
Controller Module

CM3620

User Guide

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Publication History

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

| Release Date | Description of Change |
|--------------------------|-------------------------------------------------------------|
| Rev. 003, February 2015 | Updated DVT results. Minor editorial changes throughout. |
| Rev. 002, September 2012 | Branding Minor editorial changes throughout. |
| Rev. 001 | First release of this document |

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 CM3620

The Controller Module (CM) 3620 is a general purpose input/output controller that monitors digital, analog, and frequency inputs, and controls solid-state switched outputs.

The principal benefit of the CM3620 is that it can be configured to meet many system requirements through component configuration options, component value modification, and custom software.



Figure 1: CM3620 controller

Note: Although the CM3620 is typically used in a vehicle, it can also be used for other applications, such as industrial automation.

The CM3620 is designed to communicate through a J1939-based Controller Area Network (CAN). Custom CAN messaging can be created in software, and the CM3620 can be used in any CAN 2.0B application, including ISO 11783.

The software offered with the CM3620 is a low-level framework that uses the Parker Vansco Software Development Kit (SDK), which is a tool that enables you to create custom application software for your product.

The CM3620 has many features, including the following:

- The CM3620 can monitor up to 36 inputs
 - ♦ 22 digital inputs (20 when unit has second CAN bus)

- ◆ 10 analog inputs
- ◆ 4 frequency inputs
- The CM3620 can control up to 20 outputs
 - ◆ 16 high-side outputs
 - ◆ 4 low-side outputs
- The CM3620 has two digital inputs that can be configured as power control inputs
- The CM3620 can provide a signal sensor power supply output rated at up to 300 mA
- The CM3620 analog inputs, frequency inputs, and high-side outputs can be configured to function as digital inputs
- The CM3620 low-side outputs can be used for current feedback if a high-side output is used for pulse-width modulation (PWM) control
- The CM3620 can monitor current flow through outputs to allow closed loop feedback control
- The CM3620 can awaken when the CAN bus changes state
- The CM3620 frequency inputs 1 and 2 can be coupled to analog inputs 1 and 2 to provide analog diagnostics of frequency sensors
- The CM3620 frequency inputs 3 and 4 have dedicated analog inputs for analog diagnostics of frequency sensors
- The CM3620 has two 35-pin Ampseal connectors that are used to interface with the inputs, outputs, and CAN communication

2. About the CM3620 User Guide

The CM3620 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 2 CAN busses, 5V sensor supply and no status LEDs.

This manual describes the hardware components of the CM3620, 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. Section Types

There are three kinds of sections in this manual: instruction, information, and example.






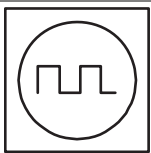

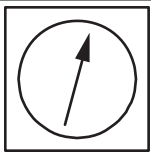
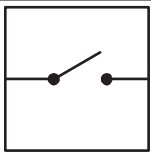


- **Instruction sections** – The only instruction section in this manual is the *Quick Start* section, which provides procedures for connecting the CM3620 to a development system, powering it up, and downloading application software.
- **Information sections** – Most sections in this manual are informational. They describe the hardware components of the CM3620, and usually have three sub-sections: capabilities, configuration options, and installation connections.







Note: The *configuration options sections* are a reference for what can be configured for each component of the CM3620. All hardware configuration must be selected early in the design process of your product, whereas some of the software configuration options can be implemented at anytime. If you already have a custom configuration for your product, you can ignore these sections.

- **Example sections** – The only example section in this manual is the *Application Examples* section, which provides descriptions, diagrams, and explanations for possible CM3620 applications.

2.2. 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 CM3620 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 CM3620 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:

- CM3620
- personal computer (PC)
- controller I/O board
- controller I/O harness (connects the CM3620 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 CM3620 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 CM3620 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 CM3620.

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 you start using the CM3620, you must install the appropriate software tools onto your PC.

The CM3620 requires the following software tools:

- **Data Link Adapter (DLA) drivers:** The DLA acts as the interface between the PC and the CM3620 CAN bus. Before using the DLA, you must install the DLA drivers.
- **Flash Loader:** Software tool that transfers application software from your PC to the CM3620.

3.3.1. Install the Data Link Adapter Driver Software

A Data Link Adapter (DLA) is needed when connecting the CM3620 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 (default path C:\Program files\Vansco\USB-DLA).
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.

3.3.2. Install the Flash Loader

The Flash Loader doesn't actually need to be installed to work. All you need to do is run **FlashLoader.exe**.

FlashLoader.exe is found within the SDK files. Contact your Parker Vansco Account Representative if you cannot find the file.

Refer to *Download Application Software using the Flash Loader* on page 10 for details on how to download software to the CM3620 using the Flash Loader.

3.4. Connect the CM3620 to a Development System

It is a good idea to connect the CM3620 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 CM3620 in a development system:

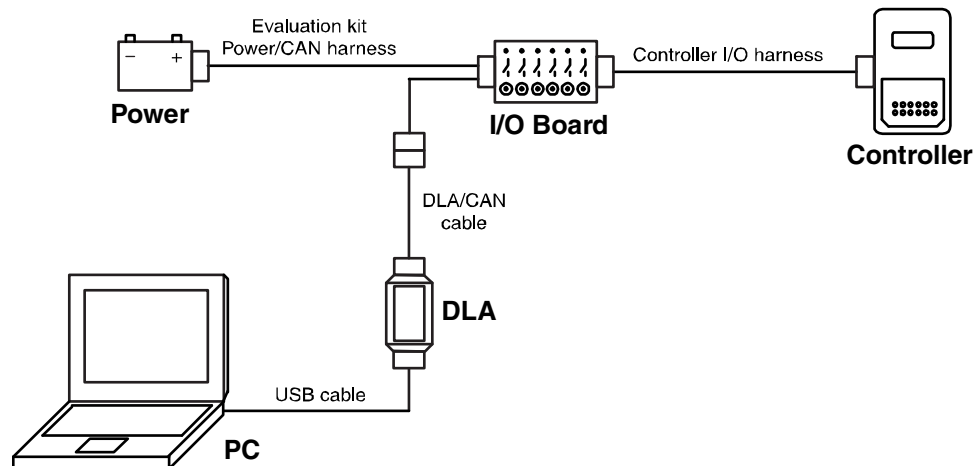


Figure 2: Development system connection

To connect the CM3620 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 CM3620 connectors.
2. Connect the Controller I/O harness to the controller I/O board connectors.
3. Connect the evaluation kit power/CAN harness to the controller I/O board's JP3 connector.
4. Do **not** connect the power wire (RED) from the evaluation kit power/CAN harness to the power supply (+) terminal at this time.
5. Connect the ground wire (BLACK) from the evaluation kit power/CAN harness to the power supply (-) terminal.
6. Connect the CAN connector from the evaluation kit power/CAN harness to the corresponding mating connector and harness on the DLA.
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 7.
7. Connect the DLA to a personal computer via the USB port.

3.4.1. Power Up the Development System

To power up the CM3620:

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

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

3.5. Download Application Software using the Flash Loader

The Flash Loader transfers application software files that were created using the Software Development Kit (SDK), from your PC to the CM3620.

This section assumes you have a Vansco Software File (VSF) that is ready to be transferred to the CM3620 using the Flash Loader. Parker Vansco provides a VSF with every CM3620.

Note: For more information about writing software for the CM3620 using the SDK, contact your Parker Vansco Account Representative.

- **If you are creating a custom application**, the provided VSF is a simple example application that can be transferred to the CM3620 to ensure the product works. Refer to the SDK manual for information on how to create a custom application.
- **If you are not creating a custom application**, the provided VSF file is the actual application that Parker Vansco has written for your CM3620.

To transfer the VSF file to the CM3620

1. Set the Controller I/O Board harness **power switch** to the **on** position.
2. Set the Controller I/O Board harness **ignition switch** to the **on** position.
3. Run **FlashLoader.exe**.

The *Flash Loader* screen opens, showing a box on the left that lists every module on the J1939 network that supports the J1939.

Note: Additional modules may appear in the modules list, as they also support J1939. Although these “extra” modules support J1939, they won't always support downloading over J1939 with the Flash Loader.

4. From the modules list, select **CM3620**.
5. From the **Software File Details** list, select your VSF file.
6. Click **Start**.

Your VSF file downloads to the CM3620.


Once complete, a confirmation screen opens.

7. Click **OK**.

The CM3620 is now running the application code.

4. Inputs

The CM3620 has digital, frequency, and analog 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 CM3620. If an inductive load must be connected to an input, use a protective diode or transorb.

4.1. 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 CM3620:

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

4.1.1. Standard Digital Inputs

The CM3620 has 18 standard digital inputs:

- `DIGITAL_3` through `DIGITAL_20` (`DIGITAL_21` and `DIGITAL_22` are used by the second CAN bus)

Note: `DIGITAL_1` and `DIGITAL_2` can also be used as standard digital inputs as long as they are not being used for power control.

4.1.1.1. Digital Input Capabilities

The following table provides specifications for the CM3620's digital inputs:

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

4.1.1.2. Standard Digital Input Configuration Options

Standard digital inputs can be configured as active high or active low, by selecting pull-up or pull-down resistors. Wetting current can also be configured, which is done by selecting specific values for the pull-up / pull-down resistors. The configuration you choose for your digital inputs depends on the application and the external device you will connect to the digital input.

- **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.

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

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

- Wetting current is determined by the value of the resistor. The maximum allowable wetting current in the CM3620 is **10 mA**. Wetting currents greater than 10 mA must be incorporated using resistors embedded in the system harness.

The following diagram shows the configuration options for the standard digital inputs:

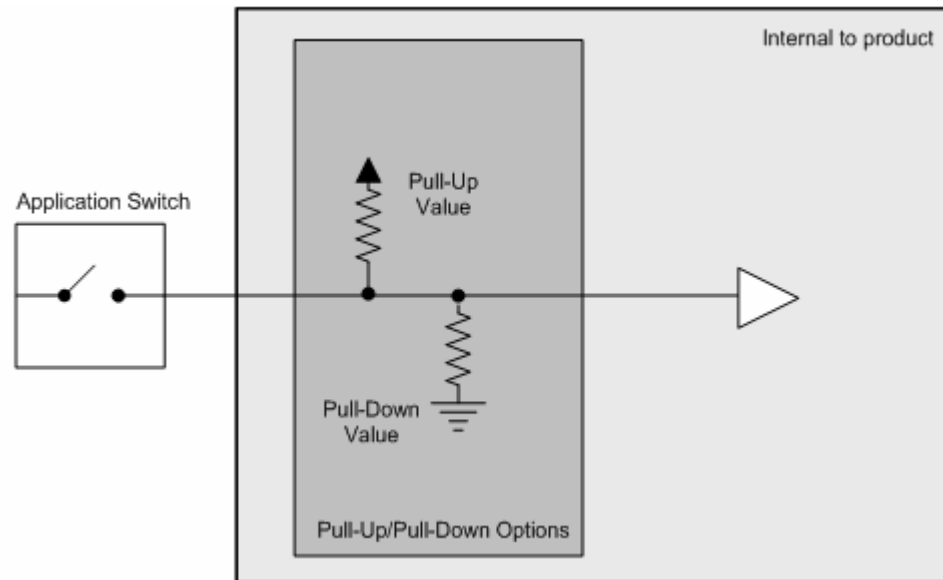


Figure 3: Standard digital input configuration options

4.1.1.3. Digital inputs connections

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

- When the switch is open, the pull-down resistor ensures that no voltage exists on the input signal, which will be interpreted by the CM3620 as inactive.
- When the switch is closed, the input is connected to battery voltage, which will be interpreted by the CM3620 as active.

Since the input 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:

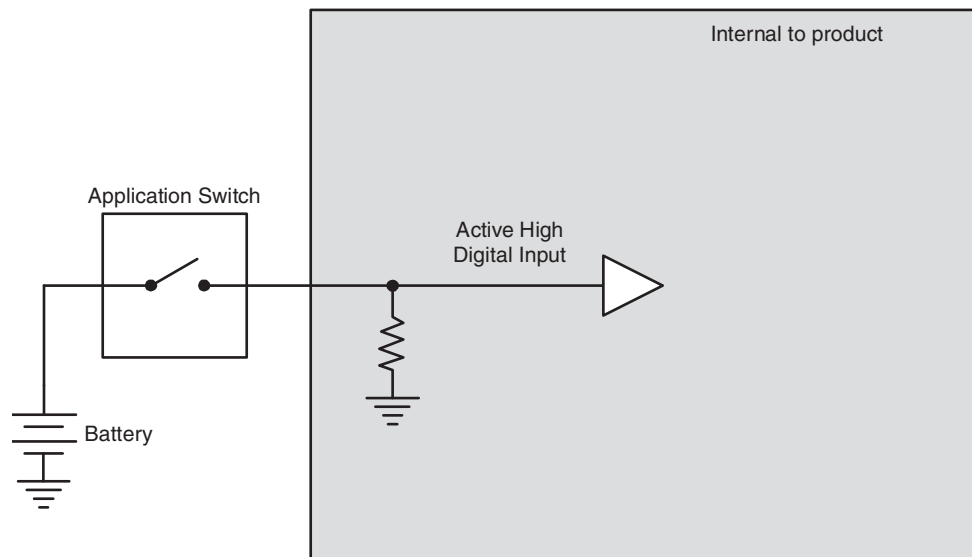


Figure 4: Active high digital input

4.1.2. Power Control Digital Inputs

The CM3620 has two active-high power control digital inputs that are used for waking up (turning on) the product, as follows:

- INPUT1_D and INPUT2_D

4.1.2.1. Power Control Digital Input Capabilities

The CM3620 has an active high power control digital input that must be activated to power up the CM3620.

The following table provides specifications for the CM3620's power control digital inputs:

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

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 CM3620 when switched high to a voltage of 4.0 V or greater, and turns the CM3620 off when switched low to a voltage less than 1.5 V. The CM3620 will also shut off when an open circuit condition occurs on the power control digital input.

4.1.2.2. Power Control Digital Input Configuration Options

The power control digital inputs (`DIGITAL_1` and `DIGITAL_2`) can be configured as power control digital inputs, or standard digital inputs. If the inputs are configured as power control, then the wetting current must also be configured.

If you configure `DIGITAL_1` and/or `DIGITAL_2` as a power control input

- The CM3620 will only power up when the power control input is active and only shut down when it is inactive.
- The input(s) configured as power control must also be configured as active high to turn on the CM3620.
- The wetting current must be configured according to the following:

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

- ◆ Because all power control digital inputs must be active high, they must have an internal pull-down resistor. The minimum pull-down resistance for digital inputs in a **24 V system is 2.8 k Ω** . The minimum pull-down resistance for digital inputs in a **12 V system is 1.2 k Ω** .

- ◆ The CM3620 has a maximum allowable wetting current of approximately **10 mA**. Wetting currents greater than 10 mA must be incorporated using resistors embedded in the system wire harness.

If you do not configure `DIGITAL_1` or `DIGITAL_2` as a power control input

- The CM3620 will power up when battery voltage is applied to the power pins (`VBATT`) (refer to the *Standard Digital Input Configuration Options* on page 12 section for details on what you can do with `DIGITAL_1` and `DIGITAL_2` when they aren't used for power control).

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

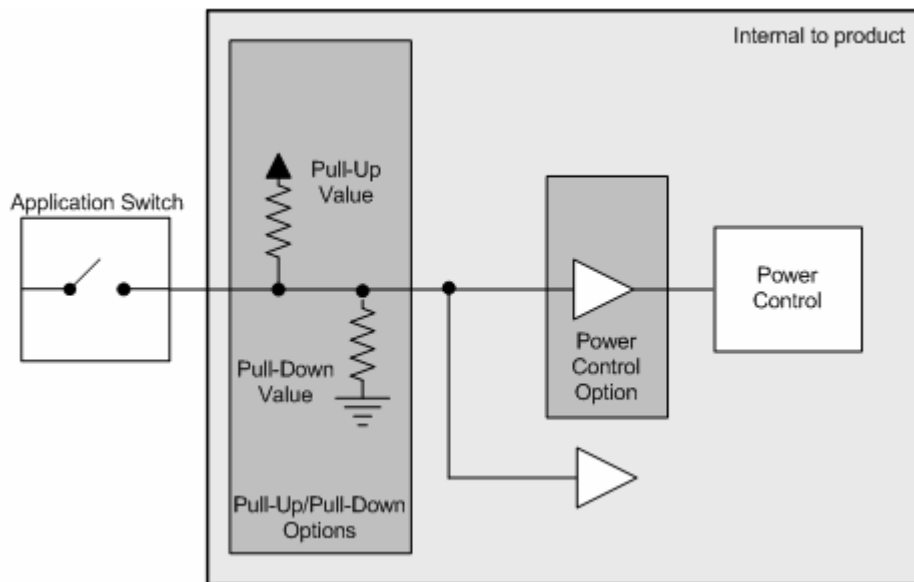


Figure 5: Power control digital input configuration options

4.1.2.3. Power Control Digital Input Installation Connections

When connecting power control inputs, note that

- 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 CM3620 to the ignition, place a fuse of 200 mA or higher in the circuit that feeds the CM3620.
- When battery power (`VBATT`) is connected, and the power control digital input is inactive, the CM3620 will go into sleep mode.

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

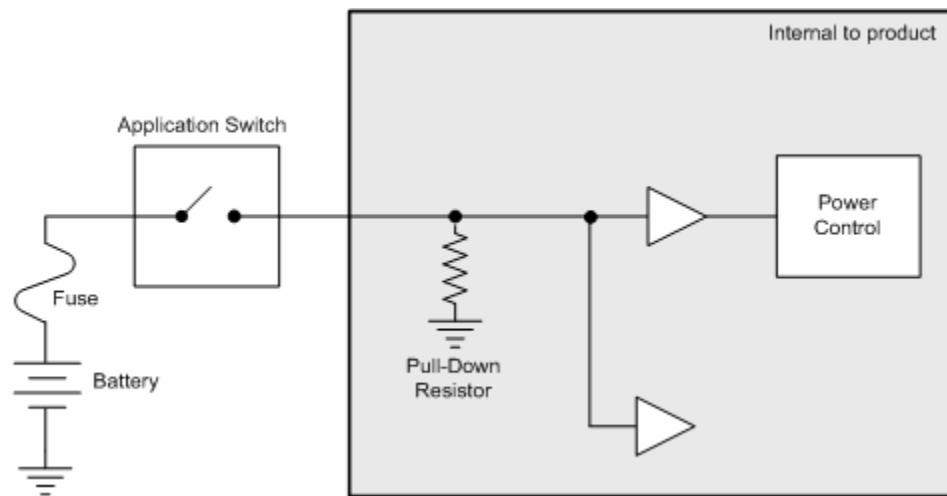


Figure 6: Power control digital input installation connections

4.2. Analog Inputs

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

There are two types of analog inputs in the CM3620:

- Amplified analog inputs
- Basic analog inputs

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

4.2.1. Amplified Analog Inputs

The CM3620 has 4 amplified analog inputs:

- ANALOG_1 through ANALOG_4

4.2.1.1. Amplified Analog Input Capabilities

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

The following table provides specifications for the CM3620's amplified analog inputs:

| Amplified Analog Input Specifications | | | | |
|-------------------------------------------------------|-------|-----|-------|------|
| Item | MIN | NOM | MAX | UNIT |
| Input voltage range | 0 | - | 32 | V |
| Analog gain | - | - | 8.5 | V/V |
| Pull-up resistance power dissipation - analog 3 and 4 | - | - | 0.5 | W |
| Pull-up resistance (24 V system) - analog 3 and 4 | 1000 | - | - | Ω |
| Pull-up resistance (12 V system) - analog 3 and 4 | 250 | - | - | Ω |
| Pull-up resistance Power Dissipation - analog 1 and 2 | - | - | 0.125 | W |
| Pull-up resistance (24 V system) - analog 1 and 2 | 4100 | - | - | Ω |
| Pull-up resistance (12 V system) - analog 1 and 2 | 1000 | - | - | Ω |
| Over-voltage | - | - | 36 | V |
| Resolution | - | 10 | - | Bit |
| Accuracy (precision option) | - | - | 3 | % |
| Accuracy (basic option) | - | - | 5 | % |
| ADC reference voltage (precision option) | 2.994 | 3.0 | 3.006 | V |
| ADC reference voltage (basic option) | 3.13 | 3.3 | 3.46 | V |
| Frequency cutoff | - | - | 12 | kHz |

4.2.1.2. Amplified Analog Input Configuration Options

With amplified analog inputs (`ANALOG_1` through `ANALOG_4`) you can

- Select either **pull-up** or **pull-down** resistors
- Select whether the pull-up voltage is configured as battery voltage or sensor voltage
- Have **reference shift resistors** for creating bridge sensor inputs
- Select the amount of **attenuation** or **gain**
- Configure the cutoff frequency for a **2-pole low-pass filter**, which is provided with each input

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

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

The ideal configuration for your analog input is based on the specifications of the sensor you plan to connect to the input. Parker Vansco will select the appropriate configuration for your analog input to ensure it is compatible with your sensor.

The following diagram shows the configuration options for amplified analog inputs:

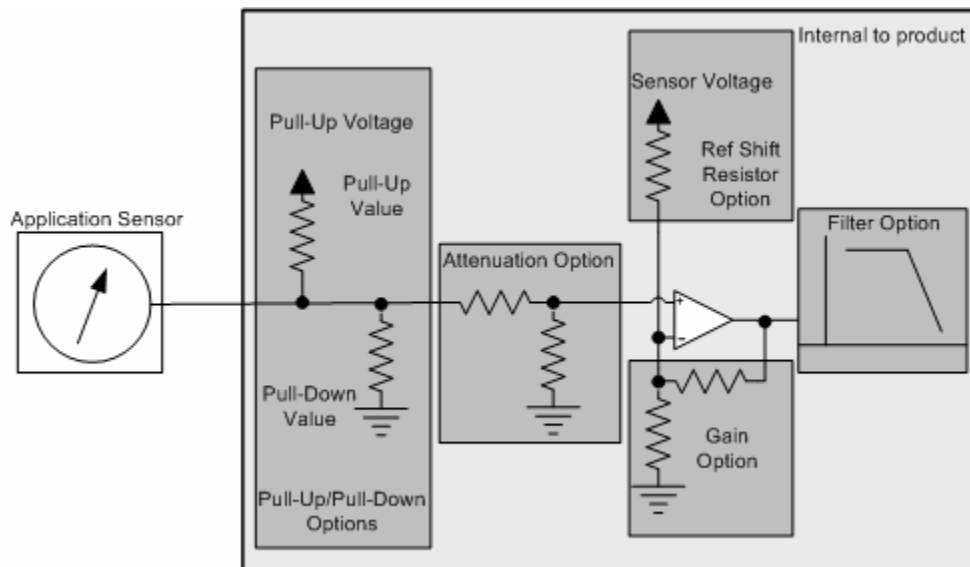


Figure 7: Amplified analog input configuration options

4.2.1.3. Amplified Analog Input Installation Connections

Refer to the *Analog Input Connections* see "Analog Input Installation Connections" on page 21 section for more details.

4.2.2. Basic Analog Inputs

The CM3620 has 6 basic analog inputs:

- ANALOG_5 through ANALOG_10

4.2.2.1. Basic Analog Input Capabilities

Basic analog inputs provide attenuation with no gain, and can be used with resistive, voltage, and 4 mA to 20 mA sensors.

The following table provides specifications for the CM3620's basic analog inputs:

| Basic Analog Input Specifications | | | | |
|--------------------------------------------------------|-------|-----|-------|----------|
| Item | MIN | NOM | MAX | UNIT |
| Input voltage range | 0 | - | 32 | V |
| Analog gain | - | - | 1 | V/V |
| Pull-up resistance power dissipation - analogs 7 to 10 | - | - | 0.5 | W |
| Pull-up resistance (24 V system) - analogs 7 to 10 | 1000 | - | - | Ω |
| Pull-up resistance (12 V system) - analogs 7 to 10 | 250 | - | - | Ω |
| Pull-up resistance power dissipation - analogs 5 and 6 | - | - | 0.125 | W |
| Pull-up resistance (24 V system) - analogs 5 and 6 | 4100 | - | - | Ω |
| Pull-up resistance (12 V system) - analogs 5 and 6 | 1000 | - | - | Ω |
| Over-voltage | - | - | 36 | V |
| Resolution | - | 10 | - | Bit |
| Accuracy (precision option) | - | - | 3 | % |
| Accuracy (basic option) | - | - | 5 | % |
| ADC reference voltage (precision option) | 2.994 | 3.0 | 3.006 | V |
| ADC reference voltage (basic option) | 3.13 | 3.3 | 3.46 | V |
| Frequency cutoff | - | - | 71 | Hz |

4.2.2.2. Basic Analog Input Configuration Options

With basic analog inputs (ANALOG_5 through ANALOG_10) you can

- Select either **pull-up** or **pull-down** resistors
- Select the amount of **attenuation**
- Configure the cutoff frequency for a **single-pole low-pass filter**, which is provided with each input

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

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

The ideal configuration for your analog input is based on the specifications of the sensor you plan to connect to the input. Parker Vansco will select the appropriate configuration for your analog input to ensure it is compatible with your sensor.

The following diagram shows the configuration options for basic analog inputs:

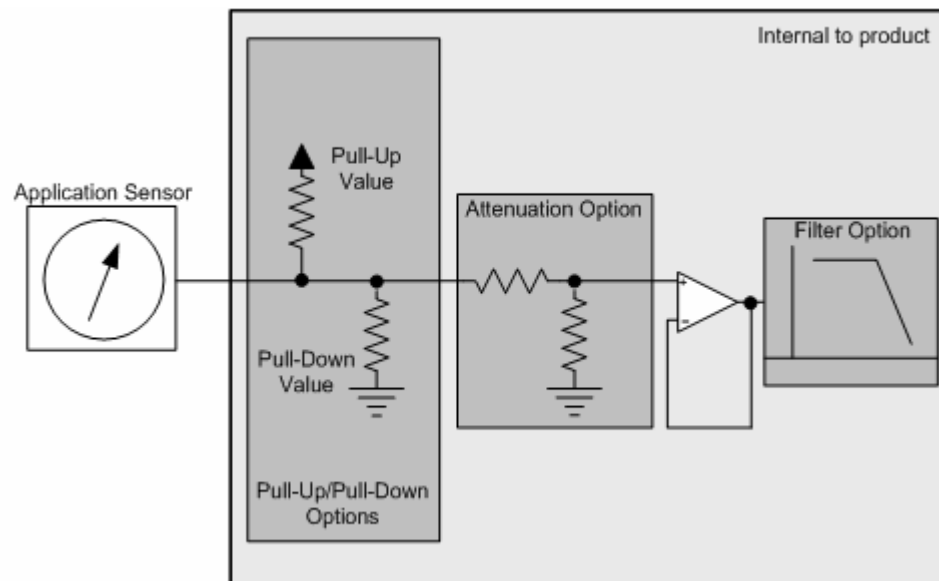


Figure 8: Basic analog input configuration options

4.2.2.3. Basic Analog Input Installation Connections

Refer to the *Analog Input Connections* see "Analog Input Installation Connections" on page 21 section for more details.

4.2.3. Analog Input Installation Connections

When connecting analog inputs, be aware of system noise and ground level shift.

System Noise

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

To reduce system noise

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

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

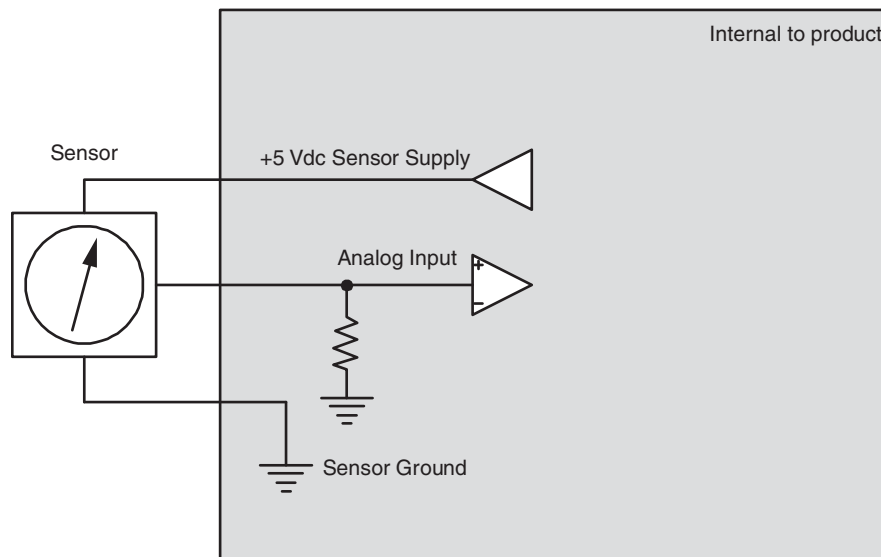


Figure 9: Analog input system noise reduction

Ground Level Shift

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

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

To reduce ground level shift for sensors that have dedicated ground wires

- Dedicate one of the five system ground inputs (GROUND) to sensors that have dedicated ground wires, and connect all sensor grounds to this system ground input.
- Splice the other four system ground inputs together in the vehicle harness (close to the connector), to provide a better ground for the noisier low-side outputs and digital circuits.
- Ensure the sensor's ground connection is close to the system ground connections. This will help ensure the signal remains within the digital activation range of the input.

Note: The CM3620 system ground inputs are rated for low-current signals, and ensure the sensor's ground is very close in voltage potential to the CM3620 ground.

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

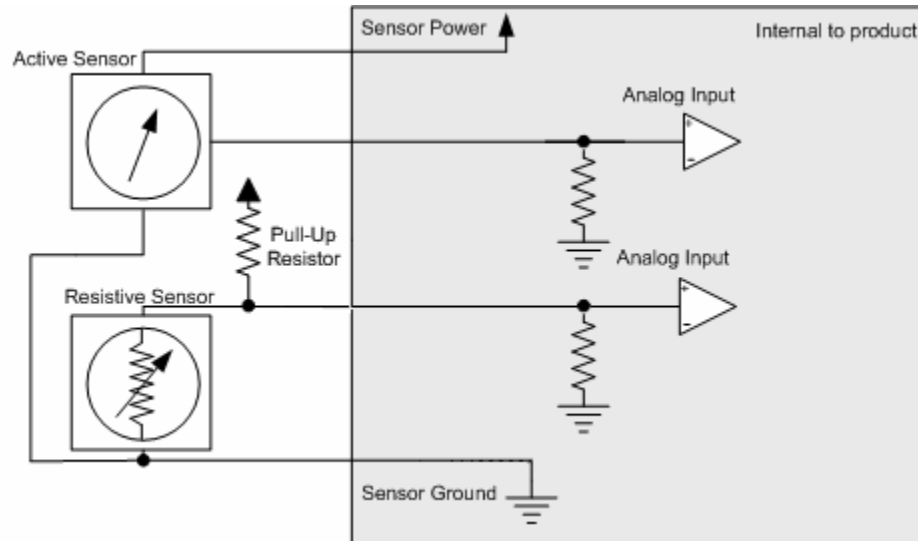


Figure 10: Analog input with ext. pull-up for sensors with ground wire

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

- Connect a ground wire from the sensor's mounting location to analog input 1. Analog input 1 can be configured as a negative amplifier, allowing it to detect a difference between the voltage of the CM3620 ground and the voltage of the sensor ground (the difference is the ground shift).

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

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

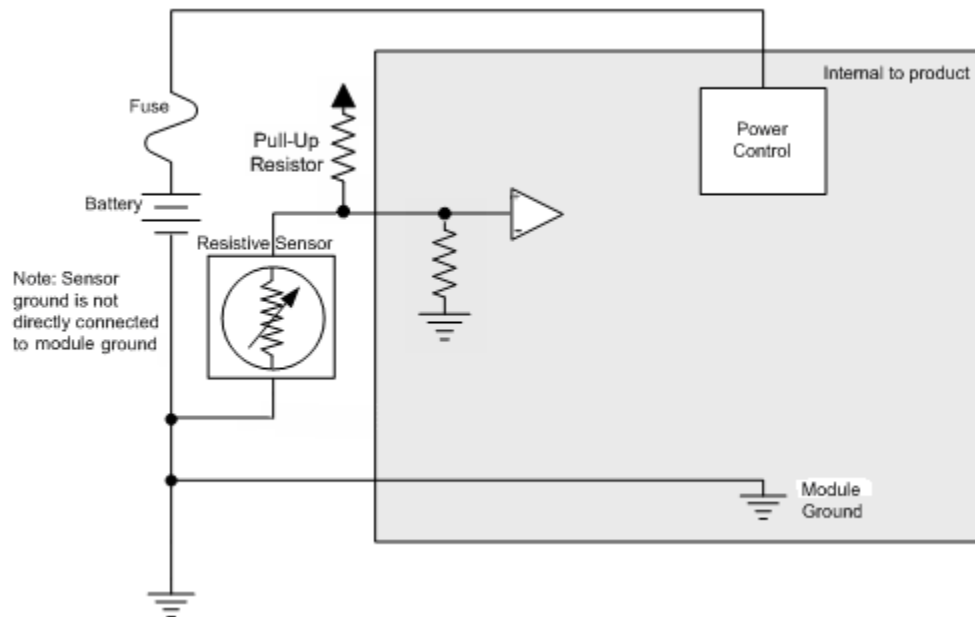


Figure 11: Analog input with ext. pull-up for sensors without ground wire

4.3. Frequency Inputs

Frequency inputs are typically used to read pulse signals.

There are two types of frequency inputs in the CM3620:

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

4.3.1. AC-Coupled Frequency Inputs

The CM3620 has 2 AC-coupled frequency inputs:

- `FREQ_1`
- `FREQ_2`

4.3.1.1. 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 that you not use these functions with AC-coupled frequency inputs.

The following table provides specifications for the CM3620's AC-coupled frequency inputs:

| AC-Coupled Frequency Input Specifications | | | | |
|-------------------------------------------|-------|-----|-------|----------|
| Item | MIN | NOM | MAX | UNIT |
| Input voltage range | -90 | - | 90 | V |
| Pull-up resistance (24 V system) | 4.7 k | - | - | Ω |
| Pull-up resistance (12 V system) | 2.2 k | - | - | Ω |
| Accuracy | - | - | 5 | % |
| Frequency range @ 2.5 Vp-p | 1 | - | 10000 | Hz |
| Frequency range @ 0.25 Vp-p | 3 | - | 850 | Hz |

4.3.1.2. AC-Coupled Frequency Input Configuration Options

With AC-coupled frequency inputs (`FREQ_1` and `FREQ_2`) you can

- Select whether the input uses a pull-up or pull-down resistor, and select a value for each resistor. The values you select for your resistors should be based on the type of sensor connected to the input.
 - ◆ If you select a pull-up resistor, it must be connected to battery voltage.

- Internally connect AC-coupled frequency inputs to analog inputs (connect `FREQ_1` to `ANALOG_5`, and `FREQ_2` to `ANALOG_6`); this is required for performing diagnostics to frequency sensors.

Note: AC-coupled frequency inputs can be configured as DC-coupled frequency inputs.

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

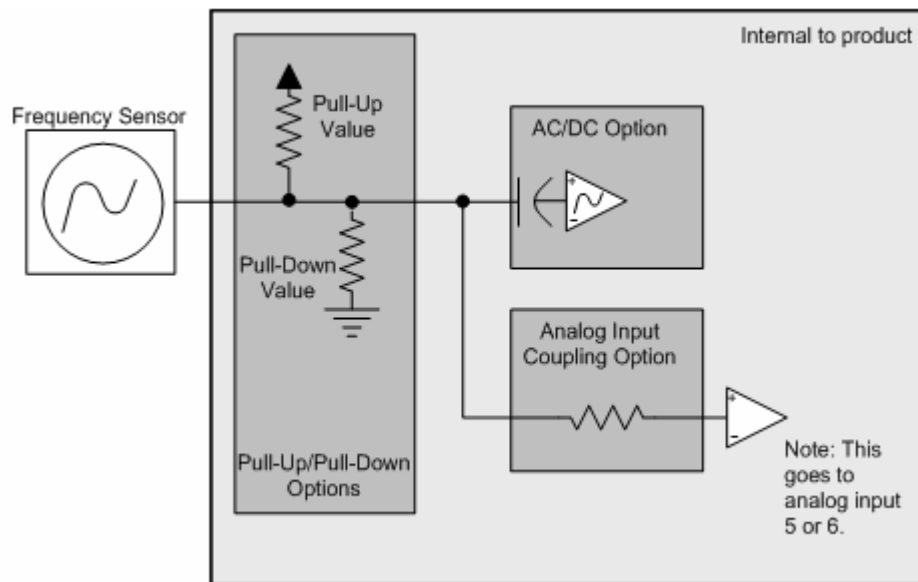


Figure 12: AC-coupled frequency input configuration options

4.3.1.3. AC-Coupled Frequency Input Installation 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 (GROUND) voltage, and the sensor ground voltage.

To reduce ground level shift:

- Dedicate one of the 5 system ground inputs (GROUND) to sensors that have dedicated ground wires, and connect all sensor grounds to this system ground input.
- Splice the other system ground inputs together in the vehicle harness (close to the connector), to provide a better ground for the noisier low-side outputs and digital circuits.
- Ensure the sensor's ground connection is close to the system ground connections. This will help ensure the signal remains within the digital activation range of the input.

Note 1: The CM3620 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:

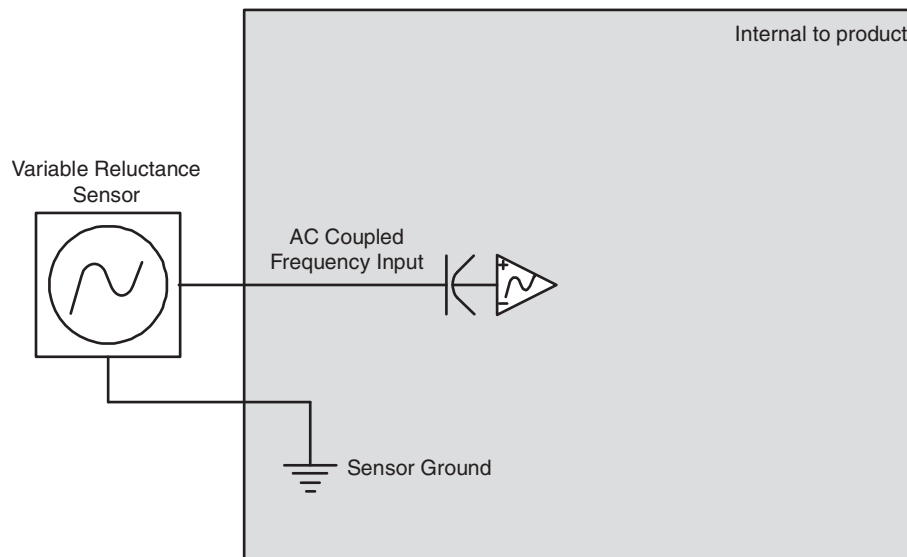


Figure 13: AC-coupled frequency input installation connections

4.3.2. DC-Coupled Frequency Inputs

The CM3620 has 2 DC-coupled frequency inputs:

- `FREQ_3`
- `FREQ_4`

4.3.2.1. 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 CM3620's DC-coupled frequency inputs:

| DC-Coupled Frequency Input Specifications | | | | |
|-------------------------------------------|-------|-------|-------|------|
| Item | MIN | NOM | MAX | UNIT |
| Input voltage range | 0 | - | 32 | V |
| Pull-up resistance power dissipation | - | 0.125 | 0.25 | W |
| Pull-up resistance (24 V system) | 4.7 k | - | - | Ω |
| Pull-up resistance (12 V system) | 2.2 k | - | - | Ω |
| Over-voltage | - | - | 36 | V |
| Frequency accuracy | - | - | 5 | % |
| Frequency range | 1 | - | 10000 | Hz |
| Minimum negative going threshold | 1.56 | - | - | V |
| Maximum positive going threshold | - | - | 3.65 | V |
| Analog gain | - | - | 1 | V/V |
| Analog resolution | - | 10 | - | Bit |
| Analog accuracy (precision option) | - | - | 3 | % |
| Analog accuracy (basic option) | - | - | 5 | % |
| ADC reference voltage (precision option) | 2.994 | 3.0 | 3.006 | V |
| ADC reference voltage (basic option) | 3.13 | 3.3 | 3.46 | V |

4.3.2.2. DC-Coupled Frequency Input Configuration Options

With DC-coupled frequency inputs (`FREQ_3` and `FREQ_4`) you can

- Select whether an input uses a pull-up or pull-down resistor, and select a value for each resistor. The values you select for your resistors should be based on the type of sensor connected to the input.
 - ♦ If you select a pull-up resistor, it must be connected to battery voltage, or sensor voltage.
- Internally connect DC-coupled frequency inputs to analog inputs (you can configure `FREQ_3` and `FREQ_4` to connect to their own internal analog circuit and each analog circuit can have their attenuation and filter cutoff configured); this is required for performing diagnostics to frequency sensors.

Note: DC-coupled frequency inputs can also be configured to function as digital or analog inputs.

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

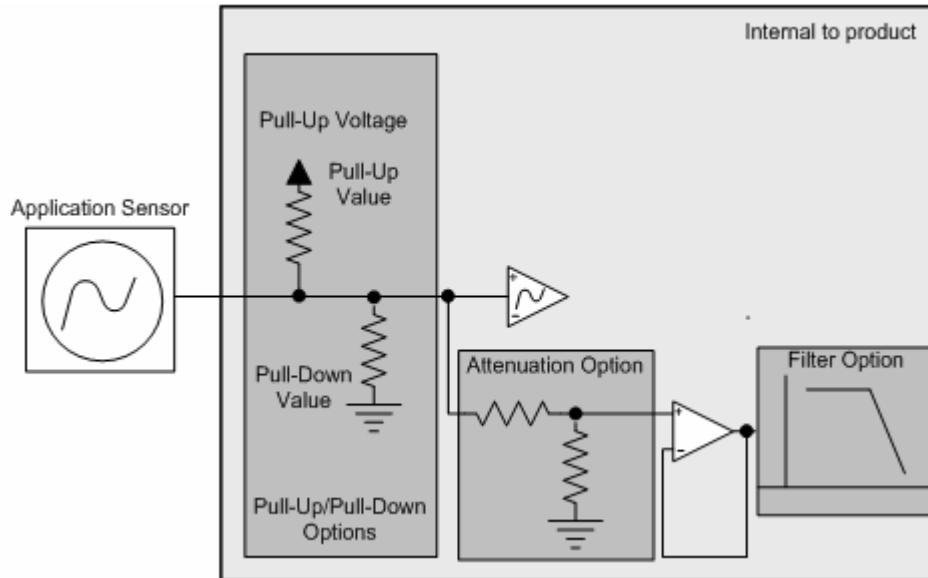


Figure 14: DC-coupled frequency input configuration options

4.3.2.3. DC-Coupled Frequency Input Installation 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 (GROUND) voltage, and the sensor ground voltage.

To reduce ground level shift:

- Dedicate one of the 5 system ground inputs (called GROUND) to sensors that have dedicated ground wires, and connect all sensor grounds to this system ground input.
- Splice the other system ground inputs together in the vehicle harness (close to the connector), to provide a better ground for the noisier low-side outputs and digital circuits.
- Ensure the sensor's ground connection is close to the system ground connections. This will help ensure the signal remains within the digital activation range of the input.

Note 1: The CM3620 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:

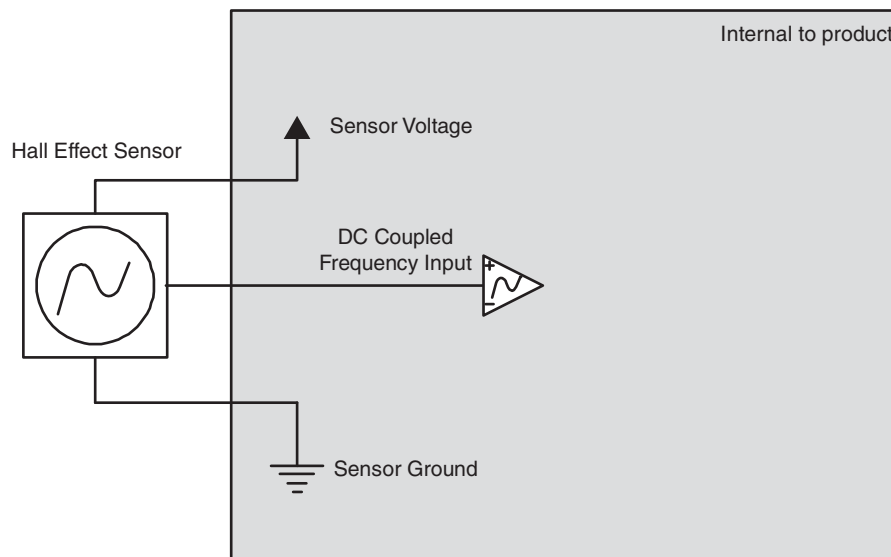


Figure 15: DC-coupled frequency input installation connections

5. Outputs

The CM3620 has 20 solid-state FET technology outputs designed for low to medium current and high inrush inductive load switching. Output currents can range up to 2.5 A.

The CM3620 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. High-Side Outputs

The CM3620 has 16 high-side outputs:

- HS_OUTPUT_1 to HS_OUTPUT_16

5.1.1. High-Side Output Capabilities

High-side outputs are used for switching voltage to loads using either a pulse width modulated (PWM) signal, or an on/off signal. They can also test for various fault conditions, which can be used for software diagnostics (refer to *High-Side Output Diagnostics and Fault Detection on page 37* 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 CM3620, where the percentage of time that the output is on vs. off is determined by the duty cycle of the signal, and the duty cycle is determined by the application software.

- When a high-side output is used as an on/off signal, the output provides battery voltage when in the on state (the application software is responsible for switching high-side outputs on and off).

The following table provides specifications for the CM3620's high-side outputs:

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

5.1.2. High-Side Output Configuration Options

The high-side outputs (HS_OUTPUT_1 to HS_OUTPUT_16) can be configured as either a digital input or a high-side output.

If you require the output to be configured as a high-side output

You need to determine if the output requires open load detection, which is typically required for critical loads where the loss of the load must be reported.

- If the output requires open load detection, the output **will** be configured with a **10 kΩ pull-up resistor**.
- If the output does not require open load detection, the output **will not** be configured with a **10 kΩ pull-up resistor**.

You need to determine if the output requires continuous open load fault detection, or software-controlled open load fault detection.

- If you require **continuous open load fault detection**, the CM3620 will be configured to continuously inject low-level current into the load, and is typically not used with LEDs, because it causes the LED to glow continuously.
- If you require **software-controlled fault detection**, the application software in the CM3620 will determine when to inject low-level current into the load.

Software-controlled fault detection is useful when the load that needs to be monitored cannot be permanently connected to a 10 k Ω pull-up, and is typically used with LEDs.

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

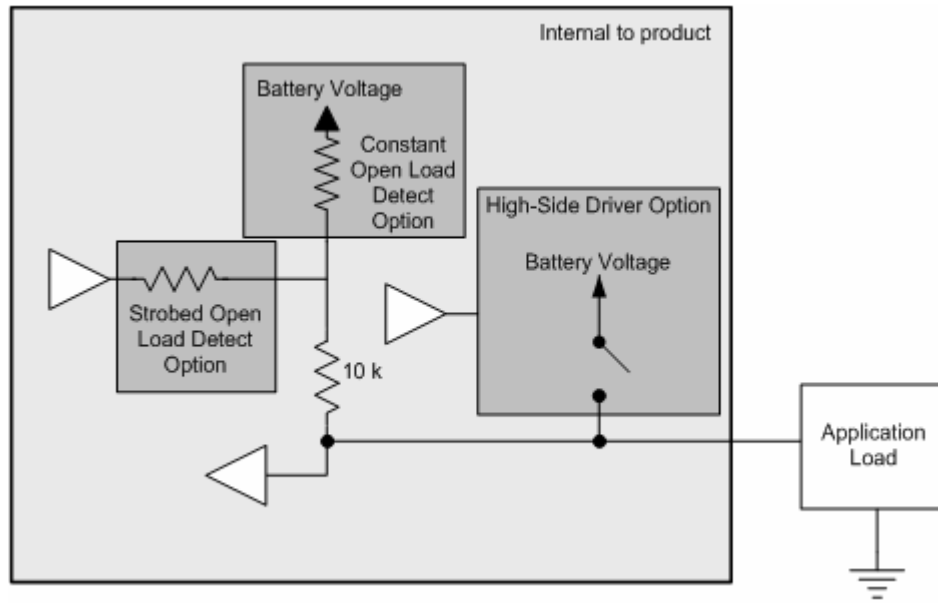


Figure 16: High-side output configured as a high-side output

If the output is configured as a digital input

- The digital input will be active low, and have a pull-up resistor that has a value of **10 k Ω** .

Note: Selecting digital inputs must be done in pairs of high-side outputs. In other words, if `HS_OUTPUT_1` is selected as a digital input, then `HS_OUTPUT_2` must also be selected as a digital input.

The following diagram shows the configuration options for using an output as a digital input:

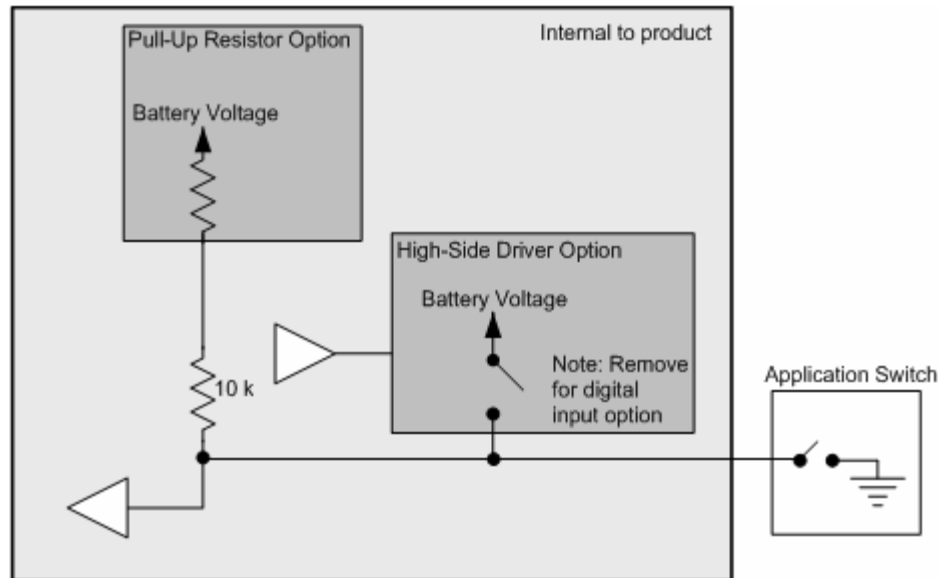


Figure 17: High-side output configured as a digital input

5.1.3. High-Side Output Installation Connections

When connecting high-side outputs, note that

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

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

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 $\frac{1}{2}$ 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 CM3620 power grounds.

The following shows a typical high-side output connection:

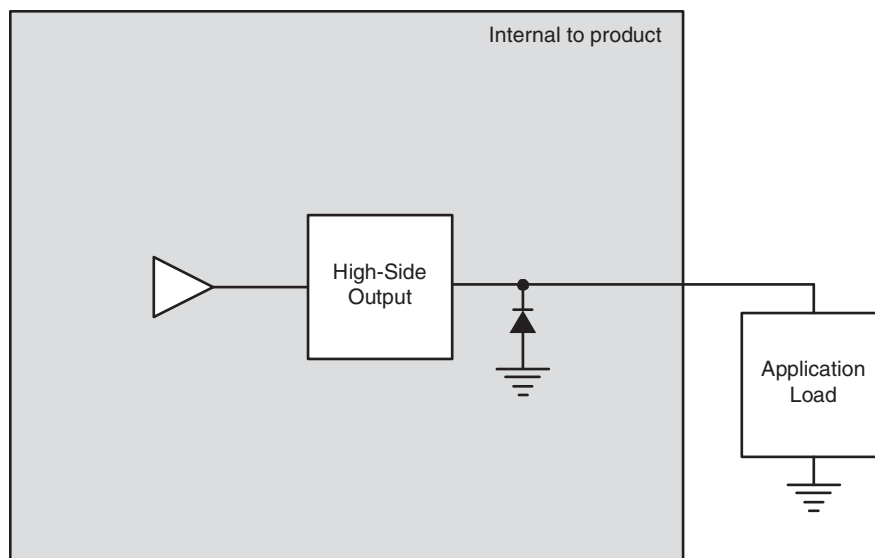


Figure 18: Typical high-side output installation connections

5.1.3.1. High-Side Output De-Rating Requirements

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

Note: How an output is de-rated is based on how all outputs are being used collectively on the CM3620.

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

Current

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

- Outputs 1 and 2 share the same circuitry as do outputs 3 and 4, 5 and 6, and so on, to outputs 15 and 16.
- The maximum allowable current for two outputs that share the same circuitry is 4 A. For example, if output 1 is driving 2.5 A, then output 2 should be derated to less than 1.5 A.

Power dissipation

You must determine how much power is dissipated by each output. The total allowable power dissipation inside the CM3620 must be less than 7 W, which will eliminate the need for additional heat sinking. Most of the power dissipation comes from the output drivers.

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

$$\left(I_{\text{out}1}\right)^2 R_{\text{dson}1} + \left(I_{\text{out}2}\right)^2 R_{\text{dson}2} + \dots + \left(I_{\text{out}N}\right)^2 R_{\text{dson}N}$$

- $I_{\text{out}N}$ = output current for output N
- $R_{\text{dson}N}$ = 0.09Ω or 0.06Ω (resistance of the high-side or low-side output FET, respectively) for output N

5.1.4. High-Side Output Diagnostics and Fault Detection

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

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

5.1.4.1. Short Circuit

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

5.1.4.2. Open Load

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

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

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

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

5.1.4.3. Short-to-Battery

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

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

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

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

5.2. Low-Side Outputs with Current Sense

The CM3620 has 4 low-side outputs:

- LS_OUTPUT_17 to LS_OUTPUT_20

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 CM3620, 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 over-current or short-circuit event when the voltage from the amplifier reaches 2.9 V; therefore, the actual usable voltage range from the amplifier is only 0 V to 2.8 V.

The following table provides specifications for the CM3620's low-side outputs:

| Low-Side Output Specifications | | | | |
|--------------------------------|------|-----|-----|----------|
| Item | MIN | NOM | MAX | UNIT |
| Switchable voltage range | 0 | - | 32 | V |
| Output current | 0 | - | 2.5 | A |
| Output on state resistance | - | 50 | - | mΩ |
| Load resistance (12 V system) | 5.3 | - | - | Ω |
| Load resistance (24 V system) | 10.7 | - | - | Ω |
| Current sense amp range | 0 | - | 2.8 | V |
| Over-current trip point | - | 2.9 | - | V |
| Current sense resolution | - | 10 | - | bit |
| Current sense accuracy | - | - | 5 | % |
| Current sense resistance | 0.1 | - | - | Ω |
| Over-voltage | - | - | 36 | V |
| PWM frequency | - | - | 500 | Hz |
| PWM resolution | - | - | 0.1 | % |
| Inductive pulse protection | - | - | 628 | V (peak) |

5.2.2. Low-Side Outputs with Current Sense Configuration Options

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

- You can configure the resistor used for sensing current so that it maximizes the accuracy of the current measurement. The maximum resistor value is **0.4 Ω**.
- You can configure the gain in the amplifier circuit that is used for current sensing so that it maximizes the accuracy of the current measurement. The maximum gain on the amplifier is **10**.
- You can configure a **2-pole low-pass filter**, which is used for sensing current, so that it reduces noise in the current measurement.

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

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

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

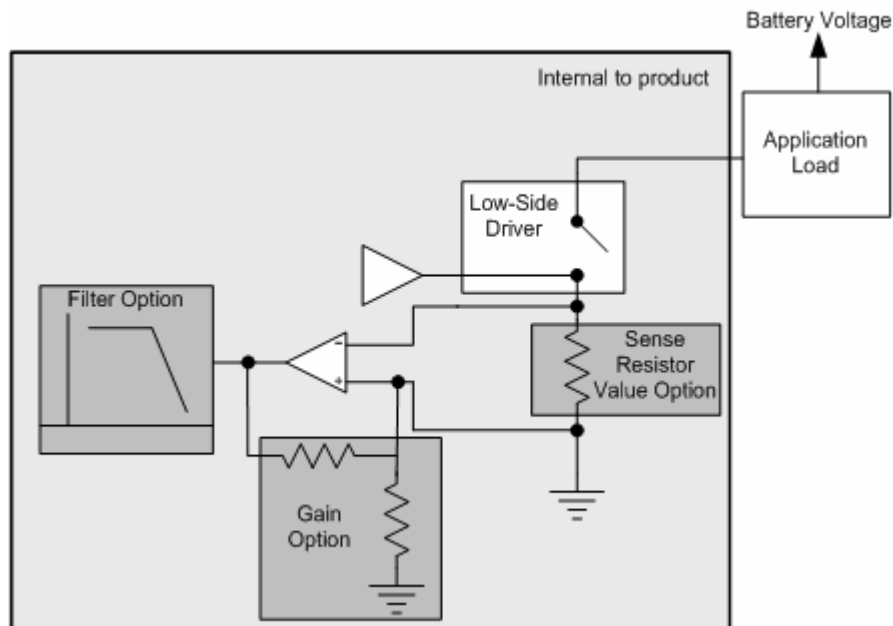


Figure 19: Low-side outputs with current sense configuration options

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 (GROUND).
- Low-side outputs provide switched ground to any load type in a vehicle.
- Low-side outputs can sink up to 2.5 A.
- When connecting a load to a low-side output, ensure the load will not drive currents greater than the maximum specified peak current, or maximum specified continuous current.

The following shows a typical low-side output connection:

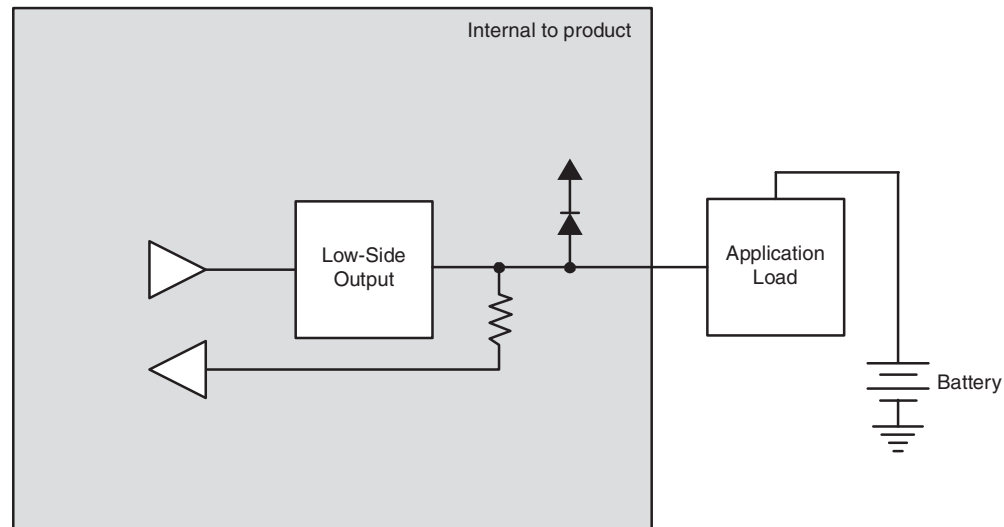


Figure 20: Low-side outputs with current sense installation connections

5.2.3.1. Low-Side Output De-Rating Requirements

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

Note: How an output is de-rated is based on how all outputs are being used collectively on the CM3620.

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

Power dissipation

You must determine how much power is dissipated by each output. The total allowable power dissipation inside the CM3620 must be less than 7 W, which will eliminate the need for additional heat sinking. Most of the power dissipation comes from the output drivers.

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

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

- I_{outN} = output current for output N
- R_{dsonN} = 0.09Ω or 0.06Ω (resistance of the high-side or low-side output FET, respectively) for output N

5.2.4. Low-Side Outputs with Current Sense Diagnostics

The CM3620's low-side outputs have the ability to report many different fault conditions, and are protected against short-circuit and over-current, open load, and short-to-ground faults.

5.2.4.1. Open Load

Open load faults occur when a high-side output pin is open circuit (not connected to a load). The high-side output circuit uses a small amount of current on the output pin to determine if an open load condition exists.

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

5.2.4.2. Short Circuit

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

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

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

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

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.

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

6. Power

The CM3620 is powered by the vehicle battery. The CM3620 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 CM3620 has 5 pins, labeled VBATT, dedicated to providing power for logic and outputs, and 5 pins, labeled GROUND, dedicated to grounding the CM3620.

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 200 mA.

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

The following table provides specifications for the CM3620 logic and output power:

| Logic and Output Power Specifications | | | | |
|----------------------------------------------|-------------|-----|-----|------|
| Item | MIN | NOM | MAX | UNIT |
| Input voltage range | 7.5 | - | 32 | V |
| Over-voltage | - | - | 36 | |
| Current draw in on state (excluding outputs) | - | 200 | - | mA |
| Current draw in on state (including outputs) | Need values | | | |
| Current draw in off state | - | - | 100 | uA |
| In-line fuse required on power pins | | 50 | | A |
| Number of power pins | | 5 | | |
| Number of ground pins | | 5 | | |

6.1.2. Logic and output power connections

When connecting the CM3620 logic and output power, note that

- Logic and output power connections are made using the VBATT and GROUND pins.
- The number of wires needed to connect the CM3620 power depends on the amount of current required by the application.
 - ◆ It is recommended that you use one 16 AWG wire for every 8 A of expected output current; however, this is not always true and depends on your application.
- The CM3620 is protected against reverse-battery connections by an internal high-current conduction path that goes from ground to power. To protect the CM3620 from damage in a reverse-battery condition, place a fuse of 50 A or less in series with the power wires in the application harness.

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 CM3620 should be fused to protect the vehicle harness.

The following shows a typical logic and output power connection:

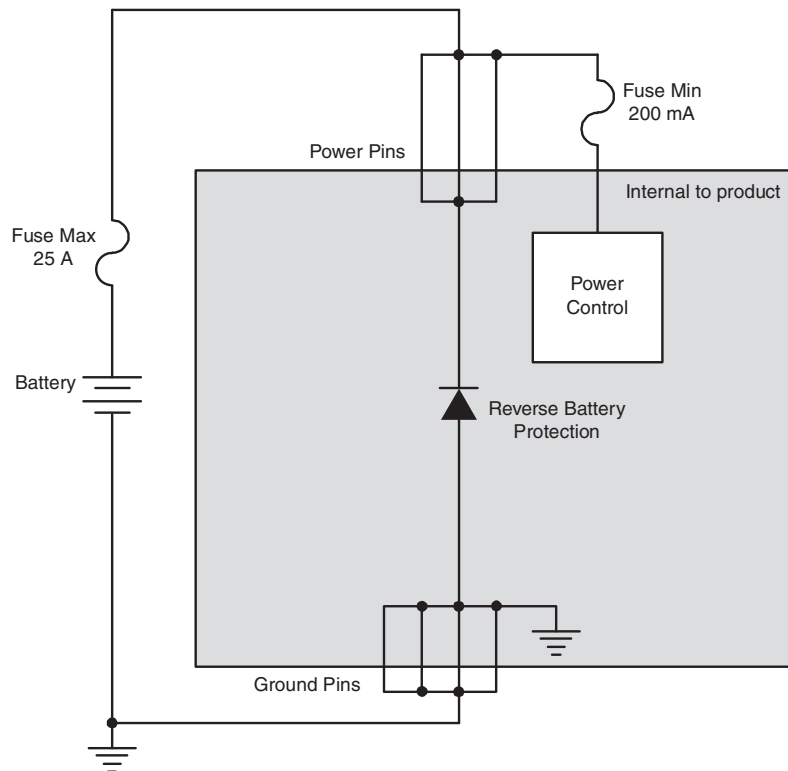


Figure 21: Logic and output power installation connections

6.2. Sensor supply

The CM3620 has one pin, labeled `vSENSOR`, dedicated to providing power to external sensor.

Warning! Do not drive more than 300 mA of current through the `vSENSOR` 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

The `vSENSOR` offers two software programmable output voltages of either 5 V or 8 V. It is a switching regulator that supplies a high output current that does not have to be de-rated when used on 24V systems.

Note: The voltage provided to the CM3620 must be 7 V or greater to ensure that the `vSENSOR` can provide 5 V. The voltage provided to the product must be 10 V or greater to ensure the sensor supply can provide 8 V.

The following table provides specifications for the CM3620's sensor power output:

| Sensor Power Specifications | | | | |
|----------------------------------|------|------|------|------|
| Item | MIN | NOM | MAX | UNIT |
| Input voltage range (5 V output) | 7 | - | 32 | |
| Input voltage range (8 V output) | 10 | - | 32 | V |
| Over-voltage | - | - | 36 | V |
| Output voltage range (5 V) | 4.74 | 5.02 | 5.30 | V |
| Output voltage range (8 V) | 7.63 | 8.09 | 8.56 | V |
| Output voltage accuracy | - | - | 6 | % |
| Output current | 0 | - | 300 | mA |

6.2.1.1. Sensor Power Fault Responses

V_{SENSOR} 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 Configuration Options

V_{SENSOR} can be configured in a custom CM3620 to supply any fixed voltage between **3.0 V** and **8.5 V**.

You have the option of using one of two regulators for providing the sensor power output, as follows:

- Low-current linear regulator
- High-current switching regulator

Note: The regulator you choose depends on your system voltage and required sensor current, as shown in Table.

6.2.3. Sensor Power Connections

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

7. Communication

The CM3620 can use two methods of communication with other modules on the vehicle or with a personal computer:

- CAN communication
- RS232 communication

7.1. Controller area network

The CM3620 has 2 Controller Area Network (CAN) communication port(s) available. The CM3620 hardware provides controller area network (CAN) communication according to the SAE J1939 specification, making the CM3620 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. Input and output information is communicated through the CAN at a sample rate of 40 Hz. Lack of regular CAN communication is an indication that there is either a problem with a module in the network, or a problem with the CAN bus.

CAN communication provides a feature called Wake on CAN, which is a way to provide power control to the CM3620.

Wake on CAN provides a low-current sleep mode that turns on the CM3620 when a CAN message is received by the module.

It is not possible to filter messages that are used to turn on the CM3620 using Wake on CAN. For this reason, any message will turn on the CM3620. The application software must be written to determine how the CM3620 will behave when it is turned on.

The following table provides specifications for the CAN:

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

7.1.2. J1939 CAN Configuration Options

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

- Wake on CAN** - You can enable or disable this feature. If enabled, the CM3620 will turn on when a CAN message is received. If disabled, CAN messages will have no effect on providing power control for the CM3620.
- Internal CAN Termination Resistor** - You have the option of configuring the CM3620 to have a **120 Ω** CAN termination resistor embedded inside the module, which is required if you plan on using CAN communication. Embedding the resistor in the module allows you to avoid designing it into the vehicle harness.

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

7.1.3. J1939 CAN Installation Connections

The CAN connection for the CM3620 should conform to the J1939 standard.

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

Note: The CM3620 does not have a CAN termination resistor, which is based on the assumption that the CAN bus is terminated in the harness.

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

- CAN Cable:** A shielded twisted-pair cable should be used when connecting multiple modules to the CAN bus. The cable for the J1939 CAN bus has three wires: CAN High, CAN Low, and CAN Shield (which connect to the corresponding CAN_HIGH, CAN_LOW, and CAN_SHIELD pins on the connector). The CAN cable must have an impedance of 120 Ω .

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

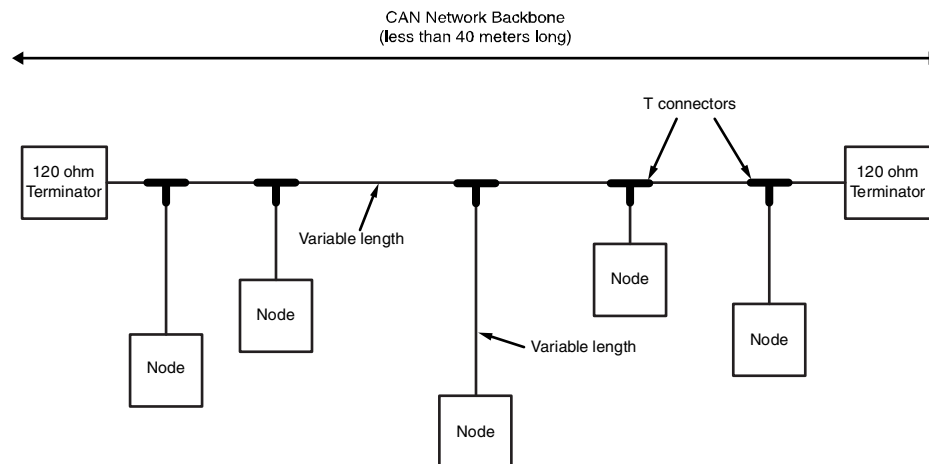


Figure 22: J1939 CAN connection

7.2. RS232 Communication

The CM3620 could send and receive data with another module, or a personal computer, using an RS232 serial port communication channel, in configurations where the second CAN bus is not present.

There are two pins that would be used for RS232 communication:

- DIGITAL_21/CAN2_LO/RS232_RX
- DIGITAL_22/CAN2_HI/RS232_TX

7.2.1. RS232 Capabilities

RS232 supports the following baud rates:

2400

4800

9600

19200

38400

57600

115200

Note: Using high baud rates will use a lot of processor resources, and it is recommended to use lower rates. The use of high baud rates should be analyzed for each application.

7.2.2. RS232 Configuration Options

There are two standard digital inputs that would be configured in a custom unit for RS232 to allow you to use RS232 communication in your system:

- DIGITAL_21/CAN2-LO/RS232_RX can be configured as an RX line that is compliant with RS232 specifications.
- DIGITAL_22/CAN2-HI/RS232_TX can be configured as a TX line that is compliant with RS232 specifications.

Note: DIGITAL_21 and DIGITAL_22 cannot be used as standard digital inputs or CAN when used for RS232 communication.

8. Connectors

The CM3620 has two 35-pin Ampseal connectors, as follows:

- Black (J1): AMP 776164-1
- White (J2): AMP 776164-2

Both connectors have pins that connect to inputs, outputs, and communication channels used by the CM3620. They also have keying that prevents you from incorrectly mating the connectors to the vehicle harness.

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



Figure 23: Black (J1): AMP 776164-1 connector



Figure 24: White (J2): AMP 776164-2 connector

8.1. Mating Connector Part Numbers

The maximum wire gage usable in the CM3620 connectors is 16 AWG with GXL insulation.

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

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

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

8.2. Connector Pin-outs

Connector pins connect to inputs, outputs, and communication channels. They provide the interface between the vehicle harness and the internal circuitry of the CM3620.

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

| Black (J1) Connector Pin-out | | |
|------------------------------|--------------|----------------------------------------|
| Pin No. | Name | Function |
| 1 | HS_OUTPUT_3 | High-side output |
| 2 | VBATT | Battery voltage input |
| 3 | VBATT | Battery voltage input |
| 4 | VBATT | Battery voltage input |
| 5 | VBATT | Battery voltage input |
| 6 | VBATT | Battery voltage input |
| 7 | ANALOG_1 | Amplified analog input |
| 8 | DIGITAL_8 | Digital input |
| 9 | DIGITAL_5 | Digital input |
| 10 | DIGITAL_3 | Digital input |
| 11 | DIGITAL_1 | Digital input - optional power control |
| 12 | LS_OUTPUT_18 | Low-side output with current sense |
| 13 | HS_OUTPUT_4 | High-side output |
| 14 | GROUND | System ground input |
| 15 | GROUND | System ground input |
| 16 | GROUND | System ground input |
| 17 | GROUND | System ground input |
| 18 | ANALOG_2 | Amplified analog input |
| 19 | ANALOG_4 | Amplified analog input |
| 20 | DIGITAL_6 | Digital input |
| 21 | DIGITAL_4 | Digital input |
| 22 | DIGITAL_2 | Digital input - optional power control |
| 23 | CAN_SHIELD | Controller Area Network Shield |
| 24 | HS_OUTPUT_5 | High-side output |
| 25 | HS_OUTPUT_6 | High-side output |
| 26 | HS_OUTPUT_7 | High-side output |
| 27 | HS_OUTPUT_8 | High-side output |
| 28 | VSENSOR | Sensor voltage output |
| 29 | FREQ_2 | Frequency input - AC-coupled |
| 30 | FREQ_1 | Frequency input - AC-coupled |

| Black (J1) Connector Pin-out | | |
|------------------------------|--------------|-------------------------------------|
| Pin No. | Name | Function |
| 31 | ANALOG_3 | Amplified analog input |
| 32 | DIGITAL_7 | Digital input |
| 33 | CAN1_LO | Controller Area Network Low signal |
| 34 | CAN1_HI | Controller Area Network High signal |
| 35 | LS_OUTPUT_17 | Low-side output w/ current sense |

| White (J2) Connector Pin-out | | |
|------------------------------|--------------|----------------------------------|
| Pin No. | Name | Function |
| 1 | LS_OUTPUT_20 | Low-side output w/ current sense |
| 2 | DIGITAL_12 | Digital input |
| 3 | DIGITAL_15 | Digital input |
| 4 | HS_OUTPUT_16 | High-side output |
| 5 | HS_OUTPUT_15 | High-side output |
| 6 | HS_OUTPUT_14 | High-side output |
| 7 | HS_OUTPUT_13 | High-side output |
| 8 | HS_OUTPUT_12 | High-side output |
| 9 | HS_OUTPUT_11 | High-side output |
| 10 | HS_OUTPUT_10 | High-side output |
| 11 | HS_OUTPUT_9 | High-side output |
| 12 | HS_OUTPUT_2 | High-side output |
| 13 | DIGITAL_9 | Digital input |
| 14 | DIGITAL_11 | Digital input |
| 15 | DIGITAL_14 | Digital input |
| 16 | DIGITAL_17 | Digital input |
| 17 | DIGITAL_19 | Digital input |
| 18 | ANALOG_5 | Basic analog input |
| 19 | ANALOG_7 | Basic analog input |
| 20 | ANALOG_9 | Basic analog input |
| 21 | FREQ_4 | Frequency input - DC-coupled |
| 22 | GROUND | System ground input |
| 23 | HS_OUTPUT_1 | High-side output |
| 24 | LS_OUTPUT_19 | Low-side output w/ current sense |
| 25 | DIGITAL_10 | Digital input |
| 26 | DIGITAL_13 | Digital input |
| 27 | DIGITAL_16 | Digital input |
| 28 | DIGITAL_18 | Digital input |
| 29 | DIGITAL_20 | Digital input |

| White (J2) Connector Pin-out | | |
|------------------------------|---------------------------------|----------------------------------|
| Pin No. | Name | Function |
| 30 | ANALOG_6 | Basic analog input |
| 31 | ANALOG_8 | Basic analog input |
| 32 | ANALOG_10 | Basic analog input |
| 33 | FREQ_3 | Frequency input - DC-coupled |
| 34 | DIGITAL_21/CAN2- LO/RS232_RX | Digital input, CAN-L or RS232 RX |
| 35 | DIGITAL_22/CAN2- HI/RS232_TX | Digital input, CAN-H or RS232 TX |

9. Installation

Because every system is different, it is not feasible to provide detailed installation instructions that will be suitable for every assembly. This chapter therefore provides only high-level guidelines on installing the CM3620.

The vehicle manufacturer is responsible for creating procedures for mounting the CM3620 in a vehicle during production assembly.

9.1. Mechanical Installation Guidelines

Use the following guidelines when installing the CM3620 in a vehicle.

9.1.1. Dimensions

The following diagram shows the dimensions of the CM3620:

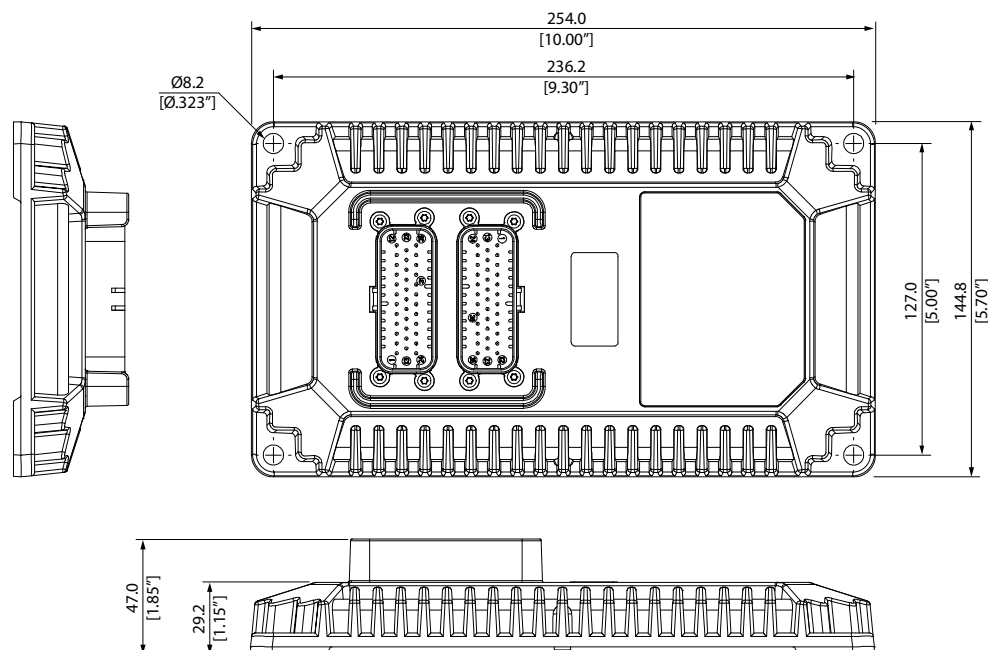


Figure 25: Dimensions

9.1.2. Selecting a Mounting Location

The CM3620 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 CM3620, review the following environmental and mechanical requirements.

Note: Do not install the CM3620 near any significant heat sources, such as a turbo, exhaust manifold, etc. Avoid installing the CM3620 near any drive-train component, such as a transmission or engine block.


9.1.2.1. Environmental Requirements

The CM3620 warranty does not cover damage caused by exposure of the product to environmental conditions that exceed its design limitations.

1. Mount the CM3620 in an environment that is within its ambient temperature range of $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$.
2. Mount the CM3620 in an environment that is within its particle ingress rating. The sealing standard for the CM3620 is EP455 level 1.

Note: The CM3620 has not been tested for water ingress according to the EP455 level 1 standard.

The CM3620 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 CM3620. The severity of a pressure wash can exceed the CM3620 pressure wash specifications related to water pressure, water flow, nozzle characteristics, and distance. Under certain conditions a pressure wash jet can cut wires.

9.1.2.2. Mechanical Requirements

Review the following mechanical requirements before selecting a mounting location for the CM3620:

- The CM3620 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 CM3620.

- The harness should be shielded from harsh impact.
- The harness should connect easily to the connector and have adequate bend radius.
- The labels should be easy to read.
- The CM3620 should be in a location that is easily accessible for service.

9.1.3. Mounting the CM3620 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 CM3620 to a vehicle:

- Secure the CM3620 with bolts in all bolt holes using Hex Head or equivalent metric size (6 mm) bolts.
- The bolts should be tightened according to the fastener manufacturer's tightening torque specifications..

The CM3620 should be mounted so that moisture drains away from it, as shown in the following:

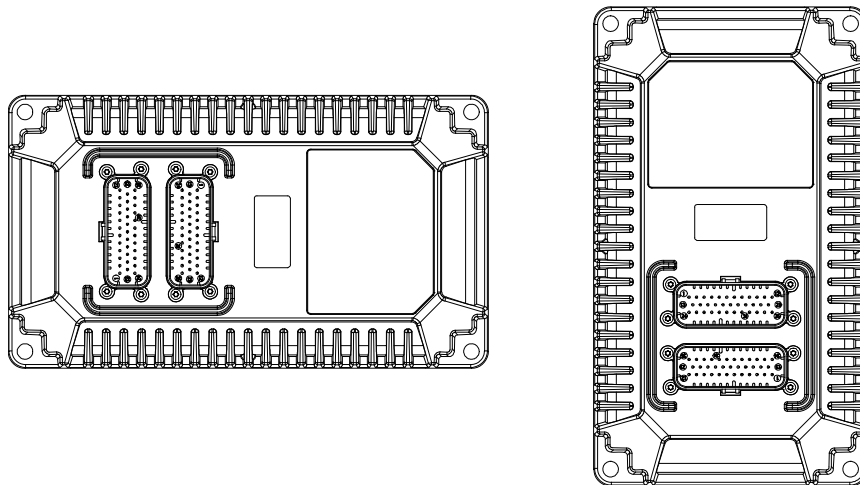


Figure 26: Recommended orientations

9.2. Electrical Installation Guidelines

Use the following guidelines when installing the CM3620 in a vehicle.

9.2.1. Designing and Connecting the Vehicle Harness

The vehicle manufacturer is responsible for designing a vehicle harness that mates with the CM3620 connector(s).

The vehicle harness design depends on the following:

- How the CM3620'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 CM3620 simply by clicking the mating connector into the connector port on the CM3620.

9.2.2. Connecting the Vehicle Harness to the CM3620

Once the vehicle harness is designed, it can be connected to the CM3620 simply by clicking the mating connector into the connector port on the CM3620.

10. Application Examples

The purpose of this section is to provide examples of how the CM3620 can be used for different purposes.

The following examples are covered in this section:

- Connecting multiple CM3620s on a vehicle
- Implementing safety interlocks
- Controlling a proportional valve
- Controlling motor speed
- Controlling a linear actuator
- Connecting various sensors

Note: It is the system designer's responsibility to ensure safe and correct vehicle operation under all conditions. These examples are for illustrative purposes only.

10.1. Connecting Multiple CM3620s on a Vehicle

The CM3620 does not have inputs dedicated specifically to module addressing.

Systems that use more than one CM3620 with different hardware configurations or different software should be addressed in the harness to prevent system malfunction due to a module being connected to the wrong place in the harness.

To allow a CM3620 to be addressed in the harness, one or more digital inputs must be dedicated to module addressing. These inputs must be permanently connected to power or to ground, depending on the digital input configuration (active high or active low).

Each CM3620 has a hardware revision ID within its hardware. Each CM3620 that has unique configuration options is assigned a unique ID in hardware and this ID can be read in the application software through the Software Development Kit (SDK).

To ensure that the correct hardware and software have been installed in the correct locations, the application software should include an address check that reads the external address by checking the digital inputs dedicated to module addressing and comparing the external address to the unique product ID.

10.2. Implementing Safety Interlocks

Safety is paramount when creating controls for a vehicle.

One safety feature that can be implemented with the CM3620 is to ensure the vehicle doesn't move when it is not being used, and no one is sitting in the operator's seat.

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

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

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:

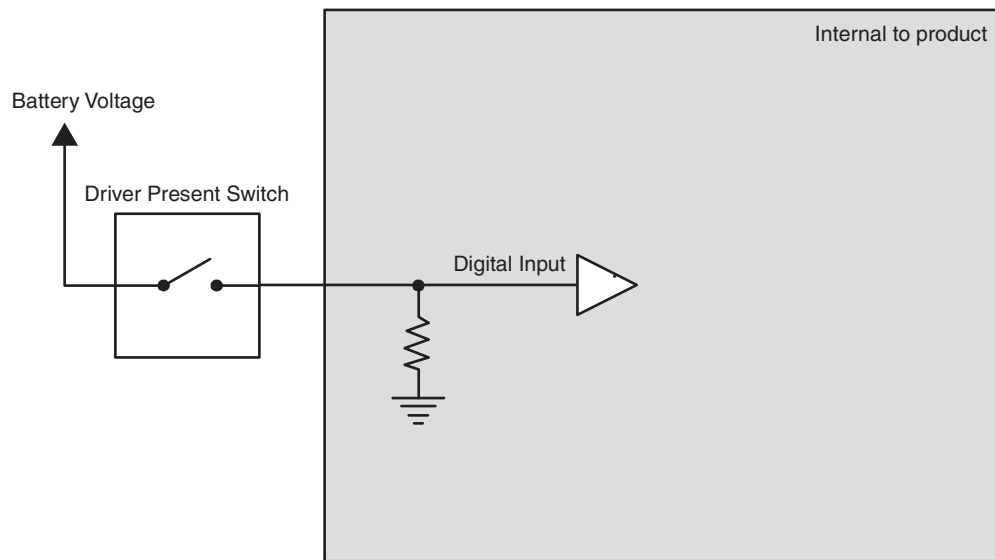


Figure 27: Seat switch interlock connection

10.3. Controlling a Proportional Valve

The CM3620 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 CM3620 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:

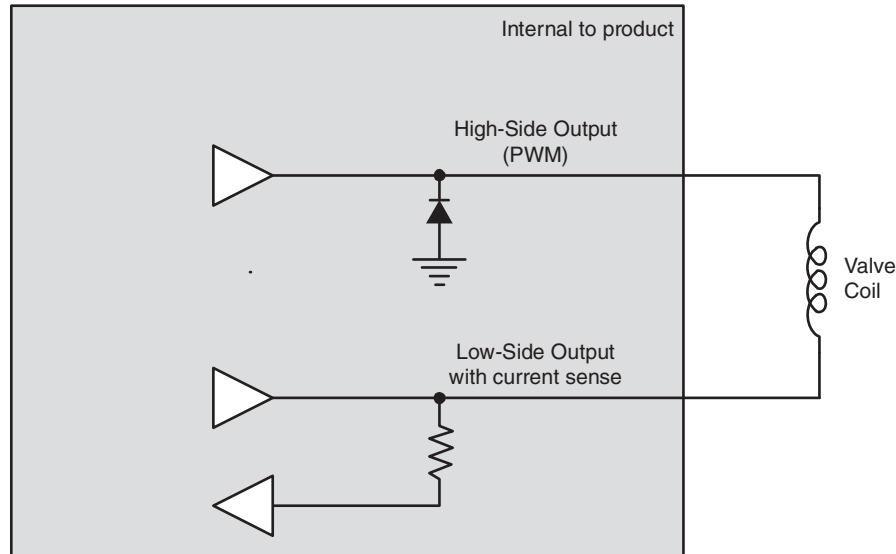


Figure 28: Connection for controlling a proportional valve

10.4. Controlling Motor Speed

The CM3620 can be used to control the DC motor speed of motors that provide a tachometer output.

Note: The CM3620 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 CM3620 to control the speed of a motor:

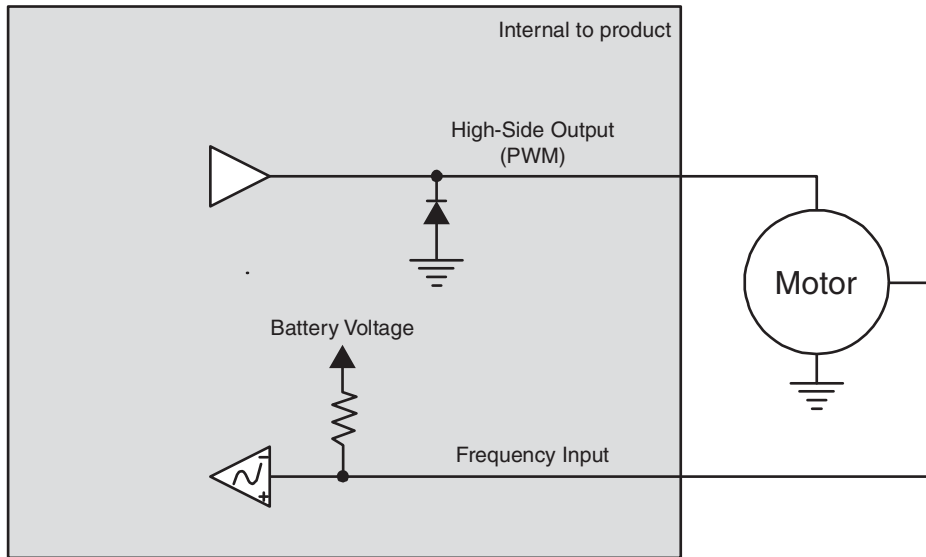


Figure 29: Connection for controlling motor speed

10.5. Controlling a Linear Actuator

The CM3620 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 CM3620 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:

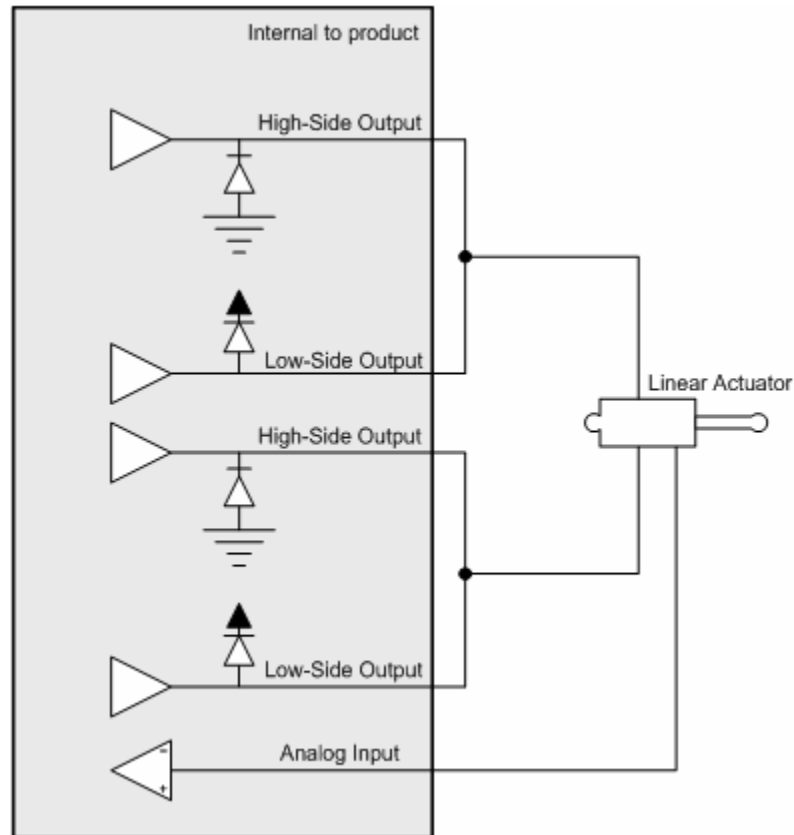


Figure 30: Connection for controlling a proportional valve

10.6. Connecting Various Sensors

There are many types of sensors that can be connected to the CM3620, 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 GROUND) as a low-current ground return for all sensors on the vehicle.

Note 2: When connecting sensors to the CM3620, use the sensor's specification to ensure that the CM3620 is configured correctly for the sensor.

10.6.1. Open Collector

Open collector sensors are compatible with each type of input on the CM3620.

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 CM3620.

The following shows a typical open collector sensor connection:

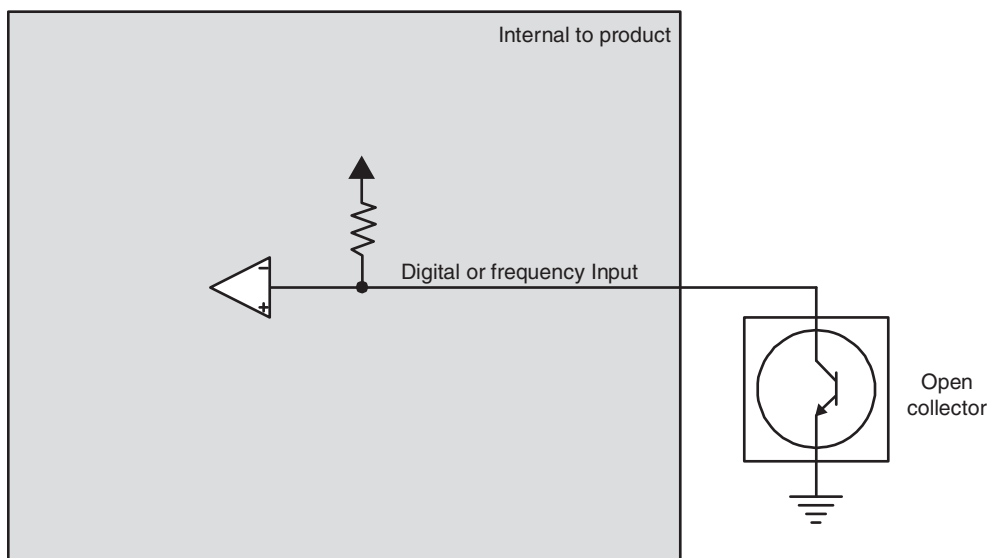


Figure 31: Open collector sensor connection

10.6.2. Variable Resistance

Variable resistance sensors change impedance to represent its 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 CM3620 cannot measure resistance directly.

To make the CM3620 measure resistance accurately, do the following:

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

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

The following shows a typical variable resistance sensor connection:

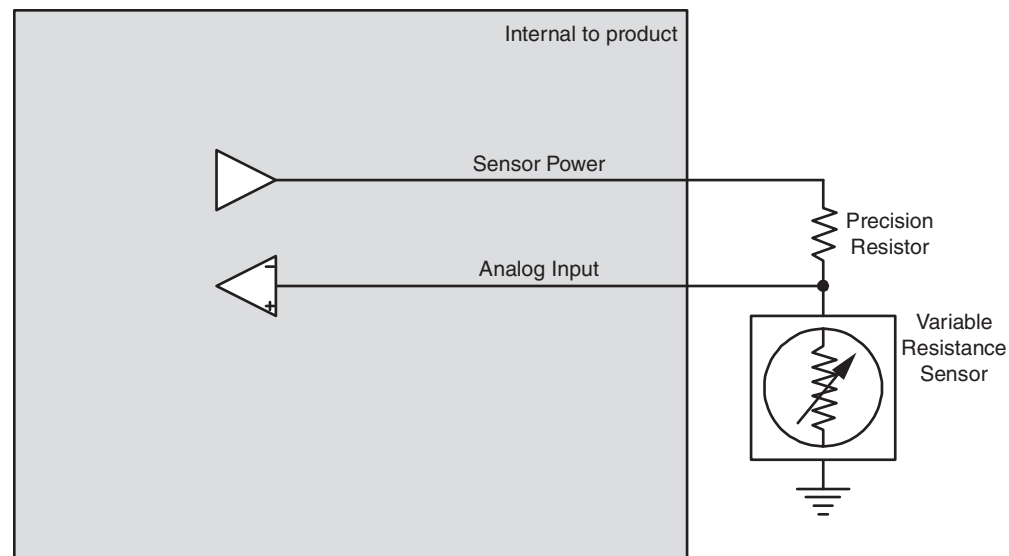


Figure 32: Variable resistance sensor connection

10.6.3. Variable Reluctance

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

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

The following shows a typical variable reluctance connection:

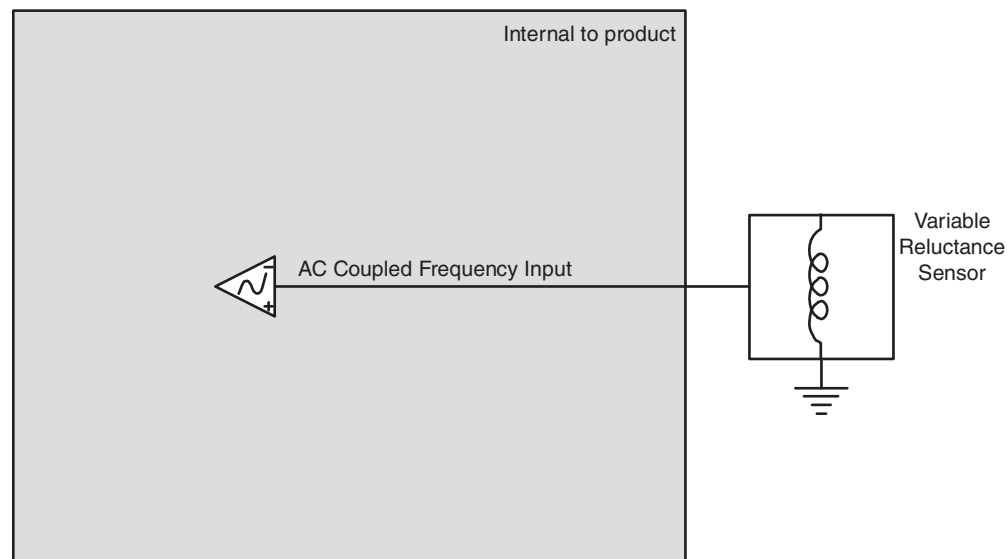



Figure 33: Variable reluctance sensor connection

10.6.4. Switch

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

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

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

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

The following shows a typical sensor switch connection:

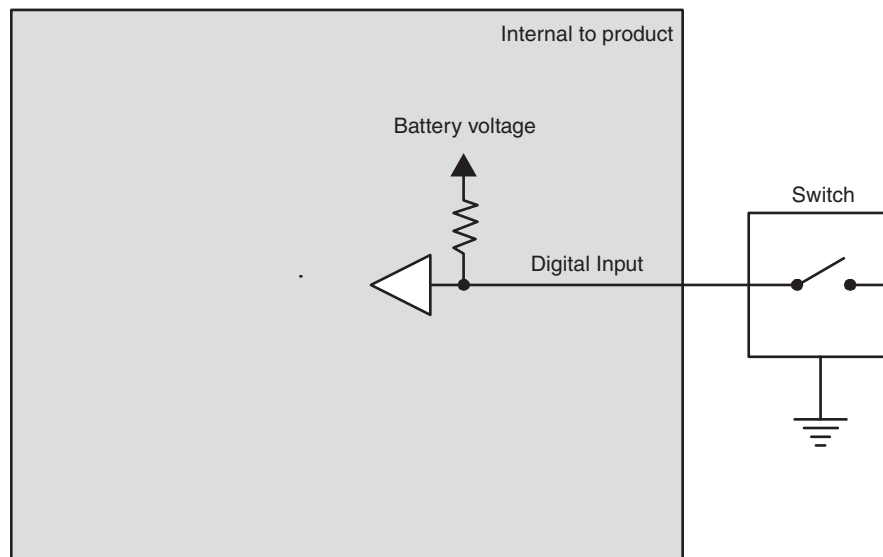


Figure 34: Switch sensor connection

10.6.5. Voltage

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

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

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

The following shows a typical voltage sensor connection:

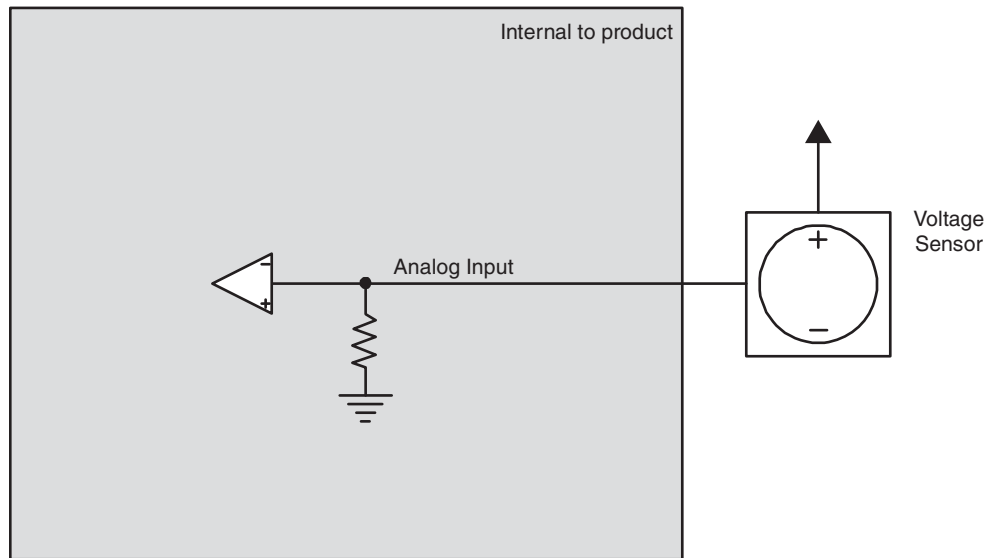


Figure 35: Voltage sensor connection

10.6.6. CMOS

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

The following shows a typical CMOS sensor connection:

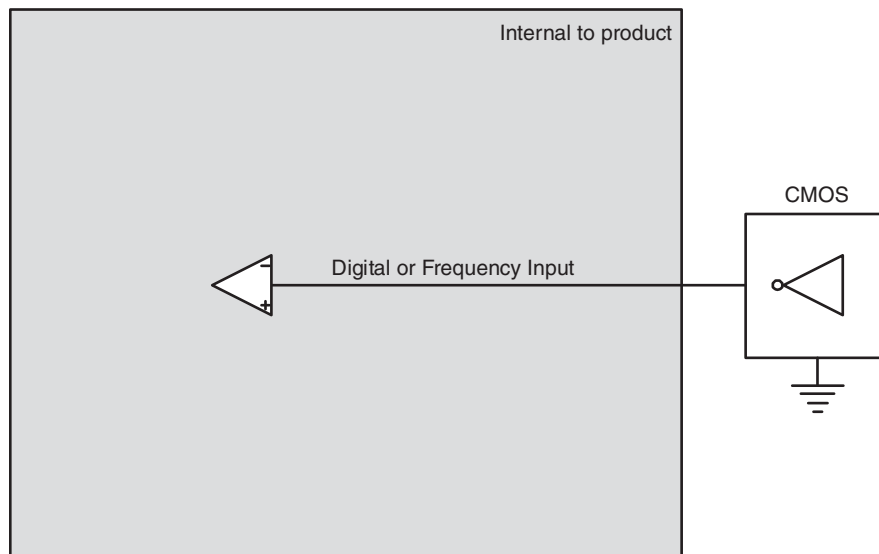


Figure 36: CMOS sensor connection

10.6.7. 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 `GROUND` pin on the CM3620.
- Connect the sensor signal to an analog input.

The following shows a typical potentiometer sensor connection:

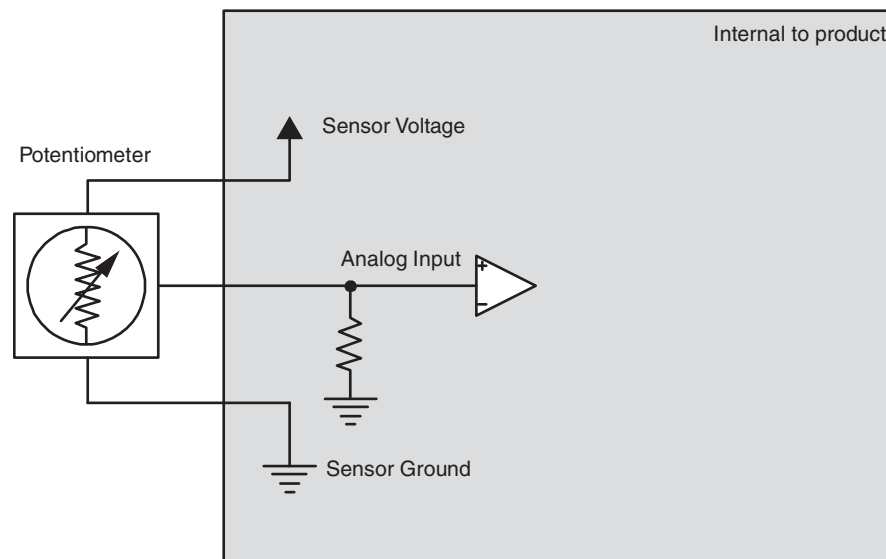


Figure 37: Potentiometer (ratiometric) sensor connection

11. Summary of Configuration Options

The configuration options for the CM3620 are detailed in many sections, depending on what you would try to configure in a custom unit.

The following table is a summary of the configuration options available for the CM3620:

| CM3620 Configuration Option Summary | | |
|-------------------------------------|------------------------------------|------------------------------------------------------|
| Feature | Feature Type | Feature Type Options |
| Inputs | Digital | Pull-up/pull-down resistance value |
| | Analog | Pull-up/pull-down resistance value |
| | | Attenuation value |
| | | Gain value |
| | | Filter cutoff frequency |
| Frequency | Pull-up/pull-down resistance value | |
| High-side outputs | Output | Output with open load detection |
| | | Output with open load detection and open load strobe |
| | Output as a digital input | |
| Low-side outputs | Output with current feedback | Gain value |
| | | Filter cutoff frequency |
| CAN | CAN communication | CAN terminator enabled |
| | | Wake on CAN enabled |

12. Summary of Test Results

The following table lists the results for verification tests performed for the CM3620:

| Ref # | Test Specification | Test Description | Deviated from Plan? | Pass / Fail? |
|-------|---------------------------------|-----------------------------------------------------------------|---------------------|--------------|
| 1. | J1455 Section 4.1.3.1 | Special Release Aug 94 24 Hour Thermal Shock | No | Pass |
| 2. | J1455 Section 4.1.3.2 | Special Release Aug 94 Thermal Shock | No | Pass |
| 3. | EP455 Section 5.1.2 | Special Release Feb 03 Storage Temperature | Note | Pass |
| 4. | J1455 Section 4.2.3 | Special Release Aug 94 24 Hour Humidity Cycle | No | Pass |
| 5. | EP455 Section 5.13.2 | Special Release Feb 03 Humidity Soak | No | Pass |
| 6. | J1455 Section 4.3.3 | Special Release Aug 94 Salt Spray Atmosphere | No | Pass |
| 7. | EP455 Section 5.8.2 | Special Release Feb 03 Chemical Exposure - Brush Application | No | Pass |
| 8. | EP455 Section 5.4.1 | Special Release Feb 03 Solar Radiation - UV Effects | Note | Pass |
| 9. | EP455 Section 5.6 | Special Release Feb 03 Pressure wash | Note | Pass |
| 10. | J1455 Section 4.9.4.2 | Special Release Aug 94 Random Vibration | Note | Pass |
| 11. | J1455 Section Appendix A | Special Release Aug 94 Swept Sine Vibration | Note | Pass |
| 12. | J1455 Section 4.10.3.4 | Special Release Aug 94 Operational Shock | Note | Pass |
| 13. | J1455 Section 4.10.3.1 | Special Release Aug 94 Handling Drop | No | Pass |
| 14. | J1455 Section 4.10.3.3 | Special Release Aug 94 Harness Shock | No | Pass |
| 15. | J1455 Section 4.11.1.1/4.11.1.2 | Special Release Aug 94 Operating Voltage | Note | Pass |
| 16. | J1455 Section 5.10.7 | Special Release Feb 03 Operational Power-Up | No | Pass |
| 17. | J1455 Section 4.11.1.2 | Special Release Aug 94 Jumper Start Voltage | Yes | Pass |

| Ref # | Test Specification | Test Description | Deviated from Plan? | Pass / Fail? |
|-------|-----------------------------|---------------------------------------------------------------------------------------------|---------------------|--------------|
| 18. | J1455 Section 4.11.1.2 | Special Release Aug 94 Steady State Reverse Polarity | No | Pass |
| 19. | EP455 Section 5.10.4 | Special Release Feb 03 Short Circuit Protection | Yes | Pass |
| 20. | EP455 Section 5.11.1 | Special Release Feb 03 Transient Accessory Noise | No | Pass |
| 21. | EP455 Section 5.11.2 | Special Release Feb 03 Transient Alternator Field Decay | No | Pass |
| 22. | EP455 Section 5.11.3 | Special Release Feb 03 Transient Batteryless Operation Level | Yes | Pass |
| 23a. | ISO 7637-2 Section 4.6.1 | Special Release 2 24 V Transient Inductive Load Switching (negative) Test Pulse 1 | Note | Pass |
| 23b. | ISO 7637-2 Section 4.6.2 | Special Release 2 24 V Transient Inductive Load Switching (positive) Test Pulse 1 | Yes | Pass |
| 24. | ISO 7637-2 Section 4.6.5 | Special Release 2 Transient Load Dump Test Pulse 5a | Note | Pass |
| 25. | ISO 7637-2 Section 4.6.3 | Special Release 2 Transient Mutual Coupling Power Lines and Signal Lines Test Pulse 3 | Note | Pass |
| 26. | J1455 Section 4.11.3.3.2 | Special Release Aug 94 EMC Susceptibility | Note | Pass |
| 27. | J1455 Section 4.11.3.3.1 | Special Release Aug 94 EMC - Emissions | Note | Pass |
| 38. | J1455 Section 4.11.12.2.5 | Special Release Aug 94 Electrostatic Discharge Operating | No | Pass |
| 31. | J1455 Section 4.11.12.2.5 | Special Release Aug 94 Electrostatic Discharge Handling | No | Pass |

Notes by Ref #:

3 – Storage Temperature: Test to Level 1.

8 – Solar Radiation (UV Effects): Distance between light source and product from 0.75 meters to 0.50 meters.

9 – Pressure Wash: Test to Level 1.

10 - Random Vibration: Subject UUT to power spectral energy to match the profile of vibration figure 10 in SAE J1455

11 – Swept Sine Vibration: Test to J1455 appendix A, Figure A1 chassis mounted. Sweep rate not specified in J1455, so sweep at a rate of 1 octave per minute. Test each mutually perpendicular axis for a period of 180 minutes on each. No resonance search or dwell times performed during this test.

12 – Operational Shock: To occur immediately before Random Vibration in each axis.

15 – Operating voltage: Range for this product is 6V to 32V (12V and 24V systems combined).

17 – Jump Start: Deviate voltage to 36V instead of 48V.

19 – Short Circuit: Deviate short to battery voltage to 32V instead of 16V.

22 – Batteryless Operation: Deviate to $12 + |25.2 \sin(2_f \times t)|$ instead of $6 + |12.6 \sin(2_f \times t)|$

23a – Inductive Load Switching: Pulse 1a = +/-200V @ 10ohm, Pulse 1b = +/-500V @ 50 ohm. Settings: to = 20ms, rep = 0.5s, Rs = 10ohm/50ohm, n = 1000, pul = 1(24V)

23b – Inductive Load Switching: Pulse 2a = 200V @ 10ohm, Pulse 2b = 500V @ 50 ohm (the spec only calls up a single pulse 2 signal which is 100V @ 10 to 50 ohm). Settings: to = 20ms, rep = 0.5s, Rs = 10ohm/50ohm, n = 1000, pul = 1(24V)

24 – Load Dump: Pulse 5 = 122V @ 2ohm, td = 350ms

25 – Mutual Coupling: Pulse 3a = -200V @ 50ohm, Pulse 3b = +200V @ 50ohm. Direct contact testing to be done. For CAN 1 and CAN 2 port pins, mutual coupling test is to be done according to ISO7637-3 which uses a cable clamp fixture to simulate true mutual coupling pulses.

26 – EMC Susceptibility:

- UUT shall be considered Class C
- Level IV & V & VI = 101V/m, Level III = 100V/m, Level II = 50V/m, Level I = 30V/m
- Use SAE J1113-1 (JUL95) for definition of Classes and regions

27 – EMC Emissions:

- Narrowband:
 - 0.1MHz to 70MHz = Class 3
 - 70MHz to 200MHz = Class 2
 - 200MHz to 1GHz = Class 1
 - EP455 Limit Line for all areas not covered by J1113 spec
- Broadband:
 - 0.1MHz to 70MHz = Class 3
 - 70MHz to 200MHz = Class 2
 - 200MHz to 1GHz = Class 1

13. Frequently Asked Questions

What does CM3620 stand for?

CM3620 stands for Controller Module 3620. The model number indicates the number of inputs and outputs available: 36 inputs and 20 outputs.

What are the recommended mounting practices for the CM3620?

Refer to the *Selecting a Mounting Location* on page 58 section for details.

Can the CM3620 be pressure washed or immersed in water?

Refer to the Environmental Requirements section for more details.

Can the CM3620 be used as an H-bridge?

Yes. The CM3620 has up to 4 low-side outputs and up to 16 high-side outputs that can be combined to form bi-directional output pairs. Refer to *Application Examples* 61 for more details on how to create an H-bridge.

Will the CM3620 work on a 42 V electrical system?

No. The CM3620 is designed for 12 V and 24 V systems.

Will the CM3620s work in a mixed 12/24 V system?

Yes. The CM3620 can be operated on either 12 V or 24 V power sources, and it can be used in a system that uses both voltage levels.

Should the CM3620 be disconnected when welding on a vehicle where it is installed?

All electrical devices should be disconnected during welding to avoid damaging them. The CM3620 warranty does not cover damage to the product when exposed to conditions that exceed the design limitations of the product.

How do I connect the CM3620?

Refer to Quick Start for details on how to connect the CM3620 in a development system.

Refer to Installing a CM3620 into a Vehicle, and *Connecting Multiple CM3620s on a Vehicle* 62 for details on how to connect the CM3620 in a vehicle.

How should I wire my CAN network?

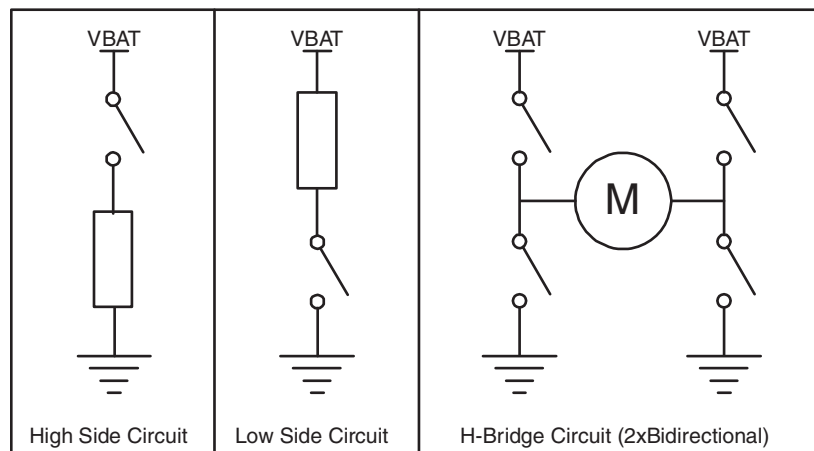
Refer to the CAN Installation Connections section for more details.

Where can I get J1939 cable and connectors?

Two manufacturers of J1939-rated connectors are ITT Cannon 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:



Can the CM3620 be used in closed-loop-control applications?

Yes. Closed-loop control can be implemented using the low-side output current feedback function, combined with a high-side output for PWM control. A current feedback control loop can be created within the application software to allow accurate current flow control in inductive loads. This is useful in hydraulic applications where a hydraulic valve must maintain constant current flow.

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

Yes. In some instances, the output current rating must be de-rated to prevent too much power dissipation inside the CM3620 enclosure. De-rating requirements are described in the specific output sections that require de-rating.

Can I use existing sensors in my vehicle with a CM3620, and if so, how do I configure each input?

The CM3620 inputs are designed to handle many different sensor types. Specific sensors will likely require specific configuration options on the inputs to ensure maximum resolution on the input for that sensor type. Consult a Parker Vansco Account Representative to learn more about creating custom input configurations for sensors.

Can the CM3620 be purchased with a company logo printed on it?

The CM3620 comes with a standard overlay. If a custom overlay is required, it must be designed and implemented before the product is manufactured. Creating a custom overlay for the CM3620 is an added charge. Contact your Parker Vansco Account Representative for details.

Will Parker Vansco consult and / or design my vehicle harness and schematic?

Parker Vansco can provide consultation services such as training, harness design, requirements definition, and system software implementation. Contact your Parker Vansco Account Representative for details.

I'm not comfortable writing my own custom software application. Can Parker Vansco write it?

Parker Vansco can provide consultation services such as training, harness design, requirements definition, and system software implementation. Contact your Parker Vansco Account Representative for details.

Is it possible to purchase the CM3620 with my custom software pre-programmed?

The CM3620 is usually only sold with bootloader software. The bootloader software allows it to be programmed with custom application software through the CAN communication port at the OEM. Pre-programming the CM3620 may be considered on a case-by-case basis with an added charge. Consult your Parker Vansco Account Representative for details.

What is the recommended maximum bus loading on the CM3620 CAN bus?

Requirements can vary by system. The industry standard is no more than 50% average bus loading. In a J1939 system, this is approximately 900 messages per second.

Do I need to fuse CM3620 power?

The power connections to the CM3620 must be fused. Refer to the Module Power Installation Connections section for more details.

Do I need to fuse outputs from the CM3620?

CM3620 outputs are internally protected and no external fusing is required.

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

No. The CM3620 has internal flyback diodes as part of its high-side output circuitry.

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

No. An external flyback diode present on circuits with internal flyback diodes will not cause problems and will not affect the current sense measurement on the corresponding low-side outputs used for current feedback.

Can I connect the CM3620 outputs in parallel?

On/off controlled outputs may be connected in parallel, but PWM'd outputs cannot because they are not guaranteed to be synchronized.

What wire gages are permitted in the CM3620 connectors?

The maximum wire gage usable in the CM3620 connectors is 16 AWG with GXL insulation.

Are strain reliefs available for the CM3620 connectors?

Strain reliefs are available for the Ampseal connectors on the CM3620. For the 35-pin connector, the part number is AMP P/N: 776463-1.

My CM3620 is broken. Whom do I call regarding warranty?

Modules should be returned to the service department of the OEM. The OEM will coordinate returns to the appropriate Parker Vansco service centre.

Does the CM3620 support wireless connections?

A wireless diagnostic system that includes a WiFi has been developed for CAN networks, by Parker Vansco. Contact your Parker Vansco Account Representative for more information.

Can I connect a CM3620 to my existing J1939 devices?

The CM3620 is fully J1939 compatible and can be programmed to communicate with any J1939 device. A custom application program would have to be developed to receive and/or transmit messages on the CAN bus in accordance with the message structure for the J1939 device in question.

Does the CM3620 support “Wake on CAN”?

Yes. The present CM3620 provides a Wake on CAN function as a configuration option. Refer to the: Controller Area Network (CAN) Communication section for more details.

Can I run the CM3620 CAN bus faster than 250 kbaud?

Yes. CAN communication speed is 100% configurable through the application software, and it can be configured up to 1 Mbps. CM3620 verification testing has only been done at 250 kbps, and EMC emissions are not guaranteed for communication rates higher than this number.

How many CM3620s can I have on a network?

The CM3620 is compliant with the SAE J1939-11 standard, which specifies that a maximum of 30 nodes can be used on a J1939 network (based on the physical specifications for the network); however, any number of CM3620s can be assigned on a CAN network within the limits of the total capacitance of the network.

The limitation on CM3620 numbers will be dictated by the amount of CAN traffic on the bus, which will vary based on the number of transmit messages assigned from each module and the rate at which these messages are transmitted.

It is recommended that the CAN bus have an average loading of less than 50% of the total baud rate of the network.

Is the I/O on the CM3620 configurable through software?

No. The CM3620 is a low-cost general-purpose I/O controller. Its I/O configurations are determined at project start time and adjusted through component configuration. Refer to the appropriate input or output section in this manual for more details about the configuration capabilities of the I/O.

Does the CM3620 offer VMM (Vansco Multiplex Module) functionality?

Yes, the CM3620 can be used as part of a VMM system.

I only need a small number of CM3620s. Are existing configurations available?

Yes. Existing configurations of the CM3620 are available as long as a custom configuration is not required. Contact a Parker Vansco Account Representative or Application Engineer to determine if an existing configuration is available for your application.

What are the volume requirements to initiate a custom configuration version of the CM3620?

Discuss this with a Parker Vansco Account Representative.

What will it cost to get a custom configuration version of the CM3620?

Discuss this with a Parker Vansco Account Representative.

How do I go about requesting a custom configuration version of the CM3620?

Contact a Parker Vansco Account Representative to discuss your requirements.

What do I need in order to write the custom software application for the CM3620?

Parker Vansco has a Software Development Kit (SDK) that provides function calls to access the hardware features on the CM3620 outlined in this manual. A manual for the SDK is available through Parker Vansco that describes how to create and use these functions. Please contact your Parker Vansco Account Representative for details about writing custom software.

14. Troubleshooting

| Problem | Possible Causes | Possible Solutions |
|----------------------------------------------------------------|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Everything is connected but there is no communication. | The CM3620 is not powered. | <ul style="list-style-type: none"> Ensure there is a voltage on the battery input pins of the product. Ensure there is a ground connection to the ground input pins of the product. If a power control input was selected in the configuration options, ensure battery power is applied to the power control input pin. |
| | The software offers some form of module addressing. | <ul style="list-style-type: none"> Verify that the digital inputs selected as address inputs are connected in the harness correctly. |
| | The CAN bus is marginal or not functional. | <ul style="list-style-type: none"> Use a PC-based CAN tool to verify that messages can be sent and received on the CAN bus. Are CAN High and CAN Low reversed? Are CAN High or CAN Low shorted to ground or to CAN Shield? Are CAN High or CAN Low open? Is the CAN bus terminated properly? |
| The CM3620 is communicating, but the outputs will not turn on. | The outputs are configured as inputs. | <ul style="list-style-type: none"> Verify your CM3620 configuration options and ensure the output you are trying to drive is not configured as a digital input. |
| | The output load is drawing too much current. | <ul style="list-style-type: none"> Verify that the output load is within the specified output resistance ratings for the CM3620 output driver. |
| | Proper input conditions are not met. | <ul style="list-style-type: none"> The custom software will be relying on certain events to occur before the output turns on. Verify all events that are required to turn the output on are occurring. |
| The CM3620 resets when the loads are turned on. | Insufficiently dimensioned desktop power supply. | <ul style="list-style-type: none"> Desktop power supplies, even if they are rated for the requested current, can sag substantially when large loads are switched on, which can be confirmed with an oscilloscope. |
| | Power drop or ground lift at a high-current connection point. | <ul style="list-style-type: none"> Make sure adequate wire gage is used to connect the CM3620's power/ground pins to the power supply. When large loads are enabled, the voltage drop (or lift at the ground) could be significant. |

15. 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.

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).

driver (hardware)

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

driver (software)

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

FET

See *field effect transistor*.

field-effect transistor (FET)

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

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.

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.

H-bridge

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

high-side output

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

hysteresis

The tendency, either by nature or design, for a device or system to remain temporarily (lag) in one state before switching to another. Hysteresis might be intentionally added to electronic circuits prevent unwanted rapid switching. A furnace, for example, is designed to remain on or off for some time after the room temperature reaches the thermostat's set point.

inductive load

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

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

load

Any component that draws current from 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.

Nyquist criterion

A theorem stating that a reconstructed signal will match the original signal provided that the original signal contains no frequencies at or higher than one-half the sampling frequency

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-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.

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.

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.

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.

wake on CAN

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

wetting current

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

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