# FCC CERTIFICATION REPORT

## FOR THE

## SBM-500A, 500 WATT ANALOG TRANSMITTER SYSTEM

THOMCAST COMMUNICATIONS,
COMWAVE DIVISION
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# TABLE OF CONTENTS

## 1.0 INTRODUCTION

This report contains all the required data for certification of Thomcast's model SBM-500A analog transmitter system. The data presented was taken from tests performed on a production transmitter system designed to transmit up to 31 ITFS/MMDS television channels, in the MDS and ITFS bands. Other information required for Certification, such as circuit diagrams and descriptions, photographs, and tune-up and maintenance procedures may be found in the technical manual, which is attached.

## 2.0 CERTIFICATION OF DATA

FCC Section 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 Raimundo Correa

Paulo Correa
Director of Engineering
Thomcast Communications, Comwave Division

## 3.0 TEST EQUIPMENT

FCC Section 2.947 (d)

The following is a list of major test equipment, which was used in testing the SBM-500A transmitter for this report:

| | |
|---|---|
| 1) Spectrum Analyzer | HP Model 8564E & 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 |
| 11) Scaler Network Analyzer | HP8713B |

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## 4.0 DESCRIPTION OF EQUIPMENT

FCC Section 2.1033

| | |
|---|---|
| 1) Instruction Books: (c)(3) | Technical manual attached |
| 2) Type of Emission: (c)(4) | |
| Visual | 5M75C3F |
| Aural | 250KF3E |
| 3) Frequency Range: (c)(5) | 2000-2700 MHz in select bands |
| 4) Operating Range: (c)(6) | +47.5 to +31.5 dBm |
| 5) Power Rating: (c)(7) | 1-2 Channels @ 47.5 dBm<br>3-4 Channels @ 42.5 dBm<br>5-8 Channels @ 38.5 dBm<br>9-16 Channels @ 35.0 dBm<br>17-31 Channels @ 31.5 dBm |
| 6) Variation of output power (c)(6) | See calibration section, document # DOC16-0005 of technical manual |
| 7) E & I on Final: (c)(8) | |
| Drain voltage | 10V |
| Drain current | 7A each |
| 8) Tune-up Procedures: (c)(9) | See calibration section, document # DOC16-0005 of technical manual |

9) Function of Active Devices: (c)(10)

The following is a list of active devices in the RF chains of the SBM-500A transmitter. The relative position of each device may be found by referring to the block diagrams and schematics found in the technical manual.

- Frequency Stability Devices: See technical manual, document # DOC13-0060 & DOC13-0059
- Spurious Suppression Circuits: Not applicable
- Describe Limiters:
  - Modulation: Not applicable
  - Power: See technical manual, document # DOC13-0062

## VHF/UHF UPCONVERTER DRIVER

***Final Amplifier*** — ***Module 04-308-02***

Board 40-229-02

U1, U2 .......... RF Amplifiers

***Power Amplifier #1*** — ***Module 04-306-02***

Board 40-225-02

Q1-Q5 .......... RF Amplifiers

***Power Amplifier #2*** — ***Module 04-307-02***

Board 40-225-02

U2-U5 .......... RF Amplifiers

***RF Precorrector*** — ***Module 04-299-02***

Board 40-226-02

U1-U3 .......... RF Amplifiers
D1, D2 .......... Diodes

Board 40-227-02

U1, U2 .......... RF Amplifiers
U3 .......... Regulator
U4 .......... OP Amplifiers
Q1 – Q4 .......... Transistors
D1 – D8 .......... Diodes

***LO AGC*** — ***Module 04-314-02***

Board 40-228-02

U1 .......... RF Amplifier
U2 .......... RF Amplifier
U3A, U3B, U3C, U3D .......... Operational Amplifier
U4 .......... Voltage Regulator
Q1 .......... Current Driver
D1, D2 .......... Attenuator Diode
D3 .......... Detector Diode
D4, D5 .......... Small Signal Diodes

***LO Multiplier*** — ***Module 08-013-02***

Board 08-010-02

IC1, IC2, IC3, IC4 .......... RF Amplifier
D1 .......... Step Recovery Diode
D2 .......... Rectifier

***VCXO PLL*** — ***Module 09-060-02***

Board 33-300-02

U1 .......... Synthesizer
U2 .......... Phase Detector
U3, U4 .......... RF Amplifier
U5 .......... Dual modulus pre-scaler
U6 .......... Voltage Regulator
Y1 .......... Crystal
IC1 .......... Frequency Divider
D1, D2, D3, D6 .......... Small Signal Diodes
D4, D5 .......... Varactor Diodes
Q1 .......... Oscillator
Q2 .......... RF Amplifier

Board 33-301-02

U1A .......... Operational Amplifier
Q1, Q2 .......... DC Switch
DS1 .......... Light Emitting Diode

***IF ALC*** — ***Module 04-129-02***

Board 33-117-02

U1A, U1B .......... Operational Amplifier
U2 .......... RF Amplifier
D1, D2 .......... Attenuator Diodes

***IF Detector*** — ***Module 12-025-02***

Board 33-324-02

U1-U3 .......... IF Amplifiers
U4 .......... DC Amplifier
D1, D2 .......... Detector Diodes
Q1 .......... DC Amplifier
Z1 .......... Zener Diode

***Envelop Detector*** — ***Module 12-017-02***

Board 33-094-02

D1,D2 .......... Detector Diodes

## POWER AMPLIFIER SEGMENTS

***Power Amplifier Segments*** — ***Module 04-294-02***

IC1 .......... SPDT Switch
D1 .......... Diode Common Cathode
D2 .......... Diode Dual Cathode
Q1 – Q5 .......... GaAs FET

## POWER SUPPLY

***Power Supply*** — ***OEM***

## 5.0 IDENTIFICATION LABEL

FCC Section 2.925, 2.926

FCC ID: CHP8BUSBM-500A
MODEL SBM-500A
SIGNAL TRANSMITTER

**WARNING:** ***Do Not Exceed <u>Per Channel</u> Output Power Rating***

| | | |
|---|---|---|
| **1-2 Channels** | **47.5 dBm/ch** | **(56.2 W)/ch** |
| **3-4 Channels** | **42.5 dBm/ch** | **(17.8 W)/ch** |
| **5-8 Channels** | **38.5 dBm/ch** | **(7.1 W)/ch** |
| **9-16 Channels** | **35.0 dBm/ch** | **(3.2 W)/ch** |
| **17-31 Channels** | **31.5 dBm/ch** | **(1.4 W)/ch** |

## 6.0 PHOTOGRAPHS

FCC Section 2.1033 (c)(11 & 12) Attached

## 7.0 MEASUREMENTS

FCC Section 2.1033 (c)(14)

- RF POWER OUTPUT

FCC Section 2.1046 (a) (c)

Visual Output Power: 47.5 dBm peak sync per channel

% Video Modulation: 87.5%

Type Video Modulation: C3F Per FCC 21.905 (a) & 74.936 (a)

Aural Output Power: 32.5 dBm average

Method of Measurement: Per FCC 2.1046 (b)

The transmitter was operated into a dummy load of substantially zero reactance with a resistance equal to the transmission line characteristic impedance. The transmitter'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 were adjusted according to the following table:

| | | |
|---|---|---|
| **1-2 Channels** | **47.5 dBm/ch** | **(56.2 W)/ch** |
| **3-4 Channels** | **42.5 dBm/ch** | **(17.8 W)/ch** |
| **5-8 Channels** | **38.5 dBm/ch** | **(7.1 W)/ch** |
| **9-16 Channels** | **35.0 dBm/ch** | **(3.2 W)/ch** |
| **17-31 Channels** | **31.5 dBm/ch** | **(1.4 W)/ch** |

The transmitter'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 transmitter's rated output.

| | |
|---|---|
| Output Power Calibration | See technical manual, document # DOC16-0005 |

- MODULATION CHARACTERISTICS

FCC Section 2.1047

- OVERALL ATTENUATION

FCC Section 2.1047 (d)

| | |
|---|---|
| Visual Output Power: | 47.5 dBm peak sync per channel |
| % Video Modulation: | 87.5% |
| Type Video Modulation: | Per FCC 73.687 (a) (4) |
| Aural Output Power: | Not applicable |
| Method of Measurement: | Per FCC 73.687 (a) (2 & 4) |
| Overall Modulation: | Measure at channel |

| Modulation Frequency (MHz) | Detected Output (dB) |
|---|---|
| 0.2 (reference) | 0.0 |
| 0.5 | 0.0 |
| 0.75 | 0.0 |
| 1.25 | -6.06 |
| 2.1 | -6.15 |
| 3.0 | -5.90 |
| 3.58 | -6.02 |
| 4.18 | -6.05 |

- ENVELOPE DELAY

FCC Section 73.687 (a) (3)

| | |
|---|---|
| Visual Output Power: | 47.5 dBm peak sync per channel |
| % Video Modulation: | 87.5% |

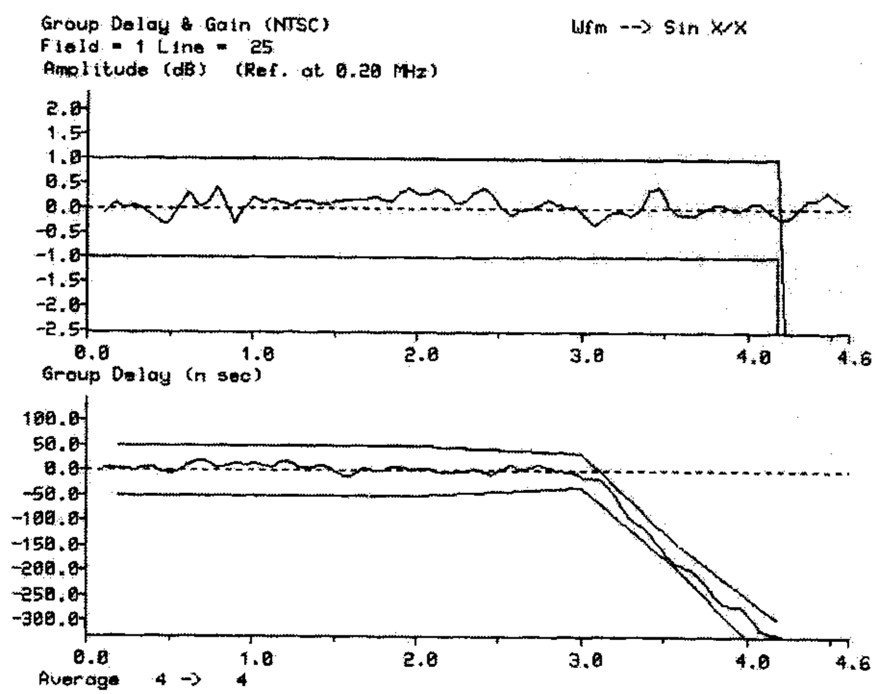
| | |
|---|---|
| Type Video Modulation: | Per FCC 73.687 (a) (4) |
| Aural Output Power: | Not applicable |
| Method of Measurement: | Per EIA RS-240, Section B (12c) |

Delay vs. Frequency:

| Frequency (MHz) | Delay (ns) |
|---|---|
| 0.2 (reference) | 0 |
| 0.5 | -5 |
| 1.0 | +20 |
| 1.5 | -10 |
| 2.1 | 0 |
| 2.5 | 0 |
| 3.0 | -20 |
| 3.2 | -30 |
| 3.4 | -100 |
| 3.58 | -150 |
| 4.0 | -300 |
| 4.18 | >-300 |

TEST DATA

Channel A COMWAVE



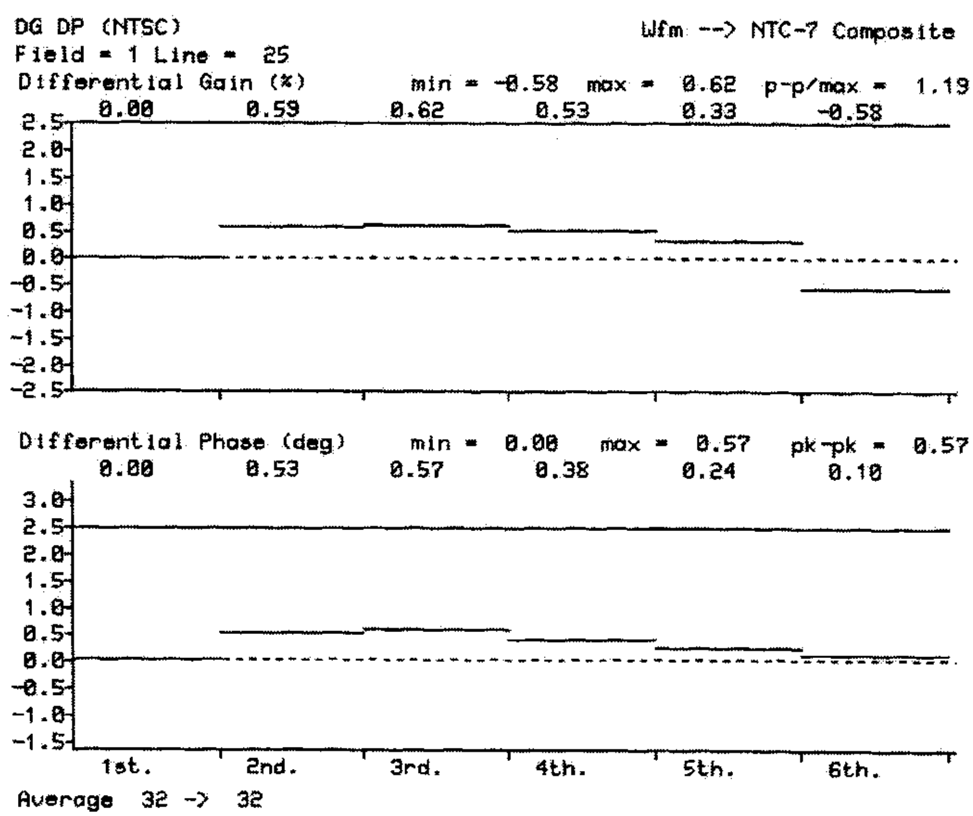
## ➢ DIFFERENTIAL PHASE AND GAIN

FCC Section 73.682 (a) (20) (vii)

| | |
|---|---|
| Visual Output Power: | 47.5 dBm peak sync per channel |
| % Video Modulation: | 87.5% |
| Type Video Modulation: | Per EIA RS-240, Section B (10c) & (11c) |
| Aural Output Power: | 32.5 dBm average |
| Method of Measurement: | Per EIA RS-240, Section B (10c) & (11c) |
| Differential Phase: | <2° |
| Differential Gain: | <1.5% |

TEST DATA

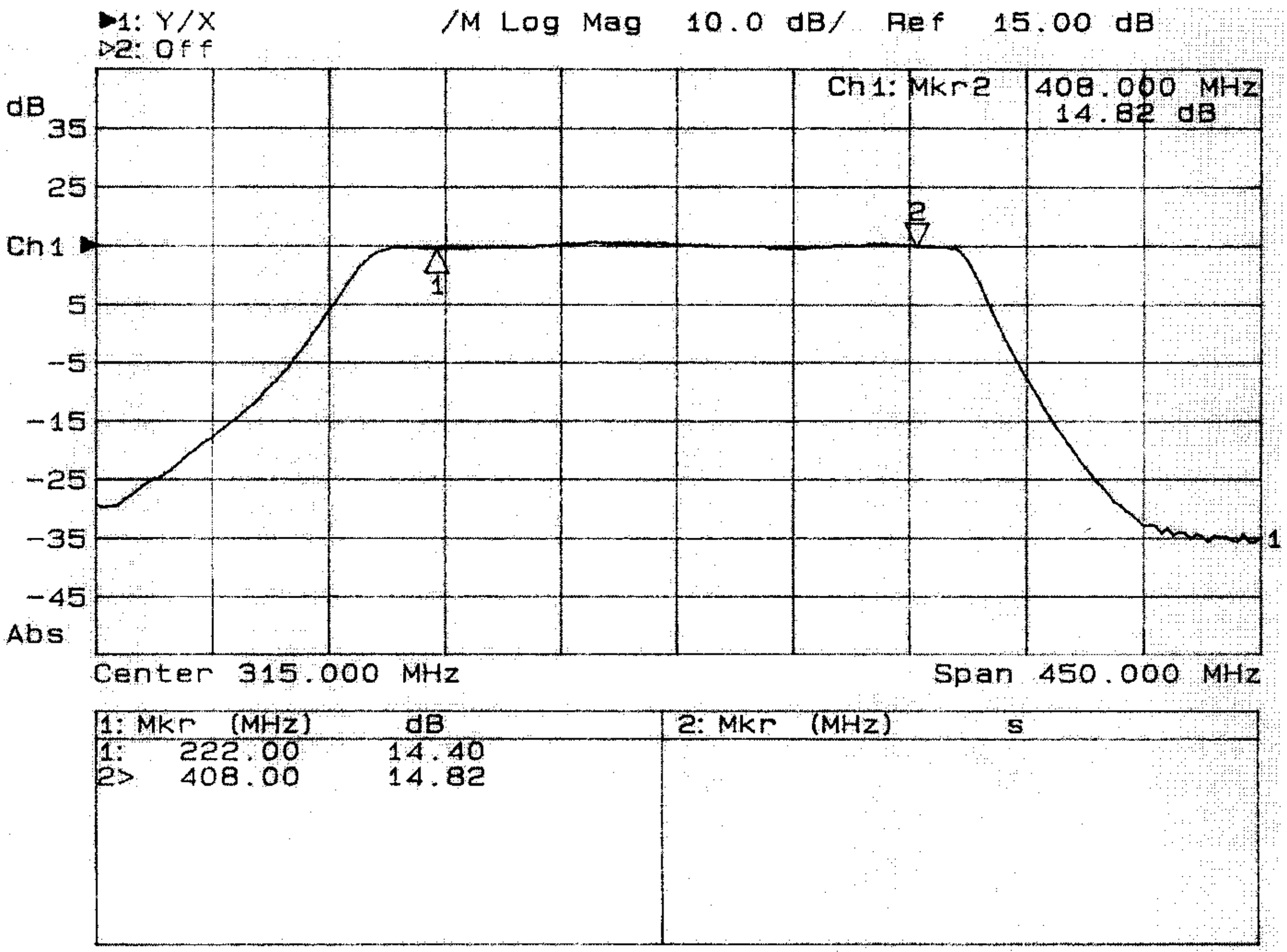
Channel A COMWAVE



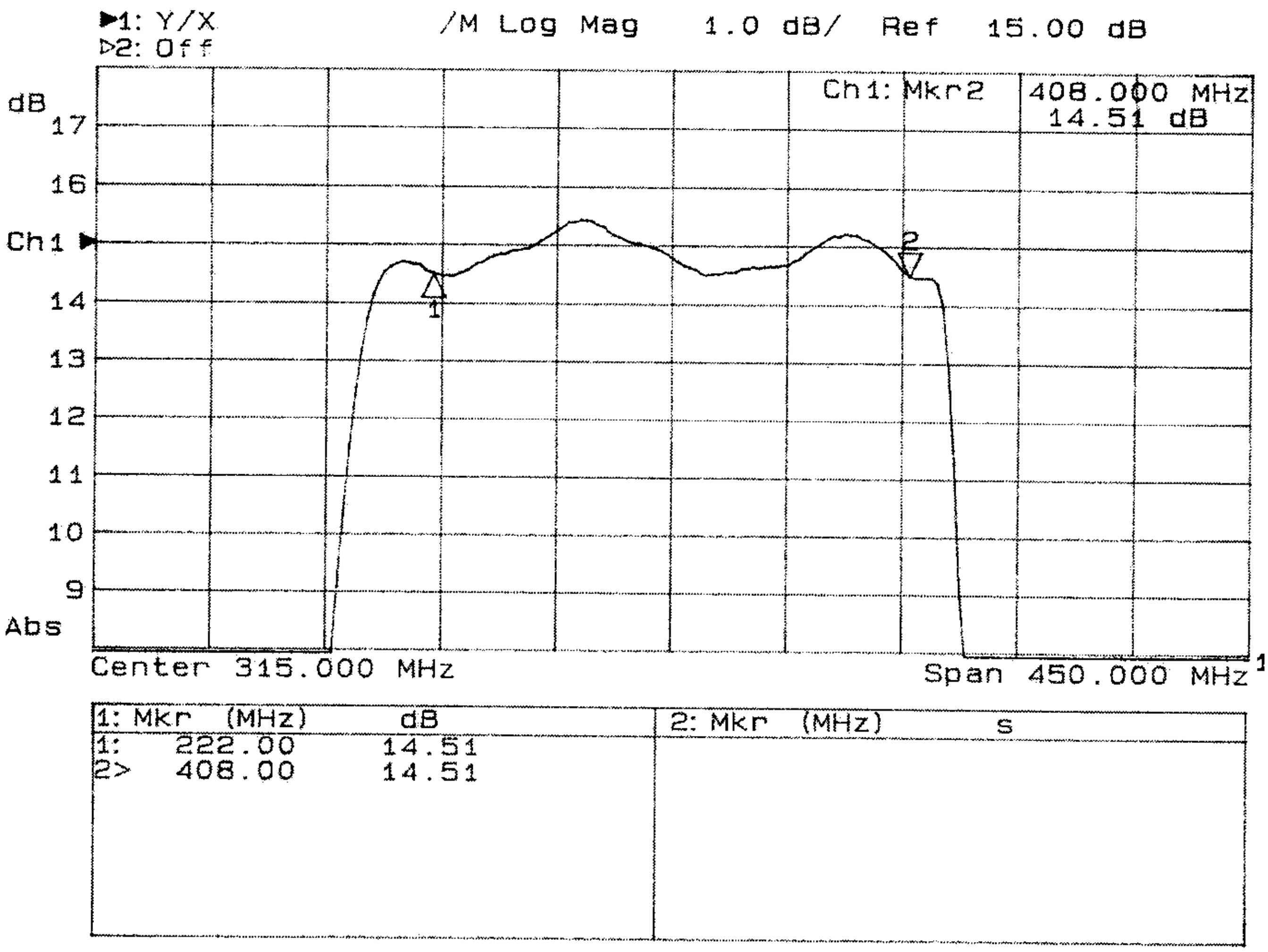
- OCCUPIED BANDWIDTH & FREQUENCY RESPONSE

FCC Section 2.1049 (e) (6) (i)

The frequency response of the SBM-500A is very flat and provides near perfect transmission of carriers without linear distortion. The frequency response was measured by injecting a CW signal into the transmitter front end at a nominal input level of –15 dBm. The signal was swept from 90 MHz to 540 MHz and the output, at microwave 2368 – 2818 MHz, was captured on an HP8713B Scaler Network Analyzer. Marker one and two correspond to the passband. See plots one and two below:




PLOT 1: Frequency Response on 10 dB/div Scale




PLOT 2: Frequency Response on 1 dB/div Scale

- VISUAL OCCUPIED BANDWIDTH

FCC Section 2.1047/2.1049/73.687 (a) (2)/74.936

| | |
|---|---|
| Visual Output Power: | 47.5 dBm peak sync per channel |
| % Video Modulation: | 87.5% |
| Type Video Modulation: | Per FCC 73.687 (a) (4) |
| Aural Output Power: | Not Applicable |
| Method of Measurement: | Per FCC 73.687 (a) (2) & (4) |

Frequency Response:

| Output Frequency (MHz) | Sidebands (MHz) | Relative to +200 KHz (dB) | Relative to Visual Carrier (dBc) |
|---|---|---|---|
| 2550.50 | -4.75 | -52.50 | -68.00 |
| 2551.07 | -4.18 | -52.60 | -68.10 |
| 2551.67 | -3.58 | -49.84 | -65.34 |
| 2552.25 | -3.00 | -46.35 | -61.85 |
| 2553.00 | -2.25 | -45.76 | -61.26 |
| 2554.00 | -1.25 | -22.80 | -38.30 |
| 2554.50 | -0.75 | -0.78 | -16.28 |
| 2554.75 | -0.50 | -0.49 | -15.99 |
| 2555.25 | Visual Carrier | ------------------ | Reference |
| 2555.75 | +0.50 | 0.00 | -15.5 |
| 2556.50 | +1.25 | +0.15 | -15.35 |
| 2557.25 | +2.00 | +0.20 | -15.30 |
| 2558.25 | +3.00 | +0.17 | -15.33 |
| 2558.83 | +3.58 | +0.33 | -15.17 |
| 2559.43 | +4.18 | -0.17 | -15.67 |
| 2560.00 | +4.75 | -46.20 | -61.70 |
| 2560.50 | +5.25 | -47.55 | -63.05 |
| 2561.25 | +6.00 | -50.20 | -65.70 |
| 2562.00 | +6.75 | -48.33 | -63.83 |

Spectrum Analyzer Settings:

| | |
|---|---|
| Center Frequency: | 2557 MHz |
| Span: | 13.00 MHz |
| Log/Div: | 10 dB |
| Resolution BW: | 30 KHz |
| VBW: | 3 MHz |
| Sweep: | 43.3 msec |

➢ AURAL FREQUENCY RESPONSE

FCC Section 2.1047

| | |
|---|---|
| Visual Output Power: | 47.5 dBm peak sync per channel |
| % Video Modulation: | 87.5% |
| Type Video Modulation: | Standard 10 riser stairstep |
| Aural Output Power: | 32.5 dBm average |
| % Aural Modulation: | 100%, 50% and 25% |

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Aural Modulation Signal: 50 Hz to 15 Hz

Aural Frequency Response:

| Frequency (Hz) | Output Relative to 1 KHz (dB) 100% Mod |
|---|---|
| 50 | -0.53 |
| 100 | -0.53 |
| 400 | -0.44 |
| 1000 | 0.0 |
| 3000 | +4.08 |
| 5000 | +7.60 |
| 7000 | +9.54 |
| 12000 | +13.62 |
| 15000 | +16.12 |

➢ AURAL OCCUPIED BANDWIDTH

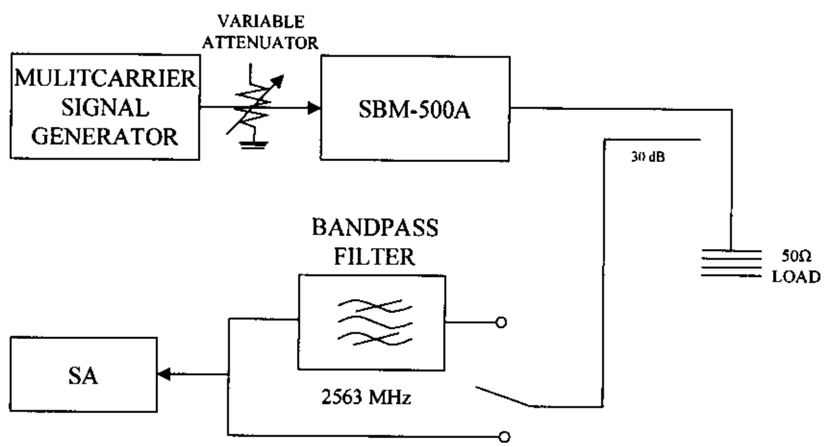
FCC Section 2.202

| | |
|---|---|
| Visual Output Power: | 47.5 dBm peak sync per channel |
| % Video Modulation: | 87.5% |
| Type Video Modulation: | Standard 10 riser stairstep |
| Aural Output Power: | 32.5 dBm average |
| % Aural Modulation: | 85% (21.25 KHz) |
| Aural Modulation Signal: | 15 KHz |
| Method of Measurement (Bn = 2M + 2DK): | Bandwidth was read at 0.5% (-23 dB) of mean power on a spectrum analyzer |
| Aural Occupied Bandwidth: | 80 KHz |

➢ SPECTRAL OCCUPANCY

The following plots demonstrate the occupied bandwidth of the composite signal(s) at the output of the transmitter 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. See also, page 15 of this report.

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.

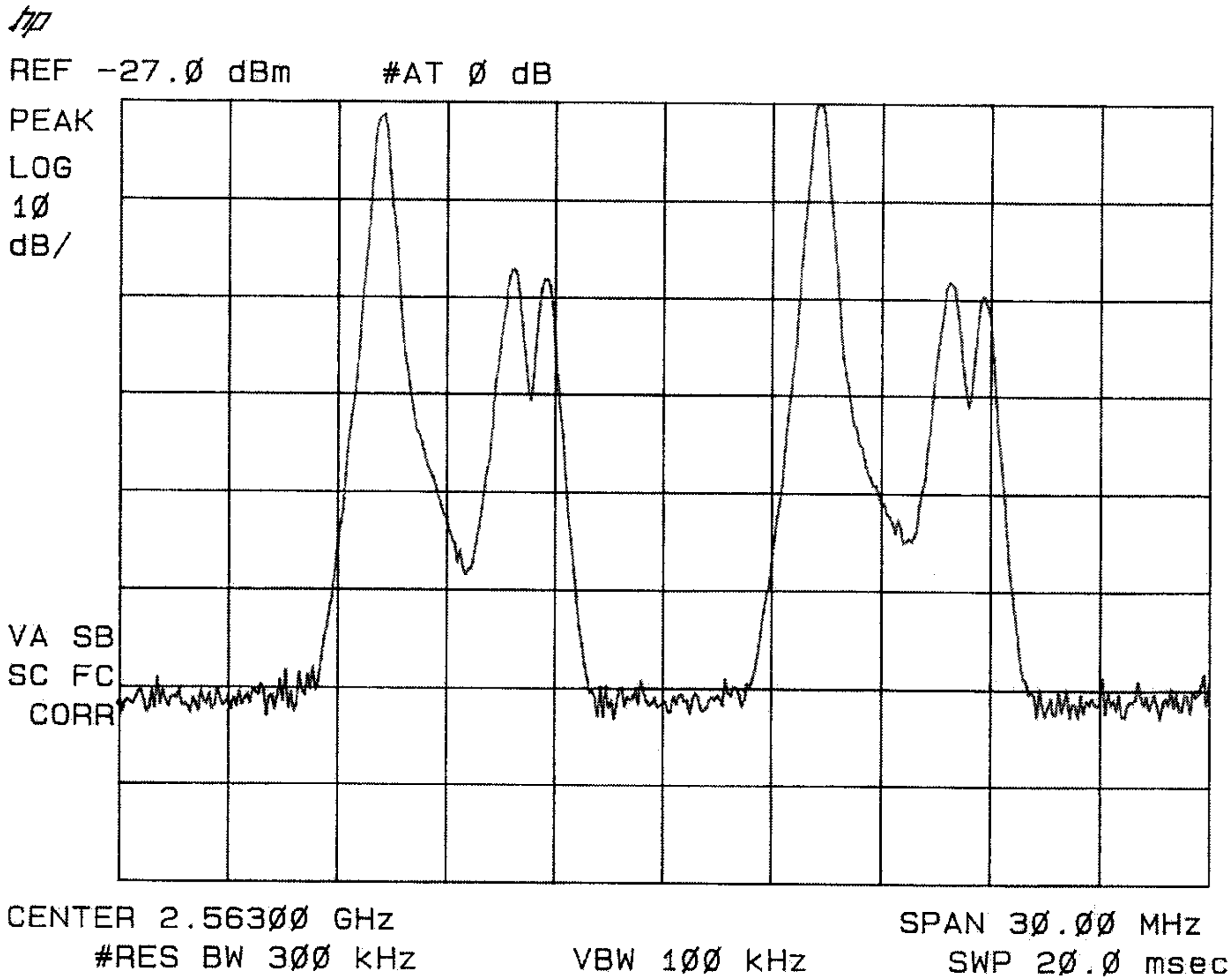



Measurement Technique

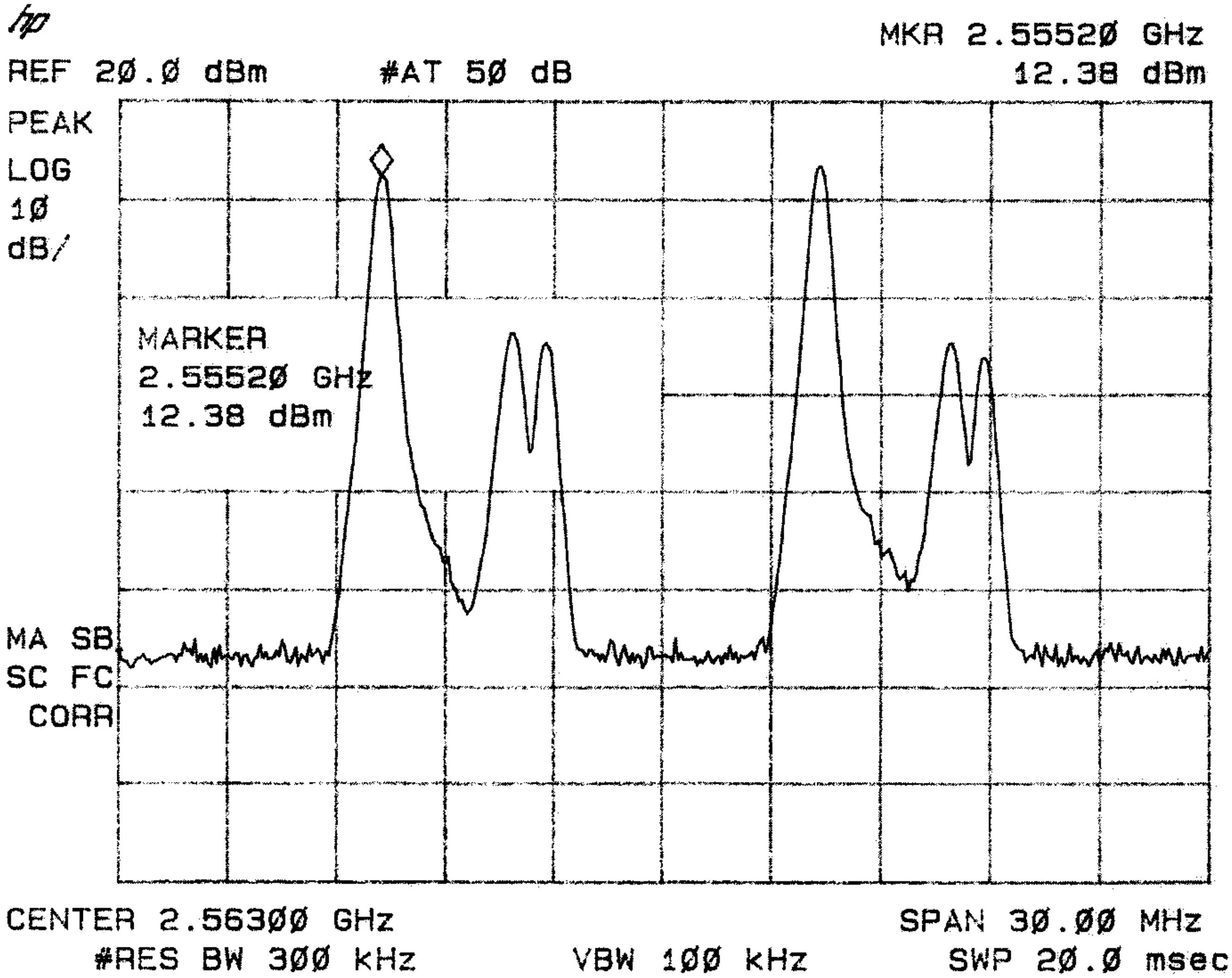
Accurately measuring out-of-band power requires sufficient dynamic range to measure both signal power and intermodulation products without undue influence from the instrumentation noise floor. Since the ultimate requirement for out-of-band signal power is –60 dB relative to in-band peak of sync power, 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 above:

Narrative Description of Occupied Bandwidth Plots

Plot 3 shows the transmitter-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 30 kHz resolution bandwidth for intermodulation measurement.

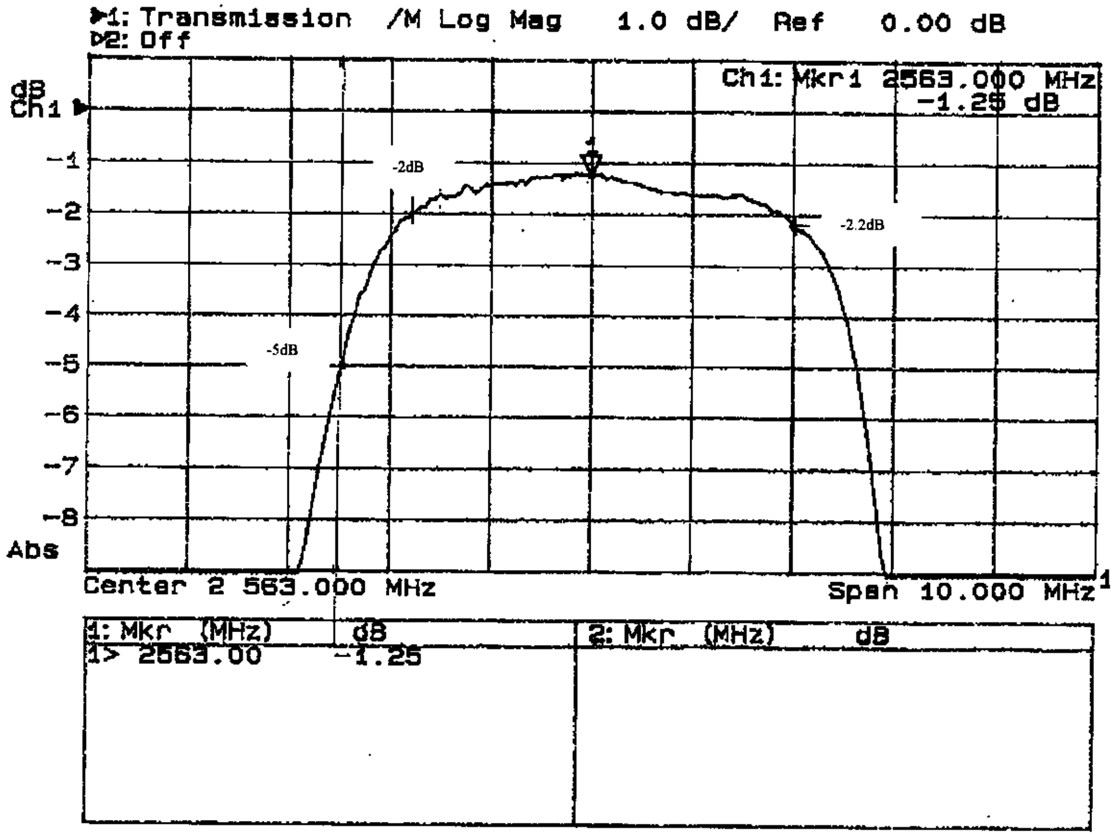


Plot 4 shows the transmitter system output signal for two composite carriers with 75% color bars modulation at an SCL of 43.5 dBm as measured by an average power meter which corresponds to 47.5 dBm peak of sync. The Spectrum Analyzer is set to display the in-band signal power (after 35-dB attenuation) of approximately 12.38 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 Transmitter 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:

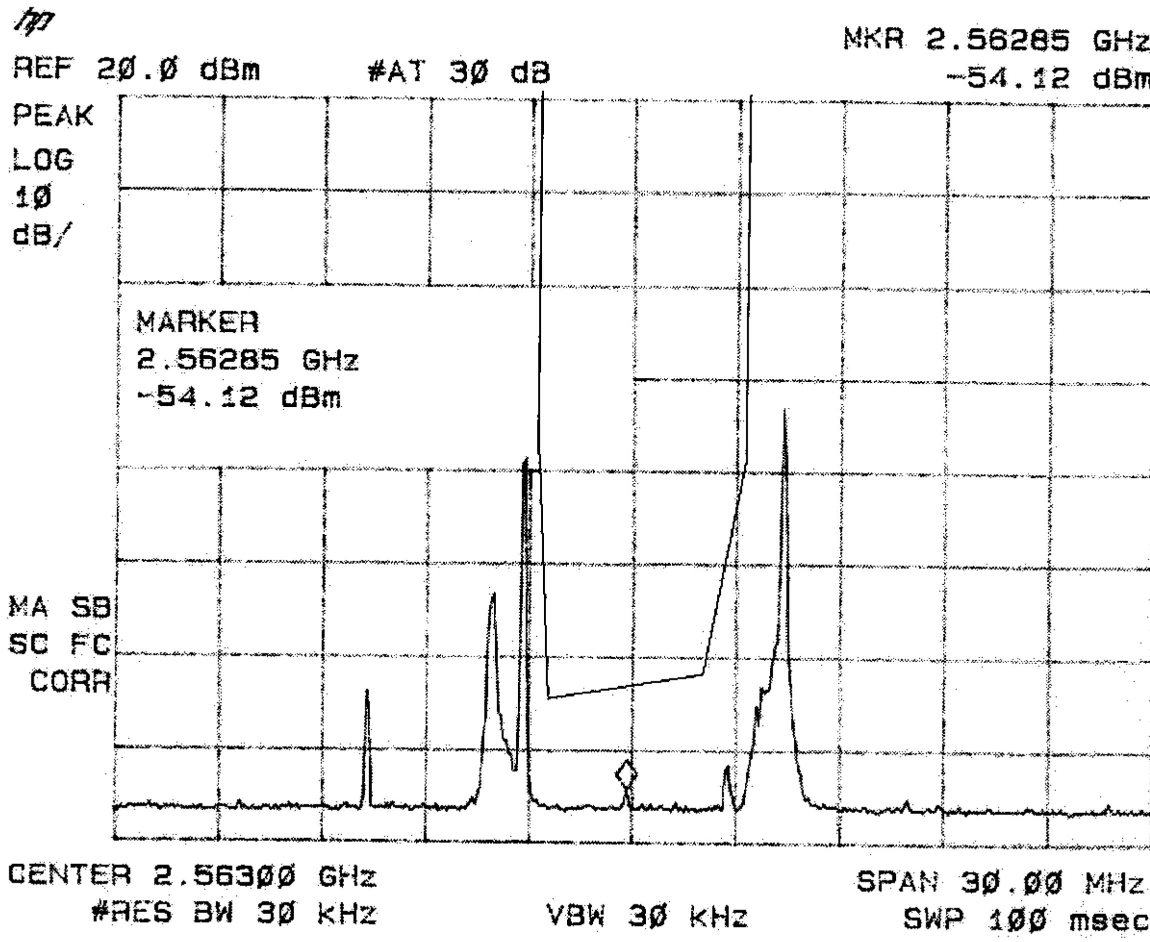



The mark with –5 dB indicates attenuation of the filter at a frequency .5 MHz higher than the band edge of the lower adjacent channel. The mark with –2.2 dB, otherwise, indicates a frequency 1 MHz lower than the edge of the higher adjacent channel. The mark of –2 dB corresponds to the visual carrier.

In plot 5, the measured out-of-band power within the limits of the unoccupied channel is –54.12 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:

-54.12 + 2.2 – 12.38 = -64.3 dB between +.5 MHz and –1 MHz of the band edges

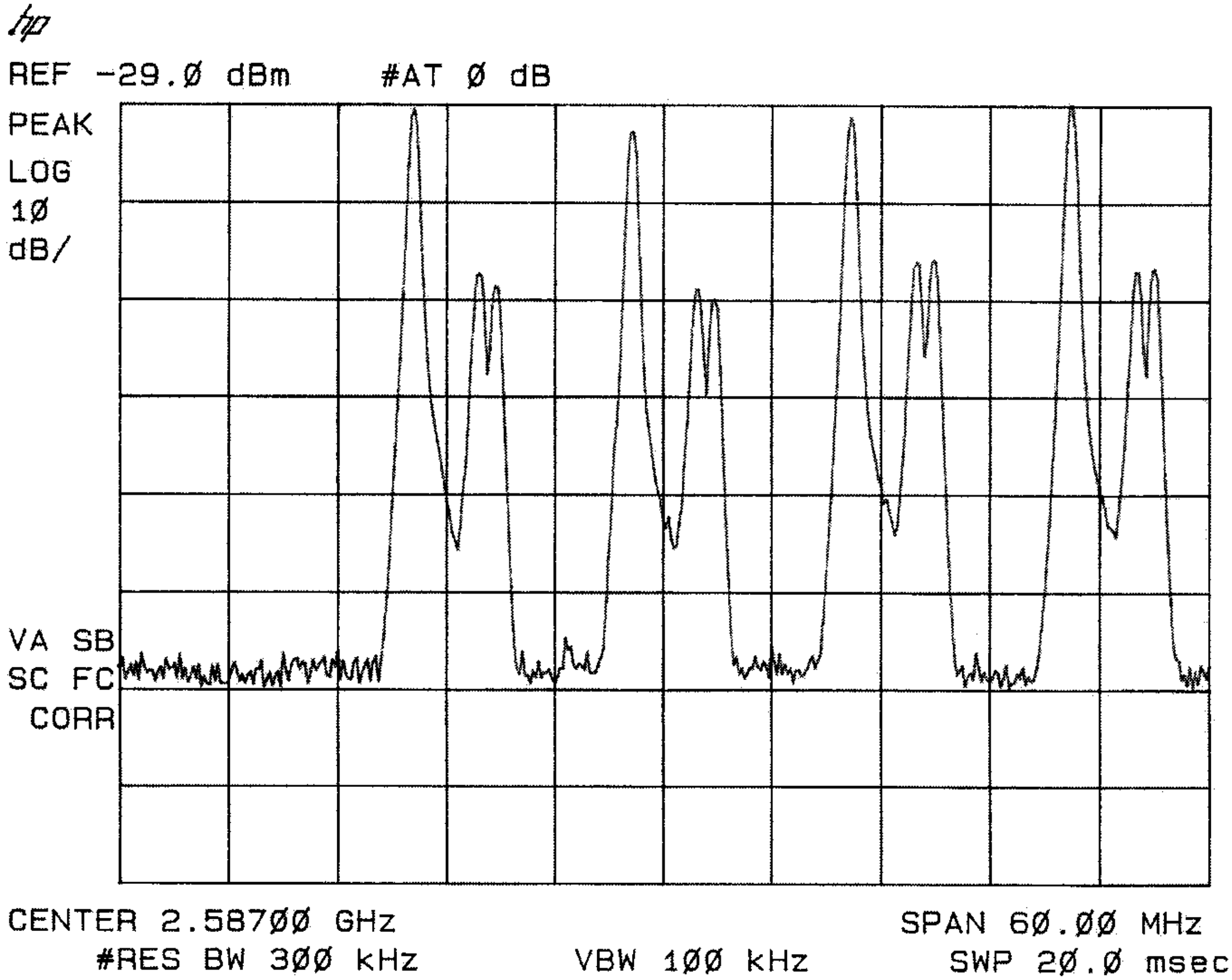
Moreover, the total measured power in the adjacent channel is more than 60 dB below the channel peak power. This shows that the system complies with the spectral occupancy mask established in FCC 74.936.




PLOT 5 – Two Carrier Out-of-band Power

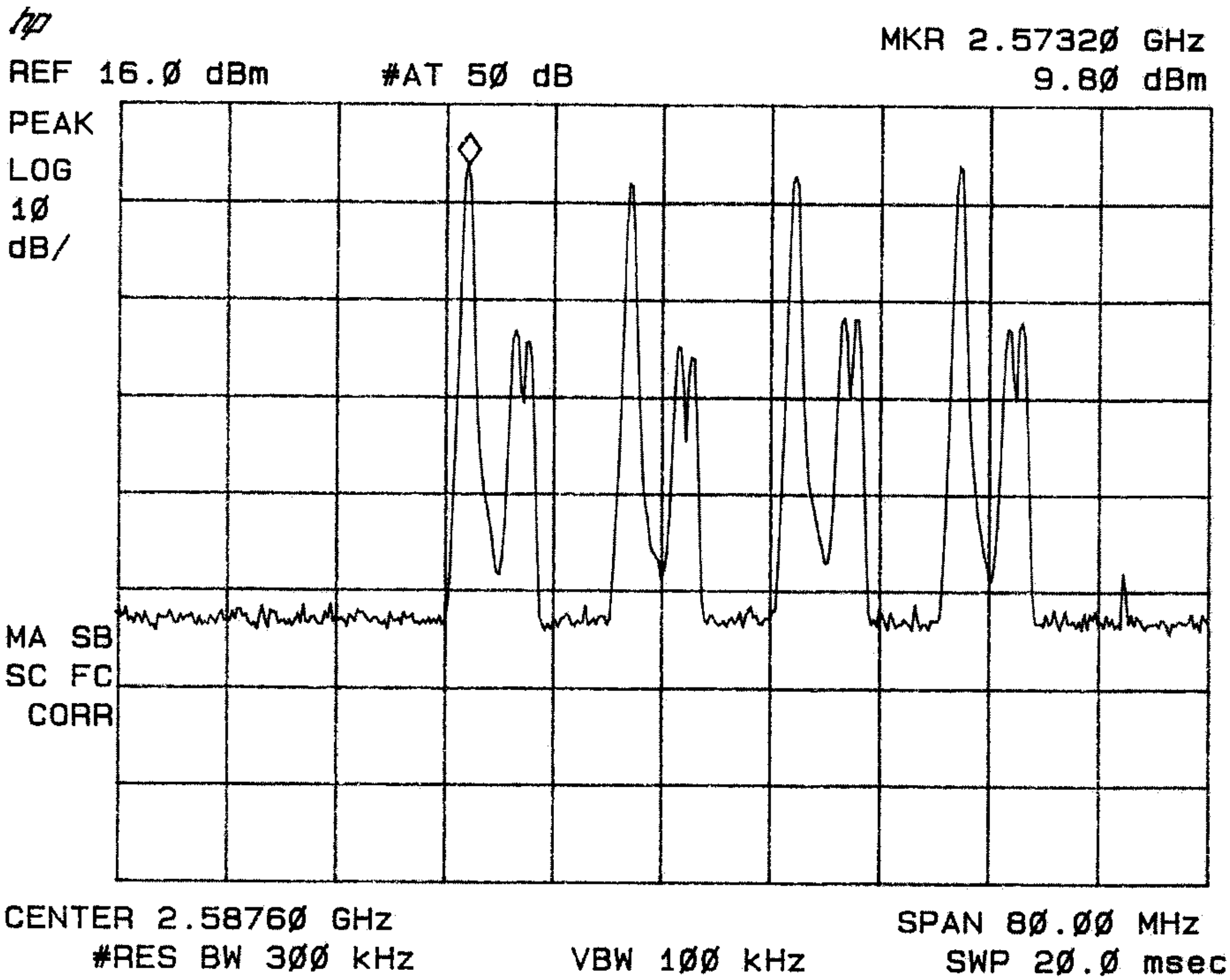
## ❖ MULTI-CARRIER INTERMODULATION PRODUCTS

This system is a multi-carrier transmitter, therefore, intercarrier intermodulation products are of concern. 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 Composite Transmitter System Output Signal

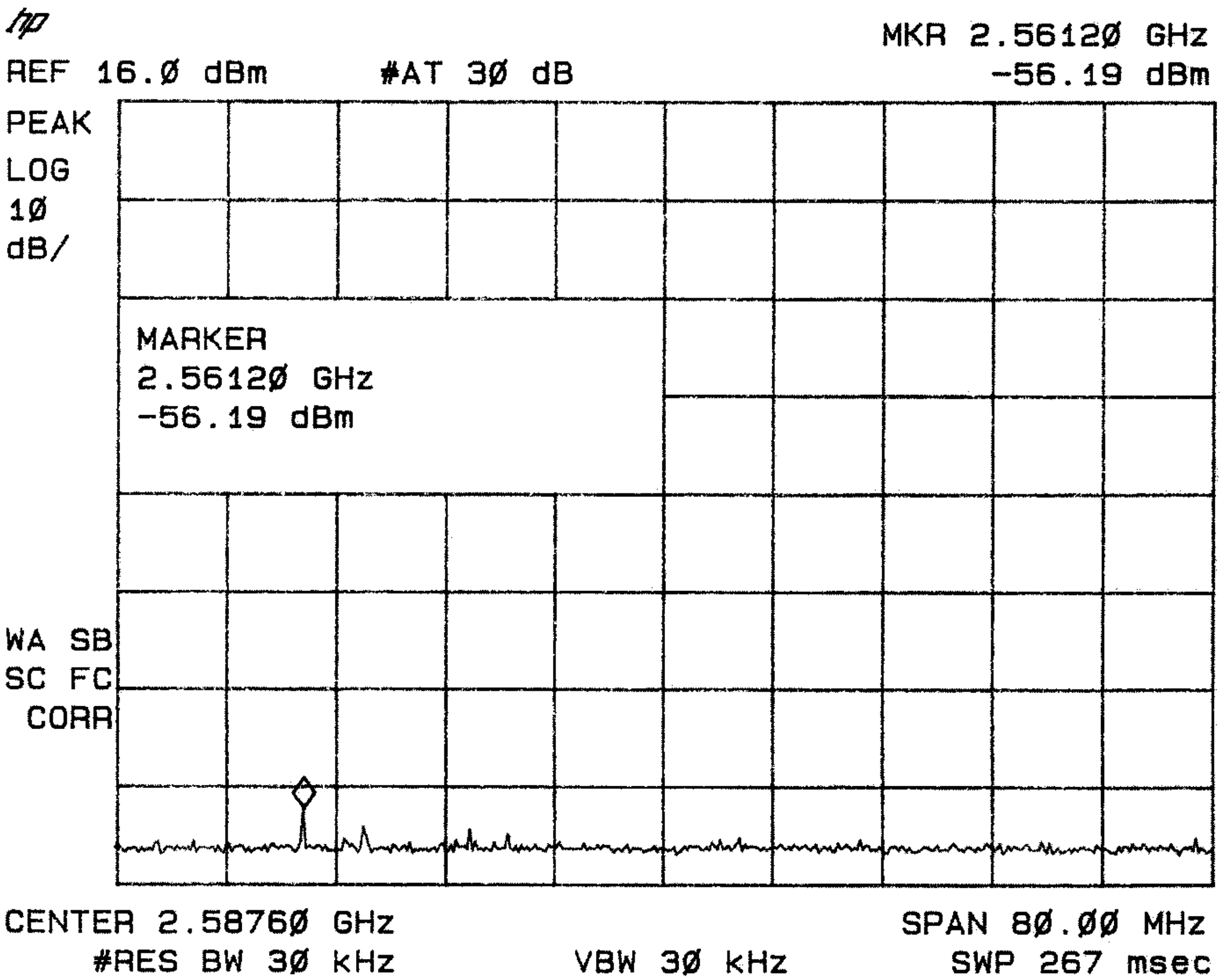
Plot 7 shows the output of the transmitter with four analog carriers. The reference is moved to 9.8 dBm since the power per carrier is 3 dB lower and the attenuator was set to 32.7 dB attenuation. Plot 8 shows the IM3 measurement with four carriers. In this case, an additional 2 dB back-off in output power was required to maintain the same level of out-of-band power as shown in plot 8.




PLOT 7: Four Carrier Composite Transmitter System Output Signal, Measurement Shown

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. $IM_3 = -(12.38\ \text{dBm} - 2\ \text{dB}_{\text{filter loss}} - (-56.19\ \text{dBm})) = -66.57$ dBc

*[1] Leffel, Michael, "Intermodulation Distortion in a Multi-Signal Environment", RF Design, June '95.*




PLOT 8: Four Carrier Out-of-band Power

- SPURIOUS EMISSIONS AT ANTENNA TERMINALS

FCC Section 2.1051/2.1057/21.908 (b)/74.936

| | |
|---|---|
| Visual Output Power: | **1-2 Channels 47.5 dBm/ch (56.2 W)/ch**<br>**3-4 Channels 42.5 dBm/ch (17.8 W)/ch**<br>**5-8 Channels 38.5 dBm/ch (7.1 W)/ch**<br>**9-16 Channels 35.0 dBm/ch (3.2 W)/ch**<br>**17-31 Channels 31.5 dBm/ch (1.4 W)/ch** |
| % Video Modulation: | 87.5% |
| Type Video Modulation: | Per EIA RS-240, Section A (6c) |
| Aural Output Power: | 32.5 dBm average |
| % Aural Modulation: | 0% |
| Spectrum Analyzer Setting: | The 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 for 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. |
| Spurious Emissions: | See chart on next page |

Spurious Emissions:

| Frequency (MHz) | Amplitude (dBc) | | Relative to Peak Visual (MHz) |
|---|---|---|---|
| 2555.25 | 0 | Visual Carrier | (reference) |
| 2546.25 | -62 | Visual Carrier | -9 |
| 2550.75 | -63 | Visual Carrier | -4.5 |
| 2551.67 | -62 | Visual Carrier | -3.58 |
| 2562.41 | -66 | Visual Carrier | 7.16 |
| 2559.75 | -65 | Aural Carrier | 4.50 |
| 2278.00 | -69 | Local Oscillator | 277.25 |
| 5110.50 | -69 | Harmonic | x 2 |
| 7665.75 | -62 | Harmonic | x 3 |
| 10221.00 | >-70 | Harmonic | x 4 |
| 12776.25 | >-70 | Harmonic | x 5 |
| 15331.50 | >-70 | Harmonic | x 6 |
| 17886.75 | >-70 | Harmonic | x 7 |
| 20442.00 | >-70 | Harmonic | x 8 |
| 22997.25 | >-70 | Harmonic | x 9 |
| 25552.50 | >-70 | Harmonic | x 10 |

- FIELD STRENGTH OF SPURIOUS RADIATION

FCC Section 2.1053, 2.1057

Visual Output Power: **2 Channels @ 47.5 dBm**
**8 Channels @ 38.5 dBm**
**31 Channels @ 31.5 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** @ 10 meters (dBm) = EIRP (dBm) - Path Loss (dB) + 2.15 dB

**Path Loss** (dB) = 20 log distance(Km) + 20 log frequency (visual carrier)(GHz) + 92.4 dB
= 20 log (.010 Km) + 20 log (2.55525) +92.4 dB
= 60.55 dB

**EIRP** (dBm) = 47.5 dBm (tx output) + 2.15dB (transmit dipole gain)
= 49.65 dBm

**Received Level** = **EIRP** dBm - **Path Loss** dB + 2.15 dB
= -8.75 dBm

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

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

$$= \text{Antilog}\left[\frac{-8.75 dBm - 2.15\ dB - 20 \log [0.117405342m] + 6.75}{20}\right]$$

= Antilog 0.7229

**E** = 5.283 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

The range of examination in these tests was from 10 MHz to 27 GHz.

## ❖ FREQUENCY STABILITY

FCC Section 2.1055 (a) (1) / 73.687 / 21.101 (a)

Method of Measurement: The upconverter was Channel tested per FCC Part 73, Subpart E, Section IV (c)

| | |
|---|---|
| Microwave L.O. (Synthesized) | 2278.00 MHz |
| IF Frequency (Modulator*) | - 277.25 MHz |
| On Channel Frequency | 2555.25 MHz |

**Modulator is certified separately.*

Frequency Stability over Temperature: **Microwave Upconverter PLL Local Oscillator**

| Temp. (C) | LO (MHz) | Error (Hz) |
|---|---|---|
| 50 | 2278.000073 | -73.00 |
| 40 | 2278.000045 | -45.00 |
| 30 | 2278.000032 | -32.00 |
| 20 | 2278.000015 | -15.00 |
| 10 | 2278.000007 | -7.00 |
| 0 | 2278.000002 | -2.00 |
| -10 | 2277.999982 | 18.00 |
| -20 | 2277.999918 | 82.00 |
| -30 | 2277.999978 | 22.00 |

The worst case of the oscillator frequency shift results in an 82.00 Hz channel error. This represents accuracy, which is well within the required channel ± 1,000 Hz tolerance requirement set on November 1, 1991, for ITFS/MMDS transmitters.

Frequency Stability over AC Input Voltage: **Microwave Upconverter PLL Local Oscillator**

| AC Line (V) | LO Frequency (MHz) | Error (Hz) |
|---|---|---|
| 95 | 2277.999987 | 13.00 |
| 100 | 2278.000009 | -9.00 |
| 110 | 2278.000009 | -9.00 |
| 115 | 2278.000007 | -7.00 |
| 120 | 2278.000008 | -8.00 |
| 125 | 2278.000007 | -7.00 |
| 130 | 2278.000009 | -9.00 |
| 135 | 2278.000008 | -8.00 |

**NOTE:**
Frequency stability of the microwave LO was totally dependent on the accuracy and stability of the 10 MHz reference oscillator. This is a purchased item with $1 \times 10^{-7}$ minimum stability specification.

## 8.0 SUMMARY

This report demonstrates that the SBM-500A television transmitter meets or exceeds the FCC certification 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.

# SBM-250, SBM-500, SBM-250/250, SBM-500/250 AND SBM-500/500 TOP LEVEL DESCRIPTION

The SBM series of transmitters is available in both redundant and non-redundant models. The SBM-250 and SBM-500 are upgradeable high power and high gain multi-channel transmitters. The redundant SBM-250 consists of two power supplies, four power amplifier segments, one backup system controller (switch and control drawer), two VHF/UHF to microwave drawers (VHF/UHF block upconverter) or (drivers), one primary, one secondary, and two or four[1], IF to VHF/UHF drawers, one or two[1] primary, one or two[1] secondary, which are contained within a rack and sub-rack. The redundant SBM-500 consists of the same drawers as the SBM-250, with the exception of the power amplifier segments, the SBM-500 system has eight segments. The backup system controller indicates output power and enables the secondary driver should a failure occur in the primary driver. The non-redundant SBM-250 consists of one power supply, four power amplifier segments, one VHF/UHF to microwave drawer (VHF/UHF block upconverter) or (driver), and one or two IF to VHF/UHF drawers. The non-redundant SBM-500 consists of the same drawers as the SBM-250, with the exception of the power amplifier segments, the SBM-500 system has eight segments. Components of the redundant system are optional, refer to the rack assembly document for more detail. In both the redundant and non-redundant system the power supplies and power amplifier segments allow hot replacement. Identical drivers are provided for both MDS and MMDS/ITFS frequencies.

A new front panel label is needed to accommodate each FCC ID. For the redundant system the labels are located on the backup system controller, refer to document # DOC22-0012 for the SBM-250 and document # DOC22-0013 for the SBM-500, and will be replaced with each upgrade as needed. For the non-redundant system, a blanking panel will be used in place of the backup system controller, the labels will be found on this panel, again, they 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 transmitter 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.

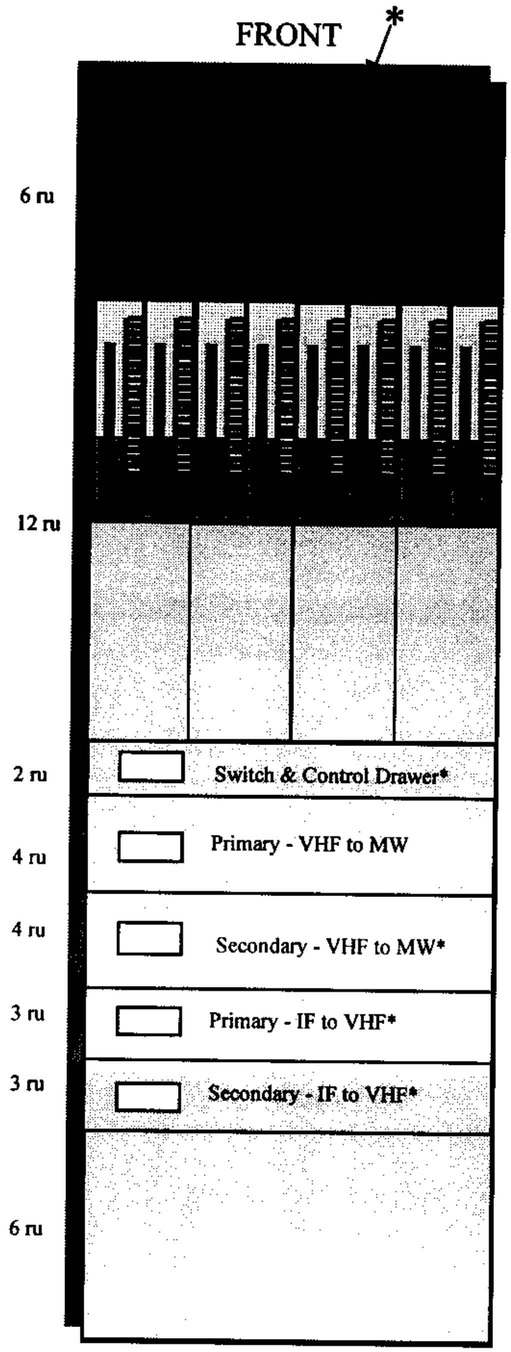
***NOTE: 1. Depending on the number of channels.***

***This could conceivably be made into a 250/250 system, which has 8 amplifier segments, 4 in the top sub-rack and 4 in the bottom sub-rack, and two power supplies. It can also be a 500/250 system, which has 12 power amplifier segments and three power supplies. Or a 500/500 system, which has 16 power amplifier segments and three power supplies. In these cases the equipment provides two outputs, one is used to broadcast and the other is used as an in band trunking system for a remote repeater site.***

| | | |
|---|---|---|
| *Created by: Kimberly Simeone 12/21/98 ECO #: 98-164* | *Checked by: Donald Wike 12/21/98* | *Released by: Paulo Correa 12/21/98* |

# *SBM-500 RACK ASSEMBLY*

**NOTE: 1ru = 1.75"**

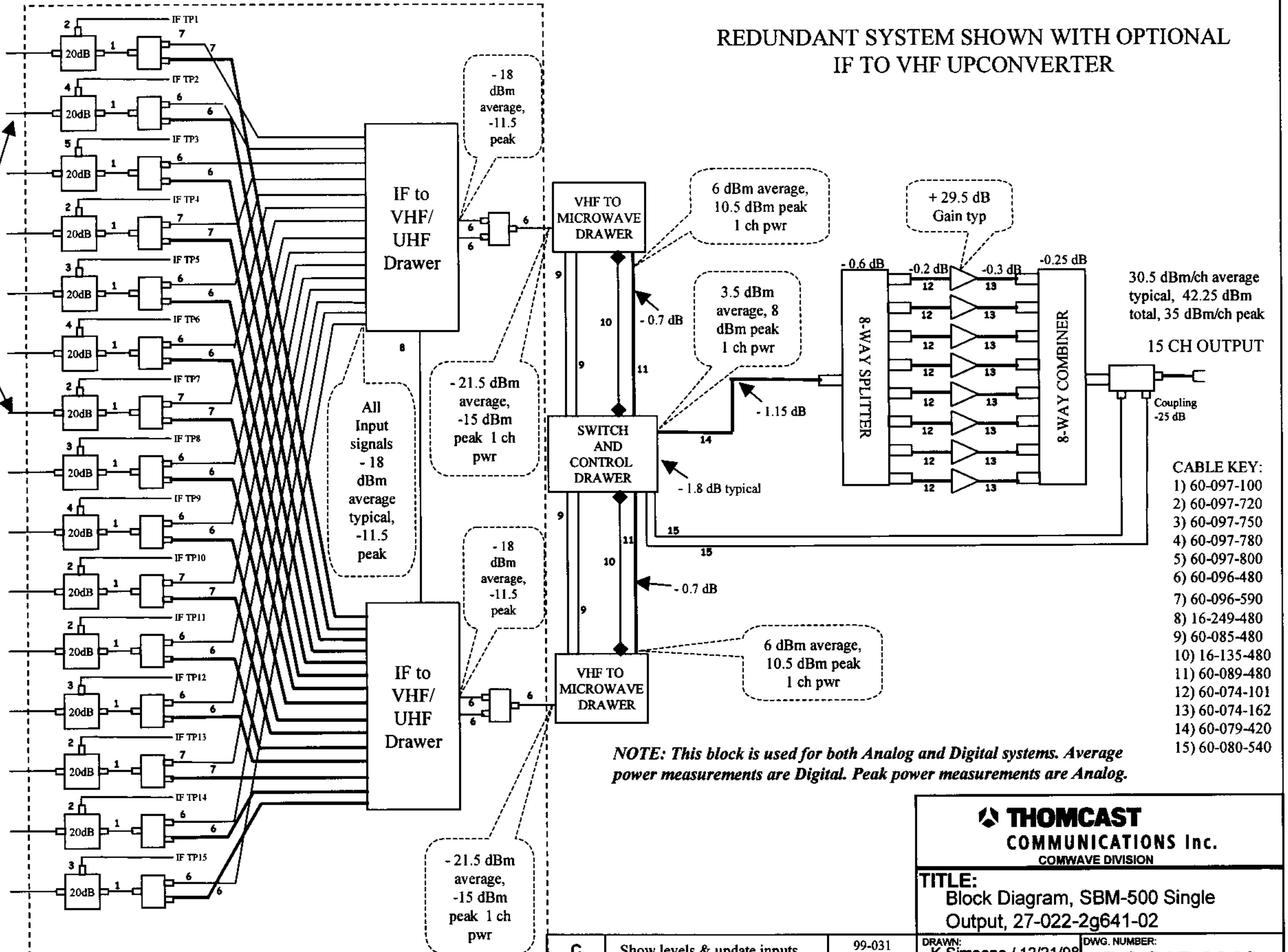



**DRAWING NOT TO SCALE**

***These components are optional**

| *Created by: Kimberly Simeone* | *Checked by: Kevin Harding* | *Released by: Donald Wike* |
|---|---|---|
| *12/9/98 ECO #: 98-164* | *12/10/98* | *12/10/98* |

# REDUNDANT SYSTEM SHOWN WITH OPTIONAL IF TO VHF UPCONVERTER




CABLE KEY:
1) 60-097-100
2) 60-097-720
3) 60-097-750
4) 60-097-780
5) 60-097-800
6) 60-096-480
7) 60-096-590
8) 16-249-480
9) 60-085-480
10) 16-135-480
11) 60-089-480
12) 60-074-101
13) 60-074-162
14) 60-079-420
15) 60-080-540

***NOTE: This block is used for both Analog and Digital systems. Average power measurements are Digital. Peak power measurements are Analog.***

**THOMCAST COMMUNICATIONS Inc.**
COMWAVE DIVISION

**TITLE:** Block Diagram, SBM-500 Single Output, 27-022-2g641-02

| REV | Description | ECO# NAME/DATE |
|---|---|---|
| C | Show levels & update inputs | 99-031 K.Simeone/3/9/99 |
| B | Showed IF to VHF dwr as optional | 98-164 K.Simeone/12/8/98 |

| | |
|---|---|
| DRAWN: | K.Simeone / 12/21/98 |
| CHECKED: | D.Wike / 12/21/98 |
| RELEASED: | P.Correa / 2/21/98 |
| DWG. NUMBER: | DOC15-0018 |
| Scale: | none |
| Sheet | 1of 1 |
| REV: C | |

# SBM SERIES MULTICARRIER TRANSMITTER SPECIFICATIONS

| DIGITAL SPECIFICATIONS | | | | |
|---|---|---|---|---|
| **Parameter** | **Specifications** | | | **Notes/Test Conditions** |
| | *OUTPUT SPECIFICATIONS*[3] | | | |
| | **SBM-250**[4] | **SBM-500**[4] | **SBM-1000** | |
| Peak Envelope Output Power | 250 Watts | 500 Watts | 1000 Watts | |
| Digital Average Output Power | | | | |
| 17 – 31 channels | 24.0 dBm | 27.0 dBm | 30.0 dBm | Non-Coherent QAM Modulated Carriers |
| 9-16 channels | 27.5 dBm | 30.5 dBm | 33.5 dBm | |
| 5-8 channels | 31.0 dBm | 34.0 dBm | 37.0 dBm | $2^{23}$-1 PN data sequence (at transmitter output) |
| 3-4 channels | 35.0 dBm | 38.0 dBm | 41.0 dBm | |
| 1-2 channels | 40.0 dBm | 43.0 dBm | 46.0 dBm | |
| Broadband Frequency Response[5] | ≤ ± 1.0 dB | | | 2000 - 2700 MHz in select bands |
| Frequency Response (single channel)[5] | ≤ ± 0.25dB | | | 2000 - 2700 MHz in select bands |
| Output Frequency | 2000 - 2700 MHz | | | In select bands |
| Output Connector / Impedance | N-female / 50 Ω | | | |
| Spurious Products[2] | ≤ -60 dBc | | | Relative to unmodulated carrier power measured @ 100 KHz RBW at the transmitter output |
| Carrier to Noise (C/N)[5] | ≥ -52 dB | | | |
| Harmonics[1] | ≤ -60 dBc | | | Relative to unmodulated carrier power measured @ 100 KHz RBW at the transmitter output |
| In-band Intermodulation Distortion[5] (CTB) | ≤ -60 dBc | | | |
| Out–of-band Intermodulation Distortion[5] | ≤ -60 dBc | | | |
| RF Output Regulation | ≤ ± .2 dB | | | Measured at transmitter output |
| Hum and Noise | ≤ -60 dBc | | | |
| Frequency Stability | ≤ ±500 Hz<br>≤ ±3 Hz (Optional LORAN C)<br>≤ ±1 Hz (Optional GPS) | | | |

| | | |
|---|---|---|
| *Created by: Kimberly Simeone 12/14/98*<br>*ECO #: 99-008, 1/21/99* | *Checked by: Donald Wike 12/14/98* | *Released by: Paulo Correa 12/14/98* |

**Specifications subject to change without notice*





*Document #: DOC19-0019*
*REV: D*

| Parameter | Specifications | | | Notes/Test Conditions |
|---|---|---|---|---|
| | SBM-250[4] | SBM-500[4] | SBM-1000 | |
| SSB Phase Noise<br>Direct measurement of microwave LO | ≤-80 dBc/Hz @ 10 KHz offset<br>≤-110 dBc/Hz @ 10 KHz offset | | | Optional<br>Standard (recommended for digital transmission) |
| Group Delay[5] | ≤ ±5 ns per channel | | | $F_c$ ±2.6 MHz<br>Measured at transmitter output |
| Digital Modulation<br>Error Vector Magnitude[5,8] (EVM) | ≤ 2.0% per channel | | | 64-QAM/8-VSB @ 5.06 Msps RMS average over 12,500 symbols<br>Measured at transmitter output using Comstream modulator and a Thomcast IF to VHF/UHF drawer |
| Digital Modulation<br>Signal to Noise Ratio[5,8] (SNR) | ≥30 dB per channel | | | 64-QAM/8-VSB @ 5.06 Msps RMS average over 12,500 symbols<br>Measured at transmitter output using Comstream modulator and a Thomcast IF to VHF/UHF drawer |
| Magnitude Linearity[5]<br>(AM-AM conversion) | ≤ ±0.125 dB per channel | | | Measured at transmitter output |
| Phase Linearity[5]<br>(AM-PM conversion) | ≤ ±0.75° per channel | | | Measured at transmitter output |
| *UHF INPUT SPECIFICATIONS* | | | | |
| Input Frequency | 222 - 408 MHz | | | Other frequency options available |
| Input Connector / Impedance | BNC-female / 75 Ω | | | |
| Input Signal Level per Carrier | Redundant<br>-21.5 dBm ± 3dB | Non-Redundant<br>-24.5 dBm ± 3dB | | Measured at input of microwave upconverter<br>$2^{23}$-1 PN data sequence (at transmitter output) |
| Input Return Loss | ≥ 15 dB | | | Measured at input of microwave upconverter |

***Digital Specification Notes:***

1. ***Undesired signal power 2 dB higher than the nominal PSD of the adjacent spectral regions that is harmonically related to unmodulated carrier.***
2. ***Undesired signal power 2 dB higher than the nominal PSD 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. ***The SBM-250 and SBM-500 includes space for upgrade to SBM-1000.***
5. ***In dual systems, broadcast and trunking, the trunking system is the one specificied.***
6. ***Weight doesn't include shipping materials.***
7. ***Frequency bands up to 200 MHz bandwidth available from 2.0 to 2.7 GHz.***
8. ***Or equivalent threshold BER measurement***

## ANALOG SPECIFICATIONS[3]

| *Parameter* | *Specifications* | | | *Notes/Test Conditions* |
|---|---|---|---|---|
| | *OUTPUT SPECIFICATIONS*[5] | | | |
| | **SBM-250A**[4] | **SBM-500A**[4] | **SBM-1000A** | |
| Peak Envelope Output Power | 250 Watts | 500 Watts | 1000 Watts | |
| Analog Peak Output Power | | | | |
| 17 – 31 channels | 28.5 dBm | 31.5 dBm | 34.5 dBm | |
| 9-16 channels | 32.0 dBm | 35.0 dBm | 38.0 dBm | |
| 5-8 channels | 35.5 dBm | 38.5 dBm | 41.5 dBm | |
| 3-4 channels | 39.5 dBm | 42.5 dBm | 45.5 dBm | |
| 1-2 channels | 44.5 dBm | 47.5 dBm | 50.5 dBm | |
| Input Frequency[6] | 222 – 408 MHz | | | Other frequency options available |
| Input Signal Level per Carrier | Redundant<br>-15 dBm ± 3dB | Non-Redundant<br>-18 dBm ± 3dB | | Measured at input of microwave upconverter |
| Frequency Response | ≤ ±1.0 dB | | | 2000 – 2700 MHz in select bands |
| Output Frequency[6] | 2000 – 2700 MHz | | | In select bands |
| Impedance / Connector<br>Input<br>Ouput | <br>75Ω / BNC<br>50Ω / EIA 7/8 or N female | | | |
| Harmonics | ≤-60 dBc | | | Measured in 30 KHz RBW at transmitter output relative to visual carrier (unmodulated carriers) |
| In-band Intermodulation Distortion[2] (CTB) | ≤-60 dBc | | | Measured in 30 KHz RBW at transmitter output relative to in-band peak power per channel |
| Out-of-band Intermodulation Distortion | ≤-60 dBc | | | Measured in 30 KHz RBW at transmitter output relative to visual carrier (unmodulated carriers) |
| RF Output Regulation | ≤ ±0.2 dB | | | |
| Spurious Products[1] | ≤ -60 dBc | | | Measured in 30 KHz RBW at transmitter output relative to visual carrier using 75% color bars video pattern |
| | *VISUAL PERFORMANCE* | | | |
| Emission | 5M75C3F or per CCIR | | | |
| Frequency Response[1,7] | ≤ ± 1 dB | | | FCC Multiburst video pattern |

| Parameter | Specifications | | | Notes/Test Conditions |
|---|---|---|---|---|
| | SBM-250A[4] | SBM-500A[4] | SBM-1000A | |
| Group Delay[1,7] | FCC 73.687 (a) (3) or per CCIR | | | Sin(x)/x video pattern |
| Differential Gain[1,7] | ≤3% | | | NTC7 composite video pattern |
| Differential Phase[1,7] | ≤2° | | | NTC7 composite video pattern |
| Sync Pulse Amplitude[1,7] | ±5% | | | NTC7 composite video pattern |
| Luminance Non-linearity[1,7] | ≤3% | | | NTC7 composite video pattern |
| Weighted SNR[1,7] | ≥55 dB | | | Quiet Line - Line 12 |
| Hum and Noise[1,7] | ≤-60 dB | | | |
| K Factor 2T[1,7] | ≤2% | | | NTC7 composite video pattern |
| Incidental Carrier Phase[1,7] Modulation (I.C.P.M.) | ≤3° | | | NTC7 composite video pattern |
| Frequency Stability | ≤ ±500 Hz<br>≤ ±3 Hz (Optional LORAN C)<br>≤ ±1 Hz (Optional GPS) | | | |
| SSB Phase Noise<br>Direct measurement of microwave LO | ≤ -80 dBc/Hz @ 10 KHz offset<br>≤ -110 dBc/Hz @ 10 KHz offset | | | Standard<br>Optional (recommended for digital transmission) |
| Carrier to Noise (C/N) | ≥52 dB | | | Measured at transmitter output |
| *AURAL PERFORMANCE* | | | | |
| Output Power[2] | 15 dB visual/aural ratio<br>+0.5 dB to -2 dB | | | Measured at transmitter output<br>Other ratios available upon request |
| Emission | 250KF3E or per CCIR | | | |
| Intercarrier Frequency Accuracy | ≤±50 Hz relative to visual carrier | | | |
| Frequency Response[1,7]<br>Mono<br>Stereo | <br>≤±1 dB 30 Hz to 15 KHz<br>≤±1 dB 50 Hz to 105 KHz w/o pre-emphasis | | | |
| Deviation | ±25 KHz (System M/N) (±50 KHz Stereo)<br>±50 KHz (System B/G/D/K/I) NICAM and IRT Stereo compatible | | | |
| Harmonic Distortion[1,7] | ≤1% | | | |
| FM Noise[1,7] | ≤-60 dB | | | |

**Specifications subject to change without notice*

| Parameter | Specifications | | | Notes/Test Conditions |
|---|---|---|---|---|
| | SBM-250A[4] | SBM-500A[4] | SBM-1000A | |
| Audio Input Level[1] | | | | |
| Mono @ ±25 KHz deviation | -10 to +10 dBm into 600Ω | | | |
| Mono @ ±50 KHz deviation | -10 to +10 dBm into 600Ω | | | |
| Stereo @ ±50 KHz deviation | -10 to +10 dBm | | | |

***Analog Specification Notes:***

1. ***Using TVM-102 modulator and VHF/UHF drawer.***
2. ***In band intermodulation specification is based on 15 dB visual to aural ratio. Contact factory for specification change due to other ratios.***
3. ***All factory test measurements made at approximately 23 °C.***
4. ***The SBM-250A and SBM-500A includes space for upgrade to SBM-1000A.***
5. ***In dual systems, broadcast and trunking, the trunking system is the one specified.***
6. ***Frequency bands up to 200 MHz bandwidth available from 2.0 to 2.7 GHz.***
7. ***Factory video/audio performance test limits may include up to 50% of the test demodulator measurement uncertainty.***

| Parameter | Specifications | | | Notes/Test Conditions |
|---|---|---|---|---|
| GENERAL | | | | |
| | SBM-250(A)[1] | SBM-500(A)[1] | SBM-1000(A) | |
| Operating Temperature Range | 0° to + 50° C | | | Frequency stability and equipment functionality guaranteed. |
| Specified Temperature Range | 13° to + 33° C | | | All Specified parameters guaranteed |
| Relative Humidity | 95 % non-condensing | | | |
| Power Requirement | 230 $V_{AC}$ ±10% single phase; 208 $V_{AC}$ ±10% three phase; 50/60 Hz | | | |
| Power Consumption per component (VA)<br>Operating AC Power (Max) 230 $V_{AC}$, 50/60 Hz | ≤ 1420 | ≤ 2560 | ≤ 5100 | Final Amplifier<br>Line PF ≥ 0.95 |
| | ≤ 200 | | | Microwave Upconverter<br>Line PF ≥ 0.7 |
| | ≤ 45 | | | Switch and Control Drawer<br>Line PF ≥ 0.7 |
| | ≤ 70 | | | Fan |
| Vertical Rack Requirements | 6 RU = 10.5” | | | Power Supply Shelf |
| | 12 RU = 21” | | | Sub-Rack |
| | 3 RU = 5.25” | | | Switch and Control Drawer |
| | 4 RU = 7” | | | Microwave Upconverter |
| Mechanical Dimensions | 80”H x 22”W x 35” D (rack)<br>203.2 cm H x 55.88 cm W x 88.9 cm D | | | 40 Rack Units (RU)<br>1 RU = 1.75” or 4.45 cm |
| **Approximate** Weight[2] | 295 lb | 295 lb | 310 lb | Rack/Sub-Rack |
| | 21.5 lb | | | Power Supply |
| | 10 lb | | | Amplifier Segment |
| | 18.5 lb | | | Switch and Control Drawer |
| | 37 lb | | | Microwave Upconverter |

***GENERAL NOTES:***

1. ***The SBM-250A and SBM-500A includes space for upgrade to SBM-1000A.***
2. ***Weight doesn't include shipping materials.***

# SECTION 2

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

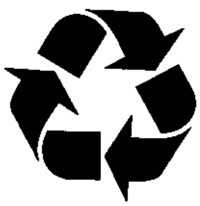
You will find installation instructions including unpacking, physical installation, environmental and safety considerations. Also included in this section is cabling instruction, as well as a basic turn-on procedure.

# INSTALLATION

## Unpacking

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 # DOC20-0001 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, 66-310-01, located in section 3, of this manual.

### *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 the 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, the rail-mounting brackets are in need of adjustment, loosen the brackets and manipulate the drawer to seat rails to match the transmitter drawer. Re-tighten the 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. Refer to document # DOC23-0045, located in section 2 of this manual, to assist in cabling.

### *Installation of the Power Amplifier Segments*

The power amplifier segments slide into the sub-rack on nylon slides and connect to the motherboard 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, thumbscrews on the segment's 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.

## SYSTEM GROUNDING

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

## ENVIRONMENTAL AND SAFETY CONSIDERATIONS

### *Environmental Considerations*

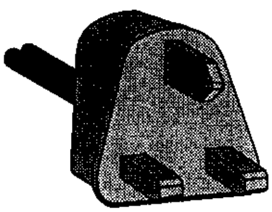
The equipment can be safely operated in ambient temperatures of -30 to +50 degrees Celsius (-22 to +122 degrees Fahrenheit). However, moderate temperatures generally extend equipment life. Although the equipment may be operated with relative humidity of up to 95%, the equipment must be protected from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

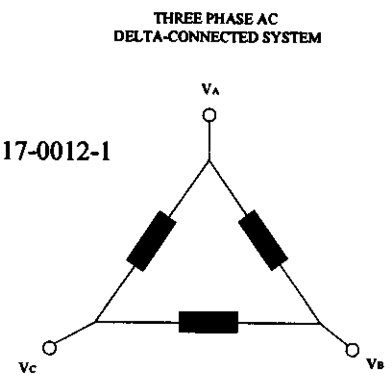


Modern high power solid state equipment contains low output voltage power supplies with very high current capability. To prevent severe burns, avoid contact of rings, watch bands, etc., with these circuits. When servicing the transmission line and antenna, care must be taken to avoid exposure to high-energy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

# AC LOADING IN AN HPB/SBM SYSTEM

The AC loading in a three-phase arrangement must be considered when configuring the transmitter/booster. Since each component will be distributed across two phases (i.e. AB AC & BC) of the DELTA connected system the load should be divided equally among the phases.

FIGURE 17-0012-1




***The line current is calculated by:*** $I_L = 1.73I_P$
$I_L$ ***is the line current &*** $I_P$ ***is the phase current***

***Power is calculated by:*** $P_{total} = 1.73(V_L I_L)(\cos\theta)$
$\cos\theta$ ***= power factor***

Figure 17-0012-1 depicts a DELTA system. The DELTA system uses no neutral the voltage between any two phases (the line voltage) is equal to that of a single phase. The line current however, is 120° out of phase with the current in any of the phases.

Balancing the load is accomplished by following document #DOC24-0006, the AC loading chart, also refer to the AC interconnection diagrams included in section 3 of the manual. The outlet strip within the rack is configured as shown in figure 17-0012-2.

The system components can be plugged into the outlet in an arrangement which best distributes the load.

The N+1 redundant power supply is connected to the three-phase power in the same manner, refer to figure 17-0012-3.

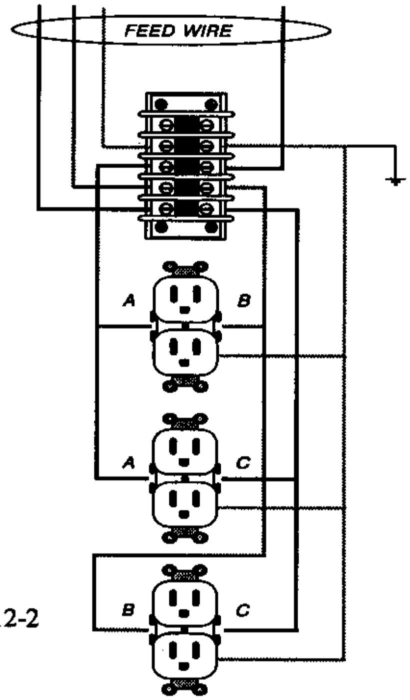



FIGURE 17-0012-2

## MTS-3 POWER SHELF
*HC POWER*
**AC DIAGRAM FOR 3-PHASE HOOK-UP**

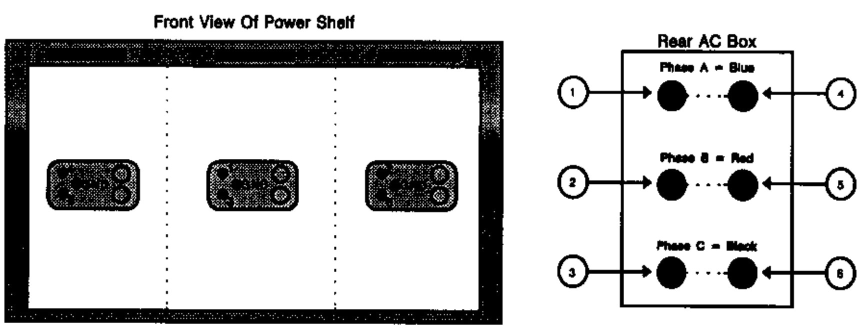



FIGURE 17-0012-3

**Drawn By: Don Wike 03/16/98**

In the case of the HPB/SBM-1000 all three power bays are occupied, phases between AB, AC, & BC are balanced. However, in cases where all three power supplies are not needed to provide redundancy one of the pairs is left unloaded. An example of this is the HPB/SBM-250, which requires only two power supply modules to power the final amplifier. In case of failure the single power segment will run the entire load. The empty bay of the power shelf is compensated by distributing the other system components to the phase pair which is unloaded by the N+1 power supply.

The fans are also strapped in accordance to load distribution, again consult the chart for proper connection. Figure 17-0012-4 gives a general overview of the AC system and the typical system components that are included.

AC DISTRIBUTION - 3 PHASE HOOK UP

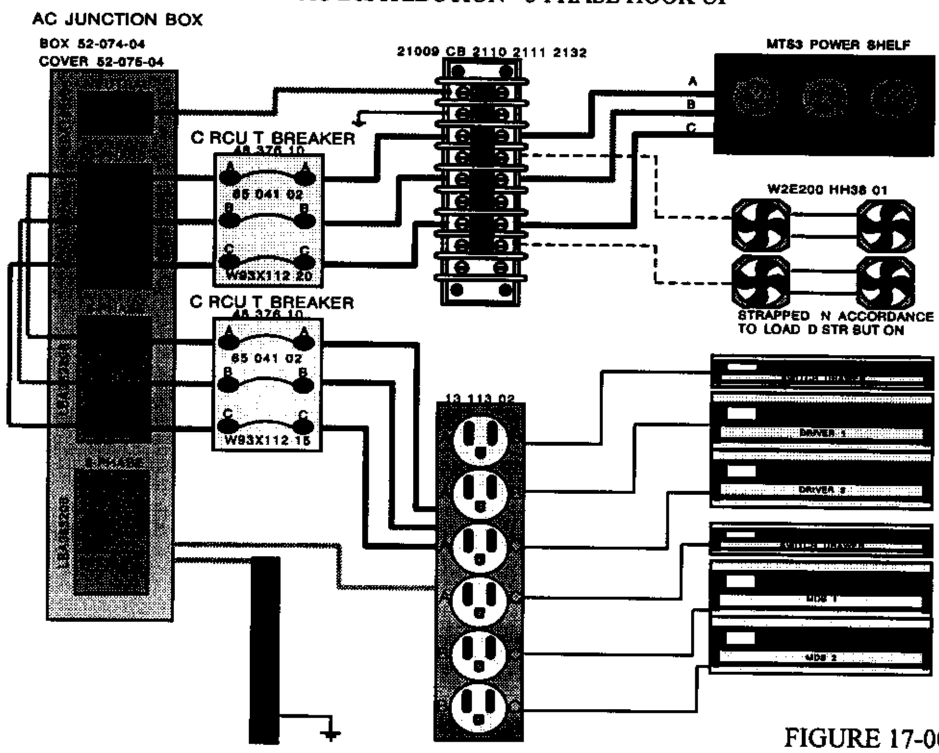



FIGURE 17-0012-4

In order to be flexible in system architecture the AC wiring is kept consistent; the load is then distributed via the use of the outlet strip and terminal block within the rack. In doing so the rack will support many variations in system components. The chart provided in this manual shows configuration for a few standard arrangements, if the configuration of your system is not shown consult the factory.

# HPB/SBM THREE PHASE AC LOADING
# DELTA CONFIGURATION

| **SBM-250** | **A & B** | **A & C** | **B & C** |
|---|---|---|---|
| Power supply | X | X | |
| VHF/UHF Block Upconverter #1 191VA | | | X |
| VHF/UHF Block Upconverter #2 191VA | | | X |
| IF to VHF Upconverter #1 169VA | X | | |
| IF to VHF Upconverter #2 169VA | | X | |
| Switch & Control Drawer 39VA | X | | |
| (2) Fans | | | X |
| **SBM-500** | **A & B** | **A & C** | **B & C** |
| Power supply | X | X | |
| VHF/UHF Block Upconverter #1 191VA | | | X |
| VHF/UHF Block Upconverter #2 191VA | | | X |
| IF to VHF Upconverter #1 169VA | X | | |
| IF to VHF Upconverter #2 169VA | | X | |
| Switch & Control Drawer 39VA | X | | |
| (2) Fans | | | X |
| **SBM-1000** | **A & B** | **A & C** | **B & C** |
| Power supply | X | X | X |
| VHF/UHF Block Upconverter #1 191VA | X | | |
| VHF/UHF Block Upconverter #2 191VA | | X | |
| IF to VHF Upconverter #1 169VA | | | X |
| IF to VHF Upconverter #2 169VA | | X | |
| Switch & Control Drawer 39VA | X | | |
| (4) Fans | | | X |

***Note: A, B, & C denote phase names see below: A=R=L1, B=S=L2, C=T=L3***

# CABLING OF THE SBM SERIES TRANSMITTER

DRIVER

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. See document # DOC23-0045 for assistance with cabling.

REFERENCE DISTRIBUTION

The reference drawer distributes a signal through the rack (refer to the system interconnect diagram, document # DOC15-0026, for more detail). The RG-59 coaxial cable enters the rack. The level should equal 15 dBm +5 dB/-10 dB at the input of each rack (point 2 on DOC15-0026). This level should be measured to determine if attenuation is needed. Place the appropriate size attenuator in-line with the frequency reference input to the rack.

IF DISTRIBUTION

The modulators that provide the input signal are typically located in a separate rack. Cabling is accomplished by distributing the modulator outputs to each rack. (Refer to DOC15-0026 for more detail). The modulator levels should be set to equal -15 dB at the entrance of the rack.

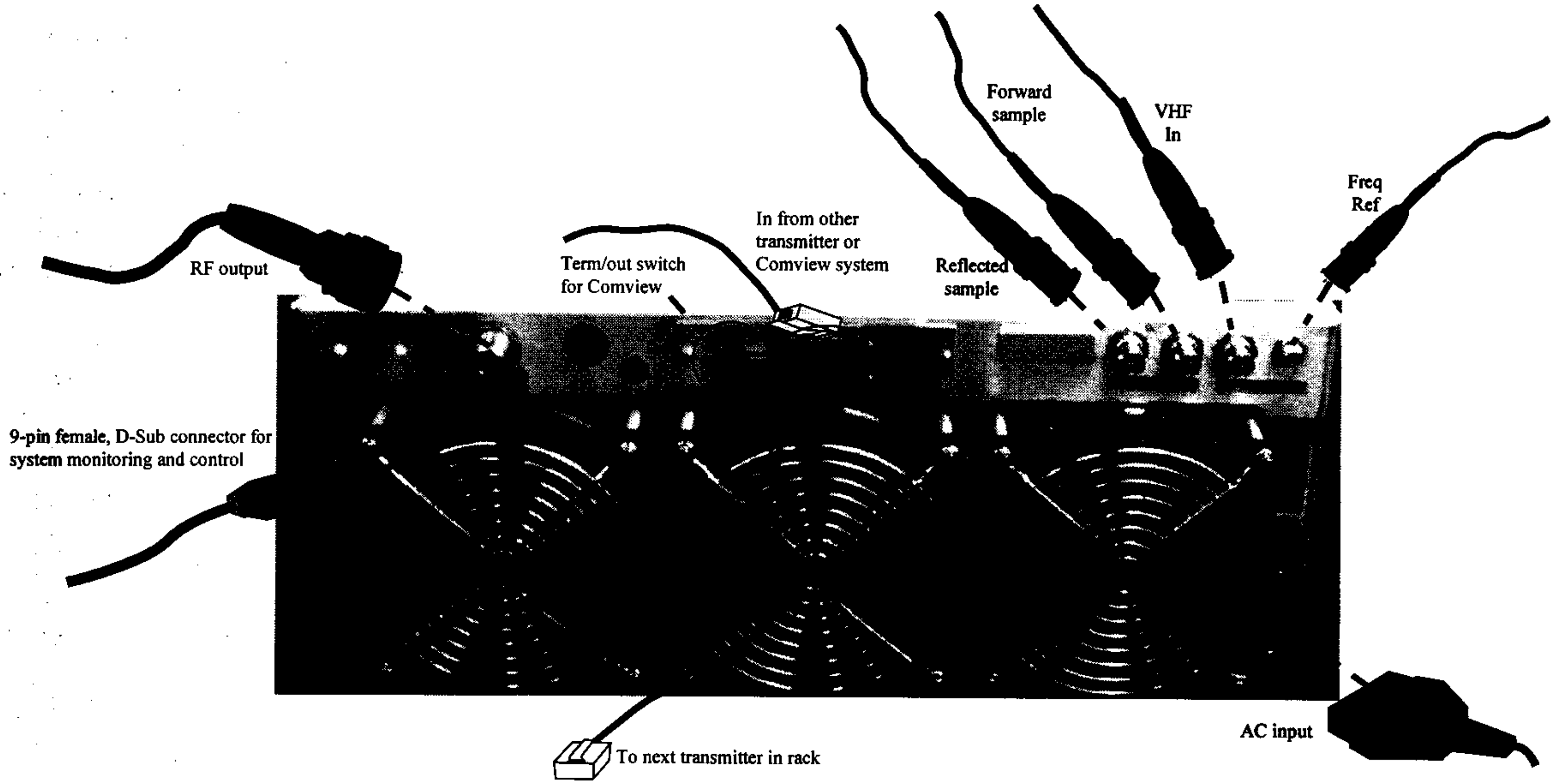
***NOTE: If splitters are used within the system, the modulator should be set to overcome the splitter's loss, i.e., 2 way splitter has 3 dB loss.***

COMVIEW INTERCONNECTIONS

Comview interconnections are achieved through six-conductor phone cables with RJ-11 connectors at each end. The first cabling harness exits the PC and enters the Net Input on the RS-485 Board of the first transmitter (refer to the rear panel of the driver chassis, document # DOC23-0039, in section 4 of this manual, for input and output locations). Another harness is cabled from the Net Output of the first transmitter to the Net Input of the second transmitter. This daisy chain effect continues to the last transmitter in the rack. At the last transmitter in the rack the connection is terminated. If there are several systems to be cabled together, the harness would be cabled from the Net Output of the last transmitter in the rack to the Net Input of the first transmitter in the next rack. (refer to DOC15-0026 for cabling).

| *Created by: Kimberly Simeone 9/30/98* | *Checked by: Donald Wike 10/8/98* | *Released by: Paulo Correa 10/12/98* |
|---|---|---|

# VHF/UHF BLOCK UPCONVERTER (DRIVER) CABLING



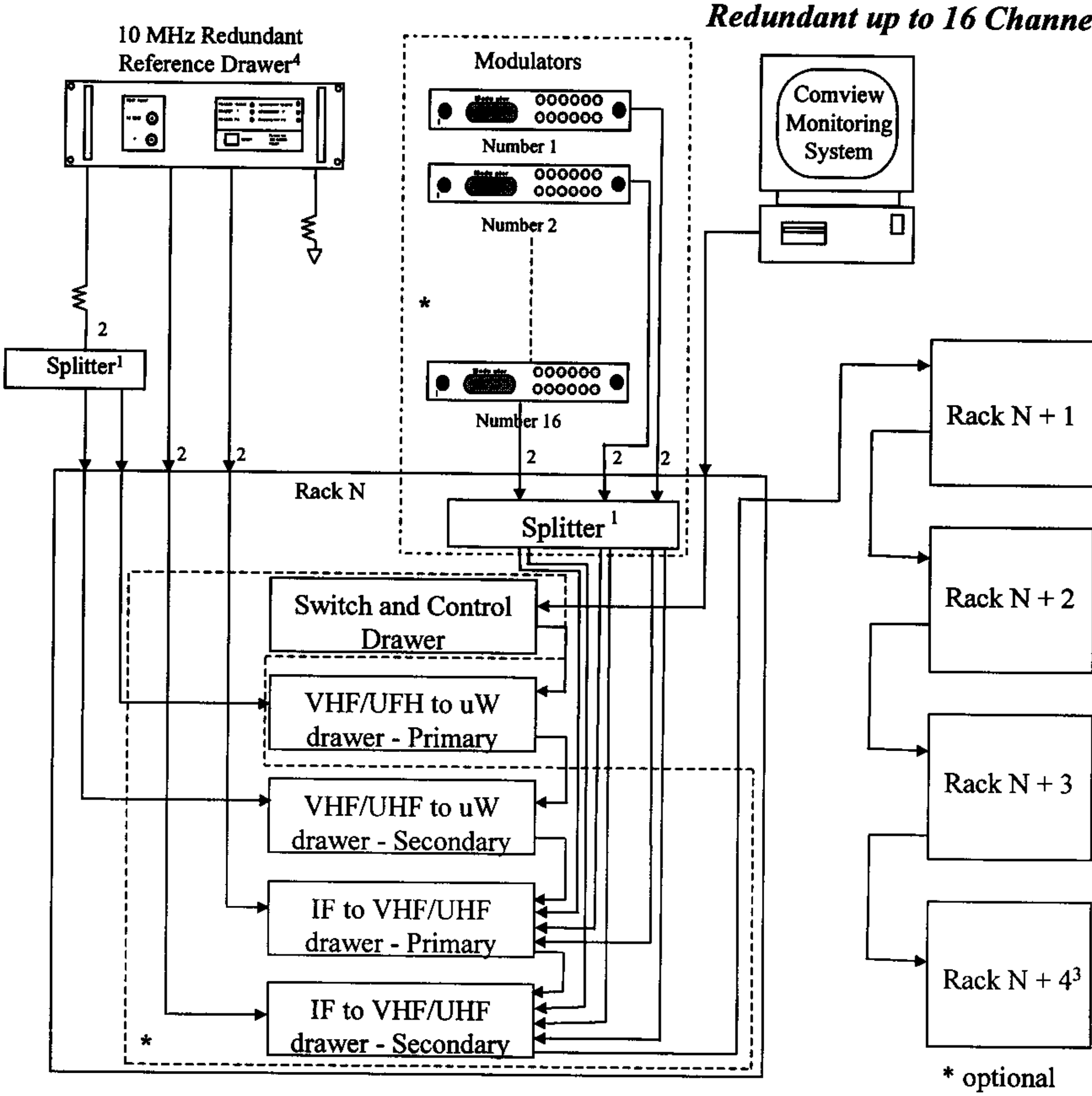

| | | |
|---|---|---|
| *Created by: Kimberly Simeone 12/8/98 ECO#: 98-164* | *Checked by: Kevin Harding 12/10/98* | *Released by: Donald Wike 12/10/98* |

*Document #: DOC23-0045*

*REV:B*

# SBM SYSTEM INTERCONNECTION

## Redundant up to 16 Channels




*1. The type of splitter used is dependent upon the configuration of the transmitter.*

*2. A certain level must be obtained at this input (refer to cabling, Document # DOC18-0013, section 2 of this manual)*

*3. The network end termination switch located on the rear panel of the driver must be set to TERM on the last transmitter in the system (all other are set to OUT).*

*4. The cables and splitter for cabling the 10 MHz Redundant Reference Drawer are sold as option kit 99-006-02.*

| Created by: Kimberly Simeone 12/21/98 ECO #: 98-164 | Checked by: Donald Wike 12/21/98 | Released by: Paulo Correa 12/21/98 |
|---|---|---|

# TURN-ON PROCEDURE FOR THE HPB/SBM SERIES OF BOOSTERS/TRANSMITTERS

***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 PROCEDURE

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 LED's continuously illuminate verifying successful initial operation:
   - IN SIGNAL ***(Modulator operation is required if an input signal is applied)***
   - INTERLOCK ***(occurs in normal operation or by the signal distribution 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 PROCEDURE

Driver Normal Operation

Rotating the function switch from "STANDBY" to any other position, besides "RESET", enables driver operation. Once the function switch is rotated, the following GREEN LED's continuously illuminate confirming normal operation:

- IN SIGNAL
- INTERLOCK
- TRANSMIT

Absence of a green LED indicates a missing signal or parameter. Continuous illumination of any red status LED indicates a failure has been detected by the diagnostic circuitry. Refer to section 3 of this manual for troubleshooting failures.

To verify other transmitter parameters using the front panel meter, rotate the function switch. +11 $V^{PS}$, AGC 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. Turning the key-lock switch to the "OFF/UNLOCKED" position and then back to the "ON/LOCKED" position will reset it. 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, see document # DOC22-0019 in section 3, and turn the key-lock switch to the "ON/LOCKED" position. Refer to Document # DOC17-0007, in section 2 of this manual, for power amplifier segment installation if needed.

# SECTION 3

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

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

# TROUBLESHOOTING OF THE SBM SERIES

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. Observing the front panel LED diagnostic display, analog panel meter and diagnostic interface will inform you of the complete operational status. This section explains various failure mode displays that may be encountered 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.*

The following LED's continuously illuminate GREEN during normal operation. Absence of a green LED indicates a missing signal or parameter that results in a controlled automatic shutdown.

**IN SIGNAL** ***(Missing IF input signal):***

CAUSES:

- Defective cabling to modulator baseband IF INPUT
- Defective modulator
- Missing IF source signal

REMEDY:

- Check Cabling
- Verify IF source signal
- Replace modulator
- Measure voltages at 25-pin diagnostic interface, J2
- Contact Comwave customer support

**INTERLOCK** ***(Missing system Interlock signal):***

CAUSES:

- RF module unplugged or shorted
- Defective module

REMEDY:

- Check driver for disconnected module(s)
- Measure voltages at 25-pin diagnostic interface, J2
- Contact Comwave customer support

**TRANSMIT** ***(No transmit):***

CAUSES:

- Missing IN SIGNAL
- Missing INTERLOCK signal
- Defective/disconnected harness
- See other diagnostic LED's

REMEDY:

- Check cabling
- Check harness between modulator and transmitter
- Troubleshoot per highlighted LED's
- Measure voltages at 25 pin diagnostic Interface J2
- Contact Comwave customer support

The following LED's 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.

**LO LEVEL** ***(Local Oscillator failure):***

CAUSES:

- Oscillator failure
- 10 MHz reference missing or low level
- Defective module

REMEDY:

- Check external cabling
- Measure voltages at 25-pin diagnostic interface, J2
- Contact Comwave customer support

**LO AGC** ***(LO AGC failure):***

CAUSES:

- Local oscillator failure
- 10 MHz reference missing or low level
- Defective module

REMEDY:

- Check external cabling
- Measure voltages at 25-pin diagnostic interface, J2
- Contact Comwave customer support

**IPA 1** ***(Defective internal power amp 1):***

CAUSES:
- Internal power amplifier 1 current
- Power supply failure
- Defective module

REMEDY:
- Measure voltages at 25 pin diagnostic interface, J2
- Contact Comwave customer support

**IPA 2** ***(Defective internal power amp 2):***

CAUSES:
- Internal power amplifier 2 current
- Power supply failure
- Defective module

REMEDY:
- Measure voltages at 25 pin diagnostic interface, J2
- Contact Comwave customer support

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

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

REMEDY:
- Check fan operation
- Check site air conditioning
- Allow transmitter to cool, check latched failure logic by rotating function switch momentarily to "STANDBY"
- Measure voltages at 25-pin diagnostic interface, J2
- Contact Comwave customer support

**R.F. POWER:** ***(Meter does not indicate 100% R.F. power):***

CAUSES:

- Driver Module
- Final Module(s)
- Switching Power Supply
- Forward metering out of adjustment

REMEDY:

- Confirm input/output power
- Troubleshoot per front panel LED diagnostic display
- Check for defective module
- Calibrate forward power and AGC metering per document # DOC16-0005, in section 3 of this manual
- Measure voltages at 25-pin diagnostic interface, J2
- Contact Comwave customer support

**POWER SUPPLY** ***(Voltage has deviated beyond a set operating window {high or low}):***

CAUSES:

- Defective main input line fuse
- Open switching power supply fuse, F1
- Shorted amplifier module
- Open motherboard fuse, F1
- Defective module

REMEDY:

- Check switching power
- supply output voltage
- Check for defective fuses(s)
- Measure voltages at 25-pin diagnostic interface, J2
- Contact Comwave customer support

**FINAL** ***(Power Amplifier) (Defective final module):***

CAUSES:

- Final module current
- Power supply failure
- Defective module

REMEDY:

- Measure voltages at 25-pin diagnostic interface, J2
- Contact Comwave customer support

To assist in troubleshooting, Comwave products employ a 25-pin computer type diagnostic interface connector, labeled J2, located on the rear of the chassis. Critical power supply, module and motherboard 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.

ANALOG METERING
The front panel analog meter provides a visual indication of the +11 V switching power supply, AGC, reflected or forward power. The +11 V switching power supply and forward power should indicate 100%. Reflected power meter readings less than 10% are typical. By observing the meter readings, transmitter performance can be interpreted. Analog meter readings in conjunction with the front panel diagnostic status LED's help to identify/isolate failures. The following information will assist in troubleshooting analog meter anomalies.

**+11 $V_{PS}$** ***(Meter does not indicate 100%):***

CAUSES:

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

REMEDY:

- Replace defective fuse(s)
- Check switching power supply output voltage
- Troubleshoot per front panel LED diagnostic display
- Adjust switching power supply output voltage per document # DOC16-0005, in section 3 of this manual
- Calibrate meter per document # DOC16-0005, in section 3 of this manual
- Measure voltages at 25 pin diagnostic interface J2
- Contact Comwave customer support

**AGC** ***(Meter does not indicate 100%):***

CAUSES:

- Exceeding ALC input limits
- Defective module

REMEDY:

- Correct input level
- Check cable
- Calibrate per document # DOC16-0005, in section 3 of this manual
- Contact Comwave customer support

**REFL PWR** ***(Reflected power is greater than 10%):***

CAUSES:

- Loose RF cable connection(s)
- RF cable kinked
- Wave guide leak/depressurized
- Reflected metering out of adjustment
- Defective module

REMEDY:

- Check integrity of all RF cable connections
- Check cabling for kinks or severe bends
- Check wave guide pressure
- Calibrate reflected metering per document # DOC 16-0005, in section 3 of this manual
- Measure voltages at 25 pin diagnostic interface J2
- Contact Comwave customer support

**FWD PWR** ***(Meter does not indicate 100%):***

CAUSES:

- Driver module
- Final module(s)
- Switching power supply
- Visual metering out of adjustment

REMEDY:

- Confirm output power
- Troubleshoot per front panel LED diagnostic display
- Replace defective module
- Calibrate fwd power metering per document # DOC16-0005 in section 3 of this manual
- Measure voltages at 25 pin diagnostic interface J2
- Contact Comwave customer support

POWER AMPLIFIER SEGMENT
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 thumbscrews 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 in document # DOC17-0007 in section 2 of this manual.

# 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.**

| Interface 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 | +11.75 | +12.00 | +12.25 | |
| **3** | -12 $V_{DC}$ PS | -11.80 | -12.00 | -12.20 | |
| **4** | +11 $V_{DC}$ PS | +10.70 | +10.80 | +10.90 | |
| **5** | +5 $V_{DC}$ PS | +4.80 | +5.00 | +5.20 | |
| **6** | N/A | N/A | N/A | N/A | |
| **7** | N/A | N/A | N/A | N/A | |
| **8** | IPA1 | - | 3.00-4.00 | - | |
| **9** | IPA2 | - | 3.00-4.00 | - | |
| **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** | Final | - | 1.29-1.58 | - | |
| **14** | N/A | N/A | N/A | N/A | |
| **15** | N/A | N/A | N/A | N/A | |
| **16** | N/A | N/A | N/A | N/A | |
| **17** | N/A | N/A | N/A | N/A | |
| **18** | N/A | N/A | N/A | N/A | |
| **19** | Remote Turnoff | <0.40 | >4.00 | 5.10 | |
| **20** | In-Signal (IF Detect) | - | 5.00 | - | |
| **21** | LO Level | - | >0.70 | - | |
| **22** | Remote Fault | 0.00 | 0.00 | 5.10 | |
| **23** | FWD Power | 1.00 | 1.35-1.45 | - | |
| **24** | AGC | N/A | 1.35-1.45 | - | |
| **25** | REFL Power | 0.00 | 0.10 | 0.30 | |

**Company Name:** ____________________ **Customer's Name:** ____________________
**Phone #:** ____________________ **Fax #:** ____________________
**Model:** ________________ **Channel:** ________ **Serial #** ***(Rear Panel)*:** ______________

Send Results to:

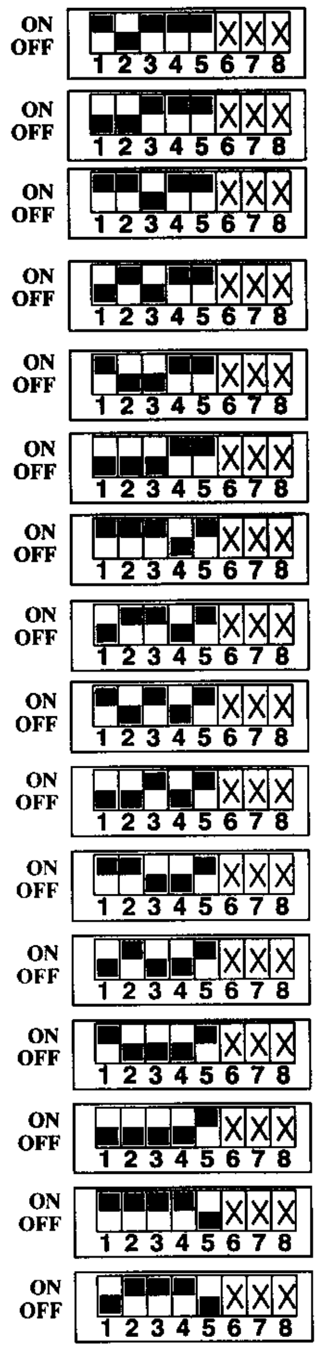
**COMWAVE- Attention Technical Support**
PO Box 69, 395 Oakhill Road, Mountaintop, PA 18707 USA
Toll Free (USA & Canada only): 1-800-266-9283
Domestic and International 1-570-474-6751
Fax #: 1-570-474-5469

| | | |
|---|---|---|
| ***Created by: Kimberly Simeone*** <br> ***12/10/98 ECO #: 98-164*** | ***Checked by: Donald Wike*** <br> ***12/21/98*** | ***Released by: Paulo Correa*** <br> ***12/21/98*** |

# *NODE ADDRESSES*

### *1 to 16 Channels*

| *MODULE POSITION* | *NODE ADDRESS* | *NODE SWITCH SETTING* |
|---|---|---|
| 1 | 2 | |
| 2 | 3 | |
| 3 | 4 | |
| 4 | 5 | |
| 5 | 6 | |
| 6 | 7 | |
| 7 | 8 | |
| 8 | 9 | |
| 9 | 10 | |
| 10 | 11 | |
| 11 | 12 | |
| 12 | 13 | |
| 13 | 14 | |
| 14 | 15 | |
| 15 | 16 | |
| 16 | 17 | |




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

| | | |
|---|---|---|
| *Created by: Kimberly Simeone*<br>*9/16/98 ECO #: 98-116* | *Checked by: Donald Wike*<br>*10/20/98* | *Released by: Paulo Correa*<br>*10/20/98* |

# EQUIPMENT FUSING AND PROTECTION

## DRIVER FUSING

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

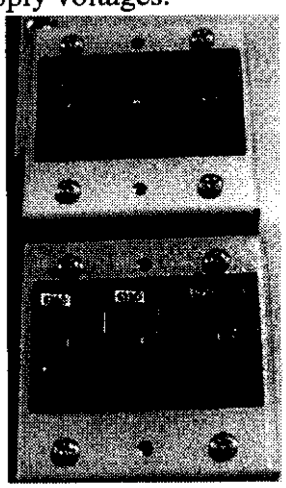
| *Location* | *Fuse* | *Value* |
|---|---|---|
| Motherboard | F1 | 4 Amperes |
| Motherboard | F2 | 25 Amperes |
| Motherboard | F3 | 25 Amperes |
| Motherboard | F4 | 4 Amperes |
| Rear Panel | Input | 12 Amperes @ 117 VAC<br>7 Amperes @ 230 VAC<br>(slow blow) |
| Power Supply | F1 | 15 Amperes @ 117 VAC<br>8 Amperes @ 230 VAC |

FIGURE 18-0015-1

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.

Three-phase: 20 Amp
Phase-to-phase: 30 Amp



Three-phase: 15 Amp
Phase-to-phase: 20 Amp

FIGURE 18-0015-2

## CIRCUIT BREAKER

A three-phase 15 and 20-Ampere circuit breaker, figure 18-0015-02, is provided with each transmitter for system protection. They are located on the rear of the rack above the fans. When the lesser Ampere circuit breaker trips the driver, switch and control drawer, and IF to VHF drawer will shut down. When the larger Ampere circuit breaker trips the AC to DC front-end converter and the power amplifier segments will shut down. In a phase-to-phase system the circuit breakers are 20-Ampere and 30-Ampere and when they are tripped it produces the same results. If either circuit trips the transmitter will be inoperable. A plastic cover is provided to protect the circuit breaker from accidental shut down (not shown in figure 18-0015-02).

***NOTE: THIS IS A PHOTO OF A THREE-PHASE SYSTEM IN A PHASE-TO-PHASE SYSTEM THERE WILL ONLY BE 2 SWITCHES ON EACH BREAKER.***

| | | |
|---|---|---|
| ***Created by: Kimberly Simeone*** ***9/30/98*** | ***Checked by: Donald Wike*** ***10/20/98*** | ***Released by: Paulo Correa*** ***10/20/98*** |

# AC POWER INTERCONNECTIONS

The AC power interconnections, see figure 13-0029-1, include an AC power distribution box, 15-Ampere/30-Ampere circuit breaker, terminal strip, AC to DC front end converter, drawers and fans. The AC power interconnections provide phase-to-phase 208 $V_{AC}$ and/or three-phase 208 $V_{AC}$* to each part of the transmitter or to each transmitter in the rack. Figure 13-0029-1 shows an example of an agile transmitter.

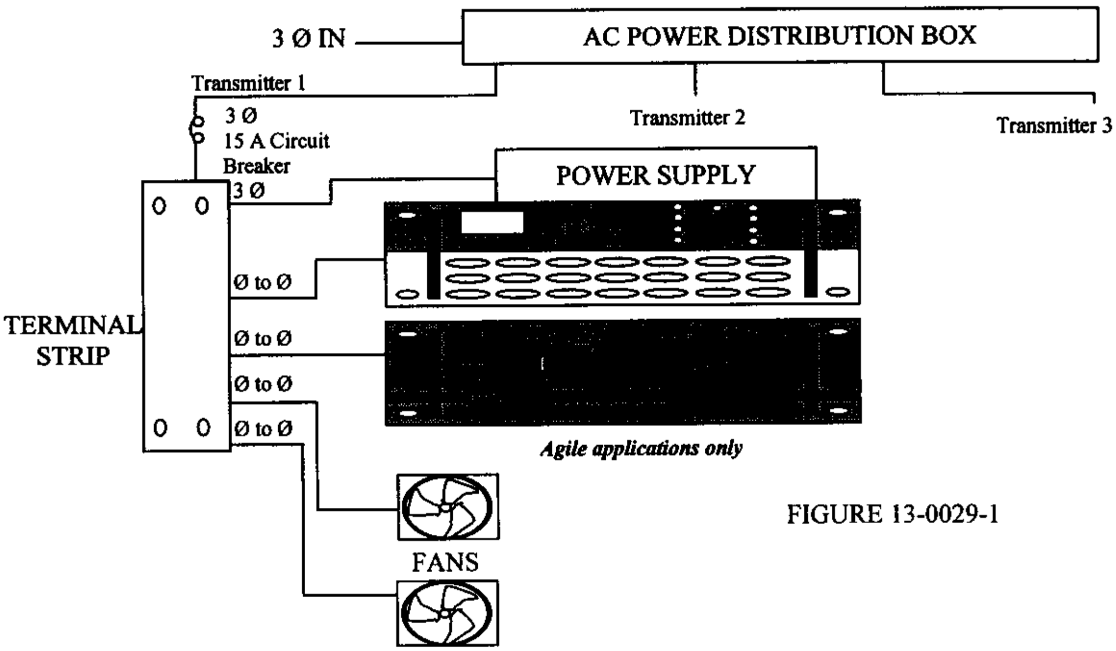
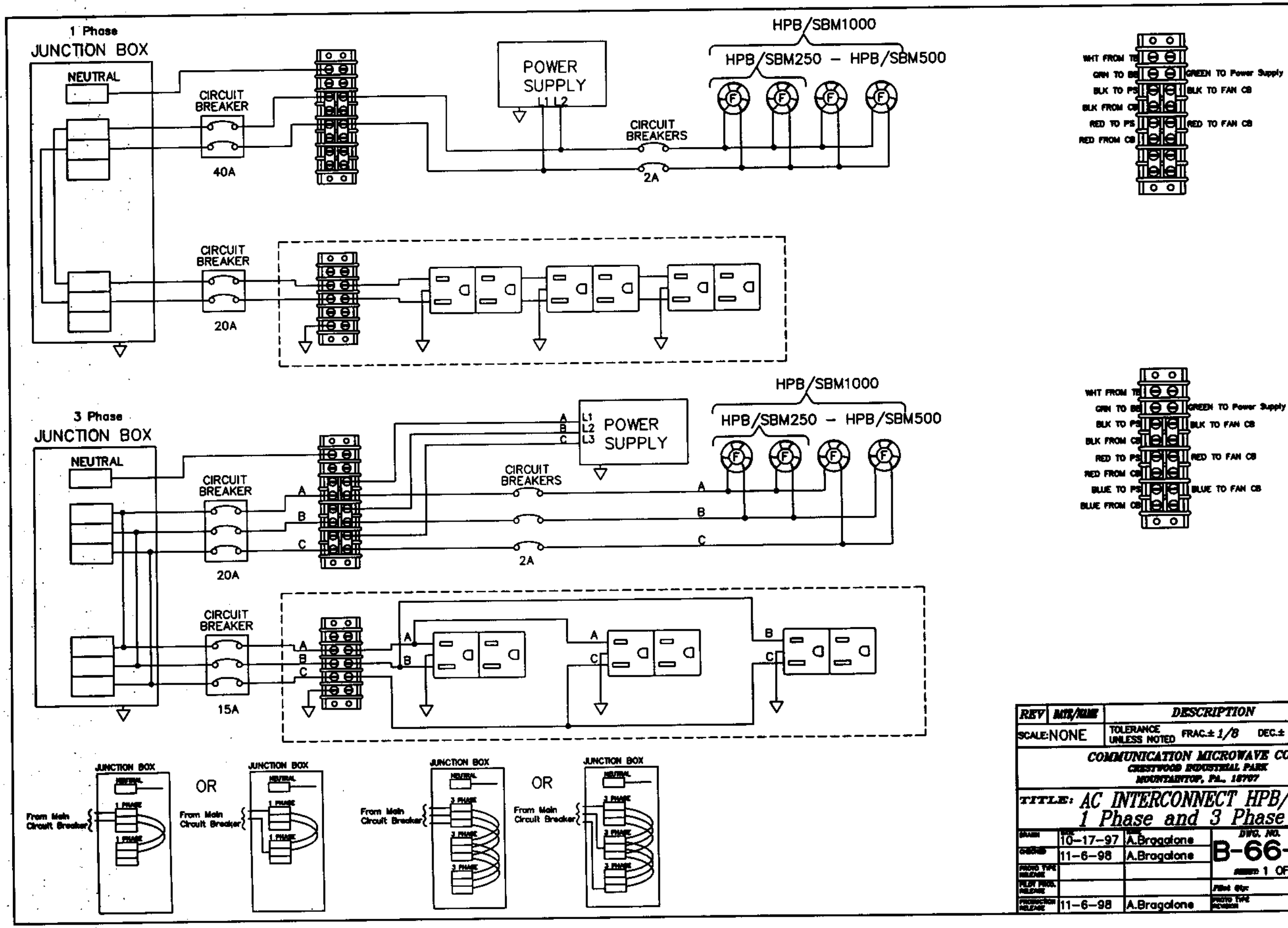



FIGURE 13-0029-1

The AC 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 AC power via two or three 350 Ampere, 600 $V_{AC}$, three pole terminal blocks. The number of terminal blocks depends upon the number of transmitters in each rack. Each transmitter has its own circuit breaker. The 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 brief description of it can be found on the equipment fusing and protection document located in section 3 of this manual, a plastic cover protects the breaker to prevent accidental shut down of the transmitter

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 or phase-to-phase power to the AC to DC front end converter and phase-to- phase 208 $V_{AC}$ to the remaining equipment. All the low power and support equipment require phase-to-phase 208 $V_{AC}$, which is delivered by a 14 AWG-three conductor line cord. The terminal strip also supplies phase-to-phase power to the 208 $V_{AC}$, 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.

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




| REV | MTE/NAME | DESCRIPTION | ECO No. |
|---|---|---|---|
| SCALE: NONE | TOLERANCE UNLESS NOTED | FRAC.± 1/8 DEC.± .005 | ANG.± .5° |

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

**TITLE: AC INTERCONNECT HPB/SBM Series 1 Phase and 3 Phase AC Power**

| | DATE | NAME | DWG. NO. |
|---|---|---|---|
| DRAWN | 10-17-97 | A.Bragalone | B-66-310-01 |
| CHECKED | 11-6-98 | A.Bragalone | SHEET 1 OF 1 |
| PROTO TYPE RELEASE | | | |
| PILOT PROD. RELEASE | | | |
| PRODUCTION RELEASE | 11-6-98 | A.Bragalone | REV. C |

# DC POWER INTERCONNECTIONS

The DC power interconnection, figure 13-0030-1, for each transmitter includes an AC to DC front end converter (power supply), a DC power harness, a DC to DC converter, and a motherboard.

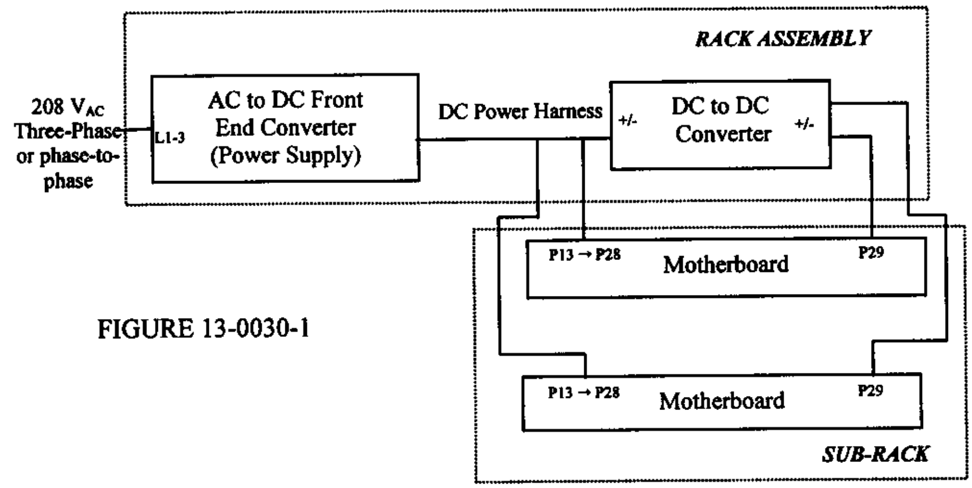
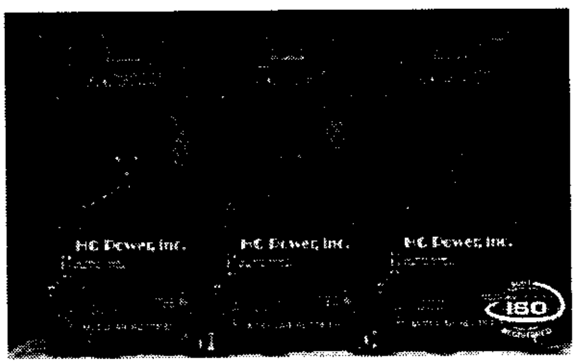



FIGURE 13-0030-1



REDUNDANT

FIGURE 13-0030-2

The power supply for the rack, figure 13-0030-2, consists of two 24-volt modules for the HPB/SBM-250 and HPB/SBM-500, and three for the HPB/SBM-1000 booster/transmitter, 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 of 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.

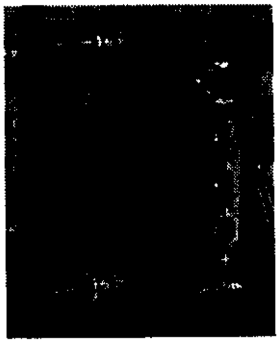


FIGURE 13-0030-3

The DC power harness provides a path for 48 $V_{DC}$ to the motherboard and the DC to DC converter. The DC power harness consists of standard tinned 14 AWG copper conductors with .032 thick polyolefin insulation rated at 600 volts.

The DC to DC converter, figure 13-0030-3, 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 motherboard on the sub-rack. In systems where there are more than eight power amplifier segments in the sub-rack two DC to DC converters are supplied, one for each motherboard.

The motherboard, figure 13-0030-4, 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 motherboard to the microcontroller board within each segment.

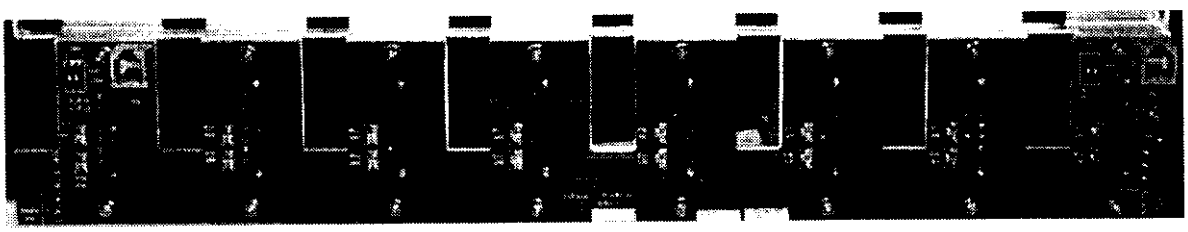
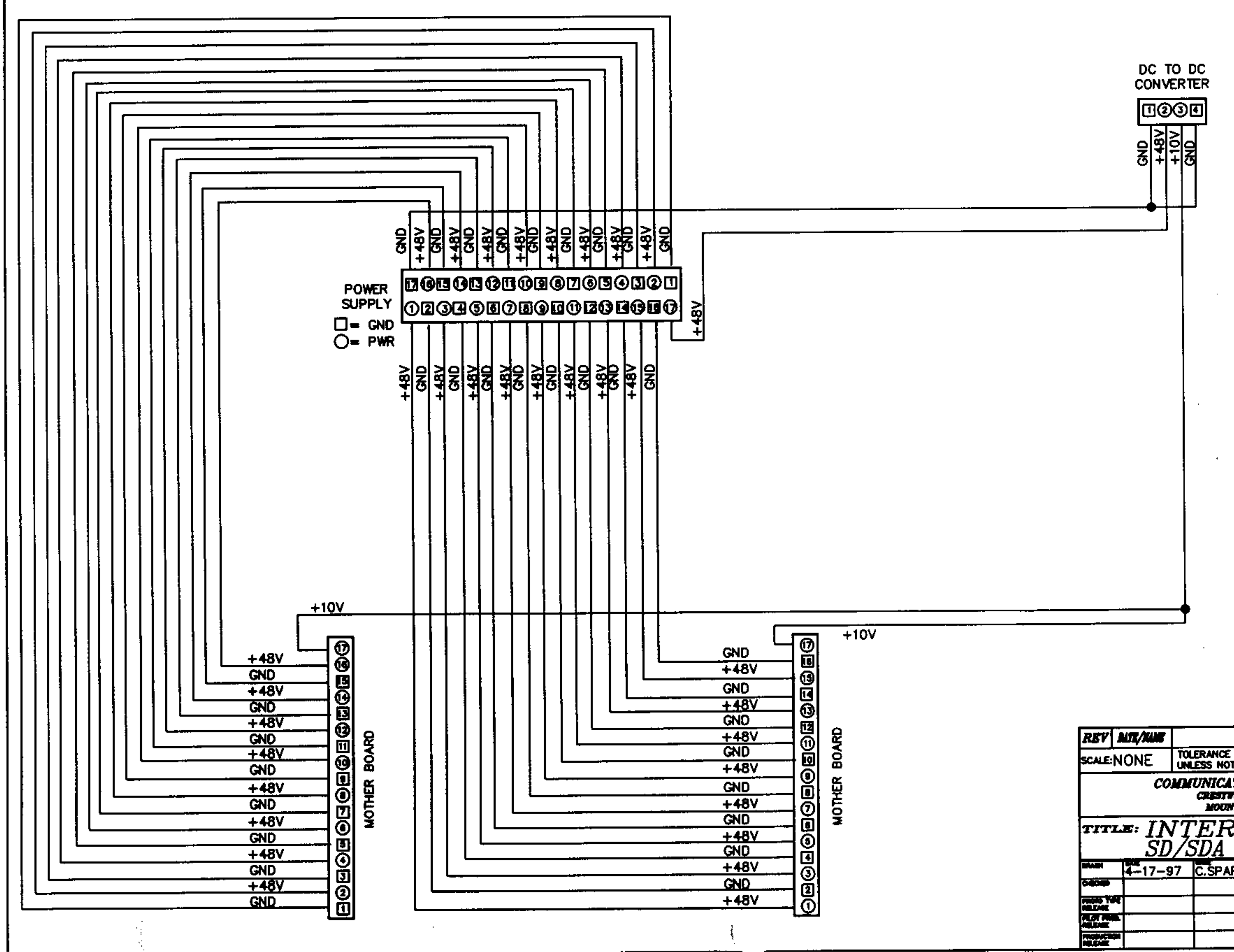


FIGURE 13-0030-4

***Note:***

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




| REV | DATE/NAME | DESCRIPTION | ECO No. |
|---|---|---|---|
| SCALE: NONE | TOLERANCE UNLESS NOTED | FRAC.± – DEC.± – | ANG.± – |

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

TITLE: INTERCONNECT, DC
SD/SDA SERIES (HIGH POWER)

| DRAWN | DATE 4-17-97 | NAME C.SPARKES | DWG. NO. B-66-304-01 |
|---|---|---|---|
| CHECKED | | | SHEET 1 OF 1 |
| PROTO TYPE RELEASE | | | |
| PILOT PROD. RELEASE | | | |
| PRODUCTION RELEASE | | | REV. |

# RF POWER INTERCONNECTIONS

The input signals interface directly to the IF to VHF/UHF drawer or to a splitter, where they are divided between redundant IF to VHF/UHF drawers. The VHF/UHF signal is heterodyned to RF and amplified in the driver chassis. The 10 MHz reference signal enters the rack, cabling varies depending how the system is racked. These signals are connected to the IF to VHF/UHF drawers through a splitter, and the VHF/UHF to microwave drawers using male F and BNC bulkhead connectors. In a non-redundant system the IF to VHF/UHF drawers cable directly to a single VHF/UHF to microwave drawer using male F and BNC bulkhead connectors.

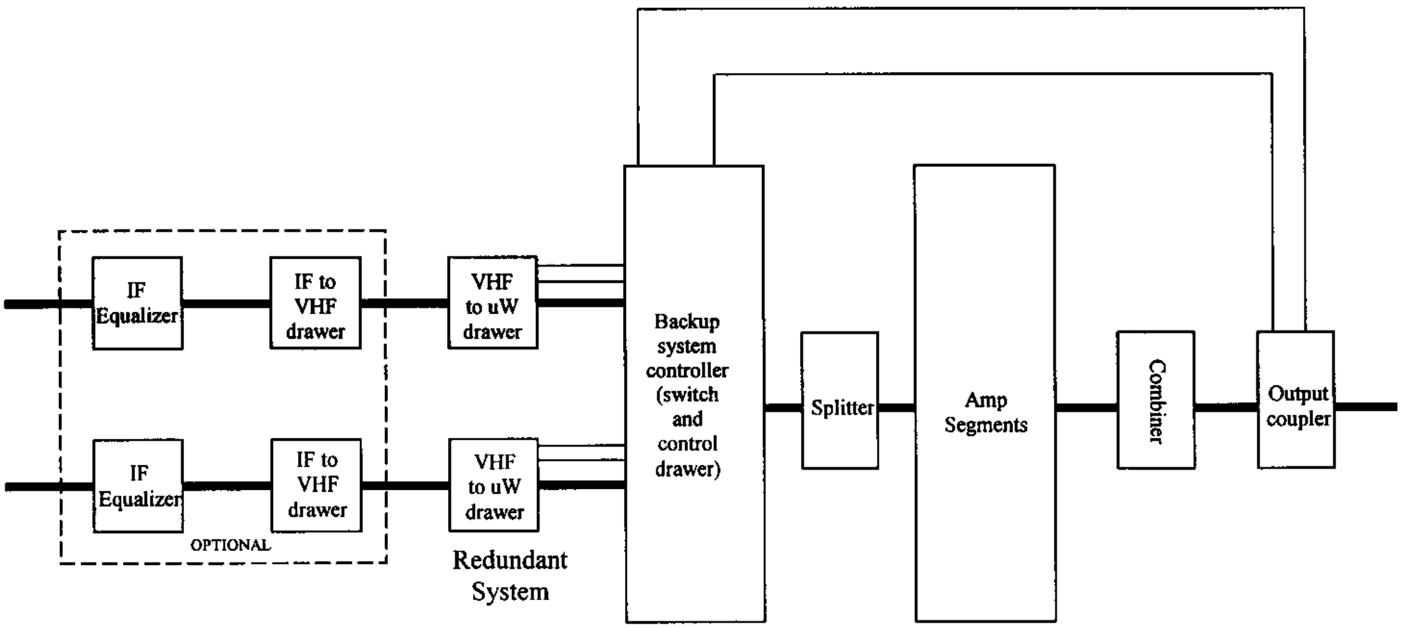



FIGURE 13-0054-1

The RF signal exits the driver chassis via an N-type connector on the rear panel. In a redundant system the output of the driver is connected to a switch and control drawer. In a non-redundant system it is connected directly to the amplifier cage. The number of splitter outputs is dependent upon the output power of the transmitter. The output of the splitter is connected to the power amplifier using an SMA to OSP floating bulkhead cable.

Each power amplifier segment increases the RF signal by 29.5 dB. The number of power amplifier segments in each transmitter is dependent upon the output power required by the transmitter. Connected to the output of each power amplifier segment, is an OSP floating bulkhead to SMA cable, which is connected to the combining network.

The combining network is a proprietary circuit that allows for hot replacement without serious degradation in power or performance. Connected to the combining network is a directional coupler, which samples the forward power and reflected power. The forward and reflected power samples are connected to the RF detector located in the switch and control drawer. The output connector of the directional coupler fits through a hole in the rear door to allow the N connector super-flex cable to be connected.

# MAINTENANCE

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

## INSPECTIONS

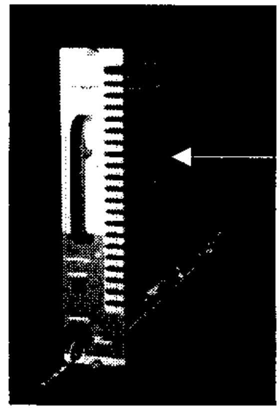



FIGURE 18-0005-1

1. Periodically inspect cooling fans on the rear door of the rack and the heatsinks of the Power Amplifier Segments for heavy accumulations of dirt and/or insects. Heavy accumulation of foreign debris impedes cooling effectiveness and could lead to premature failure. Should any debris be detected, shut down the transmitter and follow the cleaning instructions to remove debris from transmitter. ***NOTE: The Agile Transmitter will automatically recover the channel of the transmitter, which is being cleaned.***

2. Record analog meter readings of each transmitter on a monthly basis. This establishes a performance historical database. These entries can identify degraded performance before it becomes a hard failure.

3. After performing routine maintenance, be sure to check the tightness of all cable connections and especially the integrity of crimp type connectors.

## CLEANING

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

# MONTHLY MAINTENANCE RECORD

| Date | Channel | Analog Metering | | | | Failure LED's | Comments |
|---|---|---|---|---|---|---|---|
| | | FWD | REF | +11VPS | AGC | | |
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|---|---|---|
| *Created by: Kimberly Simeone 9/29/98* | *Checked by: Donald Wike 10/8/98* | *Released by: Paulo Correa 10/12/98* |

# METERING CALIBRATION

COMWAVE service technicians prior to shipping complete calibration of the system; however, re-calibration of the driver may become necessary when the input or output power levels are changed. Due to the equal gain of the power amplifiers, re-calibration of the segments is not necessary.


## WARNING


***NOTE: This procedure is applicable for only making MINOR adjustments to output power and analog metering. Do NOT adjust power more than ±.5 dB. Adjustments more than ±.5 dB may result in increased intermodulation distortion products. For larger adjustments to output power re-calibration of the IF Precorrector is necessary. Contact Comwave customer service for further assistance, see Document # DOC20-0001 for contact information.***

For proper calibration, adjustments are performed in a specific sequence. Before beginning, place the Driver into "STANDBY.

REFER TO DOCUMENT # DOC23-0042 FOR NUMBER REFERENCES.

**DIGITAL METERING**

<u>DIGITAL INPUT AGC CALIBRATION</u>

- Break the circuit(3) between the –10dB coupler and the precorrector and connect an HP435B power meter, or equivalent, to the coupler output.
- Apply a digital VHF/UHF input signal, having –18 dBm ± 3 dB minimum per carrier at the driver input(1).
- Turn the switch(2) on the VHF/UHF AGC module to "MANUAL".
- Set, with the manual control potentiometer(4) on the VHF/UHF module, to a reading of 0 dBm at the power meter.
- Rotate the function switch on the front panel to AGC.
- Set AGC metering control(5) to read 100% on the front panel meter.
- Turn the switch(2) on the AGC module from "MANUAL" to "AUTO" and set the auto control potentiometer(6) to read 100% on the front panel meter.
- Disconnect the power meter and reconnect the cable(3) between the –10 dB coupler and the precorrector.

<u>DIGITAL FWD POWER (OUTPUT ALC CALIBRATION)</u>

- Apply microwave digital signal, having 0 dBm total power to the precorrector input (J1)(3), be sure to turn the switch(7) on the precorrector to the on position.
- Connect an external coupler to the system output, see document # DOC22-0018, and a power meter to its forward power port. Make sure power meter is set to a scale proper to read the expected levels.

- Turn the switch[8] on the precorrector to "MANUAL".
- Adjust, by means of a manual control potentiometer[9], the output power of the system to be the power required, see figure 16-0005-1 below.
- Place front panel switch to forward power position and adjust the metering control[10] to set the reading to 100%.
- Turn the precorrector switch[7] back to "AUTO" and adjust the auto control potentiometer[11] to set the front panel reading back to 100%.

## ANALOG METERING

***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.***

***Example:***

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

ANALOG INPUT AGC CALIBRATION

- Break the circuit[3] between the –10dB coupler and the precorrector and connect an HP435B power meter, or equivalent, to the coupler output.
- Apply a analog VHF/UHF input signal, having –18 dBm ± 3 dB minimum per carrier at the driver input[1].
- Turn the switch[2] on the VHF/UHF AGC module to "MANUAL".
- Set, with the manual control potentiometer[4] on the VHF/UHF module, to a reading of 0 dBm at the power meter.
- Rotate the function switch on the front panel to AGC.
- Set AGC metering control[5] to read 100% on the front panel meter.
- Turn the switch[2] on the AGC module from "MANUAL" to "AUTO" and set the auto control potentiometer[6] to read 100% on the front panel meter.
- Disconnect the power meter and reconnect the cable[3] between the –10 dB coupler and the precorrector.

ANALOG FWD POWER (OUTPUT ALC CALIBRATION)

- Apply microwave analog signal, having 0 dBm total power to the precorrector input (J1)[3], be sure to turn the switch[7] on the precorrector to the on position.
- Connect an external coupler to the system output, see document # DOC22-0018, and a power meter to its forward power port. Make sure power meter is set to a scale proper to read the expected levels.
- Turn the switch[8] on the precorrector to "MANUAL".
- Adjust, by means of a manual control potentiometer[9], the output power of the system to be the power required, see figure 16-0005-1 below.
- Place front panel switch to forward power position and adjust the metering control[10] to set the reading to 100%.
- Turn the precorrector switch[7] back to "AUTO" and adjust the auto control potentiometer[11] to set the front panel reading back to 100%.

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

| POWER SPECIFICATION CHART – dBm PER CHANNEL | | | | | |
|---|---|---|---|---|---|
| | *CH 1-2* | *CH 3-4* | *CH 5-8* | *CH 9-16* | *CH 17-31* |
| **SBM-250** | 40.0 | 35.0 | 31.0 | 27.5 | 24.0 |
| **SBM-500** | 43.0 | 38.0 | 34.0 | 30.5 | 27.0 |
| **SBM-1000** | 46.0 | 41.0 | 37.0 | 33.5 | 30.0 |

FIGURE 16-0005-1

## REFLECTED OUTPUT POWER METERING

- Rotate the function switch to "STANDBY" and turn the RF precorrector switch[8] to "MANUAL."
- For a redundant system: Momentarily interchange the coax cables at the switch and control drawer rear panel, figure 16-0005-2, AMP FWD & AMP REF. For a non-redundant system: Switch the cables at the driver input.

AMP1 FWD, AMP1 REFL        AMP2 FWD, AMP2 REFL

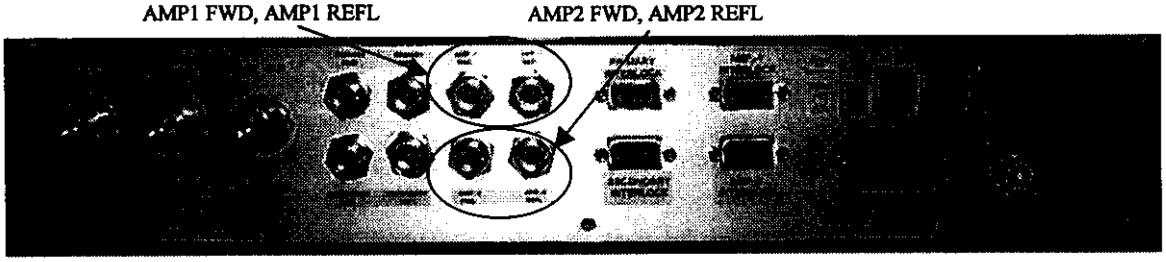


FIGURE 16-0005-2

- Rotate the function knob from "STANDBY" to "REF" to enable transmitting.
- Adjust the motherboard reflected metering potentiometer[12] so that the driver front panel meter indicates 100% reflected power. Refer document # DOC23-0042, for potentiometer locations.
- Rotate the function knob to "STANDBY."
- Return the coax cables to the original configuration.
- Turn the RF precorrector switch[8] to "AUTO."
- Rotate the function knob to "REF." The meter should indicate less than 7% residual reflected power reading into a resistive termination.

## +11V SWITCHING POWER SUPPLY METERING

- Using a digital voltmeter, measure the switching power supply output.
- Confirm that the switching power supply voltage output is +10.80 $V_{DC}$.
- Rotate the function switch to +11 VPS.
- Adjust the motherboard +11 VPS potentiometer, VR3, so that the driver front panel meter indicates 100% +11 VPS metering. Refer to figure 16-0005-3 below, for potentiometer locations.

Potentiometer locations

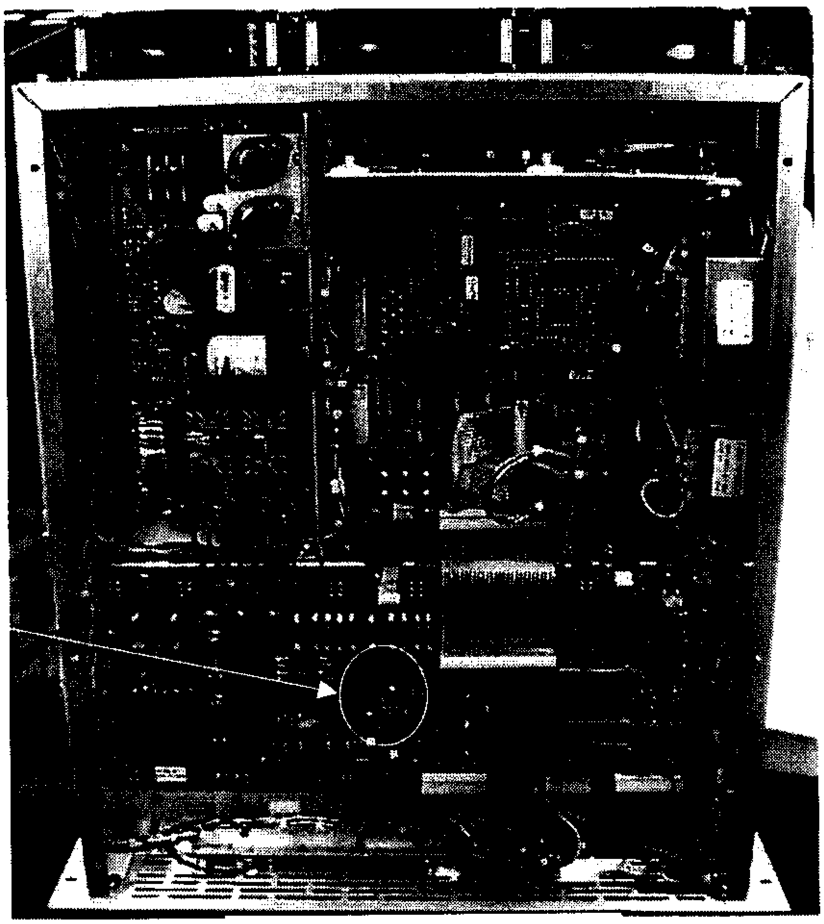
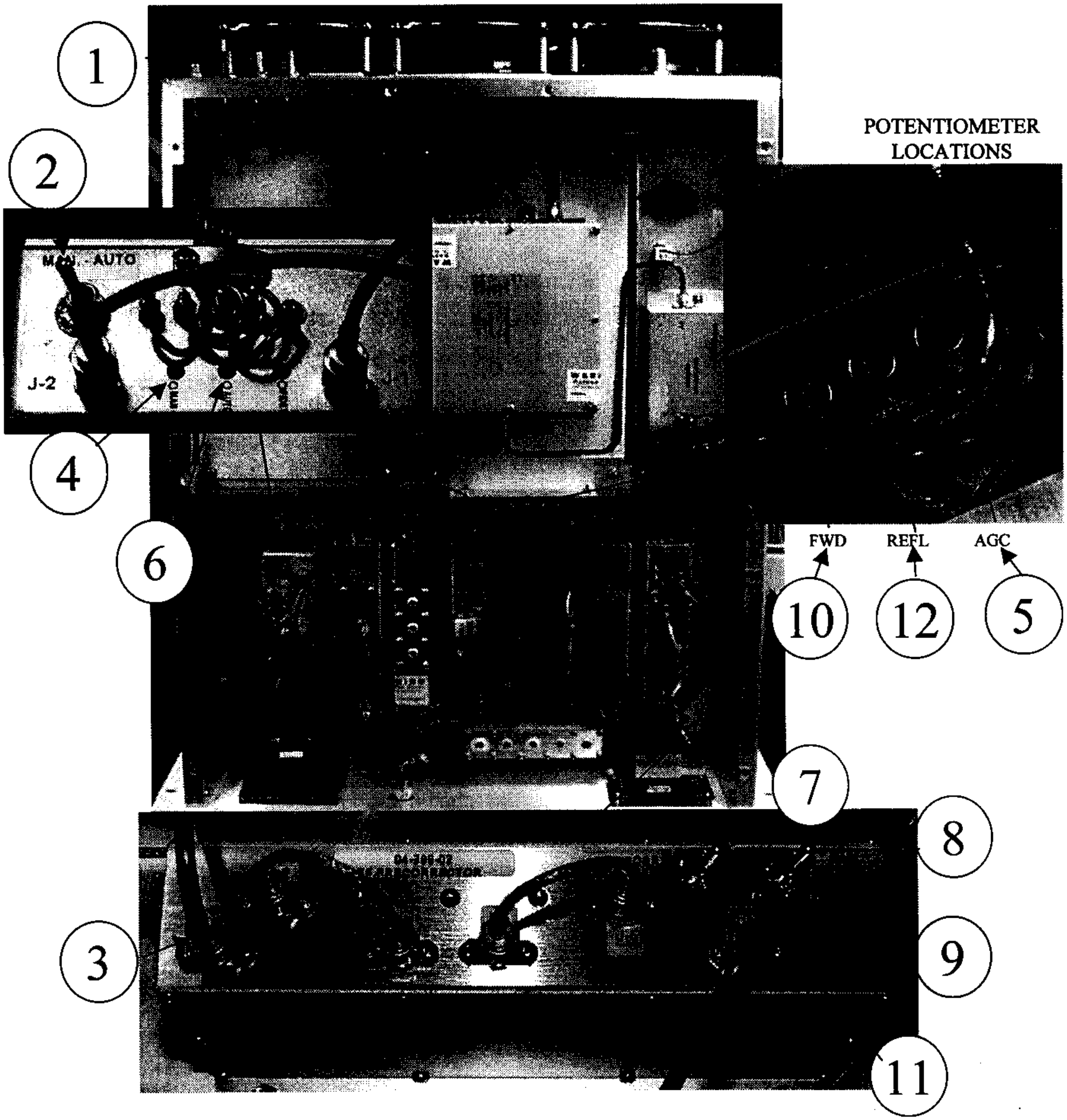


FIGURE 16-0005-3

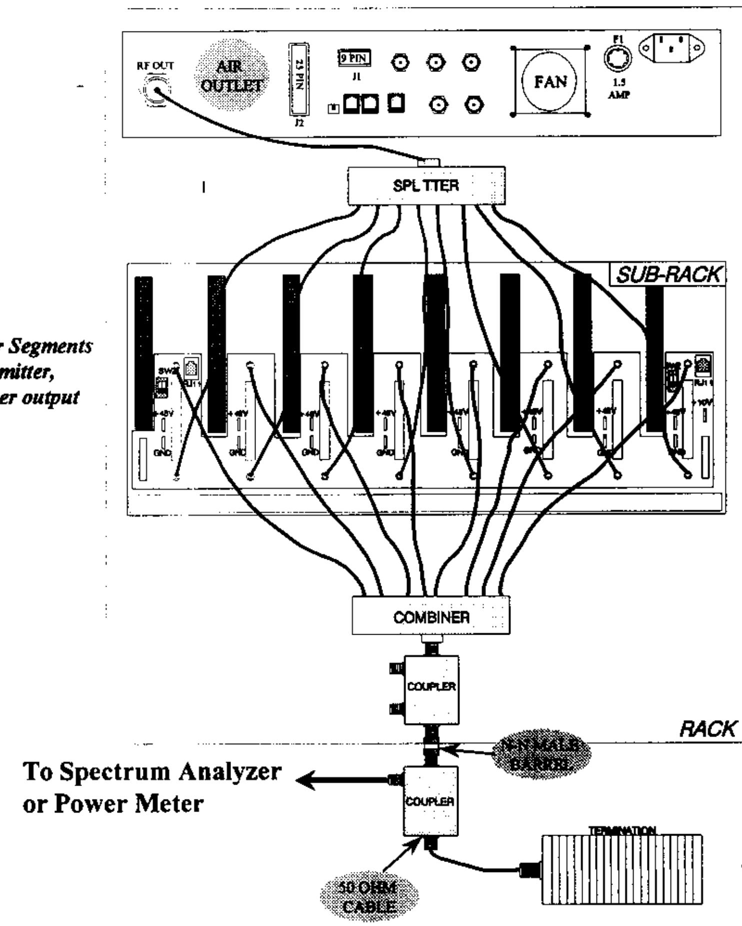
# *SBM SERIES CALIBRATIONS*




| Created by: Kimberly Simeone 9/25/98 | Checked by: Donald Wike 10/8/98 | Released by: Paulo Correa 10/12/98 |
|---|---|---|

# *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.*

| | | |
|---|---|---|
| *Created by: Kimberly Simeone 9/15/98* | *Checked by: Donald Wike 10/2/98* | *Released by: Andre Castro 10/2/98*<br>*Paulo Correa 10/12/98* |

*Document #: DOC22-0018*

*REV: A*

# SECTION 4

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

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

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

# RACK THEORY OF OPERATION

The rack is an integral part of the transmitter assembly. It supplies three-phase or phase-to-phase AC power to the transmitter, 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 high power series of transmitters/boosters and to allow for future upgrades to higher output power levels.

Three-phase or phase-to-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 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.***

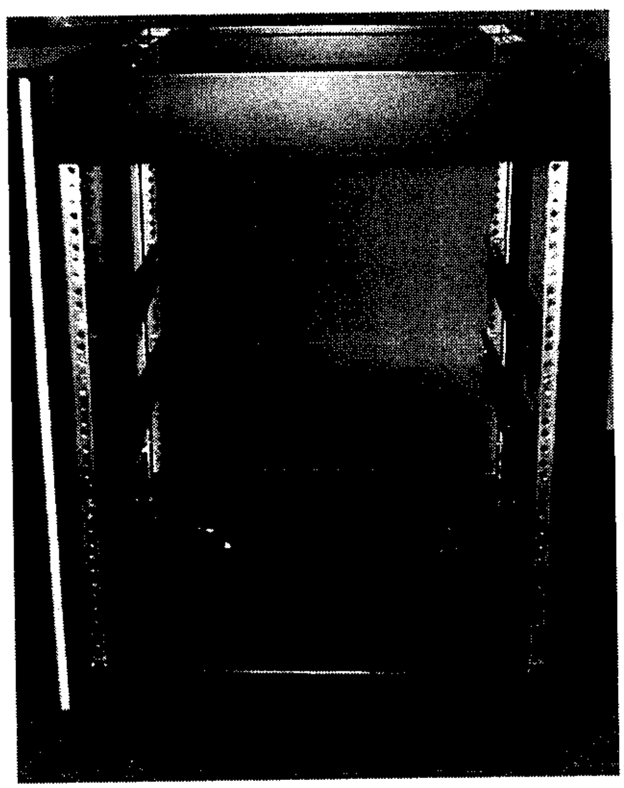
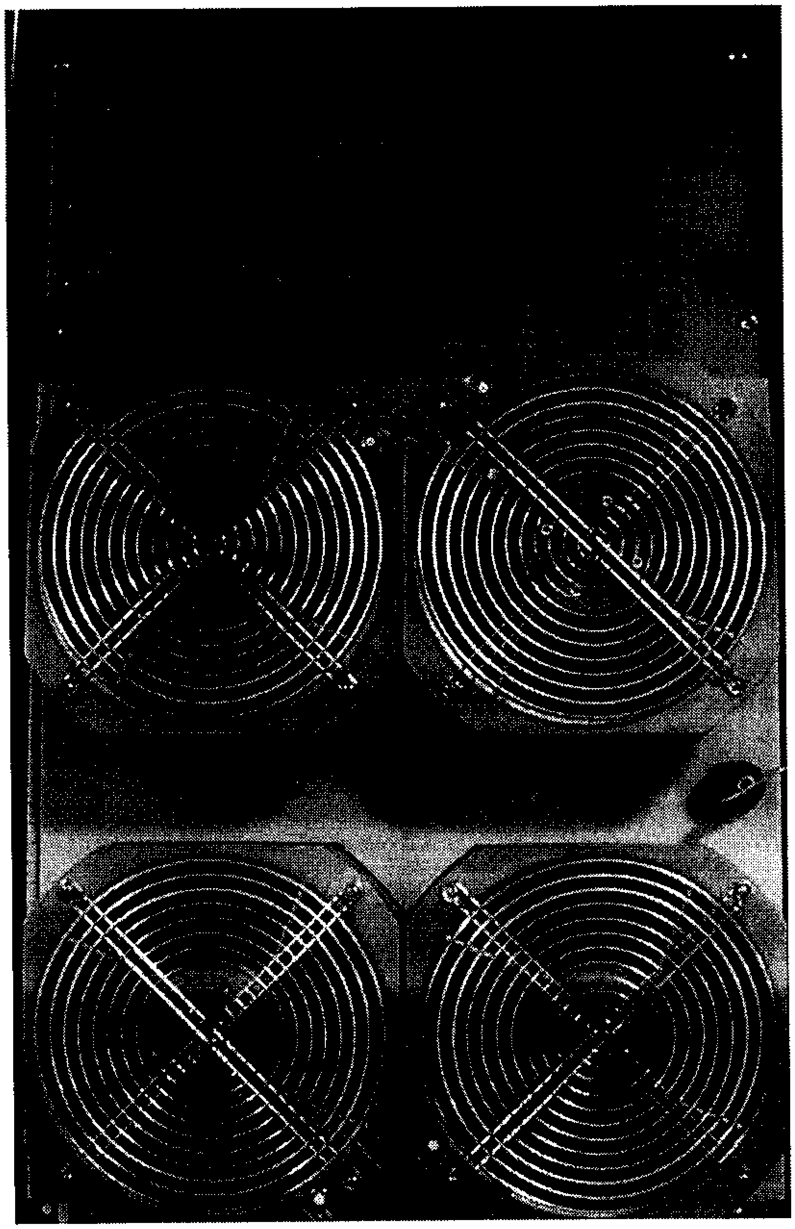


FIGURE 14-0005-1

| *Created by: Kimberly Simeone*<br>*9/16/98 ECO #: 98-116* | *Checked by: Donald Wike*<br>*10/20/98* | *Released by: Paulo Correa*<br>*10/20/98* |
|---|---|---|

# SBM/HPB SERIES REAR VIEW



| Created by: Kimberly Simeone 10/3/98 | Checked by: Donald Wike 10/20/98 | Released by: Paulo Correa 10/20/98 |
|---|---|---|

# SUB-RACK THEORY OF OPERATION

The sub-rack, figure 14-0006-1, is the unit that 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 one or more *motherboards, (35-080) guide rails, protective Lexan overlay, and miscellaneous sheet metal parts. Each segment slides into the sub-rack on nylon slides and connects to the motherboard(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 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, thumbscrews 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.

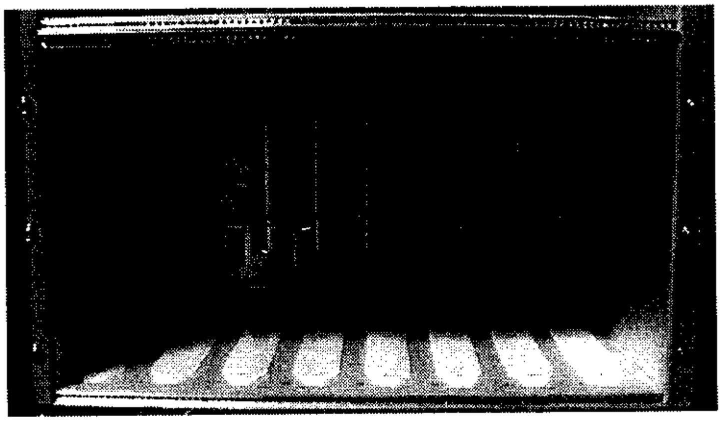


FIGURE 14-0006-1

***Note that one motherboard is needed for up to eight segments, and two motherboards are needed when more than eight segments are used.***

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.

MOTHERBOARD TO SYSTEM INTERFACE:

Power, ground, and data interface between the motherboard(s) and the system are discussed below. ***Note that numerical references to the diagram of the sub-rack rear panel are provided to make the test easier to follow.***

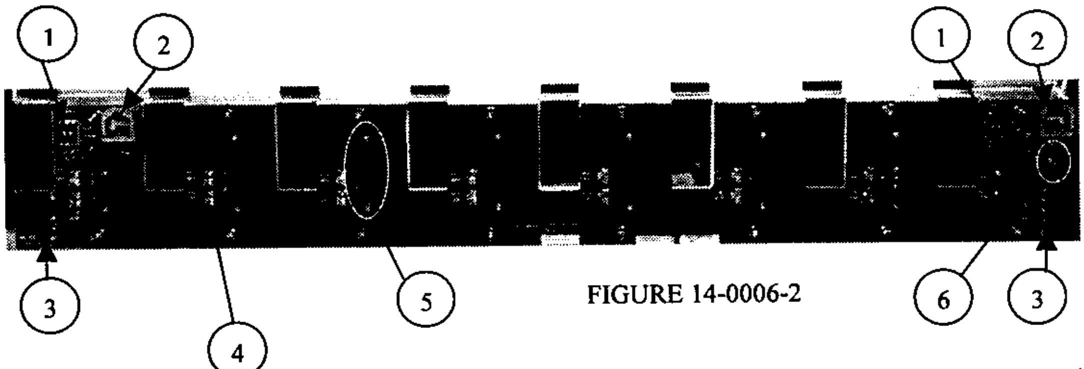



FIGURE 14-0006-2

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 motherboard(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 motherboard(s). A two position DIP switch(1) located on the motherboard(s) can be set to OPEN for communication, or CLOSED for termination.

MODULE TO MOTHERBOARD INTERFACE:

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

# VHF TO MICROWAVE DRAWER THEORY OF OPERATION (VHF/UHF BLOCK UPCONVERTER) OR (DRIVER)

The multicarrier driver receives a block of VHF/UHF signals typically at –15dBm/ carrier, which is upconverted to an S-band frequency. To prevent transmission of noise the driver will shutdown in the absence of input signal. The driver stage is capable of producing an output power of 24dBm per carrier when loaded with 31 channels. Refer to the block diagram 66-321-01 for RF signal path.

The input signal being received is sent to a variable attenuator. The attenuator regulates the signal level prior to predistortion. A high level mixer is applied to transition the signal block to microwave. The magnitude of the signal is then increased by the intermediate amplifier stages. The signal is filtered to prevent out-of-band products from being amplified and transmitted.

An RF precorrector reduces the intermodulation products, which occur at the output of the power amplifiers. Overall power regulation is provided by a second feedback loop. An external coupler provides an RF metering sample to an envelope detector for forward and reflected power measurement. The detected voltage represents the output power. The RF precorrector module uses this voltage to regulate the drive level needed by the power amplifier array

FRONT PANEL FEATURES, REFER TO DOCUMENT # DOC23-0038 FOR NUMBER REFERENCES.

1. ***METER:*** Provides a visual indication of transmitter status and performance of +11 V switching power supply, forward power, reflected power, or AGC. The meter is calibrated to display relative measurements. The seven position rotary selector switch controls meter function.

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

| | |
|---|---|
| ***RESET:*** | Transmitter in a state of interrupt. |
| ***STANDBY:*** | Disables transmitting. Power remains applied to all circuits, except the microwave amplifier modules. Meter will read approximately 0 %. |
| ***METER OFF:*** | Transmitter is enabled. Metering disabled. Meter will read approximately 0%. |
| ***+ 11 V PS:*** | Provides status of main switching power supply. |

Meter reads 100 % indicating proper switching power supply voltage.

***AGC:*** Provides status of incoming IF signal. Meter reads 100% indicating nominal signal level.

***REFL PWR:*** Relative reflected power measurement. Readings of less than 10 % are typical.

***FWD PWR:*** Relative forward output power measurement. 100 % meter reading confirms correct output power.

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

***IN SIGNAL:*** Illuminates GREEN with presence of input signal.

***INTERLOCK:*** Illuminates GREEN when interlock logic conditions are satisfied. Interlock Logic conditions are satisfied when all Microwave Amplifier Modules have -12 V gate bias.

***TRANSMIT:*** Illuminates GREEN when in transmit mode.

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

***LOCAL OSCILLATOR:*** Absence of the local oscillator reference signal. Transmitter shut down occurs.

***TEMPERATURE:*** Internal chassis temperature exceeds +140 degrees Fahrenheit (+ 60 degrees Celsius). Transmitter shut down occurs. Allow transmitter to cool. Transmitter reset can be attempted by rotating the front panel function switch to RESET.

***LO AGC:*** The local oscillator loses level. Transmitter shut down occurs.

| | |
|---|---|
| ***IPA 1:*** | Indicates a failure or an out of tolerance condition with the intermediate power module. Transmitter usually operates at reduced output power. |
| ***IPA 2:*** | Indicates a failure or an out of tolerance condition with the intermediate power module. Transmitter usually operates at reduced output power. |
| ***RF POWER:*** | Indicates a failure or an out of tolerance condition with the driver module. Transmitter usually operates at reduced output power. |
| ***POWER SUPPLY:*** | A failure in the +11 volt power supply or an out of tolerance condition. Transmitter shut down occurs. |
| ***FINAL:*** | Indicates a failure or an out of tolerance condition with the intermediate power module. Transmitter usually operates at reduced output power. |

4. ***OCS TP:*** A front panel mounted test point used to monitor the local oscillator.

REAR PANEL FEATURES, REFER TO DOCUMENT # DOC23-0039 FOR NUMBER REFERENCES.

1. ***J2:*** Female 25 pin D-Sub connector for diagnostics monitoring.
2. ***J1:*** Female 9 pin D-Sub connector for system monitoring and control.
3. ***RF OUT:*** RF output connector (Female N type).
4. ***ACCESS HOLES:*** For phone jack connectors and a termination switch from the RS 485 Board used for communication to Comview Network.

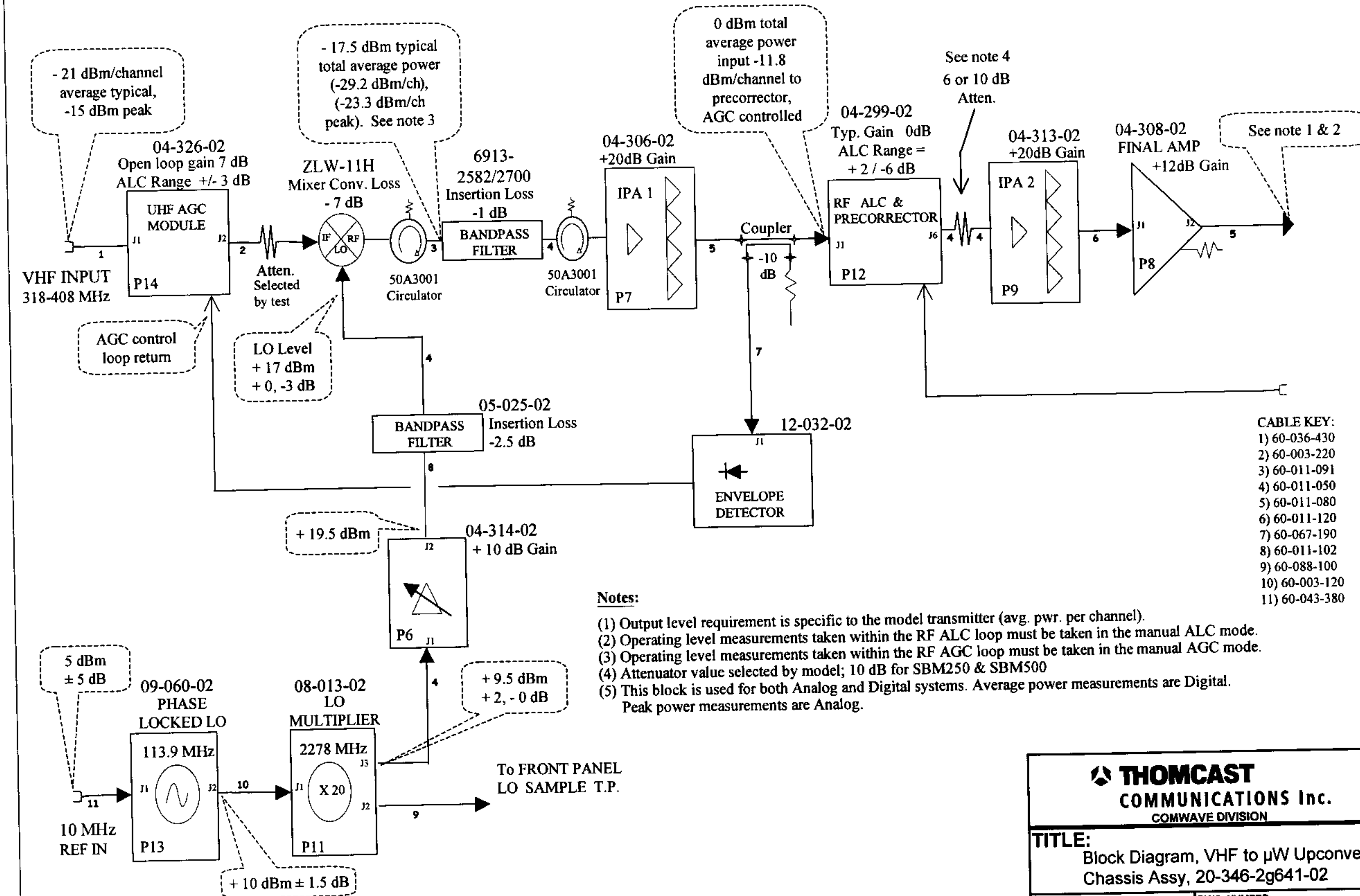
**INPUT CONNECTORS (FEMALE BNC'S):**

5. ***REFLECTED SAMPLE:*** Input from external coupler for measurement of VSWR in the system.
6. ***FORWARD SAMPLE:*** Input from external coupler for maintaining proper output power of the system.
7. ***VHF IN***: Input signal from an external system (combining network or IF to VHF upconverter)
8. ***FREQ REF:*** Input signal from an external frequency reference source.
9. ***POWER SWITCH:*** Turn power on and off.

10. ***FUSE:*** Main line fuse location (7amperes).

11. ***AC INPUT:*** AC Line input power cord connector.

12. ***FAN:*** A rear mounted DC Fan provides switching power supply cooling.




**Notes:**

(1) Output level requirement is specific to the model transmitter (avg. pwr. per channel).
(2) Operating level measurements taken within the RF ALC loop must be taken in the manual ALC mode.
(3) Operating level measurements taken within the RF AGC loop must be taken in the manual AGC mode.
(4) Attenuator value selected by model; 10 dB for SBM250 & SBM500
(5) This block is used for both Analog and Digital systems. Average power measurements are Digital. Peak power measurements are Analog.

CABLE KEY:
1) 60-036-430
2) 60-003-220
3) 60-011-091
4) 60-011-050
5) 60-011-080
6) 60-011-120
7) 60-067-190
8) 60-011-102
9) 60-088-100
10) 60-003-120
11) 60-043-380

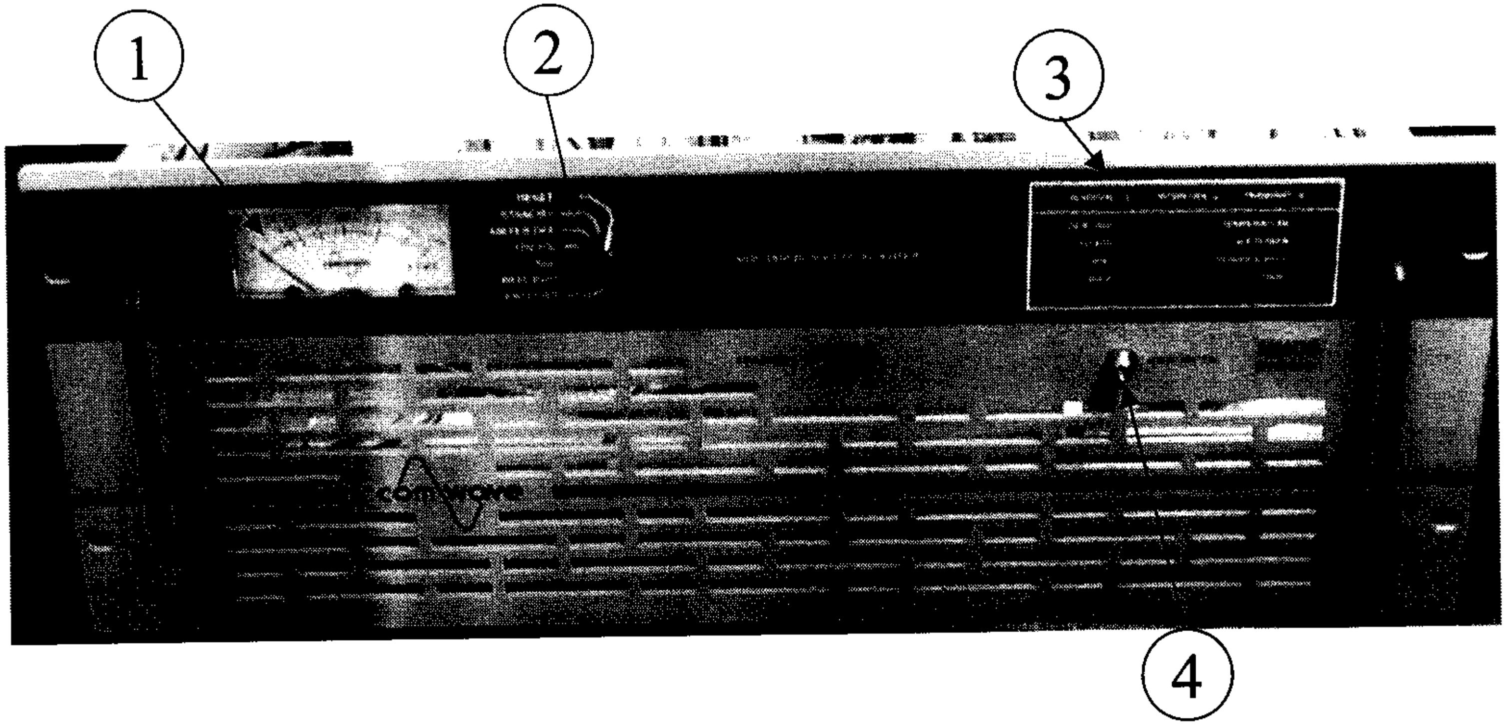
THOMCAST COMMUNICATIONS Inc.
COMWAVE DIVISION

TITLE:
Block Diagram, VHF to µW Upconverter
Chassis Assy, 20-346-2g641-02

| | | | | |
|---|---|---|---|---|
| DRAWN: D.Wike / 1/9/98 | DWG. NUMBER: DOC15-0043 | | | |
| CHECKED: J.Fisher / 3/2/99 | | | | |
| RELEASED: D.Wike / 3/9/99 | Scale: none | Sheet 1of 1 | REV: A | |

| REV | Description | ECO# NAME/DATE |
|---|---|---|

# VHF/UHF BLOCK UPCONVERTER (DRIVER) FRONT PANEL

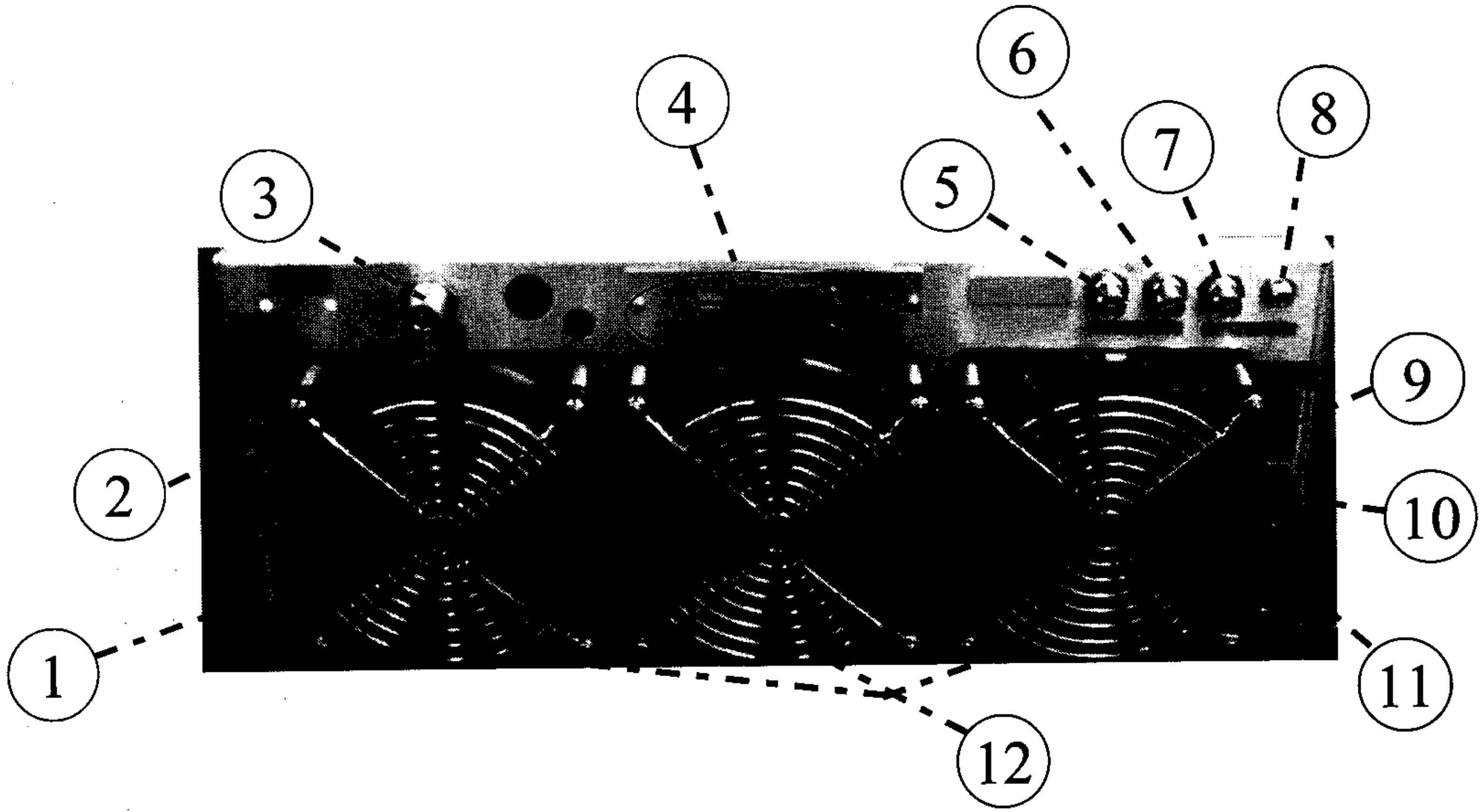



| | | |
|---|---|---|
| Created by: Kimberly Simeone 9/24/98 | Checked by: Donald Wike 10/20/98 | Released by: Paulo Correa 10/20/98 |

Document #: DOC23-0038

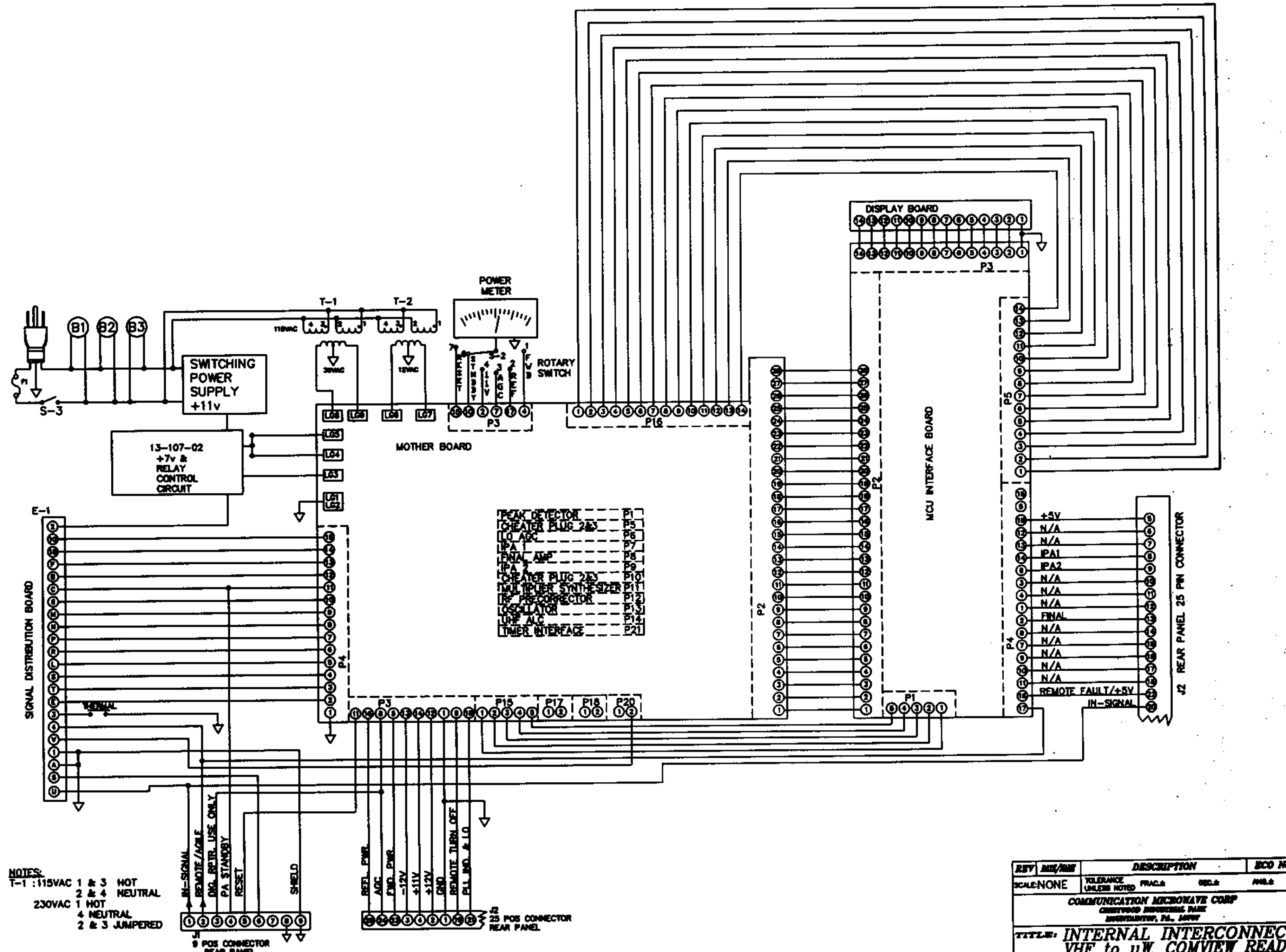
REV: A

# VHF/UHF BLOCK UPCONVERTER (DRIVER) REAR PANEL




| | | |
|---|---|---|
| Created by: Kimberly Simeone 9/24/98 | Checked by: Donald Wike 10/20/98 | Released by: Paulo Correa 10/20/98 |

Document #: DOC23-0039
REV: A




| REV | | DESCRIPTION | ECO No. |
|---|---|---|---|
| SCALE: NONE | TOLERANCE UNLESS NOTED | FRAC.± DEC.± ANG.± | |

COMMUNICATION MICROWAVE CORP

TITLE: INTERNAL INTERCONNECT VHF to uW, COMVIEW READY

03/31/96 D. WIKE

C-66-323-01

1 OF 1

09/29/98 D. WIKE

P1

REV. A

# SBM-SERIES DRIVER SPECIFICATIONS

*Reference Input: (Other CCIR systems available)*

| *Parameter* | *Specification* | *Notes/Test Conditions* |
|---|---|---|
| Frequency | 10MHz | |
| Impedance | 75 ohms | |
| Level | 10 dBm ± 3 dB or +58 dBmV ± 3 dB | |
| Connector | F | |

*VHF/UHF Input: (Other CCIR systems available)*

| *Parameter* | *Specification* | *Notes/Test Conditions* |
|---|---|---|
| Frequency Range | 222 to 408 MHz | Other frequency options available upon request |
| Impedance | 75 ohms | |
| Level | -18 dBm ± 3 dB or +30 dBmV ± 3 dB | Power measured per channel. |
| Connector | BNC | |

*MMDS Output: (Other CCIR systems available)*

| *Parameter* | *Specification* | | | *Notes/Test Conditions* |
|---|---|---|---|---|
| Frequency Range | 2.0 GHz to 2.7 GHz | | | Nominally 10% bandwidth over 2000-2700 MHz. Available bands: 2000-2200 MHz; 2200-2400; 2500-2700 MHz. Contact factory for other specialty bands. |
| Frequency Response | ≤ ±1 dB | | | |
| Impedance | 50 ohms | | | |
| C/N Carrier to Noise | ≥ -52 dBc | | | |
| Level | SBM-250 | SBM-500 | SBM-1000 | |
| 15 channels<br>31 channels | 2.5 dBm<br>-1 dBm | 5.5 dBm<br>2 dBm | 8.5 dBm<br>5 dBm | |
| Connector | N female | | | |
| Local Oscillator Front Panel Sample | + 9dBm ±2dB | | | |

| | | |
|---|---|---|
| *Created by: Kimberly Simeone*<br>*12/14/98 ECO #: 98-164* | *Checked by: Donald Wike*<br>*12/14/98* | *Released by: Andre Castro*<br>*12/21/98* |

| *Parameter* | *Specification* | *Notes/Test Conditions* |
|---|---|---|
| Phase Noise @ 10KHz offset | ≤110 dBc/Hz | |
| Conversion Accuracy | ≤±500 Hz<br>≤±3 Hz (Optional LORAN C)<br>≤±1 Hz (Optional GPS) | Frequency Stability depends upon the modulator selected. Refer to the Modulator Manual for Frequency Stability Specifications. |

***General***

| *Parameter* | *Specification* |
|---|---|
| Power Requirement | 117/230 $V_{AC}$, 50/60 Hz (<200 VA) |
| Functional Operating Temperature | 0°C to 50°C |
| Normal Operating Temperature Range | 13°C to 33°C |
| Relative Humidity | 95% non-condensing |
| Dimensions | 6.97"H x 19.00"W x 22.50"D<br>17.70 cm H x 48.30 cm W x 57.20 cm D |
| Shipping Weight[1] | 56 LB. (25.4 kg) |

*Notes:*

1. ***Shipping weight includes transmitter and shipping material.***

# LOCAL OSCILLATOR MULTIPLIER

The Local Oscillator Multiplier module receives an input signal at J1 and provides a frequency multiplied output at J2 and J3. The output frequency is 20 times the input at +7 dBm ± 2 dB.

Multiplier action is based upon the operation of step-recovery diode D1. The diode is biased to conduct during a portion of the input cycle. The depletion layer of the junction is charged during this period. When the signal changes polarity, the diode is biased off and produces a sharp pulse rich in harmonics. The bandpass filter is tuned to select the 20th harmonic.

The signal is then amplified and split to form the two outputs of the module. The LO signal is detected within the module providing a DC signal proportional to the output power for monitoring by diagnostics.

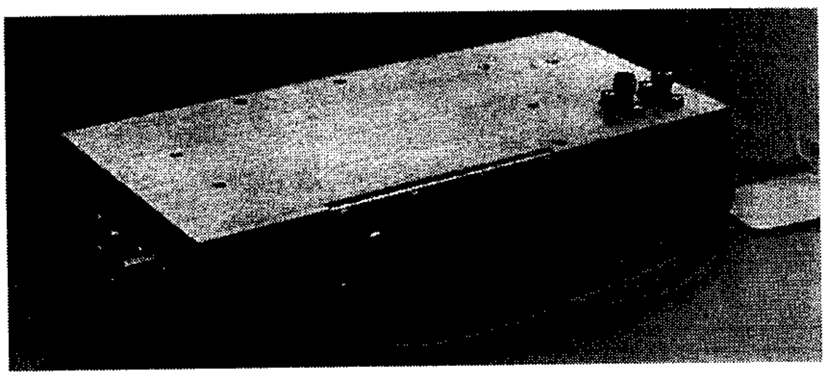


FIGURE 13-0060-1

## LOCAL OSCILLATOR MULTIPLIER SPECIFICATIONS

| *Local Oscillator Multiplier Specifications* | |
|---|---|
| Input Level | +10 ± 3 dB |
| Input Frequency Range | 95 MHz – 137.5 MHz |
| Output Level | +9 ± 3 dB |
| Output Frequency Range | 1.9 GHz + 2.75 GHz |
| Power Level Detectors (@ 10K Ω load) | .4 VDC @ + 6 dBm output level |
| Input/Output Impedance | 50 Ω |
| VCC | 12 VDC @ 450 mA |

***DOCUMENT #: DOC19-0030***
***REV: A***

# VCXO PLL

The Voltage Controlled Crystal Oscillator (VCXO) Phase Locked Loop and Local Oscillator Multiplier modules determine the microwave upconverter mixer input frequency. The initial frequency is determined by a VCXO crystal. Crystal frequency is dependent upon the desired transmitter output frequency. Crystal frequency stability is a function of the applied 10 MHZ input reference (J1). The VCXO output level at J3 is +7 dBm ± 2 dB. This signal is applied to the Local Oscillator Multiplier (J1) which multiplies it by a factor of 20.

The VCXO PLL board generates a DC control voltage proportional to the offset to return the oscillator to the selected frequency. The VCXO circuit uses dividers that are programmed by miniature board mounted switches to achieve the 12.5 KHz frequency reference. This signal is then applied to one input of a Phase Detector. The other input to the Phase Detector is derived through a sample of the VCXO frequency. A second dual prescaler divides the frequency again to achieve the desired 12.5 KHz. Should the VCXO deviate in frequency, this change is seen at the Phase Detector input and an error correction voltage is generated to pull the VCXO back to the desired frequency. The step size of the module is 12.5 KHz, which results in a step size of 250 KHz once multiplied to the microwave LO.

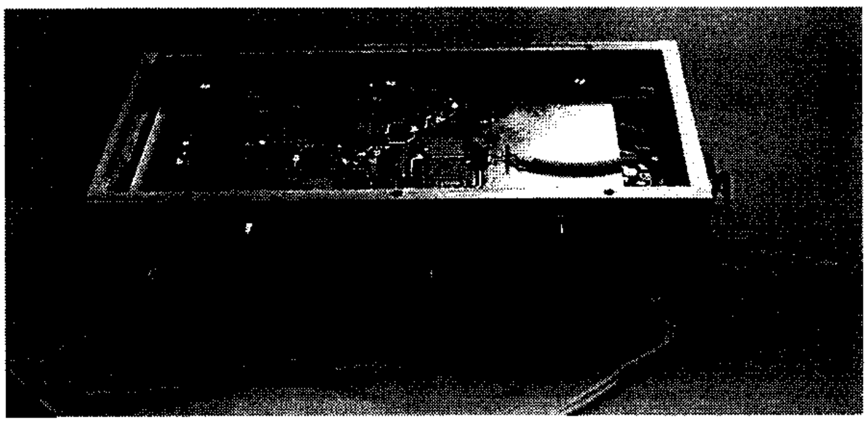


FIGURE 13-0059-1

## VCXO PLL SPECIFICATIONS

| *VCXO PLL Specifications* | |
|---|---|
| Frequency Reference Input | 10 MHz |
| Frequency Reference Level | +5 dB ± 5 dB |
| Reference Input Impedance | 75 Ω |
| Output Level | +10 dB ± 3 dB |
| Output Frequency Range | 95 MHz – 137.5 MHz |
| Output Impedance | 50 Ω |
| Ø Lock Alarm TP1 | Logic high indicates Ø Lock |
| Voltage Control TP2 | Nominal 5.5 VDC |
| VCC | +12 VDC @ 300 mA |

***DOCUMENT #: DOC19-0031***
***REV: A***

# BANDPASS FILTER

This filter consists of a four-section bandpass filter with variable input and output loading probes. It is used to remove undesired signals following theLO. 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 not used in this application.

Notch Filter

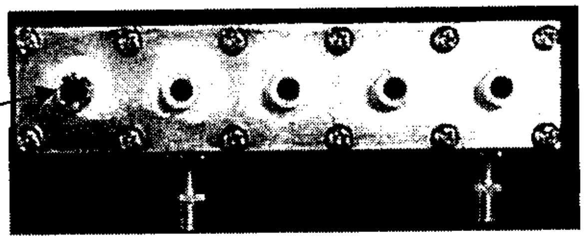


FIGURE 13-0051-1

## BANDPASS FILTER SPECIFICATIONS

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

*DOCUMENT #: DOC19-0022*
*REV: A*

# AMPLIFIER WITH ALC

The ALC modules for the local oscillator are broadband output level controlled modules with a dynamic range of P1dB=+21dBm based on MMIC technology devices. These blocks have a gain range from 5 to 14dB and are fed by a +12V power supply at .4A maximum current. Access for the RF signal is made by means of J1 and J2 respectively input and output. Distinct controls are available for both manual and automatic modes, which can be set by means of an external switch.

## AMPLIFIER WITH ALC SPECIFICATIONS
## (04-305, 04-314)

### RF SPECIFICATIONS
### (04-308-02/04-314-02)

| Parameter | Typical | Limit | Notes/Test Conditions |
|---|---|---|---|
| $S_{11}$ (dB) | -15 | -12maximum | 2.0 GHz to 2.7 GHz |
| $S_{21}$ (dB) | 5 to 14 | - | 2.0 GHz to 2.7 GHz |
| Total Flatness (dB) | 0.5 | 1 maximum | 2.0 GHz to 2.7 GHz |

### DC SPECIFICATIONS
### (04-305-02/04-314-02)

| Parameter | Specifications | Notes/Test Conditions |
|---|---|---|
| Total current (mA) | 400 maximum | |
| Power Supply Voltage (V) | 12 | |

*Document #: DOC19-0028*
*REV: A*

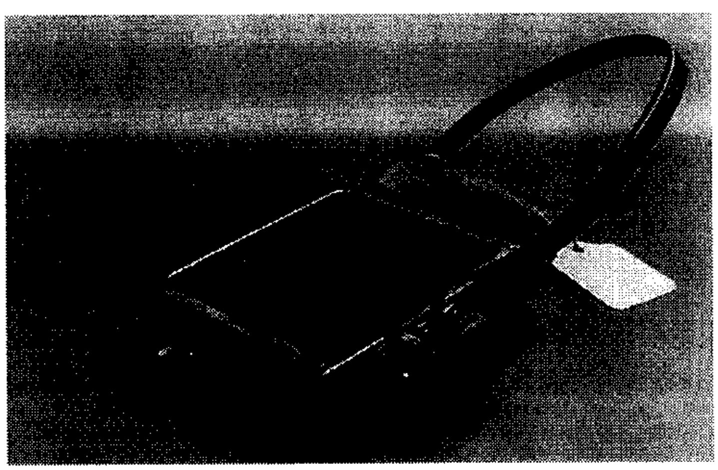


FIGURE 13-0057-1

| Created by: Andre Castro 9/1/98 | Checked by: Donald Wike 10/20/98 | Released by: Paulo Correa 10/20/98 |
|---|---|---|

# VHF/UHF ALC MODULE

The VHF/UHF ALC module performs two functions in the system, automatic level control and detection of the incoming signal. It accepts a range of frequency from 60MHz to 422MHz. Once internal the VHF/UHF signal is split two ways, one path leads to a signal detector, the other is the main path which forms the ALC section of the module. The ALC can be set to capture and maintain a signal ±4dB of the nominal input. User adjustments for calibrations of AUTO level control as well as MANUAL control is accessible from the module exterior other meter calibrations are adjustable within the chassis. A selector switch dictates the mode of operation. The control loop for ALC extends beyond the module. A sample of RF signal level is sampled at the transmitter's mid section. This sample is converted to a DC voltage in a detector circuit (which should not be confused with the level detector on board) and feedback to the ALC section of this module is via pin 5 of the harness. Once calibrated the module will provide for approximately 8dB of gain from input to output.

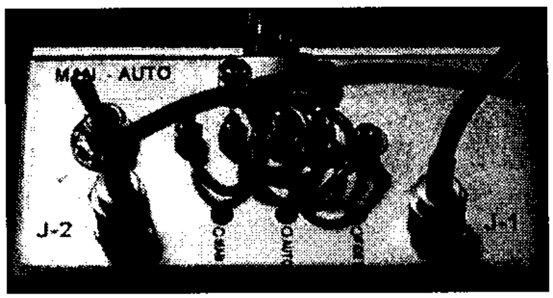



FIGURE 13-0066-1

The on board detector is a feature which enables external diagnostic monitors to view the incoming signal level. This level is compared to a threshold set via an adjustment on the front side of the module. If the level is to low the module indicates this condition by changing it's output from a TTL logic level high to a logic level low. This DC indication exits the module through the harness on pin 6.

## VHF/UHF ALC MODULE SPECIFICATIONS

| *VHF/UFH ALC Module Specifications* | |
|---|---|
| Input Frequency Range | 60 – 422 MHz |
| Input Attenuation Range | 15dB |
| Nominal Gain | 8 dB |
| ALC Capture Range | ±4 dB |
| Input Level Detection | Signal presence is indicated by TTL logic high |
| Input/Output Impedance | 75 Ω |

***DOCUMENT #: DOC19-0032***
***REV: A***

| | | |
|---|---|---|
| ***Created by: Donald Wike*** ***10/9/98*** | ***Checked by: Donald Wike*** ***10/23/98*** | ***Released by: Paulo Correa*** ***10/23/98*** |

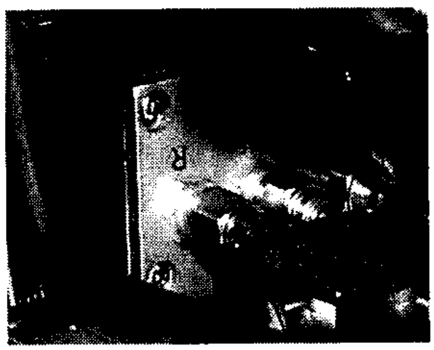
# MIXER

This module consists of a balanced mixer being driven from the LO injection input via the SMA connector labeled "L" on the module top cover and an IF input via an SMA connector labeled "I". The heterodyned product exits the module through the port labeled "R".

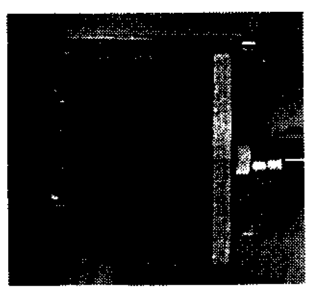
## SPECIFICATIONS

| FREQUENCY MHz | | CONVERSION LOSS dB | | | | LO-RF ISOLATION, dB | | | | | | LO-IF ISOLATION, db | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LO/RF | IF | MID-BAND | | | TOTAL RANGE | L | | M | | U | | L | | M | | U | |
| $f_L$ - $f_U$ | | | | | | | | | | | | | | | | | |
| 10-3000 | 10-1000 | 6.83 | .09 | 10 | 12 | 27 | 20 | 25 | 18 | 23 | 16 | 27 | 20 | 25 | 18 | 23 | 16 |

FIGURE 13-0065-1



FRONT VIEW



SIDE VIEW

FIGURE 13-0065-2

| Created by: Kimberly Simeone 10/9/98 | Checked by: Donald Wike 10/20/98 | Released by: Paulo Correa 10/20/98 |
|---|---|---|

# BANDPASS FILTER

This filter consists of a multi-section bandpass filter with fixed 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.

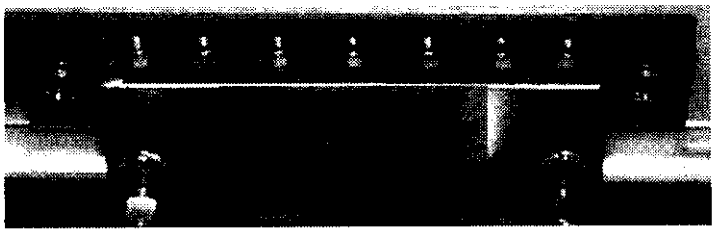


FIGURE 13-0050-1

## BANDPASS FILTER SPECIFICATIONS

| *Specification**** | |
|---|---|
| Bandwidth (1 dB) | 200 MHz/118 MHz |
| Insertion Loss | 1 dB ± 0.5 dB |
| Tuning Range:<br>MMDS/ITFS | 2.5 – 2.7 GHz/2.582 – 2.7 GHz |

*DOCUMENT #: DOC19-0021*
*REV: A*

****NOTE: Other frequencies are available.*

| | | |
|---|---|---|
| *Created by: Kimberly Simeone 9/24/98* | *Checked by: Donald Wike 10/20/98* | *Released by: Paulo Correa 10/20/98* |

# INTERMEDIATE POWER AMPLIFIER

The intermediate power amplifier modules are amplifiers with a low noise figure (5dB) high dynamic range (P1dB=+28dBm) based on MMIC technology devices. With an internal configuration of one device driving four, these blocks have a typical gain of 20dB and are fed by a +7V power supply at .75A. Access for the RF signals is made by means of J1 and J2 respectively input and output.

## INTERMEDIATE POWER AMPLIFIER SPECIFICATIONS
**(04-306-02 & 04-313-02)**

### RF SPECIFICATIONS

| *Parameter* | *Typical* | *Limit* | *Notes/Test Conditions* |
|---|---|---|---|
| $S_{21}$ (dB) | 20 | 19.5 minimum | 2.00 GHz to 2.75 GHz |
| $S_{11}$ (dB) | 6dB | 5dB minimum | 2.00 GHz to 2.75 GHz |
| Total Flatness (dB) | 0.5 | 0.75 | 2.00 GHz to 2.75 GHz |

### DC SPECIFICATIONS

| *Parameter* | *Specifications* | *Notes/Test Conditions* |
|---|---|---|
| Power supply (V) | 7 ± 0.5 | |
| DC Current (A) | 0.76 maximum | |

*DOCUMENT #: DOC19-0023*
*REV: A*

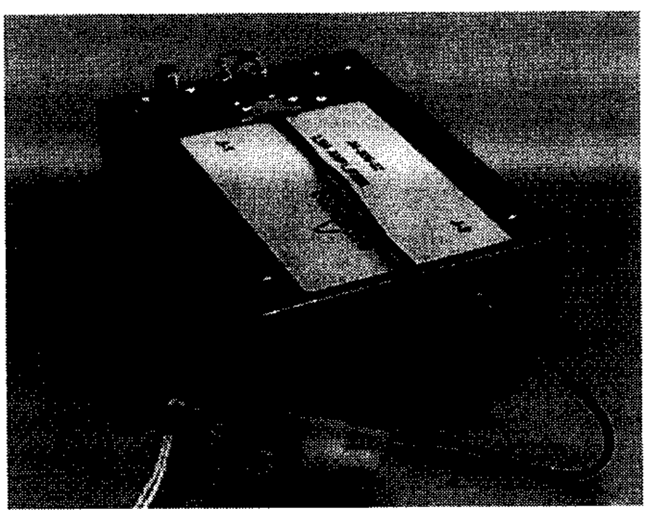


FIGURE 13-0052-1

| *Created by: Andre Castro 9/1/98* | *Checked by: Donald Wike 10/20/98* | *Released by: Paulo Correa 10/20/98* |
|---|---|---|

# ENVELOPE DETECTOR

The envelope detector is a single input module that receives a forward power sample from a -10 dB coupler connected between IPA1 and RF precorrector. The forward sample is applied to SMA J1. The circuit detects the RF sample converting it into representative DC voltage. This voltage is sent to the motherboard for peak detection and/ or feedback control for the front end ALC system.

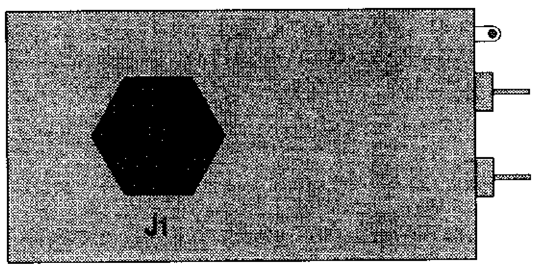



FIGURE 13-0023-1

# BROADBAND PRECORRECTOR

The precorrector module contains correction circuitry and an automatic level control. Linearity correction circuitry precorrects mainly for third order products developed in the solid state power amplifier. The ALC maintains 100% output power over a ±2dB input variation. An RF frequency range based processor improves its overall performance over the IF type because it avoids the bandwidth limitations imposed by the band/channel filter.

Correction made is applied to J1, by means of subtraction of a pre-generated distortion from the one present at the output of the system. A RF input signal about 0dBm. This signal is amplified and split in two ways. One goes through a linear path while the other goes through the circuitry that generates the desired distortion. Both signals are combined and amplified to recover the losses of their processing. Finally, the resulting signal goes through the broadband attenuator that performs the ALC.

The module has two switches, one for turning on/off the pre-correction (1) and the second one to set the system into ALC or Manual mode (2). Five internal controls are accessible from exterior of the module. First is the control (3) for pre-distortion signal amplitude, second (4) is for module internal adjustment, third (5) is for superposing pre-distortion and output distortion signals, fourth (6) is to adjust output power in ALC mode and the fifth control (7) is to adjust output power in Manual mode. The 12V power-supply, the detected voltage, proportional to the output power, and a sample of the ALC voltage transit in/out the module through connector P1 (8).

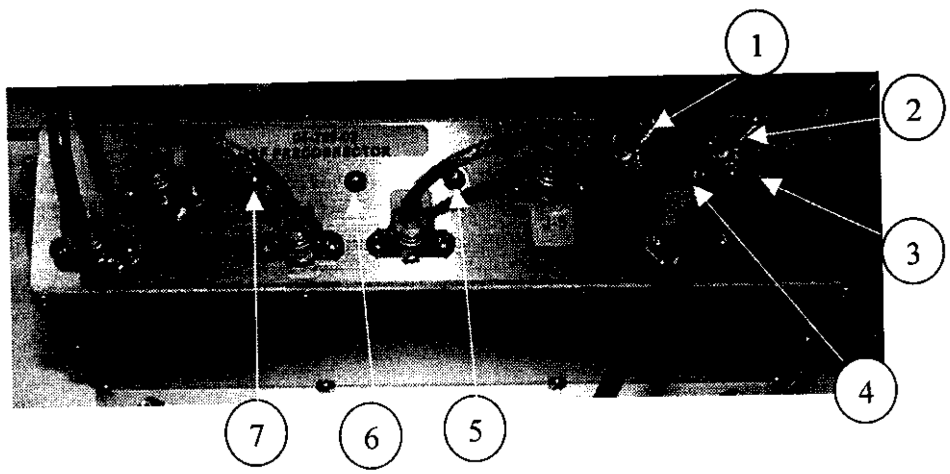



FIGURE 13-0062-1

FOR AGILE SYSTEMS ONLY:
This option is only available for agile transmitters and requires changes in the configuration of the jumpers (9) inside the module. The first four controls mentioned in the above paragraph can be set externally with the help of a personal computer, the pre-distortion calibration software and the 34-015 board. In that case, up to 31 different sets

of pre-correction can be set and stored into the 34-015 board. All voltages that control pre-correction externally reach the module through connector P2 (10). Refer to figures 13-0062-1 and figure 13-0062-2 for numerical references.

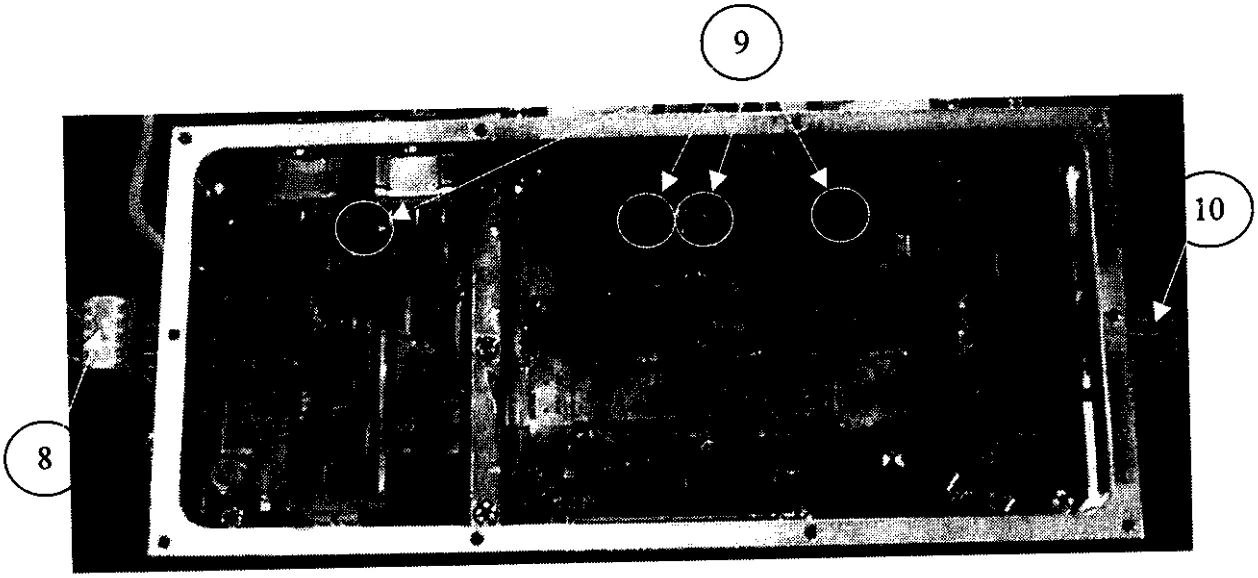



FIGURE 13-0062-2

## RF SPECIFICATIONS (04-299-02)

| *Parameter* | *Typical* | *Notes/Test Conditions* |
|---|---|---|
| | | |
| $S_{21}$ (dB) | 3 | 2.0GHz TO 2.8GHz |
| $S_{11}$ (dB) | 7dB | 2.0GHz TO 2.8GHz |
| $S_{21}$ Range (dB) | $-3<S_{21}<7$ | 2.0GHz TO 2.8GHz |
| Total Flatness (dB) | ±1 | 2.0GHz TO 2.8GHz |

## DC SPECIFICATIONS (04-299-02)

| *Parameter* | *Specifications* | *Notes/Test Conditions* |
|---|---|---|
| Power Supply (V) | 12 ± 0.5 | - |
| DC Current (A) | .700 | S21 = 2dB; Maximum pre-distortion |

*Document #: DOC19-0026*
*REV: A*

# INTERMEDIATE POWER AMPLIFIER

The intermediate power amplifier module is a broadband amplifier with high dynamic range (P1dB=+22dBm) based on GaAs technology devices. With an internal configuration of two devices in parallel, this block has a typical gain of 10dB and is fed by a +10.5V power supply at 1.44A. Access for the RF signals is made by means of J1 and J2 respectively input and output, while J3 is an output for RF sample 10dB below.

## INTERMEDIATE POWER AMPLIFIER SPECIFICATIONS
**(04-308-02)**

### RF SPECIFICATIONS

| *Parameter* | *Typical* | *Limit* | *Notes/Test Conditions* |
|---|---|---|---|
| $S_{11}$ (dB) | -17 | -15 maximum | 2.0 GHz to 2.7 GHz |
| $S_{21}$ (dB) | 10 | 9.5 minimum | 2.0 GHz to 2.7 GHz |
| Total Flatness (dB) | 0.3 | 0.5 | 2.0 GHz to 2.7 GHz |

### DC SPECIFICATIONS

| *Parameter* | *Specifications* | *Notes/Test Conditions* |
|---|---|---|
| $ID_1$, $ID_2$ (mA) | 1440 | |
| $VD_1$, $VD_2$ (V) | 10.5 | |

*DOCUMENT #: DOC19-0024*
*REV: A*

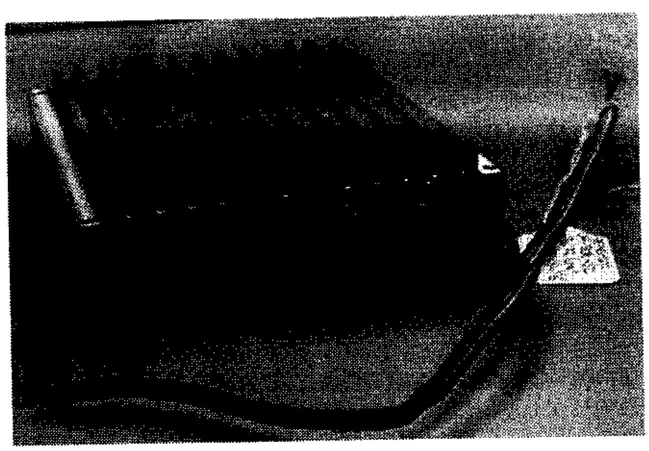


FIGURE 13-0053-1

| | | |
|---|---|---|
| *Created by: Andre Castro 9/1/98* | *Checked by: Donald Wike 10/20/98* | *Released by: Paulo Correa 10/20/98* |

# MOTHERBOARD

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

Jumper configurations: The motherboard is factory set with all jumpers positioned in accordance to the system architecture. Changing these jumpers is only necessary if upgrading to/from digital transmission. In the case of Common Amplification, configure as a digital transmitter. The following will help in choosing the proper settings.

***Note: If a two position jumper is to be opened, attach the plastic jumper cap to one of the pins so you will not lose it.***

- Jumper JK1: (3-pin jumper) Allows for operation with an Aural Final amplifier in analog applications providing the signal path for the power detector, and in the case of digital completes the logic path for the IF Detector module.

| Setting | Description |
|---|---|
| 1 & 2 | Aural Final |
| 2 & 3 | IF Detector |

- Jumper JK2: (3-pin jumper) This jumper provides +11 volt power to the aural driver module, or +12 volt power to the IF Equalizer for use in a digital transmitter.

| Setting | Description |
|---|---|
| 1 & 2 | Aural Driver |
| 2 & 3 | Dig, IF. EQ. |

- Jumper JK3: (2-pin jumper) Remains shorted in analog and digital applications. However, in a digital repeater system removing the jumper allows for the AGC voltage of the receiver to be monitored.

| Settings | Description |
|---|---|
| shorted | Analog & Digital TX. |
| Open | Digital Repeater |

- Jumper JK4: (3-pin jumper) This high current jumper provides +11 volt power to the Aural final in analog applications and +12 volt power to the IF Detector module in digital operation.

| Settings | Description |
|---|---|
| 1 & 2 | Aur. Final Pwr. |
| 2 & 3 | IF Det. Pwr. |

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

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

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

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

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

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

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

Envelope Detector: Integrated onto the motherboard, the envelope detector is responsible for stripping off the carrier signal. Serving as an average detector, it receives samples of both forward and reflected RF power; then, it converts this energy to a proportional DC voltage composed of a DC level and an AC component.

<u>+11 Volt Power Supply Fusing:</u> The motherboard contains three fuses that protect the switching power supply. F1 (15 Amperes) provides power to the driver and prefinal. F2 (25 Amperes) provides power to final amplifier B and F3 (25 Amperes) to final amplifier A.

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

# MICROCONTROLLER INTERFACE BOARD

The optional Microcontroller interface board is a second generation diagnostic and control interface function. It, along with the GCB-11, provides full diagnostics and control, along with network communications capabilities required to support the ComView monitoring system.

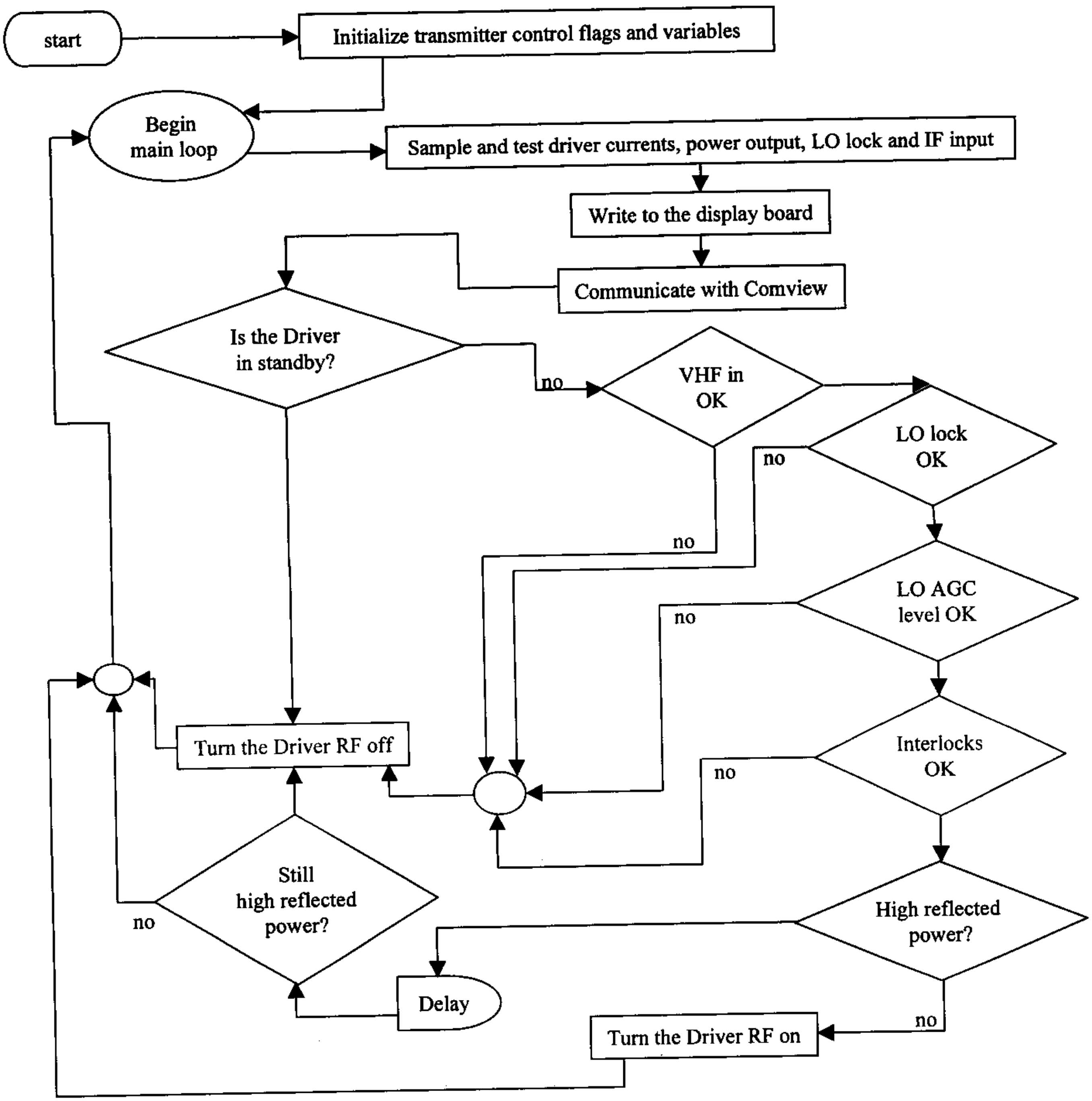
The Microcontroller Interface Board controls the front panel LED or LCD display, MUX addressing, and interlock, transmit functions through octal latches. The MCU receives various input signals, scales these inputs, and forwards them over a multiplex buss to the Microcontroller unit (MCU, GCB11) for processing. The scaling amplifiers receive current converted voltage samples from amplifier modules, amplifying them by appropriate factors for common working levels. Scaled outputs are sent to 16 channel analog multiplexers. The multiplexers receive addressing information from the Microcontroller through a hex level translator. The multiplexed output is further scaled (reduced by a voltage divider network and is sent to the Microcontroller for processing).

The following chart cross references the signal, scaling amp, and multiplex output.

| *INPUT SIGNAL* | *SCALING AMP* | *MULTIPLEX OUTPUT* |
|---|---|---|
| Final A (Q2, 6, 7) | U1D | MUXBUS1 11 |
| Final A (Q1, 3, 4, 5) | U2A | MUXBUS1 12 |
| Final B (Q2, 6, 7) | U3A | MUXBUS1 14 |
| Final B (Q1, 3, 4, 5) | U3C | MUXBUS1 13 |
| Driver #1 (Q2, 3) | U2C | MUXBUS1 08 |
| Driver #2 (Q4, 5) | U2D | MUXBUS1 07 |
| Mixer (Q1) | U2B | MUXBUS1 09 |
| PreFinal (Q2) | U3D | MUXBUS2 03 |
| LO Locked | U1A | MUXBUS1 05 |
| ALC IN | U1B | MUXBUS1 10 |
| +12 $V_{DC}$ | U1C | MUXBUS2 04 |
| -12 $V_{DC}$ | U3B | MUXBUS2 08 |
| +11 $V_{DC}$ | U4B | MUXBUS2 02 |
| Thermal | U5D | MUXBUS2 01 |
| IN SIGNAL | U5C | MUXBUS2 00 |
| PS INTERLOCK | U17A | MUXBUS1 06 |
| Gate 1 | U17B | MUXBUS2 09 |
| Gate 2 | U17C | MUXBUS2 10 |
| Gate 3 | U17D | MUXBUS2 11 |
| Gate 4 | U18A | MUXBUS2 12 |
| Gate 5 | U18B | MUXBUS2 13 |
| Forward Power | U18C | MUXBUS2 07 |
| N/A | U18D | MUXBUS2 06 |
| REFL Power | U19A | MUXBUS2 05 |

| | | |
|---|---|---|
| *Created by: Kimberly Simeone 9/30/98* | *Checked by: Donald Wike 10/20/98* | *Released by: Paulo Correa 10/20/98* |

# *FIRMWARE FLOWCHART*
# *VHF/UHF TO uW UPCONVERTER*




| *Created by: Kimberly Simeone 10/26/98* | *Checked by: Chris Smith 10/26/98* | *Released by: Carl P. Ungvarsky 10/26/98* |
|---|---|---|

# CHASSIS MONITORING AND CONTROL FUNCTIONS

The microcontroller (MCU) board and its operating program (firmware) handle internal monitoring and control functions in the chassis. The microcontroller board firmware begins execution after a RESET or power-up. The firmware instructs the MCU board hardware to collect samples of various chassis parameters, such as voltages and currents. Refer to the document following this for a table with a list of the parameters monitored in this chassis. The firmware determines the pass/fail status of each parameter by testing the sample values against fixed limits. The results of these tests are used to update the chassis front panel LED diagnostics.

The firmware uses the pass/fail state of some critical parameters to determine the control state of the chassis. For example, failure of one of these critical parameters may cause the chassis to disable RF power output. See the above-mentioned table for a description on the control action caused by failures of these parameters.

The chassis may be interfaced to a ComView master control station (MCS), allowing centralized monitoring and control; see document # DOC30-0005 in section 4 of this manual, for interconnections. The chassis and its internal MCU board are interfaced to the ComView RS485 network through the RS485 board at the rear panel and chassis internal harnesses; see document # DOC13-0009 in section 4 of this manual, for more information on the RS485 board. Messages sent by ComView are received by the MCU board and firmware and are processed by the firmware. The firmware responds to a ComView *Status Query* message by sending the current values of the parameters, listed in the above-mentioned table, over the network interface to ComView. The parameter names, current values, and other relevant information are displayed on ComView's *Detailed Status* screen.

ComView control commands are received and processed by the firmware, and the appropriate control action is taken by the firmware and MCU board. For example, if ComView sends the *STANDBY* command to the chassis, the firmware will instruct the MCU board to change the control state of the chassis to *STANDBY*. This will cause the RF power output to be disabled. Furthermore, a change in the chassis control state is indicated in the status information provided to ComView. ComView displays the current control state and the time that the last change in state occurred. For example, if the user sets the front panel control switch to the *STANDBY* position, the chassis will go to the *STANDBY* control state, and ComView will indicate that the chassis is in *STANDBY* and is generating no RF power.

For a more detailed discussion of ComView system functions and features, refer to the <u>*ComView User's Guide*</u>, document # 97-01030, which can be obtained from Comwave.

# LIST AND DESCRIPTION OF PARAMETERS MONITORED IN VHF/UHF TO MICROWAVE UPCONVERTER CHASSIS

| *Parameter Name* | *Test Type* | *Description* | *Priority (high: FAIL causes SHDN)* | *Latching in MCU (Cleared by STBY or RESET)* | *Latches the Fault Alarm Relay* |
|---|---|---|---|---|---|
| Transmit Status | PASS (in TRANSMIT state) if value is logic 1 | Indicates the current state of the chassis. A zero indicates that this chassis is not outputting RF power, either because the chassis is in STANDBY or there are failures. | | | |
| Standby Switch Status | ON AIR if above low limit STANDBY if below low limit | Indicates control state from Front panel standby switch. A zero value indicates a shutdown command from this source. When chassis is in STANDBY, no RF power is output. | | | |
| Reflected Fault (shdn) | PASS (no refl fault) if value is logic 1 | Failure of this logic parameter indicates high reflected power in this chassis. Failure causes shutdown of this chassis (see Reflected Power). This parameter is latching and may be cleared by cycling the equipment in and out of STANDBY or RESET. | High priority | Yes | Yes |
| VHF Detect | PASS if above low limit | Failure indicates loss of VHF input, resulting in shutdown of this chassis. | High priority | | |
| LO Lock | PASS if above low limit | Failure indicates loss of LO phase lock, resulting in shutdown of this chassis. | High priority | | |
| LO AGC | PASS if above low limit | Failure indicates that the LO signal is outside of its AGC range (level too low), resulting in shutdown of this chassis. | High priority | | |
| AGC Signal | PASS if value is between low limit and high limit | Measurement of the VHF AGC level. Reading outside of limits will not result in shutdown of this chassis. | Medium priority | | |
| ALC Signal | PASS if value is between low limit and high limit | Measurement of the RF output ALC level. Reading outside of limits will not result in shutdown of this chassis. | Medium priority | | Yes |

| | | |
|---|---|---|
| *Created by: Kimberly Simeone 10/23/98* | *Checked by: Chris Smith 10/23/98* | *Released by: Carl P. Ungvarsky 10/23/98* |

| ***Parameter Name*** | ***Test Type*** | ***Description*** | ***Priority (high: FAIL causes SHDN)*** | ***Latching in MCU (Cleared by STBY or RESET)*** | ***Latches the Fault Alarm Relay*** |
|---|---|---|---|---|---|
| RF Power | PASS if value is between low limit and high limit | Value above or below limits indicates forward output power above or below 100% power. Value of approx. 1.4 indicates 100% power. Reading outside of limits will not result in shutdown of this chassis. | Medium priority | | |
| Fault Alarm Relay | PASS if value is logic 0 | If one or more of a selected group of parameters fails (see Latches the Fault Alarm Relay column), a hardware relay in this chassis will be actuated. The actuated state is controlled and latched by the MCU. For example, if Reflected Power fails, the chassis will shut down and the Reflected Power condition will not continue; however, the Fault Alarm Relay parameter will indicate FAIL since the relay is latched. Failure will not result in shutdown of this chassis. | Medium priority | Yes | |
| Thermal | PASS if above low limit | If chassis internal thermostat becomes excessively hot, value will rise above 2.5V (failure). Failure causes shutdown of this chassis. | High priority | | |
| Remote A<br>Remote B | If either value is logic 0, equipment will go into STANDBY state | Indicates state of control inputs from the switching control drawer. A zero value indicates a STANDBY command from this source. | | | |
| Interlock Status | PASS if value is logic 1 | Logical ANDing of the states of the gate interlocks and PS Interlock (see below). Failure causes shutdown of this chassis. | High priority | | |

| Parameter Name | Test Type | Description | Priority (high: FAIL causes SHDN) | Latching in MCU (Cleared by STBY or RESET) | Latches the Fault Alarm Relay |
|---|---|---|---|---|---|
| Gate Interlock 1<br>Gate Interlock 2<br>Gate Interlock 3<br>Gate Interlock 4<br>Gate Interlock 5 | PASS if value is between low limit and high limit | Measurements of the negative voltage fed back by an internal module to the chassis diagnostics. Failure of a parameter indicates short circuit, open circuit, of fault condition in chassis internal interlock harnessing.<br><br>These parameters may indicate WARNING during stabliization of the chassis after turn-on.<br><br>Failure causes shutdown of this chassis. | High priority | | |
| PS Interlock | PASS if value is between low limit and high limit | Failure of this parameter indicates chassis internal switching power supply voltage is above or below safe limits. Failure causes shutdown of this chassis. | High priority | | |
| Negative12V PS<br>Positive11V PS<br>Positive12V PS | PASS if value is between low limit and high limit | Measurements of output voltages of power supplies. Readings outside of limits will not result in shutdown of this chassis. | Low priority | | |
| IP1<br>IP2<br>Final Current | PASS if value is between low limit and high limit | Measurements of amplifier currents. Readings outside of limits will not result in shutdown of this chassis. | Low priority | | Yes |
| Fwd Output Power | PASS if value is between low limit and high limit | Indicates overall system power (forward) output. Reading outside of limits will not result in shutdown of this chassis. | High priority | | |
| Reflected Output Power | PASS if below high limit | Indicates system reflected power. Typical value should be close to 0V. Failure occurs when value rises above 0.632V, resulting in shutdown of this chassis.<br>Following a shutdown due to high reflected power, the Reflected Fault (shdn) parameter will indicate failure. | High priority | | Yes |

# SIGNAL DISTRIBUTION BOARD

The signal distribution board receives and distributes various interlock and turn on signals that control transmit operation. The board contains 3 LED's and a switch. Under normal operating conditions all LED's illuminate.

| | | |
|---|---|---|
| DS2 | green: | Video input signal is present. |
| DS3 | yellow: | Power supply enable present. |
| DS4 | red: | Interlock conditions present. |

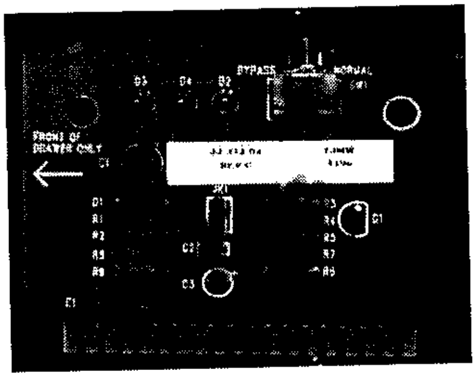


FIGURE 13-0064-1

Switch SW1 is a video bypass enable switch. It provides +5 VDC to bias Q1 on thereby enabling DS2. The normal position for this switch is OFF. When the switch is OFF, an external input video presence signal must be supplied to turn the transmitter ON. This signal typically originates from a video presence board contained inside the modulator. When this switch is positioned ON, this places the transmitter into BYPASS mode or in a constant ON condition. This enables the transmitter to continue transmitting even though there is no video signal present.

The following chart cross-references these input/output signals:

| SIGNAL | INPUT | OUTPUT | ORIGIN/DESTINATION |
|---|---|---|---|
| PS Enable | | X | Switching Power Supply |
| Thermal | X | | Thermal Relay |
| Remote A | X | | External Connector J1-2 |
| PS Interlock | X | | Motherboard P4-10 |
| Remote A | | X | Motherboard P4-15 |
| IN-Signal | | X | Motherboard P4-14 |
| Interlock | X | | Motherboard P4-12 |
| TX-ON | X | | Motherboard P4-11 |
| Stand-by | X | X | Motherboard P4-2 |
| Thermal | | X | Motherboard P4-13 |
| + 5 VDC | X | | Motherboard P4-5 |
| Gate 5 | X | | Motherboard P4-9 |
| Gate 4 | X | | Motherboard P4-8 |
| Gate 3 | X | | Motherboard P4-7 |
| Gate 2 | X | | Motherboard P4-6 |
| Gate 1 | X | | Motherboard P4-4 |
| Remote B | X | | Motherboard P4-3 |
| Video Presence | X | | External Connector J1-1 |

FIGURE 13-0064-2

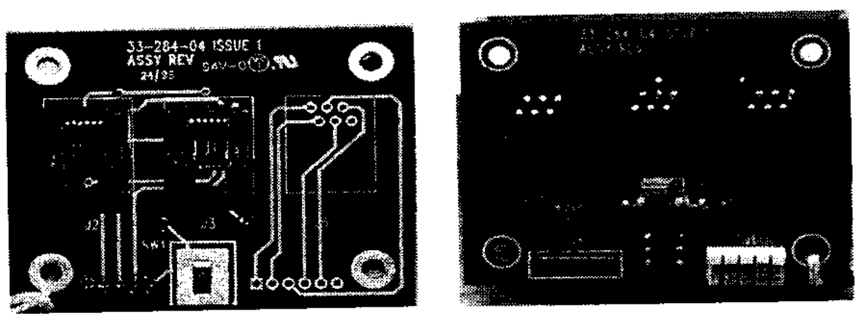
| *Created by: Kimberly Simeone 10/9/98* | *Checked by: Donald Wike 10/20/98* | *Released by: Paulo Correa 10/20/98* |
|---|---|---|

# RS-485 COMMUNICATIONS BOARD

An RS-485 communications board is mounted to the inside rear of the chassis. It interfaces each drawer's microcontroller unit (MCU) to a communications bus for status monitoring with a common computer/master control station. The system is capable of monitoring up to 32 individual units.

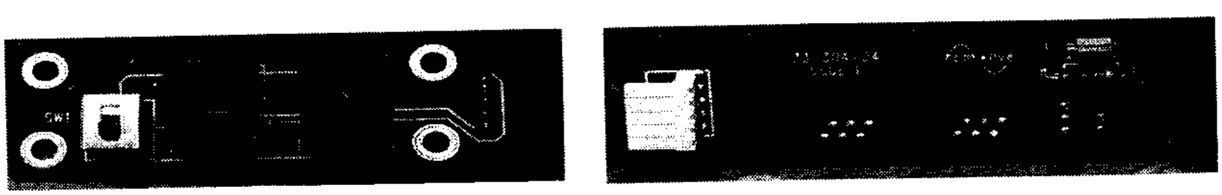
The board has a 5 pin input connector with connections to two rear panel mounted 6 pin telephone type receptacles (RJ11). It functions as the interface between the drawer's MCU, the communications bus, and a computer monitoring system. The bus consists of a double twisted shielded pair cable which daisy-chain links (parallels) drawers 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 RS-485 communications board located on the rear of the sub-rack. When a status monitoring computer system is used, all RS-485 communications boards ordinarily have this switch set to the "OUT" position with the exception of the last RS-485 communications board in the daisy chain series. The last board normally has the switch set to "TERM". This action terminates the communications bus at the last RS-485 communications board of the daisy link chain establishing proper bus impedance. The interconnection is shown in Document # DOC30-0005.



FRONT 33-284 BOARD BACK

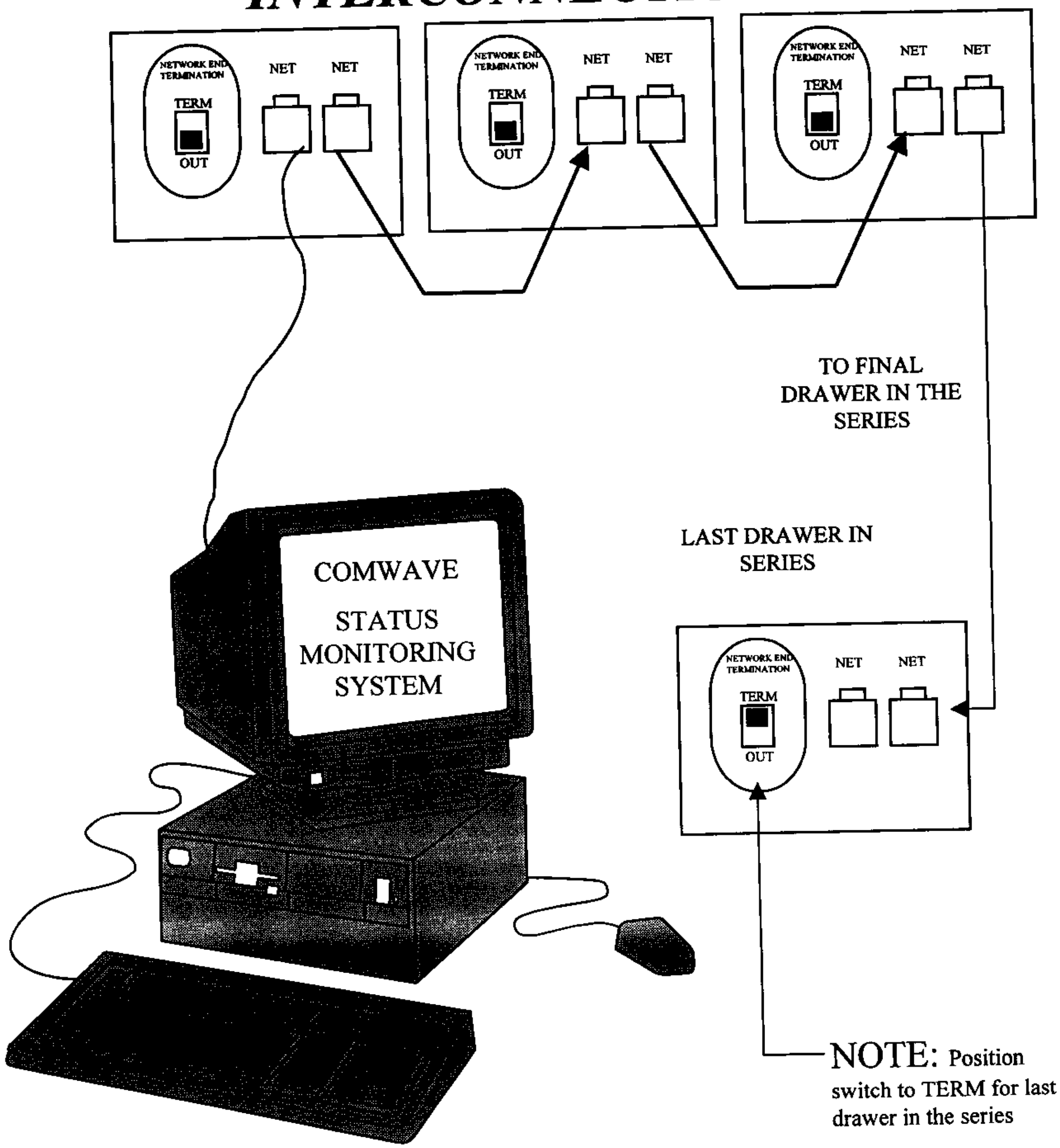
FIGURE 13-0009-1



FRONT 33-304 BOARD BACK

FIGURE 13-0009-2

# *COMVIEW STATUS MONITORING INTERCONNECTIONS*




IBM COMPATIBLE
WITH RS-485 CARD

| | | |
|---|---|---|
| *Created by: Kimberly Simeone 9/3/98* | *Checked by: Jeanette Mulligan 9/4/98* | *Released by: Andre Castro 10/2/98; Paulo Correa 10/20/98* |

# POWER AMPLIFIER SEGMENT THEORY OF OPERATION

## POWER AMPLIFIER SEGMENT GENERAL DESCRIPTION:

The power amplifier segments of the high power single channel transmitter series or broadband booster 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 that 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.

The power amplifier segment consists of a microwave amplifier[2], control board[1], DC to DC converter[3], 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[4].

FRONT VIEW

SIDE VIEW

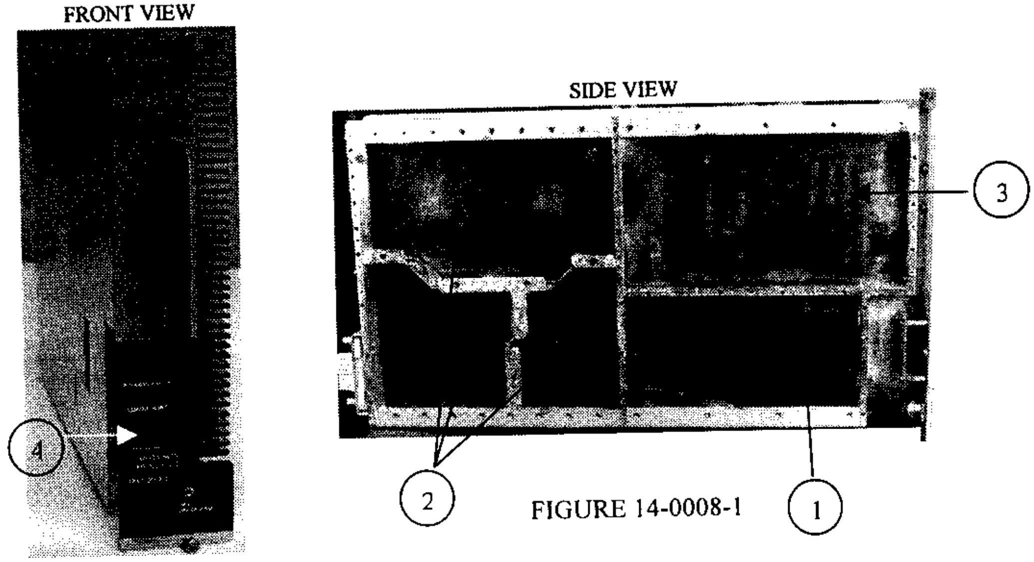



FIGURE 14-0008-1

## POWER AMPLIFIER SEGMENT OPERATION

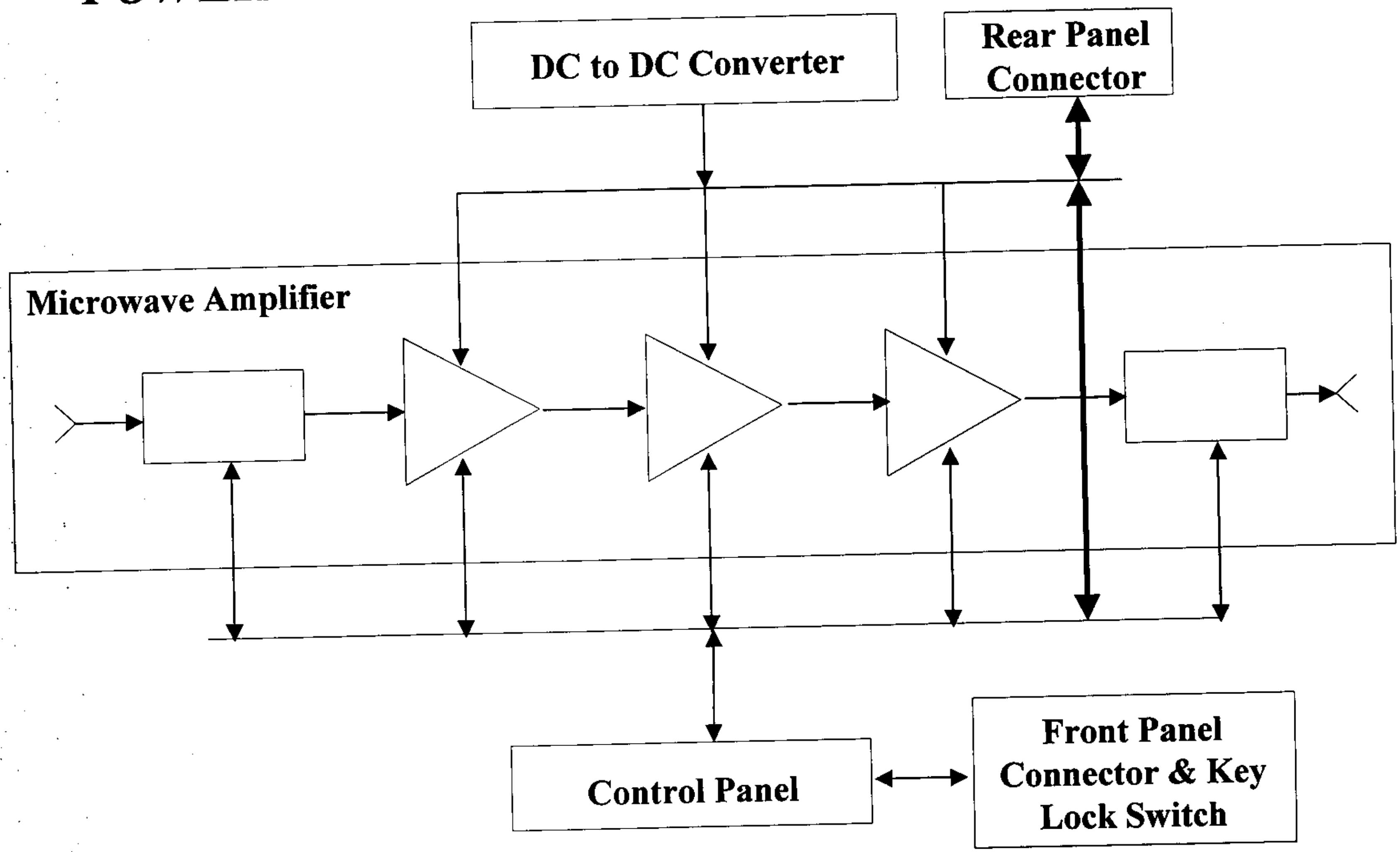
The amplifier segment is equipped with a key lock switch on the front panel to retain it in place. When pushing-in or pulling-out the Segment, turn the key lock switch to the OFF position. After plugging the amplifier segment into the sub-rack and tightening the front panel thumbscrews, turn the key-lock 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 FET's 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 airflow passes through the heatsink from the front to the rear of the sub-rack. The airflow 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<br>Analog 17.5 dBm (@ P1 dB) |
| Output Power | Digital 41.5 dBm<br>Analog 47.0 dBm (P1 dB) |
| Dimensions | 2.1"H x 10.3"W x 17.1"D<br>5.3 cm H x 26.1 cm W x 43.4 cm D |
| Weight | 9 lbs (4 Kg) |

*DOCUMENT #: DOC19-0014*
*REV: C*

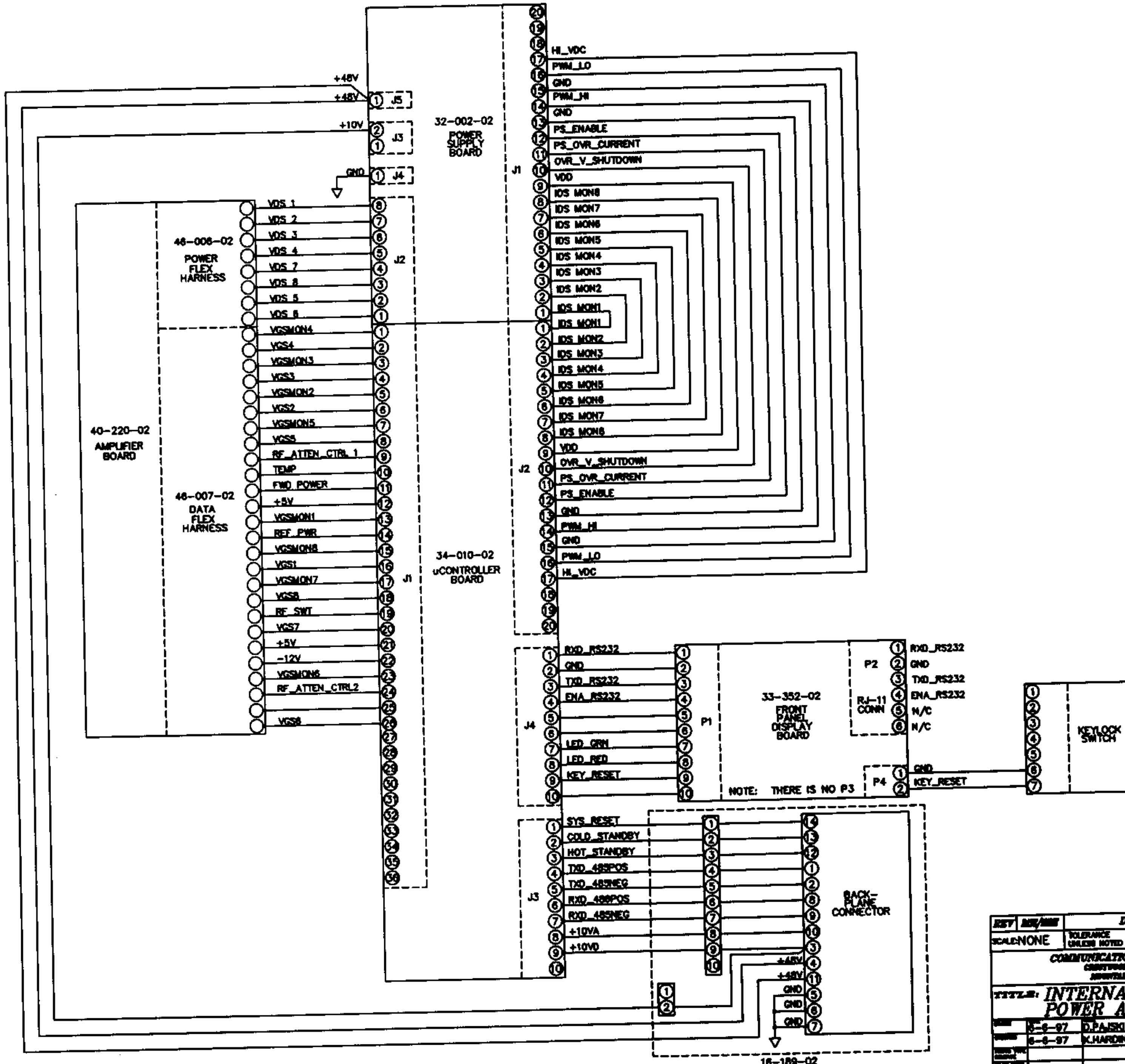
# POWER AMPLIFIER SEGMENT BLOCK DIAGRAM




| Created by: Kimberly Simeone 9/15/98<br>ECO #: 98-116 | Checked by: Donald Wike 9/18/98 | Released by: Andre Castro 10/2/98<br>Paulo Correa 10/29/98 |
|---|---|---|

Document #: DOC15-0013

REV: C




| | | | |
|---|---|---|---|
| REV | DESCRIPTION | | ECO No. |
| SCALE: NONE | TOLERANCE UNLESS NOTED | FRAC.± 1/8 DEC.± .005 | ANG.± .5 |

COMMUNICATION MICROWAVE CORP

TITLE: INTERNAL INTERCONNECT, POWER AMPLIFIER SEGMENT

| | | |
|---|---|---|
| 6-6-97 | D.PAJSKI | C-66-306-01 |
| 6-6-97 | K.HARDING | 1 OF 1 |
| 8-11-97 | A.BRAGALONE | P1=A |

REV. A

# POWER AMPLIFIER BOARD

## POWER AMPLIFIER BOARD GENERAL DESCRIPTION

The power amplifier board has a high gain architecture, providing 29.5 dB gain and an output 1-dB compression of 47 dBm. 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 that sets the overall 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 provide 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 that 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.

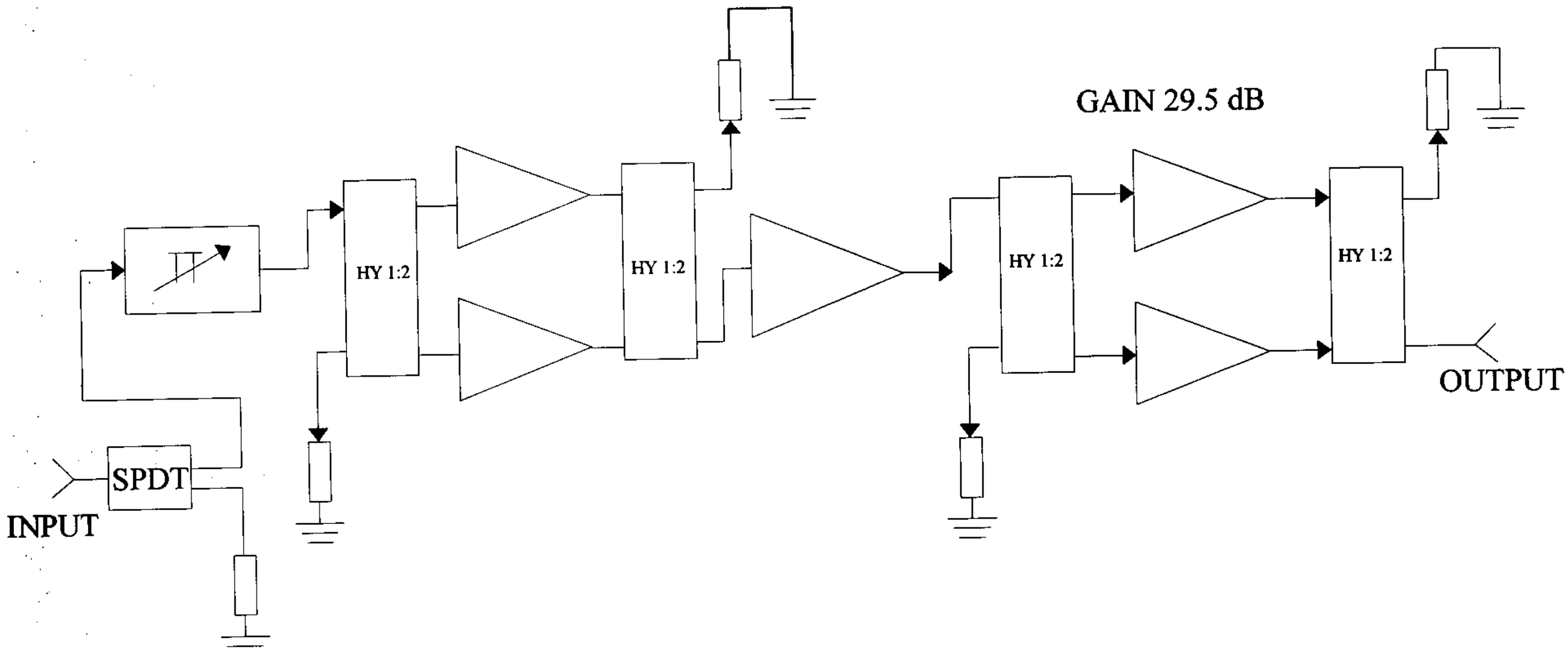
The microwave circuit amplifies the input signal with high linearity performance and broadband frequency response. This feature allows the amplifier to be used for any channel without retuning. An IC on the amplifier board protects the FET's from catastrophic failure. The temperature sensor supplies 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 |

*DOCUMENT #: DOC19-0015*
*REV: C*

# POWER AMPLIFIER BOARD BLOCK DIAGRAM




| Created by: Kimberly Simeone 9/15/98<br>ECO #: 98-116 | Checked by: Donald Wike 10/2/98 | Released by: Andre Castro 10/2/98<br>Paulo Correa 10/19/98 |
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*Document #: DOC15-0014*

*REV: B*

# 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.

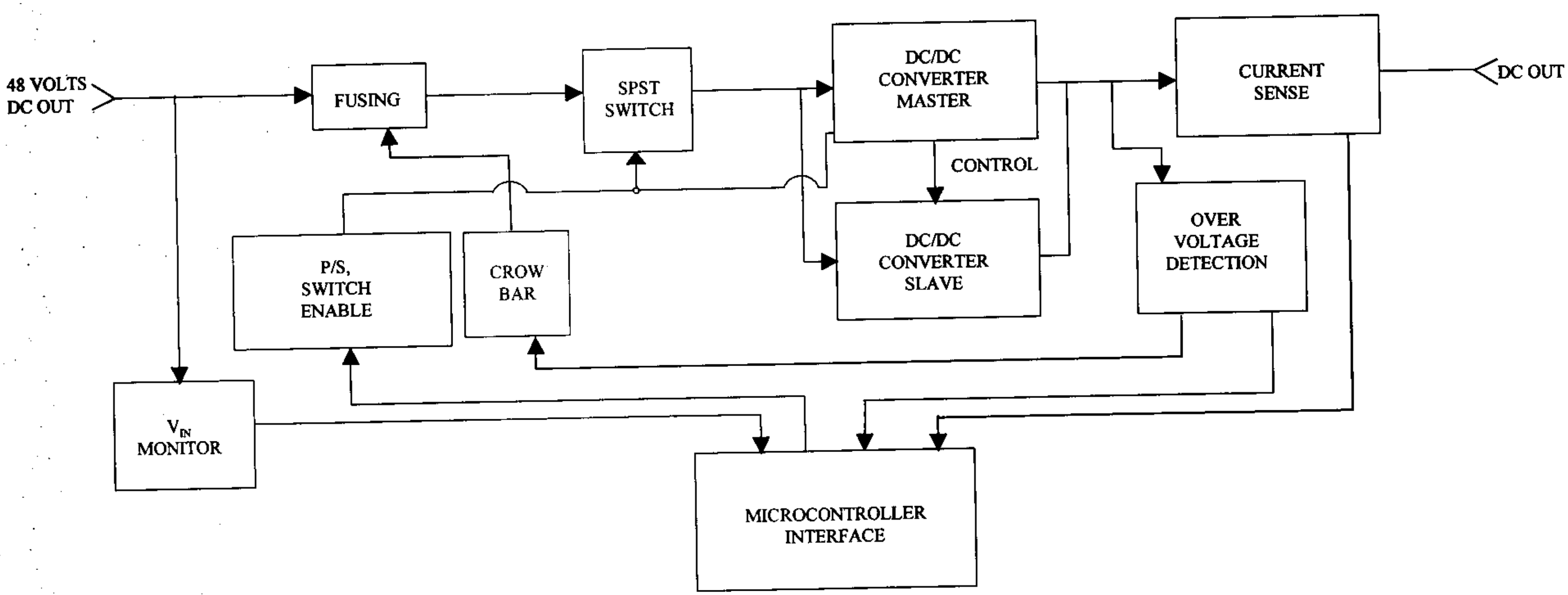
The control board will then detect the output voltage. If the output voltage rises above the nominal value to a preset value, the crowbar will be activated and cause the fuse to open. When this occurs the control board will disable the standby switch and the DC/DC converters. The power supply distributes 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% |

*Document #: DOC19-0017*
*REV: C*

# POWER SUPPLY BLOCK DIAGRAM

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|---|---|---|
| *Created by: Kimberly Simeone 9/15/98*<br>*ECO #: 98-116* | *Checked by: Donald Wike 9/18/98* | *Released by: Andre Castro 10/2/98*<br>*Paulo Correa 10/19/98* |

*Document #: DOC15-0016*

*REV: C*

# 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 unit (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.

The control board monitors drain currents drawn by FETs in the RF power amplifier section of the power amplifier segment. The control board achieves this by monitoring the voltages dropped across series resistors in the drain supply circuits on the power supply board. The control board from the power supply connector J2 receives these eight voltages. 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 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. Unity gain inverter op-amp circuits to negative voltages (e.g. -Vgs) then invert these positive 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. A MUX IC in a manner similar to that for the drain MUX described above multiplexes the monitored gate signals, input on RF power amplifier connector J1. A unity gain inverter op-amp circuit to provide a positive voltage to the AN1/VGSMON input on the MCU A/D converter inverts the time-varying MUX output, which generally carries negative voltages.

The control board provides various logic inputs and outputs. 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 that 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 segment's 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.

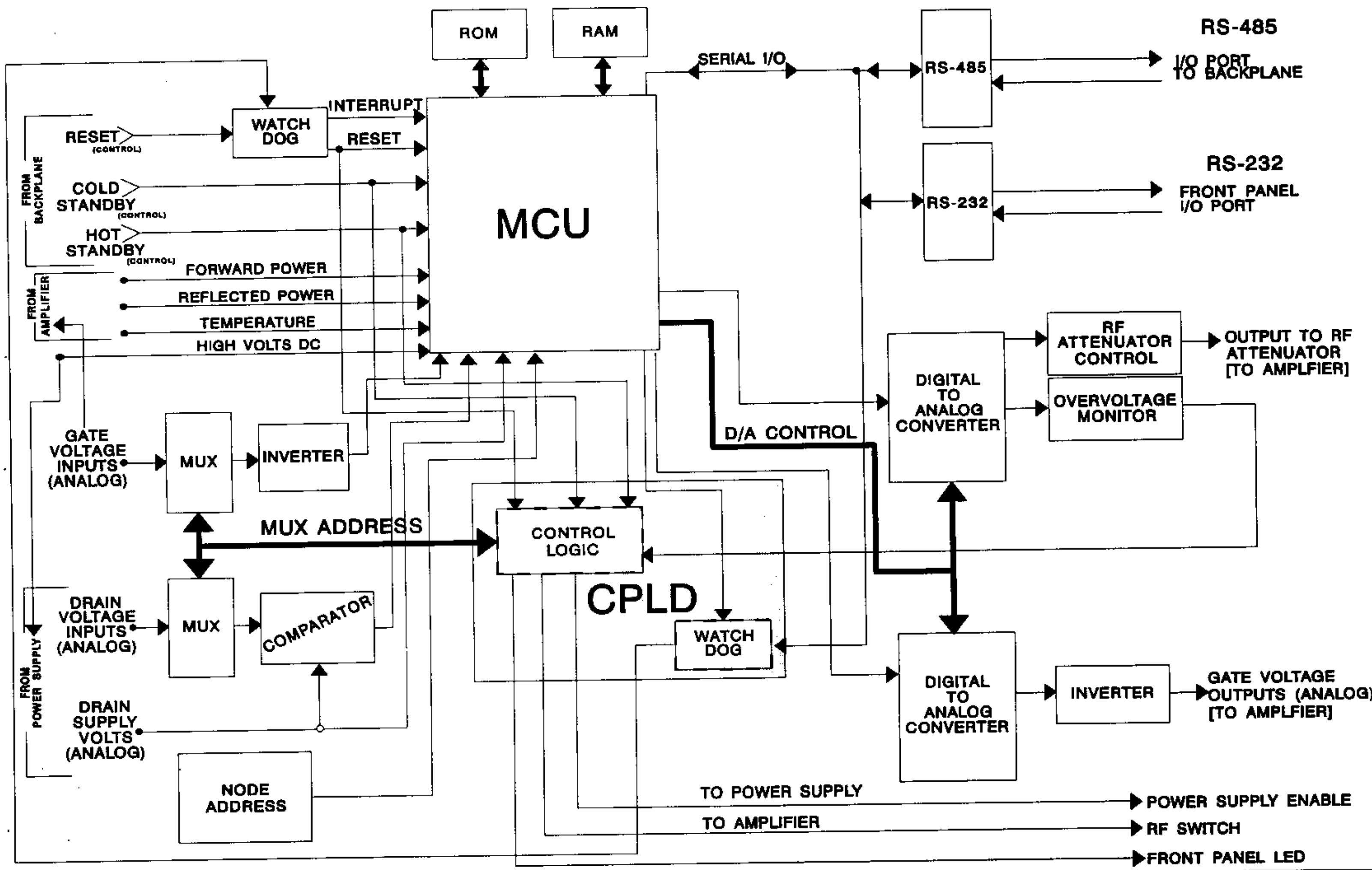
Two power supply voltage inputs of approximately +10 $V_{DC}$ are provided to the Control Board to supply the digital regulator and analog regulator circuits. The digital regulator circuits are fused by F1 at their +10 $V_{DC}$ input. A linear voltage regulator develops +5$V_{DC}$ for the digital circuitry. 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. Another linear voltage regulator develops +5 $V_{DC}$ for the analog circuitry. The +5$V_{DC}$ 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<br>13.0 cm H x 8.9 cm W x 1.5 cm D typ |

***DOCUMENT #: DOC19-0016***
***REV: C***

# CONTROL BOARD BLOCK DIAGRAM

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|---|---|---|
| *Created by: Kimberly Simeone 9/15/98*<br>*ECO #: 98-116* | *Checked by: Donald Wike 9/18/98* | *Released by: Andre Castro 10/2/98*<br>*Paulo Correa 10/20/98* |

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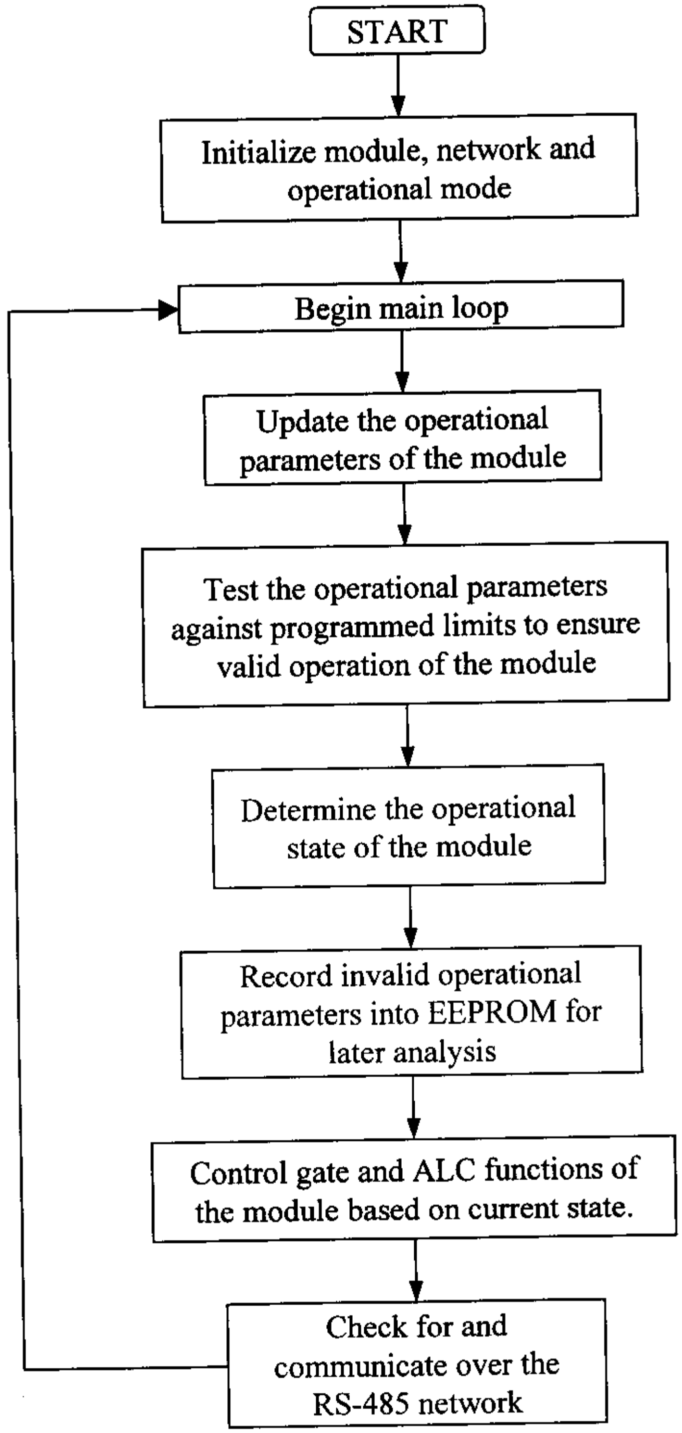
*REV: C*

# FIRMWARE FLOWCHART

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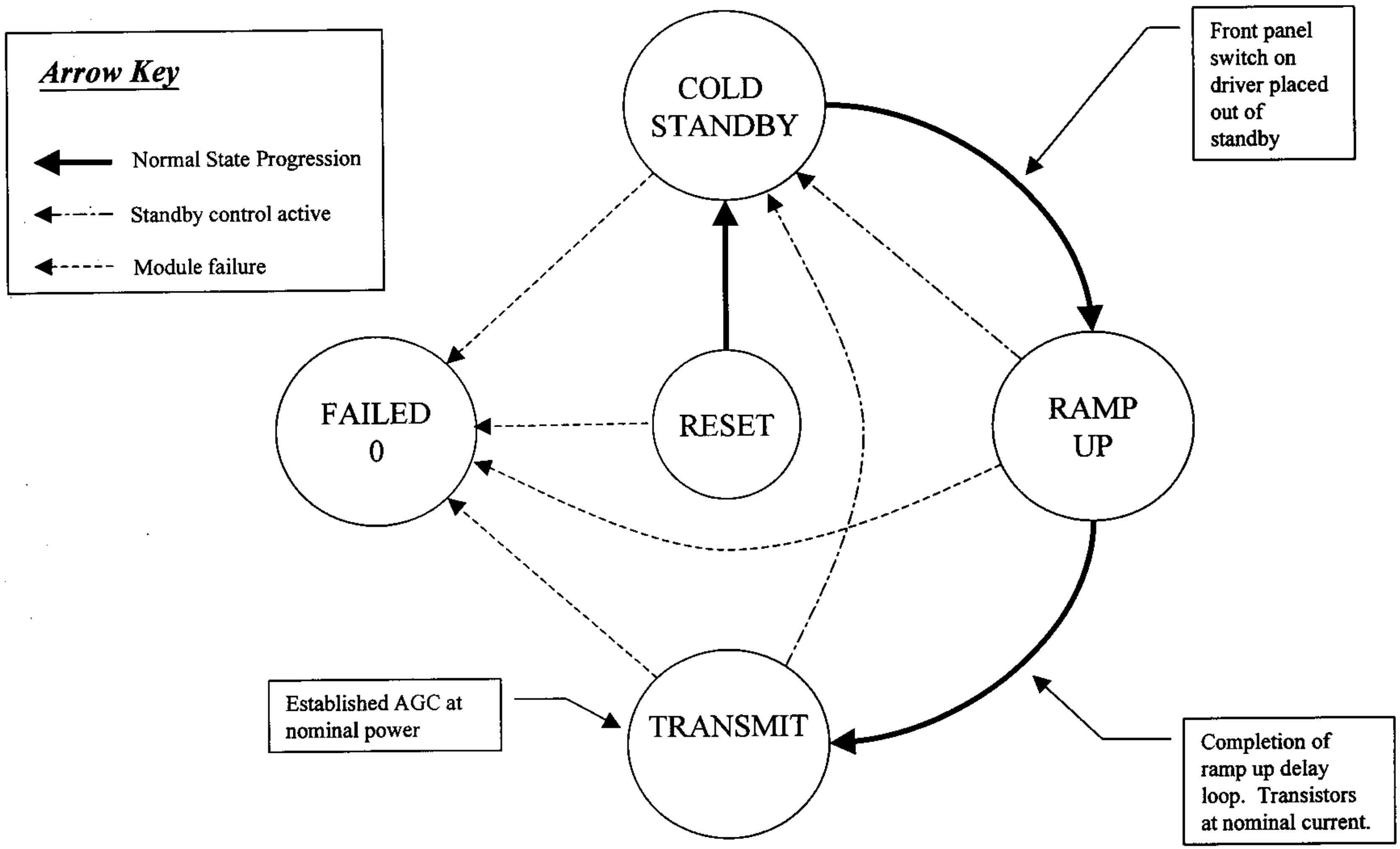
| *Created by: Kimberly Simeone 11/20/98* | *Checked by: Christian Smith 11/23/98* | *Released by: Donald Wike 11/23/98* |

# AMPLIFIER SEGMENT STATE FLOW DIAGRAM

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| *Created by: Kimberly Simeone 11/23/98* | *Checked by: Christian Smith 11/23/98* | *Released by: Donald Wike 11/23/98* |

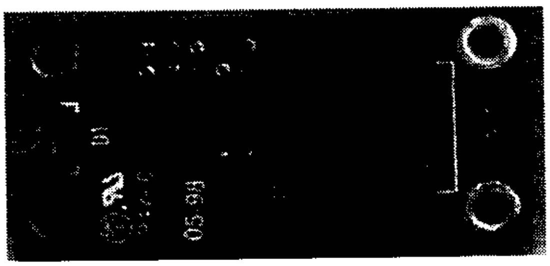
*Document #: DOC21-0006*

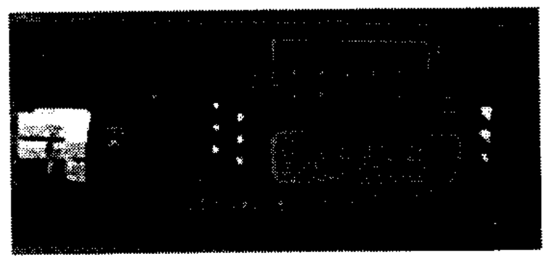
*REV: A*

# RS-232 COMMUNICATIONS BOARD

An RS-232 communications board is mounted to the inside front of the chassis. It allows the drawer to be interfaced to a personal computer for both monitoring and control.

The board has a 10 pin input connector with connection to a 6 pin telephone type connector (RJ11). Additionally, the board has a bi-color LED that can be used to indicate the overall status of the drawer in which it is being used, and/or whether the drawer is receiving power.





FRONT 33-352 BOARD BACK

FIGURE 13-0010-1

| *Created by: Kimberly Simeone 9/3/98* | *Checked by: Jeanette Mulligan 9/4/98* | *Released by: Andre Castro 10/2/98; Paulo Correa 10/20/98* |
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