APPENDIX B

OPERATING/SERVICE/INSTRUCTION MANUAL

SERVICE MANUAL HMS SERIES UHF RF POWER AMPLIFIERS

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TABLE OF CONTENTS

PRODUCT DESCRIPTION

The HMS series of TPL power amplifiers are intended for use in base station or repeater applications. 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 which allows operation, metering, and monitoring of an RF power amplifier. It's 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: 400 - 512 MHz.

OPERATING MODE : FM

MODEL	POWER INPUT	NOMINAL POWER OUTPUT
PA6-2EF-HMS	80-200mW	300W
PA6-2BF-HMS	5-12W	300W
PA6-2GF-HMS	20-45W	300W

OPERATING TEMPERATURE RANGE: -20° to +50° Celsius.

OPERATING VOLTAGE: 110 VAC Standard, 220 VAC Optional.

EIA DUTY CYCLE: 100%

RECEIVER INSERTION LOSS: 1 dB maximum, when optional receive relay is specified.

HARMONIC ATTENUATION: Meets FCC Type Acceptance requirements.

FUSING: 15 Amperes for 110 Volt operation, 7.5 Amperes for 220 Volt operation.

OPTIONS:

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

Repeater Configuration (standard):
Supplied without a carrier operated relay (COR).

Base Station Configuration:
Supplied with a COR.

NOTE:

This amplifier has been factory-tuned to the frequency specified at the time of order and will operate within ±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 efficiency of this amplifier will degrade if it is operated into anything but a 50 Ohm load. Lowered efficiency may mean any, or all, of the following; lower power output, increased current drain, higher operating temperature, and reduced life.

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

Mount the unit where dust and other debris are not likely to clog the cooling fins. 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" terminal and the antenna to the "RF OUTPUT" terminal on the amplifier, with 50 Ohm coaxial cable and TYPE N plugs. TYPE N plug assembly is shown on the following pages.

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.

FIGURE 1

MAINTENANCE

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

Removal of the RF Amplifier.

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

1. Disconnect the cables from the RF input and RF output terminals 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 from the top.

Removal of the Power Supply.

The power supply can be used 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 connectectors from the power supply.

6. Disconnect the AC and DC power cables to the supply.

7. Remove the 4 screws on the bottom of the HMS unit that connect 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 meter, a liquid crystal display. The voltage to be monitored is 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 Amperes
B CURR	Amplifier "B" DC Amperes
TOT CURR	Total DC Amperes

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 I 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.

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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.

Indicator	Function/Characteristic
RF ON Lamp	Steady green light indicating that RF is being supplied to the amplifier
SWR Lamp	Flashing red alarm when output load VSWR is too high
OTEMP Lamp	Flashing red alarm when amplifier chassis is too warm
LOPWR Lamp	Flashing red alarm when RF output power is too low
FANS Lamp	Flashing red alarm when fans are not operating.

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:

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Monitor Signals

FUNCTION	PIN	Signal Definition	SOURCE	MODE	VOLTAGE	CURRENT
INS	2	Input RF power	High impedance	Analog	5V = 100 units	-------
VDS	4	Driver voltage	High impedance	Analog	0.1V=1V	-------
IBS	5	B current	Buffer Amp	Analog	0.1V=1A	-------
LOPWR	6	Low Power	Open collector, series 100 ohms	Active Low	15 V Max	50 mA Max
SWR	7	Standing WaveRatio	Open collector, series 100 ohms	Active Low	15 V Max	50 mA Max
OTEMP	8	Over temperature	Open collector, series 100 ohms	Active Low	15 V Max	50 mA Max
PFS	10	Forward power	High impedance	Analog	5V = 500W	-------
VCS	11	Final Voltage	High impedance	Analog	0.1V=1V	-------
IAS	12	A current	Buffer amp	Analog	0.1V=1A	-------
RF ON	13	RF ON indicator	Open collector, series 100 ohms	Active Low	15 V Max.	50 mA Max.
TEMP.	14	Temperature	Buffer Amp. 1.0K series R.	Analog	10V Max.	10mA Max.
SFLT	15	System fault	Open collector, series 100 ohms	Active low	15VMax	50 mA Max
FOF	16	Fans off	Open collector, series 100 ohms	Active low	15VMax	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	-------

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 through P8 and switch SW1. Their functions are as follows.

Ref. Desig	Function/Adjustment
P1	RF output power level adjustment. This is a 10 turn potentiometer
P2	Zero adjustment for side "B" power amplifier current calibration.
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.
P8	Zero adjustment for side "A" power amplifier current calibration.
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.

DC Adjustments

Make all DC adjustments with AC power on. Start with RF drive reduced to 0 (zero) and the RF output terminated.

P2 Toggle the front panel switch until the top line of the display reads B CURR. Adjust the potentiometer to get an upscale reading on the front panel meter, then back off the adjustment until the meter just reads 0 (zero).

P8 Toggle the front panel switch until the top line of the display reads A CURR. Adjust the potentiometer to get an upscale reading on the front panel meter, then back off the adjustment until the meter just reads 0 (zero).

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.

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.

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 lamp should then extinguish.

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 Toggle the front panel switch until the top line of the display reads FWD PWR. Attach a 3:1 SWR load to the output and note the forward 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 reads the reflected power. This should be set to read 1/4 the forward power level noted above.

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 lamp begins to flash. The lamp should extinguish when the SWR is reduced or the normal load is connected.

CIRCUIT DESCRIPTIONS

RF Amplifier PA6-2EF-HMS

The model PA6-2EF-HMS RF amplifier consists of an RF predriver, driver, four final stages, low pass filter, dual directional coupler, RF detector, RF signal splitter, RF signal combiner, and a thermistor. It amplifies a 400 to 512 MHz RF input to produce a 300W RF output. The pre-driver has approximately 18dB gain, the driver has a gain of approximately 10 dB, and the combined gain of the final stages along with the filter and coupler is approximately 8 dB. The DC voltage to the pre-driver is approximately 12 VDC and is derived by resistors R2 and R3, and buffered by darlington transistor Q2.

DC Power to the driver stage is controlled by the darlington transistor. This transistor allows power to be reduced by high temperature, high VSWR conditions, or the control potentiometer, P1.

A detector is present on the RF input. This detector provides a measure of the amplitude of the RF input, to the control board.

A dual directional coupler on the output provides outputs to the control board which indicate the amplitude of forward and reflected RF output power.

A thermistor measures the operating temperature on the heatsink.

RF Amplifier PA6-2BF-HMS

The model PA6-2BF-HMS RF amplifier consists of an RF driver, four final stages, low pass filter, dual directional coupler, RF detector, RF signal splitter, RF signal combiner, and a thermistor. It amplifies a 400 to 512 MHz RF input to produce a 300W RF output. The driver has a gain of approximately 10 dB, and the combined gain of the final stages along with the filter and coupler is approximately 8 dB.

DC Power to the driver stage is controlled by a darlington transistor. This transistor allows power to be reduced by high temperature, high VSWR conditions, or the control potentiometer, P1.

A detector is present on the RF input. This detector provides a measure of the amplitude of the RF input to the control board.

A dual directional coupler on the output provides outputs to the control board which indicate the amplitude of forward and reflected RF output power.

A thermistor measures the operating temperature on the heatsink.

RF Amplifier PA6-2GF-HMS

The model PA6-G2F-HMS RF amplifier consists of an input attenuator, RF driver, four final stages, low pass filter, dual directional coupler, RF detector, RF signal splitter, RF signal combiner, and a thermistor. It amplifies a 400 to 512 MHz RF input to produce a 300W RF output. The driver has a gain of approximately 10 dB, and the combined gain of the final stages along with the filter and coupler is approximately 8 dB.

DC Power to the driver stage is controlled by a darlington transistor. This transistor allows power to be reduced by high temperature, high VSWR conditions, or the control potentiometer, P1.

A detector is present on the RF input. This detector provides a measure of the amplitude of the RF input to the control board.

A two way power splitter divides the input signal evenly between the driver and the detector.

A dual directional coupler on the output provides outputs to the control board which indicate the amplitude of forward and reflected RF output power.

A thermistor measures the operating temperature on the heatsink

HMS Control Board 101293

The HMS control board contains: meter buffer circuits, adjustments, and a power leveling circuit.

CURRENT A CKT. U5A,U5D,U1A. 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 through a .005 Ohm sense resistor located on the amplifier heat sink. The source side of the sense resistor is connected to IR while the load side is connected to IA. When the amplifier current is zero the collector currents in matched transistors, U5A and U5D are equal. With VR8 adjusted properly the collector voltage of U5A is equal to the collector voltage of U5D. The output of U1A is proportional to the difference between the collector voltages. It is zero when no current flows in the sense resistor. DC current to the amplifier creates a voltage drop across the sense resistor. This causes the collector voltages of Q5A and Q5D to differ. This difference is amplified by U1A. The scale factor for this circuit is 0.1 volts = 1.0 amps.

CURRENT B CKT U5B,U5C,U1B. This is the same as the current A circuit. It measures the current to the "B" side of the amplifier.

PWR REFL CKT(U30) This circuit amplifies and buffers the output of the reverse coupler and drives the meter. It's sensitivity is controlled by P7.

SWR BUF CKT(U3B) This circuit compares the output of the PWR REFL CKT to a preset threshold. It drives a warning light, 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, turns on voltage to the driver stage, and enables the Low Power alarm light. The input threshold is adjusted by P4.

PWR MTR CKT(U3C) This circuit buffers and amplifies the output from the forward coupler. It drives the meter, a warning lamp, and the voltage to the driver stage.

DRVR VOLTS REG(U3A, Q4, Q9) This circuit amplifies the difference between the detected RF output of the amplifier and a preset reference. It adjusts the DC voltage of the driver to keep the output at the reference level. An over temperature condition, or a high SWR will pull down the reference causing the output power to be lowered. SW1 allows the circuit to be operated open loop for calibration.

FAN DETECTOR(Q11,Q12) The fan, when rotating, 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 transtor Q11, or Q12 to be turned on. Either transistor turned on activates the FANS LED alarm.

Digital Panel Meter Board. (101921)

The digital panel meter board accepts test signals from the control board, multiplexes these signals to an analog to digital converter, and 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 a 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 the HC05 controller selects the analog input to be 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 front 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 factory 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. Bird 43 thru line watt meter
b. Plug in elements covering proper frequency and power ranges.
c. Insulated tuning tool
d. Dummy load

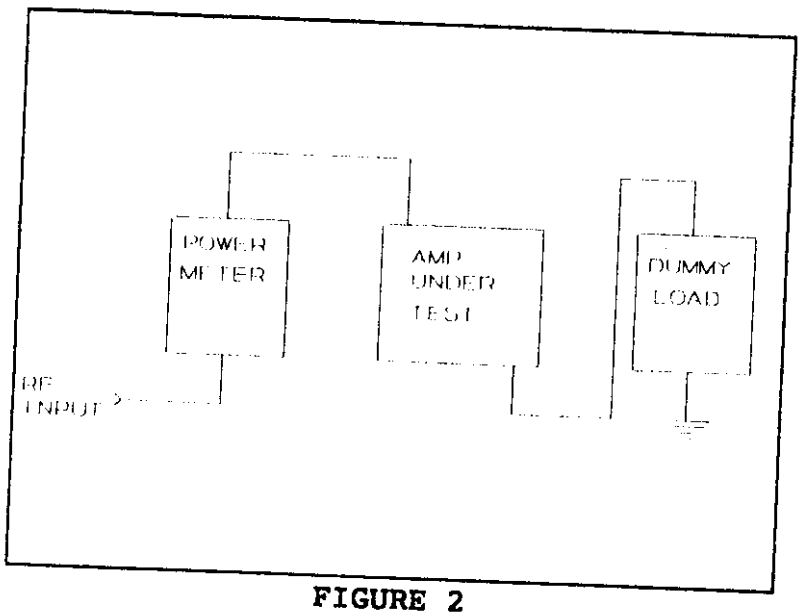

FIGURE 2
TEST SET UP

TUNING ADJUSTMENT PROCEDURE
FOR MODEL PA6-2EF,PA6-2BF,PA6-2GF

STEP	ADJUST	FUNCTION	INSTRUCTIONS
1.	Set up amplifier in accordance with test set-up diagram. minimum specified RF power at the desired frequency. Set SW1 on the rear panel to the up (DC Feedback) position, and set P1 for maximum VD on test meter.		
2.	C11 Driver Boards	Output Tuning	Adjust for maximum power out.
3.	C1Driver Boards	Input Tuning	Adjust for maximum power out.
4.	C11 Final Boards	Output Tuning	Adjust for maximum power out.
5.	C1 Final Boards	Input Tuning	Adjust for maximum power out.
6.		Overall tuning	Adjust input drive to actual operating power and repeat all steps for optimum performance.
7.			Set SW1 on the rear panel to the down RF feedback position. Set power output as described in the section: Operator Ajustments.

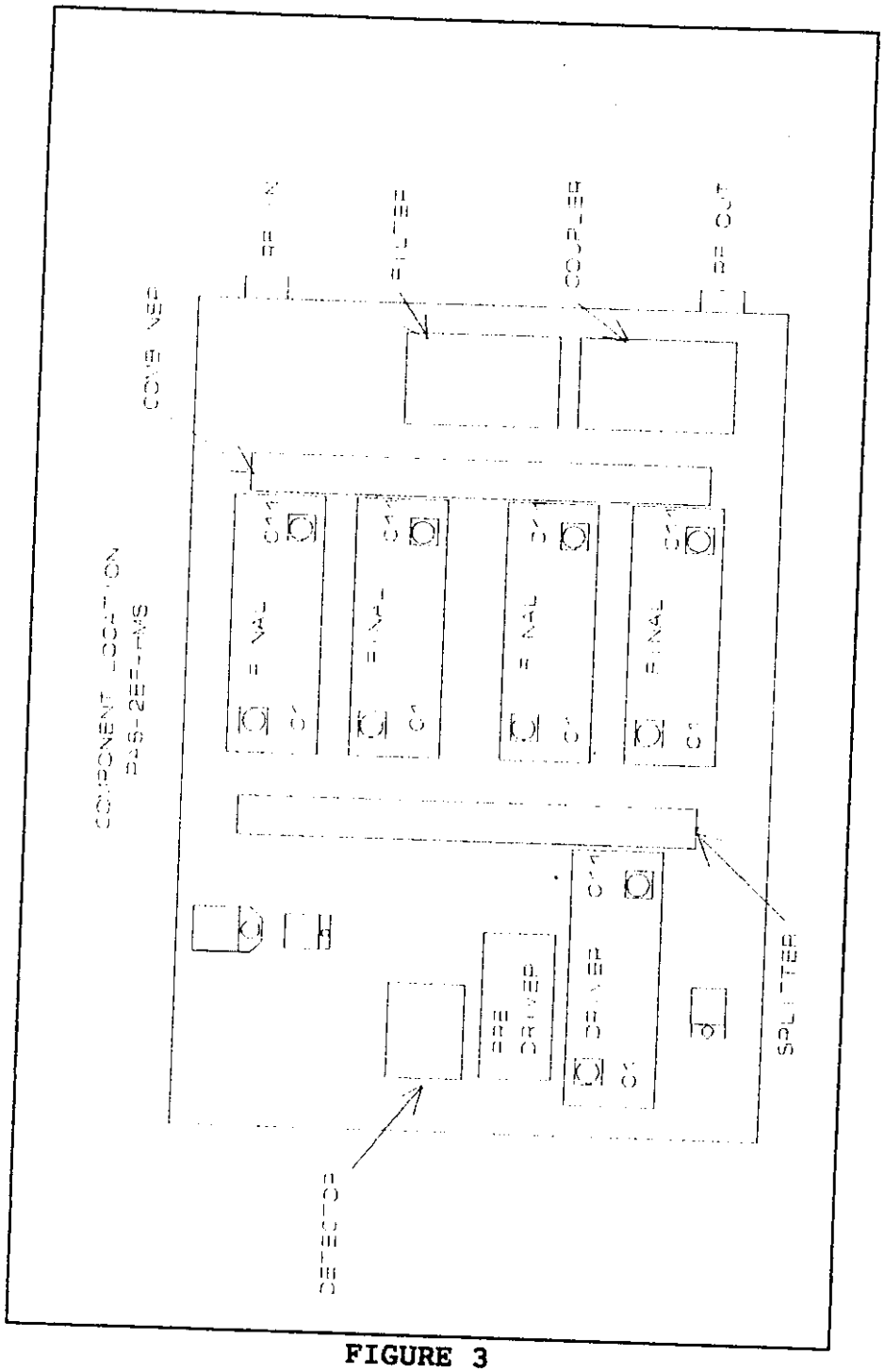

FIGURE 3