

067-0502-01 CALIBRATION FIXTURE

Amplitude Calibrator and Comparator



The Amplitude Calibrator and Comparator provides an accurate source for positive and negative DC voltage and current as well as 60 Hz and 1 kHz squarewaves. Amplitudes are available from 0.2 mV to 100 V in a 1, 2, 5 sequence.

The comparator provides a means for making voltage measurements by alternately chopping from an accurate reference voltage (internal supply or external input) and from an unknown input, and viewing the resultant signal on an oscilloscope.

The Amplitude Calibrator and Comparator is intended to be used for verifying the accuracy of Tektronix oscilloscope amplitude calibrators.

SECTION 1
CHARACTERISTICS

ELECTRICAL

Characteristics	Performance Limits
Amplitude Accuracy, 1 kHz Squarewave	Within 0.25% of amplitude setting into a 1 M Ω load
Squarewave Rep Rate	1 kHz within 20%
Amplitude Accuracy, DC	100 VDC within 0.25% into a 1 M Ω load
Maximum Input Voltage (UNKNOWN and EXT REF INPUT)	100 V
Power Supply	
Accuracy	
+300 VDC (Floating)	Within 2%
+125 VDC (Floating)	Within 10%
+100 VDC (Floating)	Within 0.1%
-100 VDC	Within 2%
Maximum Ripple	
+300 VDC (Floating)	15 mV P-P
+125 VDC (Floating)	5 mV P-P
+100 VDC (Floating)	2 mV P-P
-100 VDC	2 mV P-P
+100 VDC	30 mV P-P
Line Voltage Range	104 to 126 volts RMS 208 to 252 volts RMS
Line Current	0.44 A at 115 V, 60 Hz
Power Consumption	43 W at 115 V

ELECTRICAL (cont)

Characteristics	Performance Limits
Line Frequency	48 to 65 Hz
Fuse	0.8 A slow-blowing type at 115 VAC 0.4 A slow-blowing type at 230 VAC
Warmup Time	5 minutes

ENVIRONMENTAL

Characteristics	Performance Limits
Temperature	Performance requirements listed apply over a temperature range of +15°C to +35°C

PHYSICAL

Characteristics	Information
Finish	Anodized aluminum front panel with blue-vinyl finished cabinet
Overall Dimensions	
Length	13-7/8 inches (35.5 cm)
Width	5 inches (12.7 cm)
Height	7-7/8 inches (20 cm)
Weight	7-1/2 lbs. (3.4 kg)

CONTROLS AND CONNECTORS

AMPLITUDE Selector

A 20-position rotary switch selecting output amplitudes from 0.2 mV to 100 V in a 1, 2, 5 sequence. A 5 mA \square position is also provided which supplies a 1 kHz squarewave or 5 mA DC to the 5 mA Current Loop.

MODE Selector

A 4-position rotary switch which selects the modes applied to the output switch. An external reference input is applied in the EXT REF position, a 1 kHz squarewave in the \square position, and a + or - DC voltage in the +DC and -DC positions.

Output Switch

A 3-position lever switch that: (1) connects the signal selected by the MODE selector directly to the OUTPUT connector when in the top position, (2) connects the signal at the UNKNOWN INPUT connector directly to the OUTPUT connector when in the bottom position or (3) when electromechanically switches between (1) and (2) at a 60 Hz rate providing a composite signal at the OUTPUT connector.

EXT REF INPUT Connector

Connects an external reference signal to the MODE selector.

UNKNOWN INPUT Connector

Connects an unknown input to the chopper or directly to the OUTPUT connector depending on the position of the output switch.

OUTPUT Connector

Provides output signal as selected by the Output switch.

5 mA \square Current Loop

Provides either a 5 mA squarewave or 5 mA DC. The arrow above the current loop indicates the direction of conventional current flow when the MODE selector is in the squarewave (\square) or +DC position. In the -DC position, current flows in the opposite direction through the loop.

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PERFORMANCE CONDITIONS

The following conditions must be met before the specified performance characteristics are valid:

1. The instrument must be calibrated at an ambient temperature between +20°C and +30°C.
2. The instrument must be operating for at least 5 minutes within +15°C to +35°C.

SECTION 2

OPERATING INSTRUCTIONS

Output Selector Switch

The 3-position switch located directly above the calibrator OUTPUT connector selects the output signal.

In the "up" position, the output signal is one of the four selected by the MODE selector. The EXT position connects the EXT REF INPUT connector directly to the OUTPUT. The \square position connects a positive-going 1 kHz squarewave, whose amplitude is set by the AMPLITUDE selector, directly to the OUTPUT. The +DC and -DC positions connect a DC voltage, whose amplitude is set by the AMPLITUDE selector, directly to the OUTPUT. In order to obtain the stated accuracy of the instrument, a 1 megohm load must be connected to the OUTPUT connector. In most cases, this load will be provided by the standard 1 megohm input resistance of the oscilloscope used.

In the "down" position, the UNKNOWN INPUT is connected directly to the OUTPUT.

In the CHOPPED position, a 60 Hz electromechanical chopper switches the output between the upper and lower positions of the output switch making the output signal a composite of the unknown input and the signal selected by the MODE selector. The purpose of the mixing is to allow a convenient comparison between the two signals selected. For example, an unknown DC voltage can be connected to the UNKNOWN INPUT and mixed with the accurate DC voltage generated by the Calibrator. Small differences between these voltages can be seen at the OUTPUT connector with a sensitive, AC-coupled oscilloscope.

In addition to comparisons, a positive-going or negative-going 60 Hz squarewave can be obtained from the Calibrator by setting the MODE switch to +DC or -DC, the Output Switch to CHOPPED, and the UNKNOWN INPUT left open. For low voltages, it is desirable to connect a 50 ohm termination or attenuator to the UNKNOWN INPUT connector to provide a low impedance to ground. In similar manner, an external voltage can be converted to a 60 Hz squarewave.

Access to the chopper for comparison of two external voltages is provided. The voltages are connected to the EXT REF INPUT and UNKNOWN INPUT connectors, the MODE selector is placed at EXT, and the Output Switch is placed at CHOPPED. The output signal is the composite of the two external voltages.

Amplitude Switch

This switch determines the amplitude of the squarewave and +DC or -DC voltages selected by the MODE selector. It does not affect external voltages connected to the EXT REF INPUT connector.

When the AMPLITUDE selector is placed at OFF, the MODE selector is provided with zero volts at a source resistance of 1001 ohms.

The 5 mA position provides either a 5 mA squarewave or 5 mA DC through the current loop. The arrow above the current loop indicates the direction of conventional current flow when the MODE selector is in the squarewave or +DC position. In the -DC position, the current flows in the opposite direction through the loop.

SECTION 3 CIRCUIT DESCRIPTION

Clamp Circuit & Multivibrator

The 100 volt reference voltage is established without the direct participation of an active element (transistor or tube). Since some characteristics of active elements change more with time than those of passive elements, it is possible to obtain a more accurate and stable reference voltage by using passive elements.

+100 VDC is established at the top of the resistive divider string by the +100 V (FL) clamp. The designation (FL) means "floating". 10 mA flows from the +300 V (FL) supply and divides at the plate of V115B. 5 mA flows into the 20 k Ω resistive divider and 5 mA flows into the +100 V (FL) supply. The output voltage is adjusted precisely to 100 volts. The forward voltage drops across the two diodes (D112, D122) in the circuit change nearly the same amount with temperature keeping the output voltage nearly constant.

1 kHz squarewaves are generated by the multivibrator, V115. When V115B is on, its plate drops to about -50 volts, diverting the current from the +300 V (FL) supply into the tube, reverse biasing both diodes and allowing the output to fall to zero. Both sides of the multivibrator are identical to keep the current constant in the +100 V (FL) reference supply.

Negative output polarity is obtained by inverting the multivibrator output. The +300 V (FL) and +100 V (FL) supplies have a common (COM) bus not connected to the chassis allowing any point in the floating supplies to be connected to ground. Hence, the two leads to the resistive divider are reversed by the MODE selector allowing current to flow in the opposite direction in the divider providing the negative output voltage.

Resistive Divider

The resistor values were calculated to give the proper attenuation when an external load of 1 megohm is connected. In the AMPLITUDE switch positions 100 volts through 0.2 volts, the loading on the main divider is provided by the external load (test oscilloscope). In the positions 0.1 volt through 0.2 millivolts, an internal 1 megohm resistor is placed across this divider to replace the external load which has moved to the second divider (999 k Ω to 1.001 k Ω).

Chassis-Ground Isolation

D300 and D301 isolate the Calibrator chassis from the power line ground to allow precise comparison measurements at low output voltages. These diodes present a high resistance to the tens of millivolts found between chassis, but still provide the safety of a grounded chassis. In the event of a malfunction, the diodes (rated at 10 amperes) will not allow the chassis to become "hot" by more than their forward voltage drop (1 volt or so). The 10 ampere rating allows some component other than the diodes to fail, thereby removing the hazard.

Internal Load Resistors

Resistors and suitable switching are part of the instrument in order to load each signal source (external, unknown, calibrator) with 1 megohm under most test conditions.

The 1 megohm input resistance of the test oscilloscope provides proper loading of the calibrator, external, and unknown inputs except when almost equal DC voltages are mixed and compared by using an AC-coupled oscilloscope. In this case, the coupling capacitor charges to the average of the DC voltages effectively removing the 1 megohm load. Hence, in the CHOPPED-DC and CHOPPED-EXT test combinations, both the calibrator and unknown voltages are provided with internal 1 megohm loads.

When the vibrating arm of the chopper connects the unknown to the output, the unknown is loaded by the the series capacitor and input resistor of the scope. However, then the chopper arm connects the output to ground, the unknown is not loaded. Since the unknown is connected to the test scope one-half of the time, the input capacitor charges to about one-half the unknown voltage. Therefore, the test scope presents an apparent input resistance of 2 megohms to the unknown and since the unknown drives this 2 megohms only half the time, the average current supplied by the unknown is the same as if it were driving a constant load of 4 megohms. Internal load resistors in the Calibrator provide a load of $4/3$ megohm to the unknown which, in parallel with the effective 4 megohms, provides the required load of 1 megohm (this loading only occurs when the AMPLITUDE selector is in the OFF position).

Floating Power Supplies

The +300 V (FL) supply is series-regulated. It supplies current for the resistive divider and 100 volt reference supply. The +125 V (FL) is shunt-regulated and provides voltage only to the reference supply.

The +100 V (FL) reference supply achieves its good stability from the temperature-compensated and aged zener diode, the high gain dual transistor, Q456, the wirewound resistors in the feedback voltage divider, and the regulated source voltage. The matched resistors in the feedback divider are necessary to permit the voltage setting pot, R451, to meet the conflicting requirements of range and resolution.

The supplies are floating to permit inversion for negative output voltages.

Grounded Power Supplies

The -100 V and +100 V supplies provide power to the squarewave calibrator.

6.3 Volts AC

A virtual ground at the center of the transformer winding is established by two 100 ohm resistors in order to equalize output transients occurring in the electromechanical chopper.

SECTION 4
MAINTENANCE

GENERAL INFORMATION

Introduction

This portion of the manual contains a complete calibration procedure for the 067-0502-01 Amplitude Calibrator and Comparator. The instrument will not often require a complete, start-from-scratch calibration, but will need occasional adjustments as components age or are replaced.

Calibration is a valuable part of preventive maintenance, since many types of minor troubles may be discovered and corrected before they become serious enough to disable the instrument. Also, certain troubles can be easily isolated to a particular section of the instrument by attempting calibration.

This section includes a list of all instruments required to calibrate the Type 067-0502-01, a check out list, and a step-by-step calibration procedure. The check out list is, essentially, a short form calibration check; it has the same sequence of steps and the same limits on checks or adjustments as the calibration procedure. This list may be used to quickly check performance or locate faulty circuits.

It will be assumed in this manual that appropriate interconnections and necessary adapters are available.

It will also be assumed that a control will be left in the position indicated on the previous step unless otherwise indicated.

All front-panel control labels of the 067-0502-01 or test instrument are in capital letters (AMPLITUDE), etc. Internal adjustment labels are identified by an R or C number (R156, C112).

Visual Inspection

The instrument should be visually inspected occasionally for such defects as poor connections, broken or damaged parts, improperly seated transistors, and heat damaged parts. The remedy for most of these defects is not obvious. A heat damaged part is usually the symptom of some defect that is not obvious. The cause of overheating should be determined and corrected before the part is replaced, otherwise the damage may be repeated.

Transistor Checks

Periodic preventive maintenance checks on the transistors are not recommended. Satisfactory operation of the instrument in all respects is adequate assurance that the transistors are performing properly.

Recalibration

To insure that the 067-0502-01 maintains its accuracy, check the calibration after each 500 hours of operation or every six months if used intermittently. Complete calibration instructions appear later in this section.

The calibration procedure can also be helpful in isolating troubles in the instrument. Also, minor troubles in the instrument that may not be apparent during normal operation may be revealed and corrected during calibration.

Ordering Parts

Many of the components are standard electronic parts that may be purchased locally. However, all standard parts in the instrument can be obtained from Tektronix through your local Tektronix Field Engineer or Field Office. Before ordering, consult the parts list of this manual to determine the value, tolerance, and rating required. Some of the parts used are not standard parts and may or may not be available for replacement. Consult any particular replacement with your local Tektronix Field Engineer or Field Office.

CALIBRATION

Equipment Required

- 1 Line Voltage Control Unit, GR Type W10MT3W
- 1 Type 530 or 540 Oscilloscope
- 1 Type 1A6 High-Gain Differential Plug-In Unit
- 1 Volt-ohm Meter, 20,000 Ω/V
- 1 X1 Probe (P6028 or equivalent)
- 2 42-inch BNC Cables (012-0057-01)
- 1 50-ohm BNC Termination (011-0049-01)
- 1 T Connector, BNC male to 2 female (103-0030-00)
- 1 Adapter, BNC dual binding post (103-0035-00)
- 1 Adapter, clip lead BNC (013-0076-00)
- 1 John Fluke Meter, Model 825 A
- 1 Resistor, 1 M Ω , 1/2 W, 1% (323-0481-00)

Power Supplies

1. After turning on power and allowing 5 minutes warmup, adjust DC voltages in the following order:

+300 V (FL)
 +125 V (FL)
 +100 V (FL) - set approximately
 -100 V

2. Check the following DC voltage:

+100 V (between 93 V and 107 V)

3. Ripple (check at nominal line, 117 V; low line, 104 V; and high line, 126 V):

Supply	Maximum peak-to-peak millivolts
+300 V (FL)	15
+125 V (FL)	5
+100 V (FL)	2
-100 V	2
+100 V	30

4. Install the case to establish normal operating temperatures.

CALIBRATION (cont)

Front Panel Output Check

1. Check for approximately correct squarewave output at all AMPLITUDE selector settings. Using current probe, check current loop for 5 mA squarewave.
2. Check for presence of +DC and -DC.
3. Check for presence of symmetrical and "clean" 60 Hz squarewaves (Output selector at CHOPPED, MODE selector at +DC and -DC). Put 50 ohm termination on UNKNOWN INPUT and examine waveform of 5 mV 60 Hz squarewaves. Waveform should be clean with only a slight tilt.
4. Apply an external signal to the EXT REF INPUT connector, place the MODE selector on EXT, place the output switch "up", and check for presence of the signal at the OUTPUT connector.
5. Apply the same signal to the UNKNOWN INPUT connector, place the Output selector "down" and check for the presence of the signal at the OUTPUT connector.

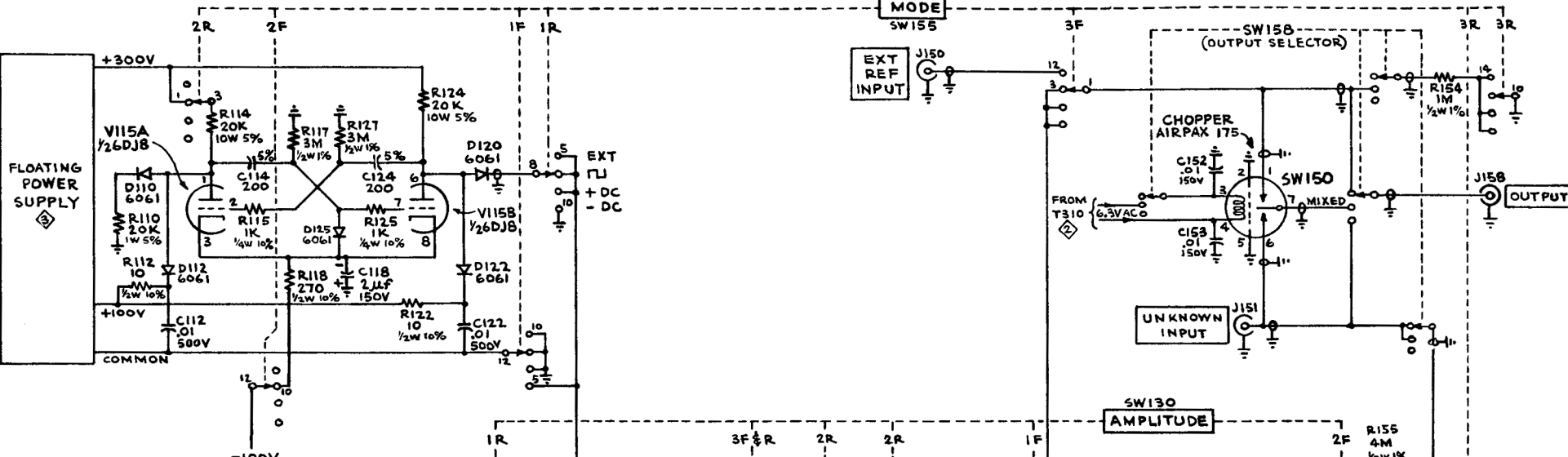
100 Volt Reference Supply

1. Install the case and allow temperature to stabilize for 10 minutes.
2. Set AMPLITUDE to 100 VOLTS, MODE to +DC.
3. Connect a 1 megohm, 1/2 watt, 1% resistor between the binding posts of the BNC to Binding Post adapter. Attach this adapter to the BNC T connector and the T connector to the calibrator OUTPUT. Connect a BNC cable from the other side of the T connector to the BNC clip lead and then to the differential voltmeter being used.
4. Using a John Fluke Differential Voltmeter (Model 825 A or other model accurate to at least 0.025%), set the output to 100 volts, within 10 millivolts. For the final adjustment, place the voltmeter on the null sensitivity showing 100 millivolts from center-scale to full-scale. Each minor division then indicates 2 millivolts. If possible, set the +100 volts within +5 millivolts and -10 millivolts.

CALIBRATION (cont)

5. After the +100 volts is set, check that it changes less than +4 millivolts from high-line to low-line.
6. Check -100 volts DC for the same tolerance.
7. Measure and record the output voltage at all settings of the AMPLITUDE selector from 100 volts through 0.1 volts. Indicated voltage must be within +0.1% of panel markings. In addition, the algebraic sum of the error on the 0.1 volt range and the worst error on any range from 100 volts through 0.2 volts must not exceed 0.15%.

AMPLITUDE Selector Setting	<u>+0.1%</u> Tolerance	<u>+0.1%</u> Tolerance Voltage Limits	
		Low	High
100 V	<u>+100</u> mV	Set to <u>+10</u> mV	
50 V	<u>+50</u> mV	49.950	50.050 (read last digit on meter)
20 V	<u>+20</u> mV	19.980	20.020
10 V	<u>+10</u> mV	9.990	10.010
5 V	<u>+5</u> mV	4.9950	5.0050 (read last digit on meter)
2 V	<u>+2</u> mV	1.9980	2.0020
1 V	<u>+1</u> mV	0.9990	1.0010
0.5 V	<u>+0.5</u> mV	0.49950	0.50050 (read last digit on meter)
0.2 V	<u>+0.2</u> mV	0.19980	0.20020
0.1 V	<u>+0.1</u> mV	0.09990	0.10010

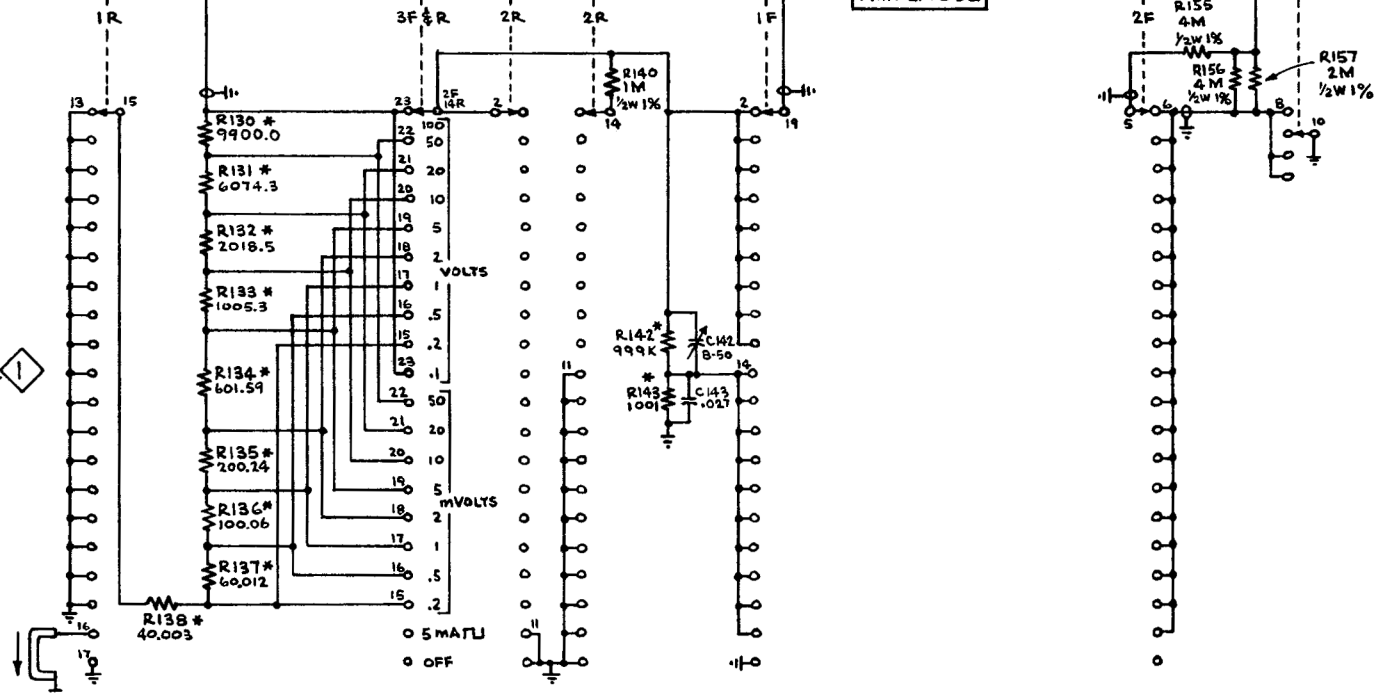


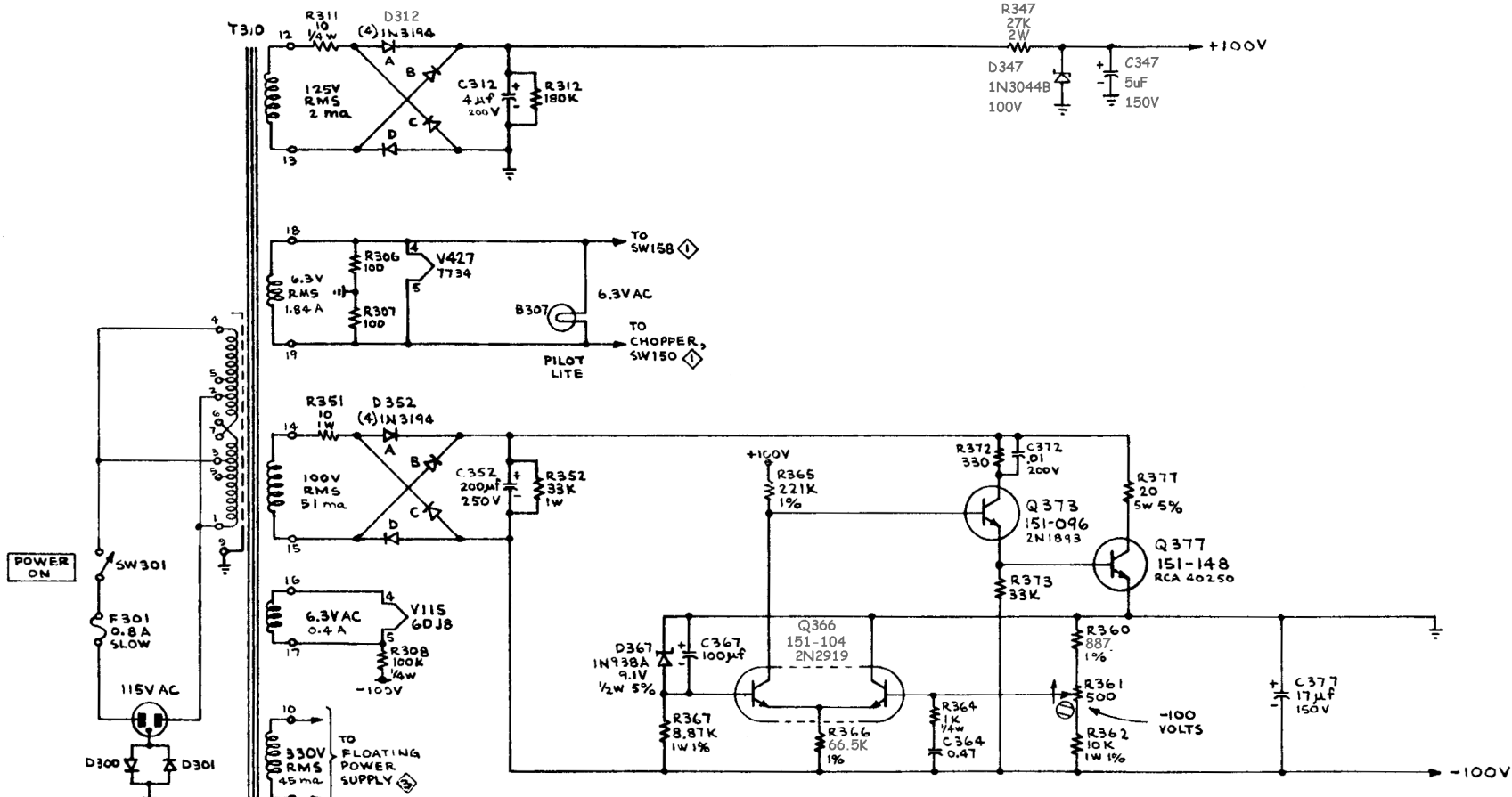
REFERENCE DIAGRAMS

- ② POWER SUPPLY
- ③ FLOATING POWER SUPPLY

* MATCHED WITHIN .025%

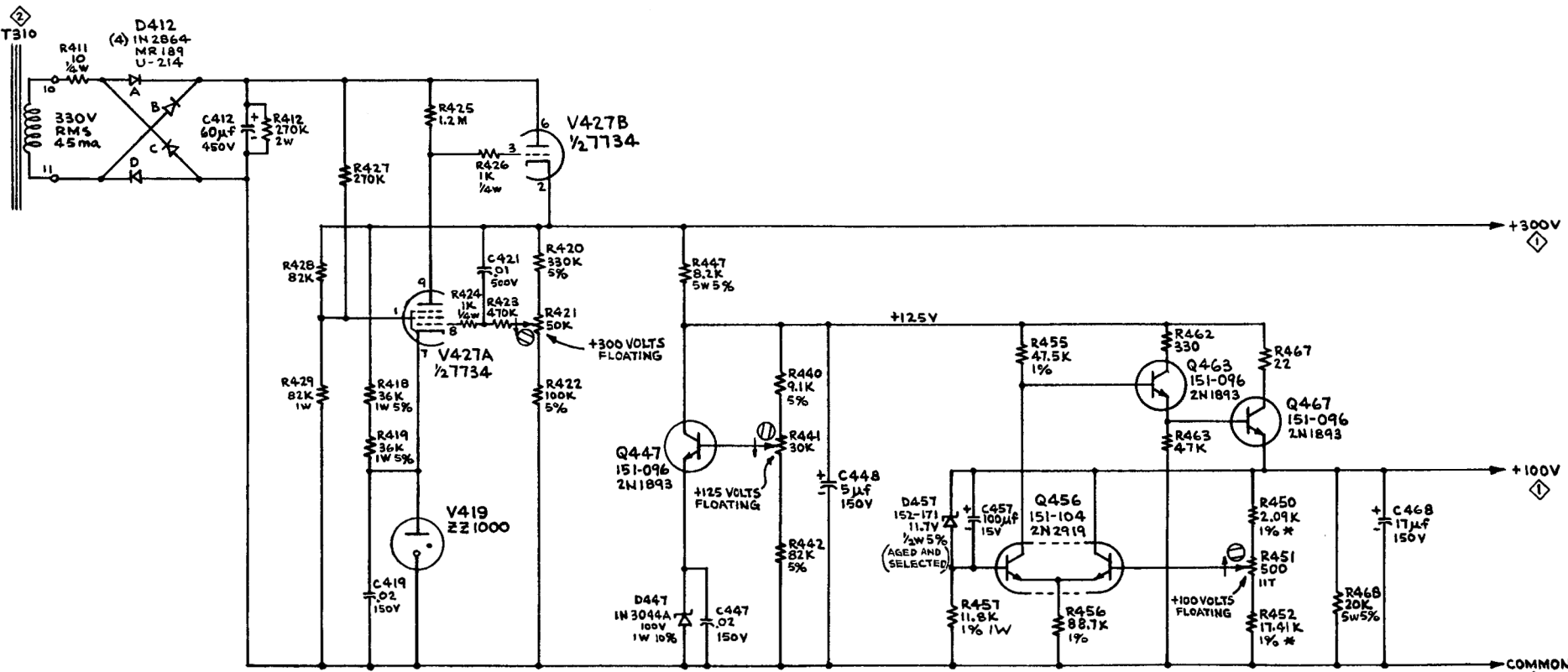
SQUARE-WAVE CALIBRATOR ①





POWER SUPPLY 2

NOTES:-
ALL RESISTORS ARE 1/2W 10%
UNLESS OTHERWISE NOTED



REFERENCE DIAGRAMS

- ① SQUARE-WAVE CALIBRATOR
- ② POWER SUPPLY

NOTES:-

* MATCHED TO 0.4%
 ALL RESISTORS ARE 1/2W 10%
 UNLESS OTHERWISE NOTED

FLOATING POWER SUPPLY ③

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Bulb						
B307	150-0018-00		Incandescent, miniature 6.3 V #12			
Capacitors						
Tolerance $\pm 20\%$ unless otherwise indicated.						
C112	283-0002-00		0.01 μF	Cer	500 V	
C114	283-0511-00		200 pF	Mica		5%
C118	290-0159-00		2 μF	Elect	150 V	
C122	283-0002-00		0.01 μF	Cer	500 V	
C124	283-0511-00		200 pF	Mica		5%
C142	281-0022-00		8-50 pF Var	Cer		
C143	285-0624-00		0.027 μF	PTM	100 V	10%
C152	283-0003-00		0.01 μF	Cer	150 V	
C153	283-0003-00		0.01 μF	Cer	150 V	
C312	290-0285-00		4 μF	Elect	35 V	10%
C347	290-0149-00		5 μF	Elect	150 V	
C352	290-0173-00		200 μF	Elect	250 V	
C364	285-0623-00		0.47 μF	PTM	100 V	
C367	290-0171-00		100 μF	Elect	12 V	
C372	285-0569-00		0.01 μF	PTM	200 V	
C377	290-0198-00		17 μF	Elect	150 V	+30%-15%
C412	290-0108-00		60 μF	Elect	450 V	
C419	283-0004-00		0.02 μF	Cer	150 V	
C421	283-0002-00		0.01 μF	Cer	500 V	
C447	283-0004-00		0.02 μF	Cer	150 V	
C448	290-0149-00		5 μF	Elect	150 V	
C457	290-0201-00		100 μF	Elect	15 V	
C468	290-0198-00		17 μF	Elect	150 V	+30%-15%

Electrical Parts List--Type 067-0502-01

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Semi-conductor Devices, Diodes				
D110	*152-0061-00		Silicon	Tek Spec
D112	*152-0061-00		Silicon	Tek Spec
D120	*152-0061-00		Silicon	Tek Spec
D122	*152-0061-00		Silicon	Tek Spec
D125	*152-0061-00			
D300	*152-0274-00		Silicon	Replaceable by 1N1200
D301	*152-0274-00		Silicon	Replaceable by 1N1200
D312 A, B	152-0066-00		Zener	1N3194
C, D				
D347	152-0087-00		Zener	1N3044B 1 W, 100 V, 5%
D352 A, B	152-0066-00		Silicon	1N3194
C, D				
D367	152-0124-00		Zener	1N938A 0.5 W, 9 V, 5%, TC
D412 A, B	152-0048-01		Silicon	Replaceable by 1N2864
C, D				
D447	152-0134-00		Zener	1N3044A 1 W, 100 V, 10%
D457	152-0171-00		Zener	1N944 0.5 W, 11.7 V, 5% (Selected,
Fuse				
F301	159-0018-00		0.8 A 3 AG	Slo-Blo
Connectors †				
J150				
J151				
J158				
Transformers				
Q366	*151-0104-00		Silicon	Replaceable by 2N2913 (Dual)
Q373	*151-0096-00		Silicon	Selected from 2N1893
Q377	*151-0148-00		Silicon	Selected 40250 (RCA)
Q447	*151-0096-00		Silicon	Selected from 2N1893
Q456	*151-0104-00		Silicon	Replaceable by 2N2913 (Dual)

† See Mechanical Parts List.

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
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Transformers (cont)

Q463	*151-0096-00		Silicon	Selected from 2N1893
Q467	*151-0096-00		Silicon	Selected from 2N1893

Resistors

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

R110	303-0203-00		20 k Ω	1 W		5%
R112	302-0100-00		10 Ω	1/2 W		
R114	308-0025-00		20 k Ω	10 W	WW	5%
R115	316-0102-00		1 k Ω	1/4 W		
R117	309-0377-00		3 M Ω	1/2 W	Prec	1%
R118	302-0271-00		270 Ω	1/2 W		
R122	302-0100-00		10 Ω	1/2 W		
R124	308-0025-00		20 k Ω	10 W	WW	5%
R125	316-0102-00		1 k Ω	1/4 W		
R127	309-0377-00		3 M Ω	1/2 W	Prec	1%
R130 [†]						
R131						
R132						
R133						
R134						
R135						
R136						
R137						
R138						
R140	323-0481-00		1 M Ω	1/2 W	Prec	1%
R142						
R143						
R154	323-0481-00		1 M Ω	1/2 W	Prec	1%
R155	309-0093-00		4 M Ω	1/2 W	Prec	1%
R156	309-0093-00		4 M Ω	1/2 W	Prec	1%
R157	309-0023-00		2 M Ω	1/2 W	Prec	1%

[†]R130 thru R138, R142 and R143 - resistor assembly Part No. *308-0567-00.

Electrical Parts List--Type 067-0502-01

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R306	302-0101-00		100 Ω	1/2 W		
R307	302-0101-00		100 Ω	1/2 W		
R308	316-0104-00		100 k Ω	1/4 W		
R311	316-0100-00		10 Ω	1/4 W		
R312	302-0184-00		180 k Ω	1/2 W		
R347	306-0273-00		27 k Ω	2 W		
R351	304-0100-00		10 Ω	1 W		
R352	304-0333-00		33 k Ω	1 W		
R360	323-0188-00		887 Ω	1/2 W	Prec	1%
R361	311-0486-00		500 Ω , Var			
R362	324-0289-00		10 k Ω	1 W	Prec	1%
R364	316-0102-00		1 k Ω	1/4 W		
R365	323-0418-00		221 k Ω	1/2 W	Prec	1%
R366	323-0368-00		66.5 k Ω	1/2 W	Prec	1%
R367	324-0284-00		8.87 k Ω	1 W	Prec	1%
R372	302-0331-00		330 Ω	1/2 W		
R373	302-0333-00		33 k Ω	1/2 W		
R377	308-0123-00		20 Ω	5 W	WW	5%
R411	316-0100-00		10 Ω	1/4 W		
R412	306-0274-00		270 k Ω	2 W		
R418	303-0363-00		36 k Ω	2 W		5%
R419	303-0363-00		36 k Ω	2 W		5%
R420	301-0334-00		330 k Ω	1/2 W		5%
R421	311-0154-00		50 k Ω , Var			
R422	301-0104-00		100 k Ω	1/2 W		5%
R423	302-0474-00		470 k Ω	1/2 W		
R424	316-0102-00		1 k Ω	1/4 W		
R425	302-0125-00		1.2 M Ω	1/2 W		
R426	316-0102-00		1 k Ω	1/4 W		
R427	302-0274-00		270 k Ω	1/2 W		

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R428	302-0823-00		82 kΩ	1/2 W		
R429	304-0823-00		82 kΩ	1 W		
R440	301-0912-00		9.1 kΩ	1/2 W		5%
R441	311-0487-00		30 kΩ, Var			
R442	301-0823-00		82 kΩ	1/2 W		5%
R447	308-0237-00		8.2 kΩ	5 W	WW	5%
R450	*310-0647-00		2.09 kΩ	4 W	Prec	
R451	311-0558-00		500 Ω, Var			
R452	*310-0648-00		17.41 kΩ	4 W	Prec	
R455	323-0354-00		47.5 kΩ	1/2 W	Prec	1%
R456	323-0380-00		88.7 kΩ	1/2 W	Prec	1%
R457	324-0296-00		11.8 kΩ	1 W	Prec	1%
R462	302-0331-00		330 Ω	1/2 W		
R463	302-0473-00		47 kΩ	1/2 W		
R467	302-0220-00		22 Ω	1/2 W		
R468	308-0272-00		20 kΩ	5 W	WW	5%
Switches						
Wired or Unwired						
Wired						
SW130	*262-0806-01		Rotary	AMPLITUDE		
SW130	260-0797-00		Rotary	AMPLITUDE		
SW150	119-0016-00			CHOPPER		
SW155	*260-0799-00		Rotary	MODE		
SW158	*260-0798-00		Lever	FUNCTION		
SW301	260-0134-00		Toggle	POWER		
Transformers						
T310	120-0615-00					

Electrical Parts List--Type 067-0502-01

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Electron Tubes			
V115	154-0187-00	6DJ8	
V419	154-0370-00	ZZ-1000	
V427	154-0260-00	7734	

SECTION 7

MECHANICAL PARTS LIST

FIG. 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q					Description
			Y	1	2	3	4	
1	333-1001-03		1					PANEL, front
2	386-1241-01		1					PLATE, sub-panel
3	214-0553-00		1					LATCH SCREW, 1.388 inches long
4	358-0255-00		1					BUSHING, latch, plastic
5	136-0047-00		1					SOCKET LIGHT ASSEMBLY, w/red jewel
6	366-0115-00		1					KNOB, charcoal--AMPLITUDE
	- - - - -		-					knob includes:
	213-0004-00		1					SCREW, set, 6-32 x 3/16 inch, HSS
7	262-0806-01		1					SWITCH, wired--AMPLITUDE
	- - - - -		-					switch includes:
	260-0797-00		1					SWITCH, unwired
	- - - - -		-					mounting hardware: (not included w/switch)
8	210-0207-00		1					LUG, solder, 3/8 ID x 5/8 inch OD, SE
9	210-0012-00		1					LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
10	210-0840-00		1					WASHER, flat, 0.390 ID x 9/16 inch OD
11	210-0413-00		1					NUT, hex., 3/8-32 x 1/2 inch
12	214-0335-00		1					BOLT, current loop
	- - - - -		-					mounting hardware: (not included w/bolt)
13	210-0593-00		2					NUT, current loop
14	361-0059-00		1					SPACER, current loop, 1 3/32 inches long
15	210-0849-00		2					WASHER, fiber, shouldered, #4
16	210-0938-00		2					WASHER, flat, #2
17	210-0259-00		2					LUG, solder, #2
18	210-0405-00		2					NUT, hex., 2-56 x 3/16 inch
19	366-0149-00		1					KNOB, charcoal--MODE
	- - - - -		-					knob includes:
	213-0004-00		1					SCREW, set, 6-32 x 3/16 inch, HSS
20	260-0799-00		1					SWITCH, unwired--MODE
	- - - - -		-					mounting hardware: (not included w/switch)
21	210-0012-00		1					LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
22	210-0840-00		1					WASHER, flat, 0.390 ID x 9/16 inch OD
23	210-0413-00		1					NUT, hex., 3/8-32 x 1/2 inch
24	260-0134-00		1					SWITCH, toggle--POWER ON
	- - - - -		-					mounting hardware: (not included w/switch)
25	210-0473-00		1					NUT, 12 sided, 15/32-32 x 0.634 inch

FIG. 1 EXPLODED (CONT)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q † y	1 2 3 4 5					Description
26	131-0126-00			1						CONNECTOR, coaxial, 1 contact, BNC
	- - - - -			-						mounting hardware: (not included w/ connector)
27	210-0255-00			1						LUG, solder, 3/8 inch
28	131-0126-00			1						CONNECTOR, coaxial, 1 contact, BNC
	210-0241-00			1						LUG, terminal, 0.515 ID x 0.625 inch OD
29	131-0274-00			1						CONNECTOR, coaxial, 1 contact, BNC, insula
30	366-0215-01			1						KNOB, charcoal--MIXED
31	260-0375-00			1						SWITCH, lever--MIXED
	- - - - -			-						mounting hardware: (not included w/switch
32	210-0004-00			2						LOCKWASHER, internal, #4
33	210-0406-00			2						NUT, hex., 4-40 x 3/16 inch
34	337-0934-00			1						SHIELD, rotary switch
	- - - - -			-						mounting hardware: (not included w/shield)
35	211-0507-00			1						SCREW, 6-32 x 5/16 inch, PHS
36	210-0457-00			2						NUT, keps, 6-32 x 5/16 inch
37	351-0122-00			1						GUIDE, slide
	- - - - -			-						mounting hardware: (not included w/guide)
	211-0538-00			2						SCREW, 6-32 x 5/16 inch, 100° csk, FHS
	- - - - -			-						(not shown)
38	212-0044-00			1						SCREW, 8-32 x 1/2 inch, RHS
39	214-0680-00			1						PIN, locating
40	441-0735-01			1						CHASSIS
	- - - - -			-						mounting hardware: (not included w/chassis)
	211-0538-00			4						SCREW, 6-32 x 5/16 inch, 100° csk, FHS
	- - - - -			-						(not shown)
41	210-0457-00			4						NUT, keps, 6-32 x 5/16 inch
42	212-0044-00			3						SCREW, 6-32 x 5/16 inch, PHS
43	337-0649-00			1						SHIELD, heat dissipating
44	- - - - -			1						TRANSISTOR
	- - - - -			-						mounting hardware: (not included w/ transistor)
	- - - - -			-						transistor)
	211-0510-00			2						SCREW, 6-32 x 3/8 inch, PHS
	386-0143-00			1						PLATE, mica, insulating
	210-0202-00			1						LUG, solder, SE #6
	210-0967-00			2						WASHER, plastic, shouldered, 0.157 x 3/8
	210-0830-00			2						WASHER, flat, 0.150 ID x 3/8 inch OD
45	210-0457-00			2						NUT, keps, 6-32 x 5/16 inch

FIG. 1 EXPLODED (CONT)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description
				y	1	2	3	4	
46	200-0293-00			1					COVER, capacitor, plastic
	- - - - -			-					1 ID x 3 9/16 inches
47	- - - - -			1					CAPACITOR
	- - - - -			-					mounting hardware: (not included w/
	- - - - -			-					capacitor)
48	211-0534-00			2					SCREW, sems, 6-32 x 5/16 inch, PHS
49	386-0254-00			1					PLATE, metal, large
	210-0457-00			2					NUT, keps, 6-32 x 5/16 inch
50	- - - - -			2					RESISTOR
	- - - - -			-					mounting hardware for each:
	- - - - -			-					(not included w/resistor)
	211-0553-00			1					SCREW, 6-32 x 1 1/2 inches, RHS
	210-0601-00			1					EYELET
51	210-0478-00			1					NUT, hex., 5/16 x 21/32 inch
52	211-0507-00			1					SCREW, 6-32 x 5/16 inch, PHS
53	- - - - -			1					RESISTOR, variable
	- - - - -			-					mounting hardware: (not included w/resistor)
	211-0034-00			2					SCREW, 2-56 x 1/2 inch, RHS
	210-0405-00			2					NUT, hex., 2-56 x 3/16 inch
54	214-0269-00			1					HEAT SINK, transistor
55	348-0063-00			1					GROMMET, plastic, 1/2 inch diameter
56	348-0056-00			1					GROMMET, plastic, 3/8 inch diameter
57	136-0181-00			4					SOCKET, transistor, 3 pin
	- - - - -			-					mounting hardware for each:
	- - - - -			-					(not included w/socket)
58	354-0234-00			1					RING, socket mounting
59	136-0015-00			2					SOCKET, tube, 7 pin
	- - - - -			-					mounting hardware for each:
	- - - - -			-					(not included w/socket)
60	213-0044-00			2					SCREW, thread forming, 5-32 x 3/16 inch, PHS
61	136-0078-00			2					SOCKET, transistor, 8 pin
	- - - - -			-					mounting hardware for each:
	- - - - -			-					(not included w/socket)
	213-0055-00			2					SCREW, thread forming, 2-32 x 3/16 inch, PHS

FIG. 1 EXPLODED (CONT)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q					Description
			Y	1	2	3	4	
62	- - - - -		1					RESISTOR, variable
	- - - - -		-					mounting hardware: (not included w/resisto
63	210-0940-00		1					WASHER, flat, 1/4 ID x 3/8 inch OD
64	210-0583-00		1					NUT, hex., 1/4-32 x 5/16 inch
65	- - - - -		2					RESISTOR, variable
	- - - - -		-					mounting hardware for each: (not included
	- - - - -		-					w/resistor)
	210-0012-00		1					LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0583-00		1					NUT, hex., 1/4-32 x 5/16 inch
66	136-0008-00		1					SOCKET, tube, 7 pin
	- - - - -		-					mounting hardware: (not included w/socket)
67	213-0044-00		2					SCREW, thread forming, 5-32 x 3/16 inch, PH
68	179-1170-01		1					CABLE HARNESS
69	- - - - -		1					TRANSFORMER
	- - - - -		-					transformer includes:
70	212-0522-00		1					SCREW, 10-32 x 2 1/2 inches, HHS
71	212-0812-00		1					WASHER, fiber, shouldered, #10
72	210-0223-00		1					LUG, solder, SE #10 long
	- - - - -		-					mounting hardware: (not included
	- - - - -		-					w/transformer)
73	220-0410-00		4					NUT, keps, 10-32 x 3/8 inch
74	348-0055-00		1					GROMMET, plastic, 1/4 inch diameter
75	384-0615-00		3					ROD, spacer
	- - - - -		-					mounting hardware for each:
	- - - - -		-					(not included w/rod)
76	212-0044-00		3					SCREW, 8-32 x 1/2 inch, RHS
77	214-0680-00		1					PIN, locating
	- - - - -		-					mounting hardware: (not included w/pin)
	210-0458-00		1					NUT, keps, 8-32 x 11/32 inch (not shown)

FIG. 1 EXPLODED (CONT)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description
				y	1	2	3	4	
78	386-0240-00			1					PANEL, rear
79	352-0002-00			1					ASSEMBLY, fuse holder
	- - - - -			-					assembly includes:
80	200-0582-00			1					CAP, fuse, black
81	352-0010-00			1					HOLDER, fuse
82	210-0873-00			1					WASHER, rubber, 1/2 ID x 11/16 inch OD
83	- - - - -			-					NUT
84	161-0033-00			1					CABLE ASSEMBLY, power, 3 cond
85	358-0161-00			1					BUSHING, strain relief
86	103-0071-00			1					ADAPTER, strain relief
	- - - - -			-					mounting hardware: (not included w/adapter)
87	212-0004-00			2					SCREW, 8-32 x 5/16 inch, PHS
88	210-0458-00			2					NUT, keps, 8-32 x 11/32 inch
89	358-0324-00			2					BUSHING, sleeve, plastic, 0.484 inch long
	- - - - -			-					mounting hardware for each:
	- - - - -			-					(not included w/bushing)
90	213-0166-00			1					SCREW, thread forming, #6
91	124-0207-00			1					TERMINAL STRIP, ceramic, 2 double notched
92	- - - - -			2					DIODE, w/mounting hardware
93	124-0145-00			6					STRIP, ceramic, 7/16 inch h, w/20 notches
	- - - - -			-					each strip includes:
	355-0046-00			2					STUD, plastic
	- - - - -			-					mounting hardware for each: (not included
	- - - - -			-					w/strip)
	361-0009-00			2					SPACER, plastic, 3/8 inch long
94	124-0146-00			6					STRIP, ceramic, 7/16 inch h, w/16 notches
	- - - - -			-					each strip includes:
	355-0046-00			2					STUD, plastic
	- - - - -			-					mounting hardware for each: (not included
	- - - - -			-					w/strip)
	361-0009-00			2					SPACER, plastic, 3/8 inch long
95	124-0147-00			2					STRIP, ceramic, 7/16 inch, w/13 notches
	- - - - -			-					each strip includes:
	355-0046-00			2					STUD, plastic
	- - - - -			-					mounting hardware for each: (not included
	- - - - -			-					w/strip)
	361-0009-00			2					SPACER, plastic, 3/8 inch long

FIG. 2 CABINET

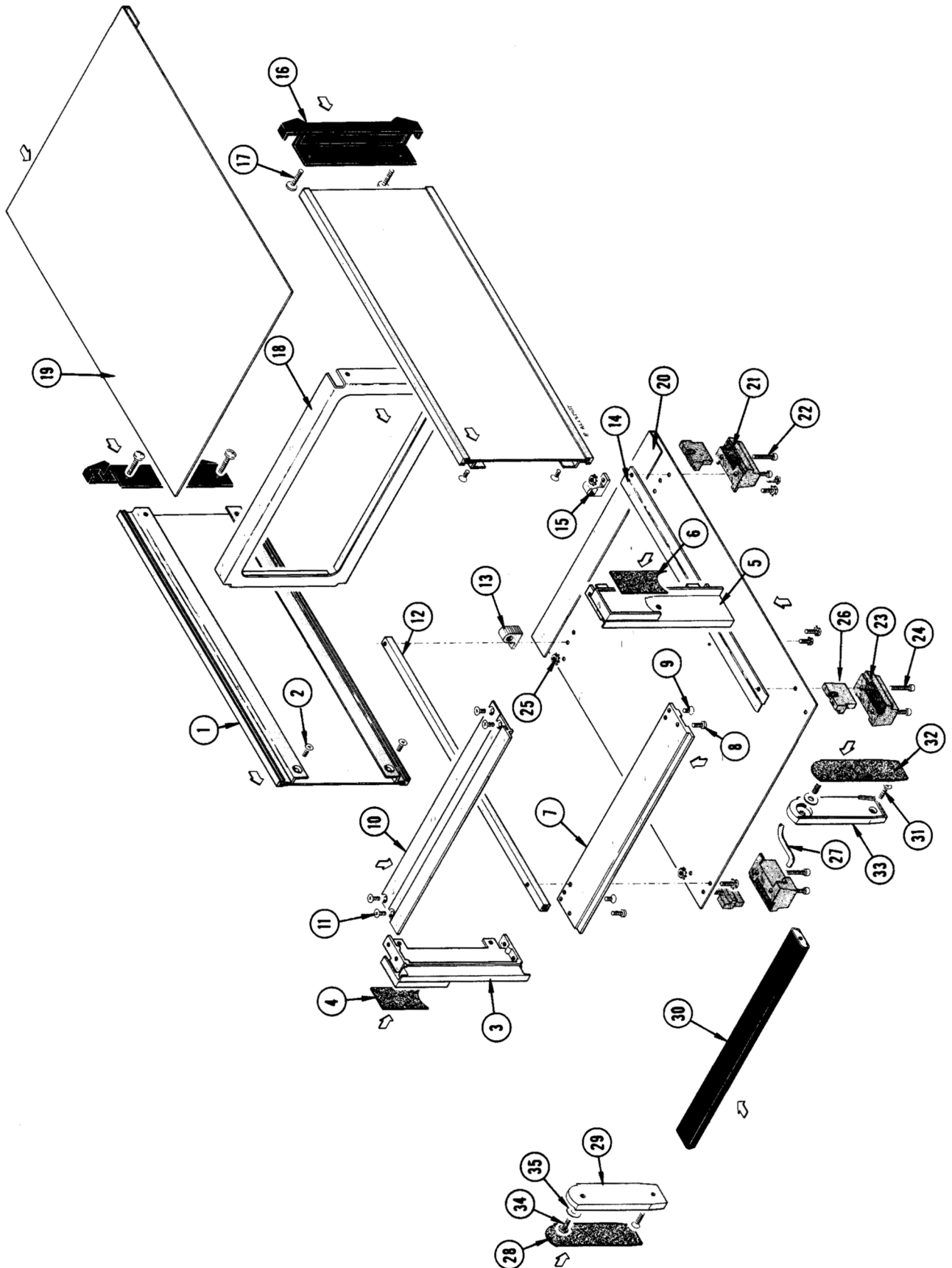


FIG. 2 CABINET

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q					Description	
			†	y	1	2	3		4
2-	437-0078-00		1						CABINET
	- - - - -		-						cabinet includes:
-1	386-0141-00		2						PLATE, side
	- - - - -		-						mounting hardware for each:
	- - - - -		-						(not included w/plate)
-2	212-0002-00		2						SCREW, 8-32 x 1/4 inch, FHS
-3	426-0253-00		1						FRAME, front, left
-4	377-0121-00		1						INSERT, frame, left
-5	426-0252-00		1						FRAME, front, right
-6	377-0120-00		1						INSERT, frame, right
-7	426-0254-00		1						FRAME, front, bottom
	- - - - -		-						mounting hardware: (not included w/frame)
-8	212-0004-00		2						SCREW, 8-32 x 5/16 inch, PHS
-9	212-0002-00		2						SCREW, 8-32 x 1/4 inch, FHS
-10	426-0255-00		1						FRAME, front, top
	- - - - -		-						mounting hardware: (not included w/frame)
-11	212-0002-00		4						SCREW, 8-32 x 1/4 inch, FHS
-12	351-0093-00		1						GUIDE, left
	- - - - -		-						mounting hardware: (not included w/guide)
	212-0023-00		1						SCREW, 8-32 x 3/8 inch, PHS
-13	358-0293-01		1						BUSHING, plug-in securing, left
	- - - - -		-						mounting hardware:
	- - - - -		-						(not included w/bushing)
	211-0510-00		1						SCREW, 6-32 x 3/8 inch, PHS
	210-0005-00		1						LOCKWASHER, external, #6
	212-0001-00		1						SCREW, 8-32 x 1/4 inch, PHS
	210-0007-00		1						LOCKWASHER, external, #8
-14	351-0092-00		1						GUIDE, right
-15	358-0294-01		1						BUSHING, plug-in securing, right
	- - - - -		-						mounting hardware:
	- - - - -		-						(not included w/bushing)
	212-0001-00		1						SCREW, 8-32 x 1/4 inch, PHS
	210-0007-00		1						LOCKWASHER, external, #8
	211-0510-00		1						SCREW, 6-32 x 3/8 inch, PHS
	210-0005-00		1						LOCKWASHER, external, #6
	210-0457-00		1						NUT, keps, 6-32 x 5/16 inch

Mechanical Parts List--Type 067-0502-01

FIG. 2 CABINET (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				Y	1	2	3	4		5
2-16	348-0075-00			2						FOOT, rear guard, left and right mounting hardware for each:
	- - - - -			-						(not included w/foot)
-17	212-0004-00			2						SCREW, 8-32 x 5/16 inch, PHS
-18	386-0139-00			1						PLATE, rear
-19	386-0138-00			1						PLATE, top
-20	386-0140-00			1						PLATE, bottom
-21	348-0073-00			2						FOOT, left front and right rear mounting hardware for each:
	- - - - -			-						(not included w/foot)
-22	211-0532-00			2						SCREW, 6-32 x 3/4 inch, FIL HS
-23	348-0074-00			2						FOOT, right front and left rear mounting hardware for each:
	- - - - -			-						(not included w/foot)
-24	211-0532-00			2						SCREW, 6-32 x 3/4 inch, FIL HS
-25	210-0457-00			2						NUT, keps, 6-32 x 5/16 inch
-26	377-0119-00			4						INSERT, foot
-27	348-0072-00			1						FOOT, flip-stand bail
-28	377-0123-00			1						INSERT, pivot, left
-29	367-0051-00			1						PIVOT, handle, left
-30	367-0052-00			1						HANDLE
	- - - - -			-						mounting hardware: (not included w/handle)
-31	212-0040-00			2						SCREW, 8-32 x 3/8 inch, FHS
-32	377-0122-00			1						INSERT, pivot, right
-33	367-0050-00			1						PIVOT, handle, right
-34	214-0054-00			2						BOLT, hinge
-35	214-0558-00			2						WASHER, thrust, 5/16 ID x 1/2 inch OD
										STANDARD ACCESSORIES
	062-1105-00			2						MANUAL, instruction (not shown)