In addition to the proportional outputs, On/Off (digital) outputs are available to energize dump valves, blocking valves, brakes, buzzers, etc. These solid state auxiliary outputs utilize field effect transistors (FET’s) to provide continuous loads up to 3 Amps.

During the final phase of the automated testing, the adjustable parameters of the board are calibrated to specifications published by the valve manufacturer. 25 turn trimpots are provided on the board to make small adjustments to “fine tune” the output. Larger adjustments can also be made to drive valves other than originally intended.

**Ordering Information**

**Example Model**

<table>
<thead>
<tr>
<th>Model</th>
<th>C</th>
<th>N</th>
<th>R</th>
<th>C</th>
<th>S</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>504</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>514</td>
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<tr>
<td>524</td>
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<td>534</td>
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</table>

**BASE CONFIGURATIONS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Current</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>504</td>
<td>180-2500mA</td>
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<tr>
<td>514</td>
<td>180-2500mA</td>
<td>451-1000Hz</td>
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<td>524</td>
<td>10-800mA</td>
<td>100-450Hz</td>
</tr>
<tr>
<td>534</td>
<td>10-800mA</td>
<td>451-1000Hz</td>
</tr>
</tbody>
</table>

**MID RANGE**

N – No Mid Range or Swap
C – Swap w/Common Mid Adjust
S – Swap w/Separate Mid Adjust

**COMMAND SOURCE VS**

5 – 5VDC Regulated
6 – 6VDC Regulated

**OUTPUT CONFIGURATIONS**

1 – PWM A & PWMB
2 – PWM A&B, Aux A&B
3 – PWM A&B, Com Aux
4 – PWM A&B, Aux A&B, Com Aux
5 – PWMA, Aux A&B, Com Aux
(Flow Control Arrangement)

**HI RANGE**

C – Common HI Trimpot Adjust
S – Separate HI Trimpot Adjust

**LOW RANGE**

C – Common LO Trimpot Adjust
S – Separate LO Trimpot Adjust
R – Range Dependent LO

**RAMP FEATURE**

N – No Ramp
R – Ramp Feature (0-5 Second Adj.)
C – Ramp Cancel

**INTERNAL RESISTORS**

N – No On-board Resistors
1 – 180Ω Padding Resistors
2 – 360Ω Padding Resistors
OPERATIONS MANUAL

MODEL 504 / 514 / 524 / 534

Features

♦ Low Drop MOSFET Outputs
♦ Independent Low Current Adjustments
♦ Independent Mid Current Adjustments
♦ Independent Hi Current Adjustments
♦ Adjustable RAMP Rate
♦ Adjustable PWM Frequency
♦ Dual Output Range (Mid/Hi)
♦ RAMP Duration Between MID and HI Ranges
♦ Epoxy Encapsulated Electronics
♦ Swap Output Feature
♦ RAMP Cancel Feature
♦ Current Sourcing w/Feedback Outputs
♦ Over-Signal Protection
♦ Short Circuit Protection
♦ Broken Lead Protection
♦ Reverse Polarity Protection
♦ Voltage Supply Transient Protection
♦ EMI and RFI Hardened

Description

The Model 504 series of valve drive boards are an electronic interface between a command source (potentiometer, joystick, foot pedal, etc.) and an electro-hydraulic valve or pump. The board receives analog signals from the command source, and provides Pulse Width Modulated Output (PWM) to drive most electrically modulated valves and pumps available today. The board also provides solid-state On/Off Outputs and other features to smoothly stroke a valve or pump with greater control and flexibility over conventional hydraulic components. The 504 family of valve drive boards are designed for use on mobile equipment where extreme environments (both weather and electrical) are encountered. The boards also offer features used in many industrial applications. The 504 board can be mounted directly to P-Q single axis joysticks or can be remotely mounted up to 100 feet from the command source.

Output from the proportional channels is Pulse Width Modulated (PWM) with current monitoring. The Model 504 boards can be configured to drive single and dual grounded proportional solenoids. The proportional current output will remain fixed within 2% during supply voltage swings and coil resistance changes, (which occurs as the valve coil temperature rises). Light emitting diodes (LED’s) are lit whenever the command signal exceeds the board’s deadband and the board begins to output. Should any of the outputs become shorted, they will shut down automatically.
In addition to the proportional outputs, On/Off (digital) outputs are available to energize dump valves, blocking valves, brakes, buzzers, etc. These solid-state auxiliary outputs utilize field effect transistors (FET’s) to provide continuous loads up to 2.5 Amps.

During the final phase of the automated testing, the adjustable parameters of the board are calibrated to specifications published by the valve manufacturer. 25 turn trim pots are provided on the board to make small adjustments to “fine tune” the PWM output to the application. Larger adjustments can also be made to drive valves other than originally intended.

Ordering Information

Example Model 504 S 5 N R S 4 -XXX

BASE CONFIGURATIONS

504 - [180-2500mA 45-450Hz]
514 - [180-2500mA 451-1000Hz]
524 - [10-800mA 100-450Hz]
534 - [10-800mA 451-1000Hz]

MID RANGE
N – No Mid Range or Swap
C – Swap w/Common Mid Adjust
S – Swap w/Separate Mid Adjust

COMMAND SOURCE VS
5 – 5VDC Regulated
6 – 6VDC Regulated

OUTPUT CONFIGURATIONS
1 – PWM A & PWM B
2 – PWM A&B, Aux A&B
3 – PWM A&B, Com Aux
4 – PWM A&B, Aux A&B, Com Aux
5 – PWMA, Aux A&B, Com Aux (Flow Control Arrangement)

HI RANGE
C – Common HI Trim pot Adjust
S – Separate HI Trim pot Adjust

LOW RANGE
C – Common LO Trim pot adjust
S – Separate LO Trim pot adjust
R – Range Dependent LO adjusts

INTERNAL RESISTORS
N – No On-board Resistors
1 – 180Ω Padding Resistors
2 – 360Ω Padding Resistors

RAMP FEATURE
N – No Ramp
R – Ramp Feature (0-5 Second Adj.)
C – Ramp Cancel
Ordering Descriptions

**Base Configurations** – There are four ranges that cover all makes and models of electro-hydraulic valves and pumps. Most will use the “504” base configuration which offers a large range of PWM at the more common PWM frequencies. The base configuration is completely adjustable within it’s range shown. The base configuration parameters must be matched to the valve or pump specifications to be driven.

**Output Configurations** – The Pulse Width Modulated outputs are current sourcing with feedback outputs. These outputs utilize the highly efficient, low drop MOSFET technology to switch the voltage supply at a rapid rate. Internal feedback circuitry ensures that the PWM delivered equals the signal received from the command source. Extremely tight current regulation circuitry disregards changes in voltage supply and coil resistance changes. The PWM outputs are well protected using a thermal type technique to shut down the outputs in the event of a short circuit. Do not put diodes in PWM lines; the PWM outputs are already protected from back feeding circuits.

A choice of configurations provides the system designer the flexibility to tailor On/Off outputs or choose the flow control arrangement for single grounded coil flow and pressure control valves. The 504 family of boards do not drive single coil “floating coil” valves or pumps directly unless the application is unidirectional only. P-Q Controls offers alternative valve drive boards or an external relay logic circuit can be used with the 504 to drive these rare types of single coil valves and pumps.

**Command Source VS** – The voltage supply for the command source is provided by the PT+ and PT- terminals of the 504 board. The 5th digit in the model number signifies the regulated voltage at these terminals (5 or 6 volts). This voltage source is adequate to power single and multi-axis joysticks, foot pedals, sensors, etc. An external signal source (such as from a PLC) with the proper signal swing can also be used to drive the 504 board. The 5vdc version is standard. The 6vdc version is compatible with older valve drive board models.

**Internal Resistors** – The command source is generally a 500 ohm potentiometer with 180 ohm padding resistors. The 180 ohm resistors attached to each leg of the potentiometer limit the voltage swing of the command source. By limiting the voltage swing, the 504 board can detect problems associated with the command source wiring (such as opens or short circuits) and automatically shut down all outputs. The “N” nomenclature, signifying no on-board resistors, is the standard. With P-Q Inductively Coupled and Hall effect command products, the “padding resistors” are built into the command circuitry. The options allowing the resistors to be placed on the board defeats the lead protection and is not recommended for most applications.

**Low Range** – Also known as “threshold”. The low range adjusts the PWM output level when the command signal just exceeds the deadband area and PWM first occurs (LED just lights). One adjustment for both A and B sides is required. Separate A&B trim pot adjustments will provide for more precise fine tuning. When the MID circuitry is activated, the proportional current at turn on (LO) will be lower than when the HI range electronics are engaged. The drop in current becomes greater as the difference between the Mid calibration and the HI calibration becomes greater. The net result is that the operator will need to move the control handle a little further in order to obtain a low function speed when in the midrange mode. Option “R” Range Dependent Lo will provide separate trim pots for Mid and Hi ranges to overcome this problem.
**Hi Range** – The PWM output level when the command signal reaches the maximum (full throw of joystick). The “HI ENA” terminal must be connected to voltage supply to output in the HI mode. This adjustment tunes the maximum speed for the application. Separate “S” trim pots will allow the A and B directions to be fine tuned independently.

**Mid Range** – The PWM output level when the command signal reaches the maximum (full throw of joystick) with no voltage supply connected to the “HI ENA” terminal. Mid is typically set half way between Lo and Hi, but can be adjusted to any PWM within the board’s capability. Available choices are no mid option, one common trim pot, and separate trim pots. If the mid option is purchased, the swap feature is also provided. Swap is an input, that when energized swaps the PWM and On/Off outputs of the board. This is useful in mobile vehicles such as manlifts where the operator can rotate the turret 180˚ and continue to drive the machine.

**Ramp Feature** – Ramp is provided to smooth the PWM output due to abrupt changes of the command signal or when switching between Mid and Hi ranges. Ramp will adjust the output rate-of-change from Lo to Hi (accel) and from Hi to Lo (decel). The ramp cancel feature cancels ramp whenever the signal is within the deadband region. This feature is useful for emergency situations since with a spring return command source, such as a joystick, the ramp will cancel when the joystick is let go and the handle returns to the neutral area. The standard option is the ramp feature “R”. If ramping to a stop is a concern, we recommend a trigger or enable bar on the joystick that will discontinue power in the event of an emergency (see the P-Q applications bulletin 940208J1.DWG for specific instructions).

**Calibration Number** – The Model 504 is an extremely versatile valve drive board. One board can be adjusted to operate a number of different valves by a number of different valve manufacturers at various voltages. However, each application requires adjusting the board’s PWM outputs to match the valve to be driven in each particular application. Each board (504/514/524/534) has a range of outputs and frequencies that are completely adjustable within its ranges. A calibration number is assigned to each board to determine the PWM output levels and frequency at the time of shipment. With a calibration number, the board is “bench tuned” to a specific application, and can be installed and operating in less time. Of course, for best performance, the board will require “fine tuning” after installation. If the application changes, the board can be re-tuned within its range as shown in the Ordering Information section.

The calibration number becomes a part of the model number:

**Example:** 534N5NRSS3-120

<table>
<thead>
<tr>
<th>Calibration Number</th>
<th>Part Number</th>
</tr>
</thead>
</table>

**What is in the Calibration Number?** In order to configure a calibration number, we must have the following information:

- Valve manufacturer and model number
- Supply voltage
- Coil resistance of valve or pump
- PWM frequency (sometimes referred to as “dither”)  
- Low current setting
- Hi current setting

990329R1AML.DOC
The information required is available from the valve manufacturer. P-Q also holds an extensive list of valve coil specifications and can assist you in choosing the proper base configuration and in assigning a calibration number.

**Mating connector:** A mating connector is required for all Model 504 boards. To order it from P-Q Controls, the part number is A-09014-12. This is made by PCD and their part number is ELFP12210. Other companies also make connectors that will mate with the board. The pin spacing is .200”.

**Installation**

1. **Voltage Supply**

Power and ground should come directly to the board from the battery or power supply. A power source between 10-30VDC is required for proper operation. The power supply must be clean and free of spikes and DC ripple. A dedicated direct connection from the battery, fuse block or power supply is strongly recommended to ensure a clean supply. Remember that the board can source as much as 8.5 amps through the voltage supply with three outputs (PWM, common and directional auxiliary) active. The power supply wiring should be sized appropriately to handle the maximum current draw anticipated. Contact P-Q for assistance as required.

2. **Command Connection**

Wiring between the command source and board should be 22 gauge or larger and must be shielded. The shield should be connected to the GND terminal of the 504 board. Do not connect the shield on the command source end. The M504 can be mounted up to 100 feet from the command source. Larger size wire is required for remote mounting (generally 18-20ga.). Contact P-Q Controls for assistance.

**NOTE:** Interference can occur where command leads are run parallel to PWM or AC leads. Mobile radios and high power AC equipment or transmission lines are other potential sources of interference. If interference is suspected, use shielded cable and mount the 504 board in a metal enclosure and ground the enclosure to chassis ground. Contact P-Q for further assistance.

**Bi-Directional Command Connection**

(Single axis joystick, foot pedal, or potentiometer)
Unidirectional Command Connection & Switched Command Configurations
(Single Axis Joystick, potentiometer, foot pedal, or switch)

Multi-Axis Joystick Command Connection
(M212/M215/ M220/M225 Joysticks and M425 Angle Sensor)

One PT+/PT- power supply from one 504 board is sufficient to power a complete multi-axis joystick.
3. Valve Coil Connection

The valve coils should be grounded to a single wire that is carried back to the ground terminal of the board. The system can then be grounded from the power supply to the board to frame ground, if required. The coil ground must be connected to the same ground potential as board ground or damage to the board may occur. A single point grounding scheme will eliminate differences in ground potential. See the P-Q installation drawing (last page) for details on single point grounding.

NOTE: In most cases, grounding the valve coils to the vehicle frame will not cause a problem. But in using an external battery to "jump" power into the system with the coils frame grounded, be sure to connect the external battery negative to the frame of the vehicle being jumped. This is to keep the external battery ground and the vehicle frame at the same ground potential.

PWM outputs A and B should not be tied together. Although damage will not occur, the board will not operate as smoothly. Use a board with the output configuration “5” (flow control arrangement) or consult P-Q for further assistance.

External flyback diodes may not be used on the proportional outputs. This diode arrangement will defeat the current source circuit. The board is already equipped with reverse polarity protection (feedback diodes) at the PWM output terminals.

4. Output Adjustment (Fine Tuning)

The Model 504 is an extremely versatile valve drive board. One board can be adjusted to operate a number of different valves by a number of different valve manufacturers at various voltages. However, each application requires adjusting the board’s PWM outputs to match the valve to be driven in each particular application. Each board (504/514/524/534) has a range of outputs and frequencies that are completely adjustable within its ranges. A calibration number is assigned to each board to determine the PWM output levels and frequency at the time of shipment. With the proper calibration number, the board is “bench tuned” to a specific application, and can be installed and operating in less time. Of course, for best performance, the board will require “fine tuning” after installation. If the application changes, the board can be re-tuned within its range as shown in the Ordering Information section.

The PWM frequency is adjusted at P-Q to the frequency recommended by the valve manufacturer for the specific valve to be driven. Adjustments to the frequency are generally not required except in experimental applications or if working with a different valve than originally intended.

To adjust the output of the board, to either fine-tune the valve operation, or to re-adjust the outputs to drive a different valve, several trim pot adjustments are provided. These trim pots are 25 turn trimmers that do not stop at their ends of travel. Depending on the options purchased, your board may have separate trim pots for the “A” and “B” outputs. Separate trim pot adjustments of the A and B coils provide maximum performance. Boards that do not have all options will have spacing between trim pots. These trim pots may not correspond to the labeling of the board. See the P-Q document 010920AML.doc for details.

After all fine-tuning is complete; Sentry Seal or nail polish should be applied to the adjusting screw to avoid inadvertent changes due to vibration.
LO A (Threshold): LO A adjusts the PWM output when the board first comes on. Move the command source slightly to its "just on" position (observe that the “A” light on the board just turns on). Adjust the LO A trim pot (CW to increase) to obtain slight motion of the function.

LO B (Threshold): LO B adjusts the PWM output when the board first comes on. Move the command source slightly to its "just on" position (observe that the “B” light on the board just turns on). Adjust the LO B trim pot (CW to increase) to obtain slight motion of the function.

HI A: Adjusts the maximum output in direction A. Move the command source to the max A position (“A” light is lit). Adjust the HI A trim pot (CW to increase) to obtain maximum desired function speed. Adjust HI A CCW to a point where speed just starts to drop; then turn trim pot CW ¼ turn to ensure full utility of the command signal swing and eliminate excess current delivered to the valve.

HI B: Adjusts the maximum output in direction B. Move the command source to the max B position (“B” light is lit). Adjust the HI B trim pot (CW to increase) to obtain maximum desired function speed. Adjust HI B CCW to a point where speed just starts to drop; then turn trim pot CW ¼ turn to ensure full utility of the command signal swing and eliminate excess current delivered to the valve.

MID A (Optional): Adjusts the midrange output in the A direction. Disconnect supply voltage from terminal "HI ENA" to put board in midrange mode. Move command source to max “A” position and adjust MID A trim pot to desired speed.

MID B (Optional): Adjusts the midrange output in the B direction. Disconnect supply voltage from terminal "HI ENA" to put board in midrange mode. Move command source to max “B” position and adjust MID A trim pot to desired speed.

RMP: Ramp is provided to smooth abrupt changes of the command signal. Ramp will adjust the output duration from threshold to max (accel) and from max output to threshold (decel). Ramp is factory preset to Off (full CCW) for ease of fine tuning. Adjust the RMP trim pot (CW to increase) to obtain desired accel/decel time.

NOTE: Since the circuitry has delay for both accelerating and decelerating a load, it is important to note that the only means of stopping the output quickly will be with a switch. The switch should interrupt the command signal or voltage supply to the board, disconnect the valve coil(s) from the board, or energize a dump or blocking valve. See the P-Q applications bulletin 940208J1.DWG for specific instructions.

AUXILIARY OUTPUTS: Digital (On/Off) outputs are capable of 2.5 amps continuous. Higher current draws or short circuits to ground will cause the output to shut down automatically. There are no adjustments to be made to the auxiliary outputs.

Troubleshooting

Refer to the Ordering Information section to determine what specific options your board is equipped with. If needed, contact a P-Q Applications Engineer to decipher the calibration number and determine what valve or pump the board was originally intended to drive.
The board is well protected from both mechanical and electrical environments. The two-part epoxy potting eliminates moisture concerns, provides excellent shock and vibration resistance, dissipates heat, and protects from mechanical damage. The board will function normally when covered with heavy dew or frost. Although not recommended, the board can function normally when submerged in water.

Electrical protection consists of reverse polarity, short circuit to ground, voltage supply transient, and loose or broken command lead protection. The board is RFI and EMI resistant and easily surpasses all CE levels.

If erratic operation is the problem, the board may only require fine tuning. See the Installation section for instructions on fine tuning the PWM outputs.

1. Equipment Required
   A. 10-30VDC supply source, 10 amps
   B. Multimeter with 0-30 VDC range
   C. Trim pot adjusting screwdriver (small slotted)
   D. Command source (or 500 ohm pot with 180 ohm padding resistors)

2. Power Board
   Power and ground should come directly to the board from the battery or power supply (see Installation section for details).

3. Voltage Regulation
   The voltage supply for the command source is provided by the PT+ and PT- terminals of the 504 board. This voltage source is adequate to power single and multi-axis joysticks, foot pedals, sensors, etc.

   Determine which voltage regulator is on your board by the 5th digit in the model number. Measure the voltage between "PT+" and "PT-" terminals of the 504 board. With a “5” in the part number the regulated supply should be 5 volts +/- .05 VDC. The regulated voltage will measure 6VDC +/- .06VDC if the 5th digit of the model number is “6”. If the board is receiving sufficient power to the VS and GND terminals, and no regulated voltage is present across the PT+ and PT- terminals, replace the board.

4. Command Source Signal
   The 504 boards are driven with a 500 ohm potentiometer with 180 ohm padding resistors, or P-Q’s inductive or Hall products. The 180 ohm resistors attached to each leg of the potentiometer limit the voltage swing of the command source. By limiting the voltage swing the 504 board can detect problems associated with the command source wiring (such as opens or short circuits) and automatically shut down all outputs. With P-Q Inductively Coupled and Hall effect command products, the “padding resistors” are built into the circuitry.
The 504 family of boards has a built-in deadband area around neutral. Although the command source is sending a signal to the board, the board does not respond until the deadband area is surpassed. Once the signal exceeds the deadband area in either the A or B direction, the appropriate PWM and auxiliary outputs are energized.

Connect a voltmeter across the SIG and PT- terminals of the 504 board. Throw the command source from its just ON position (LO) to its full ON position (MAX). If the command source is suspected of being faulty, connect a potentiometer and resistor network to the board.

**SIGNAL SWING:**

<table>
<thead>
<tr>
<th>Command Level</th>
<th>LED Status</th>
<th>Signal to PT- (5VDC)</th>
<th>Signal to PT- (6VDC)</th>
</tr>
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<tbody>
<tr>
<td>Max B</td>
<td>Off</td>
<td>1.0V</td>
<td>1.2V</td>
</tr>
<tr>
<td>Lo B (Threshold)</td>
<td>Off</td>
<td>2.2V</td>
<td>2.64V</td>
</tr>
<tr>
<td>Neutral</td>
<td>Off</td>
<td>2.5V</td>
<td>3.0V</td>
</tr>
<tr>
<td>Lo A (Threshold)</td>
<td>Just Turned On</td>
<td>2.8V</td>
<td>3.36V</td>
</tr>
<tr>
<td>Max A</td>
<td>On</td>
<td>4.0V</td>
<td>4.8V</td>
</tr>
</tbody>
</table>

An incorrect signal swing indicates an improper command source or faulty wiring. A correct signal swing with no lights and no output indicates a shorted output connection or faulty board. To verify, disconnect all output leads and monitor LED lights while operating the command source.

5. **CHECK COIL CONTINUITY**

Disconnect the PWM output wires A and B from the 504 board. Check the resistance of each coil and associated wiring by connecting an ohmmeter across the A output wire and the GND terminal at the board. Repeat the procedure for the B output wire. The resistance of each coil and lead wire should be close to the coil resistance specified for the valve coil the board is intended to drive.

Reconnect the valve coil output wires to the board. If you do not have a valve coil to connect to the board, a resistor of high wattage and resistance close to that of the valve coil can be used as a test load.
6. CHECK PWM OUTPUTS

Connect an ammeter in series with the valve as in the following diagram:

![Diagram of PWM output check](image)

Throw the command source and confirm that current is being delivered to the valve. The current at turn-on and at full command should closely match the output specifications for the valve or pump.

NOTE: A voltmeter may be used in place of an ammeter. This will eliminate the need to disconnect wires to place the ammeter in series with the valve coil. The voltmeter can be connected across the GND and A or B terminals at the board. Voltmeter readings are less reliable than ammeter readings due to the constant current source nature of the 504 (the voltage will vary with the supply and will rise as the coil heats up).

7. Check Auxiliary Outputs

Auxiliary outputs are optional. Check your model number to determine if your board is equipped with these additional outputs.

Common and directional auxiliary outputs are solid-state On/Off MOSFET outputs used to energize dump or blocking valves, release brakes, energize lights, etc. These outputs are completely protected with a thermal shutdown technique. In the event of a short circuit to the auxiliary or the PWM outputs, the board will not reset to normal operation unless the short has been removed, and either the power cycled or the joystick returned to neutral. Diodes are not necessary to protect from back feeding, since diodes are already present on the board. Diodes can be added to the output for logic circuits.

Connect a voltmeter across the auxiliary output and the GND terminal. When an LED lights the auxiliary output will be active. The output should measure slightly less than the voltage supply delivered to the board. These outputs can also be checked with a load applied across the proper Aux terminal and ground; a DC lamp or buzzer works well.
**Common Aux** = A 2.5 amp solid-state On/Off output energized whenever the command signal exceeds the deadband in either the A or B direction. Useful for energizing blocking valves or dump valves, releasing brakes, etc.

**Aux A** = A 2.5 amp solid-state On/Off output energized whenever the command signal exceeds the deadband in the "A" direction. Useful for energizing directional valves (flow and pressure control arrangements) and energizing specific functions such as back-up alarms, throttles, etc.

**Aux B** = A 2.5 amp solid-state On/Off output energized whenever the command signal exceeds the deadband in the "B" direction. Useful for energizing directional valves (flow and pressure control arrangements) and energizing specific functions such as back-up alarms, throttles, etc.

If the board still does not respond properly, call P-Q Controls, Inc. at (860) 583-6994 and ask to speak to one of our application engineers for assistance.

**General Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Typical</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Supply (VS)</td>
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<td>30</td>
<td>Vdc</td>
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<tr>
<td>Transient Protection</td>
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<td>V</td>
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<td>Reverse Polarity</td>
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<td>Vdc</td>
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<td>Current Consumption at Null</td>
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<td>Regulated Voltage (5VDC)</td>
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<td>Vdc</td>
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<td>Regulated Voltage Current Capability</td>
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<td>mA</td>
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</tr>
<tr>
<td>Signal Input Resistance</td>
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<td>ohms</td>
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</tr>
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<td>Signal Input Null (5VDC)</td>
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<td>Vdc</td>
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</tr>
<tr>
<td>Signal Input Max (5VDC Referred to Null)</td>
<td>±1.30</td>
<td>±1.50</td>
<td>±1.70</td>
<td>Vdc</td>
</tr>
<tr>
<td>Signal Input Min (Referred to Null)</td>
<td>±0.225</td>
<td>±0.300</td>
<td>±0.375</td>
<td>Vdc</td>
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<tr>
<td>Over-signal Protection (Referred to Null)</td>
<td>±1.70</td>
<td>±2.00</td>
<td>Vdc</td>
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<tr>
<td>Frequency Range</td>
<td>45</td>
<td>1000</td>
<td>Hz</td>
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<tr>
<td>Minimum PWM Output</td>
<td>10</td>
<td></td>
<td>mA</td>
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<tr>
<td>Maximum PWM Output</td>
<td>2500</td>
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<td>mA</td>
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<tr>
<td>Short Circuit Current Limit</td>
<td>4.0</td>
<td></td>
<td>Amps</td>
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<tr>
<td>Voltage Drop at Max Current @ 3 Amps</td>
<td>1.6</td>
<td></td>
<td>Vdc</td>
<td></td>
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<tr>
<td>Signal Trip Point A (5vdc)</td>
<td>2.8</td>
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<td>Vdc</td>
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<tr>
<td>Signal Trip Point B (5vdc)</td>
<td>2.2</td>
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<tr>
<td>Max Current</td>
<td>2.5</td>
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<td>Amps</td>
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<td>Short Circuit Current Limit</td>
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<td>Vdc</td>
<td></td>
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<tr>
<td>Voltage Drop at Max Current</td>
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<td>Vdc</td>
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<tr>
<td>Max Reverse Voltage</td>
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<td>Power Up Delay (PWM Output)</td>
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<td>ms</td>
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<tr>
<td>Power Off Delay (PWM Output)</td>
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<tr>
<td>Signal On Delay (Full Scale PWM Output)</td>
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<td>ms</td>
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<tr>
<td>Load Impedance</td>
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<td>80</td>
<td>Ohms</td>
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<tr>
<td>Operating Temperature Range</td>
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<td>+85</td>
<td>°C</td>
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<tr>
<td>Signal Off Delay (Full Scale PWM Output)</td>
<td>50</td>
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<td>ms</td>
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