APPENDIX A
OPERATING MANUAL

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SERVICE MANUAL LOW BAND VHF HMS SERIES RF POWER AMPLIFIERS

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LOS ANGELES, CA 90065

L-PA1-HMS-S-H0

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PRODUCT DESCRIPTION

The **HMS** series of **TPL** power amplifiers are intended for use in base station or repeater applications with 100% duty cycle. They are all high power units and in various configurations will cover the frequency range extending from Low Band VHF to 960 MHz.

An **HMS** amplifier is a self-contained unit that allows operation, metering, and monitoring of all parameters of a RF power amplifier. Its major components are: enclosure, front panel, rear panel, power amplifier, power supply, cooling fans, and metering and monitoring circuits. The entire assembly is designed to be installed in a nineteen-inch rack.

For operator convenience views of the top, front, and rear of the amplifier are presented in the illustrations section.

GENERAL SPECIFICATIONS

FREQUENCY RANGE: 35-50 MHz (Operating frequency to be specified)

OPERATING MODE : FM

TABLE 1

MODEL	POWER INPUT	NOMINAL POWER OUTPUT
PA1-3AF-HMS	2 - 4 W	300 W
PA1-3BF-HMS	4 - 8 W	300 W
PA1-3CF-HMS	8 - 15 W	300 W
PA1-3DF-HMS	15 - 25 W	300 W
PA1-3FF-HMS	25 - 35 W	300 W
PA1-3GF-HMS	35 - 70 W	300 W

OPERATING TEMPERATURE RANGE: 0° to +50° Celsius.

OPERATING VOLTAGE: 110 VAC Standard, 220 VAC Optional, 50-400Hz

EIA DUTY CYCLE: 100%

BYPASS PATH INSERTION LOSS: 1 dB maximum (35-50 MHz), when carrier operated relay (COR), is specified.

HARMONIC AND SPURIOUS EMISSIONS ATTENUATION: Meets or exceeds FCC Type Acceptance requirements.

FUSING: Appropriate circuit breaker.

REMOTE MONITORING CONNECTOR: A DB-25 connector for remote access to metering and indicators is a standard feature on all **HMS** amplifiers.

Repeater Configuration (standard): Supplied without a COR.

Base Station Configuration (optional): Supplied with a COR.

Input Drive Power (See Table 1): Special drive levels can be accomodated if specified at time of order.

GENERAL SPECIFICATIONS (continued)

OPTIONS:

The **HMS** power amplifiers are available in several options and configurations, when specified at the time of order.

NOTE:

This amplifier has been factory-tuned to the frequency specified at the time of order and will operate within ± 2.5MHz of that frequency. For operation at any other frequency, see the Tune Up Instructions section.

CAUTION!

Check the amplifier upon receipt for visible damage. If any is noticed, please call **TPL** at **800 HI POWER** to request a RMA number (Return Material Authorization). If purchased through a dealer, ask them to follow this procedure for best results.

EXPENSIVE COMPONENTS MAY BE DESTROYED IF THE AMPLIFIER IS TURNED ON IN A DAMAGED CONDITION.

OPERATING PRECAUTIONS

CAUTION: This amplifier produces RF voltages that can cause painful and dangerous RF burns. Use caution! Connect and disconnect all RF connections with the DC power and drive power off.

DRIVE POWER: RF power transistors, although quite rugged in most respects, are easily damaged by overdrive. Be careful not to overdrive this amplifier, even for an instant. Higher than rated drive power may destroy the transistors and **VOID ANY WARRANTY.**

TERMINATIONS: The parameters of this amplifier will degrade if it is operated into anything but a 50 Ohm load. That may mean any, or all, of the following: Lower power output, increased current drain, higher operating temperature, lower efficiency and reduced lifetime.

INSTALLATION

This unit is designed for mounting in a standard 19" rack. When picking a location in the rack, considerations must be given to RF power output cable lengths, as well as cooling.

Mount the unit where dust and other debris are not likely to clog the cooling fans. Avoid mounting the amplifier directly above hot pieces of equipment that could artificially raise the amplifier temperature.

Connect the radio transmitter to the "RF INPUT" Type N connector and the antenna to the "RF OUTPUT" Type N connector on the amplifier. Use 50 Ohm coaxial cable.

Plug the AC line cord into the system AC power receptacle.

For safety, make sure the rack and all equipment connecting to the amplifier have proper AC grounds. Do not rely on coaxial cable shields for AC grounding.

Assure the installation has proper lightning protection.

MAINTENANCE

Major components of the HMS amplifiers can be easily removed and replaced.

Removal of the RF Amplifier Assembly

The RF amplifier assembly can be removed using the following steps:

1. Disconnect the cables from the RF input and RF output connectors on the rear of the amplifier.
2. Disconnect the power and signal connector on the right side of the amplifier.
3. Remove 6 screws, connecting the amplifier heat sink to the chassis. See the top view of the amplifier.
4. Remove 2 screws, connecting the amplifier heat sink to the rear panel. See the rear view of the amplifier.
5. Remove the RF amplifier assembly from the top.

Removal of the Power Supply.

The power supply can be removed using the following steps:

1. Make sure that AC power is disconnected from the HMS unit.
2. Remove the screws holding the rear panel. There are two screws on each side, two on the top, and one on the bottom.
3. Carefully disconnect the cables from the interconnect board.
4. Remove the rear panel.
5. Disconnect the two molex connectors from the power supply.
6. Disconnect the AC and DC power cables to the power supply.
7. Remove the 4 screws on the bottom of the HMS unit that mount the power supply.
8. Remove the power supply through the rear of the HMS unit.

METERING AND TEST POINTS

The following signals and voltages are indicated on the front panel LCD meter. The parameters to be monitored are selectable via the front panel momentary contact toggle switch. The display has two lines of text. The top line indicates the parameter to be measured while the bottom line indicates the measured value and its units. Refer to the front panel drawing in the illustrations section for the location of the meter and switch. The following is a list of display positions and functions:

Display Position	Function
HMS STATUS	**Meter default position**
FWD PWR	**Output RF Forward Power Level**
RFL PWR	**Output RF Reverse (Reflected) Power Level**
RF INPUT	**Input RF Power Level (Relative Reading Only)**
DRIVER V	**DC Voltage, Driver Amplifier**
FINAL V	**DC Voltage, Final Amplifier**
A CURR	**Amplifier "A" DC Current (Usually the driver stage)**
B CURR	**Amplifier "B" DC Current (Usually the final stage)**
TOT CURR	**Total DC current**

The switch can be toggled in either direction. If the switch is not toggled for approximately three minutes the display reverts to the **HMS STATUS** position.

The primary purpose for the front panel switch is to provide a tool for maintenance of the RF amplifier system. A table for recording values for each parameter shown by the panel meter is included as **APPENDIX 1** of this manual. It is strongly recommended that these parameters be entered in the table upon initial installation of the RF amplifier and at regularly scheduled intervals after that. In case of a system failure, values can be recorded in the table and the table faxed to **TPL Communications**. This will greatly aid our technical personnel to make any necessary repairs to the system.

In addition to the front panel metering, system monitoring is provided by front panel indicators. Five indicators are used and have the following functions and characteristics:

METERING AND TEST POINTS (continued)

Indicator	Function/Characteristic
RF ON	Steady green LED indicating that RF is being supplied to the amplifier
SWR	Flashing red LED alarms when output load VSWR is too high
OTEMP	Flashing red LED alarms when amplifier Heat Sink is too warm
LOPWR	Flashing red LED alarms when RF output power is too low
FANS	Flashing red LED alarms when a fan failure has occurred.

OPERATOR ADJUSTMENTS

A display contrast adjustment is provided on the front panel, between the LCD display and the meter select switch. This is a ten turn pot.

Other operator adjustments are accessible through the rear panel. These are potentiometer **P1**, **P3** through **P8** and switch **SW1**. Their functions are as follows:

Ref. Design	Function/Adjustment
P1	**Rf output power level adjustment. This is a 10 turn potentiometer.**
P3	**SWR threshold set to determine the alarm level for the front panel indicator.**
P4	**Determines the threshold for a valid input RF power level.**
P5	**Low RF power output threshold set to determine the alarm level for the front panel indicator.**
P6	**Meter calibration potentiometer for RF power output.**
P7	**Meter calibration potentiometer for RF reflected power.**
P8	**Calibration setting for relative input power.**
SW1	**Determines the method of RF output power control. The up position provides regulated DC control. The down position provides RF feedback leveling control.**

A basic understanding of RF principles is necessary before making any adjustments to the unit. This includes knowledge of the relationship of forward and reflected power relative to SWR etc. Adjustment also requires the familiarity and use of test equipment. If in doubt consult your dealer or the factory about changes.

OPERATOR ADJUSTMENTS (continued)

RF Adjustments

The necessary adjustment procedure to change the RF power level is as follows:

Provide a proper low SWR RF termination for the amplifier.

SW1 Set this switch to the up (DC Feedback) position.

P1 This is the basic power adjustment for the unit. It is a 10 turn potentiometer which sets the RF output power level. Changing its setting may require resetting all other adjustments. To make this adjustment it is necessary to monitor the output with a calibrated RF power meter. As a reference, set the adjustment to produce nominal RF output.

P5 Lower the RF input drive (from its nominal level) until the RF output drops to its lowest acceptable value. Adjust P5 until the front panel lamp begins to flash. Restore normal drive power. The LED should then extinguish.

P4 Set the RF input drive to a level 6 dB below the nominal drive level. Adjust P4 to activate the amplifier and its fans at this threshold.

P8 Adjust this potentiometer to a nominal 20 units at nominal input.

SW1 Return the switch to the down (RF Feedback) position.

P6 Toggle the front panel switch until the top line of the display reads **FWD PWR**. With the proper RF termination still in place, monitor the RF forward power output on a calibrated power meter. Set **P1** to provide nominal power output. Adjust P6 so that the front panel meter is in agreement with the calibrated power meter. Note this power reading.
Note: the recommended output power range is from the specified maximum output level to one half that value. Consult the factory if a lower power level is required. In all cases, a spectrum analyzer should be used to assure that no spurious signals are generated when the power level is changed.

P7 Attach a 3:1 SWR load to the output and measure with external calibration power meter, the reflected power. Toggle the front panel switch until the top line of the display reads **RFL PWR** and adjust **P7** so that the front panel meter is in agreement with calibration power meter.

P3

The optimum setting for this SWR threshold adjustment is to have the alarm trigger with a 3:1 SWR. It may however be set anywhere at the users discretion. With the 3:1 SWR used in the previous step still terminating the amplifier, apply normal RF drive and adjust the potentiometer until the front panel **SWR LED** begins to flash. The lamp should extinguish when the SWR is reduced or the normal load is connected.

REMOTE MONITORING

The monitored functions are described in other sections. These same functions, some of which are displayed by LED's on the front panel, are available in the **REMOTE MONITOR** connector on the rear panel. The outputs are as follows:

Monitor Signals

Function	Pin	Signal Definition	Source	Mode	Voltage	Current
INS	2	Input RF power	Source R=5k	Analog	5V=100 units	-------
PRS	3	Reflected Power	Source R=5k	Analog	5V=600W	-------
VDS	4	Driver voltage	Source R=5k	Analog	0.1V=1V	-------
IBS	5	B current	Buffer Amp	Analog	0.1V=1A	-------
LOPWR	6	Low Power	Open collector, series 100Ohm	Active Low	15 V Max	50 mA Max
SWR	7	Standing Wave Ratio Alarm	Open collector, series 100Ohm	Active Low	15 V Max	50 mA Max
OTEMP	8	Over temperature alarm	Open collector, series 100Ohm	Active Low	15 V Max	50 mA Max
PFS	10	Forward power	Source R=5k	Analog	5V = 600W	-------
VCS	11	Final Voltage	Source R=5k	Analog	0.1V=1V	-------
IAS	12	A current	Buffer amp	Analog	0.1V=1A	-------
RF ON	13	RF ON indicator	Open collector, series 100Ohm	Active Low	15 V Max	50 mA Max
TEMP	14	Temperature	Buffer Amp, series 1000 Ohm	Analog	10V Max	10mA Max
SFLT	15	System fault alarm	Open collector, series 100Ohm	Active Low	15V Max	50 mA Max
FOF	16	Fans off alarm	Open collector, series 100Ohm	Active Low	15V MAX	50 mA Max
AOF2	17	Amp off	Command Input	Active Low	15V Max 0V Min	2 mA Max
GND	1,9	Ground	Chassis and signal ground	----------	0 V	-------

CIRCUIT DESCRIPTION

RF Amplifier

The low band VHF HMS series RF power amplifier consist of two major blocks:

RF deck and Power Supply with control circuitry.
RF deck includes: Input RF sensor, with optional attenuators, final stage, low pass filter and dual directional coupler.

The power supply with control circuitry includes: Feedback controlled power supply, control board, digital display board and LED board.

The amplifier amplifies a 35 - 50 MHz RF signals to produce 300 watts of nominal RF output. The max gain of the amplifier is 22 dB. DC voltage is controlled by feedback from output directional coupler to the power supply, allowing output RF power to be reduced by high temperature or high VSWR condition.

Changes of the input power within a specified range will also control the Power Supply to keep an RF output power constant.

An input RF sensor, installed on the input of the RF deck, provides a measure of the amplitude of the RF input signal to the control board and digital display board.

A low pass filter attenuates harmonics below FCC requirements. An output directional coupler provides outputs to the control board which indicate the amplitude of forward and reflected RF output power. A thermistor measures the operating temperature of the amplifier heat sink.

HMS Control Board 101298 Rev. N

The **HMS** control board contains the various control circuits, the adjustment and calibration potentiometers, the RF active feedback control, the dc voltage regulator and reference circuits, the system fault comparator, and the LED drivers for system status. For reference, see schematic 101293-2

CURRENT A CKT. (UA, U7A). This circuit outputs a ground referenced voltage which is proportional to the DC current to the "A" side of the power amplifier. The DC current to the "A" side of the power amplifier flows throught a .005 Ohm sense resistor located on the amplifier enclosure. The source side of the sense resistor is connected to IR while the load side is connected to IA. U5 is high side current to voltage convertor. When the amplifier current is zero the output of U5 is zero. The output of U5 is amplified and buffered by U7A. The ouput of U7A is sent to the **HMS** status meter and is displayed as **"A CURR"**. The scale factor for this circuit is 0.1 volts = 1.0 amps.

CURRENT B CKT (U6, U7B). This is the same as the current "A" circuit. It measures the current to the "B" side fo the amplifier and is displayed as **"B CURR"**.

PWR REFL CKT (U3D). This circuit amplifies and buffers the output of the reverse coupler and drives the meter. It's sensitivity is controlled by **P7**.

CIRCUIT DESCRIPTION (continued)

RF Amplifier

SWR BUF CKT (U3B). This circuit compares the output of the **REFL PWR** CKT to a present threshold. It drives a warning LED, and lowers the amplifier's output power when the SWR threshold is exceeded. The SWR threshold is adjusted by **P3**.

INPUT SENSE CKT (U1C). This circuit buffers the detected RF input to the amplifier. It's output turns on the fans, and enables the **LO PWR** alarm LED. The input threshold is adjusted by **P4**, and input drive calibration is adjusted by **P8**.

FWD PWR MTR CKT (U3C). This circuit buffers and amplifies the output from the forward coupler. It drives the meter and a warning LED, an provides power out feed back control to **SW1** and **P1**. Meter calibration is set by **P6**.

ACTIVE FEEDBACK CONTROL CKT (U3A, Q4). This circuit amplifies the difference between the detected RF output of the amplifier and a preset reference. It adjusts the DC voltage to the driver stage to keep the output at the reference level. An over temperature condition, or high SWR will pull down the reference voltage at U3A, Pin 3, causing the output power to be lowered. **SW1** allows the circuit to be operated open loop for calibration. **P1** is used to set the desired output power.

FAN DETECTOR (Q11, Q12). The fan tachometer outputs a square wave at approximately 1KHz. The negative half of the square wave is rectified and filtered, keeping the appropriate transistor off. Loss of the square wave causes the negative bias to be lost, causing the respective transistor Q11, or Q12 to be turned on. Either transistor turned on activates the **FANS LED** alarm.

Digital Panel Meter Board, T-101921

The digital panel meter board accepts test signals from the control board, multiplexes these signals to an analog, to digital converter, formats and outputs the signals to a liquid crystal display (LCD). The major components of the panel meter board are: Input filters, voltage regulator, analog to digital converter, and controller. On the rear of the board there is 14 pin header and a potentiometer. The header connects directly with the LCD display unit on the front panel. The potentiometer is accessible by a hole in the front panel. This potentiometer controls the contrast of the display.

VOLTAGE REGULATOR (U1). This is a precision voltage reference. It provides the reference to the analog to digital converter and 5VDC to the other circuits on the board.

ANALOG TO DIGITAL CONVERTER (ADC) (U2). This circuit is a twelve bit analog to digital converter and multiplexer. The input multiplexer, controlled by theHC05 controller selects the analog input to tbe tested. The ADC converts the analog input to a 12 bit digital word. This digital word is output to the controller in serial format.

MICRO-CONTROLLER (U3). The micro controller selects the input data, controls the ADC and outs the digital data to the fron panel display unit. A two position header, **JP1**, allows the panel meter to be used for either **HMS** or **LMS** series amplifiers. A shunt across **JP1** causes the **LMS** series to be selected. Otherwise the **HMS** series is selected.

TUNE UP INSTRUCTIONS

This amplifier comes from the manufacturer pre-tuned to the customer's requested frequency. However, should it be necessary to change operating frequencies, or should tuning be necessary, the following procedure is recommended:

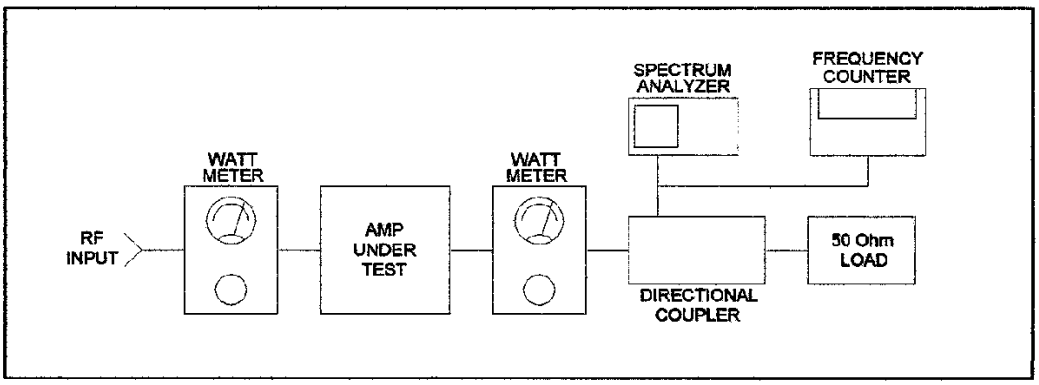
(1) Set the transmitter to the center of the desired frequency range.

(2) Adjust the power amplifier in a test set-up similar to that shown.

(3) The following equipment will be needed for proper alignment:

a. Two Bird 43 thru line watt meters
b. Plug in elements covering proper frequency and power ranges.
c. Insulated tuning tool
d. Dummy load
e. Spectrum Analyzer
f. Frequency Counter
g. Directional Coupler

(4) Follow tuning instructions described in the service manual.



TEST SET UP
FIGURE 1

TUNING ADJUSTMENT PROCEDURE
FOR LOW BAND VHF SERIES RF POWER AMPLIFIER
PA1-3XF-HMS

Step	Instructions
1.	Terminate the input to an appropriate signal source and an output into an adequate 50 Ohm load.
2.	Monitor the drain current with a current probe at TL1 and TL2, apply the minimum RF drive necessary to activate the power amplifier (the Green LED on front panel should illuminate). Observe the drain current increase to at least 150 mA per each transistor.
3.	Increase the RF drive to the minimum rated input level and observe an output power. Adjust C2 (see schematic diagram 102283) for minimum reflected power and C15 for maximum output power. The nominal rated power should be achieved.
4.	Observe the drain current consumption at TL1 and TL2 of about 5 - 6 Amps per transistor.