

User Manual

Model AA-24G-5KW-PT



(Image above may differ from the model number listed on manual)

R.F. MICROWAVE AMPLIFIER SYSTEM

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Purpose of the Equipment

The 6548 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 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 TWTA. The STANDBY, OPERATE and RESET buttons control various stages of the TWTA operation.

The computer interface, specified at time of manufacture allows the user to emulate the STANDBY, OPERATE and RESET buttons remotely.

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 suitable for use with an oscilloscope.

- 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.
- Computer interface - Connection for user-specified external communications.
- Primary power - User-specified 120 or 240VAC 50-60 Hz power input.



Picture 1: Front view

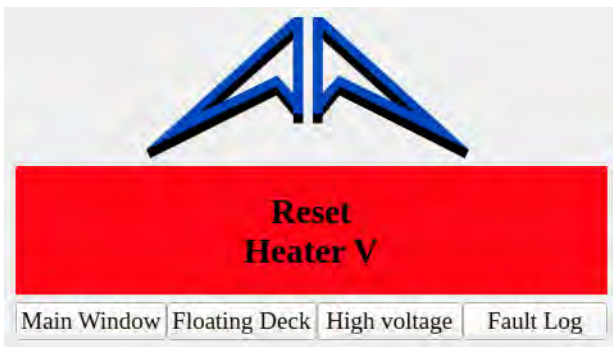
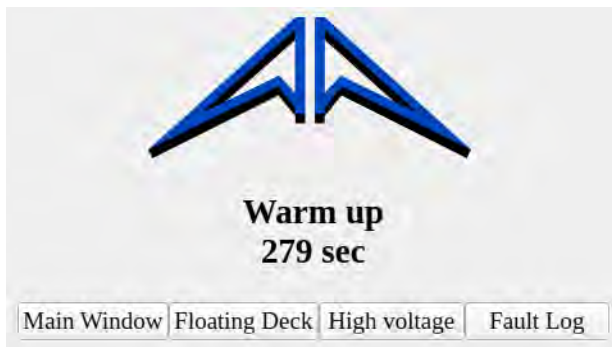


Picture 2: Back view

Front Panel Display

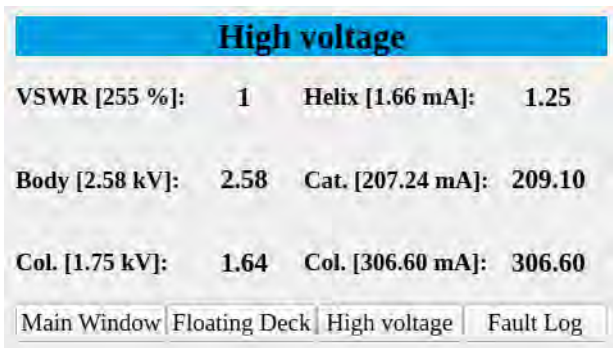
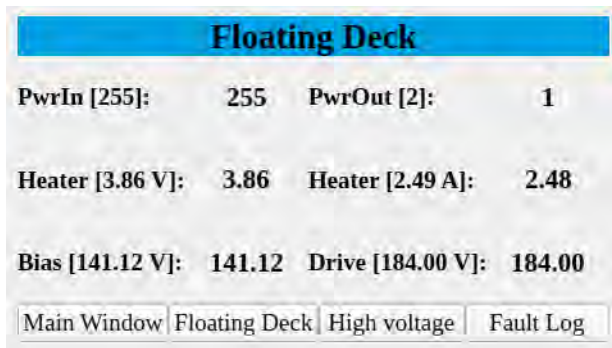
Front panel display interface consists of 4 windows, Main, Floating Deck, High Voltage and Fault Log. There are buttons to switch between the windows on the bottom of the screen.

Main window shows basic information about the unit status. It indicates which of the states the unit is in. In WARM UP state (Picture 3) the main window has a white background and shows how much time is left to finish the warm up. In STANDBY the background is yellow and the screen shows the word “Standby”. In OPERATE the background is green, the screen shows the word “Operate” and the status of the pulse input. Finally, in RESET, the main window shows the word “Reset” on a red background and indicates what faults were present at the time RESET was triggered (Picture 4).



Picture 3: Front panel display, Main, Warm up Picture 4: Front panel display, Main, Reset

Main window is shown by default after the unit turns on.



Picture 5: Front Panel Display, Floating Deck Picture 6: Front Panel Display, High Voltage

Floating Deck and High Voltage windows (picture 5 and 6) present readings of all the monitored parameters. When the unit is in WARM UP, STANDBY or OPERATE states the values are updated in real time. When the unit encounters a fault all the values represent readings from the moment the fault was encountered.

Fault count					
Bias V:	0	Cathode I:	0	Heater V:	0
Body V:	0	Collector V:	0	Heater I:	3
VSWR:	0	Collector I:	0	Drive V:	3
Temp:	0	Interlock:	2	Helix I:	0
		Wup bypass:	0		

Main Window Floating Deck High voltage Fault Log

Picture 7: Front Panel Display, Fault Log

Fault Log screen (picture 7), shows the count of faults which have occurred since the last time the fault log was cleared.

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 on the status bar.

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 bar. The TWTA can be now placed in OPERATE.

Operate:

Press the OPERATE button to place the TWTA in OPERATE state. 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 Body and Collector supplies simultaneously within 5-30 ms after the OPERATE command is received. The microprocessor allows up to 1.2 seconds for the voltages to reach their nominal values. 320 ms 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. Therefore TWT beam current will be present in a range between slightly over 320 ms to 1520 ms after the TWTA is placed in operate.

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 bar shows the word "Reset" and lists the faults which triggered the RESET. When the unit is in RESET, values shown on the front panel display and sent by the 0x04 (status) remote command are the values latched in memory at the moment when unit encountered a fault.

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

TWT Temperature, cover Interlock and Anode Voltage 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 and will not trigger a fault until the TWTA is in operate.

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:

Two conditions will cause the Reset button to flash: 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 the TWTA is in this mode the Floating Deck Part C is disabled to protect the TWT against catastrophic damage. The TWTA will not communicate with an external PC. To clear a Flashing Reset the TWTA must be power-cycled. If the voltage that caused the reset remains out of range the amplifier will enter the Flashing Reset mode again after the power cycle.

Remote/Local Lockout:

The optional remote/local lockout feature prevents dual control of the TWTA; either the local or remote control is active, but not both. If the latching Remote switch is depressed the switch will illuminate and the TWTA can only be controlled by the external computer. When the switch is depressed again,

control will be solely from the front panel switches. If the TWTA is in OPERATE and the Remote switch state is changed the TWTA will automatically be placed in STANDBY.

Optionally (set at TWTA manufacture) the lockout feature will disable/enable remote control while retaining local control at all times.

If the TWTA encounters a fault, the Reset button (physical or application) should be pressed before the Remote switch state is changed.

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.

Remote Operation

Communication protocol over RS-232

Communications are via a simple byte protocol over standard RS-232 interface.

The protocol consists of a set of single byte commands. No additional bytes should be sent before or after a command, as they might confuse the main processor and result in undefined behavior. There is no handshaking involved, and no hardware flow control, just a simple command - answer sequence.

The commands cause the unit to echo the byte sent to it or send a specified number of bytes encoding the requested information. The length of the answer is specified for each command.

Command	Byte	Response Length	Response
Go to standby	0x01	1	Echo 0x01
Go to operate	0x02	1	Echo 0x02
Reset	0x20	1	Echo 0x20
Send status and analog readings	0x04	31	DATA

Go to standby command causes the amplifier to turn off the high voltage and go to STANDBY mode. It is equivalent to pressing the STANDBY button on the front panel.

Go to operate command causes the amplifier to apply the high voltage to the tube and go to OPERATE mode. It is equivalent to pressing the OPERATE button on the front panel.

Reset causes the amplifier to go back to STANDBY from RESET. It is equivalent to pressing the RESET button on the front panel.

Send status and analog readings command causes the amplifier to send 31 bytes of data described in the following subsection.

Status and analog readings data format

The 0x04 command causes the amplifier to send 31 bytes of data to the computer.

The first three bytes consist of flags indicating the status of the unit. Byte 3 and 4 indicate warm up time, and the rest encode the analog status values.

Byte	bit	description
0	7	: Body V fault
0	6	: Heater V fault
0	5	: Drive V fault
0	4	: Heater I fault

0 3 : Collector V fault
 0 2 : Collector I fault
 0 1 : Bias V fault (when triggered, the unit goes to FLASHING RESET)
 0 0 : Cathode I fault

1 7 : (unused)
 1 6 : set if unit has a tube with a collector, cleared otherwise
 1 5 : (unused)
 1 4,3 : bit(4,3) == 0,0 – no pulses received
 bit(4,3) == 0,1 – pulses received, PW limited
 bit(4,3) == 1,0 – pulses received, PRF limited
 bit(4,3) == 1,1 – pulses received
 1 2 : set if local control disabled, cleared otherwise
 1 1 : (unused)
 1 0 : (unused)

2 7,6 : bit(7,6) == 0,0 – the unit is in STANDBY
 bit(7,6) == 0,1 – the unit is in RESET
 bit(7,6) == 1,0 – the unit is in OPERATE
 2 5 : Interlock fault
 2 4 : Helix I fault
 2 3 : VSWR fault
 2 2 : (unused)
 2 1 : Tube temperature fault
 2 0 : (unused)

Byte 3, 4 : Warm up timer,
 $t = ((\text{Byte 3}) + (\text{Byte 4}) * 256) * 0.032 \text{ s}$

Byte 5 : actual PWR out (optional)
 Byte 6 : (unused)
 Byte 7 : actual PWR in (optional)
 Byte 8 : actual VSWR
 Byte 9 : actual Helix I,
 $I = (\text{Byte 9}) * 0.4157 \text{ mA}$

Byte 10 : nominal PWR out (optional)
 Byte 11 : (unused)
 Byte 12 : nominal PWR in
 Byte 13 : nominal VSWR in %
 Byte 14 : nominal Helix I,
 $I = (\text{Byte 14}) * 0.4157 \text{ mA}$

Byte 15 : actual Cathode I
 $I = (\text{Byte 15}) * 1.867 \text{ mA}$

Byte 16 : actual Bias V
 $V = (\text{Byte 16}) * 0.98 \text{ V}$

Byte 17 : actual Collector I,
 $I = ((\text{Byte 17}) - 30) * 2.044 \text{ mA}$

Byte 18 : actual Collector V,

$V = (\text{Byte } 18) * 0.0548 \text{ kV}$
 Byte 19 : actual Heater I,
 $I = (\text{Byte } 19) * 0.0189 \text{ A}$
 Byte 20 : actual Drive V,
 $V = (\text{Byte } 20) * 1.0 \text{ V}$
 Byte 21 : actual Heater V,
 $V = ((\text{Byte } 21) - 106) * 0.0476 \text{ V}$
 Byte 22 : actual Body V,
 $V = (\text{Byte } 22) * 0.0548 \text{ kV}$

 Byte 23 : nominal Cathode I
 $I = (\text{Byte } 23) * 1.867 \text{ mA}$
 Byte 24 : actual Bias V
 $V = (\text{Byte } 24) * 0.98 \text{ V}$
 Byte 25 : actual Collector I,
 $I = ((\text{Byte } 25) - 30) * 2.044 \text{ mA}$
 Byte 26 : actual Collector V,
 $V = (\text{Byte } 26) * 0.0548 \text{ V}$
 Byte 27 : actual Heater I,
 $I = (\text{Byte } 27) * 0.0189 \text{ A}$
 Byte 28 : actual Drive V,
 $V = (\text{Byte } 28) * 1.0 \text{ V}$
 Byte 29 : actual Heater V,
 $V = ((\text{Byte } 29) - 106) * 0.0476 \text{ V}$
 Byte 30 : actual Body V,
 $V = (\text{Byte } 30) * 0.0548 \text{ kV}$

Explanations of analog values

- **PWR in and PWR out** - If the optional power monitoring is not installed the first two lines of the display will read as shown.
- **VSWR** - For pulsed amplifiers, VSWR will display either 0 or 255. If the reflected power is within acceptable levels the value is zero. If the reflected power is excessive the reading will shift to 255 and the TWTA will fault.

For CW amplifiers VSWR indicates reflected power proportionate to actual reflected power.

- **Heater I, Heater V** - TWT filament current and voltage.
- **Bias V (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.

- **Drive V** - Monitors positive drive voltage with maximum and minimum limits. Fault protocol similar to Heater; 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 TWTA's 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 pulses are applied (pulsed TWTA's). CW TWTA's will produce Cathode current whenever the TWTA is in operate.
- **Helix I** - Helix current is present only when the TWTA is in Operate and pulses are applied (pulsed TWTA's). CW TWTA's will produce Helix current whenever the TWTA is in operate.

Explanation of Faults and Flags

- **Temperature** - 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.
- **PRF** - When the maximum Pulse Repetition Frequency limit of the TWTA has been exceeded and internal limiting circuitry engaged. Indication only, will not cause a fault.
- **PW (Pulse Width)** - When the maximum Pulse Width limit of the TWTA has been exceeded and internal limiting circuitry engaged. Indication only, will not cause a fault.