TECHNICAL MANUAL

FM-2.5K

FM TRANSMITTER

994 8047 001

HARRIS CORPORATION

Broadcast Products Division

T.M. NO. 888 1759 001

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MANUAL REVISION HISTORY

MCN OR REV. NO	MCN OR REV. DATE	ECN NO.	DESCRIPTION OF CHANGE
1	12/04/81	26655	On page 6-5, table 6-3 for 994 6871 002, change Z4,Z4 384 0362 000, Rectifier, HV (4500V dc) to Z4,Z5,Z6,Z7, Rectifier, Silicon, EFT-15H20. Figure 7-6, schematic 852 6671 002, Overall Schematic, FM-2.5K. Change to Revision C by changing Z4 and Z5 to Z4,Z5,Z6, and Z7 per attached sketch.
2	01/27/82	26812	Change Figure 7-5. PA Efficiency Curve, drawing number 815 3518 001 from Rev. B to Rev. C. Revision A: March 1982
A-1	07/19/82	MCR 784-81-055	Make the following changes to text: Page 2-5, paragraph 2-44, change TB6 to TB2 Page 2-5, paragraph 2-44.d., delete "A remote input of 6 Vdc from the remote control location to terminals 8 (+) and 9 (-) energizes relay K8 to activate this feature." On page 2-6, paragraph 2-44.3, change R51 to R9. On page 2-6, paragraph 2-44.f. change R11 to R12.
		ENG REQ	On page 4-3, in paragraph 4-17, item K6. Change information in parenthesis from (900 mA at 2.5 kW output) to (1000 mA at 2.5 kW output).

WARNING

THE CURRENTS AND VOLTAGES IN THIS EQUIPMENT ARE DANGEROUS. PERSONNEL MUST AT ALL TIMES OBSERVE SAFETY REGULATIONS.

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical/electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care. HARRIS CORPORATION shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed. The following National Fire Protection Association (NFPA) standards are recommended as references:

- Automatic Fire Detectors, No. 72E
- Installation, Maintenance, and Use of Portable Fire Extinguishers, No. 10
- Halogenated Fire Extinguishing Agent Systems, No. 12A

WARNING

ALWAYS DISCONNECT POWER BEFORE OPENING COVERS, DOORS, ENCLOSURES, GATES, PANELS OR SHIELDS. ALWAYS USE GROUNDING STICKS AND SHORT OUT HIGH VOLTAGE POINTS BEFORE SERVICING. NEVER MAKE INTERNAL ADJUSTMENTS, PERFORM MAINTENANCE OR SERVICE WHEN ALONE OR WHEN FATIGUED.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits, know your equipment and don't take chances.

WARNING

IN CASE OF EMERGENCY ENSURE THAT POWER HAS BEEN DISCONNECTED.

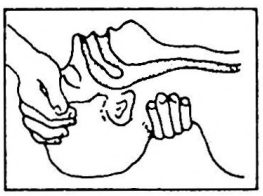
Treatment of Electrical Shock

1. If victim is not responsive follow the A-B-Cs of basic life support.

PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

(A) AIRWAY

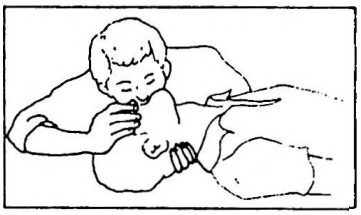
IF UNCONSCIOUS,
OPEN AIRWAY



LIFT UP NECK
PUSH FOREHEAD BACK
CLEAR OUT MOUTH IF NECESSARY
OBSERVE FOR BREATHING

(B) BREATHING

IF NOT BREATHING,
BEGIN ARTIFICIAL
BREATHING

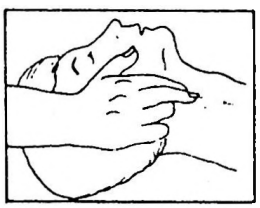


TILT HEAD
PINCH NOSTRILS
MAKE AIRTIGHT SEAL

4 QUICK FULL BREATHS

REMEMBER MOUTH TO MOUTH RESUSCITATION
MUST BE COMMENCED AS SOON AS POSSIBLE

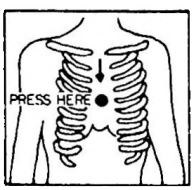
CHECK CAROTID PULSE



IF PULSE ABSENT,
BEGIN ARTIFICIAL
CIRCULATION

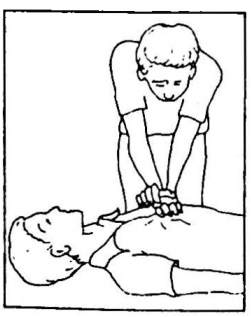
(C) CIRCULATION

DEPRESS STERNUM 1 1/2" TO 2"



APPROX. 80 SEC. { ONE RESCUER
15 COMPRESSIONS
2 QUICK BREATHS

APPROX. 60 SEC. { TWO RESCUERS
5 COMPRESSIONS
1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS
WHEN SECOND PERSON IS GIVING BREATH

Call for medical assistance as soon as possible.

2. If victim is responsive.

   a. keep them warm
   b. keep them as quiet as possible
   c. loosen their clothing
      (a reclining position is recommended)

FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be complete first-aid procedures, it is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

Treatment of Electrical Burns

1. Extensive burned and broken skin

   a. Cover area with clean sheet or cloth. (Cleanest available cloth article.)
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
   c. Treat victim for shock as required.
   d. Arrange transportation to a hospital as quickly as possible.
   e. If arms or legs are affected keep them elevated.

NOTE

If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold). Allow victim to sip slowly about 4 ounces (a half of glass) over a period of 15 minutes. Discontinue fluid if vomiting occurs. (Do not give alcohol.)

2. Less severe burns - (1st & 2nd degree)

   a. Apply cool (not ice cold) compresses using the cleanest available cloth article.
   b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
   c. Apply clean dry dressing if necessary.
   d. Treat victim for shock as required.
   e. Arrange transportation to a hospital as quickly as possible.
   f. If arms or legs are affected keep them elevated.

REFERENCE: ILLINOIS HEART ASSOCIATION

AMERICAN RED CROSS STANDARD FIRST AID AND PERSONAL SAFETY MANUAL (SECOND EDITION)

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WARNING: Disconnect primary power prior to servicing.

SECTION I

GENERAL DESCRIPTION

1-1. INTRODUCTION.

1-2. This technical manual contains information necessary to install, operate, maintain, and service the FM-2.5K FM Broadcast Transmitter.

1-3. EQUIPMENT PURPOSE.

1-4. The Harris FM-2.5K is a 2500 watt FM Transmitter designed for continuous broadcast operation. The transmitter uses the Harris MS-15 FM exciter and a two tube amplifier to provide reliable and efficient operation in the 87.8 to 108 MHz commercial FM broadcast band. Exciter plug-in modules provide monaural or stereophonic operation with up to two SCA channels. Plug-in module provisions for operation of a future quadraphonic transmission system are also provided by the exciter.

1-5. PHYSICAL DESCRIPTION.

1-6. The entire unit, including the exciter, IPA, PA, associated power supplies, metering, low-pass filter, and control circuits are contained in one cabinet. All required metering is provided by four meters located on a panel along the top edge of the transmitter cabinet and a filament voltage meter located behind the front door. The front door opens to expose the exciter and all required operating controls necessary for normal operation in full view of all front panel indicators. Both the front and rear doors may be removed for better access if desired. The PA and IPA area is accessed through an interlocked rear cover and the control and power supply area is accessed through the rear door.

1-7. The following controls are located on the front panels.

(a) Filament ON

(b) Filament OFF

(c) Plate ON

(d) Plate OFF

(e) Power/VSWR Selector

(f) Power Calibrate

(g) VSWR Calibrate

(h) Multimeter Selector

(i) Power Raise/Lower

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(j) PA Bias Adjust

(k) PA Plate Tuning

(l) PA Output Loading

(m) PA Grid Tuning

(n) PA/IPA Filament Voltage

(o) PA Filament Voltage

(p) IPA Filament Voltage

(q) IPA Plate Tuning

(r) IPA Output Loading

(s) Remote/Local

(t) Potentiometers (4) for adjustment of PA Plate Current Remote Reading, Recycle, PA Overload, and PA Plate Voltage Remote Reading

1-8. FUNCTIONAL DESCRIPTION.

1-9. POWER SUPPLIES.

1-10. Three power supplies are used for the following functions:

1. PA Bias Voltage

2. (a) IPA Plate and Screen Grid Voltage
   (b) PA Screen Grid Voltage

3. PA Plate Voltage

1-11. FM EXCITER.

1-12. The FM exciter produces a frequency modulated output continuously variable from three to 15 watts into a 50 ohm load for any channel assignment within the 87.5 to 108 MHz commercial FM broadcast band. Servicing is simplified as the exciter is modular in concept and discrete functions are complete within individual plug-in modules. The metering panel contains a true peak reading audio meter and a multimeter which monitors important RF, audio, and control voltages. Light emitting diode status indicators monitor critical functions on each plug-in module. Operational modes include up to two SCA channels, monophonic, stereophonic, and provisions for future quadraphonic transmission.

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1-13. RF CIRCUITS.

1-14. Two tubes comprise the transmitter RF chain. A 4X150A tetrode IPA amplifies the exciter output as required to drive the single-ended, class C operated, 5CX1500A PA stage to output 2500 watts of RF power. Fixed bias ensures dependable PA stage operation. Grid leak bias protected by the control circuitry and neutralization ensures stable IPA stage operation. Forced air cooling and an air switch arrangement ensures cool operation and long tube life.

1-15. RF output power is inductively coupled from the plate lines and the amplifier loading is changed by a variable output loading control. The RF output to the antenna is fed through a second harmonic stub filter, directional coupler, and a low-pass filter arrangement.

1-16. METERING.

1-17. Two meters and an arrangement of light emitting diodes provides status indications of exciter operation and five meters monitor transmitter parameters relative to the IPA and PA stages.

1-18. CONTROL CIRCUITS.

1-19. The FM-2.5K control circuits contains an automatic recycle feature which turns off high voltage momentarily if a fault occurs and then automatically restores the transmitter to operation. If the fault is still present or another overload occurs, another interruption cycle is accomplished. Up to three or four recycles within a preset time interval may be attempted before the transmitter shuts down and must be manually reset.

1-20. SAFETY. If the cabinet back door is opened during operation, the high voltage and PA screen power supplies are discharged and the ac primary voltage to both power supplies is opened. The power supplies must be manually reenergized after this sequence occurs. Use of the safety stick to discharge all supplies is recommended before servicing.

1-21. EQUIPMENT CHARACTERISTICS.

1-22. ELECTRICAL CHARACTERISTICS.

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1-23. Table 1-1 lists electrical operating characteristics and parameters of the FM-2.5K FM broadcast transmitter.

1-24. MECHANICAL/ENVIROMENTAL CHARACTERISTICS.

1-25. Table 1-2 lists physical and enviromental characteristics of the FM-2.5K FM broadcast transmitter.

Table 1-1. Electrical Characteristics

FUNCTION	CHARACTERISTIC
PRIMARY POWER REQUIREMENTS Transmitter Exciter	 197/250V, 60 or 50 Hz, single-phase 115 Vac, 60 or 50 Hz, single-phase
POWER CONSUMPTION (Typical for 2.5 kW RF Output)	4800 watts (approximate) transmitter 150 watts for exciter
POWER FACTOR	90%
POWER LINE VARIATION (Slow)	±5%
RF POWER OUTPUT	800 W to 2.5 kW (FCC Type Accepted)
RF OUTPUT IMPEDANCE	50 ohms
RF FREQUENCY RANGE	87.5 to 108 MHz
MAXIMUM VSWR	1.7 to 1
RF OUTPUT TERMINATION	1-5/8 inch (4.13 cm) EIA flange
RF HARMONIC SUPPRESSION	Meets all FCC requirements.
TUBES USED	1-4X150A (IPA) 1-5CX1500A (PA)
AM Noise	55 dB
FM Noise	65 dB
Refer to exciter specifications for additional characteristics.	

ELECTRICAL CHARACTERISTICS SUBJECT TO CHANGE WITHOUT NOTICE

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Table 1-2. Mechanical/Enviromental Characteristics

FUNCTION	CHARACTERISTIC
Weight (Unpacked)	Domestic 730 pounds (331.13 kg) Export 740 pounds (335.66 kg)
(Packed)	Domestic 1051 pounds (476.73 kg) in 5 pieces Export 1165 pounds (476.73 kg) in 4 pieces
Cubage (Packed)	Domestic 94.6 ft^3 (2.68 m^3) Export 103.5 ft^3 (2.93 m^3)
Size	Width, 29 inches (73.7 cm) Depth, 33 inches (84 cm) Height, 78 inches (198 cm)
Front Door Swing	29 inches (73.7 cm)
Operating Temperature Range	0^o C to 50^o C. Usable to -20^o C with slight reduction in operating parameters.
Maximum Altitude	7500 feet (2250 meters) above sea level
Maximum Humidity	95% non-condensing
COOLING AIR REQUIREMENTS	140 CFM (3.96 M^3/Min) nominal 1.8 inches (4.57 cm) water gauge
AIR INLET SIZES Lower Front Panel:	20.875 in. x 7 in. x 1 in. (53.02 cm x 17.78 cm x 2.54 cm)
Lower Back Door:	24 in. x 24 in. x 1 in. (60.96 cm x 60.96 cm x 2.54 cm)
Blower:	8.5 in. 8.5 in. x 1 in: (21.59 cm x 21.59 cm x 2.54 cm)
AIR OUTLET SIZE	18 in (45.72 cm) x 14 in (35.56 cm)
Refer to exciter spedifications for additional characteristics.	

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2-22. Carefully lower the 5CX1500A in its socket until it rests on the socket base. Check to see if the tube contacts line up with the socket fingers and rotate the tube until it hits a stop.

2-23. Install the anode and blocking capacitor assembly over the 5CX1500A anode. Align the four captive screws with the press-in nuts on the plate lines and tighten securely.

2-24. Position the B+ feed connector on the 5CX1500A anode cap and tighten the holding screw. Dress the B+ wire to the right in a smooth radius to the tubing.

2-25. Inspect the IPA circuitry. Make certain the 4X150A is properly seated and the anode clamp holds the chimney against the tube socket. Install the cover on the IPA enclosure. Push the air tube from the PA enclosure down to the stenciling (Air Tube) through the grommeted hole in the IPA cover.

2-26. Install the covers on the PA enclosure.

2-27. Connect the transmission line to transmitter RF output at the directional coupler, DC1.

2-28. Install the FM Exciter modules that were removed for shipping.

2-29. Read Paragraph 5-15c.

2-30. WIRING CONNECTIONS

WARNING

Ensure primary power is off before proceeding.

2-31. After the transmitter is physically in place and the components removed for shipment have been re-installed, the audio and ac power should be brought to the transmitter.

2-32. The audio input line enters the base of the transmitter near the wire channel and connects directly to terminal board, the FM Exciter.

2-33. The ac input for the transmitter should come from low reactance, 50/60 Hz, single phase supply with approximately a 5500 VA capacity. A terminal board is installed on the rear left side of the base for ac connections.

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2-34. The ac input cabling should be in agreement with local electrical codes and capable of supplying the transmitter power requirements. An ac primary power disconnect or a means to completely deenergize the transmitter primary circuit for servicing is strongly recommended. If the program leads must be routed in close proximity to the ac power input wiring, the program leads should be separately shielded.

2-35. Connect 115 VAC to terminals 1 and 2 of TB5. This terminal board is located in front of the blower mounting.

2-36. A good ground at FM frequencies is mandatory to keep stray RF currents to a minimum. RF interference usually shows up in one of two ways feedback or high noise, and in some cases, both. It should be pointed out that even a small amount of unshielded wire makes a very efficient antenna for FM frequencies. If RF from the cabinet field is transferred to the audio equipment, it can be rectified and may show up as noise or feedback. A single common ground point from the transmitter base to a good grounding system, such as a water pipe or actual earthing ground is recommended. A grounding stud is located adjacent to the AC input terminal board.

2-37. INITIAL CHECKOUT.

WARNING

Ensure primary power is off before proceeding. Discharge components in each area before checking wiring.

2-38. Each transmitter is thoroughly checked out during factory final test but adjustment is normally required during installation due to shipping, variations in primary power, antenna systems, or transmission line differences. A 20k ohms/volt multimeter (Simpson 260 or equivalent) is required to assist the checkout.

2-39. Before proceeding with initial FM-2.5K testing, ensure the exciter is completely installed, all parts are back in position and correctly wired, tubes are in their sockets, the transmitter is connected to a suitable RF load, and all signal monitors are connected.

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2-40. The complete transmitter should be inspected at this time. Check the following:

a. Ensure primary power is connected.

b. Ensure primary power is connected to the exciter.

c. Ensure audio inputs are connected to the exciter.

d. Ensure all connections at terminal boards and components are tight.

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information for installing the FM-2.5K transmitter and performing pre-operational checks. Many components are removed from the transmitter after final test for transport. These components will be identified with appropriate instructions for reinstallation and wiring.

2-3. UNPACKING.

2-4. Carefully unpack the FM-2.5K transmitter and perform a visual inspection to determine that no apparent damage was incurred during shipment. Retain the shipping materials until it has been determined that the unit is not damaged. The contents of the shipment should be as indicated on the packing list. If the contents are incomplete or if the unit is damaged electrically or mechanically, notify the carrier and Harris Corporation, Broadcast Products Division.

2-5. INSTALLATION.

2-6. Prior to installation, the manual should be carefully studied to obtain a thorough understanding of the principles of operation, circuitry and nomenclature. This will facilitate proper installation and initial checkout.

2-7. COOLING AIR REQUIREMENTS.

2-8. If a means of exhausting hot air from the transmitter enclosure or room is used, the duct system must not introduce any back pressure on the transmitter air exhaust. Allowances must be made for a minimum air flow of 140 CFM (3.96 m^3/minute) to ensure that only a limited amount of direct heat is dissipated into the transmitter interior. The duct work must have a cross sectional area equal to the opening at the top of the transmitter. Sharp right angle bends in the duct system are not permissible. If it is necessary to turn a right angle, a radius type bend must be used. The exhaust fan in the duct system must overcome any duct losses and overcome any wind pressures if vented to the outside.

2-9. After the transmitter has operated at full output for a number of hours, the temperature rise inside the transmitter must not exceed a rise of 68°F (38°C) above the ambient temperature measured at the blower air intake. The ambient air temperature must not rise above 120°F (48.89°C) under any circumstance.

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2-10. TRANSMITTER PLACEMENT.

2-11. In advance of actual placement of the equipment, certain planning should be accomplished. Holes are provided in the base of the transmitter for entry of power, audio and remote control wires. Also, several knockout holes are provided if other entry positions are desired. Refer to the installation drawing.

2-12. Either side of the transmitter may be placed against a wall or other equipment. Complete accessibility for maintenance and installation is provided in the FM-2.5K by access from the rear of the transmitter cabinet.

2-13. Set the transmitter in place on a smooth and level location near power and signal cables. The sides of the FM-2.5K may be placed against a wall or other equipment as complete accessibility for installation and maintenance is provided by the rear door. The floor must be capable of supporting a load of approximately 100 pounds per square foot (487 kg/m^2).

2-14. COMPONENT INSTALLATION.

2-15. Tubes, capacitors, connectors, cables etc., are shipped in separate cartons. The removal of components varies due to method and requirements of shipment. All removed items will be tagged to permit reinstallation in the transmitter. Arrange these components in separate groups according to the section from which they are removed. Parts in the interior should be installed first. The transmitter rear door and the internal access panels should be removed and left off until the installation of removed components and cabinet wiring hook-up is complete.

2-16. Items such as interconnecting wires and cables, shock mounted devices and miscellaneous small parts may be taped or tied in for shipment. Remove all tape, string and packing material that has been used for this purpose.

2-17. Symbol numbers and descriptions are provided on each removed component corresponding to the schematic diagram, parts list and packing list. Symbol numbers are also stenciled near the cabinet location of each removed item. Terminals and wires carry tags with information telling how to reconnect each item. Mounting hardware will be found either in small bags attached to each removed component or inserted in the tapped holes where each component mounts. Reinstall each component in its proper location.

CAUTION

Avoid bumping all tubes. Due to the mass of large tubes, bumping will introduce stresses which may cause internal damage.

2-18. Before operation, refer to the tune-up and operating procedure provided in Section III.

2-19. Install the time delay relay, K4.

2-20. Remove all the covers from the PA and IPA enclosures.

2-21. Loosen the 4 captive screws that hold the PA anode and blocking capacitor assembly to the vertical plate lines. Remove the assembly from the PA enclosure.

e. Remove any extra hardware lying within the cabinet and tighten all nuts and bolts.

f. Rotate the blower to be sure no obstructions are present.

g. Check relay and solenoid armature operation manually. Ensure all have free, unobstructed movement.

h. All wires and cabling should be dressed properly and secured.

i. All ducts and shielding should be in place.

j. Ensure the two Allen head set screws at the adjustment end of the second harmonic trap are tight.

2-41. Refer to the factory test data sheets supplied with the transmitter and adjust the controls as indicated. As the transmitter was checked into a 50 ohm resistive load, any system with a mismatch will change the tuning and loading. Therefore the recorded control indications may not agree exactly with actual operation.

2-42. Set the REMOTE/LOCAL switch to LOCAL.

2-43. CONNECTIONS TO REMOTE CONTROLS.

2-44. The FM-2.5K transmitter may be operated by remote control by installing a remote control system. If the transmitter is to be remotely controlled, it is important to initiate thorough inspection and maintenance procedures at the transmitter location. Installation of equipment to monitor temperature and humidity at the remote transmitter site is also suggested. Terminations provided in the FM-2.5K allow remote control of the following transmitter functions by connection to TB2 when the REMOTE/LOCAL switch is set to remote.

a. POWER ON. Connect the remote power switch to terminals 1 and 2. A continuously closed contact activates the primary power circuit. This contact is maintained as a fail-safe requirement.

b. HIGH VOLTAGE OFF. Remove the jumper from terminals 3 and 4. Normally closed contacts open momentarily to turn off the plate supply voltage.

c. HIGH VOLTAGE ON. Normally open contacts which momentarily close connect to terminals 4 and 5 to activate this function.

d. RF POWER RAISE/LOWER.

Normally open contacts connect between the common terminal (12) and terminals 6 and 7. A contact closure between terminals 6 and 12 will energize motor B2. The direction of motor rotation will lower the PA screen potential and reduce the RF output power. A contact closure between terminals 7 and 12 will energize motor B2 which will rotate in the opposite direction.

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This will raise the PA screen potential and increase the RF output power. Power for the motor (115 Vac) is obtained from the single-phase primary ac input.

e. PA PLATE VOLTAGE METERING. This circuit provides 10 Vdc maximum to operate a remote meter which connects to terminals 9 (-) and 10 (+). An adjustment (R9) matches the input requirements of the monitoring device.

f. PA PLATE CURRENT METERING. This circuit provides 10 Vdc maximum to operate a remote meter which connects to terminals 9 (-) and 11 (+). An adjustment (R12) matches the input requirements of the monitoring device.

g. RF POWER OUTPUT METERING. A remote indication of sampled RF output power is provided by the M4845 remote RF rectifier unit. An adjustment matches the input requirements of the monitoring device which connects to terminals 13 (+) and 14 (-).

SECTION III

OPERATION

3-1. ADJUSTMENT.

3-2. Refer to the exciter publication and check out exciter operation. Do not turn the exciter off when checkout is complete.

3-3. Install the back door and then turn ON the ac supply to the transmitter.

3-4. Position the IPA Output Loading, the PA Grid Tuning, the PA Plate Tuning and the PA Output Loading to the setting indicated on the Test Data Sheet.

3-5. Set the Local/Remote switch to Local.

3-6. Primary power may now be turned ON by depressing the FILAMENT ON switch button. The blower should begin to turn and come up to speed. After the blower reaches operating speed, air pressure in the PA enclosure will operate the air switch. The air switch closing will allow the filament voltage to be applied to the 4X150A and the 5CX1500A. The light behind the Filament ON button should light.

3-7. The indication of PA or IPA Filament Voltage is determined by a toggle switch on the upper front panel and the voltage is read on the Filament Voltage meter. Adjust the PA filament voltage for 4.8V and the IPA filament voltage the 5.8V. (See Paragraph 5-26.)

3-8. A 180 second time delay prevents the plate voltage from being turned ON immediately after the filaments are turned ON. This allows the tube's cathodes to reach a stable operating temperature.

3-9. Check the PA bias voltage (PA E_{G1}) on the Multimeter. The voltage is read on the 0-1000 Volt Scale. Change the PA Bias Voltage Adjust to obtain the same reading as recorded on the test data sheet.

3-10. Change the Multimeter Selector to read the IPA control grid current (IPA I_{G1}) on the 0 to 50 mA scale. The current range will be 5-15 mA. The control grid circuitry is several megahertz wide and will not require any adjustment.

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3-11. Switch the Multimeter to the PA control gird current (PA I_{G1}) position.

3-12. Depress the PLATE ON switch button. The light will illuminate.

3-13. Adjust the PA Grid Tuning for maximum PA control grid current (PA I_{G1}) on the multimeter. The current is read on the 0-50 mA scale and should be in the 10 to 30 mA range.

3-14. Adjust the IPA Tuning for a dip in IPA cathode current (IPA I_k).

3-15. Switch the multimeter to the PA screen grid current (PA I_{G2}) position and note the reading on the 0-250 mA scale. Adjust the PA Plate Tuning for maximum screen grid current. The screen grid current should be maintained lower than 125 mA.

3-16. Check the PA screen grid voltage (PA E_{G2}) on the 0-1000 volt scale of the Multimeter. Adjust the screen voltage as necessary with the Power Raise/ Power Lower switch to obtain the test data sheet value.

3-17. Check the VSWR on the transmission line. Position the Power/VSWR Selector Switch on the front panel to VSWR Calibrate position and set the Power Output meter for full scale deflection with the VSWR Calibrate control. Turn the selector switch to VSWR and read the reflected wave. Although the transmitter will operate into a 1.7:1 mismatch, it is recommended to keep the VSWR to a minimum. If a high VSWR is noticed it is generally traced to transmission line and/or antenna problems.

3-18. Since the transmitter was checked into a 50 ohm resistive load, any system with a mismatch will probably change the tuning. Therefore, the recorded test data knob settings may not agree with actual operation.

3-19. The Power Output meter should read in the green at this time. The green range is 90% to 105% of rated power and was adjusted at the factory so 100% equals 2.5 kW output or the designated power output (See Paragraph 3-26).

3-20. As a "touch up" procedure the following steps may be followed:

a. The IPA Output Loading and IPA Plate Tuning should be adjusted for the IPA I_k value indicated on the test data sheet. Adjust the IPA Output Loading for the level of current flowing and the IPA Plate Tuning for a dip in the IPA I_k.

b. Adjust the PA Grid Tuning for maximum PA I_{G1}. This indication should be close to a peak as the IPA Plate Tuning is adjusted for resonance.

c. Switch the multimeter to the PA I_{G2} position. As the PA Plate Tuning is adjusted the PA I_{G2} will peak close to the PA plate current dip. Adjust the PA Output Loading and/or PA screen voltage to obtain 2500W output and then retue the PA plate circuitry. The PA should be tuned for best efficiency and overall operation at 2500 Watts.

3-21. The Power Raise/Power Lower switch is also used to compensate for any change in power output due to ac line voltage variation.

3-22. RF drive to the IPA is controlled by the Output Control on the 15 Watt Amplifier of the FM Exciter. The drive level is set so approximately 10 mA of IPA I_{G1} is indicated. The IPA grid drive relay must be energized before the IPA and PA high voltages can be applied.

3-23. Refer to the test data sheets of your transmitter for the performance readings you can expect when the transmitter is operating at 2500 Watts or your designated power level.

3-24. The operation of the transmitter is very simple and once adjusted should require only a nominal amount of touching up the tuning at regular maintenance periods.

3-25. The overload is set for correct operating level at the factory. The PA plate overload is set for approximately .950 Amperes plate current. The adjustment for the overload is located under a small cover plate located on the front panel. It is referred to as symbol number R10 on the schematic.

3-26. OPERATION AT OUTPUT POWER BELOW 2500 WATTS.

3-27. If specified, the transmitter will be tested at reduced power at the Harris factory and the operating parameters noted on the test data sheets. The Power Output meter will be calibrated at the designated power and the PA efficiency recorded at 90%, 100% and 105% power level.

3-28. The basic change at reduced power output will be changing the secondary connections of the high voltage supply transformer T4. The connections are:

1. 2000 to 1700 Watts
   (a) IPA power output is 45 Watts.
   (b) Use terminals #1 and #4 (4700V no load).
   (c) PA Ep will be approximately 4000V dc.
2. 1700 to 1300 Watts
   (a) IPA power output is 45 Watts.
   (b) Use terminals #1 and #3.
   (c) PA Ep will be approximately 3300V dc.
3. 1300 to 1000 Watts
   (a) IPA power output is 40 Watts.
   (b) Use terminals #1 and #2 (330V no load).
   (c) PA Ep will be approxiamtely 2700V dc.

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3-29. Any final touch up should be accomplished by varying the PA screen voltage and changing the PA plate loading with the PA Output Loading Control. Retune the plate and grid circuitry. Observe the PA I_{G2} carefully and do not

3-30. The PA plate overload adjust is set for 150 mA. to 200 mA., above normal plate current when the amplifier is tuned to resonance.

SECTION IV

CIRCUIT DESCRIPTION

4-1. INTRODUCTION.

4-2. The FM-2.5K circuits will be described in the following sections:

a. Power Amplifier (PA)

b. Intermediate Power Amplifier (IPA)

c. Exciter

d. Power Supply

e. Control Circuits

f. Metering

4-3. POWER AMPLIFIER. The power amplifier of the FM-2.5K employs a single 5CX1500A tube in a RF grounded cathode amplifier circuit. The plate circuit is a shorted, one-quarter wavelength configuration with the plate line operated at dc ground potential. Coarse plate tuning is preset per operating freqency at the Harris factory. The PLATE TUNING knob on the front panel is used for fine tuning.

4-4. RF output power is inductively coupled from the plate lines and the amplifier loading is changed by a variable output loading control. Harmonics above the second are attenuated by a filter built in the PA enclosure output circuitry. The second harmonic is reduced by a 1/4 wavelength adjustable shorting stub.

4-5. The grid circuit is capacitively tuned from the front panel. The length and width of the grid inductor varies per frequency so the grid tuning capacitor is always 1/2 mesh or more. The RF input is direct coupled and connected at the factory for best match between the PA input and IPA output.

4-6. The screen voltage is supplied through a motor controlled rheostat from a 700V dc power supply.

4-7. A constant voltage ($\pm$ 1%) transformer and a rheostat provide a continuously adjustable, regulated filament voltage. The spedified PA filament voltage is 5 VAC $\pm$ 5%. (See Paragraph 5-26).

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4-8. INTERMEDIATE POWER AMPLIFIER. The intermediate power amplifier uses a 4X150A tube in a RF grounded cathode amplifier circuit. The plate circuit is inductively tuned and the loading changed with a variable capacitor. RF output of this stage is set at 50 Watt to obtain 2500 Watts out of the power amplifier. At lower transmitter outputs the IPA output is reduced to 45 Watts or 40 Watts.

4-9. The grid circuit is inductively tuned and sealed at the Harris factory. Since the circuit is several megahertz wide and will not require field adjustment, the variable inductors are accessible only with IPA cover off. The RF input is direct coupled.

4-10. Several test points were installed for voltage measurements of various tube parameters.

4-11. The screen voltage is zener regulated from the 700V dc plate supply.

4-12. A constant voltage (± 1%) transformer and a rheostat provide a continuous adjustable, regulated filament voltage. The specified IPA filament voltage is 6 VAC ± 5%.

4-13. EXCITER. Refer to the exciter publication.

4-14. POWER SUPPLY. The high voltage power supply furnishes 3, 3.5 or 4.5 kV dc for the power amplifier. The basic configuration of the supply is single phase, full wave bridge circuitry with a two section choke input filter. Primary taps on the plate transformer, T4 can be changed to compensate for input line voltage variations. Secondary taps are used when the power amplifier is operated at reduced power.

4-15. A 700V dc supply is used to provide IPA screen gird, IPA plate and PA screen grid voltages. The supply is a single phase, full wave circuitry with a single section choke input filter. Primary taps on transformer, T3 can be changed to compensate for input line voltage variation.

4-16. Power amplifier control grid bias voltage is supplied from a single phase, full wave bridge circuit with a capacitve filter. Voltage variation from -80 to -130V dc is available by the PA Bias Voltage Adjust.

4-16. CONTROL CIRCUITS.

4-17. The control circuits of the FM-2.5K consists of the following:

K1 - Plate Contactor applies primary voltage to the transformer T3 and T4.

K2 - Primary Contactor applies voltage to the blower.

K3 - Auxiliary Relay applies holding voltage to K1 if the air switch, door interlock, grid drive relay contacts, and the time delay relay contact are closed.

K4 - Time Delay Relay allows cathode of the tubes to reach operating temperature before high voltage is applied.

K5 - Recycle Relay energizes when the PA overload relay is energized a number of times. The number of times is determined by control R7. The overload relay contacts are in parallel across the relay circuit for K5. When the relay energizes and the contacts open, C6 starts to charge. If the contacts are open for a sufficient length of time for C6 to charge to the point that the voltage will energize K5, the contacts of K5 will break the hold circuit of K3 and the plate voltages will be switched OFF. If K5 does not operate, the overload contacts will close after an overload and the plate contactor K1 will again energize.

K6 - Plate Overload Relay adjusted to interrupt the high voltage when the plate current becomes excessive (1000 mA at 2.5 kW output).

S6A - High Voltage Interlock Switch is actuated by the back door. Its contacts are in the control circuit of K3.

S6B - High Voltage Shorting Switch is opened by the back door. As the door is removed the 4500V and 700V supplies are grounded.

S8 - Air Switch closes after the air pressure in the r.f. plenum reaches proper pressure. The ac circuit is then completed to the filament transformer, bias supply, and the time delay.

4-18. RF FILTERING. The FCC requires the harmonics of the operating frequency to be 80 dB or 43 dB +10 x log of the Power Output in Watts (whichever is highest) below the carrier reference. For a 2500 Watt transmitter the harmonics are required to be 77 dB below carrier.

4-19. The 2nd harmonic filter FL1, is adjusted at the Harris factory to appear as a short circuit for the correct frequency in the 176 to 216 mHz range.

4-20. Any frequency above the 2nd harmonic is attenuated by the low-pass filter in the PA enclosure.

4-21. METERING.

4-22. Four meters are located on the cabinet meter panel and one meter on the upper front panel for measuring various parameters.

4-23. The first meter from the left is used as a Multimeter in conjunction with the Multimeter Selector on the upper front panel. The following functions may be measured:

FUNCTION	SCALE
IPA I_{G1}	0-50 mA

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IPA I_K	143	0-250 mA
PA I_{G1}	38	0-50 mA
PA E_{G1}	121	0-1000 V
PA I_{G2}	65	0-250 mA
PA E_{G2}	460	0-1000 V

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4-24. The second meter reads the PA Plate Current and is located in the ground return of the 4500V dc supply.

4-25. The third meter reads PA Plate Voltage and is located on the low potential side of the meter multiplier resistor.

4-26. The fourth meter is for indicating Power Output and VSWR on the transmission line. This meter works in conjunction with the directional coupler mounted in the output transmission line and a function switch located on the upper front panel.

4-27. Calibration of the Power Output meter is accomplished against a known standard at the Harris factory. Unless the meter is calibrated every six months against a known standard in the field it cannot be used for power output recordings on the station transmitter log. The FCC accepts the indirect method of computing power output using the DC input and efficiency of the final power amplifier stage.

4-28. An ac voltmeter is mounted to the upper front panel for measuring the PA and IPA filament voltages.

4-29. Test points are installed on the IPA panel for measuring the following parameters with an external meter.

TP1	.587 100	IPA Screen Grid Voltage
TP2	-43.8	IPA Control Grid Voltage
TP3	2.72	IPA Cathode Voltage
TP4		Ground

SECTION V

MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides preventive maintenance checks, cleaning, corrective maintenance nad troubleshooting information.

5-3. PURPOSE.

5-4. The information contained in this section is intended to provide guidance to establish a comprehensive maintenance program to promote operational readiness and eliminate downtime. Particular emphasis is placed on preventive maintenance and record keeping functions.

5-5. STATION RECORDS.

5-6. The importance of keeping station performance records cannot be overemphasized. Separate logbooks should be maintained by operation and maintenance activities. These records can provide data for predicting potential problem areas and analyzing equipment malfunctions.

5-7. TRANSMITTER LOGBOOK.

5-8. As a minimum performance characteristic, the transmitter should be monitored (using front panel indicators) and the results recorded in the transmitter logbook at each shift change or at least once per day.

5-9. MAINTENANCE LOGBOOK.

5-10. The maintenance logbook should contain a complete description of all maintenance activities required to keep the transmitter operational. A list of maintenance information to be recorded and analyzed to provide a data base for a failure reporting system is as follows:

DISCREPANCY	Describe the nature of the malfunction. Include all observable symptoms and performance characteristics.
CORRECTIVE ACTION	Describe the repair procedure used to correct the malfunction.
DEFECTIVE PARTS(S)	List all parts and components replaced or repaired. Include the following details: a. COMPONENT TIME IN USE b. COMPONENT PART NUMBER c. COMPONENT SCHEMATIC NUMBER d. COMPONENT ASSEMBLY NUMBER e. COMPONENT REFERENCE DESIGNATOR

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SYSTEM ELAPSED TIME	Total transmitter time on.
NAME OR REPAIRMAN	Person who actually made the repair.
STATION ENGINEER	Indicates chief engineer noted and approved the transmitter repair.

5-11. SAFETY PRECAUTIONS.

5-12. It is very dangerous to attempt to make measurements or replace components with power on. The design of the transmitter provides safety features such that when a door is opened, an interlock switch removes transmitter high voltage. Do not short out or bypass interlock switches as maintenance shortcut.

5-13. A grounding stick which consists of a metal rod with a pheonlic plastic handle is provided as a safety feature. The metal end is connected to transmitter ground. Use the grounding stick to touch every part in the area or circuit on which maintenance is to be performed before attempting maintenance.

5-14. PREVENTIVE MAINTENANCE.

5-15. Preventive maintenance is a systematic series of operations performed periodically on equipment. As these procedures cannot be applied indiscriminately, specific instructions are necessary.

a. Visual Inspection is the most important preventive maintenance operation because it determines the necessity for the others. Become thoroughly acquainted with normal operating conditions in order to recognize and identify abnormal conditions readily. The remedy for most visible defects is obvious, however care must be taken if heat damaged components are located. Overheating is usually a symptom of trouble. It is essential to determine the actual cause of overheating before the heat damaged component is replaced, otherwise the damage may be repeated. Inspect for:

   1. Overheating, indicated by discoloration, bulging of parts and peculiar odors.

   2. Leakage of grease and oil.

   3. Oxidation.

   4. Dirt, corrosion, rust, mildew and fungus growth.

b. Check parts for overheating, especially rotating parts such as the blower motor. The need for lubrication, the lack of proper ventilation, or the existence of some defect can be detected and corrected before serious trouble occurs. Become familiar with operating temperatures in order to recognize deviations from the normal range.

c. Tighten loose screws, bolts, and nuts. Do not tighten indiscriminately as fittings that are tightened beyond the pressure for which they are designed may be damaged or broken. A regular check on the tightness of the two Allen head set screws in the adjustment end of the second harmonic trap should be made as part of the transmitter preventive maintenance program. If these screws become loose, RF currents will cause heating at this point and result in burning and destruction of the short and other parts of the filter.

d. Clean parts when inspection shows that cleaning is required.

e. Make adjustments when inspection shows that adjustments are necessary to maintain normal operation.

f. Lubricate meshing mechanical surfaces at specified intervals with specified lubricants to prevent mechanical wear and keep the equipment operating normally. Do not over lubricate.

g. Paint surfaces with the original type of paint (use prime coat if necessary) when inspection shows rust, worn or broken paint film.

5-16. FILTER CLEANING.

5-17. One air filter is provided in the front of the cabinet and two air filters are provided in the cabinet back door. Clean the filters periodically with warm water and a mild detergent with replacement done on an as-required basis. Additional filters may be ordered from Harris to assist in maintenance (see table 5-1).

CAUTION

DO NOT OIL THE FILTERS. THE FILTERS WILL CLOG

IF OILED. ALL FILTERS ARE TO BE INSTALLED DRY.

Table 5-1. Air Filters.

AIR FILTER	SIZE	HARRIS PART NO.
LOWER FRONT PANEL	20.875 in X 7 in. X 1 in. (53.02 cm X 17.78 cm X 2.54 cm)	827-5285-015
LOWER BACK DOOR	24 in. X 24 in. X 1 in. (60.96 cm X 60.96 cm X 2.54 cm)	827-5285-013
BLOWER	8.5 in. X 8.5 in. X 1 in. (21.59 cm X 21.59 cm X 2.54 cm)	827-5285-004

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5-18. BLOWER MAINTENANCE.

5-19. Inspect the blower and flushing for dust accumulation periodically. Remove the dust with a vacuum cleaner and brush. Check the blower for wear. The blower motor bearings are sealed and lubricated for approximately 20,000 hours of operation to provide trouble-free operation. A blower that is noisy or shows wear will require unit replacement or replacement of the bearings. The blower mounting bolts should be checked for tightness.

5-20. Each motor is cooled by the air passing over the motor. If the ambient air temperature is too high or the air flow is restricted, then the lubricant will gradually be vaporized from the motor bearings and bearing failure will occur. If very dirty air passes over the motor, the accumulation must be wiped from the motor and the dust must be blown out of the motor before the collection of dust impares the motor cooling.

5-21. If the unit is operated to move very dusty air, the concave side of the impeller blades will collect this dust and the material will build up on the surface. If this happens, the performance of the blower will be reduced and unbalance will result with a possibility of damage to the blower.

5-22. MAINTENANCE OF COMPONENTS.

5-23. The following paragraphs provide information for component maintenance.

5-24. SEMICONDUCTORS. Routine checking of semiconductors used in the FM-2.5K is not required. The best check of semiconductor performance is actual operation in the transmitter. When semiconductors are replaced, check circuitry operation which may be affected. Replacement semiconductors should be of the original type or a recommended direct replacement. Preventive maintenance of transistor is accomplished by performing the following steps:

a. Inspect the semiconductors and surrounding area as accumulations of dirt or dust could form leakage paths.

b. Examine all semiconductors for loose connections or corrosion.

5-25. CAPACITORS. Preventive maintenance of capacitors is accomplished as follows:

a. Examine all capacitor terminals for loose connections or corrosion.

b. Ensure that component mountings are tight.

c. Examine the body of each capacitor for swelling, discoloration, or other evidence of breakdown.

d. Inspect oil-filled and electrolytic capacitors for leakage signs.

e. Use standard practices to repair poor solder connections with a low-wattage soldering iron.

f. Clean cases and bodies of all capacitors.

5-26. TUBES. Life of the tubes used in the FM-2.5K is dependent upon correct filament volatage and the flow of air over the anode of the tube. If required, remove the tube and clean the fins of dust periodically to assure free airflow and long tube life. Air may be blown through the fins in the reverse direction or the anode may be cleaned with soap and water or denatured alcohol.

5-27. It is good practice to determine in the field for each particular combination of equipment and operating power level, the nominal filament voltage for best tube life. This is best done in the field by measuring some important parameter of performance such as plate current, power output, or distortion while filament voltage on the power tube is reduced. At some point in a filament voltage there will be a noticeable reduction in plate current, or power output, or an increase in distortion. Operation may safely be at a filament voltage slightly higher than that point at which performance appeared to deteriorate. A recheck should be made in 12 to 24 hours to make certain that emission is stable.

5-28. Initial setting may be approximately 4.8 Volts for the PA tube. As the tube ages the filament voltage should be raised to increase the emission for satisfactor operation.

5-29. The filament voltage for the IPA is not as critical and it should be set for 6 Volts.

5-30. IPA GRID CIRCUIT.

5-31. The IPA grid circuit is tuned initially for the best match between the IPA input and the FM exciter output. The reflected power should be 1/2W or less with 6W forward power as indicated by the exciter wattmeter. Adjustment of L9 and L10 will have a minimal effect.

5-32. FIXED RESISTORS. Preventive maintenance of fixed resistors is accomplished by the following steps:

a. When inspecting a chassis, printed circuit board, or descrete component assembly, examine resistors for dirt or signs of overheating. Discolored, bulging, cracked, or chipped components indicate a possible overload.

b. When replacing a resistor ensure the replacement value corresponds to the component designated by the schematic diagram.

c. Clean dirty resistors with a small brush.

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5-33. VARIABLE RESISTORS. Preventive maintenance of variable resistors follows:

a. Inspect and tighten all loose mountings, connections and control knob set screws (do not disturb knob alignment).

b. If necessary, clean components with a dry brush or cloth.

c. When dirt is difficult to remove, clean with a cloth moistened with cleaning solvent.

5-34. TRANSFORMERS. Preventive maintenance of transformers is accomplished by performing the following:

a. Feel each transformer soon after power removal for signs of overheating.

b. Inspect each transformer for dirt, loose mounting brackets and rivets, loose terminal connections, and insecure connecting lugs. Dust, dirt or moisture between terminals may cause flashovers. Insulating compound or oil around the base of a transformer indicates overheating or leakage.

c. Tighten loose mounting lugs, terminals, or rivets.

d. Clean with a dry cloth. Use cleaning solvent if required.

e. Clean corroded contacts or connections with No. 0000 sandpaper.

f. Replace defective transformers.

5-35. FUSES. Preventive maintenance of fuses is accomplished by the following:

a. When a fuse blows, determine the cause before installing a replacement.

b. Inspect fuse caps and mounts for charring and corrosion.

c. Examine fuse clips for dirt, improper tension, and loose connections.

d. If necessary tighten fuse clips and connections to the clips. The tension of the fuse clips may be increased by carefully pressing the clip sides closer together.

e. Dust fuses and clips with a small brush.

5-36. METERS. Preventive maintenance of the meters is accomplished as follows:

a. Inspect meters for loose, dirty, or corroded mountings and connections.

b. Examine leads for frayed insulation and broken strands.

c. Check for cracked or broken plastic cases and cover glasses.

d. Tighten loose mountings or connections. Since meter cases are made of plastic, exercise care to prevent breakage.

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e. Clean meter cases and glass cover with a dry cloth.

f. Remove dirt from mountings and connections with a stiff brush.

g. Remove corrosion with No. 0000 sandpaper.

5-37. RELAYS. Replace hermetically sealed relay if defective. Non-hermetically sealed relays are considered normal if:

a. The relay is mounted securely.

b. Connecting leads are not frayed and the insulation is not damaged.

c. Terminal connections are tight and clean.

d. Moving parts travel freely.

e. Spring tension is correct.

f. Contacts are clean, adjusted properly and make good contact.

g. The coil shows no signs of overheating.

h. The assembly parts are clean and not corroded.

5-38. SWITCHES. Preventive maintenance of switches is accomplished by checking the following:

a. Inspect switches for defective mechanical action or looseness of mounting and connections.

b. Examine cases for chips or cracks. Do not disassembly switches.

c. Inspect accessible contact switches for dirt, corrosion, looseness of mountings and connections.

d. Check contacts for pitting, corrosion, or wear.

e. Operate the switches to determine if each moves freely and is positive in action. In gang and wafer switches, the rotor should make good contact with the stationary member.

f. Tighten all loose connections and mountings.

g. Adjust contact tension.

h. Clean and dirty or corroded terminal connection or switch section with No. 0000 sandpaper.

i. Replace defective switches.

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5-39. INDICATORS AND INDICATOR SWITCHES. Preventive maintenance of indicator lamps and indicator switches is accomplished by checking the following:

a. Examine indicator sockets for corrosion, loose nuts and condition of rubber grommets.

b. Examine indicator switch by pulling the plastic cover (indicator assembly) from the case.

c. Inspect indicator assemblies for broken or cracked covers, loose envelopes, loose mounting screws, and loose or dirty connections.

d. Tighten loose mounting screws and solder loose connections. If connections are dirty or corroded, clean with No. 0000 sandpaper before soldering.

e. Clean indicator covers, bases, and glass bulbs with a dry cloth.

f. Clean corroded socket contacts and connections with No. 0000 sandpaper. Low operating voltages require clean contacts and connections.

5-40. PRINTED CIRCUIT BOARDS. Preventive maintenance of printed circuit boards is accomplished by checking the following:

a. Inspect the printed circuit boards for cracks or breaks.

b. Inspect the wiring for open circuits or raised foil.

c. Check components for breakage or discoloration due to overheating.

d. Clean off dust and dirt with dry compressed air and a brush as required.

e. Use standard practices to repair solder connections with a low wattage soldering iron.

5-41. CORRECTIVE MAINTENANCE.

5-42. Corrective maintenance for the transmitter is limited by the objective of minimum down time. Maintainability and care are considerable simplified for operation and maintenance personnel as the transmitter is designed and built with highly reliable and proven elements to minimize down time. If the need to remove and replace a defective component rises, refer to Section II, Installation. Reverse the sequence of installation to remove the component and re-install as described.

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5-43. TROUBLESHOOTING.

5-44. Most roubleshooting consists of visual checks. Because of high voltages present in the transmitter, it is not safe to work with power energized. The meters, indicators, and fuses should be used to determine which stage is malfunctioning. The meters which indicate transmitter operating parameters are located across the front of the cabinet. All tuning controls are adjustable in view of the meters. Internal components may be accessed from both the front and rear.

5-45. In event of problems, isolate the trouble area to one of the following with the meters and indicators for each section:

a. Antenna and Feedline

b. Power Supply and Control Circuits

c. IPA Section

d. PA Section

e. Exciter

5-46. Once the trouble is isolated to a specific area, refer to the theory section of this manual for circuit discussion to aid in problem resolution. In event parts are requried, refer to Section VI, Parts List.

5-47. As aids to troubleshooting, schematic diagrams are provided in Section VII.

5-48. TECHNICAL ASSISTANCE.

5-49. Technical assistance and troubleshooting recommendations are available from Harris Field Service Department during normal working hours. Emergency technical service is available 24 hours a day. Telephone 217/222-8200 to contact the Field Service Department or address correspondence to Field Service Department, Harris Corporation Broadcast Products Division, P.O. Box 4290 Quincy, Illinois 62305-4290, USA. The Harris factory may also be contacted through a TWX facility (910-246-3312) or a TELEX service (40-4347).

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SECTION VI

PARTS LIST

6-1. INTRODUCTION.

6-2. This section provides a description. reference designator and part number for selected replaceable parts and assemblies required for proper maintenance of the FM-2.5K FM Transmitter. Table 6-1 lists assemblies having replaceable parts, the table number listing the parts, and the page number on which the table is located. Identity of the assembly nomenclature in table 6-1 signifies the equipment level within the overall equipment configuration.

NOTE

Actual component values may vary slightly from component values listed on schematics and parts lists. Due to industry-wide shortages, it is sometimes necessary to use parts other than those specified. In every case, however, a substitute part is selected for conformance to overall design specifications so that equipment performance is not affected. Components that are frequency determined or peculiar to individual equipment are identified by a Harris part number and FM-2.5K FM Transmitter assembly component number on the final test addendum sheets shipped with the equipment.

6-3. REPLACEABLE PARTS SERVICE.

6-4. Replacement parts are available 24 hours a day, seven days a week from the Harris Service Parts Department. Telephone 217/222-8200 to contact the service parts department or address correspondence to Service Parts Department, Harris Broadcast Products Division, Harris Corporation, P.O. Box 4290. Quincy, Illinois 62305-4290, USA. The Harris factory may also be contacted through a TWX facility (910-246-3312) or a TELEX service (40-4347).

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Table 6-1. Replaceable Parts Index

Table 6-5. Switch Panel Assembly - 992 2704 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
DS1,DS2	396 0182 000	Lamp, #381	2
S2,S3,S4,S5	604 0445 000	Switch, Pushbutton, from Z Contact	4
	598 0118 000	Lens Cap, Green for S2,S4	2
	598 0119 000	Lens Cap, Red for S3,S5	2

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Table 6-6. Meter Panel Assembly - 992 2705 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C8,C10,C11,C17	516 0082 000	Capacitor, .01 uF, 1 kV	4
M1	632 0575 000	Meter, Plate Voltage, 0-5 kV	1
M2	632 0661 000	Meter, Power Output/VSWR	1
M3	632 0026 000	Meter, Plate Current, 0-1A	1
M4	632 0662 000	Meter, Multimeter	1

Table 6-2. FM-2.5K, 2.5 kW FM Transmitter - 994 8047 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
V1	374 0120 000	Tube, 5CX1500A, Eimac	1
V2	374 0018 000	Tube, 4X150A, Eimac	1
	814 9994 002	Inductor, Above 104 mHz	1

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Table 6-3. Basic Transmitter Assembly - 994 6871 002

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
B1	432 0081 000	Blower, Rotron, CXH29A52B	1
B3	436 0004 000	Motor, 115V, 50/60 Hz	1
C9	516 0382 000	Capacitor, 2000 pF, 15 kV	1
C12,C13	524 0155 000	Capacitor, 220 uF, 450V	2
C14,C15	510 0557 000	Capacitor, 6 uF, 5 kV	2
C53	510 0329 000	Capacitor, .25 uF, 1 kV	1
DC1	927 3270 004	Directional Coupler, 620 0484 000, (Part of FL1)	X
FL1	942 5822 001	Filter, 2nd Harmonic	1
L1,L2	476 0306 000	Inductor, Filter Choke, 10 Hy	2
L3	476 0304 000	Inductor, Filter Choke, 10 Hy	1
R26,R27	542 0099 000	Resistor, 15k ohm, 10W	2
R28,R29	542 0341 000	Resistor, 40k ohm, 160W, 5%	2
R30	542 0149 000	Resistor, 25k ohm, 20W	1
R32	914 3424 001	Resistor, Meter Multiplier, 5 Megohm	1
R53	542 0214 000	Resistor, 1.5k ohm, 50W	1
S6	927 3931 001	Switch, SPDT, HV Interlock	1
T1	472 0687 000	Transformer, Filament	1
T3	472 0712 000	Transformer, Plate	1
T4	472 0711 000	Transformer, Plate	1
T5	472 0677 000	Transformer, Constant Voltage	1
TB2	614 0104 000	Terminal Board, 14 Terminal	1

Table 6-3. Basic Transmitter Assembly - 994 6871 002 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
TB3	614 0223 000	Terminal Board, 2 Terminal	1
TB4,TB5	614 0092 000	Terminal Board, 2 Terminal	2
Z2,Z3	384 0268 000	Rectifier, LV (700V dc)	2
Z4 thru Z7	384 0362 000	Rectifier, Silicon, EFT-15H20	4

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Table 6-4. Screen Motor Assembly - 992 2703 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
B2	436 0106 000	Motor, 2 RPM, Hurst CA Series	1
C5	508 0009 000	Capacitor, .5 uF, 200V	1
R14	542 0084 000	Resistor, 3k ohm, 10W	1
S9,S10	604 0052 000	Switch, SPST	2
R19	552 0371 000	Rheostat, 5k ohm, 75W, 10%	1

Table 6-7. Upper Front Panel Assembly - 992 2706 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C54	516 0082 000	Capacitor, .01 uF, 1 kV	1
K2	570 0158 000	Contactor, 4 pole, 30A	1
K3	574 0099 000	Relay, DPDT, 115V ac coil 50/60Hz	1
M5	630 0169 000	Meter, 0-10 VAC	1
R7	550 0065 000	Potentiometer, 5k ohm, 2W, 10%	1
R9	550 0068 000	Potentiometer, 15k ohm, 2W, 10%	1
R10	550 0061 000	Potentiometer, 1k ohm, 2W, 10%	1
R11	542 0168 000	Resistor, 15 ohm, 25W	1
R12	550 0059 000	Potentiometer 500 ohm, 2W, 10%	1
R13	552 0381 000	Rheostat, 16 ohm, 100W, 10%	1
R17	552 0321 000	Rheostat, 1.5k ohm, 25W, 10%	1
R20	542 1149 000	Resistor, 1.8 ohm, 2W, 5%	1
R21	542 1148 000	Resistor, .36 ohm, 2W, 5%	1
R22	548 0125 000	Resistor, 1 megohm, 4W, 1%	1
R23	542 1149 000	Resistor, 1.8 ohm, 2W, 5%	1
R24	542 1148 000	Resistor, .36 ohm, 2W, 5%	1
R25	548 0125 000	Resistor, 1 megohm, 4W, 1%	1
R35	914 9092 000	Potentiometer, 10K ohm, 2W	1
R50	552 0973 000	Rheostat, 200 ohm, 12.5W	1
S1	604 0032 000	Switch, Toggle, DPDT	1
S7	602 0056 000	Switch, Lever, 2 Pole, 3 Positive	1
S11	914 9091 002	Switch, Rotary, 2Pol, 2-11 Positive	1

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Table 6-7. Upper Front Panel Assembly - 992 2706 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
S12	914 9091 001	Switch, Rotary, 3 Pole, 3 Positive	1
S13	604 0032 000	Switch, Toggle, DPDT	1

Table 6-8. PA Enclosure Assembly - 992 2707 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C16,C18	516 0205 000	Capacitor, 500 pF, 5 kV	2
C19	520 0155 000	Capacitor, Variable, 5-100 pF	1
C20	516 0204 000	Capacitor, 100 pF, 5 kV	1
C21	516 0361 000	Capacitor, 1000 pF, 1 kV	1
C22,C23,C24,C25, C26,C27	516 0205 000	Capacitor, 500 pF, 5 kV	6
C28	516 0361 000	Capacitor, 1000 pF, 1 kV	1
C30,C31,C32,C33	516 0210 000	Capacitor, 200 pF, 7.5 kV	4
C34	915 0770 000	Capacitor, Variable, 6-12 pF	1
C35,C36	516 0200 000	Capacitor, 25 pF, 5 kV	2
C51,C52	516 0205 000	Capacitor, 500 pF, 5 kV	2
J2	612 0317 000	Receptacle, BNC, UG1094U	1
L4	814 9994 001	Inductor, PA Grid, 1/2" Wide	1
L5,L6	942 5768 001	Inductor, PA Plate	2
L7	815 0067 000	Inductor, PA Output	1
L8	915 0089 000	Inductor, PA Output Filter	1
R31	546 0170 000	Resistor, 50 ohm, 100W	1
R33	540 0579 000	Resistor, 47 ohm, 2W, 5%	1
R34	540 0626 000	Resistor, 4.3k ohm, 2W, 5%	1
R43	540 0626 000	Resistor, 4.3k ohm, 2W, 5%	1
S8	604 0258 000	Switch, Air, .3" to 1" Water	1
T7	472 0709 000	Transformer, PRI., 10V, Sec. 30V	1
V1	374 0120 000	Tuve, 5CX1500A, Eimac	1

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Table 6-8. PA Enclosure Assembly - 992 2707 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
XCH1	404 0157 000	Tube, Chimney, 5CX1500A	1
XV1	927 5241 001	Socket, Tube, Modified	1

Table 6-9. Bias and Relay Shelf Assembly - 992 2708 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C6	522 0105 000	Capacitor, 50 uF, 150V dc	1
C7	524 0162 000	Capacitor, 530 uF, 250V dc	1
CR3	384 0020 000	Diode, 1N2071	1
K4	576 0088 000	Relay, Time Delay, 180 Sec.	1
K5	574 0153 000	Relay, SPDT	1
K6	572 0125 000	Relay, DPST, 6V dc	1
K7	572 0052 000	Relay, SPDT	1
R8	540 0618 000	Resistor, 2k ohm, 2W, 5%	1
R16	542 0030 000	Resistor, 1k ohm, 5W	1
R18	542 0036 000	Resistor, 2k ohm, 5W	1
T2	472 0208 000	Transformer, Bias Triad N68X	1
XK4	404 0016 000	Socket, M1P8T	1
Z1	384 0121 000	Rectifier, Bias	1

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Table 6-10. IPA Assembly - 992 2709 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
C37	500 0852 000	Capacitor, 1000 pF, 500V	1
C38	516 0450 000	Capacitor, Feedthru, 1000 pF, 500V	1
C39,C40,C41,C42, C43	516 0361 000	Capacitor, Feedthru, 1000 pF, 1 kV	5
C44,C45,C46,C47	516 0457 000	Capacitor, 1000 pF, 500V	4
C48	516 0361 000	Capacitor, Feedthru, 1000 pF, 1 kV	1
C49	516 0205 000	Capacitor, 500 pF, 5 kV	1
C50	520 0155 000	Capacitor, Variable, 5.3 - 102 pF, 600V	1
CR4	386 0155 000	Diode, Zener, 1N3015A	1
J5,J6	612 0317 000	Receptacle, BNC, UG1094U	2
L9	914 9991 001	Coil, IPA Grid Tuning	1
L10	914 9992 001	Coil, IPA Input Loading	1
L11	494 0004 000	Choke, 7 uH, Z50 Ohmite	1
L12	914 9993 001	Coil, IPA Plate Tuning	1
R37	550 0054 000	Potentiometer, 50 ohm, 2W, 10%	1
R38,R39	540 0563 000	Resistor, 10 ohm, 2W, 5%	2
R40	540 0603 000	Resistor, 470 ohm, 2W, 5%	1
R41,R42	544 1613 000	Resistor, 100 ohm, 4W, 5%	2
R45	540 0611 000	Resistor, 1000 ohm, 2W, 5%	1
R46	540 0603 000	Resistor, 470 ohm, 2W, 5%	1
R47	540 0601 000	Resistor, 390 ohm, 2W, 5%	1

Table 6-10. IPA Assembly - 992 2709 001 (Continued)

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R48	542 0060 000	Resistor, 100 ohm, 10W	1
R49	542 0193 000	Resistor, 15k ohm, 25W	1
T6	472 0090 000	Transformer, IPA Filament	1
TP1,TP2,TP3	612 0312 000	Test Point, White	3
TP4	612 0311 000	Test Point, Black	1
V2	374 0018 000	Tube, 4X150A, Eimac	1
XCH2	404 0073 000	Chimney, SK606, Eimac	1
XV2	404 0251 000	Socket, Tube, SK600A, Eimac	1

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Table 6-11. AC Panel Assembly - 992 3295 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
DS3,DS4	406 0358 000	Indicator, Blown Fuse (F4,F5)	2
F1	398 0049 000	Fuse, SloBlo, 1/2A	1
F2,F3	398 0056 000	Fuse, SloBlo, 1-1/2A	2
F4,F5	398 0319 000	Fuse, 35A, 250V	2
K1	570 0158 000	Contactor, 4 pole, 30A	1
XF1,XF2,XF3	402 0074 000	Fuseholder, Indicating	3
(XF4,XF5)	402 0118 000	Fuseholder, 2 pole, Circle #411	1

Table 6-12. Meter Multiplier Assembly - 938 4433 001

REF. SYMBOL	HARRIS PART NO.	DESCRIPTION	QTY.
R1 thru R20	548 0373 000	Resistor, 249k ohm, 1/2W, 1%	20

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SECTION VII

DIAGRAMS

7-1. INTRODUCTION.

7-2. This section provides schematic, interconnection and wiring diagrams necessary for maintaining the FM-2.5K Transmitter. The following diagrams are contained in this section:

Figure		Number
7-1	Block Diagram, FM-2.5K	815 3522 001
7-2	Coarse Plate Tuning Chart, FM-2.5K	815 0206 001
7-3	Installation Layout, FM-2.5K	838 4123 001
7-4	2nd Harmonic Filter, FM Transmitters	814 8554 001
7-5	PA Efficiency Curve, FM-2.5K	815 3518 001
7-6.	Overall Schematic, FM-2.5K	852 6671 002

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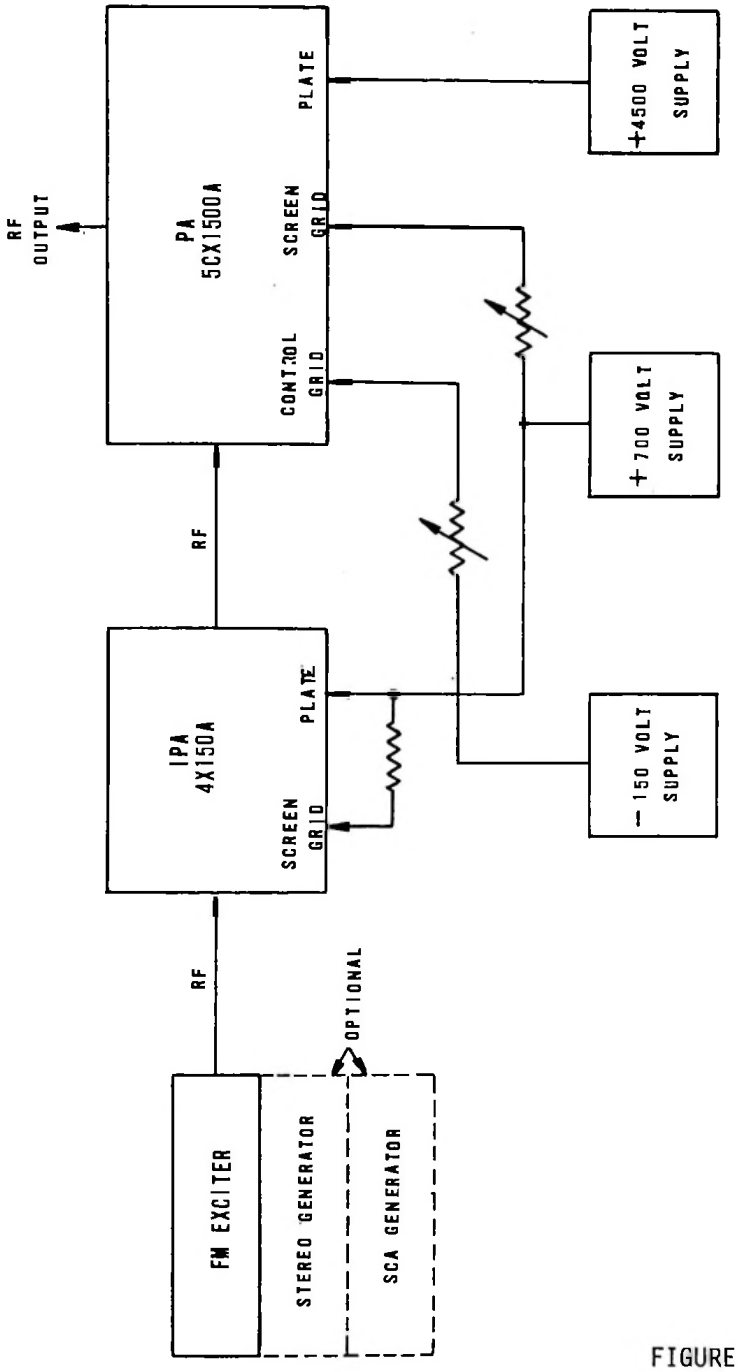


FIGURE 7-1. BLOCK DIAGRAM
FM-2.5K
815 3522 001

WARNING: Disconnect primary power prior to servicing.

POSITION OF COARSE TUNING SHORTING LINE ALONG PLATE LINE L5	
HOLE NUMBER FROM TOP	FREQUENCY RANGE (MHz)
LINE REMOVED	87.5 - 88.1
1	88.3 - 88.9
2	89.1 - 89.9
3	90.1 - 91.7
4	91.9 - 93.3
5	93.5 - 95.9
6	96.1 - 98.9
7	99.1 - 101.9
8	102.1 - 105.9
9	106.1 - 107.1
10	107.3 - 107.9
11	

FIGURE 7-2. COARSE PLATE TUNING CHART FM-2.5K 815 0206 001

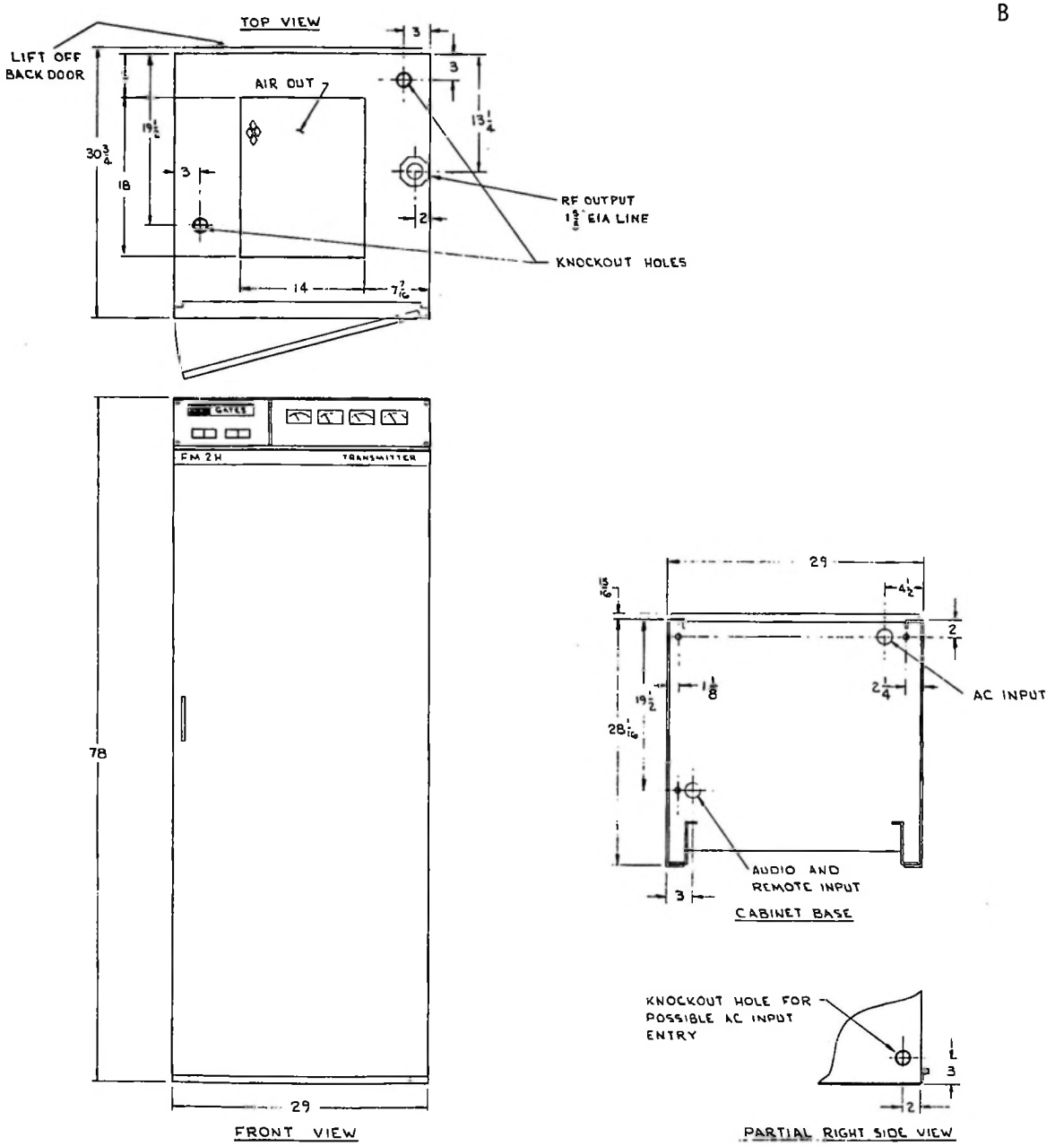


FIGURE 7-3. INSTALLATION LAYOUT
FM-2.5K
838 4123 001

7-7/7-8

WARNING: Disconnect primary power prior to servicing.

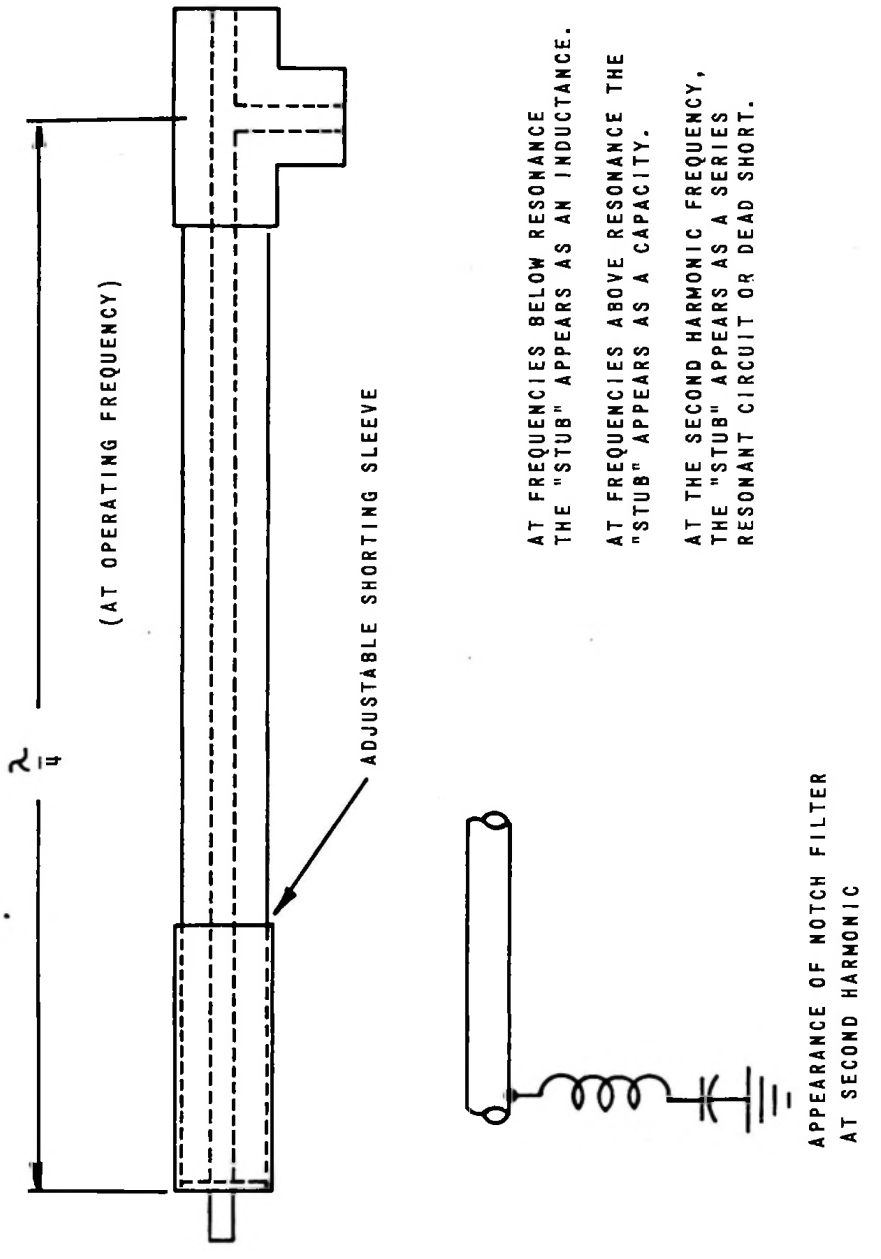
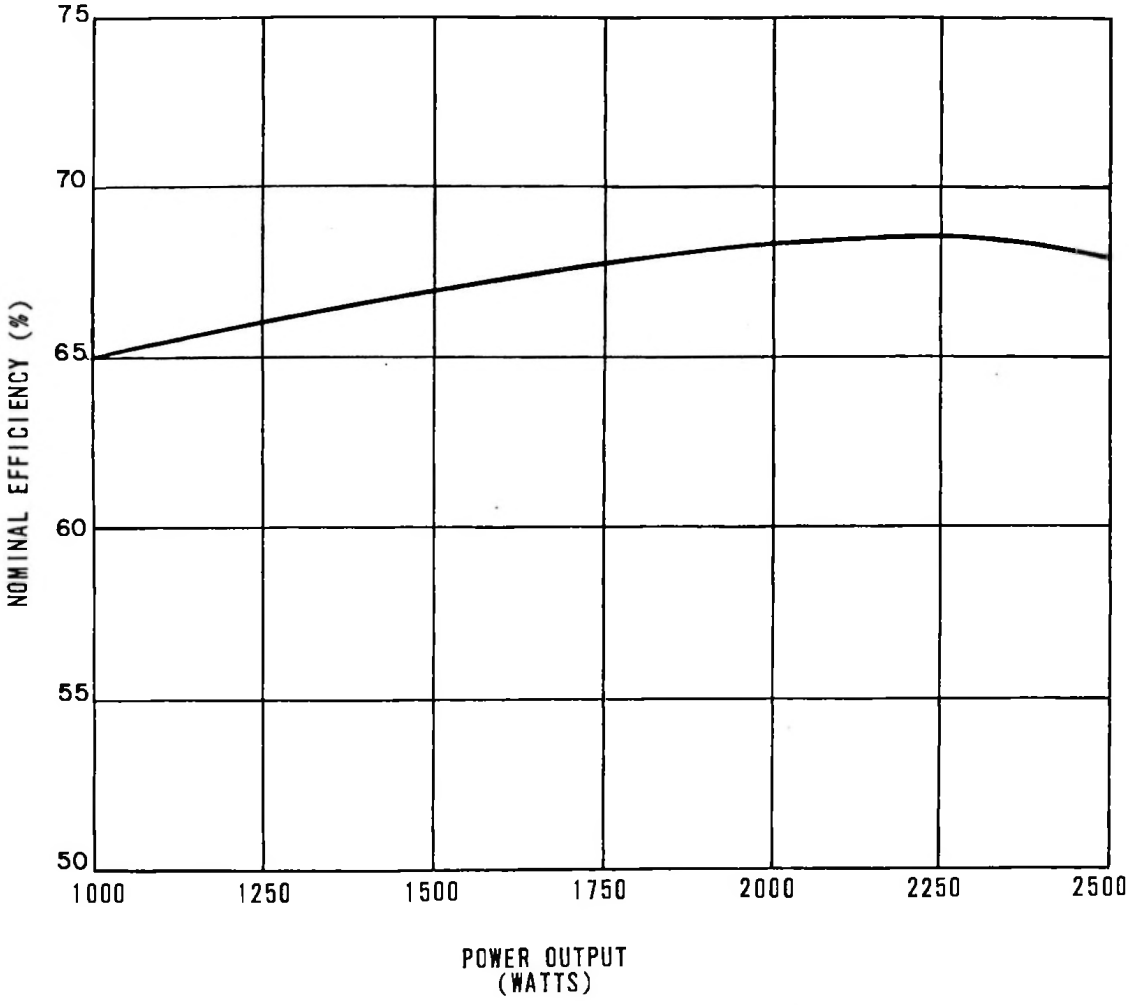


FIGURE 7-4. 2ND HARMONIC FILTER
FM TRANSMITTERS
814 8554 001

7-9/7-10



REFER TO TRANSMITTER FACTORY TEST DATA FOR THE EFFICIENCY FACTOR DETERMINED ON FINAL TEST

PA FREQUENCY CURVE
FM-2.5H3
815 3518 001

11/12

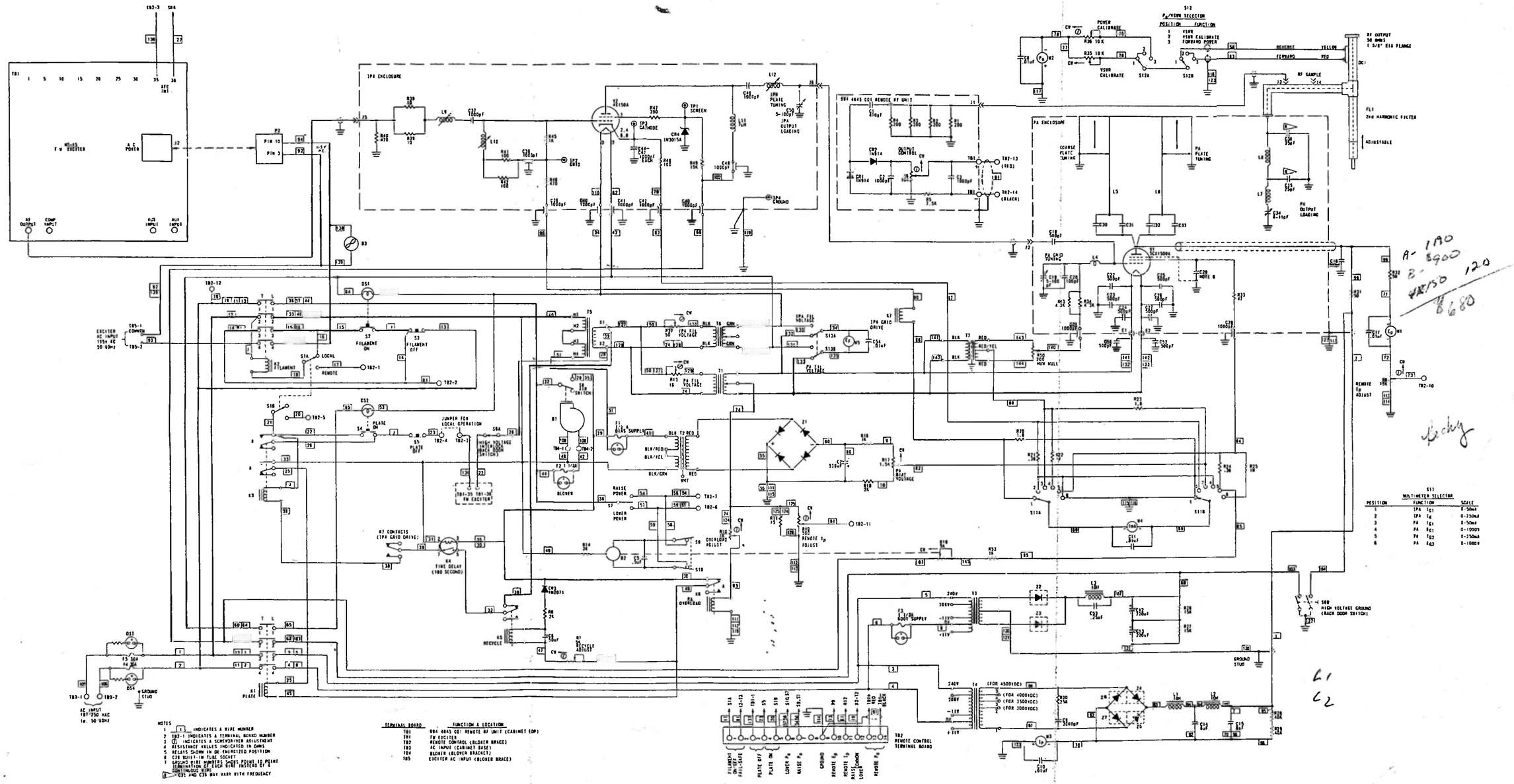


FIGURE 7-6. OVERALL SCHEMATIC
FM-2.5K
852 6671 002

7-13/7-14

HARRIS

INSTRUCTION BOOK ADDENDUM

HARRIS CORPORATION BROADCAST GROUP
P.O. BOX 4290 QUINCY, IL 62305

EQUIPMENT: FM2.5K SERIAL NO. 84-5836-003

I. B. NO. 888- DATE: 5-15-84

It has always been the policy of the Harris Corporation, Broadcast Products Division, to give our customers the advantage of the latest product improvements. This addendum insures you that the latest improvements have been incorporated in your equipment. This way we can provide up to date information without a delay due to printing new instruction manuals.

Please make the necessary corrections as listed below. Please use ink for a permanent record.

This addendum may be removed after corrections have been made.

Thank you for your cooperation.

Page/Drawing No.	Changes
	1. For TPO of 2100 watts: a. R-53 is a 1.5K ohm, 50 watt resistor. (P.N. 542-0214-000). b. A 1K ohm, 50 watt resistor has been added in series with R-53. (P.N. 542-0213-000). c. T4 secondary is tapped at 1 and 4.

WHITE — ORIGINAL PINK — SALES GREEN — CENTRAL FILES CANARY — TEST DEPT.

FINAL TEST DATA

FOR

HARRIS FM TRANSMITTER

MODEL FM-2.5K

Customer: KOPO

MARANA, AZ.

Impedances: RF 50 ohms; Audio 600/2K ohms

Frequency; 98.3 Mhz

Power Out; 2100 Watts

Line; 240 Volts 1 Phase 60 Hertz

F.O. # 0304212 -68169

Prod. & S.O.

Transmitter S/N 84-5836-003

MX-15 Exciter S/N 84-6302-033

Options:

RELEASED FOR SHIPMENT

Test Tech James C. Bailey Date 5-15-84

Manufacturing Date 5-15-84

NOTE: Data taken under factory conditions. Apparent exciter performance may be limited due to test equipment capability.

FM-2.5K TEST DATA

F.O. 68169 DATE 5-15-84 PAGE 2 OF 4

I. DIAL READINGS

IPA Output Loading	8.2
PA Grid Tuning	74
PA Output Loading	56
PA Plate Tuning	0070.8

II. METER READINGS

IPA Filament Voltage	6.0	V
IPA Control Grid Current	5	mA
IPA Cathode Current	170	mA
PA Filament Voltage	5.0	V
PA Control Grid Current	17.5	mA
PA Control Grid Voltage (H.V. OFF)	-120	V
PA Screen Grid Current	52	mA
PA Screen Grid Voltage	405	V
PA Plate Current	740	mA
PA Plate Voltage	3925	V
RF Output	2100	W
VSWR (50 Ohm Load)	1.01:1	

III. PARAMETERS MEASURED WITH AN EXTERNAL METER

IPA Cathode Voltage at TP3	17.5	V
IPA Control Grid Voltage at TP2 (H.V. OFF)	-23	V
IPA Screen Grid voltage at TP1	195	V
1 Phase Line Voltage	240	V
1 Phase Line Current	19.2	A

FM-2.5K TEST DATA

F.O. 68169 DATE 5-15-84 PAGE 3 OF 4

IV. SUPPLEMENTAL INFORMATION

AC Supply Line Frequency 60 Hz

PA Plate Dissipation 804 W

PA Plate Efficiency 72.3 %

IPA Plate tuning slug screw extends 5/8 inches from the front panel.

Distance from the coarse PA plate tuning line to the PA tube deck is 17 inches.

Distance from the fine PA plate tuning line to the PA tube deck is 16 3/16 inches.

PA overload set for 900 mA.

PA PLATE EFFICIENCY AT CUSTOMER OPERATING POWER

	Ip (mA)	Ep (V)	Efficiency (%)
90% 1890 W	665	3950	71.9
100% 2100 W	740	3925	72.3
105% 2205 W	770	3925	72.9

FM-2.5K/MX-15 WIDE BAND TEST DATA

F.O. 68169 DATE 5-15-84 Page 4 of 4

I. OPERATIONAL FUNCTIONS:	CHECK		CHECK
1. INDICATORS	✓	6. VSWR SHUTDOWN	✓
2. LOCAL METERING	✓	7. "LOCK-UP" TIME	✓
3. REMOTE METERING	✓	8. AGC	✓
4. LOCAL CONTROLS	✓	9. FREQUENCY CAL. OUTPUT	✓
5. REMOTE CONTROLS	✓		

II. SPECIFIED PERFORMANCE:	SPEC	MEASURED
1. CARRIER FREQUENCY	CUSTOMER ± 300Hz	98,300,006HZ
2. INDICATED RF OUTPUT PWR (SET AT) 3W to 15W		6w
3. AUDIO INPUT LEVEL (± 75KHz DEV.) 1.0 ±0.1VRMS		1.0VRMS
4. AUDIO RESPONSE	≤ 0.2dB	0.1DB
@ 30Hz 0.0	@ 15KHz 0.0	
@ 1KHz 0.0 REF.	@ 53KHz -0.1	
5. F.M. NOISE	≤ -80dB	-83DB
6. A.M. NOISE	≤ -55dB	-57DB
7. I.M. DISTORTION (60/7000 Hz, 1:1, DE-EMP)	≤ 0.05%	.01%
8. INDICATED REFLECTED POWER	RELATIVE	.1w
9. AFC VOLTAGE		8.9V