VMM3120

Vansco Multiplexing Module (VMM) 3120

User Manual HY33-5004-IB/US
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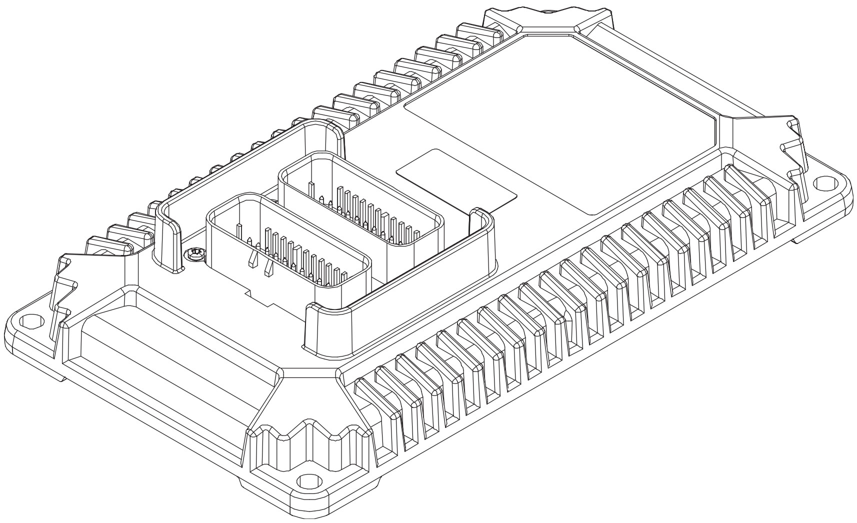

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Contents

1. Introduction

These instructions are meant as a reference tool for the vehicle manufacturer's design, production, and service personnel.

The user of this manual should have basic knowledge in the handling of electronic equipment.

1.1. Safety symbols

Sections regarding safety, marked with a symbol in the left margin, must be read and understood by everyone using the system, carrying out service work or making changes to hardware and software.

The different safety levels used in this manual are defined below.

WARNING

Sections marked with a warning symbol in the left margin, indicate that a hazardous situation exists. If precautions are not taken, this could result in death, serious injury or major property damage.

CAUTION

Sections marked with a caution symbol in the left margin, indicate that a potentially hazardous situation exists. If precautions are not taken, this could result in minor injury or property damage.

NOTICE

Sections marked with a notice symbol in the left margin, indicate there is important information about the product. Ignoring this could result in damage to the product.

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.

2. Precautions

2.1. 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.

WARNING

Mounting, modification, repair and maintenance must be carried out in accordance with the manufacturer's regulations. The manufacturer has no responsibility for any accidents caused by incorrectly mounted or incorrectly maintained equipment. The manufacturer does not assume any responsibility for the system being incorrectly applied, or the system being programmed in a manner that jeopardizes safety.

WARNING

Damaged product may not be used. If the control system shows error functions or if electronic modules, cabling or connectors are damaged, the system shall not be used.

WARNING

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.

NOTICE

As much as possible of the welding work on the chassis should be done before the installation of the system. If welding has to be done afterwards, the electrical connections on the system must be disconnected from other equipment. The negative cable must always be disconnected from the battery before disconnecting the positive cable. The ground wire of the welder shall be positioned as close as possible to the place of the welding. The cables on the welding unit shall never be placed near the electrical wires of the control system.

2.1.1. Construction regulations

CAUTION

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. The machine must be built if possible, so that the supply voltage to the control system's electrical units is disconnected when the operator leaves the operator’s station.

2.1.2. Safety during installation

CAUTION

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

2.1.3. Safety during start-up

WARNING

The machine's engine must not be started before the control system is mounted and its electrical functions have been verified.

Ensure that no one is in front, behind or nearby the machine when first starting up the machine.

Follow the instructions for function control in the Start-up section.

2.1.4. Safety during maintenance and fault diagnosis

CAUTION

Ensure that the following requirements are fulfilled before any work is carried out on the hydraulics control electronics.

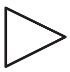
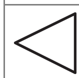
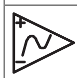
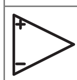
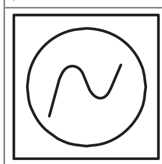
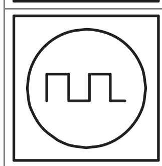
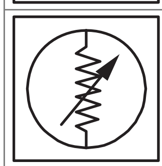
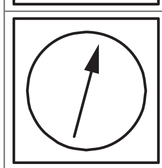
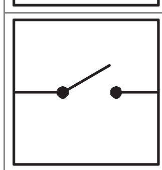
- The machine cannot start moving.
- Functions are positioned safely.
- The machine is turned off.
- The hydraulic system is relieved from any pressure.
- Supply voltage to the control electronics is disconnected.

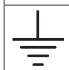
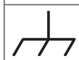
3. How to Use this Manual

This manual describes the hardware components of the VMM3120, but does not explain how to write or configure the software. For more information about software, refer to the appropriate software manual, or contact your Parker Vansco Account Representative.

3.1. Diagram Conventions

There are many connection diagrams found throughout this manual. The following table provides meanings for the different symbols used in those diagrams:

Symbol	Meaning
	General input
	General output
	Frequency input
	Analog input
	Frequency sensor
	Pulse sensor
	Resistive sensor
	General sensor
	Application switch

Symbol	Meaning
	Load
	Pull-down resistor
	Pull-up resistor
	Battery
	Fuse
	Resistor
	Ground
	Chassis ground

4. Quick Start

This section provides step-by-step instructions on how to connect the VMM3120 to a development system, install the required software tools, and download ladder logic application software.

4.1. 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 VMM3120 to a **development system** (desktop) and power it up.
4. Download ladder logic **application software**.

4.2. Gather Required Materials

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

- A **VMM3120**
- A **personal computer** (PC)
- A **controller I/O board**
- A **controller I/O harness** (connects the VMM3120 to the controller I/O board)
- An **evaluation kit power harness** (connects the controller I/O board to the power supply)
- A **Data Link Adapter (DLA) kit** (comes with cables needed for connecting the DLA to your PC and to the rest of the system)
- A **desktop power supply** compatible with the VMM3120 and controller I/O board loads (a 12 VDC, 3 A fixed voltage supply is generally suitable, unless driving more significant loads)
- A **procurement drawing** for the version of VMM3120 you are using, that represents the configuration options for your variant of the product.
- **Software tools** and files required for programming and downloading software for the VMM3120.

NOTICE

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.

4.3. Install the Required Software Tools

Before you start using the VMM3120, you must install the software tools onto your PC.

The VMM3120 requires the following software tools:

- **Data Link Adaptor (DLA) drivers**: The DLA acts as the interface between the PC and the VMM3120. 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 VMM3120. Contact your Parker Vansco Account Representative, or visit the Parker website to get further information on how obtain a product key.

4.3.1. Install the Data Link Adaptor (DLA) Driver Software

A Data Link Adaptor (DLA) is needed when connecting the VMM3120 in a development system.

The Parker Vansco DLA requires drivers that you must install on your PC.

NOTICE

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.

To install the Parker Vansco DLA drivers

1. **Download** the driver, run the extracted file and follow the *Install Wizard*.
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**.
4. Click **Finish**.

The USB DLA is now recognized and ready to be used. See the Vansco DLA kit user manual for more detailed instructions.

4.4. Connect the VMM3120 to a Development System

It is a good idea to connect the VMM3120 to a development system (PC, Controller I/O Board, power source, and DLA) to verify your ladder logic application. The development system is an ideal environment for creating and downloading ladder logic software applications.

The following is an overall block diagram of how to connect the VMM3120 in a development system:

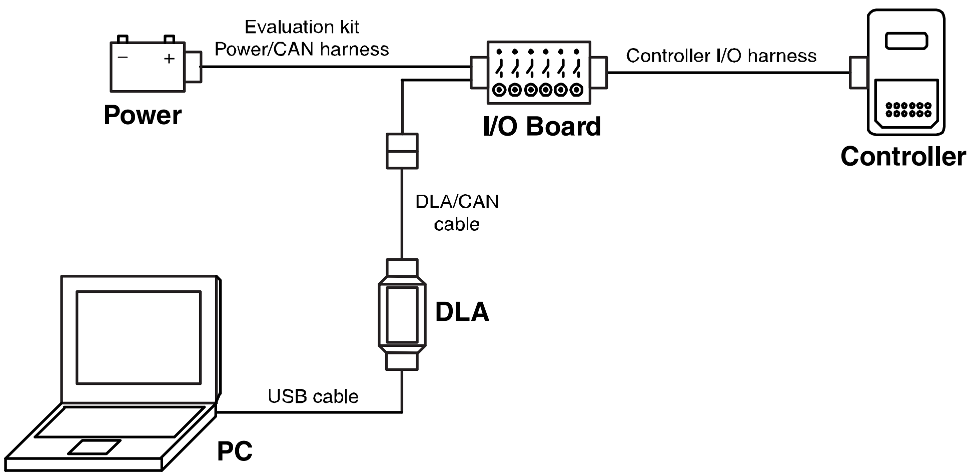


Figure 1: Development system connection

To connect the VMM3120 in a development system, do the following:

NOTICE

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

1. Connect the **Controller I/O harness** to the VMM3120 connectors.
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.
7. Connect the **DLA** to a personal computer via the USB port.

NOTICE

You must install the DLA drivers before connecting the DLA to the PC.

4.4.1. Power Up the Development System

Once the VMM3120 is set up in a development system, you need to power it up.

To power up the VMM3120, do the following:

1. Ensure 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 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 - 28 VDC**.
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**.

NOTICE

If `INPUT_1` or `INPUT_2` is configured as a power control input, you must turn on the corresponding digital input switch on the controller I/O board (Digital Input 1 or Digital Input 2). Refer to the *Controller I/O Board Reference Manual* for further details.

4.5. Create and Download Ladder Logic Software Applications

Software applications can be created and downloaded to the VMM3120.

The software applications for the VMM3120 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.

5. Inputs

The VMM3120 has three types of inputs, as follows:

- Digital
- Analog
- Frequency

NOTICE

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 VMM3120. If an inductive load must be connected to an input, use a protective diode or transorb.

5.1. VMM3120 Digital Input Types

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

There are 4 types of digital inputs in the VMM3120:

- Programmable Digital Inputs
- Digital Inputs
- Power Control Digital Inputs
- Addressing Digital Inputs

5.1.1. VMM3120 Digital Inputs

The VMM3120 has 15 digital inputs:

- `INPUT3_D` through `INPUT19_D` (`INPUT11_D` and `INPUT14_D` are not used)

INFORMATION

`INPUT1_D` and `INPUT2_D` can also be used as standard digital inputs as long as they are not being used for power control.

5.1.1.1. Digital Input Capabilities

The following table provides specifications for the VMM3120's digital inputs:

Table 1: Digital Input Specifications

Item	MIN	NOM	MAX	UNIT
Input voltage range	0	-	32	V
Pull-up/pull-down resistance (24 V system)	2.8 k	-	-	Ω

Item	MIN	NOM	MAX	UNIT
Minimum negative going threshold	1.56	-	-	V
Maximum positive going threshold	-	-	3.65	V
Cutoff frequency (hardware)	-	170	-	Hz
Over-voltage	-	-	36	V
Wetting current	-	-	10	mA

5.1.1.2. Digital Input Configurations

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

- **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.

All digital inputs have their wetting current configured according to the following:

INFORMATION

A digital switch (typically connected to a digital input) usually requires wetting current (a small current that burns off contact oxidation when it is activated). The amount of required wetting current required is based on battery voltage and on the value of the pull-up or pull-down resistor.

- Wetting current is determined by the value of the resistor. The maximum allowable wetting current in the VMM3120 is **10 mA**. Wetting currents greater than 10 mA must be incorporated using resistors embedded in the system harness.

The diagram in the Digital Input Installation Connections shows the configuration for the digital inputs.

5.1.1.3. Digital Input Installation Connections

You must be aware of the following when connecting digital inputs:

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

- **When the switch is open**, the pull-down resistor will ensure no voltage exists on the input signal, which will be interpreted by the VMM3120 as inactive.
- **When the switch is closed**, the input is connected to battery voltage, which will be interpreted by the VMM3120 as active.

Since the input is active high

- It must be connected to battery power to ensure there is a battery connection when the state of the input changes.
- The power provided to the digital switch connected to the input must be provided through a fuse in the wire harness.

The following shows a typical active high digital input connection:

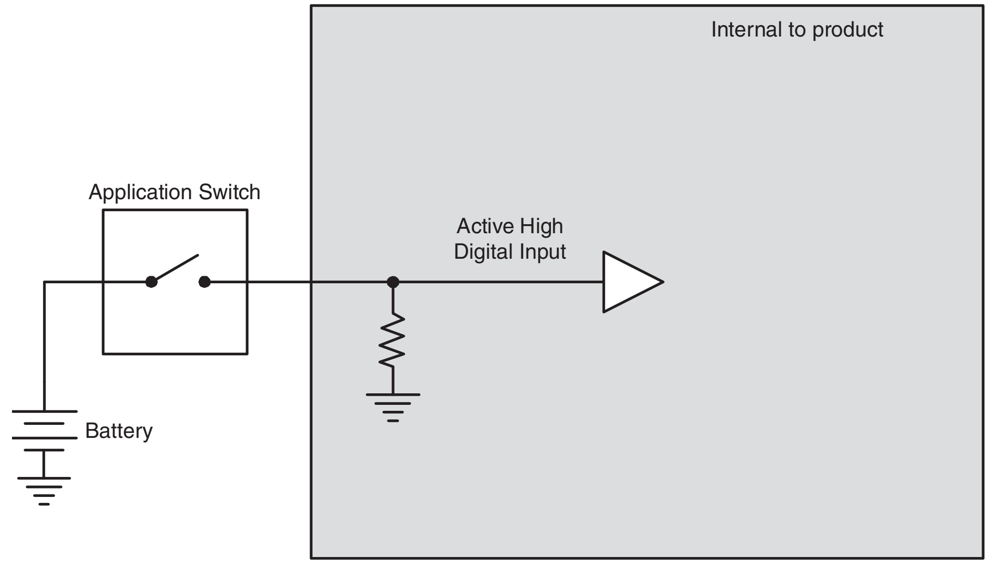


Figure 2: Active high digital input

5.1.2. VMM3120 Addressing Inputs

Digital inputs `ADDR1`, `ADDR2` and `ADDR3` 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.

These inputs are all low-side inputs with 2.2K ohm internal pull-up resistors. The inputs are pulsed to ensure that a floating pin is read as inactive by the module.

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).

Table 2: VMM System Addressing

Address Inputs 3	2	1	VMM address
0	0	0	VMM1
0	0	1	VMM2
0	1	0	VMM3
0	1	1	VMM4
1	0	0	VMM5
1	0	1	VMM6
1	1	0	VMM7
1	1	1	VMM8

The following shows a typical addressing digital input connection.

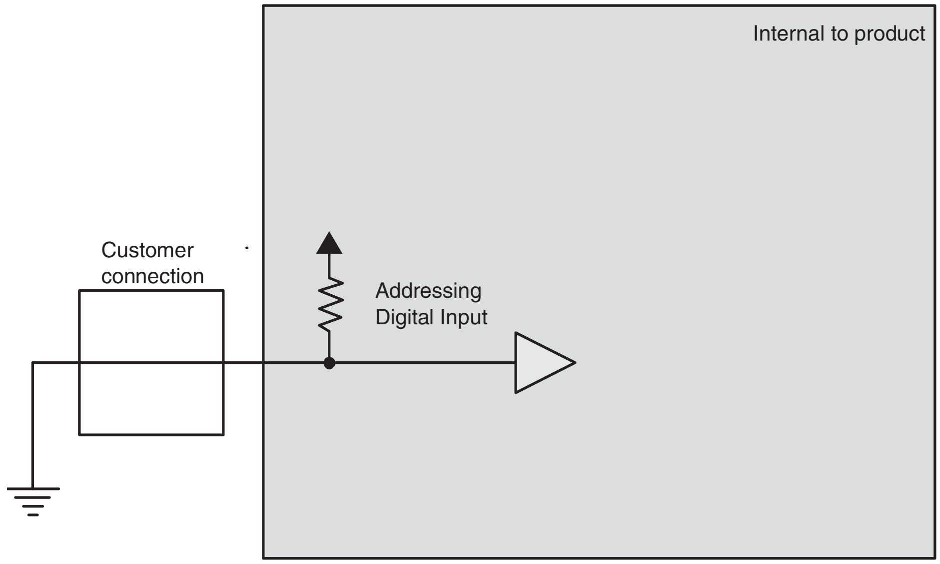


Figure 3: Addressing digital input connections

5.1.3. Power Control Digital Inputs

The VMM3120 has two active-high power control digital inputs that are used for waking up (turning on) the product, as follows:

- `INPUT1_D` and `INPUT2_D`

5.1.3.1. Power Control Digital Input Capabilities

The VMM3120 has an active high power control digital input that must be activated to power up the VMM3120.

The following table provides specifications for the VMM3120's power control digital inputs:

Table 3: Power Control Digital Input Specifications

Item	MIN	NOM	MAX	UNIT
Input voltage range	0	-	32	V
Pull-up/pull-down resistance (24 V system)	2.8 k	-	-	Ω
Minimum negative going threshold	1.56	-	-	V
Maximum positive going threshold	-	-	3.65	V
Cutoff frequency (hardware)	-	170	-	Hz
Over-voltage	-	-	36	V
Wetting current	-	-	10	mA

INFORMATION

The power control digital input voltage must be greater than 4.0 V before it is considered an active high input.

The power control digital input wakes-up the VMM3120 when switched high to a voltage of 4.0 V or greater, and turns the VMM3120 off when switched low to a voltage less than 1.5 V. The VMM3120 will also shut off when an open circuit condition occurs on the power control digital input.

5.1.3.2. Power Control Digital Inputs Configuration

The digital inputs (`INPUT1_D` and `INPUT2_D`) are configured as power control digital inputs. When the inputs are configured as power control, then the wetting current must also be configured.

When `INPUT1_D` and/or `INPUT2_D` are configured as a power control input:

- The VMM3120 will only power up when the power control input is active and only shut down when it is inactive.
- The wetting current must be configured according to the following:

INFORMATION

A digital switch (typically connected to a digital input) usually requires wetting current (a small current that burns off contact oxidation when it is activated). The amount of wetting current required is based on battery voltage and on the value of the pull-down resistor.

  - Because all power control digital inputs must be active high, they must have an internal pull-down resistor. The pull-down resistance for digital inputs is **2.8 kΩ**.
  - The VMM3120 has a maximum allowable wetting current of approximately **10 mA**. Wetting currents greater than 10 mA must be incorporated using resistors embedded in the system wire harness.

The following diagram shows the configuration for the power control inputs:

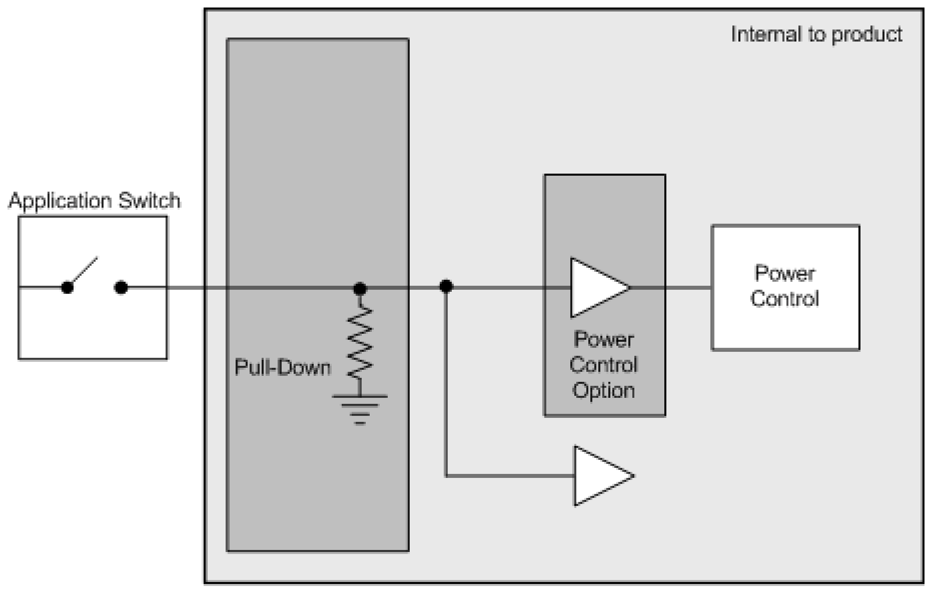


Figure 4: Power Control Digital Input Configuration

5.1.3.3. Power Control Digital Input Installation Connections

You must be aware of the following when connecting power control inputs:

- The power control digital input is usually connected to the vehicle ignition, but it can be connected to any power source in a system.
- To protect the harness that connects the VMM3120 to the ignition, place a fuse of **200 mA** or higher in the circuit that feeds the VMM3120.
- When battery power (`VBATT`) is connected, and the power control digital input is inactive, the VMM3120 will go into sleep mode.

The following diagram shows a typical power control digital input connection:

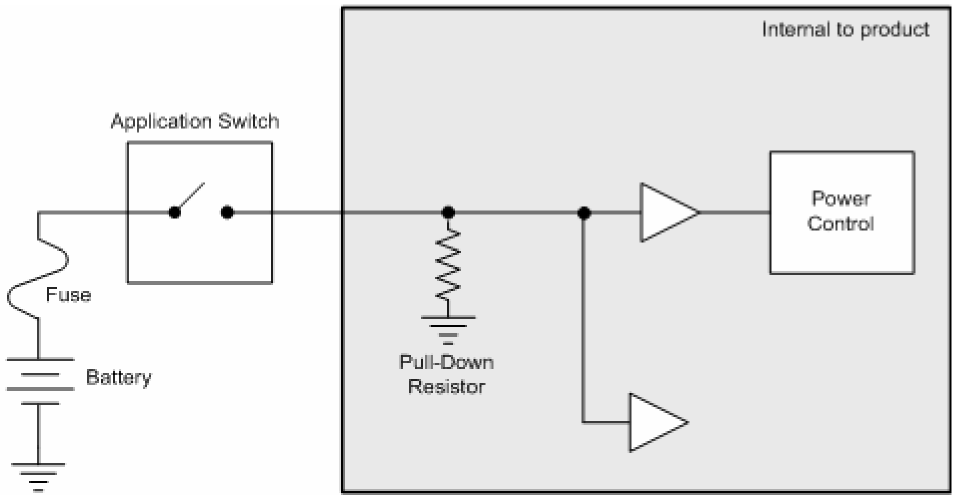


Figure 5: Power control digital input installation connections

5.2. VMM3120 Analog Inputs

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

The VMM3120 has 10 analog inputs:

- `INPUT20_A` through `INPUT29_A`

INFORMATION

Analog inputs can be configured to function as standard digital inputs.

5.2.1. Analog Input Capabilities

Analog inputs can provide attenuation and gain, and are usable with resistive sensors and voltage sensors.

The following table provides specifications for the VMM3120's amplified analog inputs:

Table 4: Analog Input Specifications

Item	MIN	NOM	MAX	UNIT
Input voltage range	0	-	32	V
Valid voltage range	0	-	5	V
Pull-down resistance	-	33.2K	-	Ω
Over-voltage	-	-	36	V
Resolution	-	10	-	Bit
Accuracy	-	-	3	%
ADC reference voltage	2.994	3.0	3.006	V
Frequency cutoff	-	-	12	kHz

5.2.2. Analog Input Configuration

With analog inputs `INPUT20_A` through `INPUT23_A`:

- The amount of **attenuation** is 0.595V/V
- The cutoff frequency for a **2-pole low-pass filter** is 39 Hz

With analog inputs `INPUT24_A` through `INPUT29_A`:

- The amount of **attenuation** is 0.595V/V
- The cutoff frequency for a **1-pole low-pass filter** is 32 Hz

INFORMATION

You should use as much filtering as possible on analog inputs to prevent anomalous analog readings in noisy environments. The amount of filtering (cut-off frequency) for your hardware filter will depend on the rate at which the analog input changes, as well as the expected response time of your system.

INFORMATION

To prevent aliasing, you should filter at half the rate of your sampling rate, according to the Nyquist criterion. If you require more filtering, a software filter can be added to your system.

The following diagram shows the configuration for analog inputs:

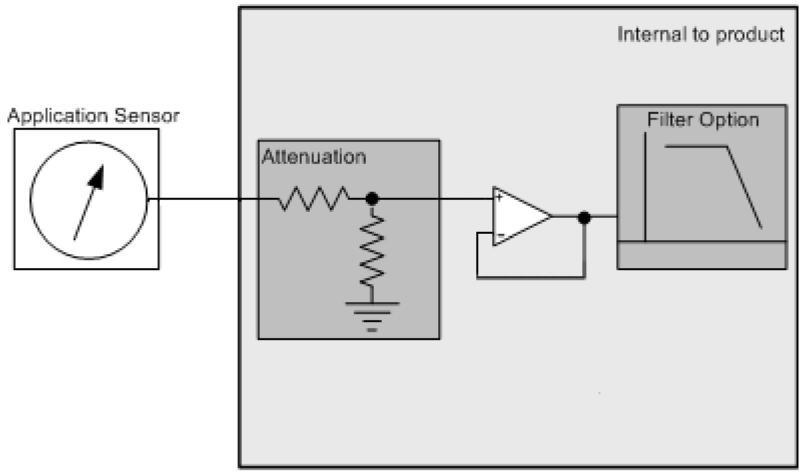


Figure 6: Analog input configuration

5.2.3. Analog Input Installation Connections

When connecting analog inputs there are two issues you must be aware of: system noise and ground shift.

System Noise

Analog inputs are more susceptible to system noise than digital inputs. Too much system noise can create inaccurate analog input readings.

To reduce system noise

- Use the shortest possible wires when connecting sensors to analog inputs, to prevent noise pickup on the sensors.

The following shows how to connect analog inputs to reduce system noise:

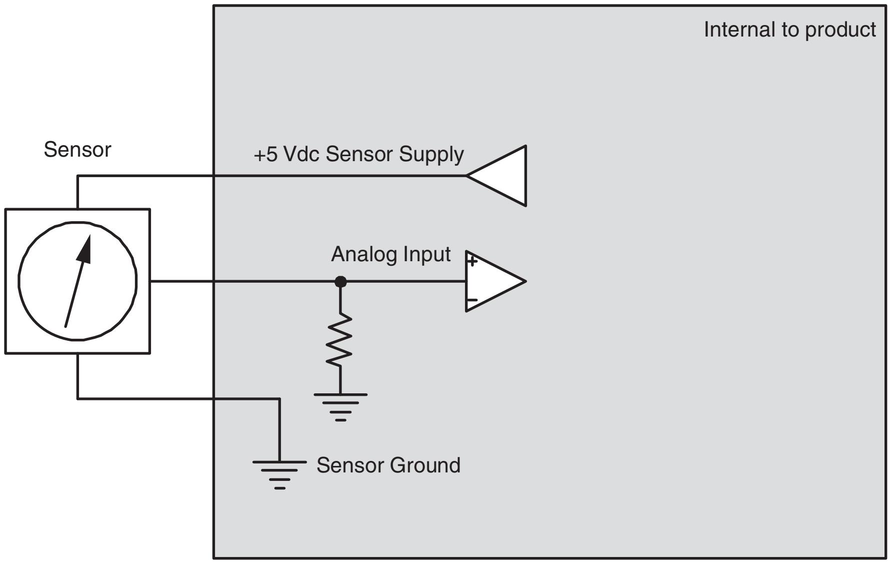


Figure 7: Analog input system noise connection

Ground Shift

The accuracy of analog inputs can be affected by ground shift. Ground shift refers to the difference between the system ground voltage (system ground inputs are called `GROUND`) and the sensor ground voltage.

There are two kinds of sensors need to be addressed: sensors that have dedicated ground wires and sensors that don't have dedicated ground wires.

To reduce ground shift for sensors that have dedicated ground wires

- Dedicate one of the five system ground inputs (`GROUND`) to sensors that have dedicated ground wires, and connect all sensor grounds to this system ground input.
- Splice the other four 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.

INFORMATION

The VMM3120 system ground inputs are rated for low-current signals, and ensure the sensor's ground is very close in voltage potential to the VMM3120 ground.

The following shows how to address ground shift with sensors that have dedicated ground wires:

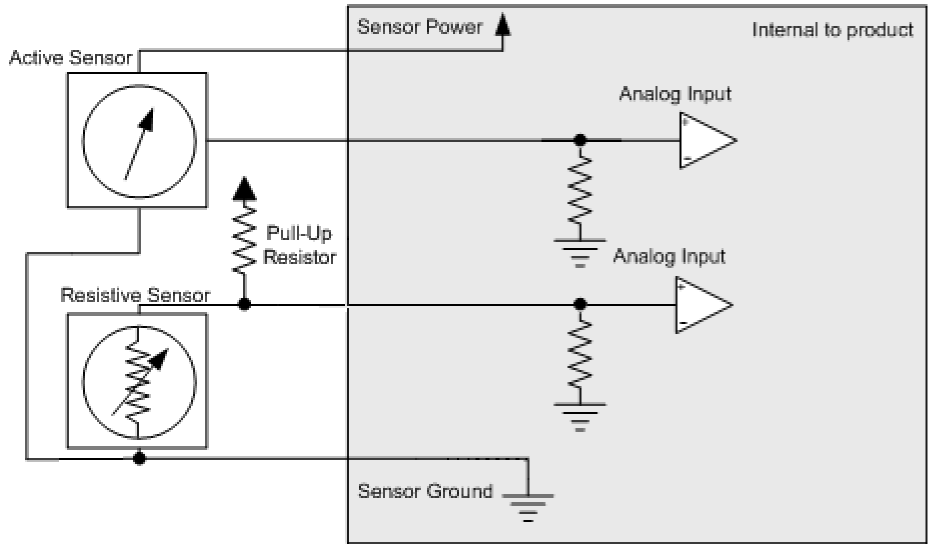


Figure 8: Analog input with ext. pull-up for sensors with ground wire

To reduce ground shift for sensors that don't have dedicated ground wires

- Connect a ground wire from the sensor's mounting location to analog input 1. Analog input 1 can be configured as a negative amplifier, allowing it to detect a difference between the voltage of the VMM3120 ground and the voltage of the sensor ground (the difference is the ground shift).

INFORMATION

Sensors that don't have dedicated ground wires are typically grounded to the vehicle chassis through the sensor's body.

The following shows how to address ground shift with sensors that do not have dedicated ground wires:

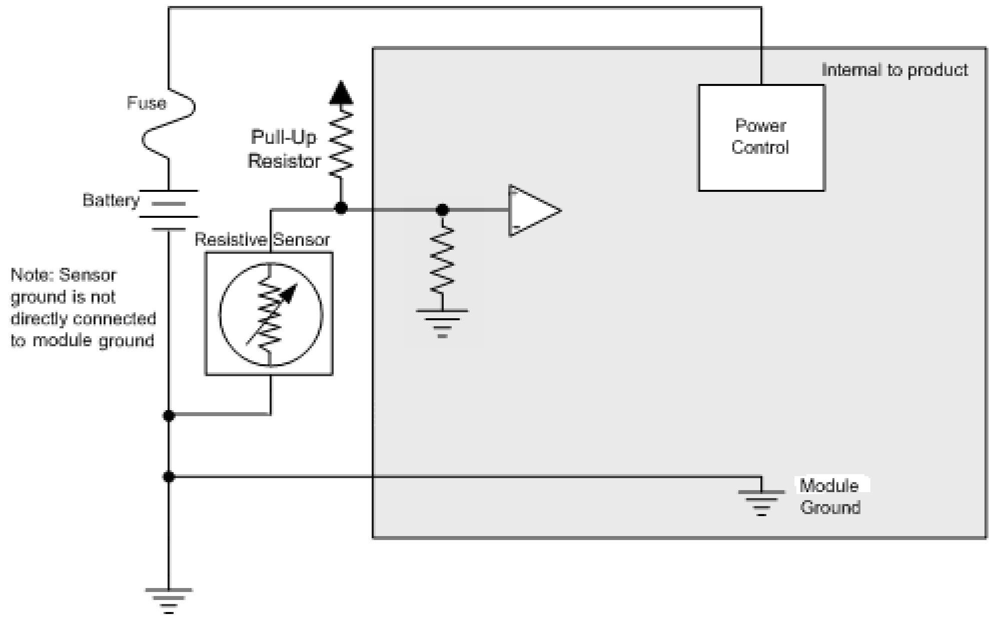


Figure 9: Analog input with ext. pull-up for sensors without ground wire

5.3. VMM3120 Frequency Inputs

Frequency inputs are typically used to read pulse signals.

There are two types of frequency inputs in the VMM3120:

- AC-coupled frequency inputs
- DC-coupled frequency inputs

5.3.1. AC-Coupled Frequency Inputs

The VMM3120 has 2 AC-coupled frequency inputs:

- `INPUT30_F` through `INPUT31_F`

5.3.1.1. VMM3120 AC-Coupled Frequency Input Capabilities

AC-coupled frequency inputs provide AC-coupling, which allows you to read the frequency of external signals that have either large DC offsets, or no ground reference. These inputs are ideal for use with variable reluctance and inductive pickup sensors.

INFORMATION

Quadrature and pulse counting is possible; however, we recommend to not use these functions with AC-coupled frequency inputs.

The following table provides specifications for the VMM3120's AC-coupled frequency inputs:

Table 5: AC-Coupled Frequency Input Specifications

Item	MIN	NOM	MAX	UNIT
Input voltage range	-90	-	90	V
Pull-up resistance (24 V system)	4.7 k	-	-	Ω
Accuracy	-	-	5	%
Frequency range @ 2.5 Vp-p	1	-	10000	Hz
Frequency range @ 0.25 Vp-p	3	-	850	Hz

5.3.1.2. AC-Coupled Frequency Input Configuration Options

AC-coupled frequency inputs have programmable gain and attenuation factors, as indicated in Table 3.

The pull-up or pull-down resistors for AC-coupled frequency inputs can be enabled or disabled; however, both pull-up and pull-down cannot be enabled at the same time. The pull-up and pull-down resistance is **3.3 kΩ**.

5.3.1.3. AC-Coupled Frequency Input Installation Connections

When connecting AC-coupled frequency inputs, there are two issues you must be aware of: system noise and ground shift.

System Noise

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

To reduce system noise:

- Connect AC-coupled frequency inputs to sensors with significant DC offset.
- Use the shortest possible wires when connecting AC-coupled frequency inputs to sensors to prevent noise pickup on the sensors.

Ground Shift

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

To reduce ground shift:

- Dedicate one of the 5 system ground inputs (`GND`) to sensors that have dedicated ground wires, and connect all sensor grounds to this system ground input.
- 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.

INFORMATION

The VMM3120 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.

INFORMATION

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 AC-coupled frequency input connection:

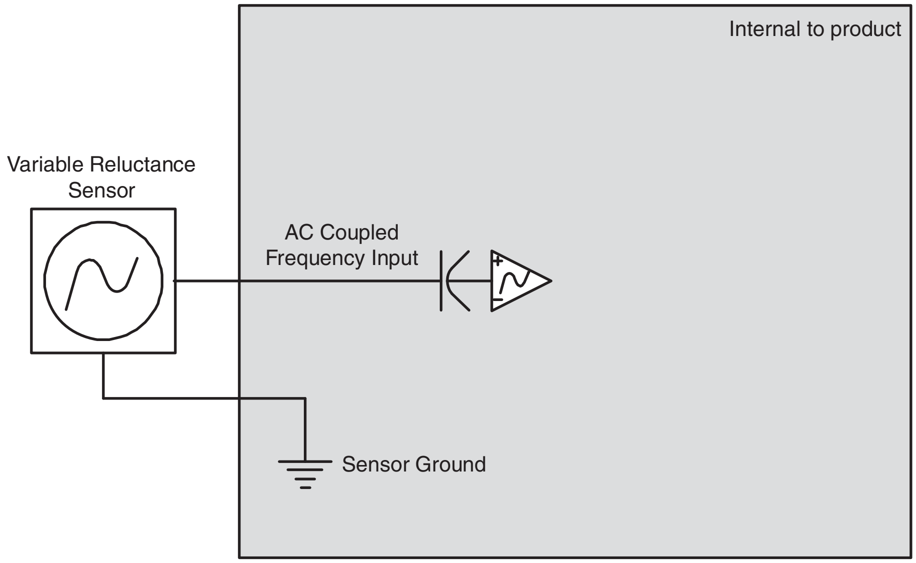


Figure 10: AC-coupled frequency input installation connections

5.3.2. DC-Coupled Frequency Inputs

The VMM3120 has 2 DC-coupled frequency inputs:

- `INPUT32_F` through `INPUT33_F`

5.3.2.1. VMM3120 DC-Coupled Frequency Input 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.

INFORMATION

Quadrature and pulse counting is possible with DC-coupled frequency inputs.

The following table provides specifications for the VMM3120's DC-coupled frequency inputs:

Table 6: DC-Coupled Frequency Input Specifications

Item	MIN	NOM	MAX	UNIT
Input voltage range	0	-	32	V
Pull-up resistance power dissipation	-	0.125	0.25	W
Pull-up resistance	4.7 k	-	-	Ω
Over-voltage	-	-	36	V
Frequency accuracy	-	-	5	%
Frequency range	1	-	10000	Hz
Minimum negative going threshold	1.56	-	-	V
Maximum positive going threshold	-	-	3.65	V
Analog gain	-	-	1	V/V
Analog resolution	-	10	-	Bit
Analog accuracy	-	-	3	%
ADC reference voltage	2.994	3.0	3.006	V

5.3.2.2. DC-Coupled Frequency Input Configuration

The DC-coupled frequency inputs

- Use a pull-up resistor.

The following diagram shows the configuration for DC-coupled frequency inputs:

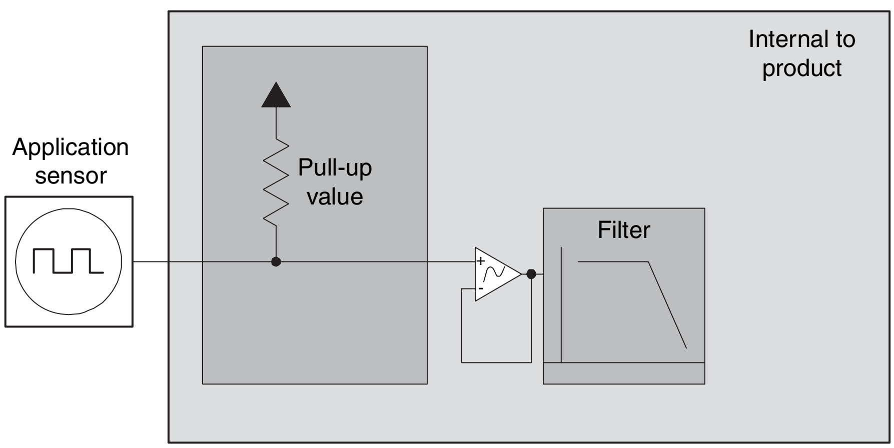


Figure 11: DC-coupled frequency input configuration

5.3.2.3. DC-Coupled Frequency Input Installation Connections

When connecting DC-coupled frequency inputs, there are two issues you must be aware of: system noise and ground 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 Shift

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

To reduce ground shift:

- Dedicate one of the 5 system ground inputs (called `GND`) to sensors that have dedicated ground wires, and connect all sensor grounds to this system ground input.
- 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.

INFORMATION

The VMM3120 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.

INFORMATION

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:

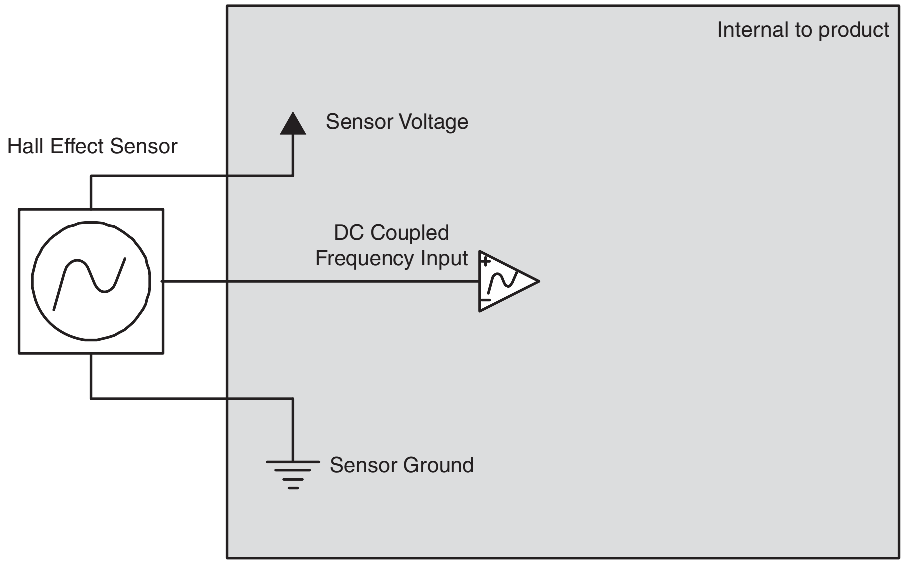


Figure 12: DC-coupled frequency input installation connections

6. Outputs

The VMM3120 has 20 solid-state FET technology outputs designed for low to medium current and high inrush inductive load switching. Output currents can range up to 2.5 A.

The VMM3120 has 2 types of outputs:

- High-side outputs
- Low-side outputs with current sense

INFORMATION

A high-side and a low-side output can be used to create a half-bridge. An H-bridge output can be created from 2 half-bridges, allowing 2 full H-bridge outputs to be produced (refer to *Controlling a Linear Actuator* for an example of how to use an H-bridge).

6.1. High-Side Outputs

The VMM3120 has 16 high-side outputs:

- `OUTPUT1_2A5_HS` to `OUTPUT16_2A5_HS`

6.1.1. High-Side Output Capabilities

High-side outputs are used for switching voltage to loads using either a **pulse width modulated (PWM) signal**, or an **on/off signal**. They can also test for various fault conditions, which can be used for software diagnostics (refer to *High-Side Output Diagnostics and Fault Detection see "High-Side Output Diagnostics and Fault Protection" on page 35* for more details).

All high-side outputs come with internal flyback diodes that provide protection when driving inductive loads.

- **When a high-side output is used as a PWM signal**, a pulsed output signal is provided by the VMM3120, where the percentage of time that the output is “on” vs. “off” is determined by the duty cycle of the signal, and the duty cycle is determined by the application software.
- **When a high-side output is used as an on/off signal**, the output provides battery voltage when in the "on" state (the application software is responsible for switching high-side outputs "on" and "off").

The following table provides specifications for the VMM3120's high-side outputs:

Table 8: High-Side Output Specifications

Item	MIN	NOM	MAX	UNIT
Switchable voltage range	6	-	32	V
Output current	0	-	2.5	A
Output on state resistance	-	90	-	mΩ
Load resistance (12 V system)	6.4	-	-	Ω
Load resistance (24 V system)	12.8	-	-	Ω
Over-voltage	-	-	36	V
PWM frequency	-	-	500	Hz
PWM resolution	-	-	0.1	%
Inductive pulse protection	-	-	628	V (peak)
Digital feedback minimum negative going threshold	1.56	-	-	V
Digital feedback minimum positive going threshold	-	-	3.65	V
Open load detection resistance	10	-	-	kΩ

6.1.2. High-Side Output Configuration

The high-side outputs (OUTPUT1_2A5_HS to OUTPUT16_2A5_HS) .

- 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 if the output is connected to sensitive loads, such as LEDs.

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

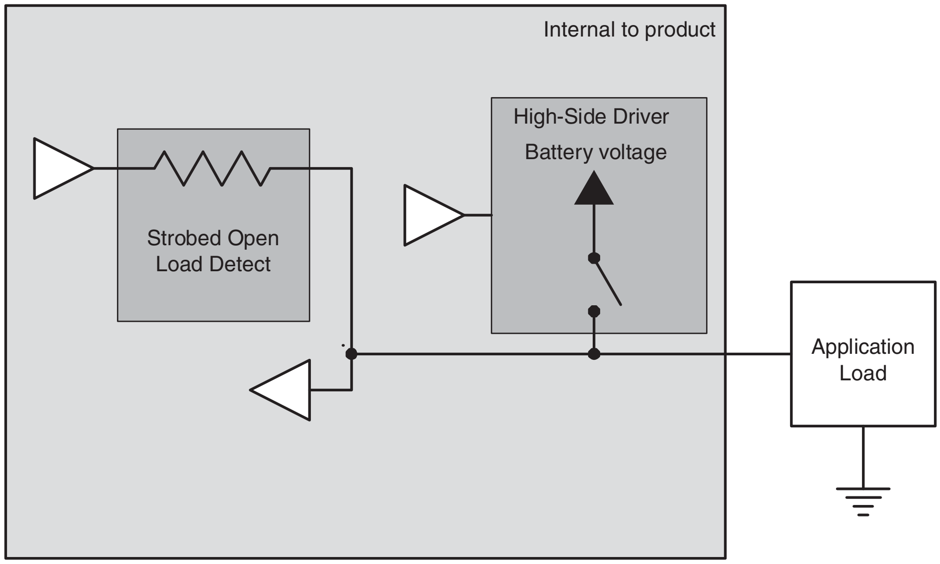


Figure 13: High side output configuration

6.1.3. High-Side Output Installation Connections

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

- High-side outputs are connected to an internal bus bar, which can be connected to a **+12 V** or **+24 V** battery. The bus bar is connected to logic power (`VBATT`), and both share the same connector pins.
- High-side outputs can provide switched battery power to any load type in a vehicle.
- High-side outputs can source up to **2.5 A**.
- High-side outputs have internal flyback diodes, which are needed when driving inductive loads (the flyback diodes absorb electrical energy when the load is turned off).

INFORMATION

Inductive loads will create an average current flow that moves out of the high-side output. When the output is on, the current flows through the output driver, and when the output is off, the current flows through the flyback diode. A duty cycle of 50% will produce the worst case average current flow through these two devices.

NOTICE

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 VMM3120 power grounds.

The following shows a typical high-side output connection:

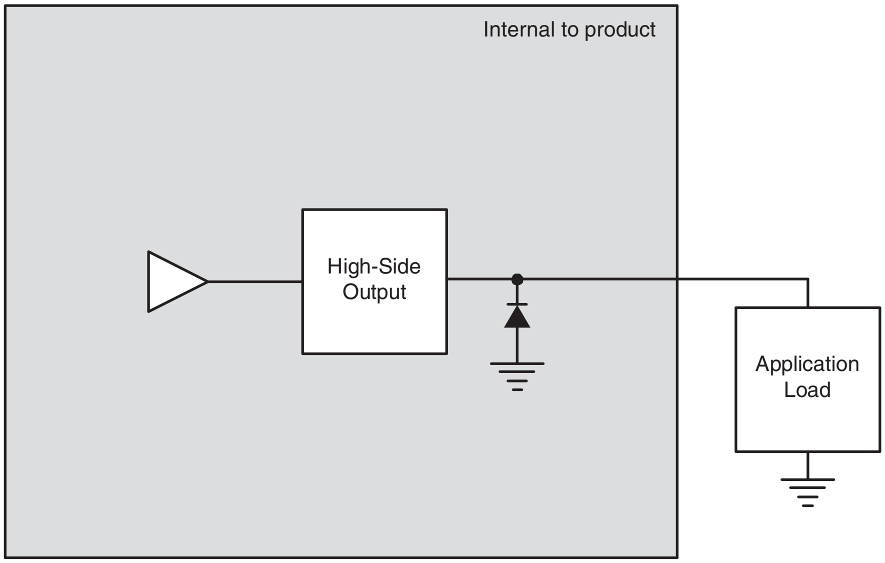


Figure 14: Typical high-side output installation connections

6.1.3.1. High-Side Output De-rating Requirements

Each high-side output is rated to continuously drive **2.5 A** of current; however, in some applications, the rating for high-side outputs must be reduced, or **de-rated**, to less than 2.5 A.

INFORMATION

How an output is de-rated is based on how all outputs are being used collectively on the VMM3120.

There are two issues that must be addressed to determine the de-rating for high-side outputs: current and power dissipation.

Current

You must determine how much current each output can drive. To determine the amount, you must look at outputs in pairs, because output current is provided from the same circuitry for each pair of outputs.

- Outputs 1 and 2 share the same circuitry as do outputs 3 and 4, 5 and 6, and so on, to outputs 15 and 16.

- The maximum allowable current for two outputs that share the same circuitry is **4 A**. For example, if output 1 is driving 2.5 A, then output 2 should be de-rated to less than 1.5 A.

Power dissipation

You must determine how much power is dissipated by each output. The total allowable power dissipation inside the VMM3120 must be **less than 7 W**, which will eliminate the need for additional heat sinking. Most of the power dissipation comes from the output drivers.

The following calculation is used to determine how much power is dissipated by the output drivers:

$$\left(I_{out1}\right)^2 R_{dson1} + \left(I_{out2}\right)^2 R_{dson2} + \cdots + \left(I_{outN}\right)^2 R_{dsonN}$$

- IoutN = output current for output N
- RdsonN = 0.09Ω or 0.06Ω (resistance of the high-side or low-side output FET, respectively) for output N

6.1.4. High-Side Output Diagnostics and Fault Protection

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.

6.1.4.1. Short Circuit

Short-circuit faults occur when a high-side output pin is shorted to ground. The output will turn off and retry as defined by the programmer.

6.1.4.2. Open Load

Open load faults occur when a high-side output pin is open circuit (not connected to a load). The use of this feature operates is defined by the programmer.

The high-side output circuit uses a small amount of current on the output pin to determine if an open load condition exists.

INFORMATION

High-side outputs with current sense can detect an open load fault when “on” or “off”. High-side outputs without current sense must be "off" to detect an open load fault.

INFORMATION

High-side outputs must be configured correctly to detect open loads.

6.1.4.3. Short-to-Battery

Short-to-battery faults occur when a high-side output pin is connected to battery voltage.

The high-side output circuit uses voltage on the output pin to determine if a short-to-battery condition exists.

INFORMATION

High-side outputs must be "off" to detect a short-to-battery fault.

INFORMATION

The output must be configured correctly for high-side outputs to be able to detect short-to-battery.

6.2. Low-Side Outputs with Current Sense

The VMM3120 has 4 low-side outputs:

- `OUTPUT1_2A5_LS` to `OUTPUT4_2A5_LS`

6.2.1. VMM3120 Low-Side Outputs with Current Sense Capabilities

Low-side outputs with current sense are used for switching grounds to loads using either a **pulse width modulated (PWM) signal**, or an **on/off signal**. They also have the ability to **sense current** that is provided to loads, through an amplifier circuit.

- **When a low-side output is used as a PWM signal**, a pulsed output signal is provided by the VMM3120, where the percentage of time that the output is "on" vs. "off" is determined by the duty cycle of the signal, and the duty cycle is determined by the application software.

INFORMATION

Current flow gets interrupted when using low-side outputs as a PWM signal, because the outputs are not "on" continuously. Therefore, current feedback control systems should use a high-side output for PWM signals, and a low-side output (turned on at 100%) for sensing current.

- **When low-side outputs are used as an on/off signal**, the output provides ground when in the "on" state (the application software is responsible for switching low-side outputs "on" and "off").
- **When low-side outputs are used to sense current**, the application software will monitor the current flowing into the low-side output, and based on the amount of current, will turn the output either "on" or "off".
    - o The amplifier that measures the sensed current has an allowable voltage range of 0 V to 3 V. The application software will protect the circuit from an over-current or short-circuit event when the voltage from the amplifier

reaches 2.9 V; therefore, the actual usable voltage range from the amplifier is only 0 V to 2.8 V.

The following table provides specifications for the VMM3120's low-side outputs:

Table 9: Low-Side Output Specifications

Item	MIN	NOM	MAX	UNIT
Switchable voltage range	0	-	32	V
Output current	0	-	2.5	A
Output on state resistance	-	50	-	mΩ
Load resistance (24 V system)	10.7	-	-	Ω
Current sense amp range	0	-	2.8	V
Over-current trip point	-	2.9	-	V
Current sense resolution	-	10	-	bit
Current sense accuracy	-	-	5	%
Current sense resistance	0.1	-	-	Ω
Over-voltage	-	-	36	V
PWM frequency	-	-	500	Hz
PWM resolution	-	-	0.1	%
Inductive pulse protection	-	-	628	V (peak)

6.2.2. Low-Side Outputs with Current Sense Configuration

The low-side outputs with current sense (`LS_OUTPUT_1` to `LS_OUTPUT_4`) are configured as follows:

- The resistor used for sensing current maximizes the accuracy of the current measurement. The resistor value is **0.1 Ω**.
- The gain in the amplifier circuit that is used for current sensing maximizes the accuracy of the current measurement. The gain on the amplifier is **10**.
- You can configure a **2-pole low-pass filter**, which is used for sensing current, so that it reduces noise in the current measurement.

INFORMATION

You should use as much filtering as possible on the low-side output's current measurement to prevent anomalous analog readings in noisy environments. The amount of filtering (cut-off frequency) for your hardware filter will depend on the rate at which the current changes, as well as the expected response time of your system. **Filtering of less than 7 Hz is not permitted**, as it will have an adverse effect on over-current and short-circuit protection times. If an application requires a cutoff frequency lower than 7 Hz, a filter can be implemented in the application software.

INFORMATION

To prevent aliasing, you should filter at half the rate of your sampling rate, according to the Nyquist criterion. If you require more filtering, a software filter can be added to your system. For example, if a current reading needs to be sampled at a rate of 20 Hz, the cutoff frequency for the filter should be 10 Hz.

The following diagram shows the configuration options for low-side outputs:

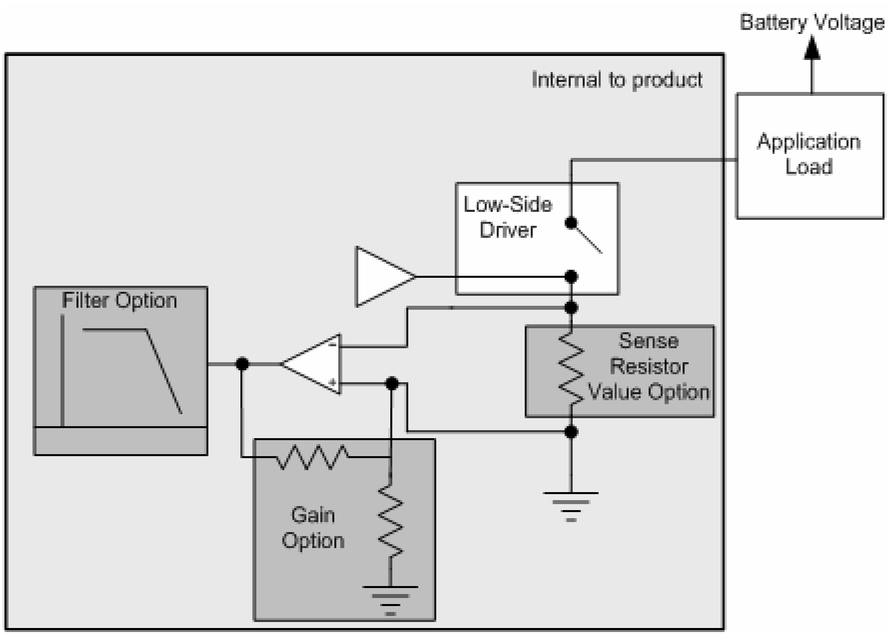


Figure 15: Low-side outputs with current sense configuration options

6.2.3. Low-Side Outputs with Current Sense Installation Connections

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

- Low-side outputs are connected to a common internal ground point that is connected to the battery ground (`GND`). Refer to *Logic and Output Power* for more details about the battery ground.
- Low-side outputs provide switched ground to any load type in a vehicle.
- Low-side outputs can sink up to **2.5 A**.
- When connecting a load to a low-side output, **ensure the load will not** drive currents greater than the maximum specified peak current, or maximum specified continuous current.

The following shows a typical low-side output connection:

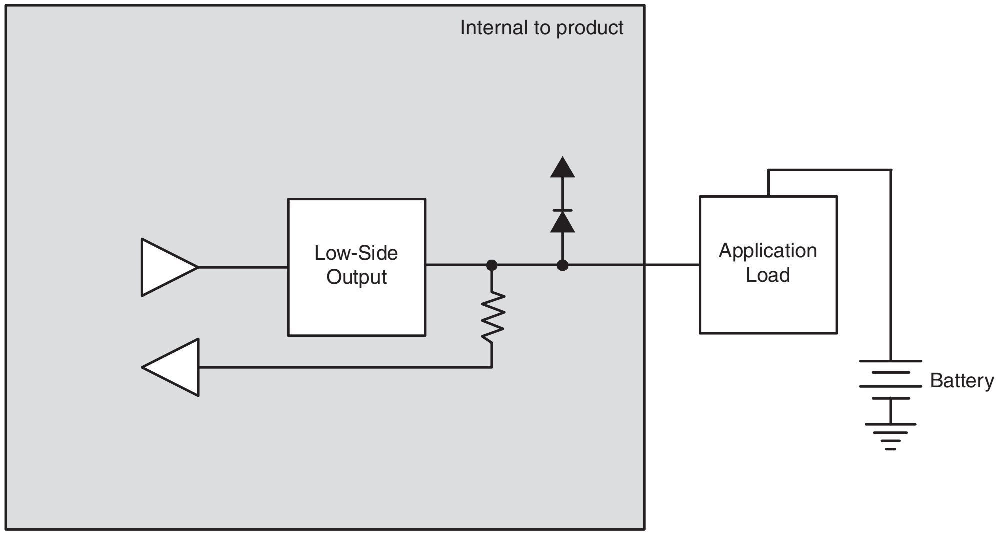


Figure 16: Low-side outputs with current sense installation connections

6.2.3.1. Low-Side Output De-rating Requirements

Each low-side output is rated to continuously drive **2.5 A** of current; however, in some applications, the rating for low-side outputs must be reduced, or **de-rated** to less than 2.5 A.

INFORMATION

How an output is de-rated is based on how all outputs are being used collectively on the VMM3120.

There is one issue that must be addressed to determine the de-rating for low-side outputs: Power dissipation.

Power dissipation

You must determine how much power is dissipated by each output. The total allowable power dissipation inside the VMM3120 must be **less than 7 W**, which will eliminate the need for additional heat sinking. Most of the power dissipation comes from the output drivers.

The following calculation is used to determine how much power is dissipated by the output drivers:

$$\left(I_{out1}\right)^2 R_{dson1} + \left(I_{out2}\right)^2 R_{dson2} + \cdots + \left(I_{outN}\right)^2 R_{dsonN}$$

- IoutN = output current for output N
- RdsonN = 0.09Ω or 0.06Ω (resistance of the high-side or low-side output FET, respectively) for output N

6.2.4. Low-Side Outputs with Current Sense Diagnostics

The VMM3120's low-side outputs have the ability to report many different fault conditions, and are protected against short-circuit and over-current, open load, and short-to-ground faults.

6.2.4.1. Short-Circuit

Short-circuit faults occur when a low-side output pin is shorted to battery and produces an output current above the specified **over-current trip point**, causing an over-current on the circuit.

When a short-circuit or over-current fault is detected, the software automatically turns off the output.

The short-circuit trip time for low-side outputs depends on how the outputs are configured.

INFORMATION

The application software can be used to reset an output from an over-current or short-circuit fault, by turning the output "off" and then "on" again.

6.2.4.2. Open Load

Open load faults occur when a low-side output pin is open circuit (not connected to a load). The use of this feature operates is defined by the programmer.

The low-side output circuit uses a small amount of current on the output pin to determine if an open load condition exists.

INFORMATION

Low-side outputs must be “on” to detect an open-load fault.

6.2.4.3. Short-to-Ground

Short-to-ground faults occur when a low-side output pin is connected to ground.

The low-side output circuit uses current on the output pin to determine if a short-to-ground condition exists.

INFORMATION

The low-side output must be configured correctly to be able to detect short-to-ground.

7. Power

The VMM3120 is powered by the vehicle battery. The VMM3120 operates in a 12 V or 24 V system, and can operate from 6 V up to 32 V, with overvoltage protection at 36 V protection.

The VMM3120 has various pins on the connectors that are used for different types of power, as detailed in the following sections.

7.1. Logic and Output Power

The VMM3120 has **5 pin(s)** dedicated to providing power for logic and outputs, called `VBATT`, and **5 pin(s)** dedicated to grounding the VMM3120, called `GND`.

INFORMATION

The power and ground connections are usually paralleled over several pins to minimize voltage drops on higher current applications.

7.1.1. Logic and Output Power Capabilities

Logic power provides power to the logic circuit, which consists of the microprocessor, RAM, etc. The logic circuit can draw a maximum of 200 mA.

Output power provides power to the output circuits through a battery or ground connection. Each output circuit can draw a maximum of 2.5 A.

The following table provides specifications for the VMM3120 logic and output power:

Table 10: Logic and Output Power Specifications

Item	MIN	NOM	MAX	UNIT
Input voltage range	7.5	-	32	V
Over-voltage	-	-	36	
Current draw in on state (excluding outputs)	-	200	-	mA
Current draw in on state (including outputs)				
Current draw in off state	-	-	100	uA
Inline fuse required on power pins		50		A
Number of power pins		5		
Number of ground pins		5		

7.1.2. Logic and Output Power Installation Connections

When connecting the VMM3120 logic and output power, you should be aware of the following:

- Logic and output power connections are made using the `VBATT` and `GND` pins.
- The number of wires needed to connect the VMM3120 power depends on the amount of current required by the application. It is recommended to use **one (1) 16 AWG wire** for every **8 A** of expected output current; however, this is not always true and ultimately depends on your application.
- The VMM3120 is protected against reverse battery connections by an internal high-current conduction path that goes from ground to power. To protect the VMM3120 from damage in a reverse battery condition, place a fuse of **50 A or less** in series with the power wires in the application harness.
- All power connections to the VMM3120 should be fused to protect the vehicle harness.

INFORMATION

The system designer is responsible for selecting the appropriate 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.

The following shows a typical logic and output power connection:

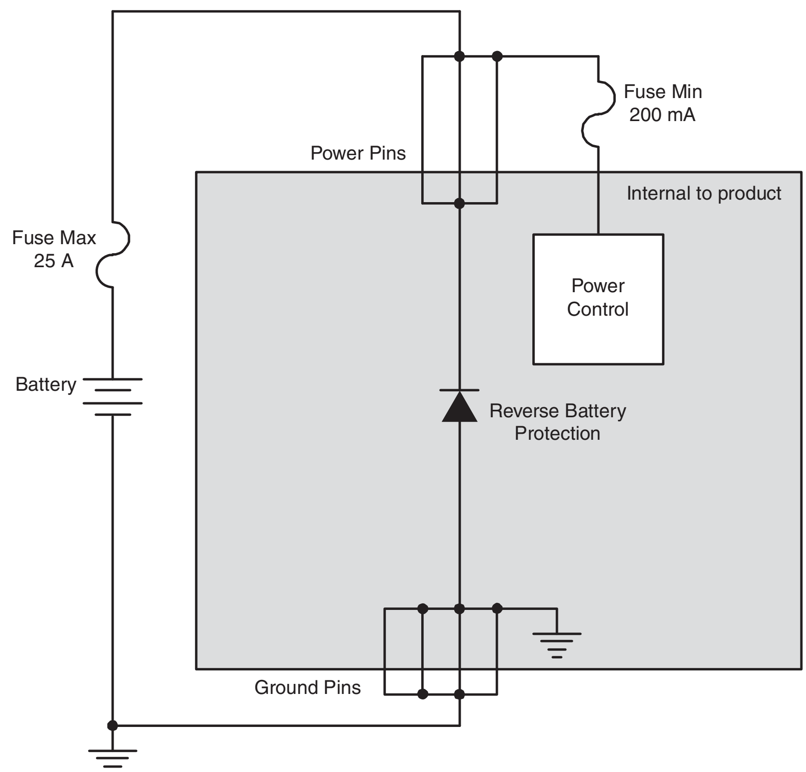


Figure 17: Logic and output power installation connections

7.2. Sensor Power

The VMM3120 has one pin dedicated to providing power to external sensors called SENSOR_SUPPLY.

WARNING

Do not drive more than **300 mA** of current through the SENSOR_SUPPLY pin. If you do, the pin will protect itself by dropping the voltage, which will result in a lack of power to your sensors, potentially causing unknown vehicle responses.

7.2.1. Sensor Power Capabilities

SENSOR_SUPPLY is a 5 V or 8 V linear power supply that is capable of continuously providing 300 mA to external sensors.

INFORMATION

The voltage provided to the VMM3120 must be 7 V or greater to ensure the SENSOR_SUPPLY can provide 5 V. The voltage provided to the product must be 10.5 V or greater to ensure the SENSOR_SUPPLY can provide 8 V.

The following table provides specifications for the VMM3120's sensor power output:

Table 11: Sensor Power Specifications

Item	MIN	NOM	MAX	UNIT
Input voltage range (5 V output)	7	-	32	
Input voltage range (8 V output)	10.5	-	32	V
Over-voltage	-	-	36	V
Output voltage range (5 V)	4.74	5.02	5.30	V
Output voltage range (8 V)	7.63	8.09	8.56	V
Output voltage accuracy	-	-	6	%
Output current	0	-	300	mA

7.2.1.1. Sensor Power Fault Responses

SENSOR_SUPPLY is designed to survive short-to-battery, short-to-ground, and over-current events. If these events occur, the circuit will recover as described in the following table:

Table 12: Sensor Power Fault Recovery

Event	Recovery
Short-to-battery (sensor voltage = battery voltage)	Sensor voltage recovers when the short is removed.
Short-to-ground (sensor voltage = ground)	Sensor voltage recovers when the short is removed.
Over-current (sensor voltage = ground)	Sensor voltage recovers when the over-current condition is removed.

7.2.2. Sensor Power Installation Connections

For information on how to connect sensors, refer to Application Examples.

8. Communication

The VMM3120 uses the Controller Area Network (CAN) communication when communicating with other modules on the vehicle, or with a personal computer:

8.1. Controller Area Network (CAN)

The VMM3120 hardware provides CAN communication according to the **SAE J1939 specification**, making the VMM3120 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.

8.1.1. J1939 CAN Capabilities

The CAN communicates information at a rate of **250 kbps**. Input and output information is communicated through the CAN at a sample 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.

CAN communication provides a feature called Wake on CAN, which is a way to provide power control to the VMM3120.

Wake on CAN provides a low-current sleep mode that turns on the VMM3120 when a CAN message is received by the module.

INFORMATION

It is not possible to filter messages that are used to turn on the VMM3120 using Wake on CAN, and therefore, any message will turn on the VMM3120. The application software must be written to determine how the VMM3120 will behave when it is turned on.

The following table provides specifications for the CAN:

Table 13: CAN Specifications

Item	MIN	NOM	MAX	UNIT
Baud rate limitations (hardware)	-	-	1000	kbps
Baud rate limitations (framework)	-	250	-	kbps
Wake on CAN current draw	-	-	500	uA
Termination resistor	120	-	-	Ω

8.1.2. J1939 CAN Configuration

There are two features associated to CAN communication that are configured:

- **Wake on CAN** - the VMM3120 will turn on when a CAN message is received.
- **Internal CAN Termination Resistor** - the VMM3120 does not have a **120 Ω** CAN termination resistor embedded inside the module, which is required to use CAN communication. You are required to design it into the vehicle harness.

INFORMATION

Putting CAN termination resistors in the module would violate the J1939 specification, which states that the resistor should be designed into the harness.

8.1.3. J1939 CAN Installation Connections

The CAN connection for the VMM3120 should conform to the J1939 standard.

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.

INFORMATION

The VMM3120 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_HIGH`, `CAN_LOW`, and `CAN_SHIELD` pins on the connector). 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 according to the following:
        a. Connect CAN Shield to the point of least electrical noise on the CAN bus.
        b. Connect CAN Shield as close to the centre of the CAN bus as possible.
        c. Use the lowest impedance connection possible.

NOTICE

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 Canon 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 metres, and must have a 120 Ω terminator resistor at each end. The 120 Ω terminator resistors eliminate bus reflections and ensure proper idle state voltage levels.

- **CAN Stubs**: The CAN stubs cannot be longer than 1 m, 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:

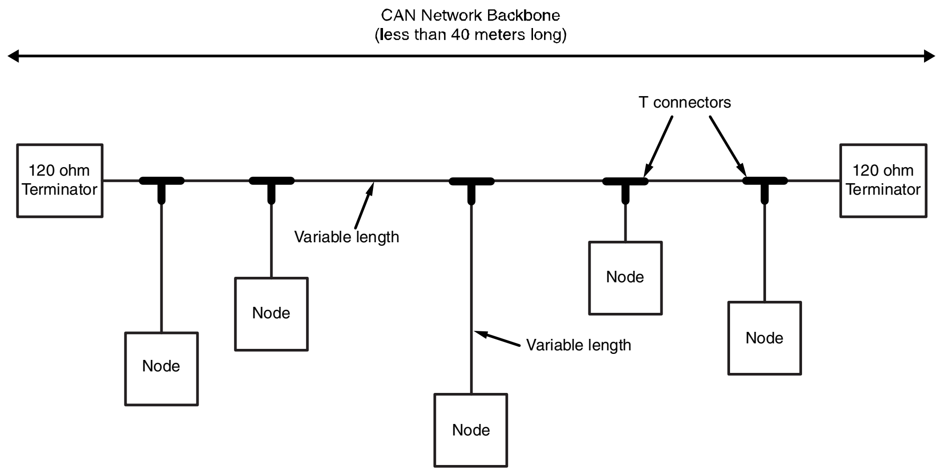


Figure 18: J1939 CAN connection

9. Connectors

The VMM3120 has two 35-pin Ampseal connectors, as follows:

- Black (J1): AMP 776164-1 (shown in Figure 23)
- White (J2): AMP 776164-2 (shown in Figure 24)

Both connectors have pins that connect to inputs, outputs, and communication channels used by the VMM3120. They also have keying that prevents you from incorrectly mating the connectors to the vehicle harness.

The vehicle harness should be designed to interface with both connectors.

The following are pictures of the required connectors:

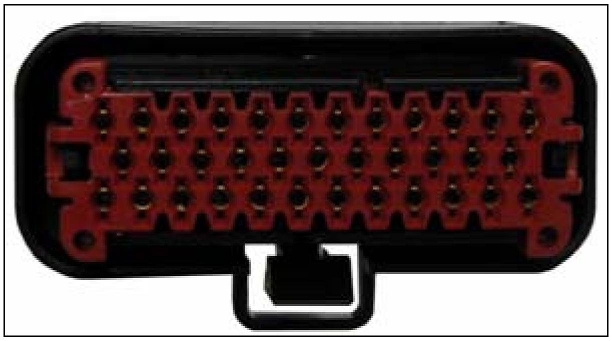


Figure 19: Black (J1): AMP 776164-1 connector

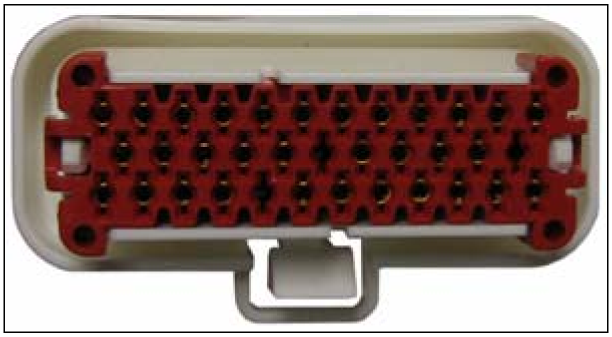


Figure 20: White (J2): AMP 776164-2 connector

9.1. Mating Connector Part Numbers

INFORMATION

The maximum wire gauge usable in the VMM3120 connectors is 16 AWG with GXL insulation.

The following table shows the part numbers for the mating connectors and terminals that are used in the vehicle harness:

Table 15: Mating Connector Part Numbers

Connector	Shell part number	Terminal part number
Black (J1) connector	AMP 776164-1	20-16AWG, Gold: AMP 770854-3
White (J2) connector	AMP 776164-2	20-16AWG, Gold: AMP 770854-3

INFORMATION

Strain reliefs are available for the connectors. The strain relief part number is AMP P/N: 776463-1.

9.2. VMM3120 Connector Pin-outs

Connector pins connect to inputs, outputs, and communication channels. They provide the interface between the vehicle harness and the internal circuitry of the VMM3120.

The following tables show the pin-outs for each connector:

Table 16: Black (J1) Connector Pin-out

Connector pin	Name	Function
1	OUTPUT3_2A5_HS	High-side output
2	VBATT	Battery voltage input
3	VBATT	Battery voltage input
4	VBATT	Battery voltage input
5	VBATT	Battery voltage input
6	VBATT	Battery voltage input
7	INPUT20_A	Amplified analog input
8	INPUT8_D	Digital input
9	INPUT5_D	Digital input
10	INPUT3_D	Digital input
11	INPUT1_D	Digital input - optional power control
12	OUTPUT18_2A5_LS	Low-side output with current sense
13	OUTPUT4_2A5_HS	High-side output
14	GND	System ground input
15	GND	System ground input
16	GND	System ground input
17	GND	System ground input
18	INPUT21_A	Amplified analog input
19	INPUT23_A	Amplified analog input
20	INPUT6_D	Digital input

Connector pin	Name	Function
21	INPUT4_D	Digital input
22	INPUT2_D	Digital input - optional power control
23	CAN_SHLD	Controller Area Network Shield
24	OUTPUT5_2A5_HS	High-side output
25	OUTPUT6_2A5_HS	High-side output
26	OUTPUT7_2A5_HS	High-side output
27	OUTPUT8_2A5_HS	High-side output
28	SENSOR_SUPPLY (+5Vdc)	Sensor voltage output
29	INPUT31_F	Frequency input
30	INPUT30_F	Frequency input
31	INPUT22_A	Amplified analog input
32	INPUT7_D	Digital input
33	CAN1_L	Controller Area Network Low signal
34	CAN1_H	Controller Area Network High signal
35	OUTPUT17_2A5_LS	Low-side output w/ current sense

Table 17: White (J2) Connector Pin-out

Connector pin	Name	Function
1	OUTPUT20_2A5_LS	Low-side output w/ current sense
2	INPUT12_D	Digital input
3	INPUT15_D	Digital input
4	OUTPUT16_2A5_HS	High-side output
5	OUTPUT15_2A5_HS	High-side output
6	OUTPUT14_2A5_HS	High-side output
7	OUTPUT13_2A5_HS	High-side output
8	OUTPUT12_2A5_HS	High-side output
9	OUTPUT11_2A5_HS	High-side output
10	OUTPUT10_2A5_HS	High-side output
11	OUTPUT9_2A5_HS	High-side output
12	OUTPUT2_2A5_HS	High-side output
13	INPUT9_D	Digital input
14	CAN2_L	Controller Area Network Low signal
15	CAN2_H	Controller Area Network High signal
16	INPUT17_D	Digital input
17	INPUT19_D	Digital input
18	INPUT24_A	Basic analog input
19	INPUT26_A	Basic analog input

Connector pin	Name	Function
20	INPUT28_A	Basic analog input
21	INPUT33_F	Frequency input
22	GND	System ground input
23	OUTPUT1_2A5_HS	High-side output
24	OUTPUT19_2A5_LS	Low-side output w/ current sense
25	INPUT10_D	Digital input
26	INPUT13_D	Digital input
27	INPUT16_D	Digital input
28	INPUT18_D	Digital input
29	ADDR1	Address pin
30	INPUT25_A	Basic analog input
31	INPUT27_A	Basic analog input
32	INPUT29_A	Basic analog input
33	INPUT32_F	Frequency input
34	ADDR2	Address pin
35	ADDR3	Address pin

10. Installing a VMM3120 into a Vehicle

Because every system is different, it is difficult for us to provide specific instructions on how to install a VMM3120 into a vehicle. Instead, we have provided **mechanical, environmental, and electrical guidelines and requirements** that you should be aware of before installing the product.

INFORMATION

The vehicle manufacturer is responsible for creating procedures for mounting the VMM3120 in a vehicle during production assembly.

10.1. Mechanical Guidelines

Ensure you review the following mechanical guideline sections before installing the VMM3120 into a vehicle.

10.1.1. Dimensions

The following diagram shows the dimensions of the VMM3120:

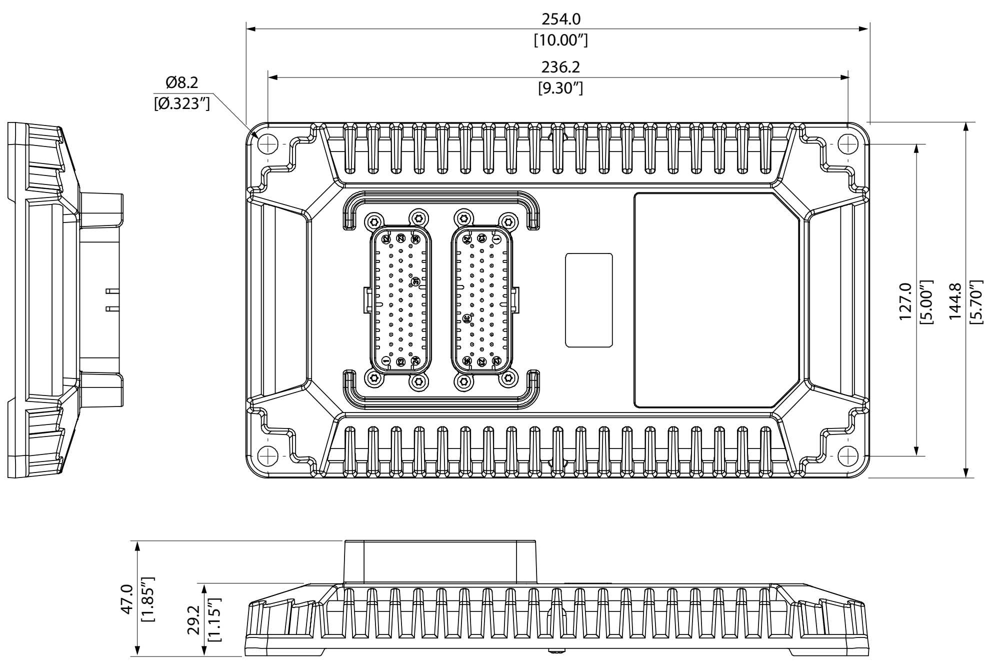


Figure 21: Dimensions

10.1.2. Selecting a Mounting Location

The VMM3120 can be installed in the vehicle's cab, or on the chassis. If used for a marine application, ensure it is protected from excessive salt spray.

Before mounting the VMM3120, ensure you review the following environmental and mechanical requirements.

NOTICE

Do not install the VMM3120 close to any significant heat sources, such as a turbo, exhaust manifold, etc. Also avoid installing the VMM3120 near any drive-train component, such as a transmission or engine block.

10.1.2.1. Environmental Requirements

NOTICE

The VMM3120 warranty does not cover damage to the product when exposed to environmental conditions that exceed the design limitations of the product.

Review the following environmental specifications before selecting a mounting location for the VMM3120:

- The VMM3120 must be in an environment that is within its ambient temperature range.
  - Safe operating temperature range for a VMM is **–40°C to +85°C**.
- The VMM3120 must be in an environment that does not exceed its particle ingress rating.
  - The sealing standard for the VMM3120 is **EP455 level 1 (IPX6)**.

NOTICE

The VMM3120 has not been tested for water ingress according to the EP455 level 1 standard.

- The VMM is protected from **aggressive pressure wash up to 1000 psi @ 1 m (3.28 ft.)**

NOTICE

Exercise caution when pressure washing the VMM3120. The severity of a pressure wash can exceed the VMM3120 pressure wash specifications related to water pressure, water flow, nozzle characteristics, and distance. Under certain conditions a pressure wash jet can cut wires.

10.1.2.2. Mechanical Requirements

Review the following mechanical requirements before selecting a mounting location for the VMM3120:

- The VMM3120 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 VMM3120.

- The harness should be **shielded from harsh impact**.
- The harness should **connect easily** to the connector and have **adequate bend radius**.
- The **labels** should be easy to read.
- The VMM3120 should be in a location that is **easily accessible for service**.

10.1.3. Mounting the VMM3120 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 VMM3120 to a vehicle:

- The VMM3120 should be secured with **bolts in all four bolt holes** using 1/4"-20 **Hex Head** or equivalent metric size (6 mm) bolts.
- The bolts should be tightened according to the fastener manufacturer's tightening torque specifications..

Recommended Mounting Orientation

The VMM3120 should be mounted vertically so moisture drains away from it, as shown in the following:

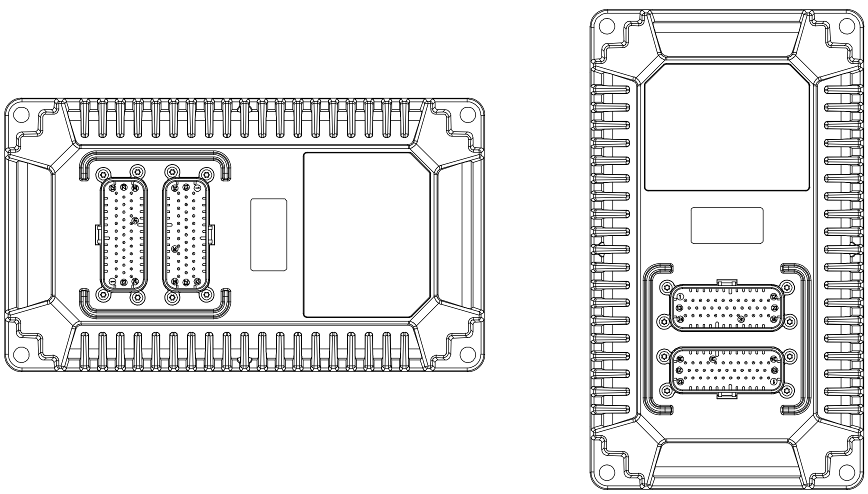


Figure 22: Recommended orientations

10.2. Electrical Guidelines

The following sections provide electrical guidelines to install the VMM3120 in a vehicle.

10.2.1. Designing the Vehicle Harness

The vehicle manufacturer is responsible for designing a vehicle harness that mates with the VMM3120 connector(s).

The vehicle harness design depends on the following:

- How the VMM3120's inputs, outputs, communication, and power pins are configured.
- Other components on the vehicle and their physical locations.
- The routing of the harness.

For guidelines and recommendations on how to connect the different elements of the VMM3120, refer to the *Installation Connections* sections found within each input, output, communication, and power section in this manual.

10.2.2. Connecting the Vehicle Harness to the VMM3120

Once the vehicle harness is designed, it can be connected to the VMM3120 simply by clicking the mating connector into the connector port on the VMM3120.

11. Application Examples

The purpose of this section is to provide examples of how the VMM3120 can be used for different purposes.

The following examples 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

INFORMATION

These examples are for illustrative purposes only.

11.1. Implementing Safety Interlocks

Safety is paramount when creating controls for a vehicle.

One safety feature that can be implemented with the VMM3120 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 ladder logic 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).

INFORMATION

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:

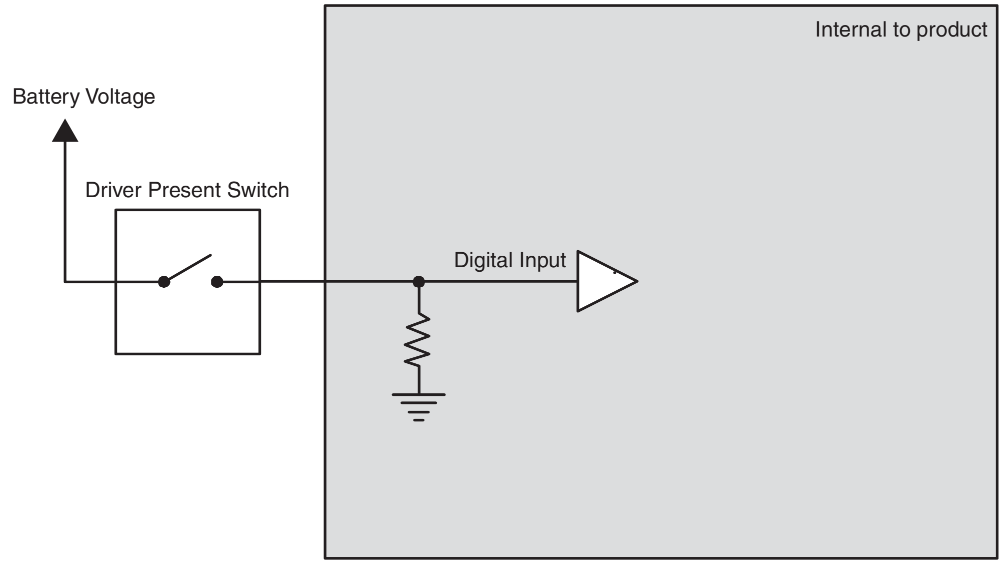


Figure 23: Seat switch interlock connection

11.2. Controlling Indicator Lights

Multiple VMM3120 can be used together in a system to control a vehicle's indicator lights.

The VMM3120s would communicate over CAN, and be connected according to the following:

- One VMM3120 could be wired to the rear indicator lights
- One VMM3120 could be wired to the front indicator lights
- One VMM3120 could be wired to the turn signal and hazard switches

The following shows how to connect three VMM3120s together in a system to control indicator lights:

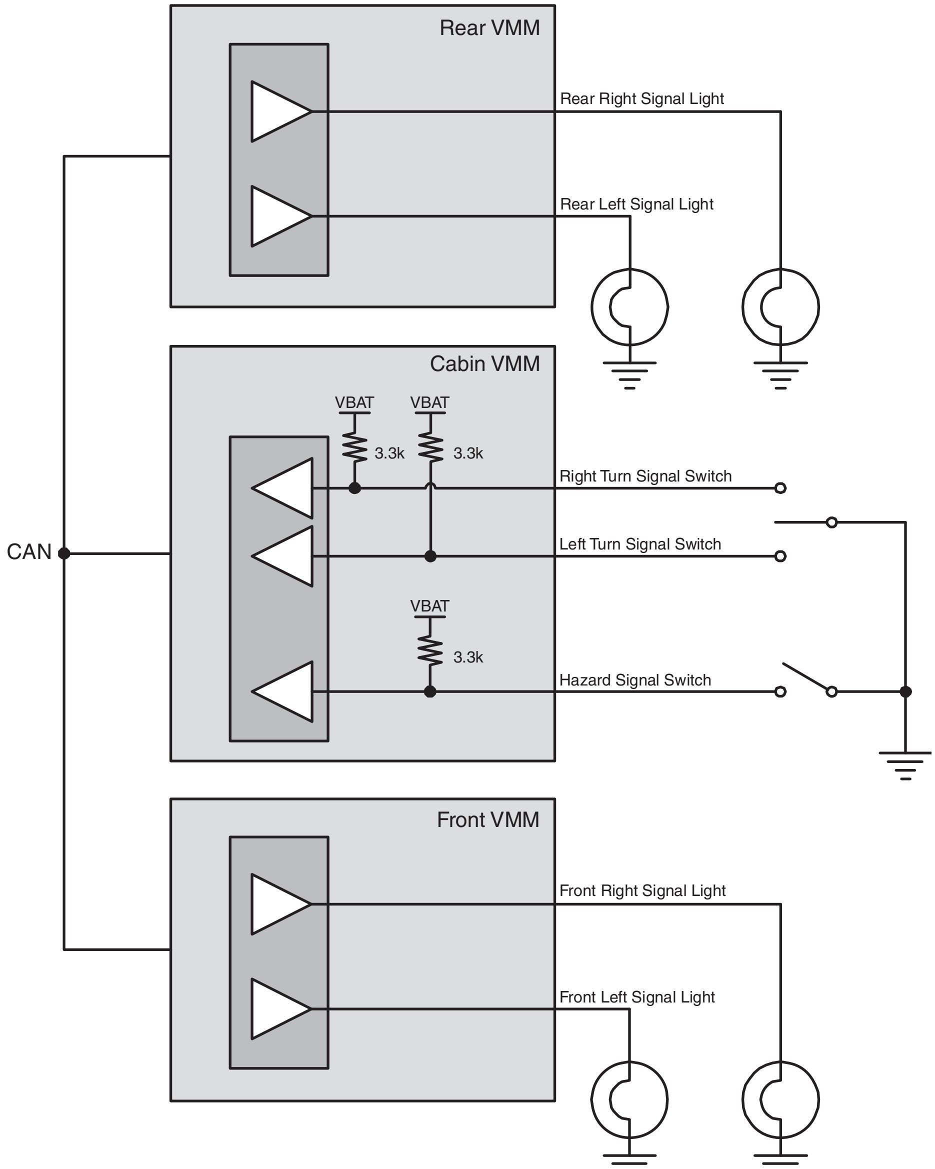


Figure 24: Indicator light connections

11.3. Controlling a Proportional Valve

INFORMATION

The VMM3120 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.

The VMM3120 can be used to control a proportional hydraulic valve through a **high-side output with PWM capability**, and a **low-side output with current sense**.

When making the connection, it is highly recommended to use the high-side and low-side outputs in pairs to avoid potential problems.

- The high-side output would drive power to the valve coil and adjust the duty cycle of a PWM signal.
- The low-side output would be used as a return path to ground for the valve coil, and provides feedback on the amount of current flowing through the valve coil.

The application code should be written so that the PWM duty cycle for the output is adjusted to achieve a target current through the valve coil.

- If current feedback is lower than target, the PWM duty cycle should increase to boost average current through the valve coil.
- If the current feedback is higher than target, the PWM duty cycle should decrease to reduce average current through the valve coil.

The following shows how to connect a high-side and low-side output to control a proportional hydraulic valve:

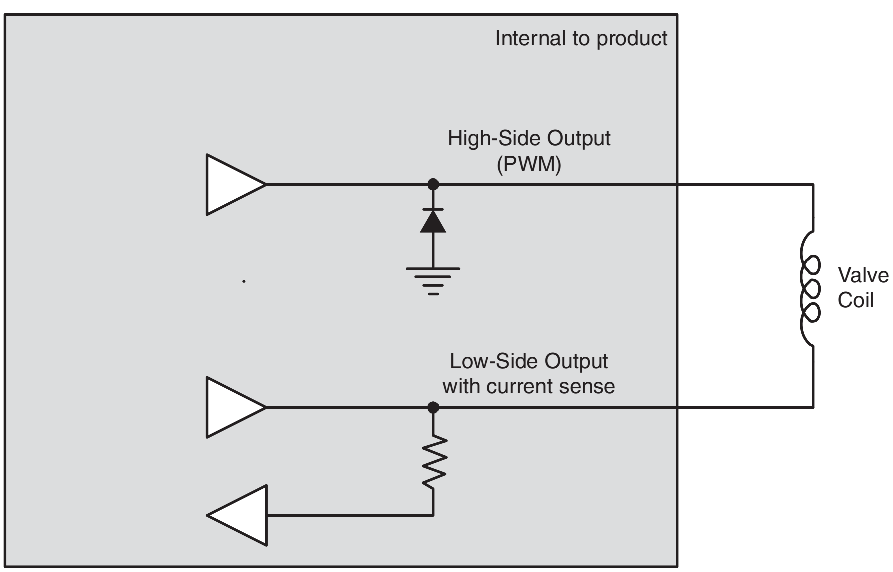


Figure 25: Connection for controlling a proportional valve

11.4. Controlling Motor Speed

INFORMATION

The VMM3120 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.

The VMM3120 can be used to control the DC motor speed of motors that provide a tachometer output.

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 VMM3120 to control the speed of a motor:

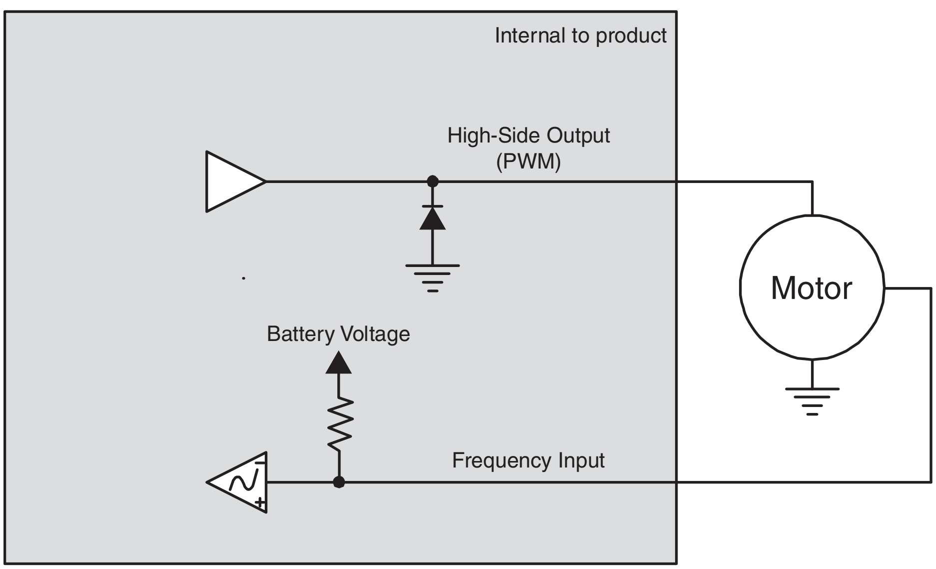


Figure 26: Connection for controlling motor speed

11.5. Using one Analog Input as Two Digital Inputs

The VMM3120 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.

INFORMATION

You will need to write ladder logic that controls the switch according to the voltage value readings provided by the analog input. Refer to the appropriate ladder logic help file, or contact your Parker Vansco Account Representative for more information on writing ladder logic.

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:

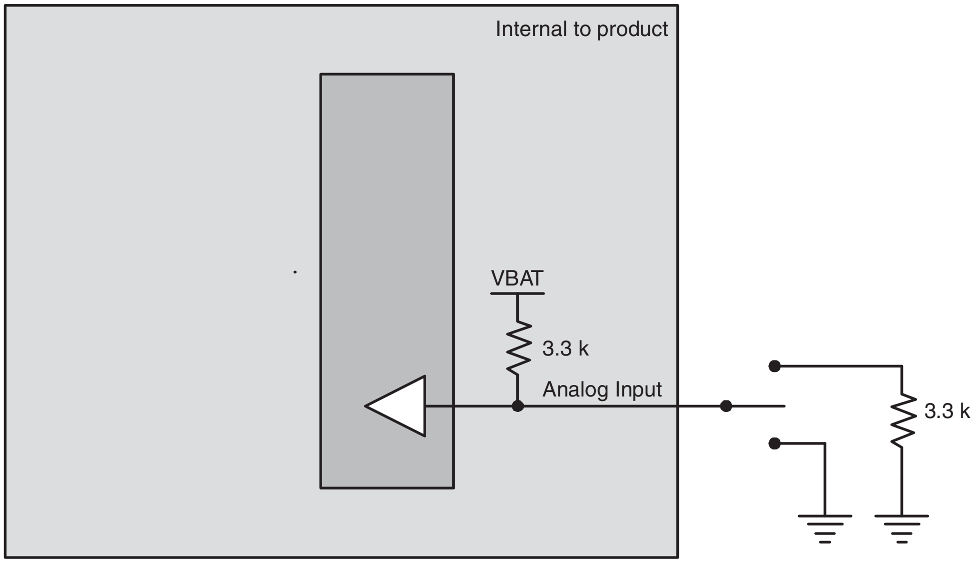


Figure 27: Connecting an analog input to an SPDT switch

11.6. Controlling a Linear Actuator

INFORMATION

The VMM3120 has Proportional Integral Differential (PID) capabilities that make it possible to control devices like an electric or hydraulic linear actuator through ladder logic. Refer to the appropriate ladder logic help file, or contact your Parker Vansco Account Representative for more details about ladder logic. This section only provides hardware connection information.

The VMM3120 can control the position of a linear actuator by using **two h-bridges of high-side and low-side outputs,** and monitor the position of the actuator using an **analog input**. When making the connections, it is highly recommended to use the high-side and low-side outputs in pairs to avoid potential problems (use high-side output 1 with low-side output 1, etc.).

The ladder logic should be written to adjust the PWM duty cycle and direction of the current to achieve a target position for the linear actuator.

The following shows how to connect high-side and low-side outputs for controlling a linear actuator:

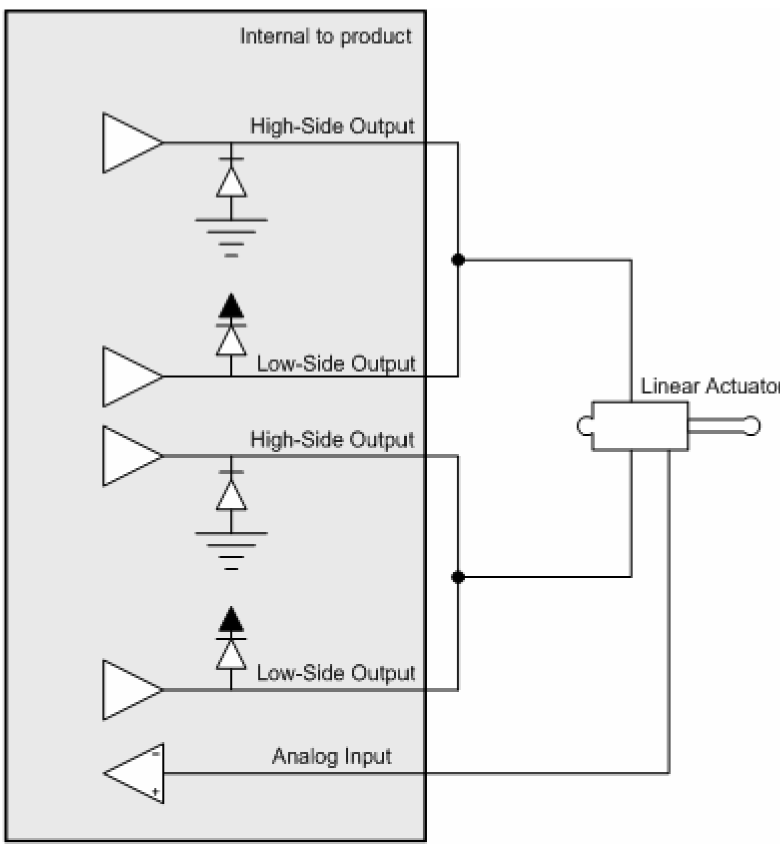


Figure 28: Connection for controlling a proportional valve

11.7. Connecting Common Sensors

There are many types of sensors that can be connected to the VMM3120, the most common are as follows:

- Open collector sensors
- Switch sensors
- Voltage sensors
- Potentiometer (ratiometric) sensors

INFORMATION

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.

INFORMATION

When connecting sensors to the VMM3120, refer to the sensor manufacturer's specifications to ensure the VMM3120 is configured correctly for the sensor.

11.7.1. Open Collector

Open collector sensors are compatible with each type of input on the VMM3120.

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".

INFORMATION

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 VMM3120.

The following shows a typical open collector sensor connection:

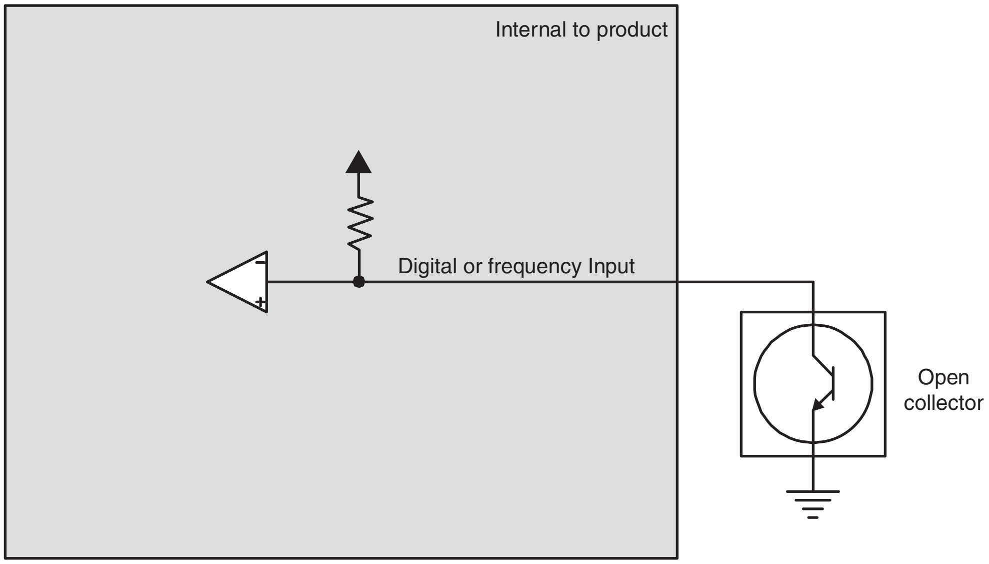


Figure 29: Open collector sensor connection

11.7.2. Connecting a switch to VMM3120

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-high sensor switches may be used by the VMM3120. To use active-high switches, the VMM3120 has an internal pull-down resistor for the digital input.

The following shows a typical sensor switch connection:

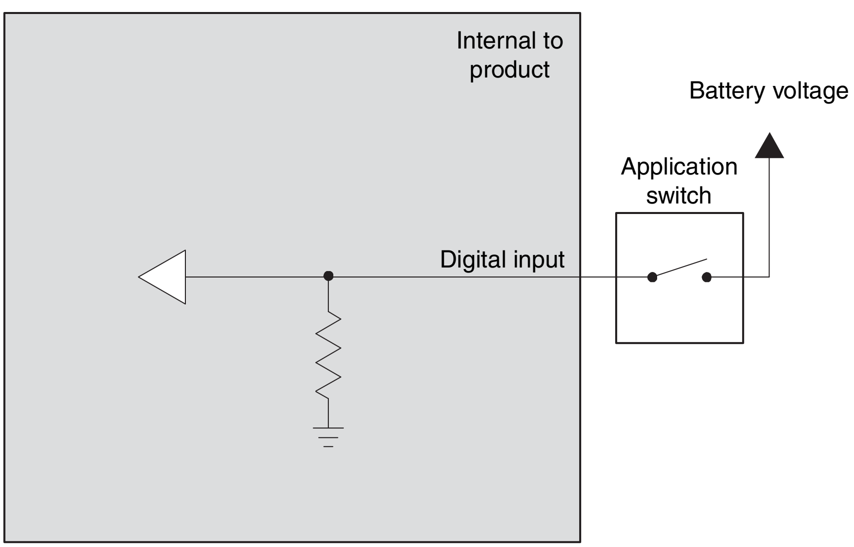


Figure 30: Switch sensor active high connection

11.7.3. 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.

INFORMATION

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:

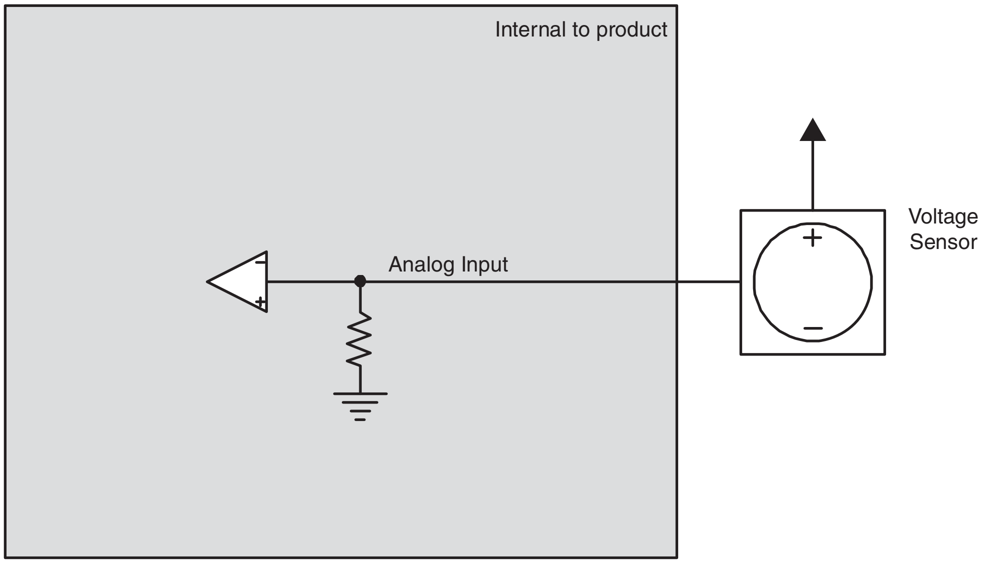


Figure 31: Voltage sensor connection

11.7.4. 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 VMM3120.
- Connect the sensor signal to an analog input.

The following shows a typical potentiometer sensor connection:

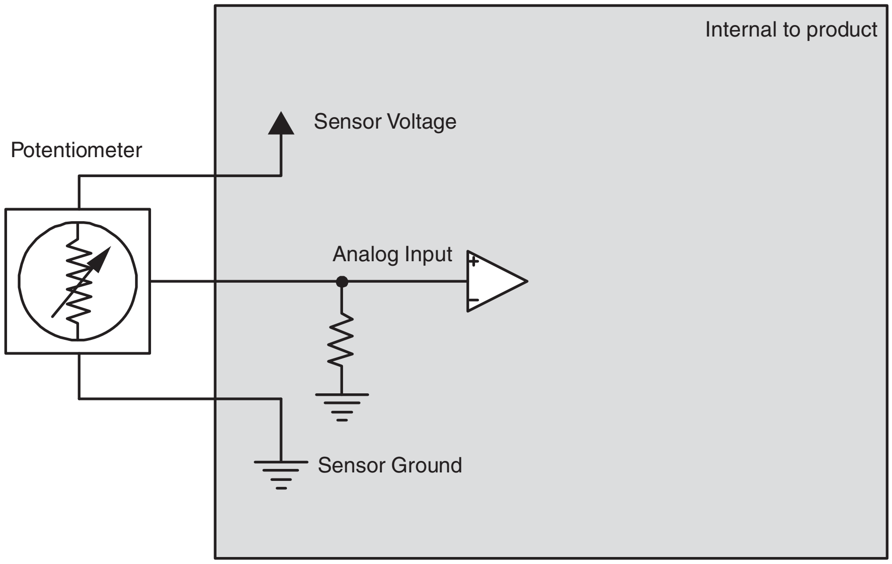


Figure 32: Potentiometer (ratiometric) sensor connection

12. Startup

12.1. Start-up procedures

This chapter contains instructions for action to be taken in connection with the initial start.

WARNING

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

12.1.1. Starting the control system

Start the control system as follows:

- Prior to start, all modules and cables are to be fitted correctly.
- Check fuses, i.e. make sure that the supply voltage to the modules is equipped with the correct fuse.
- Make sure that connections for supply voltage and return lines are correct in the cable's conductor joint.
- Make sure the emergency stop works.
    - o The emergency stop should disconnect the supply voltage to all modules.

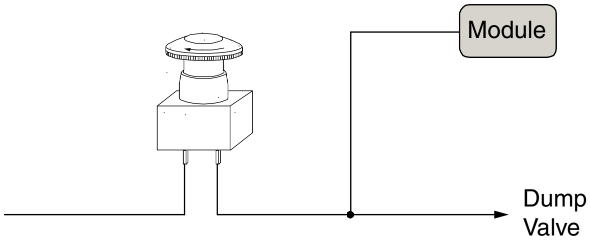


Figure 33: Emergency stop

Alternatively, the emergency stop may also shut off the diesel engine or a dump valve, and with that depressurize the hydraulic system.

12.1.2. Prepare for system start

WARNING

Make sure no one is in dangerous proximity to the vehicle to avoid injuries when it starts.

Prepare for the initial system start as follows:

- The engine for the hydraulic system's pump shall be in off position.
- Make sure that all connectors are properly connected.
- Turn on the control system.
- Make sure that voltage is being supplied to all modules.
- Make sure the emergency stop is functioning properly.

12.1.3. Start the system

Start the system as follows:

- Start the engine for the hydraulic system's pump, assuming that the above mentioned inspections have been carried out and shown correct values.
- Calibrate and adjust input and output signals, and check every output function carefully.
- In addition to these measures, the machine shall also meet the machine directives for the country in question.

13. Appendix A

13.1. VMM3120 Technical Overview

Table 18: Environmental specifications

Ref. #	Test Specification	Test Description	Dev. Y/N	Notes
1.	J1455 (Aug 94) Section 4.1.3.1	24 Hour Temperature Cycle	Y	
2.	J1455 (Aug 94) Section 4.1.3.1	Thermal Shock	N	
3.	EP455 (Feb 03) Section 5.1.2	Storage Temperature	N	
4.	J1455 (Aug 94) Section 4.2.3	24 Hour Humidity Cycle	N	GF
5.	EP455 (Feb 03) Section 5.1.2	Humidity Soak	N	GF
6.	J1455 (Aug 94) Section 4.3.3	Salt Spray Atmosphere	N	GF
7.	EP455 (Feb 03) Section 5.8.2	Chemical Exposure - Brush Application	N	GF
8.	EP455 (Feb 03) Section 5.4.1	Solar Radiation - UV effects	Y	GF
9.	60529 IEC Edition 2.1 2001-02	Sealing Tests – Pressure Wash	N	
10.	J1455 (Aug 94) Section 4.9.4.2	Random Vibration	N	
11.	J1455 (Aug 94) Appendix A	Swept Sine Vibration	N	
12.	J1455 (Aug 94) Section 4.10.3.4	Operational Shock	N	
13.	J1455 (Aug 94) Section 4.10.3.1	Handling Drop	N	GF
14.	J1455 (Aug 94) Section 4.10.3.3	Harness Shock	Y	GF
15.	J1455 (Aug 94) Section 4.11.1.1/4.11.1.2	Operating Voltage	N	

16.	J1455 (Aug 94) Section 5.10.7	Operational Power-Up	N	
17.	J1455 (Aug 94) Section 4.11.1.2	Jumper Start Voltage	Y	
18.	J1455 (Aug 94) Section 4.11.1.2	Steady State Reverse Voltage	N	
19.	EP455 (Feb 03) Section 5.10.4	Short Circuit Protection	Y	
20.	EP455 (Feb 03) Section 5.11.1	Transient Accessory Noise	N	
21.	EP455 (Feb 03) Section 5.11.2	Transient Alternator Field Decay	Y	
22.	EP455 (Feb 03) Section 5.11.3	Transient Batteryless Operation	Y	
23.	ISO 7637-2 (2004) Section 5.6.1	Test Pulse 1 - 24V Transient Inductive Load Switching Power Lines	Y	
24.	ISO 7637-2 (2004) Section 5.6.1	Test Pulse 1 - 24V Transient Inductive Load Switching I/O Lines	Y	
25.	ISO 7637-2 (2004) Section 5.6.5	Transient Load Dump (Test Pulse 5a)	N	
26.	ISO 7637-2 (2004) Section 5.6.3	Transient Mutual Coupling Power Lines (Test Pulse 3a/3b)	N	
27.	ISO 7637-3 (1995 E)	Transient Mutual Coupling Signal Lines (Test Pulse 3a/3b Coupling Clamp)	N	
28.	J1455 (Aug 94) Section 4.11.3.3.2	EMC Susceptibility	Y	
29.	J1455 (Aug 94) Section 4.11.3.3.1	EMC Emissions	Y	
30.	J1455 (Aug 94) Section 4.11.12.2.5	Electrostatic Discharge Operating	Y	
31.	J1455 (Aug 94) Section 4.11.12.2.5	Electrostatic Discharge Handling	Y	

Key: Y=yes, N=no, GF=grandfathered

13.1.1.1. List of Deviations

The following table lists the deviations and notes for each test.

Ref. #	Initial Requirement	Deviation	Reason
1	Min temp: -40 °C Max temp: +120 °C	Min temp: -40 °C Max temp: +85 °C	Design limitation
8	Distance to the UUT 75 cm	Distance to the UUT 50cm	Equipment deviation
15	Rate of voltage change:1V/ms	Actual rate: 1V/s	Not able to monitor impaired function during milliseconds.
17	48 V	36 V	Design limitation
19	16 V	32 V	Unit is designed as 12V/24V product. 32V is more appropriate level.
21	Source impedance 15Ω	Source impedance 10Ω	Equipment limitations
21	Repetition rate 0.2Hz	Repetition rate 0.02Hz	Equipment limitations
22	6 + |12.6sin(2pft)|	12 + |25.2sin(2pft)|	
22	Frequency range: 500Hz-1.5kHz	Frequency range: 800Hz-1.5kHz	Equipment limitations
23/ 24	24V system: V=600V	24V system: V=500V	UUT is 24V system
28/ 29	Test bench size: 2500mmx900mm	Test bench size: 1800mmx800mm	Equipment limitations
28/ 29	UUT and antenna minimum distance from the enclosure: 2m (walls and ceiling)	Actual enclosure size: 3.05x3.05 Biconical Antenna width: 1.35m Log periodic antenna length: 75cm	Equipment limitations
28/ 29	UUT and antenna minimum distance from absorber:1m	Actual enclosure size: 3.05x3.05 Biconical Antenna width: 1.35m Log periodic antenna length: 75cm	Equipment limitations
30/ 31	C=250pF	C=330pF	Harsher test
30/ 31	UUT positioned on a static dissipative mat	UUT positioned on a piece of dielectric foam	ISO 10605 requirement

14. Glossary of Terms

AC-coupled

A circuit that eliminates the DC offset voltage of the signal. This circuit is typically used with frequency inputs that have a DC offset. Note that the DC offset value varies by product.

active-high

Input type that is considered "on" when it reads a battery voltage level and "off" when it is floating or grounded.

active-low

Input type that is considered "on" when it reads a ground voltage level and "off" when it is floating or connected to battery voltage.

aliasing

A situation can arise in digital systems where a sampled analog value produces a measured signal with a frequency that is less than the actual analog signal. Aliasing occurs when the analog signal being sampled has a frequency greater than half the sample rate.

amplified

A circuit that applies a gain with a value greater than one (1) to a measured signal, which is typically used with analog inputs.

analog input

An input that allows a voltage level to be read and converted to discrete digital values within a microprocessor.

anti-alias filtering

Filters incorporated in hardware that ensure the analog value being read by the module does not have a frequency component greater than half the sample rate.

application software

A level of software that makes a product (hardware) perform desired functions for the end user.

attenuation

Decreasing the voltage level of an input signal to maximize the resolution of an input.

CAN

Controller Area Network

CAN High

One of the wires used in the shielded twisted-pair cable, which provides the positive signal that, when connected with CAN Low, provides a complete CAN differential signal.

CAN Low

One of the wires used in the shielded twisted-pair cable, which provides the negative signal that, when connected with CAN High, provides a complete CAN differential signal.

CAN Shield

A shielding that wraps around the CAN High and CAN Low wires (twisted-pair), completing the shielded twisted-pair cable.

CMOS

CMOS stands for Complimentary Metal-Oxide Semi-Conductor

Controller Area Network

A computer network protocol designed for the heavy equipment and automotive environment that allows microcontrollers and other devices to communicate with each other without using a host computer; also known as CAN.

controller I/O board

A development product that allows users to test products on a bench in a development environment before installing the product on a vehicle.

controller module

Any module that has embedded software used for controlling input and output functions.

current feedback

A circuit that allows software to measure the amount of current provided by the outputs. This circuit is typically connected to an analog input that is connected to the microprocessor. Note that current feedback is also known as current sense or current sensing.

current feedback control

Varying the duty cycle of an output so the output provides a desired amount of current to the load.

current sensing

When an analog input reads the amount of current flowing through an output driver circuit.

Data Link Adaptor (DLA)

A development tool that connects the CAN bus to a personal computer (through a USB or RS232 port), so that programming and diagnostics can be performed on the product before installing it in a vehicle.

DC-coupled

A circuit used with signals that have minimal DC offset. The signal being read by this circuit must fall within the detection threshold range specified for the input.

de-rating

To reduce the rated output current level to a value less than the specified rating. De-rating is typically done so a product does not over-heat.

digital input

An input that is typically controlled by an external switch that makes the input either active (on), or inactive (off).

driver (hardware)

An electronic device that switches power or ground to an external load. The driver is a key component used in all output circuits.

driver (software)

A block of software that provides access to different hardware components.

FET

Field Effect Technology

Field Effect Transistor (FET)

An electronic device used either as a power switch, or amplifier in electronic circuitry. FETs are typically used as drivers.

frequency input

An input that allows a frequency value to be read from an oscillating input signal.

gain

Increasing the voltage level of an input signal to maximize the resolution of an input.

ground shift

The difference in ground potential from one harness location to another, which is typical in systems with large wire harnesses and high current loads.

half-bridge

When a high-side and low-side switch are used together to provide a load with both a battery voltage and a ground.

H-bridge

A combination of two half-bridge circuits used together to form one circuit. H-bridges provide current flow in both directions on a load, allowing the direction of a load to be reversed.

high-side output

An output that provides switched battery voltage to an external load.

hysteresis

Causes the activation and deactivation voltage levels on an input to overlap, which ensures the input only changes state when there is a significant shift in voltage.

inductive load

A load that produces a magnetic field when energized. Inductors are electrical components that store energy and are characterized by the following equation:

$$E_{\text{stored}} = \frac{1}{2}LI^2$$

load

Any component that draws current from the module, and is typically switched “on” and “off” with outputs. Examples include bulbs, solenoids, motors, etc.

logic power

Power pins for the microprocessor and logic peripherals.

low-side output

An output that provides a switched ground voltage to an external load.

Nyquist Criterion

The Nyquist criterion states that to avoid aliasing, ensure your analog input sample rate is greater than twice the frequency of your analog signal.

open load

A fault state that occurs when a load that should be connected to an output becomes disconnected, which typically occurs because of a broken/worn wire in the wire harness or a broken/worn connector pin.

over-current

A fault state that occurs when a load draws more current than specified for an output, which results in the output shutting down to protect the circuitry of the product.

over-voltage

When the voltage exceeds the normal operating voltage of the product, which results in the VMM3120 shutting down to protect its circuitry.

power control input

A digital input that is used to turn on the product. When the input is active, the product "turns on” and operates in normal mode, and when the input is inactive, the product “powers down” and will not operate.

procurement drawing

A mechanical drawing showing the dimensions, pin-outs, and implemented configuration options for a Parker Vansco product.

Proportional Integral Differential (PID)

This refers to the proportional-integral-differential closed-loop control algorithm.

pull-down

A resistor that connects an input to a ground reference so that an open circuit can be recognized by the microprocessor, which is typically used on active-high digital inputs or analog inputs.

pull-up

A resistor that connects an input to a voltage reference so that an open circuit can be recognized by the microprocessor, which is typically used on active-low digital inputs or analog inputs.

Pulse Width Modulation (PWM)

A type of square wave frequency signal where the ratio of “on” time vs. “off” time is determined by the duty cycle of the signal. The duty cycle refers to the percent of time the square wave is “on” vs. “off”. PWM signals are typically used to drive varying amounts of current to loads, or to transmit data.

sensor power

A regulated voltage output that provides a set voltage level for analog sensors attached to the product.

shielded twisted-pair cable

A type of cable used for CAN communication that consists of two wires (CAN High and CAN Low) twisted together. These wires are covered by a shield material (CAN Shield) that improves the cable's immunity against electrical noise.

short-to-battery

A fault state that occurs when an input or output pin on the product is connected to battery power, potentially resulting in high current flow.

short-to-ground

A fault state that occurs when an input or output pin on the product is connected to system ground, potentially resulting in high current flow.

system noise

Electrical interference generated from external devices that affect the behaviour of inputs, outputs and sensors. System noise can be generated from things like the vehicle alternator, engine, transmission, etc.

trip time

The amount of time it takes a circuit to protect itself after a fault occurs.

Wake on CAN

A method of power control that makes the product turn on when a CAN message is received from another module in the system, and turn off as determined by the application software.

wetting current

The amount of current that flows into, or out of, a digital input. The current helps eliminate oxidation on the contacts of digital switches and relays. Switches with gold or silver contacts typically require much less wetting current than standard tinned contacts.

15. Index

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