TECHNICAL MANUAL

OPERATOR'S

ORGANIZATIONAL, DS, GS, AND DEPOT MAINTENACE

MANUAL

ELECTORNIC MARKER GENERATOR AN/USM-271

(NSN 6625-00-982-1543

This copy is a reprint which includes current pages from Changes 1 and 2. Title was changed by Change 2.

HEADQUARTERS, DEPARTMENT OF THE ARMY

FEBRUARY 1971

WARNING

DANGEROUS VOLTAGES

EXIST IN THIS EQUIPMENT

Be especially careful when working on the

power supply where a potential of 270 volts

may be encountered.

DON'T TAKE CHANCES

This manual is an authentication of the manufacturer's commercial literature which, through usage, has been found to cover the data required to operate and maintain this equipment. Since the manual was not prepared in accordance with military specifications, the format has not been structured to consider level of maintenance nor to include a formal section on depot overhaul standards.

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TECHNICAL MANUAL
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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASIHNGTON, D. C. , *8 February 1971*

Operator's, Organizational, DS, GS, and Depot Maintenance Manual ELECTRONIC MARKER GENERATOR ANI/USM-271 (NSN 6625-00-982-1543)

CAUTION

Special 3%o silver solder is required on the ceramic terminal strips in this equipment. A 40- to 75-watt soldering iron should be used and it should be tinned with the same special solder. Additional quantities of the solder may be procured under FSN 3439-912-8698. Ordinary solder may be used only in dire emergency.

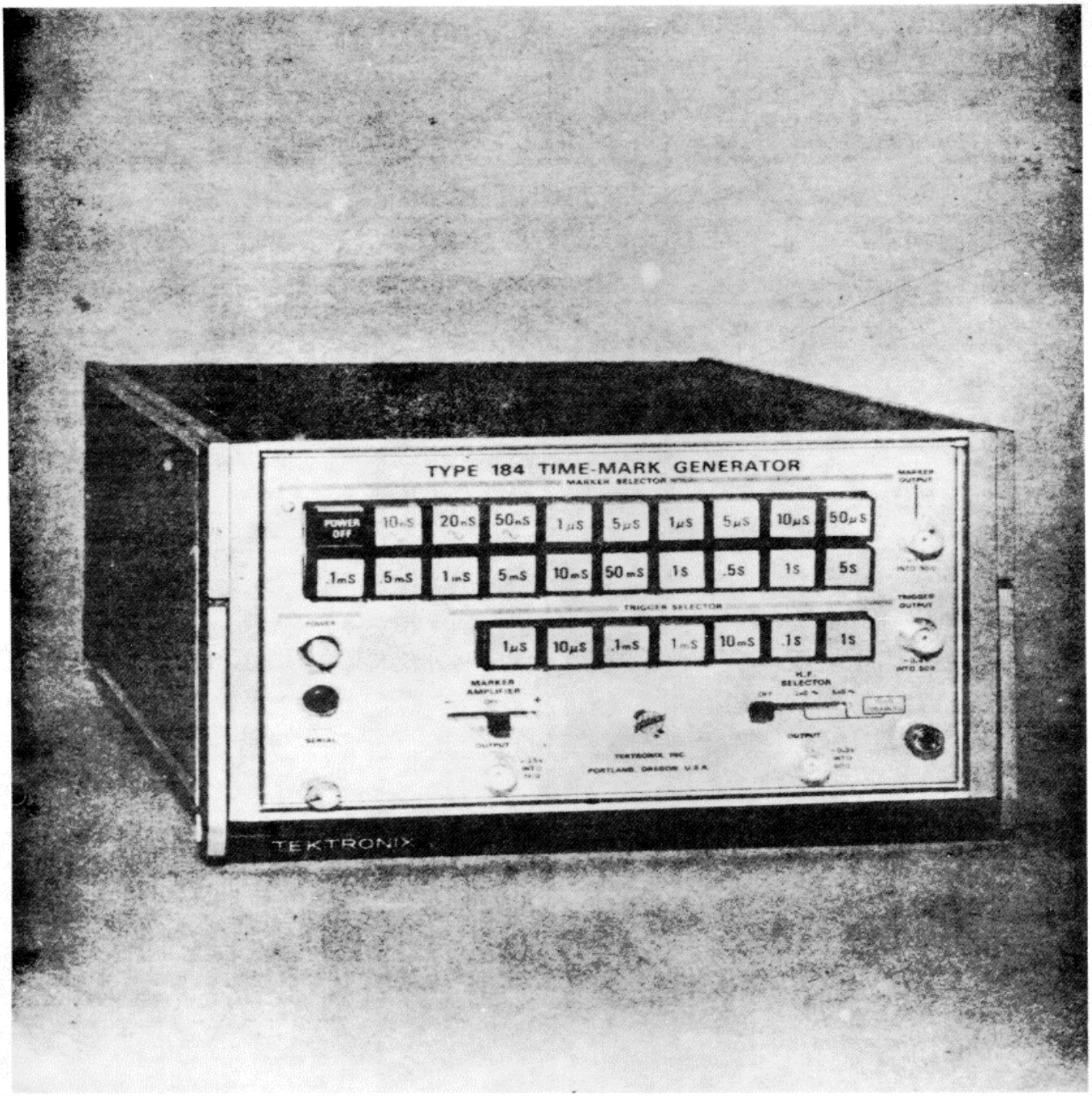


Fig. 1-1. TYPE 184 TIME-MARK GENERATOR

(A)

SECTION 1
INTRODUCTION

1-1. Scope

a. This manual includes installation and operation instructions and covers organizational, general sup port, and depot maintenance. It describes Electronic Marker Generator AN/USM-271 and its major components, Electronic Marker Generator SG-767/U, Special Purpose Electrical Cable Assembly CX-10551/U, Radii Frequency Cable Assembly CG 3363/U, and Electrical Dummy Load DA463/U. The equipment is identified throughout this manual as the Tektronix Inc. Type 184.

b. This manual is an authentication of the manufacturer's commercial literature which, through usage has been found to cover the data required to operate and maintain this equipment. Since the manual was not prepared in accordance with military specifications, the format has not been structured to considered category of maintenance nor to include a formal section on depot maintenance. Refer to the maintenance allocation chart, appendix C, for maintenance functions allocated to each category of maintenance.

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to the latest issue of DA Pam 3104 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to deter mine whether there are modifications work order (MWO's) pertaining to the equipment.

1-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment Maintenance forms, records, and report; which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38750.

b. Report of Packaging and Handling Deficiencies Fill out and forward DD Form 6 (Packaging Improvement Report) as prescribed in A; 700-58/NAVSUPINST 4030.29/AFR 71-13/MC(P4030.29A, and DSAR 4145.8.

c. Discrepancy in Shipment Report (DISREP).(SF361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVUSPINST 4610.33A/AFR 75-18/MCO P4610.19B, and DSAR 4500.15.

1-4. Destruction of Army Electronics Materiel.

Destruction of Army electronics materiel to preventing enemy use shall be in accordance with TM 750244-2.

1-5. Administrative storage

For procedures, forms and records, and inspections - required during-administrative storage of this equipment, refer to TM 740-90-1.

1-6. Reporting of Errors

Report of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded direct to Commander, US Army Electronics Command, ATTN: DRSEL-MA-Q, Fort Monmouth, NJ 07703.

1-7. Reporting Equipment Improvement Recommendations (EIR)

EIR will be prepared using DA Form 2407, Maintenance Request. Instructions for preparing EIR's are provided in TM 38-750, The Army Maintenance Management System. EIR's should be mailed directly to Commander, US Army Electronics Command, ATTN: DRSEL-MAQ, Fort Monmouth, NJ 07703. A reply will be furnished directly to you.

1-8. Purpose and Use

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 up to 5 seconds. All outputs of the Type 184 are frequency controlled by a stable 10-MHz crystal oscillator.

1-9. Operating Data

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

b. Marker Periods.

(1) *Sinusoidal* 10, 20, and 50 nanoseconds (ns) (H.F. SFTECTOR) must be off for 10 ns markers.

(2) *Periodic Pulses.*

(a) 0.1, 0.5, 1, 5, 10, 50 As.

(b) 0.1, 0.5, 1, 5, 10, 50 ms.

(c) 0.1, 0.5, 1, 5 S.

c. Hf Output. Provides 2 ns or 5 ns sine-wave markers of 0.3-volt minimum amplitude (into 50).

d. Marker Amplifier Output Provides positive or negative time marks of 25-volt minimum amplitude (into 1). Marker intervals are from 1 microsecond (i s) to 5 seconds (s) established by the pushbutton MARKER SELECTRO switches.

e. Trigger Output. Provides positive triggers of 0.4-volt minimum amplitude (into 50). Period is established

by pushbutton TRIGGER SELECTOR switches.-Trigger periods are land 10, s; 0.1, 1, and 10 ms; 0.1 and 1

f. Other Characteristics.

(1) *Crystal Oscillator.* Crystal is contained in temperature controlled oven at 750 C.

(a) Frequency. Adjustable to 10-MHz standard

(b) Stability. Maximum change in frequency, : ppm (parts per million) in 24 hours.

(2) *Power Requirements.* 93.5 to 135 volts ac or 18 to 270 volts ac, 50 to 400 Hertz, 40 watts approximately

(3) *Warmup Time*. Two hours warmup time is required after the instrument is connected to a power source; allow crystal oven to stabilize 5 minutes for rated accuracies at 250 C ±5° C (if the crystal oven is stabilized).

1-10. Mechanical Specifications

The dimensions of the Type 184 are 9 inches wide, 6 inches high, and 14-4 inches long. The front panel is anodized aluminum and the cabinet is finished in blue vinyl paint. No special ventilation is required.

1-11. Items Comprising an Operable Equipment

NSN	Qty	Nomenclature	Fig No.
6625-W0-982-1543		Generator Electronic Marker AN/USM-271 Consisting of:	1-1
	2	Cable Assembly, Radio Frequency CG-3363/U (3 ft. S in.)	
6625-00-935-2634	1	Cable Assembly, Special Purpose, Electrical CX-10551U (8 ft. 1 in.)	
6625-00-935-4954	1	Dummy Load, Electrical DA-463/U	
6625-00-054-3479	1	Generator, electronic Marker SG-767/U	

1-12. Test Equipment Cross Reference

The following is a cross reference of test equipment referenced in this manual and items authorized in the maintenance allocation chart.

Commercial test equipment	*Authorized test equipment*
Oscilloscope, Tektronix 540 and 560 series	Oscilloscope AN/USM-273
Variable autotransformer General Radio p/n W10MT3W	Transformer, Variable Power TF-510/U
Digital counter	Counter, Electronic, Digital Readout AN/USM-257, including Converter, Frequency, Electronic CV-2350/U. Electronic CV-2350/U
Dc voltmeter	Multimenter ME-333/U
Ac voltmeter	Voltmeter, Electronic AN/USM-265.

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 11 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 .1µs to 5s are individually selected or stacked by depressing pushbutton selector switches. Sine-wave marker intervals of 10, 20 and 50 n 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 (1µs 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 50f) in amplitude.

High amplitude time markers, (>25 V into 1 k(i) from 1 its to 5s 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-canceling 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 f.

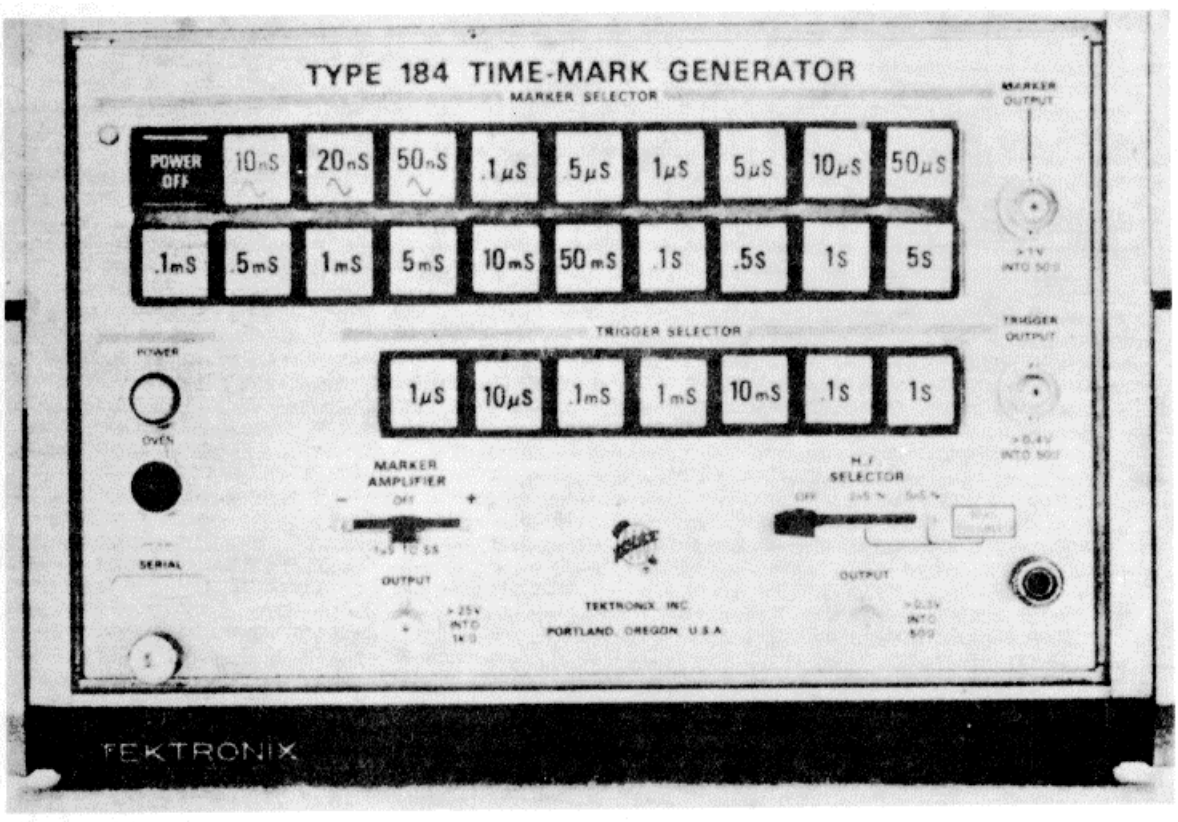


Fig. 2-1. TYPE 184 TIME-MARK GENERATOR

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 decode time markers. They are available at the TRIG GER OUTPUT connector as positive-gain pulses with a minimum amplitude of 0. volts into 50o.

H.F. SELECTOR — Selects 2ns (50OOMHz) or 5ns (200MH2 sine-wave signal and applies either to th OUTPUT connector directly below the H.F SELECTOR switch. Amplitude of these sine wave time-marker intervals at the OUTPU connector is greater than 0.3 volts int 50f. When the H.F. SELECTOR switch in either of these two positions, the 10n 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 /s to 5s established by the MARKER SELECTOR pushbutton switches are available as positive or negative, amplified time markers at the OUT- PUT connector below the switch. The amplitude of these time markers is greater than 25 volts into 1 k;.

POWER — Power is applied when any one of the IndicatorMARKER 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

3-1 . 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.

3-2. Block Diagram

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

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

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

Time markers from .1 s through 5 s, selected by the MA ER SELECTOR switch, are applied through an emitter lower to the MARKER OUTPUT connector. These mar 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, .I ms, 1 ms, 10 .1 s and 1 s may be selected by the pushbutton TRIGGER SELECTOR switch. The selected trigger pulse is fed to emitter follower which provides positive trigger signals 0.4 volt minimum amplitude (into 50) at the OUTI connector.

3-3. OSCILLATOR AND MULTIPLIERS

Oscillator

The oscillator V10 is connected as a crystal-controlled grid, tuned-cathode oscillator. The plate tank is tuned the 5th harmonic, which quintuples the oscillator frequency Double-tuned tanks in the cathode and plate circuits crease 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 turned provide high Q and attenuate frequencies other than the desired output. The output signal is link-coupled to match the load.

50ns 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 100MHz 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 200MHz board employs four diodes, connected as q 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 2ns circuit quintuples the 100MHz from the plate tank of V40. The link-coupled 100MHz 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 100MHz 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 500MHz. 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 SW;400 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.

3-4. SHAPER AND COUNTDOWN CIRCUITS

Countdown and shaper circuits for the .1 /s to 10ms 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 /s 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

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

.5 μs, (:5) Countdown

Countdown is achieved by the bucket and ladle action of C105 and C107-C108IO. C105 dumps its charge each .1 Ms through 0114 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 a and provides the .5 , s time markers

The voltage step from the .1)Ls shaper amplifier is also applied through C105 to the emitter of Ql14. The positive 1 s pulse turns Q114 on and dumps a charge into C107 and CI08. 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 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 Tl15 drives the transistor to saturation and generates a sharp positive-going pulse. Diode Dl15 prevents negative voltage excursions at the out- put 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 76ns 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 hold- off 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 .5ps marker pulse drives Q130 into conduction. Feedback from the transformer T130 drives the transistor to saturation. Capacitor C130 is charged to approximate 10 volts during this on time. When the transformer field collapses and drives Q130 to the off state, the decay- ing charge on C130 will prevent the second .5 , s time mark from triggering Q130 on. When the third input .5 s 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 As 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 count- down from 1 μs to 5μs 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 Jo the back voltage developed when C152 is discharged.

10 μs to 10 ms Countdown Circuits

These circuits are identical to the above 5 Es 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 50ms and .5s 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.

3-5.

Marker Amplifier

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

Marker intervals from 1 μs to 5s 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

(A)l

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

3-6. 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 tops of a single transformer T501. These regulators will maintain a constant regulated output with ac input fluctuations of 93.5 to 135 or 187 to 270 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 volt- age 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 volt- age 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 0576. 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 volt- age 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. Volt-age error signals are amplified and applied to the emitter- follower Q523 which controls the current through the series regulator transistor Q527.

3-7. Marker and Trigger Selector 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 5s, connect through the push-button 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 us 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 is to 1 s. Contact is mode through pushbutton contacts and applied to emitter-follower transistor 0423. The output is a minimum trigger pulse of 0.4 V into 50 Ωtermination at the TRIGGER OUTPUT connector J425.

SECTION 4
MAINTENANCE

4-1. PREVENTIVE MAINTENANCE DATA

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 appears in Section 7 of this manual.

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. 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.

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. Other- wise, the damage may be repeated.

4-2.
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.

4-3. 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.

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/s-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 re- moved.

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. Use of ordinary solder should be avoided On the ceramic terminal strips. Use a 40- to 75-watt soldering iron with I/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. additional quantities may be procured on FSN 3439-912 8698.

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 interconnecting plug pins, switch terminals, potentiometers etc.), ordinary 60/40 solder can be used. The solder iron should have a 40. to 75-watt rating with a l/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 sup- plied under separate pert numbers. The old spacers may be reused if they are not damaged.

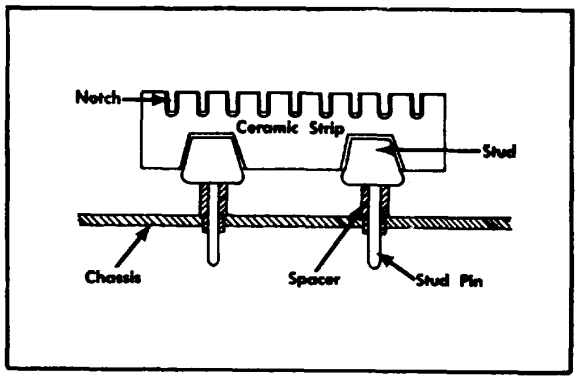


Fig. 4-1. Ceramic terminal strip assembly.

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.

4-4.

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

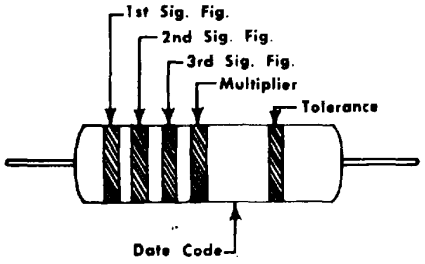
Tubes and transistors should not be replaced unless actually defective. However, temporary substitution is often the fastest and best way to detect a defective tube or transistor. Before substituting a tube or transistor, it is suggested that circuit conditions be checked to be certain that a replacement 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.

4-5. Troubleshooting Aids

This manual and the instrument contain many feature 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. 42.



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.

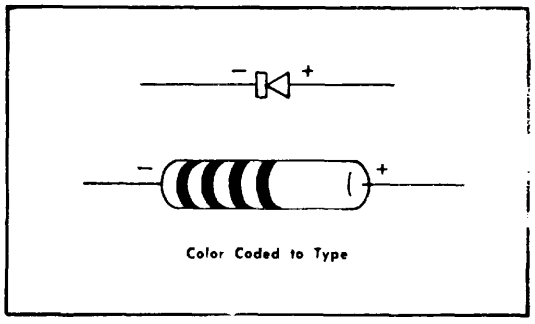


Fig. 4-3. Diode polarity of the glass diodes used in the Type 184.

Fig. 4-3. identifies the polarity of the glass diode types used in this instrument.

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 volt- ages 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.

4-6. 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 10ns circuit is disabled when the H.F. SELECTOR switch 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 count- down circuits are dependent on the preceding circuit to the basic oscillator frequency of 10MHz (.1 ps). 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.

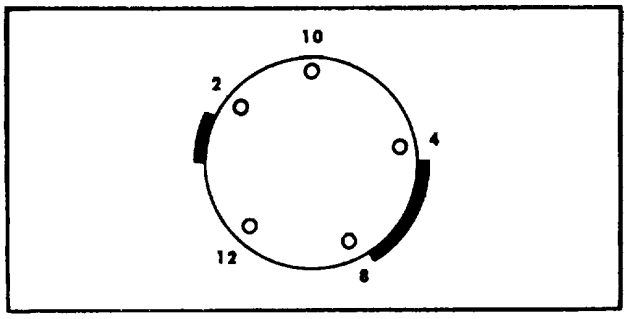


Fig. 4-4. Nuvistors tube pin identification.

Isolate the trouble to the source. For example; failure of the 1μs marker circuit could be caused from failure of the preceding countdown circuit, .5 and .1 ps. 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 volt- age or waveform in the circuit. Typical voltages and wave- forms 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 token 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 10X probe.

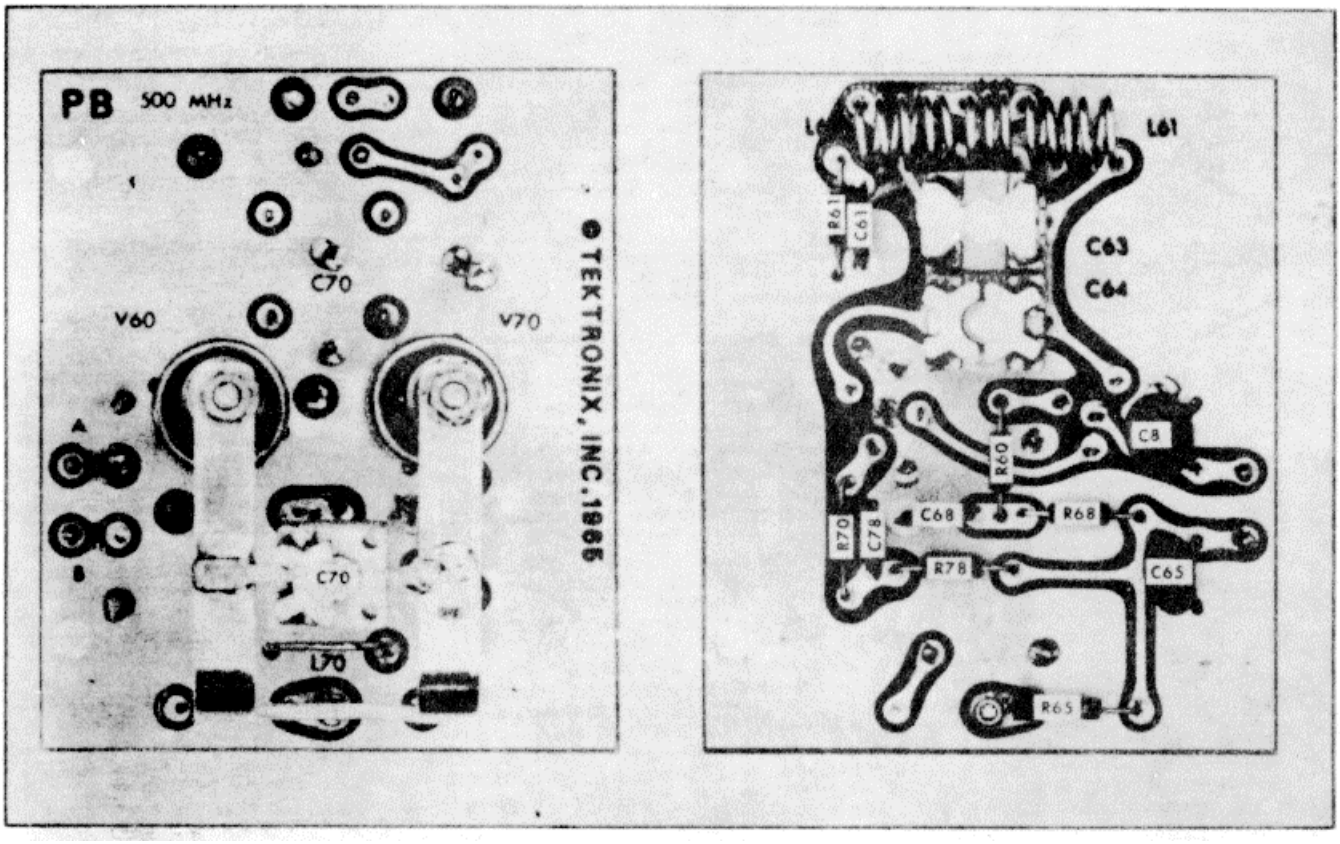


Fig. 4-5. 500MHz (2 ns) etched- wiring board.

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

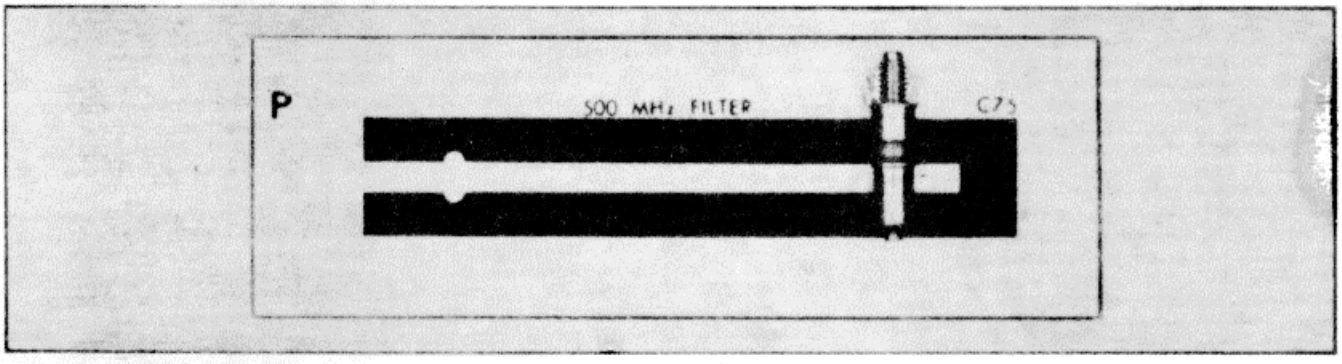


Fig. 4-7. 500MHz filter etched- wiring board.

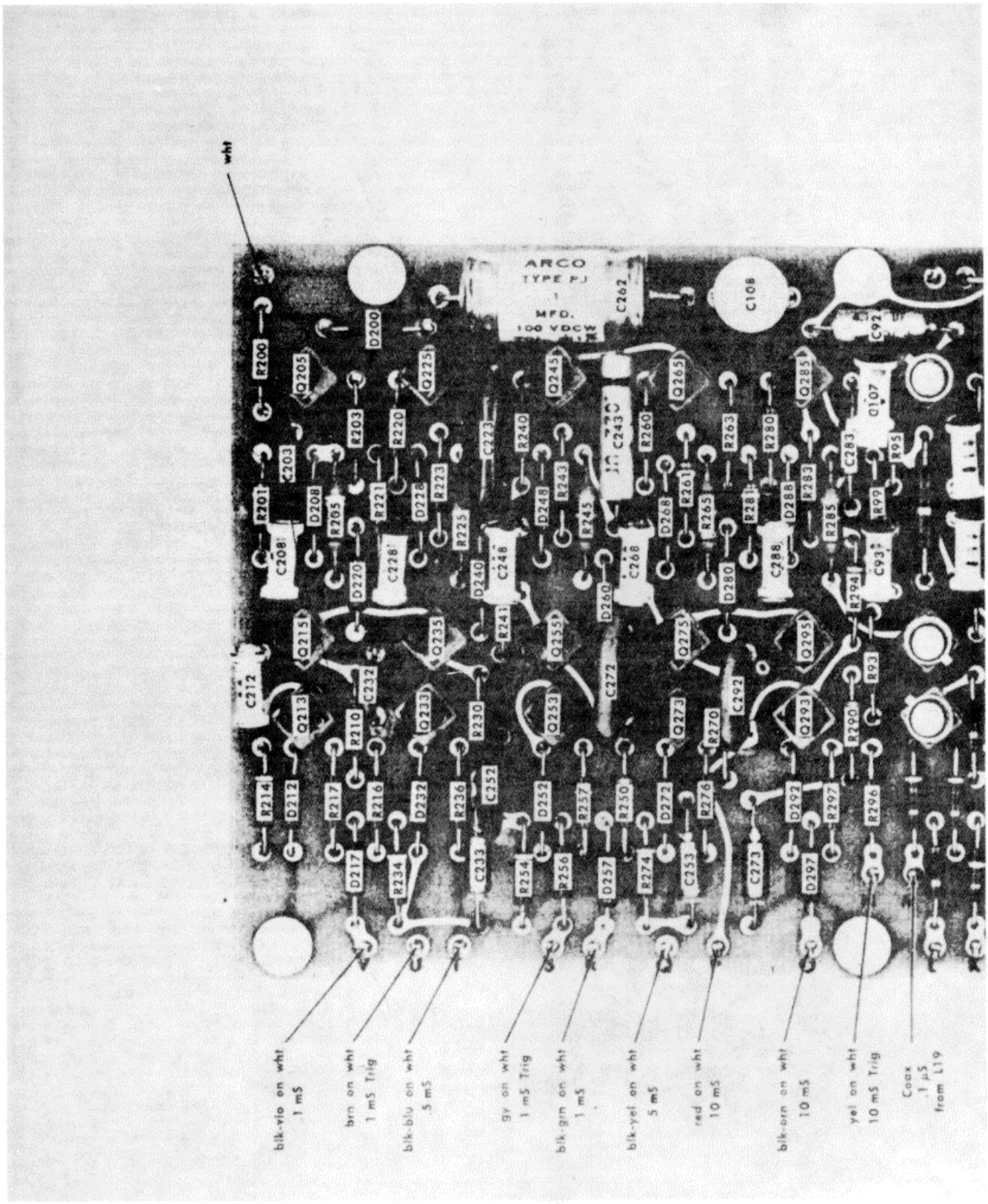


Fig. 4-8a. Upper portion of the .1 µs to 10 ms countdown etched-wiring board.

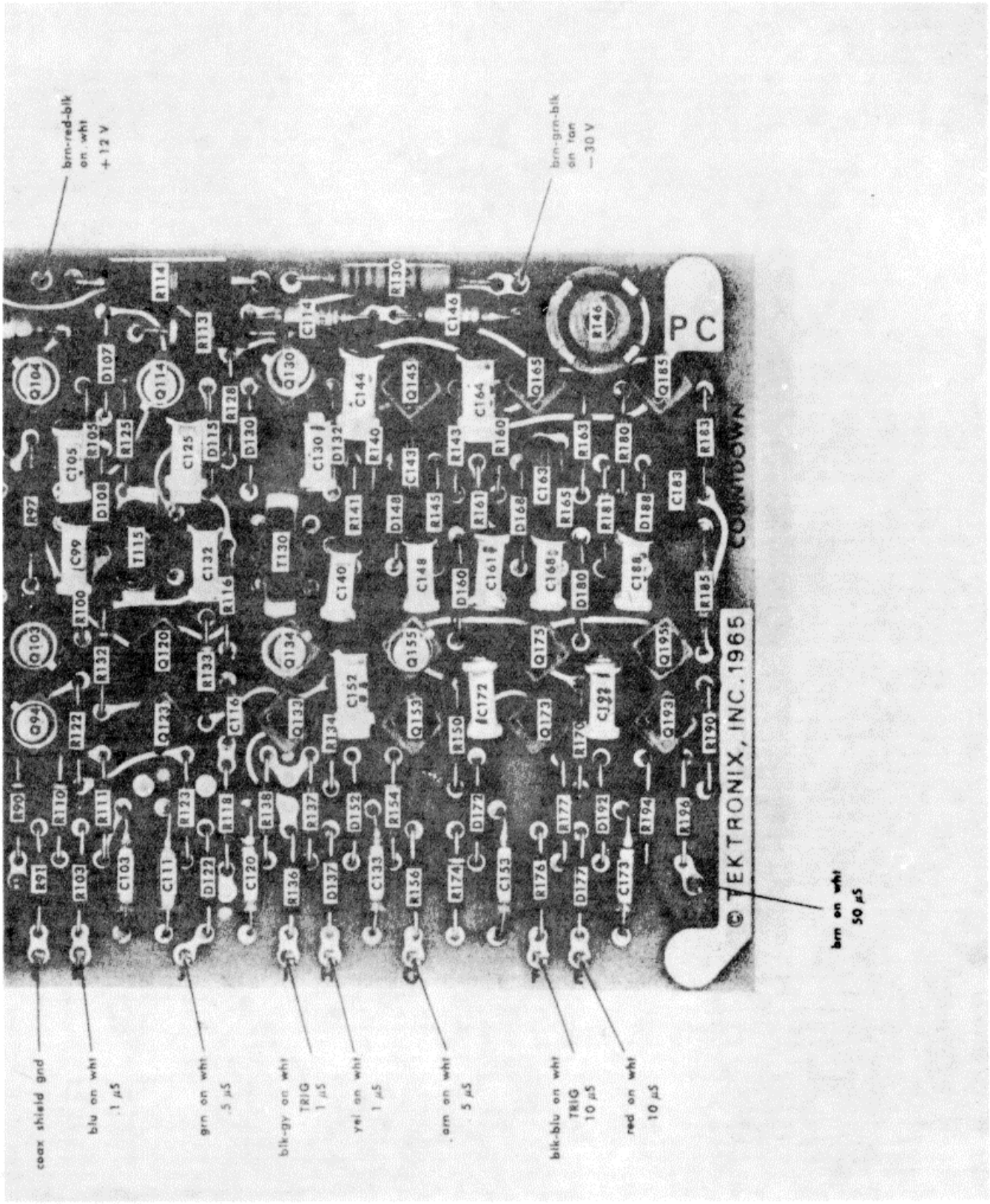


Fig 4-8b. Lower portion of the .1 µs to 10ms countdown etched-wing board.

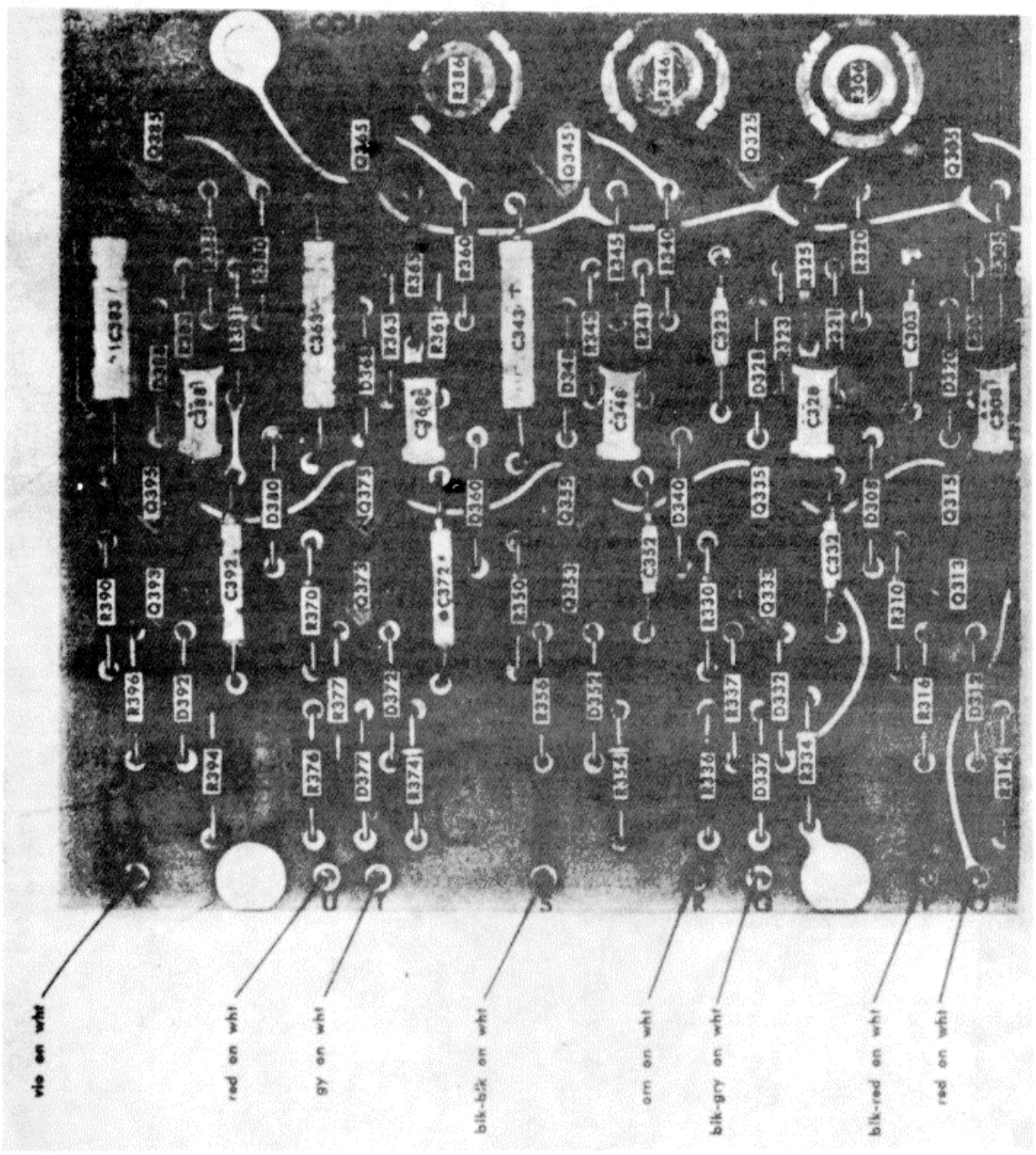


Fig. 4-9a. Lower portion of he 50 ms to 5 s countdown and power regulator etched-wiring board.

(A)

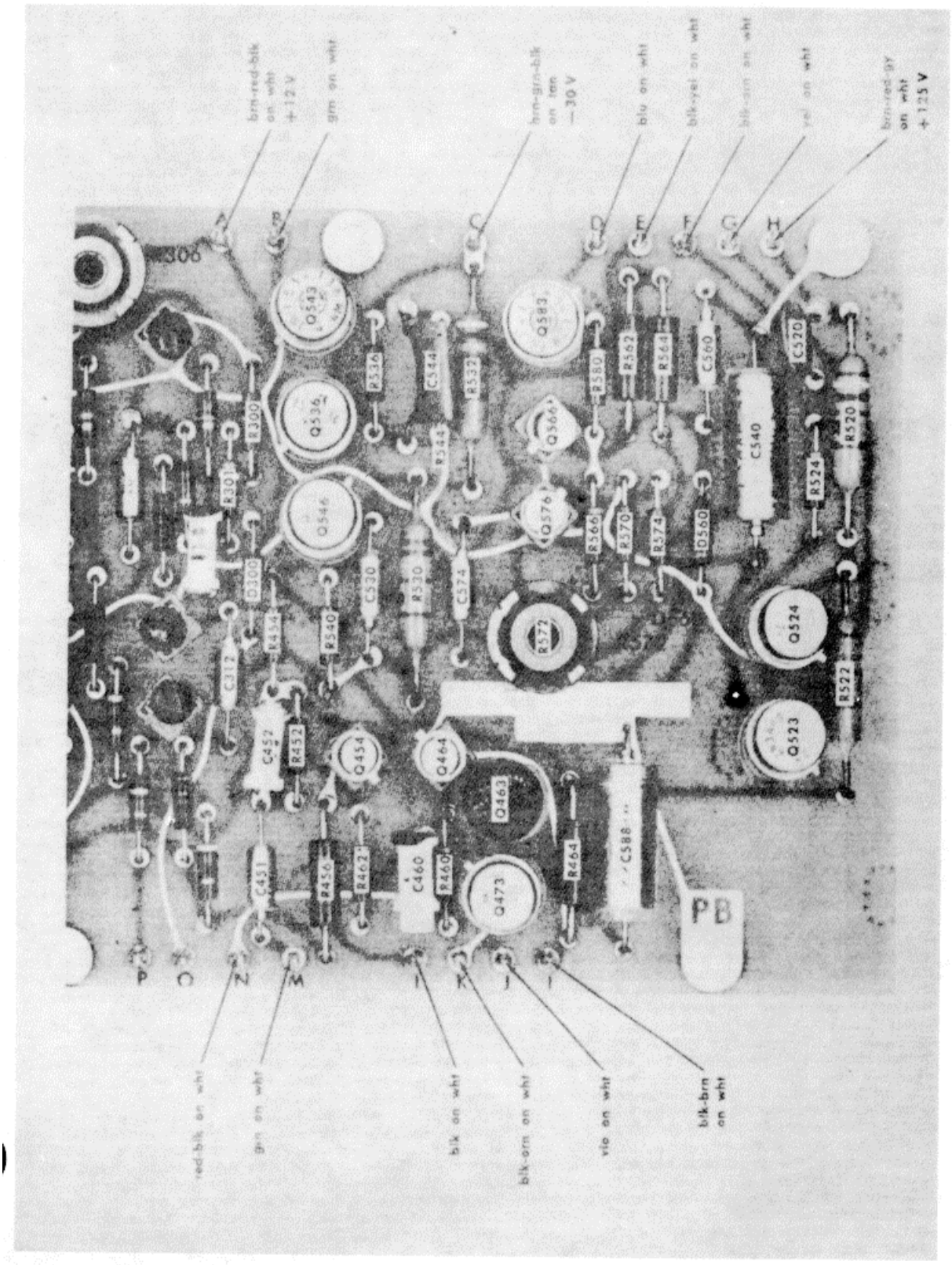


Fig. 4-9b. Upper portion of he 50 ms to 5 s countdown and power regulator etched-wiring board.

SECTION 5
PERFORANCE CHECK

5-1.
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.

5.2.
Recommended Equipment

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

For the most accurate and convenient performance check special calibration fixtures are used in this procedure.

1. Test oscilloscope. Bandpass dc to 30MHz; 0.05 volts/ div deflection factor. Tektronix 540-Series oscilloscope with Type L Plug-In Preamplifier recommended.
2. 1 X probe with BNC connector. Tektronix P6028 Probe recommended.
3. 10OX probe with BNC connector. Tektronix P6006 Probe recommended.
4. Test oscilloscope with' sampling system. Input impedance 50Ω, risetime, 0.4ns maximum. Tektronix 560- Series with Types 3S76 and 3T or Tektronix 540-Series with Type 1S1 Plug-In Unit recommended.
5. Electronic Digital Frequency Counter. Frequency measurement dc to 20MHz. Example: Hewlett Packard 5244L Electronic Counter or equivalent.
6. Termination (one). Impedance 50 o; BNC connectors, Tektronix Part No. 011-0049-00.
7. 5X attenuator. Impedance 50n; GR connectors. Tektronix Part No. 017-0079-00.
8. Adapters, GR to BNC, female. Tektronix Part No. 017- 006300.
9. Adapter, clip lead to BNC. Tektronix Part No. 013- 0076o00.
10. Adapter, BNC to dual binding post. Tektronix Part No. 103 0035-00.
11. Cable (two). Impedance 50 n; type RG58/AU, length 42 inches, BNC connectors. Tektronix Part No. 012-0057
12. Termination. 1 kΩ(, 1/2 watt, 1% tolerance (Special).

5-3.
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.

5-4.
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.

5-5. PERFORMANCE CHECKS

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 +30 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 ;S marker from the MARKER OUTPUT connector through a 50 (I coaxial cable and 50 termination resistor to the Input connector of a digital frequency counter or equivalent frequency measuring device.

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

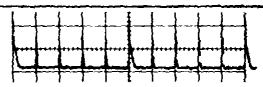
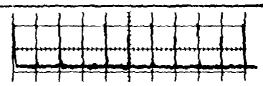
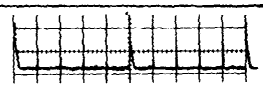
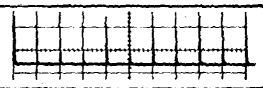
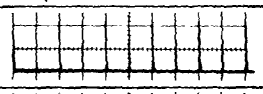
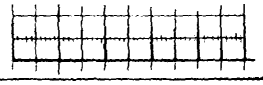
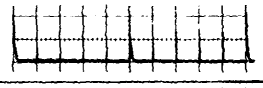
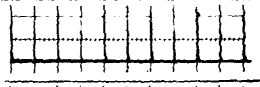
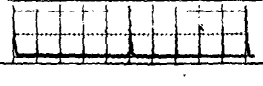
d. Remove the coaxial cable and 50f termination from the frequency measuring device.

3. Check .1 /S to 5 /LS 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	10 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 50coaxial cable and 5 termination resistor to the vertical Input connector of vertical plug-in unit (Type L) in the test oscilloscope.

d. Set the Type 184 and test oscilloscope controls 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 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 5s in 1-5-10 sequence, 25-V minimum amplitude into 1 kg.

b. Connect a BNC to binding post adopter to the MARKER AMPLIFIER OUTPUT connector. Attach a 1 kΩ 1/2 watt, 1% resistor across the dual binding post adopter. Connect a clip lead to BNC adapter to the dual binding post adapter (red lead to the red binding post). Connect a 50f2 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 deflatfion 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 with 7 intervals of 1 μs to 1 s in 1-10 sequence, 0.4-V minimum amplitude into 50 n

b. Apply the signal from the TRIGGER OUTPUT connector through a 50 Ω coaxial cable and 50Ω 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

Type184 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 signal 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 5XT, 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

Crt controls — Adjust for well focused display of nominal brightness

Time Base Plug-In Unit (Type 3T77)

Time/Div	As indicated in Table
Sweep Mode	Normal
Trigger	+ nt
Horiz Mag	X1
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

Type184 TRIGGER SELECTOR	Test Oscilloscope Time/Cm	Cycle/Div
50 nS	50 nSEC	1
20 nS	20 nSEC	1
10 nS	IO nSEC	1

e. Remove the 50 0 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-500MHz (2 ns) and 200MHz (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

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

Type184 TRIGGER SELECTOR	Test Oscilloscope Time/Cm	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

ALIGNMENT AND ADJUSTMENT

6-1.
Introduction

This procedure can be used either as an operational check or to completely adjust the instrument. The title of each numbered step begins with either "Adjust" (1) 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" step 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 ore 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 adjust the Type 134 and should not be construed as final calibration. If the Type 184 performs within the guide tolerances given in adjustment procedure, it will meet all listed specifications in the Characteristics section of the manual. The official calibration procedure is listed in TB 750-236.

6-2. EQUIPMENT REQUIRED

The following equipment or its equivalent is required for adjustment of the Type 184. Specifications are the minimum necessary for accuracy 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.

The maintenance allocation chart in Appendix C lists the tools and test equipment available to Army maintenance personnel.

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

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

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

4. Test oscilloscope with sampling system: Input impedance 50 1, risetime 0.4 mS maximum. Tektronix 560-Series with Types 3S76 and 3T77 or Tektronix 540-Series with Type 1Sl 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 ex- ample: General Radio WlOMT3W Metered Variac Auto- transformer.

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

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

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

9. 5X Attenuator: Impedance 50Ω, GR connectors. Tektronix Port 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 50Ω, type RG58/AU, length 42 inches, BNC connectors. Tektronix Part No. 012-0057-00.

14. Termination (special): 1 kΩ resistor, 1/2 watt, 1% tolerance.

Adjusting Tools (see Fig. 6-2)

Description

a. Insulated screwdriver, 11/2-inch shaft, non-metallic
b. Screwdriver, 3-inch shaft
c. Tuning rod, 5-inch

*Parts per million.

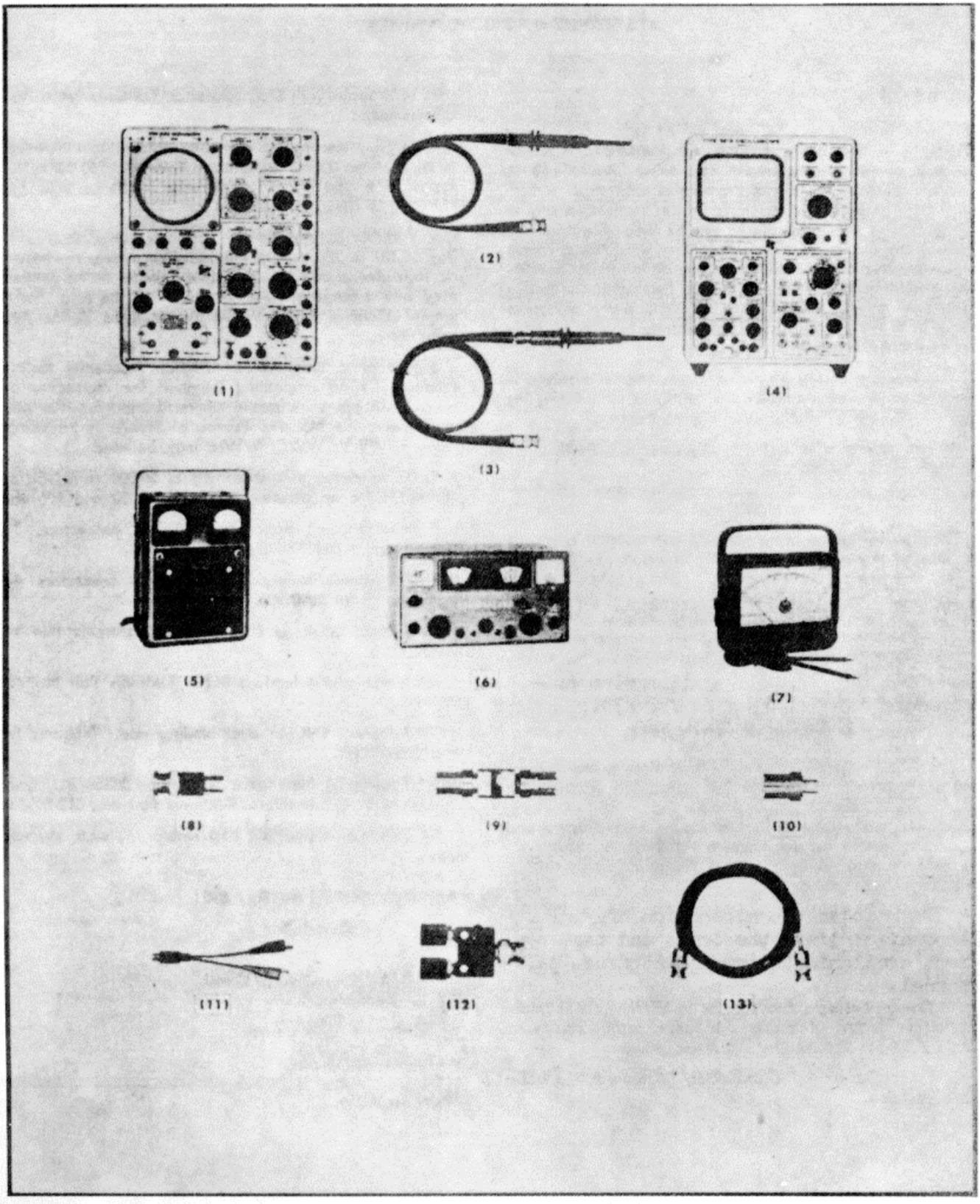


Fig. 6-1. Equipment recommended for calibration.

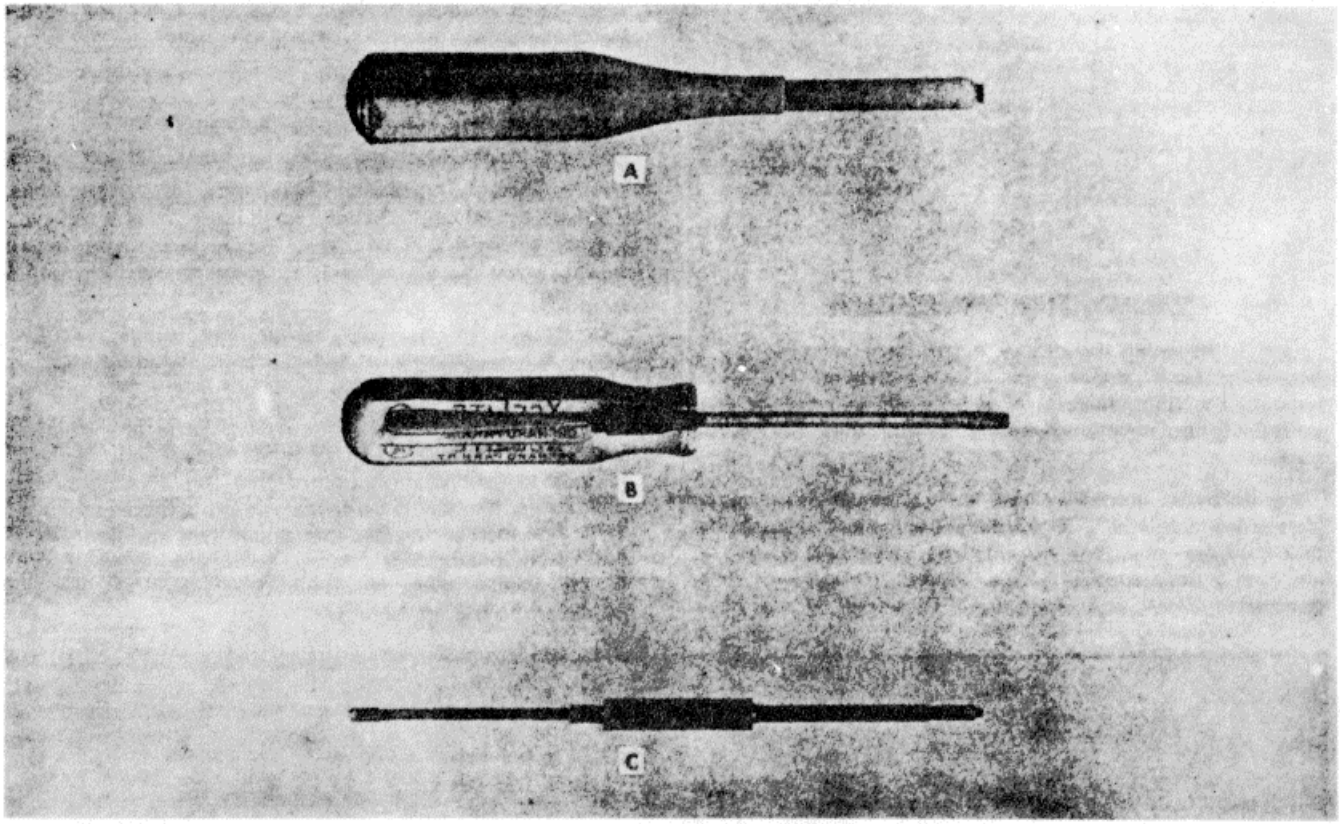


Fig. 6-2. Adjusting tools.

6-4. 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.

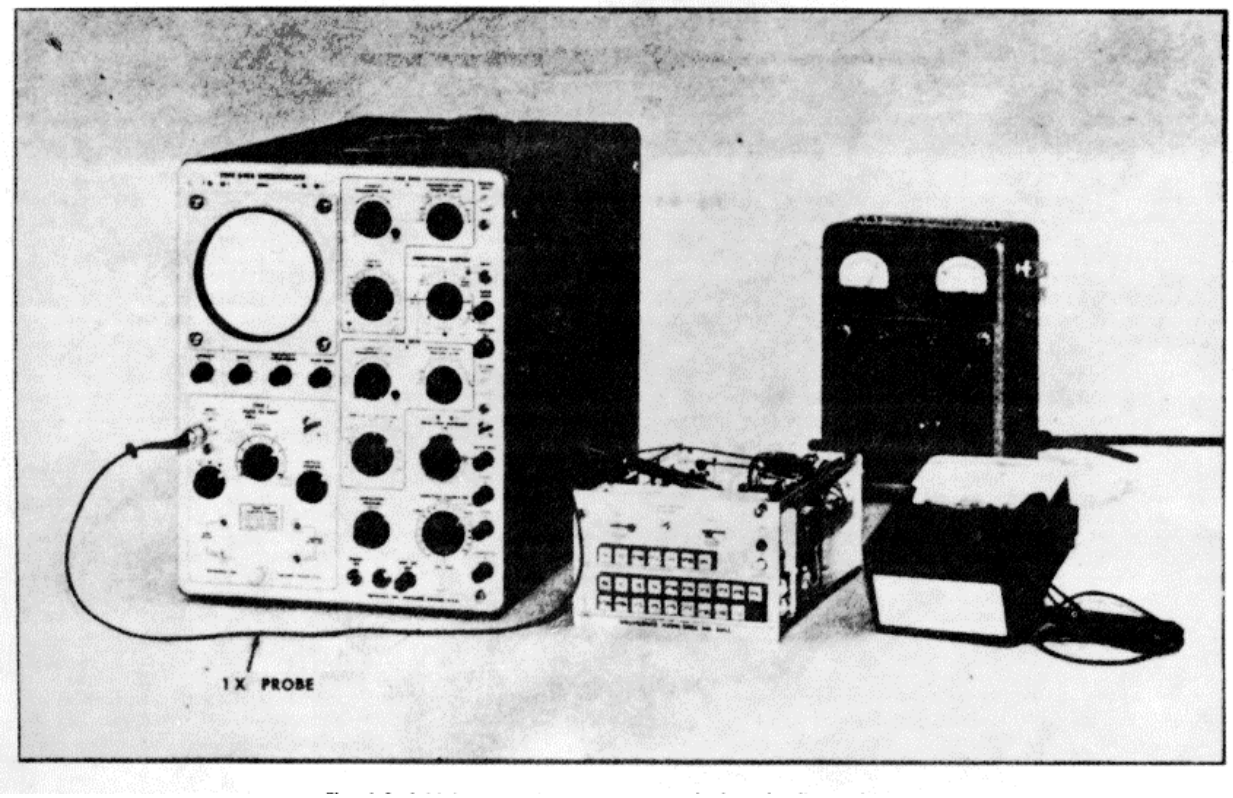


Fig. 6-3. Initial test equipment set-up to check and adjust voltages.

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 Rip
-30V	±3%	15mV p-p
+12V	±3%	30mV p-p
+125V	±3%	60mV p-p

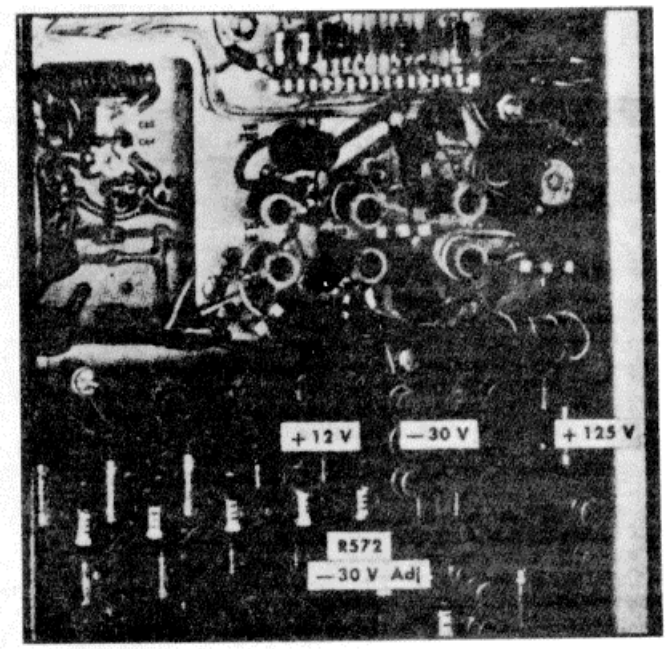


Fig. 6-4. Voltage test points and adjustments.

(A)

1. Check Oven Light

a. Check oven light operation.

b. After 5 minute warm-up time, oven should cycle on and off.

c. Interaction - None.

Fig. 6.5. Typical test oscilloscope display of power supply ripple (60-ce line) vertical deflection, 0.5 volts/div, sweep rate. 5

2. Adjust -30 Volt Power Supply (1)

a. Test equipment setup is shown in Fig. 63.

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 1X probe to the test oscilloscope input.

c. Check-regulation and ripple of the power supplies while changing the output voltage between 93.5 to 135 (or 187 to 270) volts ac. Power supply test points are shown in Fig. 64. Power supply specifications are shown in Table 61 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 X probe.

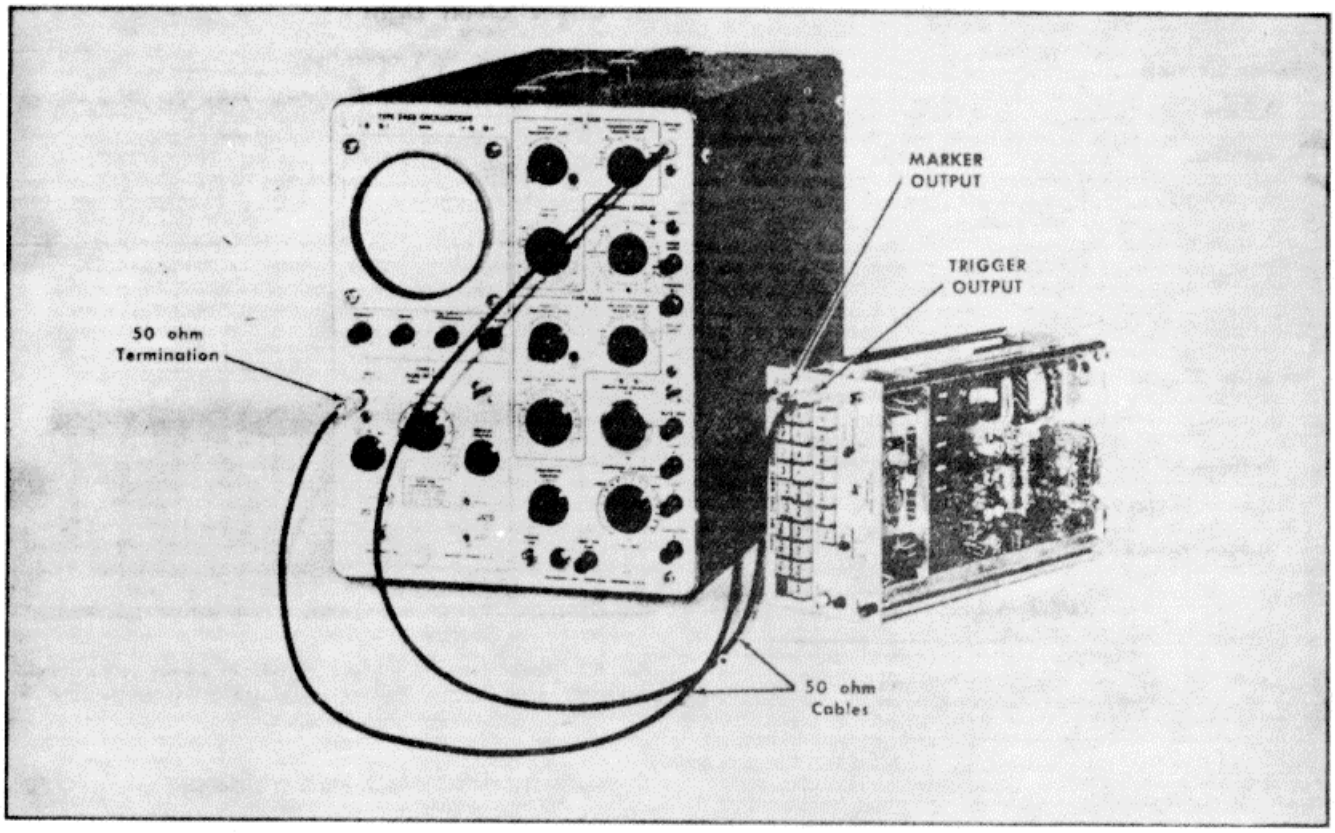


Fig. 6-6. Checking end adjusting .1 μS and .5 μs time-markers. Step 4.

Control Settings:

Type 184	
MARKER SELECTOR	.1μS
TRIGGER SELECTOR	1μS
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

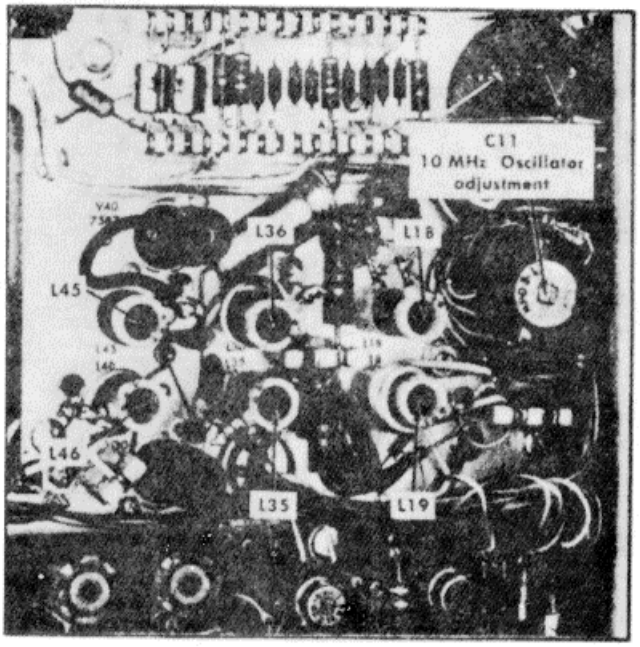


Fig. 6-7. 10 MHz (.1μs) 50 MHz(20ns) and 100 MHz (10) oscillator and multiplier adjustment. Step 4, 10.

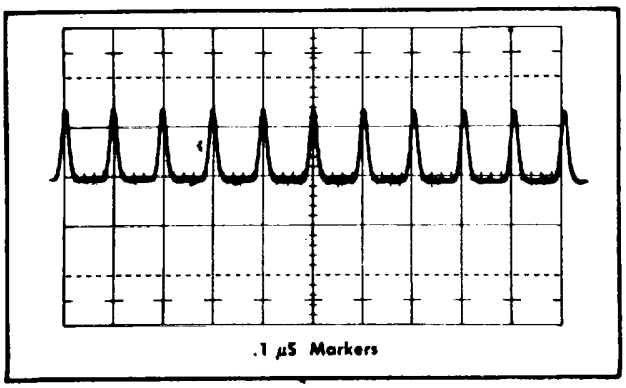


Fig. 6-8. Typical display of .1μS markers.

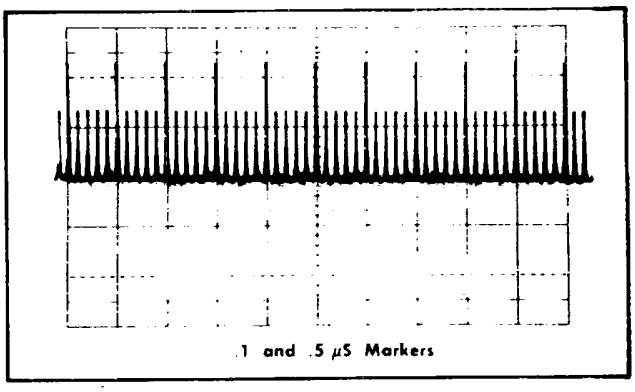


Fig. 6-8b.Typical display of .1 and 5 μS markers.C108 adjusted for accuracy of .5 μs markers L-18 adjusted for uniformity of the .1 μs markers

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

4. Adjust .1μS and .5 , μS Time-Markers (1)

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 L18 (Fig. 6-7) for marker amplitude and uniformity

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

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

g. Adjust L18 and CIOB simultaneously for proper count of the .5μS markers and uniformity of the .1μ.S marker See Fig. 68b.

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

NOTE

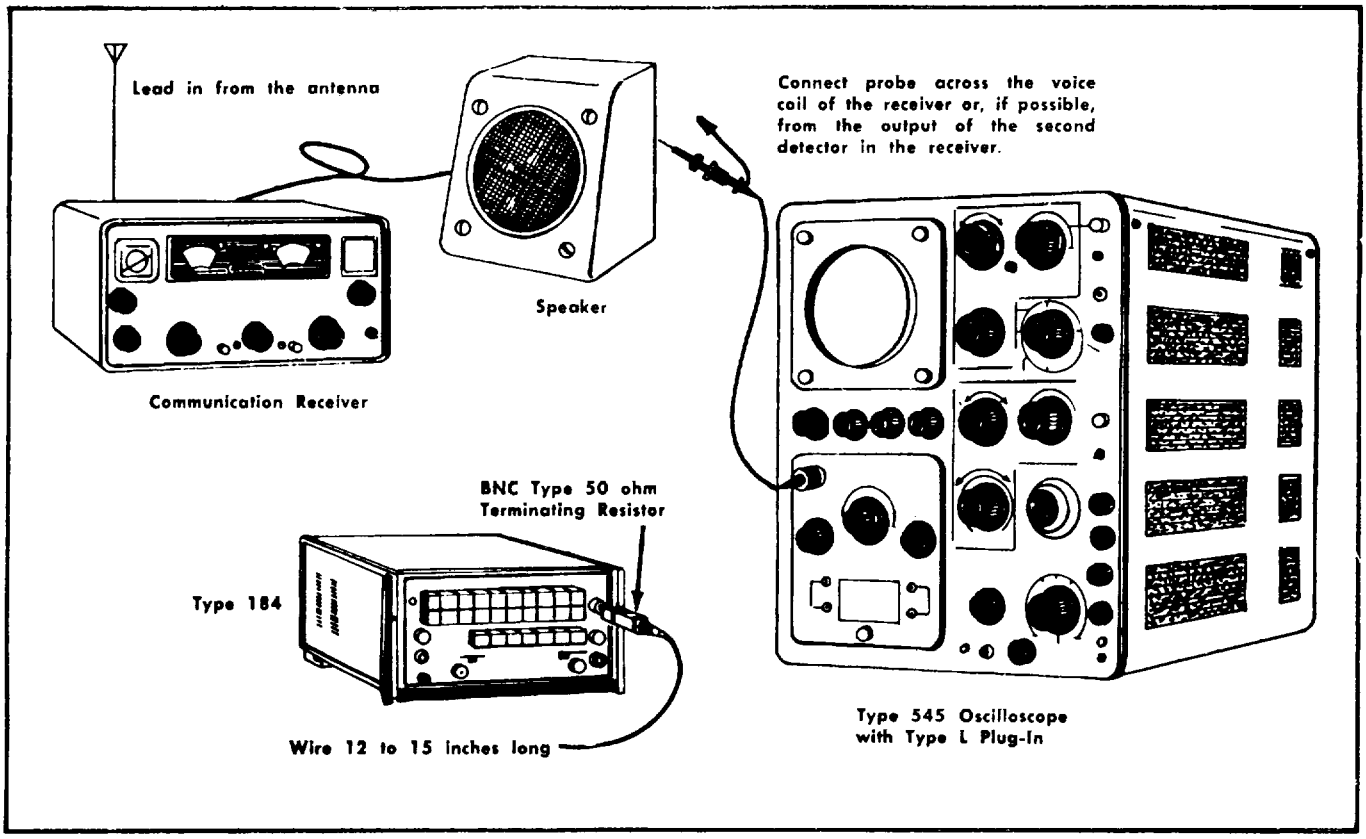


Fig. 6-10a. Suggested setup for adjusting crystal oscillator to laboratory standard. Step 5

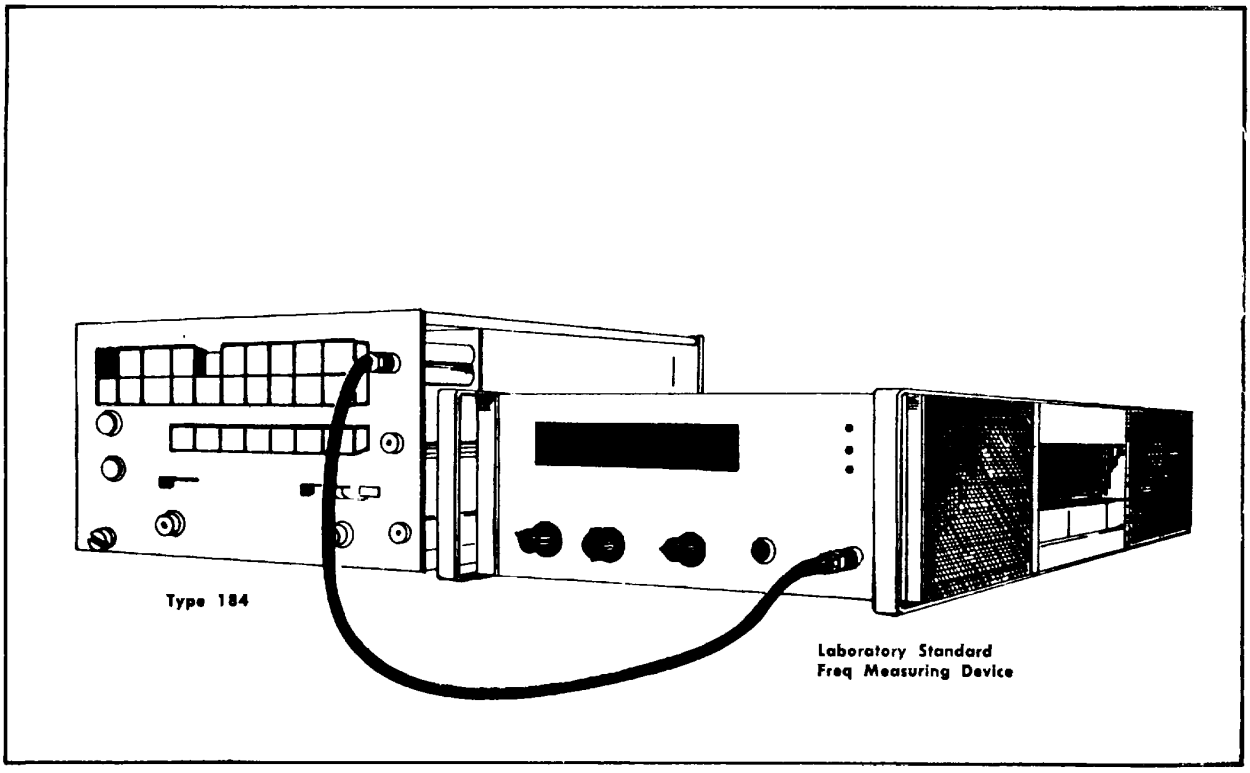


Fig. 6-10b. Suggested setup for adjusting crystal oscillator frequency to National Bureau of Standard. Step 5

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 (1)

Adjusting the crystal oscillator frequency requires an accurate 10MHz frequency standard or frequency measuring device. The National Bureau of Standards through transmitting stations at Boulder City, Colorado (WWC), Washington, D.C. (WWV) or Hawaii (WWH) provide one -means 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 1μS markers from the MARKER OUTPUT connector through a 50 Q 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 20MHz, 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 care- fully 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 OUT- PUT 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 Cl1 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.

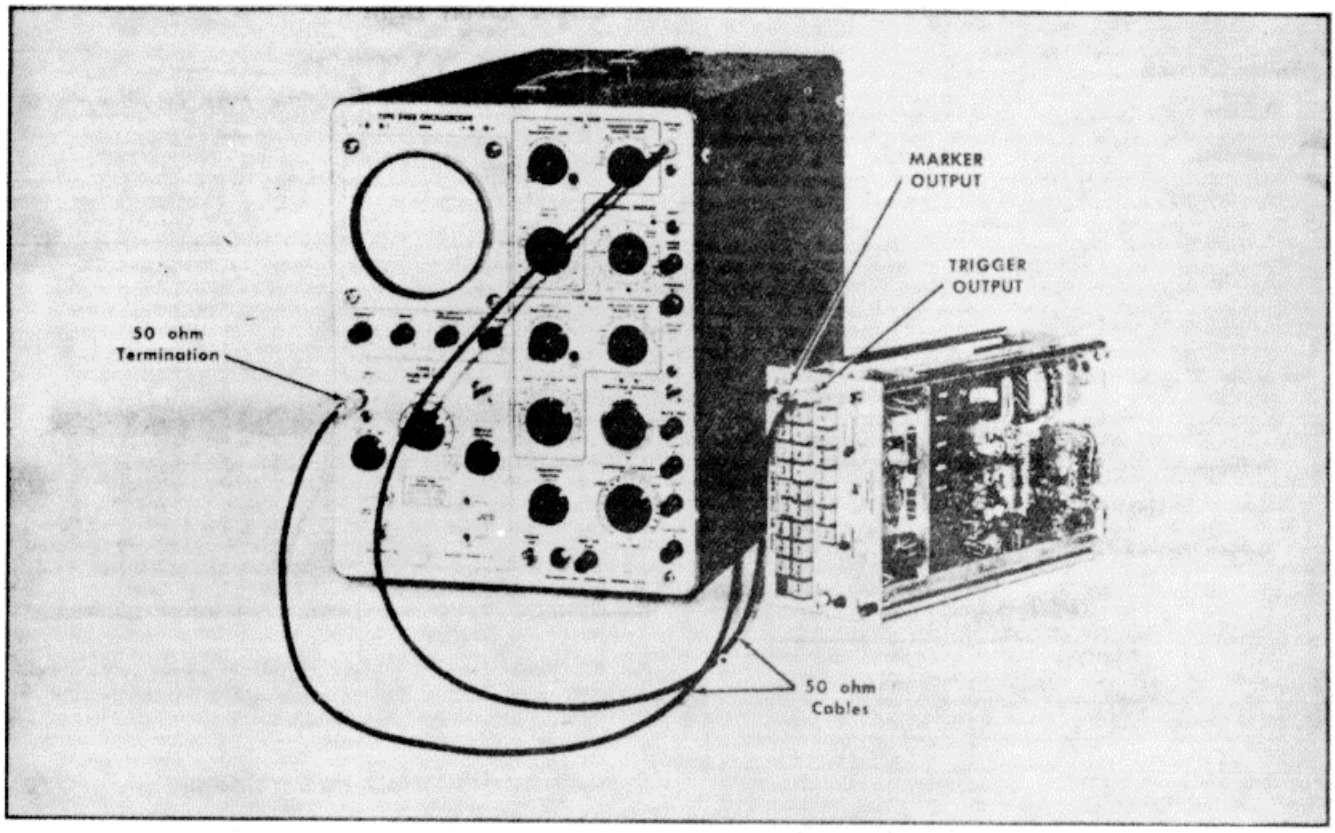


Fig. 6-11. Test equipment setup for checking time-marker accuracy and amplitude. Step 6 and step 7.

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 (1)

a. Test equipment setup is shown in Fig. 611.

b. Adjust the Triggering Level control when required, for a stable display as each step in Table 62 is followed.

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

7. Check Marker Amplitude- 1 volt minimum

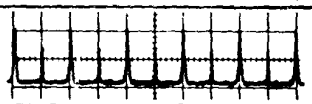
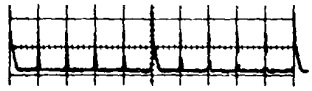
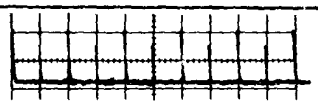
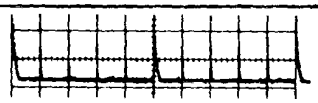
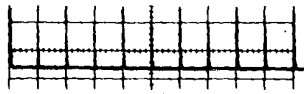
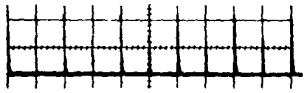
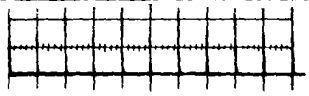
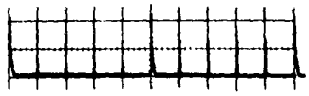
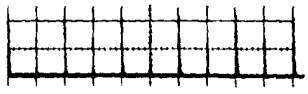
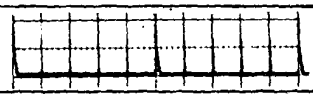
a. Test equipment setup is shown in Fig. 6-11.

b. Repeat the steps of Table 6-2 pushing only one MARK. ER 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

(A)

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. 5-12a)	
.5 μS and 1 μS	.5 μSEC	1 μS		
1 μS and 5 μS	1 μSEC	10 μS	R146 (Fig. 5-12a)	
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	10 mS		
10 mS and 50 mS	10 mSEC	.1 S	R306 (Fig. 5-12b)	
50 mS and .1 S	10 mSEC	1 S		
.1 S and .5 S	.1 SEC	1 S	R346 (Fig. 5-12b)	
.5 S and 1 S	.5 SEC	1 S		
1 S and 5 S	1 SEC	1 S	R386 (Fig. 5-12b)	

(A)

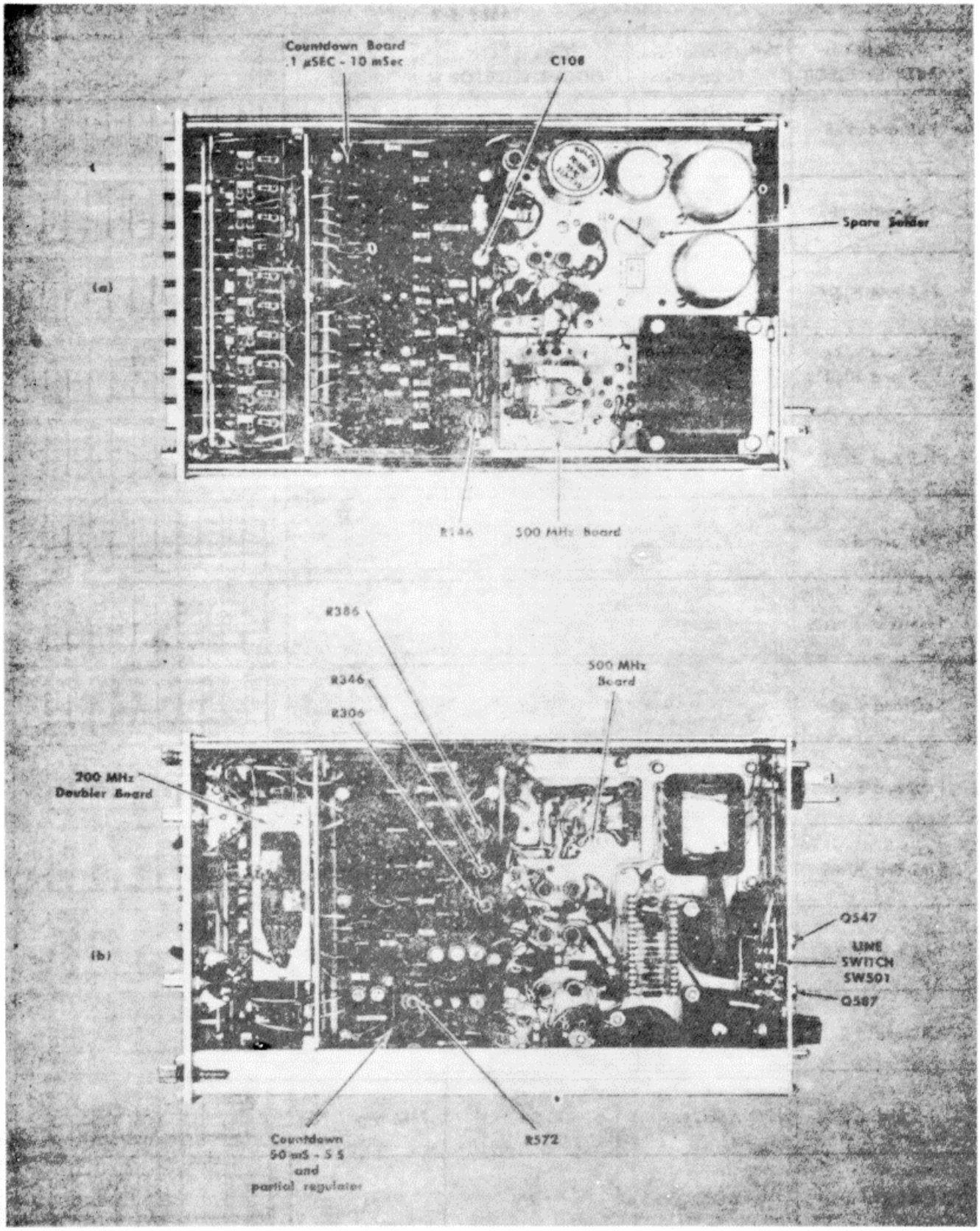


Fig. 6-12. Time Marker timing adjustments. a. Countdown board .1 μS-10 ms. Step 6. b. Location of R306, R346, R386. Step 6.

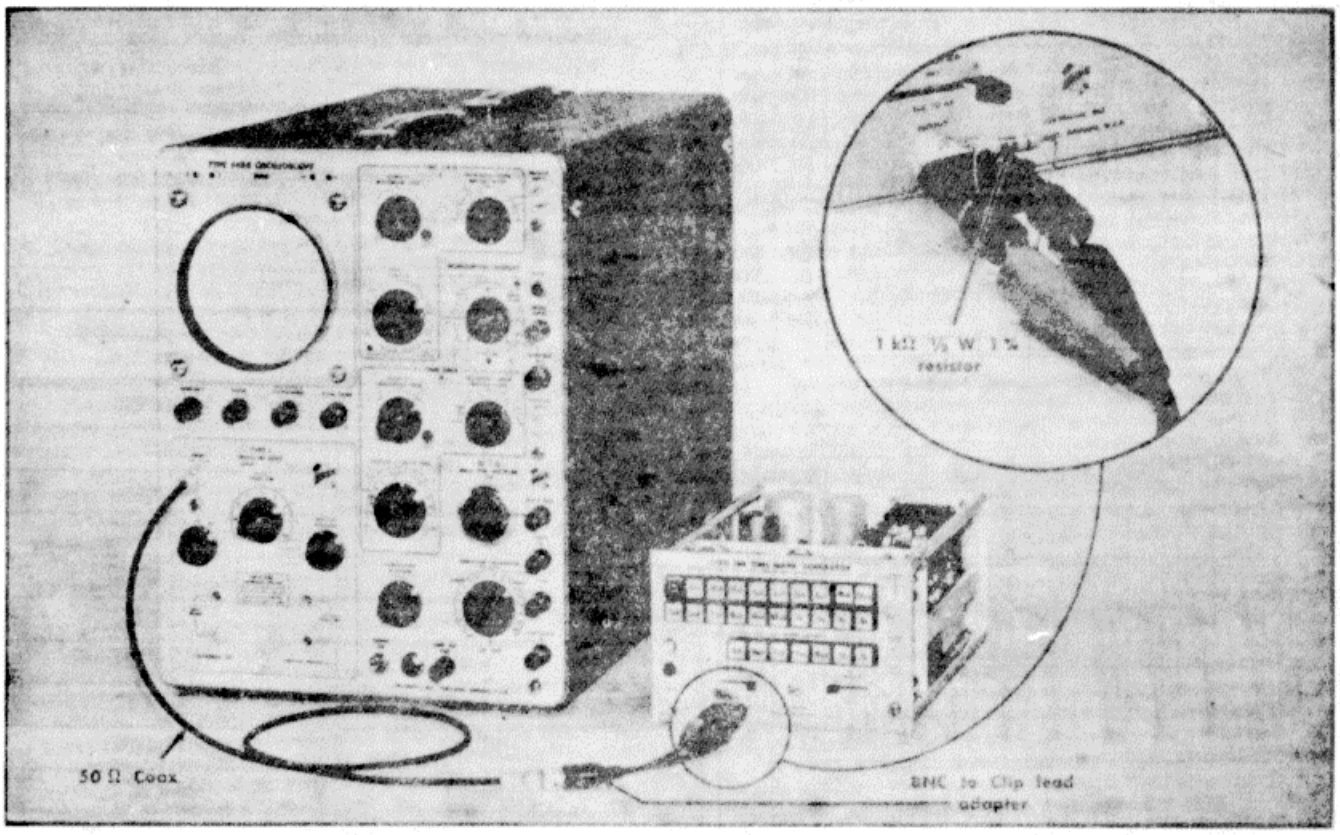


Fig. 6-13. Test equipment setup to measure Marker Amplifier signal amplitude. Step 8.

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 1μs to 5 s in 1-5-10 sequence, 25 V minimum amplitude into 1kΩ.

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

c. Switch the MARKER AMPLIFIER switch to 9+) position. check the amplitude of the Marker Amplifier output signal for each setting listed in Table 6-3. See Fig. 6-14a.

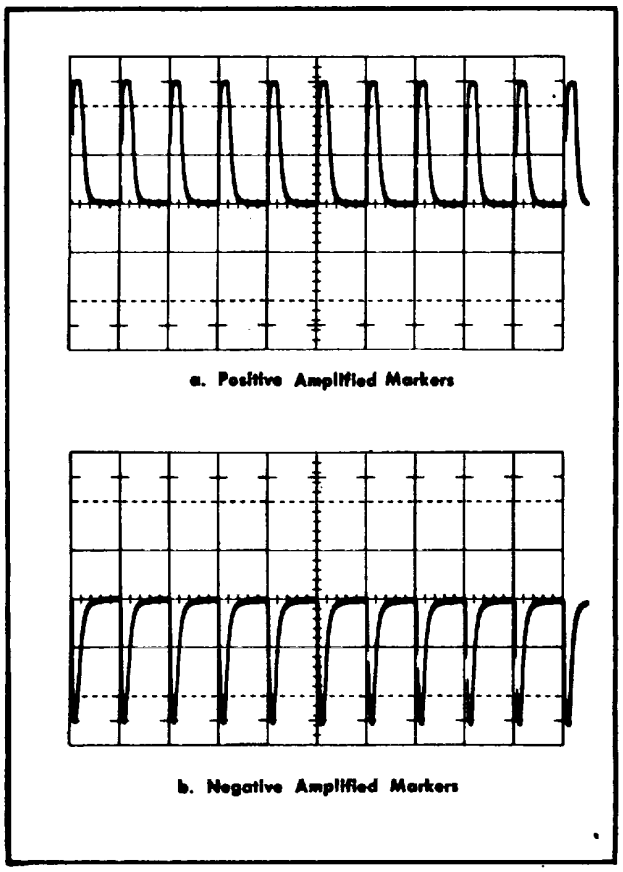


Fig. 6-14. Marker Amplifier Otuput Signals into 1 kΩ. Volts/cm 10, Time/cm (Table 5-3).

d. Change the MARKER AMPUFIER switch to the (-I 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. 614b.

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

TABLE 6-3

Type 184 MARKER SELECTOR	Test Oscilloscope Time/Cm
1µ5	10µSEC
5µS	10µSEC
10µS	.1 mSEC
50µS	.1 mSEC
.1mS	1 mSEC
5mS	1 mSEC
1mS	10 mSEC
5mS	10 mSEC
10mS	100 mSEC
50mS	100 mSEC
.1S	1 SEC
5S	1 SEC
1S	1 SEC
5S	1 SEC

NOTE

(A)

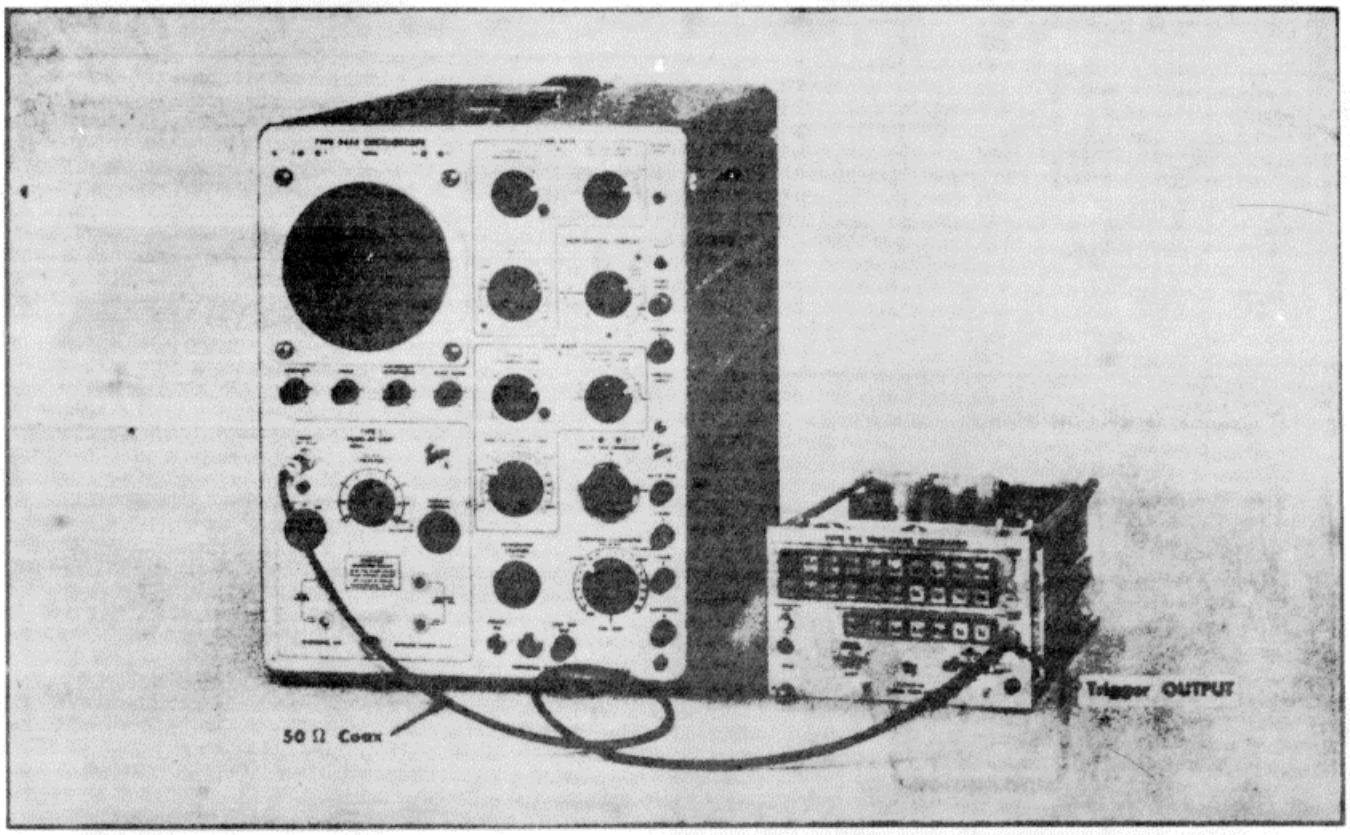


Fig. 6-15. Test equipment setup for checking trigger output amplitude and timing interval. Step 9

Control Settings:

Type 184

MARKER SELECTOR	None
TRIGGER SELECTOR	As shown in Table 6-4
MARKER AMPLIFIEP	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 of 1 µs to 1 s in 1-10 sequence, 0.4V minimum amplitude into 50Ω.

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.

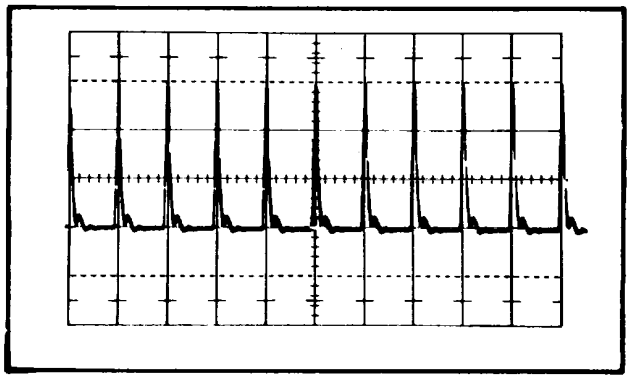


Fig. 6-16. Typical TRIIGER OUTPUT display. Volts/cm .2.

TABLE 6-4

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

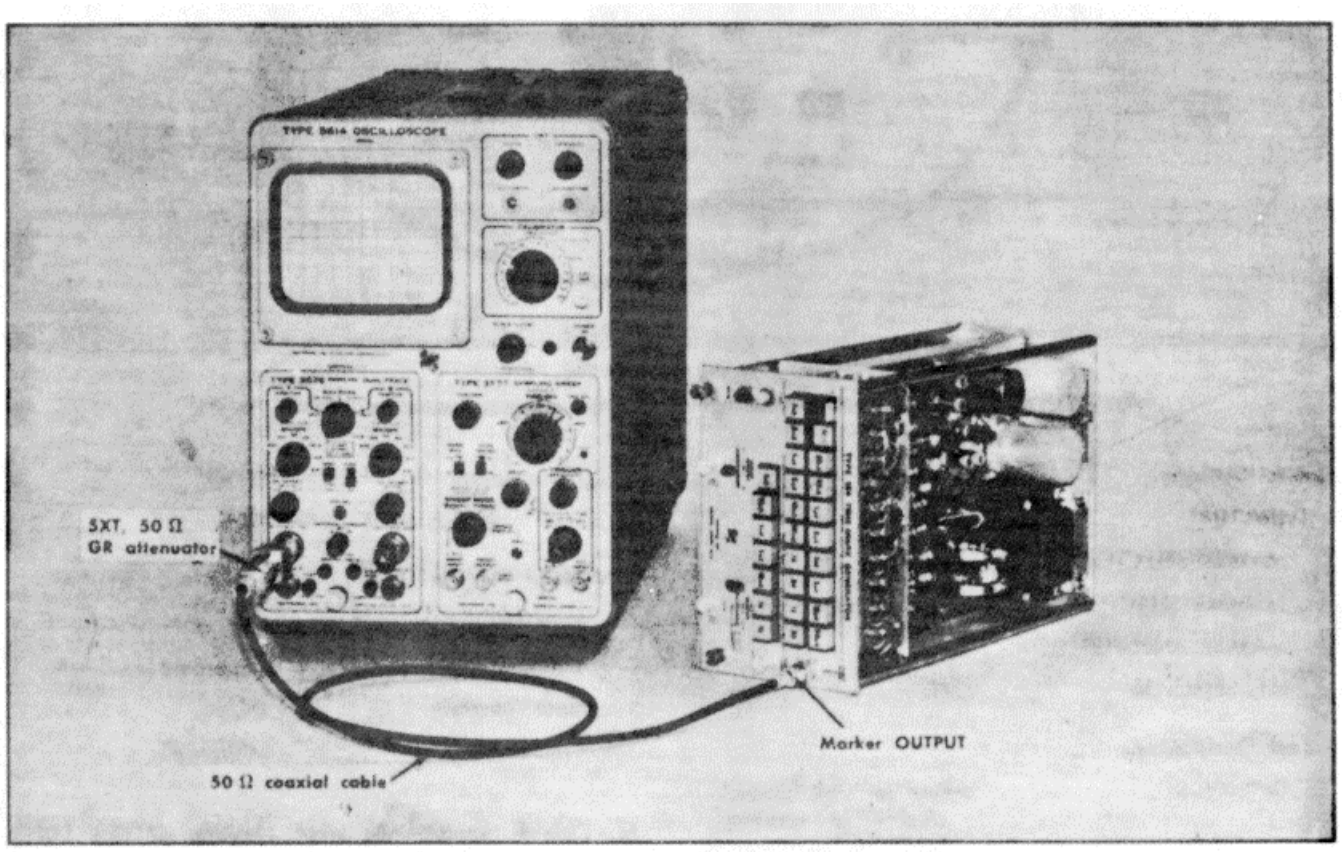


Fig. 6-17. Test equipment setup to check and adjust 10, 20 and 50 ns sine-wave markers. Step 10

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	X1
Dots Per Div	100

Vertical Plug-In Unit

Mv/Div	100nl
Input Selector	A Only

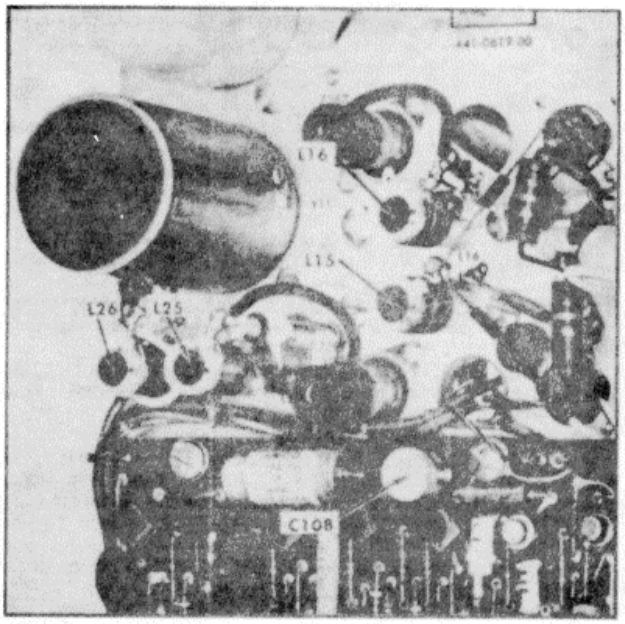


Fig. 6-18. .5µs maker adjustment C108 and 50 MHz (20 ns adjustment L16, L15. Step 10.

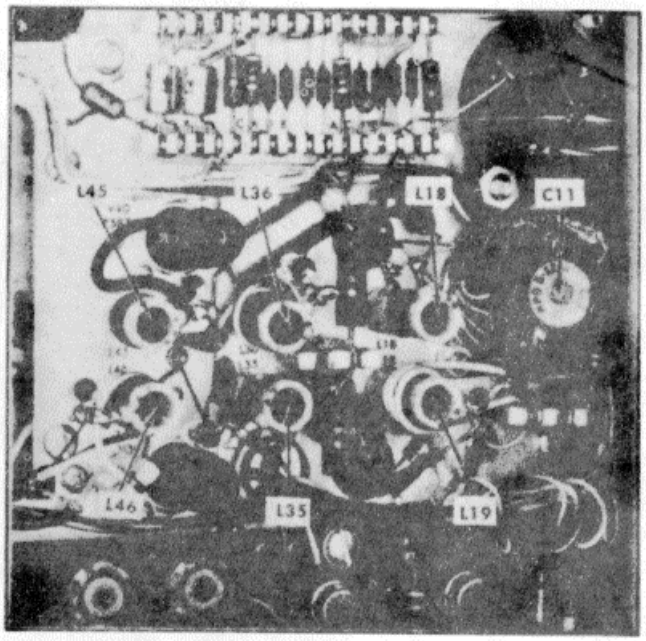


Fig. 6-19. 10 MHz (.1µs) 50 MHz (20ns) and 100 MHz (10ns) oscillator and multiplier adjustments. Step 4, 10.

10. Check and Adjust Sine-wave Markers: (1) 10, 20, 50nS 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 mS sine-wave markers.

TABLE 6-5

Type 184 MARKER SELECTOR	Test Oscilloscope Time/Div	Adjust for maximum signal amplitude and one marker/div
.1µS	.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)

NOTE

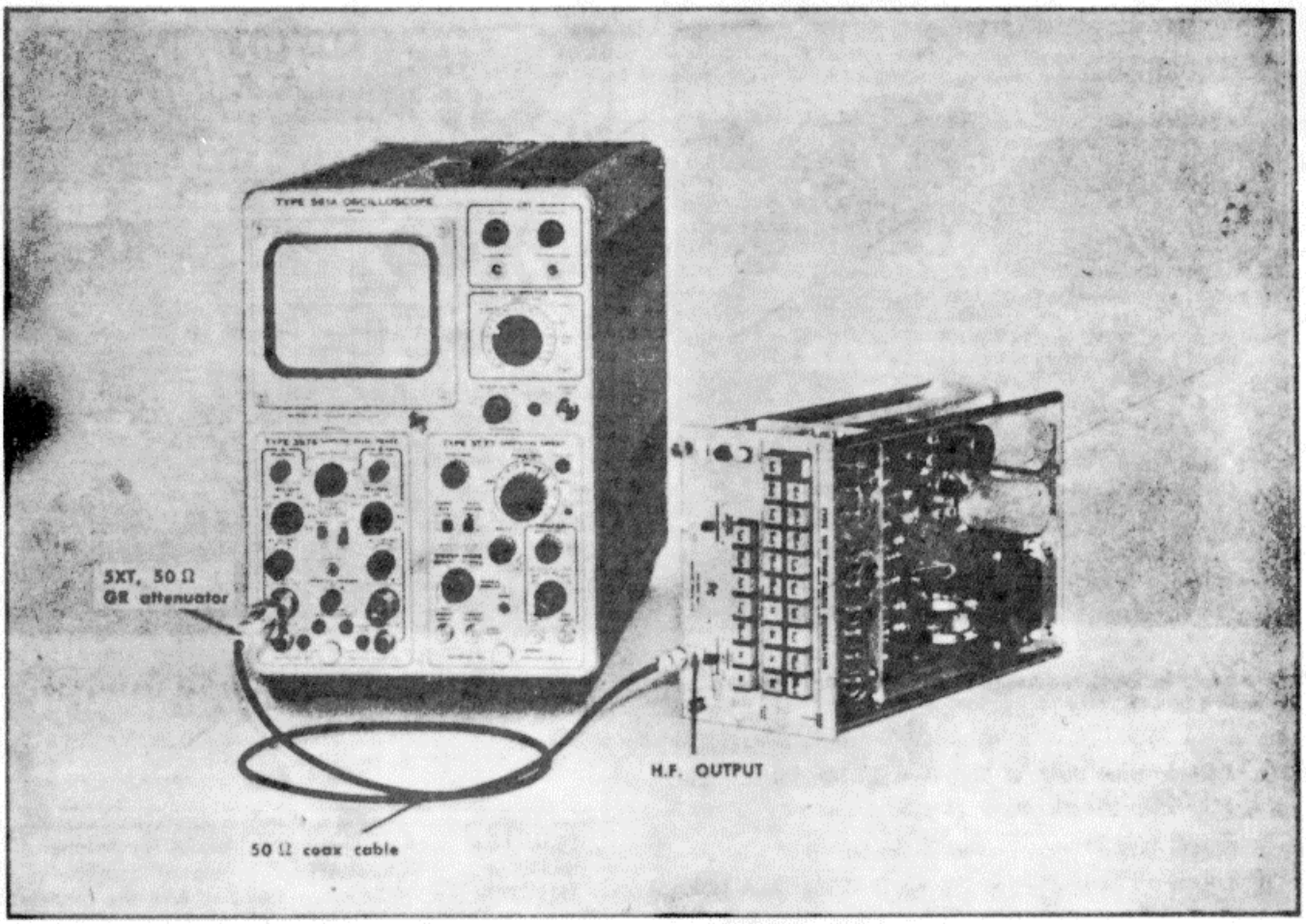


Fig. 6-20. Test equipment setup to check AND ADJUST 2NS AND 5NS SINE-WAVE MARKERS. Step 11.

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	X1
Dots Per Div	100

Vertical Plug-In Unit

Mv/Div	50
Input Selector	A Only

11. Check and Adjust H.F. Sine-wave Markers (1): 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.

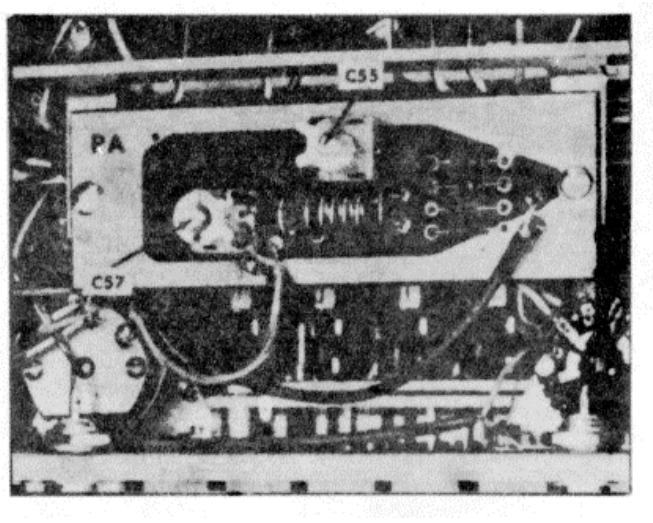


Fig. 6-21. Adjustment C55, C57, 5 nS H.F. oscillator.

TABLE 6-6

Type 184 H.F.SELECTOR	Test Oscilloscope Time/Div	Adjust for maximum signal amplitude and one marker/die
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.

Error! Not a valid filename.

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.

NOTE

SECTION 7
PREVENTIVE MAINTENANCE INSTRUCTIONS

7-1. Scope of Maintenance

The maintenance duties assigned to the operator and organizational repairman of this equipment are listed below together with a reference to the paragraphs covering the specific maintenance functions. The preventive maintenance procedures require no special tools or test equipment.

a. Daily preventive maintenance checks and services chart (para 7-5).

b. Weekly preventive maintenance checks and services chart'(para 7 -6).

c. Monthly preventive maintenance checks and services chart (para 7-8).

d. Quarterly preventive maintenance checks and services chart (para 7-10).

e. Cleaning (para 7-11).

f. Touchup painting Instructions (para 7-12)

7-2. Materials Required for Maintenance

WARNING

The fumes of Trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable, but exposure of the fumes to an open flame converts the fumes to highly toxic, dangerous gases.

a. Trichloroethane.

b. Cleaning cloth.

c. Fine sandpaper.

d. Touchup paint.

7-3. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedure given in paragraphs 7-4 through7-12 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts outline functions to be performed at specific intervals. These checks and services are to maintain equipment in a combat-serviceable condition; that is, in a good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and the normal conditions. The References column lists the illustration or paragraphs that contain additional information. If the defect cannot be found by performing the corrective action indicated, higher category maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38750.

7-4. Preventive Maintenance Checks and Services Periods

Preventive maintenance checks and services of this equipment are required daily, weekly, monthly, and quarterly. Paragraph 7-6 specifies checks and services that must be performed weekly. If the equipment is mainted in a standby condition, the daily and weekly checks and services should be accomplished at the same time. The maintenance checks and services that are accomplished monthly are specified in paragraph 7-8 Quarterly maintenance checks and services are specified in paragraph 7 -10.

7-5. Daily Preventive Maintenance Checks and Services Chart

Seq No.	*Item to be inspected*	*Procedure*	*Reference*
1	Completeness	Check to see that equipment is complete.	App. B.
2	Cleanliness	Exterior of equipment must be clean and dry free of fungus, dirt, dust or grease.	Para 7-11
3	Operational check	Check operational efficiency.	
4	Controls	Check to see that controls operate smoothly and are fastened in place securely.	

7-6. Weekly Preventive Maintenance Checks and Services Chart

Seq No.	*Item to be inspected*	*Procedure*	*Reference*
1	Cables	Inspect cords, cables,and wires for chafed, cracked, or frayed insulation. Replace connectors that are broken, stripped, or worn.	
2	Handles	Inspect handles for loose new or sharp edges. Replace or tighten as necessary.	
3	Metal surfaces	Inspect exposed metal surface for rust and corrosion. Clean and touch up with paint as required.	Para 7-11 and 7-12

7-7. Monthly Maintenance

Perform the maintenance functions indicated in the monthly preventive maintenance checks and services chart (para 7-8) once each month. Periodic daily (para 7-5)ana weekly (para7-6) services constitute a part of the monthly checks. Amonth is defined as approximately 30-calender days of 8-hour-per-day operation. If the equipment is operated 16 hours a day, the monthly preventive maintenance checks and services should be performed at 15-day intervals. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions. Equipment maintained in a standby (ready for immediate operation) condition must have monthly preventive maintenance checks and services. Equipment in limited storage (requires service before operation) does not require monthly preventive maintenance.

7-8. Monthly Preventive Maintenance Checks and Services Chart

Seq No.	*Item to be inspected*	*Procedure*
1	Terminations	Inspect for loose connections and cracked or broken insulation.
2	Control panel	Clean panel thoroughly and check all surfaces for chips, cracks or abnormal wear.
3	Hardware	Inspect all hardware for possible damage.

7-9. Quarterly Maintenance

Quarterly preventive maintenance checks and services are required for this equipment. Periodic daily, weekly, and monthly services constitute a part of the quarterly preventive maintenance checks and services and must be performed concurrently. All deficiencies or shortcomings will be recorded in accordance with the requirements of

TM 88-750. Perform all the checks and services listed in the quarterly preventive maintenance checks and services chart (para 7-10) in the sequence listed. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions. Equipment maintained in a standby (ready for immediate operation) condition must have quarterly preventive maintenance checks and services. Equipment in limited storage (requires service before operation) does not require quarterly preventive maintenance. An inventory of spare parts is an essential part of the quarterly checks and services program.

7-10. Quarterly Preventive Maintenance Checks and Services Chart

Seq No.	*Item to be inspected*	*Procedure*	*Reference*
1	Publications	Check to see that all publications are complete, serviceable, and current	DA Pam 31-4.
2	Modifications	Check DA Pam 310-7 to determine whether new applicable MWO's have been published. ALL URGENT MWO's must be applied immediately. ALL NORMAL MWO's must be scheduled.	TM 38-750 and DA Pam 310-7.
3	Spare parts	Check all spare parts (operator and organizational) for general condition and method of storage. No overstock should be evident and all shortages must be on valid requisitions.	App. B.

7-11. Creaning

Inspect the exterior surfaces. The surfaces must be free of dust, dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean, soft cloth.

b. Remove grease, fungus, and ground-in dirt. Use a damp cloth (not wet) with trichloroethane to clean terminations. If dirt on the body of the unit is difficult to remove, use mild soap and water.

c. Remove dust or dirt from the jack and plugs with a brush.

7-12. Touchup Painting Instructions

Remove dust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to applicable cleaning and refinishing practices specified in TB 746-10.

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APPENDIX A
REFERENCES

Following is a list of publications available to the operator and maintenance personnel of Electronic Marker Generator AN/USM-271:

DA Pam 3104	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Equipment Index of Modification Work Orders.
SB 38100	Preservation, Packaging and Packing Materials, Supplies, and Equipment Used by the Army.
TB SIG 35561	Depot Inspection Standard for Repaired Signal Equipment.
TB SIG 355-2	Depot Inspection Standard for Refinishing Repaired Signal Equipment.
TB SIG 3553	Depot Inspection Standard for Moisture and Fungus Resistant Treatment.
TB 43-0118	Field Instructions for: Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters.
TB 43-180	Calibration Requirements for the Maintenance of Army Materiel.
TM 114625-93815	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Transportable Maintenance Calibration Facility AN/TSM-55A.
TM 11~65153815	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Hewlett-Packard AC Voltmeter, Models 400E and 400EL.
TM 11;621722-15	Operator's, Organizational, Direct Support, General Support, and Depot Maintenance Manual Including Repair Parts and Special Tools Lists: Oscilloscope AN/USM-273.
TM 116625 2383-24P	Organizational, Direct Support, and General Support Maintenance Repair Parts and Special Tools List: Electronic Marker Generator AN/USM-271.
TM 114625-238:15	Operator's, Organizational, DS, GS, and Depot Maintenance Manual Including Repair Parts and Special Tools List: Multimeter ME333/U and J-Omega Volt-Ohmmeter Types 213A, 215A, and 219A.
TM 38-750	The Army Maintenance Management System (TAMMS).
TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-2	Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command).

APPENDIX B
BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

B-1. Scope

This appendix lists items which accompany AN/ US-271or are required for installation, operation, or operator's maintenance.

B-2. General

This Basic Issue Items List is divided into the following sections:

a. Basic Issue Items--Section II. A list of items which accompany the AN/UMK-2?1 and are required by the operator/crew for installation, operation, or maintenance.

b. Maintenance and Operating Supplies-Section III. Not applicable.

B-3. Explanation of Columns

The following provides an explanation of columns in the tabular list of Basic Issue Items, Section ll.

a. Source, Maintenance, and Recoverability Codes (SMR), Column 1:

(1) Source code, indicates the selection status and source for the listed item. Source codes are:

Code *Explanation*

P-Repair parts which are stocked in or supplied from the GSA/DSA, or Army supply system and authorized for use at indicated maintenance categories.

P2-Repair parts which are procured and stocked for insurance purposes because the combat or military essentiality of the end item dictates that a minimum quantity be available in the supply system.

P-Assigned to items which are NSA design con trolled: unique repair parts, special tools, test measuring and diagnostic equipment, which are stocked and supplied by the Army COMSEC logistic system, and which are not subject to the provisions of AR 38041.

P10-AEsigned to items which are NSA design con trolled: special tools, test, measuring and diagnostic equipment for COMSEC support, which are accountable under the provisions of AR 38041, and which are stocked and supplied by the Army CCMSEC logistic system.

Code *Explanation*

M-Repair parts which are not procured or stocked, but are to be manufactured in indicated maintenance levels.

A-Assemblies which are not procured or stocked as such, but are made up of two or more units. Such component units carry individual stock numbers and descriptions, are procured and stocked separately and can be assembled to form the required assembly at indicated maintenance categories.

X-Parts and assemblies which are not procured or stocked and the mortality of which normally is below that of the applicable end item or component. The failure of such part or assembly should result in retirement of the end item from the supply system.

X1-Repair parts which are not procured or stocked. The requirement for such items will be filled by use of the next higher assembly or component.

X2-Repair parts which are not stocked. The indicated maintenance category requiring such repair parts will attempt to obtain same through cannibalization. Where such repair parts are not obtainable through cannibalization, requirements will be requisitioned with accompanying justification, through normal supply channels.

C-Repair parts authorized for local procurement. Where such repair 'parts are not obtainable from local procurement, requirements will be requisitioned through normal supply channels accompanied by a supporting statement of nonavailability from local procurement.

G-Major assemblies that are procured with PEMA funds for initial issue only as exchange assemblies at DSU and GSU level. These assemblies will not be stocked above DS and GS level or returned to depot supply level.

(2) Maintenance code, indicates the lowest category of maintenance authorized to install the listed item. The maintenance level code is:

C..... Operator/Crew

0 ..... Organizational Maintenance

(3) Recoverability code indicates whether unserviceable items should be returned for recovery or salvage. Items not coded are expendable. Recoverability codes are:

Code *Explanation*

R-Repair parts and assemblies that are economically reparable at DSU and GSU activities and nor-

Code *Explanation*

mally are furnished by supply on an exchange basis.

S-Repair parts and assemblies which are economic reparable at DSU and GSU activities and which normally are furnished by supply on an exchange basis. When items are determined by a GSU to be uneconomically reparable, they will be evacuated to a depot for evaluation and analysis before final disposition.

T-High dollar value recoverable repair parts which are subject to special handling and are issue on an exchange basis. Such repair parts normally are repaired or overhauled at depot maintenance activities.

U-Repair parts specifically selected for salvage by reclamation units because of precious metal con tent, critical materials, or high dollar value reusable casings or castings.

b. Federal Stock Number, Column 2. This column indicates the Federal stock number as- signed to the item and will be used for requisitioning purposes.

c. Description, Column 3. This column indicates the Federal item name and any additional description of the item required. A part number or other reference number is followed by the applicable five-digit Federal supply code for manufacturers In parentheses.

d. Unit of Measure (U/M), Column 4. A 2 character alphabetic abbreviation indicating the amount or quantity of the item upon which the allowances are based, e.g., ft, ea, pr, etc.

e. Quantity Incorporated in Unit, Column 5 This column indicates the quantity of the item used in AN/USH-271. A "V" appearing in this column in lieu of a quantity indicates that a definite quantity cannot be indicated (e.g., shims, spacers, etc).

f. Quantity Furnished with Equipment, Column 6. This column indicates the quantity of an item furnished with the equipment.

g. Illustration, Column 7. This column is divided as follows:

(1) Figure Number, Column 7a. This column indicates the figure number of the illustration in which the item is shown.

(2) Item Number, Column 7b. Not applicable.

B-4. Explanation of Columns in the Tabular List of Maintenance and Operating Supplies-Section III

Not applicable.

SECTION II BASIK ISSUE ITEMS

(1) SMR Code	(2) Federal Stock Number	(3) Description Ref no. & mfr Code / Usable on code	(4) Unit of Meas	(5) Qty inc in Unit	(6) Qty furn with equip	(7) Illustration (A) Fig no.	(7) Illustration (B) Item No.
	6625-982-1543	GENERATOR, ELECTRONIC MARKER AN/USM-271: (This item is nonexpendable))				1-1	
		Tm 11-6625-2383-15	EA	1	1		
		A quantity of one technical manual is packed with each equipment. Where a valid need exists additional copies may be requisitioned and kept on hand.					
P-O		CABLE ASSEMBLY, RADIO FREQUENCY CG-3363/U (3 ft. 3 in)	EA	2	2		
P-O	6625-935-2364	CABLE ASSEMBLY, SPECIAL PURPOSE, ELECTRICAL CX-10551/U (8 ft. 1 in)	EA	1	1		
P-O	5985-087-4954	DUMMY LOAD, LECTRICAL DA-463/U	EA	1	1		
P-O	5960-958-0080	ELECTRON TUBE: 7587 (81349)	EA	6	2	FO-2	V10, V20, V30, V40, V60, V70
P-O	5920-284-7734	FUSE, CARTRIDGE: MDL6-10 (71400)	EA	1	5	FO-7	F502
G-C-R	6625-054-3479	GENERATOR, ELECTRONIC MARKER SG-767/U	EA	1	1		
P-O		LAMP, GLOW: EG03CCBNE2E (03797)	EA	1	1	FO-7	B504
P-O	3240-933-5817	LAMP, INCANDESCENT: 150-0052-00 (80009)	EA	1	1	FO-7	B534
		NO ACCESSORIES, TOOLS, OR TEST EQUIPMENT ARE TO BE ISSUED WITH THIS EQUIPMENT					
		NO BASIC ISSUE ITEMS ARE MOUNTED IN OR ON THIS EQUIPMENT					

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APPENDIX C
MAINTENANCE ALLOCATION

Section I. INTRODUCTION

C-1. General

This appendix provides a summary of the maintenance operations for the ANIUSM-271. It authorizes categories of maintenance for specific maintenance functions on reparable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

C-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

a. Inspect To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean, preserve, drain, paint, or to replenish fuel/lubricants/hydraulic fluids or compressed air supplies.

d Adjust Maintain within prescribed limits by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align To adjust specified variable elements of an item to about optimum or desired performance.

f Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment/system.

h. Replace. The act of substituting a serviceable like- type part, subassembly, model (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module/component/assembly, end item or system. This function does not include the trial and error replacement of running spare type items such as fuses, lamps, or electron tubes.

j. Overhaul That periodic maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (e.g., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc) considered in classifying Army equipment/components.

C-3. Column Entries

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d Column 4, Maintenance Category. Column 4 specifies, by the listing of a "worktime" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "worktime" figures will be shown for each category. The number of man-hours specified by the "worktime" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time and quality

assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C - Operator/Crew
0 - Organizational
F - Direct Support
H - General Support
D- Depot

e. Column 5, Tools and Equipment Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

C-4. Tool and Test Equipment Requirements (Table 1)

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

SECTION II MAINTENANCE ALLOCATION CHART FOR ELECTRONIC MARKER GENERATOR AN/USM-271

(1)	(2)	(3)	(4)					(5)	(6)
GROUP NUMBER	COMPONENT ASSEMBLY	MAINTENANCE FUNCTION	MAINTENANCE CATEGORY C	O	F	H	D	TOOLS AND EQUIPMENT	REMARKS
00	ELECTRONIC MARKER GENERATOR AN/USEM-271	Inspect		0.2				Visual	
		Test		0.3				7	
		Test				0.8		1 thru 8	
		Service		0.4				7	
		Adjust				0.5		1 thru 7	
		Repair				0.6		7, 8	
		Overhaul					2.0	1 thru 8	
01	ELECTRONIC MARKER GENERATOR SG-767U	Inspect		0.2				Visual	
		Service		0.4				7	
		Adjust				0.5		1 thru 7	
		Repair				0.5		7, 8	
		Overhaul					2.0	1 thru 7	
0101	PANEL, GENERATOR	Inspect		0.2				Visual	
		Repair				0.5		7, 8	
0102	50-ms TO 5-SECOnD COUNTDOWN AND POWER REGULATOR CIRCUIT CARD ASSEMBLY	Inspect				0.1		Visual	
		Replace				0.1		7	
		Repair				0.5		7, 8	
0103	0.1 MICROSECOND TO 10-ms COUNTDOWN CIRCUIT CARD ASSEMBLY	Inspect				0.1		Visual	
		Replace				0.1		7	
		Repair				0.5		7, 8	
0104	500-MHz (2ns) CIRCUT CARD AASSEMBLY	Inspect				0.1		Visual	
		Replace				0.1		7	
		Repair				0.1		7, 8	
0105	200-MHz (5 ns) CIRCUIT CARD AASSEMBLY	Inspect				0.1		Visual	
		Replace				0.1		7	
		Repair				0.1		7, 8	
0106	CHASSIS AND CABINET ASSEMBLY	Inspect		0.1				Visual	
		Adjust				0.3		1 thru 7	
		Repair				0.5		7, 8	
		Repair		0.2				7	
		Overhaul					1.0	1 thru 8	

TABLE 1. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR ELECTRONIC MARKER GENERAL AN/USM-271

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER
1	H, D	CONVERTER, FREQUENCY, ELETRONIC CV-2350/U	5895-00-054-3474
2	H, D	COUTERS, ELZCTRONIC, DIGITAL READOLA/USl-257	6625-00-935-1457
3	H, D	MULTIMETER ME-333/U	6625-00-935-1425
4	H, D	OSCILLOSCOPE MIUS/-273	6625-00-930-663T
5	R, D	TRANSFORMER, VARIABLE, POR TF-510/U	6120-00-054-7794
6	D	VOLTMETER, ELECTRONIC AN/USM-265	6625-00-054-3487
7	0	Tools and test equipment available to the repairperson because of his/her assigned mission.	
8	H, D	Tools and test equipment mounted in AN/TSM-55(V}	

By Order of the Secretary of the Army:

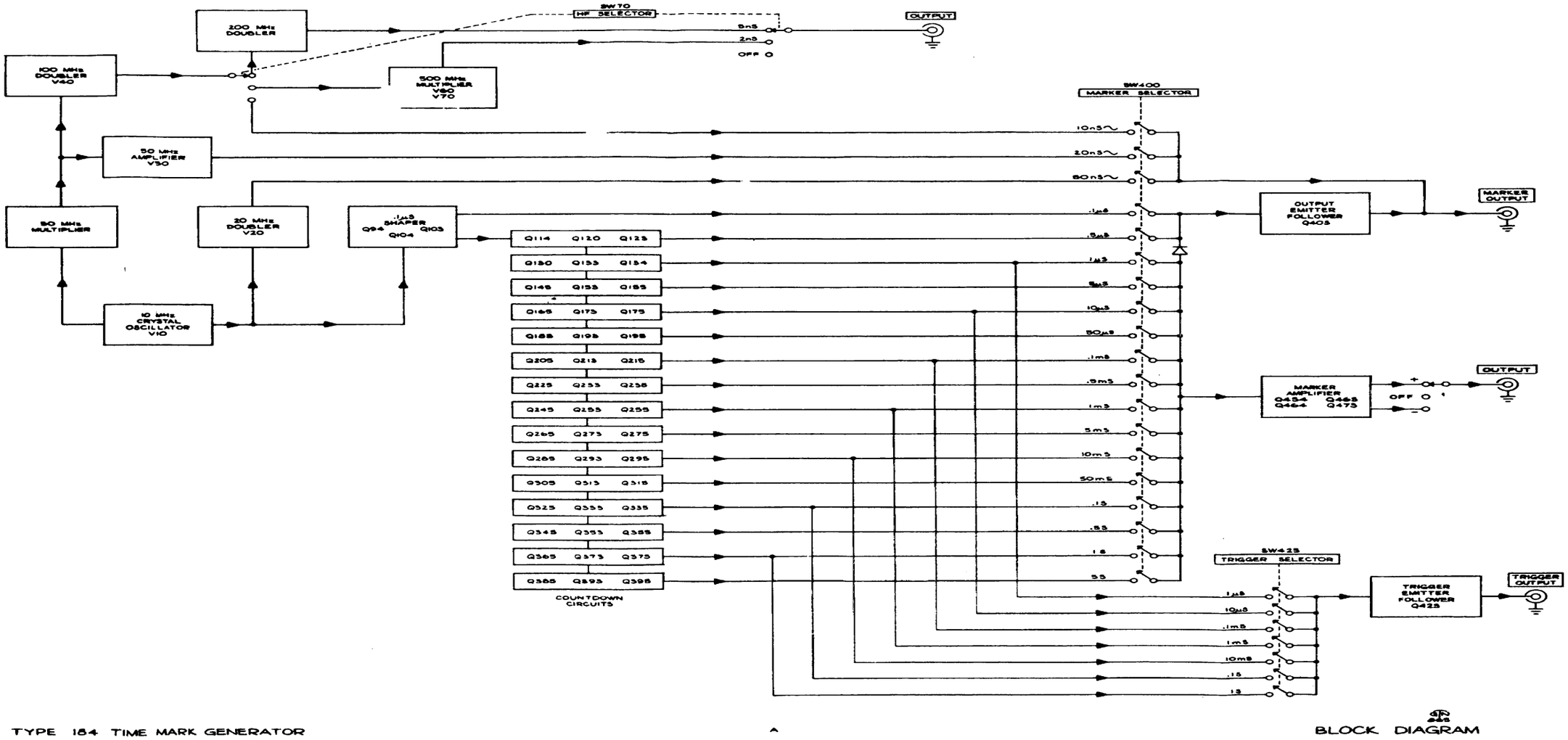
W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:

KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

Distribution
Active .Army:
U-SASA (2)
CNGB (1)
ACSC-E (2)
TSG (1)
Dir of Trans (’1)
Cof Engrs (1)
CofSptS (1)
UCSAARENBR
USAMEB (10)
USAMC (1)
USAMICOM (5)
CONARC (5)
ARADCOM (2)
ARADCOM Rgn (1)
OS Maj Comd (4)
USARV (5)
USACDC (1)
USACDCEC (’10)
USACDOCEA (1)
USACDCOEA (Ft Huachuca) (1)
LOGCOMD (2) except
1st LOGCOMD (5)
9th LOGOOMD (5)
USASTRATCOM (6)
USASTRATCOM-SIG, GP-T (2)
USASTRATOOM-EUR (5)
USASTRATCOM-PAC (5)
USASTRATCOM-SO (5)
USASTRATCOM-A (2)
UUSAESC (40)
MDW (1)
Armies (2)
Corps (2)
1st Cav Div (2)
Ft Carson (7)
Ft Huachuca (5)
WSMR (3)
Svc Colleges (2)
USASCS (10)
USASFSS (’10)
USAADS (2)
USAINTS (3)
(2) USAFAS (2)
USAARMS (2)
USAIS (2)
USAES (2)
UASAOC&S (2)
Army Dep (2) except
SAAD (30)
LBAD (14)
TOAD (14)
ATAD (10)
LEAD (7)
Gen Dep (2)
Sig See, Gen Dep (5)
Sig Dep (5)
ATS (1)
WRAMC (1)
UISAMOC (3)
USAERDAA (2)
USAERDAW (5)
USACRREL (2)
Sig FLDMS (1)
Units org under fol TOE (2ea):
9-550(EK)
11-158
29-134
29-267
29-670
ARNG;: Nor, -l.
USAR: None.
For explanation of abbreviations used, see AR 310-50.

*U.S. GOVERNMENT PRINTING OFFICE: 1990 - 262-912 (30594)

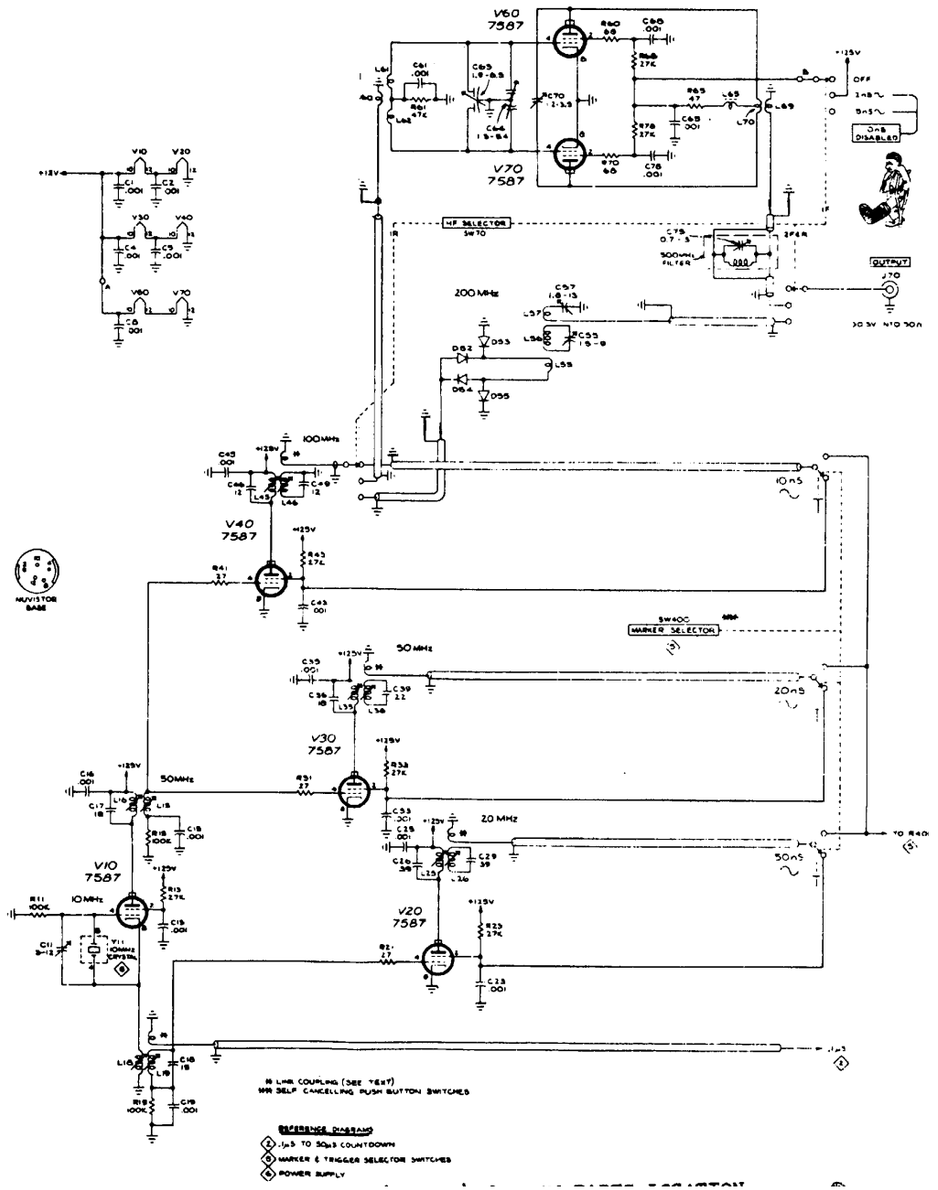


TYPE 184 TIME MARK GENERATOR

BLOCK DIAGRAM

TYPE 184 TIME MARK GENERATOR

BLOCK DIAGRAM



TYPE 184 TIME MARK GENERATOR OSICLLATOR & MULTIPLIERS (1)

FIGURES 4-5 THRU 4-9 SHOW PARTS LOCATON.

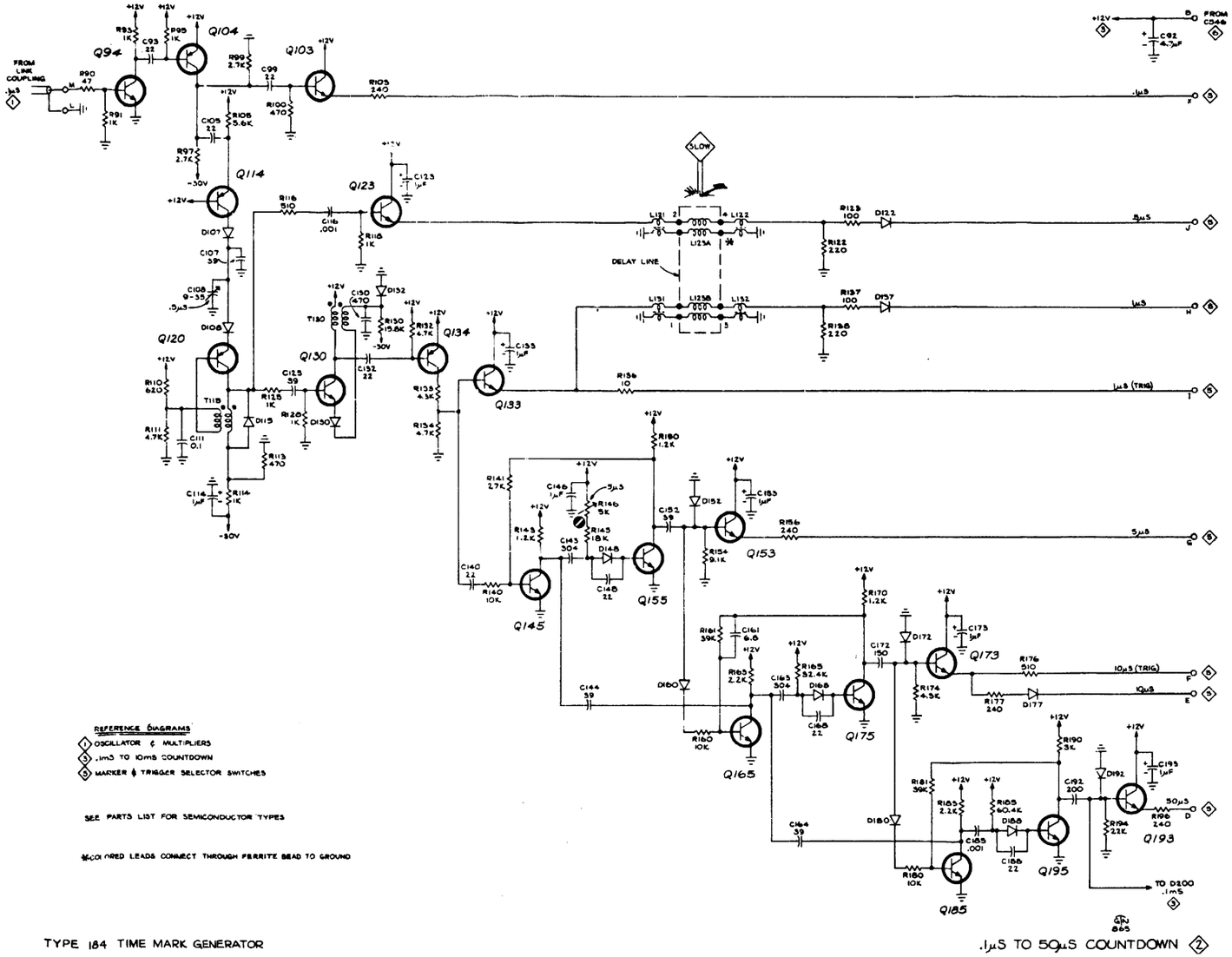
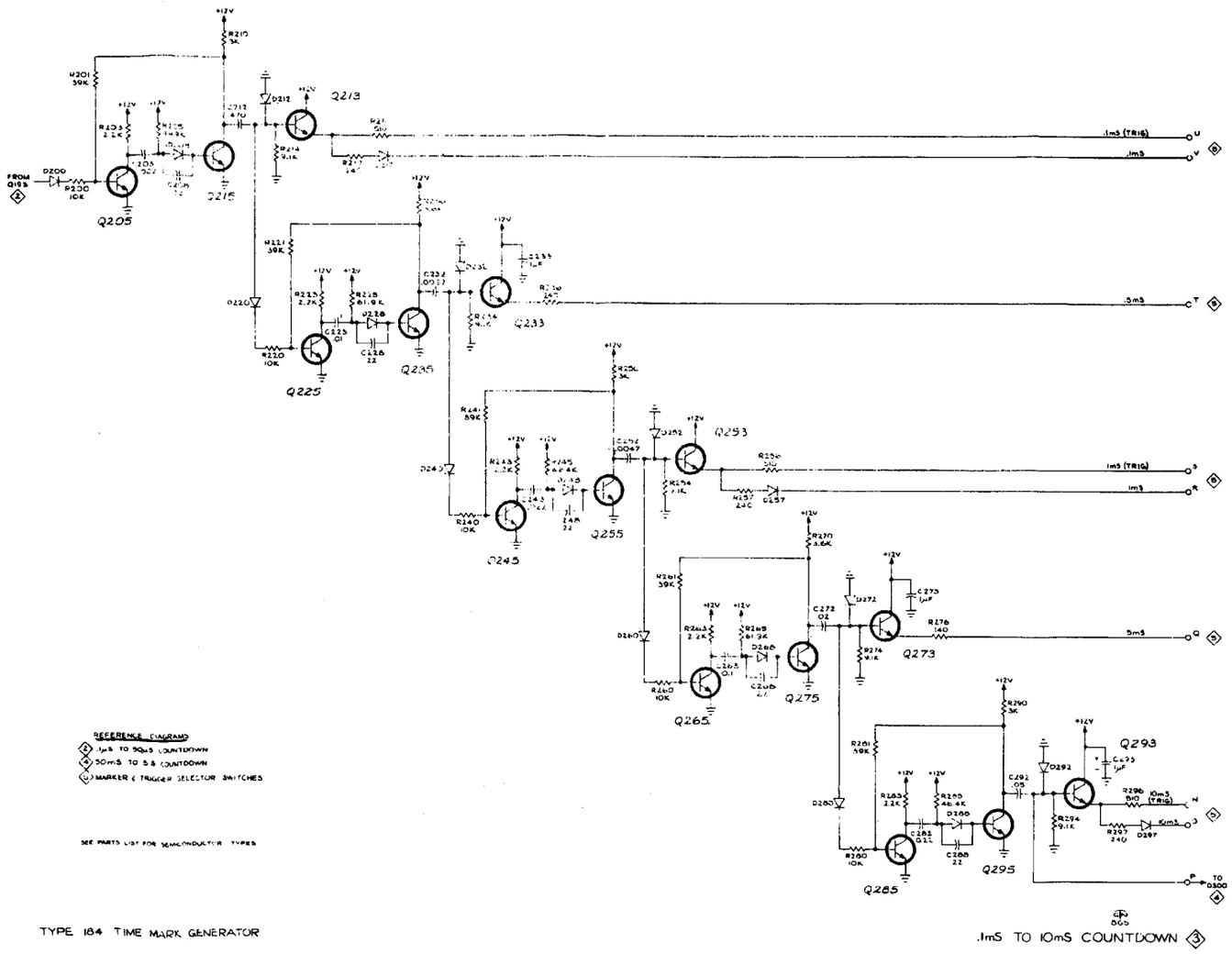


FIGURE 4-5 THRU 4-9 SHOW PARTS LOCATION.



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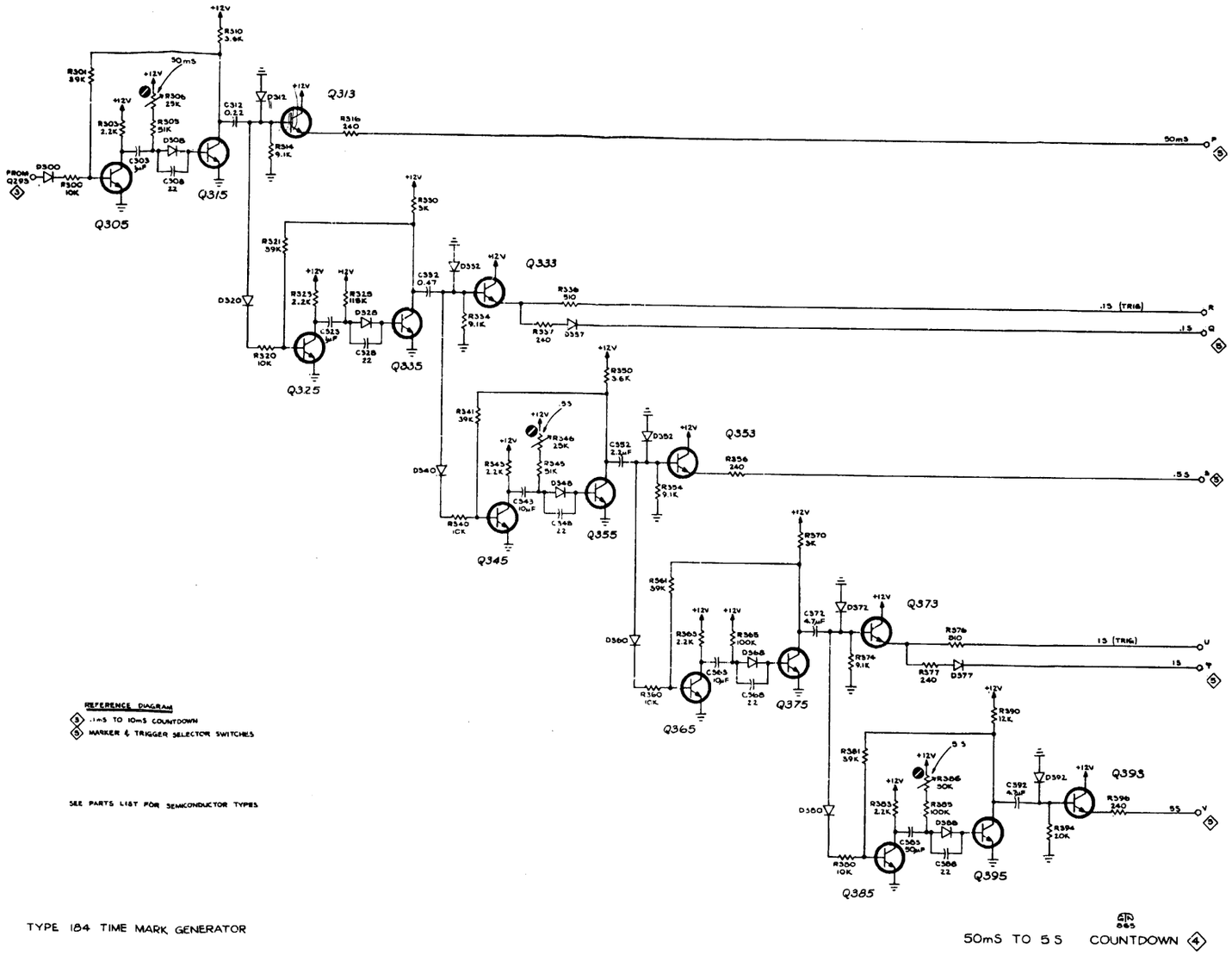

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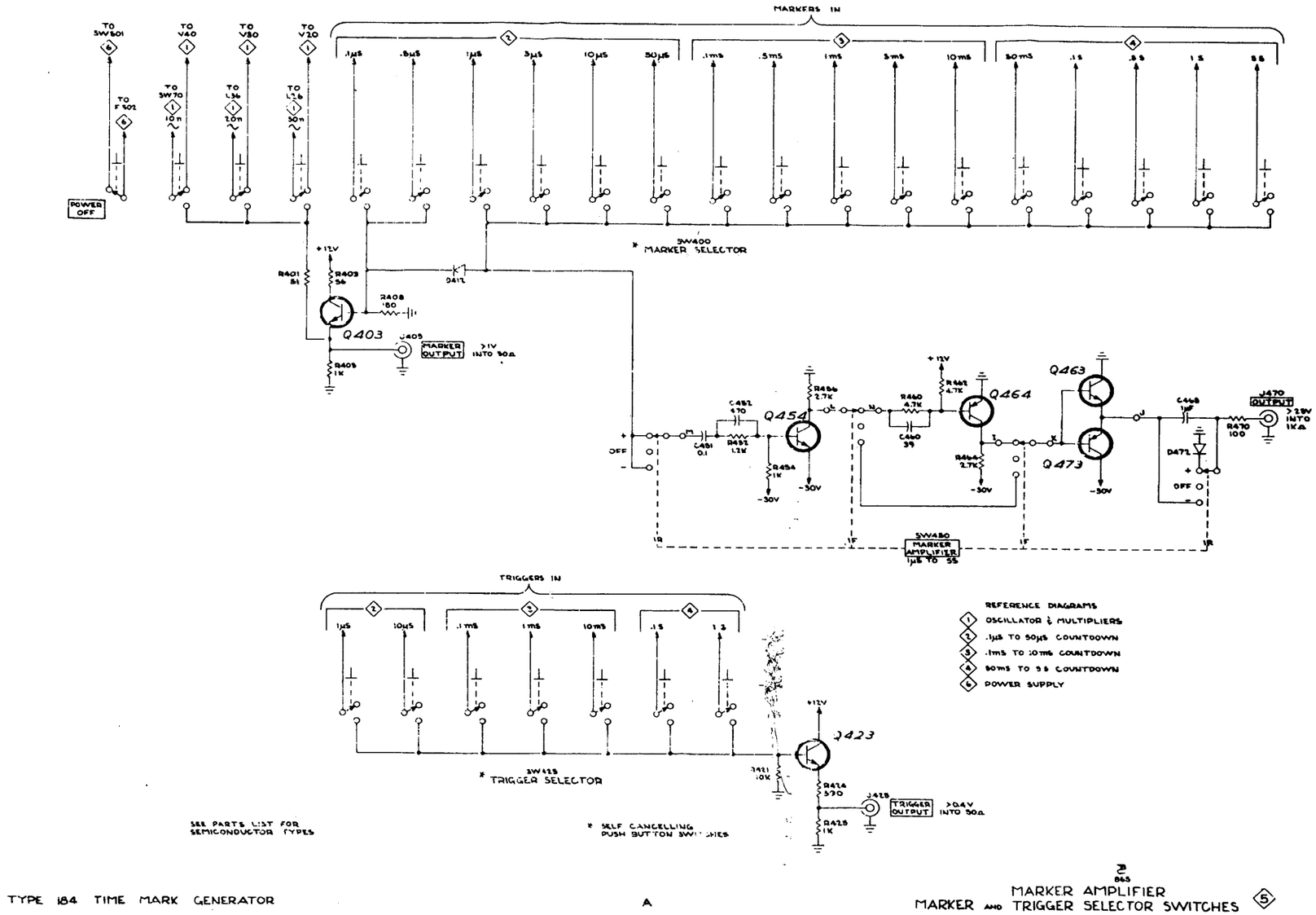

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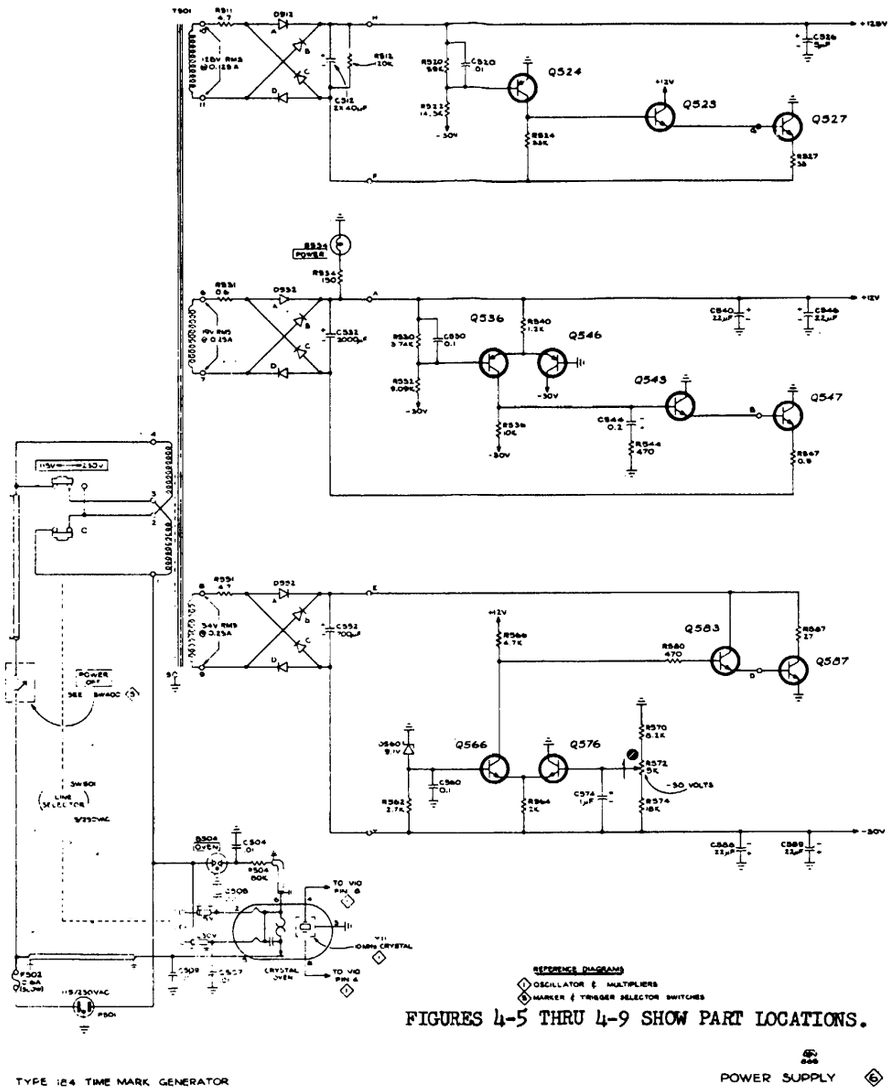

FIGURES 4-5 THRU 4-9 SHOW PART LOCATIONS.

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