TECHNICAL MANUAL

DOC33-0002

SB020D-1 – 20 Watt Transmitter

COMWAVE

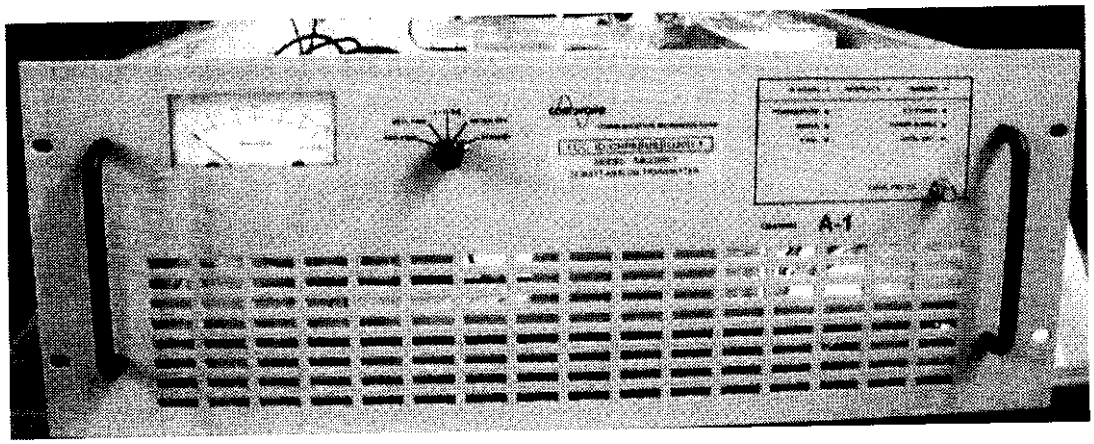

FIGURE 10-0004-1

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Document #: DOC10-0004
REV: A

COMWAVE TWO YEAR LIMITED WARRANTY

Comwave warrants each product of its manufacture to be free from any defect in material and workmanship for a period of two years after delivery to, and return by the original purchaser. No returns, however, will be accepted unless accompanied by a written factory return authorization.

The limit of liability under this warranty shall be to repair or replace any product, or part thereof, which proves to be defective after inspection by Comwave with the exception of tubes, semiconductor devices, lamps, fuses or equipment (i.e. modulators) manufactured by others, which are subject to only such loss adjustment as Comwave may obtain for the suppliers thereof.

This warranty shall not apply to any Comwave product which has been modified, physically or electrically damaged, or to modules which seals have been broken, or any product which has been subjected to conditions exceeding the applicable specifications or ratings or improper service techniques.

Comwave will not be liable for any direct or consequential injury, loss or damage incurred through the use, or the inability to use, any Comwave product.

Comwave reserves the right to make design changes to any Comwave product without incurring any obligation to make the same changes to previously purchased units.

This warranty is the full extent of the obligation and liability assumed by Comwave with respect to any and all Comwave products. Comwave neither makes, nor authorizes any person to make, any other guarantee or warranty concerning Comwave products.

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For the SB020D-1 Transmitter

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SECTION 1

This section will describe the top-level, which will explain the way the entire system works. There may also be a front view of the product, along with a pictorial of the FCC ID label, if available. An RF signal path diagram and power distribution interconnection diagram may also be included.

There are specifications for the entire system included and a system block diagram, if available.

TOP LEVEL DESCRIPTION

The SB020D-1 transmitting system generates a digital compatible 20-watt peak visual power vestigial sideband television signal on all MDS, MMDS, and ITFS channels. The SB020D-1 is configurable for NTSC, PAL, or SECAM and is Stereo, SAP, PROCHANNEL, and Scrambling ready. A few features of this system include advanced circuit design using broadband gallium arsenide microwave amplifiers, high efficiency switching power supplies, extensive monitoring/diagnostic capability, field replaceable modules, and easy access.

The SB020D-1 transmitting system consists of an SB020D-1 microwave upconverter/amplifier and an IF modulator. All equipment has been designed to accept standard 19" rack mounting. The system occupies a total vertical rack space of 8.75 inches or 22.23 centimeters. Individual spatial requirements are for a 7" transmitter drawer and 1.75" modulator. The transmitting system is typically configured for the users operating line voltage, 117 or 230 V_{AC}.

The SB020D-1 can receive separate or combined Intermediate Frequency (IF) AM modulated visual and FM modulated aural carriers that are converted to visual and aural S-band frequencies. These signals are amplified together through a common amplifier chain providing a microwave carrier.

This manual covers the SB020D-1 system Theory of Operation, Installation, Operation, Troubleshooting, Maintenance, and Calibration. It is divided into chapters with accompanying figures for clarity.

SPECIFICATIONS SHEET
SB020D-1

VISUAL PERFORMANCE:	
Output Power	1 - 20 Watts Peak Sync
Output Frequency	Any 6, 7, or 8 MHz Channel, 2000-2700 MHz
Emission	Visual 5M75C3F or Per CCIR
Impedance/Connector Input Output	 75ohms/F female 50ohms/N female
Input Level	Video 1 VP-P ± 6dB
Frequency Stability	±500Hz (High Stability Options Available)
Frequency Response [1,2,3]	± 1dB
Envelope Delay [1] Analog Input Digital I.F. Input	 Per FCC 73.687A(3) or CCIR ± 10 nanoseconds
Harmonics	-65dBc
Spurious Products [1]	-60dBc (out of band)
Intermodulation Distortion (IM3)	-70dBc (in band)
Differential Gain [1]	< 3%
Differential Phase [1]	< 2 degrees
Hum and Noise [1]	-60dB
K Factor 2T [1]	< 2%
I.C.P.M. [1]	
R.F. Output Regulation	± 0.2dB
Phase Noise @ 10kHz	-80dBc (standard) ≤-110dBc (optional)

AURAL PERFORMANCE:	
Output Power	.032 - .63 Watts (15 dB visual/aural ratio at RF out connector)
Emission	250KF3E or Per CCIR
Inter Carrier Frequency Accuracy	±50 Hz relative to visual carrier
Frequency Response [1] Mono Stereo	 ± 1dB 30 Hz to 15 KHz ± 1 dB 50 Hz to 105 KHz w/o pre-emphasis
Pre-Emphasis	50 or 75 microseconds (defeatable)
Deviation	25 KHz (system M/N) (Stereo 50 KHz) 50 KHz (system B/G/D/K/I)

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**Specifications subject to change without notice*

Harmonic Distortion [1]	<1%
FM Noise [1]	-60dB
Audio Input Level [1] Mono @ 25 KHz deviation Mono @ 50 KHz deviation Stereo @ 50 KHz deviation	 -10 to +10 dBm into 600 ohms -10 to +10 dBm into 600 ohms -10 to +10 dBm

GENERAL:	
Power Requirement	117/230 VAC 50/60Hz (600 watts)
Ambient Temperature	-30° to 50°C
Relative Humidity	95% non-condensing
Vertical Rack Requirement	8.75 inches (22.2 Cm)
Dimensions	8.75" H x 19" W x 22.5" D 22.2 cm H x 48.3 cmW x 57.2 cm D
Weight	65 lbs. (29.5 Kg)

NOTE:

1. ***Using TVM-102 modulator.***
2. ***±.25 dB upconverter amplifier drawer with optional group delay and frequency equalizer @ the output of the channel combiner.***
3. ***Spectral occupancy per FCC ruling for both analog and digital.***

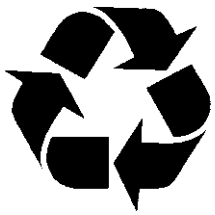
SECTION 2

This section is designed to assist you in setting up and turning on your system.

You will find installation instructions including unpacking, physical installation, environmental and safety considerations. Also included in this section is cabling instruction, as well as a basic turn-on procedure.

INSTALLATION

Unpacking Information



While unpacking, carefully compare the packing list with the equipment, checking for in-transit damage at the same time. Should any damage be noted, notify the freight carrier at once to file a freight claim. Do not discard any packing material until told to do so by the carrier. Also, notify Communication Microwave Corp (COMWAVE) of any damages or of missing materials from the shipment.

Retain original boxes and internal packing materials to adequately protect equipment to be returned to the factory for repairs, upgrades, or modifications.

Physical Installation

COMWAVE transmitters have been designed to accept standard 19-inch rackmounts with slide rails. Slide rails enable easy access to internal adjustable controls and other maintenance/adjustments. In most cases, COMWAVE provides a system equipment rack layout diagram that will assist in the proper installation and orientation of equipment.

The transmitter system requires 8.75" of vertical rack space (including a modulator). Generally, all equipment is mounted in close proximity in the same rack for the convenience of cabling. Mount the slide rails into the rack with the hardware supplied. Use tapered screws for mounting the front brackets (tapered screws allow the drawer to be fully seated).

Pull slide rails outward until they lock into place. Carefully align drawer with slide rails and mate. Unlock slide rails by depressing the lock button on each rail while pushing drawer inward. Drawer should slide easily into rack. If binding occurs, rail mounting brackets are in need of adjustment. Loosen brackets and manipulate drawer to seat rails to match receiver drawer. Tighten brackets once free sliding motion has been achieved.

System Grounding

For proper system operation, it is imperative that the system be adequately grounded. Each individual equipment rack requires grounding to the main building ground. When bolting ground wires to racks, sand finish to remove paint ensuring a good bond.

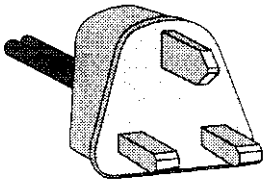
Environmental Considerations

The equipment can be safely operated in ambient temperatures of -30 to +50 degrees Celsius (-22 to +122 degrees Fahrenheit). However, moderate temperatures generally extend equipment life. Although the equipment may be operated with relative humidity of up to 95%, the equipment must be protected from conditions which cause condensation within the equipment.

If a rear door is used to secure the rack cabinet, forced ventilation through the cabinet is required (600 cfm minimum per transmitter is recommended). An air or temperature interlock should be incorporated for protection against interruption of ventilation. The area should be kept dry and clean.

There should be sufficient space in front of the receiver cabinet for the serviceman and test equipment, plus the full extension of the racked 22" deep chassis. A minimum of 36" behind the cabinet should be free for rear cabinet access and air movement. Also, ample room must be available at the cabinet rear for cable placement.

Safety Considerations



This equipment utilizes a grounding plug on all power cords. For personal safety, do not defeat this feature. As with all similar types of equipment, high voltage can be accessed when the chassis cover is removed. Special care should be given in areas of fuses, line switches, and power supplies.

Modern high power solid state equipment contains low output voltage power supplies with very high current capability. To prevent severe burns, avoid contact of rings, watches etc., with these circuits. When servicing the transmission line and antenna, care must be taken to avoid exposure to high-energy microwave.

COMPOSITE VISUAL AND AURAL OUTPUT CABLING FOR THE TVM –102 MODULATOR

This section explains cabling and interconnects between the transmitter and TVM-102 modulator. Refer to accompanying figure for cabling.

VIDEO:

VIDEO INPUT:

The modulator requires a baseband video input program source signal. Connect the Baseband video source to the modulator VIDEO INPUT using RG59/U 75-ohm cable.

VIDEO IF LOOP:

A small coaxial RG-59/U jumper is provided and is required to loop the VIDEO IF OUT back into the VIDEO IF INPUT.

AURAL:

AUDIO INPUT:

Connect an Audio (600 Ω balance input) source using twisted shielded audio cable to set screw jacks +AUD, -AUD, and GND.

AUDIO IF LOOP:

Using a male F to male F cable, connect the Audio IF loop OUT to Audio IF loop input.

IF:

IF OUTPUT:

The CMPST IF OUTPUT is the common aural and visual IF signal cable using a male F to male BNC RG-59/U 75-ohm cable. This is cabled directly to the IF IN jack of the transmitter.

IN-SIGNAL:

IN SIGNAL:

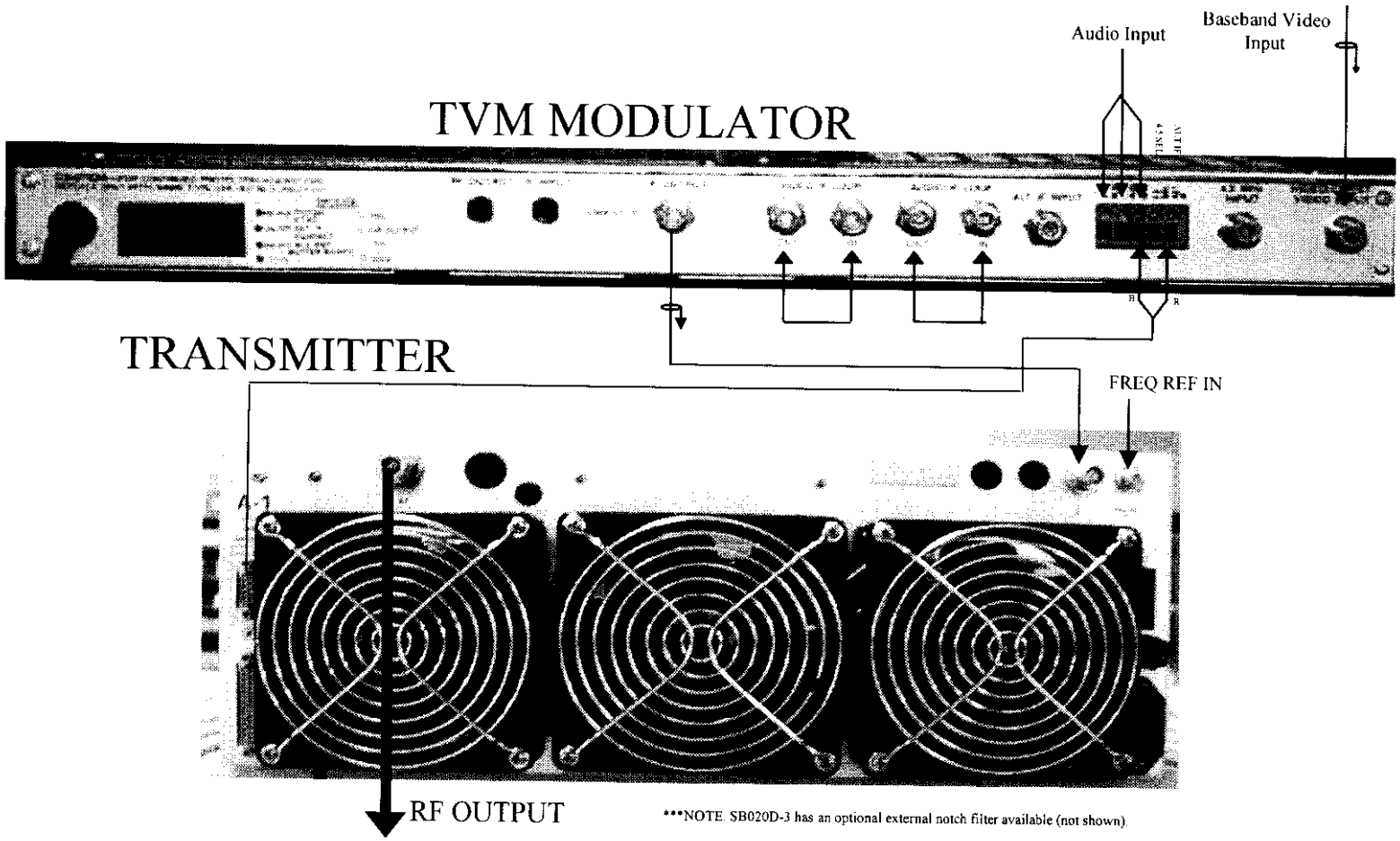
A video presence signal is established by using a pre-made cable assembly provided by COMWAVE. Connect the two pre-tinned bare wires to the small screw type terminals labeled ALT IF (RED wire) and GND (BLACK wire) and the remaining ends to J1 (9 pin connector) of the transmitter.

OPTIONS:

ALT IF INPUT:

If used, an alternate IF reference source signal is connected to the ALT IF INPUT to lock the modulator to a high stability reference source.

SYSTEM INTERCONNECTIONS, TVM MODULATOR



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OUTPUT CABLING FOR THE COMSTREAM MODULATOR *(OPTIONAL)*

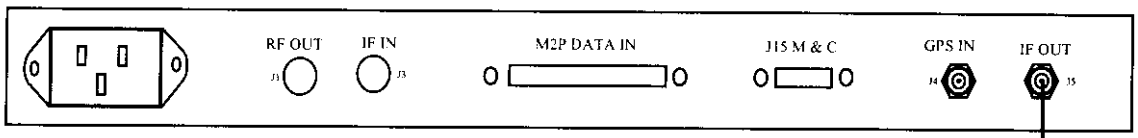
This section explains cabling and interconnections between the transmitter and the Comstream Modulator. Refer to document # DOC30-0007.

IF OUTPUT:

The IF OUTPUT is the digital QAM signal Cable using a male to male BNC RG-59/U 75 ohm Cable directly to the Visual IF (VIS IF) jack of the transmitter.

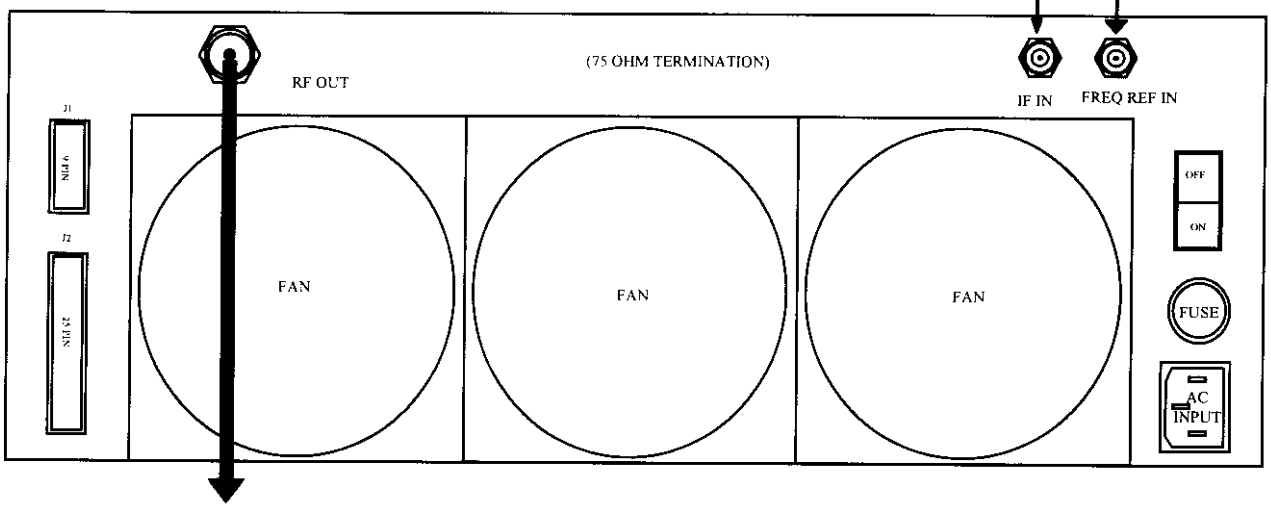
SYSTEM INTERCONNECTIONS, COMSTREAM MODULATOR

COMSTREAM MODULATOR



FREQ REF IN

TRANSMITTER



RF OUTPUT

***NOTE: The SB020D-3 has an optional external notch filter available (not shown)

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10 MHz REFERENCE IN

An externally applied 10 MHz reference signal is needed to determine the stability of an individual transmitter PLL synthesizer. This signal can originate from an optional 10 MHz Reference Drawer, Loran C, GPS receiver, or from another transmitter which contains a 10 MHz reference oscillator internally. An internal 10 MHz reference can drive up to three additional transmitters. Use RG59/U 75-ohm cable.

Reference Signals

Two methods are available to apply 10 MHz reference signals to phase lock a transmitter system. An internal reference card is used to lock up to four transmitters. When more than four transmitters are to be locked to the same reference, an external reference drawer is required. The reference signal level should be +10 dBm +5 dB/-10dB.

Internal Phaselocking of Transmitters: ***(Option Kit)***

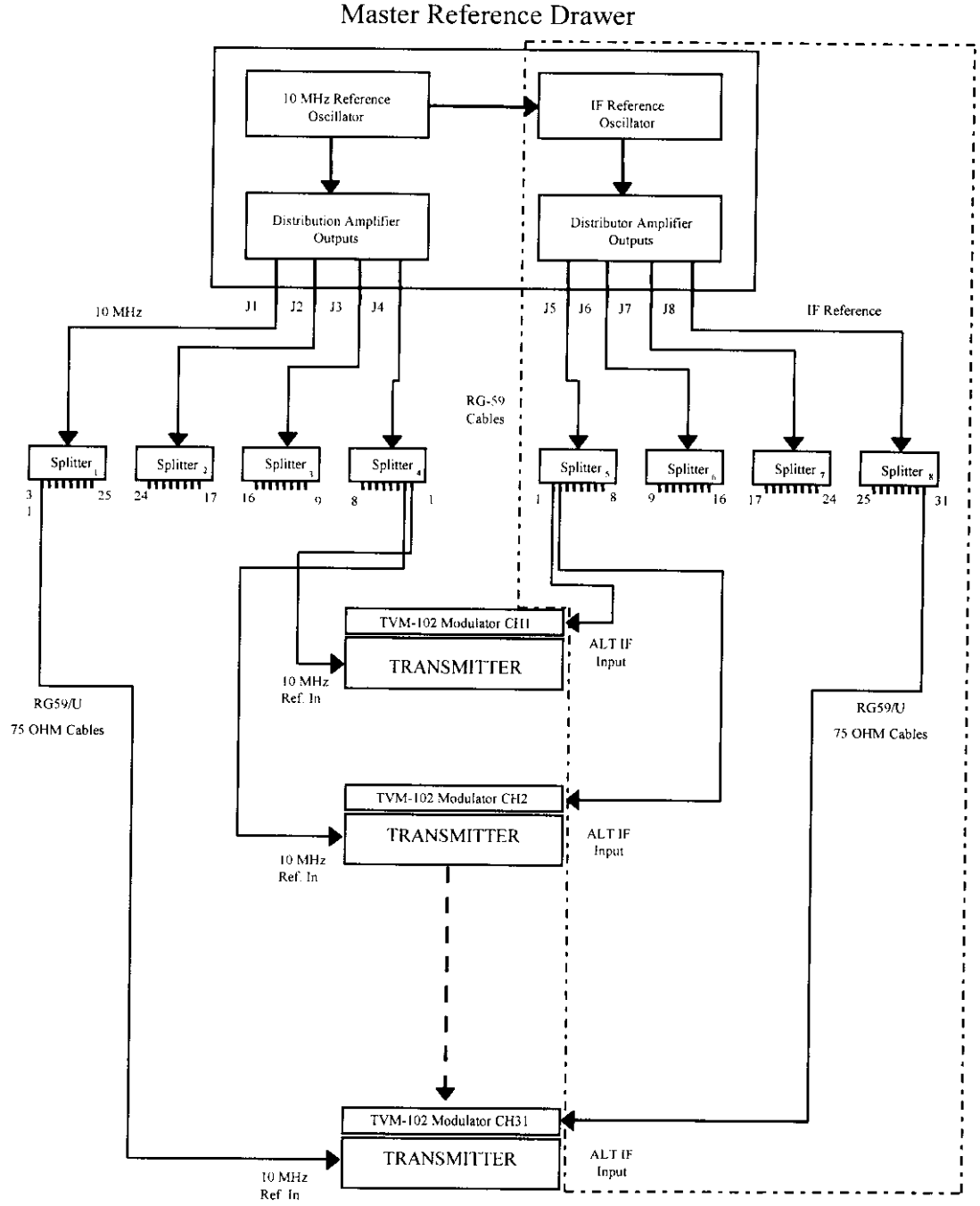
In a one to four channel co-located transmitter system, one transmitter, usually the lowest channel unit, will contain a precision 10 MHz reference oscillator module assembly. A three way signal splitter with cables is provided to distribute the reference signal to the remaining three units. Should this primary transmitter be taken off line, the reference oscillator assembly must be removed and placed into another transmitter of this type. All transmitters have the provision to accept this reference oscillator assembly.

External Phaselocking of Transmitters: ***(Standard Configuration)***

When more than four transmitters are co-located, the 10 MHz reference normally located inside the lowest transmitter channel of the group is removed and an external 10 MHz reference drawer along with a 10 MHz cable kit are used. This drawer contains a precision 10 MHz reference oscillator and distribution system. Options are available for redundancy and/or tighter tolerances including an option that will lock to the global positioning satellite system. See attached document for cabling details.

NOTE: The 10 MHz output signals are of a high level (+17 dBm) and should NOT be directly cabled to any transmitter/modulator. These signals must first be routed through splitters to reduce the signals to acceptable levels. Located in the 10 MHz cable kit are four 8-way CATV splitters with cable and appropriate connectors. When connected to any rear panel 10 MHz jack of the reference drawer, each output of the 8-way splitter may be connected directly to any transmitter 10 MHz input. The 8-way splitter has -10 dB typical loss.

EXTERNAL PHASELOCKING SYSTEM INTERCONNECTIONS



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Document #: DOC30-0009

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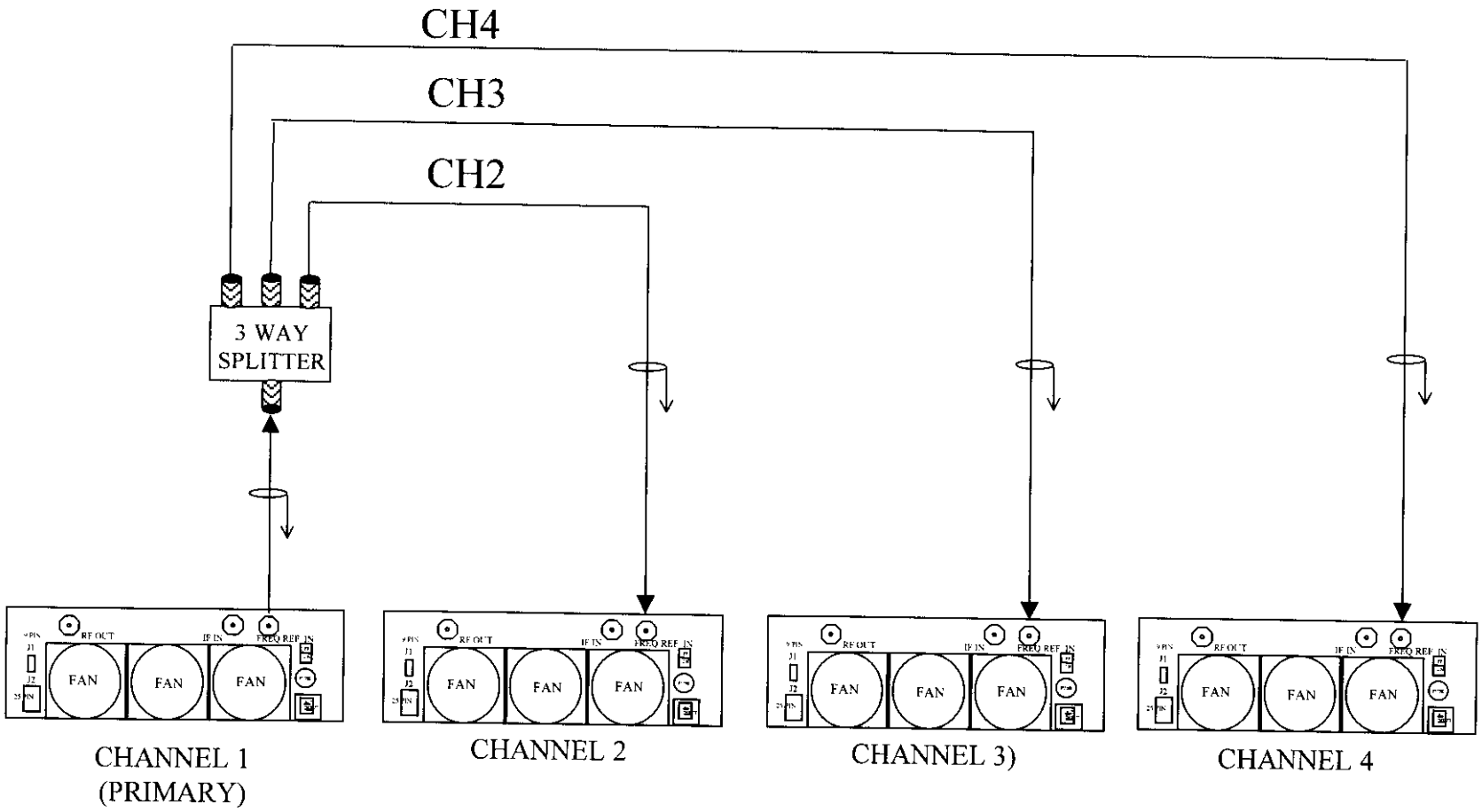
INTERNAL 10 MHz PHASELOCKING INTERCONNECT, OPTION KIT 99-014



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Document #: DOC30-0008

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TURN ON PROCEDURE

This section covers initial unit turn-on and explains normal operation of the transmitter. Prior to any initial equipment turn-on, verify that all appropriate wiring interconnections have been accomplished, see following pages.

Initial Turn-On

1. Ensure the rear mounted main power ON/OFF switch is in the OFF position.
2. Position the front panel rotary function switch to STANDBY.
3. Insert the power plug into a power outlet.
4. Position the main power switch to ON.
   *Fan noise should be heard.
5. The following GREEN LED's continuously illuminate verifying successful turn ON.
   *IN SIGNAL (if an input signal is applied; requires modulator operation)
   *INTERLOCK

Normal Operation

Rotating the function switch from STANDBY to any other position enables operation. At that time, the following GREEN LED's continuously illuminate confirming normal operation.

*IN SIGNAL (must have an input signal applied to transmit; requires modulator operation)
*INTERLOCK
*TRANSMIT

Absence of a green LED indicates a missing signal or parameter. Continuous illumination of any red status LED indicates a failure has been detected by the diagnostic circuitry. Refer to the troubleshooting section for failures.

To verify other transmitter parameters using the front panel meter, rotate the function switch. +11 V PS and FWD PWR should have meter readings of 100%. REFL PWR is a function of the combiners, transmission line, and antenna. Reflected power readings less than 10% are typical.

SECTION 3

Once you have completely installed your system this section will assist in dealing with many issues.

In this section you will find troubleshooting information as well as fusing and protection information, including AC power, DC power and RF power, if available. You will also find simple maintenance instructions and calibration steps if needed.

TROUBLESHOOTING

FAILURE MODE DISPLAYS

Comwave transmitters employ comprehensive diagnostic circuitry that monitors the status of power amplifier modules and critical circuits. Failures can be readily interpreted by observing the front panel LED diagnostic display and/or monitoring the analog panel meter. By observing the diagnostic display and metering, the complete transmitter, operational status is known. Due to the internal transmitter design Comwave does not recommend the repair of these modules on site. Contact Comwave customer support should a failure occur. This section explains the various failure mode displays that may be encountered and possible solutions.

The following status-monitoring LED's continuously illuminate GREEN during normal operation. Absence of an LED indicates a missing signal or parameter, which results in a controlled automatic transmitter shut down.

IN SIGNAL: Missing video input signal from modulator.

Causes:

- Defective cabling to modulator baseband VIDEO INPUT
- Defective/disconnected interlock harness from modulator to transmitter
- Modulator failure
- Missing baseband source signal to the modulator

Remedy:

- Check cabling
- Check harness between the modulator and transmitter
- Verify video source signal
- Replace modulator
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

INTERLOCK: Missing system Interlock signal.

Causes:

- RF module unplugged or shorted

Remedy:

- Check for disconnected module(s) or substitution plugs
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

TRANSMIT: No transmit.

Causes:

- Missing IN SIGNAL or in-signal BYPASS (switch on logic PCB)
- Missing INTERLOCK signal
- Defective cabling from modulator to transmitter
- See other diagnostic LED's

Remedy:

- Check cabling
- Troubleshoot per highlighted LED's
- Replace modulator
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

When a failure is detected by the diagnostic circuitry, the appropriate RED status monitoring LED continuously illuminates. Controlled automatic transmitter shut down is a function of the failure and severity. Presence of a RED status LED with normal meter readings and/or normal transmitter operation indicates an out of tolerance condition with that circuit.

TEMPERATURE: Internal chassis temperature exceeded + 140 degrees Fahrenheit (+60 degrees Celsius).

Causes:

- Fans inoperative
- Heavy accumulation of debris on fans or heatsinks
- Module(s) overheating
- Site air conditioning

Remedy:

- Check fan operation
- Check site air conditioning
- Allow transmitter to cool: Reset latched failure logic by rotating function knob momentarily to "STANDBY"
- Contact Comwave customer support

DRIVER: Defective driver module.

Causes:

- Driver module(s)
- Switching power supply

Remedy:

- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

FINAL AMP: Defective final module.

Causes:
- Final module
- Switching power supply

Remedy:
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

RF POWER: Output power has decreased too less than 50 % of full output.

Causes:
- Driver module(s)
- Final output module(s)
- Power supply

Remedy:
- Check final output RF power levels
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

PWR SUPPLY: Defective + 11 volt DC switching power supply.

Causes:
- Main input line fuse
- Switching power supply fuse
- Power Supply
- Shorted module(s)

Remedy:
- Check fuses
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

LOCAL OSC: Local Oscillator failure.

Causes:
- Oscillator failure
- External cabling
- 10 MHz Reference

Remedy:
- Check external cabling
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

VCXO LO OSC ***(optional)***: Voltage Controlled Crystal Oscillator failure.

Causes:

- Oscillator failure
- External cabling
- Internal or External 10 MHz Reference missing

Remedy:

- Check external cabling
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

DIAGNOSTIC INTERFACE

To assist in troubleshooting, COMWAVE transmitters employ a 25-pin computer type diagnostic interface connector located at the rear of the chassis. This connector is identified as J2. Critical power supply, module, and motherboard voltage test points can be accessed/monitored at this connector. Should a failure occur, the combination of meter readings, diagnostic LED status lights, and the diagnostic interface voltage test points help identify the failure.

Attached you will find an example diagnostic interface High/Low Window data sheet. This identifies each interface pin, the associated internal test point, nominal value, and the expected voltage range.

ANALOG METERING

The front panel analog meter provides a visual indication of the +11 V_{DC} switching power supply, reflected power, or forward power. The +11 V_{DC} switching power supply and forward power should indicate 100%. Reflected power meter readings less than 10% are typical. By observing the meter readings, transmitter performance can be interpreted. Analog meter readings in conjunction with the front panel Diagnostic status LED's help to identify/isolate failure(s). The following information is provided to assist in troubleshooting analog meter anomalies.

+11 VPS: Meter does not indicate 100%.

Causes:

- Defective switching power supply
- Shorted module
- Open switching power supply fuse F2
- Open main AC input fuse
- Switching power supply out of adjustment
- Metering out of adjustment

Remedy:

- Replace defective fuse(s)
- Check switching power supply output voltage
- Troubleshoot per front panel LED Diagnostic display
- Adjust switching power supply output voltage, refer to Calibration documents in section 3.
- Calibrate per document # DOC23-0015.
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

REFL PWR: Reflected power is greater than 10%.

Causes:

- Loose RF cable connection(s).
- RF cable kinked
- Wave guide damaged/depressurized
- Reflected metering out of adjustment

Remedy:

- Check integrity of all RF cable connections
- Check cabling for kinks or severe bends
- Check wave-guide for physical distortion and pressurization.
- Calibrate reflected metering per Calibration section, document # DOC23-0014.
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

FWD PWR: Meter does not indicate 100% visual power.

Causes:

- Driver module
- Final module(s)
- Switching power supply
- R.F. cable problem
- Metering out of adjustment

Remedy:

- Confirm output power
- Troubleshoot per front panel LED Diagnostic display
- Replace defective module
- Calibrate visual power metering per Calibration section, document # DOC23-0014
- Measure voltages at 25 pin Diagnostic Interface J2
- Contact Comwave customer support

SB020D-1 AND SB020D-3 TRANSMITTER TROUBLESHOOTING WORKSHEET

J2: REAR PANEL DIAGNOSTIC PIN	FUNCTION CHECKED	LOW LIMIT "V_{DC}"	NOMINAL VOLTAGE "V_{DC}"	HIGH LIMIT "V_{DC}"	MEASURED VOLTAGE
1	Ground	0.00	0.00	0.00	
2	+12 VDC PS	11.5	12.00	12.25	
3	- 12 VDC PS	-11.80	-12.00	-12.20	
4	+11 VDC PS	10.70	11.00	11.1	
5	+5 VDC PS	4.50	5.00	5.5	
6	Driver Mixer Q1	2.5	4.1	5.74	
7	Driver AMP 1 Q2, 3	2.0	4.5	7.0	
8	Driver AMP 2 Q4, 5	.9	1.08	1.5	
9	N/A	N/A	N/A	N/A	
10	Final Amp Q1, 3, 4, 5	7.0	8.8	10.6	
11	Final Amp Q2, 6, 7	4.8	6.6	8.5	
12	N/A	N/A	N/A	N/A	
13	N/a	N/A	N/A	N/A	
14	N/A	N/A	N/A	N/A	
15	N/A	N/A	N/A	N/A	
16	N/A	N/A	N/A	N/A	
17	N/A	N/A	N/A	N/A	
18	N/A	N/A	N/A	N/A	
19	Remote off	N/A	5.0	N/A	
20	IN Signal	N/A	5.0	N/A	
21	LO	N/A	>1.3	N/A	
22	Remote Fault	N/A	0.00	N/A	
23	FWD Power	N/A	1.40	N/A	
24	N/A	N/A	N/A	N/A	
25	REFL Power	N/A	.10	N/A	

FILL IN ALL THE ABOVE BLANK SPACES COMPLETELY

COMPANY NAME:_____ CUSTOMER'S NAME:_____
PHONE NUMBER:_____ FAX NUMBER:_____
MODEL:_____CHANNEL:_____ SERIAL NUMBER (REAR PANEL):_____

SEND RESULTS TO:

COMWAVE-ATTENTION
TECHNICAL SUPPORT

TOLL FREE PHONE ("USA" & Canada only)
1-800-COMWAVE (1-800-266-9283)
1-717*-474-6751
1-717*-474-5469 FAX
see note on document # DOC20-0001

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SB020D-1 AND SB020D-3 DIAGNOSTIC HI/LOW WINDOWS

Parameter	*Low*	*Nominal*	*High*
+11 V PS	8.95	11.0	12.6
Drvr Mixer	2.5	4.1	5.74
Drvr Amp 1	2.0	4.5	7.0
Drvr Amp 2	.9	1.08	1.5
Vis PreFinal	1.5	2.2	3.0
Final Amp	7.0	8.8	10.6
Final Amp	4.8	6.6	8.5

EQUIPMENT FUSING AND PROTECTION

Fuses: Five replaceable fuses are found in this chassis. The fuse locations and values are as follows:

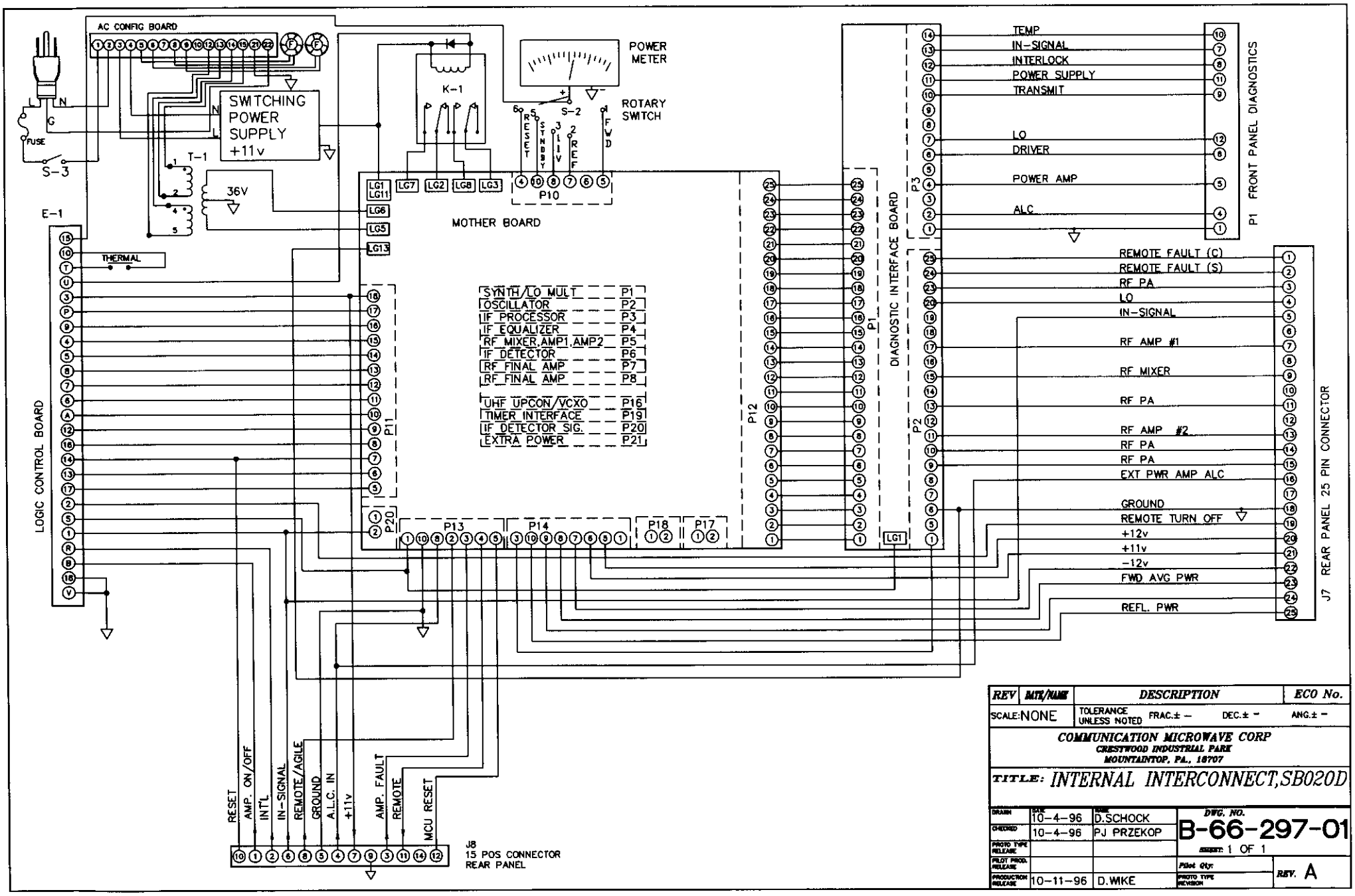
Location	Name	Value
Mother Board	F1	15 amperes
Mother Board	F2	25 amperes
Mother Board	F3	25 amperes
Rear Panel AC	Input	12 amperes @ 117 VAC or 7 amperes @ 230 VAC
Power Supply	F1	15 amperes @ 117 VAC or 8 amperes @ 230 VAC

FIGURE 18-0007-1

Surge Suppression: COMWAVE transmitters employ a metal oxide varistor (MOV) voltage suppressor across the AC line input for protection from moderate power surges. The surge suppressor value is dependent upon the AC line input voltage. 117 VAC employs a 150 VAC MOV and 230 VAC uses a 275 VAC MOV.

Thermal Protection: Thermal protection is accomplished using thermostats that close when the internal temperature exceeds +140 degrees Fahrenheit (+ 60 degrees Celsius). When thermal shut down occurs, a logic control board removes power from the finals until the unit is sufficiently cooled.

Interlocks: Interlocks are designed for transistor bias protection for both the FET gate and drain power supply voltages. See the logic control PC assembly description, Document # DOC13-0016.



REV	MTL/NAME	DESCRIPTION	ECO No.
SCALE: NONE	TOLERANCE UNLESS NOTED	FRAC.± — DEC.± — ANG.± —	

COMMUNICATION MICROWAVE CORP
CRESTWOOD INDUSTRIAL PARK
MOUNTAINTOP, PA., 18707

TITLE: INTERNAL INTERCONNECT,SB020D

	DATE	NAME
DRAWN	10-4-96	D.SCHOCK
CHECKED	10-4-96	PJ PRZEKOP
PROTO TYPE RELEASE		
PILOT PROD. RELEASE		
PRODUCTION RELEASE	10-11-96	D.WIKE

DWG. NO. B-66-297-01
SHEET 1 OF 1
PILOT QTY:
PROTO TYPE REVISION
REV. A

INSPECTIONS AND CLEANING

COMWAVE products have been carefully designed to be maintenance free. Only periodic inspection and cleaning is necessary.

Inspections:

1. Inspect heat sinks monthly for heavy accumulations of dirt and/or insects. Heavy accumulation of foreign debris impedes cooling effectiveness and could lead to premature failure.

2. Should any debris be found, shut down the transmitter and unplug the AC line cord. Remove the top cover and remove any accumulation of foreign debris.

3. After performing routine maintenance be sure to check the tightness of all cable connections and especially the integrity of RG-58/U crimp type connectors.

Cleaning:

Clean face plate and outside cover using a damp non-abrasive cloth with a mixture of a mild detergent and water.

MONTHLY MAINTENANCE RECORD

Date		Analog Metering			Failure LEDs	Comments
		FWD	REF	+11VPS		

Created by: Kimberly Simeone 5/26/98	Checked by: Donald Wike 9/18/98	Released by: Andre Castro 10/2/98

Document #: DOC18-0006
REV: A

CALIBRATION DESCRIPTION

Front panel meter M1 provides an analog indication of the +11 V_{DC} power supply, reflected power, aural power, or peak visual power. The 2 V_{DC} full-scale meter is calibrated to indicate 100% at 1.4 V_{DC}. Rotary function switch S1 selects the parameter to be monitored.

+11 V_{DC} Power Supply: Meter reads 100% during normal operation. Voltage from the switching power supply is sampled from the motherboard using resistor R43 and calibration potentiometer VR1.

Reflected Power: Meter indicates relative reflected power. A directional coupler on the output samples reflected power from a -20 dB port. This sample is reduced by a 3 dB attenuator and is envelope detected by D2 and R6/C2. Reflected metering is calibrated by adjusting mother-board potentiometer VR3.

FWD Power: Meter indicates relative peak visual output power. A directional coupler on the output samples forward power from a -20 dB port. This sample is reduced by a 3 dB isolation attenuator and is envelope detected by D1 and R3/C1 in the detector module assembly. A DC voltage proportional to the carrier power is sent to motherboard U2C. U2C is a buffer amplifier, which drives D1 and C1/R8 to the peak signal value. U2D/U1C then buffer this voltage to meter calibration motherboard potentiometer VR4.

CALIBRATIONS

The following section explains calibration of the transmitter. The user must be thoroughly familiar with use of applicable test equipment. Qualified service personnel prior to shipping have performed all calibrations, alignments, and adjustments at the factory. Additional adjustments are not necessary or advised, however there may circumstances when it's required.

System Power Calibrations

This section covers adjustments of the forward output power and calibrations of the front panel output power and reflected metering.

WARNING

NOTE: This procedure is applicable for only making MINOR adjustments to output power and analog metering. Do NOT adjust power more than ±.5 dB. Adjustments more than ±.5 dB may result in increased intermodulation distortion products.

This procedure sets the transmitter output power while transmitting a modulated signal. Calibration of output power and metering circuitry is a straightforward task. For proper calibration, adjustments are performed in a specific sequence. The following information is provided to assist in proper calibration.

Forward Output Power

Required Equipment:

- Spectrum Analyzer
- 30 dB Directional Coupler
- Two N to N Male Barrels
- N to BNC Adapter
- Video Generator
- Microwave Power Meter
- 50 Watt, 50 Ohm Load
- Small Flat Blade Screwdriver
- Alignment Tuning Tool

1. Place the transmitter in STANDBY to disable transmitting.

2. Attach a -30 dB directional coupler to the transmitter output. Terminate the coupler output into a 20 watt or greater, 50 ohm load. Connect a microwave power meter to

the -30 dB coupled port. Refer to document # DOC22-0005 for a Comstream modulator and document # DOC22-0006 for a TVM modulator.

3. Apply a modulated signal to the transmitter IF input. Set video generator to black picture (No set up / 0 IRE).

4. Turn IF Precorrector ALC switch S2 to "OFF."

5. Rotate function switch from STANDBY to "FWD PWR" to enable transmit.

6. Calculate power meter reading necessary for 100% output, accounting for the coupler loss.

EXAMPLE

Transmitter Output @ 20 Watts:				
Visual	20.00 Watts			
Aural	.6 Watts			
Total	20.60 Watts	=		43.14 dBm
-30 dB Coupler			=	- 30.00 dBm
				13.14 dBm
Correction Factor (Black Picture/no set up)		=		2.20 dBm
Expected Power Meter Reading		=		+ 10.94 dBm

7. Adjust motherboard variable potentiometer VR4 to indicate 100% forward power output, see document # DOC23-0016 for potentiometer locations.

8. Turn ALC switch S2 "ON."

Reflected Power

1. Place the transmitter in STANDBY to disable transmitting.

2. Attach a -30 dB directional coupler to the transmitter output. Terminate the
3. coupler output into a 20 watt or greater, 50 ohm load. Connect a microwave power meter to the -30 dB coupled port. Refer to document # DOC22-0005 for a Comstream modulator and document # DOC22-0006 for a TVM modulator.

4. Rotate the function switch to STANDBY.

5. Turn the IF Precorrector ALC switch S2 "OFF."

6. Momentarily interchange the coax cables at the Envelope Detector ports.

7. Rotate the function knob from STANDBY to REF POWER to enable transmit.

8. Adjust motherboard potentiometer VR3 for 100% reflected power reading, see document # DOC23-0016 for potentiometer locations.

9. Rotate function knob to STANDBY.

10. Return Envelope Detector coax cables to their original configuration.

11. Turn IF Precorrector ALC switch S2 "ON."

12. Rotate the function switch to REF POWER. The meter should indicate less than 7% residual reflected power reading into a resistive termination.

+ 11 V_{DC} Switching Power Supply Metering

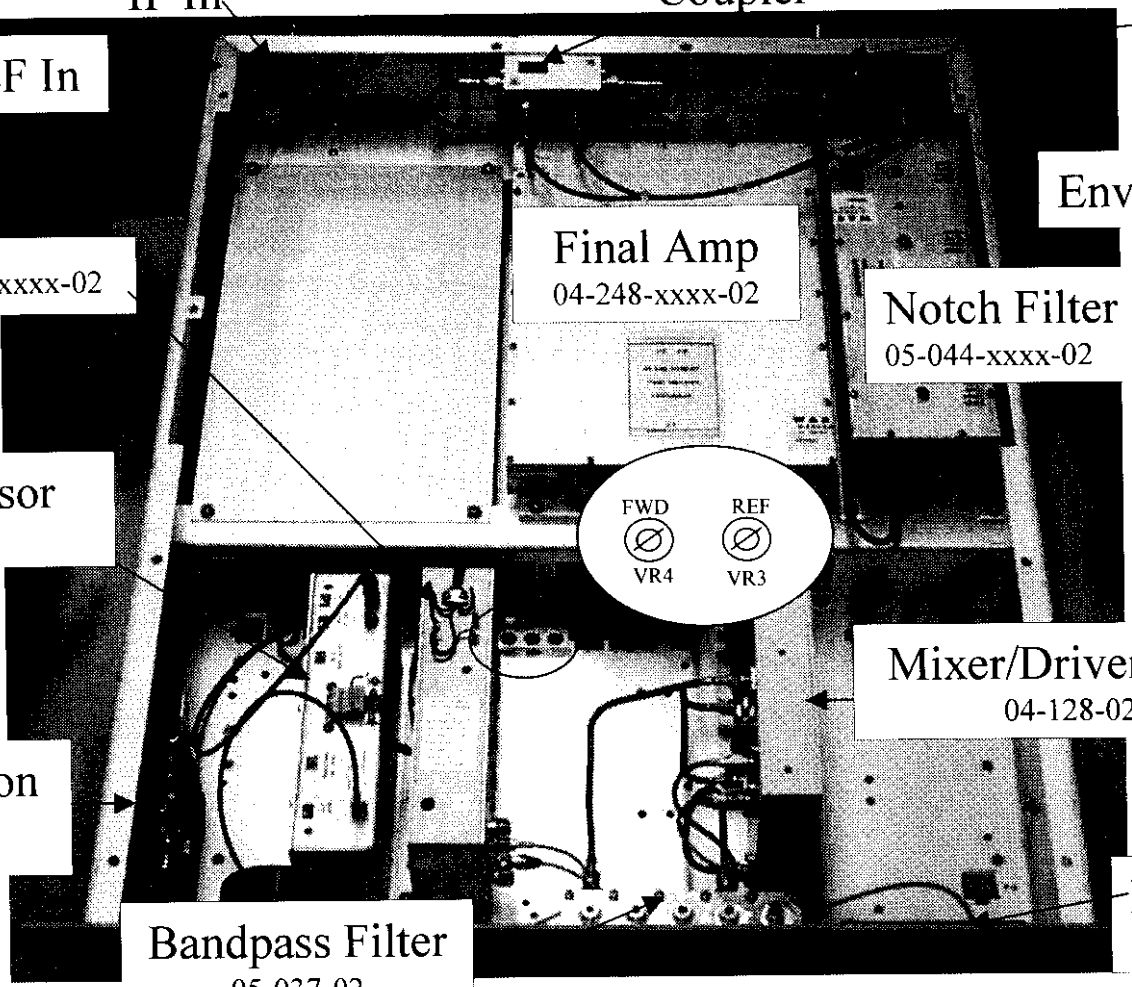
1.) Using a digital voltmeter, measure the switching power supply output.

2.) Confirm switching power supply voltage output is + 11 V_{DC}. If required, adjust switching power supply VR59 (Deltron switching power supplies).

3.) Rotate function switch to +11 VPS.

4.) Adjust motherboard potentiometer VR1 to correspond to 100% +11 VPS metering, see document # DOC23-0015 for location of potentiometer.

SB020D-1 METERING ADJUSTMENTS

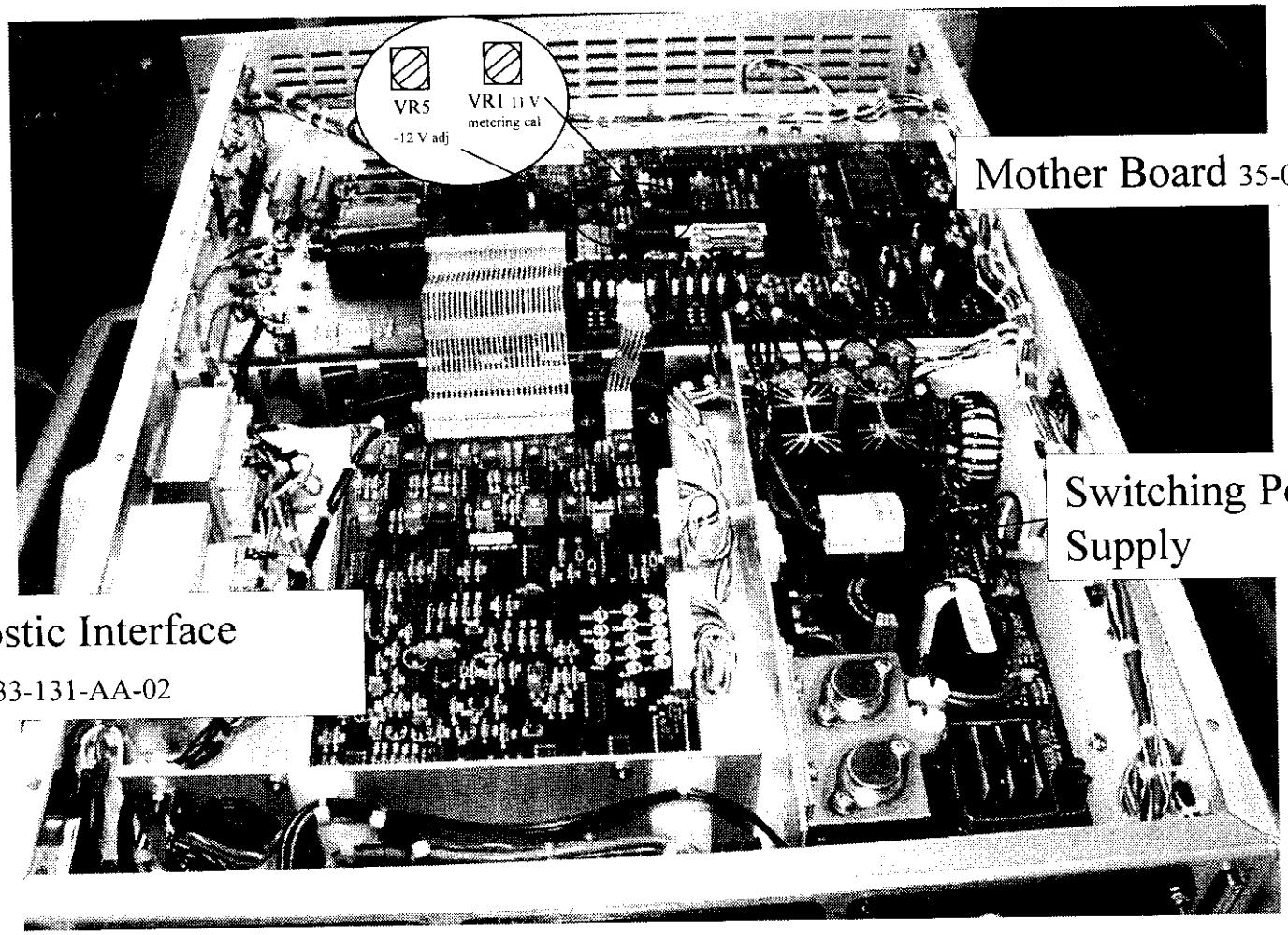


Created by: Kimberly Simeone 7/23/98	*Checked by: Ivan Hernandez 9/12/98*	*Released by: Paulo Correa 10/28/98*

Document #: DOC23-0016

REV: A

SB020D-1 & SB020D-3 +11 VPS METERING ADJUSTMENT



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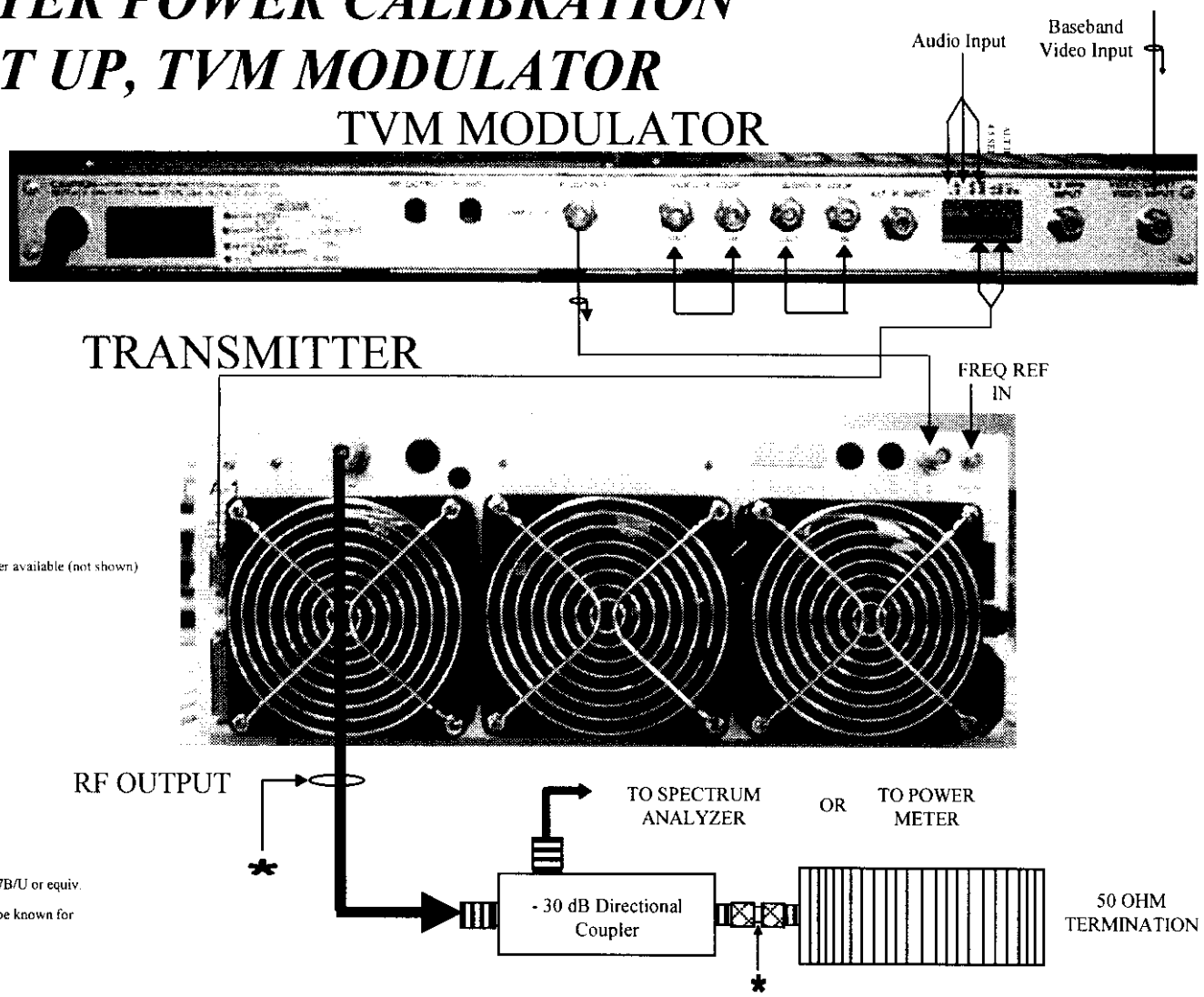
Document #: DOC23-0015

REV: A

TRANSMITTER POWER CALIBRATION TEST SET UP, TVM MODULATOR



***NOTE SB020D-3 has an optional external notch filter available (not shown)

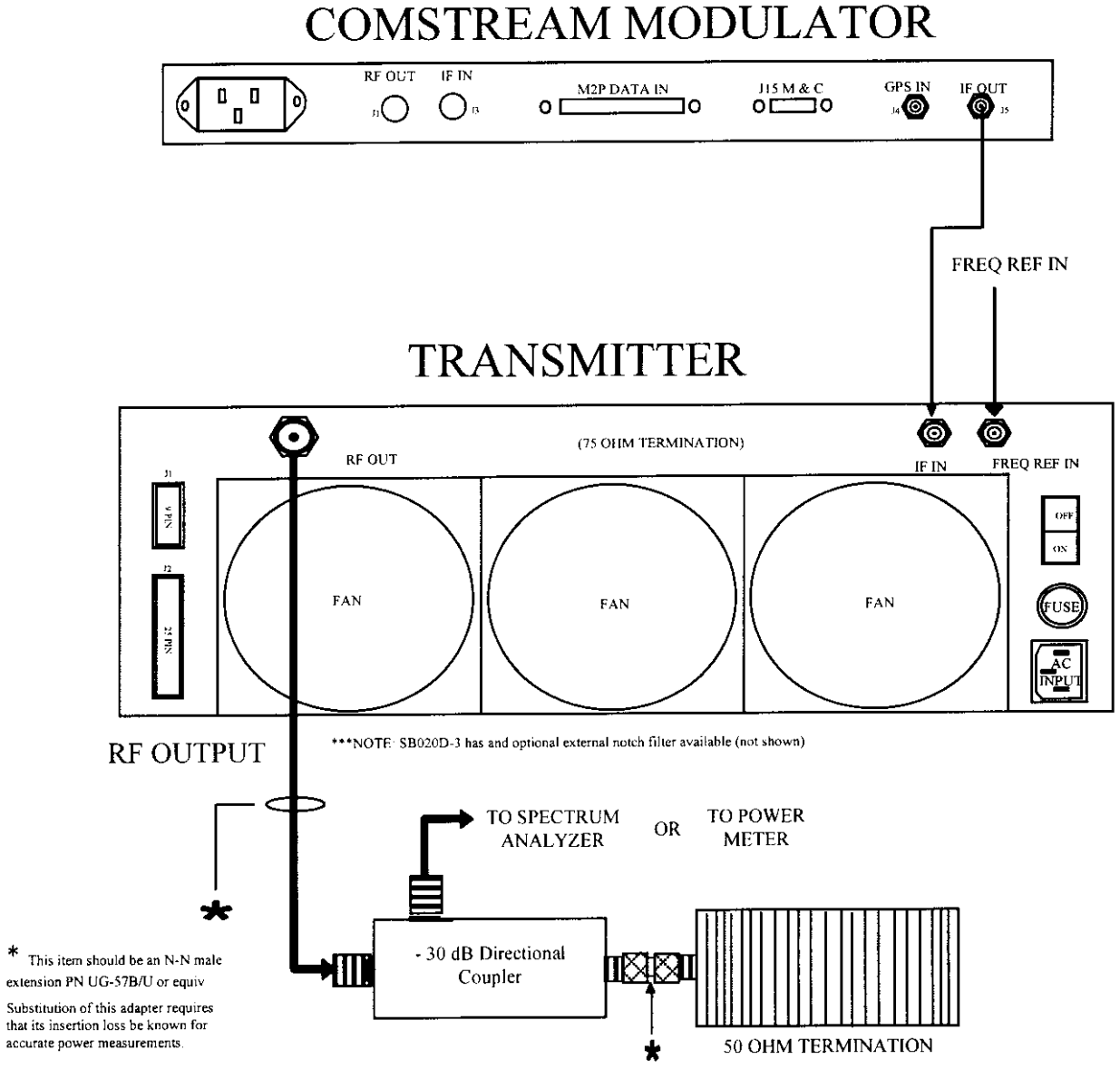
* This item should be an N-N male extension PN UG-57B/U or equiv.
Substitution of this adapter requires that its insertion loss be known for accurate power measurements.

Created by: Kimberly Simeone 7/13/98	*Checked by: Ivan Hernandez 9/12/98*	*Released by: Paulo Correa 10/28/98*

Document #: DOC16-0012

REV: A

TRANSMITTER POWER CALIBRATION TEST SET UP, COMSTREAM MODULATOR



Created by: Kimberly Simeone 7/23/98	*Checked by: Ivan Hernandez* 9/12/98	*Released by: Paulo Correa* 10/28/98

INPUT LINE VOLTAGE CONFIGURING

This transmitter can be configured to operate at 110 to 120 VAC or 220 to 240 VAC. The factory normally configures the transmitter for the user's AC operating line voltage. However, circumstances may develop that dictate using the transmitter at a different input AC line voltage. The following information describes how to reconfigure a transmitter for a different input AC line voltage.

Notes: 1. See troubleshooting section for Equipment Fusing.
2. This procedure is only applicable to Deltron Switching Power Supplies.

DELTRON SWITCHING POWER SUPPLY:

The Deltron switching power supply operating input line voltage is changed by reconfiguring a jumper wire, changing an input Metal Oxide Varistor (MOV), replacing power supply fuse F1 and main chassis fuse, and replacing cooling fans with correct AC voltage rating. To reconfigure the switching power supply to a different input line voltage, perform the following:

1. Turn off the transmitter AC power and disconnect the AC line cord from the power receptacle. Locate the switching power supply.

2. Refer to document # DOC22-0004 to reconfigure the main switching power supply jumper. If necessary, remove power supply to gain access. Locate the wire jumper. Using needle-nosed pliers, carefully pull jumper from stud mount labeled either E2 or E3. Move jumper to stud mount corresponding to desired AC line input voltage.

3. For proper surge protection, the correct MOV must be installed across the switching power supply input terminals "L" and "N". For 110 to 120 VAC line voltages, use an MOV rated at 150 VAC (part number 150L10A). For 220 to 240 VAC line voltages, use an MOV rated at 275 VAC (part number 275L20).

4. Replace switching power supply input line fuse F1 with appropriate rating depending upon the input voltage selected. Use a 15-ampere fuse for 117 VAC and an 8-ampere fuse for 230 VAC. See power supply PCB labeling.

5. Replace rear mounted main input AC fuse, located on the rear panel of the transmitter. Use a 12-amp fuse for 117 VAC and a 6-amp fuse for 230 VAC.

6. Remove and replace cooling fans to correspond to new operating voltage.

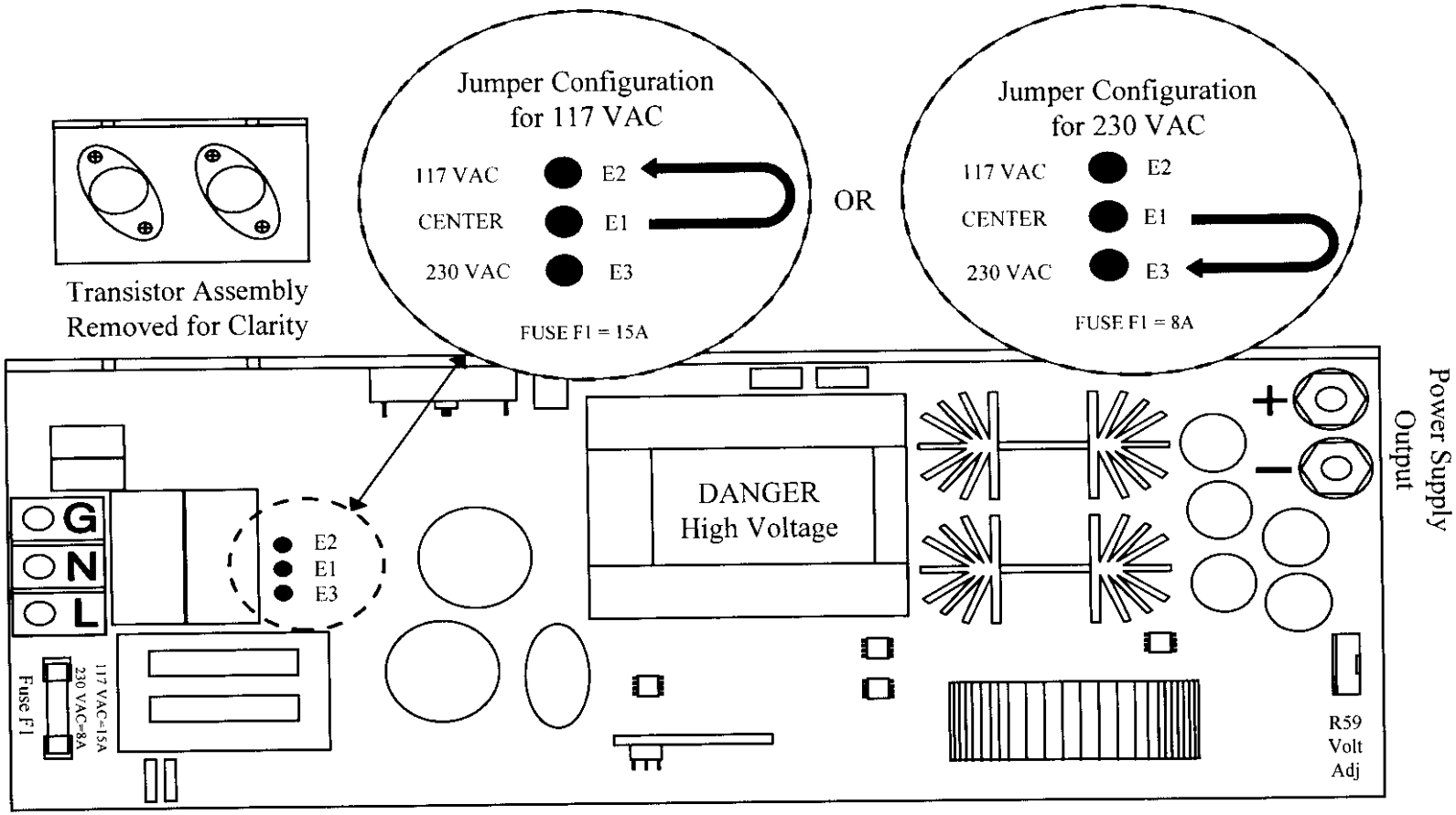
7. Switching power supply has been reconfigured. Reinstall power supply.

Created by: Kimberly Simeone *7/27/98*	*Checked by: Ivan Hernandez* *9/12/98*	*Released by: Paulo Correa* *10/28/98*

LINEAR POWER SUPPLY:

The linear power supply operates from a power transformer that requires specific configuring for the AC input source used. The primary transformer wiring is changed to reflect the AC input line voltage. See document # DOC22-0004 for details. For 230 VAC operation, the center terminals are connected using a white jumper wire. For 117 VAC operation, one center terminal is connected to one primary input as shown in DOC22-0004.

INPUT LINE VOLTAGE FOR A DELTRON 500 WATT POWER SUPPLY



Created by: Kimberly Simeone 7/23/98	*Checked by: Donald Wike 10/28/98*	*Released by: Paulo Correa 10/28/98*

Document #: DOC22-0004

REV: A

SECTION 4

Now that your system is up and running, it is time for a brief description of each module/board found within the system.

This section will break your system down into individual segments. You will find theory of operations for individual sections of your system, along with specifications if available. It is recommended that you contact Comwave customer service when you need repairs.

Additionally, schematics may be included in this section, if available.

DRAWER – INTERNAL THEORY OF OPERATION

The SB020D-1 receives an Intermediate Frequency (IF) AM modulated visual and FM modulated aural carrier which is converted to S-band frequency. These microwave carriers are sent through a common amplifier chain to produce an RF output signal. The transmitter provides a visual output of 20 watts peak sync and a 15 dB ratio or visual to aural power. An RF signal path block diagram follows, document # DOC15-0008.

The visual (-8dBm) and aural (-23 dBm) IF carriers are combined internally by the transmitter. (It is also capable of accepting an externally combined signal, depending upon the needs of the system). The IF input signal is cabled to an IF Processor where precorrection is introduced to reduce most linear distortions of the final amplifier. The IF Processor also contains an Automatic Level Control (ALC) circuit for maintaining 100% output power over a ±2dB IF input range. Both precorrection and ALC can be turned off by individual switch controls located on the module exterior.

The IF Processor output is applied to a driver module where the IF signal is converted with a microwave local oscillator. A bandpass filter follows the mixer to prevent out-of-band products from being amplified and transmitted. The signal then goes back to the driver, where it is amplified.

The Final Amplifier is a broad band, fixed gain linear amplifier that does not require any tuning. A -20 dB directional coupler follows providing forward and reflected power samples to an envelope detector. The envelope detector sends the detected samples to the motherboard for metering. The Notch Filter is the last module the signal passes through before exiting the transmitter, here, the signal is corrected for intermodulation distortions. 43 dBm peak visual and + 28 dBm aural power are available at the RF output.

SB020D-1 FRONT/REAR DESCRIPTIONS

This section explains the SB020D-1 front and rear panel features.

FRONT PANEL
Refer to document # DOC23-0018 for numerical references.

1. METER: Provides a visual indication of transmitter status and performance of + 11 V_{DC} switching power supply, reflected power, or forward average power. Meter is calibrated to display relative measurements. The five-position rotary function switch controls meter function.

2. FUNCTION SWITCH: A five-position, user selectable, rotary switch that controls front panel analog meter monitoring. The following parameters are selectable for monitoring by the function switch.

STANDBY:	Disables transmitting. Serves as system reset. Power remains applied to all circuits. Meter will read approximately 0 %.
METER OFF:	Transmitter is enabled. Metering disabled. Meter will read approximately 0 %.
+ 11 V PS:	Provides status of main switching power supply. Meter reads 100 % indicating proper power supply voltage.
REF PWR:	Relative reflected power measurement. Readings less than 10 % are typical.
FWD PWR:	Relative average forward output power measurement. 100 % meter reading confirms 20 watts peak visual output.

3. LED's: Status monitoring LED's which provide visual indication of operating parameters and internal diagnostics. The following status monitoring LED's illuminate GREEN during normal operation. Absence of an LED indicates a missing signal or parameter that results in a controlled automatic transmitter shut down.

IN SIGNAL:	Presence of an input signal.
INTERLOCK:	Interlock logic conditions are satisfied.
TRANSMIT:	In transmit mode.

The following status monitoring RED LED's remain OFF during normal operation. When a failure is detected, the appropriate LED will illuminate RED. Controlled automatic transmitter shut down is a function of failure severity. Presence of a RED status LED with normal meter readings and/or normal transmitter operation indicates an out of tolerance condition with that circuit.

TEMPERATURE:	Internal chassis temperature has exceeded + 160 degrees Fahrenheit (+ 71 degrees Celsius). Transmitter shut down occurs. Allow transmitter to cool. Transmitter reset can be attempted by rotating the front panel function switch to STANDBY.
LOCAL OSC:	Absence of the local oscillator reference signal. Transmitter shut down occurs.
RF POWER:	Transmitter average output power has decreased too less than 50 % of full output. Transmitter shut down occurs.
PWR SUPPLY:	A failure in the + 11 volt DC main switching power supply or an out of tolerance condition has been detected by the diagnostic and monitoring circuitry. Transmitter shut down occurs.
DRIVER:	A failure or an out of tolerance condition with the driver module. Transmitter usually operates at reduced aural output power.

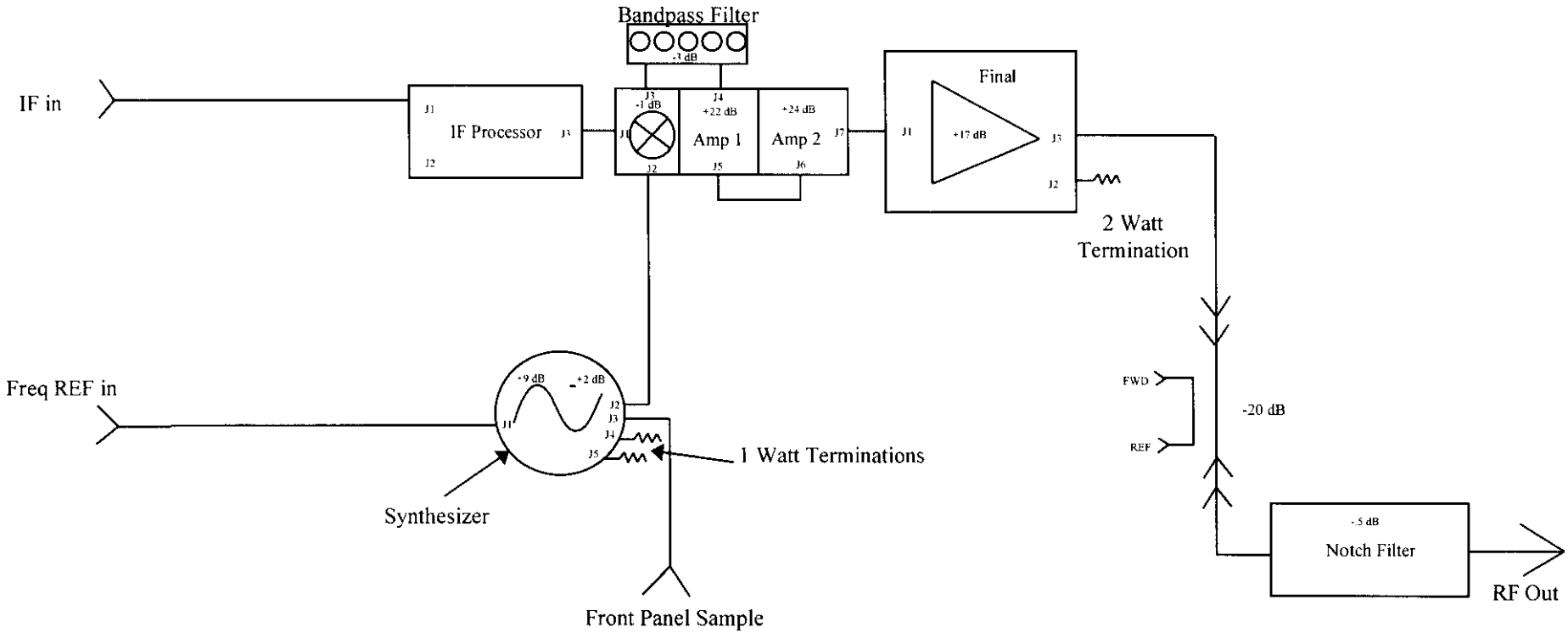
FINAL: A failure or an out of tolerance condition with the final module. Transmitter usually operates at reduced aural output power.

4. LOCAL OSC TP: A front panel mounted Local Oscillator test point at +9 dBm, ± 3 dB.

REAR PANEL
Refer to document # DOC23-0019 for numerical references.

1. J2: 25-pin connector for diagnostics and module voltage level monitoring.
2. J1: 9-pin connector that supplies a video presence signal between the modulator and the transmitter.
3. RF OUT: Combined visual/aural output female N type connector.
4. IF IN: Composite visual/aural input signal from modulator (female BNC connector).
5. FREQ REF IN: An external 10 MHz reference signal input connector (female F connector). When an internal reference card is used, this connector becomes an output to drive 3 transmitters.
6. POWER SWITCH: Main chassis ON/OFF power switch.
7. FUSE: Main line fuse location.
8. AC INPUT: AC Line input power cord connector.
9. FANS: Three rear-mounted fans provide for cooling. Fans are wired for either 117 VAC or 230 VAC depending upon the user application.

SB020D-1 BLOCK DIAGRAM

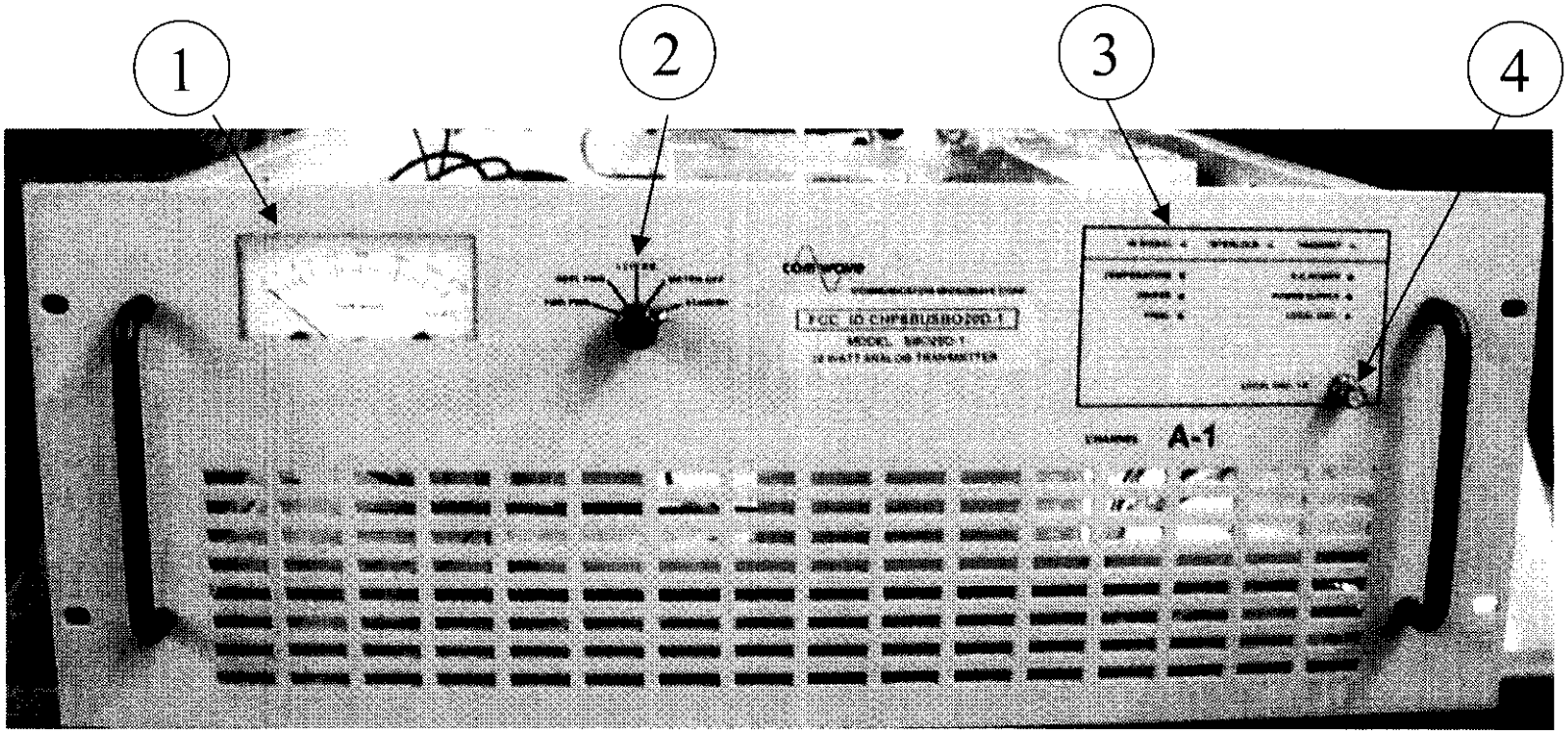


Created by: Kimberly Simeone 7/23/98	*Checked by: Ivan Hernandez 9/12/98*	*Released by: Paulo Correa 10/28/98*

Document #: DOC15-0008

REV: A

SB020D-1 FRONT PANEL

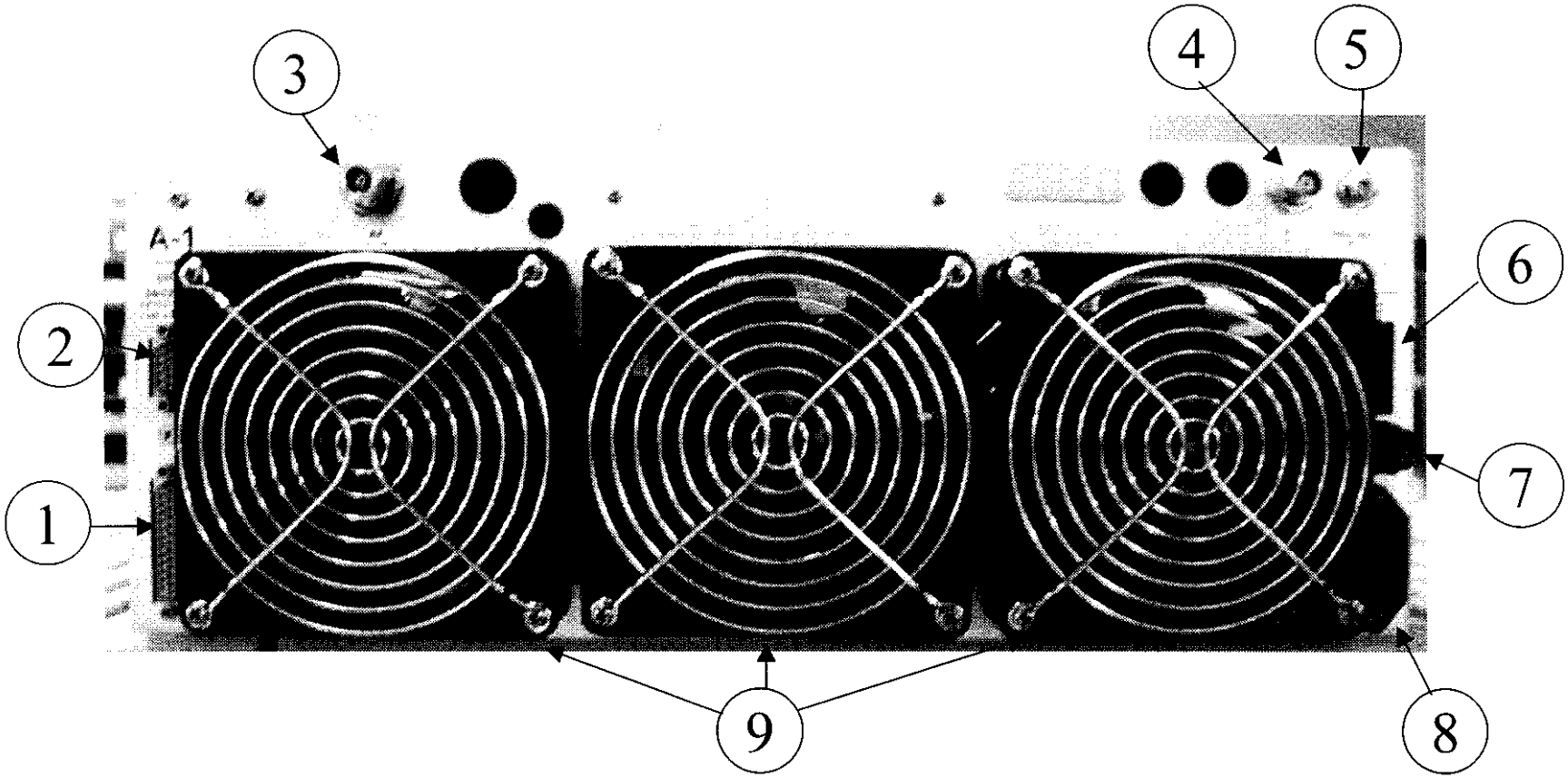


Created by: Kimberly Simeone 8/5/98	*Checked by: Ivan Hernandez 9/12/98*	*Released by: Paulo Correa 10/28/98*

Document #: DOC23-0018

REV: A

SB020D-1 REAR PANEL



Created by: Kimberly Simeone 9/11/98	*Checked by: Ivan Hernandez 9/12/98*	*Released by: Paulo Correa 10/28/98*

Document #: DOC23-0019

REV: A

IF PROCESSOR

The precorrector module contains linearity correction circuitry and an automatic level control (ALC). Linearity correction circuitry pre-corrects for non-linearities developed in the solid state power amplifiers. The ALC maintains 100% output power over a $\pm$ 2 dB IF input range. An IF signal is applied to J1 with a precorrected ALC regulated output signal appearing at J3.

The IF input signal is attenuated by a variable pin diode attenuator circuit. Depending upon the amount of forward bias, pin diodes act as variable resistors to the RF signal.

Following input attenuation, a two port passive combiner receives the IF signal. The combiner is typically used in systems when an auxiliary IF carrier signal is required. The auxiliary carrier is combined to the IF signal and is amplified in common service.

The IF signal is sent through two stages of amplification and is applied to temperature compensated linearity correction circuitry. The signal is applied to three linearity correction circuits each correcting for a separate part of the signal. With switch S1 ON, a voltage is applied to each circuit forward biasing schottky diodes, enabling compensation. When the switch is OFF, a voltage is applied reverse biasing the diodes, disabling compensation. Compensation of each circuit is adjustable by potentiometers. These adjustments control the amount of forward bias through the compensating diodes.

A band switching circuit is employed when used with an agile transmitter. This circuit selects the biasing network to a pin diode. A control signal is received that enables a relay to select between two levels of compensation. This allows improved compensation at the band extremes.

The signal is sent to a final pin diode circuit where a reference signal determines the RF output attenuation/level control. Switch, S2, selects between automatic ALC or a predetermined manual reference level. A manual reference is determined by varying the output from an 8 V_{DC} regulator. The ALC circuitry compares a voltage proportional to average output power with a predefined reference and adjusts the variable pin diode attenuator to make the two voltages equal.

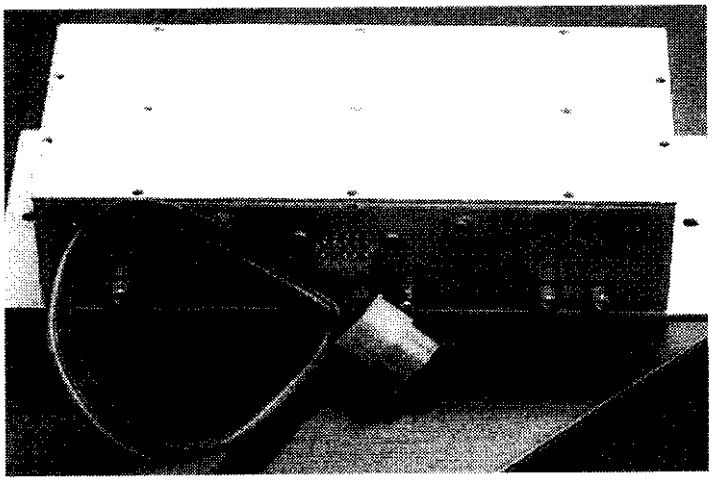


FIGURE 13-0034-1

Created by: Kimberly Simeone 9/14/98 ECO #: 98-116	*Checked by: Donald Wike* 9/18/98	*Released by: Andre Castro* 10/2/98

IF PROCESSOR SPECIFICATIONS

PARAMETER	*SPECIFICATION*
Input Impedance	50 or 75 Ω
Adjustable Range	20 dB typical
IF Input any NTSC/PAL standards 64 QAM/256 QAM & 8-VSB/16-VSB	 -8dBm (+/-2dB) peak power -15 dBm (+/-2dB) avg. power
AUX Input	any Auxiliary carrier up to -8dBm peak power
Output Impedance	50 Ω
Limit	set to 2 dB above transmitters rated power
ALC Range	+/-2 dB from nominal
Frequency Response In-band (all standards up to 8Mhz wide) Broadband (30Mhz to 350Mhz)	 .5dB +/- .5dB 8dB +/- 3dB
Gain	6dB +/- 3dB
Power supply requirements Voltage Current	 +12V +/- .5V 250ma typical @ 25 ° Celsius 500ma typical @ 0° Celsius
Temperature range No precorrection change Minimal precorrection change	 0 TO 50° Celsius -30 TO 50° Celsius

Created by: Kimberly Simeone 10/28/98	*Checked by: Donald Wike 10/29/98*	*Released by: Paulo Correa 10/29/98*

**Specifications subject to change without notice*

Document #: DOC19-0035
REV: A

MIXER/DRIVER AMPLIFIER

This module consists of three compartments: a Mixer, an Intermediate Amplifier #1, and a Driver Amplifier #2. No user tuning adjustments are needed or provided.

Mixer: This section consists of a balanced mixer being driven from the LO injection input via the 180° balun and an IF signal input via a low pass filter. A microwave short is formed by a capacitor. The heterodyned product is coupled out of the diodes by a printed Wilkinson hybrid. This hybrid will substantially reduce the LO injection signal at the output due to its out of phase cancellation. The microwave signal is amplified by a low noise, 50-ohm hybrid amplifier that is biased by a resistor. Decoupling of the supply is by a printed decoupling line, two capacitors, and a resistor.

Intermediate Amplifier #1: This amplifier consists of two identical bi-polar transistor amplifiers in cascade. A transistor base bias via two resistors is derived from a common collector resistor. As current attempts to rise above the nominal 14 mA, voltage to the base circuit is reduced, thus causing a stabilizing feedback. A printed decoupling line, two capacitors and a resistor provides base and collector decoupling.

Drive Amplifier #2: This amplifier consists of two similar FET transistor amplifier stages in cascade. From a common module feedthrough filter, +10 V_{DC} is supplied to each transistor's drain circuit via a printed decoupling line and two capacitors. From a common -12 volt feedthrough, negative gate voltage is divided down and calibrated by two resistor networks. The potentiometers set the drain current of each device.

MIXER/DRIVER SPECIFICATIONS

Mixer/Driver Specifications	
Power Supply Requirements	+10 V @ 1.1 Amp -12 V @ 12 mA
Device Current	Q-1 - 45 mA Q-2 - 14 mA (typical) Q-3 - 14 mA (typical) Q-4 - 360 mA Q-5 - 720 mA
Sectional Gain	Mixer 0dB + 1dB, -2dB Amp #1 22 dB ± 1dB Amp #2 24 dB ± 1dB
Center Frequency	MDS 2.15 GHz ITFS/MMDS 2.6 GHz
1 dB Bandwidth	MDS 50 MHz ITFS/MMDS 200 MHz/min.
Input/Output Impedance	50 Ω

DOCUMENT #: DOC19-0006
REV: A

Created by: Kimberly Simeone *9/10/98 ECO #: 98-116*	*Checked by: Donald Wike* *9/18/98*	*Released by: Andre Castro* *10/2/98*

BANDPASS FILTER

This filter consists of a four-section bandpass filter with variable input and output loading probes. It is used to remove out-of-band mixing products following the mixer. Tuning elements are variable length lines inside each cavity. Coupling between each section consists of fixed apertures, which set the bandwidth. A fifth section is coupled into the last section of the filter. This section forms a notch filter, which is tuned to the L.O. frequency.

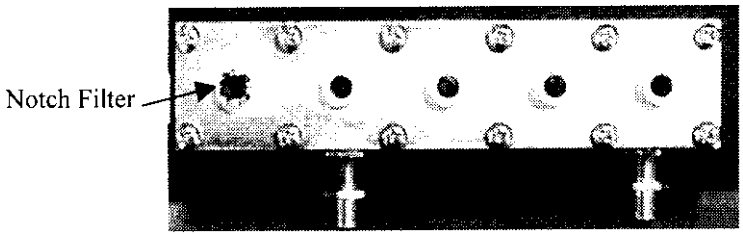


FIGURE 13-0035-1

BANDPASS FILTER SPECIFICATIONS
05-025

	Specification
Bandwidth (1 dB)	20 MHz
Insertion Loss	1 dB ± 0.5 dB
Tuning Range: MMDS/ITFS	2.05 – 2.4 GHz

DOCUMENT #: DOC19-0022
REV: A

BANDPASS FILTER SPECIFICATIONS
05-037

	Specification
Bandwidth (1 dB)	20 MHz ± 10%
Insertion Loss	2.5 dB ± 0.5 dB
Tuning Range: MMDS/ITFS	2.45 – 2.75 GHz minimum

DOCUMENT #: DOC19-0011
REV: A

MICROWAVE SYNTHESIZER

The microwave synthesizer module determines the microwave upconverter mixer input and transmitter output operating frequency. The operating frequency is determined by programming of the phase locked loop frequency synthesizer. Miniature DIP switches SW1 and SW2 set N counter and A counter PLL programming inputs. A 10 MHz input reference signal applied to J1 determines the frequency stability of the PLL.

The synthesizer module uses a microwave prescaler, dual modulus prescaler, and internal dividers to reduce the 10 MHz reference and microwave voltage controlled oscillator (VCO) frequencies to 25 kHz for the 09-049 series or 125 KHz for the 09-073 series. These signals are applied to separate inputs of a phase detector. Input signals of equal phase generate no change in output. Should the VCO deviate in frequency, a phase shift is detected causing an integrator/low pass filter to generate a DC control voltage proportional to the offset frequency. This control voltage is applied to the microwave VCO to return it to the selected frequency.

The microwave local oscillator frequency is derived by adding (or subtracting in certain cases) the desired transmitter channel frequency to the incoming IF frequency:

EXAMPLE:

Visual Output Frequency	+	Visual IF	=	Microwave LO Frequency
2501.25 MHz	+	45.75 MHz	=	2547 MHz
Aural Output Frequency	+	Aural IF	=	Microwave LO Frequency
2505.75 MHz	+	41.25 MHz	=	2547 MHz

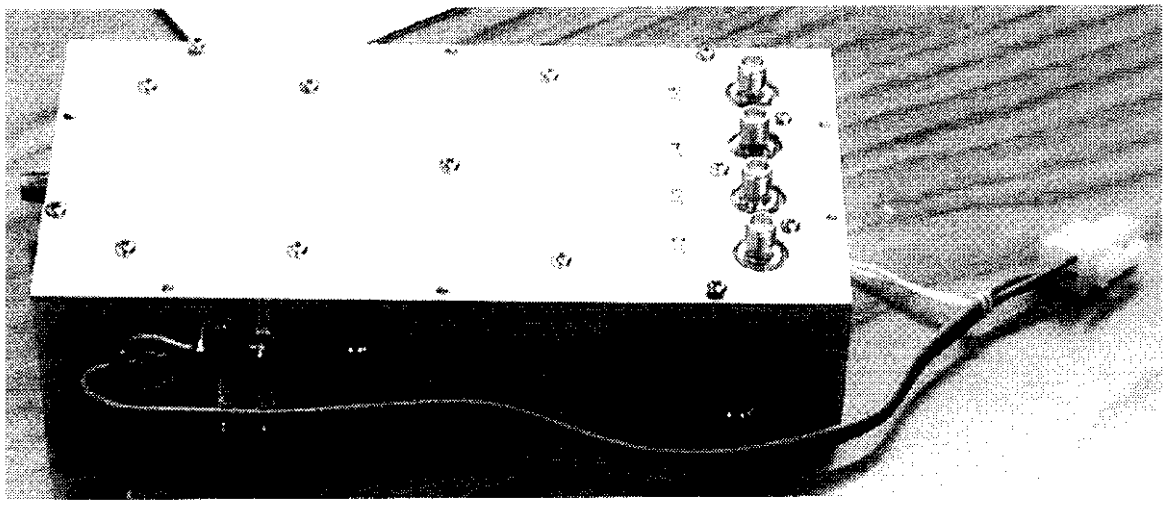


FIGURE 13-0020-1

MICROWAVE SYNTHESIZER

PARAMETER	*SPECIFICATION*
VCO P/Ns	V803SE01, V604SC01
Reference Input Frequency	10 MHz (Standard) accuracy 1 x 10^{-7} min
RF Output Frequency Range	Low Band: 2.0 - 2.4 GHz, High Band: 2.35 - 2.75 GHz
Reference Sensitivity	1 input at +10 dBm, +5 dB/-10dB
RF Output Level	4 outputs at +9 dBm, ±2 dB
Step Size 09-049 series 09-073 series	 50 KHz 250 KHz
Output Impedance	4 outputs at 50 ohms **NOTE: All unused ports must be terminated**
Isolation Between Ports:	J2-J3: ≥ 25 dB J2-J4: ≥ 35 dB J2-J5: ≥ 35 dB J3-J5: ≥ 35 dB J3-J4: ≥ 35 dB J4-J5: ≥ 25 dB
Phase Noise at 10 KHz (1 KHz Res BW)	-85 dBc/Hz min
Spurious	0 to ±10 KHz — below 1/f noise floor ±10 KHz to ±50 KHz — -60 dBc or greater ±50 KHz to beyond — -65 dBc or greater
Harmonics	-35 dBc or greater
Phase Lock Indication Locked state Unlocked state	 3.30 vdc typical (across 10K ohms) .290 vdc typical (across 10K ohms)
Power Supply Requirements	+12 vdc ± .5v +12 vdc 450 mA typical +12.5 vdc 750 mA typical
Temperature Range	-30 to +50° Celsius

Created by: Kimberly Simeone 10/28/98	*Checked by: Donald Wike 10/29/98*	*Released by: Paulo Correa 10/29/98*

**Specifications subject to change without notice*

Document #: DOC19-0034
REV: A

FINAL AMPLIFIER

The Final Amplifier module receives an input signal at J1 and provides an amplified output at J3. The amplifier module consists of seven FET amplifier transistors operating in a two driving five parallel configuration. Printed input hybrids (H2, H3, and H4) split the input signal to drive the five transistors equally. Output hybrids (H5, H6, H7, and H8) recombine the amplified signals to a common output.

Biasing of each FET is identical, therefore, only Q1 is discussed. +10 VDC is supplied to the drain through an EMI feed through filter. A printed decoupling line, C63, C64, C5, and R6 decouple the drain circuit. Negative 12 volts DC gate bias enters the module through a common EMI feed through filter. This voltage is divided and calibrated by resistors R2, R3, and VR1. VR1 sets the operating drain current. A printed decoupling line, C62, C3, and R4 decouple the gate circuit. No tuning adjustments are needed or provided.

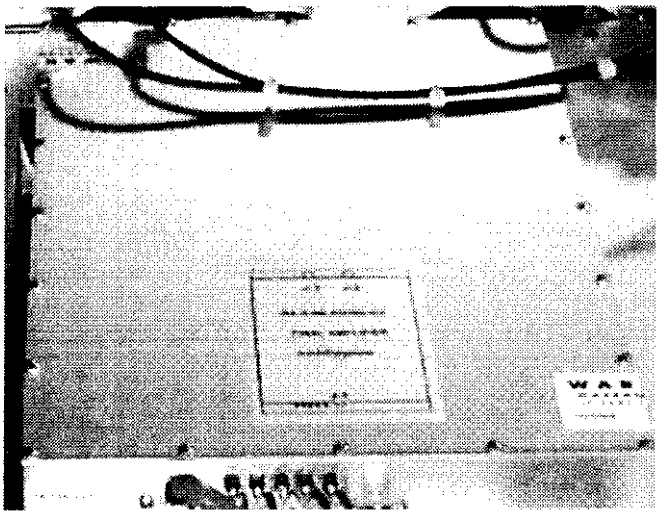


FIGURE 13-0022-1

FINAL AMPLIFIER SPECIFICATIONS

Final Amplifier Specifications	
Power Supply Requirements	+10 V_{DC} @ 15.4 Amp -12 V_{DC} @ 52.5 mA
Drain Current	Q1 to Q7 -2.2 Amp each
Module Gain	17 dB ± 1 dB
Center Frequency	ITFS/MMDS -2.6 GHz
1 dB Bandwidth	200 MHz
Minimum Output Power	+ 45 dBm
Input/Output Impedance	50 ohm

Document #: DOC19-0007
REV: A

Created by: Kimberly Simeone 7/21/98	*Checked by: Ivan Hernandez 9/12/98*	*Released by: Paulo Correa 10/29/98*

ENVELOPE DETECTOR

The envelope detector is a two input module that receives forward visual and reflected power samples from a -20 dB coupler connected to the power combiner output. The forward sample is applied to SMA J1 and the reflected sample to SMA J2. D1/D2 and R3/C1 and R6/C2 detect the RF sample converting it into representative DC voltages. These voltages are sent to the motherboard for peak detection/feedback control. The visual sample is used for ALC control and the reflected sample for diagnostics.

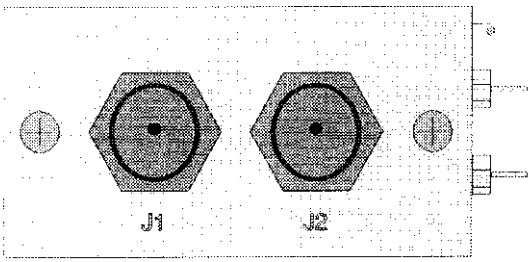


FIGURE 13-0023-1

NOTCH FILTER

The notch filter is the last module the signal passes through before exiting the transmitter. The purpose of the notch filter is to correct for intermodulation distortions. There are four notches in the filter which are divided into two sections. The sections are composed of two non-adjacent notches as shown in the diagram below.

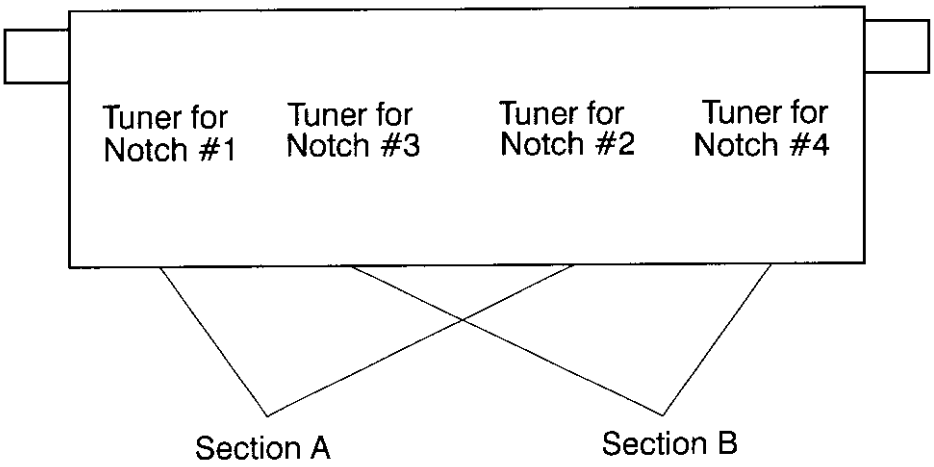


FIGURE 13-0032-1

For digital use:
Section A consists of Notches One and Two which are tuned to minus 1.5 times and minus 1 times the channel bandwidth with respect to the center frequency of the channel (F_C - BW and F_C - 1.5 BW). Notches Three and Four, Section B, are tuned as section A, F_C + BW and F_C + 1.5 BW.

For analog use:
Section A consists of Notch One and Notch Two which are tuned to the frequency of the video carrier (f_V) minus the separation of the frequency between the visual and aural carriers (f_V - f_A) and 2(f_V - f_A). Therefore, Notch One and Notch Two are tuned to f_V - (f_V - f_A) and f_V - 2(f_V - f_A). Notch Three and Notch Four, Section B, are tuned for f_V + (f_V - f_A) and f_V + 2 (f_V - f_A).

(The notch filter is factory tuned for a precise frequency response before the transmitter is shipped.)

Note: Each section may be tuned either above or below the channel center frequency, but no two adjacent notches are to be tuned in the same direction.

Created by: Kimberly Simeone *9/15/98 ECO #: 98-116*	*Checked by: Donald Wike* *9/18/98*	*Released by: Andre Castro* *10/2/98*

Example: Notches One and Three cannot be tuned to $f_V - (f_V - f_A)$ and $f_V - 2(f_V - f_A)$ below the channel.

The frequency for each notch in an analog system, is calculated as follows:

2501.25 MHz - (2505.75 -2501.25) = 2496.75

2501.25 MHz - 2(2505.75-2501.25) = 2492.25

NOTCH FILTER SPECIFICATIONS

Specifications		
Notch Characteristics	FREQ. (GHz)	ATTEN (dB)
	2.0	≈20
	2.7	≈12
Insertion Loss		
Channel Center Frequency ± 3 MHz	.6 dB maximum (analog)	
Channel Center Frequency ± 2.6 MHz	.5 dB maximum (digital)	

DOCUMENT #: DOC19-0010
REV: A

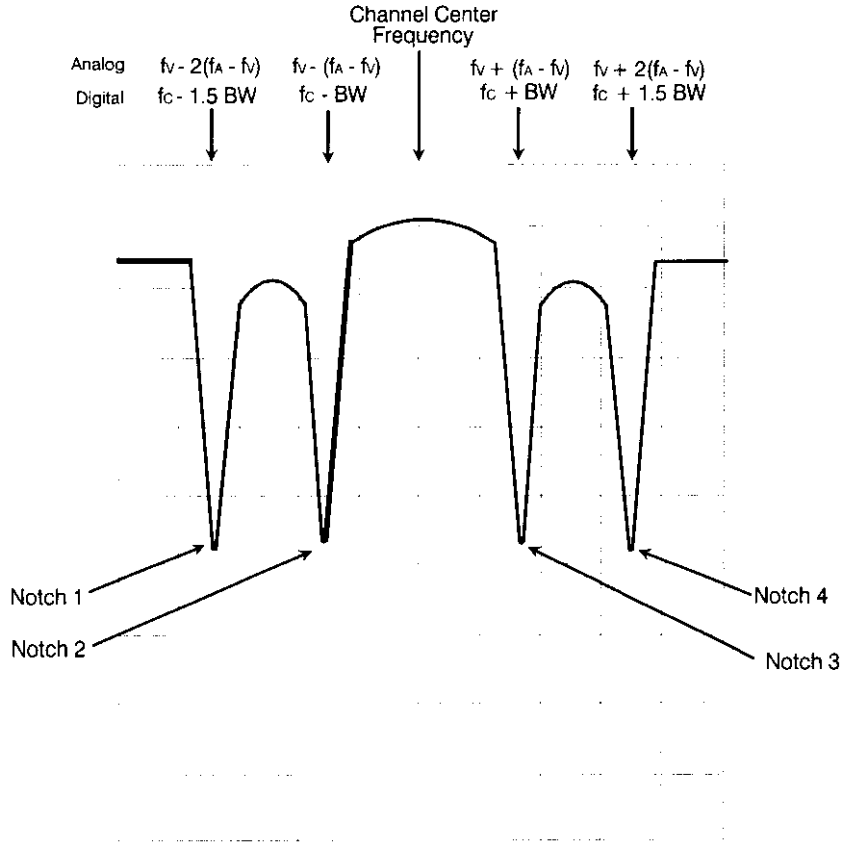


FIGURE 13-0032-2

MOTHERBOARD

The Motherboard performs a variety of functions allowing operation for both analog and digital applications. Located on the underside of the transmitter, it provides the majority of the interconnections among other circuit boards and modules. The board contains linear power supplies, current sampling resistors, metering adjustments, one +12 volt power supply fuse, and three +11 volt power supply fuses.

Interconnections: Power and logic signals are routed to/from various module or circuit card assemblies via the motherboard and main harness. Consult the interconnection diagram, to be provided at a later date, for guidance. The Synthesizer, IF Processor, and amplifier modules plug directly into this board for DC supply and monitoring.

Linear Power Supplies: -12, + 12, and +5 volt linear power supplies are located on this printed circuit board. These DC power supplies provide power to operational amplifiers, comparators, gating circuits, and other modules.

- The negative 12-volt circuit consists of a center tapped full wave rectifier, filtering capacitors, and an adjustable regulator. The voltage can be calibrated adjusting VR5 on the board, while monitoring TP1. Short circuit protection is provided internal to the regulator.

Note: This adjustment should only be done in operation mode, due to FET gate pinch off during transmitter turn on. While in a standby or reset condition the negative supply will read approximately -15 V_{DC}. When rotated from standby a small time delay will occur before returning to - 12 volts.

- The positive 12-volt circuit consists of a center tapped full wave rectifier, filtering capacitors, fixed 12-volt regulator and a current boost transistor. The current boost transistor, when conducting, provides a parallel path for added current to the 1.5 amp. regulator. A fuse (F4) is provided on the motherboard for short circuit protection. A voltage test point (TP2) is provided for monitoring.

- The positive 5-volt circuit consists of a full wave rectifier, filtering capacitor, and a fixed 5-volt regulator. Short circuit protection is provided internal to the regulator. A voltage test point (TP3) is provided for monitoring.

Sampling Resistors: The +11 volt switching power supply connects to screw terminals 3, 4, & 5 to distribute power to the driver, prefinal, and final amplifier modules. Power is distributed through series current sample resistors. These resistors develop voltage drops proportional to the supplied drain current. Samples are routed to the diagnostics board for processing.

+11 Volt Power Supply Fusing: The motherboard contains three fuses that protect the switching power supply. F1 (15 Amperes) provides power to the driver and prefinal, if applicable.

Metering Calibration: The front panel analog meter or LCD display is calibrated by trim potentiometers located on the motherboard. These adjustments calibrate the +11 V_{DC} switching power supply (VR1), Aural (VR2) when applicable, Reflected power (VR3), and Forward power (VR4). These potentiometers are accessible when the transmitter's cover is removed, they are located in the center of the chassis. Consult the Calibration section of the manual for detailed procedure.

LOGIC CONTROL P.C. ASSEMBLY

This plug-in circuit board serves to control the operation of the upconverter/amplifier by providing eight basic functions:

A.	Auto ON/OFF Transmitter Control	E.	Thermal Interlock
B.	Video Presence Control Bypass	F.	External Amplifier Interlock
C.	Power Supply Comparator Interlock	G.	Local Standby Control
D.	FET Bias Interlock	H.	Remote Standby Control

Turn ON of the transmitter/power supply occurs upon logic satisfaction of AND gates U3A and U3B. With all AND gate inputs satisfied with TTL highs, the output of U3B is high turning on Q3. Q3 sinks current from Q4, keeping it in cutoff allowing +5 VDC to the power supply enable and turn on the switching power supply. Failures or missing input signals disable the switching power supply.

The Logic Control Board contains three status LED's. Under normal operating conditions all LED's illuminate verifying successful turn ON and satisfaction of conditional logic. Red LED D1 verifies that each amplifier module has proper -12 VDC gate bias. Green LED D2 indicates the presence of an applied video input signal. Yellow LED D3 verifies the switching power supply enable.

A. Auto ON/OFF Transmitter Control: Transmit ON/OFF operation is initiated by a TTL high (>3.1 volts) from a modulator video sense circuit, receiver auto-on circuit, or any other external control voltage applied to board inputs at connector E-1 (V) originating from rear panel connector J-1, pin 1. When a video presence voltage is available, Darlington transistor Q2 is biased ON illuminating D2, the Video Presence Green LED. The turn ON signal is delayed to U3B pin 4 by the time constant of R22 and C1. This prevents an instantaneous turn ON of the transmitter due to transients.

B. Video Presence Control Bypass: A video presence control bypass switch SW-1 is located on the side of the PC board assembly. The normal position for this switch is DOWN. DOWN is the equivalent of OFF. When the switch is down, an external input video presence signal must be supplied to turn the transmitter ON. This signal typically originates from a video presence board contained inside the modulator. When this switch is positioned UP, this places the transmitter into BYPASS mode or in a constant ON condition by providing +5 VDC to the input of AND gate U3B pin 4. This enables the transmitter to continue transmitting even though there is no video signal present.

C. Power Supply Comparator Interlock: +11 VDC switching power supply voltage is sampled and monitored by comparator U2B. A series resistive summing circuit consisting of mother PC board fuses F1/F2/F3, resistors R34, R35, R36, and R14 form a voltage divider at a nominal 3.0 VDC input to pin 3 of the comparator.

A fixed threshold voltage of 3.5 VDC is applied to the inverting input of U2B pin 2 and creates a "window" for monitoring the power supply. The operating window is 8.95 to 12.4 VDC. A switching supply voltage sample within the window causes the comparator to output a logic low and sink the +5 VDC pull up voltage from the gate of SCR D4. With D4 disabled, a logic high is present on U3A pin 9. Satisfaction of AND gates U3A and B pass a turn ON signal through Q3. With Q3 biased on, Q4 remains in cutoff. The +5 VDC source powers yellow Power Supply enable LED D3 and supplies a turn On signal to the switching power supply.

A switching power supply deviation above +12.4 VDC causes the comparator to output a logic high and enable the SCR gate. The SCR fires and pulls U3A pin 9 low removing the power supply enable signal.

Comparator U10B on the Diagnostic Interface Board determines the low limit parameter. Any open mother board fuse(s) reduces the comparator input voltage and toggles U10B low resulting in illumination of the RED front panel PWR SUPPLY diagnostic LED.

D. FET Bias Interlock: Negative 12 VDC gate bias from driver and final amp are fed back to edge card connector E-1 pins M, N, P, R, and S. These inputs provide protection in the event of a low or missing amplifier gate voltage. For each circuit, a comparator with fixed voltage reference of +1.15 VDC on the non-inverting input and gate bias sample on the non-inverting input is used. The -12 VDC gate bias is reduced by an input resistors and is combined with +5 VDC providing +.75 VDC to the inverting inputs.

Absence of -12 VDC allows the inverting input to be higher than the non-inverting input causing the comparator to toggle low. A low output from any of the five comparators sinks the pull up voltage. This action extinguishes the red gate bias LED D1 and applies a logic low to AND gate U3A pin 10, shutting down the transmitter.

Illumination of the on board red status LED (D1) indicates that all module gate bias inputs are present.

E. Thermal Interlock: A thermal interlock is provided to shut down the transmitter in the event the internal temperature exceeds +160 degrees Fahrenheit (+71 degrees Celsius). Actuation of the thermostat closes internal contacts and supplies a ground to monitoring circuitry. The ground removes the TTL high from U3A pin 12 thereby disabling the +11 VDC switching power supply. The thermostat automatically resets after a cooling period.

F. External Amplifier Interlock (Remote B): A remote/agile standby control is available for external ON/OFF control of the transmitter without any delays. This interlock return is available at E1 pin T or rear mounted connector J1 pin(2). Voltage is held at +5 VDC by R26/D6. A ground placed on this line pulls AND gate U3A (11) low and disables both the interlock and +11 VDC switching power supply.

G. Local Standby Control: Local standby control of the transmitter is achieved by rotating the front panel function switch to standby. The function switch places a low resistance on R29, which lowers the voltage to approximately 0 volts at U3B-5 for a TTL low. The output of AND gate U3B toggles low to disable the +11 VDC switching power supply.

H. Standby Control (Remote A): A remote standby interlock turn OFF return is available at E1 pin 4 or rear mounted connector J2 (19). Voltage is held at +5 VDC by R28/D7. A ground placed on this line pulls AND gate U3B (3) low and disables the +11 VDC switching power supply.

DIAGNOSTIC INTERFACE BOARD

The Diagnostic Interface Board, located on the chassis underside, receives various signals, performs comparisons to set reference levels, forwards compared outputs to the front panel LED Display board, and provides remote fault status monitoring. The interface board determines amplifier module status by monitoring +11 VDC switching power supply drain currents drawn through motherboard series sampling resistors.

Each module has associated diagnostic circuitry which monitor the operating currents. Excessive or lack of proper current draw causes the respective comparator output to go low and illuminate the applicable front panel diagnostic LED.

SWITCHING POWER SUPPLY

The transmitter chassis contains four power supplies: +12 V_{DC}, +5 V_{DC}, and -12 V_{DC} linear power supplies and a switching +11 V_{DC} power supply. The linear power supplies are found on the motherboard, whereas the switching supply is an independent module.

+11 V_{DC} Switching Power Supply: This supply powers the RF driver amplifiers, and final amplifiers. This is the largest of the power supplies and is capable of 42 amperes minimum. The modular chassis design allows utilization of several commercial supplies. 15-ampere fuse F1 and 25 ampere fuses F2 and F3 located on the motherboard protect the supply DC output.

SECTION 5

This section will provide you with the information you will need to contact Comwave customer service and to return equipment for repair.

CUSTOMER SERVICE

Comwave's customer service personnel are available 24 hours a day to assist with any questions or complications that may arise. After regular business hours, 8-5 Monday through Friday, an answering service will answer calls and forward messages to the appropriate person.

Comwave
Crestwood Industrial Park
395 Oakhill Road
Mountaintop, PA 18707

1-800-266-9283	USA & Canada
1-717-474-6751	International & USA
(Please note as of 12/98, our area code will change from 717 to 507)	
1-717-474-5469	FAX
(Please note as of 12/98, our area code will change from 717 to 507)	

EQUIPMENT RETURNS

In the event the equipment requires return for factory service, please follow the guidelines listed. Comwave cannot be held responsible for damaged equipment received due to improper packing. Contact Comwave with any questions or concerns regarding returning or packaging of equipment.

1. ***Contact Comwave:*** Call Comwave to report the problem and to obtain a "Return Authorization" number (RA). This enables Comwave to accurately track and identify returned equipment for prompt and efficient service. If you do not obtain an RA number prior to sending equipment back Comwave cannot be held responsible for delays in receiving the equipment. These delays will inevitably cause time loss in repairing and returning your product to you.

2. ***Obtain packaging materials:*** Use original boxes and packing materials when returning any equipment. This will safeguard against most in-transit damages. If original boxes and packing materials are not available, contact Comwave to obtain replacement materials prior to shipping. Replacement materials are provided at a nominal cost.

3. ***Pack equipment:*** Use original packing materials and directions provided. Most equipment is packed in a box within another box; this varies with each product. Double boxing provides maximum protection.

Caution: Do not pack equipment using "PEANUTS." Equipment packed using "PEANUTS" as filler does NOT provide sufficient protection during shipping. Rough handling by the carrier may cause permanent damage to the equipment being returned. COMWAVE cannot be held responsible for damaged equipment received due to improper packing.

PACKAGING FOR RETURN

1. Start with an empty box, figure 20-0002-1, from Comwave, if you don't have one please inform customer service when you contact them for a return authorization (RA) number, which you MUST do prior to returning ANY equipment. A box consists of 4 parts, one cardboard box, one cardboard tube, and two polyethylene endcaps, see figure 20-0002-2. If you need to assemble a flattened box, use 2" clear box tape over the bottom seam, using three layers, to assure strength. Then put 4 pieces of fiberglass strapping tape over the edges.

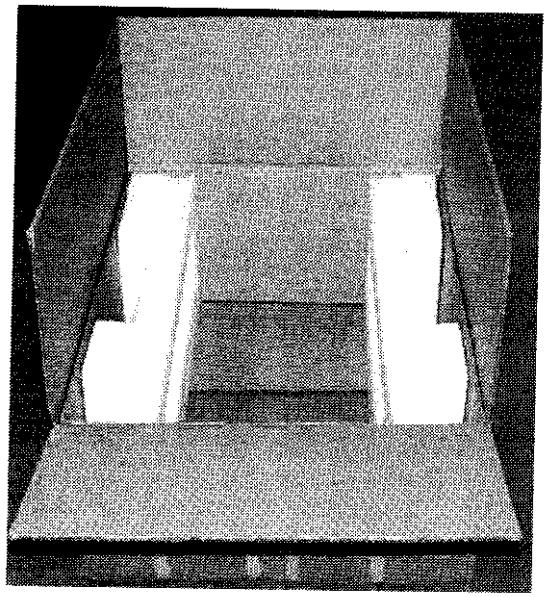


FIGURE 20-0002-1

2. Place the cardboard tube in the box as shown in figure 20-0002-3.

3. Place the polyethylene endcaps against the sides of the equipment as shown in figure 20-0002-4. ***NOTE the front panel fits snuggly into a slotted opening in the endcap.***

4. Put the transmitter into the box with the cardboard tube already in it as shown in figure 20-0002-5.

5. Close the box and seal the top seam with 2" clear box tape, using three layers to assure strength. Then put 4 pieces of fiberglass strapping tape over the edges. Clearly mark the RA number on the outside of the box before shipping.

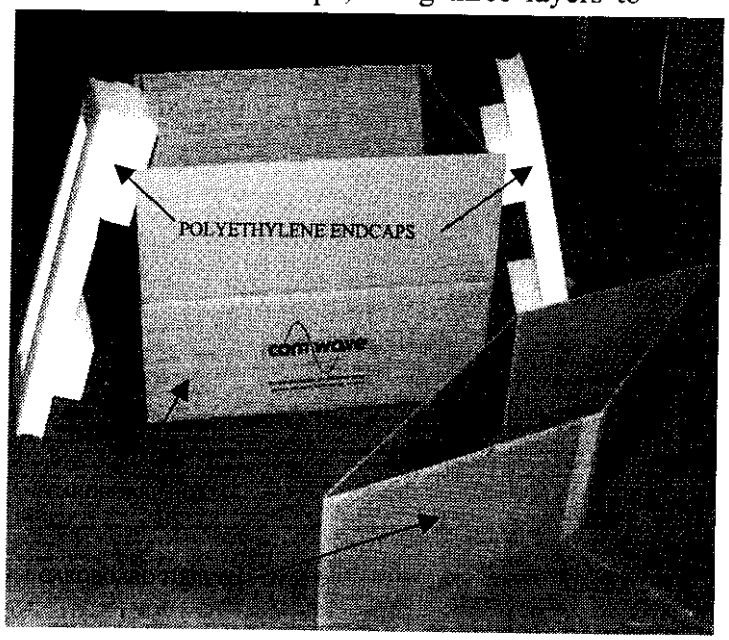


FIGURE 20-0002-2

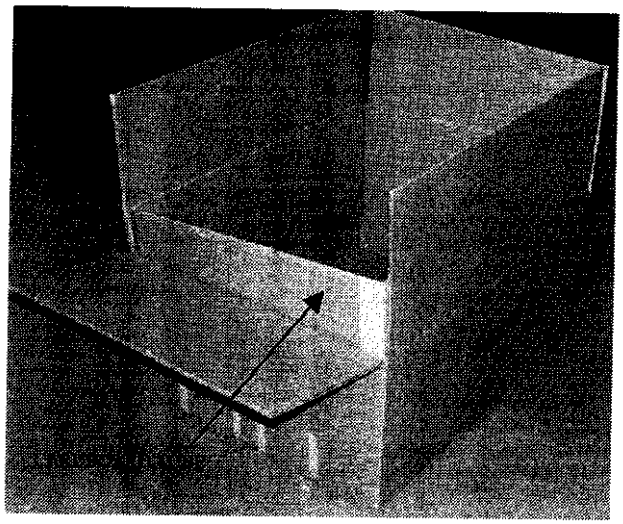


FIGURE 20-0002-3

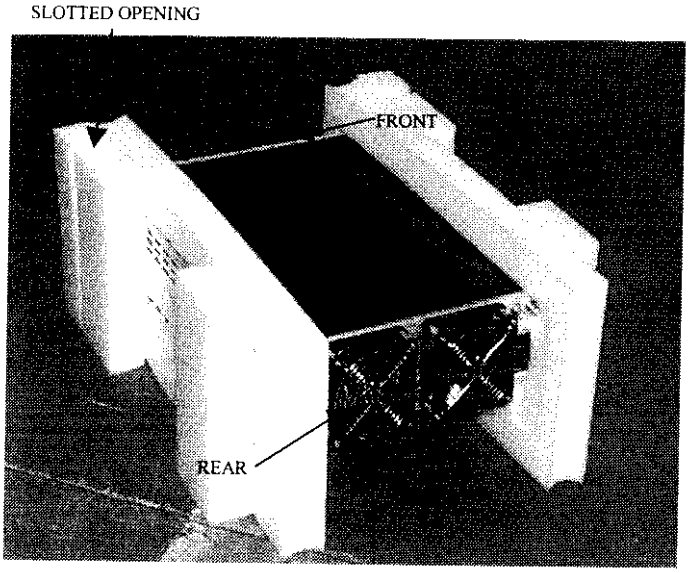


FIGURE 20-0002-4

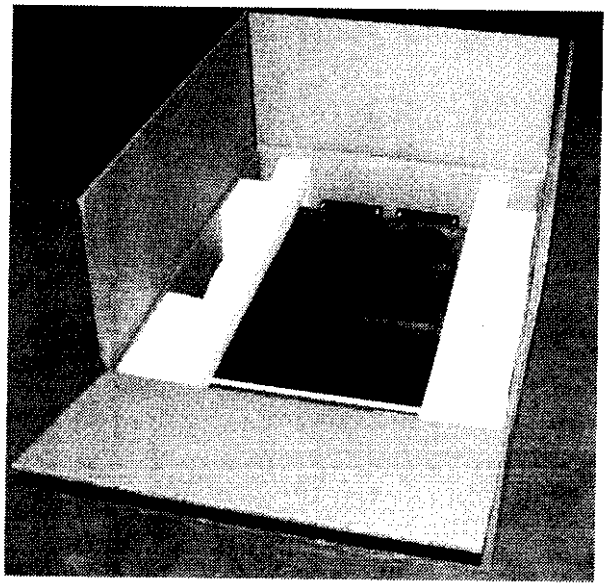


FIGURE 20-0002-5

STANDARD FREQUENCIES PAL M FORMAT 6MHz

GROUP	BANDWIDTH (MHz)	VISUAL (MHz)	AURAL (MHz)
A1	2500-2506	2501.25	2505.75
A2	2512-2518	2513.25	2517.75
A3	2524-2530	2525.25	2529.75
A4	2536-2542	2537.25	2541.75
C1	2548-2554	2549.25	2553.75
C2	2560-2566	2561.25	2565.75
C3	2572-2578	2573.25	2577.75
C4	2584-2590	2585.25	2589.75
E1	2596-2602	2597.25	2601.75
E2	2608-2614	2609.25	2613.75
E3	2620-2626	2621.25	2625.75
E4	2632-2638	2633.25	2637.75
G1	2644-2650	2645.25	2649.75
G2	2656-2662	2657.25	2661.75
G3	2668-2674	2669.25	2673.75
G4	2680-2686	2681.25	2685.75
B1	2506-2512	2507.25	2511.75
B2	2518-2524	2519.25	2523.75
B3	2530-2536	2531.25	2535.75
B4	2542-2548	2543.25	2547.75
D1	2554-2560	2555.25	2559.75
D2	2566-2572	2567.25	2571.75
D3	2578-2584	2579.25	2583.75
D4	2590-2596	2591.25	2595.75
F1	2602-2608	2603.25	2607.75
F2	2614-2620	2615.25	2619.75
F3	2626-2632	2627.25	2631.75
F4	2638-2644	2639.25	2643.75
H1	2650-2656	2651.25	2655.75
H2	2662-2668	2663.25	2667.75
H3	2674-2680	2675.25	2679.75
H4	2686-2692	2687.25	2691.75
MDS1	2150-2156	2154.75	2150.25
MDS2	2156-2162	2160.75	2156.25
MDS2A	2156-2160		

NOTE: VIDEO AND AUDIO CARRIERS ARE INVERTED ON MDS CHANNELS

Created by: Kimberly Simeone *6/3/1998*	*Checked by: Ivan Hernandez* *9/12/98*	*Released by: Paulo Correa* *10/28/98*