Vansco Multiplexing Module

VMM0604

User Guide

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Contents

Publication History

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

Revision	Description of Change
Rev. 001	First release of this document
Rev. 002	Updated template and minor edits

Safety

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

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

The term "manufacturer" refers to Parker Hannifin Corporation.

Safety symbols

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

Danger! Risk of death or injury.

Warning! Risk of damage to equipment or degradation of signal

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

General safety regulations

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

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

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

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

Welding after installation

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

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

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

Construction regulations

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

Safety during installation

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

Safety during start-up

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

Safety during maintenance and fault diagnosis

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

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

1. Understanding the VMM0604

The Vansco Multiplexing Module (VMM) 0604 is a software-programmable, multiplexing, input/output controller that monitors dedicated and general-purpose inputs, and controls solid-state-switch outputs.

The VMM modules can be configured to meet many system requirements through I/O configuration options and ladder logic software.

Figure 1: VMM0604

The VMM0604 is designed to communicate through a J1939-based Controller Area Network (CAN). Custom CAN messaging can be created in software, and the VMM0604 can be used in any CAN 2.0B application.

The VMM0604 is controlled by Ladder Logic software.

- You can write the software in ladder logic using the Vansco Multiplex Module Software (VMMS) tool. Contact your Parker Vansco Account Representative for more details about the VMMS.

The VMM0604 has many features, as follows:

- The VMM0604 can monitor up to 12 inputs:
  - 6 general purpose inputs (can be used as digital, analog, or frequency).
  - 5 digital inputs (active low inputs used for addressing).

    - 1 power control input.
- The VMM0604 has 8 outputs, rated at 3 A maximum current:
    - 4 high-side outputs.
    - 4 low-side outputs (these outputs monitor current, and can be used for current feedback if a high-side output is used for pulse-width modulation).
- The VMM0604 has one 35-pin Ampseal connector that is used to interface with the inputs, outputs, and CAN.
- The VMM0604 has 12 diagnostic LEDs that are used to indicate the state and fault status of inputs, outputs, power, and CAN.
- The VMM0604 can detect and log the following faults on the outputs:
    - Short-circuit
    - Overcurrent
    - Open load
    - Short-to-battery
    - Short-to-ground

2. About the VMM0604 User Guide

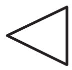
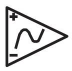
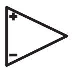
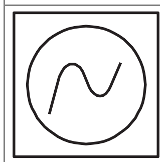
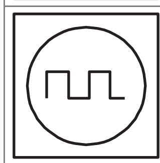
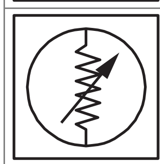
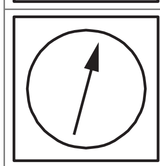
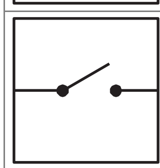
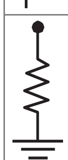
The VMM0604 is designed to be used with configuration (stuffing) options, where specific customer requirements are met by modifying components and component values on a project by project basis. The manual cannot address all of the configurations that are possible - but only focuses on the most commonly used configuration.

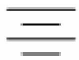
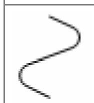
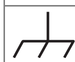
The configuration in this manual has 1 CAN bus, 5V sensor supply and status LEDs.

This manual describes the hardware components of the VMM0604, 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.

2.1. Diagram conventions

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

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

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

3. Quick Start

This section provides step-by-step instructions on how to connect the VMM0604 multiplexing module to a development system, install the required software tools, and download the application software.

3.1. 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 VMM0604 to a development system (desktop) and power it up.
4. Download application software.

3.2. Gather Required Materials

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

- VMM0604 multiplexing module
- personal computer (PC)
- controller I/O board
- controller I/O harness (connects the VMM0604 to the controller I/O board)
- evaluation kit power harness (connects the controller I/O board to the power supply)
- Data Link Adapter (DLA) kit (comes with cables needed for connecting the DLA to your PC and to the rest of the system)
- desktop power supply compatible with the VMM0604 and controller I/O board loads (a 12 V DC, 3 A fixed voltage supply is generally suitable, unless driving more significant loads)
- procurement drawing for the version of VMM0604 you are using, indicating the configuration options for your variant of the product.

- software tools and files required for programming and downloading software for the VMM0604.

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

3.3. Install the Required Software Tools

Before using the VMM0604 multiplexing module, install the following software tools onto your PC:

- Data Link Adapter (DLA) drivers
  - The DLA acts as the interface between the PC and the VMM0604. 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 VMM0604 multiplexing module. Contact your Parker Vansco Account Representative, or visit the Parker website to get further information on how obtain a product key.

3.3.1. Install the Data Link Adapter Driver Software

A Data Link Adapter (DLA) is needed when connecting the VMM0604 multiplexing module in a development system.

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

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

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

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

3.4. Connect the VMM0604 multiplexing module to a Development System

It is a good idea to connect the VMM0604 multiplexing module to a development system (PC, Controller I/O Board, power source, and DLA) to verify your application. The development system is an ideal environment for creating and downloading software applications.

The following shows how to connect the VMM0604 multiplexing module in a development system:

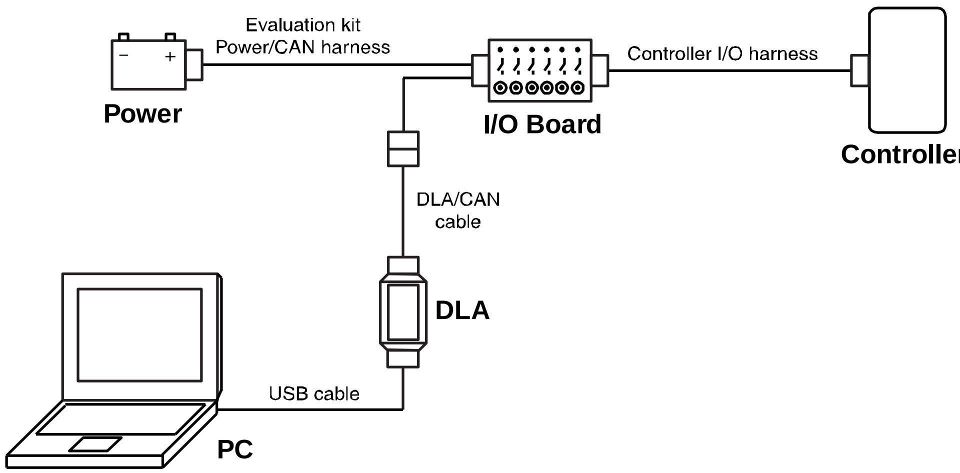


Figure 2: Development system connection

To connect the VMM0604 multiplexing module in a development system, do the following:

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

1. Connect the Controller I/O harness to the VMM0604 multiplexing module.
2. Connect the Controller I/O harness to the controller I/O board connectors.
3. Connect the evaluation kit power/CAN harness to the controller I/O board's JP3 connector.
4. Do **not** connect the power wire (RED) from the evaluation kit power/CAN harness to the power supply (+) terminal at this time.
5. Connect the ground wire (BLACK) from the evaluation kit power/CAN harness to the power supply (-) terminal.
6. Connect the CAN connector from the evaluation kit power/CAN harness to the corresponding mating connector and harness on the DLA.

   Note: Do not proceed to the next step before the DLA drivers have been installed. See *Install the Data Link Adapter Driver Software* on page 16.

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

3.4.1. Power Up the Development System

Once the VMM0604 is connected in a development system, you need to power it up.

To power up the VMM0604 multiplexing module, do the following:

1. Ensure all controller I/O board digital inputs, jumpers, and dip switches are properly configured for the VMM0604. Refer to the *Controller I/O Board Reference Manual* for further details.
2. Connect the power wire (red) from the evaluation kit power/CAN harness to the power supply (+), and turn the power supply on.
3. Turn on the controller I/O board switch that corresponds with the power control input on the VMM0604 (refer to the *Controller I/O Board Reference Manual* for details). The VMM0604 will power up.

Note: If the module does not power up and you are unsure if a power control input is set on the VMM0604, try switching all the inputs on the controller I/O board to high, and then to low. If you continue to have problems, consult the Troubleshooting/FAQ section in the *Controller I/O Board Reference Manual* for help.

3.5. Create and Download Ladder Logic Applications

Software applications can be created and downloaded to the VMM0604 multiplexing module.

The software applications for the VMM0604 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.

4. Inputs

The VMM0604 has 3 types of inputs

- Active high wake up input for power control
- General purpose inputs type 1 that may be configured as analog, frequency, and active low digital inputs.
- General purpose inputs type 2 that may be configured as analog, frequency, and active high digital inputs.

⚠ ***Damage to equipment!*** Do not connect inputs directly to unprotected inductive loads such as solenoids or relay coils, as these can produce high voltage spikes that may damage the VMM0604. If an inductive load must be connected to an input, use a protective diode or transorb.

4.1. Programmable Multi-Purpose Inputs

The VMM0604 has programmable multi-purpose inputs that can be configured either as analog, digital, or frequency (ADF) through software, as follows:

- INPUT1_ADF through INPUT6_ADF

The following table provides the voltage ranges for the VMM0604 general purpose inputs:

Table 1: General Purpose Input Voltage Ranges

Max Input Voltage	DC Freq Low Min	DC Freq High Max	AC Freq Min	Analog Resolution	Very Weak Pull-Down
0.60 V	0.16 V	0.40 V	250 mVpp	0.59 mV	No
0.75 V	0.20 V	0.50 V	250 mVpp	0.73 mV	No
1.50 V	0.40 V	1.00 V	250 mVpp	1.47 mV	No
3.00 V	0.80 V	2.00 V	250 mVpp	2.93 mV	No
3.11 V	0.83 V	2.08 V	250 mVpp	3.05 mV	Yes
3.89 V	1.04 V	2.59 V	250 mVpp	3.80 mV	Yes
4.05 V	1.08 V	2.70 V	250 mVpp	3.96 mV	Yes
5.07 V	1.35 V	3.38 V	250 mVpp	4.96 mV	Yes
6.57 V	1.75 V	4.38 V	250 mVpp	6.41 mV	Yes
7.80 V	2.08 V	5.19 V	250 mVpp	7.61 mV	Yes
8.21 V	2.19 V	5.48 V	250 mVpp	8.04 mV	Yes
10.14 V	2.70 V	6.76 V	250 mVpp	9.91 mV	Yes
15.59 V	4.17 V	10.42 V	250 mVpp	15.28 mV	Yes
16.44 V	4.40 V	10.99 V	250 mVpp	16.11 mV	Yes
20.29 V	5.41 V	13.51 V	250 mVpp	19.81 mV	Yes
32.88 V	8.79 V	21.98 V	250 mVpp	32.23 mV	Yes

4.1.1. Multi-Purpose Used as Programmable Digital Input

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

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

- INPUT1_ADF to INPUT6_ADF

Note: There are 6 other digital inputs in addition to these inputs (refer to *Digital Inputs* on page 33 for more details).

4.1.1.1. Digital Input Capabilities

The following table provides specifications for the VMM0604's standard digital inputs:

Table 2: Digital Input Specifications

Item	Min	Nom	Max	Unit
Input voltage range	0	-	32	V
Pull-up / down resistance	3.1 k	-	3.5 k	Ω
Minimum negative going threshold	1.3	-	-	V
Maximum positive going threshold	-	-	3.4	V
Cutoff frequency *(hardware)*[1]	-	12	-	kHz
De-bounce time *(software)*[2]	25	-	50	ms
Overvoltage	-	-	36	V
Wetting current @ 12 V	3.43	-	3.87	mA
Amplifier *gain*[3]	-	0.592	-	V/V
Leakage current sleep mode - pin @ 12 V	-	-	4.1	mA

4.1.1.2. Digital Input Configuration Options

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

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

4.1.1.3. Active-High Digital Input Connections

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

- When an active-high switch is open, the pull-down resistor ensures that no voltage exists on the input signal, which will be interpreted by the VMM0604 as inactive.
- When the switch is closed, the input is connected to battery voltage, which will be interpreted by the VMM0604 as active.

[1] Assumes there is a zero ohm source impedance from driving source. The actual cutoff in the application will be partially determined from the source impedance and VMM input capacitance.
[2] De-bounce time is based on a sampling rate of 40 Hz.
[3] Amplifier gain on digital inputs is only adjustable in "black box" software. It is only pre-set to the value in the table if using ladder logic.

For an input that is active-high

- It must be connected to battery power so that 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.

A typical active-high digital input connection is shown below:

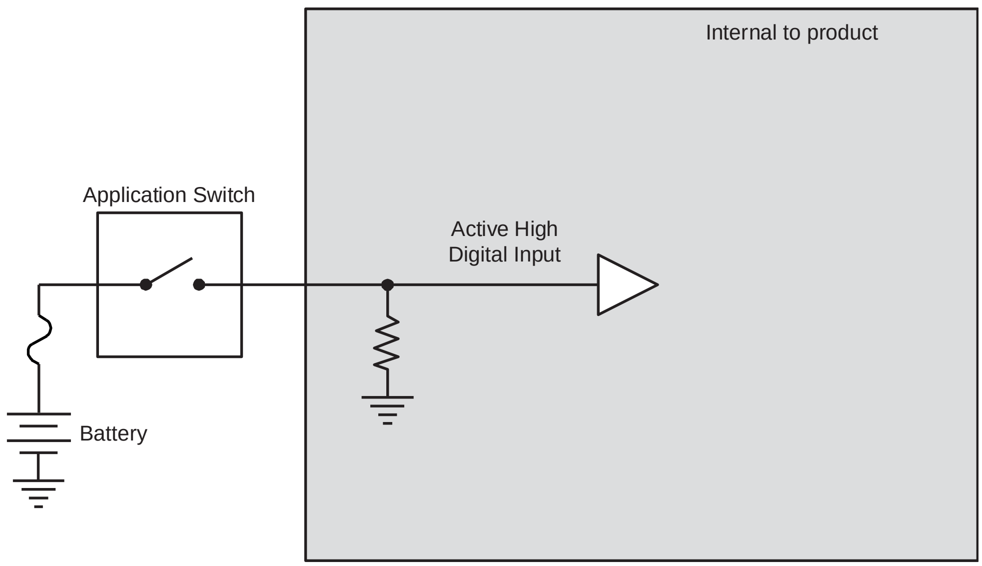


Figure 3: Active high digital input

4.1.2. Multi-Purpose Used as Analog Input

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

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

- INPUT1_ADF to INPUT6_ADF

4.1.2.1. Analog Input Capabilities

The following table provides specifications for the VMM0604 analog inputs:

Table 3: Analog Input Specifications

Item	Min	Nom	Max	Unit
Input voltage range	0	-	32	V
Overvoltage	-	-	36	V
Pull-up / down resistance	3.1 k	-	3.5 k	Ω
Input resistance – pull-up/pull-down disabled	74 k	-	-	Ω
Input capacitance	9	10	11	nF
Cutoff frequency *(hardware)*[4]	-	12	-	kHz
Accuracy	-	-	3	%
Resolution[5]	4.375	-	4.422	mV
Analog gain	-	Program-mable	-	V/V
Reference voltage	2.984	3.0	3.016	V
Leakage current sleep mode - pin @ 12 V	-	-	4.1	mA

[4] Assumes there is a zero ohm impedance from driving source. The actual cutoff in the application will be partially determined from the source impedance and VMM input capacitance.
[5] 10 bit ADC at worst case reference voltage, with 0.5 LSB fault.

4.1.2.2. Analog Input Configuration Options

If one of the VMM0604's general purpose inputs is configured as an analog input, the input will be converted by the microprocessor using a 10-bit analog to digital converter (ADC) that is referenced to **3.0 V**.

There are **16 programmable gain and attenuation factors** that allow you to optimize the voltage resolution for each analog input, by converting the maximum external voltage signal expected on an analog input to as close to 3.0 V as possible.

Note: The attenuation and gain columns in the table represent the state of the two attenuation transistors and two gain transistors on each analog input circuit.

The pull-up or pull-down for analog 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.

Table 4: Gain and Attenuation Factors

Amp Gain	Max Voltage	Attenuation 1	Attenuation 2	Gain 1	Gain 2
5.008	0.599	OFF	OFF	ON	ON
4.005	0.749	OFF	OFF	OFF	ON
2.000	1.5	OFF	OFF	ON	OFF
1	3	OFF	OFF	OFF	OFF
0.963	3.115	ON	OFF	ON	ON
0.771	3.893	ON	OFF	OFF	ON
0.740	4.053	OFF	ON	ON	ON
0.592	5.065	OFF	ON	OFF	ON
0.457	6.569	ON	ON	ON	ON
0.385	7.796	ON	OFF	ON	OFF
0.365	8.209	ON	ON	OFF	ON
0.296	10.144	OFF	ON	ON	OFF
0.192	15.591	ON	OFF	OFF	OFF
0.182	16.440	ON	ON	ON	OFF
0.148	20.286	OFF	ON	OFF	OFF
0.091	32.877	ON	ON	OFF	OFF

4.1.2.3. Analog input connections

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

System noise

To prevent noise pickup on the sensors,

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

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

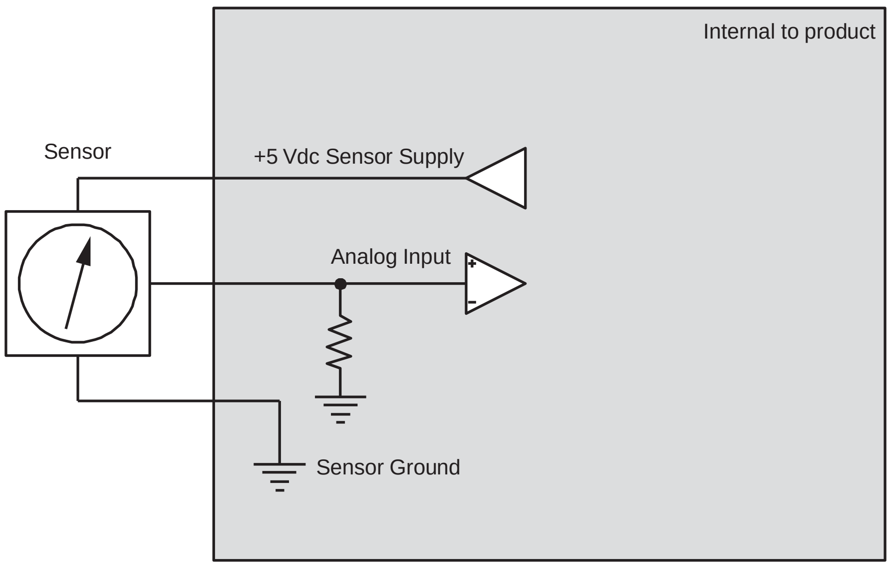


Figure 4: Analog input system noise reduction

Ground level shift

To reduce ground level shift:

1. Dedicate one of the 4 system ground inputs (GND) to sensors that have dedicated ground wires, and connect all sensor grounds to this system ground input.
2. Splice the other system ground inputs together in the vehicle harness (close to the connector) to provide a better ground for the noisier low-side outputs and digital circuits.

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

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

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

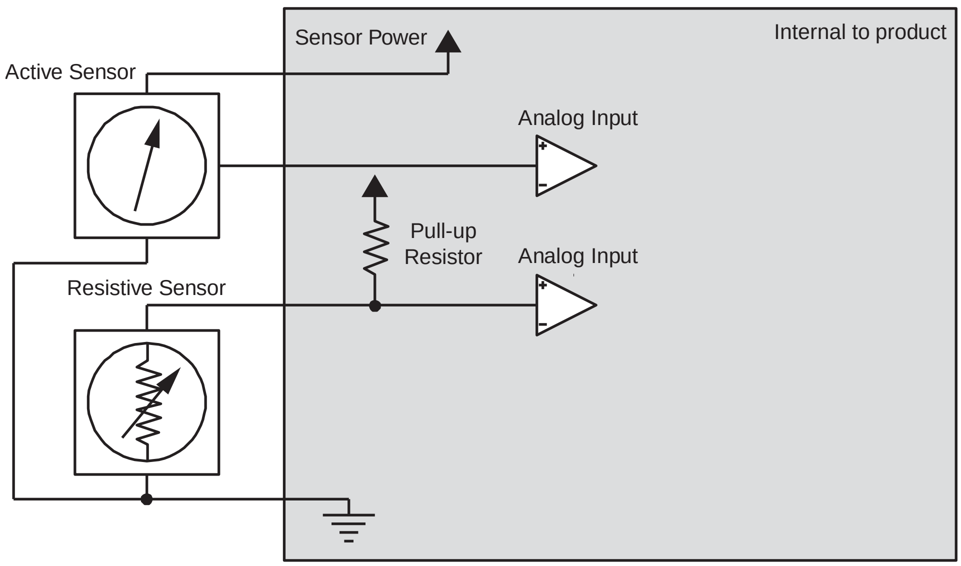


Figure 5: Analog input ground shift connection for sensors that have dedicated ground wires

4.1.3. Multi-Purpose Used as AC-Coupled Frequency Input

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

- INPUT1_ADF and INPUT2_ADF

4.1.3.1. 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.

Note: 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 VMM0604 general purpose inputs when used as AC-coupled frequency inputs:

Table 5: AC-Coupled Frequency Input Specifications

Item	Min	Nom	Max	Unit
Input voltage *range*[6]	-90	-	90	V
Pull-up / down resistance	3.1 k	-	3.5 k	Ω
Input resistance – pull-up/pull-down disabled	74 k	-	-	Ω
Input capacitance	9	10	11	nF
AC-coupling capacitance	-	0.3	-	uF
Frequency range @ 0.25 Vp-p	5	-	10000	Hz
Accuracy	-	-	5	%
Resolution	0.1	-	-	Hz
Switching threshold *voltage*[7]	-	1.65	-	V
Leakage current sleep mode - pin @ 12 V	-	-	4.1	mA

4.1.3.2. AC-Coupled Frequency Input Configuration Options

AC-coupled frequency inputs have 16 programmable gain and attenuation factors.

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.

[6] Input voltage range assumes that the inductive pickup will increase in voltage as flywheel speed increases. Analog input pull-up configuration options must be selected accordingly to prevent damage on those components at these voltage extremes.
[7] The switching threshold on AC-coupled inputs is not programmable, and is set internally to ensure proper conversion of the input signal through a comparator circuit. The value given in the table is not a physical value on the product's input pin.

4.1.3.3. AC-Coupled Frequency Input Connections

When connecting AC-coupled frequency inputs, be aware of system noise and ground level 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 Level Shift

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

To reduce ground level shift:

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

Note 1: The VMM0604 system ground inputs are rated for low-current signals, which ensures the sensor’s ground is very close in voltage potential to the system ground.

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

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

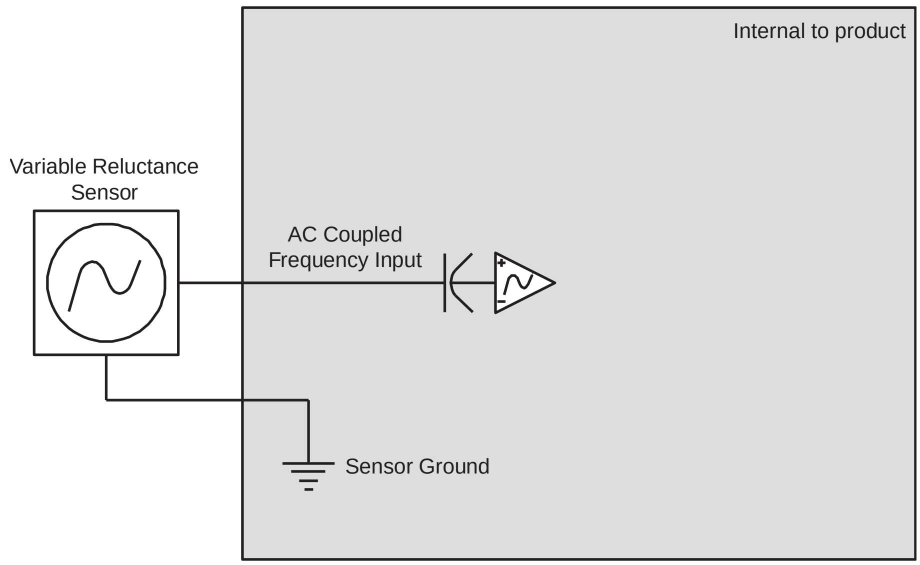


Figure 6: AC-coupled frequency input installation connections

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

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

- INPUT3_ADF to INPUT6_ADF

4.1.4.1. 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.

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

The following table provides specifications for the VMM0604 general purpose inputs when used as DC-coupled frequency inputs:

Table 6: DC-Coupled Frequency Input Specifications

Item	Min	Nom	Max	Unit
Input voltage range	0	-	32	V
Pull-up / down resistance	3.1 k	-	3.5 k	Ω
Input resistance – pull-up/pull-down disabled	74 k	-	-	Ω
Input capacitance	9	10	11	nF
Frequency range @ 0.25 Vp-p	1	-	10000	Hz
Accuracy	-	-	5	%
Resolution	0.1	-	-	Hz
Switching threshold voltage (software)	-	Program-mable	-	V
Leakage current sleep mode - pin @ 12 V	-	-	4.1	mA

4.1.4.2. DC-Coupled Frequency Input Configuration Options

DC-coupled frequency inputs have 16 programmable gain and attenuation factors, as indicated in Table 3.

The pull-up or pull-down resistors for DC-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.

4.1.4.3. DC-Coupled Frequency Input Connections

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

System Noise

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

To reduce system noise:

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

Ground Level Shift

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

To reduce ground level shift:

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

Note 1: The VMM0604 system ground inputs are rated for low-current signals, which ensures the sensor's ground is very close in voltage potential to the system ground.

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

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

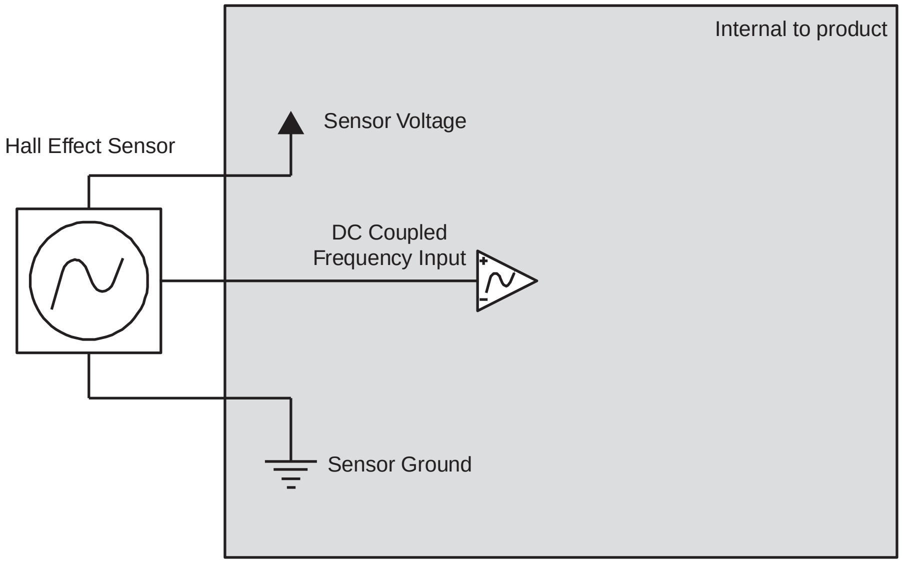


Figure 7: DC-coupled frequency input installation connections

4.2. Digital Inputs

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

There are three types of digital inputs in the VMM0604:

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

4.2.1. Programmable Digital Inputs

The general purpose inputs can be used as programmable digital inputs. Refer to *Multi-Purpose Used as Programmable Digital Input* on page 21 for more details.

4.2.2. Power Control Digital Inputs

The VMM0604 has 1 active high digital input dedicated to power control that is used for waking up (turning on) the product, called `POWER_CONTROL`.

4.2.2.1. Power Control Digital Input Capabilities

The VMM0604 has an active high power control digital input that must be activated to power up the VMM0604.

Note: 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 VMM0604 when switched high to a voltage of 4.0 V or greater, and puts the VMM0604 in sleep mode (turns it off) when switched low to a voltage less than 1.7 V. The VMM0604 will also go into sleep mode when an open circuit condition occurs on the power control digital input.

The following table provides specifications for the power control digital input:

Power Control Digital Input Specifications				
Item	**Min**	**Nom**	**Max**	**Unit**
Input voltage range	0	-	32	V
Pull-down resistance	3.1 k	-	3.5 k	Ω
Minimum negative going threshold	2.14	-	-	V
Maximum positive going threshold	-	-	4.0	V
Power-up threshold	-	1.7	-	V
Cutoff frequency *(hardware)*[8]	-	85	-	Hz
De-bounce time *(software)*[9]	25	-	50	ms
Overvoltage	-	-	36	V
Wetting current @ 12 V	3.43	-	3.87	mA
Leakage current sleep mode - battery @ 12 V	-	-	200	uA

4.2.2.2. Power Control Digital Input Installation Connections

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

- 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 VMM0604 to the ignition, place a fuse of 200 mA or higher in the circuit that feeds the VMM0604.
- If your VMM0604 must always be powered, the power control digital input can be directly connected to a fused battery power input (called VBATT), which will provide constant power.
- When battery power (VBATT) is connected, and the power control digital input is inactive, the VMM0604 will go into sleep mode.

[8] Assumes there is a zero ohm source impedance from driving source. The actual cutoff in the application will be partially determined from the source impedance and VMM input capacitance.
[9] De-bounce time is based on a sampling rate of 40 Hz.

The following shows a typical power control digital input connection:

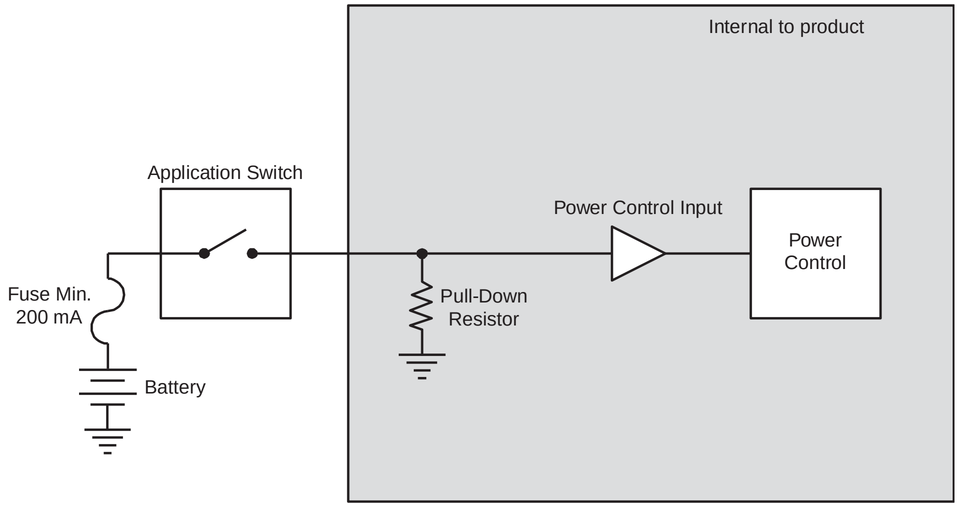


Figure 8: Power control digital input installation connections

4.2.3. Addressing Digital Inputs

The VMM0604 has 5 active low digital inputs that are used for module addressing on the CAN network:

- ADDR1 to ADDR5

4.2.3.1. Addressing Digital Input Capabilities

The following table provides specifications for the VMM0604 addressing digital inputs:

Addressing Digital Input Specifications				
Item	**Min**	**Nom**	**Max**	**Unit**
Input voltage range	0	-	32	V
Overvoltage	-	-	36	V
Pull-up resistance	9.8 k	-	10.2	kΩ
Minimum negative going threshold	0.9	-	-	V
Maximum positive going threshold	-	-	2.15	V
Cutoff frequency (hardware)	-	80	-	Hz
De-bounce *time*[10]	-	-	-	ms
Wetting current	316	-	343	uA
Leakage current sleep mode - pin grounded or floating	-	0	-	A

[10] De-bounce time for address inputs is based on hardware cutoff frequency. The software reads the address in succession during power-up until it receives two consecutive results that are the same. The time between readings is in the microsecond range so there is technically no software de-bounce on these inputs.

4.2.3.2. Addressing Digital Input Connections

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.

The inputs are all active low inputs with 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 (connected to ground), and those that are floating.

VMM system addressing (active=1, floating=0)					
Address Inputs					
5	4	3	2	1	VMM address
0	0	0	0	0	VMM1
0	0	0	0	1	VMM2
0	0	0	1	0	VMM3
0	0	0	1	1	VMM4
0	0	1	0	0	VMM5
|	|	|	|	|	|
1	1	1	1	0	VMM31

Note: Address 32 is reserved and therefore may not be used in a system design.

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

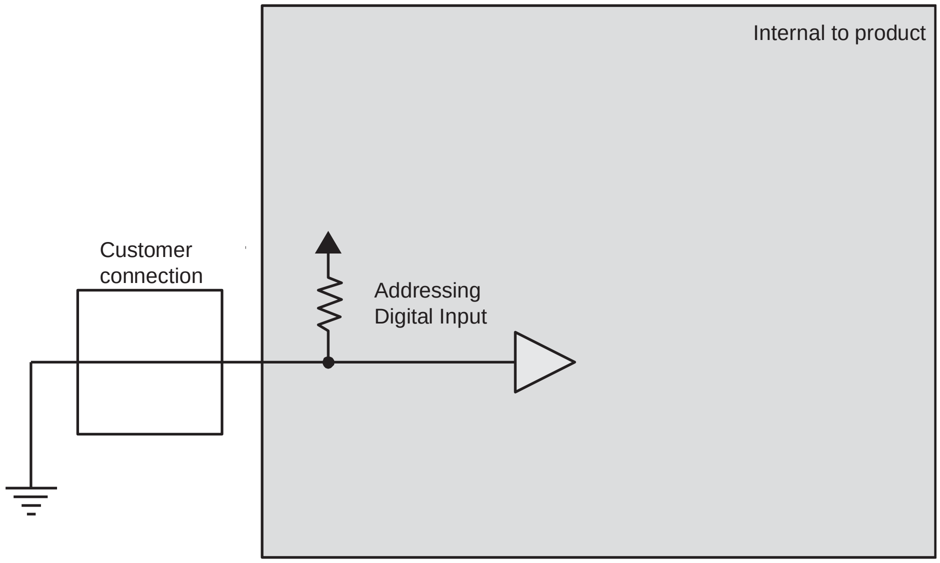


Figure 9: Addressing digital input connections

5. Outputs

The VMM0604 has 8 solid-state FET technology outputs designed for low to medium current and high inrush inductive load switching. Output currents can range up to 3.0 A.

The VMM0604 has 2 types of outputs:

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

Note: 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).

5.1. VMM0604 High-Side Outputs

The VMM0604 has 4 high-side outputs:

- `OUTPUT1_3A_HS` to `OUTPUT4_3A_HS`

5.1.1. High-Side Output Capabilities

High-side outputs are used for switching voltages 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 (see High-Side Output Diagnostics and Fault Protection 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 VMM0604, 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).

High-Side Output Specifications				
Item	**Min**	**Nom**	**Max**	**Unit**
Operational voltage range	6	-	32	V
Overvoltage	-	-	36	V
Output current range	0	-	3	A
Load impedance @ 12 V	4	-	-	Ω
PWM frequency	5	-	500	Hz
PWM *resolution*[11]	-	0.1	-	%
Flyback diode *current*[12]	-	-	1	A
Short-circuit current limit (Tjunc = -40ºC to +150ºC)	9	15	23	A
Short-circuit trip time	-	2	-	ms
Thermal protection	-	150	-	ºC
Digital feedback negative threshold	1.5	-	-	V
Digital feedback positive threshold	-	-	3.58	V
Digital feedback cutoff frequency	-	26	-	kHz
Open-load detection – max detectable load @ 12 V	-	-	1.4 k	Ω
Open-load detection pull-up	9.8 k	-	10.2	kΩ
Current sensing	-	No	-	-
Analog feedback	-	No	-	-

5.1.2. High-Side Output Installation Connections

When connecting high-side outputs, note that

- High-side outputs are connected to an internal bus bar, which is connected to the battery. The bus bar is also 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 3.0 A max.
- 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).

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

[11] This is the typical value. Actual value is dependent on the base frequency, since the counter used for this operation has a finite number of steps.
[12] This is an average current value, meaning a worst case PWM current of 2 A at 50% duty cycle is possible with inductive loads.

of 50% will produce the worst case average current flow through these two devices.

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

When connecting high-side outputs, 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 VMM0604 power grounds.

The following shows a typical high-side output connection:

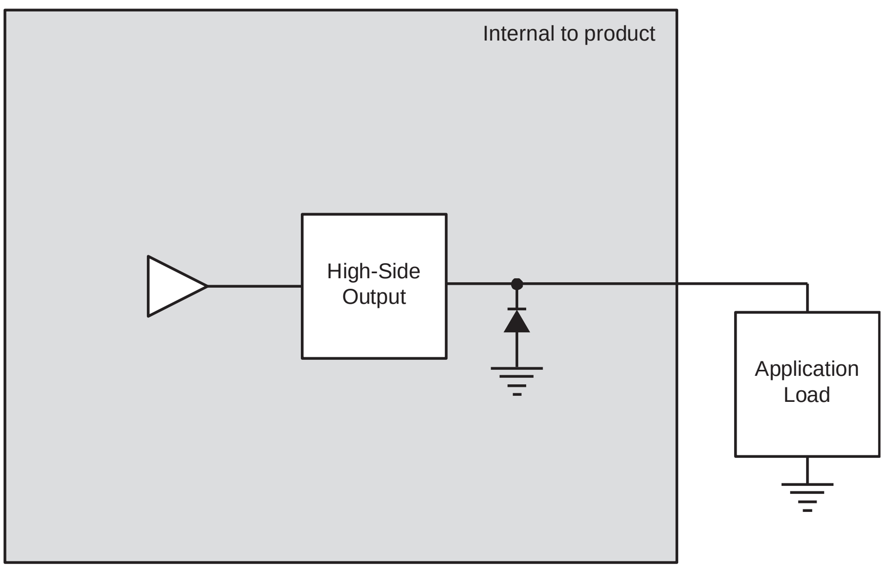


Figure 10: Typical high-side output installation connections

5.1.3. High-Side Output Diagnostics and Fault Protection

The VMM0604 high-side outputs have the ability to report many different fault conditions. They are protected against short-circuit and overcurrent, open load, and short-to-battery faults.

Note: The VMM0604 LEDs can be used to indicate output fault status through the application software.

5.1.3.1. Short Circuit

Short-circuit faults occur when a high-side output pin is shorted to ground. Refer to the VMM0604 Platform Framework API document distributed with the SDK for details on how to recover from a short circuit.

5.1.3.2. 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 in the VMM0604 Platform Framework API document distributed with the SDK.

Note: Low-side outputs must be on to detect an open-load fault.

5.1.3.3. 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.

Note: To detect a short-to-battery fault, high-side outputs must be off.

5.2. VMM0604 Low-Side Outputs with Current Sense

The VMM0604 has 4 low-side outputs:

- `OUTPUT5_3A_LS` to `OUTPUT8_3A_LS`

5.2.1. 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 VMM0604, 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.

Note: 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.
    - 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 overcurrent 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 VMM0604 low-side outputs:

Low-Side Outputs with Current Sense Specifications				
Item	**Min**	**Nom**	**Max**	**Unit**
Operational voltage range	0	-	32	V
Overvoltage	-	-	36	V
Output current range	0	-	3	A
Load impedance @ 12 V	-	4	-	Ω
PWM	-	No	-	-
Short-circuit protection	-	Yes	-	-
Thermal protection	-	No	-	-
Analog feedback gain (current sense) - programmable	6.008 (0.6)	Program-mable	10 (1)	V/V (V/A)
Analog feedback cutoff frequency @ min gain	-	12	-	Hz
Current sense resistance	0.099	-	.101	Ω
Current sensing resolution - 0 to 3 A range	-	5	14.5	mA
Current sensing resolution - 0 to 2 A range	-	3	8.7	mA
Current sensing accuracy	-	-	3.5	%
Short-circuit trip time	-	-	500	us
Short-circuit current limit	-	14	-	A
Overcurrent trip point - 0 to 3 A range	-	3.1	-	A
Overcurrent trip point - 0 to 2 A range	-	2.1	-	A
Overcurrent trip time	-	1	-	s
Open-load detection	-	No	-	-
Digital feedback	-	No	-	-

5.2.2. Low-Side Outputs with Current Sense Configuration Options

There are two programmable gain and attenuation factors that allow you to convert the maximum voltage expected on the low-side outputs to as close to 3.0 V as possible (to optimize the voltage resolution).

Gain and Attenuation for Low-Side Outputs with Current Sense			
Amp Gain	**Max Current (A)**	**Attenuation 1**	**Gain 1**
6.008	5	ON	ON
10	3	OFF	OFF

5.2.3. Low-Side Outputs with Current Sense Installation Connections

When connecting low-side outputs, note that

- Low-side outputs are connected to a common internal ground point that is connected to the battery ground (GND).
- Low-side outputs provide switched ground to any load type in a vehicle.
- Low-side outputs can sink up to 3.0 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:

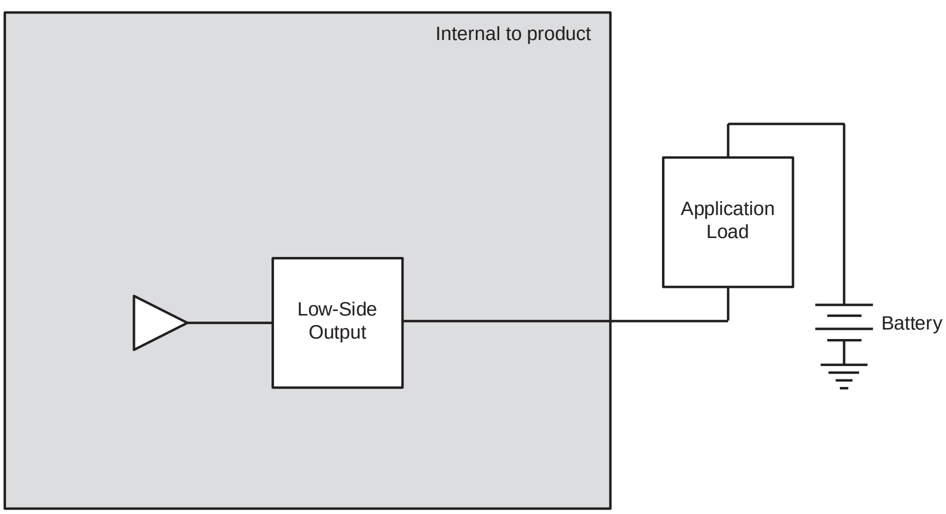


Figure 11: Typical low-side output connection

5.2.4. Low-Side Outputs with Diagnostics and Fault Protection

The VMM0604 low-side outputs have the ability to report many different fault conditions, and are protected against short-circuit, overcurrent, and short-to-ground faults.

Note: The VMM0604 diagnostic LEDs indicate the output's status.

5.2.4.1. Short-Circuit

Short circuit faults occur when a low-side output pin is shorted to battery. For details on how to recover from a short circuit refer to the VMM0604 Platform Framework API document distributed with the SDK.

5.2.4.2. Overcurrent

Overcurrent faults occur when a low-side output pin draws more current than the specified overcurrent trip point.

When an overcurrent fault is detected, the hardware automatically turns off the output.

The overcurrent trip time for low-side outputs is approximately 1 second.

Note: The VMM0604 can be programmed to automatically reset an output from an overcurrent fault.

5.2.4.3. 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.

6. Power

The VMM0604 is powered by the vehicle battery. The VMM0604 operates in a 12 V or 24 V system, and can operate from 6 V up to 32 V, with over-voltage protection at 36 V.

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

6.1. Logic and output power

The VMM0604 has 3 pins, labeled VBATT, dedicated to providing power for logic and outputs, and 4 pins, labeled GND, dedicated to grounding the VMM0604.

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

6.1.1. 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 300 mA.

Output power provides power to the output circuits through a battery or ground connection. Each output circuit can draw a maximum of 3 A.

The following table provides specifications for the VMM0604 logic and output power:

Logic and Output Power Specifications				
Item	**Min**	**Nom**	**Max**	**Unit**
Input voltage range	6	-	32	V
Overvoltage	-	-	36	V
Current draw in on state (excluding outputs)	-	-	300	mA
Current draw in on state (including outputs)	-	-	13	A
Current draw in sleep *mode*[13]	-	-	1	mA
Inline fuse required on power pins (ATO *style)*[14]	-	25	-	A
Number of power pins	-	3	-	-
Number of ground pins	-	4	-	-

6.1.2. Logic and output power connections

When connecting the VMM0604 logic and output power, note that:

- Logic and output power connections are made using the VBATT and GND pins.
- When there are multiple output power pins, the number of wires needed to connect the VMM0604 power depends on the amount of current required by the application.
  - It is recommended that you use the largest AWG wire allowed by your connector for the VBATT and GND pins, to meet the amount of expected output current; however, this is not always true and depends on your application.
- The VMM0604 is protected against reverse-battery connections by an internal high-current conduction path that goes from ground to power. To protect the VMM0604 from damage in a reverse-battery condition, place a fuse of 25 A or less in series with the power wires in the application harness.

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

- All power connections to the VMM0604 should be fused to protect the vehicle harness.

[13] Assumes there is no current flow through input or output connections in harness. Either active high inputs are not connected to battery during sleep mode, or active-low inputs are not connected to ground during sleep mode.
[14] This is required to ensure proper reverse battery protection on the module. Failure to include this fuse in the end application harness could result in damage to the module and/or the application harness.

The following shows a typical logic and output power connection:

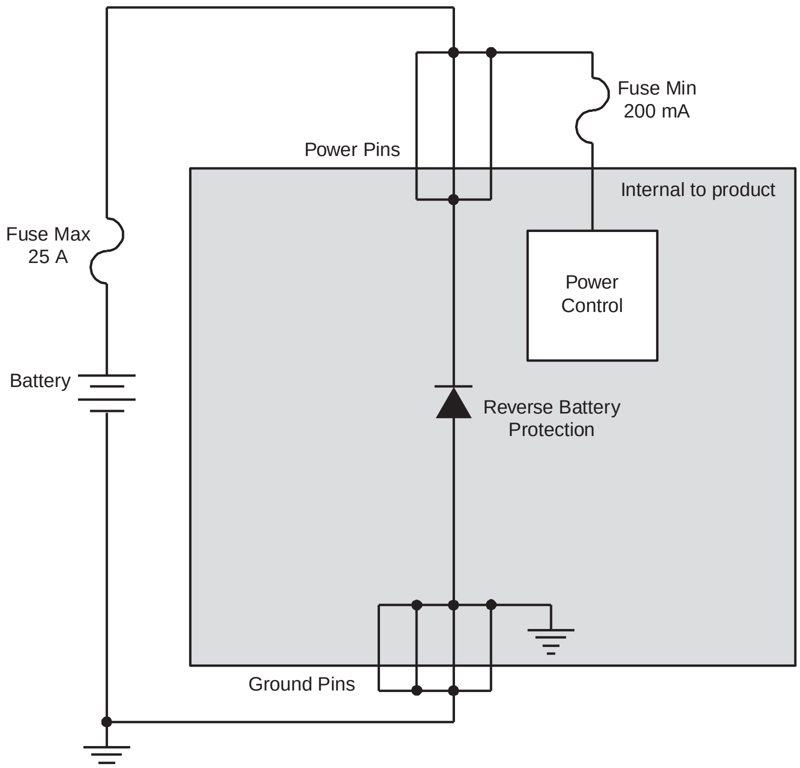


Figure 12: Logic and output power installation connections

6.2. Sensor supply

The VMM0604 has one pin, labeled `SENSOR_SUPPLY`, dedicated to providing power to external sensor.

> ⚠ ***Warning!*** Do not drive more than 100 mA of current through the `SENSOR_SUPPLY` pin. Doing so will cause the pin to protect itself by dropping the voltage, which will result in a lack of power to the sensors, causing unknown vehicle responses.

6.2.1. Sensor Power Capabilities

`SENSOR_SUPPLY` is a 5V linear power supply that is capable of continuously providing up to 100mA to external sensors.

Note: The voltage provided to the VMM0604 must be 6.5 V or greater to ensure the sensor supply can provide 5 V.

Depending on system voltage, `SENSOR_SUPPLY` is capable of delivering different amounts of current to the sensors, as detailed in the following table:

Maximum Sensor Current at Various Voltages	
Input Voltage	**Maximum Sensor Current**
6.5–14 VDC	100 mA
14–24 VDC	50 mA
24–32 VDC	30 mA

The following table provides specifications for the VMM0604 sensor power:

Sensor Power Specifications				
Item	**Min**	**Nom**	**Max**	**Unit**
Input voltage range	6.5	-	32	V
Overvoltage	-	-	36	V
Output voltage range	4.8	5	5.2	V
Output voltage accuracy	-	4	-	%
Output current (linear) @ 6.5 to 14 V battery	0	-	100	mA
Output current (linear) @ 14 to 24 V battery	0	-	50	mA
Output current (linear) @ 24 to 32 V battery	0	-	30	mA
Number of sensor power connector pins	-	1	-	-

6.2.1.1. 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:

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.

6.2.2. Sensor Power Connections

For information on how to connect sensors, refer to *Application Examples* on page 60.

7. Communication

The only type of communication available to the VMM0604 is Controller Area Network (CAN) communication.

7.1. Controller area network

The VMM0604 has 1 Controller Area Network (CAN) communication port(s) available. The VMM0604 hardware provides controller area network (CAN) communication according to the SAE J1939 specification, making the VMM0604 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.

7.1.1. J1939 CAN Capabilities

The CAN communicates information at a rate of 250 kbps. VMM0604 input and output information is transmitted through the CAN at a broadcast rate of 40 Hz. Lack of regular CAN communication is an indication that there is either a problem with a module in the network, or a problem with the CAN bus.

The following table provides specifications for the CAN:

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

7.1.2. J1939 CAN Installation Connections

The CAN connection for the VMM0604 should conform to the J1939 standard. The J1939 standard is a robust automotive specification that is a good CAN installation guideline even when the J1939 CAN protocol is not being used.

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

Note: The standard variant of the VMM0604 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). When a module does not have a CAN_SHIELD pin, the CAN Shield should be connected to an available ground terminal attached to the negative battery. The CAN cable must have an impedance of 120 Ω.

- The CAN cable is very susceptible to system noise; therefore, CAN shield must be connected as follows:

  a. Connect CAN Shield to the point of least electrical noise on the CAN bus.

  b. Connect CAN Shield as close to the center of the CAN bus as possible.

  c. Use the lowest impedance connection possible.

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

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

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

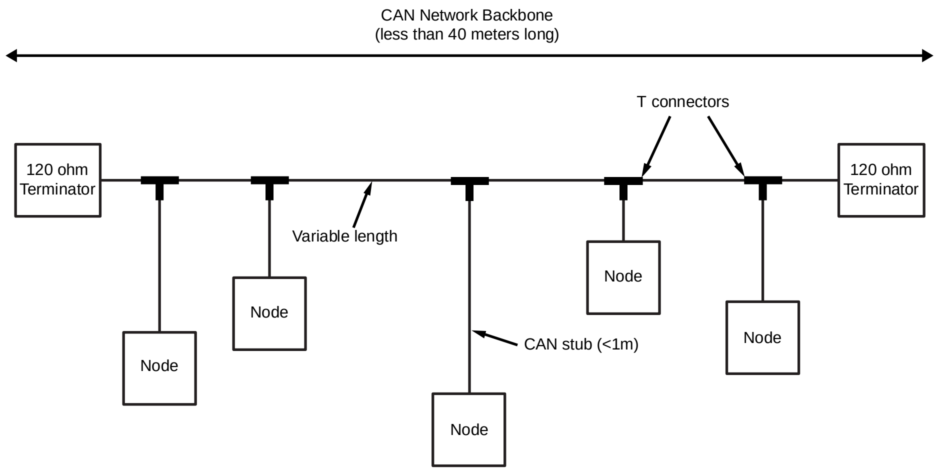


Figure 13: J1939 CAN connection

8. VMM0604 Diagnostic LEDs

The VMM0604 has 12 red LEDs that are used to indicate the status of inputs, outputs, power and the Controller Area Network (CAN).

The following shows the VMM0604's LEDs as they appear on the product:

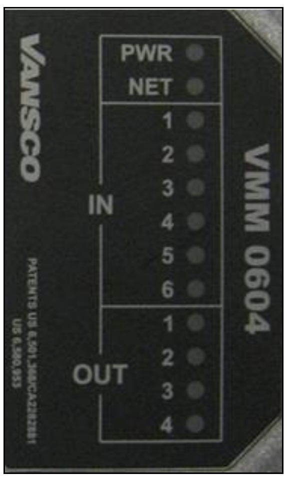


Figure 14: VMM0604 LEDs

8.1. Input LEDs

Input LEDs are used to indicate the status of inputs.

Input LEDs are labeled “IN” (1 to 6) on the VMM0604.

8.2. Output LEDs

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

Output LEDs are labeled “OUT” (1 to 4) on the VMM0604.

8.3. Power LED

The power LED (labeled PWR) is used to indicate the status of power, software, and faults on the VMM0604.

8.4. Network LED

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

9. Connectors

The VMM0604 has one 35-pin Ampseal connector that connects to inputs, outputs, power, and the Controller Area Network (CAN). The connector has keying that prevents you from incorrectly mating it to the vehicle harness. The vehicle harness must be designed to interface with the connector.

The following is a picture of the required mating connector:

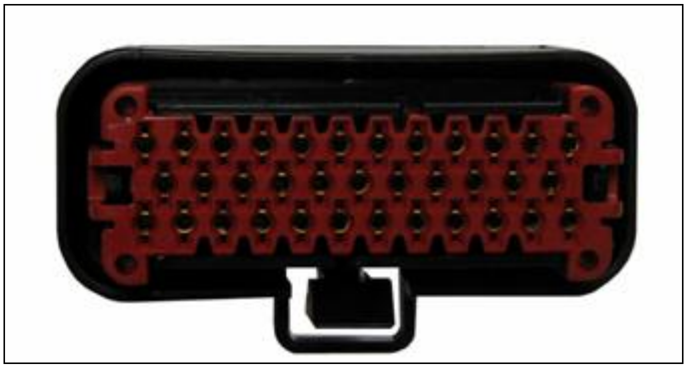


Figure 15: Black (J1) connector

9.1. Mating Connector Part Numbers

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

Table 18: Mating Connector Part Numbers

Connector	Shell Part Number	Terminal Part Number
Black (J1) Connector	AMP 776164-1	20-16AWG, Gold: AMP 770-854-3

9.2. Connector Pinouts

Connector pins connect to inputs, outputs, power, and communication channels. They provide the interface between the vehicle harness and the internal circuitry of the VMM0604.

The following table shows the pinout for the VMM0604 connector:

Table 19: Connector Pinout

Pin no.	Name	Function
1	OUTPUT3_3A_HS	3A High-side output
2	OUTPUT7_3A_LS	3A Low-side output
3	SENSOR_SUPPLY	Power for external sensors
4	ADDR4	Addressing digital input
5	ADDR3	Addressing digital input
6	ADDR2	Addressing digital input
7	ADDR1	Addressing digital input
8	VBATT	Logic and output power
9	VBATT	Logic and output power
10	VBATT	Logic and output power
11	OUTPUT5_3A_LS	3A Low-side output
12	OUTPUT1_3A_HS	3A High-side output
13	N-C	Not connected
14	ADDR5	Addressing digital input
15	CAN1_H	CAN 1 High
16	GND	Ground
17	INPUT6_ADF	Input: Analog, Digital, or Frequency
18	GND	Ground
19	N-C	Not connected
20	GND	Ground
21	N-C	Not connected
22	GND	Ground
23	N-C	Not connected
24	OUTPUT8_3A_LS	3A Low-side output
25	OUTPUT4_3A_HS	3A High-side output
26	CAN_SHLD	CAN Shield
27	CAN1_L	CAN 1 Low
28	POWER_CONTROL	Active high wake-up input
29	INPUT5_ADF	Input: Analog, Digital, or Frequency

Pin no.	Name	Function
30	INPUT4_ADF	Input: Analog, Digital, or Frequency
31	INPUT3_ADF	Input: Analog, Digital, or Frequency
32	INPUT2_ADF	Input: Analog, Digital, or Frequency
33	INPUT1_ADF	Input: Analog, Digital, or Frequency
34	OUTPUT2_3A_HS	3A High-side output
35	OUTPUT6_3A_LS	3A Low-side output

10. Installation

Because every system is different, it is not feasible to provide detailed installation instructions that will be suitable for every assembly. This chapter therefore provides only high-level guidelines on installing the VMM0604.

The vehicle manufacturer is responsible for creating procedures for mounting the VMM0604 in a vehicle during production assembly.

10.1. Mechanical Installation Guidelines

Use the following guidelines when installing the VMM0604 in a vehicle.

10.1.1. VMM0604 Dimensions

The following shows the dimensions of the VMM0604 in millimeters [inches]:

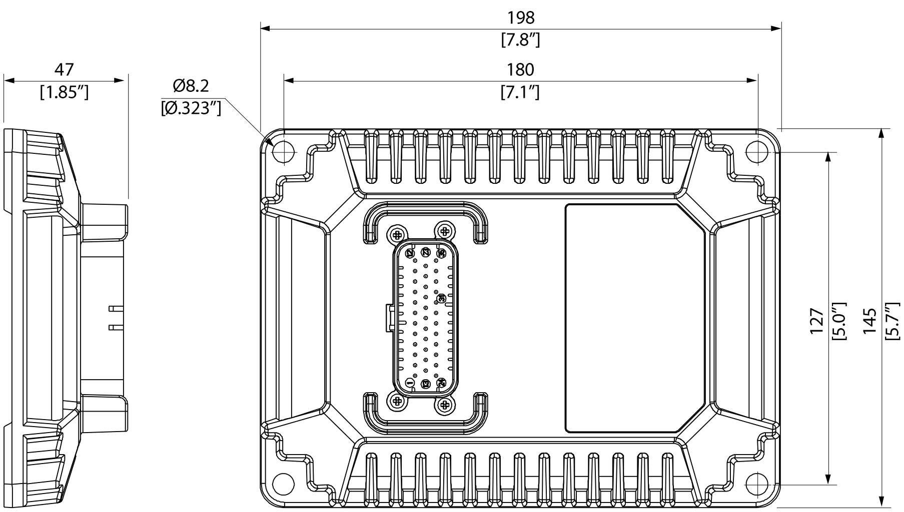


Figure 16: Dimensions of the VMM0604

10.1.2. Selecting a Mounting Location

The VMM0604 can be installed in the vehicle's cab or on the chassis. If used in a marine application, ensure that it is protected from excessive salt spray.

Before mounting the VMM0604, review the following environmental and mechanical requirements.

Note: Do not install the VMM0604 near any significant heat sources, such as a turbo, exhaust manifold, etc. Avoid installing the VMM0604 near any drive-train component, such as a transmission or engine block.

10.1.2.1. Environmental Requirements

The VMM0604 warranty does not cover damage caused by exposure of the product to environmental conditions that exceed its design limitations.

1. Mount the VMM0604 in an environment that is within its ambient temperature range of –40 °C to +85 °C.
2. Mount the VMM0604 in an environment that is within its particle ingress rating. The sealing standard for the VMM0604 is EP455 level 1.

Note: The VMM0604 has not been tested for water ingress according to the EP455 level 1 standard.

The VMM0604 is protected from aggressive pressure wash up to 1000 psi at 1 m (3.28 ft.).

⚠ ***Warning! Damage to equipment.*** Exercise caution when pressure-washing the VMM0604. The severity of a pressure wash can exceed the VMM0604 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 VMM0604:

- The VMM0604 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 VMM0604.
- The harness should be shielded from harsh impact.
- The harness should connect easily to the connector and have adequate bend radius.
- The labels and LEDs should be easy to read.
- The VMM0604 should be in a location that is easily accessible for service.

10.1.3. Mounting the VMM0604 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 VMM0604 to a vehicle:

- Secure the VMM0604 with bolts in all bolt holes using Hex Head 1/4"-20 or equivalent metric size (6 mm) bolts.
- The bolts should be tightened according to the fastener manufacturer's tightening torque specifications.

10.2. Electrical Installation Guidelines

Use the following guidelines when installing the VMM0604 in a vehicle.

10.2.1. Designing and Connecting the Vehicle Harness

The vehicle manufacturer is responsible for designing a vehicle harness that mates with the VMM0604 connector(s).

The vehicle harness design depends on the following:

- How the VMM0604's inputs, outputs, communication, and power pins are configured.
- Other components on the vehicle and their physical locations.
- The routing of the harness.

Suggested wire sizing for the various connections are as follows:

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

Once the vehicle harness is designed, it can be connected to the VMM0604 simply by clicking the mating connector into the connector port on the VMM0604.

11. Application Examples

The purpose of this section is to provide examples of how the VMM0604 can be used for different purposes.

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

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

11.1. Implementing Safety Interlocks

Safety is paramount when creating controls for a vehicle.

One safety feature that can be implemented with the VMM0604 is to ensure the vehicle doesn't move when it is not being used, and no one is sitting in the operator's seat.

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

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

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

The following diagram shows a typical seat switch interlock connection:

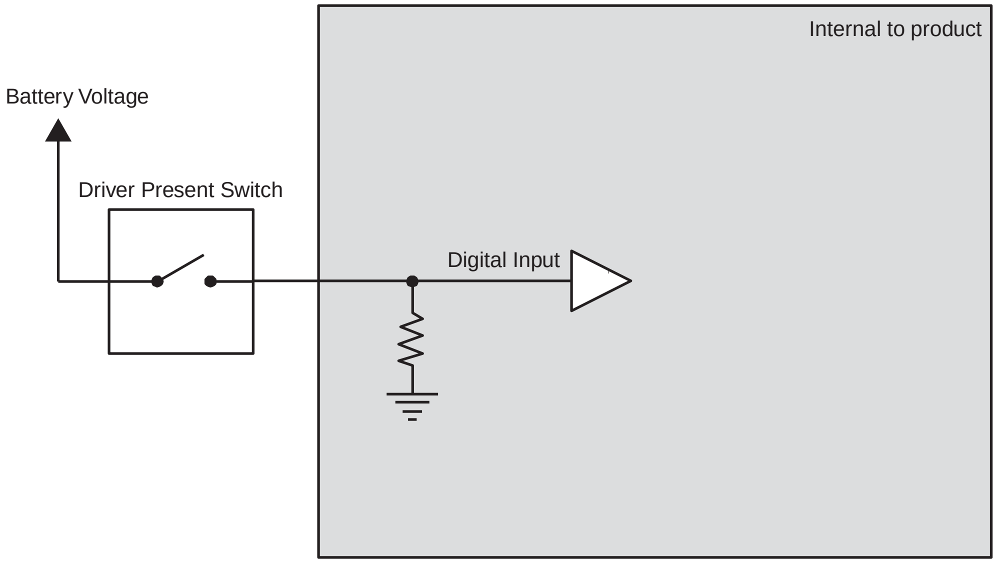


Figure 17: Seat switch interlock connection

11.2. Controlling Indicator Lights

Multiple VMM0604 can be used together in a system to control a vehicle's indicator lights. For example, you could connect three VMM0604s, communicating over the CAN bus, as follows.:

- Connect one VMM0604 to the rear indicator lights.
- Connect one VMM0604 to the front indicator lights.
- Connect one VMM0604 to the turn signal and hazard switches.

The following shows how to connect three VMM0604s together in a system to control indicator lights:

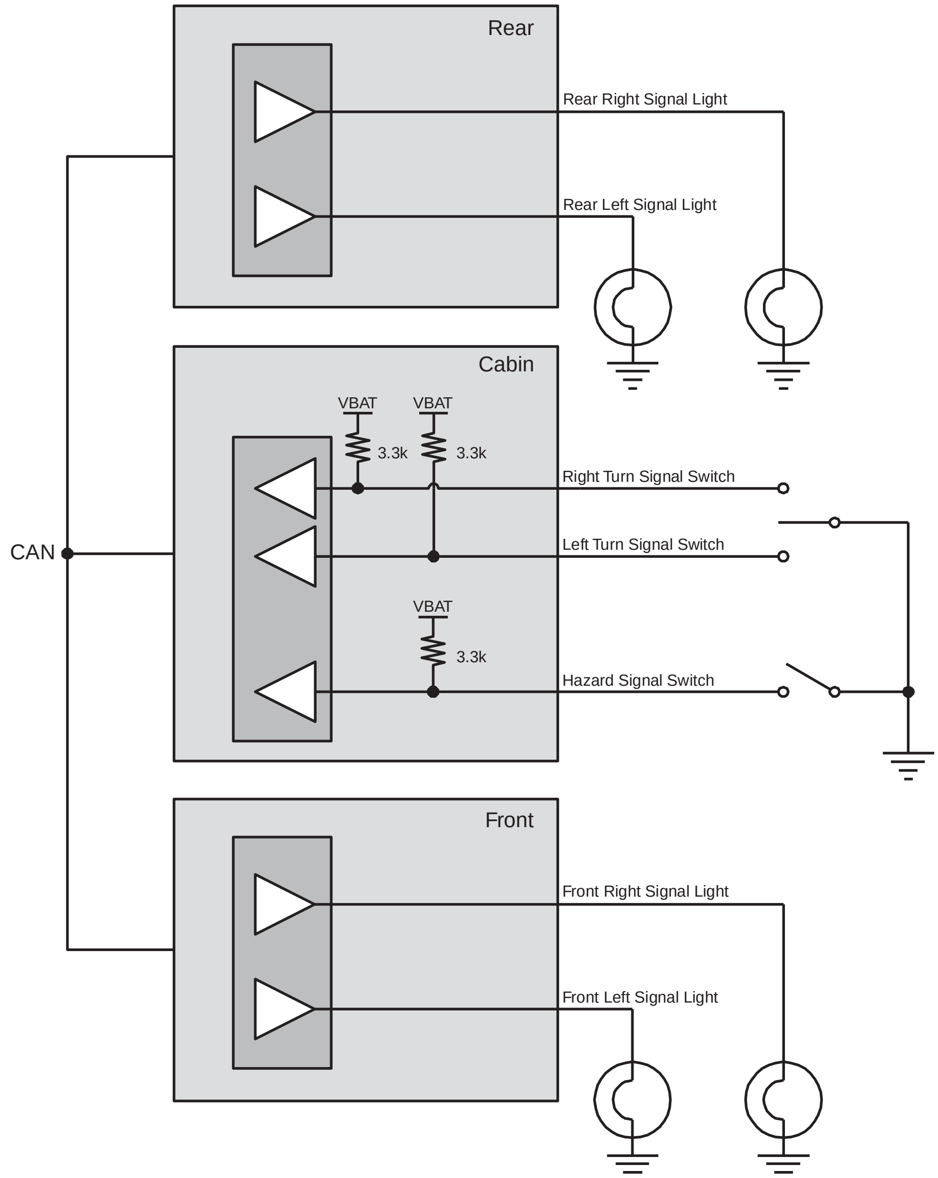


Figure 18: Indicator light connections

11.3. Controlling a Proportional Valve

The VMM0604 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.

Note: The VMM0604 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.

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:

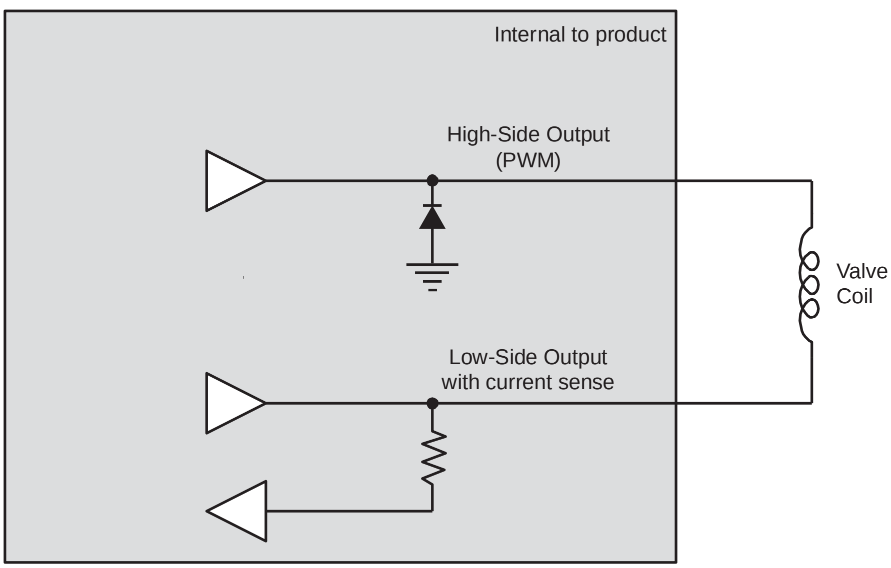


Figure 19: Connection for controlling a proportional valve

11.4. Controlling Motor Speed

The VMM0604 can be used to control the DC motor speed of motors that provide a tachometer output.

Note: The VMM0604 has Proportional Integral Differential (PID) capabilities that make it possible to control devices like proportional valves through software. Refer to the appropriate software manual, or contact your Parker Vansco Account Representative for more details about software. This section only provides hardware connection information.

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

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

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

The following shows how to connect the VMM0604 to control the speed of a motor:

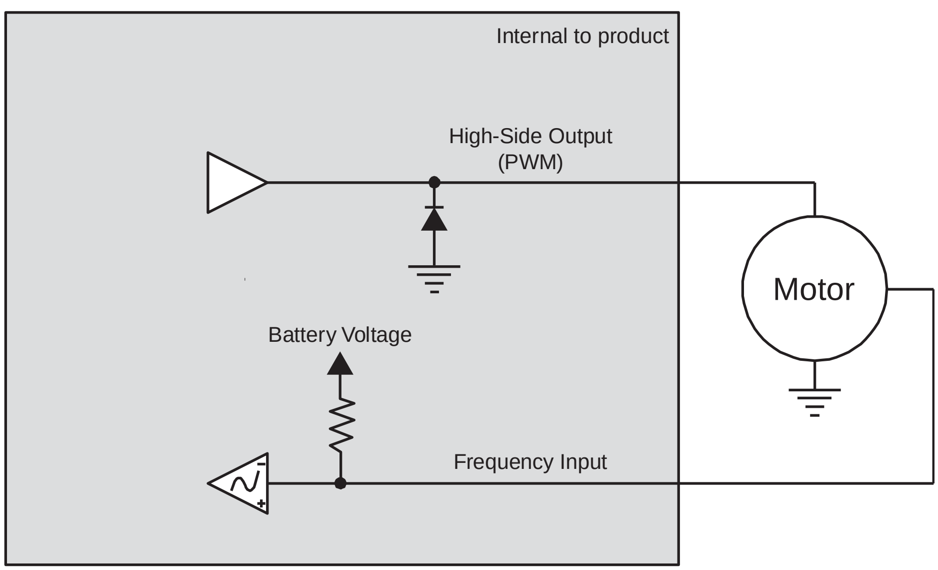


Figure 20: Connection for controlling motor speed

11.5. Using one Analog Input as Two Digital Inputs

The VMM0604 allows you to use one analog input as two digital inputs, which is useful in reducing harness lead or if you are running out of digital inputs in your system.

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

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

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

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

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

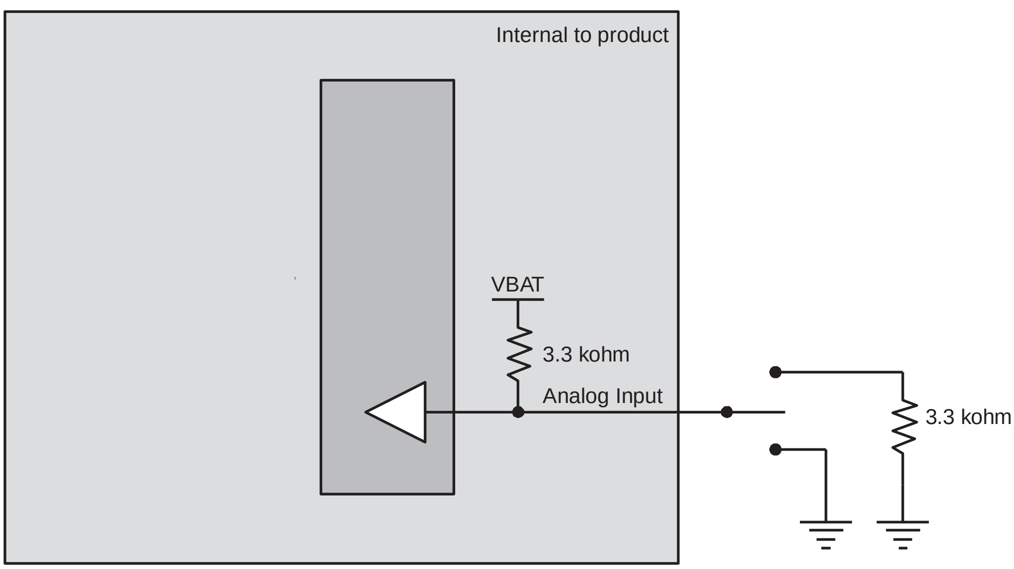


Figure 21: Connecting an analog input to an SPDT switch

11.6. Controlling a Linear Actuator

The VMM0604 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.).

Note: The VMM0604 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 software 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:

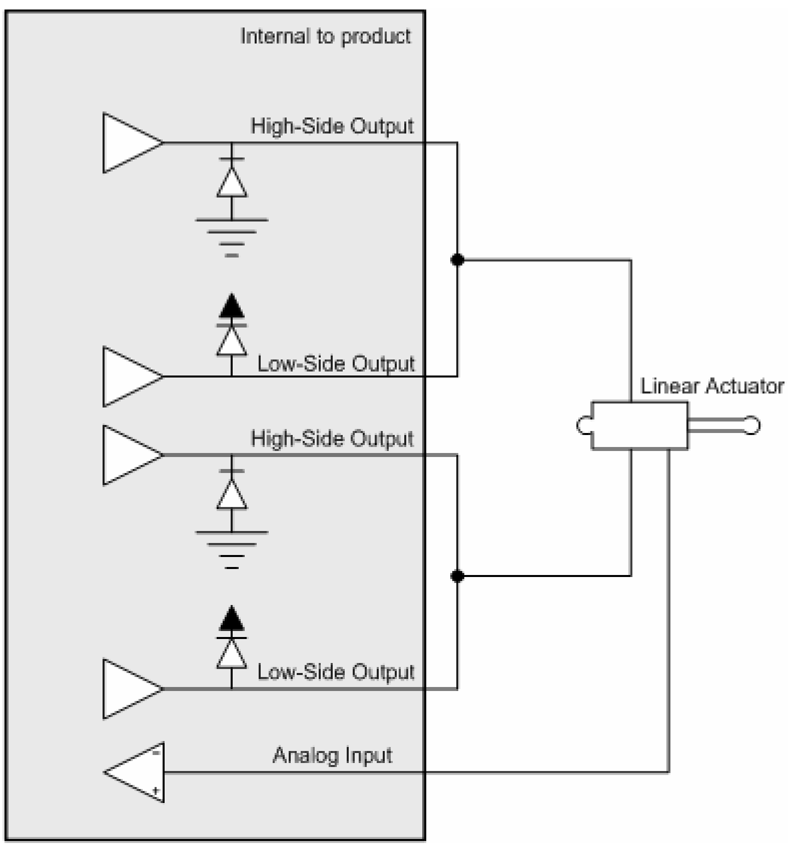


Figure 22: Connection for controlling a proportional valve

11.7. Connecting Various Sensors

There are many types of sensors that can be connected to the VMM0604, as follows:

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

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

Note 2: When connecting sensors to the VMM0604, use the sensor's specification to ensure that the VMM0604 is configured correctly for the sensor.

11.7.1. Open Collector

Open collector sensors are compatible with each type of input on the VMM0604.

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

Note: Open collector sensors need a pull-up or pull-down resistor to bias the state of the sensor when the sensor is not activated. Pull-up and pull-down resistors are internal to the VMM0604.

The following shows a typical NPN open collector sensor connection:

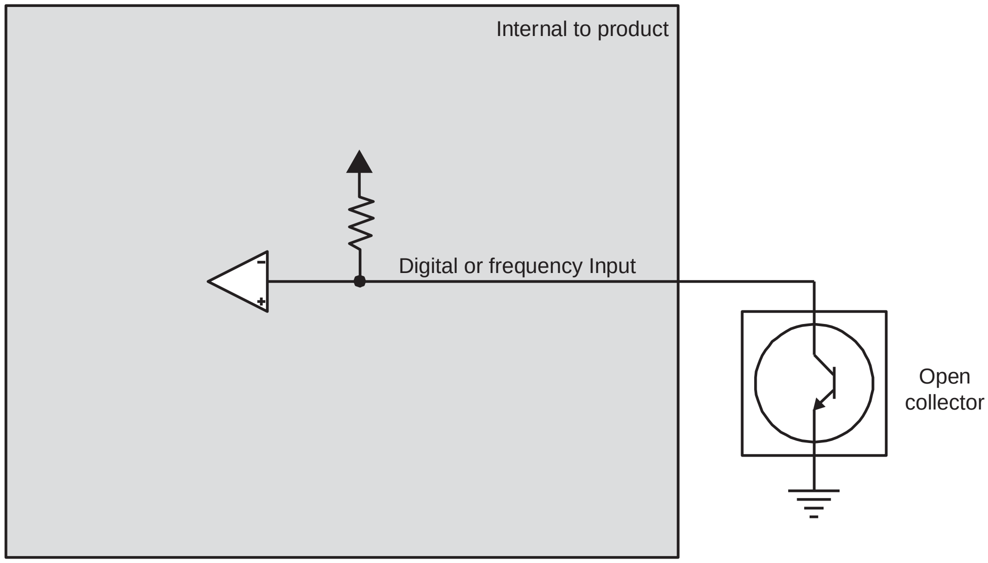


Figure 23: Open collector sensor connection

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

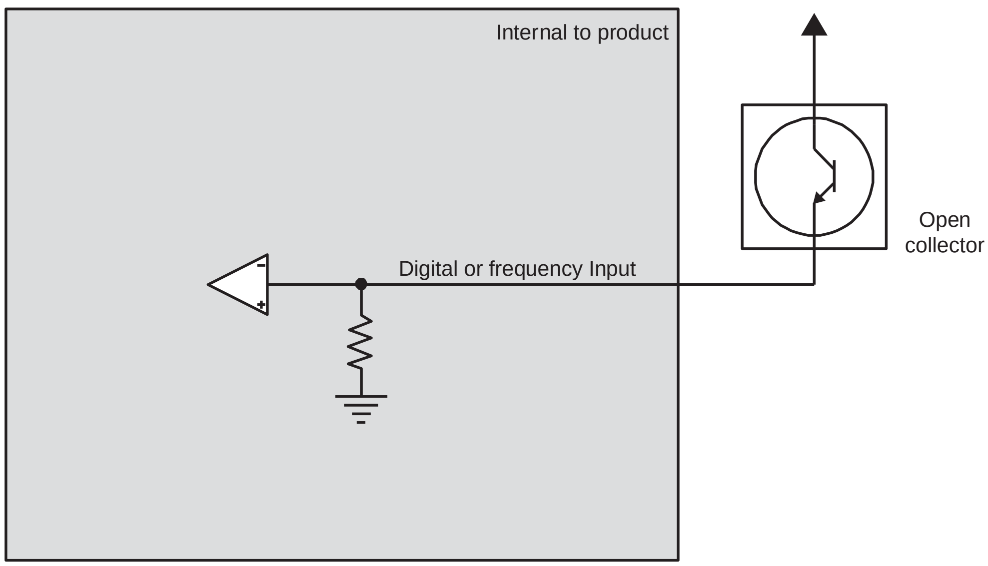


Figure 24: Open collector active high connection

11.7.2. Variable Resistance

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

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

The VMM0604 cannot measure resistance directly.

To make the VMM0604 measure resistance accurately, do the following:

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

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

The following shows a typical variable resistance sensor connection:

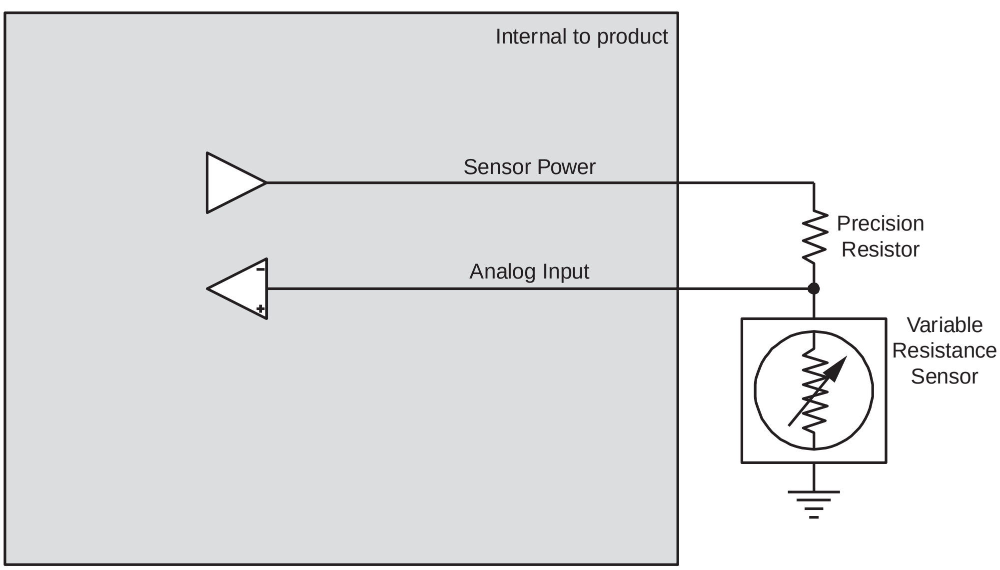


Figure 25: Variable resistance sensor connection

11.7.3. Variable Reluctance

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

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

The following shows a typical variable reluctance connection:

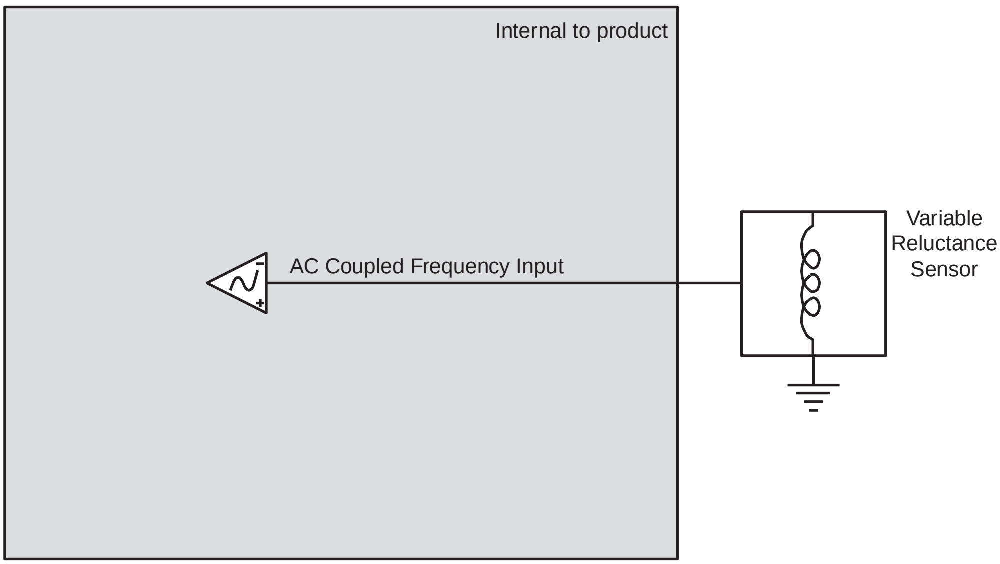


Figure 26: Variable reluctance sensor connection

11.7.4. Switch

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

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

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

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

The following shows a typical sensor switch connection:

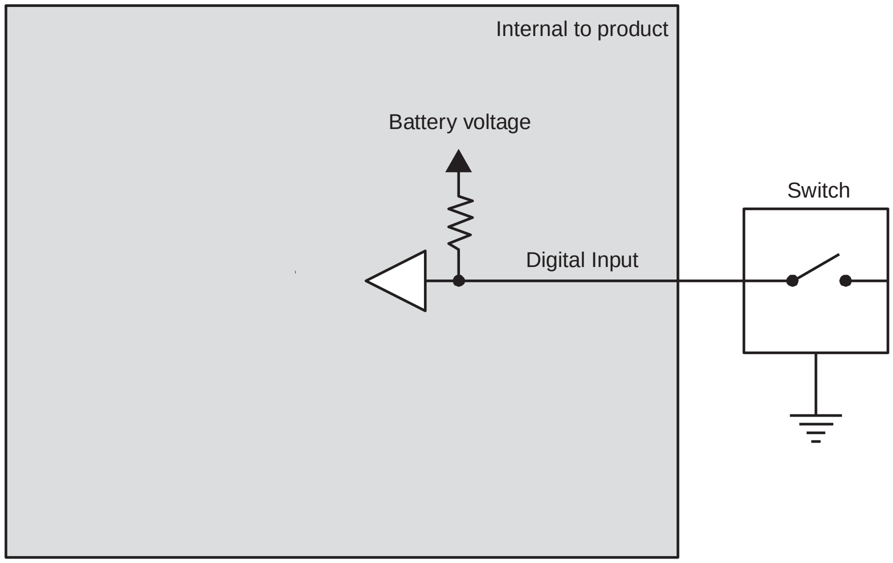


Figure 27: Switch sensor connection

11.7.5. Voltage

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

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

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

The following shows a typical voltage sensor connection:

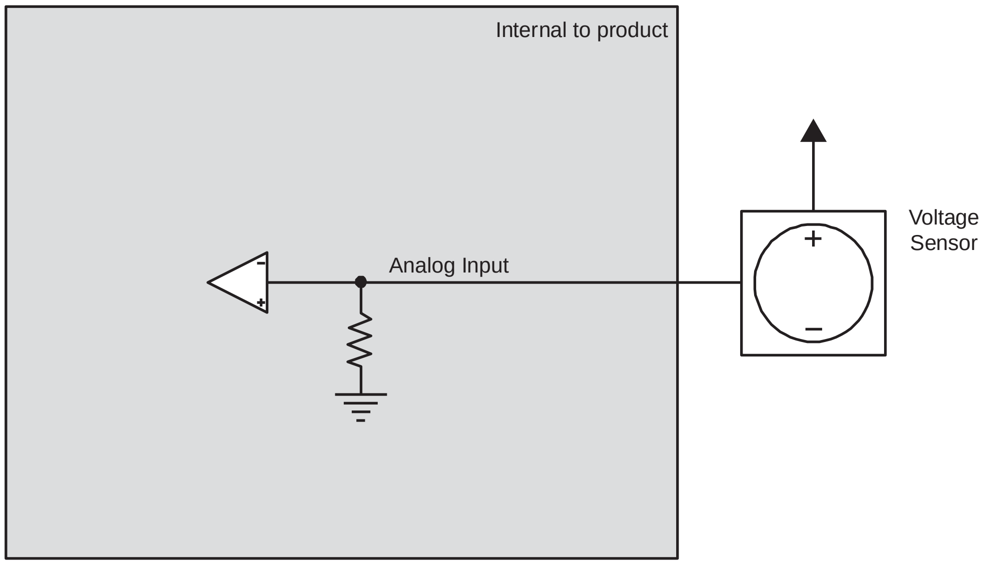


Figure 28: Voltage sensor connection

11.7.6. CMOS

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

The following shows a typical CMOS sensor connection:

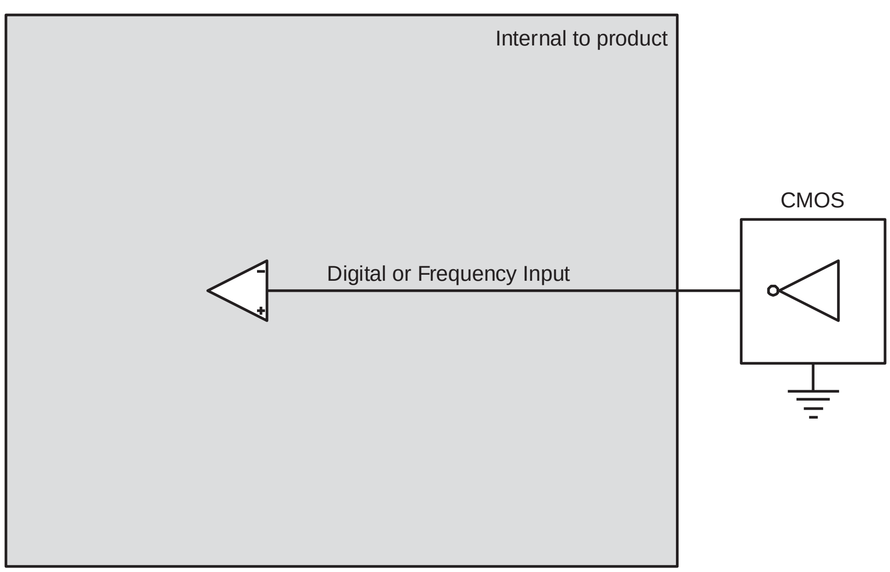


Figure 29: CMOS sensor connection

11.7.7. Potentiometer (Ratiometric)

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

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

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

- Connect one end of the sensor to the `SENSOR_SUPPLY` pin, and the other end to a `GND` pin on the VMM0604.
- Connect the sensor signal to an analog input.

The following shows a typical potentiometer sensor connection:

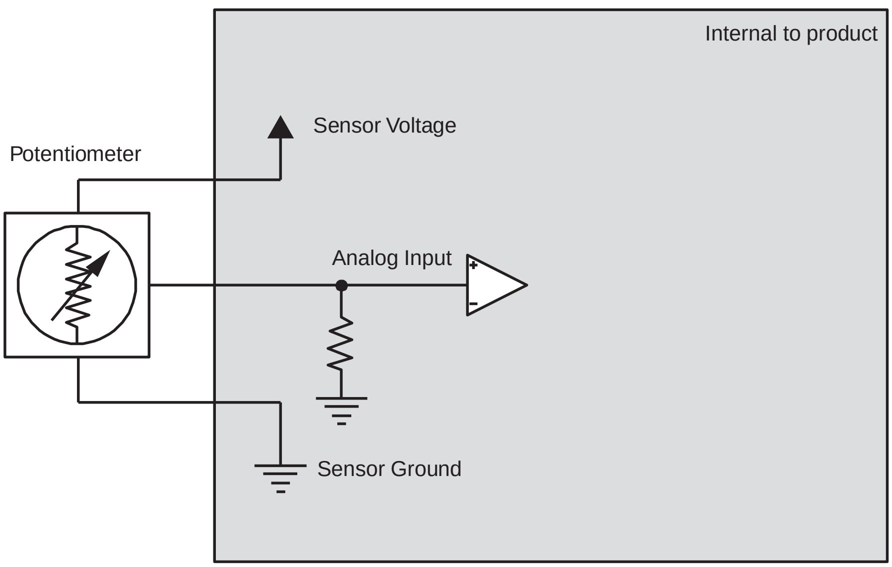


Figure 30: Potentiometer (ratiometric) sensor connection

12. Startup

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

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

Starting the control system

Start the control system as follows:

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

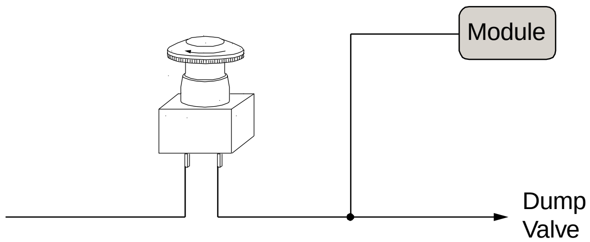


Figure 31: Emergency stop

Prepare for system start

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

Prepare for the initial system start as follows:

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

Start the system

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

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

13. Appendix A

13.1. VMM0604 Technical Overview

The following table lists the verification tests that were performed for the VMM0604:

Table 20: Test Specifications

Ref #	Test Specification	Test Description	Deviated from Plan?
1.	J1455 (Jun 2006) Section 4.1.3.1	24 Hour Thermal Cycle	No
2.	J1455 (Jun 2006) Section 4.1.3.2	Thermal Shock	No
3.	EP455 (Feb 03) Section 5.1.2	Storage Temperature	No
4.	J1455 (Jun 2006) Section 4.2.3	24 Hour Humidity Cycle	No
5.	EP455 (Feb 03) Section 5.13.2	Humidity Soak	No
6.	J1455 (Jun 2006) Section 4.3.3	Salt Spray Atmosphere	No
7.	EP455 (Feb 03) Section 5.8.2	Chemical Exposure	No
8.	EP455 (Feb 03) Section 5.4.1	Solar Radiation - UV Effects	*Yes*[15]
9.	EP455 (Feb 03) Section 5.4.1	Pressure Wash	No
10.	J1455 (Jun 2006) Section 4.9.4.2	Random Vibration	No
11.	J1455 (Jun 2006) Section 4.10.3.1	Handling Drop	No
12.	J1455 (Jun 2006) Section 4.11.3.3	Harness Shock	No
13.	J1455 (Jun 2006) Section 4.11.3.4	Operational Shock	No

[15] UUT distance changed to 0.5 m instead of 0.75 m.

Ref #	Test Specification	Test Description	Deviated from Plan?
14.	J1455 (Jun 2006) Section 4.13.1	Operating Voltage	No
15.	EP455 (Feb 03) Section 5.10.7	Operational Power Up	*Yes*[16]
16.	J1455 (Jun 2006) Section 4.13.1	Cold Cranking Voltage	No
17.	J1455 (Jun 2006) Section 4.13.1	Jumper Starts Voltage	*Yes*[17]
18.	J1455 (Jun 2006) Section 4.13.1	Steady State Reverse Polarity	No
19.	EP455 (Feb 03) Section 5.10.4	Short Circuit Protection	*Yes*[18]
20.	EP455 (Feb 03) Section 5.11.1	Transient Accessory Noise	No
21.	EP455 (Feb 03) Section 5.11.2	Transient Alternator Field Decay	*Yes*[19]
22.	EP455 (Feb 03) Section 5.11.3	Transient Batteryless Operation Level	*Yes*[20]
23.	J1455 (Jun 2006) Section 4.13.2	Transient Inductive Load Switching Pulse 1	*Yes*[21]
24.	J1455 (Jun 2006) Section 4.13.2	Transient Load Dump	*Yes*[22]
25.	J1455 (Jun 2006) Section 4.13.2	Transient Mutual Coupling Power Lines	No
26.	J1455 (Jun 2006) Section 4.13.2	Transient Mutual Coupling Signal Lines	No
27.	J1455 (Jun 2006) Section 4.13.2.2.3	Electrostatic Discharge Operating	*Yes*[23]
28.	J1455 (Jun 2006) Section 4.13.2.2.3	Electrostatic Discharge Handling	*Yes*[24]
29.	J1455 (Jun 2006) Section 4.13.3	EMC - Susceptibility	*Yes*[25]
30.	J1455 (Jun 2006) Section 4.13.3	EMC - Emissions	*Yes*[26]

[16] Rate changed to 1 V/s instead of 1 V/ms.
[17] Maximum voltage changed to 36 V instead of 48 V.
[18] Each UUT pin was exposed to +32 V and system ground.
[19] Source impedance of 1 ohm. Repetition rate of 0.02 Hz for 60 test cycles.
[20] Frequency swept from 800 Hz - 1500 Hz over 5 minute period. Applied voltage tested to 12+25.2sin(2Pift) for 24 V systems.
[21] Source impedance is 10 ohm (equipment limitation).
[22] Source impedance of 2 ohm, and signal of 28 +122e*-t/0.1 as per J1455 draft issued April 8 (Rev 01).
[23] Approach rate of the test probe uncontrolled until discharge occurs. Test probe dimensions differ from J1455 requirements.
[24] Approach rate of the test probe uncontrolled until discharge occurs. Test probe dimensions differ from J1455 requirements.
[25] EMC geometry smaller than referenced specification recommends. Field strength is not 100 V/m over the whole frequency range.
[26] EMC geometry smaller than referenced specification recommends.

13.2. Frequently Asked Questions (FAQ)

What are the recommended mounting practices for the VMM?

Refer to Selecting a Mounting Location for details.

Can the VMM be pressure washed or immersed in water?

Refer to *Environmental Requirements* on page 58 for details.

Can the VMM be used as an H-bridge?

Yes. The VMM has separate high-side and low-side outputs that can be combined in the harness to create an H-bridge. Refer to *Application Examples* on page 60 for more details on how to create an H-bridge.

Will the VMM work on a 42 V electrical system?

No. The VMM is designed for 12 V and 24 V systems.

Should the VMM be disconnected when the welding on a vehicle where it is installed?

All electrical devices should be disconnected during welding to avoid damaging them. The VMM warranty does not cover damage to the product when exposed to conditions that exceed the design limitations of the product.

How does the power control feature work?

Refer to *Power* on page 45 for details.

How should I wire my CAN network?

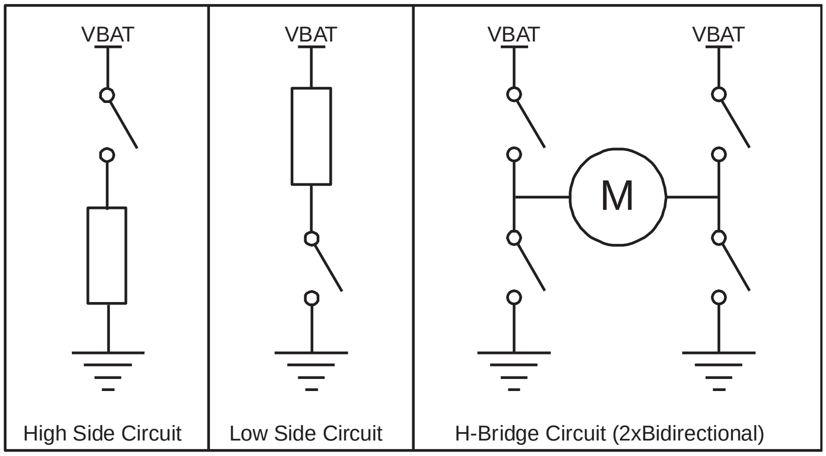
Refer to *Communication* on page 49 for details.

Where can I get J1939 cables and connectors?

Two manufacturers of J1939-rated connectors are ITT Canon and Deutsch. Raychem, a subdivision of Tyco, manufactures a shielded cable compliant with J1939-11. These are manufacturers that Parker Vansco has experience with, but this should not be considered an exhaustive list of J1939 cable and connector suppliers. Consult your local wire and connector distributors for details.

What kind of circuits can be created with the outputs?

Outputs can be used to create high-side, low-side, and H-bridge circuits, as shown in the following:



How do I program the VMM?

The VMM can be programmed using ladder logic. Consult your Parker Vansco Account Representative for more details.

Do the output currents require de-rating in certain conditions?

VMM outputs do not require de-rating. They are specified to operate continuously at the maximum temperature and the maximum rated current.

Can I plug my existing sensor into a VMM, and if so, how do I configure the input?

Refer to *Sensor Power* see "*Sensor supply*" on page 47, or *Connecting Various Sensors* on page 67 for details on connecting sensors. Contact your Parker Vansco Account Representative for more information if needed.

Is it possible to purchase the VMM with a company logo printed on it?

Parker Vansco may consider customizing the overlay on a case-by case-basis. Consult your Parker Vansco Account Representative for details.

Is it possible to purchase a pre-programmed VMM?

Yes. Contact your Parker Vansco Account Representative for details on getting your VMM pre-programmed.

What torque should I apply to the mounting bolts?

Refer to the fastener manufacturer's recommendations for mounting bolt tightening torque.

Is it possible to get the VMMs with different connector options?

No. VMM connector options are not offered because the connectors are integral to the circuit board and mechanical enclosure design.

What is the maximum bus loading on the CAN network?

Requirements can vary by system; however, the industry standard is no more than 50% average bus loading.

Do I need to fuse VMM power?

Yes. Power connections to the VMM should be fused. Refer to *Power* on page 45 for more details.

Do I need to fuse VMM outputs?

VMM outputs are internally protected and no external fusing is required.

How much wetting current is provided by the VMM inputs?

Wetting currents can vary by module and by input type. Wetting current specifications are found in the specifications tables for each input.

Do I need an external flyback diode on my inductive load?

No. The VMM has internal flyback diodes as part of its high-side driver circuitry, and therefore an external flyback diode is not needed.

Is it a problem to have an external flyback diode on my inductive load? Will it affect my current sense measurement?

No. Having an external flyback diode present on circuits with internal flyback diodes will not cause problems and will not affect the current sense measurement.

Does the VMM offer analog outputs?

No; however, with the addition of external circuitry, an output can be PWM'd to generate an analog voltage.

Can I vary the frequency of my PWM output?

The frequency of each output is determined through software. Consult the appropriate software manual for details.

Can I connect VMM outputs in parallel?

You can connect on/off controlled outputs in parallel, but PWM’d outputs cannot as they are not guaranteed to be synchronized.

My VMM is broken. Who do I call regarding warranty?

Broken VMMs should be returned to the service department of the OEM, and the OEM will co-ordinate returns to the appropriate Parker Vansco service center.

Does the VMM support wireless connections?

The VMM does not support wireless connections; however, Parker Vansco offers a CAN to WiFi module. Contact your Parker Vansco Account Representative for details.

Can I connect the VMM to my existing J1939 devices?

Yes. The VMM is fully J1939 compatible and has generic J1939 messaging capability to support any custom communication scheme.

Can I use the VMM to power another VMM?

Yes, an output on your VMM can be used to power other VMMs, or to excite other VMMs' power control inputs.

Does the VMM0604 support "Wake on CAN"?

No.

Can I run my VMM CAN bus faster than 250 kbps?

No. When the VMM is used in a VMM system, it can only communicate at 250kbps.

Can I use other Parker Vansco products such as the CM3620 with my VMMs?

Yes, however, the software required for each is different. Interfacing to these type modules must be done through the generic CAN and J1939 messaging included in the VMMS software tool.

13.3. Troubleshooting

This section assumes that the product is connected in a Development System.

The following table provides possible solutions for potential problems:

Problem	Possible Causes	Possible Solutions
Everything is connected, but there is no CAN communication.	The VMM is not powered.	• Ensure all of your connecting points in the desktop setup are properly seated. • Ensure the power supply is on and connected to a VMM0604 within your desktop setup. • Ensure the power control input is active (refer to the power control input section for details). The power LED will flash once every second when the VMM0604 is powered.
	The CAN bus is not set up correctly.	• Ensure there is a 120 Ω terminating resistor at each end of the CAN bus.

14. Glossary

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 on when it reads a battery voltage level, and off when it is floating or grounded.

active low

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

aliasing

In analog-to-digital conversion, distortion that occurs when the analog signal being sampled has a frequency greater than half the sample rate. An example of aliasing is the wagon-wheel effect often seen in films, in which a spoked wheel appears to rotate differently from its true rotation.

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

A gradual decrease in a current's intensity. Such a decrease may occur naturally, or intentionally through the use of an attenuator.

black box

A custom-compiled algorithm written in C programming language that allows a system designer to implement algorithms that are not possible in ladder logic.

CAN bus

See *controller area network (CAN) bus*.

CAN high

The positive wire in a shielded twisted-pair cable, which, when connected with a CAN low, provides a complete CAN differential signal.

CAN low

The negative wire in a shielded twisted-pair cable, which, when connected with a CAN high, provides a complete CAN differential signal.

CAN shield

The shielding that wraps around the CAN high and CAN low wires in a shielded twisted-pair cable.

CMOS

See *Complementary Metal-Oxide Semi-Conductor*.

controller area network (CAN) bus

A communications network bus that permits data from sensors and other equipment within a motor vehicle to communicate with each other and, through telltales and other diagnostic tools, with the operator.

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. Also known as current sense or current sensing.

current feedback control

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

current sensor

A device that detects electrical current in a wire and generates a signal proportional to it.

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

DC coupling passes the full spectrum of frequencies including direct current. The signal being read by this circuit must fall within the detection threshold range specified for the input.

de-rating

The reduction of the rated output current level to a value less than the specified rating. De-rating is typically done so that a product does not overheat.

digital input

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

dimension

To select values so that they generate optimal results.

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.

field-effect transistor (FET)

A transistor whose flow of charge carriers is controlled by an external electric field.

floating input

An input, isolated from a ground connection, that does not resist being pulled high or low when inactive.

frequency input

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

gain

To increase the voltage level of an input signal to maximize the resolution of an input.

general purpose input

An input that can be used as an analog, digital, or frequency input.

ground level shift

An undesirable condition in which the ground level elevates. This condition can cause inputs to activate when they shouldn't.

half-bridge

The simultaneous use of a high-side switch and a low-side switch in order to provide a load having both a battery voltage and a ground.

harness address pins

The pins a product uses to identify itself within a system.

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.

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:

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

ladder logic

A programming language often used in industrial-control settings to control electromechanical devices in a relay. Programs written in this language resemble ladders: two vertical rails with a series of horizontal rungs—each representing a logical rule—between them. Ladder programs for Parker Vansco products are written using Vansco Multiplexing Module Software (VMMS).

load

Any component that draws current from a 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.

multiplexing

Transmitting multiple messages simultaneously over one channel in a local area network.

open load

The disconnection of a load from an output, often because of a broken or worn wire or connector pin.

overcurrent

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.

overvoltage

A situation in which the voltage in a circuit rises above its upper design limit.

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; when the input is inactive, the product powers down and will not operate.

procurement drawing

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

proportional-integral-differential (PID) controller

A system or device controller that, through constant feedback about differences between the desired state and the current state, adjusts inputs accordingly. An example of such a controller is one that prevents a vehicle from traveling faster than a specified speed, regardless of the amount of pressure on the gas pedal.

pull-down resistor

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 resistor

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 counter

A device that detects and counts pulses occurring on a frequency input for a given period of time.

pulse-width modulation (PWM)

A digital logic circuit programmed to produce a pulse having any desired period or duty cycle. It is a means of controlling variable speed motors. See also duty cycle.

quadrature

A shaft rotation monitoring technique that provides the speed, position, and direction of the shaft.

RS232

An inexpensive type of serial communication used on most PC and laptop computers that doesn't define the communication protocol, making it attractive for embedded applications. RS232 is an older technology that is slowly being phased out of production in favor of USB.

sample rate

The rate at which the microprocessor reads analog voltage levels.

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 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 is connected to system ground, potentially resulting in high current flow.

switch outputs

An output that is digital in nature. It switches to battery and/or ground levels.

system noise

Electrical interference generated from external devices that affect the behavior 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.

VMM

Vansco Multiplexing Module

VMM system

A collection of multiplexing products that function together in a system through software.

VMMS

Vansco Multiplexing Module Software.

wetting current

The minimum current needed to flow through a mechanical switch to break through any film of oxidation that may be on the switch contacts.

15. Index

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