

User Manual

AA-1218G-3.5KW-PT



R.F. MICROWAVE AMPLIFIER SYSTEM

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Purpose of the Equipment

The TWTA is designed to amplify RF signals to high power levels. It consists of a TWT and other RF components, solid state electronic power supplies, control logic, built-in fault and status monitors so as to provide safety to the operator, the electronics, and the TWT.

WARNING!

- Do Not operate this equipment with the covers removed.
- Do Not have the equipment plugged into AC Power with the covers removed.
- Do Not remove the covers without waiting 5 minutes after the unit has been unplugged from AC power
- Do Not operate this equipment without both RF input and RF output being properly terminated.
- Do Not bypass or attempt to modify the operation of the Safety Interlock Switch.
- Without covers in place, personnel can be subjected to dangerous High Voltages which can cause serious injury or death. Without the covers in place there will be inadequate cooling to the internal components resulting in serious damage.
- Without the RF input and RF output being properly terminated, serious injury to personnel can occur.
- Without the RF input and RF output being properly terminated, serious damage to the internal components can occur.

CAUTION

Read the preceding paragraphs before operating the power supplies.

General System Introduction

Prime power is connected to the TWTA unit via the three prong socket in the rear of the enclosure. It is fused and controlled by the Main Relay.

The Front Panel Switches control the TWTA. The WARM UP button controls the Main Relay to power the unit. The STANDBY, OPERATE and RESET buttons control various stages of the unit operation.

The Front Panel Display shows current status of the unit and allows to change certain parameters.

The computer interface, specified at time of manufacture, allows the user to emulate the STANDBY, OPERATE and RESET buttons remotely as well as read status of the unit and change amplifier's settings and parameters. It also allows to set the internal video pulse generator.

The Low Voltage Power Supply provides regulated and filtered low voltages to various components within the TWTA. It also contains a microprocessor to monitor cooling fan currents.

The TWT is connected to the external termination points with various RF configurations specified at time of manufacture.

Installation

Locate amplifier in such a manner that adequate cool air is available to the fan inlet on the front of the unit. Do not restrict space in the back of the unit such that exhaust air is confined or blocked.

Properly terminate both RF input and RF output with appropriate RF components and at appropriate drive and frequency levels.

Connect AC power to appropriate voltage and frequencies only, with 15 amp service minimum and adequate gauged wiring (12AWG recommended).

Safety ground in connector must be used, and, for 120vac applications, Line and Neutral must not be reversed. If reversed, the unit will not function.

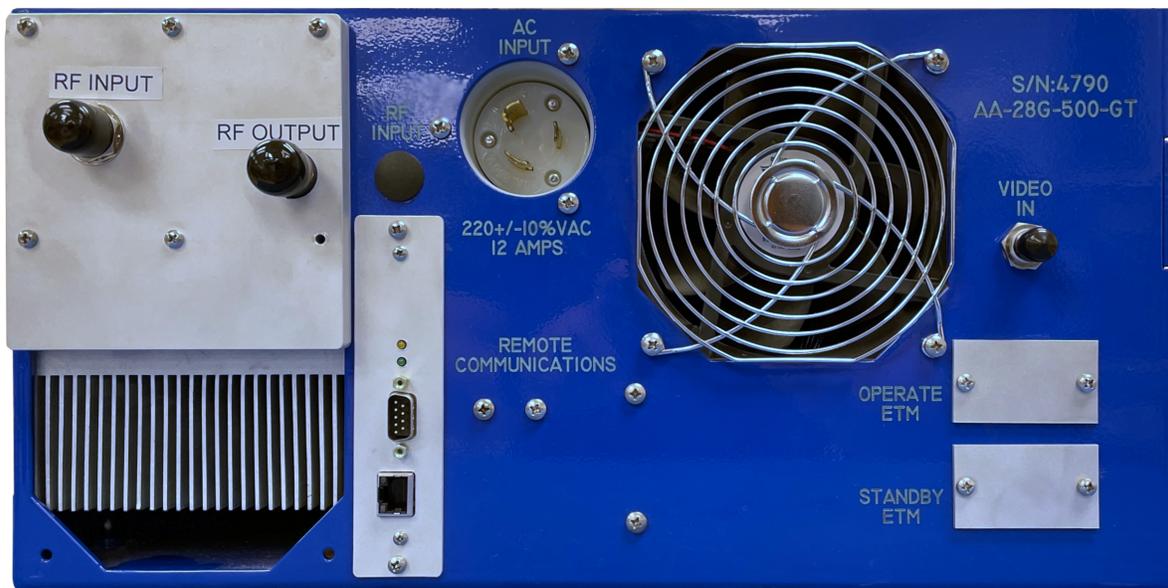
TWTA connections

- Output sample –40 dB - Provides a sample of the output power at a 40 dB reduction for power monitoring and spectral analysis.
- Input sample –20 dB - Provides a sample of the input power at a 20 dB reduction for power monitoring and spectral analysis.
- Interstage sample –20 dB - A sample of the RF stream between the Solid State Amplifier and the TWT at a 20 dB reduction. Provides a means of TWT gain calibration.
- Detected video output - A crystal-detected representation of the RF output power.

- Video pulses - Pulsed application only. Input for user-supplied video pulses.
- RF input - TWT Input for user-supplied RF.
- RF output - Amplified TWT RF output.
- Remote communications - Connection for user-specified external communications.
- Primary power - User-specified 120 or 240VAC 50-60 Hz power input.



Picture 1: Front view

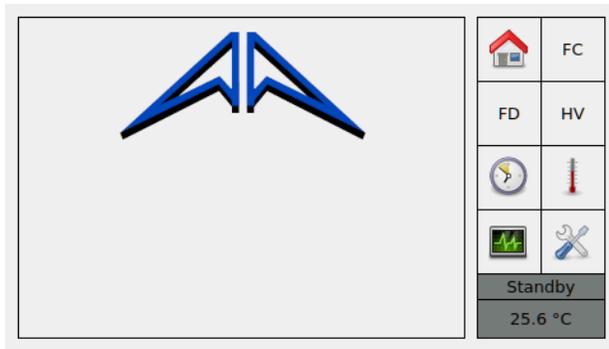


Picture 2: Back view

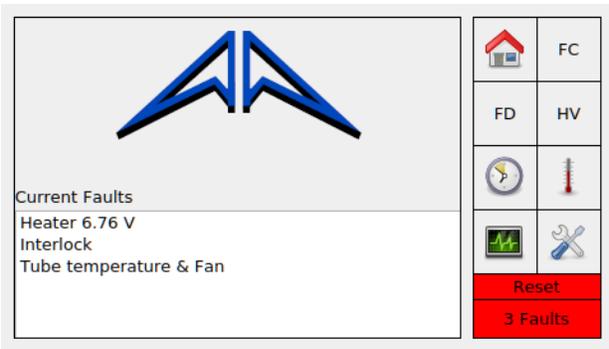
Front Panel Display

Front panel display interface consists of 8 screens, Home, Fault Count, Floating Deck, High Voltage, Elapsed Time Meters, Temperature, Input Pulses and Settings. A panel of 8 buttons on the left side allows to switch between screens. There is also a status area in the lower right corner which constantly shows the current state of the unit.

There are 4 main states of operation of the amplifier. In WARM UP, the unit is waiting until the tube heater achieves the correct temperature and all the currents and voltages stabilize. In this state the status bar shows how much time is left to finish the warm up. After the warm up time finishes the unit enters STANDBY. In STANDBY and OPERATE the status area shows ambient temperature inside the unit. Finally, in the case of RESET, the status area shows how many faults were present at the time RESET state was triggered.

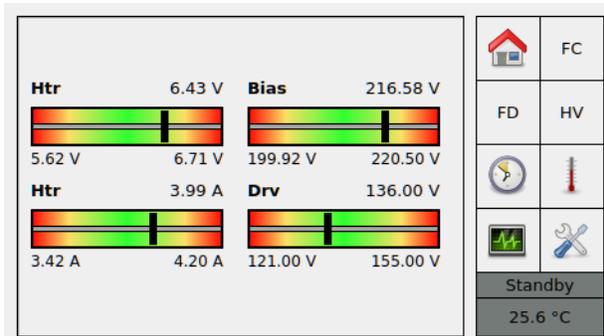


Picture 3: Home screen, Standby

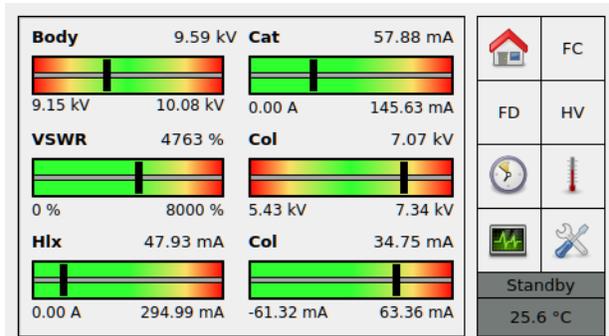


Picture 4: Home Screen, Reset

Home Screen (picture 3) is the screen shown by default after the unit turns on.

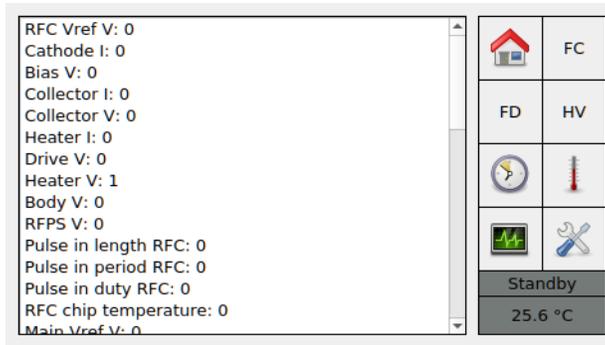


Picture 5: Floating Deck Screen



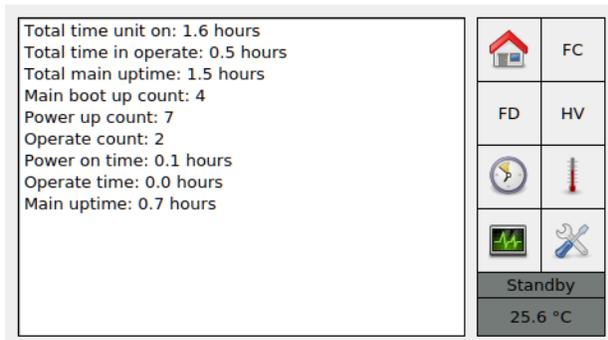
Picture 6: High Voltage Screen

Floating Deck and High Voltage screens (picture 5 and 6) present readings of the monitored parameters. The values are updated in real time.

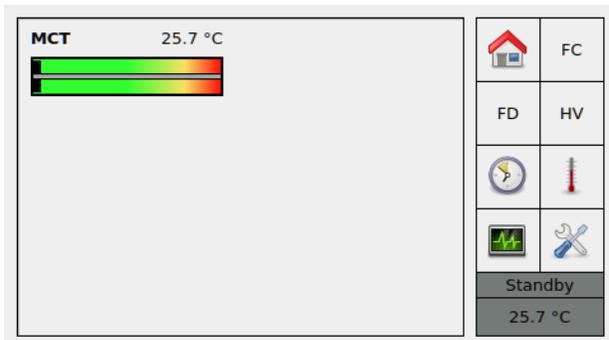


Picture 7: Fault Count Screen

Fault Log screen (picture 7), shows the count of faults which have occurred since the last time the fault log was cleared. Some faults correspond to analog values shown on other screens, some correspond to interlock switches connected to various components of the amplifier and other hardware and software errors. See appendix and appendix for detailed explanations.



Picture 8: Elapsed Time Meters Screen



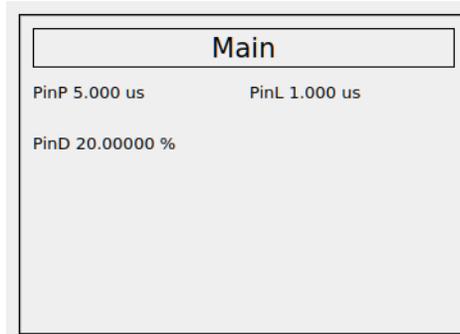
Picture 9: Temperature Screen

Elapsed Time Meters screen (Picture 8) shows the following information:

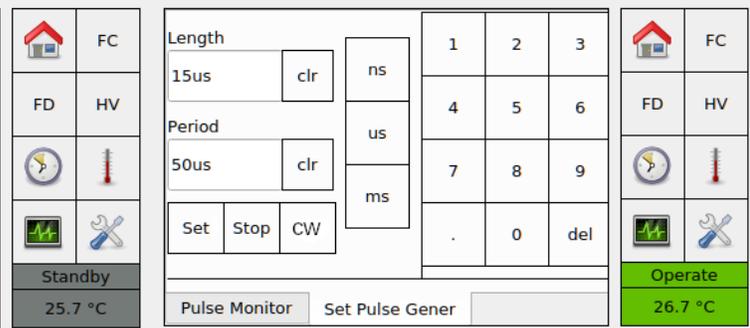
- Total time unit on – Total Time the unit has been in powered on.
- Total time in operate – Total Time the unit has been in OPERATE (high voltages on).
- Total time main uptime – The main control board is powered whenever the prime power input is connected to AC power. This timer measures total time the main control board was powered.
- Main boot up count – This counter is incremented each time the main control board is powered on, meaning essentially each time the prime power input is connected to AC power.
- Power up count – This counter is incremented each time the unit goes from POWER OFF to STANDBY.
- Operate count – This counter is incremented each time the unit turns on high voltages (even, if there is a fault and it goes to reset immediately).
- Power on time – Time since last power on.

- Operate time – Time since last time the high voltages were turned on. If in state other than OPERATE it shows the duration the unit was in OPERATE last time.
- Main uptime – Time since last time the main control board was powered, meaning essentially the last time the prime power input was connected to AC power.

Temperature screen (Picture 9) shows the temperature of the main control processor, which in general represents the ambient air temperature inside the unit.



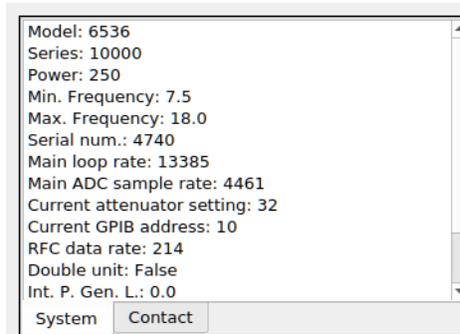
Picture 10: Pulses screen



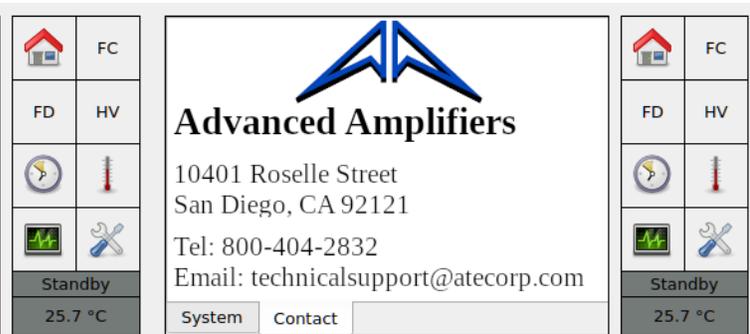
Picture 11: Set internal pulse generator screen

The Pulses screen (Picture 10) shows measurements of the incoming “video” pulses. PpinP stands for Pulse in Period, PinL for Pulse in Length and PinD for Pulse in Duty [cycle]. When the pulse input is set to CW, PinP and PinL is undefined while PinD shows 100 %. The values shown correspond to pulses which will modulate the amplifier’s output, when the amplifier is in OPERATE. So the values represent the output of the internal pulse generator, when it is activated, and video pulse input, when it is deactivated.

Set pulse generator screen (Picture) is used to set the internal pulse generator values. Tapping ns, us or ms button automatically switches the focus from Length to Period field. It is necessary to choose a unit prefix, otherwise the value will be interpreted as seconds – most likely leading to incorrect settings. Set sets the pulses and turns on the internal pulse generator, deactivating the external pulse input. Stop stops the internal pulse generator and activates the external pulse input. CW switches the internal pulse generator to CW mode, also deactivating the external pulse input.



Picture 12: Options screen, System tab



Picture 13: Contact screen

Options screen consists of 4 tabs. Contact tab (picture 13) shows the contact information of the amplifier's manufacturer. System tab (picture 12) shows general information about the amplifier and selected technical data.

The following information is available: Model, Series, Rated power output, Min. and max. supported frequency and serial number, ADC sampling rate for main control and RF control.

Operation

Terminate TWTA RF input and output. Connect external Interface as desired. Apply prime power.

Caution: The TWTA must never be placed in Operate without proper RF termination. This can lead to TWT oscillations which can permanently damage the TWT.

Power TWTA On:

Press the manual WARM UP button to power the TWTA. The manual WARM UP button will illuminate. Front panel display will show “Warm up” and the remaining warm-up time in the status area.

At initial power-up, heater voltage will be less than nominal to limit excessive current drawn by a cold filament. As the filament warms it will draw less current and the filament voltage will increase until nominal voltage is reached. Negative Bias voltage is applied to the Grid. Body and Collector supplies are off. The standard warm-up period is 5 minutes.

Standby from Warm-up:

After the warm-up period has elapsed the TWTA is placed in STANDBY by the main microprocessor. High voltage supplies and Grid voltage remain unchanged from the WARM UP state. The manual STANDBY button is illuminated and the WARM UP/OFF button is extinguished. The front panel display will indicate “Standby” on the status area. The TWTA can be now placed in OPERATE.

Operate:

Press the OPERATE button to place the TWTA in OPERATE state or send the OPERATE command from the remote computer. The OPERATE button is illuminated and the STANDBY button is extinguished. The front panel display will indicate “Operate” on the status bar and the background color will change to green.

The Main microprocessor engages the Collector voltage soon after the OPERATE command is received and the Body voltage 500 ms after the Collector voltage stabilizes. Then it waits up to 3 seconds for the Collector voltage to stabilize before going to OPERATE. Both STANDBY and OPERATE buttons are illuminated during the High Voltage on sequence. The amplifier goes to RESET if the voltages don't reach the nominal values within allowed time. 8 s after the high voltages have reached their nominal values, pulses are passed unaltered to the Floating Deck where they are subject to PRF (Pulse Frequency) and PW (Pulse Width) limiting. The TWT beam current will be present within up to 13.5 s after the TWTA OPERATE command is sent.

If RF and video pulses (pulsed units) are supplied, the TWTA will produce an amplified RF output.

Standby from Operate:

When placed in STANDBY by user command, the main processor sequentially interrupts video pulses to the Floating Deck, disengages the Body and Collector supplies and returns the TWTA to STANDBY.

The STANDBY button illuminates and the OPERATE button is extinguished. Front panel display shows “Standby” on the status bar again.

Power TWTA Off:

After placing the TWTA in STANDBY press WARM UP button to power-down the TWTA.

If the TWTA was operating at high-duty the amplifier should be run in STANDBY an additional length of time to allow the TWT to cool.

Reset:

If any monitored parameter falls outside the limits set in the processors, the Main processor interrupts pulses and disengages the high voltage supplies in a fashion similar to STANDBY but latches the system in RESET. The RESET button is illuminated and the front panel display status area shows the word “Reset” and the Home screen lists the faults which triggered the RESET, together with values latched at the moment the fault occurred.

After the cause of the fault has been corrected press the RESET button to return the TWTA to STANDBY.

TWT Temperature, cooling fans, cover Interlock, VSWR and Helix Current are all directly monitored by the Main Control and will cause the Main Control processor to place the TWTA in RESET if the amplifier is in WARMUP, STANDBY or OPERATE.

Heater Voltage and Current, Drive Voltage, Collector Voltage and Current, Body Voltage and Cathode Current are all directly monitored by the RF Control. Collector Voltage and Body Voltage will not trigger a fault until the TWTA is in operate. Heater Current and Heater Voltage will not trigger a fault during a specified time after the unit was turned on.

Grid Voltage and the RF Control Board +9V supply are handled uniquely; they are monitored by the RF Control processor but will initiate a Flashing Reset.

Flashing Reset:

FLASHING RESET indicates a fault which needs the Main Control board to turn the unit off to prevent serious damage.

The following events will trigger the Flashing Reset.

Grid voltage out of range or the RF Control Board +9V supply too high. High +9V supply or high grid voltage (absolute value) will cause a FLASHING RESET at any time while low grid voltage will cause a FLASHING RESET only in WARM UP or STANDBY. Low grid voltage in OPERATE will not cause a fault.

When there is an unexpected behavior of Main Control Board or RF Control Board firmware which trigger a watchdog to reset the microcontroller. After such a reset, the unit will immediately go to FLASHING RESET.

When the Main Control loses communication with RF Control or when it is not able to detect it after being turned on.

When there is a uncorrectable error when reading microcontroller flash memory from a critical region.

When the TWTA is in this mode all the components, except the Main Control Board are disabled, to protect from damage. Front panel display will be switched off and the external communication port might be disabled (depends on the type of the communication port). To clear a Flashing Reset the TWTA must be power-cycled. If the condition that caused the FLASHING RESET remains, the amplifier will enter the FLASHING RESET mode again.

Gassy TWT:

If the TWTA has been inactive for several months the TWT may build up gasses. This allows the TWT to arc internally and cause repeated TWTA faults.

To correct this condition, operate the TWTA for an extended period with no input pulses. When a fault occurs, reset the TWTA and return to operate. A TWT that is recovering will be evidenced by a widening period between faults. The length of time required will be determined by the particular TWT, possibly up to twenty-four hours.

The TWTA should be operated periodically to prevent gassing.

Internal Pulse Generator:

The Internal Pulse Generator can be controlled remotely (Refer to the “10000 Series Communication Protocol” document for more details) and from the Front Panel Display (see page 8).

Remote Operation

Please refer to the document “10000 Series Communication Protocol” for details regarding command encoding, status and analog readings data format as well as command syntax description.

Explanations of analog values

- **VSWR** - For pulsed amplifiers, VSWR will display either a value close to 0, if the reflected power is within acceptable levels, or a value above 8000, if the reflected power is excessive. In the former case, the TWTA will fault.
- **Heater I, Heater V** - TWT filament current and voltage. The faults are ignored during WARM UP.
- **Grid V** - Indicates the voltage at the TWT grid. When the TWTA is in Warmup or Standby the grid voltage will be virtually identical to bias voltage, reflecting the bias voltage that is applied to the grid. The operator should not misinterpret the Grid display as a direct representation of bias voltage.

When in Operate with pulses applied the Grid will display a lower (absolute) value due to the positive drive pulses interspersed with the negative bias voltage. The amount of reduction is directly proportional to the duty cycle of the pulses applied.

- **Bias V** - Direct measurement of Bias Voltage. Not present in all units (depends on RFC version).
- **Drive V** - Monitors positive drive voltage with maximum and minimum limits. TWTA will not fault until placed in Operate.
- **Collector V** - Indicates collector voltage. Collector voltage is present only when the TWTA is in Operate.
- **Collector I** - Indicates collector current with maximum limits only. Collector current is present only when the TWTA is in Operate with pulses applied (pulsed TWTA's). CW TWTAs will produce Collector current whenever the TWTA is in operate.
- **Body V** - Indicates body voltage with maximum and minimum limits. Body voltage is present only when the TWTA is in Operate. Also known as Cathode or Helix voltage.
- **Cathode I** - Indicates cathode current with maximum limits only. Cathode current is present only when the TWTA is in Operate and CW or pulses are applied (pulsed TWTA's).
- **Helix I** - Helix current is present only when the TWTA is in Operate and CW or pulses are applied (pulsed TWTA's).

Explanation of Faults and Flags

- **Temperature & Fan** - TWT temperature has exceeded acceptable levels or a cooling fan is outside its current range. Causes a fault.
- **Interlock** - The enclosure cover has been removed or loosened. Causes a fault.