

# INSTRUCTION MANUAL

Serial Number \_\_\_\_\_

**TYPE 106**  
**SQUARE-WAVE  
GENERATOR**

*Tektronix, Inc.*

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070-0523-00

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## WARRANTY

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

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

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Fig. 1-1. Type 106 Square-Wave Generator.



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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.

# SECTION 1

## CHARACTERISTICS

### Introduction

The Tektronix Type 106 Square-Wave Generator is a compact, general-purpose square-wave generator. This instrument provides three square-wave outputs; a high-amplitude output (120 volts unterminated), and positive-going and negative-going fast-rise outputs (one nanosecond or less risetime into 50 ohms). Repetition rate of the output square waves is variable from 10 Hz to 1 MHz. A sync input feature

is provided to synchronize the Type 106 with an external signal source. A trigger output allows the Type 106 to trigger external devices.

The Performance Check procedure given in Section 5 of this manual provides a convenient means of checking the performance requirements. The following characteristics apply over an ambient temperature range of 0°C to +50°C. Warm-up time for given accuracy is five minutes.

### ELECTRICAL CHARACTERISTICS

#### Square-Wave Generator

Characteristic	Performance Requirement		Supplemental Information
Repetition Rate	10 hertz to 1 megahertz		In 5 decade steps. Variable between steps with MULTIPLIER control
Repetition Rate Accuracy	Within $\pm 10\%$ of indicated value		Symmetry control centered
Multiplier Range	Provides continuously variable repetition rate to 10 times the rate selected by the REPETITION RATE RANGE switch		
Symmetry	Duty cycle variable from 45% or less to 55% or more		
High Amplitude Output Risetime	12 nanoseconds or less into 50-ohm load at 12 volts 20 nanoseconds or less into 50-ohm load at 0.5 volts		120 nanoseconds or less unterminated (risetime when unterminated can be calculated by: $T_r = 2.2 RC$ , where R is the 600-ohm internal resistance of the Type 106 and C is capacitance of load)
Amplitude range	Into 50-ohm load	Unterminated	240 milliamps maximum
	0.5 volts or less to 12 volts or greater	7 volts or less to 120 volts or greater	
Leading edge aberrations	$\pm 2\%$ or less in first 100 nanoseconds into 50 ohms		Measured on positive-going transition of signal
Flat top aberrations			0.5% or less, peak to peak, after first 100 nanoseconds
Trailing edge aberrations			Disregard aberrations in the last 100 nanoseconds preceding trailing edge
Polarity	Output level measured from a negative potential to ground		
Output impedance			600 ohms at OUTPUT connector
Fast Rise Output Risetime	1 nanosecond or less into 50-ohm load		Up to 500 millivolts
Amplitude range	50 millivolts or less to 500 millivolts or more into 50-ohm load		
Polarity	Simultaneous fast-rising positive-going and negative-going outputs		
Leading edge aberrations	+ and - 2%, or less, or + and - 6 millivolts, whichever is greater in the first 5 nanoseconds		Measured on positive-going transition of + OUTPUT signal and negative-going transition of - OUTPUT signal
Flat top aberrations			Less than 0.5% after first 5 nanoseconds
Symmetry change with change in amplitude			150 nanoseconds, or less, 50 millivolts to 500 millivolts
Output impedance			50 ohms at + OUTPUT and - OUTPUT connectors

## Characteristics—Type 106

Characteristic	Performance Requirement	Supplemental Information
Sync Input Requirements Pulse or square wave	2.5 volts to 50 volts, 100 Hertz to 1 Megahertz	For stable operation, risetime of applied pulse should be less than 12.5% of the period
Sine wave		5 volts to 100 volts peak to peak, 100 Hertz to 1 Megahertz
Input resistance		Approximately 1 megohm at DC
Trigger Output Output signal	Positive and negative trigger pulses coincident with the rise and fall of the OUTPUT (HI AMPLITUDE) signal	
Risetime (rate of change)	50 nanoseconds or less into 50-ohm load, between 0 and 0.1 volt	
Time jitter	300 picoseconds or less	Jitter measured one full cycle after test oscilloscope is triggered (see Section 6)
Delay time	50 nanoseconds or less from leading edge of trigger pulse to leading edge of all output signals (positive trigger pulse only for fast-rise outputs)	
Amplitude	0.10 volt or more into 50-ohm load	Approximately 0.4 volts unterminated
Output impedance		150 ohms

### Power Supply

Line Voltage 115-volts nominal	103.5 to 126.5 volts, RMS, AC line voltage provides regulated DC voltages	Range selected by 115 V-230 V Selector switch on rear panel
230-volts nominal	207 to 253 volts, RMS, AC line voltage provides regulated DC voltages	
Line Frequency	50 to 60 hertz	
Line Fuse 115-volts nominal		1.25 A, slow blow
230-volts nominal		0.6 A, slow blow
Power Consumption		Approximately 85 watts at 115-volt line

### ENVIRONMENTAL CHARACTERISTICS

The following environmental test limits apply when tested in accordance with the recommended test procedure. This instrument will meet the electrical performance requirements given in this section following environmental test. Complete

details on environmental test procedures, including failure criteria, etc., may be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

Characteristic	Performance Requirement	Supplemental Information
Temperature Operating	0° C to +50° C	Fan at rear circulates air throughout instrument. Automatic resetting thermal cutout protects instrument from overheating.
Non-operating	-40° C to +65° C	
Altitude Operating	15,000 feet maximum	
Non-operating	50,000 feet maximum	May be tested during non-operating temperature tests
Vibration Operating and non-operating	Vibrate for 15 minutes along each axis at a total displacement of 0.015 inch (1.9g at 50 c/s) with the frequency varied from 10-50-10 c/s in one minute cycles. Hold at any resonant point for 3 minutes. If no resonant points are found, vibrate at 50 c/s for 3 minutes on each axis.	Instrument secured to vibration platform during test. Total vibration time, about 55 minutes.

Characteristic	Performance Requirement	Supplemental Information
Shock Non-operating	One shock of 30 g, one-half sine, 11 milli-second duration along each major axis	Guillotine type shock
Transportation  Package vibration	Meets National Safe Transit type of test when correctly packaged  Vibrate for one hour slightly in excess of 1 g	  Package should just leave vibration surface
Package drop	Drop from a height of 30 inches on one corner, all edges radiating from that corner and all flat surfaces	Total of 10 drops

**MECHANICAL CHARACTERISTICS**

Characteristic	Information
Construction	
Chassis	Aluminum alloy
Cabinet	Aluminum alloy with blue-vinyl finish
Panel	Aluminum alloy with anodized finish
Circuit boards	Glass-epoxy laminate
Overall Dimensions (measured at maximum points)	
Height	6 inches
Width	9 inches
Depth	14 <sup>3</sup> / <sub>4</sub> inches

Connectors	
SYNC INPUT	BNC
TRIGGER OUTPUT	BNC
OUTPUT	GR874
+ OUTPUT	GR874
- OUTPUT	GR874

**Standard Accessories**

Standard accessories supplied with the Type 106 are listed on the last pullout page at the rear of this manual. For optional accessories available for use with the Type 106, see the current Tektronix, Inc. catalog.

# SECTION 2

## OPERATING INSTRUCTIONS

### General

To use the Type 106 effectively, the operation and capabilities of the instrument must be known. This section describes the function of the front- and rear-panel controls and connectors, gives first-time and general operating information and lists some basic applications for this instrument.

### Voltage Considerations

The Type 106 can be operated from either a 115- or a 230-volt nominal line. The 115 V - 230 V Selector switch on the rear panel changes the instrument from one operating range to the other. Use a small screwdriver or other pointed tool to slide this switch to the desired position.

#### CAUTION

The Type 106 should not be operated when the 115 V - 230 V Selector switch is in the wrong position for the nominal line voltage applied. Operation of the instrument in the wrong voltage range will either provide incorrect operation or damage the instrument.

When changing operating ranges, the line fuse must be changed. Table 2-1 lists the correct fuse for the applicable nominal line voltage.

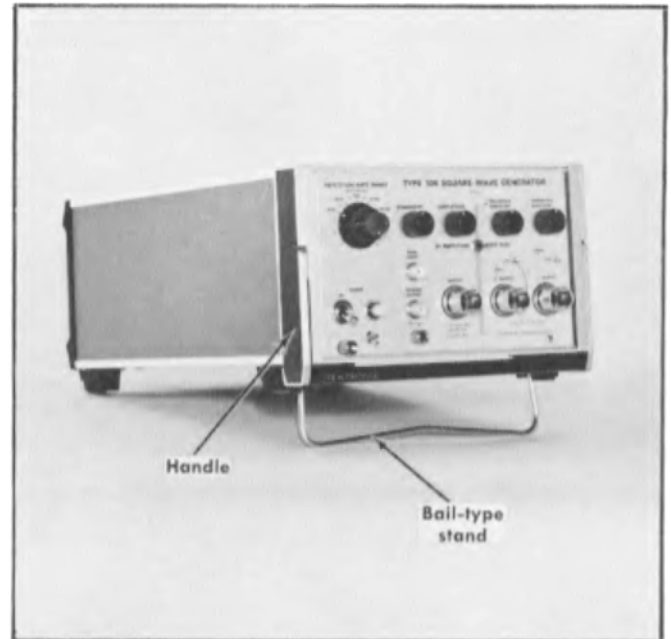
**TABLE 2-1**  
**Line Fuses**

Nominal Line Voltage	Fuse Rating
115-volts	1.25 A, slow-blow
230-volts	0.6 A, slow-blow

### Cooling

To maintain a safe operating temperature, the Type 106 is cooled with air drawn in at the rear, and blown out the top and bottom of the cabinet. A thermal cutout in the instrument provides thermal protection and disconnects the power to the instrument if the internal temperature exceeds a safe operating level. Power is automatically restored when the temperature returns to a safe level. The cabinet is designed to distribute air flow throughout the instrument for the most efficient cooling. Operation of the instrument for extended periods without the cabinet may cause it to overheat and the thermal cutout to open more frequently.

Adequate clearance must be provided on all sides to allow heat to be dissipated away from the instrument. The clearance provided by the feet at the bottom and rear should be maintained. If possible, allow about one inch of clearance on the sides and top. Do not block or restrict the air flow from the air-intake holes in the cabinet.



**Fig. 2-1. Handle and bail-type stand.**

### Handle and Stand

The handle of the Type 106 can be pulled out for convenient carrying of the instrument. When not in use, the handle folds out of the way, into the trim of the instrument cabinet (see Fig. 2-1).

A bail-type stand is mounted beneath the cabinet. This stand permits the Type 106 to be positioned for convenient operation (see Fig. 2-1). The instrument may also be set on the rear feet either for operation or storage.

## CONTROLS AND CONNECTORS

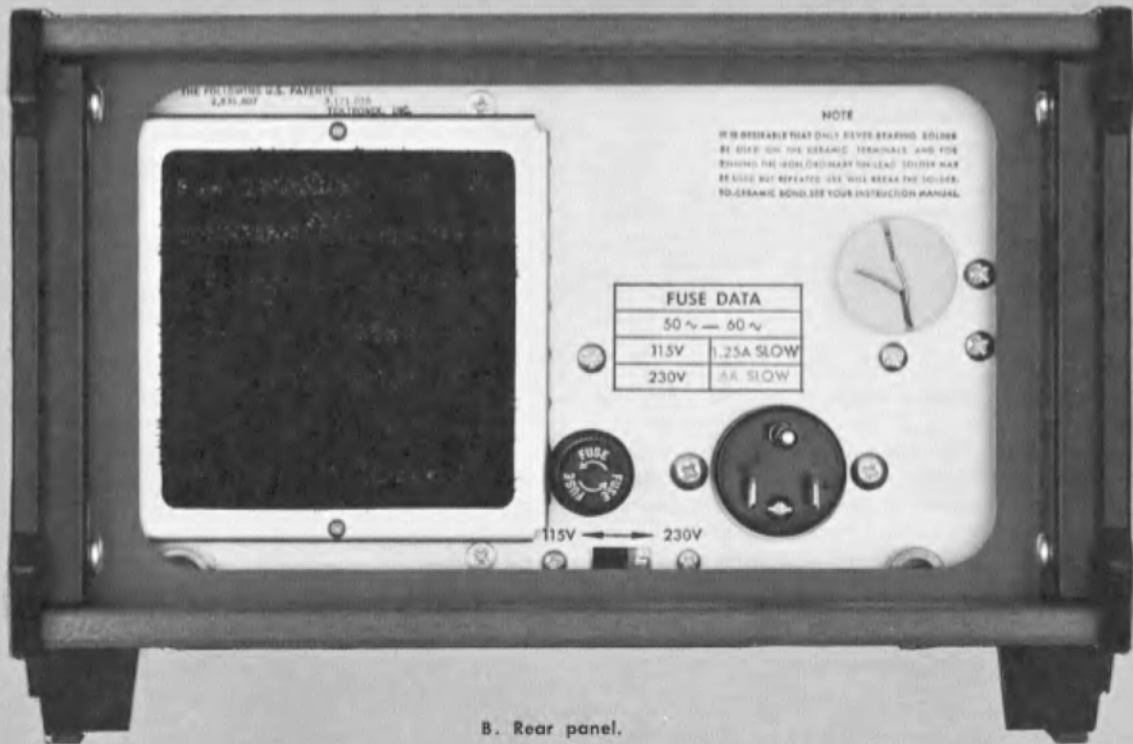
A brief description of the function or operation of the front- and rear-panel controls and connectors follows. Fig. 2-2 shows the front and rear panels of the instrument. More detailed operation is given in this section under General Operating Information.

#### Front Panel

- |                       |  |
|-----------------------|--|
| REpetition RATE RANGE | Determines the repetition rate of the output square wave.  |
| MULTIPLIER            | Provides variable repetition rate within the range selected by the REpetition RATE RANGE switch. |
| SYMMETRY              | Varies the duty cycle of the output square wave.   |



A. Front panel.



B. Rear panel.

Fig. 2-2. Front- and rear-panel controls and connectors.

AMPLITUDE	Determines amplitude of the square wave available at the OUTPUT (HI AMPLITUDE) connector.
SYNC INPUT	Input connector for a synchronizing signal.
POWER	Switch: Applies power to instrument. Light: Indicates when POWER switch is on and the instrument is connected to a power source.
TRIGGER OUTPUT	Output connector for trigger signal which is coincident with the rise and fall of the OUTPUT (HI AMPLITUDE) signal.
OUTPUT	Output connector for the HI AMPLITUDE square-wave signal.
HI AMPLITUDE-FAST RISE	Selects either the HI AMPLITUDE or the FAST RISE square-wave output.
+TRANSITION AMPLITUDE	Determines amplitude of the square wave available at the + OUTPUT connector.
—TRANSITION AMPLITUDE	Determines amplitude of the square wave available at the — OUTPUT connector.
+ OUTPUT	Output connector for the positive-going FAST RISE square-wave signal.
— OUTPUT	Output connector for the negative-going FAST RISE square-wave signal.

**Rear Panel**

Fuse	Fuse for power input.
115 V - 230 V Selector	Selects nominal operating range of instrument.
Power	Input connector for line power.

**FIRST-TIME OPERATION**

The following steps will demonstrate the basic function of the controls and connectors of the Type 106. It is recommended that this procedure be followed completely for first-time familiarization with this instrument.

1. Set the front-panel controls as follows:

REPETITION RATE RANGE	1 kHz
MULTIPLIER	1
SYMMETRY	Midrange
AMPLITUDE	Midrange
HI AMPLITUDE — FAST RISE	HI AMPLITUDE
+TRANSITION AMPLITUDE	Midrange
—TRANSITION AMPLITUDE	Midrange
POWER	Off

2. Connect the Type 106 to a power source that meets the voltage and frequency requirements of this instrument.
3. Check to be sure that the 115 V - 230 V Selector switch on the rear panel is in the correct position for the applied voltage.
4. Set the POWER switch to ON. Allow about five minutes warm up before proceeding.

5. Connect the five-nanosecond GR cable from the OUTPUT (HI AMPLITUDE) connector through the in-line termination to the vertical input of a test oscilloscope (Tektronix Type 545B/1A2 or equivalent).

6. Set the test oscilloscope controls for a display three to four divisions in amplitude, DC coupled, with about one complete cycle displayed on the CRT.

7. Set the REPETITION RATE RANGE switch to 10 kHz. Note that the repetition rate is increased ten times as shown by about one cycle/division. Return the REPETITION RATE RANGE switch to 1 kHz.

8. Turn the MULTIPLIER control to 10. Note that the repetition rate of the square wave is increased about ten times as shown by about one cycle/division. Return the MULTIPLIER control to 1.

9. Rotate the SYMMETRY control throughout its range. Note that the duty cycle (symmetry) of the square wave changes from about 55% in the counterclockwise position to about 45% in the clockwise position. Return the SYMMETRY control to midrange.

10. Rotate the AMPLITUDE (HI AMPLITUDE) control throughout its range. Note the change in output amplitude between about 0.5 volt and 12 volts. Also note that the square wave starts from a negative reference potential and goes positive to zero volts. The positive-going transition of the square wave is the portion to which the risetime and aberration characteristics apply.

11. If the test oscilloscope has a dual-trace vertical system, connect a 50-ohm BNC cable between the TRIGGER OUTPUT connector and the remaining vertical input connector. Note that the trigger output pulses are coincident with the rise and fall of the OUTPUT (HI AMPLITUDE) square wave. (If the test oscilloscope is single trace, compare coincidence of trigger output pulses and square-wave rise and fall on separate displays.) Disconnect the 50-ohm BNC cable.

12. Disconnect the five-nanosecond cable from the OUTPUT connector and connect it to the + OUTPUT connector. Set the HI AMPLITUDE—FAST RISE switch to FAST RISE. Adjust the vertical deflection factor to produce a display about three divisions in amplitude.

13. Rotate the + TRANSITION AMPLITUDE control throughout its range. Note the change in output amplitude between about 50 millivolts and 500 millivolts. Also note that the square wave starts from a negative potential and goes to zero volts. The fast-rise portion of the square wave is the positive-going transition.

14. Disconnect the five-nanosecond cable from the + OUTPUT connector and connect it to the — OUTPUT connector.

15. Rotate the — TRANSITION AMPLITUDE control throughout its range. Note the change in output amplitude between about 50 millivolts and 500 millivolts. Also note that the square wave starts from a positive potential and goes to zero volts. The fast-rise portion of the square wave is the negative-going transition.

16. If an external signal is available (2.5 - 50 volt square wave or 5 - 100 volt sine wave) the function of the SYNC INPUT connector can be demonstrated (suggested source, 1-kHz oscilloscope calibrator). Connect the external signal

# TYPE 106

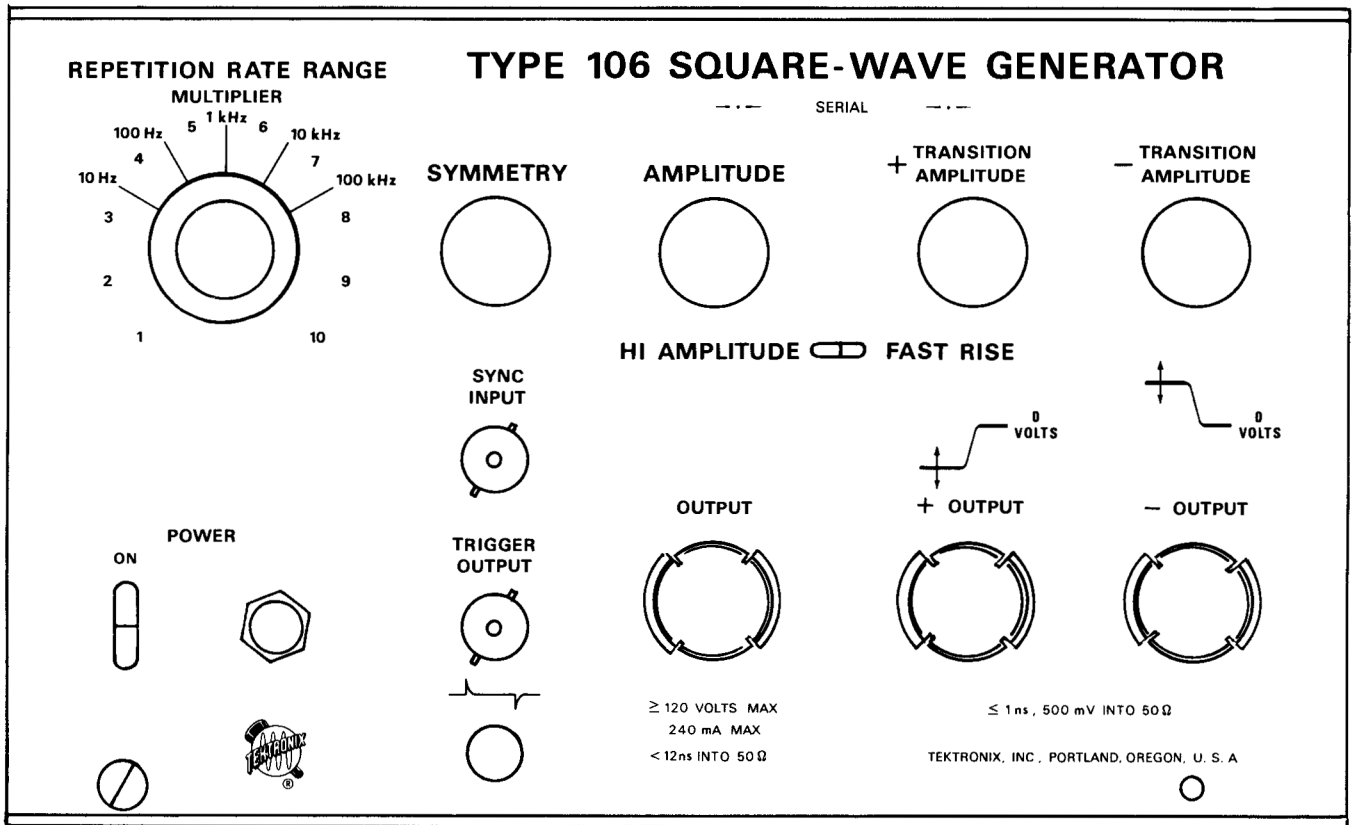


Fig. 2-3. Control set-up chart.

to the SYNC INPUT connector. Set the REPETITION RATE RANGE switch to 100 kHz and the MULTIPLIER to about 7. Note the repetition rate of the square wave and then disconnect the sync signal. Note the change in repetition rate indicating that the square wave is no longer synchronized with the external signal.

17. This completes the basic operation procedure for the Type 106. More information will be given under General Operating Information in this section.

### CONTROL SETUP CHART

Fig. 2-3 shows the front panel of the Type 106. This chart can be reproduced and used as a test-setup record for special measurements, applications or procedures, or it may be used as a training aid for familiarization with this instrument.

### GENERAL OPERATING INFORMATION

#### Output Signals

The output signals available from the Type 106 are shown in Fig. 2-4. These waveform photographs were taken on an oscilloscope which was triggered from the TRIGGER OUTPUT signal to show time relationship of the signals. Notice the zero reference level shown for the square-wave outputs, in particular, the fast-rise outputs. The signal available at the + OUTPUT connector is a positive-going signal which starts from a negative potential and goes to zero volts. The signal available at the - OUTPUT connector is a negative-going signal which starts from a positive potential and goes to zero volts. The polarity indications on the front panel refer to the portion of the square wave which possesses the desired characteristics (e.g., the + OUTPUT signal has a fast-rising, positive-going leading edge).

#### Output Termination

Minimum risetime and optimum pulse characteristics can be obtained only if the outputs are terminated in 50 ohms. A special in-line termination is supplied with the Type 106 for this purpose. This termination also serves as an adapter from the GR outputs of the Type 106 to a BNC input connector on the device under test. If terminations other than this in-line termination are used, they must be capable of dissipating the power available at the OUTPUT (HI AMPLITUDE) connector.

To obtain output amplitudes above about 12 volts from the OUTPUT (HI AMPLITUDE) connector, the output cable must be unterminated. This will result in slower risetime and more pulse aberrations. However, the resultant waveform is satisfactory for most applications where a high-amplitude square wave is needed such as checking the compensation of an attenuator.

#### Trigger Output

In some applications, it may be desirable to trigger the device under test from a signal which is coincident with the leading edges of the square-wave signal applied. The signal available at the TRIGGER OUTPUT connector is intended for

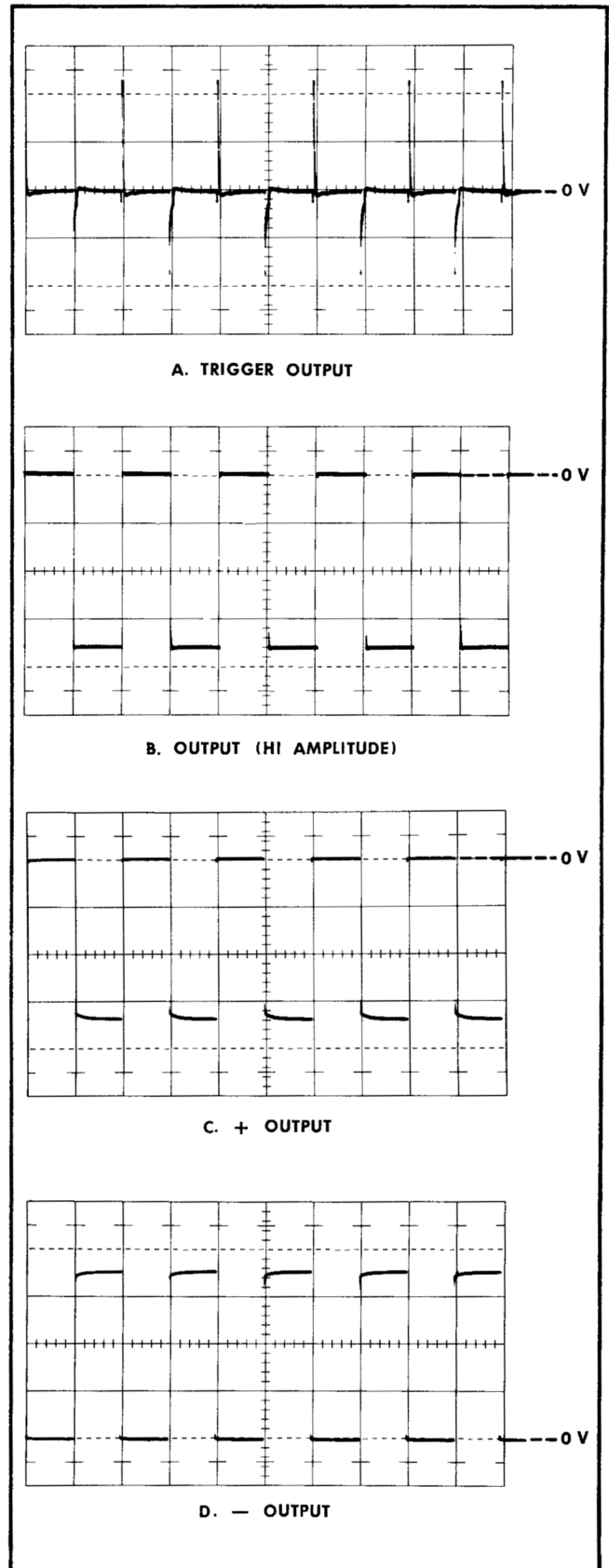


Fig. 2-4. Output signals available from the Type 106. Dotted line shows zero-volt DC level for each waveform (repetition rate, 100 kHz).

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this purpose. The positive-going and negative-going trigger pulses are coincident with the rise and fall, respectively, of the square wave at the OUTPUT (HI AMPLITUDE) connector. The positive-going trigger pulses are coincident with the fast-rise outputs. However, the negative-going pulses may lead the trailing edge of the fast-rise outputs.

### Symmetry

The SYMMETRY control on the front panel allows the relationship between the time duration of the positive and negative portions of the square wave to be adjusted with respect to each other. This control allows at least  $\pm 5\%$  change in the duty cycle of the output square wave. The symmetry of the square wave may be adjusted to provide equal time duration for the positive and negative portions, or it may be adjusted to make either portion longer in duration. The SYMMETRY control may need re-adjustment when changing repetition rate, output amplitude or when using sync operation as described in the following topic.

### Sync Operation

The output square waves of the Type 106 can be synchronized with an external signal source or an accurate frequency source (such as a Tektronix Type 184 Time-Mark Generator) by applying the external signal to the SYNC INPUT connector. Use the following procedure to synchronize the Type 106 output signals with an external signal.

1. Connect the external signal to the SYNC INPUT connector. If the signal is a pulse or a square wave, it must be between 2.5 and 50 volts in amplitude; if it is a sine wave, it must be between 5 and 100 volts in amplitude, peak to peak.
2. Set the REPETITION RATE RANGE switch and the MULTIPLIER control to a repetition rate setting slightly less than that of the applied synchronizing signal.
3. Adjust the symmetry control for a symmetrical output square wave.

## BASIC APPLICATIONS

The following information describes the procedure and technique for using the Type 106 Square-Wave Generator to make basic measurements. These applications are not described in detail since each application must be adapted to the requirements of the individual measurements. Familiarity with the Type 106 will permit these basic techniques to be applied to a wide variety of uses.

### Risetime Measurements

The Type 106 can be used in conjunction with an oscilloscope to measure risetime. Risetime is normally measured between the 10% and 90% points on the leading edge of a waveform. Falltime can be measured using this same basic technique to measure the time between the 90% and 10% point on the trailing edge.

Before measuring the risetime of the device under test, the combined risetime of the Type 106 and the oscilloscope

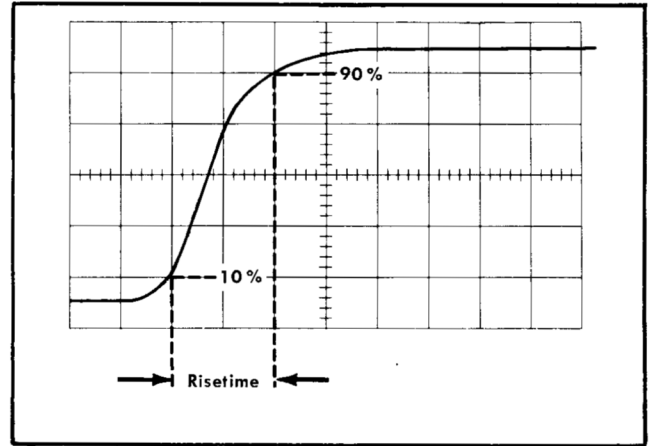


Fig. 2-5. Risetime measurement on a typical waveform.

must be known. Steps 1 through 4 of the following procedure measure this combined risetime. These steps may also be used to measure the risetime of an oscilloscope vertical system by substituting the resultant risetime in the formula given in step 8 (see Example 2) and computing the risetime.

1. Connect the + or - OUTPUT signal to the input of the oscilloscope. Terminate the output of the Type 106 correctly as described in this section.
2. Set the oscilloscope to display the leading edge of the waveform.
3. Determine the 10% and 90% points on the leading edge of the waveform.
4. Measure the time duration between these points (see Fig. 2-5). This is the combined risetime of the Type 106 and the oscilloscope ( $T_{re}$ ).
5. Connect the output of the Type 106 to the input of the device under test. Terminate the Type 106 output as in step 1.
6. Connect the output of the device under test to the input of the oscilloscope. Terminate the device in its characteristic impedance for optimum performance.
7. Set the oscilloscope controls to display the leading edge of the waveform.
8. Measure the time duration between the 10% and 90% points on the leading edge of the waveform. This is the overall risetime ( $T_{rt}$ ). Substitute this value in the formula:

$$T_r = (T_{rt}^2 - T_{re}^2)^{1/2}$$

Where  $T_r$  = Risetime of device under test

$T_{rt}$  = Overall risetime

$T_{re}$  = Risetime of measuring equipment

### NOTE

When the combined risetime of the measuring equipment is 0.1 times or less that of the overall risetime, it affects the calculations very slightly and may be ignored for most computations. The risetime of the device under test then becomes the value measured in step 8.

**Example 1.** To illustrate the use of this method to measure the risetime of an external device, assume that the overall risetime is 17 nanoseconds and the risetime of the measuring equipment is 7 nanoseconds.

Substituting the given values in the formula:

$$T_r = (17^2 - 7^2)^{1/2} = (289 - 49)^{1/2} = (240)^{1/2}$$

The risetime of the device under test is 15.5 nanoseconds.

**Example 2.** To illustrate the use of this method to measure the vertical risetime of an oscilloscope, assume that the

overall risetime is 5 nanoseconds. The risetime of the applied signal (Type 106 fast-rise output) is 1 nanosecond.

Substituting the given values in the formula:

$$T_r = (5^2 - 1^2)^{1/2} = (25 - 1)^{1/2} = (24)^{1/2}$$

The risetime of the device under test is 4.9 nanoseconds.

Notice that although the risetime of the measuring equipment (generator) is 0.2 times the overall risetime it decreases the actual risetime by only 0.1 nanosecond.

### Checking System Response

The square-wave output of the Type 106 can be used for checking the response of active or passive systems. Since the characteristics of the Type 106 pulse are known (see Characteristics section), distortion of the waveform beyond these limits is due to the device under test. The following procedures list several of the tests which can be made.

**Compensation.** The compensation of an AC-voltage divider such as is used in the input attenuator of an oscilloscope or a passive attenuator probe, can be checked by observing its response when a square-wave signal is applied. Correct response is shown by optimum square corner on the displayed waveform. If the waveform has spike, rolloff or front-corner rounding, the system is not correctly compensated. Fig. 2-6 shows typical waveforms illustrating correct and incorrect compensation adjustments.

**Low-Frequency Response.** Limited low-frequency response is shown by a trailing-edge droop in the flat-top portion of the square wave (see Fig. 2-7). Apply a symmetrical square-wave of a repetition rate which is not affected by the low-frequency limit. Note the amplitude and then slowly reduce the square-wave frequency until the trailing corner of the square wave falls to 63% of the amplitude at the leading edge. The low-frequency response (30% down) of

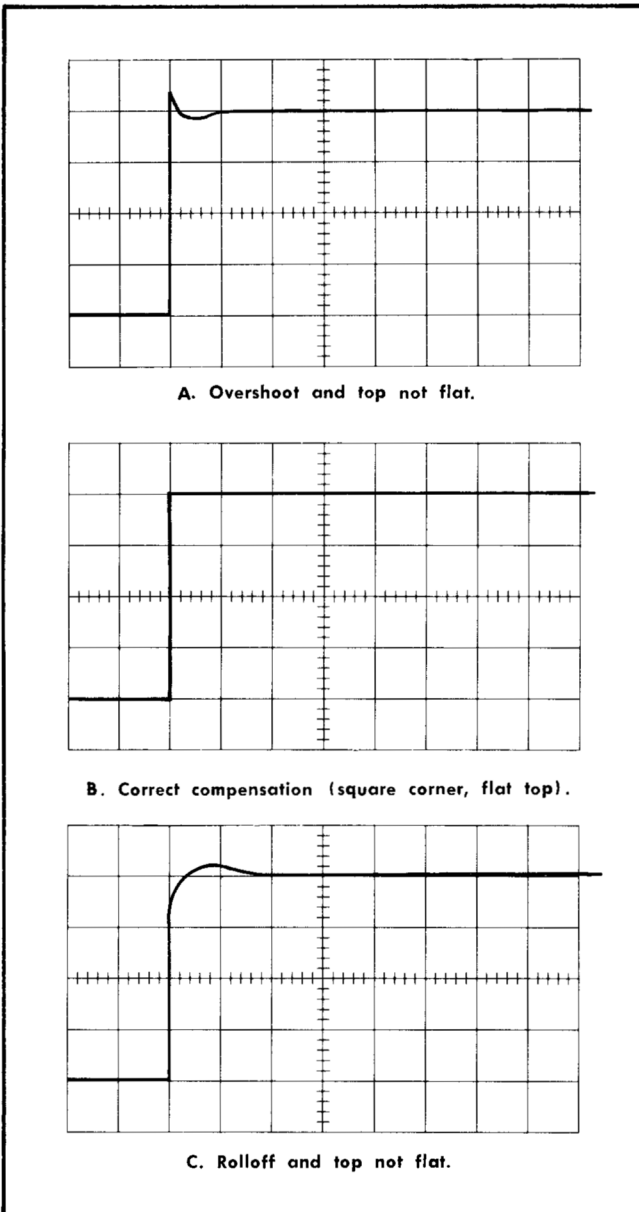


Fig. 2-6. Typical waveforms showing correct and incorrect compensation adjustments.

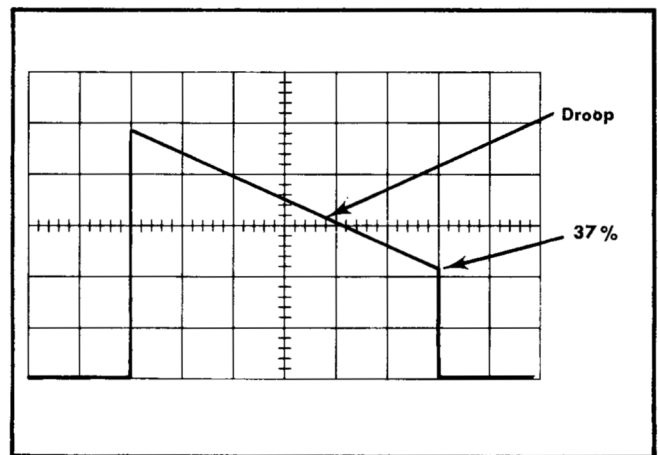


Fig. 2-7. Typical waveform showing limited low-frequency response.

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is one half the repetition rate of the applied square wave signal at this point.

**High-Frequency Response.** Incorrect high-frequency response will be shown by aberrations at the front corner of the square wave. Ringing indicates incorrect peaking adjustments. Overshoot and roll-off indicate incorrect capacitive compensation. Fig. 2-8 shows these effects on a typical waveform (see Fig. 2-6 for effect of compensation).

Limited high-frequency response is also shown by a slower risetime. Risetime of the waveform is measured as discussed under Risetime Measurements. The upper frequency response limit (at 30% down) can be calculated from the measured risetime using the formula:

$$f = \frac{0.35}{T_r}$$

Where  $f$  = upper 30% down frequency

$T_r$  = Risetime

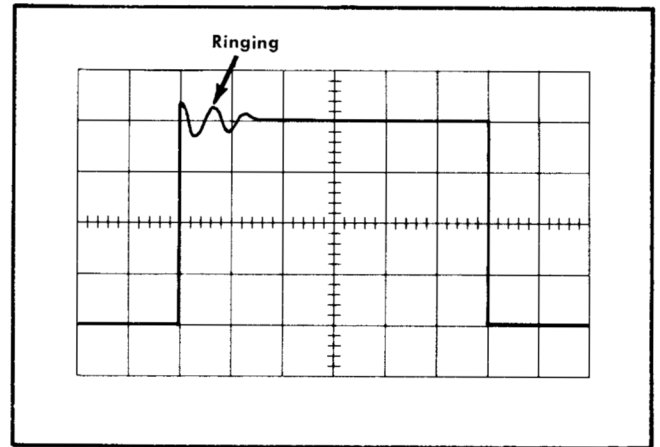


Fig. 2-8. Typical waveform showing ringing at front corner.

# SECTION 3

## CIRCUIT DESCRIPTION

### Introduction

This section of the manual contains an electrical description of the circuits in the Type 106 Square-Wave Generator. A detailed block diagram is given in the following circuit description. Complete schematic diagrams are given in the Diagrams section. Refer to these diagrams for electrical values and relationship throughout the following circuit description.

### GENERATOR CIRCUIT

#### Multivibrator

The frequency of the output square wave is determined by the Multivibrator, V15 and V25. These tubes are connected as an astable multivibrator with the feedback connected from the plate of each tube to the control grid of the other. The repetition rate of the output square wave is changed by selecting the feedback capacitors, C17A-E and C27A-E, with the REPETITION RATE RANGE switch, SW17. The MULTIPLIER control, R31, varies the repetition rate within the range selected by SW17, by changing the voltage level to which the feedback capacitors C17 and C27 charge. The emitter follower Q33 isolates the MULTIPLIER control, R31, from the multivibrator and allows a more linear change in repetition rate. The Rep Rate Multiplier Cal ( $\times 1$ ) adjustment, R30, provides calibration of the repetition rate when the MULTIPLIER control is set to 1.

The Symmetry Range adjustment, R9, is adjusted to balance the plate current of V15 and V25 to produce a symmetrical square wave when the SYMMETRY control is set to mid-range. The RC networks R12-C12 and R22-C22 provide correct operation of the multivibrator for low-frequency operation. L13 and L23 provide high-frequency peaking and aid in switching the multivibrator.

Symmetry of the square wave can be controlled by the front-panel SYMMETRY control. This control changes the balance between the levels on the screen grids of the multivibrator tubes to alter their cycle of operation. The symmetry of the output square wave can be changed from a duty cycle of 45% or less to 55% or more. The Rep Rate Multiplier Cal ( $\times 10$ ) adjustment, R6, varies the level of the screen grids equally to provide correct repetition rate when the MULTIPLIER control is set to 10.

#### Sync Amplifier

Synchronizing signals connected to the SYNC INPUT connector are AC-coupled to the base of Q4 by C1. Transistor Q4 is normally biased off. Therefore, only the input pulses which exceed this bias are allowed to pass to the Multivibrator stage through D5. This diode disconnects the two circuits when the Multivibrator voltage goes more negative than the voltage at the collector of Q4.

The output signal is synchronized with an external signal in the following manner. The synchronizing signal from Q4 and D5 is applied to the grid of V15 through C27 and

R14. This pulse will switch V15 off and force the multivibrator to operate at a different frequency than that selected by the REPETITION RATE RANGE switch and the MULTIPLIER control. However, in order for this forced switching to occur, the multivibrator must be operating at a repetition rate slightly less than the repetition rate of the applied signal. When V15 is forced off, V25 will come on and conduct in the normal manner through its half of the cycle. The output square wave produced in this manner will be unsymmetrical, since V25 conducts for the normal period and V25 is forced out of conduction sooner than normal. This can be compensated for in normal use by balancing the duty cycle of the square wave with the SYMMETRY control.

#### Shaper Amplifier and Trigger Output

The output square wave from the Multivibrator stage is shaped and amplified by Q34. When the signal at the cathode of V15 goes positive, it will have some overshoot at the leading edge. Q34 eliminates this overshoot and produces a square-cornered signal at its collector.

Emitter-follower Q43 provides isolation between the Drive Amplifier and Trigger Output stages and the Shaper Amplifier. The trigger signal available at the front-panel TRIGGER OUTPUT connector is obtained at the emitter of Q43. This signal is differentiated by the network C45-R46.

#### Driver Amplifier

The Driver Amplifier Q54 provides the final amplification for the control signal before it is applied to the Output Amplifier stage. D53 and D54 protect the transistor from being overdriven by a large signal at the base. The output signal at the collector of Q54 is coupled to the grids of the Output Amplifier tubes to control the frequency of the output square wave.

#### Output Amplifier

The four tubes in the Output Amplifier, V64-V74-V84-V94, are connected in parallel to provide high output current. The load resistor for this stage is R99 when operated unterminated. When the OUTPUT connector is connected to a terminated system, the load resistor is R99 paralleled by the external termination. The square corner and flat top of the output square wave is achieved by switching the plates of the Output Amplifier tubes from a negative potential to ground. The cathodes are at a negative potential. When the rising portion of the square wave begins, the plates of the Output Amplifier tubes are also at a negative potential. The signal applied from the Driver Amplifier stage turns the Output Amplifier tubes off and their plates rise positive to ground. Then, when the Multivibrator stage switches, the Output Amplifier tubes conduct and the plates go negative again to complete the cycle.

The amplitude of the output square wave is controlled by varying the cathode potential of the Output Amplifier tubes.

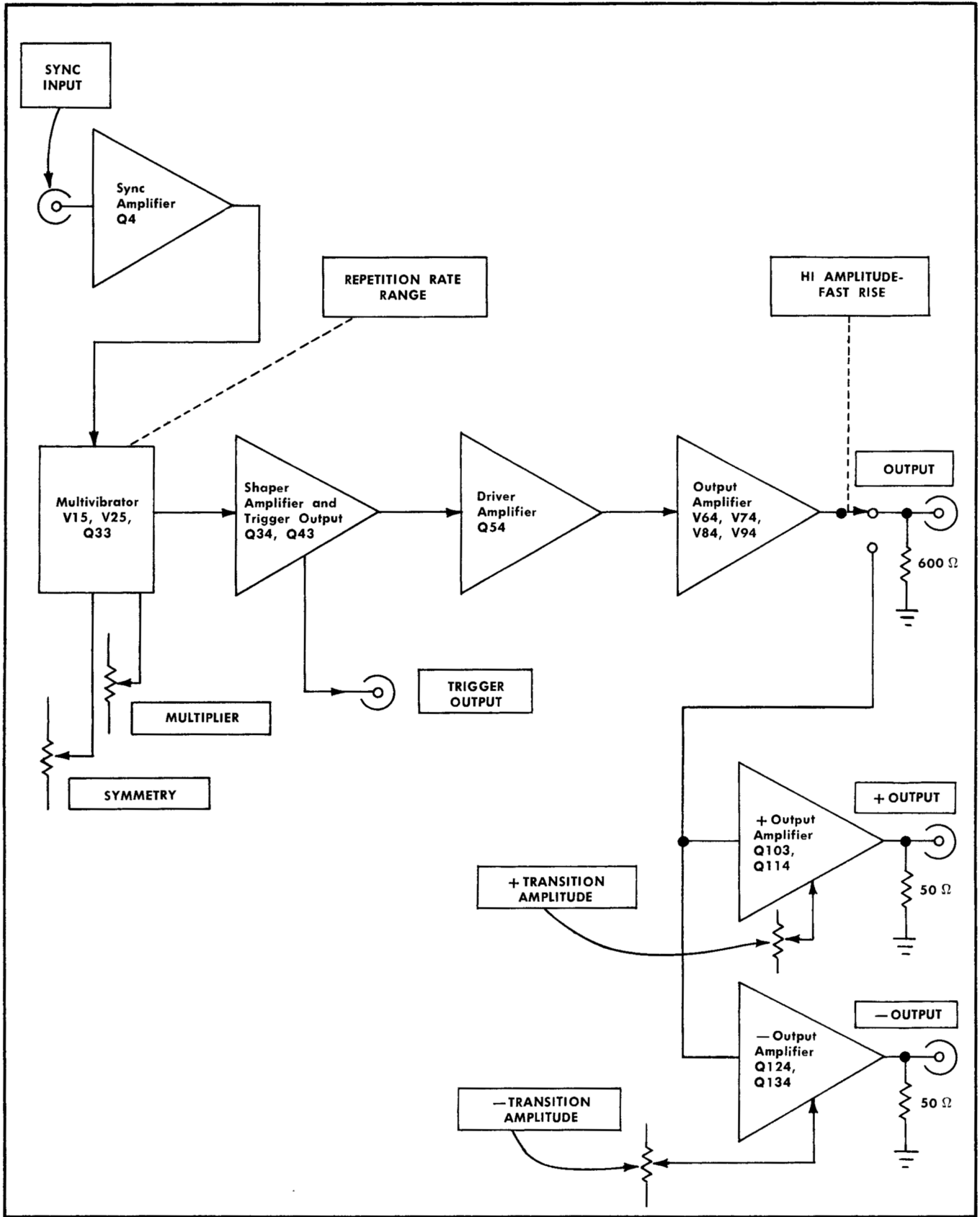


Fig. 3-1. Detailed block diagram of the Generator circuit.

The AMPLITUDE control, R246, (located in the Power Supply), varies the output of the A Supply which is connected to the cathodes. As the cathode level is raised (towards ground) the current through the tubes is limited to produce a square-wave output of less amplitude.

The output of the Output Amplifier stage is connected either to the OUTPUT connector when the HI AMPLITUDE — FAST RISE switch is set to HI AMPLITUDE or to the + and — Output Amplifiers in the FAST RISE position.

### + Output Amplifier

When the HI AMPLITUDE — FAST RISE switch is set to FAST RISE, the amplitude of the square wave produced by the Output Amplifier stage is fixed at maximum by SW242B in the Power Supply. This square-wave output signal is applied to transistors Q103 and Q124 through the compensating networks C102-C103-R103 and C122-C123-R123. Emitter follower Q103 passes the signal on to Q114. The purpose for Q103 is to match the delay that exists in the — Output stage because of the inverter transistor Q124. D103 protects the base of Q103 from going more negative than the emitter. D105 clamps the signal which is applied to Q114 so it is always positive.

Quiescently when Q114 is off, current is flowing between ground and the —10-Volt supply through R119, D118, D117, R114 and R115. As Q114 comes on, this current is interrupted and current flows between the +10-Volt supply and the —10-Volt supply through D104, Q103, R107, Q114, R114 and R115. This reverse biases D117 and D118 which interrupts current through R119. D117 and D118 are low-capacitance, fast turnoff diodes which provide a fast leading edge. When these diodes turn off, the voltage at the +OUTPUT connector rises quickly from a negative potential to ground which produces a positive-going fast-rise square-wave output. The +TRANSITION AMPLITUDE control, R115, varies the output amplitude by changing the current which flows quiescently through R119. C107 and C118 provide adjustment for optimum square corner on the leading edge of the output square wave. D114 clamps the output so it does not rise above ground potential.

### — Output Amplifier

The —Output Amplifier operates in much the same manner as described for the +Output Amplifier. Q124 inverts the signal applied to Q134, D123 protects Q124, and D125 clamps the signal so it is always negative. Quiescently, current is flowing between ground and the +10-Volt supply through R139, D138, D137, R134 and R135. As Q114 comes on, this current is interrupted and current flows between the —10-Volt supply and the +10-Volt supply through D124, Q124, R127, Q134, R134 and R135. This reverse biases D137 and D138 which interrupts current through R139. When D137 and D138 turn off, the voltage at the —OUTPUT connector goes quickly from a positive potential to ground which produces a negative-going fast-rise square-wave output. The —TRANSITION AMPLITUDE control, R135, varies the output amplitude by changing the current which flows quiescently through R139. C127 and C138 provide adjustment for optimum square corner on the leading edge of the square wave. D134 clamps the output so it does not go below ground potential.

## POWER SUPPLY

### General

The Power Supply provides the operating power for the Type 106 from five regulated supplies. Electronic regulation is used to provide stable output voltages. A switch on the rear panel changes the instrument from 115-volt nominal line to 230-volt nominal line operation.

### Power Input

Power is applied to the instrument through P201 and is applied to the primary of the transformer, T201, through the line fuse F201, POWER switch SW201, thermal cutout TK201 and the 115 V-230 V Selector switch SW202. The fan is connected across one half of the split primary winding. The 115 V-230 V Selector switch connects the split primaries of T201 in parallel for 115-volt nominal operation or in series for 230-volt nominal operation.

Thermal cutout TK201 provides thermal protection for the instrument by opening to interrupt the applied power if the internal temperature becomes too high.

### A — 150-Volt Supply

The output of one secondary winding of T201 is rectified by bridge rectifier D222 to provide power for the A —150-Volt Supply. The rectified power is regulated as follows to provide a stable output voltage:

Reference for this supply with respect to the A Supply is provided by zener diode D224 which holds the emitter of Q224 approximately 75 volts more positive than the output of the A — 150 Volt Supply. Divider R228-R229 sets the base voltage of Q224 about half way between the output voltages of the A Supply and this supply, and the collector current of Q224 controls the conduction of Q227 to regulate the output. As the A Supply voltage is changed to adjust output pulse amplitude, the resulting voltage changes through Q224 and Q227 cause the output of this supply to follow the A Supply at a level approximately 150 volts more negative than the A Supply.

Ripple in the output voltage is held to a minimum by feeding a sample of the output back to the regulator transistor Q227. To understand this operation, assume that the ripple is in the negative half of its cycle. This negative voltage change at the output is connected to the emitter of the error amplifier Q224 through D224 resulting in increased current flow through Q224. The increased collector current of Q224 pulls the base of Q227 negative and reduces its collector current. The result is a reduction in output current which opposes the original output change due to ripple, and provides a stable output voltage. In a similar manner, the regulator circuit compensates for changes in input voltage or changes in load current.

### A Supply

Rectified voltage for operation of the A Supply is provided by voltage divider R246-R247-R248 between the —20-Volt Supply and ground. The A Supply in reference to ground

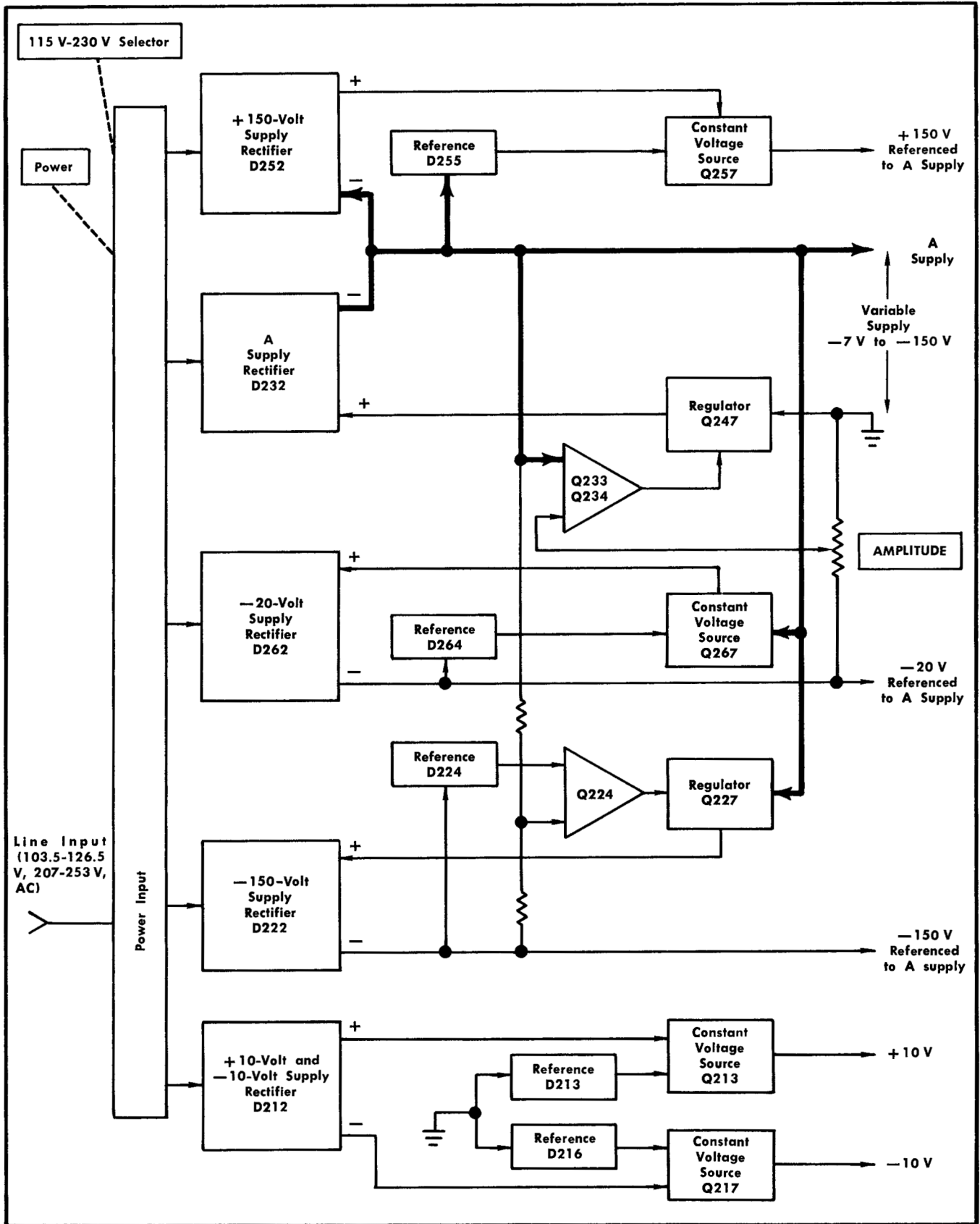


Fig. 3-2. Detailed block diagram of Power Supply circuit.

is a variable voltage output that is held constant at a selected value by the differential amplifier Q233-Q234. The differential amplifier samples the A Supply voltage and compares it against an adjustable voltage derived from the —20-Volt Supply. The AMPLITUDE control, R246 and the Amplitude Cal adjustment, R247 comprise the voltage divider to select the A Supply voltage. The AMPLITUDE control changes the level at the base of Q234 to vary the output of this supply (resulting in a change in the square-wave amplitude). The Amplitude Cal adjustment is adjusted to provide correct maximum amplitude of the square wave. Q223 and Q234 comprise the error amplifier and Q247 is the regulator transistor. Regulation is controlled in a manner similar to that described for the A —150-Volt Supply.

### **A + 150-Volt Supply**

Rectifier D252 provides power for operation of the A + 150-Volt Supply. Zener diode D255 provides reference voltage for the output of the supply. Since the anode of D255 is connected to the output of the A Supply, it will maintain a voltage at the base of Q257 which follows the changes of the A Supply but is 150 volts more positive. The output voltage at the emitter of the constant voltage source transistor,

Q257, will follow the voltage at its base and maintain a + 150 volt difference between this supply and the A Supply.

### **A — 20-Volt Supply**

Rectifier D262 provides power for operation of the A — 20-Volt Supply. Zener diode D264 provides the reference for the output of this supply. D264 is connected from the base of Q267 to the A — 20-Volt output and maintains a 20 volt difference between the base-emitter of Q267 and the output. The output voltage follows the level at the emitter of Q267 (A Supply voltage) but is always 20 volts more negative.

### **+10-Volt and — 10-Volt Supplies**

Rectifier D212 provides power for operation of the +10-Volt and —10-Volt Supplies. Transistors Q213 and Q217 are constant voltage source transistors whose emitters follow the voltage established at the base. The +10-volt output is established by Zener diode D213 at the base of Q213. The —10-volt output is established by Zener diode D216 connected to the base of Q217. The POWER ON light is connected to the output of the —10-Volt Supply to indicate when power is applied and the instrument is turned on.

# SECTION 4

## MAINTENANCE

### Introduction

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance, or troubleshooting of the Type 106.

### PREVENTIVE MAINTENANCE

#### General

Preventive maintenance consists of cleaning, visual inspection, lubrication, etc. Preventive maintenance performed on a regular basis will help prevent instrument failure and will improve reliability of the instrument. The severity of the environment to which the Type 106 is subjected will determine the frequency of maintenance.

#### Cleaning

The Type 106 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components prevents efficient heat dissipation. It also provides an electrical conduction path.

#### CAUTION

**Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Some chemicals to avoid are benzene, toluene, xylene, acetone or similar solvents.**

**Air Filter.** The air filter should be visually checked every few weeks and cleaned or replaced if dirty. More frequent inspections are required under severe operating conditions. The following procedure is suggested for cleaning the filter. If the filter is to be replaced, order new air filters from your local Tektronix Field Office or representative; order by Tektronix Part No. 378-0035-01.

1. Remove the filter by pulling it out of the retaining frame on the rear panel. Be careful not to drop any of the accumulated dirt into the instrument.
2. Flush the loose dirt from the filter with a stream of hot water.
3. Place the filter in a solution of mild detergent and hot water.
4. Squeeze the filter to wash out any dirt which remains.
5. Rinse the filter in clear water and allow it to dry.
6. Coat the dry filter with an air-filter adhesive (available from air conditioner suppliers or order Tektronix Part No. 006-0580-00).
7. Let the adhesive dry thoroughly.
8. Re-install the filter in the retaining frame.

**Exterior.** Loose dust accumulated on the outside of the Type 106 can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened with a mild solution of water and detergent. Abrasive cleaners should not be used.

**Interior.** Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning ceramic terminal strips and circuit boards.

#### Lubrication

The reliability of potentiometers, rotary switches, and other moving parts can be maintained if they are kept properly lubricated. Use a cleaning-type lubricant (such as Tektronix Part No. 006-0218-00) on shaft bushings and switch contacts. Lubricate switch detents with a heavier grease (such as Tektronix Part No. 006-0219-00). Potentiometers should be lubricated with a lubricant which will not affect electrical characteristics (such as Tektronix Part No. 006-0220-00). Do not use excessive lubrication. A lubrication kit containing the necessary lubricants and instructions is available from Tektronix, Inc. Order Tektronix Part No. 003-0342-00.

During routine maintenance, the fan-motor bearings should be lubricated. Fig. 4-1 shows the lubrication holes in the fan. Place a few drops of light machine oil in the holes. Remember that too much lubrication is as harmful to the fan motor as too little lubrication.

#### Visual Inspection

The Type 106 should be inspected occasionally for such defects as broken connections, broken or damaged ceramic terminal strips, improperly seated tubes or transistors, damaged circuit boards or heat-damaged parts.

The remedy for most visible defects is obvious; however, care must be taken if heat-damaged parts are located. Overheating is usually only a symptom of trouble. For this reason, it is essential to determine the actual cause of overheating before the heat-damaged part is replaced; otherwise, the damage may be repeated.

#### Tube and Transistor Checks

Periodic checks of the tubes and transistors in the Type 106 are not recommended. The best check of tube or transistor performance is its actual operation in the instrument. More detail on checking tube and transistor operation is given under Troubleshooting.

## Recalibration

To assure accurate measurements, check the calibration of this instrument after each 500 hours of operation or every six months if used infrequently. In addition, replacement of components may necessitate recalibration of the affected circuits. Complete instructions are given in the Calibration section.

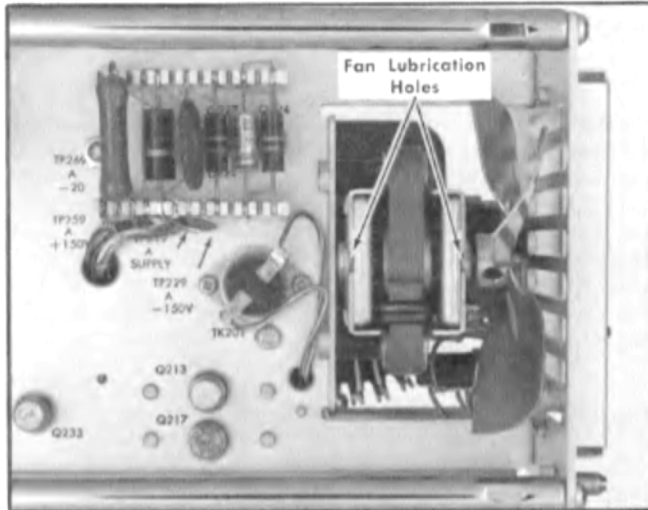


Fig. 4-1. Location of lubrication holes in fan (right side).

The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases minor troubles not apparent during normal use may be revealed and/or corrected by recalibration.

## CORRECTIVE MAINTENANCE

### General

Corrective maintenance consists of component replacement and instrument repair. Special techniques or procedures required to replace components in the Type 106 are described here.

### Obtaining Replacement Parts

**Standard Parts.** All electrical and mechanical part replacements for the Type 106 can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, consult the parts lists for value, tolerance and rating.

#### NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance at high frequencies. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

**Special Parts.** In addition to the standard electronic components, some special parts are used in the Type 106. These parts are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special parts are indicated in the parts list by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc.

**Ordering Parts.** When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type.
2. Instrument serial number.
3. A description of the part (if electrical, include circuit number).
4. Tektronix Part Number.

## Soldering Techniques

### WARNING

Disconnect the instrument from the power source before soldering.

**Ceramic Terminal Strips.** Solder used on the ceramic terminal strips should contain about 3% silver. Ordinary tin-lead solder can be used occasionally without damage to the ceramic terminal strips. Use a 40- to 75-watt soldering iron with a 1/8-inch wide chisel-shaped tip. If ordinary solder is used repeatedly or if excessive heat is applied, the solder-to-ceramic bond may be broken.

A roll of 3% silver is mounted on the rear of the instrument. Additional silver solder should be available locally, or it can be purchased directly from Tektronix, Inc. Order by Tektronix Part No. 251-0514-00.

Observe the following precautions when soldering ceramic terminal strips.

1. Use a hot iron for a short time. Apply only enough heat to make the solder flow freely.
2. Maintain a clean, properly tinned tip.
3. Avoid putting pressure on the ceramic terminal strip.
4. Do not attempt to fill the terminal-strip notch with solder; use only enough solder to cover the wires adequately.
5. Clean the flux from the terminal strip with a flux-remover solvent.

**Circuit Boards.** 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 wiring from the base material.

The following technique should be used to replace a component on a circuit board. Most components can be replaced without removing the boards from the instrument.

1. 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.

2. 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.

3. If a wire extends beyond the solder joint, clip off the 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. 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.

4. 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.

5. Clip the excess lead that protrudes through the board.

6. Clean the area around the soldered connection with a flux-remover solvent. Be careful not to remove information printed on the board.

**Metal Terminals.** When soldering metal terminals (e.g., switch terminals, potentiometers, tube or transistor socket contacts, etc.), ordinary 60/40 solder can be used. The soldering iron should have a 40- to 75-watt rating with a  $\frac{1}{8}$  inch wide chisel-shaped tip.

Observe the following precautions when soldering metal terminals:

1. Apply only enough heat to make the solder flow freely.
2. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.
3. If a wire extends beyond the solder joint, clip off the excess.
4. Clean the flux from the solder joint with a flux-remover solvent.

## Component Replacement

### WARNING

Disconnect the instrument from the power source before replacing components.

**Removing the Cabinet.** The Type 106 is held into the cabinet by the securing screw on the lower left corner of the front panel. To remove the cabinet, loosen this screw and slide the instrument out of the cabinet.

### CAUTION

The cabinet of the Type 106 is designed to direct the flow of air through the instrument. Operation of the instrument for a prolonged period of time without the cabinet may cause the instrument to overheat and the thermal cutout to open more frequently.

**Ceramic Terminal Strip Replacement.** A complete ceramic terminal strip assembly is shown in Fig. 4-2. Replace-

ment strips (including studs) and spacers are supplied under separate part numbers. The old spacers may be re-used if they are not damaged.

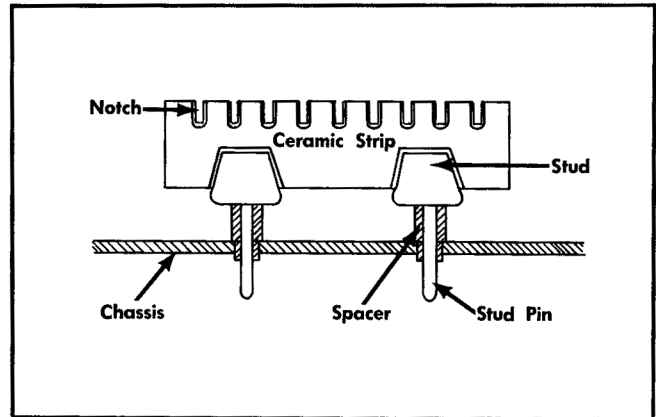


Fig. 4-2. Ceramic terminal strip assembly.

To replace a ceramic terminal strip, first unsolder all connections. Then, the damaged strip can be pried or pulled loose from the chassis. If the spacers come out with the strip, remove them from the stud pins to be used for installation of the new strip.

After the damaged strip has been removed, place the undamaged spacers in the chassis holes. Then, carefully press the studs into the spacers until completely seated. If necessary, use a soft mallet and tap lightly, directly over the stud area of the strip.

**Circuit Board Replacement.** If a circuit board is damaged and cannot be repaired, the entire assembly including all soldered-on components, or the board only, can be replaced. Part numbers are given in the Mechanical Parts List for either the completely-wired board or the unwired board.

All connections are soldered to the circuit boards. Most of the components mounted on the boards can be replaced without removing the board from the instrument. Observe the soldering precautions given under Soldering Techniques in this section. However, if the board itself must be replaced, use the following procedure:

1. Unsolder all leads connected to the board. Observe the soldering precautions given in this section.
2. Remove the securing nut holding the connector and circuit board assembly to the front panel (see Fig. 4-3) and remove the assembly. Use a General Radio wrench designed for this purpose.
3. Loosen the two clamp screws (see Fig. 4-3).
4. Unsolder the connection between the connector and the board and separate the units. (See Connector Repair or Termination Replacement which follows to repair these parts.)
5. To replace the board, reverse the order of removal. Correct connection of the interconnecting leads is shown in Figs. 4-6 and 4-7.

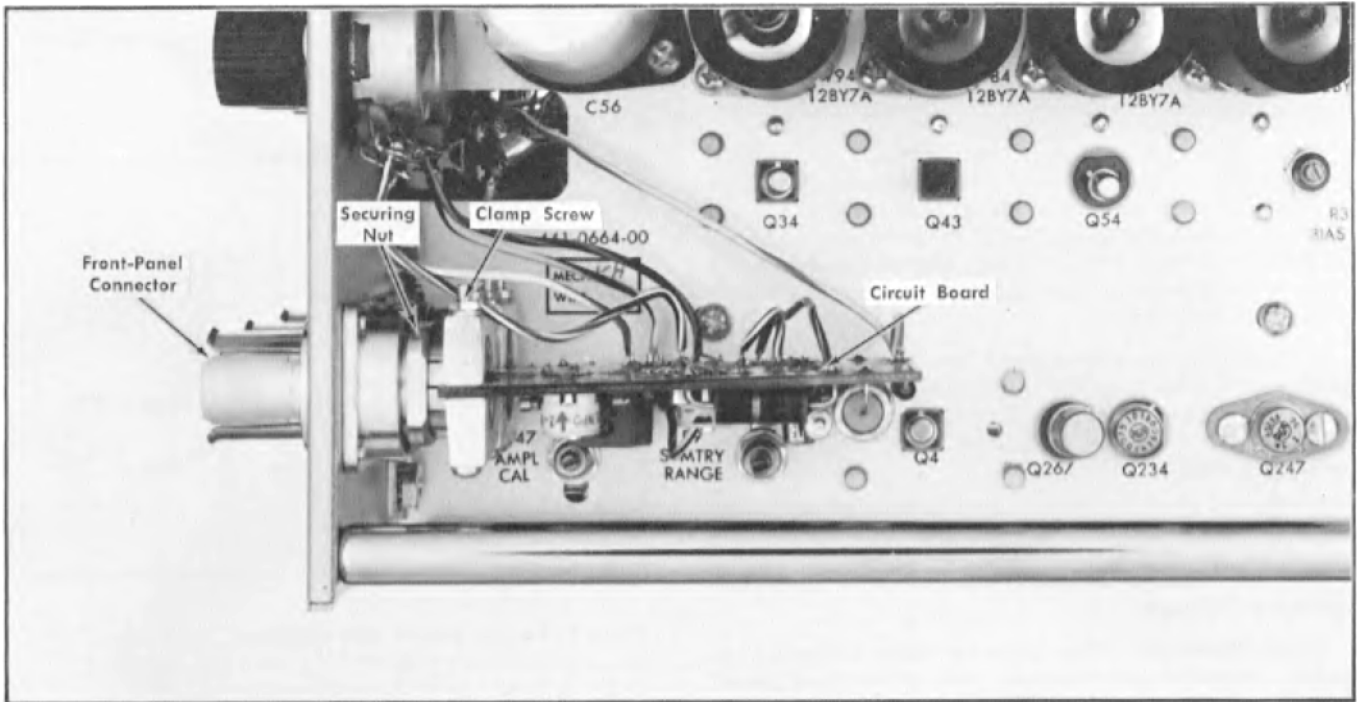


Fig. 4-3. Removing the + and - Output circuit board assemblies.

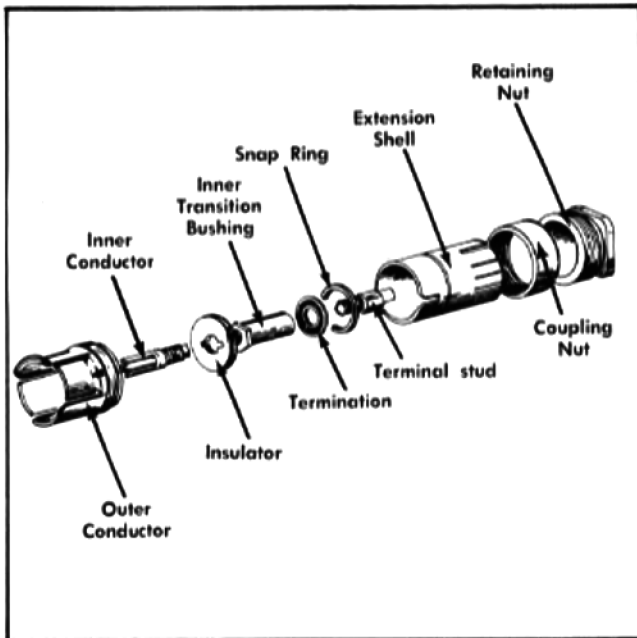


Fig. 4-4. Exploded view of + and - Output connectors.

**Connector Repair or Termination Replacement.** Use the following procedure to repair the connector or replace the termination. Fig. 4-4 shows the connector and its parts.

1. Follow steps 1 through 4 of the procedure under Circuit Board Replacement.
2. Use a special General Radio jig to hold the inner contact of the connector. Then, remove the hex nut on the

outside of the termination. The disc termination can now be removed from the connector.

3. To completely disassemble the connector, remove the remaining hex nut.

4. The connector can be re-assembled by reversing the steps above.

**Tube and Transistor Replacement.** Tubes and transistors should not be replaced unless actually defective. If removed during routine maintenance, return them to their original sockets. Unnecessary replacement of tubes or transistors may affect the calibration of this instrument. Replacement tubes or transistors should be of the original type or a direct replacement. When tubes or transistors are replaced, check the calibration of that part of the circuit which may be affected.

**Rotary Switches.** Individual wafers or mechanical parts of rotary switches are normally not replaced. If a switch is defective, replace the entire assembly. Replacement switches can be ordered either wired or unwired; refer to the Electrical Parts List for the applicable part number.

When replacing a switch, it is recommended that the leads and switch terminals be tagged with corresponding identification tags as the leads are disconnected. Then, use the old switch as a guide for installing the new one. An alternative method is to draw a sketch of the switch layout and record the wire color at each terminal.

## TROUBLESHOOTING

### Introduction

The following information is provided to facilitate troubleshooting of the Type 106, if trouble develops. Information

contained in other sections of this manual should be used along with the following information to aid in locating the defective component.

**Troubleshooting Aids**

**Diagrams.** Circuit diagrams are given on foldout pages in Section 9. The circuit number and electrical value of each component in this instrument as well as important voltages and waveforms are shown on the diagrams.

**Component Numbers.** The circuit number of each electrical part in this instrument is shown on the circuit diagram. Each main circuit is assigned a series of circuit numbers. Table 4-1 lists the main circuits in the Type 106 and the series of circuit numbers assigned to each. For example, using Table 4-1 a resistor numbered R134 is identified as being located in the Fast Rise Output circuit.

**TABLE 4-1**  
Circuit Numbers

Circuit Number on Diagrams	Circuit
1 - 99	Generator
100 - 199	Fast Rise Output
200 - 299	Power Supply

**Switch Wafer Identification.** Switch wafers shown on the diagrams are coded to indicate the position of the wafer in the complete switch assembly. The numbered portion of the code refers to the wafer number counting from the front or mounting end of the switch toward the rear. The letters F and R indicate whether the front or rear of the wafer performs the particular switching function. For example, a wafer designated 2R indicates that the rear of the second wafer is used for this particular switching function.

**Circuit Boards.** Figs. 4-6 and 4-7 show the circuit boards used in the Type 106. Each electrical component on the boards is identified by its circuit number. Correct connection of the interconnecting leads is also shown. The boards are outlined on the diagrams with a blue line. These pictures used along with the diagrams will aid in locating the components mounted on the circuit boards.

**TABLE 4-2**

SUPPLY	BACK-GROUND COLOR	1st STRIPE	2nd STRIPE	3rd STRIPE
A Supply	Tan	Violet	Green	Black
A +150 V	White	Brown	Brown	Green
A -150 V	Tan	Brown	Brown	Green
A -20 V	Tan	Brown	Red	Brown
-10 Volt	Tan	Brown	Black	Brown
+10 Volt	White	Brown	Black	Black

**Wiring Color-Code.** All insulated wire used in the Type 106 is color-coded according to the EIA standard color-code (as used for resistors) to facilitate point-to-point circuit tracing. The widest color stripe identifies the first color of the code. Power-supply voltages can be identified by three color stripes and the following background color-code: white, positive voltage; tan, negative voltage. Table 4-2 shows the wiring color-code for the power-supply voltages

used in the Type 106. The remainder of the wiring in the Type 106 is color-coded with two or less stripes or has a solid background without stripes. The color-coding helps to trace a wire from one point in the instrument to another.

**Resistor Color-Code.** A number of precision metal-film resistors are used in this instrument. These resistors can be identified by their grey body color. If a metal-film resistor has a value indicated by three significant figures and a multiplier, it will be color-coded according to the EIA standard resistor color-code. If it has a value indicated by four significant figures and a multiplier, the value will be printed on the body of the resistor. For example, a 333 kΩ resistor will be color-coded, but a 333.5 kΩ resistor will have its value printed on the resistor body. The color-code sequence is shown in Fig. 4-5.

Composition resistors are color-coded according to the EIA standard resistor color-code.

**Troubleshooting Techniques**

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks assure proper connection, operation and calibration. If the trouble is not located by these checks, the remaining steps

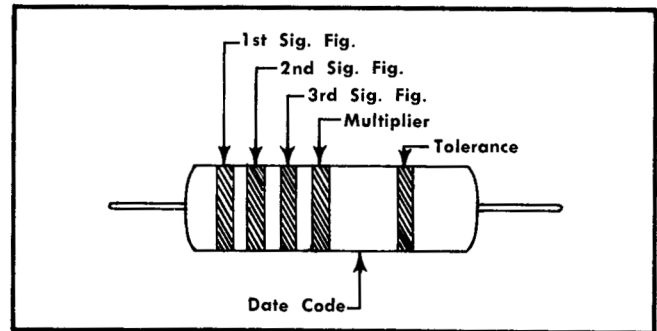


Fig. 4-5. Color-coding of metal-film resistors.

aid in locating the defective circuit and component. When the defective component is located, it should be replaced following the replacement procedures given in this section.

**1. Check Associated Equipment.** Before proceeding with troubleshooting of the Type 106, check that the equipment used with the Type 106 is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source.

**2. Check Control Settings.** Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control, see the Operating Instructions section of this manual.

**3. Check Instrument Calibration.** Check the calibration of the instrument, or the affected circuit if the trouble exists in one circuit. The indicated trouble may only be a result

of misadjustment, or may be corrected by calibration. Complete instructions are given in the Calibration section of this manual. Individual calibration steps can be performed out of sequence. However, if the step affects the calibration of other circuits in the instrument, a more complete calibration will be necessary.

**4. Isolate Trouble to a Circuit.** To isolate a trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. When trouble symptoms appear in more than one circuit, check all affected circuits. Methods of checking the circuits are given in steps 5 through 7.

Incorrect operation of all circuits often indicates trouble in the Power Supply. Check first for correct voltage of the individual supplies. However, a defective component elsewhere in the instrument can appear as a power-supply trouble and may also affect the operation of other circuits.

After the defective circuit has been located, proceed with steps 5 through 7 to locate the defective component(s). If the trouble has not been isolated to a circuit using the procedure described here, check voltages and waveforms as explained in step 6 to locate the defective circuit.

**5. Visual Check.** Visually check the circuit in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged circuit boards or damaged components.

**6. Check Voltages and Waveforms.** Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are shown on the diagrams.

#### NOTE

**Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the first diagram page.**

A. **VOLTAGES.** Voltage measurements should be taken with a 20,000 ohms/volt DC voltmeter. Accuracy of the voltmeter should be within 3% on all ranges. Be sure that the test prods are well insulated to prevent accidental shorting of components.

B. **WAVEFORMS.** Use a test oscilloscope which has the following minimum specifications:

Bandwidth: DC to 30 MHz

Deflection factor: 0.05 volts/division minimum

Input impedance: 1 Megohm paralleled by about 20 pF

**7. Check Individual Components.** The following procedures describe methods of checking individual components in the Type 106. Components which are soldered in place can be checked most easily by disconnecting one end. This eliminates incorrect measurements due to the effects of surrounding circuitry.

A. **TUBES AND TRANSISTORS.** The best check of tube and transistor operation is actual performance under operating conditions. If a tube or transistor is suspected of being defective, it can best be checked by substituting a new component or one which has been checked previously. However, be sure that circuit conditions are not such that a replacement tube or transistor might also be damaged. If substitute tubes or transistors are not available, a dynamic tester may be used (such as Tektronix Type 570 or Type 575). Static-type testers are not recommended since they do not check operation under simulated operating conditions.

B. **DIODES.** 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.**

C. **RESISTORS.** Resistors can be checked with an ohmmeter. Check the Electrical Parts List for the tolerance of resistors used in this instrument. Resistors should be replaced if the measured value is outside the specified tolerance.

D. **INDUCTORS.** Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit. Partial shorting often reduces high-frequency response (roll-off).

E. **CAPACITORS.** A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter, or by checking whether the capacitor passes AC signals.

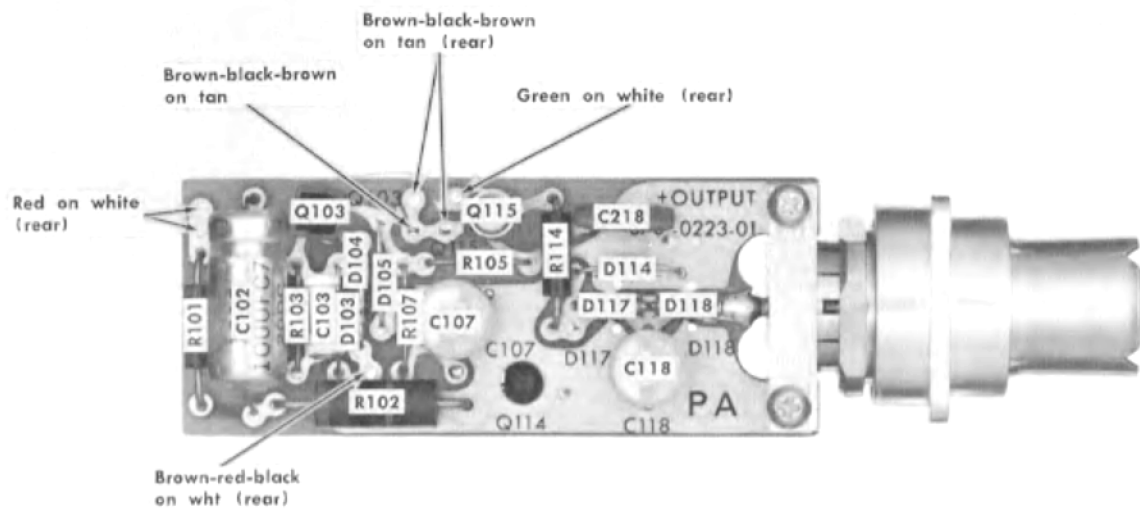


Fig. 4-6A. + Output Amplifier circuit board (above SN 1190).

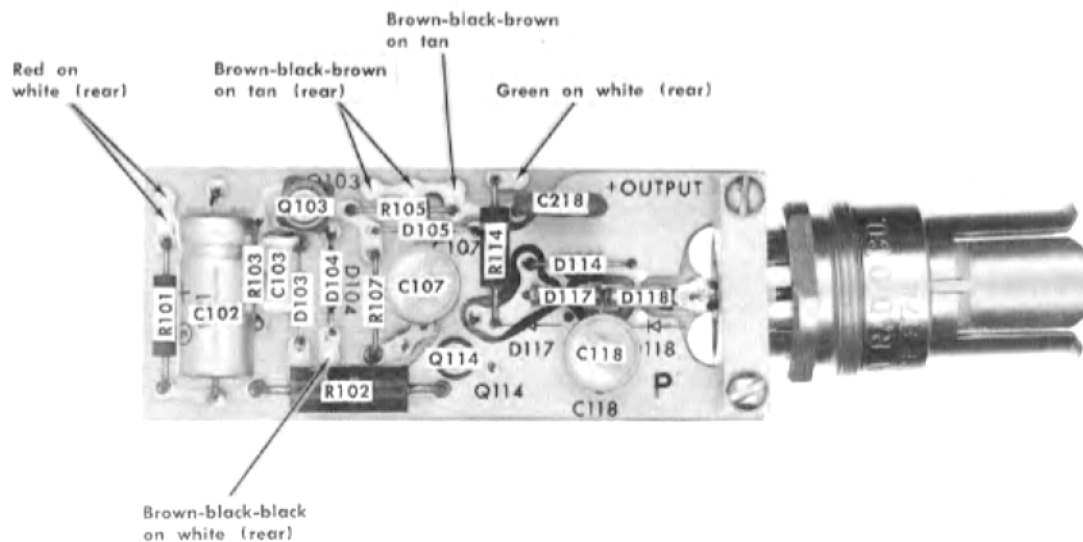


Fig. 4-6B. + Output Amplifier circuit board (SN 200 to 1189).

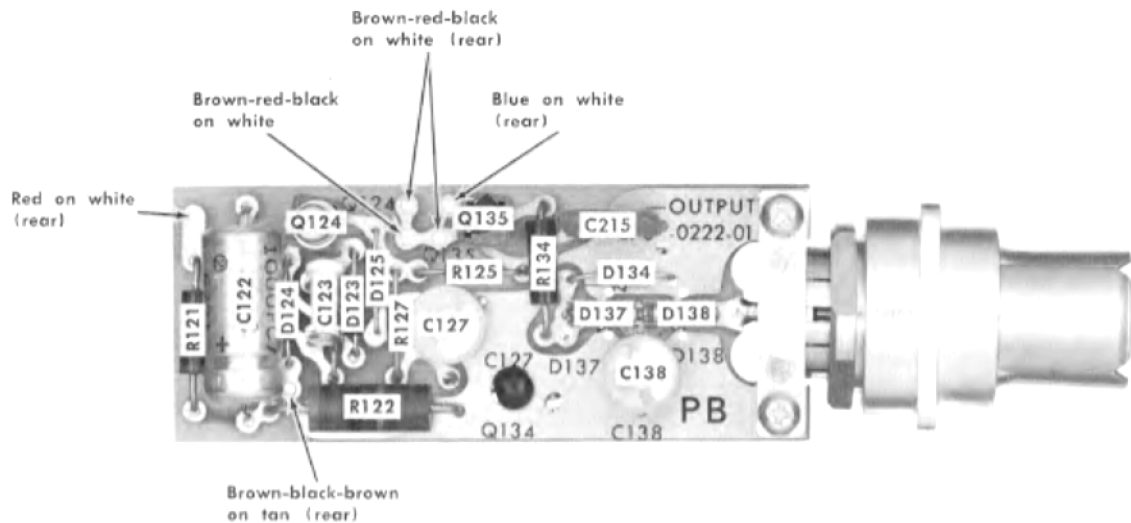


Fig. 4-7A. — Output Amplifier circuit board (above SN 1190).

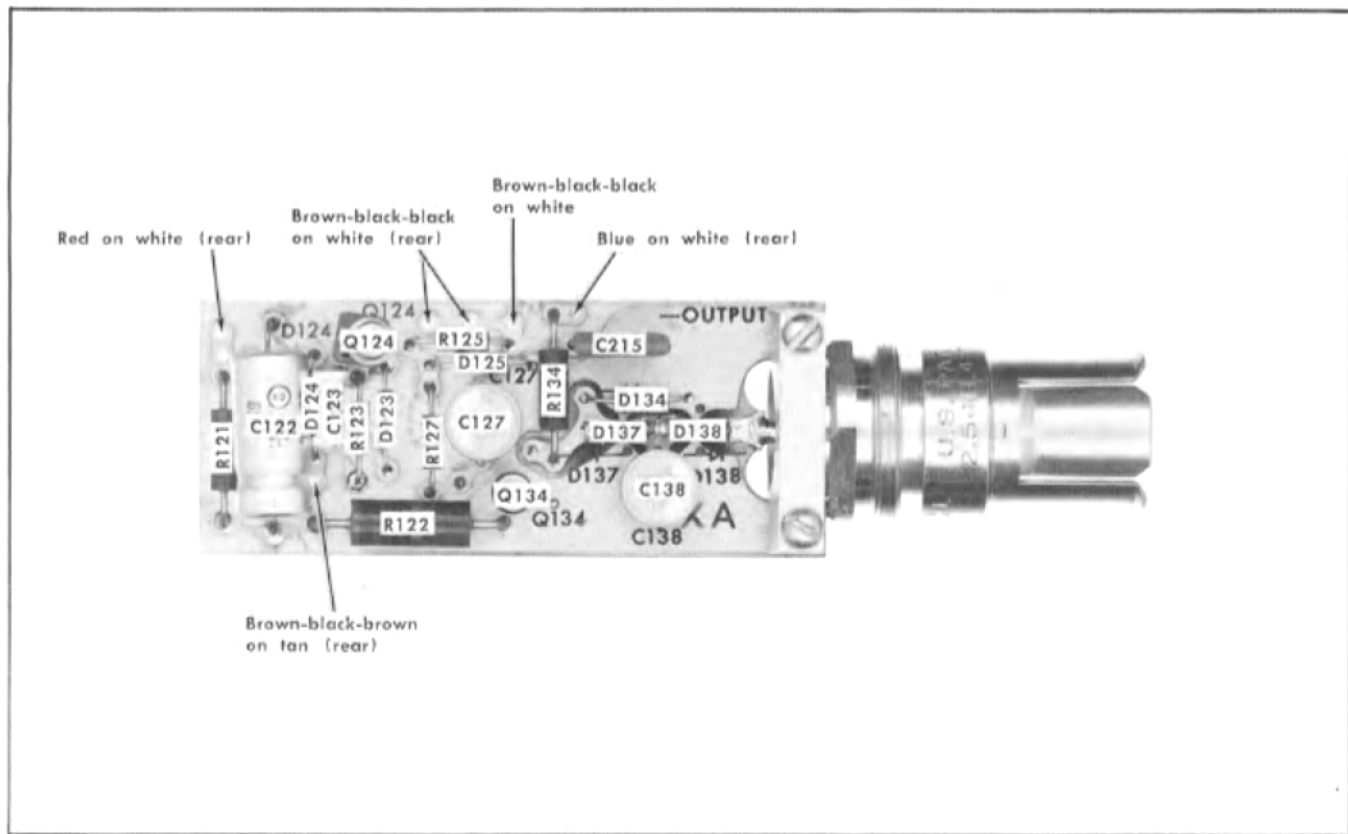


Fig. 4-7B. — Output Amplifier circuit board (SN 200 to 11891).

# SECTION 5

## PERFORMANCE CHECK

### Introduction

This performance check procedure is provided to check the operation of the Type 106 without removing the cabinet. This procedure may be used for incoming inspection, instrument familiarization, reliability testing, calibration verification, etc.

If the instrument does not meet the performance requirements given in this procedure, internal checks and/or adjustments are required. See the Calibration section. All performance requirements given in this section correspond to those given in the Characteristics section.

### Recommended Equipment

The following equipment is recommended for a complete performance check. Specifications given are the minimum necessary to perform this procedure. All equipment is assumed to be calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

1. Test oscilloscope. Frequency response, DC to 30 MHz; minimum deflection factor, 20 millivolts/division; accuracy, within  $\pm 3\%$ ; must have 1 kHz amplitude calibrator output voltages of 1, 5 and 50 volts and a dual-trace vertical system. Tektronix Type 545B Oscilloscope with Type 1A2 Dual-Trace Plug-In Unit recommended.

2. Sampling oscilloscope. Risettime, 0.35 nanoseconds; calibrated deflection factor, 10 millivolts/division minimum; calibrated sweep range, equivalent to 100 nanoseconds/division to 0.2 nanoseconds/division. Tektronix Type 661 Oscilloscope with Type 4S3 Sampling-Probe Dual-Trace Unit and Type 5T3 Timing Unit recommended.

3. Delay cable. Impedance, 50 ohms; electrical length, 60 nanoseconds; connectors, GR874. Tektronix Type 113 Delay Cable recommended.

4. Time-mark generator. Marker outputs, 1 microsecond to 1 second; marker accuracy, within 0.1%. Tektronix Type 184 Time-Mark Generator recommended.

5. Cable. Impedance, 50 ohms; type RG-213/U; electrical length, five nanoseconds; connectors, GR874. Tektronix Part No. 017-0502-00.

6. Thru-line termination. Impedance, 50 ohms; wattage ratings, 1.0 watts; accuracy,  $\pm 3\%$ ; connectors, GR874 input with BNC female output. Tektronix Part No. 017-0083-00.

7. Adapter. Connectors, GR874 and BNC female. Tektronix Part No. 017-0063-00.

8. Cable (two). Impedance, 50 ohms; type, RG-58A/U; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0057-01.

9. Termination. Impedance, 50 ohms; accuracy,  $\pm 3\%$ ; connectors, BNC. Tektronix Part No. 011-0049-00.

10. BNC T connector. Tektronix Part No. 103-0030-00.

11. Attenuator. Attenuation,  $10\times$ ; impedance, 50 ohms; accuracy,  $\pm 3\%$ ; connectors, GR874. Tektronix Part No. 017-0078-00.

12. VP-2 Voltage Pickoff. Tektronix Part No. 017-0077-00.

13. End-line termination. Impedance, 50 ohms; accuracy,  $\pm 3\%$ ; connectors, GR874. Tektronix Part No. 017-0081-00.

### PERFORMANCE CHECK PROCEDURE

#### General

In the following procedure, control settings or test equipment connections should not be changed except as noted. If only a partial check is desired, refer to the preceding step(s) for setup information. Type 106 front-panel control titles referred to in this procedure are capitalized (e.g., AMPLITUDE).

The following procedure uses the equipment listed under Recommended Equipment. If equipment is substituted, control settings or setup may need to be altered to meet the requirements of the equipment used.

#### Preliminary Procedure

1. Connect the Type 106 to a power source which meets the voltage and frequency requirements of this instrument.

2. Set the Type 106 controls as follows:

REPETITION RATE RANGE	1 kHz
MULTIPLIER	10 (clockwise)
SYMMETRY	Midrange
AMPLITUDE	Counterclockwise
HI AMPLITUDE — FAST RISE	HI AMPLITUDE
+ TRANSITION AMPLITUDE	Counterclockwise
— TRANSITION AMPLITUDE	Counterclockwise
POWER	ON

3. Allow at least five minutes warm up at  $25^{\circ}\text{C}$ ,  $\pm 5^{\circ}$  for checking the instrument to the given accuracy.

#### 1. Check Amplitude Control Range

a. REQUIREMENT—0.5 volt or less to 12 volts or greater into 50-ohm load. 7 volts or less to 120 volts or greater, unterminated.

## Performance Check—Type 106

b. Connect the OUTPUT (HI AMPLITUDE) connector to the input of the test oscilloscope through the five-nanosecond GR cable and the 50-ohm in-line termination.

c. Set the test oscilloscope vertical deflection to 0.1 volts/division and the sweep rate to 50 microseconds/division.

d. CHECK—Test oscilloscope display amplitude for five divisions or less (0.5 volt or less).

e. Set the test oscilloscope vertical deflection to 2 volts/division.

f. Turn the AMPLITUDE (HI AMPLITUDE) control fully clockwise.

g. CHECK—Test oscilloscope display amplitude for six divisions or greater (12 volts or greater).

h. Set the test oscilloscope vertical deflection to 20 volts/division.

i. Remove the 50-ohm in-line termination and connect the five-nanosecond cable to the test oscilloscope input using the GR-to-BNC adapter.

j. CHECK—Test oscilloscope display for 6 divisions minimum amplitude (120 volts or greater).

k. Turn the AMPLITUDE (HI AMPLITUDE) control fully counterclockwise.

l. Set the test oscilloscope vertical deflection to two volts/division.

m. CHECK—Test oscilloscope display for 3.5 divisions or less amplitude (seven volts or less).

### 2. Check Symmetry Range

a. REQUIREMENT—Duty cycle variable from 45% or less to 55% or greater.

b. Connect the OUTPUT (HI AMPLITUDE) connector to the input of the test oscilloscope through the five-nanosecond GR cable and the 50-ohm in-line termination.

c. Set the AMPLITUDE (HI AMPLITUDE) control to mid-range.

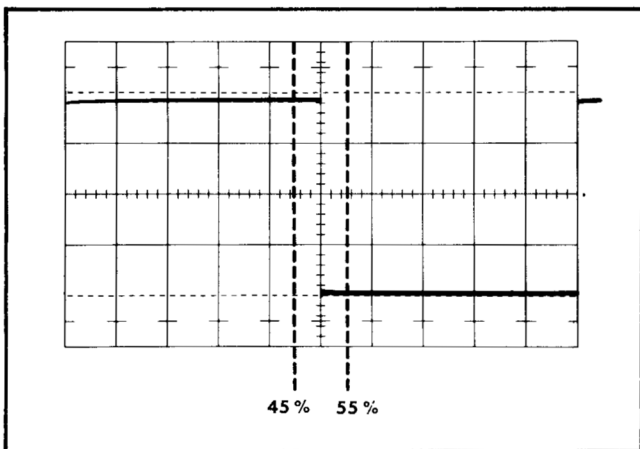


Fig. 5-1. Typical test oscilloscope display showing symmetry limits.

d. Set the SYMMETRY control fully clockwise.

e. Set the test oscilloscope sweep rate to display one complete cycle in 10 divisions (use variable control).

f. CHECK—Positive portion of square wave for duration of 5.5 divisions or more (55% duty cycle or more; see Fig. 5-1).

g. Set the SYMMETRY control fully counterclockwise.

h. If necessary, readjust the sweep rate to display one complete cycle in 10 divisions.

i. CHECK—Positive portion of square wave for duration of 4.5 divisions or less (45% duty cycle or less; see Fig. 5-1).

### 3. Check Repetition Rate

a. REQUIREMENT—Repetition rate range of at least  $1\times$  to  $10\times$  value indicated by REPETITION RATE switch.

b. Connect the time-mark generator output to the channel 2 input connector of the test oscilloscope through a 50-ohm BNC cable and a 50-ohm termination. Set the time-mark generator for .1 millisecond markers.

c. Set the AMPLITUDE (HI AMPLITUDE) control to mid-range.

d. Set the test oscilloscope vertical deflection to display about two divisions of the signal on each channel in the alternate mode.

e. Using the Type 106, time-mark generator and test oscilloscope settings given in Table 5-1, check repetition rate for correct maximum and minimum repetition rate at each position of REPETITION RATE switch.

f. Disconnect all test equipment.

### 4. Check Synchronized Operation

a. REQUIREMENT—Output signal synchronizes with 2.5 to 50 volt input square wave.

b. Connect the test-oscilloscope amplitude calibrator to the SYNC INPUT connector and the channel 1 input connector through a BNC T connector and two 50-ohm BNC cables.

c. Connect the OUTPUT (HI AMPLITUDE) connector to the channel 2 input connector through a five-nanosecond GR cable and a 50-ohm in-line termination.

d. Set the REPETITION RATE RANGE switch to 100 Hz and the multiplier to about 7.

e. Set the test oscilloscope amplitude calibrator for five volts output and the sweep rate to 0.5 millisecond/division.

f. Set the test oscilloscope to trigger from channel 1 in the chopped mode.

g. CHECK—Test oscilloscope for stable display of the channel 2 waveform (readjust the MULTIPLIER if necessary).

h. Set the test oscilloscope amplitude calibrator for 50 volts output.

i. CHECK—Test oscilloscope for stable display of the channel 2 waveform.

j. Set the test oscilloscope amplitude calibrator for one volt output.

**TABLE 5-1**  
Repetition Rate

REPETITION RATE RANGE Swith Setting	MULTIPLIER Control Setting	Time Markers Applied	Test Oscilloscope Sweep Rate	CRT Display (Cycles/Marker)
100 kHz	cw	10 $\mu$ s	1 $\mu$ s/div	$\geq 10$
100 kHz	ccw	10 $\mu$ s	1 $\mu$ s/div	$\leq 1$
10 kHz	cw	0.1 ms	10 $\mu$ s/div	$\geq 10$
10 kHz	ccw	0.1 ms	10 $\mu$ s/div	$\leq 1$
1 kHz	cw	1 ms	0.1 ms/div	$\geq 10$
1 kHz	ccw	1 ms	0.1 ms/div	$\leq 1$
100 Hz	cw	10 ms	1 ms/div	$\geq 10$
100 Hz	ccw	10 ms	1 ms/div	$\leq 1$
10 Hz	cw	0.1 s	10 ms/div	$\geq 10$
10 Hz	ccw	0.1 s	10 ms/div	$\leq 1$

k. CHECK—Test oscilloscope for drift of the channel 2 waveform due to inadequate sync signal.

l. Disconnect all test equipment.

## 5. Check Trigger Output

a. REQUIREMENT—Amplitude, 0.1 volt positive and negative into 50 ohms.

Risetime, 50 nanoseconds or less, between 0 and 0.1 volt.

Delay Time, 50 nanoseconds or less.

b. Connect the TRIGGER OUTPUT connector to the channel 2 input connector of the test oscilloscope through a 50-ohm BNC cable and a 50-ohm BNC termination.

c. Connect the OUTPUT (HI AMPLITUDE) connector to the channel 1 input of the test oscilloscope through a 50-ohm GR cable and a 50-ohm in-line termination.

d. Connect the vertical plug-in unit trigger output to the test oscilloscope trigger input through a 50-ohm BNC cable for external triggering. Set the plug-in unit trigger selector switch to channel 1.

e. Set the test oscilloscope to display the channel 2 signal at a vertical deflection of 0.1 volt/division and a sweep rate of 10 microseconds/division.

f. Set the REPETITION RATE RANGE switch to 100 kHz and the MULTIPLIER control to 1.

g. CHECK—Test oscilloscope display for positive and negative pulse amplitude of 1 division minimum (0.1 volt minimum; see Fig. 5-2A).

h. Set the test oscilloscope sweep rate to 40 nanoseconds/division (use magnifier).

i. Position the display to observe the leading edge of the positive pulse.

j. CHECK—Test oscilloscope display for 50 nanoseconds or less between the 0 and 0.1 volt levels of the trigger pulse (see Fig. 5-2B).

k. Set the test oscilloscope vertical Mode switch to Alt.

l. Position the 50% points of both waveforms to the horizontal centerline.

m. CHECK—Test oscilloscope display for one division or less spacing between the 50% amplitude points of the two waveforms (see Fig. 5-3C).

n. Disconnect all test equipment.

## 6. Check Hi Amplitude Output Into 50 ohms

a. REQUIREMENT—Risetime (terminated in 50 ohms), 12 nanoseconds or less.

Aberrations, 2% or less in first 100 nanoseconds following leading edge.

b. Connect the TRIGGER OUTPUT connector to the 1 M $\Omega$  external trigger input connector of the sampling system through a 50-ohm BNC cable and a 50-ohm BNC termination.

c. Connect the OUTPUT (HI AMPLITUDE) connector to the sampling-system vertical input through a 10 $\times$  GR attenuator, five-nanosecond GR cable, 60-nanosecond delay line and the VP-2 voltage pickoff to the P6038 sampling probe. Terminate the output of the VP-2 with a 50-ohm GR termination. Set the MULTIPLIER control to 10.

d. Set the sampling-system vertical deflection to 200 millivolts/division, time position range switch to one microsecond and magnify the sweep to five nanoseconds/division.

e. Set the triggering and time-position controls for a stable display of the first leading edge.

f. Set the AMPLITUDE (HI AMPLITUDE) control for a five-division display.

g. CHECK—Sampling system display for 2.4 divisions or less between the 10% and 90% points of the leading edge (12 nanoseconds or less; see Fig. 5-3A).

h. Set the sampling system sweep rate to 50 nanoseconds/division and the vertical deflection to 20 millivolts/division. Reposition the top of the waveform onto the viewing area with the DC offset control.

i. CHECK—Sampling system display for aberrations  $\pm$  one division or less in first two divisions following the leading edge ( $\pm 2\%$  or less in first 100 nanoseconds; see Fig. 5-3B).

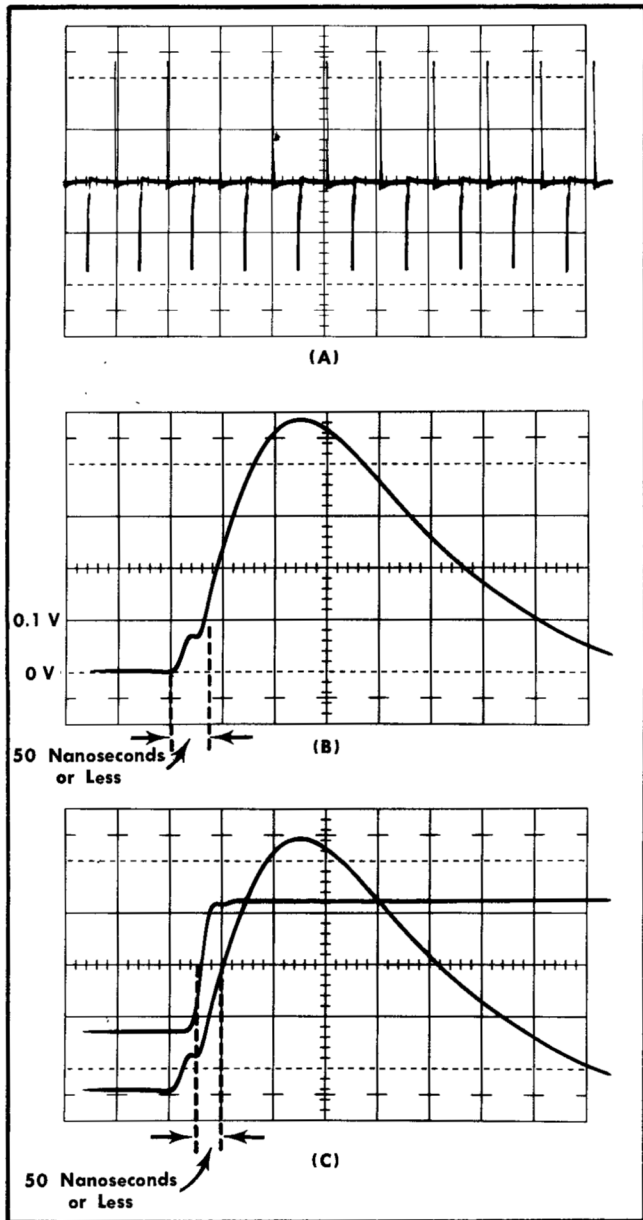


Fig. 5-2. Typical test oscilloscope display when checking TRIGGER OUTPUT; (A) amplitude, (B) risetime, (C) delay time.

### 7. Check + Fast Rise Output

- a. REQUIREMENT—Minimum amplitude, 50 millivolts or less.

Maximum amplitude, 500 millivolts or more.

Risetime, one nanosecond or less.

Aberrations, + and - 2% or less in first five nanoseconds following leading edge.

- b. Disconnect the five-nanosecond GR cable from the 10X attenuator and connect it to the + OUTPUT connector.

- c. Set the HI AMPLITUDE - FAST RISE switch to FAST RISE.

- d. Set the sampling system sweep rate to 10 nanoseconds/division.

- e. CHECK—Sampling system display for 2.5 division or less amplitude (50 millivolts or less).

- f. Set the sampling system vertical deflection to 100 millivolts/division.

- g. Set the + TRANSITION AMPLITUDE control fully clockwise.

- h. CHECK—Sampling system display for five division or more amplitude (500 millivolts or more).

- i. Set the + TRANSITION AMPLITUDE control for five divisions of vertical deflection.

- j. Set the sampling-system time position range switch to 100 nanoseconds and magnify the sweep to one nanosecond/division.

- k. CHECK—Sampling system display for one division or less between the 10% and 90% points of the leading edge (one nanosecond or less; see Fig. 5-4A).

- l. Set the sampling system vertical deflection to 10 millivolts/division. Reposition the top of the waveform onto the viewing area with the DC offset control.

- m. CHECK—Sampling system display for aberrations  $\pm$  one division or less in first five divisions following the leading edge (+ and - 2% or less in first five nanoseconds; see Fig. 5-4B).

### 8. Check - Fast Rise Output

- a. REQUIREMENT—Minimum amplitude, 50 millivolts or less.

Maximum amplitude, 500 millivolts or more.

Risetime, one nanosecond or less.

Aberrations, + and - 2% or less in first five nanoseconds following leading edge.

- b. Disconnect the five-nanosecond cable from the + OUTPUT connector and connect it to the - OUTPUT connector.

- c. Set the sampling-system vertical deflection to 20 millivolts/division and the sweep rate to 10 nanoseconds/division.

- d. CHECK—Sampling system display for 2.5 division or less amplitude (50 millivolts or less).

- e. Set the sampling system vertical deflection to 100 millivolts/division.

- f. Set the - TRANSITION AMPLITUDE control fully clockwise.

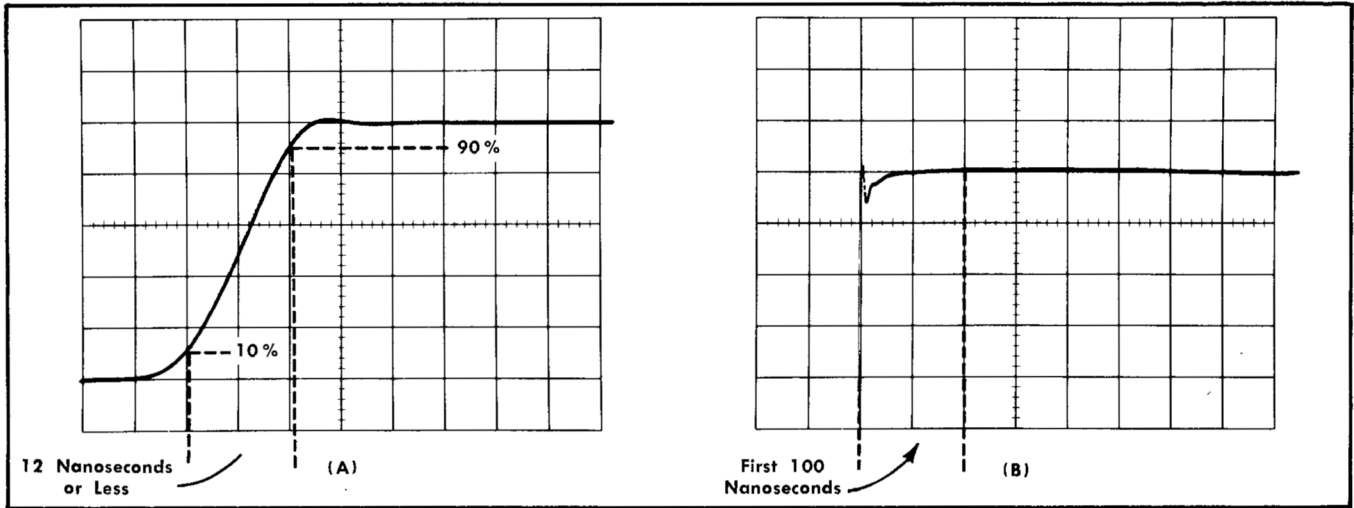


Fig. 5-3. Typical sampling system display when checking OUTPUT (HI AMPLITUDE), (A) risetime, (B) aberrations in first 100 nanoseconds.

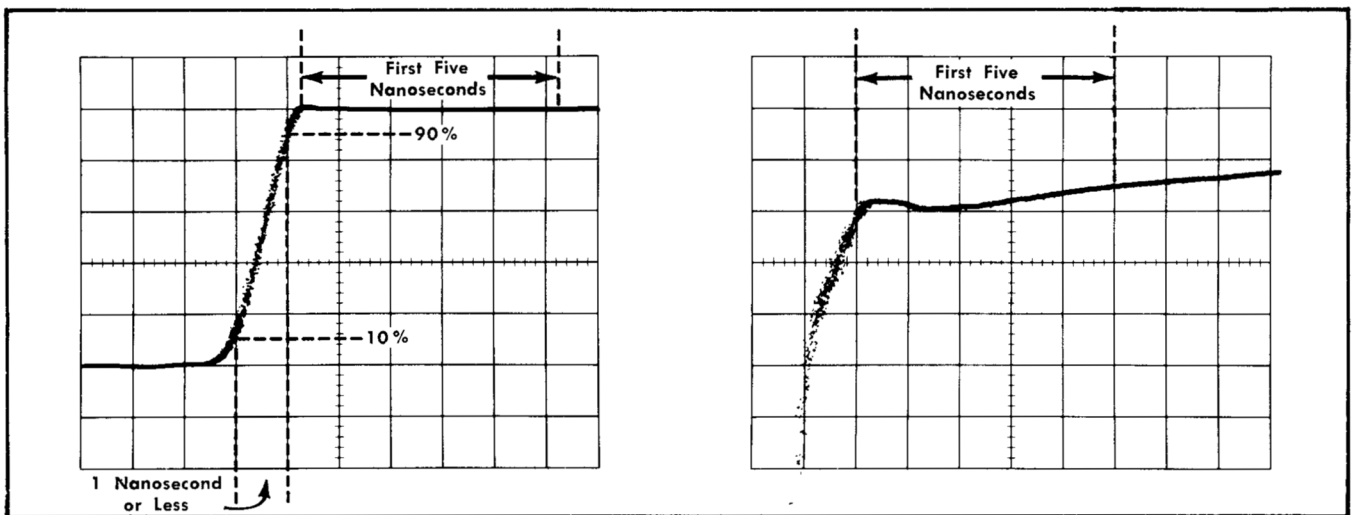


Fig. 5-4. Typical sampling system display when checking + OUTPUT; (A) risetime, (B) aberrations in first five nanoseconds.

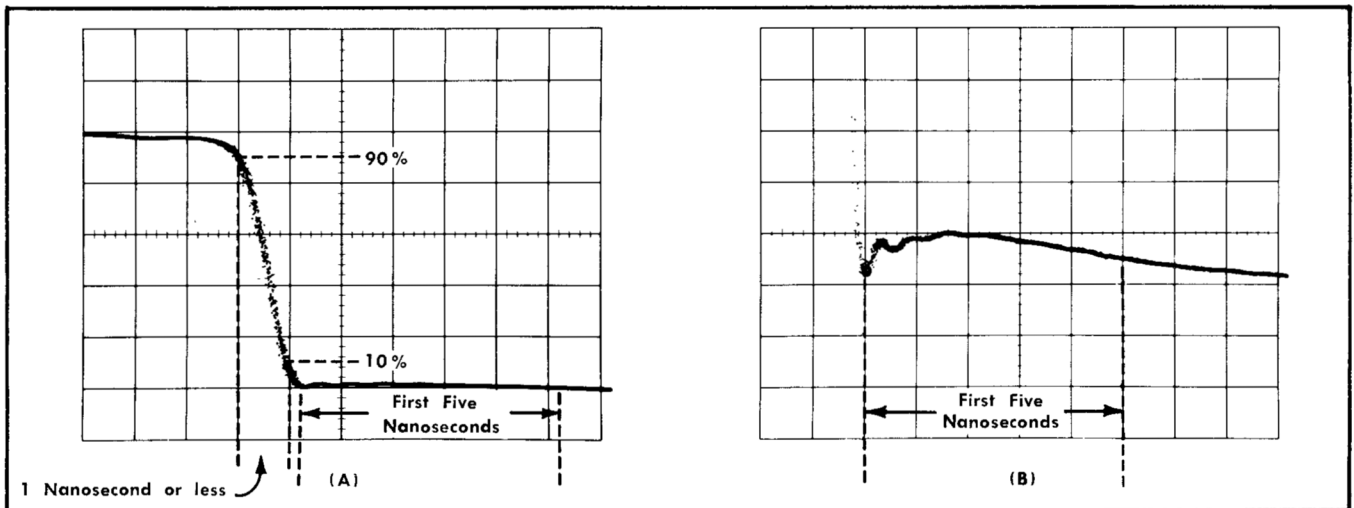


Fig. 5-5. Typical sampling system display when checking - OUTPUT; (A) risetime, (B) aberrations in first five nanoseconds.

## Performance Check—Type 106

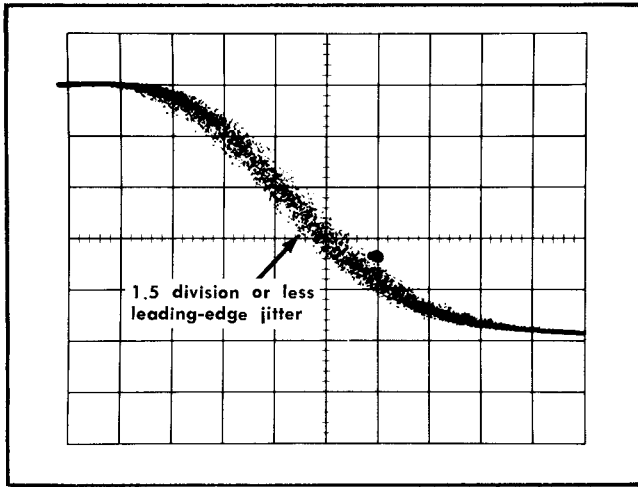


Fig. 5-6. Typical sampling system display of trigger jitter.

g. CHECK—Sampling system display for five division or more amplitude (500 millivolts or more).

h. Set the — TRANSITION AMPLITUDE control for five divisions of vertical deflection.

i. Set the sampling system time position range switch to 100 nanoseconds and magnify the sweep to one nanosecond/division.

j. CHECK—Sampling system display for one division or less between the 10% and 90% points of the leading edge (one nanosecond or less; see Fig. 5-5A).

k. Set the sampling system vertical deflection to 10 millivolts/division. Reposition the top of the waveform onto the viewing area with the DC offset control.

l. CHECK—Sampling system display for aberrations  $\pm$  one division or less in first five divisions following the leading edge (+ and - 2% or less in first five nanoseconds; see Fig. 5-5B).

### 9. Check Trigger Jitter

a. REQUIREMENT—300 picoseconds or less.

b. Set the sampling system to magnify the sweep rate to 0.2 nanosecond/division and set the triggering controls for a stable display. Set the sampling system vertical deflection to 100 millivolts/division.

c. CHECK—Rotate the MULTIPLIER control throughout its range and check for 1.5 division or less jitter in the leading edge of the waveform (300 picoseconds or less; see Fig. 5-6).

d. Remove the five-nanosecond cable from the — OUTPUT connector and connect it to the + OUTPUT connector.

e. CHECK—Rotate the MULTIPLIER control throughout its range and check for 1.5 divisions or less jitter in the leading edge of the waveform (300 picoseconds or less).

f. Disconnect all test equipment.

This completes the performance check procedure for the Type 106. If the instrument has met all performance requirements given in this procedure, it is correctly calibrated and within the specified tolerances.

# SECTION 6

## CALIBRATION

### Introduction

Complete calibration information for the Type 106 is given in this section. This procedure calibrates the instrument to the performance requirements listed in the Characteristics section. The Type 106 can be returned to original performance standards by completion of each step in this procedure. If it is desired to merely touch up the calibration, perform only those steps entitled Adjust . . . ①. A short-form calibration procedure is also provided in this section for the convenience of the experienced calibrator. The short-form procedure may be used as a calibration record or an index to the steps in the complete Calibration Procedure.

The Type 106 should be checked, and recalibrated if necessary, after each 500 hours of operation, or every six months if used infrequently, to assure correct operation and accuracy. The Performance Check section of this manual provides a complete check of instrument performance without making internal adjustments. Use the performance check procedure to verify the calibration of the Type 106 and determine if recalibration is required.

### EQUIPMENT REQUIRED

#### General

The following equipment, or its equivalent, is required for complete calibration of the Type 106 (see Figs. 6-1 and 6-2). Specifications given are the minimum necessary for accurate calibration of this instrument. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

1. Variable autotransformer. Must be capable of supplying 200 volt-amperes over a range of 103.5 to 126.5 volts (207 to 253 volts for 230-volt nominal line). (If autotransformer does not have an AC voltmeter to indicate output voltage, monitor output with an AC voltmeter with range of at least 135 or 270 volts, RMS). For example, General Radio W10MT3W Metered Variac Autotransformer.

2. DC voltmeter. Minimum sensitivity, 20,000 ohms/volt; accuracy, checked to within  $\pm 1\%$  at  $-150$ ,  $-10$ ,  $+10$  and  $+150$  volts; range, 0 to 350 volts. For example, Simpson Model 262.

3. Test oscilloscope. Frequency response, DC to 30 MHz; minimum deflection factor, 20 millivolts/division; accuracy, within  $\pm 3\%$ ; must have 1 kHz amplitude calibrator output voltages of 1, 5 and 50 volts and a dual-trace vertical system. Tektronix Type 545B Oscilloscope with Type 1A2 Dual-Trace Plug-In Unit recommended.

4.  $10\times$  probe with BNC connector. Tektronix P6008 Probe recommended.

5. Sampling oscilloscope. Risettime, 0.35 nanoseconds; calibrated deflection factor, 20 millivolts/division minimum; calibrated sweep range, equivalent to 100 nanoseconds/division to 0.2 nanosecond/division. Tektronix Type 661 Oscilloscope with Type 4S3 Sampling-Probe Dual-Trace Unit and Type 5T3 Timing Unit recommended.

6. Delay cable. Impedance, 50 ohms; electrical length, 60 nanoseconds; connectors, GR874. Tektronix Type 113 Delay Cable recommended.

7. Time-mark generator. Marker outputs, 1 microsecond to 1 second; marker accuracy, within 0.1%. Tektronix Type 184 Time-Mark Generator recommended.

8. Cable. Impedance, 50 ohms; type RG-213/U; electrical length, five nanoseconds; connectors, GR874. Tektronix Part No. 017-0502-00.

9. Thru-line termination. Impedance, 50 ohms; wattage rating, 1.0 watts; accuracy,  $\pm 3\%$ ; connectors, GR874 input with BNC female output. Tektronix Part No. 017-0083-00.

10. Adapter. Connector, GR874 and BNC female. Tektronix Part No. 017-0063-00.

11. Cable (two). Impedance, 50 ohms; type, RG-58A/U; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0057-01.

12. Termination. Impedance, 50 ohms; accuracy,  $\pm 3\%$ ; connectors, BNC. Tektronix Part No. 011-0049-00.

13. BNC T connector. Tektronix Part No. 103-0030-00.

14. Attenuator. Attenuation,  $10\times$ ; impedance, 50 ohms; accuracy,  $\pm 3\%$ ; connectors, GR874. Tektronix Part No. 017-0078-00.

15. VP-2 Voltage Pickoff. Tektronix Part No. 017-0077-00.

16. End-line termination. Impedance, 50 ohms; accuracy,  $\pm 3\%$ ; connectors, GR874. Tektronix Part No. 017-0081-00.

17. Insulated screwdriver.  $1\frac{1}{2}$ -inch shaft, non-metallic. Tektronix Part No. 003-0000-00.

18. Screwdriver. 3-inch shaft. Tektronix Part No. 003-0192-00.

### CALIBRATION RECORD AND INDEX

This short-form calibration procedure is provided to aid in checking the operation of the Type 106. It may be used as a calibration guide by the experienced calibrator, or it may be used as a record of calibration. Since the step numbers and titles used here correspond to those used in the complete procedure, this procedure also serves as an index to

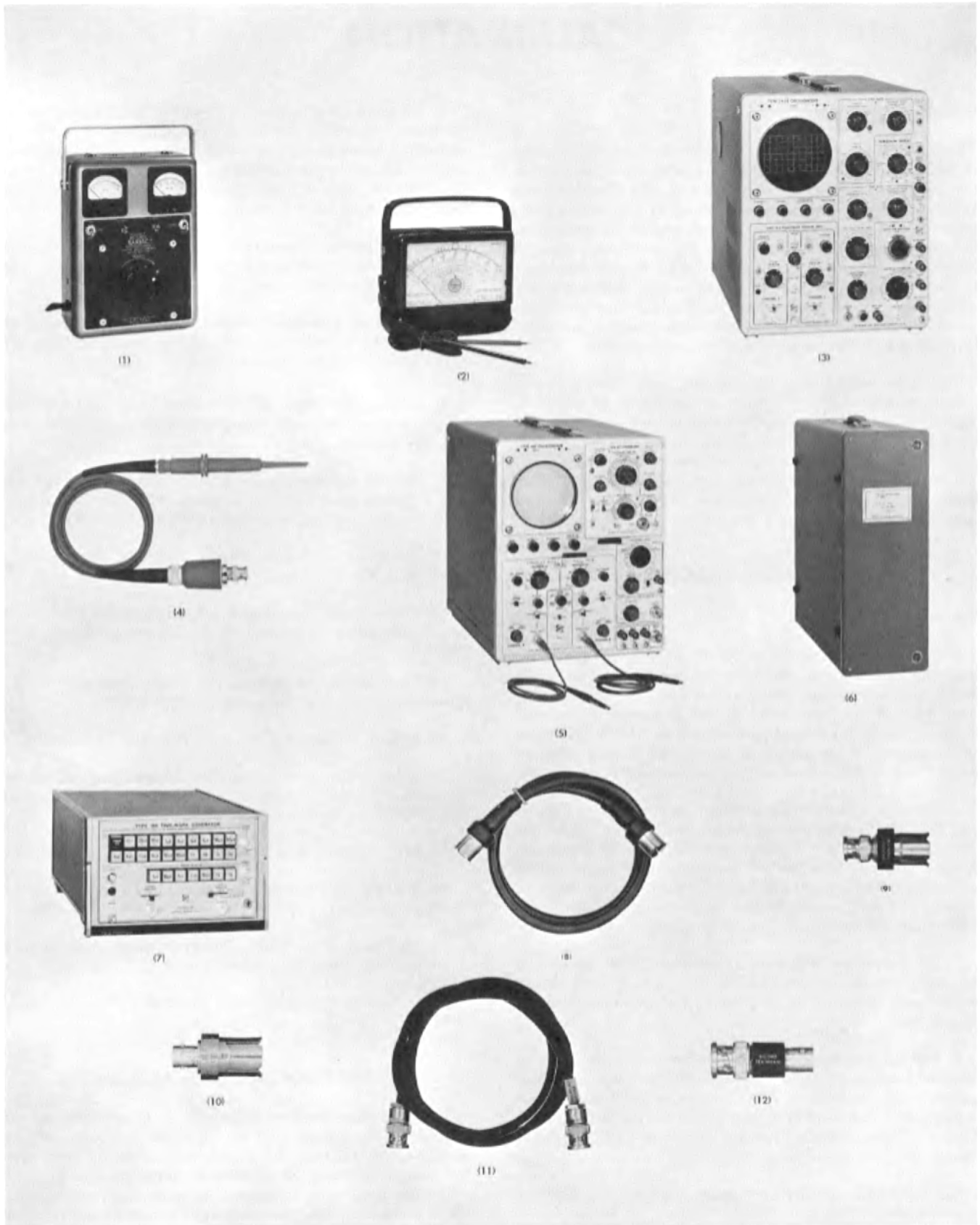


Fig. 6-1. Recommended calibration equipment. Items 1 through 12.

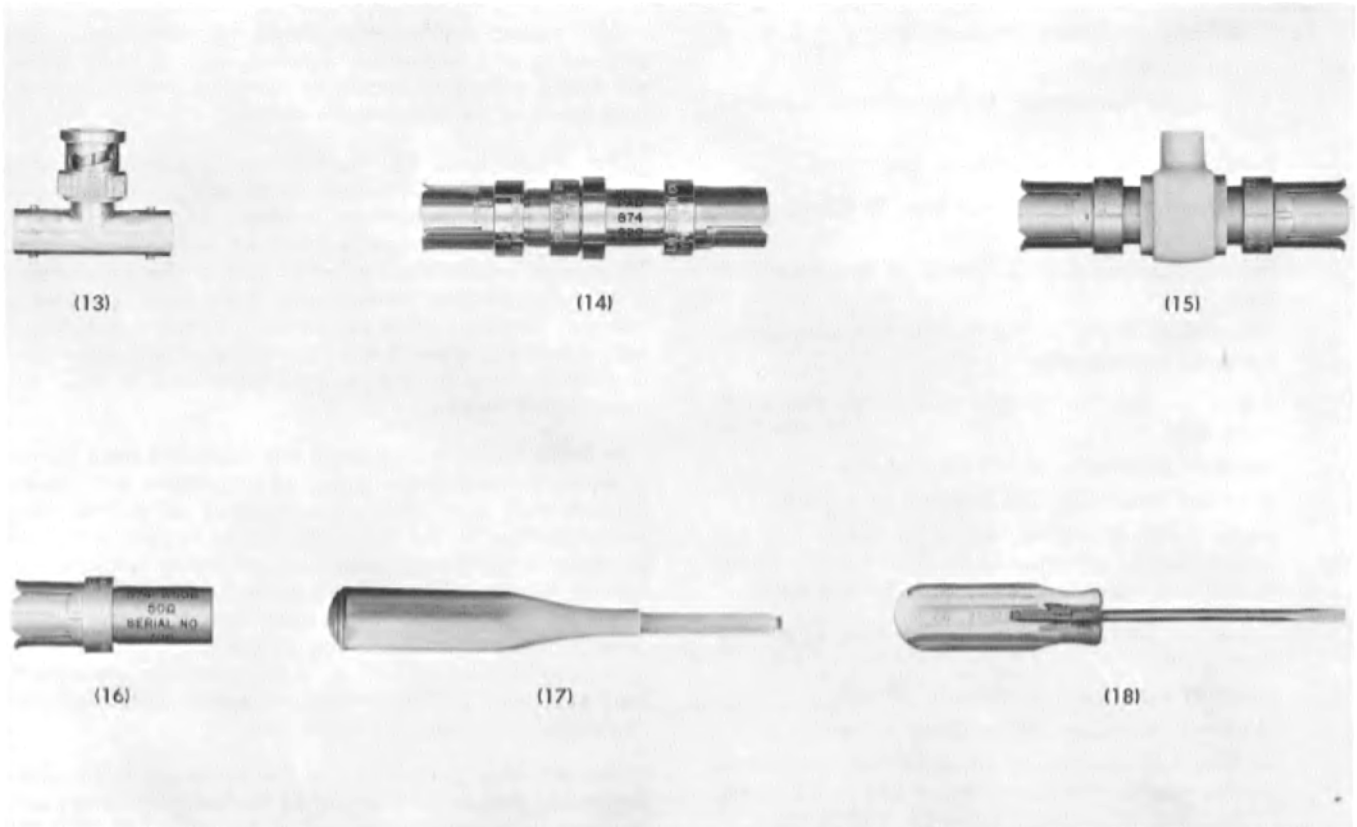


Fig. 6-2. Recommended calibration equipment. Items 13 through 18.

locate a step in the complete Calibration Procedure. Performance requirements correspond to those given in the Characteristics section.

Type 106, Serial No. \_\_\_\_\_

Calibration Date \_\_\_\_\_

Calibration Technician \_\_\_\_\_

- 1. Adjust Amplitude Cal. Page 6-5.  
12-volts output amplitude or greater.
- 2. Check Amplitude Control Range. Page 6-5.  
0.5 volt or less, minimum, termination in 50 ohms.  
7 volts or less to 120 volts or greater, unterminated.
- 3. Check A + 150, A - 150, A -20, +10 and - 10 Volt Power Supplies. Page 6-6.
 

A + 150-Volt supply	+ 150 volts, $\pm 15$ volts
A - 150-Volt supply	- 150 volts, $\pm 15$ volts
A - 20-Volt supply	-20 volts, $\pm 2$ volts
+10-Volt supply	+10 volts, $\pm 1.5$ volts
-10-Volt supply	-10 volts, $\pm 1.5$ volts
- 4. Check A Supply Regulation. Page 6-6.  
12-volt output amplitude (terminated in 50 ohms)  $\pm 1.2$  divisions.
- 5. Check A +150, A -150, A -20, +10 and -10 Volt Supply Regulation. Page 6-7.

A + 150-Volt supply	Within $\pm 15$ volts
A - 150-Volt supply	Within $\pm 15$ volts
A - 20-Volt-supply	Within $\pm 2$ volts
+10-Volt supply	Within $\pm 1.5$ volt
-10-Volt supply	Within $\pm 1.5$ volt

- 6. Check Power-Supply Ripple. Page 6-8.
 

A supply	$\pm 0.75$ volt, peak to peak
A + 150-Volt supply	$\pm 0.75$ volt, peak to peak
A - 150-Volt supply	$\pm 0.75$ volt, peak to peak
A - 20-Volt supply	$\pm 0.75$ volt, peak to peak
+10-Volt supply	$\pm 0.2$ volt, peak to peak
-10-Volt supply	$\pm 0.2$ volt, peak to peak
- 7. Adjust Symmetry Range. Page 6-10.  
45% to 55% change in duty cycle.
- 8. Adjust Repetition Rate Multiplier. Page 6-11.  
Correct repetition rate at 1 and 10. Correct knob position at 5.
- 9. Adjust Bias Level. Page 6-12.  
50% duty cycle at 1 MHz.
- 10. Check Repetition Rate. Page 6-12.  
Correct maximum and minimum repetition rate at each position of REPETITION RATE switch.
- 11. Check Synchronized Operation. Page 6-12.  
Output signals synchronize with 5 and 50 volt input square wave.

## Calibration—Type 106

- 12. Check Trigger Output. Page 6-13.  
Amplitude, 0.1 volt.  
Risetime, 50 nanoseconds or less, between 0 and 0.1 volt.  
Delay time, 50 nanoseconds or less.
- 13. Check Hi Amplitude Output Into 50 Ohms. Page 6-14.  
Risetime (terminated in 50 ohms), 12 nanoseconds or less.  
Aberrations,  $\pm 2\%$  or less in first 100 nanoseconds following leading edge.
- 14. Adjust + Fast Rise Output and Check Operation. Page 6-14.  
Minimum amplitude, 50 millivolts or less.  
Maximum amplitude, 500 millivolts or more.  
Risetime and aberrations, adjust for one nanosecond or less risetime with aberrations + and  $- 2\%$  or less in first five nanoseconds following leading edge.
- 15. Adjust  $-$  Fast Rise Output and Check Operation. Page 6-16.  
Minimum amplitude, 50 millivolts or less.  
Maximum amplitude, 500 millivolts or more.  
Risetime and aberrations, adjust for one nanosecond or less risetime with aberrations + and  $- 2\%$  or less in first five nanoseconds following leading edge.
- 16. Check Trigger Jitter. Page 6-17.  
300 picoseconds or less jitter in leading edge of + and  $-$  output square waves.

### CALIBRATION PROCEDURE

#### General

The following procedure is arranged in a sequence which allows the Type 106 to be calibrated with the least interaction of adjustments and reconnection of equipment. However, some adjustments affect the calibration of other circuits within the instrument. In this case, it will be necessary to check the operation of other parts of the instrument. When a step interacts with others, the steps which need to be checked will be noted.

Any needed maintenance should be performed before proceeding with calibration. Troubles which become apparent during calibration should be corrected using the techniques given in the Maintenance section.

The Adjust . . . **I** steps in the following procedure provide a check of instrument performance, whenever possible, before the adjustment is made. The symbol **I** is used to identify the steps in which an adjustment is made. To prevent recalibration of other circuits when performing a partial calibration, readjust only if the listed tolerance is not met. However, when performing a complete calibration, best overall performance will be provided if each adjustment is made to the exact setting, even if the check is within the allowable tolerance.

In the following procedure, a test equipment setup picture is shown for each major group of adjustments and checks. Beneath each setup picture is a complete list of front-panel control settings for the Type 106. To aid in locating individual controls which have been changed during complete calibration, these control names are printed in bold type. If only a partial calibration is performed, start with the nearest setup picture preceding the desired portion. Type 106 front-panel control titles referred to in this procedure are capitalized (e.g., AMPLITUDE). Internal adjustment titles are initial capitalized only (e.g., Amplitude Cal).

The following procedure uses the equipment listed under Equipment Required. If substitute equipment is used, control settings or setup may need to be altered to meet the requirements of the equipment used.

#### Preliminary Procedure

1. Remove the cabinet from the Type 106.
2. Connect the autotransformer to a suitable power source.
3. Connect the Type 106 to the autotransformer output.
4. Set the autotransformer output voltage to 115 (or 230 volts).
5. Set the Type 106 POWER switch to ON. Allow at least five minutes warm up at  $25^{\circ}\text{C}$ ,  $\pm 5^{\circ}$ , before checking the instrument to the given accuracy.

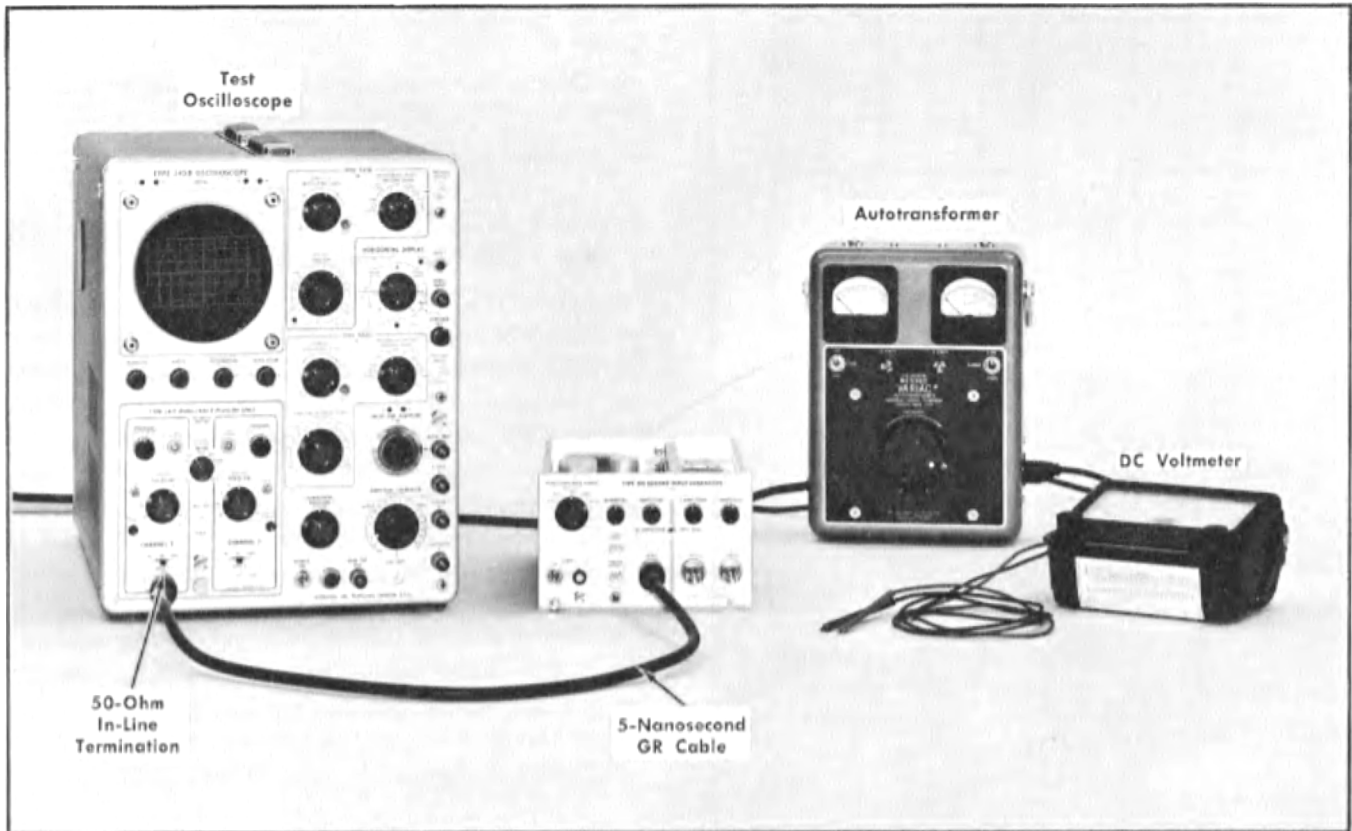


Fig. 6-3. Initial test equipment setup for steps 1 — 5.

### Front-panel control settings

REPETITION RATE RANGE	1 kHz
MULTIPLIER	10 (clockwise)
SYMMETRY	Midrange
AMPLITUDE	Clockwise
HI AMPLITUDE — FAST RISE	HI AMPLITUDE
+ TRANSITION AMPLITUDE	Midrange
— TRANSITION AMPLITUDE	Midrange
POWER	ON

#### 1. Adjust Amplitude Cal

- a. Test equipment setup is shown in Fig. 6-3.
- b. Connect the OUTPUT (HI AMPLITUDE) connector to the input of the test oscilloscope through the five-nanosecond GR cable and the 50-ohm in-line termination.
- c. Set the test oscilloscope vertical deflection to two volts/division, input coupling to DC and the sweep rate to 50 microseconds/division.

d. CHECK—Test oscilloscope display amplitude for six divisions or greater (12 volts or greater, see Fig. 6-4A).

e. ADJUST—Amplitude Cal adjustment, R247 (see Fig. 6-4B) for a compromise setting to bring the terminated and unterminated voltage ranges within limits.

f. INTERACTION—Check all steps.

#### 2. Check Amplitude Control Range

- a. Turn the AMPLITUDE (HI AMPLITUDE) control fully counterclockwise.
- b. Set the test oscilloscope vertical deflection to 0.1 volt/division.
- c. CHECK—Test oscilloscope display for five divisions or less amplitude (0.5 volt or less).
- d. Remove the 50-ohm in-line termination and connect the five-nanosecond cable to the test oscilloscope input using the GR-to-BNC adapter.
- e. Set the test oscilloscope vertical deflection to two volts/division.
- f. CHECK—Test oscilloscope display for 3.5 divisions or less amplitude (seven volts or less).
- g. Turn the AMPLITUDE (HI AMPLITUDE) control fully clockwise.

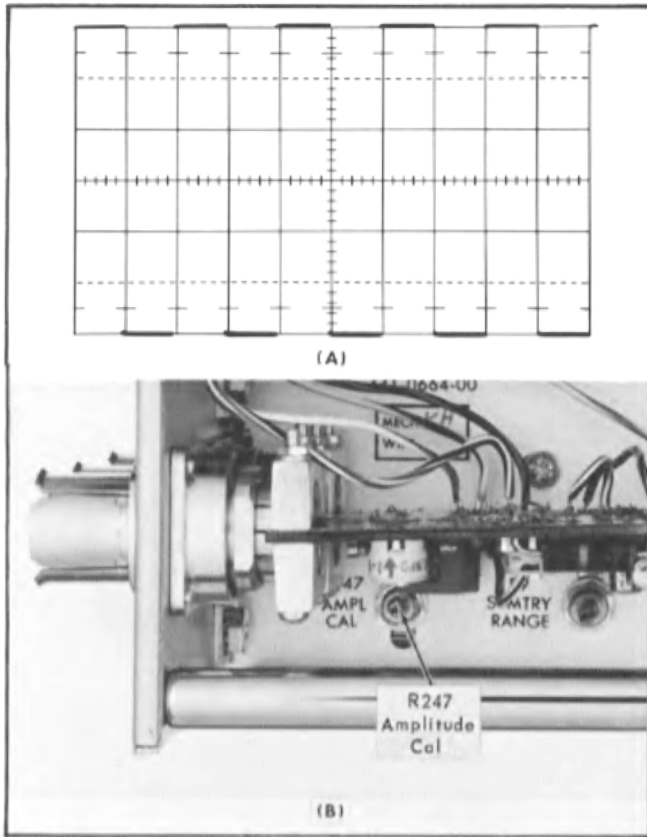


Fig. 6-4. (A) Typical test oscilloscope display when adjusting A Supply output voltage, (B) location of Amplitude Cal adjustment (right side).

- h. Set the test oscilloscope vertical deflection to 20 volts/division.
- i. CHECK—Test oscilloscope display for 6 divisions or greater amplitude, (120 volts or greater).
- j. Remove all cable to facilitate the next step.

### 3. Check A +150, A -150, A -20, +10 and -10 Volt Power Supplies

- a. Connect the DC voltmeter between TP259 and TP249 (see Fig. 6-5A); connect the negative lead to TP249.
- b. CHECK—Meter reading for +150 volts,  $\pm 15$  volts.
- c. Connect the DC voltmeter between TP229 and TP249 (see Fig. 6-5A); connect the negative lead to TP249.
- d. CHECK—Meter reading for -150 volts,  $\pm 15$  volts.
- e. Connect the DC voltmeter between TP269 and TP249 (see Fig. 6-5A); connect the negative lead to TP249.
- f. CHECK—Meter reading for -20 volts,  $\pm 2$  volts.
- g. Connect the DC voltmeter between the +10-volt test point (emitter of Q213, see Fig. 6-5B) and chassis ground.
- h. CHECK—Meter reading for +10 volts,  $\pm 1.5$  volts.
- i. Connect the DC voltmeter between the -10-volt test point (emitter of Q217, see Fig. 6-5B) and chassis ground.
- j. CHECK—Meter reading for -10 volts,  $\pm 1.5$  volts.

### 4. Check A Supply Regulation

- a. Connect the OUTPUT (HI AMPLITUDE) connector to the input of the test oscilloscope through the five-nanosecond GR cable and the 50-ohm in-line termination.
- b. Set the test oscilloscope vertical deflection to two volts/division.

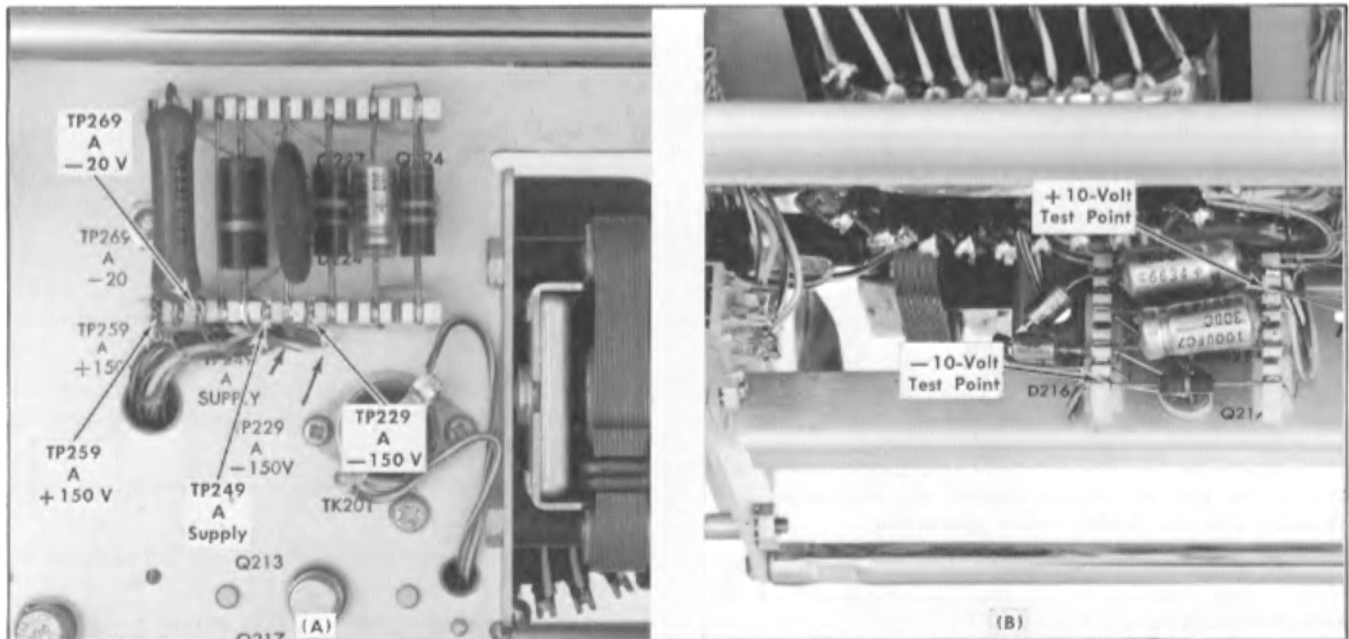


Fig. 6-5. (A) Location of A Supply, A +150, A -150 and A -20 volt test points (right side), (B) location of +10 and -10 volt test points (bottom side).

c. CHECK—Test oscilloscope display for  $\pm 0.6$  division maximum change while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253 volts for 230 volts nominal).

### 5. Check A +150, A -150, A -20, +10 and -10 Volt Supply Regulation

a. Connect the DC voltmeter between TP259 and TP249 (see Fig. 6-5A).

b. CHECK—Meter reading for  $\pm 15$  volts maximum change while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253 volts for 230 volts nominal).

c. Connect the DC voltmeter between TP229 and TP249 (see Fig. 6-5A).

d. CHECK—Meter reading for  $\pm 15$  volts maximum change while varying the autotransformer output voltage between

103.5 and 126.5 volts (207 and 253).

e. Connect the DC voltmeter between TP269 and TP249.

f. CHECK—Meter reading for  $\pm 2$  volts maximum change while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253).

g. Connect the DC voltmeter between the +10 volt test point (see Fig. 6-5B) and chassis ground.

h. CHECK—Meter reading for  $\pm 1.5$  volt maximum change while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253).

i. Connect the DC voltmeter between the -10 volt test point (see Fig. 6-5B) and chassis ground.

j. CHECK—Meter reading for  $\pm 1.5$  volt maximum change while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253).

k. Disconnect all test equipment.

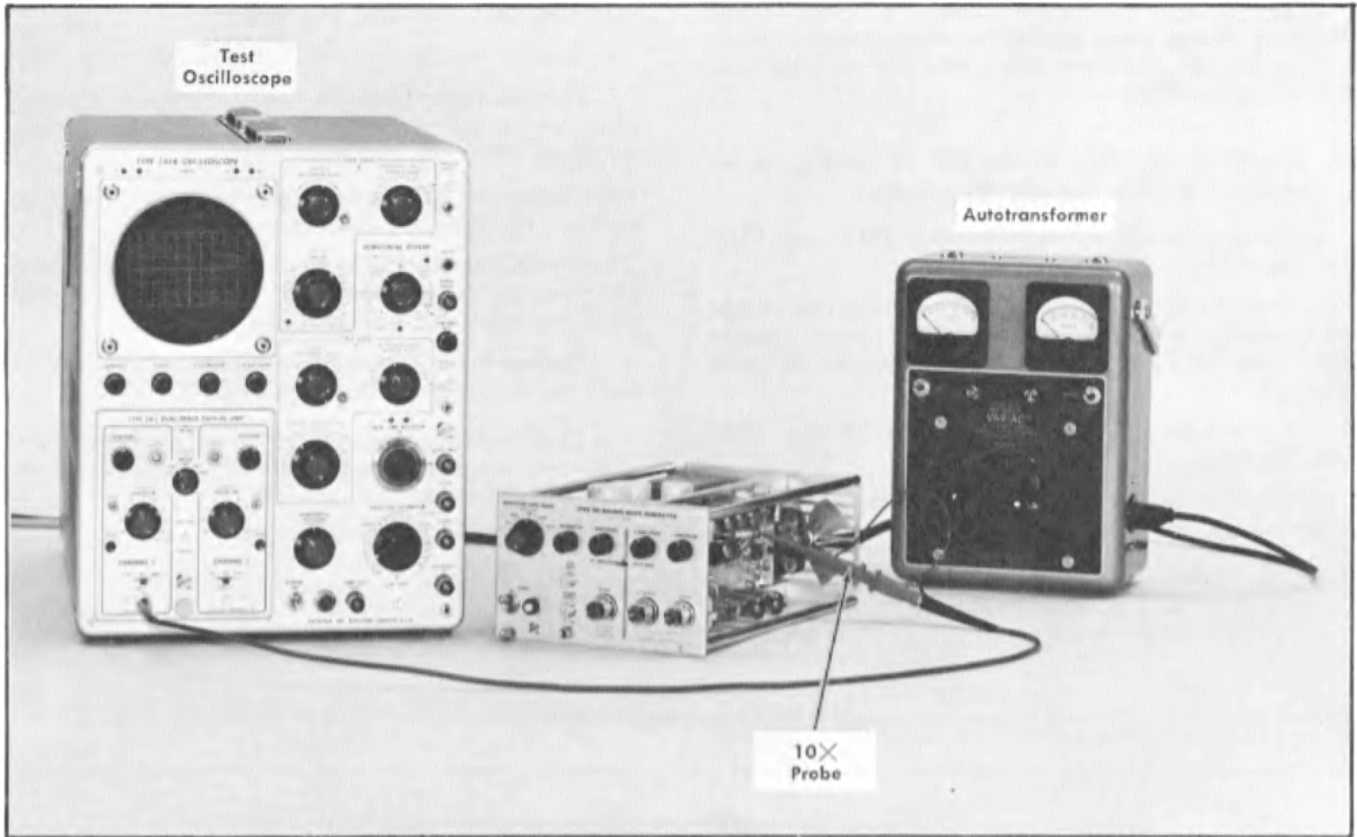


Fig. 6-6. Test equipment setup for step 6.

**Front-panel control settings**

REPETITION RATE RANGE	1 kHz
MULTIPLIER	10 (clockwise)
SYMMETRY	Midrange
<b>AMPLITUDE</b>	<b>Counterclockwise</b>
HI AMPLITUDE — FAST RISE	HI AMPLITUDE
+ TRANSITION AMPLITUDE	Midrange
— TRANSITION AMPLITUDE	Midrange
POWER	ON

**6. Check Power Supply Ripple**

- a. Test equipment setup is shown in Fig. 6-6.
- b. Connect the 10X probe to the test oscilloscope input connector.
- c. Set the test oscilloscope for a vertical deflection of 0.02 volt/division, AC coupled, at a sweep rate of five milliseconds/division.

- d. Connect the probe tip to TP249 (see Fig. 6-5A). Connect the probe ground lead to chassis ground.
- e. CHECK—Test oscilloscope display for 3.75 divisions maximum line-frequency ripple ( $\pm 0.75$  volt) while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253 volts for 230 volts nominal). Fig. 6-7 shows a typical test oscilloscope display of power supply ripple.
- f. Connect the probe tip to TP259 (see Fig. 6-5A). Connect the probe ground lead to chassis ground.
- g. CHECK—Test oscilloscope display for 3.5 divisions maximum line-frequency ripple ( $\pm 0.75$  volt) while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253).
- h. Connect the probe tip to TP229 (see Fig. 6-5A). Connect the probe ground lead to chassis ground.
- i. CHECK—Test oscilloscope display for 3.5 divisions maximum line-frequency ripple ( $\pm 0.75$  volt) while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253).
- j. Connect the probe tip to TP269 (see Fig. 6-5A). Connect the probe ground lead to chassis ground.
- k. CHECK—Test oscilloscope display for 3.5 divisions maximum line-frequency ripple ( $\pm 0.75$  volt) while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253).

l. Connect the probe tip to the +10 volt point (see Fig. 6-5B). Connect the probe ground lead to chassis ground.

m. CHECK—Test oscilloscope display for one division maximum line-frequency ripple ( $\pm 0.2$  volt) while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253).

n. Connect the probe tip to the -10 volt test point (see Fig. 6-5B). Connect the probe ground lead to chassis ground.

o. CHECK—Test oscilloscope display for one division maximum line-frequency ripple ( $\pm 0.2$  volt) while varying the autotransformer output voltage between 103.5 and 126.5 volts (207 and 253).

p. Return the autotransformer output voltage to 115 (230) volts. (If the line voltage is about 115 (230) volts, the Type 106 can be connected directly to the line; otherwise leave the instrument connected to the autotransformer for the remainder of the procedure.)

q. Disconnect all test equipment.

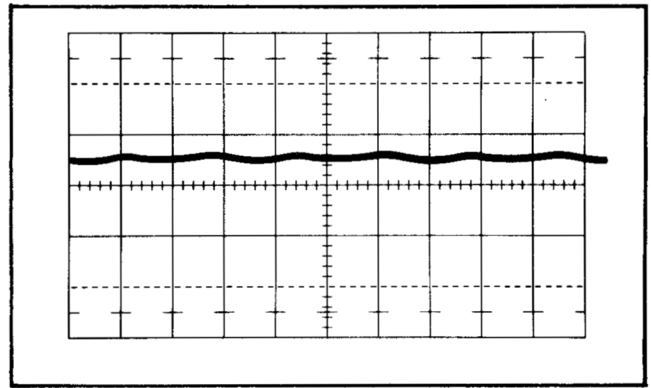


Fig. 6-7. Typical test oscilloscope display of power-supply ripple (60-cycle line). Sweep rate, 5 milliseconds/division; vertical deflection, 0.2 volt/division (0.02 volt/division and 10 $\times$  probe).

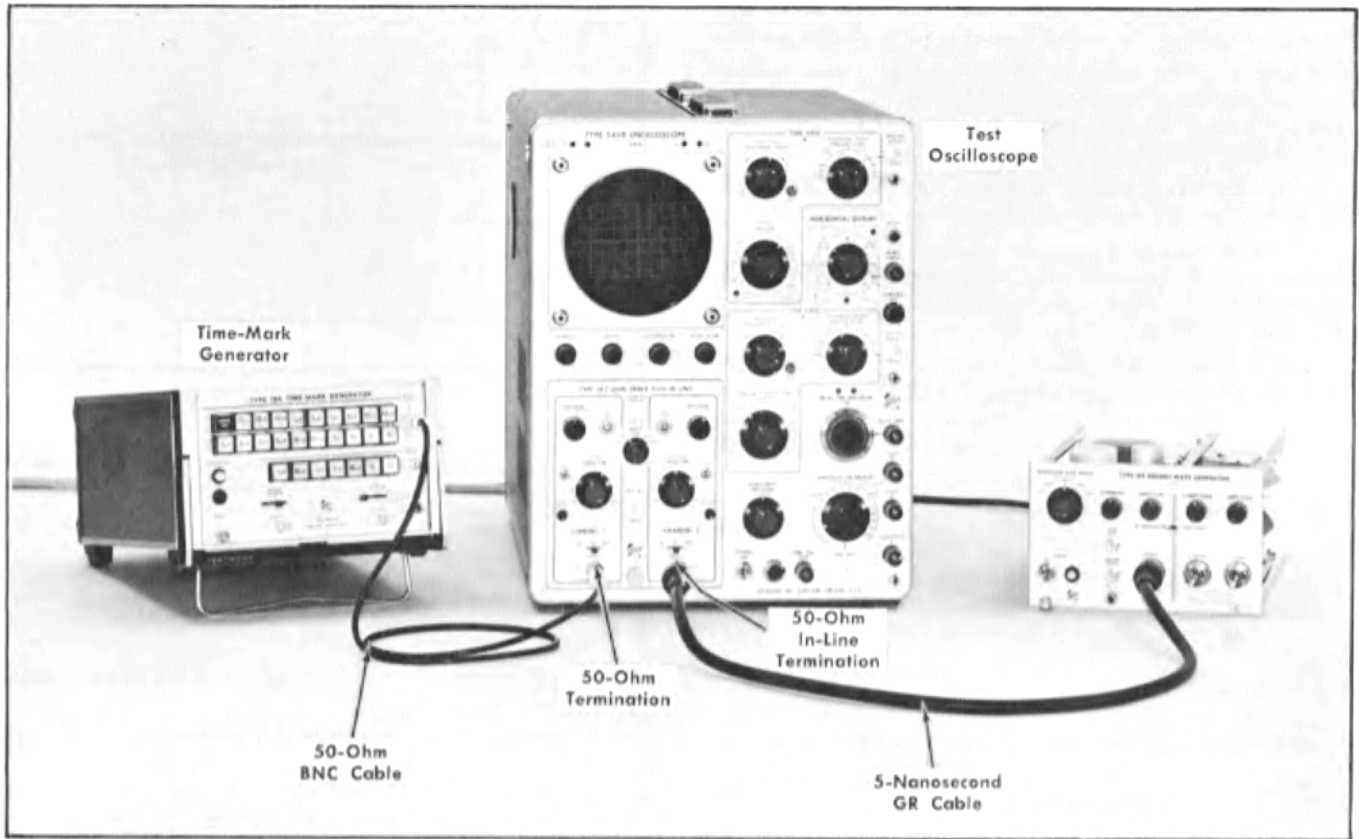


Fig. 6-8. Initial test equipment setup for steps 7 — 12.

**Front-panel control settings**

REPETITION RATE RANGE	1 kHz
MULTIPLIER	10 (clockwise)
SYMMETRY	Midrange
<b>AMPLITUDE</b>	<b>Midrange</b>
HI AMPLITUDE — FAST RISE	HI AMPLITUDE
+ TRANSITION AMPLITUDE	Midrange
— TRANSITION AMPLITUDE	Midrange
POWER	ON

**7. Adjust Symmetry Range**



- a. Test equipment setup is shown in Fig. 6-8.
- b. Connect the OUTPUT (HI AMPLITUDE) connector to the channel 2 input of the test oscilloscope through the five-nanosecond GR cable and the 50-ohm in-line termination.

- c. Set the test oscilloscope vertical deflection to display about four divisions and the sweep rate to display one complete cycle in 10 divisions (use variable time/division control).
- d. CHECK — Test oscilloscope display for five-division duration of the positive portion of the square wave (50% duty cycle).
- e. ADJUST — Symmetry Range adjustment, R9 (see Fig. 6-9A), for five-division duration of the positive portion.
- f. Set the SYMMETRY control fully clockwise; reset the time/division controls for one complete cycle in 10 divisions.
- g. CHECK—Test oscilloscope display for 5.5 divisions or more duration of the positive portion of the square wave (55% or more; see Fig. 6-9B).
- h. Set the SYMMETRY control fully counterclockwise; reset the time/division controls for one complete cycle in 10 divisions.
- i. CHECK — Test oscilloscope display for 4.5 division or less duration of the positive portion of the square wave (45% or less; see Fig. 6-9B).
- j. Return the SYMMETRY control to midrange.

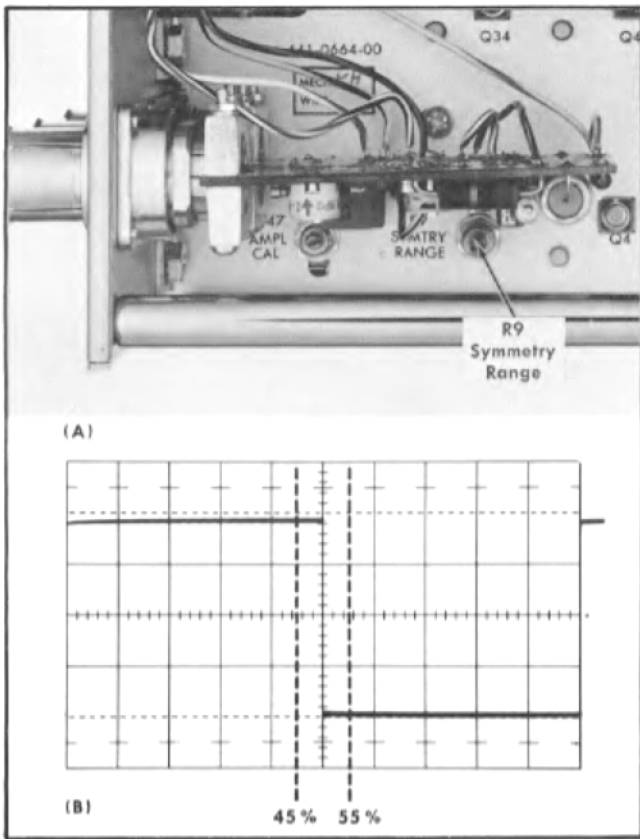


Fig. 6-9. (A) Location of Symmetry Range adjustment (right side), (B) typical test oscilloscope display showing correct SYMMETRY control range.

### 8. Adjust Repetition Rate Multiplier ❶

- a. Connect the time-mark generator output to the channel 1 input connector of the test oscilloscope through a 50-ohm BNC cable and a 50-ohm BNC termination.
- b. Set the time-mark generator for one-microsecond markers.
- c. Set the AMPLITUDE (HI AMPLITUDE) control fully clockwise.
- d. Set the REPETITION RATE RANGE switch to 100 kHz.
- e. Set the test oscilloscope vertical deflection to display about two divisions of the signal on each channel in the alternate mode at a sweep rate of one microsecond/division.
- f. CHECK — Test oscilloscope display for one cycle for each marker displayed (see Fig. 6-10A).
- g. ADJUST — Rep Rate Multiplier Cal ( $\times 10$ ) adjustment, R6 (see Fig. 6-10B), for one cycle for each marker displayed.
- h. Set the MULTIPLIER control fully counterclockwise to 1.

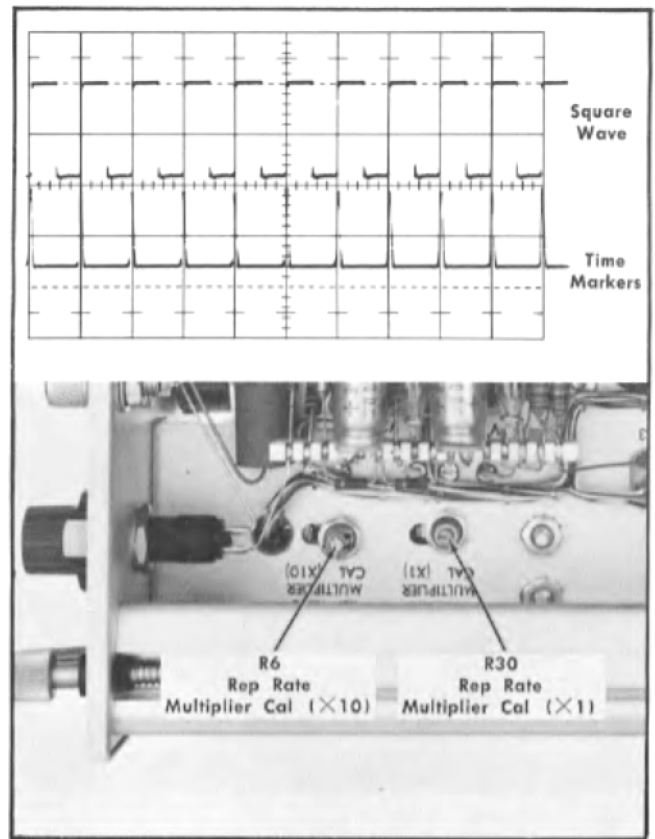


Fig. 6-10. (A) Typical test oscilloscope display when adjusting repetition rate multiplier, (B) location of repetition rate multiplier (bottom side).

- i. Set the test oscilloscope sweep rate to 10 micro-seconds/division.
- j. Set the time-mark generator for 10 microsecond markers.
- k. CHECK — Test oscilloscope display for one cycle for each marker displayed (see Fig. 6-10A).
- l. ADJUST — Rep Rate Multiplier Cal ( $\times 1$ ) adjustment, R30 (see Fig. 6-10B), for one cycle for each marker displayed.
- m. Recheck steps b through l as necessary for correct repetition rate.
- n. Set the test oscilloscope sweep rate to 2 microseconds/division.
- o. Set the time-mark generator for one microsecond markers.
- p. Set the MULTIPLIER control for exactly one cycle for each two markers displayed.
- q. CHECK—MULTIPLIER control should be at 5.
- r. ADJUST—Loosen set screw in MULTIPLIER knob and reposition for correct indication.

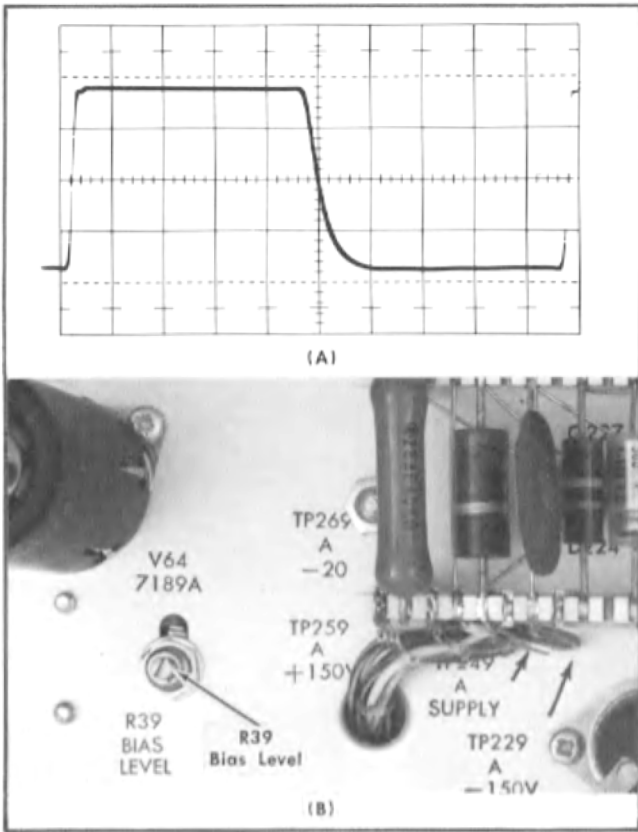


Fig. 6-11. (A) Typical test oscilloscope display when adjusting bias level, (B) location of bias level adjustment (right side).

**9. Adjust Bias Level**

- a. Set the MULTIPLIER control fully clockwise.
- b. Set the test oscilloscope sweep rate to 0.1  $\mu$ s/division and set the vertical Mode switch to channel 2.
- c. CHECK—Test oscilloscope display for 50% duty cycle (see Fig. 6-11A).
- d. ADJUST—Bias Level adjustment R39 (see Fig. 6-11B) for 50% duty cycle.
- e. Set the REPETITION RATE RANGE switch to 1 kHz.

**TABLE 6-1**  
Repetition Rate

REPETITION RATE RANGE Switch Setting	MULTIPLIER Control Setting	Time Markers Applied	Test Oscilloscope Sweep Rate	CRT Display (Cycles/Marker)
100 kHz	cw	10 $\mu$ s	1 $\mu$ s/div	$\geq 10$
100 kHz	ccw	10 $\mu$ s	1 $\mu$ s/div	$\leq 1$
10 kHz	cw	0.1 ms	10 $\mu$ s/div	$\geq 10$
10 kHz	ccw	0.1 ms	10 $\mu$ s/div	$\leq 1$
1 kHz	cw	1 ms	0.1 ms/div	$\geq 10$
1 kHz	ccw	1 ms	0.1 ms/div	$\leq 1$
100 Hz	cw	10 ms	1 ms/div	$\geq 10$
100 Hz	ccw	10 ms	1 ms/div	$\leq 1$
10 Hz	cw	0.1 s	10 ms/div	$\geq 10$
10 Hz	ccw	0.1 s	10 ms/div	$\leq 1$

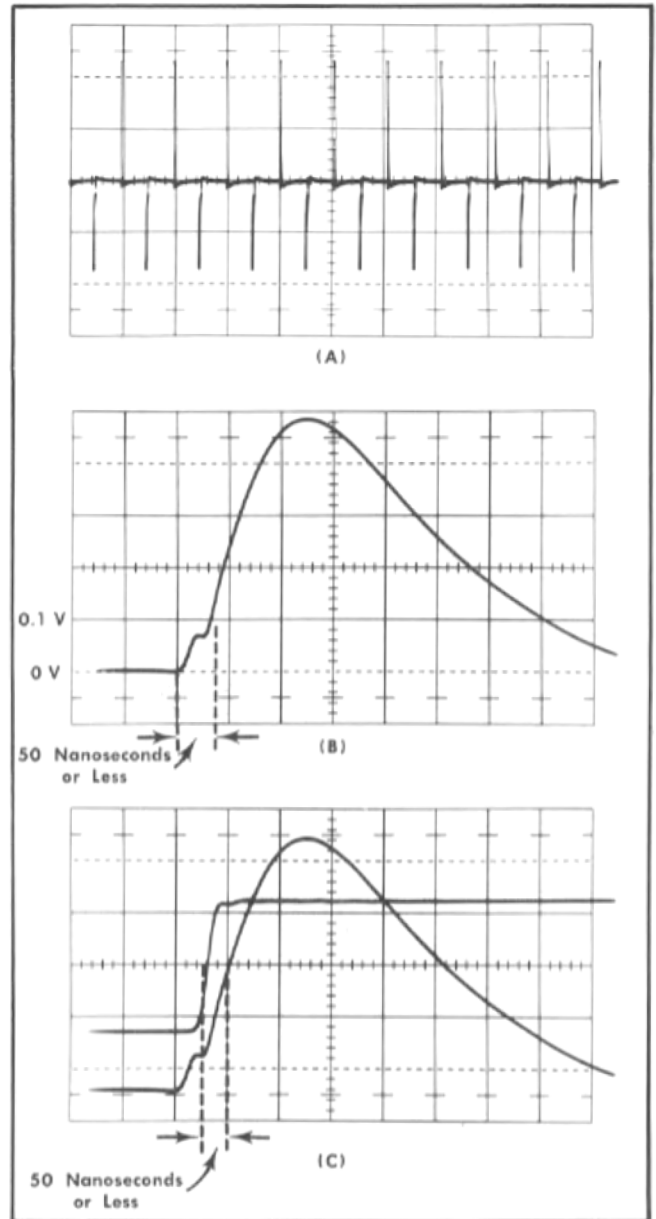


Fig. 6-12. Typical test oscilloscope display when checking TRIGGER OUTPUT. (A) Amplitude, (B) risetime, (C) delay time.

- f. Set the test oscilloscope sweep rate to 10  $\mu$ s/division.
- g. CHECK—Test oscilloscope display for 50% duty cycle.
- h. ADJUST—Bias level adjustment, R39 for 50% duty cycle.
- i. Recheck steps a through h. A compromise setting may be necessary to provide best duty cycle for both checks c and g.

**10. Check Repetition Rate**

- a. Set the test oscilloscope vertical Mode switch to Alt.
- b. CHECK—Using the Type 106, time-mark generator and test oscilloscope settings given in Table 6-1, check repetition rate for correct maximum and minimum repetition rate at each position of REPETITION RATE switch.
- c. Disconnect all test equipment.

## 11. Check Synchronized Operation

- a. Connect the test oscilloscope amplitude calibrator to both the SYNC INPUT connector and the channel 1 input connector through a BNC T connector and two 50-ohm BNC cables.
- b. Connect the OUTPUT (HI AMPLITUDE) connector to the channel 2 input connector through a five nanosecond GR cable and a 50-ohm in-line termination.
- c. Set the REPETITION RATE RANGE switch to 100 Hz and the MULTIPLIER control to about 7.
- d. Set the test oscilloscope amplitude calibrator for five volts output and the sweep rate to 0.5 millisecond/division.
- e. Set the test oscilloscope to trigger from channel 1 in the chopped mode.
- f. CHECK — Test oscilloscope for stable display of the channel 2 waveform (readjust the MULTIPLIER control if necessary).
- g. Set the test oscilloscope amplitude calibrator for 50 volts output.
- h. CHECK — Test oscilloscope for a stable display of the channel 2 waveform.
- i. Set the test oscilloscope amplitude calibrator for one volt output.
- j. CHECK — Test oscilloscope display for drift of the channel 2 waveform due to inadequate sync signal.
- k. Disconnect all test equipment.

## 12. Check Trigger Output

- a. Connect the TRIGGER OUTPUT connector to the channel 2 input connector of the test oscilloscope through a 50-

ohm BNC cable and a 50-ohm BNC termination.

- b. Connect the OUTPUT (HI AMPLITUDE) connector to the channel 1 input connector of the test oscilloscope through a 50-ohm GR cable and a 50-ohm in-line termination.
- c. Connect the vertical plug-in unit trigger output to the test oscilloscope trigger input through a 50-ohm BNC cable for external triggering. Set the plug-in unit trigger selector switch to channel 1.
- d. Set the test oscilloscope to display the channel 2 signal at a vertical deflection of 0.1 volt/division and a sweep rate of 10 microsecond/division.
- e. Set the REPETITION RATE RANGE switch to 100 kHz and the MULTIPLIER control to 1.
- f. CHECK—Test oscilloscope display for positive and negative pulse amplitude of 1 division minimum (0.1 volt peak minimum; see Fig. 6-12A).
- g. Set the test oscilloscope sweep rate to 40 nanoseconds/division (use magnifier).
- h. Position the display to observe the leading edge of the positive pulse.
- i. CHECK—Test oscilloscope display for one division or less between the 0 and 0.1 volt level of the trigger pulse (50 nanoseconds or less; see Fig. 6-12B).
- j. Set the test oscilloscope vertical Mode switch to Alt.
- k. Position the 50% points of both waveforms to the horizontal centerline.
- l. CHECK—Test oscilloscope display for one division or less spacing between the 50% amplitude points of the two waveforms (50 nanoseconds or less; see Fig. 6-12C).
- m. Disconnect all test equipment.

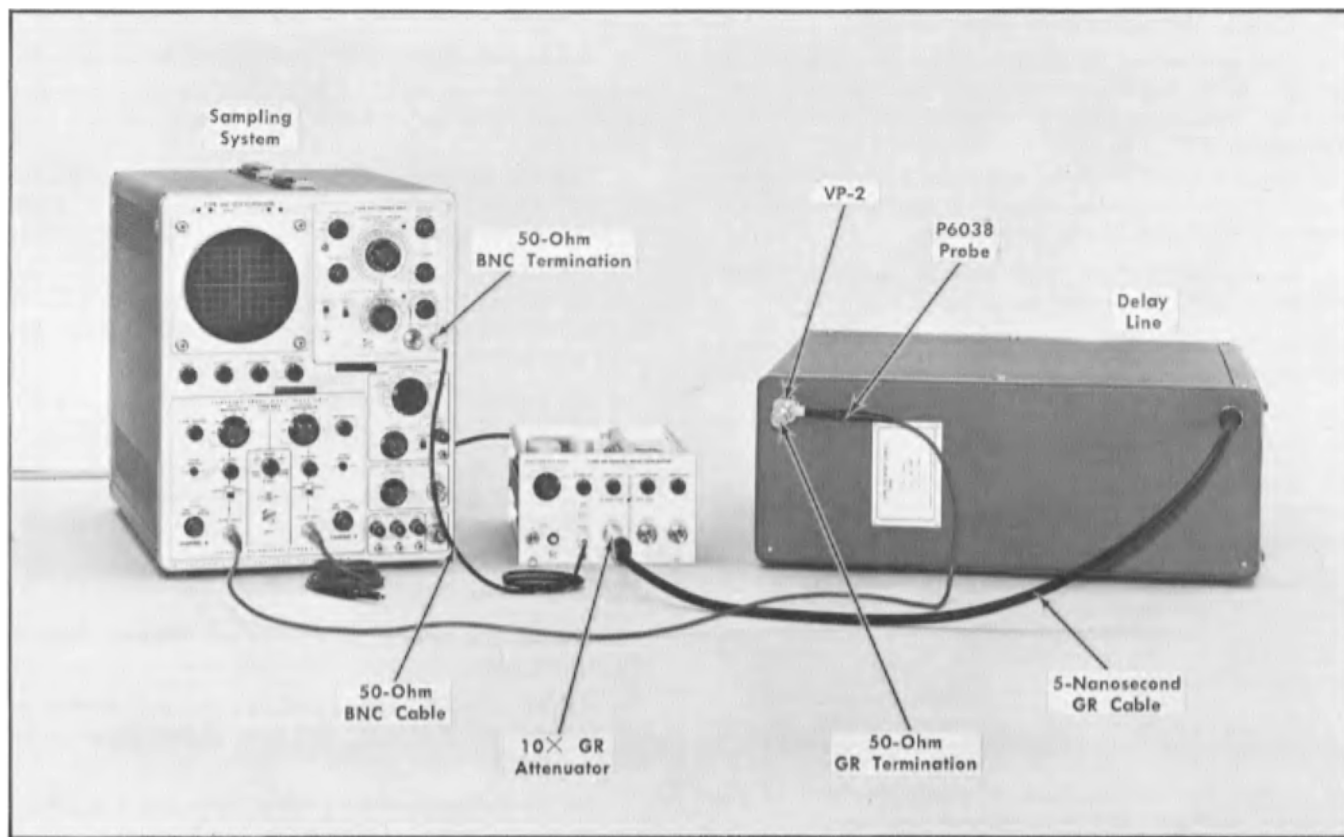


Fig. 6-13. Initial test equipment setup for steps 13 — 16.

**Front-panel control settings**

REPETITION RATE RANGE	100 kHz
MULTIPLIER	10 (clockwise)
SYMMETRY	Midrange
AMPLITUDE	Midrange
HI AMPLITUDE — FAST RISE	HI AMPLITUDE
+ TRANSITION AMPLITUDE	Midrange
- TRANSITION AMPLITUDE	Midrange
POWER	ON

**13. Check Hi Amplitude Output Into 50 Ohms**

- a. Test equipment setup is shown in Fig. 6-13.
- b. Connect the TRIGGER OUTPUT connector to the 1 MΩ external trigger input connector of the sampling system through a 50-ohm BNC cable and a 50-ohm BNC termination.
- c. Connect the OUTPUT (HI AMPLITUDE) connector to the sampling system vertical input through a 10× GR attenuator, five-nanosecond GR cable, 60-nanosecond delay line and the VP-2 voltage pickoff to the P6038 sampling

probe. Terminate the output of the VP-2 with a 50-ohm GR termination.

- d. Set the sampling system vertical deflection to 200 millivolts/division, time position range switch to one microsecond and magnify the sweep to five nanosecond/division.
- e. Set the triggering and time position controls for a stable display of the first leading edge.
- f. Set the AMPLITUDE (HI AMPLITUDE) control for a five division display.

g. CHECK — Sampling system display for 2.4 divisions or less between the 10% and 90% points of the leading edge (12 nanoseconds or less; see Fig. 6-14A).

h. Set the sampling system sweep rate to 50 nanoseconds/division and the vertical deflection to 20 millivolts/division. Reposition the top of the waveform onto the viewing area with the DC offset control.

i. CHECK—Sampling system display for aberrations ± one division or less in first two divisions following the leading edge (±2% or less in first 100 nanoseconds; see Fig. 614B).

**14. Adjust + Fast Rise Output and Check Operation**

- a. Disconnect the five-nanosecond GR cable from the 10× attenuator and connect it to the + OUTPUT connector.
- b. Set the HI AMPLITUDE — FAST RISE switch to FAST RISE.

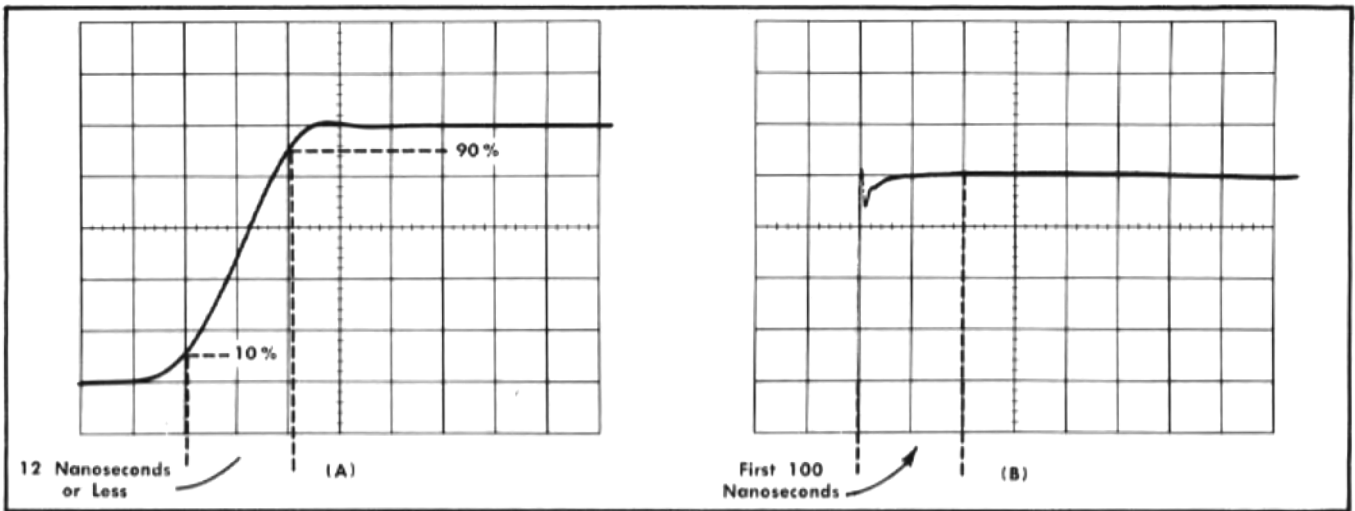


Fig. 6-14. Typical sampling system display when checking OUTPUT (HI AMPLITUDE), (A) risetime, (B) aberrations in first 100 nanoseconds.

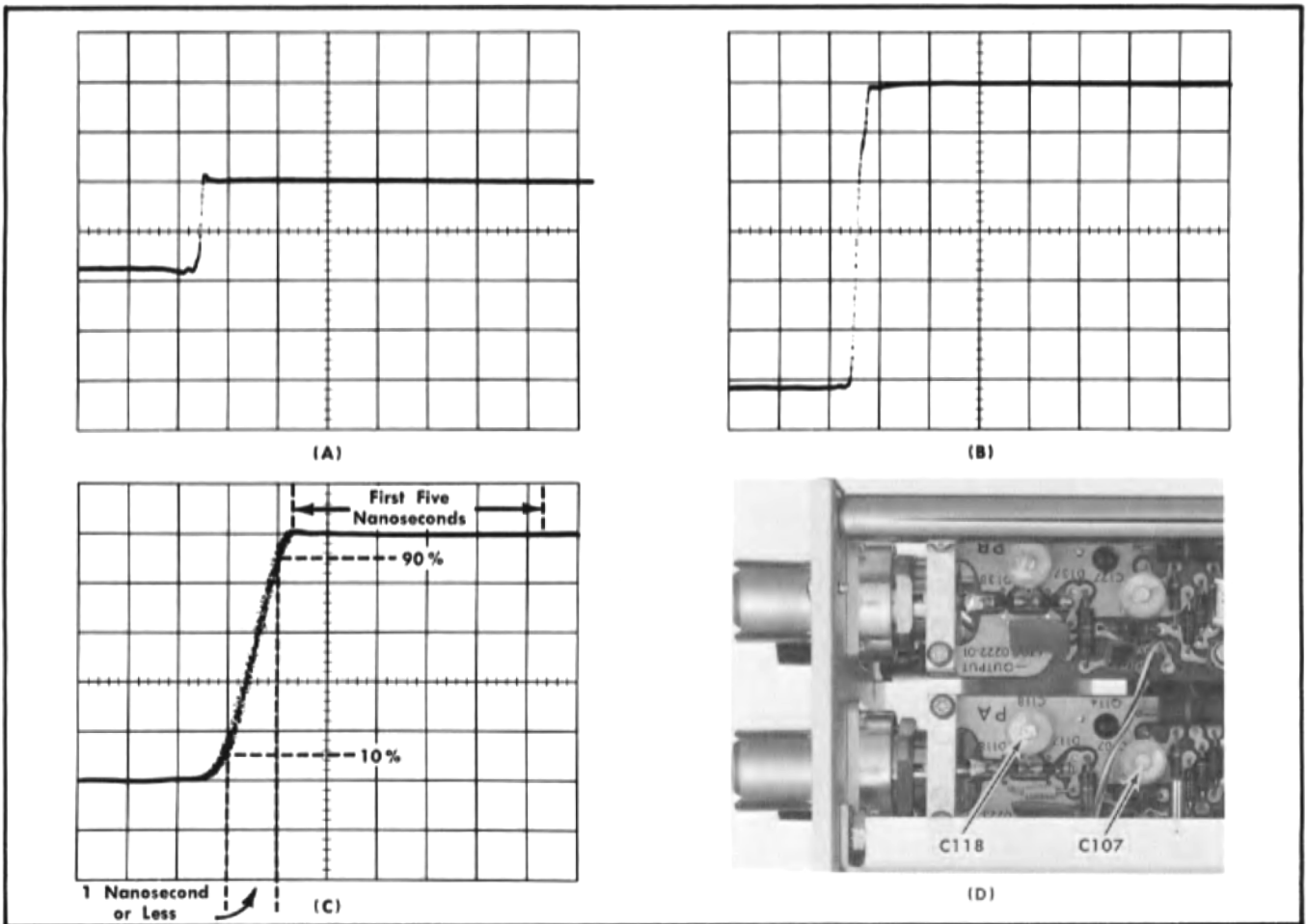


Fig. 6-15. Typical sampling system display when checking + OUTPUT; (A) minimum amplitude, (B) maximum amplitude, (C) risetime and aberrations. (D) Location of C107 and C118 (bottom side).

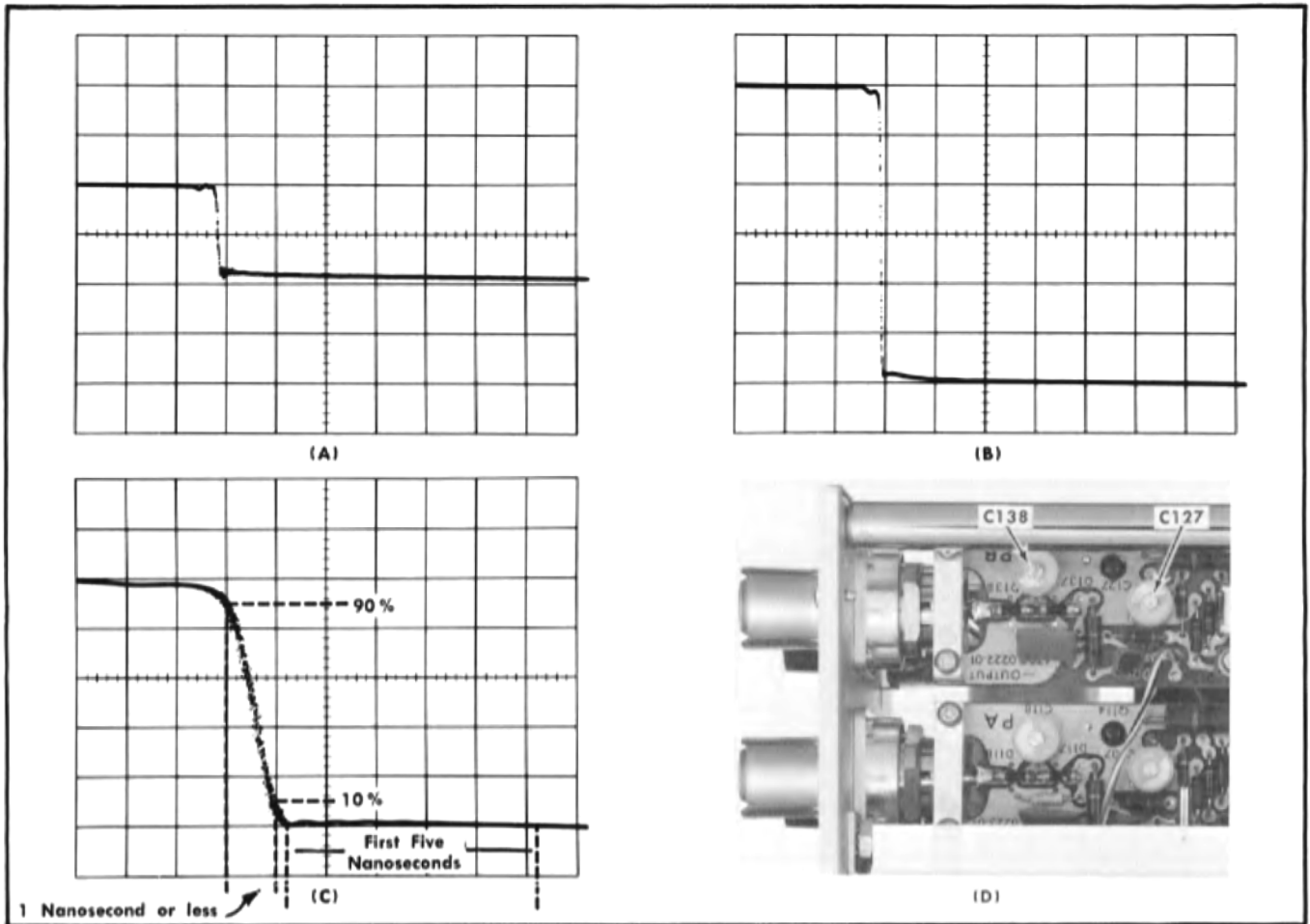


Fig. 6-16. Typical sampling system display when checking — OUTPUT; (A) minimum amplitude, (B) maximum amplitude, (C) risetime and aberrations, (D) location of C127 and C138 (bottom side).

- c. Set the sampling-system sweep rate to 10 nanoseconds/division.
- d. Set the + TRANSITION AMPLITUDE control fully counterclockwise.
- e. CHECK—Sampling system display for 2.5 divisions or less amplitude (50 millivolts or less; see Fig. 6-15A).
- f. Set the sampling system vertical deflection to 100 millivolts/division.
- g. Set the + TRANSITION AMPLITUDE control fully clockwise.
- h. CHECK — Sampling system display for five divisions or more amplitude (500 millivolts or more; see Fig. 6-15B).
- i. Set the + TRANSITION AMPLITUDE control for five divisions of vertical deflection.
- j. Set the sampling system time position range switch to 100 nanoseconds and magnify the sweep to one nanosecond/division.
- k. CHECK — Sampling system display for one division or less between the 10% and 90% points of the leading edge with  $\pm 0.1$  division or less aberrations in the first five divi-

sions following the leading edge one nanosecond or less risetime with  $\pm 2\%$  or less aberrations in first five nanoseconds; see Fig. 6-15C).

l. ADJUST—C107 and C118 (see Fig. 6-15D) for optimum risetime and square corner at the top of the leading edge of the waveform. A compromise setting may be necessary to obtain one-nanosecond risetime with + and - 2% or less aberrations.

### 15. Adjust — Fast Rise Output and Check Operation ①

- a. Remove the five-nanosecond cable from the + OUTPUT connector and connect it to the - OUTPUT connector.
- b. Set the sampling system vertical deflection to 20 millivolts/division and the sweep rate to 10 nanoseconds/division.
- c. Set the - TRANSITION AMPLITUDE control fully counterclockwise.
- d. CHECK—Sampling system display for 2.5 divisions or less amplitude (50 millivolts or less; see Fig. 6-16A).

- e. Set the sampling system vertical deflection to 100 millivolts/division.
- f. Set the — TRANSITION AMPLITUDE control fully clockwise.
- g. CHECK—Sampling system display for five divisions or more amplitude (500 millivolts or more; see Fig. 6-16B).
- h. Set the — TRANSITION AMPLITUDE control for five divisions of vertical deflection.
- i. Set the sampling system time position range switch to 100 nanoseconds and magnify the sweep to one nanosecond/division.
- j. CHECK — Sampling system display for one division or less between the 10% and 90% points of the leading edge with  $\pm 0.1$  division or less aberrations in the first five divisions following the leading edge (one nanosecond or less risetime with  $\pm 2\%$  or less aberrations in first five nanoseconds; see Fig. 6-16C).
- k. ADJUST—C127 and C138 (see Fig. 6-16D) for optimum risetime and square corner at bottom of the leading edge of the waveform. A compromise setting may be necessary to obtain one-nanosecond risetime with + and - 2% or less aberrations.

### 16. Check Trigger Jitter

- a. Insert the Type 106 into the cabinet.
- b. Set the sampling system to magnify the sweep rate to 0.2 nanosecond/division and set the triggering controls for a stable display.
- c. CHECK — Rotate the MULTIPLIER control throughout its range and check for 1.5 divisions or less jitter in the leading edge of the waveform (300 picoseconds or less; see Fig. 6-17).

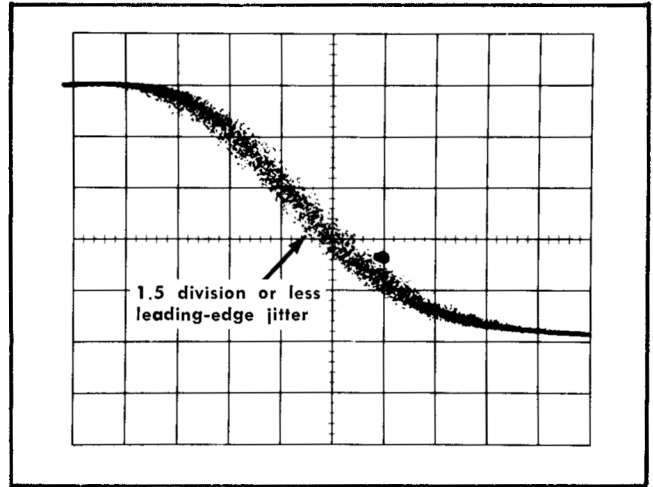


Fig. 6-17. Typical sampling system display of trigger jitter.

- d. Remove the five-nanosecond cable from the — OUTPUT connector and connect it to the + OUTPUT connector.
- e. CHECK — Rotate the MULTIPLIER control throughout its range and check for 1.5 divisions or less jitter in the leading edge of the waveform (300 picoseconds or less).
- f. Disconnect all test equipment.

This completes the calibration procedure for the Type 106. If the instrument has been completely calibrated to the tolerances given in this procedure, it will meet the performance requirements given in the Characteristics section of this Instruction Manual.

## PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	met.	metal
cer	ceramic	mtg hdw	mounting hardware
comp	composition	OD	outside diameter
conn	connector	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	PHB	pan head brass
DE	double end	PHS	pan head steel
dia	diameter	plstc	plastic
div	division	PMC	paper, metal cased
elect.	electrolytic	poly	polystyrene
EMC	electrolytic, metal cased	prec	precision
EMT	electrolytic, metal tubular	PT	paper, tubular
ext	external	PTM	paper or plastic, tubular, molded
F & I	focus and intensity	RHB	round head brass
FHB	flat head brass	RHS	round head steel
FHS	flat head steel	SE	single end
Fil HB	fillister head brass	SN or S/N	serial number
Fil HS	fillister head steel	SW	switch
h	height or high	TC	temperature compensated
hex.	hexagonal	THB	truss head brass
HHB	hex head brass	thk	thick
HHS	hex head steel	THS	truss head steel
HSB	hex socket brass	tub.	tubular
HSS	hex socket steel	var	variable
ID	inside diameter	w	wide or width
incd	incandescent	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 7

## ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No	Description	S/N Range
<b>Bulbs</b>			
B15	150-0027-00	Neon, NE-23	
B25	150-0027-00	Neon, NE-23	
B219	150-0052-00	Incandescent, 10 V, 40 mA (white lens)	200-1169
B219	150-0065-00	Incandescent, 10 V, 40 mA (green lens)	1170-up
<b>Capacitors</b>			
Tolerance $\pm 20\%$ unless otherwise indicated.			
C1	283-0008-00	0.1 $\mu\text{F}$ Cer	500 V
C2	281-0534-00	3.3 pF Cer	500 V $\pm 0.25$ pF
C10	290-0194-00	10 $\mu\text{F}$ EMT	100 V
C12	290-0136-00	2.2 $\mu\text{F}$ EMT	20 V
C17A	283-0052-00	105 pF Cer	500 V 1%
C17B } C17C } C17D } C17E }	*295-0096-00	0.001 $\mu\text{F}$ 0.01 $\mu\text{F}$ 0.1 $\mu\text{F}$ 1 $\mu\text{F}$	Timing Capacitor
C20	290-0194-00	10 $\mu\text{F}$ EMT	100 V
C22	290-0136-00	2.2 $\mu\text{F}$ EMT	20 V
C27A	283-0052-00	105 pF Cer	500 V 1%
C27B } C27C } C27D } C27E }	*295-0096-00	0.001 $\mu\text{F}$ 0.01 $\mu\text{F}$ 0.1 $\mu\text{F}$ 1 $\mu\text{F}$	Timing Capacitor
C37	281-0518-00	47 pF Cer	500 V
C43	283-0008-00	0.1 $\mu\text{F}$ Cer	500 V X635-up
C45	281-0523-00	100 pF Cer	350 V
C52	281-0543-00	270 pF Cer	500 V 10%
C56	290-0012-00	2 x 40 $\mu\text{F}$ EMC	250 V 200-1354
C56†	290-0075-00	2 x 10 $\mu\text{F}$ EMC	250 V 1355-up
C92	281-0525-00	470 pF Cer	500 V X635-up
C94	281-0536-00	1000 pF Cer	500 V 10% 200-634
C94	283-0059-00	1 $\mu\text{F}$ Cer	25 V +80%—20% 635-up
C95	281-0605-00	200 pF Cer	500 V 200-634
C95	283-0008-00	0.1 $\mu\text{F}$ Cer	500 V 635-up
C102	290-0137-00	100 $\mu\text{F}$ EMT	30 V +75%—15%
C103	281-0536-00	1000 pF Cer	500 V 10%
C107	281-0091-00	2-8 pF Cer	Var 200-1189
C107	281-0093-00	5.5-18 pF Cer	Var 1190-up
C118	281-0091-00	2-8 pF Cer	Var
C122	290-0137-00	100 $\mu\text{F}$ EMT	30 V +75%—15%
C123	281-0536-00	1000 pF Cer	500 V 10%
C127	281-0091-00	2-8 pF Cer	Var 200-1189
C127	281-0093-00	5.5-18 pF Cer	Var 1190-up
C138	281-0091-00	2-8 pF Cer	Var

†Only one 10  $\mu\text{F}$  section is utilized.

Capacitors (Cont)

Ckt. No.	Tektronix Part No.		Description		S/N Range
C212	290-0278-00	550 $\mu$ F	EMC	50V	
C213	290-0137-00	100 $\mu$ F	EMT	30 V	+75%—15% X680-up
C215	283-0059-00	1 $\mu$ F	Cer	25 V	+80%—20%
C217	290-0137-00	100 $\mu$ F	EMT	30 V	+75%—15% X346-up
C218	283-0059-00	1 $\mu$ F	Cer	25 V	+80%—20%
C222	290-0019-00	150 $\mu$ F	EMC	250 V	
C224	283-0008-00	0.1 $\mu$ F	Cer	500 V	
C227	290-0285-00	4 $\mu$ F	EMT	200 V	+50%—10%
C228	290-0164-00	1 $\mu$ F	EMT	150 V	
C229	283-0008-00	0.1 $\mu$ F	Cer	500 V	
C232	290-0016-00	125 $\mu$ F	EMC	350 V	
C234	283-0008-00	0.1 $\mu$ F	Cer	500 V	
C244	283-0008-00	0.1 $\mu$ F	Cer	500 V	
C246	283-0008-00	0.1 $\mu$ F	Cer	500 V	
C247	290-0159-00	2 $\mu$ F	EMT	150 V	X1355-1549X
C248	290-0159-00	2 $\mu$ F	EMT	150 V	X1355-1549X
C249	290-0397-00	1 $\mu$ F	EMT	450 V	+50%—10% X1550-up
C252	290-0089-00	3 x 20 $\mu$ F	EMC	350 V	
C255	290-0285-00	4 $\mu$ F	EMT	200 V	+50%—10%
C262	290-0278-00	550 $\mu$ F	EMC	50 V	
C268	283-0059-00	1 $\mu$ F	Cer	25 V	+80%—20%

Connectors

J1	131-0106-00	Coaxial, 1 contact, female, BNC
J49	131-0106-00	Coaxial, 1 contact, female, BNC
J99 <sup>1</sup>		
J119 <sup>1</sup>		
J139 <sup>1</sup>		

Diodes

D3	*152-0185-00	Silicon	Replaceable by 1N4152	
D4	152-0071-00	Germanium	ED 2007	200-697
D4	*152-0185-00	Silicon	Replaceable by 1N4152	698-up
D5	*152-0185-00	Silicon	Replaceable by 1N4152	
D32	*152-0185-00	Silicon	Replaceable by 1N4152	X1480-up
D33	152-0071-00	Germanium	ED 2007	200-1479
D33	*152-0185-00	Silicon	Replaceable by 1N4152	1480-up
D34	*152-0185-00	Silicon	Replaceable by 1N4152	
D35	*152-0185-00	Silicon	Replaceable by 1N4152	
D53	*152-0185-00	Silicon	Replaceable by 1N4152	
D54	152-0071-00	Germanium	ED 2007	200-609
D54	152-0079-00	Germanium	HD1841	610-up
D103	*152-0185-00	Germanium	Replaceable by 1N4152	
D104	152-0076-00	Zener	1N4372 0.4 W, 3 V, 10%	200-2089
D104	152-0278-00	Zener	1N4372A 0.4 W, 3 V, 5%	2090-up
D105	*152-0185-00	Silicon	Replaceable by 1N4152	
D114	152-0071-00	Germanium	ED 2007	200-609
D114	152-0079-00	Germanium	HD1841	610-up
D117	*152-0209-00	Tek GaAs		
D118	*152-0209-00	Tek GaAs		
D123	*152-0185-00	Silicon	Replaceable by 1N4152	
D124	152-0076-00	Zener	1N4372 0.4 W, 3 V, 10%	200-2089
D124	152-0278-00	Zener	1N4572A 0.4 W, 3 V, 5%	2090-up

<sup>1</sup>See Mechanical Parts List.

## Diodes (Cont)

Kct. No.	Tektronix Part No.	Description	S/N Range
D125	*152-0185-00	Silicon	Replaceable by 1N4152
D134	152-0071-00	Germanium	ED 2007
D134	152-0079-00	Germanium	HD1841
D137	*152-0209-00	Tek GaAs	
D138	*152-0209-00	Tek GaAs	
D212	152-0199-00	Rectifier bridge MDA 942-3 (Motorola)	
D213	152-0120-00	Zener	1N3020B 1 W, 10 V, 5%
D216	152-0120-00	Zener	1N3020B 1 W, 10 V, 5%
D222	152-0232-00	Rectifier bridge assembly	
D224	152-0101-00	Zener	1N3041B 1 W, 75 V, 5%
D232	152-0232-00	Rectifier bridge assembly	
D233	*152-0185-00	Silicon	Replaceable by 1N4152
D234	*152-0185-00	Silicon	Replaceable by 1N4152
D243	*152-0185-00	Silicon	Replaceable by 1N4152
D252	152-0232-00	Rectifier bridge assembly	
D255	152-0240-00	Zener	UZ 5215 5 W, 150 V, 10%
D262	152-0199-00	Rectifier bridge MDA 942-3 (Motorola)	
D264	152-0060-00	Zener	1N3027A 1 W, 20 V, 10%
D264	152-0291-00	Zener	1N3027B 1 W, 20 V, 5%

## Fuse

F201	159-0041-00	1.25 A, 3 AG, Slo-Blo	
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## Inductors

L13	*108-0057-00	8.8 $\mu$ H	
L23	*108-0057-00	8.8 $\mu$ H	
L64	276-0507-00	Core, Ferramic Suppressor	X635-up
L65	276-0507-00	Core, Ferramic Suppressor	X635-up
L74	276-0507-00	Core, Ferramic Suppressor	X635-up
L75	276-0507-00	Core, Ferramic Suppressor	X635-up
L84	276-0507-00	Core, Ferramic Suppressor	X635-up
L85	276-0507-00	Core, Ferramic Suppressor	X635-up

## Plug

P201	*131-0102-00	3 wire, male	200-801
P201	*131-0102-01	3 wire, male	802-1354
P201	*131-0102-02	3 wire, male	1355-2449X

## Transistors

Q4	*151-0195-00	Silicon	Replaceable by MPS 6515
Q33	151-0169-00	Silicon	2N3439
Q34	*151-0108-00	Silicon	Replaceable by 2N2501
Q34	151-0190-00	Silicon	2N3904
Q43	151-0190-00	Silicon	2N3904
Q54	151-0190-00	Silicon	2N3904
Q103	*151-0108-00	Silicon	Replaceable by 2N2501
Q103	151-0223-00	Silicon	2N4275
Q114	*151-0142-00	Silicon	Selected from 2N3546
Q114	151-0221-00	Silicon	2N4258

Transistors (Cont)

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q115	151-0188-00	Silicon 2N3906	X1190-up
Q124	*151-0108-00	Silicon Replaceable by 2N2501	
Q134	*151-0109-00	Silicon Selected from 2N918	200-929
Q134	*151-0223-00	Silicon 2N4275	930-up
Q135	151-0190-00	Silicon 2N3904	X1190-up
Q213	*151-0136-00	Silicon Replaceable by 2N3053	
Q217	*151-0134-00	Silicon Replaceable by 2N2905	200-679
Q217	151-0208-00	Silicon 2N4036	680-up
Q224	151-0150-00	Silicon 2N3440	
Q227	151-0150-00	Silicon 2N3440	
Q233	*151-0136-00	Silicon Replaceable by 2N3053	
Q234	151-0150-00	Silicon 2N3440	
Q247	*151-0196-00	Silicon Replaceable by 40256	200-777
Q247	151-0201-00	Silicon 2N3739	778-1354
Q247	151-0251-00	Silicon 2N4240	1355-up
Q257	151-0149-00	Silicon 2N3441	
Q267	*151-0136-00	Silicon Replaceable by 2N3053	

Resistors

Resistors are fixed, composition,  $\pm 10\%$  unless otherwise indicated.

R1	302-0105-00	1 M $\Omega$	1/2 W		
R2	315-0473-00	47 k $\Omega$	1/4 W		5%
R3	315-0104-00	100 k $\Omega$	1/4 W		5%
R4	315-0152-00	1.5 k $\Omega$	1/4 W		5%
R5	301-0275-00	2.7 M $\Omega$	1/2 W		5%
R6	311-0408-00	20 k $\Omega$		Var	
R8	311-0353-00	25 k $\Omega$		Var	
R9	311-0256-00	300 $\Omega$		Var	
R10	303-0203-00	20 k $\Omega$	1 W		5%
R11	323-0168-00	549 $\Omega$	1/2 W		Prec 1%
R12	315-0752-00	7.5 k $\Omega$	1/4 W		5%
R14	302-0330-00	33 $\Omega$	1/2 W		
R15	301-0131-00	130 $\Omega$	1/2 W		5%
R16	302-0330-00	33 $\Omega$	1/2 W		
R17	323-0406-00	165 k $\Omega$	1/2 W		Prec 1%
R17B	301-0206-00	20 M $\Omega$	1/2 W		5%
R17C	301-0226-00	22 M $\Omega$	1/2 W		5%
R17D	301-0226-00	22 M $\Omega$	1/2 W		5%
R17E	301-0915-00	9.1 M $\Omega$	1/2 W		5%
R20	303-0203-00	20 k $\Omega$	1 W		5%
R21	323-0168-00	549 $\Omega$	1/2 W		Prec 1%
R22	315-0752-00	7.5 k $\Omega$	1/4 W		5%
R24	302-0330-00	33 $\Omega$	1/2 W		
R25	301-0680-00	68 $\Omega$	1/2 W		5%
R26	302-0330-00	33 $\Omega$	1/2 W		
R27	323-0406-00	165 k $\Omega$	1/2 W		Prec 1%
R27B	301-0206-00	20 M $\Omega$	1/2 W		5%
R27C	301-0226-00	22 M $\Omega$	1/2 W		5%
R27D	301-0226-00	22 M $\Omega$	1/2 W		5%
R27E	301-0915-00	9.1 M $\Omega$	1/2 W		5%
R30	311-0326-00	10 k $\Omega$		Var	
R31*	311-0026-00	100 k $\Omega$		Var	
R34	301-0131-00	130 $\Omega$	1/2 W		5%
R35	315-0392-00	3.9 k $\Omega$	1/4 W		5%

\*Furnished as a unit with SW17.

## Resistors (Cont)

Ckt. No.	Tektronix Part No.		Description		S/N Range
R35	301-0562-00	5.6 k $\Omega$	1/2 W	5%	635-up
R36	315-0823-00	82 k $\Omega$	1/4 W	5%	200-634
R36	301-0473-00	47 k $\Omega$	1/2 W	5%	635-up
R37	303-0273-00	27 k $\Omega$	1 W	5%	
R38	305-0303-00	30 k $\Omega$	2 W	5%	
R39	311-0390-00	25 k $\Omega$		Var	
R42	316-0101-00	100 $\Omega$	1/4 W		X430-up
R43	302-0393-00	39 k $\Omega$	1/2 W		
R45	315-0681-00	680 $\Omega$	1/4 W	5%	
R46	315-0151-00	150 $\Omega$	1/4 W	5%	
R52	302-0472-00	4.7 k $\Omega$	1/2 W		
R55	304-0271-00	270 $\Omega$	1 W		
R56	304-0100-00	10 $\Omega$	1 W		200-634X
R59	302-0104-00	100 k $\Omega$	1/2 W		
R61	316-0330-00	33 $\Omega$	1/4 W		
R62	301-0222-00	2.2 k $\Omega$	1/2 W	5%	
R63	316-0100-00	10 $\Omega$	1/4 W		
R71	316-0330-00	33 $\Omega$	1/4 W		
R72	301-0222-00	2.2 k $\Omega$	1/2 W	5%	
R73	316-0100-00	10 $\Omega$	1/4 W		
R81	316-0330-00	33 $\Omega$	1/4 W		
R82	301-0222-00	2.2 k $\Omega$	1/2 W	5%	
R83	316-0100-00	10 $\Omega$	1/4 W		
R91	316-0330-00	33 $\Omega$	1/4 W		
R92	301-0222-00	2.2 k $\Omega$	1/2 W	5%	
R93	316-0100-00	10 $\Omega$	1/4 W		
R99	308-0392-00	600 $\Omega$	14 W	WW	2%
R101	302-0100-00	10 $\Omega$	1/2 W		
R102	303-0820-00	82 $\Omega$	1 W	5%	
R103	316-0102-00	1 k $\Omega$	1/4 W		
R105	316-0472-00	4.7 k $\Omega$	1/4 W		
R107	316-0220-00	22 $\Omega$	1/4 W		
R114	301-0241-00	240 $\Omega$	1/2 W	5%	200-1189
R114	301-0201-00	200 $\Omega$	1/2 W	5%	1190-up
R115	311-0587-00	5 k $\Omega$		Var	200-1189
R115	311-0117-00	5 k $\Omega$		Var	1190-up
R116	315-0202-00	2 k $\Omega$	1/4 W	5%	X1190-1449
R116	315-0182-00	1.8 k $\Omega$	1/4 W	5%	1450-up
R119	307-0068-00	50 $\Omega$		1%	
R121	302-0100-00	10 $\Omega$	1/2 W		
R122	303-0820-00	82 $\Omega$	1 W	5%	
R123	316-0102-00	1 k $\Omega$	1/4 W		
R125	316-0472-00	4.7 k $\Omega$	1/4 W		
R127	316-0220-00	22 $\Omega$	1/4 W		
R134	301-0241-00	240 $\Omega$	1/2 W	5%	200-1189
R134	301-0201-00	200 $\Omega$	1/2 W	5%	1190-up

Electrical Parts List—Type 106

Resistors (Cont)

Ckt. No.	Tektronix Part No.	Description	S/N Range
R135	311-0587-00	5 kΩ	200-1189
R135	311-0117-00	5 kΩ	1190-up
R136	315-0202-00	2 kΩ 1/4 W	X1190-1449
R136	315-0182-00	1.8 kΩ 1/4 W	1450-up
R139	307-0068-00	50 Ω	1%
R206	302-0104-00	100 kΩ 1/2 W	
R207	302-0104-00	100 kΩ 1/2 W	
R213	304-0101-00	100 Ω 1 W	
R216	304-0101-00	100 Ω 1 W	
R217	304-0270-00	27 Ω 1 W	200-679
R217	304-0100-00	10 Ω 1 W	680-up
R218	302-0271-00	270 Ω 1/2 W	
R219	316-0121-00	120 Ω 1/4 W	
R221	307-0057-00	5.1 Ω 1/2 W	5%
R226	308-0168-00	40 kΩ 8 W	WW
R227	306-0152-00	1.5 kΩ 2 W	
R228	303-0153-00	15 kΩ 1 W	5%
R229	303-0153-00	15 kΩ 1 W	5%
R232	306-0104-00	100 kΩ 2 W	
R233	301-0102-00	1 kΩ 1/2 W	5%
R234	315-0302-00	3 kΩ 1/4 W	5%
R235	315-0302-00	3 kΩ 1/4 W	5%
R236	316-0100-00	10 Ω 1/4 W	
R237	316-0223-00	22 kΩ 1/4 W	200-464
R237	316-0472-00	4.7 kΩ 1/4 W	465-up
R241	316-0101-00	100 Ω 1/4 W	200-1354
R241	316-0470-00	47 Ω 1/4 W	1355-up
R242	308-0315-00	150 Ω 10 W	WW 5%
R242	306-0270-00	27 Ω 2 W	
R246	311-0023-00	50 kΩ	Var
R247	311-0171-00	5 kΩ	Var
R248	301-0302-00	3 kΩ 1/2 W	5%
R251	316-0100-00	10 Ω 1/4 W	
R255	301-0153-00	15 kΩ 1/2 W	5%
R261	307-0113-00	5.1 Ω 1/4 W	5%
R264	302-0681-00	680 Ω 1/2 W	
R267	302-0820-00	82 Ω 1/2 W	
R268	302-0392-00	3.9 kΩ 1/2 W	

Switches

	Unwired	Wired		
SW17 <sup>a</sup>	260-0771-00	*262-0742-00	Rotary	REPETITION RATE RANGE
SW201	260-0199-00		Toggle	POWER
SW202	260-0675-00		Slide	115 V-230 V 200-1619
SW202	260-0675-01		Slide	115 V-230 V 1620-up
SW242	260-0398-00		Toggle	HI AMPLITUDE FAST RISE
				200-2089
SW242	260-0834-00		Toggle	HI AMPLITUDE FAST RISE
				2090-up

<sup>a</sup>Furnished as a unit with R31.

**Transformer**

Ckt. No.	Tektronix Part No.	Description	S/N Range
T201	*120-0420-00	Power	

**Thermal Cutout**

TK201	260-0677-00	Opens 158°F, ±5°; Closes 128°F, ±10°	
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**Test Points**

TP229	344-0105-00	Clip, Test Point	
TP249	344-0105-00	Clip, Test Point	
TP259	344-0105-00	Clip, Test Point	
TP269	344-0105-00	Clip, Test Point	

**Electron Tubes**

V15	154-0212-00	6EW6	200-1919
V15	154-0367-00	8136	1920-up
V25	154-0212-00	6EW6	200-1919
V25	154-0367-00	8136	1920-up
V64	154-0503-00	7189A	
V74	154-0503-00	7189A	
V84	154-0503-00	7189A	
V94	154-0503-00	7189A	

## 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 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**

FIG. 1	FRONT
FIG. 2	CHASSIS
FIG. 3	CABINET
FIG. 4	ACCESSORIES

# SECTION 8 MECHANICAL PARTS LIST

FIG. 1 FRONT

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q					Description	
		Eff	Disc	y	1	2	3	4		5
1-1	366-0081-00			1						KNOB, red—MULTIPLIER
	- - - - -			-						knob includes:
	213-0004-00			1						SCREW, set, 6-32 x 3/16 inch, HSS
-2	366-0142-00			1						KNOB, charcoal—REPETITION RATE RANGE
	- - - - -			-						knob includes:
	213-0004-00			1						SCREW, set, 6-32 x 3/16 inch, HSS
-3	262-0742-00			1						SWITCH, wired—REPETITION RATE RANGE
	- - - - -			-						switch includes:
	260-0771-00			1						SWITCH, unwired—REPETITION RATE RANGE
	384-0231-00			1						ROD, extension
-4	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: (not included w/resistor alone)
	210-0012-00			1						LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0413-00			2						NUT, hex., 3/8-32 x 1/2 inch
-5	376-0014-00			1						COUPLING, resistor
-6	407-0223-00			1						BRACKET
	- - - - -			-						mounting hardware: (not included w/switch)
-7	210-0413-00			1						NUT, hex., 3/8-32 x 1/2 inch
-8	210-0840-00			1						WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0012-00			1						LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	211-0597-00			2						SCREW, 6-32 x 1/4 inch, RHS (not shown)
	210-0457-00			2						NUT, keps, 6-32 x 5/16 inch (not shown)
-9	366-0148-00			1						KNOB, charcoal—SYMMETRY
	- - - - -			-						knob includes:
	213-0004-00			1						SCREW, set, 6-32 x 3/16 inch, HSS
-10	- - - - -			4						RESISTOR, variable
	- - - - -			-						mounting hardware for each: (not included w/resistor)
	210-0840-00			1						WASHER, flat, 0.390 ID x 9/16 inch OD
	210-0590-00			1						NUT, hex., 3/8-32 x 7/16 inch
	210-0012-00			1						LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-11	366-0148-00			1						KNOB, charcoal—AMPLITUDE
	- - - - -			-						knob includes:
	213-0004-00			1						SCREW, set, 6-32 x 3/16 inch, HSS
-12	366-0148-00			1						KNOB, charcoal—+TRANSITION AMPLITUDE
	- - - - -			-						knob includes:
	213-0004-00			1						SCREW, set, 6-32 x 3/16 inch, HSS
-13	366-0148-00			1						KNOB, charcoal—-TRANSITION AMPLITUDE
	- - - - -			-						knob includes:
	213-0004-00			1						SCREW, set, 6-32 x 3/16 inch, HSS
-14	136-0164-00			1						SOCKET, lamp
	- - - - -			-						mounting hardware: (not included w/socket)
	210-0590-00			2						NUT, hex, 3/8-32 x 7/16 inch
	210-0978-00			1						WASHER, flat, 3/8 ID x 1/2 inch OD
	210-0012-00			1						LOCKWASHER, internal, 3/8 ID x 1/2 inch OD

FIG. 1 FRONT (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q † y	Description				
					1	2	3	4	5
1-15	260-0199-00			1	SWITCH, unwired—POWER ON				
	- - - - -			-	mounting hardware: (not included w/switch)				
	210-0414-00			1	NUT, hex., 1 <sup>5</sup> / <sub>32</sub> -32 x 3 <sup>1</sup> / <sub>16</sub> inch				
	354-0055-00			1	RING, locking				
	210-0902-00			1	WASHER, flat, 0.470 ID x 2 <sup>1</sup> / <sub>32</sub> inch OD				
	210-0473-00			1	NUT, switch, 1 <sup>5</sup> / <sub>32</sub> -32 x 0.634 inch, 12 sided				
-16	260-0398-00	200	2089	1	SWITCH, unwired—HI AMPLITUDE FAST RISE				
	260-0834-00	2090		1	SWITCH, unwired—HI AMPLITUDE FAST RISE				
	- - - - -			-	mounting hardware: (not included w/switch)				
	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD				
	210-0940-00			1	WASHER, flat, 1 <sup>1</sup> / <sub>4</sub> ID x 3 <sup>3</sup> / <sub>8</sub> inch OD				
	210-0562-00			1	NUT, hex., 1 <sup>1</sup> / <sub>4</sub> -40 x 5 <sup>1</sup> / <sub>16</sub> inch				
-17	214-0553-00			1	SCREW, latch, 0.375 diameter x 1.388 inches long				
-18	358-0255-00			1	BUSHING, latch				
-19	129-0035-00			1	ASSEMBLY, binding post				
	- - - - -			-	assembly includes:				
	355-0507-00			1	STEM, binding post				
	200-0103-00			1	CAP, binding post				
	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD				
	210-0455-00			1	NUT, hex., 1 <sup>1</sup> / <sub>4</sub> -28 x 3 <sup>3</sup> / <sub>8</sub> inch				
-20	131-0106-00			2	CONNECTOR, coaxial, BNC				
	- - - - -			-	mounting hardware for each: (not included w/connector)				
-21	210-0255-00			1	LUG, solder				
-22	333-0926-00			1	PANEL, front				
	- - - - -			-	mounting hardware: (not included w/panel)				
	213-0088-00			1	SCREW, thread forming, #4 x 1 <sup>1</sup> / <sub>4</sub> inch, PHS, phillips				
-23	214-0210-00			1	ASSEMBLY, solder spool				
	- - - - -			-	assembly includes:				
	214-0209-00			1	SPOOL, w/o solder				
	- - - - -			-	mounting hardware: (not included w/assembly)				
	361-0007-00			1	SPACER, plastic, 0.188 inch long				
-24	384-0615-00			3	ROD, spacer				
	- - - - -			-	mounting hardware for each: (not included w/rod)				
	212-0044-00			1	SCREW, 8-32 x 1 <sup>1</sup> / <sub>2</sub> inch, RHS, phillips				
-25	352-0002-00			1	ASSEMBLY, fuse holder				
	- - - - -			-	assembly includes:				
	352-0010-00			1	HOLDER, fuse				
-26	200-0582-00			1	CAP, fuse, black				
-27	210-0873-00			1	WASHER, rubber, 1 <sup>1</sup> / <sub>2</sub> ID x 1 <sup>1</sup> / <sub>16</sub> inch OD				
-28	- - - - -			1	NUT				
-29	260-0675-00	200	1619	1	SWITCH, unwired—115 V-230 V				
	260-0675-01	1620		1	SWITCH, unwired—115 V - 230 V				
	- - - - -			-	switch includes:				
	260-0675-00			1	SWITCH, unwired				
	337-1036-00			1	SHIELD, solder				
	- - - - -			-	mounting hardware: (not included w/switch)				
	211-0008-00			2	SCREW, 4-40 x 1 <sup>1</sup> / <sub>4</sub> inch, PHS				
	210-0406-00			2	NUT, hex., 4-40 x 3 <sup>1</sup> / <sub>16</sub> inch				

FIG. 1 FRONT (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † Y	1 2 3 4 5					Description
					1	2	3	4	5	
1-30	378-0035-01			1						FILTER, air
-31	131-0102-00	200	801	1						CONNECTOR, 3 wire
	131-0102-01	802	1354	1						CONNECTOR, 3 wire
	131-0102-02	1355		1						CONNECTOR, 3 wire
	- - - - -			-						connector includes:
-32	129-0041-00	200	801	1						POST, ground
	129-0041-01	802	1354	1						POST, ground
-33	200-0185-00	200	801	1						COVER, plastic
	200-0185-01	802	1354	1						COVER, plastic
	204-0335-00	1355		1						BODY-CONTACT ASSEMBLY
-34	210-0003-00	200	801X	2						LOCKWASHER, external #4
-35	210-0551-00	200	801X	2						NUT, hex., 4-40 x 1/4 inch
	211-0132-00	X802	1354	1						SCREW, sems, 4-40 x 1/2 inch, PHS
	211-0534-00	1355	2539	1						SCREW, sems, 6-32 x 5/16 inch, PHS
	211-0614-00	2540		1						SCREW, sems, 6-32 x 1/4 inch, PHS
-36	211-0015-00	200	801	1						SCREW, 4-40 x 1/2 inch, RHS
	213-0088-00	802	1354	1						SCREW, thread forming, 4-40 x 1/4 inch, PHS
	213-0146-00	1355		1						SCREW, thread forming, #6 x 0.313 inch, PHS
-37	214-0078-00			2						PIN, connecting
-38	377-0041-00	200	801	1						INSERT
	377-0051-00	802	1354	1						INSERT
	214-1016-00	1355		1						INSULATOR, connector
-39	386-0933-00	200	1354	1						PLATE, mounting
	386-1356-01	1355		1						PLATE, mounting
	- - - - -			-						mounting hardware: (not included w/connector
-40	211-0542-00	200	1289	2						SCREW, 6-32 x 5/16 inch, THS
	211-0514-00	1290		2						SCREW, 6-32 x 3/4 inch, PHS
	210-0457-00			2						NUT, keps, 6-32 x 5/16 inch
	337-0955-00	X1290		1						SHIELD, connector
-41	386-1022-00			1						PLATE, rear
-42	214-0680-00			1						PIN, locating
	- - - - -			-						mounting hardware: (not included w/pin)
	210-0458-00			1						NUT, keps, 8-32 x 1 1/32 inch
-43	386-1021-00			1						PLATE, sub-panel, front
-44	132-0040-00			1						ADAPTER, panel
	- - - - -			-						mounting hardware: (not included w/adapter)
-45	211-0101-00			4						SCREW, 4-40 x 1/4 inch, 100° CSK, FHS
-46	132-0002-00			1						SLEEVE, conductor, outer
-47	132-0029-00			1						CONDUCTOR, inner
-48	132-0028-00			1						INSULATOR
-49	132-0030-00			1						TRANSISTION, inner
-50	132-0007-00			1						RING, snap
-51	132-0023-00			1						SHELL, 1/16 ID x 5/8 inch OD
-52	132-0001-00			1						NUT, coupling
-53	132-0121-00			1						NUT, retaining
-54	351-0096-00			1						RAIL, guide
	- - - - -			-						mounting hardware: (not included w/rail)
	212-0044-00			1						SCREW, 8-32 x 1/2 inch, RHS
	214-0680-00			1						PIN, locating
	211-0512-00			2						SCREW, 6-32 x 1/2 inch, 100° CSK, FHS

FIG. 1 FRONT (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y	Description				
					1	2	3	4	5
1-55	670-0223-00	100	1189	1	ASSEMBLY, circuit board, +OUTPUT				
	670-0223-01	1190		1	ASSEMBLY, circuit board, +OUTPUT				
	- - - - -			-	assembly includes:				
	388-0685-00	100	1189	1	BOARD, circuit				
	388-0685-01	1190		1	BOARD, circuit				
-56	132-0040-00			1	ADAPTER, panel				
-57	132-0002-00			1	SLEEVE, conductor, outer				
-58	132-0029-00			1	CONDUCTOR, inner				
-59	132-0028-00			1	INSULATOR				
-60	358-0175-00			1	BUSHING, inner transistion				
-61	132-0007-00			1	RING, snap				
-62	355-0108-00			1	STUD, terminal				
-63	205-0050-00			1	SHELL, extension				
-64	132-0001-00			1	NUT, coupling				
-65	132-0121-00			1	NUT, retaining				
-66	211-0020-00			2	SCREW, 4-40 x 1 1/8 inches, RHS				
-67	391-0056-00			2	BLOCK				
-68	210-0054-00			2	LOCKWASHER, #4, split				
-69	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch				
-70	344-0108-00			4	CLIP				
-71	136-0220-00	100	1189	1	SOCKET, transistor, 3 pin				
	136-0220-00	1190		2	SOCKET, transistor, 3 pin				
	- - - - -			-	mounting hardware: (not included w/assembly)				
-72	211-0101-00			4	SCREW, 4-40 x 1/4 inch, 100° CSK, FHS				
-73	670-0222-00	100	1189	1	ASSEMBLY, circuit board, —OUTPUT				
	670-0222-01	1190		1	ASSEMBLY, circuit board, —OUTPUT				
	- - - - -			-	assembly includes:				
	388-0686-00	100	1189	1	BOARD, circuit				
	388-0686-00	1190		1	BOARD, circuit				
-74	132-0040-00			1	ADAPTER, panel				
-75	132-0002-00			1	SLEEVE, conductor, outer				
-76	132-0029-00			1	CONDUCTOR, inner				
-77	132-0028-00			1	INSULATOR				
-78	358-0175-00			1	BUSHING, inner transistion				
-79	132-0007-00			1	RING, snap				
-80	355-0108-00			1	STUD, terminal				
-81	205-0050-00			1	SHELL, extension				
-82	132-0001-00			1	NUT, coupling				
-83	132-0121-00			1	NUT, retaining				
-84	211-0020-00			2	SCREW, 4-40 x 1 1/8 inches, RHS				
-85	391-0056-00			2	BLOCK				
-86	210-0054-00			2	LOCKWASHER, #4, spilt				
-87	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch				
-88	344-0108-00			4	CLIP				
-89	136-0220-00	100	1189	1	SOCKET, transistor, 3 pin				
	136-0220-00	1190		2	SOCKET, transistor, 3 pin				
	- - - - -			-	mounting hardware: (not included w/assembly)				
-90	211-0101-00			4	SCREW, 4-40 x 1/4 inch, 100° CSK, FHS				
-91	380-0105-00			1	HOUSING, filter				
	- - - - -			-	mounting hardware: (not included w/housing)				
	211-0081-00			2	SCREW, 2-56 x 9/16 inch, RHS				
	210-0001-00			2	LOCKWASHER, internal #2				
	210-0405-0C			2	NUT, hex., 2-56 x 3/16 inch				

FIG. 2 CHASSIS

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † y	Description	
		Eff	Disc			
2-1	136-0071-00	200	239	2	SOCKET, tube, 7 pin, miniature	
	136-0008-00	240		2	SOCKET, tube, 7 pin, w/ground lugs	
	- - - - -	-		-	mounting hardware for each: (not included w/socket)	
	213-0044-00	-		2	SCREW, thread forming, 5-32 x 3/16 inch, PHS, phillips	
-2	136-0181-00	-	-	9	SOCKET, transistor, 3 pin	
	354-0234-00	-	-	-	mounting hardware for each: (not included w/socket)	
-	-	-	-	1	RING, locking	
-3	348-0031-00	-	-	8	GROMMET, plastic, snap-in, 0.180 inch OD	
-4	348-0055-00	-	-	1	GROMMET, plastic, 1/4 inch diameter	
-5	210-0201-00	-	-	9	LUG, solder, SE #4	
	- - - - -	-	-	-	mounting hardware for each: (not included w/lug)	
	213-0044-00	-	-	1	SCREW, thread forming, 5-32 x 3/16 inch, PHS, phillips	
-6	- - - - -	-	-	5	RESISTOR, variable	
	210-0940-00	-	-	-	mounting hardware for each: (not included w/resistor)	
	210-0583-00	-	-	1	WASHER, flat, 1/4 ID x 3/8 inch OD	
-	-	-	-	1	NUT, hex., 1/4-32 x 5/16 inch	
-7	- - - - -	-	-	1	TRANSISTOR	
	- - - - -	-	-	-	mounting hardware for each: (not included w/transistor)	
	211-0507-00	-	-	2	SCREW, 6-32 x 5/16 inch, PHS, phillips	
	386-0143-00	-	-	1	PLATE, insulator, mica	
	210-0983-00	200	509	2	WASHER, shouldered, #6 hole, black, anodized	
	210-0811-00	510		2	WASHER, shouldered, fiber, #6	
	210-0006-00	-		1	LOCKWASHER, internal, SE #6	
	210-0202-00	-		1	LUG, solder, SE #6	
	210-0802-00	-		2	WASHER, flat, 0.150 ID x 0.312 inch OD	
	210-0407-00	-		2	NUT, hex., 6-32 x 1/4 inch	
-8	348-0067-00	-		-	1	GROMMET, plastic, 5/16 inch diameter hole
-9	- - - - -	-		-	1	CAPACITOR
	- - - - -	-		-	-	mounting hardware: (not included w/capacitor)
-10	211-0532-00	-		-	2	SCREW, 6-32 x 3/4 inch, Fil HS, phillips
-11	432-0048-00	-	-	1	BASE, capacitor mounting	
-12	386-0254-00	-	-	1	PLATE, large, fiber	
-13	210-0457-00	-	-	2	NUT, keps, 6-32 x 5/16 inch	
-14	- - - - -	-	-	1	CAPACITOR	
	- - - - -	-	-	-	mounting hardware: (not included w/capacitor)	
-15	211-0597-00	-	-	2	SCREW, 6-32 x 1/4 inch, RHS, phillips	
-16	386-0254-00	-	-	1	PLATE, large, fiber	
-17	- - - - -	-	-	4	CAPACITOR	
	- - - - -	-	-	-	mounting hardware for each: (not included w/capacitor)	
-18	211-0597-00	-	-	2	SCREW, 6-32 x 1/4 inch, RHS, phillips	
-19	386-0252-00	-	-	1	PLATE, small, fiber	

FIG. 2 CHASSIS (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † Y	Description
		Eff	Disc		
2-20	200-0293-00			1	COVER, capacitor, plastic, 1.365 ID x 2 1/16 inches long
-21	200-0260-00			1	COVER, capacitor, plastic, 1.365 ID x 2 1/32 inches long
-22	200-0257-00			1	COVER, capacitor, plastic, 1 inch ID x 2 17/32 inches long
-23	200-0256-00			3	COVER, capacitor, plastic, 1 inch ID x 2 1/32 inches long
-24	- - - - -			1	TRANSFORMER
	- - - - -			-	transformer includes:
-25	212-0516-00			4	SCREW, 10-32 x 2 inch, HHS
-26	210-0812-00			4	WASHER, shouldered, #10, fiber
	- - - - -			-	mounting hardware: (not included w/transformer)
-27	220-0410-00			4	NUT, keps, 10-32 x 3/8 inch
-28	441-0665-00			1	CHASSIS, horizontal
	- - - - -			-	mounting hardware: (not included w/chassis)
	211-0538-00			3	SCREW, 6-32 x 5/16 inch, 100° csk, FHS (not shown)
-29	211-0597-00			7	SCREW, 6-32 x 1/4 inch, RHS, phillips
-30	- - - - -			1	THERMAL CUTOUT
	- - - - -			-	mounting hardware: (not included w/thermal cutout)
-31	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-32	337-0005-00			2	SHIELD, tube socket
	136-0072-00			2	SOCKET, tube, 9-pin
	- - - - -			-	mounting hardware for each: (not included w/socket)
	211-0033-00			2	SCREW, sems, 4-40 x 5/16 inch, PHS
	210-0004-00	200	634	2	LOCKWASHER, internal, #4
	210-0004-00	635		1	LOCKWASHER, internal, #4
	210-0201-00	X635		1	LUG, solder, SE #4
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-33	136-0218-00			3	SOCKET, transistor, 3 pin
	- - - - -			-	mounting hardware for each: (not included w/socket)
	354-0285-00			1	HOLDER, locking
-34	348-0056-00			1	GROMMET, plastic, 0.354 ID x 0.406 inch OD
-35	441-0664-00	200	777	1	CHASSIS, vertical
	441-0664-01	778		1	CHASSIS, vertical
	- - - - -			-	mounting hardware: (not included w/chassis)
	211-0538-00			5	SCREW, 6-32 x 5/16 inch, 100° csk, FHS (not shown)
-36	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
-37	147-0008-00			1	MOTOR
	- - - - -			-	mounting hardware: (not included w/motor)
-38	213-0089-00			2	SCREW, 10-32 x 3/8 inch, HHS
-39	369-0024-00			1	BLADE, fan, 3 1/2 inch

FIG. 2 CHASSIS (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † Y	Description
		Eff	Disc		
2-40	- - - - -			1	TRANSISTOR
	- - - - -			1	mounting hardware: (not included w/transistor)
	211-0097-00	200	777	2	SCREW, 4-40 x 5/16 inch, PHS
	211-0510-00	778		2	SCREW, 6-32 x 3/8 inch, PHS
	386-1094-00	200	777	1	PLATE, insulator mica
	386-0143-00	778		1	PLATE, insulator mica
	210-0849-00	200	777	2	WASHER, shouldered, #4 fiber
	210-0811-00	778		2	WASHER, shouldered, #6 fiber
	210-0994-00	200	777	2	WASHER, flat, 0.125 ID x 0.250 inch OD
	210-0802-00	778		2	WASHER, flat, 0.150 ID x 0.312 inch OD
	210-0586-00	200	777	2	NUT, keps, 4-40 x 1/4 inch
	210-0457-00	778		2	NUT, keps, 6-32 x 5/16 inch
-41	214-0269-00			1	HEAT SINK, 5/16 diameter x 3/4 inch long
-42	337-0491-00			4	SHIELD, tube
-43	124-0147-00			2	STRIP, ceramic, 7/16 inch h, w/13 notches
	- - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - -			-	mounting hardware for each: (not included w/strip)
	361-0007-00			2	SPACER, plastic, 0.188 inch long
-44	124-0149-00			8	STRIP, ceramic, 7/16 inch h, w/7 notches
	- - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - -			-	mounting hardware for each: (not included w/strip)
	361-0007-00			2	SPACER, plastic, 0.188 inch long
-45	179-1022-00			1	CABLE HARNESS
-46	124-0154-00			3	STRIP, ceramic, 7/16 inch h, w/20 notches
	- - - - -			-	each strip includes:
	355-0082-00			2	STUD, plastic
	- - - - -			-	mounting hardware for each: (not included w/strip)
	361-0039-00			2	SPACER, plastic, 0.531 inch long
-47	124-0155-00			2	STRIP, ceramic, 7/16 inch h, w/16 notches
	- - - - -			-	each strip includes:
	355-0082-00			2	STUD, plastic
	- - - - -			-	mounting hardware for each: (not included w/strip)
	361-0039-00			2	SPACER, plastic, 0.531 inch long
-48	337-0005-00			1	SHIELD, tube socket
	136-0072-00			1	SOCKET, tube, 9 pin
	- - - - -			-	mounting hardware: (not included w/socket)
	211-0033-00			2	SCREW, sems, 4-40 x 5/16 inch, PHS
	210-0004-00	200	345	2	LOCKWASHER, internal, #4
	210-0004-00	346		1	LOCKWASHER, internal, #4
	210-0201-00	X346		1	LUG, solder, SE #4
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch

FIG. 2 CHASSIS (Cont)

Fig. & Index No.	Part No. Tektronix	Serial/Model Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
-49	124-0179-00	200	345	FT.						STRIP, brass (1 piece 0.250 foot long and 1 piece 0.833 foot long)
	124-0179-01	346		1						STRIP, brass, 3 <sup>3</sup> / <sub>4</sub> inches long
-50	343-0015-00	X346		1						CLAMP, capacitor
	- - - - -			-						mounting hardware: (not included w/clamp)
	211-0514-00			1						SCREW, 6-32 x <sup>3</sup> / <sub>4</sub> inch, PHS
	385-0079-00			1						ROD, hex.
	210-0203-00			1						LUG, solder, SE #6, long
	210-0457-00			1						NUT, keps, 6-32 x <sup>5</sup> / <sub>16</sub> inch
-51	337-0005-00			1						SHIELD, tube socket
	136-0072-00			1						SOCKET, tube, 9 pin
	- - - - -			-						mounting hardware: (not included w/socket)
	211-0033-00			2						SCREW, sems, 4-40 x <sup>5</sup> / <sub>16</sub> inch, PHS
	210-0004-00			2						LOCKWASHER, internal, #4
	210-0406-00			2						NUT, hex., 4-40 x <sup>3</sup> / <sub>16</sub> inch

FIG. 3 CABINET

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q † y	1 2 3 4 5					Description
	437-0080-00			1						CABINET
	- - - - -			-						cabinet includes:
3-1	386-1020-00			2						PLATE, side
	- - - - -			-						mounting hardware for each: (not included w/plate alone)
	212-0002-00			2						SCREW, 8-32 x 1/4 inch, 100° CSK, FHS, phillips
-2	426-0253-00			1						FRAME, front, left
-3	377-0121-00			1						INSERT, frame, left
-4	426-0252-00			1						FRAME, front, right
-5	377-0120-00			1						INSERT, frame, right
-6	426-0254-00			1						FRAME, front, bottom
	- - - - -			-						mounting hardware: (not included w/frame alone)
	212-0004-00			2						SCREW, 8-32 x 5/16 inch, PHS, phillips
	212-0002-00			2						SCREW, 8-32 x 1/4 inch, 100° CSK, FHS, phillips (not shown)
-7	426-0255-00			1						FRAME, front, top
	- - - - -			-						mounting hardware: (not included w/frame alone)
	212-0002-00			4						SCREW, 8-32 x 1/4 inch, 100° CSK, FHS, phillips
-8	351-0093-00			1						GUIDE, left
	- - - - -			-						mounting hardware: (not included w/guide alone)
	212-0023-00			1						SCREW, 8-32 x 3/8 inch, PHS, phillips
	210-0007-00			1						LOCKWASHER, external, #8
-9	351-0092-00			1						GUIDE, right
-10	358-0293-01			1						BUSHING, plug-in securing, left
	- - - - -			-						mounting hardware: (not included w/bushing alone)
	211-0510-00			1						SCREW, 6-32 x 3/8 inch, PHS, phillips
	210-0005-00			1						LOCKWASHER, external, #6
	212-0001-00			1						SCREW, 8-32 x 1/4 inch, BHS, phillips
	210-0007-00			1						LOCKWASHER, external, #8
-11	358-0294-01			1						BUSHING, plug-in securing, right
	- - - - -			-						mounting hardware: (not included w/bushing alone)
	211-0510-00			1						SCREW, 6-32 x 3/8 inch, PHS, phillips (not shown)
	210-0005-00			1						LOCKWASHER, external, #6 (not shown)
	212-0001-00			1						SCREW, 8-32 x 1/4 inch, PHS, phillips (not shown)
	210-0007-00			1						LOCKWASHER, external, #8 (not shown)
-12	386-0139-00			1						PLATE, rear
-13	386-1023-00			1						PLATE, bottom
-14	386-1024-00			1						PLATE, top
-15	348-0075-00			2						FOOT, rear guard, left and right
	- - - - -			-						mounting hardware for each: (not included w/foot alone)
	212-0004-00			2						SCREW, 8-32 x 5/16 inch, PHS, phillips

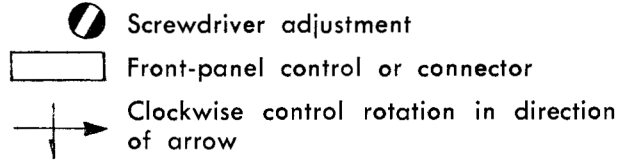
FIG. 3 CABINET (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q					Description	
			t	y	1	2	3		4
3-16	348-0074-00		1						FOOT, rear, left
	- - - - -		-						mounting hardware: (not included w/foot alone)
	211-0532-00		2						SCREW, 6-32 x 3/4 inch, Fil HS, phillips (not shown)
	348-0074-00		1						FOOT, front, right (not shown)
	- - - - -		-						mounting hardware: (not included w/foot alone)
	211-0532-00		2						SCREW, 6-32 x 3/4 inch, Fil HS, phillips (not shown)
	210-0457-00		1						NUT, keps, 6-32 x 5/16 inch (not shown)
-17	378-0073-00		1						FOOT, front, left
	- - - - -		-						mounting hardware: (not included w/foot alone)
	211-0532-00		2						SCREW, 6-32 x 3/4 inch, Fil HS phillips
	210-0457-00		1						NUT, keps, 6-32 x 5/16 inch (not shown)
	348-0073-00		1						FOOT, rear, right (not shown)
	- - - - -		-						mounting hardware: (not included w/foot alone)
	211-0532-00		2						SCREW, 6-32 x 3/4 inch, Fil HS, phillips (not shown)
-18	377-0119-00		4						INSERT, foot
-19	348-0072-00		1						FOOT, flip-stand bail
-20	367-0052-00		1						HANDLE
	- - - - -		-						mounting hardware: (not included w/handle alone)
	212-0040-00		2						SCREW, 8-32 x 3/8 inch, 100° CSK, FHS, phillips
-21	367-0051-00		1						PIVOT, handle, left
-22	377-0123-00		1						PIVOT, insert, left
-23	367-0050-00		1						PIVOT, handle, right
-24	377-0122-00		1						PIVOT, insert, right
-25	214-0054-00		2						BOLT, hinge
	214-0558-00		2						WASHER, thrust, 5/16 x 1/2 inch

# SECTION 9

## DIAGRAMS

The following symbols are used on the diagrams:



### IMPORTANT

#### Voltage and Waveform Conditions

Voltages measured with a 20,000 ohms/volt VOM. All readings in volts. Voltages are measured with respect to chassis ground unless otherwise noted.

Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System and Projected Graticule. The test oscilloscope had the following characteristics: Minimum deflection factor, 0.05 volt/division (0.5 volt/division using 10 $\times$  probe); frequency response, DC to 30 MHz. DC input coupling was used except as noted otherwise. To indicate true time relationship between signals, the test oscilloscope was externally triggered from the TRIGGER OUTPUT pulse.

Voltages and waveforms on the schematics (shown in blue) are not absolute and may vary between instruments because of differing component tolerances, internal calibration or front-panel control settings. Any apparent differences between voltage levels measured with the voltmeter and those shown on the waveforms are due to circuit loading of the voltmeter.

Voltages and waveforms were obtained under the following conditions unless otherwise noted on the individual diagrams:

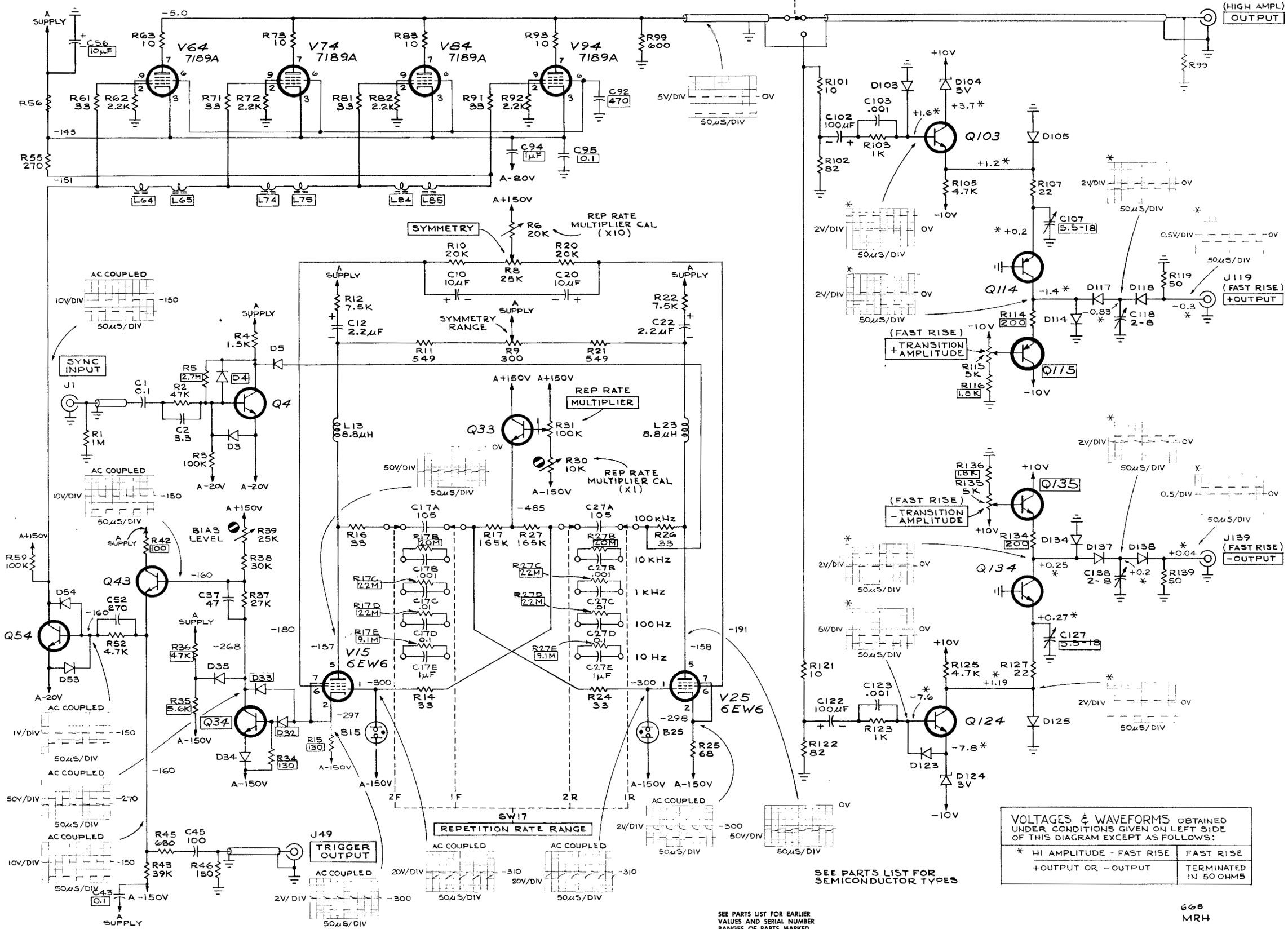
#### Front-panel control settings

REPETITION RATE RANGE	1 kHz
MULTIPLIER	10
SYMMETRY	Midrange
AMPLITUDE	Clockwise
HI AMPLITUDE — FAST RISE	HI AMPLITUDE
+ TRANSITION AMPLITUDE	Clockwise
— TRANSITION AMPLITUDE	Clockwise
POWER	ON
OUTPUT (connector)	Terminated in 50 ohms
+ OUTPUT (connector)	Unterminated
— OUTPUT (connector)	Unterminated

#### Other conditions

Line voltage	115 volts
Output cable	Five-nanosecond GR cable RG-213 V
Output termination	50-Ohm in-line

**VOLTAGE & WAVEFORM CONDITIONS**



VOLTAGES & WAVEFORMS OBTAINED UNDER CONDITIONS GIVEN ON LEFT SIDE OF THIS DIAGRAM EXCEPT AS FOLLOWS:

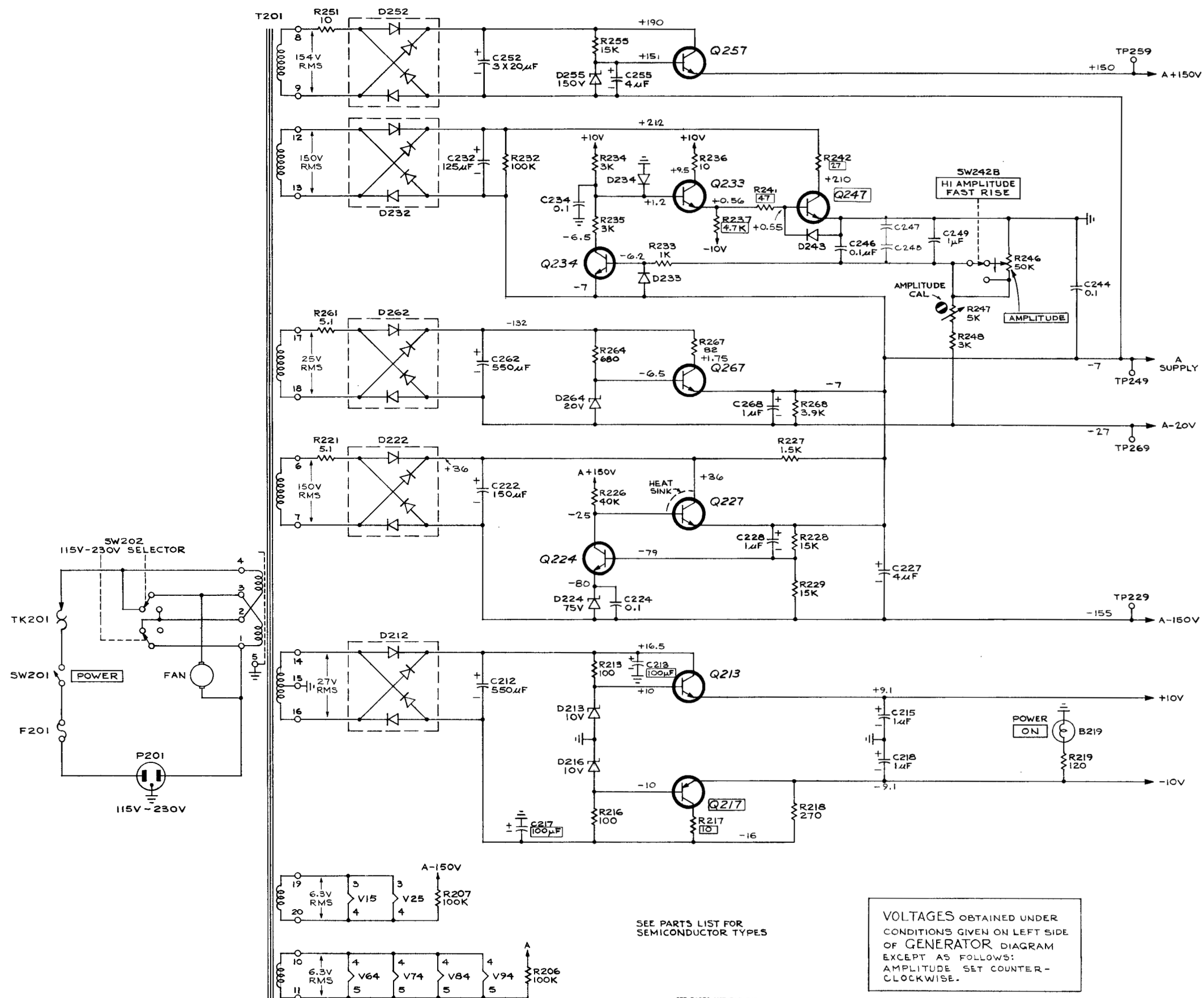
* HI AMPLITUDE - FAST RISE	FAST RISE
+OUTPUT OR -OUTPUT	TERMINATED IN 50 OHMS

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

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

668 MRH

**GENERATOR**

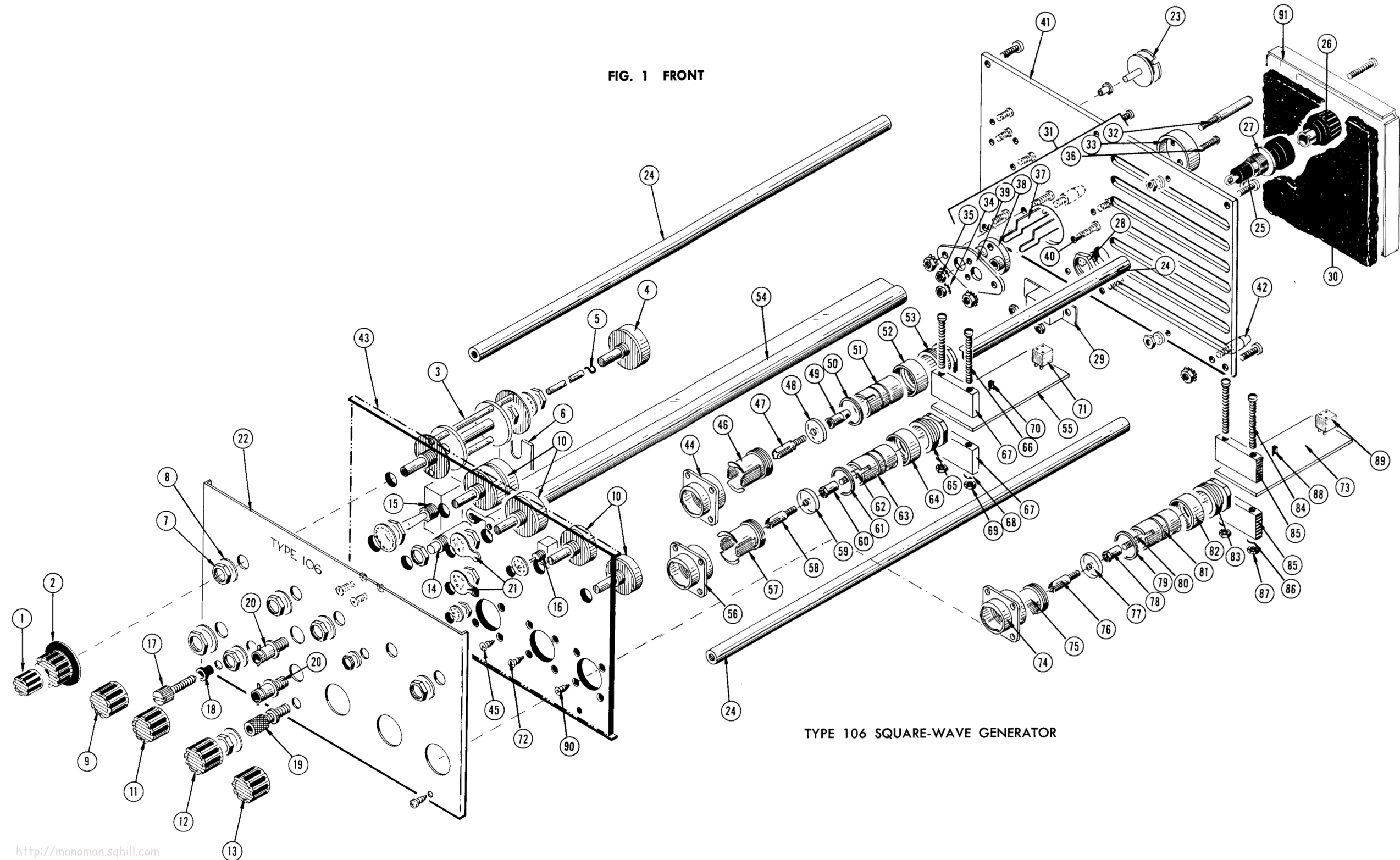


SEE PARTS LIST FOR SEMICONDUCTOR TYPES

VOLTAGES OBTAINED UNDER CONDITIONS GIVEN ON LEFT SIDE OF GENERATOR DIAGRAM EXCEPT AS FOLLOWS:  
 AMPLITUDE SET COUNTER-CLOCKWISE.

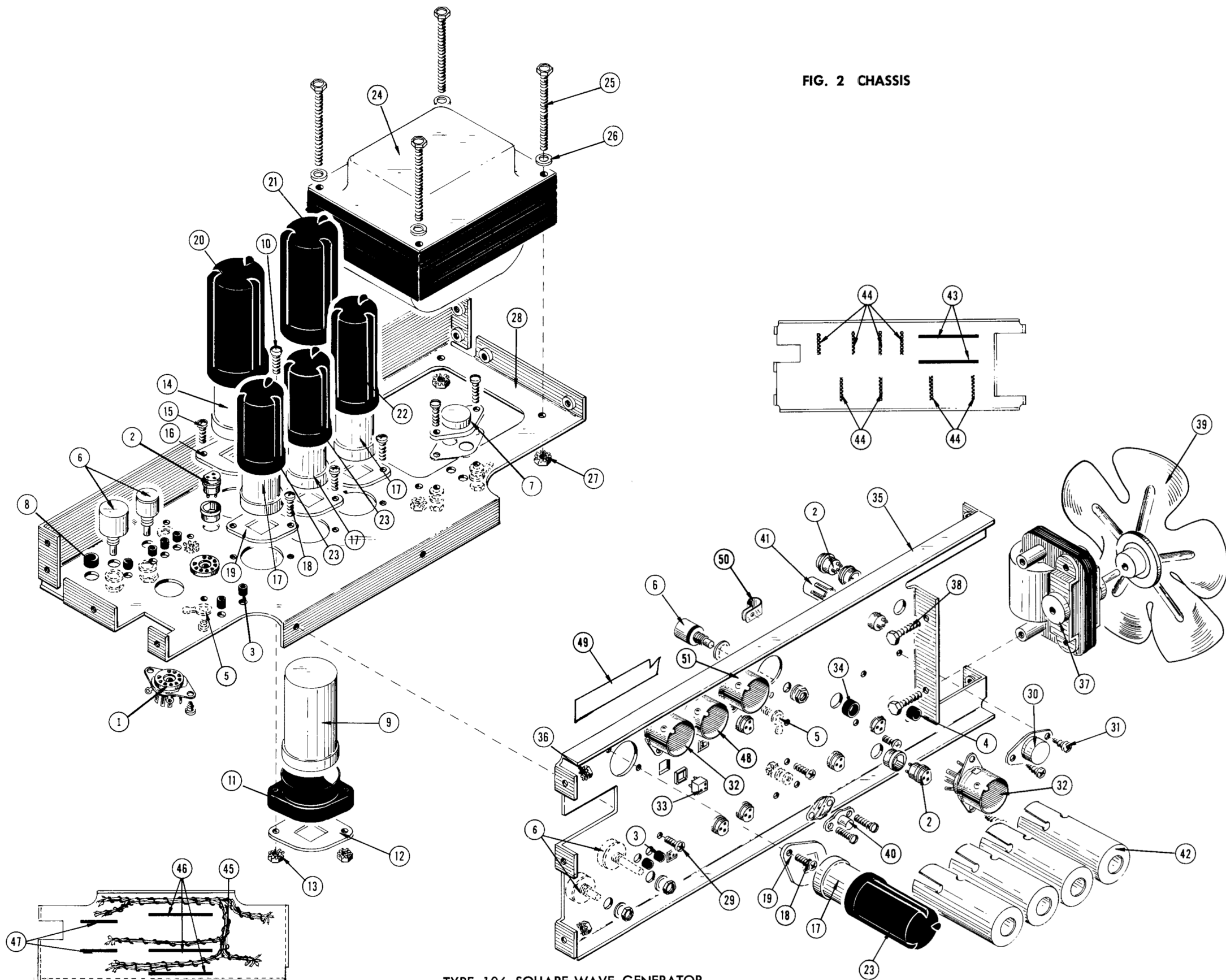
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

FIG. 1 FRONT



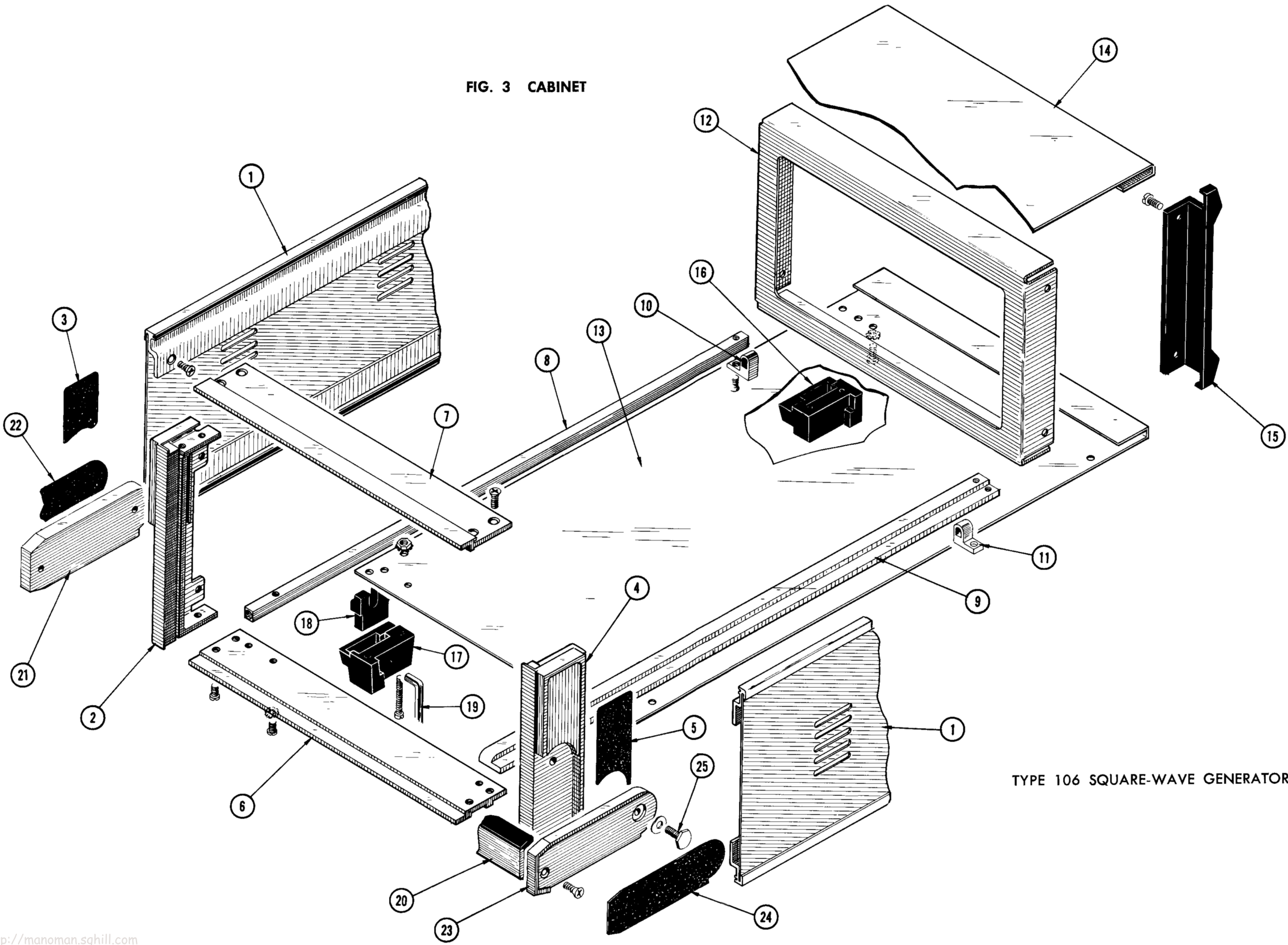
TYPE 106 SQUARE-WAVE GENERATOR

FIG. 2 CHASSIS



TYPE 106 SQUARE-WAVE GENERATOR

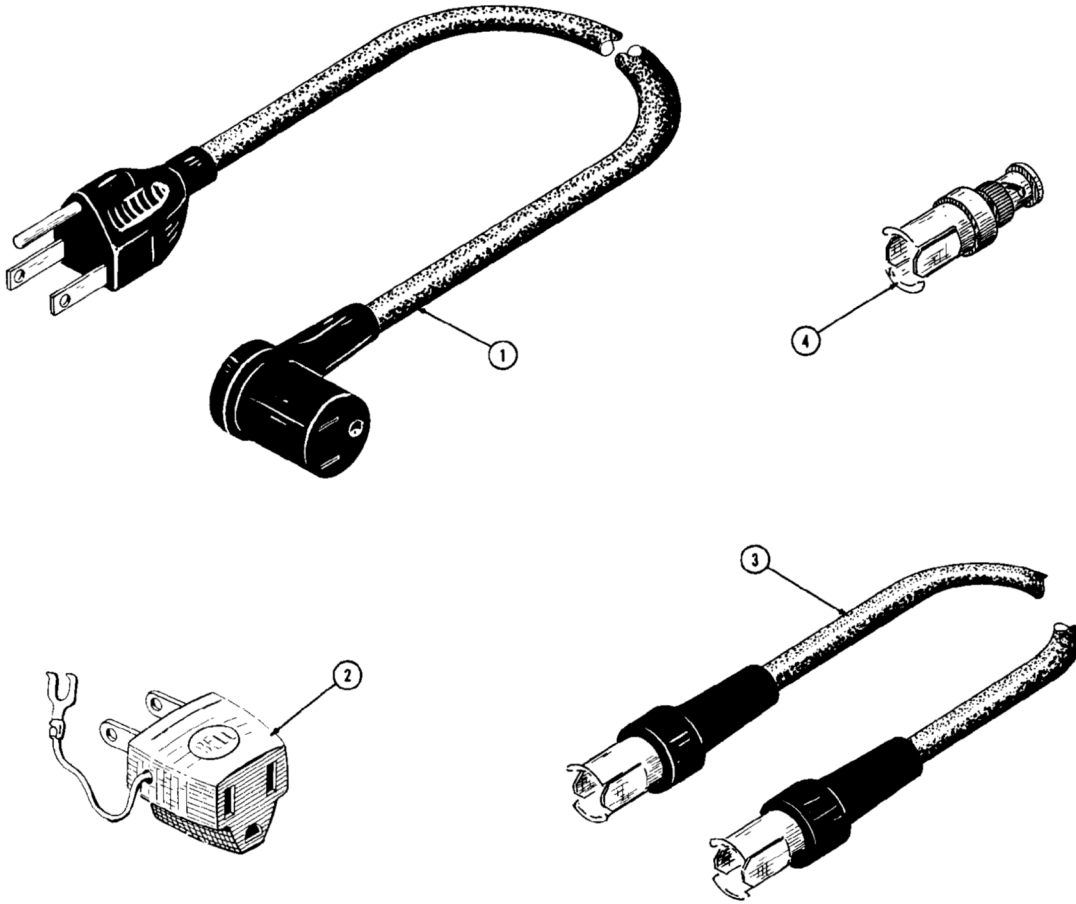
FIG. 3 CABINET



TYPE 106 SQUARE-WAVE GENERATOR

FIG. 4 STANDARD ACCESSORIES

+



+ <sup>A</sup>

TYPE 106 SQUARE-WAVE GENERATOR

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q						Description
					†	1	2	3	4	
4-1	161-0024-00	200	969	1						CORD, power, 3 conductor, 8 feet
	161-0024-01	970	2069	1						CORD, power, 3 conductor, 8 feet
	161-0024-03	2070		1						CORD, power, 3 conductor, 8 feet
-2	103-0013-00			1						ADAPTER, power cord, 3 to 2 wire
-3	017-0502-00			1						CABLE, 50 Ω, 5 ns
-4	017-0083-00			1						TERMINATION, 50 Ω, GR to BNC
	070-0523-00			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

MODIFICATION INSERT

## FAST RISE SWITCHING DIODE REPLACEMENT

Type 106 -- SN 1190-3337

Installed in Type 106 SN \_\_\_\_\_ Date \_\_\_\_\_

This insert has been written to supplement the Instruction Manual for this instrument. The information given in this insert will supersede that given in the manual.

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### GENERAL INFORMATION

Silicon Diodes, PN 152-0458-00, replace GaAs Diodes, PN 152-0209-00, which are no longer available.

The silicon diodes are not a direct replacement and must be replaced in pairs as follows:

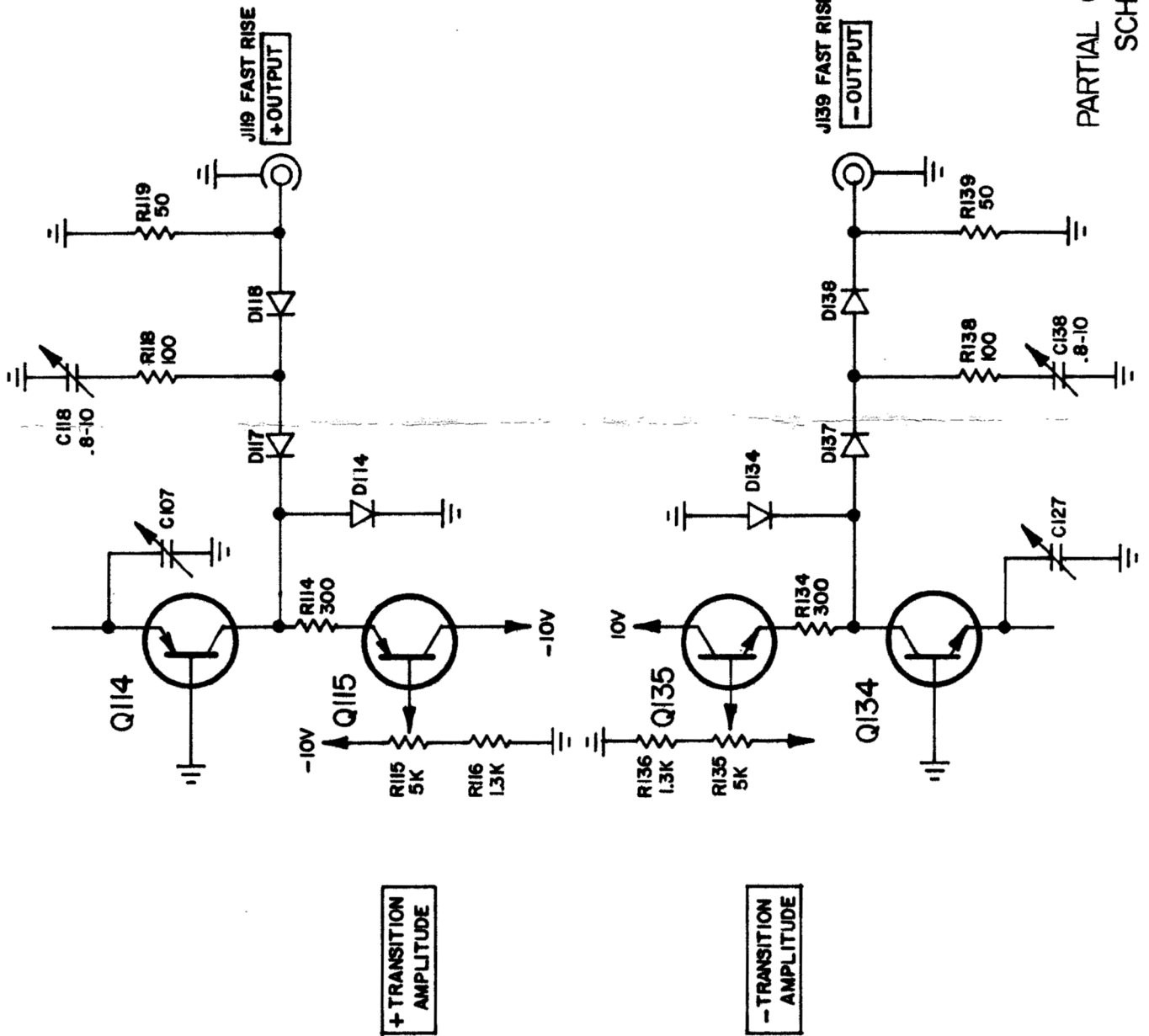
- 1) D117-D118 in the + FAST RISE OUTPUT.
- 2) D137-D138 in the - FAST RISE OUTPUT.

\* Usable SN 200-1189 if 050-0494-00 has been installed.

ELECTRICAL PARTS LIST

Ckt.No.	Part Number	Description			
		CAPACITORS			
C118	281-0152-00	.8-10pF		var	
		DIODES			
D117	152-0458-00	Silicon			
D118	152-0458-00	Silicon			
		OR			
D137	152-0458-00	Silicon			
D138	152-0458-00	Silicon			
		RESISTORS			
R114					
		OR			
R134	301-0301-00	300Ω	comp.	1/2W	5%
R116					
		OR			
R136	315-0132-00	1.3k	comp.	1/4W	5%
R118					
		OR			
R138	317-0101-00	100Ω	comp.	1/8W	5%

SCHEMATIC



PARTIAL GENERATOR  
SCHEMATIC

<http://manoman.sqhill.com>

STANDARD ACCESSORIES CORRECTION

FIG. 4 ACCESSORIES

CHANGE and ADD the following to Fig. & Index No. 4-1:

161-0024-01	970	2069	1 CORD, power, 3 conductor, 8 feet
161-0024-03	2070	2449	1 CORD, power, 3 conductor, 8 feet
161-0033-01	2450		1 CORD, power, 3 conductor, 7 feet 7 inches

M14,247/569

## ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTIONS

## CHANGE TO:

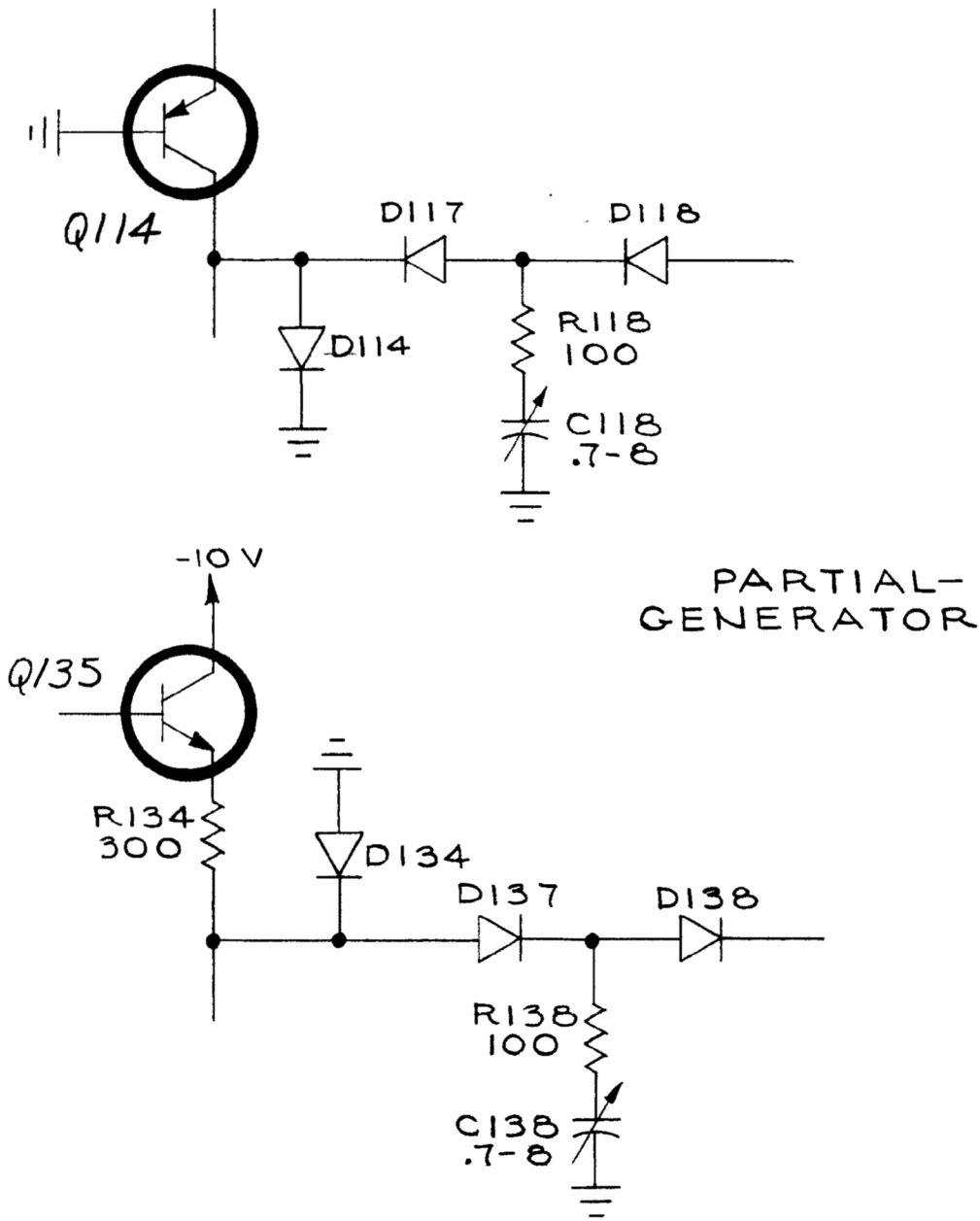
C118	281-0037-00	.7-3 pF, Var			
C138	281-0037-00	.7-3 pF, Var			
D117	152-0458-00	Silicon		Schottky Barrier	
D118	152-0458-00	Silicon		Schottky Barrier	
D137	152-0458-00	Silicon		Schottky Barrier	
D138	152-0458-00	Silicon		Schottky Barrier	
R114	301-0301-00	300 $\Omega$	1/2 W		5%
R116	315-0132-00	1.3 k $\Omega$	1/4 W		5%
R134	301-0301-00	300 $\Omega$	1/2 W		5%
R136	315-0132-00	1.3 k $\Omega$	1/4 W		5%

## ADD:

R118	317-0101-00	100 $\Omega$	1/8 W	Fixed	5%
R138	317-0101-00	100 $\Omega$	1/8 W	Fixed	5%

M16,002/270

SCHEMATIC CORRECTION



TYPE 106

TENT SN 3370

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

D114	152-0071-00	Germanium	ED 2007
D134	152-0071-00	Germanium	ED 2007

M16,265/470



# product modification

050-0495-00  
M16002

Type 106

## FAST RISE SWITCHING DIODE REPLACEMENT

For TEKTRONIX® Type 106 SQUARE WAVE GENERATORS  
Serial Numbers 1190-3337\*

Silicon Diodes, PN 152-0458-00, replace GaAs Diodes, PN 152-0209-00, which are no longer available.

The silicon diodes are not a direct replacement and must be replaced in pairs as follows:

- 1) D117-D118 in the + FAST RISE OUTPUT.
- 2) D137-D138 in the - FAST RISE OUTPUT.

This Parts Replacement Kit is divided in two parts, Part I is for + FAST RISE OUTPUT (D117-D118) and Part II is for - FAST RISE OUTPUT (D137-D138).

It is not necessary to replace the diodes in both the + or - OUTPUT channels at the same time.

If you are replacing the diodes in both the + and - OUTPUT channels order two 050-0495-00 kits.

\* Usable SN 200-1189 if 050-0494-00 has been installed.

NOTE: If the serial number of your instrument is above those listed, or if this kit has been installed, disregard the instructions as PN 152-0458-00 is a direct replacement for use in the FAST RISE OUTPUT Channel that has been modified.

PARTS INCLUDED IN PARTS REPLACEMENT KIT:

Ckt.No.	Quantity	Part Number	Description			
D117-D118 OR D137-D138	2 ea	152-0458-00	Diode, silicon			
C118 OR C138	1 ea	281-0152-00	Capacitor .8 - 10pF			
R114 OR R134	1 ea	301-0301-00	Resistor, comp.	300Ω	1/2W	5%
R116 OR R136	1 ea	315-0132-00	Resistor, comp.	1.3k	1/4W	5%
R118 OR R138	1 ea	317-0101-00	Resistor, comp.	100Ω	1/8W	5%

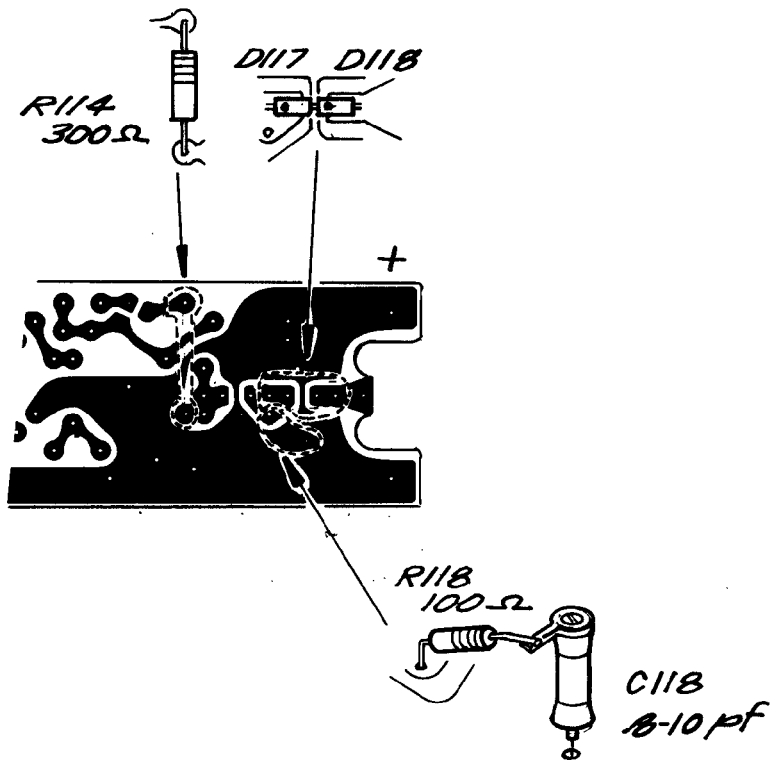


FIG. 1

## INSTRUCTIONS

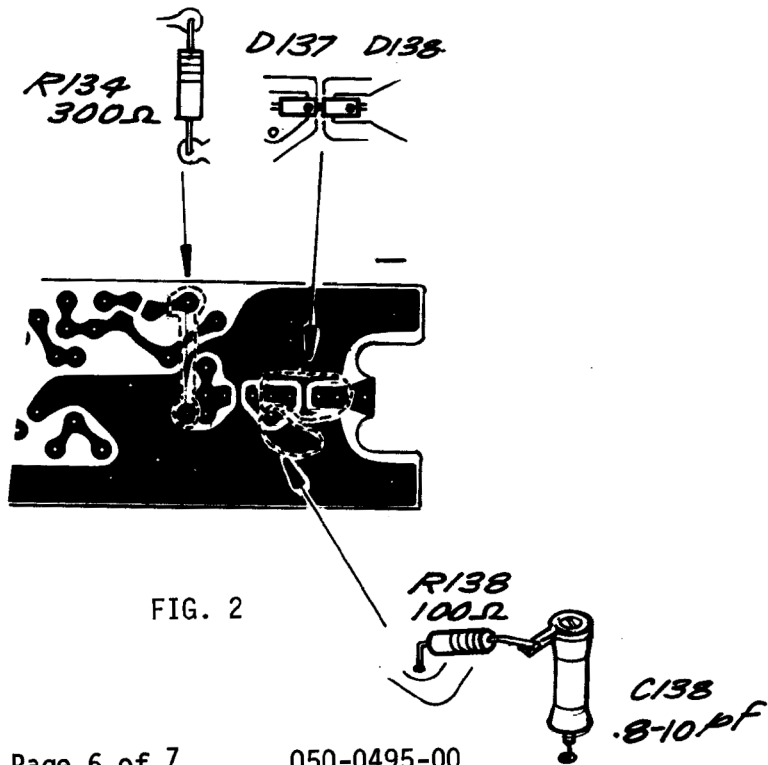
### PART I

TO REPLACE D117-D118 ON THE + FAST RISE OUTPUT BOARD. SEE FIG. 1.

Remove the following components:

- ( ) 1. D117-D118, two clip mounted diodes.
- ( ) 2. R114, a  $200\Omega$  1/2W 5% resistor.
- ( ) 3. C118, a 2-8pF variable capacitor, connected to the junction of D117-D118.
- ( ) 4.⊕ Replace R116, a 1.8k 1/4W 5% resistor, connected between the inside terminal of R115 (+ TRANSISTION AMPLITUDE potentiometer) and ground, with a 1.3k 1/4W 5% resistor.
- ( ) 5.⊕ Install C118-R118, a series connected .8-10pF capacitor and a  $100\Omega$  1/8W resistor, from the junction of D117-D118 and ground. (The hole near edge of board for old C118 will have to be enlarged to accomodate new capacitor C114.)
- ( ) 6.⊕ Install R114, a  $300\Omega$  1/2W 5% resistor.
- ( ) 7.⊕ Install D117-D118, two clip mounted silicon diodes. Install with cathodes (dots) as shown in Fig. 1.

⊕ Indicates part included in kit.



INSTRUCTIONS (continued)

PART II

TO REPLACE D137-D138 ON THE - FAST RISE OUTPUT BOARD. SEE FIG. 2.

Remove the following components:

- ( ) 1. D137-D138, two clip mounted diodes.
- ( ) 2. R134, a 200 $\Omega$  1/2W 5% resistor.
- ( ) 3. C138, a 2-8pF variable capacitor, connected to the junction of D137-D138.
- ( ) 4.⊕ Replace R136, a 1.8k 1/4W 5% resistor connected between the inside terminal of R135 (- TRANSITION AMPLITUDE potentiometer), and ground, with a 1.3k 1/4W 5% resistor.
- ( ) 5.⊕ Install C138-R138, a series connected .8-10pF capacitor and a 100 $\Omega$  1/8W 5% resistor, from the junction of D137-D138 and ground. (The hole near edge of board for old C138 will have to be enlarged to accomodate new capacitor C138.)
- ( ) 6.⊕ Install R134 a 300 $\Omega$  1/2W resistor.
- ( ) 7.⊕ Install D137-D138, two clip mounted silicon diodes. Install with cathodes (dots) as shown in Fig. 2.

⊕ Indicates part included in kit.

JT:1s