rf/microwave instrumentation

Operating and Service Manual

8000TP1G1z5

Model

10027894

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

declare that our product(s);

the Model 8000TP1G1z5

to which this declaration relates is in compliance with the requirements of the:
EEC EMC Directive (89/336/EEC) in accordance with Article 10 (2) of the directive, with the provision that the user must install the equipment as directed by the “Instructions for European EMC Conformity” in the Operating and Service Manual.

This product(s) is in compliance with the requirements of the Low Voltage Directive (72/23/EEC) in accordance with safety standard IEC EN60950 (1995).

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

Donald R. Shepherd
Chairman

Instructions for European EMC Conformity

⚠ WARNING ⚠

It is the responsibility of the user of this equipment to provide electromagnetic shielding, filtering and isolation which is necessary for EMC compliance to Directive 89/336/EEC. The equipment must therefor be operated in a shielded area which provides a sufficient level of attenuation to meet the radiated emissions and immunity specifications. All AC, DC and Control lines connected to the equipment and entering or exiting the shielded area must have sufficient isolation to meet the conducted emissions and immunity specifications. The following minimum levels are suggested for use in accordance with the rated power of the equipment.

Rated Power	Minimum shielding attenuation	Minimum line isolation
100 watts	50 dB	50 dB
101 - 1000 watts	60 dB	60 dB
1001 - 10,000 watts	70 dB	70 dB

Since this equipment is designed to generate high levels of Radio Frequency energy, it is also essential that the user read and follow the “Instructions for Safe Operation” in this manual. If other equipment is operated in the shielded room it may be disturbed by the amplifier.

⚠ ACHTUNG ⚠

Der Benutzer dieses Gerätes ist dafür verantwortlich, daß die elektromagnetische Abschirmung und Filterung gewährleistet ist, welche gemäß Richtlinie 89/336/EEC notwendig ist. Das Gerät muß deshalb in einem geschirmten Raum betrieben werden, welcher eine ausreichenden Schirmung bietet, um die Emissions- und Störfestigkeitsspezifkation einzuhalten. Alle Wechsel- und Gleichspannungsleitungen sowie Steuerleitungen, die mit dem Gerät verbunden sind und in den geschirmten Raum von außen hereingeführt werden, müssen ausreichend gefiltert sein, um die Emissionsspezifkation einzuhalten. Es werden folgenden Minimalwerte der Schirmdämpfung und Filterung in den unterschiedlichen Leistungsklassen empfohlen.

Hochfrequenzleistung	min. Schirmdämpfung	min Filterdämpfung
100 Watt	50 dB	50 dB
101-1000 Watt	60 dB	60 dB
1001-10.000 Watt	70 dB	70 dB

Falls andere elektrische oder elektronische Geräte gleichzeitig mit dem Gerät betrieben werden, kann es zu Beeinflussungen kommen. Da das Gerät zur Erzeugung von Hochfrequenzenergie dient ist es daher auch unbedingt notwendig, daß der Benutzer die Sicherheitsvorschriften in der Bedienungsanleitung liest und einhält.

⚠ AVERTISSEMENT ⚠

Il est de la responsabilité de l'utilisateur de cet équipement d'assurer la protection électromagnétique, le filtrage et l'isolation nécessaires, afin de se conformer à la directive 89/336/EEC concernant la C.E.M. Par conséquent, cet équipement doit être mis en fonctionnement dans une enceinte d'atténuation suffisante pour satisfaire aux spécifications d'émissivité et de susceptibilité. Toutes les alimentations alternatives, continues ainsi que les liaisons de contrôle connectées à cet équipement, qui entrent ou sortent de cette enceinte doivent avoir une isolation suffisante pour satisfaire aux spécifications concernant les émissions conduites et d'immunité. Pour une utilisation conforme, les niveaux d'atténuation minimums suivants sont suggérés en fonction de la puissance de sortie de l'équipement:

Puissance de sortie	Atténuation minimum de l'enceinte	Isolation minium de la ligne
100 Watts	50 dB	50 dB
101 à 1.000 Watts	60 dB	60 dB
1.001 à 10.000 Watts	70 dB	70 dB

Puisque cet équipement est destiné à générer de forts niveaux R.F., il est essentiel que l'utilisateur se conforme aux instructions de sécurité indiquées dans ce manuel. Tout autre équipement en fonctionnement dans la cage de Faraday peut-être perturbé par 1'amplificateur.

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.

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.

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TABLES

1. DESCRIPTION AND SPECIFICATIONS

This manual provides operating, interfacing and selected service information pertinent to Amplifier Research Model 8000TP1G1z5 Broadband Microwave Amplifier. The Model 8000TP1G1z5 is an 8000 watt pulsed L-band traveling-wave tube amplifier (TWTA). This manual supports 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 traveling wave tube (TWT) to provide rated power output over the TWT amplifier's full bandwidth. The amplifier is well suited for susceptibility and general laboratory testing where instantaneous bandwidth, high gain and moderate harmonic levels are required.

This amplifier resides in a standard 19" rack mount chassis which has a DIN 7-16 RF output, N-type RF input, N-type forward sample port, N-type reverse sample port, BNC pulse input, IEEE-488 communications interface, and a 15-pin d-sub for external interlocking.

Primary power is 190-260 volts, 50/60 Hz, single phase with ground (3 wire). Efficient switching power supplies result in minimum power consumption. A fast regulation control loop and a high degree of filtering ensure performance within specifications over a wide range of operating conditions. The amplifier is fully enclosed, and the service panels of the amplifier 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 Instrumenation offers a number of accessories for use with this amplifier including:

- Directional coupler
- Antenna
- Flexible transmission line

Refer to a current AR 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.

Model 8000TP1G1z5, M1 through M6 8,000 Watt Pulse Amplifier 1GHz–1.5GHz

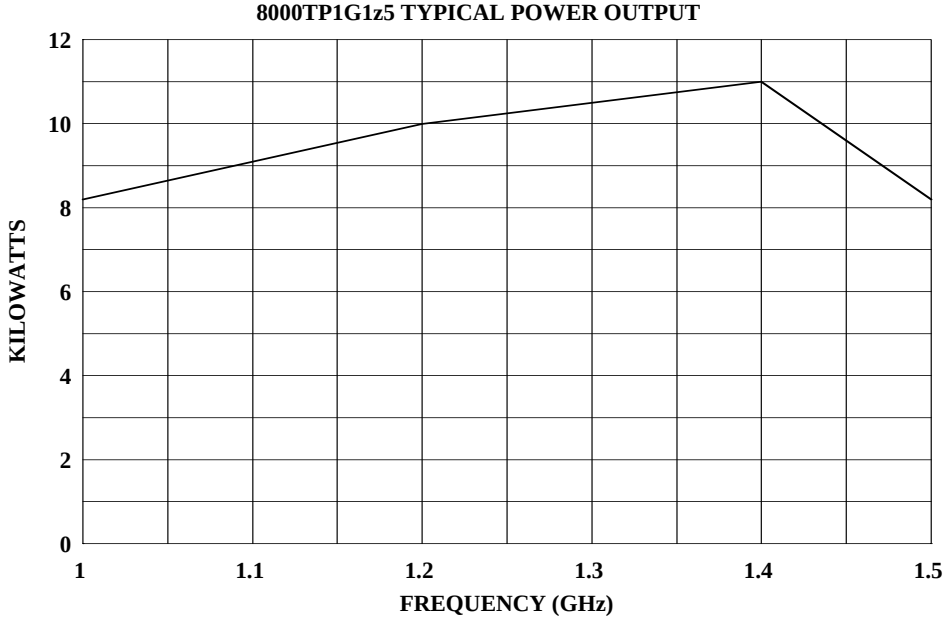
The Model 8000TP1G1z5 is a self contained, forced air cooled, broadband traveling wave tube (TWT) microwave amplifier designed for pulse applications at low duty factors where instantaneous bandwidth and high gain are required. A reliable TWT provides a conservative 8000 watts minimum peak RF pulse power at the amplifier output connector. Stated power specifications are at the fundamental frequency.

The amplifier's front panel digital display shows forward and reflected average power output or forward and reflected peak power, plus extensive system status information accessed through a series of menus via soft keys. Status indicators include power on, warm-up, standby, operate, faults, excess average or peak reflected power warning and remote. Standard features include a built-in IEEE-488 (GPIB) interface, 0dBm input, TTL Gating, VSWR protection, gain control, RF output sample ports, auto sleep, plus monitoring of TWT helix current, cathode voltage, collector voltage, heater current, heater voltage, baseplate temperature and cabinet temperature. Modular design of the power supply and RF components allow for easy access and repair. Use of switching mode power supplies results in significant weight reduction.

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

See Model Configurations for alternative packaging and special features.

The export classification for this equipment is 3A999. 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.



SPECIFICATIONS, MODEL 8000TP1G1z5

POWER (Fundamental), Peak Pulse, @ Output
- Nominal ..... 10,000 watts
- Minimum ..... 8000 watts

FLATNESS ..... ±6 dB maximum

FREQUENCY RESPONSE ..... 1-1.5 GHz

INPUT FOR RATED OUTPUT ..... 1.0 milliwatt maximum

GAIN (at maximum setting) ..... 69 dB minimum

GAIN ADJUSTMENT (continuous range) ..... 35 dB minimum

INPUT IMPEDANCE ..... 50 ohms, VSWR 2.5:1 maximum

OUTPUT IMPEDANCE ..... 50 ohms, VSWR 2.5:1 typical

MISMATCH TOLERANCE ..... Output pulse width foldback protection at peak reflected power exceeding 2000 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.

PULSE CAPABILITY
- Pulse Width ..... 0.07 – 40 microseconds.
- Pulse Rate (PRF) ..... 100 kHz maximum
- Duty Cycle ..... 1% maximum.
- RF Rise and Fall ..... 70 ns max (10% to 90%).
- Delay ..... 300 ns maximum from pulse input to RF 90%
- Pulse Width Distortion ..... ±30 ns maximum (50% points of output pulse width compared to 50% points of input pulse width)
- Pulse Off Isolation ..... 80 dB minimum, 90 dB typical
- Pulse Input ..... TTL level, 50 ohm nominal termination

NOISE POWER DENSITY
- (pulse on) ..... Minus 55 dBm/Hz maximum; Minus 65 dBm/Hz typical
- (pulse off) ..... Minus 140 dBm/Hz (typical)

HARMONIC DISTORTION ..... Minus 15 dBc maximum

PRIMARY POWER ..... 190-260 VAC, 50/60 Hz single phase, 1 KVA maximum

CONNECTORS
- RF input ..... Type N female on rear panel
- RF output ..... Type DIN 7-16 on rear panel
- RF output forward and reflected sample ports ..... Type N female on rear panel
- Pulse input ..... Type BNC female on rear panel
- GPIB ..... IEEE-488 female on rear panel
- Interlock ..... DB-15 female on rear panel

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

SIZE (W x H x D) ..... 50.3 x 26 x 94 cm, 19.8 x 10.3 x 37 in

WEIGHT (approximate) ..... 57 kg, 125 lbs

EXPORT CLASSIFICATION 3A999

MODEL CONFIGURATIONS

E **Package Alternatives.** May select an alternative from the following [E1C or (E1C and E2S) and/or E3H]:

E1C **Cabinet:** Without outer enclosure for rack mounting, size (W x H x D) 49 x 22 (5U) x 94 cm, 19 x 8.75 (5U) x 37 in., Subtract approximately 11 kg, 25 lbs, for removal of outer enclosure.

E2S **Slides:** slides installed, add approximately 2 kg, 5 lbs.

E3H **Handles:** Front pull handles installed.

S **Special Features:** May select a special feature (extra cost) [S1E]

S1E **Extended Frequency Range:** Extended operation down to 0.9 GHz at reduced power of 5 kW minimum from 0.9 to 1.0 GHz.

Model Number	Features	
	E	S
8000TP1G1z5	Base model	–
M1	E1C	–
M2	E3H	–
M3	E1C & E3H	–
M4	E1C & E2S	–
M5	E1C & E2S & E3H	–
M6	E2S & E3H	S1E

Model number example: Model 8000TP1G1z5M2 would have option E3H front pull handles installed.

2. THEORY OF OPERATION

2.1 DESIGN OF THE AMPLIFIER

The Model 8000TP1G1z5 TWT amplifier consists of three principal subsystems. From top to bottom, these are the control module (A30762-310), the RF assembly (A33882-000), and the TWT power supply (A30767-310). These will be discussed in greater detail below. The system is completed by a number of cables that interconnect the subsystems.

See the build tree in Section 5.1 for information about how the parts lists are structured.

2.2 CONTROL MODULE

The control head consists of three boards: the display board (A22700-900) provides the user interface (display, buttons, and rotary encoder); the CPU board (A25450-000) contains the CPU, bus management hardware, DRAM, EPROMs, and static RAM; and the datalink board (A22488-013) provides the I/O to the amplifier system as well as the IEEE-488 communication bus for computer interfacing.

The control head is provided with its own +5VDC supply, which other than through the interface bus, is electrically isolated from the amplifier. Communication between the control head and the interface board in the system is achieved via 200um fiber optic linked pairs, Each fiber optic link pair is connected to the HPA Interface Board (A25444-001) from the datalink board. Data is steered by an address byte in the data stream from the microprocessor.

2.3 DESCRIPTION OF THE RF ASSEMBLY

The TWTA consists of two stages of RF amplification: a high-gain, low power solid state preamp (E02588-000) which provides the required drive to the TWT (E02576-000).

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 with a built-in voltage-controlled variable attenuator which permits control of the amplifier's output power from the control module. The solid state preamp's output is connected to the input of the TWT through a low pass filter to attenuate any out of band signal to the TWT.

A directional coupler is installed near the TWT output for power metering, sample port and VSWR protection for the tubes. A reflected power foldback circuit utilizing the reflected power port reduces the system's gain under conditions of high VSWR so that a gradual increase in reflected power will not result in a VSWR fault.

The RF output is 7-16 DIN coaxial connector located on the rear panel.

The control module monitors and controls the RF assembly via the HPA interface board (A25444-001). This board generates the analog voltage that controls the variable attenuator and has A-to-D converters for metering the power levels.

The TWT is convection cooled using a 400 Hz high speed fan. This fan is used to cool the TWT heatsink and the power supply heat sink.

2.4 DESCRIPTION OF THE TWT POWER SUPPLY

The power supply chassis contains a modular TWT power supply assembly, an HPA interface board (A25444-001), as well as an AC input line filter and a front panel circuit breaker.

The power supply assembly 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 (A23687-150). Control logic and TWT protection circuits are contained in the HPA logic and Control Assembly (A16485-000).

The Heater Power Supply Module (A27840-011) powers the TWT DC heater. This warms up the cathode of the TWT to allow electrons to be released and travel through the TWT providing gain on the RF that is input to the TWT. These electrons are released when the Grid Modulator (A33076-001 and A33077-000) provides a voltage that is lower than the cathode voltage. This voltage (in this system is about +500VDC referenced to cathode) allows the electrons to migrate off of the cathode towards the collector of the TWT.

The high voltage power supply consists of the following: Switching transistors are on the Power Inverter Module (A16487-382) and switching is controlled by the PWM Board (A21459-093). The high voltage transformer and rectifiers are contained in the HV Rectifier (A28273-001). The high voltage DC is filtered in the HV Filter Assembly (A21458-011).

Interconnects between the power supply modules are through a motherboard (A22498-016) and wiring harness. The motherboard connects all of the power supply modules (heater, inverter, logic, HV filter, HV rectifier, grid modulator, and PFC). The Power Factor Correction (PFC) module ensures that the input AC voltage and current are in phase which reduces the peak power requirements from the AC supply and provides near perfect (~99%) power factor correction. The wiring harness connects the logic module to the HPA interface board.

The HPA interface board permits the control module to control the power supply and monitor analog values and fault status. This information is feed through a fiber optic link to the control head. The HPA interface board also contains hard-interlocks for the top and bottom panels and the external interlock/inhibit.

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, inspect the shipping container for obvious signs of external damage. If damage is observed, notify the carrier and contact an authorized service representative.

One panel of the shipping container can be removed to gain access to the TWTA. This panel may be positioned to use as a ramp when removing the TWTA from the shipping container.

Save and store the shipping container in case the unit needs to be moved to another site or returned to the manufacturer for repair.

3.2.2 Mounting

When the chassis is mounted in a rack, the TWTA must be located on a nominally flat surface, and restrained so that it will not inadvertently roll out of position. The casters are *not* provided with brakes. Set the leveling feet when the TWTA is properly positioned for use.

When rolling the unit, fully recess the leveling feet to maximize floor clearance.

CAUTION:

Avoid pulling more than two drawers/assemblies out of the rack at the same time. Although unlikely, the weight of the drawers/assemblies may cause the rack to tip over.

3.2.3 Cooling Requirements

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

CAUTION:

Do not position the TWTA in such a way that the air intakes or outlets are blocked, or that the exhaust air flow is directed into air intakes. See Paragraph 3.5 for location of air intakes and air outlets. Make sure that the intake air is 45°C or below. Great care must be taken to minimize any exhaust air restrictions. Avoid mounting heat-producing equipment near the TWTA, especially below the TWTA's air intakes. Pay special attention to the location of RF loads and lossy coaxial cable connected directly to the TWTA which may conduct heat back to the TWTA. Use supplemental fans as necessary to cool these components, directing this heat away from the rear of the TWTA. Failure to provide adequate cooling can result in the unit shutting down from overtemperature conditions. The TWTA dissipates approximately 8.0 kilowatts when in the Operate mode.

3.2.4 AC Line Power Connections

AC line power connection to the TWTA is a 3-conductor cable attached to the junction box. The cable is provided unterminated, and appropriate wiring to the cable must be provided by the user. The cable conductor function is color coded

Color	Function
Black	Phase
White	Neutral
Green	Safety ground

3.2.5 RF Connections

The RF output connector is a 7-16 DIN female coaxial connector. Refer to specification sheet for alternative connector types.

CAUTION:

Never operate the TWTA without a matched output load rated for at least 1000 watts, continuous duty. The TWTA is not provided with an output isolator. While the TWTA is protected from excessive reflected power by foldback and VSWR circuits, it is poor practice to power the unit up without a load or an antenna. Even with no drive, "looping" oscillation can result in RF output if the TWTA 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.

CAUTION:

Never operate the TWTA without a matched input termination or drive source. When operating the unit with an antenna and without adequate isolation to the input, use caution in selecting well-shielded input cables and signal source. Use a 6dB or larger pad (RF attenuator) directly at the TWTA input connector to reduce risk of "looping" oscillation.

3.2.6 External Interlock Connector

The TWTA is provided with an external interlock capability via a 15-pin-D connector. To enable the high-voltage power supply, it is necessary to provide continuity between pins 3 and 4 of this connector. 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 disable the RF output for either 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 ensure that power is removed for personnel safety.

3.3 FRONT PANEL FEATURES

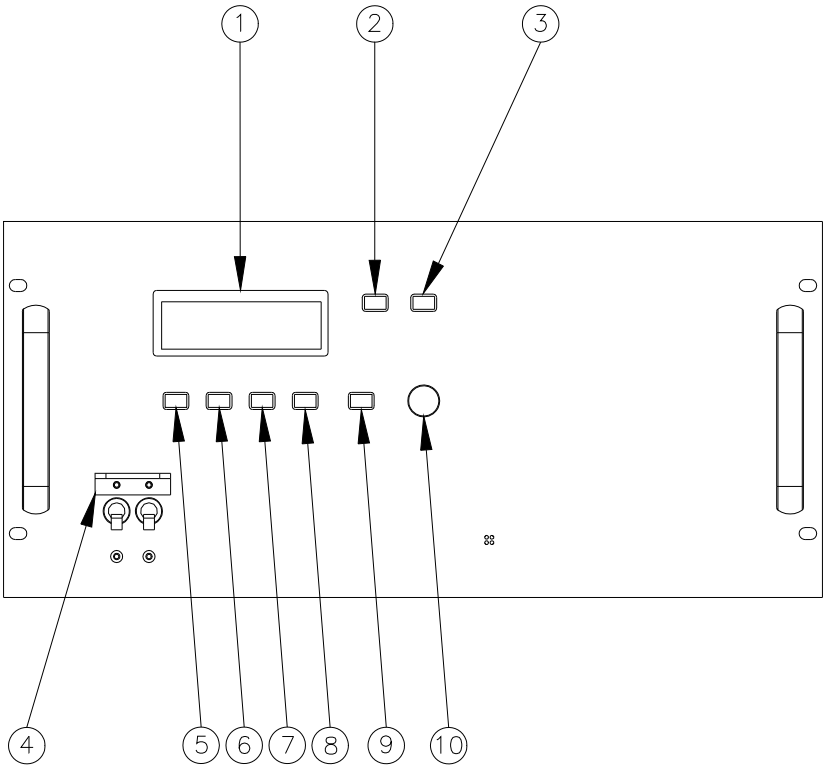


Figure 3-1. Front Panel Features

Table 3-1. Front Panel Features

Label	Title	Function
1	Display	Displays numerous parameter values and fault messages.
2	STANDBY	Push-button; biases grid off and turns off high voltage.
3	OPERATE	Push-button; turns on high voltage when all faults and heater delay are cleared.
4	Main Breaker	Switchable 10A circuit breaker, provides AC power to the entire system.
5-8	S1...S4	"Soft Key" push-buttons; various menu selection functions.
9	EXIT	Push-button; terminates various menu selection routines and returns to the previous menu level.
10	ADJUST	Rotary knob used as an input device to change values of a variety of parameters.

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 3-2 provides a roadmap for navigating between the screens.

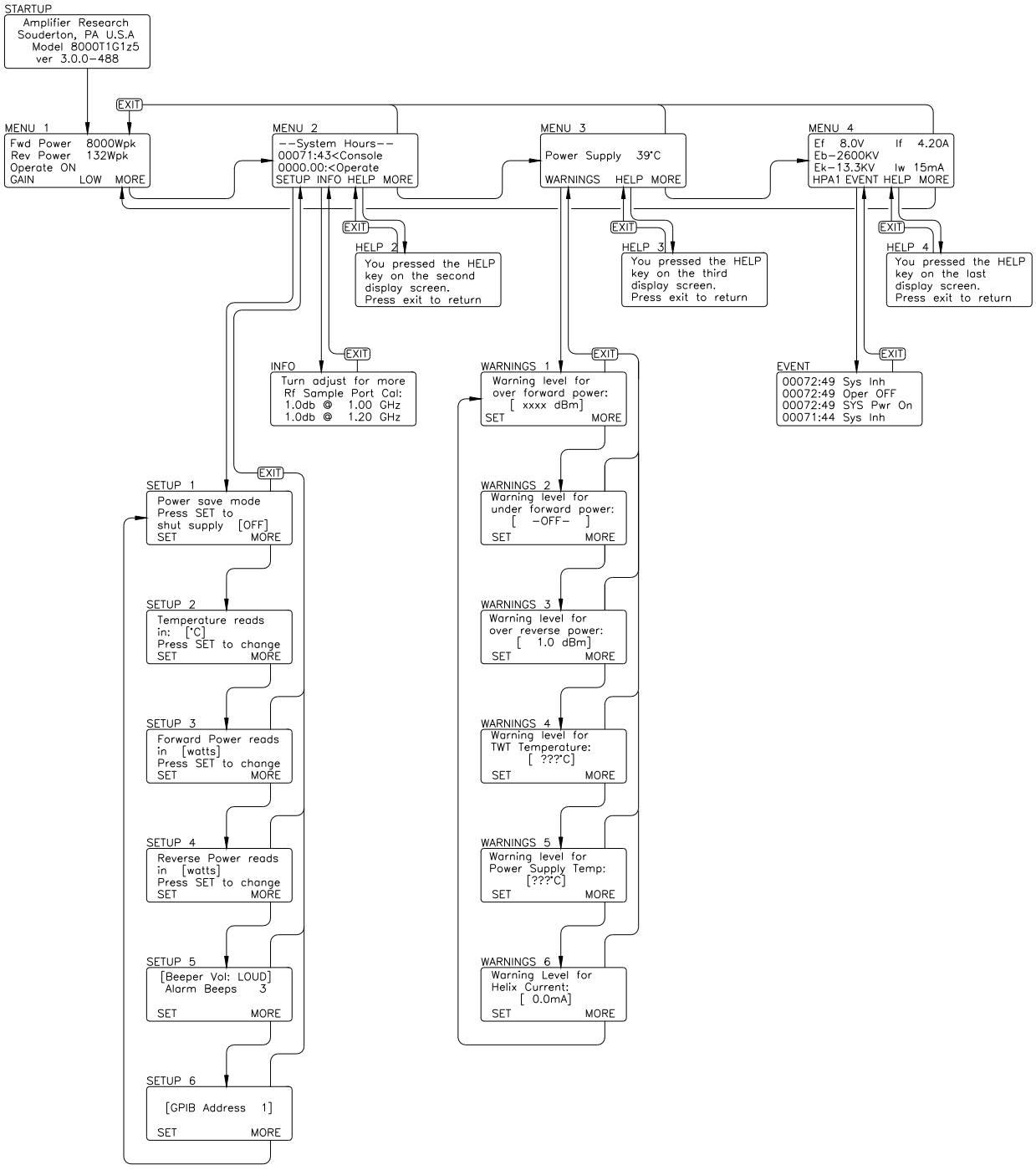


Figure 3-2. Front Panel Display Screens

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	Functions
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	Power supply temperature (°C or °F)
MENU 4	Heater voltage (Ef)
	Heater current (If)
	Collector voltage (Eb)
	Cathode voltage (Ek)
	Helix current (Iw)

Help Screens - On most 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. Pressing S1 (SET) toggles between On and OFF. Pressing MORE brings up the SETUP 2 screen. This toggles display of temperature parameters between Fahrenheit and Celsius degrees. Pressing S1 (SET) changes the selection. The setting displayed when the screen is exited will be retained. Pressing MORE again brings up the SETUP 3 screen, which allows a choice of displaying forward power in strip-chart form, or in dBm or watts. Pressing MORE again brings up SETUP 4, which allows a choice of dBm or watts for displaying reflected power. Pressing MORE again brings up SETUP 5, 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 6 allows the IEEE-488 address to be set. Pressing 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.

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 deactivate Sleep Mode: 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.

Warnings Screens - From MENU 3, S1 (labeled WARNINGS) selects WARNINGS 1 which allows the operator to enter the maximum forward power. The existing value is between brackets[]; pressing SET puts arrows >< around the value, indicating that the adjust knob is active. The effect of the warning setpoint is as follows: if the forward power exceeds the setpoint, the audible alarm will sound (if configured in SETUP 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 reverse power level is set. Note that these are warning levels at which the beep sounds; the actual maximum reverse 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 which 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 fault, refer to Table 5. 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. Most faults turn HV off. Faults that do not turn off HV are specified in Table 5. When such faults are cleared, the system will automatically resume the standby state and users may again select the Operate mode.

Some faults (EXTERNAL INHIBIT) will turn off the grid of the tubes to disable RF output while the fault is being displayed on the screen. HV will remain on during these faults. Once the fault is corrected, the fault will clear and the system will turn RF back on automatically. This automatic return to operation is provided for selected faults due to influences external to the TWTA.

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

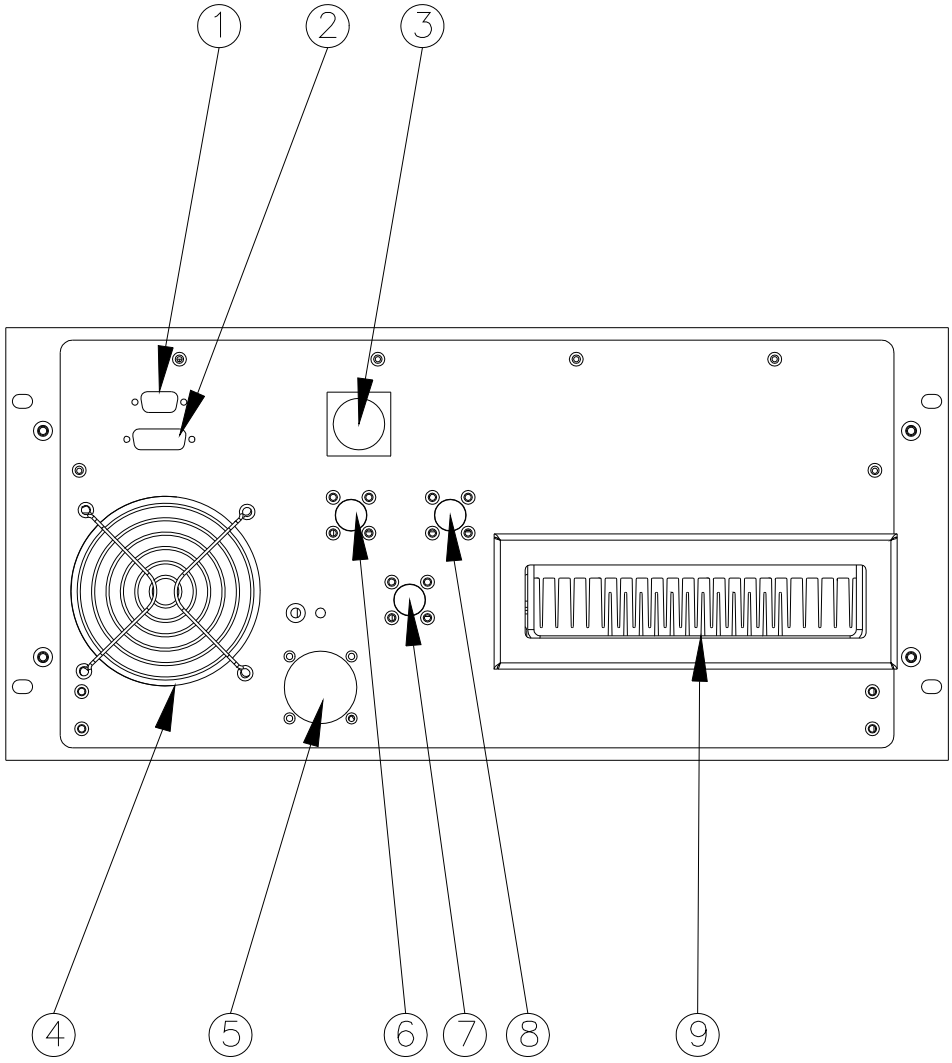


Figure 3-3. Rear Panel Features

Table 3-2. TWTA Rear Panel Features

Label	Title	Function
1	EXTERNAL INTERLOCK	Connector to remote temperature switch protecting the isolator or load; D-sub 15-pin female
2	REMOTE INTERFACE	Remote control connector. 24 pin hermaphrodite
3	RF OUT	Type 7-16 DIN female coaxial connector flange.
4	EXHAUST FAN	Cooling air outlet.
5	AC IN	AC power input cable. 190-260VAC, single phase, 50/60 Hz
6	FORWARD SAMPLE	RF forward sample (Type N, female)
7	RF INPUT	RF input connector Type N, female
8	REVERSE SAMPLE	RF reverse sample (Type N, female)
9	AIR FILTER	Cooling air intake.

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. Set RF generator level below -50dBm and set desired frequency in specified range. Connect a load suitable for 1500 watts continuous operation to the RF output connector. The load VSWR should be less than 2.0:1 A power meter and suitable attenuators may be connected to the RF sample port. (Refer to RF sample port calibration factors on the rear of the unit or on the *Info* screen in MENU 2). These show the relation between the amplifier output power and the RF sample port power as a function of frequency.

Set keylock to LOCAL.

Switch on the circuit breakers on the two power supplies. Switch on the MAIN POWER circuit breaker. The fans 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.

CAUTION:

Do not allow the TWTA to remain in the STANDBY state for extended periods of time. If the TWTA will not be used in the OPERATE state within an hour, shut the TWTA off or activate the Sleep Mode to have continued remote GPIB access. The reason for this precaution is that in the STANDBY mode, the TWTs' cathodes run very hot since they are not cooled by electrons boiling off the surface, and small amounts of out-gassing are not cleaned up by the electron beam. *Extended operation in the standby state can result in irreparable damage to TWTs!*

Push S4 (MORE) three times to go to MENU 4. Verify that the heater voltage and current for TWT #1 are near their nominal levels. Press MORE again to view MENU5 and verify the values for TWT #2. The values of these parameters at the time the TWTA left the factory are logged on the test data sheet.

Push the OPERATE pushbutton. 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 near 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 0dBm to reach the desired FWD PWR on the display and power meter (connected to forward sample port). The forward power indication will become active, with maximum value 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 0dBm (Input drive above +13dBm may damage the unit). The reverse 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 0dBm 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 current with no drive and with 1000 watts RF output mid-band are logged on the test data sheet. The value of the helix current is a good qualitative indicator that RF drive is present.

To shut the system down, turn down the RF generator level below -50dBm and press STANDBY. Allow the TWTA to cool down until the TWT temperatures drops below 50°C, then turn off main power

3.7 REMOTE IEEE-488 OPERATION

The TWTA is provided with an IEEE-488 interface that 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		
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)		
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	TWTHPA1F=[ ]F
RDTMPTWTC	Returns TWT temp (°C)	°C	TWTHPA1C=[ ]C
RDTMPPSF	Returns power supply temp (°F)	°F	PSHPA1F=[ ]F
RDTMPPSC	Returns power supply temp (°C)	°C	PSHPA1C=[ ]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
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 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

Command	Function	Units	Response format
RDPRD	Returns reverse power out (dBm)	dBm	Pr=[ ]dBm
RDPRW	Returns reverse 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 reverse power warning setpoint (dB)	dBm	Prhi=[ ]dBm
SPPRHID	Sets over reverse power warning setpoint (dBm)	dBm	
RDPRHIW	Returns over reverse power warning setpoint (W)	watts	Prhi=[ ]W
SPRHIW	Sets over reverse power warning setpoint (W)	watts	
*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.
1	Last command 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.
60	Command not allowed
901	Assert error: invalid table argument *
902	Assert error: invalid table argument *

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

Table 3-5. Catalog of Fault Codes

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

Fault Code	Meaning
0	No fault
40	FIL NOT READY
41	LOW LINE1
42	CATH O/VOLTAGE
43	BODY O/CURRENT
44	CATH U/VOLTAGE
47	COLL U/VOLTAGE
48	INVERTER FAULT
49	INTERLK OPEN
50	TUBE ARC
51	TWT OVER TEMP(h)
52	CABINET O/TEMP(h)
54	EXTERNAL INHIBIT
55	OVER REV POWER
58	PANEL OPEN
59	LATCHED FAULT

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	Power supply off or failed
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.

<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 for the units.

If remote is not enabled, set commands and commands to the system logic (i. e., OPERATE;, 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 5.6. 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 users 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.

3.8 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 Amplifier Research 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 who obtains 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 not the cathode). 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 becomes 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.

4. MAINTENANCE

The TWTA requires a minimum of routine maintenance**.** The only moving parts are the elements of switches, relays and blowers. Preventive maintenance is recommended in Paragraph 4.3.

In the event that the TWTA needs repairs, it is recommended that the unit be returned to the factory. However, some user service organizations may choose to perform their own preventive maintenance, and under some circumstances returning the unit to the factory may be impractical. The highly modular construction of the TWTA facilitates troubleshooting to the level of readily replaced subassemblies. Section 5 provides partial technical documentation to support field repairs. Nevertheless, the factory or its service representative should be contacted before undertaking repair work on these TWTAs. **Warnings and Cautions must 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, power supply voltages and currents, and system temperatures of the TWTA should be logged on a regular basis. Maintenance should be performed if significant deviations from the logged values appear. For a unit still under warranty, contact an authorized service representative if impaired performance is suspected.

The air intake filters are the only items that require routine service. The frequency of service depends on the environment where the TWTA is used, and must be determined by inspection

If there is accumulated dust on any of the air intake filters, remove them and clean them with dry compressed air. If the filters show signs of deterioration, purchase replacement units.

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

Remove the power supply subassembly from the rack as follows:

NOTE: Due to the weight in excess of fifty pounds, the removal of some of the amplifier's units from the cabinet is a two person operation.

1. Disconnect power. Remove any other cables. On the front of the unit, remove the four screws (two outside screws on each side) mounting the front panel to the cabinet. Carefully slide the unit out of the front of the cabinet. Depress the buttons on each slide rail to remove the unit from the rack
2. Remove the screws that secure the upper and lower covers. Remove the covers to gain access to the interior of the unit.
3. Vacuum dust and debris from inside the enclosure. Clean dust from the power supply high voltage leads. Remove any dirt from around the high voltage connectors. While the cover is off, check for loose wires, components or fasteners.
4. Reassemble in reverse order. Reconnect rear panel cables.

CAUTION:

Be especially careful with type SMA RF connectors, which are fragile and easily damaged when incorrectly aligned during the assembly process.

4.4 TROUBLESHOOTING

Symptom	Possible cause
TWT or power supply overtemperature	Air inlet filter(s) dirty
	Collector heat sink dirty
	Inadequate clearance behind TWTA
	High air inlet temperature
	Defective fan or blower
No response when main power turned on	Disconnected power cable
	Defective circuit breaker
Control module display does not come up; unit does not beep when powered up	Shorted or defective control module power supply
Control module does not boot	Internal fiber optic cable defective
	Control head PC board defective
Control module "datalink failure" error appears	HPA interface failure.
	Data steering board failure
	Fiberoptic link failure
	Fiberoptic converter board failure
Heater power supply does not come up	Defective low voltage power supply module
	Defective heater power supply module
No high voltage	Keylock switch on **INHIBIT** or **REMOTE**
	Defective high voltage power supply.
Voltages normal, but no RF output, helix current low	No RF input
	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 or loose connectors and internally for unmated or loose parts**.**

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

4.5 NON-REPAIRABLE MODULES

The Heater power supply (A27840-011), the HV filter (A21458-011), and the HV rectifier (A28273-001) are encapsulated modules and are not repairable. Contact an authorized service representative if replacement modules are needed.

5. 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

Item Number	Item Description	Qty	Ref Des
A38001-100	HPA, 93PL, 1-1.5 GHZ, SINGLE PHASE, IEEE-488, WITH KEYLOCK		
10-38001-100	HPA, 93PL	0	
14-38001-100	ATP, 93PL	0	
15-38001-100	SPEC, 93PL	0	
80-38001-000	PACKAGE OUTLINE 93PL	0	
85-27500-000	BLUE BOOK, AR PULSED UNIT	1	
91-91205-01202	93PL,PS	0	
A23692-000	INSULATED FAN DRIVER	1	A6
A25444-001	HPA INTERFACE BOARD (200UM GLASS FIBERS)	1	A3
A26946-001	CONTROL HEAD ENCLOSURE,IEEE-488.	1	A4
A27502-932	MICROWAVE POWER ASSY, 93PL, FWD AND REV SAMPLE	1	A2
A30137-002	FRONT PANEL ASSY, 93PL (AR)	1	A5
A30740-931	HPA WIRING KIT, IEEE-488, 93PL	1	A9
A30750-000	PULSE MONITOR BOARD	1	A13
A33072-002	PULSED TWT PS FOR PITOW L113A, 93PL	1	A1
A33182-002	CABINET ASSY 93PL, AR	1	

5.2 SCHEMATICS

10-16485-000	HPA Logic and Control (A23050-210)
10-25444-001	HPA Interface Board (A25444-001)
10-38001-100	93PL Schematogram

5.3 PARTS LISTS

A16485-000	HPA Logic and Control Module
A25444-001	HPA interface Board
A33072-002	HV Power Supply
A27502-932	Microwave Power Assembly

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

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
	B16485-000	LOGIC & CONTROL BOARD	2
C48, C49	C06103-000	CAP, 10MF, +/-20%, 25V, SOLID TANT, RADIAL [KEMET T356E106K025AS]	4
C11	C16333-000	CAP,33MF,25V,AERL,(NICHICON UVX1E330M)	2
C47	C17104-000	CAP,100MF,50V,AERL,(NICHICON, UVRIJIOIMPD)	2
C2, C5, C15, C41	C31028-000	CAP,1000PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION)	8
C3, C9, C13, C14, C17, C19, C21, C22, C23, C27, C28, C29, C30, C31, C33, C36, C46	C31032-000	CAP,0.01MF,200VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	34
C10, C24, C101	C31036-000	CAP,0.1MF,100VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	6
C1, C4, C6, C7, C16, C18, C25, C26, C32, C34, C37, C38, C39, C40, C43, C44, C45, C50	C31040-000	CAP,1MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	36
C100	C31065-000	CAP,2.7MF,50V,10%,CER,1% FAILURE,(KEMET CSR13G275KM)	2
D16, D23, D31	D10965-000	ZENER,15V,(FAIRCHILD SEMICONDUCTOR, 1N965B)	6
D1, D3, D4, D5, D7, D8, D9, D10, D11, D12, D13, D17, D18, D19, D20, D21, D22, D25, D26, D28, D30, D33, D35, D37, D38, D40	D14454-000	DIODE,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4454)	52
D32	D14728-000	ZENER,3.3V,1W,10%,AXIAL,(MOTOROLA 1N4728)	2
D36	D14733-000	ZENER,5.1V,1W,10%,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4733A)	2
	F00101-000	WASHER,#4 NAS,(PRO-STAINLESS NAS620C4)	8
	F00107-000	#4 SPLIT LOCK WASHER,SST	4
	F31004-000	NUT,4-40,HX,SMALL PATTERN,MIL-SPEC	4
	G00043-000	HEX STANDOFF ,4-40 THREAD SS,FOR D SUBMIN CONN (PRO STAINLESS, 620013)	4
J2	J10370-000	CONN,37 PIN,MALE,D-SUB,PCB RIGHT ANGLE, (AMP, 747252-4)	2
J7	J12294-000	CONN RIGHT ANGLE MALE 29 PIN,(SAME AS J12291 W/NO MODIF),(HYPERTRONIC KA29/127BPMC10T,&HARDWARE	2
J4, J5	J18086-000	CONN,,SMA,JACK RECEPTACLE,RIGHT ANGLE,0-18GHZ,PC MOUNT [JOHNSON COMPONENTS 142-0701-301]	4
L1	L00200-000	WIDE BAND CHOKE,(VK200 10/3B FERROXCUBE)	2
	N23061-000	MODULE CHASSIS LOGIC	2
Q2	Q22907-000	TRANSISTOR,PNP, (ST, 2N2907A) TO-18	2
R1, R9, R19, R37, R44, R50	R00100-000	RES,10 OHM,1/4W,5%,CC,(OHMITE, OD100JE)	12
R4, R20, R27, R29, R39	R01100-000	RES,100 OHM,1/4W,5%,CC,(OHMITE, OD101JE)	10
R5, R7, R17, R18, R28, R34, R49, R53, R59, R71, R72, R87	R02100-000	RES,1K,1/4W,5%,CC,(OHMITE, OD102JE)	24
R12	R02150-000	RES,1.5K,1/4W,5%,CC,(A/B RC07GF152J)	2
R110	R02200-000	RES,2K,1/4W,5%,CC,(A/B RC07GF202J)	2
R6	R02270-000	RES,2.7K,1/4W,5%,CC,(OHMITE, OD272JE)	2
R43	R02330-000	RES,3.3K,1/4W,5%,CC,(A/B RC07GF332J)	2

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
R30, R31, R36	R02470-000	RES,4.7K,1/4W,5%,CC,(OHMITE, OD472JE)	6
R45	R03100-000	RES,10K,1/4W,5%,CC,(OHMITE, OD103JE)	2
R35	R05820-000	RES,8.2M,1/4W,5%,CC,(OHMITE, OD825JE)	2
R100	R21100-000	RES,1K, 1%,MF,100PPM,(DALE RN55D1001F)	2
R23	R21110-000	RES,1.1K, 1%,MF,100PPM,(DALE RN55D)	2
R67	R21402-000	RES,4.02K, 1%,MF,100PPM,(DALE RN55D)	2
R10	R21412-000	RES,4.12K, 1%,MF,100PPM,(DALE RN55D4121F)	2
R24	R21464-000	RES,4.64K, 1%,MF,100PPM,(DALE RN55D4641F)	2
R38	R21523-000	RES,5.23K, 1%,MF,100PPM,(DALE RN55D)	2
R52, R73	R21887-000	RES,8.87K, 1%,MF,100PPM,(DALE RN55D)	4
R75	R21990-000	RES,9.76K, 1%,MF,100PPM,(DALE RN55D9761F)	2
R98	R22105-000	RES,10.5K, 1%,MF,100PPM,(DALE RN55D1052F)	2
R102	R22499-000	RES,49.9K, 1%,MF,100PPM,(DALE RN55D4992F)	2
R42, R47, R48, R60, R61, R74, R101	R23100-000	RES,100K, 1%,MF,100PPM,(DALE RN55D1003F)	14
R54	R23169-000	RES,169K,1%,MF,100PPM,(DALE, RN55D)	2
R41	R23255-000	RES,255K, 1%,MF,100PPM,(DALE RN55D2553F)	2
R40	R23270-000	RES,270K, 1%,MF,100PPM,(DALE RN55D)	2
R55, R46	R23698-000	RES,698K, 1%,MF,100PPM,(DALE RN55D6983FB14)	4
R66	R23953-000	RES,953K, 1%,MF,100PPM,(DALE RN55D9533F)	2
R21	R24124-000	RES,1.24M, 1%,MF,100PPM,[DALE RN55D]	2
R33	R24200-000	RES,2M, 1%,MF,100PPM,(DALE RN55D)	2
R62	R30035-000	RES,10K, 1%,MF,100PPM,(DALE RN55D1002F)	2
R32	R31091-000	RES,47K,1/4W,5%,CC,<=1% FAIL,(A/B RCR07)	2
R11	R32004-000	TRIMPOT,1K,1/2W,10%,CERMET,20T,SIDE ADJ,(BI TECHNOLOGIES, 67XR1KLF)	2
R13, R14	R32049-000	TRIMPOT,5K,1/2W,10%,CERMET,20T,SIDE ADJ,(BI TECHNOLOGIES, 67XR5KLF)	4
U4, U5, U6	U02390-000	IC,QUAD COMPARATOR,(NAT LM139J)	6
U7	U03240-000	IC,LOW POWER OP AMP,(NAT LM324)	2
U9	U10070-000	REFERENCE,PRECISION 10V [LINEAR TECH LT1031DCH]	2
U8	U17805-000	IC,5V REGULATOR,TO-220,(NAT LM340T-5.0)	2
U1, U2, U3	U20148-000	IC,HEX INVERTER,SCHMIDTT TRIGGER,(74HC14) (SSD)	6
RP4, RP8	U30106-000	IC,10K,RES NETWORK,6 PIN,SIP (DALE MSP06A-01-103G)	4
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)	12
	W12803-000	WIRE,SOLID,TEFLON,28 AWG,250V,(ALPHA 2842/1-GREEN)	2

5.3.2 Parts List, HPA Interface Board (200UM Glass Fibers), A25444-001

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
U15	A31346-000	DAC REPLACEMENT BOARD FOR U00725. DUAL CHANNEL	2
	B25444-000	HPA INTERFACE BOARD	2
C161	C03105-000	CAP, 0.01MF, +/-10%, 100V, CER, RADIAL [AVX SR201C103KAA]	2
C171	C04223-000	CAP, 0.22MF, +/-10%, 35V, TANT, RADIAL [JAMCO 33507]	2
C20, C32, C100	C05153-000	CAP, 1.5MF, 35V, TANT, RADIAL [AVAX, TAP155K035SCS]	8
C129, C163	C05223-000	CAP ,2.2MF, +/-10%, 35V, SOLID SEALED TANT, RADIAL [SPRAGUE 199D225X9035BA1]	4
C80, C81, C164	C06103-000	CAP, 10MF, +/-20%, 25V, SOLID TANT, RADIAL [KEMET T356E106K025AS]	6
C15	C06220-000	CAP, 22MF, +/-10%, 16V, SOLID TANT, RADIAL [AVX TAP226K016SCS]	2
C99	C16103-000	CAP,10MF,35V,AERL,(NICHICON UVR1V100MDA)	2
C101	C17472-000	CAP,470MF,16V,AERL,(NICHICON UVX1C471M)	2
C47, C67	C17474-000	CAP,470UF,50V,AERL,[PANASONIC P5279]	4
C44	C30066-000	CAP 47 MF, 35V, SOLID TANT. RADIAL, (KEMET T356M476K035AS)	2
C6, C7, C9, C13, C16, C39, C43, C69, C165, C166	C31016-000	CAP,100PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION)	20
1, 2, 3, 4, 5, 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,	C31036-000	CAP,0.1MF,100VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	122
C12, C14, C17, C18, C19, C21, C27, C29, C31, C34, C36, C38, C45, C46, C52, C54, C55, C56, C57, C58, C59, C60, C61, C66, C68, C7	C31040-000	CAP,1MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION)	90
D8, D10, D12, D14, D15, D16, D18, D19	D14007-000	DIODE,1000V,1A,AXIAL,(DIODES, INC. 1N4007)	16
D1-D7	D14454-000	DIODE,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4454)	14
D9, D17	D14733-000	ZENER,5.1V,1W,10%,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4733A)	4
I1	I10074-000	LED,GREEN,ALGAAS,NON-DIFFUSED,(HLMP1540)	2
J5	J10021-000	HEADER,2 PIN,MALE,RIGHT ANGLE,SERIES 7478 (MOLEX 22-05-3021)	2
J1	J10371-000	D-SUB,37 PIN MALE,PCB MOUNT,STRAIGHT (POSITRONICS MD37M3S000)	2
XU17	J14161-000	SKT,DIP,16 PIN,MACH SLEEVES,(AUGAT 516-AG11D)	2
XU26	J14202-000	SKT,DIP,20 PIN,MACH SLEEVES,(SAMTEC ICA-320-SGT)	2
XU15	J14281-000	SKT,DIP,28 PIN,MACH SLEEVES,(SAMTEC ICA-628-SGT)	2
TP0	J16210-000	TEST JACK,BLACK,VERTICAL,(EF JOHNSON 105-0853-001)	2
TP1	J16211-000	TEST JACK,BROWN,VERTICAL,(EF JOHNSON 105-0858-001)	2
TP2	J16212-000	TEST JACK,RED,VERTICAL,(EF JOHNSON 105-0852-001)	2
TP3	J16213-000	TEST JACK,ORANGE,VERTICAL,(EF JOHNSON 105-0856-001)	2
TP4	J16214-000	TEST JACK,YELLOW,VERTICAL,(EF JOHNSON 105-0857-001)	2
TP5	J16215-000	TEST JACK,GREEN,VERTICAL,(EF JOHNSON 105-0854-001)	2

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
J3	J18180-000	CONN,D-SUB,15 PIN,MALE,STRAIGHT,PCB MOUNT (POSITRONIC MD15M3000)	2
J2	J18181-000	D-SUB 25 PIN MALE,PCB MOUNT STRAIGHT,(POSITRONIC MD25M30000)	2
J4	J18183-000	D-SUB,37 PIN FEMALE,PCB MOUNT,STRAIGHT,(POSITRONIC MD37F3000)	2
XJ1-XJ4	J31014-000	SPRING LATCH KIT,D-SUB,(AMPHENOL 17-529)	8
K1-K6	K02009-000	RELAY,DPDT,5VDC,125V @ 0.5A / 30VDC @ 1A CONTACTS,PCB TERMINALS,SEALED (OMRON G6H-2-DC5)	12
L1-L4	L00200-000	WIDE BAND CHOKE,(VK200 10/3B FERROXCUBE)	8
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8	Q22222-000	TRANSISTOR,NPN, (ST, 2N2222A) TO-18	16
R41	R00680-000	RES,68 OHM,1/4W,5%,CC,(A/B RC07GF680J)	2
R2	R01220-000	RES,220 OHM,1/4W,5%,CC,(OHMITE, OD221JE)	2
R1	R04200-000	RES,200K,1/4W,5%,CC,(A/B RC07GF204J)	2
R6, R8, R58	R20100-000	RES,100 OHM, 1%,MF,50PPM,(DALE RN55C1000F)	6
R57	R20200-000	RES,200 OHM, 1%,MF,100PPM,(DALE RN55D)	2
R59	R22332-000	RES,33.2K, 1%,MF,100PPM,(DALE RN55D)	2
R4, R7	R23100-000	RES,100K, 1%,MF,100PPM,(DALE RN55D1003F)	4
R3, R5	R30071-000	TRIMPOT,10K,1/2W,10%,CERMET,100PPM,20T,TOP ADJ,(BI TECNOLOGIES, 67WR10KLF)	4
R9, R12, R15, R22, R35, R40, R44	R30103-000	RES,10K,1/8W,1%,MF,AXIAL,50PPM,(DALE RN50C1002F)	14
R17, R18, R19, R20, R21, R23, R25, R28, R31, R42, R43, R46	R30140-000	RES,1K,1/8W,1%,MF,50PPM,(DALE RN50C1001F)	24
R13, R14, R24, R26, R27, R29, R32, R37, R38, R39, R47, R100	R31164-000	RES,100K,1/20W,1%,FILM,AXIAL,50PPM,MIL,(DALE RN50C1003F)	24
U7, U8	U00027-000	IC,ULTRA LOW NOISE PRECISION OP AMP,(ANALOG DEVICES OP27GP)	4
U26	U00029-000	CONVERTER,NO OIL,16BIT,A TO D,SERIAL OUT,[BURR-BROWN ADS7809PB,PB],[ANALOG DEVICES AD977CN]	2
U17	U00524-000	IC,INSTRUMENTATION AMP,(ANALOG DEVICES AD524A) (SSD)	2
U9, U10, U18	U04090-000	IC,4CH ANALOG MULTIPLEXER,(DATEL MXD-409)	6
DP2, DP4, DP5, DP8, DP9	U08010-000	IC,8 COMMON CATHODE CLAMPING DIODES,9 PIN SIP,(ROHM DAN801)	10
DP1, DP3, DP6, DP7, DP10	U08011-000	IC,8 COMMON ANODE CLAMPING DIODES,9PIN SIP,(ROHM DAP801)	10
U27	U11165-000	IC,6.5536MHZ CLOCK OSCILLATOR,1/2 SIZE,(ECLIPTEK EC1100HS-6.5536MHZ) (SSD)	2
U40	U11528-000	IC,VERSALINK TRANSMITTER,HORIZONTAL, (200UM FIBER) (HFBR-1528)	2
U54	U12521-000	IC,FIBER OPTIC RECEIVER,HORIZONTAL,(HFBR-2521) (SSD)	2
U36	U17545-000	DRIVER,OIL,DS75451N,DUAL AND,[TI, SN:75451BP)	2
U6, U19, U34, U39, U60	U20148-000	IC,HEX INVERTER,SCHMIDTT TRIGGER,(74HC14) (SSD)	10
U42	U20738-000	IC,DUAL J-K FLIP-FLOP W/RESET, (NXD SEMI-CONDUCTORS, 74HC73N)	2
U51	U21328-000	IC,QUAD 2 INPUT NAND,SCHMIDTT TRIGGER,(74HC132) (SSD)	2
U52	U21388-000	IC,3 TO 8 DECODER/DEMULTIPLEXER,INVERTING,(74HC138) (SSD)	2
U32	U21536-000	IC,DUAL 4 INPUT DIGTAL MULTIPLEXER,(74F153) (SSD)	2
U35	U22598-000	IC,8 BIT ADDRESSABLE LATCH W/RESET,(74HC259) (SSD)	2
U47	U23909-000	IC,DUAL 4 BIT BINARY/BIQUINARY COUNTER (74HCT390) (SSD)	2
U41, U48	U24018-000	IC,JOHNSON DECADE COUNTER W/10 DECODED OUTPUTS,(74HC4017) (SSD)	4
U45	U24138-000	IC,8 BIT BINARY DOWN COUNTER,(74HC40103) (SSD)	2

REF. DESIG.	ETM P/N	DESCRIPTION	QUANTITY
U43	U26889-000	IC,8 BIT MAGNITUDE COMPARATOR,(74HCT688) (SSD)	2
U22, U24, U57	U28008-000	IC,QUAD 2 INPUT AND,(74HC08) (SSD)	6
U4, U49, U58	U28032-000	IC,QUAD 2 INPUT OR,(74HC32) (SSD)	6
U44, U46	U28040-000	IC,12 BIT DECADE COUNTER,(74HCT4040) (SSD)	4
U5, U13, U14, U23, U25, U33, U50	U28074-000	IC,DUAL D FLIP FLOP W/RESET,(74HC74) (SSD)	14
U2	U28123-000	IC,DUAL RETRIGGERABLE 1-SHOT,(74HC123) (SSD)	2
U31, U53	U28164-000	IC,8 BIT SERIAL IN PARALLEL OUT SHIFT REGISTER,(74HC164) (SSD)	4
U3, U12, U28, U37, U38	U28165-000	IC,8 BIT PARALLEL IN SERIAL OUT SHIFT REGISTER,(74HC165) (SSD)	10
RP6	U32001-000	IC,1K FEED-THROUGH RES NETWORK,16 PIN DIP,(A/B 316B102)	2
RP1-RP5	U32103-000	IC,10K FEED-THROUGH RES NETWORK,16 PIN DIP, [BOURNS 4116R-1-103LF]	10
U56	U40008-000	REGULATOR,OIL,5V,100MA,TO-92,[MOTOROLA MC78L05ABP]	2
U55	U40012-000	FLIP-FLOP,OCTAL D-TYPE LATCH WITH RESET,[NATIONAL MM74HC273N]	2

5.3.3 Parts List, High Voltage Power Supply, A33072-002

Item Number	Item Description	Qty	Ref Des
A33072-002	PULSED TWT PS FOR PITOW L113A, 93PL		
A16485-000	HPA LOGIC AND CONTROL MODULE	1	A3
A16487-382	POWER BOARD ASSEMBLY,PULSED TWTA	1	A5
A21458-011	HV FILTER FOR 93PL & 73PL WITH ADDITIONAL CONNECTORS		
A21458-014	CAPACITOR BANK FOR 93PL (AR)	1	A12
A21459-093	PWM BD FOR PITOW L113A	1	A10
A22498-016	HPA HEAT SINK/MOTHER BOARD 1.6KW 3KV (FOR P1102)	1	A1
A23683-100	POWER FACTOR MODULE (500W)	1	A4
A23687-150	LOW VOLTAGE POWER SUPPLY MODULE, AC INPUT 230VAC, 50/60HZ, 200W	1	A2
A25398-022	FACTORY SELECT, 13PL	1	A11
A27840-011	HEATER 9V 4A	1	A9
A28273-001	H.V. RECTIFIER FOR 73PL 93PL	1	A6
A31127-001	MODULATOR MOTHER BOARD ASSEMBLY- TRANSVERSE FINS	1	A15
A33076-001	PULSE TOP SWITCH MODULE, 0 - 700V PT, SAME AS -001 WITH 1K INPUT Z	1	A13
A33077-000	BIAS MODULE	1	A14

5.3.4 Parts List, Microwave Power Assembly A27502-932

Item Number	Item Description	Qty	Ref Des
A27502-932	MICROWAVE POWER ASSY, 93PL, FWD AND REV SAMPLE		
E00888-015	CABLE,RF FLEX,15,SMA,M TO M,20 GHZ,50 OHM,0.141 CABLE, [SRC 150-150-150150]	1	W1
E00888-024	CABLE,RF FLEX,24,SMA,MALE TO MALE,20 GHZ,50 OHM, (SRC, 150-150-150240)	1	W2
E02576-000	TWT, 1.0-1.5 GHZ, 10KW, 1% DUTY, [PITOW, L113A]	1	A2
E02588-000	SSPA, 1.0-1.5GHZ, 46DBM, 49DB GAIN (KMIC TBD)	1	A1
E02609-000	HIGH POWER COAXIAL CABLE,20.0LONG,SC-SP/N-SP,(MALIK CABLE DEVICES, CA-SCPS020.0NPS012]	1	W5
E03088-000	COUPLER, 2000W, 0.8 - 2.5 GHZ, SC-F IN, 7-16-F OUT, [RLC, M-4150]	1	A3
E20066-000	ATTENUATOR,10DB,2W,DC-18GHZ,SUB-MINATURE,(INMET, 18A-10)	3	A7-A9
E20130-000	ADAPTER,SMA MALE TO SMA FEMALE,RIGHT ANGLE (SST FINISH))	4	
E20145-316	LOW PASS FILTER, 1.5 GHZ, SMA, [MICROLAB, FXR LA15F]	3	A10-A12
E20284-000	ZERO-BIAS SCHOTTKY DETECTOR,10MHZ-18.5GHZ,POSITIVE OUT PUT POLARITY,(RLC, M-3747)	2	D1, D2
E20288-000	DIRECTIONAL COUPLER,0.5-2.0 GHZ,-10DB,(MAC TECHNOLOGY C2023-10)	2	A5, A6

5.4 RECOMMENDED SPARE PARTS

A27840-011	Heater Supply, Hi Power
A21458-011	HV Filter
A28273-001	HV Rectifier
A16487-382	Power Inverter Module
A21459-093	PWM Board
A23687-150	Low Voltage Power Supply Module

5.5 SAMPLE PROGRAM FOR IEEE-488 COMMUNICATION

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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  END
```

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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