

INSTRUCTION MANUAL

Serial Number _____

067-0521-01

**CALIBRATION
FIXTURE**

Tektronix, Inc.

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070-0407-02



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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.

067-0521-01 CALIBRATION FIXTURE
LOAD/PULSER FOR 530-540-550 SERIES

SERIAL

1/16 AMP

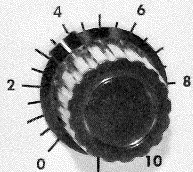


+225 V

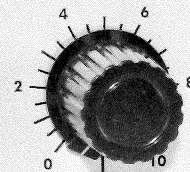
VERTICAL
POSITION



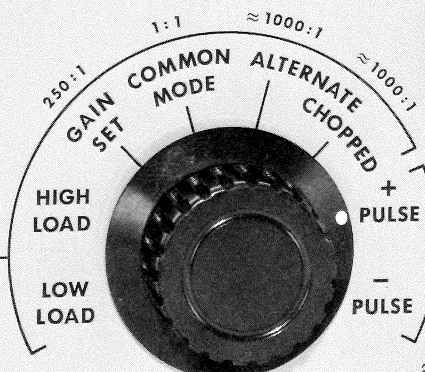
VARIABLE
(LOAD POSITIONS ONLY)



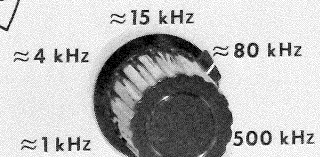
AMPLITUDE



TEST FUNCTION



REPETITION RATE



TEKTRONIX, INC.

PORTLAND, OREGON, U.S.A.

Fig. 1-1. Type 067-0521-01 Calibration Fixture.

SECTION 1

CHARACTERISTICS

Change information, if any, affecting this section will be found at the rear of the manual.

General Description

The Type TU-7 Type 1M1, 067-0521-00 and 067-0521-01 are electrically similar instruments. The Type designation was changed from TU-7 to Type 1M1 at Serial Number 500 to 067-0521-00 at Serial Number 1387, and to 067-0521-01 at Serial Number 3995. All references to "Calibration Fixture" in this manual apply equally to TU-7, 1M1, 067-0521-00 and 067-0521-01 units unless specifically stated otherwise.

The 067-0521-01 Calibration Fixture (hereafter referred to as Calibration Fixture) is a versatile single-unit calibration aid for use with all Tektronix 530-, 540-, or 550- Series Oscilloscopes using 1-series or letter-series vertical plug-in units. The Calibration Fixture is the only plug-in unit required for calibrating the oscilloscope. An input connector on the front panel permits application of various external signals for use in the calibration procedure. The self-contained unit also generates fast-rise pulses for checking risetime and adjusting transient response of the oscilloscope vertical amplifier.

The Calibration Fixture permits checking the regulation limits of the power supplies. In addition, the unit provides a quick check of the oscilloscope alternate sync pulse and chopped blanking circuitry. For oscilloscopes capable of displaying two time-base signals alternately, the Calibration Fixture checks the ability of the alternate-sweep switching circuitry to lock the channels of a dual-trace plug-in unit to the time bases of the oscilloscope.

ELECTRICAL

TEST FUNCTION Switch Positions

LOW LOAD, HIGH LOAD

These two switch positions permit the oscilloscope low-voltage power supplies to be loaded from minimum to maximum. External signals applied through the EXT INPUT connector on the front panel of the unit will be AC-coupled to the oscilloscope vertical amplifier to produce a normal display. Maximum vertical sensitivity of the Calibration Fixture and oscilloscope combination is about 0.5 volt/cm when the VARIABLE control is set fully clockwise.

GAIN SET

Permits setting the gain of the oscilloscope vertical amplifier with a 100-volt calibrator signal applied to the EXT INPUT connector. The 250-to-1 fixed ratio of this position attenuates the 100-volt signal to 0.4 volt which produces 4 cm of vertical deflection on the CRT when the oscilloscope vertical amplifier gain adjustment has been set accurately.

COMMON MODE

Checks common-mode rejection ratio and DC balance of the oscilloscope vertical amplifier.

ALTERNATE

Checks operation of the alternate-mode synchronizing circuits in the oscilloscope. Also permits checking for proper sweep slaving in oscilloscopes having two time bases that can be displayed alternately. Any external signal applied to the EXT INPUT connector is attenuated by a factor of approximately 1000 by an internal attenuation network.

CHOPPED

Checks oscilloscope for proper operation in the chopped mode. Free-running rate of the dual-trace switching multi-vibrator is approximately 100 kHz. Any external signal applied to the EXT INPUT connector is attenuated approximately 1000 times by the internal attenuation network.

+ PULSE, — PULSE

In these two switch positions, a fast-rise square wave (with a risetime considerably less than the vertical deflection system risetime of a Type 546 or Type 547 Oscilloscope) is applied to the vertical-deflection system of the oscilloscope being adjusted. The amplitude of either a + or — pulse display can be varied between approximately 2 cm and 6 cm.

Other Controls and Connectors

REPETITION RATE

Instruments with serial numbers 3995 and above have a five-position switch to select the approximate pulse repetition rate of the Pulse Generator circuit as follows: 1 kHz, 4 kHz, 15 kHz, 80 kHz and 500 kHz. Instruments below serial number 3995 have a three-position switch, permitting selection of a LOW, MED or HIGH position which provides repetition rates of approximately 5 kHz, 100 kHz or 600 kHz, respectively.

AMPLITUDE

Adjusts amplitude of the pulse applied to the oscilloscope vertical amplifier when the TEST FUNCTION switch is set to +PULSE or —PULSE.

VARIABLE

Controls amplitude of the signal applied through the EXT INPUT connector when the TEST FUNCTION switch is set to LOW LOAD or HIGH LOAD. The minimum deflection factor is approximately 0.5 volt/cm with the VARIABLE control set fully clockwise.

VERTICAL POSITION

Controls vertical positioning of the trace or display on the CRT in all TEST FUNCTION positions except COMMON MODE.

+225 V Pushbutton

Provides approximately +225 volts at the front-panel output banana jack when the pushbutton is pressed.

+225 V Banana Jack

Convenient source of +225 volts for checking DC balance of each stage of a distributed vertical amplifier. With the voltage output connected to the cathodes, the stage is effectively cut off when the +225 V pushbutton is pressed.

FUSE

Front-panel $\frac{1}{16}$ -amp fast-blow fuse protects the oscilloscope

+225-volt supply if a low-resistance path occurs from the banana jack connector to ground.

EXT INPUT

Connector for applying external signals to the oscilloscope vertical system through the Calibration Fixture. Useful for applying the calibrator signal when setting the gain of the oscilloscope vertical amplifier and for inserting signals for calibrating the time-base generator(s), trigger circuit(s), and trace geometry.

MECHANICAL

Construction

Aluminum-alloy chassis with anodized front panel. Circuit board sub-chassis.

SECTION 2

OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This information should be used in conjunction with the calibration procedure section of the oscilloscope instruction manual. If desired, any of the following adjustments or checks may be performed without regard to sequence.

The Calibration Fixture is calibrated and ready for use as shipped from the factory.

Power-Supply Output Voltages

NOTE

The oscilloscope should be completely recalibrated whenever its —150 V power supply is re-adjusted.

To check the oscilloscope power-supply voltages, proceed as follows:

1. Insert the Calibration Fixture into the oscilloscope.
2. Apply design-center line voltage to the oscilloscope and turn on the oscilloscope Power switch.
3. Set the Calibration Fixture TEST FUNCTION switch to LOW LOAD.
4. Measure the voltages at the power-supply test points as described in the oscilloscope instruction manual.

Power Supply Regulation and Ripple

To check the oscilloscope low-voltage power supply regulation and ripple, proceed as follows:

1. Set the oscilloscope Amplitude Calibrator switch to Off and set the oscilloscope triggering so the time-base circuit(s) does not free run.
2. With the TEST FUNCTION switch set to LOW LOAD, measure the ripple (with a test oscilloscope) of the various supplies with the line voltage at 126.5 volts (or 253 volts if the oscilloscope is wired for 230-volt operation).
3. Set the line voltage at 103.5 volts (or 207 volts) and set the TEST FUNCTION switch to HIGH LOAD. Measure the ripple of the various supplies. Refer to the oscilloscope instruction manual for ripple voltage limits.

Oscilloscope Vertical Gain

To check or set the oscilloscope vertical gain, proceed as follows:

1. Set the TEST FUNCTION switch to the GAIN SET position.
2. Apply a 100-volt peak-to-peak Calibrator signal to the Calibration Fixture EXT INPUT connector.

3. Free-run the oscilloscope time base at about 1 ms/cm. Two traces should be visible on the CRT. Use the VERTICAL POSITION control to center the display.

4. Adjust the oscilloscope Vertical Gain control for exactly 4 cm vertical distance between the two traces. Keep the display centered vertically on the CRT while making this adjustment.

5. Turn the Calibrator off and disconnect the signal lead.

Oscilloscope Vertical Amplifier Balance

The amount of vertical amplifier AC unbalance must be small for optimum common-mode rejection ratio and for linear amplifier operation. To check the amount of DC unbalance, a suggested procedure is as follows:

1. Set the TEST FUNCTION switch to COMMON MODE.

WARNING

Approximately +300 V exists at the points used in the following step. Do not permit these points to be short-circuited to ground.

2. Using the blade of a small screwdriver which has an insulated handle, short the CRT vertical deflection-plate pins together.
3. Note the position of the trace. This is the electrical center of the CRT vertical deflection plates.
4. Remove the screwdriver from the CRT pins.
5. Note the amount of vertical distance that the trace shifts between the shorted condition and the non-short condition. Refer to the oscilloscope instruction manual for the vertical unbalance limit.

If the oscilloscope vertical amplifier has a distributed amplifier section, the +225 V front-panel connector on the Calibration Fixture supplies +225 volts when the pushbutton switch is pressed. A lead connected from this connector can be used to apply +225 volts to the cathodes of the tubes in the vertical amplifier. This voltage effectively cuts the tubes off for checking the DC balance of each stage. This procedure is explained in detail in applicable oscilloscope manuals.

Oscilloscope Alternate-Trace Sync Pulse Check

Set the TEST FUNCTION switch to ALTERNATE. If two traces appear on the CRT, the oscilloscope time-base generator is producing proper alternate-trace sync pulses for the plug-in unit. Check each sweep rate to be sure the sync pulse

is present with sufficient amplitude. If the oscilloscope has two time bases, make the same check for the other time base.

Alternate-Sweep Slaving Check

If the oscilloscope is capable of alternating between two time bases, check this mode of operation as follows:

1. Set the oscilloscope Horizontal Display switch to Alternate.
2. Set the Time/Cm switches to .5 ms.
3. Set both Triggering Mode switches to Auto, and both Triggering Source switches to Plug-In.
4. Set the TEST FUNCTION switch to ALTERNATE.
5. Apply a 100-volt peak-to-peak Calibrator signal to the EXT INPUT connector.
6. Adjust the Triggering Level controls of both time bases to trigger the displays. (For a Type 547 Oscilloscope, the Trace Separation control should be set to zero.)
7. Check that 0.5 cm of the Calibrator waveform is displayed when Time Base A is generating its sweep (lower trace), and that approximately 1 trace width of the Calibrator waveform is displayed when Time Base B generates its sweep (upper trace). Fig. 2-1 shows the oscilloscope display.

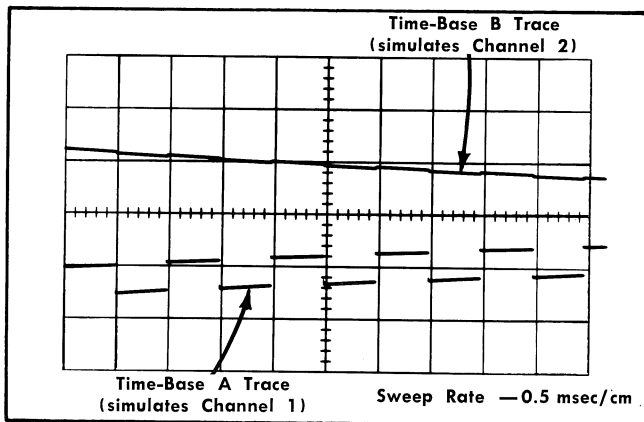


Fig. 2-1. Alternate-sweep slaving check.

8. Check that Time Base A is locked to the lower trace by turning the Time Base A Time/Cm switch. The waveform in the upper trace should not change.

In this check, the lower trace simulated the Channel 1 operation of a dual-trace plug-in preamplifier and the upper trace simulated Channel 2.

Oscilloscope Chopped-Mode Operation

To check the oscilloscope for chopped-mode operation (with no input signal applied), proceed as follows:

1. Set the TEST FUNCTION switch to CHOPPED.

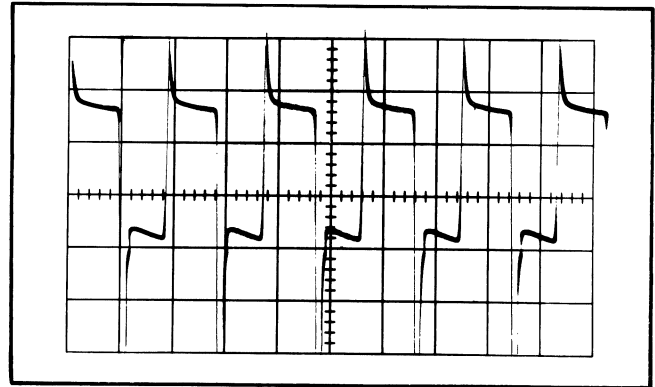


Fig. 2-2. Chopped waveform display.

2. Set the oscilloscope Time/Cm switch to 5 μ s/cm.
3. Adjust the oscilloscope triggering controls for a stable chopped waveform display (Fig. 2-2).
4. Set the oscilloscope CRT Cathode Selector switch to the Chopped Blanking position and check that the fast rising and falling portions (switching portions) of the display are blanked so only the "on" segments of each trace are visible (Fig. 2-3).
5. If the oscilloscope has two time bases, make the same check using the other time base.
6. After checking the chopped mode of operation, return the oscilloscope CRT Cathode Selector switch to the CRT Cathode position.

Oscilloscope Vertical Amplifier Transient Response

After completing the oscilloscope calibration procedure for vertical amplifier unbalance and after checking the vertical gain, check the transient response as follows:

1. Set the TEST FUNCTION switch to + PULSE.
2. Set the REPETITION RATE switch to 500 or HIGH. (For the Type 547 Oscilloscope, set switch to 80 or MED.)

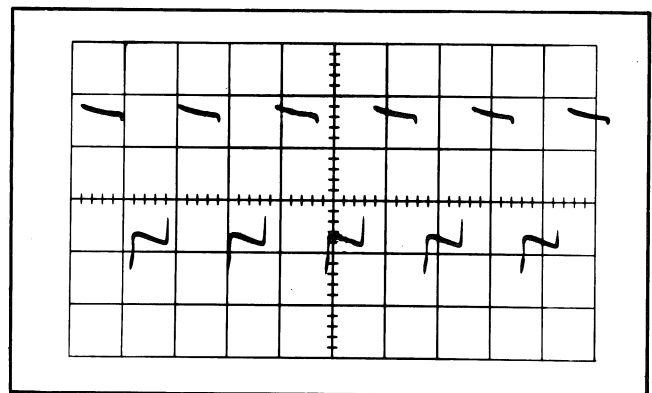


Fig. 2-3. Chopped blanking check with CRT Cathode Selector switch at Chopped. Vertical switching lines are blanked.

3. Set the oscilloscope Time /Cm switch to $.1 \mu\text{s}/\text{cm}$.
4. Set the VARIABLE AMPLITUDE control to produce a display 4 cm in amplitude for 6-cm scan oscilloscopes or 3 cm in amplitude for 4-cm scan oscilloscopes.

NOTE

Do not use a plug-in extension with the Calibration Fixture for the high frequency checks. The extension may cause considerable ringing to appear on the display of fast-rising pulses such as the Pulse Generator signal.

5. Carefully focus and check the display. If the wave-shape does not show good transient response because of over-shoot, rolloff or other aberrations, proceed with the adjustments described in the oscilloscope instruction manual.

Other Checks

The Calibration Fixture can be used as a limited band-pass plug-in unit. It is useful for inserting calibrated time marks into the vertical system when adjusting the oscilloscope geometry, trigger circuits, and time-base circuits for proper operation. For making a sine-wave bandpass check of an oscilloscope preamplifier system, use a 1-series or letter-series plug-in unit rather than the plug-in test unit.

When using the Calibration Fixture to couple an input signal to the oscilloscope vertical amplifier, the deflection factor of the unit is about 0.5 volt/cm with the TEST FUNCTION switch set to LOW LOAD or HIGH LOAD and the VARIABLE control turned fully clockwise. LOW LOAD is the normal position of the TEST FUNCTION switch for displaying signals applied through the EXT INPUT connector.

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

SECTION 3

CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

General Information

Fig. 3-1 is a block diagram of the Calibration Fixture. The circuitry of the unit may be separated into three major divisions: the Power Supply Loading Circuit, the Dual-Trace Switching Circuit, and the Pulse Generator Circuit. All three of these circuits are controlled by TEST FUNCTION switch SW10.

positions of the TEST FUNCTION switch are used to connect the correct loads to the low-voltage power supplies. The GAIN SET position provides a check of the gain of the oscilloscope vertical amplifier. The COMMON MODE position of the switch provides a check of the oscilloscope vertical amplifier rejection ratio. The last four positions of the TEST FUNCTION switch operate the dual-trace switching circuit or the pulse generator circuit and will be discussed under those headings.

POWER SUPPLY LOADING CIRCUIT

General Operation

The purpose of this circuit is to operate the regulated power supplies of the oscilloscope under extreme load conditions to determine if they regulate properly. Fixed-resistor dummy loads are used to simulate the loading effect of plug-in preamplifiers. The LOW LOAD and HIGH LOAD

Detailed Description

Refer to the schematic diagram near the back of the manual. When TEST FUNCTION Switch SW10 is set to the LOW LOAD position, the main load on the —150-volt supply is provided through R125, with slight additional loading through the dual-trace switching multivibrator circuit. The +100-volt supply is loaded primarily by R124, R18, and

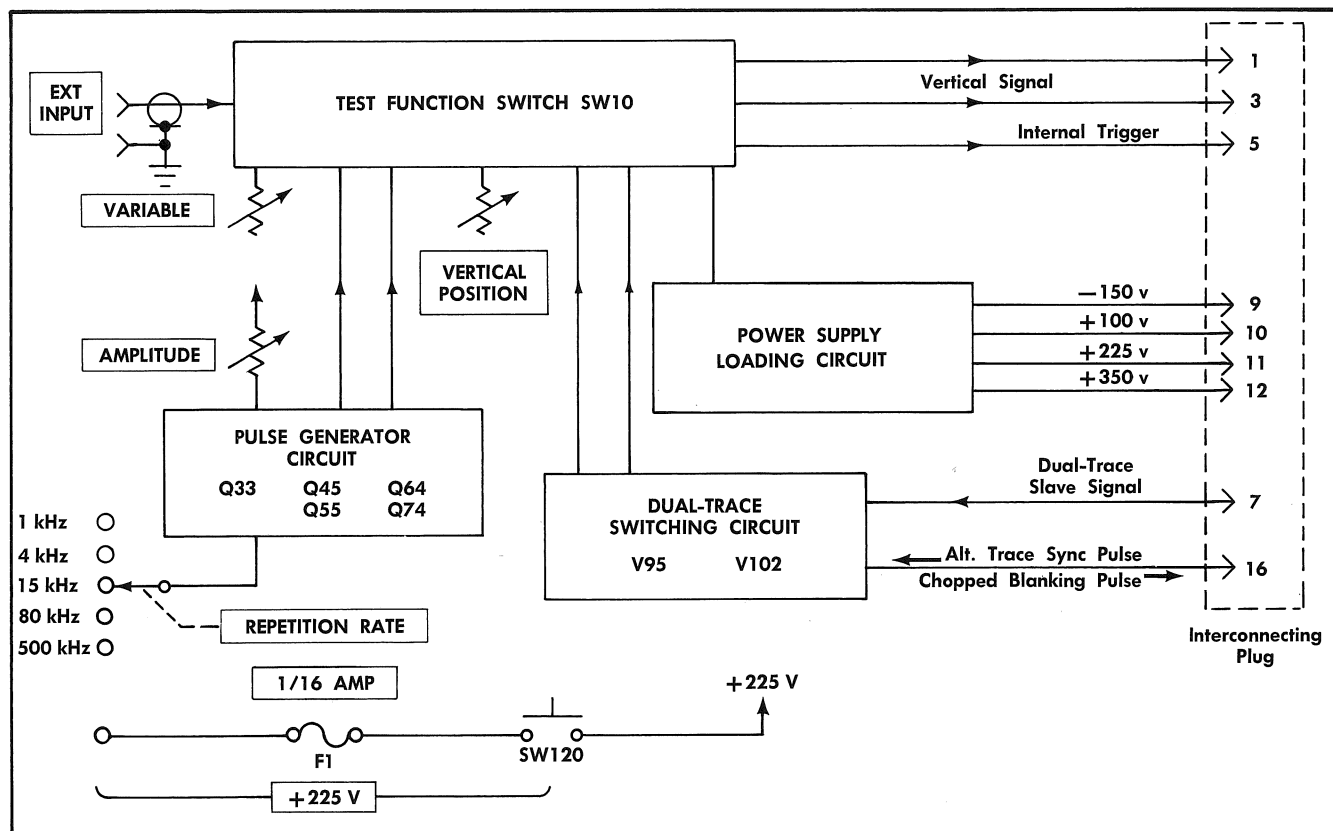


Fig. 3-1. Calibration Fixture block diagram. (The REPETITION RATE switch on units below serial number 3995 has only 3 positions - LOW, MED, and HIGH.)

R19, with additional loading through R85 and R86. Minimum loading for the +225-volt supply is provided by R122, as well as the resistors in the vertical position network, R80A, B, C, D, R81 and R82. The +350-volt supply receives no load in the LOW LOAD position. All of the minimum load resistances remain in the circuit at all times.

When the TEST FUNCTION switch is set to the HIGH LOAD position, additional dummy load resistors are connected to all four low-voltage power supplies. R116 loads the -150-volt supply; R111 and R112 in parallel load the +100-volt supply; R109 and R110 in parallel load the +225-volt supply; and R106 and R107 in parallel load the +350-volt supply.

Pins 1 and 3 of the interconnecting plug are the input signal and vertical positioning connections for the oscilloscope vertical amplifier. When using the LOW LOAD or HIGH LOAD positions, an external signal applied to the EXT INPUT connector is AC coupled through C22 to pin 1 of the interconnecting plug. Since the signal is applied to pin 1 only, it provides single-ended drive to the vertical amplifier. Front-panel VARIABLE control R11, connected between the junction of R10/C10 and ground, controls the amount of input signal applied to pin 1. R10 and C10 provide some input signal frequency compensation. Vertical positioning of the trace is provided by the voltage applied to pin 3 of the interconnecting plug through the VERTICAL POSITION network.

An internal trigger signal is applied from the junction of R12 and R14 to pin 5 of the interconnecting plug. For oscilloscopes that can trigger directly from the plug-in unit, this signal simulates the internal trigger signal from a dual-trace plug-in preamplifier, such as the Tektronix Type 1A1.

In all positions of the TEST FUNCTION switch except COMMON MODE, + PULSE, and -PULSE, two separate voltage dividers set the DC voltages at pins 1 and 3 of the interconnecting plug at +67.5 volts with the trace centered and no signal applied. This voltage, which simulates the nominal output voltage of a plug-in preamplifier, is essential at the input of the oscilloscope for linear operation of the vertical amplifier. The voltage at pin 1 is set by voltage divider R16, R17, R18 and R19. The voltage at pin 3 is set by voltage divider R84, R85, R86, vertical positioning network R80A, B, C, D, R81, and VERTICAL POSITION control R82. The VERTICAL POSITION control varies the divider voltage applied to pin 3 of the interconnecting plug and thus controls the vertical position of the display in all positions of the TEST FUNCTION switch except COMMON MODE.

In the GAIN SET position of the TEST FUNCTION switch, a precision 250-to-1 divider consisting of R17 in series with parallel resistors R18 and R19 sets the amount of input calibrator signal applied to the oscilloscope vertical amplifier. Thus, if a 100-volt peak-to-peak calibrator signal is used, the divider DC couples a 0.4-volt signal to pin 1 of the interconnecting plug. This signal results in a 4-cm deflection on the CRT if the gain of the oscilloscope vertical amplifier is set correctly.

In the COMMON MODE position of the TEST FUNCTION switch, a signal applied to the INPUT connector is AC coupled through C22 and applied equally through R25 and R26 to pins 1 and 3 of the interconnecting plug. The TEST FUNCTION switch disconnects the AMPLITUDE and VERTICAL PO-

SITION controls. In this position, voltage divider R16, R17, R18 and R19 sets the DC voltage at both pin 1 and pin 3. Since the same signal is applied in phase to both sides of the oscilloscope vertical amplifier, the signals will cancel if the rejection ratio of the amplifier is high. The position of the trace on the CRT should be the balance point of the oscilloscope vertical amplifier, whether or not a COMMON MODE signal is applied to the input.

DUAL-TRACE SWITCHING CIRCUIT

General Operation

The Dual-Trace Switching Circuit consists of plate-coupled switching multivibrator V95A/V95B and steering diodes V102A/V102B. Under normal conditions, the circuit performs five general functions:

1. When the TEST FUNCTION switch is set to ALTERNATE, the switching multivibrator operates in a bistable configuration. An alternate-trace sync pulse from the oscilloscope at the end of each sweep is applied via pin 16 on the interconnecting plug, switching the multivibrator from one state to the other by turning on the steering diode that was cut off. The output of the multivibrator is a sequence of two DC levels for each complete cycle of operation. The two levels produce two alternate traces on the CRT. A signal applied to the EXT INPUT connector also appears at pin 1 of the interconnecting plug, and is displayed by the lower trace, simulating the Channel 1 operation of a dual-trace preamplifier plug-in unit. The upper trace, which simulates Channel 2, displays essentially no signal.

2. In the ALTERNATE mode of operation, a portion of the applied signal is picked off and used as an internal trigger signal at pin 5 of the interconnecting plug. If the oscilloscope is capable of internally triggering on the signal at pin 5, a stable display of the applied signal can be obtained.

3. In the ALTERNATE mode of operation, if the oscilloscope has two time bases that can be operated alternately, a "slave pulse" signal is applied from the oscilloscope via pin 7 of the interconnecting plug through the steering diode stage to the switching multivibrator. The slave pulse sets the state of the multivibrator so the upper trace will be displayed when Time Base B generates its sweep. At the end of the Time Base B sweep, a sync pulse applied through pin 16 and the steering diode causes the multivibrator to switch states so the lower trace will be displayed while Time Base A generates its sweep.

4. When the TEST FUNCTION switch is set to the CHOPPED position, the switching multivibrator is in an astable configuration. The free-running rate of the circuit is approximately 100 kHz. The output of the circuit is a sequence of two DC levels which produces a display of two traces chopped into off-on segments at the 100 kHz rate. A signal applied to the INPUT of the Calibration Fixture is AC coupled to pin 1 of the interconnecting plug and is displayed by the "on" segments of the lower trace. The upper and lower traces simulate the operation of Channels 2 and 1 respectively of a dual-trace preamplifier operated in the chopped mode.

5. With the Calibration Fixture set for CHOPPED mode, the switching multivibrator produces blanking pulses that are applied through pin 16 of the interconnecting plug to

the oscilloscope blanking circuit. The blanking pulses cause the CRT beam to be blanked during the time the beam is being switched from one trace to the other.

Detailed Description

ALTERNATE Operation With Single Time Base Oscilloscope (or With Single Time Base Selected at a Multiple Time Base Oscilloscope). Refer to Fig. 3-2. When the TEST FUNCTION switch is in the ALTERNATE position, a switch contact connects R92 and R96 to ground. The resulting voltage division sets up V95A and V95B for bistable operation. Assume that V95B is cut off and V95A is conducting, demanding about 6 mA of current through D89 and D90.

A signal applied to the EXT INPUT connector appears across the voltage divider made up of R13 and R89-R88 in parallel with D89. Since D89 is conducting heavily, it offers very low AC impedance to ground (less than 100 Ω). Almost all of the signal is dropped across R13, with an insignificant amount passing through C22 to the oscilloscope vertical amplifier circuit.

With V95A conducting and V95B cut off, the voltage divider in the V102 cathode circuit (R102, D102, R101) permits V102B to conduct. Since a much lower potential appears on the plate of V102A than on the plate of V102B, V102A is cut off.

When the oscilloscope completes its horizontal sweep, retrace causes a negative "sync pulse" signal to appear at terminal 16 of the interconnecting plug. This is coupled through C105, V102B, and C97 to the grid of V95A, causing the multivibrator to change states.

With V95A cut off, no current flows through D90. The R88-R90 voltage divider attempts to place approximately 0.33 V at the top of R88. Since R89 and D89 are in parallel with R88, the voltage pulls the D89 anode up to about 0.1 V, causing about 120 μ A to flow through D89. This current flows through R89, where it combines with that through R88. Note that 120 μ A and 0.1 V indicates that D89 has an impedance of approximately 800 Ω under this condition.

Signals at the EXT INPUT connector are applied to the same circuit as when V95A was conducting, except that the decreased current through D89 holds that component in a much higher impedance state. When viewed from the EXT INPUT, D89 in parallel with R89-R88 now offers an impedance of about 600 Ω .

The voltage divider formed by R13 (560 k Ω) and this 600 Ω cause the signal developed at the R13-R89 junction to be approximately 1/1000 of that applied to the EXT INPUT connector. This small signal passes through C22 and is applied to the oscilloscope vertical circuit during the time that V95A is cut off.

The preceding explanation used approximate values. The actual attenuation is listed as being approximately 1000:1, since it is a function of the individual diode used for D89 and of the value of signal applied to the EXT INPUT connector.

During the time that V95A is cut off, its high plate potential causes V102A to conduct. The low potential at the V95B plate holds V102A out of conduction. The next Sync Pulse to arrive is felt through C105, D102, V102B and C91, and is

applied to the grid of V95B, again causing the multivibrator to change states. D89 again becomes a low impedance for signals applied to the EXT INPUT connector.

Each time that the multivibrator changes states, the voltage applied to C22 by D89 changes by about 0.2 V. C22 charges and discharges through the principal path which consists of R22, R20, R18, R19, R88, R89 and D89, giving it an RC time of slightly over 10 ms. When a fast sweep is selected at the oscilloscope (0.2 ms/cm or faster), the multivibrator changes state before C22 can change its charge appreciably, and two relatively flat and separate traces can be seen. When slower sweep rates are selected, C22 charges and discharges appreciably during sweep time, and the differentiated output appears on the two traces as shown in the waveform at output terminal 1 in Fig. 3-2.

ALTERNATE Operation With Alternate Time Base Selected at a Multiple Time Base Oscilloscope. Refer to the schematic diagram at the rear of the manual, and to the idealized waveforms shown in Fig. 3-3. When alternate sweep mode is selected at an oscilloscope capable of alternating between time-base circuits, an alternate slave pulse is applied through pin 7 to C101 (Fig. 3-3C). The positive portion of the slave pulse exists during "A" sweep time. When "A" sweep retrace occurs, the differentiated negative-going edge of the slave pulse passes through V102A (Fig. 3-3E), cutting off V95B and turning V95A on. The voltage at D89 anode goes to about 0.3 V. If a signal is present at the EXT INPUT, most of it is shunted through D89 to ground. Therefore when B sweep occurs at the oscilloscope, a negligible signal appears on it.

Note the situation that would have existed if V95A had been conducting and V95B had been cut off prior to the time the slave pulse went negative. The circuit would not need to be reset to display the "B" sweep. V95A would hold V102A cut off, blocking the differentiated negative edge of the slave pulse. While V95B is cut off, its plate potential controls the voltage at pins 1 and 7 of V102B, and at the cathode of D102. The differentiated negative edge of the slave pulse back-biases D102, preventing the pulse from reaching V102B. When the oscilloscope is operating in alternate mode, no Sync Pulse is sent to the plug-in when the "A" sweep retraces. The back-biased status of V102A and D102 plus the absence of an "A" sweep retrace Sync Pulse means that no signal reaches V95A or V95B when the A sweep ends, and the circuit remains ready to display the "B" sweep.

After the "B" sweep is presented, the "B" retrace causes the "B" Sync Pulse (Fig. 3-3D) to be applied through terminal 16 and C105 to pin 1 of V102B (Fig. 3-3F). Since V102B is conducting, the Sync Pulse passes through to the grid of V95A, cutting off V95A and turning V95B on. The voltage across D89 drops to about 0.1 V and its impedance increases. When the "A" sweep occurs, the lower D89 voltage causes the trace to be displayed below that caused by the "B" sweep (oscilloscope Trace Separation knob set to 0). The increased impedance of D89 (which occurs when V95A is cut off) causes the "A" sweep vertical signal at pin 1 to contain approximately 1/1000 of the signal applied to the EXT INPUT connector.

After the "A" sweep has transpired, the slave pulse again resets the multivibrator to prepare for the next cycle.

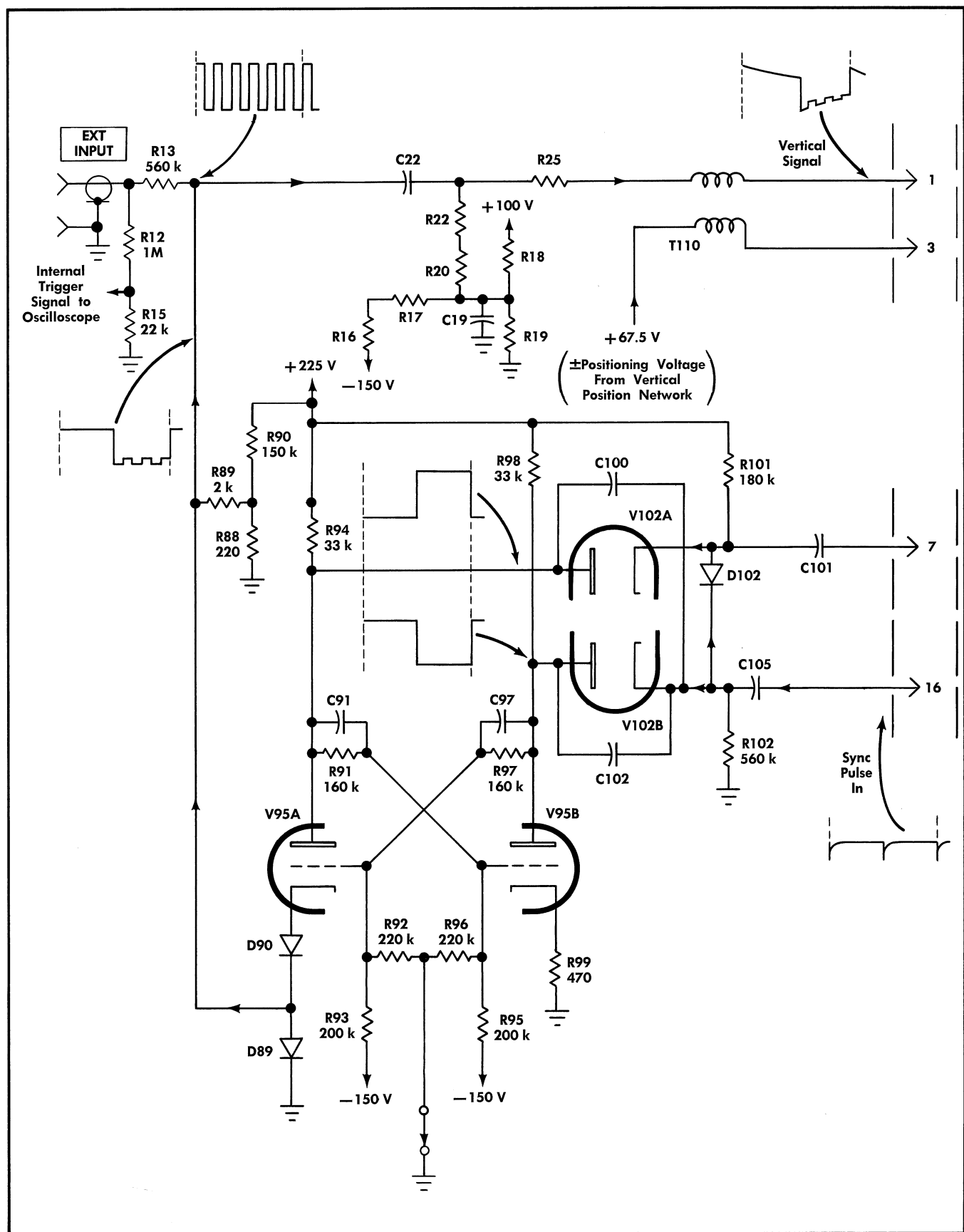


Fig. 3-2. Simplified schematic of Dual-Trace Switching circuit showing basic operation with TEST FUNCTION switch at ALTERNATE.

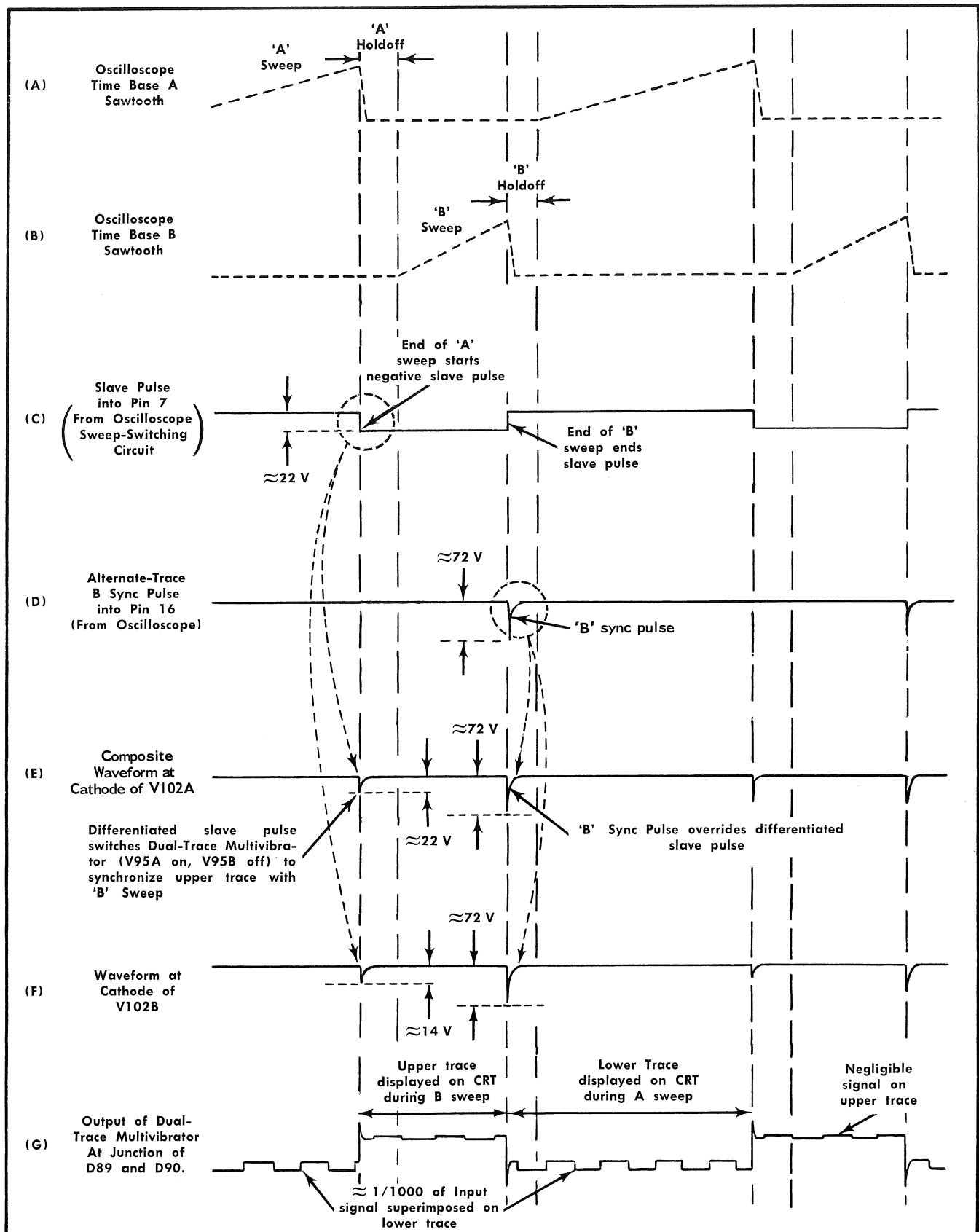


Fig. 3-3. Timing relationship of waveforms during ALTERNATE operation with oscilloscopes capable of alternate-sweep switching. Sweep rate of Time Base B is set twice as fast as Time Base A.

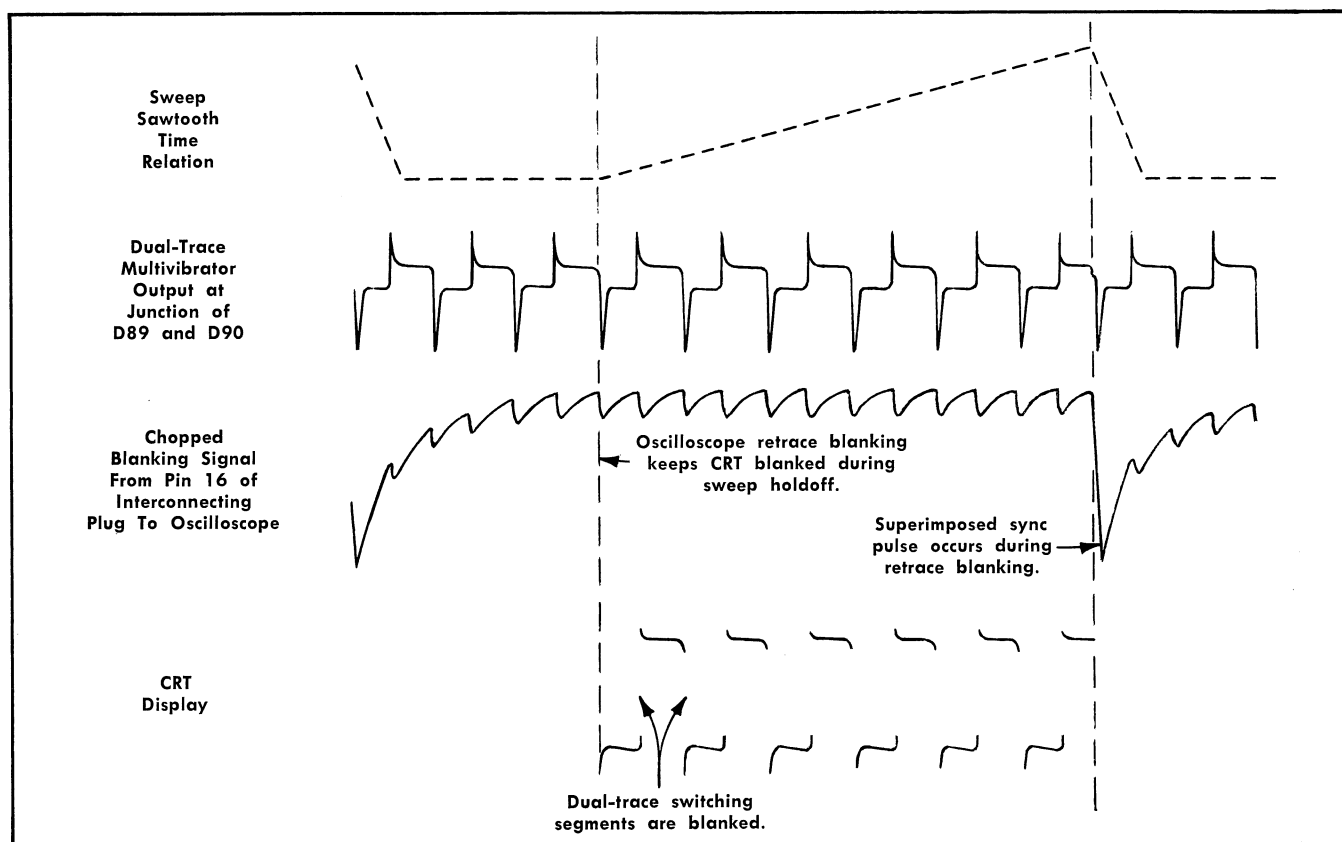


Fig. 3-4. Timing of chopped blanking pulses from Calibration Fixture to oscilloscope CRT Cathode with TEST FUNCTION switch at CHOPPED.

CHOPPED Operation. When the TEST FUNCTION switch is set to the CHOPPED position, the voltage in the grid circuit of the switching multivibrator sets the circuit for free-running operation. The repetition rate of the multi-vibrator in the CHOPPED mode is approximately 100 kHz, set by the supply voltages and the resistor-capacitor combination in the grid and plate circuits.

As the multivibrator switches from one state to the other, the output signal switches between approximately 0.1 and 0.3 V as V95A turns on and off. This causes upper and lower trace segments to appear in a manner similar to that explained in ALTERNATE mode. At sweep rates of approximately 0.2 ms and below, adjacent segments will merge and appear as an upper and lower trace. AC signals being applied to the EXT INPUT connector will appear on the lower trace, just as in ALTERNATE operation.

A second output is produced in the plate circuits of the multivibrator and coupled out through C100 and C102. Each time the multivibrator switches states, the voltage in the plate circuit of one tube drops fast as the tube turns on, stays at the lower voltage level until the other tube turns on, then rises slowly to its maximum value as the capacitance charges through a relatively high impedance path. The waveforms produced in both plate circuits of the switching multivibrator are coupled through C100 and C102 to the cathode circuit of V102B where they are combined and applied through C105 and pin 16 of the interconnecting plug to the oscilloscope blanking circuit. The frequency of the composite output chopped blanking signal is twice the re-

petition rate of the switching multivibrator. See Fig. 3-4. This output signal is inverted and amplified in the oscilloscope and applied to the CRT cathode to blank the CRT beam. Blanking occurs each time the multivibrator changes state, preventing D89 transients from being seen on the CRT.

PULSE GENERATOR CIRCUIT

General Operation

Refer to the schematic in the back of the manual. The Pulse Generator circuit consists of rate generator multivibrator Q45-Q55, constant voltage transistor Q33, current switching transistors Q64-Q74, and disconnect diodes D64, D65, D74 and D75. When the TEST FUNCTION switch is set to the + PULSE or — PULSE position, the rate generator operates as an astable circuit. One complete multivibrator cycle turns the current-switching transistors on and off. When these transistors are turned on, they shunt across the disconnect diodes. The diodes then turn off very fast, producing a fast step-function output. When the current-switching transistors are turned off again, the disconnect diodes conduct and the output pulse ends.

Detailed Description

For the following discussion, assume that the TEST FUNCTION switch is set to the + PULSE or — PULSE position and the AMPLITUDE control is turned fully clockwise to the max-

imum amplitude position. The TEST FUNCTION switch connects the +100-volt supply to the collector circuit of Q33, and applies about +75 volts to the base of the transistor through D30 and R30. The transistor is thus turned on with emitter current provided through D35 and R39 from ground. When the circuit is correctly adjusted, the voltage at the emitter of Q33 is approximately +75 volts, providing all positive supply voltages for the Pulse Generator circuit. The +60 volts existing at the anode of D35 provides the supply voltage for the base circuits of the rate generator multivibrator and for one end of the amplitude control network. DRIVE BAL R40 is adjusted so the push-pull output voltages are equal.

Rate Generator Operation. The voltage dividers between the +60 V line and the collectors of Q45 and Q55 (R46-R55 and R56-R45) determine the base voltage of the transistors. The RC network connected between the emitters of Q45 and Q55 determines the switching frequency of the rate generator. Assume that Q45 just cut off and Q55 started conducting. Under this condition, the Q45 collector voltage increased and caused the Q55 base to go to a higher voltage than that of the Q45 base. The Q55 emitter follows its base, pulling up on the RC network which is connected between the emitters. Electrons flow through R43 to charge up the capacitors, momentarily holding the Q45 emitter high enough (about +66 V) to keep Q45 cut off. As the capacitors charge up, the electron flow through R43 decreases, lowering the voltage across it. When the voltage becomes low enough (about +65 V), the Q45 emitter-base junction becomes forward biased and Q45 starts conducting. Its collector voltage drops and the base voltage of Q55 follows, cutting Q55 off. The Q55 emitter voltage attempts to decrease, causing the RC network to charge in the opposite direction. Electron flow up through R53 initially holds the Q55 emitter high enough to keep Q55 cut off. As the capacitors become charged, the electron flow through R53 decreases, lowering the voltage at the Q55 emitter. Q55 again starts to conduct, lowering its collector voltage. The rate generator changes state and the cycle then repeats itself.

The value of capacitance existing between the two emitters is selected by the REPETITION RATE switch. Five repetition rates are available in instruments serial number 3995 and above (067-0521-01) - 1 kHz, 4 kHz, 15 kHz, 80 kHz and 500 kHz. Instruments below serial number 3995 have three repetition rates—LOW (5 kHz), MED (100 kHz), and HIGH (600 kHz). All frequencies given are approximate.

Current Switching Transistors and Disconnect Diodes Operation. The average current through R40 and R41 plus the filtering action of C41, C42 and C43 hold the volt-

age at the base of Q64 at +67.5 V. Assume that Q45 is conducting and Q55 is cut off. Approximately $\frac{1}{4}$ mA flows through R46, R55 and R54, causing approximately 0.1 V drop across R54. This puts the base of Q74 at approximately +67.4 V. The +75 V potential applied to R61 in the emitter circuit of Q74 pulls the Q74 emitter up to about +67.5 V, permitting Q74 to conduct about 7.5 μ A through R61. With +67.5 V on the Q64 emitter and +67.5 V on its base, Q64 is effectively cut off. The 7 V difference which exists between the bottom of R72 and the top of R62 causes about 6 mA to flow through R74, D74, D75, R76, R66, D65, D64 and R64. This causes about 0.6 V to exist between the bottom of R76 and the top of R66. The 0.6 V is also felt through R78 and R68, applying a 0.6 V signal difference between P11 terminals 1 and 3.

When the rate generator changes state, Q45 cuts off and Q55 turns on. Current through R54 increases the voltage across it to about 1.2 V. This same voltage is felt across the base-emitter junctions of Q74 and Q64, which are in series with each other. Q74 is a germanium device and Q64 is silicon. With about 0.4V forward biasing Q74 and 0.8 V forward-biasing Q64, both transistors are turned on hard. This causes the transistors to place a short circuit current path in parallel with D74, D75, R76, R66, D65 and D64. The fast action of snap-off diodes D74, D75, D65 and D64 causes the current through them to stop very quickly. With no current through R66 and R76, the top and bottom of these resistors assume the +67.5 V applied to the R66-R76 junction. This causes the voltage which is applied to P11 terminals 1 and 3 to be identical, effectively applying 0 signal to the oscilloscope. The CRT trace rapidly moves upward to its 0-signal position. The fast action of the circuit presents a pulse rise-time of not more than 3 ns to the oscilloscope vertical circuit.

When the rate generator again changes state, Q64 turns off, Q74 changes to its low-conduction state and diodes D64, D65, D74 and D75 snap on to again provide current to R66 and R76. The cycle then repeats itself.

The output of the Pulse Generator circuit simulates a fast-rise input pulse from a 50-ohm system. The impedance presented to the oscilloscope vertical amplifier is determined primarily by the values of R66 and R76. The center voltage at the output (+67.5 volts) is adjusted by PULSE DC LEVEL control R30 during calibration. Vertical positioning of the pulse display on the CRT is controlled by DC voltages added to the output through R69 and R79.

Operation of the Pulse Generator circuit is exactly the same in — PULSE as in + PULSE, but the polarity of the output is reversed by the TEST FUNCTION switch.

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SECTION 4

MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

PREVENTIVE MAINTENANCE

Cleaning the Interior

Internal cleaning should precede calibration since the cleaning process could affect the calibration status.

One way to clean the interior is by vacuum and/or low-pressure compressed air (high-velocity air could damage certain components). Hardened dirt may be removed with a soft bristled brush, cotton-tipped swab, or cloth dampened with a water and mild detergent solution. Pay special attention to high-voltage circuits where conductive dust can cause arcing.

The contacts on the plug-in interconnecting jack and plug should be lightly lubricated with an oil of the type used on rotary-switch contacts. To extend the life of the contacts, clean and relubricate if the oil becomes contaminated with abrasive dust.

Visual Inspection

The instrument should be inspected occasionally for such defects as poor connections, broken or damaged ceramic terminal strips, improperly seated tubes or transistors, and heat-damaged parts. The remedy for most visible defects is obvious. However, overheating is usually a symptom of other defects and the damage may be repeated unless the cause is determined before parts are replaced.

Tube and Transistor Checks

Periodic preventive maintenance checks on the tubes and transistors used in the instrument are not recommended. The circuits within the instrument generally provide the most satisfactory means of checking tube or transistor performance. Performance of the circuits is thoroughly checked during recalibration, and substandard tubes and transistors will usually be detected at that time.

Recalibration

To insure accurate measurements, the instrument calibration should be checked after each 1000 hours of operation or every six months if used intermittently. Complete calibration instructions are contained in Section 5.

The calibration procedure can be helpful in isolating major troubles in the instrument. Moreover, minor troubles not apparent during regular operation may be revealed and corrected during calibration.

CORRECTIVE MAINTENANCE

General Information

Removal or replacement procedures for most parts in the Calibration Fixture are obvious. However, some parts require special procedures. Removal and replacement of these parts are discussed in the following paragraphs.

Many components in the Calibration Fixture are mounted in a particular way to reduce stray inductance and capacitance. Therefore carefully install replacement components in the same manner as the original installation.

After replacing any electrical components, be sure to check the calibration of the instrument. Components of the same type usually exhibit slightly different characteristics and will often affect calibration.

Standard Parts

Many components in the instrument are standard electronic parts available locally. However, all parts can be obtained through a Tektronix Field Engineer or Field Office. Before purchasing or ordering, consult the parts list to determine the value, tolerance, and rating required.

Special Parts

Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured to Tektronix specifications. These and most mechanical parts should be ordered directly from the Tektronix Field Engineer or Field Office. See "Parts Ordering Information" and "Special Notes and Symbols" on the first page of the Electrical Parts List.

Soldering

Special silver-bearing solder is used to establish a bond to the ceramic terminal strips in Tektronix instruments. This bond may be broken by repeated use of ordinary tin-lead solder or excessive heating. Solder containing about 3% silver is recommended. Silver-bearing solder is usually available locally or may be purchased in one-pound rolls through the Tektronix Field Engineer or Field Office. Order by part number 251-0514-00.

Soldering to Ceramic Strips

1. Use a wedge-shaped soldering-iron tip about $\frac{1}{8}$ -inch wide. This will permit applying heat directly to the solder in the terminal without touching the ceramic, thereby reducing the amount of heat required.

2. Maintain a clean, properly tinned tip.
3. Use a hot iron for a short time. A 50- to 75- watt iron with good heat storage and transfer properties is adequate.
4. Avoid putting pressure on the strip with the soldering iron or other tools. Excessive pressure may cause the strip to crack or chip.

Soldering to Etched-Wiring Boards

1. To remove a component, cut the leads near the body. This frees the leads for individual unsoldering.
2. Grip the lead with needle-nose plier. Apply the tinned tip of a 40-watt pencil solder iron to the lead between the pliers and the board, then pull gently.
3. When the solder first begins to melt, the lead will come out, leaving a clean hole. If the hole is not clean, use a scribe or pointed tool and the soldering iron to open the terminal hole. A vacuum-type solder-removing tool is very helpful in removing solder.
4. Bend the leads on the new component to the correct shape and carefully insert the leads into the holes.
5. Apply the iron for a short time at each connection on the side of the board opposite the component, to properly seat the component.
6. Apply the iron and a little solder to the connections to finish the solder joint. The solder should be applied to the wire, not the soldering iron.
7. Clip any excess leads that extend through the board.

Ceramic Terminal Strips

Fig. 4-1 shows an assembled ceramic terminal strip. Replacement strips with studs attached are supplied under a single part number and spacers under another number. The original spacers may be re-used if undamaged.

Usually, a strip can be pried out of the chassis or pulled out with a pair of pliers. In some cases, you may choose to use a hammer and punch to drive out the studs from the opposite side of the chassis.

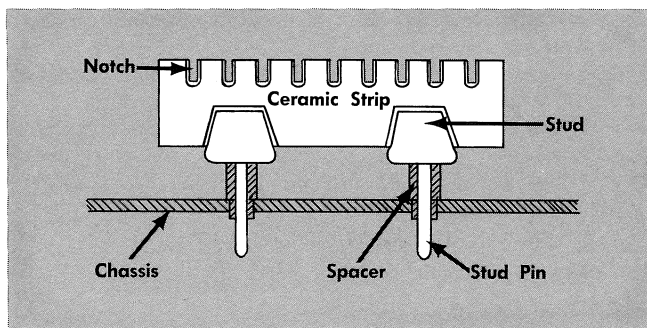


Fig. 4-1. Ceramic terminal strip assembly.

When the damaged strip has been removed, place new or used (but undamaged) spacers in the chassis holes. Then carefully force the studs of the new strip into the spacers until they are completely seated. If necessary, use a soft-faced mallet and tap lightly over the stud area of the strip.

Switch Replacement

Individual wafers normally are not replaced in switch assemblies. Replacement switches may be ordered from Tektronix either unwired or with the associated wires and components attached.

When soldering leads to a switch, do not let solder flow around and beyond the terminal rivet. Do not heat the switch excessively. Either situation may destroy the contact spring tension.

Tubes and Transistors

Tubes and transistors should not be replaced unless actually defective. When a defect is suspected, it is suggested that circuit conditions be checked first to be certain that a replacement tube or transistor will not be immediately destroyed. In some cases, these checks will also show whether or not the tube or transistor is at fault.

When circuit conditions are known to be safe, install a tube or transistor that is known to be good and check for proper operation. If the original tube or transistor proves acceptable, return it to its original socket to avoid unnecessary recalibration.

TROUBLESHOOTING

Operational Checks

If trouble is encountered in the Calibration Fixture, first perform a visual inspection of the entire unit. If a visual inspection does not reveal the cause of trouble, change tubes or transistors, depending on the area of the trouble.

As a troubleshooting aid, Table 4-1 provides resistance values to ground at the terminals of the 16-pin interconnecting plug at the rear of the unit. The resistance measurements were taken with the unit disconnected from the oscilloscope. The measurements are not absolute since semiconductors are used in the circuitry. Therefore, for future reference, blank columns are provided in the table for recording measurements and type of meter used.

NOTE

To make the unit more accessible for servicing, use either a Tektronix 6½-inch extension (Part No. 013-0055-00) or a 30-inch flexible extension (Part No. 012-0038-00). Remember, however, that if the TEST FUNCTION switch is set to + PULSE or — PULSE, the oscilloscope display will contain some overshoot and ringing due to the lead lengths in the extension.

TABLE 4-1

Resistance Measurements for Instruments Serial Number 3995 and Above (067-0521-01)

J11 Pin	TEST FUNCTION Switch	Ohmmeter ¹ Scale Used	Approximate Resistance to Chassis Ground for Typical Instruments	Ohmmeter (Type _____) (SN _____) Scale Used	Resistance to Chassis Ground (067-0521-01) (SN _____)
1	LOW LOAD, HIGH LOAD, COMMON MODE, ALTERNATE, CHOPPED	×100,000	120 k		
1	GAIN SET	×1000	13 k		
1	+ PULSE, — PULSE	×1000	17 k		
2	All Positions	×1	0		
3	LOW LOAD, HIGH LOAD, GAIN SET ALTERNATE, CHOPPED	×1000	45 k		
3	COMMON MODE	×100,000	120 k		
3	+ PULSE, — PULSE	×1000	17 k		
4	All Positions	×1	0		
5	LOW LOAD, HIGH LOAD, ALTERNATE, CHOPPED	×1000	17 k		
5	GAIN SET, COMMON MODE, + PULSE, — PULSE	×1000	20 k		
6	All Positions	×100,000	Infinite		
7	All Positions	×100,000	Infinite		
8	All Positions	×1	0		
9	LOW LOAD, GAIN SET, COMMON MODE, + PULSE, — PULSE	×1000	39 k		
9	HIGH LOAD	×1000	2.4 k		
9	ALTERNATE, CHOPPED	×1000	35 k		
10	LOW LOAD, GAIN SET, COMMON MODE, ALTERNATE, CHOPPED	×1000	17 k, 12.1 k ²		
10	HIGH LOAD	×1000	1.5 k		
10	+ PULSE, — PULSE	×1000	4.8 k, 12 k ²		
11	LOW LOAD, GAIN SET, COMMON MODE, + PULSE, — PULSE	×1000	17 k, 21 k ²		
11	HIGH LOAD	×1000	2.5 k		
11	ALTERNATE, CHOPPED	×1000	14 k, 16 k ²		
12	All positions except HIGH LOAD	×100,000	Infinite		
12	HIGH LOAD	×1000	14 k		
13	All Positions	×100,000	Infinite		
14	All Positions	×100,000	Infinite		
15	All Positions	×10	500 Ω		
16	LOW LOAD, HIGH LOAD, COMMON MODE, GAIN SET, + PULSE, — PULSE	×100,000	120 k		
16	ALTERNATE, CHOPPED	×1000	48 k		

¹Meter used to obtain these measurements was a 20,000 Ω/volt DC meter with a center-scale reading of 4.5 k on the ×1,000 Ω scale. For the ×1,000 Ω scale, center-scale deflection current is 160 μA; 320 μA at full scale.

²Ohmmeter leads are connected first in one direction, then the other, to obtain the two readings.

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SECTION 5

PERFORMANCE CHECK / CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

General

The 067-0521-01 Calibration Fixture (hereafter called Calibration Fixture) should be performance-checked and/or calibrated every six months or 1000 operating hours, whichever occurs first. A complete procedure is provided here for checking and/or adjusting the instrument. The Performance Check permits checking the instrument's calibration status without removing the instrument covers or performing internal adjustments. The Calibration Procedure gives details for checking and adjusting the instrument to provide optimum operation. Follow the appropriate comments to perform either the Performance Check or the Calibration Procedure.

Procedure steps are arranged in logical sequence to avoid unnecessary repetition. To perform a partial procedure, individual steps may be done providing that any steps listed under INTERACTION are also performed.

Equipment Required

The following items are required to complete this procedure. The "indicator oscilloscope" is the one in which the Calibration Fixture is inserted. It is referred to by that name throughout the procedure to differentiate between it and the "test oscilloscope".

1. Indicator oscilloscope, Tektronix 530-, 540-, or 550-Series. Must operate properly and be calibrated for vertical gain and sweep timing.

2. Test oscilloscope. Laboratory-type. DC to at least 1 MHz bandpass, AC and DC input coupling, 0.02 to 20 volts/division input deflection factor. (Not required for Performance Check).

3. 10X probe, for test oscilloscope. High impedance input. (Not required for Performance Check).

4. 42-inch 50-ohm coaxial cable with BNC connectors (Tektronix part No. 012-0057-01).

5. Amplitude calibrator. 1 kHz square-wave output; amplitudes from at least 0.5 volt to 100 volts peak-to-peak, accuracy within 3%. The oscilloscope Calibrator may be used.

6. DC voltmeter. At least 20,000 ohms/volt impedance; 0.5% accuracy at 67.5-volt reading.

7. Ohmmeter or multimeter. Resistance scale of $\times 1$, $\times 10$, $\times 1000$, and $\times 100,000$; 3% accuracy; minimum ohmmeter voltage on each resistance range must be 1 volt. $R \times 1k$ scale should provide 1.5V and less than 2mA output. (Not required for Performance Check).

8. Oscilloscope, sampling-type, dual-trace. 50-ohm inputs with GR connectors; at least 10 to 100 mV/div input deflection factor; bandpass to 825 MHz; capable of operating in differential mode. This instrument and the following two items are required only for checking the risetime of the Pulse Generator output.

9. Two 50-ohm coupling capacitors (874-K), with GR connectors, for sampling oscilloscope. (Tektronix part No. 017-0028-00).

10. 16-pin plug-in extension, specially modified for checking Pulse Generator output. Construction of the extension is illustrated in Fig. 5-6.

PRELIMINARY INSTRUCTIONS

1. Calibration Procedure only:

a. Lay the indicator oscilloscope (item 1 under Equipment Required) on its right side. If rackmounted, leave the indicator oscilloscope upright.

b. Remove the oscilloscope bottom panel and left side panel. (Top and left side panel on rackmounted instruments.)

NOTE

Do not insert the Calibration Fixture into the indicator oscilloscope until instructed later in the procedure.

2. Connect the test instruments to the power line.

3. Turn on all test instruments except the indicator oscilloscope.

4. Set the indicator oscilloscope front panel controls as follows:

Time/Cm	1 ms
Triggering	Auto, AC, External

5. Set the Calibration Fixture controls as follows:

TEST FUNCTION	LOW LOAD
VARIABLE	Centered
VERTICAL POSITION	Centered
AMPLITUDE	Centered
REPETITION RATE	80 kHz or MED

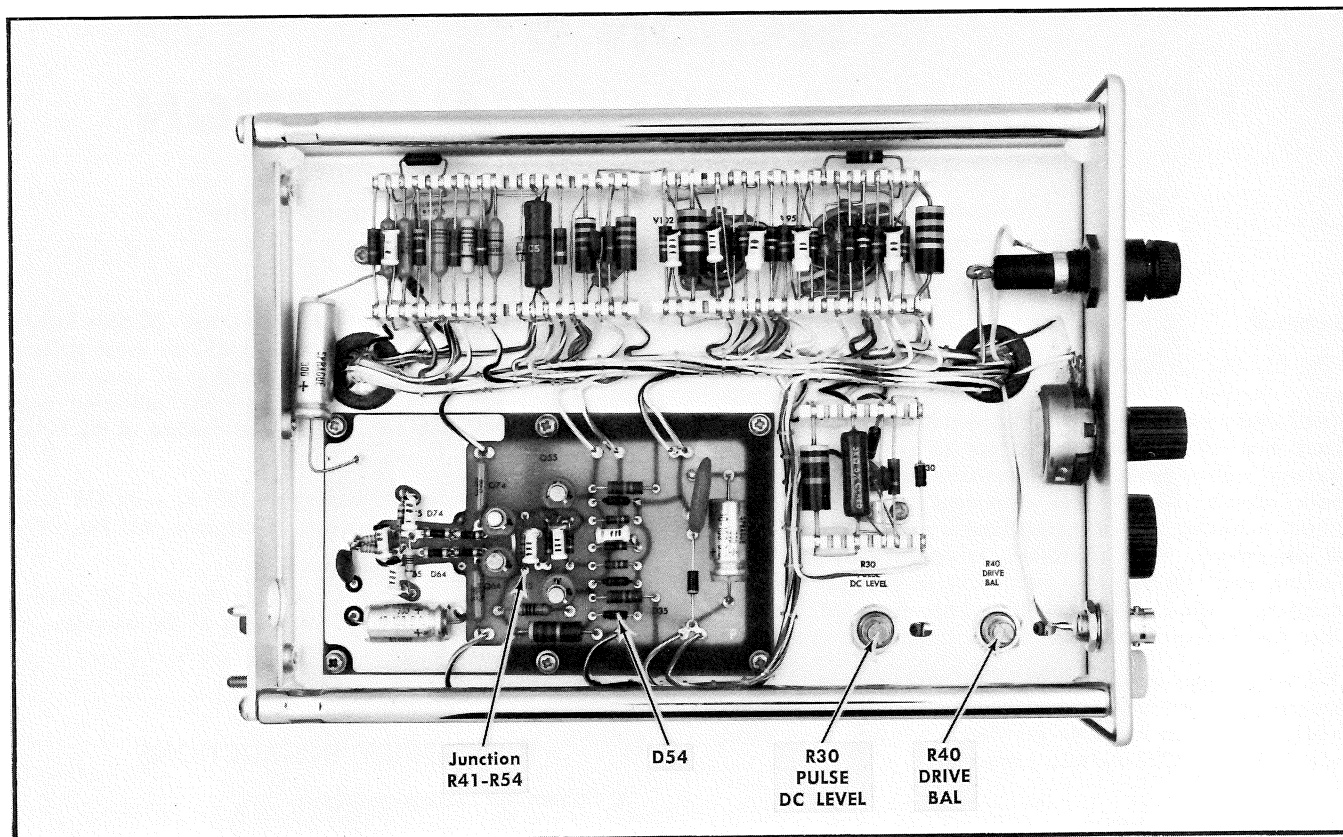


Fig. 5-1. Left side of the Calibration Fixture, showing location of adjustments and test point.

PROCEDURE

1. Check Resistance (Calibration Procedure only)

NOTE

This step applies only to instruments serial number 3995 and above and is required only if the instrument has been malfunctioning and/or has been worked on.

a. With the Calibration Fixture disconnected from the indicator oscilloscope, measure the resistances between interconnecting plug pins and ground. Compare the results against Table 4-1.

2. Check Protection Diode — Pulse Generator (Calibration Procedure only)

a. Set the ohmmeter to the $\times 1$ scale. With the Calibration Fixture disconnected from the indicator oscilloscope, check the in-circuit resistance across D54 for a low resistance (approximately 5 to 15 Ω) in one direction and infinite resistance in the other direction. **IMPORTANT:** Connect the ohmmeter only as long as required to make the measurement. Continuous application could damage the diode because of meter current exceeding the diode rating. See Fig. 5-1 for D54 location.

3. Check +225 V Output

a. Insert the Calibration Fixture into the indicator oscilloscope.

b. Turn the instrument power on and allow 10 minutes for warmup.

c. Check that the TEST FUNCTION switch is at LOW LOAD.

d. Connect the voltmeter (item 6) between ground and the +225 V front-panel jack.

e. Press the +225 V pushbutton and check for approximately +225 V; then check for zero volts with the pushbutton released.

4. Check VARIABLE Control

a. The preliminary control settings apply.

b. Check that the Time Base (Time Base A on multiple time base oscilloscopes) triggering controls are at Auto and External.

c. Adjust the Focus and Intensity controls for a sharp trace.

d. Connect a 50 Ω coaxial cable (item 4) from the Calibrator (item 5) to the Calibration Fixture EXT INPUT connector.

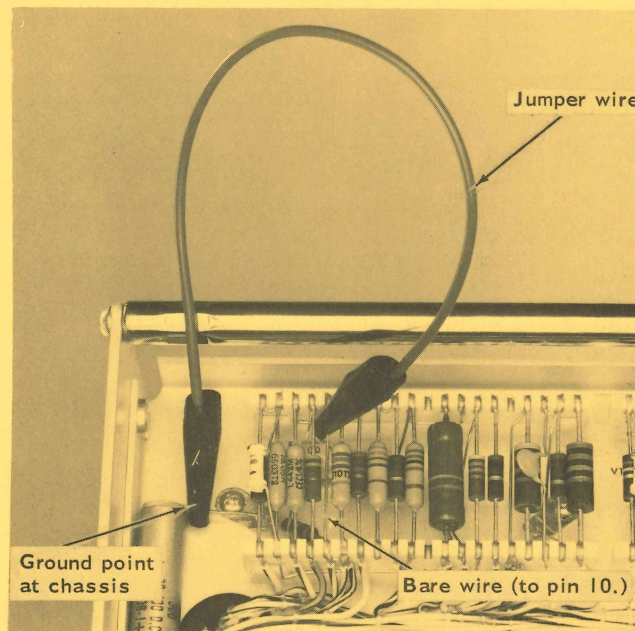
e. Set the Calibrator for an output amplitude of 0.5 V.

NOTE

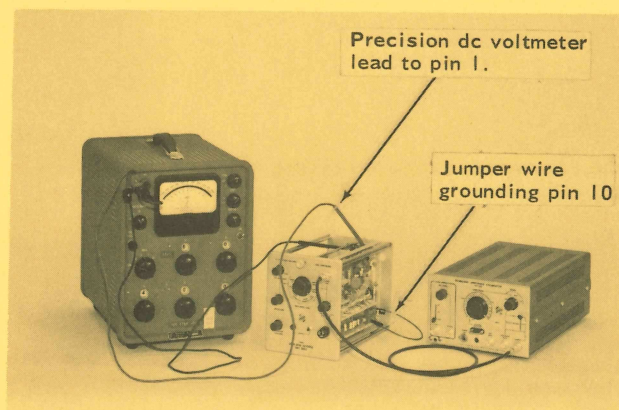
The following procedure replaces step 6 on page 5-3 in Section 5, Performance Check/Calibration for the 067-0521-01, Calibration Fixture. It also requires the use of a Precision DC Voltmeter: Accuracy within $\pm 0.05\%$; meter resolution 50 μV ; range 0 to 500 volts. For example, Fluke Model 801B.

6. Check GAIN SET:

- a. Requirement--Input signal division ratio of 250:1, accuracy 1%.
- b. Turn off the test oscilloscope and remove the 067-0521-01.
- c. Change the TEST FUNCTION switch to GAIN SET and connect pin 10 of the interconnecting plug to chassis ground with a short jumper. See figure below:



- d. With the 067-0521-01 disconnected from the test oscilloscope, apply 100 volt dc signal from the standard amplitude calibrator to EXT INPUT.
- e. Connect the precision dc voltmeter between pin 1 of the interconnecting plug and ground. See figure below:
- f. Check--For a voltmeter reading of 0.4 V ± 4 mV.
- g. Turn the standard amplitude calibrator off and disconnect the cable from the 067-0521-01 EXT INPUT connector.
- h. Remove the jumper from the 067-0521-01.



f. Turn the Calibration Fixture VARIABLE control fully clockwise and check for approximately 1 cm between the two traces which represent the upper and lower excursions of the Calibrator signal.

g. Turn the VARIABLE control fully counterclockwise and check that the two traces merge and appear as one trace.

5. Check VERTICAL POSITION Control

a. The preliminary setup applies except that a Calibrator signal is being applied to the EXT INPUT connector.

b. Set the Calibrator to 10 V and adjust the VARIABLE control for six divisions separation between traces.

c. Rotate the VERTICAL POSITION control and note that the lower trace can be positioned to or above the highest graticule line, and that the upper trace can be positioned to or below the lowest graticule line.

d. Return the VERTICAL POSITION control to midrange.

6. Check GAIN SET Function

a. The preliminary setup applies, except that a Calibrator signal is being applied to the EXT INPUT connector.

b. Set the TEST FUNCTION switch to GAIN SET.

c. Set the Calibrator for a 100 V square wave and check the display for 4 cm \pm 4 mm of vertical deflection.

7. Check COMMON MODE Function

a. The preliminary setup applies except that a Calibrator signal is being applied to the EXT INPUT connector.

b. Set the Calibrator to 0.

c. Set the TEST FUNCTION switch to COMMON MODE and check that the trace remains near CRT vertical center.

d. Set the Calibrator to 1 V.

e. Check that the trace remains near CRT vertical center and that less than 1 division of vertical display (separation between traces) exists.

f. (Calibration Procedure only) Using the test oscilloscope (items 2 and 3) and AC coupling, check for a 1 V \pm 30 mV peak-to-peak square wave signal at terminals 1 and 3 of the interconnecting plug. See Fig. 5-2. Then disconnect the probe.

WARNING

+67.5 V DC exists at terminals 1 and 3.

8. Check ALTERNATE Operation

a. The preliminary setup applies except that Calibrator signal is being applied to the EXT INPUT connector.

b. Set the TEST FUNCTION switch to ALTERNATE.

c. Set the Calibrator for a 100 V square wave signal.

d. Turn the indicator oscilloscope Time/Cm switch through-out its range and check the display. At the fastest sweep

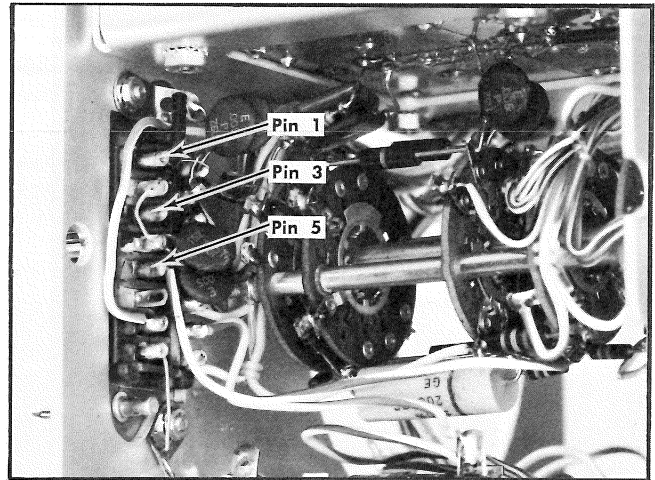


Fig. 5-2. Bottom view of the Calibration Fixture, showing interconnecting-plug pin locations.

rates two traces should be displayed with the lower trace containing approximately $\frac{1}{2}$ division of Calibrator signal. At a sweep rate of approximately 5 ms/cm, the two traces should appear to merge shortly after the start of the sweep. At sweep rates slower than 50 ms/cm, the two traces should be presented alternately, and occupy the approximate same position on the CRT. See Fig. 5-3 for reference waveforms.

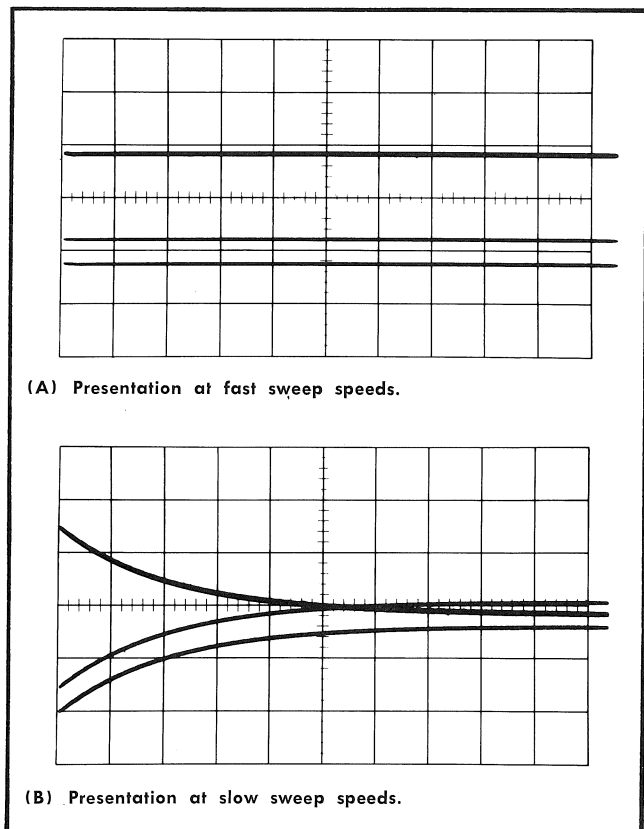


Fig. 5-3. ALTERNATE operation reference waveforms.

9. Check Internal Plug-In Trigger

a. The preliminary setup applies except that the TEST FUNCTION switch is at ALTERNATE and a Calibrator signal is being applied to the EXT INPUT connector.

b. Set the indicator oscilloscope Time/Cm to 1 ms/cm, and set its Triggering Mode switch to "triggered" (not Auto or Free Run).

c. Set the Calibrator to 20 V.

d. Calibration Procedure only:

(1) Check that the indicator oscilloscope triggering source switch is at External.

(2) Using the test oscilloscope, check the signal amplitude at terminal 5 of the interconnecting plug (Fig. 5-2). It should be a 350 mV \pm 70 mV peak-to-peak square wave.

(3) Disconnect the probe.

e. Performance Check only: the indicator oscilloscope must have a "Plug-In" trigger source position to perform this check:

(1) Set the indicator oscilloscope trigger source switch to "Plug-In".

(2) Check that a triggered display can be obtained by adjusting the triggering controls. The lower trace should contain a stable display of approximately 0.2 divisions of Calibrator signal.

10. Check ALTERNATE Sweep Slaving

NOTE

This check can be made only on an oscilloscope (such as the Type 547) that can switch alternately between two time bases.

a. The preliminary setup applies except that the TEST FUNCTION switch is at ALTERNATE and a Calibrator signal is being applied to the EXT INPUT connector.

b. Set the indicator oscilloscope Time Base A Time/Cm switch to 1 ms and the Time Base B Time/Cm switch to .5 ms.

c. Set the Calibrator for a 100 V square wave signal.

d. Set both Triggering Source switches to Plug-In and adjust the triggering controls of both time bases to trigger the two displays.

e. Turn the Time Base A Time/Cm switch through a few positions while watching the display. The number of cycles of Calibrator signal being presented on the lower trace should change, indicating that the lower trace is slaved to Time Base A.

f. Turn the Time Base B Time/Cm switch through a few positions. The number of cycles of calibrator signal being

presented on the upper trace should change, indicating that the upper trace is slaved to Time Base B. (The Calibrator signal on the upper trace will be barely discernible).

g. Turn the Calibrator off and disconnect the cable from the EXT INPUT connector.

11. Check CHOPPED Operation

a. The preliminary setup applies.

b. Set the TEST FUNCTION switch to CHOPPED.

c. If a multiple time base indicator oscilloscope is being used, set its Horizontal Display switch to Time Base A, its Triggering Source switch to Internal/Norm. If another oscilloscope is being used, set its triggering source switch to + Internal.

d. Set the indicator oscilloscope Time/Cm control to 10 μ s.

e. Adjust the triggering controls as necessary to obtain a stable display; check the chopped waveform for between 8 and 12 cycles per 10 cm. See Fig. 5-4 (A).

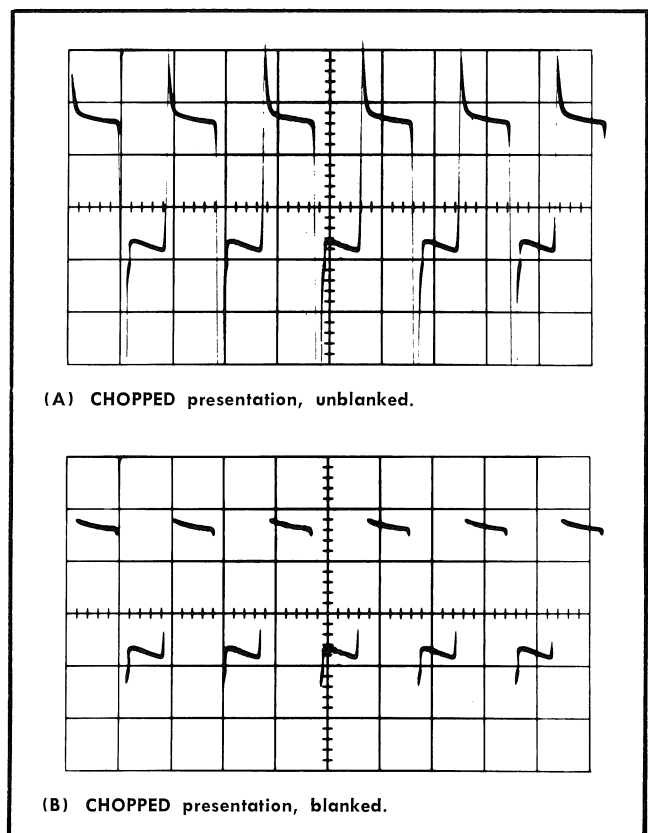


Fig. 5-4. CHOPPED signal presentation; 10 μ s/cm sweep rate.

12. Check CHOPPED Blanking Pulse Output

a. The preliminary setup applies except that the TEST FUNCTION switch is at CHOPPED, the indicator oscilloscope Time/Cm is at 10 μ s and its triggering controls are set for + Internal or Internal/Norm.

b. Set the indicator oscilloscope CRT Cathode Selector switch (rear of oscilloscope) to Chopped Blanking and check the CRT display for blanking of the vertical portions of the chopped waveform. See Fig. 5-4 (B).

c. Return the CRT Cathode Selector switch to the CRT Cathode position.

13. Adjust DRIVE BAL R40 (Calibration Procedure only)

a. The preliminary setup applies.

b. Set the TEST FUNCTION switch to + PULSE.

c. Trigger the pulse display and adjust the AMPLITUDE control for 4 cm of vertical deflection.

d. With the test oscilloscope, check for equal pulse amplitude (approximately 200 mV) at pins 1 and 3 of the interconnecting plug.

e. Adjust DRIVE BAL R40 (Fig. 5-1) as necessary to obtain equal amplitudes.

f. Disconnect the probe.

g. INTERACTION—Step 14.

14. Adjust PULSE DC LEVEL R30 (Calibration Procedure only)

a. The preliminary setup applies.

b. Using the DC voltmeter, measure the + 100 V supply at the indicator oscilloscope + 100 V test point. (Consult the applicable oscilloscope manual for test point location.)

c. Calculate the following upper and lower limits:

Low Limit $\approx .66 \times$ voltage measured

Upper Limit $\approx .69 \times$ voltage measured

d. Move the voltmeter lead to the R54-R41 junction. See Fig. 5-1.

e. Check that the DC voltmeter reading falls between the upper and lower limits calculated in part c of this step.

f. Adjust PULSE DC LEVEL R30 (Fig. 5-1) as necessary to make the voltage fall between the upper and lower limits calculated in part c of this step.

15. Check Pulse Repetition Rate

a. The preliminary setup applies except that the indicator oscilloscope Triggering controls are set at + Internal or Internal/Norm.

b. Set the TEST FUNCTION switch at + PULSE and the AMPLITUDE control at 0.

c. Check the + PULSE display for repetition rates as indicated in Table 5-1.

TABLE 5-1

REPETITION RATE	Time/Cm	Required Display (Cycles per 10 divisions)
Serial Number 3995 and above		
1 kHz	1 ms	10 ± 2.5
4 kHz	.2 ms	8 ± 2
15 kHz	50 μ s	7.5 ± 1.9
80 kHz	10 μ s	8 ± 2
500 kHz	2 μ s	10 ± 2.5
Serial Numbers below 3995		
LOW	.2 ms	10 ± 2.5
MED	10 μ s	12 ± 3
HIGH	2 μ s	12 ± 3

d. USING THE VERTICAL POSITION control, set the top of the display to graticule center.

e. Set the TEST FUNCTION switch to — PULSE and check that the bottom of the display now is near graticule center.

f. Return the TEST FUNCTION switch to + PULSE.

16. Check AMPLITUDE Control

a. The preliminary setup applies except that the TEST FUNCTION switch is at + PULSE, the REPETITION RATE switch is 500 kHz (or HIGH), the indicator oscilloscope Time/Cm is at 2 μ s and the Triggering controls are set at + Internal or Internal/Norm.

b. With the AMPLITUDE control fully counterclockwise, check for not more than 2.8 cm vertical deflection.

c. Turn the AMPLITUDE control fully clockwise.

d. Check for 5.6 cm or more vertical deflection.

17. Check Overshoot and Ringing

a. The preliminary setup applies except that the TEST FUNCTION switch is at + PULSE, the REPETITION RATE switch is at 500 kHz (or HIGH), and the indicator oscilloscope Triggering controls are at + Internal or Internal/Norm.

b. Adjust the VERTICAL POSITION and AMPLITUDE controls as necessary to obtain a 4 cm centered display.

c. Switch the indicator oscilloscope Time/Cm to .2 μ s and adjust the Horizontal Position controls as necessary to position the display as in Fig. 5-5.

d. Check overshoot and ringing. It should be less than or equal to ± 0.1 division. See Fig. 5-5.

18. Check PULSE Risetime

NOTE

The PULSE risetime is determined by the circuit parameters and the switching characteristics of gallium arsenide diodes D64, D65, D74 and D75. It is not adjustable.

- a. The preliminary setup applies except that the TEST FUNCTION switch is at + PULSE.
- b. Set the REPETITION RATE switch to 80 kHz or MED.
- c. Adjust the AMPLITUDE control for 4 cm of vertical deflection.
- d. Turn the indicator oscilloscope power off and remove the Calibration Fixture.
- e. Insert the special plug-in extension (see Fig. 5-6) in the plug-in jack.
- f. Plug the Calibration Fixture into the extender.
- g. Turn the indicator oscilloscope power on. (If the indicator oscilloscope has a plug-in sensing switch in the plug-in compartment, pull forward on the switch plunger.)
- h. Place the coupling capacitors (item 9 of Equipment Required) on the input connectors of the sampling oscilloscope.

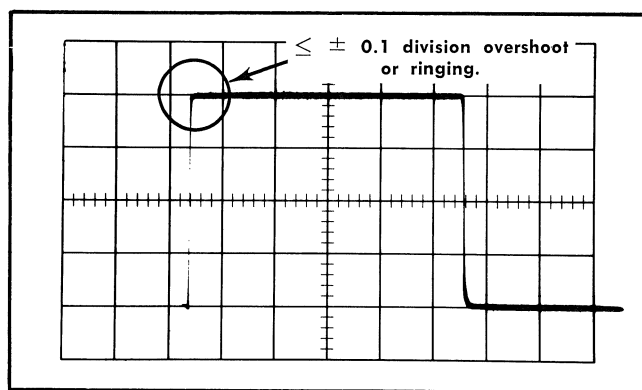


Fig. 5-5. Transient response waveform; 0.2 μ s/cm sweep rate.

- i. Set the sampling oscilloscope (item 8) to 1 ns/div and + Internal Triggering.
- j. Connect the coaxial cable from pin 1 of the interconnecting jack to the capacitor on the Channel A Input.
- k. Connect the cable from pin 3 to the capacitor on the Channel B Input.
- l. Display the Channel A signal on the sampling oscilloscope.

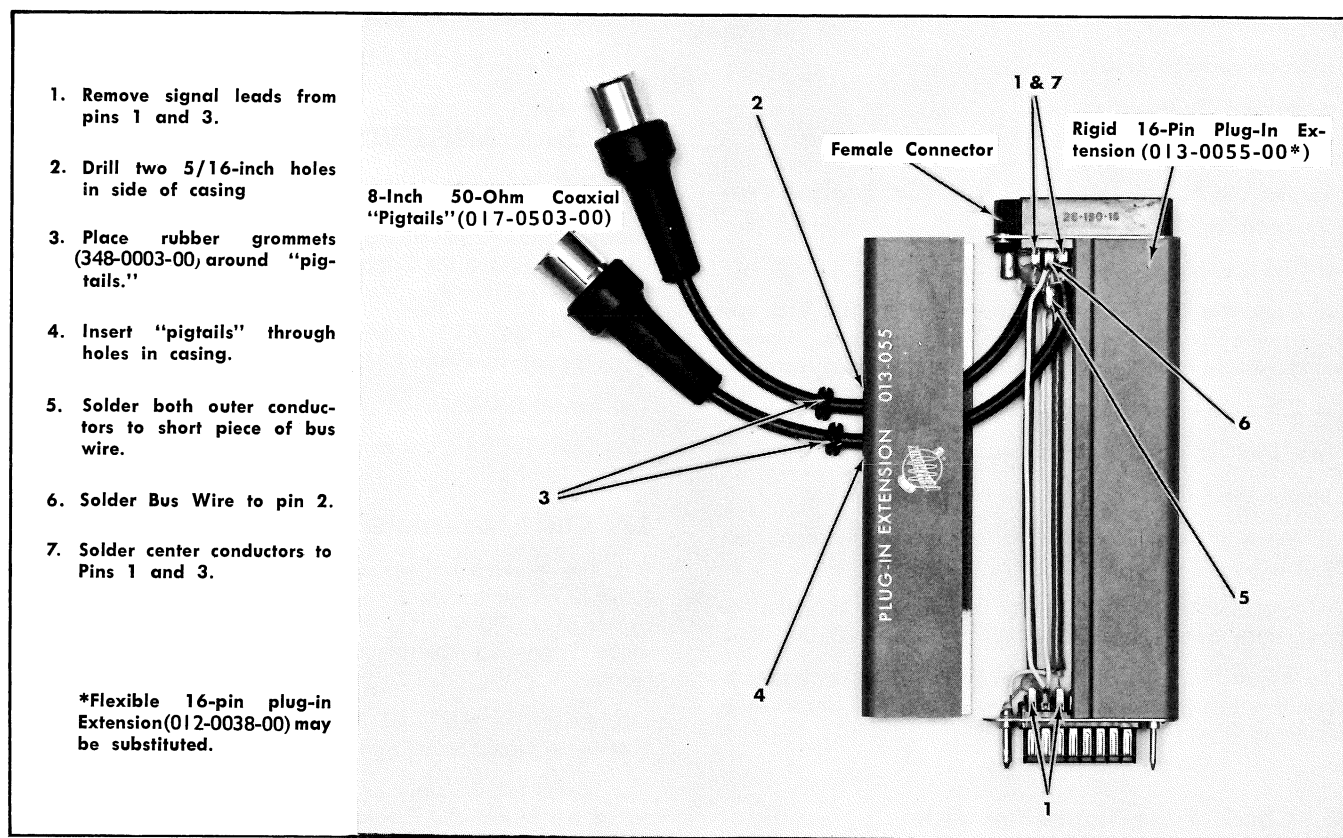


Fig. 5-6. Construction of special extender for checking pulse risetime. Tektronix part numbers are given in parenthesis.

m. Set the Channel A mV/cm switch and Variable control for 2.5 cm of vertical deflection.

n. Switch to Channel B and adjust for 2.5 cm of vertical deflection.

o. Set the sampling oscilloscope for a differential display (A+B, B inverted).

p. Center the display and readjust the Variable mV/cm controls slightly to produce 5 cm of vertical deflection.

q. Check for a risetime of 3 ns or less between the 10% and 90% points of the step function as shown in Fig. 5-7.

NOTE

If the risetime appears to be in excess of 3 ns, it is possible that the coaxial cables may be cross-connected. In this event the wrong edge of the pulse would be observed. Exchange the connections and again check for 3 ns or less risetime.

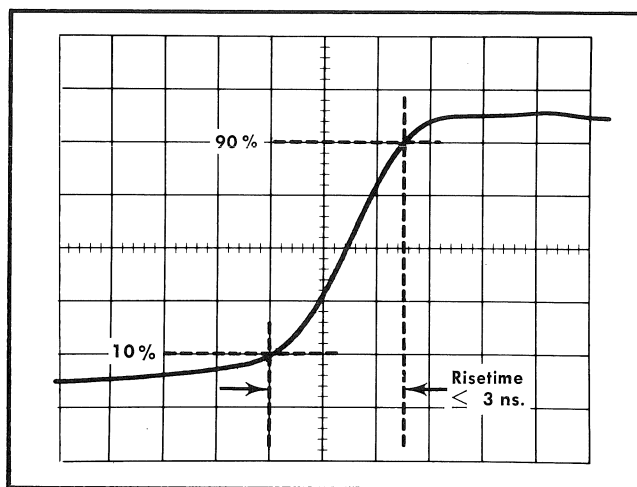


Fig. 5-7. +PULSE risetime waveform. Obtained with a Tektronix Type 561A oscilloscope, 351 vertical plug-in unit, 3T77A horizontal plug-in unit, C-12 camera system and projected graticule.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

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	P/O	part of
DE	double end	PHB	pan head brass
dia	diameter	PHS	pan head steel
div	division	plstc	plastic
elect.	electrolytic	PMC	paper, metal cased
EMC	electrolytic, metal cased	poly	polystyrene
EMT	electrolytic, metal tubular	prec	precision
ext	external	PT	paper, tubular
F & I	focus and intensity	PTM	paper or plastic, tubular, molded
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	RHS	round head steel
Fil HB	fillister head brass	SE	single end
Fil HS	fillister head steel	SN or S/N	serial number
h	height or high	S or SW	switch
hex.	hexagonal	TC	temperature compensated
HHB	hex head brass	THB	truss head brass
HHS	hex head steel	thk	thick
HSB	hex socket brass	THS	truss head steel
HSS	hex socket steel	tub.	tubular
ID	inside diameter	var	variable
inc	incandescent	w	wide or width
		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.

SECTION 6

ELECTRICAL PARTS

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.		Description			S/N Range	
Capacitors							
Tolerance $\pm 20\%$ unless otherwise indicated.							
C10	281-0534-00	3.3 pF	Cer	500 V	± 0.25 pF 10%		
C19	281-0551-00	390 pF	Cer	500 V			
C22	285-0572-00	0.1 μ F	PTM	200 V			
C33	283-0000-00	0.001 μ F	Cer	500 V			
C35	290-0194-00	10 μ F	EMT	100 V			
C39	Use	283-0057-00	0.1 μ F	Cer	200 V		
C41		290-0194-00	10 μ F	EMT	100 V		
C42		290-0226-00	20 μ F	EMT	100 V		
C43		283-0001-00	0.005 μ F	Cer	500 V		
C45		281-0518-00	47 pF	Cer	500 V		
C47	283-0051-00	0.0033 μ F	Cer	100 V	5%	100-1409	
C47	285-0627-00	0.0033 μ F	PTM	100 V	5%	1410-3994X	
C48	283-0004-00	0.02 μ F	Cer	150 V		100-1409	
C48	285-0683-00	0.022 μ F	PTM	100 V	5%	1410-3994X	
C49	283-0026-00	0.2 μ F	Cer	25 V		100-1409	
C49	285-0623-00	0.47 μ F	PTM	100 V		1410-3994X	
C50	283-0026-00	0.2 μ F	Cer	25 V		100-1409X	
C52	281-0525-00	470 pF	Cer	500 V			
C55	281-0518-00	47 pF	Cer	500 V			
C56	285-0627-00	0.0033 μ F	PTM	100 V	5%	X3995-up	
C57	285-0566-00	0.022 μ F	PTM	200 V	10%	X3995-up	
C58	285-0719-00	0.015 μ F	PTM	100 V	5%	X3995-up	
C59	285-0703-00	0.1 μ F	PTM	100 V	5%	X3995-up	
C60	285-0684-00	0.056 μ F	PTM	100 V	5%	X3995-up	
C61	285-0623-00	0.47 μ F	PTM	100 V		X3995-up	
C62	285-0576-00	1 μ F	PTM	100 V	10%	X3995-up	
C63	285-0576-00	1 μ F	PTM	100 V	10%	X3995-up	
C65	281-0505-00	12 pF	Cer	500 V	10%		
C66	281-0547-00	2.7 pF	Cer	500 V	10%		
C67	281-0601-00	7.5 pF	Cer	500 V	5%		
C68	283-0059-00	1 μ F	Cer	25 V			
C69	283-0001-00	0.005 μ F	Cer	500 V			
C78	283-0059-00	1 μ F	Cer	25 V			
C79	283-0001-00	0.005 μ F	Cer	500 V			
C83	285-0572-00	0.1 μ F	PTM	200 V			

Capacitors (cont)

Ckt. No.	Tektronix Part No.	Description	S/N Range
C91	281-0519-00	47 pF Cer	500 V 10%
C97	281-0519-00	47 pF Cer	500 V 10%
C100	281-0505-00	12 pF Cer	500 V 10%
C101	281-0519-00	47 pF Cer	500 V 10%
C102	281-0505-00	12 pF Cer	500 V 10%
C105	283-0000-00	0.001 μ F Cer	500 V
C120	283-0001-00	0.005 μ F Cer	500 V
C121	283-0001-00	0.005 μ F Cer	500 V
C122	283-0001-00	0.005 μ F Cer	500 V
C125	283-0001-00	0.005 μ F Cer	500 V

Diodes

D30	152-0024-00	Zener 1N3024B	15 V	
D35	152-0024-00	Zener 1N3024B	15 V	
D46	*152-0107-00	Silicon, Replaceable by 1N647		
D54	*152-0061-00	Silicon, Tek Spec		
D56	*152-0107-00	Silicon, Replaceable by 1N647		
D64 } D65 } D74 } D75 }	Use *152-0193-00	GaAs Tek Spec		
D80	152-0142-00	Zener 1N972A	0.4 W, 30 V, 10%	X1720-2599
D80	152-0282-00	Zener 1N972B	0.4 W, 30 V, 5%	2600-up
D89	152-0008-00	Germanium		
D90	152-0008-00	Germanium		
D102	*152-0061-00	Silicon, Tek Spec		

Fuse

F120	159-0024-00	1/16 Amp 3AG Fast Blo
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Transistors

Q33	*151-0103-00	Replaceable by 2N2219		
Q45	*151-0108-00	Replaceable by 2N2501		
Q55	*151-0108-00	Replaceable by 2N2501		
Q64	151-0097-00	2N955		100-1859
Q64	151-0120-00	Selected from 2N2475		1860-up
Q74	*151-0083-00	Selected from 2N964		

Resistors

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

R10	302-0103-00	10 k Ω	1/2 W		
R11	311-0395-00	2.5 k Ω		Var	
R12	316-0105-00	1 M Ω	1/4 W		
R13	302-0564-00	560 k Ω	1/2 W		
R14	316-0104-00	100 k Ω	1/4 W		
R15	316-0223-00	22 k Ω	1/4 W		
R16	301-0335-00	3.3 M Ω	1/2 W		5%
R17	323-0668-00	1.442 M Ω	1/2 W	Prec	1/4 %
R18	323-0670-00	8.570 k Ω	1/2 W	Prec	1/4 %
R19	323-0669-00	18.05 k Ω	1/2 W	Prec	1/4 %

Resistors (Cont)

Ckt. No.	Tektronix Part No.	Description	S/N Range
R20	301-0151-00	150 Ω	$\frac{1}{2}$ W
R21	321-0613-00	5.03 k Ω	$\frac{1}{8}$ W
R22	302-0104-00	100 k Ω	$\frac{1}{2}$ W
R25	316-0151-00	150 Ω	$\frac{1}{4}$ W
R26	316-0151-00	150 Ω	$\frac{1}{4}$ W
R30	311-0052-00	300 Ω	Var
R32	302-0222-00	2.2 k Ω	$\frac{1}{2}$ W
R33	308-0062-00	3 k Ω	5 W
R34	301-0821-00	820 Ω	$\frac{1}{2}$ W
R39	305-0432-00	4.3 k Ω	2 W
R40	311-0006-00	1 k Ω	Var
R41	304-0471-00	470 Ω	1 W
R43	Use 301-0153-00	15 k Ω	$\frac{1}{2}$ W
R44	322-0097-00	100 Ω	$\frac{1}{4}$ W
R45	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R46	316-0273-00	27 k Ω	$\frac{1}{4}$ W
R52	315-0220-00	22 Ω	$\frac{1}{4}$ W
R53	Use 301-0153-00	15 k Ω	$\frac{1}{2}$ W
R54	321-0122-00	182 Ω	$\frac{1}{8}$ W
R54	321-0152-00	374 Ω	$\frac{1}{8}$ W
R55	316-0102-00	1 k Ω	$\frac{1}{4}$ W
R56	316-0273-00	27 k Ω	$\frac{1}{4}$ W
R62 ¹	Use 311-0007-00	1 k Ω	Var
R61	316-0105-00	1 M Ω	$\frac{1}{4}$ W
R63	302-0332-00	3.3 k Ω	$\frac{1}{2}$ W
R64	323-0633-00	801 Ω	$\frac{1}{2}$ W
R65	321-0289-00	10 k Ω	$\frac{1}{8}$ W
R66	321-0068-00	49.9 Ω	$\frac{1}{8}$ W
R67	321-0189-00	909 Ω	$\frac{1}{8}$ W
R68	321-0289-00	10 k Ω	$\frac{1}{8}$ W
R69	302-0225-00	2.2 M Ω	$\frac{1}{2}$ W
R72 ¹	Use 311-0007-00	1 k Ω	Var
R74	323-0633-00	801 Ω	$\frac{1}{2}$ W
R76	321-0068-00	49.9 Ω	$\frac{1}{8}$ W
R78	321-0289-00	10 k Ω	$\frac{1}{8}$ W
R79	302-0225-00	2.2 M Ω	$\frac{1}{2}$ W
R80A	Use 315-0104-00	100 k Ω	$\frac{1}{4}$ W
R80B	Use 315-0104-00	100 k Ω	$\frac{1}{4}$ W
R80C	Use 315-0104-00	100 k Ω	$\frac{1}{4}$ W
R80D	Use 315-0104-00	100 k Ω	$\frac{1}{4}$ W
R81	Use 301-0433-00	43 k Ω	$\frac{1}{2}$ W
R81	324-0306-00	15 k Ω	1 W
R82	311-0152-00	2 x 500 k Ω	Var
R83	302-0225-00	2.2 M Ω	$\frac{1}{3}$ W
R84	302-0105-00	1 M Ω	$\frac{1}{2}$ W

¹R62 and R72 furnished as a unit.

Resistors (Cont)

Ckt. No.	Tektronix Part No.	Description		S/N Range		
R85	323-0368-00	66.5 k Ω	1/2 W	Prec	1%	
R86	323-0396-00	130 k Ω	1/2 W	Prec	1%	
R87	301-0151-00	150 Ω	1/2 W		5%	
R88	302-0221-00	220 Ω	1/2 W			
R89	301-0202-00	2 k Ω	1/2 W		5%	
R90	302-0154-00	150 k Ω	1/2 W			
R91	301-0164-00	160 k Ω	1/2 W		5%	
R92	301-0224-00	220 k Ω	1/2 W		5%	
R93	301-0204-00	200 k Ω	1/2 W		5%	
R94	306-0333-00	33 k Ω	2 W			
R95	301-0204-00	200 k Ω	1/2 W		5%	
R96	301-0224-00	200 k Ω	1/2 W		5%	
R97	301-0164-00	160 k Ω	1/2 W		5%	
R98	306-0333-00	33 k Ω	2 W			
R99	301-0471-00	470 Ω	1/2 W		5%	
R100	303-0333-00	33 k Ω	1 W		5%	
R101	301-0184-00	180 k Ω	1/2 W		5%	
R102	302-0564-00	560 k Ω	1/2 W			
R104	301-0155-00	1.5 M Ω	1/2 W		5%	
R106	304-0224-00	220 k Ω	1 W			
R107	308-0024-00	15 k Ω	10 W	WW	5%	
R109	308-0108-00	15 k Ω	5 W	WW	5%	100-199
R109	Use 308-0093-00	12 k Ω	8 W	WW	5%	200-up
R110	308-0044-00	3.8 k Ω	25 W	WW	5%	
R111	306-0822-00	8.2 k Ω	2 W		5%	
R112	308-0059-00	2.25 k Ω	10 W	WW	5%	
R116	308-0018-00	2.5 k Ω	10 W	WW	5%	
R121	324-0603-00	27.8 k Ω	1 W	Prec	1%	100-1719X
R122	308-0025-00	20 k Ω	10 W	WW	5%	100-199
R122	308-0027-00	30 k Ω	10 W	WW	5%	200-up
R123	*312-0642-00	500 Ω	20 W	WW	1%	
R124	301-0623-00	62 k Ω	1/2 W		5%	
R125	303-0433-00	43 k Ω	1 W		5%	

Switches

	Unwired	Wired			
SW10A	260-0610-00	*262-0644-00	Rotary	TEST FUNCTION	
SW10B	260-0598-00	*262-0639-00	Rotary	TEST FUNCTION	
SW50	260-0599-00	Use *262-0638-01	Rotary	REPETITION RATE	100-3994
SW50	260-1049-00	*262-0638-02	Rotary	REPETITION RATE	3995-up
SW120	260-0247-00		Push-Button	+225 V	

Transformer

T110	*120-0286-00	Toroid	2 turns, Bifilar
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Electron Tubes

V95	154-0039-00	12AT7
V102	154-0016-00	6AL5

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.

SECTION 7

MECHANICAL PARTS LIST

FIG. 1 EXPLODED VIEW

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † Y	Description
		Eff	Disc		
1-1	352-0002-00			1	ASSEMBLY, fuse holder
	- - - - -			-	assembly includes:
	352-0010-00			1	HOLDER, fuse
-2	200-0582-00			1	CAP, fuse, black
-3	210-0873-00			1	WASHER, rubber, 1/2 ID x 1 1/16 inch OD
-4	- - - - -			1	NUT
-5	260-0247-00			1	SWITCH, pushbutton—+225 V
	- - - - -			-	mounting hardware: (not included w/switch)
-6	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
-7	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-8	136-0140-00			1	SOCKET, banana jack
	- - - - -			-	mounting hardware: (not included w/socket)
	210-0895-00			1	WASHER, insulating, charcoal (not shown)
-9	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
-10	210-0465-00			1	NUT, hex., 1/4-32 x 3/8 x 3/32 inch
-11	366-0220-00			1	KNOB, charcoal—VERTICAL POSITION
	- - - - -			-	knob includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch, HSS
-12	- - - - -			2	RESISTOR, variable
	- - - - -			-	mounting hardware for each: (not included w/resistor)
-13	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD, SE
-14	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 1 1/16 inch OD
-15	210-0840-00			1	WASHER, flat, 0.390 ID x 7/16 inch OD
-16	210-0590-00			1	NUT, hex., 3/8-32 x 7/16 inch
-17	333-0791-00	100	499	1	PANEL, front, TU7
	333-0875-00	500	1386	1	PANEL, front, 1M1
	333-0875-01	1387	3994	1	PANEL, front, 067-0521-00
	333-0875-02	3995		1	PANEL, front, 067-0521-01
-18	366-0220-00			1	KNOB, charcoal—VARIABLE
	- - - - -			-	knob includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch, HSS
-19	366-0220-00			1	KNOB, charcoal—REPETITION RATE
	- - - - -			-	knob includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch, HSS
-20	262-0638-00	100	1409	1	SWITCH, wired—REPETITION RATE
	262-0638-01	1410	3994	1	SWITCH, wired—REPETITION RATE
	262-0638-02	3995		1	SWITCH, wired—REPETITION RATE
	- - - - -			-	switch includes:
	260-0599-00	100	3994	1	SWITCH, unwired
	260-1049-00	3995		1	SWITCH, unwired
	- - - - -			-	mounting hardware: (not included w/switch)
-21	210-0840-00			1	WASHER, flat, 0.390 ID x 7/16 inch OD
-22	210-0590-00			1	NUT, hex., 3/8-32 x 7/16 inch
-23	366-0117-00			1	KNOB, charcoal—TEST FUNCTION
	- - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS

FIG. 1 EXPLODED VIEW (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y	1	2	3	4	5	Description
1-24	262-0644-00			1						SWITCH, wired—TEST FUNCTION
	- - - - -			-						switch, includes:
	260-0610-00			1						SWITCH, unwired
	- - - - -			-						mounting hardware: (not included w/switch)
-25	210-0840-00			1						WASHER, flat, 0.390 ID x $\frac{9}{16}$ inch OD
-26	210-0413-00			1						NUT, hex., $\frac{3}{8}$ -32 x $\frac{1}{2}$ inch
-27	262-0639-00			1						SWITCH, wired—FUNCTION
	- - - - -			-						switch includes:
	260-0598-00			1						SWITCH, unwired
	- - - - -			-						mounting hardware: (not included w/switch)
-28	210-0012-00			1						LOCKWASHER, internal, $\frac{3}{8}$ ID x $\frac{1}{2}$ inch OD
-29	210-0840-00			1						WASHER, flat, 0.390 ID x $\frac{9}{16}$ inch OD
-30	210-0413-00			1						NUT, hex., $\frac{3}{8}$ -32 x $\frac{1}{2}$ inch
-31	210-0586-00			1						NUT, keps, 4-40 x $\frac{1}{4}$ inch
-32	406-0998-00			1						BRACKET, switch mounting
	- - - - -			-						mounting hardware: (not included w/switch)
-33	210-0457-00			2						NUT, keps, 6-32 x $\frac{5}{16}$ inch
-34	376-0007-00			1						COUPLING
	- - - - -			-						coupling includes:
	213-0005-00			2						SCREW, set, 8-32 x $\frac{1}{8}$ inch, HSS
-35	131-0106-00			1						CONNECTOR, coaxial, 1 contact, BNC, w/hardware
-36	366-0220-00			1						KNOB, charcoal—AMPLITUDE
	- - - - -			-						knob includes:
	213-0020-00			1						SCREW, set, 6-32 x $\frac{1}{8}$ inch, HSS
-37	- - - - -			3						RESISTOR, variable
	- - - - -			-						mounting hardware for each: (not included w/resistor)
-38	210-0840-00			1						WASHER, flat, 0.390 ID x $\frac{9}{16}$ inch OD
-39	210-0413-00			1						NUT, hex., $\frac{3}{8}$ -32 x $\frac{1}{2}$ inch
-40	366-0125-00			1						KNOB, securing
	- - - - -			-						knob includes:
	213-0004-00			1						SCREW, set, 6-32 x $\frac{3}{16}$ inch, HSS
-41	210-0894-00			1						WASHER, plastic, 0.190 ID x $\frac{7}{16}$ inch OD
-42	384-0510-00			1						ROD, securing
	- - - - -			-						rod includes:
-43	354-0025-00			1						RING, retaining
-44	- - - - -			1						RESISTOR
	- - - - -			-						mounting hardware: (not included w/resistor)
-45	212-0037-00			1						SCREW, 8-32 x $1\frac{3}{4}$ inch, Fil HS
-46	210-0809-00	100	4199	1						WASHER, centering
	210-0808-00	4200		1						WASHER, centering
-47	210-0462-00			1						NUT, hex., 8-32 x $\frac{1}{2}$ inch
-48	212-0004-00			1						SCREW, 8-32 x $\frac{5}{16}$ inch, PHS
-49	- - - - -			4						RESISTOR
	- - - - -			-						mounting hardware for each: (not included w/resistor)
-50	211-0553-00			1						SCREW, 6-32 x $1\frac{1}{2}$ inch, RHS
-51	210-0601-00			1						EYELET
-52	210-0478-00			1						NUT, hex., $\frac{5}{16}$ x $2\frac{1}{32}$ inch long
-53	211-0507-00			1						SCREW, 6-32 x $\frac{5}{16}$ inch, PHS

FIG. 1 EXPLODED VIEW (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y						Description
					1	2	3	4	5	
1-54	- - - - -			1						RESISTOR
-55	212-0037-00			-						mounting hardware: (not included w/resistor)
-56	210-0808-00			1						SCREW, 8-32 x 1 ³ / ₄ inch, Fil HS
-57	210-0462-00			1						WASHER, centering
	210-0228-00			1						NUT, hex., 8-32 x 1 ¹ / ₂ inch
-58	212-0004-00			1						LUG, solder, SE #8, long (not shown)
				1						SCREW, 8-32 x 5 ⁵ / ₁₆ inch, PHS
-59	136-0008-00			1						SOCKET, tube, 7 pin, w/ground lugs
-60	213-0044-00			-						mounting hardware: (not included w/socket)
				2						SCREW, thread forming, 5-32 x 3 ³ / ₁₆ inch, PHS
-61	136-0015-00			1						SOCKET, tube, 9 pin, w/ground lugs
-62	213-0044-00			-						mounting hardware: (not included w/socket)
				2						SCREW, thread forming, 5-32 x 3 ³ / ₁₆ inch, PHS
-63	136-0181-00			1						SOCKET, transistor, 4 pin
-64	354-0234-00			-						mounting hardware: (not included w/socket)
				1						RING, socket mounting
-65	348-0006-00			1						GROMMET, rubber, 3 ³ / ₄ inch
-66	210-0201-00			3						LUG, solder, SE #4
-67	213-0044-00			-						mounting hardware for each: (not included w/lug)
				1						SCREW, thread forming, 5-32 x 3 ³ / ₁₆ inch, PHS
-68	131-0017-00			1						CONNECTOR, 16 contact
-69	211-0008-00			-						mounting hardware: (not included w/connector)
-70	210-0201-00			2						SCREW, 4-40 x 1 ¹ / ₄ inch, PHS
-71	210-0406-00			2						LUG, solder, SE #4
				2						NUT, hex., 4-40 x 3 ³ / ₁₆ inch
-72	384-0508-00	100	319	4						ROD, frame, 3 ³ / ₈ x 8 ⁷ / ₈ inches
	384-0631-00	320		4						ROD, spacer, 0.375 diameter x 8 ⁷ / ₈ inches
-73	212-0044-00			-						mounting hardware: (not included w/rod)
				1						SCREW, 8-32 x 1 ¹ / ₂ inch, RHS
-74	670-0202-00			1						ASSEMBLY, circuit board
	388-0592-00			-						assembly includes:
-75	344-0064-00	100	499	1						BOARD, circuit
	344-0108-00	500		8						CLIP, diode
-76	136-0150-00	100	559	8						CLIP, diode
	136-0183-00	560		4						SOCKET, transistor, 3 pin
				4						SOCKET, transistor, 3 pin
-77	211-0008-00	100	1369	-						mounting hardware: (not included w/assembly)
	211-0116-00	1370		6						SCREW, 4-40 x 1 ¹ / ₄ inch, PHS
-78	210-0586-00			6						SCREW, sems, 4-40 x 5 ⁵ / ₁₆ inch, PHS
				6						NUT, keps, 4-40 x 1 ¹ / ₄ inch

FIG. 1 EXPLODED VIEW (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q t y	1	2	3	4	5	Description
1-79	387-0901-00			1						PLATE, rear
-80	441-0542-00			1						CHASSIS
	- - - - -			-						mounting hardware: (not included w/chassis)
	211-0538-00			3						SCREW, 6-32 x 5/16 inch, 100° csk, FHS (not shown)
-81	211-0504-00			3						SCREW, 6-32 x 1/4 inch, PHS
-82	387-0900-00			1						PLATE, sub-panel, front
-83	179-0850-00			1						CABLE HARNESS, chassis
-84	179-0851-00			1						CABLE HARNESS, switch
-85	124-0148-00			2						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, 0.406 inch long
-86	124-0145-00			4						STRIP, ceramic, 7/16 inch h, w/9 notches
	- - - - -			-						each strip includes:
	355-0046-00			2						STUD, plastic
	- - - - -			-						mounting hardware for each: (not included w/strip)
	361-0009-00			2						SPACER, plastic, 0.406 inch long

STANDARD ACCESSORIES

070-0407-02

2 MANUAL, instruction (not shown)

WAVEFORMS and VOLTAGE READINGS were obtained under following conditions:		
CONTROLS	SETTINGS	
VARIABLE	centered	
VERTICAL POSITION	centered	
AMPLITUDE	fully counterclockwise	
REPETITION RATE	80 kHz or MED	
Input Signal	none	
TEST FUNCTION	Pulse Gen. ckt.	All other ckts.
	+ PULSE	CHOPPED
Test Oscilloscope Bandpass	30 MHz	
DC Voltmeter Impedance	20,000 Ω /volt	



④

FIG. 1 FRONT

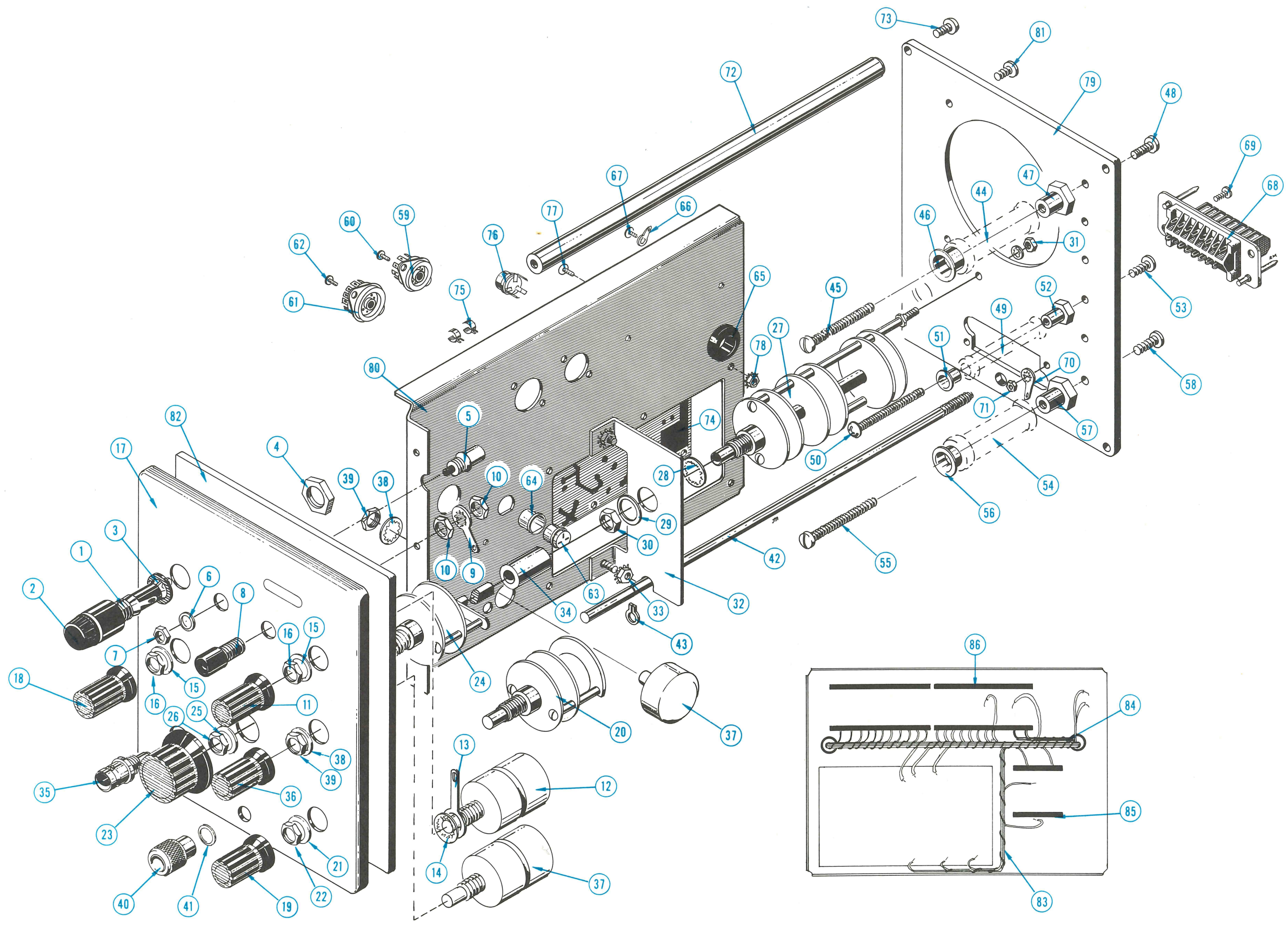


FIG. 1

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.

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

D64	152-0463-00	Schottky Barrier matched pair		
D65				
D74	152-0463-00	Schottky Barrier matched pair		
D75				
R63	301-0152-00	1.5 k Ω	1/2 W	5%

ADD:

D70	152-0185-00	Silicon	Replaceable by 1N4152	
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