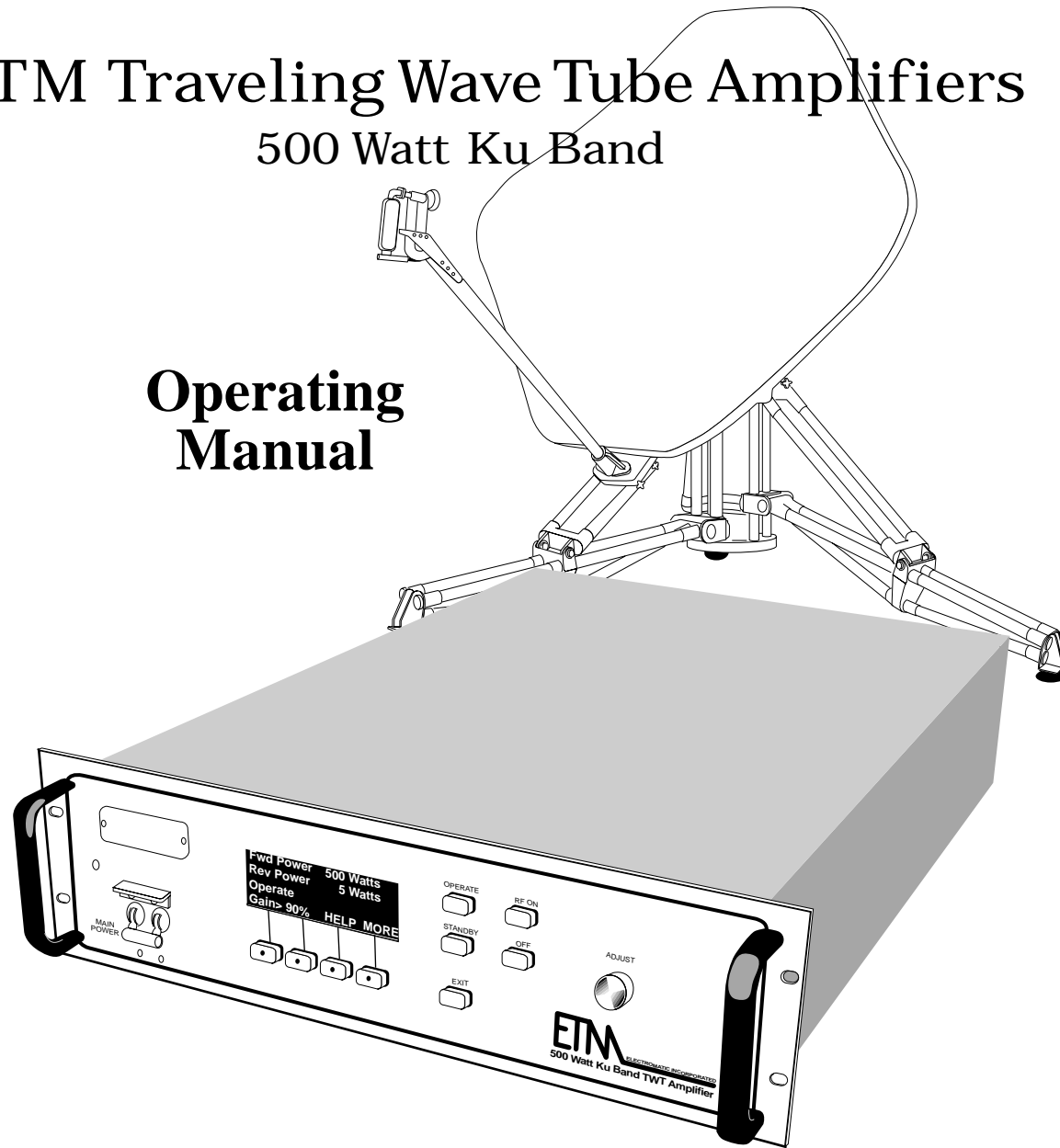


ETM Traveling Wave Tube Amplifiers

500 Watt Ku Band

Operating Manual





Amplifier Serial Number
TWT Serial Number
Output Arm Serial Number
Preamplifier Serial Number
Software Version
Shipping Date

ETM Model 500Ku

500 Watt Ku Band Traveling Wave Tube Amplifier

Operating Manual

ETM Electromatic Incorporated
35451 Dumbarton Court
Newark, CA 94560

Telephone (800) 883-4386
Outside USA (510) 797-1100

Fax (510) 797-4358
www.etm-inc.com

About this manual

Manual Applicability


This is the general operating manual for all ETM TWTAs in the 500 watt Ku-band range.


The items listed below may vary depending on the configuration ordered by the customer. Please refer to your purchase order and any enclosed acceptance test data to confirm that you received the correct TWT A configuration.

- Frequency range
- Power levels at the output flange
- Type of output waveguide
- Primary input power configuration

Symbols

The following warning and caution symbols are used throughout this manual:

 Warning: A hazard exists that may result in personal injury or loss of life.

 Caution: Failure to follow the procedures given may result in damage to the equipment.

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Notice

The information in this document was believed to be correct at the time of publication, and every effort was made to ensure that the most current information was shipped with each machine. If subsequent modifications were made to your unit, and you need information on these, please contact the ETM documentation department.

If you have technical or editorial comments concerning this manual, please write them on photocopies of the relevant pages and send them to the documentation department or contact the Customer Service department. This assistance will be greatly appreciated.

Safety

- This equipment operates at potentially lethal voltages. Only trained, qualified personnel should operate, maintain, or service it. Service work must be performed only by technicians thoroughly familiar with the high voltages present in microwave tube amplifiers in general, and with this equipment in particular.
- Electrical equipment in this TWTA generates and stores high-voltage energy that can result in electrocution. Do not operate the TWTA with the cover or the front panel removed.
- This equipment generates high power microwave radiation. Always operate the unit into a properly assembled waveguide structure or suitable RF load.
- Never handle the TWT leads or the high-voltage connectors unless it has been positively established that the high-voltage filter capacitors have been discharged to a known safe level.
- Improper grounding of this equipment can result in electric shock. The TWTA is provided with a line cord with a safety ground wire. Never operate this equipment except with the power line cord provided. It is the user's responsibility to ascertain that the power outlet is grounded.
- To avoid explosion, never operate this TWTA in an explosive atmosphere. This equipment is not certified for operation in an explosive atmosphere.

WARNING



In a fault condition, there is a possibility that high voltages (other than AC line I/P) may be present when the equipment is powered up and in the STBY mode.

Extreme caution is required when either top or bottom panels are removed.

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Getting Started

If you have to get on the air quickly, most of the information you need is on page 4: *Getting on the Air*.

It will tell you how to

- Turn the system on
- Configure the interlock
- Set the gain
- Switch the RF on

However, the user interface offers much more than that. This manual will also show you how to do the following, quickly and easily:

- Optimize system performance
- Set alarms for operation outside certain limits

The flexible control interface makes basic operation **very** easy, yet provides enough power to satisfy the systems specialist. At the same time, all users will appreciate the fault protection and early warning circuits that provide several levels of protection for the traveling wave tube.

If You Need Help

ETM stands behind every product purchased. If you need help at any time, you can call us at

(800) 883-4386

If you are outside the U.S., the number is

(510) 797-1100

If you prefer to send a fax enquiry to the attention of the Customer Service department, the number is

(510) 797-4358

We will answer promptly using the same mode of communication you used to contact us.

e-mail

sales@etm-inc.com support@etm-inc.com

Manual Updates

From time to time, new versions of software may require slight changes to the material presented in this document. Check inside the back cover for supplementary pages that may have been added to keep the manual up to date.

Manual Organization

The manual is organized for ease of use. In most cases, example screens or figures are presented on the right hand page, and the corresponding text is located on the left hand page.

Installation

Unpacking

Upon receiving the TWTA, unpack the unit from the packing container and inspect it for any obvious signs of external damage. If you notice any damage, contact ETM via the 24-hour toll-free number, (800) 883-4386. Outside the United States call (510) 797-1100.

Save the container in case the unit needs to be returned to ETM in the future for calibration or service.

Mounting

You can operate the TWTA as a benchtop unit, or use the mounting slides provided to install it in a rack. If you mount it in a rack, don't rely on the front panel alone to bear all the weight. Provide support for the sides or the bottom as well, otherwise the chassis is likely to be damaged.

Interlock Connections

A DB-15 connector on the rear panel of the TWTA provides hardware interlock and fault status. Jumpers must be installed on this connector before the TWTA will operate. Wiring details are on the next page, and the location of the connector is shown on the diagram of the rear panel on page 4.

The TWTA is normally shipped with interlock and inhibit jumpers connected.

Cooling

The TWTA dissipates approximately 1.8 kilowatts. The high speed 400 cycle cooling fan must move a large volume of air, and it is important not to obstruct the air flow around the rear of the unit. Do not position the TWTA in such a way that the air inlet or outlet is blocked, or that the exhaust flow is directed into the intake. If the unit is rack mounted, make sure that the inlet air is 50°C or below. If necessary, fabricate a duct to direct the hot exhaust air out of the enclosure. Avoid mounting heat-producing equipment in the same rack, especially below the TWTA.

Booster blower kits are available from ETM for use at altitudes greater than 10,000 feet and ambient temperatures that exceed 45°C.

CAUTION

Inadequate cooling may result in damage or premature failure.

RF Connections

Connect your antenna line to the WR-75 waveguide output flange. If a load is used instead for testing, it must be able to dissipate 600 watts continuously. The load VSWR should be less than 2.0:1.

Connect an RF source to the input RF connector on the rear panel. The RF input signal should be in the frequency range of the unit. For full power operation, the input drive signal should be as per the ETM data. The maximum input drive signal should normally be less than +5dBm for saturation.

CAUTION

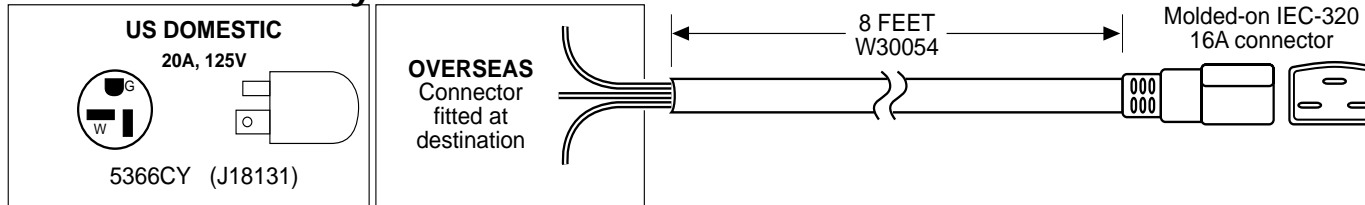
Never attempt to operate the unit without first connecting a suitably rated output load.

Installation

Power

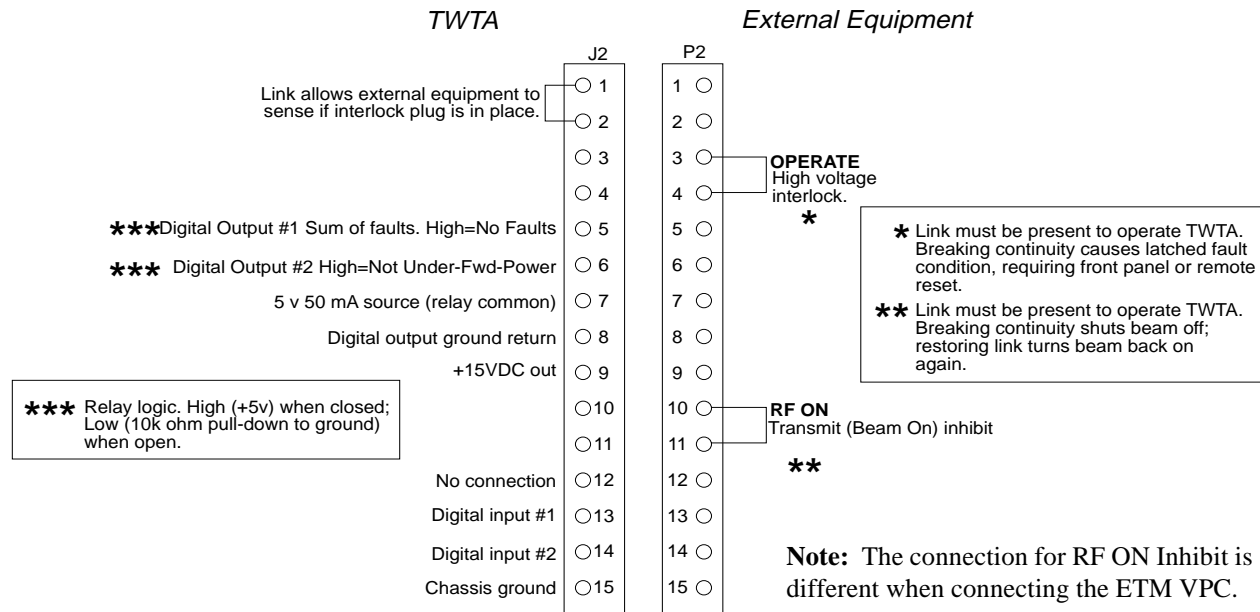
The TWTA's 3-wire cord should be plugged into a grounded outlet. Domestic units are shipped with the AC power connector shown below. Overseas units are shipped with the wires trimmed ready to receive a connector at the destination.

TWT Line Cord Assembly

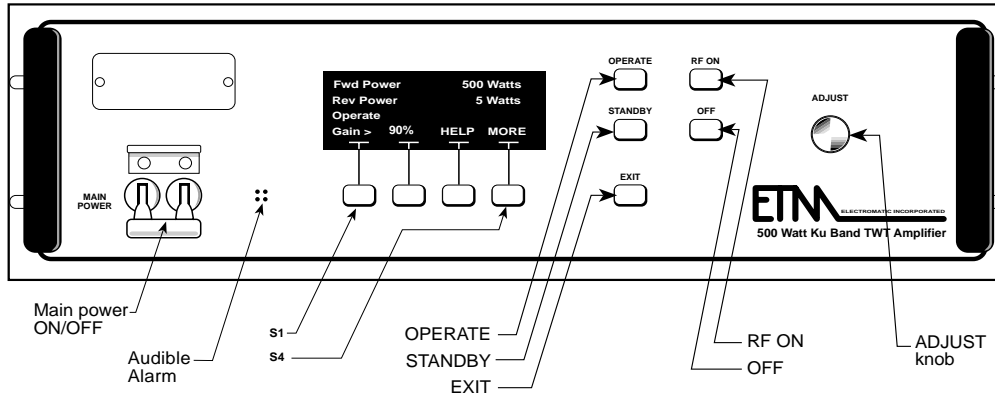


Interlock Wiring

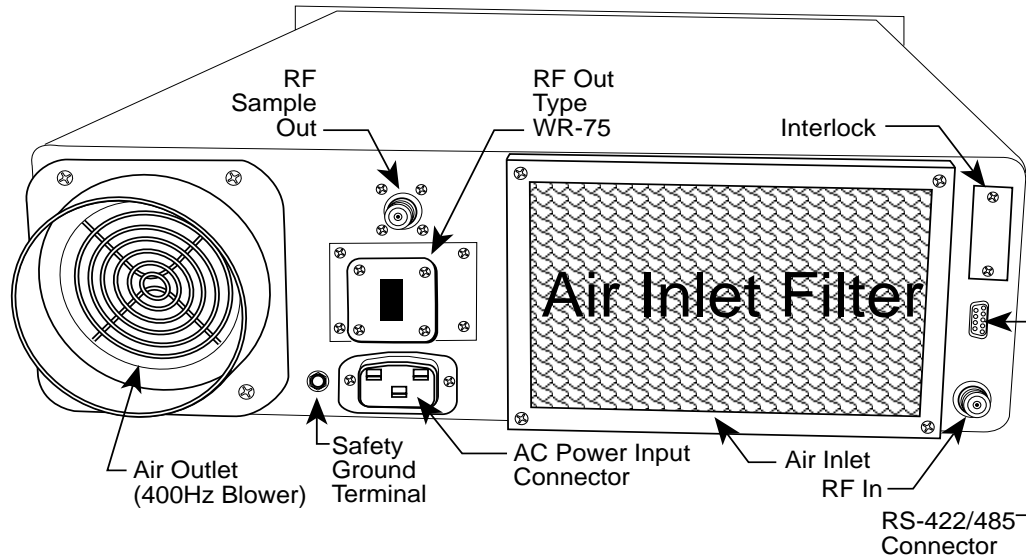
The location of this DB-15 connector is shown on the diagram of the rear panel on the next page.



Getting on the Air

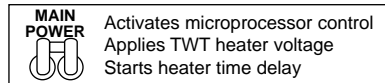


Front Panel Controls



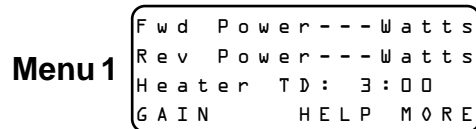
Rear Panel Connectors

1 Switch on MAIN POWER

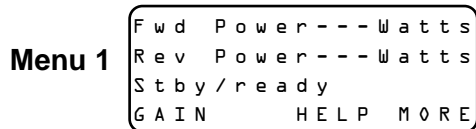


Make sure you hear the fan running.

After several identification messages, MENU 1 will appear on the front panel display:



The heater warmup-delay (third line of display) will be counting down. When it expires, the message “STBY/READY” will appear.

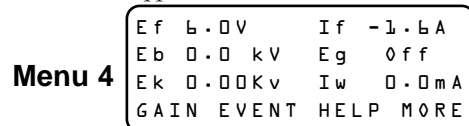


2 Press GAIN (S1 button)

Turn the ADJUST knob fully counterclockwise to set the gain to 0%.

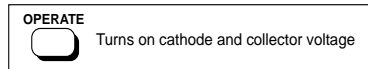
3 Press MORE (S4 button) three times

MENU 4 appears:



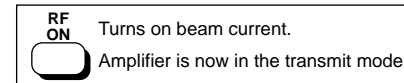
Note: Readings will vary depending on the type of HPA.
Check with ETM test data.

4 Press OPERATE



Getting on the Air

5 Press RF ON.



Check that the helix current I_w is around 1-3 mA.

6 Press MORE or EXIT

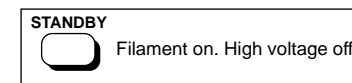
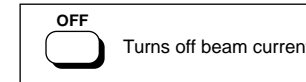
MENU 1 reappears

Press GAIN again and turn the Adjust knob slowly clockwise to bring up the RF drive. Check the value of forward power displayed to make sure you don't overdrive the TWT. The reverse power level should remain well below 20 watts (+43dBm), assuming that the output is properly matched. The helix current should not exceed a few milliamps.

***Now check that all voltages and currents are as per ETM's test data. Any anomaly - call ETM's Customer Service Dept.**

Shut Down Sequence

Press RF OFF and then STANDBY



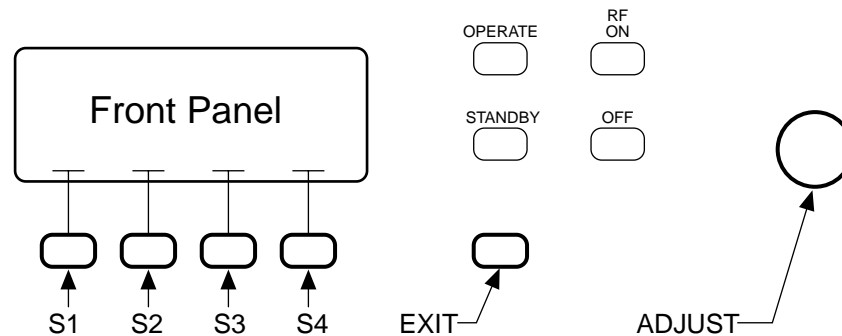
If possible, allow the system to cool down until the TWT base plate temperature drops below 50°C before turning off the Main Power circuit breaker. Menu 1 displays “COOL-DOWN” until the TWT temperature is within 10°C of the cabinet temperature.

CAUTION

**In the RF-Off/Operate-On mode, the TWT is on.
To completely turn RF off, go to STANDBY.**

The Display and Menu System

The front panel displays information on TWTA parameters and system status. Data is displayed in pages that will fit on the screen, and can be accessed through a system of menus. Four soft keys, S1 through S4, the EXIT key, and the ADJUST knob allow navigation within the menu system.



Soft Keys S1-S4

The current function of each soft key is displayed in the screen area immediately above it.

- S1 Entry to Setup screens 1-4 from Menu 2
Entry to Warning screens 1-6 from Menu 3
- S2 Entry to Faults screen from Menu 4
- S3 Entry to contextual help screens from top-level Menus 1 through 4
- S4 Entry to next level down; from the lowest level, returns to the top.

EXIT

Returns to the top level from within a menu sequence.

ADJUST

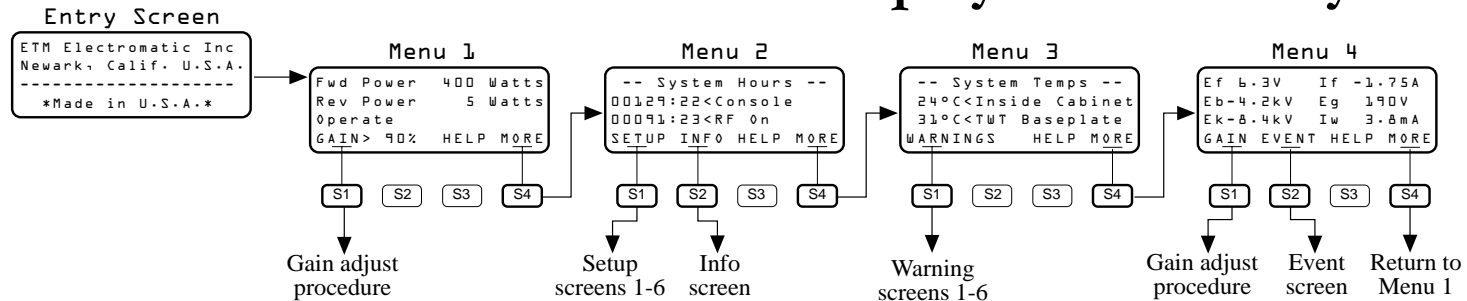
This knob is used to

- Set the amplifier gain
- Scroll through lists of menu items
- Select parameter values for change

Menu 1

Shows forward and reverse power in watts, dBm, or bar graph. The reverse power may also be displayed as a percentage of forward power. Use the setup screens (described later) to change display units. Pressing S1 (GAIN) allows you to adjust the gain while monitoring its effect on output power. The third line of this screen normally shows operating status, but changes to helix current when GAIN is selected for adjustment, and will be overwritten by a message if a fault occurs.

The Display and Menu System



Menu 2

Shows console hours and RF hours. The “RF ON” clock runs whenever the unit is at “RF ON”. The console hours clock runs whenever the unit’s main power circuit breaker is on and represents TWT filament hours.

S1 (SETUP) allows entry to the sequence of setup screens described on the next page.

S2 (INFO) displays the information below:

- The model number
- The serial number
- The software version currently installed
- Calibration factors for the RF sample port

These items are also listed on a table attached to the rear of the instrument.

Menu 3

This screen displays temperatures inside the cabinet and at the TWT baseplate. Normal temperature for the cabinet is between

2°C to 40°C, and between 70°C and 110°C for the baseplate. The system will shut down if the cabinet temperature exceeds 65°C, or the baseplate temperature exceeds 120°C. Use the Warnings screens (described later) to select levels that will result in audible alarms.

Menu 4

This screen displays key TWT parameters. These are listed below along with their normal operating ranges.

E_F Filament Voltage:	5.5 to 6.3V
I_F Filament Current:	-1.5 to -1.8A
E_B Collector Voltage:	-6.0 to -6.8kV
E_G Grid drive Voltage:	140 to 230V
E_K Cathode Voltage:	-10.1 to -10.7kV
I_w Helix Current:	
RF OFF:	0.5 - 3.0mA
With RF in:	1.0 to 8.0mA

Note: Menu displays for specialized systems such as the Automatic and Redundant configurations will have additional display information.

Setup Screens

A diagram of the Setup Screen sequence appears on page 10.

Entry to the SETUP screens is from the top-level screen Menu 2. (EXIT to reach the top level, and MORE until Menu 2 appears).

```
-- System Hours --  
00129:22<Console  
00091:23<RF On  
SETUP INFO HELP MORE
```

Menu 2

5

Entering Setup from Menu 2

Press the SETUP (S1) on Menu 2 to see the first Setup screen. Press MORE repeatedly to cycle through the six-screen sequence.

Returning to Menu 2

Press the EXIT button on the front panel.

Entering Parameters or Values

Parameters or values displayed on the screen are stored when you press MORE or EXIT (move to the next screen or return to Menu 2).

Setup Screen 1: Auto Cycle, No Surge, Remote

1. Turn the ADJUST knob until square brackets enclose the desired function, Auto Cycle, No Surge, or Remote. Press SET. The square brackets ([]) change to arrows (> <), indicating that the value can be changed.
2. Press SET to set the function ON or OFF.

An explanation of Auto Cycle, No Surge, and Remote appears on the page opposite, following this summary of menu functions.

Setup Screen 2: Fahrenheit or Celcius

Press SET until the desired selection, °F or °C, is enclosed in square brackets.

Setup Screen 3: Power Display Units

Press SET until the desired selection, dBm, watts, or bar graph, is enclosed in square brackets.

Setup Screen 4: Reverse Power Display Units

Press SET until dBm, watts, % of fwd power, or bar graph is enclosed in square brackets.

Setup Screens

Setup Screen 5: Beeper Volume and Count

Beeper Volume

Turn the ADJUST knob until Beeper Vol is enclosed in square brackets. Press SET. The square brackets ([]) change to arrows (> <), indicating that the value can be changed. Use the Adjust Knob to select OFF, SOFT, NORMAL, or LOUD. Press SET again.

Number of Alarm Beeps

Turn the ADJUST knob until Alarm Beeps is enclosed in square brackets. Press SET. The square brackets ([]) change to arrows (> <), indicating that the value can be changed. Use the Adjust Knob to select 0, 1, 2, 3, 4, or 5. Press SET again. Once completed, press EXIT twice to return to main menu.

Setup Screen 6

Details of this screen appear in the Computer Interface Section.

Auto Cycle, No Surge, and Remote

Auto Cycle

When primary power is restored after an interruption, the system will return to the On state that existed before the interruption. For example, if the TWTA is at RF On, and Auto Cycle is selected, it will automatically recycle the amplifier to turn RF On after a primary power interruption.

The control system will warn you at power up if Auto cycle is enabled. To cancel, simply press either the RF Off or Standby key.

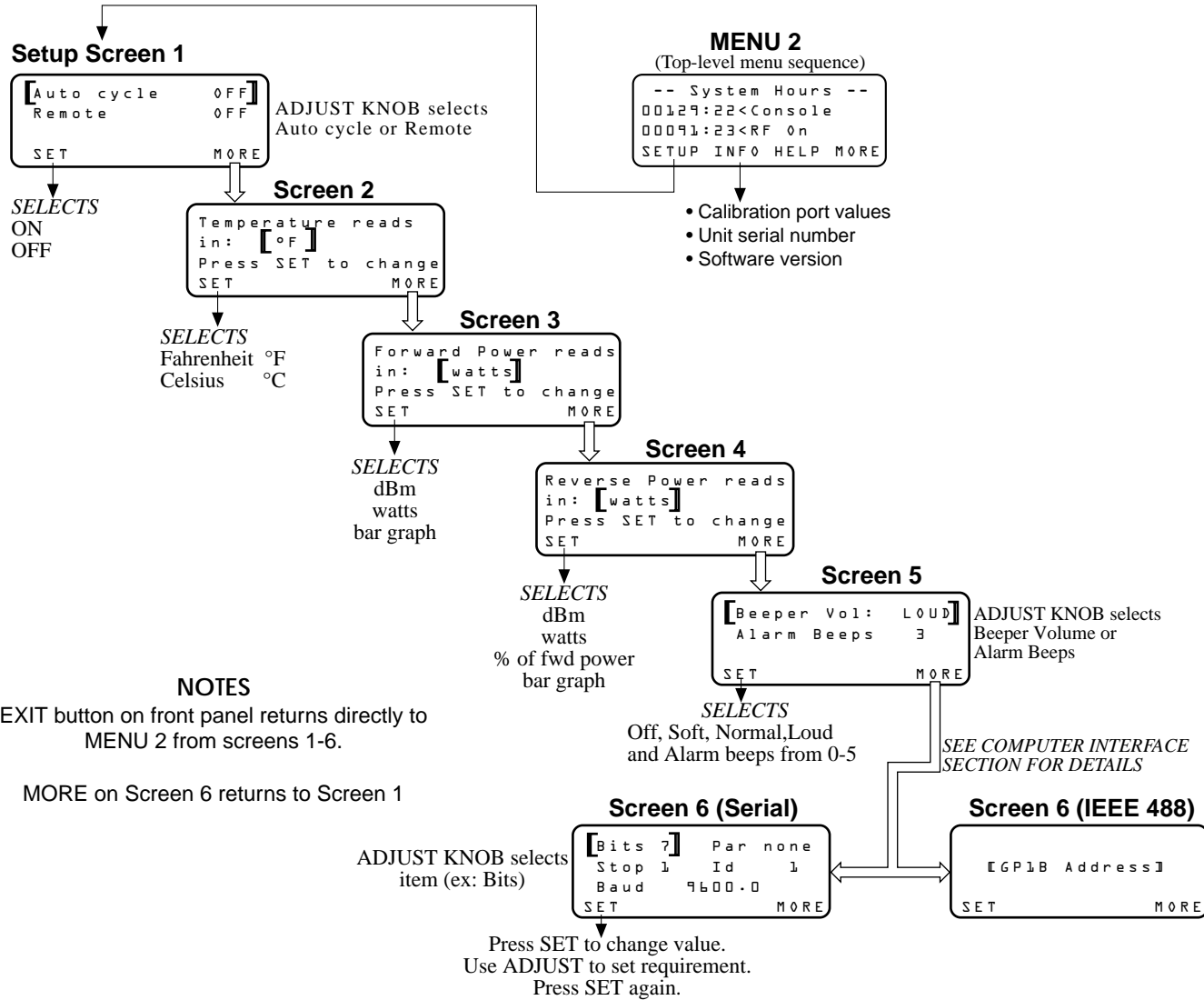
No Surge

This feature allows the TWTA to be turned on when operated with a marginally sized generator or other slow responding power service. Normally, when the operator presses RF On, the current draw on the primary power line immediately changes from 3 or 4 amps to full load. With No Surge selected, the current draw is slowly increased over a 30 second period. For best results the gain should be set to 0% during the No Surge ramp on time.

Remote

When Remote is off, a device connected to the TWTA's computer interface may monitor the amplifier's status but may not control the **Operate**, **Standby**, **RF Off** or **RF On** keys. When Remote is On, the external device has full control of the amplifier. Pressing the **RF Off** or **Standby** keys cancels the Remote mode, and causes the system to revert to local control.

Setup Screens



5

System Events Screen

This screen is accessed from Menu 4 (EVENT: S2 KEY) at the top level. The display shows the last four system events along with the console hours reading at the time they occurred. The latest event (top line) flashes. You can view the last 100 events by scrolling with the ADJUST knob. Numbering (left side) is from newest to oldest; the more recent the event, the lower the number. The numbers disappear a few seconds after scrolling ceases, revealing more event text. After reviewing the event screen, you can press EXIT to return to Menu 4 at the top level.

```
0078:21 SYSTEM FAULT  
0066:25 SYSTEM FAULT  
0060:17 FIL U/VOLT  
0049:20 FIL U/VOLT
```

Events Screen

Warnings screens

Warnings

You can use the warnings screens to set alarms that will be triggered if certain values fall outside limits acceptable to your system. These alarms operate independently of the TWTA's built-in protection circuitry. Alarms will beep at thirty-second intervals and a warning message will appear on line 3 of MENU 1. The number of alarm beeps and the alarm volume can be changed in Setup MENU 4 (See previous page).

To Change the Limits

If you are not already at the top menu level, press EXIT and then MORE until MENU 3 appears. It contains the word "WARNINGS" in the lower left.

```

-- System Temps --
24°C<Inside cabinet
31°C<TWT baseplate
WARNINGS    HELP MORE

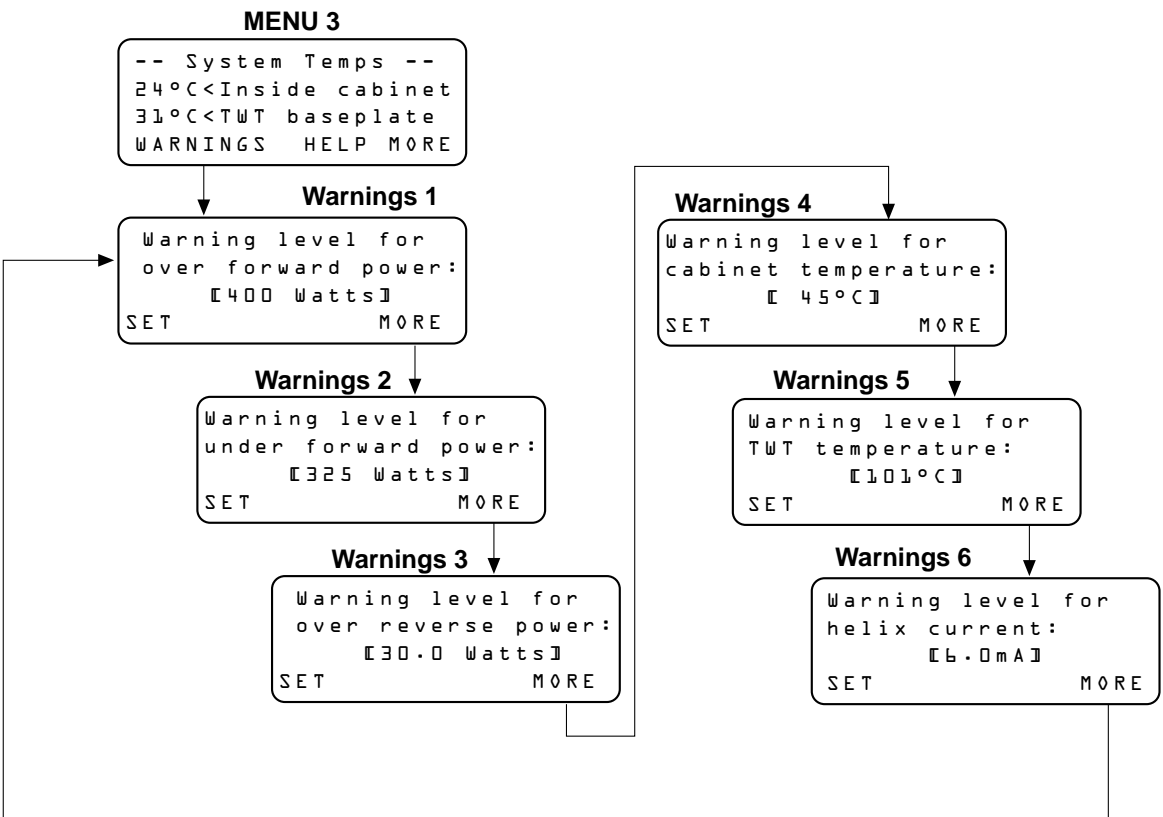
```

Menu 3

1. From MENU 3, press WARNINGS and then MORE until the setup screen appears that contains the limit to be changed.
2. Press SET. The square brackets enclosing the old limit ([]) change to arrows (> <), indicating that the value can be changed.
3. Use the ADJUST knob to set the desired limit value.
4. Complete the adjustment by pressing SET again. Press EXIT to return to the top level, or MORE to go to the next warnings menu. The new limits are retained.

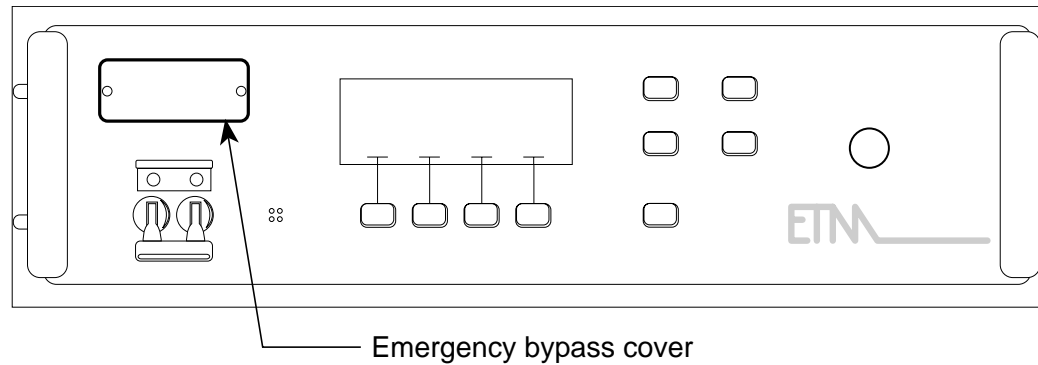
Note: If it is required to enter the menus behind password control - Select Menu 3 and press soft key S2.

Warnings screens



Emergency Bypass Operation

The TWTA has controls that allow it to operate in the unlikely event that the microprocessor unit should malfunction. The controls are located under a cover on the front panel of the unit.



7

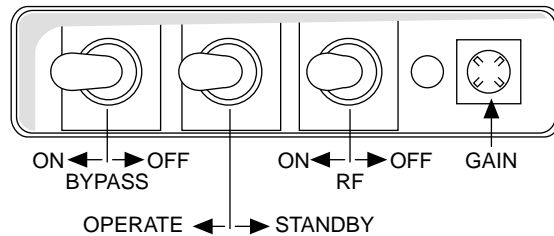
CAUTION

You should only use the bypass mode to stay on the air in an emergency. Though the TWT's hardware protection circuitry still functions, the software doesn't, and you won't receive any advance warning of an impending failure.

Emergency Bypass Operation

To use the controls, proceed as follows:

Remove the two screws that attach the emergency bypass control cover to the front panel. Below the cover are three toggle switches, and to the right of them a potentiometer.



These function as follows:

- The left-hand switch selects emergency bypass on/off (left = on).
- The center switch selects operate/standby (left = operate).
- The right-hand switch selects RF on/off (left = RF on).
- The potentiometer controls the gain; turn clockwise to increase power out.

The switches are normally set to the right.

Note: The potentiometer will rotate clockwise from 7 o'clock to 5 o'clock; 7 will equal a gain % of 0.

To select this mode, proceed as follows:

After turning the unit on, you will have to wait three minutes for the heater time delay to expire before you can begin.*

To select emergency bypass mode, move the left hand switch to the left.

To turn on the high voltage/beam on, move the center switch to the left.

To turn the RF on, move the right-hand switch to the left.

To adjust the gain, turn the potentiometer using a small screwdriver or calibration tool. Note that the gain control is a single-turn potentiometer, and is quite sensitive. Adjust it slowly. Since the control unit isn't operating, you'll have to monitor the power output level by some other means, such as a power meter at the RF sample port. Sample port calibration is labeled on the back panel.

*** Depending on the cause for going to emergency operation, the automatic heater time delay may not function properly. Please ensure that three to five minutes of heater warm-up time have elapsed before you set the center switch to OPERATE. Insufficient heater warm-up time can damage the TWT.**

Computer Interface

Interface Capabilities

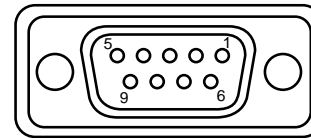
Except for calibration, the computer interface provides access to most front panel facilities.

These include

- Turn High Voltage ON/OFF
- Turn Transmit ON/OFF
- Read voltage, current and gain.
- Set warning levels
- Set gain

Implementation

A subminiature DB-9 connector on the rear panel of the TWTA supports half-duplex RS-422 or RS-485 serial communication with an external computer.



Pin number	RS-422	RS-485
1	N.C.	N.C.
2		*
3	R+	R+/T+
4	T+	*
5	GND	GND
6	T-	*
7	R _L **	R _L **
8		*
9	R-	R-/T-

* For 2-wire RS-485 operation, jumper pins 2 and 4 (R+ to T+) and jumper pins 6 and 8 (R- to T-).

** To terminate the receiver with 120 ohms, jumper pin 9 (R-) to pin 7 (R_L). This termination is not usually needed at 19,200 baud or below.

Hardware Configuration Using Setup Screen 6

```
[Bits 7] Par none
Stop 1 Id 1
Baud 9600.0
SET MORE
```

Setup Screen 6

On machines that use the IEEE GPIB bus, a screen appears that allows the user to select a bus address from 1-30.

To display Setup Screen 6, proceed as follows:

1. If not already at the top level, press EXIT on the front panel. At the top level, press MORE until Menu 2, (System Hours) appears. Select SETUP in Menu 2 and proceed through the setup screens by pressing MORE until Screen 6 appears. It will display the parameters for baud rate, bits per character, stop bits, parity, and ID number.
2. Turn ADJUST knob until square brackets enclose the desired parameter. Press SET. The square brackets ([]) change to arrows (> <), to indicate that the value can be changed.
3. Use the ADJUST knob to assign values to each function. Press SET.
4. When all parameters are set, press EXIT to confirm the change and return to Menu 2 at the top level.

A complete description of the Setup Screens appears in Section 5.

Computer Interface

Serial Interface Parameters

Select values that match the capabilities of the host computer.

Bits

Choices: 7 or 8

For normal use, select 8.

Stop Bits

Choices: 1 or 2

For normal use, select 1.

Parity

Choices: Odd, even, or none

For normal use, select none.

ID

Choices: any number between 1 and 99

Select a unique number as address for each station.

Baud Rate

Choices: 19,200, 9600, 7200, 4800, 3600, 2400, 2000, 1800, 1200, 600, 300, 150, 134.5

Select the highest rate your equipment can handle.

Computer Interface

Software Commands

Command blocks are formatted as follows:

STX	>	0	1	␣	R	D	E	K	ETX	0	1	CR
Prefix		Address		ASCII blank	Command				Suffix	2-digit ASCII checksum		Terminator

All characters are 8-bit ASCII.

Address

Set in the setup screen described on the previous page. The address must be unique for each station connected.

Checksum

The sum of all characters following the first occurrence of an STX character, all the way to the end and including ETX. The sum is divided by 256.

Command to Read Status: RDSTAT

Host Command	Reply From Equipment
RDSTAT	STATUS=[Status Code]

Where Status Code is one of the following:

- 0 No status to report. No command was given.
- 1 Last command was successful
- 10 Last command failed. Invalid command.
- 11 Last command failed. Data was unparseable.
- 20 Last command failed. Data was beyond high limit.
- 21 Last command failed. Data was beyond low limit.
- 22 Last command failed. Data was out of range.
- 23 Last command failed. Data was wrong polarity.
- 50 Remote mode not enabled.
- 60 Not allowed. Example: Issuing RESET when no latched fault exists.

A RDSTAT Message exchange

STX	>	0	1	␣	R	D	S	T	A	T	ETX	0	2	CR		
Command																
ACK	STX	>	0	1	␣	S	T	A	T	U	S	=	2	2	ETX	CR
Reply: status =22 (Last command failed)																

Notes

- The command block begins with PREFIX and ends with TERMINATOR.
- The command begins with SPACE and ends with SUFFIX.
- The checksum is used to test for transmission errors.
- The ASCII character ">" is a delimiter.

STX=02d	ETX=03d	ACK=06d
NAK=21d	SPACE=32d	(d=decimal value)

Computer Interface

Software Commands

Command to Read Fault: RDFLT

Host Command	Reply From Equipment
RDFLT	flt=[Fault Code]

System faults listed by fault code number:

Fault Code	Fault
8	Filament not ready
9	Low line voltage
10	Cathode overvoltage
11	Body overcurrent
12	Cathode undervoltage
15	Collector undervoltage
16	Inverter fault
17	Interlock open
18	Tube arc
19	TWT overtemperature (h)
20	Cabinet overtemperature (h)
23	Over reverse power
26	Panel open
29	External inhibit
30	Grid overvoltage
31	Emergency mode
32	Over forward power
33	Under forward power
34	Over reverse power (s)
49	TWT overtemperature (s)
50	Cabinet overtemperature (s)

If Redundant Switch:

14	WG switch fault
----	-----------------

Computer Interface

Basic Command Set

Host Command	Local Response	Meaning
PWR-ON	CR	Turn HV on
PWR-OFF	CR	Turn HV off
XMIT-ON	CR	RF On
XMIT-OFF	CR	RF Off
RESET	CR	Clear system faults
RDS/N	s/n=[value]	Read unit serial number
RDSTAT	Status = [STATUS CODE]	Refer to Status Code command set
RDFLT	Status = [FAULT]	Refer to Fault Code command set
RDCONHR	ConHr=[value]	Read console hours
RDRFHR	RfHr=[value]	Read transmit hours
RDEK	Ek=[value]	Read TWT cathode voltage
RDEB	Eb=[value]	Read TWT collector voltage
RDEG	Eg=[value]	Read TWT grid drive voltage
RDEF	Ef=[value]	Read TWT filament voltage
RDIF	If=[value]	Read TWT filament current
RDIW	Iw=[value]	Read TWT helix current
RDTMPTWTF	TWTF=[value]	Read TWT baseplate temperature in °F
RDTMPTWTC	TWTC=[value]	Read TWT baseplate temperature in °C
RDTMPPSF	PSF=[value]	Read power supply temperature in °F
RDTMPPSC	PSC=[value]	Read power supply temperature in °C
RDTWTOTF	TWTOTF=[value]	Read TWT overtemperature warning level in °F
STWTOTF	None	Set TWT overtemperature warning level in °F
RDTWTOTC	TWTOTC=[value]	Read TWT overtemperature warning level in °C
STWTOTC	None	Set TWT overtemperature warning level in °C
RDPSOTF	PSOTF=[value]	Read power supply overtemperature warning level in °F
SPSOTF	None	Set power supply overtemperature warning level in °F

Computer Interface

Basic Command Set (Cont.)

Host Command	Local Response	Meaning
RDPSOTC	PSOTC=[value]	Read power supply overtemperature warning level in °C
SPSOTC	None	Set power supply overtemperature warning level in °C
RDIWOC	IwOC=[value]	Read helix overcurrent in mA
SIWOC	None	Set helix overcurrent in mA
RDLOGIC	Sys=[Logic code]	Refer to Logic Code Table at the end of this list
RDA	A=[value]	Read gain
SA X	None	Set gain X = gain in %
RDHTDREM	HTD=[value]	Read time remaining on heater time delay
RDPOD	Po=[value]	Read power output in dBm
RDPOW	Po=[value]	Read power output in watts
RDPRD	Pr=[value]	Read reverse power in dBm
RDPRW	Pr=[value]	Read reverse power in watts
RDPOHID	Pohi=[value]	Read over forward power in dBm
SPOHID	None	Set over forward power warning level in dBm
RDPOLOD	Polo=[value]	Read under forward power in dBm
SPOLOD	None	Set under forward power warning level in dBm
RDPOHIW	Pohi=[value]	Read over forward power in watts
RDPOLOW	Polo=[value]	Read under forward power in watts
RDPRHID	Prhi=[value]	Read over reverse power in dBm
SPRHID	None	Set over reverse power warning level in dBm
RDPRHIW	Prhi=[value]	Read over reverse power in watts
SPOHIW	None	Set over forward power warning level in watts
SPOLOW	None	Set under forward power warning level in watts
SPRHIW	None	Set over reverse power warning level in watts

Computer Interface

Basic Command Set (Cont.)

Host Command	Local Response	Meaning
<i>If Redundant Switch</i>		
SSWMODE X	CR	Set switch mode X = 0 Off 1 Manual 2 Auto
RDSMODE	swmode = X	X = 0 Off 1 Manual 2 Auto
SSWANT	CR	Set switch to antenna
RDSWPOS	swpos = X	X = 0 Load 1 Antenna
<i>If ALC is supplied and enabled</i>		
SALC X	CR	Set ALC X = 0 Off 1 On
<i>If a single thread waveguide switch is supplied and enabled</i>		
STSWITCH X	CR	Set switch X = 0 Antenna 1 Load

Computer Interface

Basic Command Set (Cont.)

Host Command	Local Response	Meaning
<i>If the HPA is equipped with Power Save mode</i>		
SYSTEM ON	CR	Applies filament voltage to the TWT and turns the control head on
SYSTEM OFF	CR	Removes filament voltage from the TWT and turns the control head off

Computer Interface

RDLOGIC Command

Format

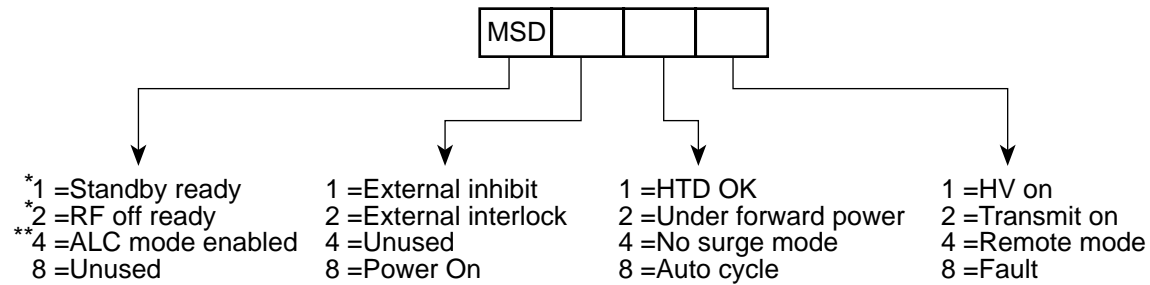
Host Command

RDLOGIC

Reply From Equipment

Sys=[Logic code]

[Logic code] consists of four ASCII hexadecimal digits to be read as follows:



* These bits are only set when the HPA is ready to proceed to the next state in the Turn-on sequence.

** If ALC is supplied and enabled.

For example, a logic code of 67hex should read as follows:

- Under forward power
- No surge mode
- HV on
- Transmit on
- Remote mode

Computer Interface

Examples of Messages sent Successfully

Host: read the gain

STX	>	0	1	␣	R	D	A	ETX	0	1	CR
-----	---	---	---	---	---	---	---	-----	---	---	----

Local:

ACK	STX	>	0	1	␣	A	=	6	7	ETX	CR
-----	-----	---	---	---	---	---	---	---	---	-----	----

Example 1

Host: set the gain to 50% of full scale

STX	>	0	1	␣	S	A	␣	5	0	ETX	0	1	CR
-----	---	---	---	---	---	---	---	---	---	-----	---	---	----

Local:

CR

Example 2

Host: read over reverse power in dBm

STX	>	0	1	␣	R	D	P	R	K	U	H	I	D	ETX	0	3	CR
-----	---	---	---	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

Local: over reverse power = 13 dBm

ACK	STX	>	0	1	␣	P	r	K	U	h	i	=	1	3	ETX	CR
-----	-----	---	---	---	---	---	---	---	---	---	---	---	---	---	-----	----

Example 3

Computer Interface

Examples of Messages sent Successfully (Cont.)

Host: turn high voltage on

STX	>	0	1	␣	P	W	R	-	O	N	ETX	0	2	CR
-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

Local:

CR

Example 4

Examples of Messages with Errors

Host: incorrect checksum

STX	>	0	1	␣	P	W	R	-	O	N	ETX	9	9	CR
-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

Local: replies with command and NAK

NAK	STX	>	0	1	␣	P	W	R	-	O	N	ETX	9	9	CR
-----	-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

Example 5

Host: message with missing prefix

>	0	1	␣	P	W	R	-	O	N	ETX			CR
---	---	---	---	---	---	---	---	---	---	-----	--	--	----

Local: no answer if missing prefix, address or suffix

Example 6

Computer Interface

Examples of Messages with Errors (Cont.)

Host: sends message to node 8 when node 1 is correct address

STX	>	0	8	␣	P	W	R	-	O	N	ETX			CR
-----	---	---	---	---	---	---	---	---	---	---	-----	--	--	----

Local: no answer

Example 7

Host: sends unknown command

STX	>	0	1	␣	P	W)	~	O	N	ETX	0	2	CR
-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

Local replies:

ACK	STX	>	0	1	␣	S	T	A	T	U	S	=	1	0	ETX	CR
-----	-----	---	---	---	---	---	---	---	---	---	---	---	---	---	-----	----

Example 8

Host: address delimiter is missing from message

STX	0	1	␣	P	W	R	-	O	N	ETX			CR
-----	---	---	---	---	---	---	---	---	---	-----	--	--	----

Local: no answer

Example 9

Host: sends message with no address

STX					P	W	R	-	O	N	ETX			CR
-----	--	--	--	--	---	---	---	---	---	---	-----	--	--	----

Local: no answer

Example 10

Troubleshooting

This section is designed to help you to troubleshoot problems that could occur while operating the amplifier in the field. The emphasis here is on procedures that do not involve removing the amplifier from its rack.

You can also call our 24 Hour Customer Support Line at **(800) 883-4ETM (4386)**. During normal business hours, (California time) our technical staff will assist you directly. Outside normal business hours, ETM's operator service will answer your call. Be sure to tell the operator that you need immediate assistance, and leave a phone number or pager number where we can reach you. A member of our technical staff will return your call as soon as possible. If you do not receive a response within 20 minutes, please call again.

The TWTA has two levels of protection: *Faults* and *Warnings*.

Hardware Fault Detection

Fault detection circuitry protects the equipment from damage if a failure is imminent. Dedicated hardware will shut down the TWT and power supply immediately if certain system parameters exceed critical levels. These parameters, and the levels that will result in shutdown, are set at the factory.

When a fault occurs, the TWTA continuously generates an audible alarm and displays a message on the front panel display. You may be able to clear a fault if it is caused by external conditions. The next four pages list some possible hardware faults due to problems outside the amplifier, and show how to clear them.

Hardware Faults Monitored and Displayed

High line voltage	Filament not ready	Interlock open	15V not ready	Grid overvoltage
Low line voltage	Filament overcurrent	Tube arc	Over reverse power	Emergency mode
Cathode overvoltage	Collector undervoltage	TWT overtemperature	Panel open	Over forward power
Body overcurrent	Inverter fault	Cabinet overtemperature	External inhibit	Under forward power
Cathode undervoltage				

Software Warnings

A software monitoring system warns of possible problems, but allows the equipment to continue running. An audible reminder alarm sounds every 30 seconds and a message appears on the third line of the Menu 1 screen if certain system parameters exceed critical levels. These parameters, and the levels that will trigger a warning, are set by the user.

*Note: User may select the auto shut down feature for certain system alarms.

Refer to Section 6: *Warnings Screens* for information on using the Warnings feature.

Troubleshooting

External Faults

The following messages usually indicate a problem outside the amplifier:

Message	Hardware Trip Point	Cause and Recommended Correction
<p>Input Line O/voltage</p> <p>Input line U/voltage</p>	<p>AC power input >10% high</p> <p>AC power input <15% low</p>	<p>Line Voltage Problems</p> <p>Check the input line voltage and the input power connection in either case. If you are using a step-down transformer, low input voltage may be caused by the TWTA loading down the transformer's output. You may require a transformer with a larger current rating.</p> <p>Also, try operating unit in "No Surge" mode.</p>
<p>OVER REV POWER</p>	<p>Reverse/reflected power greater than 40 watts (Normally, the reflected power should not exceed 10% of the forward power)</p>	<p>High Reflected Power</p> <ol style="list-style-type: none"> 1. Check the waveguide output connection. Inspect the output waveguide run all the way from the amplifier output to the antenna feed. Loose connections, a dented, pinched or otherwise damaged waveguide or waveguide load, misaligned gaskets, or stuck waveguide switches are all possible causes of high reflected power. 2. Check the RF input signal. Any input signal or input signal component outside the frequency band from 14.0 to 14.5 GHz will be rejected by the TWTA's internal filter system and may result in a high reflected power fault. 3. If the Over Rev Power fault only occurs during the toggling of a waveguide switch, consider using the external interlock connection (J2 on the rear panel, pins 10 and 11) to inhibit the RF output during switching. 4. If the Over Rev Power fault only occurs during power combined or dual path feeds, the reflected power may actually be forward power from the other amplifier. Check the phasing and connections on your power combining system.

Troubleshooting

External Faults (Cont.)

The following messages may indicate a problem outside the amplifier. You can also set warnings for these items. Refer to Section 6: *Warnings Screens* for information on using the Warnings feature.

Message	Hardware Trip Point	Cause and Recommended Correction
BODY O/CURRENT	Body current greater than 10 mA	<p>Helix over current</p> <ol style="list-style-type: none"> 1. Too much input drive (overdrive) 2. Consistent operation into a badly matched load (See high reflected power) 3. Try unit in “No Surge” mode. 4. Try unit in “Pulse” mode. <p>Check the value of I_w on the Menu 4 screen. Normally the TWT should run with body current much less than 8 mA.</p>
TWT Over Temperature Cabinet Over Temperature	Temperature greater than 120°C Temperature greater than 65°C	<p>For both TWT and cabinet temperature problems,</p> <ul style="list-style-type: none"> • Check the air intake filter and exhaust ports on the rear of the unit. Make sure that the pathways are completely unobstructed. Make sure that the large volume of air generated by the high speed 400 cycle fan is moving through the system whenever the circuit breaker is on. • The air temperature at the air intake may be too warm. Be sure that neither this TWTA nor any other device is exhausting hot air near the air intake. If necessary, construct a duct to steer hot air away from the air intake.

Troubleshooting

Internal Faults

The following messages indicate that the problem may be in the amplifier:

Message	Cause
Cath U/Voltage	The cathode power supply voltage is less than 10kV.
Cath O/Voltage	The cathode power supply voltage is more than 11kV.
*Fil U/Current	The filament power supply current is less than 1.4A.
*Fil O/Voltage	The filament power supply voltage is more than 6.5V.
*Fil O/Current	The filament power supply current is more than 3.0A.
Coll U/Voltage	The collector voltage is too low.
Inverter Fault	The high voltage power inverter has failed.
Tube Arc	A high voltage arc occurred.
Grid O/Voltage	The grid drive voltage is more than 350V.

*The message “Filament not ready” appears under these conditions

Microprocessor Control Faults

The following messages indicate that the problem is in the microprocessor control system.

Message	Recommended Correction
Database Corrupt Communication Failure Cannot Restore CU line voltage too low to operate	<ol style="list-style-type: none"> 1. Do not press OK. 2. Turn off the main power circuit breaker. 3. Wait 10 seconds. 4. Turn power back on. If the problem persists, use Emergency Bypass Operation. Call ETM.

Troubleshooting

Low Power Output Problems

Symptom	Probable Cause
<p data-bbox="548 472 699 500">No Output</p> <p data-bbox="289 513 968 565">After turning the unit on and following the procedure “Getting on the Air” on page 4, there is no RF power out from the unit.</p>	<p data-bbox="1039 487 1738 560">Check the external interlock connector on the rear panel. A jumper or external closure must be installed between pins 3 and 4, and pins 10 and 11.</p> <p data-bbox="1039 591 1749 800">Check the input drive. Is the RF source turned on and connected to the rear RF input connector? To determine whether the problem is with the RF input or with the TWTA’s power supply and TWT, monitor the baseplate temperature. Follow the normal turn on sequence and allow a few minutes for warmup. If the TWT baseplate temperature increases after the RF ON switch is activated and decreases after RF OFF is pressed, the power supply and TWT are probably functioning properly.</p>
<p data-bbox="541 846 705 873">Low Output</p> <p data-bbox="296 894 953 922">TWTA power remains one dB or more below rated power output.</p>	<p data-bbox="1039 898 1705 1107">Try turning down the gain adjustment. If power increases as you decrease gain, you were overdriving the TWT. Check the input drive level. For maximum power output, the drive level into the amplifier should be as stated in the ETM acceptance test data. Check that the RF input connection on the rear panel is not loose. Check the pins on the mating connector for damage, and the teflon insulator for metal particles.</p>

Technical Specifications

Frequency Range:	13.75-14.50 GHz, Ku-Band
Output Power at the Amplifier flange:	450 watts, minimum 485 watts, typical
Amplifier Gain:	65 dB min.
Gain Slope:	0.03 max. – over any 40 MHz
Gain Stability:	0.25 dB/24-hours, any frequency with constant drive
Gain Adjustment:	0-35 dB, continuously adjustable
Intermodulation Products:	-24dBc at 7dB backoff
AM to PM Conversion:	6°/dB at rated power
Harmonic Output:	-60 dBc
Residual AM:	-50dBc to 4kHz max. 4kHz to 500kHz -20(1.15 + logF) (F in kHz) max. -85dBc above 500kHz
Phase Noise:	Meets limits 1 & 2 of IESS-308
Noise and Spurious Outputs:	-65 dBW/4 kHz max.
Group Delay: <i>(In any 40 MHz band)</i>	Linear: 0.05 nanoseconds/MHz Parabolic: 0.01 nanoseconds/MHz squared Ripple: 0.50 nanoseconds/MHz peak to peak
Input VSWR:	1.20: 1 max
Load VSWR:	1.50: 1 for spec. compliance 2.00: 1 continuous operation
RF Connectors:	Input: Type N; rear panel (SMA optional) Output: WR 75; rear panel Sample Port: Type N; rear panel (SMA optional)
Metering:	VFD, 4 lines, 20 Characters
AC Power:	99-255 VAC, 50/60 Hz, single phase, 1800VA
Mechanical:	Dimensions: 19 x 5.25 x 24 in. Weight: 67 lbs. Integral forced air cooling

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Appendix A

One-For-One Redundant Switch System (Option)

Features

- Complete waveguide switch system for ETM's 5.25 inch (3U) series HPAs.
- Includes switch, high-power load, all interconnecting waveguides, and cabling.
- Power and control logic for switch operation supplied by the HPAs.

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Installation

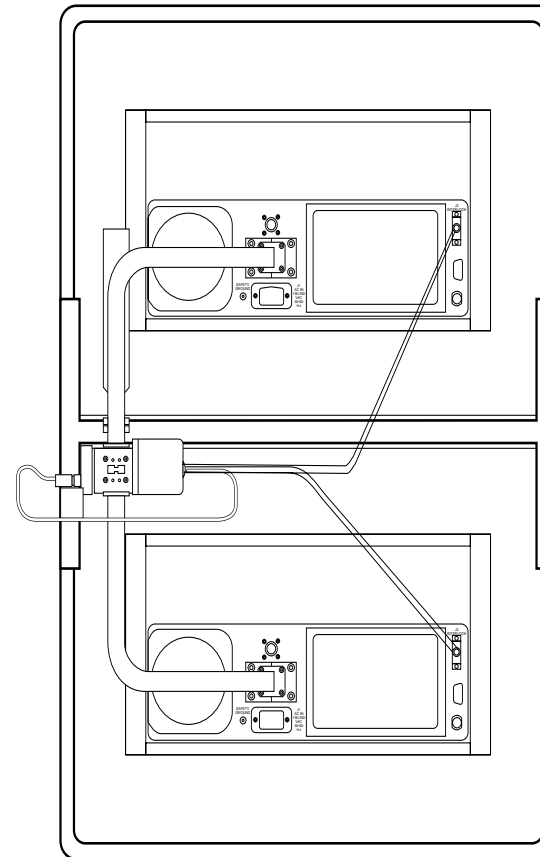
The System as Shipped

A carrying case 34" X 26" X 15" overall contains all components, installation tools, and the following documentation:

- Parts List
- Schematic Diagram
- Wiring Diagram

To make installation easier, some parts are pre-assembled before shipment. The diagram on the right shows the assembled switch. In this example, the switch is configured for operation with two 400 C/Ku units. The configuration may differ slightly to accommodate other models.

As shipped, the switch and the HPAs are set up for Manual mode.



Installation

Installation Procedure

1. Align the flyaway cases directly on top of each other and remove the front and rear covers. The HPAs must be installed in the bottom three rack units of each case.
2. Lock the two cases together using the two H-shaped Case Clamps (N25471). Tighten them with the draw latches that normally secure the covers. The clamp centerline should be at approximately the height of the split between the cases.
3. Remove the protective covers from the HPA RF output flanges and from the waveguide flanges on the switch assembly.
4. Install the switch assembly on the output flanges. The switch module will be to the left of the RF output flanges, facing the rear panels, and the load must be pointing upward. Join the flanges with all eight screws.
5. Remove the wing nuts from the heat shield and brace parts. Split the two halves of the brace. Slide the part with the heat shield down over the load, and engage the lower half by sliding it over the waveguide and rotating 90°.
6. Clamp the brace parts around the case clamp rail and tighten the wing nuts.
7. Install P1 into the 15-pin D-sub interlock socket (J2) of the upper amplifier.
8. Install P2 in J2 of the lower unit.
9. Install P3 in the switch circular connector.
10. Connect the antenna feed to port 1 of the switch.

The installation is now complete and the switch is ready for service.

Operation

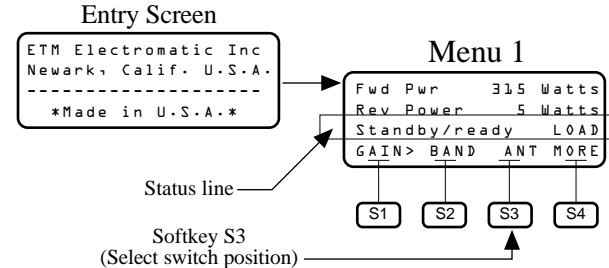
The HPAs are shipped from the factory in manual mode with forward underpower setpoint deselected (set to OFF). If these parameters are changed, the controller will “remember” the new settings at the next power up. ETM recommends returning the HPA’s redundant switch settings to the factory values before packing up, so that the units will come on at a known setting next time.

Manual mode

In manual mode, no automatic changeover occurs. The HPA attached to the dummy load can be switched to the antenna by the operator regardless of its own status.

1. Install switch assembly as described in section 2.0. Make sure port 1 of the switch is terminated with a suitable load or with the antenna.
2. Plug the amplifiers into a good AC source.¹ Turn on the front panel breakers and allow the units to warm up.
3. Observe that the status line (the third line) of the Menu 1 screen indicates the switch position. ANT means the HPA is connected to the antenna; LOAD means it is connected to the dummy load.
4. Observe that the HPA on the dummy load (the standby unit) has the prompt ANT above the third softkey.

5. Press the softkey S3. The switch will be heard to transfer. The ANT prompt will disappear and the indication “-SW-” will appear for several seconds. The “LOAD” on the status line will be replaced by “ANT.” If in manual mode, the other HPA will now show “LOAD” on the status line and the “ANT” prompt above the third softkey. If in auto mode, “ANT” will be replaced by “LOAD” above the third softkey.



¹ ETM recommends using 208 to 240 VAC where available, in preference to 120 VAC. When the amplifiers operate from 120 VAC, any voltage drop in the power distribution wiring can bring the operating voltage close to the low line limit. Operating from higher line voltages eliminates the risk of line undervoltage shutdowns.

Operation

Automatic mode

If port 1 of the switch is connected to the antenna, be aware that RF will be radiated in this procedure.

1. To enable the automatic mode, the switch mode of the HPAs must be changed. The switch mode is changed in the Setup screen, accessed from the Menu 2 screen. A diagram of the complete Setup sequence appears in Section 7, “Setup Screens” in the main manual.
2. Press S4 (labeled “MORE”) and when Menu 2 appears, press S1 (labeled “SETUP”) The SETUP menu has been modified from the standard HPA to make the switch mode selection the first SETUP screen. Press S1 (labeled “SET”) to change the mode. You can now cycle through each of three modes. When “AUTO” appears, press the “EXIT” key.
3. Press the EXIT key twice to return to Menu 1.
4. Repeat the setup process for the other HPA.
5. Observe that the status line position indication has not changed.
6. Push the OPERATE key on the standby unit. When the display shows “RF OFF/READY”, push the RF ON key. You will hear a click as the switch automatically transfers the HPA to the antenna. The switch transferred because the status signal of the unit on the antenna was low due to the unit not being in the RF ON state. As soon as the standby unit went to RF ON and was able to transmit and observed that its partner was not ready to transmit, it switched itself to the antenna.
7. Notice that there are no prompts above S3 on either unit. This is because in automatic mode operator-controlled switching is only permitted from one transmitting HPA to another.
8. Now push the operate key on the second HPA, the one currently indicating “LOAD”. When the “RF OFF/READY” status display comes on, push RF ON.
9. Observe that there is now a prompt over the S3 of both units: the antenna unit shows “LOAD” and the standby unit shows “ANT”.
10. Press S3 on either unit and observe that this will cause a switch transfer. Pressing the key labeled “LOAD” causes the HPA to drop its status signal momentarily, causing its partner to switch itself to the antenna.
11. Interrupt the operation of the antenna unit by pushing RF OFF, or by pushing STANDBY, or by shutting off line power. Any of these will cause the other unit to connect itself to the antenna.

Operation

Automatic Mode with Forward Underpower Enabled

1. Push the STANDBY keys on both HPAs to turn off the amplifiers.
2. Provide RF to the RF input jacks of both amplifiers.
3. Turn the gain on both HPAs down to 0%.
4. Put the amplifiers back in OPERATE and RF ON.
5. Increase gain to obtain reasonable forward power, say 50 dBm, on both HPAs.
6. Press S4 (labeled “MORE”) twice to get to Menu 3. Press S1 (labeled “WARNINGS”) to enter the warning menus.
7. The first warning screen sets the software reverse overpower limit. Press S4 (labeled “MORE”) to get to the forward underpower setpoint.
8. Press S1 (labeled “SET”) to activate the adjustment knob. If the knob is turned far counterclockwise, the letters “-OFF-” appear, indicating that forward underpower warning is deselected. Turn the knob until a power level somewhat below the forward power out is reached; 48 dBm would be reasonable.
9. Press S1 (still labeled “SET”) again to disconnect the adjust knob.
10. Press the EXIT key twice: once to exit the warning menu, again to return to Menu 1.
11. Repeat the process for the other HPA.
12. Now press S1 (labeled “GAIN”) on the HPA attached to the antenna. Slowly turn the rotary knob counterclockwise, observing the forward power level. You will note that when the forward power drops below the setpoint (48 dBm in this example), the waveguide switch will transfer the standby HPA to the antenna.

Operation

Emergency Bypass Operation

The emergency bypass mode is provided for the unlikely event that HPA-controlled switching needs to be locked out. In the emergency bypass mode, the HPA does not send the 15 volt signal to the switch motor, and there is no softkey prompt for switching. The emergency bypass mode is selected as in step 2 of Automatic mode operation on page 5. Choose the “OFF” option in the SETUP 1 menu.

The waveguide switch is provided with a knob that allows direct operator selection of the switch position. It is located under the round dust cover on the switch motor. If the cover is removed, the switch position can be read off the knob, and the knob can be turned by hand.

It is safe to move the switch while running at full RF power. The operation of the HPAs is interlocked through auxiliary switches so that the RF output is inhibited while the switch is being moved.

Troubleshooting

As the bulk of the logic and control circuitry resides in the HPA itself, the scope of field repairs to the switch is limited.

Symptom	Corrective Action
Switch "chatters" in automatic mode	<ol style="list-style-type: none">1. Change forward underpower setpoints.2. Turn off forward underpower.3. Operate in manual mode, and when time permits, inspect the harness for broken wires.
Switch does not move	<ol style="list-style-type: none">1. Operate in emergency bypass mode; remove knob cover and work switch by hand.2. Inspect the harness for broken wires.3. Inspect the switch.
Switch operates spuriously, even in emergency bypass mode.	<ol style="list-style-type: none">1. Unplug harness from HPAs. Install 15-pin D-sub interlock jumper plugs. Remove knob cover and work switch by hand. <p><i>Note:</i> the jumper plugs defeat the switch interlock. Go to RF OFF before moving the switch, or an over reverse power condition will occur when the switch is moved.</p>

Theory of Operation

The One-for-One Redundant Switch Assembly is a complete waveguide switch system for ETM's 5.25 inch series HPAs. Power and control logic for the switch's operation is supplied by the HPAs themselves. The system includes the switch, a high-power load, all interconnecting waveguides and cabling.

The switch has two functional positions: In position 1 the upper HPA is connected to the output of the switch (presumably the antenna) and the lower HPA is connected to the high power load. In position 2, the upper unit is on the load and the lower HPA is connected to the antenna. If the switch is in any other position, whether from manual manipulation, active transition, or switch malfunction, the RF output of the HPAs is inhibited.

The operator can select any of three modes of switch operation: Manual mode, Automatic mode, and Emergency Bypass mode. In the manual mode, the standby HPA (the unit on the load) switches to the antenna when commanded by the operator. In the automatic mode, the standby unit switches itself to the antenna if the other HPA malfunctions. In the Emergency Bypass mode the HPAs do not actuate the switch.

To eliminate contention between the HPAs, the control logic allows only one HPA to initiate a switch transition. Only the HPA currently on the dummy load can operate the switch, thereby connecting itself to the antenna. The HPA currently on the antenna cannot by itself move the switch to the dummy load. For this reason, if one HPA is shut off, the remaining HPA can only make the transition from the dummy load to the antenna, not vice-versa.

Each HPA sends the other a status signal indicating whether it is operating properly. This signal is high when the amplifier is at RF on and making power at or above an operator-selected minimum forward power level. If the forward power drops, or if the amplifier malfunctions or is shut off, the status signal will go low. If an HPA in the automatic mode sees that its partner's signal has gone low, and its own status signal is high, it will switch itself to the antenna. If the other unit comes back, no switchover takes place. The minimum forward power feature can be deselected so that automatic changeover occurs only due to HPA shutdown or HPA fault.

