

INSTRUCTION MANUAL

190A
.....
190B
sine-wave generator

Tektronix, Inc.

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WARRANTY

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

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

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

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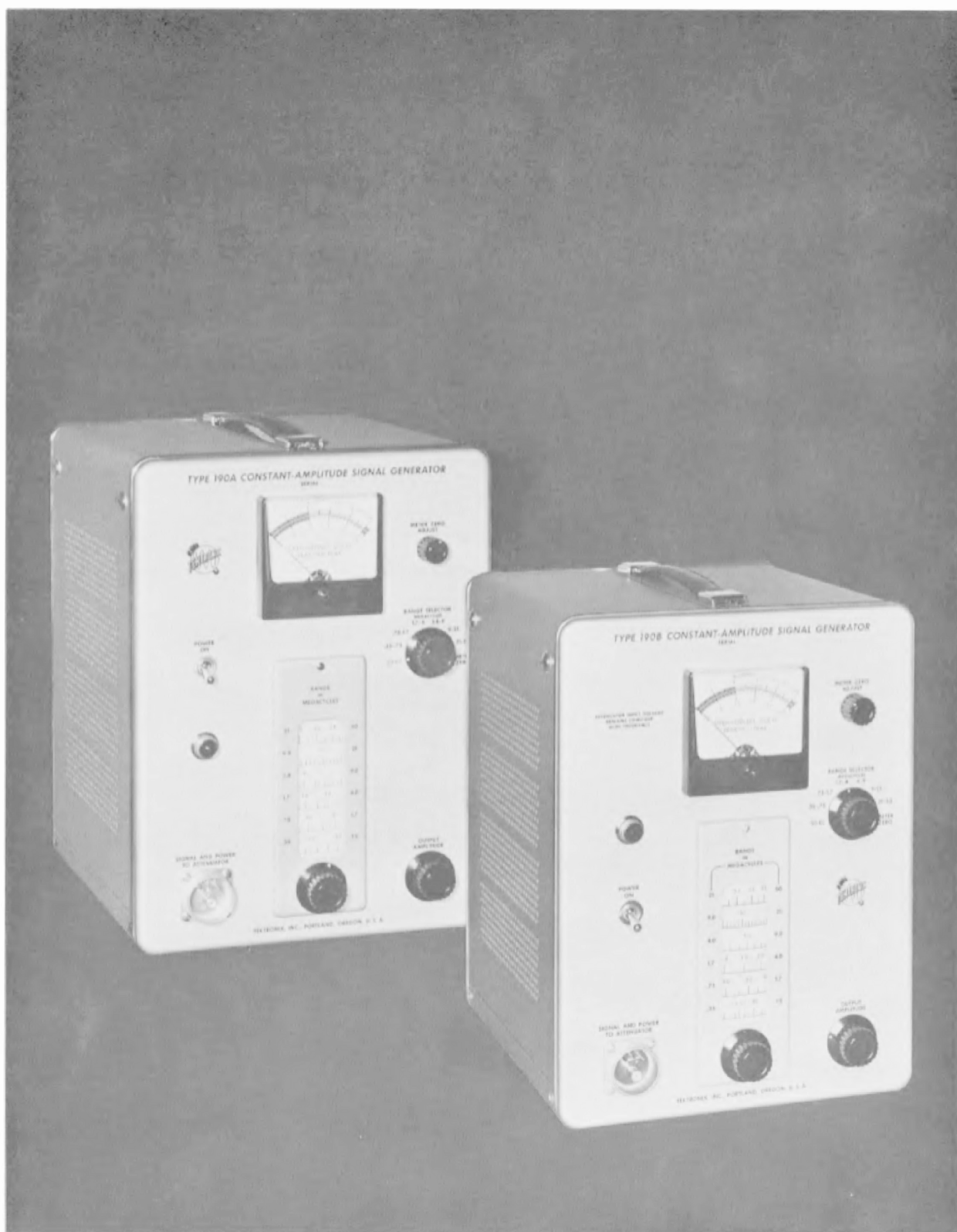


CONTENTS

Warranty

- Section 1 Characteristics
- Section 2 Operating Instructions
- Section 3 Circuit Description
- Section 4 Maintenance and Calibration
- Section 5 Parts List and Schematics

A list of abbreviations and symbols used in this manual will be found on page 5-1. Change information, if any, is located at the rear of the manual.



Type 190A/190B

SECTION 1

CHARACTERISTICS

General

The Tektronix Type 190A/190B Constant-Amplitude Signal Generator produces sine waves whose amplitude remains constant as the frequency is varied provided the load limitations of the instrument are not exceeded. A meter indicates the peak-to-peak voltage of these sine waves at the input to an attenuator.

This instrument is useful for making frequency-response measurements of broadband devices operating in the frequency range from 350 kilocycles to 50 megacycles.

Output Frequency

Continuously variable from 350 kc to 50 mc in 6 ranges.

Additional setting at 50 kc, variable over a narrow band.

Indication accurate within 2 per cent.

Output Amplitude

Attenuator

Continuously variable from 40 millivolts to 10 volts peak-to-peak in seven ranges. The amplitude indicated on the 0-10 VOLTS scale of the meter is the peak-to-peak voltage at the input to the attenuator in the attenuator head. Indication is accurate within 10% of full scale.

Amplitude Variation

Type 190A Attenuator. When the meter is in the constant amplitude region, the load resistance is at least 50 ohms and load capacitance not exceeding 10 pf. The output amplitude varies less than ± 2 per cent from 50 KC to 30 MC; less than ± 5 per cent from 30 MC to 50 MC.

Type 190B Attenuator. When the meter is in the constant amplitude region and the load shunt capacitance does not exceed 50 pf, the output amplitude from 5 Volt through .1 Volt ranges will vary less than $\pm 2\%$ from 50 KC through 30 MC and less than $\pm 5\%$ from 30 MC through 50 MC.

When the meter is in the constant amplitude region and the load shunt capacitance does not exceed 10 pf, the output amplitude of the 10 Volt range will vary less than $\pm 2\%$ from 50 KC through 30 MC and less than $\pm 5\%$ from 30 MC through 50 MC.

NOTE

The Type 190A or B attenuator is primarily designed to connect directly with the system under test. Any additional length of L connectors, T connectors, wire or coax will cause some change in the output consistency of the Type 190.

The change will be dependent on the capacitance being driven, the length of additional inductance, the voltage range being used, and the frequency.

Harmonic content

Maximum harmonic content is not specified. The harmonic content of a typical instrument will not exceed 5 per cent.

Output connection

The attenuator unit is fitted with a male coaxial connector.

Output Impedance Using a Type 190A Attenuator

Nominal, 52 ohms. Actual values:

Attenuator setting volts, peak-to-peak	Output impedance in ohms, approx.
10	0
5	39
2.5	49
1.0 to .1	52

Output Impedance Using a Type 190B Attenuator

Nominal, 25 ohms. Actual values:

Attenuator setting volts, peak-to-peak	Output impedance in ohms, approx.
10	0
5 to .1	25

Mechanical specifications

Size: Main unit— $9\frac{3}{4}$ " wide, $13\frac{1}{2}$ " high, 11" deep.

190A Attenuator unit— $2\frac{5}{8}$ " x $2\frac{1}{4}$ " x 2".

190B Attenuator unit— $2\frac{3}{8}$ " x $1\frac{3}{4}$ " x $3\frac{11}{32}$ ".

Connecting cable—36" long.

Construction: Aluminum alloy.

Finish: Anodized panel, baked blue Vinyl cabinet.

Power requirements: 105-125 volts or 210-250 volts, 50-800 cycles, 100 watts.

Accessories

Information on accessories for use with this instrument is included at the rear of the mechanical parts list.

SECTION 2

OPERATING INSTRUCTIONS

Handling

The Type 190A/190B Constant-Amplitude Signal Generator depends on free circulation of air for cooling. Be sure to leave adequate clearance at the sides of the instrument to prevent overheating. The instrument is rigidly constructed for portable operation, but it should not be subjected to excess vibration or rough handling.

Power Requirements

Unless tagged otherwise, this instrument is connected at the factory for operation from 105 to 125 volts, 50 to 800 cycles AC (117 volts nominal). However, provisions are made for easy conversion to operate at 210 and 250 volts, 50 to 800 cycles (234 volts nominal).

The power transformer is provided with split input windings, normally connected in parallel for 117 volt operation, but which can be connected in series for 234-volt operation.

When wired for 117-volt operation, terminals 1 and 2 are joined by a bare bus wire, and terminals 3 and 4 are similarly joined, as shown in Fig. 2-1a. To convert to 234-volt operation, remove the bare bus wires between these terminals. Substitute a single connecting wire between terminals 2 and 3, as shown in Fig. 2-1b.

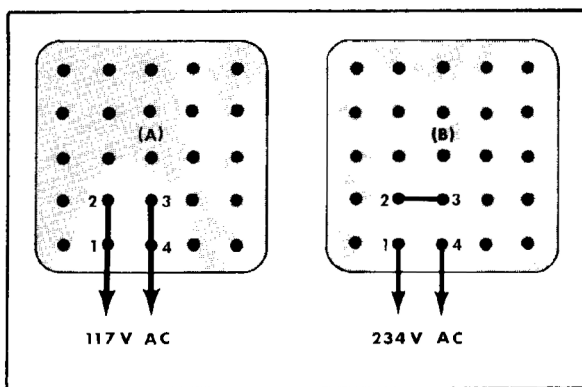


Fig. 2-1 Converting the power transformer from 105-125 volt operation to 210-250 volt operation.

Initial Operation Using a Type 190A or B Attenuator

Connect the instrument to a proper source of line-power. Turn the RANGE SELECTOR to the METER ZERO position. Connect the ATTENUATOR unit to the main unit and turn the POWER switch to ON. After a two- to three-minute warmup period, the meter pointer can be set to zero with the METER ZERO ADJUST.

Connect the output of the Type 190A/190B attenuator-generator to the instrument under test. Set the RANGE

SELECTOR and RANGE IN MEGACYCLES Controls to positions for required frequency. The peak-to-peak output voltage is adjustable by the combined settings of the ATTENUATOR and OUTPUT AMPLITUDE Controls. You can determine the proper scale and decimal location by the setting of the ATTENUATOR. The input to the ATTENUATOR is indicated on the top scale of the meter.

The output of the Type 190A attenuator terminated into 50 ohms and working into less than 10 pf will be within 10% of the meter reading in the 10 V region and less than the meter reading in all other attenuator settings.

Type 190A Attenuator Only. The output amplitude is indicated by the meter if the Type 190A Attenuator is unterminated and working into less than 10 pf.

Type 190B Attenuator Only. The output amplitude is indicated by the meter if the Type 190B is unterminated externally and working into 10 pf of shunt capacitance in the 10 volt region and 50 pf in the 5 volt —.1 volt region.

If terminated the output will be the ratio of the source resistance to the load resistance times the unterminated output voltage.

Frequency selection

To obtain a specific frequency from your Type 190A/190B attenuator-generator set the RANGE SELECTOR and RANGE IN MEGACYCLES Control to the proper positions for the desired frequency. To obtain 5 megacycles, for example, set the RANGE SELECTOR Control to the 4.0-9.0 position, and set the RANGE IN MEGACYCLES Control to position 5, on the drum, beneath the scribed line. Frequency can be read directly from the drum-dial calibrations.

An additional setting at 50 kilocycles is provided to set the peak-to-peak output amplitude in preparation for checking the passband of a wide-band amplifier. To get a 50 kilocycle output, set the RANGE SELECTOR Control to the red 50 KC position and adjust the RANGE IN MEGACYCLES Control to the 50 KC point on the lowest scale of the drum.

Output Amplitude

The top scale of the meter indicates the peak-to-peak voltage applied across the input terminals of the ATTENUATOR. The OUTPUT AMPLITUDE control sets this voltage, which should be kept above 4 volts for rated accuracy. The voltage to the ATTENUATOR is constant, regardless of the output frequency.

The ATTENUATOR divides the input voltage in seven steps between .1 and 10 volts peak-to-peak. The three full-scale voltages on the meter show which scale to read for each ATTENUATOR setting. Intermediate voltages can be read directly from the meter provided the ATTENUATOR is unterminated and is working into the proper shunt capacitance. For settings of the terminated ATTENUATOR other than the 10 VOLT position, the output amplitude will be less

Operating Instruction—Type 190A/190B

than that indicated by the meter. To determine the output amplitude, read the significant figures from the meter scale and locate the decimal point from the ATTENUATOR position.

Type 190A Attenuator Only. You can expect a deviation in output amplitude for an increase in frequency above 30 megacycles if the total capacitance seen by the ATTENUATOR is greater than 10 pf. This deviation would not be indicated on the meter since the ATTENUATOR input is maintained constant and the output varies depending upon the reactance seen by the ATTENUATOR. An attenuator will minimize the effect of capacitance in excess of 10 pf.

Type 190B Attenuator Only. You can expect a deviation in output amplitude for an increase in frequency above 30 megacycles if the total capacitance seen by the ATTENUATOR is greater than 10 pf in the 10 volt range and 50 pf in the 5 to .1 range.

This deviation would not be indicated on the meter since the ATTENUATOR input is maintained constant and the output varies depending upon the reactance seen by the ATTENUATOR. An attenuator will minimize the effect of capacitance in excess of 10 pf.

Meter zero adjust

Turn the POWER switch ON and allow the instrument about three minutes to warm up. Set the RANGE SELECTOR switch to the METER ZERO position and adjust the METER ZERO ADJUST control to zero the meter. This adjustment should be checked from time to time to correct for normal changes in tube characteristics. You should also check the meter zero each time you change V50, D60 or D61 (or V50, V51 and V60 in instruments below serial number 8140.).

NOTE

The Type 190A Attenuator furnished with your instrument is interchangeable and may be used without modification with Types 190, 190A and 190B. Type 190B generators above serial number 8139 must have the Type 190B attenuator used with them. The Type 190B attenuator can be used with any 190, 190A or 190B, if V51 is removed from its tube socket.

OPERATING DESCRIPTION OF CONTROLS AND CONNECTORS

METER	Indicates input to ATTENUATOR in volts, peak-to-peak.
METER ZERO ADJUST	Sets meter to zero reading when RANGE SELECTOR switch is in the METER ZERO position.
RANGE IN MEGACYCLES	Variable control sets and indicates frequency.
RANGE SELECTOR	Eight-position switch that selects the frequency range or METER ZERO function.
OUTPUT AMPLITUDE	Variable control sets input amplitude to ATTENUATOR unit.
POWER	On-off switch in primary of power transformer.
ATTENUATOR	Seven-position attenuator switch.

SECTION 3

CIRCUIT DESCRIPTION

The Type 190A/190B Constant-Amplitude Signal Generator maintains its output level constant by automatically controlling the oscillator plate voltage through sampling diodes and a feedback loop.

BLOCK DIAGRAM

Oscillator

The Variable-Frequency Oscillator applies the signal voltage through a flexible interconnecting cable to the attenuator unit. The signal voltage applied to the attenuator depends on the dc voltage applied to the oscillator plate.

Attenuator

The attenuator unit reduces the input voltage to a value selected by a rotary switch, and makes the attenuated signal available through a coaxial connector on the attenuator housing.

Sampling Diodes

The Sampling Diodes, located in the attenuator housing, rectify a portion of the signal voltage at the attenuator input. The resulting dc voltage, which is proportional to the peak-to-peak value of the signal, is fed back through the cable to the main unit. At the main unit, this dc voltage is fed to an electronic voltmeter and a dc-Feedback Amplifier.

Electronic Voltmeter

The electronic voltmeter indicates the peak-to-peak voltage applied to the input of the attenuator unit.

Feedback Amplifier

The Feedback Amplifier is part of the feedback loop between the Sampling Diodes and the dc plate voltage of the Variable-Frequency Oscillator. The feedback circuit automatically changes the oscillator plate voltage by adjusting the variable power supply to maintain the prescribed signal voltage at the Sampling Diodes.

Variable Power Supply

The variable power supply adjusts its output voltage according to the variable dc signal from the Feedback Amplifier. The dc output voltage is applied to the plate of the oscillator tube at the proper level to maintain a constant oscillator signal amplitude.

DETAILED CIRCUIT DESCRIPTION

Variable-Frequency Oscillator

Oscillator tube V30 is connected as a grounded-cathode Colpitts oscillator. Plate current is supplied to the grid end

of the coil through R25, R26 and L20. The tuning capacitors are C28A and C28B. The ratio of plate-to-grid ac voltage is arranged to be 3 to 1 by choosing C28A three times as large as C28B.

The switched inductors, which provide the various frequency ranges, have adjustable powdered-iron slugs and individual capacitor trimmers. This permits the frequency span of each range to be accommodated to the precalibrated dial.

Individual switched output coils, inductively coupled to the oscillator coils, provide approximately the same output voltage at each range. RANGE SELECTOR switch, SW30, performs the coil selection.

Interconnecting Cable

The oscillator output connects to the SIGNAL AND POWER TO ATTENUATOR connector through a coaxial cable. A multiple-conductor cable and plug, permanently connected to the attenuator unit, plugs into the front panel connector on the main unit. This cable includes a coaxial lead to conduct the oscillator signal to the ATTENUATOR. Another conductor delivers the dc signal from the Sampling Diodes to the main unit. The Type 190A Attenuator cable has one additional conductor which supplies heater current to the Sampling Diodes, the return for the heater current being the ground connection.

Attenuator

The signal sent through the coaxial lead is applied to the various input points on the step attenuator by means of the ATTENUATOR switch, SW60. The positions of the ATTENUATOR switch are labeled to show the open-circuit voltages that result when a 10-volt peak-to-peak voltage is applied to the attenuator input.

Sampling Diodes

The sampling diodes, V60A and V60B (SN 5001-8139) or D60 and D61 (SN 8140-up) develop a negative dc voltage across C61. This voltage is very nearly equal to the peak-to-peak voltage across the attenuator input. V60B or D61 conducts during a portion of the positive half of the ac signal permitting C60 to charge toward the peak value of this signal. The charge assumed by C60 is negative on the diode side, positive on the input side. V60A or D60 conducts during a portion of the negative half of the ac signal charging C61 negatively. After a few cycles, C60 charges until V60B or D61 conducts only during positive peaks so that the common connection between V60B or D61 plate and V60A or D60 cathode is held negative by the amount of the positive peak voltage. C61 charges until it holds the plate of V60A or D60 at such a voltage that it conducts only during the negative peaks. Thus C61 charges to a dc voltage equal to the peak-to-peak voltage of the ac signal at the attenuator input. The dc voltage from the Sampling Diodes is delivered to the main unit through the intercon-

Circuit Description—Type 190A/190B

necting cable where it is filtered by R40 and C40 and then applied to the electronic voltmeter circuit through R50.

Vacuum-Tube Voltmeter

METER CALIBRATE, R50, is adjusted to develop about two volts negative at the grid of V50A when the Sampling Diode voltage is about 10 volts. S/N 5001-8139 Thermal Balance Diodes, V51A and V51B, are connected in the same configuration as V60. V51 produces a bias voltage at the grid of V50B that is proportional and nearly equal to the no-signal voltage at the grid of 50A. This circuit helps to compensate for cathode-emission changes that accompany line-voltage changes, thus keeping the voltmeter scale more linear at the low end of the scale. SN 8140-up Ground is used as a reference for the grid of V50B.

The meter is connected between cathodes of V50A and V50B to indicate the difference in cathode voltages. The METER ZERO ADJUST Control, R51, permits an initial balance to be obtained for the zero-signal condition.

Feedback Amplifier

Feedback Amplifier, V40, receives a voltage from the Sampling Diodes that is proportional to the dc voltage at the electronic voltmeter. This dc voltage is subtracted from the adjustable positive dc voltage of the OUTPUT AMPLITUDE Control, R43, and applied to the grid of V40. The plate of V40 is dc coupled to the grid of V20 whose plate, in turn, controls the grid of the series regulator of V15. The regulated voltage from the cathode of V15 supplies the plate voltage to the oscillator tube, thus controlling the oscillator amplitude.

If you adjust the OUTPUT AMPLITUDE Control so that its positive output voltage is increased, the plate current of V40

will increase so that its plate voltage will decrease. This voltage change, amplified and reversed in direction by V20, increases the grid voltage of V15, so that the cathode current of V15 increases. The resulting increase in cathode voltage of V15 causes the plate voltage of the oscillator V30 to increase, so that the amplitude of the oscillations is increased. This develops a larger negative voltage from the Sampling Diodes, V60A and V60B or D60 and D61. This negative voltage, applied to the grid of V40, results in a new equilibrium condition, with the grid potential of V40 near the value it had before the OUTPUT AMPLITUDE setting was changed.

Line voltage changes do not change the oscillation amplitude, because the dc voltage across the OUTPUT AMPLITUDE Control is stabilized by the voltage reference tube, V6.

Changes in gain of the oscillator tube V30 do not change the oscillation amplitude, because a reduction in amplitude, for example, will deliver a smaller negative voltage to the grid of V40. The rise in grid voltage of V40 will result in a rise in plate voltage to oscillator V30 and the original equilibrium condition will again be established.

Power Supply

DC voltage is supplied by rectifying ac power from transformer T1 through V1, a full-wave rectifier. A voltage-regulator tube, V6, supplies stabilized 105 volts to those points in the circuit likely to be most sensitive to voltage variation.

Plate voltage is supplied to the oscillator tube through a series-regulator tube V15. The regulator-tube grid is controlled by a two-stage dc-coupled amplifier V20 and V40, whose output voltage varies in the proper sense to compensate for any change in the oscillator output voltage by making an opposite change in oscillator plate voltage.

SECTION 4

MAINTENANCE and CALIBRATION

Replacement of Components

Replacements for all parts in the Type 190A/190B Constant-Amplitude Signal Generator can be purchased directly from Tektronix at current prices. However, since most of the components are standard electronic and radio parts, they can generally be obtained locally in less time than is required to obtain them from the factory. Before purchasing or ordering parts, be sure to consult the parts list to determine the tolerances and ratings required. The parts list gives the values, tolerances, ratings and Tektronix part number for each component in the instrument.

In addition to the standard components, special parts are manufactured by Tektronix or manufactured by other companies to Tektronix specifications. These parts and most mechanical parts should be obtained directly from Tektronix or the local Tektronix Field Office, since they are difficult or impossible to obtain from other sources.

Parts Ordering Information

You will find a serial number in the front of this manual. This is the serial number of the instrument for which this manual was prepared. Be sure the manual number matches the number of the instrument when you order parts.

Since the production of your instrument, some of the parts may have been superseded by improved components. In such cases, the part numbers will not be listed in your Parts List. However, if you order a part from Tektronix and it has been superseded by an improved component, the new part will be shipped in place of the part ordered. Your local Tektronix Field Engineering Office has knowledge of these changes and may call you if a change in your purchase order is necessary. Replacement information sometimes accompanies the improved components to aid their installation.

When ordering parts, be sure to include both the description of the part and the Tektronix part number found in the Parts List. For example, if the serial number of your Type

190A or 190B were 1122, a certain capacitor would be ordered as follows: C40, .01 microfarad, fixed, 400 v, 20%, part number 285-510 for Type 190A, Serial Number 1122.

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 the solder 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 to 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.

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 $\frac{1}{16}$ to $\frac{1}{8}$ inch of the tip. For soldering to ceramic terminal strips tin the iron with solder containing about 3% silver.
4. Apply one corner of the tip to the notch where you wish to solder (see Figure 4-2).

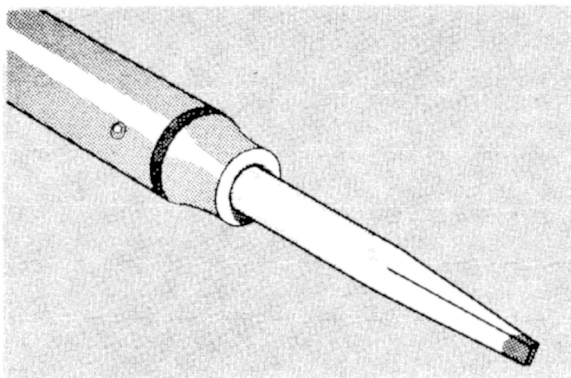


Fig. 4-1. Soldering iron tip properly shaped and tinned.

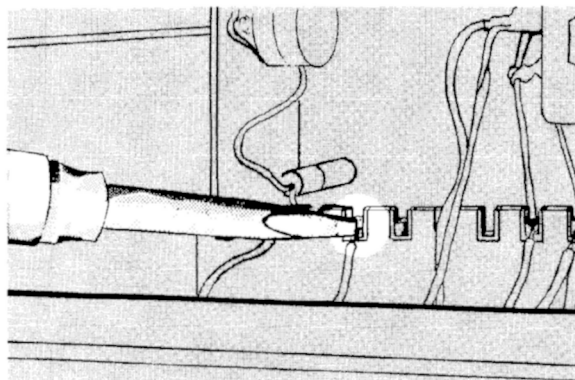


Fig. 4-2. Correct method of applying heat in soldering to a ceramic strip.

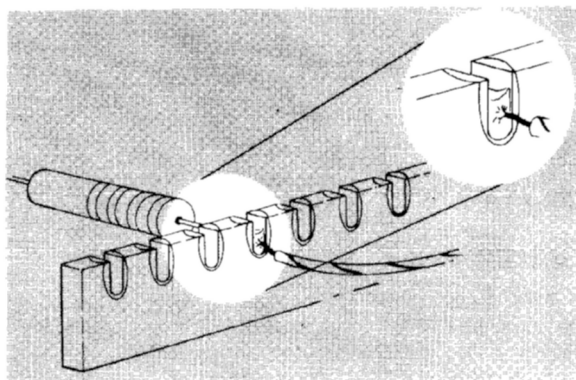


Fig. 4-3. A slight fillet of solder is formed around the wire when heat is applied correctly.

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.

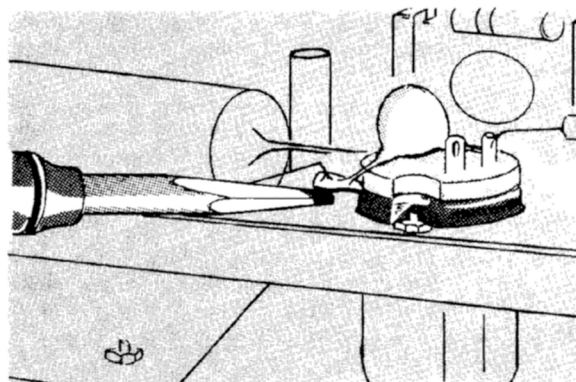


Fig. 4-4. Soldering to a terminal. Note the slight fillet of solder formed around the wire.

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. 4-4.

General Soldering Considerations

When replacing wires in terminal slots clip the ends neatly as close to the solder joint as possible. In clipping the ends of wires take care the end removed does not remain in the instrument.

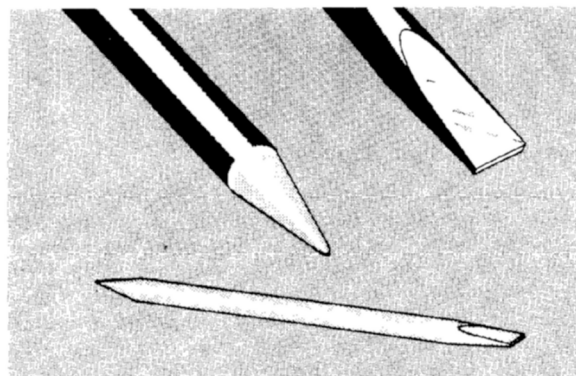


Fig. 4-5. A soldering aid constructed from a 1/4 inch wooden dowel.

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 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.

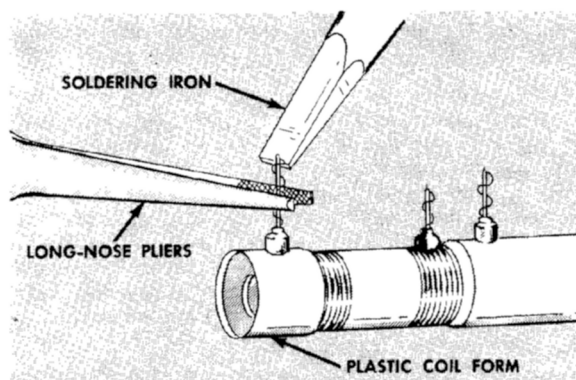


Fig. 4-6. Soldering to a terminal mounted in plastic. Note the use of the long-nosed pliers between the iron and the coil form to absorb the heat.

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

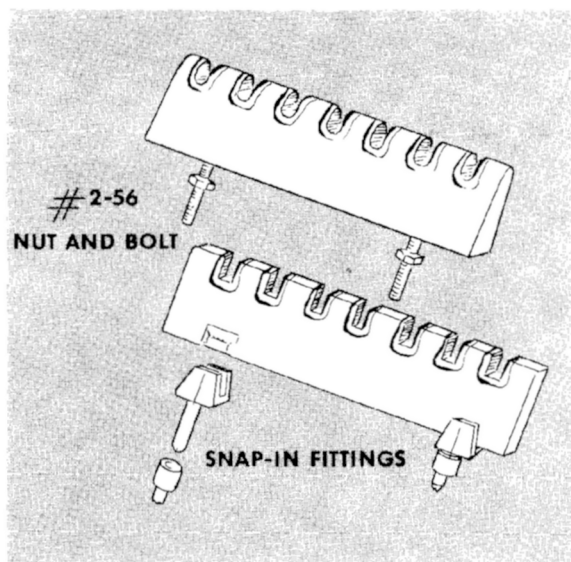


Fig. 4-7. Two types of ceramic strip mountings.

protruding ends of the bolts, and fasten them firmly with another set of #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.

TROUBLESHOOTING

General

Troubles are usually caused by tube failures. You can frequently correct them by finding the bad tube and replacing it with a good one. However, sometimes a tube burns up resistors or overstresses capacitors when it fails, and if this happens you will also have to find these bad components. Sometimes they can be found by visual inspection. One way to find bad tubes is to replace all suspected tubes at one time, and if the trouble is helped, return the old ones, one at a time, until the offending one is discovered.

Power Supply

Correct operation of the power supply is necessary for proper operation of the instrument, so an early step to take is to check the output of the power supply.

If the instrument fails to operate at all, including the pilot light, check the source of power and determine that the power-cord plug is securely in place. Then check the fuse at the back of the instrument near the power receptacle.

If the output voltage is high and not variable, possible suspects are V20 or V40. If this voltage is low you might suspect V1 or V15. Failure of V6 would be indicated by a change in output amplitude with a change in line voltage.

CALIBRATION PROCEDURE

Meter calibration

Recheck the meter calibration if you replace V50, D60 or D61 (or V50, V51 or V60 in instruments below serial number 8140).

1. Zero the meter with the METER ZERO ADJUST as outlined in the Operating Instructions.
2. Set output frequency to about 500 kc and display 10 volts peak-to-peak on a calibrated oscilloscope.
3. Adjust the METER CALIBRATE control to indicate 10 volts.
4. Recheck METER ZERO ADJUST and then METER CALIBRATE, alternately, as they interact.

Frequency Calibration

Replacement of the oscillator tube, V40, may require a slight realignment of the oscillator coils and trimmers to make the oscillator frequency agree with the drum-dial scale.

A frequency meter or the Tektronix Type 180 Time-Mark Generator can be used to make this adjustment. A detector can be easily assembled from a 1N34A crystal for use with the Type 180.

Each tuned circuit is adjustable by a powdered-iron slug in the coil and a trimmer capacitor. You can recalibrate the drum-dial scale to agree with the oscillator, by changing the inductance and capacitance for a specific frequency range. Varying the coil inductance shifts the frequency band and changes the frequency difference a small amount. The trimmer capacitor varies the frequency difference but has a greater effect at the high-frequency end of each range.

You can realign the Type 190A/190B using the following procedure for each tuned circuit with the check points listed below.

1. Set the frequency standard.

Maintenance and Calibration—Type 190A/190B

2. Set the drum-dial scale at the low-frequency check point.
3. Adjust the coil for a beat note.
4. Set the drum-dial scale at the high-end check point.
5. Adjust the trimmer.
6. Set the drum-scale at the low-end check point and readjust the coil.
7. Check the high-end check point again and adjust the trimmer if necessary.
8. Repeat between the low and high ends until the drum-dial scale agrees within one per cent or better of the frequency standard.

The following check points are convenient to use in calibrating the drum-dial scale.

Set the Type 180 at 50 μ sec.

Scale	Check point	Adjust
50 kc	50 kc	L28

Set the Type 180 at 5 μ sec.

Scale	Check point	Adjust
.35-.75	.4, .6	L30, C30
.75-1.7	.8, 1.6	L31, C31
1.7-4.0	1.8, 4.0	L32, C32

Set the Type 180 at 1 μ sec.

Scale	Check point	Adjust
4.0-9.0	4.0, 8.0	L33, C33
9.0-21.0	10.0, 20.0	L34, C34
21.0-50.0	22.0, 46.0	L35, C35

SECTION 5

PARTS LIST and DIAGRAMS

PARTS ORDERING INFORMATION

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



Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

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

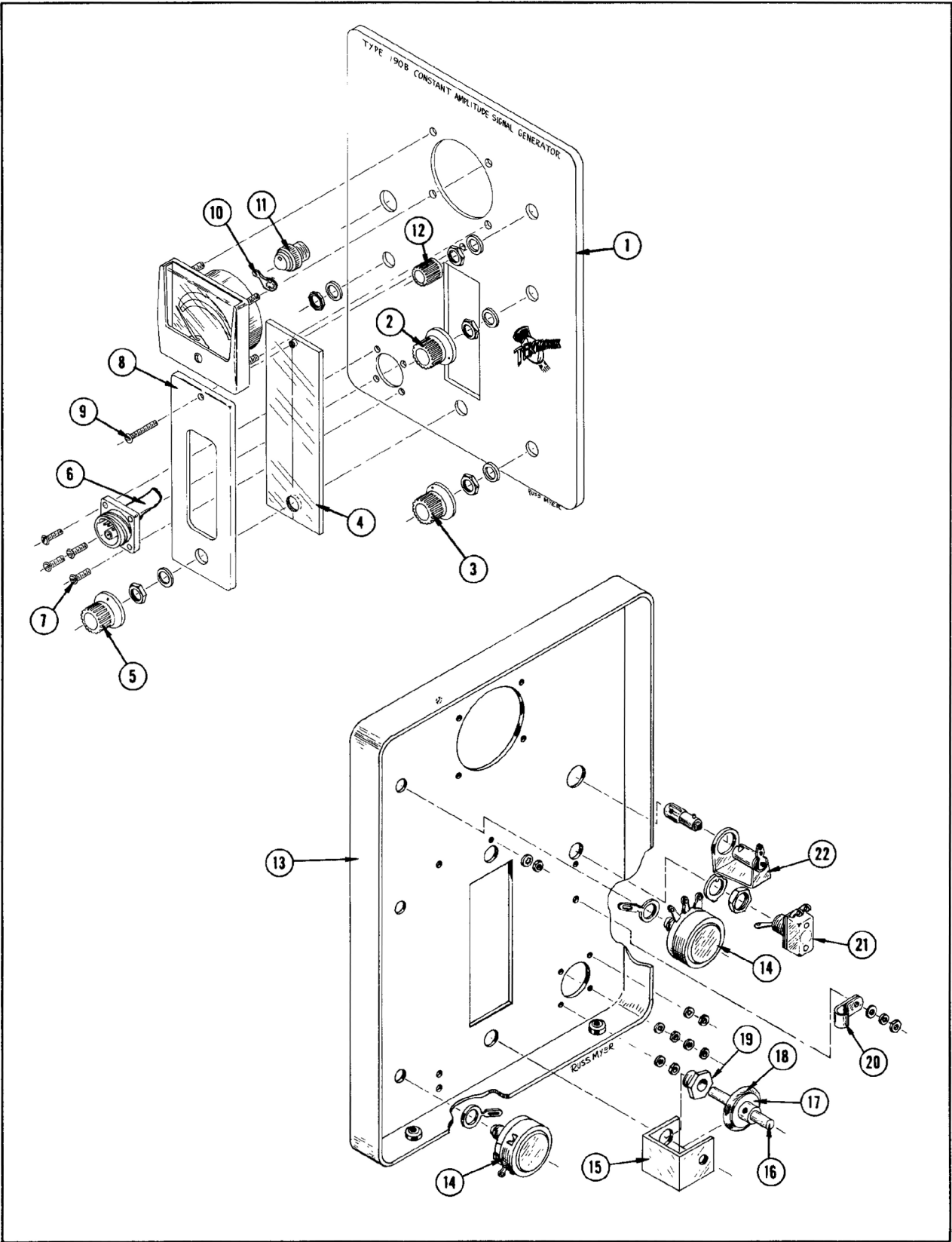
ABBREVIATIONS AND SYMBOLS

a or amp	amperes	mm	millimeter
BHS	binding head steel	meg or M	megohms or mega (10^6)
C	carbon	met.	metal
cer	ceramic	μ	micro, or 10^{-6}
cm	centimeter	n	nano, or 10^{-9}
comp	composition	Ω	ohm
cps	cycles per second	OD	outside diameter
crt	cathode-ray tube	OHS	oval head steel
CSK	counter sunk	p	pico, or 10^{-12}
dia	diameter	PHS	pan head steel
div	division	piv	peak inverse voltage
EMC	electrolytic, metal cased	plstc	plastic
EMT	electrolytic, metal tubular	PMC	paper, metal cased
ext	external	poly	polystyrene
f	farad	Prec	precision
F & I	focus and intensity	PT	paper tubular
FHS	flat head steel	PTM	paper or plastic, tubular, molded
Fil HS	fillister head steel	RHS	round head steel
g or G	giga, or 10^9	rms	root mean square
Ge	germanium	sec	second
GMV	guaranteed minimum value	Si	silicon
h	henry	S/N	serial number
hex	hexagonal	t or T	tera, or 10^{12}
HHS	hex head steel	TD	toroid
HSS	hex socket steel	THS	truss head steel
HV	high voltage	tub.	tubular
ID	inside diameter	v or V	volt
incd	incandescent	Var	variable
int	internal	w	watt
k or K	kilohms or kilo (10^3)	w/	with
kc	kilocycle	w/o	without
m	milli, or 10^{-3}	WW	wire-wound
mc	megacycle		

SPECIAL NOTES AND SYMBOLS

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, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

FRONT



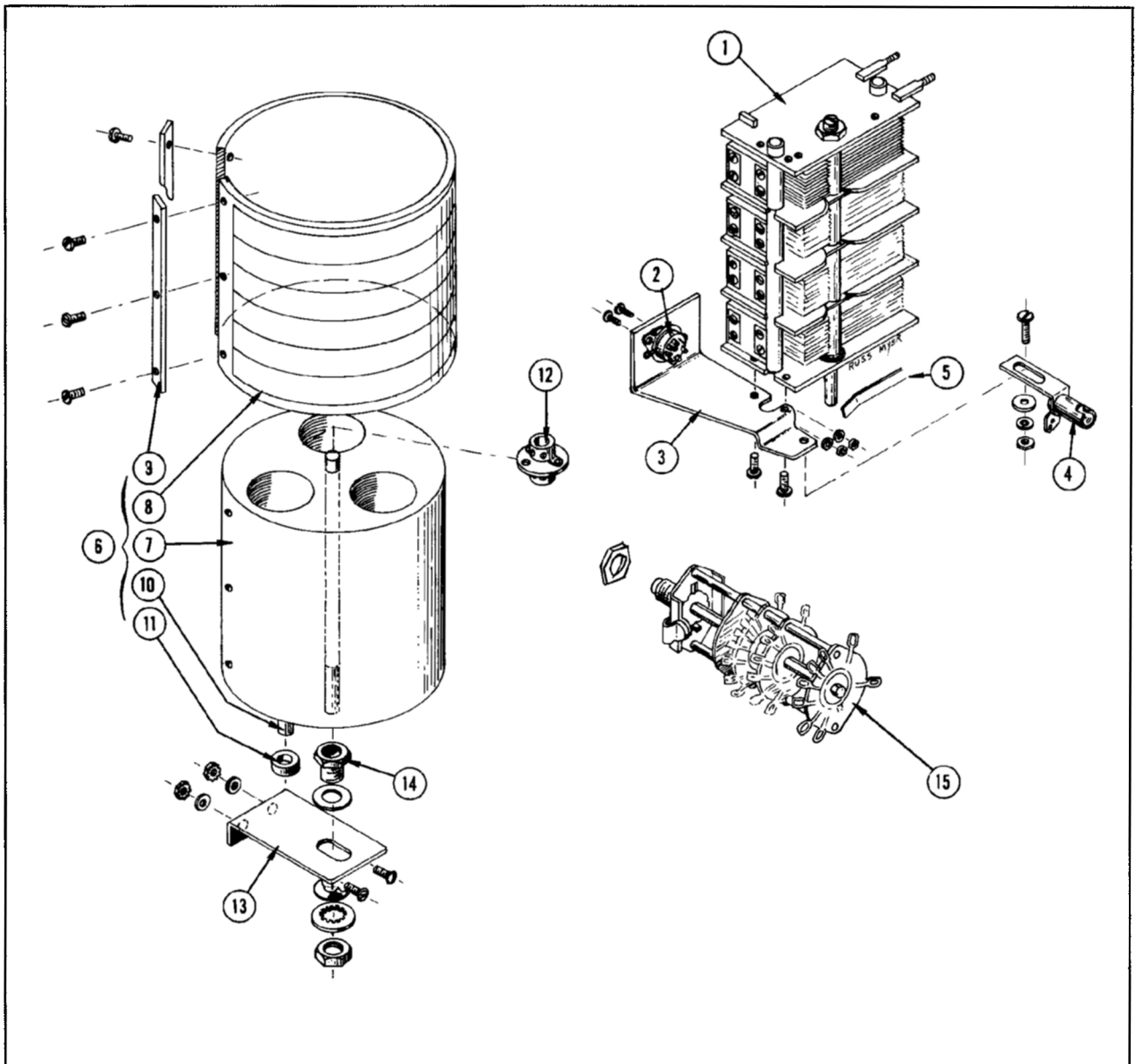
FRONT

REF. NO.	PART NO.	SERIAL/MODEL NO.		QTY.	DESCRIPTION
		EFF.	DISC.		
1	333-0277-00	5001	6509	1	PANEL, front, 190A
	333-0632-00	6510		1	PANEL, front, 190B
2	366-0042-00	5001	8899	1	KNOB, large black—RANGE SELECTOR
	366-0117-00	8900		1	KNOB, large charcoal—RANGE SELECTOR
	- - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $\frac{3}{16}$ inch HSS
3	366-0042-00	5001	8899	1	KNOB, large black—OUTPUT AMPLITUDE
	366-0117-00	8900		1	KNOB, large charcoal—OUTPUT AMPLITUDE
	- - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $\frac{3}{16}$ inch HSS
4	331-0039-00			1	GRATICULE, scribed
5	366-0043-00	5001	8899	1	KNOB, large black—RANGE IN MEGACYCLES
	366-0201-00	8900		1	KNOB, large charcoal—RANGE IN MEGACYCLES
	- - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $\frac{3}{16}$ inch HSS
6	175-0015-00			1	CABLE, power to attenuator (see ref. #7)
	- - - - -			-	cable includes
7	131-0015-00			1	CONNECTOR, 4 contact, male
	- - - - -			-	mounting hardware: (not included w/cable)
	211-0012-00			4	SCREW, 4-40 x $\frac{3}{8}$ inch BHS
	210-0004-00			4	LOCKWASHER, internal, #4
	210-0406-00			4	NUT, hex, 4-40 x $\frac{3}{16}$ inch
8	333-0278-00	5001	6509	1	PANEL, graticule cover, 190A
	333-0645-00	6510		1	PANEL, graticule cover, 190B
	- - - - -			-	mounting hardware: (not included w/panel)
9	211-0014-00			1	SCREW, 4-40 x $\frac{1}{2}$ inch BHS
	210-0004-00			1	LOCKWASHER, internal, #4
	210-0406-00			1	NUT, hex, 4-40 x $\frac{3}{16}$ inch
10	210-0223-00			2	LUG, solder, $\frac{1}{4}$ inch
11	378-0518-00			1	JEWEL, light, pilot
12	366-0044-00	5001	8899	1	KNOB, small black—METER ZERO ADJUST
	366-0113-00	8900		2	KNOB, small charcoal—METER ZERO ADJUST
	- - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $\frac{3}{16}$ inch HSS
13	386-0569-00	5001	6509	1	PLATE, front subpanel, 190A
	387-0348-00	6510		1	PLATE, front subpanel, 190B
	- - - - -			-	plate includes:
	354-0057-00			1	RING, ornamental
14	- - - - -			2	POT
	- - - - -			-	mounting hardware for each: (not included w/pot)
	210-0207-00			1	LUG, solder, $\frac{3}{8}$ inch
	210-0012-00			1	LOCKWASHER, internal, $\frac{3}{8}$ x $\frac{1}{2}$ inch
	210-0840-00			1	WASHER, .390 ID x $\frac{9}{16}$ inch OD
	210-0413-00			1	NUT, hex, $\frac{3}{8}$ -32 x $\frac{1}{2}$ inch
15	406-0044-00			1	BRACKET, drive wheel
	- - - - -			-	mounting hardware: (not included w/bracket)
	211-0538-00			1	SCREW, 6-32 x $\frac{5}{16}$ inch FHS phillips

FRONT (Cont'd)

REF. NO.	PART NO.	SERIAL/MODEL NO.		Q T Y.	DESCRIPTION
		EFF.	DISC.		
16	384-0502-00			1	ROD, shaft, drum
17	401-0002-00			1	WHEEL, aluminum
	- - - - -			-	wheel, includes:
	213-0006-00			1	SCREW, set, 8-32 x $\frac{3}{16}$ inch HSS
18	354-0012-00			1	RING, rubber, drum drive
19	358-0009-00			1	BUSHING, hex, $\frac{3}{8}$ -32 x $\frac{1}{2}$ x $\frac{5}{8}$ inch
	- - - - -			-	mounting hardware: (not included w/bushing)
	210-0840-00			1	WASHER, .390 ID x $\frac{9}{16}$ inch OD
	210-0413-00			1	NUT, hex, $\frac{3}{8}$ -32 x $\frac{1}{2}$ inch
20	343-0003-00			1	CLAMP, cable, $\frac{1}{4}$ inch
	- - - - -			-	mounting hardware: (not included w/clamp)
	211-0559-00			1	SCREW, 6-32 x $\frac{3}{8}$ inch FHS phillips
	210-0803-00			1	WASHER, 6L x $\frac{3}{8}$ inch
	210-0006-00			1	LOCKWASHER, internal, #6
	210-0407-00			1	NUT, hex, 6-32 x $\frac{1}{4}$ inch
21	260-0134-00			1	SWITCH, toggle—POWER ON
	- - - - -			-	switch includes:
	210-0414-00			1	NUT, hex, $\frac{15}{32}$ -32 x $\frac{9}{16}$ inch
	- - - - -			-	mounting hardware: (not included w/switch)
	354-0055-00			1	RING, locking, switch
	210-0902-00			1	WASHER, .470 ID x $2\frac{1}{32}$ inch OD
	210-0473-00			1	NUT, switch, $\frac{15}{32}$ -32 x $\frac{5}{64}$ inch, 12 sided
22	136-0025-00			1	SOCKET, light

VARIABLE AIR CAPACITOR, DRUM AND SWITCH



REF. NO.	PART NO.	SERIAL/MODEL NO.		Q T Y.	DESCRIPTION
		EFF.	DISC.		
1	-----			1	CAPACITOR, air, variable
	211-0507-00	5001	6509X	-	mounting hardware: (not included w/capacitor)
	210-0803-00			4	SCREW, 6-32 x 5/16 inch BHS
	210-0006-00	X6510		4	WASHER, 6L x 3/8 inch
	210-0202-00	X6510		1	LOCKWASHER, internal, #6
	210-0407-00	X6510		3	LUG, solder, SE #6
				4	NUT, hex, 6-32 x 1/4 inch

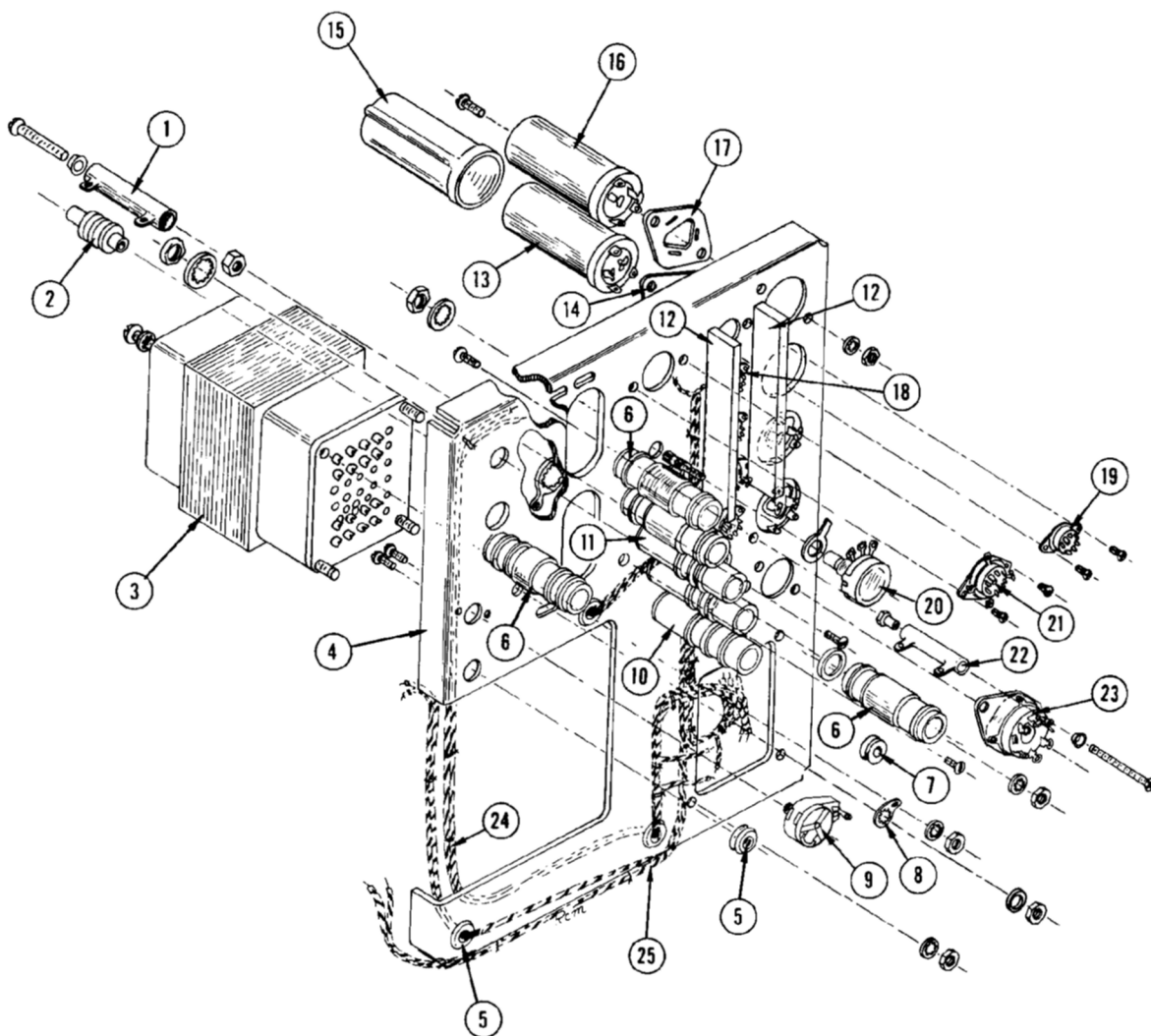
VARIABLE AIR CAPACITOR, DRUM AND SWITCH (Cont'd)

REF. NO.	PART NO.	SERIAL/MODEL NO.		QTY.	DESCRIPTION
		EFF.	DISC.		
2	136-0008-00 - - - - - 211-0033-00 210-0004-00 210-0406-00			1 - 2 2 2	SOCKET, STM7G mounting hardware: (not included w/socket) SCREW, 4-40 x $\frac{5}{16}$ inch PHS w/lockwasher LOCKWASHER, internal, #4 NUT, hex, 4-40 x $\frac{3}{16}$ inch
3	406-0043-00 406-0653-00 - - - - - 211-0504-00 212-0001-00	5001 6510 5001 6510	6509 6509	1 1 - 2 2	BRACKET, oscillator BRACKET, oscillator mounting hardware: (not included w/bracket) SCREW, 6-32 x $\frac{1}{4}$ inch BHS SCREW, 8-32 x $\frac{1}{4}$ inch BHS
4	136-0001-00 - - - - - 211-0507-00 210-0803-00 210-0006-00 210-0407-00			1 - 1 1 1 1	SOCKET, graticule lamp mounting hardware: (not included w/socket) SCREW, 6-32 x $\frac{5}{16}$ inch BHS WASHER, 6L x $\frac{3}{8}$ inch LOCKWASHER, internal, #6 NUT, hex, 6-32 x $\frac{1}{4}$ inch
5	131-0061-00	5001	6509X	1	CONNECTOR, terminal
6	650-0209-00 - - - - -			1 -	ASSEMBLY, drum assembly includes:
7	105-0002-00 105-0002-00 105-0049-00	5001 7186 8010	7185 8009	1 1 1	DRUM, aluminum DRUM, plastic (material change w/o changing part no.) DRUM, aluminum
8	331-0038-00 331-0071-00 331-0109-00 107-0007-00	5001 6510 8070 5001	6509 8069 8069X	1 1 1 1	DIAL, clear plastic DIAL, clear plastic DIAL, opaque plastic SHEET, paper
9	381-0017-00 - - - - - 213-0045-00 211-0504-00 213-0088-00	 5001 7186 8010	 7185 8009	2 - 3 3 3	BAR, bakelite mounting hardware for each: (not included w/bar) SCREW, self-tapping, 4-40 x $\frac{5}{16}$ inch PHS phillips SCREW, 6-32 x $\frac{1}{4}$ inch BHS SCREW, thread forming, 4-40 x $\frac{1}{4}$ inch PHS phillips
10	166-0039-00 166-0038-00 - - - - - 211-0520-00 212-0031-00 210-0006-00 210-0804-00	5001 X8010 5001 X8010 5001 X8010	7185X 7185X 7185X	1 1 - 1 1 1 1	TUBE, spacer, 1 inch TUBE, spacer, $\frac{3}{4}$ inch (included w/drum) mounting hardware: (not included w/tube) SCREW, 6-32 x $1\frac{1}{4}$ inches RHS SCREW, 8-32 x $1\frac{1}{4}$ inches RHS LOCKWASHER, internal, #6 WASHER, 8S x $\frac{3}{8}$ inch
11	358-0019-00			1	BUSHING, neoprene
12	376-0003-00 - - - - - 213-0020-00			1 - 4	COUPLING, fiber mounting hardware: (not included w/coupling) SCREW, set, 6-32 x $\frac{1}{8}$ inch HSS
13	406-0045-00 406-0652-00 - - - - - 211-0510-00 210-0803-00 210-0457-00	5001 6510 5001 5001	6509	1 1 - 2 2 2	BRACKET, drum BRACKET, drum mounting hardware: (not included w/bracket) SCREW, 6-32 x $\frac{3}{8}$ inch BHS WASHER, 6L x $\frac{3}{8}$ inch NUT, keps, 6-32 x $\frac{5}{16}$ inch

VARIABLE AIR CAPACITOR, DRUM AND SWITCH (Cont'd)

REF. NO.	PART NO.	SERIAL/MODEL NO.		Q T Y.	DESCRIPTION
		EFF.	DISC.		
14	358-0029-00			1	BUSHING, hex, $\frac{3}{8}$ -32 x $1\frac{13}{32}$ inch
	- - - - -			-	mounting hardware: (not included w/bushing)
	210-0840-00			1	WASHER, .390 ID x $\frac{9}{16}$ inch OD
	210-0013-00			1	LOCKWASHER, internal, $\frac{3}{8}$ x $1\frac{1}{16}$ inch
	210-0413-00			1	NUT, hex, $\frac{3}{8}$ -32 x $\frac{1}{2}$ inch
15	260-0169-00			1	SWITCH, unwired—RANGE SELECTOR
	- - - - -			-	mounting hardware: (not included w/switch)
	210-0013-00			1	LOCKWASHER, internal, $\frac{3}{8}$ x $1\frac{1}{16}$ inch
	210-0840-00			1	WASHER, .390 ID x $\frac{9}{16}$ inch OD
	210-0413-00			1	NUT, hex, $\frac{3}{8}$ -32 x $\frac{1}{2}$ inch

CHASSIS



CHASSIS

REF. NO.	PART NO.	SERIAL/MODEL NO.		QTY.	DESCRIPTION
		EFF.	DISC.		
1	----- 212-0037-00 210-0808-00 210-0409-00 210-0462-00 210-0008-00 210-0804-00 212-0004-00	5001 6510 5001 5001 X6510	6509 6509X 6509X	2 - 1 1 2 1 1 1 1	RESISTOR mounting hardware for each: (not included w/resistor) SCREW, 8-32 x 1 ³ / ₄ inches Fil HS WASHER, resistor centering NUT, hex, 8-32 x ⁵ / ₁₆ inch NUT, hex, resistor mounting LOCKWASHER, internal, #8 WASHER, 8S x ³ / ₈ inch SCREW, 8-32 x ⁵ / ₁₆ inch BHS
2	----- 211-0507-00			1 - 1	COIL, fixed mounting hardware: (not included w/coil) SCREW, 6-32 x ⁵ / ₁₆ inch BHS
3	----- 212-0017-00 212-0542-00 210-0804-00 210-0812-00 ----- 210-0458-00 220-0410-00	5001 8350 5001 8350 5001 8350	8349 8349	1 - 4 4 2 4 - 4 4	TRANSFORMER transformer includes: SCREW, 8-32 x 5 inches HHS SCREW, 10-32 x 5 inches HHS WASHER, 8S x ³ / ₈ inch WASHER, fiber, #10 mounting hardware: (not included w/transformer) NUT, keps, 8-32 x ¹¹ / ₃₂ inch NUT, keps, 10-32 x ³ / ₈ inch
4	441-0143-00 441-0350-00 ----- 212-0040-00 210-0008-00 210-0409-00	5001 6510	6509	1 1 - 6 5 5	CHASSIS, 190A CHASSIS, 190B mounting hardware: (not included w/chassis) SCREW, 8-32 x ³ / ₈ inch FHS phillips LOCKWASHER, internal, #8 NUT, hex, 8-32 x ⁵ / ₁₆ inch
5	348-0004-00			5	GROMMET, ³ / ₈ inch
6	----- 210-0013-00 210-0413-00			5 - 1 1	COIL, variable mounting hardware for each: (not included w/coil) LOCKWASHER, internal, ³ / ₈ x ¹¹ / ₁₆ inch NUT, hex, ³ / ₈ -32 x ¹ / ₂ inch
7	348-0003-00			1	GROMMET, ⁵ / ₁₆ inch
8	210-0201-00 ----- 213-0044-00			1 - 1	LUG, solder, SE #4 mounting hardware: (not included w/lug) SCREW, thread cutting, 5-32 x ³ / ₁₆ inch PHS phillips
9	----- 211-0008-00			1 - 2	CAPACITOR mounting hardware: (not included w/capacitor) SCREW, 4-40 x ¹ / ₄ inch BHS
10	----- 210-0207-00 210-0013-00 210-0413-00	X8380		1 - 1 1 1	COIL, variable mounting hardware: (not included w/coil) LUG, solder, ³ / ₈ inch LOCKWASHER, internal, ³ / ₈ x ¹¹ / ₁₆ inch NUT, hex, ³ / ₈ -32 x ¹ / ₂ inch

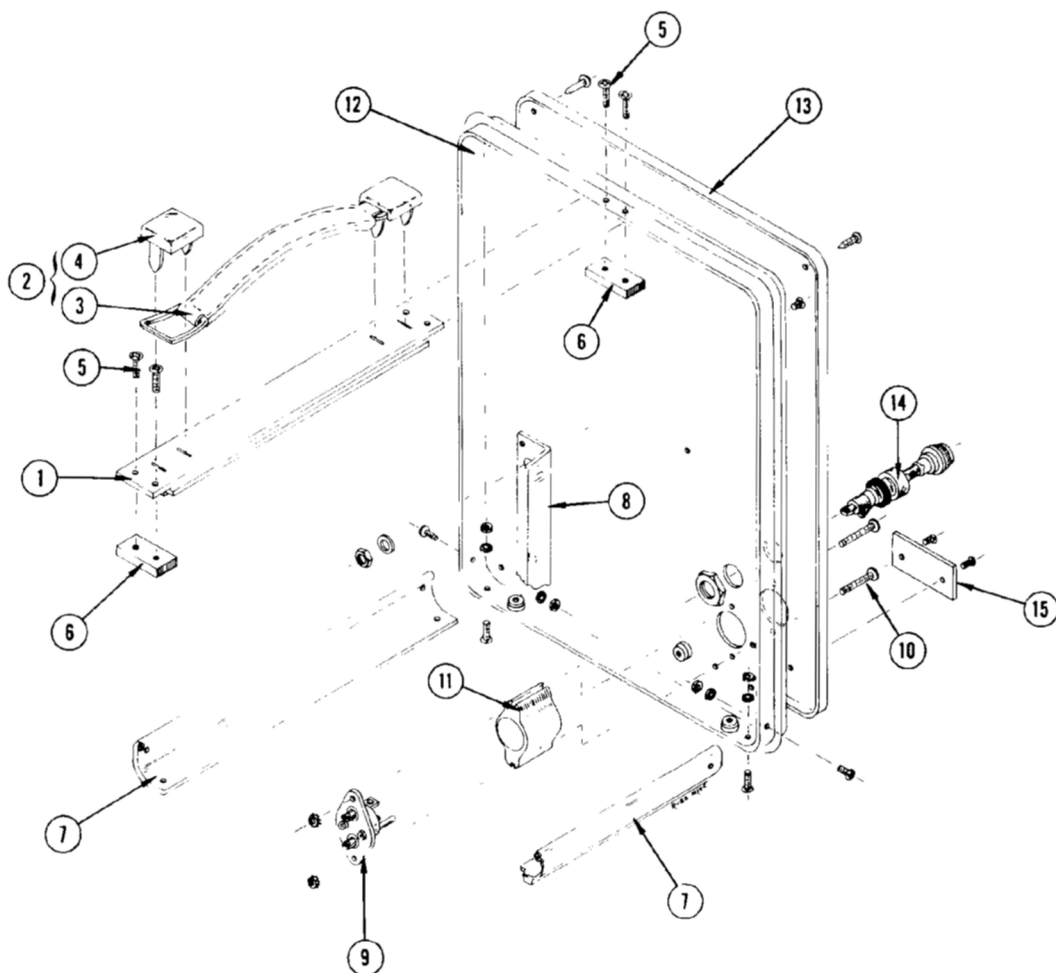
CHASSIS (Cont'd)

REF. NO.	PART NO.	SERIAL/MODEL NO.		Q T Y.	DESCRIPTION
		EFF.	DISC.		
11	- - - - - 210-0207-00 210-0013-00 210-0413-00			1 - 1 1 1	COIL, variable - mounting hardware: (not included w/coil) LUG, solder, $\frac{3}{8}$ inch LOCKWASHER, internal, $\frac{3}{8} \times 1\frac{1}{16}$ inch NUT, hex, $\frac{3}{8}$ -32 x $\frac{1}{2}$ inch
12	124-0014-00 - - - - - 210-0850-00 210-0405-00 210-0002-00	5001	5719	4 - 2 4 2	STRIP, ceramic, $\frac{3}{4}$ inch x 7 notches - mounting hardware for each: (not included w/strip) WASHER, #2 NUT, hex, 2-56 x $\frac{3}{16}$ inch LOCKWASHER, external, #2
	124-0089-00 - - - - - 355-0046-00 - - - - - 361-0009-00	5720		4 - 2 - 2	STRIP, ceramic, $\frac{3}{4}$ inch x 7 notches - each strip includes: STUD, nylon - mounting hardware for each: (not included w/strip) SPACER, nylon, .313 inch
13	- - - - -			2	CAPACITOR
14	- - - - - 386-0252-00 211-0534-00 210-0006-00 210-0407-00			- 1 2 2 2	mounting hardware for each: (not included w/capacitor) PLATE, fiber, small capacitor SCREW, 6-32 x $\frac{5}{16}$ inch PHS w/lockwasher LOCKWASHER, internal, #6 NUT, hex, 6-32 x $\frac{1}{4}$ inch
15	200-0257-00			1	COVER, capacitor
16	- - - - -			2	CAPACITOR
17	- - - - - 386-0253-00 211-0534-00 210-0006-00 210-0407-00			- 1 2 2 2	mounting hardware for each: (not included w/capacitor) PLATE, metal, small capacitor SCREW, 6-32 x $\frac{5}{16}$ inch PHS w/lockwasher LOCKWASHER, internal, #6 NUT, hex, 6-32 x $\frac{1}{4}$ inch
18	136-0008-00 - - - - - 211-0033-00 210-0004-00 210-0406-00 213-0044-00	5001 5001 5001 6510	6509 6509 6509	3 - 2 2 2 2	SOCKET, STM7G - mounting hardware for each: (not included w/socket) SCREW, 4-40 x $\frac{5}{16}$ inch PHS w/lockwasher LOCKWASHER, internal, #4 NUT, hex, 4-40 x $\frac{3}{16}$ inch SCREW, thread cutting, 5-32 x $\frac{3}{16}$ inch PHS phillips
19	136-0008-00 - - - - - 211-0033-00 210-0004-00 210-0406-00 213-0044-00	5001 5001 5001 5001 6510	8139X 6509 6509 6509	1 - 2 2 2 2	SOCKET, STM7G - mounting hardware: (not included w/socket) SCREW, 4-40 x $\frac{5}{16}$ inch PHS w/lockwasher LOCKWASHER, internal, #4 NUT, hex, 4-40 x $\frac{3}{16}$ inch SCREW, thread cutting, 5-32 x $\frac{3}{16}$ inch PHS phillips

CHASSIS (Cont'd)

REF. NO.	PART NO.	SERIAL/MODEL NO.		QTY.	DESCRIPTION
		EFF.	DISC.		
20	- - - - - 210-0207-00 210-0012-00 210-0840-00 210-0413-00			1 - 1 1 1 1	POT mounting hardware: (not included w/pot) LUG, solder, $\frac{3}{8}$ inch LOCKWASHER, internal, $\frac{3}{8}$ x $\frac{1}{2}$ inch WASHER, .390 ID x $\frac{9}{16}$ inch OD NUT, hex, $\frac{3}{8}$ -32 x $\frac{1}{2}$ inch
21	136-0015-00 - - - - - 211-0033-00 210-0004-00 210-0406-00 213-0044-00	5001 5001 5001 6510	6509 6509 6509	2 - 2 2 2 2	SOCKET, STM9G mounting hardware for each: (not included w/socket) SCREW, 4-40 x $\frac{5}{16}$ inch PHS w/lockwasher LOCKWASHER, internal, #4 NUT, hex, 4-40 x $\frac{3}{16}$ inch SCREW, thread cutting, 5-32 x $\frac{3}{16}$ inch PHS phillips
22	- - - - - 211-0553-00 210-0601-00 210-0478-00 211-0507-00			1 - 1 1 1 1	RESISTOR mounting hardware: (not included w/resistor) SCREW, 6-32 x $1\frac{1}{2}$ inches RHS phillips EYELET NUT, hex, resistor mounting SCREW, 6-32 x $\frac{5}{16}$ inch BHS
23	136-0011-00 - - - - - 211-0534-00 210-0006-00 210-0407-00 213-0044-00	5001 5001 5001 6510	6509 6509 6509	1 - 2 2 2 2	SOCKET, STM8G mounting hardware: (not included w/socket) SCREW, 6-32 x $\frac{5}{16}$ inch PHS w/lockwasher LOCKWASHER, internal, #6 NUT, hex, 6-32 x $\frac{1}{4}$ inch SCREW, thread cutting, 5-32 x $\frac{3}{16}$ inch PHS phillips
24	179-0491-00	X6510		1	CABLE HARNESS, 110 volt
25	179-0052-00 179-0492-00	5001 6510	6509	1 1	CABLE HARNESS, chassis CABLE HARNESS, chassis

REAR AND FRAME



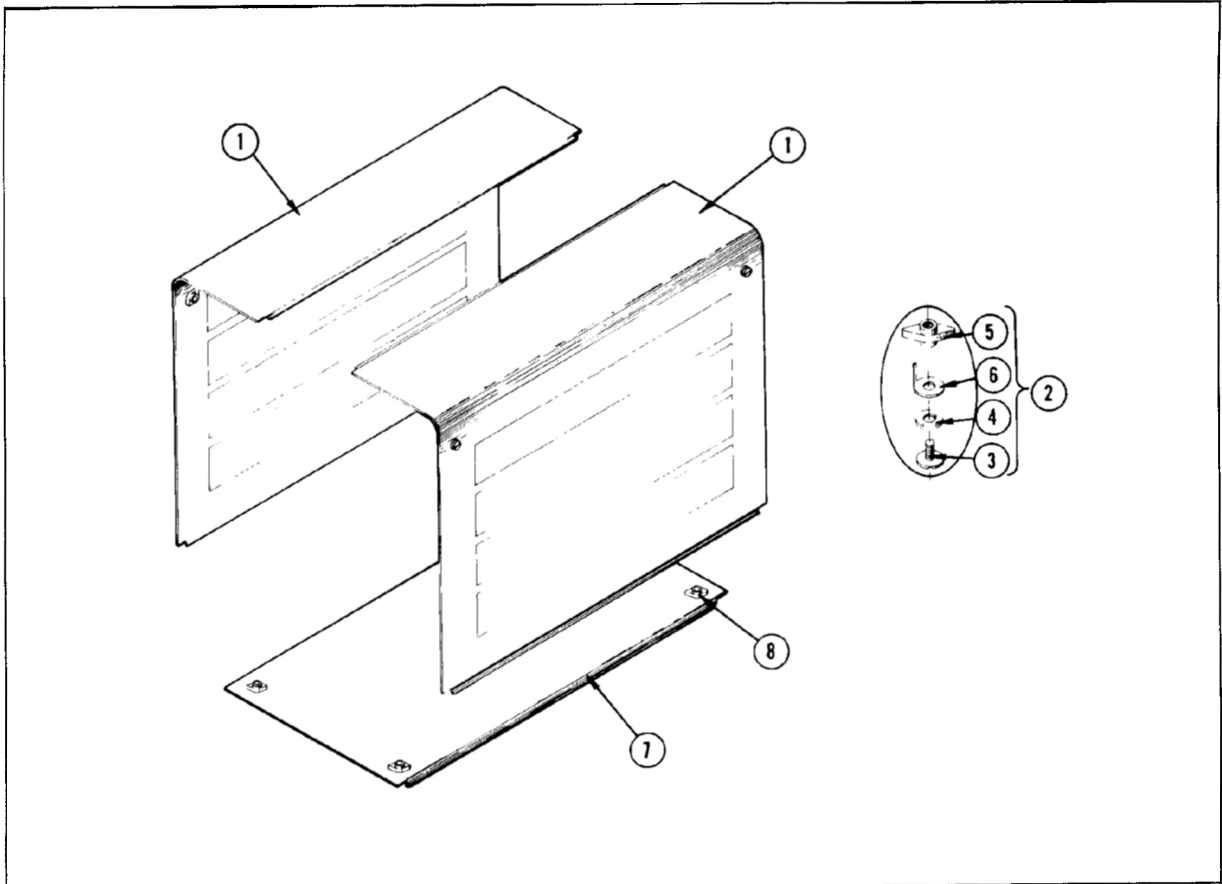
REAR AND FRAME

REF. NO.	PART NO.	SERIAL/MODEL NO.		QTY.	DESCRIPTION
		EFF.	DISC.		
1	381-0070-00	5001	6219	1	BAR, top support, w/handle (see ref. #5 & #6)
	381-0163-00	6220	8247	1	BAR, top support, w/handle (see ref. #5 & #6)
	381-0233-00	8248		1	BAR, top support, w/handle (see ref. #5 & #6)
	- - - - -			-	bar includes:
2	367-0039-00	5001	8247	1	ASSEMBLY, handle
	367-0043-00	8248		1	ASSEMBLY, handle
	- - - - -			-	assembly includes:
3	367-0001-00	5001	8247	1	HANDLE, leather
	367-0037-00	8248		1	HANDLE, decora
4	343-0052-00	5001	8247	2	CLAMP, handle
	344-0098-00	8248		2	CLIP, handle
	212-0518-00	X8248		2	SCREW, 10-32 x $\frac{5}{16}$ inch BHB
5	- - - - -			-	mounting hardware: (not included w/bar)
	211-0537-00			4	SCREW, 6-32 x $\frac{3}{8}$ inch THS phillips
6	381-0084-00			2	BAR, aluminum
7	122-0020-00	5001	6219	2	ANGLE, frame, bottom
	122-0063-00	6220		2	ANGLE, frame, bottom
	- - - - -			-	mounting hardware for each: (not included w/angle)
	211-0542-00			4	SCREW, 6-32 x $\frac{5}{16}$ inch THS phillips
	210-0006-00			4	LOCKWASHER, internal, #6
	210-0407-00			4	NUT, hex, 6-32 x $\frac{1}{4}$ inch
8	406-0241-00			1	BRACKET, transformer support (included w/transformer)
	- - - - -			-	mounting hardware: (not included w/bracket)
	212-0040-00			2	SCREW, 8-32 x $\frac{3}{8}$ inch FHS phillips
	210-0804-00			2	WASHER, 8S x $\frac{3}{8}$ inch
	210-0458-00			2	NUT, keps, 8-32 x $\frac{1}{32}$ inch
9	131-0010-00	5001	5599	1	CONNECTOR, motor base, 2 contact (see ref. #10)
	131-0102-00	5600	7619	1	CONNECTOR, motor base, 3 wire (see ref. #10)
	131-0150-00	7620		1	CONNECTOR, motor base, 3 wire (see ref. #10)
	- - - - -			-	connector includes:
	129-0041-00	X5600		1	POST, ground, thread one end
	200-0185-00	X5600		1	COVER, motor base
	205-0014-00	X7620		1	SHELL, motor base
	210-0003-00	X5600		2	LOCKWASHER, external, #4
	210-0551-00	X5600		2	NUT, hex, 4-40 x $\frac{1}{4}$ inch
	211-0015-00	X5600		1	SCREW, 4-40 x $\frac{1}{2}$ inch RHS
	214-0078-00	X5600		2	PIN, connecting
	377-0041-00	X5600		1	INSERT, black urea
	386-0933-00	X5600	7619X	1	PLATE, motor base
10	- - - - -			-	mounting hardware: (not included w/connector)
	213-0041-00	5001	5599	2	SCREW, thread cutting, 6-32 x $\frac{3}{8}$ inch THS phillips
	211-0545-00	5600	7619	2	SCREW, 6-32 x $1\frac{1}{4}$ inches THS phillips
	213-0104-00	7620		2	SCREW, thread forming, 6-32 x $\frac{3}{8}$ inch THS phillips
	210-0457-00	X5600	7619X	2	NUT, keps, 6-32 x $\frac{5}{16}$ inch
11	361-0012-00	X5600	7619X	1	SPACER, motor base

REAR AND FRAME (Cont'd)

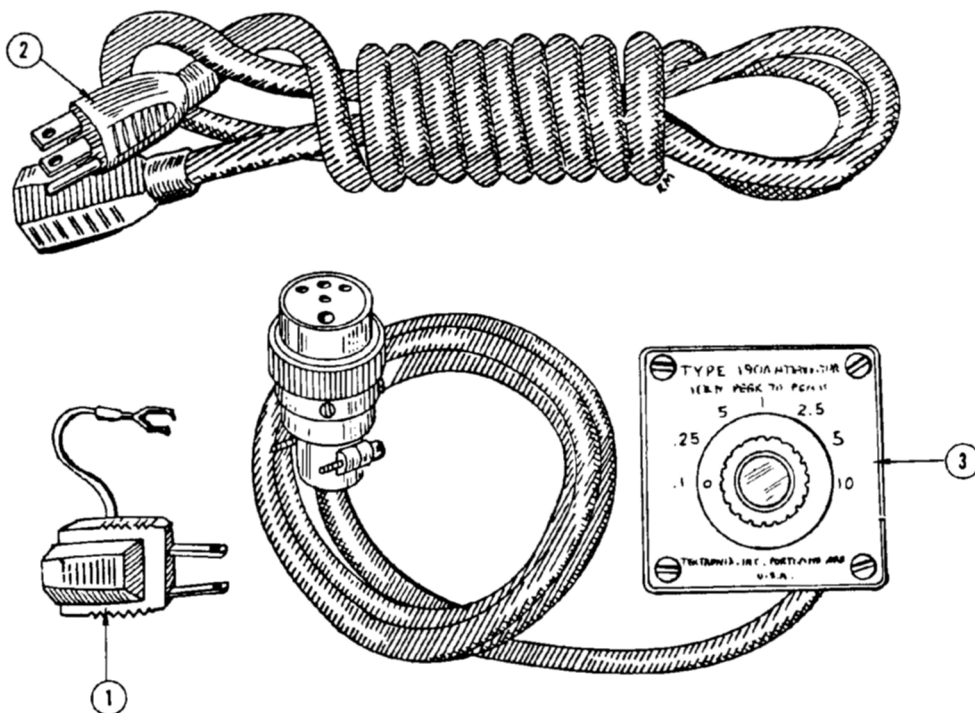
REF. NO.	PART NO.	SERIAL/MODEL NO.		Q T Y.	DESCRIPTION
		EFF.	DISC.		
12	386-0570-00	5001	6509	1	PLATE, rear subpanel
	387-0349-00	6510	7619	1	PLATE, rear subpanel
	387-0700-00	7620		1	PLATE, rear subpanel
	- - - - -			-	plate includes:
13	354-0057-00			1	RING, ornamental
	386-0580-00	5001	6219	1	PLATE, rear overlay
	387-0044-00	6220	7619	1	PLATE, rear overlay
	387-0699-00	7620		1	PLATE, rear overlay
	- - - - -			-	mounting hardware: (not included w/plate)
	213-0104-00			3	SCREW, thread forming, 6-32 x 3/8 inch THS phillips
14	352-0002-00			1	ASSEMBLY, fuse holder
	- - - - -			-	assembly includes:
	352-0010-00			1	HOLDER, fuse
	200-0582-00			1	CAP, fuse
	210-0873-00			1	WASHER, rubber, 1/2 ID x 1 1/16 inch OD
15	- - - - -			1	NUT, fuse holder
	334-0649-00	5001	7989	1	TAG, voltage rating
	334-0650-00	7990		1	TAG, voltage rating
	- - - - -			-	mounting hardware: (not included w/tag)
	213-0088-00			2	SCREW, thread forming, 4-40 x 1/4 inch PHS phillips

CABINET



REF. NO.	PART NO.	SERIAL/MODEL NO.		QTY.	DESCRIPTION
		EFF.	DISC.		
1	386-0567-00	5001	6219	2	PLATE, cabinet side
	387-0042-00	6220		2	PLATE, cabinet side
	- - - - -			-	each plate includes:
2	214-0057-00			2	ASSEMBLY, fastener
	- - - - -			-	each assembly includes:
3	213-0033-00			1	SCREW, fastening, 8-32 x 1/2 inch
4	210-0847-00			1	WASHER, nylon, .164 ID x .500 inch OD
5	210-0480-00			1	NUT, latch, nylon
6	105-0007-00			1	STOP
7	386-0568-00	5001	5379	1	PLATE, cabinet bottom
	386-0823-00	5380	6219	1	PLATE, cabinet bottom (see ref. #8)
	387-0043-00	6220		1	PLATE, cabinet bottom (see ref. #8)
	- - - - -			-	plate includes:
	214-0057-00	5001	5379X	4	FASTENER, latch, assembly
8	- - - - -			-	mounting hardware: (not included w/plate)
	211-0507-00	X5380		4	SCREW, 6-32 x 5/16 inch BHS

ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO.		QTY.	DESCRIPTION
		EFF.	DISC.		
1	103-0013-00	X5600		1	ADAPTER, power cord
2	161-0004-00	5001	5599	1	CORD, power
	161-0008-00	5600	5735	1	CORD, power
	161-0010-00	5736		1	CORD, power
3	011-0024-00	5001	8139	1	ATTENUATOR UNIT
	011-0054-00	8140		1	ATTENUATOR UNIT
--	070-0413-00			2	MANUAL, instruction (not shown)

Type 190A (S/N 5001-6509)

Type 190B (S/N 6510-up)

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description				S/N Range	
Bulbs							
B1	150-001	Incandescent #47	Dial Light				
B2	150-001	Incandescent #47	Pilot Light				
Capacitors							
Tolerance $\pm 20\%$ unless otherwise indicated.							
Tolerance of all electrolytic capacitors as follows (with exceptions):							
3V — 50V = -10% , $+250\%$							
51V — 350V = -10% , $+100\%$							
351V — 450V = -10% , $+50\%$							
C1	Use 290-0010-00	2 x 20 μf	EMC	450 v			
C2	Use 290-0010-00	2 x 20 μf	EMC	450 v			
C8	Use 290-0010-00	2 x 20 μf	EMC	450 v			
C9	Use 290-0010-00	2 x 20 μf	EMC	450 v			
C20	283-002	.01 μf	Cer	500 v			
C22	283-002	.01 μf	Cer	500 v			
C26	285-552	.018 μf	MT	600 v			
C27	Use 283-0083-00	.0047 μf	Cer	500 v			
C28A,B	281-021		Air	Var	5%		
	281-054		Air	Var	RANGE IN MEGACYCLES 5001-6509 6510-up		
C29	281-525	470 pf	Cer	500 v			
C30	281-028	20-125 pf	Cer	Var			
C31	281-005	1.5-7 pf	Cer	Var	5001-6509		
	281-027	.7-3 pf	Tub.	Var	6510-up		
C32	281-005	1.5-7 pf	Cer	Var	5001-6509		
	281-027	.7-3 pf	Tub.	Var	6510-up		
C33	281-005	1.5-7 pf	Cer	Var	5001-6509		
	281-027	.7-3 pf	Tub.	Var	6510-up		
C33B	281-529	1.5 pf	Cer	500 v $\pm .25$ pf			
C34	281-005	1.5-7 pf	Cer	Var	5001-6509		
	281-027	.7-3 pf	Tub.	Var	6510-up		
C35	281-007	3-12 pf	Cer	Var	5001-6509		
	281-012	7-45 pf	Cer	Var	6510-up		
C36	281-501	4.7 pf	Cer	500 v ± 1 pf			
C40	285-510	.01 μf	MT	400 v			
C41	283-004	.02 μf	Cer	150 v			

Parts List—Type 190A/190B

Capacitors (Cont'd)

Ckt. No.	Tektronix Part No.	Description	S/N Range
C42	283-004	.02 μ f Cer 150 v	5001-8139X
C50	285-510	.01 μ f MT 400 v	
C60	283-004	.02 μ f Cer 150 v	
C61	283-004	.02 μ f Cer 150 v	

Diodes

D60	152-129	Germanium 1N87A	X8140-up
D61	152-129	Germanium 1N87A	X8140-up

Fuses

F1	159-003	1.6 Amp 3AG Slo-Blo 117 v oper
	159-018	.8 Amp 3AG Slo-Blo 234 v oper

Inductors

L20	*108-008	6.3 mh					
L26	*108-056	1.2 μh					X5149-up
L27	*108-103	2.5 μh					
L28	*114-058	2.4-4 mh	Var	Core	276-508		
L29	*108-119	5.8 μh					
L30	*114-059	1.5-2.1 mh	Var	Core	276-508		
L31	*114-060	.4-.76 mh	Var	Core	276-508		
L32	*114-061	70-99 μh	Var	Core	276-508		
L33	*114-062	9-16 μh	Var	Core	276-508		
L34	*114-063	1.8-3 μh	Var	Core	276-508		
L35	*114-064	.3-.5 μh	Var	Core	276-508		

Meter

M50	149-013	0-200 μ amps
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Resistors

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

R1	304-224	220 k	1 w		
R2	304-224	220 k	1 w		
R3	308-014	250 Ω	10 w	WW	5%
R5	308-033	4.5 k	20 w	WW	5%
R6	308-033	4.5 k	20 w	WW	5%

Resistors (Cont'd)

Ckt. No.	Tektronix Part No.		Description	S/N Range
R8	304-224	220 k	1 w	
R9	304-224	220 k	1 w	
R15	302-474	470 k	1/2 w	
R16	302-270	27 Ω	1/2 w	
R17	302-270	27 Ω	1/2 w	
R20	304-182	1.8 k	1 w	
R21	306-562	5.6 k	2 w	
R22	302-684	680 k	1/2 w	
R25	306-472	4.7 k	2 w	5001-5719
	306-562	5.6 k	2 w	5720-up
R26	306-472	4.7 k	2 w	5001-5719
	306-562	5.6 k	2 w	5720-up
R29	302-393	39 k	1/2 w	
R40	302-472	4.7 k	1/2 w	
R41	302-125	1.2 meg	1/2 w	
R42	302-106	10 meg	1/2 w	
R43	311-035	500 k	Var	OUTPUT AMPLITUDE
R44	302-394	390 k	1/2 w	
R45	302-153	15 k	1/2 w	
R46	302-103	10 k	1/2 w	
R50	311-026	100 k	Var	METER CALIBRATE
R51	311-005	500 Ω	Var	METER ZERO ADJUST
R52	302-391	390 Ω	1/2 w	
R55	302-681	680 Ω	1/2 w	
R56	302-223	22 k	1/2 w	5001-8139X
R57	302-683	68 k	1/2 w	5001-8139X
R60	322-097	100 Ω	1/4 w	Prec 1% X8140-up
R66	301-750	75 Ω	1/2 w	Prec 5% 5001-5009
	309-171	73 Ω	1/2 w	Prec 1% 5010-8139
	322-097	100 Ω	1/4 w	Prec 1% 8140-up
R67	301-111	110 Ω	1/2 w	5% 5001-5009
	309-173	109 Ω	1/2 w	Prec 1% 5010-8139
	322-618	50 Ω	1/4 w	Prec 1% 8140-up
R68	301-151	150 Ω	1/2 w	5% 5001-5009
	309-174	136 Ω	1/2 w	Prec 1% 5010-8139
	322-615	16.7 Ω	1/4 w	Prec 1% 8140-up
R69	301-750	75 Ω	1/2 w	5% 5001-5009
	309-172	78 Ω	1/2 w	Prec 1% 5010-8139
	322-619	66.7 Ω	1/4 w	Prec 1% 8140-up
R70	301-151	150 Ω	1/2 w	5% 5001-5009
	309-175	156 Ω	1/2 w	Prec 1% 5010-8139
	322-615	16.7 Ω	1/4 w	Prec 1% 8140-up
R71	301-750	75 Ω	1/2 w	5% 5001-5009
	309-172	78 Ω	1/2 w	Prec 1% 5010-8139
	322-616	21.4 Ω	1/4 w	Prec 1% 8140-up

Part List—Type 190A/190B

Resistors (Cont'd)

Ckt. No.	Tektronix Part No.		Description			S/N Range
R72	301-121	120 Ω	$\frac{1}{2}$ w		5%	5001-5009
	309-174	136 Ω	$\frac{1}{2}$ w	Prec	1%	5010-8139
	322-617	47.7 Ω	$\frac{1}{4}$ w	Prec	1%	8140-up
R73	301-111	110 Ω	$\frac{1}{2}$ w		5%	5001-5009
	309-173	109 Ω	$\frac{1}{2}$ w	Prec	1%	5010-8139
	322-616	21.4 Ω	$\frac{1}{4}$ w	Prec	1%	8140-up
R74	301-151	150 Ω	$\frac{1}{2}$ w		5%	5001-5009
	309-174	136 Ω	$\frac{1}{2}$ w	Prec	1%	5010-8139
	322-615	16.7 Ω	$\frac{1}{4}$ w	Prec	1%	8140-up
R75	301-750	75 Ω	$\frac{1}{2}$ w		5%	5001-5009
	309-172	78 Ω	$\frac{1}{2}$ w	Prec	1%	5010-8139
	322-619	66.7 Ω	$\frac{1}{4}$ w	Prec	1%	8140-up
R76	301-151	150 Ω	$\frac{1}{2}$ w		5%	5001-5009
	309-175	156 Ω	$\frac{1}{2}$ w	Prec	1%	5010-8139
	322-615	16.7 Ω	$\frac{1}{4}$ w	Prec	1%	8140-up
R77	301-750	75 Ω	$\frac{1}{2}$ w		5%	5001-5009
	309-172	78 Ω	$\frac{1}{2}$ w	Prec	1%	5010-8139
	322-615	16.7 Ω	$\frac{1}{4}$ w	Prec	1%	8140-up
R78	301-750	75 Ω	$\frac{1}{2}$ w		5%	5001-5009
	309-172	78 Ω	$\frac{1}{2}$ w	Prec	1%	5010-8139
	322-619	66.7 Ω	$\frac{1}{4}$ w	Prec	1%	8140-up
R79	322-615	16.7 Ω	$\frac{1}{4}$ w	Prec	1%	X8140-up
R80	322-616	21.4 Ω	$\frac{1}{4}$ w	Prec	1%	X8140-up
R81	322-617	47.7 Ω	$\frac{1}{4}$ w	Prec	1%	X8140-up
R82	322-616	21.4 Ω	$\frac{1}{4}$ w	Prec	1%	X8140-up
R83	323-626	50 Ω	$\frac{1}{2}$ w	Prec	1%	X8140-up

Switches

	Unwired	Wired			
SW1	260-134		Toggle	POWER ON	
SW30	260-169	*262-129	Rotary	RANGE SELECTOR	5001-6509
SW30	260-169		Rotary	RANGE SELECTOR	6510-up
SW60	260-171	*262-130	Rotary	ATTENUATOR	5001-8139
	260-520	*262-558			8140-up

Transformer

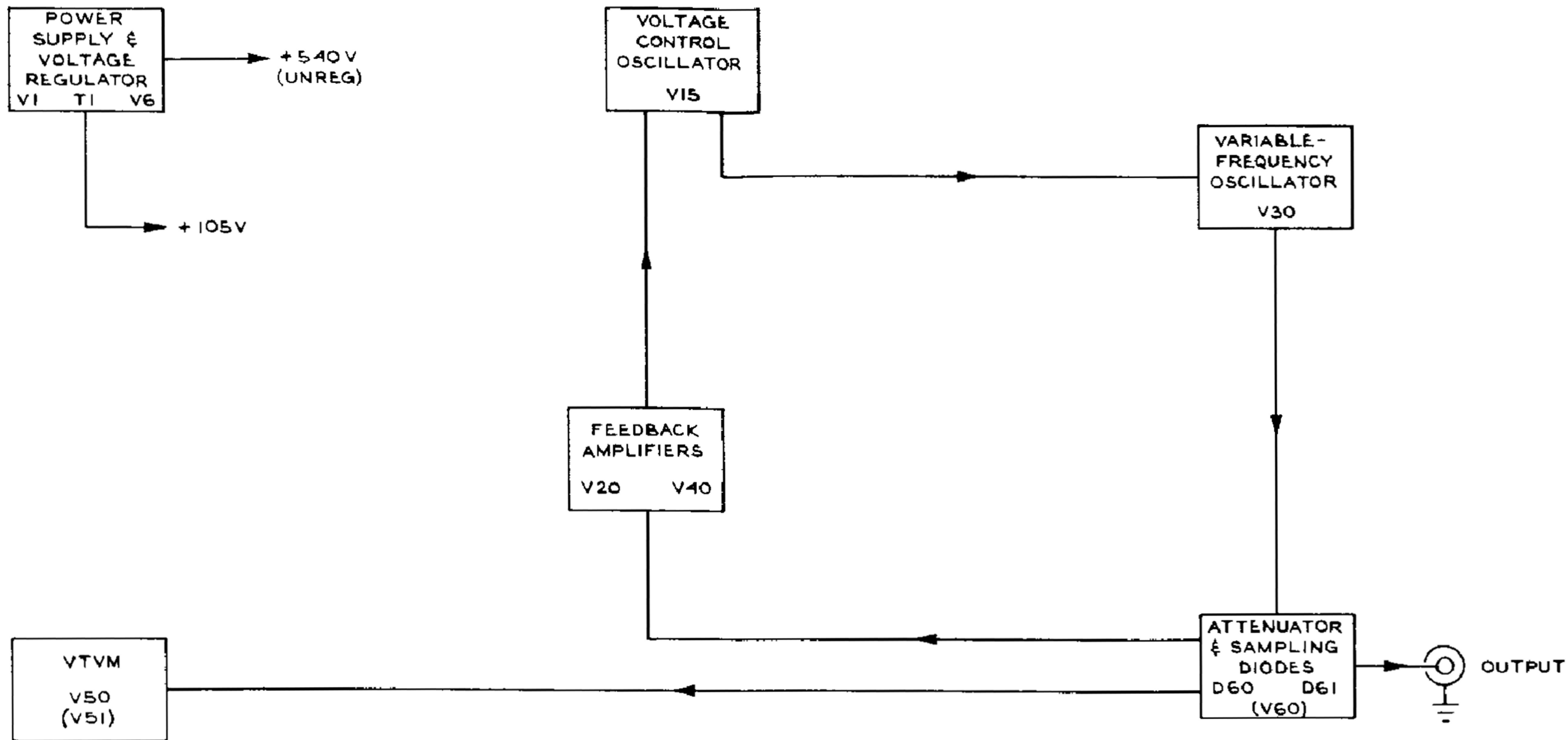
T1	Use *120-0045-01	Power
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Electron Tubes

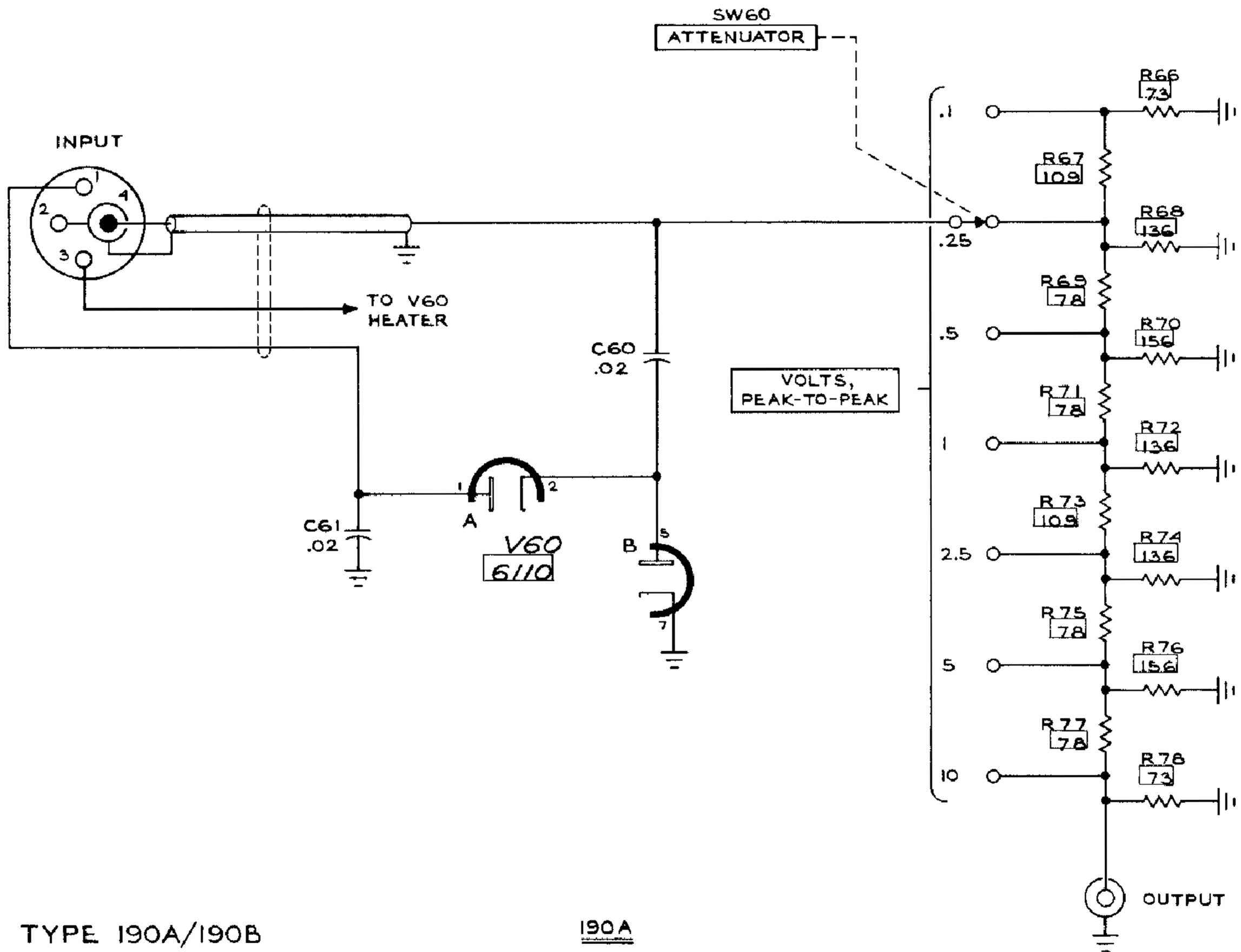
V1	154-009	5Y3
V6	154-075	0B2
V15	154-041	12AU7

Electron Tubes (Cont'd)

Ckt. No.	Tektronix Part No.	Description	S/N Range
V20	154-022	6AU6	
V30	154-029	6C4	
V40	154-022	6AU6	
V50	154-041	12AU7	
V51	154-016	6AL5	5001-8139X
V60	use *050-015	Replacement Kit	5001-6059
	154-240	6110	6060-8139X



BLOCK



TYPE 190A/190B

190A

