INSTRUCTION MANUAL

Serial Number _

TYPE 191

CONSTANT AMPLITUDE SIGNAL GENERATOR

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

070-0522-00


TYPE 191
CONSTANT AMPLITUDE
SIGNAL GENERATOR
SERIAL
AMPLITUDE
FREQUENCY RANGE
MEGAHERTZ
1.6-3.6
3.6-8
.75-1.6
8-18
.35-.75
18-42
50 kHz ONLY
42-100
AMPLITUDE RANGE
50-500mV
5-50mV
.5-5V
POWER
ON
OUTPUT
TEKTRONIX, INC., PORTLAND, OREGON, U.S.A.
TEKTRONIX

SECTION 1
CHARACTERISTICS

General

The Tektronix Type 191 Constant-Amplitude Signal Generator produces sine waves whose amplitude remains constant as the frequency is varied, provided the load limitations of the instrument are not exceeded. Front-panel controls indicate the peak-to-peak voltage of these sine waves at the input to a 50 ohm load.

This instrument is useful for making frequency-response measurements of broadband devices operating in the frequency range from 350 kilohertz to 100 megahertz.

The following characteristics apply over an ambient temperature range of 0° C to +50° C. Warm-up time for the given accuracies is 5 minutes at 25° C ±5° C.

MECHANICAL CHARACTERISTICS

Characteristic	Information
Construction	Aluminum-alloy chassis, panel and cabinet. Glass laminated circuit boards.
Finish	Anodized panel, blue vinyl-coated cabinet.
Overall Dimensions (measured at maximum points)	6½ inches high, 9 inches wide, 15⅝ inches long.

STANDARD ACCESSORIES

Standard accessories supplied with this instrument will be found on the last pullout page at the rear of this manual. For optional accessories, see the Tektronix, Inc. catalog.

TYPE 191 OUTPUT

Characteristic	Performance Requirement	Supplemental Information
Frequency Accuracy	Within ±2% of the selected frequency when the output is terminated with 50 ohms. When the output is not terminated with 50 ohms the accuracy is still ±2% except on the 0.5-5 V range where the accuracy is ±5%.	The frequency accuracy of the 50 kHz reference frequency is 50 kHz ±2%. The tolerance takes into account the effect that the Frequency (dial) setting will have on the frequency accuracy.
Amplitude Accuracy at 50 kHz into a 50 ohm ±1% load	The 0.5-5V range is within ±3% of the indicated amplitude, the 50-500 mV range is within ±4% of the indicated amplitude, and the 5-50 mV range is within ±5% of the indicated amplitude.	The open circuit unterminated output will be twice the amplitude of the terminated output (marked on the front panel), but the output tolerances will remain the same as those stated for the terminated output.
Harmonic Content		Typically less than 5%.
Amplitude Regulation into 50 ohms at OUTPUT connector, or through 5 ns (40 inches) or less of RG-8A/U coaxial cable.	When a Type 191, properly terminated in 50 ohms, is set for any output amplitude between 5 mV and 5.5 V, the amplitude at any frequency will vary less than ±3% from the actual amplitude value at 50 kHz, except for an output between 5 mV and 55 mV and a frequency between 42 MHz and 100 MHz where the amplitude variation will be less than +3% and −5%.	The use of RG-8A/U coaxial cable is important for good amplitude regulation at high frequencies. A 40 inch length of RG-58A/U coaxial cable, for example, can introduce a 1.5% amplitude loss at 100 MHz.

POWER REQUIREMENTS

Line Voltage Regulation	Power supplies must regulate when the line Voltage is within ±10% of the appropriate transformer center value.	
Line Voltage Center Values	105 VAC, 115 VAC, 125 VAC, 210 VAC, 230 VAC, and 250 VAC.	Center values obtained by using appropriate transformer taps.
Line Voltage Fuses	Type 3AG, 0.4 amp slow-blow for 115 V operation. Type 3AG, 0.2 amp slow-blow for 230 V operation.	
Line Frequency Operating Range	50 to 400 Hz.	
Input Power Consumption		Approximately 25 watts.

SECTION 3

CIRCUIT DESCRIPTION

Introduction

This section of the manual contains an electrical description of each circuit in the Type 191. A block diagram of the instrument is located in the Diagrams section of this manual. The block diagram shows the relationships between the circuits of the instrument.

Schematic diagrams are also located in the Diagrams section. These diagrams should be referred to for electrical values and relationships of components.

BLOCK DIAGRAM

Oscillator

The Oscillator output signal is supplied to both the Peak To Peak Detector and the 50 Ω Wideband Attenuator. The frequency of the Oscillator is controlled by the FREQUENCY RANGE switch and the Frequency dial. The output signal amplitude of the Oscillator is controlled by the DC voltage applied to the plate of the Oscillator tube V10 via the Series Regulator tube. This DC voltage is controlled by the AMPLITUDE switch and the VARIABLE control settings and by the comparison process occuring in the Peak To Peak Detector.

50 Ω Wideband Attenuator

The 50 Ω Wideband Attenuator takes the normal 1 to 11 volt signal supplied from the Oscillator and, depending upon the AMPLITUDE RANGE switch setting, either supplies the signal through 50 ohms to the OUTPUT connector (.5-5V), attenuates the signal 10× (50-500 mV), or attentuates the signal 100× (5-50 mV).

The output resistance of the Type 191 is 50 ohms in all positions of the AMPLITUDE RANGE switch.

Comparison Voltage

The DC voltage from the Comparison Voltage circuit applied to the Peak To Peak Detector determines the Oscillator output signal amplitude applied to the 50 Ω Wideband Attenuator.

Peak To Peak Detector

The output of the Oscillator and the Comparison Voltage are compared in the Peak To Peak Detector and any necessary correction voltage to correct the output signal amplitude is sent to the Feedback DC Amplifier.

Feedback DC Amplifier

This amplifier recieves the correction voltage from the Peak To Peak Detector and then supplies the amplified correction voltage to the grid of V94, the Series Regulator Tube.

Series Regulator

The correction voltage from the Feedback DC Amplifier varies the grid potential of V94, which causes the Series Regulator tube to adjust the amount of plate voltage available to the Oscillator tube.

Unregulated Power Supply

The Unregulated Power Supply makes available about +450 volts of DC voltage to the plate of the Series Regulator tube, V94.

DETAILED CIRCUIT DESCRIPTION

Oscillator

Oscillator tube V10 is connected as a grounded cathode Class C Colpitts Oscillator. Plate current is supplied to the grid end of switched inductors through R90, R99, R98, L98 and Zener diode D98. L98 and resistors R98, R99 and R90 isolate the Oscillator from the low output impedance of the Series Regulator, thereby increasing the Q of the Oscillator circuit. Zener diode D98 provides a voltage drop to furnish Q94 with sufficient collector voltage when the Oscillator output amplitude is minimum.

Feedback to the grid of V10 to maintain oscillations is provided from the grid end of the switched inductors through C8 and R8.

The tuning capacitor (Frequency dial) for the Oscillator is composed of C10A, B, C and D. Sections C10A, B and C of the tuning capacitor are electrically connected in parellel in the grid circuit while only section C10D of the tuning capacitor is connected to the plate circuit. This permits the ratio of plate to grid AC voltage to be 3 to 1.

The switched inductors which provide the various frequency ranges have adjustable powdered iron slugs and individual trimmer capacitors. These adjustments permit the frequency span of each range to be accommodated to the precalibrated dial. The selection of inductor is determined by the FREQUENCY RANGE switch, SW10.

The switched inductor for the 50 kHz ONLY range also has an adjustable powdered iron slug. Large fixed capacitors are connected in parallel with C10 to reduce the necessary inductance for 50 kHz operation. The large capacitors result in a negligible frequency difference (less than ±1%) from 50 kHz at any setting on the frequency dial.

The ferrite beads L11 and L12 mounted on the leads of T10 minimize high frequency currents induced when the oscillator is operating in the 42 MHz to 100 MHz range.

The individually switched output coils, inductively coupled to the oscillator coils, provide oscillator signal to the output networks. The inductor and capacitor in each of the output networks except for the 42 to 100 MHz range output coil, constitute low pass filter which partially removes the higher frequency harmonics from the output oscillator signal. The

resistor in each of the output networks except for the 42 to 100 MHz range reduces the Q of the resonant circuit which is formed by the components of the output network. Low Q is necessary for minimum disturbance of the Oscillator. The resistor and capacitor on the 42 to 100 MHz range constitute a low pass filter. The inductor reduces the amount of capacitance presented to the Oscillator circuit when the Type 191 OUTPUT connector is unterminated.

Toroid L64 located on the coaxial cable from the output point to the sampling point, reduces the amount of stray radio frequency current flowing in the shield of the coaxial cable.

50 Ω Wideband Attenuator

The Oscillator signal at the sampling point goes two ways. One path is through R40 to the 50 Ω Wideband Attenuator. The 50 ohm output impedance of the Oscillator is set by R40. This is true because the steady state impedance of the sampling point approaches zero ohms.

In all positions of the AMPLITUDE RANGE switch, both the input and output impedances of the 50 Ω Wideband Attenuator are 50 ohms. This is accomplished by the impedance of R40 and the 50 ohm T section attenuators. Each of the T section attenuators is stacked, i.e., the .5-5 V range has no signal attenuation ahead of the OUTPUT connector, while the 50-500 mV range has 10 times signal attenuation and the 5-50 mV range has 100 times signal attenuation.

The AMPLITUDE RANGE switch positions are labeled to indicate the output signal amplitude range, when the Type 191 OUTPUT connector is properly terminated into 50 ohms.

Toroid L49, located on the coaxial cable from the output of the 50 Ω Wideband Attenuator to the OUTPUT connector, reduces the amount of stray radio frequency current flowing in the shield of the coaxial cable.

Comparison Voltage

The Comparison Voltage circuit is a Kelvin-Varley divider. The voltage picked off from the divider, which is determined by the AMPLITUDE switch position, is applied across the VARIABLE control R58. The output voltage from R58 is fed to point C of the circuit board (Peak To Peak Detector circuit).

To obtain, for example, a 5 volt peak-to-peak Oscillator signal at the sampling point the output voltage from the Comparison Voltage circuit must be —5 volts.

TRACKING (R55) and AMPL CAL (R51) controls adjust the divider so the Oscillator output amplitude will agree with the front panel labeling. The AMPLITUDE switch and VARIABLE control labels indicate, in conjunction with the AMPLITUDE RANGE switch, the output signal amplitude when the Type 191 OUTPUT connector is properly terminated into 50 ohms.

Peak To Peak Detector

The function of the Peak to Peak Detector is to provide a DC voltage to the Feedback DC Amplifier which represents the difference between the DC comparison voltage and the actual peak-to-peak voltage (Oscillator output amplitude) at the sampling point. The output of the detector under steady conditions is a DC voltage established at the junction of R71 and the base of Q74.

For a first analysis of the Peak To Peak Detector operation, diodes D60 and D67 will be assumed to be ideal; that is, when conducting they have zero voltage drop across them. Now, assume that the comparison voltage is —10 volts. The peak-to-peak voltage will also be 10 volts because of the action of the Feedback DC Amplifier and Series Regulator. When the output sine wave is at its most negative point, —5 volts, the junction of D60 and D67 will be at —10 volts. When the Oscillator output sine wave is at its most positive point, +5 volts, the junction of D60 and D67 will be at zero volts. The detector output under these conditions will therefore be zero volts, since C66 and C67 will charge to the most positive voltage appearing on the anode of D67. In other words, C63 and C64 pass the sine wave at full amplitude to the junction of D60 and D67, but displace it negatively by a DC voltage equal to one-half the Oscillator output peak-to-peak amplitude. The waveform at the junction of D60 and D67 varies, therefore, from —10 volts to zero volts. Since the detector output must supply a direct current of about 10 μA whose source is the charge stored in C63 and C64, these capacitors must receive periodic charging currents. During the time D67 is conducting (at the positive Oscillator output sine wave peak), the charge passes from C63 and C64 to C66 and C67. This charge removal from C63 and C64 is replaced at the negative Oscillator sine wave peak when D60 conducts momentarily. The charge gained by C63 and C64 at each negative peak is exactly equal to the charge lost at each positive peak. If for any reason the Oscillator output amplitude changes, a corresponding change in the detector output will provide an error signal to the Feedback DC Amplifier which will act to restore the amplitude to its correct value.

If the comparison voltage is changed, the feedback circuit will act to make the Oscillator output amplitude change the same amount.

When D60 and D67 are real instead of ideal diodes, with forward voltages of about 0.6 volts each, the actual detector output voltage is —1.2 volts instead of zero volts for the description given above. The differential amplifier consisting of Q74 and Q84 is arranged to accept this voltage by having the base of Q84 offset about —1.2 volts by means of D80, D81 and R80.

C60, C64, and C67 are disc capacitors with low inductance connections to readily pass high frequency current pulses. C61, C63, and C66 are larger capacitors to provide more charge storage at lower frequencies. Ferrite beads L61, L63, and L66 provide damping for the capacitors on which they are mounted. R60-C60 and R67-C67 are low-pass filter networks and R64 is a damping resistor. Toroid L70 minimizes stray radio frequency current in the coaxial cable shield.

Feedback DC Amplifier

The current output of the Peak To Peak Detector determines a voltage at the base of Q74. The voltage at the base of Q74 is compared to the voltage at the base of Q84, the other half of a differential amplifier. The voltage at the

base of Q84 is determined by the combined junction voltages of D80 and D81 and by the current through R80 and R81. The difference in voltage between the two inputs to the differential amplifier determines the voltage presented at the base of emitter follower Q93. From the emitter follower Q93 the signal is fed to the base of common emitter amplifier Q94. The output voltage of Q94 is then fed to the grid of V94, part of the Series Regulator circuit.

A differential amplifier is used as part of the Feedback DC Amplifier so temperature compensated DC voltage amplification can be obtained without inversion. The inversion in the Feedback Amplifier is due to the common emitter amplifier stage. The overall gain of the Feedback DC Amplifier is about 100,000.

Any temperature or DC offset voltage variations in the voltage at the base of Q74 caused by the Peak To Peak Detector or sampling diodes D60 and D67, is compensated for in the Feedback DC Amplifier by diodes D80 and D81, located in the base circuit of Q84. Diodes D80 and D81 introduce a temperature dependent voltage on the base of Q84 which approximately matches the temperature dependent voltage on the base of Q74 caused by the sampling diodes D60 and D67. D80 and D81 also provide an offset voltage to match the detector output.

R72 and C72 decrease the AC voltage gain of the Feedback DC Amplifier to prevent oscillation.

R70 and C71 comprise a low pass filter to bypass radio frequency voltage components to ground at the amplifier input.

Series Regulator

The output voltage of the Feedback DC Amplifier is fed to the control grids of Series Regulator tube V94 where it controls the conduction of V94. By varying the grid voltage of V94 (connected as a cathode follower), the amount of plate voltage available to the Oscillator tube V10 can be controlled, thereby controlling the output signal amplitude of the Oscillator.

During the initial warm-up time of V94 after the instrument has been turned on, D94 prevents a high positive voltage from appearing on the grid with respect to the cathode. If such a large electric field were repeatedly applied to a cold cathode, cathode damage would eventually occur. R97 prevents a charge being stored on the cathodes of V94 after the instrument has been turned off.

R95 and R96 prevent parasitic oscillation in V94.

Power Supply

Primary. Power is applied to the instrument through P101. Line filter C101-C102 reduces the effect on the power line of signals generated in the instrument. SW105, as connected at the factory, permits the instrument to be easily converted from 115 volts to 230 volts by connecting the two transformer primaries in parallel for 115 volt operation or by connecting the two transformer primaries in series for 230 volt operation.

+6.2 and —11 Volt Supply. Output from transformer T101 is rectified by diodes D112A and D112B resulting in about 40 volts being applied across the parallel network of C113 and R117-D117-D118-R115. Output from the same winding of T101 is also rectified by D112C and D112D resulting in about 40 volts being applied across the parallel network of C115 and R115-R118. The output from diodes D112A and D112B supplies Zener diode D117 with current. Zener diode D11 in conjunction with D118, R115 and R118 then establishes a voltage of +6.2 volts at the junction of D117 and R117.

D118 is connected in series with D117 to provide a temperature compensation for the +6.2 volt supply.

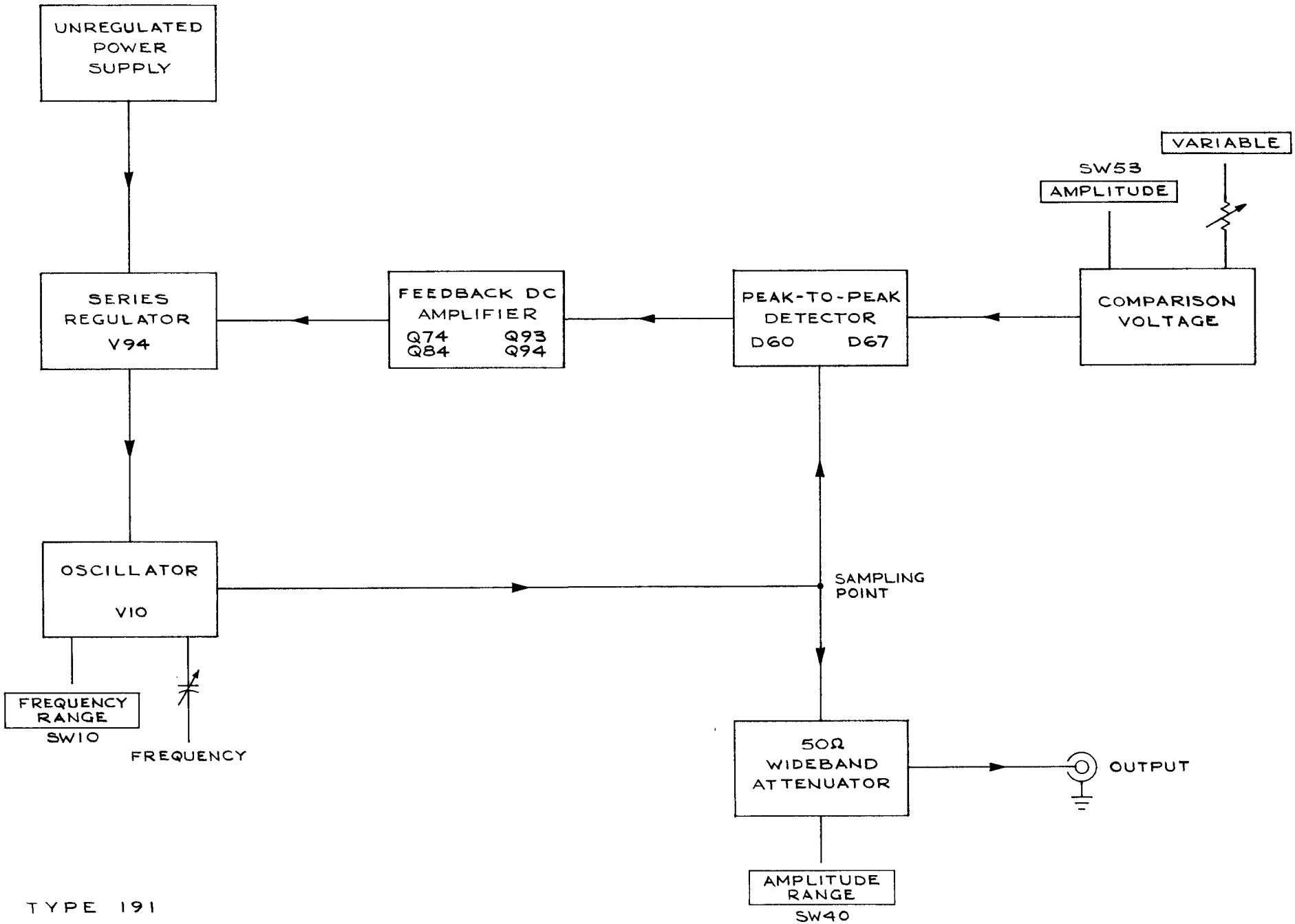
R115 and R118 provide compensation for any change in line voltage that might cause a current change in D117 and D118. This current change through the dynamic resistance of D117 and D118 (about 15 ohms total) will produce a voltage change across the two diodes. R115 and R118 introduce a voltage of opposite polarity to the cathode of D118 which offsets the change across D117 and D118. This compensation is established so the characteristic of the +6.2 volt supply acting together with the operational amplifier in the —11 volt supply produces minimum change in the —11 volt output as the line voltage varies.

The +6.2 volts is supplied to the input of an operational amplifier stage consisting of Q123 and Q127. The operational amplifier stage has a gain of about —1.8, which is adjustable. The input resistor of the operational amplifier is R120 and the feedback resistance is made up of R121 and R122 in series. The connection of the two transistors of the operational amplifier stage provides temperature compensation for the emitter-base voltages.

The +6.2 volts which is supplied to the operational amplifier stage is inverted and amplified to obtain the —11 volts. The —11 VOLTS control R122 adjusts the gain of the operational amplifier and therefore the output voltage. The stable —11 volts is then used as the reference supply for the signal amplitude.

+450 Volt Supply. Output from transformer T101 is rectified by D132A, B, C and D and applied across C132A and B for an unregulated output voltage of +450 volts. R140 and R135 are bleeder resistors for the supply; R140 discharges the filter capacitor when the POWER switch has been turned off. If, however, the instrument has had the line power removed but the Power switch remains on, then R135 discharges the filter capacitor, but at a slower rate.

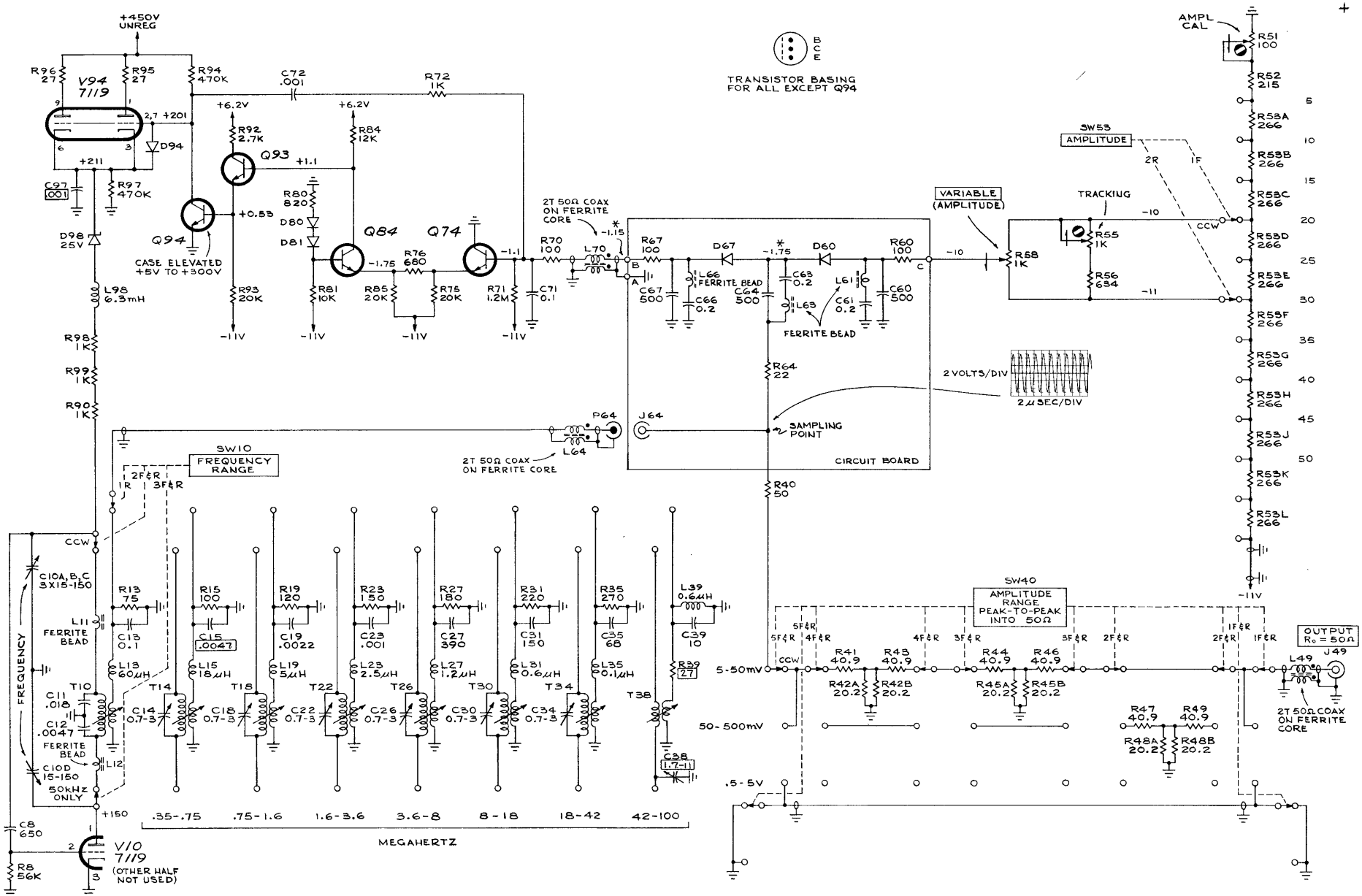
R137 and R138 elevate the heater of V94 to approximately 180 volts to minimize heater-to-cathode leakage.



TYPE 191

MRH
1065

BLOCK DIAGRAM



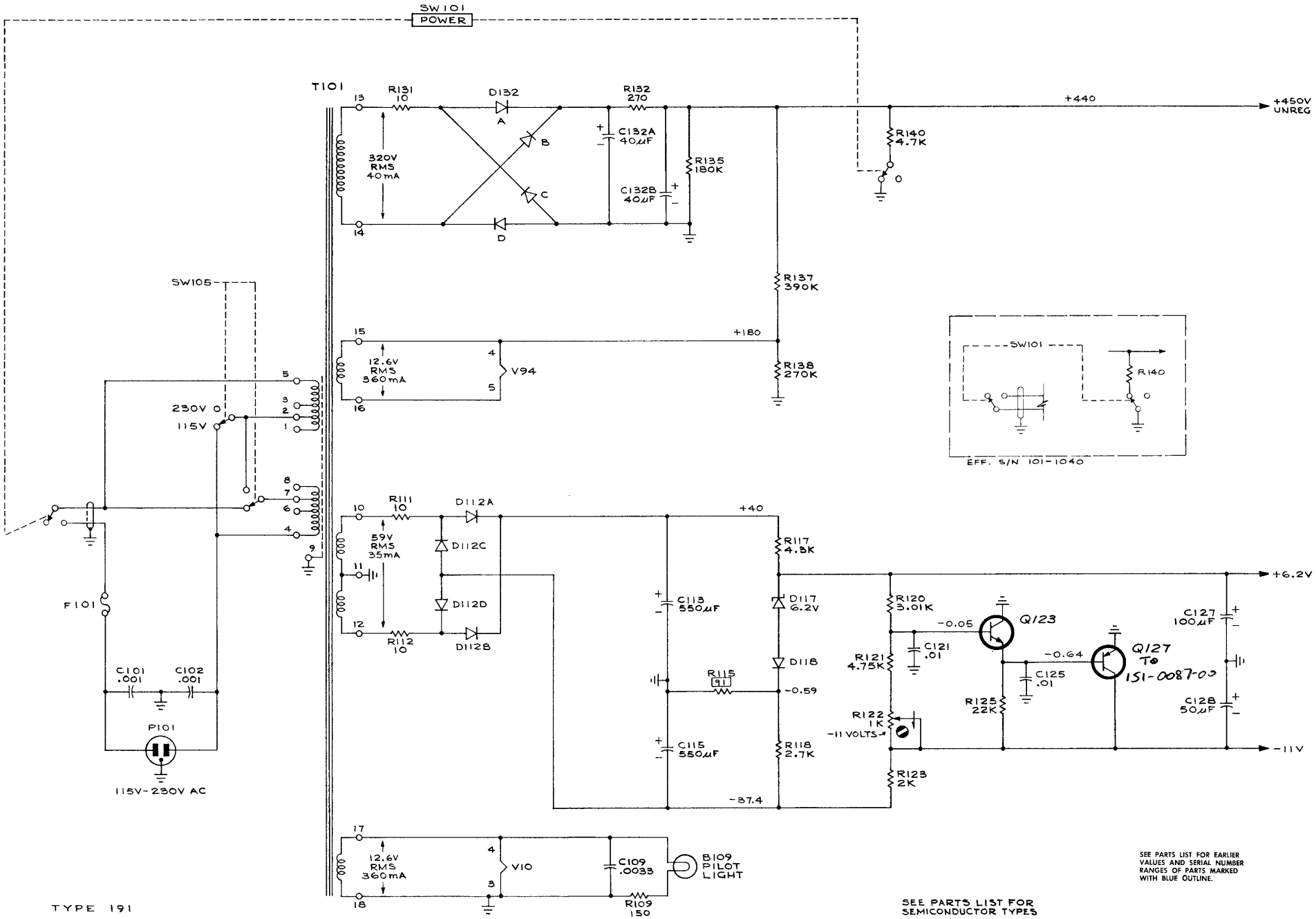
*HIGHEST PRACTICAL VOLTMETER RANGE USED

INACTIVE TANK CIRCUITS ARE SHORTED BY FREQUENCY RANGE SWITCH

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

567 MRH



MRH
567

POWER SUPPLY

MANUAL CHANGE INFORMATION

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

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

CORRECTION NOTICE

Due to a temporary shortage of 40.9 Ω, 1/8 W, ½% resistors, a 41.2 Ω, 1/8 W, 1% resistor, selected to be within the tolerance range of the original resistor, may have been substituted for R41, R43, R44, R46, R47 and R49 in this instrument.

When ordering replacement parts, order the 40.9 Ω resistor for which information is given in the parts list.

TYPE 191 TENT SN 1660

PARTS LIST CORRECTION

CHANGE TO:

B109	150-0065-00	Incandescent, 10 V, 40 mA

TYPE 191 TENT SN 1580

PARTS LIST CORRECTION

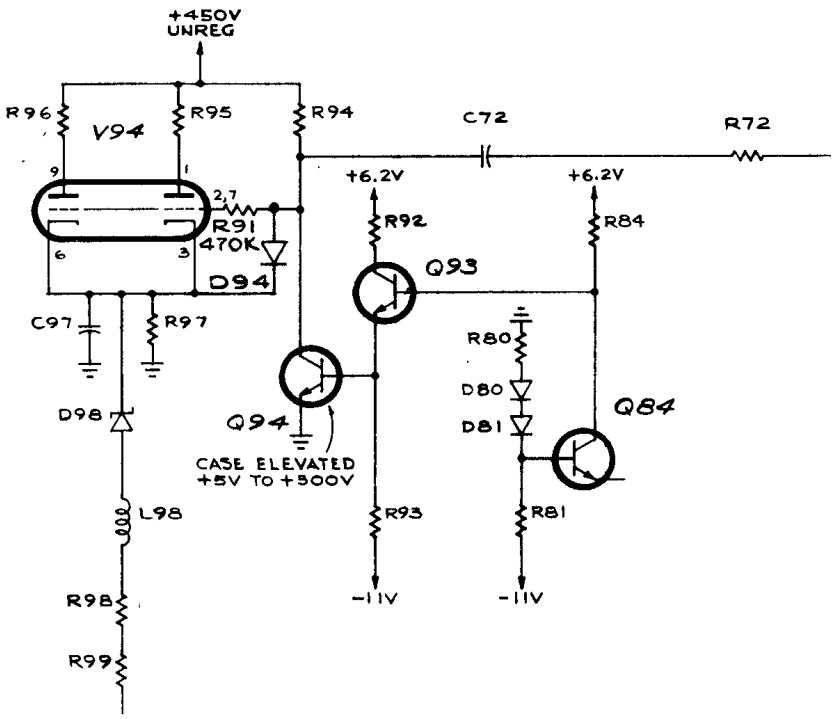
CHANGE TO:

Q94	151-0169-00	Silicon	2N3439	

ADD:

R91	302-0474-00	470 K	1/2 W	10 %

SCHEMATIC CORRECTION



PARTIAL

CONSTANT AMPLITUDE SIGNAL GENERATOR

TYPE 191 TENT SN 1354

PARTS LIST CORRECTION

CHANGE TO:

R115	315-0910-00	91 Ω (nominal installed value)	1/4 W	5 %

M12,422/567