

rf/microwave instrumentation

Operating and Service Manual

4000TP4G8

Model

10031106

Part Number

Serial Number

160 School House Road, Souderton, PA 18964 • 215-723-8181 • Fax 215-723-5688 • www.arworld.us

EC Declaration of Conformity

We; Amplifier Research 160 School House Road Souderton, PA 18964

declare that our product;

the Model 4000TP4G8 amplifiers

to which this declaration relates is in compliance with the requirements of the EEC EMC Directive (89/336/EEC) and Low Voltage Directive (73/23/EEC) in accordance with the relative standards listed below:

EMC: EN 50082-1: 1992 Electromagnetic compatibility – Generic immunity standard EN 50081-1: 1992 Electromagnetic emissions requirements for Industrial, Scientific, and Medical (ISM) Equipment

Safety: EN 60950 (1995)

The CE marking is affixed on the device according to the EC Directives.

Quald R. Shaeland

Donald R. Shepherd President

INSTRUCTIONS FOR SAFE OPERATION

Observe the following safety guidelines to help ensure your own personal safety and to help protect your equipment and working environment from potential damage.

INTENDED USE

This equipment is intended for general laboratory use in generating, controlling, and measuring levels of electromagnetic Radio Frequency (RF) energy. Ensure that the device is operated in a location which will control the radiated energy and will not cause injury or violate regulatory levels of electromagnetic interference.

SAFETY SYMBOLS

These symbols may appear in your user manual or on equipment.

This symbol is marked on the equipment wh is necessary for the user to refer to the manua important safety information. The caution symbol denotes a potential haz Attention must be given to the statemen prevent damage, destruction, or harm.	
4	Dangerous voltages are present. Use extreme care.
	Indicates a terminal intended for connection to an external conductor for protection against electrical shock in case of a fault, or the terminal of a protective earth (ground) electrode.
	Indicates invisible laser radiation-do not view directly with optical instruments.
	Indicates frame or chassis ground connection terminal.
\sim	Indicates alternating current.
X	Indicates this product must not be disposed of with your other household waste.
<u> </u>	Indicates that the marked surface and adjacent surfaces can attain temperatures that may be hot to the touch.

EQUIPMENT SETUP PRECAUTIONS



Review the user manual and become familiar with all safety markings and instructions. Protection provided by the equipment may be impaired if used in a manner not specified by AR RF/Microwave Instrumentation (AR).

- Follow all lifting instructions specified in this document.
- Place the equipment on a hard, level surface.
- Do not use the equipment in a wet environment, for • example, near a sink, or in a wet basement.

- Position your equipment so that the power switch is easily • accessible.
- Leave 10.2 cm (4 in) minimum of clearance on all vented sides of the equipment to permit the airflow required for proper ventilation. Do not restrict airflow into the equipment by blocking any vents or air intakes. Restricting airflow can result in damage to the equipment, intermittent shut-downs or safety hazards.
- Keep equipment away from extremely hot or cold temperatures to ensure that it is used within the specified operating range.
- While installing accessories such as antennas, directional couplers and field probes, take care to avoid any exposure to hazardous RF levels.
- Ensure that nothing rests on your equipment's cables and • that the cables are not located where they can be stepped on or tripped over.
- Move equipment with care; ensure that all casters and/or cables are firmly connected to the system. Avoid sudden stops and uneven surfaces.

BEFORE APPLYING POWER

Your AR equipment may have more than one power supply cable. Use only approved power cable(s). If you have not been provided with a power cable for the equipment or for any ACpowered option intended for the equipment, purchase a power cable that is approved for use in your country. The power cable must be rated for the equipment and for the voltage and current marked on the equipment's electrical ratings label.

Incorrectly installing or using an incompatible line voltage may increase the risk of fire or other hazards. To help prevent electric shock, plug the equipment and peripheral power cables into properly grounded electrical outlets. These cables are equipped with three-prong plugs to help ensure proper grounding. Do not use adapter plugs or remove the grounding prong from a cable.

Do not modify power cables or plugs. Consult a licensed electrician or AR trained service technician for equipment modifications. Always follow your local/national wiring rules.



Do not operate the equipment if there is physical damage, missing hardware, or missing panels.

SAFETY GROUND



This equipment is provided with a protective earth terminal. The mains power source to the equipment must supply an uninterrupted safety ground of sufficient size to attach wiring terminals, power

cord, or supplied power cord set. DO NOT USE this equipment if this protection is impaired.

Revised 0517

INSTRUCTIONS FOR SAFE OPERATION

HAZARDOUS RF VOLTAGES



The RF voltages on the center pin of an RF output connector can be hazardous. The RF output connector should be connected to a load before AC power is applied to the equipment. Do not come into the the center pin of the RE output connector or

contact with the center pin of the RF output connector or accessories connected to it. Place the equipment in a nonoperating condition before disconnecting or connecting the load to the RF output connector.

ACOUSTIC LIMITATIONS

If equipment noise exceeds 80dB, ear protection is required.

MAINTENANCE CAUTION

Adjustment, maintenance, or repair of the equipment must be performed only by qualified personnel. Hazardous energy may be present while protective covers are removed from the equipment even if disconnected from the power source. Contact may result in personal injury. Replacement fuses are required to be of specific type and current rating.

ENVIRONMENTAL CONDITIONS

Unless otherwise stated on the product specification sheet, this equipment is designed to be safe under the following environmental conditions:

- Indoor use
- Altitude up to 2000m
- Temperature of 5°C to 40°C
- Maximum relative humidity 80% for temperatures up to 31°C. Decreasing linearly to 50% at 40°C.
- Main supply voltage fluctuations not to exceed ± 10% of the nominal voltage or minimum and maximum autoranging values.
- Pollution degree 2: Normally non-conductive with occasional condensation. While the equipment will not cause hazardous condition over this environmental range, its performance may vary.

EQUIPMENT CONTAINING LASERS



AR Field Probes (FL/PL Series) and Field Analyzers (FA Series) are Class 1 laser products containing embedded Class 4 lasers. Under normal use, the laser radiation is completely contained within the

fiber optic cables and poses no threat of exposure. Safety interlocks ensure that the laser is not activated unless the cables are properly connected. Always exercise caution when using or maintaining laser products. Do not view directly with optical instruments.

RF ANTENNAS

- This equipment (antenna or antenna assembly) may be heavy, requiring two persons to lift. Use caution when installing or removing unit. Follow all equipment setup and lifting instructions specified in this document.
- Ensure connectors are appropriate for intended operation. Connectors are specified in the user manual and product specification sheet.
- Do not exceed the maximum RF input level stated in the specifications. Refer to the user manual and product specification sheet to determine the applicable RF levels.
- Excessive RF input could damage the equipment or connectors, causing safety hazards.
- When in operation, the RF voltages on the antenna elements can be hazardous. Do not come into contact with the antenna or elements when the RF input connector is connected to a live RF source.
- To avoid injury to personnel and accidental damage to power amplifier or antenna, disable the RF output of power amplifier before connecting or disconnecting the input connection to the antenna.
- Perform periodic inspections of antenna and field probe systems to verify calibration due date, proper operation, and overall condition of equipment.

RACK MOUNTED TWT MODELS

Some TWT models are supplied without the removable enclosure offered for benchtop use. These rack-mountable models may be supplied with either carry handles or slides and front handles installed. Follow all lifting instructions specified in this document and installation instructions supplied in the TWT user manual.

LIFTING INSTRUCTIONS FOR AR EQUIPMENT

Because most products must be handled during distribution, assembly and use, the risk of serious injury due to unsafe product handling should be a fundamental consideration of every user. An authoritative guideline for



eliminating unwarranted risk of injury caused by lifting is provided by the NIOSH Work Practices (Publication #94-110) available at:

https://www.cdc.gov/niosh/docs/94-110/pdfs/94-110.pdf.

In general, observe the following guidelines for lifting a weight of 50 lb or more:

- Use lifting eye (for floor standing) or side handles (table top) to lift unit only.
- Use equipment of adequate capacity to lift and support unit.
- If using forklift to move unit, be sure forks are long enough to extend beyond the side of the unit.
- For additional information, follow the link specified above.

ADDITIONAL WARNINGS & NOTES



WARNING:

This equipment generates high voltages and high power Radio Frequency energy.

Please read and follow the instructions for safe operation of this unit.



WARNING:

This equipment operates at potentially lethal voltages. Only trained, qualified personnel should operate, maintain, or service it.

Hazardous energy may be present while protective covers are removed from the equipment even if disconnected from the power source. Contact may result in personal injury.



CAUTION:

Adjustment, maintenance, or repair of the equipment must be performed only by qualified personnel.



CAUTION:

Replacement fuses are required to be of specific type and current rating.



CAUTION:

The information in this document was obtained from reliable sources and was believed to be accurate at the time of publication. Since subsequent modifications to the machine may have been made, use this information only as a guide. Carefully compare the unit's actual configuration and operation to the descriptions in this manual before you undertake to operate, service, or modify this machine. Any variance or modification should be noted, dated, and initialed in the discrepant part of all manuals on hand for future reference. If you have technical or editorial comments you wish to make to the manufacturer, please write them on photocopies of the relevant sheets.

NOTE: The contents of this document are the property of the manufacturer and this document is delivered on the express condition that it not be disclosed, reproduced in whole or in part, or used for manufacture for anyone other than the manufacturer without its written consent, and that no right is granted to disclose or so use any information in this document.



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Suggested Periodic Maintenance for TWT Amplifiers

- 1. Keep monthly log of the voltages, currents and temperatures as shown on Menus. Also record Date, "Console" and "Operate" hours. Take readings in Operate mode with the gain at zero (0%) percent. Leave unit in Operate mode for 20 minutes (Max Duty if Pulsed Unit), and then record data. Review the log to identify trends and contact factory if required.
- 2. Keep monthly log of performance with active RF. At mid-band frequency, with Gain set to 100%, apply RF drive that will provide rated power. This will help indicate if the gain or power is changing and if the traveling wave tube or pre-amp needs service. Record the following:
 - a. RF Drive Level
 - b. Forward Power
 - c. Reverse Power
 - d. Body Current (Iw)
 - e. Sample Port Power reading (if possible).
- 3. Remove air intake filter and clean using compressed air and/or vacuum cleaner.
- 4. Ensure air inlet and outlet are unobstructed.
- 5. Check that AC Input connections are secure. Make sure the AC cable is not damaged or deteriorated.
- 6. Check that both input and output RF connections (waveguide or coax) are connected tightly and un-damaged.

CONTENTS1		
1.	DESCRIPTION AND SPECIFICATIONS	. 1
1.1	General	. 1
1.2	TWTA Description	. 1
1.3	Suggested Applications	. 1
1.4	Specifications	. 1
1.5	Test Data Sheet	. 1
2.	THEORY OF OPERATION	.3
2.1	Design of the Amplifier	. 3
2.2	Description of the RF Subsystem	. 3
2.3	Description of the Power Supply Subsystem	. 3
3.	OPERATION	. 5
3.1	Warnings and Cautions	. 5
3.2	Installation	. 6
3.2.1	Unpacking	. 6
3.2.2	Mounting	. 7
3.2.3	Cooling Requirements	. 7
3.2.4	AC Line Power Connections	. 8
3.2.5	RF Connections	. 8
3.3	Front Panel Features	. 9
3.3	Rear Panel Features	10
3.5	Front Panel and Soft Keys	10
3.5.1	Overview	10
3.5.2	Menu Screens	13
3.5.3	Setup Screens	13
3.5.4	Sleep Mode	14
3.5.5	Warning Screens	14
3.5.6	Miscellaneous Screens	15
3.6	Initial Turn On and Warm-up Procedure	16
3.8	RF Operation	17
4.	MAINTENANCE	19
4.1	Safety Warnings and Cautions	19
4.2	Unauthorized Repairs	19
4.3	Preventive Maintenance	19
4.4	Troubleshooting	20
4.5	Non-Repairable Modules	21
4.6	Recommended Spare Parts	21
5.	TECHNICAL DOCUMENTATION	23
5.1	Top Level Build Tree (see Appendix C)	25
5.1.1	A38004-100 Pulsed HPA	25
5.2	Schematics	27
5.3	Parts Lists	29

5.3.2 HPA Interface Board (A25444-001)	32
Appendix A Remote RS422/485 Computer Interface	35
Interface Capabilities	35
Implementation	35
Hardware Configuration Using Setup Screen 7	35
FIGURES	
3-1 Front Panel	9
3-2 Rear Panel	10
3-3 Soft Key Display	11
3-4 Menu Map	12
•	
TABLES	
3-1 Front Panel Features	9
3-2 Rear Panel Features	10
3-3 Soft Keys S1-S4	11

1. DESCRIPTION AND SPECIFICATIONS

1.1 GENERAL

This manual provides operating, interfacing and selected service information pertinent to the AR Model 4000TP4G8 Broadband Microwave amplifier. The Model 4000TP4G8 is a pulsed 4,000 watt L-band traveling wave tube amplifier (TWTA).

1.2 TWTA DESCRIPTION

The amplifier uses a 4,000 watt traveling wave tube (TWT) to provide 4,000 watts minimum output over the TWT amplifier's full bandwidth, higher in other parts of the band. The amplifier is well suited for applications where instantaneous bandwidth and high gain are required. The amplifier is completely self-contained and packaged for standard 19-inch rack mounting.

Primary power is 190-260 volts 50-60 Hz, single phase. An efficient switching power supply design provides minimum power consumption. A fast regulation control loop and a high degree of filtering ensure performance within specifications over a wide range of operating conditions. The amplifier is fully enclosed, and the upper and lower panels of the rack mountable amplifier are interlocked to reduce the likelihood of accidental contact with high voltage.

1.3 SUGGESTED APPLICATIONS

This equipment is intended for general laboratory environments. It is designed to be used in the process of generating, controlling and measuring high levels of electromagnetic Radio Frequency (RF) energy. Therefore the output must be connected to an appropriate load such as an antenna or field generating device. It is the responsibility of the user to assure the device is operated in a location which will control the radiated energy such that it will not cause injury and will not violate regulatory levels of electromagnetic interference.

1.4 SPECIFICATIONS

Refer to the AR data sheet at the end of this section for detailed specifications.

1.5 TEST DATA SHEET

Test Data for a specific unit is prepared at the time of manufacture and is included with the unit's copy of this manual.



Features

4000TP4G8

- Pulse Amplifier
- M1-M11, M24
- 4000 Watts
- 4GHz-8GHz

The Model 4000TP4G8 is a self-contained, forced air cooled, broadband traveling wave tube (TWT) microwave amplifier designed for pulse applications at low to moderate duty factors where instantaneous bandwidth and high gain are required. A reliable TWT provides a conservative 3800 watts minimum peak RF pulse power at the amplifier output connector. Stated power specifications are at the fundamental frequency.

The amplifier's front panel digital display shows forward and reflected average power output or forward and reflected peak power, plus extensive system status information accessed through a series of menus via soft keys. Status indicators include power on, warm-up, standby, operate, faults, excess average or peak reflected power warning and remote. Standard features include a built-in IEEE-488 (GPIB) interface, OdBm input, TTL Gating, VSWR protection, gain control, RF output sample port, auto sleep, plus monitoring of TWT helix current, cathode voltage, collector voltage, heater current, heater voltage, baseplate temperature and cabinet temperature. Modular design of the power supply and RF components allow for easy access and repair. Use of switching mode power supplies results in significant weight reduction.

Housed in a stylish contemporary cabinet, the amplifier provides readily available pulsed RF power for a variety of applications in Test and Measurement, (including EMC RF pulse susceptibility testing), Industrial and University Research and Development, and Service applications. AR also offers a broad range of amplifiers for CW (Continuous Wave) applications.

See Model Configurations for alternative prime power, packaging, and special features.

The export classification for this equipment is 3A999.d. These commodities, technology or software are controlled for export in accordance with the U.S. Export Administration Regulations. Diversion contrary to U.S. law is prohibited.

4000TP4G8 Typical Peak Pulse Power Output



AR RF/Microwave Instrumentation 160 School House Rd Souderton, PA 18964 215-723-8181

For an applications engineer call:800.933.8181

www.arworld.us

Specifications

4000TP4G8

- Pulse Amplifier
- M1-M11, M24
- 4000 Watts
- 4GHz-8GHz

 POWER (Fundamental), Peak Pulse, @ Output: Nominal:
 5000 watts;

 Minimum:
 3.8 kW from 4-4.5 GHz

 4.0 kW from 4.5-7.5 GHz

3.8 kW from 7.5-8.0 GHz

FLATNESS: ±10 dB maximum

FREQUENCY RESPONSE: 4-8 GHz

INPUT FOR RATED OUTPUT: 1.0 milliwatt maximum

GAIN (at maximum setting): 66 dB minimum

GAIN ADJUSTMENT (continuous range): 35 dB minimum

INPUT IMPEDANCE: 50 ohms, VSWR 2.5:1 maximum

OUTPUT IMPEDANCE: 50 ohms, VSWR 2.5:1 typical

MISMATCH TOLERANCE: Output pulse width foldback protection at peak reflected power exceeding 1000 watts. Will operate without damage with any magnitude and phase of source and load impedance. May oscillate with unshielded open due to coupling to input. Should not be tested with connector off. See S3M special option, if applicable.

PULSE CAPABILITY:

Pulse Width	0.07 – 50 microseconds.
Pulse Rate (PRF)	100 kHz maximum
Duty Cycle	4% maximum.
RF Rise and Fall	35 ns max (10% to 90%).
Delay	300 ns maximum from pulse
	input to RF 90%
Pulse Width Distortion	±50 ns maximum (50%
	points of output pulse width
	compared to 50% points of
	input pulse width)
Pulse Off Isolation	80 dB minimum, 90 dB typi-
	cal
Pulse Input	TTL level, 50 ohm nominal
	termination

NOISE POWER DENSITY:

(pulse on)	Minus 65 dBm/Hz (maximum); Minus
	75 dBm/Hz (typical)
(pulse off)	Minus 140 dBm/Hz (typical)

HARMONIC DISTORTION: Minus 0 dBc maximum

PRIMARY POWER: See Model Configurations

CONNECTORS:

RF input:	Type N female, rear panel
RF output:	Type WRD350 waveguide flange, rear
	panel
RF output forw	ard sample port:
	Type N female, rear panel
Pulse input:	Type BNC female, rear panel
GPIB:	IEEE-488 female, rear panel
Interlock:	DB-15 female, rear panel

COOLING: Forced air (self contained fans), air entry and exit in rear.

SIZE AND WEIGHT: See Model Configurations

EXPORT CLASSIFICATION: 3A999.d

Page 2

Model Configurations

Page 3

4000TP4G8

- Pulse Amplifier
- M1-M11, M24
- **4000** Watts
- 4GHz-8GHz
- Ε Must select one enclosure type from the following [E1 or E2 or E2S]:
- E1 with removable outer enclosure, size 19.8 x 12 x 28 in., 51 x 31 x 71 cm, weight 155 lbs, 71 kg.
- E2 without outer enclosure, for rack mounting, size 19 x 10.48(6U) x 28 in, 51 x 27(6U) x 71 cm, weight of E1 less 30 lbs, 14 kg.
- E2S without outer enclosure, for rack mounting with slides and front pull handles installed, size 19 x 10.48(6U) x 28 in, 51 x 27(6U) x 71 cm, weight of E2 plus 5 lbs, 2kg.
- Ρ Must select one primary power from the following [P1 or P2]
- P1 208 VAC $\pm 10\%$ three phase 50/60 Hz 2.5 KVA maximum
- P2 190-260 VAC single phase 50/60 Hz 2.5 KVA maximum
- S May select a special feature (extra cost) from the following [S1R or S3M]:
- S1R Reflected power sample port, type N female connector on rear panel. Forward and reflected sample port calibration data supplied on disk in Excel format at 51 points, evenly spaced over specified frequency response.
- S3M Special Mismatch Tolerance Operation: Amplifier will permit up to 2kW reflected power at maximum 8µs pulse width and .8% duty, without VSWR trip or fold-back. Exceeding 2kW reflected power will cause the unit to truncate pulse within 2µs. For pulses beyond 8µs, exceeding 1kW will cause the unit to truncate the pulse. If exceeding .8% duty with reflected power exceeding 1kW, the amplifier will truncate the pulse within 2μ s. The amplifier will continue to truncate pulses until reflected power dissipates from outside source. Operation with truncated pulses for >250mS will result in latched "Truncated Pulse Fold Back" displayed on screen and over the remote interface, including an audible alarm. Operation with truncated pulses for 5 to 10 seconds will cause "Over Reverse" fault and a shutdown of high voltage and the amplifier.

Model		Featur	es
4000TP4G8	Е	Р	S
4000TP4G8	E1	P2	-
M1	E2	P2	-
M2	E2S	P2	-
M3	E1	P1	-
M4	E2	P1	-
M5	E2S	P1	-
M6	E1	P2	S1R
M7	E2	P2	S1R
M8	E2S	P2	S1R
M9	E1	P1	S1R
M10	E2	P1	S1R
M11	E2S	P1	S1R
M24	E1	P1	S3M

2. THEORY OF OPERATION

2.1 DESIGN OF THE AMPLIFIER

The Model 4000TP4G8 TWT amplifier consists of two main subsystems. The power supply subsystem and the RF subsystem, which are discussed in sections 2.2 and 2.3, respectively.

These two subsystems work in conjunction with the control system. The heart of the microprocessor control system is the CPU board (A25450-000). The microprocessor control system supervises the power supply and RF gain controls and processes operator input by enabling communication with a host computer over the RS422/485 interface or local control through the front panel display and buttons.

Communication of operational status with the amplifier is via fiber-optic links to the HPA interface assembly (A25444-001). The HPA interface assembly provides fault monitoring capabilities for discrete fault logic and analog readbacks. This assembly also contains the digital to analog circuits for controlling the solid state pre-amp's (SSPA) gain adjustment.

2.2 DESCRIPTION OF THE RF SUBSYSTEM

The TWTA consists of two stages of RF amplification: a solid state pre-amp (SSPA) assembly with adjustable gain (E02822-000) and a traveling-wave tube amplifier (E02595-002).

The Type N RF input connector is located on the rear panel. The RF input is fed to the input connector on the solid state pre-amp. The solid state pre-amp's output drives the RF input of the TWT. The RF output of the TWT is a WRD-350 waveguide. The output is directed through a high power coupler (E02814-000) which provides forward and reverse sample ports before directing the RF output through the rear panel.

The reverse port on the directional coupler is connected to a crystal detector, whose output is used for VSWR protection by the power supply logic board, for VSWR measurement in the leveling loop, and for reverse power measurement on the HPA interface board.

The forward port output is split by a -10 dB coupler. The output is connected to a crystal detector via a pad. The output of the crystal detector is used on the HPA interface board to measure forward power. The -10dB port of the coupler is connected to the RF sample port on the rear panel.

Amplifier gain is determined by the solid state pre-amp, which has a voltage-controlled attenuator. The CPU board determines the output of a digital-to-analog converter (DAC) on the HPA interface board. This analog reference is directed to the SSPA for the purpose of controlling the gain of the amplifier.

2.3 DESCRIPTION OF THE POWER SUPPLY SUBSYSTEM

The TWT power supply is of modular construction. All modules are connected through a motherboard, and are very easy to replace. This makes maintenance fast and easy.

Low Voltage Power Supply Module: AC/DC converter which generates the +15VDC/-15VDC/+5VDC needed for housekeeping.

Logic and Control Module: This module controls the power supply, monitors all the voltages and currents of the unit, and provides protection for the power supply and the TWT.

Power Factor Corrector Module: This switching module forces the line current waveform to follow the line voltage waveform. This minimizes the line harmonics and maintains the power factor near unity. The output of this module provides the 375VDC bus used by the high voltage switching power supply.

Power Board Assembly: This module contains a 120kHz switching buck regulator, and a 60kHz H-Bridge, which converts the DC regulated voltage to an AC signal. This regulated AC waveform is applied to the primary of the high voltage transformer. Control is by the pulse width modulation board. The post regulator, which is a fast linear regulator for the helix voltage, is also included in this module.

Diode/Cap Assembly: This module contains the high voltage transformer and the high voltage rectifiers.

High Voltage Filter: This module contains the high voltage capacitors for the cathode and the collector voltages. This module filters ripple from the high voltage rectifiers, monitors the cathode and collector voltages, and sends a feedback signal to the post regulator.

Heater Power Supply Module: Powers the TWT DC heater. It uses +15VDC input and provides isolated -6.3 VDC at cathode potential.

Grid Modulator Module: The Grid module generates two floating voltages at cathode potential, and switches its output between those voltages, at a rate of up to 50kHz. Bias and pulse top voltage for the TWT grid are provided by the Modulator Assembly.

Interconnects between the power supply modules are through a motherboard. It is installed in a finned heat sink assembly to which the modules are bolted. The incoming cabinet air cools the heat sink.

3. OPERATION

3.1 WARNINGS AND CAUTIONS

Throughout this manual, the symbol:

WARNING:



indicates that a hazard exists that may result in personal injury or loss of life.



CAUTION:

indicates that failure to follow procedures may result in damage to the equipment.



WARNING: DANGER - High Voltage Present:

Electrical equipment in this TWTA generates and stores high-voltage energy that can result in electrocution. Do not operate the TWTA with covers or the front panel removed.

Service work must be performed only by technicians thoroughly familiar with the high-voltages present in microwave tube amplifiers in general, and with this equipment in particular.

Never handle the TWT leads or the high-voltage connectors unless the unit has been unplugged and it has been positively established that the high-voltage filter capacitors have been discharged to a *known* safe level.



WARNING: Safety Ground

This equipment is provided with a protective earth terminal. The main power source to the equipment must supply an uninterrupted safety ground to input wiring terminals, power cord, or supplied power cord set. The equipment MUST NOT BE USED if this protection is impaired.



WARNING: Explosive Atmosphere To avoid explosion, never operate this TWTA in an explosive atmosphere. This equipment is not certified for operation in an explosive atmosphere.

WARNING:

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A malfunctioning power supply can cause damage to the TWT. If you are troubleshooting the TWTA, remove the TWT and substitute suitable loads to prevent damage to the TWT.

WARNING:



This equipment generates high power microwave radiation. Always operate the unit into a properly assembled waveguide structure or suitable RF load.

WARNING:



Hazardous energy may be present while protective covers are removed from the equipment even if disconnected from the power source. Contact may result in personal injury.

WARNING:

4

Place the equipment in a non-operating condition before disconnection or connecting the load to the RF output connector.



WARNING:

In a fault condition, there is a possibility that high voltages (other than AC line Input) may be present when the equipment is powered up and in the STBY mode. Extreme caution is required when either top or bottom panels are removed.

3.2 INSTALLATION

3.2.1 Unpacking

Upon receiving the TWTA, unpack the unit and inspect it for obvious signs of external damage. If damage is observed, notify the carrier and contact an authorized service representative.

Save and store the shipping container in case the unit needs to be returned in the future for calibration or repair.



CAUTION:

The RF amplifier should not be operated if there is physical damage, missing hardware or missing panels.

3.2.2 Mounting

NOTE: Due to the weight of the unit, the removal of the amplifier from the cabinet or rack is a two-person operation.

Disconnect power and any other cables. Remove any screws connecting the HPA to a rack or cabinet. Carefully remove the HPA from the rack or cabinet. If slide rails are used, depress the buttons on each slide rail to remove the unit from the rack.

CAUTION:



Never rack mount the TWTA using the front panel alone. The chassis is likely to be damaged unless its weight is supported. Slide rails can be used in a rack mount configuration.

For rack mount installation of multiple units, the units should be separated vertically by at least 1 3/4 inches. This will allow room for necessary support rails, facilitate installation and removal of the units, and help prevent overheating.

3.2.3 Cooling Requirements

Each TWTA chassis is provided with an internal cooling fan. It is important that air movement around the rear of the unit be unobstructed.

CAUTION:



Do not position the TWTA in such a way that the air intakes or outlets are blocked, or that the exhaust flow is directed into the intake. See Sections 3.3 and 3.5 for locations of air intakes and air outlets. Make sure that the intake air is 50°C or below. If necessary, fabricate a short duct to direct the hot exhaust air out of the rack enclosure. Great care must be taken to minimize any exhaust air restrictions. Avoid mounting heatproducing equipment in the same rack, especially below the TWTA. Failure to provide adequate cooling can result in the unit shutting down from overtemperature conditions.

The TWTA dissipates approximately 1.5 –2.5 kilowatts when in the operate mode.

3.2.4 AC Line Power Connections

AC line power connection to the Power Supply Chassis is made at the AC inlet J1, which is a male, 4 pin receptacle, MS3102A22-22P. The power connector pinout is as follows.

(A)	А	AC
(D B)	В	Neutral
C	С	Safety Ground
\smile	D	NC



WARNING:

Improper grounding of this equipment can result in electric shock. The TWTA must be operated only with a line cord with a safety ground wire. It is the user's responsibility to ascertain that the power connector is properly wired and that the power outlet is grounded.

CAUTION:



Main supply voltage fluctuation not to exceed the nominal voltage range of 190-260 VAC.

3.2.5 RF Connections

The RF output connector is WRD-350 waveguide.

The RF input connector is type N.



CAUTION:

Never operate the TWTA without a matched output load rated for at least 8,000 watts, peak and/or 450W continuous. The TWTA is not provided with an output isolator. Full reflected power may irreparably damage the TWT. Even with no drive, "looping" oscillation can result in RF output high enough to damage the tube if it is operated without a load. The VSWR detection circuit is provided to protect the tube from *progressive* failure or mismatch of the output load; it should not be relied on for protection from the absence of a load.

If an external isolator is installed at the output of the TWTA, either the isolator should have a load capable of dissipating the full output of the TWTA or the isolator load should be provided with a temperature sensing switch. The temperature switch should be normally closed, self-resetting, and with a temperature rating such that there is no possibility of damaging the load by overheating before the switch opens.

3.3 FRONT PANEL FEATURES



Figure 3-1. Front Panel

Table 3-1. Front Panel Features

1 MAIN POWER Switchable 15 A. circuit breaker 2-5 S1S4 Soft Key push buttons; various menu selection functions. 6 STANDBY Push-button; turns high voltage and heater off. 7 EXIT Push-button; terminates various menu selection routines and returns to the previous menu level. 8 OFF Push-button, turns RF off by setting the grid modulator to "bias off" 0 Emergency witch even Provides access to emergency bypass switches, which permit manual control	Label	Title	Function
2-5 S1S4 Soft Key push buttons; various menu selection functions. 6 STANDBY Push-button; turns high voltage and heater off. 7 EXIT Push-button; terminates various menu selection routines and returns to the previous menu level. 8 OFF Push-button, turns RF off by setting the grid modulator to "bias off" 0 Emergency witch eaven Provides access to emergency bypass switches, which permit manual control	1	MAIN POWER	Switchable 15 A. circuit breaker
6 STANDBY Push-button; turns high voltage and heater off. 7 EXIT Push-button; terminates various menu selection routines and returns to the previous menu level. 8 OFF Push-button, turns RF off by setting the grid modulator to "bias off" 0 Emergency witch even Provides access to emergency bypass switches, which permit manual control	2-5	S1S4	Soft Key push buttons; various menu selection functions.
7 EXIT Push-button; terminates various menu selection routines and returns to the previous menu level. 8 OFF Push-button, turns RF off by setting the grid modulator to "bias off" 0 Emergency system access to emergency bypass switches, which permit manual control	6	STANDBY	Push-button; turns high voltage and heater off.
8 OFF Push-button, turns RF off by setting the grid modulator to "bias off" 0 Emergency switches, which permit manual control	7	EXIT	Push-button; terminates various menu selection routines and returns to the previous menu level.
Provides access to emergency bypass switches, which permit manual control	8	OFF	Push-button, turns RF off by setting the grid modulator to "bias off"
of the amplifier.	9	Emergency switch cover	Provides access to emergency bypass switches, which permit manual control of the amplifier.
10 OPERATE Push-button; turns on high voltage when all faults and heater time delay are cleared.	10	OPERATE	Push-button; turns on high voltage when all faults and heater time delay are cleared.
11 RF On Push-button, allows video pulse to set the grid modulator to "bias on"	11	RF On	Push-button, allows video pulse to set the grid modulator to "bias on"
12 ADJUST Rotary knob used as an input device to change values of a variety of parameters.	12	ADJUST	Rotary knob used as an input device to change values of a variety of parameters.

3.3 REAR PANEL FEATURES



Figure 3-2 Rear Panel

Table 3-2 Rear Panel Features

Label	Title	Function
1	PULSE INPUT	Modulator Pulse Input: BNC female
2	RF INPUT	RF Input: Type N female
3	FWD SAMPLE	Forward Power Sample Port: -50dB coupling factor, Type N female
4	RS-422/485	Remote Control Connector: D-Sub 9-pin female
5	SAFETY GROUND	Internal and External Safety Ground Stud
6	RF OUTPUT	RF Output: WRD-350
7	EXTERNAL INTERLOCK	Connector for remote interlock and inhibit functions: D-Sub 15-pin female
8	AIR EXHAUST	Convection cooling exhaust
9	AIR INTAKE	Convection cooling inlet
10	AC INPUT	Circular AC Input connector: 190-260VAC

3.5 FRONT PANEL AND SOFT KEYS

3.5.1 Overview

The purpose of the front panel display is to permit the operator to access extensive information about the condition and operation of the TWTA. To accomplish this, a number of informational screens are programmed. It is important for the operator to be able to select the screen with the required information. Screen selection is accomplished by pressing an appropriate soft key, or by pressing the EXIT key. When a soft key is active, its function is displayed on the bottom line of the display. Figure 3-4 provides a "roadmap" for navigating between the screens.

3.5.1.1 Soft Keys



Figure 3-3 Soft Key Display

Table 3-3 Soft Keys S1-S4

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

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

3.5.1.2 EXIT

Returns to the top level from within a menu sequence.

3.5.1.3 ADJUST

This knob is used to:

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



Figure 3-4 Menu Map

3.5.2 Menu Screens

Menu Screens - The screens at the highest level are called menu screens. There are four menu screens. At power on, the MENU 1 screen is displayed. Each of the menu screens has the soft key S4 labeled MORE. The MORE key (S4) causes the next menu screen to appear. From MENU 4, MORE causes MENU 1 to reappear. In short, MORE permits scrolling through the menu screens. The EXIT key returns display to MENU 1 from any other menu screen.

The menu screens display system status and parameter levels. They are configured as follows:

Monu 1	Econord newor (har graph watte or dP)
wenu i	Forward power (bar graph, watts, or db)
	Reflected power (bar graph, watts, dB or % forward power)
	System status (if a latched fault exists, MENU 1 is displayed with the system shutdown message)
Menu 2	- System Hours -
	Console hours (active when main power circuit breaker is on, represents TWT filament hours)
	Operate hours (active when HV is on)
Menu 3	Power supply temperature (°C or °F)
	Cabinet temperature (°C or °F)
	TWT baseplate temperature (°C or °F)
Menu 4	Heater voltage (Ef)
	Heater current (If)
	Collector voltage (Eb)
	Cathode voltage (Ek)
	Helix current (lw)
	Grid voltage (eg) (If Applicable)

NOTE: Readings and headings on Menu 1-4 will vary depending on the type of HPA. Check test data.

Help Screens S3 - On each of the menu screens 1, 2, 3 and 4 soft key S3 is labeled HELP. If S3 is selected, a message describing the functions of that screen will be displayed. Use the ADJUST knob to scroll through the message. The EXIT key will return you to the screen from which the help screen was called.

3.5.3 Setup Screens

Setup Screens Menu 2 - Labeled SETUP selects the first of the setup screens.

SETUP 1: allows the user to manually shut off the heater power supply and put the HPA into Sleep Mode (see Section 3.5.4). Pressing S1 (SET) toggles between ON and OFF. Pressing MORE again brings up the SETUP 2.

SETUP 2: toggles Auto Cycle On/OFF and Remote. Pressing S1 (SET) changes the selection. The setting displayed when the screen is exited will be retained.

Pressing MORE brings up the next screen, SETUP 3.

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

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

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

SETUP 3: toggles display of temperature parameters between Fahrenheit and Celsius degrees. Pressing S1 (SET) changes the selection. The setting displayed when the screen is exited will be retained. Pressing MORE again brings up the next screen, SETUP 4.

SETUP 4: allows a choice of displaying forward power in stripchart form, or in dBm or watts. Pressing MORE again brings up the next screen, SETUP 5.

SETUP 5: allows a choice of displaying reflected power in stripchart form, % of forward power, or in dBm or watts. Pressing MORE again brings up the next screen, SETUP 6.

SETUP 6: toggles the desired number of alarm beeps and the desired beep volume. S1 (SET) toggles between parameters, and the adjust knob is used to enter the data. Pressing MORE again brings up the next screen, SETUP 7.

SETUP 7: allows the RS-422/485 address to be set. Pressing MORE again brings the user back to SETUP 1.

3.5.4 Sleep Mode

Sleep Mode (see Section 3.5.3) - The Sleep Mode feature allows the *user* to selectively shut off the heater module of the power supply. This can be done manually through the front panel or remotely via the computer interface. This is typically used during extended periods of *remote* operation to improve tube life, by turning off the filaments (Sleep Mode activated). This eliminates excessive STANDBY hours on the TWTs while still permitting remote capability to turn on the amplifier.

To activate Sleep Mode locally: Press the MORE soft key to get to MENU 2. At MENU 2 press the SETUP soft key to get to SETUP 1. At SETUP 1 press SET to activate Sleep Mode (turn heater and fan off). The system will ask **Are you sure?** Press SET again.

After activating the Sleep Mode: Screen will display Cooling On while heaters cool down. System Off notifies user that the amplifier is in Sleep Mode

To de-Activate Sleep Mode locally: Press the ON soft key to de-activate Sleep Mode. Amplifier will return to MENU 1. When de- activating the Sleep Mode the heaters will require at least a 3 minute heater time delay. Wait the full 3 minutes prior to selecting OPERATE.

3.5.5 Warning Screens

Warnings Screens Menu 3 - Labeled WARNINGS, selects the first of six setup screens

WARNINGS 1: allows the operator to enter the maximum forward power. The existing value is between brackets[]; pressing SET puts arrows >< around the value, indicating that the adjust knob is active. The effect of the warning setpoint is as follows: if the forward power exceeds the setpoint, the audible alarm will sound (if configured in SETUP 5). This warning will be repeated every thirty seconds until the over forward power condition is cleared. In addition, a warning message will appear on line 3 (the status line) of MENU 1. In the event that the alarm is heard, the operator should go to MENU 1 to determine the cause. Pressing MORE brings up the next screen, Warnings 2.

WARNINGS 2: allows the under forward power set-point to be entered. Adjusting this to the minimum value causes -OFF- to be selected, disabling this alarm. Pressing MORE again brings up the next screen, Warnings 3.

WARNINGS 3: allows for the maximum reflected power level to be set. Note that these are warning levels at which the beep sounds; the actual maximum reflected power level that generates a system fault is set in hardware in the TWT power supply HPA Logic and Control Module. Pressing MORE brings up the next screen, Warnings 4.

WARNINGS 4: allows input of the maximum power supply temperature. Entering this parameter is performed as above. Pressing MORE brings up the next screen, Warnings 5.

WARNINGS 5: allows input of the maximum TWT collector block temperature. If either parameter exceeds the setpoint, the audible alarm will sound every 30 seconds (if configured), and a warning message will appear on line 3 of MENU 1. Pressing MORE brings up the next screen, Warnings 6.

WARNINGS 6: permits setting the maximum helix current. Any helix current above this setpoint will result in an audible alarm (if configured), repeated every 30 seconds; and a warning message is displayed on the status line of MENU 1. Pressing MORE again returns display to WARNINGS 1. As before, pressing EXIT from any of the warnings screens returns display to MENU 3.

3.5.6 Miscellaneous Screens

Info Screen MENU 2 S2 - (labeled INFO) selects a screen that displays the RF sample port calibration factors at various frequencies across the band. In addition, this screen displays the model number, serial number and firmware revision information, which may be required by a service representative when providing technical assistance. The EXIT key returns the display to MENU 2.

Event Screen Menu 4 S2 - Labeled EVENT provides a display of events logged by the control system. These events include AC power-up, heater warm-up, change from standby to operate, faults, and resets. The events are stored in a first-in-first-out (FIFO) software buffer that has room for 100 events; as new events are logged, the older ones are discarded.

System Shutdown Screen - In the event of a system shutdown due to a latched fault (i.e., a fault such as body over-current or power low line that requires a reset), the MENU screen is replaced by a screen indicating the nature of the fault. Soft key S4 (labeled OK) is implemented as a reset key; pressing S4 brings back the MENU screens. Line 3 of MENU 1, which normally displays the operational state of the TWTA, is used as a fault display line until the fault is cleared. When the fault clears the system will automatically resume the standby state and high voltage on will be enabled once again.

Factory Service Screens - A number of screens intended for factory service and calibration are behind passwords and are not accessible to the user.

System Malfunction Screens - A number of screens are reserved to display error messages. These messages are not normally seen and indicate a malfunction of the TWTA. System malfunction messages include the following:

- Database corrupt
- Communication failure
- Cannot restore
- CU line voltage too low to operate. System shutdown

In the event that one of these appears, shut off the TWTA and contact an authorized service representative before proceeding.

CAUTION:



Attempts to operate the TWTA despite control unit problems may result in loss of the static RAM database and calibration information.

3.6 INITIAL TURN ON AND WARM-UP PROCEDURE

Before Applying Power

1. Verify that the equipment line voltage is compatible with the TWTA.

NOTE: If the user does not have a 5VDC max TTL signal pulse connected to the pulse input BNC connector, there will be no RF output.

- 2. Install the TWTA as discussed in Section 3.2. Provide an RF generator to the RF input Type N connector. Set RF generator level below -50dBm and set desired frequency in specified range. Connect a load suitable for 8000 watts peak operation to the output connector. The load VSWR should be less than 2.0:1. A power meter and suitable attenuators may be connected to the RF sample port. (Refer to RF sample port calibration factors on the rear of the unit or on the *Info* screen in MENU 2). These show the relationship between the amplifier output power and the RF sample port power as a function of frequency. When only the power of the fundamental frequency is to be measured and when operating near rated power use filters, a frequency selective receiver, or a spectrum analyzer to reduce the harmonic content of the measured level.
- 3. Switch on the MAIN POWER circuit breaker. The fan will operate. Allow three minutes for the filaments on the TWTs to warm up.

The front panel display will show several identification messages and then MENU 1 screen. The third line will indicate the heater time delay is active. Allow the heater warm-up delay to expire. Line three will indicate STANDBY/READY.

- 4. Push S4 (MORE) three times to go to MENU 4. Verify that the heater voltage and current are near their nominal levels. The values of these parameters at the time the TWTA left the factory are logged on the test data sheet.
- 5. Push the OPERATE push-button. Stay in Menu Screen 4. You will now see the cathode and collector voltages rise. Verify that the collector and cathode voltages are near nominal. The values of these parameters at the time the TWTA left the factory are logged on the test data sheet.
- 6. Set Gain to 0%. Push RF ON, check the helix current (Iw). The helix current should be close to the nominal value for no RF drive. The value of this parameter at the time the TWTA left the factory is logged on the test data sheet.
- 7. Push S4 (MORE) or EXIT to get to Menu 1.
- 8. Set the TWTA gain to maximum.
- 9. Adjust the RF generator to slowly increase the RF drive toward 0 dBm to reach the desired forward power on the display and power meter (connected to the forward sample port). The forward power display will become active, with a maximum reading when peak power output is achieved.

An alternate procedure is to pre-set the gain to a minimum, set the RF generator to 0 dBm and then slowly increase the TWTA gain to set the desired RF output level.

Observe that the helix current is sensitive to the RF drive level of the TWT. It is at a minimum with no RF drive. The helix currents with no drive and with rated RF output mid-band are logged on the test data sheet. The value of the helix current is a good qualitative indicator of RF drive present.

To shut the system down, push RF OFF and then STANDBY. Allow the TWTA to cool down until the TWT temperature drops below 50°C, then turn off main power.

3.8 RF OPERATION

NOTE: If the user does not have a 5VDC max TTL signal pulse connected to the pulse input BNC connector, there will be no RF output.

The RF chassis is provided with a front-panel BNC connector which must be connected at all times to generate RF output. The impedance of the pulse gate input is approximately 50 ohms.

For Pulsed operation, provide a TTL pulse signal from a pulse generator at the BNC connector on the rear panel of the RF chassis. In pulse mode the signal will be used for pulsing the beam of the TWT and hence the RF output. As compared with providing a pulsed RF input, pulsing the beam of the TWT offers low noise between pulses. It also offers reduced prime power consumption for low duty factor pulsing, since the beam current is off most of the time.

Best performance is obtained when the input RF drive is set at or just below the level which causes peak power output. Do not set input drive above 0 dBm

CAUTION:



Input drive above +10 dBm may damage the unit

The reverse (reflected) power level should remain below 10% of the forward power, assuming that the output is properly matched.

4. MAINTENANCE

The TWTA does not require routine scheduled maintenance. The only moving parts are the elements of switches, relays and the fans. Preventive maintenance is recommended in Section 4.3.

The TWTA is basically a factory repairable unit. However, since limited logic schematics and partial parts information is supplied in this manual (Section 5) some user service organizations may choose to perform their own corrective maintenance. Warnings and Cautions should be observed.

4.1 SAFETY WARNINGS AND CAUTIONS



WARNING: Adjustment, maintenance, and repair of the equipment must be performed only by qualified personnel. Service work must be performed only by technicians thereauchly familian with the high values present in

only by technicians thoroughly familiar with the high voltages present in microwave tube amplifiers in general, and with this equipment in particular.

Never handle the TWT leads or the high-voltage connectors unless the unit is unplugged and it has been positively established that the high-voltage filter capacitors have been discharged to a *known* safe level.

CAUTION:



A malfunctioning power supply can cause damage to the TWT. If you are troubleshooting the TWTA, remove the TWT and substitute suitable loads to prevent damage to the TWT.

Replacement fuses are required to be of specific type and current rating.

4.2 UNAUTHORIZED REPAIRS



CAUTION:

Unauthorized repairs or modification of this product during the warranty period may void the warranty. In the event that the TWTA malfunctions while it is still under warranty, always contact an authorized service representative.

4.3 PREVENTIVE MAINTENANCE

The RF characteristics and power supply voltages and currents of the TWTA should be logged on a regular basis. Maintenance should be performed if significant deviations from the logged values appear. If the unit is under warranty, contact an authorized service representative if impaired performance is suspected.

The frequency of service depends on the environment where the TWTA is used, and must be determined by inspection. If significant dust has been noted on or around the air intake grill, it may be desirable to vacuum the dust and debris from inside the chassis. To open the chassis:

1. Remove the amplifier from the cabinet or rack as follows:

NOTE: Due to the weight of the unit, the removal of the amplifier from the cabinet or rack is a two-person operation.

- 2. Disconnect power and any other cables or waveguide. Remove any screws connecting the HPA to a rack or cabinet. Carefully remove the HPA from the rack or cabinet. If slide rails are used, depress the buttons on each slide rail to remove the unit from the rack.
- 3. Remove the screws that secure the upper and lower covers. Remove the covers to gain access to the interior of the TWTA.
- 4. Vacuum dust and debris from inside the chassis. Clean dust from the TWTA and its flying leads. Remove any dirt from around the three high voltage connectors. While the cover is off, check for loose wires, components or fasteners.
- 5. Re-assemble in the reverse order.

Maintenance Actions (Review)

Periodic maintenance of AR amplifiers consists of 3 primary actions:

- Clean around the air intake grill on a regular basis.
- Maintain a log of the amplifier's operating parameters. This will allow identification of problem areas before faults occur and allow quick corrective action.
- Keep the equipment as clean as possible and ensure that the front panel buttons are kept clean from dirt and dust ingress.

4.4 TROUBLESHOOTING

Symptom	Possible cause
TWT or power supply overtemperature	Air inlet grille blocked or dirty Collector heat sink dirty Inadequate clearance behind TWTA High air inlet temperature Defective blower or power supply
No response when main power turned on	External breaker tripped
Fan comes on but control module display does not come up; unit does not beep when powered up	Defective control module or control module power supply
Control module does not boot	EPROM(s) missing.
Control module datalink failure error appears	HPA interface failure. Fiberoptic link failure <u>+</u> 15 VDC supply failure
Heater power supply does not come up	Defective low voltage power supply module Defective heater power supply module
No high voltage	Open external interlock Keylock switch on INHIBIT or REMOTE Defective high voltage power supply.
Voltages normal, but no RF output, helix current low	No RF input Defective remote control board Defective SSA Gain turned down

After review of the symptoms of the failure, the user may want to check for a loose connector or component especially after rough handling of the unit. Look externally for physical damage and internally for unmated or loose parts.

The service technician should become familiar with the internal mechanical construction to permit correct reassembly. Limited troubleshooting may be conducted, with caution, based on the failure symptom and an understanding of the logic/schematic diagrams.

4.5 NON-REPAIRABLE MODULES

The following modules are encapsulated and not repairable. Contact an authorized service representative if replacement modules are needed.

A30594-001 Grid Modulator Assembly

- A33176-001 High Voltage Filter Assembly
- A33185-000 High Voltage Diode/Cap Assembly
- A33090-001 Capacitor Bank

4.6 RECOMMENDED SPARE PARTS

- A27824-100 Heater Power Supply Module
- A30467-000 Power Inverter
- A30594-001 Grid Modulator Assembly
- A33176-001 High Voltage Filter Assembly
- A33185-000 High Voltage Diode/Cap Assembly
- A23683-003 Power Factor Correction Module
- A26452-150 Low Voltage Power Supply Module
- E02822-000 SSPA, C-Band, 4.0-8.0 GHz
- E01120-000 Fan 11000 RPM, 400Hz

5. TECHNICAL DOCUMENTATION

The purpose of this technical documentation section is to provide a guide to the TWTA for technician-level servicing. It is intended for use by qualified technical personnel who *must* troubleshoot and repair the TWTA in the field. Such repairs are typically limited to replacement of modules or major components. For this reason, documentation pertaining to the highest levels of the system and to system control logic are included.

5.1 TOP LEVEL BUILD TREE (SEE APPENDIX C)

5.1.1 A38004-100 Pulsed HPA

Level	Item Number	Item Description	Qty	Ref Des
1	10-38004-100	HPA, 4KW PULSED, 43PC	0	
1	14-38004-100	ATP, 43PC	0	
1	15-38004-100	PRODUCT SPEC, 43PC	0	
1	33-38004-100	LABEL, 43PC	0	
1	80-38004-100	43PC PACKAGE OUTLINE	0	
1	85-27500-001	BLUE BOOK, PULSED UNIT	0	
1	91-91209-04202	43PC,PS,422	0	
1	A23692-000	INSULATED FAN DRIVER	1	A1
1	A25444-001	HPA INTERFACE BOARD (200UM GLASS FIBERS)	1	A2
1	A27392-007	RF OUTPUT PROTECTION BOARD, ARC DETECT, NO LASER, +5VDC IN	1	A3
1	A27506-102	HPA SYSTEM CONTROL FRONT PANEL, SINGLE PHASE	1	A4
1	A27509-001	CONTROL UNIT ASSY, RS-485, 200UM HCS	1	A5
1	A30445-006	WIRING KIT, 43PC	1	A13
1	A30447-008	MICROWAVE POWER ASSY, 43PC	1	A7
2	A31674-000	HARNESS, FIBER OPTIC, ARC DETECTOR	2	A1,A6
2	E00888-015	CABLE,RF FLEX,15,SMA,M TO M,20 GHZ,50 OHM,0.141 CABLE, [SRC 150-150-150150]	2	W6,W7
2	E01376-000	COUPLER, -10DB, 0.8 - 4.2 GHZ SMA, 2 KWPIC, 50W, AVG., FEMALES, [RLC M-3728]	1	A5
2	E02595-002	TWT, 4.5KW, 4.0 - 8.0 GHZ, PULSED 4% DUTY, +/- 4DB EQ, WRD-350, [TELEDYNE, MEC-3103]	1	A4
2	E02672-000	RF GASKET, WRD-350 GROOVED FLANGE, D-STYLE [CONTINENTAL MICROWAVE, GSK350]	1	
2	E02814-000	OUTPUT ARM, 4-8 GHZ, DUAL COUPLERS, ARC DETECTOR, WRD-350 [APOLLO, TBD]	1	A2
2	E02822-000	SSPA, 4-8 GHZ, 35DBM OUT, 37DB GAIN [KMIC TBD]	1	A3
2	E20145-000	FILTER,LOW PASS,8 GHZ, SMA(MICROLAB/FXR LA-80F)	3	FL1,FL2,FL3
2	E20284-000	ZERO-BIAS SCHOTTKY DETECTOR,10MHZ-18.5GHZ,POSITIVE OUT PUT POLARITY,(RLC, M-3747)	2	D1,D2
1	A30537-102	HV BREAKOUT BOX, NO POTTING, EG REF TO EK, SAME AS - 100 WITH SHORTER LEADS AND ALTERNATE PACKAGING	1	A14
1	A30750-006	PULSE MONITOR BOARD, SAME AS -001 WITH VSWR TRIP LEVEL ADJUST TO 1.2V AND CROWBAR JUMPER INSTALLED	1	A8
1	A30770-004	POTTED RESISTOR ASSEMBLY	1	A9
1	A30771-002	RESISTOR CAPACITOR SNUBBER ASSY	1	A10
1	A30956-001	OPTICAL RS-485/RS-422 BOARD (200UM HCS OPTICS)	1	A11
1	A33053-100	POWER CORD ASSEMBLY, SINGLE PHASE, 240VAC, 20A	1	
1	A33069-100	POWER SUPPLY, TWT MEC-3103, SINGLE TWT WITH PFC	1	A6
2	A23050-085	HPA LOGIC AND CONTROL MODULE WITH IW BLANKING CIRCUIT, C-BAND	1	A11

Level	Item Number	Item Description	Qty	Ref Des
2	A23065-001	INPUT FILTER MODULE, PHASE LOST DETECTION NOT USED	1	A7
2	A23683-003	AVR CURRENT MODE PFC, 3KW , 200-250VAC INPUT (CAN OPERATE WITH A23065-001)	1	A9
2	A26452-150	LOW VOLTAGE POWER SUPPLY MODULE 150W	1	A8
2	A27816-000	MOTHER BOARD	1	A10
2	A27818-000	TANK MODULE (NO CAPS)	1	A4
2	A27824-100	HEATER SUPPLY, HI POWER, 6.3V 6A, WITHOUT CATH REF INPUT LEAD	1	A1
2	A30467-000	PHASE & POST POWER INVERTER	1	A6
2	A30594-001	GRID MODULATOR MODULE, W/O CATH REF INPUT LEAD	1	A2
2	A33176-001	HV FILTER FOR TWT MEC 3102 AND MEC 3103 WITHOUT EXTERNAL CAP ASSY	1	A3
2	A33185-000	HV RECTIFIER & TRANSFORMER ASSEMBLY FOR 83PC	1	A5
1	A33090-001	CAPACITOR BANK FOR ONE TWT, 43PX	1	A12
1	A33288-006	CABINET KIT, 43PC	1	

5.2 SCHEMATICS

 10-23050-085
 HPA Logic and Control (A23050-085)

 10-25444-001
 HPA Interface (A25444-001)

 10-25450-000
 CPU Board (A25450-000)

 10-38004-100
 43PC Pulsed HPA

5.3 PARTS LISTS

A23050-085HPA Logic and Control AssemblyA25444-001HPA Interface Board

5.3.1 HPA Logic and Control Board (A23050-085)

Item Number	Item Description	Qty	Ref Des
10-23050-085	HPA LOGIC AND CONTROL	0	
61-23050-083	NOTES	0	
B23050-000	LOGIC & CONTROL BOARD	1	
C06103-000	CAP, 10MF, +/-20%, 25V, SOLID TANT, RADIAL [KEMET T356E106K025AS]	2	C48,C49
C16333-000	CAP,33MF,25V,AERL,(NICHICON UVX1E330M)	1	C11
C17104-000	CAP,100UF,63V,AERL,(NICHICON, UVR1J101MPD)	1	C47
C31028-000	CAP,1000PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION)	3	C2,C5,C15
C31032-000	CAP,0.01MF,200VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	17	C9,C13,C14,C17,C19,C21,C22,C27,C2 8,C30,C31,C33,C34,C36,C41,C46,C58
C31036-000	CAP,0.1MF,100VDC,10%,CER, (KEMET, M39014/2-1310V)	5	C10,C24,C52,C101,R69
C31039-000	CAP,0.47MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	1	C99
C31040-000	CAP,1MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	18	C1,C3,C4,C6,C7,C16,C18,C25,C26,C3 2,C37,C38,C39,C40,C43,C44,C45,C50
C31065-000	CAP,2.7MF,50V,10%,CER,1% FAILURE,(KEMET CSR13G275KM)	1	C100
D10965-000	ZENER,15V,(FAIRCHILD SEMICONDUCTOR, 1N965B)	3	D16,D23,D31
D14454-000	DIODE,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4454)	22	D1,D3,D5,D7,D8,D9,D10,D11,D12,D13, D17,D18,D19,D21,D25,D26,D28,D29,D 30,D35,D37,D38
D14728-000	ZENER,3.3V,1W,10%,AXIAL,(MOTOROLA 1N4728)	1	D24
D14733-000	ZENER,5.1V,1W,10%,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4733A)	1	D36
F00101-000	WASHER,#4 NAS,(PRO-STAINLESS NAS620C4)	4	
F00107-000	#4 SPLIT LOCK WASHER,SST	2	
F31004-000	NUT,4-40,HX,SMALL PATTERN,MIL-SPEC	2	
G00043-000	HEX STANDOFF ,4-40 THREAD SS,FOR D SUBMIN CONN (PRO STAINLESS, 620013)	2	
J10370-000	CONN,37 PIN,MALE,D-SUB,PCB RIGHT ANGLE, (AMP, 747252-4)	1	J2
J12294-000	CONN RIGHT ANGLE MALE 29 PIN,(SAME AS J12291 W/NO MODIF),(HYPERTRONIC KA29/127BPMC10T,&HARDWARE	1	J7
J18086-000	CONN,,SMA,JACK RECEPTACLE,RIGHT ANGLE,0-18GHZ,PC MOUNT [JOHNSON COMPONENTS 142-0701-301]	2	J4,J5
L00200-000	WIDE BAND CHOKE, (VK200 10/3B FERROXCUBE)	1	L1
N23061-000	MODULE CHASSIS LOGIC	1	
Q22907-000	TRANSISTOR, PNP, (ST, 2N2907A) TO-18	1	Q2
Q26661-000	FET, 90V @ 1.5A ,N.CH DMOS, (T.O.39) POWER (SSD) (SUPERTEX, 2N6661)	1	Q1
R00100-000	RES,10 OHM,1/4W,5%,CC,(OHMITE, OD100JE)	6	R1,R9,R19,R37,R44,R50
R01100-000	RES,100 OHM,1/4W,5%,CC,(OHMITE, OD101JE)	5	R4,R20,R27,R29,R39
R02100-000	RES,1K,1/4W,5%,CC,(OHMITE, OD102JE)	11	R5,R7,R17,R18,R28,R34,R45,R59,R71 ,R72,R87
R02330-000	RES,3.3K,1/4W,5%,CC,(A/B RC07GF332J)	1	R43
R02470-000	RES,4.7K,1/4W,5%,CC,(OHMITE, OD472JE)	3	R30,R31,R36
R02560-000	RES,5.6K,1/4W,5%,CC,(OHMITE, OD562JE)	1	R75
R03100-000	RES,10K,1/4W,5%,CC,(OHMITE, OD103JE)	1	R38
R05820-000	RES,8.2M,1/4W,5%,CC,(OHMITE, OD825JE)	1	R35
R20243-000	RES,243 OHM, 1%,MF,100PPM,(DALE RN55D2430F)	1	R23
R21100-000	RES,1K, 1%,MF,100PPM,(DALE RN55D1001F)	1	R49
R21301-000	RES,3.01K, 1%,MF,100PPM,(DALE RN55D)	1	R10
R21402-000	RES,4.02K, 1%,MF,100PPM,(DALE RN55D)	1	R67
R21750-000	RES,7.5K, 1%,MF,100PPM,(DALE RN55D)	1	R24
R21887-000	RES,8.87K, 1%,MF,100PPM,(DALE RN33D)	<u> </u>	R52,R73
R23100-000	RES,10.5K, 1%,MF,100PPM,(DALE RN55D1052F) RES,100K, 1%,MF,100PPM,(DALE RN55D1003F)	9	R98 R6,R42,R47,R48,R60,R61,R74,R99,R1
R23169-000	RES 169K 1% ME 100PPM (DALE RN55D)	1	R54
R23249_000	RES 249K 1% ME 100PPM (DALE RN55D)	2	R46 R53
R23698-000	RES 698K 1% ME 100PPM (DALE RN55D6983ER14)	3	R33 R40 R55
R23750-000	RES 750K 1% ME 100PPM (DALE RN55D)	1	R41
R23953-000	RES,953K, 1%,MF,100PPM,(DALE RN55D9533F)	1	R66
· · · · · · · ·			

Item Number	Item Description	Qty	Ref Des
R30035-000	RES,10K, 1%,MF,100PPM,(DALE RN55D1002F)	2	R21,R62
R31091-000	RES,47K,1/4W,5%,CC,<=1% FAIL,(A/B RCR07)	1	R32
R32004-000	TRIMPOT,1K,1/2W,10%,CERMET,20T,SIDE ADJ,(BI TECHNOLOGIES, 67XR1KLF)	1	R11
R32020-000	TRIMPOT,10K,1/2W,10%,CERMET,20T,SIDE ADJ,(BI TECHNOLOGIES, 67XR10KLF)	3	R12,R15,R16
R32049-000	TRIMPOT,5K,1/2W,10%,CERMET,20T,SIDE ADJ,(BI TECHNOLOGIES, 67XR5KLF)	2	R13,R14
U02390-000	IC,QUAD COMPARATOR,(NAT LM139J)	3	U4,U5,U6
U03240-000	IC,LOW POWER OP AMP,(NAT LM324)	1	U7
U10070-000	REFERENCE, PRECISION 10V [LINEAR TECH LT1031DCH]	1	U9
U17805-000	IC,5V REGULATOR,TO-220,(NAT LM340T-5.0)	1	U8
U20148-000	IC,HEX INVERTER,SCHMIDTT TRIGGER,(74HC14) (SSD)	3	U1,U2,U3
U30106-000	IC,10K,RES NETWORK,6 PIN,SIP (DALE MSP06A-01-103G)	2	RP4,RP8
U30410-000	IC,10K,2%,0.40A,10 PIN,ISOLATED RESISTORS (DALE MSP10C- 03-103G OR BOURNS 4610H-102-103)	6	RP1-2,RP5-7,RP9
W12803-000	WIRE,SOLID,TEFLON,28 AWG,250V,(ALPHA 2842/1-GREEN)	1	

5.3.2 HPA Interface Board (A25444-001)

Item Number	Item Description	Qty	Ref Des
A25444-001	HPA INTERFACE BOARD (200UM GLASS FIBERS)	1	A3
10-25444-001	HPA INTERFACE BOARD	0	
12-00003-001	GENERIC HPA INTERFACE BOARD QUICK CHECK TEST PROCEDURE	0	
16-25444-000	HPA INTERFACE BOARD	0	
61-25444-001	NOTES	0	
88-25444-000	HPA INTERFACE BOARD	0	
A31346-000	DAC REPLACEMENT BOARD FOR U00725. DUAL CHANNEL	1	U15
B25444-000	HPA INTERFACE BOARD	1	
C03105-000	CAP, 0.01MF, +/-10%, 100V, CER, RADIAL [AVX SR201C103KAA]	1	C161
C04223-000	CAP, 0.22MF, +/-10%, 35V, TANT, RADIAL [JAMCO 33507]	1	C171
C05153-000	CAP, 1.5MF, 35V, TANT, RADIAL [AVAX, TAP155K035SCS]	4	C20,C32,C100
C05223-000	CAP ,2.2MF, +/-10%, 35V, SOLID SEALED TANT, RADIAL [SPRAGUE 199D225X9035BA1]	2	C129,C163
C06103-000	CAP, 10MF, +/-20%, 25V, SOLID TANT, RADIAL [KEMET T356E106K025AS]	3	C80.C81.C164
	CAP, 22MF, +/-10%, 16V, SOLID TANT, RADIAL [AVX		
<u>C06220-000</u>		1	
<u>C16103-000</u>		1	<u></u>
<u>C17472-000</u>		1	
<u>C1/4/4-000</u>	CAP,470UF,50V,AERL,[PANASONIC P5279] CAP 47 MF, 35V, SOLID TANT. RADIAL, (KEMET	2	C47,C67
C30066-000	T356M476K035AS)	3	C44
C31016-000	CAP,100PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION)	10	,C166
<u>C31036-000</u> C31040-000	CAP,0.1MF,100VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION) CAP,1MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	<u>61</u>	C1,C2,C3,C4,C5,C10,C11,C22,C23,C2 4,C25,C26,C28,C30,C33,C35,C40,C41, C42,C48,C49,C50,C51,C53,C62,C63,C 64,C65,C70,C71,C73,C77,C79,C83,C8 5,C87,C88,C89,C91,C94,C96,C97,C98, C102,C103,C105,C107,C108,C109,C1 10,C111,C112,C113,C114,C115,C116, C117,C121,C125,C132,C167 C12,C14,C17,C18,C19,C21,C27,C29,C 31,C34,C36,C38,C45,C46,C52,C54,C5 5,C56,C57,C58,C59,C60,C61,C66,C68, C72,C75,C82,C84,C86,C90,C92,C93,C 95,C104,C106,C118,C119,C120,C122, C123,C124,C133,C168,C169
D14007-000		8	
D14454-000	DIODE AXIAI (MOTOROI A 1N4454)	7	D1-D7
D14733-000	ZENER 5 1V 1W 10% AXIAL (MOTOROLA 1N4733)	2	D9 D17
110074-000	LED GREEN ALGAAS NON-DIFFUSED (HI MP1540)	1	1
J10021-000	HEADER,2 PIN,MALE,RIGHT ANGLE,SERIES 7478 (MOLEX 22-05- 3021)	1	J5
J10371-000	D-SUB,37 PIN MALE,PCB MOUNT,STRAIGHT (POSITRONICS MD37M3S000)	1	J1
J14161-000	SKT,DIP,16 PIN,MACH SLEEVES,(AUGAT 516-AG11D)	1	XU17
J14202-000	SKT,DIP,20 PIN,MACH SLEEVES,(SAMTEC ICA-320-SGT)	1	XU26
J14281-000	SKT,DIP,28 PIN,MACH SLEEVES,(SAMTEC ICA-628-SGT)	1	XU15
J16210-000	TEST JACK,BLACK,VERTICAL,(EF JOHNSON 105-0853-001)	1	ТРО

Item Number	Item Description	Qty	Ref Des
J16211-000	TEST JACK, BROWN, VERTICAL, (EF JOHNSON 105-0858-001)	1	TP1
J16212-000	TEST JACK,RED,VERTICAL,(EF JOHNSON 105-0852-001)	1	TP2
J16213-000	TEST JACK, ORANGE, VERTICAL, (EF JOHNSON 105-0856-001)	1	ТР3
J16214-000	TEST JACK, YELLOW, VERTICAL, (EF JOHNSON 105-0857-001)	1	TP4
J16215-000	TEST JACK, GREEN, VERTICAL, (EF JOHNSON 105-0854-001)	1	TP5
J18167-000	D-SUB,37 PIN,FEMALE,PCB MOUNT,RIGHT ANGLE (AMP 745784-4)	1	J4
J18180-000	CONN,D-SUB,15 PIN,MALE,STRAIGHT,PCB MOUNT (POSITRONIC MD15M3000)	1	J3
J31013-000	CONN,D-SUB,25 PIN,MALE,RIGHT ANGLE,PCB MOUNT,[AMP 747238-4]	1	J2
J31014-000	SPRING LATCH KIT.D-SUB.(AMPHENOL 17-529)	4	XJ1-XJ4
K02009-000	RELAY,DPDT,5VDC,125V @ 0.5A / 30VDC @ 1A CONTACTS,PCB TERMINALS,SEALED (OMRON G6H-2-DC5)	6	K1-K6
L00200-000	WIDE BAND CHOKE, (VK200 10/3B FERROXCUBE)	4	L1-L4
Q22222-000	TRANSISTOR,NPN, (ST, 2N2222A) TO-18	8	Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8
R00680-000	RES,68 OHM,1/4W,5%,CC,(A/B RC07GF680J)	1	R41
R01220-000	RES,220 OHM,1/4W,5%,CC,(A/B RC07GF221J)	1	R2
R04200-000	RES,200K,1/4W,5%,CC,(A/B RC07GF204J)	1	R1
R20100-000	RES,100 OHM, 1%,MF,100PPM,(DALE RN55C)	3	R6,R8,R58
R20200-000	RES,200 OHM, 1%,MF,100PPM,(DALE RN55D)	1	R57
R22332-000	RES,33.2K, 1%,MF,100PPM,(DALE RN55D)	1	R59
R23100-000	RES,100K, 1%,MF,100PPM,(DALE RN55D)	2	R4,R7
R30071-000	TRIMPOT,10K,1/2W,10%,CERMET,100PPM,20T,TOP ADJ.(BECKMAN 67W)	2	R3.R5
R30103-000	RES,10K,1/8W,1%,MF,AXIAL,100PPM,(DALE CMF-50 / RN50C1002F)	7	R9,R12,R15,R22,R35,R40,R44
R30140-000	RES.1K.1/8W.1%.MF.50PPM.(DALE RN50C)	12	R17,R18,R19,R20,R21,R23,R25,R28,R 31,R42,R43,R46
	RES,100K,1/20W,1%,FILM,AXIAL,100PPM,MIL,(DALE	10	R13,R14,R24,R26,R27,R29,R32,R37,R
R31164-000	IC,ULTRA LOW NOISE PRECISION OP AMP,(ANALOG DEVICES	12	38,R39,R47,R100
U00027-000	OP27GP)	2	U7,U8
U00029-000	ADS7809PB,PB],[ANALOG DEVICES AD977CN]	1	U26
U00524-000	IC, INSTRUMENTATION AMP, (ANALOG DEVICES AD524A) (SSD)	1	U17
U04090-000	IC,4CH ANALOG MULTIPLEXER,(DATEL MXD-409)	3	U9,U10,U18
<u>U08010-000</u>	IC,8 COMMON CATHODE CLAMPING DIODES,9 PIN SIP,(ROHM DAN801)	5	DP2,DP4,DP5,DP8,DP9
U08011-000	IC,8 COMMON ANODE CLAMPING DIODES,9PIN SIP,(ROHM DAP801)	5	DP1,DP3,DP6,DP7,DP10
U11165-000	IC,6.5536MHZ CLOCK OSCILLATOR,1/2 SIZE,(ECLIPTEK EC1100HS-6.5536MHZ) (SSD)	1	U27
U11528-000	IC,VERSALINK TRANSMITTER,HORIZONTAL, (200UM FIBER) (HFBR-1528)	1	U40
U12521-000	IC,FIBER OPTIC RECEIVER,HORIZONTAL,(HFBR-2521) (SSD)	1	U54
U17545-000	DRIVER,OIL,DS75451N,DUAL AND,[TI, SN:75451BP)	1	U36
U20148-000	IC,HEX INVERTER,SCHMIDTT TRIGGER,(74HC14) (SSD)	5	U6,U19,U34,U39,U60
U20738-000	IC,DUAL J-K FLIP-FLOP W/RESET, (NXD SEMI-CONDUCTORS, 74HC73N)	1	U42
U21328-000	IC,QUAD 2 INPUT NAND,SCHMIDTT TRIGGER,(74HC132) (SSD)	1	U51
1121388-000	IC,3 TO 8 DECODER/DEMULTIPLEXER, INVERTING, (74HC138)	1	1152
U21536-000		1	1132
	(000)	•	

Item Number	Item Description	Qty	Ref Des
U22598-000	IC,8 BIT ADDRESSABLE LATCH W/RESET,(74HC259) (SSD)	1	U35
U23909-000	IC,DUAL 4 BIT BINARY/BIQUINARY COUNTER (74HCT390) (SSD)	1	U47
U24018-000	IC,JOHNSON DECADE COUNTER W/10 DECODED OUTPUTS,(74HC4017) (SSD)	2	U41,U48
U24138-000	IC,8 BIT BINARY DOWN COUNTER,(74HC40103) (SSD)	1	U45
U26889-000	IC,8 BIT MAGNITUDE COMPARATOR,(74HCT688) (SSD)	1	U43
U28008-000	IC,QUAD 2 INPUT AND,(74HC08) (SSD)	3	U22,U24,U57
U28032-000	IC,QUAD 2 INPUT OR,(74HC32) (SSD)	3	U4,U49,U58
U28040-000	IC,12 BIT DECADE COUNTER,(74HCT4040) (SSD)	2	U44,U46
U28074-000	IC,DUAL D FLIP FLOP W/RESET,(74HC74) (SSD)	7	U5,U13,U14,U23,U25,U33,U50
U28123-000	IC,DUAL RETRIGGERABLE 1-SHOT,(74HC123) (SSD)	1	U2
U28164-000	IC,8 BIT SERIAL IN PARALLEL OUT SHIFT REGISTER,(74HC164) (SSD)	2	U31,U53
U28165-000	IC,8 BIT PARALLEL IN SERIAL OUT SHIFT REGISTER,(74HC165) (SSD)	5	U3,U12,U28,U37,U38
U32001-000	IC,1K FEED-THROUGH RES NETWORK,16 PIN DIP,(A/B 316B102)) 1	RP6
U32103-000	IC,10K FEED-THROUGH RES NETWORK,16 PIN DIP,(A/B 316B103)	5	RP1-RP5
U40008-000	REGULATOR, OIL, 5V, 100MA, TO-92, [MOTOROLA MC78L05ABP]	1	U56
U40012-000	FLIP-FLOP,OCTAL D-TYPE LATCH WITH RESET,[NATIONAL MM74HC273N]	1	U55

Appendix A Remote RS422/485 Computer Interface

INTERFACE CAPABILITIES

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

These include

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

IMPLEMENTATION

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

		0
Pin number	RS-422	RS-485
1	N.C.	N.C.
2		*
3	R+	R+/T+
4	T+	*
5	GND	GND
6	T-	*
7	R L **	R ∟ ★★
8		*
9	R-	R-/T-

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

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

HARDWARE CONFIGURATION USING SETUP SCREEN 7

Bits	8] Par none
Ŝtop	1 Id 1
Baud	19200.0
SET	MORE

Setup Screen 7

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

Rev A

To display Setup Screen 7, proceed as follows:

- 1. If not already at Menu 1, press EXIT on the front panel until Menu 1 appears. At Menu 1, press MORE until Menu 2 (System Hours) appears. Select SETUP in Menu 2 and proceed through the setup screens by pressing MORE until Screen 7 appears. It will display the parameters for baud rate, bits per character, stop bits, parity, and ID number.
- 2. Turn ADJUST knob until square brackets enclose the desired parameter. Press SET. The square brackets ([]) change to arrows (> <), to indicate that the value can be changed.
- 3. Use the ADJUST knob to assign values to each function. Press SET.
- 4. When all parameters are set, press EXIT to confirm the change and return to Menu 2 at the top level.

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

Serial Interface Parameters

Select values that match the capabilities of the host computer.

Bits

Choices: 7 or 8 For normal use, select 8.

Stop Bits

Choices: 1 or 2 For normal use, select 1.

Parity

Choices: Odd, even, or none For normal use, select none.

ID

Choices: any number between 0 and 99 Select a unique number as address for each station.

Baud Rate

Choices: 19200, 9600, 7200, 4800, 3600, 2400, 2000, 1800, 1200, 600, 300, 150, 134.5 Select the highest rate your equipment can handle.

Software Commands



All characters are 8-bit ASCII.

Address

Set in the setup screen described on the previous page. The address must be unique for each station connected. A generic address of '99' can be used to establish communication to the control board. Then the desired address can be set by using the commands in this section. When using this generic address be sure to only have one power supply connected at a time or else communication errors will persist.

Checksum

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

Command to Read Status: RDSTAT

Host Command Reply From Equipment

RDSTAT STATUS=[*Status Code*]

Where *Status Code* is one of the following:

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

A RDSTAT Message Exchange



Notes

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

STX=02d ETX=03d ACK=06d

NAK=21d SPACE=32d (d=decimal value)

Command to Read Fault: RDFLT

Host Command Reply From Equipment

RDFLT flt=[Fault Code]

System faults listed by fault code number:

No Fault
Filament not ready
Low line voltage
Cathode overvoltage
Body overcurrent
Cathode undervoltage
Collector undervoltage
Inverter fault
Interlock open
Tube arc
TWT overtemperature (h)

Cabinet overtemperature (h)

23	Over reverse power
24	Not Used
25	Not Used
26	Panel open

External inhibit

Grid overvoltage/Anode overvoltage/Focus Electrode overvoltage

(HPA Dependent)

Basic Command Set

Host Command	Local Response	Meaning
PWR-ON	CR	Turn HV on
PWR-OFF	CR	Turn HV off
XMIT-ON	CR	RF On
XMIT-OFF	CR	RF Off
SYSTEM-ON	CR	Removes HPA from Power Save (Sleep) Mode
SYSTEM-OFF	CR	Places HPA in Power Save (Sleep) Mode
RESET	CR	Clear system faults
RDS/N	s/n=[value]	Read unit serial number
RDSTAT	Status = [STATUS CODE]Refer to Status Code command set	
RDFLT	Status = [FAULT]	Refer to Fault Code command set
RDCONHR	ConHr=[value]	Read console hours
RDCONMN	ConMn=[value]	Read console minutes
RDRFHR	RfHr=[value]	Read transmit hours

RDRFMN	RfMn=[value]	Read transmit minutes
RDEK	Ek=[value]	Read TWT cathode voltage
RDEB	Eb=[value]	Read TWT collector voltage
RDEG	Eg=[value]	Read TWT grid drive voltage
RDEFE	Efe=[value]	Read TWT focus electrode voltage
RDEF	Ef=[value]	Read TWT filament voltage
RDIF	lf=[value]	Read TWT filament current
RDIW	lw=[value]	Read TWT helix current
RDTMPTWTF	TWTF=[value]	Read TWT baseplate temperature in °F
RDTMPTWTC	TWTC=[value]	Read TWT baseplate temperature in °C
RDTMPPSF	PSF=[value]	Read power supply temperature in °F
RDTMPPSC	PSC=[value]	Read power supply temperature in °C
RDTWTOTF	TWTOTF=[value]	Read TWT overtemperature warning level in °F
STWTOTF	None	Set TWT overtemperature warning level in °F
RDTWTOTC	TWTOTC=[value]	Read TWT overtemperature warning level in °C
STWTOTC	None	Set TWT overtemperature warning level in °C
RDPSOTF	PSOTF=[value]	Read power supply overtemperature warning level in °F
SPSOTF	None	Set power supply overtemperature warning level in °F
RDPSOTC	PSOTC=[value]	Read power supply overtemperature warning level in °C
SPSOTC	None	Set power supply overtemperature warning level in °C
RDIWOC	lwOC=[value]	Read helix overcurrent in mA

Basic Command Set

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

SPOHIW	None	Set over forward power warning level in watts
SPOLOW	None	Set under forward power warning level in watts
SPRHIW	None	Set over reverse power warning level in watts
RDMSG	ACSII	Message displayed on front panel
RDFLTMSG	ACSII	Message displayed when fault is not zero
RDFLOG X	ACSII	Event Log X=Event Number X is 0 to 99 Events
RDALC	ALC[value]	Reads ON or OFF
SALC X	CR	X=1 for ALC ON, X=0 for ALC OFF

RDLOGIC Command

Format

Host Command **Reply From Equipment**

RDLOGIC Sys=[Logic code]

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



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

**

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

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

Examples of Messages sent Successfully

Host: read the gain

STX > 0 1 1 R D A ETX 0	1 CR	0	ETX	Α	D	R	þ	1	0	٨	STX
-------------------------	------	---	-----	---	---	---	---	---	---	---	-----

Local:

	АСК	STX	>	0	1	ø	Α	=	6	7	ETX	CR
Ľ		•		•	-		Λ	_	U			•

Example 1

Host: set the gain to 50% of full scale

STX	>	0	1	þ	S	Α	ø	5	0	ETX	0	1	CR

Local:

CR

Example 2

Host: read over reverse power in dBm

STX	>	0	1	þ	R	П	Р	R	κ	U	н	D	FTX	0	Q	CB
	· ·	v		~											5	

Local: over reverse power = 13 dBm

ACK	STX	>	0	1	þ	Ρ	r	Κ	U	Н	ï	=	1	3	ETX	CR
-----	-----	---	---	---	---	---	---	---	---	---	---	---	---	---	-----	----

Example 3

Host: turn high voltage on

STX > 0 1 b	P W R -	ONETX02CR
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Local	
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Example 4

Examples of Messages with Errors

Host: incorrect checksum

STX	>	0	1	þ	Ρ	W	R	-	0	Ν	ΕТХ	9	9	CR
-----	---	---	---	---	---	---	---	---	---	---	-----	---	---	----

Local: replies with command and NAK

NAK STX > 0 1 Ø P	WR-ONETX99CR
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Example 5

Host: message with missing prefix

>	0	1	ø	Ρ	W	R	-	0	Ν	ΕТХ			CR
---	---	---	---	---	---	---	---	---	---	-----	--	--	----

Local: no answer if missing prefix, address or suffix

Example 6

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

STX > 0 8 9 P W R - 0 N ETX 0

Local: no answer

Example 7

Host: address delimiter is missing from message

								-			-	
STX	0	1	þ	Ρ	W	R	-	0	N	ETX		CR

Local: no answer

Example 8

Host: sends message with no address

		-									
STX			Ρ	W	R	I	0	Ν	ЕТХ		CR

Local: no answer

WARRANTIES: LIMITATION OF LIABILITY

Seller warrants (i) that seller has title to the goods sold and (ii) that Amplifiers (all parts excluding traveling wave and vacuum tubes), Antennas, field monitors, field probes, field analyzers, field analyzer processor units, system controllers, system interlock, power meters, leak detectors, RF conducted probes, RF conducted clamps, Multi-tone, EMI receiver systems, RF down converters, RF conducted immunity systems, conducted immunity accessories, radiated immunity test systems, safety meters, safety sensor heads, tripods, directional couplers, waveguide adapters, termination loads, load attenuators, impedance stabilization networks, and coaxial cables will be free from defects in material and workmanship for a period of three (3) years from date of shipment shown on AR RF/Microwave Instrumentation invoice.

All modules, used in the amplifiers for the 1-6 GHz, 4-18 GHz, 6-18 GHz, all HPM products, and other applications, are hermetically-sealed. This sealing process protects the internal hybrid circuitry from humidity that could compromise the long term reliability of the product. These modules are not field-repairable and should *never* be opened outside of AR's Microelectronics Lab. The modules in these product lines have a security label on two sides of the modules between the housing and lid/cover. If the security label is removed and or cut, the **warranty of the module will be voided**.

Traveling Wave Tubes in the 200T2G8A, 250T1G3 and 250T8G18 will be free from defects in material and workmanship for a period of two (2) years from date of shipment.

Vacuum tubes in the 'L' series amplifiers, other traveling-wave tubes in models not previously listed and power heads will be free from defects in material and workmanship for a period of one (1) year.

Contact AR RF/Microwave Instrumentation for warranty information regarding items not listed.

Seller's sole responsibility in fulfilling these warranties shall be to repair or replace any goods which do not conform to the foregoing warranties or, at seller's option, to give buyer credit for defective goods. The warranty is valid only when used in the country specified at time of order. Warranty service must be obtained from the repair facility designated at that time. If warranty service is not available in the country where the equipment is to be used, it must be returned to AR RF/Microwave Instrumentation. Warranty service will be provided only for defective goods which are returned within the warranty period, freight costs prepaid to AR RF/Microwave Instrumentation or its designated repair facility.

There are no other warranties, express or implied, including any warranty of merchantability or fitness. Seller shall not be responsible for any incidental or consequential damages arising from any breach of warranty.

No person other than an officer of Amplifier Research Corporation, has any authority to bind seller to any affirmation, representation or warranty except as specifically included in the preceding terms and conditions.