

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

---

ORGANIZATIONAL, DS, GS,  
AND DEPOT MAINTENANCE MANUAL

FREQUENCY CONVERTER,  
HEWLETT-PACKARD  
MODEL 5253B

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HEADQUARTERS, DEPARTMENT OF THE ARMY  
MAY 1967

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Section I  
Figure 1-1

Model 5253B



Figure 1-1. Model 5253B and Accessory

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## SECTION I

### GENERAL

#### 1-A.1. Scope

This manual includes installation and operation instructions and covers operator's, organizational, direct support (DS), general support (GS), and depot maintenance. It describes Hewlett-Packard (Federal Supply Code 28480) Frequency Converter Model 5253B (fig. 1-1) with serial numbers prefixed by 513 and 450. A basic issue items list for this equipment is not included in this manual.

#### 1-A.2. Index of Publications

Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment. DA Pam 310-4 is an index of current technical manuals, technical bulletins, supply manuals (types 7, 8, and 9), supply bulletins, lubrication orders, and modification work orders that are available through publications supply channels. The index lists the individual parts (-10, -20, -35P, etc) and the latest changes to and revisions of each equipment publication.

#### 1-A.3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700-58 (Army), NAVSANDA Publication 378 (Navy), and AFR 71-4 (Air Force).

c. Reporting of Equipment Manual Improvements. Report of errors, omissions, and recommendations for improving this manual by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to DA Publications) and forwarded direct to Commanding General, U. S. Army Electronics Command, ATTN: AMSEL-MR-NMP-AD, Fort Monmouth, New Jersey 07703.

**1-1. DESCRIPTION.**

1-2. The Hewlett-Packard Model 5253B Frequency Converter is a plug-in unit which converts a Hewlett-Packard Model 5243L or 5245L Electronic Counter into a direct reading counter from 50 to 512 Mc.

1-3. The stability and accuracy of the basic counter are retained by multiplying a 10-Mc signal, derived from the 1-Mc internal time base of the counter, to a selectable harmonic frequency between 50 and 500 Mc. This known harmonic of 10 Mc is then heterodyned with the INPUT signal. If the resulting difference frequency is between 100 kc and 12 Mc (bandwidth of amplifier in plug-in), it is counted and displayed by the counter. The frequency of the INPUT signal is then indicated by the combination of the MIXING FREQUENCY control (in megacycles; front panel of plug-in) and the digital display of the counter (in megacycles).

1-4. A front panel meter, by monitoring the difference-frequency output of the plug-in to the counter, aids in selecting the desired MIXING FREQUENCY and also in

determining if INPUT signal amplitude is adequate for accurate frequency measurement.

**1-5. SPECIFICATIONS.**

1-6. Table 1-1 contains all technical specifications for the Model 5253B when operated in the Model 5243L or Model 5245L Electronic Counter. Test specifications given in the Maintenance Section (Section V) of this manual, for the purposes of troubleshooting and adjustment, do not represent the technical specifications of the instrument.

**1-7. EQUIPMENT SUPPLIED.**

1-8. A 50-ohm coaxial cable, 48 inches long, male BNC to male BNC, is furnished with the Model 5253B.

**1-9. COOLING.**

1-10. The Model 5253B is cooled by the ventilation system of the counter in which it is installed. See operating and service manual of counter for cooling system maintenance instructions.

**Table 1-1. Specifications\***

|                      |   |
|----------------------|---|
| RANGE:               | As converter for 5243L or 5245L counter, 50 Mc to 512 Mc, using mixing frequencies of 50 Mc to 500 Mc in 10 Mc steps. |
| ACCURACY:            | Retains accuracy of 5243L or 5245L counter  |
| INPUT VOLTAGE RANGE: | 50 mv to 1 v RMS  |
| MAXIMUM INPUT:       | 2 v RMS or 100 vdc will not damage the instrument   |
| INPUT IMPEDANCE:     | Approximately 50 ohms   |
| LEVEL INDICATOR:     | Meter aids frequency selection; indicates output voltage level to counter   |
| REGISTRATION:        | Counter display is added to the converter dial reading  |
| WEIGHT:              | Net 5-1/2 lbs, shipping 9 lbs   |

\*When installed in Hewlett-Packard Model 5243L or Model 5245L Electronic Counter.

Model 5253B

Section II  
Paragraphs 2-1 to 2-14**SECTION II****PREPARATION FOR USE****2-1. UNPACKING AND INSPECTION.**

2-2. Inspect the equipment for any damage incurred during transit. If the equipment has been damaged, report the damage on DD Form 6 (para 1-A.3).

**2-3. ELECTRICAL INSPECTION.**

2-4. The performance check procedure (Paragraph 5-31) may be used to verify proper electrical operation as part of an incoming quality control inspection.

**2-5. STORAGE AND RESHIPMENT.**

2-6. **PACKAGING.** To protect valuable electronic equipment during storage or reshipment, always use the best packaging methods available.

a. Original. Place instrument in original container. Replace each packing pad and filler in the exact position that it originally occupied.

b. Alternate. Cover panel with soft wrapping paper. Wrap corrugated cardboard completely around instrument and place in strong corrugated cardboard container (350 lb/sq in. bursting test). Insert filler material between wrapped instrument and container to obtain a snug fit on all surfaces. Filler should be rubberized hair (2 in. thick), excelsior (6 in. thick), or equivalent.

2-7. **ENVIRONMENT.** Conditions during storage and shipment should normally be limited as follows:

a. Maximum altitude 20,000 feet (6,096 meters).

b. Minimum temperature -40°F (-40°C).

c. Maximum temperature 167°F (75°C).

**CAUTION**

**TURN COUNTER POWER OFF  
BEFORE INSTALLING OR  
REMOVING FREQUENCY  
CONVERTER.**

**2-8. INSTALLATION.**

2-9. The Model 5253B plugs into the rectangular compartment at the right-hand side of the front panel of the Model 5243L or 5245L Electronic Counter. To install unit in counter, first check that retaining screw (see Figure 3-1) is turned fully counterclockwise, then push unit firmly into compartment until front panel of plug-in is flush with front panel of counter. Then turn retaining screw clockwise until it is tight.

2-10. To remove unit from counter, turn retaining screw counterclockwise to its stop. Then grasp mixing frequency selector (see Figure 3-1) and firmly pull unit from counter. If any difficulty is encountered with installation or removal, check that retaining screw is fully counterclockwise.

**2-11. POWER REQUIREMENTS.**

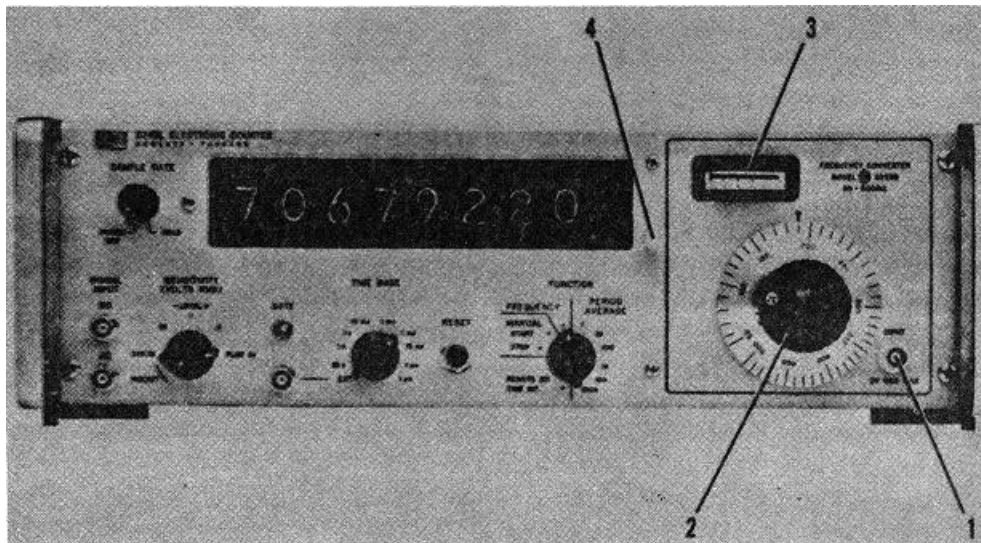
2-12. All electrical power required to operate the Model 5253B is supplied by the counter in which the unit is installed.

**2-13. ELECTRICAL CONNECTIONS.**

2-14. INPUT connector on front panel of plug-in (see Figure 3-1) is the only external electrical connection to the unit. All other connections are made through the 50-pin connector at the rear of plug-in when installed in counter.

01874-2

Section III  
Figure 3-1



1. INPUT signal connector.
2. MIXING FREQUENCY SELECTOR. Calibrated in mc, this control tunes the internal cavity to select a harmonic of 10 me to be heterodyned with the INPUT signal.
3. LEVEL INDICATOR METER. The meter circuit continuously monitors the level of the difference-frequency output of converter to counter. When meter reads in the green portion of its scale, INPUT signal amplitude is adequate for accurate frequency measurement.
4. RETAINING SCREW. The screw which holds the converter in place is located on the front panel of the counter. To tighten, turn fully clockwise. To loosen, turn fully counter-clockwise.

Figure 3-1. Front Panel

01874-3

**SECTION III**

**OPERATION**

**3-1. FRONT PANEL.**

3-2. The functions of the front panel control, meter, connector, and retaining screws are given in Figure 3-1.

**3-3. MAXIMUM INPUT VOLTAGES.**

3-4. Damage to the converter may result if an AC signal greater than 2 v RMS or a DC voltage greater than 100 v is applied to converter INPUT connector.

**3-5. OPERATING PROCEDURES.**

**3-6. NORMAL RANGE MEASUREMENTS.**

3-7. Figure 3-2 is the procedure to be used for measurement of frequencies from 50. 1 to 512 Mc with INPUT signal amplitudes from 50 mv to 1 v RMS.

**3-8. EXTENDED RANGE MEASUREMENTS.**

3-9. The frequency of signals not within the normal range of 50.1 to 512Mc, 50 mv to 1v RMS, may be measured using the following procedures:

3-10. 50 TO 50.1 MC, 50 MV TO 1 V RMS. Perform steps 1 through 5 of Figure 3-2. Then:

- a. Set mixing frequency control to slightly more than 60 Mc.
- b. Turn mixing frequency control slowly clockwise until level indicator meter first reaches a maximum reading in the green portion of its scale.
- c. Subtract counter display (in Mc) from reading of mixing frequency control (in Mc) for frequency of INPUT signal.

3-11. 50 TO 512 MC, AMPLITUDE LESS THAN 50 MV RMS. The front panel level indicator meter indicates in the green portion of its scale only when converter is properly tuned and amplitude of INPUT signal is adequate for accurate frequency measurement. However, because of conservative specifications of both the converter and counter, frequencies may often be accurately measured when meter reads in the red portion of its scale. To make these extended range measurements:

- a. Follow normal procedure (Figure 3-2 or Paragraph 3-10, depending upon frequency range) except that mixing frequency control should be tuned for first maximum reading on the level indicator meter, regardless of the color of region maximum.
- b. Check frequency measurement result as described in Paragraph 3-12, or c. Insert an external variable attenuator (such as Hewlett-Packard Model 355A or 355C) in the transmission line between the converter and the source of INPUT signal. Vary attenuation from 0 to 1 db during final step of frequency measurement procedure. If counter display does not change more than momentarily (during switching of attenuator), INPUT signal is above noise threshold and frequency measurement result is valid.

**3-12. DOUBLE-CHECKING FREQUENCY MEASUREMENT RESULT.**

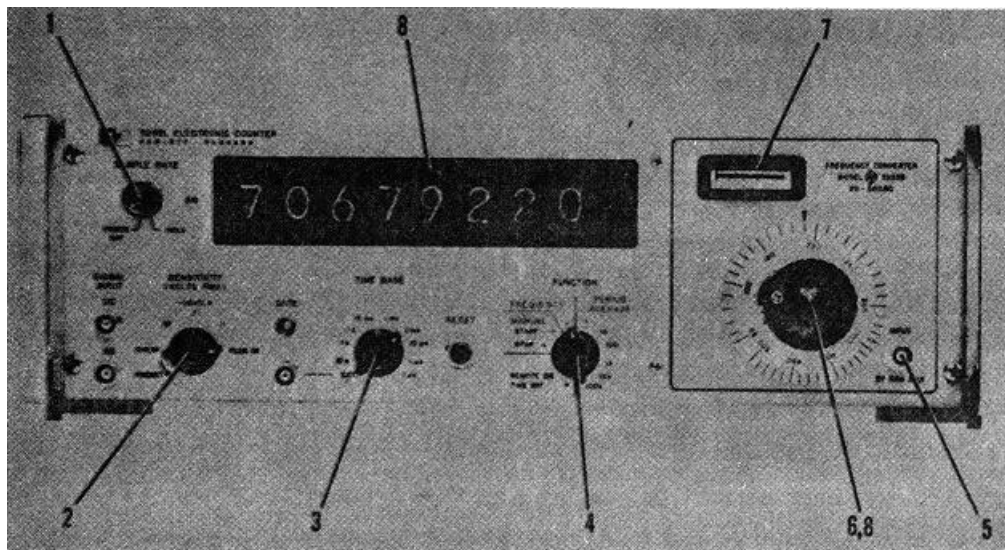
3-13. Because of the heterodyne action of the converter, frequency measurement results obtained at any one setting of the mixing frequency control may be checked at other settings. See Figure 3-3 for examples.

**Table 3-1. Frequency Resolution**

| INPUT SIGNAL FREQUENCY = 151.1223344 Mc<br>MIXING FREQUENCY CONTROL set to 140 Mc |                    |                        |
|---|--------------------|------------------------|
| Time Base Setting   | Counter Display    | Measurement Resolution |
| .1 μs   | * (no display)     |                        |
| 1 μs  | 1 1. Mc            | 1 5 1. Mc              |
| 10 μs   | 1 1.1 Mc           | 1 5 1.1 Mc             |
| .1 ms   | 1 1.1 2 Mc         | 1 5 1.1 2 Mc           |
| 1 ms  | 1 1 1 2 2. kc      | 1 5 1.1 2 2 Mc         |
| 10 ms   | 1 1 1 2 2.3 kc     | 1 5 1.1 2 2 3 Mc       |
| .1 s  | 1 1 1 2 2.3 3 kc   | 1 5 1.1 2 2 3 3 Mc     |
| 1 s   | 1 1 1 2 2.3 3 4 kc | 1 5 1.1 2 2 3 3 4 Mc   |
| 10s   | 1 1 2 2.3 3 4 4 kc | 1 5 1.1 2 2 3 3 4 4 Mc |



Section III  
Figure 3-2



1. Turn SAMPLE RATE control slightly out of POWER OFF position.
  2. Set SENSITIVITY to PLUG IN.
  3. Set TIME BASE to .1 ms.\*
  4. Set FUNCTION to FREQUENCY.
  5. Connect signal whose frequency is to be measured to INPUT of converter.
  6. Set mixing frequency control to read slightly less than 50 Mc.
  7. Slowly turn mixing frequency control counterclockwise until level indicator meter first reaches a maximum reading in the green portion of its scale.
  8. Add counter display (in Mc) to mixing frequency control reading (in Mc) for frequency of INPUT signal.
- \* TIME BASE setting may vary, depending on desired resolution of INPUT signal frequency. See Table 3-1.

Figure 3-2. Frequency Measurement Procedure

Model 5253B

Section III  
Paragraphs 3-14 to 3-15

**3-14. AID TO RAPID TUNING**

3-15. To easily obtain an indication of the proper MIXING FREQUENCY when rapidly tuning the Model 5253B through its frequency range in search of an unknown INPUT frequency, set counter FUNCTION control to MANUAL START. This allows the counter to

totalize each cycle of any difference frequency produced during rapid tuning. When counter display changes, indicating that the MIXING FREQUENCY is heterodyning with the INPUT frequency and producing a difference frequency within the frequency range of the basic counter, set counter FUNCTION control to FREQUENCY and proceed with measurement.

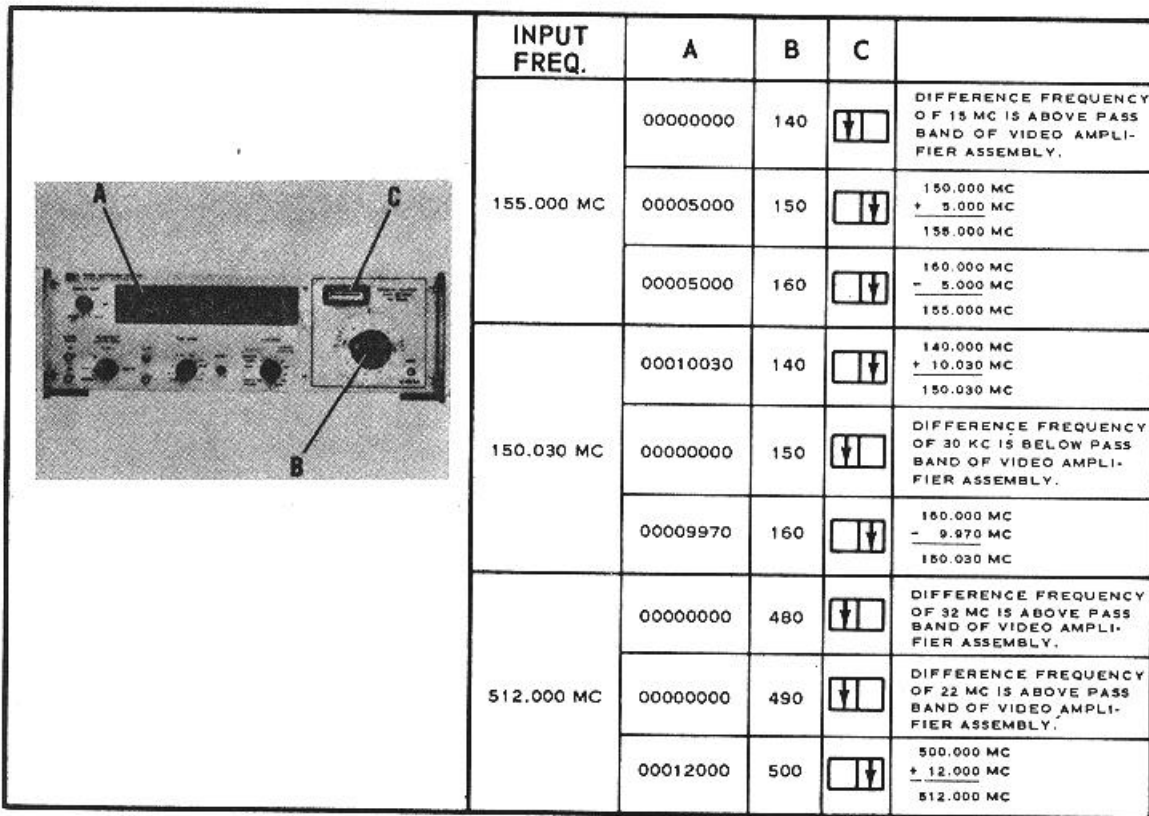


Figure 3-3. Typical Frequency Measurements

Section IV  
 Figures 4-1 and 4-2

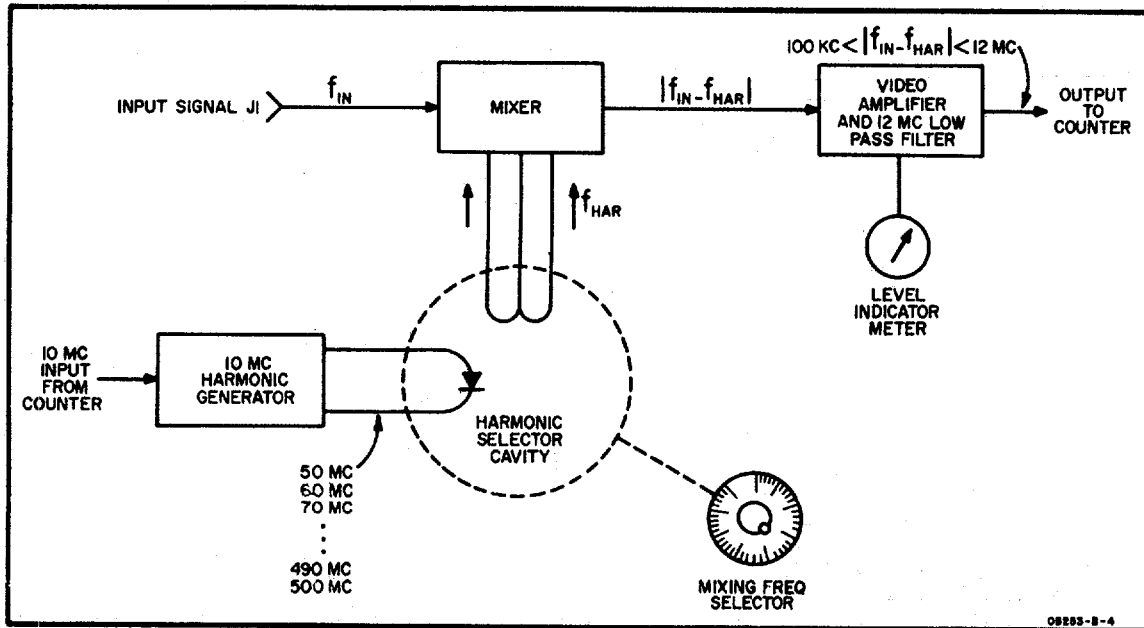


Figure 4-1. Block Diagram

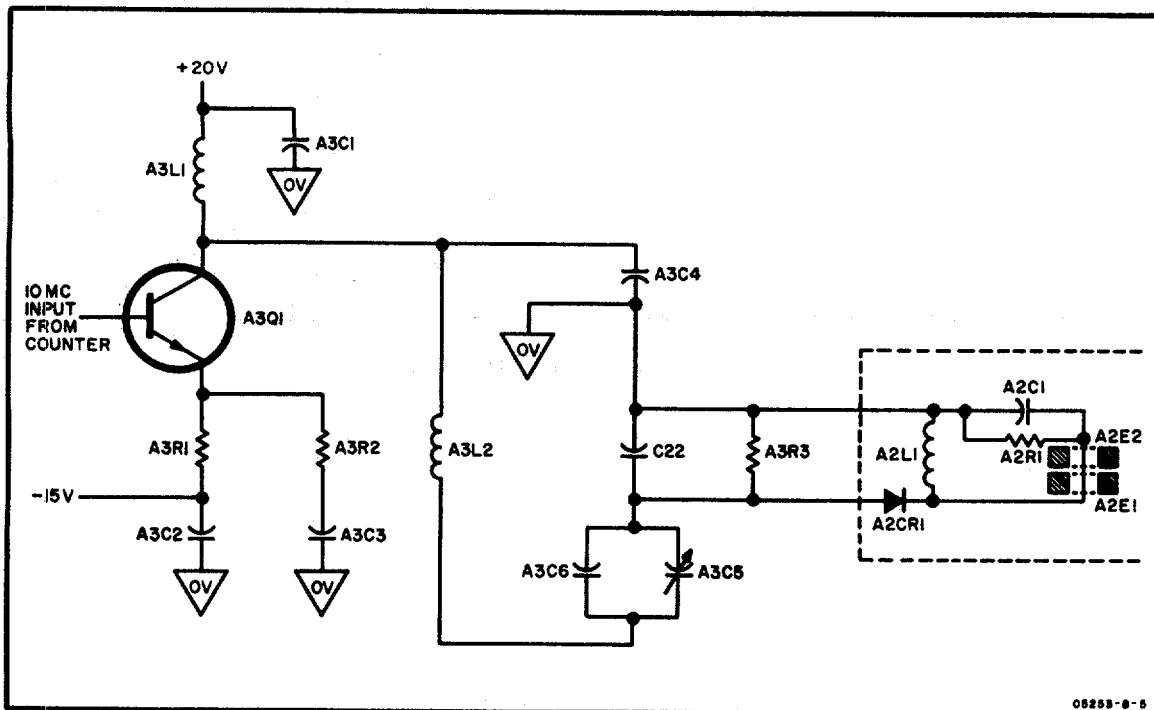


Figure 4-2. Harmonic Generator (A2, A3)

**SECTION IV**

**PRINCIPLES OF OPERATION**

**4-1. GENERAL**

4-2. The Model 5253B is a heterodyne frequency converter designed to extend the range of frequency measurement of the Model 5243L and 5245L Electronic Counters to 512 Mc.

4-3. The converter contains four basic functional sections: harmonic generator, harmonic selector cavity, mixer, and video amplifier (see Figure 4-1).

4-4. In normal operation, the harmonic generator produces all of the harmonics of 10 Mc between 50 and 500 Mc. The harmonic selector cavity is tuned to select one of these harmonics to be supplied to the mixer. The mixer output is the difference frequency produced by the mixing of the INPUT frequency and the frequency supplied by the harmonic selector cavity. This difference frequency is amplified by the video amplifier and supplied to the counter input circuit. A low-pass filter within the video amplifier prevents all difference frequency signals above approximately 12 Mc from reaching the counter input circuit. The output of the video amplifier is monitored by a meter circuit which indicates when difference frequency output amplitude is

greater than minimum signal required by counter input circuit.

**4-5. HARMONIC GENERATOR (A2,A3), AND HARMONIC SELECTOR CAVITY**

4-6. A 10-Mc signal, supplied by the Counter, is amplified by A3Q1 to cause a tuned circuit, composed of A3L2, A3C4, A3C5, A3C6, and C22, to oscillate at 10-Mc (Fig. 4-2). Step-recovery diodes A2CR1, takes energy from this tuned circuit during a portion of each cycle of the 10-Mc oscillation and produces a sharp step in the current following in the input loop of the harmonic selector cavity. This current step makes available, inside the cavity, all harmonics of 10 Mc from 10 Mc (fundamental) to over 500 Mc (fiftieth harmonic). The remaining components of the step-recovery diode network (Assembly A2) are used to maintain the sensitivity of the counter across its frequency range. The harmonic selector cavity is tuned to resonate at a particular harmonic of 100Mc between 50 and 500 Mc so that energy at that frequency is coupled from the input loop to the output loops providing one of the two inputs to the mixer circuit (Fig. 4-4).

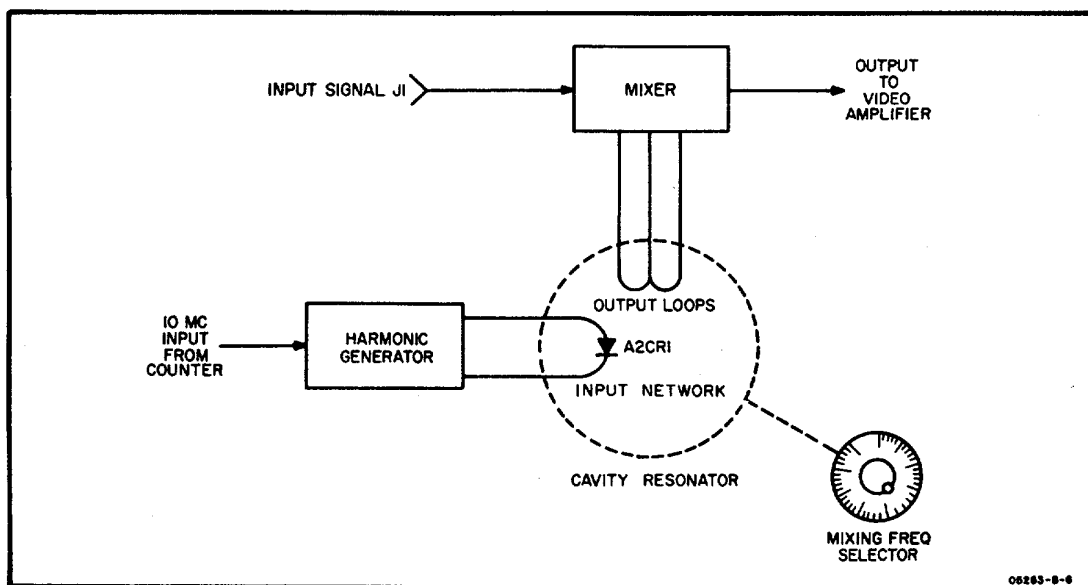


Figure 4-3. Harmonic Selector Cavity

4-7. MIXER (A4)

4-8. Matched diodes are used in a balanced mixer circuit in order to minimize the generation of even-order harmonics of both the INPUT signal and the selected mixing frequency. The balanced input signal required by the circuit is accomplished by grounding the junction of the two resistors of equal value, A4R1 and A4R2, and installing ferrite rings (E1, E2, and E3) around the input coaxial cable (see Figure 4-4). Both sides of resistor A4R1 are returned to common for DC currents. However, for AC currents in the frequency range of 50 to 512 Mc, the impedance of the input signal path is large, due to the inductance provided by the ferrite rings E1, E2, and E3, causing a balanced AC signal condition at the mixer diodes. Limiting diode A4CR2 prevents INPUT signals of high amplitude from overloading the mixer circuit. The output of the mixer diodes, during normal operation when the converter is properly tuned, is a complex signal containing the INPUT signal frequency, the frequency of the harmonic of 10 Mc to which the harmonic selector cavity is tuned, the frequency that is the sum of these two frequencies, and the frequency that is the difference between these two frequencies. Inductor A41.1 reduces the amplitude of any signal with a frequency above approximately 15 Mc before the signal reaches the input to the video amplifier. The output of the mixer circuit is then essentially composed of the difference frequency signal.

4-9. VIDEO AMPLIFIER ASSEMBLY (A1)

4-10. The output of the mixer circuit is amplified by transistors A1Q1 and A1Q2 and is fed to the 12-Mc low-pass filter network (see Figure 4-5). This filter passes any signal frequency below approximately 12 Mc and attenuates all higher frequency signals. The low pass filter output is amplified by A1Q3 and A1Q4 and fed to the last transistor amplifier, A1Q5, which provides both the output to the counter and the drive for the level indicator meter. The limiter diode, A1CR1, prevents the amplitude of the video amplifier output signal from exceeding approximately 300 mv RMS so that counter input circuits will not be overloaded. The low frequency limit of the video amplifier, determined by the bypass and interstage coupling networks, is approximately 100 kc. The converter output signal to the counter, when converter is properly tuned, will be between approximately 100kc and 12Mc and will have an amplitude that is less than approximately 300 mv RMS.

4-11. LEVEL INDICATOR METER

4-12. The DC current supply for the meter is produced by metering detector A1CR3 and smoothed by capacitor A1C16 (see Figure 4-6). The value of shunt resistor A1R20 is selected to make level indicator meter M1 read at red-green border when amplitude of converter output to counter is in excess of the 100mv RMS minimum signal amplitude normally required by the counter for accurate frequency measurement.

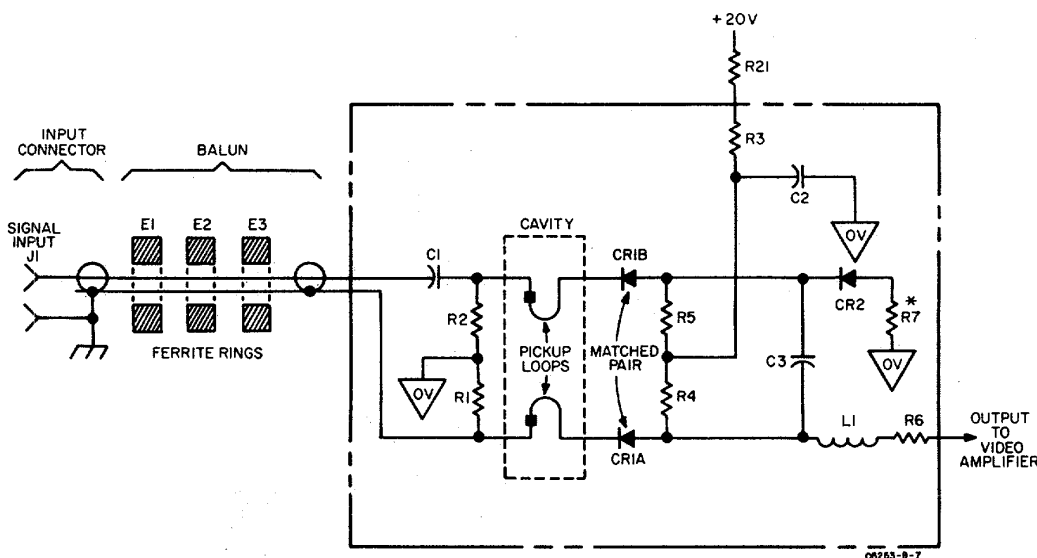


Figure 4-4. Balanced Mixer,(A4)

Model 5253B  
 Figures 4-5 and 4-6

Section IV

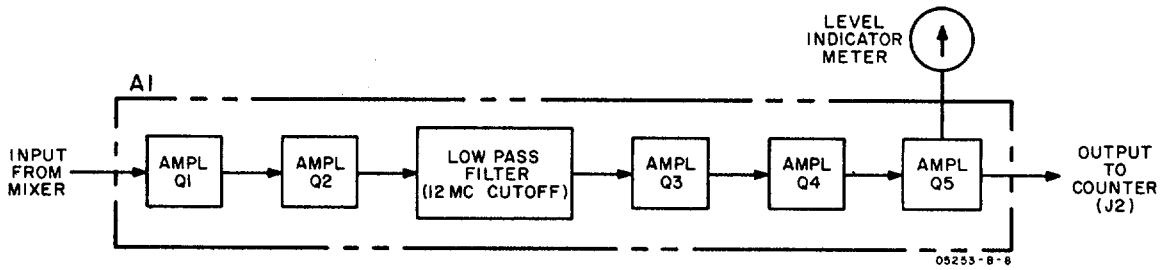


Figure 4-5. Video Amplifier (A1)

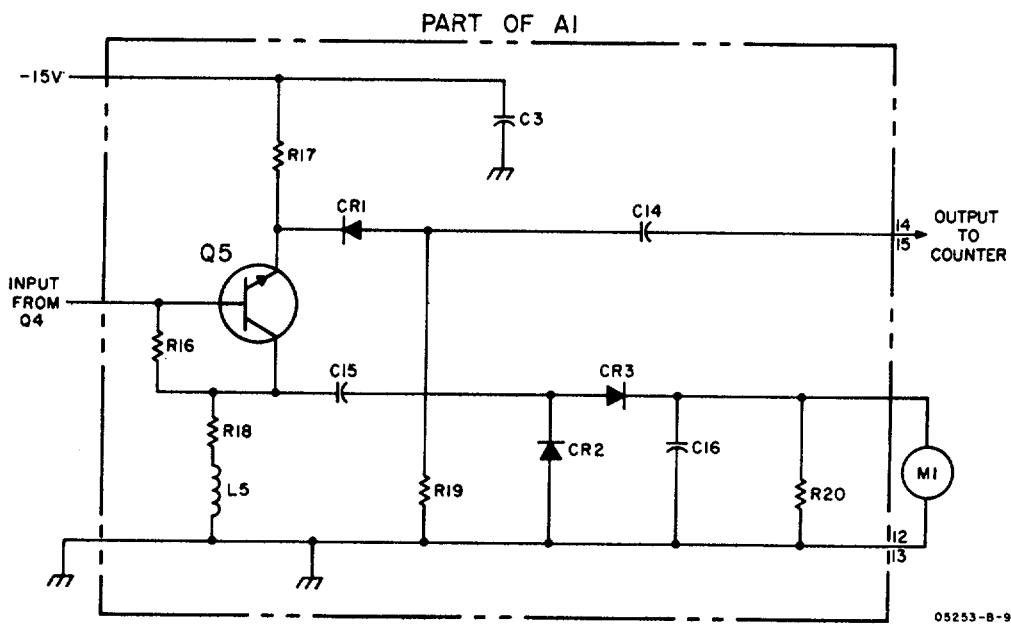


Figure 4-6. Level Indicator Meter Circuit

01874-2

**SECTION V  
MAINTENANCE**

**5-1. GENERAL.**

**5-2. INTRODUCTION.**

5-3. This section contains information concerning periodic maintenance, troubleshooting and recommended test equipment, repair, circuit adjustments, and performance testing. A complete schematic diagram of the converter is at the rear of this section (Figure 5-5).

**5-4. PERIODIC MAINTENANCE.**

5-5. No special maintenance procedures are required when the converter is operated in normal environments. However, if unit is subjected to operation in extremely dusty environments, periodically clean all gears with a lint-free cloth and apply a coating of light, petroleum base, open-gear grease to all gear teeth.

**5-6. TEST EQUIPMENT.**

5-7. All test instruments required for performance testing, troubleshooting, and circuit adjustment after repair are listed in Table 5-1. Instruments having equivalent specifications may be substituted for the specific instruments recommended.

**5-8. TROUBLESHOOTING.**

5-9. Table 5-2 lists resistances from connecting pins on connector J11 to chassis (when unit is not connected to counter) to aid in troubleshooting. Table 5-3 is a suggested troubleshooting procedure which lists circuit conditions at Test Points throughout the converter. These Test Points are keyed to the component location

drawings, Figures 5-1, 5-2, 5-3 and 5-4, and also to the schematic diagram, Figure 5-5. Voltages listed in Table 5-3 are approximate and may vary widely between instruments, due to variations in component values. Table 5-4 lists recommended adjustments to be made after repair of any section of the converter.

**Table 5-2. Resistance Troubleshooting Aid**

| Location    | Resistance (to Chassis)* |
|-------------|--------------------------|
| J2 - Pin 1  | > 100 megohms            |
| J2 - Pin 15 | 1 K ohms +20%            |
| J2 - Pin 20 | 140 K ohms +20%          |
| J2 - Pin 25 | 125 K ohms +20%          |

\* Unit not connected to counter.

**5-10. REPAIR AND REPLACEMENT.**

5-11. Paragraphs 5-12 through 5-19 are replacement procedures to aid in repair of the converter. Detailed procedures for replacement of all the individual components of the unit are beyond the scope of this manual. In-field repair is, for the most part, simple and straightforward. However, do not attempt adjustment of the gearing arrangement, the harmonic selector cavity or the step-recovery diode. Figures 5-6 and 5-7 show mechanical parts locations.

**Table 5-1. Recommended Test Equipment**

| Instrument           | Required Characteristics                             | Use  | Instrument Recommended   |
|----------------------|--|--|--|
| Electronic Counter   |  | Supply Power, Visual Operational Indicator | Ⓢ Model 5243L or<br>Ⓢ Model 5245L  |
| RF Millivoltmeter    | 1 Mc to 20 Mc<br>10 mv to 10 vdc<br>10 mv resolution | Circuit Adjustment, Troubleshooting        | Ⓢ Model 411A with Pen Type Probe Tip, Ⓢ11022A (formerly Ⓢ411A-21B)                   |
| DC VTVM and Ohmmeter | 0 to +25 vdc<br>0.1 v resolution<br>0 to 100 M ohms  | Circuit Adjustment, Troubleshooting        | Ⓢ Model 412A   |
| VHF Signal Generator | 50 Mc to 480 Mc<br>10 mv to 1 v                      | Circuit Adjustment, Troubleshooting        | Ⓢ Model 608C   |
| Oscilloscope         | 15 Mc bandwidth                                      | Circuit Adjustment, Troubleshooting        | Ⓢ Model 175A with<br>Ⓢ Model 1752A High Gain Amplifier and<br>Ⓢ Model 1780A Aux Unit |
| Extension Cable      | 50 pin straight-thru connections                     | Circuit Adjustment, Troubleshooting        | Ⓢ 10506A (formerly ⓈAC-16Y)  |

**Table 5-3. Troubleshooting Procedure**

TEST EQUIPMENT:  $\Phi$  Model 411A RF Millivoltmeter with  $\Phi$  11022A (formerly 411A-21B) Pen Type Probe Tip,  
 $\Phi$  Model 412A DC VTVM

|   |  |
|---|--|
| REMOVE $\Phi$ 5253B FROM COUNTER;<br>SELF-CHECK COUNTER                               | See counter manual for self-check procedure.   |
| CONNECT $\Phi$ 5253B TO COUNTER WITH EXTENSION CABLE, $\Phi$ 10506A (formerly AC-16Y) | Extension cable available from $\Phi$ ; see parts list.  |
| 1 +20 VDC<br>2 -15 VDC  | Checks power supplied to plug-in from counter; see counter manual for power supply adjustment procedure.   |
| 3 + 6 VDC<br>2 VAC  | Checks 10-Mc drive of harmonic generator.  |
| 4 + 2 VDC<br>- 2 VDC<br>2 VAC   | Checks generator diode drive. Voltages vary widely because of both the detuning effect of volt-meter probe and the variable value of A3R3. DC voltage may be either + or -, depending upon factory determined generator diode orientation. |
| 5 +100 MV DC<br>6 +100 MV DC  | Voltages vary widely because of diode characteristics. Voltages are 0 VDC when diode shorted, and +20 VDC when diode open. Voltages should be approximately equal because of matched characteristics.                                      |

CONNECT SIGNAL GENERATOR TO  $\Phi$  5253B.  
SET GENERATOR TO 52 MC, CW, 100 MV.  
SET COUNTER CONTROLS AND 5253B TO MEASURE FREQUENCY OF INPUT SIGNAL.

|  |  |
|--|--|
| 7 5 MV RMS   | This voltage is total harmonic energy output of mixer and varies widely. |
| 8 -11.3 VDC<br>30 MV RMS   | Checks bias and amplification of A1Q2 and A1Q1.                          |
| 9 -12.3 VDC<br>17 MV RMS   | General check of low pass filter section                                 |
| 10 -9.3 VDC<br>360 MV RMS  | Checks bias and amplification of A1Q3 and A1Q4                           |
| 11 -7.1 VDC<br>300 MV RMS  | Checks operation of A1Q5   |
| 12 0 VDC<br>190 MV RMS   | Checks operation of limiter, A1CR1                                       |
| 13 0 MV DC WHEN METER READS AT LEFT END OF SCALE;<br>50 MV DC WHEN METER READS FULL SCALE;<br>15 MV DC WHEN TEST POINT #12 IS 100 MV RMS, AND METER READS AT RED-GREEN BORDER. | Checks accuracy of meter circuit in relation to output to counter        |



**Model 5253B**

**5-12. PRINTED CIRCUIT COMPONENT REPLACEMENT.**

5-13. Component lead-holes in the Model 5253B circuit boards have plated walls to insure good electrical contact between conductors on the opposite sides of the board. To prevent damage to this plating and also to the replacement component, apply heat sparingly and work carefully. The following replacement procedure is recommended:

- a. Remove defective component.
- b. Melt solder in component lead-holes. Use clean, "dry" soldering iron to remove excess solder. Clean holes with toothpick or wooden splinter. Do not use metal tool for cleaning as this may damage the through hole plating.
- c. Bend leads of replacement component to the correct shape and insert component leads in component lead-holes. Using heat and solder sparingly, solder leads in place. Heat may be applied to either side of board as is convenient. A heat sink (long-nose pliers, commercial heat-sink tweezers, etc. ) should be used when replacing transistors and diodes in order to prevent excessive heat from being conducted by the leads from the soldering iron to the component.
- d. Through-hole plating breaks are indicated by the separation from the board of the round conductor-pad on either side of the board. To repair breaks, press conductor-pads against board and solder replacement component lead to conductor-pad on both sides of the board.

**5-14. VIDEO AMPLIFIER ASSEMBLY REPLACEMENT.**

5-15. If video amplifier printed circuit board requires replacement, follow this procedure:

- a. Remove the converter from counter.
- b. Unscrew and remove small screw (MP1; see Figure 5-4) which holds video amplifier AI in place. Remove screws which secure supporting bracket to front panel. Remove supporting bracket.
- c. Firmly grasp assembly at component-free end and pull out of socket using a slight back-and-forth sideways movement.
- d. Check that the connecting terminals of replacement assembly are clean. Push replacement assembly firmly into socket and check for proper seating. Replace supporting bracket and all screws.
- e. All replacement video amplifier assemblies are adjusted and inspected at the factory for optimum performance. However, if a general operational check is desired, perform the in-cabinet performance check given in Paragraph 5-31.

**5-16. MIXER DIODE REPLACEMENT.**

5-17. If either of the matched pair of mixer diodes (A4CR1A or A4CR1B) is found to be defective, both diodes should be replaced. The recommended replacement procedure is as follows:

- a. Remove mixer-assembly shield cover (see Figure 5-3).
- b. Remove diodes from spring clips, noting orientation.
- c. Install replacement diodes with same orientation.
- d. Replace mixer-assembly shield cover.
- e. Perform the sensitivity check (Paragraph 5-28) to insure that converter operation is within specifications.

**5-18. METER REPLACEMENT PROCEDURE.**

5-19. If the level indicator meter requires replacement, follow this procedure:

- a. Remove converter from counter.
- b. Unscrew and remove small retaining screw (MP1; see Figure 5-4) which holds video amplifier board AI in place. Remove screws which secure supporting bracket to front panel. Remove supporting bracket.
- c. Firmly grasp video amplifier board at the component-free end and pull board out of socket using a slight back-and-forth sideways movement.
- d. Place converter on bench with bottom plate resting on bench surface and with the front panel facing to the rear of the bench.
- e. Remove screw (MP2) which holds aluminum spacer-rod (MP3) to plastic rear-support (MP4; see Figure 5-2). Grasp spacer-rod and turn counterclockwise to remove rod from front support.
- f. Cut connecting wires at meter terminals.
- g. Remove screws (MP5, 6; see Figure 5-4) from meter bezel at sides of meter. Push bezel forward as far as possible.
- h. Remove screws (MP7, 8) on top of meter bracket.
- i. Grasp meter and gently pull meter (and bracket) backwards out of front panel hole, at the same time twisting rear of meter slightly sideways to the right and pulling up.
- j. Remove bracket and hardware from meter and install in identical manner on replacement meter.  
Hardware which may come from the manufacturer with the replacement meter may be discarded.
- k. Place meter (with bracket) in unit by reversing removal procedure.
- m. Replace screws on top of meter bracket.
- n. Replace meter bezel at sides of meter.

**Section V**  
**Paragraphs 5-20 to 5-23**

p. Check that meter terminals are not close to front bearing-block. Bend terminals away from block if necessary.

q. Strip 1/4-inch insulation from ends of each connecting wire and solder to meter terminals. Black wire goes to inside terminal and white wire goes to outside terminal.

r. Replace aluminum spacer-rod. Tighten only "finger-tight" as excessive torque may break end of rod.

s. Replace screw which holds spacer-rod to rear support.

t. Replace video amplifier assembly, supporting bracket, and all screws.

**5-20. HARMONIC GENERATOR ADJUSTMENT.**

5-21. To adjust the harmonic generator assembly, proceed as follows:

a. Remove converter from counter and reconnect to counter with Extension Cable, #-10506A.

b. Connect VHF Signal Generator to converter INPUT and set to 472 Mc, CW, at 100 mv.

c. Connect RF Millivoltmeter to Test Point #12 (see Figure 5-4).

d. Set converter mixing frequency control to 470 Mc, and tune for maximum reading on RF Millivoltmeter.

e. Vary output of VHF Signal Generator to make converter level indicator meter read at red-green border.

f. Using plastic tuning tool, tune A3C5 (see Figure 5-2) for maximum reading on RF Millivoltmeter. Tune A3C5 through hole in harmonic generator assembly shield cover.

**5-22. LOW PASS FILTER ADJUSTMENT.**

5-23. To adjust the low pass filter in the video amplifier assembly, proceed as follows:

a. Remove converter from counter and reconnect to counter with Extension Cable, (HP) 10506A.

b. Connect VHF Signal Generator to converter INPUT and set to 110 Mc, CW, at 50 mv.

c. Connect RF Millivoltmeter to Test Point #12 (see Figures 5-4 and 5-5).

d. Set converter mixing frequency control to 100 Mc and tune for maximum reading on RF Millivoltmeter.

e. Set Signal Generator to 116.2 Mc, CW, at 1 v.

f. Using plastic tool, adjust variable inductor AI L4 (see Figures 5-1 and 5-5) for minimum reading of RF Millivoltmeter.

g. Set Signal Generator to 120.2 Mc, CW,, at 1 v.

h. Using plastic tool, adjust variable inductor AI L3 (see Figures 5-land 5-5)for minimum reading of RF Millivoltmeter.

i. Set Signal Generator to 115 Mc, CW, at 1 v.

j. Reading of RF Millivoltmeter should be less than 100 mv. If reading is above 100 mv, troubleshoot video amplifier assembly.

**Table 5-4. Adjustments after Repair**

| AFTER REPLACING COMPONENT IN THIS SECTION: | PERFORM:  |
|--|---|
| Harmonic generator (A3)                    | Harmonic generator adjustment (Paragraph 5-20)                                      |
| Mixer (A4)                                 | Sensitivity check (Paragraph 5-28)  |
| A1Q1                                       | Sensitivity check (Paragraph 5-28)  |
| A1Q2                                       | Sensitivity check (Paragraph 5-28), and Low pass filter adjustment (Paragraph 5-22) |
| Low Pass Filter                            | Sensitivity check (Paragraph 5-28), and Low pass filter adjustment (Paragraph 5-22) |
| A1Q3                                       | Sensitivity check (Paragraph 5-28), and Low pass filter adjustment (Paragraph 5-22) |
| A1Q4                                       | Sensitivity check (Paragraph 5-28), and Low pass filter adjustment (Paragraph 5-22) |
| Meter circuit                              | Meter accuracy check (Paragraph 5-29)   |

**Model 5253B**

**5-24. METER CALIBRATION ADJUSTMENT. (pri.)**

- a. Turn counter power off, remove converter from counter, and reconnect to counter with Extension Cable, (HP) 10506A.
- b. Set VHF Signal Generator to 102 Mc, CW, at 50 mv and connect to INPUT of converter.
- c. Set counter controls as shown in Figure 3-2. Counter should display approximately 2 Mc.
- d. Vary VHF Generator output to make level indicator meter read at red-green border.
- e. Using RF Millivoltmeter, measure voltage at Test Point #12. Voltage should be between 100 mv and 130 mv. If not, change value of resistor A1R19 to change voltage to between 100 mv and 130 mv. If voltage is too high, increase value of A1R19. If voltage is too low, decrease value of A1R19. Repeat steps d and e after changing value of A1R19.

**5-25. MECHANICAL ADJUSTMENT OF METER ZERO.**

**5-26. TRUE SIGNAL LEVEL INDICATION.** Level indicator meter is adjusted at the factory for proper mechanical zero. However, normal aging of meter components may change indicated zero level. To insure accuracy of input signal level indication, periodic adjustment of meter zero may be necessary.

**5-27. ZERO-SET.** When meter is properly zero-set, pointer rests over the zero calibration mark at the left-hand end of meter scale when converter is (1) at normal operating temperature, (2) in normal operating position, and (3) without power. Proceed as follows:

- a. Allow counter and converter to operate for one hour to permit meter movement to reach normal operating temperature.
- b. Turn counter off and allow one minute for all capacitors to discharge.
- c. Remove converter from counter to enable access to rear of meter.
- d. Remove adhesive-backed-paper cover from meter zero-adjustment access hole on top-rear of meter.
- e. Carefully insert small tool in access hole and engage adjustment fork.
- f. Vary setting of adjustment fork until meter reads zero.
- g. Remove tool and replace adhesive-backed-paper cover on access hole. This completes meter zero adjustment procedure.

**5-28. SENSITIVITY CHECK.**

- a. Turn counter power off, remove converter from counter, and reconnect to counter with Extension Cable, (HP) 10506A.

- b. Set VHF Signal Generator to 52 Mc, CW, at 50 mv and connect to INPUT of converter.
- c. Adjust controls as shown in Figure 3-2.
- d. Set converter mixing frequency control to 50 Mc. Counter should display approximately 2 Mc.
- e. Using RF Millivoltmeter, measure output of converter at Test Point #12 (see Figures 5-4 and 5-5). Voltage should be at least 100 mv.
- f. Repeat above steps c, d, and e with VHF Generator frequency of 472 Mc and converter mixing frequency control set to 470 Mc. Converter output to counter, as measured by RF Millivoltmeter, should be at least 100 mv.
- g. A similar check may be made at any frequency within the range of the Model 5253B. Converter output to counter should be at least 100 mv when difference frequency is between 100 kc and 12 Mc and converter is properly tuned.

**5-29. METER ACCURACY CHECK.**

- a. Turn counter power off, remove converter from counter, and reconnect to counter with Extension Cable, (HP) 10506A.
- b. Set VHF Signal Generator to 102 Mc, CW, at 50 mv and connect to INPUT of converter.
- c. Set controls as shown in Figure 3-2. Set converter mixing frequency control to 100 Mc. Counter should display approximately 2 Mc.
- d. Vary output of VHF Signal Generator for converter level indicator to make meter read at red-green border.
- e. Using RF Millivoltmeter, measure converter output to counter at Test Point #12. Voltage should be between 100 mv and 130 mv. If not, see Paragraph 5-24 for meter calibration adjustment procedure.

**5-30. LOW PASS FILTER CHECK.**

- a. Turn counter power off, remove converter from counter and reconnect to counter with Extension Cable, (HP) 10506A.
- b. Set VHF Signal Generator to 110 Mc, CW, at 50 mv and connect to INPUT of converter.
- c. Set controls as shown in Figure 3-2. Set converter mixing frequency control to 100 Mc. Counter should display approximately 10 Mc.
- d. Connect RF Millivoltmeter to Test Point #12. Vary output of VHF Signal Generator for RF Millivoltmeter reading of 100 mv. Note output level of VHF Signal Generator.

**Section V**  
**Paragraph 5-31**

e. Set VHF Signal Generator to 115 Mc at same output level as noted in step d above. Converter output to counter, as shown on RF Millivoltmeter, should not exceed 50 mv. If converter output to counter is greater than 50 mv, see Paragraph 5-23 for low pass filter adjustment procedure.

**5-31. IN-CABINET PERFORMANCE CHECK.**

a. Turn counter power off and install converter.

b. Set VHF Signal Generator to 52 Mc, CW, at 50 my and connect to INPUT of converter.

c. Set controls as shown in Figure 3-2. Counter should display approximately 2 Mc.

d. Set VHF Signal Generator to any frequency between 50 Mc and 512 Mc with output of 50 my. Counter should display correct frequency at any frequency within this range.

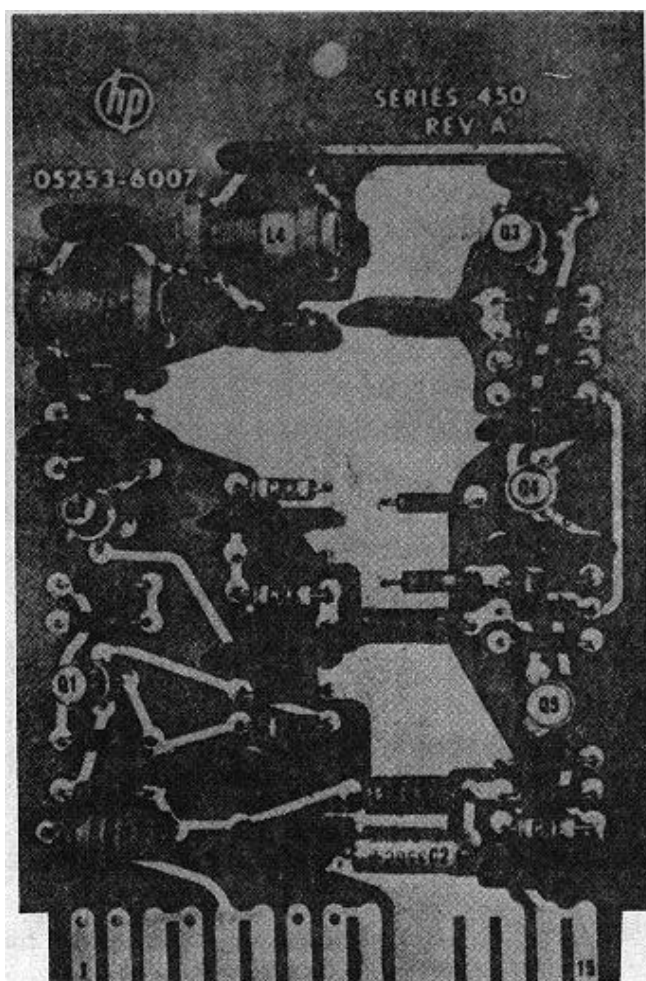


Figure 5-1. Video Amplifier Assembly AI Component Location

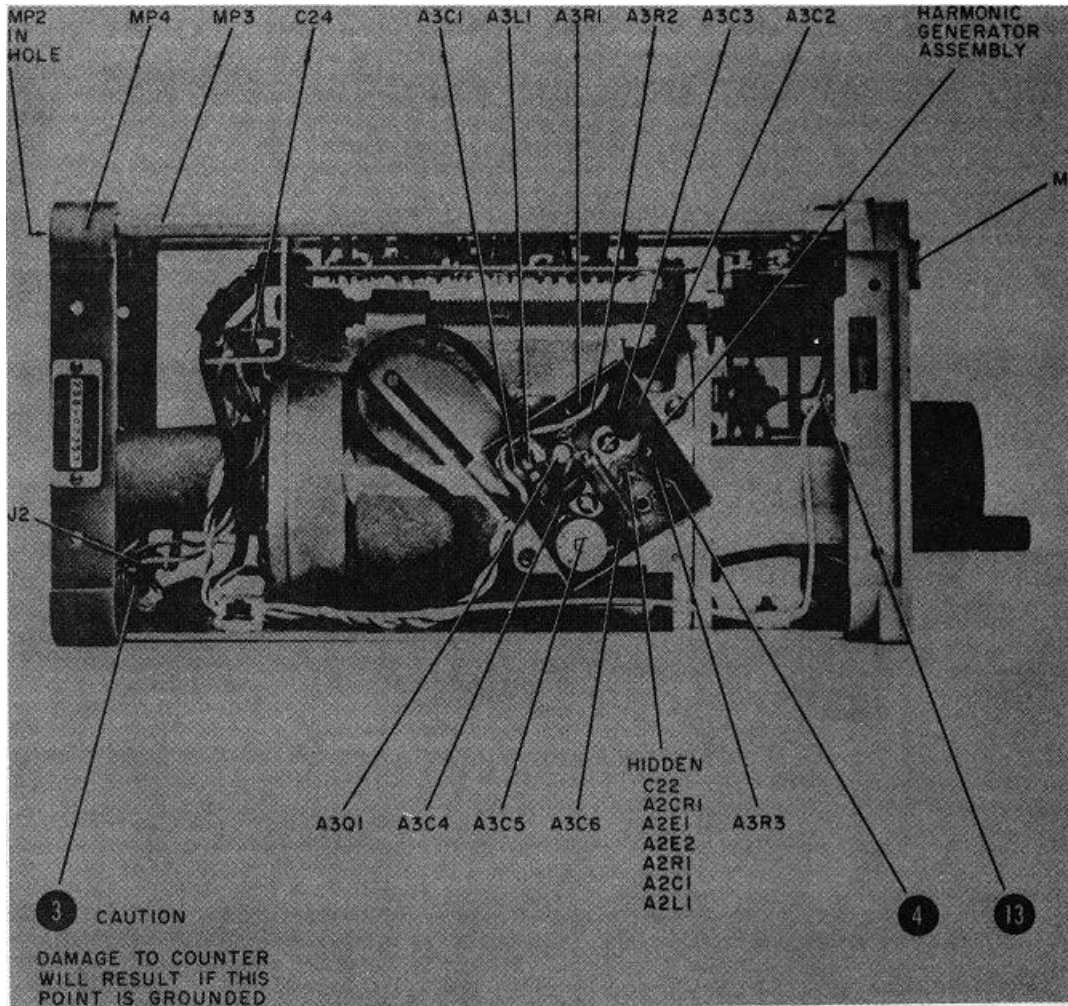


Figure 5-2. Left Side View

01874-3  
05253-A-7

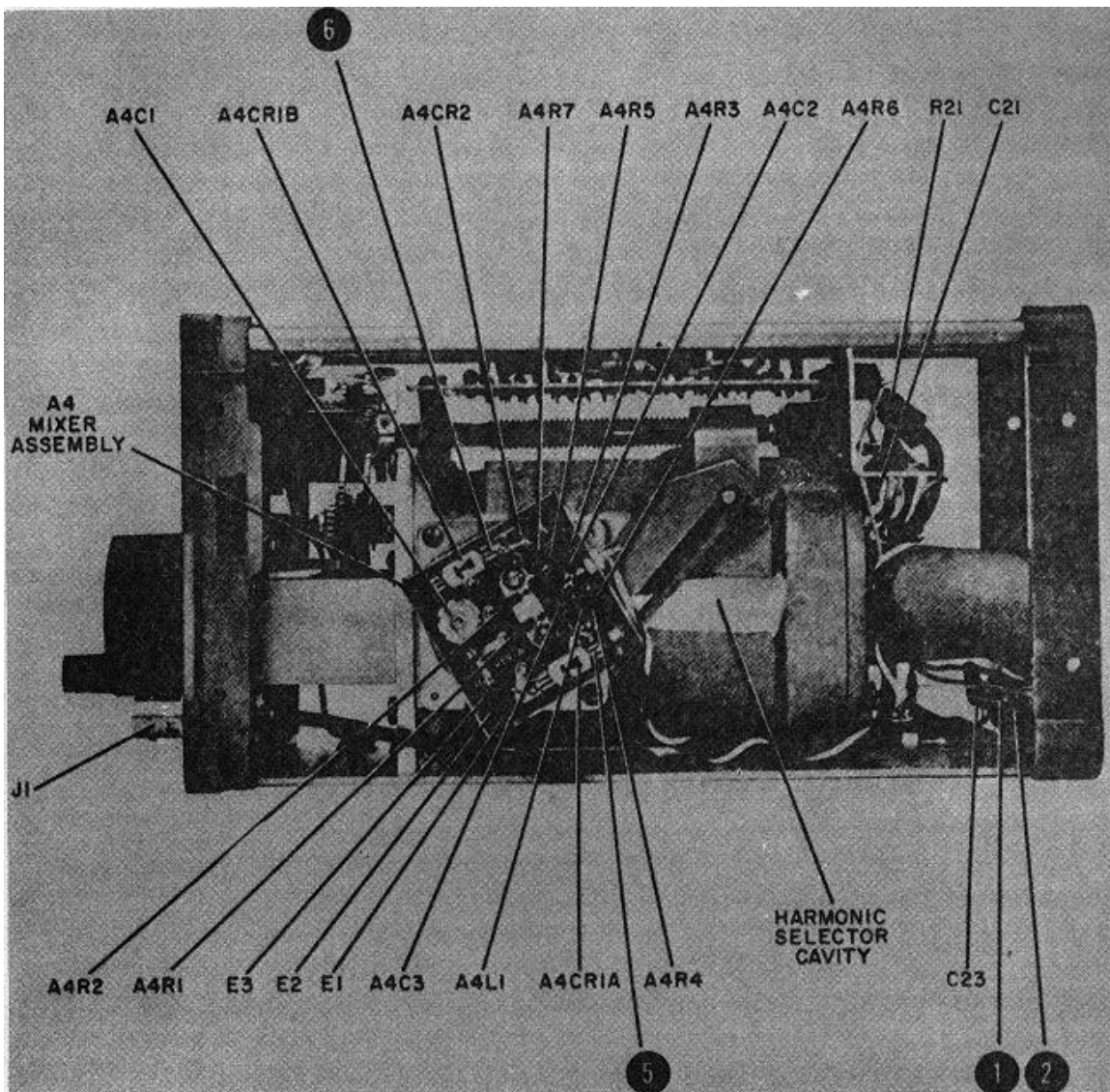
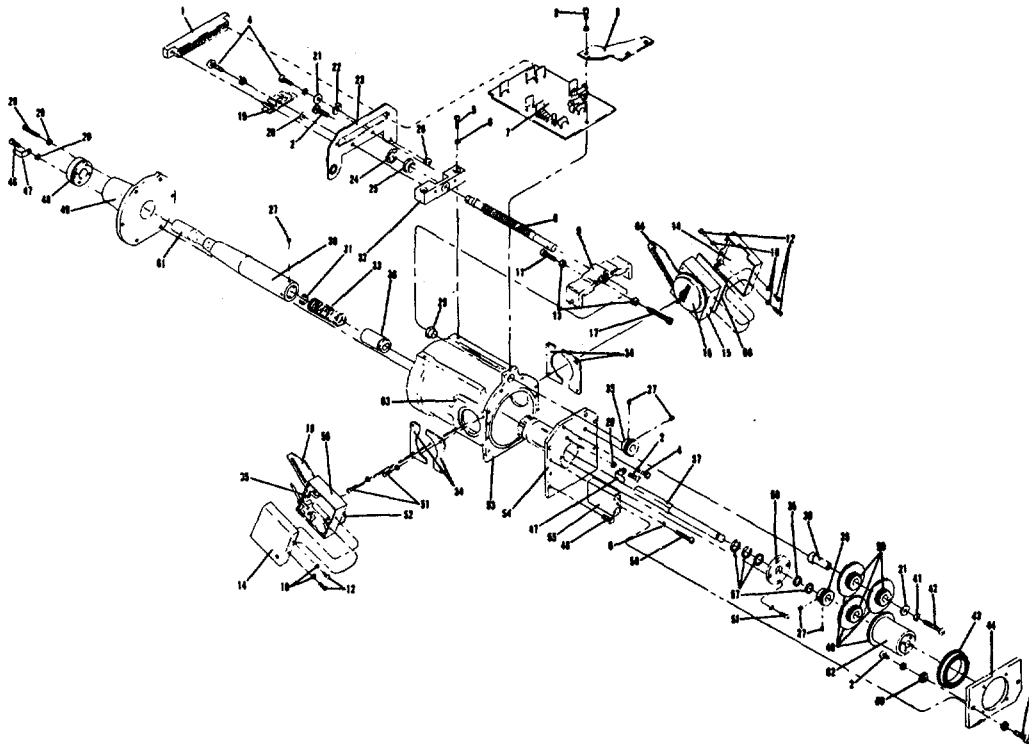


Figure 5-3. Right Side View

Section V  
Figure 5-6

TM 11-6625-1515-15  
Model 5253B



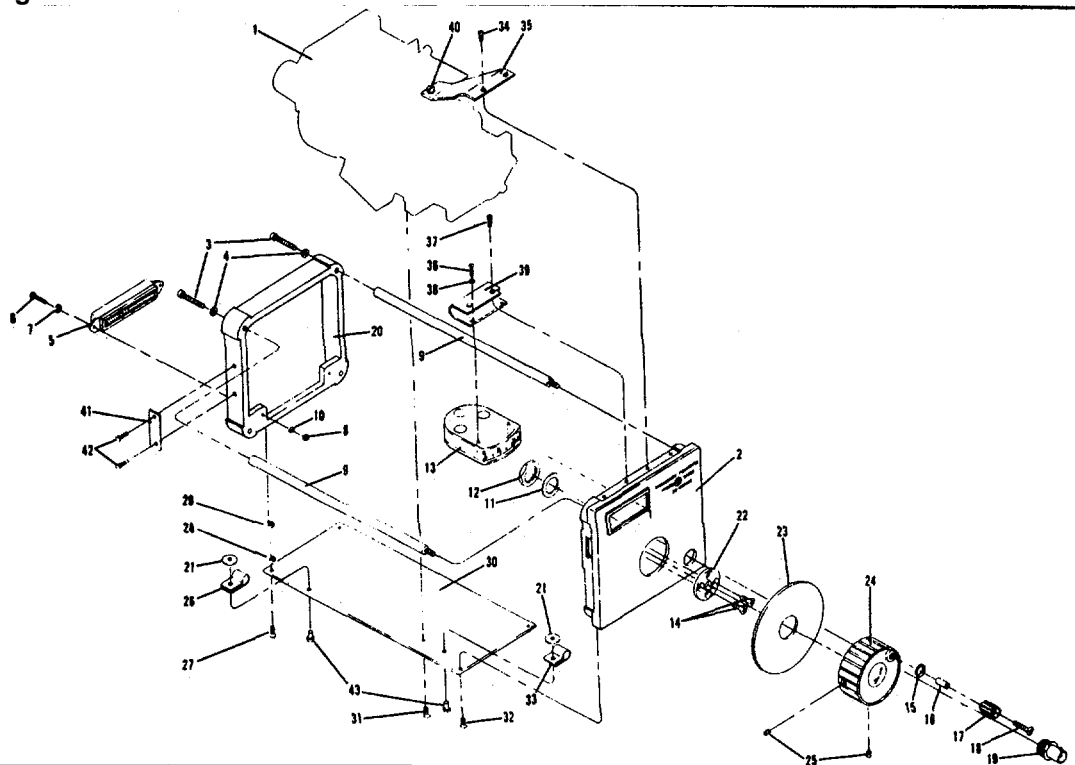
| REF. | STOCK NO.  | DESC.   | QTY |
|------|------------|---|-----|
| 1    | 1251-0135  | Connector, Printed<br>Crt. 15                   | 1   |
| 2    | 2390-0007  | Screw BH SS 6-32 x .312<br>with Lock            | 7   |
| 3    | 05253-0006 | Bracket, Panel                                  | 1   |
| 4    | 2390-0009  | Screw BR SS 6-32 x .375<br>with Lock            | 4   |
| 5    | 2380-0003  | Screw Fil H SS 6-32 x .5                        | 2   |
| 6    | 2190-0046  | Washer Lock Split No.<br>6.141 ID               | 6   |
| 7    | 05253-6007 | Ass'y, Vidio Amplifier                          | 1   |
| 8    | 525C-37A   | Shaft, Loop Drive                               | 1   |
| 9    | 5253A-12A  | Yoke, Loop Drive                                | 1   |
| 10   | 2190-0014  | Washer Lock Internal<br>No. 2                   | 6   |
| 11   | 3030-0003  | Screw Cap 6-32 x .375                           | 2   |
| 12   | 0520-0025  | Screw Mach RH 2-56<br>.125 LG                   | 6   |
| 13   | 2500-0001  | Nuts - Hex BRS 6-32 x<br>1/4 x 3/32 In.         | 4   |
| 14   | 5253A-41B  | Cover   | 2   |
| 15   | 5253A-55A  | Shield  | 1   |
| 16   | 5253A-17C  | Bushing   | 1   |
| 17   | 3030-0078  | Screw Cap Hex Dr 6-32 x<br>1.125                | 2   |
| 18   | 525C-108-  | Left Cam<br>AL                                  | 1   |
| 19   | 0360-0018  | Board-Terminal 4 Ins.<br>1 GRD                  | 1   |
| 20   | 2190-0008  | Term A1A1GA1A1<br>Washer Lock External<br>No. 6 | 3   |

| REF. | STOCK NO.  | DESC.   | QTY |
|------|------------|---|-----|
| 21   | 3050-0066  | Washer Brass .375 OD<br>.147 ID               | 2   |
| 22   | 1400-0053  | Clamp Cable for .188<br>Dia. Cable            | 1   |
| 23   | 5253A-12D  | Bracket, Connector                            | 1   |
| 24   | 0510-0083  | Ring Retain Ext .025<br>Thk                   | 1   |
| 25   | 1410-0047  | Bushing Flanged .252 ID<br>25 LG              | 2   |
| 26   | 0510-0001  | Fastener Steel .281 Dia.<br>.083 Thk          | 1   |
| 27   | 3030-0022  | Screw-Set Stil 6-32 x 1/8<br>HD LSS Hex Drive | 8   |
| 28   | 2200-0009  | Screw Mach RH SS 4-40<br>.5 LG                | 4   |
| 29   | 2190-0004  | Washer Lock Internal<br>No. 4                 | 4   |
| 30   | 05253-2004 | Probe   | 1   |
| 31   | 5-25C-71E  | Collar, Spring                                | 1   |
| 32   | 5253A-17A  | Bearing                                       | 1   |
| 33   | 1460-0082  | Spring Comp 1.5 LG<br>.484 OD                 | 1   |
| 34   | 5253A-12B  | Retainer                                      | 4   |
| 35   | 525C-24B   | Gear, Drive                                   | 2   |
| 36   | 525C-17A   | Order 525C-25A                                | 1   |
| 37   | 5253A-37A  | Shaft   | 1   |
| 38   | 3050-0017  | Washer Phos Br .375 OD<br>.26 ID              | 1   |
| 39   | 5253A-37B  | Shaft   | 1   |
| 40   | 5253A-24A  | Gear  | 4   |
| 41   | 2190-0006  | Washer Lock Split Ring<br>No. 6               | 1   |

| REF. | STOCK NO.  | DESC.   | QTY |
|------|------------|---|-----|
| 42   | 2360-0013  | Screw RH SS 6-32 x l                          | 1   |
| 43   | 1410-0021  | Bearing Ball 1.5 OD<br>1.063 Bore             | 1   |
| 44   | 5253A-17D  | Holder  | 1   |
| 45   | 2550-00089 | Screw Mach BH SS 8-32<br>X .5 with Lock       | 2   |
| 46   | 2390-0001  | Screw BH SS 6-32 x .5                         | 12  |
| 47   | 0360-0042  | Solder Lug - Brs .144<br>Mtg Hole 90 Deg Bend | 2   |
| 48   | 05253-2002 | Collar, Rear                                  | 1   |
| 49   | 05253-2011 | Flange, Cavity                                | 1   |
| 50   | 5253A-55B  | Shield  | 1   |
| 51   | 2200-0004  | Screw Mach RH SS 4-40<br>with Lock .250 LG    | 8   |
| 52   | 05253-6004 | Generator Bushing Ass'y                       | 1   |
| 53   | 5253A-20A  | Cavity  | 1   |
| 54   | 05253-6001 | Ass'y, Probe Positioning                      | 1   |
| 55   | 5253A-47B  | Support                                       | 2   |
| 56   | 2380-0004  | Screw Fil N H SS 6-32 x<br>.750               | 4   |
| 57   | 3050-0028  | Washer Brass .4375 OD<br>.251D                | 4   |
| 58   | 05253-2009 | Bushing, Probe Support                        | 1   |
| 59   | 525C-24C   | Gear, Idler                                   | 3   |
| 60   | 565A-17A   | Retainer, Bearing                             | 4   |
| 61   | 05253-6006 | Ass'y Support Capacitor                       | 1   |
| 62   | 5253A-40A  | Hub   | 1   |
| 63   | 1480-0061  | Pin Cross .06 ID .312LG                       | 4   |
| 64   | 525C-108-  | Right Cam<br>AR                               | 1   |
| 65   | 5253A-65B  | Board Ass'y, Circuit                          | 1   |
| 66   | 5253A-65C  | Board Ass'y, Circuit                          | 1   |

Figure 5-6., Mechanical Parts Location - 5253B

Section V  
Figure 5-7



| REF. | STOCK NO.  | DESC.                                | QTY |
|------|------------|--------------------------------------|-----|
| 1    |            | See Figure No. 5-6                   |     |
| 2    | 05253-2014 | Panel, Front                         | 1   |
| 3    | 2380-0004  | Screw Fil H SS 6-32 x .750           | 2   |
| 4    | 2190-0046  | Washer Lock 8 Spit No. 6 .141 ID     | 2   |
| 5    | 1251-0099  | Connector Male 50 Pin                | 1   |
| 6    | 0525-0003  | Screw - Mach BD NH 3-56 .50 LG       | 2   |
| 7    | 2190-0031  | Washer Lock Internal No. 3           | 2   |
| 8    | 0615-0001  | Nut-Hex SS 3-36 Thrd .1875 WD        | 2   |
| 9    | 5262A-47A  | Rod, 7-9/16 in. Log No. 4 Split Lock | 2   |
| 10   | 2190-0019  | Washer - Lock Int .650 OD .512 ID    | 2   |
| 11   | 2190-0068  | BNC Hex Nut Bra                      | 1   |
| 12   | 2850-0054  | Meter 0-1 Ma Edge View Per. Spec.    | 1   |
| 13   | 1120-0140  | Screw - Mach FH SS 6-32 x 1-4        | 1   |
| 14   | 2370-0012  | Washer Phos Br .375 OD .26 ID        | 2   |
| 15   | 3050-0017  | Bushing Knob .219 OD .140 ID         | 1   |

| REF. | STOCK NO.  | DESC.                                 | QTY |
|------|------------|---------------------------------------|-----|
| 17   | 0370-0050  | Knob - Round 3/8 OD .221 ID .525 LG   | 1   |
| 18   | 2410-0001  | Screw OH SS 6-32 x .625               | 1   |
| 19   | 1250-0102  | Cable Jack-Blk HD Mtg. Series BNC     | 1   |
| 20   | 5262A-83A  | Guide, Plastic 4-3/16 In. x 4-3/8 In. | 1   |
| 21   | 3050-0066  | Washer Brass .375 OD .147 ID          | 2   |
| 22   | 05253-2012 | Plate, Frequency Dial                 | 1   |
| 23   | 5000-0062  | Dial Blank - Alum 1.75 ID 2.875 OD    | 1   |
| 24   | 0370-0126  | Knob - Crank 1-5/8 D 1/4 Shaft Blk    | 1   |
| 25   | 3030-0001  | Screw Set Stil Hex Dr 8/32 x .1875 LG | 2   |
| 26   | 1400-0024  | Clamp Cable for .25 Dia Cable         | 1   |
| 27   | 2210-0003  | Screw - Mach FH SS 4-40 .375 LG       | 2   |
| 28   | 2190-0019  | Washer Lock Split Ring No. 4          | 2   |
| 29   | 2340-0001  | Nut Hex BNP 4-40 .188 WD              | 2   |

| REF. | STOCK NO.  | DESC.                                     | QTY |
|------|------------|---|-----|
| 30   | 05253-0005 | Plate, Bottom                             | 1   |
| 31   | 2210-0002  | Screw - Mach FH SS 4-40 .250 LG           | 3   |
| 32   | 2210-0018  | Screw - Mach SS 4-40 x 3/16 100 Deg FH SD | 2   |
| 33   | 1400-0082  | Clamp Cable .375 WD .125 ID               | 1   |
| 34   | 2210-0018  | Screw - Mach SS 4-40 x 3/16 100 Deg FH SD | 2   |
| 35   | 05253-0006 | Bracket, Panel                            | 1   |
| 36   | 0520-0022  | Screw - Mach RH 2-56 .50 LG               | 2   |
| 37   | 2210-0018  | Screw - Mach SS 4-40 x 3/16 100 Deg FH SD | 2   |
| 38   | 2190-0014  | Washer Lock Internal No. 2                | 2   |
| 39   | 05251-0002 | Bracket, Meter                            | 1   |
| 40   | 2390-0007  | Screw BH SS 6-32 x .312                   | 1   |
| 41   | 7122-0097  | Plate Name Serial Dwg 50 MM 1874          | 1   |
| 42   | 3040-0006  | Screw Drive RH SS 0 x .1875               | 2   |
| 43   | 0361-0011  | Rivet - Semi Tub, Alum OH 1/8 Dia 1/4 LG  | 2   |

Figure 5-7. Mechanical Parts Location - 5253B



HEADQUARTERS  
DEPARTMENT OF THE ARMY  
WASHINGTON, D.C., 16 May 1967

TM 11-6625-1515-15 is published for the use of all concerned.

Distribution:

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USAMB (1)  
USACDCEC (1)  
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USACDCCEA:  
Ft Huachuca (1)

Eighth USA (5)  
SAAD (5)  
TOAD (5)  
LEAD (3)

*NG:* None.

*USAR:* None.

For explanation of abbreviations used, see AR 320-50.

AGO 7881A

Figure 5-4

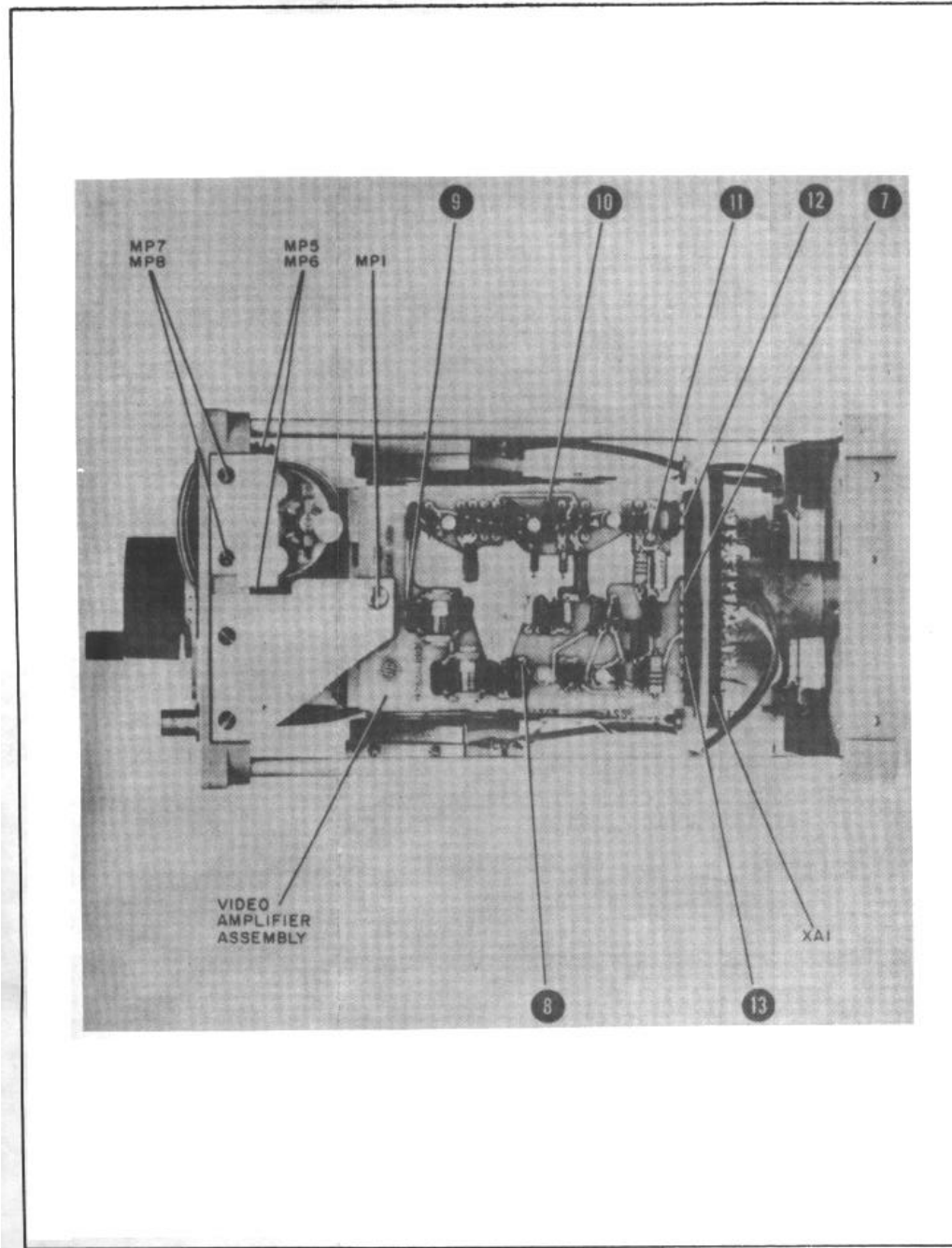


Figure 5-4. Top view- Test Points

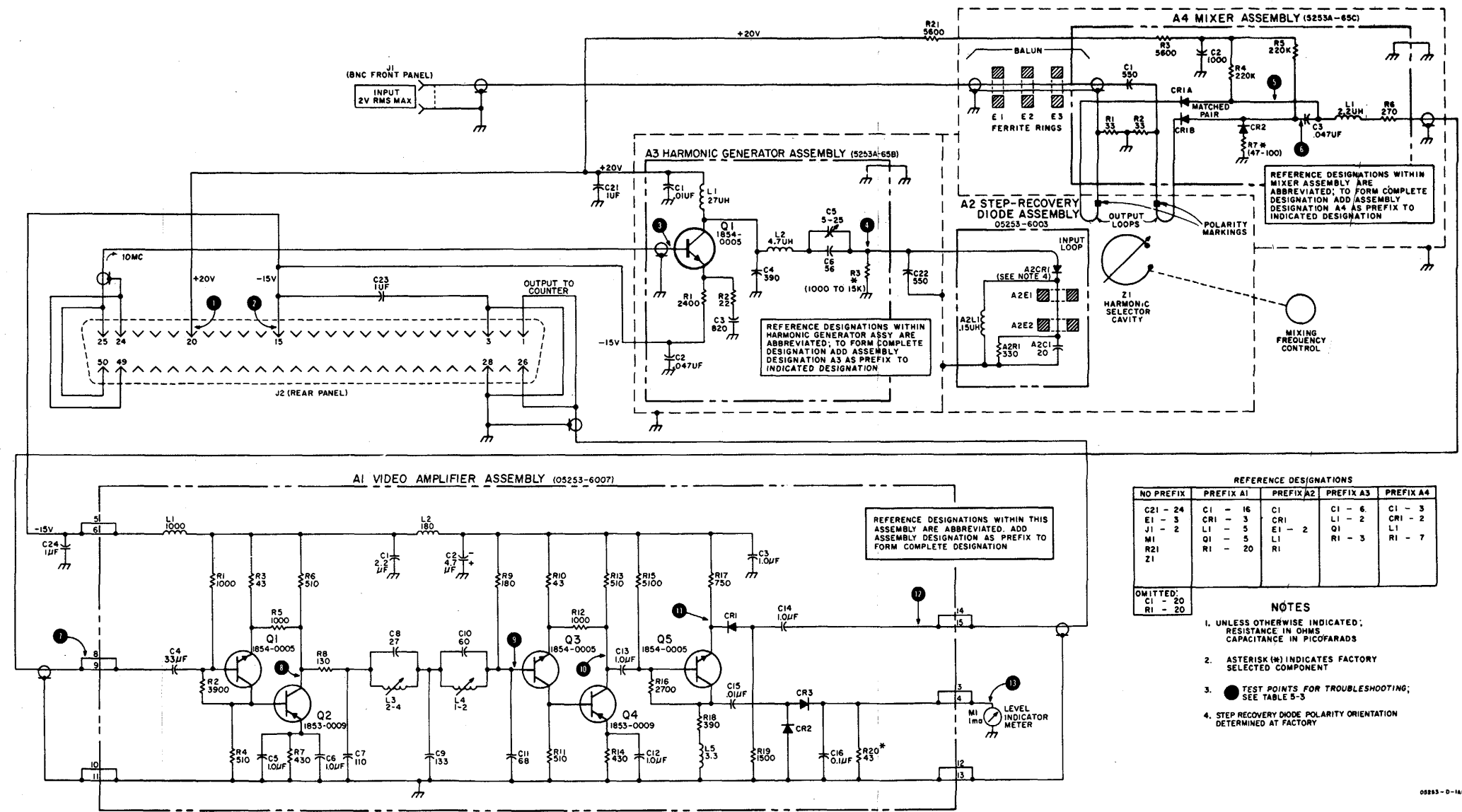


Figure 5-5. Schematic Diagram



## The Metric System and Equivalents

### *Linear Measure*

1 centimeter = 10 millimeters = .39 inch  
 1 decimeter = 10 centimeters = 3.94 inches  
 1 meter = 10 decimeters = 39.37 inches  
 1 dekameter = 10 meters = 32.8 feet  
 1 hectometer = 10 dekameters = 328.08 feet  
 1 kilometer = 10 hectometers = 3,280.8 feet

### *Weights*

1 centigram = 10 milligrams = .15 grain  
 1 decigram = 10 centigrams = 1.54 grains  
 1 gram = 10 decigrams = .035 ounce  
 1 decagram = 10 grams = .35 ounce  
 1 hectogram = 10 decagrams = 3.52 ounces  
 1 kilogram = 10 hectograms = 2.2 pounds  
 1 quintal = 100 kilograms = 220.46 pounds  
 1 metric ton = 10 quintals = 1.1 short tons

### *Liquid Measure*

1 centiliter = 10 milliliters = .34 fl. ounce  
 1 deciliter = 10 centiliters = 3.38 fl. ounces  
 1 liter = 10 deciliters = 33.81 fl. ounces  
 1 dekaliter = 10 liters = 2.64 gallons  
 1 hectoliter = 10 dekaliters = 26.42 gallons  
 1 kiloliter = 10 hectoliters = 264.18 gallons

### *Square Measure*

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch  
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches  
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet  
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet  
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres  
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

### *Cubic Measure*

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch  
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches  
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

## Approximate Conversion Factors

| <i>To change</i> | <i>To</i>          | <i>Multiply by</i> | <i>To change</i>   | <i>To</i>     | <i>Multiply by</i> |
|------------------|--------------------|--------------------|--------------------|---------------|--------------------|
| inches           | centimeters        | 2.540              | ounce-inches       | Newton-meters | .007062            |
| feet             | meters             | .305               | centimeters        | inches        | .394               |
| yards            | meters             | .914               | meters             | feet          | 3.280              |
| miles            | kilometers         | 1.609              | meters             | yards         | 1.094              |
| square inches    | square centimeters | 6.451              | kilometers         | miles         | .621               |
| square feet      | square meters      | .093               | square centimeters | square inches | .155               |
| square yards     | square meters      | .836               | square meters      | square feet   | 10.764             |
| square miles     | square kilometers  | 2.590              | square meters      | square yards  | 1.196              |
| acres            | square hectometers | .405               | square kilometers  | square miles  | .386               |
| cubic feet       | cubic meters       | .028               | square hectometers | acres         | 2.471              |
| cubic yards      | cubic meters       | .765               | cubic meters       | cubic feet    | 35.315             |
| fluid ounces     | milliliters        | 29.573             | cubic meters       | cubic yards   | 1.308              |
| pints            | liters             | .473               | milliliters        | fluid ounces  | .034               |
| quarts           | liters             | .946               | liters             | pints         | 2.113              |
| gallons          | liters             | 3.785              | liters             | quarts        | 1.057              |
| ounces           | grams              | 28.349             | liters             | gallons       | .264               |
| pounds           | kilograms          | .454               | grams              | ounces        | .035               |
| short tons       | metric tons        | .907               | kilograms          | pounds        | 2.205              |
| pound-feet       | Newton-meters      | 1.356              | metric tons        | short tons    | 1.102              |
| pound-inches     | Newton-meters      | .11296             |                    |               |                    |

### Temperature (Exact)

|    |                           |                               |                        |    |
|----|---------------------------|-------------------------------|------------------------|----|
| °F | Fahrenheit<br>temperature | 5/9 (after<br>subtracting 32) | Celsius<br>temperature | °C |
|----|---------------------------|-------------------------------|------------------------|----|

