TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST (INCLUDING DEPOT REPAIR PARTS AND SPECIAL TOOLS LIST)

GENERATOR SWEEP SIGNAL AN/USM-203A

This copy is a reprint which includes current pages from Change 1.

HEADQUARTERS DEPARTMENT OF THE ARMY
NOVEMBER 1973

WARNING

Be careful when working on the 115-volt line connections. Serious injury or death may result from contact with these terminals.

DO NOT TAKE CHANCES!

TECHNICAL MANUAL
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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *23 November 1973*

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE MANUAL

GENERATOR, SWEEP SIGNAL AN/USM-203A (NSN 625-00-935-0145)

REPORTING OF ERRORS

You can improve this manual by recommending improvements using DA Form 2028 located in the back of the manual. Simply tear out the self adressed form, fill it out as shown on the sample, fold it where shown, and drop it in the mail.

If there are no blank DA Form 2028-2 in the back of your manual, use the standard DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward to the Commander, US Army Communications and Electronics Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703.

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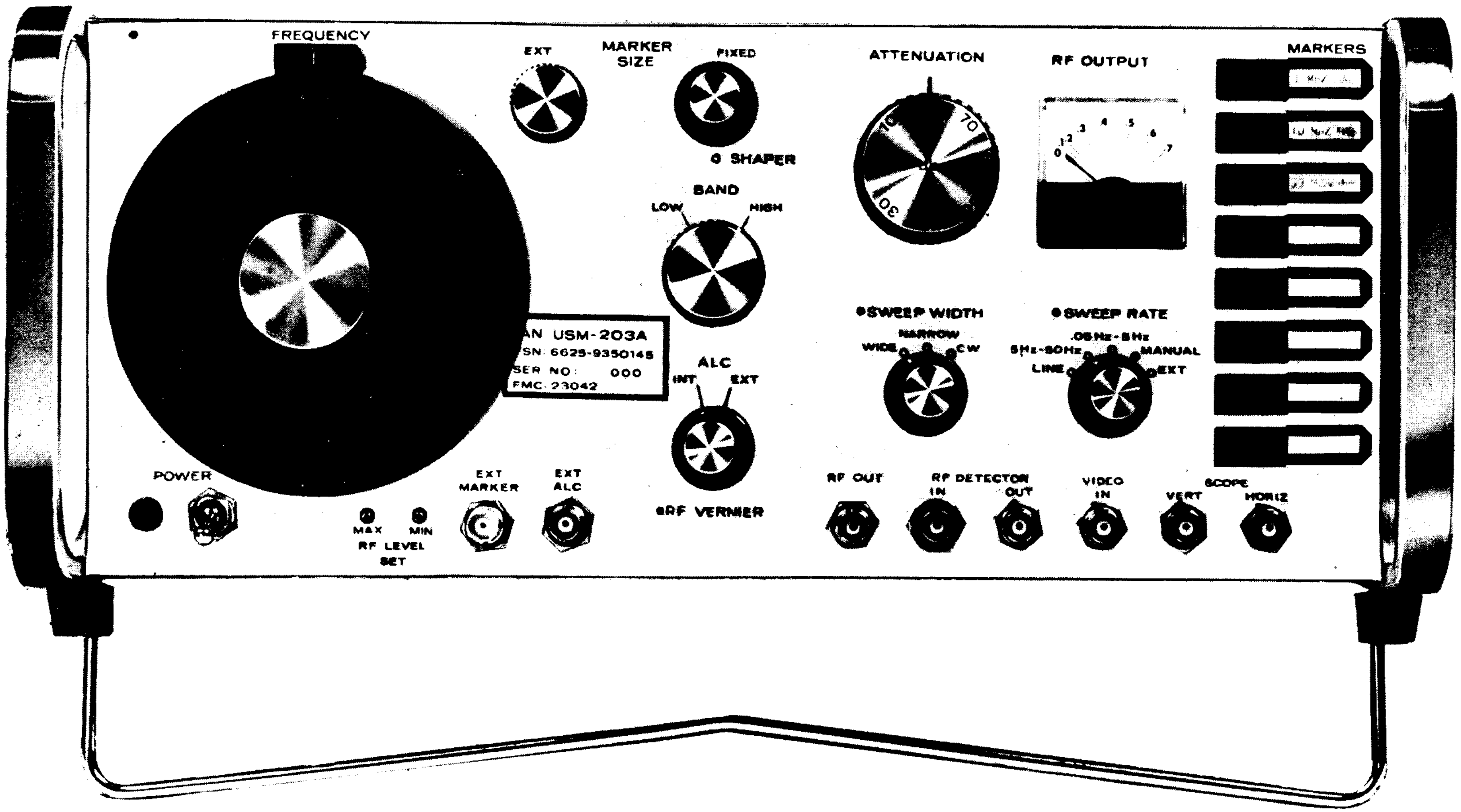

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Figure 1-1. Front view of AN/USM-203A.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual describes Sweep Signal Generator AN/USM-203A. It covers the purpose, use, instructions for installation and operation, and the technical characteristics of the AN/USM-203A. The following maintenance categories are covered: operator/crew (C), organizational (0), direct support (F), and general support (H).

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to DA Pam 310-4 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 determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

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

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33 B/AFR 75-18/MCO P4610.19C and DLAR 4500.15.

1-4. Reporting Equipment Improvement Recommendations (EIR)

EIR's will be prepared using Standard Form 368, Quality Deficiency Report. Instructions for preparing EIR's are provided in TM 38-750, The Army Maintenance Management System. EIR's should be mailed direct to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703. A reply will be furnished direct to you.

1-5. Administrative Storage

There is no special procedures for preparing this equipment for limited storage. Place all ancillary items in a bag and tie or tape the bag to the equipment. Place equipment in limited storage, ie, organizational storage room. Protect equipment from dust, humidity, and extreme temperature changes.

1-4. Destruction of Army Material

Demolition and destruction of electronic equipment will be under the direction of the commander and in accordance with TM 750-244-2.

1-7. Deleted

Section II. DESCRIPTION AND DATA

1-8. Purpose and Use

The AN/USM-203A is a source of rf energy which provides both fixed frequency and sweep frequency signals. Frequency, sweep frequency, and sweep rate are adjustable from front panel controls. The frequency range covered is 500 kHz to 1200 MHz in two bands. The low band covers 500 kHz to 300 MHz, and the high band 300 MHz to1200 MHz. The output may be continuously adjusted over an 80 dB range to 0.5 volt rms into a 50-ohm load. Provision is made for the use of both internal and external frequency marker generators. Internal harmonic markers are provided at 1.0-, 10.0-, and 50.0-MHz intervals. The AN/USM-203A is used in the field test radar, if amplifiers, rf communications, and video frequency equipment. It can be used as a chirp radar simulator and for wideband testing. The stability is sufficient for narrow band circuit testing. A broad choice of sweep rates permits the use of either an oscilloscope display or an external graphic recorder. Provision is made for external detection of rf signals, or an internal detector can be used. Front panel connectors are available to permit external control of sweep rate, rf level, and frequency identification.

1-9. Description

A front view of the AN/USM-203A is shown in figure 1-1. The functions of the controls and receptacles are indicated by the front panel markings associated with each item. See figure 3-2 for the power cord entrys, fuse, and external drive connector. The AN/USM-203A is constructed of an aluminum alloy frame consisting of two side rails, a rear panel, and a backing panel. The frame is assembled with threaded fasteners and inserts. The aluminum front panel is mounted to the frame and covers the backing panel. Printed circuit assemblies are mounted to the aluminum frame. Aluminum slide panels (dust covers) protect the sides, the top, and the bottom of the AN/USM-203A. Aluminum surfaces are anodized.

1-10. System Application

Sweep frequency measurement techniques are used to measure the characteristics of devices which operate at high frequencies, and whose response must be determined over a broad range of frequencies. If a device or system contains resonance or antiresonance points within the sweep frequency range of the AN/USM-203A, a display can be obtained which shows the resonance peaks or depressions in the passband of interest. Filters, amplifiers, receivers, and other passive. or active devices can be tested. The following list of potential applications will suggest the range of utility of the AN/USM-203A.

a. Transfer characteristic measurements.

b. Impedance plots.

c. System flatness.

d. Insertion loss measurements.

e. Return loss measurements.

f. Small signal analysis.

g. Open and closed loop response.

h. Reflectometer systems to measure reflection and transmission characteristics.

i. Microwave spectroscopy.

j. High Q swept frequency cavity measurements.

k. Bandpass measurement-typical test set-up.

NOTE

A typical test setup using the AN/USM-203A sweep signal generator is shown in figure 1-2. Other test setups are possible which use external leveling, an external detector, a graphic recorder, or a combination of these options. BNC connectors and -50 ohm coaxial cable are used in the external circuit.

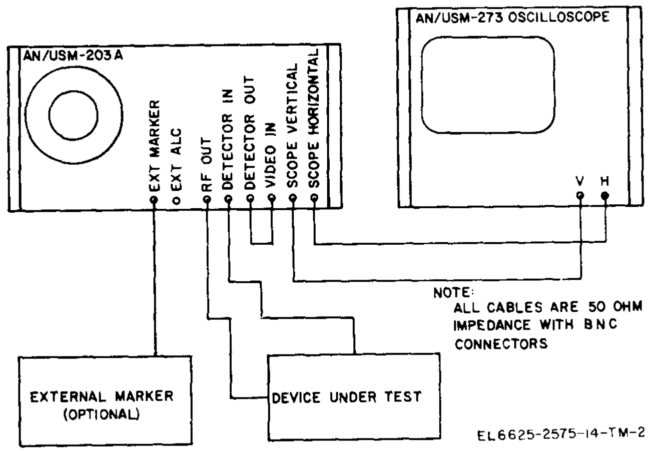

Figure 1-2. Typical setup using AN/USM-203A.

1-11. Technical Characteristics

Center frequency range Continuously variable from 500 kHz to 1200 MHz in two ranges.

Range:

vhf . . . . Continuously variable from 500 kHz to 300 MHz.

uhf	Continuously variable from 300 MHz to 1200 MHz.
Sweep Width:	
Narrow	Continuously variable from 10 kHz to 1 MHz.
Wide	Continuously variable from 500 kHz to 40% of center frequency.
Rf output voltage	At least 0.5 rms into a 50-ohm resistive load.
RF Output Voltage Variation:	
vhf	Not more than ±0.25 dB at maximum sweep width.
uhf	Not more than ±0.5 dB at maximum sweep width.
Spurious beats and Harmonics	At least 25 dB below the fundamental frequency.
Source Impedance	operates into a 50-ohm load (nominal).
Source vswr	Not greater than 1.5 when properly terminated at any design frequency.
Sweep linearity	Within ±5 percent of the sweep width.
SweepRate:	
Line	At the powerline frequency.
Variable	Continuously variable from 0.05 Hz to 60 Hz.
Manual	Manual control of sweep rate.
Horizontal output voltage	18 volts peak-to-peak, ±1.8V DC at either extreme and at the sweep frequency.
Frequency dial accuracy	±1 dial division (±10 MHz).
Rf output meter accuracy	±3 percent.
Internal frequency marker:	
Accuracy	±0.01 percent at 1 MHz.
Attenuation	0 dB to70 dB in 10-dB steps ±2 dB at any design frequency. Rf output control provides a vernier over a 10-dB range.
Internal detector vswr	No greater than 1.2 at any design frequency when terminated in 50-ohm load.
Internal detector efficiency	At least 75 percent at any design frequency.
Internal detector frequency response	Within ±0.5 dB on the vhf range and within ±1 dB on the uhf range.
Weight	24 pounds.
Size	6 7/8 inches high by 17 inches wide by 16 inches deep.
Power consumption	15 watts, 115 volts, 50/60 Hz, single phase. (230-volt operation is possible by changing the primary taps of the power transformer.)

NOTE

If 230-volts ac power is used, FI must be replaced by a ½-ampere slo-blo, type 3AG fuse.

CHAPTER 2

SERVICE UPON RECEIPT AND INSTALLATION

2-1. Unpacking

An illustration of the packing of the AN/USM-203A is shown in figure 2-1.

2-2. Checking Unpacked Equipment

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD Form 6, as prescribed in AR 700-58.

b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of TM 38-750. The equipment consists of a single unit.

c. Check to see whether the equipment has been modified. (Equipment which has been modified will have the MWO number on the front panel, near the nomenclature plate.) Check also to see whether all currently applicable MWO's have been applied. (Current MWO's applicable to the equipment are listed in DA Pam 310-7.)

d. AN/USM-203A, after it is unpacked, is ready for use on a service bench as received. No special mounting procedure is required unless the equipment is to be rack mounted; special adapters are required for rack mounting. These adapters are not supplied as a part of the basic issue item list and must be obtained through normal distribution channels.

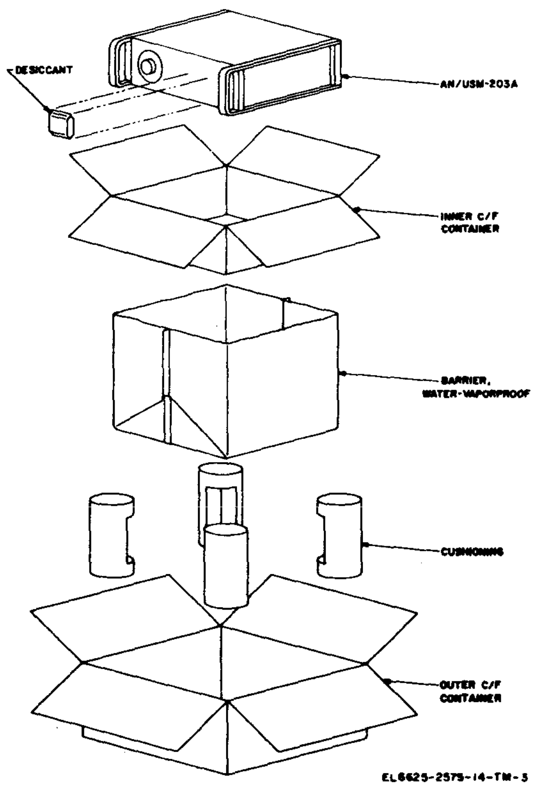

Figure 2-1. AN/USM-203A packaging.

CHAPTER 3

OPERATING INSTRUCTIONS

Section I. CONTROLS AND INSTRUMENTS

3-1. Damage from Improper Settings

Observe the following cautions to avoid damage to the equipment.

CAUTION

The following combinations of switch settings and open connectors can damage the rf section of the AN/USM-203A.

POWER Switch set to ON.
BAND switch set to HIGH.
EXT ALC connector not coupled to external monitor.
ALC switch set to EXT.

CAUTION

The AN/USM-203A can be operated at either 115 volts, 50/60 Hz, single phase, or 230 volts, 50/60 Hz, single phase. Damage will result if the unit is wired internally for 115 volts, and is connected to a 230-volt line. A yellow label attached to the power cord near the plug indicates 115 volts. A red label indicates 230 volts.

3-2. Operator's Controls

a. The front panel (fig. 3-1) and rear panel (fig. 3-2) controls features, and functions are tabulated in table 3-1.

b. Internal switch S102 is located on the main printed circuit board and normally is shipped in the video blanking position. The switch may be set to rf blanking so that the B+ to the rf oscillator and video amplifier are turned off during. the sweep display retrace. This control is not available to the operator, and its setting shall be determined at the time of calibration.

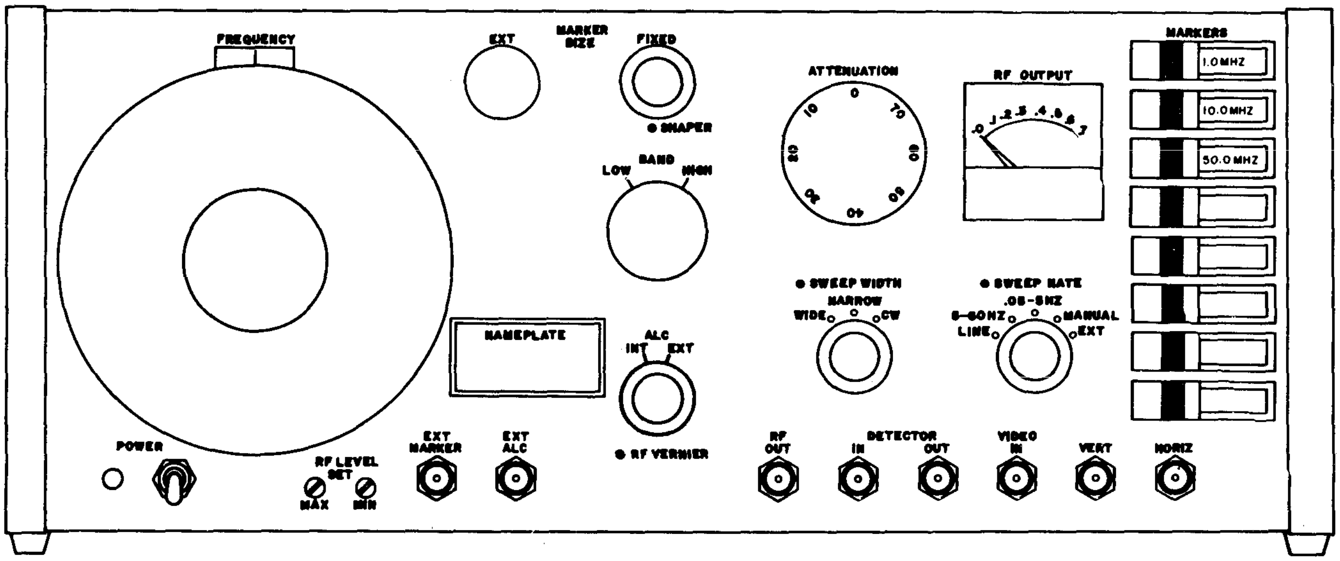

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Figure 3-1. AN/USM-203A front panel features.

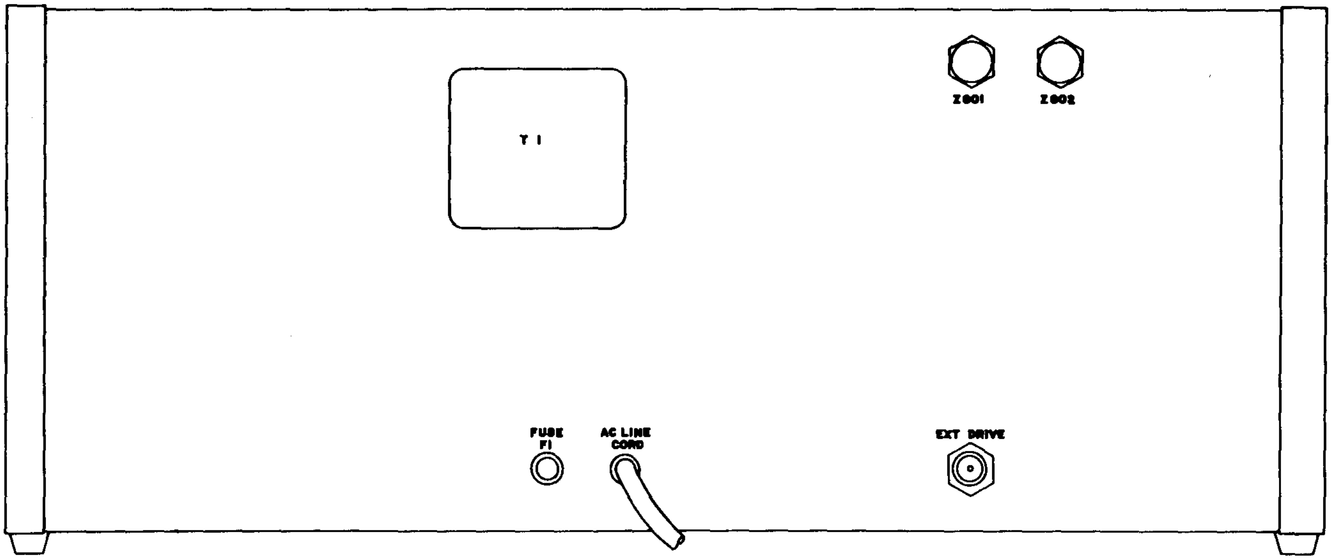

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Figure 3-2. AN/USM-203A rear panel features.

Table 3-1. Operator's Controls

NOTE

This table covers only items used by the operator; items used by higher category maintenance personnel are covered in instructions for the applicable maintenance category.

Control or indicator	Function
ALC switch ---------	External level control. Internal level control.
RF VERNIER -----	Vernier control of rf level over a 10-dB range.
SWEEP WIDTH switch and vernier.	Narrow: Continuously variable from 10 kHz to 1 MHz. Wide: Continuously variable from 500 kHz to 40% of center frequency.
SWEEP RATE switch.	Sweep rate at line frequency. Sweep rate 5 to 60 Hz. Sweep rate 0.05 to 5 Hz. Manual control of sweep. Sweep rate controlled by an external signal.
SWEEP RATE vernier.	Varies sweep rate in variable and manual positions.
BAND switch --------	Frequency range 0.5 MHz to 300 MHz. Frequency range 300 MHz to 1200 MHz.
MARKER SIZE EXTERNAL [illegible]	Adjusts external marker level to control amplitude of displayed [illegible]
RF OUTPUT METER.	Indicates sweep generator rf output in volts rms. Normal maximum is 0.5 volt.
MARKER switches	1-, 10-, and 50-MHz harmonic markers are added to the sweep display by setting the individual switches. Five optional plug-in markers are controlled from individual marker switches.
MARKER SIZE FIXED control.	Controls amplitude of marker.
MARKER SHAPE control.	Controls shape of markers.
ATTENUATION switch.	Provides 0 to 70 dB of attenuation in 10-dB steps.
CENTER FREQUENCY control.	Selects designated frequency.
RF LEVEL SET MAX control.	Sets upper rf output limit.
RF LEVEL SET MIN control.	Sets lower rf output limit.

Table 3-2. Connectors and Rear Panel Devices

Designation	Application
RF OUT	Rf output available at this connector.
ALC	External level control signal input.
EXT MARKER.	External marker generator input.
VIDEO IN	Input for detected rf output from device.
SCOPE VERT.	Output to vertical channel of display.
SCOPE HORIZ.	Output to horizontal channel of display.
RF DETECTOR IN.	Input from device under test.
RF DETECTOR OUT.	Output to VIDEO IN connector.

REAR PANEL DEVICES

Designation	Application
F1	Fuse receptacle.
EXT DRIVE.	Input for external sweep control signal.
LINE	Power cord entrance to chassis.

Section II. OPERATION UNDER USUAL CONDITIONS

3-3. Operator's Initial Adjustments (fig. 1-2 and 3-1)

a. Initial Control Adjustments. Determine the mode of operation pertinent to the test to be accomplished, and set the controls of the AN/USM-203A as follows:

(1) *BAND switch.* Set this control to the LOW BAND (500 kHz to 300 MHz), or to the HIGH BAND (300 MHz to 1200 MHz), according to the frequency range required.

(2) *CENTER FREQUENCY dial.* Set this dial to the frequency required.

(3) *SWEEP RATE.* Determine the sweep rate best suited to display the results of the test.

(4) *ALC control.* Set the ALC control to the internal monitor, unless it has been determined that an external level control is required.

(5) *ATTENUATION control.* Set the attenuation control to maximum (70 dB).

(6) *MARKER switches.* 1-MHz, 10-MHZ, and 50-MHz harmonic markers are provided. Determine the frequency marker interval (in MHz) best suited to the range of sweep frequency to be observed.

(7) *RF DETECTOR IN.* Connect the device under test to the detector input.

(8) *RF DETECTOR OUT.* Connect the detector output to the VIDEO IN connector.

(9) *VIDEO IN.* Connect the RF DETECTOR OUT connector to the VIDEO IN connector.

(10) *FIXED MARKER SIZE.* Set the fixed marker size control to midrange.

(11) *MARKER SHAPER.* Set the marker shape control to midrange.

(12) *EXT MARKER SIZE.* If an external marker generator is used, the input is connected to the EXT MARKER connector. Set the fixed marker size control fully clockwise. Adjust the EXT MARKER SIZE control to produce the maximum marker amplitude required.

b. Initial Adjustment of Associated Equipment. Make the necessary adjustments to associated equipment.

c. Power Cord. Insert the power cord AN/USM-203A into a receptacle supplying 115 volts, 60 Hz, single phase.

3-4. Operating Procedures

a. Check interconnections between the AN/USM-203A and associated equipment.

b. Check the initial adjustments of the AN/USM-203A and any associated equipment.

c. Apply power to associated equipment such as the display device, external oscillators, or rf power instrumentation.

d. Readjust the associated equipment to quiescent conditions (absence of inputs from the AN/USM-203A).

e. Set the AN/USM-203A power switch to ON. The AN/USM-203A uses solid-state active devices; the outputs develop immediately when energized. Allow a warmup time of 20 minutes for the equipment to reach optimum stability.

f. Upon applying power to the AN/USM-203A, a signal will be delivered to the device under test and associated instrumentation. Immediately scan all associated equipment for evidence of out-of-limit operation which could result in damage to instrumentation,

g. Increase rf output of the AN/USM-203A by decreasing attenuation, until an adequate display is presented on the external device.

h. Readjust associated equipment as necessary to adequately indicate or display the process under observation.

i. Readjust the AN/USM-203A controls as required for optimum presentation on the display device.

j. The AN/USM-203A is designed for continuous operation within its ratings. No particular procedure is required for standby operation.

k. Operation of the AN/USM-203A may be discontinued by setting the power switch to OFF.

Section. III. OPERATION UNDER UNUSUAL CONDITIONS

3-5. Extreme Dry and Moist Heat

No particular procedure is required to operate under conditions of extreme dry heat (up to 50°C) or moist heat (up to 50°C and 90% humidity).

3-6. Extreme Cold, Salt Air and Sea Spray, Sand, and Dust

a. Cold Climate. No special procedure is required to operate in temperatures down to minus 18°C. A 20-minute warmup time should be allowed for maximum stability,

b. Salt Air and Sea Spray. Operation in an environment of salt air and sea spray requires that the instrument be protected completely from infiltration of these elements.

c. Sand and Dust. Operation in an environment of sand and dust requires that the instrument be protected from infiltration of these elements.

CHAPTER 4

OPERATOR/CREW MAINTENANCE INSTRUCTIONS

4-1. Lubrication, Repair Parts, Tools, and Test Equipment

No lubrication, repair parts, tools, or test equipment are required by the operator.

4-2. Preventive Maintenance Services

Preventive maintenance on the AN/USM-203A is limited to observations by the operator. Disconnect the power from the unit if the AN/USM-203A does not operate normally. Any instrument which does not operate normally shall be sent to a higher maintenance category.

CHAPTER 5

ORGANIZATIONAL MAINTENANCE

Section I. GENERAL REQUIREMENTS

5-1. Scope of Organizational Maintenance

Organizational maintenance is limited to procedures that can be accomplished without removing the instrument from its case. Operational checks are limited to those determinations which can be made using the auxiliary equipment normally associated with the use of the AN/USM-203A.

5-2. Tools, Equipment, and Materials Required

a. Tools Required. Allen wrenches: #6 (1/16 inch), #8 (5/64 inch).

b. Material. Trichloroethane.

WARNING

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

Section II. EXTERNALLY SERVICEABLE DETAILS

5-3. Fuse Replacement

a. The fuse which protects the instrument in the event that excessive current is drawn from the line is located on the rear panel.

b. Remove the fuse by pressing down on the cap and turning counterclockwise to the stop. Withdrew the fuse and the cap, and then remove the fuse from its receptacle.

c. The fuse is a type 3-AG, rated at 1 ampere. (Littelfuse 312001)

NOTE

See paragraph 1.11 for 230-volt operation.

d. Insert the fuse in the receptacle of the cap.

e. Insert the fuse and cap assembly into the receptacle at the rear of the instrument.

f. Turn the cap until the two metal protrusions mate with the notches in the receptacle. Press down and turn clockwise to the stop.

g. If the fuse fails again when the instrument is turned on, report the condition to higher category maintenance.

5-4. Single Function Control Knobs

a. Single function control knobs are used on the following controls:

(1) ATTENUATION control.

(2) BAND switch.

(3) EXTERNAL MARKER SIZE.

b. All single function knobs are secured to their shafts by means of recessed setscrews. Two screws are used on the band switch and attenuator controls, while only one is used on the external marker size control. These screws require a #8 Allen wrench.

c. The band switch and the attenuator controls must be properly positioned on their shafts before tightening the setscrews.

(1) The band switch has only two positions, LOW and HIGH. The actual position of the shaft may be determined by temporarily tightening one setscrew and establishing that the switch is in the counterclockwise position. The setscrew is then loosened, the knob index located to indicate the low position, and the knob secured in this position.

(2) The attenuator controls are capable of 360° of rotation, and the 0-dB position must be

located electrically. This may be done by connecting an ohmmeter between ground and the center pin of the rf output connector. The highest resistance reading indicates the 0-dB position.

5-5. Coaxial Controls

u. Coaxial controls are used on the following controls:

(1) Fixed marker size and MARKER SHAPE.

(2) ALC AND RF VERNIER.

(3) SWEEP WIDTH switch and SWEEP WIDTH vernier.

(4) SWEEP RATE switch and SWEEP RATE vernier.

b. Two sizes of setscrews are used on the coaxial controls.

(1) The outer diameter knob requires the use of #8 Allen wrench.

(2) The inner diameter knob requires the use of a #6 Allen wrench.

CHAPTER 6

FUNCTIONING OF EQUIPMENT

6-1. Block Diagram

a. The AN/USM-203A sweep signal generator is a solid-state electronic instrument which provides frequency coverage from 0.5 to 1200 MHz in two bands. An external oscilloscope or graphic recorder is required for external display purposes, or the instrument may be operated as a cw generator.

b. The block diagram (fig. 8-4) of the AN/USM-203A can be divided into five major sections.

(1) Power supply.

(2) Sweep drive circuits.

(3) Automatic level control and blanking circuits.

(4) Rf circuits.

(5) Marker circuits.

NOTE

No power supply connections are shown.

c. The following paragraphs describe the electrical operation of the AN/USM-203A. Detailed operation may be followed in the schematic diagram (fig. FO-3).

6-2. Power Supply (fig. FO-3)

a. Five separate outputs are provided: +200 volts dc, +30 volts dc, and - 30 volts dc (all regulated), +50 volts dc unregulated, and a 60-Hz line-synchronizing signal. The four dc sources supply the various sweep generator functions shown in the schematic diagrams. The line-sync signal is used in the rate generator.

b. Each regulated dc source is a series-type transistor regulator. The +30-volt and - 30-volt regulated sources are complementary duals. Corresponding polarized capacitors and diodes in the respective supplies are of the same type, but the polarities are reversed. To permit duality, complementary transistors are interchanged in the positive and negative supplies.

c. The +30-volt supply uses a constant current generator (Q2) to provide constant bias current to Q3 and Q4. Diode VR2 and resistor R3 protect the regulator against overloads by limiting the drive to series-pass transistor Q1. Zener diode VR3 and temperature-compensating diode CR7 provide the voltage reference. Resistor R7 is used to adjust the output voltage to +30 volts. Transistor Q4 amplifies differences between the output voltage sample and the reference voltage, and drives Q3 in Darlington connection with Q1 to automatically compensate for load voltage error. Capacitors C4, C5, and C6 are used (if required) for stabilization.

d. The +200-volt supply is similar to the other regulated sources except no constant current generator is used. Gas discharge tube 12 is the 82-volt reference. Other components are specified to provide the +200-volt output.

6-3. Sweep Drive Circuits (fig. FO-3)

a. *Rate Generator*. The rate generator has five modes of operation. These five modes are achieved by changing the operating characteristics of the basic rate generator, which consists of a Schmitt trigger and a Miller integrator.

(1) The bistable Schmitt trigger consists of Q101 and, Q102 and associated resistive networks. The output at the collector of Q102 is a square wave which is coupled to the blanking circuitry and to the Miller integrator.

(2) The Miller integrator consists of Q103 and Q104 and associated resistor and capacitor networks. The integrated output at the collector of Q104 is a triangular wave. The free-running condition is established by coupling the output of Q104 to the input of the Schmitt trigger. The output at the collector of Q104 is coupled to the linearity circuitry through emitter follower Q105.

(3) SWEEP RATE switch S103, a front panel control, is used to select the desired mode of operation. In the LINE position, the 60-Hz line-sync signal drives the Schmitt trigger at a 60-Hz rate. In the 5- to 60-Hz and 0.05- to 5-Hz positions, the trigger integrator combination is free-running. The SWEEP RATE may be continuously adjusted by R120B R120C, the front panel vernier control. In each case, the respective rc time constants (R118, R120B, and C102 for the 5-to 60-Hz rate; and R117, R120C, C102, and C103 for the 0.05- to 5-Hz rate) determine the sweep rate.

(4) In the MANUAL and EXT modes, the trigger and integrator are inoperative. In the MANUAL mode, the sweep drive and the horizontal oscilloscope drive voltages are determined by the position of R120A in voltage divider network R123, R120A, and R127. Resistor R120A is ganged to R120B and R120C, the front panel vernier adjustment. In the EXT position, an external generator is used in place of the internal rate circuit.

b. Linearity Circuit. The linearity circuit amplifies and reshapes the input triangular wave. It is required to provide a linear frequency-versus-voltage characteristic in the rf output display at all SWEEP WIDTH settings, and in both the LOW and HIGH frequency bands.

(1) The triangular wave from the rate generator is coupled to emitter follower Q105. Three outputs are coupled from separate voltage dividers in the emitter circuit of Q105. One output is the SCOPE HORIZ drive, a triangular signal.

(2) The other two outputs are coupled to common-base transistor circuits, linear amplifier Q106 and nonlinear amplifier Q107. The nonlinear amplifier characteristics are controlled by the diode break circuit consisting of resistors R136 through R146, diodes CR104 through CR113, and resistors R148 through R157. As a positive-going signal is coupled to the emitter of Q107, the individual diodes are reverse-biased; but as the collector voltage increases, individual diodes conduct in sequence, and the output signal is reshaped by the nonlinear, diode break circuit.

(3) The outputs of the linear and nonlinear amplifiers are coupled to the front panel SWEEP WIDTH switch and potentiometer combination S101, R146A, and R146B. The two combined signals maintain rf output sweep linearity under all conditions of SWEEP WIDTH and frequency. The resultant drive signal is coupled to varactor diode CV501 in the tunable oscillator.

6-4. Rf Circuits (fig. FO-3)

a. Bandswitch. The rf sections of bandswitch S601 consist of coaxial switches S601-1A and S601-1B. In the HIGH band position, the variable oscillator is direct-coupled to R602, and Z603 to RF OUT connector J611. In the LOW band position, the variable oscillator signal is coupled to the mixer where it mixes with the fixed 700-MHz oscillator signal. Lowpass filter FL551 couples the mixer difference frequency to the video amplifier where the signal is amplified. From the video amplifier, the signal is coupled to the output. Bandswitch S601 includes sections 2A, 2B, 2C, 2D, 3B, 3C, and 3D in addition to the rf sections. These additional sections couple or uncouple B + and rf blanking voltages to the respective high and low band circuits.

b. High Frequency Band. The variable uhf oscillator uses a mechanically tunable line to tube the range of 300 MHz to 1200 MHz. Adjustable resistor R509 is ganged to the shaft of the tuned-lined control to provide a nearly constant output over the tuning range. In the WIDE and NARROW sweep modes, varactor CV501 is electronically varied by the reshaped sweep drive signal to provide a linear frequency-versus-voltage characteristic. In the cw mode, the varactor drive voltage is held constant. Transistor Q501 is the amplifying device in the variable oscillator. The oscillator output at connector J501 is coupled from a grounded loop network of resistors, R500, R501, and R507. In the high frequency range, the variable oscillator output is coupled through filter FL501, bandswitch S601, the monitor, and attenuator Z603 to RF OUT connector J611. The ATTENUATION control consists of a series of resistive pi pads which provide 0 to 70 dB of output attenuation in 10-dB steps while maintaining an impedance of 50 ohms.

c. Low Frequency Band. In LOW BAND operation, the variable-oscillator signal is mixed with the 700-MHz, fixed-oscillator signal. The low-level output is couped through FL551 to the video amplifier. The video amplifier output is coupled to coaxial switch section S601-1B and to the monitor. The amplified signal is coupled to the attenuator and to RF OUT connector J611. The sweep signal is generated in the variable uhf oscillator.

(1) *Fixed-frequency oscillator*. The *700* MHz fixed-frequency oscillator consists of transistors Q551 and Q552, a resonant line, a trimmer capacitor, and associated biasing circuits. The oscillator output is loop-coupled to the mixer by resistor R554. One end of R554 is common to the case.

(2) *Mixer and low-pass filter*. The mixer is a double-balanced diode mixer with balanced transformer inputs from the 700-MHz fixed oscillator and the variable oscillator. Transformers T551 and T552 are wound on toroidal ferrite cores. The output of the mixer is coupled from the common point of the diode star (consisting of CR551 through CR554) to RL551. Low-pass filter FL551 couples the difference frequency of the two oscillators to J401, the input to the video amplifier.

(3) *Video amplifier*. The input signal is amplified by four cascaded, rf-coupled, common-emitter amplifier stages. This four-stage video amplifier has a relatively flat response from 0.5 MHz to 300 MHz. Capacitors C402, C408,C415, and C422 permit adjustment of gain in individual stages to level the output throughout the low band. The first three stages are supplied by leveled B+. The fourth stage, with dual-emitter lead transistor Q404, has a higher power output and is supplied by +50 volts dc.

d. Rf Detector Circuit. The rf detector circuit consists of diode CR603 and associated components including R613 and R614. Diode CR603 detects the signal from the' device under test and couples a negative output voltage (when connected) to the video input connector.

6-5. Automatic Level Control (ALC) and Blanking Circuits (fig. FO-3)

a. The monitor senses the rf output signal at the junction of CR601 and R602. The monitor output, a negative detected signal, is coupled to the base of transistor Q206, the sampling input of a differential amplifier.

b. The base of Q207, the reference half of the differential amplifier, is coupled to a stable, but adjustable bias voltage. Any difference between the negative monitor sample and the reference voltage appears at the collector of Q206 as an amplified, phase-inverted error signal. The collector output of Q206 is further amplified and phase-inverted by Q202. The collector output of Q202 is coupled to the base of emitter follower Q201 where the change in leveled B+ restores the rf output to its normal value. The leveled B + is applied to the variable oscillator in the HIGH band mode and to the first three stages of the video amplifier in the LOW band mode.

c. Any change in rf output voltage is automatically corrected by the ALC circuit. Since the rf output voltage at the monitor is constant for a given voltage reference, this point is a zero-impedance, constant voltage point, and R602 is the source impedance of the sweep generator.

d. The DC reference point in the ALC system, the base of Q207, can be adjusted from the front panel RF VERNIER control. By adjusting the RF VERNIER control, the leveled B+ is adjusted and the rf output level may be continuously adjusted over a 10-dB range. The rf output indicating meter (M601) is coupled through R611 and R612 to the base of Q206.

e. Front panel switch S201 bypasses the internal monitor and couples the ALC circuit to the front panel EXT ALC connector. The AN/USM-203A may be leveled at a remote location if an external voltage monitor is used.

f. The blanking circuit reduces the displayed vertical signal to a zero baseline during the sweep retrace. Two blanking modes, rf and VIDEO, are controlled from internal slide switch S102 on the main printed circuit board. The Schmitt trigger generates the blanking signal. In rf blanking, the rf output is blanked during retrace. Transistors Q204 and Q203 saturate, Q201 is cut off, and the leveled B+ is blanked.

g. In the VIDEO blanking position, the blanking signal is coupled to the gate of JFET Q109, an electronic switch which shorts the SCOPE VERT connector to ground during the retrace interval.

6-6. Marker Circuits (fig. FO-3)

a. The AN/USM-203A is supplied with a birdie-bypass marker system. A front panel connector is provided for an external marker. Internal receptacles are provided for eight plug-in markers. Three internal markers of 1.0, 10.0, and 50.0 MHz are supplied with the AN/USM-203A. All markers are controlled independently from front panel switches. In the marker system, a sample of the swept rf signal is mixed with the fundamental or a harmonic of the plug-in markers to produce beatnotes, or birdies. These birdies are then amplified, shaped, and added to the demodulated video signal and applied to the vertical channel of the oscilloscope.

b. Three rf sweep samples are obtained from the rf output at the monitor point (the junction of CR601 and R602), and coupled to the resistance bridge consisting of R603, R604, R605, and R606. Two of the samples at J606 and J609 are provided for each of four optional internal markers. When an EXT MARKER is used, the signal is coupled to mixer diode CR602 where it mixes with the third sweep sample from the resistor bridge. The resulting signal is coupled to external amplifier Q306, a high gain, common emitter amplifier.

c. Resistor R331 is a front panel EXT MARKER SIZE control which allows the external marker system to accept a wide variation in signal source amplitudes.

d. Each of the eight plug-in marker receptacles has its own internal size adjustment. The markers produced in each plug-in can be independently controlled in amplitude with potentiometers R305, R306, R311, R312, R317, R318, R324, and R325. This allows each marker to be adjusted to a different amplitude and gives rapid identification of the various markers on the oscilloscope display.

e. Four amplifier stage are built on the plug-in marker printed circuit board. Each amplifier stage is fed from two plug-in marker receptacles. The output of all four amplifier stages is fed through common emitter amplifier Q305. The plug-in marker signals from Q305 and the external marker signal from Q306 are coupled to a common birdie amplifier stage which includes the MARKER SHAPER circuit consisting of C307, C308, C309, C310, C311, C315, C316, C317, L301, R334, R335, R342, and R343. The shaped marker is further amplified in Q307.

f. After amplification, the markers are applied to MARKER SIZE potentiometer R339, which is a f rent panel adjustment. The markers are available at the SCOPE VERT output connector on the front panel.

CHAPTER 7

DIRECT SUPPORT MAINTENANCE

Section I. GENERAL

NOTE

AN/USM-203A Sweep Signal Generators which require direct support maintenance shall be processed according to the procedures that follow. If rf assemblies are defective, the AN/USM-203A will require general support maintenance (chapter 8).

7-1. Test Equipment Required

a. The following test equipment or equal is required:

(1) Multimeter TS-362B/U, FSN : 6626-242-6032.

(2) Oscilloscope AN/USM-273, FSN :6626-079-3676.

(3) Voltmeter, Electronic AN/USM-98B, FSN :6625-753-2116.

(4) Wattmeter AN/USM-260.

b. The following accessory or equal is required: Attenuator pad, standard 2.0 dB, Weinschel, Model 50-2.

7-2. Removal of Enclosure Panels

To gain access to the AN/USM-203A main chassis, remove the enclosure panels as follows:

a. Remove the four screws at the rear of the instrument which retain the two side panels.

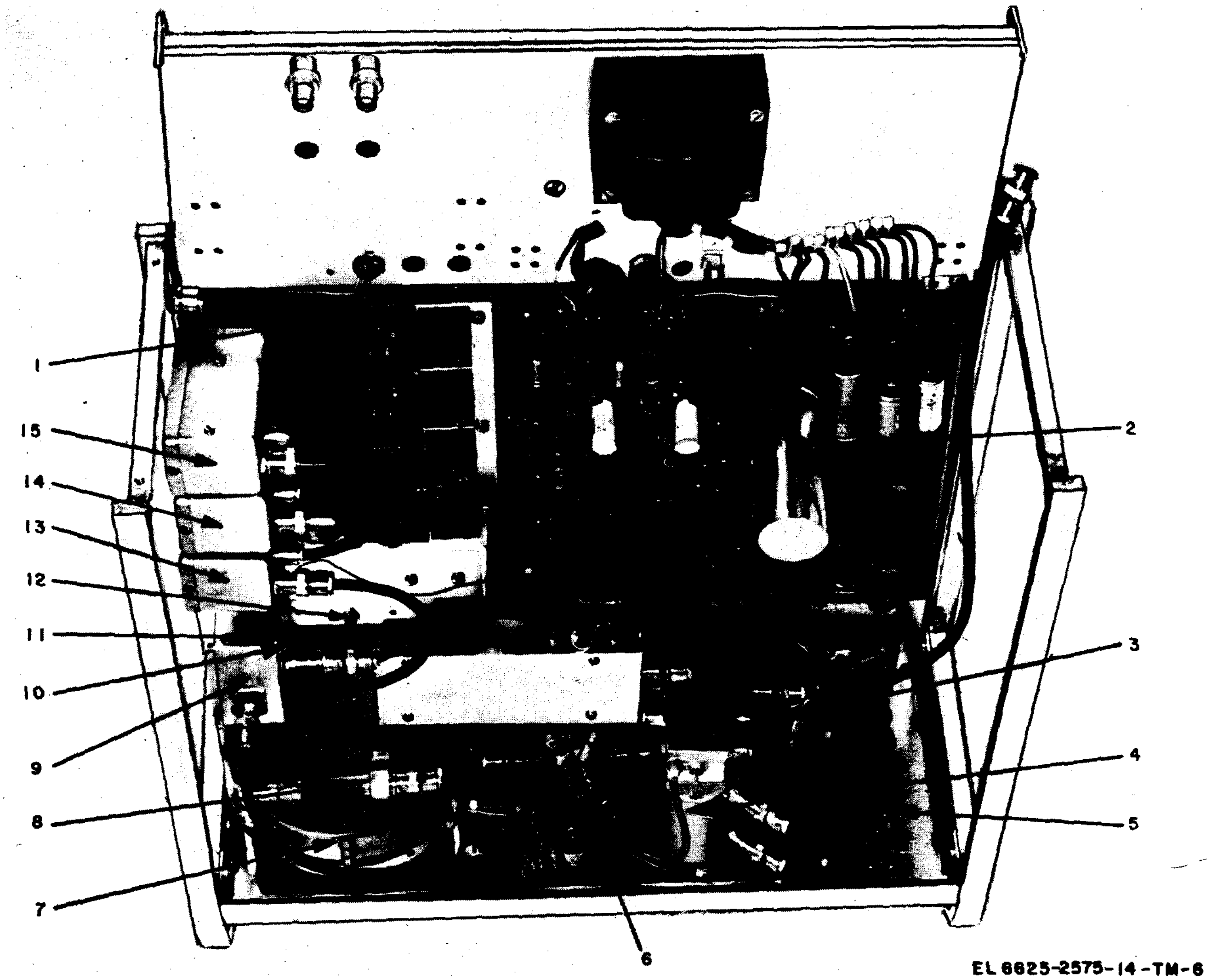
b. Slide the two side panels out the rear of the instrument.

c. Slide the top panel toward the rear approximately 1 inch to release the retaining lip at the front of the panel. Lift the top panel off the instrument.

d. Slide the bottom panel toward the rear of the instrument until it clears the four plastic feet, and remove the bottom panel. Figure 7-1 shows the AN/USM-203A with the enclosure panels removed.

WARNING

Voltages up to +200 volts are present in the AN/USM-203A when ac line power is applied.



1	Plug-in marker pc board	6	Band switch S601	11	Video amplifier
2	Main printed circuit board	7	Variable oscillator	12	R612, meter adjustment
3	Monitor/mixer assembly	8	Low-pass filter FL501	13	50.0-MHz plug-in marker
4	Attenuator Z603	9	Fixed-oscillator mixer	14	10.0-MHz plug-in marker
5	Marker switch bank	10	C553, oscillator adjustment	15	1.0-MHz plug-in marker

Figure 7-1. AN/USM-203A with enclosure panels removed.

Section II. TROUBLESHOOTING

7-3. Troubleshooting Approach

a. In troubleshooting the AN/USM-203A, systhematically isolate the defect by a process of elimination from the symptom to a particular circuit, and then to a particular component or assembly. Refer to chapter 6 for equipment functioning and to the schematic diagram (fig. FO-3).

b. After an instrument failure has been verified, sectionalization should begin with the front panel controls, and proceed to localization by checking voltages and waveforms at particular test points in the AN/USM-203A. The +30-volt and the - 30-volt regulated supplies should be checked because they are common to several AN/USM-203A circuits.

c. To aid the troubleshooter, a test point guide is presented in table 7-1. Voltages are tabulated and waveforms are shown which are typical of an operating AN/USM-203A. In addition, a troubleshooting guide is presented in table 7-2 which lists symptoms, probable causes, and recommended corrective actions.

NOTE

Troubleshooting and repair of rf assemblies shall be performed at higher maintenance categories.

7-4. Test Point Guide

a. The dc voltages in table 7-1 and the waveforms in figures 7-2 through 7-8 are typical of those in a normal AN/USM-203A when the unit is connected to a 115-volt ac line, the POWER switch is at ON, and a 20-minute warmup is used. Other front panel controls and the internal blanking switch are set as follows:

BAND ---------------- HIGH.
ATTENUATOR ------------- 0 dB.
BLANKING ----- VIDEO (main PC board).
SWEEP WIDTH ---------- WIDE.
SWEEP WIDTH vernier --- Fully clockwise.
CENTER FREQUENCY --- 1000 MHz.
SWEEP RATE -------------- LINE.
RF VERNIER ----------- Set to 0.5 volts rms into a 50-ohm load.
ALC-------------------------- INT.
MARKERS ------------ ON (1.0, 10.0, and 50 MHz).
FIXED MARKER SIZE --- Midrange.

CAUTION

In making measurements, the chassis of the AN/USM-203A shall be connected to the chassis or ground connection of the test instrument.

b. To locate test points, see figures 7-9, 7-10, and 7-11. The dc voltage measurements are made with a high-impedance voltmeter. The shield of the voltmeter probe shall be common to the AN/USM-203A chassis. The waveform measurements are made. with a de-coupled, high-impedance oscilloscope probe at the test point. The probe shield is common to the AN/USM-203A chassis. The waveforms (fig. 7-2 through 7-8) displayed on the oscilloscope are typical for the AN/USM-203A. Variation from the typical voltages or waveshapes should be carefully noted during troubleshooting.

Table 7-1. Teat Point Guide for AN/USM-203A

Test Point		Voltage (Test point to mound)	Function
Component	Terminal		
Q3	Emitter	+35v dc	Q1 base drive voltage
VR2	Cathode	+36v dc	Q3 base drive voltage
VR2	Anode	+30 ±1v dc	+ 30v dc regulated output
VR3	Cathode	+7.5v dc	Reference voltage for +30v dc
Q 7	Emitter	—33v dc	Q5 base drive voltage
VR5	Anode	—34v dc	Q7 base drive voltage
VR5	Cathode	—30 ±1v dc	- 30v dc regulated output
VR6	Anode	—7.5v dc	Reference voltage for - 30v dc
Q1O	Emitter	+201v dc	Q9 base drive voltage
Q11	Emitter	+82v dc	Q10 base drive voltage
VR7	Anode	+200 ±5v dc	+ 200v dc regulated output
C 2	Positive	+45 to +65v dc	+ 50v dc Supply
Q201	Emitter	+30v dc	Leveled B+ voltage
Q202	Collector	+31v dc	Q201 base drive voltage
Q206	Base	—1.0v dc	Leveler sample voltage
Q207	Base	—1.2v dc	Leveler reference voltage
Q102	Collector	See figure 7–2	Schmitt trigger output
Q105	Emitter	See figure 7–3	Emitter follower
Q106	Collector	See figure 7–4	Linear amplifier output
Q107	Collector	See figure 7–5	Nonlinear amplifier
J301	4	See figure 7–6	Output of LO-MHZ marker
J302/J303	4	See figure 7–7	Output of 10.0- and 50-MHz markers
Q305	Collector	See figure 7–8	Output of first stage of marker amplifier.

NOTE

All voltages indicated in column 3 are typical, except where a specific tolerance or range is given.

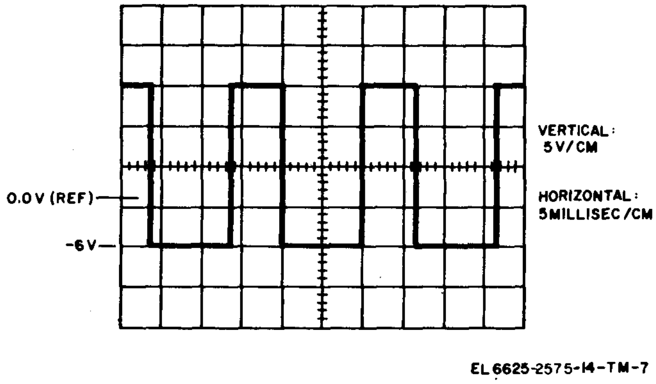


Figure 7-2. Typical display at Q102 collector.

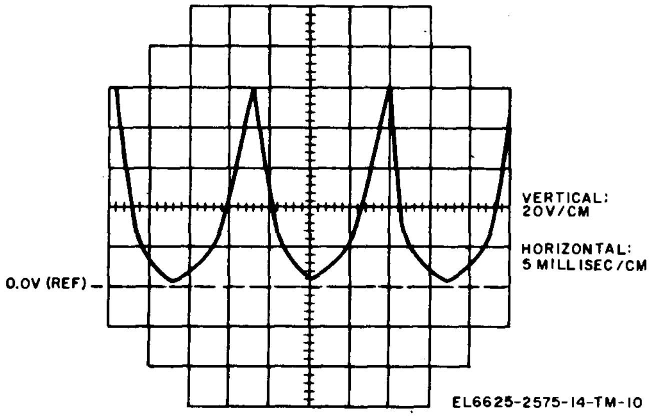


Figure 7-5. Typical display at Q107 collector.

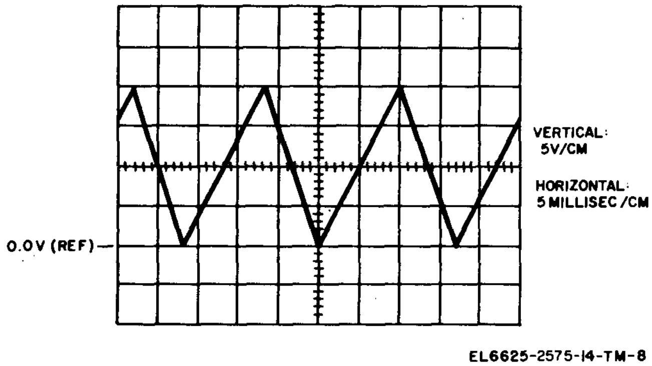


Figure 7-3. Typical display at Q105 emitter.

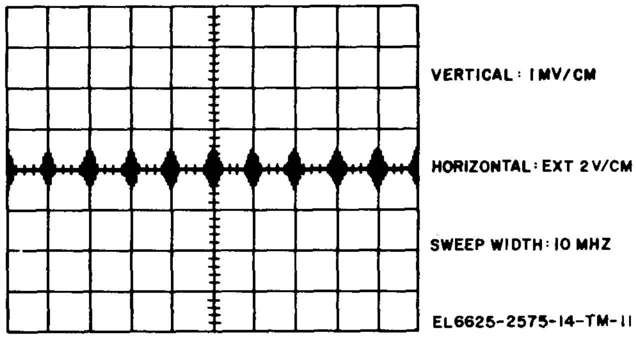


Figure 7-6. Typical display at J301-4.

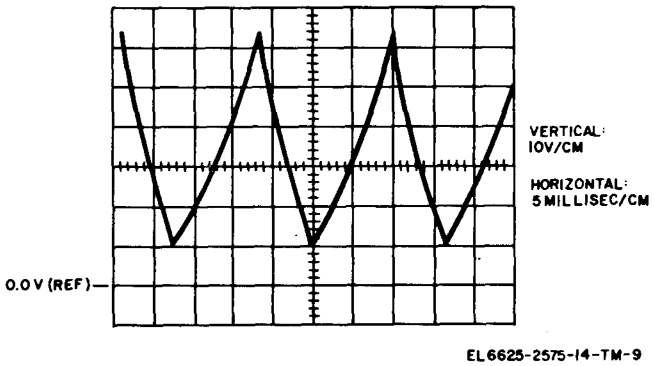


Figure 7-4. Typical display at Q106 collector.

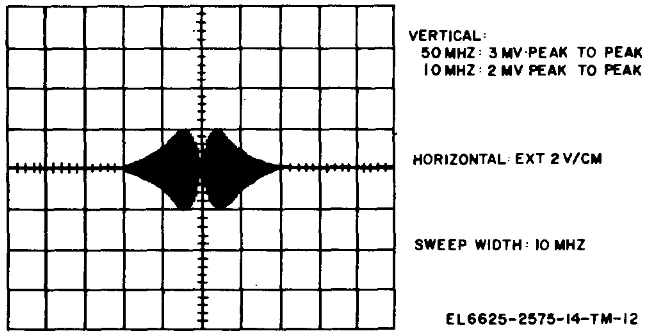


Figure 7-7. Typical display at J302-4 and J303-4.

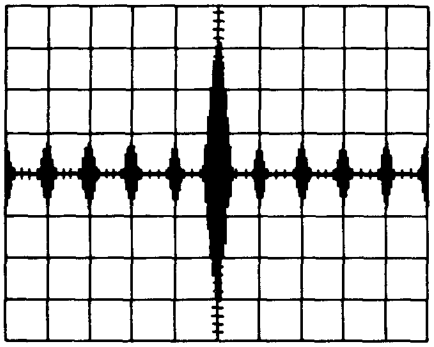


Figure 7-8. Typical display at Q305 collector.

7-5. Troubleshooting Guide

Table 7-2 provides a list of common failures which may occur. If the failure occurs in an rf assembly, replacement or repair shall be made at a higher maintenance category. Rf cables should be tested if no rf signal is present. A defective internal rf detector can be found by substituting an operable external detector in the setup shown in figure 1-2.

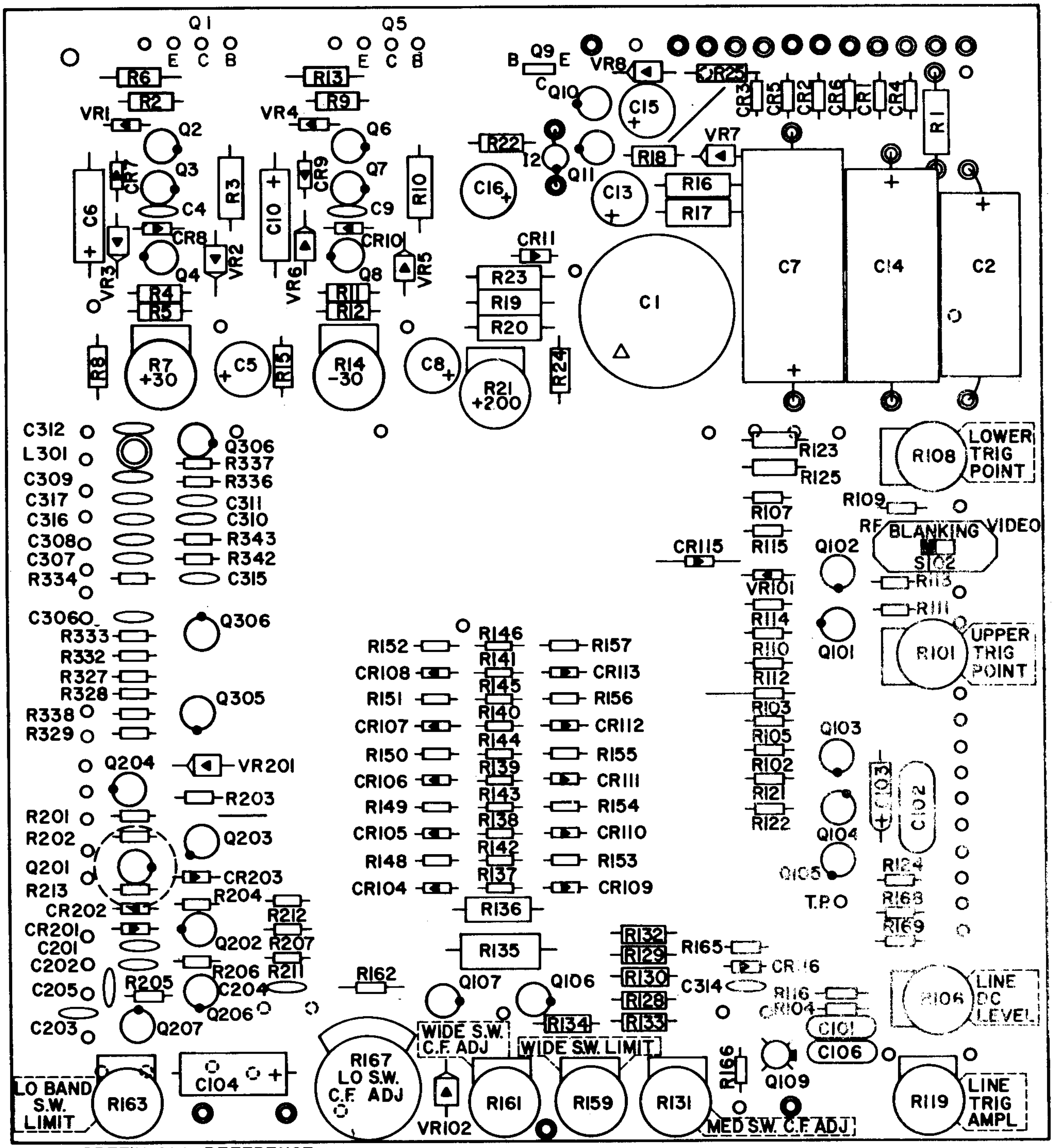
NOTE

In troubleshooting units in multiple defects, by very careful to determine the primary defect. If the primary defect is not corrected, the failure will occur again.

Table 7-2. Troubleshooting Guide

Symptom	Probable cause	Corrective action
1. Power switch ON, but indicator light is off.	*a.* F1. *b.* I1.	*a.* Replace F1. *b.* Replace I1.
2. F1 blows when power switch is at ON.		*a.* Isolate defect and repair as necessary.
	b. Shorted power supply outputs	*b. See* chapter 8. (Repair or replace defective rf assembly as required).
3. *No* RF OUT in either HIGH band or LOW band.	*a.* Power supply voltages, *b.* Leveler voltage.	*a.* Isolate defect and repair as necessary.
	c. Variable oscillator. *d.* Rf cables. *e.* Rf detector. *f.* Monitor/mixer.	*b. See* chapter 8. (Replace or repair defective rf assembly.)
4. RF OUT in HIGH band only.	*a.* Fixed oscillator/mixer. *b.* Bandswitch S601. *c.* Video amplifier. *d.* Rf cables.	*a.* See chapter 8. (Replace or repair defective rf assembly.)
5. Insufficient RF OUT in HIGH band.	*a.* Potentiometer R210 (MAX LEVEL SET). *b.* +30-volt and -30-volt supply. c. Leveler transistors (Q201, Q202) .	*a.* Isolate defect and repair as necessary.
	d. Variable oscillator. *e.* Band switch.	*b. See* chapter 8. (Replace defective rf assembly.)
6. Excessive variations in RF OUT in both bands.	*a.* Leveler transistors (Q201, Q202).	*a.* Isolate defect and repair as necessary.
	a. Variable oscillator. *b.* Monitor/mixer.	*b. See* chapter 8. (Repair or replace defective rf assembly.)
7. Insufficient RF OUT in LOW band, and RF OUT variations excessive.	*a.* Video amplifier. *b.* Fixed oscillator/mixer.	*a.* See chapter 8. (Replace or repair defective rf assembly.)
8. No SCOPE HORIZ output.	Q101, Q102, Q103, Q104, Q105.	Isolate defect and repair as necessary.

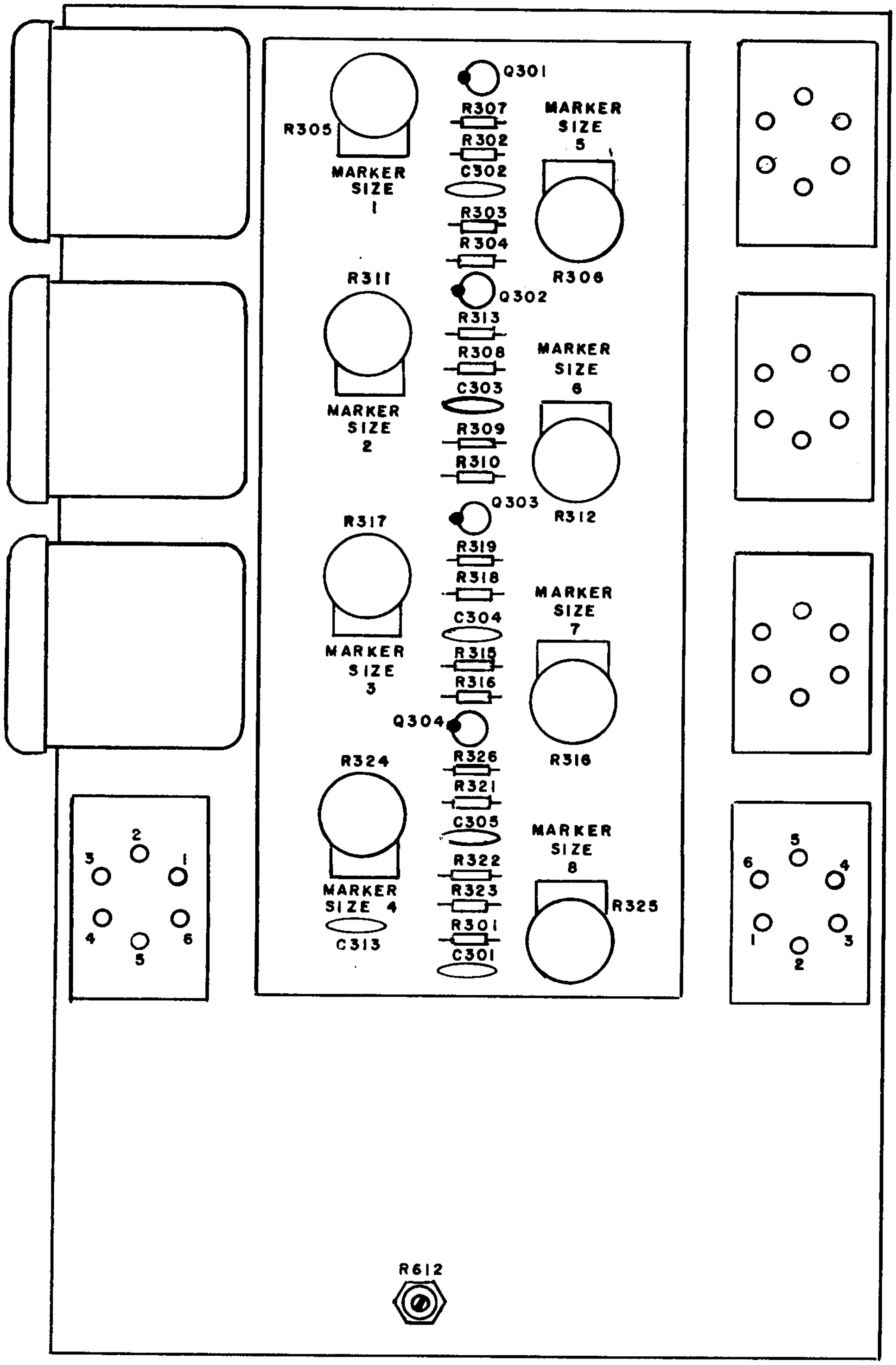
Symptom	Probable cause	Corrective action
9. *No* SCOPE HORIZ output.	Q101, Q102, Q103, Q104.	Isolate defect and repair as necessary.
10. No blanking video mode.	Q109, S102.	Isolate defect and repair as necessary.
11. No blanking RF mode.	Q203, Q204, S102.	Isolate defect and repair as necessary.
12. Insufficient SWEEP WIDTH.	*a*. +200v dc Supply. *b*. Q106, Q107.	*a*. Isolate defect and repair as necessary.
	c. Variable oscillator.	*b*. See chapter 8. (Replace defective rf assembly.)
13. Power supply will not adjust properly.	*a*. VR3, CR7 (+30v dc Supply). *b*. VR6, CR9 (-30v dc Supply). *c*. 12.(+ 200v dc Supply) .	Isolate defect and repair as necessary.
14. +30v dc will not regulate.	VR3, CR7, Q1, Q4.	Isolate defect and repair as necessary.
15. -30v dc will not regulate.	VR6, CR9, Q5, Q8.	Isolate defect and repair as necessary.
16. +200v de will not regulate.	12, Q9, Q11.	Isolate defect and repair as necessary.
17. +30v dc not present or ripple is excessive.	*a*. CR2, CR6, C1D, C6. *b*. *Q1*, Q2, Q3, Q4.	Isolate defect and repair as necessary.
18. -30v dc not present or ripple is excessive.	*a*. CR3, CR5, C7, C10. *b*. Q5, Q6, Q7, Q8.	Isolate defect and repair as necessary.
19. +200v dc not present or ripple is excessive.	*a*. CR1, CR4, C1A, C1B. *b*. C16, C14, Q9, Q10, Q11.	Isolate defect and repair as necessary.
20. RF OUT (output) has excessive voltage variation in both bands.	*a*. R210 (RF LEVEL SET MAX) . *b*. Q202, Q203, Q206, Q207.	*a*. Isolate defect and repair as necessary.
	c. Monitor/mixer;	*b*. See chapter 8. (Repair defective rf assembly.)
21. RF OUT (output) frequency does not track dial.	*a*. +200v dc Supply. *b*. Q106, Q107. c. Loose dial setscrews.	*a*. Isolate defect and repair as necessary.
	d. Variable oscillator. e. Fixed oscillator.	*b*. See chapter 8. (Replace or repair defective rf assembly.)
22. +50v dc not present.	CR1, CR6, R1, C1C, C2.	Isolate defect and repair as necessary.
23. No internal or external frequency markers.	Q307	Isolate defect and repair as necessary.
24. Internal frequency markers, but no external frequency markers.	*a*. Q306	*a*. Isolate defect and repair as necessary.
	b. Monitor/mixer	*b*. See chapter 8. (Repair defective rf assembly.)
25. Individual marker produces no displayed frequency marker.	*a*. Q301, Q302, Q303, or Q304. *b*. Individual plug-in marker. *c*. R301 through R308 require adjustment.	Isolate defect and repair as necessary.
26. External frequency marker, but no internal plug-in marker display.	Q305.	Isolate defect and repair as necessary.



NOTE: PREFIX ALL REFERENCE DESIGNATIONS WITH A4A8

EL6625-2575-14-TM-14

Figure 7-9. Main printed circuit board assembly.



NOTE:
PREFIX ALL REFERENCE DESIGNATIONS WITH A4A7.

EL6625-2575-14-TM-15

Figure 7-10. Plug-in marker/printed circuit board.assembly.

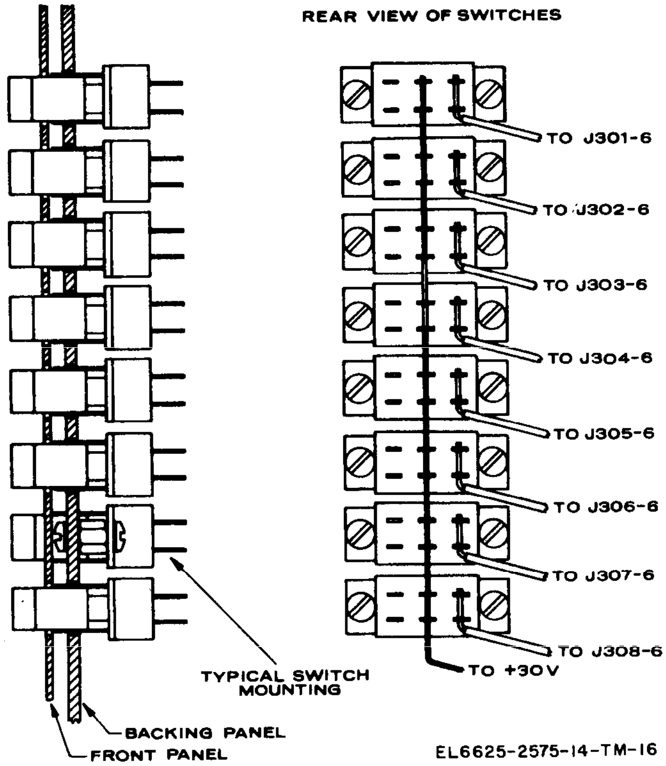


Figure 7-11. Plug-in marker switch bank.

Section III. REPAIRS

7-6. Repair Procedures

a. Repair procedures shall consist of quality standards for wiring and soldering of electronic equipment. Additional precautions are required to restore the AN/USM-203A to its original condition. When replacing defective parts, be sure to localize heat to the solder joints affected. All solder joints shall be smooth, bright, and feathered out to a thin edge, indicating proper flow and wetting action. Leads should be tagged for identification when assemblies are removed. Lead length and component position should be duplicated when components are replaced.

b. Small diameter coaxial cable connections require special attention to prevent breaks and shorts. Cable shall be replaced if excessive stresses are caused by shortening the cable to make repairs.

c. Precautions shall be observed when removing and replacing components on the printed circuit assemblies. Attempt to restore the board to its original condition. Remove flux and cleaning agent residue from the board.

7-7. Disposition of Repaired Units

When repairs on a defective AN/USM-203A have been completed, perform the alignment and calibration required (para 1-5). Any AN/USM-203A that cannot be satisfactorily repaired shall be sent to a higher maintenance category.

Section IV. TEST PROCEDURES

7-8. General Test Information

The extent of repair on the AN/USM-203A will determine whether or not alignment is required. If a repaired AN/USM-203A (unit under test) meets the test requirements in paragraphs 7-9, 7-10, and 7-11, alignment is not required.

7-9. Initial Tests

Follow the procedures in paragraph 7-4 and Table 7-1, the test point guide. If the unit under test is within the stated voltage tolerances, and is in agreement with the typical voltages and waveshapes, proceed to paragraph 7-10. If the unit under test is in obvious disagreement with table 7-1, troubleshoot the unit under test for defects (sect. III). If the unit under test appears questionable, proceed to the alignment procedure in section V. If the unit under test cannot be repaired satisfactorily, send it to a higher maintenance category.

7-10. Typical Test Displays

a. Use the test setup in figure 7-12.

b. Connect the unit under test and the oscilloscope to a 115-volt, 50/60-Hz, single-phase power source.

c. Set the front panel POWER switches of both the unit under test and the oscilloscope to ON. Allow a 20-minute warmup period.

d. Set the front panel controls of the unit under test as follows.:

(1) BAND ----------------- HIGH.
(2). ATTENUATOR. ------------ 0 dB.
(3) SWEEP WIDTH ------------ WIDE.
(4) SWEEP WIDTH vernier-- Fully clockwise.
(5) CENTER FREQUENCY 1000 MHz.
(6) SWEEP RATE ------------ LINE.
(7) RF VERNIER ------- Set to 0.5 volt rms on RF OUTPUT meter.
(8) ALO ----------------- INT.
(9) 50.0 MHz MARKER ---- ON.
(10) FIXED MARKER SIZE Midrange.
(11) MARKER SHAPER -------Midrange.
(12) BLANKING (main PC board) ---------------- VIDEO.

e. Set the display oscilloscope as follows:

(1) Vertical input de-coupled.

(2) Vertical sensitivity to 0.1 volt/cm.

(3) Horizontal input to external.

(4) Adjust horizontal display to 10 cm width.

f. The oscilloscope display of the unit under test shall be typically as shown in figure 7-13.

g. To determine the rf output voltage variation in the HIGH BAND (uhf), proceed as follows :

(1) Insert a standard 2-dB attenuator between the unit under test RF OUT connector and the RF DETECTOR IN connector.

(2) Observe the decreased amplitude in the display which represents the attenuated output.

(3) The difference between the attenuated amplitude and the amplitude observed in *f* above represents a difference of 2 dB in rf output to the detector.

(4) Remove the 2-dB attenuator, and return to the conditions in figure 7-12.

(5) Adjust the CENTER FREQUENCY between 300 MHz and 1200 MHz.

(6) Using linear interpolation, determine that the rf output does not vary more than 2.0 dB or ±1.0 dB.

NOTE

Disregard the sharp decrease in rf output at the upper and lower cutoff points.

h. To determine the rf output voltage variation in the LOW BAND (vhf), proceed as follows :

(1) Set the unit under test BAND switch to LOW, and the CENTER FREQUENCY dial to 150 MHz (red scale).

(2) The display shall be typically as shown in figure 7-14.

(3) Using linear interpolation, determine that the display or detected output does not vary more than 1.0 dB, or ±0.5 dB.

NOTE

Disregard the sharp decrease in rf output at the zero-beat point, and at the cutoff above 300 MHz.

i. To determine minimum detector efficiency, proceed as follows.

(1) Set the f rent panel controls of the unit under test as in above.

(2) Set the display oscilloscope as in above.

(3) Observe the display in figure 7-13.

(4) The minimum amplitude shall be 0.53 volt, or 75-percent detector efficiency.

(5) 0.53 volt is the product of 0.5 by 1.414 by 0.75 (the detector efficiency).

j. To determine sweep linearity, proceed as follows.

(1) Set the front panel controls of the unit under test as in *d* above.

(2) Set the display oscilloscope as in e above, except adjust the horizontal display so that the 750-MHz marker and the 1150-MHz marker are spaced 8 centimeters apart.

(3) Align the end markers with the vertical graticule lines in the display.

(4) Observe the oscilloscope display and determine which marker deviates farthest from its respective graticule line.

(5) The sweep linearity may be obtained from the following equation:

$$\text{NON-LINEARITY (\%)} = \frac{\text{MAX DEV MHz} \times 100}{400 \text{ MHz}}$$

The nonlinearity shall not exceed 5 percent (5%).

k. Evaluation of performance follows:

(1) If the unit under test conforms closely to the requirements and typical displays in a through *i* above, proceed to paragraph 7-11.

(2) If the displays are obviously distorted, or no displays appear, check a through *i* above. If necessary, repeat the troubleshooting procedure in Section III.

(3) If the displays and the test results are marginal or are slightly out of tolerance, proceed to the alignment procedure in paragraph 7-12. After alignment, repeat the test procedures.

7-11. Additional Test Displays

Use the test procedure in paragraph 7-10 and the test setup in figure 7-12, but make the following front panel control changes.

a. Test the unit in the 5-60 Hz, the .05-5 Hz, and the MANUAL positions of SWEEP RATE. The display shall trace a counterclockwise pattern as in figure 7-13, except at a rate depending on the SWEEP RATE vernier setting.

b. Test the unit in the NARROW SWEEP WIDTH position. Proceed as follows.

(1) Set SWEEP WIDTH switch to NARROW.

(2) Set the 1.0 MHz MARKER to ON.

(3) Set the 50.0 MHz MARKER to ON.

(4) Set SWEEP RATE switch to LINE.

(5) Set other controls as in paragraph 7-10.

(6) Observe the oscilloscope display.

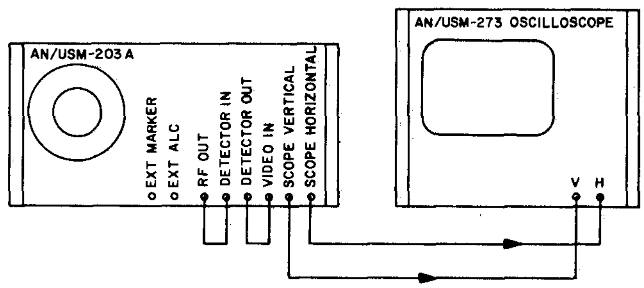


Figure 7-12. Test Setup.

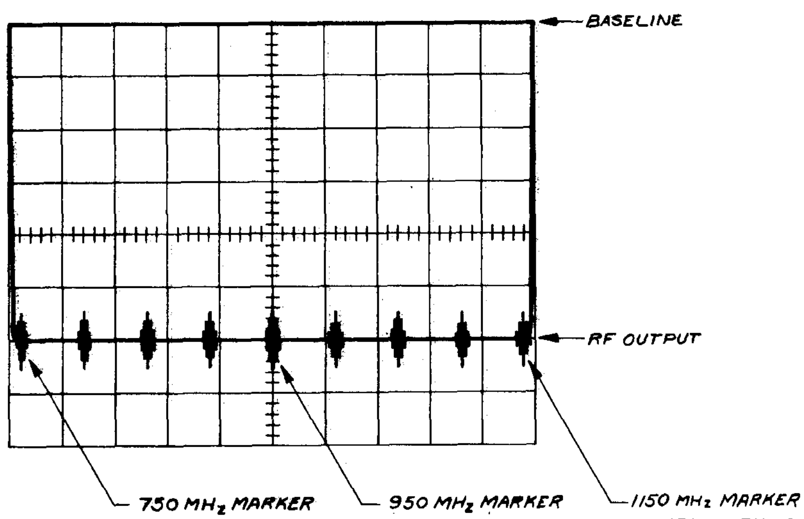


Figure 7-13. High band test display.

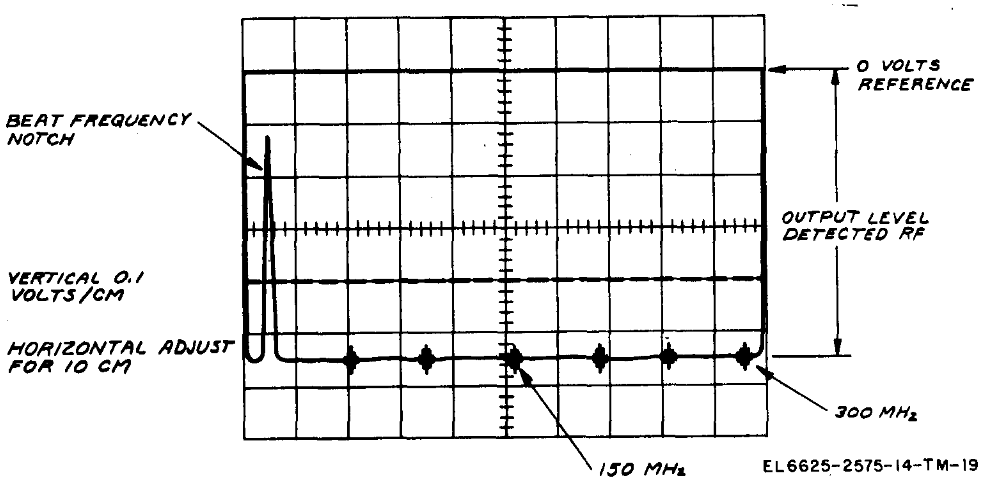


Figure 7-14. Low band test display.

(7) Adjust the SWEEP WIDTH vernier to present a sweep width of approximately 10 MHz by observing the displayed markers.

(8) Adjust the CENTER FREQUENCY dial over the HIGH BAND.

(9) Center each 50 MHz marker, and observe the 50-MHz dial graduations. Each 50-MHz marker when centered in the display shall be aligned within ±1 division (±10 MHz) of each dial graduation of 50 MHz.

NOTE

As frequency is decreased, the sweep width decreases, and the displayed marker amplitudes increase. Adjust the SWEEP WIDTH vernier and the FIXED MARKER SIZE controls to obtain the required display.

c. Test the unit in the cw mode. Proceed as follows.

(1) Set the SWEEP WIDTH switch to CW.

(2) Set all MARKERS to OFF.

(3) Set other controls as in paragraph 7-10.

(4) Observe the oscilloscope display.

(5) A horizontal line approximately 0.6 volt below the top horizontal graticule line shall be displayed.

(6) Set the 50 MHz MARKER to ON.

(7) An expanded marker will be displayed along the horizontal display at each 50-MHz interval.

(8) A notch or zero-beat will be observed when the CENTER FREQUENCY DIAL is rotated slowly.

(9) Observe the notches in the display and the 50-MHz dial graduations. The notches, when centered in the display, shall be aligned within ±1 division (±10 MHz) of each 50-MHZ dial graduation.

d. Check the rf output for 0.5-volt rms minimum output at the fully clockwise position of the RF VERNIER. Observe the RF OUTPUT meter and the display amplitude. The amplitude shall be 0.53 volt minimum.

e. Test the SWEEP WIDTH for maximum and minimum sweep widths using the three internal markers.

f. Test the unit in the LOW BAND position and at maximum SWEEP width. The scope display shall be typically as shown in figure 7-14.

g. Make tests in *a* through *f* above for LOW BAND performance. Units meeting all requirements in paragraphs 7-10 and 7-11 are ready for use.

Section V. ALIGNMENT AND ADJUSTMENT PROCEDURES

The following procedures should be undertaken only if required to improve unit performance specified in section IV.

NOTE

In some cases, the adjustment and alignment procedures may require a compromise between two or more characteristics. When the procedures in section V are completed, perform the test procedures in section IV.

7-12. Power Supply Adjustment

CAUTION

Adjustment of power supply voltages may cause major misalignment. Do not adjust voltage before checking both LOW and HIGH BAND CENTER FREQUENCY dial calibration.

a. Use the test setup in paragraph 7-4. Monitor the voltages as in table 7-1. Do not make adjustments if voltages are within tolerances.

b. If required, adjust R7 to obtain a voltage reading of +30 volts dc ±1. The peak-to-peak ripple as measured with an at-coupled oscilloscope is 6 mV (typical).

c. If required, adjust R14 to obtain a voltage reading of -30 volts dc ±1. The peak-to-peak ripple as measured with an at-coupled oscilloscope is 4 mV (typical).

d. If required, adjust R21 to obtain a voltage reading of +200 volts dc ±5. The peak-to-peak ripple as measured with an at-coupled oscilloscope is 15 mV (typical).

7-13. Rate Generator Alignment

To align the rate generator, perform the procedures in a through o below.

a. Use the test setup in paragraph 7-10 and figure 7-12 with all MARKERS at OFF.

b. Set the SWEEP RATE switch to MANUAL.

c. Adjust the SWEEP RATE vernier control from one extreme to the other.

d. Adjust the horizontal gain and horizontal position controls of the oscilloscope so the dot on the CRT display is visually aligned with the extreme left-hand vertical graticule line when the SWEEP RATE vernier control is fully counterclockwise.

e. In combination with d above, adjust the oscilloscope controls so the dot on the CRT display is visually aligned with the extreme right-hand vertical graticule line when the SWEEP RATE vernier control is fully clockwise.

f. The SCOPE HORIZ voltage should be 1.0 volt ±0.5 in d above and 18 volts ±2 in above.

g. Return the CRT display to the horizontal positions obtained in *d* and *e* above.

h. Set the SWEEP RATE switch to the .05 to 5 Hz position. Do not change oscilloscope controls.

i. The oscilloscope display shall be viewed as tracing a rectangular pattern counterclockwise.

j. Adjust the lower trigger point control (R108) so the upper left-hand corner of the rectangle is visually aligned at the upper left-hand corner of the graticule.

k. Adjust the upper trigger point control (R101) so the upper right-hand corner of the rectangle is visually aligned at the upper right-hand corner of the graticule.

l. Repeat *j* and *k* above as required until both conditions of alignment occur simultaneously. Do not change the oscilloscope controls.

m. Set the SWEEP RATE switch to LINE.

n. Adjust the line trigger amplitude control (R119) and the line DC level control (R106) until a rectangular pattern of the same size as that obtained in *j* through *e* above is displayed.

o. Repeat the alternate adjustments of R119 and R106 until the rectangular pattern is aligned with the respective graticule corners.

7-14. Frequency Dial Alignment

Use the test procedures in paragraphs 7-11b and c. Misalignment may be caused by dial slippage, by aging of components, or by incorrect settings of the regulated power sources.

a. Dial Slippage.

(1) Check the HIGH BAND.

(2) If the dial error is greater than one division at 1200 MHz and is either constant or erratic cover the HIGH BAND, slippage may have occurred.

(3) Adjust the two #6 setscrews that secure the dial-venier collar to the oscillator shaft. Use a 1/16-inch hex key. The collar is located between the vernier and the variable oscillator (fig. 7-1) .

(4) Position the shaft as required to release and then properly reposition the dial for frequency alignment.

(5) Tighten both setscrews.

b. High Band Alignment. Adjust R161 (fig. 7-9) for dial misalignment of approximately 10 MHz. Check the entire range for proper alignment of 50-MHz markers within ±1 dial division (±10 MHz).

c. Low Band Alignment.

(1) Align the HIGH BAND in *b* above.

(2) Set the CENTER FREQUENCY dial to 700 MHz.

(3) Adjust the SWEEP WIDTH vernier to approximately 20 MHz.

(4) Fine-tune the dial until the 700-MHz marker is centered in the display.

(5) Set the BAND switch to LOW.

(6) Adjust C553 (fig. 7-1) as required to center the zero beat.

(7) Check the LOW BAND at 50-MHz intervals, and adjust C553 if required for alignment within ±1 dial division (±10 MHz).

7-15. Sweep Width Alignment

To align the sweep width circuit, proceed as follows:

a. Use the test setup in figure 7-12.

b. Set the AN/USM-203A controls as follows:

(1) BAND SWITCH to HIGH.

(2) CENTER FREQUENCY dial to 300 MHz.

(3) SWEEP WIDTH switch to WIDE.

(4) SWEEP WIDTH vernier fully clockwise.

(5) ALC switch to INT.

(6) RF VERNIER to 0.5-volt rms output.

(7) 1.0 MHz MARKER switch only to ON.

(8) FIXED MARKER SIZE to midrange.

c. Set the AN/USM-273 oscilloscope as follows:

(1) Vertical input de-coupled.

(2) Vertical gain to 0.1 volt/cm.

(3) Horizontal input to external.

(4) Horizontal controls to produce a centered 10-cm display.

d. Adjust R161 (fig. 7-9) to produce nearly equal spacings between the 1.0-MHZ markers across the 10-cm horizontal display.

NOTE

The marker spacings at the right-hand end of the display will increase sharply as R161 is adjusted. Readjust R161 slightly so that the marker spacings are more equally spaced.

e. Set blanking switch S102 (fig. 7-9) to RF.

f. Set 1.0 MHz MARKER switch to OFF.

g. Set 50.0 MHz MARKER switch to ON.

h. Adjust the CENTER FREQUENCY dial to 1000 MHz. Observe the 50.0-MHZ displayed markers, so that the 1000-MHZ marker is identified in the display. As sweep width increases, more markers are displayed.

i. Adjust R159 (fig. 7-9) for 400-MHz sweep width. The 1000-MHz marker will shift to the right in the display. This shift is normal.

j. Set S102 (fig. 7-9) for VIDEO blanking, the normal setting.

k. Set SWEEP WIDTH switch to NARROW.

l. Adjust SWEEP WIDTH vernier fully clockwise.

m. Set the CENTER FREQUENCY dial to 1200 MHz.

n. Adjust R131 (fig. 7-9) as required to center the 1200-MHz marker in the display.

o. Adjust SWEEP WIDTH vernier fully counterclockwise.

p. Adjust R167 (fig. 7-9) to display the 1200-MHz marker in the center of the display at NARROW sweep width.

q. Set the BAND switch to LOW, and carefully adjust the center frequency dial about the 300-MHz graduation (red scale) to place the 300-MHz marker in the center of the oscilloscope trace. Note any deviation from the 300-MHz graduation when the marker is in the center of the trace. If this deviation exceeds the equivalent of 5 MHz, an adjustment of the fixed-frequency oscillator is indicated. If this adjustment is required, go to *r* below. If this adjustment is not required, go to s below.

r. Adjust the fixed-frequency oscillator, as described in paragraph 7-14b to place the 300-MHz marker in the center of the oscilloscope trace.

s. Set the unit under test controls as follows:

(1) BAND SWITCH to LOW.

(2) SWEEP WIDTH switch to WIDE.

(3) SWEEP WIDTH vernier fully clockwise.

t. Adjust the CENTER FREQUENCY dial to approximately 150 MHz (red scale), and place the zero-beat notch at the extreme left of the oscilloscope trace.

u. Alternate] y adjust low band sweep width potentiometer (LB SW) R163 (fig. 7-9) and the CENTER FREQUENCY dial. Place the zero-beat notch and the 300-MHz marker at the extremes of the oscilloscope trace.

7-16. Rf Output Voltage Adjustment

Use the following procedures to adjust the rf output voltage, and the RF OUTPUT meter.

a. Set the AN/USM-203A front panel controls and S102 as follows:

(1) BAND ---------- HIGH.
(2) ATTENUATOR ---------- 0dB.
(3) SWEEP WIDTH ---- CW.
(4) BLANKING ---------- S102 to VIDEO.
(5) CENTER FREQUENCY 1200 MHz.
(6) SWEEP RATE --------------- LINE.
(7) RF VERNIER -------- Fully clockwise.
(8) ALC ---------------------------- INT.
(9) MARKERS----------- A11 OFF.

b. Couple the AN/USM-203A RF OUT connector to the AN/USM-260) power meter, using the associated thermistor mount (477B) and the 200-ohm negative coefficient thermistor.

NOTE

The thermistor mount uses a type-N male connector for the rf input. No adapter is required to insert this connector into the BNC female connector of the AN/USM-203A.

c. The RF OUTPUT meter should indicate O. Adjust the meter to zero, using the screw adjustment if required.

d. Adjust the power meter for measurements in the 0- to 10-mW range.

e. Connect the power plugs of both the AN/USM-203A and the AN/USM-260 to a 115-volt, 50/60-Hz, single-phase power source.

f. Set both power switches to ON, and allow a 20-minute warmup period.

g. Monitor the rf output, and adjust R210, the MAX RF LEVEL SET potentiometer, a slotted front-panel control, for an indication of 5 mW on the power meter; 5 mW into a 50-ohm load is 0.5 volt rms.

h. Adjust R612, the slotted control located on the main chassis behind the variable oscillator (fig. 7-1) for a reading of 0.5 volt rms on the RF OUTPUT meter.

i. Adjust the RF VERNIER control fully counterclockwise.

j. Monitor the rf output, and adjust potentiometer R209, MIN RF LEVEL SET, a slotted, front-panel control, for an indication of 10 dB down from the maximum set in *h* above. The indicated rf output shall be 0.5 mW.

k. Repeat g above with the RF VERNIER fully clockwise.

l. Adjust the CENTER FREQUENCY dial from 1200 to 300 MHz in the HIGH BAND. The power output shall be 5 mW minimum and 6.3 mW maximum in the HIGH BAND.

m. Set the BAND switch to LOW.

n. Adjust the CENTER FREQUENCY dial from 500 kHz to 300 MHz (red) in the LOW BAND. The power output shall be 5 mW minimum and 5.6 mW maximum.

o. Repeat g through *k* above for an output of 5 mW minimum and 5.6 mW maximum from 500 kHz to 300 MHz.

p. Repeat checks on both HIGH and LOW BAND so that *l* and *o* above are within required limits.

7-17. Marker Amplitude Adjustment

Refer to figure 7-10 for the location of marker amplitude controls. Use the test setup in figure 7-12.

a. Eight individual marker sizes are provided. Refer to figure 7-15 for connection of plug-in markers.

b. Resistor R305 adjusts the displayed amplitude of the 1.0-MHZ harmonic marker, R311 for the 10.0-MHZ harmonic marker, and R317 for the 50. 0-MHZ harmonic marker.

c. With the FIXED MARKER SIZE control set at midrange, adjust R317 for 0.2-volt amplitude of the 50. 0-MHZ marker. Adjust R311 for 0.1-volt amplitude for the 10.0-MHZ marker, and R305 for 0.05-volt amplitude. All amplitudes are peak-to-peak values.

d. When using the external marker, set the FIXED MARKER SIZE fully clockwise.

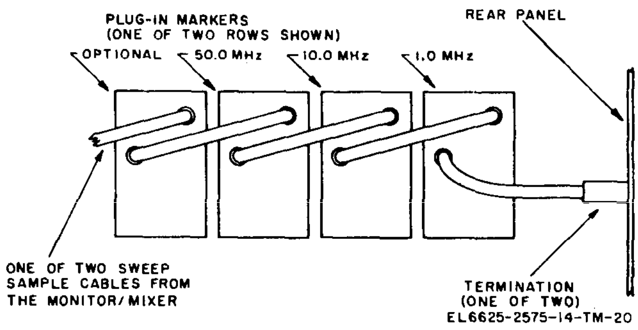


Figure 7-15. Connection of plug-in markers.

7-18. Blanking Mode Test

Blanking switch S102 (fig. 7-9) located on the main printed circuit board assembly is used to select VIDEO or RF blanking.

a. Follow the test procedure in paragraph 7-10.

b. Observe the typical test display in figure 7-13.

c. Set switch S102 first to VIDEO and then to rf blanking.

d. Little difference shall be noticed in the test display between VIDEO or rf blanking.

e. Set S102 to the VIDEO blanking (normal) position.

7-19. Input Power Option

The unit under test may be wired for 115-volt ac, 60-Hz, single-phase or 230-volt- ac, 60-Hz, single-phase operation. See figure 7-16 for the connection diagram on the main printed circuit board.

CAUTION

Use a 1.0-ampere slo-blo fuse for 115-volt operation, and a 1/2-ampere slo-blo fuse for 230-volt operation. (See rear panel fuseholder F1 in figure 3-2.)

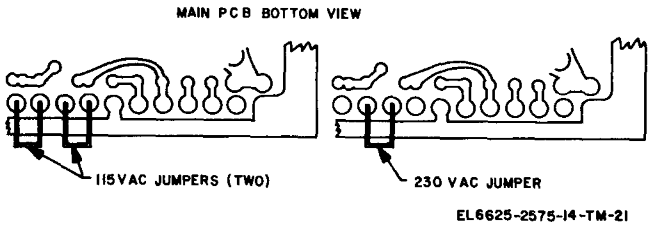


Figure 7-16. 115 volt/230 volt input power option.

CHAPTER 8

GENERAL SUPPORT MAINTENANCE

Section I. GENERAL

8-1. Scope of GS Maintenance

AN/USM-203A sweep signal generators which require maintenance at general support can be grouped as follows:

a. Units which require repair of rf assemblies.

b. Units which require replacement of rf assemblies.

c. Units which cannot be repaired at lower maintenance categories.

d. Units which are a combination of the preceding groups.

NOTE

Defective rf assemblies (fig. 7-1) which may be replaced, but shall be repaired only at depot level, are as follows:

(1) Bandswitch (S601).

(2) Attenuator (Z603).

(3) Plug-in harmonic markers (1.0, 10.0, and 50.0 MHz).

(4) Video amplifier.

(5) Variable oscillator.

8-2. Test Equipment Required

a. The following test equipment or equal is required:

(1) Multimeter TS-352B/U, FSN: 6625-242-5032.

(2) Oscilloscope AN/USM-281, FSN: 6625-228–2201.

(3) Voltmeter, Electronic AN/USM-98B, FSN: 6625-753-2115.

(4) Wattmeter AN/URM-120, FSN: 6625-813-8430.

(5) Signal Generator AN/USM-44, FSN: 6625-669-4031.

(6) Frequency Counter, AN/USM-207A, FSN: 6625-911-6368.

(7) Spectrum Analyzer AN/UPM-84, FSN: 6625-557-8262.

b. Adapter UG-274A/U, tee, FSN: 5935-201-2411 or equal is required.

Section II. TROUBLESHOOTING AND REPAIR

8-3. Approach

Follow the procedures in chapter 7, section II, but in addition concentrate on the rf circuits.

a. Monitor dc voltages at the input terminals of active rf assemblies.

b. Carefully test BNC connectors and coaxial cable assemblies for continuity and quality.

c. Use signal substitution techniques in isolating defective rf assemblies.

d. Refer to the troubleshooting guide in table 7-2.

e. Refer to the technical characteristics in paragraph 1-11.

f. Refer to the block diagram (fig. 8-4) and schematic diagram (fig. FO-3).

8-4. Procedures

a. Repair Standards. General support maintenance procedures, tests, and standards form a part of the repair of defective AN/USM-203A units.

b. Modifications Work Orders. Perform all modification work orders (MWO) applicable to the AN/USM-203A before making specified tests. See DA Pam 310-7 for applicable listings.

c. Special Procedures. Because of the high maximum frequency and broadband coverage of the AN/USM-203A, component lead lengths, position, and solder connections in rf circuits are critical. Before replacing a defective component, closely observe the physical layout of the associated components which must be repositioned or removed. The new component should closely conform to the layout of the replaced component. Failure to closely reconstruct the original layout may prevent normal operation of the AN/USM-203A. The calibration or alignment procedure will normally provide compensation for new components and for min or changes in circuit geometry.

8-5. Rf Detector Assembly Repair

NOTE

The diode only shall be replaced. If replacement of the diode does not correct the defect, a replacement detector assembly shall be installed.

a. Remove the bottom panel as in paragraph 7-2.

b. Remove the BNC connector from the detector output.

c. Remove the rf detector assembly from the front panel by removing the hex nut (RH thread).

d. Using finger pressure only, unscrew the two halves of the rf detector in a counterclockwise direction for approximately 2 turns (RH thread). Diode CR603 is clamped in the split bushing (fig. 8-1).

e. Using linger pressure only, slide the diode from the bushing.

f. Observe the diode polarity for the negative detector. The clamped end is the cathode which is color-coded green.

g. Insert the new diode with correct polarity.

h. Rejoin the two detector halves by tightening the mating threads in a clockwise direction with finger pressure only.

i. Install the rf detector assembly in the AN/USM-203A.

8-6. Monitor/Mixer Assembly

Five components in the monitor/mixer assembly require special instructions for removal or replacement. These components are CR601, R602, R603, and R605. Unless the complete assembly is replaced, removal of the front panel is unnecessary.

CAUTION

Components in the monitor block are part of the ALC system. When removing or replacing components, be careful to duplicate the original positions as closely as possible.

a. Removal of Diode CR601 (15). Refer to figure 8-2 and proceed as follows:

(1) Remove the top AN/USM-203A dust cover (para 7-2).

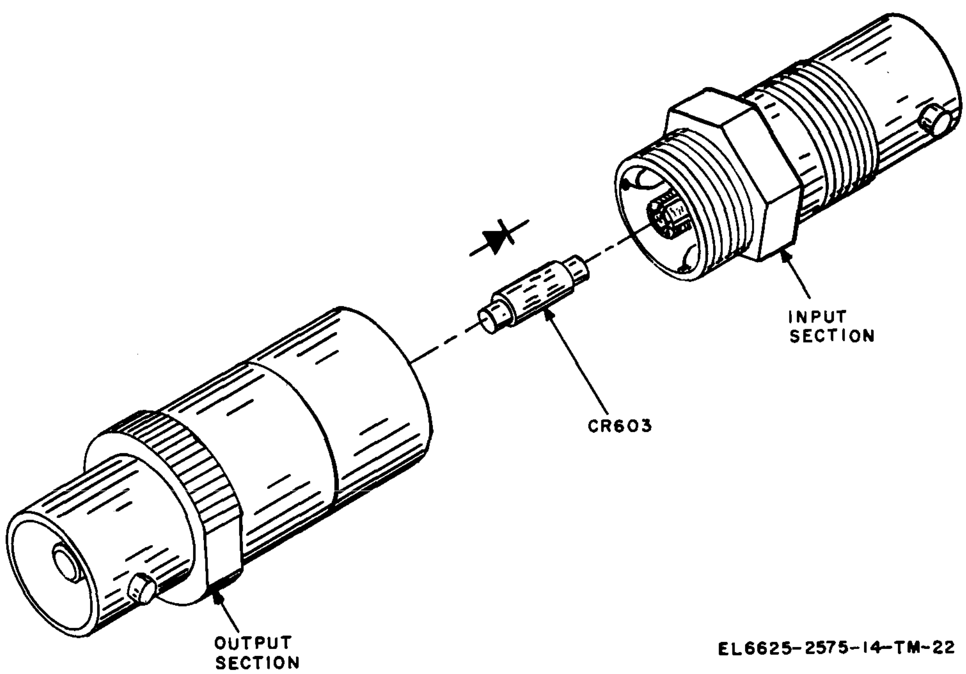


Figure 8-1. Rf detector assembly.

(2) Uncouple connectors R604 from J604 (11) and P607 from J607 (19).

(3) Uncouple P605 from 2601, the 50-ohm termination on the rear panel.

(4) Uncouple P609 from the 50-MHz plug-in marker.

(5) Unsolder the inner conductor of the miniature coax cable from feedthrough capacitor C604 (2).

(6) Unsolder the coax shield from the ground terminal (1).

(7) Remove the two panhead screws from the mixer cover.

(8) Remove the cover from the mixer box (25). The mixer components will be exposed as shown in figure 8-2.

(9) Remove the two screws which secure the mixer box (25) to the rear of attenuator Z603.

(10) Locate the monitor/mixer assembly in an accessible position for repair.

(11) Remove the two screws which secure the capacitor mounting plate (13) to the monitor block (12).

(12) Unsolder the anode lead of CR601 (15) from feedthrough capacitor C601 (14) and straighten the lead.

(13) With heat applied to the lead of diode CR601 (15), carefully lift the mounting plate (13) and feedthrough capacitor C601 (14) from the monitor block (12).

(14) The anode end of diode CR601 is exposed.

(15) Press CR601 (15) against the monitor block (12).

(16) Unsolder the cathode lead of CR601 (15) from the resistor contact (16).

(17) Remove CR601 (15) from the monitor/mixer assembly.

b. Removal of Diode CR604, and Resistors R603 and R605.

(1) Remove CR601 as in a above.

(2) Unsolder R603 (20) from the center conductor of J605.

(3) Unsolder R605 (10) from the center conductor of J604.

(4) Remove four screws from the monitor clock that secure it to the mixer box. Do not move the block or box.

(5) Unsolder the cathode lead of diode CR-604 (9) and, at the same time, separate the monitor block from the mixer box with a gentle pulling action on the mixer box.

(6) Gently pull the cathode lead of CR604 (9) through feedthrough capacitor C602 (8).

(7) Unsolder CR604 (9), R603 (20), and R605 (10) from the resistor contact (16). Avoid excessive heat and pulling force.

c. Removal of Load Resistor R602. Proceed as follows:

(1) Remove CR601 as in a above.

(2) Remove CR604, R603, and R605 as in *b* above.

(3) Apply heat to the resistor contact (16) until the solder is molten.

(4) At the same time, unscrew J604 (11) from the monitor block (12) while the solder is molten, and separate J604 from the resistor contact (16).

(5) Unscrew J607 (19) from the monitor block (12).

(6) Unsolder both resistor contacts (16) and (18) from the load resistor R602 (17).

CAUTION

When replacing R602, keep the axis of the resistor centered in the monitor block, but avoid stress on the resistor leads. Avoid stress on CR601 and CR-604. Observe the positions and lead.

d. Replace components in the monitor/mixer assembly as required.

e. Replace the monitor/mixer assembly in the AN/USM-203A.

8-7. Fixed Oscillator/Mixer Assembly

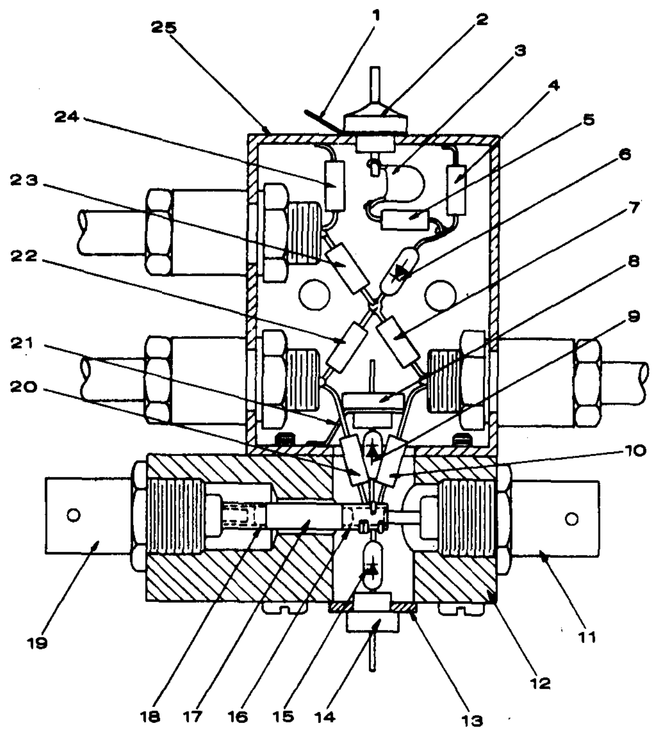
Refer to figures 7-1 and 8-3 and proceed as follows to repair the fixed oscillator/mixer.

a. To gain access to the fixed oscillator/mixer assembly, remove the enclosure panels (para 7-2).

b. Unsolder the B+ lead from C557 (13, fig. 8-3).

c. Disconnect P551 from J551 (23) connector.

d. Remove the two panhead screws which secure the fixed oscillator/mixer assembly to the chassis of the AN/USM-203A.



1	Ground terminal	14	Capacitor C601
2	Capacitor C604	15	Diode CR601
3	Capacitor C603	16	Resistor contact MP9
4	Resistor R608	17	Resistor R602
5	Resistor R609	18	Resistor contact MP9
6	Diode CR602	19	Connector J607
7	Resistor R604	20	Resistor R603
8	Capacitor C602	21	Ground terminal
9	Diode CR604	22	Resistor R606
10	Resistor R605	23	Resistor R607
11	Connector J604	24	Resistor R610
12	Monitor Block MP10	25	Mixer box (enclosure) A4A5MP7
13	Capacitor mounting plate		

Figure 8-2. Monitor/mixer assembly A4A5.

e. Disconnect J401 from filter FL551 (16) and carefully remove the fixed oscillator/mixer from the AN/USM-203A.

f. Remove the four cover screws.

g. Remove the cover, The fixed oscilltor components, including transistors Q551 (6) and Q552 (9) are accessible for replacement.

NOTE

Closely observe the position of components and their lead lengths. Replace components as closely as possible to their original position.

h. To gain access to mixer components, the printed circuit assembly must be removed from the enclosure.

i. Unsolder capacitor C555 (20) and resistor R558 (19) from filter FL551.

j. Unsolder capacitor C554 (28) from connector J551.

k. Remove the six panhead screws which secure the mounting bracket (3) to the enclosure.

l. Carefully withdraw the mounting bracket and mixer printed circuit board assembly from the enclosure.

m. The mixer components are accessible for removal and replacement.

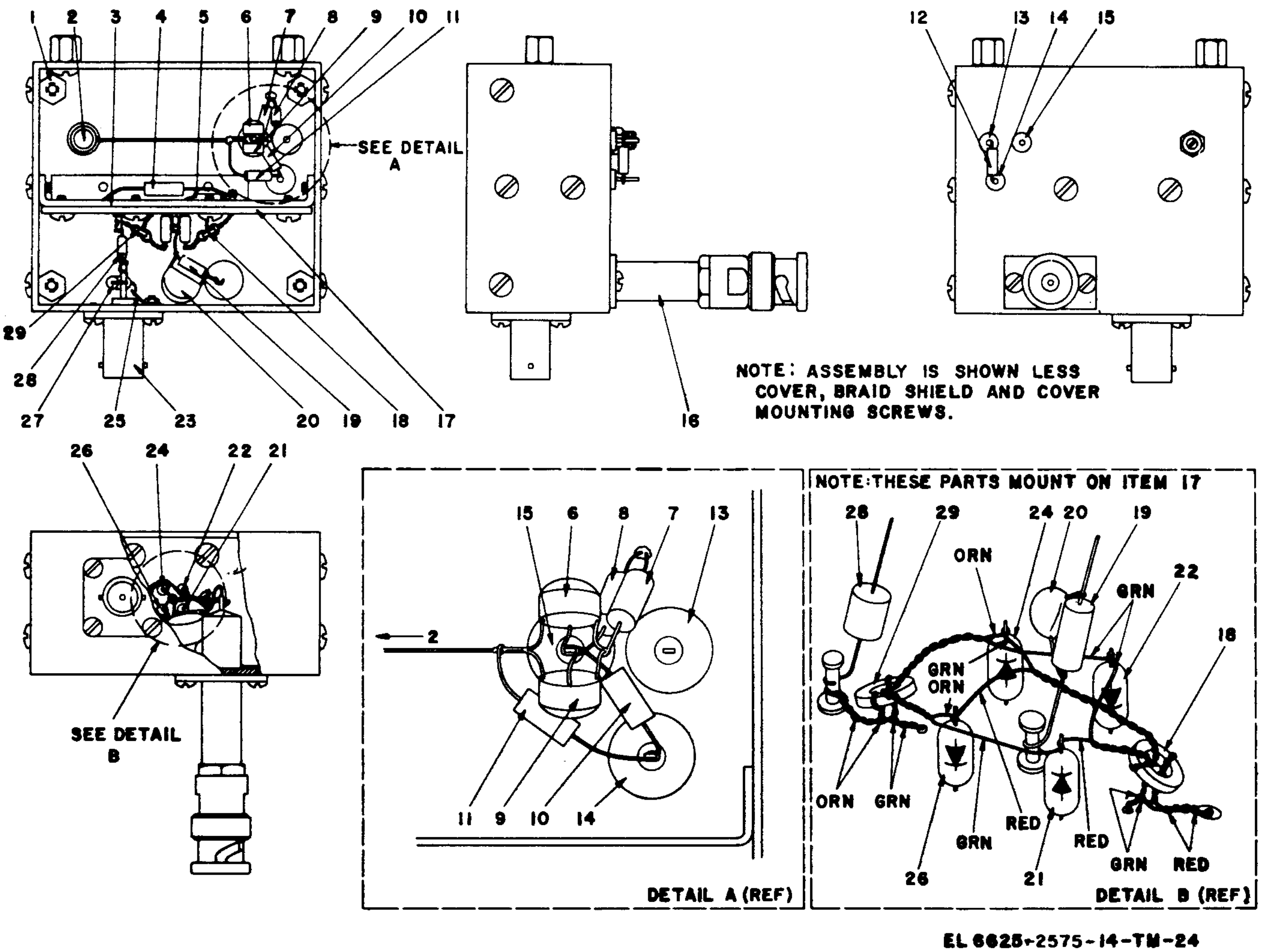
n. Remove and replace mixer diodes CR-551 (26), CR552 (24), CR553 (22), and CR554 (21) if required. Remove and replace other components if required.

NOTE

Observe the same precautions in restoring the original layout as in other rf assemblies. When diodes are replaced, use the correct polarities.

o. Assemble the fixed oscillator/mixer in the reverse order of disassembly and with the same care.

p. Replace the repaired fixed oscillator in the AN/USM-203A assembly.



1	Spacer, cover MP3	11	Inductor L551	21	Diode CR554
2	Capacitor C553	12	Resistor R557	22	Diode CR553
3	Mounting bracket	13	Capacitor C557	23	Connector J551
4	Resistor R554	14	Capacitor C552	24	Diode CR552
5	Resistor R556	15	Capacitor C551	25	Terminal ground
6	Transistor Q551	16	Filter FL551	26	Diode CR551
7	Resistor R551	17	Printed-circuit board A4A3A2	27	Resistor R555
8	Resistor R552	18	Transformer T551	28	Capacitor C554
9	Transistor Q552	19	Resistor R558	29	Transformer T552
10	Resistor R553	20	Capacitor C555		

Figure 8-3. Fixed oscillator/mixer/filter assembly A4A3.

Section III. REPLACEMENT OF RF ASSEMBLIES

8-8. Front Panel Removal

To replace the band switch, the rotary attenuator, and the variable oscillator, remove the front panel as follows:

a. Remove the slide panels (para 7-2).

b. Remove all control knobs.

c. Remove the three screws which fasten the CENTER FREQUENCY dial to the variable oscillator assembly.

NOTE

The dial and the variable oscillator are calibrated as an assembly and should be reassembled as a compatible pair.

d. Remove the retaining nuts on the power switch and the BNC connectors except the RF DETECTOR IN connector.

e. Unsolder the pilot light leads at the power switch and at the lead splice.

f. Remove the two leads from the rf output meter.

g. Remove the BNC connector and cable from the rear of the rf detector assembly.

h. Remove the two screws from each of the two side rails which secure the front panel to the AN/USM-203A.

i. Remove the front panel assembly including the rf detector and the rf output meter. The backing panel is now exposed for removal of rf assemblies and other components.

NOTE

Refer to figure 7-1 for the location of the rf assemblies.

8-9. Bandswitch S601

To replace S601, proceed as follows:

a. Remove the AN/USM-203A slide panels (para 7-2).

b. Remove the AN/USM-203A front panel (para 8-8).

c. Disconnect and identify the six BNC cable connectors.

d. Unsolder all leads from the two wafer sections of the switch.

NOTE

Check the lead and terminal locations so the leads may be soldered to the correct terminals on the replacement switch.

e. Remove the two 8-32 screws from the backing panel which locate the band switch.

f. Remove the band switch from the AN/USM-203A.

g. Replace the band switch with a new or serviceable unit.

h. Reassemble all hardware, leads, and cables as required.

8-10. Attenuator Z603

To replace Z603, proceed as follows:

a. Remove the AN/USM-203A enclosure panels (para 7-2).

b. Remove the AN/USM-203A front panel (para 8-8).

c. Remove the monitor/mixer assembly (para 8-3a).

d. Remove coaxial cable connectors P608 and P610 from the attenuator.

e. Remove the two 8-32 screws from the backing panel which locate the attenuator.

f. Remove the attenuator from the AN/USM-203A.

g. Replace defective attenuator Z603 with a new or serviceable unit.

h. Remount all hardware and cables in the AN/USM-203A as required.

8-11. Video Amplifier

To replace the video amplifier, proceed as follows:

a. Remove the AN/USM-203A enclosure panels (para 7-2).

CAUTION

Tag all leads and note the diode polarity as each lead is unsoldered.

b. Locate the four terminals on the back side of the video amplifier, and identify each lead for reassembly.

(1) Unsolder the lead from C433.

(2) Unscrew the lug which ties the shield of the coaxial cable to the case.

(3) Unsolder the center conductor of the coax lead and the cathode lead of VR401 from the standoff terminal.

(4) Unsolder the anode lead of VR401 from C429.

c. Disconnect the BNC connector at the amplifier output.

d. Remove the two screws which secure the video amplifier bracket to base of the instrument.

e. Disconnect the BNC connector from the rigid coaxial filter (FL551).

f. Remove the video amplifier assembly from the instrument.

g. Install an operating video amplifier in the instrument by reversing the disassembly procedure.

8-12. Variable Oscillator

To replace the variable oscillator, proceed as follows.

a. Remove the AN/USM-203A enclosure panels (para 7-2).

b. Remove the AN/USM-203A front panel (para 8-8).

c. Disconnect the BNC connector (P501) from filter FL501. The filter shall remain attached to the variable oscillator.

d. Remove two of the three 6-32 panhead screws that secure the variable oscillator assembly to the backing panel.

e. Hold the oscillator with one hand, and carefully remove the third screw. Except for two wires, the oscillator is detached.

f. Position the oscillator so that the two wires on the front panel may be unsoldered from feed-through terminals C502 and C503.

g. Remove the variable oscillator from the AN/USM-203A.

h. Using the three screws removed in *d* and *e* above, attach the CENTER FREQUENCY dial to the mating holes in the vernier drive.

i. Install an operating variable oscillator in the AN/USM-203A by reversing the disassembly procedure.

8-13. Harmonic Markers

To replace the 1.0-, 10.0-, or 50.0-MHZ. plug-in harmonic markers, proceed as follows:

a. Remove the AN/USM-203A enclosure panels (para 7-2).

b. Remove the BNC connector which connects to the adjacent plug-in marker, or, for the 1.0-MHz plug-in marker to Z602, the terminating impedance on the rear panel. (See figure 7-15).

c. Remove the screw which holds the marker bracket to the chassis.

d. Unplug the six-pin, plug-in marker from its socket in the marker printed circuit board assembly.

e. Replace the defective marker with an operative marker of the same type.

f. Reverse the disassembly procedure.

Section IV. TEST PROCEDURES

8-14. General

When an AN/USM-203A has been repaired, perform the test procedures in paragraphs 7-4, 7-10, 7-11, 8-15, and 8-16.

NOTE

Results of the test procedures may indicate that further troubleshooting, repair, and alignment must be performed. Section VI provides additional alignment and adjustment procedures that should enable the unit under test to meet the technical characteristics in paragraph 1-11.

If the unit cannot be made ready for use, it shall be sent to the depot for evaluation.

Calibration procedure can be used in place of the test and adjustment procedures in Chapters 7 and

8-15. Minimum Sweep Width

a. Connect the RF OUT connector of the unit under test to the input of Electronic Counter, Digital Readout AN/USM-207A. Use a 50-ohm BNC-to-BNC cable approximately 30 inches long.

b. Set the front panel controls of the unit under test as follows:

(1) BAND - - - - - - - - - - - - - - - - - - HIGH.

(2) ATTENUATOR - - - - -0dB.

(3) CENTER FREQUENCY. 1000 MHz.

(4) SWEEP RATE - - - -MANUAL.

(5) SWEEP WIDTH switch. NARROW.

(6) SWEEP WIDTH vernier. Fully counterclockwise.

(7) ALC - - - - - - - - - - - - - -INT.

(8) MARKERS - - - - - - - -All OFF.

c. Energize both the unit under test and the counter.

d. Set the SWEEP RATE vernier fully clockwise, and read the counter frequency.

e. Set the SWEEP RATE vernier fully counterclockwise, and read the counter frequency.

f. Subtract the frequency obtained in *e* above from the frequency obtained in *d* above.

g. The frequency difference shall be 10 kHz maximum.

h. Set the unit under test controls as in *b* above, but set the SWEEP WIDTH switch to WIDE.

i. Set the SWEEP RATE vernier fully clockwise, and read the counter frequency.

j. Set the SWEEP RATE vernier fully counterclockwise, and read the counter frequency.

k. Subtract the frequency obtained in *j* above from the frequency obtained in *i* above.

l. The frequency difference shall be 500 kHz maximum.

8-15. Spurious and Harmonic Distortion

a. Connect the RF OUT connector of the unit under test to the input of the spectrum analyzer.

b. Set the front panel controls of the unit under test as follows:

(1) SWEEP WIDTH switch - - - - - - - CW.
(2) MARKERS - - - - - - - - - - - - - - - - All OFF.
(3) RF VERNIER - - - - - - - - - - - - - - - - - 0.5 volt rms.
(4) BAND switch - - - - - - - - - - - - - - - - - LOW.
(5) ALC - INT.
(6) ATTENUATOR - - - - - - - - - - - - - - 0dB.

c. Adjust the CENTER FREQUENCY from 20 to 300 MHz.

d. Follow the instructions in the spectrum analyzer operator's manual, and proceed as follows:

(1) Display the rf amplitude in the frequency domain.

(2) Calibrate the display amplitude in dB.

(3) Obtain a display of the fundamental frequency of the unit under test.

e. While gradually adjusting the CENTER FREQUENCY of the unit under test, tune the main dial of the spectrum analyzer, and observe spurious and harmonic responses of the unit under test. Any spurious signal or harmonic component shall be at least 25 dB below the fundamental frequency (CENTER FREQUENCY) of the unit under test.

f. Repeat *e* above with the BAND switch set to HIGH and at the same time, adjust the CENTER FREQUENCY of the unit under test from 300 to 1200 MHz.

Section V. ALIGNMENT AND ADJUSTMENT PROCEDURES

8-17. General Alignment and Adjustment Information

a. When a repaired AN/USM-203A has been tested as required in Section V, alignment and adjustment procedures may be required. The purpose of Section VI is to enable a repaired unit to meet the technical characteristics in paragraph 1-11 by resetting internal controls.

b. Be careful when making adjustments to correct a given out-of-tolerance condition. An adjustment which corrects one condition may degrade another. When an adjustment affects more than one operating characteristic, another adjustment must be used to bring the system into balance. A series of alternate adjustments may be required to achieve the desired results.

c. Because some of the AN/USM-203A adjustments do interact, repeat the test procedures in Section V in sequence after final adjustments are made.

8-18. Power Supply Adjustment

Follow the procedures in paragraph 7-12.

NOTE

Adjustment of the power supply voltages may cause major misalignment of both the HIGH and LOW BAND CENTER FREQUENCY dial calibration.

8-19. Rate Generator, Frequency Dial, and Sweep Width Alignment

To align the rate generator, frequency dial, and sweep width, follow the procedures in paragraphs 7-13 through 7-15, respectively.

8-20. Rf Output Voltage Adjustment

Adjust the rf output voltage by performing the procedures in paragraph 7-16.

8-21. Marker Amplitude Adjustment

Adjust the marker amplitude by performing the procedures in paragraph 7-17.

NOTE

Marker frequency accuracy may be checked by zero-beating an external signal generator which is monitored by a frequency counter with displayed 1.0-, 10.0-, and 50.0-MHZ internal markers in the AN/USM-203A.

8-22. Blanking Mode Selection

Follow the procedures in paragraph 7-18.

NOTE

BLANKING switch S102 must be set to VIDEO (normal position) when setting the RF OUTPUT. In the RF position the rf signal is blanked, and an average voltage output is indicated on the RF OUTPUT meter.

8-23. Input Power Option

See paragraph 7-19 for selection of 115-volt or 230-volt input line power.

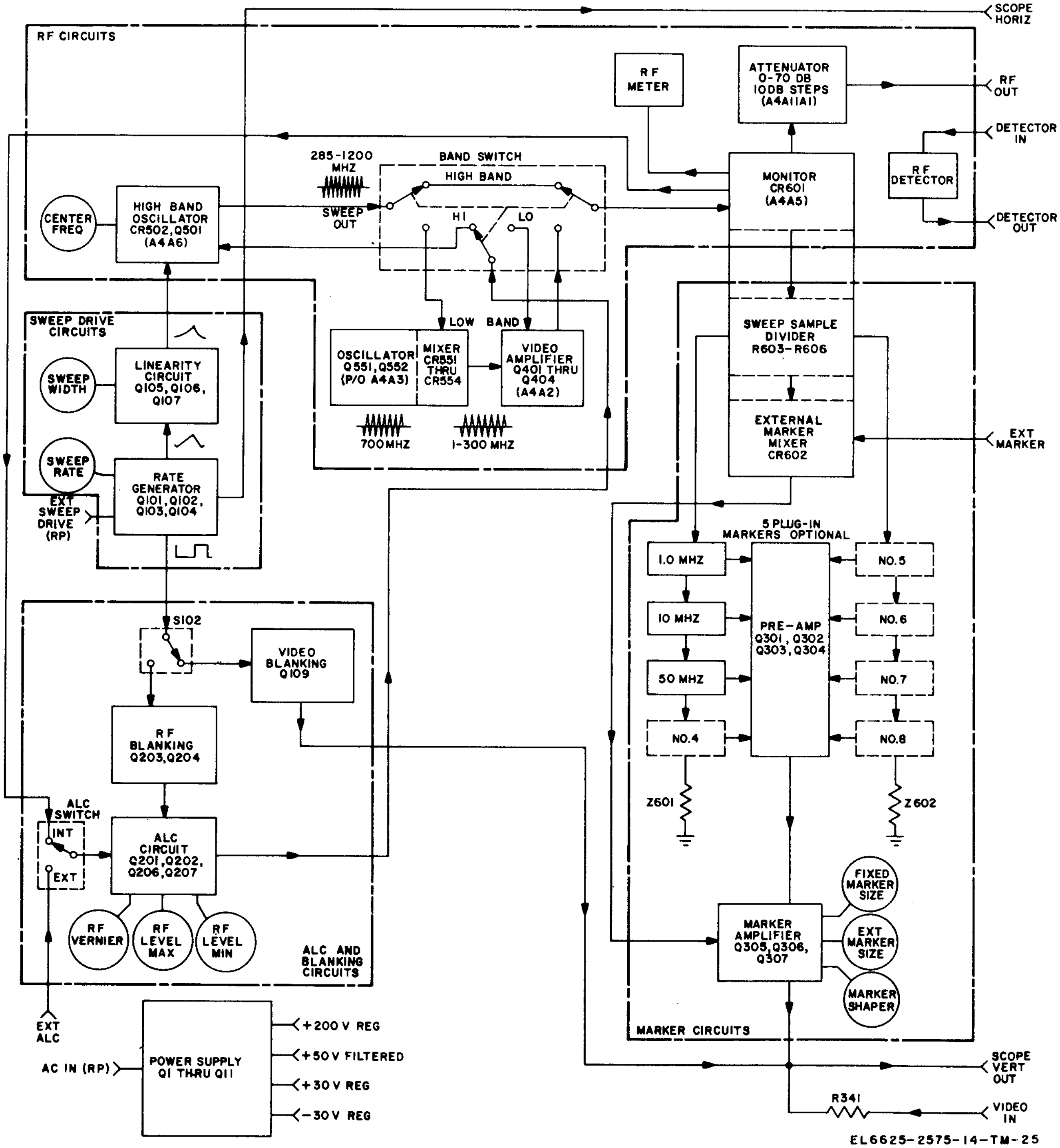


Figure 8-4. AN/USM-203A, block diagram.

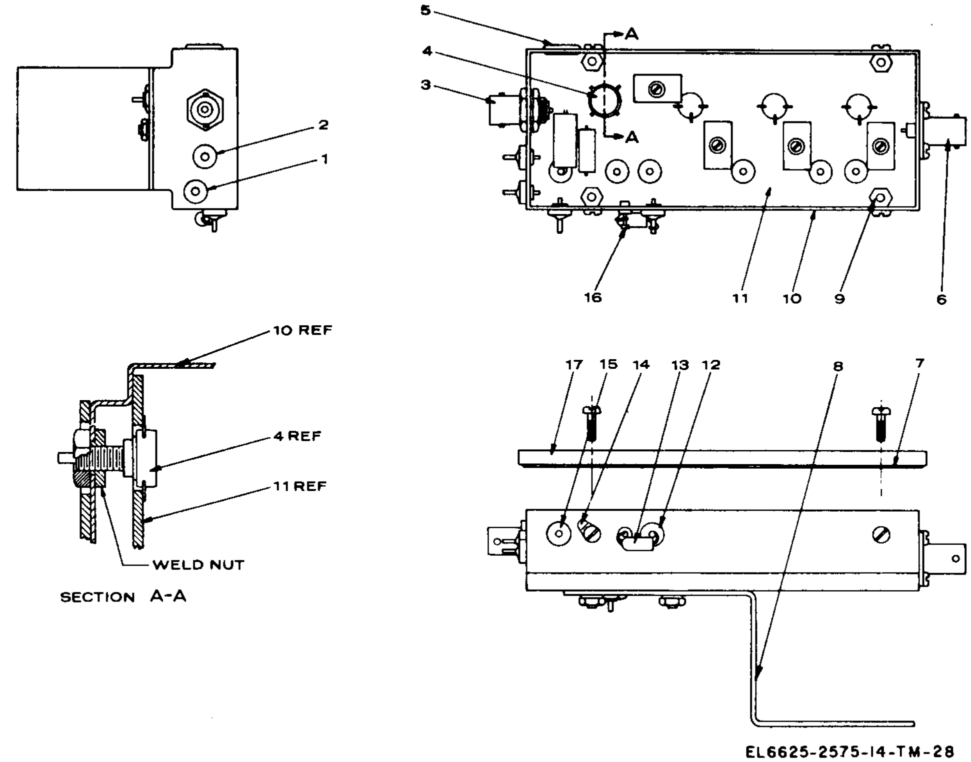


Figure 8-5. Video amplifier assembly.

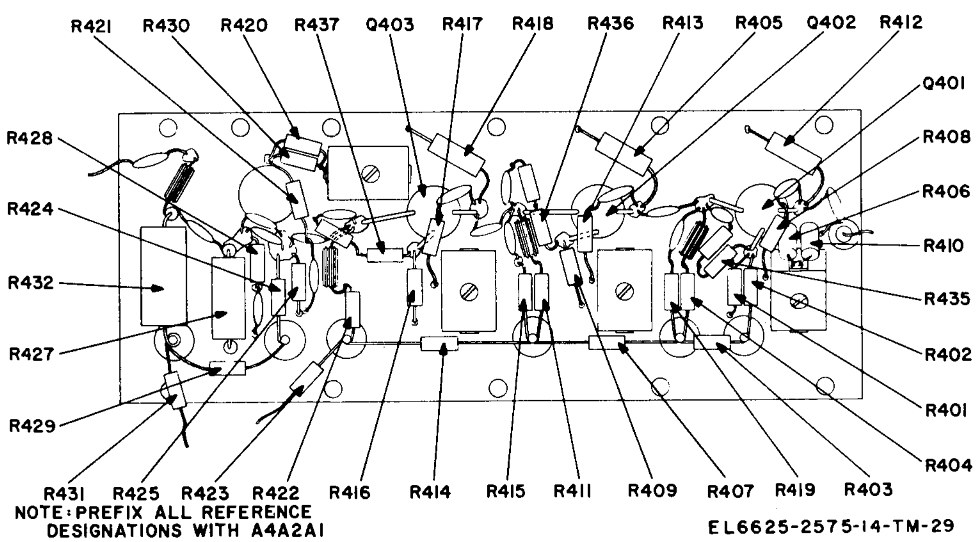


Figure 8-6. Video amplifier circuit board A4A2, resistor location.

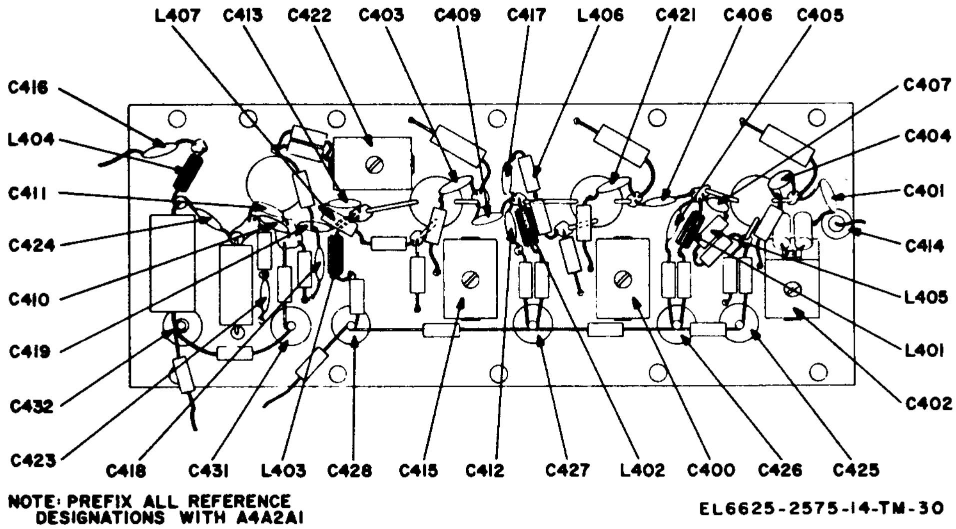


Figure 8-7. Video amplifier circuit board A4A2, capacitor location.

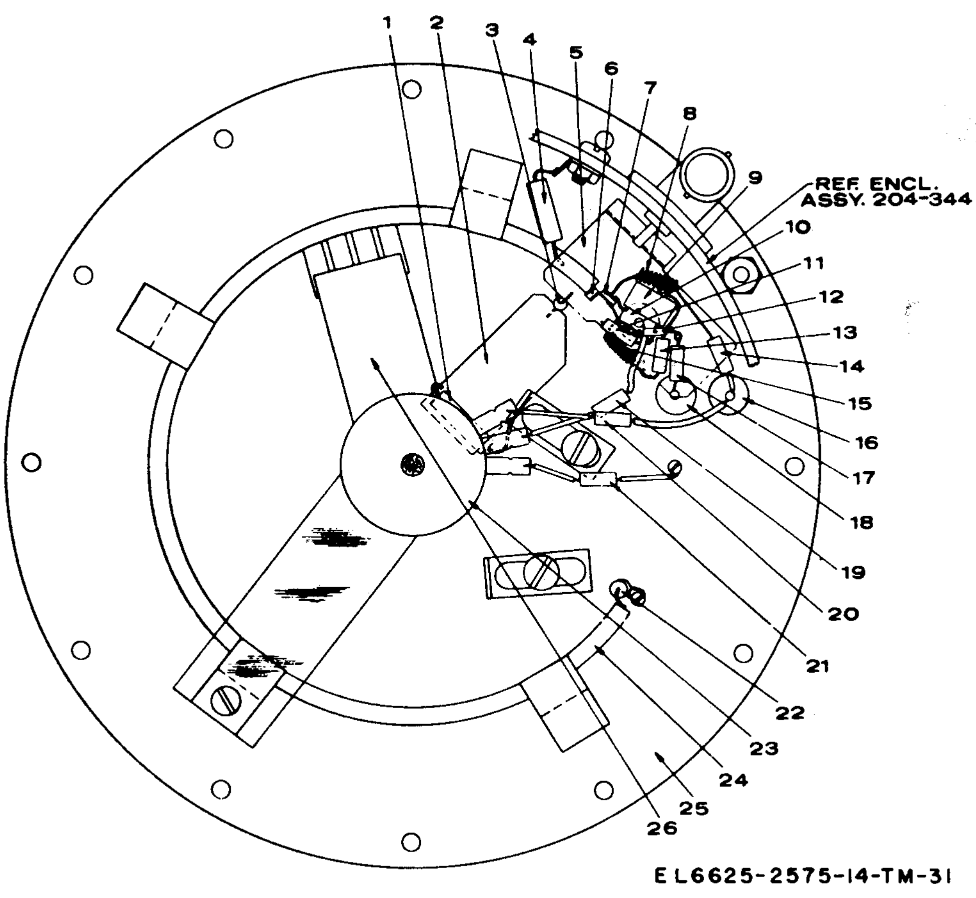


Figure 8-8. Variable oscillator baseplate component layout.

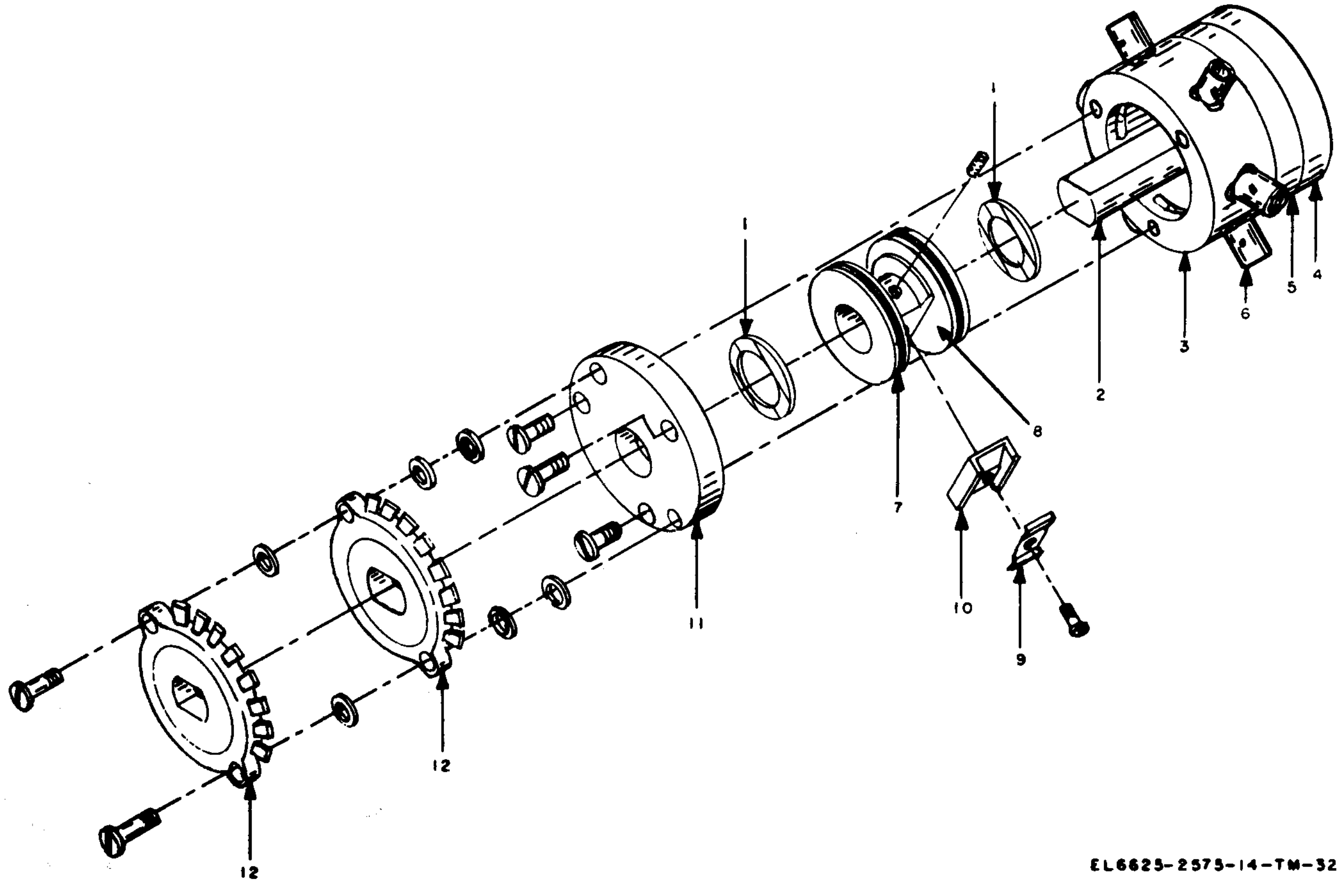


Figure 8-9. Rf bandswitch assembly.

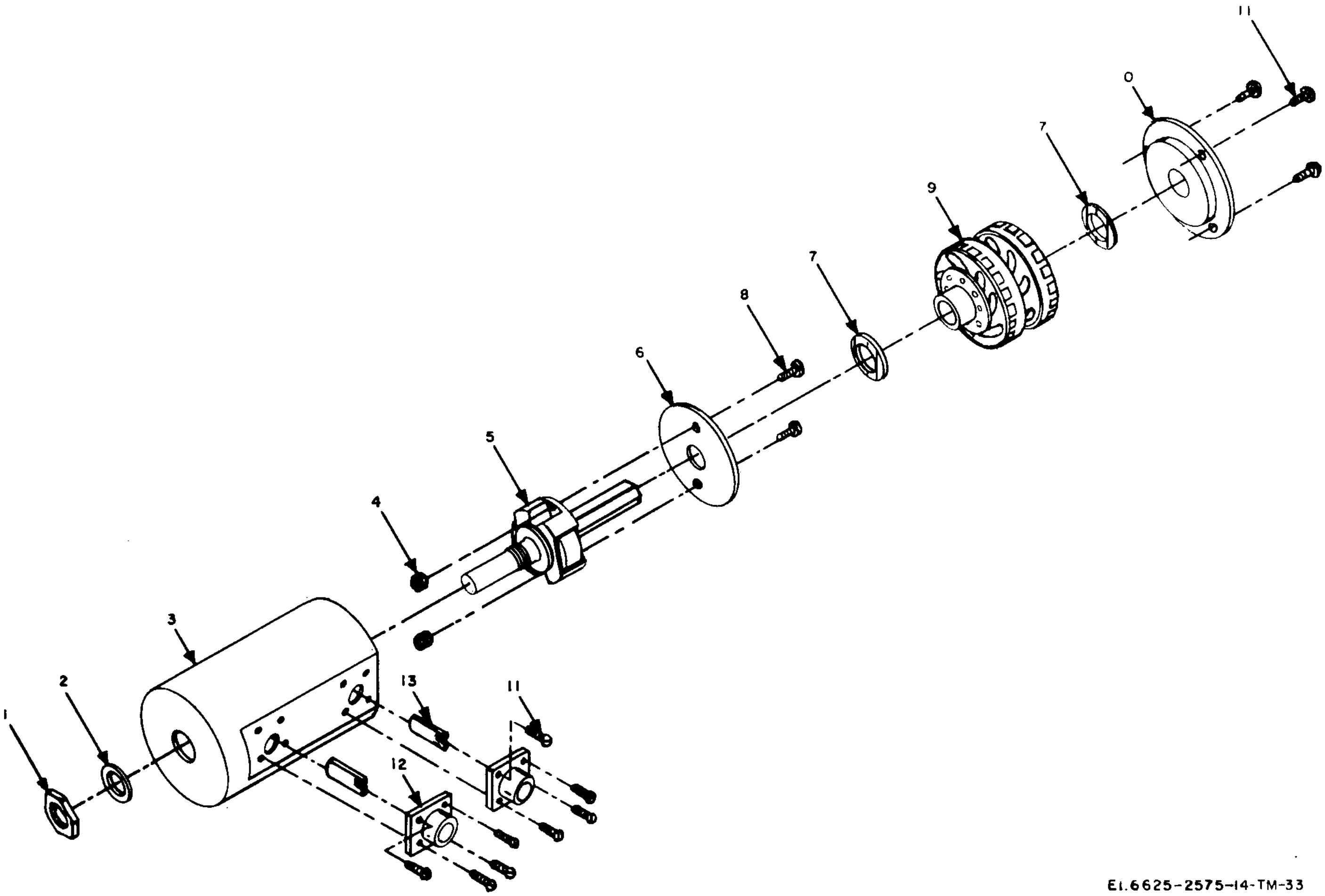


Figure 8-10. Rotary attenuator assembly.

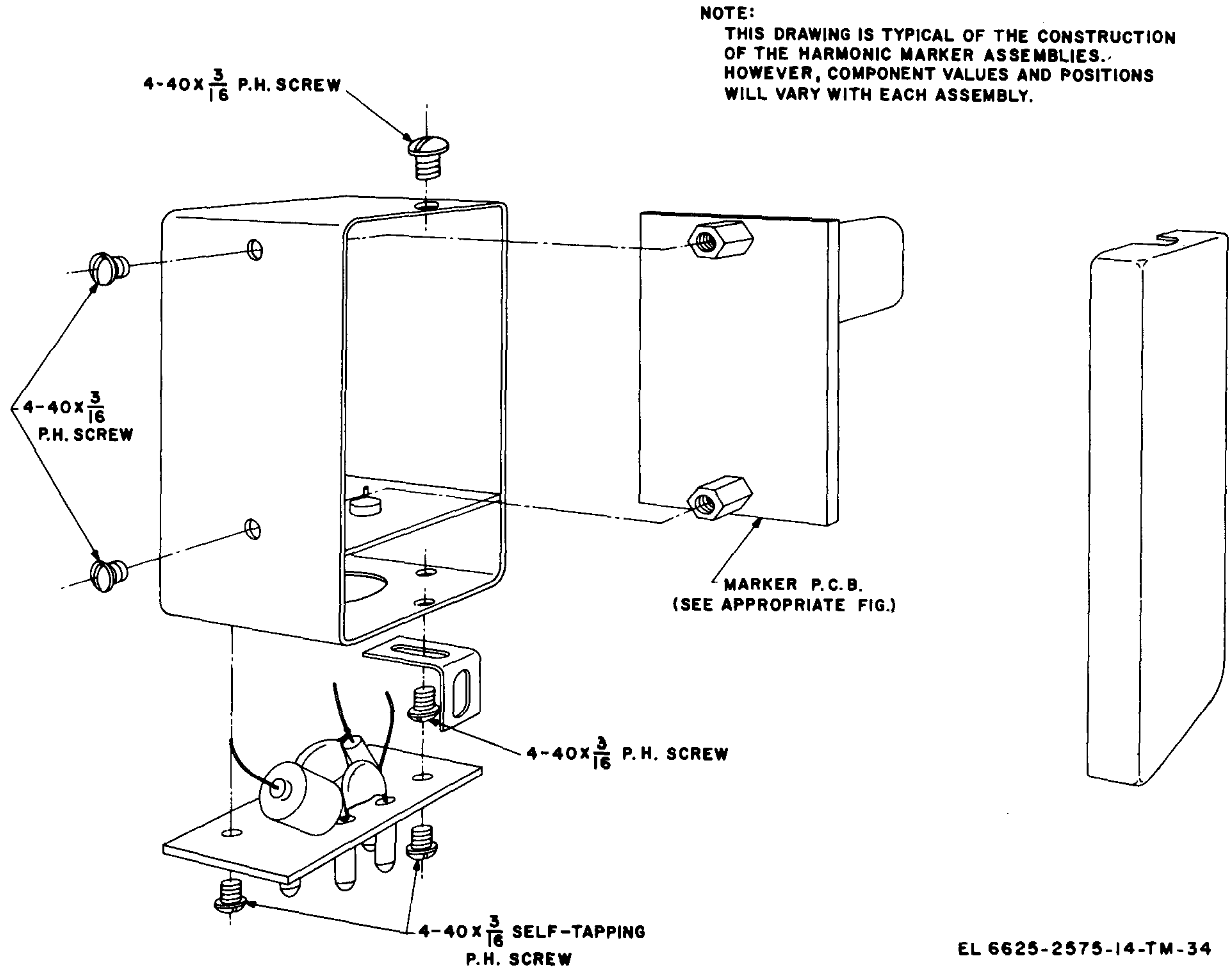


Figure 8-11. Harmonic marker assembly.

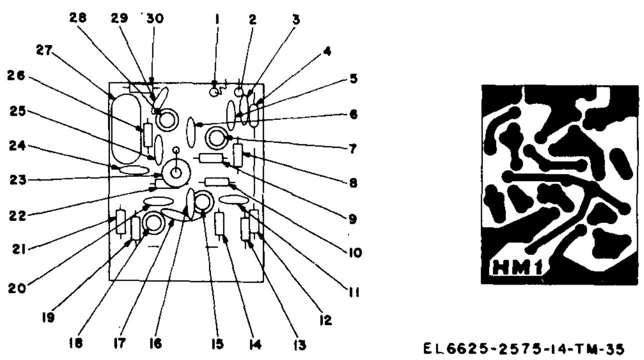


Figure 8-12. 1.0-MHz harmonic marker printed circuit assembly.

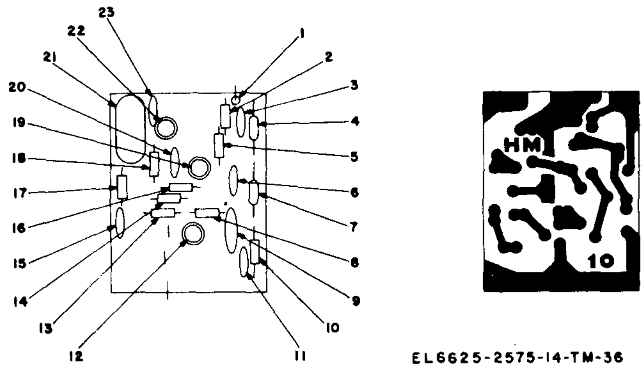


Figure 8-13. 10.0-MHz harmonic marker printed circuit assembly.

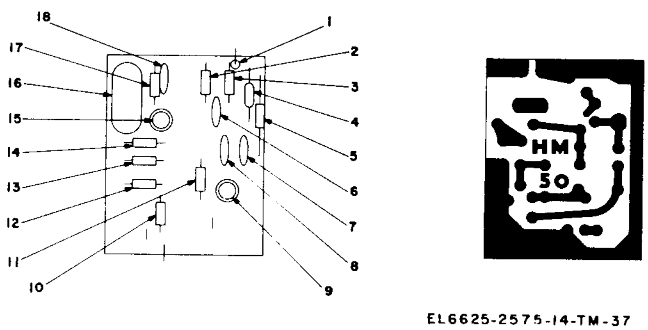


Figure 8-14. 50-MHz harmonic marker printed circuit assembly.

APPENDIX A

REFERENCES

DA Pam 310-4	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.
TB 746-10	Field Instructions for Painting and Preserving Electronics Command Equipment.
TB 750-236	Calibration Requirements for the Maintenance of Army Materiel.
TM 11-6625-366-15	Operator's, Organizational, DS, GS, and Depot Maintenance Manual: Multimeter TS-352B/U.
TM 11-6625-700-10	Operator's Manual: Digital Readout, Electronic Counter AN/USM-207.
TM 11-6625-1703-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual Including Repair Parts and Special Tool Lists: Oscilloscope AN/USM-281A.
TM 38-750	The Army Maintenance Management Systems (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 C
MAINTENANCE ALLOCATION

Section I. INTRODUCTION

C-1. General

This appendix provides a summary of the maintenance operations for AN/USM-203A. It authorizes categories of maintenance for specific maintenance functions on repairable 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 (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To 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 bring 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 equipments used in precision measurement. Consists of comparisons 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 or system.

h. Replace. The act of substituting a serviceable like type part, subassembly, or module (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 or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., 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 materiel 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 equipments/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 task-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 areas follows:

C - Operator/Crew
O - 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.

f. Column 6, Remarks. Column 6 contains, an alphabetic code which leads to the remark in section IV, Remarks, which is pertinent to the item opposite the particular code.

C-4. Tool and Test Equipment Requirements (See III).

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.

C-5. Remarks (See IV)

a. Reference Code. This code refers to the appropriate item in section II, column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing in section II.

SECTION II MAINTENANCE ALLOCATION CHART
FOR

Sweep Signal Generator, AN/USM-203A

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQPT.	(6) REMARKS
00	Generator, Sweep Signal AN/USM-203A	Inspect		0.2					
		Test				0.7		1 Thru 8	
		Service		0.4				9	
		Repair		0.2				9	
		Repair				0.5		8	
		Overhaul					2.0	1 Thru 8	
01	Chassis Assembly, A4	Inspect		0.2					
		Test				0.5		1 Thru 7	
		Repair				0.5		1 Thru 8	
02	Main Circuit Board Assembly, A4A8	Test		0.2				4	
		Repair				1.0		4.8	
03	Amplifier Marker Assembly, A4A7	Test		0.2				4	
		Repair				0.8		4.8	
0301	1 MHz Marker Assembly, A1	Inspect		0.1					
		Test				0.2			
		Replace				0.1			
		Repair					1.0	1 Thru 8	
030101	Circuit Board Assemlby, A1A1	Test				0.1		4	
		Repair				0.2		4.8	
0302	10 MHz Marker Assembly, A2	Inspect		0.1					
		Test				0.2			
		Replace				0.1			
		Repair					1.0	1 Thru 8	
030201	Circuit Board Assembly, A2A1	Test				0.1			
		Repair				0.2			
0303	50 MHz Marker Assembly, A3	Inspect		0.1					
		Test				0.2			
		Replace				0.1			
		Repair					1.0	1 Thru 8	
030301	Circuit Board Assembly, A3A1	Test				0.1			
		Repair				0.2			
04	Video Amplifier, A4A2	Inspect		0.1					
		Test				0.2			
		Replace				0.1			
		Repair					1.0	1 Thru 8	
0401	Circuit Board Assembly, A4A2A1	Test				0.1			
		Repair				0.2			
05	Fixed Oscillator, A4A3	Inspect		0.1					
		Test				0.2			
		Repair				0.4		1 Thru 8	
06	Monitor Mixer, A4A5	Inspect		0.1					
		Test				0.2			
		Repair				0.4		1 Thru 8	
07	Variable Oscillator, A4A5	Inspect		0.1					
		Test				0.2			
		Replace				0.1			
		Repair					1.0	1 Thru 8	
08	Backing Panel Assembly, A4A11 (Rear Panel)	Inspect		0.1					
		Test				0.2			
		Repair				0.5		1 Thru 8	
0801	Attenuator, A4A11A1	Inspect		0.1					
		Test				0.2			
		Replace				0.1			
		Repair					1.0	1 Thru 8	
0802	Bandswitch Assembly, A4A11A2	Inspect		0.1					
		Test				0.2			
		Replace				0.1			
		Repair					1.0	1 Thru 8	

SECTION II **MAINTENANCE ALLOCATION CHART**
FOR

Sweep Signal Generator, AN/USM-203A

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQPT.	(6) REMARKS
0803		Test			0.1				
		Replace				0.1			
		Repair				0.1		8	

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
		AN/USM-203A (continued)		
1	H,D	Attenuator CN-764/U	5985-00-020-2290	
2	H,D	Comparator, Frequency, Electronic CM-77/USM	6625-00-080-7204	
3	H,D	Counter, Electronic, Digital Readout AN/USM-207A	6625-00-044-3228	
4	H,D	Multimeter ME-26D/U	6625-00-913-9781	
5	H,D	Oscilloscope AN/USM-281A	6625-00-228-2201	
6	H,D	Test, Set, Oscillator AN/PRM-10	6625-00-339-2046	
7	H,D	Wattmeter AN/URM-98	6625-00-566-4990	
8	H,D	Tool Kit TK-100/G	5180-00-605 0079	
9	O	Tools and Test Equipment available to the Organizational Repairman because of his assigned mission		

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By Order of the Secretary of the Army:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

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Major General, United States Army
The Adjutant General

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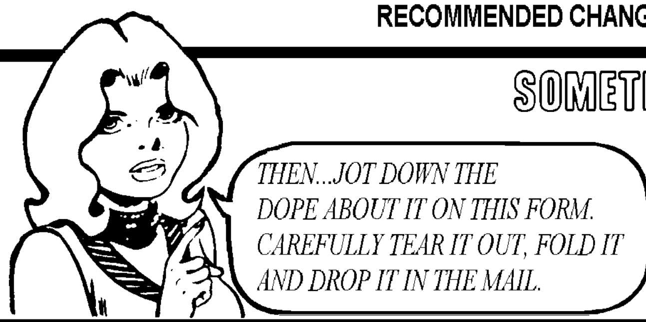

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THE METRIC SYSTEM AND EQUIVALENTS

'NEAR MEASURE

. Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

'EIGHTS

Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

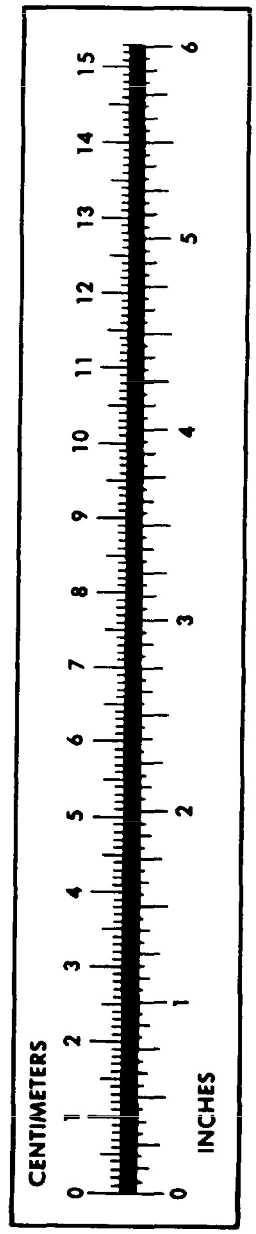
TEMPERATURE

5/9(°F - 32) = °C
212° Fahrenheit is evuivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5C° + 32 =°F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
ıts	Liters	0.473
arts	Liters	0.946
allons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
'ers	Gallons	0.264
.ms	Ounces	0.035
.ograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pounds-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
'lometers per Liter	Miles per Gallon	2.354
›meters per Hour	Miles per Hour	0.621



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