rf/microwave instrumentation

Operating and Service Manual

500T2G8

Model

10006896

Part Number

Serial Number

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

rf/microwave instrumentation

EC Declaration of Conformity

We; AR RF/Microwave Instrumentation
160 School House Road
Souderton, PA 18964

declare that our product;

the Model 500T2G8 amplifier

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.

Donald R. Shepherd
Chairman

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 when it is necessary for the user to refer to the manual for important safety information. The caution symbol denotes a potential hazard. Attention must be given to the statement to prevent damage, destruction, or harm.
	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.
	Indicates alternating current.
	Indicates this product must not be disposed of with your other household waste.
	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 AC-powered 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.***

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 contact with the center pin of the RF output connector or accessories connected to it. Place the equipment in a non-operating 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 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.

rf/microwave instrumentation

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.

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FIGURES

TABLES

1. DESCRIPTION AND SPECIFICATIONS

This manual provides operating, interfacing and selected service information pertinent to AR RF/Microwave Instrumentation Model 500T2G8 Broadband Microwave Amplifier. The Model 500T2G8 is a 500 watt S/C band traveling-wave tube amplifier (TWTA). This manual supports models offering three phase and single phase operation, as well models offering additional special features. Refer to the model specification sheet to determine the applicable features of this unit.

1.1 TWTA DESCRIPTION

The amplifier uses a broadband traveling-wave tube (TWT) to provide 500 watts minimum output over the TWT amplifier's full bandwidth. The amplifier is well suited for susceptibility and general laboratory testing where instantaneous bandwidth and high gain are required.

The amplifier is completely self-contained and packaged for standard 19-inch rack mounting. The front panel of the rack mountable amplifier is 8.75 inches high, and the overall unit is 25.25 inches deep, excluding the rear-panel connectors. For bench top use, the amplifier is supplied in an enclosure with integral carrying handles.

Primary power is 208 volts (±10%) 50/60 Hz., three-phase, five-wire or alternatively depending upon Model 190-260VAC single-phase 50/60 Hz. An efficient switching power supply design provides minimum power consumption. In addition, the dual collector TWT is designed to minimize prime power consumption at low RF output levels. 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 enclosure are interlocked to reduce the likelihood of accidental contact with high voltage.

1.2 SUGGESTED APPLICATIONS

- RF Susceptibility testing
- Antenna and component testing
- Equipment calibration
- General laboratory instrumentation

1.3 SPECIFICATIONS

Refer to the AR Data Sheet on the following pages for detailed specifications.

1.4 ACCESSORIES

AR RF/Microwave Instrumentation offers a number of accessories for use with this amplifier including:

- Directional coupler
- Antenna
- Flexible transmission line

Refer to a current AR RF/Microwave Instrumentation catalog for Microwave Accessories.

1.5 TEST DATA SHEET

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

500T2G8

- M2–M98
- 500 Watts CW
- 2.5GHz–7.5GHz

Features

The Model 500T2G8 is a self-contained, forced air cooled, broadband traveling wave tube (TWT) microwave amplifier designed for applications where instantaneous bandwidth and high gain are required. A reliable TWT provides a conservative 500 watts minimum at the amplifier output connector. Stated power specifications are at fundamental frequency.

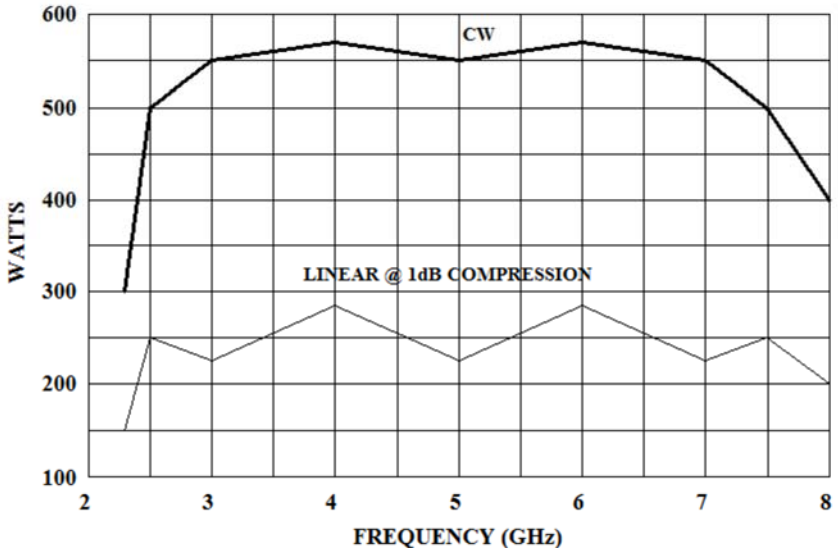
The amplifier's front panel digital display shows forward and reflected output plus extensive system status information accessed through a series of menus via soft keys. Status indicators include power on, warm-up, standby, operate, faults, excess reflected power warning and remote. Standard features include a built-in IEEE-488 (GPIB) interface, 0dBm input, 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 a switching mode power supply results in significant weight reduction.

Housed in a stylish contemporary cabinet, this unit is designed for benchtop use, but can be removed from the cabinet for rack mounting. The Model 500T2G8 provides readily available RF power for a variety of applications in Test and Measurement, (including EMC RF susceptibility testing), Industrial and University Research and Development, and Service applications.

See model configuration for primary power, alternative packaging and special features.

The export classification for this equipment is EAR99. 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.

500T2G8 TYPICAL POWER OUTPUT



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500T2G8

- M2–M98
- 500 Watts CW
- 2.5GHz–7.5GHz

Specifications

POWER (fundamental), CW, @ Output Connector:

Nominal	541 watts
Minimum	500 watts
Linear @ 1 dB Compression	125 watts minimum

FLATNESS: ±8 dB maximum, equalized for ±5 dB maximum at rated power

FREQUENCY RESPONSE: 2.5–7.5 GHz instantaneously

INPUT FOR RATED OUTPUT: 1.0 milliwatt maximum

GAIN (at maximum setting): 57 dB minimum

GAIN ADJUSTMENT (continuous range): 35 dB minimum

INPUT IMPEDANCE: 50 ohms, VSWR 2.0:1 maximum

OUTPUT IMPEDANCE: 50 ohms, VSWR 2.5:1 typical

MISMATCH TOLERANCE: Output power foldback protection at reflected power exceeding 100 watts. Will operate without damage or oscillation 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.

MODULATION CAPABLITY: Will faithfully reproduce AM, FM, or pulse modulation appearing on the input signal. AM peak envelope power limited to specified power.

NOISE POWER DENSITY: Minus 85 dBm/Hz (maximum); Minus 95 dBm/Hz (typical)

HARMONIC DISTORTION: Minus 3dBc maximum; Minus 3.5dBc typical

CONNECTORS:

RF input:	Type N female, rear
RF output:	7-16 DIN female, rear
RF output sample port:	Type N female, rear
GPIB:	IEEE–488 (f), rear
Interlock:	DB-15 (f), rear

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

WEIGHT AND SIZE: See Model Configurations

EXPORT CLASSIFICATION: EAR99

Model Configurations

E Must select one enclosure type from the following [E1 or E2 or E2S]:

E1 removable outer enclosure, size 20 x 10 x 27 in., 50.8 x 25.4 x 68.6 cm; add 14 kg (30 lbs) to weight of E2.

E2 without outer enclosure, size 20 x 8.75 x 26 in, 50.8 x 22.2 x 66.1 cm; weight 41 kg (90 lbs).

E2S enclosure removed for rack mounting; slides and handles installed, size 20 x 8.75 x 26 in, 50.8 x 22.2 x 66.1 cm; add 2 kg (5 lbs) to weight of E2.

P Must select one primary power from the following [P1 or P2]

P1 208 VAC ± 10% three phase 50/60 Hz 3.5 KVA maximum

P2 190-260 VAC single phase 50/60 Hz 3.5 KVA maximum

S May select a special feature (extra cost) from the following [{S3V or (S1R and/or S4P and/or S5V}):

S1R Reflected power 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.

S3V Shipped without outer cabinet, flatness ± 3 dB max at rated power, and a video pulse capability to offer blanking capability to use for noise quieting. See Video Pulse Capability table below.

S4P Power minimum 650 watts from 3.0 GHz to 3.6 GHz.

S5V Video pulse capability to offer blanking capability to use for noise quieting. See Video Pulse Capability table below.

S5V & S3V - VIDEO PULSE CAPABILITY

Pulse Width:	0.05 microseconds min
Pulse Rate (PRF):	100 kHz max
RF Rise and Fall:	30 ns max (10% to 90%)
Delay:	300 ns max from pulse input to RF90%
Pulse width distortion:	±30 ns max (50% points of output pulse width compared to 50% points of input pulse width)
Noise Power Density, (pulse off):	Minus 140 dBm/Hz (typical)
Connector, Video:	BNC-female on rear panel

500T2G8

- M2–M98
- 500 Watts CW
- 2.5GHz–7.5GHz

Model Configurations

Model	Features			Model	Features			Model	Features		
	E	P	S		E	P	S		E	P	S
500T2G8	E1	P1	-	M32	E1	P1	S1R & S4P	M77	E1	P2	S4P & S5V
M2	E2	P1	-	M33	E2	P1	S1R & S4P	M78	E2	P2	S4P & S5V
M3	E1	P2	-	M34	E2S	P1	S1R & S4P	M79	E2S	P2	S4P & S5V
M4	E2	P2	-	M35	E1	P2	S1R & S4P	M80	E1	P1	S1R & S4P & S5V
M5	E2S	P1	-	M36	E2	P2	S1R & S4P	M81	E2	P1	S1R & S4P & S5V
M6	E2S	P2	-	M37	E2S	P2	S1R & S4P	M82	E2S	P1	S1R & S4P & S5V
M7	E2	P2	S3V	M50	E1	P1	S5V	M83	E1	P2	S1R & S4P & S5V
M8	E2S	P2	S3V	M51	E2	P1	S5V	M84	E2	P2	S1R & S4P & S5V
M11	E1	P1	S1R	M52	E2S	P1	S5V	M85	E2S	P2	S1R & S4P & S5V
M12	E2	P1	S1R	M53	E1	P2	S5V	M98	See Individual Specification Sheet		
M13	E1	P2	S1R	M54	E2	P2	S5V				
M14	E2	P2	S1R	M55	E2S	P2	S5V				
M15	E2S	P1	S1R	M56	E1	P1	S1R & S5V				
M16	E2S	P2	S1R	M57	E2	P1	S1R & S5V				
M25	E2S	P2		M58	E2S	P1	S1R & S5V				
M26	E1	P1	S4P	M59	E1	P2	S1R & S5V				
M27	E2	P1	S4P	M60	E2	P2	S1R & S5V				
M28	E2S	P1	S4P	M61	E2S	P2	S1R & S5V				
M29	E1	P2	S4P	M74	E1	P1	S4P & S5V				
M30	E2	P2	S4P	M75	E2	P1	S4P & S5V				
M31	E2S	P2	S4P	M76	E2S	P1	S4P & S5V				

2. THEORY OF OPERATION

2.1 DESIGN OF THE AMPLIFIER

The Model 500T2G8 TWT amplifier consists of four principal subsystems. Two of these subsystems, the microwave power assembly and the TWT power supply are discussed in Sections 2.2 and 2.3, respectively.

The other two subsystems are the microprocessor control system and the TWTA packaging. These both consist of a number of subassemblies. See the build tree in Section 5.1 for further information about how the parts lists are structured.

The heart of the microprocessor control system is the control head assembly (A22933-300), which consists of the CPU board (A18450-006) and the data link board (A22488-001). The microprocessor control system supervises the power supply, provides metering display, processes operator front panel inputs, and enables communication with a host computer over the IEEE-488 interface. Communication from the front panel is through the HPA display board (A22700-900).

The control head is provided with its own power supply and, other than thru the IEEE-488 interface bus, is electrically isolated from the amplifier. Communication with the amplifier is via fiberoptic links to the HPA interface assembly (A25444-000).

The TWTA packaging consists of cabinet assembly (A26858-001). The cooling system utilizes a 400 Hz. high-speed tubeaxial blower with a dedicated power supply.

2.2 DESCRIPTION OF THE RF CIRCUIT

The TWTA consists of two stages of RF amplification: a solid-state preamp assembly with adjustable gain (E01136-000) and a traveling-wave tube amplifier (E08072-000).

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 preamp. The solid-state preamp's output drives the RF input of the TWT via an equalizer. The RF output of the TWT is a Type S-C coaxial connector. The output is directed through a short cable to a -40/-30 dB dual directional coupler. The output 7-16 DIN connector of the coupler protrudes through the rear panel of the TWTA to function as the RF output connector.

The reflected port output of the dual directional coupler is split by a -10 dB coupler. The direct output is connected to a detector diode, whose output is used for VSWR protection by the power supply logic board, for VSWR measurement in the leveling loop, and for reflected power measurement on the HPA interface board. The side port of this -10 dB coupler provides a reflected RF sample at a Type N connector on the rear panel.

The forward port output of the dual directional coupler is split by a -10 dB coupler. The direct output is connected to a detector diode via a pad. The output of the detector diode is used on the HPA interface board to measure forward power, and for providing output level input to the automatic forward power limiting circuit. The side port of this coupler is connected to the forward Type N RF sample port on the rear panel.

Amplifier gain is determined by the solid-state amplifier (SSA), which has a voltage-controlled variable gain stage. The control head determines the output of a digital-to-analog converter (DAC) on the HPA interface board. The output of the DAC controls the SSA gain. The emergency bypass board (A24830-001) is mounted behind the front panel. It is provided with a circuit that increases the attenuation so that reflected power is limited to a level that can be safely sustained without damage to the amplifier (on the order of 100 watts).

emergency bypass operation (see Section 3.7) the gain control signal is provided locally by means of a potentiometer on the emergency bypass board. However, the foldback circuit remains on line in emergency bypass operation.

2.3 DESCRIPTION OF THE POWER SUPPLY

The single phase version (A22525-311) is described. The TWT power supply is of modular construction. Low voltage power for logic and control of the entire power supply assembly is provided by the low voltage power supply module (A23687-001). In addition this module provides DC power for the HPA interface and emergency bypass board. Control logic and TWT protection circuits are contained in the HPA logic and Control Assembly (A16485-000).

The Heater Power Supply Module (A10010-000) powers the TWT DC heater. Grid bias and pulse top are provided by the Grid Modulator Module (A21422-000).

The high voltage power supply consists of the following: the power factor module (A23683-000) converts line voltage to DC for the high voltage switching supply. Switching transistors are on the Power Board Assembly (A23719-000), and switching is controlled by the Pulse Width Modulation (PWM) Board (A10017-511). The high voltage transformer and rectifiers are contained in the High Voltage Diode/Cap Assembly (A21425-296). The high voltage DC is filtered in the HV Filter Assembly (A21461-500).

Low voltage 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 heat sink is cooled by the incoming cabinet air. The Heat Sink/Motherboard assembly is A23280-000.

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 fatal 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

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.

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.

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.

3.2.2 Mounting and Removing

The TWTA may be operated as a standalone benchtop unit, or it may be installed in a 19" rack.

If rack mounting is desired, first remove the amplifier from the cabinet, then install the amplifier in the rack.

NOTE: Due to the weight of the unit, the installation or removal of the amplifier is a two person operation.

Before removing the amplifier from the cabinet or rack, disconnect power, RF, and any other interface connectors. On the rear of the unit, remove any screws used to connect brackets to amplifier. On the front of the unit, remove the four screws holding the front panel to the rack. Carefully slide the amplifier out of the front of the cabinet or rack.

CAUTION:

Never rack mount the TWTA using the front panel alone. The chassis is likely to be damaged unless its weight is supported. Bottom support rails must be provided in a rack mount configuration.

See Figure 3-1 (below) for the locations of threaded holes that may be used for supplementary support of the rear of the TWTA. Screws installed in these threaded holes may be removed and replaced with screws of appropriate length to thread 3/8 – 5/8 inch to the TWTA chassis.

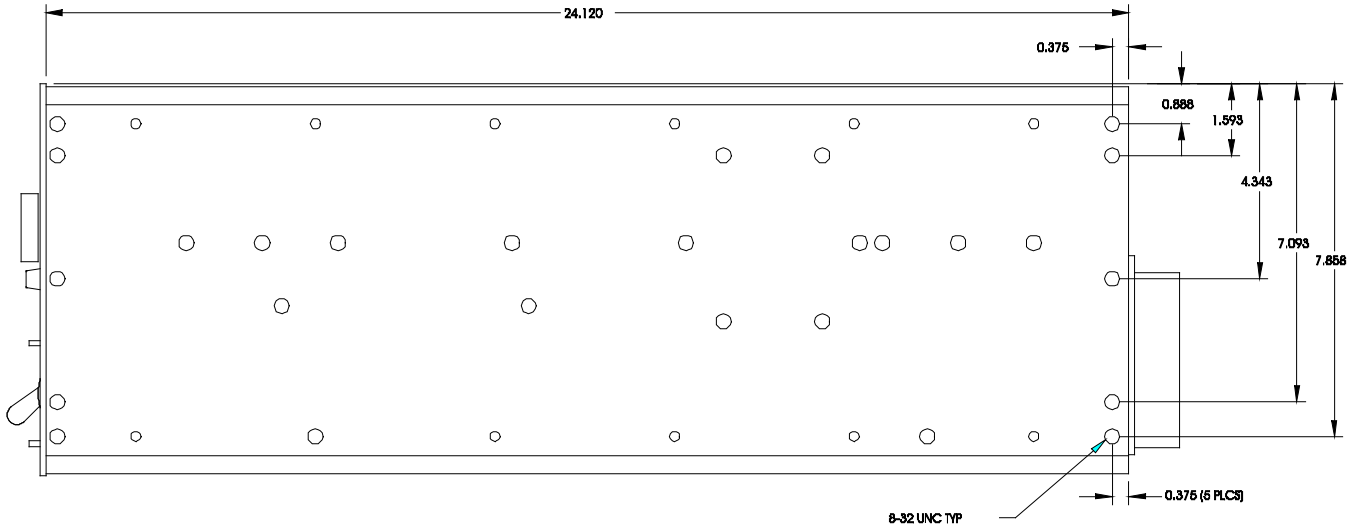

Figure 3-1. Side View of TWTA Showing Threaded Holes

If bottom supports are used for rack mount installation of multiple units, the amplifiers should be separated vertically by at least 1 3/4 inches. This will allow room for necessary support rails and facilitate installation and removal of the units.

3.2.3 Cooling Requirements

The TWTA is provided with a cooling fan. It is important that air movement around the rear of the unit be unobstructed.

CAUTION:

For either bench or rack mounting, do not position the TWTA in such a way that the air intake or outlet are blocked, or that the exhaust flow is directed into the intake. See paragraph 3.5 for location of air intake and air outlet. If the unit is rack mounted, make sure that the intake air is 45°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 flow restrictions. Avoid mounting heat-producing equipment in the same rack, especially below the TWTA. Failure to provide adequate cooling can result in the unit's shutting down from overtemperature conditions.

The TWTA dissipates approximately 2400 watts when in the operate mode at full RF power.

3.2.4 AC Line Power Connections

3.2.4.1 Three-Phase Models only

AC line power connection to the TWTA is made on a terminal block inside the power supply/control module enclosure. Access to the terminal block screws is by removal of the bottom panel. Strain relief for a 0.70 inch diameter cable is provided on the rear panel. The power cord must be five-wire, with conductors of 14 gauge or heavier. For use in North America, the following color codes for the power cable should be observed:

Green	Ground
White	Neutral
Red	Phase
Black	Phase
Orange	Phase

The amplifier is insensitive to phase rotation. Some amplifiers for the North American market may be provided with a power cord.

3.2.4.2 Single-Phase Models only

The AC line power connection to the TWTA is made through an IEC-320 16A connector on the rear panel. The connector is provided with a bracket that can be used to secure the mating plug from accidental withdrawal. The power cord must be 3-wire, with conductors of 12-gauge or heavier.

Units are provided with an unterminated 3-wire cord. To use this line cord, it should be terminated with a suitable plug to a 190 to 260 VAC 50-60 Hz single-phase source as follows:

Color		Function
International Harmonized	**North American**	
Brown	Black	Line
Blue	White	Neutral
Yellow/Green	Green	Safety Ground

CAUTION:

Connect plug to J1 and secure plug with bracket only when no AC is supplied to the cord.

Some amplifiers for the North American market may be provided with a suitably terminated power cord.

3.2.5 RF Output Connections

The RF output coaxial connector is 7-16 DIN.

CAUTION:

Never operate the TWTA without a matched output load rated for at least 1000 watts, 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 and foldback 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. The TWTA may be interlocked with the switch by connecting it between pins 10 and 11 of the external interlock connector (J2). If no external isolator is used, retain the jumpers between pins 3 and 4 and between pins 10 and 11 in the mating connector for J2. See Section 3.2.6, External Interlock Connector, below.

If an external absorptive filter is installed at the output of the TWTA, either the absorptive filter should be capable of dissipating the full output of the TWTA or it should be provided with a temperature sensing switch as described above.

3.2.6 External Interlock Connector

The TWTA is provided with an external interlock capability via a 15-pin female D-sub connector, J2. To enable the high voltage power supply, it is necessary to provide continuity between J2 pins 3 and 4. If the amplifier shuts down because the interlock was opened, it will be necessary to reset the system to return to standby (see *System shutdown screen* in Section 3.4). Users may adopt this interlock feature to turn off the high voltage power supply and disable the RF output either for equipment protection or as a backup for personnel protection.

CAUTION:

Do not rely on the external interlock for personnel protection. The intent of the external interlock feature is to disable the RF output for equipment protection. Use proper operating and safety procedures to insure that power is removed for personnel safety.

In addition, the interlock is provided with an external inhibit function. To enable the TWT grid on, it is necessary to provide continuity between pins 10 and 11 of J2. Breaking continuity drives the grid to the bias condition, shutting off the tube and disabling the RF output. As soon as continuity is restored, the tube will again be turned on; no reset is required.

There is an internal jumper between J2 pins 1 and 2; a continuity check through these pins can be used to verify the presence of the amplifier in the instrumentation system.

3.3 FRONT PANEL FEATURES

Refer to Figure 3-2 below.

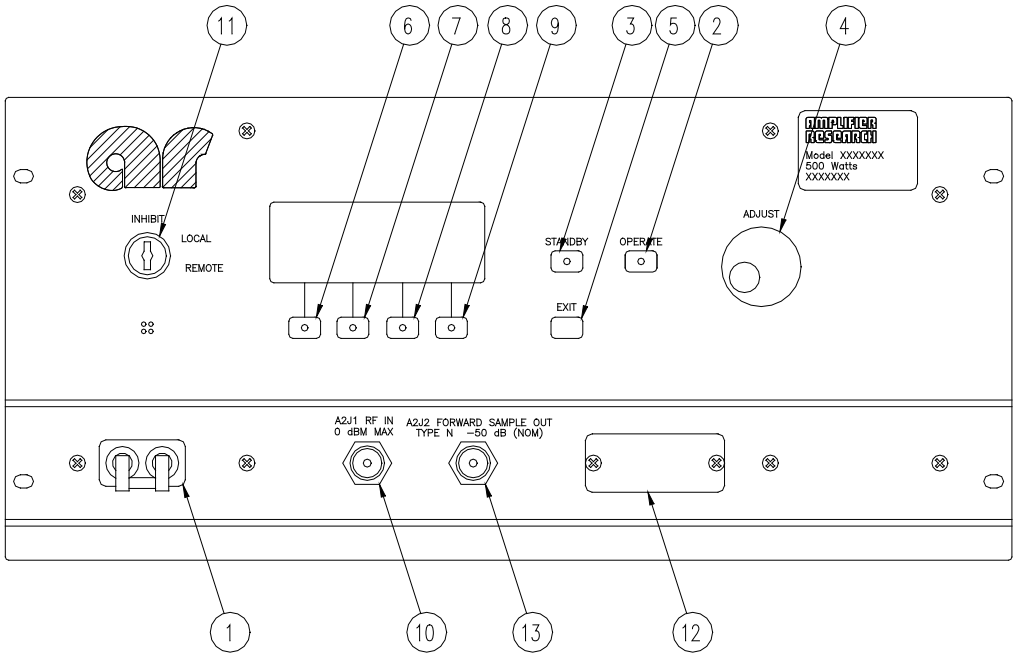

Figure 3-2. Front Panel Features

Table 3-1. Front Panel Features

Item	Title	Function
1	MAIN POWER	Switchable 15 A. circuit breaker; connects primary power to power supplies.
2	OPERATE	Push-button; turns on high voltage when all faults and heater delay are cleared.
3	STANDBY	Push-button; biases grid off and turns off high voltage.
4	ADJUST	Rotary knob used as an input device to change values of a variety of parameters.
5	EXIT	Push-button; terminates various menu selection routines and returns to the previous menu level.
6-9	S1...S4	"Soft Key" push-buttons; various menu selection functions.
10	RF INPUT	RF input; N female connector (on front panel connector configurations)
11	KEYLOCK SWITCH	Allows operator to inhibit the TWTA, to enable front panel control, or to enable computer control.
12	EMERGENCY SWITCH COVER	Provides access to emergency bypass switches, which permit manual control of the amplifier.
13	RF FORWARD SAMPLE	RF sample: N female connector (on front panel connector configurations)

3.4 FRONT PANEL DISPLAY AND SOFT KEYS

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 3-3 provides a roadmap for navigating between the screens.

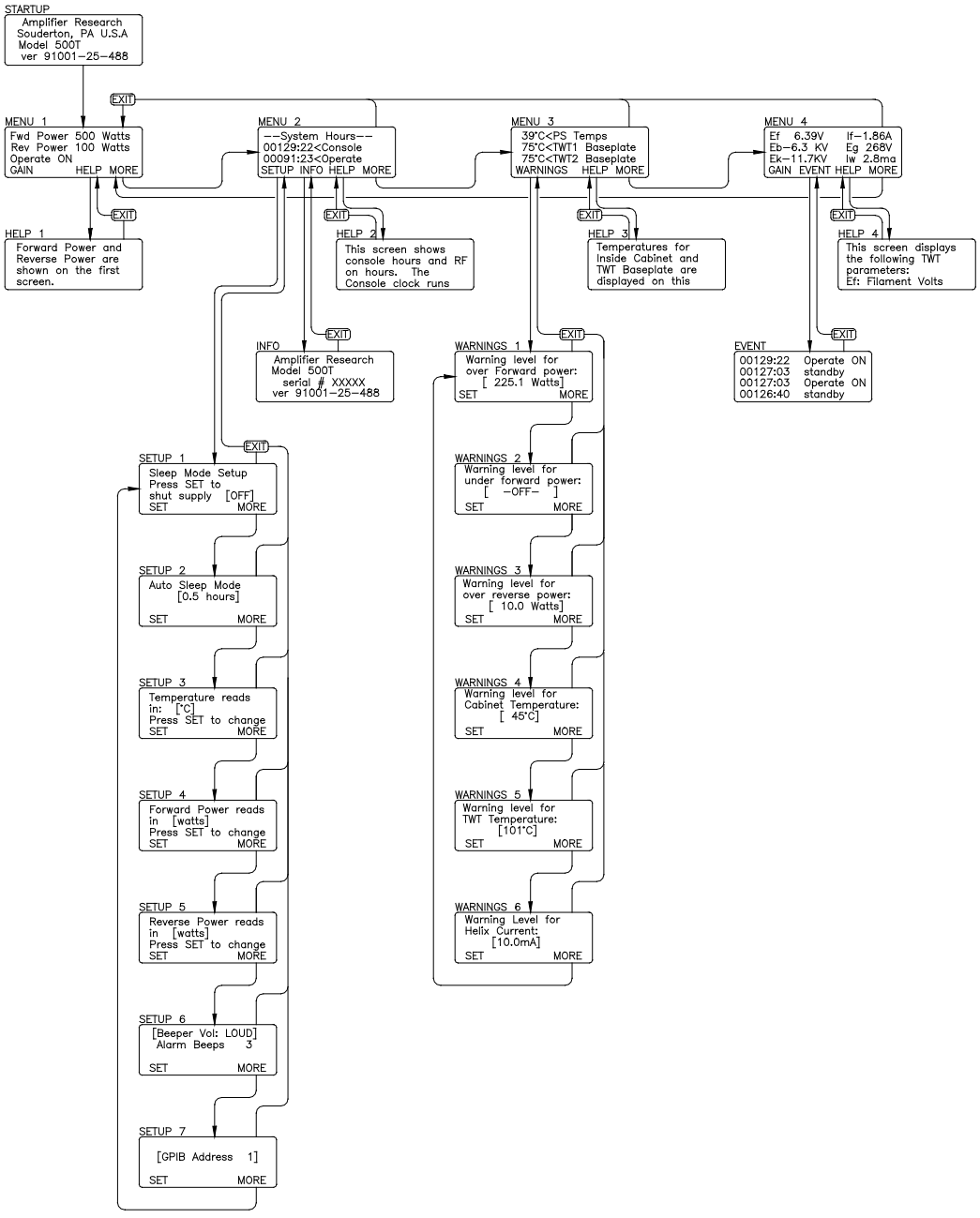

Figure 3-3. Front Panel Display Screens

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:

MENU	FUNCTION
MENU 1	Forward power (watts, dBm, or bar graph,)
	Reverse power (watts, dBm, or % forward power)
	System status (if a latched fault exists, MENU 1 is displayed with the system shutdown message)
MENU 2	Console hours (active when AC power is on)
	Operate hours (active when HV is on)
MENU 3	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 (Iw)

Help Screens - On each of the menu screens, 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.

Setup Screens - From MENU 2, S1 (labeled SETUP) selects the first of several setup screens, SETUP 1. This allows the user to manually shut off the heater power supply and put the HPA into Sleep Mode (see below). Pressing S1 (SET) toggles between ON and OFF. Pressing MORE again brings up the SETUP 2 screen, which allows the user to change the Auto Sleep Mode timer setting. Pressing SET will change the timer options in half hour increments from 0.5 to 3.0 hours. Pressing MORE again will save the timer setting and bring up the SETUP 3 screen, which toggles the 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 SETUP 4 screen, which allows a choice of displaying forward power in strip chart form, or in dBm or watts. Pressing MORE a third time brings up SETUP 5, which allows a choice of dBm, watts, or % of forward power for displaying reverse power. MORE brings up SETUP 6, which allows entering 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. Setup 7 allows the IEEE-488 address to be set. MORE returns you to SETUP 1. EXIT returns you from any of the setup screens to MENU 2.

Sleep Mode - The Sleep Mode feature allows the *user* to selectively shut off the heater module of the power supplies. 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 approximately a 5 minute heater time delay. Wait the full 5 minutes prior to selecting OPERATE.

For remote activation of Sleep Mode or to set the Auto Sleep Mode timer remotely see Table 3-3 in Section 3.8.

Warnings Screens - From MENU 3, S1 (labeled WARNINGS) selects WARNINGS 1 allowing 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 3).

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 WARNINGS 2, which allows the under forward power setpoint to be entered. Adjusting this to the minimum value causes -OFF- to be selected, disabling this alarm.

In WARNINGS 3, the maximum reflected power level is 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 (A16485).

MORE brings up WARNINGS 4, which allows input of the maximum cabinet temperature. Entering this parameter is performed as above.

MORE brings up WARNINGS 5, identical to the previous screen except that it deals with 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.

From WARNINGS 5, MORE brings up WARNINGS 6, which 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.

Info Screen - From 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 that may be required by a service representative when providing technical assistance. The EXIT key returns the display to MENU 2.

Event Screen - From 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 overcurrent or power low line that requires a reset), the MENU screen is replaced by a screen indicating the nature of the fault. Softkey 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.

3.5 REAR PANEL FEATURES

See Figure 3-4 below.

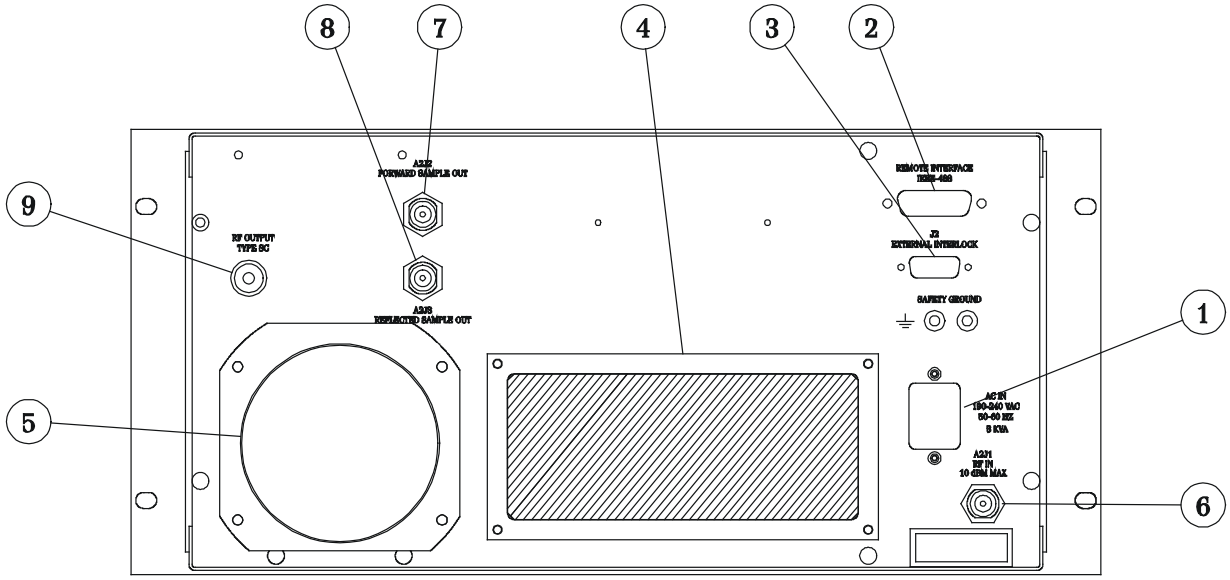

Figure 3-4. Rear Panel Features

Table 3-2. Rear Panel Features

Item	Title	Function
1.	AC POWER IN	AC power input strain relief (single phase model shown)
2.	IEEE-488	Remote control connector: 24 pin hermaphrodite
3.	EXTERNAL INTERLOCK	Connector for remote interlock and inhibit functions: D-sub 15-pin female
4.	—	Cooling air intake.
5.	—	Cooling air outlet.
6.	RF INPUT	RF input; N female connector (on rear panel connector configurations)
7.	RF FORWARD SAMPLE	RF sample: N female connector (on rear panel connector configurations)
8.	RF REVERSE SAMPLE	RF sample: N female connector (optional) (on rear panel connector configuration)
9.	RF OUTPUT	RF output: 7-16 DIN female connector

3.6 INITIAL TURN ON AND WARM-UP PROCEDURE

Install the TWTA as discussed in Section 3.2 Provide an RF generator to the RF input Type N connector A2J1. Set RF generator level below -50 dBm and set desired frequency in specified range. Connect a load suitable for 1000 watts continuous operation to the output S-C connector. The load VSWR should be less than 2.0:1 A power meter and suitable attenuators may be connected to the RF forward sample out port A2J2. Refer to the RF sample port calibration factors on the rear of the unit or on the *Info* screen in MENU 2. These show the relation 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.

The load VSWR under power can be checked by using a power meter with suitable attenuators connected to the RF reflected sample out port A2J3. Refer to the RF reflected sample port calibration factors on the rear of the unit. These show the relation between the amplifier power reflected back into the output ports and the RF reflected sample port power as a function of frequency.

Set keylock to LOCAL.

Switch on the MAIN POWER circuit breaker. The fan will operate. The front panel display will show several identification messages and then the MENU 1 screen. The third line will indicate that the heater time delay is active.

Allow the heater warm-up delay to expire. Line three will indicate OFF/READY.

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.

Push the OPERATE push-button. You will now see the cathode and the collector voltages rise. Verify that the collector and cathode voltages are near nominal. The helix current should be close to the nominal value for no RF drive. Then push MORE or EXIT to go back to MENU 1.

Set the TWTA gain to maximum. Adjust the RF generator to slowly increase the RF drive toward 0 dBm to reach the desired FWD PWR on the display and power meter (connected to the forward sample port). The forward power bar graph will become active, with maximum length when peak power output is achieved. 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 (Input drive above +20 dBm may damage the unit). The reflected power level should remain below 10% of the forward power, assuming that the load is properly matched.

An alternate procedure is to pre-set the TWTA gain to 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, turn down the RF generator level below -50 dBm and press STANDBY. Allow the TWTA to cool down until the TWT temperature drops below 70°C, then turn off main power

3.7 EMERGENCY BYPASS OPERATION

For reference, see schematic 10-24830-000 in Section 5.2.

The TWTA is provided with a means of operating the amplifier manually in the event that there is a failure of the control module and it is imperative that the amplifier remain on line.

CAUTION:

Emergency bypass operation disables all microprocessor based interactive features and possibly some diagnostic features. For this reason, the emergency bypass mode of operation should be used only when the control unit fails and when it is essential to remain on line.

To access the manual controls, remove the two 4-40 screws securing the emergency switch cover on the front panel. Emergency bypass mode is selected by pushing the left-hand switch (S1) to the left. The center switch (S2) toggles between high voltage on (left) and high voltage off (right). The right-hand switch (S3) selects beam on in the left hand position, and beam off (RF off) in the right-hand position. There is a manual control for the gain adjustment as well. This is a flat, square single-turn pot (R1).

CAUTION:
Do not adjust 20-turn pot R11; its function is to set the reflected RF foldback level, and it is calibrated at the factory.

3.8 REMOTE IEEE-488 OPERATION

The TWTA is provided with a communication interface that conforms electrically to the IEEE-488 standard. It permits remote emulation of OPERATE, STANDBY, and RESET push-buttons as well as access to parameter measurements, system faults, gain adjustment, and control unit status. The following tables summarize the commands and the return codes.

Table 3-3. Catalog of IEEE-488 Commands

Command	Function	Units	Response format
RDSTAT	Returns status code of processing of previous command (see Table 3-4)		STATUS=[ ]
RDFLT	Returns system fault code (see Table 3-5)		flt=[ ]
OPERATE;	Emulates OPERATE push-button		
STANDBY;	Emulate STANDBY push-button		
POWER:OFF;	Emulate STANDBY push-button		
RESET;	Emulates RESET softkey		
RDS/N	Returns serial number		s/n=[ ]
RDCONHR	Returns console hours		ConHr=[ ]
RDRFHR	Returns RF hours		RfHr=[ ]
RDEK	Returns cathode voltage	KV	Ek=[ ]
RDEB	Returns collector voltage	KV	Eb=[ ]
RDEF	Returns heater voltage	V	Ef=[ ]
RDIF	Returns heater current	A	If=[ ]
RDIW	Returns helix current	mA	Iw=[ ]
RDTMPTWTF	Returns TWT temp (°F)	°F	TWTF=[ ]F
RDTMPTWTC	Returns TWT temp (°C)	°C	TWTC=[ ]C
RDTMPPSF	Returns power supply temp (°F)	°F	PSF=[ ]F
RDTMPPSC	Returns power supply temp (°C)	°C	PSC=[ ]C
RDTWTOTF	Returns TWT overtemp warning setpoint (°F)	°F	TWTOTF=[ ]F
STWTOTF	Sets TWT overtemp warning setpoint (°F)	°F	
RDTWTOTC	Returns TWT overtemp warning setpoint (°C)	°C	TWTOTC=[ ]C
STWTOTC	Sets TWT overtemp warning setpoint (°C)	°C	
RDPSOTF	Returns power supply overtemp warning setpoint (°F)	°F	PSOTF=[ ]F
SPSOTF	Sets p. s. overtemp warning setpoint (°F)	°F	
RDPSOTC	Returns p. s. overtemp warning setpoint (°C)	°C	PSOTC=[ ]C

Command	Function	Units	Response format
SPSOTC	Sets p. s. overtemp warning setpoint (°C)	°C	
RDIWOC	Returns helix overcurrent warning setpoint	mA	IwOC=[ ]
SIWOC	Sets helix overcurrent warning setpoint	mA	
RDLOGIC	Returns logic state code (see Table 3-6)		Sys=[ ]
RDA	Returns gain	%	A=[ ]
SA	Sets gain	%	
RDHTDREM	Returns remaining heater time delay	sec.	HTD=[ ]s
RDPOD	Returns forward power out (dBm)	dBm	Po=[ ]dBm
RDPOW	Returns forward power out (W)	watts	Po=[ ]W
RDPRD	Returns reflected power out (dBm)	dBm	Pr=[ ]dBm
RDPRW	Returns reflected power out (W)	watts	Pr=[ ]W
RDPOHID	Returns over forward power warning setpoint (dBm)	dBm	Pohi=[ ]dBm
SPOHID	Sets over forward power warning setpoint (dBm)	dBm	
RDPOLOD	Returns under forward power warning setpoint (dBm)	dBm	Polo=[ ]dBm
SPOLOD	Sets under forward power warning setpoint (dBm)	dBm	
RDPOHIW	Returns over forward power warning setpoint (W)	watts	Pohi=[ ]W
SPOHIW	Sets over forward power warning setpoint (W)	watts	
RDPOLOW	Returns under forward power warning setpoint (W)	watts	Polo=[ ]W
SPOLOW	Sets under forward power warning setpoint (W)	watts	
RDPRHID	Returns over reflected power warning setpoint (dB)	dBm	Prhi=[ ]dBm
SPPRHID	Sets over reflected power warning setpoint (dBm)	dBm	
RDPRHIW	Returns over reflected power warning setpoint (W)	watts	Prhi=[ ]W
SPRHIW	Sets over reflected power warning setpoint (W)	watts	
SYSTEM:ON;	Emulates pressing the System ON button from System OFF (Exit Sleep Mode)		
SYSTEM:OFF;	Emulates pressing the Power Save button. (Enter Sleep Mode)		
RDHTRAUTOOFF	Returns heater auto off delay	hours	
SHTRAUTOOFF	Sets heater auto off delay (see Table 3-9)		
*IDN?;	Returns the product model number		[ ]
*STA?;	Returns status string (see Table 3-7)		[ ]
*STB?;	Returns status string (see Table 3-8)		[ ]

Table 3-4. Catalog of Status Codes

(The **RDSTAT** command causes the TWTA to return a string in the form **STATUS=[*code*],** where **[*code*]** is an ASCII number whose meaning is given below)

Status Code	Meaning
0	No command was given or last command was successful.
2	Last command is in process.
3	Last command failed to complete. Time-out.
10	Last command failed. Invalid command.
11	Last command failed. Data was unparseable.
20	Last set command failed. Data was beyond high limit.
21	Last set command failed. Data was beyond low limit.
22	Last set command failed. Data was out of range
23	Last set command failed. Data was wrong polarity
50	Last command failed. Local system does not have remote enabled.
51	Remote system is not ready to accept commands.
901	Assert error: invalid table argument*
902	Assert error: invalid calibration*

* Please call a service representative if you observe this error.

Table 3-5. Catalog of Fault Codes Returned by RDFLT Command

(The **RDFLT** command causes the TWTA to return a string in the form **flt=[*code*],** where **[*code*]** is an ACSII number whose meaning is given below).

Fault Code	Meaning
0	No fault
7	System Fault
8	Heater Fault (Fil not Ready)
9	Low Line
10	Cathode overvoltage
11	Body overcurrent
12	Cathode undervoltage
15	Collector undervoltage
16	Inverter fault
17	Internal interlock open
18	Tube arc
19	TWT (hardware) overtemperature
20	Power supply (hardware) overtemperature
22	External inhibit
23	Over reflected power
26	Panel Open
27	Latched Fault
30	Grid Overvoltage
49	TWT (software) overtemperature
50	Cabinet (software) overtemperature

Table 3-6. Catalog of System State Codes

(The **RDLOGIC** command causes the TWTA to send a string containing an operational state code consisting of 4 ASCII characters representing hex digits. The response is in the form **Sys=*[w][x][y][z][eol]*** where the hex values of ***[w],[x],[y]*** *and* ***[z]***are formed as shown below)

z bit	Meaning
0 (LSB)	High voltage on
1	Transmit on
2	Remote mode
3 (MSB)	Fault

y bit	Meaning
4 (LSB)	Heater time delay expired
5	Under forward power warning
6	Foldback active
7 (MSB)	Inhibit mode

x bit	Meaning
8 (LSB)	External inhibit
9	Interlock open
10	(not used)
11 (MSB)	(not used)

w bit	Meaning
12 (LSB)	(not used)
13	Sleep Mode Active
14	(not used)
15 (MSB)	(not used)

Table 3-7. *STA?; Response Codes

(The command ***STA?;** causes the TWTA to send a string indicative of the current system state)

*STA?; response	Meaning
SLEEP	Sleep Mode active (heater off)
WARM-UP	System is in heater time delay.
STANDBY	System is ready to allow high voltage on
OPERATE	High voltage is on and beam is on
FAULT	High voltage is off and system requires reset

Table 3-8. *STB?; Response Codes

(The command ***STB?;** causes the TWTA to send a string containing an operational state code consisting of 2 ASCII characters representing hex digits. The response is in the form **STATUS:*[x][y][eol]*** where the hex values of *[x]* and *[y]* are formed as shown below)

y bit	Meaning
0 (LSB)	Power status; always 1(power on)
1	Standby status; 0 if not in standby, 1 if in standby
2	Operate status; 0 if not in operate, 1 if in operate
3 (MSB)	Fault status; 0 if no fault, 1 if fault exists

x bit	Meaning
4 (LSB)	Mode switch; always 1 (reset)
5	Blank switch; always 1 (off)
6	Blank status; always 0 (off)
7 (MSB)	Not used; always 0

Table 3-9. Catalog of Heater Auto Off Time Delay Codes

Argument	Meaning
0	0.5 hour heater auto off time delay
1	1.0 hour heater auto off time delay
2	1.5 hour heater auto off time delay
3	2.0 hour heater auto off time delay
4	2.5 hour heater auto off time delay
5	3.0 hour heater auto off time delay

Command syntax is in this form:

<command mnemonic> <parameter> <carriage return>

Where:

<command mnemonic> consists of one of any valid command found in Table 3-3.

<parameter> (as applicable) consists of one ASCII space character followed by a number.

<carriage return> consists of an ASCII carriage return.

All commands are case sensitive.

The system will return parameter values, fault codes, and status codes regardless of whether remote is enabled. The parameter value is returned as a string of 20 characters or less, consisting of a label, =, and a value. For example, outputting the command **RDEF** to the TWTA would result in the TWTA sending back the string **Ef=6.03** (assuming the heater voltage is 6.03 volts). Units are usually not returned; see Table 3-3 for the units.

If remote is not enabled, set commands and commands to the system logic (i. e., OPERATE; or STANDBY; or RESET;) will not be accepted.

It is recommended that the **RDSTAT** command be used to provide the host program with a report on how a command was processed.

A small sample program that can send commands and receive the strings returned by the TWTA is included in Section 5.4. It is written in Hewlett-Packard's "Rocky Mountain" BASIC. The program assumes that the IEEE-488 bus is at address 7 and that the address of the TWTA is 01.

Remote operation is determined by the application (software) program in the system controller. This application program will aid the user in generating the Command Codes and displaying/monitoring the Status Codes. Consult the application program user's instructions for Remote operation procedure.

The application program should issue only one string at a time. After each functional command is issued the status should be checked to ensure that the command has been properly executed. The application program should allow sufficient time for the function to be completed before checking the status.

The application program should facilitate checking the status just prior to issuing a command, since the status could have been changed by a fault condition of the amplifier or by operator activation of the amplifier. Periodic checking of the status is also recommended.

3.9 TWTA GENERAL CONSIDERATIONS

This section is intended to offer some guidelines regarding operation, storage and use of Amplifier Research TWTAs.

Storage: TWTAs, as with other electronic equipment, are best stored in a benign environment at reasonably constant temperature. Service life is not improved by periodic operation.

Availability: For critical missions, and after long periods of storage, it is recommended that TWTA operation be checked sufficiently in advance of the mission to permit repair if required. Though service life is not improved by periodic operation, users experiencing amplifier trip due to body over current may benefit by periodically operating a unit with high voltage and grid on, but no RF drive. Such operation for about one hour on a weekly basis should effectively reduce nuisance tripping. Since the cathode structure has finite life, extended periods of non-functional operation of TWTAs is not recommended. An alternate approach, if periodic trip off has been observed, is to operate the unit without RF input for 1-2 hours before planned functional operation, resetting the unit after occasional trip off.

Cooling during Operate Mode: AR TWTAs have their air outlets and inlets on the rear panels. It is important to prevent the heated air, which is expelled from the TWTA's air outlets, from being recycled into the air inlets. Applications should have a clearance behind the TWTA of at least two feet for single bench top units and at least three feet for the higher power units, or the heated air should be ducted away.

Operation in Standby Mode: Standby mode for TWTAs readies the unit for operation. In this mode the filaments are on but the high voltage is off. TWTAs should not be left in this Standby mode for extended periods. Where practical, operational procedures should limit the time on Standby mode to less than approximately one hour. (See *Explanation of…,* below)

Operate Turn on: When selecting the Operate mode, when high voltage is first turned on, there may be some internal TWT arcing which can cause protective circuits to deselect the Operate mode, thereby returning the unit to the Standby mode. There may be a report of body over-current fault. In either case, if there is no other contraindication, the Operate mode may be selected again. This procedure may be repeated, if needed up to 25 times, until the Operate mode is actually set. If this condition persists, contact AR Customer Service for additional assistance. (See *Explanation of…,* below)

Noise Power Density (NPD): TWTAs produce rf noise over their operating frequency range, as specified by the Noise Power Density (NPD). This noise is significantly higher than the noise produced by typical solid state amplifiers, and is inherent in present TWTAs. The noise may surprise users new to TWTAs when it

accumulates and results in a significant indication in a broadband measurement device – such as a power meter or field probe. The error produced by this indication is not significant when operating near rated TWTA power levels, but may cause difficulty when trying to operate high power TWTAs at low output power levels..

For example, consider a hypothetical typical NPD of –76 dBm/Hz, from a 4 GHz bandwidth amplifier. A broadband detector might see the NPD as [-76 dBm/Hz + 10 (log 4 x 10^9) BW factor = -76 + 96=] +20 dBm, or 0.1 watts. This power is insignificant for a user operating at 200 watts (+53 dBm), but may be very noticeable to a user trying to operate below 1 watt (+30 dBm). [One watt is 0.5% of (23dB below) rated power for a 200-watt amplifier.] A field probe user obtaining a 200 V/M field with 200-watts may see a field as high as [53dBm – 20dBm = 33dB below 200 V/M=] 4.5 V/M due to this hypothetical NPD.

For these applications the use of a lower power amplifier is highly recommended, especially when considering safety issues. Alternatively, additional power loss in the form of an added high power microwave attenuator, or preferably an increased space loss for radiated fields, may be used to lower the noise received by the broadband measurement device.

Explanation of Limiting the Time in Standby mode and of Repeated Operate Selection.

Traveling wave tubes tend to get "gassy" if they are left in a Standby mode for extended periods of time. In this Standby mode, the heater (filament) is on but there is no high voltage applied to the collector (or high voltage is applied to the collector but the grid is off). This is the normal state after a tube's warm up time, just prior to entering the Operate mode.

In this state the cathode end of the TWT is heating up but the electron Beam is off. In other words, there is no cathode current. As the cathode heats up, gas trapped in the structure of the tube can be released, thus corrupting the vacuum of the tube. If the tube become too "gassy", arcing may occur when the high voltage is fully applied in the Operate mode. Another possible failure mode is a body over-current fault when the beam is turned on and the tube is "gassy".

Occasional arcing is normal for a TWT. The support components are designed to handle this, protecting both the TWT and its support circuitry. However, if the tube arcs two or three times in rapid succession, or worse yet repeatedly, a fault will be sensed that will shut the high voltage off, thus removing the unit from Operate status. The remedy usually recommended is to repeat the selection of the "Operate" mode until the unit remains in Operate. It has been found that most of the faults that can be cleared by this method will be cleared within 25 attempts to enter the Operate mode.

Once the tube is operating normally, gas will continue to evolve at a slow enough rate that the TWTA will not fault. This happens because the gas in the tube will interact with the beam and become ionized. As the electrons in the beam hit the gas molecules they ionize the gas, at which point it is accelerated into the collector structure and "buried" deep enough so that it ceases to be a problem.

To preclude this gassing problem, and thus reduce the need for repeating the Operate selection, it is recommended that the time in Standby be limited – to about one hour. Extended periods in Standby may result in an inability to clear the fault by this method. In this case, service measures may be needed to correct the unit. Thus, users should reduce the likelihood of occurrence of this problem by limiting the amount of time in the Standby mode.

The service measures involve pulsing of the tube beam current and gradually increasing the duty of the pulsing until the unit will operate continuously. Note that a similar condition can exist for tubes with grids when the TWTA is in the Operate mode (high voltage is on) but gating (control) input is set so that the grid turns off the TWT beam current. Operational procedures should also limit the time in this mode.

4. MAINTENANCE

The TWTA does not require routine scheduled maintenance**.** The only moving parts are the elements of switches, relays and the blower. 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 WARNING

WARNING:

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 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.

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.

If there is accumulated dust on the air intake grill, clean it with dry compressed air.

If significant dust has been noted on the air intake grill, it may be desirable to vacuum the dust and debris from inside the enclosure.

To open the enclosure:

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, RF, and any other interface connectors. On the rear of the unit, remove any screws used to connect brackets to the amplifier. On the front of the unit, remove the four screws holding the front panel onto the cabinet. Carefully slide the amplifier out of the front of the cabinet.

3. Remove the screws that secure the lower cover and the screws that secure the upper cover. Remove the covers to gain access to the interior of the TWTA.

4. Vacuum dust and debris from inside the enclosure. 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. Reassemble in the reverse order.

4.4 TROUBLESHOOTING

Symptom	Possible cause
TWT or power supply overtemperature	Air inlet filter 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	Panel open interlock switch open; external interlock jumper removed
Control module display does not come up; unit does not beep when powered up	Shorted or defective control module power supply Control module failure
Control module does not boot	EPROM(s) missing.
Control module "datalink failure" or “Communication Problem” error appears	HPA interface failure. Fiberoptic link failure ±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 re-assembly. 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 High Voltage Diode/Cap Assembly (A21425-296), the High Voltage Filter Assembly (A21461-500), the Grid Modulator Assembly (A21422-000), and the Heater Supply (A10010-000) are encapsulated modules and are not repairable. Contact an authorized service representative if replacement modules are needed.

4. TECHNICAL DOCUMENTATION

NOTE 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, only documentation pertaining to the highest levels of the system and to system control logic is included.

5.1 TOP LEVEL BUILD TREE

5.1.1 Three Phase

	A26901-313	500W TWT AMPLIFIER, SC-BAND, 3 PHASE (AR)
1A1	A22826-500	POWER SUPPLY FOR TWT 5296 , 3 PHASE
1A1A1	A23280-000	HEAT SINK/MOTHER BOARD
1A1A2	A23687-001	LOW VOLTAGE POWER SUPPLY MODULE
1A1A3	A16485-000	HPA LOGIC AND CONTROL MODULE
1A1A4	A10006-500	THREE PHASE INPUT FILTER
1A1A5	A23719-000	H - BRIDGE BOARD FOR 2000W LOAD
1A1A5L1	A09405-000	INDUCTOR
1A1A5T1 (E42)	A09402-000	XFMR,GATE DRIVE (HAND WOUND)
1A1A5T2 (E41)	A09403-000	XFMR,GATE DRIVE (HAND WOUND)
1A1A6	A21425-500	DIODE CAP ASSY FOR TWT MEC5196
1A1A6T1	A09567-000	HV TRANSFORMER FOR TWT MEC5196
1A1A7	A21461-500	HV FILTER FOR 5196
1A1A8	A21422-000	GRID MODULATOR MODULE
1A1A8A1	A18415-000	MODULATOR HIGH VOLTAGE BOARD
1A1A8A1T1	A09227-000	PULSE TOP XFMR,HAND WOUND
1A1A8A1T2	A09228-000	FEEDBACK XFMR,HAND WOUND
1A1A8A1T3	A09229-000	BIAS XFMR,HAND WOUND
1A1A8A1T4-T5	A09230-000	XFMR,GATE DRIVE (HAND WOUND)
1A1A8A2	A23715-000	MODULATOR CONTROL BOARD
1A1A9	A10010-000	HEATER POWER SUPPLY MODULE
1A1A9T1	A09409-000	XFMR,HEATER FEEDBACK
1A1A9T2	A09408-000	XFMR,HEATER POWER
1A1A10	A10017-511	PWM BD FOR 500T2G8
1A1A11	A25398-511	FACTORY SELECT FOR 500T2G8
1A1A6A	A21425-296	DIODE CAP ASSY FOR TWT 5296
1A1A6AT1	A09578-000	HV XFMR FOR TWT 5296
1A2	A26857-003	MICROWAVE POWER ASSY FOR 500T SC
1A3	A26856-000	HPA SYSTEM CONTROL FRONT PANEL ASSY
1A3A1	A22700-900	HPA DISPLAY BOARD
1A3A2	A24830-001	EMERGENCY BYPASS BOARD
1A4	A22933-300	CONTROL HEAD ENCLOSURE, IEEE-488
1A4A2	A18450-006	MAIN CPU
1A4A3	A22488-001	GPIB/LINK TRANSCEIVER BOARD
1A5	A25444-000	HPA INTERFACE BOARD (PLASTIC FIBERS)
1A6	A23692-000	INSULATED FAN DRIVER
1A6T1	A09594-000	FAN DRIVER TRANSFORMER
1A7	A26862-000	HPA WIRING KIT, AR 500T SC
1A7A10	A24830-001	EMERGENCY BYPASS BOARD
1A8	A26858-000	HPA CABINET AR 500T SC BAND 3 PHASE

5.1.2 Single Phase

	A26901-311	500W TWT AMPLIFIER, SC-BAND, 1 PHASE (AR)
1A1	A22826-501	POWER SUPPLY FOR TWT 5296 , 1 PHASE
1A1A1	A23280-000	HEAT SINK/MOTHER BOARD
1A1A2	A23687-001	LOW VOLTAGE POWER SUPPLY MODULE
1A1A3	A16485-000	HPA LOGIC AND CONTROL MODULE
1A1A4	A23683-000	1500W AVR CURRENT POWER FACTOR
1A1A4L4	A09006-000	PFC INDUCTOR FOR 100VAC-255VAC
1A1A5	A23719-000	H - BRIDGE BOARD FOR 2000W LOAD
1A1A5L1	A09405-000	INDUCTOR
1A1A5T1 (E42)	A09402-000	XFMR,GATE DRIVE (HAND WOUND)
1A1A5T2 (E41)	A09403-000	XFMR,GATE DRIVE (HAND WOUND)
1A1A7	A21461-500	HV FILTER FOR 5196
1A1A8	A21422-000	GRID MODULATOR MODULE
1A1A8A1	A18415-000	MODULATOR HIGH VOLTAGE BOARD
1A1A8A1T1	A09227-000	PULSE TOP XFMR,HAND WOUND
1A1A8A1T2	A09228-000	FEEDBACK XFMR,HAND WOUND
1A1A8A1T3	A09229-000	BIAS XFMR,HAND WOUND
1A1A8A1T4-T5	A09230-000	XFMR,GATE DRIVE (HAND WOUND)
1A1A8A2	A23715-000	MODULATOR CONTROL BOARD
1A1A9	A10010-000	HEATER POWER SUPPLY MODULE
1A1A9T1	A09409-000	XFMR,HEATER FEEDBACK
1A1A9T2	A09408-000	XFMR,HEATER POWER
1A1A10	A10017-511	PWM BD FOR 500T2G8
1A1A11	A25398-511	FACTORY SELECT FOR 500T2G8
1A1A6A	A21425-296	DIODE CAP ASSY FOR TWT 5296
1A1A6AT1	A09578-000	HV XFMR FOR TWT 5296
1A2	A26857-003	MICROWAVE POWER ASSY FOR 500T SC
1A3	A26856-001	FRONT PANEL ASSY, AR 500T SINGLE PHASE
1A3A1	A22700-900	HPA DISPLAY BOARD
1A3A2	A24830-001	EMERGENCY BYPASS BOARD
1A4	A22933-300	CONTROL HEAD ENCLOSURE, IEEE-488
1A4A2	A18450-006	MAIN CPU
1A4A3	A22488-001	GPIB/LINK TRANSCEIVER BOARD
1A5	A25444-000	HPA INTERFACE BOARD (PLASTIC FIBERS)
1A6	A23692-000	INSULATED FAN DRIVER
1A6T1	A09594-000	FAN DRIVER TRANSFORMER
1A7	A26862-001	HPA WIRING KIT, AR 500T SC SINGLE PHASE
1A7XJ1	A30346-000	EMI MODIFICATION KIT FOR 400KU
1A7XJ1A1	A28181-000	POWER ENTRY FILTER BOARD
1A8	A26858-001	HPA CABINET AR 500T SC BAND 1 PHASE

5.1.3 500 Watt TWT Amplifier SC-Band Single Phase AR with Sample and Input Connectors on Front Panel

	A26901-321	
1A1	A22826-501	POWER SUPPLY FOR TWT 5296 , 1 PHASE , PFC
1A1A1	A23280-000	HEAT SINK/MOTHER BOARD
1A1A2	A23687-001	LVPS, 85-265VAC IN, 15V/4A, 5V/1.5A-15V/0.5A OUT
1A1A3	A16485-000	HPA LOGIC AND CONTROL MODULE
1A1A4	A23683-230	1500W AVR CURRENT POWER FACTOR CORRECTED LOOP FOR INSTABILITY AT 230V
1A1A4L4	A09006-000	PFC INDUCTOR FOR 100VAC-255VAC
1A1A5	A23719-000	H - BRIDGE BOARD FOR 2000W LOAD, SIMILAR TO A16487
1A1A5L1	A09405-000	INDUCTOR
1A1A5T1 (E42)	A09402-000	XFMR,GATE DRIVE (HAND WOUND)
1A1A5T2 (E41)	A09403-000	XFMR,GATE DRIVE (HAND WOUND)
1A1A7	A21461-500	HV FILTER
1A1A8	A21422-000	GRID MODULATOR MODULE
1A1A8A1	A18415-000	MODULATOR HIGH VOLTAGE BOARD
1A1A8A1T1	A09227-000	PULSE TOP XFMR,HAND WOUND
1A1A8A1T2	A09228-000	FEEDBACK XFMR,HAND WOUND
1A1A8A1T3	A09229-000	BIAS XFMR,HAND WOUND
1A1A8A1T4-T5	A09230-000	XFMR,GATE DRIVE (HAND WOUND)
1A1A8A2	A23715-000	MODULATOR CONTROL BOARD
1A1A9	A10010-000	HEATER POWER SUPPLY MODULE
1A1A9D30	A32660-000	DIODE BLOCK
1A1A9T1	A09409-000	XFMR,HEATER FEEDBACK
1A1A9T2	A09408-000	XFMR,HEATER POWER
1A1A10	A10017-511	PWM BD FOR 500T2G8
1A1A11	A25398-511	FACTORY SELECT FOR 500T2G8
1A1A6A	A21425-296	DIODE CAP ASSY FOR TWT 5296
1A1A6AT1	A09578-000	HV XFMR FOR TWT 5296
1A2	A26857-005	MICROWAVE POWER ASSY FOR 500T SC FOR AR UNITS WITH 7/16 CONNECTOR OUTPUT
1A3	A26856-007	FRONT PANEL ASSY AR 500WATT L-BAND SINGLE PHASE
1A3A1	A22700-900	HPA DISPLAY BOARD
1A3A2	A24830-001	EMERGENCY BYPASS BOARD
1A4	A22933-300	CONTROL HEAD ENCLOSURE, IEEE-488
1A4A1	A31609-000	E00765-000 PS/TIE WRAP ASSEMBLY
1A4A2	A18450-006	DO NOT USE IN NEW DESIGNS OR PRODUCTS MAIN CPU BOARD,INVERTED (20MHZ, TIMEKEEPER)
1A4A3	A22488-001	GPIB/LINK TRANSCEIVER BOARD, 5U AND 6U TWT PRODUCTS
1A5	A25444-000	HPA INTERFACE BOARD (PLASTIC FIBERS)
1A5U15	A31346-000	DAC REPLACEMENT BOARD FOR U00725. DUAL CHANNEL
1A6	A23692-000	INSULATED FAN DRIVER
1A6T1	A09594-000	FAN DRIVER TRANSFORMER
1A7	A26862-001	HPA WIRING KIT, AR 500T SC SINGLE PHASE
1A7XJ1	A30346-000	EMI MODIFICATION KIT FOR 400KU
1A8	A26858-001	HPA CABINET AR 500T SC BAND SINGLE PHASE
1A8A1	A26858-002	HPA MECHANICAL KIT AR 500T SC BAND SINGLE PHASE

5.2 SCHEMATICS

10-16485-000	HPA Logic and Control (A16485-000)
10-24830-000	Emergency Bypass Board (A24830-001)
10-26901-311	500W TWT Amplifier, SC Band, Single Phase, AR (A26901-311)
10-25444-000	HPA Interface (A25444-000)

5.3 PARTS LISTS

A16485-000	HPA logic and control assembly
A22826-500	500W SC-Band Power Supply, Three Phase
A22826-501	500W SC-Band Power Supply, Single Phase
A24830-001	Emergency Bypass Board
A25444-000	HPA interface board
A26857-003	Microwave Power Assembly, 500W SC-Band
A26901-311	500W SC-Band TWT Amplifier, Single Phase
A26901-313	500W SC-Band TWT Amplifier, Three Phase

5.3.1 Parts List, HPA Logic and Control Module, A16485-000

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
	B16485-000	HPA LOGIC AND CONTROL BOARD	1
C11	C16333-000	CAP,33MF,25V,AERL,(NICHICON UVX1E330M)	1
C2, C5, C15, C58	C31028-000	CAP,1000PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION)	4
C3, C9, C10, C13, C14, C17, C19, C21, C22, C27, C28, C30, C31, C33, C36, C46	C31032-000	CAP,0.01MF,200VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	16
C61	C31033-000	CAP,0.022MF,100VDC,10%,CER,1% FAILURE,(KEMET CKR06B223K W/V OPTION)	1
C24, C60	C31036-000	CAP,0.1MF,100VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	2
C1, C4, C6, C7, C16, C18, C25, C26, C32, C34, C37, C38, C39, C40, C41, C43, C44, C45, C48, C49	C31040-000	CAP,1MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	20
D16, D23, D31	D10965-000	ZENER,15V,(DIODES INC 1N965B)	3
D1, D3, D4, D5, D7, D8, D9, D10, D11, D12, D13, D17, D18, D19, D21, D22, D25, D26, D28, D30, D35, D37,	D14454-000	DIODE,AXIAL,(MOTOROLA 1N4454)	24
D36	D14733-000	ZENER,5.1V,1W,10%,AXIAL,(MOTOROLA 1N4733)	1
	F00010-000	WASHER,#2,LOCK,SST	3
	F10086-000	PHP,2-56 X 3/16SST	3
J2	J10370-000	CONN,37 PIN,MALE,D-SUB,PCB RIGHT ANGLE, (AMP 747252-4)	1
	J18075-000	MALE SCREW LOCK,FOR D SUBMIN CONN,(AMP 205817-1)	1
J4, J5	J18086-000	CONN,,SMA,JACK RECEPTACLE,RIGHT ANGLE,0-18GHZ,PC MOUNT [JOHNSON COMPONENTS 142-0701-301]	2
J1	N25003-000	HYPERTRONICS CONN,29 PIN MALE RIGHT ANGLE,(CUT ENDS)	1
Q2	Q22907-000	TRANSISTOR,PNP,2N2907A,TO-18	1
R1, R9, R19, R37, R44, R50	R00100-000	RES,10 OHM,1/4W,5%,CC,(A/B RC07GF100J)	6
R4, R20, R27, R29	R01100-000	RES,100 OHM,1/4W,5%,CC,(A/B RC07GF101J)	4
R5, R17, R18, R28, R34, R45, R49, R53, R54, R59, R71, R88	R02100-000	RES,1K,1/4W,5%,CC,(A/B RC07GF102J)	12
R6	R02270-000	RES,2.7K,1/4W,5%,CC,(A/B RC07GF272J)	1
R30, R31, R36	R02470-000	RES,4.7K,1/4W,5%,CC,(A/B RC07GF472J)	3
R86, R87	R02510-000	RES,5.1K,1/4W,5%,CC,(A/B RC07GF512J)	2
R75	R02560-000	RES,5.6K,1/4W,5%,CC,(A/B RC07GF562J)	1
R38, R77, R90	R03100-000	RES,10K,1/4W,5%,CC,(A/B RC07GF103J)	3
R32	R03470-000	RES,47K,1/4W,5%,CC,(A/B RC07GF473J)	1
R35	R05820-000	RES,8.2M,1/4W,5%,CC,(A/B RC07GF825J)	1
R13, R14	R10002-000	TRIMPOT,5K,1/2W,10%,CERMET,20T,SIDE ADJ,(BOURNS 3296X-1-502)	2
R76	R21499-000	RES,4.99K,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R10	R21523-000	RES,5.23K,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R16	R21866-000	RES,8.66K,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R52, R73	R21887-000	RES,8.87K,1/2W,1%,MF,100PPM,(DALE RN55D)	2
R67	R21953-000	RES,9.53K,1/2W,1%,MF,100PPM,(DALE RN55D)	1

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
R47, R48	R22200-000	RES,20K,1/2W,1%,MF,100PPM,(DALE RN55D)	2
R79, R80	R22470-000	RES,47K,1/2W,1%,MF,100PPM,(DALE RN55D)	2
R42, R60, R61, R89	R23100-000	RES,100K,1/2W,1%,MF,100PPM,(DALE RN55D)	4
R33, R55	R23698-000	RES,698K,1/2W,1%,MF,100PPM,(DALE RN55D)	2
R41	R23750-000	RES,750K,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R21	R23845-000	RES,845K,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R66	R23953-000	RES,953K,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R12, R15	R32020-000	TRIMPOT,10K,1/2W,10%,CERMET,20T,SIDE ADJ,(BECKMAN 67X)	2
U4, U5, U6	U02390-000	IC,QUAD COMPARATOR,(NAT LM139J)	3
U7	U03240-000	IC,LOW POWER OP AMP,(NAT LM324)	1
U9	U10070-000	REFERENCE,PRECISION 10V [LINEAR TECH LT1031DCH]	1
U8	U17805-000	IC,5V REGULATOR,TO-220,(NAT LM340T-5.0)	1
U1, U2, U3	U20148-000	IC,HEX INVERTER,SCHMIDTT TRIGGER,(74HC14) (SSD)	3
RP8	U30106-000	IC,10K,RES NETWORK,6 PIN,SIP (DALE MSP06A-01-103G)	1
RP1-2, RP5-7, RP9	U30410-000	IC,10K,2%,0.40A,10 PIN,ISOLATED RESISTORS (DALE MSP10C-03-103G OR BOURNS 4610H-102-103)	6
RP4	U31020-000	IC,1K RES NETWORK,SIP,(BECKMAN L061C102G)	1
W3-W8	W12200-000	WIRE, 22 AWG, BLU, 600V, TEFLON, (BELDEN 83006)	6

5.3.2 Parts List, Power Supply for TWT 5196/5296 , 3 A22826-500

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
A4	A10006-500	THREE PHASE INPUT FILTER	1
A9	A10010-000	HEATER POWER SUPPLY MODULE	1
A10	A10017-511	PWM BD FOR 500T2G8	1
A3	A16485-000	HPA LOGIC AND CONTROL MODULE	1
A8	A21422-000	GRID MODULATOR MODULE	1
A6A	A21425-296	DIODE CAP ASSY FOR TWT 5296	1
A6	A21425-500	DIODE CAP ASSY FOR TWT MEC5196	1
A7	A21461-500	HV FILTER FOR 5196	1
A1	A23280-000	HEAT SINK/MOTHER BOARD	1
A2	A23687-001	LOW VOLTAGE POWER SUPPLY MODULE	1
A5	A23719-000	H - BRIDGE BOARD FOR 2000W LOAD, SIMILAR TO A16487	1
A11	A25398-511	FACTORY SELECT FOR 500T2G8	1

5.3.3 Parts List, Power Supply for TWT 5196 /5296 , 1 A22826-501

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
A9	A10010-000	HEATER POWER SUPPLY MODULE	1
A10	A10017-511	PWM BD FOR 500T2G8	1
A3	A16485-000	HPA LOGIC AND CONTROL MODULE	1
A8	A21422-000	GRID MODULATOR MODULE	1
A6A	A21425-296	DIODE CAP ASSY FOR TWT 5296	1
A7	A21461-500	HV FILTER FOR 5196	1
A1	A23280-000	HEAT SINK/MOTHER BOARD	1
A4	A23683-000	1500W AVR CURRENT POWER FACTOR	1
A2	A23687-001	LOW VOLTAGE POWER SUPPLY MODULE	1
A5	A23719-000	H - BRIDGE BOARD FOR 2000W LOAD, SIMILAR TO A16487	1
A11	A25398-511	FACTORY SELECT FOR 500T2G8	1

5.3.4 Parts List, Emergency Bypass Board, A24830-001

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
	B24830-000	EMERGENCY BYPASS BOARD	1
C3-C5	C04105-000	CAP,0.1MF,100V,20%,MON,(KEMET C331C104M1R5CA)	3
C6	C30010-000	CAP,10MF,35V,TANT,RADIAL,(NEMCO TB10-35K1)	1
C2	C31028-000	CAP,1000PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION)	1
C1	C31032-000	CAP,0.01MF,200VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	1
C7	C31040-000	CAP,1MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	1
D1, D2	D14454-000	DIODE,AXIAL,(MOTOROLA 1N4454)	2
D3, D4	D14733-000	ZENER,5.1V,1W,10%,AXIAL,(MOTOROLA 1N4733)	2
I2, I3	I10066-000	LED,RED,HIGH EFFICIENCY,HIGH BRIGHTNESS	2
I1, I4	I10096-000	LED,GREEN,DIFFUSED,T1-3/4 (XC55G)	2
TP2	J16212-000	TEST JACK,RED,VERTICAL,(EF JOHNSON 105-0852-001)	1
TP3	J16213-000	TEST JACK,ORANGE,VERTICAL,(EF JOHNSON 105-0856-001)	1
J2	J18086-000	CONN,,SMA,JACK RECEPTACLE,RIGHT ANGLE,0-18GHZ,PC MOUNT [JOHNSON COMPONENTS 142-0701-301]	1
J1	J18180-000	CONN,D-SUB,15 PIN,MALE,STRAIGHT,PCB MOUNT (POSITRONIC MD15M3000)	1
Q1-Q3	Q22222-000	TRANSISTOR,NPN,2N2222A,TO-18	3
Q4, Q5	Q22907-000	TRANSISTOR,PNP,2N2907A,TO-18	2
R18, R23	R01100-000	RES,100 OHM,1/4W,5%,CC,(A/B RC07GF101J)	2
R21	R01150-000	RES,150 OHM,1/4W,5%,CC,(A/B RC07GF151J)	1
R19	R02100-000	RES,1K,1/4W,5%,CC,(A/B RC07GF102J)	1
R3, R5, R7	R02220-000	RES,2.2K,1/4W,5%,CC,(A/B RC07GF222J)	3
R22	R02330-000	RES,3.3K,1/4W,5%,CC,(A/B RC07GF332J)	1
R16, R17	R02470-000	RES,4.7K,1/4W,5%,CC,(A/B RC07GF472J)	2
R24	R02510-000	RES,5.1K,1/4W,5%,CC,(A/B RC07GF512J)	1
R4, R6, R8, R9, R13, R15	R03100-000	RES,10K,1/4W,5%,CC,(A/B RC07GF103J)	6
R1	R12107-000	TRIMPOT,1K,1/2W,10%,CERMET,1T,SIDE ADJ,(BECKMAN 72XL)	1
R20	R20267-000	RES,267 OHM,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R10, R11, R12	R23100-000	RES,100K,1/2W,1%,MF,100PPM,(DALE RN55D)	3
R2	R30074-000	TRIMPOT,1K,1/2W,10%,CERMET,100PPM,20T,TOP ADJ,(BECKMAN 67W)	1
S2, S3	S22004-000	SWITCH,TOGGLE,DPDT,PC MNT,(AUGAT MTA-206N-PC)	2
S1	S22010-000	SWITCH,TOGGLE,4PDT,ON-NONE-ON,125V @ 6A,(AUGAT MTA-406N-PC)	1
U2	U11458-000	IC,DUAL OP AMP,(NAT LM1458CN)	1
U1	U17805-000	IC,5V REGULATOR,TO-220,(NAT LM340T-5.0)	1

5.3.5 Parts List, HPA Interface Board (Plastic) A25444-000

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
	B25444-000	HPA INTERFACE BOARD	1
C161	C03105-000	CAP,0.01MF,100V,CER,10%,RADIAL,(AVX SR201C103KAA)	1
C171	C04223-000	CAP,0.22MF,35V,TANT,RADIAL, [JAMCO 33507]	1
C20, C32, C100	C05153-000	CAP,1.5MF,35V,TANT,RADIAL,(AVAX, TAP155K035SCS)	4
C129, C163	C05223-000	CAP,2.2MF,35V,10%,SOLID SEALED TANT,RADIAL,(SPRAGUE 199D225X9035BA1)	2
C80, C81, C164	C06103-000	CAP,10MF,25V,20%,SOLID TANT,RADIAL,(AVX TAP106M025HSB)	3
C15	C06220-000	CAP,22MF,16V,SOLID TANT,RADIAL,(AVX TAP226K016SCS)	1
C99	C16103-000	CAP,10MF,35V,AERL,(NICHICON UVR1V100MDA)	1
C101	C17222-000	CAP,220MF,16V,AERL,(NICHICON, UVR1C221MEA)	1
C47, C67	C17224-000	CAP,220MF,50V,AERL,(ILL CAP 227RAR050A)	2
C44, C168, C169	C30066-000	CAP 47 MF, 35V, SOLID TANT. RADIAL, (KEMET T356M476K035AS)	3
C165, C166, C6, C7, C9, C13, C16, C39,	C31016-000	CAP,100PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION)	10
10, 11, 22, 23, 24, 25, 26, 28, 30, 33, 35, 40, 41, 42, 48, 49, 50, 51, 53, 62, 63, 64, 65, 70, 71, 73, 77, 79, 83, 85, 87, 88, 89, 91, 94, 96, 97, 98, 102, 103, 105, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 121, 125, 132, 167,	C31036-000	CAP,0.1MF,100VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	61
C12, C14, C21, C27, C29, C31, C34, C36, C38, C17, C18, C19, C37, C54, C55, C56, C57, C58, C59, C60, C61, C118, C119, C120, C122, C123, C124, C133, C46, C52, C66, C68, C72, C75, C82, C84, C86, C90, C92, C93, C95, C104, C106,	C31040-000	CAP,1MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	44
D8, D10-D16, D18-D19	D14007-000	DIODE,1000V,1A,AXIAL,(MOTOROLA 1N4007)	10
D1-D7	D14454-000	DIODE,AXIAL,(MOTOROLA 1N4454)	7
D9, D17	D14733-000	ZENER,5.1V,1W,10%,AXIAL,(MOTOROLA 1N4733)	2
I1	I10074-000	LED,GREEN,ALGAAS,NON-DIFFUSED,(HEWLETT PACKARD HLMP-1540)	1
J5	J10021-000	HEADER,2 PIN,MALE,RIGHT ANGLE,SERIES 7478 (MOLEX 22-05-3021)	1
J1	J10371-000	D-SUB,37 PIN MALE,PCB MOUNT,STRAIGHT (POSITRONICS MD37M3S000)	1
XU17	J14161-000	SKT,DIP,16 PIN,MACH SLEEVES,(AUGAT 516-AG11D)	1
XU26	J14202-000	SKT,DIP,20 PIN,MACH SLEEVES,(SAMTEC ICA-320-SGT)	1
XU15	J14281-000	SKT,DIP,28 PIN,MACH SLEEVES,(SAMTEC ICA-628-SGT)	1
TP0	J16210-000	TEST JACK,BLACK,VERTICAL,(EF JOHNSON 105-0853-001)	1
TP1	J16211-000	TEST JACK,BROWN,VERTICAL,(EF JOHNSON 105-0858-001)	1
TP2	J16212-000	TEST JACK,RED,VERTICAL,(EF JOHNSON 105-0852-001)	1
TP3	J16213-000	TEST JACK,ORANGE,VERTICAL,(EF JOHNSON 105-0856-001)	1

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
TP4	J16214-000	TEST JACK,YELLOW,VERTICAL,(EF JOHNSON 105-0857-001)	1
TP5	J16215-000	TEST JACK,GREEN,VERTICAL,(EF JOHNSON 105-0854-001)	1
TP6	J16216-000	TEST JACK,BLUE,VERTICAL,(EF JOHNSON 105-0860-001)	1
J4	J18167-000	D-SUB,37 PIN,FEMALE,PCB MOUNT,RIGHT ANGLE (AMP 745784-4)	1
J3	J18180-000	CONN,D-SUB,15 PIN,MALE,STRAIGHT,PCB MOUNT (POSITRONIC MD15M3000)	1
J2	J31013-000	CONN,D-SUB,25 PIN,MALE,RIGHT ANGLE,PCB MOUNT,[AMP 747238-4]	1
XJ1-XJ4	J31014-000	SPRING LATCH KIT,D-SUB,(AMPHENOL 17-529)	4
K1-K6	K02009-000	RELAY,DPDT,5VDC,125V @ 0.5A / 30VDC @ 1A CONTACTS,PCB TERMINALS,SEALED (OMRON G6H-2-DC5)	6
L1-L4	L00200-000	WIDE BAND CHOKE,(VK200 10/3B FERROXCUBE)	4
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8	Q22222-000	TRANSISTOR,NPN,2N2222A,TO-18	8
R2	R01220-000	RES,220 OHM,1/4W,5%,CC,(A/B RC07GF221J)	1
R41	R01680-000	RES,680 OHM,1/4W,5%,CC,(A/B RC07GF681J)	1
R1	R04200-000	RES,200K,1/4W,5%,CC,(A/B RC07GF204J)	1
R4, R7	R05820-000	RES,8.2M,1/4W,5%,CC,(A/B RC07GF825J)	2
R6, R8, R58	R20100-000	RES,100 OHM,1/2W,1%,MF,100PPM,(DALE RN55D)	3
R57	R20200-000	RES,200 OHM,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R11	R20243-000	RES,243 OHM,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R16	R20845-000	RES,845 OHM,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R59	R22332-000	RES,33.2K,1/2W,1%,MF,100PPM,(DALE RN55D)	1
R3, R5	R30071-000	TRIMPOT,10K,1/2W,10%,CERMET,100PPM,20T,TOP ADJ,(BECKMAN 67W)	2
R9, R12, R15, R22, R35, R36, R40, R44,	R30103-000	RES,10K,1/8W,1%,MF,AXIAL,100PPM,(DALE CMF-50 / RN50C1002F)	9
R17, R19, R20, R21, R23, R25, R28, R31, R42, R43, R46, R18	R30140-000	RES,1K,1/8W,1%,MF,50PPM,(DALE RN50C)	12
R13, R14, R24, R26, R27, R29, R32, R37, R38, R39, R47	R31164-000	RES,100K,1/20W,1%,FILM,AXIAL,100PPM,MIL,(DALE RN50C1003F)	11
U7, U8	U00027-000	IC,ULTRA LOW NOISE PRECISION OP AMP,(ANALOG DEVICES OP27GP)	2
U26	U00029-000	CONVERTER,NO OIL,16BIT,A TO D,SERIAL OUT,[BURR-BROWN ADS7809PB,PB],[ANALOG DEVICES AD977CN]	1
U17	U00524-000	IC,INSTRUMENTATION AMP,(ANALOG DEVICES AD524A) (SSD)	1
U15	U00725-000	IC,DUAL 16 BIT DIGITAL TO ANALOG CONVERTER,(BURR-BROWN DAC-725) (SSD)	1
U1	U03171-000	IC,ADJUSTABLE VOLTAGE REGULATOR,15W,1.5A, TO-220,(NAT LM317T)	1
U9, U10, U18	U04090-000	IC,4CH ANALOG MULTIPLEXER,(DATEL MXD-409)	3
DP2, DP4, DP5, DP8, DP9	U08010-000	IC,8 COMMON CATHODE CLAMPIMG DIODES,9 PIN SIP,(ROHM DAN801)	5
DP1, DP3, DP6, DP7, DP10	U08011-000	IC,8 COMMON ANODE CLAMPING DIODES,9PIN SIP,(ROHM DAP801)	5
U27	U11165-000	IC,6.5536MHZ CLOCK OSCILLATOR,1/2 SIZE,(ECLIPTEK EC1100HS-6.5536MHZ) (SSD)	1
U40	U11528-000	IC,VERSALINK TRANSMITTER,HORIZONTAL, (200UM FIBER) (HEWLETT PACKARD HFBR-1528)	1
U54	U12521-000	IC,FIBER OPTIC RECEIVER,HORIZONTAL,(HP HFBR-2521) (SSD)	1

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
U36	U17545-000	DRIVER,OIL,DS75451N,DUAL AND,[NATIONAL SEMICONDUCTOR DS75451N]	1
U6, U19, U34, U39, U60	U20148-000	IC,HEX INVERTER,SCHMIDTT TRIGGER,(74HC14) (SSD)	5
U42	U20730-000	IC,DUAL J-K FLIP FLOP W/RESET,(7473) (SSD)	1
U51	U21328-000	IC,QUAD 2 INPUT NAND,SCHMIDTT TRIGGER,(74HC132) (SSD)	1
U52	U21388-000	IC,3 TO 8 DECODER/DEMULTIPLEXER,INVERTING,(74HC138) (SSD)	1
U32	U21536-000	IC,DUAL 4 INPUT DIGTAL MULTIPLEXER,(74F153) (SSD)	1
U35	U22598-000	IC,8 BIT ADDRESSABLE LATCH W/RESET,(74HC259) (SSD)	1
U47	U23909-000	IC,DUAL 4 BIT BINARY/BIQUINARY COUNTER (74HCT390) (SSD)	1
U41, U48	U24018-000	IC,JOHNSON DECADE COUNTER W/10 DECODED OUTPUTS,(74HC4017) (SSD)	2
U45	U24138-000	IC,8 BIT BINARY DOWN COUNTER,(74HC40103) (SSD)	1
U43	U26889-000	IC,8 BIT MAGNITUDE COMPARATOR,(74HCT688) (SSD)	1
U22, U24, U57	U28008-000	IC,QUAD 2 INPUT AND,(74HC08) (SSD)	3
U4, U49, U58	U28032-000	IC,QUAD 2 INPUT OR,(74HC32) (SSD)	3
U44, U46	U28040-000	IC,12 BIT DECADE COUNTER,(74HCT4040) (SSD)	2
U5, U13, U14, U23, U25, U33, U50	U28074-000	IC,DUAL D FLIP FLOP W/RESET,(74HC74) (SSD)	7
U2	U28123-000	IC,DUAL RETRIGGERABLE 1-SHOT,(74HC123) (SSD)	1
U31, U53	U28164-000	IC,8 BIT SERIAL IN PARALLEL OUT SHIFT REGISTER,(74HC164) (SSD)	2
U3, U12, U28, U37, U38	U28165-000	IC,8 BIT PARALLEL IN SERIAL OUT SHIFT REGISTER,(74HC165) (SSD)	5
RP6	U32001-000	IC,1K FEED-THROUGH RES NETWORK,16 PIN DIP,(A/B 316B102)	1
RP1-RP5	U32103-000	IC,10K FEED-THROUGH RES NETWORK,16 PIN DIP,(A/B 316B103)	5
U56	U40008-000	REGULATOR,OIL,5V,100MA,TO-92,[MOTOROLA MC78L05ABP]	1
U55	U40012-000	FLIP-FLOP,OCTAL D-TYPE LATCH WITH RESET,[NATIONAL MM74HC273N]	1

5.3.6 Parts List, Microwave Power Assy for 500T SC, A26857-003

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
W6	E00748-405	CABLE,RF,FLEXIBLE,4.5,SMA,(UNITED MICROWAVE AA-150-00.04.5)	1
W1	E00888-007	CABLE,RF FLEX, 7,SMA,MALE TO MALE,20 GHZ,50 OHM,BLUE FEP TEFLON (DICAR EZ402-2121-07)	1
W5	E00888-009	CABLE,RF FLEX, 9,SMA,MALE TO MALE,20 GHZ,50 OHM,0.141 CABLE,INSULATED JACKET,[SRC 150-150-150090]	1
W2	E00888-012	CABLE,RF FLEX,12,SMA,MALE TO MALE,20 GHZ,50 OHM,0.141 CABLE,INSULATED JACKET,[SRC 150-150-150120]	1
W3	E00888-015	CABLE,RF FLEX,15,SMA,MALE TO MALE,20 GHZ,50 OHM,0.141 CABLE, INSULATED JACKET, [SRC 150-150-150150]	1
A1	E01136-000	SSPA, 2.5 - 8 GHZ, 30DBM, 33 DB GAIN, VGA , CPI CMA2580B(XX)	1
A3	E01416-000	DUAL COUPLER 2.5-8.0 GHZ,-40/-30 DB, 600W,SC (F) INPUT,7/16 (F) DIN OUTPUT,(RLC M3714B)	1
A2	E08072-000	TWT, 2.5-7.5 GHZ, 535 W CW, GRID, +/-4 DB EQ (TELEDYNE MEC-5296, GRID, +/-4 DB EQ)	1
ATT1	E20066-000	ATTENUATOR,10DB,2W,DC-18GHZ,(OMNI SPECTRA 2082-6147-10)	1
A5, A6	E20129-000	COUPLER,10DB,4-18GHZ,SMA,(MAC TECHNOLOGIES C4258-10)	2
W4	E20277-000	RF CABLE,12.35",SC STR PLUG BOTH ENDS,HIGH POWER,100C,(MALIK CABLE DEVICES	1
D1, D2	E20284-000	ZERO-BIAS SCHOTTKY DETECTOR,10MHZ-18.5GHZ,POSITIVE OUT PUT POLARITY,(KRYTAR 301 AP)	2
	J18160-000	CONN,1 PIN,FEMALE,20KV,10A,0.180 DIA. LEAD,[CONNECTRONICS 11039-02]	5

5.3.7 Parts List, 500W TWT Amplifier, SC-Band, Single, A26901-311

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
A1	A22826-501	POWER SUPPLY FOR TWT 5196 /5296 , 1 PHASE , PFC	1
A4	A22933-300	CONTROL HEAD ENCLOSURE, IEEE-488	1
A6	A23692-000	INSULATED FAN DRIVER	1
A5	A25444-000	HPA INTERFACE BOARD (PLASTIC FIBERS)	1
A3	A26856-001	FRONT PANEL ASSY, AR 500T SINGLE PHASE	1
A2	A26857-003	MICROWAVE POWER ASSY FOR 500T SC FOR AR UNITS WITH 7/16 CONNECTOR OUTPUT	1
A8	A26858-001	HPA CABINET AR 500T SC BAND SINGLE PHASE	1
A7	A26862-001	HPA WIRING KIT, AR 500T SC SINGLE PHASE	1

5.3.8 Parts List, 500W TWT Amplifier, SC-Band, Three, A26901-313

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
A1	A22826-500	POWER SUPPLY FOR TWT 5196 / 5296 , 3 PHASE	1
A4	A22933-300	CONTROL HEAD ENCLOSURE, IEEE-488	1
A6	A23692-000	INSULATED FAN DRIVER	1
A5	A25444-000	HPA INTERFACE BOARD (PLASTIC FIBERS)	1
A3	A26856-000	HPA SYSTEM CONTROL FRONT PANEL ASSY AR 500T	1
A2	A26857-003	MICROWAVE POWER ASSY FOR 500T SC FOR AR UNITS WITH 7/16 CONNECTOR OUTPUT	1
A8	A26858-000	HPA CABINET AR 500T SC BAND THREE PHASE	1
A7	A26862-000	HPA WIRING KIT, AR 500T SC	1

5.4 SAMPLE PROGRAM FOR IEEE-488 COMMUNICATION

```
1000  ! ********************************************
1010  ! *     IEEE-488 COMMUNICATIONS SOFTWARE       *
1030  ! *     7/24/92  AARON D. McCLURE              *
1040  ! ********************************************
1041  DIM F$[80]
1042  DIM A$[80]
1050  CLEAR SCREEN
1060  INPUT "INPUT COMMAND TO SEND TO POWER SUPPLY.  EXIT TO QUIT.",A$
1070  IF A$="EXIT" THEN 1130
1080  OUTPUT 701;A$
1090  IF A$[1,2]<>"RD" THEN GOTO 1060
1095  IF A$[1,1]="*" THEN GOTO 1100
1100  ENTER 701;F$
1110  PRINT "OUTPUT FROM COMMAND ",A$," IS ",F$
1120  GOTO 1060
1130  CLEAR SCREEN
1140  EN
```

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.

Vacuum tubes in the 'L' series amplifiers, traveling-wave tubes in TWT amplifiers, 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.

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