



MCL OPERATIONS & MAINTENANCE MANUAL

FOR MT4000 TWTA

October 24, 2003

<u>Mark Schmeichel</u>	<u>10/24/03</u>
Engineering	Date

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TN4000-1

Technical Note

Description of MT4000 TWTA

November 15, 2005

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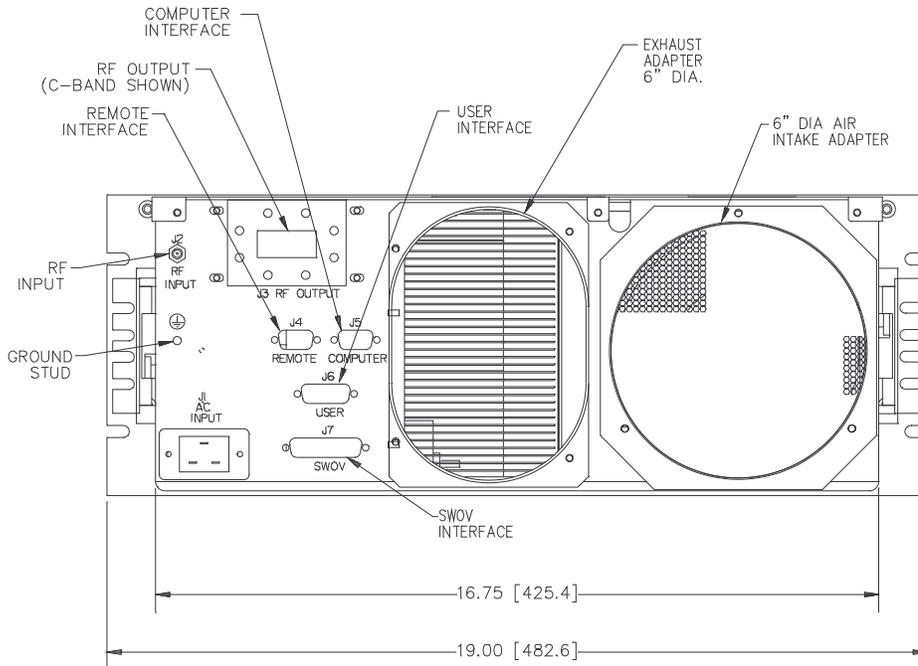
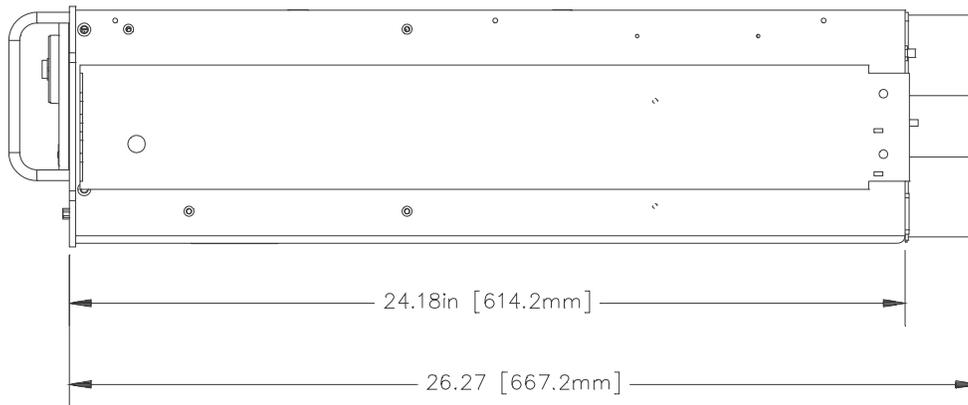
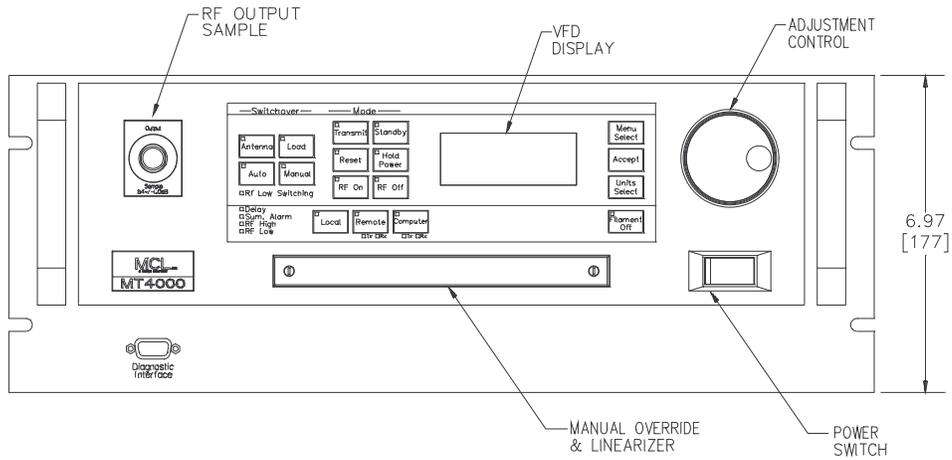
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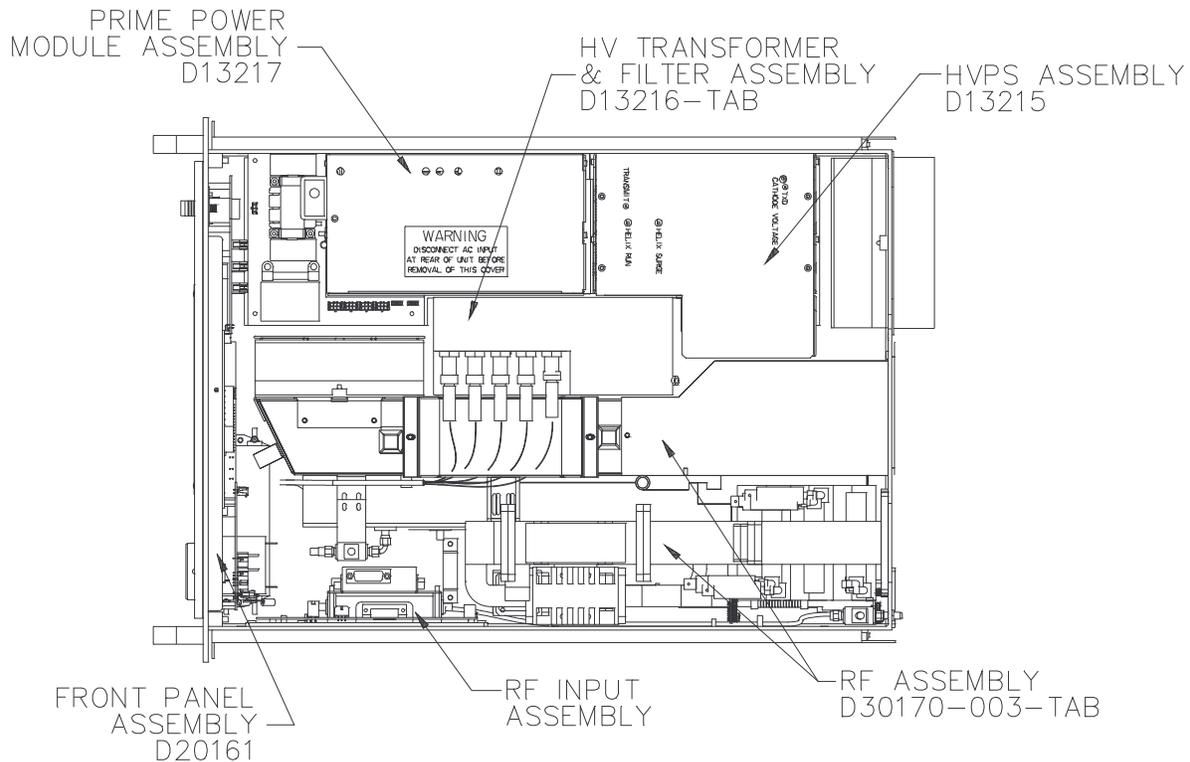
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1.0 SCOPE

1.1 Physical



The MT4000 has been designed with several field replaceable assemblies shown in the figure below:



1.2 Functional

The MT4000 is designed to provide continuous status to multiple interface at the same time. However, only one of these interfaces may control the operational states of the MT4000 at one time. The user at the TWTA front panel will be provided plain English feedback on system status and diagnostics through a four line vacuum fluorescent display (VFD), membrane panel CCA with discrete LED's and buttons and a digital encoder used to adjust the amplifier parameters.

- Event Log screen with report of failure level, date & time.
- Sample port coupling factor screen.
- Front panel software communications configuration for both Remote & Computer interfaces.
- Continuous attenuator adjustment in dB.
- Auto Power control & status.
- Filament off state.
- 1:1 Switchover Control.
- Local, Remote or Computer control modes.
- Internal Control bus consisting of high priority parallel signals and lower priority serial (RS485) bus communications. These signals connect multiple remotely located satellite CCAs to the main logic controller (BFC).
- Manual Override Control.
- Optional Linearizer Control.
- Front Panel RS232 Diagnostic Interface for data downloads and maintenance functions.

The MT4000 front panel does include the indicators, status and controls shown in the following table:

Function	Local			Remote & Control		
	Numeric Value	Status	Control	Numeric Value	Status	Control
HPA AC Power Control		X	X			
Filament Off		X	X		X	X
Delay		X	X		X	X
Transmit (Transmit Selected)		X	X		X	X
Standby		X	X		X	
Local Control		X	X		X	
Remote Control		X	X		X	X
Computer Control		X	X		X	X
Reset (Fault)			X			X
Fault Counter Enable		X	X		X	X
Fault Counter Window (time)		X	X		X	X
Fault Counter Number		X	X		X	X
Units Select (dBm, W or dBW)			X			
RF On		X	X		X	X
RF Off		X	X		X	X
Hold Power			X			X
Meter, Tube Drive Power	X			X		
Meter, RF Forward Power	X			X		
Meter, RF Reflected Power	X			X		
Meter, Helix Voltage	X			X		
Meter, Helix Current	X			X		
Meter, Filament Current	X			X		
Meter, Tube Temperature	X			X		
Meter, Remaining Filament Delay	X			X		
Sample Port Cal Factor Table	X					
Set, Attenuation	X		X	X		X
Set, Time & Date	X		X	X		X

Function	Local			Remote & Control		
	Numeric Value	Status	Control	Numeric Value	Status	Control
Limit, Auto Power Window Percentage	X			X		
Limit, Tube Overdrive Alarm	X			X		
Limit, Tube Overdrive Fault	X			X		
Limit, Tube Temperature Alarm	X			X		
Limit, RF Reflected Power Alarm	X			X		
Limit, RF Reflected Power Fault	X			X		
Limit, RF Low Alarm	X			X		
Limit, RF High Alarm	X			X		
Limit, Filament Under Current Fault	X			X		
Summary Alarm		X			X	
Alarm, RF High		X			X	
Alarm, RF Low		X			X	
Alarm, Tube Overdrive		X			X	
Alarm, RF Reflected Power		X			X	
Alarm, Tube Temp		X			X	
Alarm, Power Supply Temp		X			X	
Alarm, Blower Failed		X			X	
Alarm, AC Low Line		X			X	
Alarm, RF Switch Failed		X			X	
Summary Fault		X			X	
Fault, HV Primary Current		X			X	
Fault, Tube Overdrive		X			X	
Fault, RF Reflected Power		X			X	
Fault, Tube Temp Switch		X			X	
Fault, Tube Temp Analog		X			X	
Fault, Waveguide Pressure		X			X	
Fault, Waveguide Arc		X			X	
Fault, Arc Test Failed		X			X	
Fault, Power Supply Temp		X			X	
Fault, Helix Surge Current		X			X	

Function	Local			Remote & Control		
	Numeric Value	Status	Control	Numeric Value	Status	Control
Fault, Helix Run Current		X			X	
Fault, Chassis Interlock		X			X	
Fault, HV Under Volt		X			X	
Fault, HV Over Volt		X			X	
Fault, Filament Under Current		X			X	
Fault, User Interlock		X			X	
User RF On/Off		X			X	
Switchover RF On/Off		X			X	
Switchover, Autoswitching		X	X		X	X
Switchover, This HPA to Antenna		X	X		X	X
Switchover, This HPA to Dummy Load		X	X		X	X
Switchover, Other HPA SWOV Fault		X			X	
Switchover, RF Low Switching		X			X	
Switchover, Exciter Alarm		X			X	
Computer Comm Tx		X				
Computer Comm Rx		X				
Remote Comm Tx		X				
Remote Comm Rx		X				

2.2 RF Specification

2.2.1 Operating Frequency Range, Rated Output Power and Gain

TWT P/N	Supplier	Frequency Range (GHZ)	TWT Rated Output Power (Watts Min)	Amplifier Rated Output Power (Watts Min/dBm)	Gain Rated/ Small Signal (dB Min)
27D3587-001	Thales or NEC	5.85 – 6.45	750	665 / 58.2	72/77
27D3587-002	Thales	5.85 – 7.10	750	665 / 58.2	72/77
27D3587-003	NEC	5.85 – 6.75	750	665 / 58.2	72/77
27D3587-004	Thales	5.85 – 6.725	750	665 / 58.2	72/77
27D3587-101	Thales, NEC or Teledyne	13.75 – 14.50	750	665 / 58.2	72/77
27D3587-102	Thales	12.75 – 14.50	750	665 / 58.2	72/77
27D3587-103	NEC	12.75 – 14.50	680	600 / 57.8	72/77
27D3587-104	Thales, NEC or Teledyne	14.50 – 15.35 (Ku-High)	750	630 / 58.0	70 (ss)
27D3587-201	Thales	17.30 – 18.40 (DBS)	500	420 / 56.2	65/71
27D3587-202	Thales	17.3-18.4	750	630/58.0	70/72
27D3587-301	NEC	7.90 – 8.40	750	665/58.2	71/76

2.2.2 Gain Variation

The small signal gain variation (dB_{p-p} maximum) of the TWTA shall not exceed any of the following conditions with a constant input drive:

CONFIGURATION	MEASUREMENT BAND	HPA OPERATING BAND				
		C	Ku	Ku-High	DBS	X
LINEARIZER OPTION	ANY 750 MHz	4.5	4.5	N/S	N/S	N/S
	ANY 500 MHz	3.5	3.5	N/S	N/S	N/S
	ANY 80 MHz	N/S	1.0	N/S	N/S	N/S
	ANY 40 MHz	0.5	N/S	N/S	N/S	N/S
NON-LINEARIZED OPTIONS	FULL BAND	N/S	N/S	3.0	N/S	2.5
	ANY 750 MHz	3.5	3.5	N/S	N/S	N/S
	ANY 500 MHz	2.5	2.5	3.0	4.0	2.5
	ANY 80 MHz	N/S	1.0	N/S	1.0	1.0
	ANY 40 MHz	0.5	N/S	N/S	N/S	N/S
NOTES						
1. Improved performance is available upon request, consult an MCL representative.						
2. Non-linearized options include SSA or BUC module IPA options						
3. N/S is not specified or not applicable.						

2.2.3 Gain Slope (Amplitude Response) less than ±0.04 dB/MHz

2.2.4 Gain Stability

2.2.4.1 Gain Stability vs. Time

Gain stability will be established with constant input drive, constant prime power, and constant temperature. After a 30-minute warm-up period, the output power shall not fluctuate more than 0.25 dB from any selected RF output level (from rated to 10 dB below rated) over a 24-hour period.

2.2.4.2 Gain Stability vs. Temperature

Gain stability will be established with constant input drive, constant prime power, and at steady-state operation at the extremes of the operational temperature requirements. After a 30-minute warm-up period within the temperature range specified in Paragraph 4.1, rate of temperature change shall not exceed 10°C/hr.

Over entire Temperature Range ±1.0 dB typical from any selected RF output level between rated power and 10 dB below rated power.

Over any 10 C Window ±0.75 dB typical from any selected RF output level between rated power and 10 dB below rated power.

2.2.5 Gain Adjustments

The HPA gain adjustment shall have the following specifications

- Range at the TWT Input 30 dB minimum
- Displayed Resolution 0.1 dB

2.2.6 Group Delay at Rated Power (in specified test band)

- Linear 0.010 ns/MHz
- Parabolic 0.005 ns/MHz²
- Ripple 0.500 ns_{p-p}

BAND	TEST BAND
C-Band, X-Band	over any 40 MHz
Ku-Band	over any 80 MHz
DBS- (Ku-Band)	over any 80 MHz

2.2.7 AM to PM Conversion

BAND	RATED OUTPUT	6 dB BELOW RATED OUTPUT
C, Ku, X	6° /dB	2.5° /dB
Ku-DBS	8° /dB	3° /dB

2.2.8 Intermodulation Distortion

When two equal level unmodulated carriers are amplified simultaneously through the TWTA, the third order intermodulation distortion products generated (measured at the output of the TWTA), shall not be greater than the following:

Sum Of Both Carriers Relative To Single Carrier Rated Output Power (dBc)	Highest Intermodulation Product Relative To Each Of The Two Carriers (dBc)	
	Without Optional Linearizer	With Optional Linearizer
C-Band, X-Band		
-4	-18	-27
-7	-24	
Ku-Band		
-4	-18	-27
-7	-24	
DBS (Ku-Band) & Ku-High band		
-4	-17	-26
-7	-23	

2.2.9 Residual AM

- Below 10 kHz -50 dBc maximum
- 10 kHz to 500kHz -20 (1.5 + log *f* dBc maximum [*f* is sideband offset in kHz])
- Above 500 kHz -85 dBc maximum

2.2.10 Harmonics (dBc max) -60 dBc

2.2.11 Output Noise Spectral Density

Maximum output noise spectral density excluding harmonics and power line related frequencies:

BAND	FREQUENCY RANGE (GHz)	OUTPUT NOISE SPECTRAL DENSITY (MAXIMUM)
C-Band	3.4 – 4.2	-150 dBW/4 kHz
	4.2 – 12.0	-70 dBW/4 kHz
Ku-Band	10.70 - 12.75	-150 dBW/4 kHz
	12.75 - 18.50	-70 dBW/4 kHz
Ku-Band (High)	13.40 - 14.062	-150 dBW/4 kHz
	14.50 - 15.35	-70 dBW/4 kHz
Ku (DBS)-Band	10.70 - 12.75	-150 dBW/4 kHz
	12.75 - 21.00	-65 dBW/4 kHz
X-Band	7.25 – 7.75	-70 dBW/4 kHz
	7.9 – 10.00	-70 dBW/4 kHz

2.2.12 Voltage Standing Wave Ratio (VSWR)

2.2.12.1 Input & Output VSWR

The TWTA shall not exceed the VSWR listed below over the frequency range listed in the table below for the given TWT. The output VSWR is as seen by the antenna feed system.

BAND	INPUT VSWR (MAXIMUM)	OUTPUT VSWR (MAXIMUM)
C/Ku/X	1.20:1	1.25:1
Ku (DBS)	1.25:1	1.30:1
Ku (High)	1.25:1	1.35:1

2.2.12.2 Load VSWR

- Shall operate continuously into 2.0:1 without damage.
- The TWTA shall not suffer damage nor permanent degradation of performance when the output waveguide is shorted or operated into a VSWR of 2.1:1 or greater at any phase. The amplifier may shutdown for self-protection when the output exceeds 2.1:1.

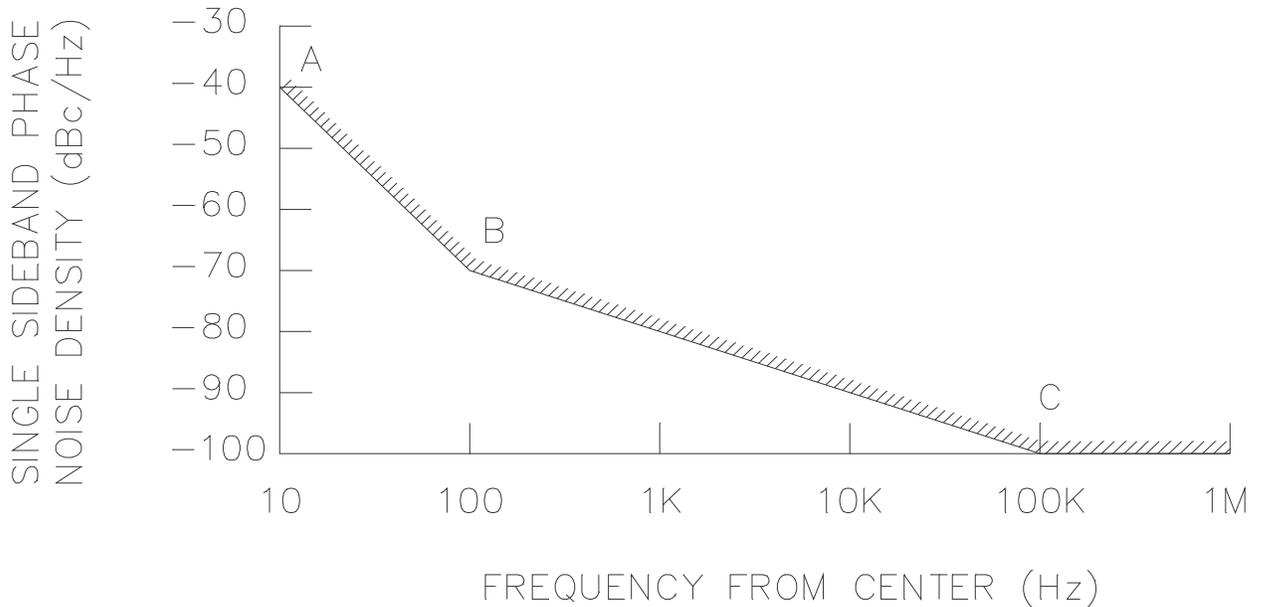
2.2.13 Output Power Switch On/Off Ratio 43 dB minimum

2.2.14 Phase Noise

INTELSAT Requirements, IESS-308-Limit 1 (Rev. 9) minus 10 dB the single sideband phase noise is assumed to consist of a continuous phase modulated component and a spurious component. The single sideband power spectral density of the continuous component shall not exceed the envelope shown in the figure. A spurious component at the fundamental AC line frequency shall not exceed -50 dB relative to the level of the transmitted carrier. The single sideband sum (added on a power basis) of all other spurious components shall not exceed -47 dB relative to the level of the transmitted carrier. (The total phase noise including both sidebands can be up to 6 dB higher.)

COORDINATES OF POINTS

POINT	DENSITY (dBc/Hz)	FREQ (Hz)
A	-40	10
B	-70	100
C	-100	100K



2.3 Interconnections

2.3.1 Grounds

2.3.1.1 Earthing Grounds

A 10-32 x 1.0” threaded stud will be provided on the back of the TWTA chassis. The stud is the central attachment point for all safety grounds of the TWTA both internal and external.

2.3.1.2 Safety Ground

The safety ground connection is located on the AC input connector.

2.3.2 AC Input Power

Designator J1
 Location Back panel of TWTA chassis
 Connector Type IEC-320

2.3.3 RF Input

Designator J2
 Location Back panel of TWTA chassis
 Connector Type SMA, Female (all bands)

2.3.4 RF Output

Designator J3
 Location Back panel of TWTA chassis

BAND	CONNECTOR	FLANGE HARDWARE
C	CPR137F	#10-32 tapped
Ku	WR75F	#6-32 tapped
Ku-DBS	WR62F	#6-32 tapped
X	WR112F	#8-32 tapped

2.3.5 Computer Interface

The computer interface can be configured as an EIA RS-232 DCE device or four-wire half duplex RS 485 connector.

Designator J5
 Location Back panel of TWTA chassis
 Connector Type Nine position “D” connector with socket contacts
 Protocol CSP (see 46A0204 & 40A1546) or SA Compatible (46A0203 & 40A1715)

2.3.6 Remote Interface

The remote interface shall be configured as a four wire half duplex RS 485 connector, utilizing a 9-pin sub D connector.

Designator	J4
Location	Back panel of TWTA chassis
Connector Type	Nine position “D” connector with socket contacts
Protocol	CSP (see 46A0204 & 40A1546) or SA Compatible (46A0203 & 40A1715)

2.3.7 Diagnostic Interface

The diagnostic interface shall be configured as an EIA RS-232 DCE device connector.

Designator	J8
Location	Front panel of MT4000
Connector Type	Nine position “D” connector with socket contacts

2.3.8 User Interface

Designator	J6
Location	Back panel of TWTA chassis
Connector Type	Fifteen position “D” connector with socket contacts

2.3.9 Switchover Interface

Designator	J7
Location	Back panel of TWTA chassis
Connector Type	Twenty-five position “D” connector with socket contacts

2.3.10 RF Output Sample Interface

Designator	J9
Location	TWTA front panel with a Sample Port label holder
Connector Type	Type N female

3.0 MECHANICAL

3.1 Dimensions and Weight

The TWTA is housed in a volume of 19 W x 7 H x 24 D inch (483W x 178H x 610D mm). The TWTA is approximately 75 lbs (34 kg) depending on the options ordered.

3.1.1 Mounting/Installation Requirements

The TWTA is configured for easy assembly into a standard 19” rack. The TWTA is intended to be a two-person lift. The TWTA will operate in any orientation.

3.2 Thermal Requirements/Cooling

3.2.1 Thermal Protection Requirements

The protection is provided in the MT4000 for the TWT to prevent exceeding the critical temperature. Thermal protection is provided for the electronics of the power supply to prevent it from exceeding critical temperature. An analog sensor is used to determine the TWT heatsink temperature.

3.2.2 Cooling Air Interface Requirements

Cooling circuit is a closed loop design with both interfaces on the rear of the TWTA. The closed loop circuit is designed to meet worst case cooling requirements when operated with a total external cooling system back pressure of 0.5 in H₂O at 190 cfm (323 m³/hr). No filtering of the supply air is designed into the TWTA; purity and air characteristics are the responsibility of the system integrator. Air filter arrestance shall be 70% or greater when tested per ASRAE 52.2.

NOTE

A filter with a minimum efficiency reporting value of 3 (MERV 3 filter) is recommended.

Power and mounting provisions have been made to easily add an optional external blower to boost airflow for high external back pressure applications. The intake and exhaust ducts take standard 6’ hoses.

4.0 ENVIRONMENTAL SPECIFICATIONS

4.1 Operating Environment

- | | | |
|-------|-------------------|--|
| 4.1.1 | Temperature | -0°C to +50°C
(Derate 1.9°C/1,000 feet of altitude) |
| 4.1.2 | Altitude | to 10,000 feet or 3048 meters (full operation) |
| 4.1.3 | Relative Humidity | to 95% non-condensing |

4.2 Non-Operating Environment

4.2.1	Temperature	-40°C to 70°C
4.2.2	Humidity	100% non-condensing
4.2.3	Altitude	to 50,000 feet (15,000 meters)
4.2.4	Vibration	Basic transportation method 514-4 of Mil-Std. 810E Category 1, Figures 514.4-1, 514.4-2, 514.4-3
4.2.5	Shock	Method 516.4 of Mil-Std-810E 10g, 11ms half sign pulse along each of three orthogonal axis

5.0 SAFETY

Meets the requirements of EN 60215 (1996) Radio Safety.

6.0 RADIATED & CONDUCTED EMISSIONS; ESD, CONDUCTED, SURGE & RADIATED IMMUNITY

ETSI EN 300 673 (2000) Electromagnetic Compatibility and Radio Spectrum Matters (ERM); EMC standard for VSAT, SNG, SIT & SUT Earth Stations operated in the frequency range between 4 GHz and 30 GHz in the Fixed Satellite Service.

EN55022 (1998) Limits and Methods of Measurement of Radio Interference Level B Characteristics of Information Technology Equipment

7.0 OPTIONS

The following options are available with the MT4000:

- Manual Override – Internal Bypass of HPA Controller
- Manual Attenuator
- Gain Linearizer – Internal to HPA
- Extended Frequency Band
- External Serial to Parallel Interface
- Remote Panel
- 1:1 Redundant System
- 1:2 Redundant System
- Phase Combined Redundant System Configurations

Consult MCL for availability and documentation of these options, and other system options.



TN4000-2

Technical Note

Installation Guide for MT4000 TWTA

October 24, 2003

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10/24/03
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1.0 SAFETY SUMMARY

1.1 General Safety Precautions

The following are general safety precautions and instructions that personnel must understand and apply during many phases of operation and maintenance to ensure personnel safety and health and the protection of property. Portions of this information may be repeated in certain chapters of this publication for emphasis.

WARNING AND CAUTION STATEMENTS

WARNING AND CAUTION statements have been strategically placed in the text to emphasize certain steps or procedures for the protection of personnel (WARNING) or equipment (CAUTION). A WARNING or CAUTION once provided should apply each time the related step is repeated, regardless of the number of times the WARNING or CAUTION is repeated throughout the text. Prior to starting any task, the WARNINGS or CAUTIONS included in the text for that task should be reviewed and understood.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must at all times observe safety regulations. Do not replace components or make adjustments inside the equipment with the voltage supply turned on. Under certain conditions, dangerous potentials may exist when the power control is in the off position, due to charges retained by capacitors. To avoid injuries, always remove power from, discharge, and ground a circuit before touching it. Adhere to all lock out/tag out requirements.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person capable of rendering aid and resuscitation is present.

RESUSCITATION

Personnel working with or near dangerous voltage shall be trained in modern methods of resuscitation.

COMPRESSED AIR

Use of compressed air for cleaning can create an environment of propelled foreign particles. Air pressure shall be reduced to less than 30 psi and used with effective chip guarding and personnel protective equipment.

1.2 Definitions of Warnings, Cautions, and Notes

WARNING

An operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in injury to or death of personnel.

CAUTION

An operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in damage to or destruction of equipment, or loss of mission effectiveness.

NOTE

An essential operating or maintenance procedure, condition, or statement which must be highlighted.

1.3 List Of Hazards

The operation of this amplifier may involve some of the following hazards; any of them could result in serious harm to personnel if proper safety precautions are not taken.

WARNING

HIGH VOLTAGE

Lethal Voltages up to 15,000 Volts are present in this amplifier when it is operating. USE EXTREME CAUTION when inside the unit. Do not insert objects through air intake screen on rear of drawer. When testing, always ground the drawer chassis.

WARNING

RF RADIATION

Exposure to RF radiation may cause serious bodily injury possibly resulting in blindness and death. Cardiac pacemakers may be affected. Always terminate both the RF input and RF output, even during tests, which involve no RF drive, to avoid the RF hazard should the TWTA oscillate.

WARNING

BERYLLIUM OXIDE

The dust or fumes from Beryllium Oxide (BeO) ceramics used in microwave tubes are highly toxic and can cause serious injury or death.

WARNING***IMPLOSION HAZARD***

Ceramic windows from microwave tubes can shatter on impact or crack in use resulting in injury from Beryllium Oxide dust or fumes.

WARNING***X-RAY RADIATION***

High voltage tubes can produce dangerous, possibly fatal X-Rays.

WARNING***HOT SURFACES***

Surface temperature of tubes and other air-cooled parts can reach several hundred degrees centigrade.

CAUTION***RF OVERDRIVE***

Drive levels as low as -17 dBm may damage the unit for the Model MT4000 depending upon the settings of the system attenuator. Please apply RF with caution. Always terminate RF input and output ports properly when AC power is supplied to the TWTA.

2.0 INTRODUCTION

This document contains information to help the system integrator to install the MCL MT4000 TWTA. Be sure to completely read this installation guide. This document assumes a familiarity and working experience with high power microwave RF amplifiers. Once the MT4000 has been installed, please read TN4000-3 - *Operation of MT4000 TWTA*, for initial turn on instructions.

3.0 HPA INSTALLATION INSTRUCTIONS

The MT4000 system is shipped in a fully assembled condition. Several steps in the installation guide will require heavy lifting and more than one person will be required. The installation personnel should have a working knowledge of electronic and SatCom equipment.

CAUTION

It is recommended that a professional HVAC engineer consult on the design of the air intake and exhaust ducts.

3.1 Unpacking the TWTA

Prior to unpacking, inspect the exterior of the packing containers for damage received during shipment. If damage is present, contact the carrier that delivered the system and submit a damage report. Failure to do this could complicate, or invalidate a claim. Carefully unpack and remove all items from their shipping containers and inspect the items further for signs of damage.

CAUTION

Be careful not to damage components with pry bars when opening shipping crates. Do not use pry bars to extract components from crates.

Save all packing materials until inspections are complete. Verify that all items listed on the packing slip have been received. Be sure to find the documentation package, which is packaged with the HPA.

3.2 Repacking the TWTA

Use original packing containers if possible. Place the unit in a clean, open work area. Cover any open RF waveguide flanges with a plastic cap designed for this purpose (adhesive tape is not recommended as it quickly deteriorates, leaving a residue on the flanges). Wrap the unit in heavy paper or plastic. Use a suitable shipping container. Surround the unit in shock absorbing material to provide a firm cushion and prevent movement inside the container. Do not allow any packing materials to enter any drawers, enclosures or waveguide. Seal the container and mark exterior “FRAGILE Electronic Equipment.” Further packaging information is available from MCL (request MCL packaging specification 34A2249).

3.3 Returning Damaged Equipment

If the system must be returned, call the factory for an RMA number (Returned Materials Authorization). See TN4000-6 - *Technical Note, Troubleshooting & Customer Service Guide*, for more information.

3.4 Typically Required Tools

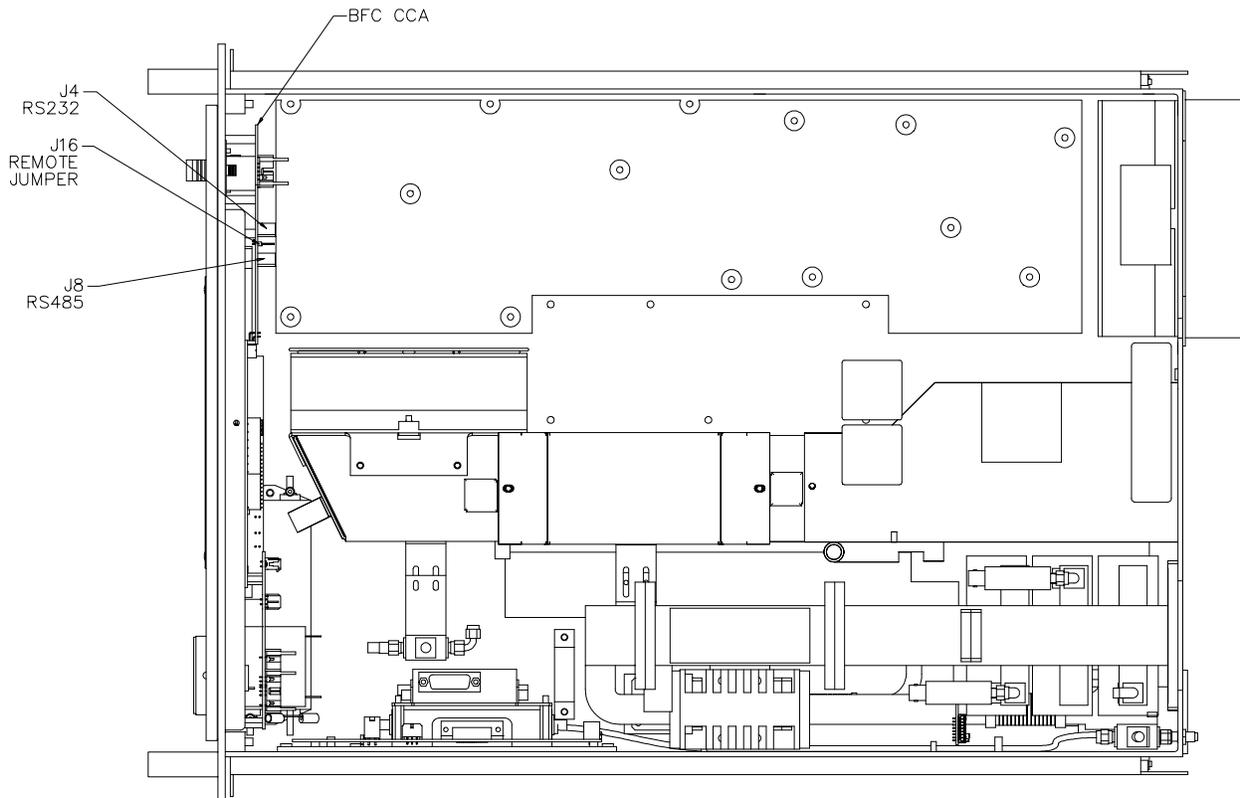
Allen wrench, 5/32 (C-Band only)
Allen wrench, 7/64 (Ku-Band including DBS)
Screwdriver, #2 Phillips
Screwdriver, Standard 1/8
5/16” torque sensing open-end wrench is recommended
5/16” blade screwdriver standard
Socket wrench set
5/16” wrench
3/8” wrench (C-Band only)

3.5 Configurations Under the HPA Top Cover

There are two hardware configurations under the HPA cover. First the Remote Panel terminating resistor jumper is located on J16 (pins 1 & 2) of the BFC. Refer to the optional Remote Panel installation technical note to determine if you need to install the jumper (it is normally not installed). Second, through the purchase order process the Computer interface hardware configuration of the MT4000 was set to either RS232 or RS485. At this time verify that the MT4000 was ordered according to the system integrators requirements. If it was not you would have to remove the HPA cover and move the cable (W25) between J8 & J4 of the front panel logic (BFC CCA).

CAUTION

Make sure the top cover of the MT4000 is attached; the cover is part of the cooling circuit.



3.6 Installation to Reduce Radiated Emissions

In order to meet the radiated emissions requirements of CE type applications (ETSI EN 300 673:2000) the system integrator is required to provide double-shielded DC cabling to the HPA. The Switchover (J7) and User (J6) interfaces require the use of a good quality double shielded (100% foil shield plus 85% or greater braided shield) cable. An example part number is a Black Box Corporation #EMN25C-0015-MF (25 pin, male-female, 15 ft long). It is also recommended that the same type cable is used on the Remote (J4) & Computer (J5) interfaces. Be sure to install the HPA chassis ground braid as detailed below.

3.7 Installation of TWTA Drawer into the Cabinet

The following steps should be taken to insure that the MT4000 is properly installed. Refer to 43D1418 – *MT4000 Interface Drawing* that is included with TN4000 –7 *Customer Schematics & Assemblies*.

CAUTION

Be sure that the MT4000 drawer is firmly supported during installation.

1. Position the MT4000 in close proximity to final installation rack (MCL supplied or other). This will eliminate any unnecessary moving of the system.
2. Install slides in rack at a location with the dimensions and required interfaces shown on 43D1418.
3. Install the MT4000 into the rack.
4. Make all RF input and output connections.

CAUTION

Be certain that all RF connections are secure and that there is a load, or an antenna, connected to the RF output waveguide. Failure to secure these connections will pose a hazard to operating personnel and could result in malfunction of the equipment.

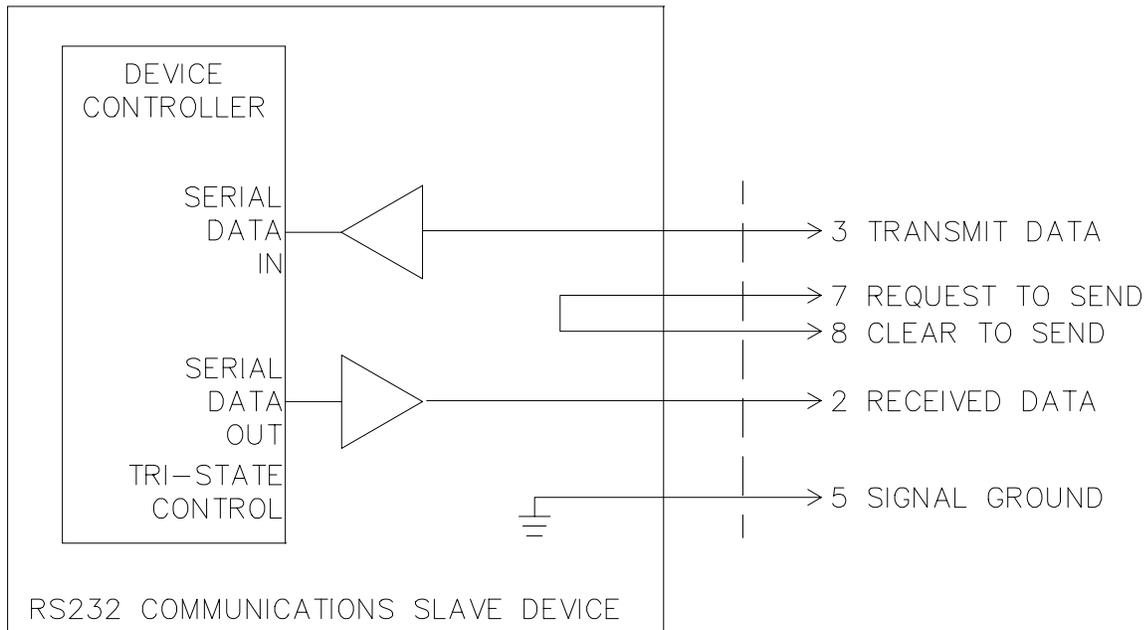
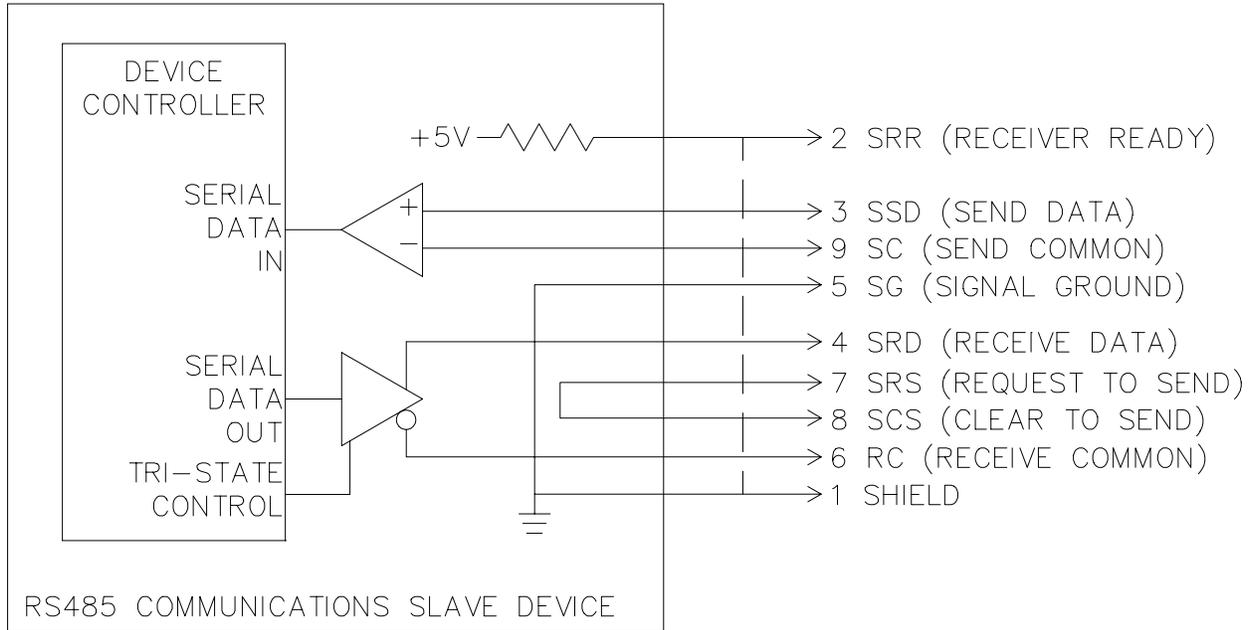
5. Install the remaining interconnects as required by the system integrator using the following paragraphs as a guide.

WARNING

Do not install the AC input until the last step of the installation process.

3.8 Computer & Remote Cable Connection

Connect the Computer interface cable according to the system integrator requirements for RS232 or RS485. The Remote interface is always a RS485 interface. If a Remote Panel was ordered see its technical note for installation instructions.



3.9 Connection to the “User” Interface

The User Interface (J6) has been supplied to provide the user a way to connect the MT4000 to other equipment. This interface is a 15 position “D” connector located on the back of the MT4000. The signals available at this interface are listed below:

CONTACT NUMBER	SIGNAL NAME		FUNCTION
1	Interlock Fault Input		Normally Closed Contact (15mA or less), Open During a Fault.
9	Fault Return		
2	Waveguide Press. Fault Input		Normally Closed Contact (15mA or less), Open During a Fault.
10	Fault Return		
3, 4, 11	Spare		
5	RF Off Input		Normally Closed Contact (15mA or less), Open During a RF Off.
12	RF Off Return		
13	N.O.	Summary Fault Output	Isolated Form C Contact Set, De-Energized is a Fault.
6	Com.		
14	N.C.		
7	N.O.	Summary Alarm Output	Isolated Form C Contact Set, De-Energized is an Alarm.
15	Com.		
8	N.C.		
Relay Outputs are rated for the following: Max. Switching Current 0.3 A DC, AC Max. Switching Voltage 100 V DC, 120 V AC Max. Switching Power 30 W, 37 VA			

3.10 Connection to the “Switchover” Interface

The Switchover Interface (J7) has been supplied to provide the user a way to connect the MT4000 to a Model D13188 switchover (or some other user supplied switchover). This interface is a 25 position “D” connector located on the back of the MT4000. The signals available are listed in the table below.

CONTACT NUMBER	SIGNAL NAME		FUNCTION
2	This HPA to the Antenna Input		Active High (+15V), Latched During Antenna.
3	This HPA to the Dummy Load Input		Active High (+15V), Latched During Load.
1	RF Off Input		Normally Closed Contact (15mA or less), Open During a RF Off.
14	Return		
6	Exciter Alarm Input		Active High (+15V), Latched During Alarm.
19, 20 – 24	Spare		N/A
15 & 16	+15V DC Output		For Model D13188 Switchover Only.
17 & 18	15V Return		
4	This HPA to the Antenna Output		Active Low (15V return), Pulsed for 200 ms.
5	This HPA to the Dummy Load Output		Active Low (15V return), Pulsed for 200 ms.
7	N.O.	Switchover Fault Output	Isolated Form C Contact Set, De-Energized is a Fault.
8	Com.		
9	N.C.		
10	Second HPA Switchover Fault Input		Active High (+15V), Latched During Fault.
13	RF Low Switching Input		Normally Open Contact (15mA or less), Closed During a RF Off.
25	Return		
11	Auto Switching Loop Input		Active High (+15V), Latched During Auto.
12	Auto Switching Loop Output		Active Low (15V return), Latched During Auto.
Relay Outputs are rated for the following:			
Max. Switching Current		0.3 A DC, AC	
Max. Switching Voltage		100 V DC, 120 V AC	
Max. Switching Power		30 W, 37 VA	

3.11 Cooling Duct Installation

See 43D1418 for interface locations.

CAUTION

Make sure the top cover of the MT4000 is attached; the cover is part of the cooling circuit.

3.11.1 Intake Air Temperature

The air supplied to the unit must be maintained between -10°C and 50°C. The maximum must be derated at 1.9°C per 1,000 ft of altitude (i.e. maximum temperature @ 3,000 ft is 44.3°C). Operation outside these limits will permanently damage the TWT. Check with local weather service to see if heating or cooling of intake air will be required at any time.

3.11.2 Ducting Back Pressure

The ductwork must be designed such that the added restriction of airflow from both the intake and exhaust ducts does not exceed 0.5 in (12.7 mm) H₂O backpressure at 190 cfm (323 m³/hr) airflow.

3.11.3 Intake Humidity and Temperature Differential

In areas of high humidity, a danger of condensation buildup exists when unconditioned air from outside the shelter is delivered to the MT4000 while the MT4000 is “cold.” The MT4000 should not be operated when a temperature difference of greater than 10°F (5.5°C) exists between the input cooling air and the MT4000 ambient temperatures. Under these conditions, a condensation check should be made before attempting a cold-start operation on the MT4000.

3.11.4 Air Filtration

The MT4000 has no air filters. It is the responsibility of the system integrator to provide filtering for each amplifier. Air filter arrestance shall be 70% or greater when tested per ASHRAE 52.2.

NOTE

A filter with a minimum efficiency reporting value of 3 (MERV 3 filter) is recommended.

3.11.5 Air Flow Warning

Two alarms have been designed into the MT4000 to indicate that there may be a clogged air filter or some other obstruction in the cooling path. These alarms are “Tube Temperature” and “Power Supply Temperature” alarms. See the initial turn on section of TN4000-3 - *Technical Note, Operation of MT4000 TWTA*.

3.11.6 Use of Shelter Air

Shelter air may be used to cool the HPA, however, care must be taken to prevent re-circulation of exhausted air back into the HPA, or exhausted air from another piece of equipment into the HPA. Also the shelter cooling system must be rated to take the heat load of the HPA exhaust. Each HPA can dissipate up to 2000 Watts into the air.

3.12 Chassis Ground Connection

A stud on the back panel has been supplied to connect system to a good permanent earth ground. This stud supplies Safety ground to the whole TWTA internal system. A ½' thick braided ground strap is recommended between the MT4000's #10-32 ground stud and earth ground. The ground strap must be kept as short as possible to prevent high frequency noise problems. This ground braid is required to meet various safety requirements.

WARNING

This ground braid is required to meet various safety requirements.

3.13 Installation of Primary Power

Connect the IEC-320 power cord supplied with the MT4000 to a prime power source of the proper voltage and frequency. The AC input connector (J1) is located on the MT4000 back panel, refer to 43D1418. The MT4000 source circuit breaker is recommended to be an equivalent to a Carlingswitch #AB2-B0-21-630. In cases of multiple amplifier installations, each amplifier shall be provided with a separate breaker.

NOTE

Prime power requirements are:

- | | | |
|--------|-------------------------------|-----------------------------------|
| 3.13.1 | Input Voltage Amplitude Range | 180-264 VAC, Single Phase, 2 wire |
| 3.13.2 | Input Frequency Range | 47 - 63 Hz |

3.13.3 Input Voltage In-Rush Current Limit

The integrated sum of all transients of in-rush current within any interval of time equivalent to three (3) consecutive one-half alternating current (AC) cycles shall not exceed 28A.

3.13.4 Input Power Factor (Minimum) 0.95

3.13.5 Input Power (Nominal) 2450 VA

3.14 Clean-Up

Make certain that all connectors are attached and tight. Remove all tools, packing materials and reference materials. Go to the initial turn on section of TN4000-3 - *Technical Note, Operation of MT4000 TWTA*.

4.0 DIAGNOSTIC INTERFACE INSTALLATION REQUIREMENTS

Find the CD that is packaged with the documentation for your HPA. This CD contains the 45A0158 Diagnostic Test program. To install this program follow the directions on the cover of the CD box. Refer to of TN4000-3 - *Technical Note, Operation of MT4000 TWTA*, for operating procedures. The system requirements for the 45A0158 Diagnostic Test program are as follows:

- Microsoft® Windows® XP, 2000, NT, 98, or 95
- 32 MB RAM
- 5 MB hard disk space
- Pentium or higher processor



TN4000-3

Technical Note

Operation of MT4000 TWTA

October 24, 2003

Mark Schmeichel
Engineering

10/24/03
Date

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Appendix D - 46A0203	SA Bus Command Set

1.0 SAFETY SUMMARY

1.1 Definitions of Warnings, Cautions, and Notes

WARNING AND CAUTION statements have been strategically placed in the text to emphasize certain steps or procedures for the protection of personnel (WARNING) or equipment (CAUTION). A WARNING or CAUTION once provided would apply each time the related step is repeated, regardless of the number of times the WARNING or CAUTION is repeated throughout the text. Prior to starting any task, THE WARNINGS or CAUTIONS included in the text for that task should be reviewed and understood.

WARNING

An operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in injury to or death of personnel.

CAUTION

An operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in damage to or destruction of equipment, or loss of mission effectiveness.

NOTE

An essential operating or maintenance procedure, condition, or statement which must be highlighted.

1.2 General Safety Precautions

The following are general safety precautions and instructions that personnel must understand and apply during many phases of operation and maintenance to ensure personnel safety and health and the protection of property. Portions of this information may be repeated in certain chapters of this publication for emphasis.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must at all times observe safety regulations. Do not replace components or make adjustments inside the equipment with the voltage supply turned on. Under certain conditions, dangerous potentials may exist when the power control is in the off position, due to charges retained by capacitors. To avoid injuries, always remove power from, discharge, and ground a circuit before touching it. Adhere to all lock out/tag out requirements.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person capable of rendering aid and resuscitation is present.

RESUSCITATION

Personnel working with or near dangerous voltage shall be trained in modern methods of resuscitation.

COMPRESSED AIR

Use of compressed air for cleaning can create an environment of propelled foreign particles. Air pressure shall be reduced to less than 30 psi and used with effective chip guarding and personnel protective equipment.

1.3 List Of Hazards

The operation of this amplifier may involve some of the following hazards; any of them could result in serious harm to personnel if proper safety precautions are not taken.

WARNING

HIGH VOLTAGE

Lethal Voltages up to 15,000 Volts are present in this amplifier when it is operating. USE EXTREME CAUTION when inside the unit. Do not insert objects through air intake screen on rear of drawer. When testing, always ground the drawer chassis.

WARNING

RF RADIATION

Exposure to RF radiation may cause serious bodily injury possibly resulting in blindness and death. Cardiac pacemakers may be affected. Always terminate both the RF input and RF output, even during tests, which involve no RF drive, to avoid the RF hazard should the TWTA oscillate.

WARNING

BERYLLIUM OXIDE

The dust or fumes from Beryllium Oxide (BeO) ceramics used in microwave tubes are highly toxic and can cause serious injury or death.

WARNING***IMPLOSION HAZARD***

Ceramic windows from microwave tubes can shatter on impact or crack in use resulting in injury from Beryllium Oxide dust or fumes.

WARNING***X-RAY RADIATION***

High voltage tubes can produce dangerous, possibly fatal X-Rays.

WARNING***HOT SURFACES***

Surface temperature of tubes and other air cooled ports can reach several hundred degrees centigrade.

CAUTION***RF OVERDRIVE***

The unit may be damaged by drive levels as low as -17 dBm for the M/N MT4000 depending upon the settings of the system attenuator. Please apply RF with caution. Always terminate RF input and output ports properly when AC power is supplied to the TWTA.

2.0 SCOPE

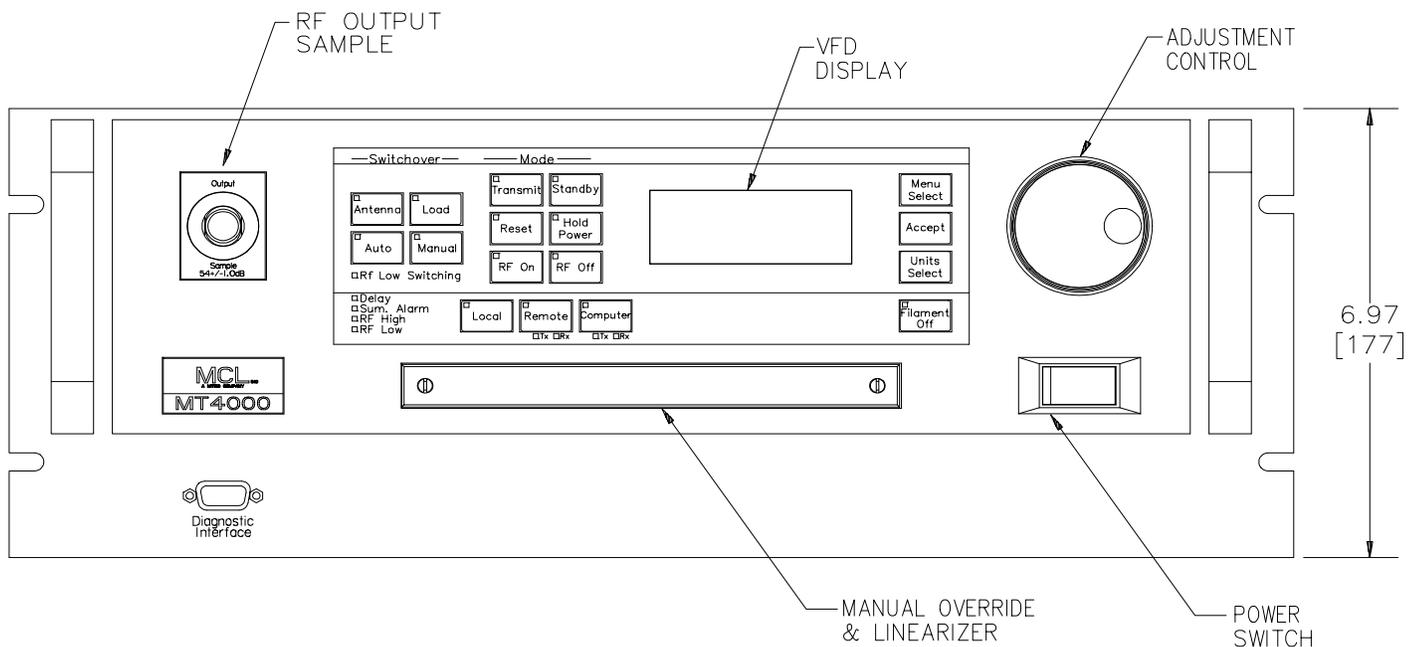
This document and its appendices will describe the controls, operator interfaces, and operating procedures for a MT4000 TWTA. This manual assumes a familiarity and working experience with high power microwave RF amplifiers.

The MCL MT4000 is designed for long and reliable life under a variety of environmental conditions. All components utilized in this system are conservatively rated and selected for high reliability and maximum use of existing designs. Mechanical and electrical safeguards are utilized throughout the system to insure safety of operating personnel.

3.0 CONTROLS & INDICATORS

Complete operational control and status is available at the local control display panel, remote panel, or computer interface. However, due to safety concerns certain controls will only be available on the Local panel.

The user at the TWTA front panel will be provided system status and diagnostics through a four line vacuum fluorescent display (VFD), membrane panel CCA LED's, membrane panel CCA buttons, and a digital encoder used to adjust the amplifier parameters.



3.1 Discrete Controls & Indicators

The indicators & controls described in this section are provided on the HPA front panel. Further description of these functions follows in later sections of this document.

3.1.1 Filament Off Button/LED

When this button is activated, from any state except Transmit, the Filament Power Supply will be turned off. When illuminated this Yellow LED will indicate that the HPA is in the Filament Off state.

3.1.2 Delay LED

Yellow LED which when illuminated will indicate the HPA is going through a filament warm up cycle and is not yet in Standby.

3.1.3 Standby Button/LED

There are two functions for this button. First, if pressed while the HPA is in the Filament Off state filament delay will be initiated, the Yellow LED in the button will be flashing. Second, if pressed while the HPA is in the Transmit state the HPA will switch to the Standby state, the Yellow LED in the button will be continuously illuminated.

3.1.4 Transmit Button/LED

While no faults are present, if this button is activated the HPA will cycle into the HV on state. When the Green LED inside the button is continuously illuminated, the HPA is in transmit. If flashing, transmit has been selected, but the amplifier is still in filament delay, and upon completion of filament delay the HPA will go into Transmit.

3.1.5 Summary Alarm LED

Yellow LED when illuminated the HPA has an alarm state that can lead to a fault condition if it is not corrected.

3.1.6 Reset Button & Summary Fault LED

When this button is activated the a fault reset will be initiated. When the Red LED inside the button is illuminated, the HPA has a fault and the high voltage is turned off.

3.1.7 RF On Button/LED

When this button is activated the SSA RF switch will be put into the ON state if no other interface is causing a RF Off state. When the Green LED inside the button is illuminated, the SSA RF switch is enabled.

3.1.8 RF Off Button/LED

When this button is activated the HPA will disable the SSA RF switch. When the Yellow LED inside the button is illuminated, the SSA RF switch is disabled.

3.1.9 Computer Rx LED

The Yellow LED will illuminate with data received from the computer port.

3.1.10 Computer Tx LED

The Green LED will illuminate with data transmitted to the computer port.

3.1.11 Remote Rx LED

The Yellow LED will illuminate with data received from the remote port.

3.1.12 Remote Tx LED

The Green LED will illuminate with data transmitted to the remote port.

3.1.13 RF High LED

The Yellow LED will illuminate when the detected forward power exceeds the user specified level.

3.1.14 RF Low LED

The Yellow LED will illuminate when the detected forward power is lower than the user specified level.

3.1.15 Local Button/LED

When this button is activated the HPA will allow the operator at the front panel to control the HPA operating configuration. When the Green LED inside the button is illuminated, the amplifier is controlled from the HPA front panel.

3.1.16 Computer Button/LED

When this button is activated the HPA will allow the device on the computer interface to control the HPA operating configuration. When the Yellow LED inside the button is illuminated, the amplifier is controlled via the computer serial port.

3.1.17 Remote Button/LED

When this button is activated the HPA will allow the device (remote panel) on the remote interface to control the HPA operating configuration. When the Yellow LED inside the button is illuminated, the amplifier is controlled via the remote serial port.

3.1.18 Auto Button/LED

When this button is activated both HPAs in the 1:1 switchover will be put into the auto switching mode. When the Green LED inside the button is illuminated the amplifier is in Automatic Switching mode.

3.1.19 Manual Button/LED

When this button is activated both HPAs in the 1:1 switchover will be put into the manual-switching mode. When the Yellow LED inside the button is illuminated the amplifier is in manual switching mode.

3.1.20 Antenna Button/LED

When this button is activated, though the 1:1 switchover this HPA will be put into the antenna port of the RF switch. When the Green LED inside the button is illuminated the amplifier is switched to the antenna port of the RF switch.

3.1.21 Load Button/LED

When this button is activated, though the 1:1 switchover this HPA will be put into the dummy load port of the RF switch. When the Yellow LED inside the button is illuminated the amplifier is switched to the dummy load port of the RF switch.

3.1.22 RF Low Switching LED

The Green LED will illuminate when RF Low alarm switching for the Auto Switching mode has been enabled through the Switchover interface.

3.1.23 Hold Power Button/LED

When this button is activated the HPA RF output power will be automatically regulated by the Auto Power function. When the Green LED inside the button is illuminated this indicates the RF output power is being automatically regulated by the Auto Power function.

3.1.24 Units Select Button

When this button is activated it will cause the HPA to toggle the displayed units of three parameters on the HPA front panel between Watts, dBm, or dBW. The three parameters are RF Forward Power, RF Reflected Power, and Tube Drive Power. The units for no other parameter will be affected including the trip levels for these parameters.

3.1.25 Accept Button

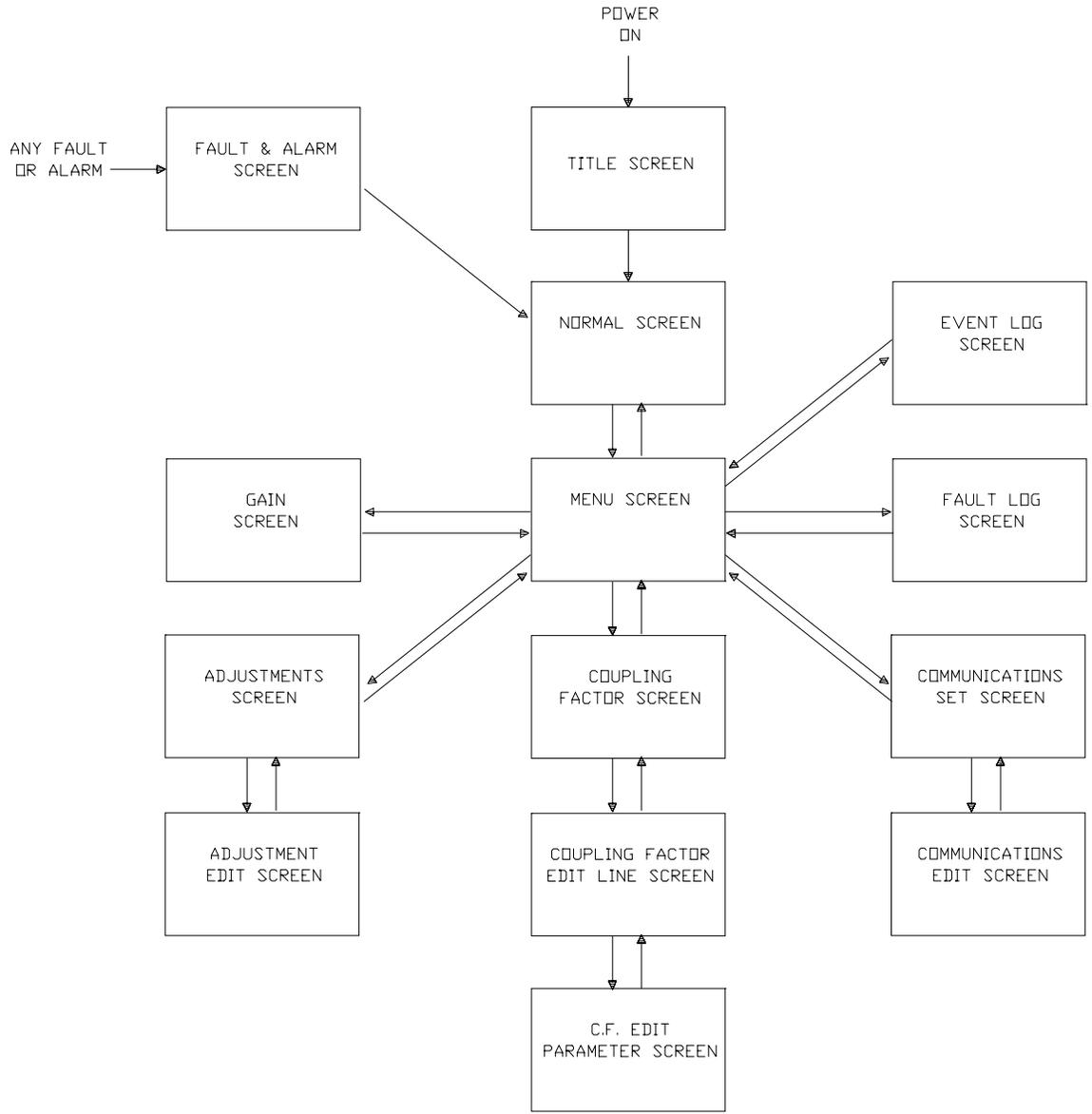
This button will be used to select adjustable parameter on any screen.

3.1.26 Menu Select Button

This button is used to move between different menus on the display.

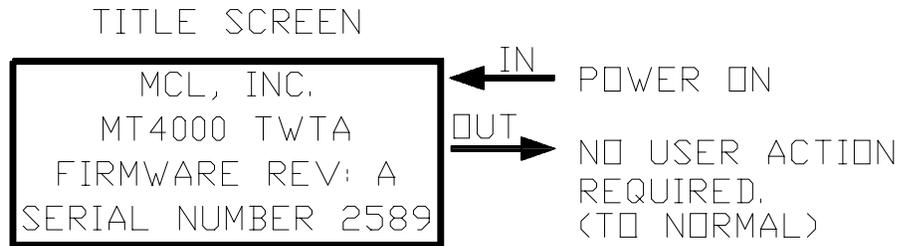
3.2 Front Panel Display & Screen Content

This figure shows an overview of the TWTA screens and the flow between these screens. The following paragraphs describe each screen and how the operator will move between them.



3.2.1 Title Screen

The *title screen* will be displayed when the TWTA first powers on and will remain on while startup testing and a lamp test is performed. This will not exceed 5 seconds.

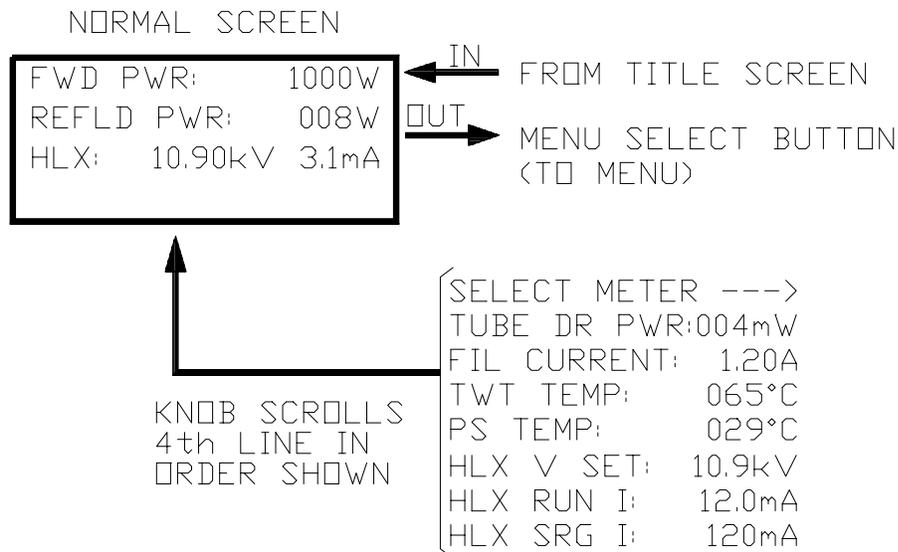


3.2.2 Encoder-Adjustment Knob

The adjustment knob along with the Accept & Menu Select buttons will be used to move from screen to screen, to move from parameter to parameter on a screen, and to adjust parameters that are displayed on these screens.

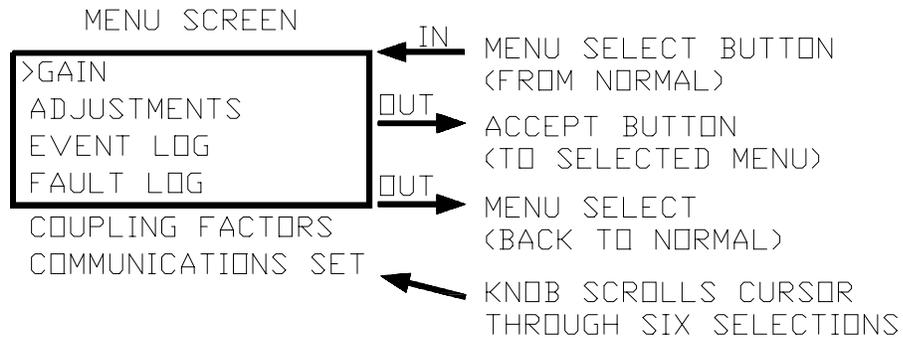
3.2.3 Normal Operating Screen

The *normal operating screen* is activated automatically after the *title screen* disappears and there are no faults or alarms present. During filament delay, the first line of the *normal operating screen* will display the remaining filament delay time. After filament delay time ends, the RF forward power value will be displayed on the first line of the display. However, if filament delay has ended and the RF On/Off state is OFF, RF OFF will be displayed on the first line. The second line will display reflected power in the same units as forward power. If Transmit Selected is active, the second line will display XMT SELECTED. The third line will always display helix current and voltage. The fourth line is used to view numeric (meter) values. To change the parameter displayed on the fourth line rotate the knob CW or CCW. CW will rotate through the list shown in the figure from top to bottom and CCW will be bottom to top. By pressing the Menu Select button from this screen the menu screen (see the next paragraph) will be displayed.



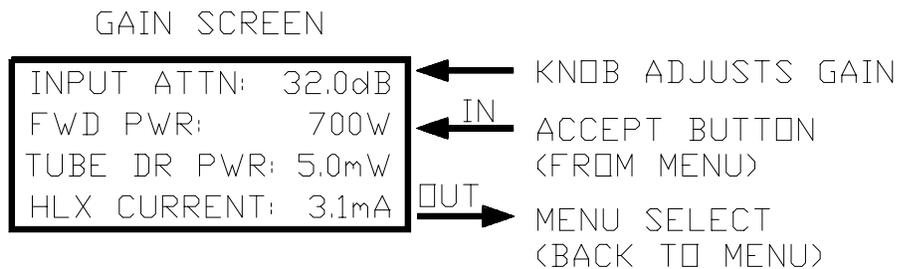
3.2.4 Main Menu Screen

This screen is accessed from the *normal screen*. When the *menu screen* shown below is displayed the operator can select from the functions listed on this menu. Though there are six menu selections, the screen can only display four at a time. By rotating the knob CW these selections will scroll up one at a time, and CCW down one at a time. Once the cursor is pointing at the desired selection the operator will press the Accept button, which will cause the selected screen to be displayed. If the operator were to press the menu select button from this screen the *normal screen* would be displayed again.



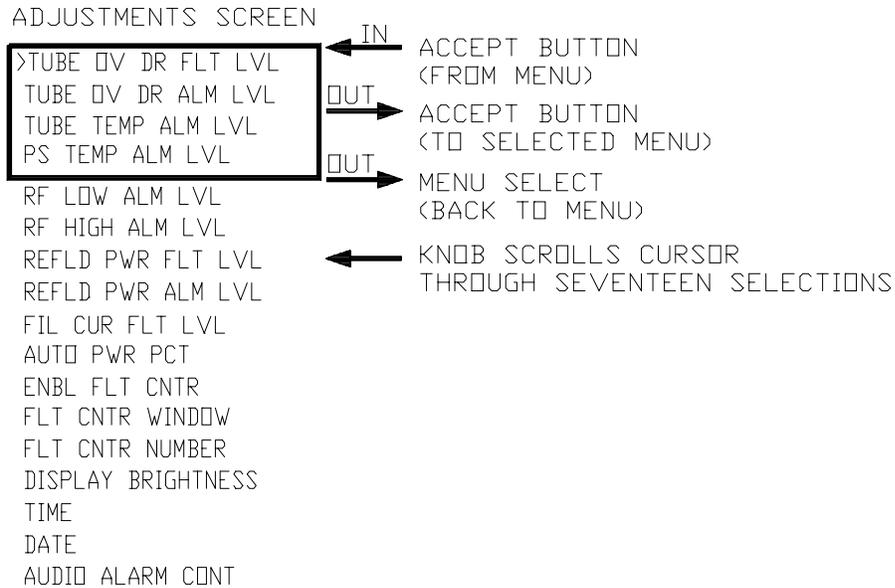
3.2.5 Gain Adjust Screen

This screen is accessed from the *menu screen*. When the screen shown below is displayed the operator can use the adjustment knob to change the HPAs input attenuator setting. If the operator were to press the menu select button from this screen the *menu screen* would be displayed again. Since the attenuator is in the input side of the HPA there is not a direct correlation between input attenuation and output power in dBm or dBW. The difference is due to the gain compression of the HPA.



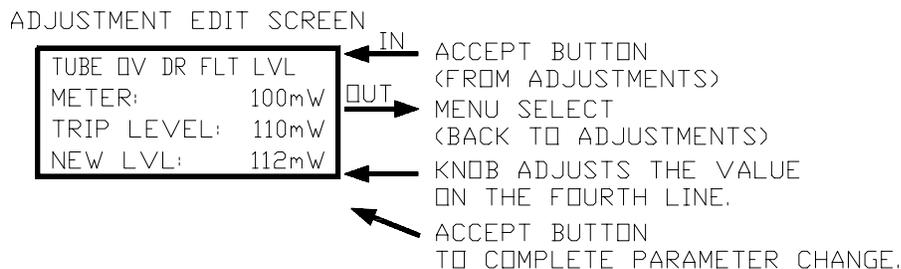
3.2.6 Adjustment Menu Screen

This screen is accessed from the *menu screen*. When the screen shown below is displayed the operator can select which parameter to modify from those listed on this menu. Notice there are seventeen menu selections, but the screen can only display four at a time. By rotating the knob CW these selections will scroll up one at a time, and CCW down one at a time. Once the cursor is pointing at the desired selection the operator will press the Accept button. This will cause the selected screen to be displayed. If the operator were to press the menu select button from this screen the *menu screen* would be displayed again.



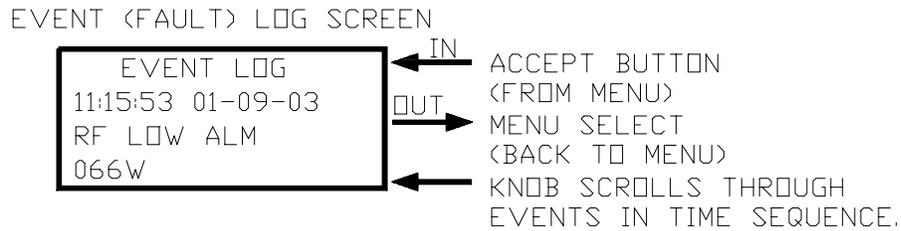
3.2.7 Adjustment Edit Screen

These screens are accessed from the *adjustment menu screen*. The screen shown below is a typical EDIT screen for an adjustable parameter. While one of these screens is displayed the operator can use the adjustment knob to change the parameter shown on the fourth line. The adjusted value will take effect once the accept button is pressed. The third line is the value of the parameter before it is adjusted. The second line is the meter associated with the parameter being adjusted. The first line is the name of the parameter being adjusted. If the operator were to press the menu select button from this screen the *adjustment menu screen* would be displayed again.



3.2.8 Event Log Screen

This screen is accessed from the *menu screen*. When the screen shown below is displayed the most recent event in the log will be presented.



The event log is stored in Non-Volatile memory on the HPA and will contain operational state changes, alarms, and faults, which have occurred in the HPA. The event log will contain the event name with a date and time stamp for when the event occurred. Events that can be stored in the log are listed in the following table. If one of the user adjustable trip levels are exceeded causing an event entry, the level that was exceeded will also be stored in the log and presented on the fourth line of the display.

The time resolution of the log will be to the nearest second (± 1 second). The event log is able to store 200 events. If the log size exceeds the available memory size the oldest events will scroll out of the log. The log is purged only through a diagnostic interface command. The event log can be downloaded through the diagnostic interface.

The operator can use the adjustment knob to scroll through the events in time sequence one at a time. By rotating the knob CW these selections will scroll backwards in time, and CCW forward in time. If the operator were to press the menu select button from this screen the *menu screen*.

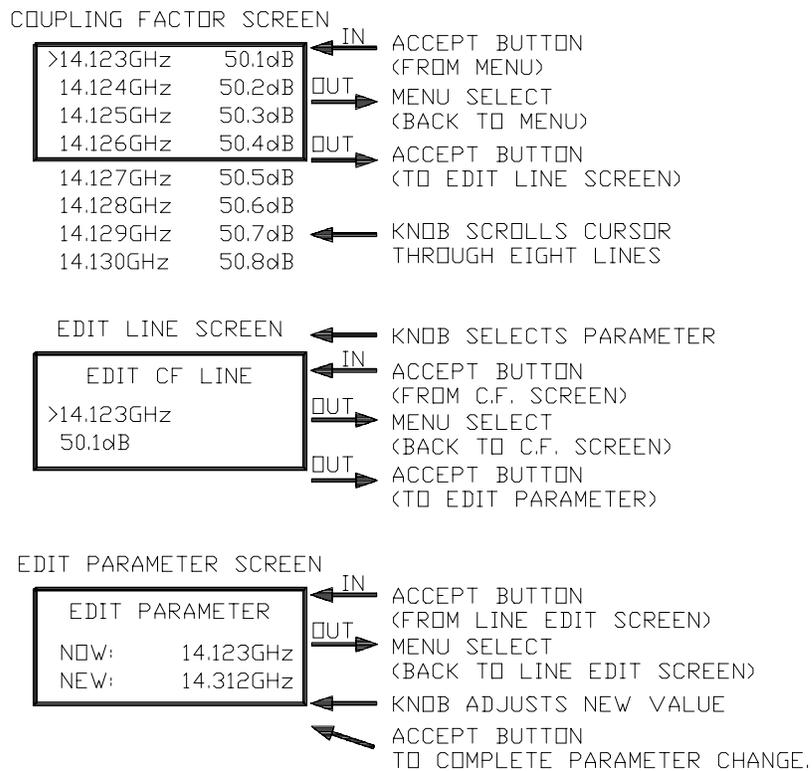
FAULTS			
Tube Temp Switch Helix Surge Filament Under Current Helix Run	Chassis Interlock User Interlock Tube Temp Analog W.G. Pressure	RF Reflected W.G. Arc HV Primary Current Arc Test Failed	Tube Overdrive HV Over Volt P.S. Temperature HV Under Volt
ALARMS (EACH ALARM HAS AN ON & OFF EVENT)			
RF Low RF High RF Interface Comm +5V Power Supply Attenuator Uncalibrated	AC Low Line Tube Overdrive Switchover & User Comm +15V Power Supply RF Forward Uncalibrated	RF Reflected Tube Temp Analog PS Interface Comm -15V Power Supply RF Reflected Uncalibrated	Exciter P.S. Temperature Blower Failed RF Switch Failed Tube Drive Uncalibrated
OPERATING STATES			
End of Log Local Override Off Local Override On Reset	Standby Transmit Transmit Selected Filament Delay On Power Off Filament Off	Local RF Off Remote RF Off Computer RF Off User RF Off Power On Local	Local RF On Remote RF On Computer RF On User RF On Remote Computer
SWITCHOVER OPERATING STATES			
Auto Second HPA SWOV Fault	Manual	This HPA to Ant SWOV RF Off	This HPA to D.L. SWOV RF On

3.2.9 Fault Log Screen

The *fault log screen* will look identical to the *event log screen* and will operate in the same manner except that all alarms, operating states, and switchover operating states will be filtered from the display. This screen will only present those events, which cause a Summary Fault and Fault Reset.

3.2.10 Coupling Factor Screen

On this screen the operator can edit or view the frequency and coupling factor for up to eight frequencies for the TWTA output sample port. These coupling factors are a convenience for the operator and are not used in any calculations within the TWTA logic. This screen is accessed from the *menu screen*. When the screen shown at the top of the figure below is displayed the operator can select which line to modify from those listed on this menu. Though there are eight menu lines to select, the screen can only display four at a time. By rotating the knob CW these selections will scroll up one at a time, and CCW down one at a time. Once the cursor is pointing at the desired selection the operator will press the Accept button. This will cause the edit screen for the selected line to be displayed (see the next paragraph). If the operator were to press the menu select button from this screen the *menu screen* would be displayed again.



3.2.11 Coupling Factor Edit Line Screen

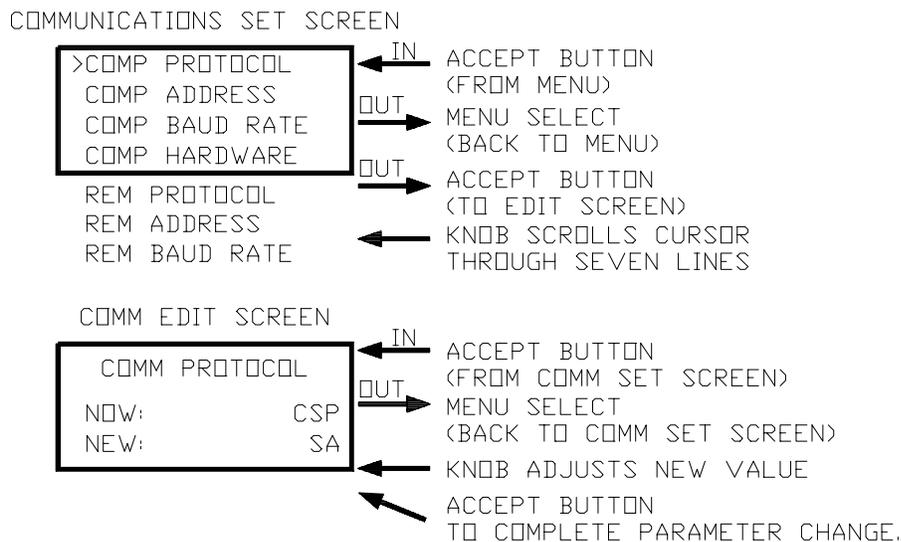
This screen is accessed from the *coupling factor screen*. When the screen shown in the middle of the figure above is displayed the operator can select the frequency or the coupling factor to edit. By rotating the knob the cursor will alternate between the two parameters. Once the cursor is pointing at the desired selection the operator will press the Accept button, this will cause the Edit Parameter screen to be displayed (see the next paragraph). If the operator were to press the menu select button from this screen the *coupling factor screen* would be displayed again.

3.2.12 Coupling Factor Parameter Edit Screen

This screen is accessed from the *coupling factor edit line screen*. The screen shown at bottom of the figure above is a typical EDIT screen for coupling factor parameters. While one of these screens are displayed the operator can use the adjustment knob to change the parameter shown on the fourth line. The adjusted value will take effect once the accept buttons is pressed. The third line is the value of the parameter before it is adjusted. If the operator were to press the menu select button from this screen the *coupling factor edit line screen* would be displayed again. These coupling factor parameters can be adjusted from only the Local panel.

3.2.13 Communications Set Up Screen

This screen will display the configuration for both the remote and computer interfaces. This screen is accessed from the *menu screen*. When the screen shown at the top of the figure below is displayed the operator can select which parameter to modify from those listed on this menu. Notice there are seven menu parameters to select from, but the screen can only display four at a time. By rotating the knob CW these selections will scroll up one at a time, and CCW down one at a time. Once the cursor is pointing at the desired selection the operator will press the Accept button. This will cause the edit screen for the selected parameter to be displayed. If the operator were to press the menu select button from this screen the *menu screen* would be displayed again.



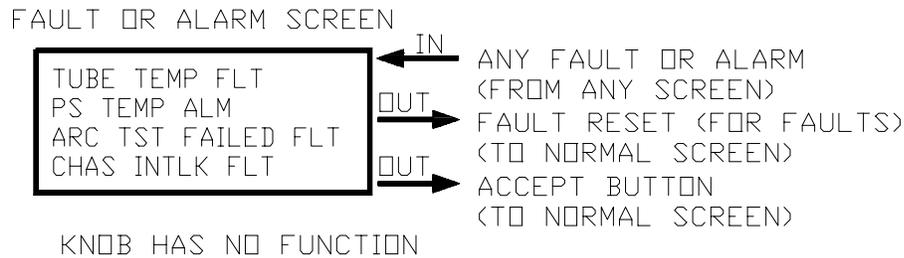
3.2.14 Communications Parameter Edit Screen

This screen is accessed from the *communications set up screen*. The screen shown in the bottom of the figure above is a typical EDIT screen for Remote or Computer interface communications parameters. While one of these screens are displayed the operator can use the adjustment knob to change the parameter shown on the fourth line. The adjusted value will take effect once the accept buttons is pressed. The third line is the value of the parameter before it is adjusted. If the operator were to press the menu select button from this screen the *communications set up screen* would be displayed again.

3.2.15 Fault & Alarm Display

The *fault & alarm display screen* automatically becomes active whenever a fault or alarm occurs or when the TWTA is put into Local Override. This screen will capture the four most recent faults and alarms that occur at the same time.

After a fault reset, if all faults are cleared, the *fault & alarm display* will be cleared and the *normal operating screen* will be displayed. However, if the Accept button were pressed while this screen is presented the *fault & alarm display* will be cleared and the *normal operating screen* will be displayed, but no faults or alarms will be cleared.



4.0 HPA OPERATION

4.1 HPA Control Modes

The MT4000 will be designed to provide continuous status to multiple interfaces all at the same time. However, only one of these interfaces may control (these control modes are mutually exclusive) the operational states of the MT4000 at any one time. These interfaces are the Local panel, Remote Interface (J4), and Computer Interface (J5).

4.1.1 Local Control

While the HPA is in the Local mode the operator at the Local panel will be allowed to control the HPA. While in the Local mode the Remote & Computer serial interfaces cannot change the operating state of the HPA, but they can still get status. From the Local panel the operator can pass control to or take control away from the Computer or Remote panel.

4.1.2 Remote Control

4.1.2.1 Control Priority

While the HPA is in the Remote mode the operator at the Remote panel or device on the remote interface will be allowed to control the HPA. While in the Remote mode the Local panel or Computer Interface cannot change the operating state of the HPA, but they can still get status. From the Remote panel the operator can pass control to or take control away from the Computer interface. For safety reasons, at no time can the Remote interface take control away from the Local panel.

4.1.2.2 Communications Configuration

The Protocol, Communications address, and bps rate for the Remote interface of the HPA can be configured through the local panel (see the *Communications Set-up Screen* paragraph of this document) or the Diagnostic interface (see the *Diagnostic Interface-Settings* paragraph of this document). The default values and adjustment range for each is shown in the table below. Configuration of the Remote interface is independent of the Computer interface. Status LEDs on the HPA front panel are connected to the transmitted and received data lines of this interface to provide communications status.

PARAMETER	DEFAULT	ADJUSTMENT RANGE
REM PROTOCOL	CSP	CSP (46A0204 & 40A1546) or SABUS (46A0203 & 40A1715)
REM ADDRESS (Hexadecimal)	01	01 through 7F (CSP) 31 through 7E (SA7670)
REM BAUD RATE	9600	1200, 2400, 3600, 4800, 9600, 14400, 19200, or 28800

4.1.2.3 Protocol & Command Set

The Protocol specifications and command sets for both CSP & SA bus are attached to this document as appendices.

4.1.3 Computer Control

4.1.3.1 Control Priority

While the HPA is in the Computer mode, the operator at the Computer device will be allowed to control the HPA. While in the Computer mode the Local panel or Remote Interface cannot change the operating state of the HPA, but they can still get status. From the Computer interface the operator can pass control to or take control away from the Remote interface. For safety reasons, at no time can the Computer interface take control away from the Local panel.

4.1.3.2 Communications Configuration

The Protocol, Communications address, and bps rate of the HPA can be configured through the local panel (see the *Communications Set-up Screen* paragraph of this document) or the Diagnostic interface (see the *Diagnostic Interface-Settings* paragraph of this document). The default values and adjustment range for each is shown in the table below. Configuration of the Computer interface is independent of the Remote interface. The hardware interface configuration also requires a cable connection change internal to the HPA (see **TN4000-2** *Technical Note, Installation Guide for MT4000 TWTA*). Status LEDs on the HPA front panel are connected to the transmitted and received data lines of this interface to provide communications status.

PARAMETER	DEFAULT	ADJUSTMENT RANGE
COMP PROTOCOL	CSP	CSP (46A0204 & 40A1546) or SABUS (46A0203 & 40A1715)
COMP ADDRESS (Hexadecimal)	01	01 through 7F (CSP) 31 through 7E (SA7670)
COMP BAUD RATE	9600	1200, 2400, 3600, 4800, 9600, 14400, 19200, or 28800
COMP HARDWARE	RS485	RS485 or RS232

4.1.3.3 Protocol & Command Set

The Protocol specifications and command sets for both CSP & SA bus are attached to this document as appendices.

4.2 HPA Operating Modes

The following paragraphs describe the operating states of the HPA. The reported status for these states is shown in the table below.

STATE	STATUS					
	FIL OFF	DELAY	STBY	XMT SELD	XMT	SUM FAULT
DC POWER ON, NO FILAMENT	ON	OFF	OFF	OFF	OFF	OFF
DC POWER ON, NO FILAMENT, WITH A FAULT	ON	OFF	OFF	OFF	OFF	ON
DURING FILAMENT DELAY, WITHOUT TRANSMIT SELECTED	OFF	ON	OFF	OFF	OFF	OFF
DURING FILAMENT DELAY, WITH TRANSMIT SELECTED	OFF	ON	OFF	ON	OFF	OFF
DURING FILAMENT DELAY, WITH A FAULT	OFF	ON	OFF	OFF	OFF	ON
STANDBY	OFF	OFF	ON	OFF	OFF	OFF
AFTER FILAMENT DELAY, WITH A FAULT	OFF	OFF	OFF	OFF	OFF	ON
TRANSMIT	OFF	OFF	OFF	OFF	ON	OFF
DURING FAULT COUNTER CYCLE, WITH TRANSMIT IMMINENT	OFF	OFF	OFF	ON	OFF	OFF
Notes: 1.Sum Fault state disables Standby, Transmit, or Transmit Selected. 2.Alarms can occur in any of the above states. 3.Standby and Transmit are mutually exclusive. 4.Transmit state disables Filament Off.						

4.2.1 Filament Off

This state occurs after a Filament Off command (Local, Remote, or Computer) has been issued. In this state the TWTA logic will be activated along with any power supplies or cooling required to keep the logic powered on. During this state the HVPS & Filament PS circuits will be shut down. The HPA cannot be in Transmit when this state is initialized.

4.2.2 Filament Delay

This state occurs after a Standby command (Local, Remote, or Computer) has been issued. During this state all TWTA circuitry will be activated except the high voltage power supply. At the end of this delay the TWTA will be in the Standby mode.

4.2.3 Standby

This state occurs after the filament warm-up delay has ended or after a Standby command (Local, Remote, or Computer) has been issued while the TWTA was in Transmit. During this state all TWTA circuitry will be activated except the high voltage power supply. The Transmit & Standby modes are mutually exclusive states.

4.2.4 Transmit

This state occurs after a Transmit command (Local, Remote, or Computer) has been issued when the TWTA was in the Standby mode. During this state all TWTA circuitry will be activated including the high voltage power supply. The Transmit & Standby modes are mutually exclusive states.

4.2.5 Transmit Selected

There are three ways Transmit Selected can be activated. First, when the HPA was in the Transmit mode then the HPA has a power failure, and then the HPA power returns. After the power failure, Transmit selected will be activated during filament delay if no faults are present during delay. Second, while the HPA is in the Delay or Filament Off mode if the operator were to press the Transmit button, Transmit Selected mode would be activated and at the end of filament warm-up delay the HPA will go into Transmit. Third, during a tube fault counter cycle. Transmit selected is a warning to the operator that the TWTA will automatically go into Transmit soon. If the Standby button is pressed the Transmit Selected mode will be canceled. Transmit Selected will be indicated in two ways on the local panel during the proportional delay. First an indication will appear on the front panel vacuum fluorescent display. Second, the Transmit LED located on the Transmit button will flash.

4.3 RF On/Off Control

The RF On & RF Off modes are mutually exclusive. The HPA status indicator will indicate the state of the SSA RF switch.

4.3.1 RF Off State

While the HPA is in the RF Off mode the SSA module RF switch will be in the RF Off state. Any of the following sources may cause an RF Off state and override all other RF On controls. Each source will be latched and must be returned to the RF On state to clear the RF Off state.

- Local panel button
- Remote interface
- Computer interface
- Switchover interface
- User interface
- Tube Overdrive Fault

4.3.2 RF On State

While the HPA is in the RF On mode the SSA module RF switch will be in the RF On state. All of the above control sources must be in the RF On state to allow the HPA to enter RF On. After the HPA goes into RF On the RF Low alarm will be delayed for two seconds.

4.4 Faults & Alarms

There are two types of warning status signals produced by the MT4000. An alarm WILL NOT affect the operating state of the HPA. A fault will shut down the high voltage power supply of the HPA.

4.4.1 Summary Alarm

Alarms WILL NOT affect the operating state of the HPA. All alarms are self clearing and do not require a Fault Reset, except RF Switch Failed alarm which will latch until the Reset button is pressed. All alarms that will be combined to generate the Summary Alarm are listed in the table below. While any alarm condition is present:

- The Summary Alarm LED located on the local panel will illuminate.
- A Summary Alarm will be indicated on the User interface (J6).
- The display will present the name of the alarm on the screen (press Accept button to clear).

ALARMS			
RF Low	AC Low Line	RF Reflected	Exciter
RF High	Tube Overdrive	Tube Temp Analog	P.S. Temperature
RF Interface	Switchover & User	PS Interface Comm	Blower Failed
Comm	Comm		
+5V Power Supply	+15V Power Supply	-15V Power Supply	RF Switch Failed
Attenuator	RF Forward	RF Reflected	Tube Drive
Uncalibrated	Uncalibrated	Uncalibrated	Uncalibrated

4.4.2 Summary Fault

All faults that are listed in the table below will cause a Summary Fault; notice the Second HPA Switchover fault is not included in this list. While a Summary Fault condition is present, the following will be true until a fault reset occurs:

- The fault LED on the Reset button will remain illuminated.
- A Summary Fault will be indicated on the User interface (J6).
- A Switchover Fault will be indicated on the Switchover interface (J7).
- The display will present the name of the fault on the screen (press Accept button to clear).
- The high voltage power supply will be forced off.
- Auto Power will be forced off.
- Standby & Transmit are disabled.

FAULTS			
Tube Temp Switch	Chassis Interlock	RF Reflected	Tube Overdrive
Helix Surge	User Interlock	W.G. Arc	HV Over Volt
Filament Under Current	Tube Temp Analog	HV Primary Current	P.S. Temperature
Helix Run	W.G. Pressure	Arc Test Failed	HV Under Volt

4.4.3 Fault Reset

The Reset button is used to reset all latched faults, it is also used to clear the RF Switch Failed alarm. Once the Reset button is pressed the following will occur:

- The fault display will be cleared.
- All fault statuses will be cleared
- The HPA will be forced into the Standby state.

4.4.4 Fault & Alarm Trip Levels Set in Hardware

Some fault & alarm trip levels associated with an analog display are adjustable in hardware. The table below is listing these parameters.

PARAMETER	ADJUSTMENT LOCATION
Helix Run Current fault	R123 of D161001
Helix Surge Current fault	R124 of D161001

4.4.5 Fault & Alarm Trip Levels Set on the Front Panel

Some fault & alarm trip levels associated with an analog display are adjustable by the operator at the HPA front panel (see the *Adjustment Menu Screen* paragraph of this document), and through the Remote or Computer interfaces. These parameters are listed in the table below.

PARAMETER	RESOLUTION	LIMITS
TUBE OV DR FLT LVL	0.1 mW	00.0-FSTD
TUBE OV DR ALM LVL	0.1 mW	00.0-FSTD
RF LOW ALM LVL ^{NOTE 1}	1 Watt	0000-FSFP
RF HIGH ALM LVL ^{NOTE 1}	1 Watt	0000-FSFP
REFLD PWR FLT LVL	1 Watt	000-FSRP
REFLD PWR ALM LVL	1 Watt	000-FSRP
TUBE TEMP ALM LVL	1° C	000-140
PS TEMP ALM LVL	1° C	000-99
FIL U CUR FLT LVL	0.01 A	0.00-5.10
NOTE 1: For these parameters if the encoder is adjusted passed the upper limit OFF will be displayed on the HPA front panel and the trip level will be disabled. FSFP = Full Scale of RF Forward Power meter. FSRP = Full Scale of RF Reflected Power meter. FSTD = Full Scale of Tube Drive Power meter.		

4.4.6 Tube Fault Counter Operation

If the MT4000 is to be left in an unattended earth station, or during a degassing operation, or if the tube is nearing the end of its life the Fault Counter may be turned on to allow the HPA to automatically reset the tube faults and return to Transmit. When the tube fault counter is enabled it will count tube electrode faults. If any fault other than those listed in this paragraph were to occur at any time in the Fault Counter sequence, the fault counter timer would be disabled and the timer reset. After a tube fault is counted and displayed it will be reset, then after the power supply has been off for 5.0 seconds the HPA will be commanded back into Transmit. After the fault is reset & before the HPA is put into Transmit, the HPA will be in the Transmit Selected mode for about 3 seconds. The fault counter delay time is 5.0 seconds, which allows the power supply and tube time to cool down. Each time a fault is counted a fault event, reset event, and transmit event will be placed into the event log.

Faults that will be counted are:

- High Voltage Under Volt fault
- High Voltage Over Volt fault
- Helix Surge Current fault
- Helix Run Current fault

The number of faults counted and the window of time during which they are counted are both adjustable by the operator (see the *Adjustment Menu Screen* paragraph of this document). The window size must be greater than five times the number of faults counted in seconds.

$$\text{Window Size [in seconds]} = 5 \times (\text{number of faults})$$

4.5 HPA Gain Control

There are several ways to control the HPAs output power; these are detailed in the following paragraphs.

4.5.1 Manual Attenuation Adjustment

Through the Gain Adjust Screen the operator can directly set the HPA output power by adjusting the HPA gain manually. On the Computer & Remote interfaces this can be accomplished in two ways. First, a Set Attenuator command has been provided which directly set the level of HPA input attenuation. Second, an Increase Attenuation & Decrease Attenuation commands have been provided. These commands adjust the attenuator from the current setting by the specified amount. All of these methods of adjust depend on the operator watching an indication of the HPA output power while making the adjustment.

Since the attenuator is in the input side of the HPA there is not a direct correlation between input attenuation and output power in dBm or dBW. The difference is due to the gain compression of the HPA. For example, a 3.0 dB change of the input attenuator will not necessarily produce a 3.0 dB change at the HPA output. However, the operator can put the HPAs RF Forward power meter into dBm or dBW units (see the *Units Select Button* paragraph of this document) and manually adjust the attenuator for the desired change in dB at the HPA output.

4.5.2 Auto Power Function

Auto Power function will regulate the RF output power within a window around the Auto Power set level. There are several conditions that can prevent Auto Power from turning on or turn it off when it is on.

4.5.2.1 Initializing Auto Power

The HPA front panel contains a Hold Power control and indicator that will be used to control the Auto Power Function from the local panel. On the Computer & Remote interfaces an Auto Power command has been provided which turns on Auto Power and sets the regulation level.

4.5.2.2 Conditions That Will Prevent Auto Power From Turning On

The HPA will refuse to perform an Auto Power command if any of the following conditions are present.

- If the TWTA is not in Transmit.
- If the Forward power sample is 0000W.
- If the Computer or Remote interface were to set the Auto power level to 0006W or less.
- If RF is Off.

4.5.2.3 Conditions That Will Suspend Auto Power

When the HPA is in Auto Power, it will stop all Auto Power attenuator action while the HPA is in the RF Off state. The HPA will remain in the Auto Power state but no attenuator action will be taken while in the RF Off state. The Auto Power attenuator action will resume once the HPA is placed back into RF On.

4.5.2.4 Conditions That Will Turn Off Auto Power

The HPA will terminate the Auto Power function if it is active when any of the following conditions occur.

- The set Auto Power level exceeds the top Forward Power calibration point.
- If the TWTA drops out of Transmit.
- If a Disable Auto Power command is received while the TWTA is in the Computer or Remote mode.
- If the Forward power sample is 0000W.
- If the operator at the Local panel were to press the Hold Power button again.
- If the Computer or Remote interface were to set the Auto power level to 0000W.
- If the RF attenuator is manually adjusted.

4.5.3 Hold Power

The MT4000 front panel contains a Hold Power control and indicator, which will be used to control the Auto Power Function. The operator will set the RF output power using the Gain Adjust Screen. Once he has obtained the desired power level he will press the Hold Power button. The LED in the Hold Power button will illuminate and the Auto Power function will regulate the RF output power to the level currently displayed on the RF Forward Power display (meter). If the operator were to press the Hold Power button again the Auto Power regulation function will turn off. Equivalent commands have been provided on the Computer & Remote interfaces.

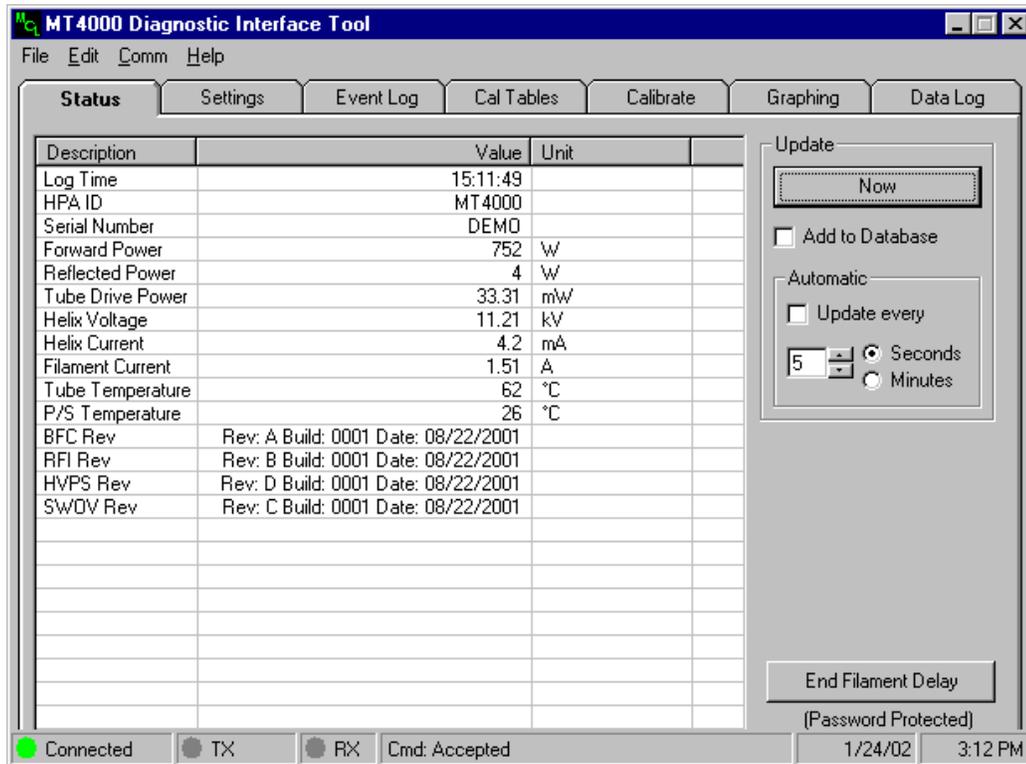
4.6 Diagnostic Interface

A RS232 diagnostic interface (J8) is provided on the front panel of the MT4000. This interface is designed to connect to a PC through a standard RS232 9-pin cable. Through this interface the operator is able to calibrate analog channels, set or adjust system parameters, download the complete event log, download analog channel calibration tables, or upload analog channel calibration tables. TN4000-6 *Technical Note, Troubleshooting & Customer Service Guide for MT4000* will describe calibration procedures, upload analog channel calibration tables, and data logging function of the 45A0158 Diagnostic Test program.

The following procedures assume that a PC is connected to the HPA diagnostic interface that has the 45A0158 Diagnostic Test program loaded on to it. These procedures give an outline for viewing, downloading, and uploading data to the HPA. The diagnostic interface program has information built into the Help menu to give the operator additional assistance. The Windows cut & paste functions are enabled on all program tabs except “Calibrate”.

4.6.1 Downloading Status

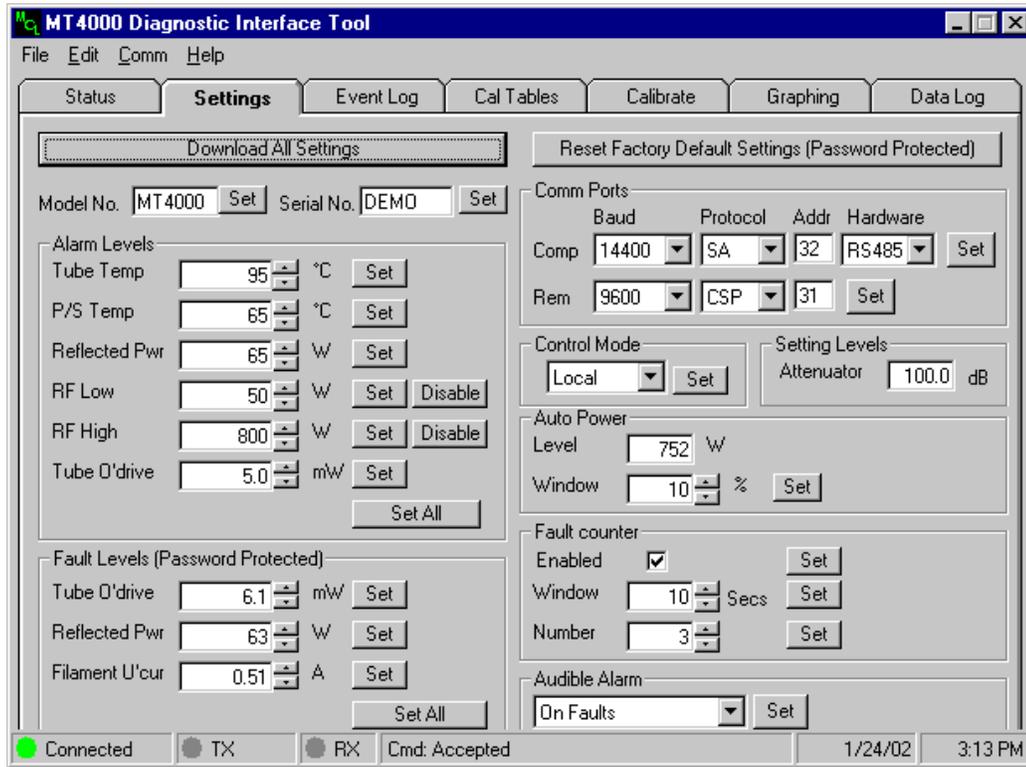
1. On the Diagnostic Interface program click on the “Status” tab (see the figure below).
2. Click on the “Now” button to refresh the status or check the “Update every” box to automatically update status.
3. To save the data to disc, once the status is done downloading, click on the “File” menu, select “Save” on that menu, then on the Save menu select “Status.” The diagnostic program will automatically produce a file name, which includes the HPA serial number, “status”, and today’s date.
4. The "add to database" box when checked will automatically save the downloads to an Access 97 or better compatible database. Downloads are stored by HPA ID, Serial Number and download time. The database can therefore handle multiple HPAs. Access 2000 can be used for advanced charting and reporting of this data. The file is stored in the application directory under filename hpa-log.mdb



From this screen you cannot change any settings or operating states of the HPA.

4.6.2 Downloading Settings

1. On the Diagnostic Interface program click on the “Settings” tab (see the figure below).
2. Click on the “Download All Settings” button to refresh the settings display.
3. To save the data to disc, once the status is done downloading, click on the “File” menu, select “Save” on that menu, then on the Save menu select “Status.” The diagnostic program will automatically produce a file name, which includes the HPA serial number, “settings”, and today’s date.



On this screen some parameters are displayed only, others can be modified individually. The “Control Mode” set button is nonfunctional on the MT4000.

4.6.3 Uploading Setting to the HPA

1. The HPA must be in a maintenance mode (the HPA is not transmitting on the antenna). It must be in Local and not carrying traffic or an interruption in service may occur.

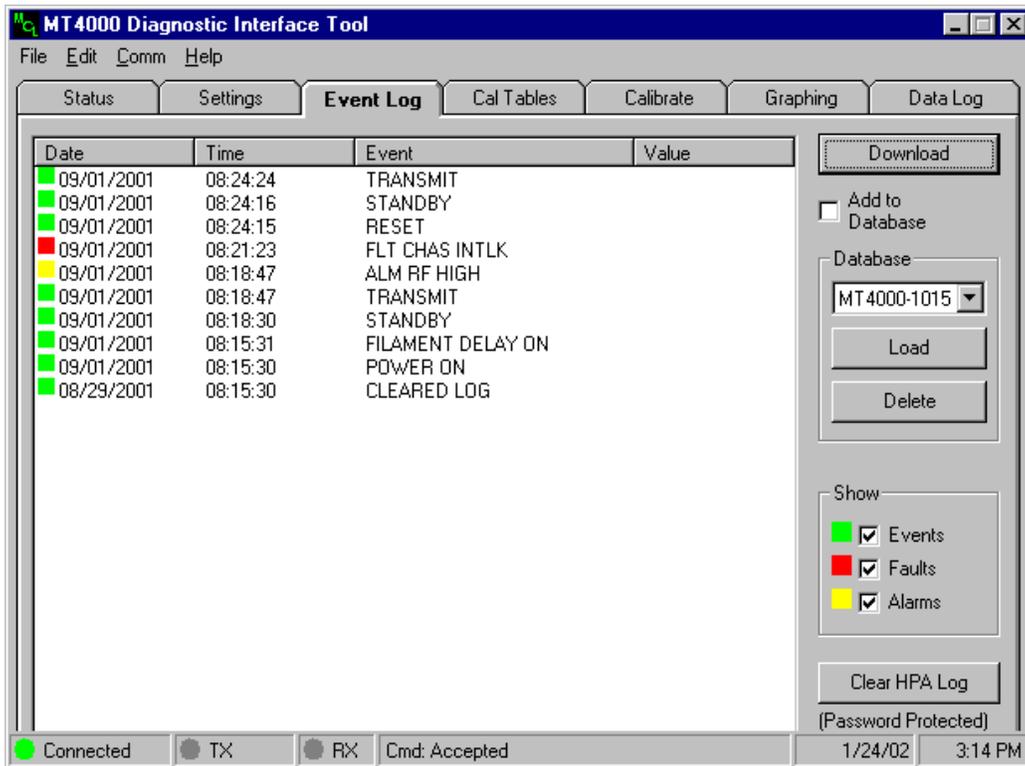
CAUTION

The HPA must be in a maintenance mode to upload settings or an interruption of service may occur.

2. On the Diagnostic Interface program click on the “Settings” tab (see the figure above).
3. If necessary, insert the disc into the PC which contains the settings file.
4. Click on the “File” menu, select “Open” on that menu, then on the Open menu select “Settings”, then select the setting file and click OK.
5. Click on the “Set All” button.
6. The status bar on the bottom of the screen should say “Cmd: Accepted” when the upload is complete.

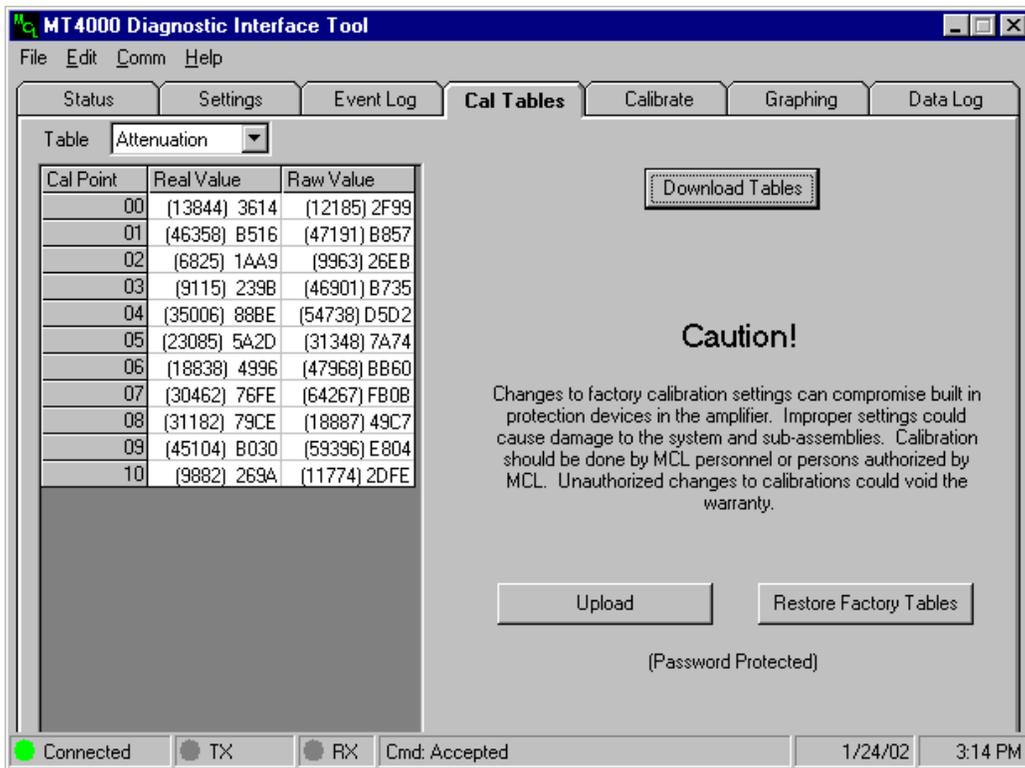
4.6.4 Downloading the Event Log

1. On the Diagnostic Interface program click on the “Event Log” tab (see the figure below).
2. Click on the “Download” button to refresh the status.
3. To save the data to disc, once the status is done downloading, click on the “File” menu, select “Save” on that menu, then on the Save menu select “Event Log.” The diagnostic program will automatically produce a file name, which includes the HPA serial number, “events”, and today’s date.
4. The "add to database" box when checked will automatically save downloads to an Access 97 or better compatible database. Downloads are stored by HPA ID, Serial Number and download time. The database can therefore handle multiple HPAs. Access 2000 can be used for advanced charting and reporting of this data. The file is stored in the application directory under filename hpa-log.mdb



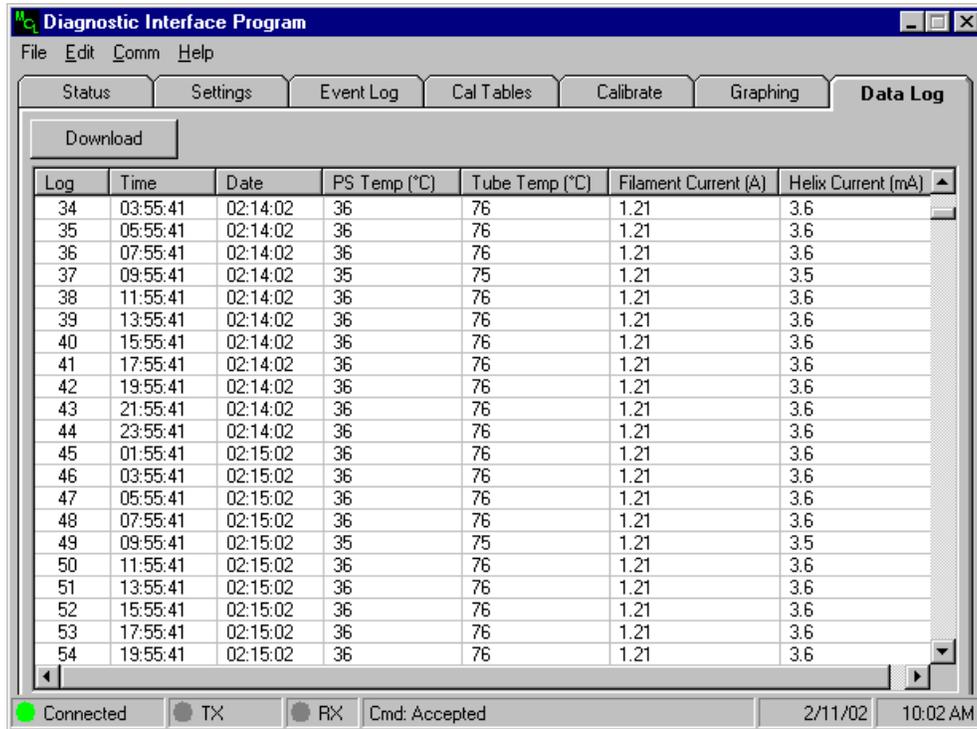
4.6.5 Down Loading Calibration Tables from the HPA

1. On the Diagnostic Interface program click on the “Cal Tables” tab (see the figure below).
2. Click on the “Download Tables” button.
3. Once the tables are done downloading, click on the “File” menu, select “Save” on that menu, then on the Save menu select “Calibration.” The diagnostic program will automatically produce a file name that includes the HPA serial number, “cal tables”, and today’s date.



4.6.6 Downloading the Data Log

1. On the Diagnostic Interface program click on the “Data Log” tab (see the figure below).
2. Click on the “Download” button to refresh the status.
3. To save the data to disc, once the status is done downloading, click on the “File” menu, select “Save” on that menu, then on the Save menu select “Data Log.” The diagnostic program will automatically produce a file name that includes the HPA serial number, “data log”, and today’s date.

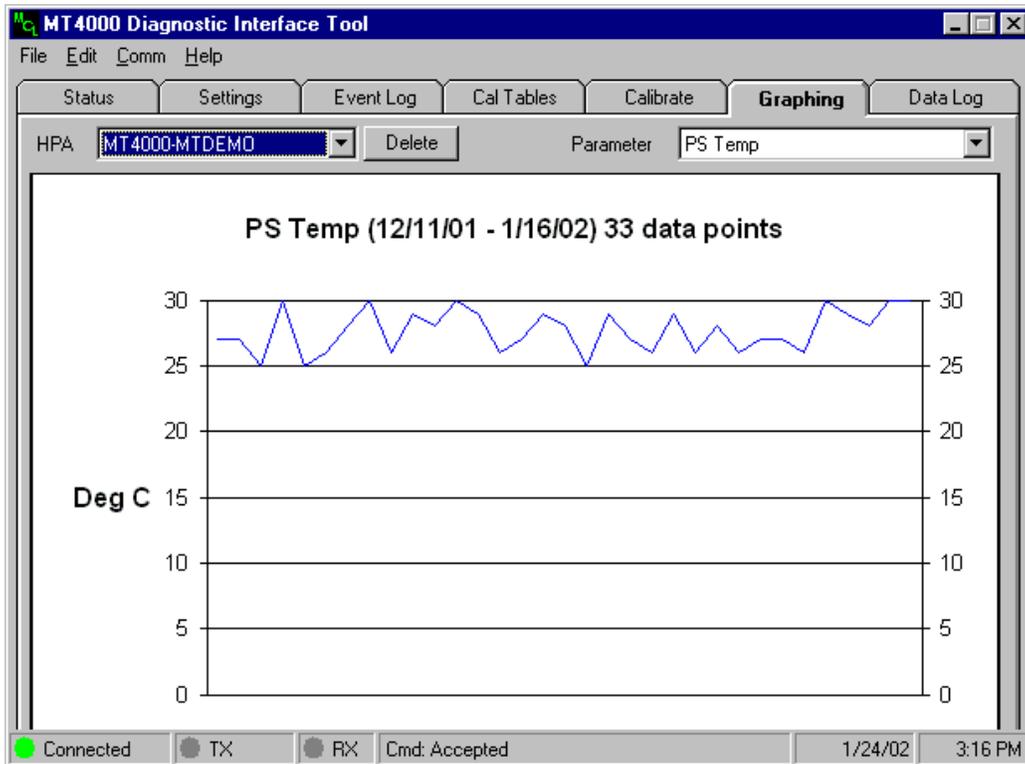


4.6.7 Graphing Tab

Data stored in the database can be viewed in graphical form on this TAB. If data is automatically updating and saved to the database the graph will also automatically update. To view data, select the HPA from the drop down list on the left side, and then select the parameter to graph from the list on the right side. There is no timescale. Data points are equally spaced across the bottom ordered by time, but not spaced relative to the time intervals they were taken. If more advanced graphing is desired it should be done using Access 97 or better.

NOTE

If the number of data points exceeds 1000 points, slower computers could take a long time to draw the graph.



4.7 Optional Local Interface Override

The Local Interface Override is an optional CCA which when activated will temporarily provide rudimentary emergency control of the amplifier in the event of a failure of the VFD display, membrane panel, or the controller.



*Use of the Local Override turns off automatic timing and some protection functions.
Use of the Local Override should only be in the event of a failure.*

4.7.1 Status to Other Interfaces During Local Override

When the HPA is switched into Local Override the local panel microprocessor will not be switched off. As long as the local panel microprocessor did not fail, the local panel will be able to provide status, however no control inputs will be accepted from the membrane panel. As long as the local panel microprocessor did not fail, the diagnostic, computer, and remote interfaces will be able to provide status, but no control will be available through those interfaces.

4.7.2 Local Override Controls

The following controls will be present on the Local Interface Override:

- Transmit push button
- Standby/Reset push button
- RF On/Off switch (two position, latched)
- RF Attn. increase/decrease switch (two position, momentary)
- Override switch (two position, latched)

4.7.3 Local Override Status

The sample port on the HPA front panel provides forward power status. There is one tri-color status LED on the Local Override assembly. The indications on the status LED will be as shown in the table below.

HPA OPERATING MODE	STATUS INDICATION
Delay	Flashing Yellow
Delay with a Fault	Flashing Red
Standby	Continuous Yellow
Fault	Continuous Red
Transmit	Continuous Green

4.7.4 Filament Delay During Local Override

There is not a "Filament Off" or "Transmit Selected" state while in Local Override mode. There is no Proportional delay while in the Local Override mode. The Filament Under fault will be disabled while the HPA is in the Local Override mode. Either of the following events can start the filament delay over again (always a 3 minute warm up delay).

- When the HPA was switched into Local Override mode while it is not in the Transmit state.
- Every time the HPA is turned on while in Local Override.

4.8 Optional Linearizer

If the TWTA was supplied with the optional linearizer, it may be necessary or desirable to fine adjust the linearizer for the specific application. The linearizer is preset at the factory to yield a 6 to 10 dB improvement in intermodulation distortion at an output power backoff of 4 dB for two carriers spaced 10 MHz apart at mid-band.

If operating with more than two carriers, near the band edges, or at an output power backoff other than 4 dB, a slight increase in performance may be obtainable with a slight adjustment of the Phase control behind the accessory panel. The Phase Voltage test points may be used as a reference during the adjustment. The factory preset Phase Voltage can be found in the MT4000 test data, which was supplied with the unit.

The linearizer Mag control is set for the specific TWT characteristics and should not be moved from the factory preset position unless the TWT is replaced.

4.9 Switchover Interface J7 and Front Panel Controls

Switchover interface J7 is dedicated to use with various redundant systems. Refer to TN4000-2 *Technical Note, Installation Guide for MT4000* paragraph "Connection to the Switchover Interface" for a detailed signal description.

4.9.1 MT4011 1:1 Redundant System

A 1:1 redundant system will consist of two HPAs, a RF switch interface box, and a RF switch (Waveguide or Waveguide/coaxial). The controlling logic for the switchover is built into every MT4000 and is accessed through the control line of the switchover interface connector (J7). Either HPA in 1:1 redundant system can act as the switchover logic depending upon the current waveguide switch position. As a result the HPAs must pass information back and forth so that switchover operation is continuous and uninterrupted. The switchover logic will use inputs from the Remote interface, Computer Interface, Local panel interface, and Switchover interface. The MT4000 front panel contains several controls and indicators for a 1:1 switchover; they are as follows.

- Antenna button/LED, puts the HPA on the Antenna port during manual.
- Load button/LED, puts the HPA on the Load port during manual
- Auto button/LED, puts both HPAs into the Auto Switching state

- Manual button/LED, puts both HPAs into the Manual Switching state
- RF Low Switching LED, indicates that a switchover will occur on a RF Low alarm.

For details on the function of these controls see the O&M manual for the MT4011.

Once the HPA is in the Auto switching mode, the amplifier on the dummy load will continually monitor the primary amplifier for failures. If the primary HPA (the one on the antenna) or its exciter fails the secondary amplifier will switch itself to the antenna.

4.9.2 Other Redundant Systems

All other redundant systems whether they are MCL systems (such as MT4012, MT40PC, ..) use only a small portion of the signals on J7. Depending on the system type the Switchover Fault relay output will indicate the state of the MT4000, the RF Off input would be used during switching, and/or the RF Low Switching input would be used to turn on switching for a RF Low alarm.

4.10 User Interface J6

User interface J6 is supplied to allow various earth station equipment (such as exciters) to be wired into the MT4000. Refer to TN4000-2 *Technical Note, Installation Guide for MT4000* paragraph “*Connection to the User Interface*” for a detailed signal description. The Interlock fault & Waveguide Pressure fault inputs will shut down the high voltage power supply and will require a fault Reset to clear. The RF Off input will shut off the HPAs RF switch but the high voltage power supply will remain on.

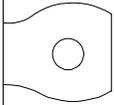
4.11 Prevention of Excessive RF Input Power

As is well known, driving a TWT past saturation will damage the tube. Saturation is the point where further input results in no further increase in power out.

It is requested that the user immediately investigate the possibility of overdrive in his installation. If this possibility exists, the following is suggested to protect the TWT:

4.11.1 The Exciter

The exciter output must be limited to less than or equal to 2 dB greater than the level required to drive the system to rated output power. This level can be found on a warning tag (see the figure below) attached to the front of each unit as well as in the system test data.



INPUT DRIVE SETUP

1. New equipment.
 - 1.1. Connect system and energize.
 - 1.1.1. HV off (HPA).
 - 1.1.2. Drive source off.
 - 1.2. Check data sheet of information on other side for required maximum input to system.
 - 1.2.1. Some equipment may have labels on the input.
 - 1.2.2. See Section 2 if values not given.
 - 1.2.3. Maximum input is defined as that value when all HPA and HPA system variable attenuators are set at minimum attenuation.
 - 1.3. Disconnect drive into system. Adjust for value in Par. 1.2.
 - 1.3.1. Increase by 2 dB, and install tamperproof limit lock.
 - 1.3.2. Decrease by 10 dB, and connect to HPA system.
 - 1.4. Use as desired.
2. Adjustment of older equipment (routine calibration, component replacement, tube replacement, etc.)
 - 2.1. Connect system and energize.
 - 2.1.1. HV off (HPA).
 - 2.1.2. Drive source off.
 - 2.1.3. All variable attenuators in HPA or HPA system at minimum attenuation.
 - 2.2. Disconnect drive.
 - 2.2.1. Set drive at 13 dB. below typical expected value in O & M Manual. Contact MCL if you are not sure.
 - 2.2.2. Reconnect drive.
 - 2.3. Energize system.
 - 2.4. Increase drive until rated power is reached.
 - 2.4.1. Phase combined systems.
 - 2.4.1.1. Rated HPA power may be reached on one HPA first. In this case, incrementally increase attenuation in this HPA. Increase input drive and repeat until both HPAs are at their rated power. Use individual HPA power monitors for this procedure. Phase combining adjustments can be done any time after this.
 - 2.4.1.2. Individual HPAs. Increase drive until rated power is reached.
 - 2.5. Turn HPAs off and disconnect drive. Measure drive power and record (somewhere on HPA, if possible).
 - 2.6. Increase drive by 2 dB, and set tamperproof limit.
 - 2.7. Reconnect.

Caution: Operation of HPA with input not connected can result in oscillation and damage to the HPA.

CAUTION

TUBE will be permanently damaged if overdriven.

Do NOT remove this tag unless you have verified that the drive source is output limited and tamperproof.

Drive source should never exceed the maximum required (input required for rated power output with all variable attenuators set to minimum attenuation) by more than 2 dB.

M/N_____ J/N_____ S/N_____

Rated power output = _____

Maximum input drive required_____dBm.

Date_____ Technician_____

4.11.2 Procedure to Limit RF Input to the HPA

1. Rated Power No Attenuation

With the HPA attenuation at minimum, measure the amount of power required to drive the MT4000 system to rated power (this is also shown on the data sheet sent with the equipments).

2. Exciter Adjustment

Set the exciter at this level and lock all exciter output adjustments permanently. Use devices that must be removed to readjust output. Alternately, set exciter at maximum and insert attenuation in the line to limit power available at the TWTA.

3. MT4000 Trip Levels

The Tube Overdrive Fault and the Tube Overdrive Alarm levels were set by MCL to protect the TWT. If the Tube Overdrive Alarm occurs this is an indication to the operator that the tube drive level is approaching the Tube Overdrive Fault. Once the tube drive level has exceeded the Tube Overdrive Fault level the HPAs RF switch and high voltage power supply will both be turned off until the RF drive level is backed down.

CAUTION

To change the Tube Overdrive Fault level from the factory set level may result in degradation or permanent damage to the TWT.

5.0 INITIAL TURN ON OF THE HPA

The following procedure should be performed the first time the HPA is turned on after receipt from MCL or after it has been in storage.

5.1 Initial Turn-On Check List

All MT4000 TWT amplifiers are ready to be activated when the following check list has been complied with:

1. The Installation procedure found in TN4000-2 *Technical Note, Installation Guide for MT4000* as been completed.
2. The HPA Main Power circuit breaker should be in the off position.
3. The MT4000 is properly mounted in the cabinet and the cabinet is firmly bolted in place.

CAUTION

Make sure the top cover of the MT4000 is attached; the cover is part of the cooling circuit.

4. Ground strap (earth) attached to safety ground stud on rear panel of MT4000.
5. Appropriate AC input voltage and frequency has been connected to the MT4000. Check AC system voltages by measuring the voltage on the mate for J1 (AC input connector).
6. All waveguide flanges are securely fastened together and input RF coaxial cable is firmly attached.
7. All electrical connections double-checked mechanically and electrically. The main AC power connector should be properly connected to J1 on the MT4000.
8. Air intake and exhaust properly installed. Make certain that the installation does not allow air to recirculate between the input and output.
9. The input RF drive source (exciter) should be properly connected with its output set to minimum and off (mute).
10. If the User Interface (J6) and Switchover Interface (J7) are not used, the supplied cheater plugs should be installed on the rear panel.
11. Connect the Remote Panel & Computer Interface cables to the rear panel.

5.2 Operating Caution List

The table below is a list of improper operating conditions. These are conditions, which could damage the TWT amplifier system and must be avoided. Also listed are the probable sources of each condition.

SYMPTOM	ORIGIN
High or Low System AC Input Power	a. Customer Power Source b. Continuous system operation with circuit breakers bypassed (“cheated”).
Excessive Tube Drive Power	Overdrive on RF System Input or TWTA Gain Adjustment Set Incorrectly
Tube or PS Temperature fault/alarms	System operation with blocked air intake and/or exhaust ports.
Tube Temperature	System operation outside the specified environmental range.
Excessive Output Reflected Power Meter Indication	a. System Output Transmission Line Connection and Customer Waveguide/Load Incompatibility. b. Operating TWTA with unterminated RF input or output ports.

CAUTION

Failure to avoid above conditions will void warranties!!

Any of these conditions indicate that a critical system parameter is either out of adjustment or the fault conditions are no longer recognizable. If these conditions should exist, no further attempt should be made to use the amplifier system until the defective circuitry or adjustment is corrected. Of most concern to the operator is potential damage to the TWTA tube because of its cost and the down time required for repair and/or replacement. Therefore, any parameter relating to the TWTA tube should be analyzed immediately to prevent damage.

5.3 Power-Up Procedure

When the above check list has been completed and the caution list is reviewed, the system is ready for activation. To activate the system, the following steps should be followed:

1. Activate the HPA Main Power circuit breaker. The HPA display and various front panel LEDs will illuminate.
2. Press the Local & Standby buttons to verify that HPA is in filament delay and will not go into Transmit without your interaction. Check that Delay is indicated on the Main screen, on the Delay LED, and the Standby LED is flashing. Remaining Filament delay will be displayed on the first line of the main screen.
3. Set the RF On/Off control to the Off position.
4. Go to the Gain screen and set the attenuation level to 32.0 dB.
5. Check for continuous illumination of the Standby LED at the end of the 3 minute warm-up cycle. Also the main screen will display forward power instead of remaining filament delay time.

CAUTION

Never activate transmit unless an RF load is connected to the RF output.

*Avoid operating the system in standby for more than 60 minutes; use the Filament Off control for long periods of Standby. See **46A0009 Extending Tube Life Information** this document is include as an appendix to **TN4000-5 Preventative Maintenance for MT4000**.*

6. Insure that the RF input to this system is at the desired frequency and that it is a frequency within the TWTA operating frequency band.
7. Depress the Transmit switch (HV On) to activate the high voltage. The “Transmit” switch will illuminate.
8. Set the RF On/Off control to the On position.
9. Set the exciter output to RF On.
10. Go to the Gain screen very carefully increase the TWT RF input drive until rated RF Forward Power is obtained (Consult the MT4000 test data for the rated output power to be expected) from the amplifier system while staying within the TWT current and voltage limitations. Monitor the output reflected RF power to insure that the transmission line is reflecting less than 10% of the output forward power.
11. If the system reaches rated output before reaching maximum gain, it will be necessary to further reduce the RF output of the exciter.
12. If the system reaches maximum gain before reaching rated output power, slowly increase the exciter output until the system reaches rated output power.

CAUTION

Under no circumstances should the TWTA be driven to an output of greater than the system’s rated output. This will result in degradation or permanent damage to the TWT.

13. Once the exciter output has been set so that the system reaches full rated output with the MT4000 gain control set to maximum gain, the exciter output should be locked in place by mechanical means or by way of a tamper proof seal. The MT4000 gain control should then be used in the future to make adjustments to the system output power.

14. Allow the system to thoroughly stabilize for no less than 5 hours.
15. If it is desired to have the system recycle into Transmit after transient tube faults, or if the system is to be left in unattended operation, see the *Tube Fault Counter Operation* paragraph of this document.

This completes the procedure necessary to bring the MT4000 TWT amplifier system into full and complete system operation. The MT4000 TWTA transmitter system is now fully operational and will stay functional until either operator shutdown or a fault condition is detected.

If problems occur during the execution of this procedure, refer to *TN4000-6 Technical Note, Troubleshooting & Customer Service Guide for MT4000*.

6.0 SHUT DOWN PROCEDURE

To discontinue operation of a MT4000 TWT amplifier system, the following procedure is recommended for system shutdown:

1. Remove the input RF drive to the amplifier system.
2. Depress Standby switch until illuminated.
3. Place the HPA into Filament Off.

NOTE

If the HPA is connected to an M&C system and you wish to keep The HPA on the bus, do not perform the following steps.

4. Let HPA remain on (to cool down) until the tube temperature is below 35°C.
5. Turn off the Main AC Power switch.

Under extreme emergencies, the operator may totally remove AC input power from the system by simply switching the Main AC Power circuit breaker to the Off position. This shutdown procedure is only for emergencies and should not be used under normal circumstances. If problems occur during the shutdown procedure, refer to *TN4000-6 Technical Note, Troubleshooting & Customer Service Guide for MT4000*.

APPENDIX A

40A1546

CSP Protocol Specification

APPENDIX B

40A1715

SA Bus Compatible Protocol Specification

APPENDIX C

46A0204

CSP Command Set

APPENDIX D

46A0203

SA Bus Command Set



TN4000-5

Technical Note

Preventative Maintenance Guide

For MT4000 TWTA

April 11, 2002

<u>Donald Surprenant</u>	<u>4/12/02</u>
Engineering	Date

<u>Dave B. Marshall</u>	<u>4/12/02</u>
Customer Service	Date

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1.0 SAFETY SUMMARY

1.1 Definitions of Warnings, Cautions and Notes

WARNING AND CAUTION statements have been strategically placed in the text to emphasize certain steps or procedures for the protection of personnel (WARNING) or equipment (CAUTION). A WARNING or CAUTION once provided will apply each time the related step is repeated, regardless of the number of times the step is repeated throughout the text. Prior to starting any task, the WARNING or CAUTIONS included in the text for that task should be reviewed and understood.

WARNING

An operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in injury to or death of personnel.

CAUTION

An operating or maintenance procedure, practice, condition, statement, etc., which if not strictly observed, could result in damage to or destruction of equipment, or loss of mission effectiveness.

NOTE

An essential operating or maintenance procedure, condition, or statement which must be highlighted.

1.2 General Safety Precautions

The following are general safety precautions and instructions that personnel must understand and apply during many phases of operation and maintenance to ensure personnel safety and health and the protection of property. Portions of this information may be repeated in certain chapters of this publication for emphasis.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must at all times observe safety regulations. Do not replace components or make adjustments inside the equipment with the voltage supply turned on. Under certain conditions, dangerous potentials may exist when the power control is in the off position, due to charges retained by capacitors. To avoid injuries, always remove power from, discharge, and ground a circuit before touching it. Adhere to all lock out/tag out requirements.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person capable of rendering aid and resuscitation is present.

RESUSCITATION

Personnel working with or near dangerous voltage shall be trained in modern methods of resuscitation.

COMPRESSED AIR

Use of compressed air for cleaning can create an environment of propelled foreign particles. Air pressure shall be reduced to less than 30 psi and used with effective chip guarding and personnel protective equipment.

1.3 List of Hazards

The operation of this amplifier may involve some of the following hazards; any of them could result in serious harm to personnel if proper safety precautions are not taken.

WARNING

HIGH VOLTAGE

Lethal Voltages up to 15,000 Volts are present in this amplifier when it is operating. USE EXTREME CAUTION when inside the unit. Do not insert objects through air intake screen on rear of drawer. When testing, always ground the drawer chassis.

WARNING

RF RADIATION

Exposure to RF radiation may cause serious bodily injury possibly resulting in blindness and death. Cardiac pacemakers may be affected. Always terminate both the RF input and RF output, even during tests, which involve no RF drive, to avoid the RF hazard should the TWTA oscillate.

WARNING

BERYLLIUM OXIDE

The dust or fumes from Beryllium Oxide (BeO) ceramics used in microwave tubes are highly toxic and can cause serious injury or death.

LIST OF HAZARDS (Continued)**WARNING*****IMPLOSION HAZARD***

Ceramic windows from microwave tubes can shatter on impact or crack in use resulting in injury from Beryllium Oxide dust or fumes.

WARNING***X-RAY RADIATION***

High voltage tubes can produce dangerous, possibly fatal X-Rays.

WARNING***HOT SURFACES***

Surface temperature of tubes and other air-cooled parts can reach several hundred degrees centigrade.

CAUTION***RF OVERDRIVE***

The unit may be damaged by drive levels as low as -17 dBm for the Model MT4000 depending upon the settings of the system attenuator. Please apply RF with caution. Always terminate RF input and output ports properly when AC power is supplied to the TWTA.

2.0 SCOPE

This document contains a preventative maintenance schedule for normal operating conditions and instructions for simple maintenance tasks, which should be performed regularly. This document also explains why it is important to keep your amplifier system well maintained and follow basic safety precautions. This document assumes a familiarity and working experience with high power microwave RF amplifiers.

3.0 MOISTURE PREVENTION

Where outside air is used for cooling, if the system has been shut off for any length of time, an inspection for moisture accumulation and water buildup in the interior of the cabinet should be performed before any attempt is made to activate the system.

CAUTION

Do not operate this system when excessive moisture is present in the interior

4.0 MAINTENANCE SCHEDULE

The following table is showing the maintenance schedule for the MT4000. There are three maintenance intervals broken down into separate tables. The MT4000 should be inspected to permit early detection of wear or damage, which if properly corrected will prevent equipment malfunction or failure. Examinations for wear, breaks, deterioration, excessive moisture, mounting integrity and other defects should be made. If the equipment has been subjected to severe environmental conditions, such as dust input ambient air, temperature extremes, or excessive shock or vibration, inspections should be more frequently performed.

MAINTENANCE SCHEDULE	
Every 3 months	Perform items in table “A”
Every 12 months	Perform items in table “A, B”
Every 24 months	Perform items in table “A, B, C”
<i>Maintenance schedule starts from date of purchase</i>	

4.1 Quarterly Maintenance

MAINTENANCE SCHEDULE A	
ITEM	PROCEDURE
Front Panel Control and Meter	Use a dry clean cloth, a soft bristle brush, a cloth moistened with warm soapy water or diluted alcohol to clean the front panel.
Connector Jacks and Plugs	Remove dust and dirt with soft bristle brush or low-pressure compressed air.
Download HPA Configuration	See the <i>Downloading Status & Downloading Settings paragraphs of TN4000-3 Technical Note Operation of MT4000 TWTA.</i>

4.2 Annual Maintenance

MAINTENANCE SCHEDULE B	
ITEM	PROCEDURE
Chassis	Turn all power off before cleaning inside the chassis. When cleaning with compressed air, wear safety goggles and use clean, dry compressed air not exceeding 25 psi. Remove top cover and clean with lint free cloth, small vacuum or compressed air. Use alcohol to clean airborne residue around HV area.
Chassis Slide	If slide does not move freely, clean the slide mechanism with alcohol and apply a light coat of lubriplate no. 110 (or equivalent). Wipe off any excess lubricant with a clean lint free cloth.
Blower	Inspect the blower and the air channel for any potential obstruction. Use compressed air or a vacuum to clean the blower and the TWT heat sink assembly.

4.3 Bi-Annual Maintenance

WARNING

Only a trained technician should perform this bi-annual maintenance procedure on the MT4000

Although care has been taken in the design of the system to provide such features as an interlock switch, high voltage points which are clearly marked, and warning labels affixed to the system, it will be necessary to defeat the interlock switch when performing certain tests outlined in **Table C**.

There are two hardware configurations under the HPA cover. Refer to the diskette that was provided with your amplifier (each diskette is unique to each amplifier). Compare the settings on the diskette with the current values on the amplifier display; if there is significant difference, then a re-calibration may be necessary. If you are equipped and able to perform High Voltage measurements, then follow **TABLE C**, if not, contact MCL Customer Service for assistance.

MAINTENANCE SCHEDULE C	
ITEM	PROCEDURE
High Voltage Calibration	<p>Compare the tube nameplate value for Helix Voltage with the display value.</p> <p>For a slight adjustment (less than 100V +/-), follow these steps:</p> <p style="padding-left: 40px;">Turn on the main breaker on the front panel. While the HPA is in Filament Off, on the HPA front panel, check the Helix Voltage Set Point, and adjust Helix Voltage adjust potentiometer until the Helix Voltage Set Point reads the TWT nameplate value.</p> <p>If there is significant difference of more than 100V +/- follow the steps below:</p> <p style="padding-left: 40px;">In the HPA, disconnect the tube leads from the HV module. Connect a HV break-out box to the HV module and then connect a MT4000 HV Load to the break-out box (see the figure on the next page). Connect the reference of a 15kV precision divider box to the HPA chassis. Connect the high voltage lead of the divider box to the cathode terminal of the break-out box.</p> <p>Adjust the Helix Voltage adjust potentiometer for the tube nameplate value.</p>
RF Calibration	<p>Check the calibration of the RF meters. If calibration is required see the RF Meter Calibration Procedure paragraph of TN4000-6 <i>Technical Note Troubleshooting & Customer Service Guide</i>.</p>
Blower	<p>Inspect the blower and the air channel for any potential obstruction. Use compressed air or a vacuum to clean the blower and the TWT heat sink assembly.</p>

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1.0 SAFETY SUMMARY

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The operation of this amplifier may involve some of the following hazards, any of them could result in serious harm to personnel if proper safety precautions are not taken.

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Lethal Voltages up to 15,000 Volts are present in this amplifier when it is operating. USE EXTREME CAUTION when inside the unit. Do not insert objects through air intake screen on rear of drawer. When testing, always ground the drawer chassis.

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RF RADIATION

Exposure to RF radiation may cause serious bodily injury possibly resulting in blindness and death. Cardiac pacemakers may be affected. Always terminate both the RF input and RF output, even during tests, which involve no RF drive, to avoid the RF hazard should the TWTA oscillate.

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WARNING***HOT SURFACES***

Surface temperature of tubes and other air-cooled ports can reach several hundred degrees centigrade.

CAUTION***RF OVERDRIVE***

The unit may be damaged by drive levels as low as -17 dBm for the M/N MT4000 depending upon the settings of the system attenuator. Please apply RF with caution. Always terminate RF input and output ports properly when AC power is supplied to the TWTA.

2.0 SCOPE

During the course of the service life of the MT4000 TWT amplifier, problems may arise and failure modes may occur. This document and its appendices will give the user information that will be useful while finding and solving problems. This document assumes a familiarity and working experience with high power microwave RF amplifiers.

The MCL MT4000 is designed for long and reliable life under a variety of environmental conditions. All components utilized in this system are conservatively rated and selected for high reliability and maximum use of existing designs. Mechanical and electrical safeguards are utilized throughout the system to insure safety of operating personnel.

WARNING

It is important when troubleshooting this equipment that the utmost caution is utilized since extremely lethal voltages exist in all areas of this amplifier system

3.0 CUSTOMER SERVICE INFORMATION

Document 40A1845 has been included as an appendix to this document. It includes information about MCL service resources available to our customers.

4.0 RECOMMENDED TEST EQUIPMENT

Below is a list of recommended test equipment your test equipment should be functional equivalent to this list. This list does not include RF adapters, directional couplers, or high power loads.

ITEM NO.	QTY	DESCRIPTION	MANUFACTURER & MODEL NUMBER
1	2	Digital Volt Meter	Fluke 25
2	1	Storage Oscilloscope	Tektronix 2221
3	2	1000:1 Scope Probe (HV)	Ross VMP30-GH-WA-AL
4	1	Filament Load	4.5 ohm 20W Precision
5	1	MT4000 Resistive High Voltage Load	MCL
6	1	10:1 Scope Probe	Tektronix P6109
7	1	Precision Digital Voltmeter	Fluke 8062A
8	1	Power Meter with power head	HP438A w/8481A
9	1	RF Sweep Generator with Plug-In	HP 8350B HP 83592A
10	1	Think-Jet Printer	HP 2225A
11	1	SMA 3 dB Power Splitter	27C1987
12	1	Clamp-on Current Meter	Bell #GC-100D
13	1	PC with Diagnostic Program and Communications Program	45A0158 & 45A0163

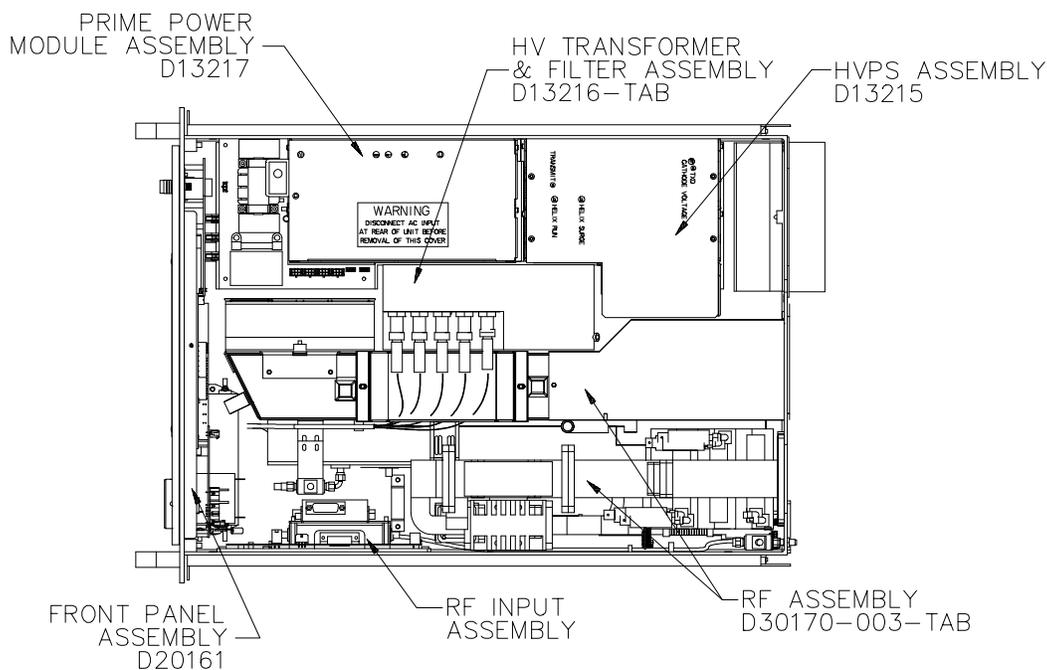
5.0 MCL OPTIONAL TEST EQUIPMENT

The following test fixtures are available for purchase from MCL.

- D21079 TWTA simulator for MT4000 Logic - Used to troubleshoot problems with the D20161 Front Panel assembly. This can also be used to troubleshoot the MT4000 controlling software (Earth station controlling software) when used with a D20161 Front Panel assembly.
- D20161 Front Panel simulator for MT4000 - This can be used to troubleshoot the MT4000 controlling software (Earth station controlling software).
- D21081 Internal Interface test fixture for MT4000 - This can be used to diagnose internal bus problems on several CCAs.
- D21080 MT4000 Parallel Interface Test Fixture - Used to verify operation of the User & Switchover interface of the MT4000.

6.0 LRU LOCATION

The figure below is showing the location of major assemblies inside the MT4000.



7.0 FAULT & ALARM TROUBLESHOOTING GUIDE

The following table will direct the operator to the appropriate assembly (with a high degree of confidence) to isolate the problem. The table is organized by the symptom or fault indication or alarm indication. As each problem area is identified, the most likely cause of the problem.

The following guide is written for a technician who has some knowledge of power supply and logic control operation. A review of TN4000-4 *Technical Note, Circuit Theory of MT4000* might be advisable before attempting to service the MT4000. It is especially important to go a step beyond simply replacing failed components to find and correct the underlying cause. The time spent in performing a few simple tests before attempting a full power turn-on will be well justified.

WARNING

High voltages are present in a fully operational MT4000. The cathode and filament voltages are over ten thousand Volts. Since these voltages could occur at locations and under conditions that are unexpected, particularly if the unit is malfunctioning, extreme caution is advised. Always make sure that the chassis is earth grounded (see installation caution). Use caution in connecting scope probe grounds.

FAULT INDICATION PRESENT		POTENTIAL PROBLEM AREA	DIAGNOSTIC AREA	
1	No indication of primary power on the HPA front panel	Input Power	1	No primary power being delivered to the HPA.
			2	Circuit Breaker (System Power) is open.
			3	Connections at J1 not secure.
		Primary Power Module (PPM)	4	Check if all PPM LEDs are illuminated
			5	Check PPM fuse
2	No standby indication.	Wrong HPA state	1	HPA is in Filament Off
			2	HPA is in Delay
		There is a fault HPA front panel	3	Check for presence of faults.
			4	Check for failed LED
			5	Be sure MT4000 is in Local.
3	Logic failed to go into Transmit	There is a fault	1	Check for presence of system faults.
			2	Be sure MT4000 is in Local.
		MT4000 not in Local	3	Check Membrane panel
		Internal communication	4	Check for satellite CCA alarms
4	Transmit activated but no helix voltage.	PPM assembly	1	Ensure that 450V is present on F1.
		HVPS assembly	2	Check the TRANSMIT LED on the HVPS assembly
5	Transmit activated HV higher than normal.	HVPS assembly	1	Check Helix Voltage Set level
			2	No high voltage to the tube, check for an open wire
		Filament Power Supply	3	Check for normal filament current
6	Transmit On normal Helix current indication but no RF output.	RF Inhibited	1	Is the HPA in the RF Off state? Is it the Switchover or User interface?

FAULT INDICATION PRESENT		POTENTIAL PROBLEM AREA	DIAGNOSTIC AREA		
		Solid State Amplifiers	2	Check the SSA output (Tube Drive Power), check attenuator setting & operation.	
			3	Check if the HPA is receiving RF input signal.	
			4	Check RF plumbing from MT4000 input to tube input.	
			5	Check +15V to the SSA	
7	Won't go from Transmit to Standby (Transmit LED off, HV off, & Standby LED on).	MT4000 not in Local	1	Put MT4000 in Local	
		Standby button failed	2	Check membrane panel	
8	Normal power out indication but no Tube Drive power out registered.	RF Input assembly	1	Defective monitor port on SSA.	
			2	Defective analog channel on the RF Interface CCA (D16989)	
9	RF Interface Comm alarm	D16989 RF Interface CCA	1	Check ribbon cable from the Switchover & User Interface CCA to the RF Interface CCA.	
			2	Check transmit data LED (DS1) on the RF Interface CCA (D16989), it should be flashing.	
10	PS Interface Comm alarm	D161001 PS Interface CCA	1	Check ribbon cable from the BFC CCA to the PS Interface CCA.	
			2	Check TXD LED on the HVPS assembly (DS2 of D161001), it should be flashing.	
11	Switchover & User Comm alarm	D16990 SWOV & User Interface CCA	1	Check ribbon cable from the BFC CCA to the SWOV & User Interface CCA.	
			2	Check transmit data LED (CR18) on the SWOV & User Interface CCA (D16990), it should be flashing.	
13	Power Supply alarm (+5V, +15V, or -15V)	D16999 BFC CCA	1	Defective analog channel	
		PPM assembly	2	Check voltages on D16999 BFC CCA (on front panel assembly)	
			3	Check if "+55V START" PPM LED is illuminated	
14	Uncalibrated alarm (RF Forward, RF Reflected, Tube Drive, or Attenuator)	RF Interface CCA (D16989)	1	Calibrate analog channel or upload calibration table	
15	RF Switch Failed alarm	1:1 (MT4011) Redundant System	1	The RF Switch is stuck or has failed to change positions in the Auto Switching mode. Clear the problem and press the Reset button.	
16	Exciter alarm	1:1 (MT4011) Redundant System	1	Exciter/RF Source has failed	
17	AC Low Line alarm	AC input	1	AC input is low	
			2	Connection at J1 not secure.	
		PPM assembly	3	Check if all PPM LEDs are illuminated	
18	RF Low alarm	Exciter/RF Source	1	Check if the HPA is receiving RF input signal	
			User Adjustment	2	Check RF Low Alarm level
				3	Check attenuator setting & operation
		RF Input Assembly	4	See if the SSA is producing RF output	
			5	See if the SSA is receiving RF input signal	
		PPM assembly	6	Check +15V to SSA	
		RF Cabling	7	Check RF plumbing from MT4000 input to tube input	
HVPS assembly	8	Check electrode voltages			
19	RF High alarm	Exciter/RF Source	1	Check the HPA RF input signal level	
			User Adjustment	2	Check RF Low Alarm level
				3	Check attenuator setting & operation

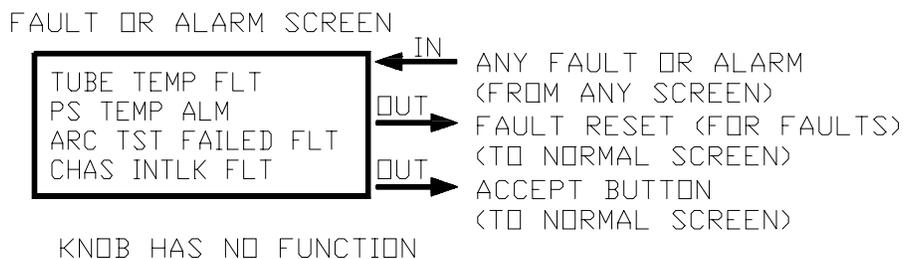
FAULT INDICATION PRESENT		POTENTIAL PROBLEM AREA	DIAGNOSTIC AREA	
20	Blower Failed alarm	Blowers	1	Check blower for obstructions
		HVPS assembly	2	Failed Fan Tach CCA (B161015)
21	Temperature alarm (Tube Analog or Power Supply)	Blowers	1	Blower has failed
		HVPS assembly	2	Check electrode voltages
		Exciter/RF Source	3	Check HPA RF Drive level
		User Adjustment	4	Check Tube Temperature Alarm level
		Air Supply	5	Check system air filter and ducts for restrictions
22	Tube Temperature Switch fault	Blowers	1	Blower has failed
		HVPS assembly	2	Check electrode voltages
		Exciter/RF Source	3	Check HPA RF Drive level
		RF Assembly	4	Check tube temp switch in the TWT
		Air Supply	5	Check system air filter and ducts for restrictions
23	Tube Temperature Analog fault	Blowers	1	Blower has failed
		HVPS assembly	2	Check electrode voltages
		Exciter/RF Source	3	Check RF Drive level
		RF Assembly	4	Check sensor on the tube heatsink
		Air Supply	5	Check system air filter and ducts for restrictions
24	Power Supply Temperature fault	Blowers	1	Blower has failed
		Air Supply	2	Check system air filter and ducts for restrictions
		PPM assembly	3	Check temperature switch on the PFC 1 CCA (D16985) heatsink
			4	Check temperature switch on the PFC 2 CCA (D16986) heatsink
		HVPS assembly	5	Check temperature switch on the Main Bridge CCA (D16997) heatsink
			6	Check temperature switch on the Main Buck CCA (D16998) heatsink
25	Tube Over Drive alarm or fault	Exciter/RF Source	1	Check HPA RF Drive level
		User Adjustment	2	Check Tube Over Drive Alarm level
			3	Check attenuator setting & operation
			4	Is the Tube Drive Meter calibrated?
		RF Input Assembly	5	Intermittent or loose RF cable
26	RF Reflected Power alarm or fault	HPA load circuit	1	Check VSWR of RF Load
			2	Check Waveguide connections
		User Adjustment	3	Check RF Reflected Power Alarm level
			4	Is the Reflected Meter calibrated?
27	Waveguide Arc fault	RF Assembly	1	In Standby check LED on the Arc Sense CCA (C16994), it should be off
			2	Smell & visual check waveguide assembly for evidence of arcing
		RF Input Assembly	3	Check the RF Interface CCA (D16989)
28	Arc Test Failed fault	RF Assembly	1	Check for open cables or wires on the Arc Sense CCA (C16994)
			2	Ohm check the arc test LED on the waveguide assembly
		RF Input Assembly	3	Check for open cables or wires on J5 of the RF Interface CCA (D16989)
29	Filament Under Current fault	User Adjustment	1	Check Filament Under Current fault level
		RF Assembly	2	Check for open or broken tube lead connections

FAULT INDICATION PRESENT		POTENTIAL PROBLEM AREA	DIAGNOSTIC AREA	
30	HV Over or Under Volt fault	HVPS assembly or TWT	1	Put the amplifier on a dummy load to determine if the tube is the problem
31	HV Primary Current fault	HVPS assembly or TWT	1	Put the amplifier on a dummy load to determine if the tube is the problem
32	Helix Run or Surge Current fault	Exciter/RF Source	1	Check RF Drive level
		User Adjustment	2	Check Helix voltage setting
		HVPS assembly or TWT	3	Check for high voltage arcing around the tube lead wires
			4	Put the amplifier on a dummy load to determine if the tube is the problem
33	Chassis Interlock fault	Interlock Switch	1	Check the HPA cover screws
			2	Check wires to S1 interlock switch
		HVPS assembly	3	Check for open cables on J2 of Main Buck CCA (D16998) and J1 of Main Bridge CCA (D16997)
34	User Interlock fault	User Interface	1	Check connections on J6 User interface
			2	Check 15 conductor cable to the SWOV & User Interface CCA (D16990)
35	Waveguide Pressure fault	User Interface	1	Check connections on J6 User interface
			2	Check 15 conductor cable to the SWOV & User Interface CCA (D16990)
36	Local Override On	HPA front panel	1	Check the NORM/BYP switch on the override panel
37	Second HPA SWOV fault	1:1 (MT4011) Redundant System	1	In a 1:1 system this indicates that the other HPA in the system has failed

8.0 BUILT IN DIAGNOSTIC FEATURES

8.1 Fault Indication

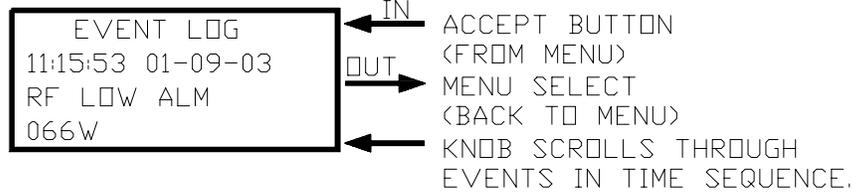
In the event of a fault or alarm or Local Override the *fault & alarm display screen* automatically becomes active. This screen will capture the four most recent faults and alarms that occur at the same time.



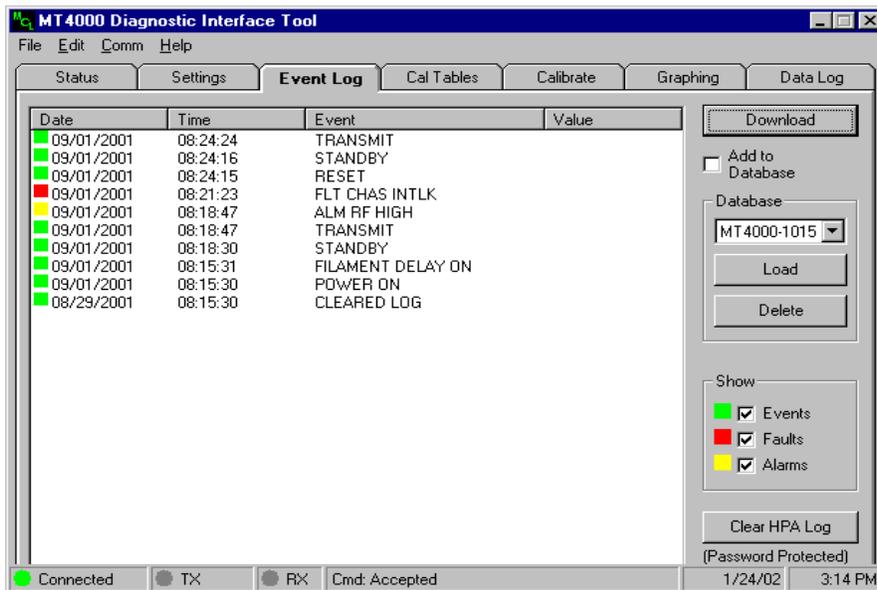
8.2 Event, Fault, & Data Logs

Once the *fault & alarm display screen* is cleared the *event log screen* or *fault log screen* can be used to analyze the sequence of events around a failure.

EVENT <FAULT> LOG SCREEN



Through the diagnostic interface the whole event log (shown below) can be downloaded and viewed at the same time. See TN4000-3 *Technical Note, Operation of MT4000 TWTA* for instructions on downloading the event log.



If the event/fault log is cleared before the failure is analyzer there is also a data log (shown below), which cannot be cleared and can only be accessed through the diagnostic interface. See TN4000-3 *Technical Note, Operation of MT4000 TWTA* for instructions on downloading the data log.

Log	Time	Date	PS Temp (°C)	Tube Temp (°C)	Filament Current (A)	Helix Current (mA)
0	00:00:00	12:30:99	0	0	0.00	0.0
1	15:16:49	01:24:02	99	120	1.21	12.2
2	16:16:49	01:24:02	99	220	2.23	22.5
3	18:16:49	01:24:02	99	220	2.23	22.5
4	21:16:49	01:24:02	99	220	2.23	22.5
5	01:16:49	01:25:02	99	220	2.23	22.5
6	06:16:49	01:25:02	99	220	2.23	22.5
7	12:16:49	01:25:02	99	220	2.23	22.5
8	19:16:49	01:25:02	99	220	2.23	22.5
9	03:16:49	01:26:02	99	220	2.23	22.5
10	12:16:49	01:26:02	99	220	2.23	22.5
11	22:16:49	01:26:02	99	220	2.23	22.5
12	13:16:49	01:25:02	99	120	1.21	12.2
13	14:16:49	01:25:02	99	220	2.23	22.5
14	16:16:49	01:25:02	99	220	2.23	22.5
15	19:16:49	01:25:02	99	220	2.23	22.5
16	23:16:49	01:25:02	99	220	2.23	22.5
17	04:16:49	01:26:02	99	220	2.23	22.5
18	10:16:49	01:26:02	99	220	2.23	22.5
19	17:16:49	01:26:02	99	220	2.23	22.5
20	01:16:49	01:27:02	99	220	2.23	22.5

8.3 Tube Fault Counter

If the MT4000 tube is nearing the end of its life the Fault Counter may be turned on to allow the HPA to automatically reset the tube faults and return to Transmit. Faults that will be counted are:

- High Voltage Under Volt fault
- High Voltage Over Volt fault
- Helix Surge Current fault
- Helix Run Current fault

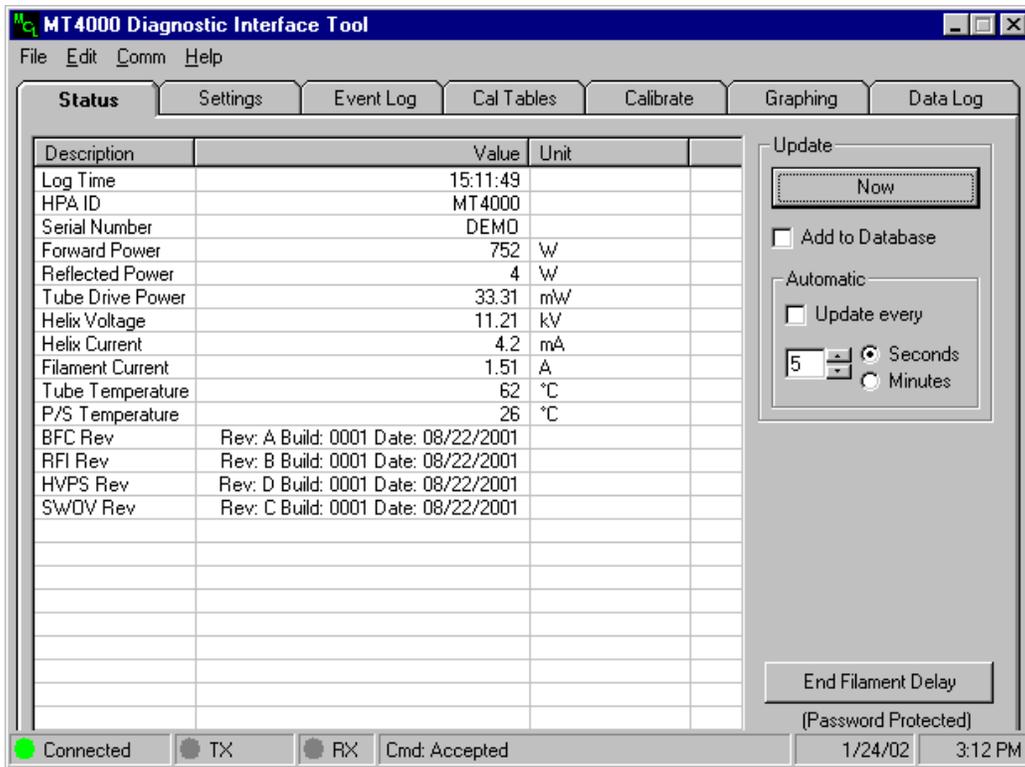
See TN4000-3 *Technical Note Operation of MT4000 TWTA* for instructions on setting up the fault counter.

8.4 Automatic Diagnostic Interface Status

The Diagnostic Interface program can be set up to automatically download status and save it to a database. Check the “update every” box and set the time between downloads. Also the “add to database” box must be checked to automatically save downloads to an Access 97 or better compatible database.

CAUTION

The Access data base file will grow large quickly if the update time is set low, be sure you have enough free disc space. Set the update time as high as you can while “Add to Database” is checked



9.0 POTENTIOMETER, LED, & TEST POINT LOCATIONS

	REF	LOCATION	FUNCTION	
POTENTIOMETERS	R123	D161001 PS Interface CCA, HVPS assembly	Helix Run Current Trip Level	
	R124		Helix Surge Current Trip Level	
	R25	D16983 Buck Current Controller, HVPS assembly	Cathode Voltage Set Level Adjustment	
	R1	C16994 Arc Sensor CCA, RF Output assembly	Waveguide Arc fault threshold	
		Adjustment hole in top back of the HV Transformer & Filter assy.	Filament Voltage set	
	WARNING! <i>DO NOT ADJUST THE FILAMENT VOLTAGE UNLESS THE HPA IS NOT IN TRANSMIT. PUSH THE INTERLOCK SWITCH IN (FAULTED POSITION) WHILE MAKING THE ADJUSTMENT.</i>			
	R60	D16989 RF Interface CCA, RF Input assembly	Tube Drive Power Analog Status Gain	
	R62		RF Forward Power Analog Status Gain	
	R63		RF Reflected Power Analog Status Gain	
	LEDS	DS1	D16989 RF Interface CCA, RF Input assembly	Internal bus transmit data, indicates D16989 is transmitting
DS2		Heartbeat, indicates operational status of D16989 (see TN4000-4)		
DS1		D161001 PS Interface CCA, HVPS assembly	Transmit, indicates the High Voltage power supply is on.	
DS2			TXD, indicates D161001 is transmitting on the Internal bus	
CR18		Switchover & User Interface CCA, Front Panel assembly	Indicates the Switchover & User Interface is transmitting on the Internal bus	
CR4		Basic Functions Controller, Front Panel assembly	Indicates a Summary Fault	
CR5			Indicates a Reset pulse	
CR6			Indicates when not in Transmit	
CR13			Indicates RF Off	
DS1		D16985 PFC2 CCA, PPM assembly	Boost Enable, indicates the line voltage is greater than 180V AC	
DS2			+55V Start, Logic Power & fans are on	
DS3			PPM Ready, bus voltage is greater than 442V DC	
DS4			+15VB, PPM house keeping power supplies are on, the line voltage is greater than 60V AC	
DS5			+15VA, PPM house keeping power supplies are on, the line voltage is greater than 60V AC	
TEST POINTS		TB1-1	D16989 RF Interface CCA, RF Input assembly	+5V DC Logic Power
		TB1-2		Return
	TB1-3	+15V DC Logic Power		
	TB1-4	Return		
	TB1-5	-15V DC Logic Power		
	TB1-6	+15V DC SSA Power		
	TB1-7	Return		
	TB1-8	SSA RF Inhibit		
	TB1-9			
	TB1-10	SSA Gain Control		
	TB2-1	D16989 RF Interface CCA, RF Input	Not used	

	REF	LOCATION	FUNCTION
	TB2-2	assembly	Tube Drive Power Sample to A to D
	TB3-1		Reflected Power Sample to A to D
	TB3-2		Forward Power Sample to A to D
	TB4-1		Not used
	TB4-2		Not used
	TB5-1		Tube Temperature Sample to A to D
	TB5-2		A to D V_{ref}
	TP1		D161001 PS Interface CCA, HVPS assembly
	TP2	Helix Run Current Sample	
	TP3	Watchdog Reset Input	
	TP4	Helix Surge Current Sample	
	TP5	Helix Run Current Set Point	
	TP6	Helix Surge Current Set Point	
	TP7	Microprocessor Transmit Command	
	TP8	10 μ s Astable Output	
	TP9	Primary Current Trip	
	TP10	Cathode Voltage Low Trip	

10.0 RF METER CALIBRATION PROCEDURES

To calibrate most analog channels the HPA must be removed from the system cabinet to provide access to the inside of the HPA.

Calibration of the HPA requires the use of MCL Document 45A0158, *Diagnostic Interface Calibration and Test Program*. A PC with a RS232 cable will be required. The cable will connect to the Diagnostic Interface on the front panel of the HPA. The Diagnostic Interface program has calibration instructions built into the calibration screen for each parameter. The HPA must be in the Local mode to be able to calibrate RF channels.

CAUTION

Calibrating any analog channel may change the fault and alarm levels associated with that channel; all settings must be rechecked after calibration.

These procedures give an outline for viewing, calibrating, and uploading data to the HPA. The diagnostic interface program has information built into the Help menu to give the operator additional assistance. The Windows cut & paste functions are enabled on all program tabs except “Calibrate”.

10.1 Uploading Calibration Tables to the HPA

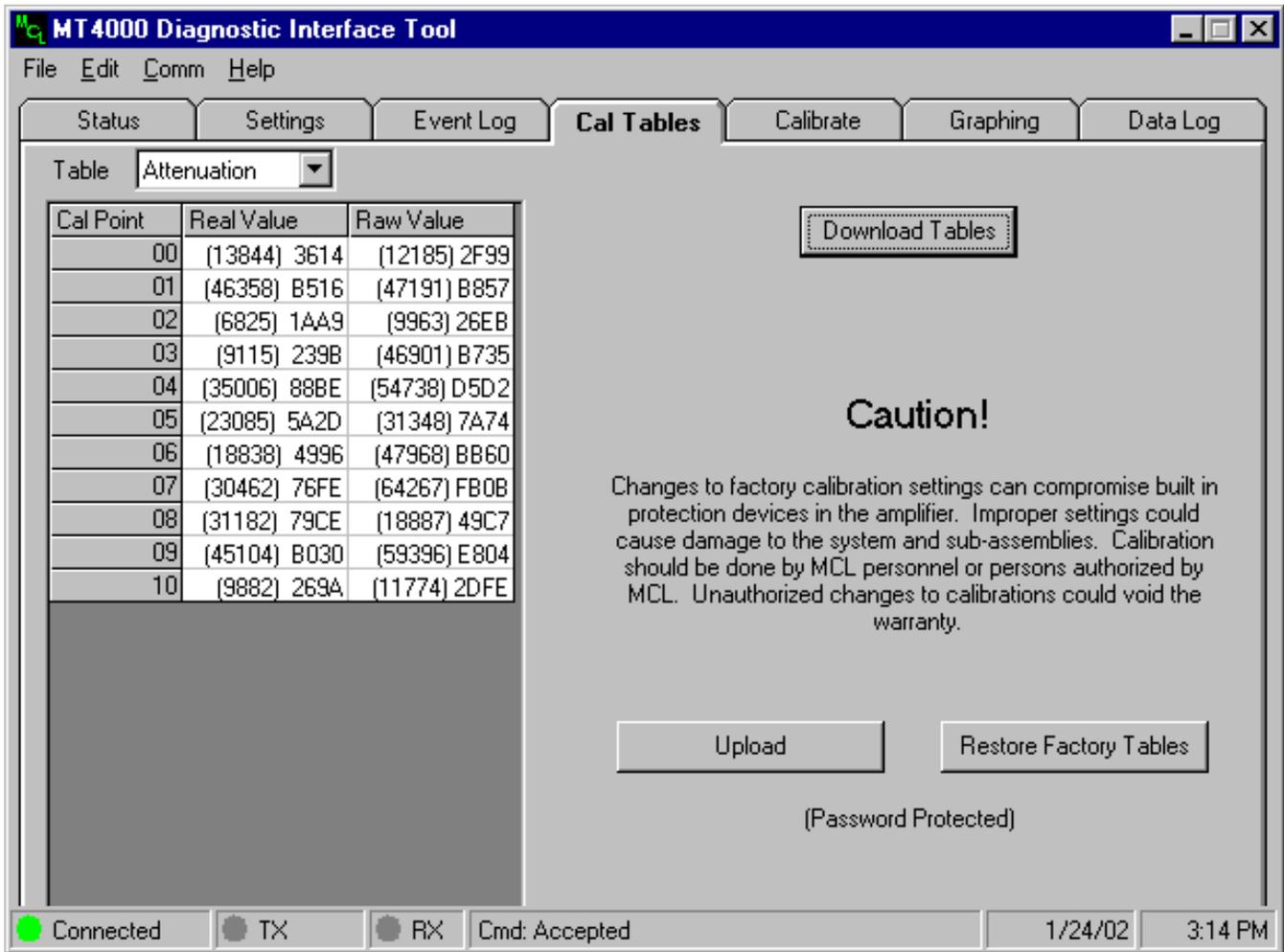
This procedure can be used after the D16989 RF Interface CCA or RF Input assembly has been replaced. The diagnostic interface program has information built into the Help menu to give the operator additional assistance.

1. The HPA must be in a maintenance mode (the HPA is not transmitting on the antenna). It must be in Local and not carrying traffic or an interruption in service may occur.

CAUTION

The HPA must be in a maintenance mode to upload calibration tables or an interruption of service may occur.

2. On the Diagnostic Interface program click on the “Cal Tables” tab (see the figure below).

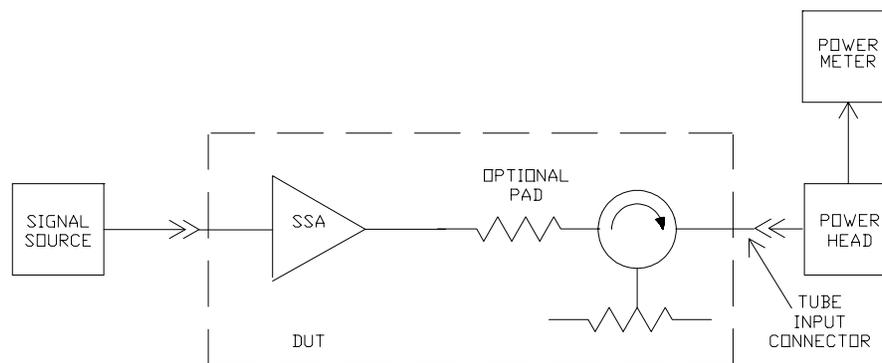


3. If necessary, insert the disc into the PC, which contains the calibration table’s file.
4. Click on the “File” menu, select “Open” on that menu, then on the Open menu select “Calibration”, then select the calibration file and click OK.
5. Click on the “Upload” button, the password is “MCL”.
6. The status bar on the bottom of the screen should say “Cmd: Accepted” when the upload is complete.

10.2 Tube Drive Power Meter Calibration

This procedure can be used after the D16989 RF Interface CCA or RF Input assembly has been replaced. The diagnostic interface program has information built into the Help menu to give the operator additional assistance. Calibrate the HPA meter as follows:

1. On the Diagnostic Interface program, click on the “Calibrate” tab. The password is “MCL”. On the “Table” selection window select “Tube Drive.” Set the “Number of Points” to 9. DO NOT click “Begin” yet.
2. The HPA circuit breaker is Off, disconnect the AC cord from the HPA.
3. Disconnect the RF input cable (including the isolator adapter, and PAD) at the tube input.



WARNING

AC power must be disconnected from the HPA during this set-up step.

4. Connect a calibrated power meter that can take +20 dBm to the open tube input cable.
5. Connect a sweeper/synthesizer to the HPA input with the output turned all the way down. Be sure the sweeper/synthesizer has an adjustment range down to -50 dBm. Once you click the “Begin” button on the Diagnostic Interface program the HPA attenuator will not be operational. Set the sweeper/synthesizer to the center frequency of the HPA on CW.
6. Reconnect the HPAs power cord, turn the HPA on, adjust the attenuator to 0.0 dB, put the HPA into Delay and RF On.
7. Connect a DVM to measure the A to D input on D16989 (RF Interface CCA) TB2 pin 2.
8. Turn potentiometer D16989-R60 full CCW this should reduce the voltage on TB2-2 to minimum.
9. Use a full-scale value as shown in the following table.

BAND	PAD VALUE		
	NONE	3dB	6dB
C	50mW	25mW	12mW
Ku	50mW	25mW	12mW
Ku (DBS)	35mW	18mW	10mW

10. Calculate calibration power levels at 100, 75, 50, 33, 25, 13, 7, 2 and 0 percent of full scale. Record the calculated points in mW and include the tenth decimal place.
11. On the Diagnostic Interface program click the “Begin” button. Once you click Begin all faults & alarms for Tube Drive power will be disabled.
12. Adjust the power level on the calibrated power meter to full scale for the Tube Drive Meter.
13. Adjust D16989-R60 to produce 3.8VDC on the DVM.
14. Adjust the sweeper/synthesizer output power level until the SSA output is 0.0mW.
15. For point #00 type in the power level (00) including the tenth decimal place but not the decimal. Click the “Set” button once you have typed the power level.
16. Increase the sweeper/synthesizer output and enter the next power level. You must enter the calibration points starting at 0 and working your way to full scale. Do not skip any points; they must be entered in order.

NOTE

There is a timer between calibration points. If you take more than 5 minutes between any two points you will have to start the calibration process again.

17. After you have entered all 9 points adjust the SSA output to the middle of the scale.
18. On the Diagnostic Interface program check the “Save” dot and click the “Done” button.

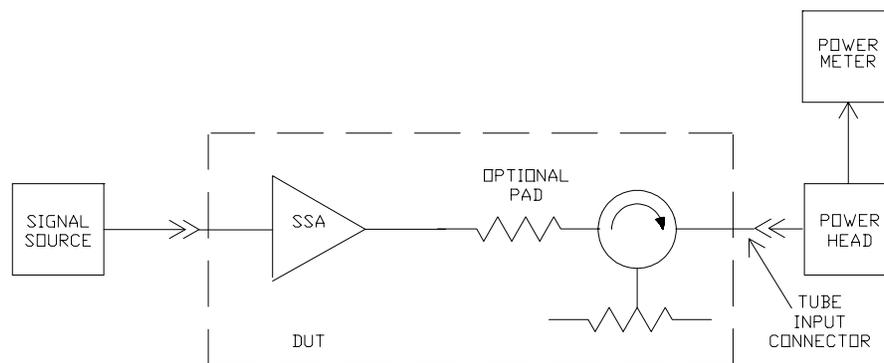
NOTE

If you cause a RF Overdrive fault the HPA will be forced into the RF Off state. You must reduce the RF level to clear the fault.

10.3 Attenuator Calibration

This procedure can be used after the D16989 RF Interface CCA or RF Input assembly has been replaced. The diagnostic interface program has information built into the Help menu to give the operator additional assistance. Calibrate the HPA meter as follows:

1. On the Diagnostic Interface program, click on the “Calibrate” tab. The password is “MCL”. Click on the “Table” selection window, select “Attenuation.” The “Number of Points” will be fixed at 12. DO NOT click “Begin” yet.
2. The HPA circuit breaker is Off, disconnect the AC cord from the HPA.
3. Disconnect the RF input cable (including the isolator adapter, and PAD) at the tube input.



WARNING

AC power must be disconnected from the HPA during this set-up step.

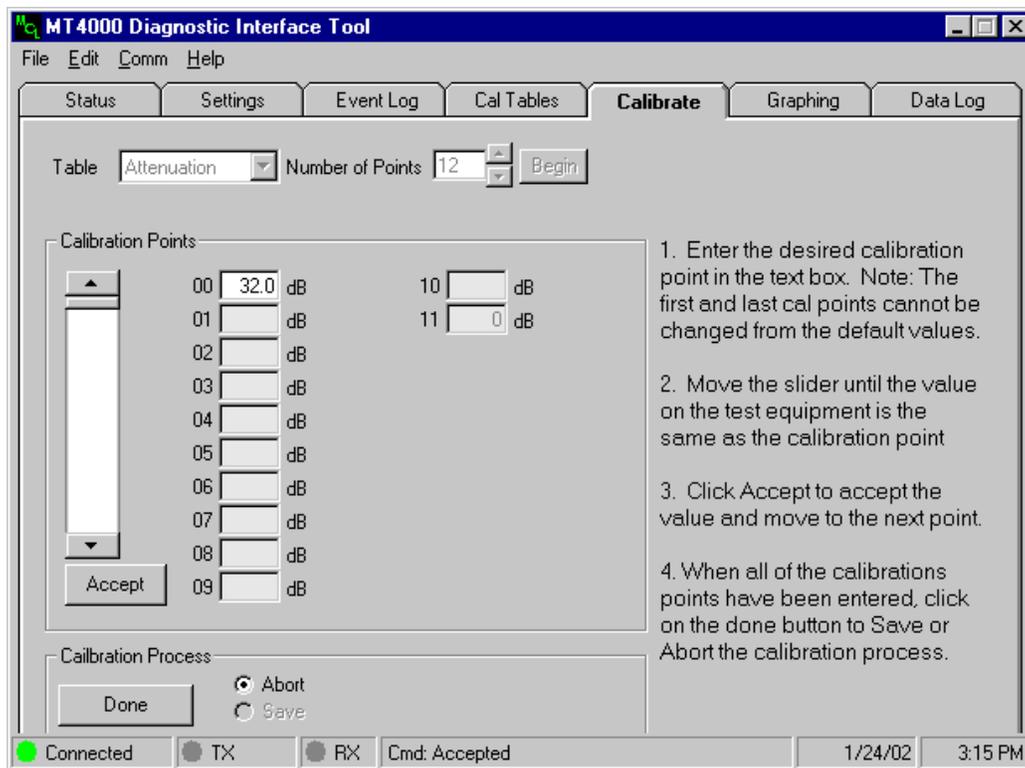
4. Connect a calibrated power meter that can take +20 dBm to the open tube input cable.
5. Connect a sweeper/synthesizer to the HPA input with the output turned all the way down. Be sure the sweeper/synthesizer has an adjustment range down to -50 dBm. Once you click the “Begin” button on the Diagnostic Interface program the HPA attenuator will not be operational. Set the sweeper/synthesizer to the center frequency of the HPA on CW.
6. Reconnect the HPAs power cord, turn the HPA on, adjust the attenuator to 0.0 dB, and put the HPA into Delay and RF On.
7. Connect a DVM to measure the attenuator (Gain Control) voltage on TB1-10 of D16989 (RF Interface CCA).

8. Adjust the attenuator to 0.0 dB and using the sweeper/synthesizer adjust the power level on the calibrated power meter to +10 dBm. At this time the DVM should read approximately 10.0V
9. Put the HP power meter in the relative mode and adjust the HPA attenuator until the HPA display is 32.0 dB. Once you click the “Begin” button on the Diagnostic Interface program the HPA attenuator will be not be operational. At this time the DVM should read approximately 0.0V.
10. Calibration attenuation levels should be as close as possible to 32.0, 31.0, 30.0, 25.0, 20.0, 15.0, 10.0, 5.0, 1.5, 0.8, 0.3, 0.0 dB.

NOTE

The SSA can have an attenuation range as low as 30.0dB. If the range is less than 31.5 dB, change the 31 dB & 30db calibration points to 29dB & 28dB.

11. On the Diagnostic Interface program click the “Begin” button (see the figure below).



12. On the PC keyboard press the enter button to enter the 32.0 dB point.

13. On the Diagnostic Interface program use the adjustment bar (on the left side of the screen) to adjust the reading on the HPA power meter to 31.0 dB. Check that each calibration point has a different and progressive voltage. Type the HP power meter reading into the point 01 box on the Diagnostic Interface program and press the enter key.
14. Repeat step 13 for each calibration point. You must enter the calibration points starting at 32.0 dB and work your way to 0.0 dB. Do not skip any points; they must be entered in order.

NOTE

There is a timer between calibration points. If you take more than 5 minutes between any two points you will have to start the calibration process again.

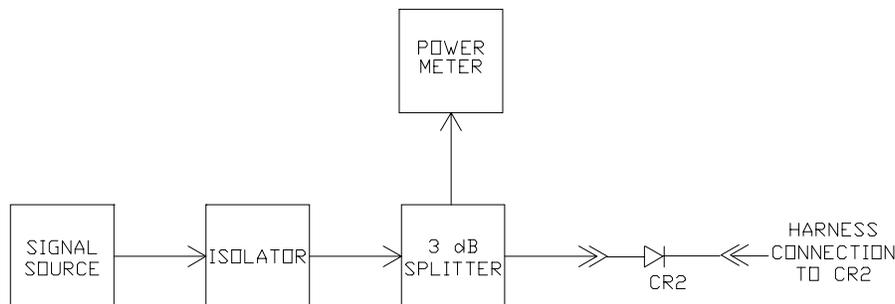
15. Check the “Save” dot and click the “Done” button once you have entered all 12 points.

10.4 Reflected Meter Calibration

This procedure can be used after the D16989 RF Interface CCA, CR2 detector, or RF output assembly has been replaced. The diagnostic interface program has information built into the Help menu to give the operator additional assistance.

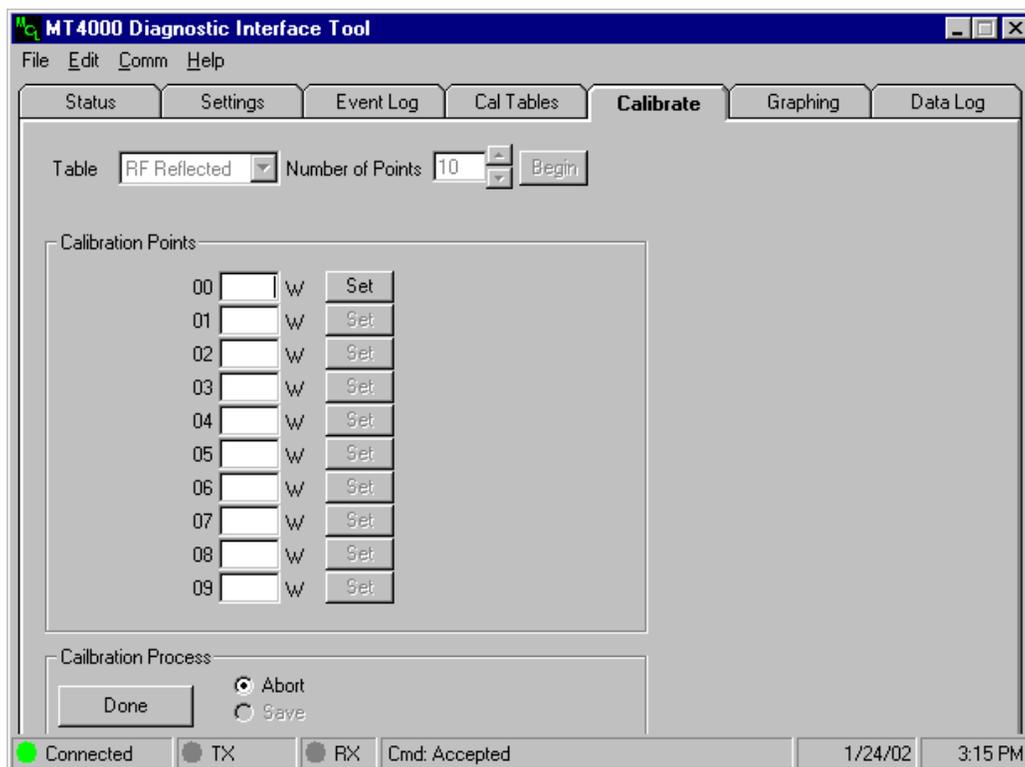
During this procedure you will be injecting a signal into the reflected power sensor but the HPA will also need to be placed into Transmit to turn on the analog status display. Be sure the RF input of the HPA is terminated. Calibrate the HPA meter as follows:

1. Disconnect the reflected power detector from port #2 of the waveguide assembly.
2. Set-up the test equipment as shown below. Leave the sweeper/synthesizer output off. Set the sweeper/synthesizer to the center frequency of the HPA on CW.



3. Connect a DVM to measure the A to D input on D16989 (RF Interface CCA) TB3 pin 1.

4. Turn potentiometer D16989-R63 full CCW; this should reduce the voltage on TB3-1 to minimum.
5. Use a full-scale value of 100W for C or Ku-band and 60W for DBS-Ku-band. Record the value used.
6. Calculate & record calibration power levels at 100, 80, 60, 40, 25, 13, 7, 4 and 0 percent of full scale.
7. Record the coupling factor at the center frequency marked on the HPA coupler port (DC1 port 2). Calculate the required detector input power for each HPA reflected power. Determine if you need a SSA on the sweeper/synthesizer output to achieve these levels.
8. Put the HPA into the Transmit mode.
9. On the Diagnostic Interface program, click on the “Calibrate” tab. The password is “MCL”. On the Diagnostic Interface program click on the “Table” selection window and select “RF Reflected.” Set the “Number of Points” to 9. Click the “Begin” button. Once you click Begin all faults and alarms for Reflected power will be disabled (see the figure below).



10. Adjust the power level on the calibrated power meter to full scale for the Reflected power Meter.

11. Adjust D16989-R63 to produce 3.8VDC on the DVM.
12. Adjust the sweeper/synthesizer output power level until the detector input is 0.0W.
13. For point #00 type in the power level (00). Click the “Set” button once you have typed the power level.
14. Increase the sweeper/synthesizer output and enter the next power level. You must enter the calibration points starting at 0 and working your way to full scale. Do not skip any points; they must be entered in order.

NOTE

There is a timer between calibration points. If you take more than 5 minutes between any two points you will have to start the calibration process again.

15. Check the “Save” dot and click the “Done” button once you have entered all 9 points. You may receive a Reflected Power fault once you press the Done button.

10.5 Forward Power Meter Calibration

This procedure can be used after the D16989 RF Interface CCA, CR1 detector, or RF output assembly has been replaced. The diagnostic interface program has information built into the Help menu to give the operator additional assistance. Calibrate the HPA meter as follows:

1. Make sure the HPA is in Standby and RF Off and adjust the attenuator to 0.0 dB.
2. Connect the sweeper/synthesizer to the HPA input with the output turned all the way down. Be sure the sweeper/synthesizer has an adjustment range down to -50 dBm. Once you click the “Begin” button on the Diagnostic Interface program the HPA attenuator will not be operational. Set the sweeper/synthesizer to the center frequency of the HPA on CW.
3. Connect a DVM to measure the A to D input on D16989 (RF Interface CCA) TB3 pin 2.
4. Turn potentiometer D16989-R62 full CCW; this should reduce the voltage on TB3-2 to minimum.
5. Use a full-scale value of 700W for C or Ku-band and 450W for DBS-Ku-band. This value may be adjusted down for lower power tubes.
6. Calculate and record calibration power levels at 100, 85, 71, 50, 20, 10, 8, 5, 3.5, 2, 1, and 0 percent of full scale shown in the data sheet.

7. Put the HPA into Transmit.
8. On the Diagnostic Interface program click on the “Table” selection window and select “RF Forward.” Set the “Number of Points” to 12. Click the “Begin” button. Once you click Begin all faults & alarms for Forward power will be disabled.
9. Put the HPA into RF On and adjust the power level on the calibrated power meter to full scale for the RF Forward power meter.
10. Adjust D16989-R62 to produce 3.8VDC on the DVM.
11. Adjust the sweeper/synthesizer output power level until the HPA output is 0W.
12. On the Diagnostic Interface program for point #00 type in the power level (00), and click the “Set” button once you have typed the power level.
13. Increase the sweeper/synthesizer output and enter the next power level. You must enter the calibration points starting at 0 and working your way to full scale. Do not skip any points; they must be entered in order.

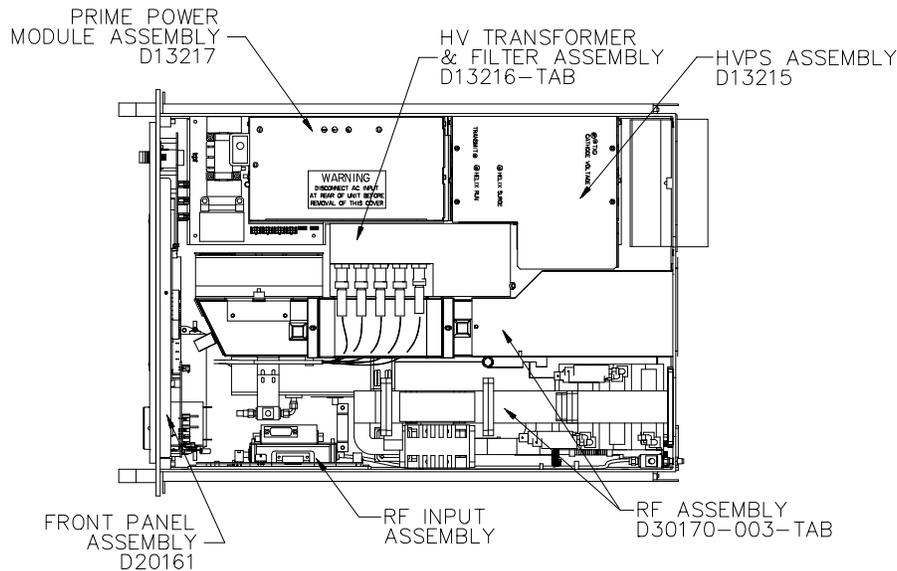
NOTE

There is a timer between calibration points. If you take more than 5 minutes between any two points you will have to start the calibration process again.

14. Check the “Save” dot and click the “Done” button once you have entered all 12 points.

11.0 FRU REPLACEMENT PROCEDURES

The following procedures assume that the individual(s) performing the procedure has a general knowledge on the usage of hand tools and hardware. It also assumes the individual(s) have a working knowledge of electronics and RF Satcom Equipment.



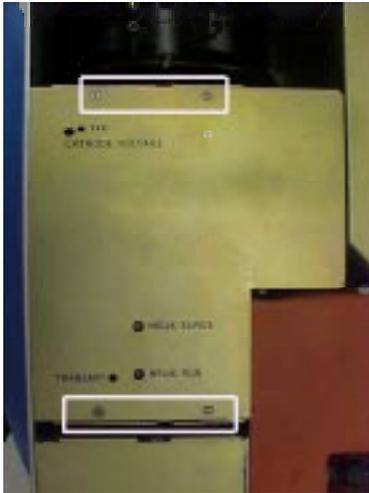
The figure above depicts the location of each Field Replaceable Units.

WARNING

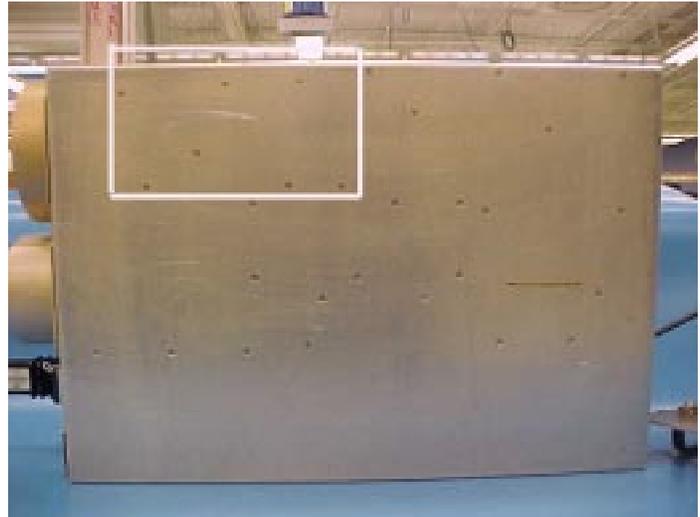
High voltages are present in a fully operational MT4000. The cathode and filament voltages are over ten thousand Volts. Since these voltages could occur at locations and under conditions, which are unexpected, particularly if the unit is malfunctioning, extreme caution is advised. Always make sure that the chassis is earth grounded (see installation caution). Use caution in connecting scope probe grounds.

11.1 D13215 High Voltage Power Supply Removal & Replacement Procedure

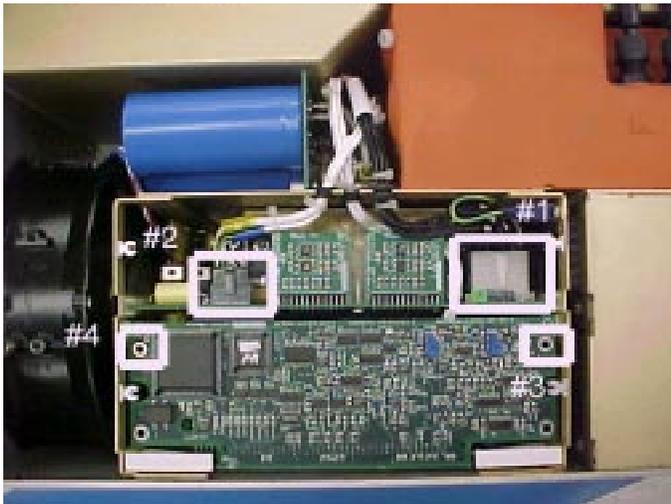
The following procedure assumes that the TWTA is disconnected from AC Power and the HPA top cover is removed. If removal of cable assemblies becomes necessary remember to label all items so when reconnecting the module(s) there is less confusion. While performing this procedure understand that HV Wires will be handled. It is very important that the wires are handled carefully.



Place the TWTA onto a bench that can properly support the weight. Remove the four screws holding the top cover of the HVPS Field Replaceable Unit (FRU) Module & remove the cover.



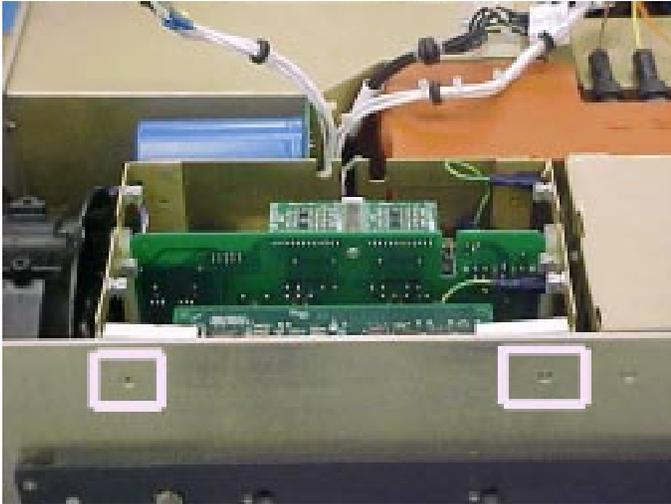
In the box shown to the right are the screws that hold the HVPS assembly in place. Remove the hardware for the HVPS. Once done, place the HPA on a bench right side up. The assembly is not removable yet.



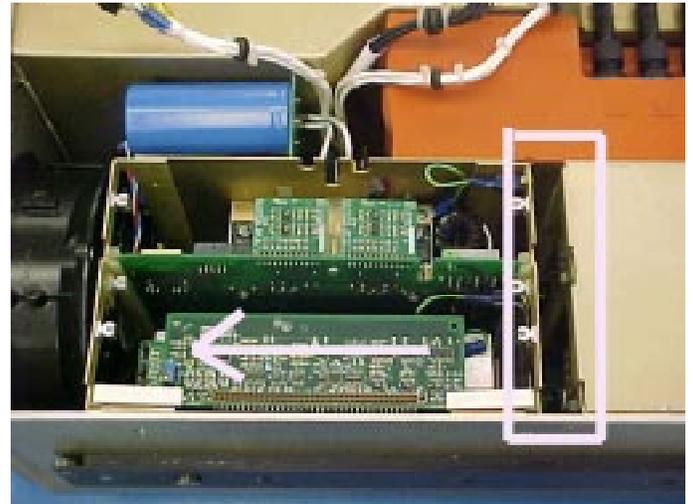
- #1: Disconnect the 'flying' HV (regulation) wire harness from the HVTFAs to the HVPS
- #2: Disconnect the 'flying' LV (feedback) wire harness from the HVTFAs to the HVPS
- #3 & #4; Remove CCA (after removing 2 screws), to expose the third connection that needs to be disconnected.

Disconnect the third connection (filaments) from the HVPS shown at the right.

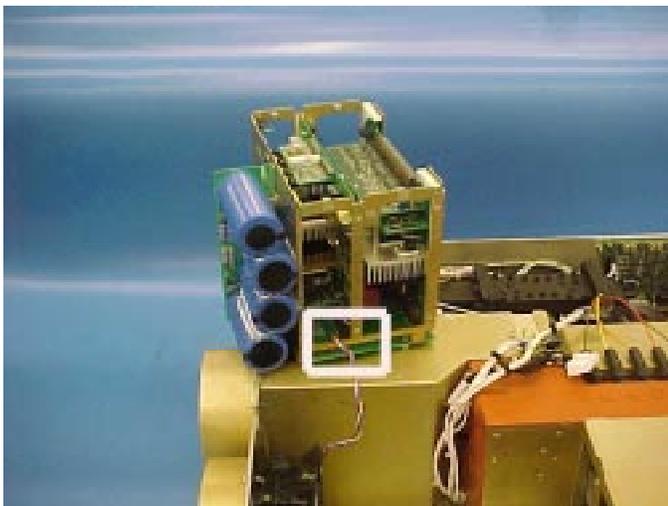




Remove the two screws on the side of the TWTA shown at the left.



Slide the HVPS assembly to the rear of the TWTA as shown at the right until the HVPS disconnects from the PPM assembly.



Once the HVPS assembly is disconnected from the PPM assembly, slowly lift it straight up and set it on the RF output assembly.

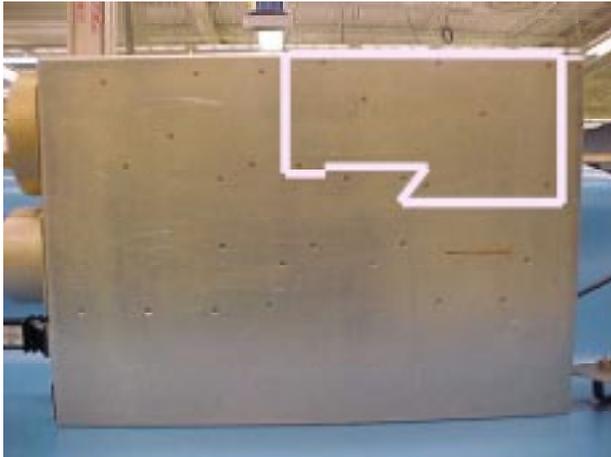
The last removal step is to disconnect the blower. The D13215 HVPS assembly can now be removed from the HPA.

The replacement procedure is the removal procedure in reverse order. Again, make sure care is taken with the HV wires. MCL will provide the necessary information to calibrate the HVPS to the MT4000 TWTA.

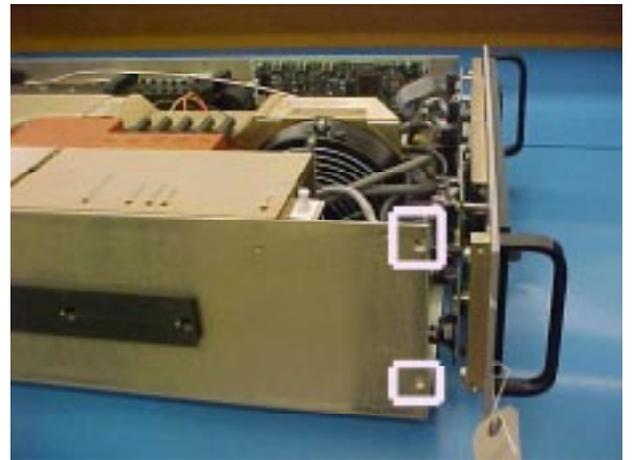
If there are any problems that are encountered with this procedure or there are other concerns please contact MCL Customer Service.

11.2 D13217 Primary Power Module Removal & Replacement Procedure

The following procedure assumes that the TWTA is disconnected from AC Power and the HPA top cover is removed. If removal of cable assemblies becomes necessary remember to label all items so when reconnecting the module(s) there is less confusion. While performing this procedure understand that HV Wires will be handled. It is very important that the wires are handled carefully.



Place the TWTA onto a bench that can properly support the weight. In the box shown to the left are the screws that hold the PPM assembly in place. Remove the hardware for the PPM. Once the hardware is removed, place the HPA on a bench right side up. The assembly is not removable yet.



Remove the D20161 front panel assembly screws, two on each side of the front panel. Once the screws are removed pull the front panel assembly forward slightly to allow space to move the PPM assembly.



Disconnect the AC wires from the PPM assembly shown at the left.

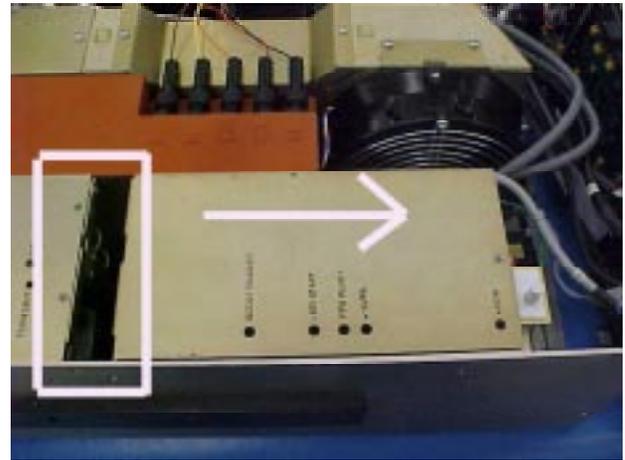


Remove the two-PPM mounting screws from the HPA sidewall (shown at right). The PPC can now be removed.



Disconnect W11 & W22 from the D20161 front panel assembly; these connect to the PPM.

Slide the PPM forward until it disconnects from the HVPS assembly. Once the PPM is disconnected it can now be removed from the MT4000 drawer. Slowly move the PPM straight out of the drawer. CAUTION, when you move the PPM make sure you do not force the unit in or out of the drawer.



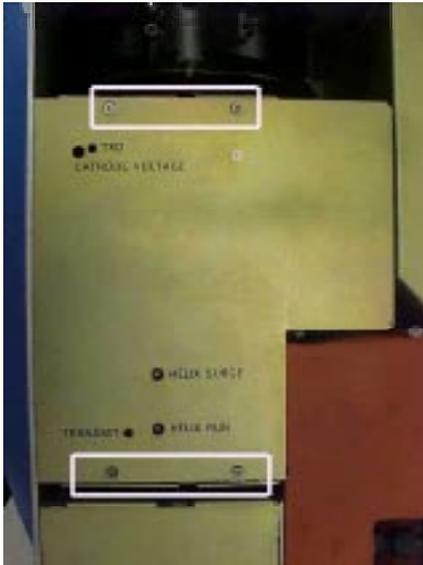
Disconnect the last cables from the PPM as shown at the left to remove the FRU from the HPA

The replacement procedure is the removal procedure in reverse order. Again, do not force the connection of the PPM assembly to the HVPS assembly. Forcing any connection can result in damage to connectors. No potentiometer adjustments are required for this procedure.

If there are any problems that are encountered with this procedure or there are other concerns please contact MCL Customer Service.

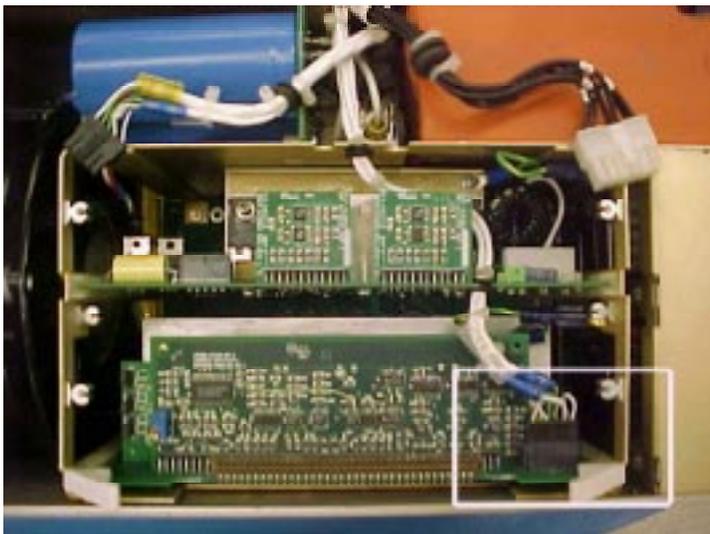
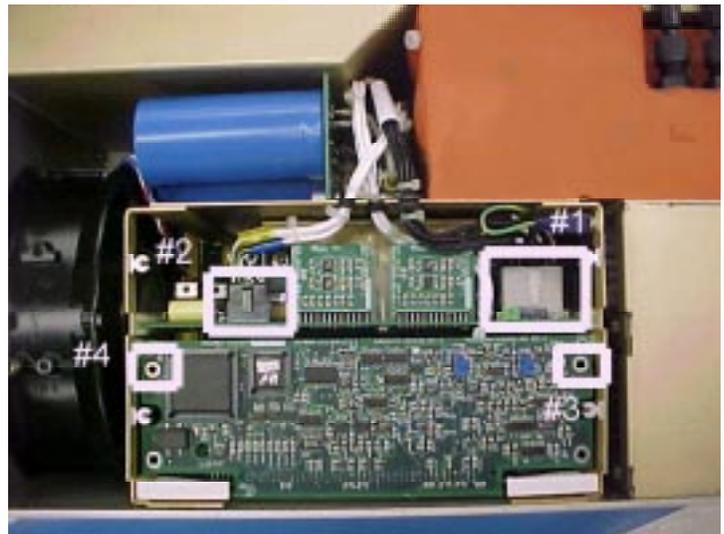
11.3 D13216-TAB High Voltage Transformer & Filter Assembly Removal & Replacement Procedure

The following procedure assumes that the TWTA is disconnected from AC Power and the HPA top cover is removed. If removal of cable assemblies becomes necessary remember to label all items so when reconnecting the module(s) there is less confusion. While performing this procedure understand that HV Wires will be handled. It is very important that the wires are handled carefully.

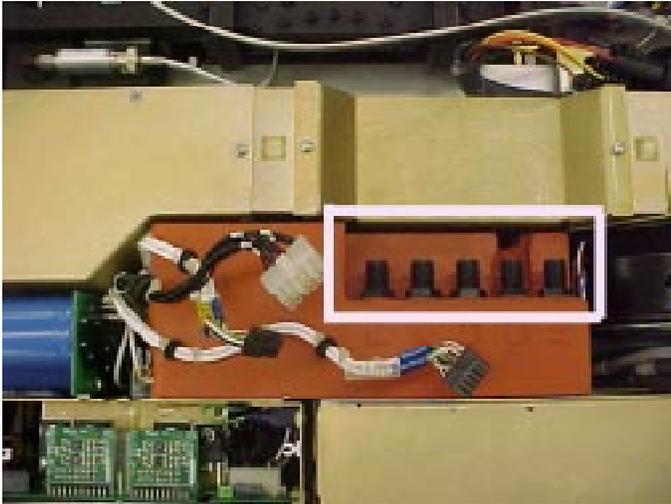


Place the TWTA onto a bench that can properly support the weight. Remove the four screws holding the top cover of the HVPS Field Replaceable Unit (FRU) Module & remove the cover.

- #1: Disconnect the ‘flying’ HV (regulation) wire harness from the HVTFA to the HVPS
- #2: Disconnect the ‘flying’ LV (feedback) wire harness from the HVTFA to the HVPS
- #3 & #4; Remove CCA (after removing 2 screws), to expose the third connection that needs to be disconnected.

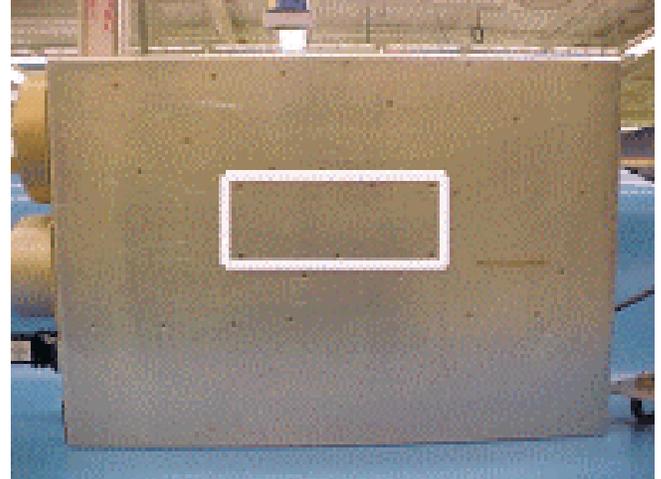


Disconnect the third connection (filaments) from the HVPS shown at the right.



Confirm the high voltage tube leads are labeled correctly. Disconnect the high voltage tube leads from the high voltage connectors shown at the left.

In the box shown to the right are the six screws that hold the High Voltage Transformer & Filter Assembly in place. Have someone hold the High Voltage Transformer & Filter Assembly in place while you remove these screws. Once the screws are removed you can lift the High Voltage Transformer & Filter Assembly out of the HPA.

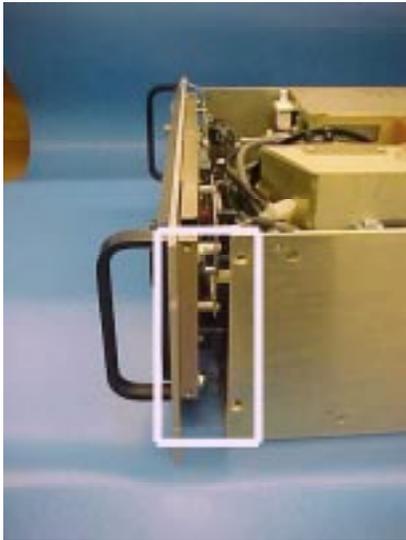


The replacement procedure is the removal procedure in reverse order. Again, make sure care is taken with the HV wires. If potentiometer adjustments are required for this procedure MCL will provide the necessary information to calibrate the High Voltage Transformer & Filter Assembly.

If there are any problems that are encountered with this procedure or there are other concerns please contact MCL Customer Service.

11.4 D20161 Front Panel Assembly Removal & Replacement Procedure

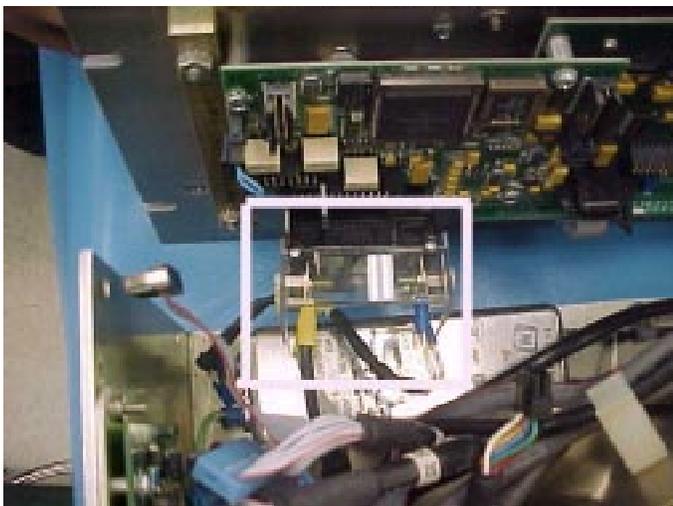
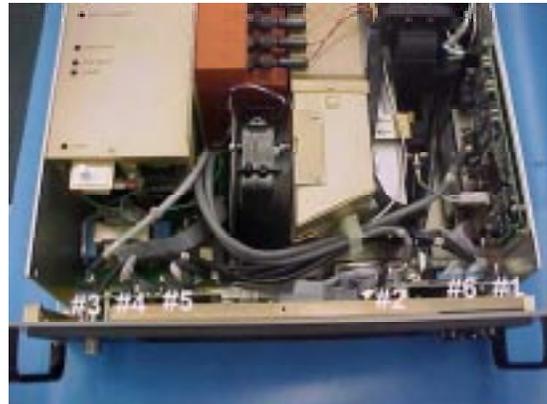
The following procedure assumes that the TWTA is disconnected from AC Power and the HPA top cover is removed. If removal of cable assemblies becomes necessary remember to label all items so when reconnecting the module(s) there is less confusion. While performing this procedure understand that HV Wires will be handled. Some wires/cables may be fixed in place (tie-wrapped) to an immovable part of the HPA. Do not force any connection or pull on any assembly if there is resistance. It is very important that the wires are handled carefully.



Place the TWTA onto a bench that can properly support the weight. Remove the D20161 front panel assembly screws, two on each side of the front panel. Once the screws are removed slightly pull the front panel assembly forward.

Disconnect the following cables from the Front Panel assembly:

- #1- W10 ribbon cable
- #2 - W21 power cable
- #3 - W22 power cable & W28 RF Sample cable
- #4 – W25 round ribbon cable
- #5 – W26 round ribbon cable
- #6 – W30 & W31 round ribbon cables



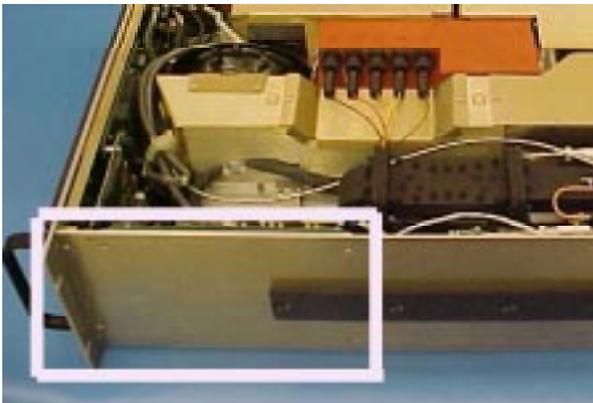
Disconnect the AC connection to the circuit breaker. You can now remove the Front panel assembly.

The replacement procedure is the removal procedure in reverse order. If the D20161 front panel assembly was completely replaced or if the Basic Function Controller CCA were replaced the configuration of the HPA (settings, some fault & alarm trip levels) will have to be reset. This can be done two ways, input the configurations manually or through the diagnostic interface. See the “*Adjustment Menu Screen*” or the “*Uploading Settings to the HPA*” paragraph of TN4000-3 *Technical Note, Operation of MT4000*.

If there are any problems that are encountered with this procedure or there are other concerns please contact MCL Customer Service.

11.5 RF Input Assembly Removal & Replacement Procedure

The following procedure assumes that the TWTA is disconnected from AC Power and the HPA top cover is removed. If removal of cable assemblies becomes necessary remember to label all items so when reconnecting the module(s) there is less confusion. While performing this procedure understand that HV Wires will be handled. Some wires/cables may be fixed in place (tie-wrapped) to an immovable part of the HPA. Do not force any connection or pull on any assembly if there is resistance. It is very important that the wires are handled carefully.

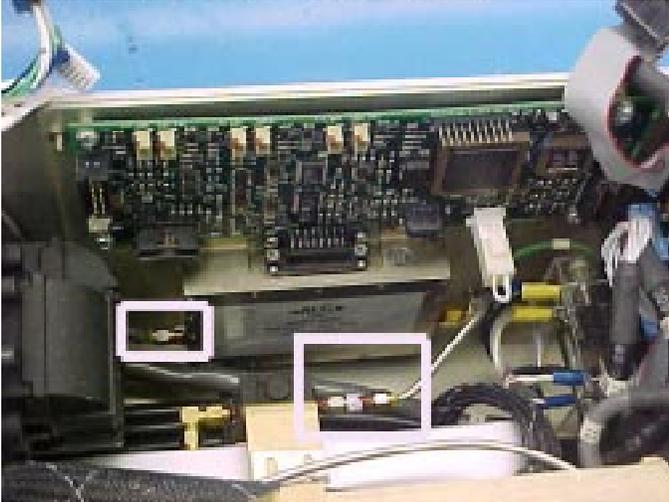


Place the TWTA onto a bench that can properly support the weight. Remove the four mounting screws from the right side wall.

Disconnect the following cables from the RF Input assembly:

- #1- W10 ribbon cable
- #2 - W20 power cable
- #3 – W19 Arc Detector cable & W29 RF interface cable





Disconnect the RF cable between the tube and SSA at the circulator on the tube input.
 Disconnect the SSA RF input cable at the SSA.
 Remove the RF Input Assembly.

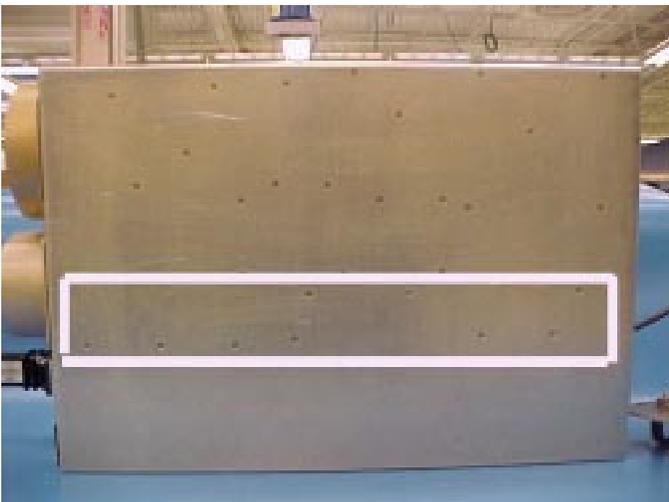
The replacement procedure is the removal procedure in reverse order. Again, make sure no part is forced back into its proper position.

After replacing the RF Input assembly the Tube Drive Power meter & attenuator will have to be calibrated. See the RF Meter Calibration Procedures section of this document.

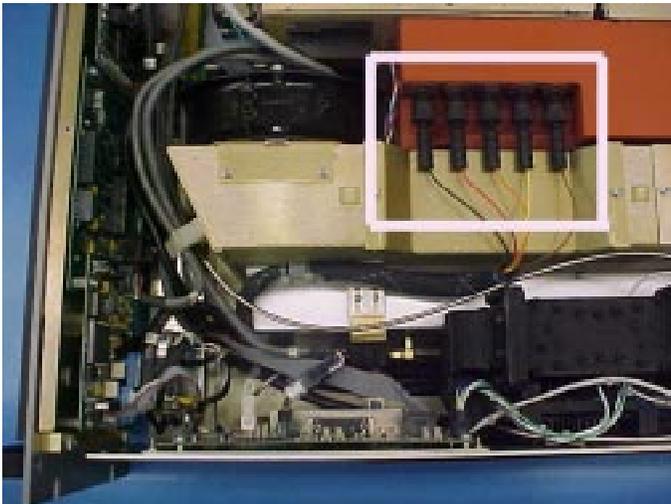
If there are any problems that are encountered with this procedure or there are other concerns please contact MCL Customer Service.

11.6 D30170-003-TAB RF Assembly Removal & Replacement Procedure

The following procedure assumes that the TWTA is disconnected from AC Power and the HPA top cover is removed. If removal of cable assemblies becomes necessary remember to label all items so when reconnecting the module(s) there is less confusion. While performing this procedure understand that HV Wires will be handled. It is very important that the wires are handled carefully.



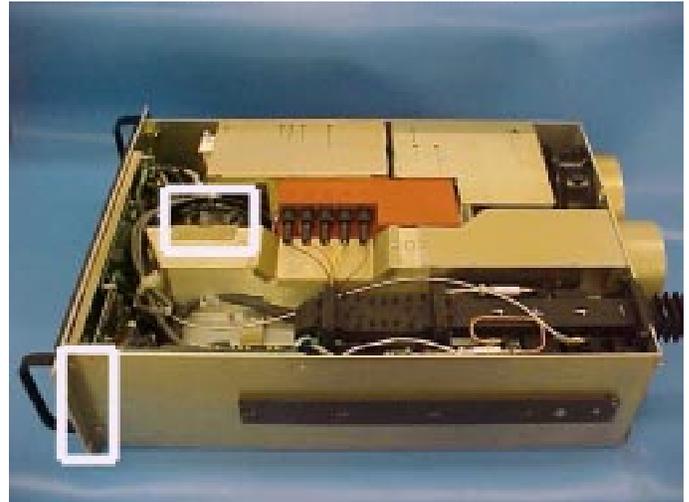
Place the TWTA onto a bench that can properly support the weight. In the box shown to the left are the nine screws that hold the RF output assembly in place. Remove these screws, once done place the HPA on a bench right side up. The assembly is not removable yet.



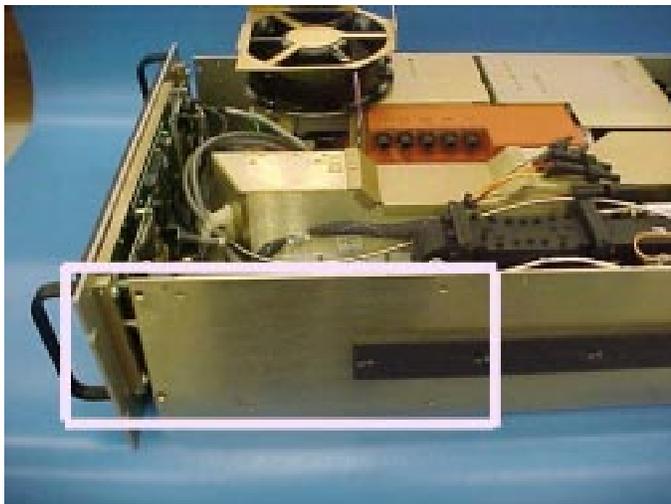
Disconnect the tube high voltage wires from the High Voltage Transformer & Filter Assembly (shown at the right). Be careful not to damage the insulation on these HV wires.

Disconnect the blower from the tube plenum by removing the two screws shown at the left.

Remove the D20161 front panel assembly screws, two on each side of the front panel. Once the screws are removed slightly pull the front panel assembly forward.



Open the cable clamp on the front of the plenum and remove the cables.

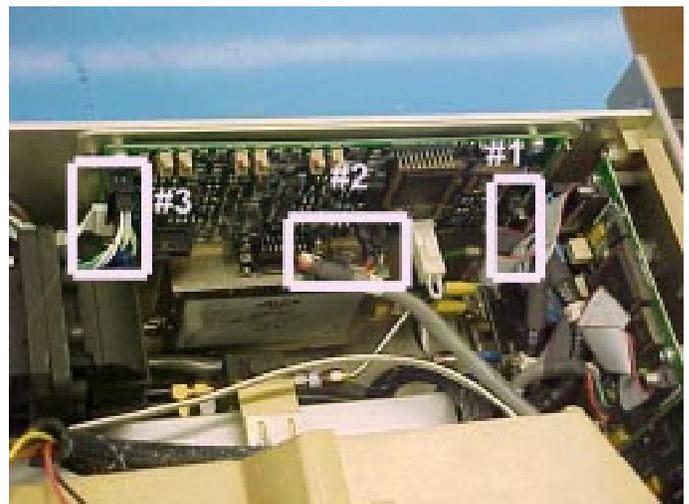


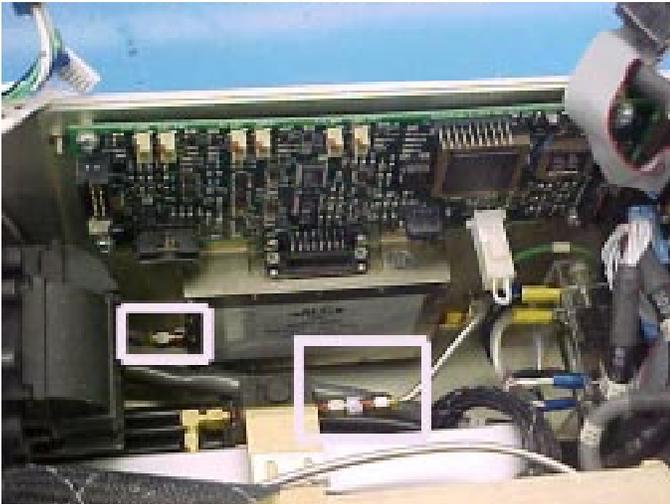
Flip the plenum blower up and on top of the PPM assembly.

Remove the four screws inside the box at the right which hold the RF Input assembly.

Disconnect the following cables from the RF Input assembly:

- #1- W10 ribbon cable
- #2 - W20 power cable
- #3 – W19 Arc Detector cable & W29 RF interface cable





On the back of the HPA remove four waveguide mounting screws and two plenum mounting screws shown at the left. Disconnect and remove the RF input cable assembly.

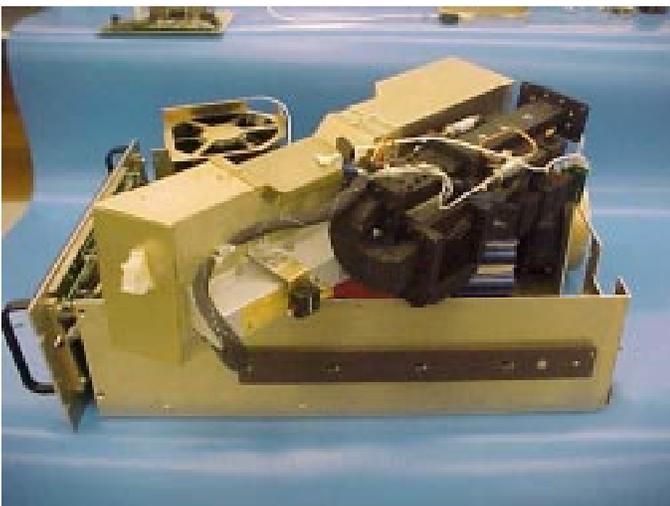
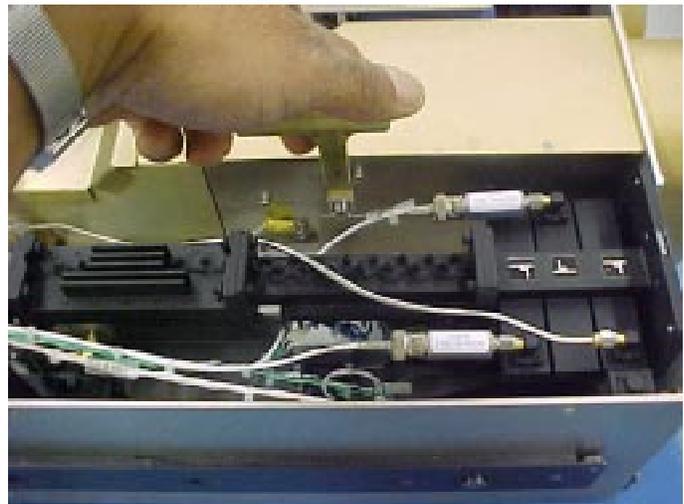
Disconnect the RF cable between the tube and SSA at the circulator on the tube input.
 Disconnect the SSA RF input cable at the SSA.
 Remove the RF Input Assembly.



NOTE

This step requires a second person.

Rotate the T-bar handle to the up position as shown at the right. Slowly and carefully lift the RF output assembly straight up until it is out of the drawer. Make sure no cables are caught as you lift the assembly out



Replace the defective component using D30170-003-TAB assembly print as a guide. NOTE: If the TWT is being replaced, be sure to use heat conductive grease on the tube baseplate.

The replacement procedure is the removal procedure in reverse order. Again, make sure no part is forced back into its proper position. Make sure care is taken with the HV wires.

After replacing the RF Output assembly the RF Forward Power & RF Reflected Power meter calibrations will be off. However, the meter calibrations may be close without going through the calibration process. If you wish to calibrate these meters to obtain the best accuracy see the RF Meter Calibration Procedures section of this document. The calibrations should be performed before the HPA is reinstalled in to the cabinet.

If there are any problems that are encountered with this procedure or there are other concerns please contact MCL Customer Service.

APPENDIX

40A1845

CUSTOMER SERVICE INFORMATION



TN4000-7

Technical Note

Customer Schematics

& Assemblies for MT4000 TWTA

October 24, 2003

Mark Schmeichel
Engineering

10/24//03
Date

LIST OF SCHEMATICS & ASSEMBLIES

43D1418	MT4000 Interface Drawing
32D3733	MT4000 System Interconnect Schematic
D30170	MT4000 Assembly Print
D20161	Front Panel Assembly
D13215	High Voltage Power Supply Assembly
D13217	Prime Power Module Assembly
D30170-003-TAB	RF Assembly
D161001	PS Interface CC Assembly
D16983	Buck Current Controller CC Assembly
D16989	RF Interface CC Assembly