TN4000-6

Technical Note

Troubleshooting & Customer

Service Guide For MT4000 TWTA

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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.

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.

LIST OF HAZARDS (Continued)

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

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.

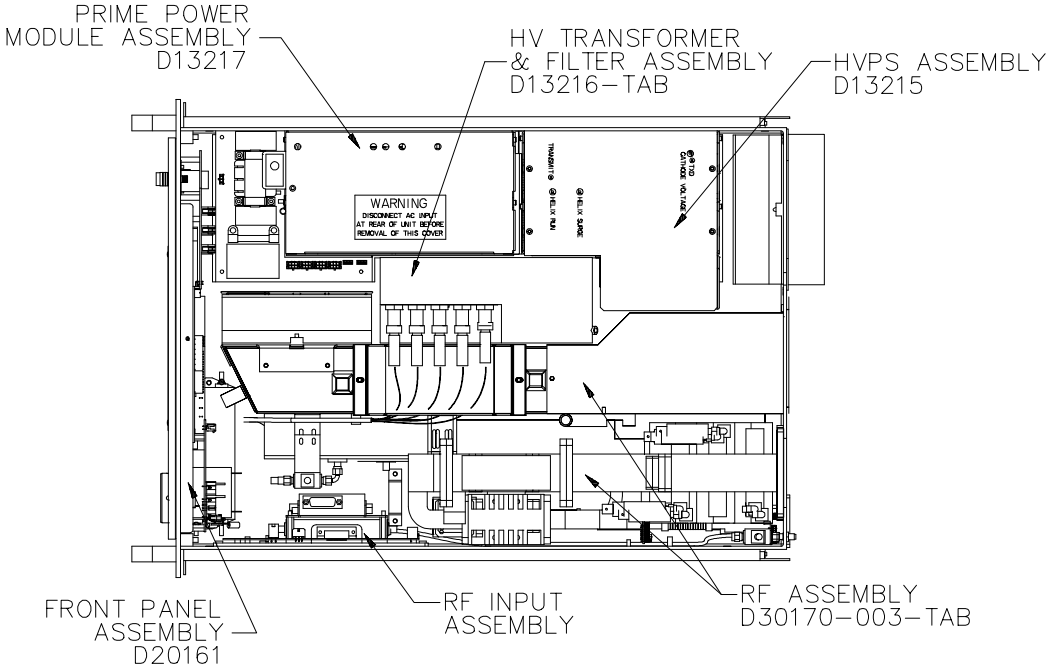
D20161 Front Panel simulator for MT4000 - This can be used to troubleshoot the MT4000 controlling software (Earth station controlling software).

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	3	Check for presence of faults.
		HPA front panel	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.
		MT4000 not in Local	2	Be sure MT4000 is 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

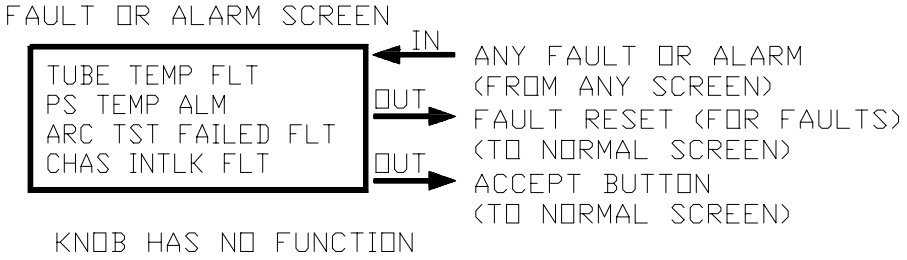
FAULT INDICATION PRESENT		POTENTIAL PROBLEM AREA	DIAGNOSTIC AREA	
20	Blower Failed alarm	Blowers	1	Check blower for obstructions
		HVPS assembly	2	Failed Fan Tach CCA (B161015)
21	Temperature alarm (Tube Analog or Power Supply)	Blowers	1	Blower has failed
		HVPS assembly	2	Check electrode voltages
		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	Intermitted 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

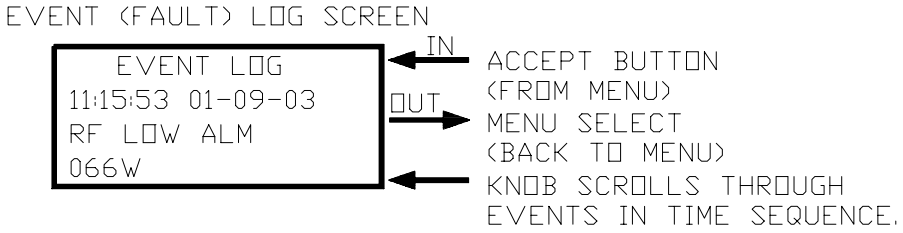
8.1 Fault Indication

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.

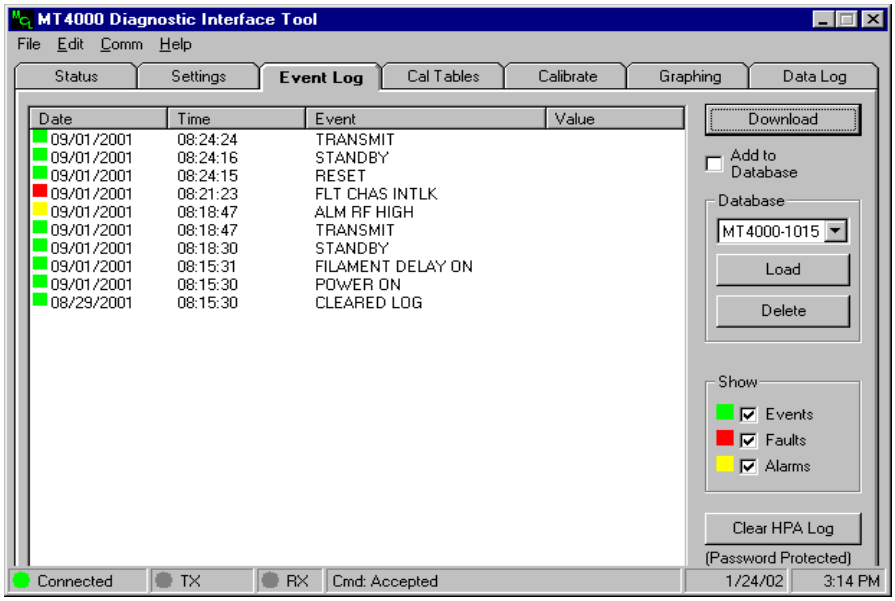


8.2 Event, Fault, & Data Logs

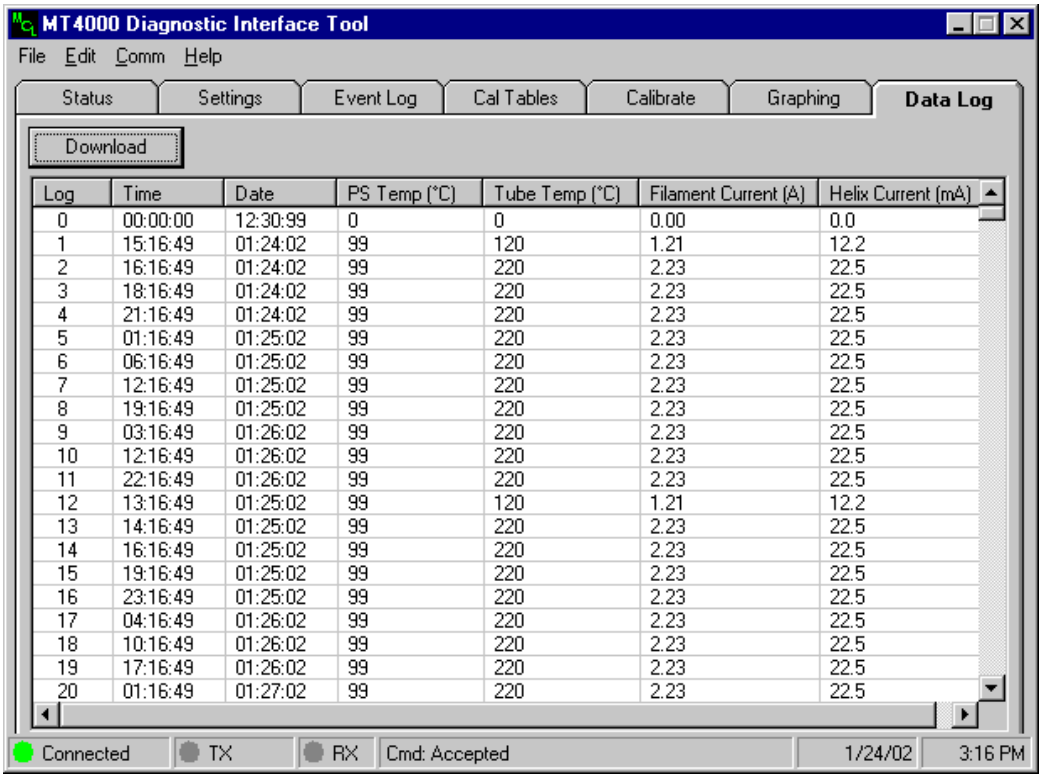
Once the *fault & alarm display screen* is cleared the *event log screen* or *fault log screen* can be used to analyze the sequence of events around a failure.



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

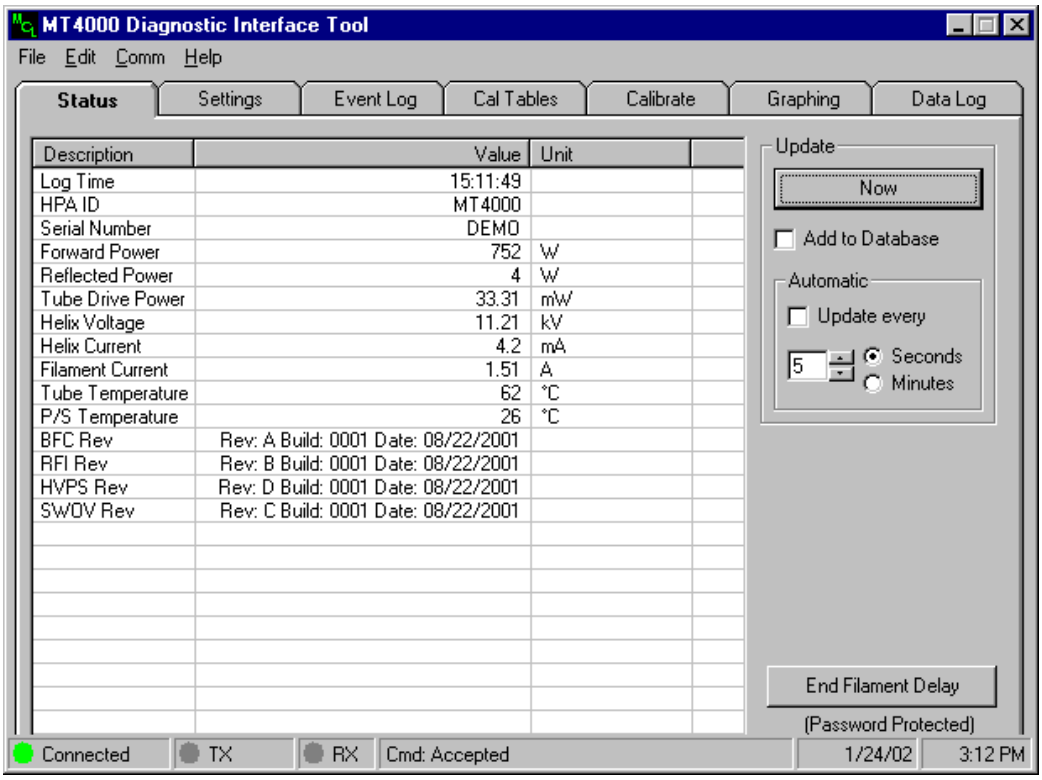
See TN4000-3 *Technical Note Operation of MT4000 TWTA* for instructions on setting up the fault counter.

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! *DO NOT ADJUST THE FILAMENT VOLTAGE UNLESS THE HPA IS NOT IN TRANSMIT. PUSH THE INTERLOCK SWITCH IN (FAULTED POSITION) WHILE MAKING THE ADJUSTMENT.*		
	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	Logic return
	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		10µs 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

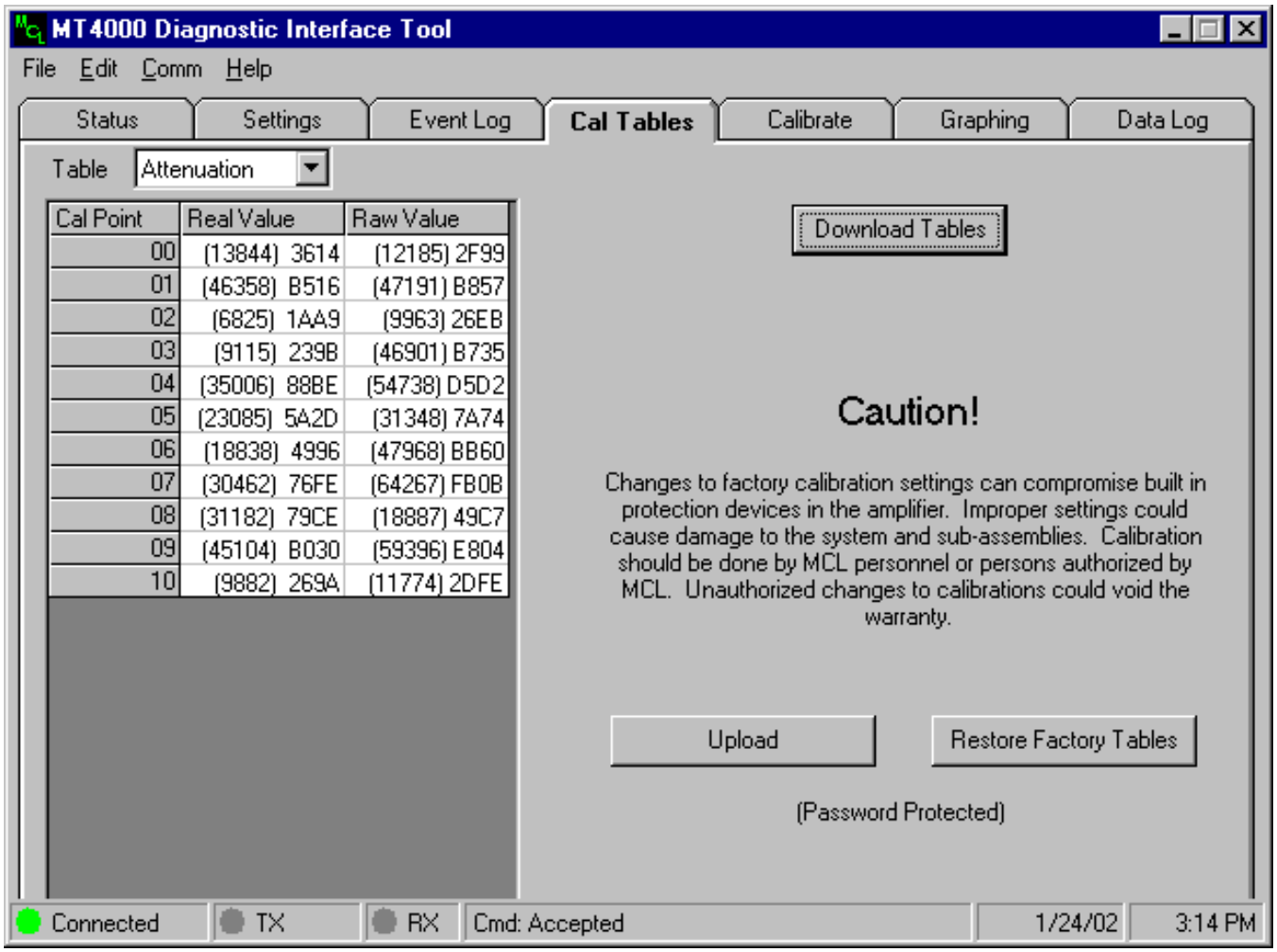
This procedure can be used after the D16989 RF Interface CCA or RF Input assembly has been replaced. The diagnostic interface program has information built into the Help menu to give the operator additional assistance.

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.

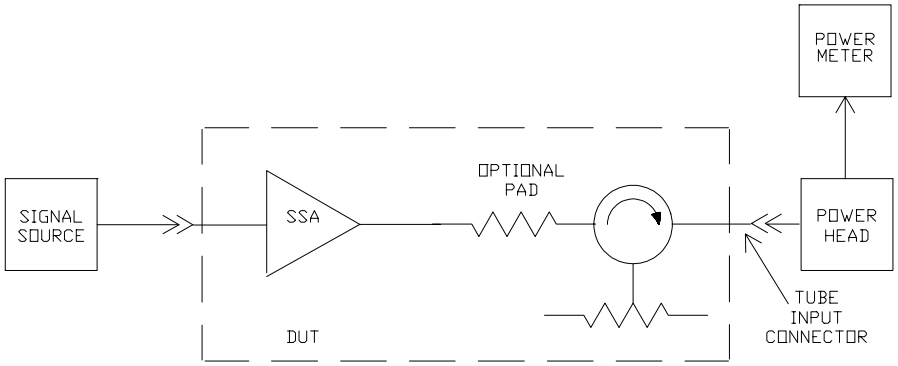
10.2 Tube Drive Power Meter Calibration

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.

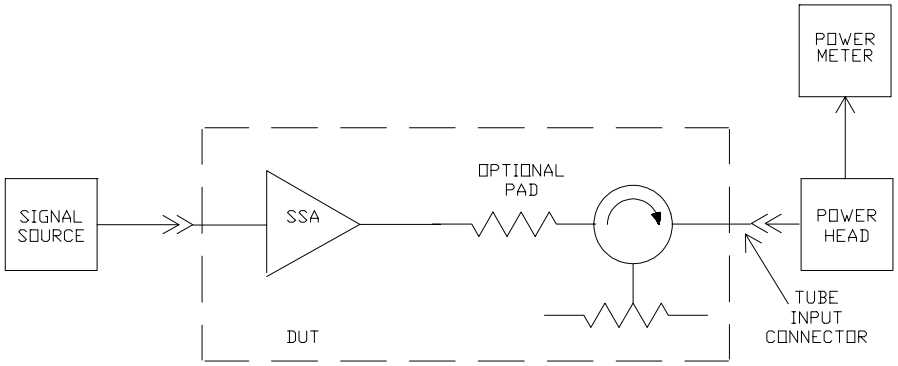
10.3 Attenuator Calibration

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

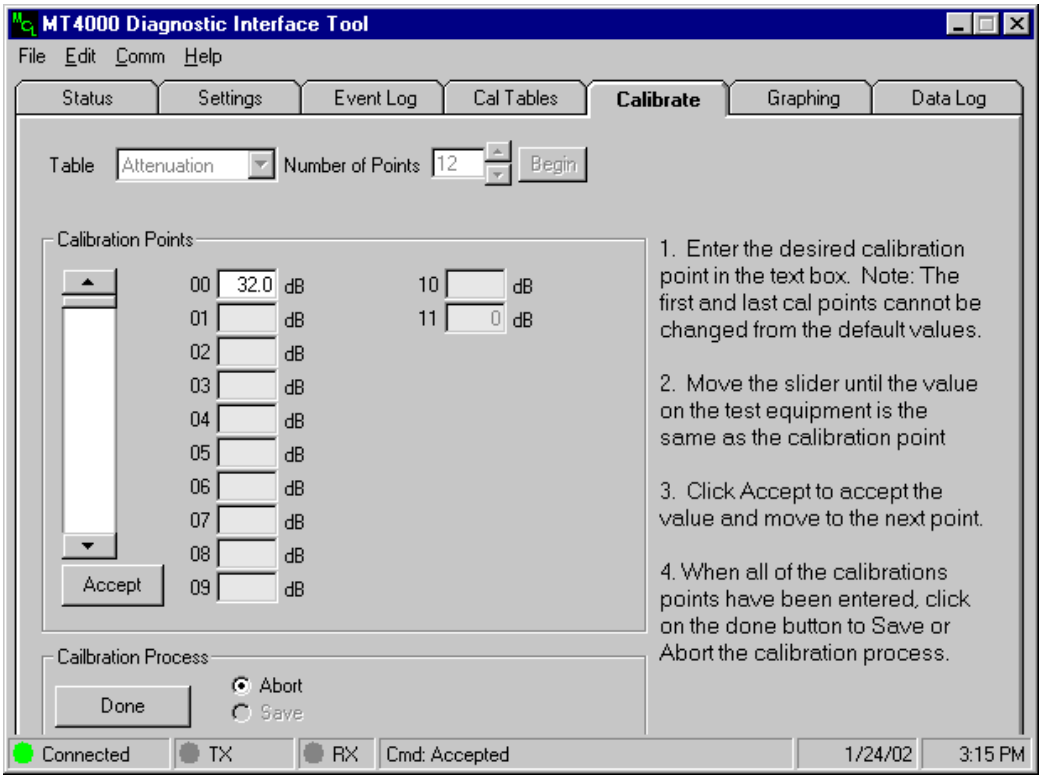
9. Put the HP power meter in the relative mode and adjust the HPA attenuator until the HPA display is 32.0 dB. Once you click the "Begin" button on the Diagnostic Interface program the HPA attenuator will be not be operational. At this time the DVM should read approximately 0.0V.

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.

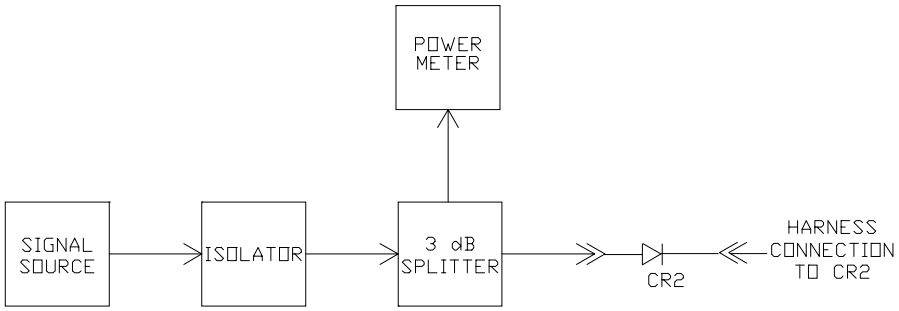
10.4 Reflected Meter Calibration

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.

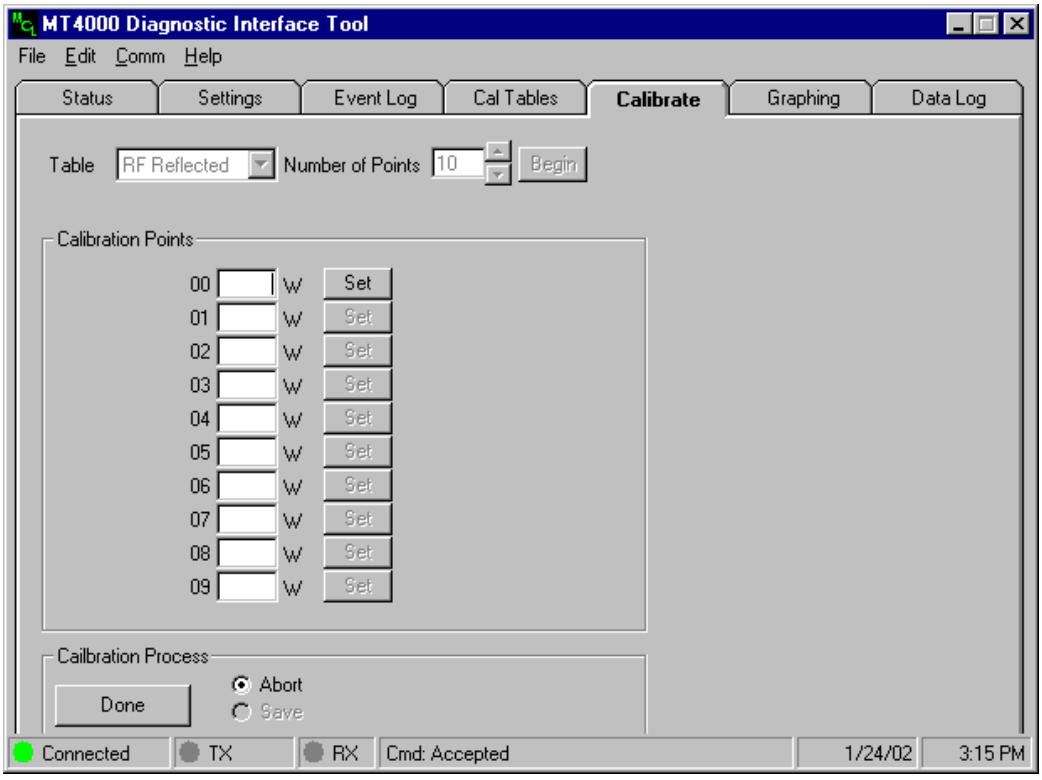
5. Use a full-scale value of 100W for C or Ku-band and 60W for DBS-Ku-band. Record the value used.

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.

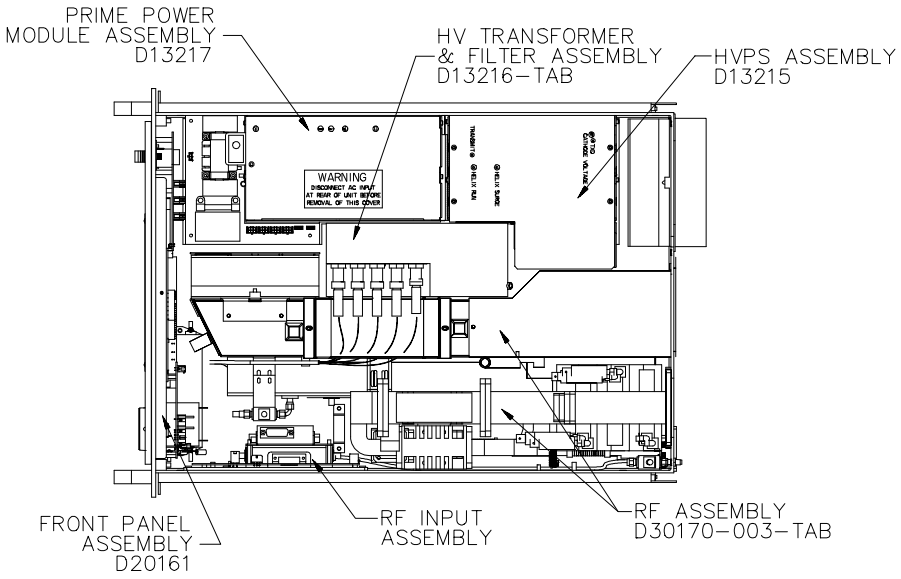
NOTE

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.

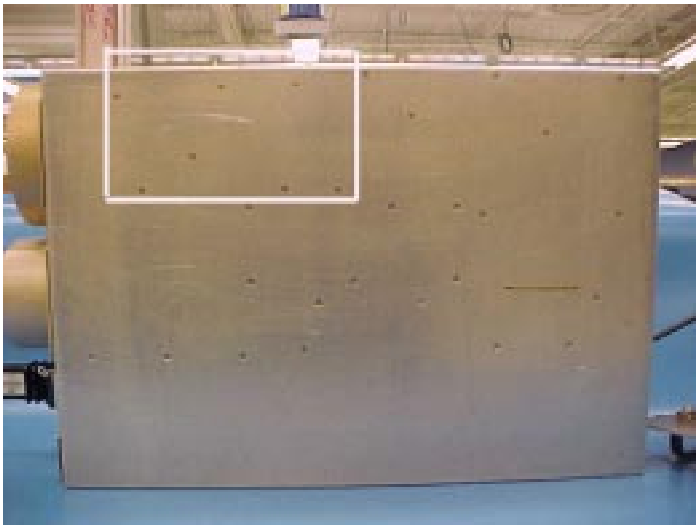
WARNING

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.

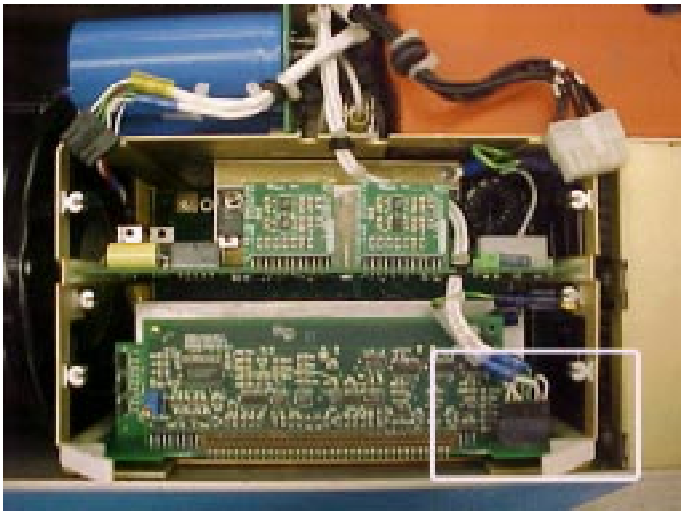
Place the TWTA onto a bench that can properly support the weight. Remove the four screws holding the top cover of the HVPS Field Replaceable Unit (FRU) Module & remove the cover.

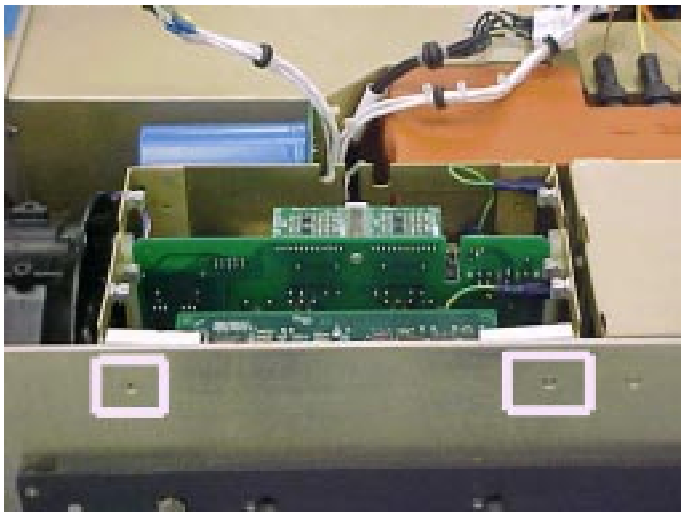


In the box shown to the right are the screws that hold the HVPS assembly in place. Remove the hardware for the HVPS. Once done, place the HPA on a bench right side up. The assembly is not removable yet.

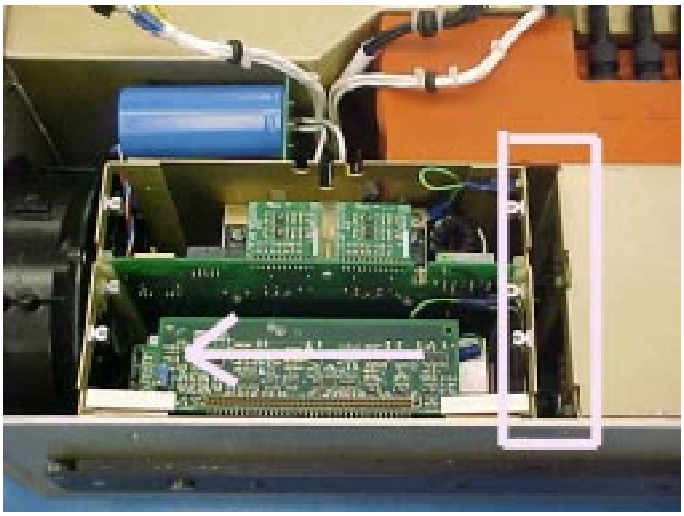
#1: Disconnect the 'flying' HV (regulation) wire harness from the HVTFA to the HVPS
#2: Disconnect the 'flying' LV (feedback) wire harness from the HVTFA to the HVPS
#3 & #4; Remove CCA (after removing 2 screws), to expose the third connection that needs to be disconnected.

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

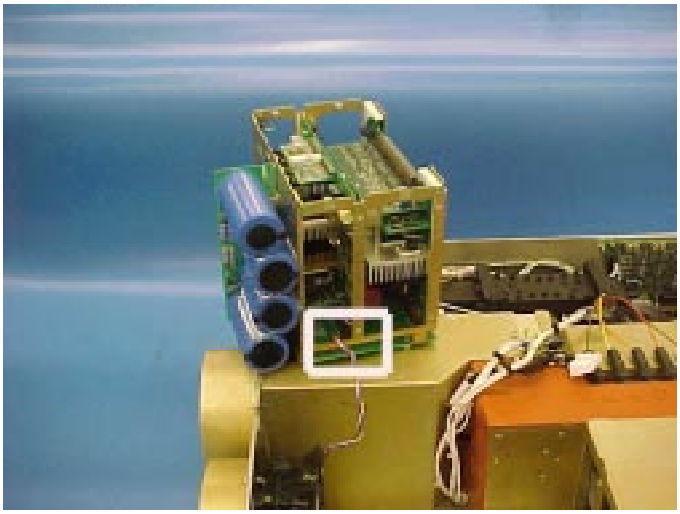




Remove the two screws on the side of the TWTA shown at the left.



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.

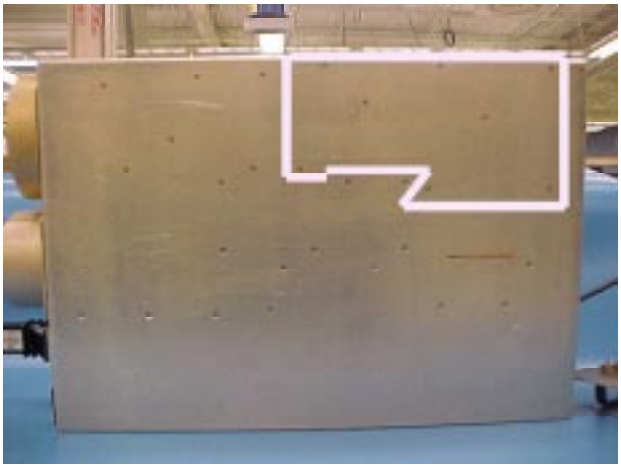
The last removal step is to disconnect the blower. The D13215 HVPS assembly can now be removed from the HPA.

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.

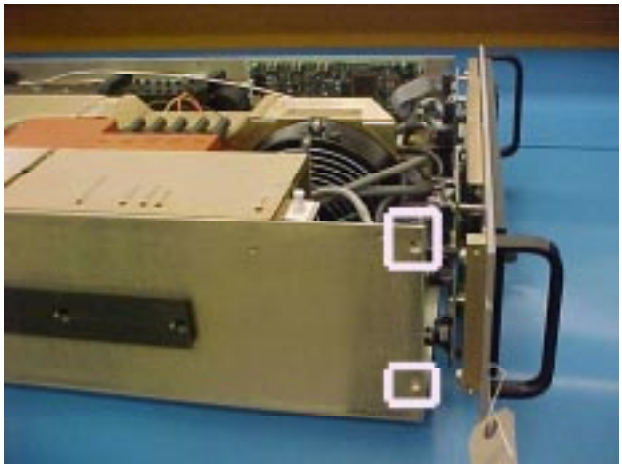
If there are any problems that are encountered with this procedure or there are other concerns please contact MCL Customer Service.

11.2 D13217 Primary Power Module Removal & Replacement Procedure

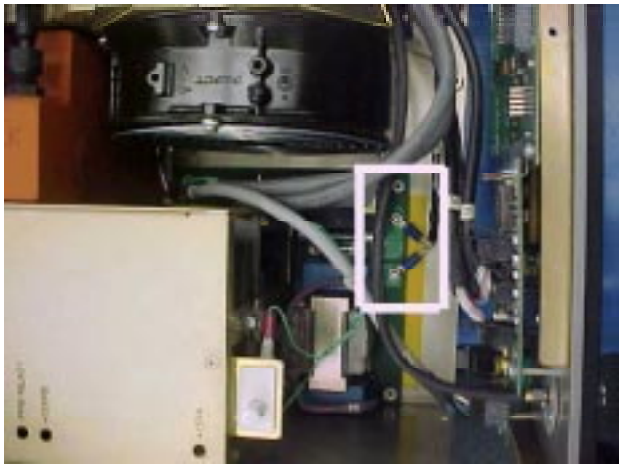
The following procedure assumes that the TWTA is disconnected from AC Power and the HPA top cover is removed. If removal of cable assemblies becomes necessary remember to label all items so when reconnecting the module(s) there is less confusion. While performing this procedure understand that HV Wires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



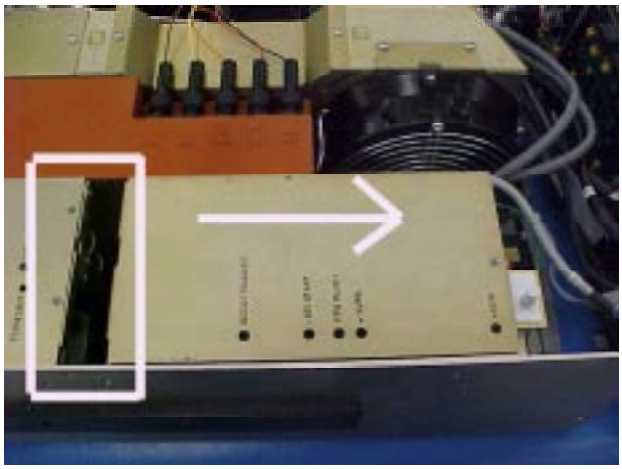
Remove the D20161 front panel assembly screws, two on each side of the front panel. Once the screws are removed pull the front panel assembly forward slightly to allow space to move the PPM assembly.



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

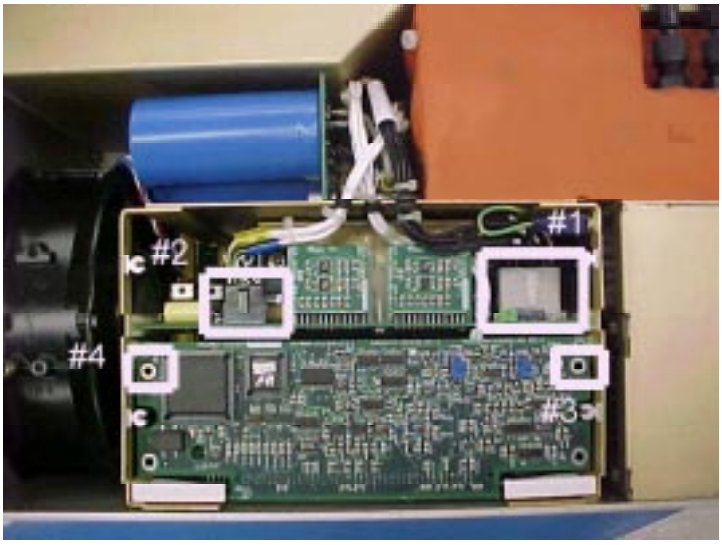
The replacement procedure is the removal procedure in reverse order. Again, do not force the connection of the PPM assembly to the HVPS assembly. Forcing any connection can result in damage to connectors. No potentiometer adjustments are required for this procedure.

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

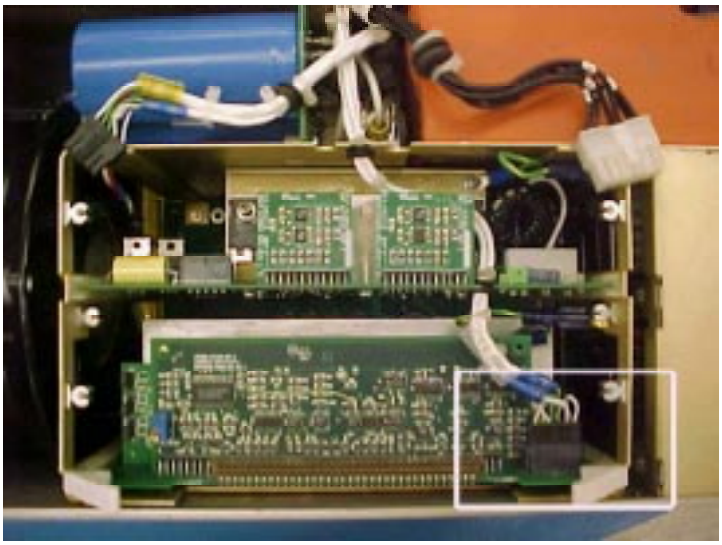
11.3 D13216-TAB High Voltage Transformer & Filter Assembly Removal & Replacement Procedure

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.

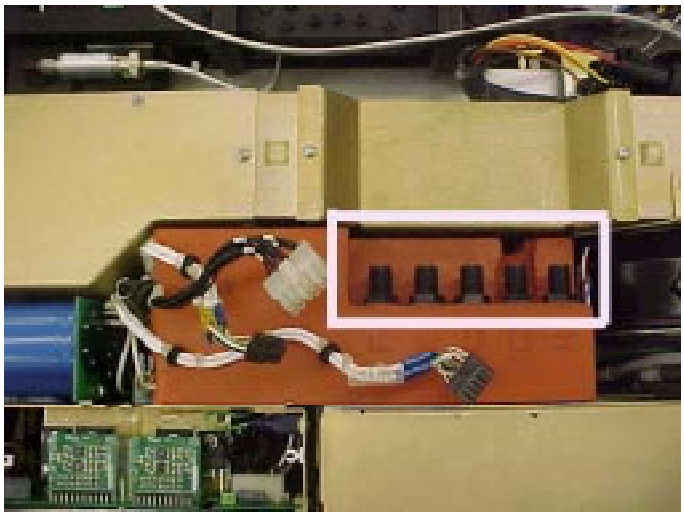
Place the TWTA onto a bench that can properly support the weight. Remove the four screws holding the top cover of the HVPS Field Replaceable Unit (FRU) Module & remove the cover.



#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.

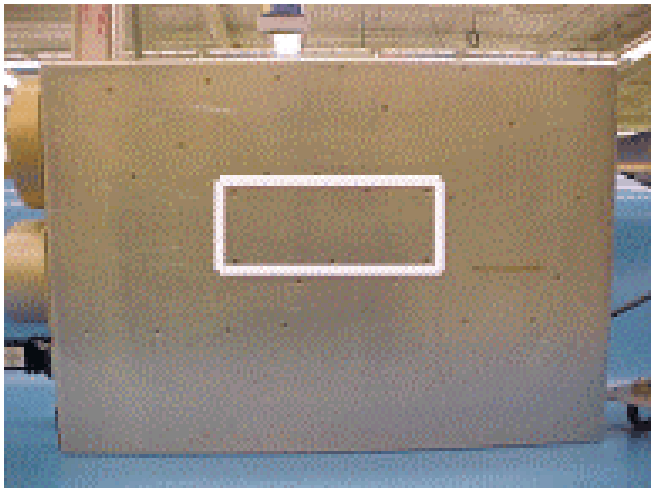


Disconnect the third connection (filaments) from the HVPS shown at the right.



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.

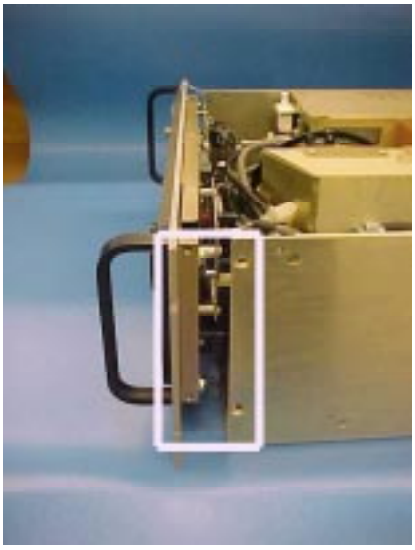


The replacement procedure is the removal procedure in reverse order. Again, make sure care is taken with the HV wires. If potentiometer adjustments are required for this procedure MCL will provide the necessary information to calibrate the High Voltage Transformer & Filter Assembly.

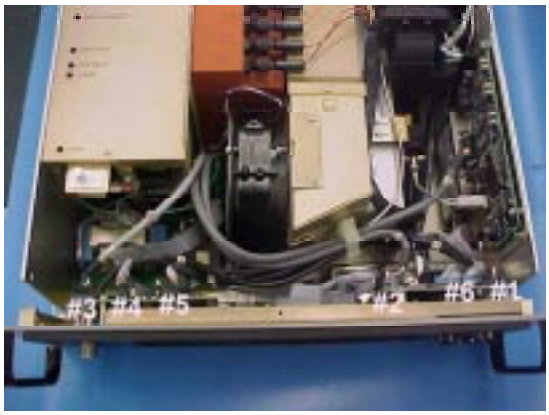
If there are any problems that are encountered with this procedure or there are other concerns please contact MCL Customer Service.

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.

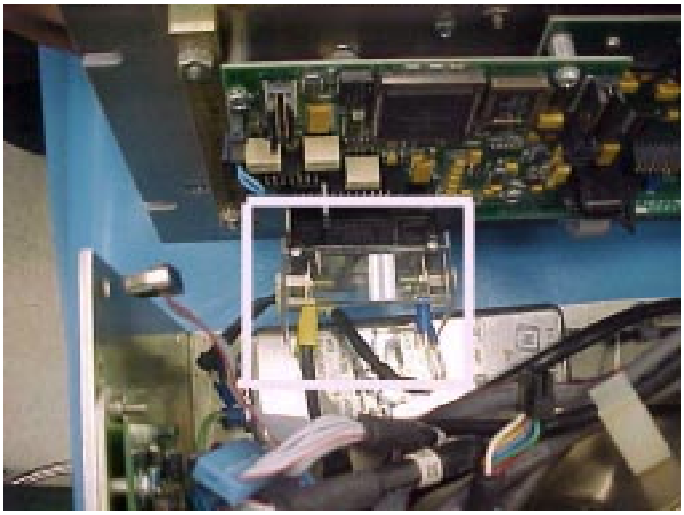


Place the TWTA onto a bench that can properly support the weight. Remove the D20161 front panel assembly screws, two on each side of the front panel. Once the screws are removed slightly pull the front panel assembly forward.



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



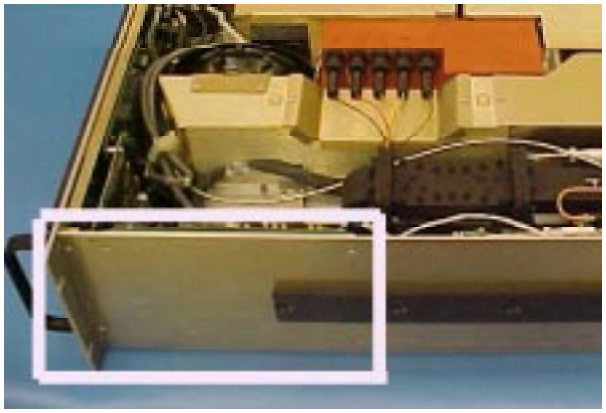
Disconnect the AC connection to the circuit breaker. You can now remove the Front panel assembly.

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.

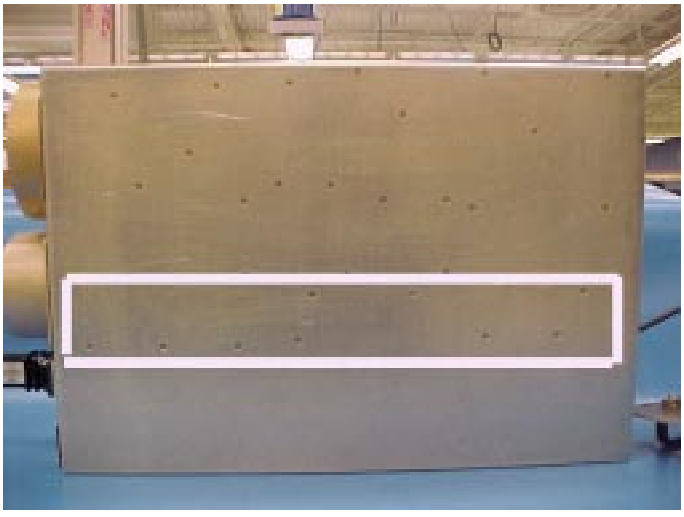
The replacement procedure is the removal procedure in reverse order. Again, make sure no part is forced back into its proper position.

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.

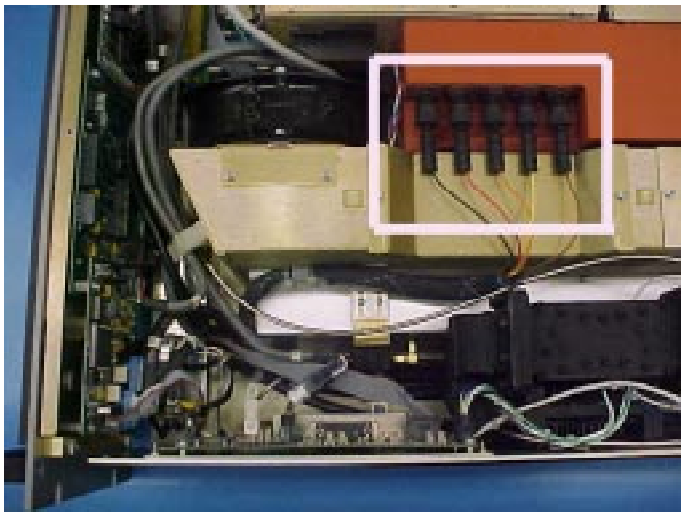
If there are any problems that are encountered with this procedure or there are other concerns please contact MCL Customer Service.

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

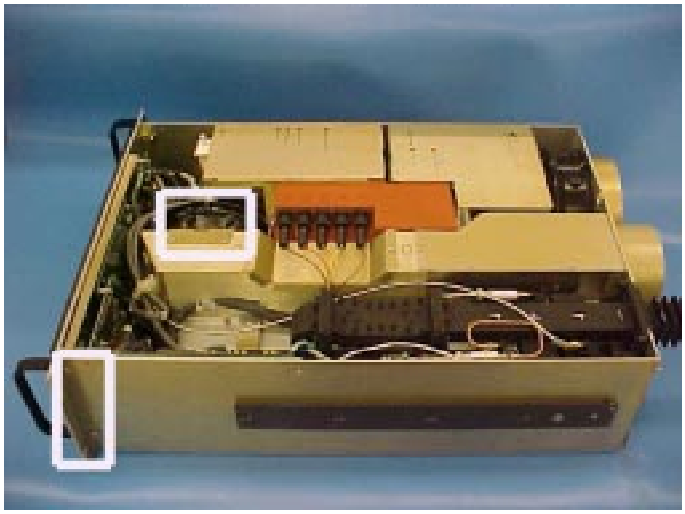
The following procedure assumes that the TWTA is disconnected from AC Power and the HPA top cover is removed. If removal of cable assemblies becomes necessary remember to label all items so when reconnecting the module(s) there is less confusion. While performing this procedure understand that HV Wires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



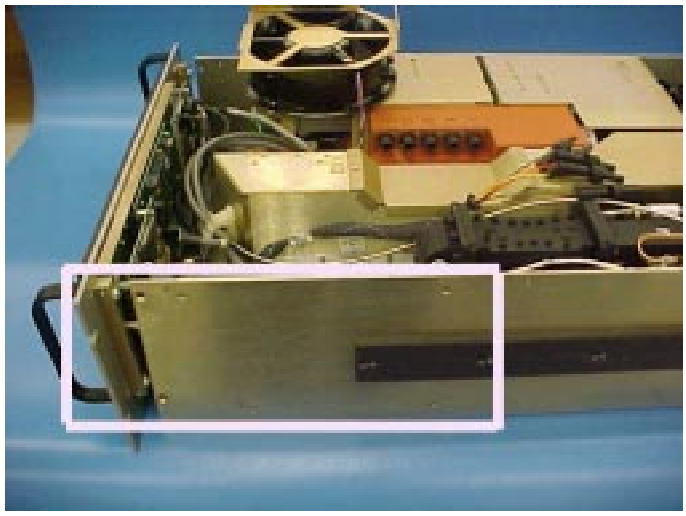
Disconnect the tube high voltage wires from the High Voltage Transformer & Filter Assembly (shown at the right). Be careful not to damage the insulation on these HV wires.



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

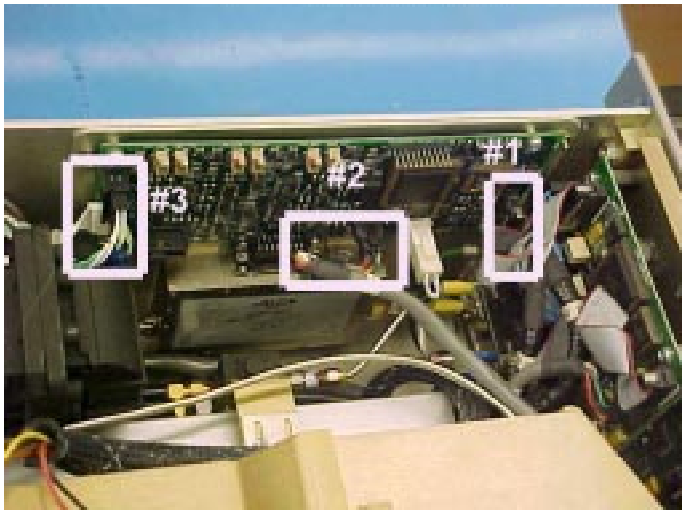
Remove the D20161 front panel assembly screws, two on each side of the front panel. Once the screws are removed slightly pull the front panel assembly forward.

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

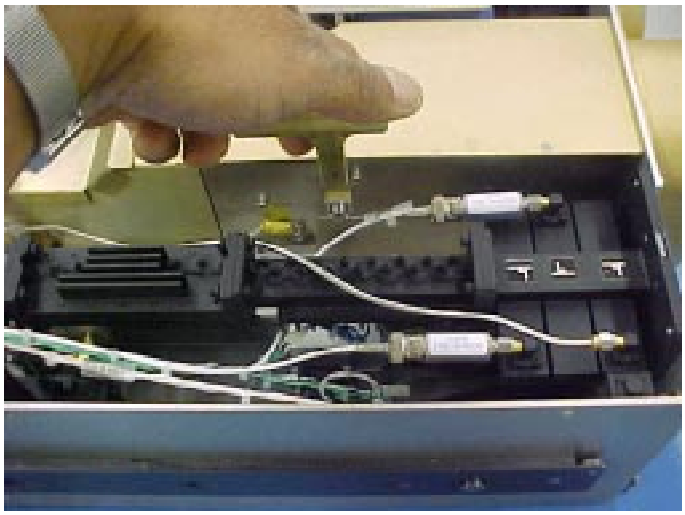
Disconnect the RF cable between the tube and SSA at the circulator on the tube input.
Disconnect the SSA RF input cable at the SSA.
Remove the RF Input Assembly.

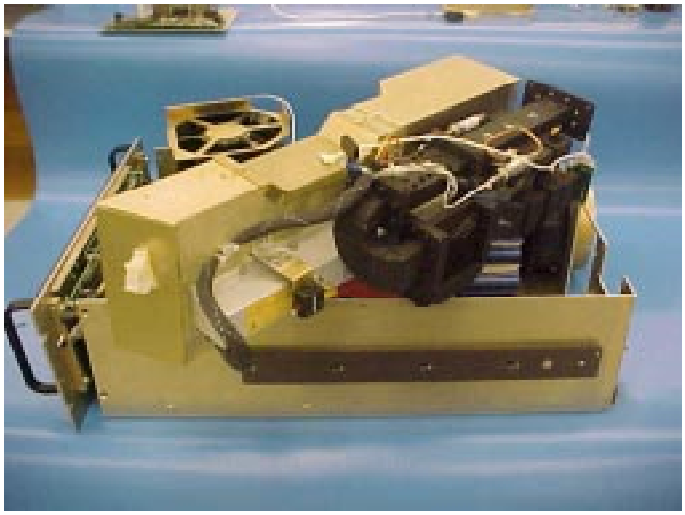
On the back of the HPA remove four waveguide mounting screws and two plenum mounting screws shown at the left. Disconnect and remove the RF input cable assembly.

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

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CUSTOMER SERVICE INFORMATION