03/02/15 Revision:**01**

PCM MANUAL

Author: Simon P. Benik
MSA Part Number: 027-0124-XXX

Table of Contents

	Page
Introduction	**2**
VCM Characteristics:	
CCM Characteristics:	
Table 1: Power Control Module Options, & resulting Part Number Suffixes	**3**
Part Number Example, and Photo of both sides of the PCM	
Table 2: Standard Electrical Specifications	**4**
Table 3: Maximum Allowable Voltages and Currents	**5**
Power Control Module, Configurations	
Voltage Control Module (VCM) Configurations, Two Examples	**6**
Current Control Module (CCM) Configurations, Two Examples	**7**
Performance Graphs	**8**
Dimensions	**9**
PCM Installation/Tuning Instructions	
A. Driving ON-OFF Solenoids with a PCM	
Step 1) Connecting to the Load to the PCM:	**10**
Thru-Hole Solder Pad Option: (valid for part number options -100, -200, -300 and -400)	
Lead Wire Option: (valid for part number options -101, -201, -301 and -401)	
Step 2) Connecting the PCM to your Power Supply:	**11**
Step 3) Tuning the PCM, to achieve the desired performance	
3)A: Tuning the PCM, by utilizing the On-Board Potentiometers	**11-13**
3)B: Tuning the PCM BY utilizing the Input Terminal Block,	**13**
B. Driving Proportional Solenoids with an MSA PCM	**14**
C. Establishing Permanent Settings for PICK and HOLD	**14**

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

Introduction

MSA's Power Control Modules (p/n 027-124-XYZ, where -XYZ defines the options and board configuration, see details in Table 1) are sophisticated devices, incorporating PWM (Pulse Width Modulation) circuitry for driving solenoids and other electromagnetic devices. These modules control the power applied during the PICK (pull-in, or actuation) state, and the HOLD state by adjusting a pre-set voltage level.

There are two distinct variants within this Power Control Module (PCM) family; the Voltage Controlled Module (VCM), and the Current Controlled Module (CCM). Additional options which are available within each of these products include potentiometers, a programming feature (for On-Off or Proportional solenoid functionality), and various Input / Output connection schemes. See Table 1 for further details.

VCM Characteristics:
The function of the VCM is primarily that of a voltage divider, providing on-off output in both the PICK and the HOLD modes.

For applications which have limited power supply capabilities, a VCM can be used to limit the wattage draw from the power supply.

Care needs to be taken to ensure that all testing and PCM adjustments involving the VCM are made with the Load (the electromagnetic device) at the intended ambient temperature, and that the Load has reached full operating temperature.

CCM Characteristics:
As with the VCM, the CCM provides both a PICK and a HOLD mode of operation. The CCM can also monitor input voltage, as well as monitor and control the output voltage/current that is sent to the Load, compensating for changes in both ambient temperature and coil temperature.

Power consumption is limited by the CCM to a strict minimum. This feature enables the same coil (in a particular electromagnetic device) to be used over a wide supply voltage range, while achieving identical behavior in all conditions.

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

Table 1: Power Control Module Options, and resulting Part Number Suffixes (027-0124-XYZ)

Option	-XYZ Part Number Suffix			
	X = 1	X = 2	X = 3	X = 4
Potentiometers	Yes	Yes	None	None
Voltage Control Module			Yes	Yes
Current Control Module	Yes	Yes		

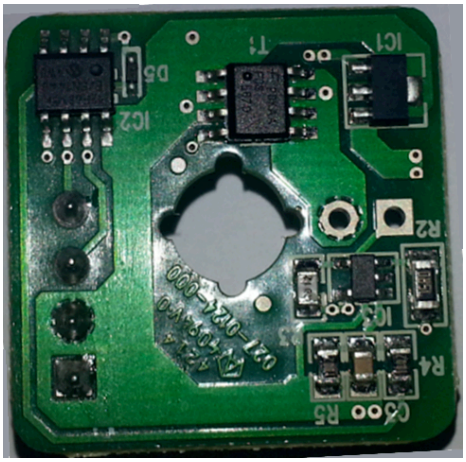
Software	Y = 0	Y = 1
	On-Off	Proportional

Output Connection Scheme	Z = 0	Z = 1
	Thru Hole	Lead Wires

Part Number Example:

Part Number 027-124-**100**: is a Current Controlled Module (CCM), with Potentiometers, and Thru-Hole output, as pictured below:

TOP



BOTTOM

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

Table 2: Standard Electrical Specifications

Parameter		Minimum	Typical	Maximum	Unit
Supply Voltage (All Devices)		7		24	V
PICK (Pulse) Current (25ms to 250 ms on-time duration)		0		10	A
PWM Frequency (ALL Devices)			21		kHz
Hold Current	CCM Devices: X = 1 or 2	0		3	A
	VCM Devices: -X = 3 or 4	0		2.4	A
Current Setting Rate*	CCM Devices: -X = 1 or 2		0.50		A/V
Duty Cycle Range*	VCM Devices: -Y= 0	10		90	Duty Cycle %
	VCM Devices: -Y= 1	0		100	Duty Cycle %
Duty Cycle Rate*	VCM Devices: -X = 3 or 4		20		Duty Cycle %/V
Input Control Signals	ALL Devices: -X = 2 or 4	0		5	V
Pull-In Time	ALL Devices: -Y = 0	25		250	ms
	ALL Devices: -Y = 1	0	0	0	ms
Pull-In Rate*	ALL Devices		45		ms/V
Delay to Pull in Mode	ALL Devices		0.5		Ms
Ambient Temperature	ALL Devices	0		85	°C

*Controllable by potentiometer for -100, -300 configurations, or input terminal block for -200, -400 configurations.

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

Table 3: Maximum Allowable Voltages and Currents

Note: Exceeding the values stated below can cause damage to the PCM.

Input/Supply Voltage (volts DC)	26.4 Volts
Input Signal Voltage (volts DC)	5.5 Volts
Output/Pulse Current: Current applied during **PICK** Mode	15 Amps

Determining the Output Current Level that your application might see can be calculated as follows:

Ohms Law Formula: V= IR, which can be reconfigured to be I=V/R,

where I is the Current, V is the Supply Voltage, and R is the resistance of the Load

When using either the VCM or the CCM, the Output current (I) must never exceed 15 amps, or damage to the PCM can result.

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

Power Control Module, Configurations

Voltage Control Module (VCM) Configuration Examples:

VCM, Examples:

027-0124-300, Voltage Control Module, Potentiometer Adjustable, Thru-Hole Output, On-Off software
027-0124-301, Voltage Control Module, Potentiometer Adjustable, Wire Lead Output, On-Off software
027-0124-310, Voltage Control Module, Potentiometer Adjustable, Thru-Hole Output, Proportional software
027-0124-311, Voltage Control Module, Potentiometer Adjustable, Wire-Lead Output, Proportional software

027-0124-400, Voltage Control Module, Terminal Block Adjustable, Thru-Hole Output, On-Off software
027-0124-401, Voltage Control Module, Terminal Block Adjustable, Wire Lead Output, On-Off software
027-0124-410, Voltage Control Module, Terminal Block Adjustable, Thru-Hole Output, Proportional software
027-0124-411, Voltage Control Module, Terminal Block Adjustable, Wire-Lead Output, Proportional software

PWM Operation	027-0124-300
Inputs	**Terminal Block** 1: Power 2: Ground
Output	**Terminal Block** 3*: Potentiometer 1 (Value) 4*: Potentiometer 2 (Time) Thru Hole 10 to 90% Duty Cycle after initial pull in time.
Adjustability	Potentiometer 1: Will correlate to 10% to 90% Duty cycle. Potentiometer 2: Will correlate to 25 to 250 ms pull in time.
Max. Continuous Current	3A
Dimensions	28 mm x 28 mm x 12mm

*Terminal block pins 3 and 4 are 0 to 5 V signal outputs from the potentiometers.

PWM Operation	027-0124-411
Inputs	**Terminal Block** 1: Power 2: Ground 3: Signal 1 Input 4: Signal 2 Input **DO NOT EXCEED 5V SIGNAL INPUT**
Output	12” Wire Leads 0 to 100% Duty Cycle after initial pull in time.
Adjustability	Signal 1: Will correlate to 0 ms pull in time. Signal 2: Will correlate to 0% to 100% Duty cycle.
Max. Continuous Current	3A
Dimensions	28 mm x 28 mm x 12mm

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

Current Control Module Configuration Examples

CCM, Examples:

027-0124-100, Current Control Module, Potentiometer Adjustable, Thru-Hole Output, On-Off software
027-0124-101, Current Control Module, Potentiometer Adjustable, Wire Lead Output, On-Off software
027-0124-110, Current Control Module, Potentiometer Adjustable, Thru-Hole Output, Proportional software
027-0124-111, Current Control Module, Potentiometer Adjustable, Wire-Lead Output, Proportional software

027-0124-200, Current Control Module, Terminal Block Adjustable, Thru-Hole Output, On-Off software
027-0124-201, Current Control Module, Terminal Block Adjustable, Wire Lead Output, On-Off software
027-0124-210, Current Control Module, Terminal Block Adjustable, Thru-Hole Output, Proportional software
027-0124-211, Current Control Module, Terminal Block Adjustable, Wire-Lead Output, Proportional software

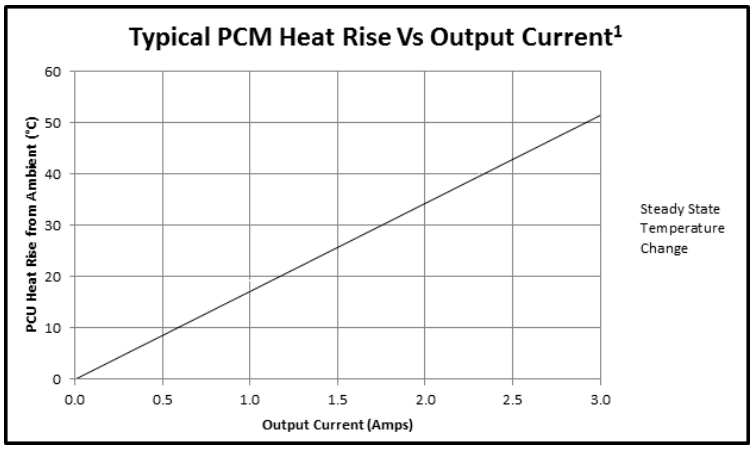
PWM Operation	027-0124-100
Inputs	**Terminal Block** 1: Power 2: Ground
Output	**Terminal Block** 3*: Potentiometer 1 4*: Potentiometer 2 **Thru Hole Power to Load** 0 to 2.4 Amps after initial pull in time.
Adjustability	Potentiometer 1: Will correlate to 0 to 2.4 Amps set current. Potentiometer 2: Will correlate to 25 to 250 ms pull in time.
Max. Continuous Current	2.4A
Dimensions	28 mm x 28 mm x 12mm

*Terminal block pins 3 and 4 are 0 to 5 V signal outputs from the potentiometers.

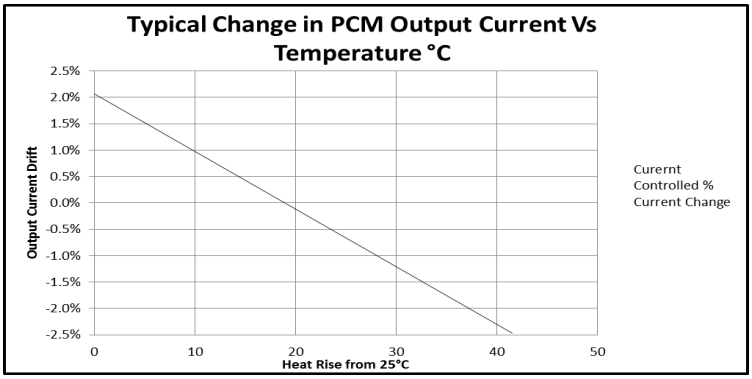
PWM Operation	027-0124-201
Inputs	**Terminal Block** 1: Power 2: Ground 3: Signal 1 Input 4: Signal 2 Input **DO NOT EXCEED 5V SIGNAL INPUT**
Output	**12” Wire leads** 0 to 2.4 Amps after initial pull in time.
Adjustability	Signal 1: Will correlate to 25 to 250 ms pull in time. Signal 2: Will correlate to 0 to 2.4 Amps set current.
Max. Continuous Current	2.4A
Dimensions	28 mm x 28 mm x 12mm

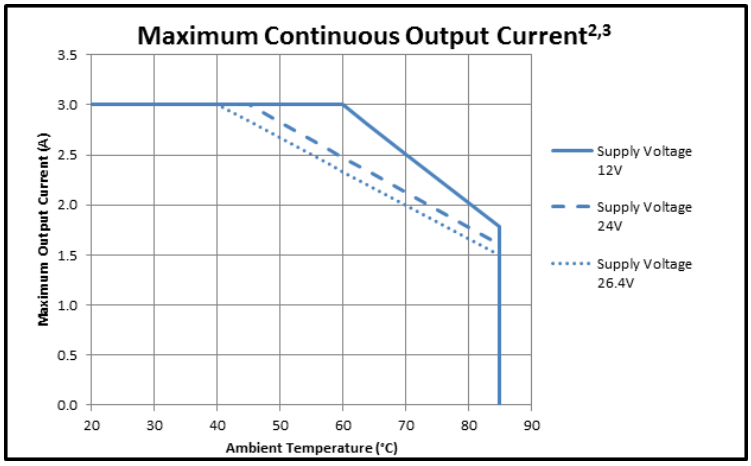
401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

Performance Graphs



1) Temperatures of individual components on the PCM can greatly exceed those in the graph above.





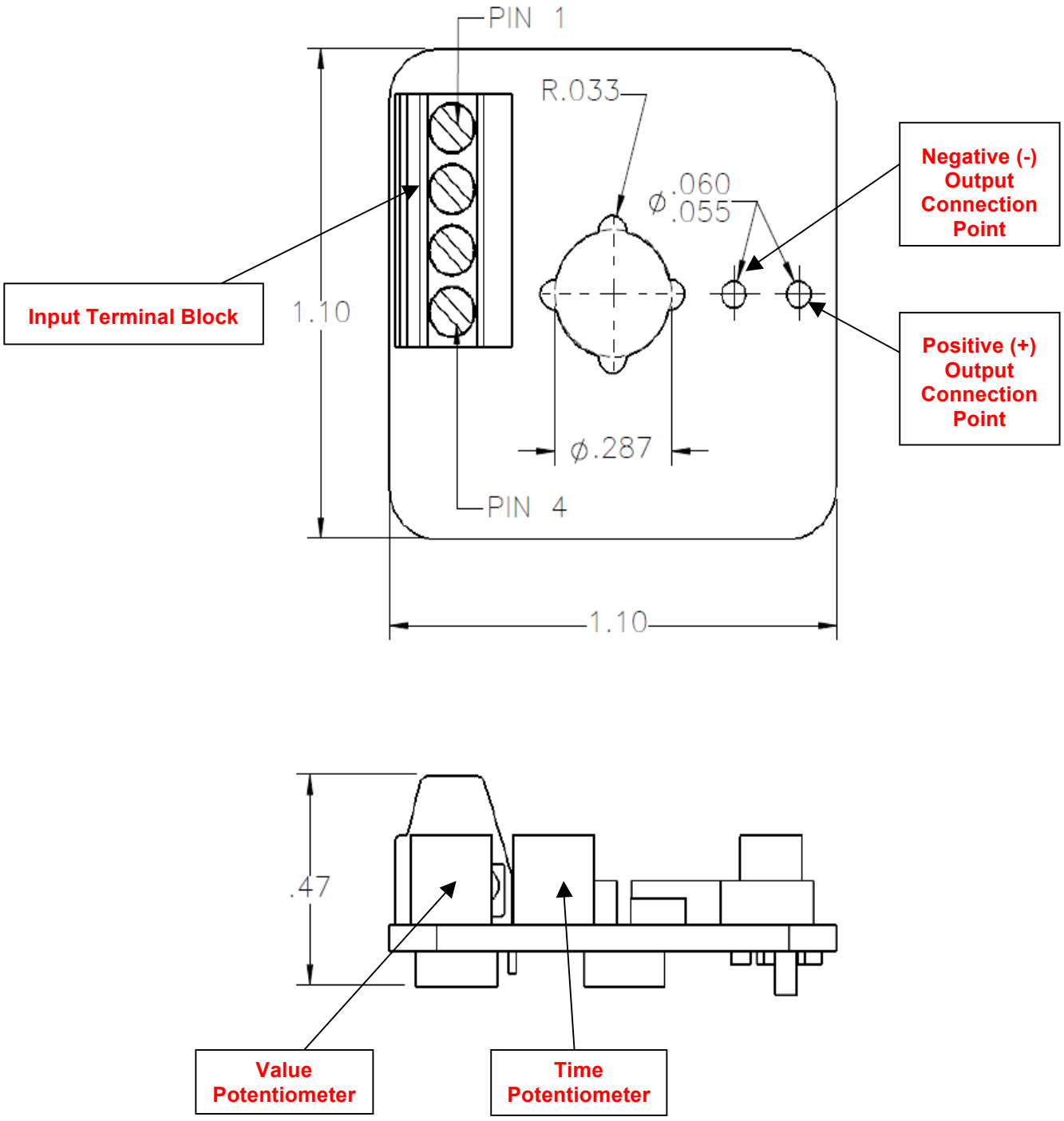
2) Current Control Modules are internally limited to 2.4A MAX continuous current output.

3) PCMs which are housed in a sealed enclosure (such as a DIN connector housing) must be limited to a MAX continuous current output that is 80% of the graphs above.

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

Dimensions:

Figure 1



401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

PCM Installation/Tuning Instructions

A. Driving ON-OFF Solenoids with a PCM

Step 1) Connecting to the Load to the PCM:

Currently, MSA's PCMs are offered in two Output configurations, either with Thru-Hole Solder Pads, or with MSA installed Lead Wires.

CAUTION:

Always connect the Load (solenoid or other electromagnetic device) to the PCM before connecting the PCM to your power supply.

Thru-Hole Solder Pad Option: (valid for part number options -100, -200, -300 and -400)

If the PCM you are using has open thru-hole solder pads, the recommended range of lead wire size for you to choose would be 16AWG to 22 AWG, with 125+°C rated insulation.

If lead wires are already attached to the electromagnetic device that you are using, ensure that they are within this range.

Use CAUTION when soldering any lead wires to the PCM, so as to avoid applying excessive heat that can damage either the PC-board, or the components that are close to the thru-hole output pads.

Polarity:

If your solenoid is polarity sensitive, note that the output thru-hole solder pads on the PCM are marked + (positive), and – (negative) (see in Figure 1, Dimensions).

Lead Wire Option: (valid for part number options -101, -201, -301 and -401)

If the PCM you are using came with Lead Wires attached by MSA, connect the Load (the electromagnetic device) to these wires.

Polarity:

If your solenoid is polarity sensitive, the Red lead is positive, and the Black lead is negative.

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

Step 2) Connecting the PCM to your Power Supply:

After the Load has been connected to the PCM, connect the input power and ground from your power source to pins 1 and 2, respectively, of the input terminal block on the PCM.

Polarity:
If your application is polarity sensitive, pin 1 is positive and pin 2 is ground.

Step 3) Tuning the PCM, to achieve the desired performance

For the remainder of this discussion, we will assume that the electromagnetic device being driven by the PCM is an ON-OFF style solenoid, and that either the solenoid or the overall system incorporate a mechanism (such as spring) to return the solenoid's plunger to the unactuated position.

Tuning a VCM should be made in the worst case scenario; lowest input voltage, highest potential ambient temperature, and highest system load on the solenoid.

Driving proportional solenoids with a PCM will be discussed in Section 4).

Step3)A: Tuning the PCM, by utilizing the On-Board Potentiometers, (valid for part number options -100, -101, -300, & -301):

1. **The first tuning task involves establishing the "HOLD" duty cycle (the ration of on-time to off-time) parameter:**

   a. Adjust (turn) the screw on the top of the "TIME" potentiometer all the way clockwise (about 5 full turns). This places the PICK (Pull-In) time at max 250ms, providing maximum PICK energy.

   b. Adjust (turn) the screw on the top of the "VALUE" potentiometer all the way counter clockwise (about 5 full turns). This reduces the HOLD duty cycle to zero.

   c. Apply power to the Input Terminal Block, and observe the reaction of the solenoid. With the PICK time set at the maximum (250ms), the solenoid plunger should pull-in to the fully actuated position. It will probably not remain actuated because the "Value" potentiometer is currently set to zero duty cycle (as stated in step 1.b).

      If the solenoid does not pull-in:

      i. verify that the output wire from the PCM to the solenoid is properly connected, and

      ii. verify that the "TIME" potentiometer is fully turned clockwise (at least 5 full turns), ensuring that maximum PICK energy is being applied.

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

d. The following steps describe the first of potentially several iterative adjustments you will need to make to fully tune the HOLD duty cycle, thereby determining how much energy, and for what duration that energy must be applied to keep the plunger in the actuated position, against the force of the return mechanism.

e. Remove input power from the Input Terminal Block, which will turn-off the PCM.
This will release the plunger, allowing the internal mechanism to return the device to the unactuated position.

f. Adjust the "VALUE" potentiometer clockwise, about 1/4 a turn.
This will slightly increase the energy/duty cycle that remains applied to the device after completion of the PICK sequence.

g. Reapply power to the Input Terminal Block to once again activate the PCM.
If the plunger pulls-in, and then remains in the actuated position, you may have completed tuning for the HOLD duty cycle.

h. If the plunger pulls-in, but does not remain in the actuated position, then you will have to repeat steps 1e,1f and 1g until the solenoid plunger stays actuated, thereby completing the HOLD Tuning sequence.

2. The second tuning task involves establishing the PICK, on-time parameter:

a. Turn-off the power to the PCM.
This will allow the plunger to return to the unactuated position.

b. Adjust the "TIME" potentiometer, counter clockwise, about 1/4 a turn.
This will slightly decrease, the on-time that pull-in energy is applied to the device.

The goal of adjusting the "TIME" pot in this manner is to incrementally reduce the on-time to a point where the plunger will not pull-in, then back-off from that setting to return to full actuation.

Taking this approach in the PICK tuning process will ensure that only the minimum energy necessary to achieve full actuation is applied, thereby reducing the potential for internal heating due to excessive PICK energy.

c. Once again, apply power to the input Terminal Block to activate the PCM, and see if the plunger pulls-in.

d. Repeat steps 2a, 2b and 2c until you are comfortable that the plunger will reliably pull-in.
Only then will the plunger "PICK" parameter be completely established.

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

Once you have successfully set both the PICK and the HOLD parameters, the potentiometer voltage values can be determined by utilizing pins 3 and 4 of the Input Terminal Block.

Pin 3 will provide the voltage for the "TIME" potentiometer, and
Pin 4 will provide the voltage for the "VALUE" potentiometer.

Once known, these voltage values can be hard-programmed into the micro-controller of subsequent Power Control Modules, eliminating the need for and the cost of the Potentiometers, as well as the time/cost and potential for variability involving ongoing manual adjustments.

CAUTION:
WHEN WORKING WITH A VOLTAGE CONTROL MODULE (VCM):
CHANGES INVOLVING EITHER THE INPUT VOLTAGE AND/OR THE SOELNOID TEMPERATURE MAY PREVENT THE SOLENOID PLUNGER FROM PULLING-IN UTILIZING THE PICK & HOLD ADJUSTMENTS MADE ABOVE.

In such scenarios, one must repeat both the HOLD and PICK tuning steps described above at the new input voltage level.

Step 3)B: Tuning the PCM BY utilizing the Input Terminal Block, (valid for part number options -200, -201, -400, & -401, which do not include Pots):

For those PCM part number options that do not include Potentiometers, the "PICK" and "HOLD" parameters can be established by utilizing the Input Terminal Block, as follows:

1. Connect an analog signal (0 to 5V, typically from a PLC) to pins 3 and 4 on the Input Terminal Block. These pins correspond to the "VALUE" and "TIME" Potentiometers, respectively.

   CAUTION: Do not exceed 5 volts for any of these input signals.

2. Adjust these two analog values utilizing the same process described in sections 3)A.1. and 3)A.2., first to establish the "HOLD" parameters, and then to establish the "PICK" parameters.

Once you have successfully determined both the PICK and the HOLD parameters, the appropriate analog signal voltages can be recorded, and then hard-programmed into the micro-controller of subsequent Power Control Modules. This will eliminate the need to, and the potential variability of providing consistent input analog signals via the Input Terminal Block.

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com

B. Driving Proportional Solenoids with an MSA PCM:

Only Power Control Module variants without Potentiometers (part number options -210, -211, -410, & -411) can be used to drive **Proportional** solenoids. The proportional module will not have pick time enabled when powered on.

Driving of such solenoids is done utilizing an external computer program or analog input. The plunger position throughout the stroke of the solenoid can then be accurately controlled in "real-time" by varying the voltage of the analog signal (between 0 and 5 volts) that is applied to pin 4 of the Input Terminal Block, the "VALUE" terminal.

The output voltage with VCM, and the output current with CCM, will correspond to the input voltage on pin 4, as depicted in Table 2.

C. Establishing Permanent Settings for PICK and HOLD:

As described previously, once both the PICK and the HOLD parameters have been established utilizing either the Potentiometers, or the Input Terminal Block method, the resulting performance can be replicated in all subsequent PCM modules by hard programing the PCM's on-board micro-controllers. Doing so will eliminate the cost and the potential for variability which can result from manual potentiometer adjustments, or analog input signals supplied via the Input Terminal Block.

401 Plaza Drive • Westmont, Illinois 60559-1233 • Phone: 630.789.0600 • Fax: 630.789.0614
Website: www.magnet-schultzamerica.com • e-mail: info@magnet-schultzamerica.com