FCC TYPE ACCEPTANCE REPORT

FOR THE

HPB1000-A, 1000 WATT ANALOG BOOSTER SYSTEM

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1.0 INTRODUCTION

This report contains all the required data for type acceptance of the Communication Microwave Corp model HPB1000-A analog booster system. The data presented was taken from tests performed on a production booster system designed to receive and amplify up to 31 ITFS/MMDS television channels, in the MDS and ITFS bands, for retransmission into shadowed service areas. Other information required for type acceptance, such as circuit diagrams and descriptions, photographs, and tune-up and maintenance procedures may be found in the Comwave HPB1000-A instruction manual. The booster system design and resultant test data reflect the revised MMDS/ITFS requirements imposed November 1, 1991.

2.0 CERTIFICATION OF DATA

FCC Paragraph 2.909 (d)

Having personally conducted the tests contained in this report, I certify that the statements and data submitted are true and correct to the best of my knowledge.

Paulo Correa
Director of Engineering
Communication Microwave Corp

3.0 TEST EQUIPMENT

FCC Paragraph 2.947 (d)

The following is a list of major test equipment, which was used in testing the HPB1000-A transmitter for this report:

1)	Spectrum Analyzer	HP Model 8593E
2)	Power Meter	HP Model 436A
3)	Frequency Counter	HP Model 5350B
4)	Digital Multimeter	Fluke Model 87
5)	TV Demodulator	TEK Model 1450-1
6)	Audio Analyzer	TEK Model VM700
7)	NTSC Test Set	TEK Model VM700
8)	NTSC Video Generator	TEK Model 1910
9)	Oscilloscope	TEK Model 2215
10)	Test Oscillator	HP 651B

4.0 DESCRIPTION OF EQUIPMENT

FCC Paragraph 2.983

1)	Type of Emission:	Visual - 5M75C3F Aural - 250KF3E
2)	Frequency Range:	2500-2700 MHz
3)	Operating Range:	+51.0 to + 34.5dBm
4)	Power Rating:	1-2 Channels @ 51.0 dBm 3-4 Channels @ 46.0 dBm 5-8 Channels @ 42.5 dBm 9-16 Channels @ 38.0 dBm 17-31 Channels @ 34.5 dBm
5)	E & I on Final:	Drain voltage 10V Drain current 7A each

6) Function of Active Devices:

The following is a list of active devices in the RF chains of the HPB1000-A transmitter. The relative position of each device may be found by referring to the block diagrams (refer to instruction manual Figure HG2-01008.

MDS DRIVER:

Final Amplifier	***Module 04-254-02***
Q1-Q7	RF Amplifiers
Power Amplifier #1	***Module 04-306-02***
Q1-Q5	RF Amplifiers
Power Amplifier #2	***Module 04-306-02***
Q1-Q5	RF Amplifiers
Power Amplifier #3	***Module 04-306-02***
Q1-Q5	RF Amplifiers

RF Precorrector	***Module 04-299-02***
Board 40-299-02	
U1-U3	RF Amplifiers
D1, D2	Diodes
Board 40-227-02	
U1, U2	RF Amplifiers
U3	Regulator
U4	OP Amplifier
Q1-Q4	Transistor
D1-D8	Diodes
RF Attenuator	***Module 13-102-02***
D1-D4	Pin Diodes
Q1	Transistor
D5-D8	Diodes
RF Attenuator	***Module 13-102-02***
D1-D4	Pin Diodes
Q1	Transistor
D5-D8	Diodes
Microwave Sensing Module	***Module 13-103-02***
D1-D6	Pin Diodes
Q1, Q2	Transistors
U2	Quad. Amplifier
U1	RF Amplifier
D11	Schottky Diodes
D7-D10	Diodes

MMDS DRIVER:

Final Amplifier		***Module 04-308-02***
U1, U2		RF Amplifiers
Power Amplifier #1		***Module 04-306-02***
Q1-Q5		RF Amplifiers
Power Amplifier #2		***Module 04-306-02***
Q1-Q5		RF Amplifiers
Power Amplifier #3		***Module 04-307-02***
U2-U5		RF Amplifiers
RF Precorrector		***Module 04-299-02***
	Board 40-226-02	
U1-U3 D1, D2		RF Amplifiers Diodes
	Board 40-227-02	
U1, U2 U3 U4 Q1-Q4 D1-D8		RF Amplifiers Regulator OP Amplifiers Transistors Diodes
RF Attenuator		***Module 13-102-02***
D1-D4 Q1 D5-D8		Pin Diodes Transistor Diodes
RF Attenuator		***Module 13-102-02***
D1-D4 Q1 D5-D8		Pin Diodes Transistor Diodes

Microwave Sensing Module	***Module 13-103-02***
D1-D6	Pin Diodes
Q1, Q2	Transistors
U2	Quad. Amplifier
U1	RF Amplifier
D11	Schottky Diodes
D7-D10	Diodes

POWER AMPLIFIER SEGMENTS:	***Module 04-294-02***
IC1	SPDT Switch
D1	Diode Common Cathode
D2	Diode Dual Cathode
Q1-Q5	GaAs FET

POWER SUPPLY:	***OEM***

7) Circuit Diagrams: See Technical Manual.

8) Instruction Books: See Technical Manual.

9) Tune Up Procedures: See Technical Manual.

10) Description of Oscillator Circuit and Frequency Stability Devices: See Technical Manual.

11) Describe Limiters: Not used.

Describe Spurious Suppression Circuits: Not used.

12) Describe Modulation Circuits: See Technical Manual.

8.0 INPUT LEVEL VERSUS OUTPUT (A.G.C.)

FCC Paragraph 74.950 (f) (4)

Visual Output Power:

2 Channel @ 51.0 dBm
8 Channels @ 42.5 dBm
31 Channels @ 34.5 dBm

Modulation: Composite Television Signals

Method of Measurement:

Thirty one leveled television channels were combined to the common input to the booster via a calibrated variable attenuator. The output level of +34.5dBm was set as outlined in the previous R.F. power output measurement. The attenuator was varied up and down to determine the low and high end.

AGC Range: > 30 dB

2 Channel Test (51 dBm/channel output):

Measured Input Level (dBm)	Measured Output Level (dBm)
-55	50.8
-50	50.8
-45	51.0
-40	51.2
-35	51.2
-25	51.0

8 Channel Test (42.5 dBm/channel output)

Measured Input Level (dBm)	Measured Output Level (dBm)
-55	42.3
-50	42.5
-45	42.5
-40	42.7
-35	42.7
-25	42.5

31 Channel Test (348.5 dBm/channel output)

Measured Input Level (dBm)	Measured Output Level (dBm)
-55	34.3
-50	34.5
-45	34.5
-40	34.7
-35	34.7
-25	34.5

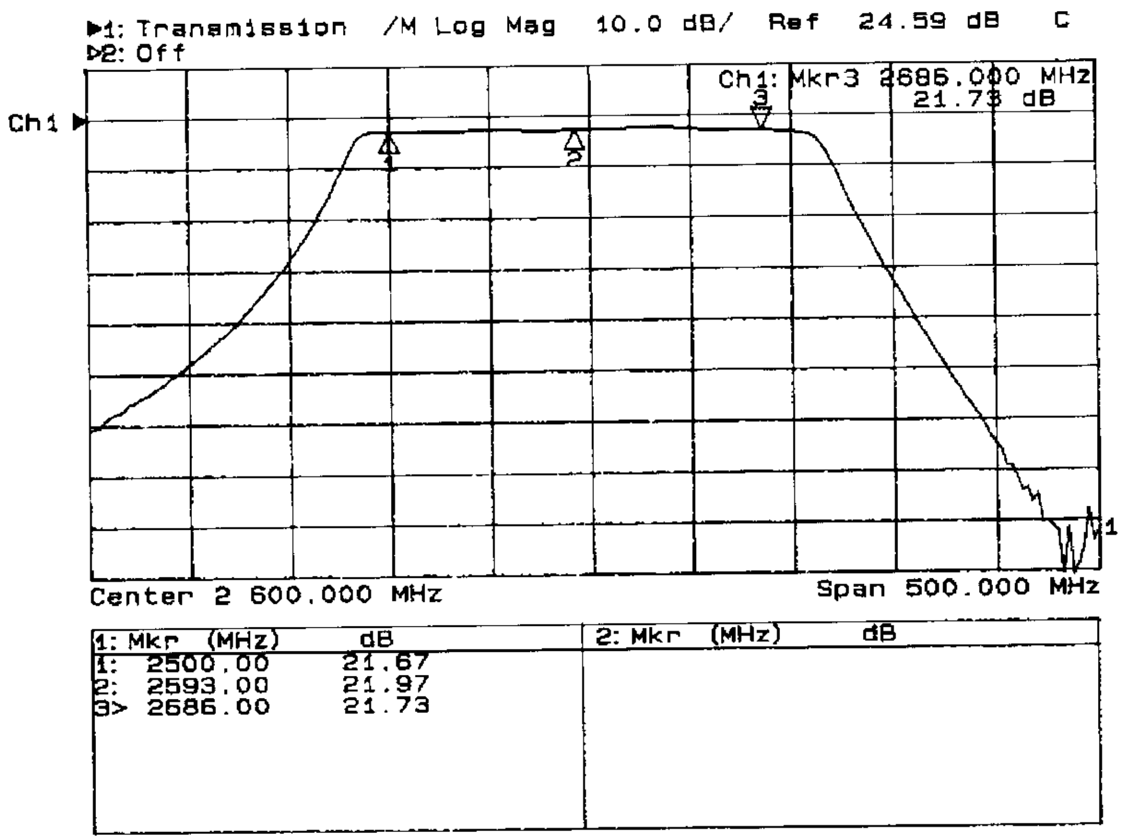
9.0 OVERALL ATTENUATION CHARACTERISTICS and OCCUPIED BANDWIDTH

FCC Paragraph 74.950(f) and 2.989 (h)

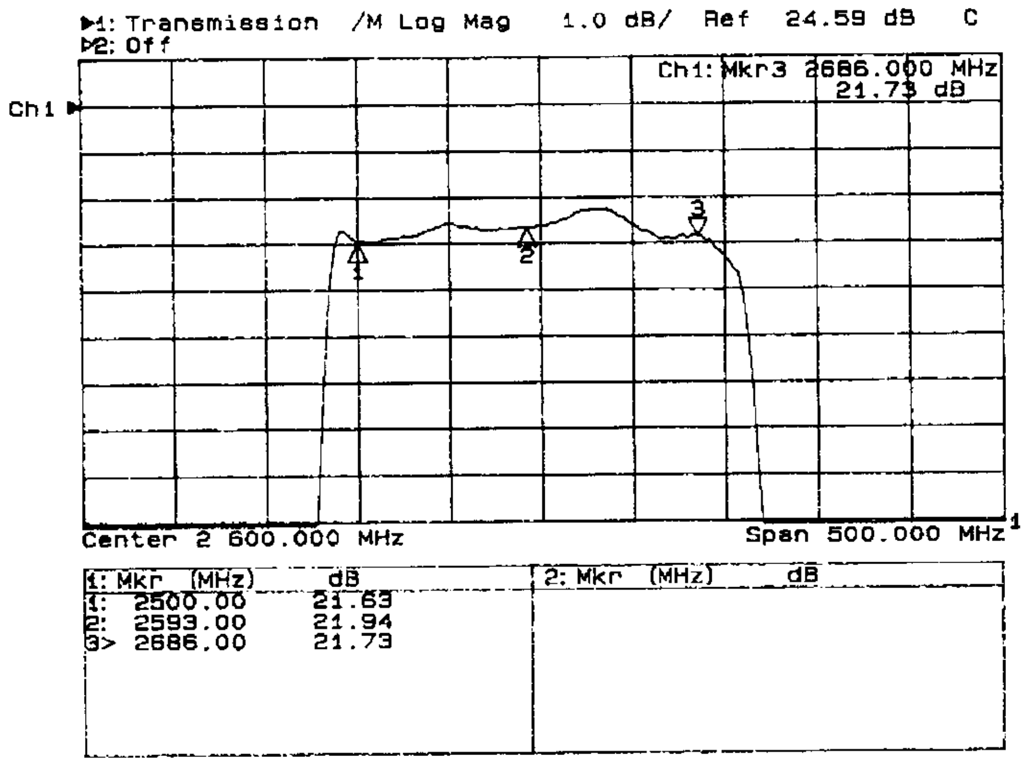
The HPB1000-A is designed for retransmission of up to 31 analog modulated carriers with little or no distortion. The booster system does not include frequency-translating subsystems so the only distortion arises from the frequency response and linearity characteristics of the system.

FREQUENCY RESPONSE

Linear distortion arises primarily from the frequency response of the booster system. The frequency response of the HPB1000-A is very flat and provides near perfect retransmission of carriers without linear distortion. The frequency response was measured by injecting a CW signal into the booster front end at a nominal input level of –30 dBm. The signal was swept from 2450 MHz to 2750 MHz and the output captured on an HP8593 spectrum analyzer. See plots 1 and 2 below:



Plot 1: Frequency Response of HPB1000-A on 10 dB/div Scale



Plot 2: Frequency Response of HPB1000-A on 1 dB/div Scale

10.0 SPURIOUS EMISSIONS AT ANTENNA TERMINALS

FCC Paragraph 2.991, 2.997, 21.908 (b)
November 1, 1991, ITFS/MMDS Ruling

Visual Output Power:	**1-2 Channels 51.0 dBm/ch (126.4 W)/ch** **3-4 Channels 46.0 dBm/ch (40.0 W)/ch** **5-8 Channels 42.5 dBm/ch (18 W)/ch** **9-16 Channels 38.0 dBm/ch (6.4 W)/ch** **17-31 Channels 34.5 dBm/ch (2.8 W)/ch**
Spectrum Analyzer Setting:	A spectrum analyzer setting used in conducting the spurious emissions test at the equipment output terminals was as follows:
Frequency Span:	2 MHz per Division
Center Frequency:	Adjusted continuously from 10 MHz to 27 GHz
Resolution Bandwidth:	100 KHz
Video Filter:	Out
Input Attenuator Setting:	Input level was set for a full scale calibration of the visual carrier. All other frequencies were referenced to this point.
Results:	Since there are no internal frequency sources, the only outputs were the MMDS signals and there resultant carrier to third order intermodulation products.
Spurious Emissions:	> -60dBc
Harmonic:	>-70dBc

SPECTRAL OCCUPANCY

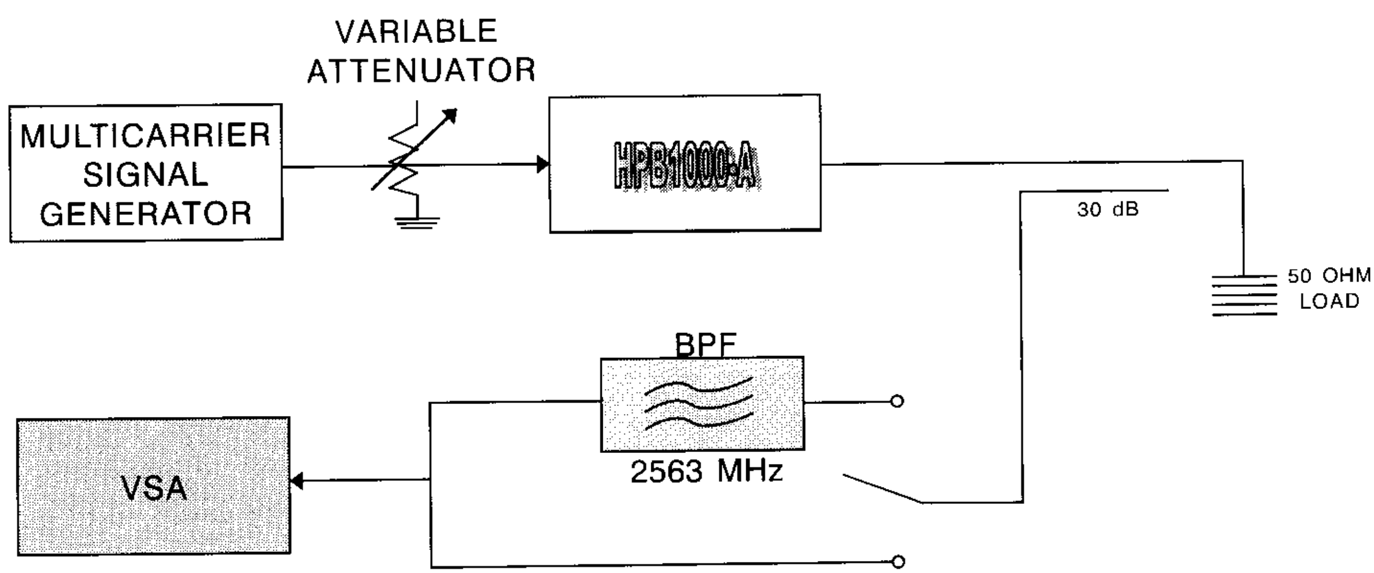
The following plots demonstrate the occupied bandwidth of the composite signal(s) at the output of the booster system power amplifier at the maximum rated peak power. The occupied bandwidth complies with the out of band emissions for analog systems. The signal(s) meets the requirements of out of band emissions less than -38 dB at the channel edge decreasing to less than -60 dB at ≤1 MHz and ≥ .5MHz from the channel edge relative to the peak of sync of the analog channel.

Due to the multi-carrier nature of the input/output signal(s), some additional measurements are necessary to accurately represent the spectral occupancy. This is due to the dynamic range of in-band signal power versus out-of-band power. In addition, we are concerned not only with the intermodulation products of a single carrier, but also those intercarrier products (sometimes referred to as CTB in the cable industry) that may appear out-of-band. For that reason, some explanation of the measurement technique is in order.

MEASUREMENT TECHNIQUE

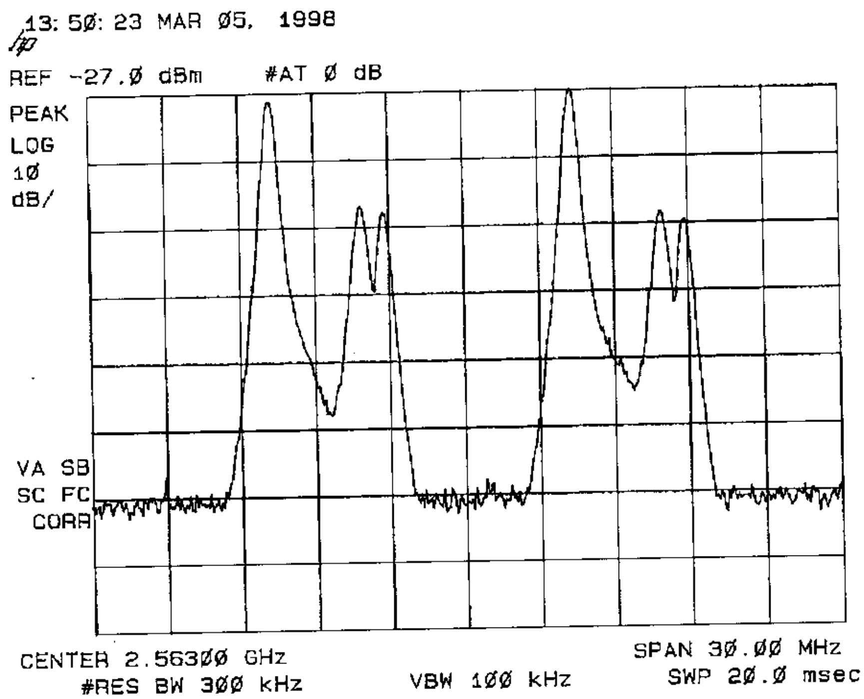
Accurately measuring out-of-band power requires sufficient dynamic range to measure both signal power and intermodulation products without undue influence from the instrumentation noise floor. Since the ultimate requirement for out-of-band signal power is –60 dB relative to in-band peak of sync power, we require at least 70 dB dynamic range to prevent noise floor interference from corrupting the measurement. To accomplish this, we have measured out-of-band power after filtering out the majority of in-band signal power since this allows us to reduce the noise floor of the spectrum analyzer. A block diagram of the test set-up is shown below:

BLOCK DIAGRAM TEST SET-UP



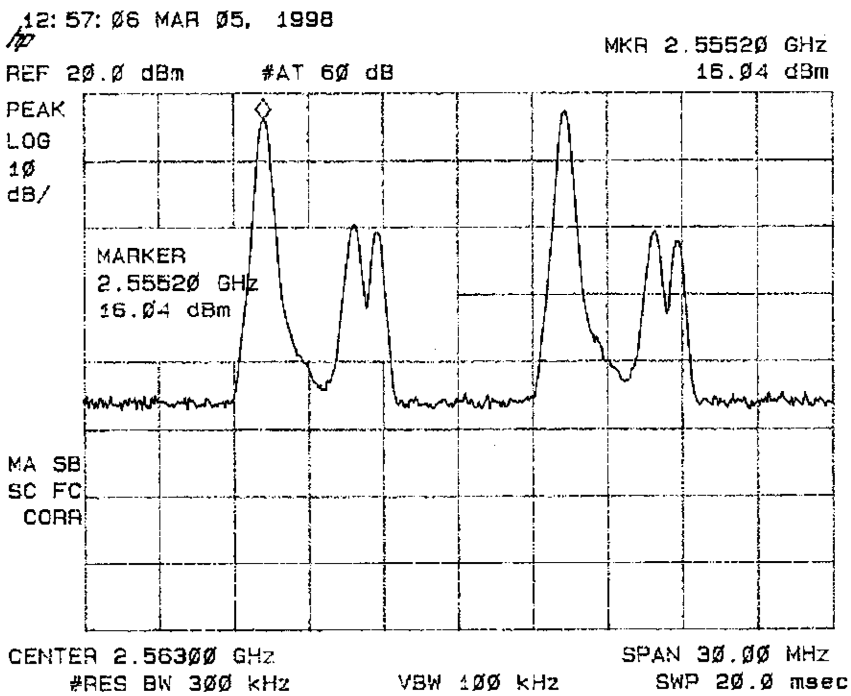
NARRATIVE DESCRIPTION OF OCCUPIED BANDWIDTH PLOTS

Plot 3 shows the booster-input signal for two carriers. Each carrier is modulated with 75% color bars. All plots were taken with a resolution bandwidth of 300 kHz for peak measurement and 30KHz resolution bandwidth for intermodulation measurement.



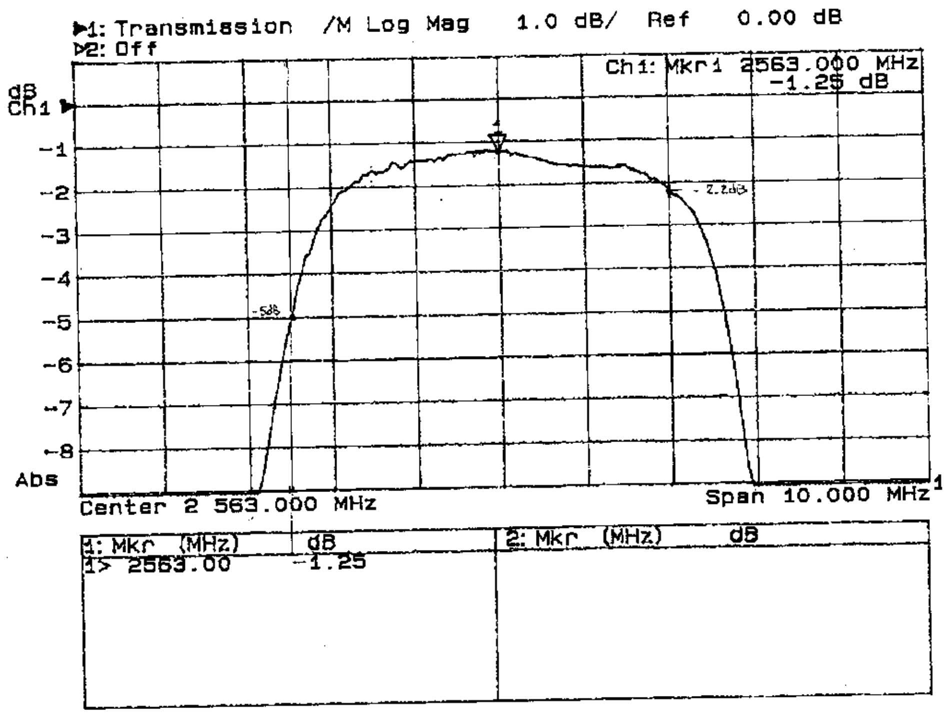
Plot 3: Two Carrier Composite Booster System Input Signal

Plot 4 shows the booster system output signal for two composite carriers with 75% color bars modulation at an SCL of 47 dBm as measured by an average power meter which corresponds to 51 dBm peak of sync. The Spectrum Analyzer is set to display the in-band signal power (after 37.7 dB attenuation) of approximately 16.04 dBm. From these plots we can see that the out-of-band requirement to be better than –38 dB relative to peak of sync is met.



Plot 4: Two Carrier Composite Booster System Output Signal

The Bandpass Filter is used to eliminate signal energy and allow us to reduce the Spectrum Analyzer input attenuator, thus lowering the noise floor to a level where we can accurately measure the out-of-band power. The Bandpass Filter has the following passband characteristics:

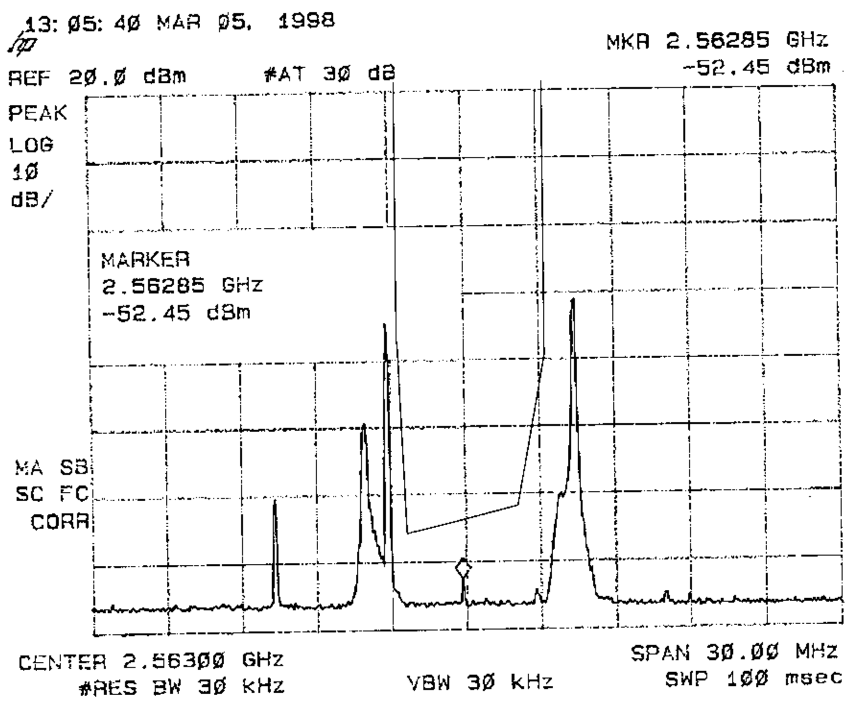


The mark with –5dB indicates attenuation of the filter at a frequency .5 MHz higher than the band edge of the lower adjacent channel. The mark with –2.2 dB, otherwise, indicates a frequency 1 MHz lower than the edge of the higher adjacent channel. The mark of –2 dB corresponds to the visual carrier.

In plot 5, the measured out-of-band power within the limits of the unoccupied channel is –52.45 dBm. Accounting for the filter insertion loss and two adjacent channels, we conclude that a single-carrier has relative out-of-band signal power given by:

$$-52.45 + 2.2 - 16.04 = 66.29 \text{ dB between } +.5 \text{ MHz and } -1 \text{ MHz of the band edges}$$

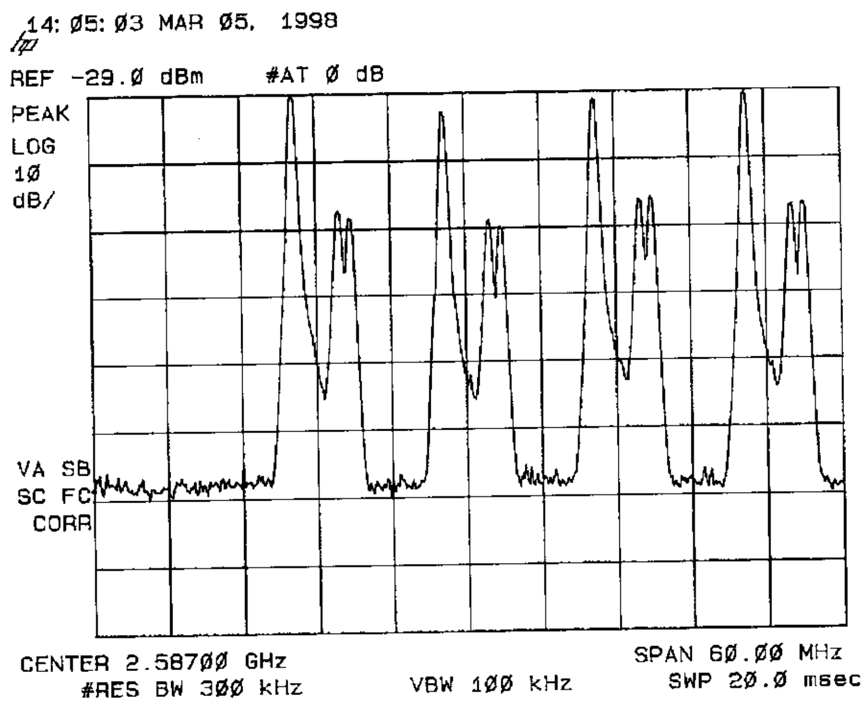
Moreover, the total measured power in the adjacent channel is more than 60 dB below the total in-band power. This shows that the system complies with the spectral occupancy mask established in FCC 74.936.



Plot 5: Measured Out-Of-Band Power

MULTI_CARRIER INTERMODULATION PRODUCTS

Since the HPB1000-A is a multi-carrier booster system, we must also be concerned with intercarrier intermodulation products. These are the third order intermodulation products that occur at $2F_1-F_2$ and $2F_2-F_1$. In plot 6, the analog carriers are positioned so that the $2F_1-F_2$ product falls into the passband of the Bandpass Filter.



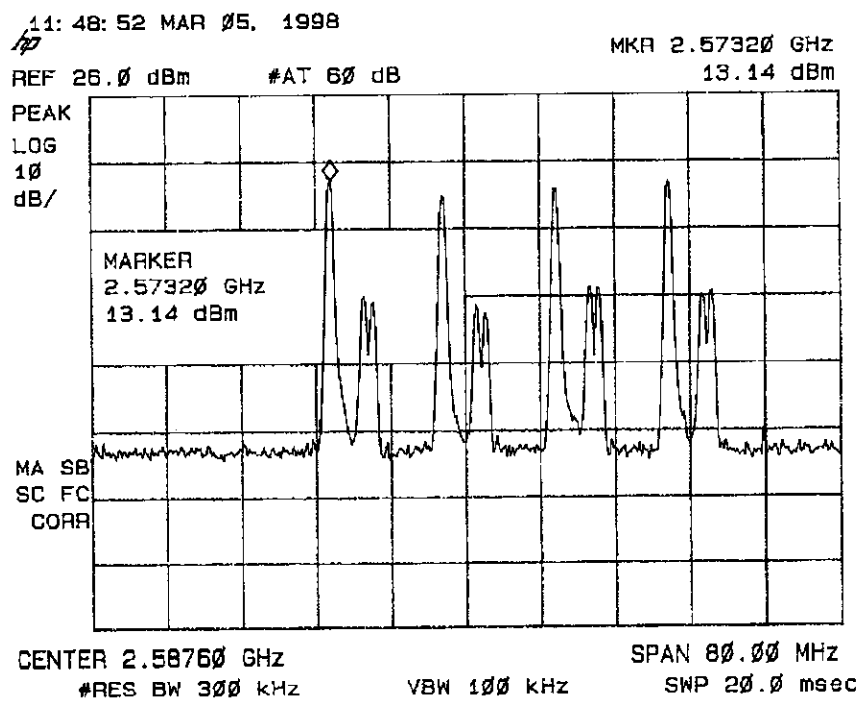
Plot 6

FOUR CARRIER MEASUREMENTS:

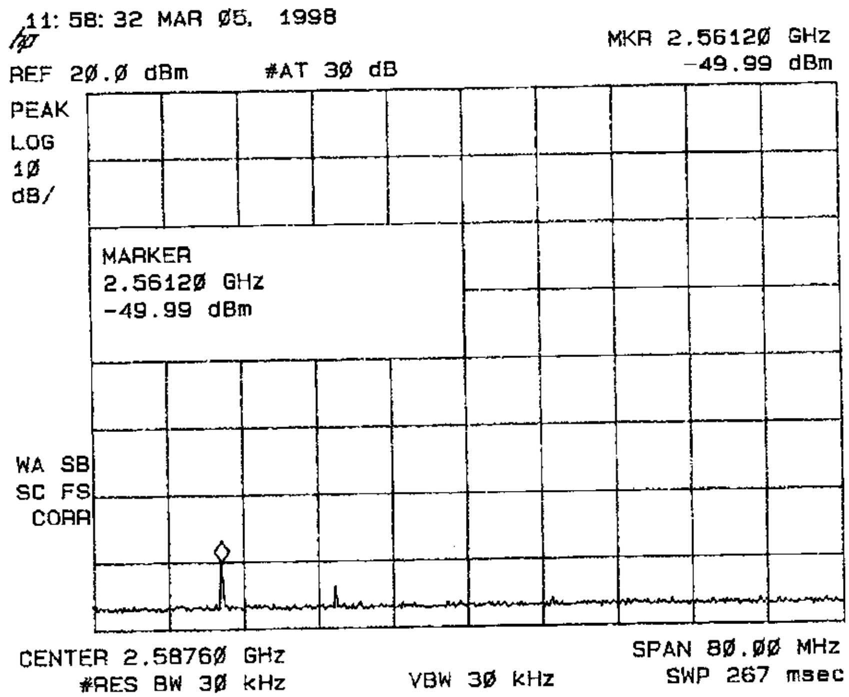
Plot 7 shows the output of the HPB1000-A with four analog carriers. The reference is moved to 13.14 dBm since the power per carrier is 3 dB lower and the attenuator was set to 34.7 dB attenuation. Plot 8 shows the IM3 measurement with four carriers. In this case, an additional 2 dB back-off in output power was required to maintain the same level of out-of-band power as shown in plot 8.

The additional back-off shown in plot 8 follows the well known requirement for multi-carrier systems. Specifically, Leffel [1] cites results showing the back-off requirement for constant IM product power as being asymptotic to 4 dB as the number of carriers approach infinity. Our laboratory test results reflect the back-off requirement predicted by Leffel. That requirement is incorporated in the rated output power per carrier as the number of carriers is increased.

[1] Leffel, Michael, "Intermodulation Distortion in a Multi-Signal Environment", RF Design, June 1995.



Plot 7: Output of HPB1000-A with Four Analog Carriers



Plot 8

$$IM_3 = -(13.14\text{ dBm} - 2\text{ dB}_{\text{filter loss}} - (-49.99\text{ dBm})) = -61.13\text{ dBc}$$

11.0 FIELD STRENGTH OF SPURIOUS RADIATION

FCC Paragraph 2.993, 2.997

Visual Output Power:	**1 Channel @ 51.0 dBm** **8 Channels @ 42.5 dBm** **31 Channels @ 34.5 dBm**
Modulation:	Composite Television Signals
Spectrum Analyzer Settings:	A spectrum analyzer used to measure the spurious emissions at a distance of 10 meters from the television transmitter was set as follows:
Frequency Span:	1 MHz per division
Center Frequency:	Adjusted continuously from 10 MHz to 27 GHz
Resolution Bandwidth:	100 KHz
Video Bandwidth:	100 KHz
Analyzer Noise Threshold:	<-89 dBm

Method of Measurement:

Absolute power of the spurious radiation was measured on a spectrum analyzer at a distance of 10 meters from the transmitter. The radiation was received with a half-wave dipole antenna (gain = 2.15 dB) and measured as an absolute power level; therefore, all measurements include the dipole gain. The relative levels of the received spurious signals were calculated with respect to the absolute power level of the transmitter's visual output received with a dipole at 10 meters. The visual received power level was calculated using:

Received Level @ 10 meters (dBm) = EIRP (dBm) - Path Loss (dB) + 2.15 dB

Path Loss (dB) = 20 log distance(Km) + 20 log frequency(GHz) + 92.4 dB
= 20 log (.010 Km) + 20 log (2.557 GHz) + 92.4 dB
= 60.55 dB

EIRP (dBmW) = 46.00 dBm (tx output) + 2.15dB (transmit dipole gain)
= 48.15 dBm

Received Level = 48.15 dBm – 60.55 dB + 2.15 dB
= -10.25 dBm

The Electric Field Intensity E(v/m) incident on a receive dipole antenna was found using:

$$\mathbf{E}\ (v/m) = \text{Antilog}\left[\frac{(\text{Received Level} - 2.15\text{ dB}) - 20\log \text{wavelength(m)} + 6.75}{20}\right]$$

$$= \text{Antilog}\left[\frac{-10.25\text{ dBm} - 20\log[.1173\text{ m}] + 6.75}{20}\right]$$

$$= \text{Antilog } .7557$$

$$\mathbf{E} = 5.698\text{ V/m}$$

Spurious Radiation:

Due to the total shielded component design needed for the high system gain enclosure, no radiated signals were detected to the threshold of the analyzer.

* Analyzer threshold = -89 dBm

12.0 FREQUENCY STABILITY

FCC Paragraph 2.995 (a-3), (d-1), 74.950 (a), 21.908, 21.101 (a)

Frequency Stability does not apply; there is no Frequency Translation.

13.0 SUMMARY

This report demonstrates that the HPB1000-A television transmitter meets or exceeds the FCC type acceptance criteria. Peak output power was verified with direct measurement of power at microwave. Measurement of spurious emissions at the RF output revealed no emissions above -60 dBc. Field strength measurements of spurious emissions revealed no detectable emissions down to the analyzer noise threshold of < - 89 dBm.

5.0 IDENTIFICATION LABEL

FCC Paragraph 2.983 (f), 2.1003 (a), 2.925, 2.926

FCC ID: CHP8BUHPB1000-A
MODEL HPB1000-A
SIGNAL BOOSTER

WARNING: ***Do Not Exceed Per Channel Output Power Rating***

1-2 Channels	**51.0 dBm/ch**	**(126.4 W)/ch**
3-4 Channels	**46.0 dBm/ch**	**(40.0 W)/ch**
5-8 Channels	**42.5 dBm/ch**	**(18 W)/ch**
9-16 Channels	**38.0 dBm/ch**	**(6.4 W)/ch**
17-31 Channels	**34.5 dBm/ch**	**(2.8 W)/ch**

6.0 PHOTOGRAPHS

FCC Paragraph 2.983 (g) Included.

7.0 RF POWER OUTPUT MEASUREMENTS

FCC Paragraph 2.985

Visual Ouput Power:	51dBm peak sync
% Video Modulation:	87.5%
Type Video Modulation:	Per FCC 73.663 (b) (1)
Aural Power	36dBm average
Method of Measurement:	Per FCC 73.663 (b)

The booster was operated into a dummy load of substantially zero reactance with a resistance equal to the transmission line characteristic impedance. The booster's peak output power was determined with one channel using the factor 1.68 times the average output. The power meter was then substituted with a spectrum analyzer calibrated to full scale reading. Additional composite channels were added and levels adjusted by the following values:

1-2 Channels	**51.0 dBm/ch**	**(126.4 W)/ch**
3-4 Channels	**46.0 dBm/ch**	**(40.0 W)/ch**
5-8 Channels	**42.5 dBm/ch**	**(18 W)/ch**
9-16 Channels	**38.0 dBm/ch**	**(6.4 W)/ch**
17-31 Channels	**34.5 dBm/ch**	**(2.8 W)/ch**

The booster's % power meter was found to be within 2% of the indications provided by the external average power meter with output variations of 80% to 110% of the booster's rated output.

Communication Microwave Corp
395 Oakhill Road
Mountaintop, PA 18707

PRELIMINARY
Technical Manual

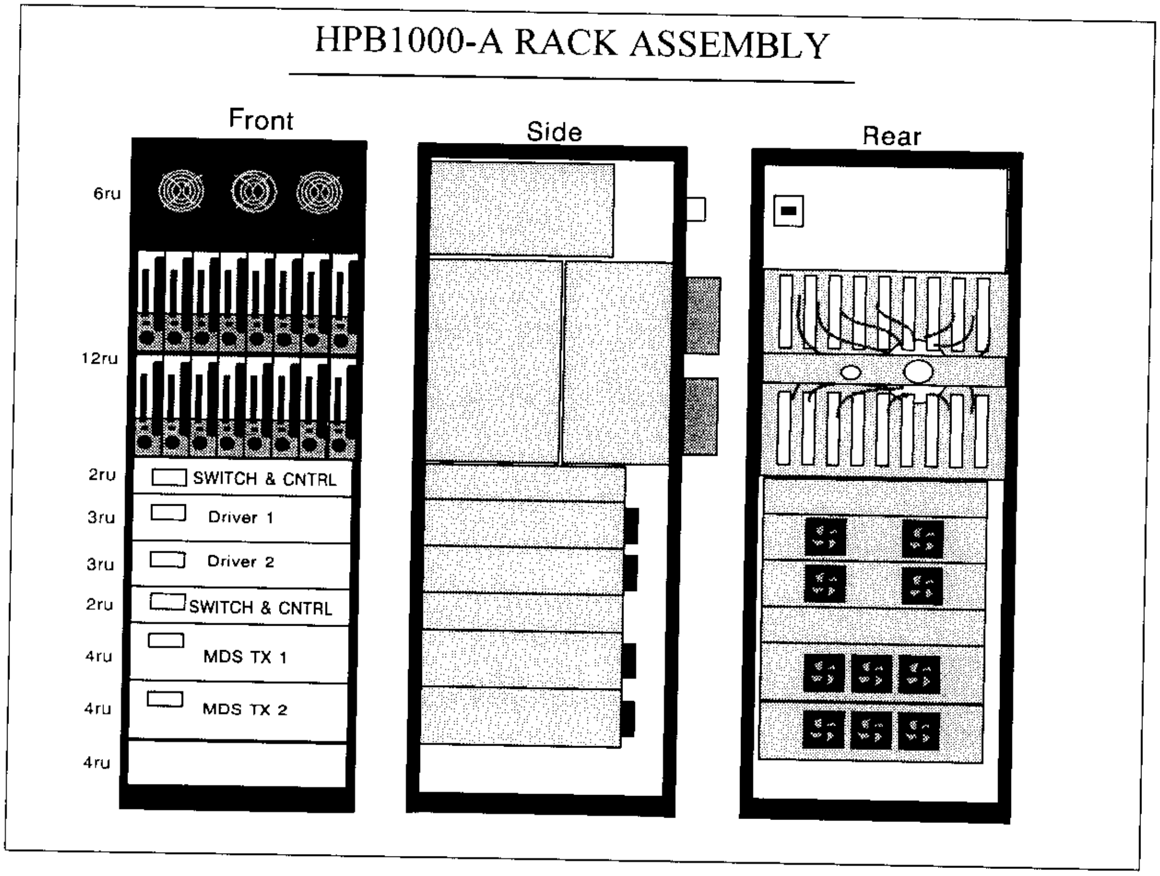
HPB1000-A
1000 Watt Booster System

comwave

Created by: Kimberly Simeone

Document #: to be assigned
REV: P1

HPB1000-A Top Level Description

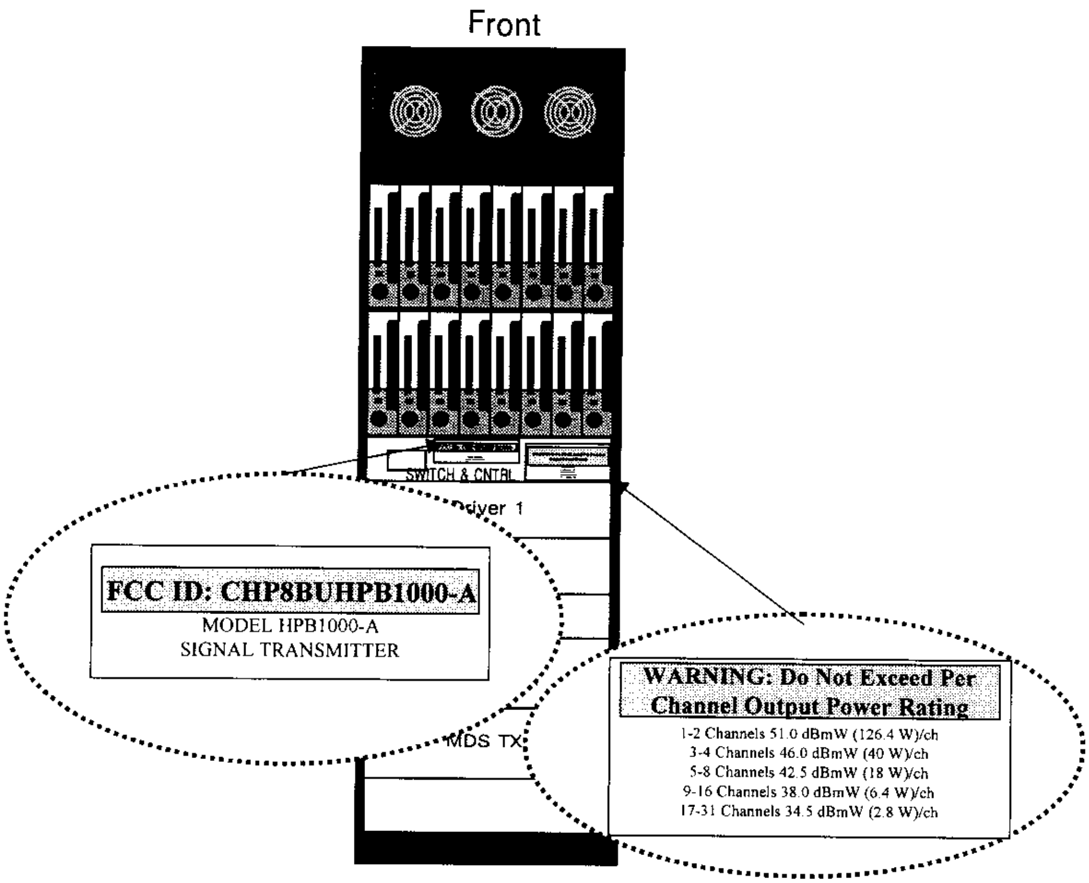


The HPB1000-A is a non-upgradeable high power and high gain, on-channel signal booster. It receives and retransmits multiple television signals to fill in shadowed service areas where line-of-site access to the headend is obscured. The HPB1000-A consists of three power supplies, eight Power Amplifier Segments, two Backup System Controllers, and four Drivers which are contained within a Rack and Sub-rack. The HPB1000-A is fully redundant. The Power Supplies and Power Amplifier Segments allow hot replacement. Identical drivers are provided for both MDS and ITFS frequencies. A Backup System Controller indicates output power and enables the secondary driver should a failure occur in the primary driver.

The HPB Series of Boosters is available in both Upgradeable and Non-Upgradeable models. A Non-Upgradeable model provides maximum space efficiency; where, the modular system architecture of an Upgradeable model allows it to be easily upgraded from 1 Watt per channel to 4 Watts per channel. Similarly, it may also be downgraded; and the Power Amplifier Segments may be used elsewhere or kept as spares for hot replacement. As the output power is modified, the model name will change respectively (refer to the following table). The Federal Communications Commission Identifier (FCC ID) will also be altered corresponding to the new model and power level.

Model Name	*Output Power per channel*	*FCC ID*
HPB250-A	1 Watt	CHP8BUHPB250-A
HPB500-A	2 Watts	CHP8BUHPB500-A
HPB1000-A	4 Watts	CHP8BUHPB1000-A

A new front panel label is needed to accommodate each FCC ID. The label is located on the Backup System Controller as shown in the diagram below and will be replaced with each upgrade as needed.



In order to maximize power density, both the Rack and Sub-rack are integral subsystems of the booster design. The Rack provides phase to phase AC power to the Drivers, DC power to the Sub-rack, and the cooling for the Power Amplifier Segments. Similarly, the Sub-rack provides an interface between the Power Amplifier Segments and the entire system.

HPB250-A/HPB500-A/HPB1000-A - HP Series of Boosters Specifications

Parameter	***Specification***			***Notes/Test Conditions***
	HPB250-A	***HPB500-A***	***HPB1000-A***	
Peak of Sync Output Power per Carrier	28.5 dBm 32.0 dBm 36.5 dBm 40.0 dBm 45.0 dBm	31.5 dBm 35.0 dBm 39.5 dBm 43.0 dBm 48.0 dBm	34.5 dBm 28.0 dBm 42.0 dBm 46.0 dBm 51.0 dBm	17-31 occupied channels; 9-16 occupied channels; 5-8 occupied channels; 3-4 occupied channels; 2 occupied channels; Referenced to booster RF output
Input/Output Connectors/Impedance	Input N female 50 ohms Output EIA7/8 or N female 50 ohms			
Input Frequency	2500 – 2686 MHz			31 occupied channels
Input Signal Level per carrier	-55 to –25 dBm			31 occupied channels
Frequency Response	±1.0 dB			2500 - 2686 MHz
Output Frequency	2500 – 2686 MHz			
Noise Figure	≤11 dB without LNA ≤5 dB with optional LNA			Referenced to RF input signal splitter; Referenced to system LNA input
Carrier to Noise Ratio	> 52 dB			31 carriers at –40 dBm peak of sync input power per carrier; Referenced to RF input signal splitter
AGC Range	> 30 dB			
Harmonics[1]	≤ -60 dBc			Relative to peak of sync output power per channel; 30 kHz RBW; Referenced to booster RF output

Specifications subject to change without notice.

Parameter	***Specification***	***Notes/Test Conditions***
Spurious[2]	≤ -60 dBc	Relative to peak of sync output power per channel; 30 kHz RBW
In-Band Intermodulation Distortion[3]	≤ -60 dB	Relative to in-band peak power per channels; 30 kHz RBW; Referenced to booster RF output
Out-of-band Intermodulation Distortion[3]	≤ -60 dB	Relative to peak of sync output power per channels; 30 kHz RBW; Referenced to booster RF output
RF Output Power Variation	≤ ± 0.2 dB	Referenced to booster RF output
Hum and Noise	≤ -60 dB	Referenced to peak of output power per carrier
Functional Operating Temperature Range	0°C to +50°C	Frequency stability and equipment functionality guaranteed
Specified Operating Temperature Range	13° to +33°C	All Specified parameters guaranteed
Relative Humidity	95% Non-condensing	

Parameter	***HPB250-A*** ***250 Watt Booster***	***HPB500-A*** ***500 Watt Booster***	***HPB1000-A*** ***1000 Watt Booster***
AC Power (Max) 230 V_{AC}, 50/60 Hz Line PF ≥ 0.95	<1950 VA	<3200 VA	<5800 VA
Weight (max)[4]	335 lbs	375 lbs	470 lbs
Mechanical Dimensions[5]	50.75"H x 19.00"W x 30.00" D 129 cm H x 48. 3cmW x 76.2 cm D	50.75"H x 19.00"W x 30.00" D 129 cm H x 48. 3cmW x 76.2 cm D	50.75"H x 19.00"W x 30.00" D 129 cm H x 48. 3cmW x 76.2 cm D

****Specifications subject to change without notice.***

Notes:

1. Undesired signal power 2 dB higher than the nominal average power of the adjacent spectral regions that is harmonically related to the fundamental carrier frequency.
2. Undesired signal power 2 dB higher than the nominal average power of the adjacent spectral regions that is harmonically related to internal system signals such as clock, LOs, etc.
3. All factory test measurements made at approximately 23°C.
4. Weight includes rack.
5. The HPB250-A and HPB500-A includes space for power upgrades to an HPB1000-A.
6. No bandpass filter is required since both in-band and out-of-band intermodulation distortion is less then 60 dB relative to in band peak of sync output power.

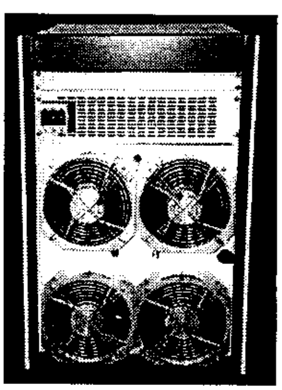
Rack Theory of Operation

The Rack is an integral part of the transmitter assembly. It supplies three phase AC power to the transmitters, DC power to the Sub-Rack, and the cooling for the Power Amplifier Segments. The rack is available in different sizes to accommodate the various physical configurations of the HP Series of transmitters/boosters and to allow for future upgrades to higher output power levels. The table below describes the types of HPSC Transmitters and the Rack configurations required by each type.

System Description	Transmitter Size RU (Rack Units)	Rack Size RU/Inch	Transmitters/ Rack	Spare Rack Units	Overall Size	Notes:
50 W Average Power (150 W Analog)	10	40/70"	4	0	77.125"H 21.063"W 34.500"D	Highest Power Density Upgradeable
100 W Average Power (300 W Analog)	10	40/70"	4	0	77.125"H 21.063"W 34.500"D	Highest Power Density Not Upgradeable
100 W-200 W Average Power (300 W - 600 W Analog)	15	45/78"	3	0	85.875"H 21.063"W 34.500"D	High Power Density Possible to Increment Output Power in 12.5W Steps. (37.5 Analog)
100 W Average Power Upgradeable (300 W Analog)	16	40/70"	2	8	77.125"H 21.063"W 34.500"D	Upgrade Path to All Power Levels Due to Lower Power Density.

Three Phase AC Power enters the AC Power Distribution Box, which is located on the top of the rack. It is connected to the AC Power Harness which distributes both three phase and phase to phase power to the entire rack.

Each transmitter requires an AC to DC Front End Converter, which is mounted behind the blanking panel, to supply the DC Power to the Sub-Rack. This power supply is connected to the Power Amplifier Segments via the DC Power Harness. The DC Power Harness connects the AC to DC Front End Converter and the Sub-Rack.



Fans attached to the rear door of the Rack supply cooling for the Power Amplifier Segments. Each fan pulls cool air from the front of the rack to the rear. The transmitters will be automatically placed into standby when the rear door of the rack is opened. This will prevent thermal shutdown of the Power Amplifier Segments. ***Note: The number of fans is dependent upon transmitter configuration.***

SD10000/HPB/SBM Rear View

Rack Power Supply for High Power Booster Series

The Power Supply for the rack consists of three 48-Volt modules in a rectifier shelf designed to minimize installation and maintenance time. Hotswap insertion technology (hot replacement) allows easy system power upgrades. The Power Supply is equipped with logic and visual status indications, automatic load sharing and complete front access.

Front panel features include PWR IN and DC OK LED indicators, output voltage and current limit adjustments, voltage and current monitor test points, and digital display indication current or voltage output of the Power Supply.

The modules are housed in a three bay rectifier shelf to provide easy-guide module insertion and extraction. Forced air cools the Power Supply by drawing ambient air through the intake on the front of the Power Supply and exhausting out the rear of the shelf.

Protection is provided against overvoltage, overcurrent, and overtemperature. The Power Supply will shut off if the voltage exceeds the nominal voltage by 20%. The AC input or the remote on/off must be recycled to restart the rectifier. The Power Supply will also shut down if the internal temperature reaches an unsafe level. Restart is automatic when the Power Supply returns to normal operating range.

AC Power Interconnections

The AC Power Interconnections include an AC Power Distribution Box, 15 Ampere circuit breaker, terminal strip, AC to DC Front End Converter, Driver Chassis, Ultra Low Phase Noise Drawer ***(Agile applications only)*** and fans. The AC Power Interconnections provide phase-to-phase 208 VAC and three phase-208 VAC* to each transmitter in the Rack.

The three-phase power is connected to the Rack through the AC Power Distribution Box, which is located on the top of the Rack. The AC Power Distribution Box distributes the three phase power via two or three 350 Ampere, 600 VAC, three pole terminal blocks. The number of terminal blocks depends upon the number of transmitters in each Rack. Each transmitter has its own 15-Ampere circuit breaker, which trips at 20 Amperes. The 15-Ampere circuit breaker is connected to the AC Power Distribution Box via 6 AWG, 3000 Volt, and stranded-tinned-copper wire with Polyvinylchloride insulation. The circuit breaker is located on the rear of the Rack. A plastic cover to prevent accidental shut down of the transmitter protects it.

The terminal strip is connected to the circuit breaker via 12 AWG Polyolefin-insulated wire, rated at 600 Volts with a breakdown voltage of 6000 Volts. The terminal strip is constructed of Phenolic-insulated material with a breakdown voltage of 9000 Volts. The Zinc-plated Steel terminals are rated at 30 Amperes of current. The terminal strip distributes the three phase power to the AC to DC Front End Converter and phase-to- phase 208 VAC to the Driver, Ultra Low Phase Noise Drawer ***(Agile applications only)*** and the fans. The Driver and Ultra Low Phase Noise Drawer require phase to phase 208 VAC, which is delivered by a 14 AWG-three conductor line cord. The terminal strip also supplies phase-to-phase power to the 208 VAC, 80-Watt, 600-CFM fans, which are mounted on the rear door of the Rack. The number of fans per transmitter is dependent upon the transmitter model. The fan power harness is constructed of eight 14 AWG wires. Two wires are required for each fan; the unused wires are fastened in place and terminated to allow for future upgrades.

The table below illustrates the configuration of a Rack for different models and the possible output power levels of each transmitter.

Parameter	***Upgradeable SD/SDA5000***		***SD/SDA10000***	***Upgradeable SD/SDA10000 (SD/SDA15000)***				***SD/SDA 20000***
Output Power								
Digital *(Fixed)*	50 W	75 W	100 W	100 W	125 W	150 W	175 W	200 W
Analog *(Fixed)*	150 W	225 W	300 W	300 W	375 W	450 W	525 W	600 W
Digital *(Agile)*	40 W	60 W	80 W	80 W	100 W	120 W	140 W	160 W
Analog *(Agile)*	120 W	180 W	240 W	240 W	300 W	360 W	420 W	480 W
Power Supplies	4 @ 1.024 KVA	4 @ 1.504 KVA	4@ 2.048 KVA	3 @ 2.048 KVA	3 @ 2.56 KVA	3 @ 3.072 KVA	3 @ 3.584 KVA	3@ 4.097 KVA
Fans	4 @ 80 VA		8 @ 80 VA	6 @ 80 VA		8 @ 80 VA	12 @ 80 VA	12 @ 80 VA
Drivers	4 @ 100 VA		4 @ 100 VA	3 @ 100 VA				3 @ 100 VA
VA TOTALS	4816 VA	6736 VA	9232 VA	6924 VA	8460 VA	10156 VA	12012 VA	13551VA

***Other power options available upon request.**

DC Power Interconnections

The DC Power Interconnection for each transmitter includes an AC to DC Front End Converter, a DC Power Harness, a DC to DC Converter, and a Mother Board.

The AC to DC Front End Converter accepts a 208 V_{AC} 3-phase input and converts it to 48 V_{DC}. The Front End Converter is a 4000-Watt MOSFET switching power supply with .985% minimum Power Factor. The 48 V_{DC} output is connected to the Mother Board and the DC to DC Converter via the DC Power Harness.

The DC Power Harness provides a path for 48 V_{DC} to the Mother Board and the DC to DC Converter. The DC Power Harness consists of standard tinned 14 gauge copper conductors with .032 thick Polyolefin insulation, rated at 600 volts.

The DC to DC Converter is a 75-Watt, 15 Amp, 48 V_{DC} to 10 V_{DC}, single output converter. It supplies 10 V_{DC} to the Power Amplifier Segments through the Mother Board on the Sub-Rack.

The Mother Board supplies 10 V_{DC} and 48 V_{DC} to the Power Amplifier Segments through connections located on eight 14-pin connectors. Control and Diagnostic signals are also routed through the Mother Board to the Microcontroller board within each segment.

The total DC power for each transmitter configuration is specified below in table A-1:

Table A-1

Transmitter Output Power (Watts)				*Amps @ 10 Volts*	*Amps @ 48 Volts*
Fixed Digital	*Fixed Analog*	*Agile Digital*	*Agile Analog*		
50	150	40	120	1.4	19.45
100	300	80	240	2.8	39.90
125	375	100	300	3.5	49.90
150	450	120	360	4.2	59.85
175	525	140	420	4.9	69.82
200	600	160	480	5.6	78.80
HPB250	HPB250-A			1.4	19.45
HPB500	HPB500-A			2.8	39.90
HPB1000	HPB1000-A			5.6	78.80

Note:

1. Each amplifier module receives 48 V_{DC} at 5 Amps.
2. Each amplifier module receives 10 V_{DC} at .35 Amps.

Sub-Rack Theory of Operation

The Sub-Rack is the unit which houses the Power Amplifier Segments and provides an interface between the Segments and the entire System. It is capable of housing up to 16 individual Segments. The Sub-Rack consists of a Mother Board (see Document #: HG3-01B02 for details, one Mother Board is needed for eight Segments and two Mother Boards are needed when more than eight Segments are used), guide rails, protective Lexan overlay, and miscellaneous sheet metal parts. Each Segment slides into the Sub-Rack on nylon slides and connects to the Mother Board(s) via floating connectors. The key-lock switch, located on the Segment's front panel, must be in the OFF position in order to plug the Segment into the subrack. This is to ensure that there is no arcing between connections before the Segment is fully engaged. Once the Segment is slid into place, thumb screws on the Segment's front panel are fastened to the Sub-Rack to secure it and provide a reliable ground connection. The key-lock switch may now be turned to the ON position to apply power to the Segment.

The interface for RF Input and Output is provided by floating OSP connectors which are mounted on the back panel of the Sub-Rack and the back side of the Power Amplifier Segment.

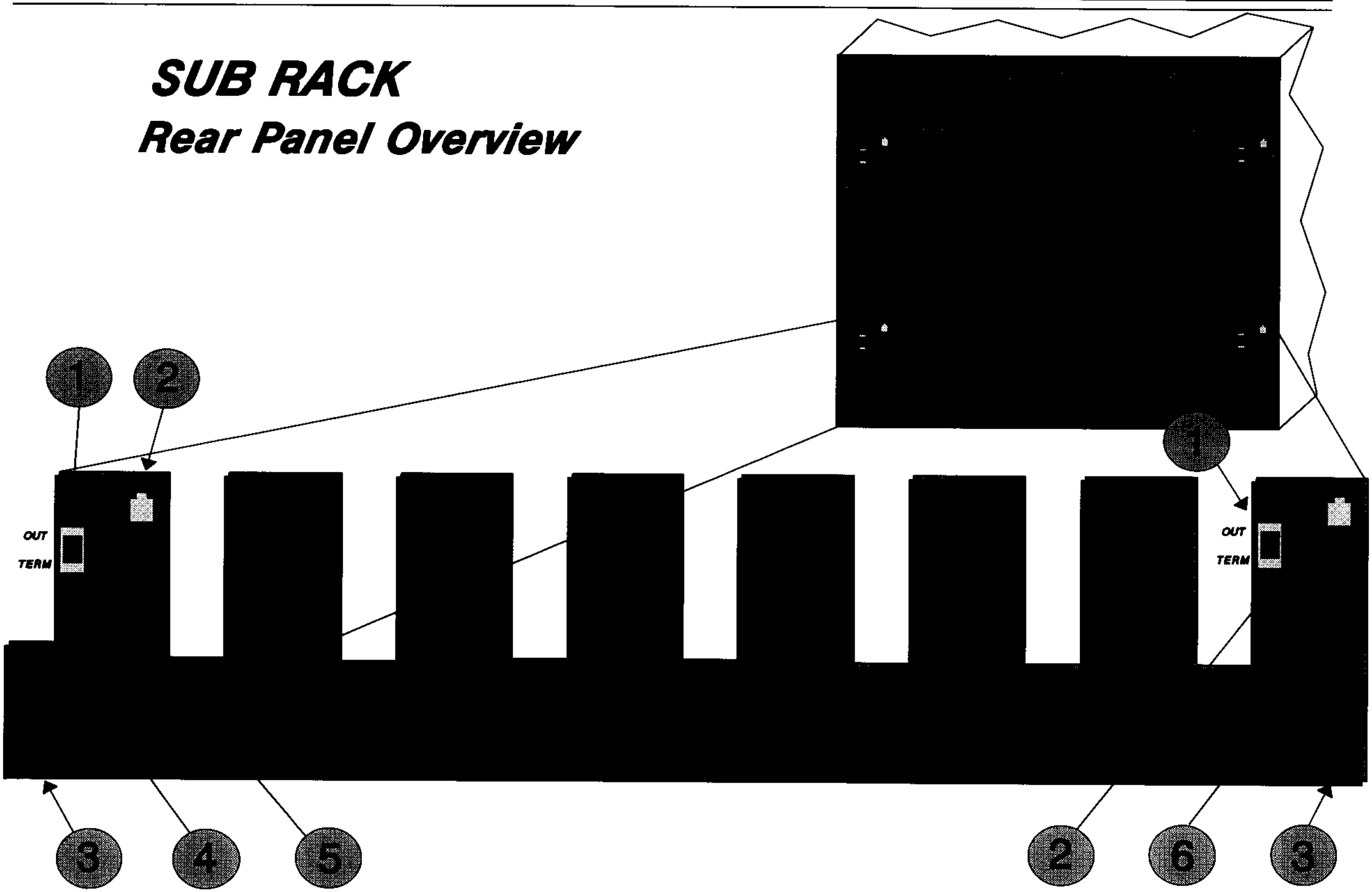
Mother Board to System Interface

Power, ground, and data interface between the Mother Board(s) and the system are as follows. A DC to DC converter supplies the mother board(s) with one 10 V_{DC} connection (6). A separate 48 V_{DC} and ground connection (4) for each Power Amplifier Segment is supplied to the mother board(s) from the main system power supply. A ten position single-row header (3) affords data input from the driver and a six position RJ-11 connector (2) provides communication of control and diagnostics data to the Mother Board(s). A two position DIP switch (1) located on the Mother Board(s) can be set to OPEN for communication, or CLOSED for termination.

Module to Mother Board Interface

Power, ground, and data interface between the Segment and the Mother Board(s) is provided through a float-mounted, blind-mating, receptacle on the Segment and a blind-mating header (5) on the Mother Board(s).

SUB RACK
Rear Panel Overview



Driver Theory of Operation

The driver receives a microwave multi-carrier signal typically from –55 dBm to –25 dBm/carrier. A stagger AGC keeps the total level of the output signal at 0 dBm ±1dB, as well as improving the C/N for a high level input signal.

The AGC chain provides the filtering necessary to reduce the noise out of the band. The constant output signal is now pre-distorted and amplified by two amplifiers. The microwave pre-corrector also performs the ALC to keep the output power of the booster constant.

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.

Specifications	
Bandwidth (1 dB)	200 Mhz ± 10%
Insertion Loss	2.5 dB ± 0.5 dB
Tuning Range:	
MDS	2.10-2.20 GHz minimum
MMDS/ITFS	2.45-2.75 GHz minimum

Intermediate Power Amplifier

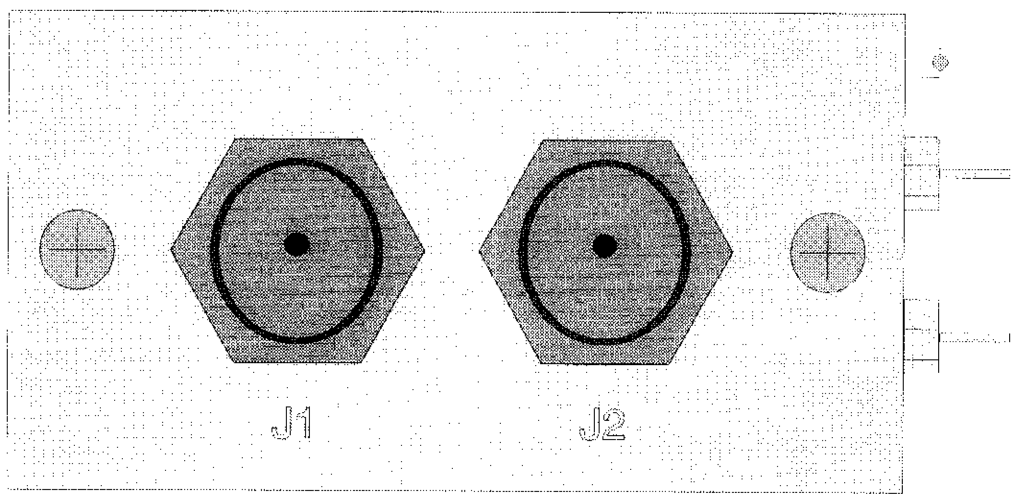
The Intermediate Power Amplifier module receives an input signal at J1 from the Mixer/Driver Amplifier module and provides an amplified output to J2. The amplifier module consists of two FET device.

An EMI feedthru filter supplies +10 V_{DC} to the drain of the FET via a printed microstrip decoupling line. Negative 12 V_{DC} gate bias enters the module using an EMI feedthru filter. This voltage is divided and calibrated by two resistors and a potentiometer. The potentiometer sets the operating drain current of the transistor. A printed decoupling line decouples the gate bias circuit. No user adjustments are needed or provided.

Specifications	
Power Supply Requirements	+10 V_{DC} @ 1.6 Amps -12 V_{DC} @ 7.5 mA
Drain Current	2.2 Amperes
Module Gain	10 dB ± 1 dB
Center Frequency	ITFS/MMDS -2.6 GHz
1 dB Bandwidth	200 MHz
Minimum Output Power	+ 22 dBm
Input/Output Impedance	50 Ω

Envelope Detector

The envelope detector is a two input module that receives forward and reflected power samples. The forward sample is applied to J1 and the reflected sample is applied to J2. Diodes convert the RF sample into a representative DC voltage, and capacitors filter the RF sample. These voltages are sent to the mother board for processing and feedback control.



Control Board

Monitoring and control of the Driver is accomplished through a Control Board located over the power supply. The Control Board utilizes an 8-bit Microcontroller (MCU) with on-board memory to perform the monitoring and control functions. The Control Board circuitry includes analog signal conditioning, A/D converters, supply voltage regulation, and two serial data interfaces.

Monitoring operations involve collecting analog signals and logic data from the Driver and the system interconnect cable. All of the inputs are routed to the Microcontoller from the Transition Board. The Transition Board routs the monitored signals from the system interconnect cable. The analog signals; temperature, forward power, reflected power, and -12volt supply are received from the Transition Board on J-1. The analog signals +11 volt sample, Mixer, Intermediate Power Amplifier #1, Drive Amplifier #2, Intermediate Power Amplifier #2, ALC return and LO as well as the control signals reset 1 and MCU standby are routed to J2 if the MCU. J3 provides RS-485 communications access to the MCU, and the control signals; Power Amplifier fault, Reset 2 and System reset.

The analog inputs; 11 volt sample, Mixer, Intermediate Power Amplifier #1, Drive Amplifier #2, Intermediate Power Amplifier, and ALC are received, selected by the MCU and related to the CPLD through an eight channel multiplexer IC. The selected signal is buffered in an operational amplifier. The -12 volt signal follows similar signal selection, however the operational amplifier inverts and scales down the voltage to ¼ of its original value. The LO, Temperature, forward and reflected signals are applied directly to operational amplifiers without multiplexed selection. These samples are over voltage limited by 5.1V zener diodes. Negative voltage protection is accomplished by Schottky diodes. The samples are routed to the MCU for A/D conversion.

The MCU also monitors the Driver control signals; Reset 1 and Reset 2. Reset1 becomes low (true) when the rear cabinet access door is opened, or when the Driver is commanded into standby by the agile controller. Reset 2 becomes true when the Driver's front panel switch is placed into standby, or when the MCU commands the Driver into standby. The MCU commands the Driver into standby by bringing the MCU standby signal low, this signal is wire OR'd to Reset 2 on the Transition Board. Power Amplifier fault monitoring is accomplished by means of monitoring the system interconnects. When an amplifier in the Sub-rack fails, a low signal is introduced onto the Power Amplifier fault line. This low signal is monitored and processed by an input port on the MCU.

The serial Input / Output (I/O) capabilities of the Driver originate on the Control Board and the MCU's SCI port. In general, the Driver may be connected on an RS-485 multidrop. Node address switch, SW1 on the Control Board, is a DIP multi-pole switch, which is programmed with a Driver's unique node address in binary form. While present on the network, a Driver may be issued specific commands from and return formatted responses to a master communications device. By default, the RS-485 driver IC is enabled and RS-485 serial I/O is available at the rear of the driver.

A computer operating properly 'watchdog' function is provided on the Control Board to safeguard against loss of MCU program control. Under normal circumstances, MCU IC input lines RESET and XIRQ will be provided with a logic-HIGH by an on-board watchdog IC. If Jumper JK3 is in place, the CPLD device must provide a toggle in the CPLD WDI Output line every 1.6 seconds to indicate to the watchdog IC that the MCU is operating properly. The CPLD will interpret a PG3/WDI input from the MCU, or activity on the UC_RS485_ENA control line, or activity on the RS-485 communications lines, as indications that the MCU is operating properly, and will toggle the CPLD WDI output line. If a toggle in the WDI line does not occur within 1.6 seconds, it is assumed the MCU is no longer executing the desired program properly. The watchdog IC will drive low the XIRQ signal, which will ultimately result in a reset of the MCU and restart of the MCU program.

Two power supply voltage inputs of approximately +9 V_{DC} are provided to the Control Board to supply the digital regulator and analog regulator circuits. The digital regulator circuits are fused by F1 at their +9 V_{DC} input. +5 V_{DC} for the digital circuitry is developed with a linear voltage regulator. The +5 V_{DC} digital circuit has a separate ground plane for the digital devices. A switching regulator IC and associated components develop DC output voltages of approximately ±14.5 V_{DC} which are then regulated by linear regulators to +12 V_{DC} and -12 V_{DC} for various digital and analog circuitry. The +5 V_{DC} analog regulator is supplied from a +9 V_{DC} input separate from the digital +9 V_{DC} input, and is fused by F2. +5 V_{DC} for the analog circuitry is developed with a linear voltage regulator. The +5V_{DC} analog circuit has a separate ground plane for the analog devices.

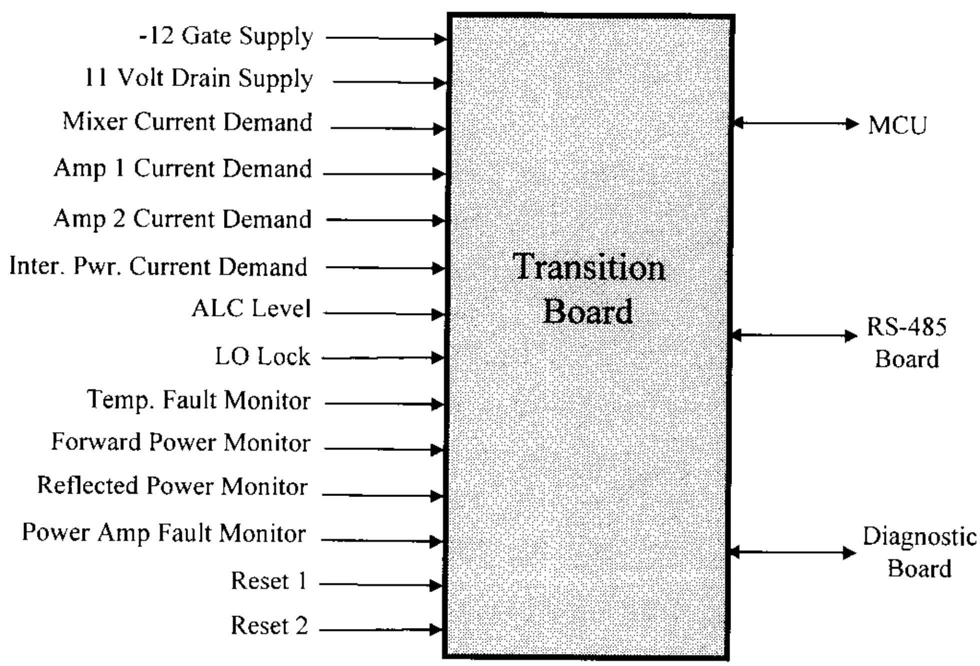
Transition Board

The Transition Board provides interfacing between the Microprocessor Control Unit (MCU), the RS 485 board, and the Diagnostics Board. The Transition Board also provides regulated power to the MCU. A PAL (Programmable Array Logic) IC provides the necessary logic for several different system shutdowns. Signals are routed on the Transition Board to the MCU for monitoring.

The MCU monitors transmitter performance by signals routed through the Transition Board. Amplifier currents, LO lock, ALC level, output power levels and temperature monitoring are read through signals routed on this board. The Transition Board allows the MCU to shutdown the Driver remotely. Also, the MCU can determine if the Driver is in standby state, and the Transition Board allows the MCU to read a fault occurring in the Power Amplifier Sub-Rack.

The Transition Board also provides an interface between the Driver and the Comview Status Monitoring System. Amplifier currents, LO lock, ALC level, output power levels and temperature data are routed to the RS-485 Board through the Transition Board.

The Transition Board also provides regulated 9 V_{DC} from the regulated 12 V_{DC} supply to the MCU by means of the Mother Board.



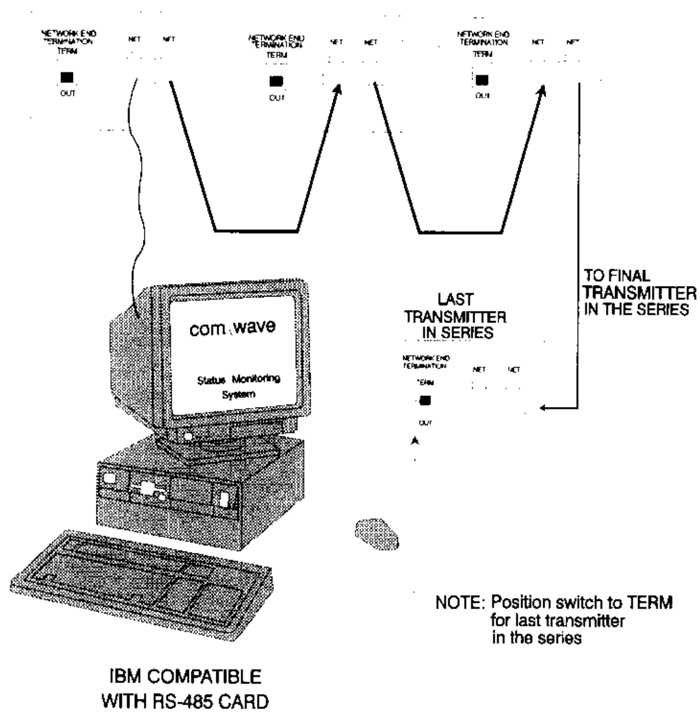
RS-485 Communications Board

An RS-485 communications board is mounted to the inside rear of the chassis. It interfaces each transmitter's Microcontroller Unit (MCU) to a communication buss for status monitoring to a common computer/Master Control Station. The system is capable of monitoring up to 32 individual transmitters.

The board has a 5 pin input connector with connections to two rear panel mounted 6 pin telephone type receptacles (RJ11). It functions as the interface between the transmitter's MCU, the communication buss, and a computer monitoring system. The buss consists of a double twisted shielded pair cable which daisy-chain links (parallels) transmitters to a common computer for complete system status monitoring.

A board mounted mini DPDT DIP switch labeled as NETWORK END TERMINATION is accessible on the Mother Board located on the rear of the Sub-Rack. When a status monitoring computer system is used, all Mother Boards ordinarily have this switch set to the "OUT" position with the exception of the last Mother Board in the daisy chain series. The last Mother Board normally has the switch set to "TERM". This action terminates the communication buss at the last Mother Board of the daisy link chain establishing proper buss impedance. The Driver also has a set of RJ11 receptacles which is used to interface with the daisy chain communication buss in the same manner as the Mother Board.

COMVIEW STATUS MONITORING INTERCONNECTION



Mother Board

The Mother Board performs a variety of functions. It provides the majority of interconnections between other circuit boards and modules. The Mother Board contains linear power supplies, comparators, current sampling resistors, metering adjustments, board mounted switches, power supply enable circuitry, +11 V_{DC} switching power supply fuse, and two board-mounted status LEDs.

Linear Power Supplies: The -12, +12, and +5 V_{DC} linear power supplies which are located on this board, route power to appropriate connectors. They provide power to operational amplifiers, comparators, gating circuits, and other modules.

Comparators: Comparators set up operating windows with respect to an input signal. Depending upon the reference biasing, the input signal can cause a logic high or low. An input signal within the upper and lower trip points cause the comparator to output the desired logic level. A signal beyond the operating window causes a toggle of the logic state setting associated gating.

The +11 V_{DC} switching power supply voltage is compared to a 12 V_{DC} reference. A deviation of the switching power supply voltage beyond set limits causes a logic low output and sinks the bias current from a transistor. With the transistor in cutoff, collector voltage is available to illuminate the front panel diagnostic display +11 V_{DC} LED.

The local oscillator feedback signal is applied to a comparator. When the signal is present, the comparator outputs a logic low, sinking the +12 V_{DC} pull up voltage. Absence of the LO signal causes a logic high which biases a transistor into conduction. The collector is pulled low reflecting back to AND gates, disabling the transmitter and illuminating the front panel LO diagnostic LED.

OPTIONAL:

An IF detected signal toggles a comparator to a TTL high supplying transmitter and power supply turn-on logic to AND gates. A board-mounted switch (SW1) by-passes the IF detected signal by sourcing +5 V_{DC}.

Current Sampling Resistors: Amplifier module power is distributed through low valued series current sampling resistors. These resistors develop voltage drops proportional to the supplied drain current. Voltage drop samples are routed to the diagnostics board for processing.

Metering Adjustments: Metering adjustments are provided to calibrate the front panel analog meter to 100%.

VR1: Reflected power adjustment.
VR3: +11 V_{DC} switching power supply adjustment.
VR4: Forward power adjustment.

Board Mounted Switches:

SW1: IF detect by-pass. Provides +5 V_{DC} to bias ON the front panel diagnostic IN SIGNAL LED and send a logic high to AND gates. Bypass enables transmitter to continue transmitting although there is no IF detected signal.

SW2: This switch is only used when the unit is configured as a driver. For the Digital Driver, this switch will always be in the ON position.

Power Supply Enable: The +11 V_{DC} switching power supply connects to the Mother Board. Power is routed through a relay to all amplifier modules upon satisfaction of logic to AND gates. The following parameters must be met in order to enable the Switching Power Supply: IF detected signal (or by-pass switch ON), transmitter not in standby, -12 V_{DC} bias interlock available, the LO must be phase locked, and thermostat open. Also in an Agile Transmitter application, a valid channel must be selected for Power Supply Enable.

Fuse: The +11 V_{DC} power supply is protected with a 10 Ampere fuse located on the Mother Board.

Status LEDs: The Mother Board contains two status LEDs, DS1 (Red) and DS2 (Yellow). Illumination of DS1 indicates the presence of -12 V_{DC} interlock bias and DS2 the presence of +12 V_{DC}.

Diagnostic Interface Board

The Diagnostic Interface Board receives various input signals, performs comparisons to set reference levels, forwards compared outputs to the front panel LED display board and rear panel connectors P1 and P2. The interface board determines module status by monitoring the drain current drawn through low valued series sampling resistors from the +11 V_{DC} switching power supply.

Diagnostic monitoring of each module is identical, therefore, the Intermediate Power Amplifier will be used as an example. The Intermediate Power Amplifier FET device receives +10 V_{DC} drain voltage through .1 ohm series sampling resistor. The FET draws 2.2 amperes which develops .220 volts across a sampling resistor. This voltage drop is sent to an operational amplifier having a gain of 10. A 2.20 V_{DC} op amp output voltage is applied to comparators. Comparators reference voltages define an operating window.

A sample voltage within the window causes both comparators to output a logic-high to a transistor. The transistor is biased ON sinking the pull up voltage from the input of an AND gate. The front panel FINAL LED is illuminated if a logic-low is not present at the input of the AND gate. A sample voltage outside the defined window causes the applicable comparator to output a logic-low to a transistor. This action sinks available base current biasing the transistor into cutoff. An AND gate receives a logic-high, and the AND gate is enabled, sending a logic high illuminating the front panel FINAL LED.

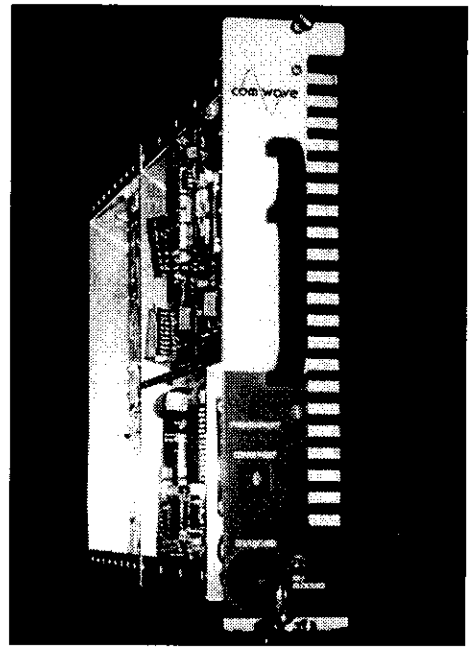
Each module has diagnostic circuitry for monitoring the current of each module. Excessive or insufficient current draw causes the respective comparator to output a logic-low and illuminate the applicable front panel diagnostic LED. Samples of the current drawn by each module are received from the Mother Board, processed by the Diagnostic Interface Board and sent to J2, a rear panel connector, for monitoring purposes.

Board-mounted potentiometers adjust the op amps gains to a multiple of approximately ten for each diagnostic input. Test points for each op amp output are provided.

Power Amplifier Segment
Theory of Operation

Power Amplifier Segment General Description

The Power Amplifier Segments of the high power single channel transmitter series use the latest technology in power FET's. The transistors provide high output power, as well as, more linearity and higher efficiency. Mechanically, the Power Amplifier Segments have a plug-in architecture which allows hot replacement. In addition to hot replacement, the architecture of the Amplifier enables flexibility to tailor the system to higher output power levels and can be easily upgraded.



Power Amplifier Segment
Front View

The Power Amplifier Segment consists of a Microwave Amplifier, Control Board, DC to DC converter, and a Front Panel. A Microcontroller System, located on the Control Board, supervises and controls the Power Amplifier Segment in each of its functions. The DC to DC converter reduces 48 V_{DC} front-end power supply input to the nominal amplifier voltage of 10.5 V. The front panel displays the status of the Amplifier Segment and interfaces the Control Board to a computer by means of a serial RS-232 port.

Power Amplifier Segment Operation

The Amplifier Segment is equipped with a key lock switch on the front panel to retain it in place. When pushing-in or pulling-out the Segment, turn the key lock switch to the OFF position. After plugging the Amplifier Segment into the sub-rack and tightening the front panel thumb screws, turn the key-lock switch to the ON position. The 10 V_{DC} secondary power supply will start-up the Control Board which applies a negative voltage to the gates of the FETs and turns the DC to DC converter on. It also adjusts the transistor's current and releases the input signal to the Microwave Amplifier. The air flow passes through the heatsink from the front to the rear of the sub-rack. The air flow loss to the other Power Amplifier Segments during hot replacement is negligible.

Power Amplifier Segment
Specifications

Parameter	*Specification*
Primary DC Voltage	48 V
Primary DC Current	4.9 A
Secondary DC Voltage	10 ±0.5 V
Secondary DC Current	0.4 A
Communication Port	RS-232 and RS-485
Input Power	Digital 12.0 dBm Analog 17.5 dBm (@ P1 dB)
Output Power	Digital 41.5 dBm Analog 47.0 dBm (P1 dB)
Dimensions	2.1"H x 10.3"W x 17.1"D 5.3 cm H x 26.1 cm W x 43.4 cm D
Weight	9 lbs (4 Kg)

***Specifications subject to change without notice.**

Power Amplifier Board

Power Amplifier Board General Description

The Power Amplifier Board has a high gain architecture with 47 dBm output power at 1 dB compression point and 29.5 dB gain. The input signal passes through a microwave switch for hot stand-by operation. This feature allows the control board to set up all DC parameters and check for proper amplifier operation without the influence of an RF signal. The signal then passes through a pin diode attenuator which sets the overal gain of the amplifier.

In the first stage, a 3 dB hybrid provides a reliable load to the driver and a flat broadband frequency response to the amplifier. The second and third stages of amplification five the proper output power with minimum distortion and high efficiency. A low output VSWR (Voltage Standing Wave Ratio) is provided by the 3 dB combining system. The directional coupler provides a sample signal proportional to the forward and reflected power. This measurement ensures that the amplifier delivers the correct power. An IC measures the operating temperature of the amplifier which is monitored by the MCU. The Amplifier is placed in a faulted state if the temperature exceeds a limit set by the MCU.

Power Amplifier Board Operation

The Control Board acknowledges the input signal presence from the Driver. It places the microwave switch in the hot stand-by mode and adjusts the current of each FET. The current sensor , located on the power supply, provides the current samples to the Control Board to check for proper operation of the transistors. The Control Board sets the variable Attenuator to the correct amplifier gain, and removes the microwave switch out of "STANDBY" and into the through path.

The microwave circuit amplifies the input signal with high linearity performance and broadband frequency response. This feature allows the amplifier to be used for any channel without retuning. The FET's are protected from catastrophic failure by an IC on the Amplifier Board. The temperature sensor supplies the control board with a voltage proportional to the heatsink temperature. The Microcontroller will sense this voltage and protect the amplifier against high temperature or from failure of the cooling system. The output directional coupler measures the forward and reflected power. These measurements provide the Microcontroller with the information needed to verify the status of the amplifier.

Power Amplifier Board Specifications

Parameter	*Specification*
Input DC Voltage	10.5 V
Input DC Current	19.8 A
RF Gain	29.5 dB
Output Power	47 dBm
Flatness (BW 200 MHz)	±.5 dB
Input VSWR	1: 1.6
Output VSWR	1: 1.5

**Specifications subject to change without notice.*

Control Board

Monitoring and control of the Power Amplifier Segment is accomplished through a Control Board located within a section of the Segment housing. The Control Board utilizes an 8-bit microcontroller (MCU) with on-board memory to perform the monitoring and control functions. The Control Board circuitry includes analog signal conditioning, A/D and D/A converters, supply voltage regulation, and two serial data interfaces.

Monitoring operations involve collecting analog signals and logic data from the Power Amplifier Segment. Analog inputs Forward Power, Reflected Power, and Temperature are received from the RF Power Amp connector J1. Analog inputs Drain Supply Voltage (V_{DD}) and High Voltage DC are received from the Power Supply connector J2. Forward Power and Reflected Power inputs are amplified by op-amps with a gain of approximately 3; while, Temperature, Drain Supply Voltage (V_{DD}) and High Voltage DC are buffered by unity gain stages. Following the V_{DD} buffer stage, a resistor divider network scales V_{DD} to 1/4 its input voltage, followed by a second unity gain buffering stage. Each of these inputs are voltage-limited to 5.1 V_{DC} by means of Zener diodes at the input to the Control Board. They are protected from voltages more negative than -0.4 V_{DC} by Schottky diodes at the output of the Op-Amp gain stages to protect the MCU A/D converter inputs.

Drain currents drawn by FETs in the RF Power Amplifier section of the Power Amplifier Segment are monitored by the Control Board, which is performed by monitoring the voltages dropped across series resistors in the drain supply circuits on the Power Supply Board. These eight voltages are received by the Control Board from the Power Supply connector J2. Each signal is selected by the MCU and related CPLD logic through an 8-channel analog multiplexer (MUX) IC, and in turn compared to V_{DD} by a differential amp/gain op-amp stage. The resulting outputs are 10 times greater than the voltages dropped across the series monitoring resistors. These outputs are protected from voltage excursion greater than 5.1 V_{DC} by Zener diodes, and from excursion more negative than -0.4 V_{DC} by Schottky diodes. The resulting signal is connected to input AN0/IDSMON on the MCU A/D converter. This signal varies through time with each of the eight monitored signals as selected by the MCU.

The Control Board generates negative FET gate supply voltages with a Digital to Analog (D/A) converter and analog voltage inverter circuits. The 8-bit D/A IC is provided with a 2.5 V_{DC} reference and with data from the MCU to set the output voltage on each of 8 channels to a positive voltage of the same value as the absolute value of the desired gate voltage. These positive voltages (e.g. +Vgs) are then inverted by unity gain inverter op-amp circuits to negative voltages (e.g. -Vgs). The negative gate voltages are output to the RF Amplifier section on RF Power Amplifier connector J1.

The negative FET gate supply voltages supplied to the RF Power Amplifier section are returned to the Control Board through internal segment harnessing. These returned gate voltages provide the Control Board with monitoring of the gate voltages arriving at the RF Amplifier section, allowing incorrect gate voltage or gate interlock break to be detected. The monitored gate signals, input on RF Power Amplifier connector J1, are multiplexed by a MUX IC in a manner similar to that for the drain MUX described above. The time-varying MUX output, which generally carries negative voltages, is inverted by a unity gain inverter op-amp circuit to provide a positive voltage to the AN1/VGSMON input on the MCU A/D converter.

Various logic inputs and outputs are provided by the Control Board. A drain supply enable logic signal, PS_ENABLE, is output from the Control Board on J2. The state of PS_ENABLE is controlled by the MCU, which tests other signals such as Standby and Gate Voltage Interlocks, to determine if it is safe to enable the power supply. The MCU outputs the Enable Signal to the CPLD, which in turn outputs the PS_ENABLE on J2. If the MCU detects a condition in which it would be improper or unsafe to allow the drain supply to operate, the CPLD will be made to output a logic-LOW on the PS_ENABLE control output.

Output signals which control the RF Power Amplifier section RF switch and attenuator are generated on the Control Board. Signal RF_SWT, output on connector J1, controls the terminated or unterminated state of the RF Power Amplifier section RF switch. RF_SWT is driven to a logic-HIGH when the Power Amplifier Segment is set to the TRANSMIT state. This logic-HIGH will cause the RF switch to route the RF Amp microwave input signal into the Amplifier circuitry. Signals RF_ATTEN_CTRL1 and -2 are analog outputs which reciprocate to control the branches of the RF attenuator network located in the RF Amplifier section. These analog voltages are developed in a D/A converter IC and NPN and PNP transistors.

The Serial Input/Output (I/O) capabilities of the Power Amplifier Segment originate on the Control Board and the MCU's SCI port. In general, the Power Amplifier Segment may be connected on an RS-485 multidrop network as an individually addressed node with other Power Amplifier Segment nodes. Node address switch, SW1, is a DIP multi-pole switch which is programmed with a Power Amplifier Segments unique node address in binary form. While present on the network, a Power Amplifier Segment may be issued specific commands from and return formatted responses to a master communications device. By default, the RS-485 driver IC is enabled and RS-485 serial I/O is available at the Board's J3 backplane connector. An RS-232 serial I/O port is also available but the RS-232 driver IC is disabled by default. This port is interfaced through an RJ-11 connector on the Power Amplifier Segment front panel. When the ENA_RS232 control input line is given a logic-LOW (as when the proper interface cable is plugged into the Power Amplifier Segment RJ-11 connector), the RS-232 port is enabled. At this time, the RS-485 port is disabled, causing a loss of communications with the RS-485 network. The same Power Amplifier Segment command and response capabilities available on the RS-485 port are provided on the RS-232 port.

A computer operating properly 'watchdog' function is provided on the Control Board to safeguard against loss of MCU program control. Under normal circumstances, MCU IC input lines RESET and XIRQ will be provided with a logic-HIGH by an on-board watchdog IC. If Jumper JK3 is in place, the CPLD device must provide a toggle in the CPLD WDI Output line every 1.6 seconds to indicate to the watchdog IC that the MCU is operating properly. The CPLD will interpret a PG3/WDI input from the MCU, or activity on the UC_RS485_ENA control line, or activity on the RS-485 communications lines, as indications that the MCU is operating properly, and will toggle the CPLD WDI output line. If a toggle in the WDI line does not occur within 1.6 seconds, it is assumed the MCU is no longer executing the desired program properly. The watchdog IC will drive low the XIRQ signal, which will ultimately result in a reset of the MCU and restart of the MCU program.

Two power supply voltage inputs of approximately +10 V_{DC} are provided to the Control Board to supply the digital regulator and analog regulator circuits. The digital regulator circuits are fused by F1 at their +10 V_{DC} input. +5 V_{DC} for the digital circuitry is developed with a linear voltage regulator. The +5 V_{DC} digital circuit has a separate ground plane for the digital devices. A switching regulator IC and associated components develop DC output voltages of approximately ±14.5 V_{DC} which are then regulated by linear regulators to +12 V_{DC} and -12 V_{DC} for various digital and analog circuitry. The +5 V_{DC} analog regulator is supplied from a +10 V_{DC} input separate from the digital +10 V_{DC} input, and is fused by F2. +5 V_{DC} for the analog circuitry is developed with a linear voltage regulator. The +5V_{DC} analog circuit has a separate ground plane for the analog devices.

Control Board Specifications

Parameter	Specification
Microcontroller type	8-bit MCU with 64 K address space
DC Input Voltage	10.0V ± 0.5 V
DC Input Current	400 mA typical @ 10.0 V
Operating Temperature	0° C to +50 ° C
Communication Ports	1: RS-485; 1: RS-232
Program stall time before COP Watchdog Reset	1.6 seconds
Number of Analog Inputs	21
Number of Logic Inputs	7
Number of Analog Outputs	10
Number of Logic Outputs	6
Physical Dimensions	5.125" H x 3.50" W x 0.58" D typ 13.0 cm H x 8.9 cm W x 1.5 cm D typ

*Specifications subject to change without notice.

300 Watt Power Supply Board

300 Watt Power Supply General Description

The Power Supply Board consists of two DC/DC converters, input and output voltage monitoring, standby switching, over voltage protection, and current sensing. All functions of the Power Supply Board are interfaced with the Control Board.

The Power Supply reduces the high voltage, low current front end power supply input to the nominal output voltage of 10.5 volts. The DC/DC converters are high power density, high efficiency, switching power supplies. The over voltage protection consists of a voltage detector, a crowbar, and the fusing. The standby switching uses a high efficiency FET.

300 Watt Power Supply General Operation

After engaging the Power Amplifier Segment, the Control Board checks the input voltage and turns the FET switch on. The DC/DC converter has a master/slave configuration, which provides the total current for the RF Amplifier. This configuration allows for accurate current sharing between the master and the slave.

The Control Board will then detect the output voltage. If the output voltage rises above the nominal value to a preset value, the crowbar will be activated and cause the fuse to open. When this occurs the Control Board will disable the standby switch and the DC/DC converters. The Power Supply distributes eight lines of power with current sensing. These lines are monitored by the Control Board and used for the current control loop.

300 Watt Power Supply Board Specifications

Parameter	*Specification*
Primary Input Voltage	48 Volts DC Nominal
Primary Input Voltage Range	36 to 76 Volts DC
Primary Input Current	7.5 Amps DC @ 48 Volts DC
Primary Input Current Range	10.0 to 4.7 Amps DC
Secondary Input Voltage	9 Volts DC
Secondary Input Current	10 Milliamps DC
Output Power	300 Watts maximum
Output Current Limit	105 to 135% of Max. rated power
Efficiency	83 to 88%

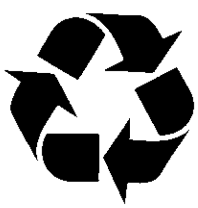
**Specifications subject to change without notice.*

Installation

Unpacking

The Racks should remain in their original packing containers until they are placed in the equipment shelter. Place all Racks outside of the shelter sequentially so they can be installed in their proper position. Packing materials should be removed from the Racks inside the equipment shelter as they are being installed.

The Drivers and Power Amplifier Segments should be removed from their boxes as they are ready to be installed. Any unused equipment should remain in the original packing box until needed. As each piece of equipment is being unpacked, compare the packing list with the contents of the box and check for in-transit damage. Should any damage be noted, notify the freight carrier immediately to file a freight claim. Also, notify Comwave of any damages or of materials missing from the shipment. Refer to the Customer Service Document # 18-01001 for information about contacting Comwave.



Please do not discard original packaging material. It should be returned to Comwave to be recycled. Be sure to retain several boxes for each type of equipment at the transmitting site. This is to be used in the event the equipment is shipped back to the factory for repairs, upgrades, or modifications to ensure adequate protection.

Physical Installation

Installation of the Rear Door

Install the rear door of each transmitter as it is unpacked. Place the hinged portion of the door over the corresponding holes in the fan shroud assembly. Insert the screws provided into the existing rack clips. After adjusting the door position, close and lock the door to ensure proper mechanical operation.

AC Power Connections to the Exhaust Fans

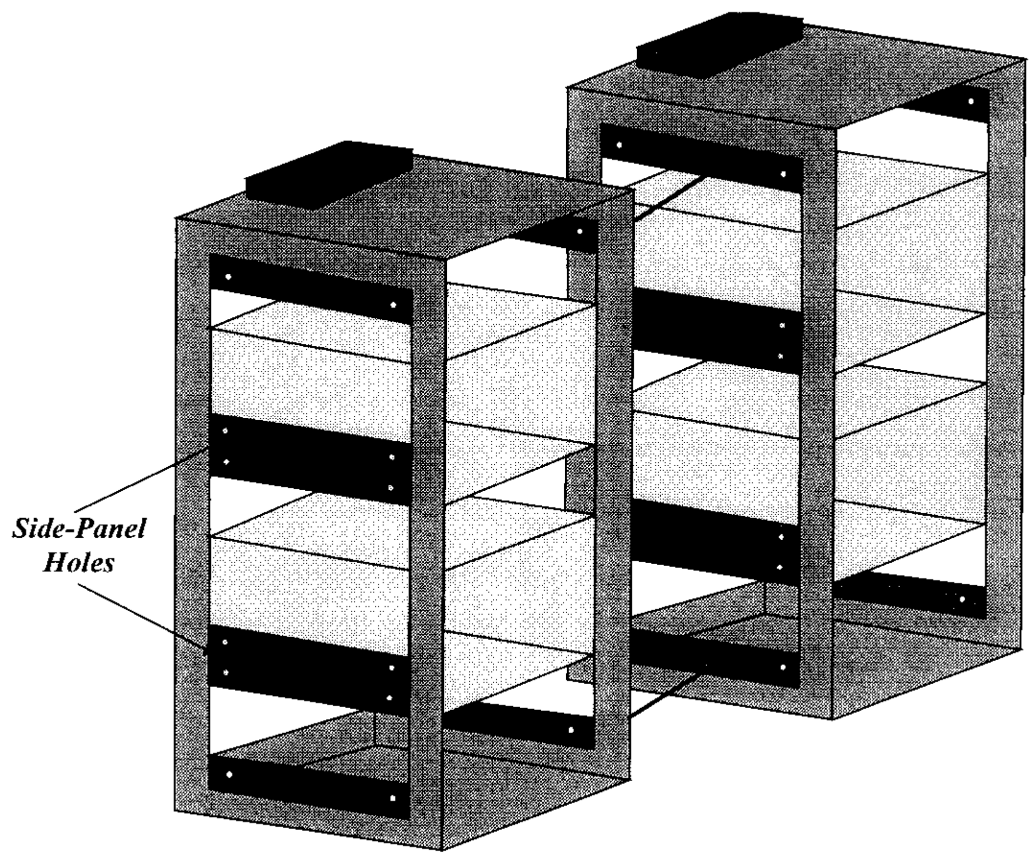
The exhaust fans located on the rear door of the Rack have attached wiring harnesses. The harnesses must be routed into the transmitter chassis through a hole in the fan shroud and connected to the AC terminal strip. The terminal strip must be accessed before the Racks are bolted together. Verify that the circuit breaker is in the OFF position. Connect the fan harness to the terminal strip following the AC Interconnect Diagram located in the schematic section of this manual.

Bolting the Racks Together

A minimum of six bolts should be used to bolt each Rack to the adjacent (three in the front and three in the rear). After all of the Racks have been placed in their final destination, insert the provided hardware in the accessible-side-panel holes of the Racks. The hardware can be located on the bottom side of the Racks. Refer to the following diagram for hole locations.

NOTE: Be sure that all three exposed planes of the Racks are straight and flush before the bolts are tightened.

After the Racks are bolted together, Bolt the side-panels to the ends of the outer Racks.



Installation of the Driver Chassis

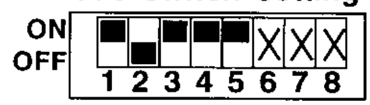
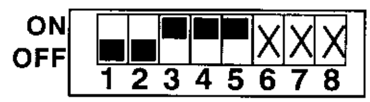
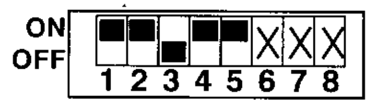
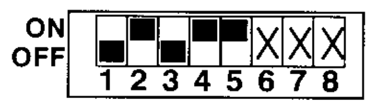
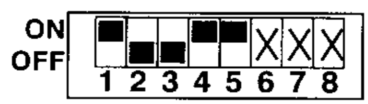
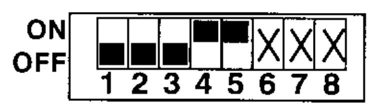
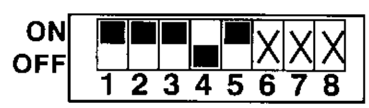
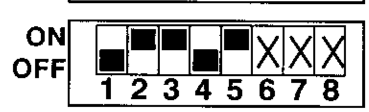
The Rack is equipped with slide rails for convenient installation of the Driver Chassis. Slide rails also enable easy access to internal adjustable controls and other maintenance/adjustments. To install the Driver Chassis in the Rack, pull the slide rails outward until they lock into place. Carefully align drawer with the slide rails and mate. Unlock the slide rails by depressing the lock button on each rail while pushing the chassis inward. The chassis 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 transmitter drawer. Tighten brackets once free sliding motion has been achieved.

Once the Driver Chassis has been installed in the Rack and the Rack slides are adjusted, cabling can begin. Pull the Driver out of the Rack until the Rack slides lock, to provide access to the rear panel of the Driver Chassis. Wrap-around labels are located on each cable to denote proper destination. Refer to the following diagram to assist in cabling of the Driver Chassis.

Installation of the Power Amplifier Segments

The Power Amplifier Segments slide into the Sub-Rack on Nylon slides and connects to the Mother Board via a floating connector. The key-lock switch, located on the Segment's Front Panel, must be in the OFF position in order to plug the Segment into the Sub-rack. This is to ensure that there is no arcing between connections before the Segment is fully engaged. Once the Segment is slid into place, thumb screws on the Segments Front Panel are provided to fasten the Segment to the Sub-rack and to provide additional ground connection. The key-lock switch may now be turned to the ON position to apply power to the Segment. Once the key-lock switch is turned on, the Segment will automatically set the gain and currents of the amplifier.

Hot Replacement of the Power Amplifier Segment may be required if a failure occurs. To remove a Segment turn the key-lock switch to the OFF position, loosen the thumb screws on the Segment's Front Panel and slide the failed Segment out of the Sub-rack. Before the replacement Segment can be installed, the Node Address must be set. A set of DIP switches is accessible through the cover of each Segment directly behind the key-lock switch. Set the DIP switches of the replacement Segment to the same positions as the failed Segment's DIP switches. Install the replacement Segment as described above.

Module Position	***Node Address***	***Node Switch Setting***
1	2	
2	3	
3	4	
4	5	
5	6	
6	7	
7	8	
8	9	

NOTE: Do not change Node Switch Settings 6, 7, and 8. They should remain as set by the factory.

Environmental and Safety Considerations

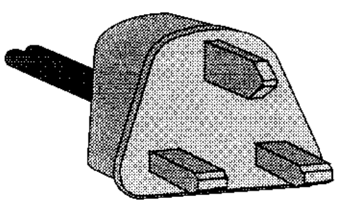
Environmental Considerations

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 my be operated with relative humidity of up to 95%, the equipment must be protected from conditions which cause condensation within the equipment.

A rear door is used to force proper ventilation through the cabinet (600 cfm fans per transmitter are used). If failure of a fan occurs, replacement should be made as soon as possible. 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 transmitter cabinet for the serviceman and test equipment plus the full extension of the racked 27" 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 safety feature. As with all similar types of equipment, high voltage can be accessed when the Driver Chassis cover is removed. Special care should be given in areas of fuses, line switches, and power supplies.

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

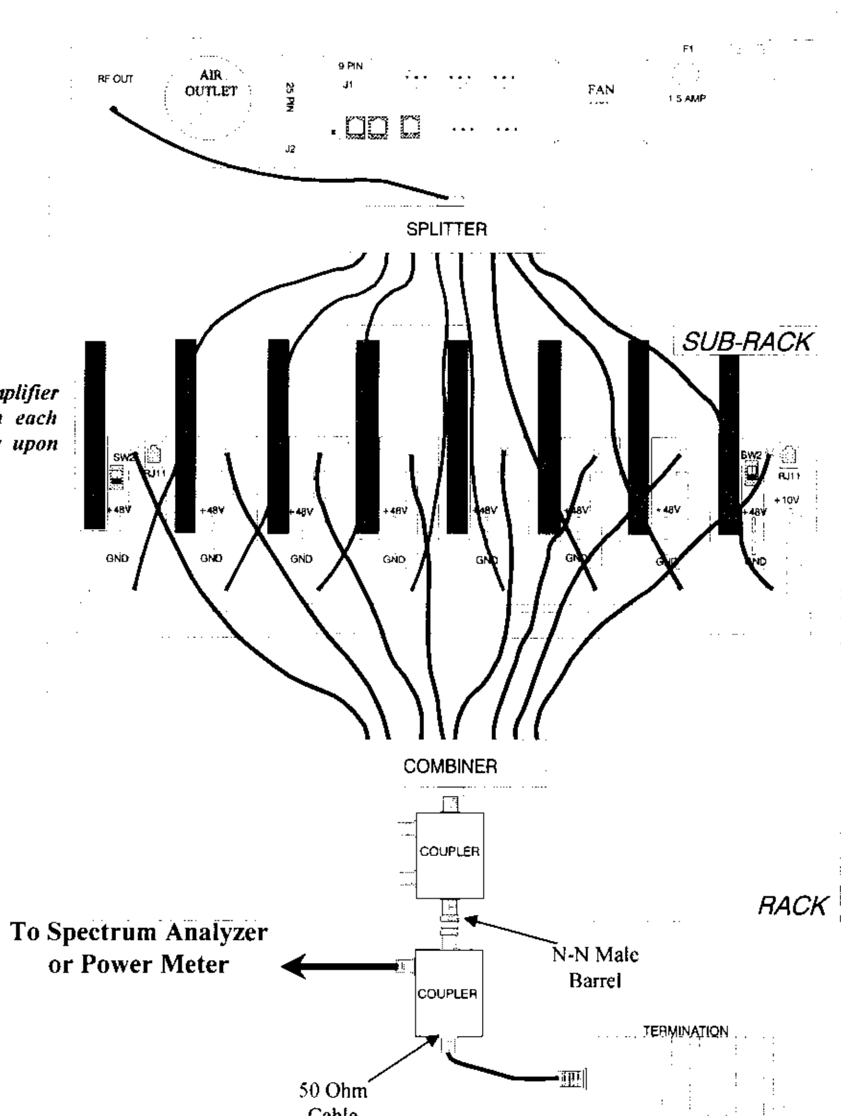
Metering Calibration

Calibration of the system is completed by COMWAVE Service Technicians prior to shipping; however, recalibration of the Driver may become necessary when the input or output power levels are changed. Due to the equal gain of the Power Amplifiers, recalibration of the Segments is not necessary.

For proper calibration, adjustments are performed in a specific sequence. Before beginning, place the Driver into "STANDBY" and attach a -30 dB directional coupler and a termination to the internal combiner as shown in the diagram below.

Power Calibration Test Setup

One to 16 Power Amplifier Segments are used in each transmitter, depending upon the power output.



A termination which is equal to or greater than the output power of the transmitter should be used.

NOTE: This procedure is applicable for making MINOR adjustments to output power and analog metering only. Do NOT adjust power more than ±5 dB. Adjustments more than ±5 dB may result in increased intermodulation distortion products. For larger adjustments to output power re-calibration of the IF Precorrector is necessary. Contact Comwave Customer Service for further assistance.

Digital Output Power Calibration

1. Apply a Digital IF Input Signal.
2. Remove the V Processor cover (six screws).
3. Turn the V Processor ALC switch, S2, to "MANUAL."
4. Connect an HP435B power meter or equivalent to the -30 dB coupler forward port.
5. Calculate the power meter reading necessary for 100% output power.

Example:

Transmitter Output @ 7.5 Watts	=	+45.00 dBm (31 carriers)*
-30 dB Coupler	=	-30.00 dB
Expected Power Meter Reading	=	+15.00 dBm

6. Rotate the function switch from "STANDBY" to "FWD PWR" to enable transmit.
7. Adjust the RF Attenuator located on the RF Processor so that the power meter reads the desired output power.
8. Adjust the Mother Board forward metering potentiometer, VR4, so that the Driver front panel meter indicates 100% forward power output. Refer to the Driver Top View Diagram on page 3 for potentiometer locations.
9. Turn the ALC switch, S2, to "AUTO."

*Different number of carrier requires the equivalent power specification chart:

1-2 channels @ 51.0 dBm
3-4 channels @ 46.0 dBm
5-8 channnels @ 42.5 dBm
9-16 channels @ 38.0 dBm
16-34 channels @ 34.5 dBm

Analog Output Power Calibration

NOTE: Analog Power output is dependent upon Modulation Depth. Obtain proper Modulation Depth prior to setting Output Power levels. Use a video generator capable of Black No Burst (O IRE = 2.2 dB correction factor) or Black Burst with setup (2.6 dB correction factor) for proper power level adjustments.

1. Apply an Analog IF Input Signal.
2. Remove the IF Processor cover (six screws).
3. Turn the IF Processor ALC switch, S2, to "MANUAL."
4. Connect an HP435B power meter or equivalent to the -30 dB coupler forward port.

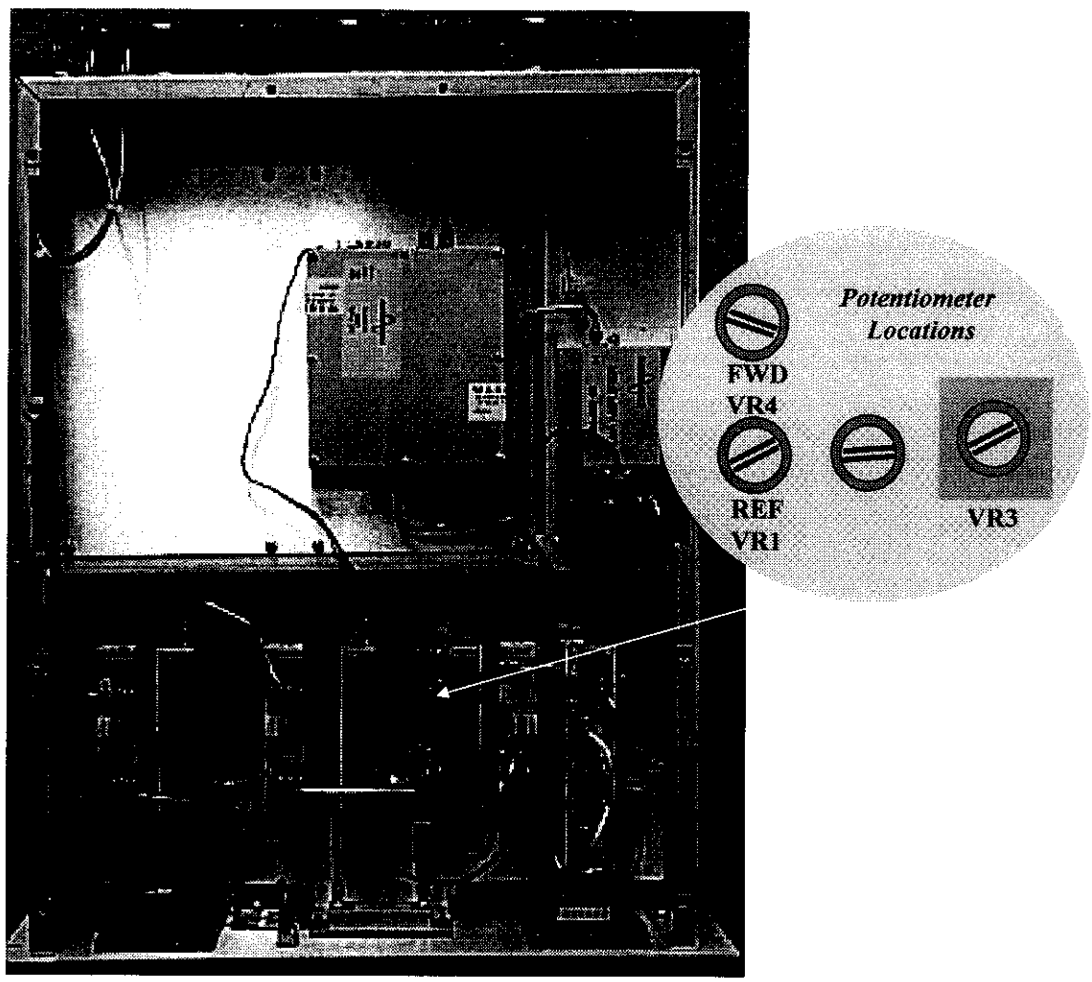
5. Calculate the power meter reading necessary for 100% output, accounting for the coupler loss and correction factor.

Example:

Transmitter Output @ 100 Watts	=	+50.00 dBm
-30 dB Coupler	=	-30.00 dB
Correction Factor	=	- 2.60 dB
Expected Power Meter Reading	=	+17.40 dBm

6. Rotate the function switch from "STANDBY" to "FWD PWR" to enable transmit.
7. Adjust the IF Attenuator located on the IF Processor so that the power meter reads the desired output power.
8. Adjust the Mother Board forward metering potentiometer, VR4, so that the Driver front panel meter indicates 100% forward power output. Refer to the Driver Top View Diagram on page 3 for potentiometer locations.
9. Turn the ALC switch, S2, the "AUTO."

Driver Top View



4. Adjust the Mother Board reflected metering potentiometer, VR1, so that the Driver front panel meter indicates 100% reflected power. Refer to the diagram of the Driver Top View for potentiometer locations.
5. Rotate the function knob to "STANDBY."
6. Return the Peak Detector coax cables to the original configuration.
7. Turn the IF Processor ALC switch, S2, "AUTO."
8. Rotate the function knob to "REF." 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 that the switching power supply voltage output is +10.80 V_{DC}.
3. Rotate the function switch to +11 VPS.
4. Adjust the Mother Board +11 VPS potentiometer, VR3, so that the Driver front panel meter indicates 100% +11 VPS metering. Refer to the diagram of the Driver Top View for potentiometer locations.

System Operation

Prior to any initial equipment turn-on, verify that all appropriate wiring interconnections have been accomplished and the installation procedures have been followed precisely. Ensure proper AC Power Distribution to the exhaust fans and cabling of the Driver Chassis and the Ultra Low Phase Noise Drawer (Agile applications only).

Initial Operation Procedures

Driver Initial Operation

1. Position the front panel rotary function switch to "STANDBY."
2. Place the circuit breaker on the rear of the Rack in the "ON" position.
3. The following GREEN LEDs continuously illuminate verifying successful Initial Operation:
   - IN SIGNAL ***(Modulator operation is required if an input signal is applied)***
   - INTERLOCK ***(Mother Board Video Presence switch, SW1, in by-pass)***

Power Amplifier Segment Initial Operation

No initial operation procedure is needed for the Power Amplifier Segments. Proceed to the Normal Operation Procedures.

Normal Operation Procedures

Driver Normal Operation

Driver operation is enabled by rotating the function switch from "STANDBY" to any other position. Once the function switch is rotated, the following GREEN LEDs continuously illuminate confirming normal operation:

- IN SIGNAL
- INTERLOCK

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 the Document # 16-01001 for troubleshooting of failures.

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

Power Amplifier Segment Normal Operation

Power Amplifier Segment operation is accomplished by turning the key-lock switch to the "ON/LOCKED" position. ***Note: The locks are an added safety feature; however, the keys are interchangeable.***

The POWER/FAULT LED should continuously illuminate GREEN. If the LED flashes RED, the Power Amplifier Segment has faulted. After three faults, a failure will occur and the Segment will shut down. It may be Reset by turning the key-lock switch to the "OFF/UNLOCKED" position and then back to the "ON/LOCKED" position. Should failure occur again, hot replacement is necessary. Turn the key-lock switch to the "OFF/UNLOCKED" position and pull the failed Segment out of the Rack by the handle. Slide a new Power Amplifier Segment into the vacant space, set the correct Node Address, and turn the key-lock switch to the "ON/LOCKED" position. Refer to Document # 14-01001 for Power Amplifier Segment Installation if needed.

Troubleshooting of the Driver

The Driver is equipped with comprehensive diagnostic circuitry that monitors the status of Power Amplifier Modules and critical circuits so failures can be readily detected. Complete operational status is known by observing the front panel LED Diagnostic Display, Analog Panel Meter and Diagnostic Interface. The following tables explain various failure mode displays and possible solutions.

NOTE: Due to internal transmitter design, there are no user serviceable modules, parts, or components. Repair of these modules is not recommended or advised. Contact COMWAVE customer support should a failure occur.

GREEN LEDs

The LED's listed below continuously operate GREEN during normal operation. Absence of a green LED indicates a missing signal or parameter which results in a controlled automatic shutdown.		
LED/Indication	*Causes*	*Possible Solutions*
IN SIGNAL (Missing Microwave signal).	• Defective cabling to IF INPUT • No Input signal • LNA failure	• Check Cabling • Verify input signal • Replace LNA • Measure voltages at 25 pin Diagnostic Interface, J2
INTERLOCK (Missing system Interlock signal).	• RF module unplugged or shorted	• Check Driver for disconnected module(s) • Measure voltages at 25 pin Diagnostic Interface, J2

RED LEDs

The following LEDs continuously illuminate RED when a failure is detected. 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.		
LED Indication	**Causes**	**Possible Solutions**
DRIVER (Defective Driver Module).	• Driver Module Current • Power Supply Failure	• Measure voltages at 25 pin Diagnostic Interface, J2
FINAL *(Power Amplifier)* (Defective Final Module).	• Final Module Current • Power Supply Failure	• Measure voltages at 25 pin Diagnostic Interface, J2
-12 V_{DC} (Low or missing -12 V_{DC}).	• Defective -12 V_{DC} source • Disconnected module • Shorted module	• Check -12 V_{DC} source • Check module connectors • Measure voltages at 25 pin Diagnostic Interface, J2
TEMPERATURE Internal chassis temperature exceeded +140 degrees Fahrenheit (+60 degrees Celsius).	• Fans inoperative • Heavy accumulation of debris on fans or heatsinks • Module(s) overheating • Site air conditioning	• Check fan operation • Check site air conditioning • Allow transmitter to cool: Reset latched failure logic by rotating function switch momentarily to "STANDBY" • Measure voltages at 25 pin Diagnostic Interface, J2
+11 V_{DC} (Switching power supply voltage has deviated beyond a set operating window {high or low}).	• Defective main input line fuse • Switching power supply module • Open switching power supply fuse, F1 • Shorted amplifier module • Open Mother Board fuse, F1	• Check switching power supply output voltage • Check for defective fuses(s) • Measure voltages at 25 pin Diagnostic Interface, J2

A 25 pin computer type Diagnostic Interface Connector, labeled as J2, is located on the rear of the chassis to assist in troubleshooting. Critical Power Supply, module and Mother Board voltage test points can be accessed/monitored at this location. Should a failure occur, the combination of meter readings, Diagnostic LED status lights, and the Diagnostic Interface voltage test points help identify the failure.

TROUBLESHOOTING WORKSHEET

This troubleshooting worksheet identifies each interface pin, the associated internal test point, nominal value, and the expected voltage range. Please fill in all blank spaces completely.

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 V_{DC} PS	+11.88	+12.00	+12.12	
3	-12 V_{DC} PS	-12.12	-12.00	-11.88	
4	+11 V_{DC} PS	+8.84	+11.00	+12.51	
5	+5 V_{DC} PS	+4.50	+5.00	+5.50	
6	Mixer	0.98	1.95	2.86	
7	AMP 1	1.24	2.75	3.78	
8	AMP 2	0.88	1.08	1.46	
9	Final Q2	1.49	2.20	2.98	
10	N/A	N/A	N/A	N/A	
11	N/A	N/A	N/A	N/A	
12	N/A	N/A	N/A	N/A	
13	System Reset	3.40	5.00	5.50	
14	ALC	1.00	1.40	2.00	
15	PA Standby	3.40	5.00	5.50	
16	PA Fault	3.40	5.00	5.50	
17	Driver Standby	3.40	5.00	5.50	
18	Reset 1	3.40	5.00	5.50	
19	Reset 2	3.40	+5.00	5.50	
20	N/A	N/A	N/A	N/A	
21	LO	0.00	.30	1.02	
22	Temp	0.00	0.70	2.50	
23	FWD Power	0.74	1.40	2.32	
24	N/A	N/A	N/A	N/A	
25	REFL Power	0.00	0.10	0.32	

Company Name: ______________ **Customer's Name:** ______________

Phone #: ______________ **Fax #:** ______________

Model: ________ Channel ________ Serial # *(Rear Panel)*: ______________

Send Results to: ***COMWAVE- Attention Technical Support*** Toll Free # (USA only): 1-800-266-9283
PO Box 69, 395 Oakhill Road 1-717-474-6751
Mountaintop, PA 18707 USA Fax #: 1-717-474-5469

ANALOG METERING

The Analog Meter provides a visual indication of the +11 V_{DC} Switching Power Supply, Peak Relative Forward or Reflected Power. The +11 V_{DC} Switching Power Supply and Forward Power should indicate 100%. Reflected power meter readings less than 10% are typical.		
LED/Indication	**Causes**	**Possible Solutions**
+11 VPS (Meter does not indicate 100%).	• Defective Switching Power Supply • Shorted Module • Open Switching Power Supply Fuse, F1 • Switching Power Supply out of adjustment • Metering out of adjustment	• Check for defective fuse(s) • Check Switching Power Supply output voltage • Troubleshoot per front panel LED Diagnostic Display • Adjust Switching Power Supply output voltage per Document # 14-04001 • Calibrate meter per Document # 14-04001 • Measure voltages at 25 pin Diagnostic Interface, J2
REFL PWR (Reflected power is greater than 10%).	• Loose RF cable connection(s) • RF cable kinked • Wave guide leak/depressurized • Reflected metering out of adjustment	• Check integrity of all RF cable connections • Check cabling for kinks or severe bends • Check wave guide pressure • Calibrate reflected metering per Document # 14-04001 • Measure voltages at 25 pin Diagnostic Interface
FWD PWR (Meter does not indicate 100% forward power).	• Driver Module • Final Module(s) • Switching Power Supply • Forward metering out of adjustment	• Confirm output power • Troubleshoot per front panel LED Diagnostic Display • Check for defective module • Calibrate forward power metering per Document # 14-04001 • Measure voltages at 25 pin Diagnostic Interface, J2

Equipment Fusing and Protection

Driver Fusing

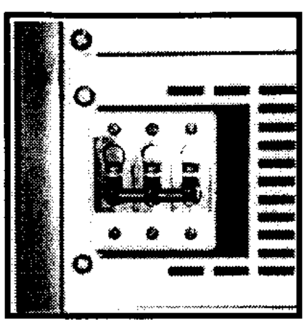
The Driver Chassis is equipped with three replaceable fuses. The locations and values of each fuse are as follows:

Location	Fuse	Value
Mother Board	F1	10.0 Amperes
Rear Panel	Input	1.5 Amperes (slow blow)
Power Supply	F1	5.0 Amperes

The AC line input is supplied with voltage suppressers to protect the equipment from moderate power surges. Thermal protection is accomplished using a thermostat that closes when internal temperature exceeds +140 degrees Fahrenheit (+60 degrees Celsius). When thermal shut down occurs, logic control removes power from the finals until the unit is sufficiently cooled.

Interlocks are designed for transistor bias protection for both the FET gate and drain power supply voltages.

Circuit Breaker



A three phase-15 Ampere circuit breaker is provided with each transmitter for system protection. It is located on the rear of the Rack above the fans. When the current exceeds 20 Amperes the circuit breaker trips and the transmitter, including AC to DC Front End Converter, Driver Drawer, Ultra Low Phase Noise Drawer ***(Agile applications only)***, Power Amplifier Segments and fans are shut down. A plastic cover is provided to protect the circuit breaker from accidental shut down.

MONTHLY MAINTENANCE RECORD

DATE	CHANNEL	FAILURE LEDs	COMMENTS

Customer Service

Comwave's customer service personnel are available 24 hours a day to assist with any questions or complications that may arise.

Communication Microwave Corp **Crestwood Industrial Park** **395 Oakhill Road** **Mountaintop, PA 18707**	
1-800-266-9283	USA only
1-717-474-6751	
1-717-474-5469	FAX

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.

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

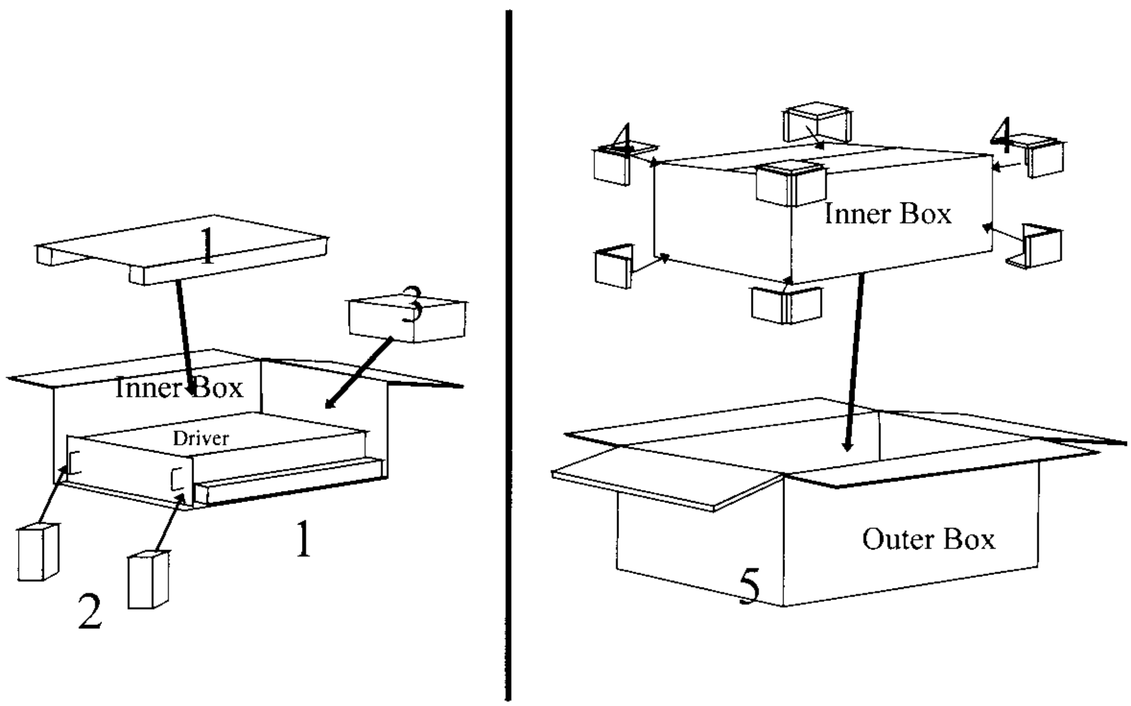
3. ***Pack equipment:*** Using original packing materials, equipment is packed in a box within another box. Double boxing provides maximum protection.

   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 return.

Packaging of the Driver for Return

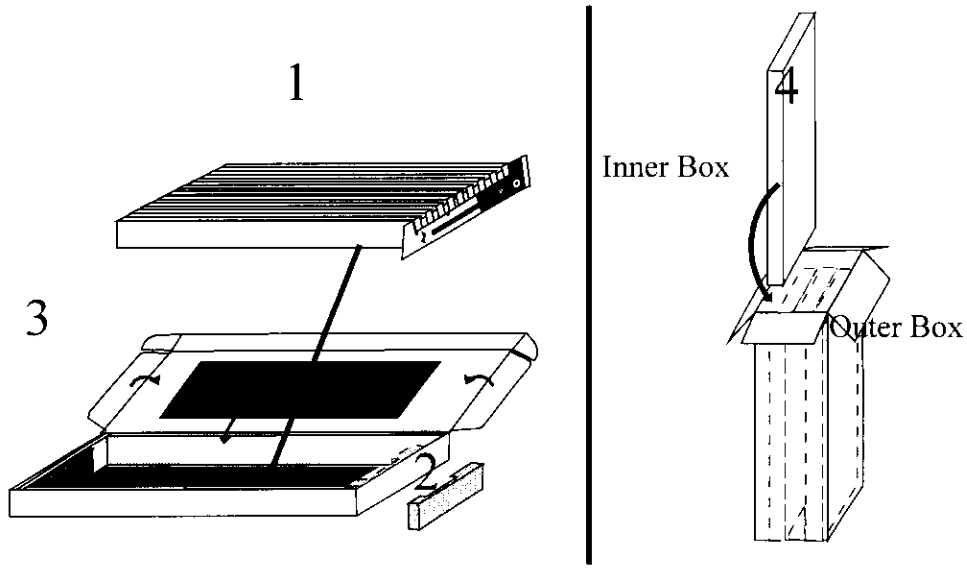
Refer to the diagram below which corresponds to each step.

1. Place the cardboard inserts above and below the equipment.
2. Insert foam against the front panel, between the handle and the corner of the inner box.
3. Insert the foam block securely behind the fans to prevent equipment from shifting upon transit.
4. Place the protective foam pieces on each corner of the inner box.
5. Place the inner box into the outer box.



Packaging of the Power Amplifier Segment for Return

1. Align the Power Amplifier Segment as shown and place into the original inner packing box.
2. Place the piece of loose foam between the handle of the Power Amplifier Segment and the side of the inner box.
3. Fold the edges of the inner box inward and close.
4. Place the inner box into the outer box, being sure to include three empty boxes for a secure fit.



Inner Box