AMERICAN CONTROL ELECTRONICS

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PML743-4-HL60

PML743-4 with 60° Hall Effect Feedback

Specifications

Model	Line Voltage (VAC)	Motor Voltage (VDC)	Continuous Motor Current (Amps)	Motor Horsepower Range
PML743-4-HL60	115 or 230	140 280	4.0*	1/20 - 1/2 1/10 - 1

* When mounted to allow upwards airflow across the plate.
De-rate to 3.0 amps when mounted in any other configuration.

AC Line Source ..... 115 or 230 VAC ± 10%, 50/60 Hz, 1Ø
AC Line Current *with 115 VAC line voltage with a 140V motor* ..... 10.6 amps
with 115 VAC line voltage with a 280V motor ..... 15.0 amps
with 230 VAC line voltage with a 280V motor ..... 10.6 amps
Hall Effect Sensors ..... 60°, 5 VDC, combined 75 mA
Acceleration Time Range ..... 0.5 - 12 seconds
Deceleration Time Range ..... 0.5 - 12 seconds
Input Impedance *(S1 to S2)* ..... >50K ohms
Analog Input Voltage Range *(isolated or non-isolated)* ..... 0 ± 5 VDC, 0 ± 10 VDC, 4-20 mA
Maximum Vibration *0 - 50 Hz (>50 Hz)* 0.5G (0.1G)
Surrounding Air Temperature Range ..... 32 - 104°F / 0 - 40°C
Weight ..... 3.22 lbs / 1.45 kg
Safety Certifications ..... cULus Listed, UL 61800-5-1, File # E132235

Installation

Mounting

- Drive components are sensitive to electrostatic discharge. Avoid direct contact with the circuit board. Hold the drive by the heat sink or enclosure only.
- Mount the drive away from heat sources. Operate the drive within the specified ambient operating temperature range.
- Prevent loose connections by avoiding excessive vibration of the drive.
- Mount the drive with its board in either a horizontal or vertical plane. Four 0.19" (5 mm) wide slots in the heat sink accept #8 pan head screws. If mounted horizontally, the drive must be de-rated to 3.0 amps.
- The heat sink should be earth grounded.

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 ENABLE 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 cover and 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 16 - 18 AWG 75°C wire for AC line (L1, L2, L2-DBL) and motor (U/A2, V/A1, W) wiring. Use 18 - 24 AWG wire for logic (COM, DIR, EN, S1, S2, S3) wiring . Follow NEC standards for wiring.
Tightening torque for power terminal TB502 on the bottom board is 9 lb-in (1.0 N-m).
Tightening torque for logic terminals TB501 and TB502 on the top board is 1.77 lb-in (0.2 N-m).

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.

Short Circuit Current Rating (SCCR): This drive is suitable for use on a circuit capable of delivering not more than 5,000 rms Symmetrical Amperes, 115/230 volts maximum.

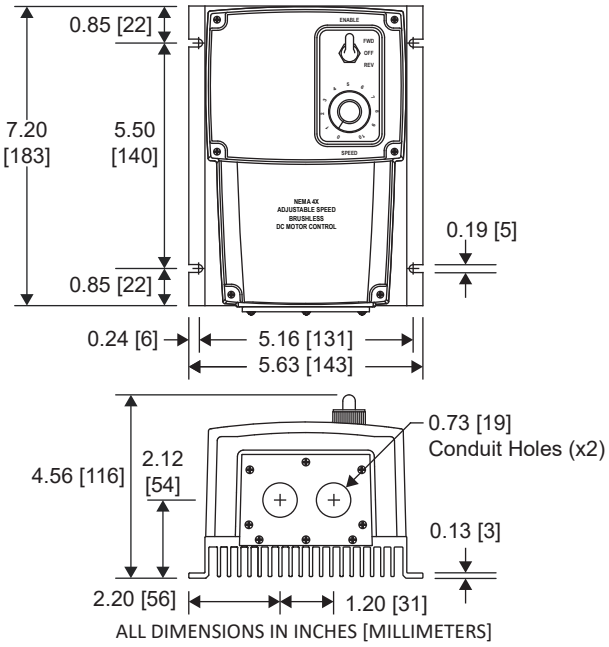
Branch Circuit Protection: This product has integral solid state circuit protection, which does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes. The UL Listing requires the use of Class J, Class CC, or Class T fuses rated at a minimum of 230 VAC. It is recommended to use fuses rated for 200% of the maximum motor current, unless using the drive in doubler operation, in which case the fuses should be rated for 400% of maximum motor current. Fuse the HOT leg of the AC line when using 115 VAC and both lines when using 230 VAC.

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.
- **It is strongly recommended to install a master power switch in the line voltage input.** The switch contacts should be rated for 250 VAC and 200% of motor nameplate current.
- **Only connect to terminal L2-DBL if using a 115 VAC line with a motor rated higher than 120 VAC.**
- **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.
- Under no circumstances should power and logic level wires be bundled together.
  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

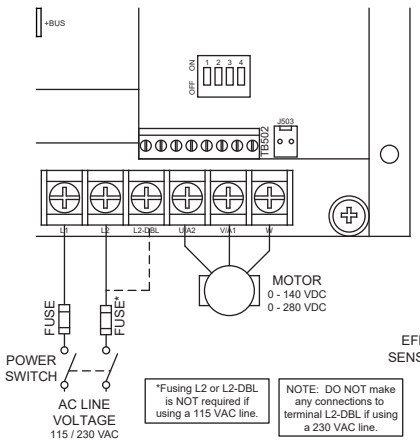


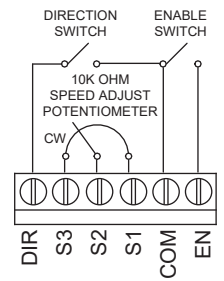
ALL DIMENSIONS IN INCHES [MILLIMETERS]

Connections

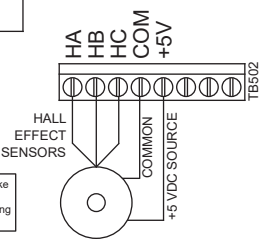
Input Power
Connect the AC line voltage to terminals L1 and L2. If doubler mode is to be used (280 VDC output with 115 VAC input), connect the AC line voltage to terminals L1 and L2-DBL. Do not make any connections to L2-DBL if using a 230 VAC line source.

Motor
Connect the motor leads to terminals U/A2, V/A1, and W.





The logic connections on TB501 are isolated up to approximately 4 kV.



Speed Potentiometer
Use a 10K ohm, 1/4 W potentiometer for speed control. Connect the counter-clockwise end of the potentiometer to S1, wiper to S2, and the clockwise end to S3. If the potentiometer works inversely of desired functionality, (i.e. to increase motor speed, you must turn the potentiometer counterclockwire), power off the drive and swap the S1 and S3 connections.

Analog Input Signal Range
Instead of using a potentiometer, the drive may be wired to follow an analog input signal. This input signal can be in the form of voltage (0 ± 5, 0 ± 10 VDC) or current (4-20 mA). The built in isolation allows the the input signal to be grounded or ungrounded (floating). Connect the signal common / negative (-) to S1 and the signal reference /positive (+) to S2. Refer to the Startup section for related jumper settings.

Enable
Short terminals EN and COM to accelerate the motor to set speed. Open the ENABLE terminals to coast or brake the motor to zero speed. Refer to DIP Switch 4 in the Statup section for jumper settings. If no ENABLE switch is desired, wire a jumper between terminals COM and EN.
Do not use the enable for emergency stopping.

Direction
Short terminals DIR and COM to change the direction of the motor. If no direction switch is desired, leave this connection open.

Hall Effect Sensors
Connect your hall effect sensor common to terminal COM. If the hall effects sensors can be powered by a +5V source, connect the source to terminal +5V. If the hall effect sensors require a source other than +5V, a seperate power source must be used to power them (the COM connection must be made to the hall effect sensors and the seperate power supply). Connect your sensors to terminals HA, HB, and HC. The specific connections will vary with each motor (ABC ACB BAC BCA CAB CBA).

Startup

SELECT SWITCHES

Select Switch (SW501)

Dip Switch 1: ON - Inverted Sensors - The motor's hall effect sensors have inverted signals.
OFF - Noninverted Sensors - The motor's hall effect sensors do not have inverted signals.

If at anytime during the wiring setup and trying different hall effect combinations the motor runs away in the reverse direction, disable the drive and toggle DIP Switch 1.
Factory default for -HL60 models is in the ON position.

Dip Switch 2: ON - High MAX SPEED - Sets a higher maximum speed on the MAX SPEED trim pot.
OFF - Low MAX SPEED - Sets a lower maximum speed on the MAX SPEED trim pot.

If during calibration, turning the MAX SPEED trim pot fully down (fully CCW) is still too high of a maximum speed, then set dip switch 2 to OFF.

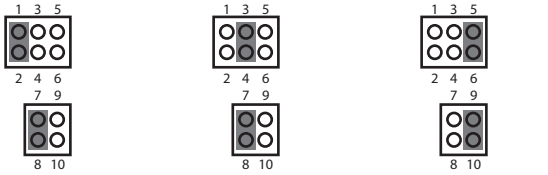
Dip Switch 3: ON - WigWag Mode - The potentiometer or analog signal determines both motor speed and direction. The direction switch will still come into effect.

	Full Speed Reverse	Zero Speed	Full Speed Forward
Potentiometer	Full CCW	12 o'clock	Full CW
0 - 5 VDC	0 VDC	2.5 VDC	5 VDC
0 - 10 VDC	0 VDC	5 VDC	10 VDC
4 - 20 mA	4 mA	12 mA	20 mA

OFF - Pot/Switch Mode - The potentiometer or analog signal (0 - 5 VDC, 0 - 10 VDC, 4-20 mA) determines the motor speed while the direction switch determines the direction. If using a bidirectional analog signal (0 ± 10 VDC), the polarity of the signal determines the direction (ie -10 VDC is full speed reverse, 0 VDC is zero speed, 10 VDC is full speed forward). The direction switch will still come into effect even with a bidirectional signal.

Dip Switch 4: ON - Brake Mode - Opening the ENABLE switch will regeneratively brake the motor to zero speed without applying the decel ramp. At zero speed, the drive will apply holding torque.
OFF - Enable Mode - Opening the ENABLE switch will coast the motor to a stop. The drive cannot provide holding torque at zero speed because it's disabled.

JUMPERS



0 to ± 5 VDC or Potentiometer
Jumper Pins 1&2 and 7&8

0 to ± 10 VDC
Jumper Pins 3&5 and 7&8

4-20 mA
Jumper Pins 5&6 and 9&10

STARTUP

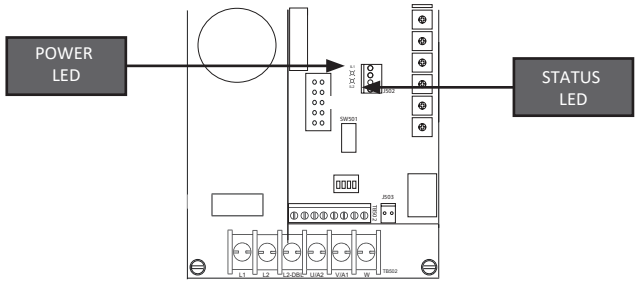
- Verify that no foreign conductive material is present on the printed circuit board.
- Ensure that all switches and jumpers are properly set.

1. Turn the speed adjust potentiometer full counterclockwise (CCW) or set the analog input voltage or current signal to minimum.
2. Apply AC line voltage.
3. Close the enable switch and verify that the green Power LED (IL1) if flashing.
4. Slowly advance the speed adjust potentiometer clockwise (CW) or increase the analog input voltage or current signal. The motor slowly accelerates as the potentiometer is turned CW or as the analog input voltage or current signal is increased. Continue until the desired speed is reached.
5. Remove AC line voltage from the drive to coast the motor to a stop.

LEDs

Power (IL1 - Green): Off: The drive does not have power.
Solid: AC line voltage is applied, but drive is disabled.
Flashing: AC line voltage is applied and drive is enabled.

Status (IL2 - Red):
Solid: Drive is in current limit.
2 Flashes: Undervoltage - Internal DC BUS voltage dropped too low.
3 Flashes: Overvoltage - Internal DC BUS voltage rose too high.
4 Flashes: Current Limit or Short Circuit - The drive is in current limit or has detected a short across the motor.
5 Flashes: Overtemperature Shut Down - Drive's temperature has reached critical temperature.
6 Flashes: Overtemperature Warning - Drive's temperature is approaching critical temperature. Maximum motor current is being reduced gradually as the drive's temperature rises.
7 Flashes: Invalid Hall Effect Sensor - One of the hall effect sensors is damaged or missing. With -HL60 models, it could also be that the hall effects are in the incorrect sequence.



Calibration

Zero Adjust (P1): The ZERO ADJ setting adjusts out any non-linearities in the logic circuit that might arise from component tolerances. This factory calibrated and should not need any adjustment.

Minimum Speed (P2): The MIN SPEED setting determines the minimum motor speed when the speed adjust potentiometer or analog signal is set for minimum speed (full CCW). It is factory set for zero speed. To calibrate the MIN SPEED:

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

Maximum Speed (P3): The MAX SPEED setting determines the maximum motor speed when the speed adjust potentiometer or analog signal is set for maximum speed. It is factory set for maximum motor rated speed. To calibrate the MAX SPEED:

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

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

Acceleration (P4): The ACCEL TIME setting determines the time the motor takes to ramp to a higher speed regardless of direction. To calibrate the ACCEL TIME, turn the ACCEL TIME trim pot CW to increase the forward acceleration time and CCW to decrease the forward acceleration time.

Deceleration (P5): The DECEL TIME setting determines the time the motor takes to ramp to a lower speed when commanded by the potentiometer or analog signal, regardless of direction. To calibrate the DECEL TIME, turn the DECEL TIME trim pot CW to increase the deceleration time.

Acceleration / Motoring Torque (P6): The MOTOR CUR LIM setting determines the maximum torque (current) for accelerating and driving the motor in the forward or reverse directions. To calibrate the MOTOR CUR LIM:

1. With the power disconnected from the drive, connect a DC ammeter in series with one of the motor phases.
2. Set the MOTOR CUR LIM trim pot to minimum (full CCW).
3. Set the speed adjust potentiometer to maximum speed (full CW) or the analog control signal signal to maximum forward speed (5 VDC, 10 VDC, 20 mA).
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 MOTOR CUR LIM trim pot CW. The reading on the ammeter should increase. If it does not, remove AC line power and connect the ammeter with one of the other phases. Reapply power. Adjust the MOTOR CUR LIM trimpot until the motor is conducting 150% of motor rated armature current. **Continuous operation beyond this rating may damage the motor.**
7. Turn the speed adjust potentiometer CCW or remove the analog control signal.
8. Remove line power, remove the stall from the motor, and remove the ammeter if it is no longer needed during normal operation.

Deceleration / Regen Torque (P7): The REGEN CUR LIM setting determines the maximum torque (current) for decelerating the motor and resisting an overhauling load in the forward and reverse directions. Turn the REGEN CUR LIM trim pot CW to increase the regen current limit and CCW to decrease the regen current limit.

PID P Gain - Kp (P8): The constant used to scale the error feedback. It's used to determine the amount of error in the set speed vs. commanded speed. The lower the Kp, the more the motor speed will drop under a load increase. However, if Kp is too high, it will cause the motor rotation to be rough. To calibrate the Kp:

1. Turn Kp and Ki to minimum (full CCW).
2. With the motor running, turn the Kp trim pot up (CW) until the motor rotation starts to become rough. Slightly turn the Kp trim pot down (CCW) until motor rotation is smooth again.

PID I Gain - Ki (P9): The constant used to scale the sum of errors over time. The lower the Ki, the longer it will take motor to return to commanded speed after a load change. If the Ki is too high, it will cause oscillation. Calibrate the Ki after calibrating Kp.