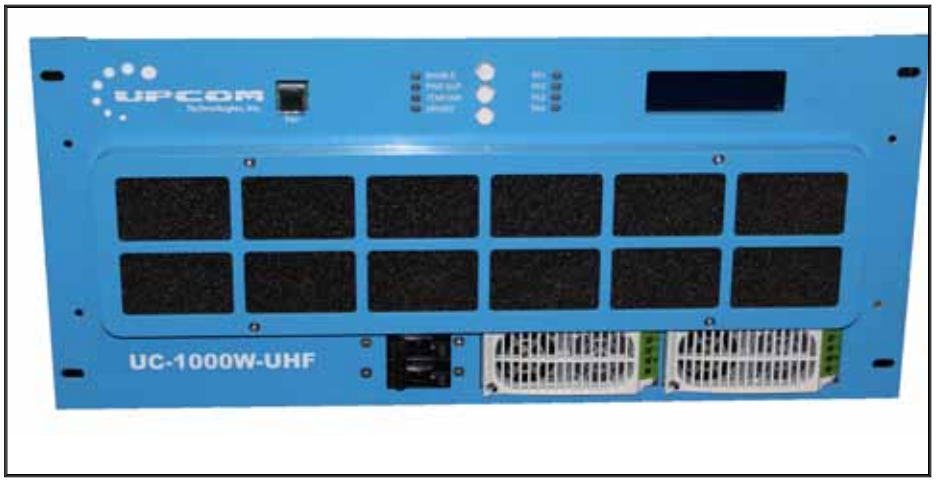
Installation
Operation
Maintenance
Troubleshooting

SCA 1000 Series
UHF Amplifier



Upcom Technologies, Inc.
San Jose, CA USA
http://www.upcom.com

Disclaimer:

This equipment is to be installed only by qualified, trained professionals and in accordance with local and federal codes. Failure to use a qualified professional will void all warranty coverage and may result in damage to equipment, facilities, installer and operator.

This equipment contains RF power densities not commonly found in compact solid state amplifiers. Extreme bodily harm and / or death may result in failure to follow instructions in this manual. Failure to comply is at the user's own risk.

Software License:

User is granted a non-exclusive license to use the software as installed or as may be installed during upgrades or repairs for this amplifier only. User has the right to transfer ownership of this software as part of a sale of amplifier.

User does not have the right to source code used in various embedded controllers in this system. User does not have the right to decompile or download source code or object code as installed in this system. Attempting this operation may damage the amplifier and will void any warranties.

User acknowledges full software license terms, and may request the full End User License Agreement by contacting Delta RF Technology. The EULA is incorporated as part of the standard Terms and Conditions of Sale. User agrees to all terms of this license agreement and acknowledges consent before installing and operating this amplifier.

Warranty, abbreviated:

A two year manufacturer's warranty covers this amplifier to the original purchaser and is non-transferrable. This warranty protects the end user against manufacturer's defects for a period of two calendar years, as measured from the date of original shipment to end user. This warranty does not cover the end user for improper installation, installation by non qualified technicians, Acts of God, intentional mis-use.

Most warranty service will require the return of the entire amplifier by the end user, although arrangements may be made to defer this requirement by obtaining written pre-approval.

Complete warranty details may be found at the end of this manual, or by contacting Manufacturer for up to date warranty details.

This warning symbol denotes important information, or brings the user's attention to areas of particular importance.

Revision History:
0.A - Initial Release S.Kazarian Jan 2008
0.B - Various Corrections, additional wiring diagrams, Eng/JK Mgm/SK Mar 2008
0.C - Changes for No display version of amplifier
0.D - Update for Non-verbose communications set / 4x20 LCD Display Wht/Blu
0.E - UHF Updates, Extended command set.

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1. Unpacking

a. Verification of Contents

Inspect the carton for any signs of shipping damage. The amplifier is designed to withstand impacts of up to 15G and is not fitted with an impact sensor. Obvious distress to crate and / or shipping box which bends sheet metal is not considered a warranty item and claims must be made directly with the carrier.

Open shipping container and save for future shipping needs. Should your amplifier be housed in a cardboard carton, a wooden crate may be ordered for greater protection. Any amplifier returned in a container other than the original will not be eligible for warranty coverage. Replacement containers may be ordered by contacting Upcom Technologies, Inc.

If the amplifier is part of a system, check to ensure there are no bent supports. Check for any cable damage or cables that have come loose in transport. Ensure amplifier is properly inserted in rack.

Verify contents of the package:

- RF Amplifier, 5U Cabinet
- Filter (opt)
- Power Supply Shelf (opt)
- 6-Position Plug (AC Mains) (opt)
- Power supplies
- This Manual
- Test Data
- Options and Configurations Page

Optional equipment which may be included in the box:

- Slides
- Power Supply Shelf

b. Damage Claims

In the event damage is discovered, the common carrier must be notified within 24 hours directly by the recipient. All packaging has been designed in accordance with best carrier practices and will protect its contents in all conditions except for mishandling. This type of damage is not considered a proper claim under warranty conditions.

2. System description

The SCA1000 UHF Amplifiers are LDMOSFET solid state power amplifiers with advanced embedded micro controller operation. These amplifiers are designed to operate under all conditions, and under most fault conditions, even critical ones. In the event of microprocessor failure, the amplifier remains on the air! A two stage amplifier chain and advanced control components result in the most robust amplifier package on the market. All components are designed and manufactured in the U.S.A.

The filter is an external mask filter provided to allow regulatory compliance for adjacent channel power emissions and spectrum mask emissions. The end user must verify the filter operation after installation as transport, temperature, and installation can affect filter operation.

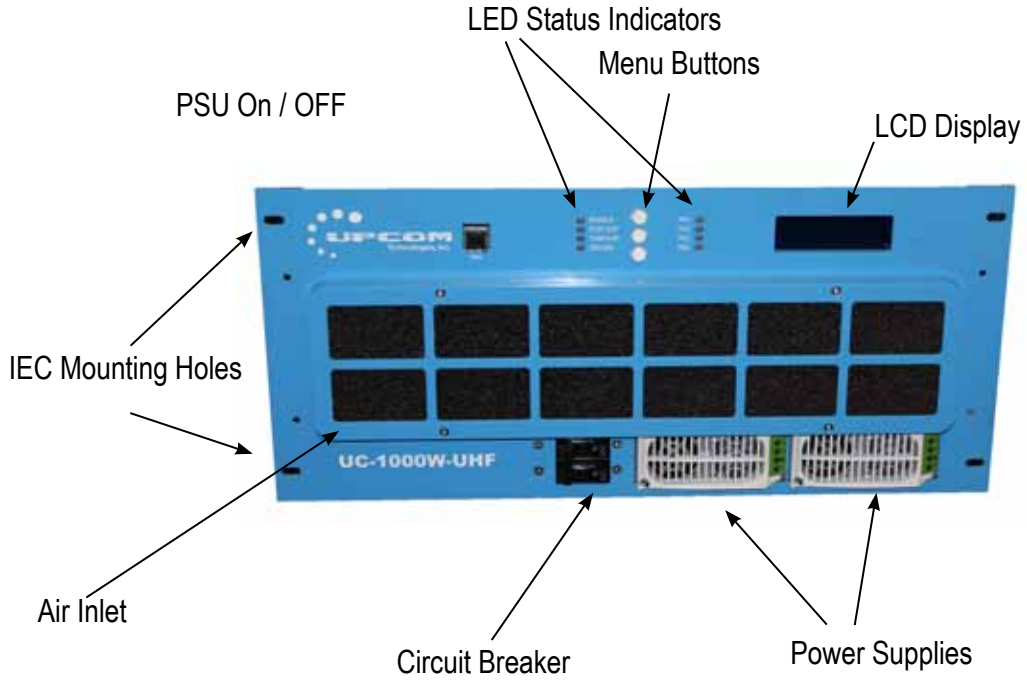
The front of the amplifier contains LED status indicators, LCD display (optional). The air inlet for the amplifier is in the front of the amplifier and it is important to keep the inlet from being obstructed or fouled with dust / dirt.

The bottom cavity of the amplifier contains the Main Control, Driver Module, RF Splitter, an Output Pallet Amplifiers.

The top cavity of the amplifier houses the remaining 3 Output Pallet Amplifiers, the 4-way power combiner and Directional Coupler.

The rear of the amplifier contains all interface, including RF input, RF output, I/O and AC input.

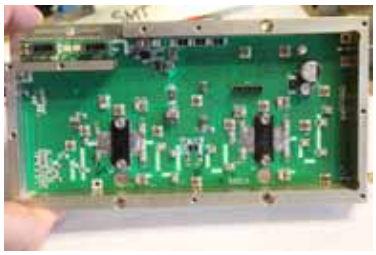
Figure 1.0 Amplifier Front



a. Amplifier Description:

The information presented in this section is designed to familiarize the end user with all aspects of amplifier operation. There are very few user serviceable parts within the RF modules, and modules are designed to be repaired or replaced as a single unit, quickly and easily. The system controller will advise the end user of any system trouble and will assist in troubleshooting.

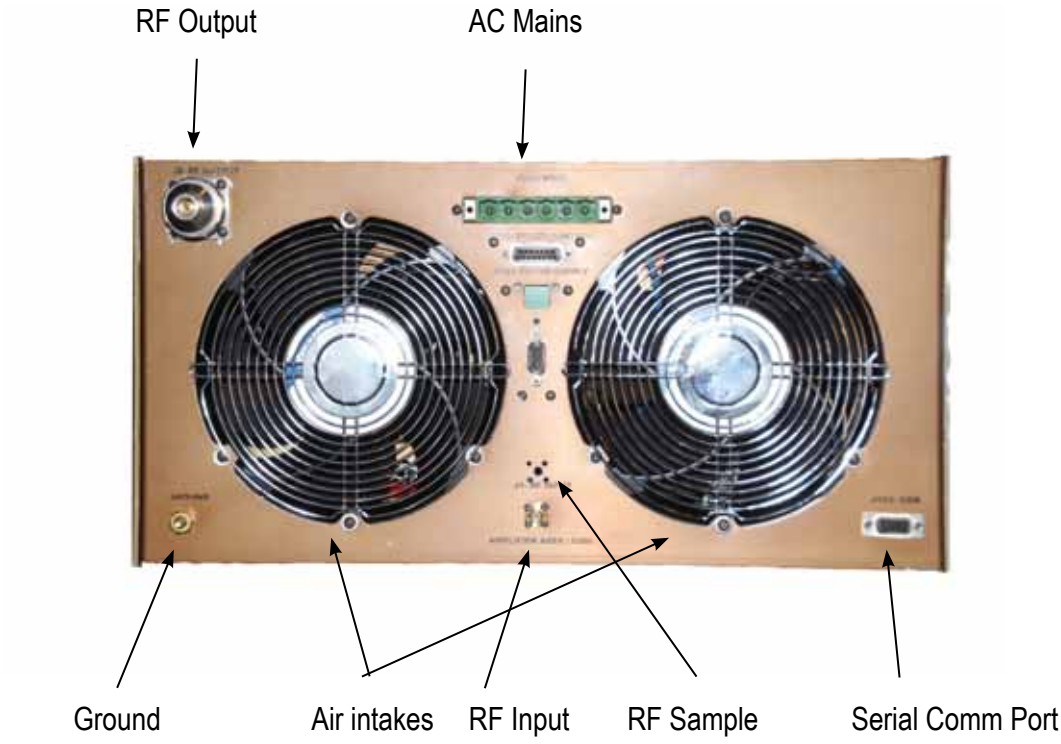
The RF amplifier portion of the SCA series UHF amplifier consists of a Driver Amplifier, RF Power Splitter, UHF Amplifier Modules, Power Combiner, Harmonic Filter, Output Directional Coupler. The system is broadband and requires no tuning for frequency change. Please refer to the block diagram for connection sequence. A detailed description follows for each RF component.



i. *Driver Amplifier*

The Driver Amplifier is a two stage LDMOSFET amplifier

Figure 1.1 - Amplifier Rear View



designed for ultra linear operation below 30 W output power. This module amplifies the input signal to necessary drive level for the output amplifiers. It is a low power component and also contains an input and output directional coupler and an optional input attenuator with 10dB minimum adjustment range. A microcontroller supervises all aspects of the amplifier's operation and protects the driver amplifier and the entire system by monitoring for unsafe operating conditions, including high temperature, input overdrive, reflected power, and low or high power supply voltage.

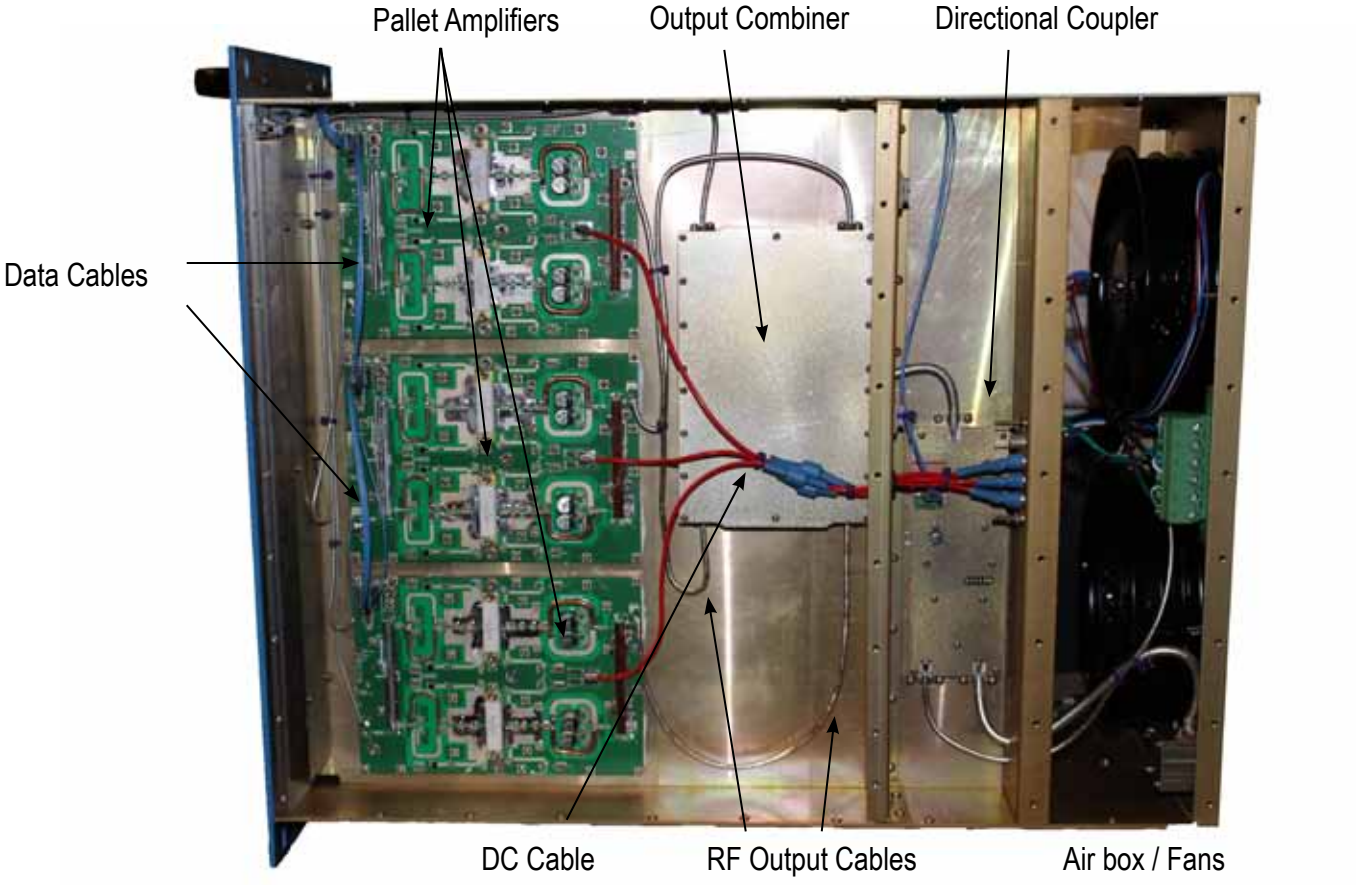
ii. *RF Power Splitter*

A 4-way Wilkinson in phase power splitter splits the output of the Driver Amplifier to provide input RF power for the output RF amplifier modules. This isolated splitter ensures a good impedance to the Driver Amplifier even in the event of UHF Amplifier Module failure. A single input RF cable feeds the splitter, and one output RF cable leads to each Output RF amplifier. There is no direct monitoring or control of this component. Isolation resistors have been sized to handle any possible combination of amplifier failure.

iii. *UHF Amplifier Module*

The UHF amplifier module is a P1000-UHF-20 RF Power Amplifier (RFPA) module based

Figure 1.2 - Amplifier Top View, Cover Removed



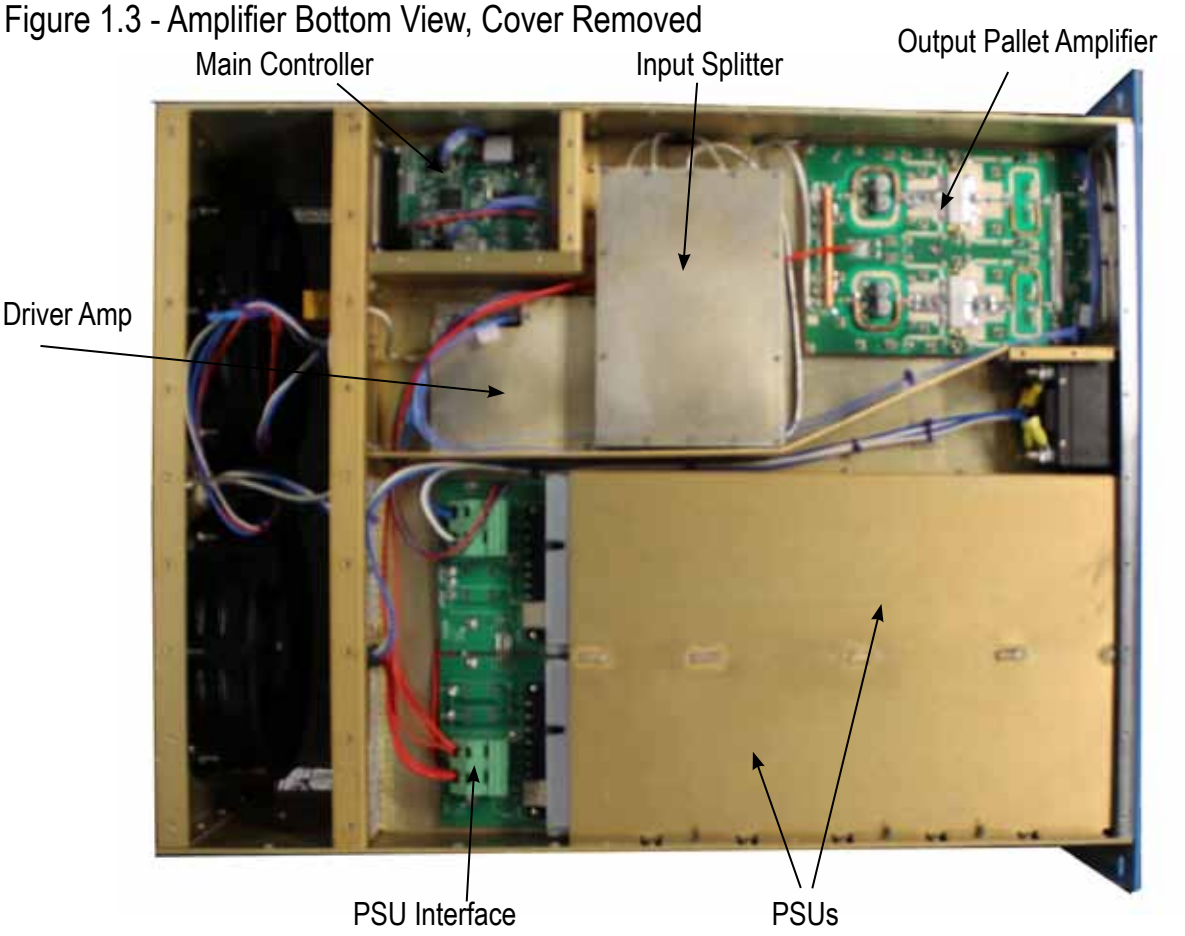
on sixth generation LDMOSFET transistor technology. The two large transistors amplify the input RF signal from approximately 5W and output over 400W at maximum power. This amplifier is based on two 600W transistors which are capable of safe operation at 500W with a 50V power supply. This amplifier requires only 325W and 48V to increase lifetime.

This Pallet Amplifier has several connections, one for RF input soldered directly to the pallet amplifier, one for RF output also soldered, one for power soldered directly to the pallet amplifier, and I/O through 5-wire cables, one in and one out. The module is fastened to the heat sink by seven screws and is easy to replace. The copper baseplate and high efficiency operation results in good operating temperatures. An on board temperature sensor connects to a microcontroller which monitors critical functions including voltage, current, baseplate temperature, input and output RF power.

iv. *Power Combiner*

The Power Combiner combines the output of all output RFPAs to a single output port. This combiner is a Wilkinson in-phase power combiner with isolation resistors sized to handle any combination of RFPA failure. If a single RFPA module fails, a portion of the

Figure 1.3 - Amplifier Bottom View, Cover Removed



power from the remaining RFPAs is dissipated in one of 8 high power flanged resistors that are part of the combiner. The resistors are sized such that any combination of failures or power imbalance feeding the combiner will not result in dissipating power in the resistors in excess of their ratings, even at maximum temperature. The isolation resistors are bolted directly to the heatsink.

The combiner has indirect monitoring provided by both the RFPA and output directional coupler. The combiner has RF cables soldered directly to the printed circuit board with connectors on the opposite end which connect to the HF Amplifier Modules.

Depending on model and configuration, the Power Combiner may be uncovered. It is extremely important never to touch any of the traces or coax while this unit is in operation. An extreme RF burn will be the result.

v. *Output Directional Coupler with Universal Directional Coupler Controller (UDCC)*

The primary RF power monitoring component in this system is the Output Directional Coupler, or ODC. A digital communications and control module, the Universal Directional Coupler Controller or UDCC, is integrated into the top cover assembly. This bidirectional power detector contains logarithmic amplifiers to convert sampled RF energy into a DC voltage scaled directly and linearly to output power. This DC output is monitored by the UDCC module which is integral to the ODC unit and provides DC power to the ODC to power the logarithmic amplifiers. The ODC samples RF energy at approximately -60dB of forward power and -60dB of reflected power. Its frequency response is typically 0.5dB across the band. The detectors are housed in a cavity inside the ODC, and for this reason, it is critical not to remove the ODC screws unless replacing the entire unit. This unit is capable of safely operating with over 3000W of RF energy continuously, and over 2000W of reflected power and should not fail under normal operating conditions. The ODC / UDCC can be user calibrated if needed through utility programs.

Fast shutdown circuits are integrated into each UDCC and allow fast trip for forward and reflected power to protect the amplifier assembly. These are user adjustable by setting the forward and reflected trip values.

A temperature sensor is mounted on the UDCC which assists in monitoring filter temperature.

ODC / UDCC Assembly with cover removed

b. Mechanical Description

A large, bonded fin, high performance heatsink is the central mechanical component of the amplifier. All heat generating components are bolted directly to the heatsink, top and bottom. Two sealed cavities are found top and bottom on the amplifier and components are on both sides. The cavities are sealed for RF purposes and are sealed against airflow incursion. If an environmental seal is required, please consult the factory. An airbox is formed at the rear of the amplifier which ensures even airflow across the heatsink. The airbox is sealed from the RF cavity and a few electrical components are located here, along with portions of the wiring harness. Fans pull air through the heatsink from

the front of the amplifier exhausting out the rear of the amplifier. Fans are sized so the amplifier can safely run on only one fan.

Models that contain external low pass filter house these components in a separate box. Air cooling is provided and must be unobstructued. Good airflow is critical for proper operation.

All cabinet and heatsink components are constructed of 6061 or 5220 grade aluminum which is chemically passivated to prevent corrosion. All painted surfaces are powder coated with military grade materials and will resist corrosion. Structural panels are 0.125" thick aluminum with thinner covers for weight savings. All hardware used in the construction of the mechanical assembly is stainless grade 18-8 or better, including lock washers, washers, bolts. If hardware is replaced, use only stainless steel material.

c. Control system

The Main Controller assembly is a 16-bit embedded microcontroller with custom software. The main controller communicates with multiple auxiliary modules to monitor and control all operations of the amplifier over a high speed RF tolerant bus. A separate analog high speed bus is used to shut down the amplifier in cases of high VSWR or overpower conditions. The system is designed to operate even if the main controller is damaged beyond repair, with protection from the high speed analog bus.

I. *Table - Control System Components*

Module Name	Qty	Interface / Cable	Function	Location
Main Controller	1	Multiple	Controls amplifier, remote control	Top rear of amplifier, bolted to heatsink
Smart Bias Controller (SBC)	5	5 wire, serial configured to Controller	Control and monitoring of pallet amplifiers.	Integrated into Pallet Amplifiers and Driver Amplifier
Universal Directional Coupler Controller (UDCC)	1/2	5 wire, serial configured to Controller	Contains both digital and analog interface for bidirectional coupler	Bolted to heatsink on top of amplifier assy.

i. *Main Controller*

This 16 bit micro controller contains various components to interface with all sections of the amplifier over a digital bus. Analog signals are routed to auxiliary components, and the main controller. The system is designed such that if the microcontroller is damaged, the amplifier will still operate. The controller board is mostly connectors, having connectors for all auxiliary components, power supplies, +5v supply, and serial / ethernet interface. The controller logs over 2500 events, so troubleshooting and operation verification is quite simple. All errors, and all user commands are recorded and stored in a last in - last out queue.

The Main Controller sits inside a shielded cavity which includes the lid of the amplifier. Operating the SCA series amplifier without a lid may result in unexpected operation as RF energy has the potential to interfere with the controller's operation. All connections are made through various connectors which are keyed and labelled. It is relatively easy to replace the main controller as long as all wires are returned to the correct locations.

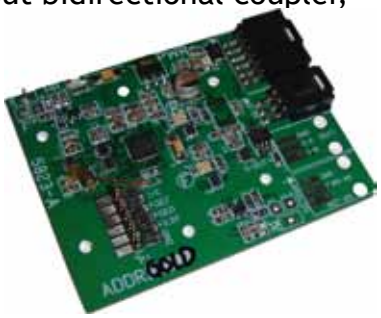
ii. *Smart Bias Controller (SBC)*

This auxiliary controller is a 16-bit embedded microcontroller with custom software. The SBC monitors all amplifier functions, and can control the amplifier's enable / disable line, control bias and monitor current, monitor Vsup, monitor temperature. In response to over current and over temperature events, it can be enabled to immediately shut down the amplifier. The SBC is embedded in the pallet amplifier itself, and connects to other PA amplifiers through a simple 5 pin wire connector bus. Each amplifier has two connections and should be connected using the shortest cable possible.

The SBC is installed in output pallet amplifiers, driver amplifiers, and intermediate power amplifiers.

iii. *Universal Directional Coupler Controller (UDCC)*

This auxiliary controller contains an 16-bit embedded microcontroller with custom software. The UDCC's primary purpose is monitoring of the output bidirectional coupler, performing math operations and reporting RF power to the main controller. The UDCC also houses a fast shutdown circuit to protect against excessive forward power and excessive reflected power, which can react in less than 1uS. The threshold for these power settings are controlled through digital potentiometers which can be set through utility program. The UDCC is connected directly to the main controller, and also the RFPAs for the fast shutdown circuit.



iv. *Ethernet Controller (optional)*

This optional interface is installed on the main controller and houses a web server along with a telnet client.

3. Installation

a. Considerations

Minimum requirements for installation include mounting in an appropriate grounded cabinet which provides unrestricted airflow. The amplifier weighs 100 - 140 pounds depending on options, with slight variation depending on configuration. Ensure the cabinet is appropriately constructed to handle this load. In the event drawer slides have been ordered, make sure the cabinet is appropriately secured to avoid tipping when the amplifier is extended fully on the drawer slides.

The cabinet must allow air from the front of the amplifier to escape the rear. This can be accomplished by mounting in an open rack, or a rack with an open top. Approximately 800 CFM of air will be moved through the heatsink under ideal conditions carrying approximately 3000 watts of heat. If not allowed to escape, the heat will warm the SCA amplifier and surrounding components until thermal shutdown occurs.

b. Mechanical

Before starting installation, ensure the breaker providing electrical service to the amplifier is turned off, and the front panel circuit breaker on the SCA series amplifier is turned to the off position. Verify all components to be connected to the amplifier, including exciter, remote controls, are also switched off.

Ensure the front of the cabinet is not obstructed, especially the front of the SCA amplifier. Ensure the rear of the amplifier is unobstructed, and airflow has a place to escape. In many circumstances, this may require the use of a vented or exhausted rack.

If so equipped, install the guide sections of the drawer slides in cabinet. Place cabinet in rack - 2 persons - and secure using front four bolts. The front flange is not designed to carry the full load of the amplifier, so if drawer slides are not used, bottom angle or flat supports will be required. Even if drawer slides are used, secure the amplifier in the cabinet using front panel screws.

c. RF

Attach RF cable to output of transmitter. If using an adaptor, ensure it is rated for the full output power of the amplifier. The cable should be connected to the antenna or dummy load prior to continuing. Connect RF cable from exciter to RF input of amplifier.

d. Electrical

Connect appropriately rated AC line to PHX-6 plug which is wired to the appropriate AC circuit panel. Insert and fasten connector on the rear of the amplifier. At no time attempt to operate the amplifier without a proper working ground. It is strongly recommended that appropriate lightning protection be added to the installation through the use of MOV type devices mounted in a properly grounded external electrical box feeding the amplifier's power supply. Attaching the lightning protection directly to the amplifier defeats the purpose of protection as high voltage spikes generated by lightning strikes

can couple directly through the amplifier's chassis. This can cause damage to electrical, control, and RF components and will void the warranty.

The communications DB-9 connector contains fault output, TTL mute input, and serial RS-232 or RS-485 communications.

II. *Table - Vsup Connections - J100*

Pin #	Signal Type	Description
1	Ground	Ground
2	Ground	Ground
3	AC Mains	+208VAC LINE 1
4	AC Mains	+208VAC LINE 2
5	Ground	Ground
6	Ground	Ground

e. Serial Communications

Standard RS-232 or RS-485 Communications port for remote control. Factory set for 'COM' style, 38400 Baud, 8 data bits, no parity, 1 stop bit. DB-9 female connector. Wiring diagram:

III. *Table - Serial Connections for J103*

Pin #	Signal Type	Description
1	Sig_Gnd	Signal Ground
2	RS-485A	Serial Communications, Non-Inverting Channel
	RS-232	Serial Communications, TX (Output)
3	RS-485B	Serial Communications, Inverting Channel
	RS-232	Serial Communications, RX (Input)
4	N/C	No connection
5	N/C	No connection
6	N/C	No connection
7	N/C	No connection
8	KILL	Active low disable, may be used as interlock
9	FAULT	Active Low Fault Output, Amplifier Requires Attention

f. Optional Ethernet Connection

If the ethernet connection is ordered, an RJ-45 jack substitutes the serial connection. This jack requires a straight through connection. The IP address is fixed to 192.168.0.10 and may be reprogrammed by following directions in the

Ethernet chapter. The ethernet port is isolated from processor functions, but the user must install proper protections to prevent damage to the communications circuitry.

4. Initial Startup and Verification

This step requires a qualified technician to verify proper installation and operation. Delta RF Technology will not be responsible for improper operation, including poor harmonic suppression, spurs, modulation, or improper output power due to poor installation.

As the amplifier is shipped from the factory, all detectors are calibrated for broadband operation. It is important to understand the output detector is not perfectly flat, but will vary by not more than 0.5dB if the load is 'perfect'. Many factors can influence this, including load VSWR and temperature. The detectors are designed to be accurate over temperature, VSWR, frequency, and power, but for a 1000 W output, the reading can vary from actual by as much as 200W in the extreme. For FCC and CIC regulations, this variation meets statutory requirements. The calibration procedure is quite simple, and requires only an accurate power meter and access to the front panel. For safety reasons, the directional couplers may not be calibrated remotely, only from the utility program.

The first time startup sequence requires use of an approved power detecting device to verify that forward power and reflected power are within limits. Acceptable measuring devices include BIRD series thru-line wattmeters and appropriate sized slug(s), high power directional couplers with thermistor type or diode type power measuring head(s).

If SCA amplifier are part of a complete system, it is recommended to individually power each SCA amplifier and test one at a time. Ensure any cables removed from individual SCA amplifiers do not short against the chassis or other high power DC connections.

Testing in a system without using main controller will require the use of 'SCA Communications Utility' which is available free of charge from the manufacturer.

Warning - dangerous levels of RF are present whenever the amplifier is operational. Attempting to operate the amplifier without output RF cables is exceptionally dangerous as it can lead to severe RF burns and even death.

A. Remove AC main power, and install RF power measuring device on amplifier output. Ensure all cables are reconnected prior to applying AC power.

B. Turn the exciter RF power to the lowest output power possible. If necessary for AC power to be applied to change exciter power, do so with the amplifier connected to an AC source.

C. If the interlock contacts have not been wired to a door or safety switch, ensure the interlock plug with shorting wire is inserted into the interlock socket on the rear of the amplifier.

D. Connect AC power and ensure DC power is applied to amplifier. Turn the main AC breaker to the ON position.

E. Verify the +5V logic supply is operational - the front panel display will light and display the startup sequence. Wait until the relay sequence is complete.

F. Start SCA Communications software and select the SCA amplifier's address.

G. Choose appropriate filter for exciter frequency. Do not attempt to broadcast off filter frequency or damage to the amplifier will result.

H. Key exciter, and verify output of power meter is 1000W CW.

I. Verify output reading on SCA program shows 800 - 1200 W CW FWD and REF must read less than 50W.

J. Remove input power.

5. Amplifier Operation

a. Modes of Operation

The amplifier continuously monitors all critical parameters, including Forward RF Power, Reflected RF Power, Input RF power, temperature of heatsink, temperature of pallet amplifiers, Bias Current, Supply current, DC Voltage. If any parameter is found to be lacking, it will cause the amplifier to protect itself, and will limit output power or shutdown. Some critical operating parameters:

IV. *Table - List of critical operating parameters*

Parameter	LSL	USL	Units
DC Supply Voltage	44.0	52.5	V, DC
Pallet Temperature	-20	85	°C
Heatsink Temperature	-20	65	°C
Fan RPM	900	9000	R.P.M.
Bias Current, each pallet (sum)	2.8	-	A, DC
Current, per pallet amplifier	-	22.0	A, DC
Forward RF Power	-	1250	W
Reflected RF Power	-	375	W
Input RF Power, model dependant	-	0.01	W
Fan Speed, Low	35	54	°C
Fan Speed, Medium	55	64	°C
Fan Speed, High	65	-	°C

b. Software Description

Any time the amplifier is enabled, the system runs 13 checks continuously:

- Power supply status (DC, FANS)
- Power supply Voltage
- Input RF Level
- Filter is switched in (optional)
- Verify RFPA currents
- Verify RFPA status
- Check RFPA temperatures
- Check amplifier temperatures at heatsink
- Verify amplifier fan operation
- Forward power is in range
- Reflected power is in range
- Pallet Amplifier Current
- UDCC - Aux no reflected power (optional)

All amplifier data is available through simple serial commands where all status bits are output. An optional utility program, SCA Communications Utility, may be used to access this information, or a program such as hyperterminal may be used.

All amplifier data is displayed on the optional front panel LCD. While no command changes may be input, errors are trapped and displayed. Pressing top or bottom buttons allows the user to scroll through amplifier parameters. Pressing the center button returns to the primary display and / or acknowledges system messages.

c. Error Checking

Once enabled, the amplifier will continuously monitor all of the following parameters, and take the actions listed.

i. *High temperature - RFPA or Heatsink*

Temperature is compiled from 7 sources - 4 from each of the pallet amplifier's SBC; the driver and control module on board temperature sensor, and the UDCC on board temperature senders. The highest reported temperature is used as 'high system temperature.'

Output power is disabled hen a predetermined heatsink threshold temperature of 85° C is experienced. Once the temperature has fallen below 80°C, the amplifier returns to normal operation. If the temperature continues to rise, the amplifier power is disabled once temperatures exceed 85°C, but will re-enable once temperatures fall below 80°C. When the first trip point is reached, and the amplifier power has been reduced, a yellow flashing indicator will light on the front panel adjacent to AIRFLOW. If the amplifier power is disabled due to temperature, a red light will flash on the front panel adjacent to AIRFLOW.

This routine additionally controls fan speed based on high system temperature.

ii. *Fan Failure - Main Heatsink*

Fan speed is continuously and separately monitored. Should either or both fans slow, such as a bearing problem, stop completely, as in a damaged motor, or stall, as in blocked heatsink, a warning will register and the AIRFLOW indicator will flash yellow. The amplifier power will not be affected unless a high temperature condition exists. The amplifier will operate with only one fan, or if the user has provided enough airflow through the heatsink by way of external exhaust. This error will clear automatically once the fault has been corrected.

iii. *RFPA - Current*

Should an RFPA current fall significantly below other RFPAs, or fall to zero, or increase above a preset threshold, the amplifier will be disabled, and the RFPA's group's LED indicator will flash red. Power output is disabled in the event of over current condition. The SCA amplifier will attempt to re-enable ten times before disabling permanently. A reset of the system, by cycling DC power, will be required to reset the amplifier.

If a bias fault occurs on more than one pallet amplifier, the display will show the po-

sition with an amber indicator. The SCA amplifier will attempt to re-enable ten times before disabling permanently. A reset of the system, by cycling DC power, will be required to reset the amplifier. If the amplifier is permanently damaged, the error will return immediately. Note - the amplifier will operate normally with one damaged pallet amplifier.

iv. *Power Supply - Voltage*

In the event a Main DC power supply voltage loses regulation, the amplifier and power supplies will be disabled to protect all components. A warning indicator will flash on the front panel next to POWER SPLY.

A yellow indicator signifies the DC supply voltage is within 1/2 volt of tolerance, either high or low, but the amplifier continues to operate. A red indicator signifies the system is shutdown due to high or low voltage supply. After power supply has returned to normal operation and voltage is within nominal supply range, the amplifier will automatically restart after approximately 60 - 90 seconds delay.

In some cases, where voltage supply level is at the lower threshold, a flashing green / red light may be observed. This is due to the voltage drop caused by current consumption in the pallet amplifiers which causes the voltage to immediately drop below threshold, starting a re-start cycle. In this case, it may be necessary to reset the power supplies or increase system voltage.

v. *RF Power - Forward and Reflected*

Forward and Reflected RF power is continuously monitored. There are two methods for RF power monitoring - software and hardware. The UDCC processes inputs from the Output Directional Coupler's forward and reflected ports. These voltages are converted to a power reading inside the UDCC and processed as forward and reflected power in watts. These values are compared to absolute maximum ratings and the amplifier is disabled for protection if any value is exceeded.

Inside the UDCC are two separate hardware paths, one for forward power and one for reflected power. A digital potentiometer, one per forward and one per reflected, are factory set to limit maximum forward and reflected. Should either pre-set value be exceeded, the amplifier is immediately shutdown for protection.

When the amplifier has entered shutdown for either forward to reflected power, software or hardware trip, (and this includes input power) the system will automatically reset once the forward / reflected power have fallen below preset levels, *and* the input power is removed.

In overdrive, all PA status lights, Driver light will turn amber, and the enable light will be solid red.

d. Front panel operation

This section describes all front panel display functions for use with optional LCD display. Use the TOP and BOTTOM buttons to scroll through data. Pressing the CENTER button selects the highlighted item. Within any menu item, the TOP and BOTTOM buttons scroll the display. Pressing the CENTER button will return to the primary display or acknowledge amplifier messages.

i. *Splash Screen*

During startup, an identification screen is displayed giving model number and other information. As each BITE is run, a brief screen is displayed showing progress. Should the system fail any of the critical BITE tests, a set of error messages will be displayed and the system will halt. Pressing the CENTER button will perform a hardware reset and the startup will repeat.

ii. *Default Status Display*

The default status display gives all important system parameters grouped by module as well as system power and status. Pressing the center button will activate the Main Menu. Pressing TOP or BOTTOM buttons will scroll through the various screens. The order for the default display is:

SUMMARY STATUS
DIRECTIONAL COUPLER
DRIVER AMPLIFIER
PALLET AMPLIFIER 1
PALLET AMPLIFIER 2
PALLET AMPLIFIER 3
PALLET AMPLIFIER 4
PSU 1
PSU 2

iii. *Main Menu*

Access the Main Menu from the default display. Using the UP and DOWN buttons scroll through the various menu items. A help scroll is included at the bottom of the display and gives some simple instructions for each of the menu items. Pressing the center button while any menu item is highlighted will either change the menu item or bring up an auxillary menu.

Menu order:

EXIT
STATUS
AMPLIFIER ON / OFF
PSU ON / OFF
FILTER 1 - 7
POWER
ATT
MOD
REMOTE ON / OFF
VIEW LOGS
UTILITY MENU

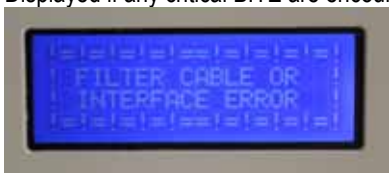
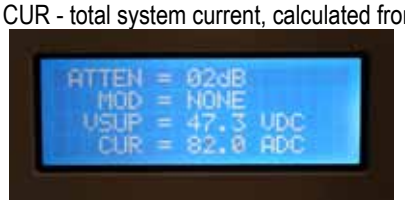
RESET

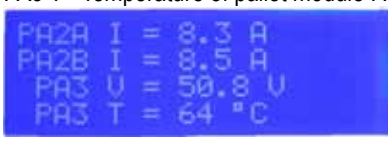
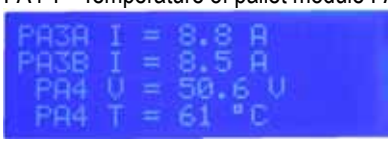
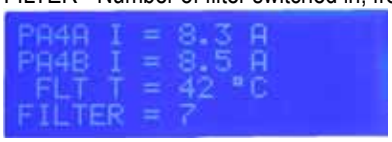
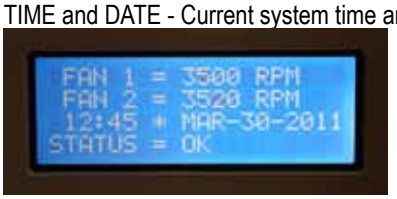
iv. *Utility Menu*

Utility Menu

V. *Table - Front Panel Display Items*

No.	Menu Item	Description
1	**SPLASH SCREEN**	Displayed upon power - up. Identification Information. Startup and Status. 

2	**SPLASH Error Screen**	Displayed if any critical BITE are encountered.  
3	**Default Display**	Primary operating information. PA Status - OFF if user disabled, ERR if an error condition exists. STBY - Amplifier is operational however has no input or output as a result. TX - amplifier is transmitting. FWD - Forward power in Watts. REF - Reflected power in Watts. TEMP - Highest system temperature, calculated from the PA modules, Driver, UDCC's 
		INPUT - Input power as measured by ICM, in mW DRV T - temperature in ICM, generally heat sink temperature, in °C DRV I - Driver Current in Amps, DC DRV V - Driver Voltage, V DC 
		ATTEN - input attenuator value, in dB. MOD - Modulation type: CW, NONE, ISB, USB, LSB, FM, AM VSUP - System Vsup as measured on primary controller, V DC VSUP = System Power Supply voltage measured at PA input, V DC CUR - total system current, calculated from sum of all PA / Driver modules, A DC 
		PA1 V - Voltage on PA1 DRFMC, V DC PA1 T - Temperature of pallet module PA1B, C PA1A I - Current of Pallet PA1A PA1B I - Current of Pallet PA1B PA2 V - Voltage on PA2 DRFMC, V DC PA2 T - Temperature of pallet module PA2A, C 

		PA2A I - Current of Pallet PA2A PA2B I - Current of Pallet PA2B PA3 V - Voltage on PA3 DRFMC, V DC PA3 T - Temperature of pallet module PA3B, C 
		PA3A I - Current of Pallet PA3A PA3B I - Current of Pallet PA3B PA4 V - Voltage on PA4 DRFMC, V DC PA4 T - Temperature of pallet module PA4A, C 
		PA4A I - Current of Pallet PA4A PA4B I - Current of Pallet PA4B FLT T - Filter box temperature, from UDCC, C FILTER - Number of filter switched in, from 1 - 7 
		UDC MN - FWD and REF emergency trip for Main (output) Directional Coupler UDC AX - FWD and REF emergency trip for Auxillary (switch) Directional Coupler If a trip has ocurred, an 'R' and / or 'F' will be displayed 
		FAN 1 and FAN 2 - displays measured RPM TIME and DATE - Current system time and date 
3	**MAIN MENU**	EXIT - returns to the default display STATUS - displays bit status screen AMPLIFIER - Turns amplifier on and off - leaves power supply on, disables the PAs or enables the PAs PSU - Turns the external power supply on and off FILTER - changes the filter sequentially POWER - Sets power level when ALC is active. ATT - Sets attenuator level for fixed attenuation, or set ALC to active MOD - Set modulation mode, used for power detector REMOTE - Sets remote commands on and off. VIEW LOGS - displays log submenu UTILITY MENU - displays Utility sub menu RESET - Performs a hard reset

VI. *Table - Error Messages*

Error messages are displayed in order of occurence. Since many errors are related, for example VSWR, High pallet amplifier current, High system current may all occur simultaneously, only the highest order CODE will actually be displayed according to this chart.

The system will automatically reset for several errors based on input conditions - please refer to section 5.C above for explanation of error conditions and reset conditions. Since many error conditions will automatically reset, the error messages are displayed for a finite period, then display resumes. Other messages, such as high forward power, require a user reset in order to resume operation. In any event, pressing the center button on the display will clear any displayed error message.

Event	Description	Result
Temperature	Temperature Fault, source will be listed PA1A, PA1B, PA2A, PA2B, PA3A, PA3B, PA4A, PA4B ********** * PALLET AMPLIFIER * * 2A OVERTEMP * **********CODE A0	Automatically Clears
Forward Power	Forward Power Trip, requires reset ********** * FORWARD * * POWER ERROR * **********CODE 80	Requires User Intervention
Reflected Power	Reflected Power Trip, requires reset ********** * REFLECTED * * POWER ERROR * **********CODE 81	Requires User Intervention
Input Power	Input Power Trip ********** * INPUT * * OVERDRIVE * **********CODE 82	Automatically Clears once input power is removed
Forward Power, Software	Forward Power Software, requires reset ********** * FORWARD * * POWER SFTWE * **********CODE 83	
Reflected Power, Software	Reflected Power Software, requires reset ********** * REFLECTED * * POWER SFTWE * **********CODE 84	
Input Power, Software	Forward Power Software, requires reset ********** * INPUT * * POWER SFTWE * **********CODE 85	

VSUP Input High	Power supply voltage is above threshold. ********** * HIGH POWER * * SUPPLY VOLTAGE * **********CODE 90	Automatically Clears once Vsup is in range
VSUP Input Low	Power supply voltage is below threshold. ********** * LOW POWER * * SUPPLY VOLTAGE * **********CODE 91	Automatically Clears once Vsup is in range
High System Current	Total current has exceed specification, requires reset ********** * SYSTEM CURRENT * * HIGH * **********CODE 92	
Pallet Amplifier High Temperature	A specific pallet amplifier has exceeded temperature specification. ********** * PALLET AMPLIFIER * * 1A OVERTEMP * **********CODE A0	
Pallet Amplifier High Current	A specific pallet amplifier has exceeded current specification. ********** * PALLET AMPLIFIER * * 1A OVERCURRENT * **********CODE A1	
Pallet Amplifier Bias Error	A specific pallet amplifier has a bias error or transistor problem. ********** * PALLET AMPLIFIER * * 1A BIAS ERROR * **********CODE A2	
Module Communications Error	Modules connected to system include DRFMC#1 through 4, (#1 - #4), ICM (#5), LCD (#6) ********** * MODULE 01 * *COMMUNICATIONS ERR* **********CODE B0	Requires User Intervention
General System Error	A general system error has forced a system halt. ********** * GENERAL SYSTEM * * ERROR. HALTED * **********CODE B1	Automatically Clears after preset time
Fan Error	A fan RPM is below specifications. ********** * FAN * * FAIL 1 * **********CODE C0	Automatically Clears when KILL line is not active
Filter Switch Error	A switch has failed to report engagement and has been disabled. ********** * FILTER ERROR * * SWITCH #3 * **********CODE D0	Automatically Clears when fan is operational

Filter Switch Error Or Cabling Error	Auxillary Directional Coupler reports high reflected power. Switch identified is active switch at time of error. ********** * FILTER ERROR * * OPEN SWITCH #3 * **********CODE D1	Requires User Intervention
UDCC or Filter Communications Error	Main UDCC or Aux UDCC bad communications through RS-485 Bus. ********** * FILTER ASSY * *COMMUNICATIONS ERR* **********CODE D1	

e. LED Display

Front panel LED's yield status at a glance. This table translates their meanings.

VII. *Table - Front Panel LED operation*

ENABLE	
GREEN	System is capable of delivering full power
GREEN (FLASH-FAST)	System is restarting
GREEN (FLASH-SLOW)	System is in standy mode
YELLOW	System is operating at reduced power due to disabled component
YELLOW (FLASH)	System power supply is disabled by user or fault or E-Switch
RED (FLASH)	Filter Fault, System is shutdown
RED	System is shut down. Includes overdrive condition.
PWR SUP	
GREEN	Power supply is nominal
YELLOW	Power supply is within 0.5V of maximum tolerance, but operational
RED	Power supply voltage is out of range, and system is shut down
TEMP / AIR	
GREEN	All temperatures are nominal
YELLOW (FLASH)	One fan is damaged
YELLOW	Temperature condition
RED (FLASH)	Both fans are non operational, system is shut down
RED	Overtemperature condition. System is Shut Down
DRIVER	
GREEN	System is nominal
YELLOW	Driver is in overdrive, reduce input, system is shut down
RED (FLASH)	Lost module communications. System is shut down
RED	Driver is turned off. System is shut down
PA1, PA2, PA3, PA4	
RED	No bias. System is shutdown due to system, temperature, etc.

RED (FLASH)	Lost module communications. System has been shut down
YELLOW	One or two amplifiers have no bias due to temperature, damage, specifications
YELLOW (FLASH)	Temperature has reached warning area, but still operational
GREEN	All functions nominal

6. Remote Control Operation

All remote communications are text based through either an RS-232, RS-485, or Ethernet connection. For a graphical user interface, use the optional Silicon Valley Power SCA Communications Utility. Amplifiers will support only one of the following methods of communication.

All communications are user initiated; the amplifier will only respond to commands sent by the user.

a. RS-232, RS-485 or Ethernet Connection

i. *Serial Connection*

Serial connection must be set to the following parameters:
Baud Rate = 9600
Data Bits = 8 bits
Parity Bits = None
Stop Bits = 1

Please refer to the electrical connections part of the manual for cable configuration.

ii. *Ethernet Connection*

Use a Telnet program, such as Microsoft Telnet. You can access this program from a Windows Command Prompt by typing 'TELNET'. The default address is 192.168.0.10. You must access this from a computer on the same sub-net.

Please refer to separate manual provided for Ethernet Device.

iii. *RS-485 Serial Connection*

Depending on manufacturer of RS-485 bridge, communications lines A & B may need to be switched in the cable. This will be a three wire communications bus which includes differential signal lines A, B and include ground. A common ground connection between serial nodes ensures voltages will remain at a safe level. Serial Connection must be set to the following parameters:

Baud Rate = 38400
Data Bits = 8 bits
Parity Bits = None
Stop Bits = 1
(half duplex)

VIII. *Table - Remote Commands*

Command Sequence, sent by user / received by amplifier:
<START> Start Transmit character, '$', ascii 36
<ADDR> Destination address, or 0x00 for broadcast command

<COMMAND> Command Byte
<DATA> Data bytes sent, may be no data
<CKSUM> Checksum byte, see below
<EOT> End of transmission byte, ascii 255.

Reply sequence, sent by amplifier / received by user:
<START> Receive character, '#', ascii 35
<ADDR> Address of replying amplifier
<COMMAND> Command Echo
<DATA> Data bytes, may be no data
<CKSUM> Checksum byte, see below
<EOT> End of transmission bytes, ascii 255.

Reply sequence for command with resulting error:
<START> Receive character, '#', ascii 35
<ADDR> Address of replying amplifier
<NAK> Ascii 21
<CKSUM> Checksum byte, see below
<EOT> End of transmission bytes, ascii 255.
This reply signifies that the command was formatted correctly and parsed correctly, but the command did not complete. Example: Filter bank error after switch, UDCC Pot program not successful or communications error with filter bank.

Reply sequence for command when password is required:
<START> Receive character, '#', ascii 35
<ADDR> Address of replying amplifier
<PW> Ascii 22
<CKSUM> Checksum byte, see below
<EOT> End of transmission byte, ascii 255.
Reply signifies a password is active on the amplifier and it must be entered in order to process any command using the <PASSWORD> command. Use the <CLEARPW> command to cancel the password. Password remains active until power cycle or reset.

The checksum is the sum of all bytes except checksum and end of transmission BYTES, MOD 128 (remainder of divison by 128). Not all commands support the broadcast address, should a broadcast address be used for a command that does not support this mode, it will be ignored. Change of address should only be used with one amplifier connected to the communications port.
Commands which are broadcast cause the amplifiers to reply in a timeslot which is 15mS delay + 5mS * address. Example, amplifier address #7 will reply beginning 50mS after parsing command.
Any data sent requiring $FF must duplicate this data, i.e. $FF $FF must be sent, otherwise the single instance of $FF will be interpreted as the <EOT> character. The second $FF is not used in checksum calculation.

Sample communications assume amplifier is on address 01. 'U' refers to user sent commands. 'A' refers to amplifier reply.

SCA Series Communications Protocol Summary.
Applies to SCA500, SCA1000, SCA1500 Series amplifiers with our without external filter.

Master Controller to Amplifier

START	ADDRESS	Command	Data		Data	Checksum	STOP
$24 Stream is ignored until start character is received	$01 Destination Address Can be $01 - $0F (individual) or $00 (broadcast)	$10 Valid Command Codes are from $10 to $7F Commands $10 to $3F may be broadcast	$XX.$XX Optional For $FF, two bytes: $FF $FF must be sent with no delay.	—	$XX.$XX Optional For $FF, two bytes: $FF $FF must be sent with no delay.	$00 - $7F Sum of all preceeding characters MOD $80	$FF End of transmission Character.

Amplifier reply to Master Controller

REPLY	ADDRESS	Command	Data		Data	Checksum	STOP
$23 Reply Start Character	$01 Replying Amplifier Address Can be $01 - $0F	$10 echoed command	$XX.$XX Optional For $FF, two bytes: $FF $FF must be sent with no delay.	—	$XX.$XX Optional For $FF, two bytes: $FF $FF must be sent with no delay.	$00 - $7F Sum of all preceeding characters MOD $80	$FF End of transmission Character.

Amplifier reply to Master Controller / Error Reply

REPLY	ADDRESS	Command	Checksum	STOP
$23 Reply Start Character	$01 Replying Amplifier Address Can be $01 - $0F	$15 Negative Acknowledgement	$00 - $7F Sum of all preceeding characters MOD $80	$FF End of transmission Character.

Communications Notes:

- To accomodate multiple amplifiers on the address bus, broadcast command replies are time slotted by amplifier address.
  Non broadcast commands receive a reply immediately.
  Time delay is 15 mS + (5mS * amplifier address)
- STOP Character is used to denote end of transmission and end of reply.
  If data is sent which includes $FF, immediately follow the data byte with a second $FF, otherwise incoming data stream will be ignored.
- Checksum is the sum of all characters preceeding the Checksum byte MOD $80.
  Where an $FF is sent as data, the second byte is ignored for checksum calculation.
- If a command is not recognized, no reply is sent. This includes commands for which checksum is invalid. This also includes using a broadcast command address with a command that may not be broadcast.
- UART receiver is ignored during transmit. Any characters received during transmit are dumped, as are any headers which do not begin with The $24 START character.
- It is highly recommended not to mix equipment types (i.e. Non SCA equipment) on the same communications bus as any data containing the START character can be mistakenly parsed for a valid command with unpredictable results.

IX. *Table - Remote Serial Commands, broadcast capable*

Com-mand	Name	Description	Sample Communications Hexadecimal
0x11	ON	Turns Amplifier ON.	U:24 01 11 36 FF A:23 01 11 35 FF
0x12	OFF	Turns Amplifier OFF.	U:24 01 12 37 FF A:23 01 12 36 FF
0x13	AGC	Sets AGC mode - BCD number 2 digit from 00 - 20 sets value of input attenuator. Both bytes FF sets to automatic gain. If AGC is set to automatic, power settings are stored but system will not steer power. It is not recommended to activate AGC in multiple amplifier combined systems.	U:24 01 13 00 00 38 FF A:23 01 13 37 FF Set 0 fixed atten U:24 01 13 FF FF 36 FF A:23 01 13 37 FF AGC automatic
0x14	PWR_SET	Sets forward output power as 4-digit BCD. Leading zeroes are required. Command may be broadcast. System will set forward power to new setting if AGC is on and if sufficient system gain exists with input power to reach the new power level.	U:24 01 14 01 05 00 00 3F A:23 01 14 38 FF Set Power to 1500W
0x15	NAK	Received as reply when command is not properly parsed or executed. Example: Filter is bad so can not be switched.	U:24 01 31 56 FF A:23 01 15 39 FF
0x16	PW	Password is required to execute command	U:24 01 11 36 FF A:23 01 16 3A FF
0x17	REMOTE_ OFF	Remote Command Execution is disabled on Remote System. Command not available	U:24 01 12 37 FF A:23 01 17 3B FF
0x1A	RTC_SET	Sets real time clock. Used for logging in amplifier. (Disabled in A.2 revision software) All values are in BCD. Byte 4 = Year Byte 5 = Month Byte 6 = Day Byte 7 = Hours Byte 8 = Minutes Byte 9 = Seconds	U:24 01 1A 11 10 01 13 14 15 1D FF A:23 01 1A 3E FF Set date to Oct 1 2011, 1:14:15PM
0x1B	PSU_ON	Turns PSU On. Will turn amplifier on if not in standby mode.	U:24 01 1B 40 FF A:23 01 1B 3F FF
0x1C	PSU_OFF	Turns PSU Off and disables amplifier.	U:24 01 1C 41 FF A:23 01 1C 40 FF
0x20	FWD_PWR	Outputs Forward RF Power as 4- digit BCD.	U:24 01 20 45 FF A:23 01 20 01 05 00 00 4A FF

Com-mand	Name	Description	Sample Communications Hexadecimal
0x21	REF_PWR	Outputs Reflected RF Power a 4-digit BCD.	U:24 01 21 46 FF A:23 01 21 00 00 01 00 46 FF
0x22	INP_PWR	Outputs Input RF Power a 4-digit BCD.	U:24 01 22 47 FF A:23 01 22 00 00 00 02 48 FF
0x23	ALL_PWR	Outputs FWD, REF, INP Power as 4-digit BCD, 12 bytes total data.	U:24 01 23 48 FF A:23 01 23 01 05 00 00 00 00 01 00 00 00 00 02 50 FF
0x31	FILTER1	Sets filter band 1.	U:24 01 31 56 FF A:23 01 31 55 FF
0x32	FILTER2	Sets filter band 2.	U:24 01 32 57 FF A:23 01 32 56 FF
0x33	FILTER3	Sets filter band 3.	U:24 01 33 58 FF A:23 01 33 57 FF
0x34	FILTER4	Sets filter band 4.	U:24 01 34 59 FF A:23 01 34 58 FF
0x35	FILTER5	Sets filter band 5.	U:24 01 35 5A FF A:23 01 35 59 FF
0x36	FILTER6	Sets filter band 6.	U:24 01 36 5B FF A:23 01 36 5A FF
0x37	FILTER7	Sets filter band 7.	U:24 01 37 5C FF A:23 01 37 5B FF
0x38	MODE_CLR	Clears Mode. Used for setting power detectors.	U:24 01 38 5D FF A:23 01 38 5C FF
0x39	MODE_AM	Sets AM Mode.	U:24 01 39 5E FF A:23 01 39 5D FF
0x3A	MODE_USB	Sets USB Mode.	U:24 01 3A 5F FF A:23 01 3A 5E FF
0x3B	MODE_LSB	Sets LSB Mode.	U:24 01 3B 60 FF A:23 01 3B 5F FF
0x3C	MODE_CW	Sets CW Mode.	U:24 01 3C 61 FF A:23 01 3C 60 FF
0x3D	MODE_ISB	Sets ISB Mode.	U:24 01 3D 62 FF A:23 01 3D 61 FF
0x3E	MODE_ISB2	Sets ISB Mode 2.	U:24 01 3E 63 FF A:23 01 3E 62 FF
0x3F	MODE_FM	Sets FM Mode.	U:24 01 3F 64 FF A:23 01 3F 63 FF

X. *Table - Remote Serial Commands, may not be broadcast*

Command	Name	Description	Sample Communications Hexadecimal
0x40	FWD_POT_SET	Sets Forward Emergency Shutdown Pot in UDCC. Data bytes are transmitted after amplifier address (Byte 4, 5). LSB 12 bits.	U:24 01 40 01 FF FF 65 FF A:23 01 40 64 FF
0x41	REF_POT_SET	Sets Reflected Emergency Shutdown Pot in UDCC. Data bytes are transmitted after amplifier address (Byte 4, 5). LSB 12 bits.	U:24 01 41 00 34 9A FF A:23 01 41 65 FF
0x42	FWD_TRIM_SET	Sets Forward Output Directional Coupler Trim Value. Data byte is transmitted after amplifier address (Byte 4). Value is signed byte.	U:24 01 42 01 68 FF A:23 01 42 66 FF
0x43	REF_TRIM_SET	Sets Reflected Output Directional Coupler Trim Value. Data byte is transmitted after amplifier address (Byte 4). Value is signed byte.	U:24 01 43 FE 66 FF A:23 01 43 67 FF
0x44	INP_TRIM_SET	Sets Input Directional Coupler Trim Value. Data byte is transmitted after amplifier address (Byte 4). Value is signed byte.	U:24 01 44 00 69 FF A:23 01 44 68 FF
0x45	FWD_AUX_POT_SET	Sets Forward Emergency Shutdown Pot in Auxillary UDCC. Data bytes are transmitted after amplifier address (Bytes 4,5) LSB 12 bits.	U:24 01 45 01 55 40 FF A:23 01 45 69 FF
0x46	REF_AUX_POT_SET	Sets Reflected Emergency Shutdown Pot in Auxillary UDCC. Data bytes are transmitted after amplifier address (Bytes 4,5) LSB 12 bits.	U:24 01 46 00 28 13 FF A:23 01 46 6A FF
0x47	FWD_AUX_TRIM_SET	Sets Forward Auxillary Output Directional Coupler Trim Value. Data byte is transmitted after amplifier address (Byte 4). Value is signed byte.	U:24 01 47 FF FF 6B FF A:23 01 47 6B FF
0x48	REF_AUX_TRIM_SET	Sets Reflected Auxillary Output Directional Coupler Trim Value. Data byte is transmitted after amplifier address (Byte 4). Value is signed byte.	U:24 01 48 FE 6B FF A:23 01 48 6C FF
0x4C	SEND_MSG	Displays message on LCD	Private Function
0x4D	SEND_MSG_USR	Displays message on LCD; user must acknowledge with a button press.	Private Function

Com-mand	Name	Description	Sample Communications Hexadecimal
0x50	STATUS	Sends complete amplifier status. Data bytes are received starting in position 4	U:24 01 50 75 FF A:23 01 50
		[4, 5] PA1A Current, 2 bytes (MSB.LSB)	0A 02
		[6, 7] PA1B Current, 2 bytes (MSB.LSB)	09 08
		[8, 9] PA2A Current, 2 bytes (MSB.LSB)	09 09
		[10, 11] PA2B Current, 2 bytes (MSB.LSB)	0A 01
		[12, 13] PA3A Current, 2 bytes (MSB.LSB)	08 0A
		[14, 15] PA3B Current, 2 bytes (MSB.LSB)	09 02
		[16, 17] PA4A Current, 2 bytes (MSB.LSB)	09 04
		[18, 19] PA4B Current, 2 bytes (MSB.LSB)	0A 02
		[20, 21] PA1 Volts, 2 bytes (MSB.LSB)	C3 52
		[22, 23] PA2 Volts, 2 bytes (MSB.LSB)	C2 03
		[24, 25] PA3 Volts, 2 bytes (MSB.LSB)	C2 54
		[26, 27] PA4 Volts, 2 bytes (MSB.LSB)	C4 03
		[28] PA1 Temperature, one byte	32
		[29] PA2 Temperature, one byte	34
		[30] PA3 Temperature, one byte	33
		[31] PA4 Temperature, one byte	33
		[32] ICM Module Temperature, one byte	2F
		[33] UDCC Temperature, one byte	1E
		[34] Filter #, one byte	07
		[35 - 38] FWD PWR, four bytes, BCD Coded	01 04 09 00
		[39 - 42] REF PWR, four bytes, BCD Coded	00 00 01 08
		[43 - 46] INP PWR, four bytes, BCD Coded	00 00 00 02
		[47 - 50] FWD PWR Aux, four bytes, BCD Coded	01 04 04 03
		[51 - 54] REF PWR Aux, four bytes, BCD Coded	00 00 00 09
		[55 - 56] System Status Word Bits 6, 5, 3, 1, 0 not used Bit 7 = PA Damaged Bit 4 = Shutdown Bit 2 = System power reduced 3dB	00 00
		[57 - 58] Filter Status Word Bits 14-8 = Open Switch / Filter, #7 - #1 Bit 7 = UDCC Communications Fault Bits 6-0 = Switch Error, Filter #7 - #1	00 00
		[59 - 60] Communications Status Word Bit 9 = UDCC Aux Comm Error Bit 8 = UDCC Main Comm Error Bit 5 = LCD Comm Error Bit 4 = Driver Comm Error Bit 3 = PA4 Comm Error	00 00

Com-mand	Name	Description	Sample Communications Hexadecimal
		Bit 2 = PA3 Comm Error Bit 1 = PA2 Comm Error Bit 0 = PA1 Comm Error	
		[61 - 62] PA Bias Status Word Bit 9 = Driver Channel 2 Bias Error Bit 8 = Driver Channel 1 Bias Error Bit 7 = PA4B Bias Error Bit 6 = PA4A Bias Error Bit 5 = PA3B Bias Error Bit 4 = PA3A Bias Error Bit 3 = PA2B Bias Error Bit 2 = PA2A Bias Error Bit 1 = PA1B Bias Error Bit 0 = PA1A Bias Error	00 00
		[63 - 64] Voltage Status Word Bit 15 = System Voltage Low Bit 14 = PS2 Fault Bit 13 = UDCC Voltage Low Bit 12 = ICM Module Voltage Low Bits 11 - 8 = PA 4 - PA1 Module Voltage Low Bit 7 = System Voltage High Bit 6 = PS1 Fault Bit 5 = UDCC Voltage High Bit 4 = ICM Module Voltage High Bits 3 - 0 = PA4 - PA1 Module Voltage High	00 00
		[65 - 66] High Temperature Status Word Bit 11 = UDCC Aux Temp High Bit 10 = UDCC Main Temp High Bit 9 = ICM Module Temp High Bit 8 = Driver PA Temp High Bit 7 = DRFMC4 Temp High Bit 6 = PA4 Module Temp High Bit 5 = DRFMC3 Temp High Bit 4 = PA3 Module Temp High Bit 3 = DRFMC2 Temp High Bit 2 = PA2 Module Temp High Bit 1 = DRFMC1 Temp High Bit 0 = PA1 Module Temp High	00 00

Com-mand	Name	Description	Sample Communications Hexadecimal
		[67 - 68] Temperature Warning Status Word Bit 15 = FAN 2 Not Rotating Bit 14 = FAN 1 Not Rotating Bit 11 = UDCC Aux Temp Warning Bit 10 = UDCC Main Temp Warning Bit 9 = ICM Module Temp Warning Bit 8 = Driver PA Temp Warning Bit 7 = DRFMC4 Temp Warning Bit 6 = PA4 Module Temp Warning Bit 5 = DRFMC3 Temp Warning Bit 4 = PA3 Module Temp Warning Bit 3 = DRFMC2 Temp Warning Bit 2 = PA2 Module Temp Warning Bit 1 = DRFMC1 Temp Warning Bit 0 = PA1 Module Temp Warning [69 - 70] Power Status Word Bit 15 = Emergency Switch Activated Bit 14 = KILL Signal Activated Bit 13 = Power Supplies Off Bit 12 = Standby Activated Bit 7 = Input Power Hardware Trip Bit 6 = Input Power Software Trip Bit 5 = Reflected Power Software Trip Bit 4 = Forward Power Software Trip Bit 3 = UDCC Aux Reflected Hardware Trip Bit 2 = UDCC Aux Forward Hardware Trip Bit 1 = UDCC Main Reflected Hardware Trip Bit 0 = UDCC Main Forward Hardware Trip	00 00 00 00
		[71-76] Real Time Clock, YY-MM-DD-HH-MM-SS	11 04 10 21 01 44 74 FF
0x51	ID	Sends amplifier Identification in Ascii Serial number, 10 bytes Revision, 10 bytes Amplifier ID, 10 bytes	U:24 01 51 76 FF A:23 01 51 34 38 31 33 2D 20 20 33 34 31 41 37 20 32 31 30 31 31 31 20 53 43 41 31 35 30 30 20 41 32 58 FF

Com-mand	Name	Description	Sample Communications Hexadecimal
0x52	RTC	Send real time clock value All values are in BCD. Byte 4 = Year Byte 5 = Month Byte 6 = Day Byte 7 = Hours Byte 8 = Minutes Byte 9 = Seconds	U:24 01 52 77 FF A:23 01 52 11 04 10 21 08 11 55 FF
0x53	SWITCH_ TIME	Sends measured filter switch time. All values are in mS. Request - Open - Close Byte 4 - Filter 1 time Byte 5 - Filter 2 time Byte 6 - Filter 3 time Byte 7 - Filter 4 time Byte 8 - Filter 5 time Byte 9 - Filter 6 time Byte 10 - Filter 7 time	U:24 01 53 78 FF A:23 01 53 18 19 17 16 19 17 18 1D FF
0x54	PWR_INFO	Outputs all relevant Power Settings [4-5] = Fwd Pot Setting, value in 12 LSB [6-7] = Ref Pot Setting, value in 12 LSB [8] = FWD Trim Value [9 = REF Trim Value [10] = INP Trim Value [11-12] = FWD AUX Pot Setting, value in 12 LSB [13-14] = REF AUX Pot Setting, value in 12 LSB [15] = FWD AUX Trim Value [16] = REF AUX Trim Value [17] AGC, one byte. 0 - 20, FF is automatic [18] Modulation, one byte 0 = None 1 = AM 2 = USB 3 = LSB 4 = CW 5 = ISB 6 = FM [19 -20] Power Setting, two bytes	U:24 01 54 79 FF A:23 01 54 02 1F 01 23 02 FE 00 02 25 00 9F 00 00 FF FF 00 05 DC 37 FF
0x55	EMULATE	Semds all display information [4 - 83] LCD Panel Lines 1 - 4, Ascii [84 - 91] LED Indicators	Private Function

Com-mand	Name	Description	Sample Communications Hexadecimal
0x60	LOG	Send two additional bytes, which represents the log record to be transmitted. Each log event returns 16 bytes. Log events are listed in most recent first order. Byte 0 - log event ID Byte 1 - Hour Byte 2 - Minute Byte 3 - Second Byte 4 - Month Byte 5 - Day Byte 6 - Year Byte 7 - Forward Power - Hi Byte Byte 8 - Forward Power - Lo Byte Byte 9 - Reflected Power - Hi Byte Byte 10 - Reflected Power - Lo Byte Byte 11 - Input Power - Hi Byte Byte 12 - Input Power - Lo Byte Byte 13 - Temperature Byte 14,15 - Modal, depending on Error Code For log codes < 0x30> only zeroes are sent after byte 7.	U:24 01 60 00 01 06 FF A:23 01 60 02 07 30 01 12 07 41 05 DC 00 13 00 05 48 00 00 59 FF
0x61	LOG_DE-TAILS	Send total number of log entries. Replies with two bytes which represents the number of log records available for read	U:24 01 61 06 FF A:23 01 61 01 43 49 FF
0x62	LOG_MULT	Send multiple log entries, up to 8 maximum. Starting Log Entry (2 bytes) Number of Log entries (1 byte) Reply will contain log entries in 16 byte increments.	U:24 01 62 00 00 08 0F FF A:23 01 62 <16 bytes> .. <16 bytes> <CKSUM> FF

Command	Name	Description	Sample Communications Hexadecimal
0x63	LOG_CRIT	Send critical log page - 8 records to a page. Log records follow the same format as 0x60 LOG command. 8 records must be sent, user must send which page desired: Page 1, Record 0 = FWD Hardware Trip Page 1, Record 1 = REF Hardware Trip Page 1, Record 2 = INP Hardware Trip Page 1, Record 3 = FWD Aux Hardware Trip Page 1, Record 4 = REF Aux Hardware Trip Page 1, Record 5 = PS Voltage High Page 1, Record 6 = PS Voltage Low Page 1, Record 7 = GP System Error Page 2, Record 0 = Filter 1 Switch Page 2, Record 1 = Filter 2 Switch Page 2, Record 2 = Filter 3 Switch Page 2, Record 3 = Filter 4 Switch Page 2, Record 4 = Filter 5 Switch Page 2, Record 5 = Filter 6 Switch Page 2, Record 6 = Filter 7 Switch Page 2, Record 7 = System Temperature Critical Page 3, Record 0 = Filter 1 Open Page 3, Record 1 = Filter 2 Open Page 3, Record 2 = Filter 3 Open Page 3, Record 3 = Filter 4 Open Page 3, Record 4 = Filter 5 Open Page 3, Record 5 = Filter 6 Open Page 3, Record 6 = Filter 7 Open Page 3, Record 7 = High System Current Page 4, Record 0 = Filter Communications	`U:24 01 63 01 09 FF` `A:`
0x68	GRAPH_DETAILS	Send the number of Graph entries (in 16 byte groups) available (2 bytes) and the time increment in minutes (1 byte).	`U:24 01 68 0D FF` `A:23 01 68 01 10 05 22 FF`
0x69	GRAPH_SET	Set the time interval for future graphs, in minutes. Legal values are 1, 2, 5, 10, 20, 30, 60.	`U:24 01 69 01 0F FF` `A:23 01 69 0D FF`

Com-mand	Name	Description	Sample Communications Hexadecimal
0x6A	GRAPH_ MULT	Send 1 - 8 records from the graph database. Send two bytes address, 0 - FFF, and number of records, 1 - 8 Reply, Within each group: Byte 0 - 2, 12 MSB FWD Max, 12 LSB FWD Min Values are divided by 5 Byte 3 - 5, 12 MSB REF Max, 12 LSB REF Min Values are divided by 5 Byte 6 - 8, 12 MSB INP Max, 12 LSB INP Min Byte 9 - Temperature Byte 10 - Status Flag Bit 0 - FWD Power Trip Bit 1 - REF Power Trip Bit 2 - INP Power Trip Bit 3 - ESwitch Bit 4 - KILL Bit 5 - Disable Bit 6 - FAN Bit 7 - LOST AC Byte 11 - Hour Byte 12 - Minute Byte 13 - Month Byte 14 - Day Byte 15 - Year	
0x70	ADDRESS	Sets amplifier address. Must be broadcast. Only one amplifier may be on the serial bus. New address is set at byte 4. Reply will contain new address if successful. KILL line must be cleared.	U:24 00 70 02 16 FF <time delay> A:23 02 70 15 FF
0x71	RESET	Performs processor hard reset, similar to power on. Command must be sent twice in succession.	U:24 01 71 16 FF A:23 01 71 15 FF U:24 01 71 16 FF No reply <aborts>
0x72	PASSWORD	Enter 10 character password to access system when password is activated. Password is sent in the clear. Replies with <NAK> if password does not match or no password is entered.	U:24 01 72 41 42 43 44 45 46 47 48 49 4A 4E FF A:23 01 15 39 FF
0x73	CLEARPW	Clears entered password.	U:24 01 73 18 FF A:23 01 73 17 FF

b. Log Error Codes

Event codes come in two categories, those that log amplifier significant settings

change and those that mark an amplifier error that forces a shutdown or marks permanent damage to the amplifier.

Some commands provide one additional byte of information, such as PA number or module identification. In cases where no additional data is required, modal byte is 0x00.

All log entries are 16 bytes total. Log codes 0x01 through 0x7F will reply

XI. *Table - Log / Error Codes*

Log Code	Description	Modal Byte
	- settings change -	
0x01	AC Voltage Removed	
0x02	AC Voltage Restored	
0x03	Emergency Switch Activated	
0x04	Remote Control Mode Restored	
0x05	Local Only Control Activated	
0x06	KILL	
0x07	User set amplifier to Disable	
0x08	User set amplifier to Enable	
0x0A	User set Power Supply to Off	
0x0B	User set Power Supply to On	
0x10	Password Change	
0x11	Incorrect Local Password Attempt	
0x12	Incorrect Remote Password Attempt	
0x1C	Real Time Clock Changed	
0x1D	Amplifier Address Changed	
0x20	FWD Power TRIM Changed	
0x21	REF Power TRIM Changed	
0x22	INP Power TRIM Changed	
0x23	FWD Aux Power TRIM Changed	
0x24	REF Aux Power TRIM Changed	
0x30	UDCC Main FWD POT Change	
0x31	UDCC Main REF POT Change	
0x32	UDCC Aux FWD POT Change	
0x33	UDCC Aux REF POT Change	
0x40	Changed to Fix Gain Mode	Gain setting
0x41	Changed to AGC Mode	Power Setting
	- error codes -	
0x80	Forward Power Trip	
0x81	Reflected Power Trip	
0x82	Input Power Trip	
0x83	Forward Aux Power Trip	
0x84	Reflected Aux Power Trip	

Log Code	Description	Modal Byte
0x88	Forward Power Trip, Software	
0x89	Reflected Power Trip, Software	
0x8A	Input Power Trip, Software	
0x90	Voltage supply too high	PS Voltage
0x91	Voltage supply too low	PS Voltage
0x92	System Current too high	Current
0xA0	Temperature Shutdown	PA# 1 - 8
0xA1	Pallet overcurrent	PA# 1 - 8
0xA2	Pallet Bias Error	PA# 1 - 8
0xB0	Module Communications Error	Module #
0xB1	General system error, unrecoverable	status Register
0xC0	Fan Failure	Fan #
0xD0	Filter Switch Error	Filter #
0xD1	Filter Fault, due to high reflected power on first UDCC	Filter #
0xD2	Filter Communications Error	

c. Rear Panel Interface Controller

Optional Accessory.

Provided with the amplifier is a 12-pin expansion plug which mates to the I/O interface on the rear of the amplifier. These signals provide a mix of analog and digital control signals which may be used to interface to legacy control systems. The plug is active whenever the amplifier is in REMOTE mode. The amplifier will not respond to commands when the amplifier is in LOCAL mode.

Some considerations for connecting the I/O interface:

Digital connections are ground to make type connections. They are protected against standard TTL levels but are not protected for higher voltages, DC or AC. They may be driven using an open collector or relay type connection to the amplifiers chassis ground. A ground reference pin is provided on the I/O interface and should be used as return for control connections. A minimum connect time of 20 mS is required for signals to be processed.

Analog connections are analog outputs which are buffered and capable of driving a 1k-ohm load only. Lower impedances will load down the circuit, and can cause damage. If a lower load is required, use an external buffer or op amp to provide necessary protection. For most applications, no additional protection is required.

XII. *Table - I/O Interface Connections*

Pin #	Signal Type	Direction	Description
1	Analog	Output	PS-1 Voltage, 1V/10V, nominal 2.65V
2	Analog	Output	PS-2 Voltage, 1V/10V, nominal 2.65V

3	Analog	Output	Current, PS-1, 1V/20A
4	Analog	Output	Current, PS-2, 1V/20A
5	-	-	OPTION, User selectable
6	-	Return	Ground
7	Digital	Input	RF 1/2 Power, 3dB down
8	Digital	Input	RF Power out down 10W increment
9	Digital	Input	RF Power out up 10W increment
10	Digital	Input	Amplifier Disable
11	Digital	Input	Amplifier Enable
12	Digital	Output	FAULT output

7. Maintenance and Calibration

The maintenance schedule is extremely simple and is measured in continuous operation time. Amplifiers which are used solely as backup will only require calibration when installed in a new environment or if the antenna is changed.

XIII. *Table - Maintenance Schedule*

Time	Component	Special Instructions
6 months	Input, Rev, Fwd Detectors	Use calibration command in this section.
6 months	Interlock	Test Interlock
Annually	Heatsink/Fans	Clean accumulated dust
Annually	Input, Rev, Fwd Detectors	Use calibration command in this section
Annually	Safety Functions	Test all safety controls on amplifier

XIV. *Table - Maintenance Schedule, harsh or dusty environment*

Time	Component	Special Instructions
monthly	SCA, Filter	Check for dust, clear from filter air filter and from heatsink fins
6 months	Input, Rev, Fwd Detectors	Use calibration command in this section.
6 months	Interlock	Test Interlock
Annually	Heatsink/Fans	Clean accumulated dust
Annually	Input, Rev, Fwd Detectors	Use calibration command in this section
Annually	Safety Functions	Test all safety controls on amplifier

2 years	Filter	Verify Filter performance
2 years	Multi Band Filter	Verify Filter performance

a. Detector Calibration Procedures

The detectors are calibrated before the amplifier leaves the factory, and every time the amplifier is submitted for repair or calibration. These detector calibration steps require specific, calibrated test equipment. It is better to skip these steps than to perform an improper calibration - a step which can cause the amplifier output to be unknown, possibly harming external equipment or violating regulatory specifications. Damage to amplifier due to improper calibration will not be covered under warranty.

This step must be performed by qualified personnel familiar with RF high power test equipment. When in doubt, consult a qualified RF Engineer.

i. *Forward Detector Calibration Procedure*

The forward calibration procedure requires the use of a dummy load or antenna with VSWR better than 1.25:1. A dummy load is preferred for all calibration. Follow the procedure when it is possible to take the amplifier off the air for approximately 30 minutes. If a permanent calibration watt meter is installed, the calibration may be carried out without interrupting the amplifiers operation.

Use of a calibrated power meter, such as a BIRD 43 series thru-line watt meter or a calibrated directional coupler with a calibrated power head, is required for proper calibration. Use of a non-calibrated source has the potential to overdrive the amplifier and can cause damage to external components, or even the amplifier itself. This will void the warranty.

- If a power meter is already attached to the system, skip the next two steps
- Remove AC power from the system and exciter by turning power off at the breaker and turning off main circuit breaker.
- Install power detector and dummy load if appropriate on the output of the system.
- Restore AC power to amplifier and exciter.
- Set Filter band 6.
- Set exciter source to 15.000 MHz, CW Mode (no modulation)
- Adjust exciter power so output power reading is 1500W (±50W).
- Compare output reading on SCA1500 program to the power meter.
- Using SCA1500 program, adjust FWD trim value up to increase indicated power reading.
- Adjust FWD trim value down to decrease indicated power reading.
- When finished, power down exciter source, remove AC power, and restore output connections.
- Maximum Trim value is -100 to +100. If TRIM value exceeds this range, replace ODC / UDCC assembly.

ii. *Reflected Detector Calibration Procedure*

The reflected calibration procedure requires the use of a calibrated attenuator capable of handling 1kW minimum. A 3dB attenuator will be used for this calibration procedure. If one is not available, it is not possible to perform the calibration. It is not possible to perform this calibration procedure without interrupting the amplifier's operation.

Use of a calibrated power meter, such as a BIRD 43 series thru-line watt meter, or a calibrated directional coupler with a calibrated power head, is required for proper calibration. Use of a non-calibrated source has the potential to overdrive the amplifier and can cause damage to external components, or even the amplifier itself. This will void the warranty.

- Remove AC power from the system and exciter by turning power off at the breaker and turning off main circuit breaker.
- Install 2 meter cable from output of amplifier to input of 3dB attenuator. Put power detector in line before the 3dB pad and connect power meter.
- Restore AC power to amplifier.
- Using SCA1500 software, set filter to band 6.
- Set exciter source to 15.000MHz, CW Mode (no modulation)
- Set amplifier power to 1000 Watts FWD output as indicated on external power meter.
- Allow to amplifier power to stabilize for 5 minutes.
- Compare reflected power reading on external power meter.
- Adjust trim value as necessary for REF Trim so power reading on SCA1500 program matches external power meter.
- When finished, power down exciter source, remove AC power, and restore output connections. Make sure to remove 3dB attenuator from output.
- Maximum Trim value is -100 to +100. If TRIM value exceeds this range, replace ODC / UDCC assembly.

iii. *Input Detector Calibration Procedure*

The Input calibration procedure requires the use of a directional coupler placed between the exciter and amplifier. It is highly recommended not to use the exciter power readout and these are frequently inaccurate. Use of a calibrated power meter is required for proper calibration.

- Remove AC power from the system and exciter by turning power off at the breaker and turning off main circuit breaker.
- Connect power monitoring between exciter and input of SCA amplifier.
- Restore AC power to the exciter only.
- Set exciter output to approximately 1W as measured on the power detector added above.
- Restore AC power to the amplifier.
- Set Filter band 6.
- Set exciter source to 15.000 MHz, CW Mode (no modulation)
- ENABLE amplifier and set output power to 1000W.
- Wait a minimum of 10 minutes, or per the exciter manufacturer's recommendations, to allow exciter power to stabilize.
- Adjust INP trim value up or down as required for readings to match.

- Power down the system as before, and restore the exciter to SCA amplifier connection.
- Return amplifier to service.
- Maximum trim value is -127 to +127. If a lower or higher trim value is required, the ICM must be replaced or requires service.

b. Verify Filter Performance

The single or multi band filter will age over time. This procedure assumes the user has verified filter performance in the first part of this procedure and found problems in the filter (or a specific filter band) and requires tuning.

Verification:

This procedure should be repeated for each band installed in the amplifier, at regular maintenance intervals as specified in the beginning of this section or at any time filter performance is suspect.

- Remove AC power from the system and exciter by turning power off at the breaker and turning off main circuit breaker.
- Install cable to large attenuator capable of dissipating 2kW minimum. Minimum attenuation is 50dB, but this may be achieved by bolting a smaller attenuator on to a higher power unit, so long as the total attenuation value is known, and the RF output for 1500W input does not exceed the safe power rating for test equipment to be used.
- Ensure that the power level intended will not cause excess harmonics in the test equipment. This ‘safe’ level is usually -10dBm to +0 dBm, and additional external attenuators can be added to achieve this level.
- Cable a suitable spectrum analyzer to the output of the power attenuator.
- Place an inline power meter between the amplifier and large attenuator. Location is not important, but it must be on the high power side, unless a low power unit is to be used with a calibration table.
- Restore AC Power
- Set exciter to the top of the band to be tested (see table at the bottom of this section). Set output for 1500W CW output, CW mode, No modulation.
- Verify output power on output power meter, ± 100W.
- Check second and third harmonics on spectrum analyzer. Maximum harmonic specification is -60dBc.
- Change exciter frequency to the bottom of the band to be tested. Set output for 1500W CW output, CW mode, No modulation.
- Check second and third harmonics on spectrum analyzer. Maximum harmonic specification is -60dBc.
- In the event harmonics fail, it may be necessary to notch out the fundamental using a notch filter set to the frequency of the signal - to verify if this is necessary, remove 10dB of attenuation and observe the change in harmonics - if they are greater than 10dB of change, it will be necessary to notch out the funadmental frequency to achieve an accurate reading.
- In many cases, ground paths will lead to false harmonic readings - pay particular attention to grounding of test equipment and ensure they do not share a common

circuit with the amplifier to be tested.

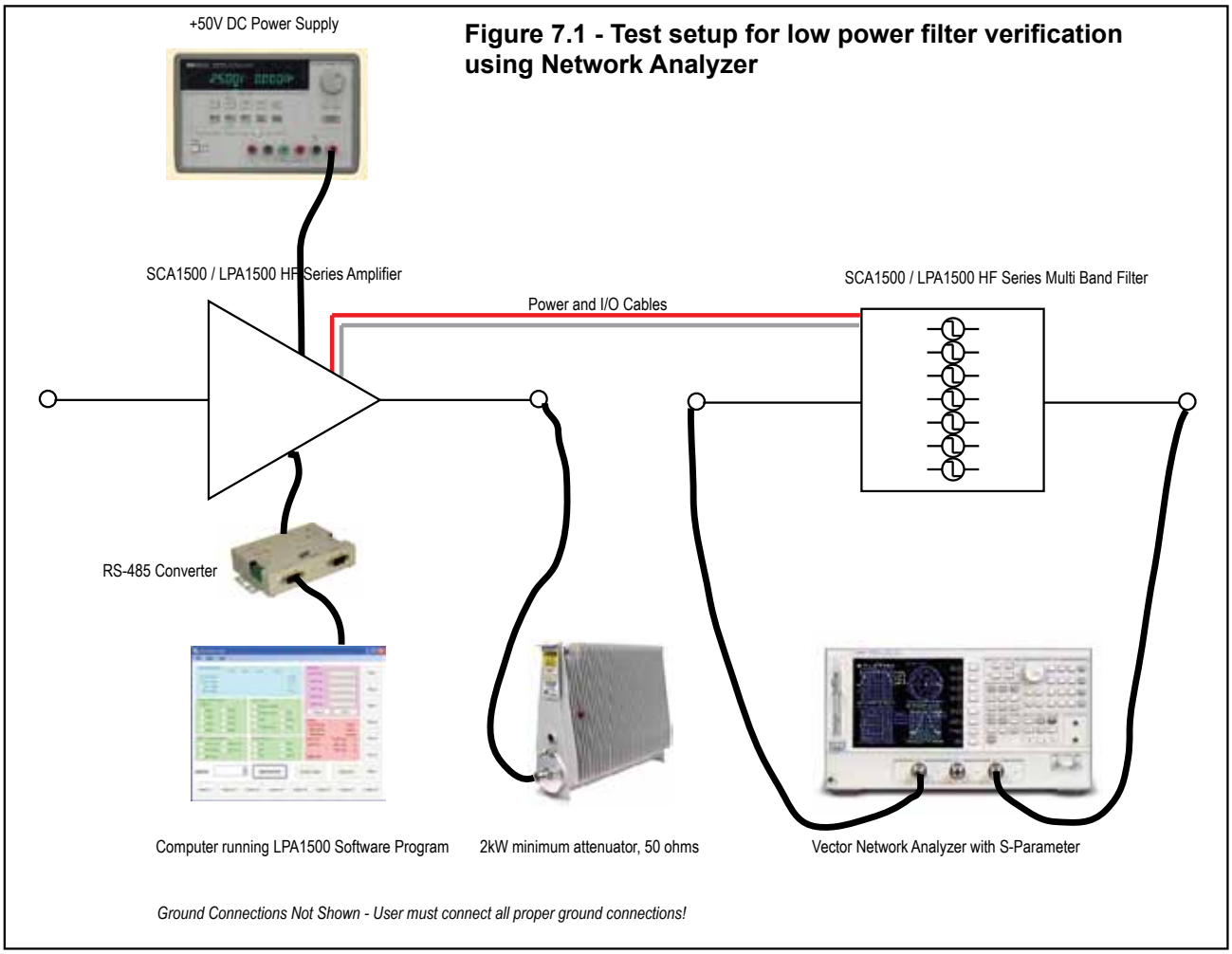


Figure 7.1 - Test setup for low power filter verification using Network Analyzer

If a filter band is found out of adjustment, it will be necessary to remove the filter or amplifier assembly that contains the filter to the test bench to perform the necessary adjustments. Two stages to this repair work, the first is to sweep and tune the filter at low power using a network analyzer, and second is to use a spectrum analyzer at higher power. If a suitable network analyzer is not available, it is possible to tune the filter without performing the network analyzer, low power step.

- Low Power Step - please refer to figure 7.1
- Use a suitable network analyzer capable of minimum 85dB dynamic range, 0 dBm output power from 1.5 - 30 MHz, sweeping from 1.5 to 90 MHz.
- Place amplifier to be tested (or filter box assembly with amplifier assembly) on the bench with cover removed to expose the filter to be tuned.
- If an amplifier assembly is on the bench, place temporary covers over both sides of the airbox so the amplifier will not overheat whilst operating.

Dangerous energy levels are present in both the amplifier and filter assemblies whenever the unit has DC power. Do not touch a soldering iron to any component with DC applied, and do not touch any component inside the cabinet with DC applied. Serious injury or death can result!

XV. *Table - Filter Specifications, Multi Band Filter, SCA1500/LPA1500 Series HF Amplifiers*

Filter Band	Low Freq. MHz	High Freq. MHz	Input Return Loss dBc	Insertion Loss, Max dB	Insertion Loss, Typ dB	Rejection, Min dBc	Rejection, Typ dBc	F2 Freq., Low MHz	F3 Freq., High MHz
1	1.5	2.3	-14	0.65	0.20	-30	-35	3.0	6.9
2	2.3	3.5	-14	0.65	0.30	-30	-45	4.6	10.5
3	3.5	5.4	-14	0.65	0.35	-30	-45	7.0	16.2
4	5.4	8.3	-14	0.65	0.40	-30	-40	10.8	24.9
5	8.3	12.7	-14	0.65	0.45	-30	-40	16.6	38.1
6	12.7	19.5	-14	0.65	0.45	-30	-35	25.4	58.5
7	19.5	30	-14	0.65	0.55	-30	-35	39.0	90.0

- Apply DC power connections and all data cables in place.
- Install cable to large attenuator capable of dissipating 2kW minimum. Minimum attenuation is 50dB, but this may be achieved by bolting a smaller attenuator on to a higher power unit, so long as the total attenuation value is known, and the RF output for 1500W input does not exceed the safe power rating for test equipment to be used. The attenuator is attached to the output of the SCA1500/ SCA1500.
- Connect the input of the filter box to Port 1 of the network analyzer.
- Connect the output of the filter box to Port 2 of the network analyzer.
- Please refer to Filter table for correct settings
- Set Network analyzer to display both S11 and S21 (Input Return Loss and Insertion Loss)
- Set Network analyzer start frequency to ‘low frequency’ in table
- Set Network analyzer stop frequency to ‘F3 high’ in table
- Set desired filter using SCA1500 program
- Ensure insertion loss in the ‘low frequency’ to ‘high frequency’ is below maximum insertion loss from table
- Ensure input return loss in the ‘low frequency’ to ‘high frequency’ is below maximum input return loss from table
- Ensure filter rejection (S21) is below minimum rejection from ‘F2 low’ to ‘F3 high’ from table
- Repeat for other bands
- If a filter band requires adjustment, the ‘first two’ coils will generally require simple adjustment. Use of a ferrite / brass rod will dramatically improve the process
- The ‘first’ coil, the coil closest to the input of the filter, will adjust the frequency of the resonance
- The ‘second’ coil will adjust the magnitude of the resonance and will have a greater affect on insertion loss
- Use a non conductive tool, such as a wooden dowel, to adjust the coil. Do not scrape the insulation!

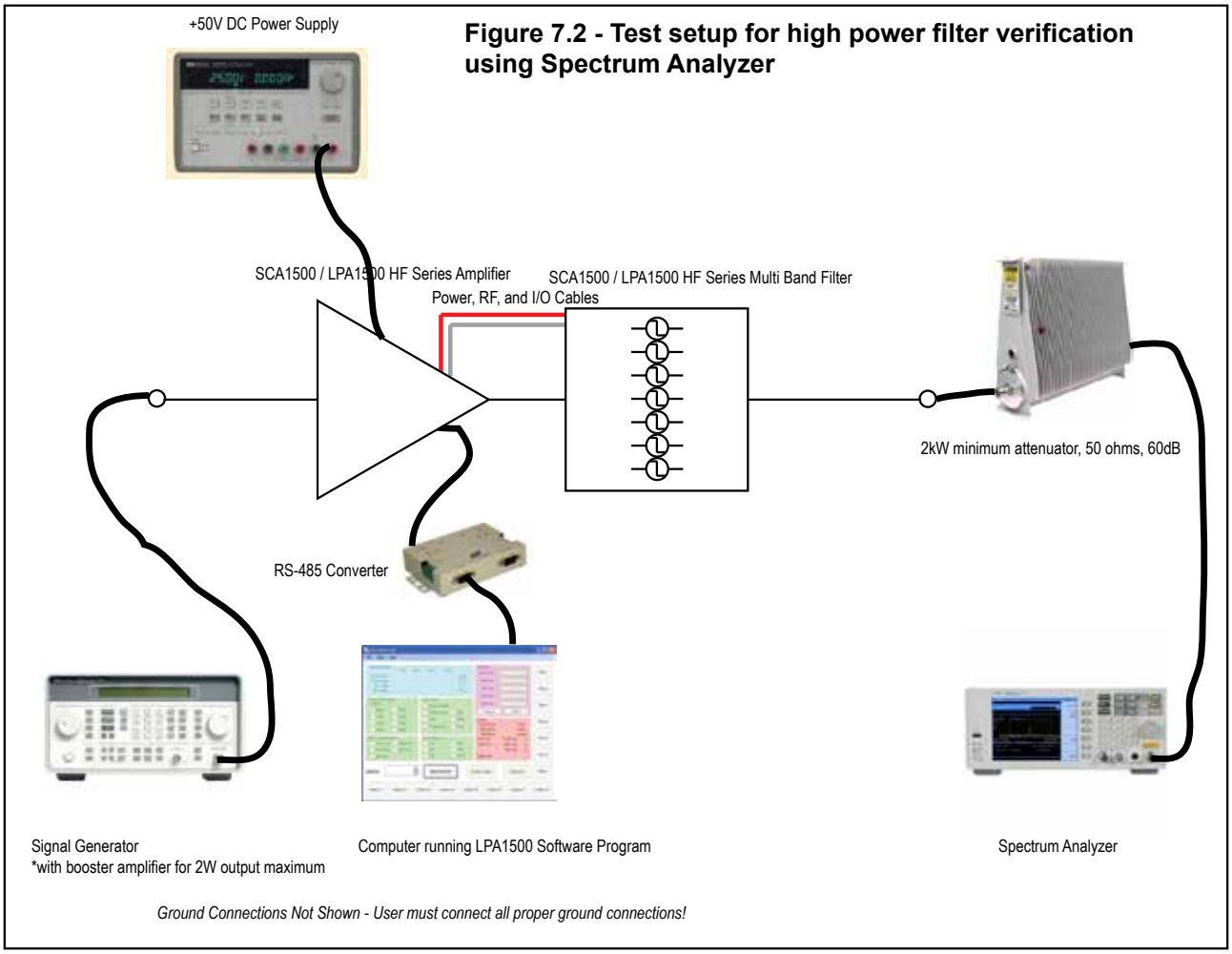


Figure 7.2 - Test setup for high power filter verification using Spectrum Analyzer

- High power test, refer to figure 7.2
- Ensure that the power level intended will not cause excess harmonics in the test equipment. This 'safe' level is usually -10dBm to +0 dBm, and additional external attenuators can be added to achieve this level.
- Attach output of large power attenuator to suitable spectrum analyzer.
- Set exciter to the top of the band to be tested (see table at the bottom of this section). Set output for 1500W CW output, CW mode, No modulation.
- Verify 1000W output power on output power meter, ± 100W.
- Set start frequency below the bottom of the band of the filter being tested.
- Set stop frequency to 4 times the top of the band to be tested.
- Key exciter and observe waveform
- Second and third harmonics must be 60dB below fundamental.
- It may be necessary to notch the fundamental using a suitable notch filter as the fundamental can generate additional harmonics in the test equipment and power meter.
- Use same adjustment technique as with low power test.

Use extreme care not to touch any acive coil as this can lead to severe injury.

c. Clean Heatsink and Fans

Using a portable light or flashlight, observe the interior of the heatsink air pathways. Look for any excessive dust build up on the inside surfaces of the heatsink. For all cleaning operations, ensure AC power is removed from amplifier before proceeding.

Using a shop vac, vacuum as much dust as possible from the front of the heatsink, and from the rear through the fan grill.

Do not use compressed air to clean heatsink surfaces. The dust generated can be hazardous to your health, and will settle on other equipment. The dust can also find its way inside fan bearings, reducing their lifetime.

For excessively dirty heatsinks and / or fans - if it becomes absolutely necessary to use compressed air to blow out the airways - follow this procedure.

Remove all services, cables, I/O from amplifier and remove from cabinet. Two persons are required for this step. Bring amplifier outside, away from people or air intakes, and remove the top lid of the amplifier. Wearing appropriate respiratory protection - dust mask, etc., blow air through the heatsink from the airbox. Be careful not to disturb any wiring or cables.

If the fans are excessively dirty, blow air through fans only from the air box side. Do not attempt to blow air from the rear of the amplifier as this will force dirt into sensitive bearings.

Check Multi Band Filter air filter. Vaccuum from front of unit. Replace disposable element if dirty or excessively soiled. This is accomplished by carefully removing the front panel (with all power removed) and removing screen assembly, separating and replacing filter element, then re-assembling. It is critical to leave metal screen assembly in place for proper operation and EMI emissions.

Re-assemble the amplifier and return to service.

d. Test Safety Functions

The following steps may be required by regulatory agencies. Unless there is any sign of safety protections malfunctioning, there is no need to perform these safety checks. These steps require the amplifier be removed from service, and be out of the cabinet with services connected. The use of a dummy load is required.

The safety systems to be tested include:
VSWR shutdown
Low Input Power
Fan Fail Detect

i. *VSWR Shutdown*

This test will ensure that VSWR shut down is functioning properly. It is not intended to test calibration or accuracy of detectors - please refer to Maintenance and Calibration section.

- Set output power to 500W output.
- Remove AC power to exciter and amplifier.
- Remove output RF cable. It is acceptable to leave the output adaptor on the amplifier.
- Make absolutely certain no cable or bare wire is within 3” of output adaptor.
- Make certain that when amplifier is powered up not to be within 12” of the output adaptor as human flesh can conduct RF energy and cause serious injury.
- Restore AC power to amplifier and exciter.
- Make sure amplifier is in ENABLE and turn on if not already on.
- Observe display - within 20 seconds, the AMP: setting should read AMP: VSWR overload.
- Observing the log, there should be four log entries relating to VSWR trip.

If amplifier does not automatically shut down, follow calibration procedure for Reflected Power in Maintenance and Calibration and repeat.

If amplifier still does not shut down, discontinue use of amplifier and contact the factory.

ii. *Low Input Power*

This test will ensure the input control module will sense and react properly to exciter power.

- Set output power to 1000W CW.
- Set exciter power to approximately +5 dBm CW.
- Turn exciter power off.
- Wait approximately 5 seconds.
- Amplifier power will drop, and press ENTER to view AMP menu
- AMP: LOW INPUT should be displayed
- Restore amplifier to normal operation.

If the amplifier does not diagnose low input, follow calibration procedure for Input Power in Maintenance and calibration and repeat above procedure.

If amplifier still does not register LOW INPUT power, then please contact the factory.

iii. *Fan Fail Detect*

This procedure can only be tested with the top cover removed. RF power does not need to be applied.

- Remove AC power from amplifier and exciter.
- Remove cables and services from amplifier and remove amplifier from cabinet (2 persons).
- Place amplifier on a worksurface and remove lid.
- Connect output RF cable to dummy load or antenna.
- It is not necessary or advisable to connect the exciter to the amplifier - leave this connection open for now. If possible, terminate the input connection with a 50 ohm termination.
- Unplug Fan 1 and Fan 2 power connectors from Main Control.

- Connect AC power to amplifier.

Do not touch any AC wires inside of chassis as these are now energized.

- Restore Amplifier function.
- Allow 10 seconds for amplifier startup, and view logs.
- Ensure FAN 2 Failure is in log
- Ensure FAN 1 Failure is in log.
- Re-attach power connectors to fans.
- Replace cover, return amplifier to service.

If MAIN CONTROL fails to detect fan outage, please consult the factory.

8. Troubleshooting

The System Main Control gives all necessary troubleshooting information to the basic module level. Each module is designed to be field replaced, but not field repaired. This may be done at a repair depot or by submitting to the factory for repair.

The simple modular system is extremely easy to maintain and troubleshoot. Only a few simple tools, along with the front panel display, are required to determine any circuit fault. Generally, improper installation, static related events such as lightning, or power supply surge, are the culprits of any circuit failures. Please refer to Block Diagram and Wiring Diagram.

The most common failure modes are diagnosed by the Main Controller. There are a few failures modes that the user must assist in troubleshooting.

The tables give general troubleshooting information which apply to both LCD display and non LCD display versions. In the event a non display version is being troubleshot, use of the SCA1500 Windows computer program will greatly assist the troubleshooting effort. All other status information may be read through the serial port. Please refer to section 6 for commands and serial port operation.

a. Problem Determination

The software in this system is designed to troubleshoot 90% of all problems. This chart will assist in troubleshooting and covers all possibilities, even those remote items not specifically tested by the main controller.

This chart is organized by symptom and can be followed accordingly.

Some troubleshooting steps require powering amplifier with lid off into a dummy load. Take great care when performing these steps !

Warning - testing procedure may require power to amplifier with lid removed. Take great care not to touch active AC and RF lines or injury may result!

XVI. *Table - Amplifier Troubleshooting*

Symptom	Display	Suspected Problem	Corrective Action
No display, No power output	**Blank**	No AC Power	Verify AC power present to cable end at amplifier Verify Circuit Breaker (customer panel) is ON Verify CIRCUIT BREAKER (front panel) is ON - attempt reset Verify DC power connections on DC versions is properly installed and both +50V and +5V are available on the connector
		Faulty Internal Wiring	Verify AC power path from HBL connector in airbox to EMI Filter, From EMI filter to Circuit Breaker, from Circuit Breaker to Logic Supply and Main Power supplies. Repair if necessary.
		Defective Logic Power Supply AND bad Main Power Supply	Verify AC power present at both power supplies and replace if necessary. Verify DC power connections on DC versions is properly installed and both +50V and +5V are available on the connector

Symptom	Display	Suspected Problem	Corrective Action
No RF Power Output	**PS x Bad**	Bad Main Power Supply	Check LEDs on front of MAIN POWER Supplies - check for flashing RED Fault, replace if defective. NO LEDs - check that POWER SUPPLIES are firmly seated in connector - are seated toward rear of amplifier. Replace MAIN POWER SUPPLY(S)
	LOW INPUT	Exciter Power is low Exciter is off Exciter is faulty	Check Input Power and fix Exciter or adjust Exciter power level
		Input Power registers ok but DRIVER AMPLIFIER damaged	Replace DRIVER or verify current through driver using shunt resistor on DRIVER
		Exciter Ok ICM OK DRIVER OK	Check splitter connections and verify visually isolation resistors. Check and / or replace RF POWER SPLITTER
	COMBINER/ FILTER	Damaged RF Combiner OR HARMONIC FILTER	Repair / Replace RF Power Combiner or HARMONIC FILTER Repair / Replace Cable connecting RF Power Combiner to HARMONIC FILTER.
	HIGH VSWR	No connection between ODC and load	Check Antenna Cable Verify Antenna VSWR Check RF OUTPUT CONNECTOR - Repair / Replace
	LOST COMMUNICATIONS WITH x	Processor has lost communication, likely due to power surge / brown out	Reset amplifier - by turning amplifier OFF and ON (remote or front panel) using PHX-6 connector on rear of amplifier.

Symptom	Display	Suspected Problem	Corrective Action
RF OUTPUT power keeps changing to 1/2 power	**VSWR 3DB TRIP**	Bad load	Check antenna or dummy load - repair / replace (use REFLECTED POWER reading to assist diagnosis).
		Bad Antenna Cable	Check antenna cable - repair / replace as needed.
		Faulty RF OUTPUT CABLE	Check RF Output cable - repair / replace as needed.
	HIGH POWER 3DB TRIP	Exciter / Input power unstable	Sharp spikes in output power can trigger hardware trip in UDCC - caused by faulty exciter or bad input cable. Check & repair or replace as needed.
			Faulty RF INPUT CABLE - repair / replace.
		Severe fluctuations in DC supply can cause amplifier to go into compression and lower max power	Evaluate DC line condition - repair.
			Verify proper MAIN POWER SUPPLY condition (logs should show POWER SUPPLY error).
Half Power or cycles between 1/2 and full or 1/2 and no power	**FAN x FAIL**	Air flow is blocked, one or two fans have failed	Check air path and correct.
			Replace affected FAN(S).
Output Power Unstable	**no message**	Exciter power is unstable	Repair / Replace exciter or input cable.
		MAIN POWER SUPPLY problem	Check DC power monitoring in status screen, if unstable, repair / replace MAIN POWER SUPPLY(S).
		Antenna / load unstable - icing or other external problem such as static	Recommend to wait one hour, if not cleared, site inspection required. Reflected power will fluctuate as viewed in STATUS.
Output Power stuck at low level	**PAx FAIL**	RF PA module measured bad	Attempt reset of amplifier by turning OFF and ON. If problem is not cleared, repair / replace indicated RF PA MODULE.

Symptom	Display	Suspected Problem	Corrective Action
Amplifier will not enable	**MASTER OFF**	The ENABLE button is OFF (RED)	Press ENABLE to turn on - from front panel only.
		If power supply is set for LOGIC SUPPLY ALWAYS ON, breaker is off	Turn on CIRCUIT BREAKER - from front panel only.
		Damaged Circuit Breaker	Sense lead on circuit breaker is damaged. Repair / replace.
Power does not match power meter or other sensor	**no message**	Sensor has drifted (FORWARD, REFLECTED, INPUT)	Detectors can drift over extreme temperature swings (40°C or more), or due to large VSWR changes - run CALIBRATION routine as found in this manual (front panel only).
REAR PANEL remote not responding to commands	**no message / fault**	Amplifier is in LOCAL mode	Change amplifier to REMOTE mode - front panel only.
Amplifier keeps going offline	**PS x BAD**	AC Mains are very unstable	Large changes in AC line condition can trigger this and cause the amplifier to shutdown for protection. Voltage swings greater than 70 VAC rapidly (<2 seconds) can cause this. In extreme cases, this can be due to industrial equipment switching on - such as air handlers, air conditioning, compressors, etc. Switch amplifier to another circuit or install appropriate power conditioning circuitry.
	LOST COMMUNICATION UDCC	Noise problems	Requires site inspection - ensure amplifier covers are securely attached. If so, inspect interior of amplifier - ensure UDCC cable is securely fastened, UDCC cover is installed, and is bolted to heatsink, ensure UDCC cable at MAIN CONTROL is properly connected. May require repair / replacement of UDCC module.
	LOST COMMUNICATION DRFMC	Noise Problems Faulty Cable Fault Module	Requires site inspection - check cable connection. Replace if no cable issue.

b. Common toolkit required

The following tools are required for all simple repairs.

- 5/16” open end wrench

- #2 socket head cap screwdriver
- #4 socket head cap screwdriver
- #6 socket head cap screwdriver (7/64)
- Small slotted screwdriver
- Small Phillips Screwdriver
- Large Phillips Screwdriver
- Electric Screwdriver recommended to remove lid screws

For moderate to advanced repairs, these additional tools are recommended.

- Heat shrink tubing
- Lighter or heat gun
- Wire Cutters
- Wire Strippers
- Soldering irons, two, 50W minimum, 1 medium tip, 1 large tip.
- Solder, fluxed. Avoid acid core solders.
- Isopropanol and cotton swabs to clean flux

c. Module Replacement

For all module replacements, it is necessary to remove the amplifier from the cabinet and place on a stable work surface. When removing the appropriate cover, keep track of all screws - ensure none drop into the amplifier cavity. After re-assembly, if any screws are missing, make sure to find all screws!

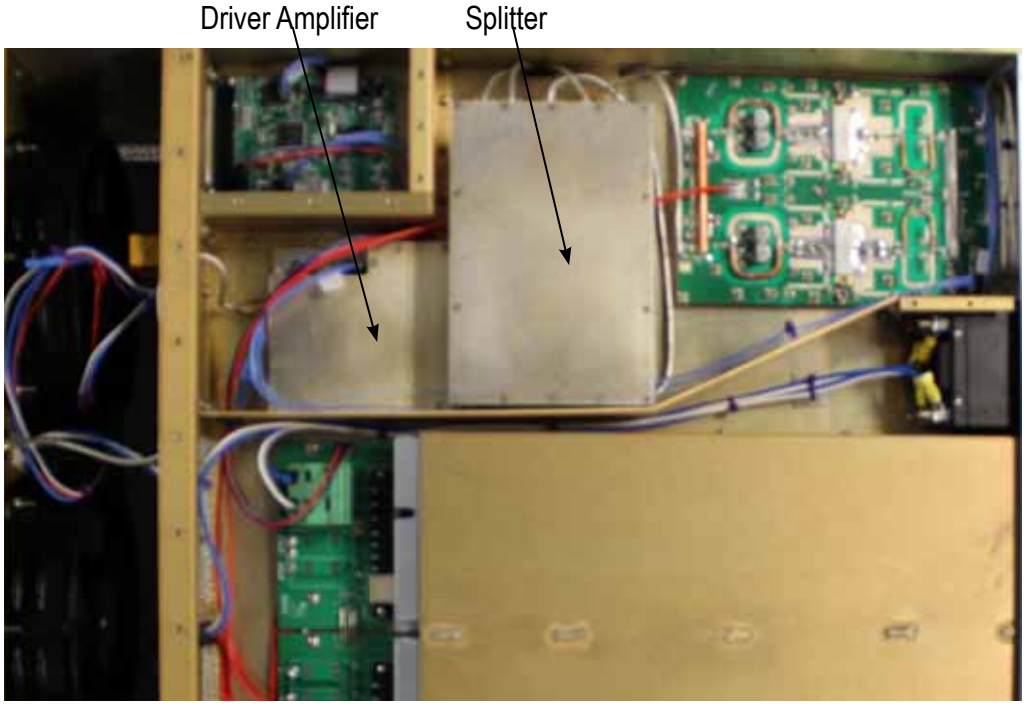
i. *MAIN CONTROL - Moderate Repair*

The MAIN CONTROL board contains connections to all components in the system. Most amplifier models have only one connection per auxiliary component. Certain models have a single DB-37 plug which is quite simple to replace. These instructions cover the multi-plug version.

All connections are latching plug types and are easily removed. Do not attempt to force any connector out of its socket - make sure to release locking tang before pulling connector out. Each wire is labelled on end - replace each connector carefully into the correct socket on the new main controller.

- Unplug all DC connectors from Main Control board.
- Remove six screws holding the main control board in place.
- Remove two screws holding DB-37 connector in place. These are accessed from the air box. A right angle philips driver or flexible screwdriver will ease this process.
- Remove main control board and replace with new board.
- Replace all DC connections.

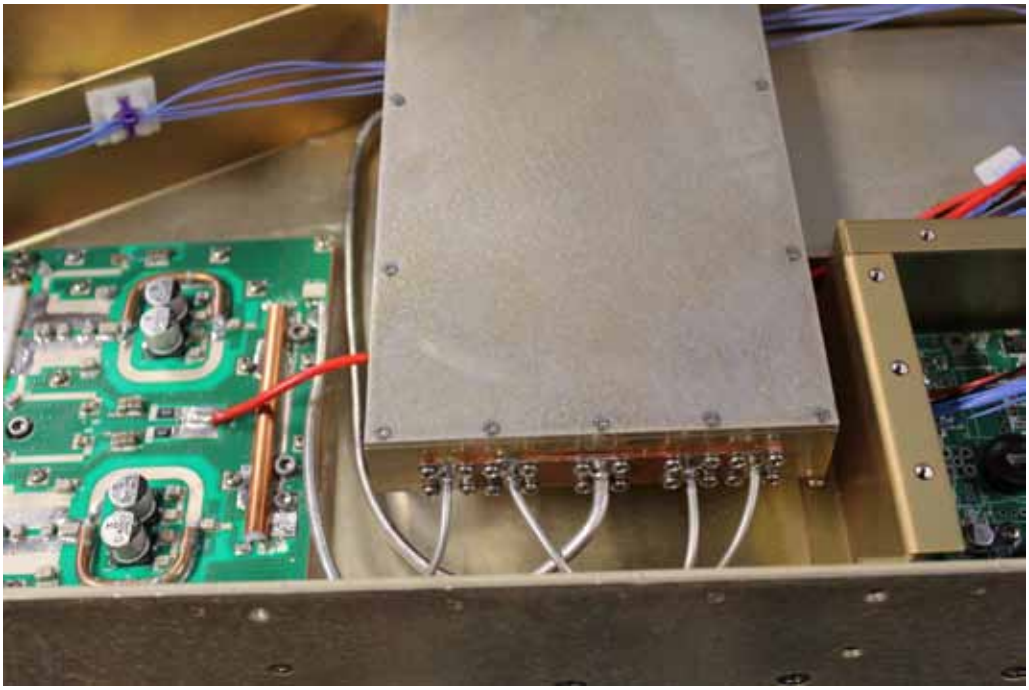
ii. *DRIVER MODULE, DRV - Moderate Repair*



The DRV module is easy to replace, but will require moving splitter box and use of a soldering iron to remove the power pin on the driver module.

The most critical step in this repair is having good thermal contact with the heatsink. This will ensure the ICM will survive overdrive conditions by providing a good thermal path for the excess heat.

- Remove the lid on the splitter by removing 14 screws. Be careful not to drop any in the chassis - and recover any that may be dropped.
- Remove 4 #8 socket head cap screws from the perimeter of the splitter, and carefully lift the splitter off the driver amplifier. Be careful not to kink any of the RF cables as they are firmly attached in the rear.
- Remove the lid screws from the driver amplifier. Be careful no to drop any in the chassis - and recover any that may be dropped.
- Remove the lid.
- Remove the two SMA connectors on each end of the amplifier.
- Desolder the red Vsup wire and set aside.
- Remove the two 5 pin data connectors from the corner of the amplifier.
- Remove the 4 #6 socket head cap screws from the driver amplifier.
- Carefully remove the driver amplifier from the chassis.
- Clean all thermal compound from the heatsink.
- Apply a thin layer of thermal compound to the bottom of the DRV module.
- Installation is the reverse of removal.



iii. *RF POWER SPLITTER - Advanced Repair*

The RF POWER SPLITTER contains five connections. There are five cables attached to

a copper plate which is affixed to the end of the splitter. The 5 center tabs of the coax must be desoldered, then the enter plate must be remove and the splitter can be pulled off.

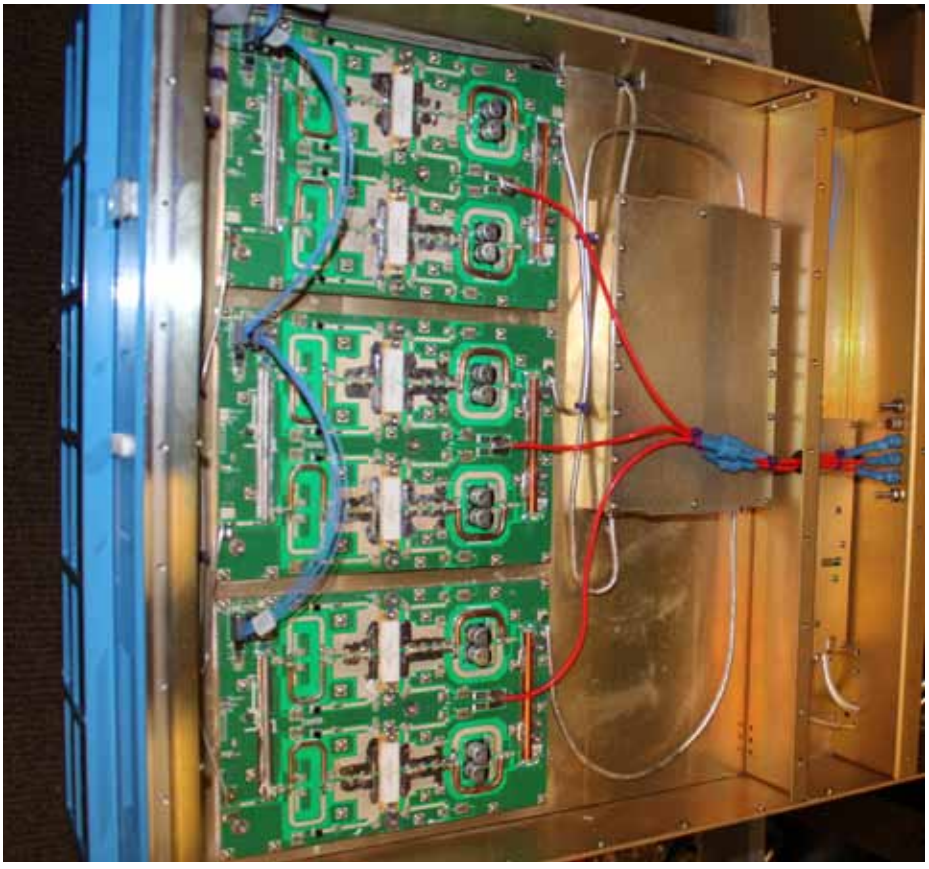
- Remove the splitter lid screws, 14 total. Be careful not to drop any inside of the amplifier and carefully recover any that drop.
- Set the lid aside.
- Using solder wick or desolder tool, carefully desolder center tabs of all five coax.
- Remove #8 socket head cap screws retaining input splitter.
- Carefully tilt connector end of input splitter up to expose screws.
- Remove 20 screws holding copper plate to the input splitter.
- When replacing Splitter, make sure the center conductors on coax do not bend or break when inserting new module.
- Installation is the reverse of removal.

iv. *RF PA MODULE - Simple Repair*

Only a #6 socket head cap screwdriver, soldering iron are required to replace PA modules. This is an easy repair and will take less than 10 minutes, plus time to remove amplifier from cabinet and remove amplifier cover.

The most critical process in this repair is ensuring good thermal contact between the bottom of the RF PA MODULE and the heatsink. The RF PA MODULE generates approximately 750W of heat when operating. If no good thermal path is present, the amplifier will overheat and cause a thermal shutdown fault.

- Ensure you have the correct PA module - please refer to the diagram for module



designations. (Most amplifiers will have small stickers labelling each unit on the heatsink. They can be obscured by wiring)

- Remove input RF cable using soldering iron.
- Remove output RF cable using soldering iron.
- Remove data I/O cables by squeezing release tabs and carefully pulling connector out.
- Desolder red Vsup wire.
- Remove seven #6 socket head cap screws from edge of amplifiers
- Remove amplifier by pulling up and twisting slightly.
- Clean thermal compound off heatsink.
- Place a thin layer of thermal compound on the replacement amplifier. Thin means less than 0.003" thickness. Use a small squeegee or metal spatula to thin compound so it is nearly transparent.
- Verify all foreign matter is removed from the heatsink
- Place new RF PA MODULE on heatsink, making sure than the RF INPUT side faces the front of the amplifier. The RF INPUT has a single SMA female connector.
- Press down on the amplifier and twist to seat amplifier.
- Replace seven screws and split washers removed in above step.
- Torque to 14 in pounds each.
- Replace 2 RF cables and I/O cables.
- Replacement of RF Transistors are considered an extremely advanced repair and should be performed only by knowledgable and trained repair personnel, therefore this subject is not covered in this manual.

v. *4- WAY POWER COMBINER - Advanced Repair*

The 4-way RF Power combiners are a conventional transformer type Wilkinson Combiner, there are two per system. Five RF cables are soldered to the outside surface using

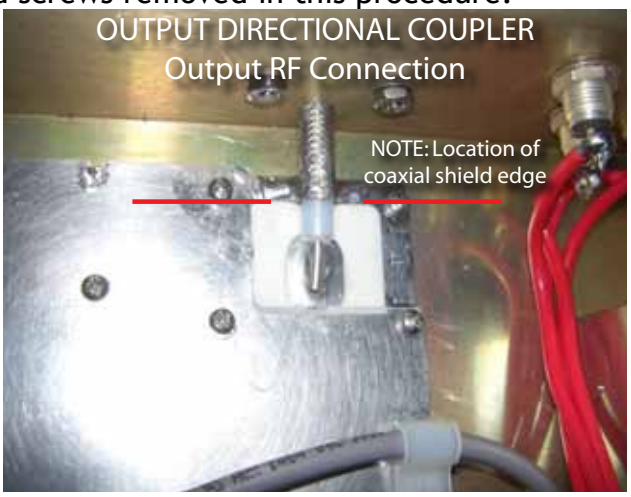
a copper flage, and the center conductor is soldered to the printed circuit board. If damage occurs, it is usually to the load and printed circuit board so the assembly is replaced as a unit.

- Remove lid screws and set lid aside.

- Remove 4 #6 socket head cap screws and set aside.
- Carefully lift combiner assembly off heatsink and remove all philips head screws attaching copper plates to combiner side.
- Using soldering iron, heat center conductor on each cable and carefully pull coax out.
- Clean thermal compound off heatsink and combiner.
- Place a thin layer of thermal compound on the combiner itself.
- Re-attached all coaxial cables being extremely careful to prevent any shorts between the shield of the coax and center pin. It is important to perform this step with the combiner above the heatsink to allow proper cable attachment
- Place new POWER COMBINER on heatsink, making sure than the RF OUTPUT side faces the rear of the amplifier.
- Press down on the combiner to seat.
- Installation is the reverse of removal.
- Replace #6 screws and torque 10 - 14 in pounds (critical!)

vi. *OUTPUT DIRECTIONAL COUPLER - Moderate Repair*

The ODC is a two PCB sandwich. This unit may be contained in the 5U Amplifier cabinet or optional 2U filter box if present. Even pressure must be applied to avoid 'hot spots' or inaccurate readings. For this reason, take great care to re-install all Phillips head screws removed in this procedure.



- Desolder output RF cable connection - this is the coax cable coming through the air baffle plate at the rear of the amplifier. Carefully lift RF cable out of the way - approximately 0.10". This may require two soldering irons.

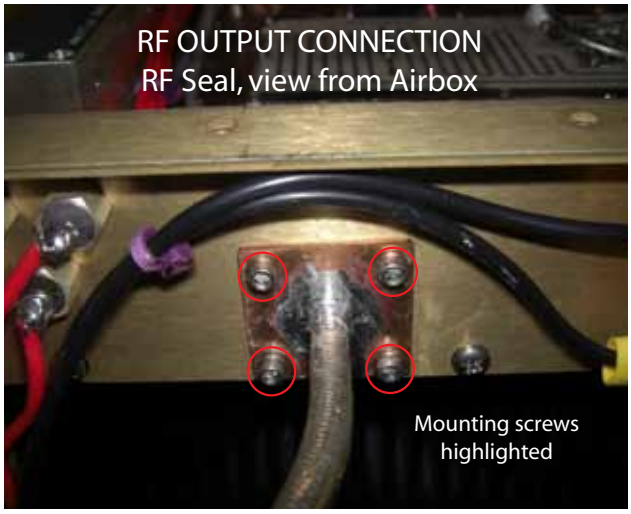
Warning: do not bend RF cable more than specified!

- Desolder jumper wire between HARMONIC FILTER and ODC and set side.
- Remove I/O cable from rear side of UDCC.
- Remove all Phillips head screws from top of ODC.
- Carefully slide ODC toward the front and left sides of the amplifier to clear the coax cable and remove old assembly.
- Installation is the reverse of removal.

- Torque Phillips head screws 6 - 8 in pounds each.

vii. *OUTPUT RF CONNECTOR - Moderate Repair*

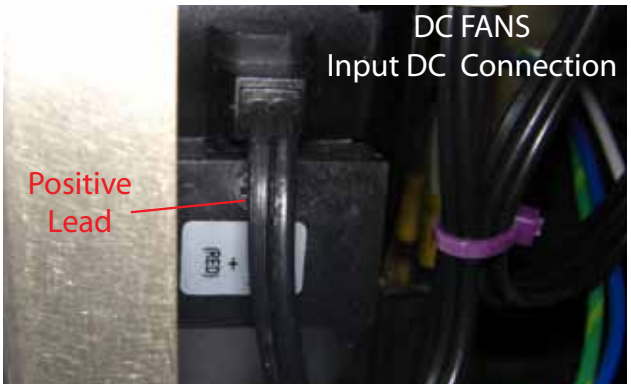
The rear output connector assembly, as well as the cable that attaches to the ODC, are replaced as a single unit. Depending on the output connector installed on the amplifier, these pictures may not apply. The standard EIA 7/8 flange configuration is shown. The most critical step in this repair is ensuring a good fit of the copper flange in the baffle plate. This 'seal' keeps RF energy from leaking into the air box and violating RF emissions specifications.



- Desolder output RF connection - this is the coax cable coming through the air baffle plate at the rear of the amplifier. Carefully lift RF cable approximately 0.10". This may require two soldering irons.
- Remove four mounting screws around perimeter of copper plate seal in air box. A short allen wrench may be required for this step.
- Make sure to capture the two nuts and lock washers inside the amplifier. (if these are PEM sockets, ignore this part)
- Remove five large mounting screws holding EIA Flange connector to rear panel.
- Cut cable ties holding RF cable to fan shroud - two or three locations depending on model. Note these locations as these cable ties must be replaced.
- Carefully slide RF cable / seal out of its place in the air box, and slide entire RF cable assembly out the bottom of the amplifier.
- Installation is the reverse of removal.
- Take great care when installing RF cable not to damage copper seal - it must seat flat.
- Torque screws on RF seal to 12 - 16 in pounds, and large hex screws on rear of cabinet tot 10 - 12 ft pounds.

viii. *DC FANS - Simple Repair*

Take care when removing the fan units not to disturb cabling around the fans. Also make sure to install the units with the airflow pointing to the rear - the manufacturers label will be facing out the rear of the amplifier when properly installed.

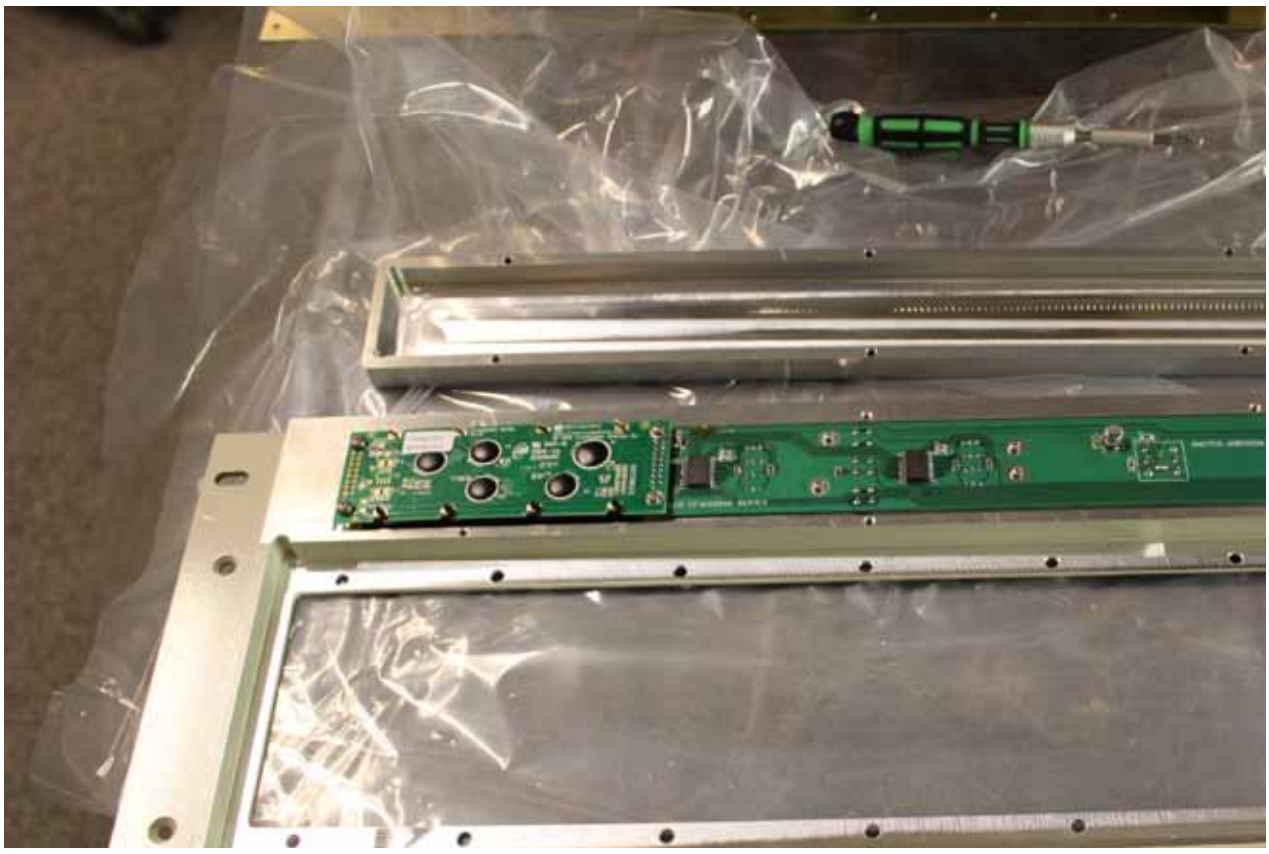


- Remove top and bottom amplifier covers.
- Remove fan finger guards by removing two screws on rear of fan. Catch nuts and split washers that are mounted on the opposite side of the fans.
- Depending on fan (left vs. right) an additional cable clamp holds either an RF cable or I/O cable wiring harness must be removed on the rear of the fan, and the cable pushed carefully out of the way.
- Remove two remaining screws in the same way.
- Remove DC wiring from terminal block.
- Slide fan out of the top of amplifier taking care to not bend or break the RF cable.
- Installation is the reverse of removal.
- Be sure to use a lock washer under each nut.
- When re-installing DC wiring, please observe wiring order:
- Purple = PWM
- White = Tack
- Red = Vsup
- Blue = Ground
- 

ix. *DISPLAY UNIT - Moderate Repair*

The display assembly is affixed to the front panel. The front panel assembly is removed and repair is performed with the front panel out of the amplifier.

- Remove amplifier grille and filter.



- Remove front 12 screws from front panel.
- Remove front row of top and bottom lid screws.
- Remove side panel screws from left and right side panels affixed to front panel (5 each side)
- Pull front panel away from amplifier 1” ONLY.
- Remove LCD cable top left of assembly.
- Remove four screws from circuit breaker and push circuit breaker out of panel.

- Place amplifier front face down on protective material.
- Remove 6 screws from LCD lid. Set lid aside.
- Remove PCB and LCD screws and remove assembly.
- Installation is the reverse of removal.

d. Additional Repair Procedures

i. *Biasing of RF PA Module and RF PA Driver Module*

Replacement PA modules come from the factory pre-biased. It is useful to follow this procedure if the customer elects to replace power transistors or any time the amplifier requires re-biasing.

Please refer to PCB diagrams in the appendix for correct pad and component locations. This procedure should be performed on the lab bench with the output of the SCA1500/SCA1500 drawer properly terminated. There will be no RF input during this procedure.

- Turn V100 counterclockwise 12 turns. This places ground on the input of the amplifier.
- Apply Vsup to the system and start. In many cases, the automatic control system will cycle power and disable the amplifier. Pay attention to the front panel indicators, if the system halts, it may be necessary to cycle power to reset the bias circuit.
- Measure voltage at TP1. Acceptable range at 25°C is 6.85V ±0.010V. Adjust with V101 as required.
- Slowly increase V100 until DC voltage on gates of input transistor Q102 is 2.800V.
- Monitor current to device by measuring voltage in mV mode across current sense resistors R121-R122. Pads are labelled ‘I SENSE’ and ‘VSUP’
- Continue to increase V100 until current is 1.00A ± 0.10A (output PA) 0.80A ± 0.10A (driver PA).
- This will correspond to 10.0mV as measured across the current resistors (8.0mV for Driver PA)
- Allow pallet to soak for 5 minutes, check and adjust as necessary.

ii. *Amplifier gain adjustment*

Amplifier system gain is nominally 33dB at 10MHz. Due to minor variations in outside connections, it may be necessary to re-adjust the overall amplifer gain.

Increases in gain are accomplished by increasing the bias level of the driver amplifier. Up to 1.0dB can be added this way, the maximum amount. Follow procedure in section 8.d.i “Biasing of RF PA Module and RF Driver Module”. Increase bias level to PA Driver module, but under no circumstances exceed 1.40A.

Reductions in system gain are accomplished by adding an attenuator to the front end of the driver. Three pads are available - R100, R101, R102. As provided, a jumper is installed in R102 which provides 0dB of attenuation (0.01 ohm resistor).

Use the following 2512 size surface mount resistors to achieve desired attenuation

XVII. *Table - Attenuator - Resistor values*

Attenuation	R100	R101	R102
0.5			
1.0			
1.5			
2.0			

9. Spare Parts List

i. *Moderate Risk Installations*

Recommended spares include:

RF PA Module, qty 1
DC FAN, qty 1

This applies to SCA1500-HF/LPA1500-HF series. Please keep in mind these components are stocked and may be acquired within one business day (Continental US) or three business days (worldwide). The amplifier will operate without reduced power with one faulty RF PA. The same is true for DC Fans, so consider this in planning spares requirements.

ii. *High Risk Installations*

For high risk installations - those installation in highly lightning prone areas, or those without reliable AC main power should consider the following list.

RF PA Module, qty 2
DC FAN, qty 1
RF Driver Module, qty 1
PSU, qty 1

iii. *Module, Power Supply Repairs*

Modules may be repaired by obtaining an RMA from Delta RF Technology, and sending module in. Normal repair is $595 for any RF module. Most repairs returned within 1 week of receipt. Pricing current as of 2011.

10. Glossary

5U - refers to EIA standard cabinet, originally designed by the telephone industry. ‘U’ is short for Unit which is the vertical space consumed by the amplifier and is 1.750”.
DMC - ‘Dual Module Controller’ - the module which controls and monitors the RF Power Amplifier Directly.
ICM - ‘Input Control Module’ - the controller placed at the input of the amplifier which monitors input power and controls amplifier gain.
ODC - ‘Output Directional Coupler’ - the component monitoring RF power at the output of the amplifier.
PA - abbreviation for ‘Power Amplifier’
RFPA - ‘Radio Frequency Power Amplifier’ - the Power Amplifier which does all the work.
UDCC - ‘Universal Directional Coupler Controller’ - the module which reads the Output Directional Coupler (ODC) and reacts accordingly.

11. Health and Safety Warning

RF Energy can be dangerous. Touching exposed RF connectors or components can lead to injury or death. Radiated RF Energy can be just as dangerous, especially near radiating elements such as coils, antennas, etc. Excercise extreme caution and bes judgment before working on any energized RF Amplifier.

Please consult the factory with any questions.