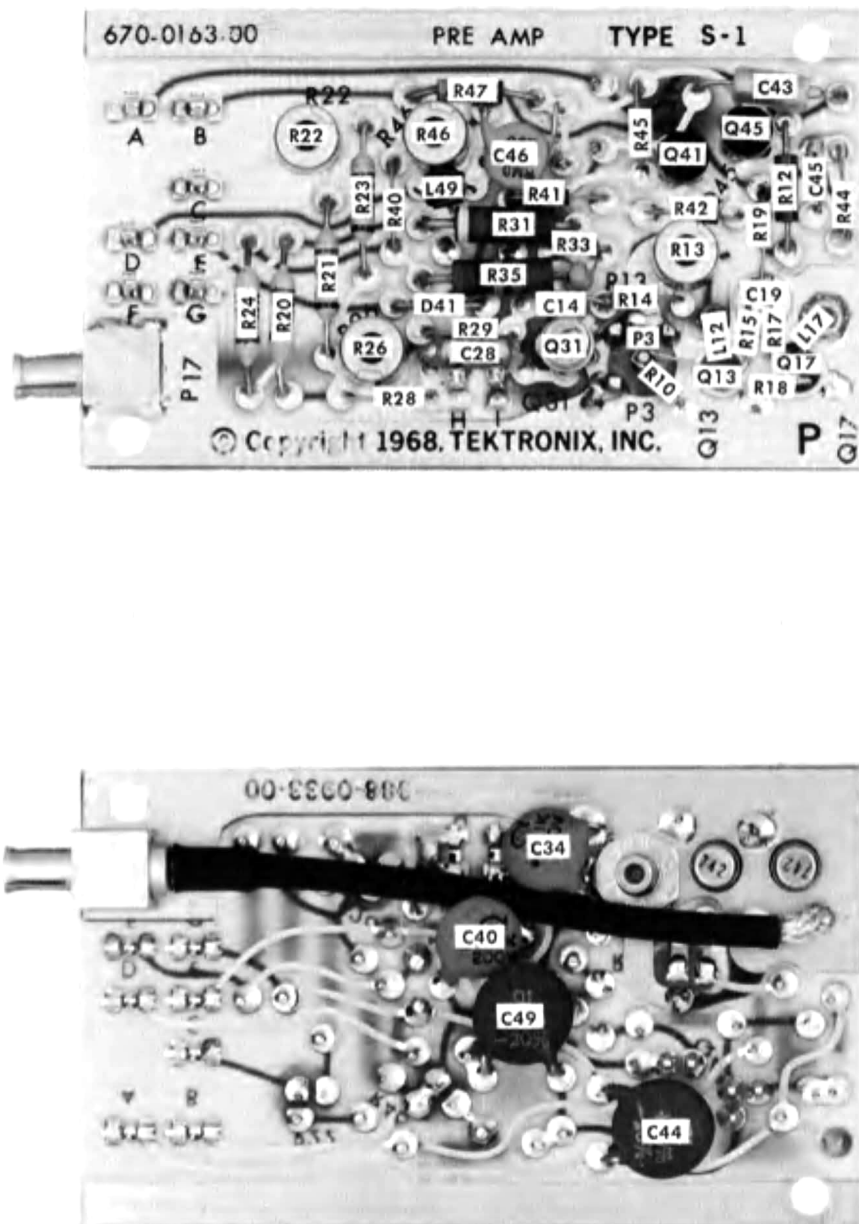


Fig. 4-5. Preamp circuit board.

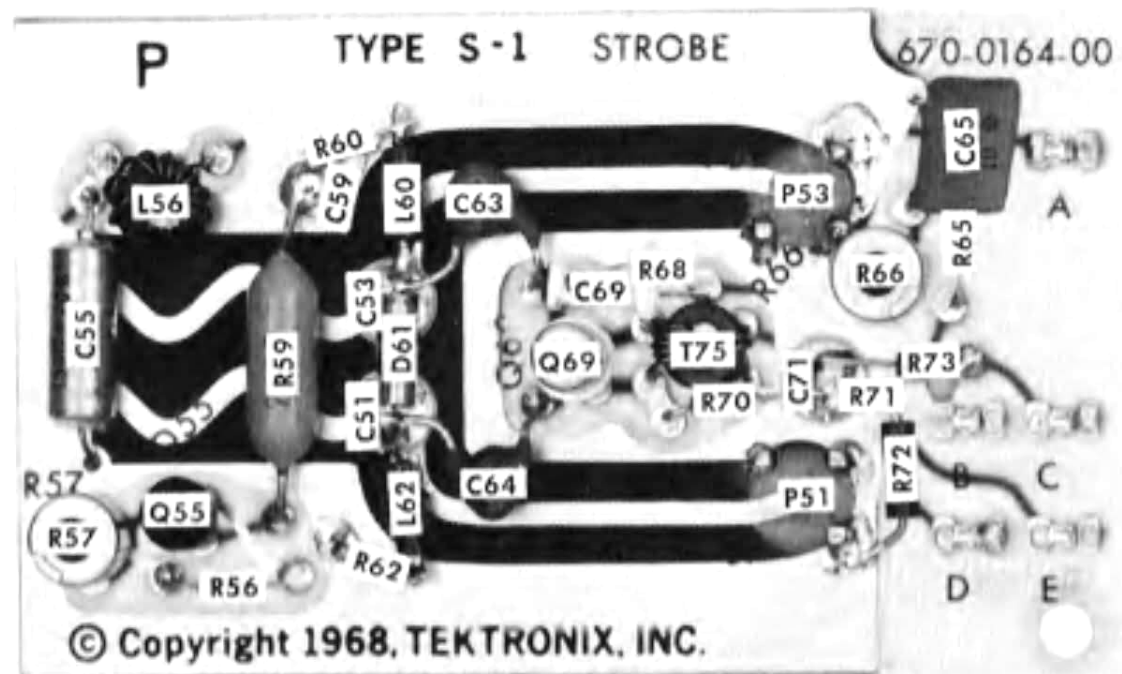
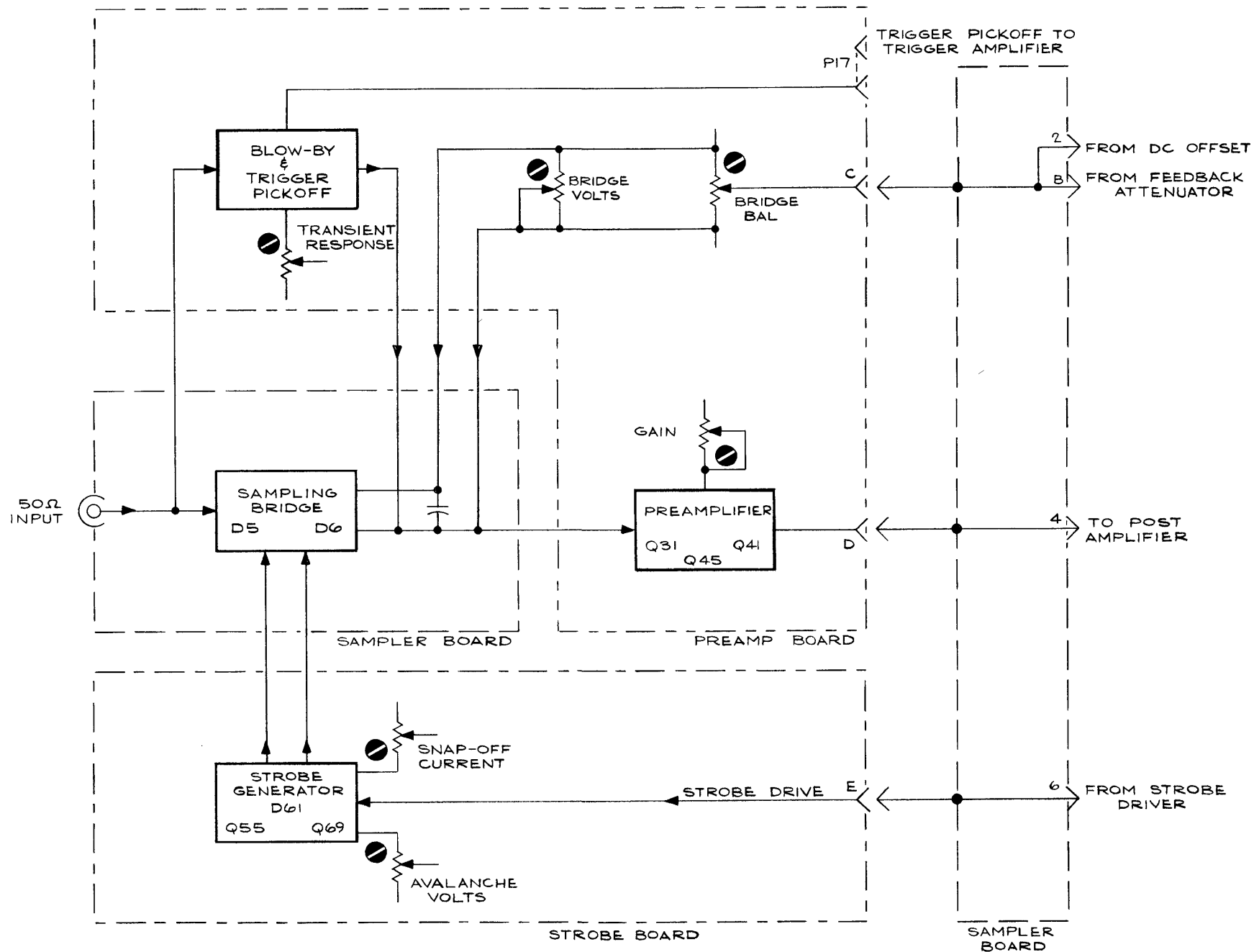
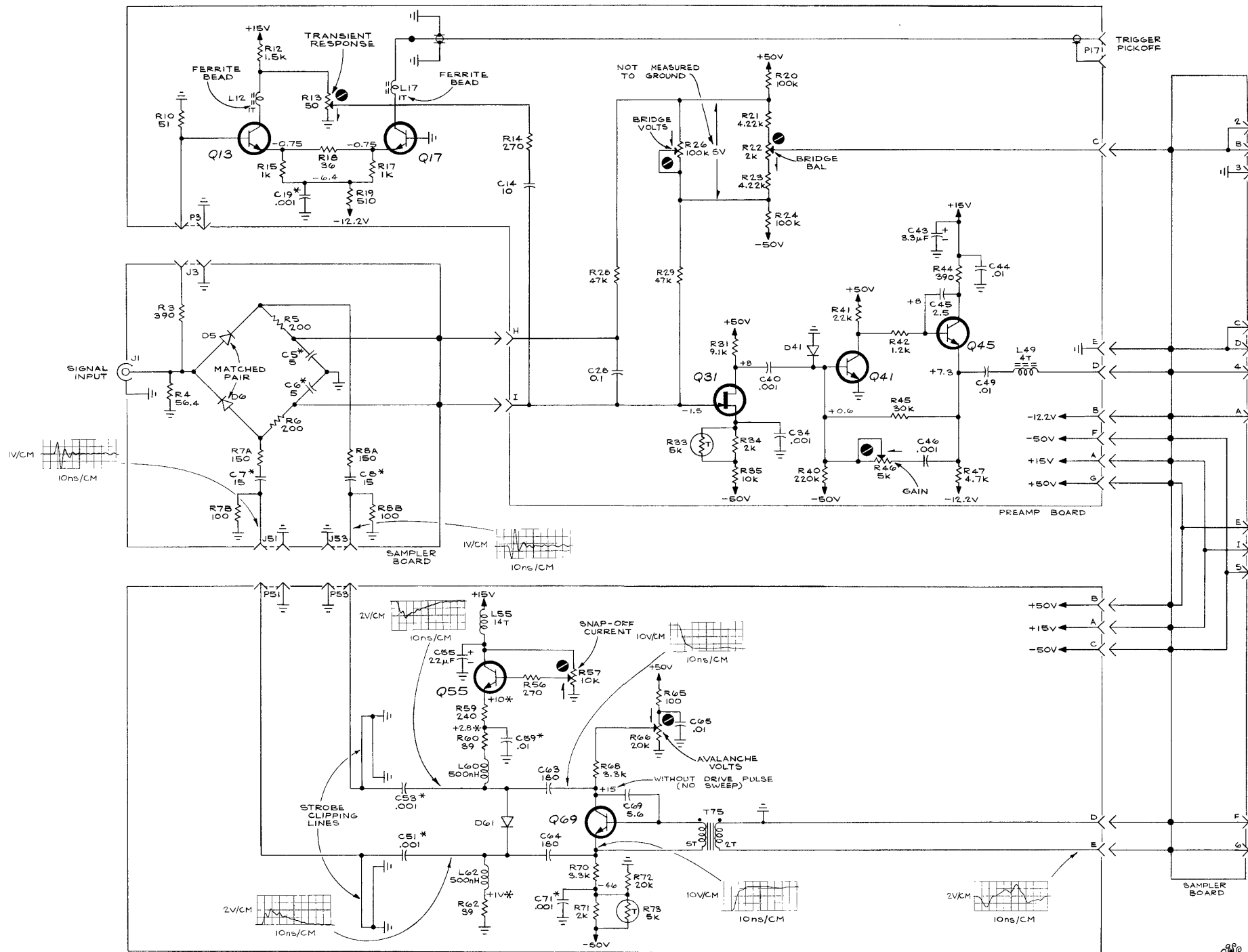


Fig. 4-6. Strobe Generator circuit board.



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* DENOTES READINGS THAT VARY WITH D61 CHARACTERISTICS.

* DENOTES LEADLESS CAPACITORS

TYPE S-1 SAMPLING HEAD