AMERICAN CONTROL ELECTRONICS ™
ACE

# PAT443-10

**1Q SCR NEMA 4X Adjustable Speed Drive with Isolation for PMDC or Field Wound Brushed Motors**

14300 De La Tour Drive
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## Specifications

| Model | Line Voltage (VAC) | Armature Voltage Range (VDC) | Continuous Armature Current (Amps) | Motor Continuous HP Range |
|---|---|---|---|---|
| PAT443-10 | 115<br>230 | 0 - 90<br>0 - 180 | 10.0 | 1/8 - 1<br>1/4 - 2 |

**AC Line Source** ........ 115 / 230 VAC ± 10%, 50/60 Hz, 1Ø
**Field Voltage** *with 115 VAC line source* ........ 50 or 100 VDC
*with 230 VAC line source* ........ 100 or 200 VDC
**Maximum Field Current** ........ 1 amp
**Acceleration Time Range** ........ 1 - 15 seconds
**Deceleration Time Range** ........ coast to stop - 15 seconds
**Input Impedance** *(S1 to S2)* ........ 3M ohms
**Analog Input Signal Range** *(isolated)* ........ 0 - 10 VDC, 4 - 20 mA
**Form Factor** ........ 1.37 at base speed
**Load Regulation** ........ <1.0% of base speed
**Speed Range** ........ 60:1
**Maximum Vibration** *0 - 50 Hz* ........ 1G
**Surrounding Air Temperature Range** ........ 50 - 104°F / 10 - 40°C
**Weight** ........ 3.25 lbs / 1.5 kg
**Safety Certifications** ........ UL/cUL Listed, File # E132235

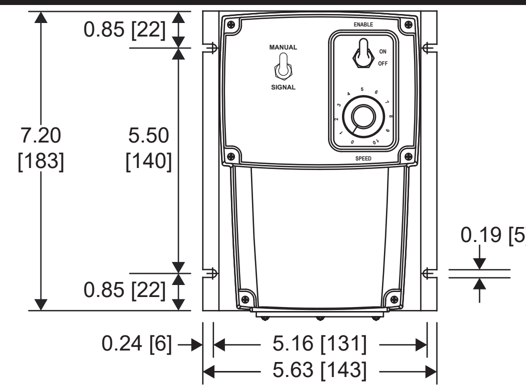
| Drive Model | Short Circuit Current Rating | | Types of Branch Circuit Protection | | Maximum Rating of Overcurrent Protection |
|---|---|---|---|---|---|
| | Maximum Current, A | Maximum Voltage, V | | | |
| PAT443-10 | 10,000 | 240 V | Non-time Delay K5 Fuse | Inverse Time Circuit Breaker | 30 A |

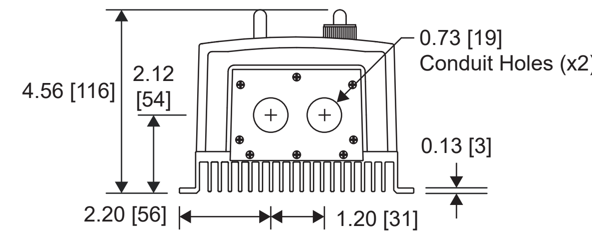
## Safety Warnings

***READ ALL SAFETY WARNINGS BEFORE INSTALLING THIS EQUIPMENT***

- **DO NOT INSTALL, REMOVE OR REWIRE THIS EQUIPMENT WITH POWER APPLIED.** Have a qualified electrical technician install, adjust and service this equipment. Follow the National Electrical Code and all other applicable electrical and safety codes, including the provisions of the Occupational Safety and Health Act (OSHA), when installing equipment.
- **Circuit potentials are at 115 or 230 VAC above earth ground**. Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Use approved personal protection equipment and insulated tools if working with power applied. Use a non-metallic screwdriver for adjusting the calibration trim pots.
- Reduce the chance of an electrical fire, shock, or explosion by using proper grounding techniques, over-current protection, thermal protection and enclosure. Follow sound maintenance procedures.
- **Removing AC line power is the only acceptable method for emergency stopping.** Do not use braking, decelerating, or coasting to a stop for emergency stopping. They may not stop a drive that is malfunctioning.
- Line starting and stopping (applying and removing AC line voltage) is recommended for infrequent starting and stopping of a drive only. Braking, decelerating to minimum speed, or coasting to a stop is recommended for frequent starts and stops. Frequent starting and stopping can produce high torque. This may cause damage to motors.
- **Do not disconnect any of the motor leads from the drive** unless power is removed or the drive is disabled. Opening any one lead while the drive is running may damage the drive.
The field output is for shunt wound motors only. Do not make any connections to F1 and F2 when using a permanent magnet motor.
- Change voltage switch settings only when the drive is disconnected from AC line voltage. Make sure both switches are set to their correct position. If the switches are improperly set to a lower voltage position, the motor will not run at full voltage and may cause damage to the transformer. If the switches are improperly set to a higher voltage, the motor will overspeed, which may cause motor damage, or result in bodily injury or loss of life.
- Be sure potentiometer tabs do not make contact with the potentiometer's body. Grounding the input may cause damage to the drive.
- This product does not have internal solid state motor overload protection. It does not contain speed-sensitive overload protection, thermal memory retention, or provisions to receive and act upon signals from remote devices for over temperature protection. If motor protection is needed in the end-use product, it needs to be provided by additional equipment in accordance with NEC standards.

## Dimensions




ALL DIMENSIONS IN INCHES [MILLIMETERS]

## Installation

**Mounting**
NEMA 4X cased drives come with two 0.73 inch (18.5 mm) conduit holes at the bottom of the case. The drives may be vertically wall mounted using the four 0.19 inch (5 mm) slotted holes on the attached heat sink. For loads less than 5 amps, the drive may be bench mounted horizontally or operated without mounting.

1. Install the mounting screws.
2. For access to the terminal strip, remove the six phillips screws on the front cover.
3. Remove the five phillips screws on the bottom plate. **Do not remove the three screws securing the bottom plate to the heat sink.**
4. Set the POWER switch to the OFF position before applying AC line voltage.
5. Install conduit hardware through the 0.73 inch (18.5 mm) knockout holes. Connect external wiring to the terminal block.
6. Place the front cover back into place. Avoid pinching any wires between the front cover and the heat sink.
7. Reinstall the 6 screws on the front cover. **The two shorter screws are for the two lower holes of the front cover.** Reinstall the 5 screws on the bottom plate.

**Wiring:** Use 14 - 16 AWG wire for AC line and motor wiring.

**Shielding Guidelines:** As a general rule, it is recommended to shield all conductors. If it is not practical to shield power conductors, it is recommended to shield all logic-level leads. If shielding of logic-level leads is not practical, the user should twist all logic leads with themselves to minimize induced noise. It may be necessary to earth ground the shielded cable. If noise is produced by devices other than the drive, ground the shield at the drive end. If noise is generated by the drive, ground the shield at the end away from the drive. Do not ground both ends of the shield.

**Fusing:** The drives provide on board fusing for the AC line (L1, L2(230)). Fuses are fast acting fuses rated for 15A at 250 VAC.

## Connections

**Input Power**
Connect the AC line power leads to terminals L1 and L2-115 if using 115 VAC line power or to terminals L1 and L2-230 if using 230 VAC line power.

**Motor**
Connect the DC armature leads to terminals A1 and A2. If the motor does not spin in the desired direction, power down the drive and reverse these connections.

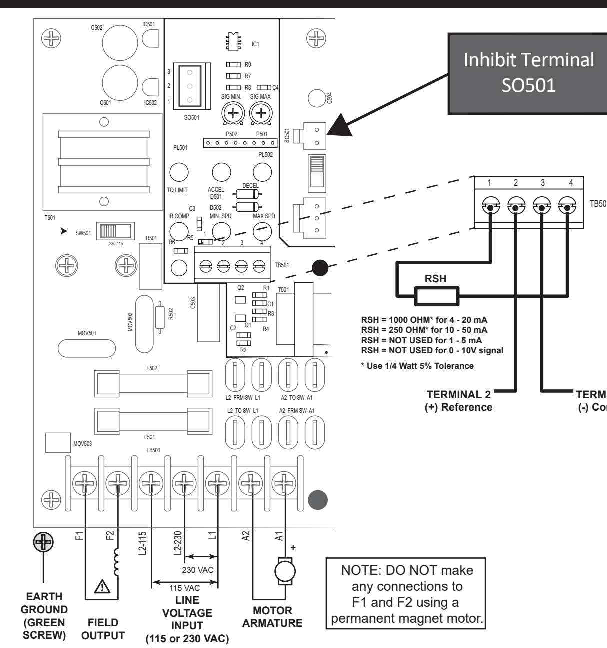
**Field**
At 115 VAC, connect the field leads to terminals F1 and L1 for a 50 VDC field or to F1 and F2 for a 100 VDC field. At 230 VAC, connect the field leads to terminals F1 and L1 for a 100 VDC field or to F1 and F2 for a 200 VDC field. **Do not make any connections to F1 and F2 if using a permanent magnet motor.**

**Speed Potentiometer (Pre-wired)**
Drives are pre-installed with a 10K ohm, 1/4 W potentiometer for speed control. Set the switch on the front cover to MANUAL to follow the potentiometer.

**Analog Signal**
Instead of using a speed adjust potentiometer, PAT443 series drives may be wired to follow an analog input signal. This input signal can be in the form of voltage (0-10 VDC) or current (1-5, 4-20, or 10-50 mA). Because these drives have built in isolation, the input signal can be grounded or ungrounded floating). Connect the signal common (-) to terminal 3 and the signal reference (+) to terminal 2 on the top board. If using a 4-20 mA signal, place a 1000 ohm resistor (RSH) across terminals 1 and 4 on the top board. If using a 10-50 mA signal, place a 250 ohm resistor (RSH) across terminals 1 and 4 on the top board. Set the switch on the front cover to AUTO to follow the remote analog signal.

**Inhibit**
Short the INHIBIT terminals to coast the motor to minimum speed. Open the INHIBIT terminals to accelerate the motor to set speed. Twist inhibit wires and seperate them from power-carrying wires or sources of electrical noise. Use shielded cable if the inhibit wires are longer than 18 inches (46 cm). If shielded cable is used, ground only one end of the shield to earth ground. Do not ground both ends of the shield. **Do not use the inhibit for emergency stopping.**

ACE offers two accessory plug harnesses for connecting to the inhibit terminals; part number KTW-0001 [18 in (46 cm) leads] and part number KTW-0002 [36 in (91 cm) leads].

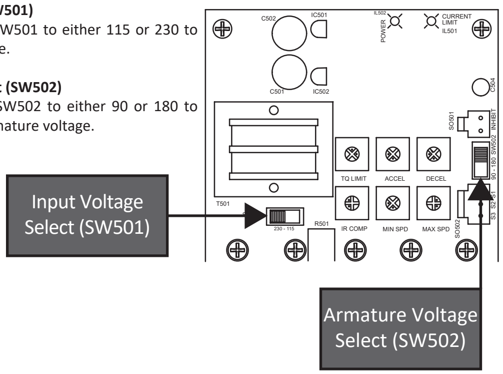


# Startup

**SELECT SWITCHES**

**Input Voltage Select (SW501)**
Set the voltage switch SW501 to either 115 or 230 to match the AC line voltage.

**Armature Voltage Select (SW502)**
Set the voltage switch SW502 to either 90 or 180 to match the maximum armature voltage.



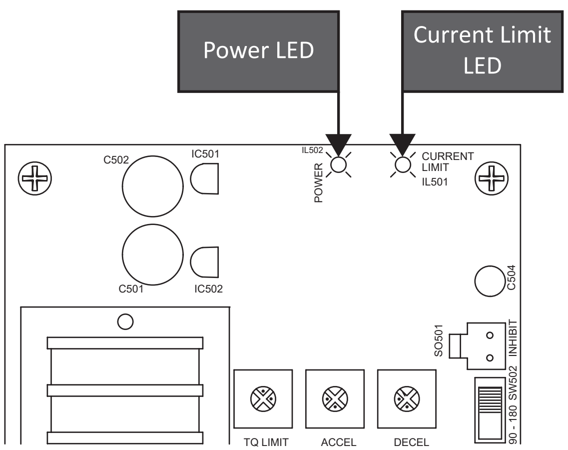

**STARTUP**

- Verify that no foreign conductive material is present on the printed circuit board.
- Ensure that all switches are properly set.

1. Set the speed adjust potentiometer to "0" (full CCW).
2. Apply AC line voltage.
3. Set the POWER switch to the ON position.
4. Slowly advance the speed adjust potentiometer clockwise (CW) or increase the analog signal. The motor slowly accelerates as the potentiometer is turned CW. Continue until the desired speed is reached.
5. Set the POWER switch to the OFF position to coast the motor to a stop.

# LEDs

**Current Limit (CURRENT LIMIT):** Red LED lights whenever the drive reaches current limit.
**Power (POWER):** Green LED lights whenever the AC line voltage is applied to the drive.

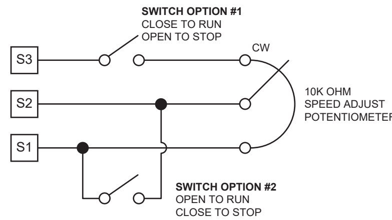




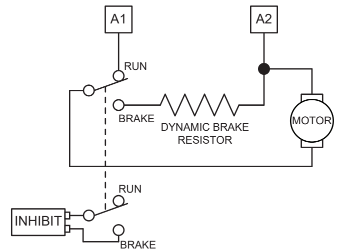

# Operation

**Coast to Minimum Speed**
See INHIBIT in the Connections section on for a description of wiring and location.

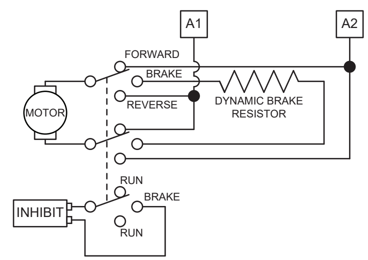
**Decelerate to Minimum Speed**
Either of the two options shown below can be used to coast a motor to zero speed. Opening Switch Option #1, or closing Switch Option #2, decelerates the motor from set speed to zero speed at a rate determined by the DECEL trim pot setting. Closing Switch Option #1, or opening Switch Option #2, will accelerate the motor to set speed at a rate determined by the ACCEL trim pot setting. If two methods of starting and stopping are required, both options can be used concurrently.




**Run/Stop Switch - Dynamic Brake to Zero Speed**
Dynamic braking may be used to rapidly stop a motor. The MIN SPD trim pot must be set for zero speed. For the RUN/BRAKE switch, use a two pole, two position switch rated for at least the armature voltage rating and 150% of the armature current rating. For the dynamic brake resistor, use a 40 watt minimum, high power, wirewound resistor. Sizing the dynamic brake resistor depends on load inertia, motor voltage, and braking time. Use a lower-value, higher-wattage dynamic brake resistor to stop a motor more rapidly. Recommended value is 15 ohms for a 90 VDC motor and 30 ohms for a 180 VDC motor.




**Reversing with Dynamic Brake**
A dynamic brake may be used when reversing the motor direction. The MIN SPD trim pot must be set for zero speed. Use a three pole, three position switch rated for a least the armature voltage rating and 150% of the armature current rating. For the dynamic brake resistor, use a 40 watt minimum, high power, wirewound resistor. Sizing the dynamic brake resistor depends on load inertia, motor voltage, and braking time. Use a lower-value, higher-wattage dynamic brake resistor to stop a motor more rapidly. Recommended values are 15 ohms for a 90 VDC motor and 30 ohms for 180 VDC motor.
**The motor must come to a complete stop before changing directions.**




**3P3T Relay for Forward/Brake/Reverse**

# Calibration

**Minimum Speed (MIN SPD):** The MIN SPD setting determines the minimum motor speed when the speed adjust potentiometer is set for minimum speed in MANUAL mode. It is factory set for zero speed. To calibrate the MIN SPD:

1. Set the drive to MANUAL mode.
2. Set the MIN SPD trim pot full CCW.
3. Set the speed adjust potentiometer for minimum speed.
4. Adjust the MIN SPD trim pot until the desired minimum speed is reached or is just at the threshold of rotation.

**Signal Minimum (SIG MIN):** The SIG MIN setting determines the minimum motor speed when the analog signal is set for minimum speed. To calibrate the SIG MIN:

1. Calibrate the MIN SPD trim pot first.
2. Set the drive to AUTO mode.
3. Set the analog signal for minimum speed.
4. Adjust the SIG MIN trim pot until the desired minimum speed is reached or is just at the threshold of rotation.

**Maximum Speed (MAX SPD):** The MAX SPD setting determines the maximum motor speed when the speed adjust potentiometer is set for maximum speed. To calibrate the MAX SPD:

1. Set the drive to MANUAL mode.
2. Set the MAX SPD trim pot full CCW.
3. Set the speed adjust potentiometer for maximum speed.
4. Adjust the MAX SPD trim pot until the desired maximum speed is reached.

**Signal Maximum (SIG MAX):** The SIG MAX setting determines the maximum motor speed when the analog signal is set for maximum speed. To calibrate the SIG MAX:

1. Calibrate the MAX SPD trim pot first.
2. Set the drive to AUTO mode.
3. Set the analog signal for minimum speed.
4. Adjust the SIG MAX trim pot until the desired minimum speed is reached or is just at the threshold of rotation.

Check the MIN SPD, SIG MIN, MAX SPD, and SIG MAX adjustments after recalibrating to verify that the motor runs at the desired minimum and maximum speed.

**Torque (TORQUE):** The TORQUE setting determines the maximum torque for accelerating and driving the motor. To calibrate the TORQUE:

1. With the power disconnected from the drive, connect a DC ammeter in series with the armature.
2. Set the TORQUE trim pot to minimum (full CCW).
3. Set the speed adjust potentiometer to maximum speed (full CW).
4. Carefully lock the motor armature. Be sure that the motor is firmly mounted.
5. Apply line power. The motor should be stopped.
6. Slowly adjust the TORQUE trim pot CW until the armature current is 150% of motor rated armature current. **Continuous operation beyond this rating may damage the motor.**
7. Turn the speed adjust potentiometer CCW.
8. Remove line power.
9. Remove the stall from the motor.
10. Remove the ammeter in series with the motor armature if it is no longer needed.

**IR Compensation (IR COMP):** The IR COMP setting determines the degree to which motor speed is held constant as the motor load changes. To calibrate the IR COMP:

1. Set the IR COMP trim pot full CCW.
2. Increase the speed adjust potentiometer until the motor runs at midspeed without load. A handheld tachometer may be used to measure motor speed.
3. Load the motor armature to its full load armature current rating. The motor should slow down.
4. While keeping the load on the motor, rotate the IR COMP trim pot until the motor runs at the speed measured in step 2. If the motor oscillates (overcompensation), the IR COMP trim pot may be set too high (CW). Turn the IR COMP trim pot CCW to stabilize the motor.
5. Unload the motor.

**Acceleration (ACCEL):** The ACCEL setting determines the time the motor takes to ramp to a higher speed. ACCEL is factory set for the shortest acceleration time (full CCW). To calibrate the ACCEL:

1. Set the speed adjust potentiometer for minimum speed.
2. Set the speed adjust potentiometer for maximum speed. Measure the time is takes the motor to go from minimum speed to maximum speed.
3. If the time measured in step 2 is not the desired acceleration time, turn the ACCEL trim pot CW for a longer acceleration time, or CCW for a shorter acceleration time. Repeat steps 1 through 3 until the acceleration time is correct.

**Deceleration (DECEL):** The DECEL setting determines the time the motor takes to ramp to a lower speed. DECEL is factory set for the shortest deceleration time (full CCW). To calibrate the DECEL:

1. Set the speed adjust potentiometer for maximum speed.
2. Set the speed adjust potentiometer for minimum speed. Measure the time is takes the motor to go from maximum speed to minimum speed.
3. If the time measured in step 2 is not the desired deceleration time, turn the DECEL trim pot CW for a longer deceleration time, or CCW for a shorter deceleration time. Repeat steps 1 through 3 until the deceleration time is correct.