Vansco Multiplexing Module

VMM1210

User Guide

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Contents

Publication History

The following table provides an overview of the changes made to this document over the course of its publication history.

Revision	Description of Change
Rev. 001	First release of this document
Rev. 002	Updated template, minor editorial changes throughout, 05/2017

Safety

Do not perform the procedures in this manual unless you are experienced in the handling of electronic equipment.

Contact the manufacturer if there is anything you are not sure about or if you have any questions regarding the product and its handling or maintenance.

The term "manufacturer" refers to Parker Hannifin Corporation.

Safety symbols

The following symbols are used in this document to indicate potentially hazardous situations:

Danger! Risk of death or injury.

Warning! Risk of damage to equipment or degradation of signal

When you see these symbols, follow the instructions carefully and proceed with caution.

General safety regulations

Work on the hydraulics control electronics may only be carried out by trained personnel who are well-acquainted with the control system, the machine, and its safety regulations.

Follow the manufacturer's regulations when mounting, modifying, repairing, and maintaining equipment. The manufacturer assumes no responsibility for any accidents caused by incorrectly mounted or incorrectly maintained equipment. The manufacturer assumes no responsibility for the system being incorrectly applied, or the system being programmed in a manner that jeopardizes safety.

Do not use the product if electronic modules, cabling, or connectors are damaged or if the control system shows error functions.

Electronic control systems in an inappropriate installation and in combination with strong electromagnetic interference fields can, in extreme cases, cause an unintentional change of speed of the output function.

Welding after installation

Complete as much as possible of the welding work on the chassis before the installation of the system. If welding has to be done afterwards, proceed as follows:

Do not place the welding unit cables near the electrical wires of the control system.

1. Disconnect the electrical connections between the system and external equipment.
2. Disconnect the negative cable from the battery.
3. Disconnect the positive cable from the battery.
4. Connect the welder's ground wire as close as possible to the place of the welding.

Construction regulations

The vehicle must be equipped with an emergency stop which disconnects the supply voltage to the control system's electrical units. The emergency stop must be easily accessible to the operator. If possible, the machine must be built so that the supply voltage to the control system's electrical units is disconnected when the operator leaves the operator’s station.

Safety during installation

Incorrectly positioned or mounted cabling can be influenced by radio signals, which can interfere with the functions of the system.

Safety during start-up

Danger! Risk of death or injury. Do not start the machine's engine before the control system is mounted and its electrical functions have been verified.

Do not start the machine if anyone is near the machine.

Safety during maintenance and fault diagnosis

Before performing any work on the hydraulics control electronics, ensure that

- The machine cannot start moving.
- Functions are positioned safely.
- The machine is turned off.
- The hydraulic system is relieved from any pressure.
- Supply voltage to the control electronics is disconnected.

1. About the VMM1210

The VMM1210 is a general purpose programmable logic controller (PLC) for vehicle and other DC applications with steady state voltages less than 32V. It has 12 inputs and 10 outputs as well as a CAN/J1939 communication port.

Figure 1: VMM1210 controller

This module is 100% compatible with other Vansco Multiplexing Modules.

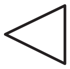
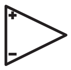
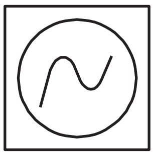
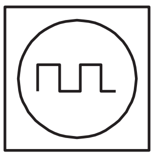
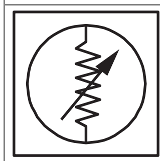
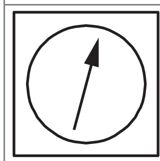
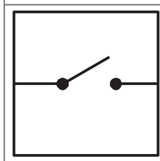
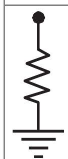
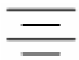
The VMM1210 performs the following tasks:

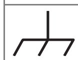
- Receives Digital/Analog/Frequency inputs:
  - The VMM1210 has 8 digital inputs capable of reading either active high or active low type digital inputs. In addition, it has 4 inputs capable of reading analog voltages, frequency values or active low type digital inputs.
- Activates Outputs:
  - The VMM1210 has 8 high current (10A max) high side outputs. In addition it has two low current (3A max) outputs capable of driving either high side or low side loads, and can also be arranged in an H-Bridge configuration. Outputs can drive any type of vehicle load including lights, relays, solenoids, fans, etc.
- Monitors Outputs:
  - The VMM1210 monitors its 10 outputs continuously for fault information. Faults include short circuits (to ground or power), over currents and open load. The VMM1210 allows systems to reduce the number of fuses by allowing the outputs to protect themselves electronically.

  - In the event of a fault, the VMM1210 will disable the output(s) that are faulted. The automatic recovery of faulted states can be turned on or off (for safety reasons). If it is turned on, the automatic fault retry can be adjusted to suit a variety of safety related situations.
  - Open load detection allows for the detection of open (burnt out) loads, this detection can be turned on or off and can also be modified to check only at power up of the system or continuously.
  - Over current levels can be adjusted in one amp increments anywhere from 1A to 12A to allow the system to react more like various fuse types.
- Communicate Input/Output State Information:
  - In order to multiplex, the VMM1210 must be able to communicate its information to other CAN/J1939 based equipment in the vehicle. The VMM1210 does this by transmitting J1939 messages representing the states of its inputs and outputs and other ladder logic based equipment. These messages are broadcast type and can be read by and acted on by any other module connected to the same CAN/J1939 network.
- Processes Ladder Logic:
  - Ladder logic is a graphical representation of standard logic (AND, OR, NOT, etc). The VMM1210 processes ladder logic written using the Vansco Multiplex Module Software package (VMMS). The ladder logic defines which inputs or arrangement of inputs turns on which outputs on the module. The inputs and outputs in the ladder logic can be from one or more modules connected together in a system via the CAN/J1939 network. For more information on the VMMS package, please refer to the VMMS User Guide, or the VMMS help files for information.

1.1. Diagram conventions

The following symbols are used in the schematic diagrams in this document:

Symbol	Meaning
	General input
	General output
	Frequency input
	Analog input
	Frequency sensor
	Pulse sensor
	Resistive sensor
	General sensor
	Application switch
	Load
	Pull-down resistor
	Pull-up resistor
	Battery

Symbol	Meaning
	Fuse
	Resistor
	Ground
	Chassis ground

2. Quick Start

This section provides step-by-step instructions on how to connect the VMM1210 multiplexing module to a development system, install the required software tools, and download the application software.

2.1. Overview

The following is a high-level overview of the steps involved with this section:

1. Gather the required materials.
2. Install the required software tools provided by Parker Vansco.
3. Connect the VMM1210 to a development system (desktop) and power it up.
4. Download application software.

2.2. Gather Required Materials

The following materials are required for the procedures in this section:

- VMM1210 multiplexing module
- personal computer (PC)
- controller I/O board
- controller I/O harness (connects the VMM1210 to the controller I/O board)
- evaluation kit power harness (connects the controller I/O board to the power supply)
- Data Link Adapter (DLA) kit (comes with cables needed for connecting the DLA to your PC and to the rest of the system)
- desktop power supply compatible with the VMM1210 and controller I/O board loads (a 12 V DC, 3 A fixed voltage supply is generally suitable, unless driving more significant loads)
- procurement drawing for the version of VMM1210 you are using, indicating the configuration options for your variant of the product.

- software tools and files required for programming and downloading software for the VMM1210.

Note: With the exception of the PC and desktop power supply, all materials and software are available from Parker Vansco. Please consult your Parker Vansco Account Representative for specific details and pricing information.

2.3. Install the Required Software Tools

Before using the VMM1210 multiplexing module, install the following software tools onto your PC:

- Data Link Adapter (DLA) drivers
  - The DLA acts as the interface between the PC and the VMM1210. Before using the DLA, you must install the DLA drivers.
- Parker Vansco Software Tools
  - Parker Vansco provides the VMMS software tool to create and download software for the VMM1210 multiplexing module. Contact your Parker Vansco Account Representative, or visit the Parker website to get further information on how obtain a product key.

2.3.1. Install the Data Link Adapter Driver Software

A Data Link Adapter (DLA) is needed when connecting the VMM1210 multiplexing module in a development system.

Note: Parker Vansco provides the latest DLA software releases through its web site. Please contact your Parker Vansco Account Representative for details on how to download the latest DLA driver software.

The Parker Vansco DLA requires the installation of drivers on your PC. To install the Parker Vansco DLA drivers:

1. Download the driver, run the extracted file, and follow the Install Wizard. Do not connect the USB-DLA until the driver installation is completed.
2. Connect the USB-DLA to a USB port on your PC. The Found New Hardware screen opens.
3. Select **Install the software automatically (Recommended)**, and then click **Next**. If the driver is not detected automatically, you can browse to the folder containing the driver.
4. After installation is finished, click **Finish**. The USB-DLA is now recognized and ready to be used.

See the Parker Vansco USB-DLA kit user manual for more detailed instructions.

2.4. Connect the VMM1210 multiplexing module to a Development System

It is a good idea to connect the VMM1210 multiplexing module to a development system (PC, Controller I/O Board, power source, and DLA) to verify your application. The development system is an ideal environment for creating and downloading software applications.

The following shows how to connect the VMM1210 multiplexing module in a development system:

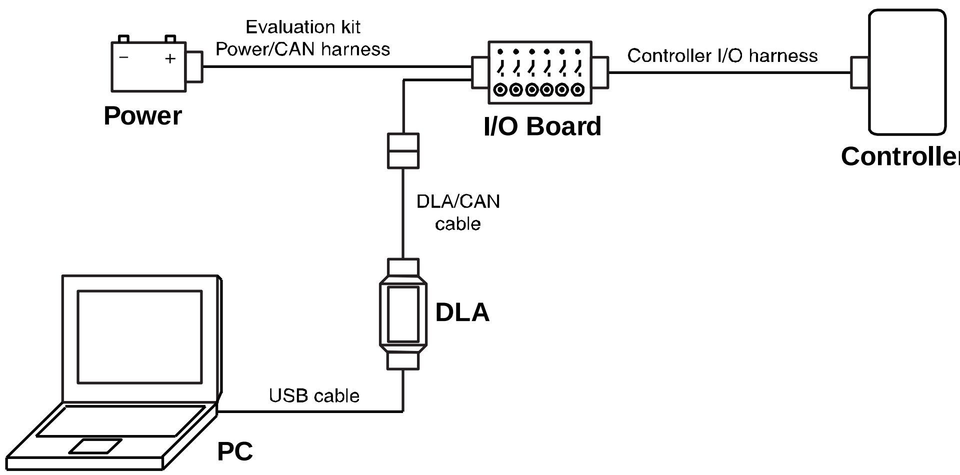


Figure 2: Development system connection

To connect the VMM1210 multiplexing module in a development system, do the following:

Note: Before connecting anything in the development system, ensure that the power supply is set to a voltage that is less than 32 V DC.

1. Connect the Controller I/O harness to the VMM1210 multiplexing module.
2. Connect the Controller I/O harness to the controller I/O board connectors.
3. Connect the evaluation kit power/CAN harness to the controller I/O board's JP3 connector.
4. Do **not** connect the power wire (RED) from the evaluation kit power/CAN harness to the power supply (+) terminal at this time.
5. Connect the ground wire (BLACK) from the evaluation kit power/CAN harness to the power supply (-) terminal.
6. Connect the CAN connector from the evaluation kit power/CAN harness to the corresponding mating connector and harness on the DLA.

   Note: Do not proceed to the next step before the DLA drivers have been installed. See *Install the Data Link Adapter Driver Software* on page 6.

7. Connect the DLA to a personal computer via the USB port.

2.4.1. Power Up the Development System

To power up the VMM1210 multiplexing module:

1. Ensure that all controller I/O board digital inputs, jumpers, and dip switches are properly configured for your module type. Refer to the *Controller I/O Board Reference Manual* for further details.
2. Ensure that the power wire (RED) on the controller I/O board is **not** connected to the power supply (refer to the *Controller I/O Board Reference Manual* for details).
3. Turn the power supply on.
4. If using a variable power supply, set the voltage to a value between 10 to 28 V DC.
5. Turn the power supply off.
6. Connect the power wire (RED) on the connector I/O board to the power supply.
7. Turn the power supply on.

Note: If an input e.g. INPUT_1 is configured as a power control input, you must turn on the corresponding digital input switch on the controller I/O board (e.g. Digital Input 1). Refer to the *Controller I/O Board Reference Manual* for further details.

2.5. Create and Download Ladder Logic Applications

Software applications can be created and downloaded to the VMM1210 multiplexing module.

The software applications for the VMM1210 can be created with the Vansco Multiplexing Module Software (VMMS) tool, using ladder logic.

Consult your Parker Vansco Account Representative for information about your software programming options.

3. Inputs

The VMM1210 has 3 main types of inputs, as follows:

- Programmable digital inputs (can be used as active high, active low, or power control)
- Dedicated addressing inputs
- Programmable multi-purpose inputs (can be used as analog, digital, or frequency)

Note: Do not connect inputs directly to unprotected inductive loads such as solenoids or relay coils, because they can produce high voltage spikes that may damage the VMM1210. If an inductive load must be connected to an input, use a protective diode or transorb.

3.1. Programmable Digital Input Types

Digital inputs are typically used with electrical signals and switches that are either on or off.

There are 2 types of programmable digital inputs in the <Product_Name>:

- Digital Inputs (active high or active low)
- Power Control Digital Inputs

These inputs can be programmed as active high or active low and as power control inputs using the VMM Software package.

3.1.1. VMM1210 Programmable Digital Inputs

The VMM1210 has 8 programmable digital inputs:

- INPUT1_D through INPUT8_D.

3.1.1.1. Programmable Digital Input Capabilities

The following table provides specifications for the VMM1210's programmable digital inputs:

Programmable Digital Input Specifications				
Item	**MIN**	**NOM**	**MAX**	**UNIT**
Input voltage range	0	-	32	V
Overvoltage (5 minutes)	-	-	36	V
Active low pull-up resistance	2.9	3.1	3.3	kΩ
Active high pull-down resistance	1.0	1.1	1.2	kΩ
Capacitance at pin	-	0.01	-	µF
Active low - inactive to active threshold	0.9	-	2.05	V
Active low - active to inactive threshold	2.25	-	3.15	V
Active high - active to inactive threshold	0.9	-	2.05	V
Active high - inactive to active threshold	2.25	-	3.15	V
Minimum detectable pulse width	75	-	-	ms

3.1.1.2. Programmable Digital Input Configuration

Digital inputs are configured as active high or active low by using pull-up or pull-down resistors internal to the module.

- When the input is configured as active high, an internal pull-down resistor is used, and the input will be active when it is switched to battery voltage.
- When the input is configured as active low, an internal pull-up resistor is used, and the input will be active when it is switched to ground.

3.1.1.3. Programmable Digital Input Installation Connections

A digital input is typically connected to a switch that is either open or closed.

- When the switch is open, the pull-up or pull-down resistor will ensure that no signal exists on the input pin, which will be interpreted by the VMM1210 as inactive.
- When the switch is closed, the input is connected to either battery voltage or ground, which will be interpreted by the VMM1210 as active.

Active-high input

The active-high output must be connected to battery power to ensure that there is a battery connection when the state of the input changes.

The following shows a typical active-high digital input connection:

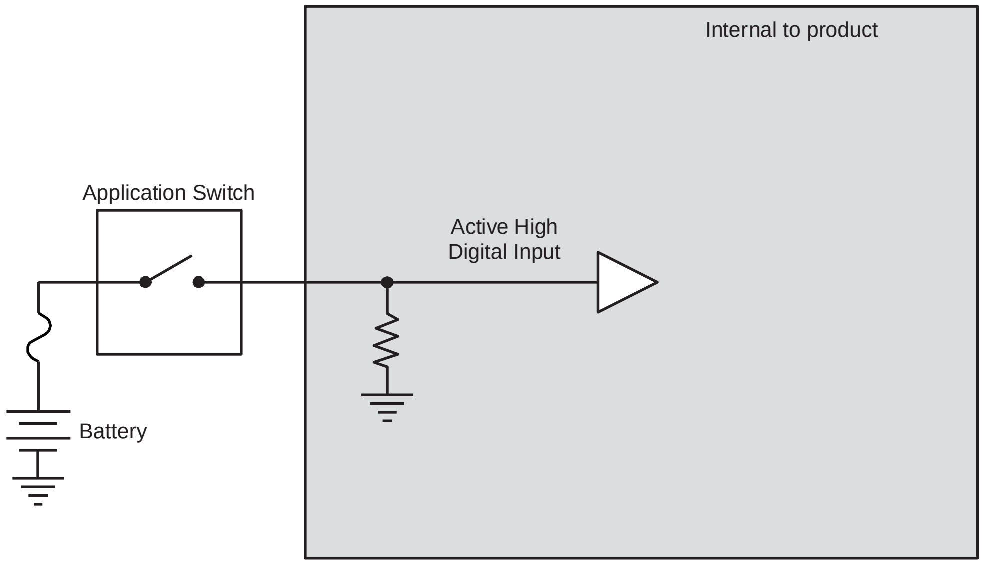


Figure 3: Active high digital input

Active low input

The active-low input must be connected to ground to ensure there is a ground connection when the state of the input changes.

The following shows a typical active-low digital input connection:

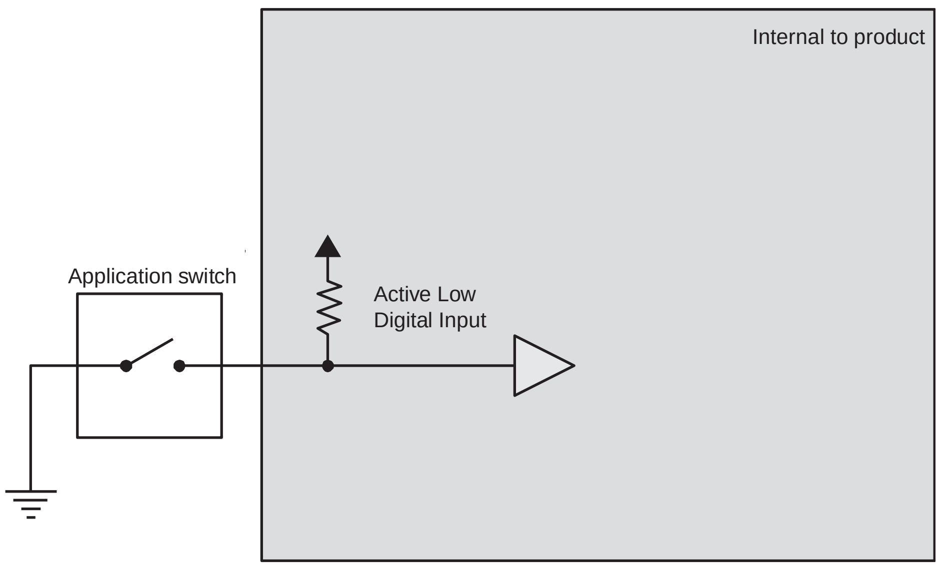


Figure 4: Active low digital input connections

3.1.2. Power Control Digital Inputs

Any of the programmable digital inputs, INPUT1_D through INPUT8_D, may be configured as power control inputs.

Power control inputs generate an internal signal in the module allowing it to "wake up" and turn on its main internal power supply. This wakes up the main processor and allows ladder logic to process.

- If no power control inputs are selected in software, the VMM1210 "wakes up" as soon as power is applied to the unit.
- By default, ladder logic files define INPUT1 as Master Power. If Master Power is active, the VMM assumes that all other VMMs are active in the system. It then performs Plug and Play functions as well as network fault functions based on the assumption that all modules are awake.
- A VMM that is blank will enable the Master Power signal so that it will perform Plug and Play at power up.
- It is possible to define the Master Power input in ladder logic. Review the VMMS Help for details on this.

If you want plug-and-play and network fault-detection functionality, you must ensure that the input defined as MASTER POWER (INPUT1 by default) is given power control functionality on each module.

At least one input on each module should be dedicated as power control.

3.1.2.1. Power Control Inputs Configuration

Power control inputs can be programmed as active high or active low. If an input is programmed as power control and active low, you need a low (ground) signal on that input pin to wake up the module. If an input is programmed as power control and active high, you need a high (battery) signal on that input pin to wake up the module. If you change the active state of that input in ladder logic and download this change to the module, the signal connected to that input pin must also change states in order to wake up the module again via that input.

For example, assume input 2 is programmed active high and power control and the wire harness has an active high dash switch connected to this input. Now assume we change the active state of this input from high to low and download this new logic to the module. The module will receive the new logic and immediately after download will turn off (assuming input 2 is the only active power control input during the download). The module will not turn on again until the signal to the input 2 pin is physically rewired such that it switches ground instead of battery.

Note: Changing power control settings on a VMM1210 may prevent you from being able to wake up the VMM unless you make corresponding changes to your wire harness and/or input connection arrangement.

3.2. Addressing Digital Inputs

Digital inputs ADDR1, ADDR2, ADDR3, ADDR4 and ADDR5 are dedicated address inputs. These inputs are used to set the system address on the module such that it is unique among all other modules in the system. The maximum allowable addresses in a VMM system is 31 including all devices on the bus (VMMs, PGM, LIMs, etc.).

These inputs are all active-low inputs with internal pull-up resistors. The inputs are read when the module starts to indicate which portion of ladder logic the module is to run. The state of these inputs must be valid before turning the VMM on. It is recommended that these inputs be permanently grounded (depending on desired address) in the vehicle harness to ensure a valid state before power up.

The addressing arrangement is shown in the following table, which shows the required inputs that need to be active and floating (active shown as 1, floating shown as 0).

VMM System Address Inputs					
5	**4**	**3**	**2**	**1**	**VMM Address**
0	0	0	0	0	VMM1
0	0	0	0	1	VMM2
0	0	0	1	0	VMM3
0	0	0	1	1	VMM4
0	0	1	0	0	VMM5
1	1	1	1	0	VMM31

Note: Address 32 is reserved and may not be used.

The following shows a typical addressing digital input connection.

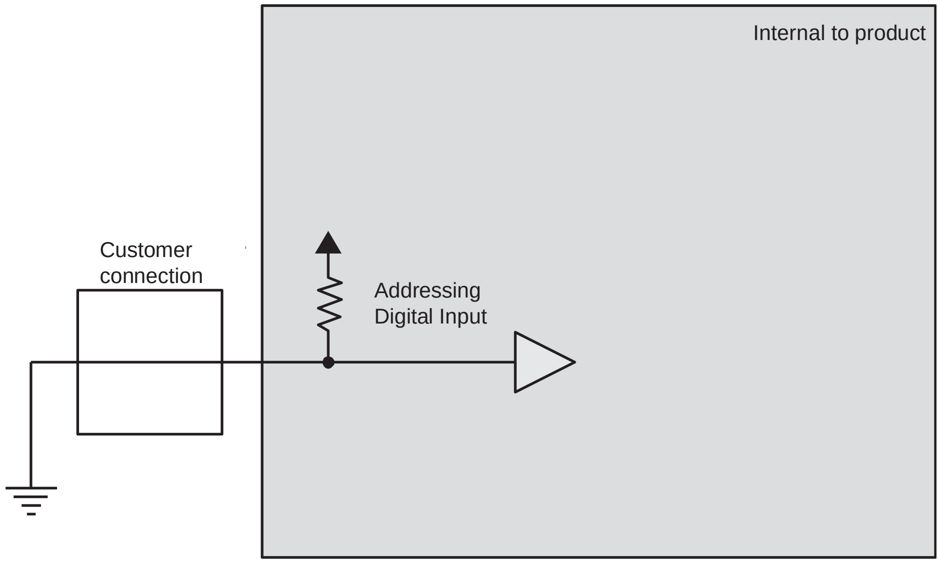


Figure 5: Addressing digital input connections

3.3. Programmable Multi-Purpose Inputs

The VMM1210 has programmable multi-purpose inputs that can be configured either as analog, digital, or frequency (ADF) through software, as follows:

- INPUT9_ADF through INPUT12_ADF

3.3.1. Multi-Purpose Used as Analog Input

Analog inputs are typically used to read electrical signals that span a voltage range.

The following multi-purpose inputs can be used as analog inputs:

- INPUT9_ADF to INPUT12_ADF

3.3.1.1. Analog Input Capabilities

The following table provides specifications for the VMM1210 analog inputs:

Analog Input Specifications				
Item	**Min**	**Nom**	**Max**	**Unit**
Input voltage range	0	-	32	V
Overvoltage (5 minutes)	-	-	36	V
Pull-up resistance	3.1	-	3.5	kΩ
Analog internal range (see note)	-	4.096	-	mV
Analog gain	1	-	6.029	V/V
Analog attenuation	.1282	-	1.0	V
Input pin capacitance	-	.01	-	µF
Note: For analog internal range, ensure that you attenuate or boost an analog input signal such that you maximize the internal range to ensure the highest resolution possible on the analog reading. For example, an analog input signal with a maximum value of 13.38V should be attenuated with 0.3061 which gives the analog input an internal range from 0 to 4.096.				

3.3.1.2. Analog Input Configuration Options

If one of the VMM1210's multi-purpose inputs is configured as an analog input, the input will be converted by the microprocessor using a 10-bit analog to digital converter (ADC).

Analog inputs allow an analog input voltage of 0 to 32 V. The inputs have programmable gain values (1, 3.007, 4.022, 6.029), and programmable attenuation values (1, 0.3061, 0.1807, 0.1282).

The gain values and attenuation values can be mixed and matched to produce other gains/attenuation factors. The maximum internal voltage range is from 0 V to 4.096 V, so the maximum external voltage should produce an internal voltage of no greater than 4.096. If it does, the analog input will clamp at maximum value. Attenuations/gains should be selected to allow the external analog input to be mapped into the internal voltage range to maximize analog input resolution.

Analog readings by the module can be used in ladder logic as either voltage readings with resolution of 0.1 V or as "raw" AD Converter 10 bit values with resolution down to 1 bit (or 0.004 V). The 1 bit resolution does not include initial error inherent in the AD Converter and the amplifier input. Additional error can result from long cable runs or mismatched grounds from sensor to module.

Note: If any of the inputs INPUT9_ADF to INPUT12_ADF are left floating and are programmed as analog inputs, they may read non-zero values in ladder logic. To avoid this, either connect the floating pin to a grounded resistor externally, or add some attenuation in ladder logic. Attenuation factors added in ladder logic will add internal pull-down resistors on the input in question.

3.3.1.3. Analog input connections

Analog inputs are susceptible to system noise, which can affect the accuracy of the signal. Signal accuracy can also be affected by ground level shift, which can cause inputs to activate when they shouldn't.

System noise

To prevent noise pickup on the sensors,

- Use the shortest possible wires when connecting analog inputs to sensors.

The following shows how to connect an analog input to reduce system noise:

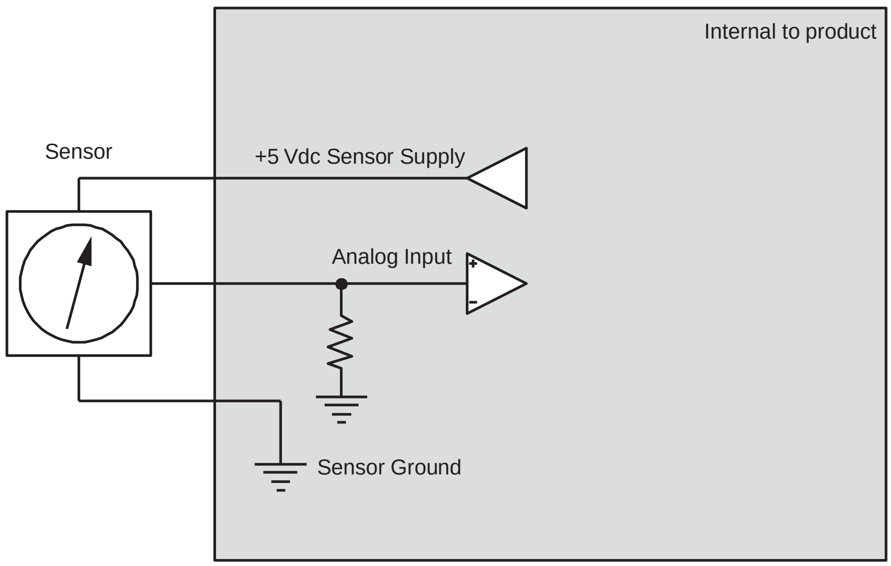


Figure 6: Analog input system noise reduction

Ground level shift

To reduce ground level shift:

1. Dedicate one of the <Number GND> system ground inputs (GND) to sensors that have dedicated ground wires, and connect all sensor grounds to this system ground input.
2. Splice the other system ground inputs together in the vehicle harness (close to the connector) to provide a better ground for the noisier low-side outputs and digital circuits.

3. Position the sensor's ground connection near the system ground connections to ensure that the signal remains within the digital activation range of the input.

Note 1: The system ground inputs are rated for low-current signals, which ensures the sensor's ground is very close in voltage potential to the system ground.

Note 2: Sensors that don't have a dedicated ground wire are typically grounded to the vehicle chassis through the sensor's body.

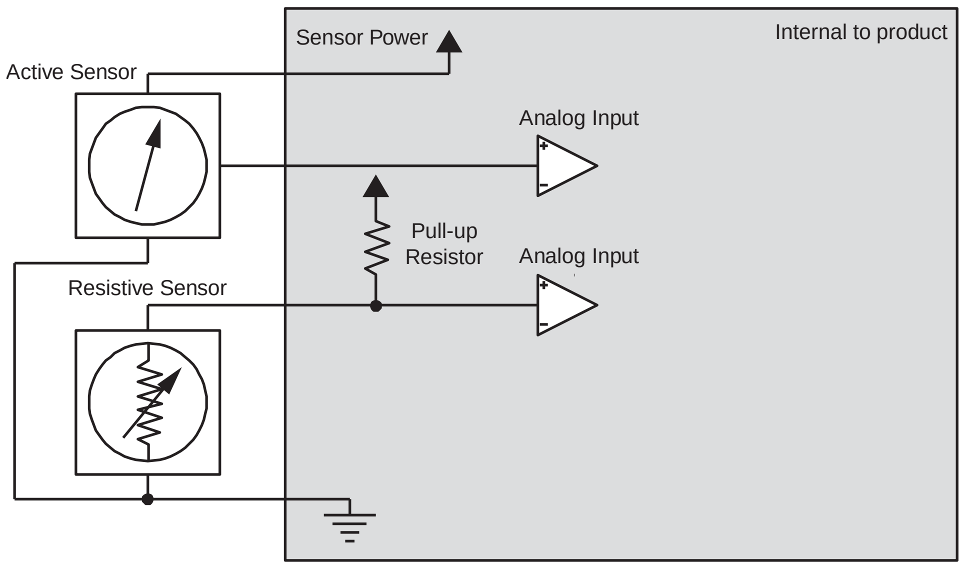


Figure 7: Analog input ground shift connection for sensors that have dedicated ground wires

3.3.2. Multi-Purpose Used as Digital Input

Digital inputs are typically used for electrical signals that are either on or off.

The following multi-purpose inputs can be used as digital inputs:

- INPUT9_ADF to INPUT12_ADF

3.3.2.1. Digital Input Capabilities

When multi-purpose inputs are used as digital inputs in the VMM1210, they are only able to be active-low digital inputs.

The following table provides specifications for the multi-purpose inputs when used as digital inputs:

Digital Input Specifications				
Item	**MIN**	**NOM**	**MAX**	**UNIT**
Input voltage range	0	-	32	V
Overvoltage (5 minutes)	-	-	36	V
Active low pull-up resistance	3.1	3.3	3.5	kΩ
Capacitance at pin	-	0.01	-	µF
Active low - inactive to active threshold	1.23	-	-	V
Active low - active to inactive threshold	-	-	2.60	V

3.3.2.2. Digital Input Configuration

Digital inputs can only be programmed as active low, and they have a pull-up resistance of 3.3 kΩ.

- Since the input is configured as active low, an internal pull-up resistor will be used, and the input will be active when it is switched to ground.

3.3.2.3. Active-Low Digital Input Connections

An active-low digital input is typically connected to a switch that is either open or closed.

- When the switch is open, the pull-up resistor will ensure no signal exists on the input pin, which will be interpreted by the VMM1210 as inactive.
- When the switch is closed, the input is connected to ground, which will be interpreted by the VMM1210 as active.

The active-low input must be connected to ground to ensure there is a ground connection when the state of the input changes.

The following shows a typical active low digital input connection:

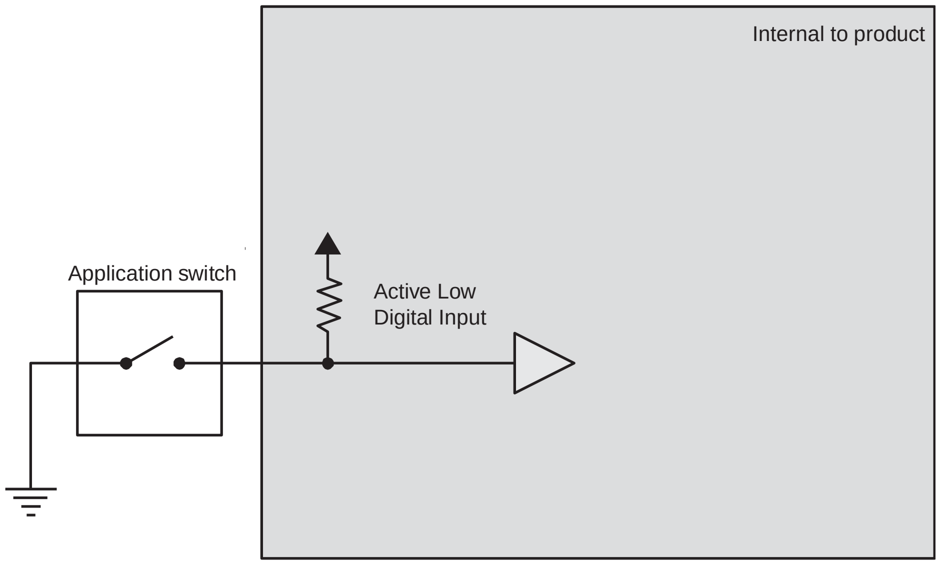


Figure 8: Active low digital input connections

3.3.3. Multi-Purpose Used as DC-Coupled Frequency Input

The following multi-purpose inputs can be used as DC-coupled frequency inputs:

- INPUT9_ADF to INPUT12_ADF

3.3.3.1. DC-Coupled Frequency Capabilities

DC-coupled frequency inputs allow you to read the frequency of external signals that have a ground reference and no DC offset. These inputs are ideal for use with hall-effect type sensors.

The following table provides specifications for the VMM1210 multi-purpose inputs when used as DC-coupled frequency inputs:

Frequency Input Specifications				
Item	**Min**	**Nom**	**Max**	**Unit**
Input voltage range	0	-	32	V
Overvoltage (5 minutes)	-	-	36	V
Pull-up resistance	3.1	-	3.5	kΩ
Frequency range	0	-	10	kHz
Frequency gain	1	-	6.029	V/V
Frequency attenuation	.1282	-	1.0	V
Input pin capacitance	-	.01	-	µF

3.3.3.2. DC-Coupled Frequency Configuration Options

Multi-purpose inputs used as frequency inputs allow a periodic waveform with frequencies ranging from 10 Hz to 10 kHz to be read as a frequency value.

An internal pull-up resistor value of approximately 3.3 kΩ can be turned on or off for this input type.

The inputs have programmable gain values (1, 3.007, 4.022, 6.029), and programmable attenuation values (1, 0.3061, 0.1807, 0.1282).

The gain values and attenuation values can be mixed and matched to produce other gains/attenuation factors.

3.3.3.3. DC-Coupled Frequency Input Connections

When connecting DC-coupled frequency inputs, be aware of system noise and ground level shift.

System Noise

DC-coupled frequency inputs are more susceptible to system noise than digital inputs.

To reduce system noise:

- Connect DC-coupled frequency inputs to sensors that produce signals with no DC offset.
- Use the shortest possible wires when connecting DC-coupled frequency inputs to sensors to prevent noise pickup on the sensors.

Ground Level Shift

Ground level shift affects the accuracy of DC-coupled frequency inputs. Ground level shift refers to the difference between the system ground input (GND) voltage, and the sensor ground voltage.

To reduce ground level shift:

- If there are more than 1 GND pins in the system, dedicate one of them to sensors that have ground wires, and connect all sensor grounds to that system ground pin.
- Splice the other system ground inputs together in the vehicle harness (close to the connector), to provide a better ground for the noisier low-side outputs and digital circuits.
- Ensure the sensor's ground connection is close to the system ground connections. This will help ensure the signal remains within the digital activation range of the input.

Note 1: The VMM1210 system ground inputs are rated for low-current signals, which ensures the sensor's ground is very close in voltage potential to the system ground.

Note 2: Sensors that don't have a dedicated ground wire are typically grounded to the vehicle chassis through the sensor's body.

The following shows a typical DC-coupled frequency input connection:

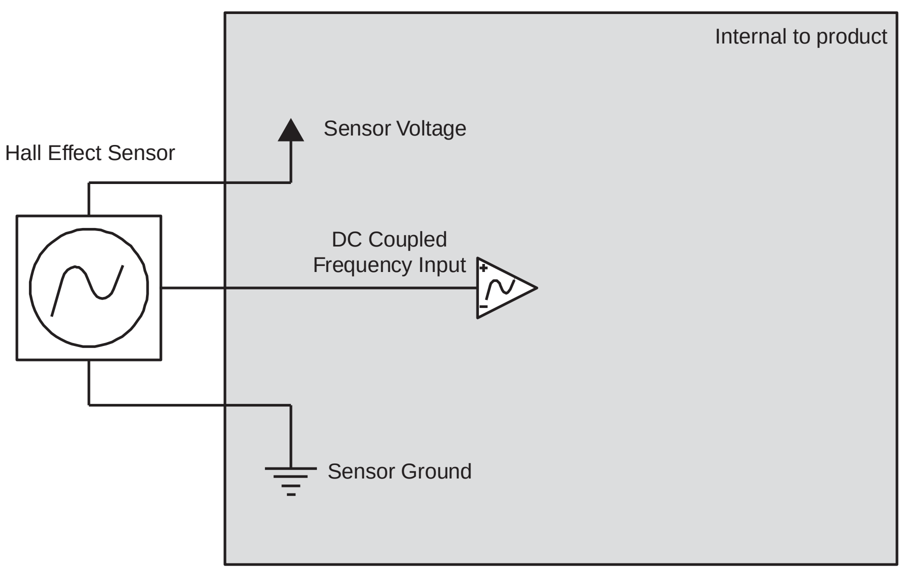


Figure 9: DC-coupled frequency input installation connections

4. Outputs

The VMM1210 has 10 solid-state outputs. Output currents can range from 1.0 A to 10.0 A.

The VMM1210 has 3 types of outputs:

- High-side outputs capable of 10 A
- High-side outputs capable of 3 A
- Low-side outputs capable of 3 A

A high-side 3 A output and a low-side 3 A output can be coupled in the external harness to create an H-bridge.

4.1. 10 A High-Side Outputs

The VMM1210 has 8 high-side outputs capable of 10 A:

- OUTPUT1_10A_HS to OUTPUT8_10A_HS

4.1.1. High-Side Output Capabilities

These outputs provide 10 A maximum continuous current. All 8 outputs can be operated at 10 A output at the same time for a total module current of 80 A maximum.

10 A High-Side Output Specifications				
Item	**MIN**	**NOM**	**MAX**	**UNIT**
Maximum output current	-	-	10	A
Over current trip point	6	-	12	A
Over current trip time	-	1	-	s
Short circuit trip point	-	45	-	A
Short circuit trip time	10	-	20	ms
Leakage to ground, off state	15	-	-	kΩ
Leakage to battery, off state	-	15	25	µA
Turn on time (enable signal to 90%)	50	-	400	µs
Turn off time (/enable signal to 10%)	30	-	110	µs
Slew rate rising edge, 10% to 30% Rload = 1Ω	1.0	1.5	2.2	V/µs
Slew rate falling edge, 70% to 40% Rload = 1Ω	1.1	1.9	2.6	V/µs
Open load detection resistance	-	10	-	kΩ
Output pin capacitance	-	0.01	-	µF

The outputs have the ability to be programmed for PWM duty cycles. Five unique programmable frequencies are available.

- OUTPUT1_10A_HS to OUTPUT4_10A_HS all have individual frequency control
- OUTPUT5_10A_HS to OUTPUT8_10A_HS have a single programmable frequency.

4.1.2. High-Side Output Configuration

For software-controlled open load detection, the programmer has the ability to choose when to bias the output through the open load detection resistor. This feature may be disabled by the programmer using software if the output is connected to sensitive loads, such as LEDs.

The following diagram shows the configuration for high-side outputs:

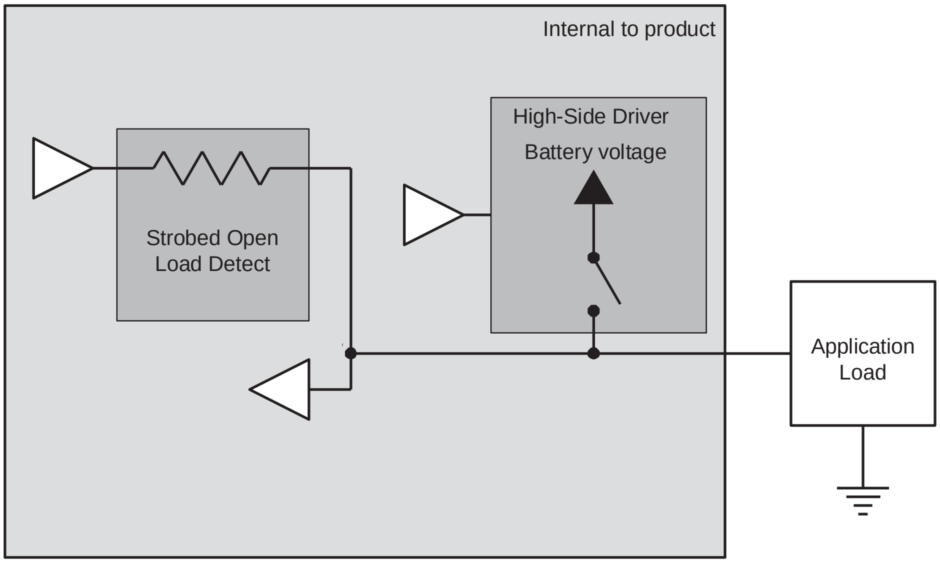


Figure 10: High side output configuration

4.1.3. High-Side Output Installation Connections

When connecting high-side outputs, note that

- High-side outputs are connected to one of two internal bus bars, which can be connected to a +12 V or +24 V battery. Each busbar powers 4x 10A outputs. Maximum load on each busbar is 40A.
- High-side outputs can provide switched battery power to a variety of load types in a vehicle.

If large inductive loads are used and the high-side output is providing a continuous PWM signal, the PWM peak current must not be greater than the specified continuous current for the output (in continuous mode, the average current flow through the diode at 50% duty cycle is approximately equal to ½ the peak current).

When connecting high-side outputs, follow these best practices:

- Do not connect high-side outputs to loads that will draw currents greater than the maximum peak current or maximum continuous current.
- Connect the load grounds in close physical proximity to the VMM1210 power grounds.

The following shows a typical high-side output connection:

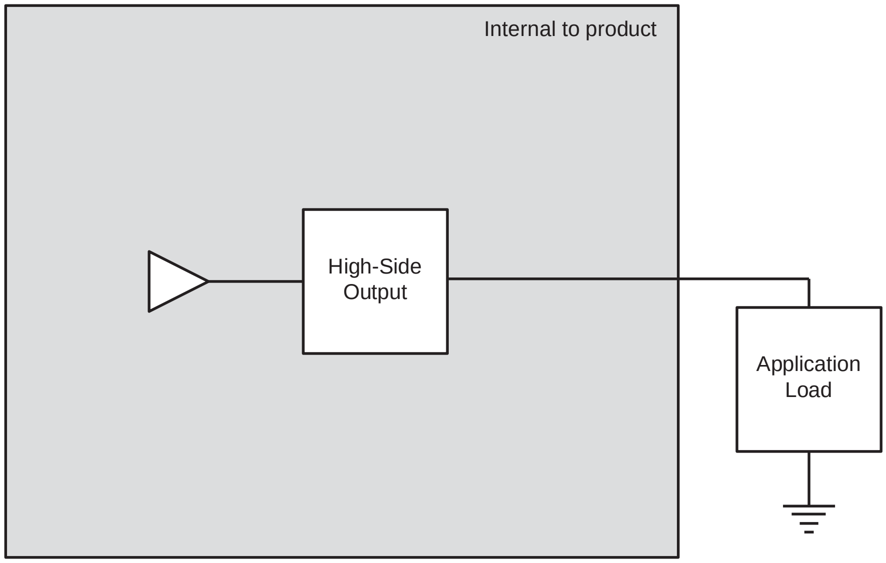


Figure 11: High-side output installation connections

4.2. 3 A High-Side/Low-Side Outputs

The VMM1210 has 2 programmable high or low-side outputs capable of 3 A:

- OUTPUT9_3A to OUTPUT10_3A

The outputs can be programmed through the VMM software package to be:

- High-side
- Low-side
- H-bridge

4.2.1. High-Side/Low-Side Output Capabilities

Each output is rated at a continuous current of 3 A. These outputs along with the other 8 outputs must have a total current of no more than 80 A per module.

High-Side/Low-Side Output Specifications				
Item	**MIN**	**NOM**	**MAX**	**UNIT**
Maximum output current	-	-	3	A
Short circuit trip point (high-side)	-	8	-	A
Short circuit trip point (low-side)	-	28	-	A
Leakage to ground, off state	4	-	-	kΩ
Leakage to battery, off state	-	-	12	µA
Acceptable Voltage on Low Side Ground (J2-1F with respect to J1-3A) (see note)	-1.0	0	2.0	V
High-side turn on time (enable signal to 90%)	80	-	400	µs
High-side turn off time (/enable signal to 10%)	80	-	400	µs
High-side slew rate rising edge, 10% to 30%, Rload = 12Ω	0.1	-	1.0	V/µs
High-side slew rate falling edge, 70% to 40%, Rload = 12Ω	0.1	-	1.0	V/µs
Low-side turn on time (enable signal to 90%)	-	40	100	µs
Low-side turn off time (/enable signal to 10%)	-	70	170	µs
Low-side slew rate rising edge, 50% to 70%, Rload = 2.2Ω	-	1	3	V/µs
Low-side slew rate falling edge, 70% to 50%, Rload = 2.2Ω	-	1	3	V/µs
Open load detection resistance	-	10	-	kΩ
Output pin capacitance	-	0.01	-	µF
Note: This is the voltage range over which the low side outputs will operate properly. Voltage differences from low side ground to logic ground beyond these levels could result in the low side outputs turning on or off unexpectedly.				

The outputs have the ability to be programmed for PWM duty cycles, excluding H-Bridge.

- The outputs have a single programmable frequency which is shared with OUTPUT1_10A_HS to OUTPUT8_10A_HS.

4.2.2. High-Side/Low-Side Output Configuration

The following diagram shows the possible configuration for high-side/low-side outputs:

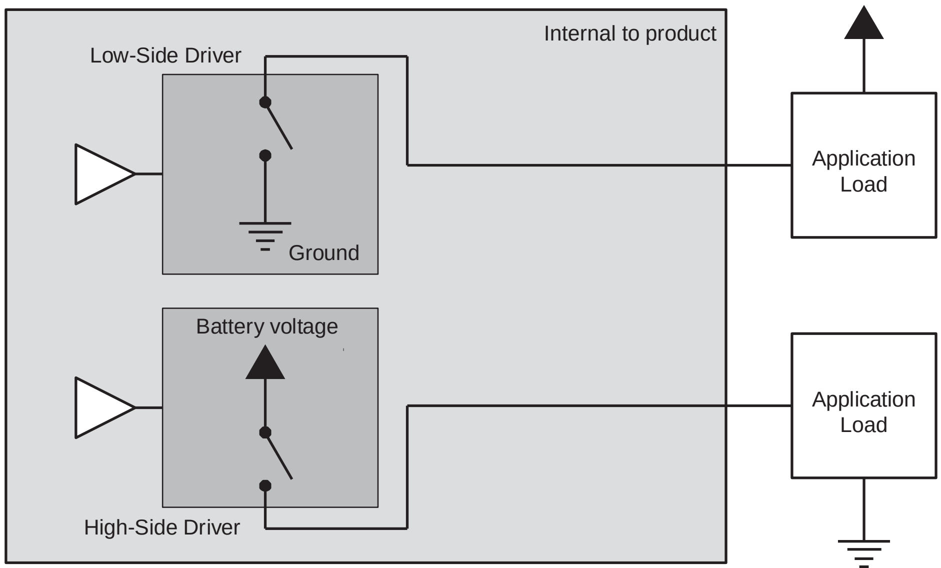


Figure 12: High-side/Low-side output configuration

4.2.3. High-Side/Low-Side Installation Connections

High-Side Output Connections

You must be aware of the following when connecting high-side outputs:

- High-side outputs are connected to one of two internal bus bars, which can be connected to a +12 V or +24 V battery. Each busbar powers 4x 10A outputs. Maximum load on each busbar is 40 A.
- High-side outputs can provide switched battery power to a variety of load types in a vehicle.

If large inductive loads are used, and the high-side output is providing a continuous PWM signal, then the PWM peak current must not be greater than the specified continuous current for the output (in continuous mode, the average current flow through the diode at 50% duty cycle is approximately equal to ½ the peak current).

When connecting high-side outputs, ensure you follow these best practices:

- High-side outputs should not be connected to loads that will draw currents greater than the maximum peak current, or maximum continuous current.
- The grounds for the loads should be connected physically close to the VMM1210 power grounds.

The following shows a typical high-side output connection:

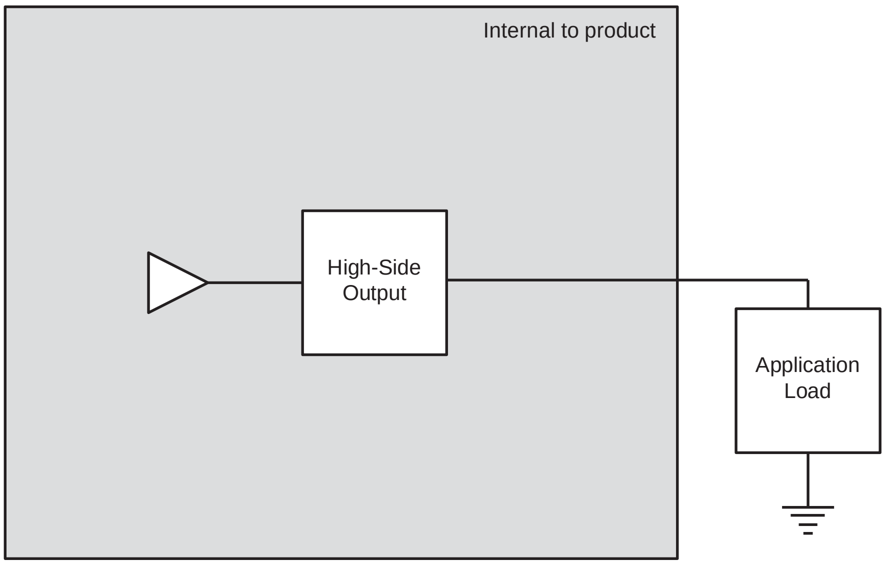


Figure 13: High-side output installation connections

Note: 3 A outputs must be externally protected with back EMF/Transient suppression diodes if connected to an inductive load of any kind.

Low-Side Output Connections

You must be aware of the following when connecting low-side outputs:

- Low-side outputs are connected to internal ground, which is connected to battery negative terminal. Maximum load on each output is 3A.
- Low-side outputs can provide switched ground path to a variety of load types in a vehicle.

The following shows a typical low-side output connection:

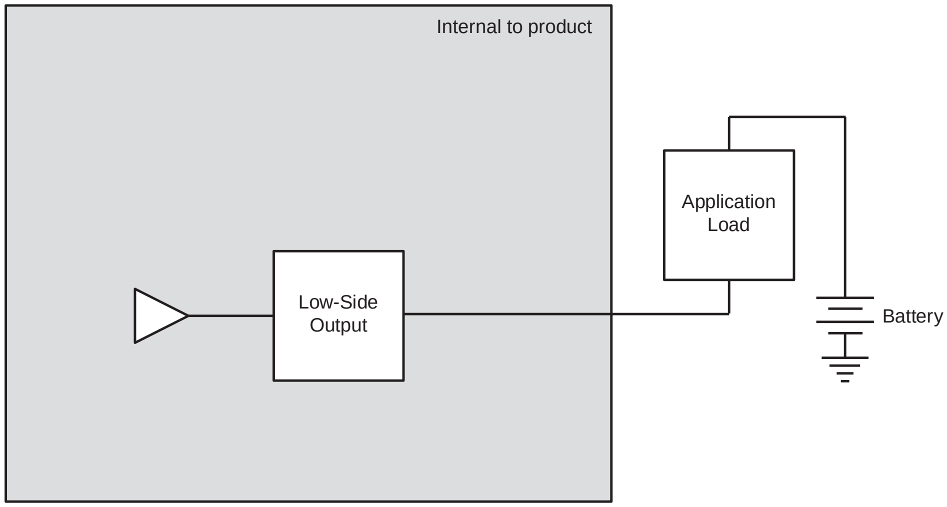


Figure 14: Typical low-side output connection

H-Bridge Connection

The high-side/low-side outputs OUTPUT9_3A to OUTPUT10_3A can be programmed through the VMM Software package to be an H-Bridge (controlled by activating the one you want to be high side). An H-Bridge allows loads to be controlled by both high side and low side switches at the same time.

H-Bridge connection allows loads to have current reversed through them which allows several load types to reverse direction (motors, solenoids, etc).

The following figures show a typical setup for an H-Bridge. These show how the H-Bridge is used to reverse current flow direction.

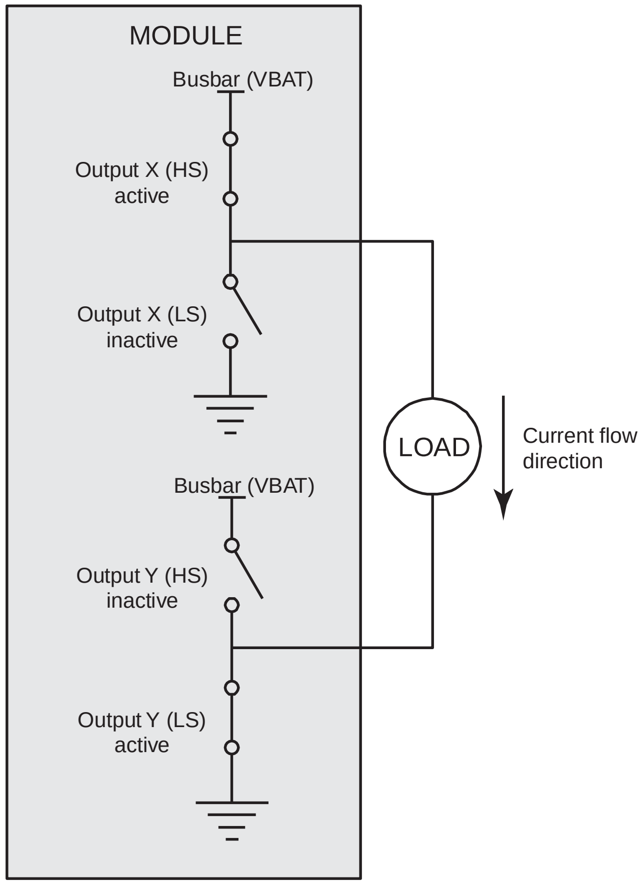


Figure 15: H-bridge forward direction

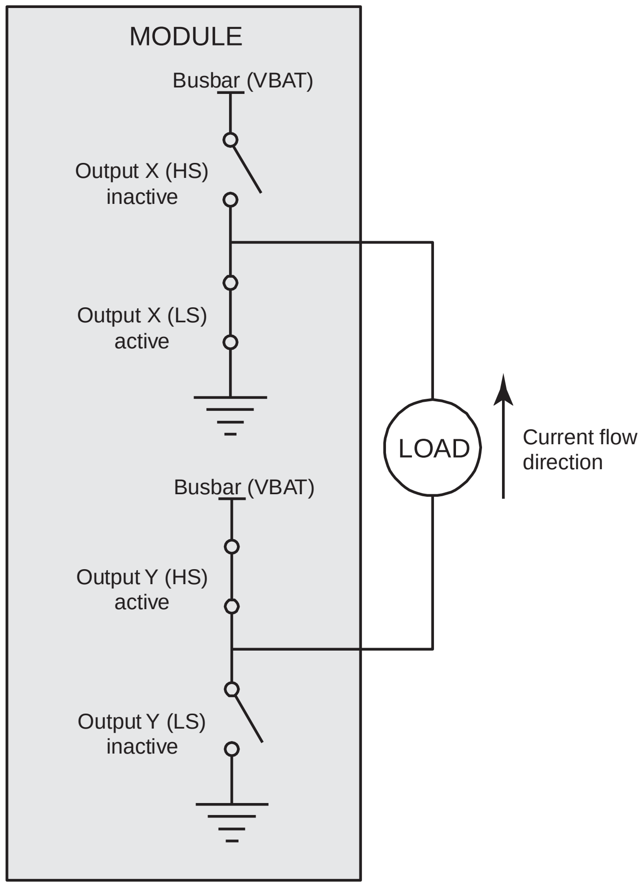


Figure 16: H-bridge reverse direction

To activate the H-Bridge as shown above, the ladder logic should make the first output active and leave the second output inactive. To reverse current flow, the ladder logic should make the first output inactive and the second output active.

If neither of the outputs are active, all switches are off and the outputs are floating. If both outputs are active at the same time, the output to go active first (i.e. the one that is processed first in ladder logic) will be high side, the other will be the low side. It is recommended that this situation be avoided by writing ladder logic to prevent both being active at the same time.

4.3. High-Side Output Diagnostics and Fault Detection

Each high-side output has the ability to report many different fault conditions.

The types of faults that are reported are determined by the configuration of your high-side outputs, and this configuration must be considered when writing the application software.

4.3.1. Over Current Fault Protection

Each output is capable of shutting down in the event that the output current goes higher than the over current shutdown set point for the module.

The over current set point is programmable via the VMM Software. The value is programmable from 12 A down to 6 A on a module by module basis. A fault is reported as a flashing output LED and via CAN/J1939 messages.

4.3.2. Short to Ground Fault Protection

Each output, OUTPUT1_10A_HS to OUTPUT8_10A_HS, is capable of shutting down in the event that the output current goes higher than approximately 45 A.

Each output, OUTPUT9_3A to OUTPUT10_3A, is capable of shutting down in the event that the output current goes higher than approximately 8 A, when configured as high-side outputs.

A fault is reported as a flashing output LED and via CAN/J1939 messages.

4.3.3. Short to Power Fault Protection

Each output is capable of detecting a short circuit to battery power when the output is in the off (inactive) state.

A fault is reported as a flashing output LED and via CAN/J1939 messages.

4.3.4. Open Load Detection

Each output is capable of detecting open loads when the output is in the off (inactive) state. Outputs OUTPUT9_3A to OUTPUT10_3A must be configured as high-side outputs to have this functionality.

This detection is programmable on or off on a module by module basis.

- If programmed as on for the module, the detection process is programmable as active only at power up, or as active on a periodic basis with adjustable time between checks.
- If programmed as on for the module, certain outputs can be programmed as ignored in the detection scheme to prevent false readings on high resistance or high voltage drop loads such as LED lights.

4.3.5. Inductive Load Protection

Outputs OUTPUT1_10A_HS to OUTPUT8_10A_HS are internally protected against 600V inductive loads as outlined in the "SAE J1455 Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design" specification.

Inductive loads which produce a greater voltage or energy content than that shown in the "SAE J1455 Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design" specification require the use of external back EMF/Transient suppression diodes when connected to any of the high-side 10 A outputs.

Outputs OUTPUT9_3A to OUTPUT10_3A must be externally protected with back EMF/Transient suppression diodes if connected to an inductive load of any kind.

5. Power

The VMM1210 is powered by the vehicle battery. The VMM1210 operates in a 12 V or 24 V system, and can operate from 7 V up to 32 V, with over-voltage protection at 36 V.

The various pins on the connectors are used for different types of power, as detailed in the following sections.

5.1. Logic Power

The VMM1210 has one pin, labeled VBATT_LOGIC, dedicated to providing power for logic circuitry, and three pins, labeled GND, dedicated to grounding the VMM1210.

5.1.1. Logic Power Capabilities

Logic power provides power to the logic circuit, which consists of the microprocessor, RAM, etc.

Logic Power Specifications				
Item	**MIN**	**NOM**	**MAX**	**UNIT**
Input voltage range	7	-	32	V
Overvoltage (5 minutes)	-	-	36	
Operating current draw at logic power pin (see note 1)	-	92	-	mA
Sleep mode current draw at logic power pin (see note 2)	-	22	-	mA
Additional current draw per inactive input (active low input type @ 13.8V), at logic power pin	-	0.66	-	mA
Additional current draw per inactive input (active high input type @ 13.8V), at logic power pin	-	7.4	-	mA
Current draw per active low input @ 13.8V	-	4.3	-	mA
Current draw per active high input @ 13.8V	-	13.8	-	mA
Inline fuse required on logic power pin	-	1	-	A
Note 1: No inputs active, unit set up for no power control inputs, so it is always on when power is applied. Input voltage 13.8 V. ***Note 2:*** No inputs active, unit set up for one power control input, so sleep mode can be activated. All inputs programmed as active low type. Input voltage 13.8 V.				

5.1.2. Logic and Output Power Connections

When connecting the VMM1210 logic power, note that

- Logic power connections are made using the VBATT_LOGIC and GND pins.
- The VMM1210 is protected against reverse-battery connections by an internal high-current conduction path that goes from ground to power. To protect the VMM1210 from damage in a reverse-battery condition, place a fuse of 1 A or less in series with the power wires in the application harness.

Note: Reverse-battery protection is only guaranteed when using standard automotive fuses.

Select fuse sizes by multiplying the maximum continuous current during normal operation by 1.333 (75% de-rating factor). Do not use slow-blow fuses for this application.

- All power connections to the VMM1210 should be fused to protect the vehicle harness.

5.2. Busbar Power

There are two main power connections for the high current bus bar battery power inputs (BUSBAR1 and BUSBAR2). The busbar inputs are separated into two connectors (J1 and J2).

5.2.1. Busbar Power Capabilities

Busbar power provides power to the output circuits through a battery or ground connection. Each busbar circuit can draw a maximum of 40 A.

The following table provides specifications for the VMM1210 busbar power:

Busbar Power Specifications				
Item	**MIN**	**NOM**	**MAX**	**UNIT**
Number of busbars	-	2	-	
Busbar voltage range	6	-	32	V
Overvoltage (5 minutes)	-	-	36	V
Busbar current (per connector)	-	-	40	A
Inline fuse required on busbar pins	-	-	50	A

5.2.2. Busbar Power Installation Connections

Connectors J3 and J4 provide power to Busbar 1 and Busbar 2 respectively, and are required if the outputs that get power from those busbars are used.The busbar power lines (J3-A/J3-B and J4-A/J4-B) are connected to 12 Vdc or 24 Vdc.

There are two pins on each of J3 and J4, these are internally connected on the VMM1210. Both pins on J3 and/or J4 need to be connected if the current flowing through an individual busbar exceeds 20A. It is recommended that the busbar power wires be kept on a dedicated high current power connection point, isolated from the logic power wires where possible.

The system VBATT_LOGIC (logic power) line (J1-1A) is connected to 12 Vdc or 24 Vdc. The system GND (logic ground) line (J1-3A) is connected to ground. It is recommended that the logic power and ground wires be kept isolated from high current power and ground studs where possible. This will prevent dips in the high current lines from affecting the logic power and ground signals at the VMM1210.

Busbar power connections in a system may be made using a ground cable or chassis ground. Examples of both are shown in the figures below.

> ⚠ Proper fusing is required on any power wires coming off of the battery terminal. This fusing is not shown in the following figures.

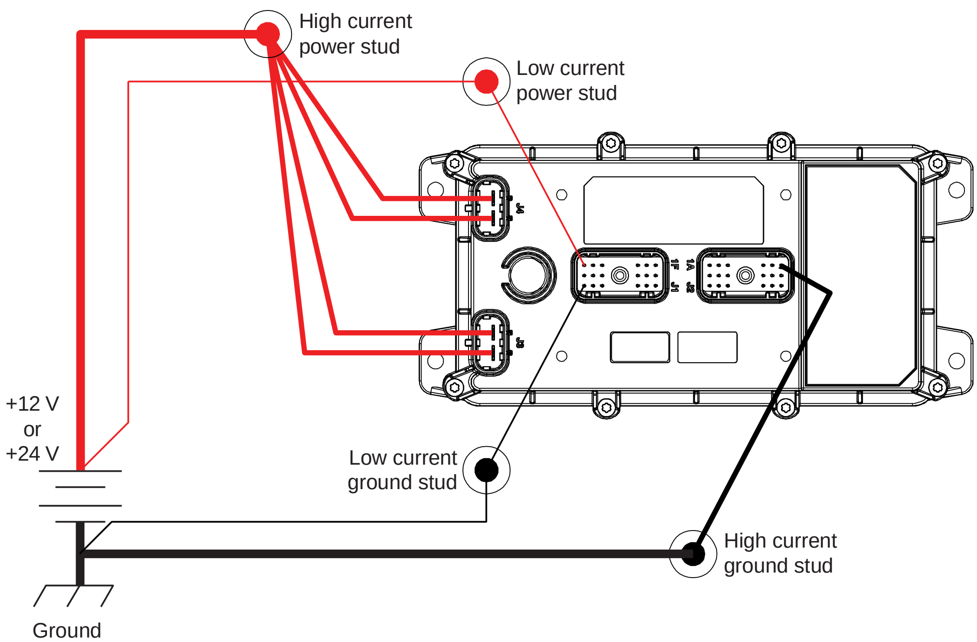


Figure 17: Cable grounded system

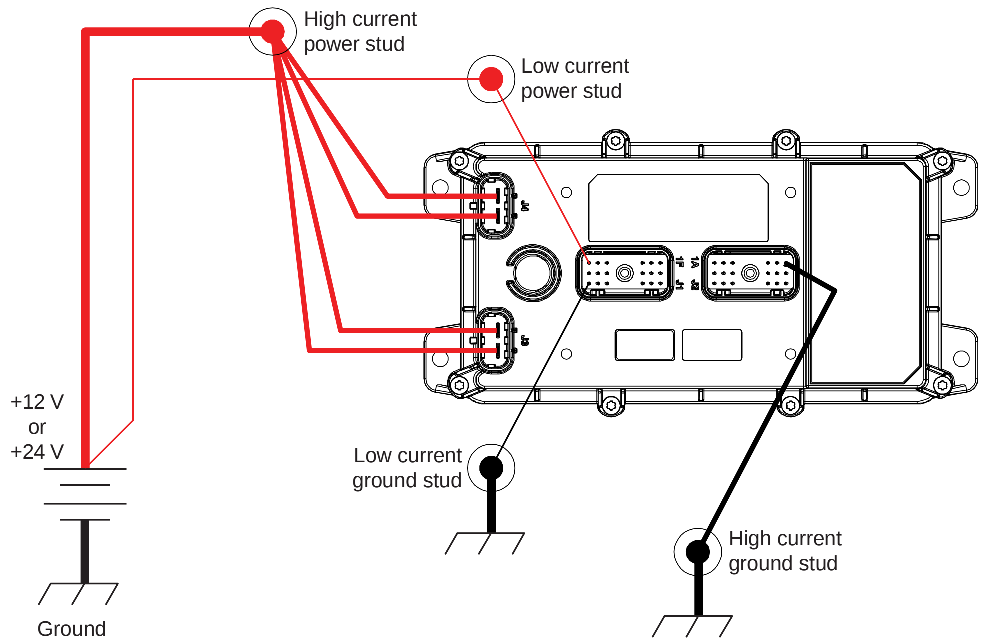


Figure 18: Chassis grounded system

6. Communication

The VMM1210 uses the Controller Area Network (CAN) communication when communicating with other modules on the vehicle, or with a personal computer.

6.1. Controller area network

The VMM1210 has 1 Controller Area Network (CAN) communication port(s) available. The VMM1210 hardware provides controller area network (CAN) communication according to the SAE J1939 specification, making the VMM1210 compatible with any CAN-based protocol through software.

CAN communication is used to communicate the status of multiple modules that are connected together in the same network.

6.1.1. J1939 CAN Capabilities

The CAN communicates information at a rate of 250 kbps. VMM1210 input and output information is transmitted through the CAN at a broadcast rate of 40 Hz. Lack of regular CAN communication is an indication that there is either a problem with a module in the network, or a problem with the CAN bus.

The following table provides specifications for the CAN:

Item	Min	Nom	Max	Unit
Max voltage	-	-	32	V
Onboard terminator option	-	No	-	
Wake on CAN option	-	No	-	
Baud rate	-	250	-	kbps
J1939 compliant	-	Yes	-	

6.1.2. J1939 CAN Installation Connections

The CAN connection for the VMM1210 should conform to the J1939 standard. The J1939 standard is a robust automotive specification that is a good CAN installation guideline even when the J1939 CAN protocol is not being used.

For a list of J1939 connection considerations, refer to the SAE J1939 specifications available through the Society for Automotive Engineers. SAE J1939-11 covers the physical aspects of the CAN bus including cable type, connector type, and cable lengths.

Note: The standard variant of the VMM1210 does not have a CAN termination resistor, which is based on the assumption that the CAN bus is terminated in the harness.

The following lists the elements that are required for a J1939 CAN connection:

- CAN Cable: A shielded twisted-pair cable should be used when connecting multiple modules to the CAN bus. The cable for the J1939 CAN bus has three wires: CAN High, CAN Low, and CAN Shield (which connect to the corresponding CAN_HI, CAN_LO, and CAN_SHIELD pins on the connector). When a module does not have a CAN_SHIELD pin, the CAN Shield should be connected to an available ground terminal attached to the negative battery. The CAN cable must have an impedance of 120 Ω.
- The CAN cable is very susceptible to system noise; therefore, CAN shield must be connected as follows:
  a. Connect CAN Shield to the point of least electrical noise on the CAN bus.
  b. Connect CAN Shield as close to the center of the CAN bus as possible.
  c. Use the lowest impedance connection possible.

Note: Ground loops can damage electronic modules. The CAN Shield can only be grounded to one point on the network. If grounded to multiple points, a ground loop may occur.

- CAN Connectors: Industry-approved CAN connectors are manufactured by ITT Cannon and Deutsch, and come in either T or Y configurations.
- CAN Harness: The CAN harness is the main backbone cable that is used to connect the CAN network. This cable cannot be longer than 40 meters and must have a 120 Ω terminating resistor at each end. The 120 Ω terminating resistors eliminate bus reflections and ensure proper idle-state voltage levels.
- CAN Stubs: The CAN stubs cannot be longer than 1 meter, and each stub should vary in length to eliminate bus reflections and ensure proper idle state voltage levels.
- Max Number of Modules in a System: The CAN bus can handle a maximum of 30 modules in a system at one time.

The following shows a typical CAN connection using the SAE J1939 standard:

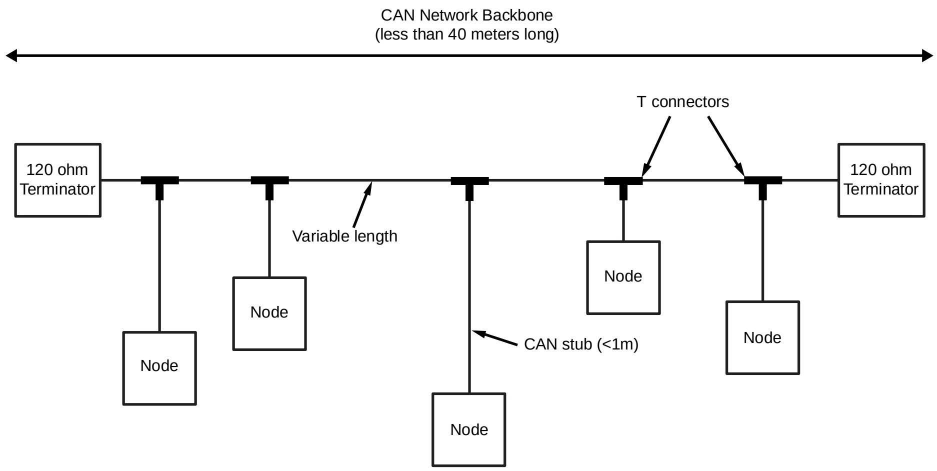


Figure 19: J1939 CAN connection

7. Diagnostic LEDs

The VMM1210 has 24 red LEDs that are used to indicate the status of inputs, outputs, power and the Controller Area Network (CAN).

The following shows the VMM1210's LEDs as they appear on the product:

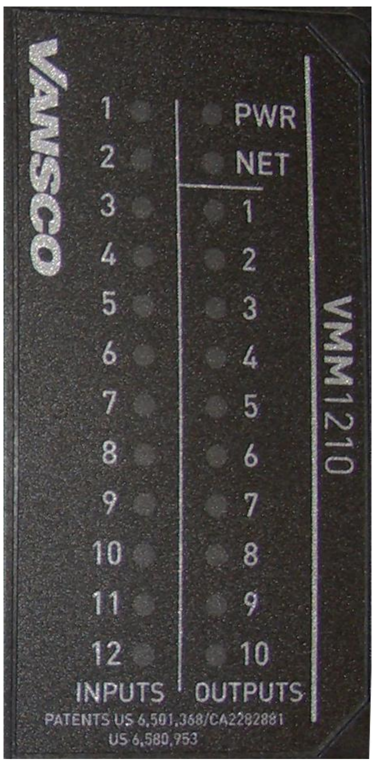


Figure 20: VMM1210 diagnostic LEDs

7.1. Input LEDs

Input LEDs are used to indicate the status of inputs.

Input LEDs are labeled “IN” (1 to 12) on the VMM1210.

7.2. Output LEDs

Output LEDs are used to indicate the status of high-side outputs.

Output LEDs are labeled “OUT” (1 to 10) on the VMM1210.

7.3. Power LED

The power LED (labeled PWR) is used to indicate the status of power, software, and faults on the VMM1210.

7.4. Network LED

The network LED (labeled NET) is used to monitor the state of the CAN network.

8. Connectors

The VMM1210 has 2 Delphi Metri-pack series 18-pin connectors, as follows:

- White (J1): Mating Connector, Delphi Metri-pack 15492547; Contacts, Delphi 12103881
- Black (J2): Mating Connector, Delphi Metri-pack 15492546; Contacts, Delphi 12103881

The connectors have pins that connect to inputs, outputs, network ports, and logic power used by the VMM1210. They also have keying that prevents you from incorrectly mating the connectors to the vehicle harness.

The following are images of the required mating connectors:

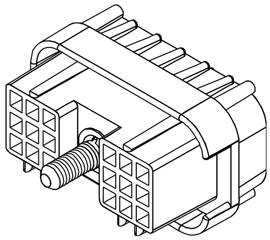


Figure 21: Connector J1

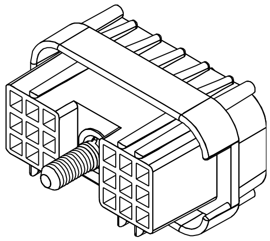


Figure 22: Connector J2

The VMM1210 also has 2 Delphi Metri-pack series 2-pin connectors for busbar power (power for High-side outputs), as follows:

- Black (J3): Mating Connector, Packard Metri-pack 12033769; Contacts, Packard 12033997
- Black (J4): same as above

The following is an image of the required connector:

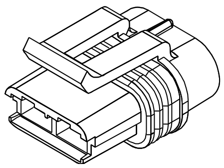


Figure 23: Connector J3/J4

8.1. Pinouts

Connector pins connect to inputs, outputs, and communication channels. They provide the interface between the vehicle harness and the internal circuitry of the VMM1210.

The following tables show the pinouts for each connector:

J1 (White) Connector Pinout		
Pin	**Name**	**Function**
1A	VBATT_LOGIC	System power (logic)
1B	ADDR3	Address input
1C	OUTPUT6_10A_HS	10A High-side output
1D	OUTPUT7_10A_HS	10A High-side output
1E	INPUT1_D	Digital input
1F	OUTPUT8_10A_HS	10A High-side output
2A	INPUT2_D	Digital input
2B	ADDR2	Address input
2C	INPUT3_D	Digital input
2D	ADDR4	Address input
2E	ADDR1	Address input
2F	INPUT4_D	Digital input
3A	GND_POWER	System ground (logic)
3B	INPUT5_D	Digital input
3C	OUTPUT1_10A_HS	10A High-side output
3D	OUTPUT2_10A_HS	10A High-side output
3E	INPUT6_D	Digital input
3F	OUTPUT5_10A_HS	10A High-side output

J2 (Black) Connector Pinout		
Pin	**Name**	**Function**
1A	RS232_RX	Not used, Pseudo port for factory use only
1B	INPUT8_D	Digital input
1C	OUTPUT3_10A_HS	10A High-side output
1D	OUTPUT10_3A	Analog or Digital input
1E	INPUT7_D	Analog or Digital input
1F	GND_LOWSIDE	Low-side output ground
2A	BOOTSTRAP	Not used, Pseudo port for factory use only
2B	INPUT9_ADF	Analog Digital or Frequency input
2C	INPUT11_ADF	Analog Digital or Frequency input
2D	INPUT10_ADF	Analog Digital or Frequency input
2E	INPUT12_ADF	Analog Digital or Frequency input
2F	CAN_SHIELD	CAN shield
3A	ADDR5	Address input
3B	RS232_TX	Not used, Pseudo port for factory use only
3C	OUTPUT4_10A_HS	10A High-side output
3D	OUTPUT9_3A	3A High-side/low-side output
3E	CAN_LO	CAN low
3F	CAN_HI	CAN high

J3 (Black) Connector Pinout		
Pin	**Name**	**Function**
A	BUSBAR1	VBATT power for outputs 1,2,4,5,9,10
B	BUSBAR1	VBATT power for outputs 1,2,4,5,9,10

J4 (Black) Connector Pinout		
Pin	**Name**	**Function**
A	BUSBAR2	VBATT power for outputs 3.6.7.8
B	BUSBAR2	VBATT power for outputs 3.6.7.8

9. Installation

Because every system is different, it is not feasible to provide detailed installation instructions that will be suitable for every assembly. This chapter therefore provides only high-level guidelines on installing the VMM1210.

The vehicle manufacturer is responsible for creating procedures for mounting the VMM1210 in a vehicle during production assembly.

9.1. Mechanical Installation Guidelines

Use the following guidelines when installing the VMM1210 in a vehicle.

9.1.1. Dimensions

The following diagram shows the dimensions of the VMM1210:

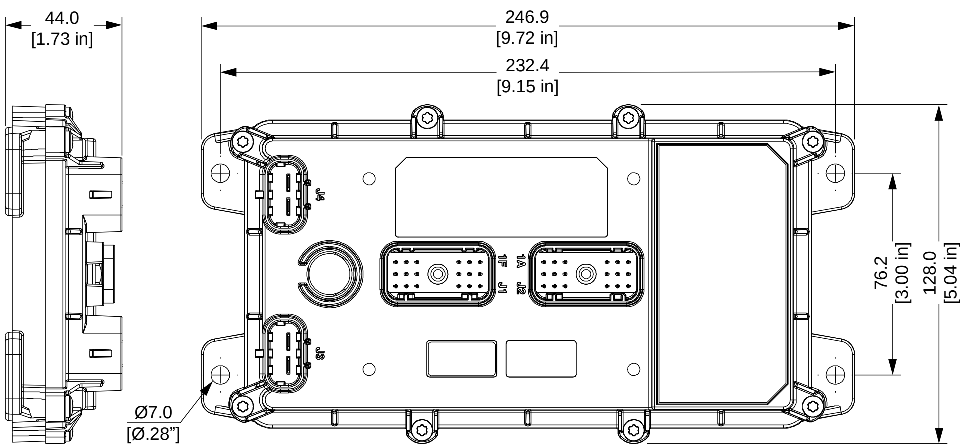


Figure 24: VMM1210 dimensions

9.1.2. Selecting a Mounting Location

The VMM1210 can be installed in the vehicle's cab or on the chassis. If used in a marine application, ensure that it is protected from excessive salt spray.

Before mounting the VMM1210, review the following environmental and mechanical requirements.

Note: Do not install the VMM1210 near any significant heat sources, such as a turbo, exhaust manifold, etc. Avoid installing the VMM1210 near any drive-train component, such as a transmission or engine block.

9.1.2.1. Environmental Requirements

The VMM1210 warranty does not cover damage caused by exposure of the product to environmental conditions that exceed its design limitations.

1. Mount the VMM1210 in an environment that is within its ambient temperature range of –40 °C to +85 °C.
2. Mount the VMM1210 in an environment that is within its particle ingress rating. The sealing standard for the VMM1210 is EP455 level 1.

Note: The VMM1210 has not been tested for water ingress according to the EP455 level 1 standard.

The VMM1210 is protected from aggressive pressure wash up to 1000 psi at 1 m (3.28 ft.).

⚠ ***Warning! Damage to equipment.*** Exercise caution when pressure-washing the VMM1210. The severity of a pressure wash can exceed the VMM1210 pressure wash specifications related to water pressure, water flow, nozzle characteristics, and distance. Under certain conditions a pressure wash jet can cut wires.

9.1.2.2. Mechanical Requirements

Review the following mechanical requirements before selecting a mounting location for the VMM1210:

- The VMM1210 should be mounted vertically so moisture will drain away from it.
- The wire harness should have drip loops incorporated into the design to divert water away from the VMM1210.
- The harness should be shielded from harsh impact.
- The harness should connect easily to the connector and have adequate bend radius.
- The labels and LEDs should be easy to read.
- The VMM1210 should be in a location that is easily accessible for service.

9.1.3. Mounting the VMM1210 to a Vehicle

It is up to the original equipment manufacturer (OEM) to ensure the product is securely mounted to the vehicle.

The following guidelines are related to physically attaching the VMM1210 to a vehicle:

- Secure the VMM1210 with bolts in all bolt holes using Hex Head 1/4"-20 or equivalent metric size (6 mm) bolts.
- The bolts should be tightened according to the fastener manufacturer's tightening torque specifications.

9.1.3.1. Recommended Mounting Orientation

The VMM1210 should be mounted vertically so moisture drains away from it, as shown in the following:

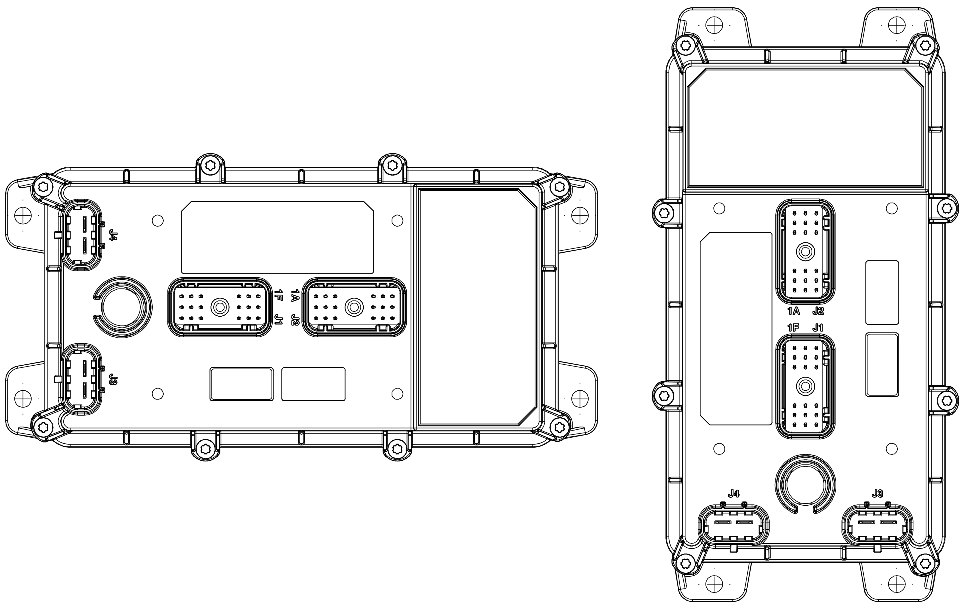


Figure 25: Recommended mounting orientation

9.2. Electrical Installation Guidelines

Use the following guidelines when installing the VMM1210 in a vehicle.

9.2.1. Designing and Connecting the Vehicle Harness

The vehicle manufacturer is responsible for designing a vehicle harness that mates with the VMM1210 connector(s).

The vehicle harness design depends on the following:

- How the VMM1210's inputs, outputs, communication, and power pins are configured.
- Other components on the vehicle and their physical locations.
- The routing of the harness.

Suggested wire sizing for the various connections are as follows:

- Inputs, 18 AWG
- Outputs, 16 AWG
- Logic power and ground, 18 AWG
- Other powers and grounds, 16 AWG
- Busbar power, if applicable, 14 AWG per 20 A of current (or 8 AWG per 40 A of current for single pin busbar connectors)

Once the vehicle harness is designed, it can be connected to the VMM1210 simply by clicking the mating connector into the connector port on the VMM1210.

10. Application Examples

The purpose of this section is to provide examples of how the VMM1210 can be used for different purposes.

The following examples (used for illustrative purposes only) are covered in this section:

- Implementing safety interlocks
- Controlling indicator lights
- Controlling a proportional valve
- Controlling motor speed
- Using one analog input as two digital inputs
- Connecting sensors

10.1. Implementing Safety Interlocks

Safety is paramount when creating controls for a vehicle.

One safety feature that can be implemented with the VMM1210 is to ensure the vehicle doesn't move when it is not being used, and no one is sitting in the operator's seat.

To prevent the vehicle from moving when no one is sitting in the operator seat:

1. Place a seat switch interlock on the operator seat and connect the switch to a digital input.
2. Write application code for the digital input so that it shuts down critical vehicle functions when the switch is open (when no one is sitting in the seat).

Note: The example above may cause unwanted shutdowns if the operator moves around while controlling the vehicle. To prevent this, use software filtering that will prevent the vehicle from shutting down unless the switch is open for more than a defined period of time.

The following diagram shows a typical seat switch interlock connection:

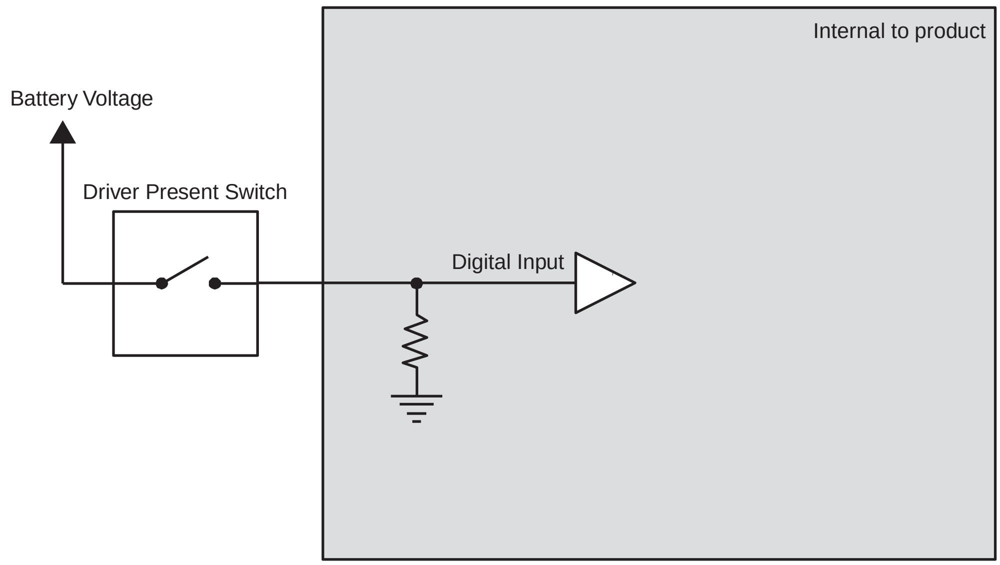


Figure 26: Seat switch interlock connection

10.2. Controlling Indicator Lights

Multiple VMM1210 can be used together in a system to control a vehicle's indicator lights. For example, you could connect three VMM1210s, communicating over the CAN bus, as follows.:

- Connect one VMM1210 to the rear indicator lights.
- Connect one VMM1210 to the front indicator lights.
- Connect one VMM1210 to the turn signal and hazard switches.

The following shows how to connect three VMM1210s together in a system to control indicator lights:

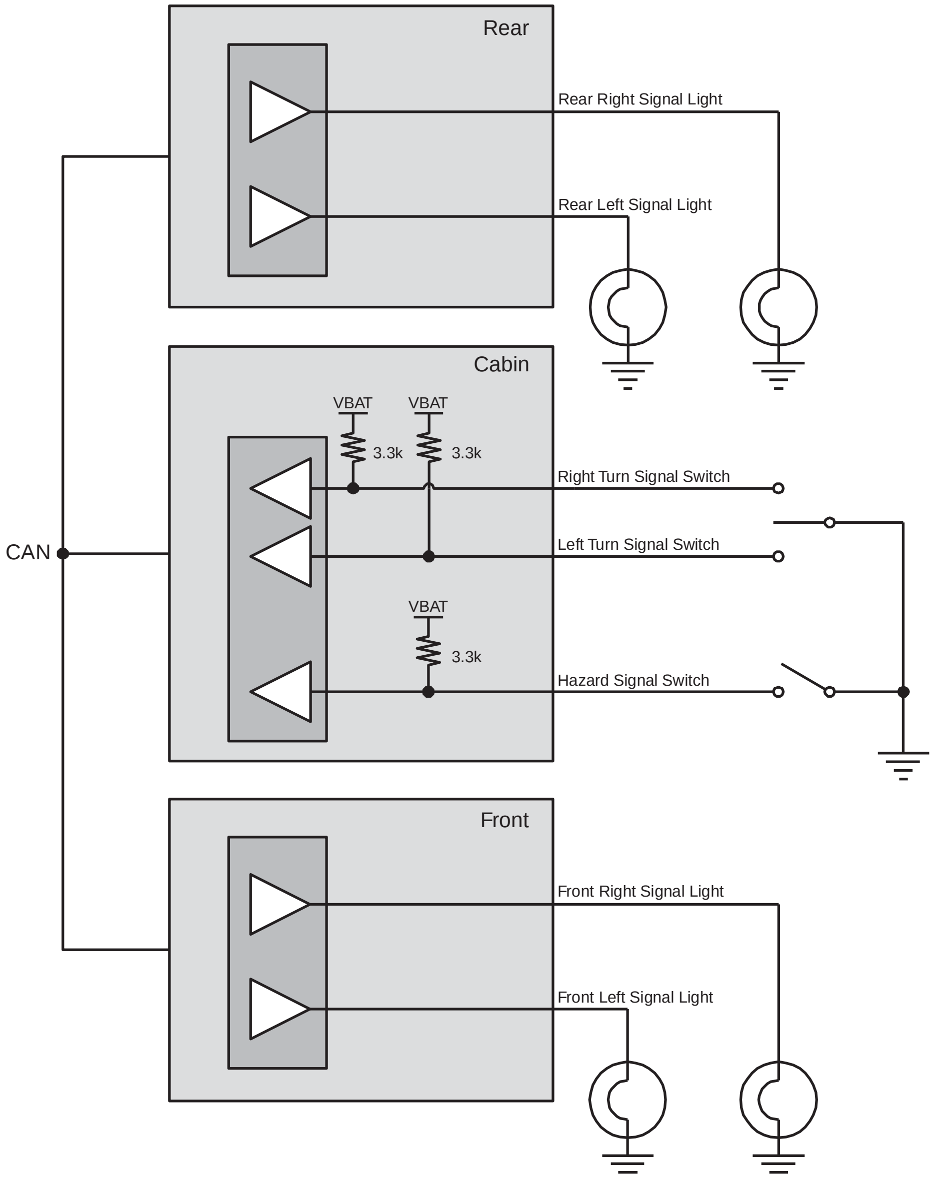


Figure 27: Indicator light connections

10.3. Controlling Motor Speed

The VMM1210 can be used to control the DC motor speed of motors that provide a tachometer output.

Note: The VMM1210 has Proportional Integral Differential (PID) capabilities that make it possible to control devices like proportional valves through software. Refer to the appropriate software manual, or contact your Parker Vansco Account Representative for more details about software. This section only provides hardware connection information.

To do this, you would use a high-side output with PWM capabilities to control the speed of the motor, and a DC-coupled frequency input to monitor the output from the motor.

The application code should be written so that the PWM duty cycle for the high-side output is adjusted to achieve a target speed (frequency) for the motor.

- If the frequency feedback is lower than target, the PWM duty cycle should increase to boost the average current through the motor to speed it up.
- If the frequency feedback is higher than target, the PWM duty cycle should decrease to reduce average current through the motor to slow it down.

The following shows how to connect the VMM1210 to control the speed of a motor:

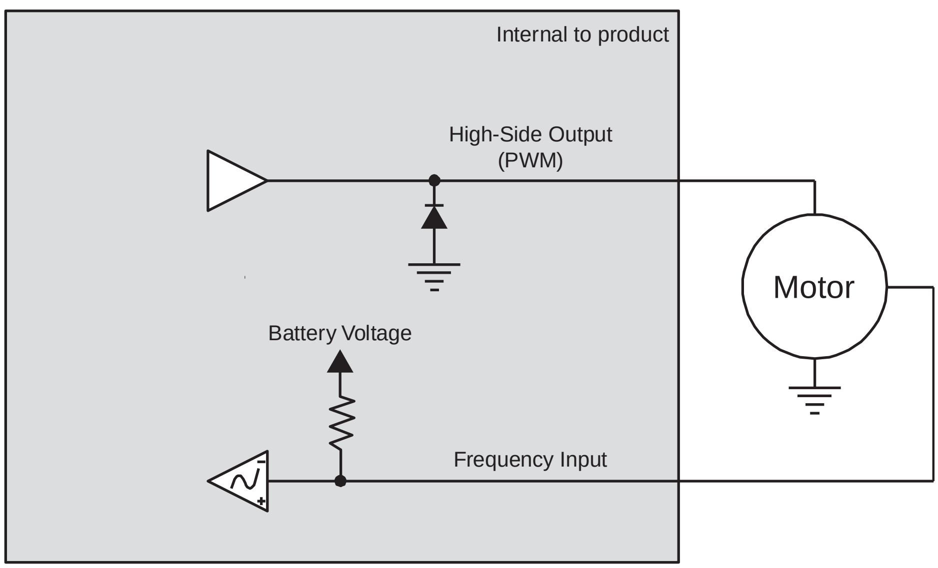


Figure 28: Connection for controlling motor speed

10.4. Using one Analog Input as Two Digital Inputs

The VMM1210 allows you to use one analog input as two digital inputs, which is useful in reducing harness lead or if you are running out of digital inputs in your system.

To do this, you would connect the analog input to a single pole, double throw (SPDT) switch.

Note: You will need to write your application logic to act according to the voltage value readings provided by the analog input. Refer to the appropriate help file, or contact your Parker Vansco Account Representative for more information.

When making the connection, ensure there is a voltage difference between the two pins on the SPDT switch. This can be done by

- enabling the internal pull-up resistor on the analog input (done through software)
- adding a resistor to one of the pins on the SPDT switch.

The following shows how to connect an analog input to a SPDT switch:

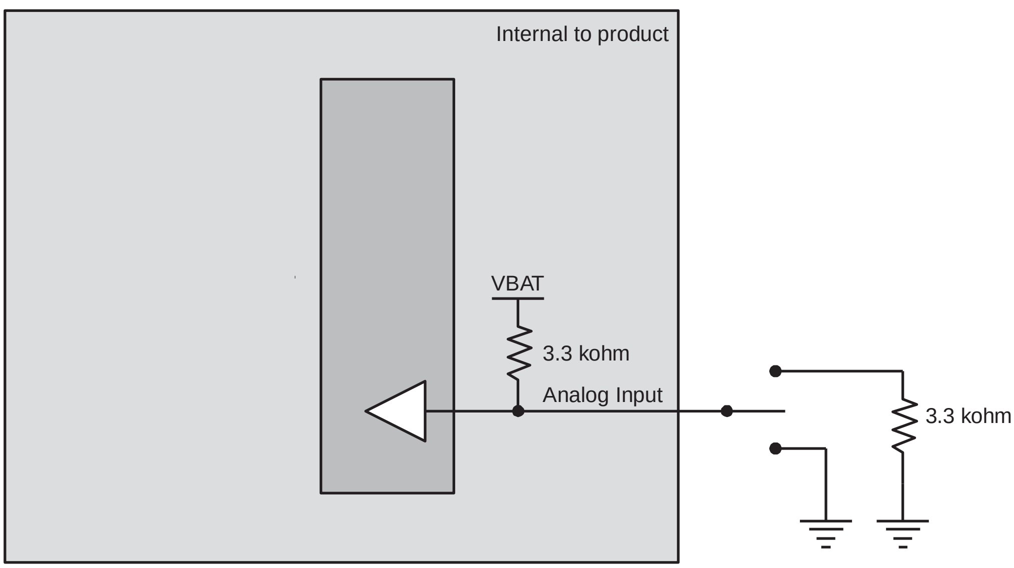


Figure 29: Connecting an analog input to an SPDT switch

10.5. Connecting Various Sensors

There are many types of sensors that can be connected to the VMM1210, as follows:

- Open collector sensors
- Variable resistance sensors
- Variable reluctance sensors
- Switch sensors
- Voltage sensors
- CMOS sensors
- Potentiometer (ratiometric) sensors

Note 1: To optimize the reading accuracy for sensors, dedicate one of the main ground pins (called GND) as a low-current ground return for all sensors on the vehicle.

Note 2: When connecting sensors to the VMM1210, use the sensor's specification to ensure that the VMM1210 is configured correctly for the sensor.

10.5.1. Open Collector

Open collector sensors are compatible with each type of input on the VMM1210.

Open collector sensors are typically used in applications that require digital or frequency measurements. They work by pulling voltage down to ground or up to power when activated, and are basically a switch that turns on and off.

Note: Open collector sensors need a pull-up or pull-down resistor to bias the state of the sensor when the sensor is not activated. Pull-up and pull-down resistors are internal to the VMM1210.

The following shows a typical NPN open collector sensor connection:

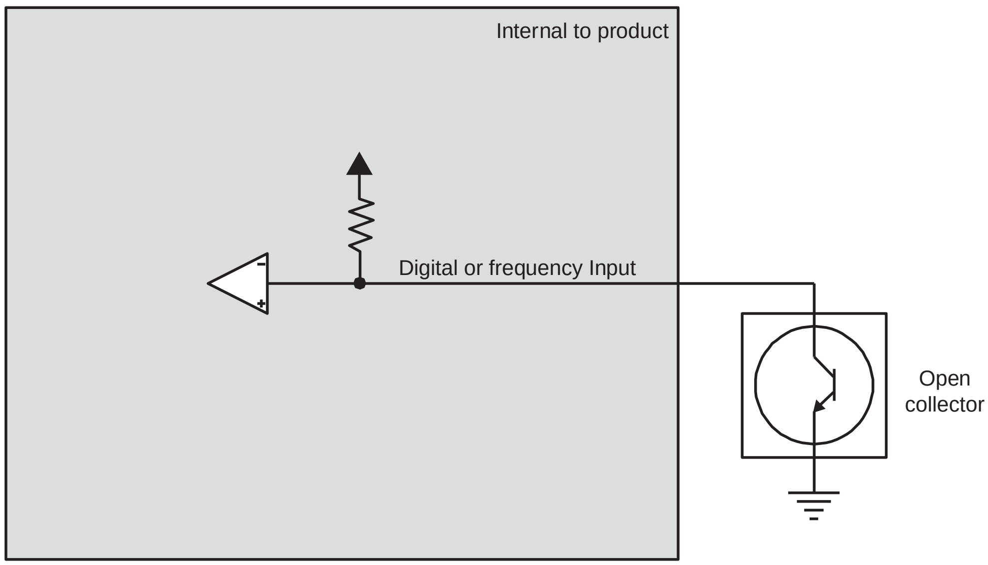


Figure 30: Open collector sensor connection

The following shows a typical PNP open collector (also called open emitter) sensor connection:

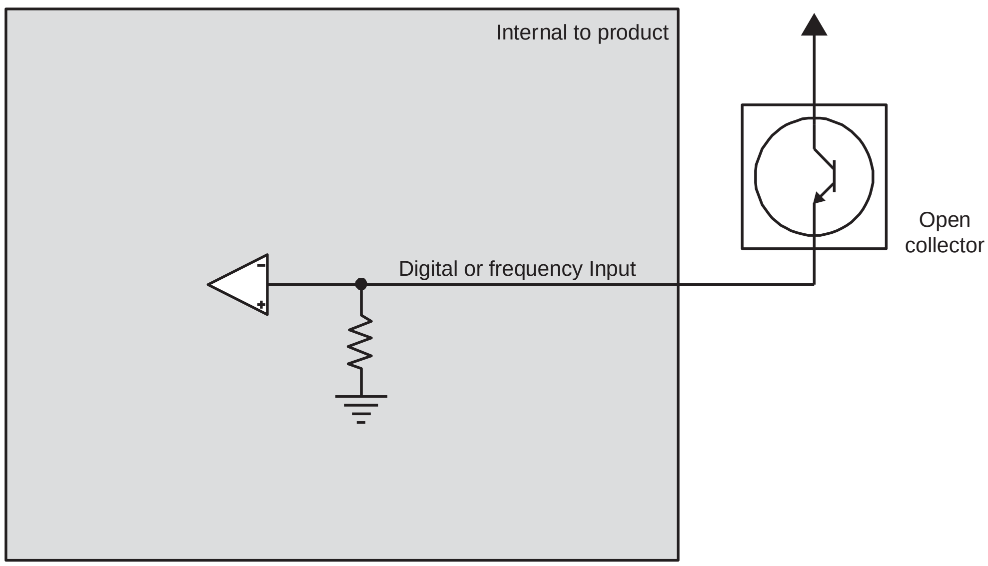


Figure 31: Open collector active high connection

10.5.2. Variable Resistance

Variable resistance sensors change impedance to represent it's measured value, and are compatible with analog inputs.

Variable resistance sensors are typically used in thermal and pressure applications. They work by changing the voltage reading on the sensor according to changes in pressure or temperature in the application.

The VMM1210 cannot measure resistance directly.

To make the VMM1210 measure resistance accurately, do the following:

- Include a precision pull-up resistor between the sensor and the sensor power output (called `SENSOR_SUPPLY`).
- Ensure the value of the precision resistor allows the maximum possible resolution for the sensor's input.
- Dimension the precision resistor to get the maximum voltage range from the sensor.

Note: Variable resistance sensor accuracy may suffer at the extremes of the sensor's range. A tolerance analysis should be performed to ensure measurement accuracy is acceptable for your application.

The following shows a typical variable resistance sensor connection:

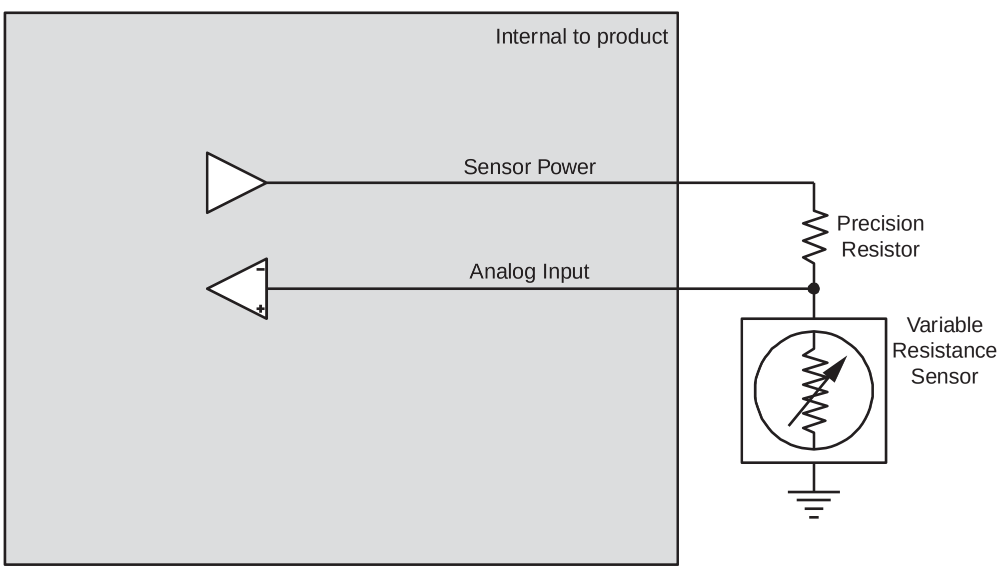


Figure 32: Variable resistance sensor connection

10.5.3. Variable Reluctance

Variable reluctance sensors are typically used in frequency measurement applications, and are compatible with AC-coupled frequency inputs.

Variable reluctance sensors do not require power (the power is induced), and they create frequency by out-putting a sine wave type signal. They work by using an increase or decrease in a magnetic field to detect the proximity of a part or device.

The following shows a typical variable reluctance connection:

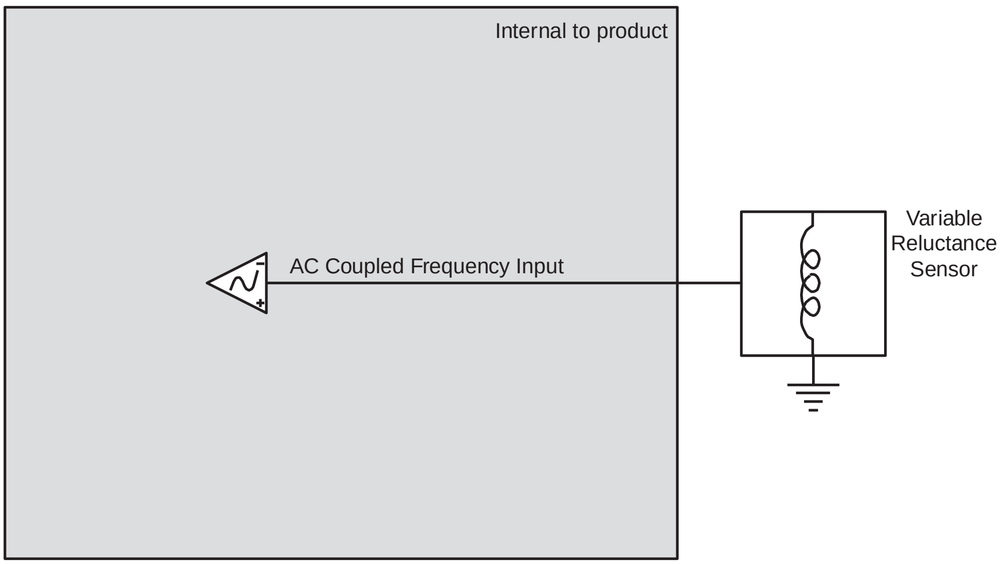


Figure 33: Variable reluctance sensor connection

10.5.4. Switch

A switch is a type of sensor that uses mechanical contacts in one of two states: open or closed. Sensor switches are used to turn sensors on and off, and can be wired directly to digital inputs.

Active-low sensor switches are common. To use active-low switches, the internal pull-up resistor on the input that the sensor is wired to must be enabled.

⚠ Use of active-low switches is not recommended. A broken wire on this type of switch, if it makes contact with the chassis, will activate the function.

Active-high sensor switches are another common type which are generally safer. To use active-high switches, the internal pull-down resistor for the input that the sensor is wired to must be enabled.

The following shows a typical sensor switch connection:

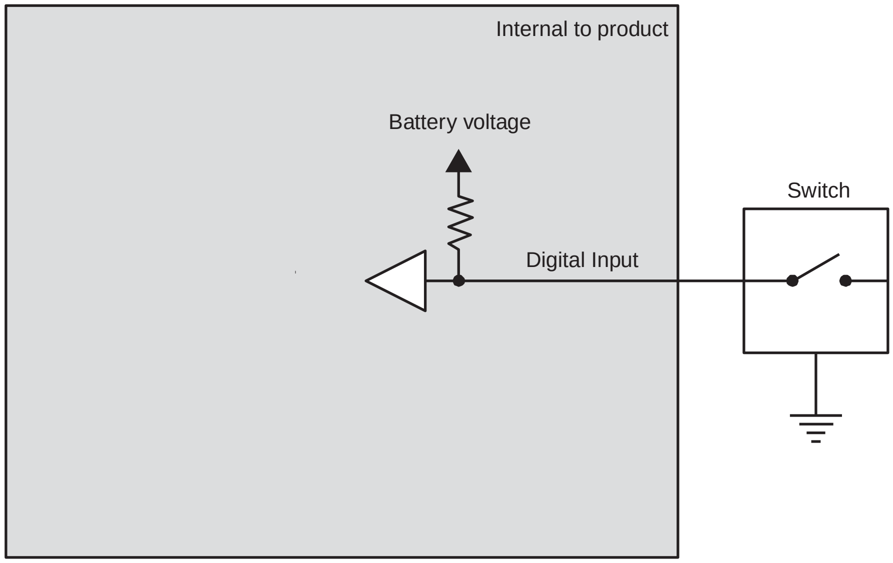


Figure 34: Switch sensor connection

10.5.5. Voltage

Voltage type sensors work by driving an analog voltage signal to report the sensor's measured value.

Voltage sensors are compatible with analog inputs, and are typically used in applications that require variable voltage measurements.

Note: Ensure you configure the analog input voltage (gain and attenuation factors) so the input's voltage is close to, but higher than, the maximum output voltage of the sensor.

The following shows a typical voltage sensor connection:

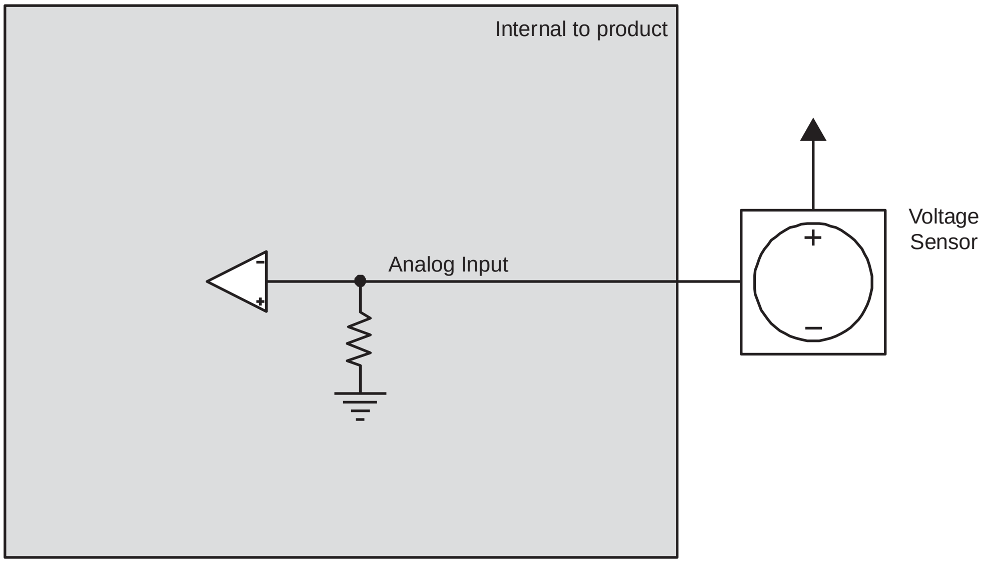


Figure 35: Voltage sensor connection

10.5.6. CMOS

A sensor with a CMOS-type output drives a high and low signal, and is typically used in digital and frequency applications, and therefore, CMOS sensors can be wired directly to digital and frequency inputs.

The following shows a typical CMOS sensor connection:

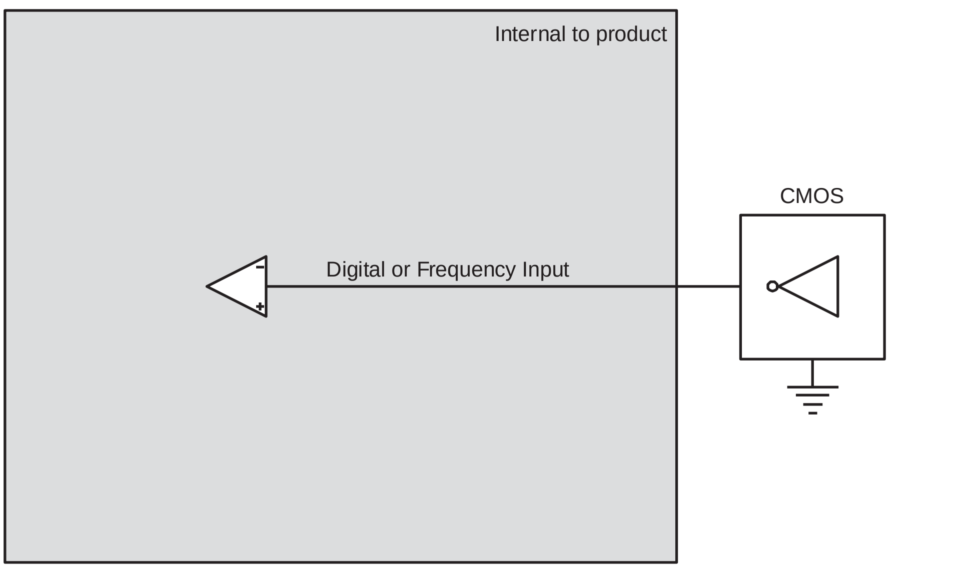


Figure 36: CMOS sensor connection

10.5.7. Potentiometer (Ratiometric)

Potentiometers and other ratiometric type sensors can be wired directly to analog inputs.

Potentiometers are resistive devices that use a wiper arm to create a voltage divider. Changes to resistive measurements happen as the wiper arm moves along a resistive element.

When connecting potentiometer sensors, it is important to do the following:

- Connect one end of the sensor to the `SENSOR_SUPPLY` pin, and the other end to a `GND` pin on the VMM1210.
- Connect the sensor signal to an analog input.

The following shows a typical potentiometer sensor connection:

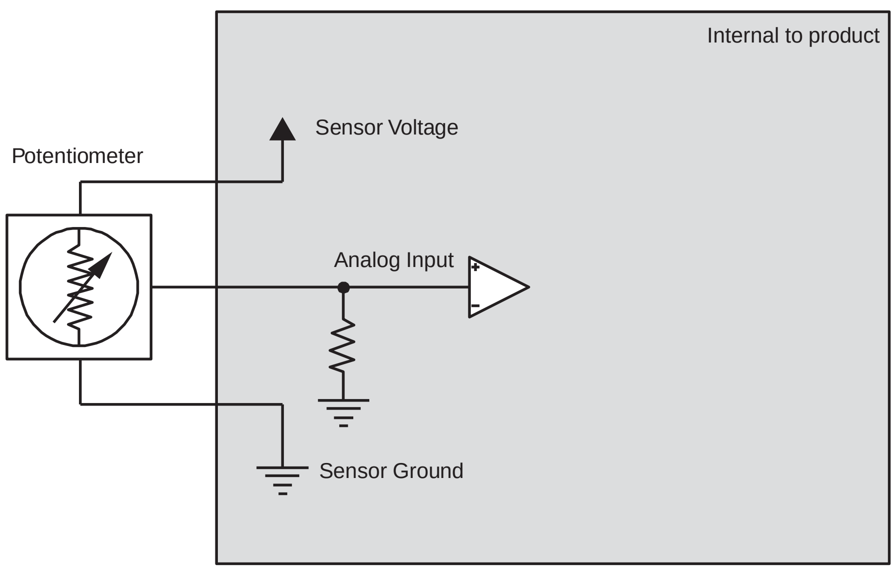


Figure 37: Potentiometer (ratiometric) sensor connection

11. Startup

Danger! Risk of injury. If the control system is not fitted properly, the machine could move uncontrollably. Do not start the machine's engine before the control system is completely fitted and its signals are verified.

In addition to the measures described below, the machine must also meet the machine directives of the country in question.

Starting the control system

Start the control system as follows:

1. Ensure that all modules and cables are fitted correctly.
2. Ensure that the correct fuses are installed.
3. Ensure that for supply voltage and return lines in the cable's conductor joint are connected correctly.
4. Verify that the emergency stop works by ensuring that it does either of the following:
   - disconnects the supply voltage to all modules
   - shuts off the diesel engine or a dump valve, thereby depressurizing the hydraulic system

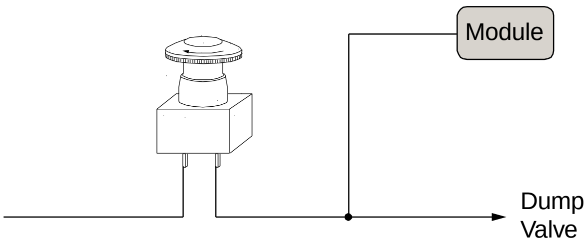


Figure 38: Emergency stop

Prepare for system start

> ***Danger! Risk of injury.*** Make sure no one is in dangerous proximity to the vehicle.

Prepare for the initial system start as follows:

1. Ensure that the engine for the hydraulic system's pump is in the off position.
2. Ensure that all connectors are properly connected.
3. Turn on the control system.
4. Ensure that voltage is being supplied to all modules.
5. Ensure that the emergency stop is functioning properly.

Start the system

After the above inspections have been completed, start the system as follows:

1. Start the engine for the hydraulic system's pump.
2. Calibrate and adjust input and output signals, and carefully check every output function.

12. Test

The following table lists the verification tests that were performed for the VMM1210:

Test Specifications			
Ref #	**Test Specification**	**Test Description**	**Deviation?**
1.	J1455 (Jun 2006) Section 4.1.3.1	24 Hour Thermal Cycle	*Yes*[1]
2.	J1455 (Jun 2006) Section 4.1.3.2	Thermal Shock	No
3.	EP455 (Feb 03) Section 5.1.2	Storage Temperature (non-operational)	No
4.	J1455 (Jun 2006) Section 4.2.3	24 Hour Humidity Cycle	No
5.	EP455 (Feb 03) Section 5.13.2	Humidity Soak	No
6.	J1455 (Jun 2006) Section 4.3.3	Salt Spray Atmosphere	*Yes*[2]
7.	EP455 (Feb 03) Section 5.8.2	Chemical Exposure	*Yes*[3]
8.	EP455 (Feb 03) Section 5.4.1	Solar Radiation - UV Effects	No
9.	EP455 (Feb 03) Section 5.6 Level 1	Pressure Wash (non-operational)	No
10.	EP455 (Feb 03) Section 5.5 Level 2	Immersion (non-operational)	No
11.	J1455 (Jun 2006) Section 4.10.4.2	Random Vibration	No
12.	J1455 (Jun 2006) Section 4.11.3.1	Handling Drop (non-operational)	No
13.	J1455 (Jun 2006) Section 4.11.3.3	Harness Shock (non-operational)	No
14.	EP455 (Feb 03) Section 5.14.1	Operational Shock	No

[1] Temperature cycle performed at 3 different voltages: 9V, 28V and 32V DC.
[2] Signs of corrosion are acceptable provided the integrity of seal is maintained.
[3] Test performed on enclosures only without PCB. Only physical signs of detrimental corrosion shall be considered a failure.

Test Specifications			
Ref #	**Test Specification**	**Test Description**	**Deviation?**
15.	J1455 (Jun 2006) Section 4.13.1.1 and Section 4.13.1.2	Operating Voltage	No
16.	EP455 (Feb 03) Section 5.10.6	Starting Voltage	*Yes*[4]
17.	EP455 (Feb 03) Section 5.10.7	Operational Power Up	*Yes*[5]
18.	J1455 (Jun 2006) Section 4.13.1	Jumper Starts Voltage	*Yes*[6]
19.	EP455 (Feb 03) Section 5.10.3	Steady State Reverse Polarity	No
20.	EP455 (Feb 03) Section 5.10.4	Short Circuit Protection	*Yes*[7]
21.	EP455 (Feb 03) Section 5.11.1	Transient Accessory Noise	No
22.	EP455 (Feb 03) Section 5.11.2	Transient Alternator Field Decay	*Yes*[8]
23.	EP455 (Feb 03) Section 5.11.3 Level 1	Transient Batteryless Operation	No
24.	J1455 (Jun 2006) Section 4.13.2.2.1	Transient Inductive Load Switching	*Yes*[9]
25.	J1455 (Jun 2006) Section 4.13.2.2.1	Transient Load Dump	*Yes*[10]
26.	J1455 (Jun 2006) Section 4.13.2	Transient Mutual Coupling Power Lines	No
27.	J1455 (Jun 2006) Section 4.13.2.2.3.2	Electrostatic Discharge Operating	*Yes*[11]
28.	J1455 (Jun 2006) Section 4.13.2.2.3.1	Electrostatic Discharge Handling	No
29.	J1455 (Jun 2006) Section 4.13.3.4.2	Radiated Susceptibility	*Yes*[12]
30.	J1455 (Jun 2006) Section 4.13.3.4.1	Radiated Emissions	*Yes*[13]
32.	EP455 (Feb 03) Section 5.3 Level 1	Dust (non-operational)	No

[4] Test for impaired function at 6.48V. Unit designed to operate at 6.48V.
[5] Rate changed to 1 V/s instead of 1 V/ms.
[6] Maximum voltage changed to 36 V instead of 48 V.
[7] Applied +24V from a battery source.
[8] Used Rs=10 Ohms and repetition = 45 seconds due to equipment limitation.
[9] Voltage applied: 14 ±500e^ -t/.001 V, and 28 ±500e^ -t/.001 V,
[10] Used Rs=1 Ohm and repetition= 90 seconds due to equipment limitation.
[11] Used 330 pF capacitor through a 2 kOhms resistor (Correct parameter as per SAE J1113/13 Figure 1A).
[12] Chamber size does not meet standard requirements, e–field not uniform across the frequency range, due to the size of the chamber.
[13] Could not meet chamber dimensions requirements.

13. Index

Parker

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