Pneumatic Control Module
User's Guide

Rev 1.0

Cross The Road Electronics

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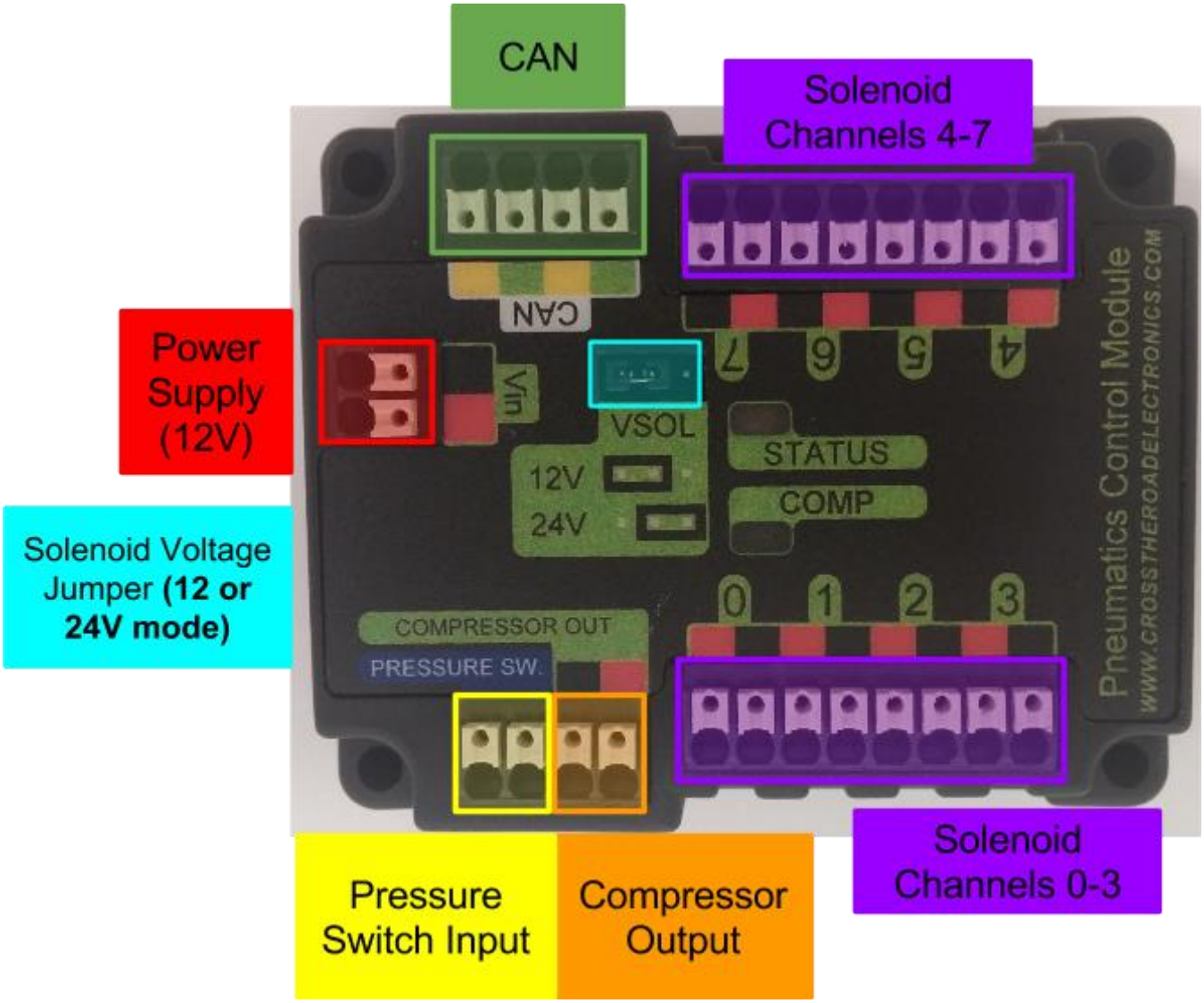
Table of Contents

1. Pneumatics Control Module at a Glance



1.1. Connection Specifications

- **Power / Pressure Switch / Compressor / Solenoid Channels / CAN**
  - All connections are Weidmuller Connectors
    - **Max Size:** 16 AWG
    - **Min Size:** 24 AWG

See Section 2.1. Weidmuller Connectors for wire insert instructions.

1.2. Electrical Specifications

Input Voltage (Vbat)	
• **Solenoids 12V Mode(1)**	11V - 16V
• **Solenoids 24V Mode(2)**	5.5V - 16V
Absolute Max Input Voltage(3)	18V
Output Voltage	
• **Solenoids**	12V or 24V
• **Max Continuous Compressor Out**	12V / 17A
Solenoid Current (Sum of all channels)	500 mA

Note 1: PCM functions below 11V, however 12V solenoids may not engage. This depends on the 12V solenoid, see solenoid datasheet for its capabilities.

Note 2: PCM boosts solenoid voltage in 24V mode, allowing solenoids to be fired in low voltage conditions.

Note 3: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

1.3. Mechanical Specifications

Length	2.720 in.
Width	2.240 in.
Height	0.774 in.
Weight	2.2 oz.

1.4. Communication Specifications

CAN bus	DW-CAN (ISO 11898)
Baud Rate	1 MB/s
CAN Termination	None
CAN High / Low	2 Ports each.
Pressure Sw.	1 Port

2. Installing a PCM

2.1. Weidmuller Connectors

Wire Insertion

- Disconnect PDP from Battery before adding or modifying connections
- Strip wire back **~0.375" (3/8")**
- Press and hold down connector button. Though this isn't necessary, it ensures the stripped wire does not deform and split into "whiskers" after excessive use. A small screwdriver can be used to easily hold down the connector button.
- Insert wire into connector opening
- Release connector button
- Pull wire to ensure wire is locked in connector
- Confirm wire strands are not extruded

Wire Inspection

- Verify that there are no "whiskers" outside of the connector that may cause a short.
- Verify that the stripped portion of the wire is not excessive enough to cause a short.
- Tug on the wire and verify wire does not pull out. If it does then recheck gauge and/or strip the wire back further.

Wire Removal

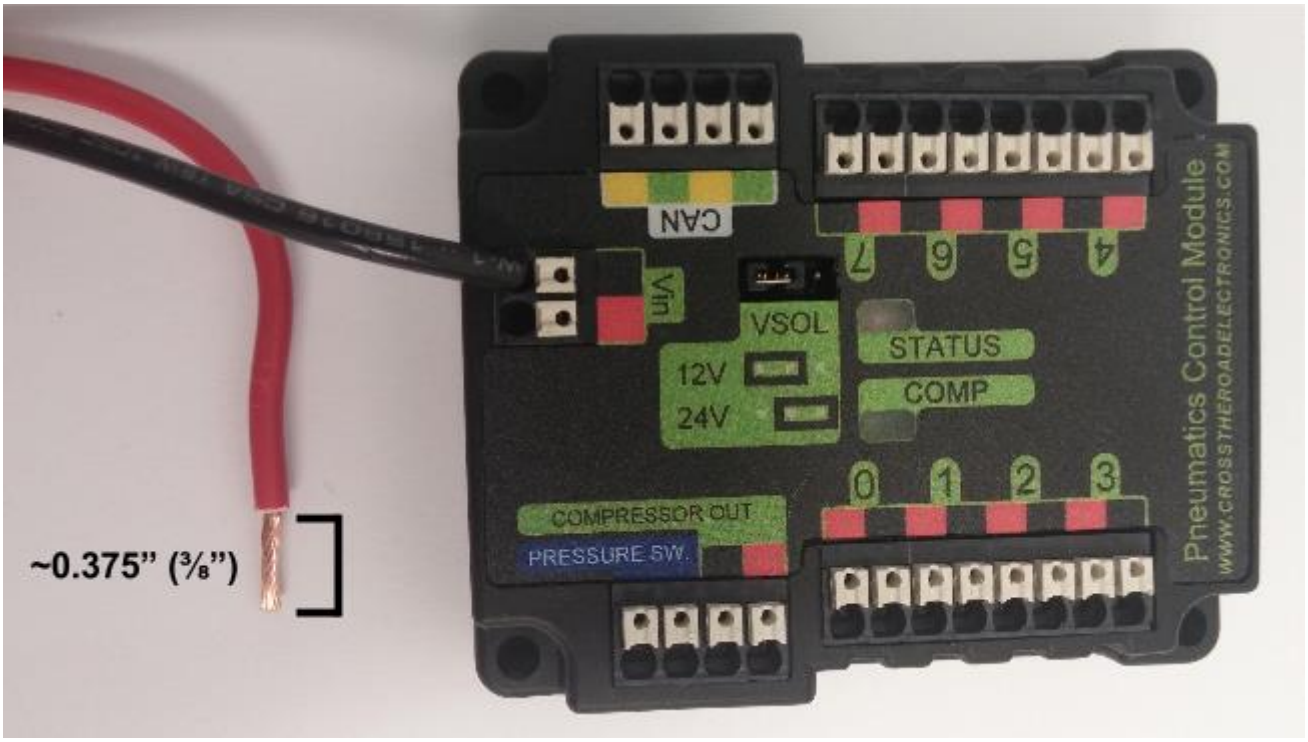
- Press and hold down connector button immediately above connector opening
- Pull wire to remove from connector

Limitations

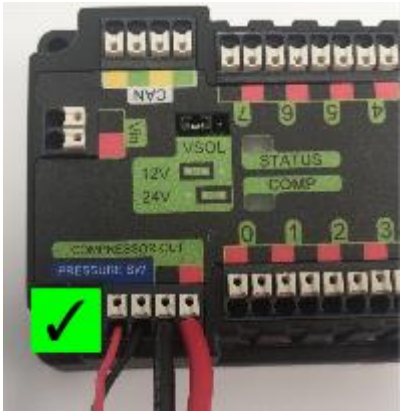
- Wire should **not be frayed** upon insertion. Extruded wire may short to adjacent channels.
- Wire should be **no larger than 16 AWG**, larger gauges will not properly fit in connector
- Wire should be **no smaller than 24 AWG**, smaller gauges will not lock in connector

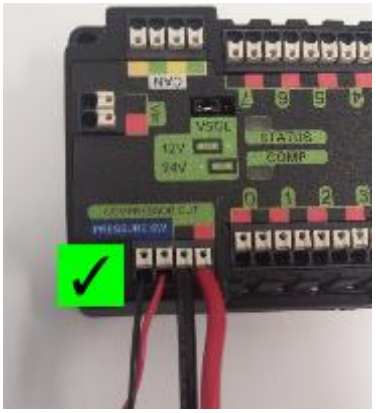
2.2. Wiring the Power Input

- 12 Volt Supply (Battery, Power Supply, etc.)
- 24 to 16 AWG Wire stripped ~0.375" (⅜")



2.3. Wiring the Compressor/Pressure Switch





- Pressure Switch may be attached in either direction, so long as both connections are made
- Compressor must match coloring on PCM

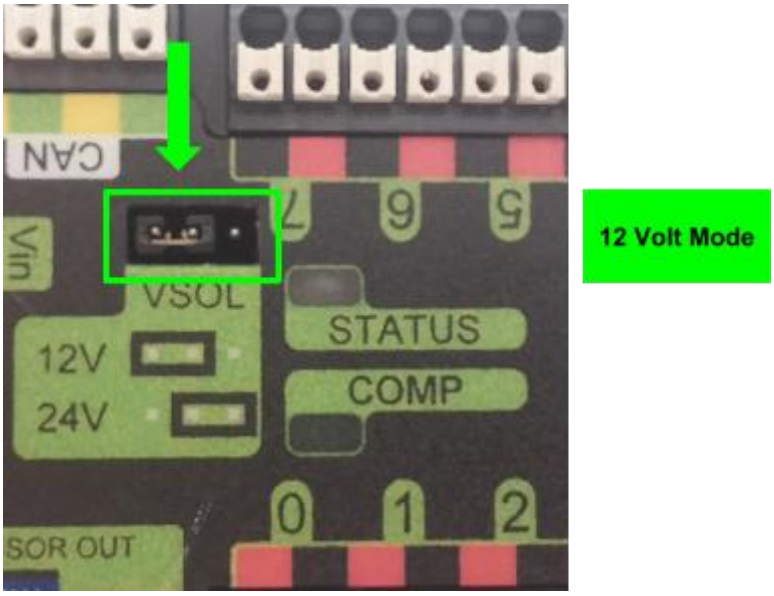
2.4. Wiring the Solenoids

Each solenoid channel has a **red**/**black** pair of Weidmuller connectors. The positive input of the solenoid connects to **red**, the negative input of the solenoid connects to **black**.

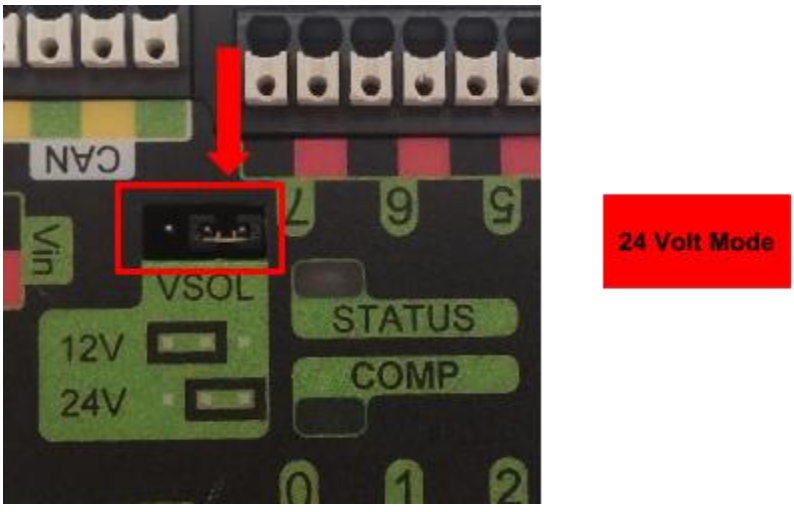
2.4.1 Selecting Solenoid Voltage

An "out of the box" PCM will default to 12V mode. This is prevents teams from connecting a 24V PCM to 12 V solenoids when initially installing a PCM.

Jumper on **12V-side pins** sets **12 Volt Mode** - **12 Volts** will be output on **red** solenoid ports at all times.

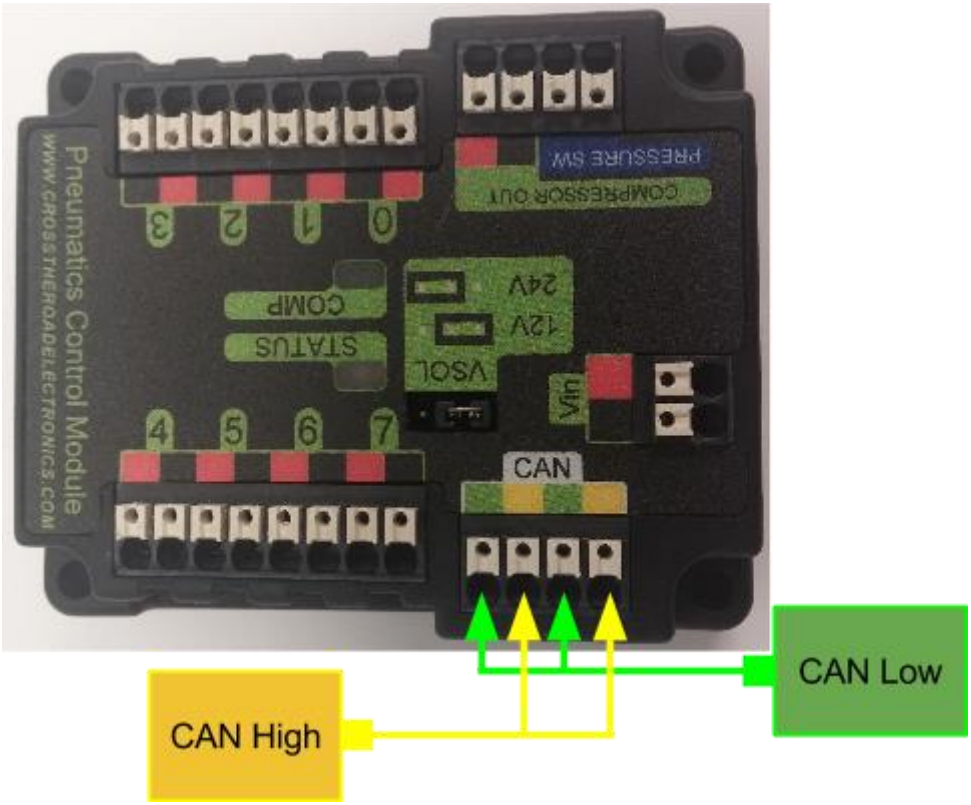


Jumper on **Status-Side pins** sets **24 Volt Mode** - **24 Volts** will be output on **red** solenoid ports at all times.



The absence of a **Solenoid Voltage Jumper** will place the PCM in **24 Volt Mode** by **default.**

2.5. CAN bus



Weidmuller Connectors are also used for CAN Communication. See Section 2.1. Weidmuller Connectors for for wire insertion and removal procedures. PDP provides termination and may be placed at the end of CAN bus chain.

NOTE: There is no Termination Resistor in the PCM. If the PCM is to be placed at the end of a CAN Bus, a termination resistor must be placed on the open PCM CAN port. To avoid this, place the PCM in the middle of the CAN Bus.

3. LED States

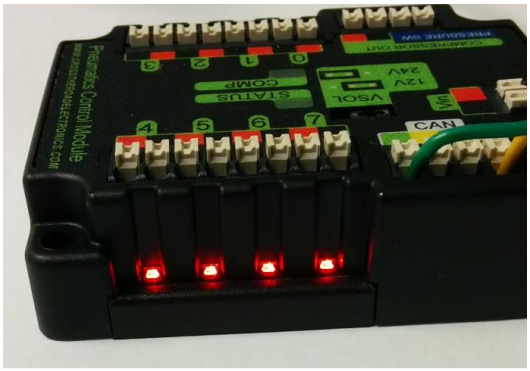
The PCM has two (2) LEDs indicating **Status (STATUS)** and **Compressor State (COMP)**.

3.1. Compressor LED

The **Compressor LED** is a green LED that indicates when the Compressor is active by illuminating. When the LED is on, the Compressor output is driving. When the LED is off, the Compressor output is **NOT** driving.

3.2. Solenoid LEDs

When a solenoid channel is activated, a corresponding red LED will illuminate on the outside border. There is one LED per channel. The LED will turn off when the solenoid output is off.



3.3. Status LED

The **Status LED** is a bi-color LED capable of three color states: **Red**, **Green**, and **Orange**. When the **Status LED** is green at any time, the PCM is functioning properly with no faults. Red or Orange indicates the presence of a fault condition. An **orange Status LED** indicates a sticky (persistent) fault, meaning a fault has occurred at some point and has not been cleared by the user. Sticky faults are persistent over power cycles. A **red Status LED** indicates an active fault. Active faults protect hardware from damage and cannot be cleared by the user. Active faults are reset upon PCM boot.

The **PCM Status LED** should **always** be illuminated (**red**, **green**, or **orange**). If the **Status LED** does not illuminate, check to ensure input power has the correct polarity and that power is supplied to the PCM.

3.3.1. STATUS LED Fault Table

*LED Color	Strobe	Slow	Long
Green	No Fault - Robot Enabled	No Fault - Robot Disabled	NA
Orange	NA	Sticky Fault	NA
Red	NA	No CAN Comm. OR Compressor Fault OR Solenoid Fault (Blinks Solenoid Index)	Compressor Fault

***If STATUS LED contains more than one color, see LED Special States Table**

3.3.2. Fault Resolution Table

Problem	Behavior	Resolution	CAN State	Robot State
Sticky Fault	PCM will slow blink orange. PCM has previously encountered (but is not actively having) a Solenoid Fault or Compressor Fault. Sticky Fault clears via user command over the CAN bus. Sticky Fault does NOT clear on power cycle.	1. Access PDP logger 2. Identify the most recent fault (Solenoid Fault or Compressor Fault) 3. Respond to the fault via the Fault Resolution Table 4. Clear the sticky fault via CAN	Good	Disabled
Solenoid Fault	PCM will blink the number of the faulted solenoid followed by a pause. Fault clears on power cycle.	1. Check faulted solenoid 2. Remove damaged solenoids 3. Remove any metal debris 4. Power cycle 5. Clear sticky fault	Good	NA
Compressor Fault	PCM will blink red in 2 second intervals. Compressor will allow new run attempt every 5 seconds. Fault clears on power cycle OR successful enabling of compressor	1. Check for short across compressor ports 2. Remove any metal debris 3. Clear sticky fault	Good	Enabled
No CAN Comm.	No PCM functionality	1. Connect CAN cable 2. Apply termination resistor 3. Power roboRIO	Bad	NA

3.3.3. Special States Resolution Table

STATUS LED Behavior	Problem	Resolution
STATUS LED alternates red and orange	Damaged Hardware	1. Contact CTRE. Device needs to be serviced 2. PCM is not warranted for use until hardware is repaired 3. DO NOT attempt to use PCM
STATUS LED alternates green and orange	In Boot-loader	1. Download latest FIRST PCM firmware from CTRE 2. Firmware field-upgrade PCM
STATUS LED will not illuminate	No Power / Incorrect Polarity	1. Connect robot battery 2. Connect Vin (PCM) to PDP power 3. Ensure no wires broken 4. Ensure correct polarity 5. Power robot

3.3.4. Complete LED Guide

Live - Solenoids NOT blacklisted are live and controlled by EnableSolX (see functional diagram)
Live - Compressor is live and controlled by CompOutput (see functional diagram)

STATUS LED Color	Blink Type	CAN Comm.	Robot State	Solenoid State	Compressor State	Problem
Green	Strobe	Good	Enabled	Live	Live	None
Green	Slow	Good	Disabled	All Channels OFF	Disabled	None
Orange	Slow	Good	Disabled	All Channels OFF	Disabled	Sticky Fault
Red	*Slow blinks bad solenoid	Good	Enabled	Live	Live	Solenoid Fault
Red	*Slow blinks bad solenoid	Good	Disabled	All Channels OFF	Live	Solenoid Fault
Red	Long Strobe	Good	NA	All Channels OFF	Disabled	Compressor Current Too High
Red	Strobe	Bad	NA	All Channels OFF	Disabled	No CAN Comm.
Red/ Orange	Slow	NA	NA	All Channels OFF	Disabled	Damaged Hardware
Green/ Orange	Slow	NA	NA	All Channels OFF	Disabled	In Boot-loader
No LED	None	NA	NA	NA	NA	No Power / Incorrect Polarity

*The number of **red** blinks correlates to the index of the blacklisted solenoid. One blink corresponds to solenoid '0'. Eight blinks corresponds to solenoid '7'. If there are multiple blacklisted solenoids, the least-value solenoid index is selected.

4. Revision History

Rev	Date	Description
1.0	30-Dec-2014	Initial Creation