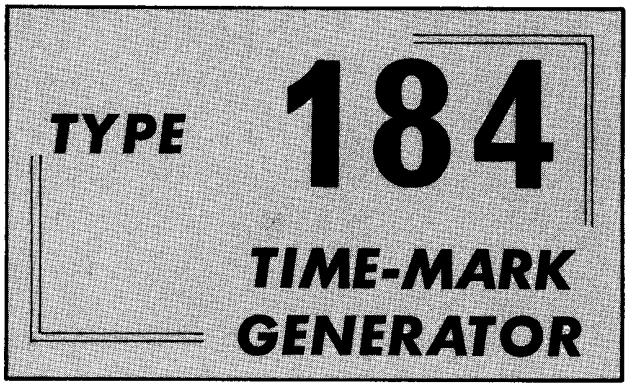
INSTRUCTION MANUAL

Serial Number 1778



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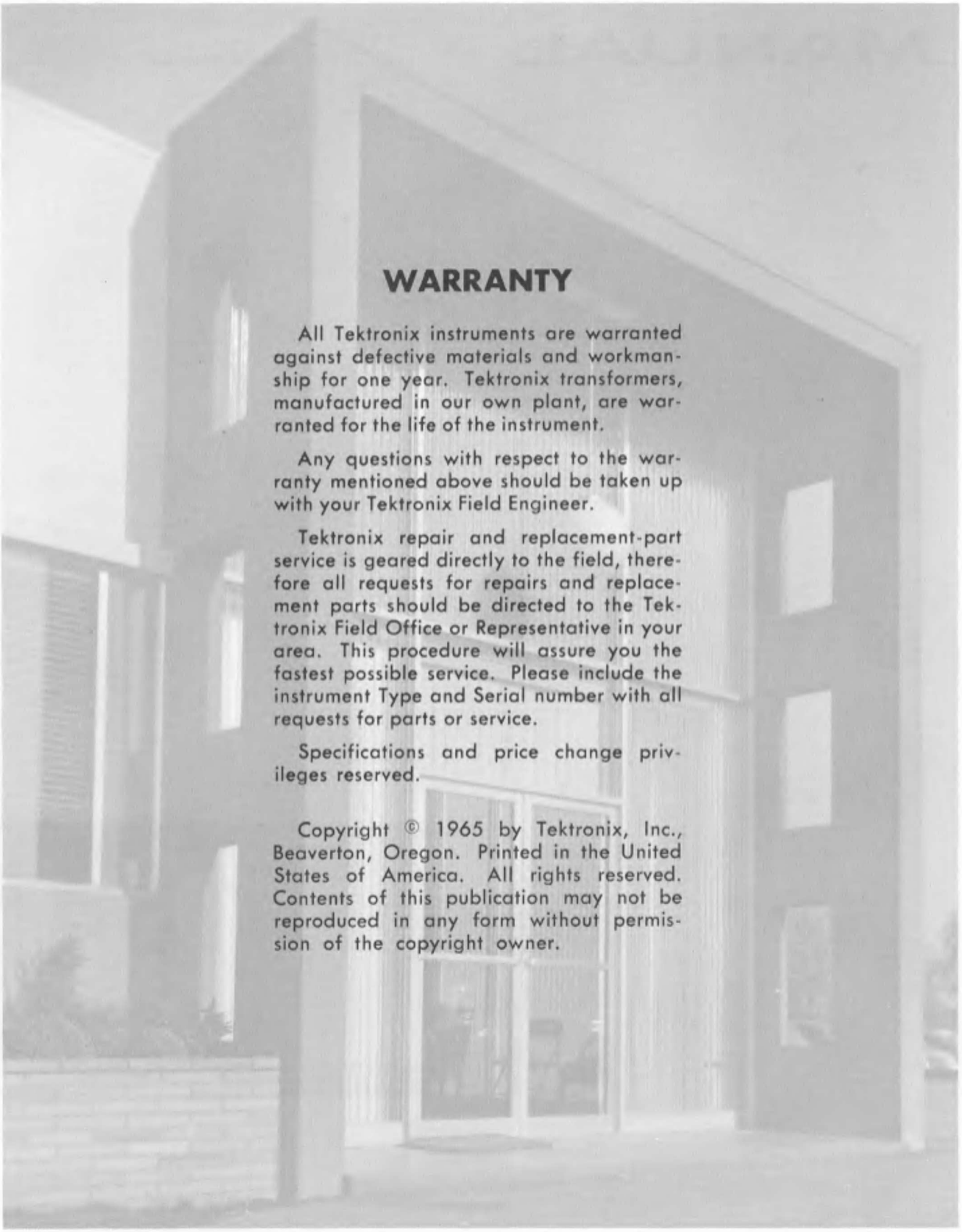


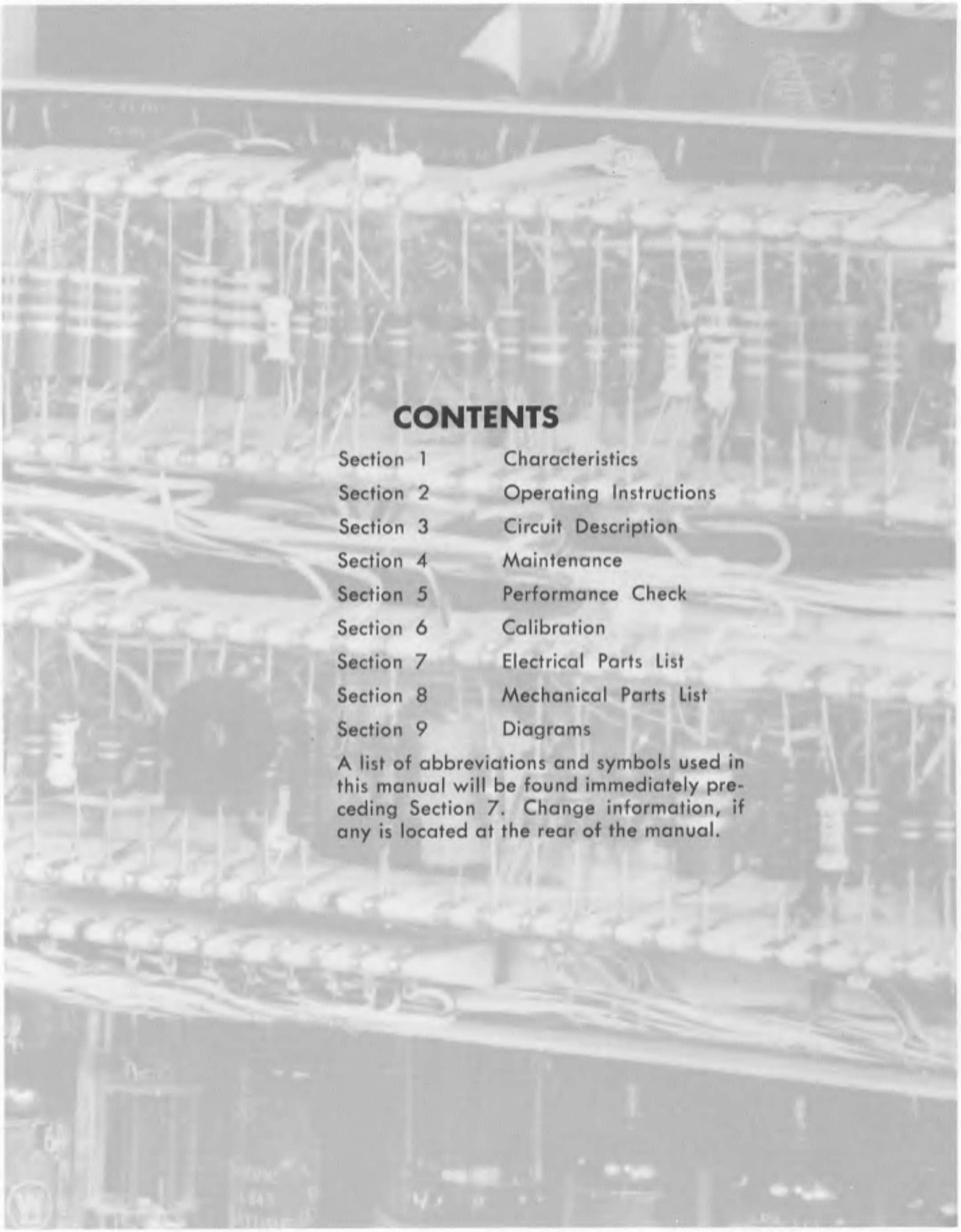
WARRANTY

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.

Specifications and price change privileges reserved.



CONTENTS

A list of abbreviations and symbols used in this manual will be found immediately preceding Section 7. Change information, if any is located at the rear of the manual.

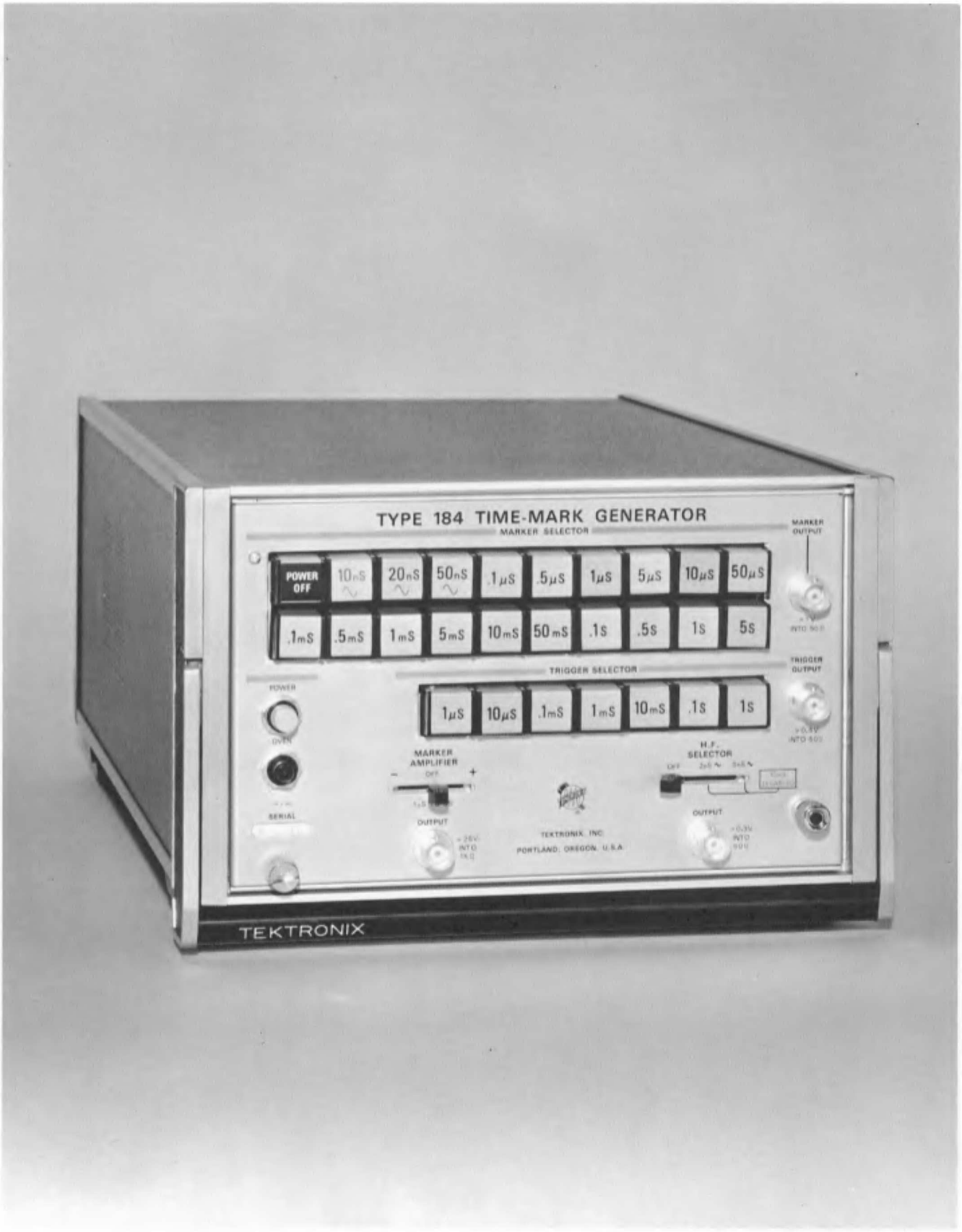


Fig. 1-1. Type 184 Time-Mark Generator

SECTION 1
CHARACTERISTICS

The Type 184 is a compact, precision-built instrument capable of producing accurate time markers for applications in the laboratory, production line or field. Sixteen time-marker selections and five sine-wave marker intervals provide time-marker selections from 2 nanoseconds to 5 seconds. Seven trigger pulse selections provide a triggering pulse rate from 1 μs to 5 s.

All outputs of the Type 184 are frequency controlled by a stable 10 MHz crystal oscillator.

Operating Data

Marker Output

Provides positive time marks of 1 volt minimum amplitude (into 50 Ω). Marker periods are established by pushbutton MARKER SELECTOR switches.

Marker Periods

Sinusoidal

10, 20 and 50 ns (H.F. SELECTOR must be off for 10 ns markers).

Periodic Pulses

.1, .5, 1, 5, 10, 50 μs

.1, .5, 1, 5, 10, 50 ms

.1, .5, 1, 5 s

HF Output

Provides 2 ns or 5 ns sine-wave markers of 0.3 V minimum amplitude (into 50 Ω).

Marker Amplifier Output

Provides positive or negative time marks of 25 V minimum amplitude (into 1 kΩ). Marker intervals from 1 μs to 5 s established by the pushbutton MARKER SELECTOR switches.

Trigger Output

Provides positive triggers of $\geq$0.4 V into 50 Ω or $\geq$2.5 V into open circuit. Period established by pushbutton Trigger Selector switches. Trigger periods are: 1 and 10 μs; .1, 1 and 10 ms; .1 and 1 s.

Other Characteristics

Crystal Oscillator	Crystal contained in a temperature controlled oven at 75°C.
Frequency	10 MHz $\pm$0.001% (25°C $\pm$5°C), 10 MHz $\pm$0.002% (0°C to +50°C) 5 minutes after turn-on if crystal oven is stabilized (instrument connected to power source for 2 hours).
Stability	$\leq$3 P/M[1] in 24 hours (25°C $\pm$5°C) after 2 hours continuous operation and after the instrument has accumulated at least 72 hours of total operating time.
Power Requirements	94.5 to 137.5 VAC or 189 to 275 VAC. 50 to 400 Hz. 40 watts approximate.
Warm-Up Time	Two hours warm-up time required after the instrument is connected to a power source, to allow crystal oven to stabilize. 5 minutes for rated accuracies at 25°C $\pm$5°C (if crystal oven is stabilized).

Mechanical Specifications

Dimensions: 9 inches wide, 6 inches high and 14¾ inches long.

Front panel is anodized aluminum. Cabinet is finished in blue vinyl paint.

No special ventilation required.

Accessories

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

[1]Parts per million.

NOTES

SECTION 2

OPERATING INSTRUCTIONS

General

The Type 184 may be operated in any normal environment if protected from moisture, dust or grease. It will operate with line voltages from 93.5 to 135 volts at 115 nominal, or from 187 to 270 volts at 230 nominal line volts. Selection of the two nominal voltages is made by means of the 115-230 Vac switch mounted on the rear panel of the instrument.

Time-marker intervals of .1 μs to 5 s are individually selected or stacked by depressing pushbutton selector switches. Sine-wave marker intervals of 10, 20 and 50 ns may also be selected by pushbutton selector switches.

Frequencies of 200 and 500 MHz which provide marker intervals of 5 and 2 nanoseconds, may be selected by the H.F. SELECTOR switch, and are available at a BNC OUTPUT connector mounted below the H.F. SELECTOR switch.

NOTE

The 10 ns (100 MHz) sine-wave marker is disabled when the 2 or 5 ns markers are in use.

The decade triggers (1 μs to 1 s) are used to trigger external associated test equipment and may be selected by the TRIGGER SELECTOR pushbuttons. They are available at the TRIGGER OUTPUT connector and are greater than 0.4 volts (into 50 Ω) in amplitude.

High amplitude time markers, (>25 V into 1 kΩ) from 1 μs to 5 s and either plus or minus polarity, are available at the OUTPUT connector below the MARKER AMPLIFIER switch. These markers are time coincident with the corresponding MARKER OUTPUT signals.

Function of Controls and Connectors

MARKER SELECTOR — Self-cancelling type pushbuttons select the respective individual or collective time marks and apply them to the MARKER OUTPUT connector. Markers up to two decades apart may be stacked by depressing the appropriate pushbuttons simultaneously.

MARKER OUTPUT — The selected time marks are available at the MARKER OUTPUT connector. The amplitude of the markers is greater than 1 volt into 50 Ω.

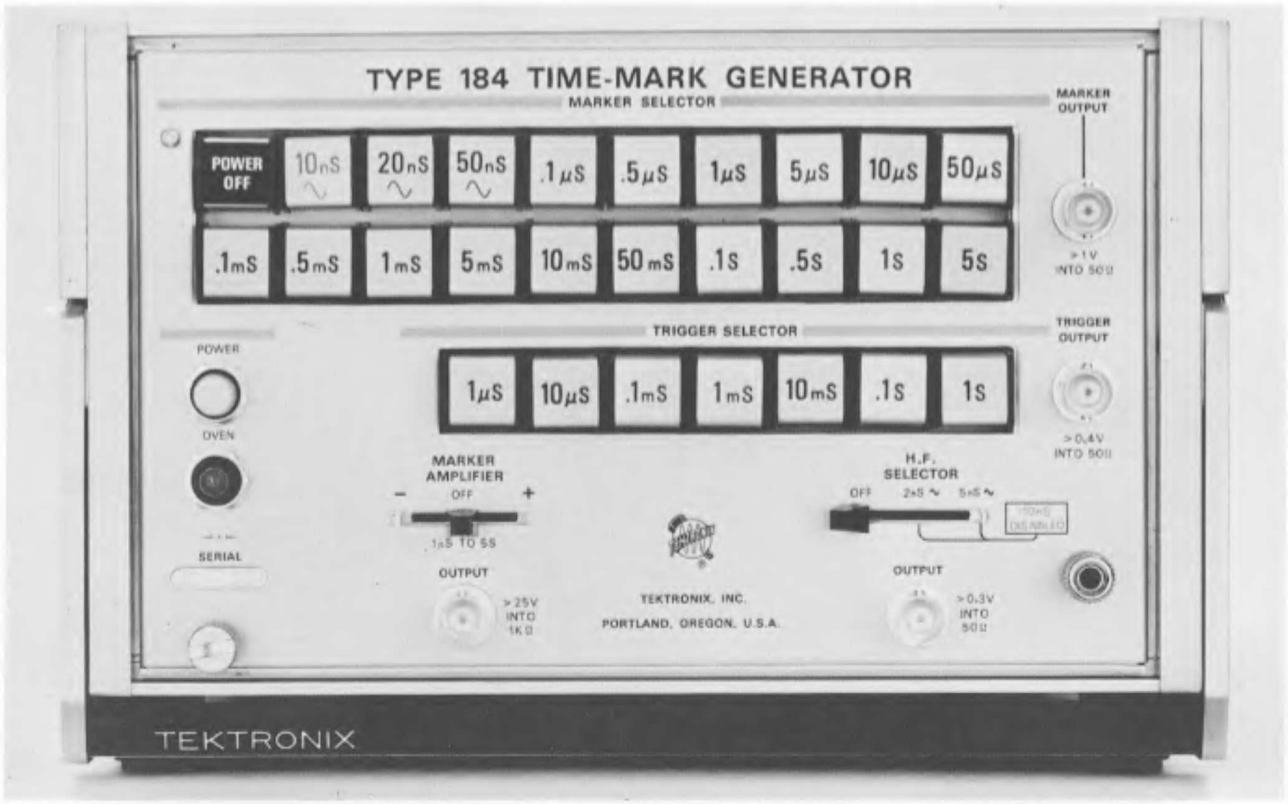


Fig. 2-1. Type 184 front-panel controls.

TRIGGER SELECTOR — Pushbutton selector switches similar to the MARKER SELECTOR switch select trigger pulses for external equipment. These selected trigger pulses are in time coincidence with the corresponding decade time markers. They are available at the TRIGGER OUTPUT connector as positive-going pulses with a minimum amplitude of 0.4 volts into 50 Ω.

H.F. SELECTOR — Selects 2 ns (500 MHz) or 5 ns (200 MHz) sine-wave signal and applies either to the OUTPUT connector directly below the H.F. SELECTOR switch. Amplitude of these sine-wave time-marker intervals at the OUTPUT connector is greater than 0.3 volts into 50 Ω. When the H.F. SELECTOR switch is in either of these two positions, the 10 ns marker interval is disabled.

NOTE

In order to obtain a sine-wave signal from the H.F. SELECTOR OUTPUT, a marker button must be pushed in to apply power to the unit.

MARKER AMPLIFIER — Time markers from 1 μs to 5 s established by the MARKER SELECTOR pushbutton switches are available as positive or negative, amplified time markers at the OUTPUT connector below the switch. The amplitude of these time markers is greater than 25 volts into 1 kΩ.

POWER Indicator — Power is applied when any one of the MARKER SELECTOR switches is pushed in. Power is turned off by the POWER OFF switch. A POWER indicating light will go on when power is applied.

OVEN Indicator — This indicating light is across the heater windings in the crystal oven and therefore monitors the operation of the thermostat. It indicates when the heater is on. The crystal oven power is independent of the POWER OFF switch.

SECTION 3

CIRCUIT DESCRIPTION

Introduction

This section describes the Type 184 circuitry with reference to the block diagram and circuits in Section 9. The reader should follow the diagrams as their description is presented.

Block Diagram

All time-marker intervals are frequency controlled by a stable crystal-controlled oscillator. The basic frequency of 10 MHz from the oscillator is multiplied by frequency doublers and quintuplers to provide timing intervals of 2 through 5 ns. The 2 or 5 ns timing intervals are connected through the H.F. SELECTOR switch to a BNC OUTPUT connector. The 10, 20 and 50 ns intervals are connected to the MARKER SELECTOR switch and applied after selection to the MARKER OUTPUT connector.

The oscillator cathode tank circuit supplies 10 MHz to the first countdown board, which shapes the 10-MHz sine wave into .1 μs time markers and counts down in steps of 2 or 5 to provide time markers from .1 μs through 10 ms.

A second countdown board provides the remaining time markers from 50 ms through 5 s.

Time markers from .1 s through 5 s, selected by the MARKER SELECTOR switch, are applied through an emitter follower to the MARKER OUTPUT connector. These markers are also applied to a Marker Amplifier which provides (+) or (—) time-markers with an amplitude greater than 25 volts (into 1 kΩ).

Positive trigger pulses of 1 μs, 10 μs, .1 ms, 1 ms, 10 ms, .1 s and 1 s may be selected by the pushbutton TRIGGER SELECTOR switch. The selected trigger pulse is fed to an emitter follower which provides positive trigger signals of 0.4 volt minimum amplitude (into 50 Ω) at the OUTPUT connector.

OSCILLATOR AND MULTIPLIERS

Oscillator

The oscillator V10 is connected as a crystal-controlled grid, tuned-cathode oscillator. The plate tank is tuned to the 5th harmonic, which quintuples the oscillator frequency. Double-tuned tanks in the cathode and plate circuits decrease intermodulation distortion.

A temperature-controlled oven housing the crystal provides frequency stability. Its operation is indicated by a front-panel indicating lamp B504, connected in parallel with the heater element of the oven. Frequency of the oscillator is primarily adjusted to a standard by means of shunt capacitor C11. The slug adjustment L18 in the cathode tank will also affect the oscillator frequency slightly.

Frequency Multipliers and Amplifiers

The multipliers are essentially frequency doublers or amplifiers with the plate tank in each case tuned to the 2nd harmonic of the grid tank. Plate tanks are double tuned, provide high Q and attenuate frequencies other than the desired output. The output signal is link-coupled to match the load.

50 ns time markers are generated after doubling the 10-MHz oscillator cathode-tank frequency in the plate tank of V20.

20 ns time markers are provided from the plate tank of V30, which operates as an amplifier with both the grid and plate tanks tuned to 50 MHz.

10 ns time markers are derived through the frequency-doubling action of V40. Output from the 100 MHz plate tank is applied by means of the H.F. SELECTOR switch to either the 2 ns or 5 ns time-interval generators or to the MARKER SELECTOR switch.

A separate 200 MHz board employs four diodes, connected as a passive doubler with the tank tuned to 200 MHz. Capacitor C57 in series with the pickoff link is adjusted to match the coupling link circuit to the 50 Ω output impedance.

The 2 ns circuit quintuples the 100 MHz from the plate tank of V40. The link-coupled 100 MHz output is selected by the H.F. SELECTOR switch and applied to the grid tank of a push-pull amplifier with the plate tank tuned to 500 MHz, to provide the quintupling action. Output of the plate tank is also link-coupled and applied through the H.F. SELECTOR switch to the OUTPUT connector J70.

Butterfly capacitor C63 is adjusted to tune the grid tank to the input 100 MHz frequency and differential capacitor C64 is adjusted to balance the drive on the grids of the pushbutton multiplier.

The plates of V60 and V70 share a common center-fed high Q quarter-wave line, that is tuned by C70 to a frequency of 500 MHz. The output terminates in a high Q, 500-MHz filter (similar to a re-entry cavity) which decouples any intermodulation signals. C75 tunes the filter to the 500-MHz output frequency.

Each amplifier and multiplier output is selected by either the MARKER SELECTOR switch SW400 or the H.F. SELECTOR switch SW70. The MARKER SELECTOR switch connects the 10, 20 or 50 ns outputs to the MARKER OUTPUT connector or grounds the screen through the output coupling loop.

SHAPER AND COUNTDOWN CIRCUITS

Countdown and shaper circuits for the .1 μs to 10 ms markers are on one etched-wiring board with the remaining countdown circuits and the power supply circuits on another.

The countdown circuits used for the 5 μs to the 5 s time-markers are monostable multivibrators with the countdown ratio determined by the multi hold-off time.

.1 μs Amplifier and Shaper

An NPN driving a PNP transistor in a complimentary circuit arrangement provides high gain to shape the input

10 MHz sine wave. This waveform is then differentiated by the coupling networks and appears at the emitter of Q103 as a positive going .1 μs time marker.

.5 μs (÷ 5) Countdown

Countdown is achieved by the bucket and ladle action of C105 and C107-C108. C105 dumps its charge each .1 μs through Q114 into a pair of capacitors C107 and C108, until enough charge has been built up so that the 5th charge from C105 triggers the blocking oscillator Q120. This occurs each .5 μs and provides the .5 μs time markers.

The voltage step from the .1 μs shaper amplifier is also applied through C105 to the emitter of Q114. The positive 1 μs pulse turns Q114 on and dumps a charge into C107 and C108. The negative portion of the input signal reverse biases the emitter-base junction. The junction then acts in the manner of an approximate 6 V Zener diode to clamp the negative portion of the input waveform.

These input charges on the ladle capacitor C105, build a staircase ramp voltage across C107 and C108. The amplitude of the ramp is governed by the base-to-emitter bias of Q120 and the size of the bucket capacitors. At approximately 11 volts the emitter-base junction is forward biased and transistor Q120 turns on.

Feedback from transformer T115 drives the transistor to saturation and generates a sharp positive-going pulse. Diode D115 prevents negative voltage excursions at the output of the transformer. The positive output pulse from Q120 is applied through C116 to the base of emitter-follower Q123. The resultant output markers from the emitter of Q123 are delayed approximately 76 ns by delay line L123A to allow stacking with other selected time markers.

1 μs (÷ 2) Countdown Circuit

Q130, T130 and associated circuitry form a single-shot blocking oscillator with an RC circuit determining the holdoff time of the oscillator. This allows every other .5 μs time-marker input pulse to cycle the oscillator and produce the 1 μs markers.

The first .5 μs marker pulse drives Q130 into conduction. Feedback from the transformer T130 drives the transistor to saturation. Capacitor C130 is charged to approximately 10 volts during this on time. When the transformer field collapses and drives Q130 to the off state, the decaying charge on C130 will prevent the second .5 μs time mark from triggering Q130 on. When the third input .5 μs time mark occurs, (C130 will have discharged sufficiently so that Q130 is enabled) Q130 is driven into conduction and the cycle repeats.

The negative pulse generated at the collector of Q130 for every other input pulse is amplified and inverted by Q134, then applied through emitter follower Q133, to the MARKER SELECTOR switch, through an approximate 14 ns delay line L123B. The 1 μs markers are also applied to the TRIGGER SELECTOR switch through R136 as 1 μs trigger signals. Multiple time-mark signals selected by the MARKER SELECTOR switch are isolated from the Trigger Pickoff and the next countdown stage by diode D137.

5 μs (÷ 5) Countdown

This circuit (Q145, Q155 and associated circuitry) is a monostable multivibrator that flips with an input trigger pulse and remains in this state until the charge on the collector-to-base coupling capacitor (C143) decreases to the level that will permit the multi to return to its quiescent state. The 5th trigger then starts the cycle again.

In the quiescent state Q155 is conducting, Q145 is off. An input positive signal to the base of Q145 turns Q145 on and Q155 off. The resultant positive signal at the collector of Q155 is an approximate 12 volt square wave, with a duration determined by the time constant of C143, R145 and R146. This time constant allows the ÷ 5 countdown from 1 μs to 5 μs markers. The output signal at the collector of Q155 is differentiated by C152 and R154, with the negative portion clamped to ground by diode D152. The positive portion of the differentiated signal is applied to both the emitter-follower Q153 and the next countdown circuit. Diode D152 will also protect the base emitter junction of Q153 from breakdown, due to the back voltage developed when C152 is discharged.

10 μs to 10 ms Countdown Circuits

These circuits are identical to the above 5 μs countdown circuit with the exception of the countdown time constant that determines the holdoff time of each counter.

50 ms to 5 s Countdown Circuits

These circuits are identical to the previous monostable multivibrators; however, they are mounted on the second board with the power supply circuits and high-amplitude marker amplifier. The 50 ms and .5 s countdown multivibrators contain calibration adjustments to set the holdoff time of the ÷ 5 multivibrators.

The series matching resistors in the time-marker path to the MARKER SELECTOR switch provide current summing in the base of the emitter followers for stacking time markers at the output.

Marker Amplifier

The amplifier provides positive or negative time markers of 25 volts minimum amplitude (into 1 kΩ).

Marker intervals from 1 μs to 5 s selected by the push-button MARKER SELECTOR switch are applied through the first section of polarity switch SW450 to Q454. Q454 is biased to remove the lower portion of the positive input time-marker signal. This together with the speed-up capacitor C452 across limiting resistor R452, provides a narrow time marker at the output.

Inverter amplifier (Q464) emitter bias is such that only the narrow portion of the input pulse turns the transistor on. The positive output time marker from the inverter amplifier or, (if the switch is in the (—) position), the output signal from Q454, is applied to the base of the complimentary emitter-follower stage, Q463 and Q473.

The complimentary emitter-follower stage provides ample current for the added capacitance of most coaxial cables

attached to the output connector and preserves the rise and fall time of the time-marker pulses.

Power Supply

The power supply for the Type 184 consists of three regulated dc voltages. Circuit details for the supplies are shown on the Power Supply schematic.

Power for the dc regulator circuits is supplied from three full-wave bridge rectifier power supplies connected to secondary taps of a single transformer T501. These regulators will maintain a constant regulated output with ac input fluctuations of 94.5 or 137.5 or 189 to 275 volts. The primary of T501 consists of equal windings which may be connected in parallel by SW501 for 115 volt input or in series for 230 volt ac input power. A crystal oven is wired independently to the ON-OFF switch SW400 so power is applied to the heater of the 75°C oven as long as the instrument is connected to a power source. The circuit for the OVEN indicating neon is complete with the thermal switch closed. This neon is therefore an indicating device of proper operation of the crystal oven thermostat. The voltage regulators are mounted on the second countdown board with the exception of the power transistors Q527, Q547 and Q587, which are mounted on the main frame heat sink.

—30 Volt Supply

The —30 volts is the prime supply and the reference voltage for the other dc regulated supplies. The circuit consists of Q583 connected as an emitter follower to drive a series current regulator transistor Q587.

Error sensing is accomplished by the comparator amplifier Q566 and Q576. Reference voltage for the —30 volt supply is established by Zener diode D560 at approximately 9.1 volts at the base of transistor Q566. The bias on the other half of the comparator Q576 is obtained from a voltage divider consisting of R574, R570 and potentiometer R572 (the —30 volt Adjust control). When R572 is properly adjusted the output voltage is exactly —30 volts.

+12 Volt Supply

The —30 volt supply is the reference voltage for the comparator amplifier Q536 and Q546. The output of the comparator amplifier is applied to the base of emitter-follower Q543 which controls the current through the series current regulator transistor Q547.

+125 Volt Supply

The +125 volt regulated supply is similar to the +12 volt regulator except for the differential comparator. Voltage error signals are amplified and applied to the emitter-follower Q523 which controls the current through the series regulator transistor Q527.

Marker and Trigger Selection Switches

Timing frequencies and timing markers are applied through the MARKER SELECTOR switch to the MARKER OUTPUT connector. Trigger signals connect through the TRIGGER SELECTOR switch to the TRIGGER OUTPUT connector. The circuit arrangement is shown in the Marker and Trigger Selector switch schematic in the Diagrams section.

Markers from .1 μs to 5 s, connect through the pushbutton switch to the base of emitter-follower transistor Q403. The output of this emitter follower at the MARKER OUTPUT connector J405 is greater than 1 volt into 50 Ω.

10 ns to 50 ns sine wave frequencies are connected through the MARKER SELECTOR switch, directly to the MARKER OUTPUT connector. 1 μs to 5 s markers connect through a polarity switch to the marker amplifier, which provides a time-marker signal of either (+) or (—) polarity and greater than 25 volts in amplitude to the OUTPUT connector.

The TRIGGER SELECTOR switch (SW425) center contacts connect to the output of decade time markers from 1 μs to 1 s. Contact is made through pushbutton contacts and applied to emitter-follower transistor Q423. The output is a minimum trigger pulse of 0.4 V into 50 Ω termination at the TRIGGER OUTPUT connector J425.

NOTES

SECTION 4

MAINTENANCE

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, lubrication, and if needed, recalibration. Preventive maintenance is generally more economical than corrective maintenance, since preventive maintenance can usually be done during idle periods at a time convenient to the user. The preventive maintenance schedule established for the instrument should be based on the amount of use and the environment in which the instrument is used.

Cleaning. Clean the instrument often enough to prevent accumulation of dirt. Dirt on the components acts as a thermal insulating blanket (preventing efficient heat dissipation) and may provide electrical conducting paths.

Clean the instrument by loosening the accumulated dust with a dry, soft paint brush. Remove the loosened dust by vacuum and/or dry, low-pressure compressed air (high-velocity air can damage certain components). Hardened dirt and grease may be removed with a cotton-tipped swab or a soft cloth dampened with water and a mild detergent solution (such as Kelite or Spray White). Abrasive cleaners should not be used.

CAUTION

Do not permit water to get inside controls or shaft bushings.

Lubrication. The life of potentiometers and selector switches is lengthened if these devices are kept properly lubricated. Use a cleaning type lubricant (such as Cramoline) on shaft bushings and switch contacts. Lubricate the switch detents with a heavier grease (Beacon grease No. 325 or equivalent). Do not over-lubricate. The necessary materials and instructions for proper lubrication of Tektronix instruments are contained in a component lubrication kit which may be ordered from Tektronix. Order Tektronix Part No. 003-0342-00.

Visual inspection. After cleaning, the instrument should be carefully inspected for such defects as poor connections, damaged parts, and improperly seated transistors. The remedy for most visible defects is obvious; however, if heat-damaged parts are discovered, determine the cause of over-heating before the damaged parts are replaced. Otherwise, the damage may be repeated.

Tube and Transistor Checks

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

Recalibration

To insure accurate measurements, the instrument calibration should be checked after each 500 hours of operation, or every six months if used intermittently.

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

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques or procedures required to replace components in this instrument are described here.

Component identification. The circuit number of each electrical part is shown on the circuit diagrams. Note that a functional group of circuits (such as the power supply) is assigned a particular series of numbers. Switch wafers are identified by counting from the first wafer behind the detent section of the switch towards the last wafer. The letters F and R indicate whether the front or rear of the wafer is used to perform the particular switching function. For example, the designation 2R printed by a switch section on a schematic identifies the switch section as being on the rear side of the second wafer when counting back from the detent section.

Parts replacement. Most of the electronic components in the Type 184 are standard items available locally. The remainder of the electronic components and most of the mechanical parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. However, all parts are obtainable through your Tektronix Field Engineer or Field Office. Before purchasing or ordering, consult the Electrical Parts List to determine the value, tolerance, and ratings required. See Parts Ordering Information and Special Notes and Symbols immediately preceding Section 7.

NOTE

When selecting the replacement parts, remember that the physical size and shape of a component may affect its performance in the circuit. Parts orientation and lead dress should duplicate those of the original part, since many of the components are mounted in a particular way to reduce or control stray capacitance and inductance. After repair, portions of the instrument may require recalibration.

Replacing components on etched-wiring boards. Use ordinary electronic grade 60/40 solder and a 35- to 40-watt pencil soldering iron with a 1/8-inch wide chisel tip. The tip of the iron should be clean and properly tinned for best heat transfer in a short time to the soldered connection. A higher wattage soldering iron, if used and applied for too long a time, ruins the bond between the etched wiring and base material by charring the glass epoxy laminate.

The step-by-step technique is as follows:

1. Remove the component by cutting the leads near the body. This frees the leads for individual unsoldering.

2. Grip the lead with needle-nose pliers. Apply the tinned tip of a 40-watt pencil soldering iron to the lead between the pliers and the board; then pull gently.

3. When the solder first begins to melt, the lead will come out, leaving a clean hole. If the hole is not clean, use the soldering iron and a toothpick or a piece of enamel wire to open the terminal hole. Do not attempt to drill the solder out, since the through-hole plating might be destroyed.

4. Clean the leads on the new component and bend them to the correct shape. Carefully insert the leads into the holes from which the defective component was removed.

5. Apply the iron for a short time at each connection on the side of the board opposite the component to properly seat the component.

6. Apply the iron and a little solder to the connections to finish the solder joint.

Ceramic terminal strips. Solder used on the ceramic terminal strips should contain about 3% silver. Ordinary tin-lead solder can be used occasionally without damage to the ceramic terminal strips. Use a 40- to 75-watt soldering iron with 1/8-inch wide chisel-shaped tip. If ordinary solder is used repeatedly or if excessive heat is applied, the solder-to-ceramic bond may be broken.

A small roll of 3% silver solder is mounted at the back of the instrument. Silver-bearing solder can be purchased directly from Tektronix in one-pound rolls; order by Tektronix Part No. 251-0514-00.

Observe the following precautions when soldering ceramic terminal strips:

1. Use a hot iron for a short time. Apply only enough heat to make the solder flow freely.

2. Maintain a clean, properly tinned tip.

3. Avoid putting pressure on the ceramic terminal strip.

4. Do not attempt to fill the terminal-strip notch with solder; use only enough solder to cover the wires adequately.

5. Clean the flux from the terminal strip with a flux-remover solvent to maintain good environmental characteristics.

Metal terminals. When soldering metal terminals (e.g., interconnecting plug pins, switch terminals, potentiometers, etc.), ordinary 60/40 solder can be used. The soldering iron should have a 40- to 75-watt rating with a 1/8-inch wide chisel-shaped tip.

Observe the following precautions when soldering metal terminals:

1. Apply only enough heat to make the solder flow freely.

2. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.

3. If a wire extends beyond the solder joint, clip the excess close to the joint.

4. Clean the flux from the solder joint with flux-remover solvent to maintain good environmental characteristics.

Ceramic terminal strip replacement. A complete ceramic terminal strip assembly is shown in Fig. 4-1. Replacement strips (including studs) and spacers are supplied under separate part numbers. The old spacers may be reused if they are not damaged.

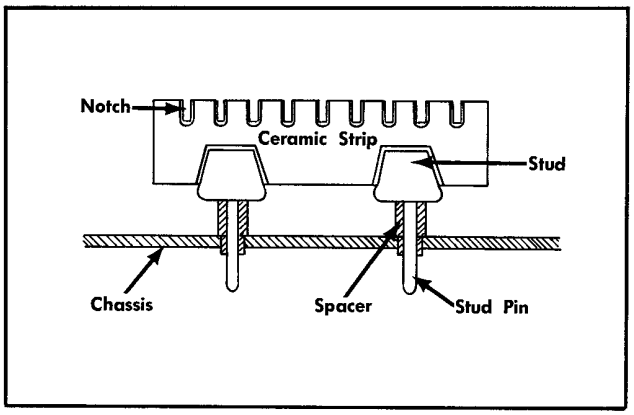


Fig. 4-1. Ceramic terminal strip assembly.

To replace a ceramic terminal strip, first unsolder all connections. Then, the damaged strip can be pried or pulled loose from the chassis. If the spacers come out with the strip, remove them from the stud pins to be used for installation of the new strip.

After the damaged strip has been removed, place the undamaged spacers in the chassis holes. Then, carefully press the studs into the spacers until completely seated. If necessary, use a soft mallet to tap lightly, directly over the stud area of the strip.

Switch Replacement

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

When soldering leads to a switch, do not let solder flow around and beyond the terminal rivet as this may destroy the contact spring tension.

Tubes and Transistors

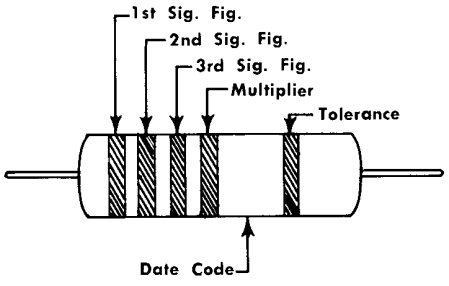
Tubes and transistors should not be replaced unless actually defective. However, temporary substitution is often the fastest and best way to detect a defective tube or transistor. Before substituting a tube or transistor, it is suggested that circuit conditions be checked to be certain that a replacement tube or transistor will not be subject to damage. In some cases, these checks will also show whether or not the tube or transistor is at fault.

When circuit conditions are known to be safe, install a tube or transistor of the same type which is known to be good and check for proper operation. If the original tube or transistor is thus proved acceptable, return it to the socket from which it came to avoid unnecessary recalibration.

Troubleshooting Aids

This manual and the instrument contain many features intended to speed and simplify maintenance. A block diagram which provides an overall picture of instrument operation is included with the diagrams in the back of this manual. The diagrams give the circuit reference number for each electrical component as well as important operating voltages, signals, and conditions for their measurement.

The instrument contains a number of stable metal-film resistors identified by their gray background color and color coding. If a resistor has three significant figures and a multiplier, it will be EIA color coded. If it has four significant figures and a multiplier, the value will be printed on the resistor. For example a 333 kΩ resistor will be color coded, but a 333.5 kΩ resistor will have its value printed on the resistor body. The color coding sequence is shown in Fig. 4-2.



Color	1st Sig. Fig.	2nd Sig. Fig.	3rd Sig. Fig.	Multiplier	Tolerance (±) %
Black	0	0	0	1	—
Brown	1	1	1	10	1
Red	2	2	2	100	2
Orange	3	3	3	1,000	—
Yellow	4	4	4	10,000	—
Green	5	5	5	100,000	0.50
Blue	6	6	6	1,000,000	0.25
Violet	7	7	7	10,000,000	0.10
Gray	8	8	8	100,000,000	0.05
White	9	9	9	1,000,000,000	—
Gold				0.1	5
Silver				0.01	—
No Color					10

Fig. 4-2. Standard EIA color code for metal-film resistors.

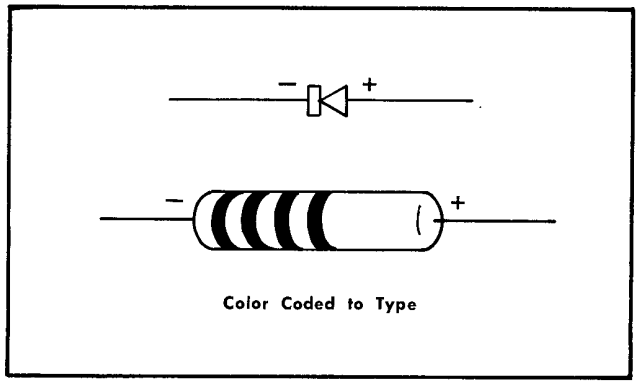


Fig. 4-3. Diode polarity of the glass diodes used in the Type 184.

Fig. 4-3 identifies the polarity of the glass diode types used in Tektronix instruments.

In-circuit diode checks. In-circuit diode checks may be performed with a voltmeter. A comparison check of the voltages on each side of the diode with the typical voltages listed on the diagram will help determine if the diode is faulty. Forward-to-back resistance ratios can be checked by referring to the schematic and pulling appropriate tubes or transistors to remove low resistance loops around the diode.

General Troubleshooting. If the instrument is not operating, attempt to isolate the trouble by a quick operational and visual check. Make sure that any apparent trouble is actually due to a malfunction within the Type 184, and not to improper control settings or a fault in associated equipment.

Operate the front-panel controls to see what effect, if any, they have on the trouble symptoms. The normal or abnormal operation of each particular control helps in establishing the nature of the trouble. The normal function of each control is listed in Section 2 of this manual.

If the trouble cannot be located by means of front-panel checks, remove the instrument from its case and check voltages and waveforms against those shown on the schematics, starting with the power supply connections. Once the trouble is isolated to a particular circuit, refer to the circuit description in Section 3 for an explanation of how the circuit normally operates.

CAUTION

Be careful when making measurements on live circuits. The small size and high density of components used in this instrument result in close spacing. An inadvertent movement of the test probes, or the use of oversized probes, may short between circuits.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks assure proper connection, operation and calibration. If the trouble is not located by these checks, the remaining steps

aid in locating the defective component. When the defective component is located, it should be replaced following the replacement procedures given in this section.

1. Check associated equipment. Before proceeding with troubleshooting of the Type 184, check that the equipment used with the Type 184 is operating correctly. Check that the signal is properly connected and that the interconnecting cables or probes are not defective. Check the power source.

2. Check control settings. Incorrect control settings can indicate a trouble that does not exist. For example—The 10 ns circuit is disabled when the H.F. SELECTOR switch is not in the OFF position.

3. Check instrument calibration. Check the calibration of the instrument, or the affected circuit if the trouble exists in one circuit. The indicated trouble may only be a result of misadjustment and may be corrected by calibration. Complete instructions are given in the Calibration section of this manual. Individual calibration steps can be performed out of sequence. However, if the circuit affects the calibration of other circuits in the instrument, a more complete calibration will be necessary.

4. Isolate trouble to a circuit. The Type 184 has 15 countdown circuits for time markers and triggers. All countdown circuits are dependent on the preceding circuit to the basic ocillator frequency of 10 MHz (.1 μs). There are 5 multiplier circuits. Three of these (20, 50 and 100 MHz) are direct multiples of the basic oscillator frequency. The remaining two are multiples of the 100 MHz signal.

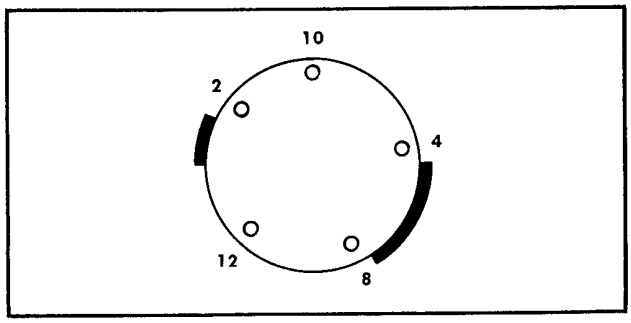


Fig. 4-4. Nuvistor tube pin identification.

Isolate the trouble to the source. For example; failure of the 1 μs marker circuit could be caused from failure of the preceding countdown circuit, .5 and .1 μs. Failure of the 5 ns sine-wave marker could be due to failure in the 100 MHz quintupler or basic oscillator.

The pin connections used to connect the etched-wiring boards to the instrument provide a unique method of circuit isolation. For example, a short in the power supply can be isolated to the rectifier circuit or the regulators by disconnecting pin connectors for that voltage at the board.

After the defective circuit has been located, proceed with step 5 through 8 to locate the defective component(s). If the trouble has not been isolated to a circuit using the procedure described here, check voltages and waveforms as explained in step 7 to locate the defective circuit.

5. Check etched-wiring board interconnections. After the trouble has been isolated to a particular circuit, check the pin connectors on the etched-wiring board for correct connection. (See Figs. 4-8 and 4-9). Each electrical component on the boards is identified by its circuit number. The circuit boards are also outlined on the diagrams with a blue line. These pictures used along with the diagrams will aid in locating the components mounted on the etched-wiring boards.

6. Visual check. Visually check the circuit in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged etched-wiring boards or damaged components.

7. Check voltages and waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are given on the schematics.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to make these readings, see the first schematic page.

a. Voltages: Voltage measurements should be taken with a 20,000 ohms/volt dc voltmeter. Accuracy of the voltmeter should be within 3% on all ranges. Be sure that the test prods are well insulated to prevent accidental shorting of components.

b. Waveforms: Use a test oscilloscope(s) which has the following minimum specifications:

Bandwidth: Dc to greater than 500 MHz.

Deflection factor: 0.05 volts/division minimum.

Input impedance: Approximately 10 megohms paralleled by about 10 pF when using a 10× probe.

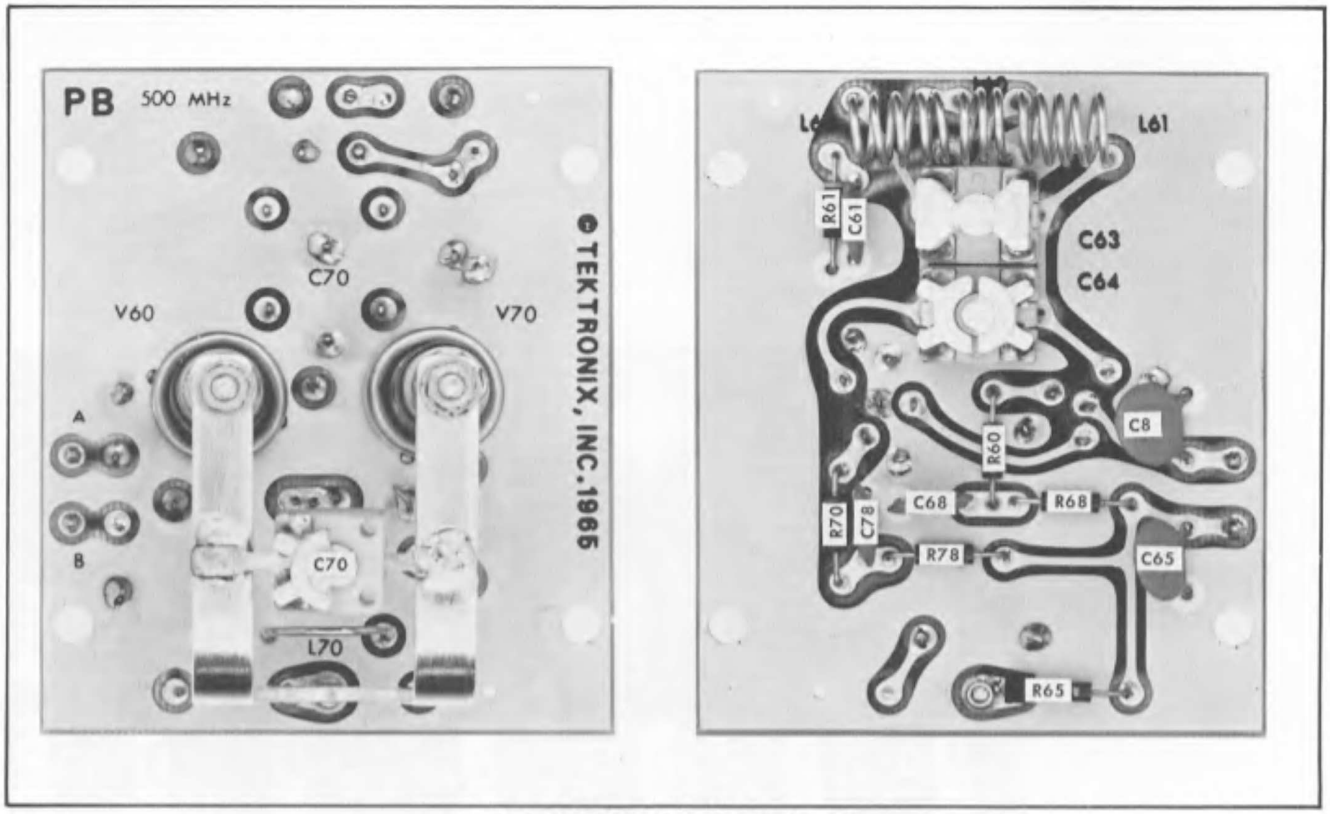


Fig. 4-5. 500 MHz (2 ns) etched-wiring board.

Fig. 4-6. 200 MHz (5 ns) etched-wiring board.

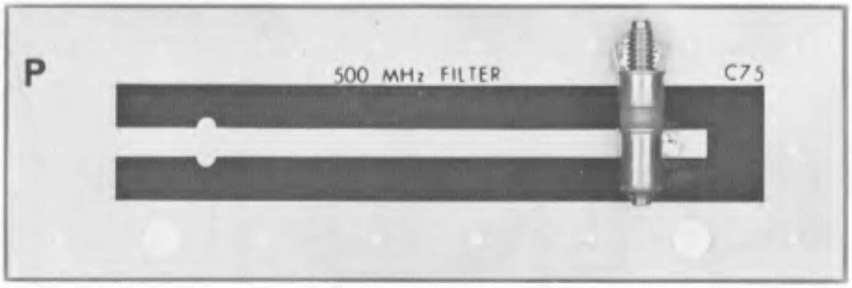


Fig. 4-7. 500 MHz filter etched-wiring board.

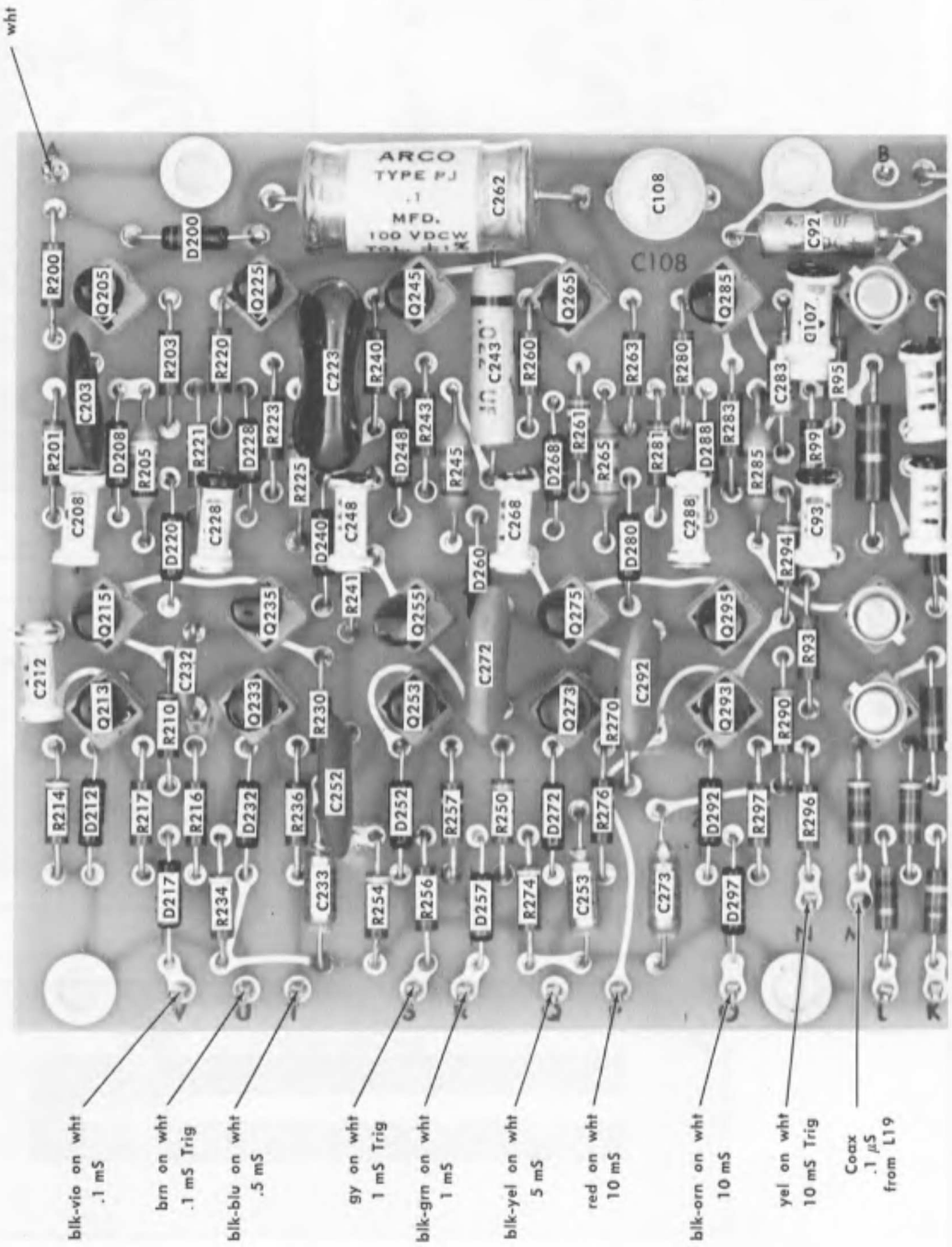


Fig. 4-8a. Upper portion of the .1 μs to 10 ms countdown etched-wiring board.

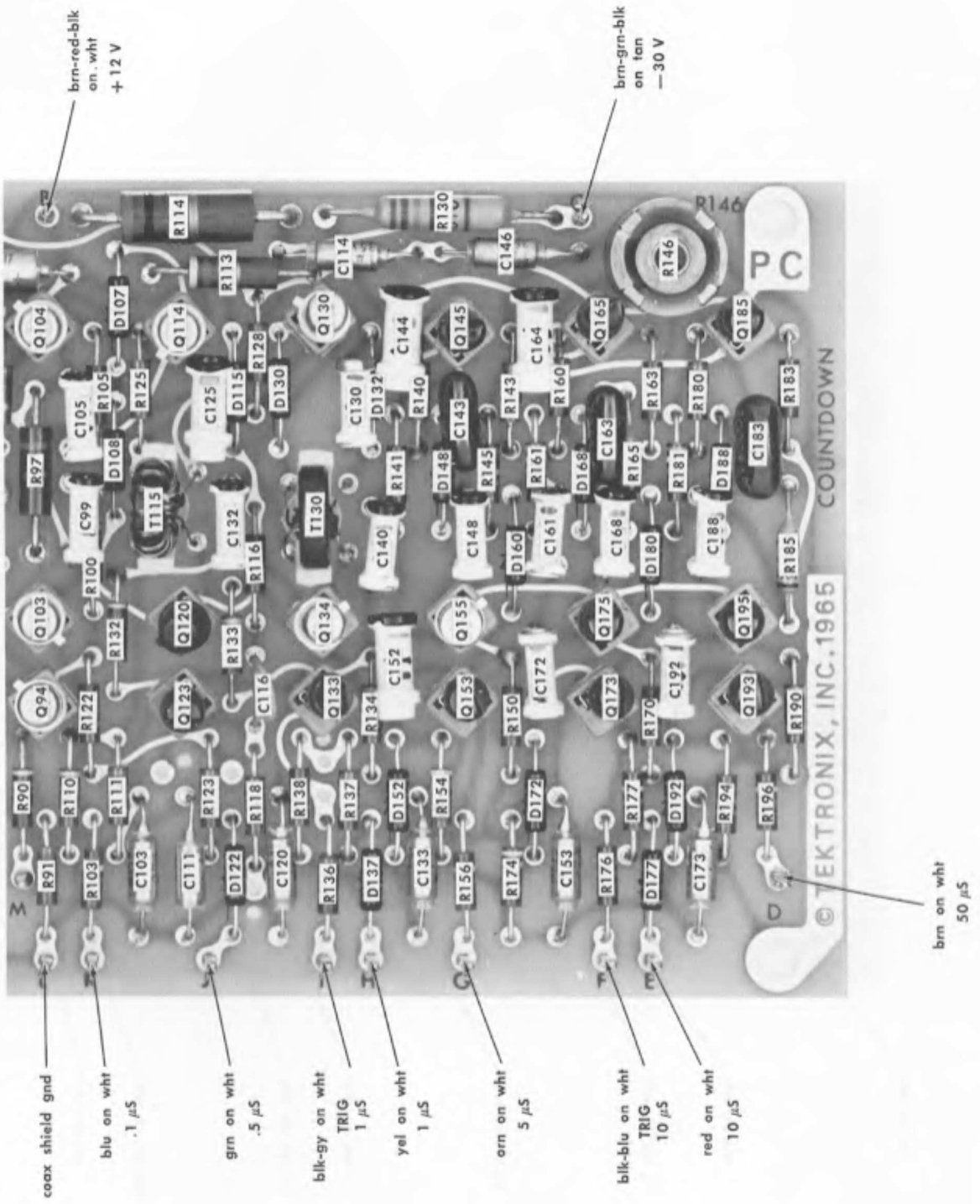


Fig. 4-8b. Lower portion of the .1 μs to 10 ms coundown etched-wiring board.

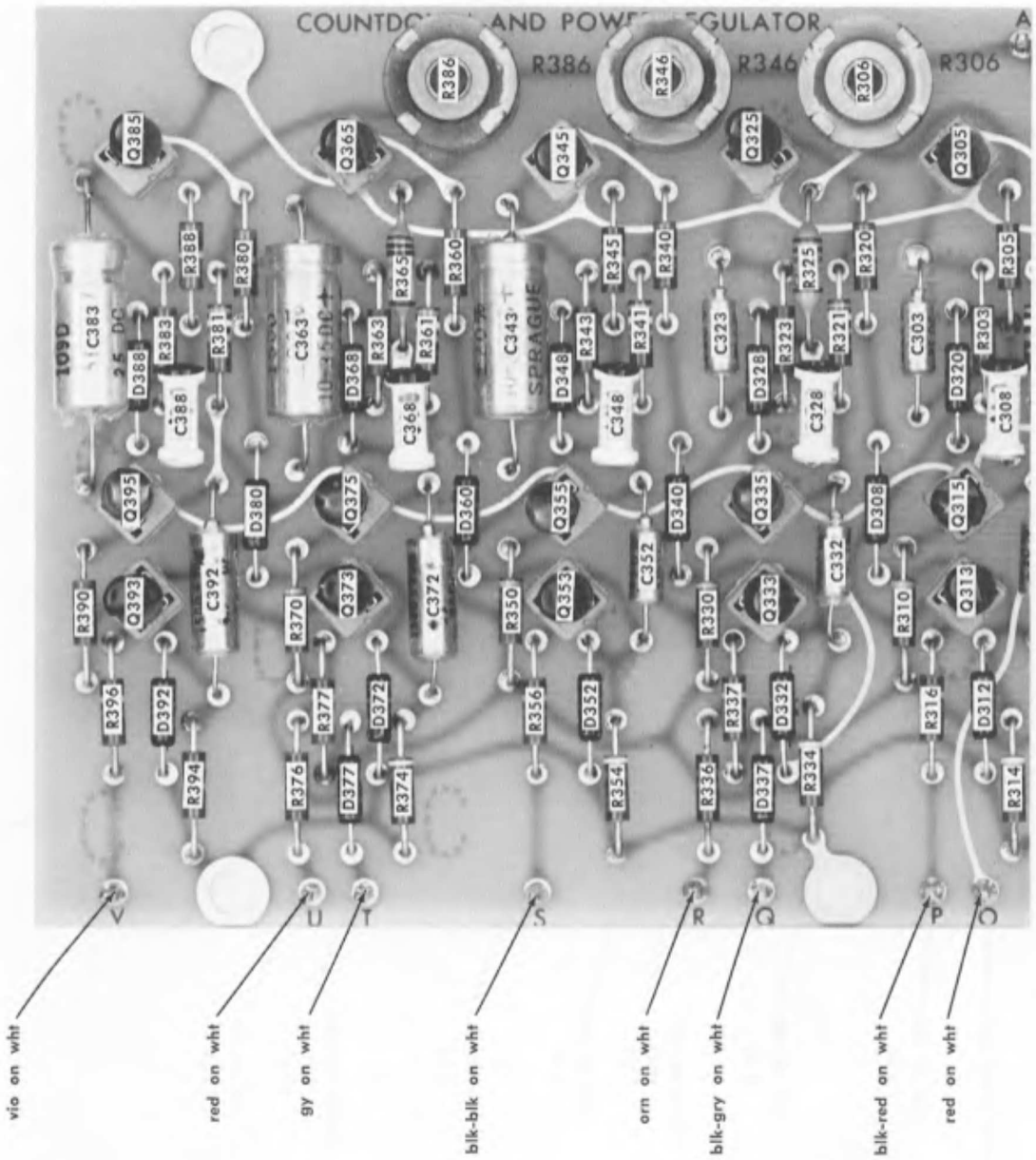


Fig. 4-9a. Lower portion of the 50 ms to 5 s countdown and power regulator etched-wiring board.

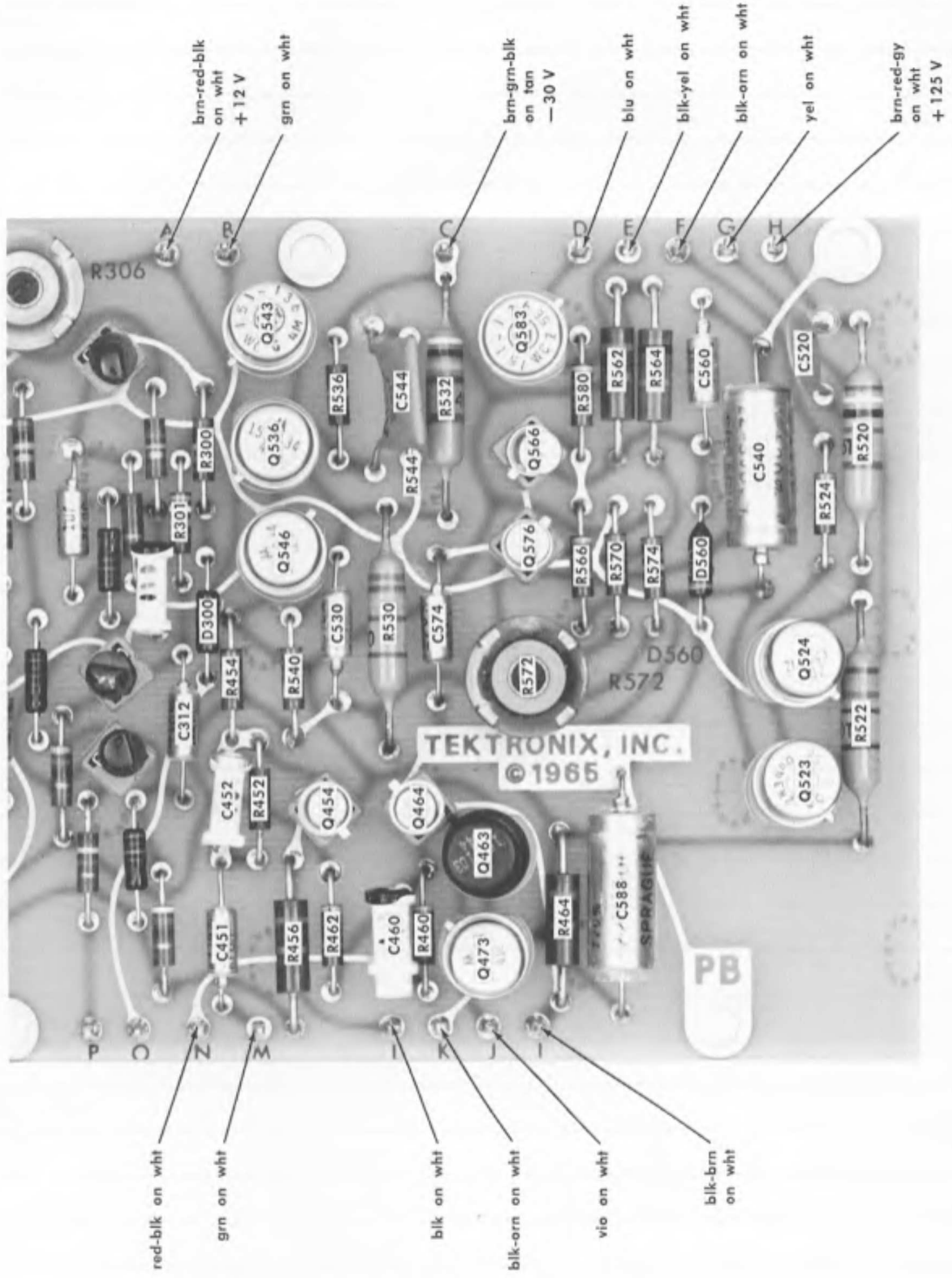


Fig. 4-9b. Upper portion of the 50 ms to 5 s countdown and power regulator etched-wiring board.

NOTES

SECTION 5
PERFORMANCE CHECK

Introduction

This performance check procedure is provided to check the operation of the Type 184 without removing the cover. This procedure may be used for incoming inspection, instrument familiarization, reliability testing, calibration verification, etc.

Failure to meet the characteristics given in this procedure indicates that the instrument requires internal checks and/or adjustments. See the Calibration section.

Recommended Equipment

The following equipment is recommended for a complete performance check. Specifications given are the minimum necessary to perform this procedure. All equipment is assumed to be calibrated and operating within the orignal specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For the most accurate and convenient performance check, special calibration fixtures are used in this procedure. These fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Test oscilloscope. Bandpass dc to 30 MHz; 0.05 volts/div deflection factor. Tektronix 540-Series oscilloscope with Type L Plug-In Preamplifier recommended.

2. 1× probe with BNC connector. Tektronix P6028 Probe recommended.

3. 10× probe with BNC connector. Tektronix P6006 Probe recommended.

4. Test oscilloscope with sampling system. Input impedance 50 Ω, risetime, 0.4 ns maximum. Tektronix 560-Series with Types 3S76 and 3T77 or Tektronix 540-Series with Type 1S1 Plug-In Unit recommended.

5. Electronic Digital Frequency Counter. Frequency measurement dc to 20 MHz. Example: Hewlett Packard 5244L Electronic Counter or equivalent.

6. Termination (one). Impedance 50 Ω; BNC connectors, Tektronix Part No. 011-0049-00.

7. 5× attenuator. Impedance 50 Ω; GR connectors. Tektronix Part No. 017-0079-00.

8. Adapters, GR to BNC, female. Tektronix Part No. 017-0063-00.

9. Adapter, clip lead to BNC. Tektronix Part No. 013-0076-00.

10. Adapter, BNC to dual binding post. Tektronix Part No. 103-0035-00.

11. Cable (two). Impedance 50 Ω; type RG58/AU, length 42 inches, BNC connectors. Tektronix Part No. 012-0057-00.

12. Resistor. 1 kΩ, ½ watt, 1% tolerance.

General Information

In the following procedure, test equipment connections or control settings should not be changed except when noted. If only a partial check is desired, refer to the preceding step(s) for setup information.

The following procedure uses the recommended equipment. If substitute equipment is used, the user must determine the settings or setup to meet the requirements of the check.

Preliminary Procedure

1. Check fuses for correct value. 115 volt operation: 0.6 amp, slow blow, 3AG. 230 volt operation: 0.3 amp, slow blow, 3AG. Check Line Voltage switch on the back panel for correct operating position (115 or 230 V).

2. Connect the Type 184 to a line voltage within the regulating range of the power supplies. Allow a minimum of 2 hours after the Type 184 is connected to a power source for the crystal to stabilize at 25°C ±5° or room ambient temperature. Turn the Type 184 on by depressing any of the MARKER SELECTOR pushbuttons. Allow 5 minutes warm-up time, if the crystal oven has stabilized, before checking the instrument to a given accuracy.

PERFORMANCE CHECK

1. Check Oven Light

Requirement—Oven light should cycle on and off after approximately 5 minutes warm-up time.

Check—Oven light operation.

2. Check Crystal Oscillator Frequency

a. Requirement—Frequency 10 MHz ±100 Hz at ambient room temperature. Crystal oven stabilized. (Two hours warm-up time after power is applied before crystal oven is stabilized.)

b. Apply the .1 μS marker from the MARKER OUTPUT connector through a 50 Ω coaxial cable and 50 Ω termination resistor to the Input connector of a digital frequency counter or equivalent frequency measuring device.

c. Check accuracy of the .1 μS markers (10 MHz crystal oscillator frequency).

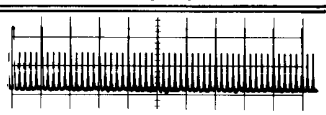
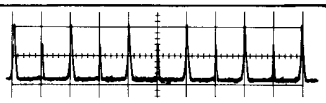
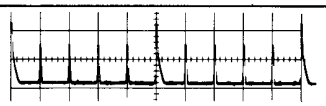
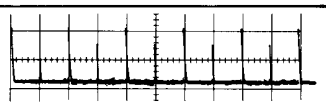
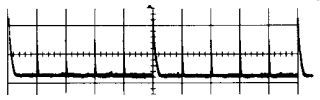
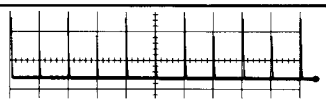
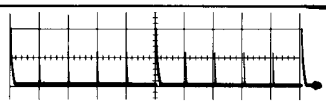
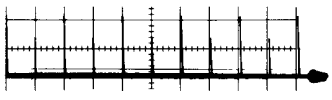
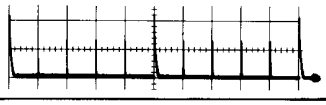
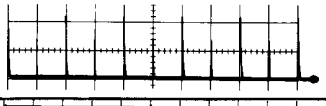
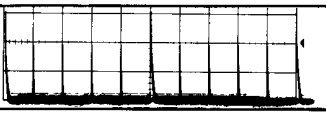
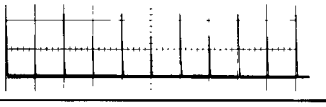
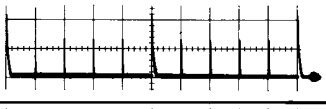
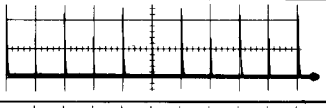
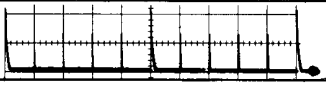
d. Remove the coaxial cable and 50 Ω termination from the frequency measuring device.

3. Check .1 μS to 5 μS Marker Timing

a. Requirement—Marker accuracy dependent on crystal oscillator.

b. Connect the TRIGGER OUTPUT of the Type 184 through a 50 Ω coaxial cable to the external Trigger Input connector of the test oscilloscope (Type 545B).

TABLE 5-1

Type 184 MARKER SELECTOR	Test Oscilloscope Time/Cm	Type 184 TRIGGER SOURCE	Typical Display
.1 μS and .5 μS	.5 μSEC	1 μS	
.5 μS and 1 μS	.5 μSEC	1 μS	
1 μS and 5 μS	1 μSEC	10 μS	
5 μS and 10 μS	5 μSEC	10 μS	
10 μS and 50 μS	10 μSEC	.1 mS	
50 μS and .1 mS	50 μSEC	.1 mS	
.1 mS and .5 mS	.1 mSEC	1 mS	
.5 mS and 1 mS	.5 mSEC	1 mS	
1 mS and 5 mS	1 mSEC	10 mS	
5 mS and 10 mS	5 mSEC	10 mS	
10 mS and 50 mS	50 mSEC	.1 S	
50 mS and .1 S	10 mSEC	1 S	
.1 S and .5 S	.1 SEC	1 S	
.5 S and 1 S	.5 SEC	1 S	
1 S and 5 S	1 SEC	1 S	

c. Connect the output of the MARKER OUTPUT connector on the Type 184 through a 50 Ω coaxial cable and 50 Ω termination resistor to the vertical Input connector of the vertical plug-in unit (Type L) in the test oscilloscope.

d. Set the Type 184 and test oscilloscope controls as follows:

Type 184

MARKER SELECTOR	.1 μS
TRIGGER SELECTOR	1 μS
MARKER AMPLIFIER	OFF
H.F. SELECTOR	OFF

Test oscilloscope

Crt controls	Adjust for well focused display of nominal brightness
Horizontal Display	Time Base A

Time Base A Controls

Time/Cm	.1 μSEC
Variable	Calibrated
Trigger Mode	AC
Trigger Slope	+Ext
Stability	Preset
Triggering Level	Midrange

Vertical Plug-In Unit (Type L)

Volts/Cm	.5
Variable	Calibrated
Input Coupling	DC
Vertical Position	Centered

e. Adjust the Triggering Level control when necessary for a stable display as each step in Table 5-1 is followed.

f. Check the marker timing in accordance with Table 5-1.

4. Check MARKER OUTPUT Amplitude

a. Requirement—Marker amplitude must be greater than 1 volt into 50 ohms.

b. Repeat the steps of Table 5-1, pushing only one MARKER SELECTOR button at a time. Check the amplitude of the time markers.

5. Check Output of MARKER AMPLIFIER

a. Requirements—Positive or negative-going markers with 14 intervals of 1 μs to 5 s in 1-5-10 sequence, 25-V minimum amplitude into 1 kΩ.

b. Connect a BNC to binding post adapter to the MARKER AMPLIFIER OUTPUT connector. Attach a 1 kΩ ½ watt, 1% resistor across the dual binding post adapter. Connect a clip lead to BNC adapter to the dual binding post adapter (red lead to the red binding post). Connect a 50 Ω coaxial cable between the clip lead to BNC adapter and the Input connector of the vertical plug-in unit in the test oscilloscope. (Fig. 6-13 in Calibration section.)

c. Set the vertical deflection factor (Volts/Cm switch) to 10.

d. Set the Trigger Slope switch of the test oscilloscope to +Int and the Time/Cm switch as listed in Table 5-2.

e. Switch the MARKER AMPLIFIER switch to (+) position and check the amplitude of the MARKER AMPLIFIER output signal for each setting listed in Table 5-2.

f. Change the MARKER AMPLIFIER switch to the (—) position and the test oscilloscope Trigger Slope to (—Int) position.

g. Check the amplitude of the MARKER AMPLIFIER output signal for a minimum —25 volt signal.

h. Remove the adapters and cables from the Type 184 and test oscilloscope.

TABLE 5-2

Type 184 MARKER SELECTOR	Test Oscilloscope Time/Cm
1 μS	10 μSEC
5 μS	10 μSEC
10 μS	.1 mSEC
50 μS	.1 mSEC
.1 mS	1 mSEC
.5 mS	1 mSEC
1 mS	10 mSEC
5 mS	10 mSEC
10 mS	100 mSEC
50 mS	100 mSEC
.1 S	1 SEC
.5 S	1 SEC
1 S	1 SEC
5 S	1 SEC

6. Check Amplitude and Timing of the TRIGGER OUTPUT

a. Requirement—Positive-going pulses in 1-10 sequence, amplitude ≥0.4 V into 50 Ω or ≥2.5 V into open circuit.

b. Apply the signal from the TRIGGER OUTPUT connector through a 50 Ω coaxial cable and 50 Ω termination to the vertical Input connector of the vertical plug-in unit (Type L).

c. Set the Volts/Cm switch on the vertical unit to .2.

d. Check the trigger timing and amplitude as listed in Table 5-3.

TABLE 5-3

Type 184 TRIGGER SELECTOR	Test Oscilloscope Time/Cm	Marks/Cm
1 μS	1 μSEC	1
10 μS	10 μSEC	1
.1 mS	.1 mSEC	1
1 mS	1 mSEC	1
10 mS	10 mSEC	1
.1 S	.1 SEC	1
1 S	1 SEC	1

7. Check Sine-wave Marker Timing and Amplitude

a. Requirement—10, 20 and 50 ns sine-wave marker signals at the MARKER OUTPUT connector with 1-V minimum peak-to-peak amplitude into 50 Ω.

b. Apply the signal from the Type 184 MARKER OUTPUT connector through a 50 Ω coaxial cable, a BNC-to-GR adapter and a 5×T, 50Ω, GR attenuator, to the Input (A) connector of the vertical plug-in unit (Type 3S76) for the sampling test oscilloscope.

c. Set the test oscilloscope and plug-in units controls as follows:

Crt controls	Adjust for well focused display of nominal brightness

Time Base Plug-In Unit (Type 3T77)

Time/Div	As indicated in Table 5-5
Sweep Mode	Normal
Trigger	+Int
Horiz Mag	×1
Dots Per Div	100

Vertical Plug-In Unit (Type 3S76)

Mv/Div	100
Input Selector	A Only

d. Check amplitude and timing of the sine-wave markers in accordance with Table 5-4.

TABLE 5-4

Type 184 MARKER SELECTOR	Test Oscilloscope Time/Div	Cycle/Div
50 nS	50 nSEC	1
20 nS	20 nSEC	1
10 nS	10 nSEC	1

e. Remove the 50 Ω coaxial cable from the Type 184 MARKER OUTPUT connector and attach to the H.F. OUTPUT connector.

8. Check Amplitude and Timing of H.F. Sine-wave Markers

a. Requirement—500 MHz (2 ns) and 200 MHz (5 nS) frequencies at the OUTPUT connector with 0.3-V minimum peak-to-peak amplitude into 50 Ω.

b. Set the Type 184 H.F. SELECTOR switch to the 5 nS position.

c. Set the Mv/Div switch on the vertical plug-in unit (Type 3S76) to 50.

d. Check the amplitude and timing of the 2 and 5 nS markers in accordance with Table 5-5.

TABLE 5-5

Type 184 H.F. SELECTOR	Test Oscilloscope Time/Div	Cycle/Div
5 nS	5 nSEC	1
2 nS	2 nSEC	1

e. Remove all cables, adapters and attenuators from the Type 184 and test oscilloscope.

SECTION 6

CALIBRATION

Introduction

This procedure can be used either as an operational check or to completely calibrate the instrument. The title of each numbered step begins with either "Adjust" ◐ or "Check", thereby identifying the step as calibration or verification. The steps are identified in this manner so any or all groups of numbered checks can be skipped without disrupting the continuity of the procedure. All "Adjust" steps, however, must be completed in the order given, because some adjustments interact with others. Remember that proper operation is only insured when all steps in the procedure have been completed and all adjustments have been made as accurately as possible.

The location of test points and adjustments is shown in each step. Waveforms which are helpful in determining the correct adjustment or operation are also shown.

Where reference is made to divisions of deflection, the indication will be major divisions.

NOTE

The performance standards described in this section of the manual are provided strictly as guides to calibration of the Type 184 and should not be construed as advertised specifications. If the Type 184 performs within the guide tolerances given in this calibration procedure, it will meet all listed specifications in the Characteristics secton of this manual.

EQUIPMENT REQUIRED

The following equipment or its equivalent is required for a complete calibration of the Type 184. Specifications are the minimum necessary for accurate calibration of the instrument. All test equipment is assumed to be calibrated and operating within its specifications. If substitute equipment is used, it must meet or exceed the specifications of the equipment recommended.

Special calibration fixtures are used where necessary. These can be obtained through your local Tektronix Field Office or representative. The part number for the calibration fixture is listed with the description of the part.

1. Test oscilloscope: Bandpass dc to 30 MHz; .05 volts/div deflection factor. Tektronix 540-Series oscilloscope with Type L Plug-In Preamplifier recommended.

2. 1× probe with BNC connector; Tektronix P6028 Probe recommended.

3. 10× probe with BNC connector: Tektronix P6006 Probe recommended.

4. Test oscilloscope with sampling system: Input impedance 50 Ω, risetime 0.4 ns maximum. Tektronix 560-series with Types 3S76 and 3T77 or Tektronix 540-Series with Type 1S1 Plug-In Unit recommended.

5. Variable autotransformer: Variable range 93.5 to 135 Vac or 187 to 270 Vac. If autotransformer does not have an ac voltmeter to monitor the output voltage, an ac voltmeter (rms) with a range of 90 to 270 volts must be used. For example: General Radio W10MT3W Metered Variac Autotransformer.

6. Frequency Standard or Digital Frequency Counter: Frequency 10 MHz, stability 0.3 ppm[1] for short time use, or over 24 hours. A stable communication receiver which can receive the National Bureau of Standards transmitting stations (WWV, WWVB, WWVH) may be used.

7. Dc voltmeter, with sensitivitiy of 20,000 ohms/volt and calibrated for an accuracy of ±1% at 30 and 125 volts.

8. Termination: Impedance 50 Ω, BNC connectors. Tektronix Part No. 011-0049-00.

9. 5× Attenuator: Impedance 50 Ω, GR connectors. Tektronix Part No. 017-0079-00.

10. Adapter: GR to BNC, female. Tektronix Part No. 017-0063-00.

11. Adapter: clip lead to BNC. Tektronix Part No. 013-0076-00.

12. Adapter: BNC to dual binding post. Tektronix Part No. 103-0035-00.

13. Cables: (2) Impedance 50 Ω, type RG58/AU, length 42 inches, BNC connectors. Tektronix Part No. 012-0057-00.

14. Resistor: 1 kΩ resistor, ½ watt, 1% tolerance.

Adjusting Tools (see Fig. 6-2)

Description	Tektronix Part No.
a. Insulated screwdriver, 1½-inch shaft, non-metallic	003-0000-00
b. Screwdriver, 3-inch shaft	003-0192-00
c. Tuning rod, 5-inch	003-0301-00

***Parts per million.**

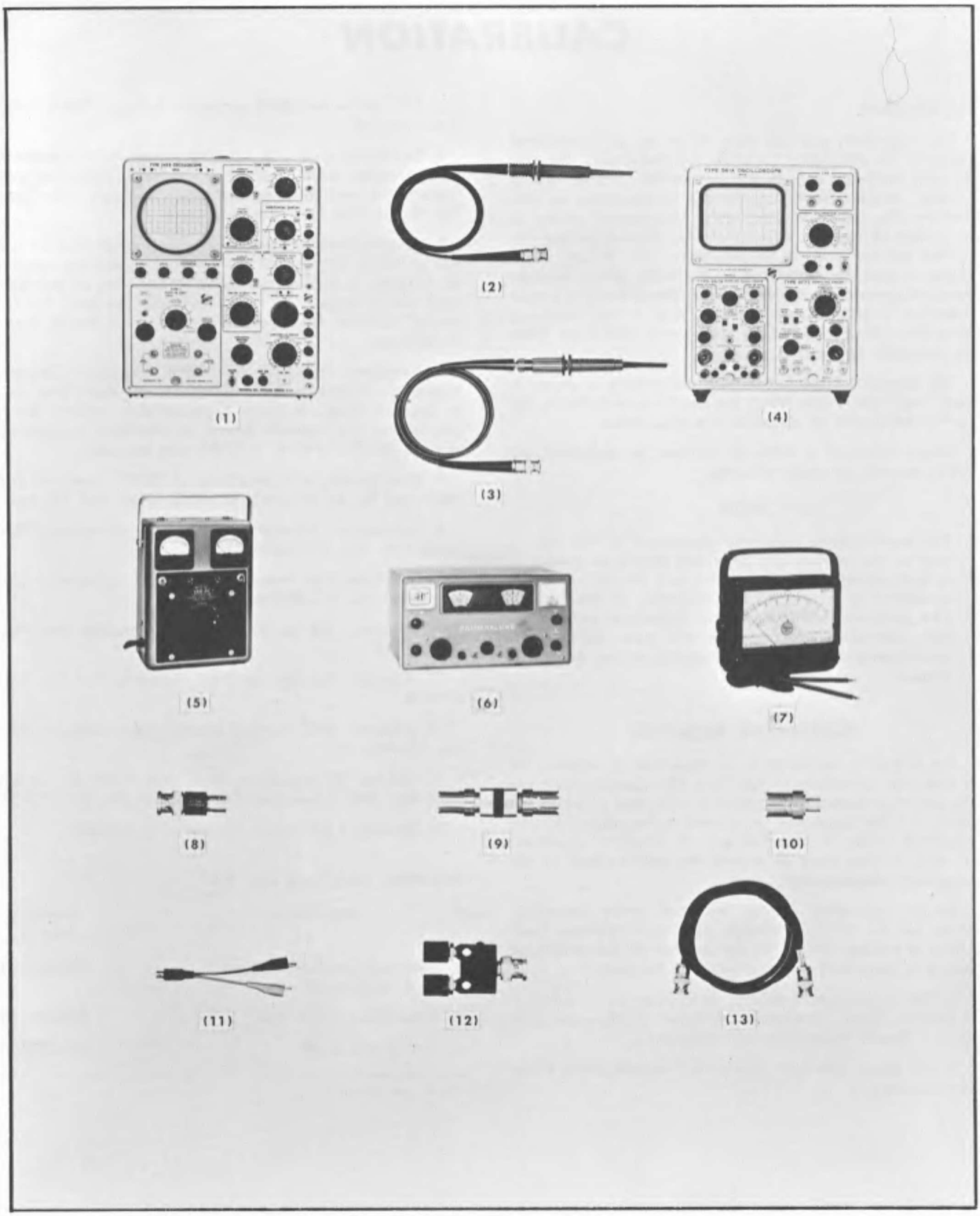


Fig. 6-1. Equipment recommended for calibration.

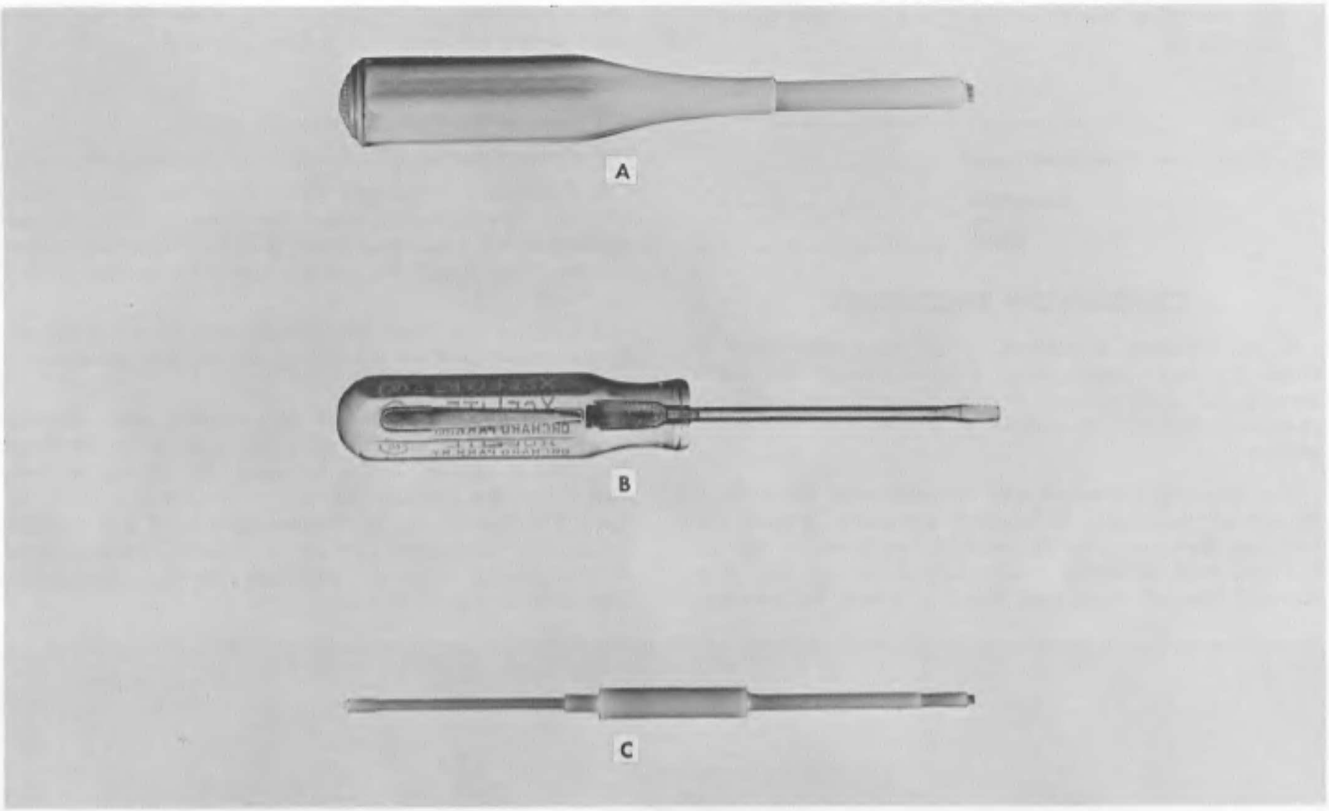


Fig. 6-2. Adjusting tools.

CALIBRATION RECORD AND INDEX

This Abridged Calibration Procedure is provided to aid in checking the operation of the Type 184. It may be used as a calibration guide by the experienced calibrator, or as a calibration record. Since the step numbers and titles used correspond to those in the complete Calibration Procedure, the following procedure serves as an index to locate a step in the complete Calibration Procedure. Characteristics are those listed in the Characteristics section of the Instruction Manual.

Type 184

Instrument Serial No. _____

1. Voltage on −30 volt terminal (pin C) _____
2. Voltage on +12 volt terminal (pin A) _____
3. Voltage on +125 volt terminal (pin H) _____
4. Regulation of −30 volt supply _____%
5. Marker accuracy and amplitude (1 volt minimum)

   Crystal oscillator frequency deviation _____Hz

.1 μS	_____	_____
.5 μS	_____	_____
1 μS	_____	_____
5 μS	_____	_____
10 μS	_____	_____
50 μS	_____	_____
100 μS	_____	_____
.5 mS	_____	_____
1 mS	_____	_____
5 mS	_____	_____
10 mS	_____	_____
100 mS	_____	_____
.5 S	_____	_____
.1 S	_____	_____
5 S	_____	_____

6. Marker Amplifier amplitude (greater than ±25 V into 1 kΩ at 1 μS) _____
7. Trigger timing accuracy and amplitude (greater than .4 V)

1 μS	_____	_____
10 μS	_____	_____
.1 mS	_____	_____
1 mS	_____	_____
10 mS	_____	_____
.1 S	_____	_____
1 S	_____	_____

8. Sine-wave marker accuracy and amplitude (greater than 1 V)

50 nS	_____	_____
20 nS	_____	_____
10 nS	_____	_____

9. H.F. sine-wave marker accuracy and amplitude (greater than 0.3 V)

   5 nS _____ _____

   2 nS _____ _____

10. Crystal oven thermostat cycles _____

Signature _____

Date _____

CALIBRATION PROCEDURE

In the following procedure, a test equipment setup is shown for each major step. Control settings are listed beneath the setup picture. If only a partial calibration is performed, start with the nearest setup preceding the desired portion.

The following procedure uses the equipment listed under "Equipment Required". If substitute equipment is used, the user must determine that the substitute equipment is equivalent and must determine proper control settings, etc. It is assumed that all equipment listed is within its manufacturer's specifications. If there is any doubt, the test equipment should be calibrated before it is used.

Preliminary Procedure

1. Remove the Type 184 from its cabinet.

2. Connect the autotransformer to a suitable power source.

3. Preliminary inspection: Check fuses for correct value. 115 volt operation: 0.6 amp, slow blow, 3 AG; 230 volt operation: 0.3 amp, slow blow, 3 AG. Check Line Switch on the back panel for correct operating position (115 V or 230 V).

4. Connect the Type 184 power cord to the autotransformer output and set the output of the autotransformer to 115 (or 230) volts.

5. Allow 2 hours warm-up time with a room ambient temperature of 25°C ±5° after the Type 184 is connected to a power source. This is necessary for the crystal oven, and hence the oscillator frequency, to stabilize. Turn the Type 184 power on, by depressing any of the MARKER SELECTOR pushbuttons. Allow 5 minutes warm-up time if the crystal oven has stabilized, before checking the instrument to a given accuracy.

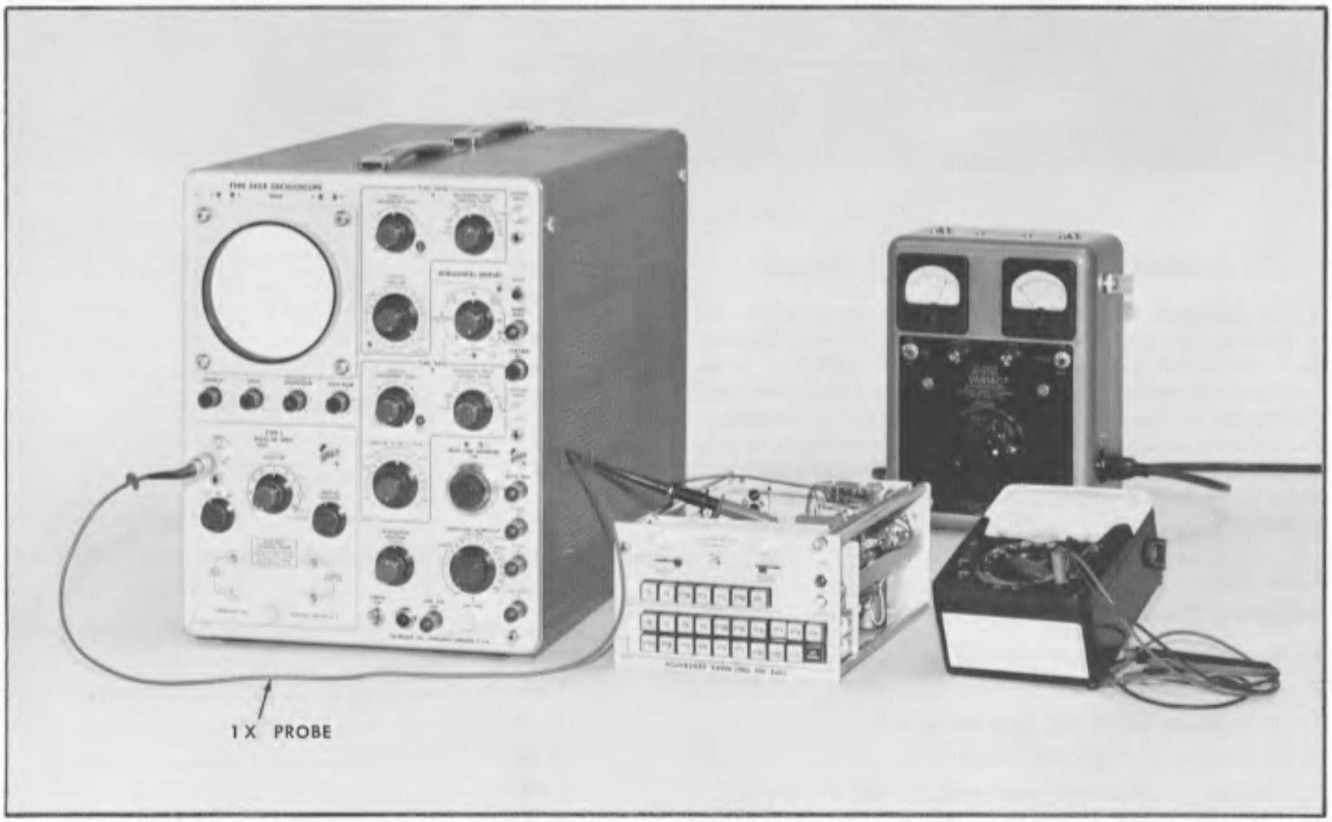


Fig. 6-3. Initial test equipment set-up to check and adjust voltages.

Set controls as follows:

Type 184

MARKER SELECTOR	1 mS
TRIGGER SELECTOR	None
MARKER AMPLIFIER	OFF
H.F. SELECTOR	OFF

Autotransformer

Line Voltage	115 (230) volts

Test Oscilloscope

Crt controls	Adjust for well focused display of nominal brightness

Horizontal Display	Time Base A
Sweep Controls	
A Time/Cm	5 mSEC
Variable	Calibrated
A Triggering Mode	AC
A Trigger Slope	+Line
A Stability	Preset
A Triggering Level	Midrange
Vertical Plug-In Unit	
Volts/Div	.05
Variable	Calibrated
Input Coupling	AC
Vertical Position	Midrange

TABLE 6-1

Supply	Typical Regulation Value	Typical maximum Frequency Ripple
—30 V	±3%	15 mV p-p
+12 V	±3%	30 mV p-p
+125 V	±3%	60 mV p-p

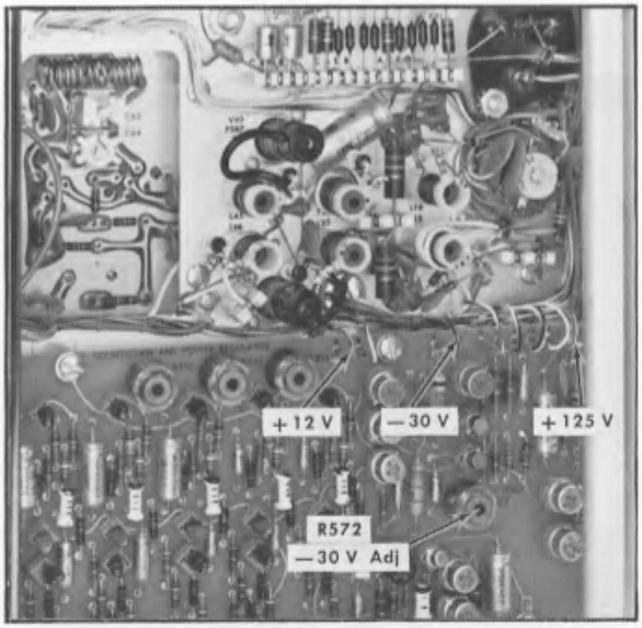


Fig. 6-4. Voltage test points and adjustments.

1. Check Oven Light

a. Check oven light operation.

b. After 5 minute warm-up time, oven should cycle on and off at approximately 1-2 minute intervals.

c. Interaction — None.

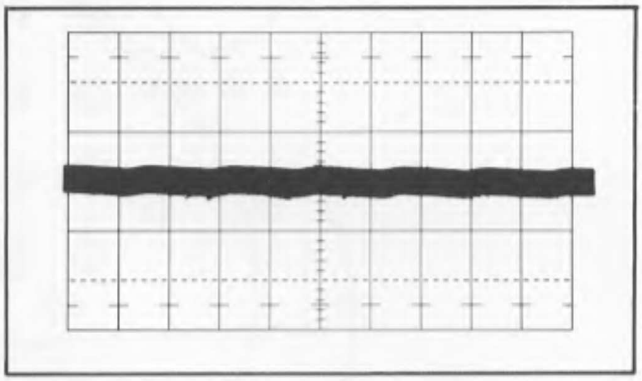


Fig. 6-5. Typical test oscilloscope display of power supply ripple (60-cycle line) vertical deflection, 0.5 volts/div, sweep rate 5 msec/div.

2. Adjust —30 Volt Power Supply

a. Test equipment setup is shown in Fig. 6-3.

b. Connect the dc voltmeter from the —30 volt supply, pin C on the power board to chassis ground. See Fig. 6-4.

c. Adjust R572, the —30 volt adjustment (Fig. 6-4), for —30 volts.

d. Interaction — May affect the operation of all circuits within the Time-Mark Generator.

3. Check Power Supply Voltages and Ripple

a. Test equipment setup is shown in Fig. 6-3.

b. Connect the 1× probe to the test oscilloscope input.

c. Check—regulation and ripple of the power supplies while changing the input supply voltage between 94.5 to 137.5 VAC (or 189 to 275 VAC). Power supply test points are shown in Fig. 6-4. Power supply specifications are shown in Table 6-1 and a typical test oscilloscope display of the ripple is shown in Fig. 6-5. Disregard high frequency hash, spikes, transients, etc.

d. Return autotransformer output to 115 (230) volts. If the line voltage is approximately 115 (230) volts, the Type 184 may be connected directly to the line for the remainder of the calibration procedure.

e. Remove 1× probe.

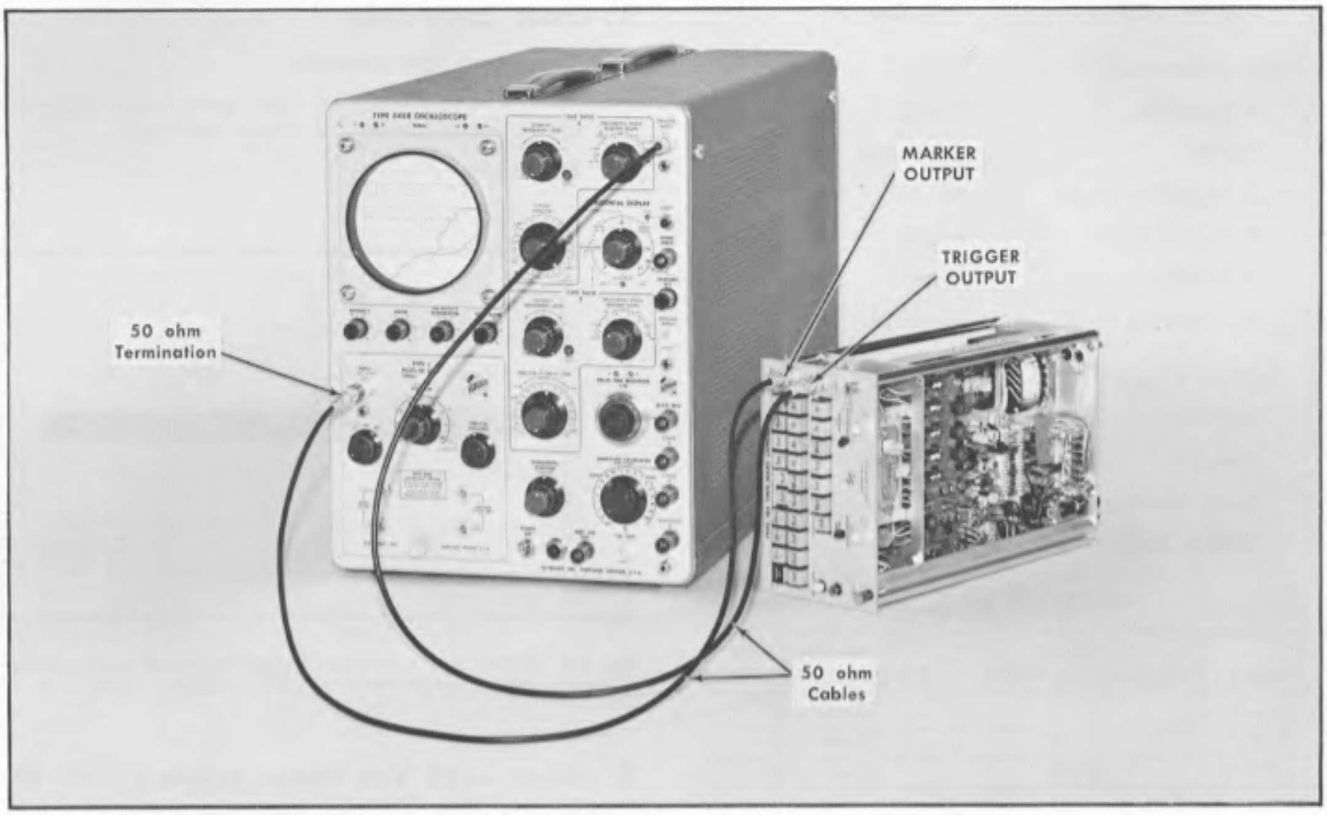


Fig. 6-6. Checking and adjusting .1 μS and .5 μS time-markers. Step 4.

Control Settings:

Type 184	
MARKER SELECTOR	.1 μS
TRIGGER SELECTOR	1 μS
MARKER AMPLIFIER	OFF
H.F. SELECTOR	OFF
Test Oscilloscope	
Crt controls	Adjust for well focused display of nominal brightness
Horizontal Display	Time Base A
Sweep Controls	
A Time/Cm	.5 μSEC
Variable	Calibrated
A Triggering Mode	AC
Trigger Slope	+Int
A Stability	Preset
A Triggering Level	Midrange
Vertical Plug-In Unit	
Volts/Div	.5
Variable	Calibrated
Input Coupling	DC
Vertical Position	Midrange

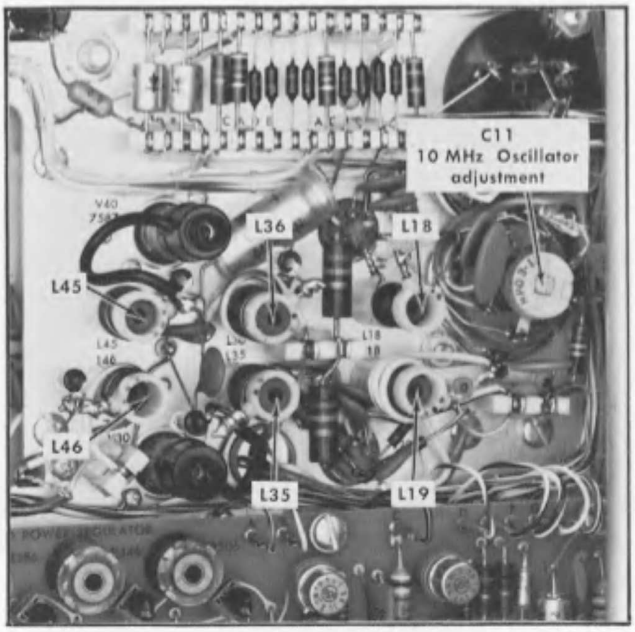


Fig. 6-7. 10 MHz (.1 μs) 50 MHz (20 ns) and 100 MHz (10 ns) oscillator and multiplier adjustments. Step 4, 10.

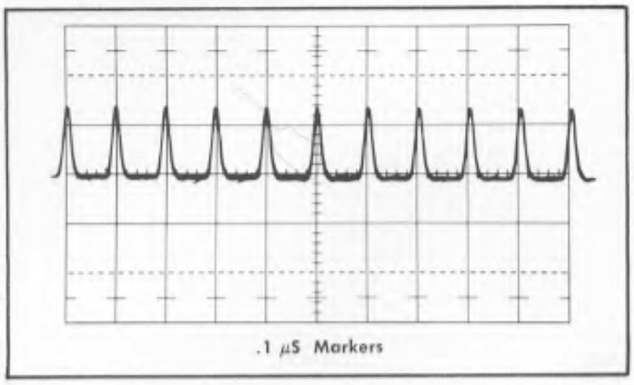


Fig. 6-8a. Typical display of .1 μS markers.

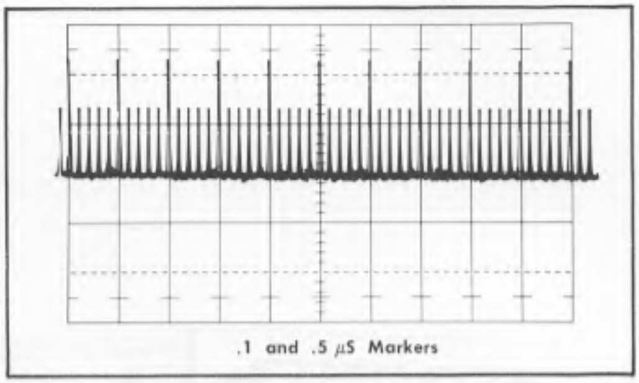


Fig. 6-8b. Typical display of .1 and .5 μS markers. C108 adjusted for accuracy of .5 μs markers. T-18 adjusted for uniformity of the .1 μs markers.

4. Adjust .1 μS and .5 μS Time-Markers ◐

a. Test equipment setup is shown in Fig. 6-6.

b. Adjust the A Triggering Level control on the test oscilloscope for a stable display, then center the display on the graticule area with the vertical and horizontal position controls. See Fig. 6-8.

c. Adjust L18 (Fig. 6-7) midway between the two signal maximum amplitude points.

d. Change the A Time/Cm switch to .5 μSEC position and adjust L19 (Fig. 6-7) for marker amplitude and uniformity.

e. Push the Type 184 .1 μS and .5 μS MARKER SELECTOR buttons simultaneously. Set the vertical plug-in unit Volts/Cm switch to 1.

f. Adjust C108 (Fig. 6-9) for one .5 μS time marker per division.

g. Adjust L19 and C108 simultaneously for proper count of the .5 μS markers and uniformity of the .1 μS markers. See Fig. 6-8b.

h. Interaction — Will affect all countdown and multiplier circuits.

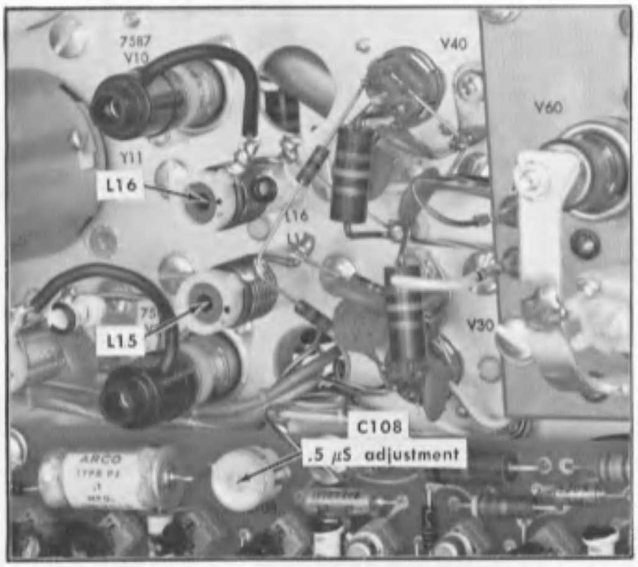


Fig. 6-9. .5 μs marker adjustment C108 and 50 MHz (20 ns) adjustment L16, L15.

NOTES

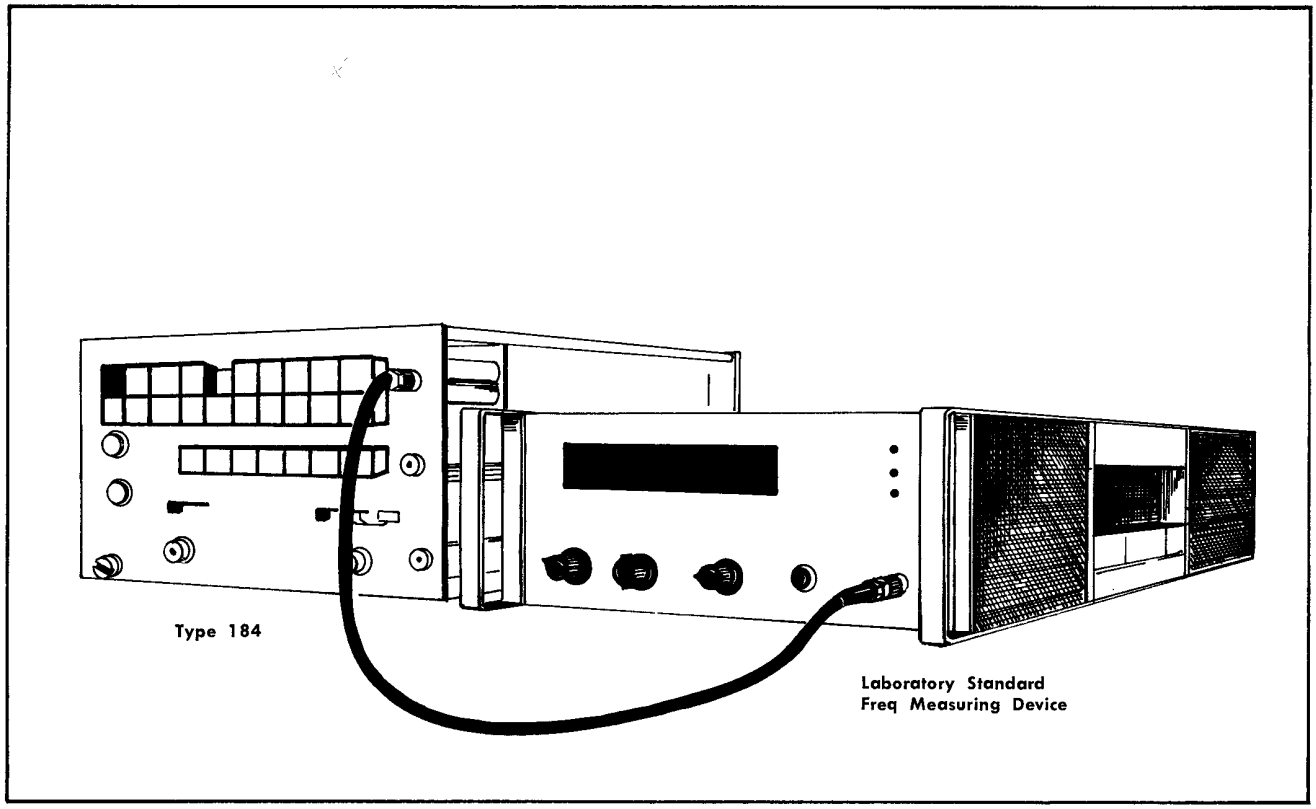


Fig. 6-10a. Suggested setup for adjusting crystal oscillator to laboratory standard. Step 5.

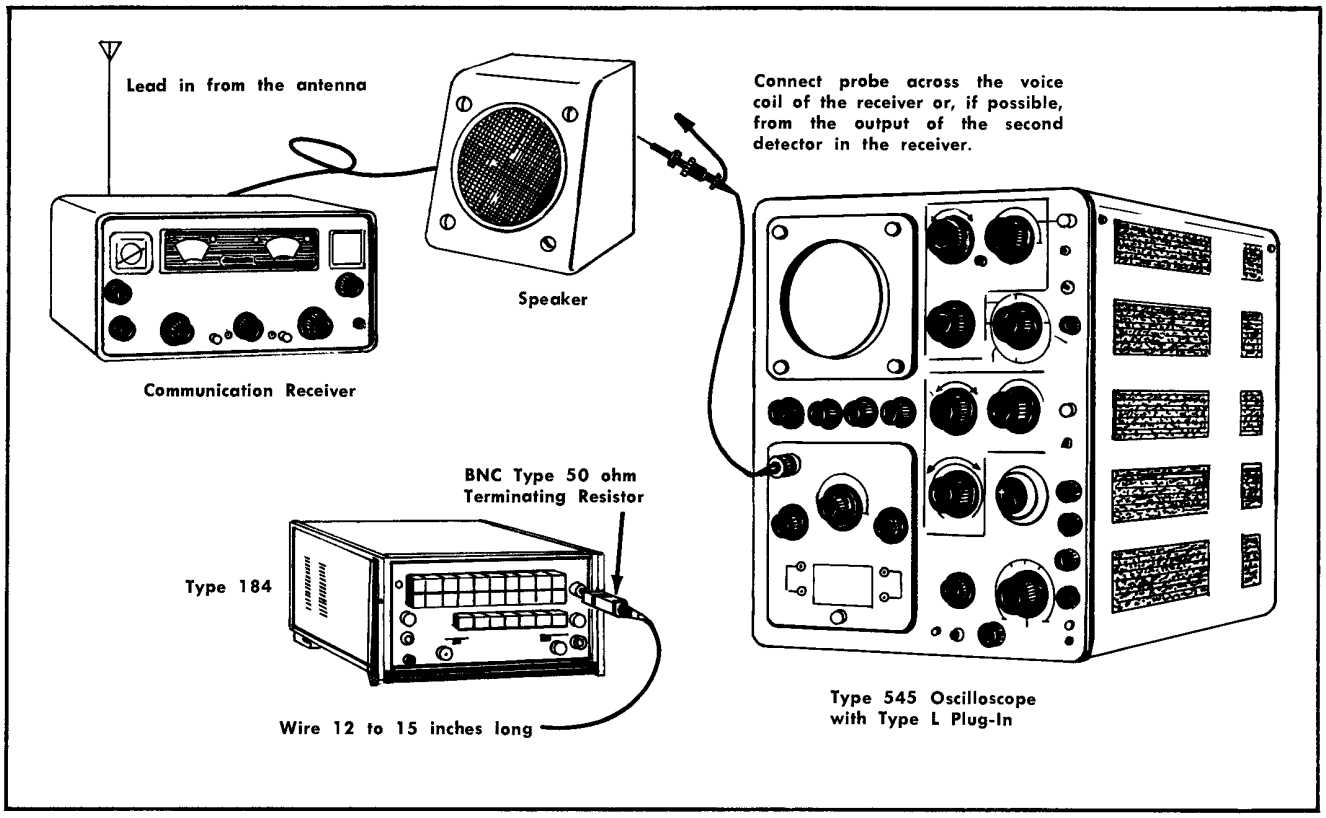


Fig. 6-10b. Suggested setup for adjusting crystal oscillator frequency to National Bureau of Standards. Step 5.

Control settings:

Type 184

MARKER SELECTOR	.1 μS
TRIGGER SELECTOR	1 μS
MARKER AMPLIFIER	OFF
H.F. SELECTOR	OFF

Test Oscilloscope

Crt controls	Adjust for well focused display of nominal brightness
Horizontal Display	Time Base A
Sweep Controls	
A Time/Cm	.1 μSEC
Variable	Calibrated
A Triggering Mode	AC
Trigger Slope	+Int
A Stability	Preset
A Triggering Level	Midrange

Vertical Plug-In Unit

Volts/Div	As required
Variable	Calibrated
Input Coupling	DC
Vertical Position	Midrange

5. Check or Adjust Crystal Oscillator ◐

Adjusting the crystal oscillator frequency requires an accurate 10 MHz frequency standard or frequency measuring device. The National Bureau of Standards through transmitting stations at Boulder, Colorado (WWVB), Washington, D.C. (WWV) or Hawaii (WWVH) provide one menas of checking the oscillator. Another method could be direct frequency measurement with an Electronic Digital Frequency Counter. The two methods are described as follows.

NOTE

Allow a minimum warm-up time of 2 hours for the crystal oven to stabilize, before attempting to measure or adjust the oscillator frequency.

Method 1

a. Test equipment setup is shown in Fig. 6-10a.

b. Apply the Type 184 .1 μS markers from the MARKER OUTPUT connector through a 50 Ω coaxial cable and 50 Ω termination to the Input connector of the Frequency Counter.

c. Adjust C11 on the Type 184 for equal drift in both directions of the frequency as the crystal oven cycles.

d. Remove the cable and termination from the Frequency Counter.

Method 2

a. Test equipment setup is shown in Fig. 6-10b. There is no direct connection between the Type 184 and either the receiver or the test oscilloscope.

b. Trigger the test oscilloscope internally from the signal input to the vertical plug-in unit.

c. The oscillator may be calibrated by beating the frequency of the crystal oscillator against the frequency from National Bureau of Standards broadcasting stations. Tune the receiver to 10 or 20 MHz, whichever is stronger. The signal of the National Bureau of Standards can be recognized by the clicks which occur once each second. During a portion of each minute a 440- or 1000-cycle tone is heard. Adjust the test oscilloscope vertical sensitivity (Volts/Cm switch) during this tone time, for a signal amplitude of approximately 4 cm. Tune the CW or Beat Note Oscillator in the communications receiver. Tune the receiver carefully until only the 440- or 1000-cycle tone can be heard, then turn off the CW or Beat Note Oscillator.

Install a 50-Ω terminating resistor on the MARKER OUTPUT connector of the Type 184 and insert a short (12- to 15-inch) piece of wire in the center conductor of the terminator.

d. Push the .1 μS MARKER SELECTOR switch on the Type 184. The short wire will act as a radiator for the .1 μS signal and will be received by the communications receiver. If the signal is too strong from the Type 184, it may block out the signal for the National Bureau of Standards, so if this occurs shorten the radiating wire from the Type 184 until both signals can be heard.

e. During the time the 440- or 1000-cycle tone is not being transmitted from the National Bureau of Standards, adjust C11 in the Type 184 for minimum beat note, or for minimum deflection of the signal on the test oscilloscope.

After the crystal oscillator frequency has been adjusted, do not disturb any of the components in the oscillator circuit. This adjustment of C11 will not affect the adjustment of the other markers since they are timed by this basic frequency and will follow small changes of the oscillator.

f. Disconnect the test equipment setup from the Type 184.

g. Interaction — Will affect accuracy of all marker and trigger signals.

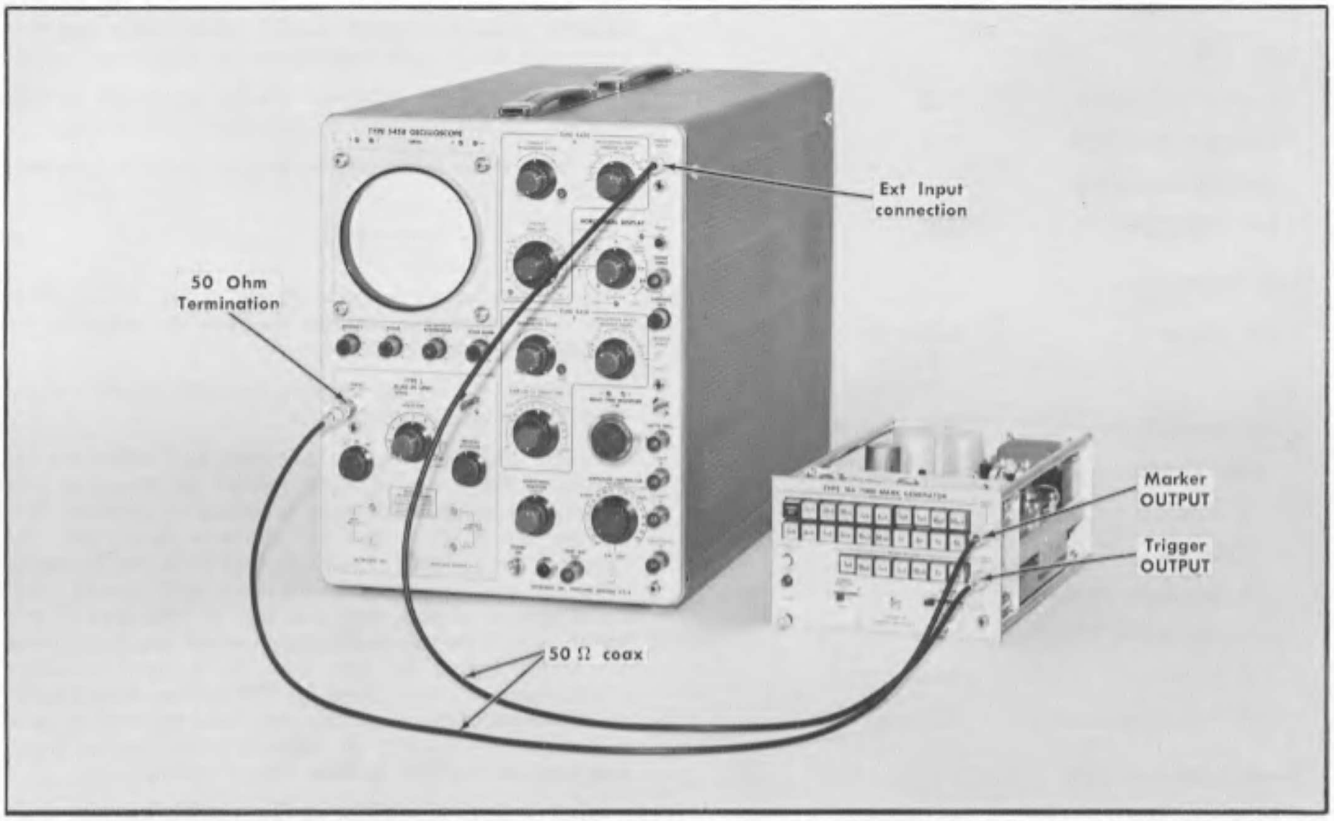


Fig. 6-11. Test equipment setup for checking time-marker accuracy and amplitude. Step 6 and step 7.

Control settings:

Type 184

MARKER SELECTOR	As shown in Table 6-2
TRIGGER SELECTOR	As shown in Table 6-2
MARKER AMPLIFIER	OFF
H.F. SELECTOR	OFF

Test Oscilloscope

Crt controls	Adjust for well focused display of nominal brightness
Horizontal Display	Time Base A
Sweep Controls	
A Time/Cm	In accordance with Table 6-2
Variable	Calibrated
A Triggering Mode	AC
Trigger Slope	+Ext
A Stability	Preset
A Triggering Level	Midrange

Vertical Plug-In Unit

Volts/Div	1
Variable	Calibrated
Input Coupling	DC
Vertical Position	Midrange

6. Adjust Marker Timing

a. Test equipment setup is shown in Fig. 6-11.

b. Adjust the Triggering Level control when required, for a stable display as each step in Table 6-2 is followed.

c. Check and adjust the marker timing according to Table 6-2.

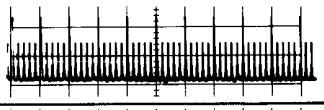
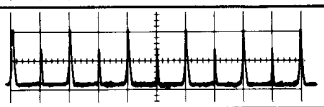
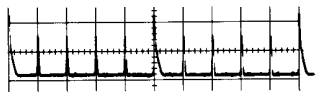
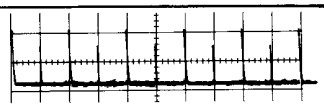
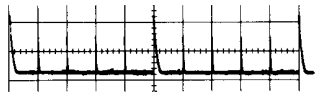
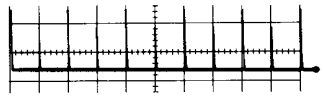
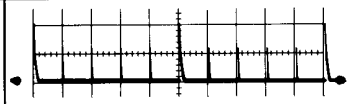
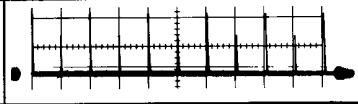
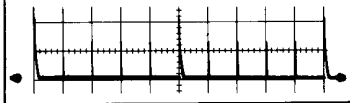
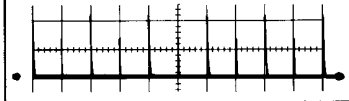
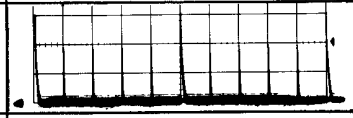
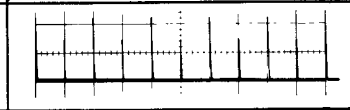
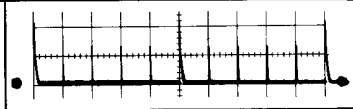
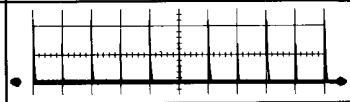
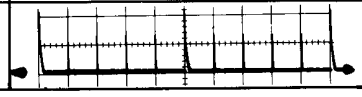
7. Check Marker Amplitude - 1 volt minimum

a. Test equipment setup is shown in Fig. 6-11.

b. Repeat the steps of Table 6-2 pushing only one MARKER SELECTOR button at a time, measuring the marker amplitude.

c. Interaction—Because the markers are derived from a previous countdown circuit, there is definite interaction to the successive counters.

TABLE 6-2

Type 184 MARKER SELECTOR	Test Oscilloscope Time/Cm	Type 184 TRIGGER SELECTOR	Adjust	Typical Display
.1 μS and .5 μS	.5 μSEC	1 μS	C108 (Fig. 6-12a)	
.5 μS and 1 μS	.5 μSEC	1 μS		
1 μS and 5 μS	1 μSEC	10 μS	R146 (Fig. 6-12a)	
5 μS and 10 μS	5 μSEC	10 μS		
10 μS and 50 μS	10 μSEC	.1 mS		
50 μS and .1 mS	50 μSEC	.1 mS		
.1 mS and .5 mS	.1 mSEC	1 mS		
.5 mS and 1 mS	.5 mSEC	1 mS		
1 mS and 5 mS	1 mSEC	10 mS		
5 mS and 10 mS	5 mSEC	.1 S		
10 mS and 50 mS	10 mSEC	.1 S	R306 (Fig. 6-12b)	
50 mS and .1 S	50 mSEC	1 S		
.1 S and .5 S	.1 SEC	1 S	R346 (Fig. 6-12b)	
.5 S and 1 S	.5 SEC	1 S		
1 S and 5 S	1 SEC	1 S	R386 (Fig. 6-12b)	

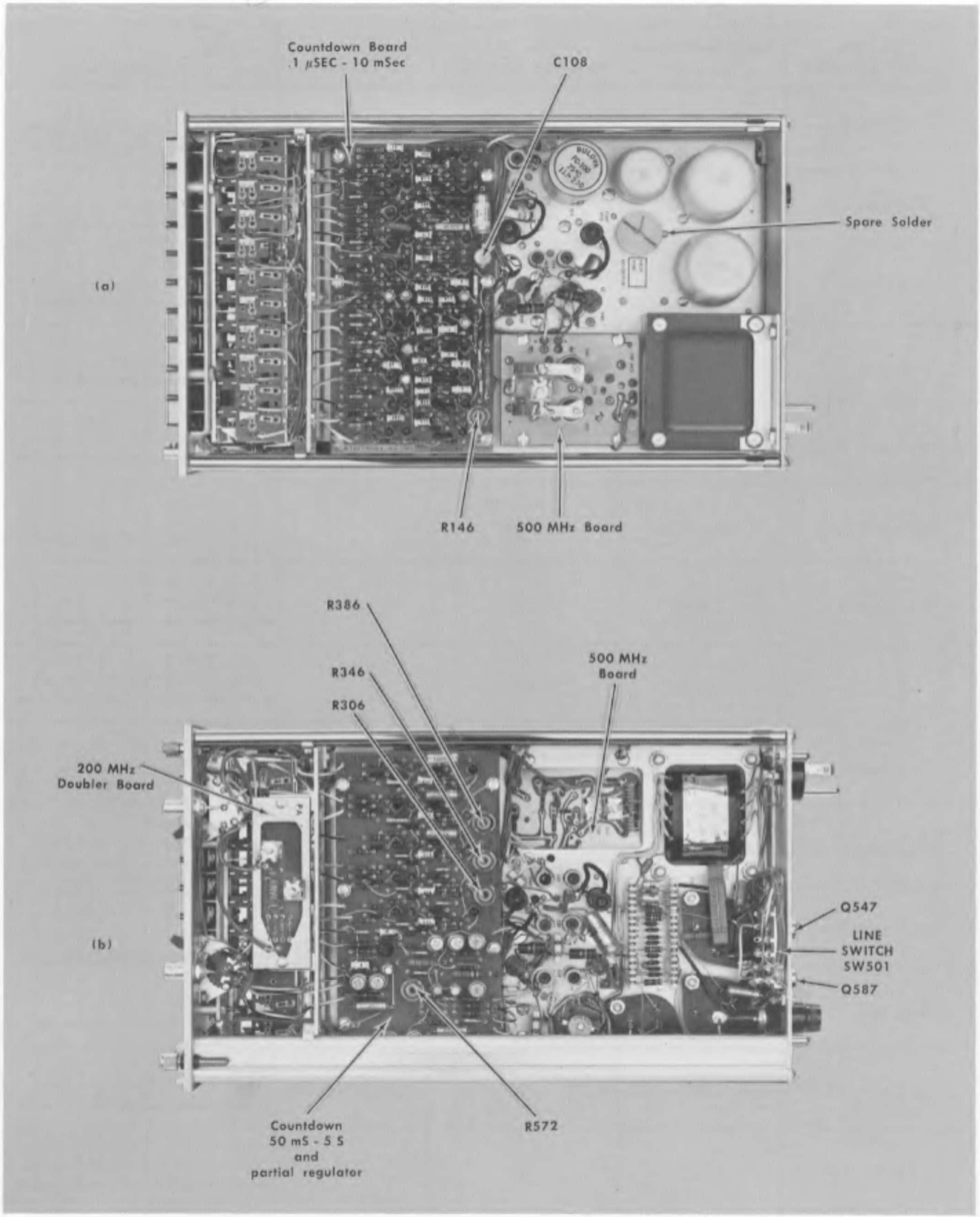


Fig. 6-12. Time Marker timing adjustments. a. Countdown board .1 μS-10 ms. Step 6. b. Location of R306, R346, R386. Step 6.

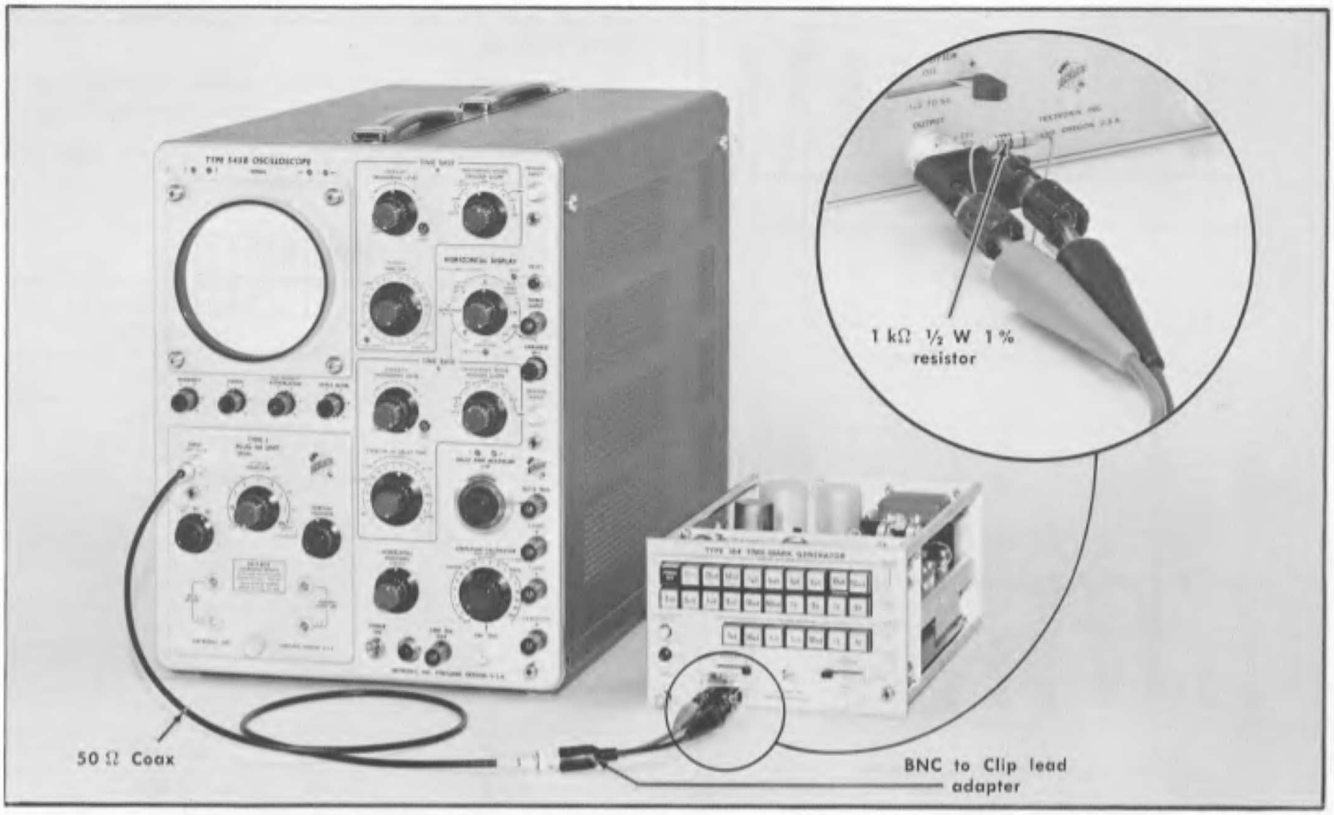


Fig. 6-13. Test equipment setup to measure Marker Amplifier signal amplitude. Step 8.

Control settings:

Type 184

MARKER SELECTOR	As directed in Table 6-3
TRIGGER SELECTOR	As directed in Table 6-3
MARKER AMPLIFIER	OFF
H.F. SELECTOR	OFF

Test Oscilloscope

Crt controls	Adjust for well focused display of nominal brightness
Horizontal Display	Time Base A
Sweep Controls	
A Time/Cm	As shown in Table 6-3
Variable	Calibrated
A Triggering Mode	AC
Trigger Slope	+Int
A Stability	Preset
A Triggering Level	Midrange

Vertical Plug-In Unit

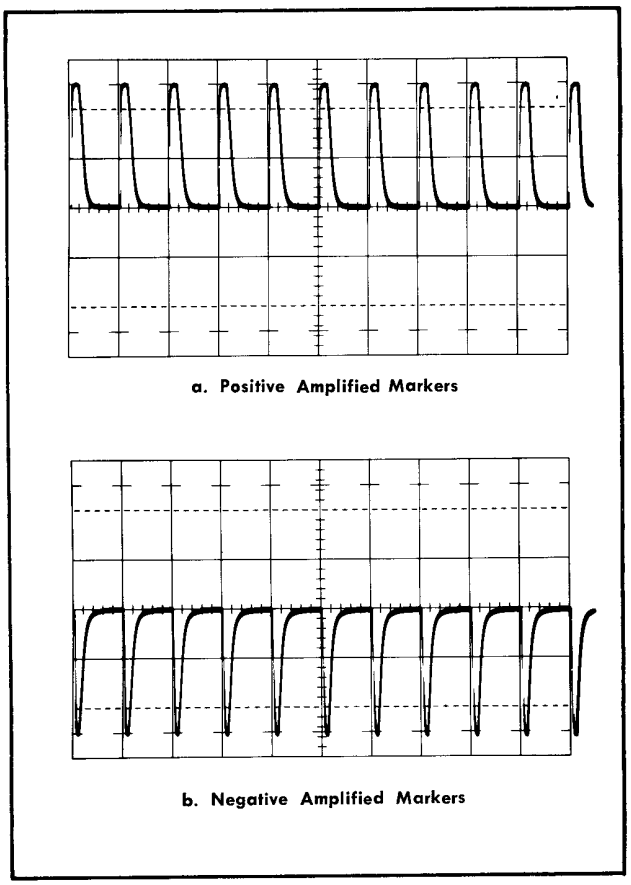
Volts/Div	10
Variable	Calibrated
Input Coupling	DC
Vertical Position	Midrange

8. Check Output of MARKER AMPLIFIER

a. Requirements—Positive or negative-going markers with 14 intervals of 1 μs to 5 s in 1-5-10 sequence, 25 V minimum amplitude into 1 kΩ.

b. The Marker Amplifier must be terminated into a resistance of 1 kΩ. Test equipment setup is shown in Fig. 6-13.

c. Switch the MARKER AMPLIFIER switch to (+) position. Check the amplitude of the Marker Amplifier output signal for each setting listed in Table 6-3. See Fig. 6-14a.



a. Positive Amplified Markers

b. Negative Amplified Markers

Fig. 6-14. Marker Amplifier Otuput Signals into 1 kΩ. Volts/cm 10, Time/cm (Table 5-3).

d. Change the MARKER AMPLIFIER switch to the (—) position and the test oscilloscope Trigger Slope switch to (—Int) position.

e. Check the amplitude of the Marker Amplifier output signal for a minimum —25 volt signal. See Fig. 6-14b.

f. Remove the adapters and cables from the Type 184 and test oscilloscope.

TABLE 6-3

Type 184 MARKER SELECTOR	Test Oscilloscope Time/Cm
1 μS	10 μSEC
5 μS	10 μSEC
10 μS	.1 mSEC
50 μS	.1 mSEC
.1 mS	1 mSEC
.5 mS	1 mSEC
1 mS	10 mSEC
5 mS	10 mSEC
10 mS	100 mSEC
50 mS	100 mSEC
.1 S	1 SEC
.5 S	1 SEC
1 S	1 SEC
5 S	1 SEC

NOTES

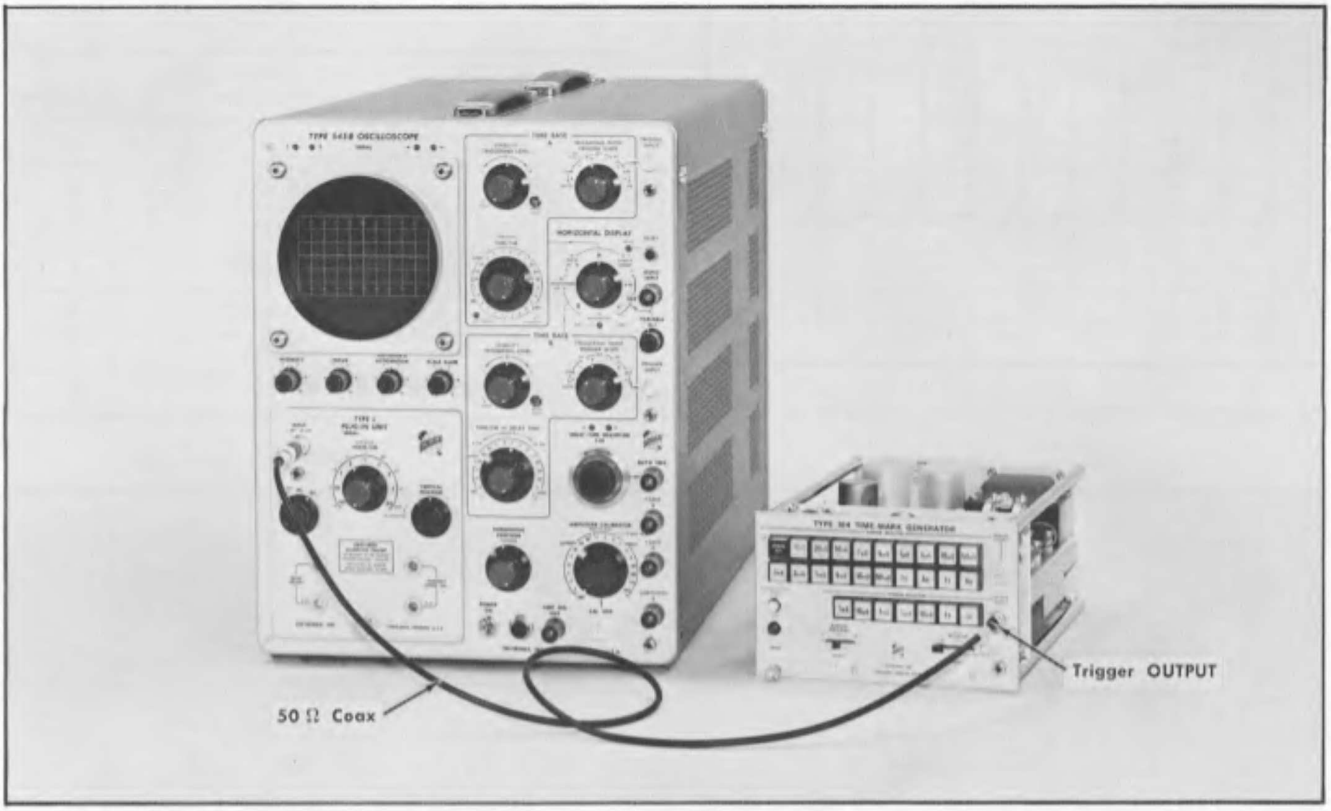


Fig. 6-15. Test equipment setup for checking trigger output amplitude and timing interval. Step 9.

Control Settings:

Type 184

MARKER SELECTOR	None
TRIGGER SELECTOR	As shown in Table 6-4
MARKER AMPLIFIER	OFF
H.F. SELECTOR	OFF

Test Oscilloscope

Crt controls	Adjust for well focused display of nominal brightness
Horizontal Display	Time Base A
Sweep Controls	
A Time/Cm	As shown in Table 6-4
Variable	Calibrated
A Triggering Mode	AC
Trigger Slope	Int
A Stability	Preset
A Triggering Level	Midrange

Vertical Plug-In Unit

Volts/Div	.2
Variable	Calibrated
Input Coupling	DC
Vertical Position	Midrange

9. Check Amplitude and Timing of the TRIGGER OUTPUT

a. Requirement—Positive-going pulses with 7 intervals in 1-10 sequence, from 1 μs to 1 s, and an amplitude $\geq$0.4 V into 50 Ω or $\geq$2.5 V into an open circuit.

b. Test equipment setup is shown in Fig. 6-15.

c. Check the trigger timing as listed in Table 6-4.

d. Check the amplitude of trigger signals. Fig. 6-16.

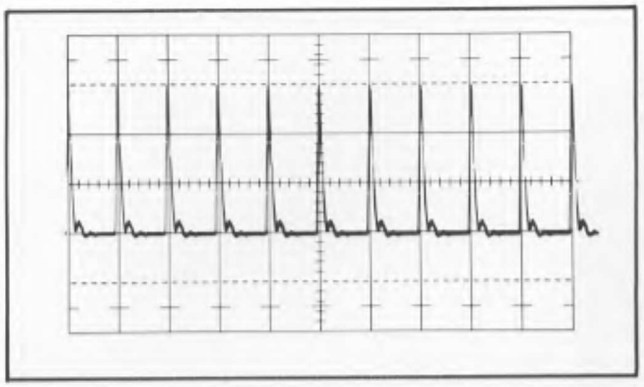


Fig. 6-16. Typical TRIGGER OUTPUT display. Volts/cm .2.

TABLE 6-4

Type 184 TRIGGER SELECTOR	Test Oscilloscope Time/Cm	Marks/Cm
1 μS	1 μSEC	1
10 μS	10 μSEC	1
.1 mS	.1 mSEC	1
1 mS	1 mSEC	1
10 mS	10 mSEC	1
.1 S	.1 SEC	1
1 S	1 SEC	1

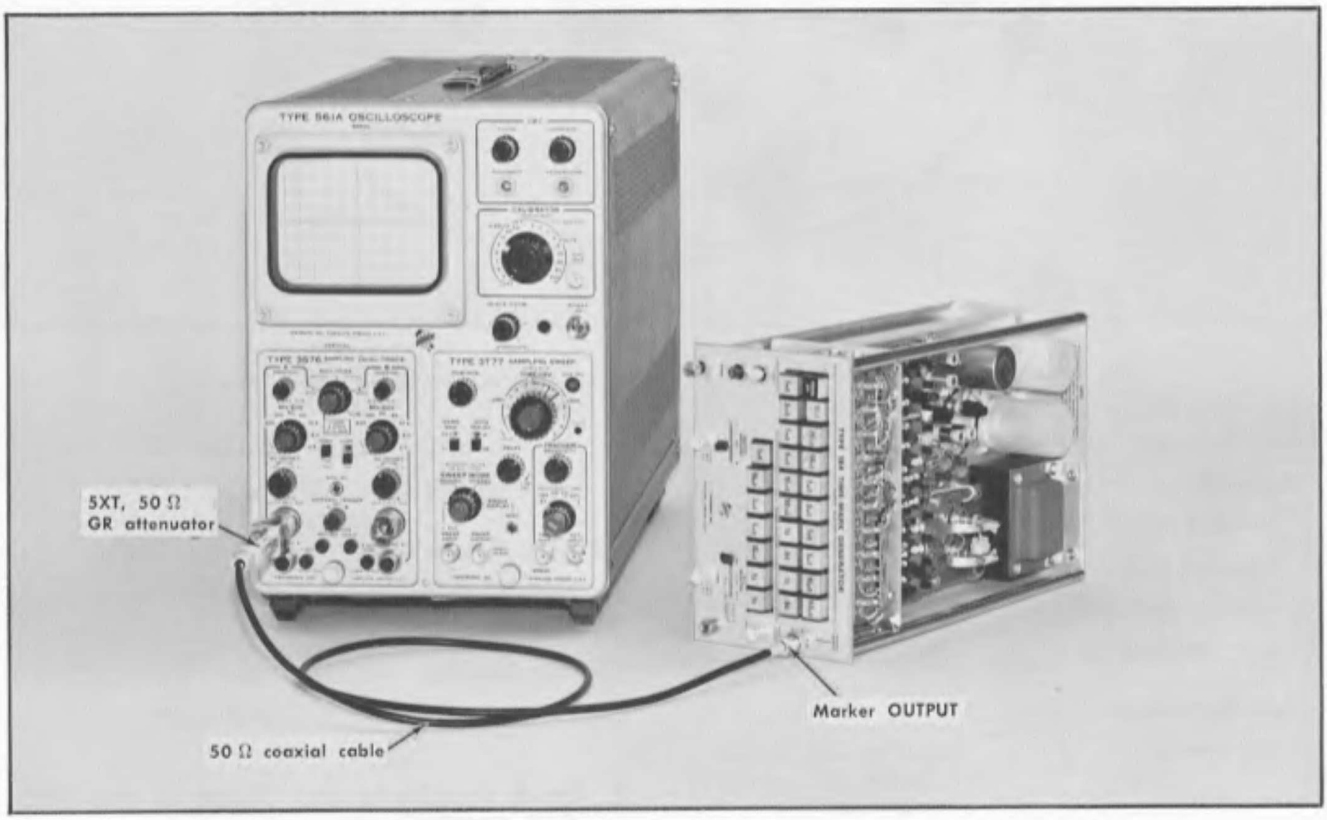


Fig. 6-17. Test equipment setup to check and adjust 10, 20 and 50 ns sine-wave markers. Step 10.

Control Settings:

Type 184

MARKER SELECTOR	As shown in Table 6-5
TRIGGER SELECTOR	OFF
MARKER AMPLIFIER	OFF
H.F. SELECTOR	OFF

Test Oscilloscope

Crt controls	Adjust for well focused display of nominal brightness

Time Base Plug-In Unit (Type 3T77)

Time/Div	As shown in Table 6-5
Sweep Mode	Normal
Trigger	+Int
Horiz Mag	×1
Dots Per Div	100

Vertcial Plug-In Unit

Mv/Div	100
Input Selector	A Only

Ⓐ

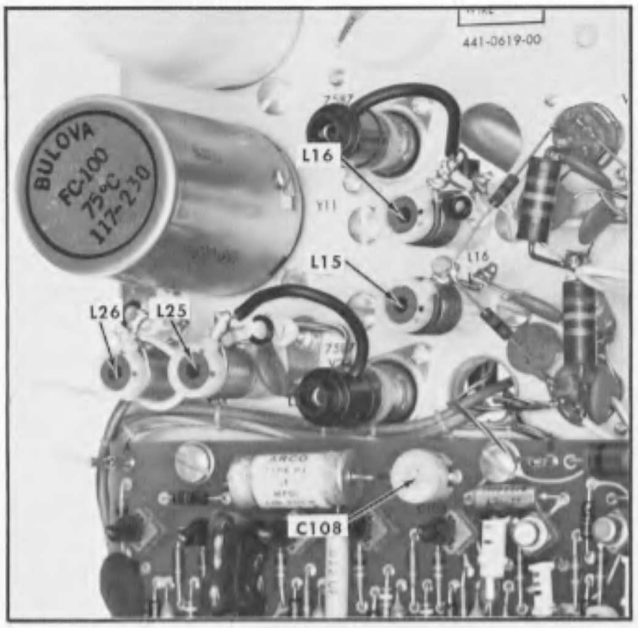


Fig. 6-18. .5 μs marker adjustment C108 and 50 MHz (20 ns) adjustments L16, L15. Step 10.

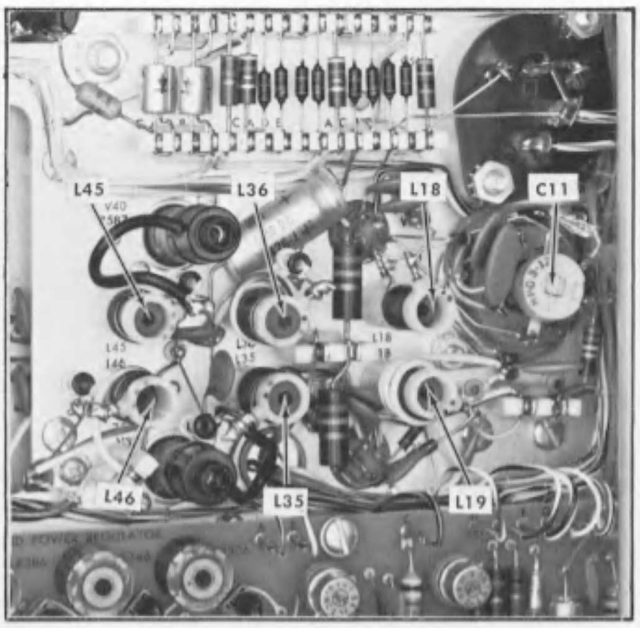


Fig. 6-19. 10 MHz (.1 μs) 50 MHz (20 ns) and 100 MHz (10 ns) oscillator and multiplier adjustments. Step 4, 10.

10. Check and Adjust Sine-wave Markers: ◐ 10, 20, 50 nS and .1 μS

a. Test equipment setup is shown in Fig. 6-17.

b. Push the 1 μS pushbutton for the TRIGGER SELECTOR.

c. Adjust the Time Base Unit, (Type 3T77) Trigger Sensitivity for a stable display.

d. Measure and adjust the sine-wave markers in accordance with Table 6-5. Minimum marker amplitude is 1 volt peak to peak.

e. Interaction—Will affect the operation of the 2 and 5 nS sine-wave markers.

TABLE 6-5

Type 184 MARKER SELECTOR	Test Oscilloscope Time/Div	Adjust for maximum signal amplitude and one marker/div
.1 μS	.1 μSEC	Check
50 ns	50 nSEC	L25, L26 (Fig. 6-17)
20 nS	20 nSEC	L15, L16, L35, L36 (Figs. 6-17 and 6-18)
10 nS	10 nSEC	L45, L46 (Fig. 6-18)

NOTES

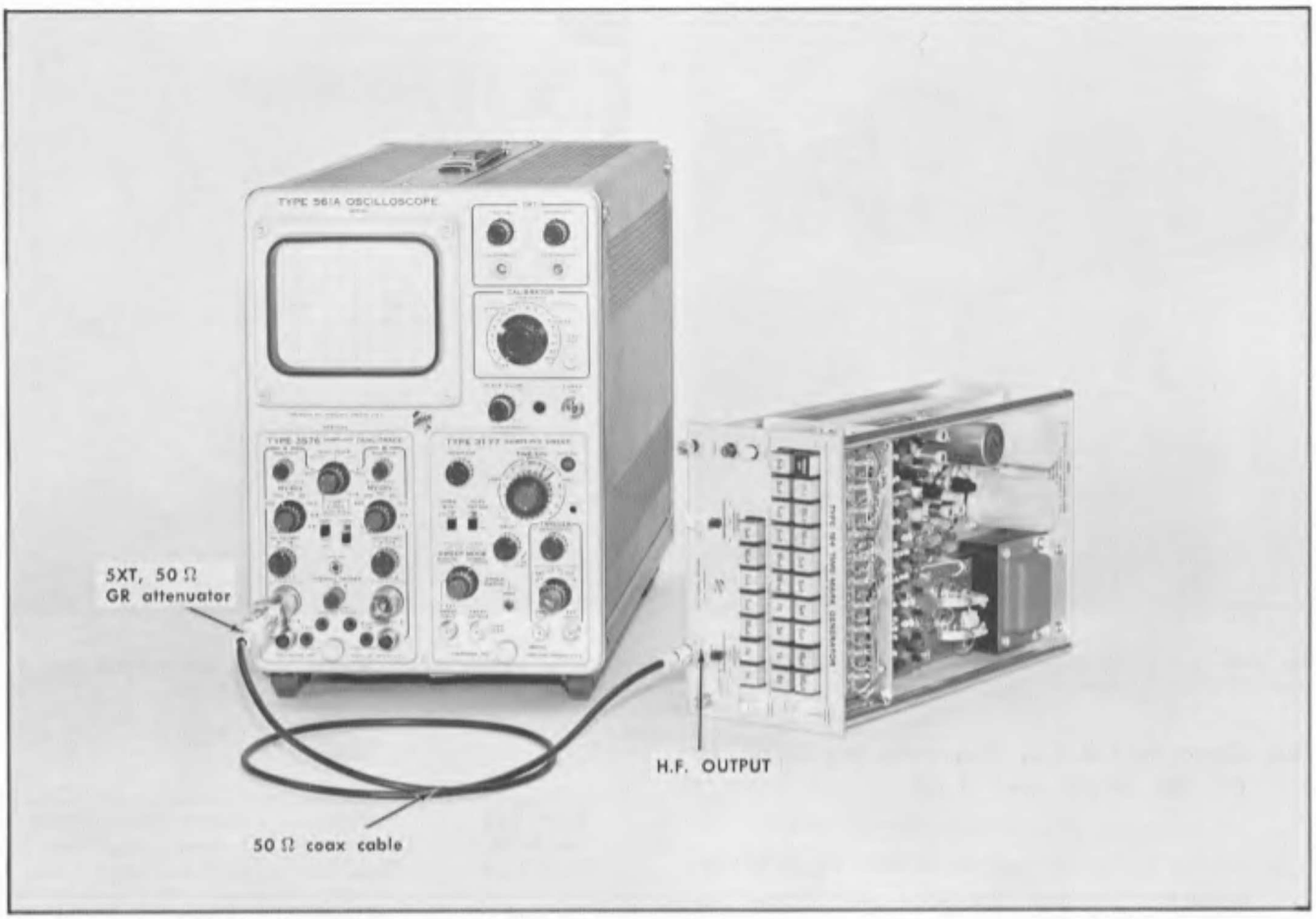


Fig. 6-20. Test equipment setup to check and adjust 2 ns and 5 ns sine-wave markers. Step 11.

Control Settings:

Type 184

MARKER SELECTOR	10 nS
TRIGGER SELECTOR	OFF
MARKER AMPLIFIER	OFF
H.F. SELECTOR	As shown in Table 6-6

Test Oscilloscope

Crt controls	Adjust for well focused display of nominal brightness

Time Base Plug-In Unit (Type 3T77)

Time/Div	As shown in Table 6-6
Sweep Mode	Normal
Trigger	+Int
Horiz Mag	×1
Dots Per Div	100

Vertical Plug-In Unit

Mv/Div	50
Input Selector	A Only

11. Check and Adjust H.F. Sine-wave Markers: 2 nS and 5 nS

a. Test equipment setup is shown in Fig. 6-20.

b. Check amplitude and adjust the sine-wave markers in accordance with Table 6-6. Minimum amplitude 0.3 volt peak to peak.

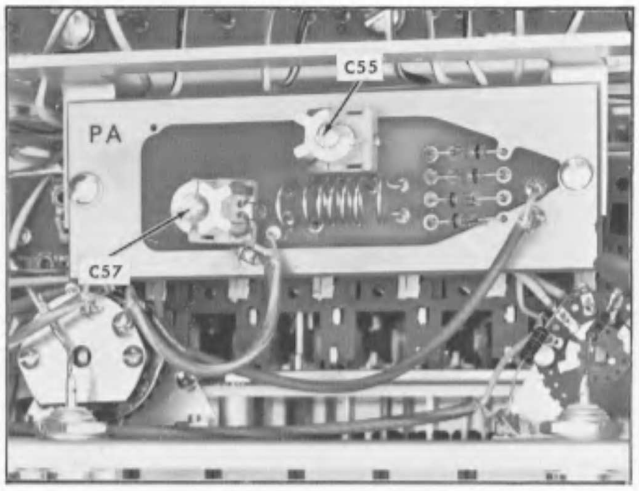


Fig. 6-21. Adjustment C55, C57, 5 nS H.F. oscillator.

TABLE 6-6

Type 184 H.F. SELECTOR	Test Oscilloscope Time/Div	Adjust for maximum signal amplitude and one marker/div
5 nS	5 nSEC	C55, C57 (Fig. 6-21)
2 nS	2 nSEC	C63, C64, C70 C75, (Fig. 6-22)

NOTE

The adjustments for any one sine-wave marker may interact with the other markers. Check and repeat if necessary.

c. Turn the H.F. SELECTOR switch to OFF and disconnect the coaxial cables and adapters from the Type 184 and test oscilloscope.

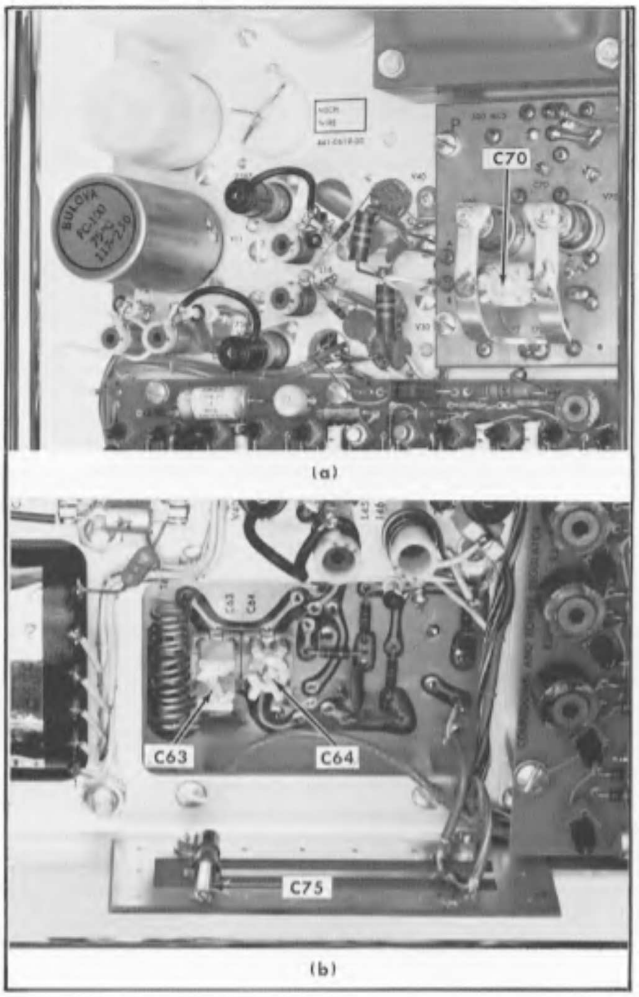


Fig. 6-22. Adjustment C63, C64, C70, C75, 2 nS H.F. oscillator. a. Top of 2 nS multiplier board. b. Bottom of 2 nS multiplier board.

NOTES

NOTES

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
°	degrees
°C	degrees Celsius (degrees centigrade)
°F	degrees Fahrenheit
°K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geqslant$	equal to or greater than
$\leqslant$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigohertz
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz
L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
+	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
Q	figure of merit
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference (see EMI)
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
$\ll$	small compared with
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub.	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xmfr	transformer

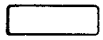
PARTS ORDERING INFORMATION

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

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

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

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.

SECTION 7
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description				S/N Range
		Bulbs				
B504	Use 150-0056-00	Neon, Assembly			OVEN	
B534	150-0052-00	Incandescent w/translucent lens			POWER	100-2199
B534	150-0065-00	Incandescent w/green lens			POWER	2200-up
		Capacitors				
Tolerance ±20% unless otherwise indicated.						
C1	283-0078-00	0.001 μF	Cer		500 V	
C2	283-0078-00	0.001 μF	Cer		500 V	
C4	283-0078-00	0.001 μF	Cer		500 V	
C5	283-0078-00	0.001 μF	Cer		500 V	
C8	283-0078-00	0.001 μF	Cer		500 V	
C11	281-0031-00	3-12 pF	Cer	Var		
C13	283-0078-00	0.001 μF	Cer		500 V	
C15	283-0078-00	0.001 μF	Cer		500 V	
C16	283-0078-00	0.001 μF	Cer		500 V	
C17	281-0558-00	18 pF	Cer		500 V	
C18	281-0509-00	15 pF	Cer		500 V	10%
C19	283-0078-00	0.001 μF	Cer		500 V	
C23	283-0078-00	0.001 μF	Cer		500 V	
C25	283-0078-00	0.001 μF	Cer		500 V	
C26	281-0517-00	39 pF	Cer		500 V	10%
C29	281-0517-00	39 pF	Cer		500 V	10%
C33	283-0078-00	0.001 μF	Cer		500 V	
C35	283-0078-00	0.001 μF	Cer		500 V	
C36	281-0558-00	18 pF	Cer		500 V	
C39	281-0511-00	22 pF	Cer		500 V	10%
C43	283-0078-00	0.001 μF	Cer		500 V	
C45	283-0078-00	0.001 μF	Cer		500 V	
C46	281-0505-00	12 pF	Cer		500 V	10%
C49	281-0505-00	12 pF	Cer		500 V	10%
C55	281-0079-00	1.5-9.1 pF	Air	Var		
C57	281-0081-00	1.8-13 pF	Air	Var		
C61	283-0078-00	0.001 μF	Cer		500 V	
C63	281-0115-00	1.9-8.5 pF	Air	Var		
C64	281-0114-00	1.3-5.4 pF	Air	Var		
C65	283-0078-00	0.001 μF	Cer		500 V	
C68	283-0078-00	0.001 μF	Cer		500 V	
C70	281-0098-00	1.2-3.5 pF	Air	Var		
C75	281-0027-00	0.7-3 pF	Tub.	Var		
C78	283-0078-00	0.001 μF	Cer		500 V	
C92	290-0187-00	4.7 μF	EMT		35 V	

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
C93	281-0511-00	22 pF	Cer	500 V	10%	
C99	281-0511-00	22 pF	Cer	500 V	10%	
C103	290-0267-00	1 μF	EMT	35 V		
C105	281-0511-00	22 pF	Cer	500 V	10%	100-648
C105	281-0617-00	15 pF	Cer	200 V		649-up
C107	281-0517-00	39 pF	Cer	500 V	10%	
C108	281-0092-00	9-35 pF	Cer Var			
C111	290-0188-00	0.1 μF	EMT	35 V	10%	
C114	290-0267-00	1 μF	EMT	35 V		
C116	283-0000-00	0.001 μF	Cer	500 V		
C120	290-0267-00	1 μF	EMT	35 V		
C125	281-0517-00	39 pF	Cer	500 V	10%	
C130	281-0580-00	470 pF	Cer	500 V	10%	
C131	281-0501-00	4.7 pF	Cer	500 V	±1 pF	X293-up
C132	281-0511-00	22 pF	Cer	500 V	10%	
C133	290-0267-00	1 μF	EMT	35 V		
C140	281-0511-00	22 pF	Cer	500 V	10%	
C143	283-0604-00	304 pF	Mica	300 V	2%	
C144	281-0517-00	39 pF	Cer	500 V	10%	
C146	290-0267-00	1 μF	EMT	35 V		
C148	281-0511-00	22 pF	Cer	500 V	10%	
C152	281-0517-00	39 pF	Cer	500 V	10%	
C153	290-0267-00	1 μF	EMT	35 V		
C161	281-0572-00	6.8 pF	Cer	500 V	10%	
C163	283-0604-00	304 pF	Mica	300 V	2%	
C164	281-0517-00	39 pF	Cer	500 V	10%	
C168	281-0511-00	22 pF	Cer	500 V	10%	
C172	281-0524-00	150 pF	Cer	500 V		
C173	290-0267-00	1 μF	EMT	35 V		
C183	283-0594-00	0.001 μF	Mica	100 V	1%	
C188	281-0511-00	22 pF	Cer	500 V	10%	
C192	281-0605-00	200 pF	Cer	500 V		
C203	283-0104-00	2000 pF	Cer	500 V	5%	
C208	281-0511-00	22 pF	Cer	500 V	10%	
C212	281-0580-00	470 pF	Cer	500 V	10%	
C223	283-0593-00	0.01 μF	Mica	100 V	1%	
C228	281-0511-00	22 pF	Cer	500 V	10%	
C232	283-0028-00	0.0022 μF	Cer	50 V		
C233	290-0267-00	1 μF	EMT	35 V		
C243	285-0683-00	0.022 μF	PTM	100 V	5%	
C248	281-0511-00	22 pF	Cer	500 V	10%	
C252	283-0083-00	0.0047 μF	Cer	500 V	5%	
C253	290-0267-00	1 μF	EMT	35 V		
C263	285-0595-00	0.1 μF	PTM	100 V	1%	
C268	281-0511-00	22 pF	Cer	500 V	10%	
C272	283-0027-00	0.02 μF	Cer	30 V		
C273	290-0267-00	1 μF	EMT	35 V		

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
C283	290-0264-00	0.22 μF	EMT	35 V	10%	
C288	281-0511-00	22 pF	Cer	500 V	10%	
C292	283-0010-00	0.05 μF	Cer	50 V		
C303	290-0267-00	1 μF	EMT	35 V		
C308	281-0511-00	22 pF	Cer	500 V	10%	
C312	290-0264-00	0.22 μF	EMT	35 V	10%	
C323	290-0267-00	1 μF	EMT	35 V		100-2059
C323	290-0183-00	1 μF	EMT	20 V	10%	2060-up
C328	281-0511-00	22 pF	Cer	500 V	10%	
C332	290-0244-00	0.47 μF	EMT	35 V	5%	
C343	290-0175-00	10 μF	EMT	35 V		100-2059
C343	290-0301-00	10 μF	Elect	20 V	10%	2060-up
C348	281-0511-00	22 pF	Cer	500 V	10%	
C352	290-0136-00	2.2 μF	EMT	20 V		
C363	290-0175-00	10 μF	EMT	35 V		
C368	281-0511-00	22 pF	Cer	500 V	10%	
C372	290-0187-00	4.7 μF	EMT	35 V		
C383	290-0158-00	50 μF	EMT	25 V	+75%—15%	
C388	281-0511-00	22 pF	Cer	500 V	10%	
C392	290-0187-00	4.7 μF	EMT	35 V		
C451	290-0188-00	0.1 μF	EMT	35 V	10%	
C452	281-0580-00	470 pF	Cer	500 V	10%	
C460	281-0603-00	39 pF	Cer	500 V	5%	
C468	290-0267-00	1μF	EMT	35 V		
C501	283-0013-00	0.01 μF	Cer	1000 V		X870-up
C504	283-0002-00	0.01 μF	Cer	500 V		100-869
C504	283-0044-00	0.001 μF	Cer	3000 V		870-up
C505	283-0002-00	0.01 μF	Cer	500 V		100-869
C505	283-0044-00	0.001 μF	Cer	3000 V		870-up
C507	283-0013-00	0.01 μF	Cer	1000 V		100-869
C507	283-0044-00	0.001 μF	Cer	3000 V		870-up
C509	283-0002-00	0.01 μF	Cer	500 V		100-869
C509	283-0044-00	0.001 μF	Cer	3000 V		870-up
C512	290-0012-00	2 x 40 μF	EMC	250 V		
C520	283-0003-00	0.01 μF	Cer	150 V		
C526	290-0149-00	5 μF	EMT	150 V		
C530	290-0188-00	0.1 μF	EMT	35 V	10%	
C532	290-0086-00	2000 μF	EMC	30 V		
C540	290-0162-00	22 μF	EMT	35 V		
C544	283-0026-00	0.2 μF	Cer	25 V		
C546	290-0162-00	22 μF	EMT	35 V		
C552	290-0295-00	700 μF	EMC	75 V		
C560	290-0188-00	0.1 μF	EMT	35 V	10%	
C574	290-0267-00	1 μF	EMT	35 V		
C588	290-0162-00	22 μF	EMT	35 V		
C589	290-0162-00	22 μF	EMT	35 V		

Diodes

D13	152-0069-00	Zener	1N3041A 1 W, 75 V, 10%	X355-up
D52	*152-0075-00	Germanium	Tek Spec	
D53	*152-0075-00	Germanium	Tek Spec	
D54	*152-0075-00	Germanium	Tek Spec	
D55	*152-0075-00	Germanium	Tek Spec	
D99	*152-0185-00	Silicon	Replaceable by 1N3605	X649-up
D105	*152-0185-00	Silicon	Replaceable by 1N3605	X649-up
D107	*152-0185-00	Silicon	Replaceable by 1N3605	

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description	S/N Range
D108	*152-0185-00	Silicon	Replaceable by 1N3605	
D115	*152-0185-00	Silicon	Replaceable by 1N3605	
D122	*152-0185-00	Silicon	Replaceable by 1N3605	
D130	*152-0185-00	Silicon	Replaceable by 1N3605	
D132	*152-0185-00	Silicon	Replaceable by 1N3605	
D137	*152-0185-00	Silicon	Replaceable by 1N3605	
D148	*152-0185-00	Silicon	Replaceable by 1N3605	
D152	*152-0185-00	Silicon	Replaceable by 1N3605	
D160	*152-0185-00	Silicon	Replaceable by 1N3605	
D168	*152-0185-00	Silicon	Replaceable by 1N3605	
D172	*152-0185-00	Silicon	Replaceable by 1N3605	
D177	*152-0185-00	Silicon	Replaceable by 1N3605	
D180	*152-0185-00	Silicon	Replaceable by 1N3605	
D188	*152-0185-00	Silicon	Replaceable by 1N3605	
D192	*152-0185-00	Silicon	Replaceable by 1N3605	
D200	*152-0185-00	Silicon	Replaceable by 1N3605	
D208	*152-0185-00	Silicon	Replaceable by 1N3605	
D212	*152-0185-00	Silicon	Replaceable by 1N3605	
D217	*152-0185-00	Silicon	Replaceable by 1N3605	
D220	*152-0185-00	Silicon	Replaceable by 1N3605	
D228	*152-0185-00	Silicon	Replaceable by 1N3605	
D232	*152-0185-00	Silicon	Replaceable by 1N3605	
D240	*152-0185-00	Silicon	Replaceable by 1N3605	
D248	*152-0185-00	Silicon	Replaceable by 1N3605	
D252	*152-0185-00	Silicon	Replaceable by 1N3605	
D257	*152-0185-00	Silicon	Replaceable by 1N3605	
D260	*152-0185-00	Silicon	Replaceable by 1N3605	
D268	*152-0185-00	Silicon	Replaceable by 1N3605	
D272	*152-0185-00	Silicon	Replaceable by 1N3605	
D280	*152-0185-00	Silicon	Replaceable by 1N3605	
D288	*152-0185-00	Silicon	Replaceable by 1N3605	
D292	*152-0185-00	Silicon	Replaceable by 1N3605	
D297	*152-0185-00	Silicon	Replaceable by 1N3605	
D300	*152-0185-00	Silicon	Replaceable by 1N3605	
D308	*152-0185-00	Silicon	Replaceable by 1N3605	
D312	*152-0185-00	Silicon	Replaceable by 1N3605	
D320	*152-0185-00	Silicon	Replaceable by 1N3605	
D328	*152-0185-00	Silicon	Replaceable by 1N3605	
D332	*152-0185-00	Silicon	Replaceable by 1N3605	
D337	*152-0185-00	Silicon	Replaceable by 1N3605	
D340	*152-0185-00	Silicon	Replaceable by 1N3605	
D348	*152-0185-00	Silicon	Replaceable by 1N3605	
D352	*152-0185-00	Silicon	Replaceable by 1N3605	
D360	*152-0185-00	Silicon	Replaceable by 1N3605	
D368	*152-0185-00	Silicon	Replaceable by 1N3605	

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Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
D372	*152-0185-00	Silicon Replaceable by 1N3605	
D377	*152-0185-00	Silicon Replaceable by 1N3605	
D380	*152-0185-00	Silicon Replaceable by 1N3605	
D388	*152-0185-00	Silicon Replaceable by 1N3605	
D392	*152-0185-00	Silicon Replaceable by 1N3605	
D412	*152-0185-00	Silicon Replaceable by 1N3605	
D472	*152-0185-00	Silicon Replaceable by 1N3605	
D512A,B,C,D(4)	*152-0107-00	Silicon Replaceable by 1N647	
D532A,B,C,D(4)	152-0066-00	Silicon 1N3194	
D552A,B,C,D(4)	*152-0107-00	Silicon Replaceable by 1N647	
D560	152-0212-00	Zener 1N936 9 V, 5%, TC	

Fuse

F502	159-0043-00	0.6 A, 3AG, Slo-Blo	

Connectors

J70	131-0106-00	Chassis mounted, coaxial, 1 contact, female	
J405	131-0106-00	Chassis mounted, coaxial, 1 contact, female	
J425	131-0106-00	Chassis mounted, coaxial, 1 contact, female	
J470	131-0106-00	Chassis mounted, coaxial, 1 contact, female	
J501	*131-0102-00	Chassis mounted, motor base, male	100-219
J501	*131-0430-00	Receptacle, electrical	220-up

Inductors

L15	*114-0172-00	0.4-0.65 μH	Var	Core 276-0511-00	
L16	*114-0172-00	0.4-0.65 μH	Var	Core 276-0511-00	
L18	*114-0113-00	6-10 μH	Var	Core 276-0511-00	
L19	*114-0113-00	6-10 μH	Var	Core 276-0511-00	
L25	*114-0171-00	1.4-2 μH	Var	Core 276-0511-00	
L26	*114-0171-00	1.4-2 μH	Var	Core 276-0511-00	
L35	*114-0172-00	0.4-0.65 μH	Var	Core 276-0511-00	
L36	*114-0172-00	0.4-0.65 μH	Var	Core 276-0511-00	
L45	*114-0173-00	0.15-0.23 μH	Var	Core 276-0511-00	
L46	*114-0173-00	0.15-0.23 μH	Var	Core 276-0511-00	
L55	*108-0348-00	Coil, 1 turn			
L56	*108-0347-00	Coil, 4½ turns			
L57	*108-0348-00	Coil, 1 turn			
L60	*108-0346-00	Coil, 2½ turns			
L61	*108-0347-00	Coil, 4½ turns			
L62	*108-0347-00	Coil, 4½ turns			
L65	276-0507-00	Core, ferramic suppressor			
L69	*114-0197-00	Coil, 1 turn			
L70	*119-0060-00	Tank, 500 MHz quintupler			

Inductors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
L121	276-0507-00	Core, ferramic suppressor	
L122	276-0507-00	Core, ferramic suppressor	
L123A,B	*119-0062-00	Delay Line Assembly	
L131	276-0507-00	Core, ferramic suppressor	
L132	276-0507-00	Core, ferramic suppressor	

Transistors

Q94	*151-0108-00	Replaceable by 2N2501	
Q103	*151-0108-00	Replaceable by 2N2501	
Q104	*151-0133-00	Selected from 2N3251	
Q114	*151-0133-00	Selected from 2N3251	
Q120	*151-0083-00	Selected from 2N964	
Q123	*151-0159-00	Replaceable by 2N918	
Q130	*151-0108-00	Replaceable by 2N2501	
Q133	*151-0159-00	Replaceable by 2N918	
Q134	*151-0133-00	Selected from 2N3251	
Q145	*151-0159-00	Replaceable by 2N918	100-648
Q145	*151-0108-00	Replaceable by 2N2501	649-up
Q153	*151-0159-00	Replaceable by 2N918	
Q155	*151-0127-00	Selected from 2N2369	
Q165	*151-0159-00	Replaceable by 2N918	
Q173	*151-0159-00	Replaceable by 2N918	
Q175	*151-0159-00	Replaceable by 2N918	
Q185	*151-0159-00	Replaceable by 2N918	
Q193	*151-0159-00	Replaceable by 2N918	
Q195	*151-0159-00	Replaceable by 2N918	
Q205	*151-0159-00	Replaceable by 2N918	
Q213	*151-0159-00	Replaceable by 2N918	
Q215	*151-0159-00	Replaceable by 2N918	
Q225	*151-0159-00	Replaceable by 2N918	
Q233	*151-0159-00	Replaceable by 2N918	
Q235	*151-0159-00	Replaceable by 2N918	
Q245	*151-0159-00	Replaceable by 2N918	
Q253	*151-0159-00	Replaceable by 2N918	
Q255	*151-0159-00	Replaceable by 2N918	
Q265	*151-0159-00	Replaceable by 2N918	
Q273	*151-0159-00	Replaceable by 2N918	
Q275	*151-0159-00	Replaceable by 2N918	
Q285	*151-0159-00	Replaceable by 2N918	
Q293	*151-0159-00	Replaceable by 2N918	
Q295	*151-0159-00	Replaceable by 2N918	
Q305	*151-0159-00	Replaceable by 2N918	
Q313	*151-0159-00	Replaceable by 2N918	
Q315	*151-0154-00	Replaceable by 2N2924	
Q325	*151-0159-00	Replaceable by 2N918	
Q333	*151-0159-00	Replaceable by 2N918	
Q335	*151-0154-00	Replaceable by 2N2924	
Q345	*151-0159-00	Replaceable by 2N918	

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q353	*151-0159-00	Replaceable by 2N918	
Q355	*151-0154-00	Replaceable by 2N2924	
Q365	*151-0159-00	Replaceable by 2N918	
Q373	*151-0159-00	Replaceable by 2N918	
Q375	*151-0154-00	Replaceable by 2N2924	
Q385	*151-0159-00	Replaceable by 2N918	
Q393	*151-0159-00	Replaceable by 2N918	
Q395	*151-0154-00	Replaceable by 2N2924	
Q403	*151-0103-00	Replaceable by 2N2219	
Q423	*151-0103-00	Replaceable by 2N2219	
Q454	151-0177-00	2N916	
Q463	*151-0103-00	Replaceable by 2N2219	
Q464	*151-0133-00	Selected from 2N3251	
Q473	*151-0134-00	Replaceable by 2N2905	
Q523	151-0150-00	2N3440	
Q524	151-0093-00	2N2043	
Q527	151-0149-00	2N3441	
Q536	*151-0134-00	Replaceable by 2N2905	
Q543	*151-0136-00	Replaceable by 2N3053	
Q546	*151-0134-00	Replaceable by 2N2905	
Q547	*151-0148-00	Selected (RCA 40250)	
Q566	*151-0151-00	Replaceable by 2N930	
Q576	*151-0151-00	Replaceable by 2N930	
Q583	*151-0136-00	Replaceable by 2N3053	
Q587	*151-0148-00	Selected (RCA 40250)	

Resistors

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

R11	315-0104-00	100 k	¼ W	5%	
R13	303-0273-00	27 k	1 W	5%	100-354X
R15	315-0104-00	100 k	¼ W	5%	
R19	315-0104-00	100 k	¼ W	5%	
R21	315-0270-00	27 Ω	¼ W	5%	
R23	303-0273-00	27 k	1 W	5%	
R31	315-0270-00	27 Ω	¼ W	5%	
R33	303-0273-00	27 k	1 W	5%	
R41	315-0270-00	27 Ω	¼ W	5%	
R43	303-0273-00	27 k	1 W	5%	
R60	315-0680-00	68 Ω	¼ W	5%	
R61	315-0473-00	47 k	¼ W	5%	
R65	315-0470-00	47 Ω	¼ W	5%	
R68	315-0273-00	27 k	¼ W	5%	
R70	315-0680-00	68 Ω	¼ W	5%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R78	315-0273-00	27 k	1/4 W		5%	
R90	315-0470-00	47 Ω	1/4 W		5%	
R91	315-0102-00	1 k	1/4 W		5%	
R93	315-0102-00	1 k	1/4 W		5%	
R95	315-0102-00	1 k	1/4 W		5%	
R97	301-0272-00	2.7 k	1/2 W		5%	
R99	315-0272-00	2.7 k	1/4 W		5%	100-648X
R100	315-0471-00	470 Ω	1/4 W		5%	
R103	315-0241-00	240 Ω	1/4 W		5%	100-648
R103	315-0201-00	200 Ω	1/4 W		5%	649-up
R105	315-0562-00	5.6 k	1/4 W		5%	100-648X
R110	315-0621-00	620 Ω	1/4 W		5%	
R111	315-0472-00	4.7 k	1/4 W		5%	
R113	301-0471-00	470 Ω	1/2 W		5%	
R114	303-0102-00	1 k	1 W		5%	
R116	315-0511-00	510 Ω	1/4 W		5%	
R118	315-0102-00	1 k	1/4 W		5%	
R122	315-0221-00	220 Ω	1/4 W		5%	
R123	315-0101-00	100 Ω	1/4 W		5%	
R125	315-0102-00	1 k	1/4 W		5%	
R128	315-0102-00	1 k	1/4 W		5%	
R130	323-0308-00	15.8 k	1/2 W	Prec	1%	
R132	315-0472-00	4.7 k	1/4 W		5%	
R133	315-0432-00	4.3 k	1/4 W		5%	100-1499
R133	315-0332-00	3.3 k	1/4 W		5%	1500-up
R134	315-0472-00	4.7 k	1/4 W		5%	100-1499
R134	315-0562-00	5.6 k	1/4 W		5%	1500-up
R136	315-0100-00	10 Ω	1/4 W		5%	
R137	315-0101-00	100 Ω	1/4 W		5%	
R138	315-0221-00	220 Ω	1/4 W		5%	
R140	315-0103-00	10 k	1/4 W		5%	
R141	315-0273-00	27 k	1/4 W		5%	
R143	315-0122-00	1.2 k	1/4 W		5%	
R145	315-0183-00	18 k	1/4 W		5%	
R146	311-0463-00	5 k		Var		
R150	315-0122-00	1.2 k	1/4 W		5%	
R154	315-0912-00	9.1 k	1/4 W		5%	
R156	315-0241-00	240 Ω	1/4 W		5%	
R160	315-0103-00	10 k	1/4 W		5%	
R161	315-0393-00	39 k	1/4 W		5%	
R163	315-0222-00	2.2 k	1/4 W		5%	
R165	321-0338-00	32.4 k	1/8 W	Prec	1%	
R170	315-0122-00	1.2 k	1/4 W		5%	
R174	315-0432-00	4.3 k	1/4 W		5%	
R176	315-0511-00	510 Ω	1/4 W		5%	
R177	315-0241-00	240 Ω	1/4 W		5%	
R180	315-0103-00	10 k	1/4 W		5%	
R181	315-0393-00	39 k	1/4 W		5%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R183	315-0222-00	2.2 k	1/4 W		5%	
R185	321-0364-00	60.4 k	1/8 W	Prec	1%	
R190	315-0302-00	3 k	1/4 W		5%	
R194	315-0223-00	22 k	1/4 W		5%	
R196	315-0241-00	240 Ω	1/4 W		5%	
R200	315-0103-00	10 k	1/4 W		5%	
R201	315-0393-00	39 k	1/4 W		5%	
R203	315-0222-00	2.2 k	1/4 W		5%	
R205	321-0356-00	49.9 k	1/8 W	Prec	1%	
R210	315-0302-00	3 k	1/4 W		5%	
R214	315-0912-00	9.1 k	1/4 W		5%	
R216	315-0511-00	510 Ω	1/4 W		5%	
R217	315-0241-00	240 Ω	1/4 W		5%	100-1499
R217	315-0181-00	180 Ω	1/4 W		5%	1500-up
R220	315-0103-00	10 k	1/4 W		5%	
R221	315-0393-00	39 k	1/4 W		5%	
R223	315-0222-00	2.2 k	1/4 W		5%	
R225	321-0365-00	61.9 k	1/8 W	Prec	1%	
R230	315-0362-00	3.6 k	1/4 W		5%	
R234	315-0912-00	9.1 k	1/4 W		5%	
R236	315-0241-00	240 Ω	1/4 W		5%	
R240	315-0103-00	10 k	1/4 W		5%	
R241	315-0393-00	39 k	1/4 W		5%	
R243	315-0222-00	2.2 k	1/4 W		5%	
R245	321-0353-00	46.4 k	1/8 W	Prec	1%	
R250	315-0302-00	3 k	1/4 W		5%	
R254	315-0912-00	9.1 k	1/4 W		5%	
R256	315-0511-00	510 Ω	1/4 W		5%	
R257	315-0241-00	240 Ω	1/4 W		5%	
R260	315-0103-00	10 k	1/4 W		5%	
R261	315-0393-00	39 k	1/4 W		5%	
R263	315-0222-00	2.2 k	1/4 W		5%	
R265	321-0365-00	61.9 k	1/8 W	Prec	1%	
R270	315-0362-00	3.6 k	1/4 W		5%	
R274	315-0912-00	9.1 k	1/4 W		5%	
R276	315-0241-00	240 Ω	1/4 W		5%	
R280	315-0103-00	10 k	1/4 W		5%	
R281	315-0393-00	39 k	1/4 W		5%	
R283	315-0222-00	2.2 k	1/4 W		5%	
R285	321-0353-00	46.4 k	1/8 W	Prec	1%	
R290	315-0302-00	3 k	1/4 W		5%	
R294	315-0912-00	9.1 k	1/4 W		5%	
R296	315-0511-00	510 Ω	1/4 W		5%	
R297	315-0241-00	240 Ω	1/4 W		5%	
R300	315-0103-00	10 k	1/4 W		5%	
R301	315-0393-00	39 k	1/4 W		5%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R303	315-0222-00	2.2 k	1/4 W			5%	
R305	315-0513-00	51 k	1/4 W			5%	
R306	311-0464-00	25 k		Var			
R310	315-0362-00	3.6 k	1/4 W			5%	
R314	315-0912-00	9.1 k	1/4 W			5%	
R316	315-0241-00	240 Ω	1/4 W			5%	
R320	315-0103-00	10 k	1/4 W			5%	
R321	315-0393-00	39 k	1/4 W			5%	
R323	315-0222-00	2.2 k	1/4 W			5%	
R325	321-0391-00	115 k	1/8 W		Prec	1%	100-2059
R325	321-0385-00	100 k	1/8 W		Prec	1%	2060-up
R330	315-0302-00	3 k	1/4 W			5%	
R334	315-0912-00	9.1 k	1/4 W			5%	
R336	315-0511-00	510 Ω	1/4 W			5%	
R337	315-0241-00	240 Ω	1/4 W			5%	
R340	315-0103-00	10 k	1/4 W			5%	
R341	315-0393-00	39 k	1/4 W			5%	
R343	315-0222-00	2.2 k	1/4 W			5%	
R345	315-0513-00	51 k	1/4 W			5%	100-2059
R345	323-0357-00	51.1 k	1/2 W		Prec	1%	2060-up
R346	311-0464-00	25 k		Var			
R350	315-0362-00	3.6 k	1/4 W			5%	
R354	315-0912-00	9.1 k	1/4 W			5%	
R356	315-0241-00	240 Ω	1/4 W			5%	
R360	315-0103-00	10 k	1/4 W			5%	
R361	315-0393-00	39 k	1/4 W			5%	
R363	315-0222-00	2.2 k	1/4 W			5%	
R365	321-0385-00	100 k	1/8 W		Prec	1%	
R370	315-0302-00	3 k	1/4 W			5%	
R374	315-0912-00	9.1 k	1/4 W			5%	
R376	315-0511-00	510 Ω	1/4 W			5%	
R377	315-0241-00	240 Ω	1/4 W			5%	
R380	315-0103-00	10 k	1/4 W			5%	
R381	315-0393-00	39 k	1/4 W			5%	
R383	315-0222-00	2.2 k	1/4 W			5%	
R385	315-0104-00	100 k	1/4 W			5%	
R386	311-0497-00	50 k		Var			
R390	315-0123-00	12 k	1/4 W			5%	
R394	315-0203-00	20 k	1/4 W			5%	
R396	315-0241-00	240 Ω	1/4 W			5%	100-1499
R396	315-0181-00	180 Ω	1/4 W			5%	1500-up
R401	301-0510-00	51 Ω	1/2 W			5%	
R403	301-0560-00	56 Ω	1/2 W			5%	
R405	302-0102-00	1 k	1/2 W				
R408	315-0181-00	180 Ω	1/4 W			5%	
R421	302-0103-00	10 k	1/2 W				
R424	301-0391-00	390 Ω	1/2 W			5%	
R425	302-0102-00	1 k	1/2 W				

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R452	315-0122-00	1.2 k	1/4 W		5%	
R454	315-0102-00	1 k	1/4 W		5%	
R456	301-0272-00	2.7 k	1/2 W		5%	
R460	315-0472-00	4.7 k	1/4 W		5%	
R462	315-0472-00	4.7 k	1/4 W		5%	
R464	301-0272-00	2.7 k	1/2 W		5%	
R470	315-0101-00	100 Ω	1/4 W		5%	
R504	302-0184-00	180 k	1/2 W			
R511	307-0023-00	4.7 Ω	1/2 W			
R512	302-0124-00	120 k	1/2 W			
R520	323-0363-00	59 k	1/2 W	Prec	1%	
R522	323-0304-00	14.3 k	1/2 W	Prec	1%	
R524	315-0333-00	33 k	1/4 W		5%	
R527	301-0330-00	33 Ω	1/2 W		5%	
R530	323-0248-00	3.74 k	1/2 W	Prec	1%	
R531	308-0245-00	0.6 Ω	2 W	WW	5%	
R532	323-0285-00	9.09 k	1/2 W	Prec	1%	
R534	301-0151-00	150 Ω	1/2 W		5%	
R536	315-0103-00	10 k	1/4 W		5%	
R540	315-0122-00	1.2 k	1/4 W		5%	
R544	315-0471-00	470 Ω	1/4 W		5%	
R547	*308-0087-00	0.5 Ω	1 W	WW	1%	
R551	307-0023-00	4.7 Ω	1/2 W			
R562	301-0272-00	2.7 k	1/2 W		5%	
R564	301-0202-00	2 k	1/2 W		5%	
R566	315-0472-00	4.7 k	1/4 W		5%	
R570	315-0822-00	8.2 k	1/4 W		5%	
R572	311-0463-00	5 k	Var			
R574	315-0183-00	18 k	1/4 W		5%	
R580	315-0471-00	470 Ω	1/4 W		5%	
R587	301-0270-00	27 Ω	1/2 W		5%	

Switches

	Unwired	Wired	
SW70	260-0725-00		Lever, HF SELECTOR
SW400	260-0727-00		Push, MARKER SELECTOR
SW425	260-0728-00		Push, TRIGGER SELECTOR
SW450	260-0726-00		Lever, MARKER AMPLIFIER
SW501	260-0747-00		Slide, 115 V - 230 V

Transformers

T115	*120-0410-00	Toroid	15 turns, bifilar
T130	*120-0409-00	Toroid	2 windings, bifilar
T501	*120-0408-00	LV Power	

Electron Tubes

Ckt. No.	Tektronix Part No.		Description	S/N Range
V10	154-0465-00	7587		
V20	154-0465-00	7587		
V30	154-0465-00	7587		
V40	154-0465-00	7587		
V60	154-0465-00	7587		
V70	154-0465-00	7587		

Crystal

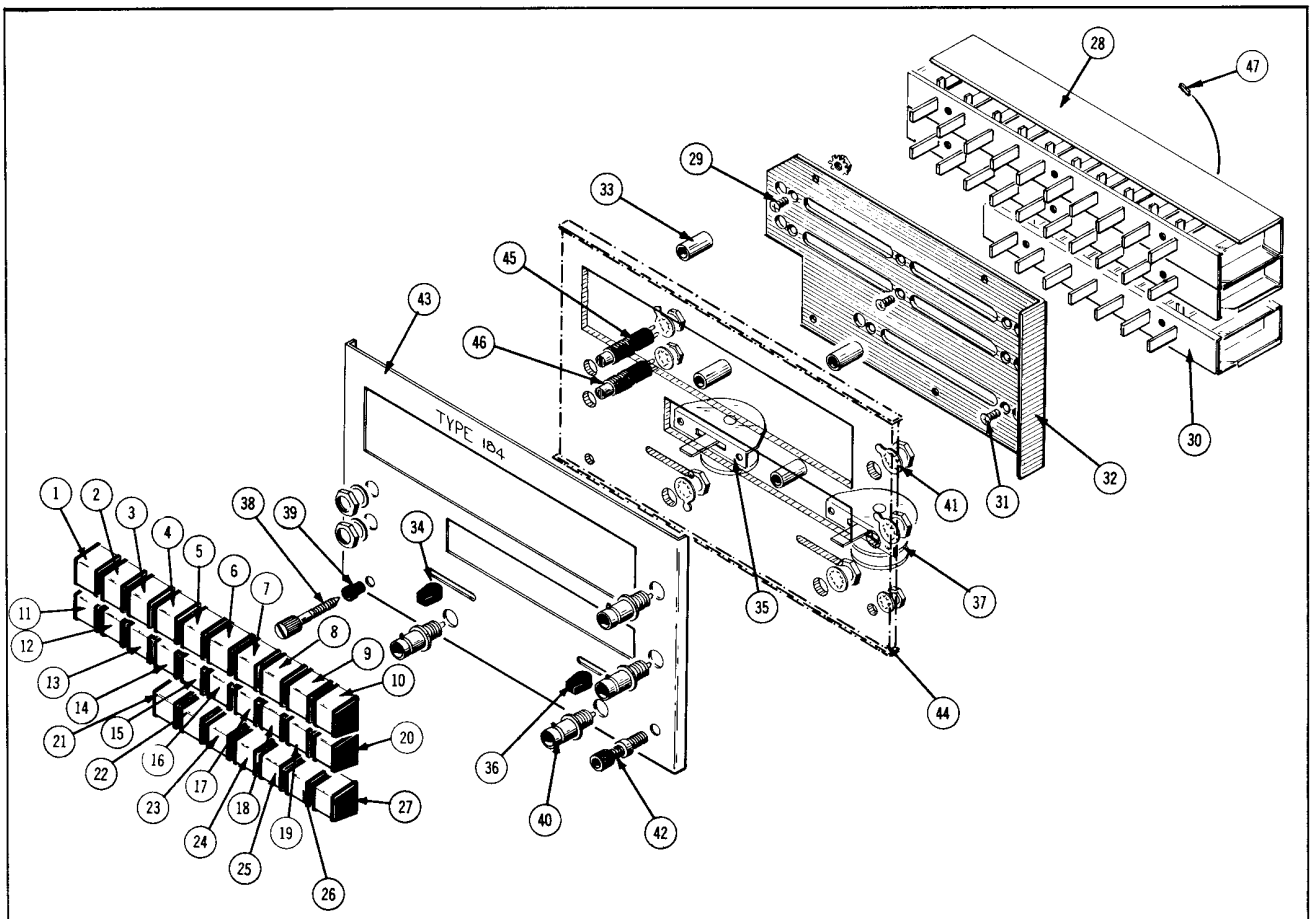
Y11	158-0023-00	Crystal Assembly, 10 MHz	100-1509
Y11	158-0023-01	Crystal Assembly, 10 MHz	1510-up

SECTION 8

MECHANICAL PARTS LIST

A list of abbreviations and special symbols in use throughout this manual will be found immediately preceding the Electrical Parts List, Section 7. Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Parts ordering information is also located immediately preceding Section 7.

FRONT



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	366-0343-03			1	KNOB, pushbutton, POWER OFF
2	366-0298-00			1	KNOB, pushbutton, 10 nS
3	366-0299-00			1	KNOB, pushbutton, 20 nS
4	366-0300-00			1	KNOB, pushbutton, 50 nS
5	366-0301-00			1	KNOB, pushbutton, .1 μS
6	366-0302-00			1	KNOB, pushbutton, .5 μS
7	366-0303-00			1	KNOB, pushbutton, 1 μS
8	366-0304-00			1	KNOB, pushbutton, 5 μS
9	366-0305-00			1	KNOB, pushbutton, 10 μS
10	366-0306-00			1	KNOB, pushbutton, 50 μS
11	366-0307-00			1	KNOB, pushbutton, .1 mS
12	366-0308-00			1	KNOB, pushbutton, .5 mS
13	366-0309-00			1	KNOB, pushbutton, 1 mS
14	366-0310-00			1	KNOB, pushbutton, 5 mS
15	366-0311-00			1	KNOB, pushbutton, 10 mS
16	366-0312-00			1	KNOB, pushbutton, 50 mS
17	366-0313-00			1	KNOB, pushbutton, .1 S
18	366-0314-00			1	KNOB, pushbutton, .5 S
19	366-0315-00			1	KNOB, pushbutton, 1 S
20	366-0316-00			1	KNOB, pushbutton, 5 S
21	366-0303-00			1	KNOB, pushbutton, 1 μS
22	366-0305-00			1	KNOB, pushbutton, 10 μS

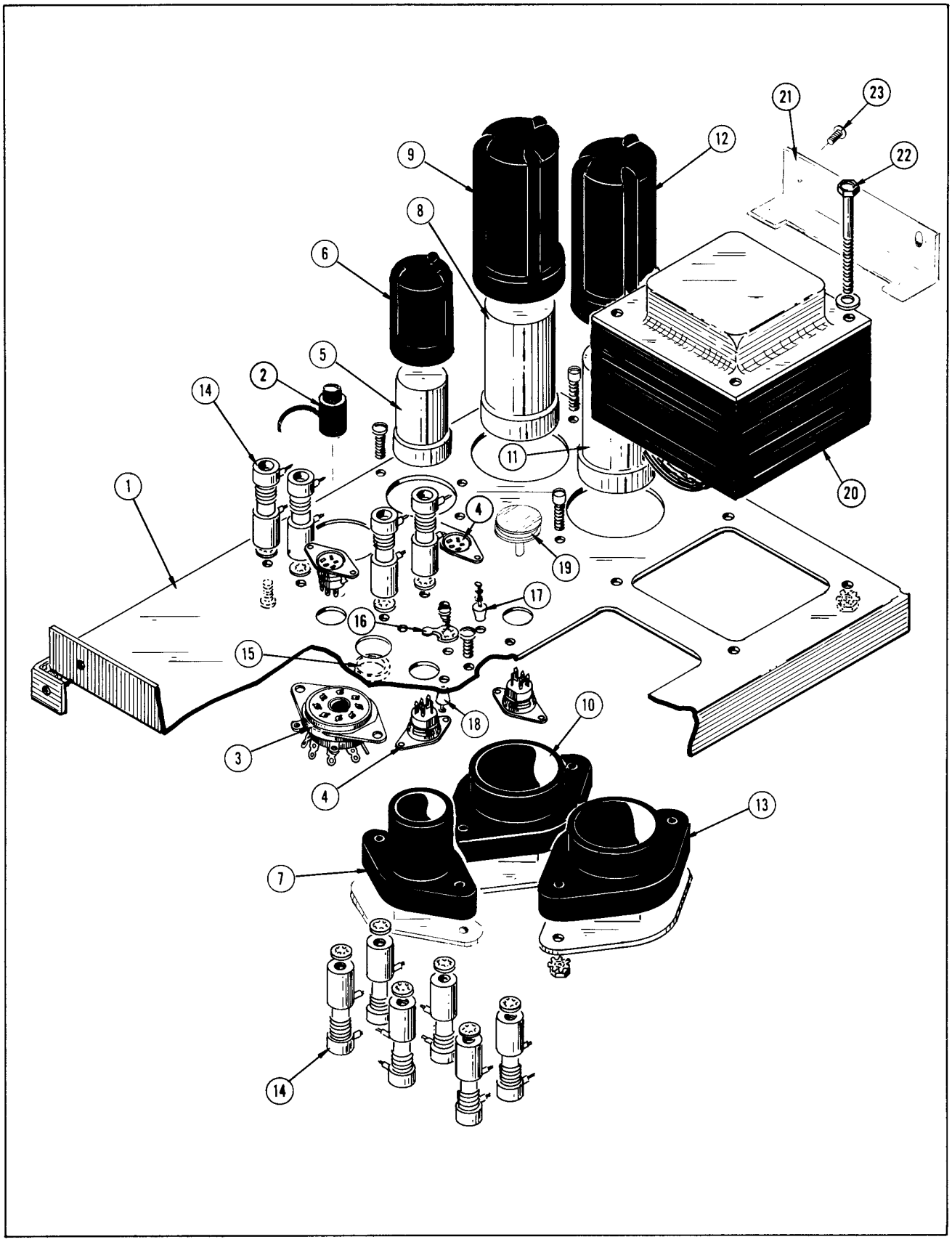
FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
23	366-0307-00			1	KNOB, pushbutton, .1 mS
24	366-0309-00			1	KNOB, pushbutton, 1 mS
25	366-0311-00			1	KNOB, pushbutton, 10 mS
26	366-0313-00			1	KNOB, pushbutton, .1 S
27	366-0315-00			1	KNOB, pushbutton, 1 S
28	260-0727-00			1	SWITCH, unwired, MARKER SELECTOR
	- - - - - -			-	mounting hardware: (not included w/switch)
29	211-0541-00			6	SCREW, 6-32 x 1/4 inch, 100° CSK, FHS, phillips
	210-0802-00			6	WASHER, 6S x 5/16 inch
30	260-0728-00			1	SWITCH, unwired, TRIGGER SELECTOR
	- - - - - -			-	mounting hardware: (not included w/switch)
31	211-0541-00			2	SCREW, 6-32 x 1/4 inch, 100° CSK, FHS, phillips
	210-0802-00			2	WASHER, 6S x 5/16 inch
32	407-0136-00			1	BRACKET, switch
	- - - - - -			-	mounting hardware: (not included w/bracket)
33	361-0104-00			4	SPACER, sleeve
	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
34	366-0215-01			1	KNOB, lever, MARKER AMPLIFIER
35	260-0726-00			1	SWITCH, lever, MARKER AMPLIFIER
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
36	366-0215-01			1	KNOB, lever, H.F. SELECTOR
37	260-0725-00			1	SWITCH, lever, H.F. SELECTOR
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
38	214-0553-00			1	SCREW, latch
39	358-0255-00			1	BUSHING, latch
40	131-0106-00			4	CONNECTOR, coaxial, 1-contact female (w/hardware)
41	210-0255-00			3	LUG, solder, pot
42	129-0103-00			1	ASSEMBLY, binding post
	- - - - - -			-	assembly includes:
	200-0103-00			1	CAP, binding post
	129-0077-00			1	POST, binding, stud
	- - - - - -			-	mounting hardware: (not included w/assembly)
	210-0455-00			1	NUT, 1/4-28 x 3/8 x 3/32 inch
	210-0046-00			1	LOCKWASHER, steel, shakeproof
43	333-0888-00			1	PANEL, front
44	386-0154-00			1	PLATE, sub-panel, front

FRONT *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
45	136-0164-00			1	SOCKET, lamp
	- - - - - -			-	mounting hardware: (not included w/socket)
	210-0590-00			1	NUT, hex., $3/8$-32 x $7/16$ inch
	210-0978-00			1	WASHER, $3/8$ ID x $1/2$ inch OD
	210-0255-00			1	LUG, solder, pot
	210-0413-00			1	NUT, hex, $3/8$-32 x $1/2$ inch
46	- - - - - -			-	LIGHT, neon, amber
	- - - - - -			-	mounting hardware: (not included w/light)
	210-0590-00			1	NUT, hex., $3/8$-32 x $7/16$ inch
	210-0978-00			1	WASHER, $3/8$ ID x $1/2$ inch OD
	210-0012-00			1	LOCKWASHER, internal, $3/8$ x $1/2$ inch
	210-0413-00			1	NUT, hex, $3/8$-32 x $1/2$ inch
47	131-0371-00			23	CONNECTOR, single contact

CHASSIS



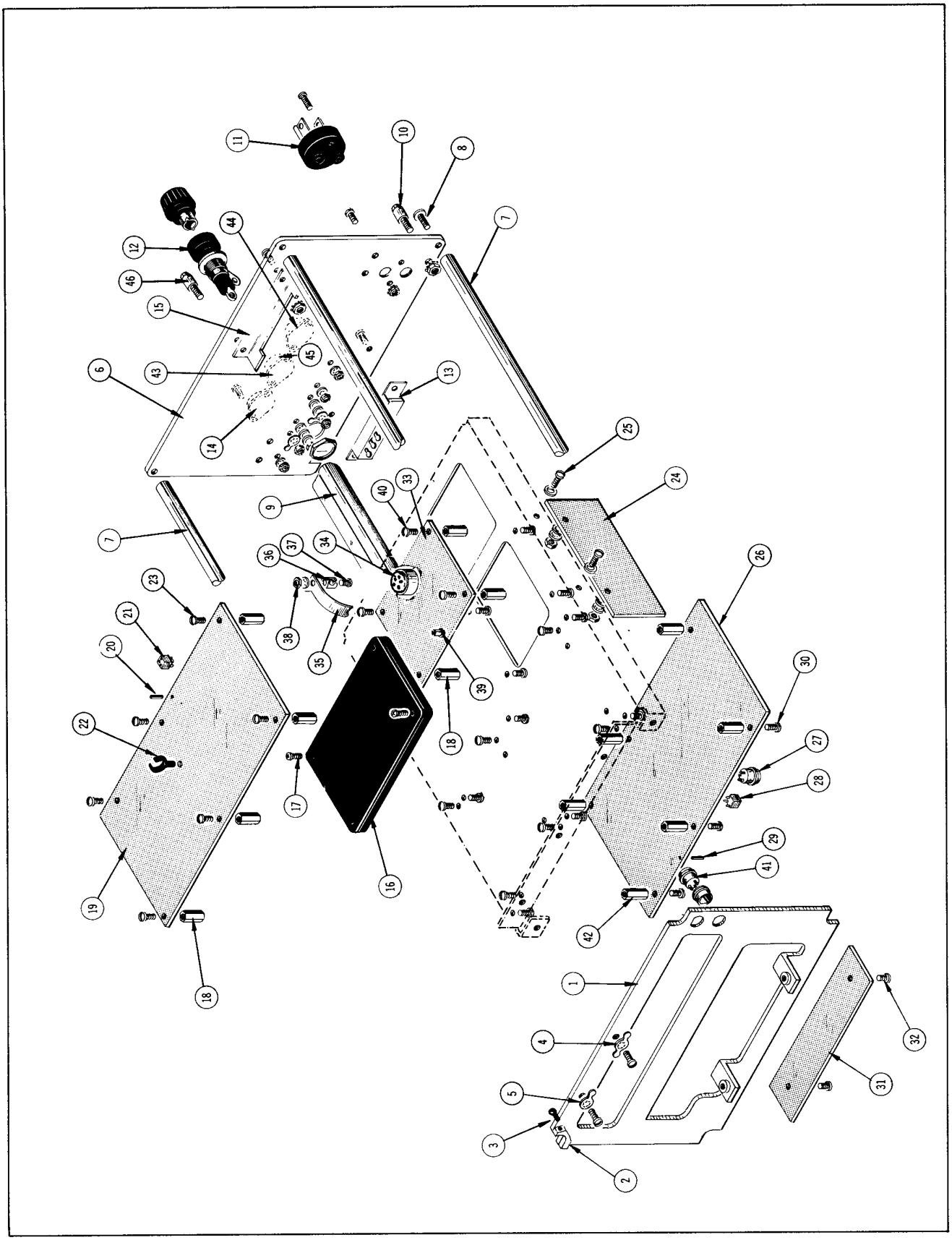
CHASSIS

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	441-0619-00			1	CHASSIS
	- - - - - -			-	mounting hardware: (not included w/chassis)
	211-0504-00			5	SCREW, 6-32 x 1/4 inch, PHS phillips
	211-0565-00			5	SCREW, 6-32 x 3/8 inch, THS, phillips
2	131-0142-00			4	CONNECTOR, cable end
3	136-0011-00			1	SOCKET, 8 pin
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS, phillips
4	136-0101-00			4	SOCKET, nuvistor
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	213-0055-00			2	SCREW, thread forming, 2-56 x 3/16 inch, PHS, phillips
5	- - - - - -			1	CAPACITOR
6	200-0533-00			1	COVER, capacitor
7	432-0047-00			1	BASE, capacitor mounting
	386-0252-00			1	PLATE, fiber
	- - - - - -			-	mounting hardware: (not included w/plate)
	211-0516-00			2	SCREW, 6-32 x 7/8 inch, PHS, phillips
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
8	- - - - - -			1	CAPACITOR
9	200-0260-00	100	239	1	COVER, capacitor
	200-0538-00	240		1	COVER, capacitor
10	432-0044-00	100	239	1	BASE, capacitor mounting
	432-0048-00	240		1	BASE, capacitor mounting
	386-0254-00			1	PLATE, fiber
	- - - - - -			-	mounting hardware: (not included w/plate)
	211-0532-00	100	239	2	SCREW, 6-32 x 3/4 inch, Fil HS, phillips
	211-0516-00	240		2	SCREW, 6-32 x 7/8 inch, PHS
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
11	- - - - - -			1	CAPACITOR
12	200-0260-00	100	239	1	COVER, capacitor
	200-0538-00	240		1	COVER, capacitor
13	386-0254-00			1	PLATE, fiber
	432-0044-00	100	239	1	BASE, capacitor mounting
	432-0048-00	240		1	BASE, capacitor mounting
	- - - - - -			-	mounting hardware: (not included w/plate)
	211-0532-00	100	239	2	SCREW, 6-32 x 3/4 inch, Fil HS, phillips
	211-0516-00	240		2	SCREW, 6-32 x 7/8 inch, PHS
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
14	- - - - - -			10	COIL
	- - - - - -			-	mounting hardware for each: (not included w/coil)
	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
	210-0006-00			1	LOCKWASHER, internal, #6

CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
15	348-0063-00			1	GROMMET, plastic, .485 ID x 1/2 inch OD
16	210-0201-00			9	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS, phillips
17	131-0359-00			1	CONNECTOR, feed through
	- - - - - -			-	mounting hardware for each: (not included w/connector)
	358-0176-00			1	BUSHING, plastic
18	131-0227-00	100	109	1	CONNECTOR, stand off
	131-0227-00	110		2	CONNECTOR, stand off
	- - - - - -			-	mounting hardware: (not included w/connector)
	358-0176-00			1	BUSHING, plastic
19	214-0210-00			1	SPOOL, solder, w/solder
	- - - - - -			-	spool includes:
	214-0209-00			1	SPOOL, solder
	- - - - - -			-	mounting hardware: (not included w/spool)
	361-0007-00			1	SPACER, nylon
20	- - - - - -			1	TRANSFORMER
	- - - - - -			-	transformer includes:
21	407-0204-00			1	BRACKET, transformer support
22	212-0517-00			4	SCREW, 10-32 x 1 3/4 inches, HHS
	210-0812-00			4	WASHER, fiber, #10
	220-0410-00			4	NUT, keps, 10-32 x 3/8 inch
23	- - - - - -			-	mounting hardware: (not included w/transformer)
	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS, phillips
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch

BOARDS & REAR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BOARDS & REAR

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	386-0153-00			1	PLATE, bulkhead
	- - - - - -			-	plate includes:
2	- - - - - -			4	CLAMP
3	211-0094-00			4	SCREW, 6-32 x 1/4 inch, THS, phillips
4	210-0204-00			1	LUG, solder, DE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
	211-0503-00			1	SCREW, 6-32 x 3/16 inch, PHS, phillips
5	210-0202-00			1	LUG, solder, SE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
	211-0503-00			1	SCREW, 6-32 x 3/16 inch, PHS, phillips
6	386-0155-00			1	PLATE, rear
7	384-0615-00			3	ROD, spacing
8	212-0044-00			4	SCREW, 8-32 x 1/2 inch, RHS, phillips
9	351-0096-00			1	GUIDE, slide
	- - - - - -			-	mounting hardware: (not included w/guide)
	211-0538-00			2	SCREW, 6-32 x 5/16 inch, FHS, phillips
10	214-0680-00			1	PIN, locating
	- - - - - -			-	mounting hardware: (not included w/pin)
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
11	131-0430-00	100	1041	1	CONNECTOR, motor base
	131-0430-01	1042		1	CONNECTOR, motor base
	- - - - - -			-	connector includes:
	386-1044-00			1	PLATE, mounting
	200-0185-00	100	1041	1	COVER, plastic.
	200-0185-01	1042		1	COVER, plastic
	377-0041-00	100	1041	1	INSERT, plastic
	377-0051-00	1042		1	INSERT, plastic
	214-0078-00			2	PIN, connecting
	129-0041-00	100	1041	1	POST, ground
	129-0041-01	1042		1	POST, ground
	211-0015-00	100	1041	1	SCREW, 4-40 x 1/2 inch, RHS, phillips
	213-0088-00	1042		1	SCREW, thread forming, 4-40 x 1/4 inch, PHS
	210-0586-00	100	1041X	2	NUT, keps, 4-40 x 1/4 inch
	211-0132-00	X1042		1	SCREW, sems, 4-40 x 1/2 inch, PHS
12	352-0002-00			1	ASSEMBLY, fuse holder
	- - - - - -			-	assembly includes:
	352-0010-00			1	HOLDER, fuse (with nut)
	210-0873-00			1	WASHER, rubber
	200-0582-00			1	CAP, fuse
13	260-0747-00			1	SWITCH, slide 115 V-230 V
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS, phillips
	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
14	- - - - - -			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)
	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS
	210-0006-00			1	LOCKWASHER, internal #6
	210-0202-00			1	LUG, solder, SE #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch

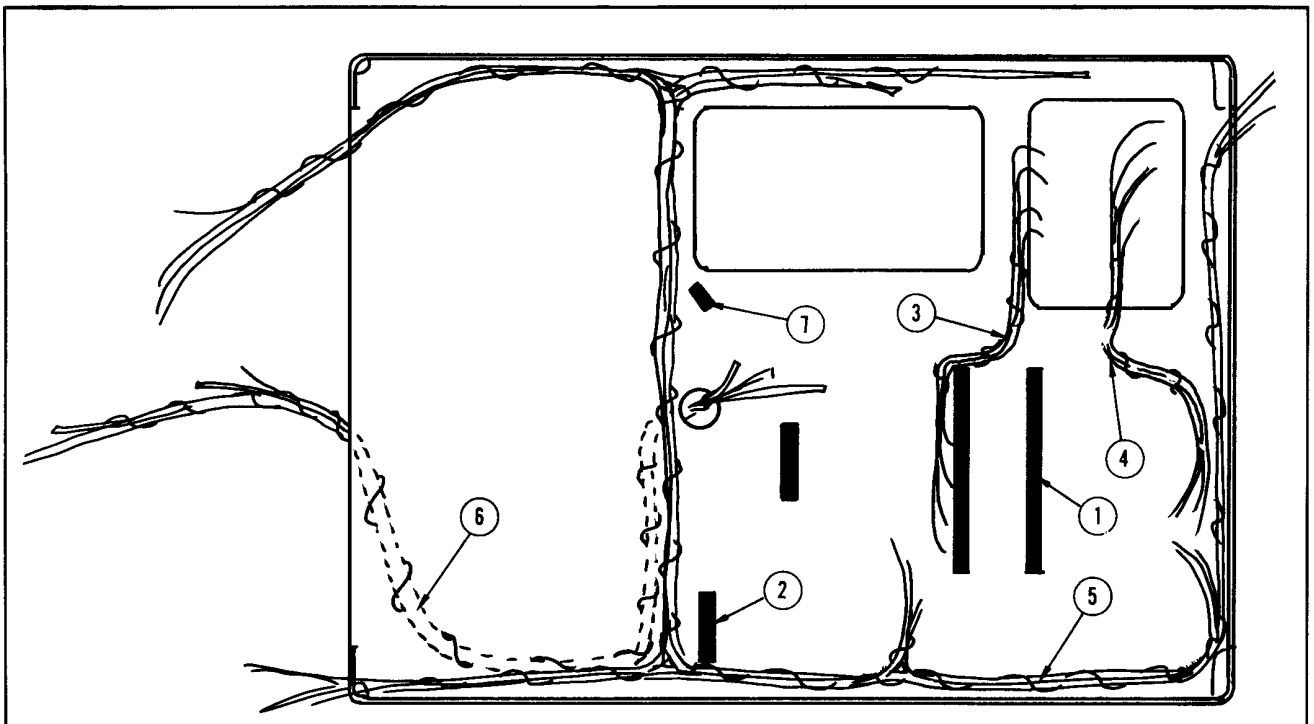
BOARDS & REAR *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
15	- - - - - -			-	SUB-PART OF TRANSFORMER (see chassis view)
16	119-0062-00			1	ASSEMBLY, DELAY LINE
	- - - - - -			-	mounting hardware: (not included w/assembly)
17	211-0014-00			2	SCREW, 4-40 x 1/2 inch, PHS, phillips
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
18	385-0080-00			10	ROD, hex., 1/4 x 7/16 inch
	- - - - - -			-	mounting hardware for each: (not included w/rod)
	211-0507-00	100	219	1	SCREW, 6-32 x 5/16 inch, PHS, phillips
	211-0504-00	220		1	SCREW, 6-32 x 1/4 inch, PHS, phillips
	210-0006-00			1	LOCKWASHER, internal #6
19	670-0207-00			1	ASSEMBLY, etched board, COUNTDOWN
	- - - - - -			-	assembly includes:
	388-0629-00			1	BOARD, etched
	- - - - - -			-	board includes:
20	214-0506-00			22	PIN, connector, straight
21	136-0220-00			33	SOCKET, transistor
22	426-0121-00			2	MOUNT, toroid
	361-0007-00			2	SPACER
	- - - - - -			-	mounting hardware: (not included)
23	211-0601-00			6	SCREW, 6-32 x 5/16 inch, PHS, w/lockwasher
24	670-0206-00			1	ASSEMBLY, etched-wiring board, 500 MHz FILTER
	- - - - - -			-	board includes:
	388-0674-00			1	BOARD, etched-wiring, unwired
	- - - - - -			-	mounting hardware: (not included w/board)
25	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS
	210-0006-00			2	LOCKWASHER, internal #6
	210-0802-00			2	WASHER, 6S
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
26	670-0208-00			1	ASSEMBLY, etched-wiring board, COUNTDOWN & POWER REGULATOR
	- - - - - -			-	board includes:
27	136-0183-00			8	SOCKET, transistor
28	136-0220-00			19	SOCKET, transistor
	388-0628-00			1	BOARD, etched
	- - - - - -			-	board includes:
29	214-0506-00			22	PIN, connector
	- - - - - -			-	mounting hardware: (not included w/board)
30	211-0601-00			6	SCREW, assembly washer, 6-32 x .313 inch, PHB
31	670-0204-00			1	ASSEMBLY, etched-wiring board, 200 MHz
	- - - - - -			-	board includes:
	388-0631-00			1	BOARD, etched-wiring, unwired
	- - - - - -			-	mounting hardware: (not included w/board)
32	211-0116-00			2	SCREW, sems, 4-40 x 5/16 inch PHS phillips

BOARDS & REAR *(Cont'd)*

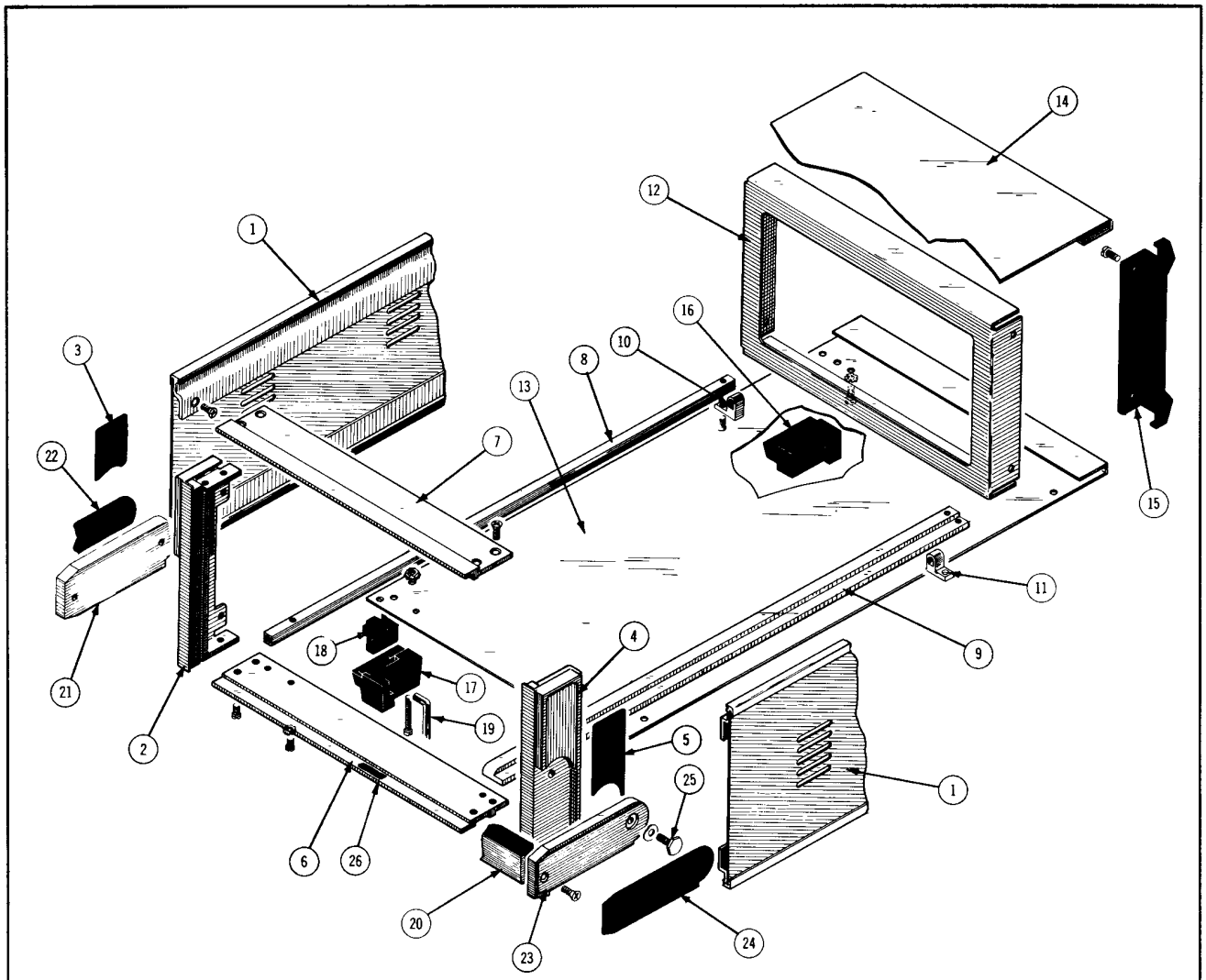
REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
33	670-0205-00			1	ASSEMBLY, etched board, 500 MHz MULTIPLIER
	- - - - - -			-	assembly includes:
	388-0630-00			1	BOARD, etched
	214-0506-00			2	PIN, connector, straight
34	136-0125-00			2	SOCKET, nuvistor, with ring
35	- - - - - -			1	TANK, tuned, 2 ns
36	344-0125-00			2	CLIP, electrical
	- - - - - -			-	mounting hardware for each: (not included w/cap)
37	211-0008-00			1	SCREW, 4-40 x 1/4 inch, PHS
	210-0004-00			1	LOCKWASHER, internal #4
38	210-0406-00			1	NUT, hex., 4-40 x 3/16 inch
39	131-0427-00			1	CONNECTOR
	- - - - - -			-	mounting hardware: (not included w/board)
40	211-0601-00			4	SCREW, 6-32 x 5/16 inch, PHS, w/lockwasher
41	136-0181-00			2	SOCKET, transistor
	354-0234-00			2	RING, transistor socket, mounting
42	385-0146-00			6	ROD, hex., 1/4 x 11/16 inch
	- - - - - -			-	mounting hardware for each: (not included w/rod)
	211-0507-00	100	219	1	SCREW, 6-32 x 5/16 inch, PHS
	211-0504-00	220		1	SCREW, 6-32 x 1/4 inch, PHS
	210-0006-00			1	LOCKWASHER, internal #6
43	- - - - - -			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)
	386-0143-00			1	PLATE, mica
	210-0811-00			2	WASHER, fiber, shouldered
	210-0802-00			2	WASHER, 6S x 5/16 inch
	210-0006-00			1	LOCKWASHER, internal #6
	210-0202-00			1	LUG, solder, SE #6
	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
	211-0511-00			1	SCREW, 6-32 x 1/2 inch, PHS
44	- - - - - -			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)
	210-0006-00			2	LOCKWASHER, internal #6
	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS
45	200-0669-00	X160		1	COVER, transistor
46	214-0680-00			1	PIN, locating

CERAMIC STRIPS & CABLE HARNESSES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	124-0146-00			2	STRIP, ceramic, 16 notch
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0008-00			2	SPACER, plastic
2	124-0119-00			2	STRIP, ceramic, 2 notch
	- - - - - -			-	each strip includes:
	355-0046-00			1	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0008-00			1	SPACER, plastic
3	179-1005-00			1	CABLE HARNESS, transformer
4	179-1003-00			1	CABLE HARNESS, power II
5	179-1002-00			1	CABLE HARNESS, power I
	- - - - - -			-	cable harness includes:
	131-0371-00			-	CONNECTOR, single contact
6	179-1004-00			1	CABLE HARNESS, switch
	- - - - - -			-	cable harness includes:
	131-0371-00			-	CONNECTOR, single contact
7	124-0118-00	100	109X	1	STRIP, ceramic, 1 notch
	- - - - - -			-	strip includes:
	355-0046-00			1	STUD, plastic
	- - - - - -			-	mounting hardware: (not included w/strip)
	361-0008-00			1	SPACER, plastic

CABINET

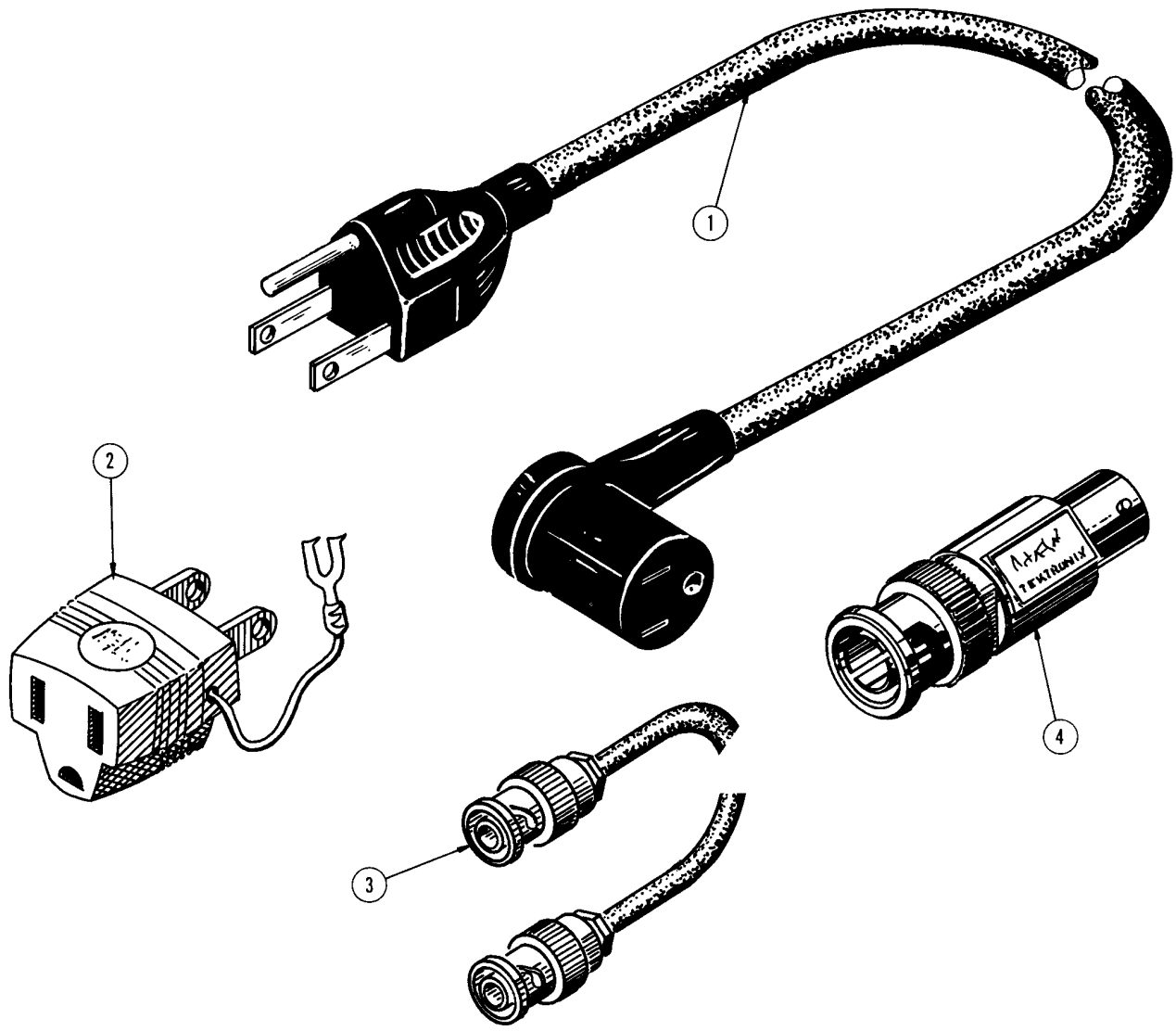


REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
-	437-0078-00			1	ASSEMBLY, cabinet
	- - - - - -			-	assembly includes:
1	386-0141-00			2	PLATE, side
2	426-0253-00			1	FRAME, front left
3	377-0121-00			1	INSERT, decorative, left
4	426-0252-00			1	FRAME, front right
5	377-0120-00			1	INSERT, decorative, right
6	426-0254-00			1	FRAME, front bottom
	- - - - - -			-	mounting hardware: (not included w/frame)
	212-0004-00			2	SCREW, 8-32 x 5/16 inch, PHS, phillips
	212-0002-00			2	SCREW, 8-32 x 1/4 inch, FHS, phillips
7	426-0255-00			1	FRAME, front top
	- - - - - -			-	mounting hardware: (not included w/frame)
	212-0002-00			4	SCREW, 8-32 x 1/4 inch 100°, CSK, FHS, phillips
8	351-0093-00			1	GUIDE, left
	- - - - - -			-	mounting hardware: (not included w/guide)
	212-0023-00			1	SCREW, 8-32 x 3/8 inch, PHS, phillips
	210-0007-00			1	LOCKWASHER, external #8

CABINET *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
9	351-0092-00			1	GUIDE, right
10	358-0293-01			1	BUSHING, plug-in securing, left
	- - - - - -			-	mounting hardware: (not included w/bushing)
	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS, phillips
	210-0005-00			1	LOCKWASHER, external #6
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
	212-0001-00			1	SCREW, 8-32 x 1/4 inch, PHS, phillips
	210-0007-00			1	LOCKWASHER, external #8
11	358-0294-01			1	BUSHING, plug-in securing, right
	- - - - - -			-	mounting hardware: (not included w/bushing)
	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS, phillips
	210-0005-00			1	LOCKWASHER, external #6
	212-0001-00			1	SCREW, 8-32 x 1/4 inch, PHS, phillips
	210-0007-00			1	LOCKWASHER, external #8
12	386-0139-00			1	PLATE, rear
13	386-0140-00			1	PLATE, bottom
14	386-0138-00			1	PLATE, top
15	348-0075-00			2	FOOT, rear guard
	- - - - - -			-	mounting hardware for each: (not included w/foot)
	212-0004-00			2	SCREW, 8-32 x 5/16 inch, PHS, phillips
16	348-0074-00			2	FOOT, bail limiting, left rear-right front
	- - - - - -			-	mounting hardware for foot, left rear: (not included w/foot)
	211-0532-00			2	SCREW, 6-32 x 3/4 inch, Fil HS, phillips
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
	- - - - - -			-	mounting hardware for foot, right front: (not included w/foot)
	211-0532-00			2	SCREW, 6-32 x 3/4 inch, Fil HS, phillips
17	348-0073-00			2	FOOT, bail limiting, right rear-left front
	- - - - - -			-	mounting hardware for foot, right rear: (not included w/foot)
	211-0532-00			2	SCREW, 6-32 x 3/4 inch, Fil HS, phillips
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
	- - - - - -			-	mounting hardware for foot, left front: (not included w/foot)
	211-0532-00			2	SCREW, 6-32 x 3/4 inch, Fil HS, phillips
18	377-0119-00			4	INSERT, foot
19	348-0072-00			1	FOOT, flip stand bail
20	367-0052-00			1	HANDLE
	- - - - - -			-	mounting hardware: (not included w/handle)
	212-0040-00			2	SCREW, 8-32 x 3/8 inch, 100°, CSK, FHS, phillips
21	367-0051-00			1	HANDLE, pivot, left
22	377-0123-00			1	INSERT, decorative, pivot, left
23	367-0050-00			1	HANDLE, pivot, right
24	377-0122-00			1	INSERT, decorative, pivot, right
25	214-0554-00			2	BOLT, hinge
	214-0558-00			2	WASHER, thrust
26	334-1016-00			1	TAG, identification

STANDARD ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	161-0024-00	100	1999	1	CORD, power
	161-0024-01	2000		1	CORD, power
2	103-0013-00			1	ADAPTER, 3- to 2-wire
3	012-0057-00	100	823	2	CABLE, BNC
	012-0057-01	824		2	CABLE, BNC
4	011-0049-00			1	TERMINATION, 50 Ω, BNC
	070-0499-00			2	MANUAL, instruction (not shown)

NOTES

VOLTAGE AND WAVEFORM CONDITIONS

Voltage readings were taken with a 20,000 ohms/volt VOM. All readings in volts. Voltages are measured with respect to chassis ground unless otherwise noted.

Waveforms shown are actual photographs taken with a Tektronix Oscilloscope Camera and Projected Graticule.

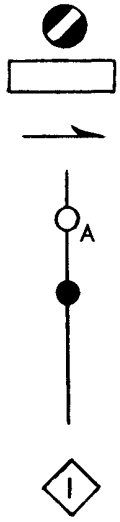
Voltages and waveforms on the schematics are not absolute and may vary between instruments. Any apparent difference between voltage levels measured with the voltmeter and those shown on the waveform are due to circuit loading by the voltmeter.

Waveforms for the high frequency circuits (10 MHz to 500 MHz) were taken with a sampling type test oscilloscope. The OUTPUT was terminated into 50 ohms. Waveforms for the .1 μs to 5 s countdown circuits were taken with a real time test oscilloscope.

To indicate true time relationship between signals, the test oscilloscope was externally triggered.

Schematic Symbols

The following are used on the schematics:



Screwdriver adjustment

Front-panel control or connector.

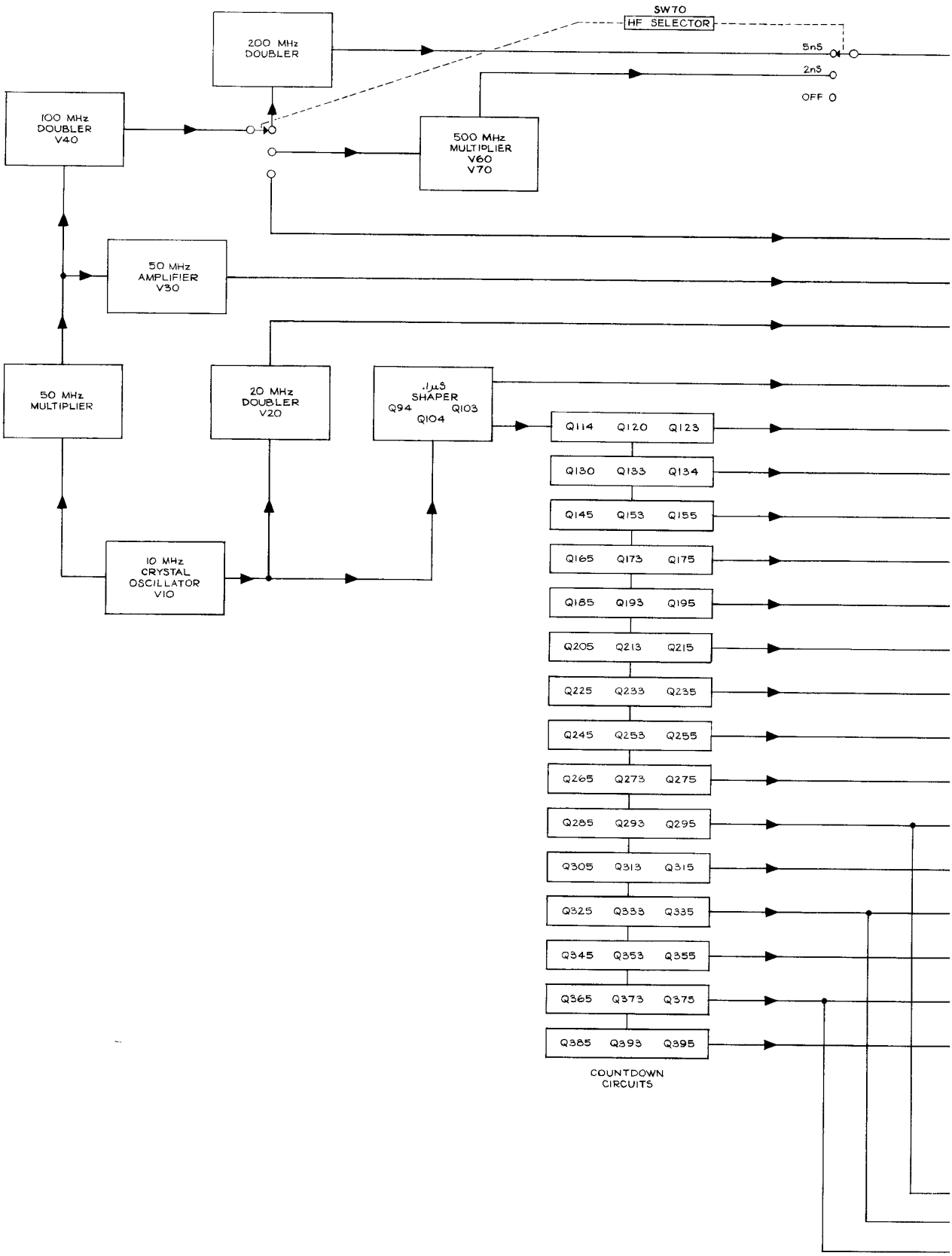
Clockwise control rotation in direction of arrow.

Connection made at indicated pin on etched-wiring board.

Connection soldered to etched-wiring board.

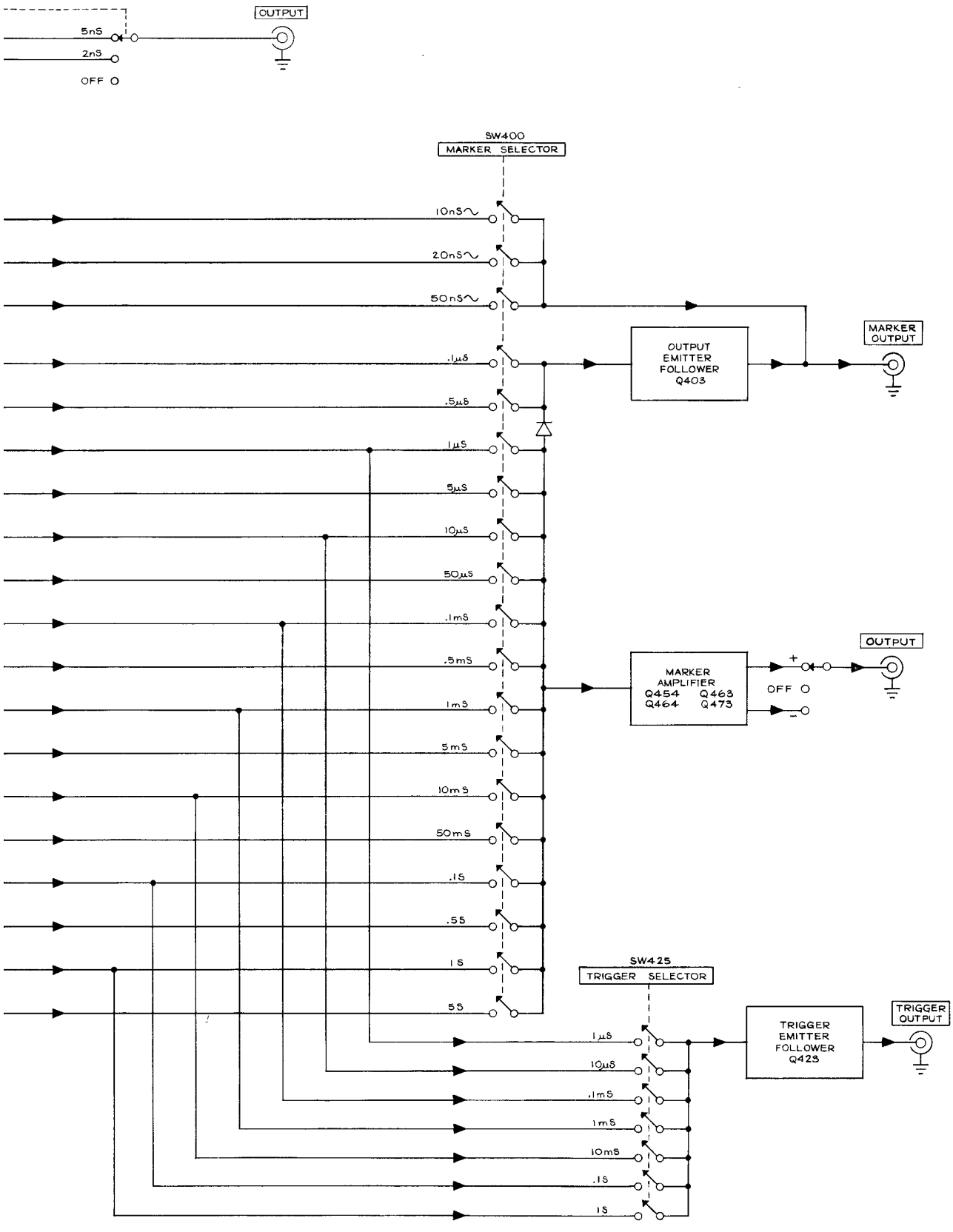
Blue line encloses components located on etched - wiring board.

Input from, or output to indicated schematic.



TYPE 184 TIME MARK GENERATOR

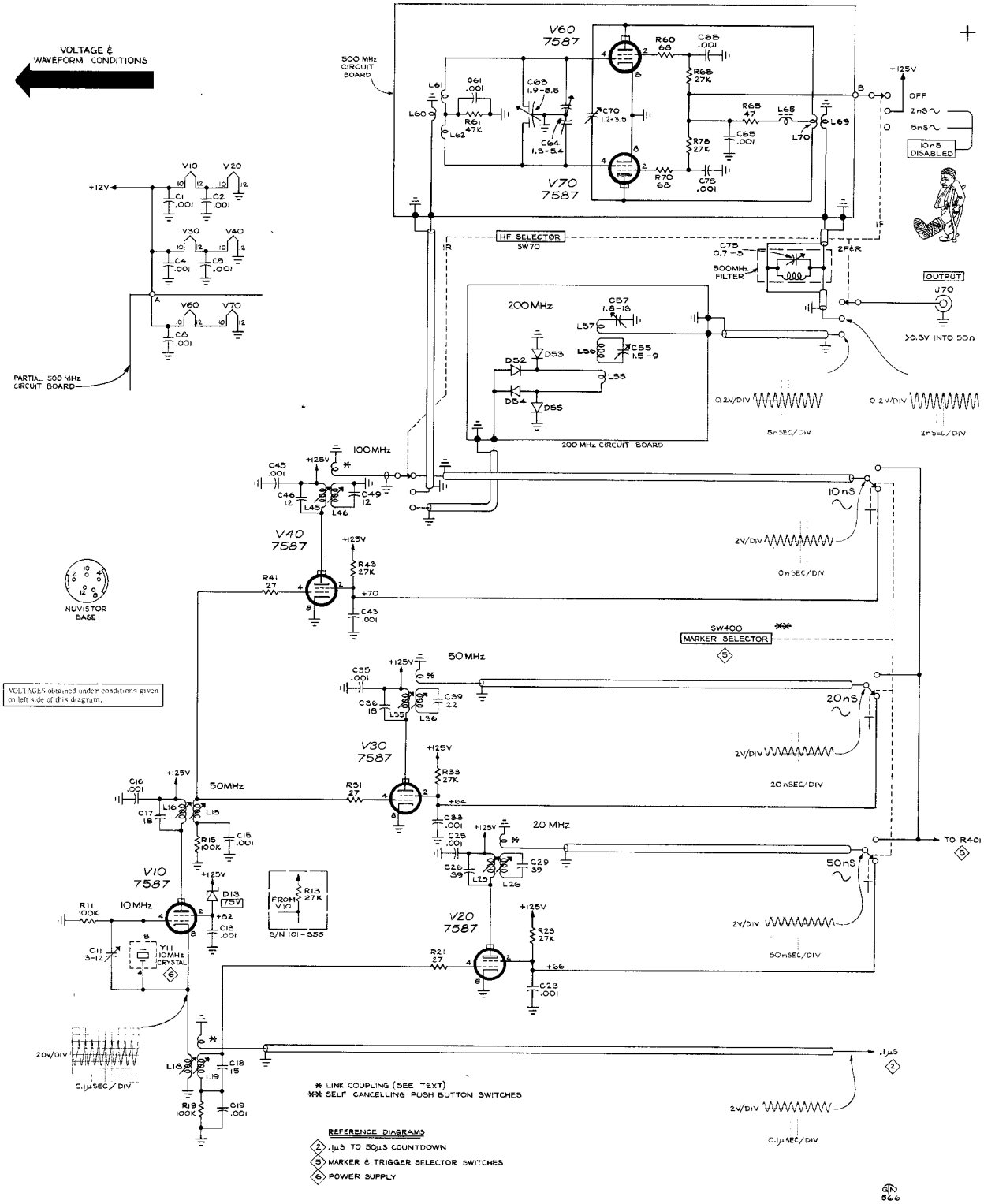
A

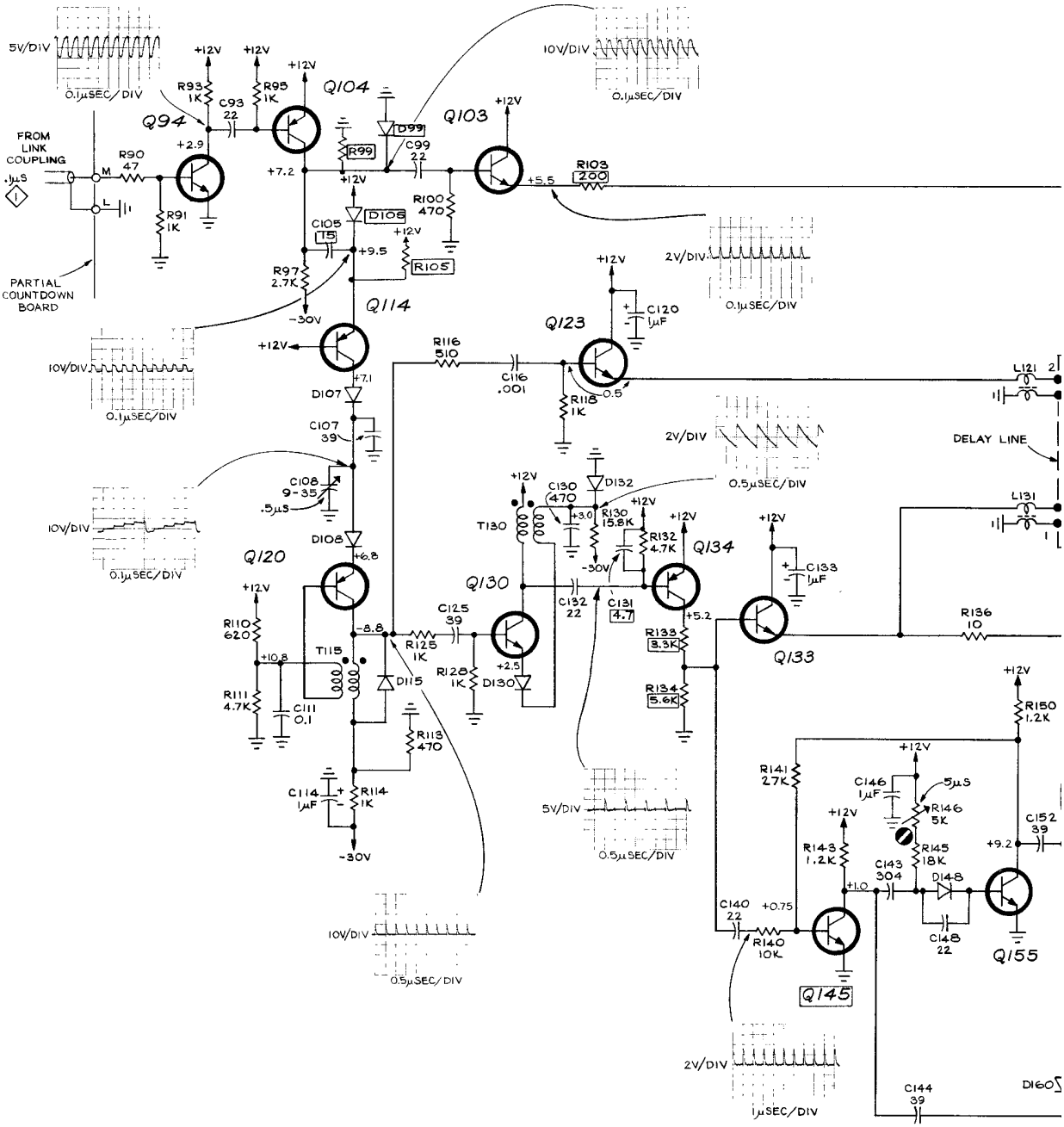


A

GN 865

BLOCK DIAGRAM


VOLTAGE & WAVEFORM CONDITIONS
500 MHz CIRCUIT BOARD
V60 7587
V70 7587
HF SELECTOR SW70
500MHz FILTER
OUTPUT J70
>0.5V INTO 50Ω
200MHz
200 MHz CIRCUIT BOARD
100MHz
50MHz
20 MHz
10MHz
V10 7587
V20 7587
V30 7587
V40 7587
10nS DISABLED
OFF
2nS
5nS
10nS
20nS
50nS
.1μS
TO R401
PARTIAL 500 MHz CIRCUIT BOARD
NUVISTOR BASE
SW400 MARKER SELECTOR
VOLTAGES obtained under conditions given on left side of this diagram.
FROM V10
S/N 101-355
Y11 10MHz CRYSTAL
* LINK COUPLING (SEE TEXT)
** SELF CANCELLING PUSH BUTTON SWITCHES
REFERENCE DIAGRAMS
2 .1μS TO 50μS COUNTDOWN
5 MARKER & TRIGGER SELECTOR SWITCHES
6 POWER SUPPLY



REFERENCE DIAGRAMS

1. OSCILLATOR & MULTIPLIERS
3. .1mS TO 10mS COUNTDOWN
5. MARKER & TRIGGER SELECTOR SWITCHES

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

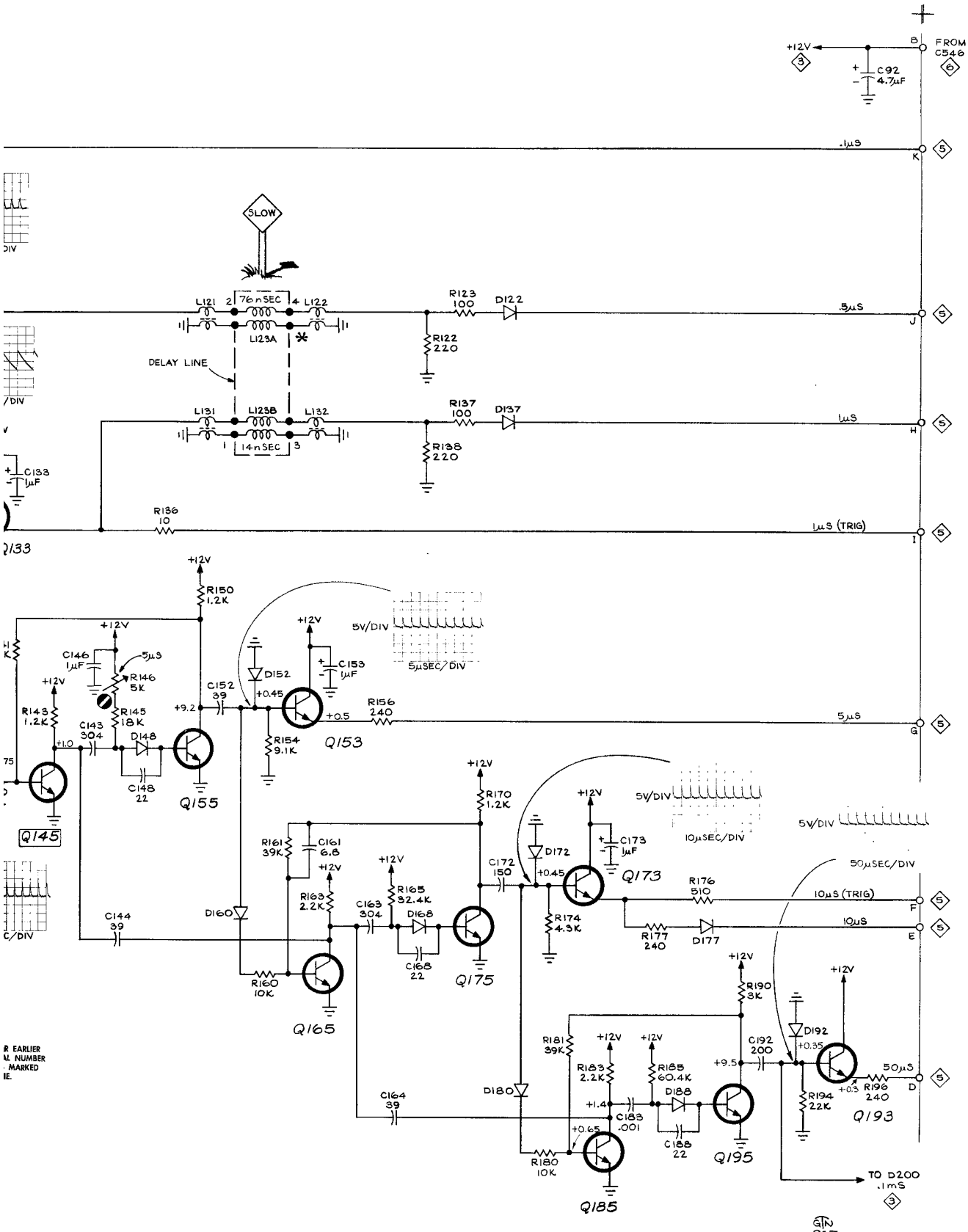
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

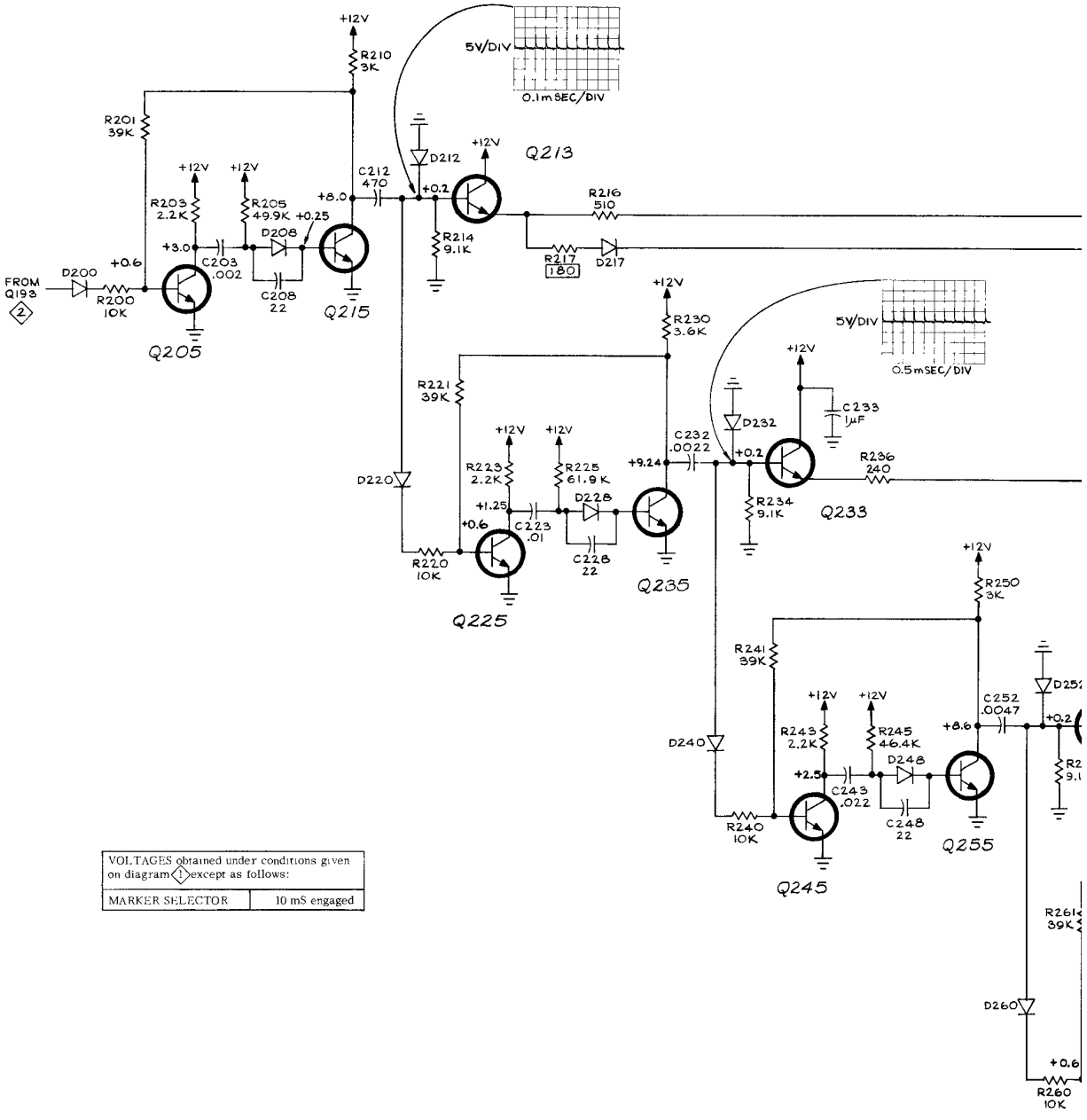
*COLORED LEADS CONNECT THROUGH FERRITE BEAD TO GROUND

VOLTAGES obtained under conditions given on diagram 1.

TYPE 184 TIME MARK GENERATOR

D


+12V
FROM C546
C92 4.7µF
.1µS
SLOW
L121
76 nSEC
L122
L123A
DELAY LINE
L131
L123B
L132
14 nSEC
R123 100
D122
R122 220
.5µS
R137 100
D137
R138 220
1µS
C133 1µF
R136 10
1µS (TRIG)
R150 1.2K
5V/DIV
5µSEC/DIV
C146 1µF
5µS
R146 5K
R143 1.2K
R145 18K
C143 304
D148
C148 22
C152 39
D152
C153 1µF
R154 9.1K
R156 240
5µS
Q153
Q155
Q145
R170 1.2K
10µSEC/DIV
D172
C173 1µF
Q173
50µSEC/DIV
R176 510
10µS (TRIG)
10µS
R177 240
D177
R161 39K
C161 6.8
R163 2.2K
D160
C144 39
R165 32.4K
C163 304
D168
C168 22
C172 150
R174 4.3K
Q175
R160 10K
Q165
R190 3K
D192
C192 200
R196 240
50µS
R194 22K
Q193
R181 39K
R183 2.2K
R185 60.4K
D188
C188 22
C183 .001
C164 39
D180
R180 10K
Q185
Q195
TO D200 .1mS
GTN 267
.1µS TO 50µS COUNTDOWN



VOLTAGES obtained under conditions given on diagram 1 except as follows:	
MARKER SELECTOR	10 mS engaged

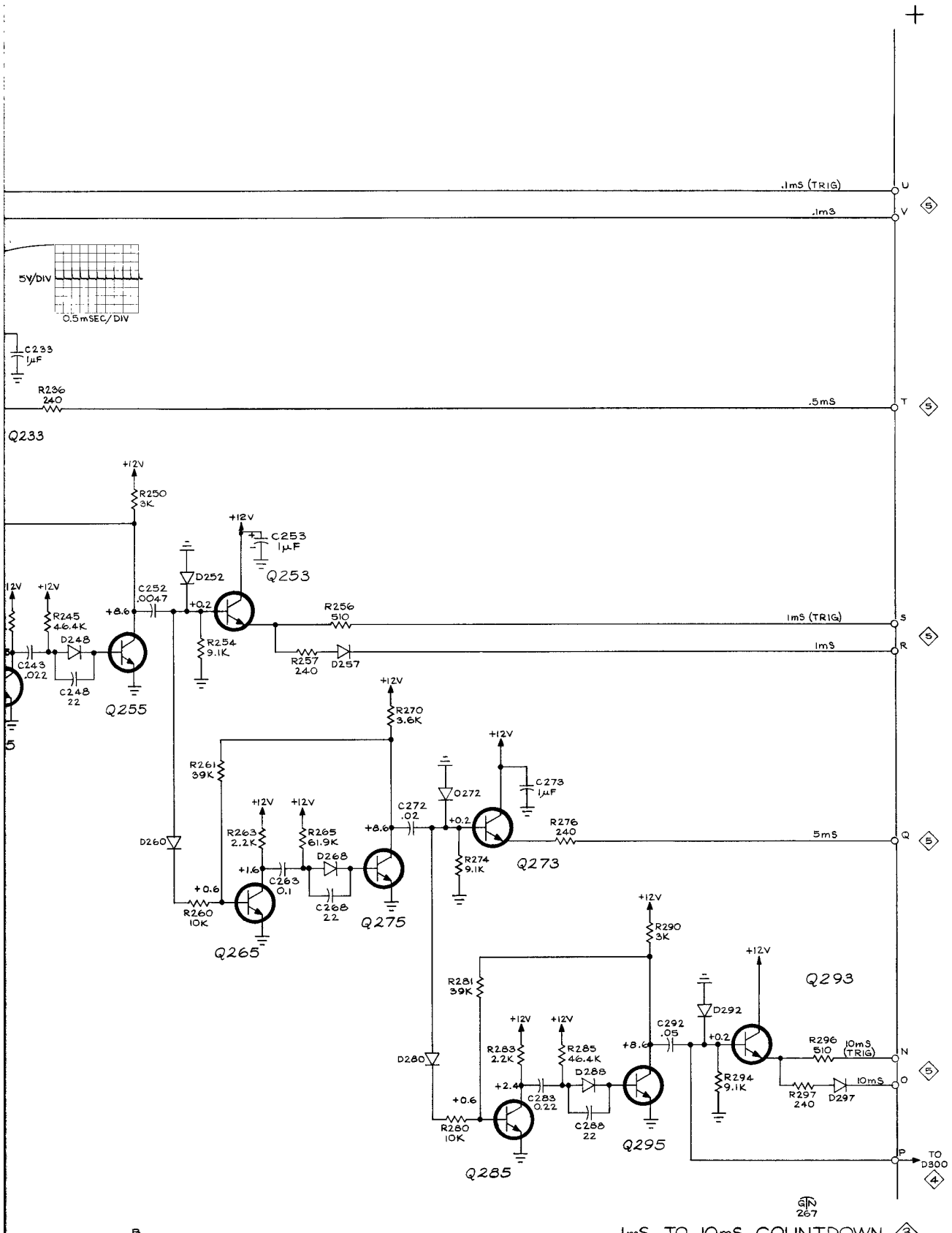
REFERENCE DIAGRAMS

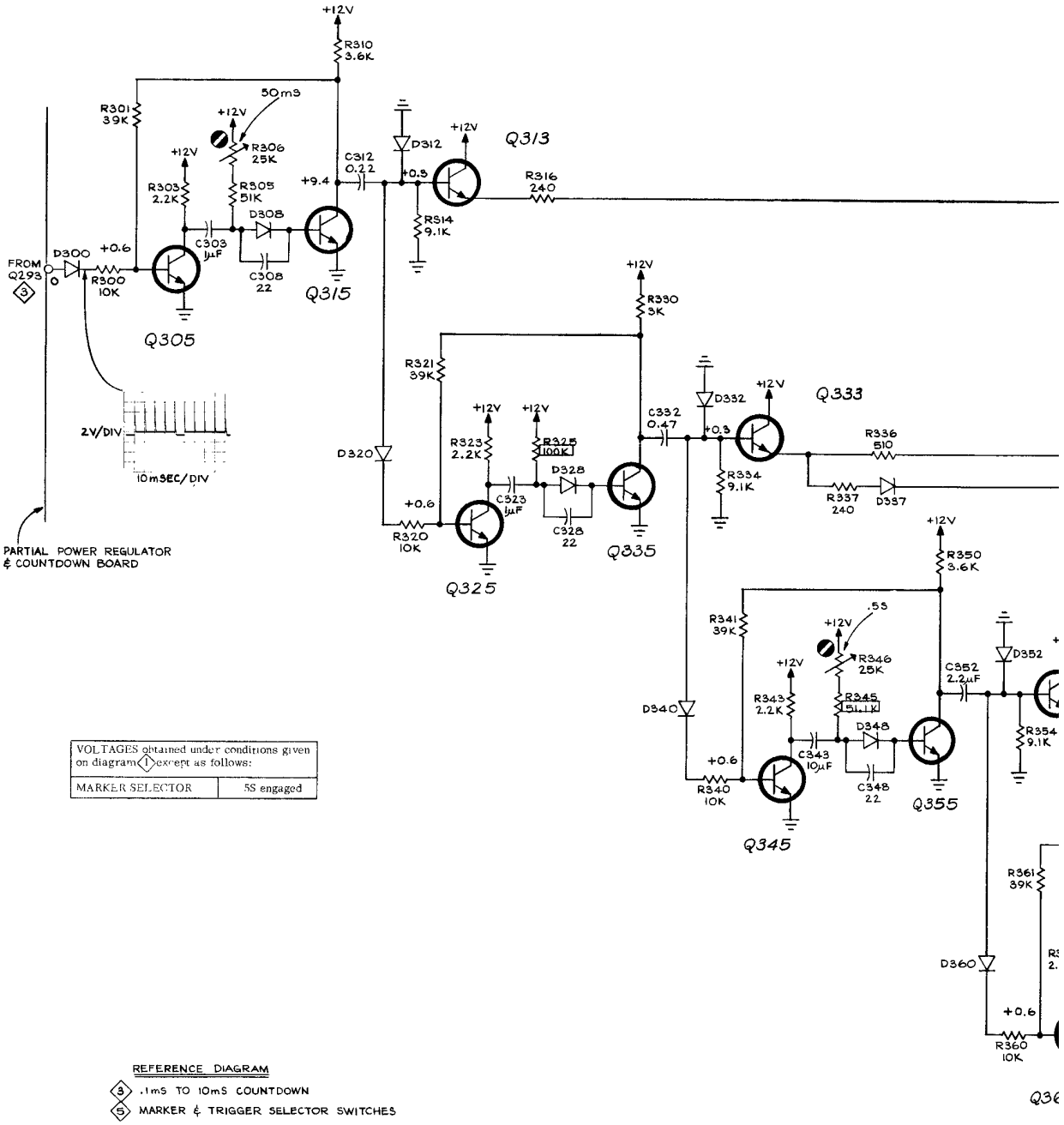
2 .1μS TO 50μS COUNTDOWN

4 50mS TO 5 S COUNTDOWN

5 MARKER & TRIGGER SELECTOR SWITCHES

SEE PARTS LIST FOR SEMICONDUCTOR TYPES


.1mS (TRIG)
U
.1mS
V
5
5V/DIV
0.5mSEC/DIV
C233
1μF
R236
240
.5mS
T
5
Q233
+12V
R250
3K
+12V
C253
1μF
Q253
D252
C252
.0047
+8.6
+0.2
R256
510
1mS (TRIG)
S
5
R254
9.1K
R257
240
D257
1mS
R
+12V
+12V
R245
46.4K
D248
C243
.022
C248
22
Q255
+12V
R270
3.6K
R261
39K
+12V
C273
1μF
D272
+12V
+12V
C272
.02
+8.6
+0.2
R276
240
5mS
Q
5
R263
2.2K
R265
61.9K
D268
D260
+1.6
C263
0.1
R274
9.1K
Q273
+0.6
R260
10K
C268
22
Q275
Q265
+12V
R290
3K
R281
39K
+12V
Q293
+12V
+12V
D292
C292
.05
+8.6
+0.2
R296
510
10mS
(TRIG)
N
5
R283
2.2K
R285
46.4K
D288
D280
+2.4
C283
0.22
R294
9.1K
R297
240
D297
10mS
O
+0.6
R280
10K
C288
22
Q295
Q285
P
TO
D300
4
GN
267
B
.1mS TO 10mS COUNTDOWN
3



VOLTAGES obtained under conditions given on diagram 1 except as follows:	
MARKER SELECTOR	5S engaged

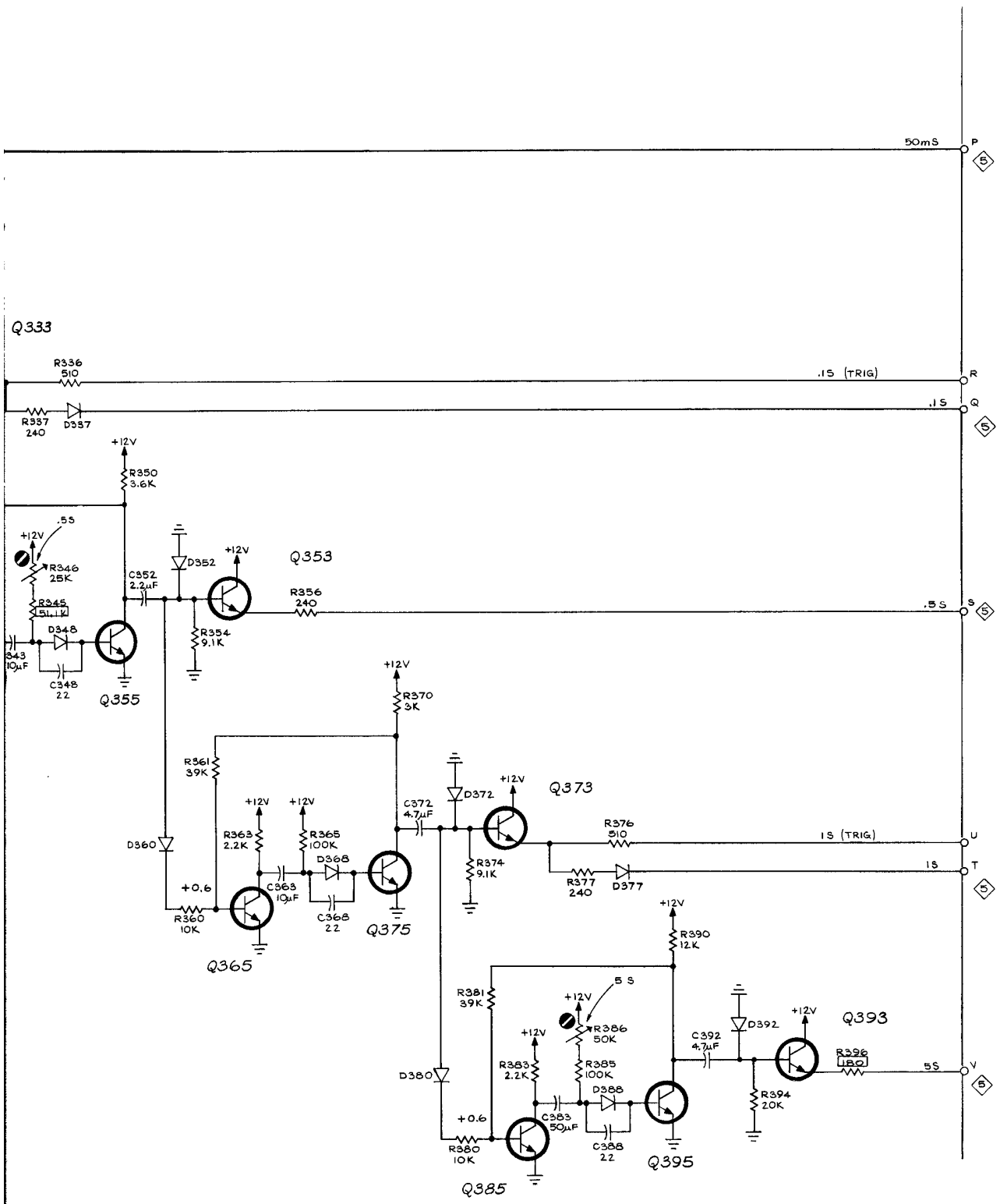
REFERENCE DIAGRAM

3 .1mS TO 10mS COUNTDOWN

5 MARKER & TRIGGER SELECTOR SWITCHES

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

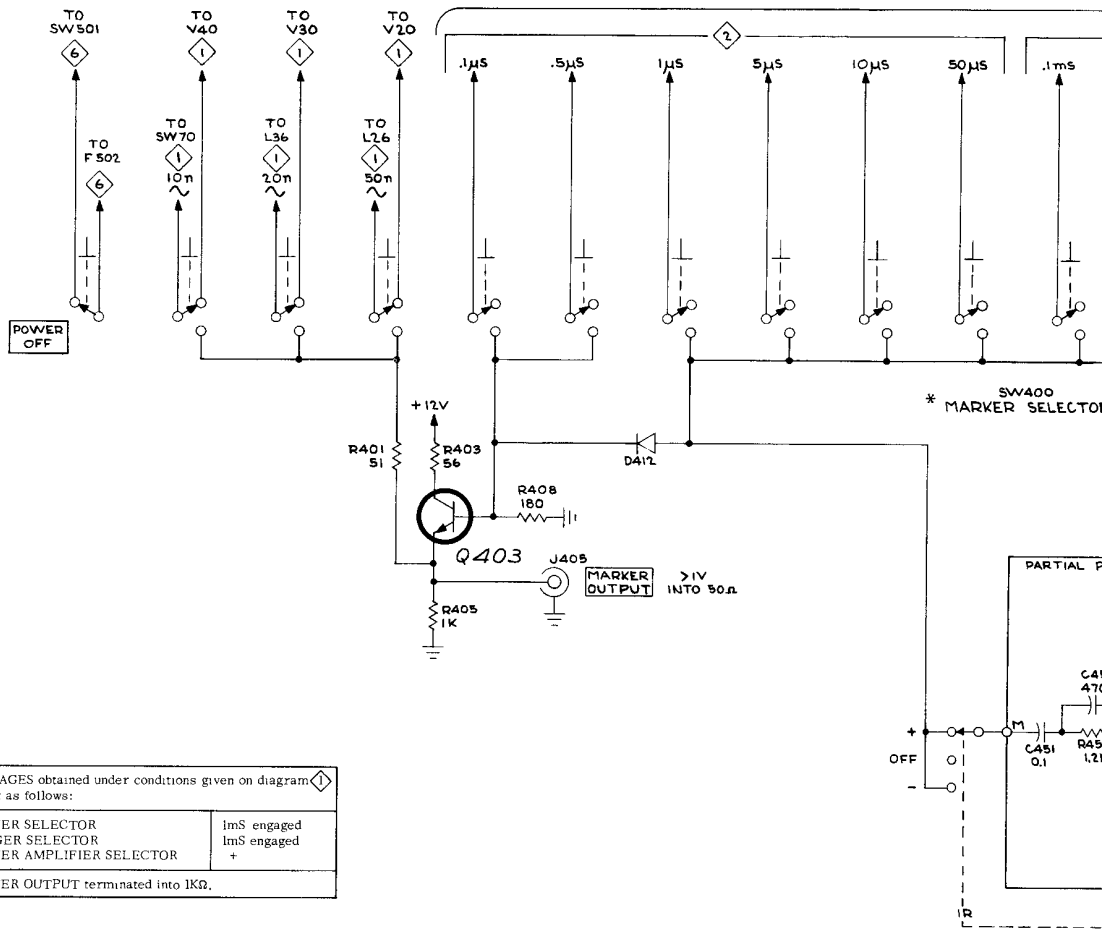
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.



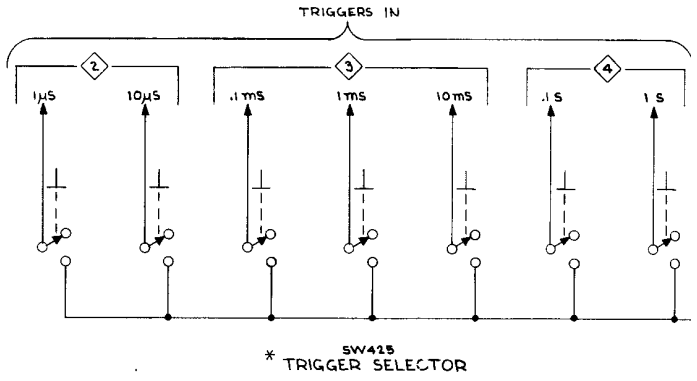
GTN
567

c

50mS TO 5 S COUNTDOWN 4

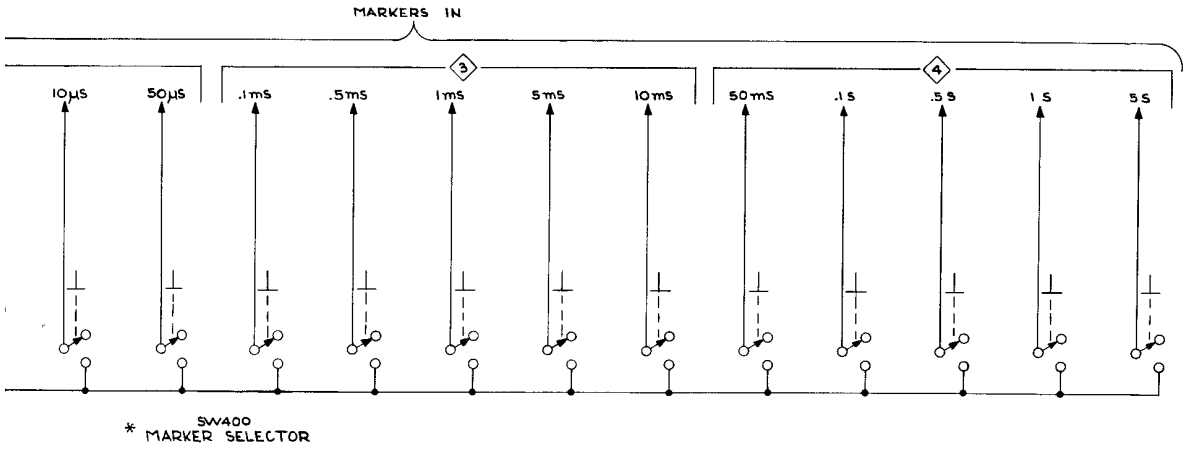


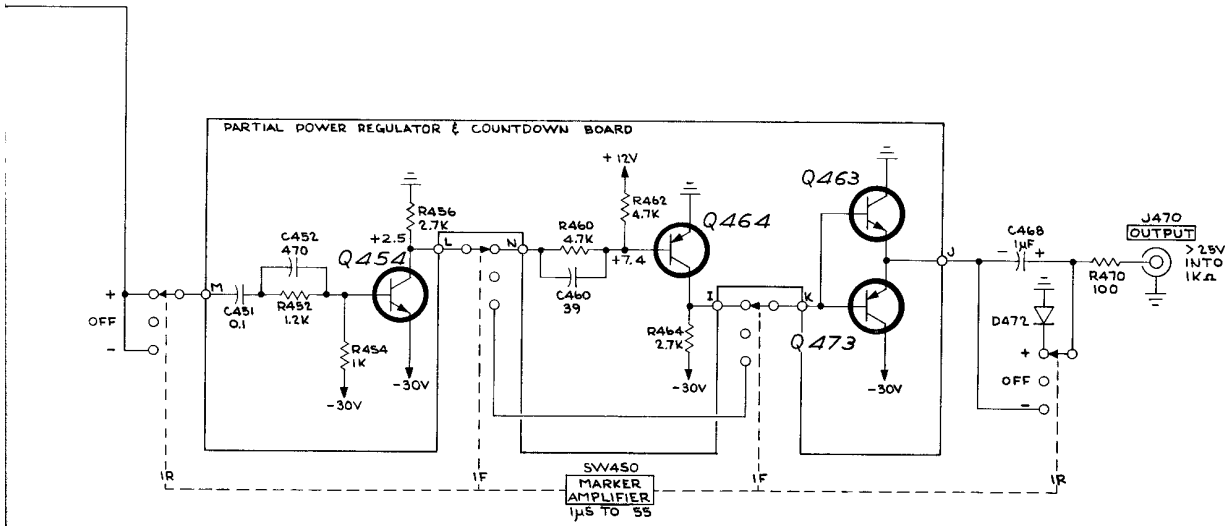
VOLTAGES obtained under conditions given on diagram ◇1 except as follows:	
MARKER SELECTOR TRIGGER SELECTOR MARKER AMPLIFIER SELECTOR	1mS engaged 1mS engaged +
MARKER OUTPUT terminated into 1KΩ.	

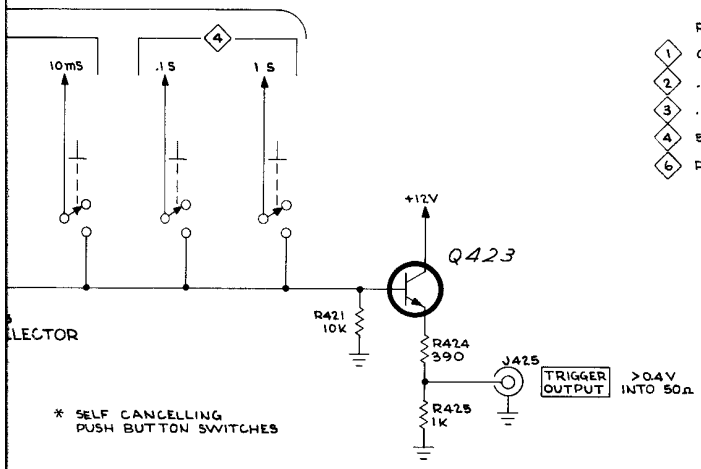


SEE PARTS LIST FOR SEMICONDUCTOR TYPES

* SELF CANCELLING PUSH BUTTON SWITCHES







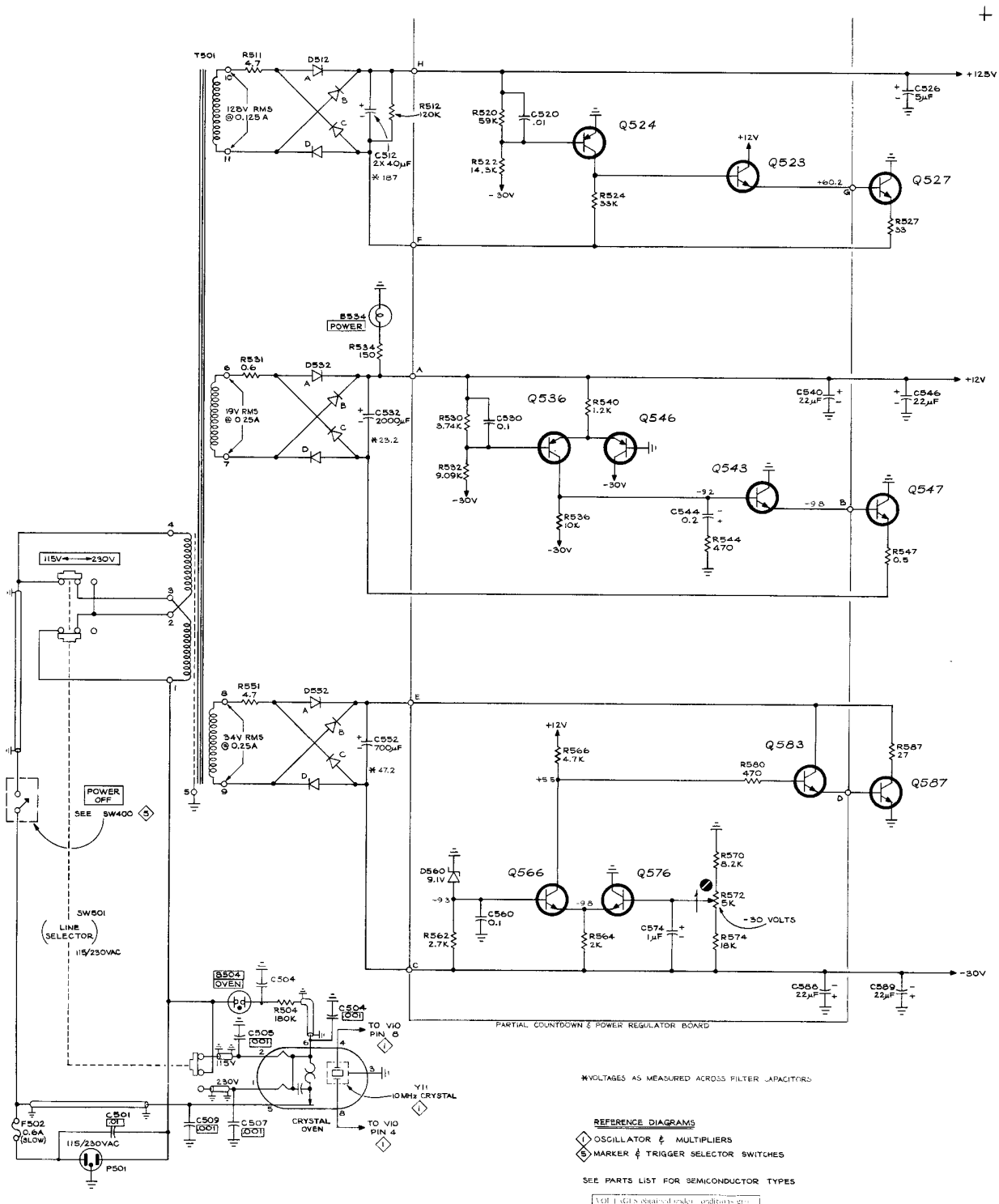
REFERENCE DIAGRAMS

1. OSCILLATOR & MULTIPLIERS
2. .1µS TO 50µS COUNTDOWN
3. .1mS TO 10mS COUNTDOWN
4. 50mS TO 5S COUNTDOWN
6. POWER SUPPLY

B
865

MARKER AMPLIFIER
MARKER AND TRIGGER SELECTOR SWITCHES 5

A1



*VOLTAGES AS MEASURED ACROSS FILTER CAPACITORS

REFERENCE DIAGRAMS

(1) OSCILLATOR & MULTIPLIERS

(5) MARKER & TRIGGER SELECTOR SWITCHES

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

Voltages and waveforms are taken under conditions given on diagram (6)

GN 966

TYPE 184 TIME MARK GENERATOR

c

POWER SUPPLY (6)

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TEXT CORRECTION

SECTION 1 CHARACTERISTICS

Page 1-1, column 2

Trigger Output

Amplitude	$\geq$0.4 V into 50 Ω or $\geq$2.5 V into open circuit.

Other Characteristics

Crystal Oscillator	Crystal contained in a temperature controlled oven at 75°C.
Frequency	10 MHz ±0.001% (25°C ±5°C), 10 MHz ±0.002% (0°C to +50°C) 5 minutes after turn-on if crystal oven is stabilized (insturment connected to power source for 2 hours).
Stability	$\leq$3 P/M in 24 hours (25°C ±5°C) after 2 hours continuous operation and 72 hours intial operation.
Power Requirements	94.5 to 137.5 VAC or 189 to 275 VAC. 50 to 400 Hz. 40 watts approximate.
Warm-up Time	Two hours warm-up time required after the instrument is connected to a power source, to allow crystal oven to stabilize. 5 minutes for rated accuracies at 25°C ±5°C (if crystal oven is stabilized).

SECTION 5 PERFORMANCE CHECK

Page 5-1, column 2

Step 2 a

Change: Requirement—Frequency 10 MHz ±100 Hz at ambient room temperature.

Page 5-3, column 2

Step 6 a

Change: Requirement—Positive-going pulses in 1-10 sequence, amplitude $\geq$0.4 V into 50 Ω or $\geq$2.5 V into open circuit.

SECTION 6 CALIBRATION

Page 6-5, column 2

Step 3 c

Change: Check—regulation and ripple of the power supplies while changing the input supply voltage between 94.5 to 137.5 VAC (or 189 to 275 VAC). Power supply.....

Page 6-15, column 2

Step 9 a

Change: Requirement—Positive-going pulses with 7 intervals in 1 to 10 sequence, from 1 µs to 1 s, and an amplitude $\geq$0.4 V into 50 Ω or $\geq$2.5 V into an open circuit.

TYPE 184

TEXT CORRECTION

Section 1 Characteristics

Page 1-1 column 2

CHANGE: Other Characteristics to read:

Stability	Frequency drift ≤3 P/M in 24 hours (25°C ±5°C) after 2 hours continuous operation and 72 hours initial operation.

Section 5 Performance Check

Page 5-3 column 2

CHANGE: Step 6 a to read:

Requirement-- Positive-going pulses in 1-10 sequence, amplitude ≥0.4 V into 50 Ω or ≥2.5 V into open circuit.

TYPE 184 TENT SN 2200

PARTS LIST CORRECTION

CHANGE TO:

B534	150-0065-00	Incandescent, 10 V, 40 mA

TYPE 184 TENT SN 2060

PARTS LIST CORRECTION

CHANGE TO:

R325	321-0385-00	100 k	1/8 W	1 %
R345	323-0357-00	51.1 k	1/2 W	1 %
C323	290-0183-00	1 µF	20 V	±10 %
C343	290-0301-00	10 µF	20 V	±10 %