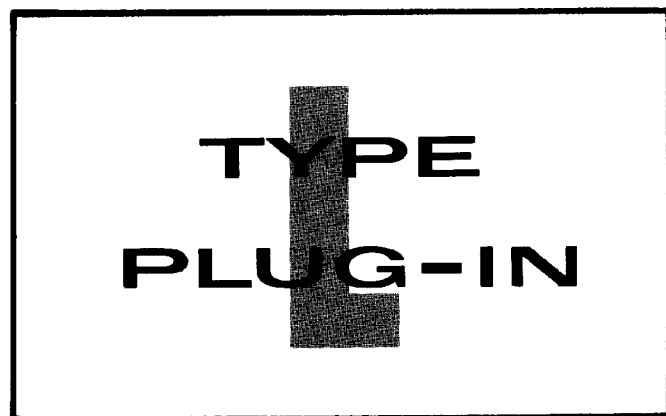


INSTRUCTION MANUAL

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Tektronix, Inc.

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070-336



WARRANTY


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

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

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

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**TYPE L
PLUG-IN UNIT**

SERIAL 401075



INPUT
1 MEG. 20 μF



VARIABLE
VOLTS/CM



**VERTICAL
POSITION**



**FAST-RISE
CALIBRATED PREAMP**
.05-20 V/CM AC/DC COUPLED
PREAMP RISETIME = .006 μSEC
.005-2 V/CM AC COUPLED
PREAMP RISETIME = .01 μSEC

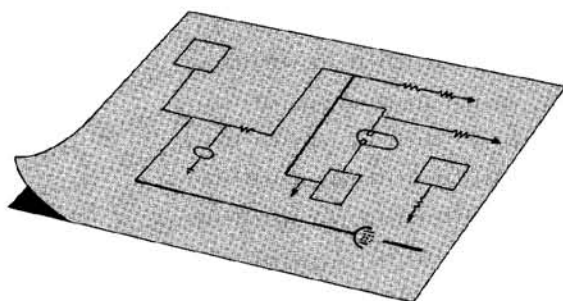


TEKTRONIX, INC.

PORTLAND, OREGON, U.S.A.

SECTION 1

CHARACTERISTICS



General Information

The Type L Plug-In is a fast-rise, high gain, calibrated preamplifier designed for use with the Tektronix 530-, 540-, 550- and *580-Series oscilloscopes. The unit contains a fast-rise dc amplifier similar to the Type K Plug-

In Unit, plus a fast-rise high-gain ac amplifier which may be used to increase the sensitivity by a factor of 10.

This instrument was adjusted at the factory for best transient response. The L Unit alone has a risetime of 6 nanoseconds in AC or

TABLE 1-1. TRANSIENT RESPONSE AND BANDPASS

Type L Unit with Oscilloscope Type:	AC-DC switch	RISETIME in nanoseconds**		BANDPASS		
		AC or DC	X10 GAIN AC	DC	AC	X10 GAIN AC
532		70	70	DC to 5MC	3cps to 5MC	3cps to 5MC
541/541A 543/543A 545/545A 555		12	14	DC to 30MC	3cps to 30MC	3cps to 24MC
531/531A 533/533A 535/535A		23	32	DC to 15MC	3cps to 15MC	3cps to 11MC
*581 *585		12	14	DC to 30MC	3cps to 30MC	3cps to 24MC
551		14	16	DC to 25MC	3cps to 25MC	3cps to 22MC
536		32	35	DC to 11MC	3cps to 11MC	3cps to 10MC

With X10 probes (Types P6017, P6000, P510, P410) minimum AC response is reduced to 0.3 cps.

*Type 81 Plug-In adaptor must be used with the 580-Series Oscilloscopes.

**Nanoseconds are 10^{-9} seconds.

DC and 10 nanoseconds in X10 GAIN AC. Table 1-1 summarizes risetimes and frequency responses available when the L Unit is used in combination with various types of Tektronix oscilloscopes.

Vertical Deflection Factors

AC or DC position of AC-DC switch: 0.05 to 20 volts per centimeter in nine calibrated steps; also continuously variable (uncalibrated) between steps, and up to 50 volts per centimeter.

X10 GAIN AC position of AC-DC switch: 0.005 to 2 volts per centimeter in nine calibrated steps; also continuously variable (uncalibrated) between steps, and up to 5 volts per centimeter.

Step Attenuator (VOLTS/CM switch) Accuracy

Within 3% of front-panel reading for all positions of VOLTS/CM switch.

Input Impedance Characteristics

Type L Plug-In Unit: 1 Megohm shunted by 20 picofarads.

Type P6017 Probe: 10 Megohms shunted by 14 picofarads.

Type P6000 Probe: 10 Megohms shunted by 11.5 picofarads.

Type P510 Probe: 10 Megohms shunted by 14 picofarads.

Type P410 Probe: 10 Megohms shunted by 8 picofarads.

Maximum Allowable Combined DC and Peak AC Input

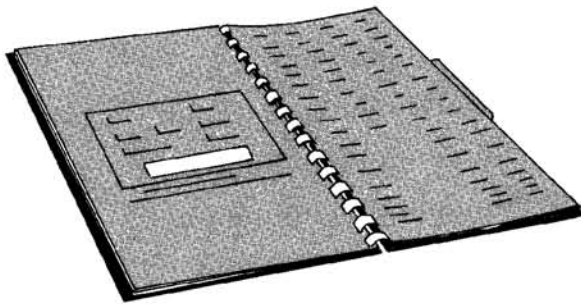
600 volts, ac-coupled.

Mechanical

Construction: Aluminum-alloy chassis.

Finish: Photoetched, anodized front panel.

Weight: Approximately 5 pounds.



SECTION 2

OPERATING INSTRUCTIONS

Markings and Functions of Controls

The functions of the controls should be understood before operating the L Unit. This section of the Instruction Manual is intended to aid in initially putting the instrument into operation and to serve as a brief reference guide. Figure 2-1 shows the front-panel controls, connectors and adjustments of the Type L Plug-In Unit and describes their functions.

In this Manual, control and adjustment markings are given as printed on the instruments, with fully capitalized words used for front-panel markings, and first-letters capitalized for names of internal adjustments. Examples: VERTICAL POSITION control; H.F. Peaking control.

On the front panel of the L Unit, red markings are related to the red VARIABLE knob, blue and black markings are related to the black knobs. The black-numbered scale around the VOLTS/CM switch is used when the AC-DC switch is in AC or DC position, and the blue scale is used when the AC-DC switch is in X10 GAIN AC position.

In the following procedures, oscilloscope controls are called by the names usually applied to them on the scopes with which the Type L Unit can be used. Alternate names for the controls are given in parentheses.

First-Time Operation

To set the oscilloscope/Type L Plug-In Unit combination in operation for the first time the following procedure is suggested:

1. Insert the Type L Unit into the plug-in compartment of the oscilloscope and tighten it with the securing rod.

2. Set the front-panel controls as follows (controls not mentioned may be in any position):

Oscilloscope:

POWER	off
INTENSITY	fully counter-clockwise
HORIZONTAL DISPLAY	NORMAL ("A", INTERNAL SWEEP)
MAGNIFIER (5X MAG.)	OFF

Main Sweep Controls:

TIME/CM	.5 MILLISEC
VARIABLE, TIME/CM	CALIBRATED, fully clockwise
TRIGGER SLOPE	-INT. (-)
TRIGGERING MODE (TRIGGERING SOURCE)	AC (AC SLOW) (INT.)
STABILITY	fully clockwise
TRIGGERING LEVEL	fully clockwise

Type L Plug-In Unit:

AC-DC	DC
VOLTS/CM	.05 (black numbers)
VARIABLE, VOLTS/CM	CALIBRATED, fully clockwise

3. Connect the power cord to the instrument and to the source of power.

4. Turn ON the POWER switch. Allow a minute for the filaments to heat and the time-delay relay to operate.

5. Before increasing the intensity, center the trace vertically with the VERTICAL POSITION control, using the Beam Indicator neons of the oscilloscope as a guide. (When both vertical

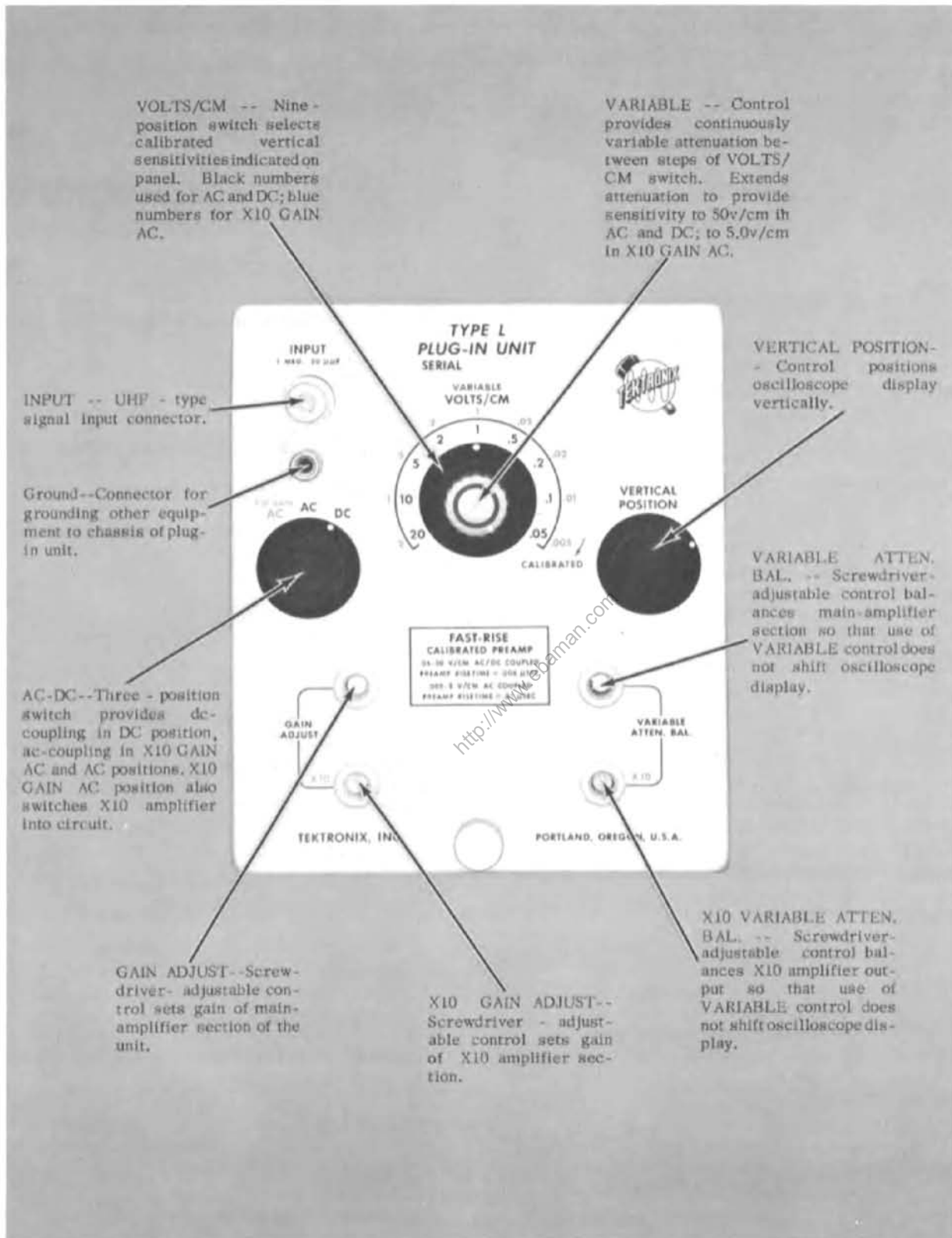


Fig. 2-1. Functions of front-panel controls and connectors of the Type L Plug-In Unit.

Beam Indicator neons are unlit, the trace is approximately centered.

6. Rotate the INTENSITY control clockwise until the free-running trace appears on the crt. Center the trace with the vertical and horizontal positioning controls.

7. Adjust the FOCUS, ASTIGMATISM and INTENSITY controls to obtain a sharp trace with adequate intensity.

8. Let the instrument warm up for at least 15 minutes before making any adjustment changes or accurate observations.

Variable Attenuator Balance Adjustment

The need for adjustment of the VARIABLE ATTEN. BAL. control is indicated by a vertical shift in the position of the trace as the VARIABLE (VOLTS/CM) control is rotated.

The Type L Unit has a separate VARIABLE ATTEN. BAL. control for each of the two amplifiers in the unit. The main amplifier section VARIABLE ATTEN. BAL. control adjusts the dc balance between the two outputs of the amplifier. The X10 VARIABLE ATTEN. BAL. control adjusts the dc level of the X10 amplifier output to match that of the First Cathode Follower, so that the trace position will not shift when changing from X10 GAIN AC to either of the other positions of the AC-DC switch. Check these adjustments in the following order:

1. Set the front panel controls as previously listed. With no signal applied to the INPUT of the plug-in unit, freerun the trace with the STABILITY and TRIGGERING LEVEL controls fully clockwise. Set the AC-DC switch at AC. Turn the VARIABLE control back and forth, watching the crt for a shift in position of the trace. If the trace moves when the control is rotated, adjust the upper VARIABLE ATTEN. BAL. control until the trace position is no longer affected by the VARIABLE control.

2. Turn the AC-DC switch to X10 GAIN AC. Check the dc balance of the X10 amplifier by rotating the VARIABLE control back and forth. If the trace moves, adjust the X10 VARIABLE ATTEN. BAL. control until rotation

of the VARIABLE control no longer affects the position of the trace. Return the VARIABLE control to the CALIBRATED position, fully clockwise.

Checking Gain Adjustment

Adjustment of the vertical gain should be checked frequently. Aging of tubes and other components causes a slight change in the gain characteristics of the plug-in. In order to make correct voltage measurements, adjustment of the gain must be correct.

The Type L Unit has two screwdriver adjustments on the front panel for setting gain--one for each amplifier in the unit. Checking the gain is done in two steps:

1. With the oscilloscope and L Unit controls positioned as above, set the oscilloscope CALIBRATOR output for .2 VOLTS. Be sure the VARIABLE (VOLTS/CM) is in CALIBRATED position. Connect a lead from the output connector of the CALIBRATOR to the INPUT connector of the Type L Unit. Adjust the STABILITY and TRIGGERING LEVEL controls of the oscilloscope for a stable display of the CALIBRATOR square wave. The peak-to-peak vertical deflection should be exactly four major graticule divisions (4cm). If incorrect, adjust the upper GAIN ADJUST control with a small screwdriver to obtain the proper amplitude.

2. With all other controls positioned as in the previous step, turn the CALIBRATOR to 20 MILLIVOLTS and set the AC-DC switch in the X10 GAIN AC position. Adjust the STABILITY and TRIGGERING LEVEL controls to obtain a stable square-wave display. Check the waveform for exactly 4 major graticule divisions (4cm) of vertical deflection. If the amplitude is not correct, adjust the X10 GAIN ADJUST control until exactly 4 cm peak-to-peak is observed. Remove the lead from the L Unit INPUT.

INPUT Coupling

For measurement of dc voltage levels or signal -to-ground voltages, it is necessary to have dc-coupling throughout the measuring instrument. With the AC-DC switch in DC position, the oscilloscope/Type L Unit combination is dc-coupled throughout.

However, it is often neither necessary nor desirable to display the dc component of the input waveform. A capacitor which is in series with the INPUT connector blocks the dc component when the AC-DC switch is in either the AC or the X10 GAIN AC position. This permits viewing of the ac part of a large input signal, as well as detailed viewing of the ac part of any signal having a dc component.

Connecting to the Signal Source

Stray electric and magnetic fields picked up by unshielded connecting cables often change the appearance of displayed waveforms. This type of distortion occurs even in the audio-frequency range, except possibly when making measurements of low-impedance circuits. In general, unshielded leads of appreciable length are not suitable for connecting the input signal to the plug-in INPUT. Shields of leads used should be grounded to the chassis of the instrument in use. Coaxial cables are recommended for most purposes.

In broadband applications, it is usually necessary to terminate a coaxial cable with a resistor which presents a resistance equal to the characteristic impedance of the cable. This prevents the production of high-frequency damped oscillation. As the length of the cable is increased it becomes more important to properly terminate the cable. The termination is placed at the oscilloscope end of the cable, although many sources require an additional termination at the source end as well.

For large amplitude signals an attenuator may be included in the connective system to provide an oscilloscope display having a more desirable amplitude than would be possible with no attenuation. Cables, attenuators and terminating resistors are listed in the Accessories section of any Tektronix oscilloscope Instruction Manual.

When checking the instruments, actual operating conditions should be simulated as nearly as possible. For example, the oscilloscope should work into a load impedance similar to that which it encounters in actual use.

The input circuit of the plug-in may sometimes produce loading of the signal source. At the INPUT connector of the Type L, the impedance of the input circuit is equivalent to

a resistance of 1 Megohm shunted with a capacitance of 20 picofarads. With a few feet of shielded cable, the capacitance may well be increased to 100 picofarads. Where the effects of these resistive and capacitive loads is significant, a probe may be used to introduce the input signal.

Use of Probes

An attenuator probe reduces both capacitive and resistive loading of the signal source and decreases apparent sensitivity of the oscilloscope. Attenuation by the probe permits observation and measurement of signal voltages in excess of those that can be accepted by the preamplifier alone.

The 10X probes (P6017, P6000, P510A, P410) supplied with the oscilloscopes accepting letter-series plug-ins may all be used with the L Unit. Input characteristics of these probes are listed in the Characteristics section of this Manual. Maximum voltage which may be applied to the probes is 600 volts dc-plus-peak-ac. Exceeding this limit may result in damage to the components inside the probe. The P510A Probe can be used only from DC to 50MC, due to the tendency for the probe to ring at 50MC and above.

If the displayed waveform contains high-frequency portions, it is generally necessary to clip the probe ground lead to the chassis of the equipment being checked.

Before using a probe, check its adjustment. An adjustable capacitor in the body of the probe is used to compensate for differences between input capacitances of various instruments. To insure the accuracy of pulse and waveform measurements, the probe adjustment should be checked when changing oscilloscopes, and occasionally when used with any scope.

Probe Compensation

To adjust the compensation of the probe to the instrument combination with which it is to be used, the following procedure is suggested:

1. Set the oscilloscope and plug-in controls as listed above in First-Time Operation. Turn the oscilloscope CALIBRATOR voltage selector to 2 VOLTS. Allow adequate time for the instru-

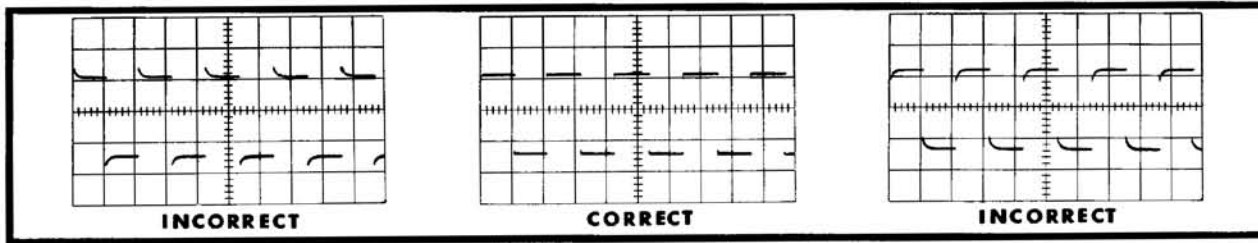


Fig. 2-2. Waveforms for adjustment of probe compensation.

ment to warm up (15 min.) after the POWER has been turned ON.

2. Connect the probe cable to the INPUT connector of the L Unit.
3. Touch the probe tip to the CALIBRATOR output connector and adjust the STABILITY and TRIGGERING LEVEL controls for a stable display of the waveform.
4. Adjust the probe capacitor for a flat top on the square wave. See Figure 2-2 for a display of the waveform. The Instruction Manual for the instrument with which the probe was supplied shows the method of adjusting the particular probe.

Voltage Measurements

Two types of voltage measurements may be made with an oscilloscope/Type L Plug-In Unit combination: (1) peak-to-peak voltage of a displayed waveform, and (2) peak voltage of a waveform with respect to a reference voltage. The following procedures are intended to show general methods, and can be modified to suit any particular application.

In measuring signal amplitudes it is important to remember that the width of the trace may be an appreciable part of the overall measurement. This is particularly true when measuring signals of small amplitude. All measurements should be consistently made from the same part of the trace--the top, center or bottom. If the center of the trace is used for one reading, it should be used for all subsequent readings. Notice that points "a" and "b" in Figure 2-3 correspond to the center of the trace.

Measuring Peak-to-Peak Voltages

To measure the peak-to-peak voltage of a

particular signal, the following method may be used:

1. Set the AC-DC switch at any convenient position. Apply the voltage signal to the INPUT connector by means of the appropriate cable or probe, and necessary terminations and attenuators. Adjust the controls of the oscilloscope and plug-in to display the signal waveform on the crt. Use as large an amplitude as possible without exceeding the size of the graticule. Be sure the VARIABLE (VOLTS/CM) control is in CALIBRATED position.

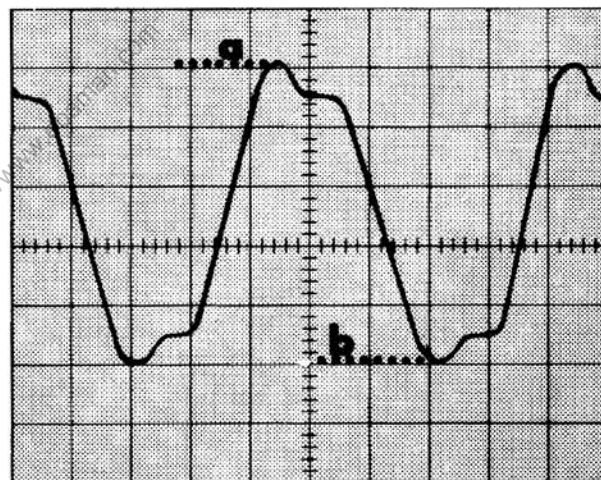


Fig. 2-3. Measurement of peak-to-peak signal amplitude.

2. Using the graticule markings, determine the vertical difference in centimeters (major graticule divisions) between the maximum and minimum peaks of the waveform.
3. Multiply the graticule measurement by the setting of the VOLTS/CM switch. Use the black numbers for AC or DC, and the blue numbers for X10 GAIN AC. This product is the voltage at the INPUT connector.
4. If an attenuator or attenuator probe is used, multiply the input voltage by the total attenuation factor of the connective system.

5. The final number is the voltage difference between the maximum and minimum peaks of the input signal. DEFLECTION x VOLTS/CM x ATTENUATION = VOLTAGE. For example, in Figure 2-3, the vertical deflection between "a" and "b" is 4.0 cm. If the AC-DC switch is at AC, the VOLTS/CM switch at .5 (black numbers), and the signal is applied through a 10X probe, the voltage calculation would be: (4.0 cm) x (0.5 VOLTS/CM) x (10) = 20.0 volts.

Measuring Peak-to-Reference Voltages

It is often desired to measure the voltage of a waveform with respect to some reference voltage, usually ground. This may be done as follows:

1. Set the AC-DC switch at DC position.
2. Connect the appropriate interconnecting cable or probe to the INPUT connector, using the necessary attenuators and terminations.
3. Adjust the controls of the oscilloscope and plug-in for a free-running trace. Be sure the VARIABLE (VOLTS/CM) control is in the CALIBRATED position.
4. Touch the input cable to the oscilloscope ground terminal or to the reference voltage being used. Adjust the VERTICAL POSITION control to set the trace at some convenient reference position such as (b) in Figure 2-4.
5. Without changing the position of any controls of the instrument, remove the cable from the reference voltage (ground) and connect it to the voltage signal source to be measured.

Adjust the oscilloscope triggering controls for a stable display. If the amplitude of the signal is inconveniently large or small, reset the VOLTS/CM switch for a more suitable value and repeat the above procedure.

6. Determine the vertical distance on the oscilloscope graticule between the waveform peak and the original trace position. Recheck the reference level.

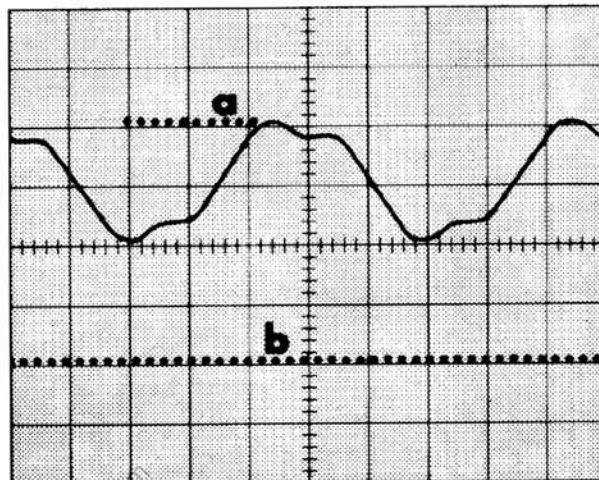
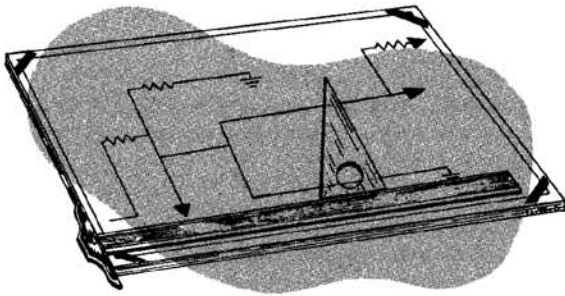


Fig. 2-4. Measurement of peak-to-reference signal level.

7. Calculate the dc voltage level in the same manner as peak-to-peak voltage is calculated: DEFLECTION x VOLTS/CM x ATTENUATION = VOLTAGE. For example, in Figure 2-4 the vertical distance between "a" and "b" is 4 cm. If the reference voltage is ground, the VOLTS/CM switch is set at .2 and the total attenuation ratio of the connecting system is 15:1, the voltage calculation would be: (4cm) x (0.2 VOLTS/CM) x (15) = 12 volts above ground, or +12 volts.

SECTION 3

CIRCUIT DESCRIPTION



General

The Type L Plug-In Unit is a fast-rise preamplifier incorporating a fast-rise high-gain ac amplifier and a fast-rise dc amplifier. Maximum ac sensitivity is 0.005 volt per centimeter, and maximum dc sensitivity is 0.05 volt per centimeter.

The main amplifier of the Type L Unit consists of a Phase Inverter Stage which produces X2 amplification, preceded and followed by cathode followers. When the AC-DC switch is in X10 GAIN AC position, a X10 amplifier is placed in cascade with the main amplifier of the unit.

Input Circuit

Either ac- or dc-coupling from the signal source may be selected with the AC-DC switch, SW5002. In DC position, the signal is coupled straight through to the VOLTS/CM switch. In AC or X10 GAIN AC the signal passes to the VOLTS/CM switch through a blocking capacitor, C5002, which removes the dc component. In addition, the X10 GAIN AC position switches the X10 amplifier into the circuit and increases and decouples the voltage on the screen of the Input Cathode Follower.

The VOLTS/CM switch, SW5052, inserts frequency-compensated attenuators into the input circuit. The nine-step attenuator has voltage-attenuation ratios of 1X, 2X, 4X, 10X, 20X, 40X, 100X, 200X, and 400X, to produce deflection factors of .005, .01, .02, .05, .1, .2, .5, 1, and 2 volts per centimeter in X10 GAIN AC and .05, .1, .2, .5, 1, 2, 5, 10 and 20 volts per centimeter in AC or DC. When the attenuators are properly adjusted, the effective resistance and capacitance at the INPUT connector remain unchanged as the attenuators are switched in the circuit.

The attenuators are frequency-compensated voltage dividers. At low frequencies, the capacitors have a high impedance and their effect in the circuit is negligible--the attenuators act as resistive dividers with the attenuation being proportional to the ratio of the resistances. As the frequency of the input signal is increased, however, the impedance of the capacitors decreases and their effect in the circuit becomes more pronounced. For high-frequency signals, the impedance of the capacitors is low in comparison to the resistance of the circuit, and the attenuators become capacitive voltage dividers. For these frequencies, the degree of attenuation is inversely proportional to the ratio of the capacitances. A variable capacitor in each attenuator provides a method for adjusting the capacitance.

Each attenuator network has a variable capacitor for adjusting the input capacitance to a standard value of 20 pf at the INPUT connector for all positions of the VOLTS/CM switch. C5732 in the grid circuit of V5832 is used to standardize the unit with the X1 network switched into the circuit. The trimmer capacitor at the input of each of the other attenuator networks adjusts the input capacitance of the attenuator to the standard value.

Frequency compensation of each attenuator network is provided by the trimmer capacitor near the attenuator output.

Input Cathode Follower

The First Cathode Follower, V5832 provides isolation between the input circuitry and the amplification circuits. It prevents changes in the amplifier from changing the input characteristics of the plug-in, and it prevents changes in the source or attenuator switching from affecting the operation of the amplifiers.

The screen grid of the First Cathode Follower is at +100 volts with only the main amplifier of the unit in operation. When the X10 Amplifier is switched into the circuit, the voltage on the screen is increased and decoupled through the decoupling network, R5802 and C5802. This serves to protect the X10 Amplifier from any slight variations which may be present in the power supply.

X10 Amplifier

The X10 ac-coupled amplifier consists of two stages of amplification, V5942 and V6042, and a cathode-follower output stage, V6132. The X10 GAIN ADJUST which controls the amount of degeneration in the cathode circuit of V6042 is a front-panel screwdriver adjustment. This control regulates the gain of the X10 Amplifier to adjust for changes which take place in the components. For calibrated operation it is set for a gain of ten.

High-frequency compensation for the X10 amplifier is provided by the series-shunt peaking coils L5942 and L6012, and by the series peaking coils L5902 and L6112. The variable inductors, L5902, L5942 and L6012, provide a means for adjusting the circuits for optimum high-frequency response.

Low-frequency peaking for the X10 amplifier is provided mainly by C6002A and C6002B in the plate circuits of V5942 and V6042. With their associated resistors, these capacitors form a low-frequency "boost" network to compensate for the low-frequency attenuation introduced in the cathode circuits, the screen circuits, and the RC coupling network between the Second Amplifier and the Second Cathode Follower. The amount of capacitance in the circuit is fixed, however the amount of attenuation can be varied with the LOW FREQ. ADJ. control, R6182, in the grid circuit of V6132. By adjusting the attenuation to match the capacitance, low-frequency distortion in the amplifier is eliminated.

A diode is included in the cathode circuit of the First Amplifier, V5942, to protect the electrolytic bypass capacitor, C5972. This capacitor could be damaged if the cathode circuit voltage went highly negative, as when the tube is removed without turning off the power.

For proper operation of the X10 amplifier, it is important that the Second Amplifier, V6042, be operated on a certain portion of its characteristic curve. To allow for slight changes in component values and for tube differences, a V6042 Cathode Current Adj. control, R5922, is provided in the plate circuit of V5942. The function of this adjustment is to set the current through V6042 by adjusting the voltage on its grid. Correct cathode current is indicated by a voltage drop of 55 volts across resistor R6072.

The output voltage of the X10 amplifier must be the same as the output voltage of the First Cathode Follower in order to present the same voltage to the grid of V6242 in the Phase Inverter. This is necessary in order to maintain balance in the main amplifier of the plug-in when switching the X10 amplifier into or out of the circuit. The X10 VARIABLE ATTEN. BAL. control, R6242, in the grid circuit of V6132 is a front-panel screwdriver adjustment which is used to set the bias on the grid of V6132 so that the cathode voltage will have the proper value.

Phase Inverter

The Phase Inverter Stage composed of V6242 and V6342 is a cathode-coupled phase inverter which converts a single-ended input signal into a push-pull output signal and provides a gain of two.

The GAIN ADJUST control (R6392) in the cathode circuit of the Phase Inverter sets the gain of the main amplifier of the plug-in unit to correspond with the front-panel calibration. This control is a front-panel screwdriver adjustment.

The VARIABLE (VOLTS/CM) control, R6352, located between the two cathodes, regulates the gain of the stage over a 2.5-to-one range by varying the amount of degeneration in the cathode circuit. Maximum gain occurs with the control in the CALIBRATED position.

If the no-signal dc voltage levels on the Phase Inverter cathodes are not equal, current will flow through the VARIABLE resistor causing a change in the gain of signals passing through the stage. Voltage on the cathode of V6342 may be adjusted to balance that of V6242, eliminating current through R6352. This is

done with the VARIABLE ATTEN. BAL. control, R6812, which adjusts the voltage on the control grid of V6342, thereby regulating current through the tube and setting the voltage on the cathode. The presence of current through R6352 is easily indicated by rotating the VARIABLE control--if current is present its magnitude will be changed by rotation of the control, producing a shift in the position of the crt trace.

The VERTICAL POSITION control, R6522, and the Vert. Pos. Range control, R6572, provide for vertical positioning of the crt beam. Each of these controls consists of two potentiometers connected between +225 volts and ground. The center tap of one potentiometer of each control is connected to one side of the push-pull circuit, and the center tap of the other is connected to the other side of the circuit. The potentiometers are wired so that as the voltage on one center tap increases, the voltage on the other center tap decreases. Turning these controls increases the dc level on the grid of one Driver Cathode Follower while decreasing the dc level on the grid of the other Driver C.F. Since the following stages are dc-coupled, this change in dc level at the Driver C.F.s

results in a vertical displacement of the crt beam.

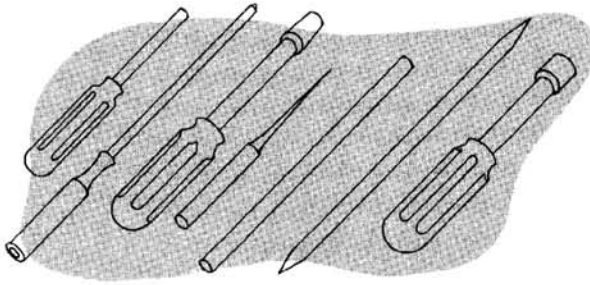
Minimum capacitive loading to the plate circuit of the Phase Inverter Stage is assured by the two sets of cathode followers at the output--the Driver C.F.s, V6732 A and B, and the Output Stage C.F.s, V6632 A and B.

Output Cathode Followers

The Output Cathode Followers provide a low-impedance signal source to drive the circuit capacitance at the plug-in interconnecting socket. This cathode follower circuit is modified by the addition of resistors in the plate circuits and capacitors cross-connected from each plate to the opposite cathode. This configuration improves the high-frequency balance of the unit.

The H. F. Peaking control, R6692 in the cathode circuit of the Output C.F.s varies the current through these tubes. For best high-frequency response, this adjustment matches the impedance of the cathode circuits to the fixed series peaking coils, L6672 and L6772.

SECTION 4



MAINTENANCE

PREVENTIVE MAINTENANCE

The L Unit is a stable instrument, and will require complete calibration very infrequently. However, to be certain that the unit is operating properly at all times, the calibration of the unit should be checked after each 500-hour period of operation (or every six months if the unit is used intermittently). A complete step-by-step procedure for calibrating the unit and checking its operation is given in the Calibration section of this manual.

Visual Inspection

Many potential and existent troubles can be detected by a visual inspection of the unit. For this reason, a complete visual check should be performed every time the unit is inoperative, needs repairs, or needs recalibration. Apparent defects may include loose or broken connections, damaged connectors, improperly seated tubes, scorched or burned parts, and broken terminal strips. The remedy for these troubles is readily apparent except in the case of heat-damaged parts. Damage to parts due to heat is often the result of other less apparent troubles in the unit. It is essential that the cause of overheating be found before replacing the damaged parts.

COMPONENT REPLACEMENT

The procedures for replacing most parts in the L Unit are obvious and detailed instructions are not required. In some cases, additional information will aid in the replacement of parts. This information is given in the following paragraphs. Because of the nature of the instrument, replacement of certain parts will require that portions of the instrument be calibrated for proper operation. Refer to the Calibration section of this manual for the procedures required.

Switches

If a switch is found to be defective and needs to be repaired or replaced, use normal care in unsoldering and disconnecting leads from the terminals.

Single wafers on wafer-type switches are not normally replaced. If a wafer is defective, the entire switch should be replaced. The VOLTS/CM switch may be ordered from the factory either unwired or with parts wired in place, as desired. Refer to the Parts List to find the wired and unwired part numbers.

When soldering leads to a wafer-type switch, do not let solder flow around and beyond the rivet on the switch terminal. The spring tension of the switch contact may be destroyed by excess solder.

Occasionally, wafer switches become erratic because of accumulated dust or other foreign material on the contacts. This condition may be corrected by using one of the cleaning-lubricating products available from electronics parts distributors. Be sure to leave a thin layer of conductive lubricant on the contacts, but no excess. Remove any excess lubricant with a moderate jet of compressed air.

Ceramic Terminal Strips

Two distinct types of ceramic strips have been used in Tektronix instruments. The earlier type mounted on the chassis by means of #2-56 bolts and nuts. The later type is mounted with snap-in plastic fittings. Both styles are shown in Figure 4-1.

When replacing a ceramic terminal strip of the type which bolts onto the chassis, first unsolder all connections, then unscrew the terminal bolt nuts on the reverse side of the

chassis and remove the terminal strip. Screw a #2-56 nut onto each bolt of the new strip, positioning the nut so that the distance between the bottom of the nut and the bottom of the ceramic strip equals the height at which you wish to mount the strip above the chassis. Secure the nuts to the bolts with a drop of red lacquer. Insert the bolts through the holes in the chassis where the original strip was mounted, placing a #2 starwasher between each nut and the chassis. Place a second set of #2 flatwashers on the protruding ends of the bolts, and fasten them firmly with another set of #2-56 nuts. Place a drop of red lacquer over each of the second set of nuts after fastening.

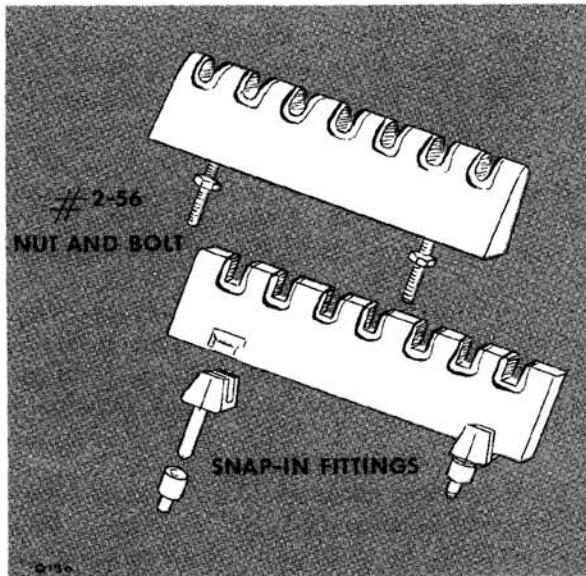


Fig. 4-1. Two types of ceramic strip mountings.

A ceramic terminal strip mounted with snap-in plastic fittings is most easily removed by unsoldering all connections, then using a plastic or hard rubber mallet to tap the mounting clips out of the chassis. This can be done by tapping on the ends of the clips protruding through the reverse side of the chassis. When a new strip is ordered, the mounting clips are furnished with and are attached to the strip. New spacers need not be ordered because the original spacers can be used two or three times before they become too loose to hold the clips securely.

When the damaged strip and clip assembly have been removed, place the spacers for the new strip assembly into the holes in the

chassis. Using a plastic or hard rubber mallet, tap the ceramic strip lightly above the mounting clips to drive the pins down through the spacers. Be certain that the clips are driven down to the spacers. Using a pair of diagonal cutters, cut off the excess length of the mounting clips.

Soldering Precautions

In the production of Tektronix instruments, a special silver-bearing solder is used to establish a bond to the ceramic terminal strips. This bond may be broken by the repeated use of ordinary tin-lead solder, or by the application of too much heat. Occasional use of ordinary solder will not break the bond however, unless too much heat is applied.

If continued maintenance work is to be performed on Tektronix instruments, it is advisable to have a stock of solder containing about 3% silver. This type of solder is often used for work on etched-circuit boards and should be readily available. It may also be purchased directly from Tektronix in one pound rolls (part number 251-514).

Because of the shape of the terminals on the ceramic terminal strips, the soldering iron should have a thin wedge-shaped tip. This allows the heat to be applied directly to the solder in the terminals and reduces the amount of heat required. It is important to use as little heat as it possible. Do not use force or twist the tip of the soldering iron in the terminal slot as this may chip or break the ceramic strip. Apply only enough solder to cover the wires adequately. Do not attempt to fill the notches with solder.

When soldering to terminal pins mounted in plastic, it is necessary to use some form of "heat sink" on the terminal between the soldering iron and the plastic, to avoid damaging the plastic. A pair of long-nosed pliers is convenient for this purpose.

REPLACEMENT PARTS

Standard Parts

Replacement for all parts used in the Type L Unit can be purchased directly from Tektronix at current net prices. Many of the components, however, are standard electronic parts that can generally be obtained locally in less time

than required to obtain them from the factory. Before purchasing a part, be sure to consult the Parts List to determine the tolerances and rating required. The Parts List gives the values, tolerances, ratings, and Tektronix part number of all components used in the instrument.

Special Parts

In addition to the standard electronic components mentioned in the previous paragraph, special parts are also used. These parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured especially for Tektronix by other companies. These parts, indicated by asterisks in the Parts List, and most mechanical parts should be ordered directly from Tektronix since they are normally difficult or impossible to obtain from other sources. All parts may be obtained through your local Tektronix Field Engineering Office.

TROUBLESHOOTING

This portion of the manual will aid you in troubleshooting the L Unit in the event that trouble develops. During troubleshooting work, the information contained in this section should be correlated with information in other sections of the manual. No attempt is made to give detailed step-by-step procedures for finding the cause of specific troubles. Instead, an attempt is made to outline a general troubleshooting guide which can be used to locate trouble which may occur in the instrument. This guide provides a means for determining the cause of a trouble from symptoms observed rather than from detailed voltage or resistance measurements.

In general, a troubleshooting procedure can be thought of as consisting of two parts, circuit isolation and circuit troubleshooting. The first step involves isolating a trouble to a definite part of the circuit. When the trouble has been isolated, detailed checks can be used to determine which part or parts are causing the trouble.

In the following troubleshooting procedures, it is assumed that the oscilloscope used with the L Unit is operating correctly. This is not always the case. Troubles occurring in the oscilloscope can usually be detected by substituting another plug-in unit for the L Unit and checking for proper operation.

A schematic diagram of the L Unit is contained in the rear portion of this manual. The reference designation of each component is shown on the circuit diagram, as well as important voltages. These should be used as troubleshooting aids. The Circuit Description may prove useful when troubleshooting within a particular circuit.

Switch wafers shown on the schematic diagram are coded to indicate the position of the wafer on the actual switch. The number portion of the code refers to the wafer number on the switch assembly, wafers being numbered from the front of the switch to the rear. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function.

All wiring used in the L Unit is color coded to facilitate circuit tracing. In addition, filament and power-supply leads are distinguishable by specific color codes. All power supply leads follow the standard RETMA code.

Preliminary Troubleshooting

Before attempting any troubleshooting work, check all front-panel controls for proper settings. If in doubt as to the settings of the controls, refer to the Operating Instructions section. Make a careful visual check of the instrument and the input connections. A source of trouble can often be detected by visual means. If no trouble is visible, apply an input signal and observe the CRT for proper wave-shapes. Adjust the front-panel controls to see the effect of each. The normal or abnormal operation of each control will indicate what sort of trouble is encountered. Once the symptoms are clearly established, the faulty circuit can usually be isolated more readily.

Circuit failure is often caused by tube failure. The most effective method of checking tubes is by direct substitution with tubes which are known to be good. It is important, however, that these tubes be returned to the same sockets from which they were removed unless they are actually defective. Unnecessary replacement or switching of tubes will often necessitate recalibration of the instrument.

If a defective tube is found and replaced, but all of the trouble is not eliminated, check the components through which the tube draws

current. Shorted tubes will often overload plate-load and cathode resistors.

Troubleshooting Procedures

It will be necessary to turn the oscilloscope on its side (opposite the L Unit) and remove the side plate and bottom plate to reveal the circuitry of the plug-in. To trace the circuits completely it will also be necessary to extend the L Unit partially out of the plug-in compartment with an EP 54 Plug-In Extension.

The first step in troubleshooting a Type L Unit is to determine whether the trouble is being produced in the main amplifier section or the X10 amplifier section. When the AC-DC switch is in either the AC or the DC position, only the main amplifier of the unit is functioning. When the switch is in the X10 GAIN AC position, the X10 amplifier is connected in series with the main amplifier section, and both sections are functioning. When trouble exists only in the X10 amplifier section, the plug-in unit will function normally when the AC-DC switch is set at either the AC or the DC position. When trouble exists in the main amplifier section, however, it will be apparent in all three positions of the switch.

The troubleshooting procedures that follow are divided into sections according to trouble symptoms. When a trouble occurs in the unit, the proper troubleshooting section can be quickly found.

1. Loss of Trace

If the sweep circuits within the oscilloscope are functioning properly, a loss of the trace can only be produced by improper vertical positioning voltages. In other words, the trace is positioned above or below the visible vertical range of the crt.

To center the beam vertically on the crt, the dc voltages at the output jacks of the Interconnecting Plug (pins 1 and 3) must be essentially equal (within a fraction of a volt). As little as a 0.2-volt difference between these two points will position the beam above or below the range of visibility.

The dc voltages at the output jacks depend upon the dc balance of the amplifier. Since the amplifier is dc-coupled from the Phase

Inverter Stage (V6242-V6342) to the Output Stage (V6632), a component failure anywhere between these two points can unbalance the amplifier and cause a loss of the trace. A dc unbalance can be caused by defective tubes, defective cathode, screen or plate resistors, shorted or leaky capacitors, open peaking coils, and incorrect ratios in the voltage dividers.

When the X10 amplifier is connected into the circuit, the Second C.F. (V6132) is dc-coupled to V6242 (the input side of the Phase Inverter Stage). Due to the coupling capacitor (C6112) between V6042 and V6132, the Second C.F. is the only stage in the X10 amplifier that can affect the dc balance of the main amplifier. If the trace is present in the main-amplifier positions of the AC-DC switch, but absent when the switch is set at the X10 GAIN AC position, it is apparent that the dc unbalance is produced by the Second C.F. stage in the preamplifier. A possible cause of this condition is an improperly adjusted X10 VARIABLE ATTEN. BAL. control, R6242.

If the trace is missing in all positions of the AC-DC switch, the defect will probably be somewhere within the main-amplifier section. A step-by-step isolation procedure can then be employed to establish the defective stage. This procedure is accomplished by shorting together corresponding points on opposite sides of the amplifier with a resistive shorting strap, described under "Equipment Required" in the Calibration Procedure. Start at the output jacks and work back toward the Phase Inverter Stage. For example, when the output jacks are shorted together the voltages at these points will be equal and the trace will appear at or near the center of the crt.

From this point, the shorting strap can be moved back, in successive steps, to the cathodes of the Output Stage, the grids of the Output Stage, the cathodes of the Driver C.F., the grids of the Driver C.F., and finally to the grids of the Phase Inverter Stage. Following this procedure, a point will be reached where the trace cannot be made to reappear when corresponding sides of the amplifier are shorted together. When this occurs, the defect has been isolated in the stage in which these points are located, and the stage can then

be investigated to locate the defective components.

When the grids of the Phase Inverter Stage are shorted together, the effect of the vertical positioning controls must be considered. In addition to the VERTICAL POSITION control, the Vert. Pos. Range control (R6572) and the VARIABLE ATTEN. BAL. control (R6812) have a pronounced effect on the vertical beam positioning. An improper adjustment of either or both of these controls can result in a loss of the trace.

There is a possibility that the loss of trace may be due to a defective tube-heater circuit. This condition can be determined by observing the tubes in the plug-in unit for heater glow. If no glow is observed, it will most likely be caused by an open heater in one or more of the tubes. Other possibilities, however, are shorted capacitor C6952, or a defective resistor at the low end of the string.

2. Inability to position the trace

If the trace is visible on the crt, but it cannot be moved with the VERTICAL POSITION control, some defect that is rendering this control inoperative is indicated. If the trace can be moved with the Vert. Pos. Range control, the VERTICAL POSITION control is probably defective. If the trace cannot be moved with the Vert. Pos. Range control, however, the trouble will lie in some circuit following the Phase Inverter Stage. The trouble could be an open H.F. Peaking control, R6692, or short between correspondingly-opposite sides of the amplifier. An examination of the lead dress, or a continuity check with an ohmmeter, will reveal the shorted condition.

3. No vertical deflection

If the horizontal trace is present on the crt, but the vertical signal is not displayed, an open circuit somewhere in the vertical deflection system is indicated. However, since the horizontal trace is present, the defective component is one that does not upset the dc balance.

If the trouble is originating in the X10 amplifier, the defective component is in the circuit of either the First Amplifier (V5942) or the Second Amplifier (V6042). Since these stages are ac-coupled to the Second C.F.

stage, an open circuit ahead of the coupling capacitor will not affect the dc balance.

If the trouble is originating in the main amplifier section, it can be isolated to either the Phase Inverter Stage or the Output Stage with the VERTICAL POSITION control. If the trace can be moved vertically, a defect in the Phase Inverter Stage is indicated. This could be an open resistor in the cathode circuit, or an open screen divider. If the trace cannot be moved with the VERTICAL POSITION control, the H.F. Peaking control (R6692) in the Output Stage is probably open.

4. Insufficient vertical gain

If the vertical deflection on the crt no longer corresponds to the calibrated value, a change in the gain characteristics of the plug-in unit is indicated. If the change in gain is very slight, as will usually be the case, the unit can be recalibrated according to the instructions presented in Calibration Procedure. If there is a considerable change in gain, however, a change of tubes or circuit components will be required.

If only the X10 amplifier is out of calibration, the First- or Second-Amplifier stage is probably at fault. Two adjustments associated with these stages, the V6042 Cathode-Current Adj (R5922), and the X10 GAIN ADJUST (R6052), are very important. Refer to the Calibration Procedure for the proper adjustment of these controls.

If the main amplifier section is out of calibration, the Phase Inverter Stage is probably at fault. It is important to note that the 12AU6 tubes in this stage are selected and paired for filament voltage and grid bias.

Unstable operation may be encountered if standard 12AU6 tubes are used as replacements.

An open VARIABLE control (R6352) will greatly decrease the gain of the Phase Inverter Stage. A change in the value of the cathode resistors, or in the value of the screen divider, can also affect the gain.

5. Waveform Distortion

If waveform distortion occurs, first check to see which positions of the VOLTS/CM switch have distortion. If the distortion occurs on one

or two ranges, check the compensation of the input attenuators. If the distortion occurs on all ranges, first check the compensation of the probe used. In signal tracing for high-frequency distortion, consider the loading effect of the probe.

Distortion can be divided into two categories: (1) low-frequency distortion, illustrated in Fig. 4-2 and (2) high-frequency distortion, illustrated in Fig. 4-3.

(1) Any low-frequency distortion in the waveform will be produced by the X10 amplifier.

(The main amplifier is dc-coupled, and its response is therefore flat down to dc.)

Low-frequency attenuation will produce the type of distortion illustrated in Fig. 4-2(a). This type of distortion can be caused by cathode and screen-bypass capacitors, and by coupling capacitors. Before attempting any component replacement, however, be sure to check the adjustment of the Low Freq. Adj. control (R6182), as explained in the Calibration Procedure.

Over-compensation of low frequencies is illustrated in Fig. 4-2(b). This condition is pro-

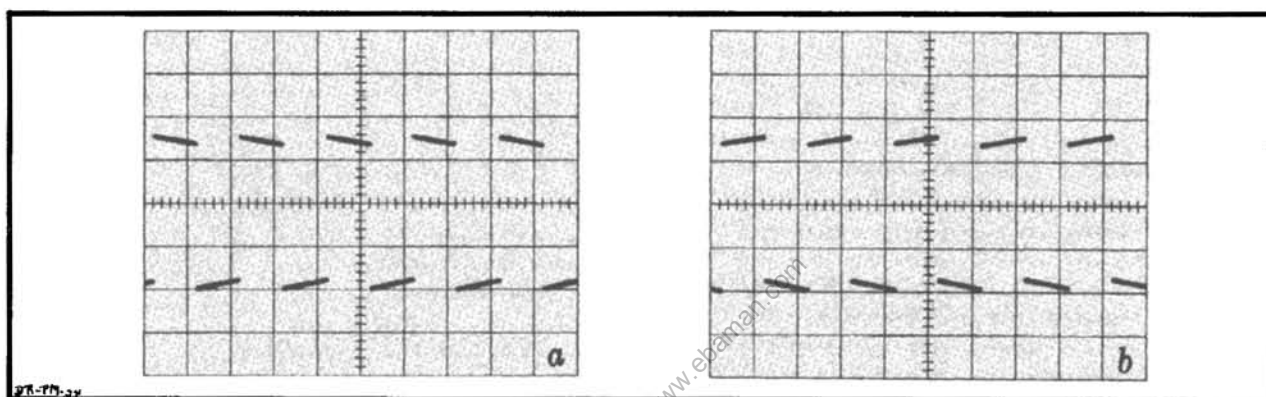


Fig. 4-2. (a) Low-frequency distortion caused by attenuation in X10-amplifier. (b) Waveform distortion from low-frequency overcompensation in X10-amplifier.

duced by excessive low-frequency "boost". Refer to the Circuit Description for an explanation of this circuit.

(2) Insufficient high-frequency peaking, which limits the risetime and consequently the bandwidth, will produce the rounded-corner type

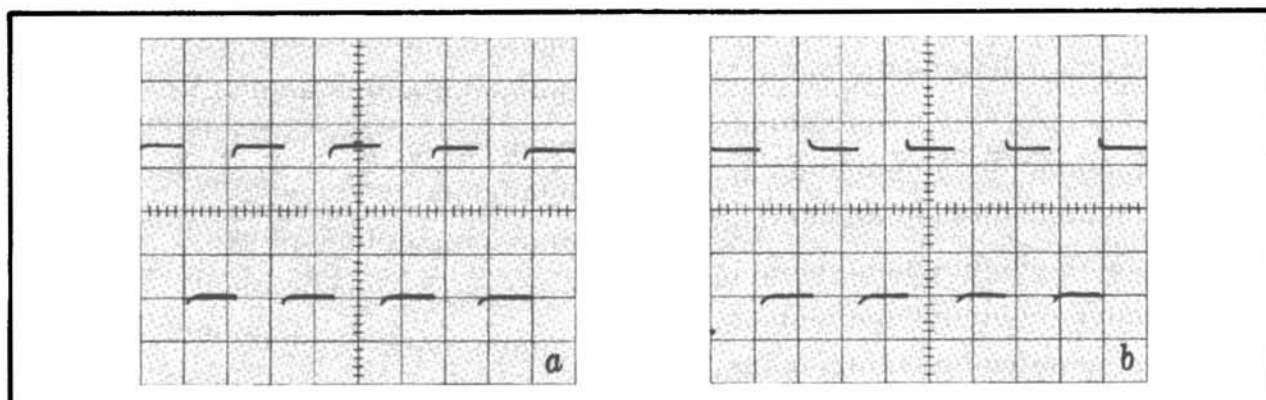


Fig. 4-3. (a) Waveform showing insufficient high-frequency peaking. (b) Spiking caused by excessive high-frequency peaking.

of distortion illustrated in Fig. 4-3(a). The transconductance of the tubes is very important in maintaining good high-frequency response. For this reason, the tubes themselves are the most frequent sources of this type of distortion. Shorted, or partially shorted peaking coils are another common source. Hot solder falling on a peaking coil is often a cause of this condition. Cross-coupling capacitors C6672 and C6772 are also very

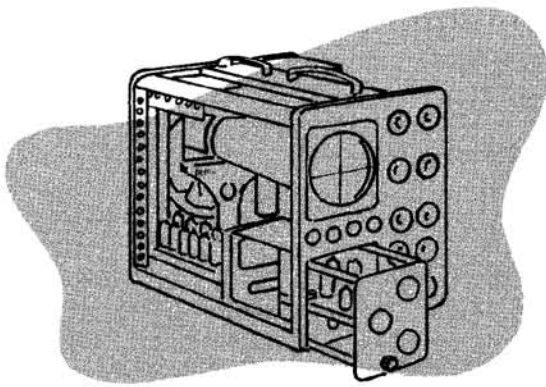
important in maintaining the proper risetime. An open condition in either capacitor will seriously affect the high-frequency response.

The overshoot condition, illustrated in Fig. 4-3(b) is produced by excessive high-frequency peaking. An improper setting of the H.F. Peaking control (R6692) can cause this condition. Refer to the Calibration Procedure for the proper adjustment of this control.

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SECTION 5

CALIBRATION PROCEDURE



Introduction

A complete procedure for checking the operational standards and calibration of the Type L Plug-In Unit is provided in this section of the manual. The steps in the procedure are arranged in correct sequence to avoid unnecessary repetition.

The step-by-step instructions also furnish an orderly approach for isolation of malfunctions which may develop. Consequently, this procedure should be used in conjunction with any maintenance and troubleshooting system.

If an abnormal indication is obtained at some point in the procedure, it is not usually necessary to locate its cause before continuing to the next step. Additional symptoms revealed by performing further steps will frequently simplify the task of locating trouble.

For this procedure, the L Unit should be used in conjunction with a properly calibrated Tektronix Type 540- or 550-Series Oscilloscope. Control settings are listed by the names usually applied to them on the scopes with which the Type L Unit may be used. Alternate names are in parentheses.

Test equipment used in a particular step should be left connected at the end of that step unless instructions state otherwise. Similarly, controls not mentioned are assumed to be in the positions they were in at the conclusion of the preceding step.

If information explaining the normal operation of front-panel controls is needed before starting the procedure, consult the Operating Instructions section of this manual.

Equipment Required

The following equipment or its equivalent is required to perform a complete calibration of the Type L Plug-In Unit.

1. Test Oscilloscope, Tektronix 540- or 550-Series.
2. Square-wave generator, Tektronix Type 105. Required specifications are: 13-nsec risetime or less; output frequencies of approximately 1 kc and 10 kc; output amplitude variable from 10 to 100 volts across 600-ohm internal load.
3. Square-wave generator, Tektronix Type 107. Required specifications are: 3 nsec risetime or less; output frequency of approximately 1 MC; output amplitude variable to at least 0.35 volt.
4. Sine-wave generator, Tektronix Type 190() Constant-Amplitude Signal Generator. Required specifications are: frequency range of 50 kc to 13 MC; output amplitude of 0.14 volt or more; output must be adjustable (manually or automatically) for constant amplitude within the above frequency range. Type 190() denotes any model of the Generator.
5. Calibrated volt-ohmmeter (VOM), with sensitivity of at least 20,000 Ω /volt.
6. 2 - 50 Ω coaxial cable, Tektronix Type P52 (012-001)
7. 1 - 50 Ω Terminating Resistor (011-045)
8. 1 - 20 pf Input Capacitance Standardizer (011-022)
9. 2 - 50 Ω X10T Attenuator (011-031)
10. 1 - 50 Ω X5T Attenuator (011-032)

10. Plug-In Extension, Type EP54 (013-019)
11. Low-capacitance insulated alignment tools.
12. Resistive shorting strap, approximately 16 inches long. (This may be made from two short lengths of insulated stranded wire, a small resistor and two test-lead clips. Solder the wires to opposite ends of the resistor, attach the test-lead clips to the free ends of the wires, and tape the resistor. The small resistor (1/2-watt, 27Ω to 100Ω) serves as a fuse.

Adjustment Procedure

Lay the test oscilloscope on its right side and remove the left-side and bottom panels. Insert the Type L Unit and preset the oscilloscope and plug-in controls as follows (controls not mentioned may be in any position):

Oscilloscope:

INTENSITY	fully counter-clockwise
HORIZONTAL DISPLAY	NORMAL ("A", INTERNAL SWEEP)
MAGNIFIER (5X MAG.)	OFF
Main Sweep Controls:	
TIME/CM	.5 MILLISEC
VARIABLE, TIME/CM	CALIBRATED, fully clockwise
TRIGGER SLOPE	-INT. (-)
TRIGGERING MODE (TRIGGERING SOURCE)	AUTOMATIC (INT.)
STABILITY	(disabled in AUTO.)
TRIGGERING LEVEL	(disabled in AUTO.)

Type L Plug-In Unit:

AC-DC	DC
VOLTS/CM	.05 (black numbers)
VARIABLE, VOLTS/CM	CALIBRATED, fully clockwise

Turn ON the POWER switch and allow adequate warm-up time for the instruments. Before increasing the intensity, center the trace with the VERTICAL POSITION and the HORIZONTAL POSITION controls, using the Beam Indicator neons as a guide. Rotate the INTENSITY control clockwise until the free-running trace appears on the crt. Adjust the FOCUS, ASTIG-

MATISM and INTENSITY controls to obtain a sharp trace with adequate intensity. Allow at least 15 minutes warm-up before making any adjustment changes.

1. Set Vertical Position Range Control

With the VERTICAL POSITION knob set at mid-range, use an insulated screwdriver to adjust the Vert. Pos. Range control on the side of the Type L, bringing the trace position to the center of the graticule.

2. Check Tubes for Gas

While watching the trace on the crt, switch the VOLTS/CM switch from .05 to .1 position. Any shift in trace position should not exceed 2 mm. If this limit is exceeded, a gassy input tube (V5832) is indicated. Check for gas in each of the other tubes by visually checking for a purple glow in the center of the tube. A blue fluorescence on the inside surface of the glass does not indicate gas, however. Replace any tube found to contain gas. Return VOLTS/CM switch to .05 position.

3. Check Tubes for Microphonics

Rap lightly on the front panel of the Type L Unit and watch the trace for ringing type microphonics (physical vibration of electrodes within a vacuum tube causing deflection of the oscilloscope trace). If the trace deflection exceeds 4 mm, a tube with excessive microphonics is indicated in the main amplifier section. Switch the AC-DC switch to X10 GAIN AC and repeat the check. If the trace deflection is more than 1 cm, a tube with excessive microphonics in the X10 amplifier section is indicated.

If these checks showed microphonics, determine which tube is defective by the following procedure: Turn off the oscilloscope and remove the Type L Unit; install an EP 54 Plug-In Extension and re-insert the L Unit; turn the scope on again; Set the AC-DC switch to the position at which microphonics were observed; with a long flexible adjustment tool, stroke the tip of each tube and watch the crt for trace deflection. Replace any tubes with excessive microphonics.

4. Check DC Output Levels

With the trace centered, check the dc voltages

at the interconnecting plug between pin 1 and ground, and between pin 3 and ground. The voltage should be between +65 and +70 volts on each pin.

5. Variable Attenuator Balance Adjustment

With the AC-DC switch in DC position, rotate the VARIABLE (VOLTS/CM) control back and forth while watching the crt for a shift in position of the trace. If the trace moves when the control is rotated, adjust the upper VARIABLE ATTEN. BAL. control on the front panel until the trace position is no longer affected by the VARIABLE (VOLTS/CM) control.

6. X10 Variable Attenuator Balance Adjustment

With the AC-DC switch at X10 GAIN AC and the VARIABLE ATTEN. BAL. control calibrated, rotate the VARIABLE (VOLTS/CM) control back and forth while watching the crt for a shift in position of the trace. If the trace moves when the control is rotated, adjust the X10 VARIABLE ATTEN. BAL. control on the front panel until the trace position is

no longer affected by the VARIABLE (VOLTS/CM) control. Return VARIABLE control to CALIBRATED position.

7. Check AC-DC Switch

Set the AC-DC switch at DC position. Apply a 100 MILLIVOLT square wave signal from the AMPLITUDE CALIBRATOR to the INPUT connector of the Type L Unit. Position the base line of the calibrator waveform on the center line of the graticule. Turn the AC-DC switch to AC. The waveform should shift down centering the display on the graticule.

8. Cathode Current Adjustment

It is very important that the voltages at the elements of V6042 be within certain limits. These voltages can be varied over a limited range by adjusting the control grid voltage of the tube. With a tube in good condition, all of the element voltages will be within proper operating limits if the cathode current is .17 milliamperes--indicated by a voltage drop of 55 volts across the precision 6-kilohm resistor, R6072.

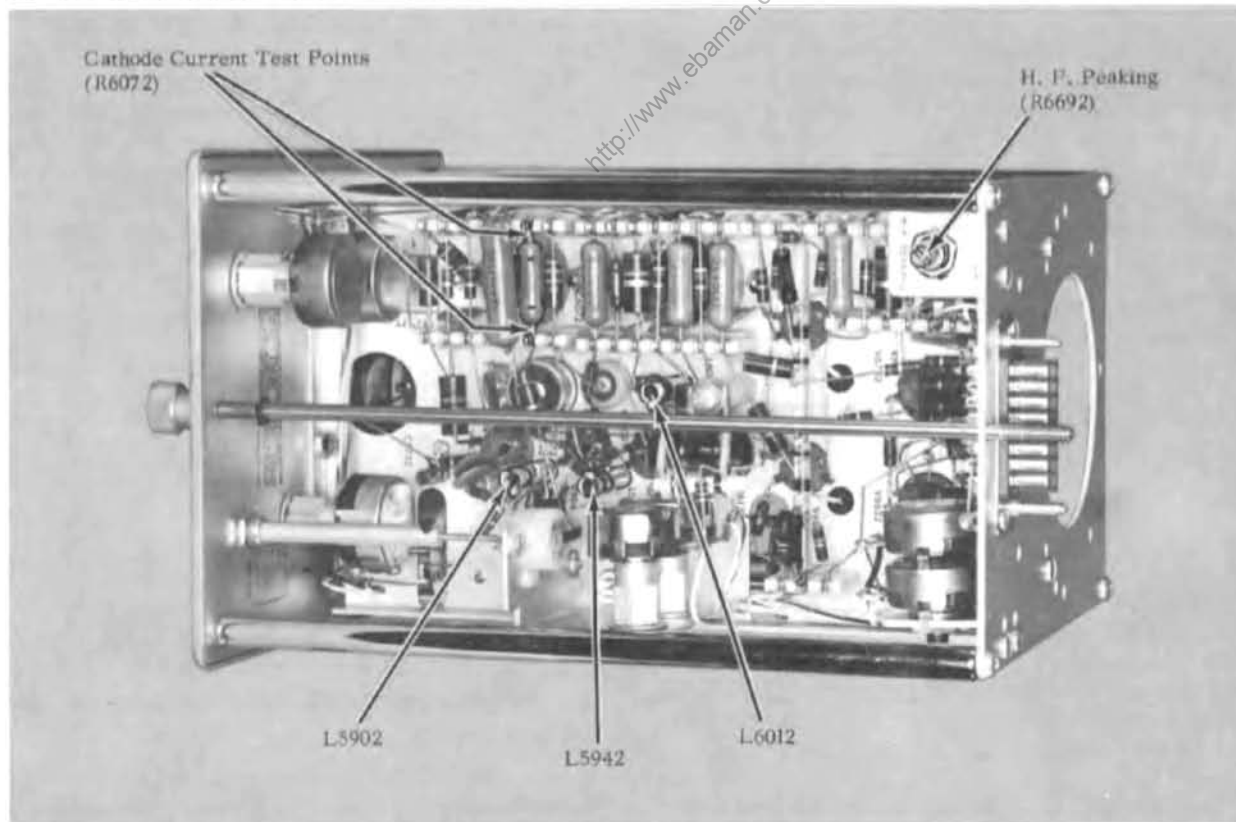


Fig. 5-1. Bottom view of L Unit showing location of Cathode Current test points and X10-amplifier high-frequency coils.

With the AC-DC switch in X10 GAIN AC position, check the voltage drop across R6072 for exactly 55 volts. See Figure 5-1. If the voltage is not correct, adjust the V6042 Cathode Current Adj. control on the left side of the L Unit.

9. Gain Adjustment, Main Amplifier Section

Set the AC-DC switch at DC position. Apply a .2 VOLT square wave from the AMPLITUDE CALIBRATOR to the INPUT connector of the L Unit. Check the crt for exactly 4 cm of vertical deflection. If incorrect, adjust the upper front-panel GAIN ADJUST control.

10. X10 Gain Adjustment

Turn the AC-DC switch to X10 GAIN AC and apply a 20 MILLIVOLT square wave from the AMPLITUDE CALIBRATOR of the oscilloscope to the Type L INPUT connector. Check for exactly 4 cm of vertical deflection. If not correct, adjust the X10 GAIN ADJUST control on the front panel.

11. Recheck Control Adjustments

There is interaction between the functions of the Variable Attenuator Balance adjustments, the Gain adjustments and the Cathode Current adjustment, as is readily seen on the Schematic Diagram of the unit. It will be necessary to recheck all of these adjustments if the settings were changed appreciably during the previous checks.

12. Reset Vertical Position Range Control

With the AC-DC switch in DC position and the VERTICAL POSITION knob centered, adjust the Vert. Pos. Range control to center the trace on the graticule.

13. Input Capacitance Standardization

With the VOLTS/CM switch at maximum sensitivity, the input capacitance is adjusted with capacitor C5732. See Figure 5-2. At this sensitivity there is no attenuator in the input coupling, so the adjustment standardizes the input capacitance of the Type L Unit.

Set the AC-DC switch in DC position and the VOLTS/CM switch at .05. Install a 20 pf Input Capacitance Standardizer on the INPUT

connector of the L Unit, and a 5X Attenuator on the Standardizer. Apply a 1 kc signal with a P52 cable from a Type 105 Square-Wave Generator to the Attenuator/Standardizer combination on the Type L Plug-In Unit. Adjust the amplitude of the display to about 3.5 cm with the OUTPUT AMPLITUDE control on the Type 105. Adjust C5732 for an optimum flat top.

14. Attenuator Input Capacitance and Frequency Compensation Adjustments

Trimmer capacitors are provided for standardizing the input capacitance and compensating the voltage dividers at each step of the VOLTS/CM switch. This is done so the plug-in will always present an input characteristic of 1 megohm of resistance shunted by 20 picofarads of capacitance, while maintaining frequency compensation. This permits a single setting of the probe adjustment suitable for all positions of the VOLTS/CM switch.

With the Input Capacitance Standardizer and the 5X Attenuator on the INPUT connector of the L Unit as in step 13, apply a 1 kc square wave from the Type 105. The AC-DC switch should be in DC position. With the OUTPUT AMPLITUDE control of the Type 105, adjust the display for an amplitude between 3cm and 3.5 cm on each of the following steps. Remove the 5X Attenuator when necessary to maintain the proper display amplitude. See Figure 5-2 for location of the trimmer capacitors. Adjust the standardizing capacitors for an optimum flat top on the square wave, and adjust the compensating capacitors for an optimum square leading corner.

VOLTS/CM SWITCH	INPUT-CAPACITANCE STANDARDIZATION	FREQUENCY COMPENSATION
	(Adjust for optimum flat top)	(Adjust for optimum square corner)
.1	C5072	C5102
.2	C5142	C5162
.5	C5202	C5222
1	C5272	C5292
2	C5342	C5362
5	C5412	C5432
10	C5502	C5522
20	C5602	C5622

15. X10 Amplifier Low-Frequency Adjustment

The following adjustment provides a means of compensating the low-frequency response of the ac-coupled X10 amplifier for optimum performance.

TYPE L
Text Correction (13)

Replace the second paragraph of step 13 and the first paragraph of step 14 with the following.

Remove the Type EP54 Plug-In Extension for this step. Now set the AC-DC switch in DC position and the VOLTS/CM switch at .05. Install a 20 pf Input Capacitance Standardizer on the INPUT connector of the L Unit, and 5X Attenuator on the Standardizer. Apply a 1 kc signal with a P52 cable from a Type 105 Square-Wave Generator to the Attenuator/Standardizer combination on the Type L Plug-In Unit. Adjust the amplitude of the display to about 3.5 cm with the OUTPUT AMPLITUDE control on the Type 105. Adjust C5732 for an optimum flat top.

Make the adjustment to C5732 from the bottom of the plug-in with a small pocket screwdriver. The screwdriver will have to be removed, each time the waveform is checked since the metal blade introduces distortion.

14. Attenuator Input Capacitance and Frequency Compensation Adjustments.

Trimmer capacitors are provided for standardizing the input capacitance and compensating the voltage dividers at each step of the VOLTS/CM switch. This is done so the plug-in will always present an input characteristic of 1 megohm of resistance shunted by 20 picofarads of capacitance, while maintaining frequency compensation. This permits a single setting of the probe adjustment suitable for all positions of the VOLTS/CM switch.

Re-install the Type EP54 Plug-In Extension. The top of the waveform in each position of the VOLTS/CM switch should match the top of the waveform as seen in the .05 position.

NOTE

This will no longer be a flat top since the EP54 introduces some peaking.

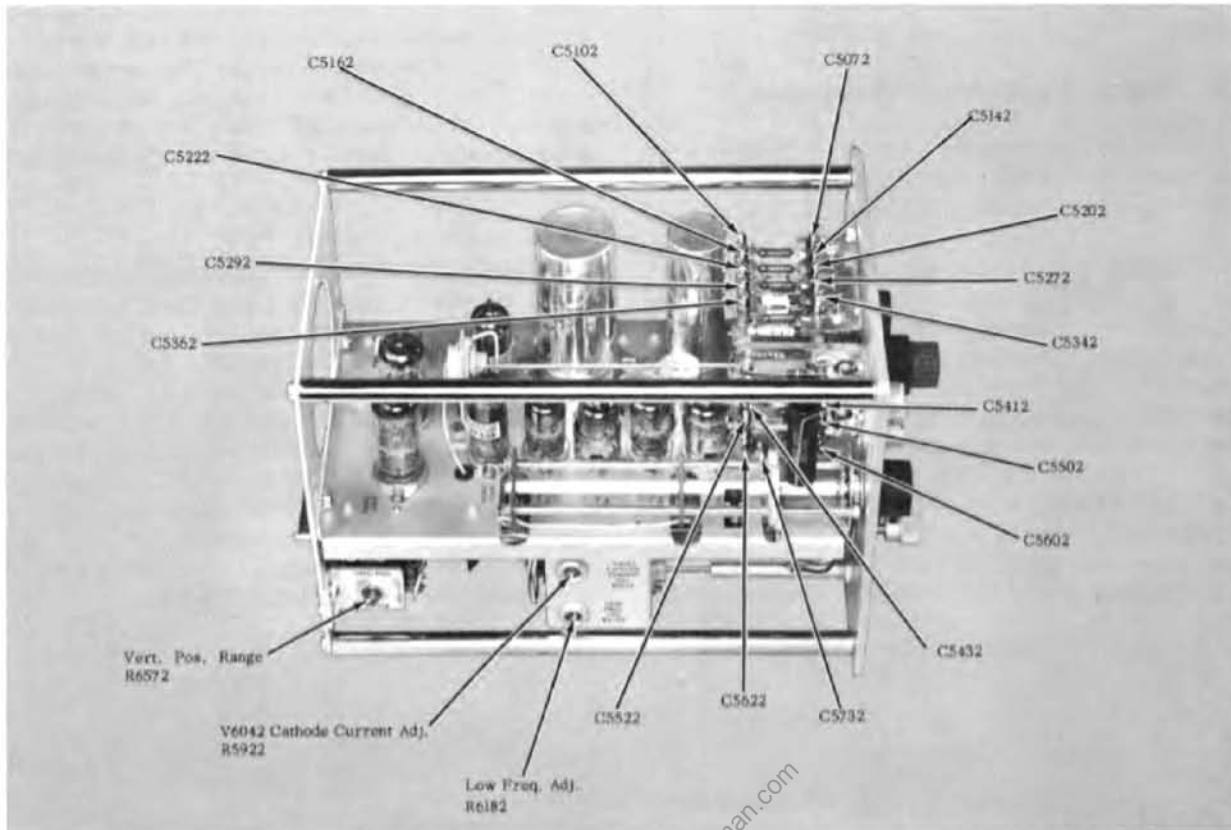


Fig. 5-2. Location of left-side internal adjustments and input attenuator adjustments.

Set the TIME/CM switch at 50 MILLISEC, the AC-DC switch at X10 GAIN AC, and the VOLTS/CM switch at .005. Apply a 50 cycle square wave from the Type 105 to the INPUT of the Type L Unit through approximately 250 to 1000X attenuation. Short the input blocking capacitor (C5001) with the resistive shorting strap. Adjust the amplitude of the display to about 3 cm with the OUTPUT AMPLITUDE control on the Type 105. Set the Low Freq. Adj. control on the left side of the L Unit for optimum level top of the square wave. Remove the clip lead.

16. High-Frequency Peaking Adjustment

The H.F. Peaking control in the Output Stage of the Type L provides for matching the impedance of the cathode circuit to the output peaking coils for best high-frequency response.

Remove the Type EP54 Plug-In Extension. Set the TIME/CM switch at .2 μ SEC, VOLTS/CM at .05 and the AC-DC switch at DC. Install a 50 Ω Terminating Resistor on the INPUT

connector of the Type L Unit. Apply a square wave of approximately 450 kc from a Tektronix Type 107 Square-Wave Generator to the Terminating Resistor on the Type L. Adjust the display amplitude with the APPROXIMATE AMPLITUDE control on the Type 107 to approximately 3 cm. Adjust the H. F. Peaking control on the bottom side of the Type L for a square-cornered waveform with no overshoot.

17. X10 Amplifier High-Frequency Adjustments

Three variable peaking coils are provided in the X10 amplifier for adjusting its frequency response.

With other controls set as in step 16, turn the AC-DC switch to X10 GAIN AC. With the 50 Ω Terminating Resistor on the INPUT connector of the Type L, install also a 10X Attenuator and apply a 450 kc square wave from the Type 107 as before. Adjust the display amplitude to approximately 3 cm with the APPROXIMATE AMPLITUDE control on the Type 107. Adjust coils L5902, L5942 and L6012 for a square leading corner of the

waveform, with fastest risetime but no overshoot.

18. Check Frequency Response

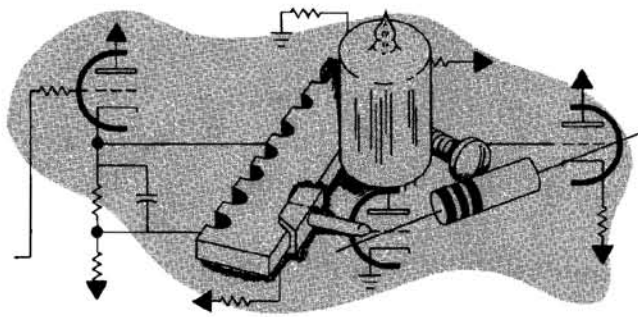
After calibrating the Type L Plug-In Unit as described in the previous paragraphs, check the frequency response of the unit.

With the 50 Ω Terminating Resistor installed on the INPUT connector of the Type L Unit, connect the Attenuator head from a Tektronix Type 190() Constant-Amplitude Signal Generator to the Terminating Resistor. Set the TIME/CM switch at 100 μ SEC, the VOLTS/CM switch at .05 (black numbers), AC-DC switch at DC, STABILITY fully clockwise and TRIGGERING MODE at AC (AC SLOW). Apply a 50 kc signal from the Type 190() and adjust the amplitude with the OUTPUT AMPLITUDE control and the ATTENUATOR switch of the

Type 190() for exactly three centimeters of vertical deflection. Without changing any other controls, increase the output frequency of the Type 190() until the vertical deflection is reduced to exactly 2.1 cm. This is the 3-db down point and should occur at approximately 30 megacycles.

Install a 10X Attenuator between the Attenuator head of the Type 190() and the Terminating Resistor on the INPUT connector of the Type L. Set the AC-DC switch at X10 GAIN AC and apply a 50 kc signal as before. Adjust the display amplitude for exactly 3 cm with the controls of the Type 190(), then without changing any other controls, increase the output frequency of the Type 190() until the vertical deflection on the crt is exactly 2.1 cm. This is the 3-db down point of the X10 amplifier and should be approximately 24 MC.

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SECTION 6

PARTS LIST AND SCHEMATICS

ABBREVIATIONS

Cer.	Ceramic	n	Nano or 10^{-9}
Comp.	Composition	Ω	ohm
EMC	Electrolytic, metal cased	p	Pico or 10^{-12}
f	Farad	PTB	Paper, "Bathtub"
G	Giga, or 10^9	PMC	Paper, metal cased
GMV	Guaranteed minimum value	Poly.	Polystyrene
h	Henry	Prec.	Precision
K or k	Kilohms or kilo (10^3)	PT	Paper Tubular
M/Cer.	Mica or Ceramic	T	Terra or 10^{12}
M or meg	Megohms or mega (10^6)	v	Working volts DC
μ	Micro. or 10^{-6}	Var.	Variable
$\mu\mu$	Micromicro or 10^{-12}	w	Watt
m	milli or 10^{-3}	WW	Wire-wound

HOW TO ORDER PARTS

Replacement parts are available from or through your local Tektronix Field Office.

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, for your order to contain the following information: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Field Office will contact you concerning any change in part number.

<http://www.ebay.com>

PARTS LIST

Values are fixed unless marked Variable.

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

Tolerance of all electrolytic capacitors are as follows (with exceptions):

3 V - 50 V = $-10\% + 250\%$

51 V - 350 V = $-10\% + 100\%$

351 V - 450 V = $-10\% + 50\%$

Ckt. No.	Tektronix Part Number		Description			S/N Range
C5002	Use *285-556	0.1 μf	PTM		600 v	
C5042	Use 281-523	100 μf	Cer.		350 v	
C5072	281-027	.7-3 μf	Tub.	Var.		
C5092	281-504	10 μf	Cer.		500 v	10%
C5102	281-027	.7-3 μf	Tub.	Var.		
C5142	281-027	.7-3 μf	Tub.	Var.		
C5152 †						
C5162	281-027	.7-3 μf	Tub.	Var.		
C5172 †						
C5202	281-027	.7-3 μf	Tub.	Var.		
C5212	281-500	2.2 μf	Cer.		500 v	$\pm 0.5 \mu\text{f}$ 101-904 905-up †
C5222	281-027	.7-3 μf	Tub.	Var.		
C5272	281-027	.7-3 μf	Tub.	Var.		
C5282 †						
C5292	281-027	.7-3 μf	Tub.	Var.		
C5312	281-519	47 μf	Cer.	Var.	500 v	10%
C5342	281-027	.7-3 μf	Tub.	Var.		
C5352 †						
C5362	281-027	.7-3 μf	Tub.	Var.		
C5382	281-530	100 μf	Cer.		500 v	10%
C5412	281-027	.7-3 μf	Tub.	Var.		
C5422 †						
C5432	281-027	.7-3 μf	Tub.	Var.		
C5452	283-539	250 μf	Mica		500 v	10%
C5502	281-027	.7-3 μf	Tub.	Var.		
C5512 †						
C5522	281-027	.7-3 μf	Tub.	Var.		
C5542	283-541	500 μf	Mica		500 v	10%
C5602	281-027	.7-3 μf	Tub.	Var.		
C5612 †						
C5622	281-027	.7-3 μf	Tub.	Var.		
C5642	283-540	750 μf	Mica		500 v	10%
C5722	283-001	.005 μf	Discap		500 v	
C5732	281-027	.7-3 μf	Tub.	Var.		
C5802	290-000	6.25 μf	EMT		300 v	
C5812	283-001	.005 μf	Discap		500 v	
C5822	283-001	.005 μf	Discap		500 v	
C5872	283-001	.005 μf	Discap		500 v	
C5902	290-000	6.25 μf	EMT		300 v	
C5972	290-030	500 μf	EMT		6 v	

† These capacitors are selected during calibration.

Parts List — Type L

Capacitors (continued)

Ckt. No.	Tektronix Part Number		Description		S/N Range
C6002A		40 μ f	EMC	475 v	
C6002B	290-063	20 μ f			
C6002C		10 μ f			
C6062	283-003	.01 μ f	Discap	150 v	
C6072	290-069	3 x 75 μ f	EMC	150 v	
C6102	283-001	.005 μ f	Discap	500 v	
C6112	285-519	.047 μ f	PTM	400 v	
C6132	283-001	.005 μ f	Discap	500 v	
C6192	283-002	.01 μ f	Discap	500 v	
C6302	283-000	.001 μ f	Discap	500 v	
C6332	283-001	.005 μ f	Discap	500 v	
C6672	283-000	.001 μ f	Discap	500 v	
C6772	283-000	.001 μ f	Discap	500 v	
C6832	283-001	.005 μ f	Discap	500 v	
C6922	283-002	.01 μ f	Discap	500 v	
C6952	283-002	.01 μ f	Discap	500 v	

Inductors

L5902	Use *114-043	.5-1 μ h	Var.		X6570-10990X
L5932	*108-209	.75 μ h			
L5942	*114-085	2-2.7 μ h	Var.		
L6012	*114-072	4-7.5 μ h	Var.		
L6112	*108-126	1.6 μ h			
L6282	*108-006	.13 μ h			X5999-10990X X5999-10990X
L6292A,B	*108-097	Plate-Peaking network 4-section			
L6302	*108-062	.45 μ h			
L6312	*108-062	.45 μ h			
L6632	*108-062	.45 μ h			
L6672	*108-112	.3 μ h			
L6732	*108-062	.45 μ h			
L6772	*108-112	.3 μ h			

Diodes

D5972	152-008	T12G			X4830-up
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Rectifiers †

SR5972	*106-037	1-100 ma plate/leg			101-4829X
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Resistors

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

R5002	302-330	33 Ω	1/2 w		
R5042	302-560	56 Ω	1/2 w		101-725
	301-620	62 Ω	1/2 w	5%	726-up
R5052	302-470	47 Ω	1/2 w		
R5092	309-140	500 k	1/2 w	Prec.	1%

† S/N 4830-up. See D5972.

Resistors (continued)

Ckt. No.	Tektronix Part Number	Description	S/N Range
R5112	309-148	1 meg	
R5162	309-141	750 k	
R5172	309-139	333 k	
R5222	309-142	900 k	
R5242	309-138	111 k	
R5292	309-143	950 k	
R5312	309-137	52.6 k	
R5362	309-144	975 k	
R5372	302-100	10 Ω	
R5382	309-136	25.6 k	
R5432	309-145	990 k	
R5442	302-101	100 Ω	
R5452	309-135	10.1 k	
R5462	302-100	10 Ω	
R5522	309-146	995 k	
R5532	302-101	100 Ω	
R5542	309-134	5.03 k	
R5552	302-100	10 Ω	
R5622	309-147	997.5 k	
R5632	302-331	330 Ω	
R5642	309-133	2.51 k	
R5652	302-100	10 Ω	
R5722	302-105	1 meg	
	302-104	100 k	101-1553
R5732	309-148	1 meg	1554-up
R5802	302-683	68 k	
R5812	302-470	47 Ω	
R5822	302-470	47 Ω	
R5832	302-470	47 Ω	
R5862	306-223	22 k	
R5872	302-470	47 Ω	
R5902	303-333	33 k	
R5912	302-105	1 meg	5%
R5922	311-015	10 k	
R5932	308-054	10 k	
R5942	309-271	650 Ω	
	*310-513	650 Ω	
R5972	308-093	12 k	
R6002	306-123	12 k	
R6012	309-338	1 k	
	*310-532	1 k	
R6032	302-100	10 Ω	
R6042	302-331	330 Ω	
R6052	Use 050-035		
	*311-283	270 Ω	
R6062	307-007	2.7 Ω	
R6072	308-052	6 k	
	308-112	6 k	
R6082	302-223	22 k	
	309-136	25.6 k	
R6102	302-470	47 Ω	

Parts List — Type L

Resistors (continued)

Ckt. No.	Tektronix Part Number		Description			S/N Range
R6132	305-223	22 k	2 w		5%	
R6142	302-470	47 Ω	1/2 w			
R6172	302-474	470 k	1/2 w			101-1609
	302-334	330 k	1/2 w			1610-up
R6182	311-042	2 meg	2 w	Var.	Low Freq. Adj.	
R6192	302-332	3.3 k	1/2 w			
R6202	302-395	3.9 meg	1/2 w			
R6222	302-474	470 k	1/2 w			
R6242	311-026	100 k	2 w	Var.	X10 DC Bal.	
R6282	308-091	2 k	5 w		WW 5%	
R6292	*310-515	500 Ω	1/2 w		Mica Plate 2%	101-5998
	309-179	500 Ω	1/2 w		Prec. 1%	5999-10990
	*310-515	500 Ω	1/2 w		Mica Plate 2%	10991-up
R6302	*310-515	500 Ω	1/2 w		Mica Plate 2%	101-5998
	309-179	500 Ω	1/2 w		Prec. 1%	5999-10990
	*310-515	500 Ω	1/2 w		Mica Plate 2%	10991-up
R6332	302-270	27 Ω	1/2 w			
R6352	Use 050-037			Var.	WW	101-1059
	*311-298	680 Ω			VARIABLE	1060-up
R6362	304-152	1.5 k	1 w			
R6372	304-152	1.5 k	1 w			
R6382	308-092	4.5 k	5 w		WW 5%	
R6392	311-012	5 k	2 w	Var.	WW Gain Adjust	
R6422	306-562	5.6 k	2 w			
R6432	302-103	10 k	1/2 w			
R6512	302-104	100 k	1/2 w			
R6522	311-028	2 x 100 k	2 w	Var.		VERTICAL POSITION
R6532	302-104	100 k	1/2 w			
R6562	302-823	82 k	1/2 w			
R6572	311-051	2 x 100 k	2 w	Var.		Vert. Pos. Range
R6582	302-823	82 k	1 w			
R6612	302-470	47 Ω	1/2 w			
R6622	302-270	27 Ω	1/2 w			
R6632	303-822	8.2 k	1 w		5%	
R6662	306-392	3.9 k	2 w			
R6672	303-822	8.2 k	1 w		5%	
R6682	303-822	8.2 k	1 w		5%	
R6692	311-008	2 k	2 w	Var.		H. F. Peaking
R6712	302-470	47 Ω	1/2 w			
R6722	302-270	27 Ω	1/2 w			
R6732	303-822	8.2 k	1 w		5%	
R6772	303-822	8.2 k	1 w		5%	
R6782	303-822	8.2 k	1 w		5%	
R6812	311-003	100 Ω	2 w	Var.		DC Bal.
R6822	304-120	12 Ω	1 w			
R6832	307-009	4.7 Ω	1 w			
R6862	308-062	3 k	5 w		WW 5%	
R6922	302-470	47 Ω	1/2 w			

Switches

Ckt. No.	Tektronix Part Number		Description	S/N Range
SW5002	Unwired	Wired	Rotary	AC-DC X10 Gain Volts/CM
SW5052	*260-173	*262-133	Rotary	

Electron Tubes

V5832	154-084	5654 †
V5942	154-084	5654 †
V6042	154-084	5654 †
V6132	154-084	5654 †
V6242 ¹	*157-038	12AU6
V6342 ¹	*157-038	12AU6
V6632	154-039	12AT7
V6732	154-039	12AT7

† 6AK5 may be substituted for 5654. Tek number 154-014.

¹ Selected pair. Furnished as a unit.

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Mechanical Parts List Type L

	Tektronix Part Number
BINDING POST CAP	200-103
BINDING POST ADAPTER STEM	355-507
BRACKET, VERT. POS. RANGE	406-126
BRACKET, HF PEAKING	406-186
BRACKET, 2 ⁵ / ₈ x 3	406-264
BRACKET, 5 ⁵ / ₈ x 2 ³ / ₁₆ x 3 ³ / ₈	406-265
BRACKET, 1 ¹ / ₂ x 2 ¹ / ₄	406-267
BRACKET, 1 ² / ₃₂ x 2 ¹ / ₁₆	406-269
BRACKET, BRONZE CLIP	406-290
BUSHING, ALUM. 3 ³ / ₈ -32 x 9 ¹ / ₁₆ x .412	358-010
CABLE HARNESS	179-158
CERAMIC STRIP 3 ³ / ₄ " x 3 notches, clip mounted	124-087
CERAMIC STRIP 3 ³ / ₄ " x 7 notches, clip mounted	124-089
CERAMIC STRIP 3 ³ / ₄ " x 11 notches, clip mounted	124-091
CHASSIS	441-146
CLAMP, CABLE 7 ¹ / ₁₆ " plastic	343-005
CLAMP, CABLE steel 1/2 ID mtg. right angle to circle	343-015
CLAMP, CABLE steel 1/2 x 3/4	343-036
CONNECTOR, CHASSIS MT., 16-contact, male	131-017
CONNECTOR, CHASSIS MT., UHF teflon center	131-051
GROMMET, RUBBER 1/4"	348-002
GROMMET, RUBBER 3/8"	348-004
KNOB, LARGE BLACK 1.225 flange, 1/4" hole	366-028
KNOB, SMALL RED	366-038
KNOB, LARGE BLACK 1.375 OD 1/4" hole thru	366-040
KNOB, ALUM.	366-125
LOCKWASHER #4 INT	210-004
LOCKWASHER #6 INT	210-006
LOCKWASHER #10 EXT	210-009
LOCKWASHER 1/4 INT	210-011
LOCKWASHER POT INT	210-012

Mechanical Parts List (continued)

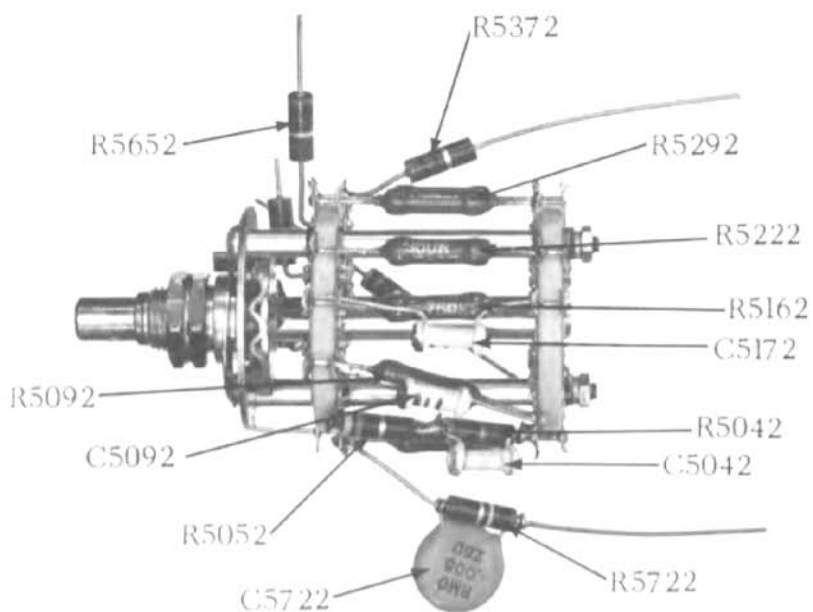
	Tektronix Part Number
LOCKWASHER $\frac{3}{8} \times 1\frac{1}{16}$ INT.	210-013
LUG, SOLDER SE4	210-201
LUG, SOLDER SE6 w/2 holes	210-202
LUG, SOLDER DE6	210-204
LUG, SOLDER SE8	210-205
LUG, SOLDER Pot, $\frac{3}{8}$	210-207
NUT, HEX 4-40 x $\frac{3}{16}$	210-406
NUT, HEX 6-32 x $\frac{1}{4}$	210-407
NUT, HEX 8-32 x $\frac{5}{16}$	210-409
NUT, HEX 10-32 x $\frac{5}{16}$	210-410
NUT, HEX $\frac{3}{8}$ -32 x $\frac{1}{2}$	210-413
NUT, HEX $\frac{3}{8}$ -32 x $\frac{1}{2}$ x $\frac{7}{16}$	210-421
NUT, HEX $\frac{1}{4}$ -28 x $\frac{3}{8}$ x $\frac{3}{32}$	210-455
NUT, HEX $\frac{3}{8}$ -32 x $\frac{1}{2}$ x $1\frac{1}{16}$	210-494
PANEL, FRONT	333-517
PLATE, PLEXIGLASS $1\frac{29}{32} \times 2\frac{1}{16}$	386-593
PLATE, PLEXIGLASS $2 \times 2\frac{1}{4}$	386-594
REAR ALUM. FRAME PLATE	387-529
RING, STEEL, FREE ID x .180	354-025
RING, POLY, $\frac{1}{2}$ ID x $\frac{9}{16}$ OD x $\frac{1}{2}$	354-068
ROD, ALUM. $\frac{1}{4} \times 2\frac{1}{16}$	384-177
ROD, FRAME $\frac{3}{8} \times 8\frac{7}{8}$ tapped 8-32	384-508
ROD, SECURING $\frac{3}{16} \times 10\frac{1}{2}$	384-510
ROD, NYLON $\frac{5}{16} \times 1\frac{1}{4}$ tapped 6-32	385-018
SCREW 4-40 x $\frac{5}{16}$ BHS	211-011
SCREW 4-40 x $\frac{5}{8}$ RHS	211-016
SCREW 4-40 x $\frac{3}{8}$ FHS	211-025
SCREW 4-40 x $\frac{5}{16}$ Pan HS w/lockwasher	211-033
SCREW 6-32 x $\frac{1}{4}$ BHS	211-504
SCREW 6-32 x $\frac{5}{16}$ BHS	211-507
SCREW 6-32 x $\frac{5}{16}$ FHS	211-508
SCREW 6-32 x $\frac{3}{8}$ FHS	211-509
SCREW 6-32 x $\frac{3}{8}$ BHS	211-510

Parts List — Type L

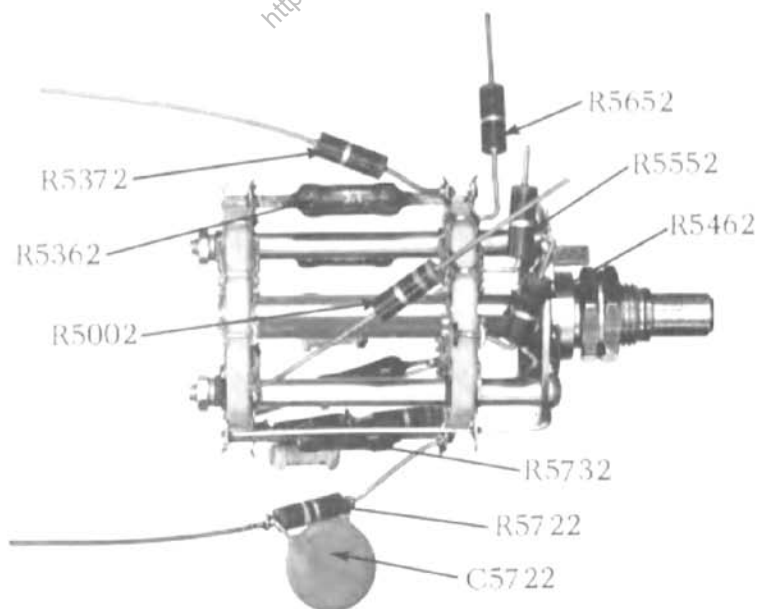
Mechanical Parts List (continued)

	Tektronix Part Number
SCREW 6-32 x $\frac{5}{16}$ Pan HS w/lockwasher	211-534
SCREW, 8-32 x $\frac{1}{4}$ BHS	212-001
SCREW 8-32 x $\frac{1}{2}$ FHS Phillips	212-043
SCREW 8-32 x $\frac{1}{2}$ RHS Phillips	212-044
SCREW, THREAD CUTTING, 4-40 x $\frac{1}{4}$ Phillips	213-035
SCREW, THREAD CUTTING, 4-40 x $\frac{5}{16}$ Phillips	213-044
SOCKET, STM7G	136-007
SOCKET, STM7 shielded	136-009
SOCKET, 7-pin w/o center pin	136-010
SOCKET, STM9	136-014
SPACER, $\frac{5}{32}$ nylon for Ceramic Strip	361-007
SPACER, ALUM. .125 ID x $\frac{3}{16}$ OD x $\frac{1}{4}$	166-025
SPACER, ALUM. .384 ID x $\frac{1}{2}$ OD x $\frac{9}{32}$	166-131
SPADE BOLT 6-32 x $\frac{3}{8}$	214-012
STRIP, COPPER $\frac{1}{8}$ x $2\frac{3}{4}$	124-073
SUBPANEL	386-592
TUBING #20 black plastic	162-504
WASHER 6L x $\frac{3}{8}$ x .032	210-803
WASHER 10S x $\frac{7}{16}$ x .036	210-805
WASHER Fiber #10	210-812
WASHER Steel .390 ID x $\frac{9}{16}$ OD x .020	210-840
WIRE #22 SOLID WHITE	175-522

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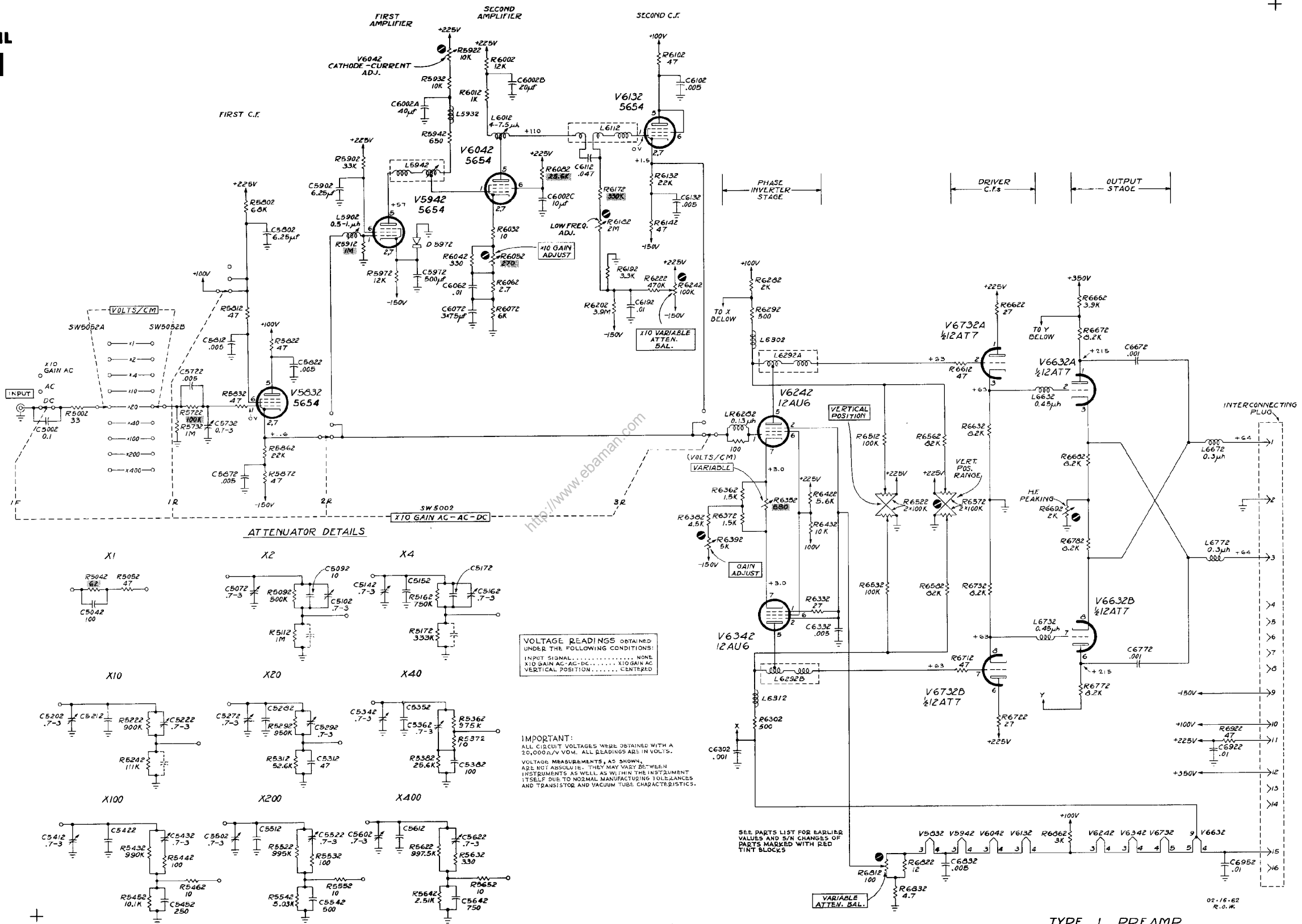


RIGHT SIDE VOLTS/CM SWITCH



LEFT SIDE VOLTS/CM SWITCH

SWITCH DETAIL



TYPE L PREAMP