Instruction and Maintenance Manual

COM5000-8

HF-SSB 5-kW Linear Power Amplifier

Cubic Defense Applications, Inc.
9333 Balboa Ave
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Manual Part No. 351804-1

CUBIC
DEFENSE APPLICATIONS, INC.
A member of the Cubic Corporation family of companies

Instruction and Maintenance Manual

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Revisions/Updates

REV	Date	Description	Approval
100	1/30/15	Initial release.	E. Wise

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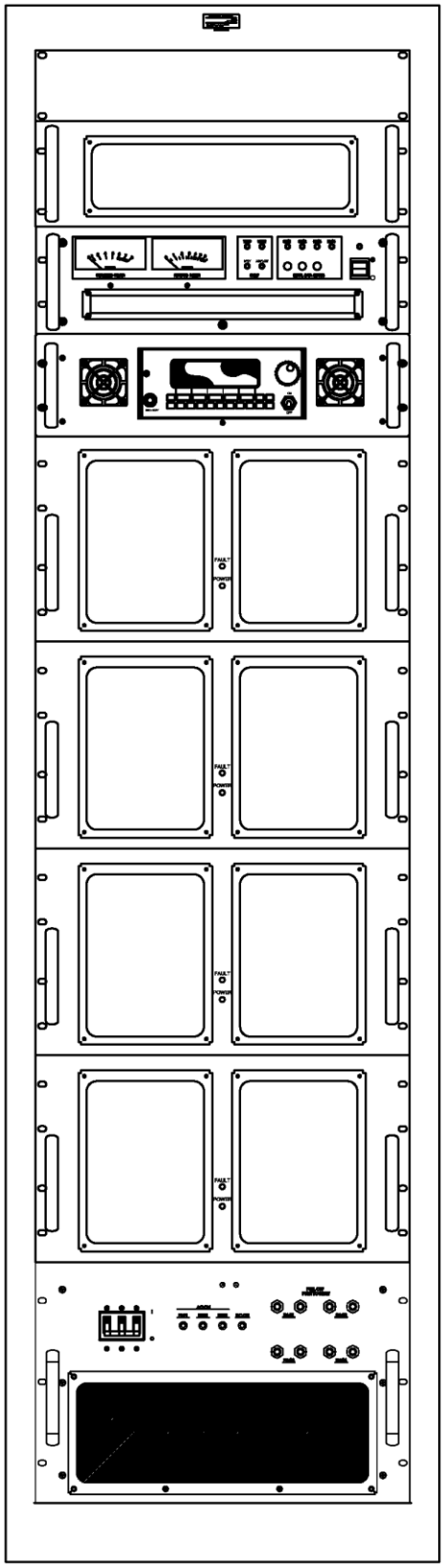
FRONT VIEW OF TRANSMITTER



GENERAL

This manual describes the 5 kW Linear Power Amplifier that is part of a 5 kW Transmitter. The 5 kW Transmitter comprises the COM5000-8 power amplifier with the T-4180 Exciter as pictured above.

This manual provides a basic description of Transmitter operation. For detailed operation of the Exciter, refer to the T-4180 manual.

CONFIGURATION

The 5-kW Transmitter (351800-1) comprises the following modules:

System Controller module	1638-1000-12
1.25 kW Power Amplifier module (Qty: 4 ea.)	351270-2
Power Supply module	351830-2
Output Combiner module	L163145-1
T-4180 Exciter module	1644-1000-4

5-kW TRANSMITTER PERFORMANCE SPECIFICATIONS (*)

Frequency Range:	2 to 30 MHz
Power Output:	Nominal 5000 watts average and PEP
RF Input Power:	+ 21 dBm nominal (from T-4180 Exciter)
Gain Flatness:	+/-0.5dB over 2.0 to 30 MHz (4455 - 5610 watts) with T-4180 Exciter
Intermodulation:	Two-tone 3rd order IM products 32dB below PEP (26dB below each tone) or better.
Harmonics:	≥ 63dBc
Impedance:	50 Ohm nominal
Load Mismatch:	Unit capable of operating into load VSWR up to 3:1 (reduced output) & survive open and shorted load. Stable with any load.
Operating Mode:	Class AB
Cooling:	Forced Air
Dimensions:	HxDxW = 85.5" x 31.6" x 23.7" (217 x 80.3 x 60.2 cm)
Weight:	775 pounds (352 kg) approximately
Temperature range:	0 to +40 degree C (Operating) -40 to +70 degree C (Storage)
Relative Humidity:	0 to 95% operating
Duty Cycle:	Continuous
Power Requirements:	187 – 240VAC (208VAC nominal), 3-phase, 47-63Hz, 50A maximum per phase.

(*) For detailed operational and external interface specifications refer to the T-4180 manual

SCOPE OF MANUAL

This Manual is intended for use by experienced technicians familiar with similar equipment. The information it contains is current as of the printing date. Subsequent engineering changes are described in supplementary Instruction Manual Revisions issued as needed. The applicable schematic diagram is updated and the changes are described in a revision column on the diagram.

GENERAL SAFETY INFORMATION

The following are general safety precautions that are not related to any specific procedures and therefore do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

KEEP AWAY FROM LIVE CIRCUITS

Personnel must at all times observe all safety precautions. Do not replace components or make adjustments inside the equipment with the high voltage supply turned on. Under certain conditions, the potential for danger may exist when the power control is in the OFF position due to charges retained by capacitors. To avoid severe shock or injuries, always remove power and ground a circuit before touching it.

DO NOT SERVICE OR MAKE ADJUSTMENTS ALONE

Under no circumstance should any person reach into the enclosure for the purpose of servicing or making adjustments to the equipment except in the presence of someone who is capable of rendering aid.

RESUSCITATION

Personnel working with or near high voltages should be familiar with modern methods of resuscitation.

HANDLING

To prevent personal injury or damage to the equipment, ensure the following lifting weights are not exceeded. Items of 40 lb (18kg) or less require one person for handling. Items of 40 to 70 lb (18 to 32kg) require two people for handling. Any items greater than 70 lb (32kg) require at least two people or a power lifting device.

To avoid personal injury, at least two people are required to install bulky items into equipment cabinets.

WARNING

When operated into an antenna, this equipment may produce electromagnetic fields in close proximity to the antenna that are in excess of Occupational Safety and Health Administration (OSHA) recommended maximum limits.

In addition, do not operate this equipment near electrical blasting caps or in an explosive atmosphere.

All equipment must be properly grounded according to installation instructions for safe operation.

Compressed air used for cleaning purposes shall not exceed 30 psi (207 kPa) and then shall be used only when goggles or face shields are used for personnel eye protection.

CAUTION

This equipment contains electrostatic discharge sensitive (ESDS) devices. Special handling methods and materials must be used to prevent equipment damage.

CHAPTER 1
DESCRIPTION

1. INTRODUCTION

1.1 GENERAL

The COM5000-8 transmitter is comprised of four 1.25kW PA Modules, a 3-phase power supply module, a 4-Way Combiner module, a System Controller module and a T-4180 exciter module. The modules are enclosed in a standard 19” rack cabinet.

The COM5000-8 is capable of delivering a nominal output power of 5000 watts over the frequency range of 2 to 30 MHz.

1.2 FEATURES

a) Continuous duty cycle voice operation.

b) Gradual reduction of output power in case of failure in a PA module.

c) Extensive BIT.

d) FCC Part 87 and Part 15 certified. FCC ID # 2AFTMCOM5000-8.

CHAPTER 2

INSTALLATION

2.1 GENERAL

2.1.1 Government Regulations

Ensure that the use of the 5-kW Transmitter satisfies government regulation. In most countries, radio transmitters may be adjusted only by persons holding a suitable government license or by personnel working under their immediate supervision.

Similarly, most countries require that the power output of a transmitter not exceed that required for satisfactory performance considering local conditions and the area to be served.

Also, frequency and power of a base station transmitter must be checked before it is placed in service, and must be rechecked every year thereafter; the results of these checks must be recorded in a permanent log available for inspection by government personnel.

2.1.2 Inspection

Carefully inspect the 5-kW Transmitter immediately upon receipt, and notify the shipper of any damage incurred in transit. If damage has occurred and it is necessary to have the system serviced, return the equipment to:

Cubic Defense Applications, Inc.

9333 Balboa Avenue
San Diego, CA. 92123
USA
Office #: (858) 505-2130
FAX #: (858) 277-1878

2.1.3 General Installation

Select the mounting location for convenience of access for electrical connections and for maintenance. Keep the antenna cable as short as possible to minimize losses. The selected location should be clean, dry and well ventilated. Do not locate the Transmitter in close proximity to strong electrical fields produced by brush motors and generators, welders, etc.

The Transmitter rack cabinet may be placed on any sturdy, horizontal surface. No preliminary internal wiring connections are required before installing the amplifier.

Make sure that adequate cooling is provided. Air intake is from the front and exhaust is from the rear ventilated door of the rack cabinet. **Be careful to prevent exhaust air from being re-circulated into the air intake.**

The PA module fans produce an airflow of ≈ 400 CFM (190 l/s) and the power supply module fans produce an airflow of ≈ 300 CFM (140 l/s). The Combiner module fans produce an airflow of ≈ 220 CFM (100 l/s) and the System Controller module fan produces an airflow of ≈ 35 CFM (16 l/s). The Exciter module airflow is 15 CFM (7 l/s). The total air flow requirement is approximately 2200 CFM (1000 l/s).

2.1.4 Rack Cabinet Installation

Install the Transmitter by first installing the rack cabinet in its intended location. It may be necessary first to remove modules from the rack cabinet in order to reduce cabinet weight or to fasten the cabinet to the floor.

2.1.4.1 Module Removal

WARNING:

The rack cabinet must be stable while removing modules. Failure to secure the rack cabinet to prevent it from tipping over may cause serious injuries or death

a) Remove the modules starting with the top module and proceed towards the bottom module. Work only with one module at a time - keep all other modules secured in the rack cabinet while removing a module.

b) To remove a module, start by removing the retaining screws that secure the module front panel to the rack cabinet. After removing all the screws, slowly pull out the module until the rack slides are fully extended and locked in this position.

c) Disconnect all the cables (coaxial and control cables and ground wires) from the rear panel of the module (see para. 2.1.4.3)

d) Disengage the locking mechanism on both of the slides by pushing in the “locks”. Then pull the module slowly out and away from the slides.

e) When removing a PA module (weight = 74 lbs./34 kg) or a Power Supply module (weight = 65 lbs./30 kg), two man lift is recommended to facilitate handling.

f) When removing the Power Supply module, observe the following:

DANGER:
Before removing AC connections from the Power Supply terminal block, make sure that the AC LINE voltage has been removed

2.1.4.2 Rack Cabinet Mounting

Prior to installation of the rack cabinet, the location must be prepared to accept mounting bolts in the locations shown in figure 2.1.4.2A. All external cables are routed through the large cable entry brush strip opening at the lower rear of the cabinet.

To access the bolt-down brackets, remove the 3 floor plates near the bottom inside of the cabinet. It may also be helpful to remove the plinth base covers that clip onto the legs at the bottom of the rack. They can be pulled off and snapped back on. Align the rack carefully such that the four 3/8” (or 10mm) mounting bolts can be inserted through the holes in the bolt-down brackets in the bottom of the cabinet. See figure 2.4.1.2A for dimensions for placing the floor bolts. Note that the bolt-down brackets can be rotated to different positions if desired.

Air exhaust for the rack cabinet is at the rear through the perforated door.

When the rack cabinet is secured to the floor, the floor plates, plinth base covers and modules can be installed. Install the modules starting with the bottom module and proceed towards the top module. Work only with one module at a time - make sure that each module is secured in the rack cabinet before installing the next module.

For module locations, see figure 2.1.4.2B.

The Power Supply module must be installed first.

Proceed as follows:

a) Pull out both cabinet rack slides (left and right) for the Power Supply. Make sure the rack slides are pulled out all the way until they lock into place.

b) Insert the Power Supply module rack slides into the cabinet rack slides.

c) Gently push the module into the rack cabinet and secure with #10-32 retaining screws.

Proceed to install the remaining modules from the bottom up, in accordance with figure 2.1.4.2B.

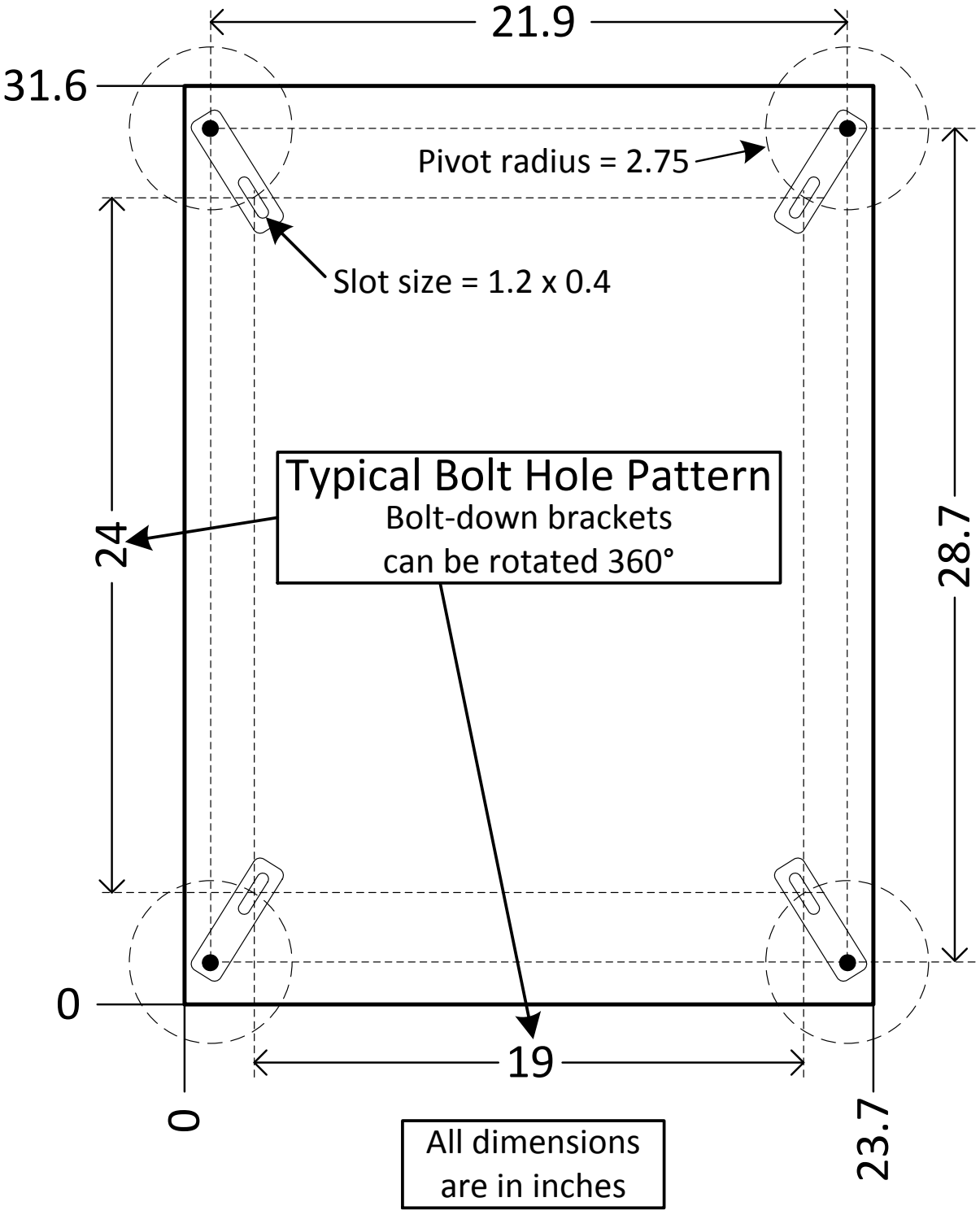


Figure 2.1.4.2A. Rack Cabinet Mounting Hole Locations

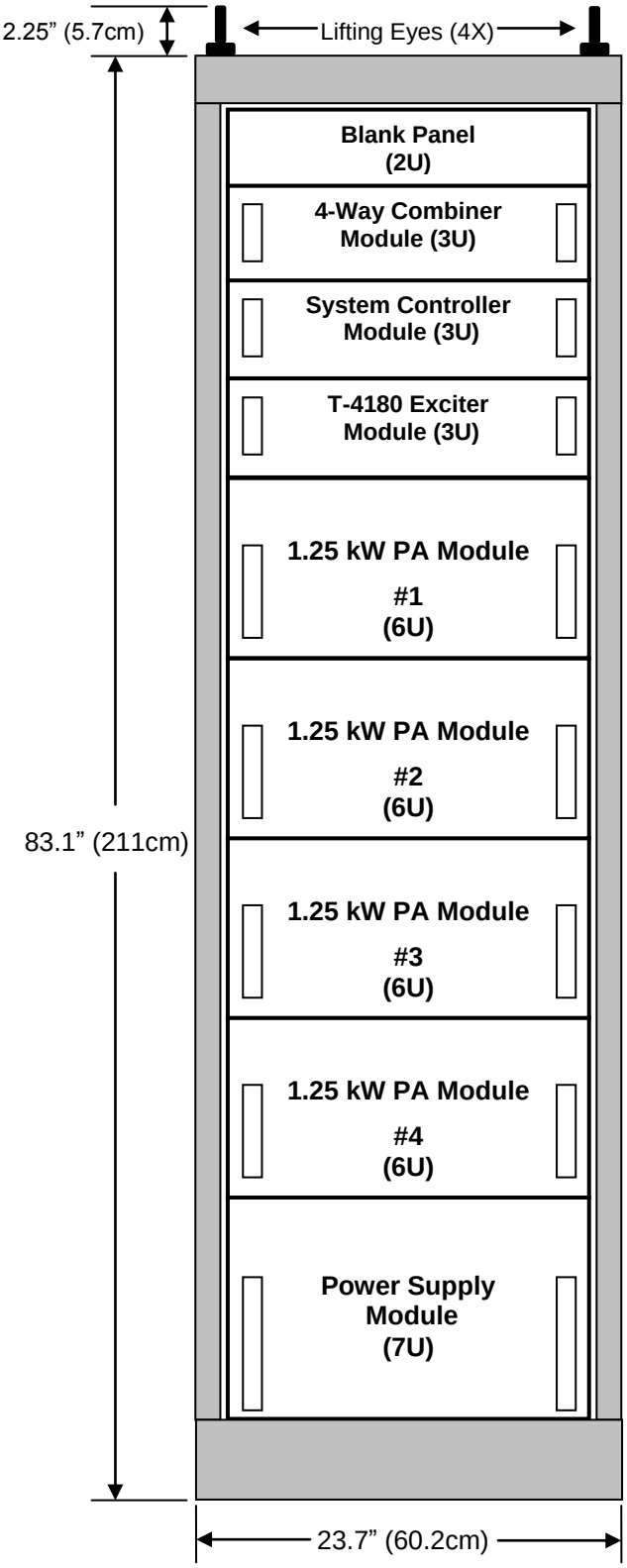


Figure 2.1.4.2B. Rack Cabinet Module Location

2.1.4.3 Reconnecting Cables To Modules

The connections are shown on the Transmitter Interconnect Wiring Diagram in schematic form (see figure 5.1). Cables are secured to cable retractors and are ready to be connected to modules except for the following large coax cables:

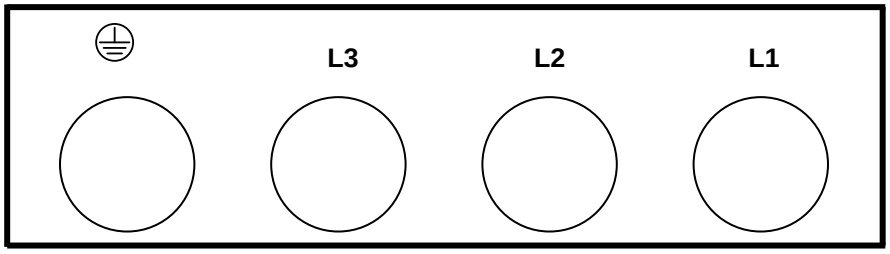
a. PA Module RF output coax cables (qty.4) are connected between the PA modules and the Combiner module.

b. Combiner output coax is connected between the Combiner and the Antenna connector.

Connection to the individual modules is described below.

2.1.4.3.1 Power Supply Module Connections

Connections to the Power Supply module rear panel terminal block are shown below:



The AC LINE Input is connected as follows:

L1: Line 1 (black)
L2: Line 2 (red)
L3: Line 3 (blue)
⏚: Ground (green)

The System Controller and Exciter module AC Line inputs connect to J2 of the Power Supply module through a splitter cable.

The 50V DC NEG (-) connections from the four PA modules are attached to the Power Supply output terminal bus bar with a 3/8” bolt. The terminal lug must directly contact the bus bar (no washers between the lug and the bus bar). Tighten the bolt securely.

The 50V DC POS (+) connectors connect to J3A and J3B.

The supply control cable 9 Pin DSUB plug connects to Power Supply connector J4.

2.1.4.3.2 System Controller Module Connections

System Controller Connector Label	System Controller Connector Type	Connected to:	Module Connector Label	Module Connector Type
RF Output J6-1	BNC	PA module #1	RF INPUT J1	BNC
RF Output J6-2	BNC	PA module #2	RF INPUT J1	BNC
RF Output J6-3	BNC	PA module #3	RF INPUT J1	BNC
RF Output J6-4	BNC	PA module #4	RF INPUT J1	BNC
RF INPUT J5	BNC	T-4180 Exciter	OUTPUT J3	BNC
Supply Control J8	9-pin DSUB	Power Supply Module	J4	9-pin DSUB
Combiner Control J1	9-pin DSUB	Combiner module	Control J6	9-pin DSUB
PA Control J7	37-pin DSUB	PA module #1, 2, 3 and 4	PA Control J3	15-pin DSUB
Exciter Interface J3	15-pin DSUB	T-4180 Exciter	PA Control J5	15-pin DSUB
AC LINE J9	IEC60320 male	Power Supply module	J2	IEC60320 female

2.1.4.3.3 Additional Module Connections

PA Modules

PA module Connector Label	PA module Connector Type	Connected to:	Combiner Module Connector Label	Combiner Module Connector Type
RF Output PA module #1 J6	N	Combiner RF IN	RF IN J2	N
RF Output PA module #2 J6	N	Combiner RF IN	RF IN J3	N
RF Output PA module #3 J6	N	Combiner RF IN	RF IN J4	N
RF Output PA module #4 J6	N	Combiner RF IN	RF IN J5	N

Combiner Module

Combiner module Connector Label	Combiner module Connector Type	Connected to:	Connector Label	Connector Type
RF OUT J1	C	Antenna connector	NA	LC

T-4180 Exciter Module

Exciter module Connector Label	Exciter module Connector Type	Connected to:	Module Connector Label	Module Connector Type
Power J1	IEC60320 male	Power Supply module	J2	IEC60320 female

2.1.4.4 External Connections to the Transmitter

All connections are routed through the cable entry brush strip located below the rear door.

AC LINE Input Connection

The External AC Line power cable connects to the terminal block inside a junction box at the bottom inside floor of the cabinet. The recommended minimum wire size is #6 AWG (16mm^2). The terminals will accept up to #4 AWG (25mm^2) wire.

The connections are labeled near the terminals:

L1:	Line 1 (black)
L2:	Line 2 (red)
L3:	Line 3 (blue)
⏚:	Ground (green)

Note: Phase is not critical. Any AC line phase may be connected to any line terminal.

The power requirement is 3-phase/4-wires (3 lines and ground), 187 – 240 VAC, 47-63Hz.

The maximum AC input current is 50A/phase.

Antenna Connection

The antenna cable is connected to the LC connector located at the inside rear of the cabinet.

Remote Control Interface

Remote control of the transmitter is provided via an RS-232/RS-422 interface on the rear of the T-4180 exciter at J4. See the T-4180 manual for details.

Audio Connection

Two balanced 600 ohm audio inputs are provided on J6 of the Exciter rear panel. A microphone input with PTT (push to talk) is also available on the front panel of the exciter. See the T-4180 manual for details.

External Reference

An external 10 MHz reference input is provided on J2 of the Exciter rear panel. See the T-4180 manual for details.

Cabinet Ground Connection

An M6 (≈¼") ground stud is located inside the lower rear of the rack cabinet (right side as viewed from the rear) to provide connection to safety ground wiring.

CAUTION:

BEFORE OPERATING THE TRANSMITTER FOR THE FIRST TIME AFTER INSTALLATION IS COMPLETE, DOUBLE CHECK THAT ALL CABLES ARE CORRECTLY INSTALLED. SEVERE DAMAGE TO THE TRANSMITTER CAN OCCUR IF CABLES ARE NOT CONNECTED OR ARE CONNECTED IMPROPERLY! IT IS HIGHLY RECOMMENDED THAT INITIALLY TESTING BE DONE WITH THE POWER SET TO 10%. IF THE TRANSMITTER IS OPERATING NORMALLY AT 10% POWER, THE POWER MAY BE GRADUALLY INCREASED TO 100%. THIS PRECAUTION IS ALSO RECOMMENDED ANY TIME A MODULE IS REPLACED.

CHAPTER 3
OPERATION

3.1. INTRODUCTION

This section describes the controls and indicators available to the operator. Basic operation of the Power Amplifier is also described. For a description of the exciter controls and display refer to the T-4180 manual.

3.2 CONTROLS AND DISPLAYS

The controls and indicators are located on the Front Panels of the following modules:

Power Supply Module
PA Module (4 each)
System Controller Module
T-4180 Exciter module (refer to the T-4180 manual)

3.2.1 Power Supply Module

Figure 3.2.1 shows the Power Supply Module Front Panel. The controls and indicators are described below:

Control/Indicator	Function
AC ON (PS#1) LED (yellow)	When lit, indicates that internal power supply invertor #1 is on and operating normally.
AC ON (PS#2) LED (yellow)	When lit, indicates that internal power supply invertor #2 is on and operating normally.
AC ON (PS#3) LED (yellow)	When lit, indicates that internal power supply invertor #3 is on and operating normally.
DC ON LED (green)	When lit, indicates that the DC output of the power supply is on.
3-Pole Toggle Circuit Breaker	Connects and disconnects the AC input to the power supply.
Push-Pull Circuit Breakers (8)	Connects and disconnects the DC outputs to individual PA modules. There are 2 circuit breakers per PA module.

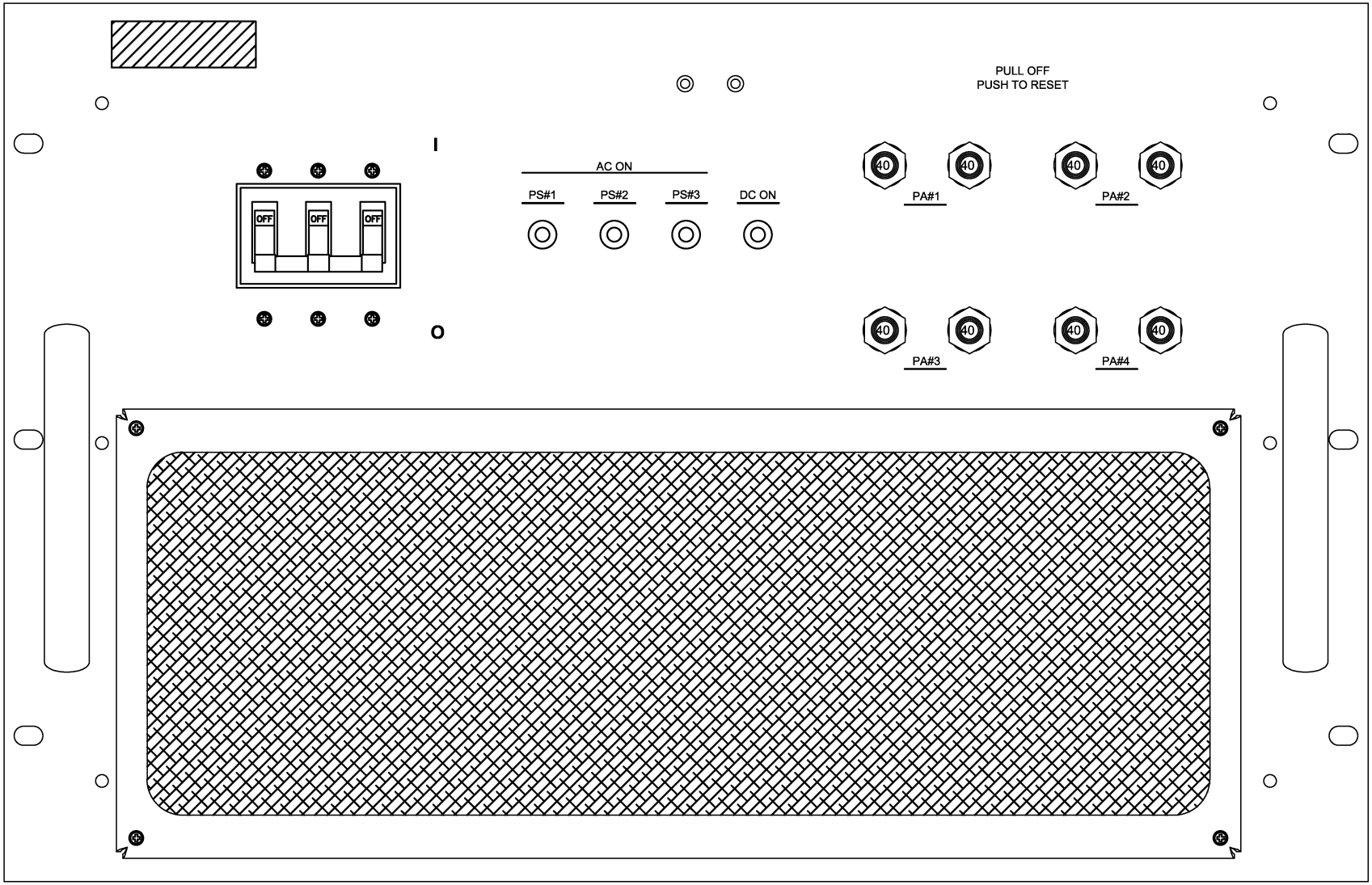


Figure 3.2.1. Power Supply Module Front Panel

3.2.2 PA Module

Figure 3.2.2 shows the PA Module front panel.

The indicators are described below:

Indicator	Function
POWER LED, (green)	When lit, indicates that bias is enabled in the PA module.
FAULT LED, (red)	When lit continuously, indicates a fault in the PA module.

3.2.3 System Controller Module

Figure 3.2.3 shows the System Controller Module front panel.

The controls and indicators are described below:

Control/Indicator	Function
Reflected Power Meter	Display reflected power in watts.
Forward Power Meter	Displays forward power in watts.
TEMP Fault LED, (red)	When lit continuously, indicates over-temperature in a PA module or in the Combiner module.
VSWR Fault LED, (red)	When lit continuously, indicates that the antenna VSWR exceeds approximately 4:1
SPLY Fault LED, (red)	When lit continuously, indicates there is a DC supply voltage fault.
AIRFLOW Fault LED, (red)	When lit continuously, indicates failure of one or more FANS in a PA module or in the Combiner module.
AMP OFF status LED (red)	When lit, indicates that the 50VDC supply voltage is not present and/or communication with the T-4180 Exciter has not been established.
STDBY status LED (yellow)	When lit indicates that the 50VDC supply module is ON and communication with the Exciter has been established.
OPER status LED (green)	When lit, indicates that the transmitter is ready to operate.
BIAS status LED (green)	When lit, indicates that the transmitter is keyed.
LINE LED, (yellow)	When lit, indicates that the AC Line voltage has been applied to the System Controller module (front panel ON/OFF switch is turned ON).
ON/OFF switch	Connects and disconnects AC Line input voltage.

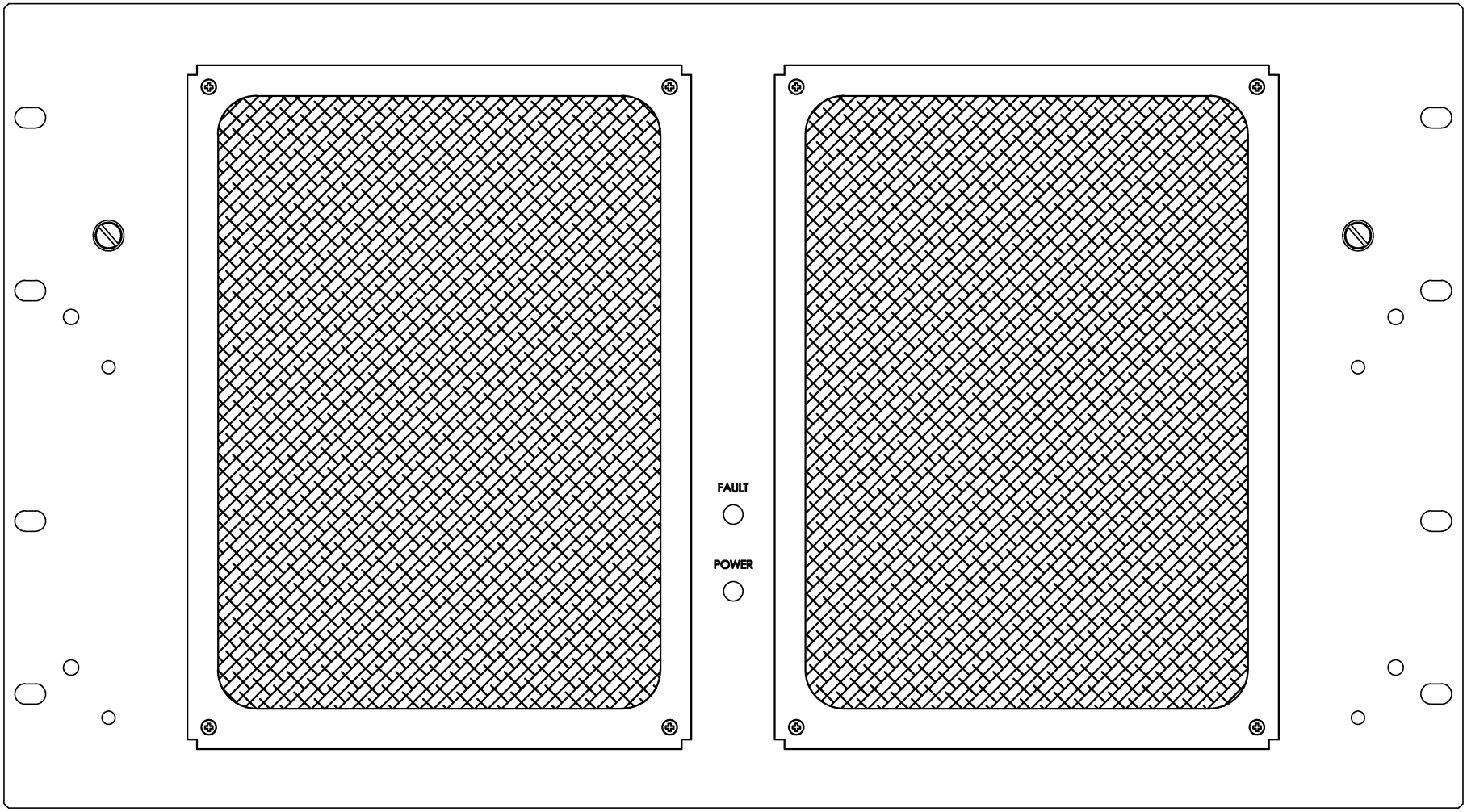


Figure 3.2.2. PA Module Front Panel

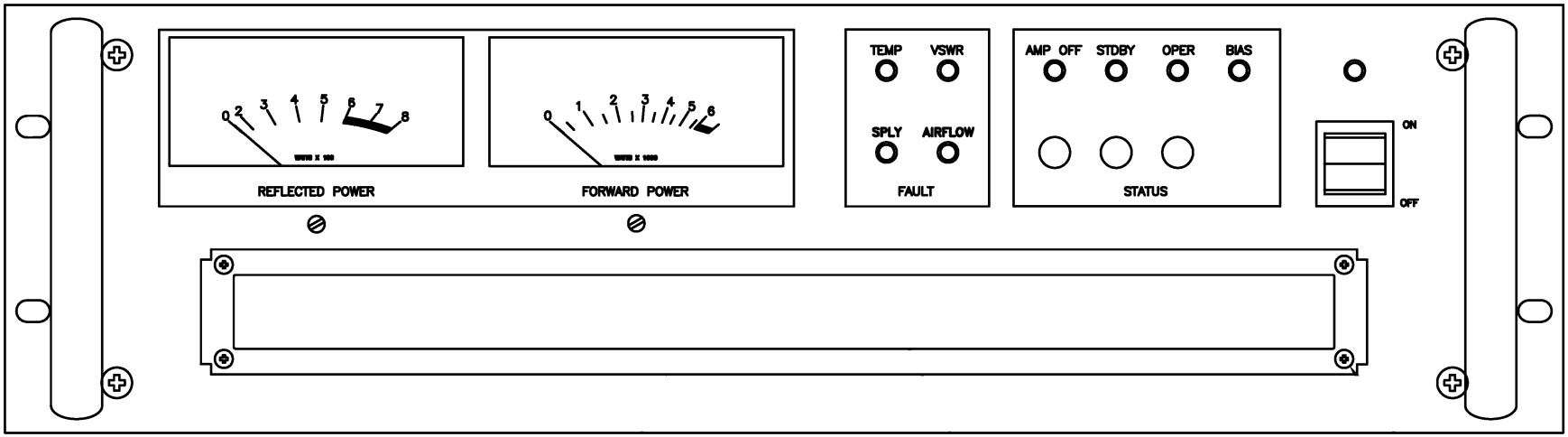


Figure 3.2.3. System Controller Module Front Panel

3.2.4 T-4180 Exciter Module

Refer to T-4180 manual.

3.3 TRANSMITTER SYSTEM OPERATION

3.3.1 General

The COM5000-8 power amplifier can be considered an "extension" of its model T-4180 exciter. Transmitter operation is described in the T-4180 Manual.

To a major degree, the COM5000-8 is transparent to the operator of the T-4180 however, the following should be noted:

b) The COM5000-8 power amplifier will continue to operate under most fault conditions providing as much power output as is possible dependent upon the particular condition.

c) Continuous BIT action is taken to prevent damage and allow for continued PA operation under most fault conditions. The actions are either dynamic (adjusting to conditions as they change), key dependent (evaluated on the next PTT), or latched in.

d) Faults and BIT responses are reported to the T-4180. The information can be accessed and read on the T-4180 front panel display or on an external computer. See section 3.3.4 below.

3.3.2 Operating The Transmitter

To turn ON the Transmitter proceed as follows:

a. Turn ON the System Controller module.

b. Turn ON the T-4180 Exciter

c. Turn the Power Supply module AC circuit breaker ON (3-handle toggle breaker).

AMP OFF mode:

When the System Controller module is turned ON – with the T-4180 and the Power Supply module turned OFF - the AMP OFF status LED indicator is lit.

If both the System Controller and the T-4180 is turned ON and serial data communication has been established between the T-4180 and the System Controller, the AMP OFF and the SPLY fault LED indicator is lit. The SPLY fault LED is lit because the 50VDC Power Supply module is turned OFF.

STDBY mode:

The Transmitter enters STDBY mode if the System Controller, the T-4180 and the 50VDC Power Supply module is turned ON. Serial data communication must also have been established between the T-4180 and the System Controller to enter STDBY mode. The transmitter remains in STDBY mode under certain fault conditions.

OPER mode:

If the System Controller, the T-4180 and the 50VDC Power Supply modules are turned ON and serial data communication has been established between the T-4180 and the System Controller, the OPER LED indicator is lit.

Note: The following conditions will prevent the Transmitter from entering OPER status (the Transmitter will remain in STDBY mode):

a. Operational Interlock (Cabinet rear door Interlock) disabled
b. One or more Drawer Interlocks are disabled
c. A serious fault condition

Note: The Transmitter may enter the OPER status even if faults have been detected. Operation is permitted – at reduced power – under many fault conditions.

In the OPER mode, the 50VDC Power Supply module green DC ON LED is turned ON.

The Transmitter system is now ready to be keyed (PTT).

For detailed operation instructions refer to the T-4180 manual.

3.3.3 Transmitter External Control Protocol

The T-4180 provides external RS-232/RS-422 control of the transmitter from a PC. Refer to the T-4180 manual.

3.3.4 Continuous Bit Operation

During operation a number of critical functions are monitored to detect performance degradation or faults. The conditions monitored in each of the modules comprising the COM5000-8 and in the rack cabinet system as well as “external” conditions monitored are described in the following.

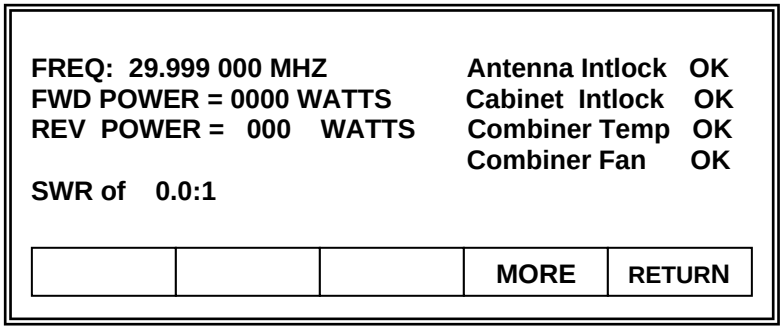
Faults are indicated by fault LED's on the System Controller front panel and on the four PA module front panels. (Note: Momentary flashing of a fault LED does not indicate a fault. The LED must be on continuously to indicate a fault.)

In addition to the System Controller and PA module LED display, the T-4180 Status display will show operational parameters and specific fault conditions.

The first of two T-4180 status screens is evoked as follows:

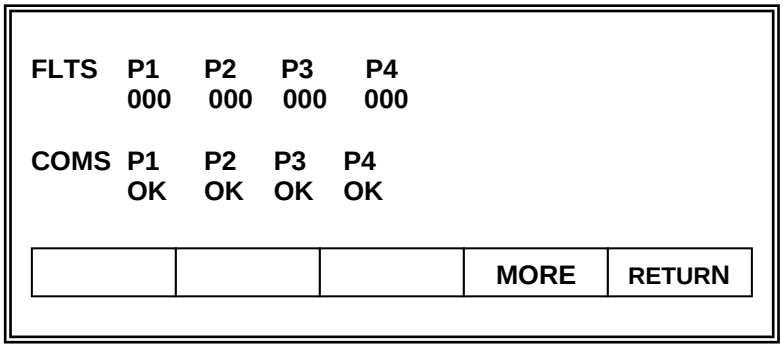
- From the T-4180 default screen press [NEXT]
- On the new screen press [PASTAT]
- The first of two status screen appears

T-4180 Status screen #1:



- Press [MORE] to view the second status screen.

T-4180 Status screen #2:



The fault indications are as follows:

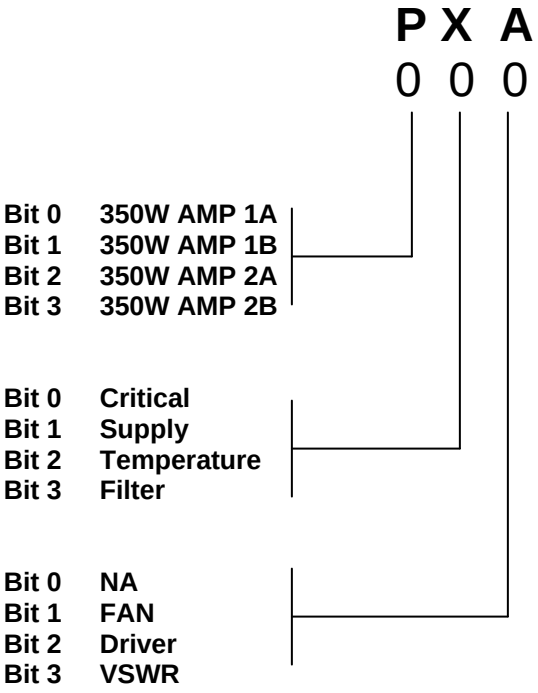
a. On screen #1, if a fault is detected, "OK" will change to "FLT".

b. "COMS" show status of serial communication with the PA module. If communication with a PA module is lost, “OK” will change to “FLT”.

c. "FLTS" show PA module faults in HEX format. The definition is shown below.

- A **critical fault** requires the 50V supply voltage to be turned OFF and then ON to reset the fault.
- Most other faults are reset by un-keying and then re-keying the Transmitter.

Fault definition:



350W AMP 1A	**350W AMP 1B**
350W AMP 2A	**350W AMP 2B**

1.25 kW PA module front view.

Example:

Supply Fault = 0 2 0
Temperature fault in 350W AMP 1A = 1 4 0
Filter Fault = 0 9 0
Critical (Bit 0) + Filter (Bit 3)

See tables on next page for detailed decoding of faults.

The two Status screens may be used with the LED indicators on the PA module and the System Controller module to locate a fault.

Note: The FWD and REV power readings on T-4180 Status screen #1 indicate the power measured at the output connector of the Combiner. The power reading is for reference only and may not match the reading of an external wattmeter - especially when operating into high VSWR conditions.

The VSWR indicates the VSWR measured at the output connector of the Combiner. The VSWR reading is for reference only and may not match the reading of an external wattmeter.

PA Module Fault Decoding Tables

Left Digit (P)	350W AMP 2B	350W AMP 2A	350W AMP 1B	350W AMP 1A
0	OK	OK	OK	OK
1	OK	OK	OK	FAULT
2	OK	OK	FAULT	OK
3	OK	OK	FAULT	FAULT
4	OK	FAULT	OK	OK
5	OK	FAULT	OK	FAULT
6	OK	FAULT	FAULT	OK
7	OK	FAULT	FAULT	FAULT
8	FAULT	OK	OK	OK
9	FAULT	OK	OK	FAULT
A	FAULT	OK	FAULT	OK
B	FAULT	OK	FAULT	FAULT
C	FAULT	FAULT	OK	OK
D	FAULT	FAULT	OK	FAULT
E	FAULT	FAULT	FAULT	OK
F	FAULT	FAULT	FAULT	FAULT

Middle Digit (X)	Filter	Temperature	Supply	Critical
0	OK	OK	OK	OK
1	OK	OK	OK	FAULT
2	OK	OK	FAULT	OK
3	OK	OK	FAULT	FAULT
4	OK	FAULT	OK	OK
5	OK	FAULT	OK	FAULT
6	OK	FAULT	FAULT	OK
7	OK	FAULT	FAULT	FAULT
8	FAULT	OK	OK	OK
9	FAULT	OK	OK	FAULT
A	FAULT	OK	FAULT	OK
B	FAULT	OK	FAULT	FAULT
C	FAULT	FAULT	OK	OK
D	FAULT	FAULT	OK	FAULT
E	FAULT	FAULT	FAULT	OK
F	FAULT	FAULT	FAULT	FAULT

Right Digit (A)	VSWR	Driver	Fan	NA
0	OK	OK	OK	Not used
1	OK	OK	OK	Not used
2	OK	OK	FAULT	Not used
3	OK	OK	FAULT	Not used
4	OK	FAULT	OK	Not used
5	OK	FAULT	OK	Not used
6	OK	FAULT	FAULT	Not used
7	OK	FAULT	FAULT	Not used
8	FAULT	OK	OK	Not used
9	FAULT	OK	OK	Not used
A	FAULT	OK	FAULT	Not used
B	FAULT	OK	FAULT	Not used
C	FAULT	FAULT	OK	Not used
D	FAULT	FAULT	OK	Not used
E	FAULT	FAULT	FAULT	Not used
F	FAULT	FAULT	FAULT	Not used

LED FAULT DISPLAY

1.25kW PA Module:

1. PA Module Temperature Fault:

A temperature (TEMP) fault is declared when the 350W AMP heatsink temperature exceeds approximately 100°C. The transmitter response is to disable bias from the affected 350W AMP and reduce system power output as needed to continue operation.

With a temperature fault in a PA module, the System Controller and PA module LED display is as shown below.

PA MODULE FAULT	1.25kW PA Module LED's		System Controller FAULT LED's			
	PWR	FAULT	TEMP	VSWR	SPLY	AIR FLOW
TEMP	ON	ON	ON	OFF	OFF	OFF

When the fault condition disappears, the fault LED's will turn OFF on the next key and power output will return to normal. (Note: Momentary flashing of a fault LED does not indicate a fault. The LED must be on continuously to indicate a fault.)

2. PA Module Fan Fault:

A fan fault is declared if the fan speed is below a specific hardware set limit. The Transmitter must be keyed in order to detect a fan fault and it takes approximately 10 seconds for the fault to be detected.

With a fan fault in a PA module, the System Controller and PA module LED display is as shown below.

PA MODULE FAULT	1.25kW PA Module LED's		System Controller FAULT LED's			
	PWR	FAULT	TEMP	VSWR	SPLY	AIR FLOW
FAN	ON	ON	OFF	OFF	OFF	ON

A fan fault is not considered a serious fault condition and operation at rated power can continue until a TEMP fault is detected. When the fault condition disappears, the fault LED's will turn OFF on the next key. It takes approximately 10 seconds of transmission for the fault to be cleared.

3. PA Module Harmonic Filter Fault:

a. Filter relay faults are declared whenever the selected filter relay pair current is above or below specific hardware set limit.

b. The loss of RF signal through the filter selected also results in a filter fault.

The Transmitter response is to disabled bias from the affected PA Module and reduce system power output as needed to continue operation.

With a filter fault in a PA module, the System Controller and PA module LED display is as shown below.

PA Module FAULT	1.25kW PA Module LED's		System Controller FAULT LED's			
	PWR	FAULT	TEMP	VSWR	SPLY	AIR FLOW
FILTER	OFF	ON	OFF	OFF	OFF	OFF

The LED display will only show that a PA module has faulted. The specific fault condition is indicated on the T-4180 Module Status screen #2.

When selecting a frequency in another filter band and transmitting, the filter fault will be cleared and transmission at full power restored on that filter and the remaining "good" filters.

4. PA Module Gain Fault:

Gain reduction or complete loss of gain in a 1.25kW PA Module may have a number of causes:

350W AMP protection fuse(s) blown
Driver output transistor failure
Driver pre-amp transistor failure
Loss of 50VDC due to tripped circuit breaker(s) on the Power Supply front panel
Miscellaneous component failures

The Transmitter response is to reduce system power output as needed to continue operation. In some case the fault condition may cause the bias to be disabled from the affected PA Module.

With a gain related fault in a PA module, the System Controller and PA module LED display is as shown below.

PA Module FAULT	1.25kW PA Module LED's		System Controller FAULT LED's			
	PWR	FAULT	TEMP	VSWR	SPLY	AIR FLOW
GAIN	OFF	ON	OFF	OFF	OFF	OFF

The LED display will only show that a PA module has faulted. The specific fault condition is indicated on the T-4180 Module Status screen #2.

When the fault condition disappears, the fault LED's will turn OFF on the next key – or in case of a critical fault – the power has been turned OFF and ON again.

Power Supply Module:

The 50VDC supply voltage is monitored by the microprocessor in the System Controller module. A power supply fault is declared whenever the supply voltage falls outside the voltage range of 45V to 53V.

Transmitter keying is inhibited if the supply voltage is above 53V in the Power Supply module.

With a fault in the 50VDC power supply, the System Controller and PA module LED display is as shown below.

Power Supply Module Fault	1.25kW PA Module LED's		System Controller FAULT LED's			
	PWR	FAULT	TEMP	VSWR	SPLY	AIR FLOW
Exceeding limits	OFF	OFF	OFF	OFF	ON	OFF

When the fault condition disappears, the fault display is cleared on the next key.

Note: The Power Supply module will start current limiting at approximately 325A and enter "constant current mode" of operation. Excessive current draw does not necessarily indicate a failure of the 50VDC supply but may be caused by the operating conditions that affect the efficiency of the Transmitter.

Combiner Module:

a. A fan fault is declared if, when keyed, the fan current is above or below specific hardware set limits.

b. A temperature (TEMP) fault is declared when the Combiner module heatsink temperature exceeds approximately 100°C.

With a fault in the Combiner module, the System Controller and PA module LED display is as shown below.

Combiner Module Fault	1.25kW PA Module LED's		System Controller FAULT LED's			
	PWR	FAULT	TEMP	VSWR	SPLY	AIR FLOW
FAN	ON	OFF	OFF	OFF	OFF	ON
TEMP	ON	OFF	ON	OFF	OFF	OFF

When the FAN fault condition disappears, the AIR FLOW fault LED will turn OFF on the next key. It takes approximately 10 seconds of transmission for this fault to be cleared. (Note: Momentary flashing of a fault LED does not indicate a fault. The LED must be on continuously to indicate a fault.)

When the Temperature fault condition disappears, the TEMP fault LED will turn OFF.

Combiner faults are also indicated on the T-4180 Module Status screen #1.

System Controller Module:

The System Controller module monitors forward (FWD) and reflected (REV) power from the VSWR detector inside the Combiner module and calculates VSWR. A VSWR fault is declared when the VSWR exceeds approximately 4:1.

With a VSWR fault the System Controller and PA module LED display is as shown below.

System Controller Module Fault	1.25kW PA Module LED's		System Controller FAULT LED's			
	PWR	FAULT	TEMP	VSWR	SPLY	AIR FLOW
VSWR	OFF	OFF	OFF	ON	OFF	OFF

The transmitter will continue to operate with reduced output power.

If a new operating frequency is selected following a VSWR fault, the power will remain low and only slowly increase to a normal value if the VSWR condition has improved.

Transmitter rack cabinet system

a. The Operational Interlock connection (Cabinet Interlock) is monitored by the System Controller. With an operational interlock switch "open" a Cabinet Interlock fault is declared. The Transmitter will remain in – or return to – STDBY mode (see OPER mode description above). In this condition, the 50VDC output of the Power Supply Module will be off.

b. The System Controller monitors the serial data communication with each of the four PA modules. A failure to communicate with a PA module generates a Communications fault. The Transmitter response is to disable the PA module bias and reduce system power output as needed.

Note: The System Controller LED display will not show Operational Interlock fault or PA module serial communications faults. The specific fault condition is indicated on the T-4180 Module Status screens.

CHAPTER 4
FUNCTIONAL DESCRIPTION

4.1 INTRODUCTION

This chapter starts with a functional description of the COM5000-8 power amplifier followed by a description of the individual modules comprising it. These modules are:

1.25kW PA Module (4 each)
Combiner Module
System Controller Module
Power Supply Module

4.2 COM5000-8 SYSTEM

A block diagram of the COM5000-8 Amplifier System is shown in figure 4.2.

The RF output signal of the T-4180 is connected to the System Controller Module, where it is split into four in-phase signals that each drives a PA module.

The outputs from the four PA modules are fed to a 4-Way, in-phase Combiner Module.

The Combiner output is routed to the antenna. Control and monitoring functions are provided by the System Controller Module.

The COM5000-8 is powered by a 3-phase Power Supply Module rated at 15kW DC out (50V @ 300A).

4.3 1.25KW PA MODULE

A block diagram of the 1.25kW PA Module is shown below in figure 4.3.

The RF output signal from the System Controller module is applied to the RF INPUT of the PA module. The signal is amplified in the Driver Amplifier and then split into four signals of approximately 10 watts each - two @ 0 degrees and two @ 180 degrees relative phase. These signals are amplified in the 350W AMP's.

The four 350W AMP outputs are combined in the 1.25 kW COMBINER and routed to the 8-band Harmonic Filter Assembly.

A PA Controller provides control and monitoring functions as well as remote control from the System Controller.

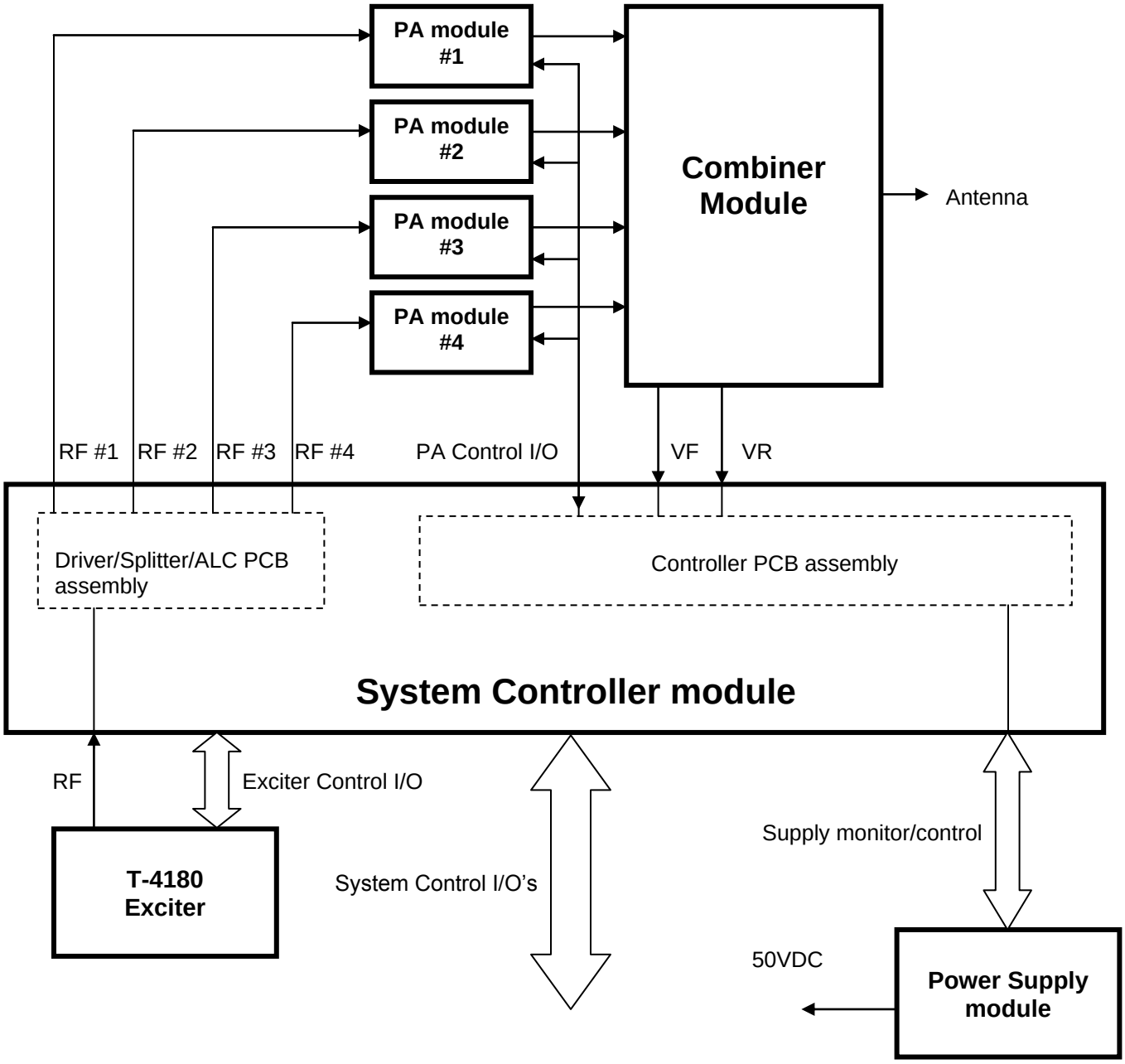


Figure 4.2. COM5000-8 Block Diagram

350W AMP

350W AMP

350W AMP

350W AMP

Figure 4.3. 1.25 kW PA module Block Diagram

4.4 COMBINER MODULE

The Combiner module receives signals from the four 1.25kW PA modules and combines the signals, in-phase, to yield the 5kW output signal. The output signal is routed through a VSWR Detector (located inside the combiner module) to provide forward and reflected power information for the System Controller.

4.5 SYSTEM CONTROLLER MODULE

A block diagram of the System Controller module is shown in figure 4.5.

The System Controller contains a Linear Power Supply, the Splitter/ALC PCB Assembly and the System Controller PCB Assembly. Together they control and protect the various modules comprising the Transmitter system.

The Splitter/ALC PCB circuitry comprises a 4-way, in-phase, splitter that divides the RF input signal from the Exciter into four signals that each drives a PA module. The RF input signal is rectified to provide a DC voltage to the Input Drive monitoring circuitry. The detected input drive level is read by the microprocessor and provides information to prevent input overdrive.

The System Controller PCB contains the following functional groups:

A) Combiner Control and monitoring circuitry provides ON/OFF switching of the Combiner FAN and receives information on the Combiner heatsink temperature.

   Voltages proportional to the forward (VF) and reflected (VR) power are routed to the Fault Sensing circuitry and to the Meter Drivers. VF and VR are also applied to the automatic level control (ALC) circuitry to maintain constant output power as well as protection against excessive antenna VSWR.

   With an antenna VSWR of 2:1, output power is reduced to approximately 2500-3500 watts. With a 3:1 antenna VSWR, output power is reduced to approximately 1500-2000 watts. These are typical values only and are not guaranteed under all possible antenna impedances.

   VF and VR voltages are read by the microprocessor and used in calculation of system gain and VSWR.

B) PA module control and monitoring circuitry communicates with the PA Controller inside each PA module. Filter select information is transmitted to and status information is received from the PA modules.

   The PTT (Key) output from the microprocessor is hard-wired to the PA modules.

C) The Power Supply control and monitoring circuitry turns the Power Supply ON and OFF and monitors the supply voltage.

D) Cabinet Interlock information is processed by the microprocessor.

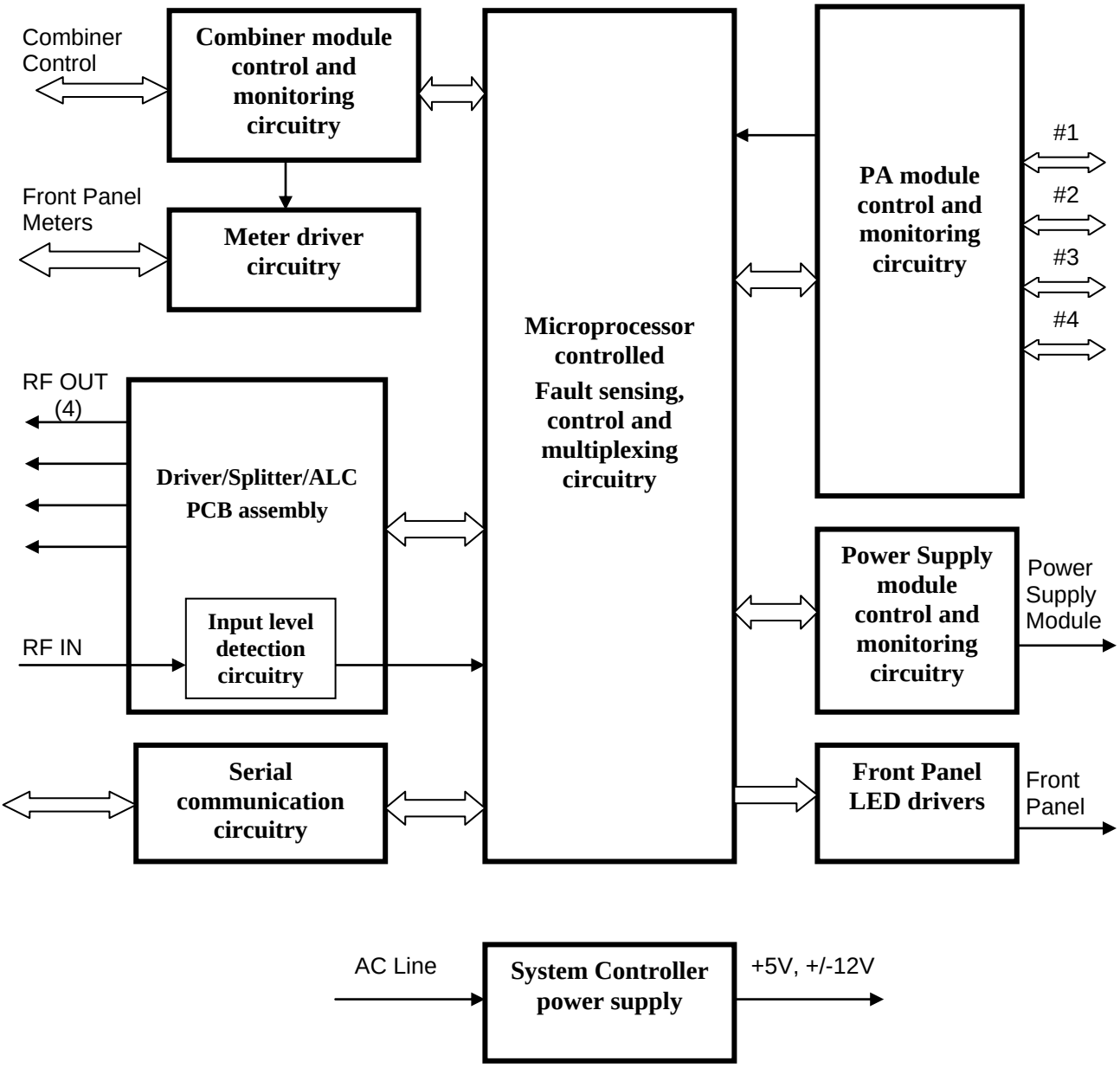


Figure 4.5. System Controller Block Diagram

4.6 POWER SUPPLY MODULE

The Power Supply consists of 3 invertors with the AC inputs and DC outputs connected in parallel. Each invertor is rated for 5 kW (50 VDC at 100 A). Total output power of the Power Supply is 15 kW (50 VDC at 300 A).

The 3-phase AC input is applied to the invertors through a 3-pole circuit breaker mounted on the front panel. This circuit breaker also serves as the AC power switch.

The DC output of the invertors is routed through 8 circuit breakers on the front panel. There are 2 circuit breakers for each 1.25 kW Power Amplifier module.

The DC output is also applied to the Accessory connector (J4) through a 3A circuit breaker.

Two of the AC input lines are routed to an auxiliary AC output connector (J2) on the rear panel. This output is protected by a 5A 2-pole circuit breaker mounted on the rear panel. The auxiliary AC output is not controlled by the front panel AC power switch. It is always present even if the front panel power switch is off. This output is used to provide 208 VAC power to the Exciter module and the System Controller module.

CHAPTER 5
MAINTENANCE

5.1 INTRODUCTION

The maintenance chapter contains a list of recommended test equipment, and instructions for mechanical disassembly, for verifying the performance of the amplifier, for routine adjustments, and for aligning the Transmitter.

For maintenance refer to the Transmitter Interconnect Wiring diagram 351803, figure 5.1.

5.2 RECOMMENDED TEST EQUIPMENT

Equipment	Manufacturer
RF Signal Generator	Agilent model N5171B
Wattmeter	Bird model 4421
10 kW sensor	Bird model 4024
1 kW sensor	Bird model 4021
50 ohm Load, 10kW	Bird model 8931-230*
Directional Coupler, 10kW	Werlatone model C1449
50 ohm Load/Attenuator, 4kW	Bird model 8329-300 with BA-230*
20dB Attenuator, 1W	Mini-Circuits model HAT-20
Variable Step Attenuator	JFW model 50BR-017
Spectrum Analyzer	Agilent model N9320B
Oscilloscope	Tektronix model TDS2012C
DVM	Fluke model 77

*Uses 230VAC blowers. For 115VAC, change -230 to -115 in model number.

Note: Equivalent equipment may be substituted.

5.3 PERIODIC MAINTENANCE

The only items that require regular maintenance are the air filters. The filters should be removed and cleaned periodically at a frequency determined by the operating environment. The filters are located on the front panel of the modules.

To remove the filters simply pull out the filter from the bracket.

The filter can be washed with a diluted soap solution. Dry the filter completely before replacement.

5.4 MODULE AND SUBASSEMBLY MAINTENANCE

All factory supplied spare modules and subassemblies are aligned prior to shipment and adjustments are normally not required following replacement of a particular subassembly obtained from the factory. The following maintenance procedures are intended for use if minor repairs have been performed in the field or for other reasons the equipment requires alignment.

5.4.1 PA Module Maintenance

For 1.25kW PA Module maintenance refer to the PA Module Interconnect wiring diagram shown in figure 5.4.1.

The 1.25kW PA Module comprises the following assemblies:

1 ea.	PA/Driver/Splitter (heatsink)	351275-1
2 ea.	PA (heatsink)	351280-1
1 ea.	PA/Combiner (heatsink)	351285-1
1 ea.	Harmonic Filter	L163184
1 ea.	PA Controller PCB	L163209-1
1 ea.	Fan Interface plate assembly	351289-1
2 ea.	1.25kW PA Module Fans	351293-1

Location of these assemblies is shown in figure 5.4.1A, 5.4.1B and 5.4.1C. The Fans are located on the rear panel of the 1.25kW PA Module.

Disassembly to gain access to the 1.25kW PA Module assemblies is described in this section. Unless otherwise noted, reassembling is done in the opposite order of disassembly.

To perform alignment of the 1.25kW PA Module it is necessary to operate the module as a “stand-alone” Amplifier – while still part of the Transmitter - as follows:

- The 1.25kW PA Module is pulled out of the Transmitter rack cabinet to gain access to subassemblies.
- The 50V Power Supply is still connected to the PA Module.
- Control connections from the T-4180 are still connected to the System Controller module in order to provide control (keying, filter selection etc.)
- The T-4180 RF Output connector is terminated into a 50 Ohm Load.
- An RF Signal Generator is used to provide the required drive signal to the PA Module.
- The PA Module is terminated in a 50 Ohm Load/Attenuator with a wattmeter inserted between the PA Module and the load.

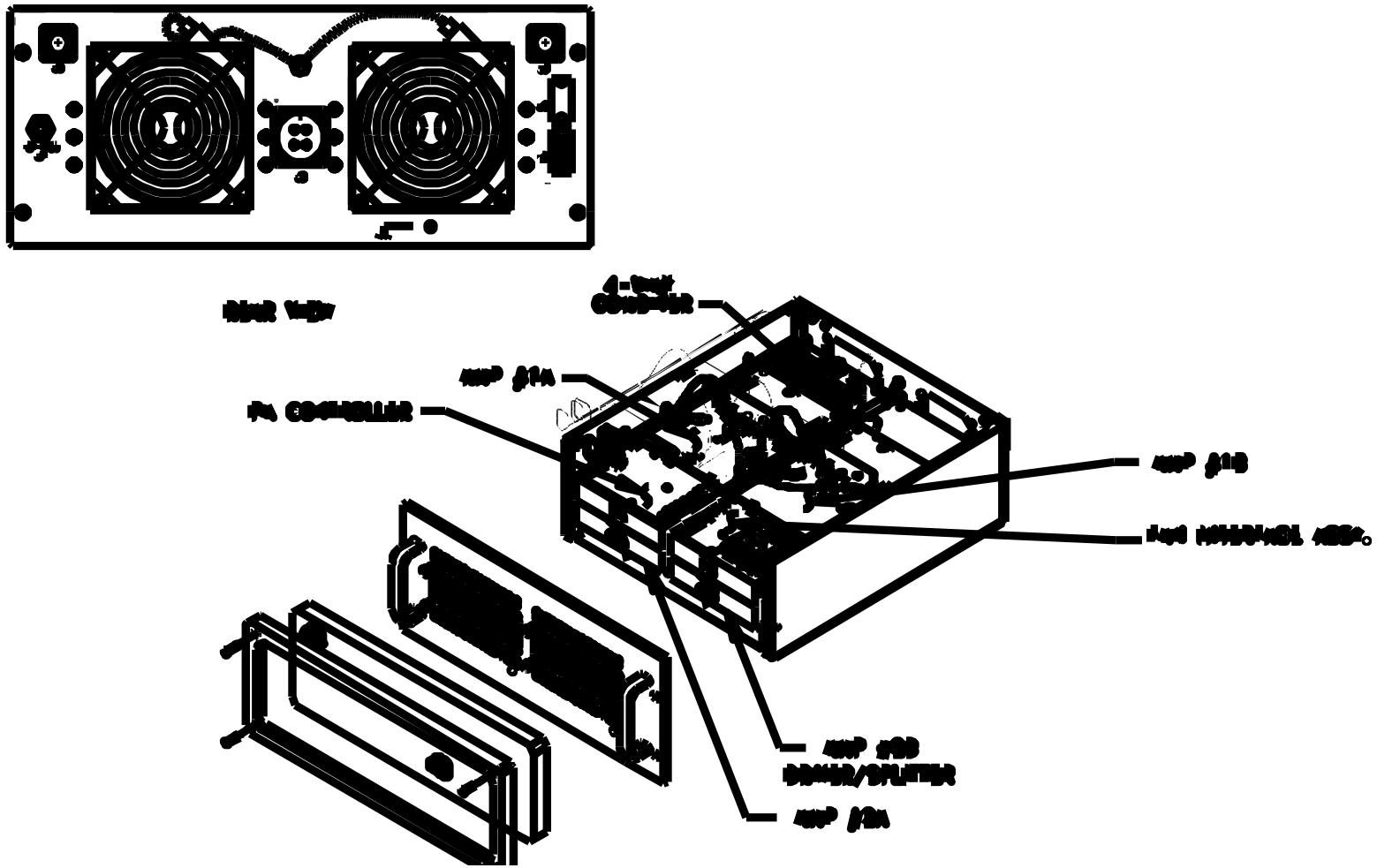


Figure 5.4.1A. 1.25kW PA Module Subassembly Location

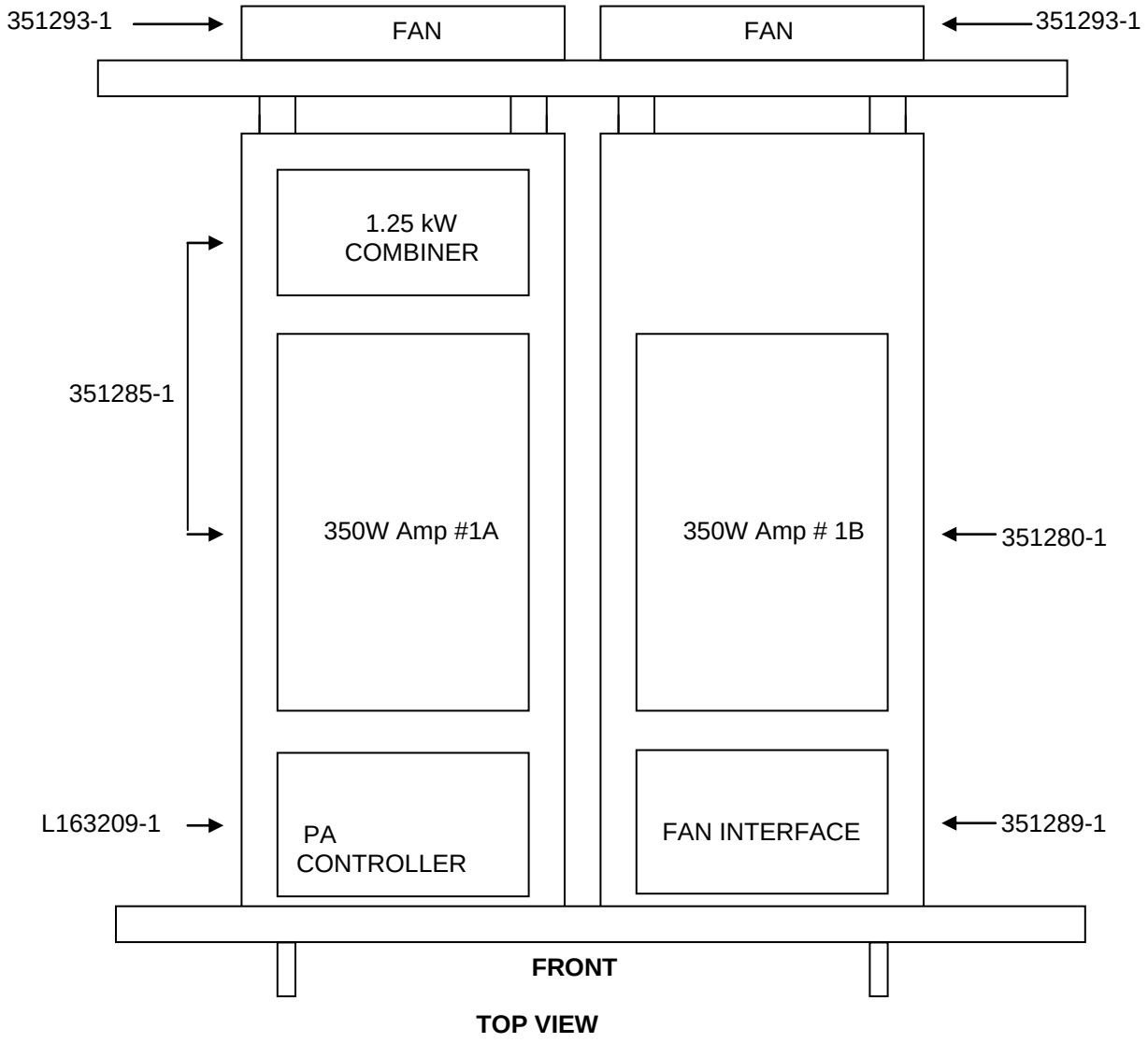
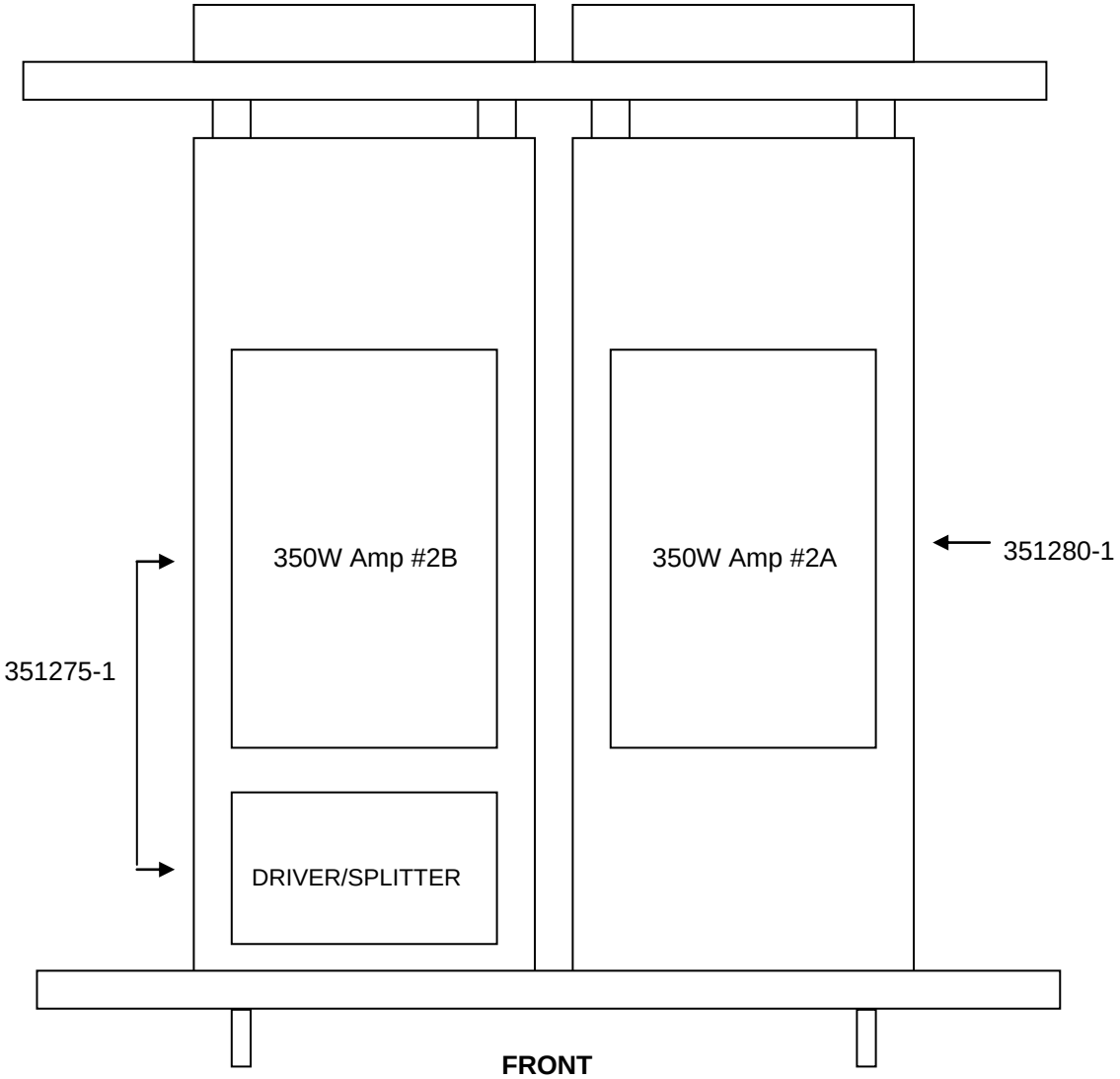


Figure 5.4.1B. 1.25kW PA Module



BOTTOM VIEW

Figure 5.4.1C. 1.25kW PA Module

5.4.1.1 Harmonic Filter Assembly Maintenance

See figure 5.4.1A

To gain access to the Harmonic Filter PCB assembly, loosen the six captive screws that secure the filter assembly cover to remove the cover.

CAUTION: RF HAZARD
ALIGNMENT OF THE HARMONIC FILTER VSWR DETECTER CAUSES EXPOSURE TO RF

Adjustments:

The following adjustments should only be performed when a PCB assembly has been repaired in the field. All PCB's are factory aligned prior to shipment.

VF/VR "Nulling":

a) Operate the PA Module as a “stand-alone” Amplifier – while still part of the Transmitter - as described in section 5.4.1 above.

b) Turn ON the Transmitter. Select an operating frequency of 16 MHz and key the system.

c) Adjust the signal generator level to obtain a power output of 1000 W at a frequency of 16 MHz.

c) Measure the DC voltage at J2 pin 4 (VR).

d) Adjust C4 for a dip (minimum) reading. The voltage should be less than 0.5 VDC.

e) Note the position of trimmer capacitor C4 as indicated by the position of the silver plating (1/2 circle) on top of the trimmer capacitor.

Adjust C9 to the same position.

f) With a power output of 1000 W, measure the voltage on J2 pin 5 (VF). Verify that this voltage is 13.3 – 13.9 V. If not adjust C9 for a voltage of 13.6V measured on J2 pin 5.

g) Un-key the system

5.4.1.2 350 W Amp Assembly Maintenance

To gain access to the bottom two 350 W Amp's remove the bottom cover. To gain access to the top two 350 W Amp's proceed as follows:

1. Loosen the two "captive" screws that secure the Filter assembly to the 1.25kW PA Module front panel.

2. Carefully move the filter module up to past its vertical position and make sure that it "leans back" onto its back stops.

3. For location of the 350 W Amp's see figure 5.4.1B and 5.4.1C.

Adjustments:

The following adjustments should only be performed when a PCB assembly has been repaired in the field. All PCB's are factory aligned prior to shipment.

Initial potentiometer setting: R42 midrange
R44, 47, 60 and 64 fully counter clockwise

Bias current adjustment:

a) Operate the PA Module as a “stand alone” Amplifier – while still part of the Transmitter - as described in section 5.4.1 above.

Initially turn the 5-kW amplifier system OFF **and make sure that the T-4180 RF Output connector is terminated into a 50 Ohm Dummy Load** to prevent RF from being applied while performing the adjustment.

Insert an ammeter in the 50 VDC connection to the 350 W Amp module to be adjusted. If necessary, temporarily remove the auxiliary 50VDC connection to eliminate its effect on the current reading. This is the thin red wire going to the Fan Interface Board.

Pre-adjust the bias adjust potentiometer R44, 47, 60 and 64 to their fully counter clockwise position.

Note: R42 is not used and should be left in its approximate midpoint position.

b) Turn ON the 5-kW Amplifier system. Key the system and observe the residual current. Slowly turn R44 clockwise for a current increase of 400 mA. Then turn R47 for an additional current increase of 400 mA (800 mA above residual). Now turn R60 clockwise for a current increase of 400 mA (1200 mA above residual). Finally turn R64 clockwise for a current increase of 400 mA (1600 mA above residual). This provides a bias current of 400 mA through each of the four MOS FET transistors.

Perform this bias adjustment quickly to avoid the transistor heating effects from influencing the adjustment. Be sure that the heatsink is getting adequate cooling during alignment to allow stable settings.

Note: If it is not desirable to key the 5-kW Amplifier system, a particular 350 W Amp can be biased independently by applying 5-8 VDC to J1-5 **after removing the plug connection to J1-5.**

c) After adjusting bias current, turn off the 5-kW amplifier system, remove the ampere meter and reconnect 50 VDC.

5.4.1.3 PA Controller PCB Assembly Maintenance

To gain access to the PA Controller PCB, proceed as follows:

1. Loosen the two "captive" screws that secure the Filter assembly to the 1.25kW PA Module front panel.

2. Carefully move the filter module up to past its vertical position and make sure that it "leans back" onto its back stops.

3. For location of the PA Controller PCB see figure 5.4.1B.

Adjustments:

The following adjustments should only be performed when a PCB assembly has been repaired in the field. All PCB's are factory aligned prior to shipment. Also, this adjustment should only be performed if the Driver/Splitter, 350 W Amplifier and Harmonic Filter adjustments have been completed.

Adjustments to perform: U3, Vref voltage

VF, VFL and VR

Nominal Power output, 50 Ohm, 1000 W

2:1 VSWR Power output, 500 W

DRVR Q1FLT Window Comparator

CAUTION: RF HAZARD
ALIGNMENT OF THE PA CONTROLLER CAUSES EXPOSURE TO RF

Initial potentiometer setting:

Potentiometers may be preset by measuring resistance and adjusting as shown below:

Note: The purpose of presetting the potentiometers is to avoid drastic misalignments that may damage the equipment when power is applied.

If the potentiometers listed below have not been replaced or adjusted, presetting should not be performed.

Resistance measurements must be performed with the PA Controller completely installed in the 1.25kW PA Module (all connections secured) but without 50V supply voltage applied.

Note: Perform the following adjustments in the order listed below.

Measure from:	Verify values:	Adjust for:	Using potentiometer:
U2 pin 3 to ground	750 – 850 Ohm	800 Ohm	VR8
U20 pin 6 - 7	800 – 900 Ohm	850 Ohm	VR5
U20 pin 1 - 2	600 – 900 Ohm	750 Ohm	VR6
U20 pin 10 - ground	750 – 850 Ohm	800 Ohm	VR7
U20 pin 12 to ground	2100-2500 Ohm	2300 Ohm	VR4

In addition,

Adjust VR9 fully **counter clockwise**

Adjust VR10 fully **clockwise**

Alignment:

a) Operate the PA Module as a “stand alone” Amplifier – while still part of the Transmitter - as described in section 5.4.1 above.

U3, Vref voltage: Turn ON the System. Measure the voltage at U3 pin 3. Set VR1 for a voltage of 2.00 VDC.

VF, VFL

b) Select a T-4180 operating frequency of 16 MHz.

c) With the 1.25kW PA Module terminated in a 50 ohm load, key the 5-kW Amplifier system. Adjust the RF Signal Generator level to obtain a power output of **1000 W.** Wait for the initial drift in power to settle in order to get a reasonably stable **1000 W** power.

d) Proceed to perform this adjustment on the PA Controller PCB Assembly with **1000 W** power output:

VF: Set VR6 for a reading of 2.00 V measured on U20A pin 1.

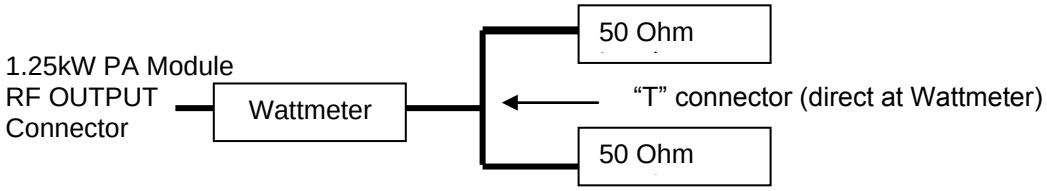
VFL: Set VR8 for a reading of 1.00 V measured on U2 pin 3.

e) Un-key the system.

VR:

f) Replace the 50 ohm load with a load producing a 2:1 VSWR (two parallel connected 50 ohm loads to form a 25 ohm load). Connect the Wattmeter and dummy loads as shown below:

g) Place the Wattmeter sensor directly on the 1.25kW PA Module RF OUTPUT connector and the "T" connector directly at the Wattmeter connector.



h) Starting with a low RF output level from the RF Signal Generator increase the generator level until the forward power reading is 500W.

i) Measure the voltage on U20-1 (VF). Adjust VR5 so the voltage measured on U20-7 is equal to the voltage at U20-1.

j) Measure the voltage on U20 pin 7. Adjust VR7 such, that the voltage measure on U20 pin 10 is 1/2 of the voltage measured on U20 pin 7.

k) Un-key the system. Set up for operation into **one 50 Ohm load**.

l) Key the system. Increase the RF drive level to obtain an output power of **1250 W**.

m) Proceed to perform this adjustment on the PA Controller PCB Assembly with **1250 W** output:

VF: Set VR6 for a reading of 2.00 V measured on U20A pin 1.

VFL: Set VR8 for a reading of 1.00 V measured on U2 pin 3.

DRVR Q1FLT Window Comparator:

This adjustment requires the Driver bias current adjustment to have been completed. See paragraph 5.4.1.4.

a) Operate the PA Module as a "stand alone" Amplifier – while still part of the Transmitter - as described in section 5.4.1 above.

b) Turn ON the System. With the system un-keyed, measure and record the DC voltage on U17 pin 4.

c) Measure the DC voltage at U17 pin 5 and adjust VR9 for a voltage **0.05 V** below the voltage measured on U17 pin 4.

d) Select an operating frequency of 29.9 MHz and key the transmitter

e) Adjust the RF Signal Generator level to obtain a power output of 1250 W. Wait for the initial drift in power to settle in order to get a reasonably stable **1250 W power.**

f) Measure and record the DC voltage at U17 pin 9.

g) Measure the DC voltage at U17 pin 8 and adjust VR10 for a voltage **1.5 V** below the voltage measured at U17 pin 9.

5.4.1.4 Driver/Splitter Maintenance

To gain access to the Driver/Splitter, remove the 1.25kW PA Module bottom cover.

The location of the Driver/Splitter is shown in figure 5.4.1C.

Adjustments:

The following adjustments should only be performed when a PCB assembly has been repaired in the field. All PCB's are factory aligned prior to shipment.

Bias current adjustment:

a) Operate the PA Module as a “stand alone” Amplifier – while still part of the Transmitter - as described in section 5.4.1 above.

Initially turn the 5-kW amplifier system OFF **and make sure that the T-4180 RF Output connector is terminated into a 50 Ohm Dummy Load** to prevent RF from being applied while performing the adjustment.

b) Remove fuse F1 on the Driver/Splitter PCB and insert an ampere meter in place of the fuse to measure the current drawn by Q1.

Pre-adjust the bias adjust potentiometers R34, R35, R36 and R37 to their counter clockwise position for minimum bias in Q1 and Q4.

c) **Q1 bias** is turned ON by shorting R30 to ground (do not key the system to apply bias). Note the "residual" current. It should be 70-90 mA. Slowly turn R36 clockwise for a current reading of 230 mA above the residual current.

Then turn R37 slowly clockwise until the total current reads 460 mA above the residual current.

e) **Q4 bias** is always ON.

With the DVM, measure and record the DC voltage across C20. This “start” voltage should be 47 – 50V.

f) Slowly turn R34 clockwise until the “start” voltage drops by 2.0 volt. Then turn R35 slowly clockwise until the “start” voltage has dropped by 4.0 volt.

g) Repeat f) a number of times until the voltage measured across C20 has dropped to 22-23 V. To improve the adjustment accuracy it may be necessary to drop the voltage by 1.0 V as the voltage across C20 approaches its final value.

h) Verify that the voltage measured on the gates of Q4 (@ R31 and @ R29) are within 0.2 volt of each other.

i) After adjusting bias current, turn OFF the 5-kW Amplifier system, remove the ampere meter and reinstall the fuse.

Driver Gain adjustment (1.25kW PA Module gain):

The DRIVER/ALC gain adjustment, using potentiometer R2, is performed to set the 1.25kW PA Module gain equal to approximately 47 dB at 29.9 MHz.

a) Operate the PA Module as a “stand alone” Amplifier – while still part of the Transmitter - as described in section 5.4.1 above.

b) Turn ON the System. Select a T-4180 operating frequency of 29.9 MHz.

c) Set the RF Signal Generator output level to +12 dBm.

d) Connect the RF Signal generator to the 1.25kW PA Module.

e) Key the Transmitter and observe the power output. Adjust R2 for a power output of 1000 W.

5.4.1.6 1.25 kW Combiner Maintenance

To gain access to the 4-Way Combiner PCB proceed as follows:

1. Loosen the two "captive" screws that secure the Filter assembly to the 1.25kW PA Module front panel.

2. Carefully move the filter module up to past its vertical position and make sure that it "leans back" onto its back stops.

3. For location of the 1.25 kW Combiner PCB see Figure 5.4.1.B.

Adjustments: No adjustments are required.

5.4.1.7 Fan Interface Maintenance

To gain access to the Fan Interface plate, proceed as follows:

1. Loosen the two "captive" screws that secure the Filter assembly to the 1.25kW PA Module front panel.

2. Carefully move the filter module up to past its vertical position and make sure that it "leans back" onto its back stops.

3. For location of the Fan Interface plate see Figure 5.4.1B.

Adjustments: No adjustments are required.

5.4.2 Combiner Module Maintenance

Adjustments: See System Controller operational adjustment in section 5.4.3.3.

5.4.3 System Controller Module Maintenance

For System Controller maintenance, refer to the System Controller Interconnect wiring diagram shown in Figure 5.4.3.

The System Controller module comprises the following assemblies:

1 ea. Driver/Splitter/ALC PCB	1638-2001-1
1 ea. System Controller PCB	1638-2000-1
1 ea. Power Supply Assy.	L162087
1 ea. Fan	21000044

Location of these assemblies is shown in Figure 5.4.3A.

To perform alignment of the System Controller Module it is necessary to operate the Transmitter as follows:

- The System Controller Module is pulled out of the Transmitter rack cabinet to gain access to subassemblies.
- All Control connections from the T-4180 are in place to permit normal operation of the Transmitter.
- The T-4180 RF Output connector is terminated into a 50 Ohm Load for certain adjustments as specified below.
- An RF Signal Generator is used to provide the required drive signal to the System Controller Module for certain adjustments as specified below.
- The Transmitter is terminated in a 50 Ohm Load/Attenuator with a wattmeter inserted between the RF output connector and the load.

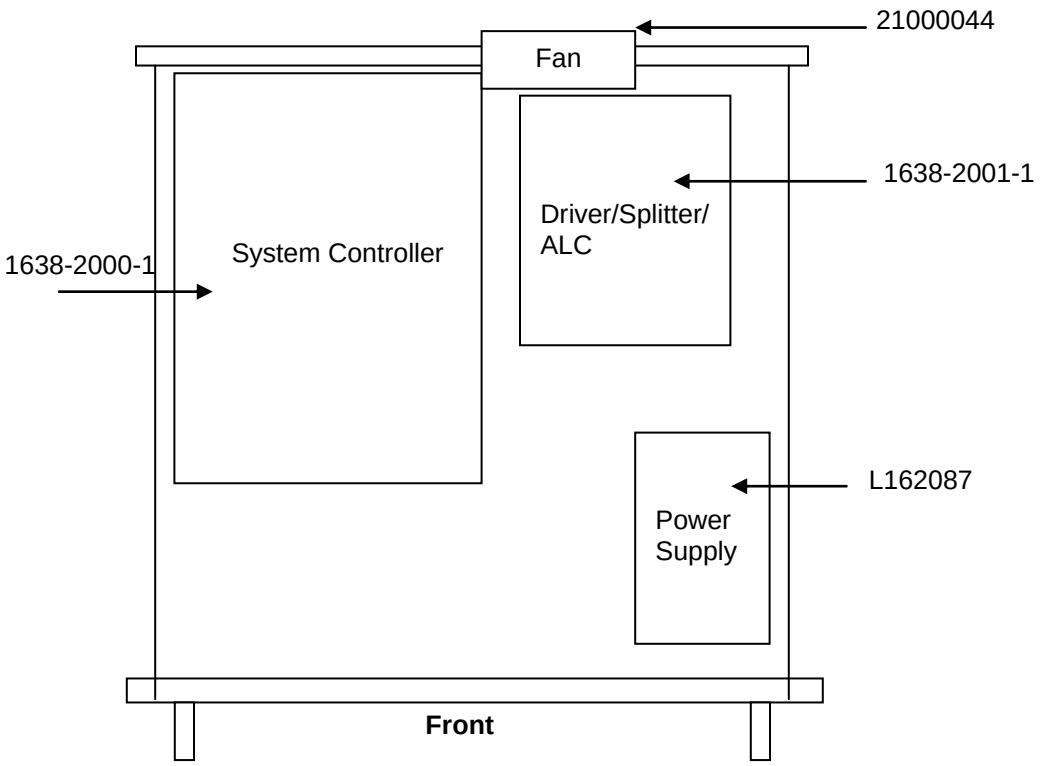


Figure 5.4.3A: SYSTEM CONTROLLER TOP VIEW

5.4.3.1 Driver/Splitter/ALC PCB Maintenance

To gain access to the Driver/Splitter/ALC PCB proceed as follows:

1. Remove the 4 retaining screws that secure the System Controller module to the rack cabinet. Pull the module slowly out all the way.

2. Remove the 6 screws on the side of the System Controller to remove the top cover. The Driver/Splitter/ALC PCB is located as shown in figure 5.4.3A.

Adjustments:

The following adjustments should only be performed when a PCB assembly has been repaired in the field. All PCB's are factory aligned prior to shipment.

Detected RF IN level adjustment:

a) Turn ON the System Controller module. Do not key the system

b) Connect the RF Signal Generator to the System Controller RF INPUT connector, J5. Set the Signal Generator level to + 16 dBm at a frequency of 2 MHz.

c) Adjust VR1 for 1.0 VDC measured on U13 pin 8 on the Driver/Splitter/ALC PCB.

This sets the normal input drive level to the microprocessor. If more than 22 dBm is applied to the RF input connector of the System Controller, the overdrive protection will engage.

d) Adjust VR2 for 0.55 VDC measured on U13 pin 14 on the Driver/Splitter/ALC PCB.

5.4.3.2 System Controller PCB Maintenance

To gain access to the System Controller PCB proceed as follows:

1. Remove the 4 retaining screws that secure the System Controller module to the rack cabinet. Pull the module slowly out all the way.

2. Remove the 6 screws on the sides of the System Controller to remove the top cover.

The System Controller PCB is located as shown in figure 5.4.3A

Adjustments:

The following adjustment should be performed when a PCB assembly has been repaired or been replaced in the field. Most of the adjustments of the System Controller require operation of the complete System. However, a few adjustments can be performed without operating the Transmitter.

The following System Controller adjustments may be performed without operating the Transmitter:

D/A Converter U2 reference voltage adjustment:

Turn on the System Controller module. Adjust VR1 of the System Controller PCB for a voltage of 2.0 VDC measured on U2 pin 3 (VREF).

5.4.3.3 System Controller Operational Adjustment

System Controller operational adjustment is performed to assure that the Transmitter operates within specified limits during normal operation.

Perform adjustments only after verifying that the operational parameters measured are out of tolerance.

With the System Controller module turned OFF, verify the setting of the System Controller PCB potentiometers listed below as follows:

Note: DO NOT PERFORM ADJUSTMENTS IF THE MEASURED VALUES ARE WITHIN THE SPECIFIED RANGE. PRESETTING THE POTENTIOMETERS LISTED BELOW ARE REQUIRED ONLY IF SERIOUS MIS-ADJUSTMENTS HAVE TAKEN PLACE.

The purpose of presetting the potentiometers is to avoid drastic misalignments that may damage the equipment when power is applied.

Resistance measurements are done on the PCB removed from the chassis or in the System Controller module with all external connections removed.

Measure resistance between:	Verify values:	Adjust:
U29 pin 3 and GND	2.2 – 2.4 K ohm	VR6 for 2300 Ohm
U29 pin 5 and GND	2.2 – 2.4 K ohm	VR7 for 2300 Ohm
U30 pin 1 and 2	2.6 – 2.8 K ohm	VR8 for 2700 Ohm
U30 pin 6 and 7	1.7 – 1.9 K ohm	VR9 for 1800 Ohm
U41 pin 1 and 2	1.6 – 1.8 K ohm	VR4 for 1700 Ohm
U41 pin 6 and 7	1.6 – 1.8 K ohm	VR3 for 1700 Ohm
U41 pin 10 and GND	4.3 - 4.7 K ohm	VR5 for 4500 Ohm
U41 pin 12 and GND	1.5 – 1.7 K ohm	VR2 for 1600 Ohm

To perform operational adjustment of the System Controller Module it is necessary to operate the Transmitter as follows:

- The System Controller Module is pulled out of the Transmitter rack cabinet to gain access to subassemblies.
- All Control connections and the RF drive signal connection from the T-4180 are in place to permit normal operation of the Transmitter.
- The Transmitter is terminated in a 50 Ohm Load/Attenuator with a wattmeter inserted between the RF output connector and the load.
- A variable attenuator (0.1 dB resolution) is inserted in the RF drive input connection between the T-4180 and the System Controller.

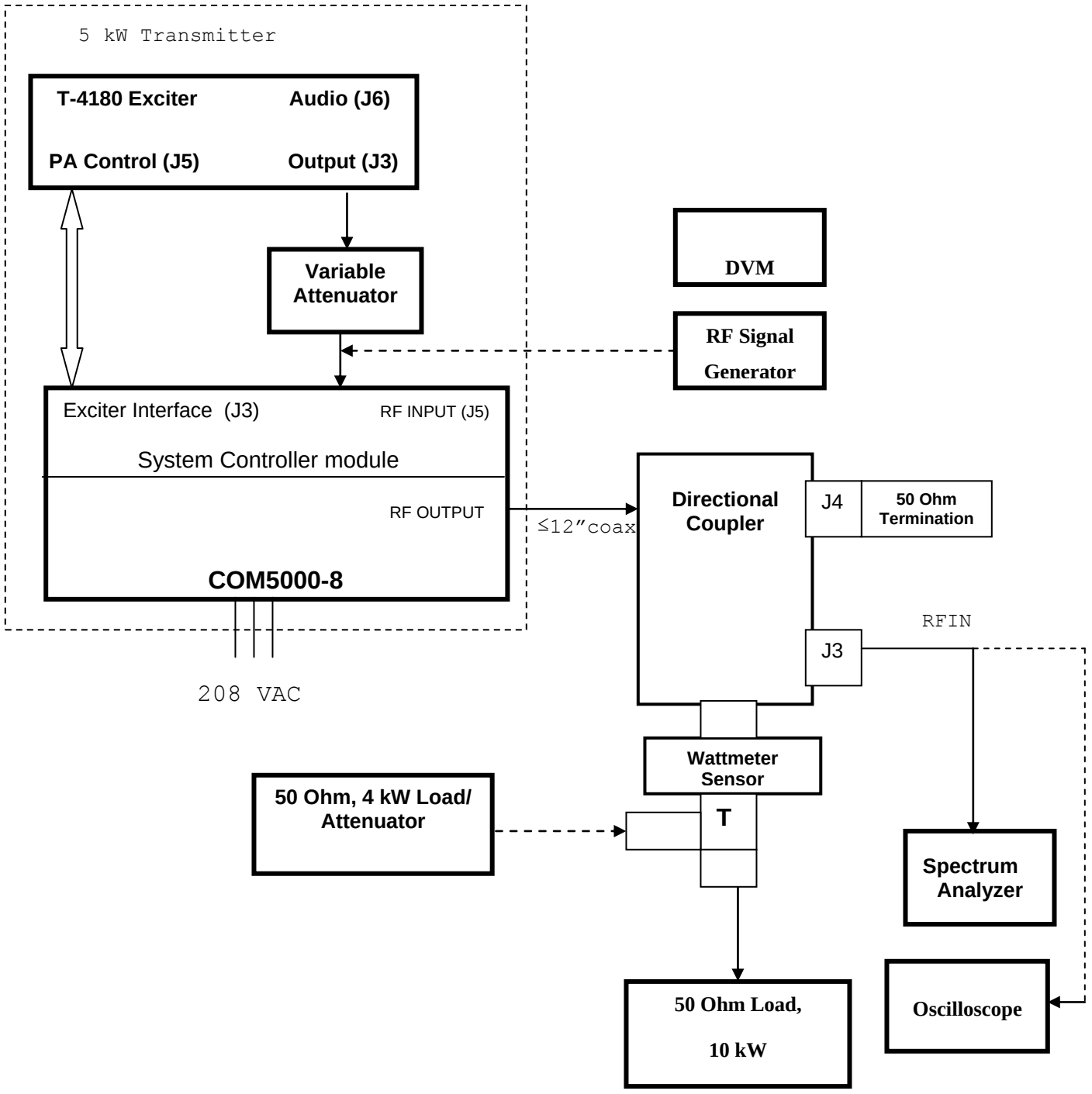


Figure 5.4.3.3. Test set up for System Controller operational adjustment

Setting System Controller potentiometers, Forward Power

a. Set up per figure 5.4.3.3. Command the Transmitter to operate on a frequency of 15 MHz, CW mode. Set the variable attenuator for maximum attenuation. Key the Transmitter.

b. Using the variable attenuator, slowly increase the power. Observe the Transmitter power output level on the wattmeter. Increase the power output to 4000W.

If it is not possible to obtain the 4000W there may be a number of reasons:

1. The ALC may be engaging - adjusting VR2 counter clockwise "releases" the ALC.

2. The Input Overdrive (ALC Splitter PCB) may be set wrong.

c. With 4000W output power:

1. Measure the DC voltage at the junction of R95 and L2 and verify that the voltage is 2.95 – 3.05 V.

2. Then adjust System Controller potentiometer VR4 for 2.00 VDC measured @ U31 pin 6.

3. Adjust VR8 for a System Controller front panel FWD PWR METER reading of 4000W.

Setting System Controller potentiometers, output power (ALC level) adjustment:

a. With a CW power output of 5000W, adjust the System Controller PCB potentiometer VR2 clockwise until the power drops to 4750W.

Un-key the system.

b. Change the T-4180 mode to ISB. Select “TONE” as modulation source with a modulation frequency of 500 Hz.

c. Key the system. While observing the PEP output power, readjust VR2 to obtain 5000W of **PEP** output power.

Un-key the system.

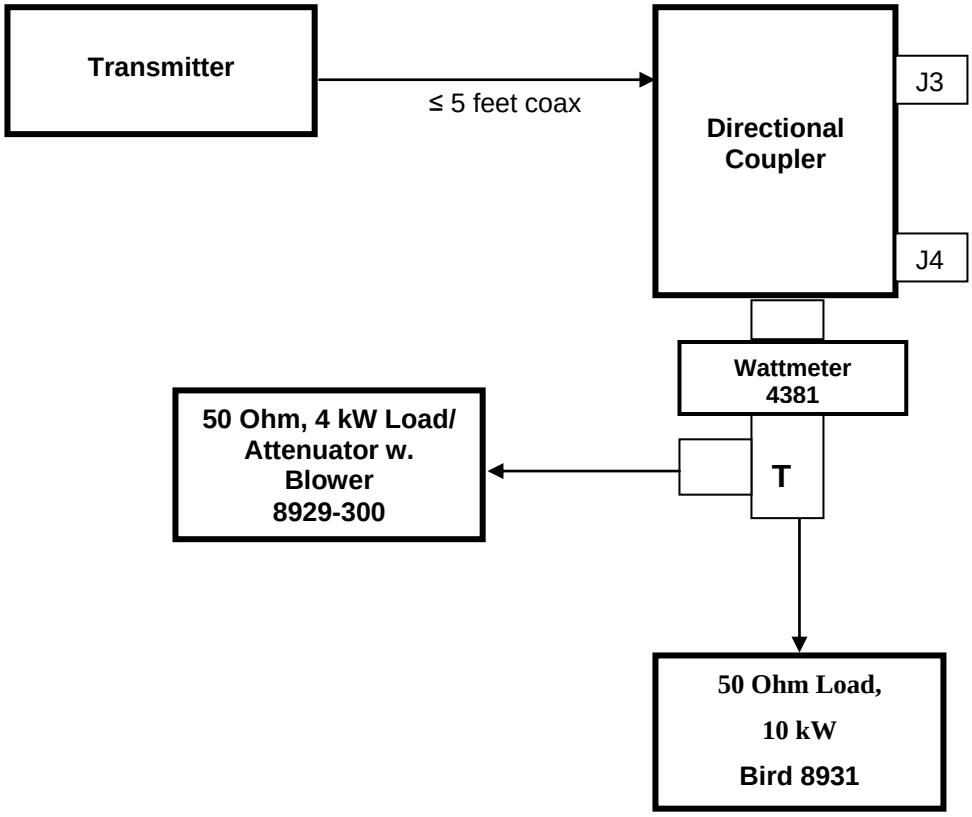
Setting System Controller potentiometers, Reflected Power

a. Connect the T-4180 – through a variable attenuator – to the COM5000-8. The variable attenuator is set for maximum attenuation. The T-4180 is set to operate in CW mode of operation at 100% power at a frequency of 15 MHz.

Key the transmitter system and observe the output power. Change the attenuation on the Variable Attenuator in small increments until the output power reaches 2000W.

b. Un-key the system. To prevent the microprocessor from reducing the power during this alignment, apply a short from the junction of R118 and C93 to ground using a “clip lead”.

c. Replace the 50 Ohm Load with two 50 Ohm loads connected in parallel to produce a VSWR of 2:1. Connect the two loads as shown below. The "T" connector must be connected directly to the Watt-Meter. The coaxial cable length from the “T” to the 50 Ohm loads is not critical. Note the placement of the Watt-Meter directly at the output of the LC connector.



d. Key the system and observe the Wattmeter reading. The forward power should be close to 2000W and the reflected power close to 200W.

By varying the RF drive level with the variable attenuator, adjust the reflected power read on the Watt-Meter for 200W - the forward power reading should be close to 2000W.

If it is not possible to obtain the 200W there may be a number of reasons:

1. The VSWR ALC may be engaging too early (VR5)

2. Actual fault conditions

e. With 200W reflected power:

Measure the DC voltage at the junction of R96 and L1 and verify that the voltage is 1.27 - 1.31 V. If not, there may be a problem in the Combiner module.

Then, if necessary:

1. Adjust VR3 for 1.16 VDC @ U31 pin 11

2. Adjust VR9 for a System Controller front panel REV PWR METER reading of 200W

f. Observe the forward power reading on the wattmeter. Adjust VR5 clockwise until the power drops to 1750W - or if no power reduction is observed - adjust VR5 fully clockwise.

g. While observing that the power output remains below **2750W**, reduce the attenuation on the Variable Attenuator in small increments until the attenuation is zero. It may be necessary to re-adjust VR5 to keep the power output below 3500W.

Note: If VR5 is adjusted fully clockwise the power must remain below 2750W

h. With zero attenuation on the variable attenuator, adjust VR5 for a forward power of 2750W.

i. Un-key the system. Remove the “clip lead” short from the junction of R118 and C93 to ground. Replace the 2:1 VSWR Load with a 50 Ohm Load.

5.4.4 Power Supply Module Maintenance

The Power Supply module provides 50 VDC at 300 A maximum to the Transmitter system. The Power Supply is a switch mode supply operating from a 3-PHASE AC Line input.

For Power Supply maintenance, refer to the Power Supply Interconnect wiring diagram shown in Figure 5.4.4.

Adjustments:

There are no adjustments that can be made in the field. Substantial disassembly of the power supply is required to adjust the output voltage. Return the power supply to the factory if the output voltage is out of tolerance (outside the range of 48-52 VDC).

5.5 SPARE MODULES AND ASSEMBLIES

Spare Modules:

Description	QTY Per COM5000-8	PART NUMBER
System Controller	1	1638-1000-12
1.25 kW Power Amplifier	4	351270-2
Power Supply	1	351830-2
Output Combiner	1	L163145-1
T-4180 Exciter	1	1644-1000-4

Spare Assemblies:

Description	QTY Per COM5000-8	PART NUMBER	Part of
PA/Driver heatsink assembly	4	351275-1	1.25kW PA Module
PA heatsink assembly	8	351280-1	1.25kW PA Module
PA/Combiner heatsink assembly	4	351285-1	1.25kW PA Module
Harmonic Filter assembly	4	L163184	1.25kW PA Module
PA Controller PCB	4	L163209-1	1.25kW PA Module
Fan Interface Plate assembly	4	351289-1	1.25kW PA Module
1.25kW PA module Fan	8	351293-1	1.25kW PA Module
ALC/Splitter PCB	1	1638-2001-2	System Controller Module
System Controller PCB	1	1638-2000-2	System Controller Module
Power Supply assembly	1	L162087	System Controller Module
System Controller module Fan	1	21000044	System Controller Module
Combiner module Fan	2	21000035	Combiner Module
AC Line Filter	1	C5915-00083	Rack Cabinet

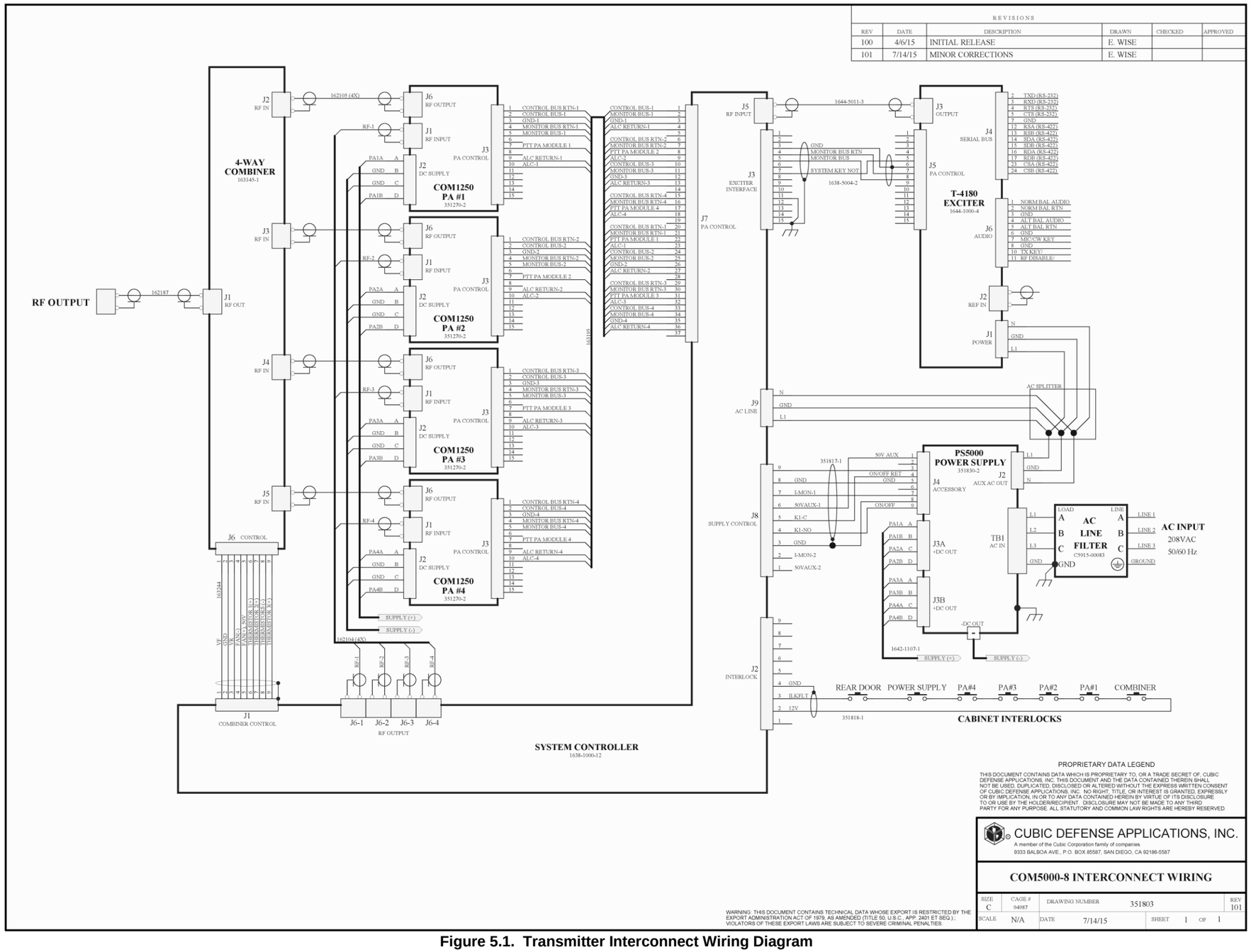


Figure 5.1. Transmitter Interconnect Wiring Diagram

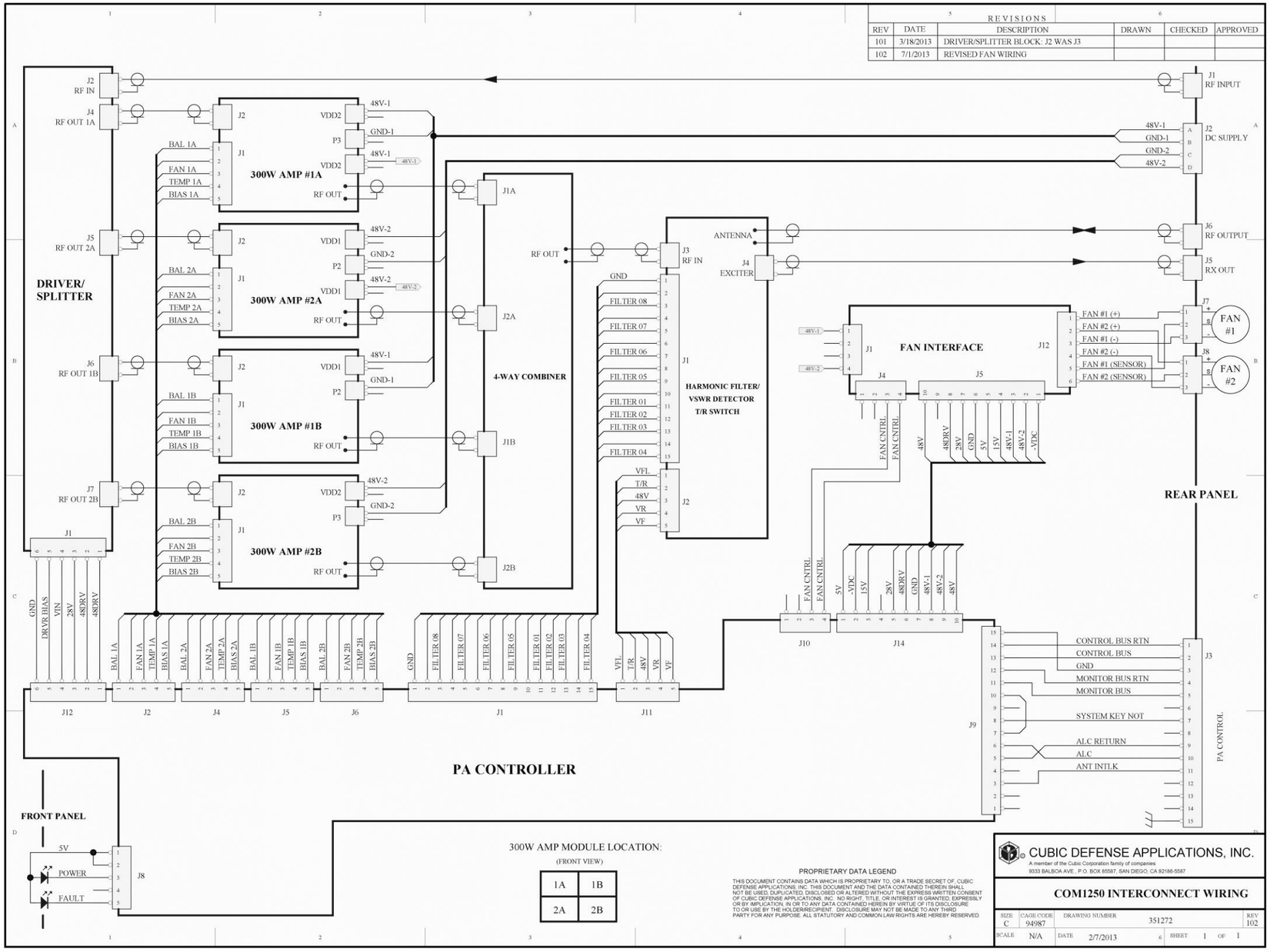


Figure 5.4.1. PA Module Interconnect Wiring Diagram

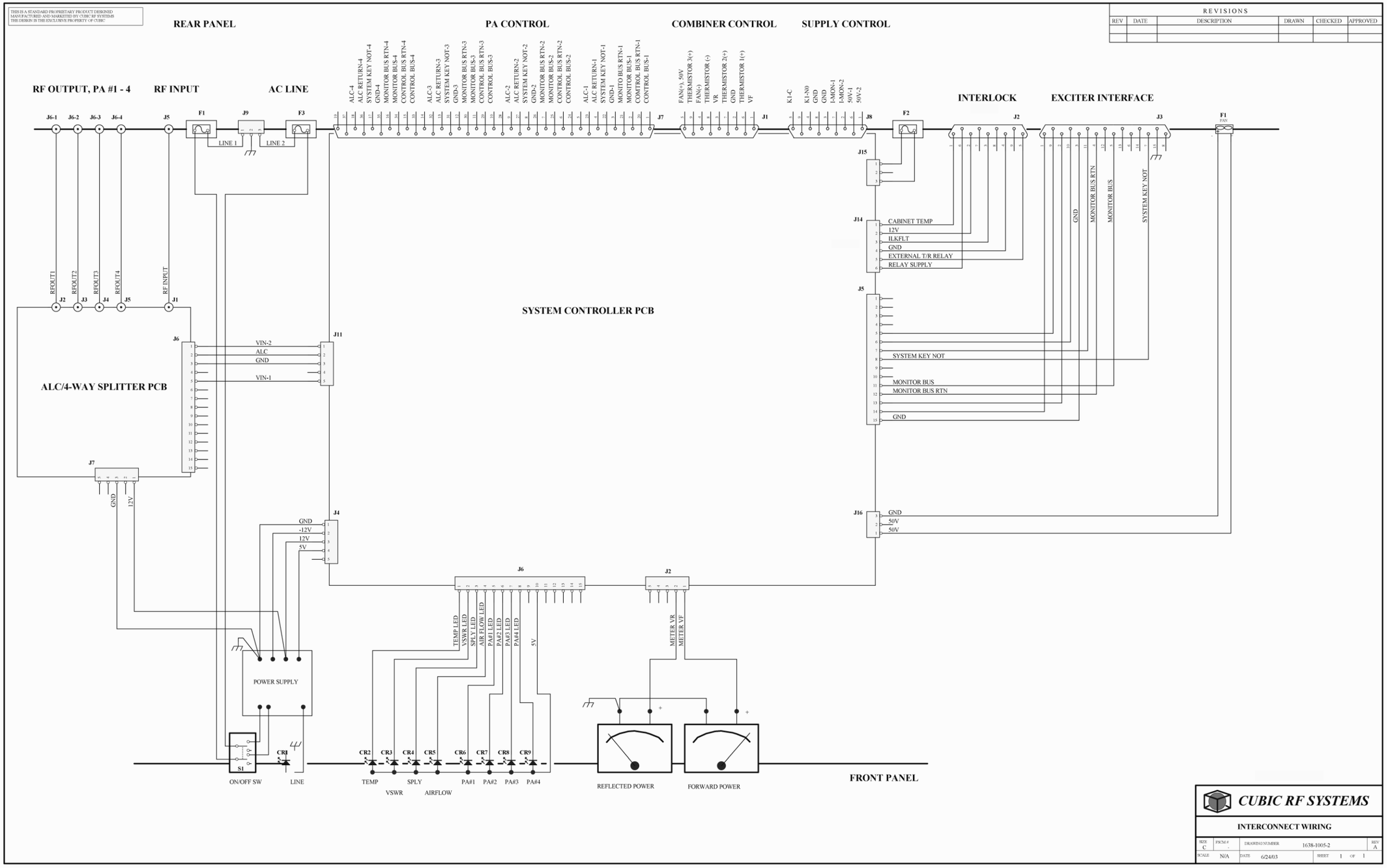


Figure 5.4.3. System Controller Interconnect Wiring Diagram

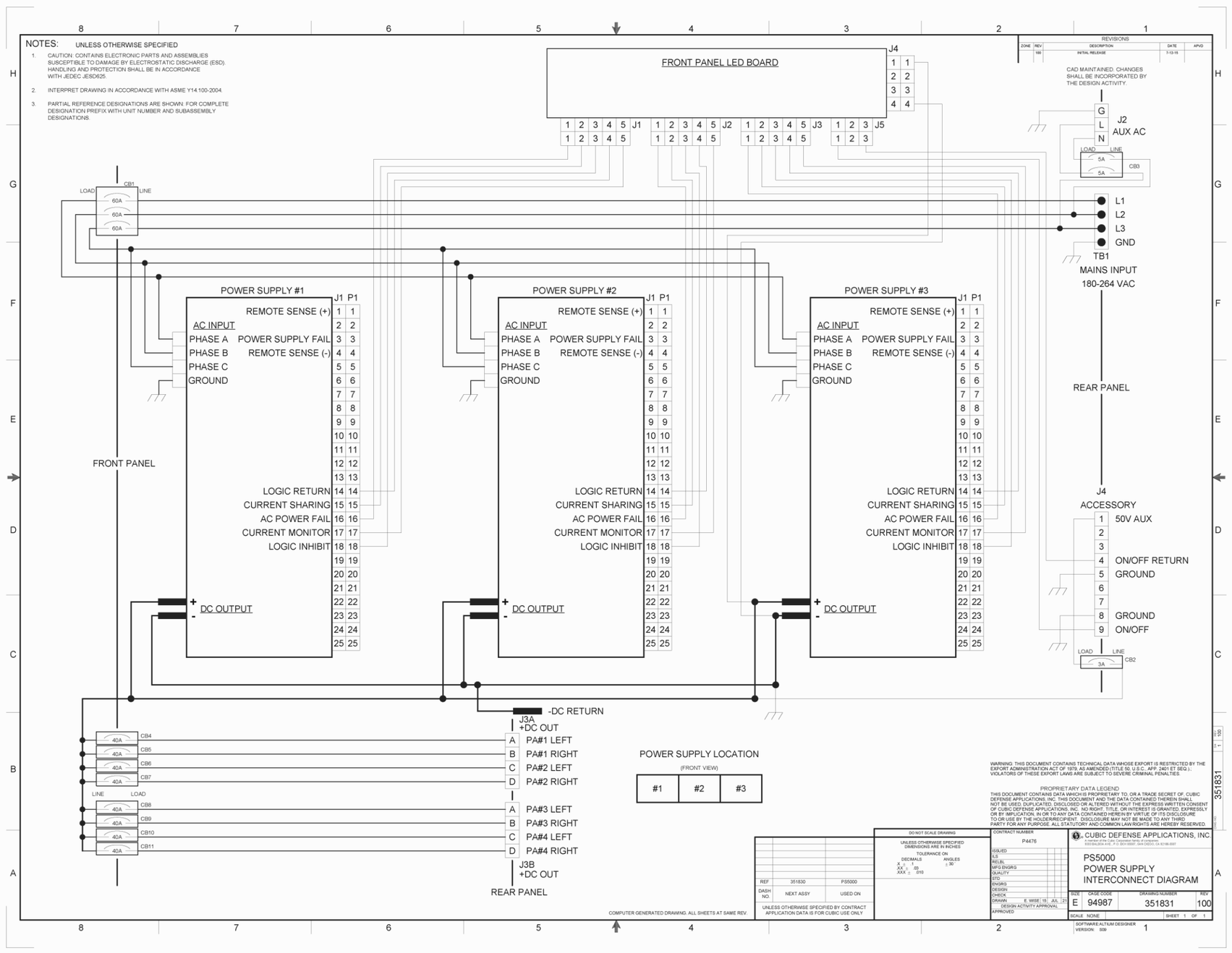


Figure 5.4.4. Power Supply Interconnect Wiring Diagram