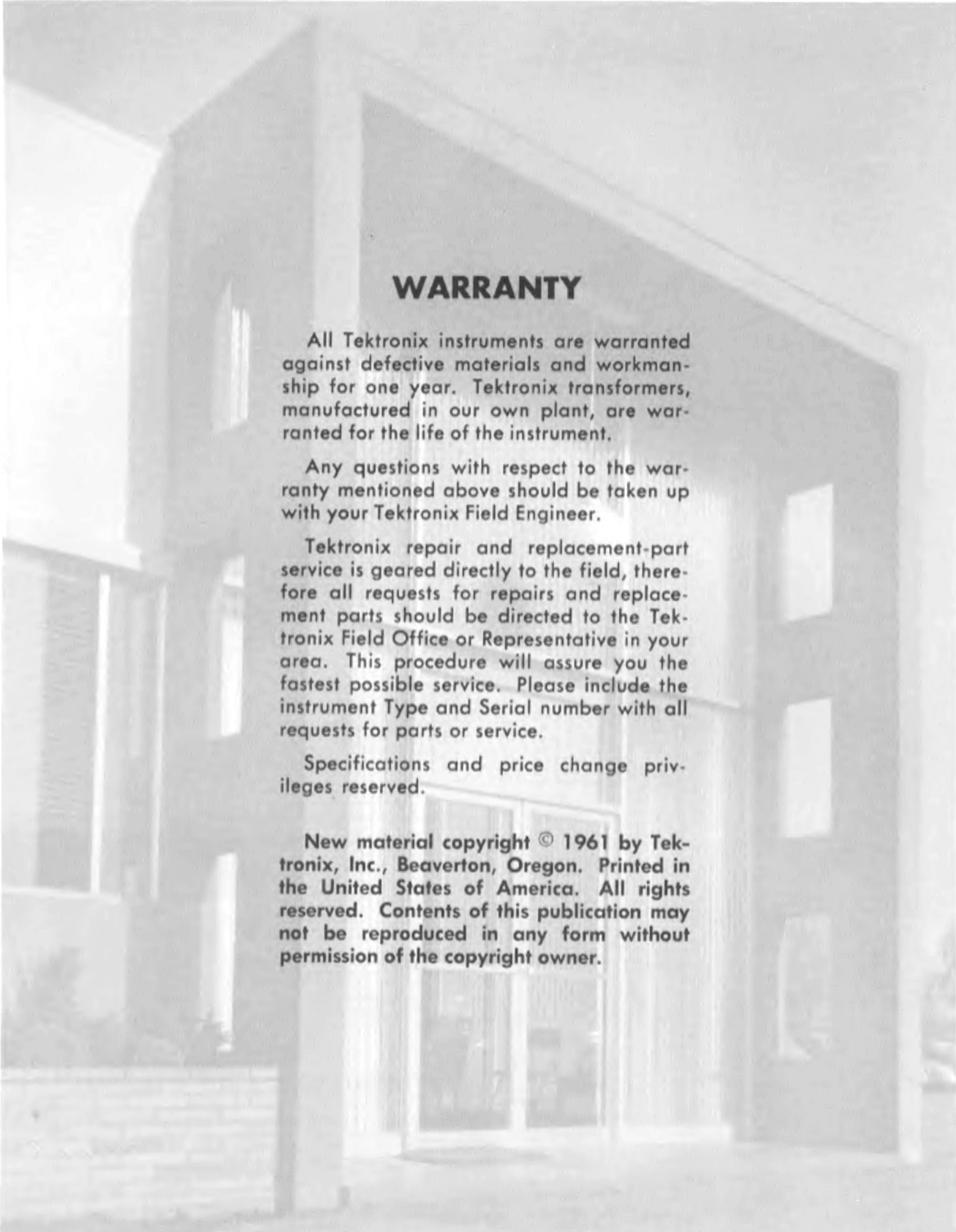
INSTRUCTION MANUAL

TYPE CA PLUG-IN

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon ● Phone MI 4-0161 ● Cables: Tektronix

Tektronix International A.G.
Terrassenweg 1A ● Zug, Switzerland ● PH. 042-49192 ● Cable: Tekintag, Zug Switzerland ● Telex 53.574

070-318



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.

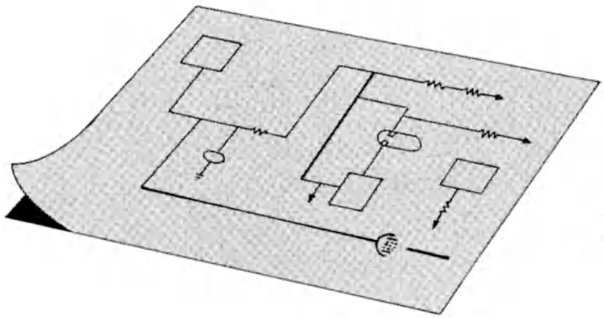
Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

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.

Specifications and price change privileges reserved.


VARIABLE
VOLTS/CM
2
1
.5
5
.2
10
.1
20
.05
CALIBRATED
1 MEG.
20 µµF
POLARITY
NORMAL
INVERTED
(+)
(−)
VERTICAL
POSITION
CHANNEL A
DC
AC
TEKTRONIX
GAIN
ADJ.
DC
BAL.
TYPE CA PLUG-IN UNIT
MODE
A ONLY
B ONLY
ALTERNATE
ADDED
ALGEBRAICALLY
CHOPPED
DUAL-TRACE
CALIBRATED PREAMP
.05-20 V/CM DC COUPLED
PREAMP RISETIME = .01 µSEC
GAIN
ADJ.
DC
BAL.
DC
AC
VARIABLE
VOLTS/CM
2
1
.5
CHANNEL B
5
.2
10
.1
20
.05
CALIBRATED
POLARITY
NORMAL
INVERTED
(+)
(−)
VERTICAL
POSITION
1 MEG.
20 µµF
SERIAL
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.

CONTENTS



SECTION 1

CHARACTERISTICS

GENERAL

The Type CA Unit contains two identical amplifier channels that can be electronically switched either by the oscilloscope sweep or at a free-running rate of approximately 100 kc. When amplifier switching is accomplished by the oscilloscope sweep, the two signals to be compared appear on alternate sweeps. Because the sweeps are identical, and time-delay characteristics of the two amplifier channels are closely controlled, time comparisons accurate within 1 nsec can be made.

Either amplifier channel can be used separately without electronic switching, making the Type

AMPLIFIER TRANSIENT RESPONSE

	Risetime	Passband	
With Instrument Type	INPUT SELECTOR switch in any position	INPUT SELECTOR switch in either DC position	INPUT SELECTOR switch in either AC position
541/541A, 545/545A, 555,581, 585	15nsec	DC to 24 Mc	2 cps to 24 Mc .2 cps to 22 Mc with P6000 or P6017 Probe
551	16 nsec	DC to 22 Mc	2 cps to 22 Mc .2 cps to 22 Mc with P6000 or P6017 Probe
531/531A, 533/533A, 535/535A	23nsec	DC to 15 Mc	2 cps to 10 Mc .2 cps to 10 Mc with P6000 or P6017 Probe.
536	35nsec	DC to 10 Mc	2 cps to 10 Mc .2 cps to 5 Mc with P6000 or P6017 Probe.
532	70nsec	DC to 5 Mc	2 cps to 10 Mc .2 cps to 5 Mc with P6000 or P6017 Probe.

CA also useful in all single-trace applications within its frequency-response and sensitivity capabilities. Maximum flexibility is obtained by providing separate positioning, sensitivity, and polarity-inverting controls for each channel.

Operating Modes

Channel A only.
Channel B only.
CHOPPED (Electronic switching at 100 kc.)
ALTERNATE (Electronic switching on alternate sweeps.)
ADDED ALGEBRAICALLY (Both channels combined at output (A +or- B)

Amplifier Sensitivity

Basic deflection factor--.05 v/cm, ac or dc.

Nine calibrated sensitivities--.05 v/cm to 20 v/cm, accurate within 3% when set on any one step.

Input Impedance

Plug-in alone 1 megohm shunted by 20 pf.

10 megohms at 14 pf with P6000 or P6017 probe.

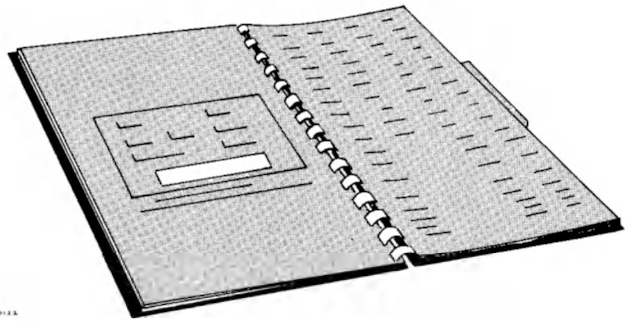
P410 probe with plug-in will be 10 megohms at 7.5 pf.

Physical Characteristics

Construction--Aluminum alloy chassis.
Finish--Photo-etched anodized panel.
Weight--4 1/2 lbs.

Accessories

2-Instruction Manuals.



SECTION 2

OPERATING INSTRUCTIONS

Plug the unit into a Tektronix convertible Oscilloscope and turn the power on. Allow the instrument to reach operating temperature, about 2 to 3 minutes and free-run the sweep at 1 millisecond/cm. Turn the MODE switch to A ONLY and the A-channel POLARITY and AC-DC switches to NORMAL and DC respectively. Position the trace to about +2 cm with the A-channel VERTICAL POSITION control.

Turn the MODE switch to B ONLY and the B-channel POLARITY and AC-DC switches to NORMAL and DC respectively. Position the trace to about -2 cm with the B-channel VERTICAL POSITION control.

Now turn the MODE switch to CHOPPED. Two traces will appear on the crt screen. Notice that the A-channel VERTICAL POSITION control moves the upper trace and the B-channel VERTICAL POSITION control moves the lower trace. Increase the sweep speed to 100 microsecond/cm and notice that each trace is composed of many start-duration elements. The two channels are being switched at approximately 100 kc so that each channel conducts for about 5μsec and then is cut off while the other channel conducts for an equal time.

Now turn the MODE switch to the ALTERNATE position. There are still two traces on the crt screen but the traces are no longer chopped into small bits. For each sweep cycle one channel is conducting and the other is cut off. The channels are switched at the end of each sweep cycle.

Note

Either of the two identical ampfilied channels can be used independently by turning the MODE switch to A ONLY or B ONLY and connecting the signal to be observed to the appropriate input. The following remarks apply equally well to either amplifier channel.

PROBE CHARACTERISTICS

PROBE TYPE	COLOR CODE	ATTENUA-TION RATIO	INPUT IMPEDANCE			INSERTION LOSS AT 30 mc (db)	VOLTAGE RATING (Peak-to-Peak)
			Resistance (megohms)	Typical Capacitance			
				Minimum*	Maximum**		
P410	Brown nose	10:1	10	8pf 12pf†	11pf 15pf†	1	600
P510	Black Nose	10:1	10		14pf	1	600
P6000	None	10:1	10	11.5pf	14.5pf	1.2	600
P6017	None	10:1	10	12.5pf	12.5pf	1	600

*When connected to instruments having 20 $\mu\mu$f capacitance (input).

**When connected to instruments with input capacitance up to 50 $\mu\mu$f.

†With 8-foot cable.

Probe Adjustment

An adjustable capacitor compensates for slight variations in input capacitance from one instrument to another. This capacitor is located in the probe body in the P510, P410, and in the termination block at the instrument end of the cable in the P6017. It takes only a few seconds to check this adjustment, and it is a good practice to make this check each time the probe is to be used. Simply touch the probe to the oscilloscope calibrator-output terminal and observe the calibrator waveform on the screen. If necessary, adjust the trimmer for a flat top on the calibrator square wave.

To adjust the Type P6000 probe, touch the probe tip to the calibrator output connector and display several cycles of the calibrator waveform. If the top and bottom of the displayed waveform is not flat, loosen the locking ring by turning it in a counterclockwise direction. Rotate the barrel of the probe as necessary to compensate the probe. Tighten the locking ring carefully after compensating the probe, being careful not to disturb the probe adjustment.

Input Coupling

It is sometimes undesirable to display the dc level of the waveform being observed. Placing the AC-DC switch in the AC position inserts a capacitor in series with the input so the dc component of the waveform is blocked and only the ac component is displayed. The low-frequency response is about 2 cps when ac coupling is used.

Output Polarity

It will be desirable to invert the displayed waveform at times, particularly when using the dual-trace feature of the Type CA. The POLARITY switch has two positions. In the NORMAL position the displayed waveform will have the same polarity as the input signal. In the INVERTED position the displayed waveform will be turned upside down; that is, a positive-going pulse will be displayed as a negative going pulse.

DC Balance Adjustment

After the plug-in unit has been in use for a period of time you will notice that the trace will change position as the VARIABLE control is rotated. This is caused by tube aging and the resultant shift in operating potentials. To correct this condition see Calibration Section.

Gain Adjustment

Aging of the tubes will also affect the gain of the plug-in unit. See Calibration Section for this adjustment.

Positioning Adjustment

The Vert Pos Range control balances the dc output level so the full range of the front-panel positioning controls can be utilized. See Calibration Section for this adjustment.

Types of Operation

Generally, three types of operation will be performed using the Type CA Unit; ALTERNATE, CHOPPED, and ADDED ALGEBRAICALLY. The three types of operation are fundamentally different so we will examine them in the order stated.

ALTERNATE

Connect the two signals to be compared to the two signal inputs and turn the MODE switch to A ONLY. Set the sweep up for triggered operation and adjust the VOLTS/CM and VERTICAL POSITION controls as necessary to display the waveform. Turn the MODE switch to B ONLY and adjust the corresponding controls as necessary to display the other waveform. Now turn the MODE switch to ALTERNATE. If necessary, touch up the oscilloscope's sweep triggering controls to obtain a stable image. Both waveforms will now be displayed on the crt screen. As the control of each amplifier is independent you can position, attenuate, or invert the signals as necessary to compare their shape, relative amplitudes, etc.

Use the AC LF REJECT triggering mode and ALTERNATE sweeps for INTernal triggering on signals having components above 10 kc. For lower-frequency signals, use the AC triggering mode. In the AC LF REJECT position, an rc filter is inserted into the circuit allowing it to recover quickly from the dc level changes encountered with the ALTERNATE sweep. To compare the phase difference between two signals, you should trigger externally using the reference signals as the trigger signal.

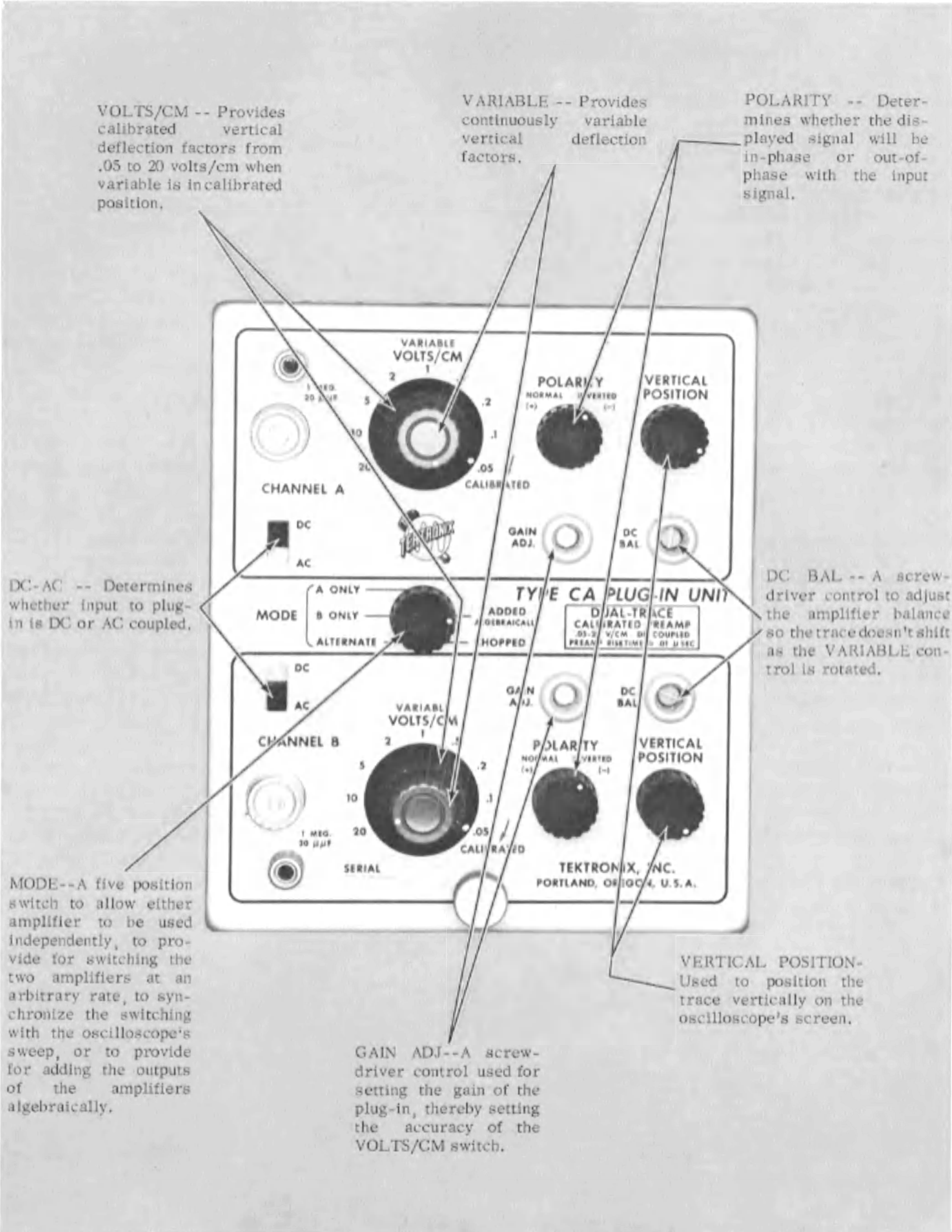


Fig. 2-1. Functions of the Type CA front panel controls.

CHOPPED

When it is necessary to observe a single transient at two parts of a circuit another procedure must be followed. In the foregoing case, one of the signals triggers the sweep and that amplifier remains conducting for the sweep duration. At the end of the sweep the amplifiers are switched and the other signal then triggers the sweep and that amplifier remains conducting for the sweep duration. Each of the signals is being displayed every other sweep cycle. If you attempted to observe a single transient in this manner the transient will pass through whichever amplifier happens to be conducting and will trigger the sweep. This will display the transient as seen by whichever amplifier is conducting but when the amplifiers are switched at the end of that sweep there will be no further signal to trigger another sweep until the next transient occurs. The problem here is to be able to observe the transient using both amplifiers during a single sweep cycle.

Turn the MODE switch to CHOPPED. Now the two amplifiers are being switched on and off independently of any signal. The switching rate is approximately 100 kc so each amplifier is conducting for about 5 μsec and then is cut off while the other amplifier conducts for an equal length of time.

It will usually be very difficult if not impossible to trigger the sweep internally from the signal so the triggering controls should be set for external triggering. The external triggering signal should bear a definite time relationship to the displayed signals.

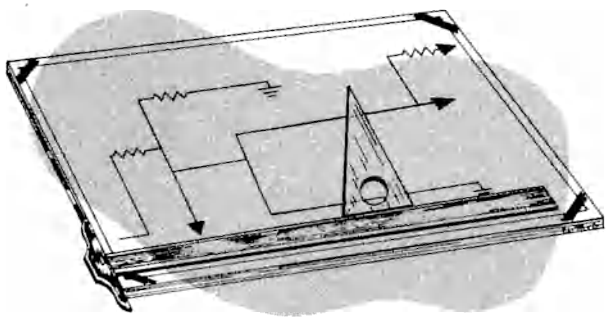
Note

It is possible that the displayed waveform could end up being the 100 kc switching waveform. This is possible particularly if the two traces are positioned very far apart.

The two signals to be observed will be connected to the two inputs and both waveforms will be displayed during one sweep cycle. Transients as short as 1 msec duration can be well delineated, with about 100 elements in each trace. As before, the independent control of each amplifier will allow you to position, attenuate, or invert the waveforms so they can be easily compared.

ADDED ALGEBRAICALLY

In many applications, the desired signal is superimposed on an undesired signal such as line frequency hum, etc. The Algebraic Output of the Type CA unit (with the MODE switch in the ADDED ALGEBRAICALLY position) makes it possible in many cases to improve the ratio of desired to undesired signal. Connect one input to a source containing both the desired and undesired signal. Connect the remaining input to a source containing only the undesired signal. Place the MODE switch in the ADDED ALGEBRICALLY position. Set the POLARITY switches to opposite polarities (depending upon the polarity of the desired signal). By careful adjustment, especially at low frequencies, of the VARIABLE controls and/or the GAIN ADJ. controls the amplitude of the undesired signal displayed can be reduced by a factor of 20 compared to the amplitude of the desired signal.



SECTION 3

CIRCUIT DESCRIPTION

AMPLIFIERS

The Type CA Plug-In Unit consists of two identical amplifier channels and a channel-switching multivibrator. The following description of the amplifiers applies equally well to either channel.

Input Coupling and Attenuation

The signal to be displayed is applied to the input cathode follower V3323 (V4323) by way of the AC-DC switch and the VOLTS/CM switch. The AC-DC switch is a two-position slide switch that bypasses C3300 (C4300) in the DC position so the input is dc coupled. In the AC position of this switch the signal must pass through C3300 (C4300) so the dc component of the signal is blocked.

The VOLTS/CM switch is a 9-position rotary switch that selects the various frequency-compensated rc attenuator sections. The sensitivity of the unit is .05 volts/cm. The input voltage is reduced by the eight individually selected attenuator sections to give nine fixed calibrated ranges.

Input Stage

The input stage consists of the cathode follower V3323 (V4323) and the cathode-coupled phase inverters V3334 and V3354 (V4334 and V4354). The control-grid dc level of V3334 (V4334) is established by the dc connection to the cathode of V3323 (V4323). The control-grid dc level of V3354 (V4354) is adjustable by means of the DC BAL controls so that the dc level of the cathodes of V3334 and V3354 (V4334 and V4354) can be made equal. Any dc level difference between these two cathodes would act as a signal and cause the trace to shift position when the VARIABLE control is rotated. The VARIABLE gain control establishes the amount of cathode coupling and thus allows the stage gain to be varied over about a 2 1/2 to 1 range.

The GAIN ADJ control permits the basic gain of the unit to be accurately set to agree with the front-panel calibration.

Polarity and Positioning

With the POLARITY switch in the NORMAL position the displayed waveform will have the same polarity as the input signal. Placing the POLARITY switch in the INVERTED position reverses the signal-grid connection of V3364 and V3374 (V4364 and V4374) and inverts the displayed waveform. Rotation of the VERTICAL POSITION control forces one plate of the input stage toward a higher potential and the opposite plate toward a lower potential. The resulting dc level shift moves the trace vertically.

Amplifier Stage and Output CF

The signal is further amplified by V3364 and V3374 or V4364 and V4374, depending on which channel is conducting. V3364 and V4364 have a common plate load and likewise V3374 and V4374. Since one amplifier is always cut off while the other is conducting, the shunt loading effect is negligible.

V4383 is the output cathode follower that provides a low-impedance source for driving the oscilloscope's vertical amplifier. The Vert. Pos. Range control located in the grid circuit of the output cathode followers permits the trace to be centered vertically under no-signal conditions.

SWITCHING CIRCUIT

A ONLY, B ONLY

V3375 is a multivibrator that is controlled by the MODE switch. With the MODE switch in the A ONLY or B ONLY position the multivibrator is held in one of its two possible states by returning one grid to a positive voltage and the other grid to a negative voltage. For example, in the A ONLY position the grid of V3375A is held positive and this half of the multivibrator conducts while the grid of V3375B is held negative and this half is cut off. When V3375A is conducting the cathode is above ground which causes V3384B to conduct and it in turn pulls the grid of V3393B toward ground lowering the plate voltage of V4334 and V4354. This reduced plate voltage cuts off the following stage (V4364 and V4374) and the B-channel amplifier is held in a non-conducting state. The converse is true of the A-channel amplifier. The grid of V3384A is near ground potential with reduced plate current, therefore, the plate of V3384A and consequently the grid of V3393A are permitted to become more positive thus providing plate voltage for V3334 and V3354. The A-channel amplifier then conducts.

ALTERNATE

Turning the MODE switch to the ALTERNATE position returns both grids of the multivibrator to a negative potential. It is then a bistable multivibrator. At the end of each sweep cycle a negative-going trigger is generated and is coupled to the multivibrator through the Trigger Coupling Diode V3382. Each trigger causes the multivibrator to "flip" from one stable state to the other. This alternately switches the amplifiers on and off. The switching rate is now determined by the repetition rate of the sweep.

CHOPPED

Turning the MODE switch to the CHOPPED position returns both grids of the multivibrator to a positive voltage and the multivibrator free runs at a rate determined by the time constant of the grid circuits. The two amplifiers are alternately cut off and allowed to conduct at the free-running rate of the multivibrator.

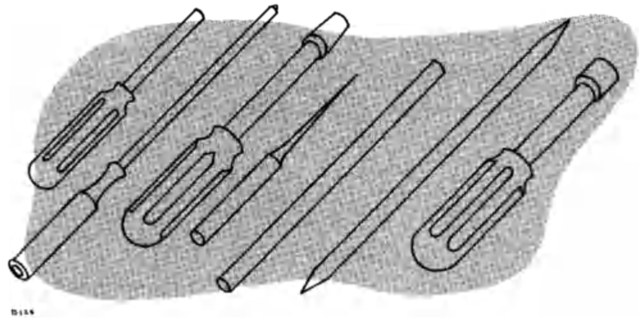
ADDED ALGEBRAICALLY

Turning the MODE switch to the ADDED ALGEBRAICALLY position returns both grids of the multivibrator to a negative voltage. Both sides of the multivibrator (V3375) are held sufficiently negative so that incoming triggers have no effect on the multivibrator grids. The cathodes of both halves of the multivibrator follow the grids down, driving V3384A and V3384B to cut off. With V3384A and V3384B cut off the plate voltage rises, carrying the grids of the following stages, V3393A and V3393B with it. The cathodes of V3393A and V3393B follow the grids up. When the cathodes are up, both amplifier channels conduct equally in the absence of any signal.

Note

> Plate voltage for the input amplifier stages of both channels is supplied by the cathodes of either V3393A or V3393B.

Under the conditions described above signals applied to both inputs will be amplified equally by either channel. Algebraic addition of the signal occurs at the grids of the output stage, V4383. In phase input signals add, out of phase input signals subtract, at the grid of each tube if the polarity switches are at the same setting.



SECTION 4

MAINTENANCE

PREVENTIVE MAINTENANCE

Calibration

The Type CA Plug-In Unit is designed for maximum stability and should not require frequent recalibration. However, to insure the accuracy of measurements, we suggest that you recalibrate the instrument after every 500-hour period of operation (or every six months if the unit is used intermittently). A complete step-by-step procedure for recalibrating the unit and checking its operation is given in the Calibration section of this manual. The accuracy of measurements made with the Type CA Unit depends not only on the accuracy of the Type CA Unit calibration but on the associated oscilloscope calibration as well. Therefore, it is essential that the oscilloscope be maintained in proper calibration.

Visual Inspection

Many potential and existent troubles can be detected by a visual inspection of the unit. for this reason, you should perform a complete visual check every time the instrument is recalibrated or repaired. Apparent defects may include loose or broken connections, damaged connectors, improperly seated tubes, scorched or burned parts, or broken terminal strips, as well as many other troubles. The remedy for these troubles is readily apparent except in the case of heat-damaged parts. Damage of parts due to heat is often the direct result of other, less apparent troubles in the circuit. It is essential that you determine the cause of overheating before replacing the damaged parts to prevent damage to the new components.

COMPONENT REPLACEMENT

The procedures for replacing most parts in the Type CA Unit are obvious. Detailed instructions for their removal are therefore not required. Other components, however, can best be removed if a definite procedure is followed or if certain precautions are taken. Additional information for the replacement of some of these parts is contained in the following paragraphs. Because of the nature of the instrument, replacement of certain parts will require that you recalibrate portions of the instrument to insure proper operation. Refer to the Calibration section of this manual.

Tubes

Care should be taken both in preventive and corrective maintenance that tubes are not replaced unless they are actually causing a definite circuit malfunction. Many times during routine maintenance it will be necessary for you to remove tubes from their sockets. It is important that these tubes be returned to the same sockets unless they are actually defective. Needless replacement or switching of tubes will many times result in unnecessary recalibration of the instrument. If tubes do require replacement, it is recommended that they be replaced by previously checked high-quality tubes.

Switches

Methods for removal of defective switches are, for the most part, obvious and only a normal amount of care is required. Single wafers are normally not replaced on the switches used in the Type CA Unit, and if one wafer is defective, the entire switch should be replaced. Switches may be ordered from Tektronix either wired or unwired as desired.

Soldering and Ceramic Strips

Many of the components in your Tektronix instrument are mounted on ceramic terminal strips. The notches in these strips are lined with a silver alloy. Repeated use of excessive heat, or use of ordinary tin-lead solder will break down the silver-to-ceramic bond. Occasional use of tin-lead solder will not break the bond if excessive heat is not applied.

If you are responsible for the maintenance of a large number of Tektronix instruments, or if you contemplate frequent parts changes, we recommend that you keep on hand a stock of solder containing about 3% silver. This type of solder is used frequently in printed circuitry and should be readily available from radio-supply houses. If you prefer, you can order directly from Tektronix in one-pound rolls. Order by Tektronix part number 251-514.

Because of the shape of the terminals on the ceramic strips it is advisable to use a wedge-shaped tip on your soldering iron when you are installing or removing parts from the strips. Fig. 4-1 will show you the correct shape for the tip of the soldering iron. Be sure and file smooth all surfaces of the iron which will be tinned. This prevents solder from building up on rough spots where it will quickly oxidize.

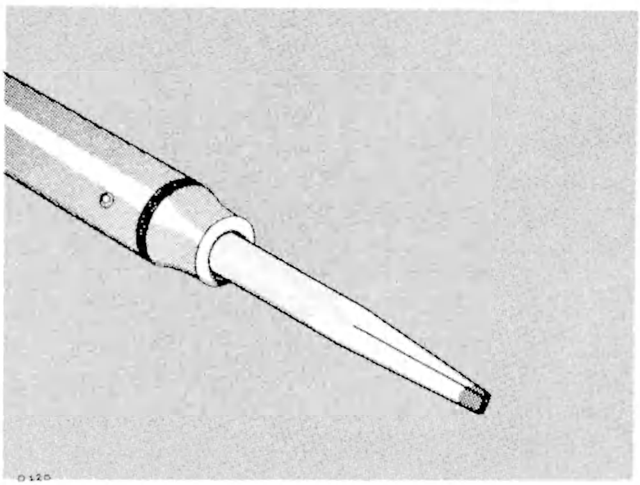


Fig. 4-1. Soldering iron tip properly shaped and tinned.

When removing or replacing components mounted on the ceramic strips you will find that satisfactory results are obtained if you proceed in the manner outlined below.

1. Use a soldering iron of about 75-watt rating.
2. Prepare the tip of the iron as shown in Fig. 4-1.
3. Tin only the first 1/16 to 1/8 inch of the tip. For soldering to ceramic terminal strips tin the iron with solder containing about 3% silver.
4. Apply only one corner of the tip to the notch where you wish to solder (see Fig. 4-2.

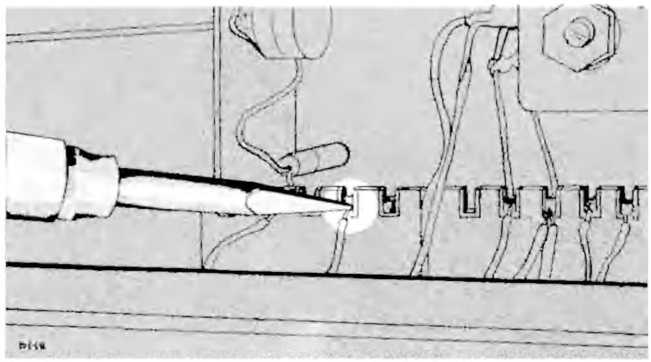


Fig. 4-2. Correct method of applying heat in soldering to a ceramic strip.

5. Apply only enough heat to make the solder flow freely.
6. Do not attempt to fill the notch on the strip with solder; instead, apply only enough solder to cover the wires adequately, and to form a slight fillet on the wire as shown in Fig. 4-3.

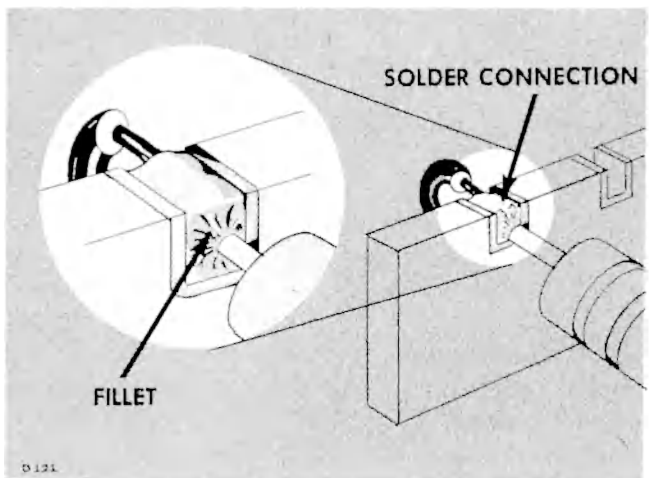


Fig. 4-3. A slight fillet of solder is formed around the wire when heat is applied correctly.

In soldering to metal terminals (for example, pins on a tube socket) a slightly different technique should be employed. Prepare the iron as outlined above, but tin with ordinary tin-lead solder. Apply the iron to the part to be soldered as shown in Fig. 4-4. Use only enough heat to allow the solder to flow freely along the wire so that a slight fillet will be formed as shown in Fig. 4-3.

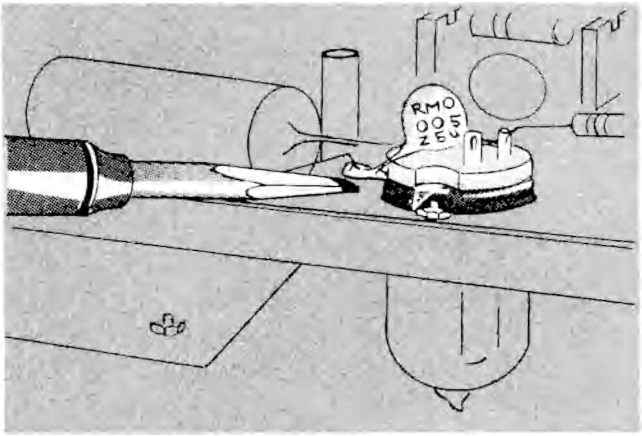


Fig. 4-4. Soldering to a terminal. Note the slight fillet of solder--exaggerated for clarity--formed around the wire.

General Soldering Considerations

When replacing wires in terminal slots clip the ends neatly as close to the solder joint as possible. In clipping ends or wires take care the end removed does not fly across the room as it is clipped.

Occasionally you will wish to hold a bare wire in place as it is being soldered. A handy device for this purpose is a short length of wooden dowel, with one end shaped as shown in Fig. 4-5. In soldering to terminal pins mounted in plastic rods it is necessary

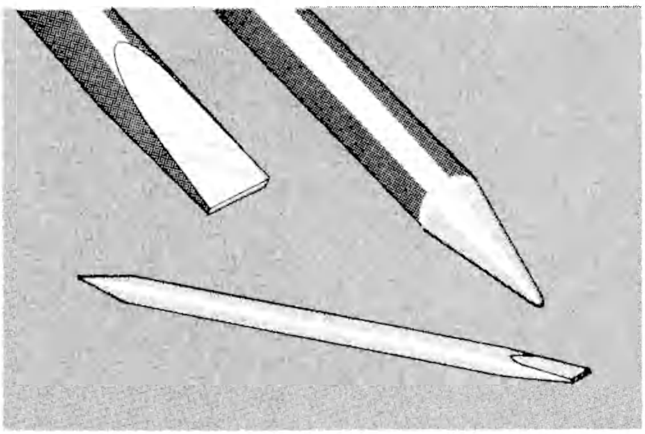


Fig. 4-5. A soldering aid constructed from a 1/4 inch wooden dowel.

to use some form of "heat sink" to avoid melting the plastic. A pair of long-nosed pliers (see Fig. 4-6) makes a convenient tool for this purpose.

Ceramic 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 Fig. 4-7.

To replace ceramic strips which bolt to the chassis, screw a #2-56 nut onto each mounting bolt, 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 glyptal. Insert the bolts through the holes in the chassis where the original

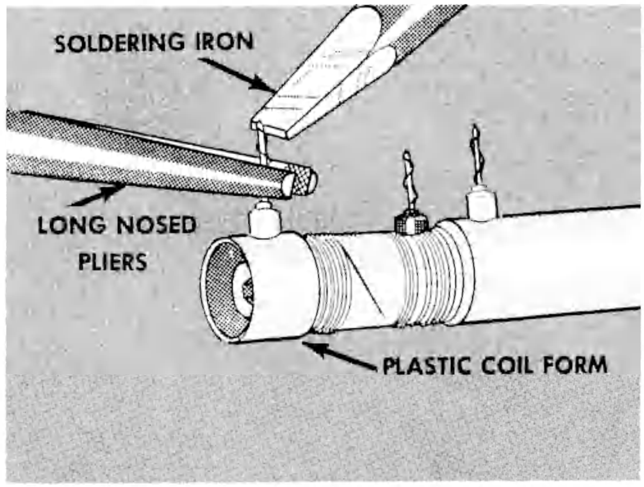


Fig. 4-6. Soldering to a terminal mounted in plastic. Note the use of the long-nosed pliers between the iron and the coil form to absorb the heat.

strip was mounted, placing a #2 starwasher between each nut and the chassis. Place a second set of #2 flatwashers on the protruding

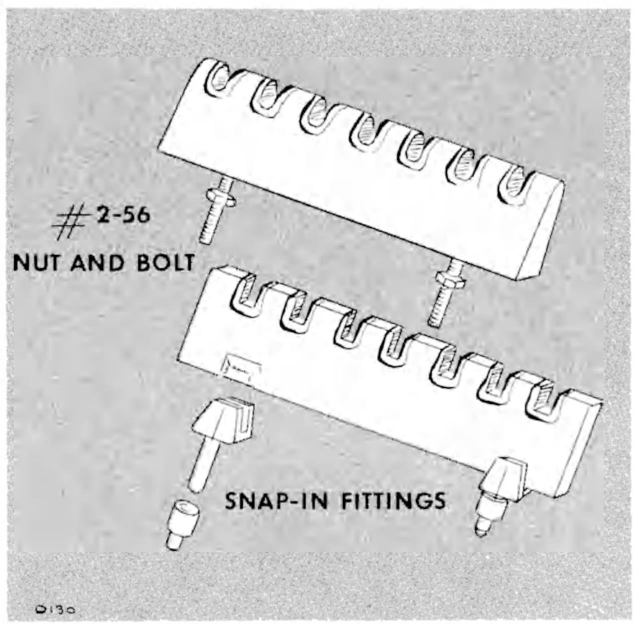


Fig. 4-7. Two types of ceramic strip mountings.

ends of the bolts, and fasten them firmly with another set #2-56 nuts. Place a drop of red glyptal over each of the second set of nuts after fastening.

Mounting Later Ceramic Strips

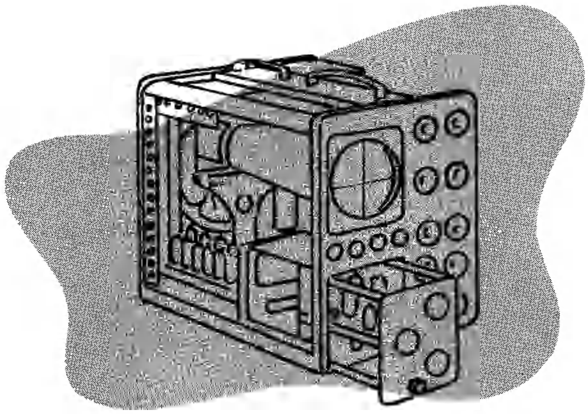
To replace strips which mount with snap-in plastic fittings, first remove the original fittings from the chassis. Assemble the mounting post on the ceramic strip. Insert the nylon collar into the mounting holes in the chassis. Carefully force the mounting post into the nylon collars. Snip off the portion of the mounting post which protrudes below the nylon collar on the reverse side of the chassis.

Note

Considerable force may be necessary to push the mounting rods into the nylon collars. Be sure that you apply this force to that area of ceramic strip directly above the mounting rods.

Color Coding

All wiring in the Type CA Unit is color coded to facilitate circuit tracing. Specific color codes are used to distinguish the leads for the power-supply voltages obtained from the oscilloscope. These power-supply leads follow the standard RETMA code. The -150 volts bus wire is coded brown-green-brown; the +350 volts bus is coded orange-green-brown; the +225 volts bus is coded red-red-brown and the +100 volts bus is coded brown-black-brown. The widest stripe identifies the first color of the code.



SECTION 5

CALIBRATION PROCEDURE

INTRODUCTION

Information contained in this section is provided as an aid to recalibrating and checking the operation of the Type CA Plug-In Unit. In addition, this section may be used to isolate troubles occuring within the unit.

Apparent troubles in the unit are often the result of improper calibration of one or more circuits. Consequently, calibration checks should be an integral part of the troubleshooting procedure. Abnormal indications occuring during calibration checks will often aid in isolating troubles to a definite circuit or stage.

In the instructions that follow, the steps are arranged in the proper sequence for a complete recalibration of the instrument. Each numbered step contains the information required to make one check, one adjustment, or a series of related adjustments or checks. The steps are arranged so that unnecessary repetition of certain checks is avoided.

In each calibration step only the required information is given. Detailed instructions pertaining to normal operation of the instrument are not included. If you are in doubt as to the proper operation of controls, refer to the Operating Instructions.

Controls not mentioned in a particular calibration step are assumed to be in the positions they were in during the previous step. All test equipment used in any particular step should be disconnected at the end of the step unless you are instructed to the contrary.

If a single control requires adjustment, it can be adjusted in the applicable step of this procedure without performing other steps as well. It will be necessary, however, that you refer to the calibration steps immediately preceding the adjustment you wish to make to determine the proper settings for the controls not mentioned in that step.

If you suspect that the unit is out of calibration but you are not aware of which particular adjustment will correct the difficulty, it is usually best to run through the entire calibration procedure. In this way you can be certain that the unit is properly calibrated without resorting to a method of random experimentation.

EQUIPMENT REQUIRED

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

1. Tektronix 540-Series convertible oscilloscope or equivalent.
2. DC voltmeter with sensitivity of at least 20,000-ohms per volt.
3. Ohmmeter.
4. Type 190 or 190A constant-Amplitude Signal Generator or equivalent, providing constant amplitude sine waves from about 50 kc to 30 mc with output amplitude constant within +or- 2%.
5. Type 105 Square-Wave Generator or equivalent with frequency range of about 25 cycles to 1 mc, risetime at least .02 microseconds and frequency indication accuracy of no poorer than +or- 3%.
6. Type 107 Square-Wave Generator or equivalent with frequency range of 400 kc to 1 mc, peak-to-peak output voltage of at least 0.1 to .5 volts, and risetime of 3 nanoseconds or less.

7. Tektronix 20pf Input Capacitance Standardizer, Tektronix part number 011-022.

8. 50 ohm 5XT attenuator, Tektronix Part Number 011-032.

9. 50 ohm cable termination, Tektronix Part Number 011-045.

10. Tektronix Type P52 Coaxial Cables, 52 ohms characteristic impedance.

11. Tektronix Dual Input Connector, see Fig. 5-1. Tektronix Part Number 003-035.

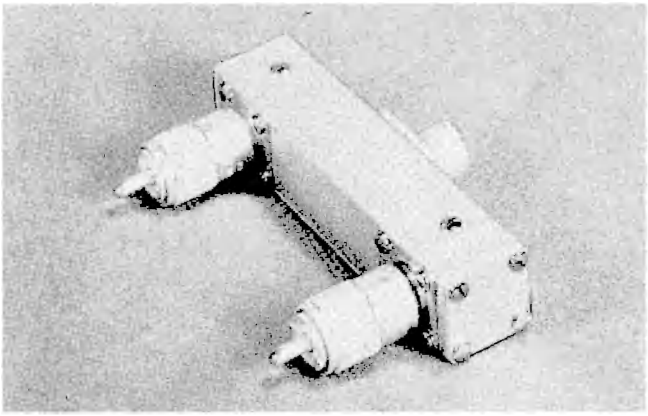


Fig. 5-1. Special Dual-Input coax connector.

12. Miscellaneous alignment tools. See Fig. 5-2.

PROCEDURE

1. Preliminary Check

Before installing the Type CA Plug-In Unit in the oscilloscope, make a careful visual inspection of the wire dress. This is particularly important if any soldering has been done to the unit. Then make the following resistance-to-ground checks at the 16-pin interconnecting plug. The table below lists the nominal resistance value from each pin to ground.

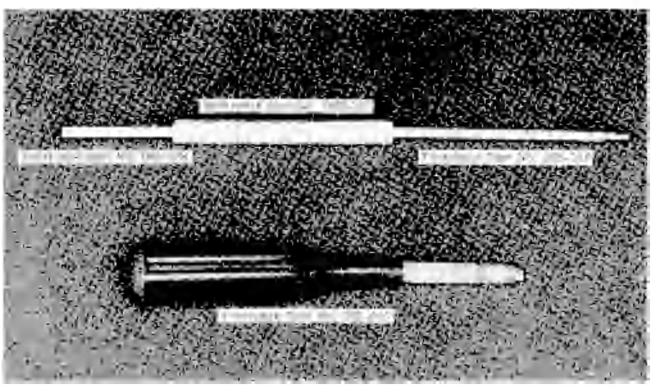


Fig. 5-2. Low capacitance, insulated alignment tools used to calibrate the Type CA.

NOMINAL RESISTANCES AT INTERCONNECTING PLUG

PIN NUMBER	RESISTANCE-TO-GROUND
1	8.5k
2	0
3	8.5k
4	infinite
5	infinite
6	infinite
7	infinite
8	0 (MODE switch at ALTERNATE)
9	12k
10	2k
11	6.3k
12	infinite
13	infinite
14	infinite
15	65Ω
16	infinite

Install the Type CA Unit in the oscilloscope. Turn on all the test equipment and allow 15 minutes for it to warm up. Set the oscilloscope controls as follows:

HORIZONTAL DISPLAY	INTERNAL SWEEP (541A) MAIN SWEEP NORMAL (545A)
TRIGGERING MODE	AUTOMATIC
TRIGGER SLOPE	-INT
STABILITY	PRESET
TIME/CM	1 MILLISEC

After the oscilloscope has warmed up, adjust the -150 Adj. so that a reading of exactly +100 volts is obtained from the +100 volt power supply of the oscilloscope.

Now preset the Type CA controls as follows:

VOLTS/CM (A and B)	.05

VARIABLE VOLTS/CM (A and B)	full right (cw)
POLARITY (A and B)	NORMAL
AC-DC (A and B)	DC
DC BAL (A and B)	mid-range
MODE switch	ALTERNATE

2. Balancing Output Stage

Connect a shorting strap between pins 1 and 3 of the 16-pin interconnecting plug. Note the vertical level of the trace. What you have just found is the vertical-system electrical center of the oscilloscope.

Now connect the shorting strap between pins 2 and 7 of V4383. The trace should now fall within 2 cm of the vertical-system electrical center just observed If it doesn't, select a new tube for V4383 which will bring it within this tolerance.

3. Adjusting DC BAL (R3341 and R4341)

Position the trace of each channel to the center graticule line. Now while rotating the VARIABLE VOLTS/CM control through its complete range, adjust the DC BAL so that the trace will remain stationary. This must be done to each channel.

4. Vertical Position Range Adjustment (R4376)

Set both of the VERTICAL POSITION controls to mid-range. Adjust the Vert. Pos. Range adjustment so that the two traces will be equidistant above and below the vertical-system electrical center found in step 2.

5. Checking POLARITY Switch

With the MODE switch in ALTERNATE position the traces to the center of the CRT. Now switch the POLARITY switches from NORMAL to INVERTED. The traces should not shift more than one centimeter.

Switch the MODE switch to ADDED ALGEBRAICALLY and the POLARITY switches to NORMAL. Position the VERTICAL POSITION controls to mid-range and check to see that the trace is within 2 cm of the vertical-system electrical center.

With the MODE switch back in the ALTERNATE position measure the voltage from pin 1 or 3, of the 16 pin interconnecting plug, to ground. This voltage should be between 66.5 volts and 68 volts.

6. Check for Gas and Microphonics

Gas check: With the input connectors grounded turn the AC-DC switches from DC to AC and observe the vertical drift of the traces. This drift should not be more than 2 millimeters.

Microphonic check: Rap the Type CA Unit lightly on the front panel and watch for the excessive ringing type of microphonics.

7. Check for Proper ALTERNATE CHOPPED Operation

Reset the oscilloscope's TIME/CM control to .1 SEC and with the plug-in MODE switch in ALTERNATE, position the two traces about 2 cm apart. Check to see that each time the sweep is triggered the trace alternates between A and B channels.

For the CHOPPED check set the TIME/CM switch on the oscilloscope to 10 microsec and the plug-in MODE switch to CHOPPED. Observe that the wave form should be approximately flat on the top and bottom.

8. GAIN ADJ. (R3356 and R4356)

Set oscilloscope as follows:

TIME/CM	1 MILLISEC
AMPLITUDE CALIBRATOR	.1 VOLT

Set the Type CA as follows:

MODE	ALTERNATE
VOLTS/CM (A and B)	.05
VARIABLE VOLTS/CM (A and B)	full right (cw)
AC-DC (A and B)	DC

Connect a jumper between the CAL OUT connector of the oscilloscope and both of the vertical input connectors of the Type CA Unit. With .1 VOLT of calibrator applied to each channel adjust the GAIN ADJ, of each channel, for 2 cm of vertical deflection on the CRT.

9. Check Operation of AC-DC Switch

With all controls set as in Step 8 position the bottom of the calibrator waveforms to the center graticule line. Now switch the AC-DC switch to AC. The waveforms should shift down so that the center graticule line will now be approximately through the center of the waveforms.

10. Check ADDED ALGEBRAICALLY Position of MODE Switch

Set plug-in controls to:

AC-DC (A and B)	DC
MODE	ADDED ALGEBRA-ICALLY

With the same amount of calibrator signal still applied as in step 9 check to see that there is 4 cm of deflection on the crt.

Now apply one volt of calibrator signal from the oscilloscope to each of the vertical inputs of the Type CA Unit. Turn the A channel POLARITY switch to INVERTED. The two signals should now cancel each other out within 1 cm. You may adjust the VERTICAL POSITION controls to accomplish this cancellation. If the cancellation just described doesn't take place, reset the A channel POLARITY switch to NORMAL and the B channel POLARITY switch to INVERTED. Now check for proper cancellation. The unit is satisfactory if either condition will permit the proper cancellation of the signal.

11. Checking VOLTS/CM Switch Position

Reset the plug-in controls as follows:

MODE	ALTERNATE
POLARITY (A and B)	NORMAL

Connect a jumper from the CAL OUT connector of A channel of the plug-in. Check for the correct deflection in each position of the VOLTS/CM switch. Now remove the jumper from A and connect it to B channel. Run through the check on this channel as you did on A channel.

Note

At the factory the accuracy of the VOLTS/CM switch is checked with an AMPLITUDE CALIBRATOR Standardizer, which employs 1/4% resistors.

VOLTS/CM Switch	AMPLITUDE CALIBRATOR VOLTS	VERTICAL CRT DEFLECTION
.05	.2	4 cm
.1	.2	2 cm
.2	.5	2.5 cm
.5	2	4 cm
1	2	2 cm
2	5	2.5 cm
5	20	4 cm
10	20	2 cm
20	50	2.5 cm

12. Adjust Input Capacitors (C3322 and C4322)

Set the VOLTS/CM switches of the Type CA Unit to .05. Apply a 1 kc signal from the Type 105 Square-Wave Generator to the Type CA Plug-In, through the P52 cable, the 5XT and capacitance standardizer. The capacitance standardizer should be connected between the P52 cable and the Type CA Unit with the 5XT between the P52 cable and the capacitance standardizer.

Attach the Type 105 to the A channel input connector of the Type CA Unit and adjust the Type 105 Output Amplitude for a deflection of approximately 3.5 cm on the oscilloscope's crt. Now adjust C3322 for optimum flat top on the waveform. Then connect the Type 105 to the B channel input connector of the Type CA Unit and adjust C4322 for optimum flat top.

13. Adjust VOLTS/CM Compensations

Maintain the same output frequency and amplitude from the Type 105 Square-Wave Generator as in step 12. Remove the capacitance standardizer from the P52 cable and install the 5XT directly to A channel input connector. When the adjustments to A channel have been completed connect the cable from the Type 105 to the B channel input connector and proceed with the adjustments for this channel. See the charts below for the adjustments to each channel. Note: When the .5 VOLTS/CM position is reached the 5XT attenuator must be removed.

A Channel Adjustments

VOLTS/CM Switch	Adj for Optimum Square Corner	Adj for Optimum Flat Top
.1	C3311C	C3311B
.2	C3312C	C3312B
.5	C3313C	C3313B
1	C3314C	C3314B
2	C3315C	C3315B
5	C3316C	C3316B
10	C3317C	C3317B
20	C3318C	C3318B

B Channel Adjustments

VOLTS/CM Switch	Adj for Optimum Square Corner	Adj for Optimum Flat Top
.1	C4311C	C4311B
.2	C4312C	C4312B
.5	C4313C	C4313B
1	C4314C	C4314B
2	C4315C	C4315B
5	C4316C	C4316B
10	C4317C	C4317B
20	C4318C	C4318B

14. H. F. Compensations

Set oscilloscope controls as follows:

TIME/CM	.2 MICROSEC

Set plug-in controls as follows:

VOLTS/CM (A and B)	.1
MODE	B ONLY

Connect the Type 107 Square-Wave Generator to the channel B input connector of the Type CA Unit, installing the Terminating Resistor between the P52 cable and the plug-in unit. Adjust the Approximate Amplitude control on the Type 107 for 3 cm of vertical deflection on the crt of the oscilloscope. Adjust the Approximate Frequency control for an approximate output frequency of 450 kc.

Now adjust L3364, L4374, L4362, L4372, L4334 and L4354 for an optimum square corner with no overshoot on the square-wave signal.

Set the MODE switch of the Type CA Unit to A ONLY and connect the Type 107, in the same manner as above, to the A channel vertical input connector. For channel A adjust L3362, L3372, L3354 and L3334 for an optimum square corner with no overshoot on the square-wave signal.

Note

When you are finished check to see that the plugs in the coils are all approximately the same depth inside the coil form. If they aren't readjust until this condition is obtained.

15. Frequency Response

The oscilloscope controls should be set as follows.

TRIGGERING MODE	AC LF REJECT
TIME/CM	.1 MILLISEC
STABILITY	full right (cw)

The plug-in controls will be set to:

VOLTS/CM (A and B)	.05
MODE	B ONLY

Adjust the Type 190 Constant Amplitude Signal Generator to obtain an output frequency of 50 kc. Attach the Type 190 to the B channel vertical input connector installing the 5XT between the 190 attenuator box and the plug-in. Adjust the Output Amplitude control on the Type 190 to obtain exactly 3 cm of vertical deflection on the crt. Adjust the Type 190 for an output frequency of 24 mc making sure not to move the Output Amplitude control. There should now be at least 2.1 cm of vertical deflection remaining.

Turn the MODE switch to A ONLY and connect the Type 190 to the B channel vertical input connector. Make sure not to disturb the control settings of the Type 190 when making this transfer. The A channel should also have at least 2.1 cm of vertical deflection.

16. High Frequency Rejection Check

Remove the Type 190 and the 5XT from the A channel vertical input connector. Install the Dual Input Connector on the Type CA Unit and then reinstall the 5XT and the Type 190 on its connector.

Adjust the Type 190 to obtain an output frequency of 50 kc and an output amplitude of one volt, as read on the meter of the Type 190. Now without changing the output amplitude of the Type 190, increase the frequency of the Type 190 to 24 mc.

Turn the MODE switch to ADDED ALGEBRAICALLY and switch the POLARITY switch of A channel to INVERTED. With the waveform positioned to the vertical system electrical center a cancellation of the signal, within 1 cm, should occur. If the cancellation just described doesn't take place try returning the A channel POLARITY switch to NORMAL and changing the B channel POLARITY switch to INVERTED. The plug-in is satisfactory if either condition will permit proper cancellation of the signal.

Now position both the AC-DC switches to AC and check to see that you have cancellation of the signal within one centimeter.

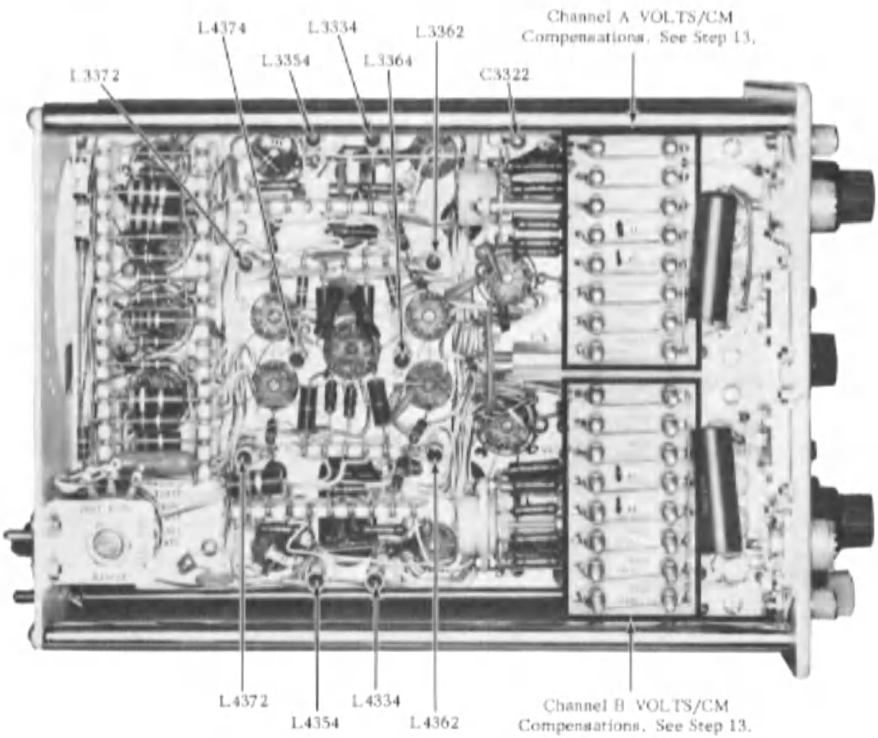


Fig. 5-3. Left side view of Type CA Unit showing location of adjustments.

PARTS LIST *and* DIAGRAMS

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
μμ	Micromicro or 10^{-12}	w	Watt
m	milli or 10^{-3}	WW	Wire-wound

SPECIAL NOTES AND SYMBOLS

+ and up

† Approximate serial number.

X000 Part first added at this serial number.

000X Part removed after this serial number.

* 000-000 Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, also reworked or checked components.

(Mod. w/) Simple replacement not recommended. Modify to value for later instruments and change other parts to match.

HOW TO ORDER PARTS

Replacement parts are available through your local Tektronix Field Office.

Improvements in Tektronix instruments are incorporated as soon as available. Therefore, when ordering a replacement part it is important to supply the part number including any suffix, instrument type, serial number, plus a modification number where applicable.

If the part you have ordered has been improved or replaced, your local Field Office will contact you if there is a change in part number.

PARTS LIST

Capacitors

Values are fixed unless marked Variable.

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part Number	Description					S/N Range
C3300	Use *285-556	.1 μf	PTM		600 v		
C3310C	281-524	150 μμf	Cer.		500 v		
C3311B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3311C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3311D††	Selected	Nominal value 8 μμf					
C3312B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3312C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3312D††	Selected						
C3312E	281-534	3.3 μμf	Cer.		500 v	±.25 μμf	
C3313B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3313C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3313D††	Selected						
C3313E	281-511	22 μμf	Cer.		500 v	10%	
C3314B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3314C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3314E	281-519	47 μμf	Cer.		500 v	10%	
C3315B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3315C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3315E	281-519	47 μμf	Cer.	Var.	500 v	10%	
C3315F	281-519	47 μμf	Cer.	Var.	500 v	10%	
C3316A†							
C3316B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3316C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3316E	283-539	250 μμf	Mica		500 v	10%	
C3317A†							
C3317B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3317C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3317E	283-541	500 μμf	Mica		500 v	10%	
C3318A††	Selected						
C3318B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3318C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3318E	283-540	750 μμf	Mica		500 v	10%	
C3321	283-003	.01 μf	Hi-Kap.		150 v	GMV	
C3322	281-027	.7-3 μμf	Tub.	Var.	500 v		
C3345	283-001	.005 μf	Discap		500 v	GMV	
C3354	281-518	47 μμf	Cer.		500 v		
C3374	283-001	.005 μf	Discap		500 v	GMV	
C3375	281-506	12 μμf	Cer.		500 v	10%	
C3378	281-519	47 μμf	Cer.		500 v	10%	
C3385	281-506	12 μμf	Cer.		500 v	10%	
C3388	281-519	47 μμf	Cer.		500 v	10%	
C4300	Use *285-556	.1 μf	PTM		600 v		
C4310C	281-524	150 μμf	Cer.		500 v		
C4311B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4311C	281-027	.7-3 μμf	Tub.	Var.	500 v		

† Added where needed.
†† These Capacitors are selected during calibration.

Capacitors *(continued)*

Ckt. No.	Tektronix Part Number	Description					S/N Range
C4311D††	Selected						
C4312B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4312C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4312D††	Selected						
C4312E	281-534	3.3 μμf	Cer.		500 v	±.25 μμf	
C4313B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4313C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4313D††	Selected						
C4313E	281-511	22 μμf	Cer.		500 v	10%	
C4314B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4314C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4314E	281-519	47 μμf	Cer.		500 v	10%	
C4315A†							
C4315B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4315C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4315E	281-519	47 μμf	Cer.		500 v	10%	
C4315F	281-519	47 μμf	Cer.		500 v	10%	
C4316A††	Selected						
C4316B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4316C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4316E	283-539	250 μμf	Mica		500 v	10%	
C4317A††	Selected						
C4317B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4317C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4317E	283-541	500 μμf	Mica		500 v	10%	
C4318A††	Selected						
C4318B	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4318C	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4318E	283-540	750 μμf	Mica		500 v	10%	
C4321	283-003	.01 μf	Hi-Kap		150 v	GMV	
C4322	281-027	.7-3 μμf	Tub.	Var.	500 v		
C4334	281-518	47 μμf	Cer.		500 v		
C4345	283-001	.005 μf	Discap		500 v	GMV	
C4384	283-000	.001 μf	Discap		500 v	GMV	
C4385	283-000	.001 μf	Discap		500 v	GMV	
C4390	283-001	.005 μf	Discap		500 v	GMV	
C4391	283-002	.01 μf	Discap		500 v	GMV	
C4393	283-002	.01 μf	Discap		500 v	GMV	
C4397	283-001	.005 μf	Discap		500 v	GMV	
C4398	283-001	.005 μf	Discap		500 v	GMV	
C4399	283-001	.005 μf	Discap		500 v	GMV	

Inductors

L3334	*114-043	.5-1 μh	Var.	core 276-506
L3354	*114-043	.5-1 μh	Var.	core 276-506
L3360	*108-072	.75 μh		
L3361	*108-072	.75 μh		
L3362	*114-051	.9-1.6 μh	Var.	core 276-506

†† These Capacitors are selected during calibration.
† Added where needed.

Inductors *(continued)*

Ckt. No.	Tektronix Part Number	Description			S/N Range
L3364	*114-042	Special			
L3370	*108-072	.75 μh			
L3371	*108-072	.75 μh			
L3372	*114-051	.9-1.6 μh	Var.	core 276-506	
L4334	*114-043	.5-1 μh	Var.	core 276-506	
L4354	*114-043	.5-1 μh	Var.	core 276-506	
L4360	*108-072	.75 μh			
L4361	*108-072	.75 μh			
L4362	*114-051	.9-1.6 μh	Var.	core 276-506	
L4370	*108-072	.75 μh			
L4371	*108-072	.75 μh			
L4372	*114-051	.9-1.6 μh	Var.	core 276-506	
L4374	*114-042	Special			
L4384	*108-112	.3 μh			
L4385	*108-112	.3 μh			

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R3310C	302-330	33 Ω	½ w			101-14520
	316-470	47 Ω	¼ w			14521-up
R3310E	302-470	47 Ω	½ w			101-14520
	316-470	47 Ω	¼ w			14521-up
R3311C	309-003	500 k	½ w	Prec.	1%	
R3311D	302-470	47 Ω	½ w			X25730-up
R3311E	309-014	1 meg	½ w	Prec.	1%	
R3312C	309-010	750 k	½ w	Prec.	1%	
R3312E	309-053	333 k	½ w	Prec.	1%	
R3313C	309-111	900 k	½ w	Prec.	1%	
R3313E	309-046	111 k	½ w	Prec.	1%	
R3314C	309-143	950 k	½ w	Prec.	1%	
R3314E	309-137	52.6 k	½ w	Prec.	1%	
R3315C	309-144	975 k	½ w	Prec.	1%	
R3315E	309-136	25.6 k	½ w	Prec.	1%	
R3316C	309-013	990 k	½ w	Prec.	1%	
R3316D	302-100	10 Ω	½ w			
R3316E	309-034	10.1 k	½ w	Prec.	1%	
R3317C	309-146	995 k	½ w	Prec.	1%	
R3317D	302-100	10 Ω	½ w			
R3317E	309-134	5.03 k	½ w	Prec.	1%	
R3318C	309-147	997.5 k	½ w	Prec.	1%	
R3318D	302-100	10 Ω	½ w			
R3318E	309-133	2.51 k	½ w	Prec.	1%	
R3320	309-014	1 meg	½ w	Prec.	1%	
R3321	302-105	1 meg	½ w			101-14520
	316-105	1 meg	¼ w			14521-up
R3322	302-470	47 Ω	½ w			101-14520
	316-470	47 Ω	¼ w			14521-up

Resistors *(continued)*

Ckt. No.	Tektronix Part Number	Description					S/N Range
R3323	316-470	47 Ω	¼ w				X25730-up
R3324	306-223	22 k	2 w				
R3332	302-270	27 Ω	½ w				
R3334	309-250	500 Ω	½ w		Prec.	1%	
R3337	309-132	5.6 k	½ w		Prec.	1%	
R3338	Use *311-279	770 Ω		Var.	WW	VARIABLE	
R3341	311-018	20 k	2 w	Var.		DC BAL.	
R3343	304-223	22k	1 w				
R3344	302-104	100 k	½ w				
R3345	302-561	560 Ω	½ w				
R3354	309-250	500 Ω	½ w		Prec.	1%	
R3355	308-053	8 k	5 w		WW	5%	
R3356	311-015	10 k	2 w	Var.	WW	GAIN ADJ.	101-39599
	311-294	15 k	2 w	Var.	WW	GAIN ADJ.	39600-up
R3357	309-132	5.6 k	½ w		Prec.	1%	
R3360	302-154	150 k	½ w				
R3361	311-028	2 x 100 k	2 w	Var.		VERT. POS.	
R3362	302-470	47 Ω	½ w				
R3364	Use 309-102	402 Ω	½ w		Prec.	1%	
R3365	*312-591	20 k	10 w		WW	5% (1 pair, matched to ±1% of each other)	
R3366	*312-590	6 k	5 w		WW	5% (1 pair, matched to ±1% of each other)	
R3370	302-154	150 k	½ w				
R3371	306-392	3.9 k	2 w				
R3372	302-470	47 Ω	½ w				
R3373	304-562	5.6 k	1 w				
R3374	301-303	30 k	½ w			5%	
R3375	306-333	33 k	2 w				
R3376	302-471	470 Ω	½ w				
R3377	302-101	100 Ω	½ w				
R3378	301-164	160 k	½ w			5%	
R3379	301-204	200 k	½ w			5%	
R3380	302-224	220 k	½ w				
R3383	316-334	330 k	¼ w				X34790-up
R3385	306-333	33 k	2 w				
R3386	302-471	470 Ω	½ w				
R3387	302-101	100 Ω	½ w				
R3388	301-164	160 k	½ w			5%	
R3389	301-204	200 k	½ w			5%	
R3390	302-224	220 k	½ w				
R3393	302-472	4.7 k	½ w				
R3394	302-472	4.7 k	½ w				
R3395	304-683	68 k	1 w				
R3396	302-123	12 k	½ w				
R3398	302-101	100 Ω	½ w				
R3399	302-101	100 Ω	½ w				
R4310C	302-330	33 Ω	½ w				101-14320
	316-470	47 Ω	¼ w				14321-up
R4310E	302-470	47 Ω	½ w				101-14320
	316-470	47 Ω	¼ w				14321-up
R4311C	309-003	500 k	½ w		Prec.	1%	
R4311D	302-470	47 Ω	½ w				X25730-up
R4311E	309-014	1 meg	½ w		Prec.	1%	

Ckt. No.	Tektronix Part Number	Description						S/N Range
R4312C	309-010	750 k	½ w		Prec.	1%		
R4312E	309-053	333 k	½ w		Prec.	1%		
R4313C	309-111	900 k	½ w		Prec.	1%		
R4313E	309-046	111 k	½ w		Prec.	1%		
R4314C	309-143	950 k	½ w		Prec.	1%		
R4314E	309-137	52.6 k	½ w		Prec	1%		
R4315C	309-144	975 k	½ w		Prec.	1%		
R4315E	309-136	25.6 k	½ w		Prec.	1%		
R4316C	309-013	990 k	½ w		Prec.	1%		
R4316D	302-100	10 Ω	½ w					
R4316E	309-034	10.1 k	½ w		Prec.	1%		
R4317C	309-146	995 k	½ w		Prec.	1%		
R4317D	302-100	10 Ω	½ w					
R4317E	309-134	5.03 k	½ w		Prec.	1%		
R4318C	309-147	997.5 k	½ w		Prec.	1%		
R4318D	302-100	10 Ω	½ w					
R4318E	309-133	2.51 k	½ w		Prec.	1%		
R4320	309-014	1 meg	½ w		Prec.	1%		
R4321	302-105	1 meg	½ w					101-14520
	316-105	1 meg	¼ w					14521-up
R4322	302-470	47 Ω	½ w					101-14520
	316-470	47 Ω	¼ w					14521-up
R4323	316-470	47 Ω	¼ w					X25730-up
R4324	306-223	22 k	2 w					
R4332	302-270	27 Ω	½ w					
R4334	309-250	500 Ω	½ w		Prec.	1%		
R4337	309-132	5.6 k	½ w		Prec.	1%		
R4338	Use *311-279	770 Ω		Var.	WW	VARIABLE		
R4341	311-018	20 k	2 w	Var.		DC BAL.		
R4343	304-223	22 k	1 w					
R4344	302-104	100 k	½ w					
R4345	302-561	560 Ω	½ w					
R4354	309-250	500 Ω	½ w		Prec.	1%		
R4355	308-053	8 k	5 w		WW	5%		
R4356	311-015	10 k	2 w	Var.	WW	GAIN ADJ.		101-39599
	311-294	15 k	2 w	Var.	WW	GAIN ADJ.		39600-up
R4357	309-132	5.6 k	½ w		Prec.	1%		
R4360	302-154	150 k	½ w					
R4361	311-028	2 x 100 k	2 w	Var.		VERT. POS.		
R4362	302-470	47 Ω	½ w					
R4365	*312-591	20 k	10 w		WW	5%	(1 pair matched ±1% of each other)	
R4366	*312-590	6 k	5 w		WW	5%	(1 pair matched ±1% of each other)	
R4370	302-154	150 k	½ w					
R4372	302-470	47 Ω	½ w					
R4374	Use 309-102	402 Ω	½ w		Prec.	1%		
R4375	302-104	100 k	½ w					
R4376	311-051	2 x 100 k	2 w			Vert. Pos. & Range		
R4377	302-104	100 k	½ w					
R4382	304-182	1.8 k	1 w					
R4383	303-822	8.2 k	1 w			5%		
R4384	303-822	8.2 k	1 w			5%		

Resistors *(continued)*

Ckt. No.	Tektronix Part Number	Description				S/N Range
R4385	303-822	8.2 k	1 w		5%	
R4386	303-822	8.2 k	1 w		5%	
R4391	302-270	27 Ω	½ w			
R4393	302-270	27 Ω	½ w			
R4395	308-062	3 k	5 w	WW	5%	
R4397	306-153	15 k	2 w			

Switches

	Unwired	Wired			
SW3300	Use 260-330		Slide	AC-DC	
SW3310	*260-146	*262-118	Rotary	VOLTS/CM A	101-25729
	*260-146	*262-483			25730-up
SW3360	*260-148		Rotary	POLARITY	
SW3380	*260-244		Rotary	MODE	
SW4300	Use 260-330		Slide	AC-DC	
SW4310	*260-146	*262-119	Rotary	VOLTS/CM B	101-25729
	*260-146	*262-484			25730-up
SW4360	*260-148		Rotary	POLARITY	

Electron Tubes

V3323	154-014	6AK5	
V3334	154-040	12AU6	
V3354	154-040	12AU6	
V3364 } V3374 }	Use *157-059	6AU6	Selected pair. Furnished as a unit.
V3375	154-039	12AT7	
V3382	154-016	6AL5	
V3384	154-039	12AT7	
V3393	154-039	12AT7	
V4323	154-014	6AK5	
V4334	154-040	12AU6	
V4354	154-040	12AU6	
V4364 } V4374 }	Use *157-059	6AU6	Selected pair. Furnished as a unit.
V4383	154-039	12AT7	

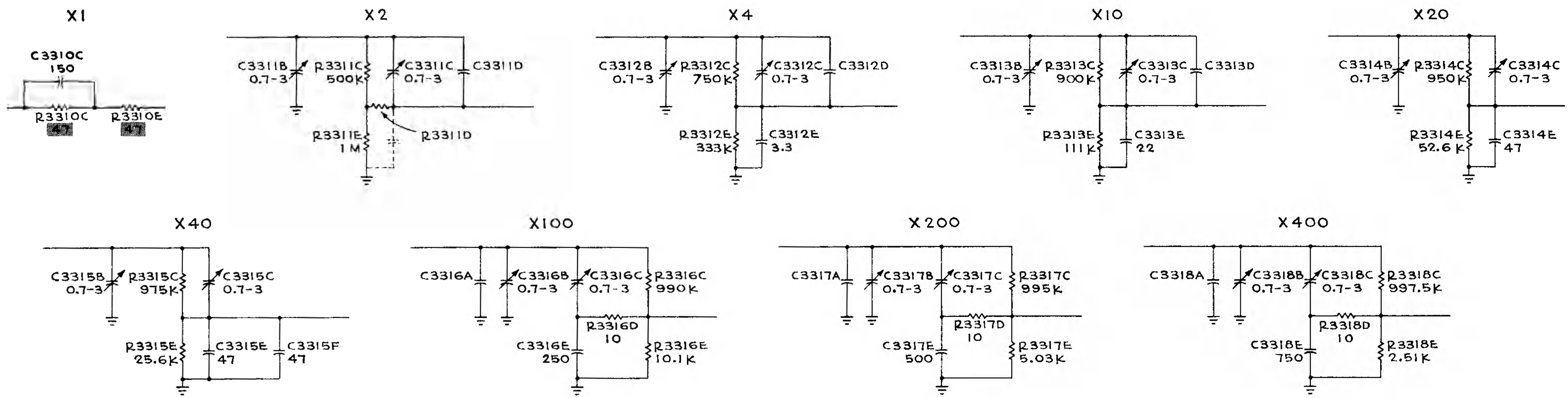
Type CA
Mechanical Parts List

	Part Number Tektronix
BRACKET, POT. MTG., VER. POS. RANGE	406-127
BRACKET, $5\frac{7}{8} \times \frac{15}{16} \times 1\frac{1}{16}$	406-206
BUSHING, $\frac{3}{8}$-32 x $\frac{9}{16}$ x .412	358-010
CABLE, HARNESS SN 101-14024	179-274
CABLE, HARNESS SN 14025-up	179-399
CAP, SCREW, POLY	200-174
CHASSIS SN 101-14024	441-226
CHASSIS SN 14025-up	441-302
CONNECTOR, CHASSIS MTD., AMPH., 16 CONTACT, MALE	131-017
CONNECTOR, CHASSIS MTD., UHF, 1 CONTACT, COAX	131-051
EYELET, TAPERED BARREL	210-601
GROMMET, RUBBER, $\frac{1}{4}$	348-002
GROMMET, RUBBER, $\frac{3}{8}$	348-004
KNOB, LARGE BLACK, $\frac{1}{4}$ HOLE THRU	366-029
KNOB, SMALL RED, $\frac{1}{8}$ HOLE PART WAY	366-031
KNOB, SMALL BLACK, $\frac{1}{4}$ HOLE PART WAY	366-033
KNOB, SMALL BLACK, $\frac{1}{8}$ HOLE PART WAY	366-047
KNOB, SMALL KNURLED ALUM., PLUG-IN SECURING	366-125
LOCKWASHER, EXT. #2	210-002
LOCKWASHER, INT. #4	210-004
LOCKWASHER, INT. #6	210-006
LOCKWASHER, INT. POT, $\frac{3}{8} \times \frac{1}{2}$	210-012
LOCKWASHER, INT. $\frac{3}{8} \times \frac{11}{16}$	210-013
LUG, SOLDER, SE4	210-201
LUG, SOLDER, SE6, LONG	210-203
LUG, SOLDER, $\frac{1}{4}$	210-223
NUT, HEX, 2-56 x $\frac{3}{16}$	210-405
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, $\frac{3}{8}$-32 x $\frac{1}{2}$	210-413

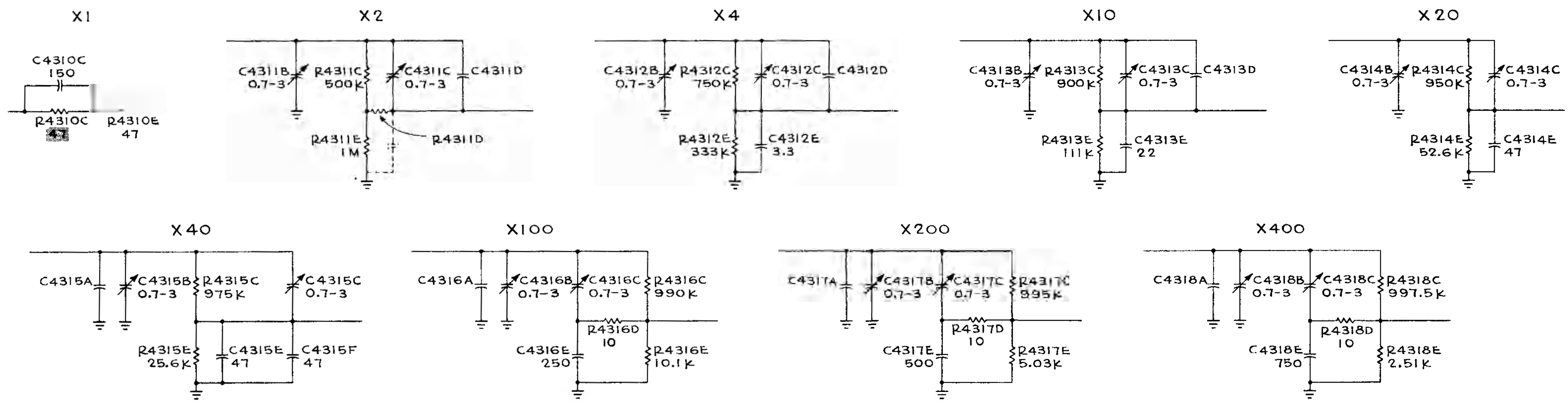
	Tektronix Part Number
NUT, HEX, $\frac{1}{4}$-28 x $\frac{3}{8}$ x $\frac{3}{32}$	210-455
NUT, KEPS, 6-32 x $\frac{5}{16}$	210-457
PANEL, FRONT	333-486
PLATE, SUBPANEL	386-476
PLATE, TEXOLITE, CHANNEL A, $\frac{1}{16}$ x $2\frac{29}{32}$ x $2\frac{11}{32}$	386-942
PLATE, TEXOLITE, CHANNEL B, $\frac{1}{16}$ x $2\frac{29}{32}$ x $2\frac{11}{32}$	386-943
PLATE, 091 x $5\frac{11}{32}$ x $6\frac{11}{32}$	387-529
POST, BINDING, ASS'Y	129-053
RING, RETAINING, FREE ID x .180	354-025
ROD, SECURING, $\frac{3}{16}$ x $10\frac{1}{2}$ W/10-24 THREAD	384-510
ROD, HEX, $\frac{1}{2}$ x $1\frac{5}{16}$, TAP $\frac{3}{8}$-32 THRU	385-158
SCREW, 4-40 x $\frac{1}{4}$ BHS	211-008
SCREW, 4-40 x $\frac{5}{16}$ BHS	211-011
SCREW, 4-40 x $\frac{1}{4}$ FHS	211-023
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 $\frac{5}{16}$ BHS	211-507
SCREW, 6-32 x $\frac{5}{16}$ FHS, 100°, CSK, PHILLIPS	211-538
SCREW, 8-32 x $2\frac{1}{4}$ RHS	212-014
SCREW, 8-32 x $\frac{1}{2}$ FHS, 100°, PHILLIPS	212-043
SCREW, 8-32 x $\frac{1}{2}$ RHS, PHILLIPS	212-044
SCREW, 4-40 x $\frac{5}{16}$ RHS, PHILLIPS THREAD CUTTING	213-034
SCREW, 5-32 x $\frac{3}{16}$ PAN H STEEL	213-044
SHIELD, ATTENUATOR, .040 x 3 x $3\frac{1}{8}$ x $\frac{5}{16}$	337-262
SOCKET, STM7	136-007
SOCKET, STM7G	136-008
SOCKET, STM9 SN 14025-up	136-014
SOCKET, STM9G	136-015
SPACER, NYLON, $\frac{3}{16}$, FOR CERAMIC STRIP	361-008
SPACER, NYLON, $\frac{3}{16}$, FOR CERAMIC STRIP	361-009
STRIP, CERAMIC, $\frac{3}{4}$ x 4 NOTCHES, CLIP MTD.	124-088
STRIP, CERAMIC, $\frac{3}{4}$ x 9 NOTCHES, CLIP MTD.	124-090

		Tektronix Part Number
STRIP, CERAMIC, $^3/_4$ x 11 NOTCHES, CLIP MTD.		124-091
STRIP, CERAMIC, $^7/_{16}$ x 5 NOTCHES, CLIP MTD.	SN 14025-up	124-093
TAG, SN INSERT		334-679
TUBING, PLASTIC INSUL., #20 GREEN		162-520
TURRET, SOCKET ASS'Y	SN 101-14024	123-007
WASHER, STEEL, 8S x $^3/_8$ x .032		210-804
WASHER, FIBER, #10		210-812
WASHER, STEEL, .390 x $^9/_{16}$ x .020		210-840
WASHER, STEEL, .093 x $^9/_{32}$ x .020		210-850
WASHER, RED FIBER, $^1/_8$ x $^{13}/_{64}$ x .035		210-906

CHANNEL A



CHANNEL B



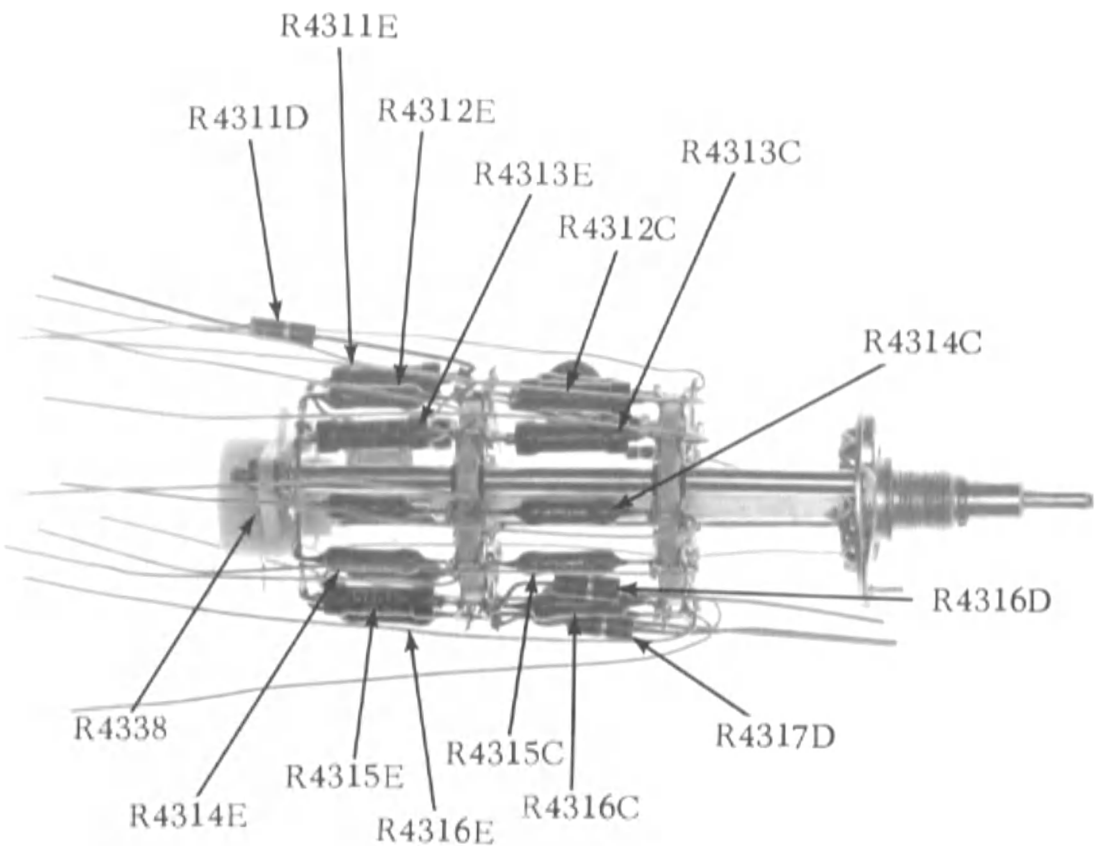
PARTS SHOWN WITHOUT VALUES ARE SELECTED COMPONENTS. SEE PARTS LIST.

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

C1

10-5-61

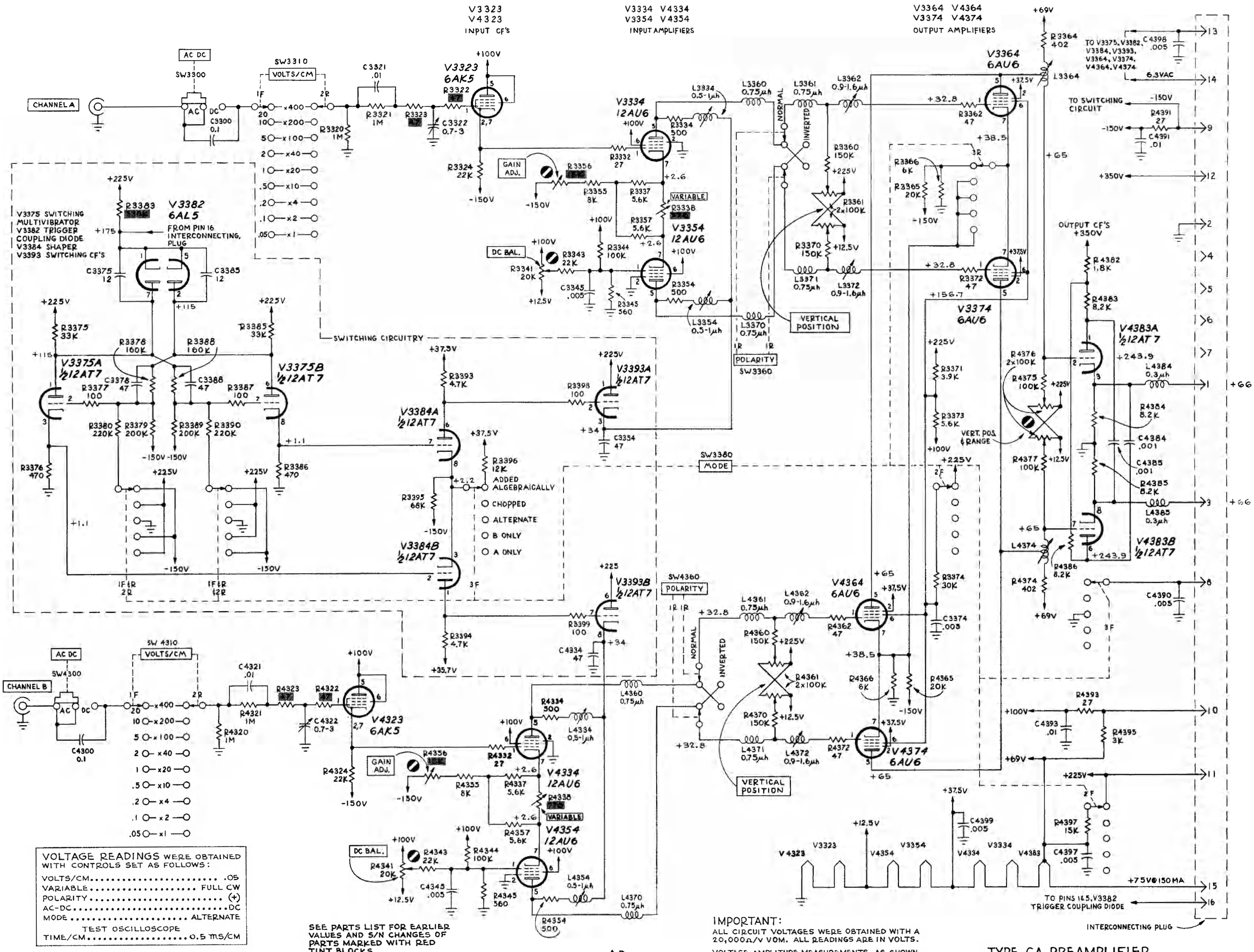
TYPE CA ATTENUATION NETWORKS



TYPE CA

A

VOLTS/CM "B" BOTTOM VIEW



VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:	
VOLTS/CM	.05
VARIABLE	FULL CW
POLARITY	(+)
AC-DC	DC
MODE	ALTERNATE
TEST OSCILLOSCOPE	
TIME/CM	0.5 mS/CM

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

AB

IMPORTANT:
ALL CIRCUIT VOLTAGES WERE OBTAINED WITH A 20,000Ω/V VOM. ALL READINGS ARE IN VOLTS.

VOLTAGE AMPLITUDE MEASUREMENTS, AS SHOWN, ARE NOT ABSOLUTE. THEY MAY VARY BETWEEN INSTRUMENTS AS WELL AS WITHIN THE INSTRUMENT ITSELF DUE TO NORMAL MANUFACTURING TOLERANCES, AND TRANSISTOR AND VACUUM TUBE CHARACTERISTICS.

TYPE CA PREAMPLIFIER

JN 2-7-62