INSTRUCTION MANUAL

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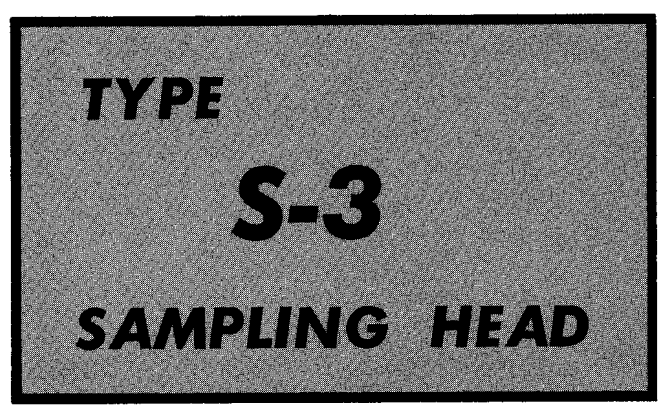

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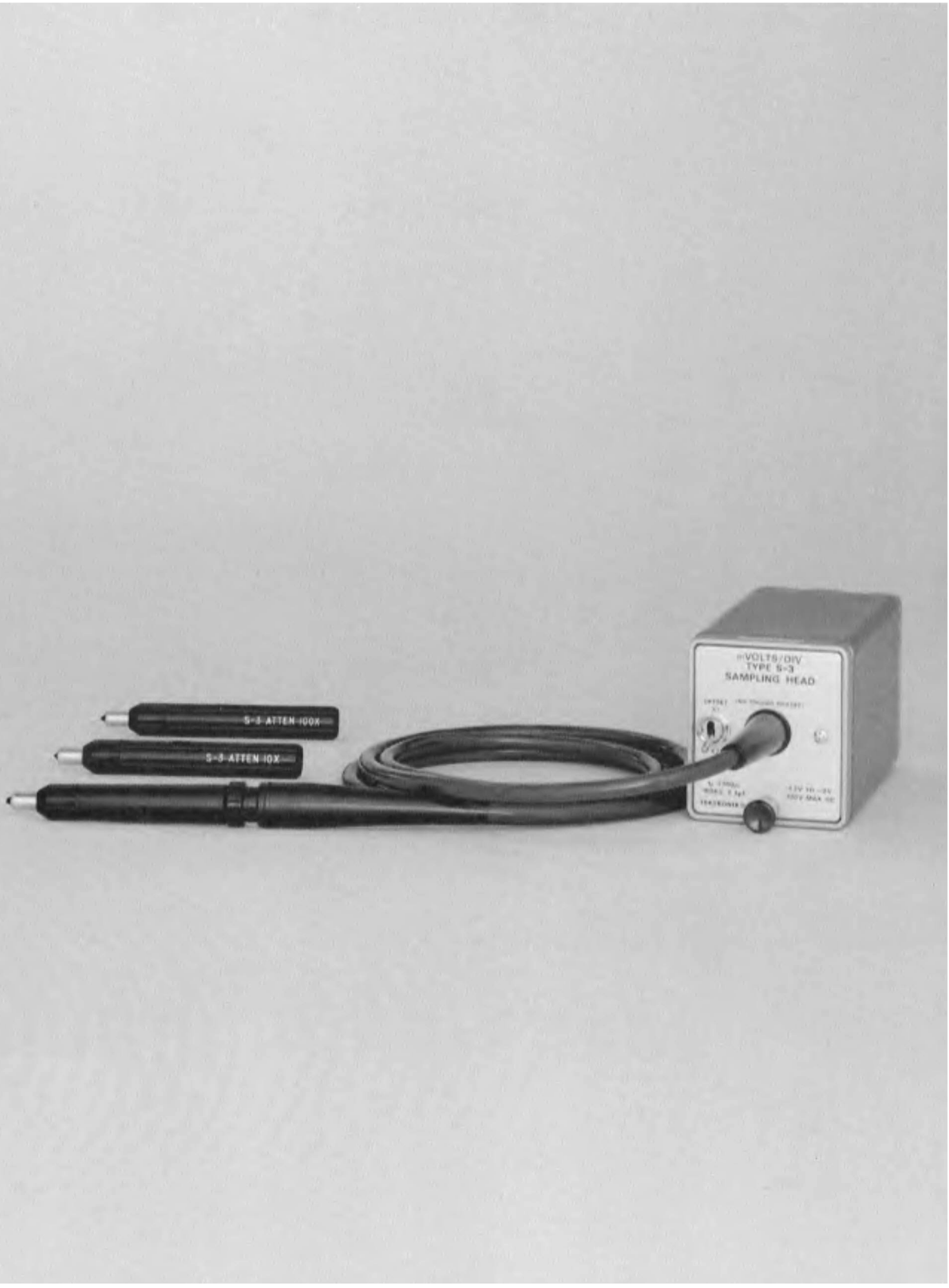

VOLTS/DIV
TYPE S-3
SAMPLING HEAD
S-3 ATTEN 100X
S-3 ATTEN 10X

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 Mechanical Parts List pullout pages.

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,

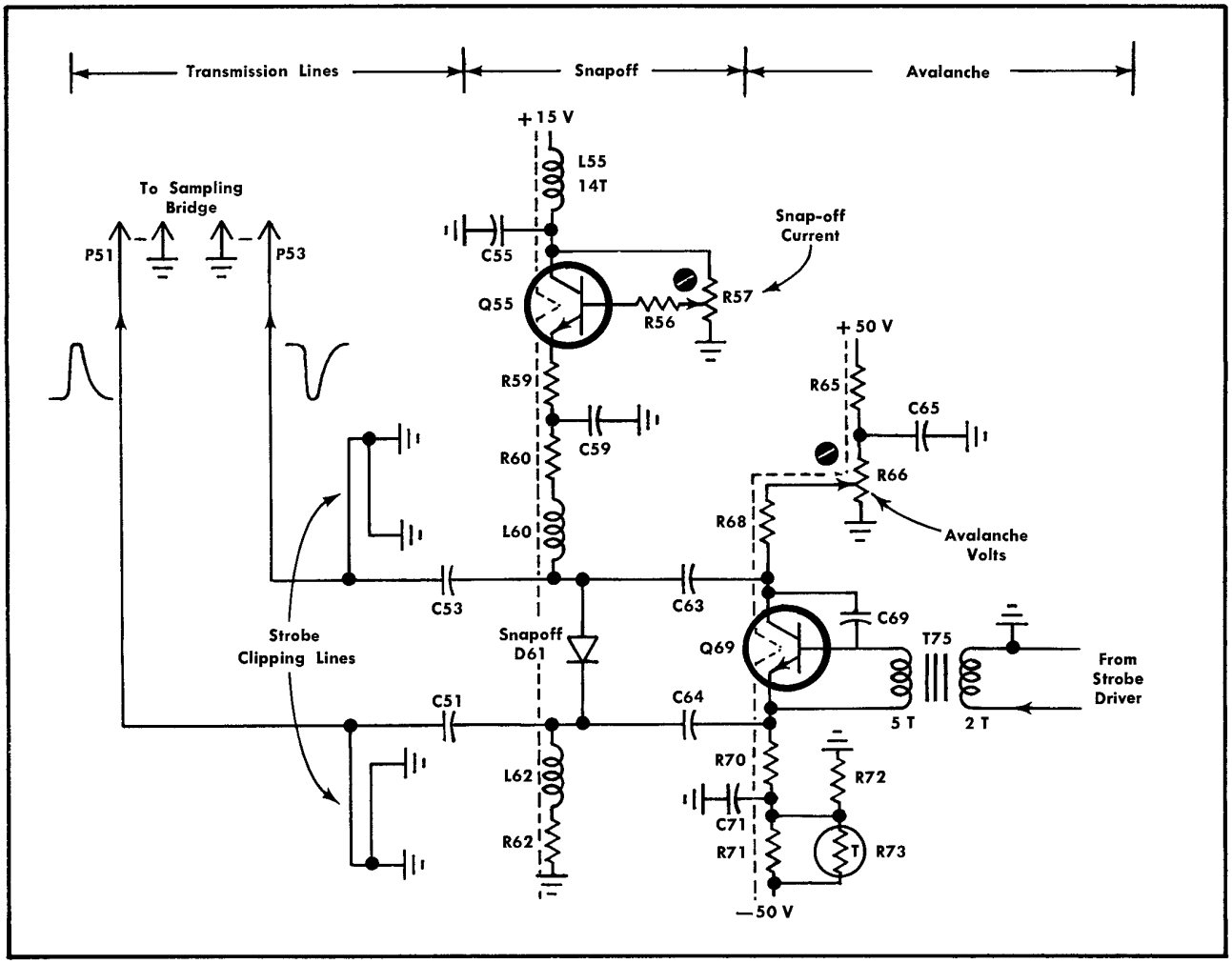


Fig. 3-1. Strobe Generator circuits.

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

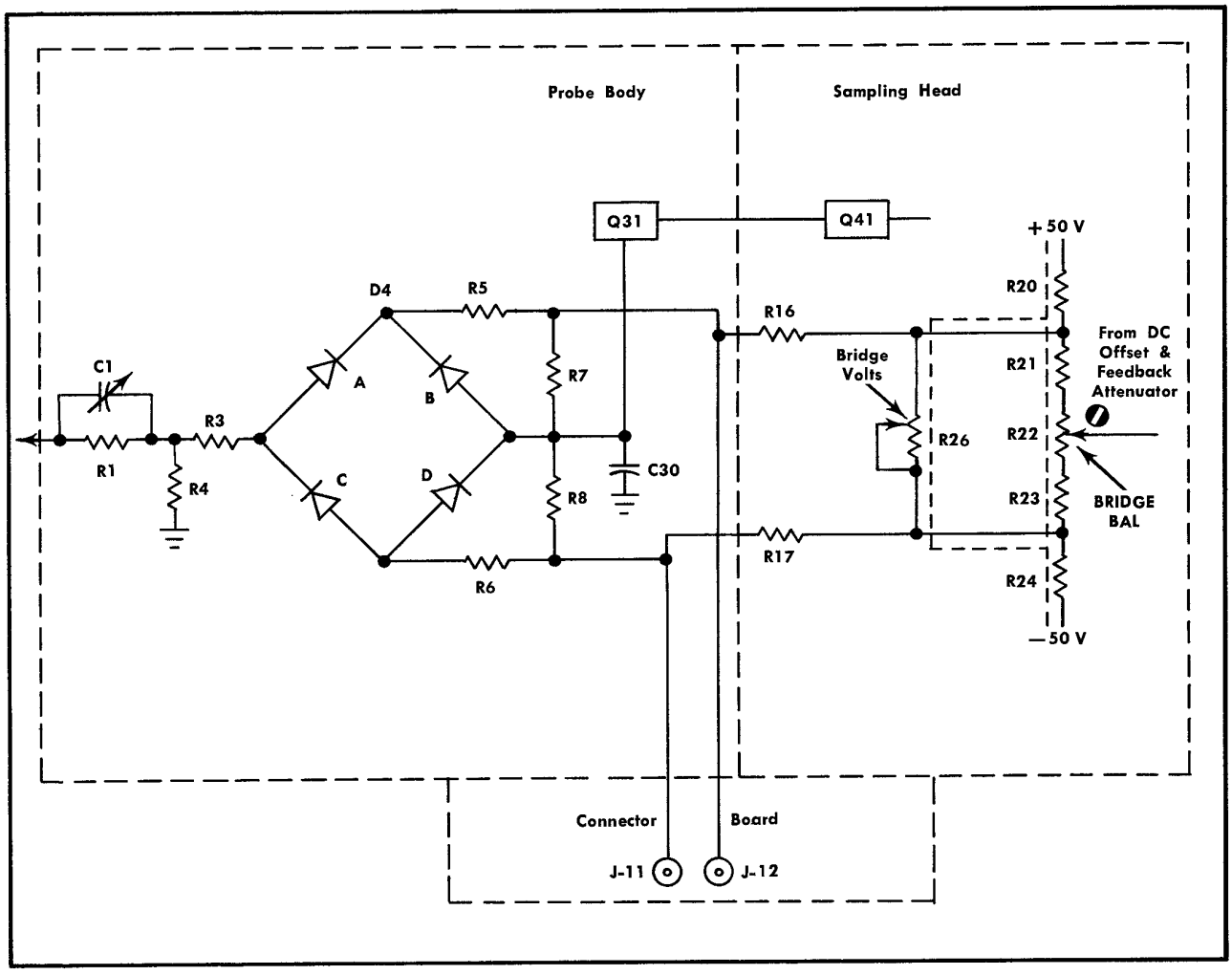


Fig. 3-2. Sampling Bridge circuit and Bridge Volts and Bridge Balance circuits.

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

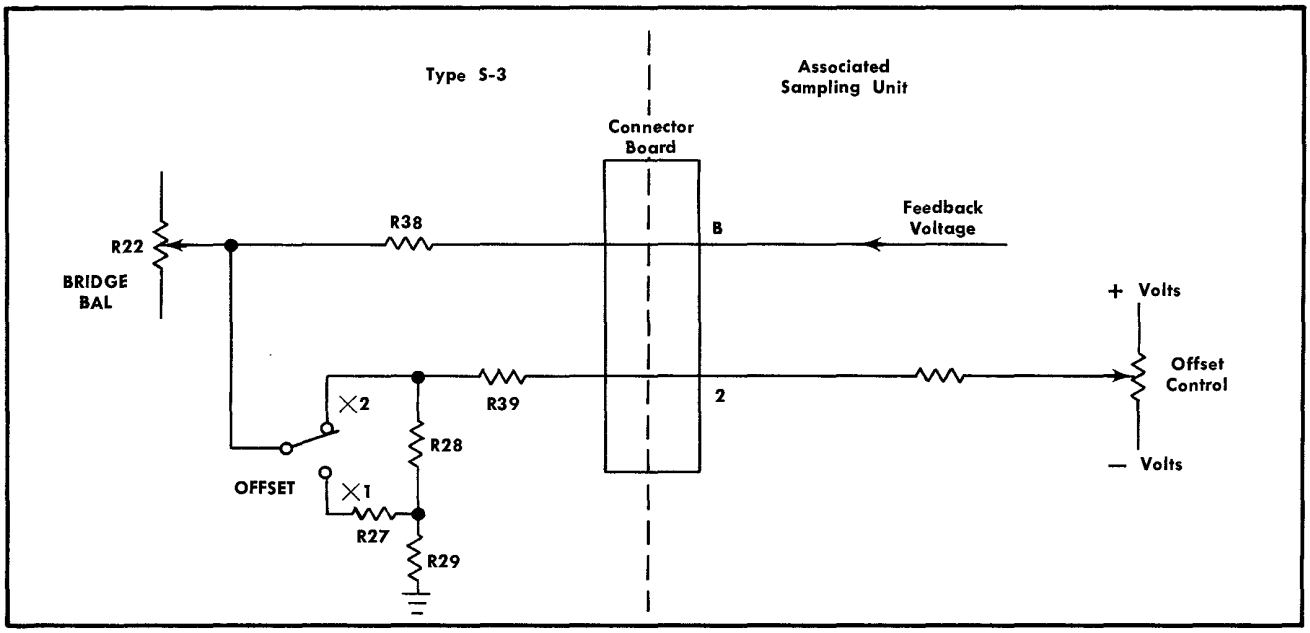


Fig. 3-3. OFFSET range switch and associated circuit.

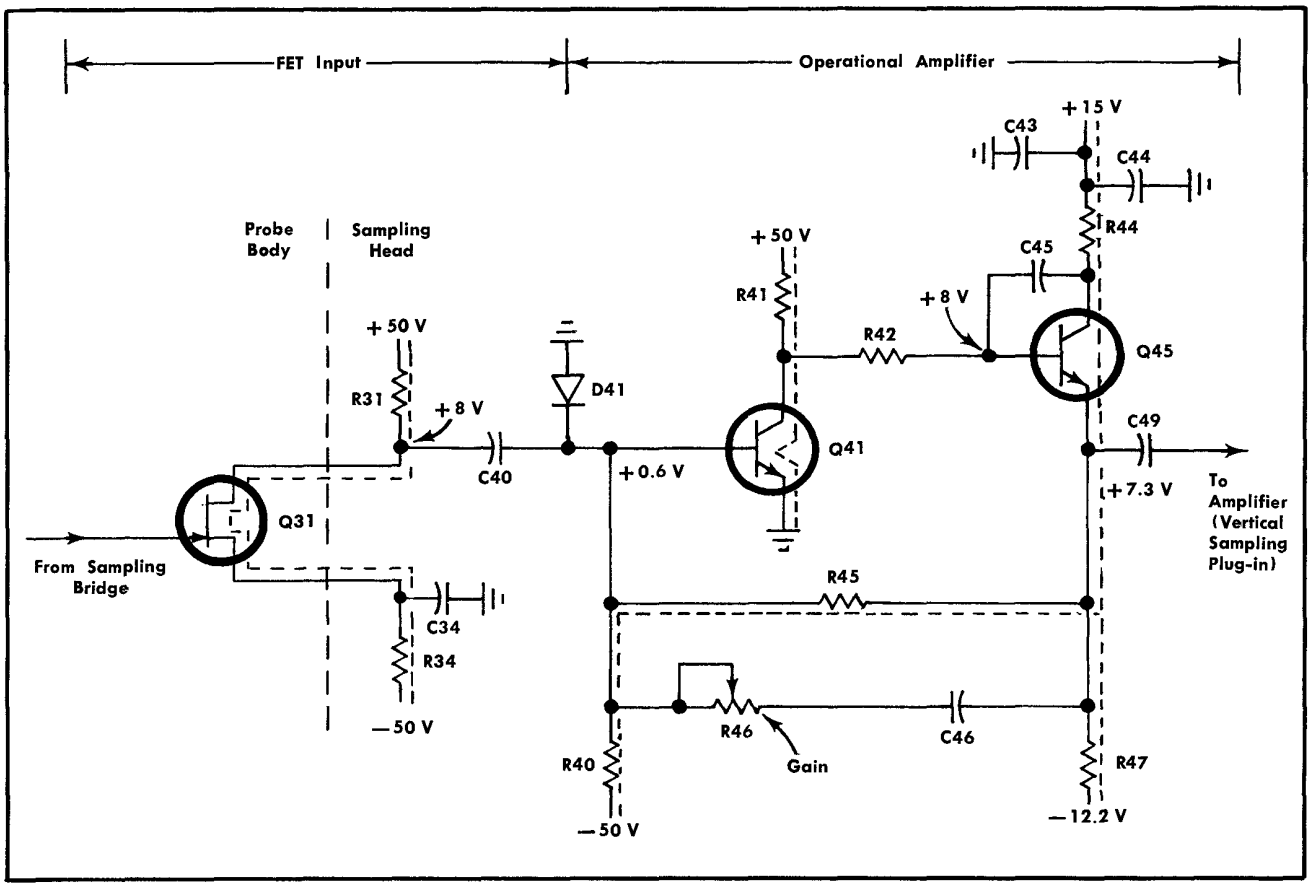
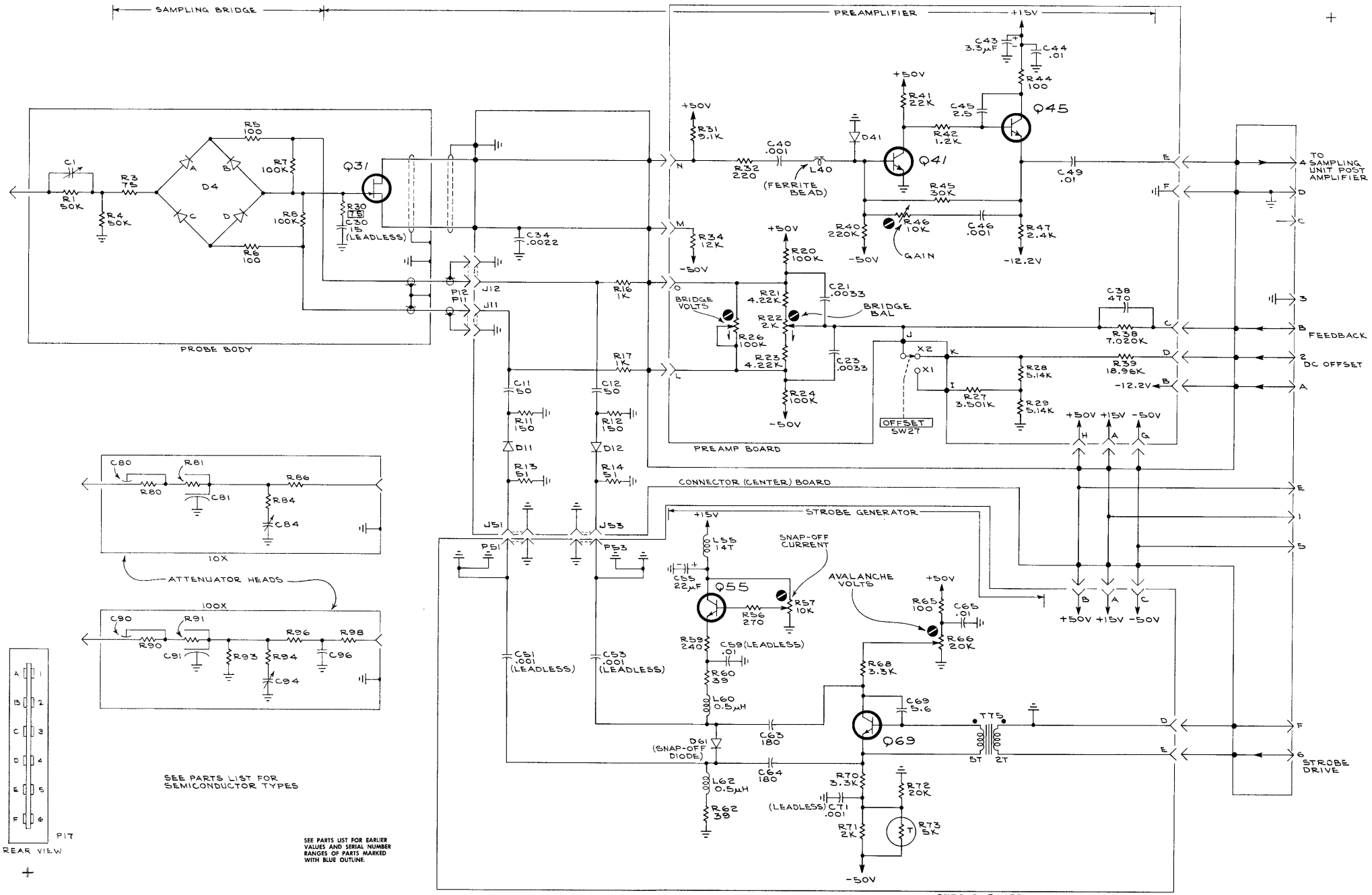


Fig. 3-4. Preamplifier circuit.

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.



TYPE S-3 SAMPLING HEAD