QUANSER
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# USER MANUAL

## AMPAQ-PWM Amplifier

Set Up and Configuration


CAPTIVATE. MOTIVATE. GRADUATE.

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This product meets the essential requirements of applicable European Directives as follows:

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- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

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**Industry Canada Notice**
This Class A digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

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# 1 PRESENTATION

## 1.1 Description

The Quanser AMPAQ-PWM, pictured in Figure 1.1, is a pulse width modulated (PWM) current amplifier designed to power Quanser experiments. The AMPAQ-PWM is a single channel amplifier, meaning it can power a single load. The AMPAQ-PWM replaces the UPM line of power amplifiers with additional benefits, including a generic data acquisition board (DAQ) interface for increased flexibility, current sensing capability, and an auxiliary E-Stop connector to allow a single E-Stop button to stop multiple devices.


Figure 1.1: Quanser AMPAQ-PWM

**Caution:** This equipment is designed to be used for educational and research purposes and is not intended for use by the general public. The user is responsible to ensure that the equipment will be used by technically qualified personnel only.

**Caution:** If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

# 2 COMPONENTS

The components on the front and back panels of the AMPAQ-PWM are depicted in Figure 2.1. Each component on the AMPAQ has an identification number that corresponds to a short description given in Table 2.1. The pin out information for the analog sensor's mini-DIN connectors and the 16-pin digital I/O connector header are shown in Figure 2.2.

| ID | Name | Description | Electrical Range |
|---|---|---|---|
| 1 | *Amplifier Command* connector | The input command signal from the DAQ is a voltage that controls the output current. The AMPAQ-PWM adjusts the output duty cycle to maintain the commanded output current. | ±10 V |
| 2 | *Current Sense* connector | This connector provides a voltage proportional to the actual output current. Scaling is 1 Volt = 2.1 Amps. The AMPAQ-PWM must be connected to a load in order for the *Current Sense* connector to output a voltage. | |
| 3 | *Status* LED | Indicates if the amplifier is powered up, as well as the status of the amplifier. When the amplifier is powered up but disabled, the LED turns red. When the amplifier is powered up and enabled, the LED turns green. | |
| 4 | *To Load* connector | This connector provides power to the load. The output current is controlled by the *Amplifier Command* signal. | 3.75 A Cont., 15 A Peak |
| 5 | *Calibrate* LED | Indicates the calibration status of the connected device (i.e. Shake Table II). | |
| 6 | *E-Stop* connector | The AMPAQ-PWM requires an E-Stop (emergency stop) button to be connected. If no E-Stop button is connected, the AMPAQ-PWM is disabled by default. | |
| 7 | *Auxiliary E-Stop* connector | Connector for an additional E-Stop to enable daisy-chaining stop commands to multiple devices. | |
| 8 | *From Device* connector | Carries the sensor I/O from the device including encoder signals, limit switch states, etc. | |
| 9 | *Limit Switch* LEDs | Indicate the status of the limit switches on the connected device | |
| 10 | *Encoder* Output connector | Connector to output the device encoder signal to an external DAQ device | |
| 11 | *Digital I/O* Output connector | Connector to output the digital signals from the device sensors to an external DAQ device | Low:0-0.8 V, High:2-5.5 V |
| 12 | *S1-S4* Analog Sensor Output connectors | Used to send the analog sensor signals from the connected device to an external DAQ | |
| 13 | *S1-S4* Analog Sensor Input connectors | Used to properly power the analog sensors on the connected device | ±12 V |
| 14 | Fuses | Replaceable fuses to protect the amplifier | |
| 15 | Power switch | Amplifier power switch | |
| 16 | Power connector | Used to connect the amplifier to the mains | |

Table 2.1: AMPAQ-PWM components

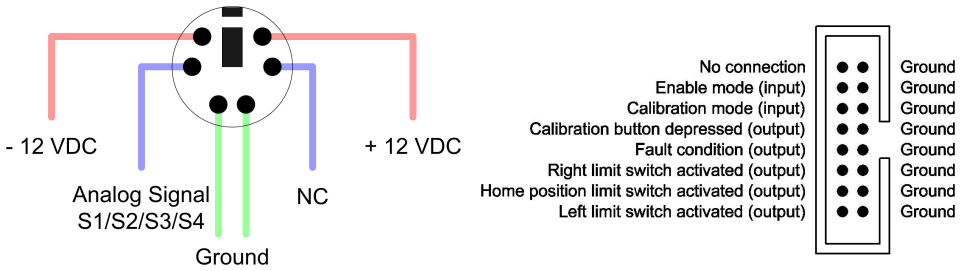
**Caution:** Do not exceed the maximum PWM *Load* ratings 3.75 A continuous, 15 A peak, and 240 VAC.

**Caution:** Do not replace the power cable provided with one of lower quality or rating.


(a) Front


(b) Back

Figure 2.1: AMPAQ-PWM components




(a) Front

(b) Back

Figure 2.2: AMPAQ-PWM analog and digital sensor connectors

# 3 SPECIFICATIONS

Table 3.1 lists the AC input requirements for the AMPAQ-PWM. The PWM output specifications are given in Table 3.2, and the general amplifier specifications are listed in Table 3.3.

| AC Input Specifications | Value |
|---|---|
| Input Voltage Range | 100 VAC - 120 VAC or<br>200 VAC - 240 VAC |
| Input Frequency Range | 50 Hz - 60 Hz |
| AC Current Rating | 3.75 A |
| Fuses | 3.5 A, 250 V, 3AG Slow Blow |
| Protection Class | Class I |

Table 3.1: AC Input Specifications

| PWM Output Specifications | Value |
|---|---|
| Maximum Continuous Output Current | 3.75 A |
| Maximum Peak Output Current<br>(Maximum duration approximately 2 seconds.) | 15 A |
| Maximum Output Voltage<br>(Output voltage is dependent on the input voltage.) | 240 VAC |
| Switching Frequency | 20 kHz |

Table 3.2: PWM Output Specifications

**Caution:** Do not exceed the maximum PWM load ratings of 3.75 A continuous, 15 A peak, and 240 VAC.

| Amplifier Specifications | Value |
|---|---|
| Amplifier Command Input | $\pm$ 10 V |
| Current Sense Output | 1 V = 2.1 A |
| Digital Inputs | Low-level: 0 V - 0.8 V<br>High-level: 2.0 V - 5.5 V |
| Digital Outputs | Low-level: 0 V - 0.6 V<br>High-level: 4.1 V - 5.2 V |
| Mass | 10.4 kg |
| Dimensions | 0.39 m $\times$ 0.39 m $\times$ 0.14 m |
| Environmental | • Standard rating<br>• Indoor use only<br>• Altitude up to 2000m<br>• Maximum relative humidity of 80% up to 31°C decreasing linearly to 50% relative humidity at 40°C<br>• Pollution Degree 2<br>• Mains supply voltage fluctuations up to $\pm$10% of the nominal voltage<br>• Maximum transient overvoltage 2500V<br>• Marked degree of protection to IEC 60529: Ordinary Equipment (IPX0) |

Table 3.3: Amplifier Specifications

**Caution:** Precaution must be taken during the connection of this equipment to the AC outlet to make sure the grounding (earthing) is in place and the ground wire is not disconnected.

**Caution:** Avoid covering the fan during operation to prevent premature thermal shutdown of the amplifier.

**Caution:** Do not position the equipment so that it is difficult to operate the on/off switch.

**Caution:** The AMPAQ-PWM devices are made to be used with Quanser designed experiment kits that have particular actuators. Use caution if the AMPAQ-PWM is being used with your own actuator. Any load to be used with the AMPAQ-PWM should have a minimum inductance of 0.1 mH.

**Caution:** Do not use the cables provided with the AMPAQ-PWM to wire it to experiments that use a different amplifier module. The AMPAQ-PWM can be used with such experiments only if plant specific cables are available.

# 4 FUSE INSTALLATION

The AMPAQ-PWM has two 3.5 Amp fuses that protect the amplifier from overcurrent through the main power connector. If you find your unit does not output power from the *To Load* connector, or otherwise stops functioning, check the fuses.

**Caution: Make sure the power to the amplifier is disconnected before changing any fuses!**

Follow this procedure to install or replace the fuses in the AMPAQ-PWM:

1. The fuse holders are located at the rear of the unit, shown in Figure 2.1 with ID #14.
2. Make sure the amplifier power cable is disconnected.
3. Remove both fuse holders. To do this, push and twist the knob counter-clockwise and pull the fuse holder out as illustrated in Figure 4.1.

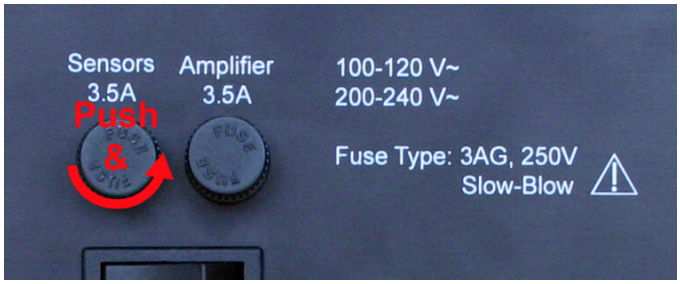



Figure 4.1: Remove fuse holders

4. As shown in Figure 4.2, remove the old fuses from the holders and insert the new ones.

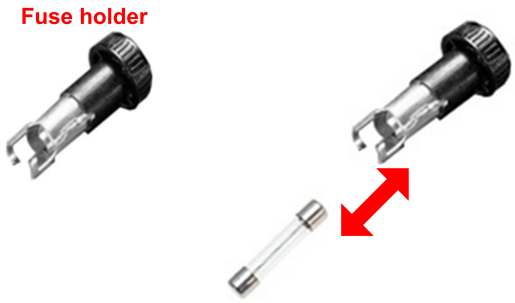



Figure 4.2: Replacing the fuse in the fuse holder

5. Ensure the fuse being installed is a **3.5 A, 250 V, 3AG Slow Blow** fuse. For example, the following fuses are acceptable replacements:
   - Digi-Key: 283-2750-ND,
   - Electrosonic: MDL-3-1/2

   **Caution:** Installing the wrong fuse rating may result in damage to your amplifier.
6. Install the fuse holders back into the amplifier. Push the fuse holder into the panel and twist the knob clockwise until secure.
7. Connect the power cable to the back of the amplifier.

# 5 WIRING PROCEDURE

## 5.1 Cable Nomenclature

The cables used to connect the Quanser AMPAQ-PWM to a Quanser DAQ and experiment are shown in Table 5.1. Depending on your configuration, not all these cables are necessary.

| Cable | Type | Description |
|---|---|---|
|  (a) RCA Cable | 2xRCA to 2xRCA | RCA-to-RCA cables connect the AMPAQ-PWM *Amplifier Command* and *Current Sense* connectors to the DAQ. RCA-to-RCA cables are also used to connect the *S1*, *S2*, *S3*, and *S4* Analog Sensor outputs to the DAQ. Three pairs are supplied. |
|  (b) Motor Cable | 4-pin-Amphenol to 4-socket-Amphenol | This cable connects the output of the AMPAQ-PWM to the desired load. |
|  (c) E-Stop | E-Stop | The E-Stop must be connected to the AMPAQ-PWM for proper operation. The E-Stop button locks in the disabled position when pressed. To release the E-Stop, twist the red button clockwise. |
|  (d) From Device Cable | DB15 to DB15 | This cable connects the AMPAQ-PWM *From Device* connector to the Shake Table II circuit board. It carries the three limit switch signals, the motor Hall effect signals, and the motor encoder signals. It also supplies the DC power required by the sensors. |
|  (e) Encoder Cable | 5-pin-stereo-DIN to 5-pin-stereo-DIN | This cable carries the encoder signals between the AMPAQ-PWM *Encoder* connector and the DAQ. These signals are: +5 VDC power supply, ground, channel A, and channel B. (Channel Z is optional.) |

| Cable | Type | Description |
|---|---|---|
|  (f) Analog Cable | 6-pin-mini-DIN to 6-pin-mini-DIN | This cable connects an external analog sensor to the AMPAQ-PWM *S1*, *S2*, *S3*, or *S4* Analog Sensor input. The cable also supplies ± 12 VDC from the AMPAQ-PWM to power the sensor. |
|  (g) Digital I/O Cable | 16-pin Ribbon Cable | This cable connects the Digital I/O connector on the AMPAQ-PWM to a Q2-USB or QPIDe terminal board. |
|  (h) Split Digital I/O Cable | Split 16-pin Ribbon Cable | This cable connects the Digital I/O connector on the AMPAQ-PWM to a Q8-USB. |

Table 5.1: Cables used to connect the AMPAQ-PWM to a Quanser DAQ and experiment

## 5.2 Typical Connections

Refer to the experiment-specific User Manual and Laboratory Guide for wiring instructions.

# 6 TROUBLESHOOTING

Follow the steps given below based on your issue with the AMPAQ-PWM.

**Amplifier does not power up.**

- Make sure the power cable is firmly connected to the power connector on the back of the amplifier
- Verify that the fuse is not burnt. If the fuse is burnt, see Section 4 for furst rating and replacement information.

**Motor/load is not being driven.**

- Verify that the fuse is not burnt. If the fuse is burnt, see Section 4 for furst rating and replacement information.
- If the AMPAQ-PWM is being used with a Quanser system, verify that all the connections illustrated in the User Manual for that Quanser product have been made correctly.
- If the Emergency stop switch is connected to the amplifier, make sure the red button is in the upper position to enable the amplifier. The amplifier cannot be enabled when the button is in the lower position. The *Enabled* LED on each channel should be lit. Twist to release the red button into the enabled position.

# 7 TECHNICAL SUPPORT

To obtain support from Quanser, go to http://www.quanser.com/ and click on the Tech Support link. Fill in the form with all the requested software and hardware information as well as a description of the problem encountered. Also, make sure your e-mail address and telephone number are included. Submit the form and a technical support person will contact you.

## Mix and match components and peripherals to suit your education or research needs

**AMPAQ-L2**

**AMPAQ-L4**

**AMPAQ-PWM**

**VoltPAQ-X1**

**VoltPAQ-X2**

**VoltPAQ-X4**

**QPIDe**

**Q2-USB**

**Q8-USB**

**NI Terminal Board**

**Q1-cRIO**

Quanser's range of control peripherals includes amplifiers and data acquisition boards. They can be purchased separately to control educational or research-grade plants. Mix and match these peripherals with Quanser plants and control design software to accelerate control system design and implementation.

To find the right peripherals for your teaching or research needs, please email info@quanser.com.



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