TEKTRONIX

INSTRUCTION MANUAL

TYPE
PLUG-IN **G** UNIT

WIDE-BAND
DIFFERENTIAL PREAMP
TYPE G
INSTRUCTION MANUAL

TEKTRONIX, INC.

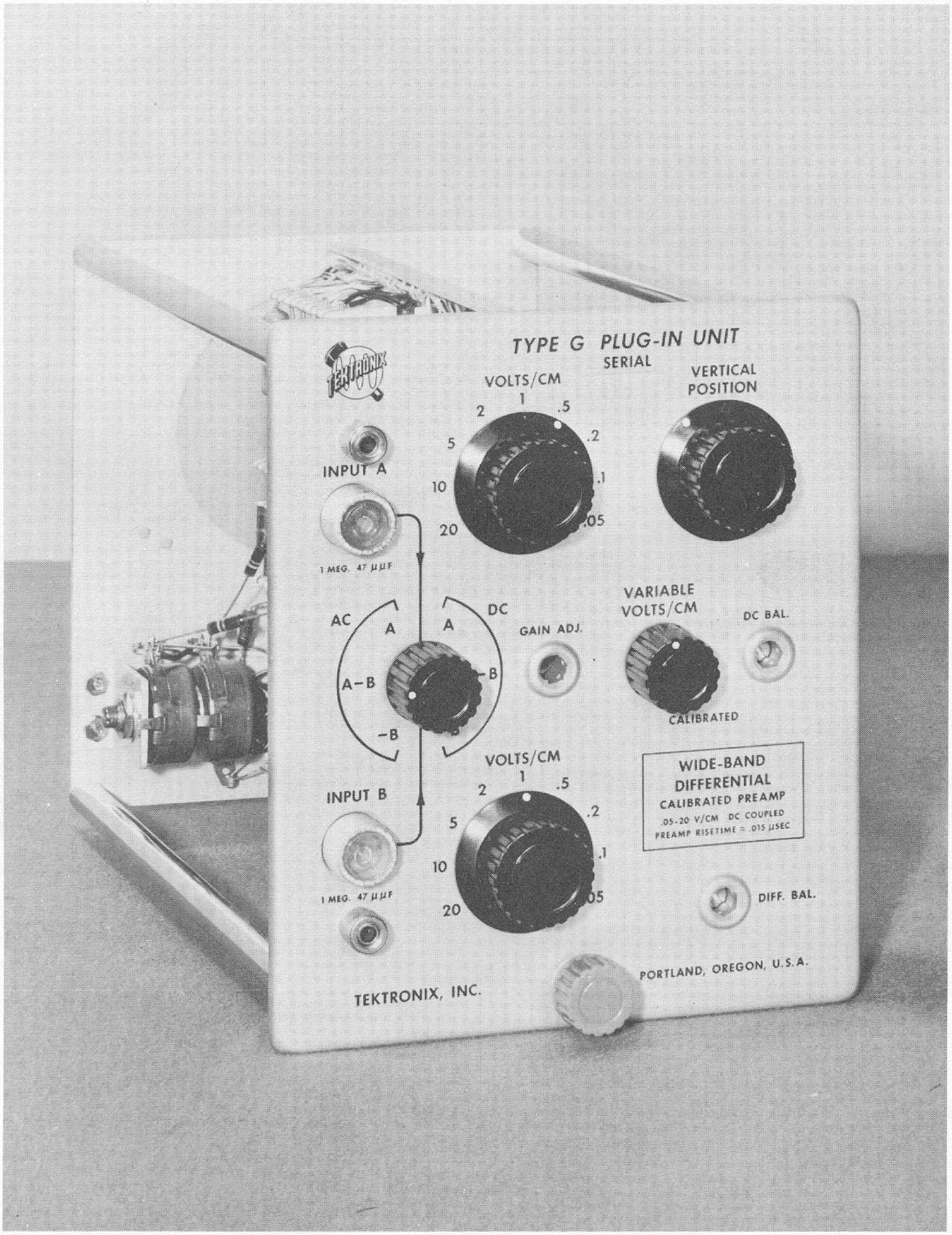
MANUFACTURERS OF CATHODE-RAY AND VIDEO TEST INSTRUMENTS

Sunset Highway and Barnes Road • P. O. Box 831 • Portland 7, Oregon, U. S. A.

Phone: CYpress 2-2611 • Cables: Tektronix

I 14-007

TYPE G SERIAL NUMBER 4466


TYPE G PLUG-IN UNIT
SERIAL
VOLTS/CM
VERTICAL POSITION
INPUT A
1 MEG. 47 µµF
AC
DC
A
A–B
–B
B
GAIN ADJ.
VARIABLE VOLTS/CM
CALIBRATED
DC BAL.
VOLTS/CM
INPUT B
1 MEG. 47 µµF
WIDE-BAND
DIFFERENTIAL
CALIBRATED PREAMP
.05-20 V/CM DC COUPLED
PREAMP RISETIME ≈ .015 µSEC
DIFF. BAL.
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.

GENERAL DESCRIPTION

GENERAL

The Type G Plug-In Unit adapts the Type 530- and 540-Series Oscilloscopes for work requiring a differential input with a high rejection ratio for in-phase signals, combined with wide bandwidth and excellent transient response. The differential input permits cancellation of unwanted or interfering signals.

TYPE G SPECIFICATIONS

Transient Response

Risetime—.015 μsec Plug-In Amplifier

Risetime—.018 μsec with Type 541 and Type 545

Risetime—.035 μsec with Type 531 and Type 535

Risetime—.07 μsec with Type 532

Frequency Response

Passband—DC to 20 mc with Type 541 and Type 545.

Passband—DC to 10 mc with Type 531 and Type 535.

Passband—DC to 5 mc with Type 532.
(Down not more than 3 db at above limits.)

Deflection Factor

Calibrated—.05 v/cm to 20 v/cm.

Continuously Variable—.05 v/cm to 50 v/cm.

Step Attenuator

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

Maximum Allowable Combined DC and Peak AC Input Voltage—600 v.

Common-mode Rejection Ratio

100 to 1 at full gain.

Input Impedance

Plug-In Unit	1 megohm, 47 μμf
With P410 probe	10 megohms, 11 μμf
With P510 probe	10 megohms, 14 μμf

Mechanical

Construction—Aluminum-alloy chassis.
Finish—Photo-etched anodized panel.
Weight—4½ lbs.

Functions of Front-Panel Controls and Connectors

INPUT A **INPUT B**	Separate signal inputs to the preamplifier by way of the input selector switch.
INPUT SELECTOR SWITCH	Six-position switch, to select either input separately or the two inputs differentially, with either ac or dc coupling.
VOLTS/CM	Two 9-position switches, one in each input circuit, to select the desired deflection factor.
VARIABLE VOLTS/CM	Control to vary the gain over a range of about 2½ to 1.
VERTICAL POSITION	Control to position the trace vertically.
GAIN ADJ	Screwdriver control to adjust the basic gain of the amplifier.
DC BAL	Screwdriver adjustment to set the dc voltage across the **VARIABLE VOLTS/CM** control to zero so the trace does not shift when the gain is varied.
DIFF BAL	Screwdriver control to provide a fine differential adjustment of the input amplifier gain for maximum rejection of the common-mode signal.

OPERATING INSTRUCTIONS

General

The Type G Plug-In Unit is designed to operate as a preamplifier for a Tektronix 530-Series or 540-Series Oscilloscope. We assume that it will be operated in that manner in the following instructions.

Input Connections

Be careful when you make connections to the preamp INPUT connectors that the external circuitry does not cause deterioration of the waveform. Improper termination of cables may cause ringing or loss of frequency response. If you use unshielded leads, keep them short as possible to minimize hum. Leads which pass near the cathode-ray-tube screen may pick up some ripple from the high-voltage power supply. If this occurs try relocating the leads or use additional shielding.

Either of the two signal inputs can be used independently by turning the INPUT SELECTOR switch to A or —B and connecting the signal to the corresponding input connector. The signal will be inverted when connected to INPUT B. Each input presents a load of 1 megohm shunted by 47 $\mu\mu$f to the signal source.

The DC and AC positions of this switch differ only in that, in the AC positions, a capacitor is inserted in series with the input to remove the dc component of the signal. When the switch is in either position marked A—B, both inputs are connected to the amplifier through individual compensated attenuators. The signal presented to the oscilloscope amplifier will be the difference between these two signals after attenuation. This makes it possible to balance out a large signal with a relatively small one, or vice versa, by appropriate selection of deflection factors.

Probe

The Type P410 probe, furnished with the 540-Series Oscilloscopes, is designed to preserve the transient response of this unit. This probe introduces no ringing but causes an additional frequency-response loss of less than 1 db at 20 mc. The Type P410 probe has a 10-1 attenuaton ratio.

The Type P510 probe is not suitable for use with the Type G Plug-In Unit and 540-Series combination when you are observing fast-rising pulses. This probe tends to ring at about 50 megacycles, and the wide passband of the G—540-Series combination will display any ringing which may occur.

Use of probes may reduce the specified Common-mode Rejection ratio to approximately 50 to 1 at full gain and even less at reduced sensitivities. The one-percent tolerances of the resistors in the probe and attenuators cause this decrease in rejection ratio.

Be sure to check the adjustment of the probe when you first connect it to a plug-in unit. The probe compensation is a function of the input capacitance of the particular plug-in unit or oscilloscope that you use the probe with. If the compensation is incorrect, the frequency response will be affected.

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 square wave are not flat, adjust the trimmer capacitor located either inside the probe body or inside the box at the other end of the cable to achieve correct square-wave response.

Coupling

It is sometimes unnecessary or undesirable to display the dc level of the waveform. In the two AC positions of the INPUT SELECTOR switch, a capacitor in series with the input blocks the dc component of the waveform so that only the ac component is displayed.

Deflection Sensitivity

The VOLTS/CM switch controls the vertical deflection factor in accurately calibrated steps. The VARIABLE control provides continuous adjustment of the deflection factor.

> NOTE: The VARIABLE control must be clockwise to the CALIBRATED position for the deflection factor to be as indicated by the VOLTS/CM control.

Differential Input

The differential input makes possible the application of balanced signals to the G preamp. The best rejection ratio for common mode signals is obtained in the unattenuated (maximum gain) position. When a balanced input is required, be sure both VOLTS/CM switches are on the same deflection factor position.

Sometimes it is desirable to use different deflection factors on the two inputs. You can buck out 60-cycles hum in a signal being viewed by applying a properly phased 60-cycle signal to the unused input. If variable attenuation is necessary this must be done externally. You can buck out up to 600 volts dc by connecting a battery to the unused input. You should not exceed 4 volts input when in the maximum gain position or at the input grid after attenuation.

Differential-Balance Adjustment

The DIFF. BAL. control balances the amplifiers so that when the same signal is connected to both inputs the output signal is reduced to a minimum. To adjust the DIFF. BAL. control connect a two-volt signal from the calibrator to both INPUT A and INPUT B without the probes connected. Set the input selector switch to A—B. Set both VOLTS/CM controls to .05. Adjust the DIFF. BAL. control to obtain a straight line on the screen.

The rejection ratio for a balanced input is reduced when the probes are used or when the VOLTS/CM switches are in positions other than for maximum deflection factor. This is caused by the one-percent tolerences of the resistors in the attenuators and input circuits. The rejection ratio can be improved for lower deflection factors by setting the DIFF. BAL. control for the specific position on the VOLTS/CM switch that is to be used. Connect the calibrator to both inputs simultaneously with a convenient calibrator output voltage for the deflection factor to be used. Set the input selector switch on A—B and adjust the DIFF. BAL. control for minimum signal. It should be possible to pass through a minimum with the DIFF. BAL. control.

Gain Adjustment

Aging of tubes will affect the gain of the plug-in unit. After the plug-in unit has been in use for a period of time, the gain adjustment should be checked. Display a calibrator waveform of .2 volts peak to peak with the VOLTS/CM switch in the .05 position. Adjust the GAIN ADJ. control until the displayed waveform is four graticule divisions in amplitude. Be sure the VARIABLE control is turned clockwise to the calibrated position before making this adjustment.

DC Balance Adjustment

The need for adjustment of the DC BAL. control is indicated by a shift in the position of the trace as the VARIABLE control is rotated. This is caused by tube aging. This adjustment should be made after the GAIN ADJ. control is set. Rotate the VARIABLE control back and forth and adjust the DC BAL. control until the trace position is no longer affected by rotation of the VARIABLE control.

Positioning Adjustment

The Vert Pos Range control balances the dc output level so the full range of the front-panel positioning control can be utilized. The Vert Pos Range control is located at the left to the rear of the plug-in unit and is accessible when the left side panel is removed. Center the VERTICAL POSITION control. Adjust the Vert Pos Range control to center the trace on the screen.

CIRCUIT DESCRIPTION

General

The Type G Plug-In Unit has a maximum deflection factor of 0.05 volts/cm. The circuit consists of two stages of amplification with input and output cathode followers.

Input Connectors

The INPUT SELECTOR switch, SW3017, connects the two input connectors to the grids of the input cathode followers. In either the A or —B positions of the switch, one of the grids is grounded and the other is connected to the input connector.

Input Attenuators

The VOLTS/CM switches, SW3347 & SW3447, insert frequency-compensated attenuators into the input circuits. Four attenuators in each switch are used singly or in tandem pairs to produce nine deflection factors. The attenuators have voltage attenuation ratios of 2X, 4X, 10X, and 100X. to produce deflection factors in volts per centimeter of deflection of 20, 10, 5, 2, 1, .5, .2, .1 and .05. When properly adjusted, the input resistance and capacitance remains unchanged as the attenuators are switched.

Input Cathode Followers

Input cathode followers V3347 & V4347, isolate the input amplifier from impedance changes caused by the different attenuator steps. When a single input is used, the grid of the opposite input cathode follower is grounded. The input cathode followers are d-c coupled to the input amplifiers. R3317 and R4317 are current-limiting resistors to limit grid current in the event an excess voltage is applied to the input.

Input Amplifiers

The input amplifier, V3457 and V4457, is a common-cathode phase-splitter amplifier. V3457 and V4457 operate as a push-pull amplifier when a push-pull signal is applied to the input. The DIFFerential BALance control, R3547, varies the voltage on the suppressor grids, raising one as it lowers the other. This increases the gain in one tube while decreasing the gain of the other. In this way the amplifier is adjusted for maximum rejection of the common-mode signal. The GAIN ADJ. control, R3747-B, adjusts the gain of the stage to agree with the front-panel calibration. This control is mounted on the same shaft as R3747-A. Inductors L3467 and L4467 provide high frequency peaking for this stage of amplification. V3457 and V4457 obtain their plate supply from the heater string through the load resistors R3467 and R4467.

DC Balance

The DC BAL. control, R3657, provides an adjustable dc grid voltage for V3657 so that its cathode is at the same dc potential as the cathode of V4657. When this control is properly set, no change in vertical positioning will result when the VARIABLE VOLTS/CM control is rotated.

Output Amplifier

The output amplifier, V3657 and V4657, is a common cathode amplifier. Inductors L3617 and L4617 form peaking networks in the plate circuits. Resistor R3607 provides the current for the amplifier plates, and a tap to the heater string provides a low impedance at this point.

The VARIABLE VOLTS/CM control, R3717, varies the gain over a 2½ to 1 ratio by varying the degeneration in the cathode circuit. The GAIN ADJ. control, R3747-A, varies the total cathode current in this stage to set the gain to agree with the front-panel calibration.

Vertical positioning is obtained by two dual potentiometers connected to the plates of the output amplifier so that current through one plate load is increased while current through the other plate load is decreased. Since the amplifier is dc coupled beyond this point, the change in plate voltage which occurs changes the position of the trace on the cathode-ray tube.

Output Cathode Followers

Output cathode followers are used to drive the capacitance of the interconnecting plug and main-amplifier input circuit. The cathode-follower circuit is modified by resistors in the plate circuits and by capacitors cross-connected from the plates to the opposite cathodes. This modification improves the high-frequency balance of the plug-in unit.

The H. F. PEAKING control, R3987, varies the current in the cathode followers. This changes the impedance at the cathodes and changes the effect of the series peaking coils, L3977 and L4977, tied to these cathodes.

MAINTENANCE

PARTS ORDERING AND REPLACEMENT

Instruction Manual

A Tektronix instruction manual usually contains hand-made changes to diagrams and parts lists, and sometimes text. These changes are in general appropriate only to the instrument the manual was prepared for. These hand-made corrections show changes to the instrument that have been made after the printing of the manual.

There is a serial number on the frontispiece and on the warranty page of this manual. This is the serial number of your instrument. Be sure the manual number matches the instrument number when you order parts.

NOTE

Always include the instrument type AND SERIAL NUMBER in any correspondence regarding the instrument.

Standard Components

Tektronix will supply replacement components at current net prices. However, since most of the components are standard electronic and radio parts you can probably obtain them locally faster than we can ship them to you from the factory in Portland, Oregon. Be sure to consult the instruction manual to see what tolerances are required.

Selected Components

We specially select some of the components, whose values must fall within prescribed limits, by sorting through our regular stocks. The components so selected will have standard RETMA color coding showing the value and tolerance of the stock they were selected from, but they will not in general be replaceable from dealer's stocks.

Checked Tubes

To obtain maximum reliability and performance we check some of the vacuum tubes used in our instruments for such characteristics as microphonics, balance, transconductance, etc. We age other tubes to stabilize their characteristics. Since there are no well defined standards of tube performance we have established our own arbitrary standards and have developed equipment to do this checking. These checked tubes can be purchased through our local Field Engineering Offices or directly from the factory in Portland, Oregon.

Tektronix Manufactured Parts

Tektronix manufactures almost all of the mechanical parts and some of the components used in the instrument. If you order a mechanical part be sure to describe the part completely to prevent any unnecessary delay in filling your order. When you have any questions about mechanical parts or Tektronix manufactured components contact our nearest Field Engineering Office or write to the Field Engineering Department at the factory in Portland, Oregon.

GENERAL INFORMATION

Color Coding

We use color coded wires in the instruments to help identify the various circuits. These wires will be either a solid color or will be a solid color (including black and white) with one or more colored stripes. The colored stripes are "read" in the same manner as the RETMA resistor color code. In the case of multiple stripes the wide stripe is read first.

Wires carrying positive regulated-power-supply voltages are white and the stripes indicate the supply voltage. For example, the +225-v supply bus will be coded red-red-brown (2-2-1) giving two significant figures and the decimal multiplier.

The negative-supply bus wires are black and the stripes indicate the supply voltage. For example, our most common negative-supply voltage is —150 v and is carried by a black wire coded brown-green-brown (1-5-1).

The mains-voltage leads to the power transformer are yellow and coded brown-brown-brown (1-1-1).

The tube heater leads are white and coded 6-1, 6-2, 6-3, etc., not to indicate that the voltages are different but to differentiate between circuits.

In other respects the color coding will vary from instrument to instrument. In general all signal-carrying leads are white and coded with a single colored stripe. In a few places where the number of leads exceeded the capabilities of single-stripe coding we have used solid-color leads.

Soldering Precaution

The solder used on the ceramic terminals of this instrument must contain a small percentage of silver. Repeated use of ordinary tin-lead solder will dissolve the fused bond of silver that makes the solder adhere to the porcelain, especially if the soldering iron is quite hot.

A quantity of the silver-bearing solder that we use at the factory is attached to each major instrument having ceramic strips. This solder, containing approximately 3% silver, is not readily available through regular channels. If you need additional silver-bearing solder for maintenance purposes you can purchase it from Tektronix in one-pound spools.

TROUBLE-SHOOTING PROCEDURE

Trouble shooting of plug-in units is somewhat complicated by the need to determine whether the trouble observed is in the plug-in unit or the oscilloscope. Many troubles can be quickly isolated by substituting another plug-in unit and looking for the same indications. Among the troubles which fall into this category are insufficient gain, inability to position the trace, noise, unbalance, and severe waveform distortion. Minor waveform distortions such as might be caused by high-frequency peaking coils or delay-line trimmers can be isolated by this method, only by substituting another plug-in unit of equal or superior bandwidth and checking for the same distortion.

Noise and unbalance problems can also be isolated by connecting a jumper from pin 1 to pin 3 of the interconnecting plug. If the trouble remains, it is probably not in the plug-in unit.

Most troubles are caused by tube failures and you can frequently find them by finding the bad tube and replacing it with a good one. It is a good practice to inspect components in the circuit with the bad tube for possible overheating as a result of the tube failure. One way to find bad tubes is to try replacing suspected tubes with good ones.

ADJUSTMENT PROCEDURE

The following outline is based on the adjustment procedure used in our own test department at the factory. Ordinarily, adjustment in the field will consist of touching up some of the dc level and balance controls as outlined in the Operating Instructions, but if readjustment of the transient response is necessary, there is a certain sequence that should be followed. The DIFFerential-BALance, GAIN ADJ, and DC BALANCE adjustments should be followed as outlined in the Operating Instructions each time a tube is changed and prior to continuing with the following procedure.

Peaking Coils

The unit must be plugged into an oscilloscope that is known to be in correct adjustment. A source of square waves or pulses of 5 mμsec rise time or better is required for optimum adjustment although the Tektronix Type 105 Square-Wave Generator will permit adjustment to within about ½% of optimum. The oscilloscope calibrator waveform is not adequate. If you use a Type 105 Square-Wave Generator, use a 52-ohm cable terminated at both ends to achieve the fastest rise time possible.

All adjustments are available when the unit is plugged into an oscilloscope that has its cabinet or panels removed.

If this unit is used in 530-Series Oscilloscopes only, the peaking coils should not be adjusted. The effect of these peaking coils can only be seen when the unit is used in 540-Series Oscilloscopes. If it is used with 540-Series Oscilloscopes the following procedure applies.

Plug the unit into a 540-Series Oscilloscope and turn the power on. Turn the VOLTS/CM switch to .05 and the VARIABLE VOLTS/CM control to the CALIBRATED position. Connect the square-wave source to INPUT A and display one or two cycles of a 250- to 500-kc square wave with two to three centimeters deflection.

The peaking coils affect the rise and leading corner of the square wave and should be adjusted for a square corner with no overshoot. Preset the HF PEAKING control counterclockwise.

1. Adjust L3617 and L4617.
2. Adjust L3467 and L4467.

The HF PEAKING control affects the leading edge only. Adjust this control to get a sharp corner on the waveform.

High-Frequency Differential Balance

Connect a sine wave generator, such as the Tektronix Type 190 Constant Amplitude Signal Generator, to both inputs of the plug-in unit. The length of the signal path should be the same to avoid a phase difference between the two signals. At the factory, we connect the Type 190 to a coax tee. To this tee, we connect two six-inch 93-ohm coax cables, each of which is terminated in 93 ohms and connected to an input of the Type G Plug-In Unit. The 93-ohm terminations must be identical to give accurate results. You can check these terminations by reversing the inputs into which they are connected after the high-frequency differential-balance adjustment is completed. If these terminations are not identical you will not have perfect differential balance. The two short cables should be of equal length because a difference in length of less than one-half inch introduces a noticeable phase difference at 20 mc.

a. Set the input-selector switch to the AC position of differential balance (A—B) and both VOLTS/CM switches to .05.

b. Set the sine-wave generator to 20 mc and the amplitude to about 2 volts. The amplitude can be determined by switching the input-selector switch to A and the "A" VOLTS/CM switch to .5.

c. Adjust C3387 and C4387 for minimum deflection of the trace.

Input Attenuators

The need for adjustment of the input attenuators is determined by observing the response to a 1-kc square wave. There are two types of adjustment to be made. One is to compensate the attenuators so the ac attenuation is equal to the dc attenuation. This involves a moderately short time constant and can be recognized as a slight rounding or overshoot at the leading corner of a 1-kc square wave. The other type of adjustment is to set the input capacitance equal in all positions of the attenuator. This can be recognized as a downward or upward slope of about the first one-half of the 1-kc square wave.

The input capacitance of the unit is accurately set to 47 $\mu\mu$f here at the factory. This permits a properly adjusted probe to be used with any 47-$\mu\mu$f-input-capacitance unit. To preserve this feature you will need to use a CS-47 Input-Capacitance-Standardizer or standardize a probe by adjusting it to a unit known to be in adjustment. Another method of obtaining the standard input capacitance is to use a Tektronix Type 130 L,C Meter to set the input capacitance in the .05 position of the VOLTS/CM switch. Then adjust the probe in this position to standardize the probe. This probe can then be used where the text calls for the Input-Capacitance Standardizer.

For best results, the attenuator adjustment should be made with a square-wave generator having a short risetime, such as the Tektronix Type 105. An approximate adjustment can be made by using the calibrator waveform, but it is easy to overcompensate the attenuator when using this waveform because of its relatively long risetime.

1. INPUT A Adjustments

a. Input Capacitance

The input capacitance of the attenuators is adjusted to match the Input Capacitance Standardizer in all positions. The unattenuated position is adjusted first.

(1) Connect the Input-Capacitance Standardizer (or standardized probe) to INPUT A.

(2) Connect the output of the square-wave generator to the standardizer.

(3) Set the square-wave generator to 1 kc and view five or six cycles on the crt screen.

(4) Adjust the capacitors listed in the table below for a flat top on the square wave.

VOLTS/CM	CAPACITOR
.05	C3327
.1	C3237
.2	C3177
.5	C3127
5	C3077

b. Attenuator Compensation

The attenuator is compensated to make the ac attenuation equal to the dc attenuation.

(1) Remove the standardizer and connect the square-wave generator to INPUT A.

(2) Set the VOLTS/CM switch in the positions indicated and adjust each capacitor in the following table for a square corner on the square wave.

VOLTS/CM	CAPACITOR
.1	C3247
.2	C3187
.5	C3137
5	C3087

2. INPUT B Adjustments

a. Input Capacitance

(1) Connect the Input-Capacitance Standardizer to INPUT B.

(2) Connect the output of the square-wave generator to the standardizer.

(3) Set the square-wave generator to 1 kc and view five or six cycles on the crt screen.

(4) Adjust the capacitors listed in the table for a flat top on the square wave.

VOLTS/CM	CAPACITOR
.05	C4327
.1	C4237
.2	C4177
.5	C4127
5	C4077

b. Attenuator Compensation

(1) Remove the standardizer and connect the square-wave generator to INPUT B.

(2) Set the VOLTS/CM switch in the positions indicated and adjust each capacitor in the following table for a square corner on the square wave.

VOLTS/CM	CAPACITOR
.1	C4247
.2	C4187
.5	C4137
5	C4087

3. Differential Compensation

The attenuators are adjustable to within very close limits by this differential adjustment. This is a very critical adjustment and should be made only when there is a spike greater than one-half centimeter on the resulting waveform of a square wave connected differentially into the plug-in unit. Be careful that you don't overcompensate one attenuator for the fault of the other. You can check each attenuator by displaying the inputs individually and observing which input needs compensation.

a. Set both **VOLTS/CM** switches to **.05** and the input selector switch to **A—B.**

b. Connect the oscilloscope calibrator to both inputs and set the calibrator to 2 volts.

c. Check the front panel adjustments as outlined in the Operating Instructions.

d. Set both **VOLTS/CM** switches to the positions indicated and switch the calibrator to the voltages listed. If there is a spike on the resulting waveform which exceeds one-half centimeter, adjust the capacitors listed just a slight amount to reduce this spike. The square wave which remains in some positions is caused by a slight unbalance in the 1% tolerance attenuator resistors.

VOLTS/CM	CAL	CAPACITOR
.1	5	C3247
		C4247
.2	10	C3187
		C4187
.5	20	C3187
		C4137
5	100	C3087
		C4087

ABBREVIATIONS

Cer.	ceramic	m	milli or 10^{-3}
Comp.	composition	Ω	ohm
EMC	electrolytic, metal cased	Poly.	polystyrene
EMT	electrolytic, metal tubular	Prec.	precision
f	farad	PT	paper tubular
h	henry	Tub.	tubular
k	kilohm or 10^3 ohms	v	working volts dc
meg	megohm or 10^6 ohms	Var.	variable
μ	micro or 10^{-6}	w	watt
μμ	micromicro or 10^{-12}	WW	wire wound

GMV guaranteed minimum value

WIDE-BAND DIFFERENTIAL DC PREAMP

Capacitors

						Order Parts by Number
C3017	.1 μf	Manufactured by Tektronix				*285556
C3067	8 μμf	Cer.	Fixed	500 v	±0.5%	281503
C3077	4.5–25 μμf	Cer.	Var.	500 v		281010
C3087	1.5–7 μμf	Cer.	Var.	500 v		281005
C3097	250 μμf	Mica	Fixed	500 v	5%	283543
C3127	4.5–25 μμf	Cer.	Var.	500 v		281010
C3137	4.5–25 μμf	Cer.	Var.	500 v		281010
C3147	100 μμf	Cer.	Fixed	500 v	10%	281530
C3177	4.5–25 μμf	Cer.	Var.	500 v		281010
C3187	3–12 μμf	Cer.	Var.	500 v		281007
C3237	3–12 μμf	Cer.	Var.	500 v		281007
C3247	4.5–25 μμf	Cer.	Var.	500 v		281010
C3257	8 μμf	Cer.	Fixed	500 v	±0.5%	281503
C3267	270 μμf	Cer.	Fixed	500 v	10%	281543
C3317	.01 μf	Cer.	Fixed	500 v	GMV	283002
C3327	4.5–25 μμf	Cer.	Var.	500 v		281010
C3367	.005 μf	Cer.	Fixed	500 v	GMV	283001
C3387	.7–3 μμf	Tub.	Var.	350 v		281027
C3457	.01 μf	Cer.	Fixed	500 v	GMV	283002
C3977	.005 μf	Cer.	Fixed	500 v	GMV	283001
C4017	.1 μf	Manufactured by Tektronix				*285556
C4067	8 μμf	Cer.	Fixed	500 v	±0.5%	281503
C4077	4.5–25 μμf	Cer.	Var.	500 v		281010
C4087	1.5–7 μμf	Cer.	Var.	500 v		281005
C4097	250 μμf	Mica	Fixed	500 v	5%	283543
C4127	4.5–25 μμf	Cer.	Var.	500 v		281010
C4137	4.5–25 μμf	Cer.	Var.	500 v		281010
C4147	100 μμf	Cer.	Fixed	500 v	10%	281530
C4177	4.5–25 μμf	Cer.	Var.	500 v		281010
C4187	3–12 μμf	Cer.	Var.	500 v		281007
C4237	3–12 μμf	Cer.	Var.	500 v		281007
C4247	4.5–25 μμf	Cer.	Var.	500 v		281010
C4257	8 μμf	Cer.	Fixed	500 v	±0.5%	281503
C4267	270 μμf	Cer.	Fixed	500 v	10%	281543
C4317	.01 μf	Cer.	Fixed	500 v	GMV	283002
C4327	4.5–25 μμf	Cer.	Var.	500 v		281010
C4367	.005 μf	Cer.	Fixed	500 v	GMV	283001
C4387	.7–3 μμf	Tub.	Var.	350 v		281027
C4457	.01 μf	Cer.	Fixed	500 v	GMV	283002

* C3017, C4017 paired to 1% of each other.

Capacitors (Continued)

C4977	.005 µf	Cer.	Fixed	500 v	GMV	283001
C4987	.01 µf	Cer.	Fixed	500 v	GMV	283002
C4997	.005 µf	Cer.	Fixed	500 v	GMV	283001
C5007	.005 µf	Cer.	Fixed	500 v	GMV	283001
C5017	.005 µf	Cer.	Fixed	500 v	GMV	283001
C5027	.01 µf	Cer.	Fixed	500 v	GMV	283002

Inductors

L3457	.45 µh	Fixed	108062
L3467	2.3–3.9 µh	Var.	114057
L3617	2.3–3.9 µh	Var.	114057
L3977	.18 µh	Fixed	108009
L4457	.45 µh	Fixed	108062
L4467	2.3–3.9 µh	Var.	114057
L4617	2.3–3.9 µh	Var.	114057
L4977	.18 µh	Fixed	108009

Resistors

R3037	15 Ω	½ w	Fixed	Comp.	10%		302150
R3087	990 k	½ w	Fixed	Prec.	1%		309013
R3097	10.1 k	½ w	Fixed	Prec.	1%		309034
R3137	900 k	½ w	Fixed	Prec.	1%		309111
R3147	111 k	½ w	Fixed	Prec.	1%		309046
R3167	27 Ω	½ w	Fixed	Comp.	10%		302270
R3187	750 k	½ w	Fixed	Prec.	1%		309010
R3197	333 k	½ w	Fixed	Prec.	1%		309053
R3247	500 k	½ w	Fixed	Prec.	1%		309003
R3257	1 meg	½ w	Fixed	Prec.	1%		309014
R3267	22 Ω	½ w	Fixed	Comp.	10%		302220
R3307	1 meg	½ w	Fixed	Prec.	1%		312583*
R3317	100 k	½ w	Fixed	Comp.	10%		302104
R3357	47 Ω	½ w	Fixed	Comp.	10%		302470
R3367	47 Ω	½ w	Fixed	Comp.	10%		302470
R3387	27 k	2 w	Fixed	Comp.	5%		305273
R3457	8.2 k	1 w	Fixed	Comp.	10%		304822
R3467	470 Ω	½ w	Fixed	Comp.	5%		301471
R3507	8 k	5 w	Fixed	WW	5%		308007
R3517	3.9 k	1 w	Fixed	Comp.	10%		304392
R3527	3.3 k	½ w	Fixed	Comp.	10%		302332
R3537	3.3 k	½ w	Fixed	Comp.	10%		302332
R3547	100 k	2 w	Var.	Comp.	20%	DIFF. BAL.	311026
R3557	100 k	½ w	Fixed	Comp.	10%		302104
R3567	3.3 k	½ w	Fixed	Comp.	10%		302332
R3607	4 k	5 w	Fixed	WW	5%		308051
R3617	470 Ω	½ w	Fixed	Comp.	5%		301471
R3647	22 k	½ w	Fixed	Comp.	10%		302223
R3657	100 k	2 w	Var.	Comp.	20%	DC BAL.	311026
R3667	47 k	½ w	Fixed	Comp.	10%		302473
R3677	47 Ω	½ w	Fixed	Comp.	10%		302470
R3707	5.6 k	1 w	Fixed	Comp.	5%		303562
R3717	690 Ω	Special				VARIABLE	311130
R3727	5.6 k	1 w	Fixed	Comp.	5%		303562
R3737	10 k	5 w	Fixed	WW	5%		308054

*R3307, R4307 are matched. Furnished as a unit.

Resistors (Continued)

R3747A,B	10kx5 k	2 w	Var.	WW	20%	GAIN ADJ.	311101
R3807	4.7 k	2 w	Fixed	Comp.	10%		306472
R3817	4.7 k	1 w	Fixed	Comp.	10%		304472
R3847	100 k	½ w	Fixed	Comp.	10%		302104
R3857	2x100 k	2 w	Var.	Comp.	20%	VERTICAL POSITION	311028
R3877	100 k	½ w	Fixed	Comp.	10%		302104
R3887	2x100 k	2 w	Var.	Comp.	20%	Vert. Pos. Range	311051
R3937	3.9 k	2 w	Fixed	Comp.	10%		306392
R3947	9.1 k	1 w	Fixed	Comp.	5%		303912
R3957	47 Ω	½ w	Fixed	Comp.	10%		302470
R3977	9.1 k	1 w	Fixed	Comp.	5%		303912
R3987	2 k	2 w	Var.	Comp.	20%	H. F. Peaking	311008
R4037	15 Ω	½ w	Fixed	Comp.	10%		302150
R4087	990 k	½ w	Fixed	Prec.	1%		309013
R4097	10.1 k	½ w	Fixed	Prec.	1%		309034
R4137	900 k	½ w	Fixed	Prec.	1%		309111
R4147	111 k	½ w	Fixed	Prec.	1%		309046
R4167	27 Ω	½ w	Fixed	Comp.	10%		302270
R4187	750 k	½ w	Fixed	Prec.	1%		309010
R4197	333 k	½ w	Fixed	Prec.	1%		309053
R4247	500 k	½ w	Fixed	Prec.	1%		309003
R4257	1 meg	½ w	Fixed	Prec.	1%		309014
R4267	22 Ω	½ w	Fixed	Comp.	10%		302220
R4307	1 meg	½ w	Fixed	Prec.	1%		312583*
R4317	100 k	½ w	Fixed	Comp.	10%		302104
R4357	47 Ω	½ w	Fixed	Comp.	10%		302470
R4367	47 Ω	½ w	Fixed	Comp.	10%		302470
R4387	27 k	2 w	Fixed	Comp.	5%		305273
R4467	470 Ω	½ w	Fixed	Comp.	5%		301471
R4617	470 Ω	½ w	Fixed	Comp.	5%		301471
R4677	47 Ω	½ w	Fixed	Comp.	10%		302470
R4847	100 k	½ w	Fixed	Comp.	10%		302104
R4877	100 k	½ w	Fixed	Comp.	10%		302104
R4947	9.1 k	1 w	Fixed	Comp.	5%		303912
R4957	47 Ω	½ w	Fixed	Comp.	10%		302470
R4977	9.1 k	1 w	Fixed	Comp.	5%		303912
R5007	5.5 k	5 w	Fixed	WW	5%		308101
R5027	47 Ω	½ w	Fixed	Comp.	10%		302470

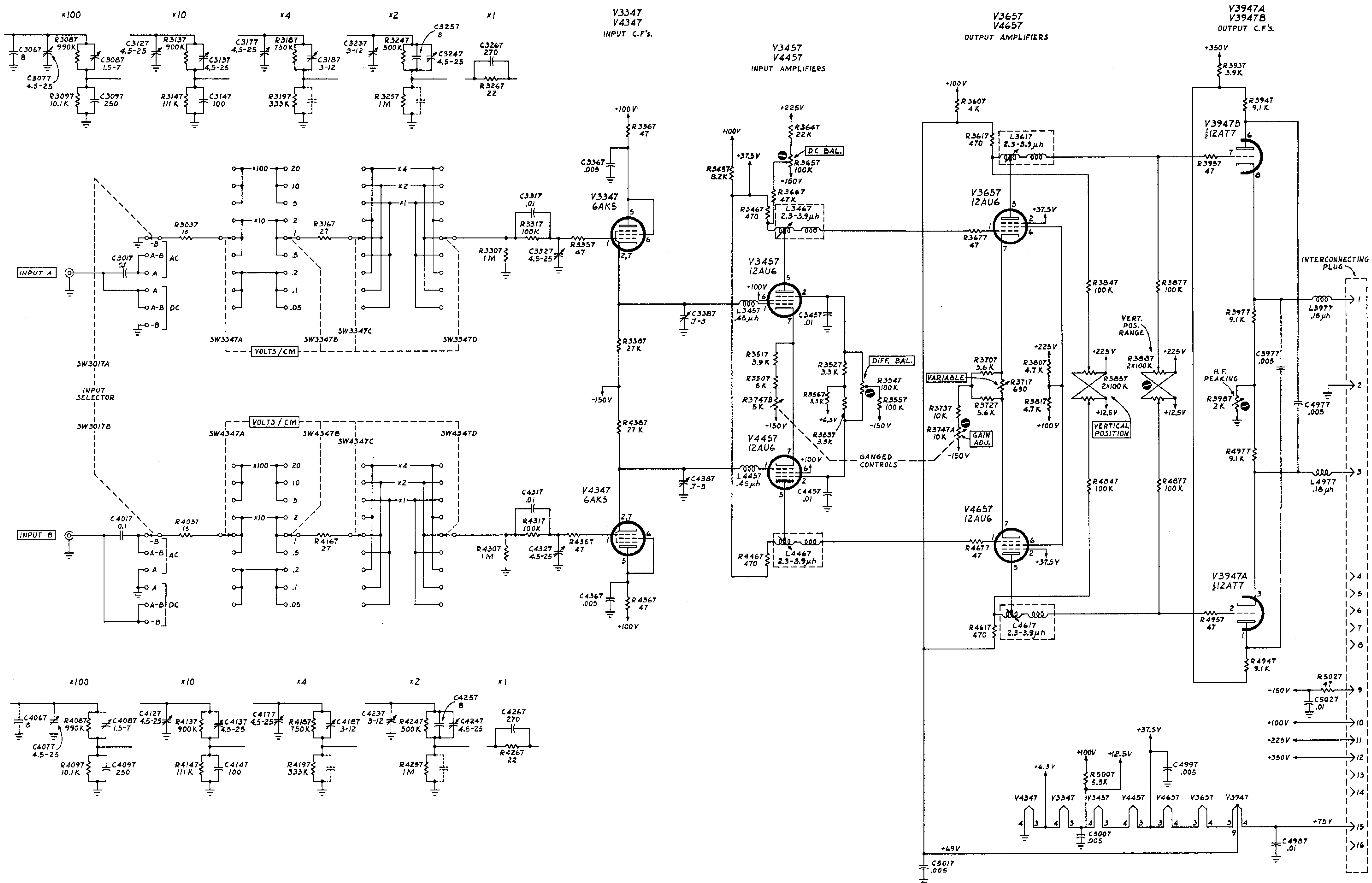
Switches

					not wired	wired
SW3017	2 wafer	6 position	rotary	INPUT SELECTOR	260167	—
SW3347	4 wafer	9 position	rotary	VOLTS/CM	260166	262126
SW4347	4 wafer	9 position	rotary	VOLTS/CM	260166	262127

Vacuum Tubes

V3347	6AK5	Input Cathode Follower	157054
V3457	12AU6	Input Amplifier	157050**
V3657	12AU6	Output Amplifier	157050**
V3947	12AT7	Output Cathode Followers	154039
V4347	6AK5	Input Cathode Follower	157054
V4457	12AU6	Input Amplifier	157050**
V4657	12AU6	Output Amplifier	157050**

*R3307, R4307 are matched. Furnished as a unit.
**V3457, V4457 are a matched pair. Furnished as a unit.
**V3657, V4657 are a matched pair. Furnished as a unit.



F

TYPE G PREAMP

3-4-59
KF

ABBREVIATIONS USED IN OUR PARTS LISTS

Cer.	ceramic	m	milli
Comp.	composition	Ω	ohm
EMC	electrolytic, metal cased	Poly.	polystyrene
EMT	electrolytic, metal tubular	Prec.	precision
f	farad	PT	paper tubular
h	henry	Tub.	tubular
k	thousands of ohms	v	working volts dc
meg	megohms	Var.	variable
μ	micro	w	watt
$\mu\mu$	micromicro	WW	wire wound

GMV guaranteed minimum value

ABBREVIATIONS USED IN OUR CIRCUIT DIAGRAMS

Resistance values are in ohms. The symbol k stands for thousands. A resistor marked 2.7 k has a resistance of 2,700 ohms. The symbol M stands for million. For example, a resistor marked 5.6 M has a resistance of 5.6 megohms.

Unless otherwise specified on the circuit diagram, capacitance values marked with the number 1 and numbers greater than 1 are in $\mu\mu$f. For example, a capacitor marked 3.3 would have a capacitance of 3.3 micromicrofarads. Capacitance values marked with a number less than 1 are in μf. For example, a capacitor marked .47 would have a capacitance of .47 microfarads.

Inductance values marked in mh are in millihenrys. Inductance values marked in μh are in microhenrys.

Your instrument WARRANTY appears on the reverse side of this sheet.

SERIAL NO. 4466

IMPORTANT

Include the INSTRUMENT TYPE and the above SERIAL NUMBER in any correspondence regarding this instrument. The above serial number must match the instrument serial number if parts are to be ordered from the manual. Your help in this will enable us to answer your questions or fill your order with the least delay possible.

WARRANTY

All Tektronix instruments are fully guaranteed against defective materials and workmanship for one year. Should replacement parts be required, whether at no charge under warranty or at established net prices, notify us promptly, including sufficient details to identify the required parts. We will ship them prepaid (via air if requested) as soon as possible, usually within 24 hours.

Tektronix transformers, manufactured in our own plant, carry an indefinite warranty.