rf/microwave instrumentation

# Operating and Service Manual

6900TP2G4M1

Model

10027888

Part Number

Serial Number

160 School House Road, Souderton, PA 18964 • 215-723-8181 • Fax 215-723-5688 • www.ar-worldwide.com

rf/microwave instrumentation

# *EC Declaration of Conformity*

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

declare that our product;

the Model 6900TP2G4

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
President

# INSTRUCTIONS FOR SAFE OPERATION

## BEFORE APPLYING POWER

**Review this manual and become familiar with all safety markings and instructions.**

**Verify that the equipment line voltage selection is compatible with the main power source.**

**Protection provided by the equipment may be impaired if used in a manner not specified by Amplifier Research.**

## INTENDED PURPOSES

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

## HAZARDOUS RF VOLTAGES

The RF voltages on the center pin of the RF output connector can be hazardous. The RF output connector should be connected to a load before AC power is applied to the amplifier. 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.

## SAFETY GROUND

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

## PHYSICAL DAMAGE

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

## 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.

## SAFETY SYMBOLS

This symbol is marked on the equipment when it is necessary for the user to refer to the manual for important safety information.

Dangerous voltages are present. Use extreme care.

**CAUTION**: The caution symbol denotes a potential hazard. Attention must be given to the statement to prevent damage, destruction, or harm.

Indicates protective earth terminal.

## RANGE OF ENVIRONMENTAL CONDITIONS

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 auto ranging 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.

## COOLING AIR

Care should be exercised not to block the cooling air inlets or outlets. Cooling air blockage can result in damage to the RF amplifier or intermittent shut-downs.

# 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.**

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**FIGURES**



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# 1. DESCRIPTION AND SPECIFICATIONS

**This manual provides operating, interfacing and selected service information pertinent to AR Model 6900TP2G4 Broadband Microwave Amplifier. This Model is a 6900 watt broadband S-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 these units.**

## 1.1 TWTA DESCRIPTION

The amplifier uses two power-combined broadband traveling-wave tubes (TWTs) to provide 6900 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 or bench top use. The front panel of the rack mountable amplifier is 17.5 inches (10U) high, and the overall unit is 35.5 inches deep, including the rear-panel connectors and vent housing. For bench top use, the amplifier is supplied in an enclosure with integral carrying handles.

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

## 1.2 SUGGESTED APPLICATIONS

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

## 1.3 SPECIFICATIONS

Refer to the AR Data Sheet at the end of this section for detailed specifications.

## 1.4 ACCESSORIES

AR 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 6900TP2G4, M1 through M11 6900 Watt Pulse Amplifier 2–4 GHz

The Model 6900TP2G4 is a self contained, forced air cooled, broadband traveling wave tube (TWT) microwave amplifier system designed for pulse applications at low to moderate duty factors where instantaneous bandwidth and high gain are required. Reliable TWT subsystems provide a conservative 6900 watts minimum peak RF pulse power at the amplifier output connector. Stated power specifications are at the fundamental frequency.

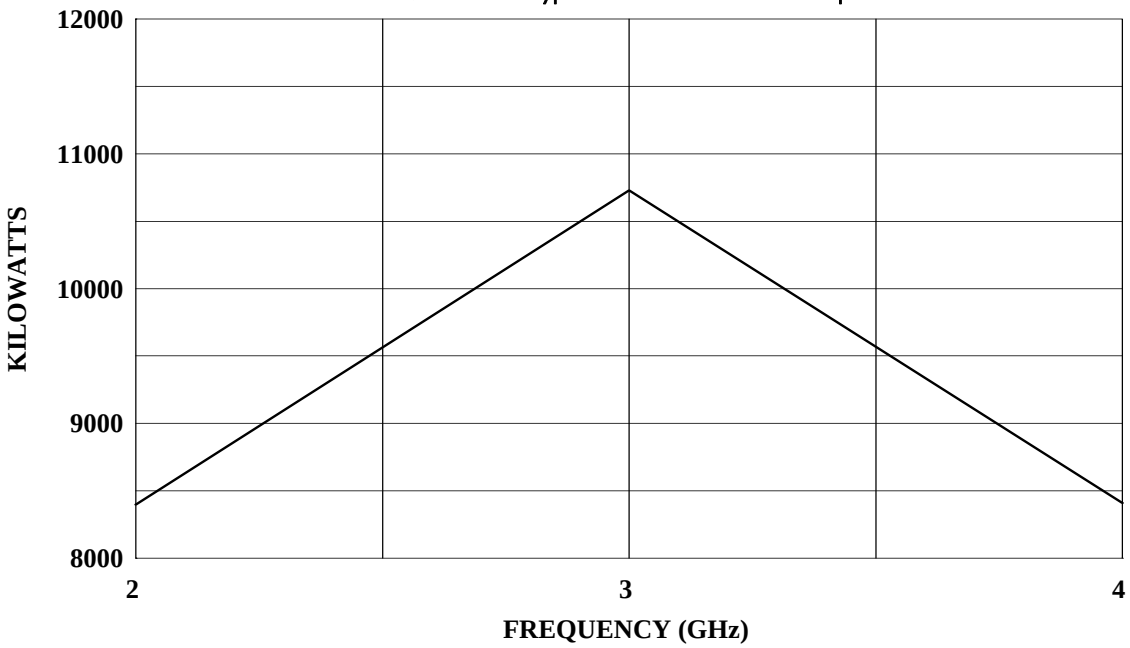
The amplifier's front panel digital display shows forward and reflected average power output or forward and reflected peak power, plus extensive system status information accessed through a series of menus via soft keys. Status indicators include power on, warm-up, standby, operate, faults, excess average 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.

The rated power is developed by efficiently power combining the outputs from two 4500 watts (nominal) pulse TWTs that are factory matched in gain and phase, resulting in an excellent combination of wide instantaneous bandwidth with improved harmonic levels.

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 prime power selection.

Model 6900TP2G4 Typical Peak Pulse Power Output



## SPECIFICATIONS, MODEL 6900TP2G4

| | |
|---|---|
| POWER (Fundamental), Peak Pulse, @ Output | |
| Nominal | 9000 watts |
| Minimum | 6900 watts |
| FLATNESS | ±8 dB maximum, ±4 dB at rated power |
| FREQUENCY RESPONSE | 2-4 GHz |
| INPUT FOR RATED OUTPUT | 1.0 milliwatt maximum |
| GAIN (at maximum setting) | 68 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 4000 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 | 0.2 – 50 microseconds. |
| Pulse Rate (PRF) | 100 kHz maximum |
| Duty Cycle | 4% maximum. |
| RF Rise and Fall | 35 ns max (10% to 90%). |
| Delay | 300 ns maximum from pulse input to RF 90% |
| Pulse Width Distortion | ±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 84 dBm/Hz (typical) |
| (pulse off) | Minus 140 dBm/Hz (typical) |
| HARMONIC DISTORTION | Minus 15 dBc maximum |
| PRIMARY POWER | See Model Configurations |
| CONNECTORS | |
| RF input | Type N female on rear panel |
| RF output | Type DIN 7-16 female on rear panel |
| RF output sample ports (forward and reflected) | 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 43 x 84 cm, 19.8 x 17 x 33 in |
| WEIGHT (approximate) | 121 kg, 265 lbs |

## MODEL CONFIGURATIONS, MODEL 6900TP2G4

**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 40 (9U) x 76 cm, 19 x 15.75 (9U) x 30 in., Subtract approximately 16 kg, 35 lbs, for removal of outer enclosure.

**E2S** **Slides:** slides installed, add approximately 5 kg, 10 lbs.

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

**P** **Prime Power:** Must select one primary power from the following [P1 or P2]

**P1** **208V, US:** 208 VAC ± 10%, 3 phase, delta (4 wire) 50/60 Hz, 5 KVA maximum

**P2** **400V, Europe:** 360-435 VAC, 3 phase, WYE (5 wire) 50/60 Hz, 5 KVA maximum. CE marked to comply with EMC European Directive 89/336/EEC for operation inside a shielded room.

| Model No. | Features | |
|---|---|---|
| | E | P |
| 6900TP2G4 | Base model | P1 |
| M1 | E1C | P1 |
| M2 | E3H | P1 |
| M3 | E1C & E3H | P1 |
| M4 | E1C & E2S | P1 |
| M5 | E1C & E2S & E3H | P1 |
| M6 | – | P2 |
| M7 | E1C | P2 |
| M8 | E3H | P2 |
| M9 | E1C & E3H | P2 |
| M10 | E1C & E2S | P2 |
| M11 | E1C & E2S & E3H | P2 |

Model number example: Model 6900TP2G4M2 would have option E3H front pull handles installed.

# 2. THEORY OF OPERATION

## 2.1 DESIGN OF THE AMPLIFIER

The AR Model 6900TP2G4 Amplifier consists of four principal subsystems. Two of these subsystems, the microwave power assembly (A33066-001) and the power supply for MEC-3102 tube (A33068-001) 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/parts list in Section 4.7 for further information about how the TWTA is structured.

The heart of the microprocessor control system is the control head assembly (A26946-001), which consists of the CPU Board (A25450-000) and the GPIB/LINK Transceiver Board A22488-013. The microprocessor control system supervises the power supply and RF gain controls, processes operator front panel input, 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 is electrically isolated from the amplifier. Communication with the amplifier is via fiber optic links and the HPA interface assembly (A25444-001).

The TWTA packaging consists of a cabinet assembly A33318-001, a cooling system utilizing three 400Hz fans and various chassis wiring components.

## 2.2 DESCRIPTION OF THE RF ASSEMBLY

The TWT amplifier consists of two stages of RF amplification: one stage of solid state pre-amp with fixed gain (E02592-000) and a traveling-wave tube (E02594-000).

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 pre-amp via a Type SMA coaxial cable. The solid state pre-amp's output is passed thru a hybrid coupler which then connects to the RF input of the TWTs. The RF output of the TWT is a Type-SC coaxial. The output of each TWT is fed into a combiner (E03195-000) to power combine the two TWTs. The combiner has two directional couplers that are used for metering the forward and reflected power. The output of the combiner is a Type DIN 7-16 output located on the rear of the unit.

The reflected port on the directional coupler is connected to a detector diode, whose output is used for VSWR protection by the power supply logic & control module. It is also used on the machine interface board for conversion from analog to digital for use by the control head to display reflected power.

One forward port on the directional coupler is likewise connected to a detector diode, whose output is used on the machine interface board for conversion from analog to digital for use by the control head to display forward power.

The reflected port output is split using a –10dB coupler (SMA-type) and fed directly to the RF sample port on the rear panel (Type-N, normally -60dB).

Amplifier gain is determined by the fixed gain solid state pre-amp (SSPA). The emergency bypass board mounted behind the front panel is provided with a circuit for control head bypass in the event of a failure.

## 2.3 DESCRIPTION OF THE POWER SUPPLY

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

**Low Voltage Module:** AC / DC converter which generates the +15VDC/-15VDC/+5VDC needed for house-keeping.

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

**Input Filter Module:** The input filter module is a AC to DC converter. It gets power from the power source three phase 190-260V AC, and converts it to 280V DC, 3000W. It has low line ripple inrush limited and phase protection.

**Phase & Post Power Converter:** The post and phase module, consists of the following:

- Fixed frequency resonant regulator and converter
- A linear regulator (Post Regulator)

The resonant converter operates at fixed frequency of 66kHz, at a power level of 2500W. It converts the incoming 280VDC into a sine wave, using a resonant tank. (resonant inductor and capacitor). That waveform is driving the primary of the high voltage transformer which generates the cathode and collector voltages. The cathode voltage is tightly regulated by the post regulator, which compensates for the output capacitor droop during the pulse.

**High Voltage Rectifier and XFMR Module, 8kW:** This module contains the high voltage transformer and the high voltage rectifiers. The voltage waveform at the transformer primary is amplified by the transformer, and rectified by the diodes to generate the cathode and collector voltages.

**8kW High Voltage Filter:** This module contains the high voltage capacitors for the cathode and the collector voltages. This module filters the ripple from the high voltage rectifiers, monitors the cathode and collector voltages, and sends a feedback signal to the post regulator.

**Tank Module:** The tank module contains a resonant inductor. It works with resonant capacitor (in the post and phase module) together to force the current from square wave to be sine wave, and drive it into the primary of the high voltage transformer.

**Storage Capacitor Assembly:** This module contains high voltage capacitors, which store the energy needed to keep the cathode voltage well regulated during the pulse. Since the main regulator loop cannot respond during the pulse, the energy is taken from the caps, and the post regulator compensates for the capacitors droop, to keep the cathode tightly regulated.

The Heater Power Supply Module powers the TWT DC heater. It uses +15VDC input and provides isolated –6.3 VDC at cathode potential.

The Grid Module controls whether the TWT is ON or OFF. It generates two floating voltages at cathode potential (one positive with respect to cathode= TWT ON, and one negative with respect to cathode =TWT OFF). It switches its output between those voltages, at a rate of up to 20kHz, controlled by the TTL drive at its input.

Interconnects between the power supply modules are through a motherboard. It is installed in a finned heat sink assembly to which the modules are bolted. The incoming cabinet air, boosted by a 400Hz fan, cools the heat sink.

## 2.4 DESCRIPTION OF ELECTRONIC CROWBAR

Because the charge in the Cathode voltage capacitor storage module exceeds the maximum energy which can be safely dissipated during a TWT tube arc, the amplifier is provided with an electronic crowbar which can shunt the stored energy through a resistor network rather than through the TWT in the event of anomalous tube behavior.

Two conditions cause the electronic crowbar to fire: an "unauthorized" pulse (a pulse that occurs in the absence of a high on the pulse gate), or an "authorized" pulse accompanied by excessive helix current. An unauthorized pulse may result from a number of abnormalities, including a TWT tube arc or a modulator glitch. The high helix current condition may result from a high pulse top voltage, excessive RF drive, or a tube arc within a pulse.

The electronic crowbar system consists of two subsystems, the Pulse Monitor Board (A30750-000) and the Crowbar Driver Board (A30655-000). The Pulse Monitor Board is responsible for making the decision to fire the crowbar, and the Crowbar Driver Board contains the triggered spark gap switch and the trigger circuitry.

### 2.4.1 Pulse Monitor Board

The Pulse Monitor Board senses TWT pulses by means of a Hall-effect current sensor applied to the cathode voltage (Ek) and heater (Ef) leads to the TWTs. Any beam current in excess of half an ampere or so results in a detected pulse signal. In 3 to 5 microseconds this signal will cause a crowbar fire output from the board unless it is masked by an "authorizing" pulse.

The "authorizing" pulse is created when all the following conditions prevail:

- The crowbar driver board is charged up and ready to fire
- A pulse gate signal is received
- High voltage power supply is turned on
- RF ON is selected
- No waveguide arc is detected
- Pulse gate is not over pulse width
- Pulse gate is not overduty
- Body current is within safe limits

When all the above conditions are met, the detected beam pulse is masked, and the crowbar will not fire during the pulse.

If either over pulse width or over-duty is detected, the pulse enable signal to the modulator is interrupted and a warning is displayed on the front panel display.

### 2.4.2 Crowbar Driver Board

The Crowbar Driver Board contains the actual crowbar switch, which is a triggered gas gap between the cathode supply and ground. The gap has a self-breakdown voltage of 20KV and will not fire when cathode voltage is applied to it unless triggered by a high voltage pulse to its trigger electrode.

The driver board contains a 300 VDC supply which charges a storage capacitor. When this capacitor is fully charged, the driver board signals the logic board that it is ready to fire the crowbar.

If a crowbar fire signal is received, a triac is turned on, dumping the charge in the storage capacitor into a 30:1 step-up trigger transformer. The transformer's secondary is wired to the triggered gap trigger electrode.

When the spark gap fires, its series resistance is reduced to a few milliohms, and a large discharge current quickly dumps the energy stored in the capacitor bank. The output resistors in the cathode supply have much more impedance than the ignited spark gap, and as a result, most of the stored energy is dissipated by these resistors. The actual energy dumped into the spark gap is low, so that the gap can fire repeatedly with no significant deterioration.

# 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

The TWTA may be operated as a standalone bench top 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.

**CAUTION:**

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

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

**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 for the locations of threaded holes on the bottom half of the TWTA chassis, which may be used for supplementary support of the TWTA.

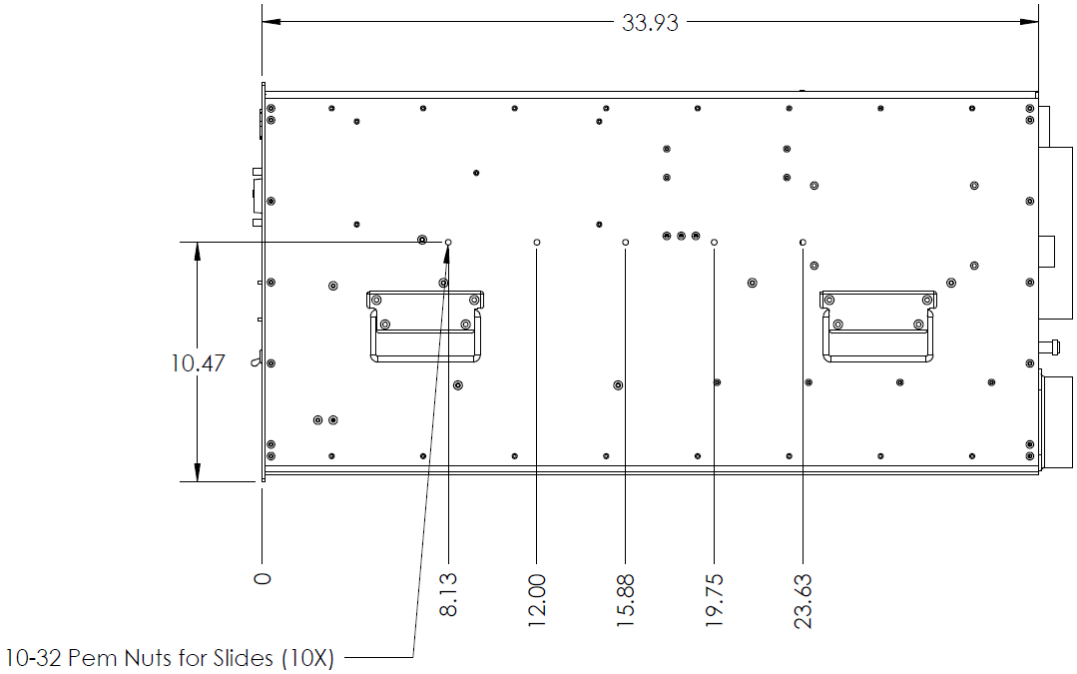



**Figure 3-1. Rack Mounting Configuration**

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 two cooling fans. 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 intakes or outlets are blocked, or that the exhaust flows are directed into the intakes. See Paragraph 3.5 for location of air intakes and air outlets. If the unit is rack mounted, make sure that the intake air is 45°C or below. If necessary, fabricate short ducts 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 over temperature conditions.**

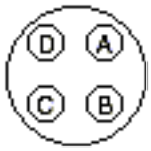
The TWTA dissipates approximately 3300 watts when in the operate mode.

## 3.2.4 AC Line Power Connections

AC line power connection to the TWTA is made at the AC inlet J1, which is a male, 20A, MS3102A22-22P (ETM P/N #J18114-000) connector. A line cord suitable for the type of AC outlet used, and consistent with local electrical codes, must be obtained to mate with J1. Minimum wire size for line cord is 14 gauge.

*NOTE: Mating connector provided. MS3106F22-22S (ETM P/N #J18115-000)*

A 4 wire line cord must be obtained and terminated with a plug to a 208 volt, three-phase source as follows:




| MS3102A22-22P | Function |
|---|---|
| A | Phase A |
| B | Phase B |
| C | Phase C |
| D | Safety Ground |

**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.**

**CAUTION:**

**Main supply voltage fluctuation not to exceed +/- 10% of the nominal voltage.**

## 3.2.5 RF Output Connections

The RF output connector is Type DIN 7-16.

**CAUTION:**

**Never operate the TWTA without a matched output load rated for at least 15,000 peak and 1,000 watt average. Full reflected power may irreparably damage the TWTs. The over reverse power detection circuit is provided to protect the tube from *progressive* failure or mismatch of the output load; it should not be relied on for protection from the absence of a load.**

## 3.2.6 External Interlock Connector

The TWTA is provided with an external interlock capability via an 15-pin 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). There is an internal jumper between J2 pins A and B; a continuity check through these pins can be used to verify the presence of the amplifier in the instrumentation system. Users may adopt this interlock feature to disable the RF output for either equipment protection or as a backup for personnel protection. Wiring details are shown below and the location of the connector is shown on Figure 3-3.

| Pin | Title | Function |
|---|---|---|
| 1 | INTERNAL JUMPER | Internal jumper from pin 1 to pin 2 |
| 2. | INTERNAL JUMPER | Internal jumper from pin 1 to pin 2 |
| 3. | EXTERNAL INTERLOCK SUPPLY | Disables High Voltage power supply in continuity is opened from pin 3 to pin 4. |
| 4. | EXTERNAL INTERLOCK RETURN | Disables High Voltage power supply in continuity is opened from pin 3 to pin 4. |
| 5-9. | NOT USED | |
| 10. | INHIBIT SUPPLY | Disables RF power output if continuity is opened from pin 10 to pin 15. |
| 11-14 | NOT USD | |
| 15 | INHINIT RETURN | Disables RF power output if continuity is opened from pin 10 to pin 15. |

**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.**

## 3.2.7 External IEEE-488 Connector

The TWTA is provided with a standard IEEE-488 connector on the rear panel. If the TWTA is mounted in a bench-top cabinet, the mating connector should be a straight-entry cable type, not a side-entry type.

## 3.3 FRONT PANEL FEATURES

Refer to Figure 3-2 below.

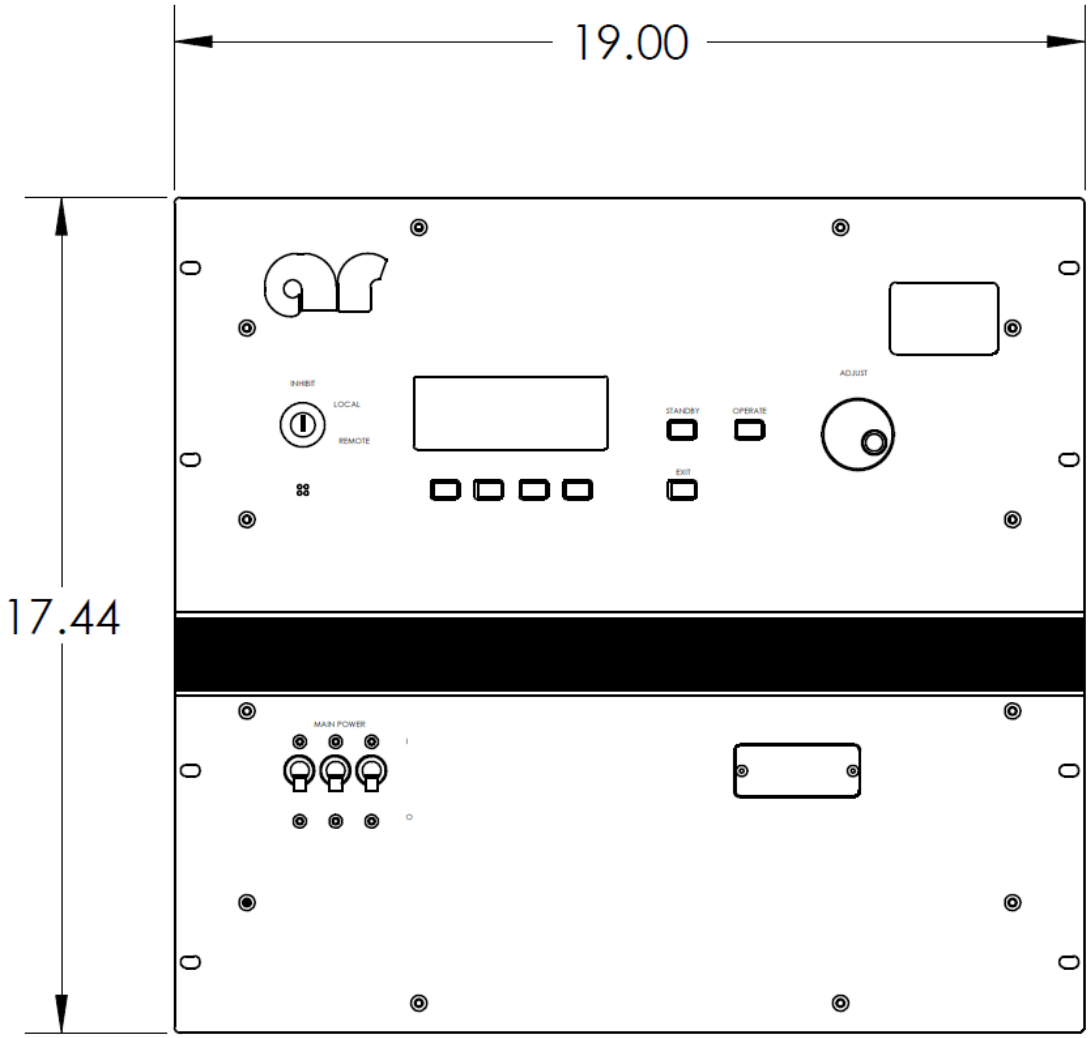



**Figure 3-2. Front Panel Features**

**Table 3-1. Front Panel Features**

| Item | Title | Function |
|---|---|---|
| 1 | MAIN POWER | Switchable 16 A. circuit breaker; connects primary power to power supplies. |
| 2. | OPERATE | Push-button; turns on high voltage and SSA when all faults and heater delay are cleared. |
| 3. | STANDBY | Push-button; shuts off SSA 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. | Display | Displays numerous parameter values and fault messages. |
| 11. | Keylock Switch | Allows operator to inhibit the TWTA, to enable front panel control, or to enable computer control. |

## 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.

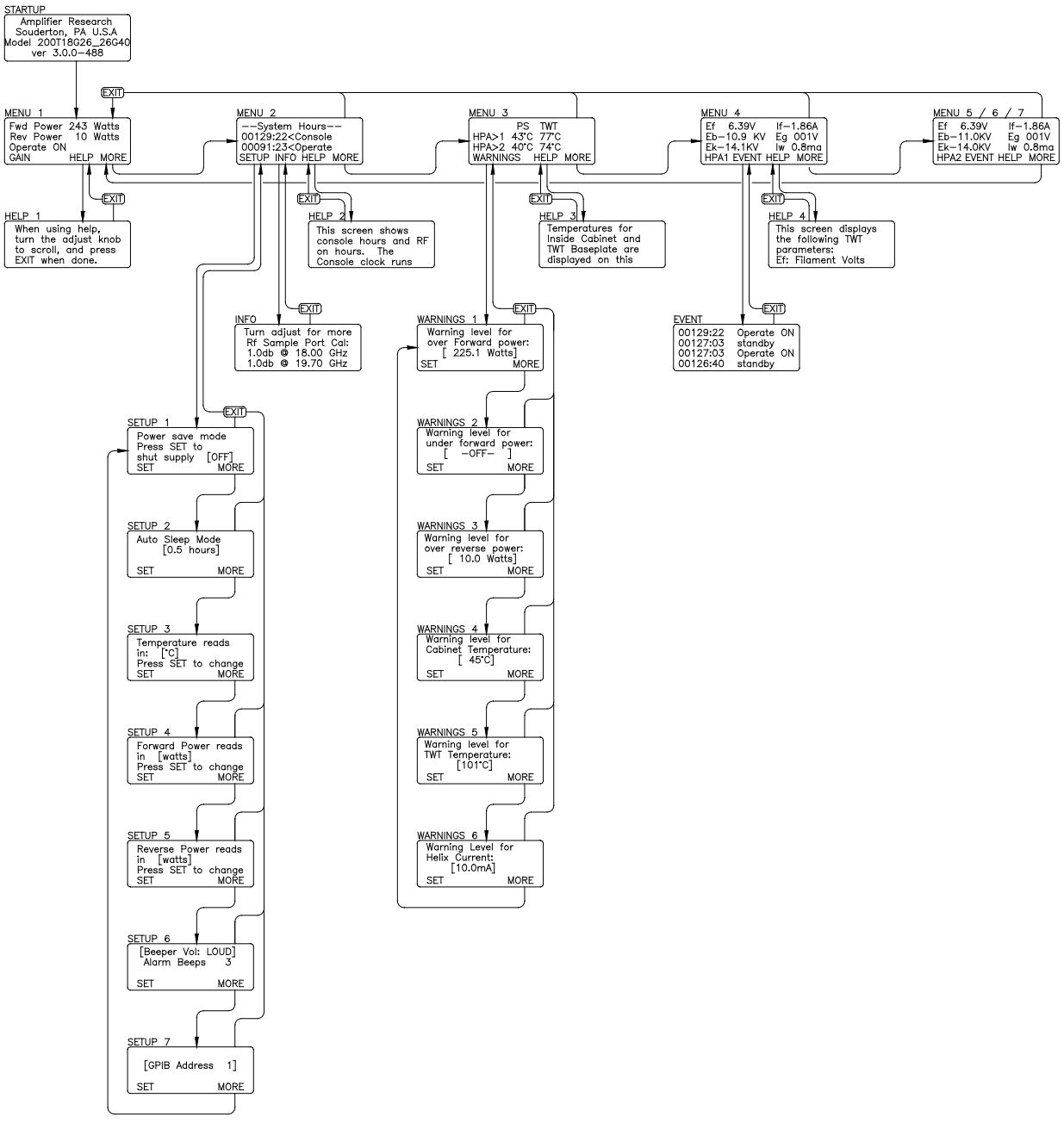



**Figure 3-3. Front Panel Display Screens**

**Menu screens:** The screens at the highest level are called menu screens. There are seven 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 7, 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 1 | Forward power (watts, dBm or bar graph) |
| | Reverse power (watts or dBm) |
| | System status (if a latched fault exists, MENU 1 is displayed with the system shutdown message) |
| MENU 2 | Forward power adv (bar graph, watts or dB) |
| | Reflected power adv (watts or dB) |
| | System Status |
| MENU 3 | - System Hours - |
| | Console hours (active when main power circuit breaker is on, represents TWT filament hours) |
| | Operate hours (active when HV is on) |
| MENU 4 | - System Temps - |
| | TWT 1 baseplate temperature (°C or °F) |
| | TWT 2 baseplate temperature (°C or °F) |
| MENU 5 | Heater voltage (Ef) |
| | Heater current (If) |
| | Collector voltage (Eb), |
| | Cathode voltage (Eg) |
| | Helix current (Iw) |
| | Grid voltage (eg) |

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

**MENU 1:** Shows forward and reverse power in watts, dBm, or bar graph. The reverse power may also be displayed as a percentage of forward power. Use the setup screens (described later) to change display units. Pressing S1 (GAIN) allows you to adjust the gain while monitoring its effect on output power. The third line of this screen normally shows operating status, but changes to helix current when GAIN is selected for adjustment, and will be overwritten by a message if a fault occurs..

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

**SETUP 1:** toggles Auto Cycle On/OFF and Remote. Pressing S1 (SET) changes the selection. The setting displayed when the screen is exited will be retained.

Pressing MORE brings up the next screen, SETUP 2.

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

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

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

**SETUP 2** toggles display of temperature parameters between Fahrenheit and Celsius degrees. Pressing S1 (SET) changes the selection. The setting displayed when the screen is exited will be retained. Pressing MORE again brings up the next screen, SETUP 3.

**SETUP 3** allows a choice of displaying forward power in stripchart form, or in dBm or watts. Pressing MORE again brings up the next screen, SETUP 4.

**SETUP 4** allows a choice of dBm or watts for displaying reflected power. Pressing MORE again brings up the next screen, SETUP 5.

**SETUP 5** toggles the desired number of alarm beeps and the desired beep volume. S1 (SET) toggles between parameters, and the adjust knob is used to enter the data. Pressing MORE again brings up the next screen, SETUP 6.

**SETUP 6** allows the IEEE-488 address to be set. Pressing MORE again returns you to SETUP 1. EXIT returns you from any of the setup screens to MENU 2.

## 3.5 REAR PANEL FEATURES

See Figure 3-4 below.

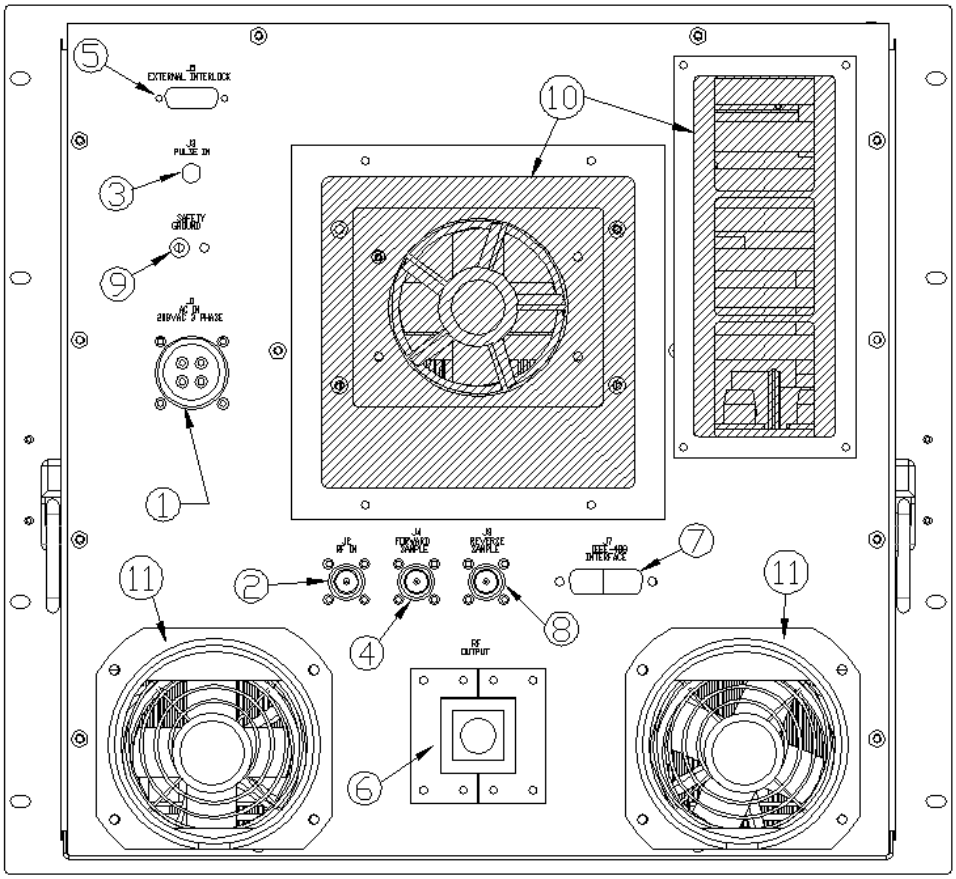



**Figure 3-4. Rear Panel Features**

**Table 3-2. Rear Panel Features**

| Item | Title | Function |
|---|---|---|
| 1. | AC POWER IN | AC power input connector:<br>MS3102A22-22P (ETM P/N #J18114-000) mates with MS3106F22-22S (ETM P/N #J18115-000) |
| 2. | RF IN | RF Input: Type-N female |
| 3. | PULSE GATE INPUT | Modulator pulse inhibit input (TTL): BNC female |
| 4. | RF FORWARD SAMPLE | RF Input: Type-N female |
| 5. | EXTERNAL INTERLOCK | Connector for remote interlock and inhibit functions: D-sub 15-pin female |
| 6. | RF OUT | RF Output Signal 68.4 dBm Min |
| 7. | IEEE-488 INTERFACE | Remote control connector: IEEE-488<br>24 pin hermaphrodite |
| 8 | REVERSE SAMPLE | RF reverse sample, Type-N Female |
| 9. | SAFETY GROUND | Safety Ground, threaded stud |
| 10. | AIR INLET | - |
| 11. | AIR OUTLET | - |

## 3.6 INITIAL TURN ON AND WARM-UP PROCEDURE

Before applying power, verify that the equipment line voltage is compatible with the TWTA.

Install the TWTA as discussed in Section 3.2. Provide an RF generator to the RF input Type N connector J3. Set RF generator level below -20 dBm and set desired frequency in specified range. Connect a load suitable for 1000 watts continuous operation to the RF output connector (20,000 watts peak). The load VSWR should be less than 2.0:1. A power meter and suitable attenuators may be connected to the RF sample port (rear panel). (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. 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.

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

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. Stay in Menu Screen 4. You will now see the cathode and collector voltages rise. Verify that the collector and cathode voltages are near nominal. The values of these parameters at the time the TWTA left the factory are logged on the test data sheet.

Set Gain to 0%. Push OPERATE, check the helix current (Iw). The helix current should be close to the nominal value for no RF drive. The value of this parameter at the time the TWTA left the factory is logged on the test data sheet.

Push S4 (MORE) or EXIT to get 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 forward power on the display and power meter (connected to the forward sample port). The forward power display will become active, with a maximum reading when peak power output is achieved.

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

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

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 10 dBm

**CAUTION:**

**Input drive above +20 dBm may damage the unit.**

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

To shut the system down, push STANDBY. Allow the TWTA to cool down until the TWT temperature drops below 50°C, then turn off main power. Menu 1 displays "COOL-DOWN" until the TWT temperature is within 15°C of the cabinet temperature.

## 3.7 EMERGENCY BYPASS

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 external interlock and certain protective and 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 plate 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 between beam on (left) and beam off (right). 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 foldback VSWR level, and it is calibrated at the factory.**

## 3.8 IEEE-488 COMMUNICATION

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, 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 5) | | STATUS=[ ] |
| RDFLT | Returns system fault code (see Table 6) | | flt=[ ] |
| PWR-ON | Emulates OPERATE push-button | | |
| PWR-OFF | Emulate STANDBY push-button | | |
| XMIT-ON | Emulate RF ON push-button | | |
| XMIT-OFF | Emulate RF OFF push-button | | |
| SYSTEM-ON | Places unit in Sleep Mode | | |
| SYSTEM-OFF | Returns unit from Sleep Mode | | |
| RESET | Emulates RESET softkey | | |
| RDS/N | Returns serial number | | s/n=[ ] |
| RDCONHR | Returns console hours | | ConHr=[ ] |
| RDCONMN | Returns console minutes | | ConMn=[ ] |
| RDRFHR | Returns RF hours | | RfHr=[ ] |
| RDRFMN | Returns RF minutes | | RfMn=[ ] |
| RDEK | Returns cathode voltage | KV | Ek=[ ] |
| RDEB | Returns collector voltage | KV | Eb=[ ] |
| RDEG | Return grid voltage | V | Eg=[ ] |
| RDEF | Returns heater voltage | V | Ef=[ ] |
| RDIF | Returns heater current | A | If=[ ] |
| RDIW | Returns helix current | mA | Iw=[ ] |
| RDTMPTWTF | Returns TWT 1 temp (°F) | °F | TWT1F=[ ]F |
| RDTMPTWTC | Returns TWT 1 temp (°C) | °C | TWT1C=[ ]C |
| RDTMPTWT2F | Returns TWT 2 temp (°F) | °F | TWT2F=[ ]F |
| RDTMPTWT2C | Returns TWT 2 temp (°C) | °C | TWT2C=[ ]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 | |
| RDIWOC | Returns helix overcurrent warning setpoint | mA | IwOC=[ ] |
| SIWOC | Sets helix overcurrent warning setpoint | mA | |
| RDLOGIC | Returns logic state code (see Table 7) | | Sys=[ ] |
| RDA | Returns gain | % | A=[ ] |
| SA | Sets gain | % | |
| RDHTDREM | Returns remaining heater time delay | sec. | HTD=[ ]s |
| RDPODP | Returns Peak forward power out (dBm) | dBm | Po=[ ]dBm Pk |
| RDPOWP | Returns Peak forward power out (W) | watts | Po=[ ]W Pk |

| Command | Function | Units | Response format |
|---|---|---|---|
| RDPRDP | Returns Peak reverse power out (dBm) | dBm | Pr=[ ]dBm Pk |
| RDPRWP | Returns Peak reverse power out (W) | watts | Pr=[ ]W Pk |
| RDPOHIDP | Returns Peak over forward power warning setpoint (dBm) | dBm | Pohi=[ ]dBm Pk |
| SPOHIDP | Sets Peak over forward power warning setpoint (dBm) | dBm | |
| RDPOLODP | Returns Peak under forward power warning setpoint (dBm) | dBm | Polo=[ ]dBm Pk |
| SPOLODP | Sets Peak under forward power warning setpoint (dBm) | dBm | |
| RDPOHIWP | Returns Peak over forward power warning setpoint (W) | watts | Pohi=[ ]W Pk |
| SPOHIWP | Sets Peak over forward power warning setpoint (W) | watts | |
| RDPOLOWP | Returns Peak under forward power warning setpoint (W) | watts | Polo=[ ]W Pk |
| SPOLOWP | Sets Peak under forward power warning setpoint (W) | watts | |
| RDPRHIDP | Returns Peak over reverse power warning setpoint (dB) | dBm | Prhi=[ ]dBm Pk |
| SPRHIDP | Sets Peak over reverse power warning setpoint (dBm) | dBm | |
| RDPRHIWP | Returns Peak over reverse power warning setpoint (W) | watts | Prhi=[ ]W Pk |
| SPRHIWP | Sets Peak over reverse power warning setpoint (W) | watts | |
| RDPOD | Returns forward power out (dBm) | dBm | Po=[ ]dBm Avg |
| RDPOW | Returns forward power out (W) | watts | Po=[ ]W Avg |
| RDPRD | Returns reverse power out (dBm) | dBm | Pr=[ ]dBm Avg |
| RDPRW | Returns reverse power out (W) | watts | Pr=[ ]W Avg |
| RDMSG | Message displayed on front panel | | |
| RDFLTMSG | Read fault or warning message on screen | | |
| RDFLOG * | Read event log<br>* 0 to 99 Event Number | | |

**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 is 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. |

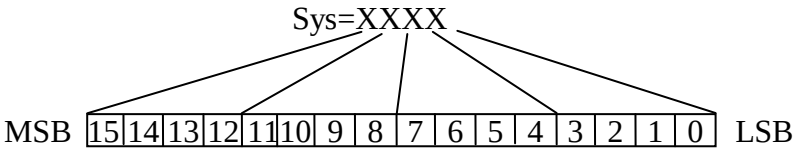
**Table 3-5: Catalog of Fault Codes**

(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 |
| 7 | System Fault |
| 8 | FIL Not Ready |
| 9 | Low Line |
| 10 | Cathode overvoltage |
| 11 | Body overcurrent |
| 12 | Cathode undervoltage |
| 13 | VSWR TWT |
| 14 | SSPA Over Temperature |
| 15 | Collector undervoltage |
| 16 | Inverter fault |
| 17 | Internal interlock open |
| 18 | Tube arc |
| 19 | TWT (hardware) overtemperature |
| 20 | Cabinet (hardware) overtemperature |
| 22 | External inhibit |
| 23 | Over reverse power |
| 25 | Over Duty |
| 26 | Panel open |
| 28 | Over Pulse Width |

**Table 3-6: Catalog of System State Codes**

(The **RDLOGIC** command causes the TWTA to return a string in the form **Sys=[*code*]**, where **[*code*]** consists of 4 hexadecimal numbers encoded in their binary values as follows)




| Bit | Meaning if high |
|---|---|
| 0 (LSB) | High voltage on |
| 1 | Transmit on |
| 2 | Remote mode |
| 3 | Fault |
| 4 | Heater time delay expired |
| 5 | Under forward power warning |
| 6 | No surge enabled |
| 7 | Auto Recycle enabled |
| 8 | External inhibit |
| 9 | External interlock |
| 10 | Foldback Active |
| 11 | Power on |
| 12 | Standby Ready |
| 13 | RF Off Ready |
| 14 | ALC enabled (if installed) |
| 15 (MSB) | Panel Open |

Command syntax is in this form:

<command mnemonic> <parameter> <carriage return>

where;

<command mnemonic> consists of one of any valid command found in Table 4.

<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 not returned; see table 3 for the units.

If remote is not enabled, set commands and commands to the system logic (i. e., PWR-ON, PWR-OFF, XMIT-ON, XMIT-OFF 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 the previous command was processed.

A small sample program that can send commands and receive the strings returned by the TWTA is included, see 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 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.

## 3.9 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 Limiting the Time in Standby mode….,* 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 Limiting the Time in Standby mode…,* 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 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 as 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 blowers. Preventive maintenance is recommended in Paragraph 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. When 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.*

   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.

2. Remove the 6 screws that secure the lower cover and the 6 screws that secure the upper cover. Remove the covers to gain access to the interior of the TWTA.

   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.

Reassemble in the reverse order.

## 4.4 TROUBLESHOOTING

| **Symptom** | **Possible cause** |
|---|---|
| TWT or power supply over temperature | Air inlet filter(s) dirty<br>Collector heat sink dirty<br>Inadequate clearance behind TWTA<br>High air inlet temperature<br>Defective blower or power supply |
| No response when main power turned on | Panel open interlock switch open |
| Control module display does not come up; unit does not beep when powered up | Shorted or defective control module power supply<br>Control module failure |
| Control module does not boot | EPROM(s) missing. |
| Control module **datalink failure** or **Communication Problem** error appears | HPA interface failure.<br>Fiberoptic link failure<br>±15 VDC supply failure |
| Heater power supply does not come up | Defective low voltage power supply module<br>Defective heater power supply module |
| No high voltage | Open external interlock<br>Keylock switch on **INHIBIT** or **REMOTE**<br>Defective high voltage power supply. |
| Voltages normal, but no RF output, helix current low | No RF input<br>Defective remote control board<br>Defective SSA<br>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 following modules are encapsulated and not repairable. Contact an authorized service representative if replacement modules are needed.

A27816-004 Heater Power Supply Module

A27818-000 Tank Module (No Caps)

A33176-000 High Voltage Filter Assembly

A33173-000 High Voltage Rectifier & XFMR Module

A33186-001 Storage Cap Assembly

A30493-004 Dual Modulator Module, Pulsed Applications

## 4.6 RECOMMENDED SPARE PARTS

A27840-004 Heater Power Supply Module

A27818-000 Tank Module (No Caps)

A33176-000 High Voltage Filter Assembly

A33173-000 High Voltage Rectifier & XFMR Module

A33186-001 Storage Cap Assembly

A30493-004 Dual Modulator Module, Pulsed Applications

A23050-084 HPA Logic and Control Module

A30467-100 Phase and Post Power Inverter

A26452-150 Low Voltage Power Supply Module

A23065-000 Input Filter Module

A23692-000 Insulated Fan Driver

# 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, 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 HPA 83PS, 2 - 4GHZ, A38003-001

| Ref Des | Item Number | Item Description |
|---|---|---|
| A6,A7,A8 | A23692-000 | INSULATED FAN DRIVER |
| A4 | A24324-003 | HPA SYSTEM CONTROL FRONT PANEL ASSEMBLY |
| A3 | A25444-001 | HPA INTERFACE BOARD (200UM GLASS FIBERS) |
| A18 | A26946-001 | CONTROL HEAD ENCLOSURE,IEEE-488. |
| A11 | A30493-004 | DUAL MODULATOR ASSY, SINGLE CATHODE REFERENCE |
| A15 | A30537-003 | HV BREAKOUT BOX, 3 COLLECTORS |
| A16 | A30655-000 | CROWBAR DRIVER BOARD, 10-15KV |
| A13 | A30750-000 | PULSE MONITOR BOARD |
| A1 | A33066-001 | MICROWAVE POWER ASSY, 83PS |
| A2 | A33068-001 | POWER SUPPLY FOR MEC-3102 SUPERTUBE |
| | A33181-001 | WIRING KIT, 83PS |
| A5 | A33186-001 | STORAGE CAP ASSEMBLY FOR 83PC AND 83PS |
| | A33318-001 | CABINET KIT |

## 5.2 SCHEMATICS

| | |
|---|---|
| 10-38003-001 | HPA, 83PS |
| 25-38003-001 | RF Block Diagram |
| 10-25444-001 | HPA Interface |
| 10-30537-003 | HV Breakout Box |
| 10-30655-000 | Crowbar Driver Board |
| 10-30750-000 | Pulse Control Monitor Board |
| 10-33186-000 | Capacitor Bank |

## 5.3 PARTS LISTS

### 5.3.1 Parts List, Insulated Fan Driver, A23692-000

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| B1 | A09594-000 | FAN DRIVER TRANSFORMER | 1 |
| D | B23692-000 | INSULATED FAN DRIVER | 1 |
| 0.1 | C00479-000 | CAP, 47PF, 1KV, CER, + /- 10%, RADIAL, 5MM LEAD SPACING [VISHAY, S470K25SL0N6TK5R ) | 3 |
| 0.1 | C01229-000 | CAP, 220PF, +/-10%, 1KV, CER [VISHAY, 562R10TST22] | 1 |
| 0 | C03109-000 | CAP, 0.01MF, 1KV, CER, ROHS COMPLAINT [VISHAY 562R5GAS10] | 1 |
| 0.1 | C03209-000 | CAP, 0.02UF, +/-20%, 1000V, CER, [VISHAY/BC COMPONENTS, S203M75Z5UN63J0R] | 1 |
| 0 | C05104-000 | CAP, 1MF, +/-10%, 50V, CER [AVX SR305C105KAA] | 6 |
| A | C06103-000 | CAP, 10MF, +/-20%, 25V, SOLID TANT, RADIAL [KEMET T356E106K025AS] | 2 |
| 0 | C06473-000 | CAP, 47MF, 25V, SOLID TANT, RADIAL [KEMET T356K476K025AS] | 1 |
| 0 | C07226-000 | CAP, 220MF, 200V, PLASTIC, RADIAL [NICHICON LGE2D221MHSA] | 2 |
| 0 | C17104-000 | CAP,100UF,63V,AERL,(NICHICON, UVR1J101MPD) | 3 |
| 0.1 | C17472-000 | CAP,470UF +/-20%, 16V,AERL,(NICHICON, UVR1C471MPD) | 1 |
| A | C31016-000 | CAP,100PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION) | 1 |
| 0.1 | C31024-000 | CAP,470PF,200VDC,10%,CER,1% FAILURE,(KEMET C056T471K2X5CM) | 1 |
| A | C31028-000 | CAP,1000PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION) | 1 |
| A | C31029-000 | CAP,0.0022MF,100VDC,10%,CER,1% FAILURE,(KEMET C052T222K1X5CM) | 1 |
| A | C31032-000 | CAP,0.01MF,200VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION) | 1 |
| A | C31036-000 | CAP,0.1MF,100VDC,10%,CER, (KEMET, M39014/2-1310V) | 7 |
| 0.1 | C34567-000 | CAP,0.56MF,400V,METAL POLY FILM,RADIAL,(PANASONIC, ECQE4564KF) | 2 |
| 0 | C35156-000 | CAP,1.5MF,250V,METAL POLY FILM,RADIAL,(PANASONIC, ECQ-E2155KS) | 1 |
| 0 | C35192-000 | CAP,0.1MF,100V,-5%,+5%,POLY,RADIAL,TEMP STAB 0% -2% FRM -55C TO 100C, 5MM PCM,[WIMA MKC2/0.1/100/5] | 1 |
| A | D00017-000 | BRIDGE,1KV,6A,10W,CHASSIS MNT,NO OIL,LEADED,[MICRO COMMERCIAL COMPONENT MCCSEMI PB610] | 1 |
| 0 | D00160-000 | DIODE,600V,1A,75NS,AXIAL,(ON SEMICONDUCTOR MUR160G) | 2 |
| 0 | D00460-000 | DIODE,600V,4A,50NS,AXIAL,(ON SEMI, MUR460G) | 5 |
| 0 | D14454-000 | DIODE,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4454) | 7 |
| 0 | D14747-000 | ZENER,20V,1W,10%,AXIAL, [ SEE PG 2, 1N4747A ] | 1 |
| 0 | D30007-000 | TRANSIENT, VOLTAGE SUPPRESSOR, 15V,500W, PK, AXIAL, 10%, BI-DIRECT, (SA15CA) | 1 |
| 0 | D31070-000 | DIODE,200V,1A,AXIAL,15NS,(VISHAY, UG1D) | 1 |
| 0 | F00101-000 | WASHER,#4 NAS,(PRO-STAINLESS NAS620C4) | 2 |
| 0 | F00107-000 | #4 SPLIT LOCK WASHER,SST | 2 |
| 0 | F10283-000 | PHP,4-40 X 1/4,SST | 2 |
| 0 | F20100-000 | NUT,4-40 HEX,SST | 2 |

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| 0 | H15004-000 | HEAT SINK,TO-220,HORZ, (AAVID 5773B) | 2 |
| 0 | J01022-000 | CONN,HOUSING,MALE,02 PIN,(MOLEX 5281-NA 10-32-1021) | 1 |
| 0 | J01032-000 | CONN,HOUSING,MALE,03 PIN,(MOLEX 5281-NA 10-32-1031) | 1 |
| 0 | J10020-000 | HEADER,2 PIN,MALE,PCB (MOLEX 22-23-2021) | 1 |
| 0 | L01090-000 | CHOKE,100UH,1.7AMPS DC,(MILLER, RL110-101K-RC) | 2 |
| 0 | Q10840-000 | MOSFET,SILICON,N-CHANNEL,500V,4.6A,40W,TO-220FP, 2.5KVRMS MAX ISOLATION,(INTERNATIONAL IRFI840GLC) | 2 |
| A | Q30020-000 | MOSFET,N CHANNEL,1000V,14A,400W,TO-247,NO OIL,[ADVANCED POWER TECHNOLOGY APT10078BLL] | 1 |
| 0 | R00010-000 | RES,2.7 OHM,1/4W,5%,CC,(OHMITE, OD27GJE) | 2 |
| 0 | R00012-000 | RES,1 OHM,1/2W,5%,CC,(SEI, RC 1/2 1 5% A) | 4 |
| 0 | R00033-000 | RES,3 OHM,1/2W,5%,CC,(OHMITE, OF30GJE) | 1 |
| 0 | R00332-000 | RES,33 OHM,1/2W,5%,CC,(OHMITE, OF330JE) | 1 |
| 0 | R01200-000 | RES,200 OHM,1/4W,5%,CC (OHMITE, OD201JE) | 1 |
| 0 | R01560-000 | RES,560 OHM,1/4W,5%,CC,(A/B RC07GF561J) | 2 |
| 0.2 | R02106-000 | RES, 1K, 4W (OPTION B), 5%, HIGH SURGE (RCD, PR1B-102-JB) | 1 |
| 0 | R03824-000 | RES,82K,1W,5%,CC,(OHMITE, OA823JE) | 2 |
| 0 | R20018-000 | RES,18.2 OHM, 1 %,MF,(DALE, RN55D18R2F) | 1 |
| 0 | R20887-000 | RES,887 OHM, 1%,MF,100PPM,(DALE RN55D8870F) | 1 |
| 0 | R21101-000 | RES,1.02K,  1%,MF,100PPM,(DALE RN55D1021F) | 4 |
| 0 | R21147-000 | RES,1.47K, 1%,MF,100PPM,(DALE RN55D1471F) | 1 |
| 0 | R21200-000 | RES,2.00K, 1%,MF,50PPM,(DALE, RN55C2001F) | 1 |
| 0 | R21215-000 | RES,2.15K, 1%,MF,100PPM,(DALE RN55D2151F) | 1 |
| 0 | R21412-000 | RES,4.12K, 1%,MF,100PPM,(DALE RN55D4121F) | 1 |
| 0.1 | R21825-000 | RES,8.25K, 1%,MF,100PPM,(DALE RN55D8251F) | 1 |
| 0 | R21990-000 | RES,9.76K, 1%,MF,100PPM,(DALE RN55D9761F) | 1 |
| 0 | R22147-000 | RES,14.7K, 1%,MF,50PPM,(DALE, RN55C1472F) | 1 |
| 0 | R22561-000 | RES,56.2K, 1%,MF,100PPM,(DALE RN65D5622F) | 2 |
| 0 | R22825-000 | RES,82.5K, 1%,MF,100PPM,(DALE RN55D8252F) | 2 |
| 0 | R23100-000 | RES,100K, 1%,MF,100PPM,(DALE RN55D1003F) | 3 |
| 0 | R30070-000 | TRIMPOT,5K,1/2W,10%,CERMET,100PPM,20T,TOP ADJ,(BI TEHCNOLOGIES 67WR5KLF) | 3 |
| 0 | R30103-000 | RES,10K,1/8W,1%,MF,AXIAL,50PPM,(DALE RN50C1002F) | 2 |
| 0 | R32090-000 | RES,10 OHM,3W,5%,FILM,AXIAL,200PPM,NO OIL,(CADDOCK MV234 10 5%) | 1 |
| 0.1 | U00425-000 | IC,OPTO ISOLATOR, 6 PIN, (FAIRCHILD, 4N25) | 1 |
| 0 | U03171-000 | IC,ADJUSTABLE VOLTAGE REGULATOR,15W,1.5A, TO-220,(NAT LM317T) | 1 |
| A | U12153-000 | HIGH/LOW SIDE SELF OSCILLATING DRIVER [INTERNATIONAL RECTIFIER IR2153D] | 1 |
| 0 | U14823-000 | CONTROLLER,NO OIL,[MICRO-LINEAR ML4823IP] | 1 |
| 0.1 | U35600-000 | NOT FOR USE IN NEW DESIGNS IC,LINEAR,REGULATOR,400VDC,TO-220,(HARRIS HIP5600IS) | 1 |
| A | Z00010-000 | VARISTOR,275VRMS & 369VDC WORKING,710V CLAMP,75J,NO OIL,[LITTLEFUSE V275LA20A] | 3 |
| 0 | Z31007-000 | TRANZORB,300V,BI-DIRECTIONAL,1.5KW,[VISHAY, 1.5KE350CA] | 1 |
| 0 | Z31009-000 | VOLTAGE SUPPRESSOR,GSI 1.5KE300A | 1 |

## 5.3.2 Parts List, HPA System Control Front Panel Assembly, A24324-003

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| A1 | A22700-900 | HPA DISPLAY BOARD | 1 |
| A2 | A24369-000 | REMOTE CONTROL BOARD | 1 |
| | A24830-000 | EMERGENCY BYPASS BOARD | 1 |
| XU1 | H13029-000 | PLASTIC KNOB WITH FINGER DIMPLE,(HP 01650-47401) | 1 |
| | H17037-000 | ESCUTCHEONAR2 1/2X1 1/4,(AR 1006659-1-101) | 1 |
| | H17038-000 | PAL NUT FOR AR ESCUTCHEON,(AR 14048) | 2 |
| J26 | J01031-000 | CONN,MALE 3 PIN,.063,(MOLEX 03-06-2032) | 1 |
| XJ26 | J03013-000 | CONN,PIN MALE,.063,(MOLEX 002-06-2103) | 3 |
| | J31014-000 | SPRING LATCH KIT,D-SUB,(AMPHENOL 17-529) | 1 |
| | N21564-001 | DISPLAY VIEW WINDOW | 1 |
| | N22933-003 | CONTROL HEAD ENCLOSURE | 1 |
| | N22934-000 | ENCLOSURE LID | 1 |
| | N22936-000 | ENCLOSURE BOTTOM | 1 |
| | N24325-000 | TRIM RAIL | 2 |
| | N24811-002 | EMERGENCY SWITCH COVER PLATE, BEIGE | 1 |
| | N37732-000 | FRONT PANEL | 1 |
| S2 | S32074-000 | SWITCH,KEYLOCK,1 POLE,3 POS,SHORTING,THROW,(ILLINOIS LOCK HD5161 AACCM-100-090-041G)WITH KEY E100 | 1 |
| U1 | U17502-000 | OPTICAL ROTARY ENCODER, PANEL MOUNT,AUTOPOT, WITH MATING CABLES | 1 |

## 5.3.3 Parts List, HPA Interface Board A25444-001

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| U15 | A31346-000 | DAC REPLACEMENT BOARD FOR U00725. DUAL CHANNEL | 1 |
| | B25444-000 | HPA INTERFACE BOARD | 1 |
| C161 | C03105-000 | CAP, 0.01MF, +/-10%, 100V, CER, RADIAL [AVX SR201C103KAA] | 1 |
| C171 | C04223-000 | CAP, 0.22MF, +/-10%, 35V, TANT, RADIAL [JAMECO 33507] | 1 |
| C20,C32,C100 | C05153-000 | CAP, 1.5MF, 35V, TANT, RADIAL [AVAX, TAP155K035SCS] | 4 |
| C129,C163 | C05223-000 | CAP ,2.2MF, +/-10%, 35V, SOLID SEALED TANT, RADIAL [SPRAGUE 199D225X9035BA1] | 2 |
| C80,C81,C164 | C06103-000 | CAP, 10MF, +/-20%, 25V, SOLID TANT, RADIAL [KEMET T356E106K025AS] | 3 |
| C15 | C06220-000 | CAP, 22MF, +/-10%, 16V, SOLID TANT, RADIAL [AVX TAP226K016SCS] | 1 |
| C99 | C16103-000 | CAP,10MF,35V,AERL,(NICHICON UVR1V100MDA) | 1 |
| C101 | C17472-000 | CAP,470UF +/-20%, 16V,AERL,(NICHICON, UVR1C471MPD) | 1 |
| C47,C67 | C17474-000 | CAP,470UF,50V,AERL,[PANASONIC P5279] | 2 |
| C44 | C30066-000 | CAP 47 MF, 35V, SOLID TANT. RADIAL, (KEMET T356M476K035AS) | 3 |
| 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) | 10 |
| C1,C2,C3,C4,C5,C10,C 11,C22,C23,C24,C25,C 26,C28,C30,C33,C35,C 40,C41,C42,C48,C49,C 50,C51,C53,C62,C63,C 64,C65,C70,C71,C73,C 77,C79,C83,C85,C87,C 88,C89,C91,C94,C96,C 97,C98,C102,C103,C10 5,C107,C108,C109,C11 0,C111,C112,C113,C11 4,C115,C116,C117,C12 1,C125,C132,C167 | C31036-000 | CAP,0.1MF,100VDC,10%,CER, (KEMET, M39014/2-1310V) | 61 |
| 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, C72,C75,C82,C84,C86, C90,C92,C93,C95,C104 ,C106,C118,C119,C120, C122,C123,C124,C133, C168,C169 | C31040-000 | CAP,1MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION) | 45 |
| D8,D10,D12,D14,D15,D 16,D18,D19 | D14007-000 | DIODE,1000V,1A,AXIAL,(DIODES, INC. 1N4007) | 8 |
| D1-D7 | D14454-000 | DIODE,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4454) | 7 |
| D9,D17 | D14733-000 | ZENER,5.1V,1W,10%,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4733A) | 2 |
| I1 | I10074-000 | LED,GREEN,ALGAAS,NON-DIFFUSED,(HLMP1540) | 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 |

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| 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 |
| 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 |
| 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 (PANASONIC, TQ2-5V) | 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, (ST, 2N2222A) TO-18 | 8 |
| R41 | R00680-000 | RES,68 OHM,1/4W,5%,CC,(A/B RC07GF680J) | 1 |
| R2 | R01220-000 | RES,220 OHM,1/4W,5%,CC,(OHMITE, OD221JE) | 1 |
| R1 | R04200-000 | RES,200K,1/4W,5%,CC,(A/B RC07GF204J) | 1 |
| R6,R8,R58 | R20100-000 | RES,100 OHM, 1%,MF,50PPM,(DALE RN55C1000F) | 3 |
| R57 | R20200-000 | RES,200 OHM, 1%,MF,100PPM,(DALE RN55D) | 1 |
| R59 | R22332-000 | RES,33.2K, 1%,MF,100PPM,(DALE RN55D) | 1 |
| R4,R7 | R23100-000 | RES,100K, 1%,MF,100PPM,(DALE RN55D1003F) | 2 |
| R3,R5 | R30071-000 | TRIMPOT,10K,1/2W,10%,CERMET,100PPM,20T,TOP ADJ,(BI TECNOLOGIES, 67WR10KLF) | 2 |
| R9,R12,R15,R22,R35,R40,R44 | R30103-000 | RES,10K,1/8W,1%,MF,AXIAL,50PPM,(DALE RN50C1002F) | 7 |
| R17,R18,R19,R20,R21,R23,R25,R28,R31,R42,R43,R46 | R30140-000 | RES,1K,1/8W,1%,MF,50PPM,(DALE RN50C1001F) | 12 |
| 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) | 12 |
| 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 AD977CNZ] | 1 |
| U17 | U00524-000 | IC,INSTRUMENTATION AMP,(ANALOG DEVICES, AD524ADZ) (SSD) | 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 CLAMPING 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) ( HFBR-1528Z) | 1 |
| U54 | U12521-000 | IC,FIBER OPTIC RECEIVER,HORIZONTAL,( HFBR-2521Z) (SSD) | 1 |
| U36 | U17545-000 | DRIVER, DUAL AND GATE [TI, SN75451BP) | 1 |
| U6,U19,U34,U39,U60 | U20148-000 | IC,HEX INVERTER,SCHMIDTT TRIGGER,(74HC14) (SSD) | 5 |
| U42 | U20738-000 | IC,DUAL J-K FLIP-FLOP W/RESET, (NXD SEMI-CONDUCTORS, 74HC73N) | 1 |
| U51 | U21328-000 | IC,QUAD 2 INPUT NAND,SCHMIDTT TRIGGER,(74HC132) (SSD) | 1 |

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| U52 | U21388-000 | IC,3 TO 8 DECODER/DEMULTIPLEXER,INVERTING,(74HC138) (SSD) | 1 |
| U32 | U21536-000 | IC, DUAL 4 INPUT DIGTAL MULTIPLEXER, 16-PIN DIP [TI SN74F153NE4] | 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,(NXP, 74HC74N) | 7 |
| U2 | U28123-000 | IC,DUAL RETRIGGERABLE 1-SHOT,(CD74HC123E) (SSD) | 1 |
| U31,U53 | U28164-000 | IC,8 BIT SERIAL IN PARALLEL OUT SHIFT REGISTER, [STMICROELECTRONICS, M74HC164B1R] | 2 |
| U3,U12,U28,U37,U38 | U28165-000 | IC,8 BIT PARALLEL IN SERIAL OUT SHIFT REGISTER,(ON SEMICONDUCTOR, MC74HC165ANG) | 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, [BOURNS 4116R-1-103LF] | 5 |
| U56 | U40008-000 | REGULATOR,5V,100MA,TO-92,[ ON-SEMI, MC78L05ABPG] | 1 |
| U55 | U40012-000 | FLIP-FLOP,OCTAL D-TYPE LATCH WITH RESET,[NATIONAL MM74HC273N] | 1 |

## 5.3.4 Parts List, Control Head Enclosure, A26946-001

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| A2 | A22488-013 | GPIB/LINK TRANSCEIVER BOARD, 5U AND 6U TWT PRODUCTS, 200UM HCS FIBERS | 1 |
| A3 | A25450-000 | CPU BOARD W/POWERFAIL (20MHZ) | 1 |
| A1 | A31609-000 | E00255-000 POWER SUPPLY ASSEMBLY | 1 |
| | H20050-000 | GROMMET,5/16HOLE,1/16THICK,3/16ID,7/16OD,(MCMASTER, 1061T12) | 1 |
| P1 | J00046-000 | CONN,HOUSING,FEMALE,4 PIN,0.1SPACING,7880 SERIES,(MOLEX 10-11-2043) | 1 |
| | J04014-000 | TERMINAL PIN HIGH PRESSURE MOLEX 7879 SERIES [MOLEX 08-50-0005] (FOR SERIES 7880 HOUSING 10-11-XXXX) | 4 |
| | J10641-000 | CONN,64 PIN,FEMALE,IDC MASS TERMINATION,(TYCO, #1-1658621-2) | 3 |
| | N22933-000 | CONTROL HEAD ENCLOSURE | 1 |
| | N24364-000 | CONTROL HEAD COVER | 1 |
| | N24365-000 | CONTROL HEAD BOTTOM | 1 |
| | N33022-000 | HEX STANDOFF 6-32 1.55 IN LONG | 4 |
| U35,U36,U37,U38 | U27512-000 | IC, 64K OTP EPROM, -40 TO +85C, 90NS (27C512) (SSD), | 4 |
| | W11600-000 | WIRE,16 AWG,BLUE,TFE,(BELDEN 83010-6) | 2 |
| W1 | W26400-000 | RIBBON CABLE, 64 COND, 28 AWG, STRANDED,.050 CENTERS [BELDEN 9L28064] | 3 |
| | W30041-000 | RIBBON CABLE, JACKETED/SHIELDED, 25 COND .050 CENTERS [BELDEN 9L28325] | 3 |
| LF1 | Y20009-000 | RFI LINE FILTER,120V/250V,1A,50/60HZ,(CORCOM IVB3) | 1 |

## 5.3.5 Parts List, Dual Modulator Assy, A30493-004

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| A1 | A23684-002 | PIJ/PSC DUAL GRID MODULATOR MODULE, WITHOUT CATH REF | 1 |
| A2 | A23684-121 | PIJ/PSC GRID MODULATOR MODULE, REGULATED REFERENCE, PULSED /CW APPLICATION. USE FOR HPAS W/ KEYLOCK | 1 |
| | A31127-001 | MODULATOR MOTHER BOARD ASSEMBLY- TRANSVERSE FINS | 1 |
| | A31127-002 | MODULATOR MOTHER BOARD ASSEMBLY WITHOUT HEAT SINK. | 1 |

## 5.3.6 Parts List, HV Breakout Box, A30537-003

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| P4,P5,P6 | J12641-000 | HV LEAD W/RIGHT ANGLE CONNECTOR,15KV,(CONNECTRONICS, OLE36-11549-01) | 3 |
| P2 | J31075-000 | CONNECTOR,20KV,24LEAD;LEAD COLOR WHITE,(CONNECTRONICS 10539-01) | 1 |
| P1 | J31076-000 | CONNECTOR,20 KV,24LEAD;LEAD COLOR RED,(CONNECTRONICS 10539-02) | 1 |
| P3 | J31077-000 | CONNECTOR,20 KV,24LEAD;LEAD COLOR YELLOW,(CONNECTRONICS 10539-04) | 1 |
| J1,J2,J3,J4,J5,J6,J7,J8 | N25239-000 | HV CONNECTOR, MODIFIED | 8 |
| | N31410-003 | HV BREAKOUT BOX ENCLOSURE | 1 |
| XJ7,XJ8 | N32056-002 | COLOR CODE RING FOR HV CONNECTOR RED (COLLECTOR 1) | 2 |
| XJ1,XJ2 | N32056-004 | COLOR CODE RING FOR HV CONNECTOR YELLOW (HEATER/CATHODE) | 2 |
| XJ3,XJ4 | N32056-006 | COLOR CODE RING FOR HV CONNECTOR BLUE (COLLECTOR 3) | 2 |
| XJ5,XJ6 | N32056-009 | COLOR CODE RING FOR HV CONNECTOR WHITE (COLLECTOR 2) | 2 |

## 5.3.7 Parts List, Crowbar Driver Board, A30655-000

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| | A30663-000 | CROWBAR DRIVER TRANSFORMER | 1 |
| | B30655-000 | CROWBAR DRIVER BOARD | 1 |
| C10 | C05108-000 | CAP, 1MF, +/-10%, 600V, POLY FILM, AXIAL [CDE MMWA6W1-K] | 1 |
| C1,C3 | C17225-000 | CAP,220UF,35V,RADIAL OIL, EPOXY END SEAL,(ILLINOIS CAP, 227KXM035MLN)) | 2 |
| C11 | C21504-000 | CAP,470PF,15KV,CER, 20%,-25C TO 85C (MURATA, DHRB34C471M2FB ) | 1 |
| C18,C23 | C31016-000 | CAP,100PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION) | 2 |
| C15 | C31034-000 | CAP,0.033MF,100VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION) | 1 |
| C12,C13,C14,C16,C17, C20,C21 | C31036-000 | CAP,0.1MF,100VDC,10%,CER, (KEMET, M39014/2-1310V) | 7 |
| C2,C22 | C31040-000 | CAP,1MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION) | 2 |
| C5 | C31067-000 | CAP,0.033MF,100V,POLY FILM,(ELECTRONIC CONCEPT PT12D333J] | 1 |
| C6,C7,C8,C9 | C35163-000 | CAP,0.1MF,500V,10%,CER,RADIAL, SMALL SIZE 0.3*0.3*.02,[WCI WRIGHT CAPACITOR, INC LEADED WC1826 | 4 |
| D11,D12,D13,D14 | D00160-000 | DIODE,600V,1A,75NS,AXIAL,(ON SEMICONDUCTOR MUR160G) | 4 |
| D15,D16,D17 | D06100-000 | DIODE,1000V,AXIAL,(DIODES INC 6A10) | 3 |
| D1,D2 | D10914-000 | DIODE,100V,100MA,250MW,4NS,(DIODES INC 1N914B) | 2 |
| D18 | D14007-000 | DIODE,1000V,1A,AXIAL,(DIODES, INC. 1N4007) | 1 |
| D7,D9,D10 | D14454-000 | DIODE,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4454) | 3 |
| D8 | D14733-000 | ZENER,5.1V,1W,10%,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4733A) | 1 |
| D3,D4 | D15272-000 | ZENER,110V,500MW,10%,AXIAL,(MICROSEMI 1N5272BDO35) | 2 |
| SCR1 | D26162-000 | TRIAC,600V,30A,STUD,(SSI, 2N6162) | 1 |
| D5,D6 | D30007-000 | TRANSIENT, VOLTAGE SUPPRESSOR, 15V,500W, PK, AXIAL, 10%, BI-DIRECT, (SA15CA) | 2 |
| .XQ3,XQ1,XQ2 | H15052-000 | HEAT SINK,T0-220,COMPACT,[AAVID 577002B00000 OR DIGI-KEY HS105-ND] | 3 |
| LED1 | I10074-000 | LED,GREEN,ALGAAS,NON-DIFFUSED,(HLMP1540) | 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 |
| TP7 | J16217-000 | TEST JACK,VIOLET,VERTICAL,(EF JOHNSON 105-0862-001) | 1 |
| TP8 | J16218-000 | TEST JACK,GREY,VERTICAL,(EF JOHNSON 105-0863-001) | 1 |
| TP9 | J16219-000 | TEST JACK,WHITE,VERTICAL,(EF JOHNSON 105-0851-001) | 1 |
| XJ1 | J31014-000 | SPRING LATCH KIT,D-SUB,(AMPHENOL 17-529) | 1 |
| J1 | J31015-000 | CONN,D-SUB,9 PIN,MALE,RIGHT ANGLE,[TYCO, 747250-4] | 1 |
| | J31075-001 | CONNECTOR,20KV,36LEAD;LEAD COLOR WHITE,(CONNECTRONICS, 10539-07) | 1 |
| L1,L2 | L00200-000 | WIDE BAND CHOKE,(VK200 10/3B FERROXCUBE) | 2 |
| L3 | L01090-000 | CHOKE,100UH,1.7AMPS DC,(MILLER, RL110-101K-RC) | 1 |
| XY1 | N31576-000 | CORONA RING | 1 |
| XY1 | N31577-000 | BASE, SPARK GAP | 1 |

| | | | |
|---|---|---|---|
| Q5,Q6 | Q00253-000 | TRANSISTOR,PNP,MJE-253,4A,100V,TO-225AA, (MOTOROLA, MJE-253) | 2 |
| Q1,Q2,Q3 | Q06420-000 | MOSFET,200V, 16A, N-CHANNEL, TO-220AB, [VISHAY, IRF640PBF] | 3 |
| Q4 | Q22222-000 | TRANSISTOR,NPN, (ST, 2N2222A) TO-18 | 1 |
| R7,R8,R9 | R00014-000 | RES,1 OHM,1W,5%,FILM | 3 |
| R11 | R00025-000 | RES, 1M, 0.1%, 1.5W, 4KV [CADDOCK MG716-1M-.1%] | 1 |
| R2,R3 | R00100-000 | RES,10 OHM,1/4W,5%,CC,(OHMITE, OD100JE) | 2 |
| R17 | R01150-000 | RES,150 OHM,1/4W,5%,CC,(A/B RC07GF151J) | 1 |
| R10 | R01224-000 | RES,220 OHM,1W,5%,CC,(A/B RC32GF221J) | 1 |
| R21 | R01474-000 | RES,470 OHM,1W,5%,CC,(ALLEN BRADLEY, RC32GF471J) | 1 |
| R18,R19,R22,R24,R25 | R02100-000 | RES,1K,1/4W,5%,CC,(OHMITE, OD102JE) | 5 |
| R14 | R02330-000 | RES,3.3K,1/4W,5%,CC,(A/B RC07GF332J) | 1 |
| R12,R15,R16,R27 | R02470-000 | RES,4.7K,1/4W,5%,CC,(OHMITE, OD472JE) | 4 |
| R6 | R03476-000 | RES,47K,2W,5%,CC,[A/B RC42G473JS] | 1 |
| R1 | R04100-000 | RES,100K,1/4W,5%,CC,(A/B RC07GF104J) | 1 |
| R4,R5 | R04332-000 | RES,330K,1/2W,5%,CC,(A/B RC20GF334J) | 2 |
| R20 | R20013-000 | RES,13 OHM, 1%,MF,100PPM,(DALE RN55D) | 1 |
| R13 | R20392-000 | RES,392 OHM, 1%,MF,100PPM,(DALE RN55D) | 1 |
| R23 | R30064-000 | RES,499K, 1%,MF,100PPM,(DALE RN65D) | 1 |
| T2 | T30148-000 | XFMR,SPARK GAP TRIGGER,(EG&G TR-148A) | 1 |
| U2 | U12611-000 | IC,OPTOISOLATOR,HIGH SPEED,( HCPL-2611) | 1 |
| U1 | U13140-000 | IC, BIMOS OPAMP WITH MOSFET INPUT/BIPOLAR OUTPUT, 4.5MGZ (INTERSIL, CA3140EZ) | 1 |
| U3 | U40008-000 | REGULATOR,5V,100MA,TO-92,[ ON-SEMI, MC78L05ABPG] | 1 |
| Y1 | Z03210-000 | SPARK GAP,TRIGGERED,10-21KV OP,(EG&G GP-46B-27) | 1 |

## 5.3.8 Parts List, Pulse Monitor Board, A30750-000

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| | B32975-000 | PULSE MONITOR BOARD | 1 |
| C36 | C06221-000 | 22MF, 25WVDC, SOLID ELECTROLYTE TANTALUM, RADIAL (SPRAGUE 199D226X9025D1V1E3) | 1 |
| C20 | C17222-000 | CAP,220MF,16V,AERL,(NICHICON, UVR1C221MED) | 1 |
| C19,C21 | C17225-000 | CAP,220UF,35V,RADIAL OIL, EPOXY END SEAL,(ILLINOIS CAP, 227KXM035MLN)) | 2 |
| C29 | C31005-000 | CAP,10PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION) | 1 |
| C4 | C31016-000 | CAP,100PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION) | 1 |
| C15,C17,C42,C43,C70 | C31028-000 | CAP,1000PF,200VDC,10%,CER,1% FAILURE,(KEMET CKR05 SERIES W/"V" OPTION) | 5 |
| C30,C45,C57 | C31032-000 | CAP,0.01MF,200VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION) | 3 |
| C1,C2,C3,C5,C6,C7,C8, C9,C10,C11,C12,C13,C 14,C16,C18,C25,C26,C 27,C28,C38,C44,C49,C 50,C51,C52,C53,C54,C 63,C64,C65,C68,C69 | C31036-000 | CAP,0.1MF,100VDC,10%,CER, (KEMET, M39014/2-1310V) | 32 |
| C22,C23,C24,C35,C37, C39,C40,C41,C46,C47, C58,C59,C60,C61,C62, C66,C67 | C31040-000 | CAP,1MF,50VDC,10%,CER,1% FAILURE,(KEMET CKR06 SERIES W/"V" OPTION) | 17 |
| D1,D2,D3,D4,D5,D6,D7, D8,D9,D10,D11,D12,D1 3 | D14454-000 | DIODE,AXIAL,(FAIRCHILD SEMICONDUCTOR, 1N4454) | 13 |
| XU14 | J00613-000 | PLCC SOCKET, 44 PIN (FCI 54020-44030LF), USE FOR HIGH VIBRATION | 1 |
| J2 | J10048-000 | CONN,HEADER,4 PIN,STRAIGHT SQUARE PIN FRICTION LOCK HEADER,4 PIN,6373 SERIES,(MOLEX 22-23-2041) | 1 |
| J3 | J10102-000 | HEADER,5 PIN,2 ROW,.1 CTR,(SAMTEC TSW-1-05-07-G-D) | 1 |
| TP0,TP10,TP20 | J16210-000 | TEST JACK,BLACK,VERTICAL,(EF JOHNSON 105-0853-001) | 3 |
| TP1,TP11,TP21 | J16211-000 | TEST JACK,BROWN,VERTICAL,(EF JOHNSON 105-0858-001) | 3 |
| TP2,TP12,TP22 | J16212-000 | TEST JACK,RED,VERTICAL,(EF JOHNSON 105-0852-001) | 3 |
| TP3,TP13,TP23 | J16213-000 | TEST JACK,ORANGE,VERTICAL,(EF JOHNSON 105-0856-001) | 3 |
| TP4,TP14,TP24 | J16214-000 | TEST JACK,YELLOW,VERTICAL,(EF JOHNSON 105-0857-001) | 3 |
| TP5,TP15 | J16215-000 | TEST JACK,GREEN,VERTICAL,(EF JOHNSON 105-0854-001) | 2 |
| TP6,TP16,TP26 | J16216-000 | TEST JACK,BLUE,VERTICAL,(EF JOHNSON 105-0860-001) | 3 |
| TP7,TP17,TP27 | J16217-000 | TEST JACK,VIOLET,VERTICAL,(EF JOHNSON 105-0862-001) | 3 |
| TP8,TP18 | J16218-000 | TEST JACK,GREY,VERTICAL,(EF JOHNSON 105-0863-001) | 2 |
| TP9,TP19 | J16219-000 | TEST JACK,WHITE,VERTICAL,(EF JOHNSON 105-0851-001) | 2 |
| J1 | J18167-000 | D-SUB,37 PIN,FEMALE,PCB MOUNT,RIGHT ANGLE (AMP 745784-4) | 1 |
| XJ1 | J31014-000 | SPRING LATCH KIT,D-SUB,(AMPHENOL 17-529) | 1 |
| L1,L2,L3,L4 | L00200-000 | WIDE BAND CHOKE,(VK200 10/3B FERROXCUBE) | 4 |
| Q1 | Q00243-000 | TRANSISTOR,NPN,(ON SEMICONDUCTOR MJE-243) | 1 |
| R21,R25 | R01100-000 | RES,100 OHM,1/4W,5%,CC,(OHMITE, OD101JE) | 2 |
| R27 | R01122-000 | RES,120 OHM,1/2W,5%,CC,(A/B RC20GF121J) | 1 |
| R26 | R01224-000 | RES,220 OHM,1W,5%,CC,(A/B RC32GF221J) | 1 |
| R11,R19,R22,R28,R29, | R02100-000 | RES,1K,1/4W,5%,CC,(OHMITE, OD102JE) | 17 |

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| R30,R32,R34,R37,R43, R46,R48,R49,R54,R55, R59,R63 | | | |
| R5,R15 | R02200-000 | RES,2K,1/4W,5%,CC,(A/B RC07GF202J) | 2 |
| R23,R38 | R02470-000 | RES,4.7K,1/4W,5%,CC,(OHMITE, OD472JE) | 2 |
| R10,R12,R20,R31,R33, R42,R57,R58,R60,R61, R62 | R03100-000 | RES,10K,1/4W,5%,CC,(OHMITE, OD103JE) | 11 |
| R8 | R03330-000 | RES,33K,1/4W,5%,CC,(A/B RC07GF333J) | 1 |
| R18 | R04100-000 | RES,100K,1/4W,5%,CC,(A/B RC07GF104J) | 1 |
| R4,R13 | R04330-000 | RES,330K,1/4W,5%,CC,(A/B RC07GF334J) | 2 |
| R17,R24,R36,R44,R45 | R05100-000 | RES,1M,1/4W,5%,CC,(OHMITE, OD105JE) | 5 |
| R50 | R20100-000 | RES,100 OHM, 1%,MF,50PPM,(DALE RN55C1000F) | 1 |
| R51 | R20200-000 | RES,200 OHM, 1%,MF,100PPM,(DALE RN55D) | 1 |
| R52 | R20392-000 | RES,392 OHM, 1%,MF,100PPM,(DALE RN55D) | 1 |
| R16,R56 | R20499-000 | RES,499 OHM, 1%,MF,100PPM,(DALE RN55D) | 2 |
| R53 | R20806-000 | RES,806 OHM, 1%,MF,100PPM,(DALE RN55D) | 1 |
| R39 | R21100-000 | RES,1K, 1%,MF,100PPM,(DALE RN55D1001F) | 1 |
| R7 | R21226-000 | RES,2.26K, 1%,MF,100PPM,(DALE RN55D) | 1 |
| R40 | R21402-000 | RES,4.02K, 1%,MF,100PPM,(DALE RN55D) | 1 |
| R6,R14 | R21447-000 | RES,4.42K, 1%,MF,100PPM,(DALE RN55D4421F) | 2 |
| R9,R41 | R23499-000 | RES,499K, 1%,MF,100PPM,(DALE RN55D4993F) | 2 |
| R3 | R30070-000 | TRIMPOT,5K,1/2W,10%,CERMET,100PPM,20T,TOP ADJ,(BI TEHCNOLOGIES 67WR5KLF) | 1 |
| R1 | R30074-000 | TRIMPOT,1K,1/2W,10%,CERMET,100PPM,20T,TOP ADJ,(BECKMAN 67W) | 1 |
| R2 | R30096-000 | TRIMPOT,50K,1/2W,10%,CERMET,20T,TOP ADJ,(BECKMAN 66W) | 1 |
| U14 | U00056-000 | PLD,EPM7064,7NS,44PLCC,INDUSTRIAL TEMP, [ALTERA EPM7064SLI44-7] | 1 |
| U15 | U00111-000 | QUAD CMOS SWITCH, DIP [NXP 74HC4016N] | 1 |
| U11,U12,U13 | U00337-000 | IC,HIGH SPEED COMPARATOR,(NAT LM361N) | 3 |
| U4,U28 | U03190-000 | IC,HIGH SPEED DUAL COMPARATOR,(NAT LM319N) | 2 |
| U29 | U12611-000 | IC,OPTOISOLATOR,HIGH SPEED,( HCPL-2611) | 1 |
| U10,U20,U21 | U17224-000 | CMOS, 18PIN DIP, 8-BIT DAC WITH OUTPUT AMPLIFIER, [ANALOG DEVICES AD7224LN] | 3 |
| U1,U6,U7 | U20148-000 | IC,HEX INVERTER,SCHMIDTT TRIGGER,(74HC14) (SSD) | 3 |

## 5.3.9 Parts List, Microwave Power Assy A33066-001

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| | A33956-000 | COMBINER ASSEMBLY, WRD-200 MAGIC TEE WITH SC-F TRANSITIONS FOR INPUT AND LOAD, 7-16 DIN OUT [MEC] | 1 |
| W2 | E00888-008 | CABLE,RF FLEX, 8,SMA,MALE TO MALE,20 GHZ,50 OHM, (SRC, 150-150-150080 ) | 1 |
| W3,W4,W5,W6 | E00888-012 | CABLE,RF FLEX,12,SMA,M TO M,20 GHZ,50 OHM,0.141 CABLE, [SRC 150-150-150120] | 4 |
| | E00888-020 | CABLE,RF FLEX,20,SMA,M TO M,20 GHZ,50 OHM,0.141 CABLE, [SRC 150-150-150200] | 2 |
| W1,W9 | E00888-024 | CABLE,RF FLEX,24,SMA,MALE TO MALE,20 GHZ,50 OHM, (SRC, 150-150-150240 ) | 2 |
| A11,A17,A18 | E01010-000 | 4GHZ LOW PASS FILTER W/SMA MALE TO FEMALE CONN,(MICROLAB LA-40F) | 3 |
| A3 | E02540-000 | P.S. 12VDC @ 12.5A 150W, 85-265VAC INPUT, W/COVER [KEPCO, RTW 12-12KC] | 1 |
| XA4 | E02551-000 | ADAPTOR, 90 DEG SWEEP, SC JACK TO SC PLUG, [ASTROLABS, 29694] | 1 |
| A1 | E02592-000 | SSPA, 2.0-4.0GHZ, 40DBM, 43DB GAIN, S-BAND, [KMIC, KNA929949BXX ] | 1 |
| A6,A7 | E02594-000 | TWT, 4.5 KW PULSED, 2.0 - 4.0 GHZ, 6% DUTY, PHASE COMB, ± 2.5 DB EQ MAX [TELEDYNE, MEC-3102] | 2 |
| A15 | E02862-000 | ATTENUATOR, 300W CW, N-TYPE FEMALE CONNECTORS, 40DB, (BIRD, 300-WA-FFN-40) | 1 |
| A16 | E02863-000 | TERMINATION, N-TYPE MALE, 50 OHMS, 2W, 500W PEAK, [ BIRD 2-18T-MN ] | 1 |
| | E02886-000 | HIGH POWER RF CABLE ASSY, 18 IN, 1-2.5 GHZ, 7/8EIA FEMALE TO TYPE N-MALE, [MALIK CA-7/8EIA018NPS/012 | 1 |
| W10,W11 | E03192-000 | CABLE, RF, HI POWER, SC-M RIGHT ANGLE, 0 DEGREE CLOCK, 15 INCHES [ STORM 090-2959-001 ] | 2 |
| | E03207-000 | OUTPUT COAX 7-16 DIN | 1 |
| | E20009-000 | ADAPTER,SMA MALE TO SMA MALE,(INMET, 5020) | 1 |
| A8,A9 | E20066-000 | ATTENUATOR,10DB,2W,DC-18GHZ,SUB-MINATURE,(INMET, 18A-10) | 2 |
| A13,A14 | E20131-000 | LINE STRETCHER DC 18GHZ, 50W MAX, (ARRA, 9428T-MF) | 2 |
| A2,A12 | E20157-000 | 2 WAY DIVIDER, 2-4 GHZ | 2 |
| A10 | E20245-000 | DIRECTIONAL COUPLER,10DB,2-8 GH8,(MAC TECH C2045-10) | 1 |
| D1,D2 | E20284-000 | ZERO-BIAS SCHOTTKY DETECTOR,10MHZ-18.5GHZ,POSITIVE OUT PUT POLARITY,(RLC, M-3747) | 2 |
| XA10,XA12 | E20400-000 | TERMINATION, 2 WATT, SMA MALE,[INMET 3004M] | 2 |
| W12 | E32077-000 | RF CABLE, 20" LONG, SC MALE-N MALE, HI PWR, 100C TEMP, (MALIK CABLE DEVICES, CA-NPS-020-SCPS-012) | 1 |
| J2,J4,J8 | J17264-000 | ADAPTER,TYPE N FEMALE TO SMA FEMALE,PANEL MOUNT,(ASTROLAB 29047) | 3 |

## 5.3.10 Parts List, Power Supply for MEC-3102, A33068-001

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| A1 | A23050-084 | HPA LOGIC AND CONTROL MODULE WITH IW BLANKING CIRCUIT, S-BAND | 1 |
| A3 | A23065-000 | INPUT FILTER MODULE, PHASE LOST DETECTION NOT USED | 1 |
| A4 | A26452-150 | LOW VOLTAGE POWER SUPPLY MODULE 150W | 1 |
| A5 | A27816-004 | MOTHER BOARD, MODIFIED FOR EXTERNAL GRID MODULATOR AND HEATER | 1 |
| A10 | A27818-000 | TANK MODULE (NO CAPS) | 1 |
| A2 | A27824-101 | HEATER SUPPLY, HI POWER, 6.3V 6A, W/ J31077 FOR CATH REF LEAD, USING J10170 FOR NON-MOTHERBOARD APPS | 1 |
| A6 | A27824-102 | HEATER SUPPLY, 6.3V 6A, W/O CATH REF LEAD, USING J10170 FOR NON-MOTHERBOARD APPLICATIONS | 1 |
| A9 | A30467-100 | PHASE & POST POWER INVERTER, REDUCED POST REGULATOR GAIN | 1 |
| A8 | A33173-000 | HV RECTIFIER & TRANSFORMER ASSEMBLY FOR 83PS | 1 |
| A7 | A33176-000 | HV FILTER FOR TWT MEC 3102 & MEC 3103 | 1 |

## 5.3.11 Parts List, Wiring Kit, A33181-001

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| B1,B2,B3 | E01120-000 | FAN, 11000 RPM, 400HZ, MODEL 1284DH, [AMETEK 010182 MODIFIED PER DRAWING] | 3 |
| A15 | E10011-000 | THREE PHASE PI FILTER,15A,LOW PROFILE,FLANGE MT,(FILTER CONCEPTS 3L15LF) | 1 |
| HS1 | E30078-000 | CURRENT TRANSDUCER,100A RMS,+/-4VDC OUT,1%,(LEM USA HAL 100-S) | 1 |
| | F00101-000 | WASHER,#4 NAS,(PRO-STAINLESS NAS620C4) | 4 |
| | F00107-000 | #4 SPLIT LOCK WASHER,SST | 2 |
| | F31004-000 | NUT,4-40,HX,SMALL PATTERN,MIL-SPEC | 2 |
| | G00043-000 | HEX STANDOFF ,4-40 THREAD SS,FOR D SUBMIN CONN (PRO STAINLESS, 620013) | 2 |
| XF1,XF2,XF3,XF4,XF5, XF6 | H14012-000 | FUSE HOLDER,(BUSSMAN HTB-44I) | 6 |
| P16B,P17B | J00020-000 | CONN,PIN & SOCKET,2 PIN,FEM,(MOLEX 03-09-1027) | 2 |
| P38,P39,P54,P56,P58 | J00021-000 | CONN,FEMALE 2 PIN .063,(MOLEX 03-06-1023) | 5 |
| P14,P31,P32 | J00023-000 | CONN,HOUSING,FEMALE,02 PIN,(MOLEX 5197-N 10-01-3026) | 3 |
| P9,P10 | J00025-000 | HOUSING,2 PIN,FEMALE,0.1 SPACING,7880 SERIES,(MOLEX 10-11-2023) | 2 |
| P43,P45,P47 | J00033-000 | CONN,FEMALE 3 PIN,.063,(MOLEX 03-06-1032) | 3 |
| P15,P33,P34 | J00034-000 | CONN,HOUSING,FEMALE,03 PIN,(MOLEX 5197-N 10-01-3036) | 3 |
| XHS1 | J00040-000 | CONN,PIN & SOCKET,4 PIN,FEM,STR,(MOLEX 03-09-1041) | 1 |
| P52 | J00046-000 | CONN,HOUSING,FEMALE,4 PIN,0.1SPACING,7880 SERIES,(MOLEX 10-11-2043) | 1 |
| P41,P42 | J00230-000 | STRAIGHT PLUG FOR TELEDYNE PULSED X-BAND TUBE [VIKING VP4/4CE26] | 2 |
| P36,P37,P53,P55,P57 | J01021-000 | CONN,MALE 2 PIN .063,(MOLEX 03-06-2023) | 5 |
| P44,P46,P48 | J01031-000 | CONN,MALE 3 PIN,.063,(MOLEX 03-06-2032) | 3 |
| XP9,XP10 | J04014-000 | TERMINAL PIN HIGH PRESSURE MOLEX 7879 SERIES [MOLEX 08-50-0005] (FOR SERIES 7880 HOUSING 10-11-XXXX) | 4 |
| XP14,XP15,XP31,XP32, XP33,XP34 | J04015-000 | PIN,TERMINAL FOR HOUSING CONNECTOR 5.08MM,(MOLEX 5194 SERIES 08-70-1030) | 15 |
| P3 | J10171-000 | CONN, 17 PIN FEMALE, CRIMP, 1/4 TURN LOCKING, [HYPERTRONICS KA17/127BEV1FRTAH] | 1 |
| P49 | J10264-000 | CONN,FEM SOCKET,26 PIN,IDC MASS TERMINATION,(THOMAS & BETTS 609-2601M) | 1 |
| J7 | J11240-000 | CONN,RIBBON,24 PIN,FEMALE,1A CONTACTS,BLUE, [3M, 3549-1000-/3448-61] | 1 |
| P5,P6 | J11370-000 | CONN,D-SUB,37 PIN,FEMALE,RIBBON (AMPHENOL, G17K37001001EU) | 2 |
| P1 | J12031-000 | CONN,D-SUB,FEMALE,3 PIN,#8 AWG,PLUG,HI POWER [ITT CANNON DAM-3W3S] | 2 |
| P51 | J12091-000 | CONN,D-SUB,9 PIN,FEMALE,CRIMP (ITT CANNON DEU-9S) | 1 |
| P2,P40 | J12250-000 | CONN,D-SUB,25 PIN,FEMALE,CRIMP | 2 |
| P50 | J12372-000 | D-SUB,37 PIN,FEMALE,CRIMP | 1 |
| TB1 | J13060-000 | TERM BLOCK,6 POS,6-32,250V,20A,(BEAU 18006) | 1 |
| XK1 | J15240-000 | SCREW TERM SOCKET/DPDT RELAY,FOR KU SERIES,(P&B 27E487) | 1 |
| | J17102-000 | BNC,BULKHEAD RECEPTACLE,GROUNDED,(AMPHENOL 31-221) | 1 |
| XP1 | J18054-000 | CONTACT,FEMALE,HI PWR,20 AMP,UP TO 12AWG WIRE,[ITT CANNON DM53744-6] | 5 |
| | J18073-000 | MALE SCREW LOCK,D SUB CONN,(AMP 205980-1) | 1 |

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| J1 | J18114-000 | CONN,4 PIN,MALE,BOX MNT,(AMPHENOL 97-3102A-22-22P) | 1 |
| XJ1 | J18115-000 | CONN, FEMALE, 4 PIN, 8 AWG, STRAIGHT PLUG, SOLDER (AMPHENOL MS3106F22-22S) | 1 |
| P20,P25,P26,P27,P28,P29,P35 | J18124-000 | CONN,SMA MALE SOLDER ATTACHMENT FOR RG188,(RADIALL. R125.072.001) | 7 |
| J2,P7,P8 | J18176-000 | CONN,D-SUB,15 PIN,FEMALE,CRIMP,(ITT CANNON DAU-15S) | 3 |
| XTB1 | J29002-000 | TERMINAL JUMPER,6-32,(BEAU 1832) | 3 |
| | J31014-000 | SPRING LATCH KIT,D-SUB,(AMPHENOL 17-529) | 4 |
| XJ2 | J31032-000 | CONN,MIL,8 PIN,MALE,STRAIGHT PLUG,CRIMP,(AMPHENOL MS3126F12-8P) | 1 |
| | J31075-000 | CONNECTOR,20KV,24LEAD;LEAD COLOR WHITE,(CONNECTRONICS 10539-01) | 2 |
| | J31076-000 | CONNECTOR,20 KV,24LEAD;LEAD COLOR RED,(CONNECTRONICS 10539-02) | 2 |
| | J31077-000 | CONNECTOR,20 KV,24LEAD;LEAD COLOR YELLOW,(CONNECTRONICS 10539-04) | 4 |
| | J31078-000 | CONNECTOR,20 KV,24LEAD;LEAD COLOR BROWN,(CONNECTRONICS 10539-03) | 2 |
| P18,P19 | J31079-000 | CONNECTOR,20 KV,24LEAD;LEAD COLOR GREEN,(CONNECTRONICS 10539-05) | 2 |
| L1 | L00060-000 | CORE,SNAP ON,EMI SUPPRESS,110 OHM @ 25MHZ, 250 OHM @ 100MHZ,1/2" HOLE , (FAIR-RITE 0443164151) | 1 |
| | N25445-000 | POTTING CONTAINER | 1 |
| | N25446-000 | POTTING CONTAINER COVER | 1 |
| | N25458-000 | RIBBON CABLE CLAMP | 4 |
| | N27721-000 | SOCKET HEAD W/SHOULDERS | 4 |
| S2,S3 | S25002-000 | SWITCH,PUSHBUTTON,SPDT,SAFETY DOOR INTERLOCK,DEFEATABLE,(MICRO SWITCH 3AC6) | 2 |
| S4 | S32074-000 | SWITCH,KEYLOCK,1 POLE,3 POS,SHORTING,THROW,(ILLINOIS LOCK HD5161 AACCM-100-090-041G)WITH KEY E100 | 1 |
| S1 | S36017-000 | C/B,3 POLE,250VAC,15A,50/60HZ,18.8A TRIP (AIRPAX IEGH-666-1-61-15.0-21-V) | 1 |
| U1 | U00052-000 | PRECISION CELSIUS TEMP SENSOR, TO-220 [NATIONAL LM35DT] | 1 |
| | W21201-000 | POWER CORD,12 AWG,5 COND,NEOPRENE COVERED,(ROYAL ELECTRIC 4A-1205) | 10 |
| | W26400-000 | RIBBON CABLE, 64 COND, 28 AWG, STRANDED,.050 CENTERS [BELDEN 9L28064] | 4 |
| W1-W5 | W30104-000 | CABLE,GLASS FIBER OPTIC,200 MICRON HCS, (OFS, BC04265-10] | 10 |
| F1,F2,F3,F4,F5,F6 | Z20020-000 | FUSE,2A,250V,3AG,SB,(LITTELFUSE 313.002) | 6 |
| Z1,Z2,Z3 | Z31022-000 | SURGE ARRESTOR,(CPCLARE AC240L) | 3 |
| Z4,Z5,Z6 | Z31024-000 | TRANZORB, 440V, 1.5KE440CA (GI 1.5KE440CA) | 3 |

## 5.3.12 Parts List, Storage Cap Assembly, A33186-001

| REF. DESIG. | ETM P/N | DESCRIPTION | QUANTITY |
|---|---|---|---|
| C1,C2,C3,C4,C5,C6,C7 | C20017-000 | CAP,0.18UF,9KV,+10%,-0%,MICA,AXIAL,3.3 W X 0.54 T X 4.40 L,[PACIFIC CAPACITOR CO. SM902G144A] | 7 |
| C8,C9,C10,C11,C12,C13,C14,C15,C16,C17 | C24252-000 | CAP,0.25MF,4200V WORKING VOLTAGE, MICA,AXIAL,(PACIFIC CAPACITORS, SM502G254C) | 10 |
| P1,P2,P3,P4 | J12641-000 | HV LEAD W/RIGHT ANGLE CONNECTOR,15KV,(CONNECTRONICS, OLE36-11549-01) | 4 |
| J1,J2,J3,J4 | J12642-000 | HV RECEPTACLE, SINGLE PIN, MALE, 15KV, SCREW MOUNT,(CONNECTRONICS OLE36-10334-03) | 4 |
| | N10019-000 | SPACER CAPACITOR | 1 |
| | N35939-001 | CAP BANK ENCLOSURE | 1 |
| | N35941-000 | CAPACITOR ENCLOSURE END PLATE | 2 |
| | N35942-001 | CAP BANK SIDE INSULATION | 2 |
| R1,R2,R6,R7,R11,R12,R15,R16,R17,R21,R22,R23 | R00106-000 | RES,10 OHM,2W,5%,CC,(A/B RC42GF100J) | 12 |
| R5,R10,R20 | R15060-000 | RES,50M,3.6W,1%,16KV,NON-INDUCTIVE,FILM (CADDOCK MG735-15-50M-1%) | 3 |
| R3,R4,R8,R9,R18,R19 | R50126-000 | RES,2.2 OHM,2W,5%,CC,AXIAL,10PPM,NO OIL,[RCD COMPONENTS PR2-2R2J] | 6 |
| R13,R14,R24,R25 | R50147-000 | RES,4.7 OHM,2W,10%,CC,AXIAL,300PPM,OIL,BULK CERAMIC COMPOSITION RES.,80J SGL PULSE,700VAC, | 4 |

## 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  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, Transient Generators, Power Meters, Directional Couplers, Field Monitoring Equipment, Conducted Immunity Generators, Signal Generators and Tripods 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. Traveling Wave Tubes in the 200T2G8A, 250T1G3 and 250T8G18 will be free from defects in material and workmanship for a period of two (2) years from date of shipment. Vacuum tubes in the 'L' series amplifiers, other traveling-wave tubes in models not previously listed and power heads will be free from defects in material and workmanship for a period of one (1) year. Contact AR RF/Microwave Instrumentation for warranty information regarding items not listed. Seller's sole responsibility in fulfilling these warranties shall be to repair or replace any goods which do not conform to the foregoing warranties or, at seller's option, to give buyer credit for defective goods. The warranty is valid only when used in the country specified at time of order. Warranty service must be obtained from the repair facility designated at that time. If warranty service is not available in the country where the equipment is to be used, it must be returned to AR RF/Microwave Instrumentation. Warranty service will be provided only for defective goods which are returned within the warranty period, freight costs prepaid to AR RF/Microwave Instrumentation or its designated repair facility.

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

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

REV0611