New Flyer Intro to Vansco Multiplexing

This document and the contents discussed herein are the confidential and proprietary information of New Flyer Industries Canada ULC and New Flyer of America Inc. and are disclosed by New Flyer in confidence. This document and the contents herein are not to be disclosed by the intended recipient without the prior written authorization of New Flyer. Any unauthorized disclosure, reproduction or other distribution of this document or information is strictly prohibited and may result in action being taken against the party making the unauthorized disclosure. This document and all copies hereof must be returned to new flyer upon request.

Safety

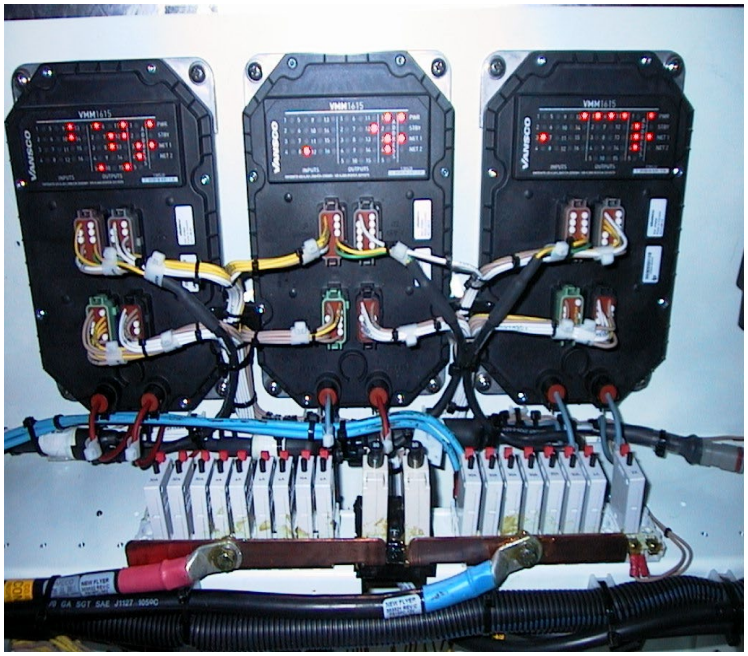
- During electrical diagnosis procedures an understanding of the vehicle's electric circuits is important to understand the results of connecting test equipment.
- During component removal or installation, ensure that the Master Run switch is set to the STOP-ENGINE position and that the Battery Disconnect switch is set to the OFF position. Failure to follow this procedure may result in personal injury or component damage.
- DO NOT start the vehicle remotely with the laptop software without first checking that the area is clear of personnel.
- Anyone who uses a service procedure or tool which is not recommended by New Flyer Industries, or the OEM must first be thoroughly satisfied that neither personal safety nor equipment safety will be jeopardized by the service methods selected.
- Refer to the New Flyer Service Manual for detailed safety procedures.

Vansco Multiplex System

- The Vansco multiplex system uses a series of remotely mounted Controller Area Network (CAN) connected modules to transmit information and operate components throughout the vehicle.
- The system consists of VMM 1615 solid state modules located throughout the vehicle.
- The modules are interconnected by a shielded CAN communication cable (backbone) which is part of the wiring harness.

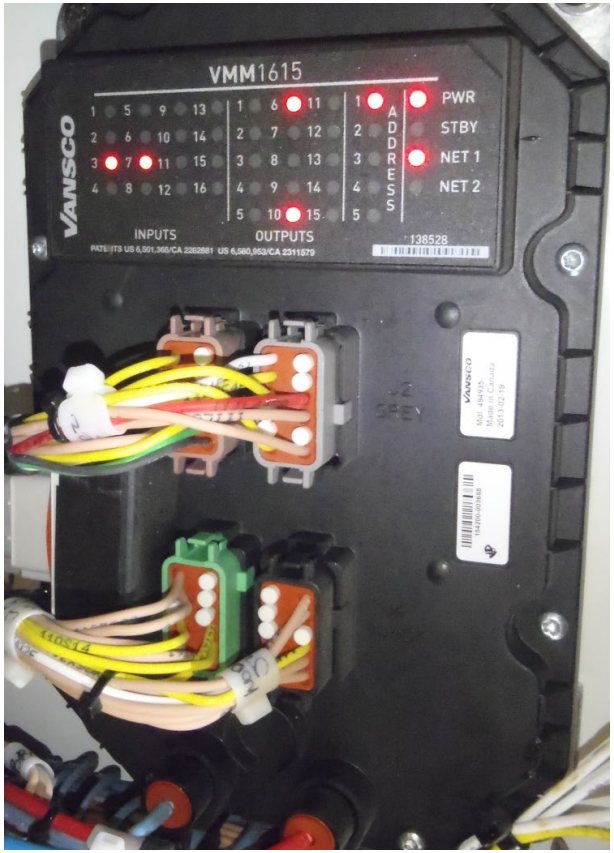
Vansco Multiplex Operation

- The VMM performs many tasks at the same time.
- Each VMM reads its inputs, processes ladder logic, switches its outputs, monitor its outputs for faults, broadcasts its state information over CAN, receives state information over CAN from other VMMs, controls its LED diagnostics, facilitates plug and play automatic programming, and facilitates CAN diagnostics.



VMM1615 Module

- The VMM 1615 modules are general purpose electronic controllers.
- Each Module has 16 inputs and 15 outputs, as well as two CAN/J1939 communication ports.
- Each Module has a power led, a net 1 led, and five address LED’s.
- Each Module has four 12 pin Deutsch connectors of different color. Brown (J-1) ,Grey (J-2), Green (J-3), and Black (J-4).
- Each module has two bus bar battery power connectors Bus Bar 1 (J-5), Bus Bar 2 (J-6).



VMM1615 - Pull-up & Pull-Down Resistors

- The Vansco 1615 modules are equipped with pull-up & pull-down resistors to make sure a circuit will not float or provide an incorrect signal.
- A pull-up resistor connects unused input pins to the dc supply voltage, (Vcc) to keep the given input HIGH.
- A pull-down resistor connects unused input pins to ground, (0V) to keep the given input LOW.
- If the circuit is simply disconnected the input would be allowed to float and it would be anybody's guess what the value of the input pin would be inside the chip.
- A non-pull-up resistor circuit is the most intuitive way to interface to a microcontroller or logic chip, and it is VERY wrong.

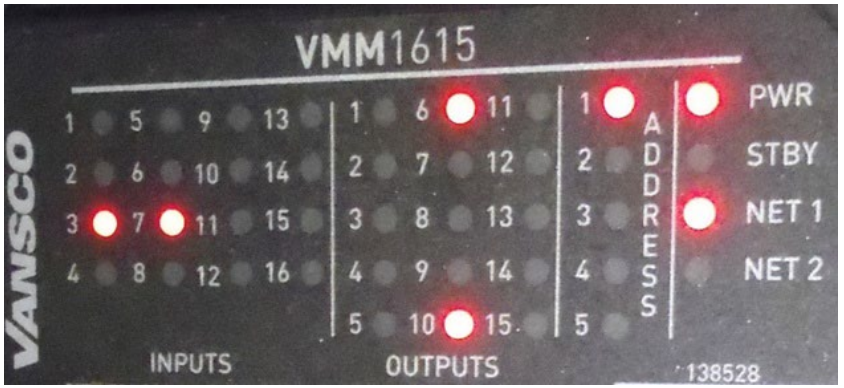
VMM1615 Pull-up & Pull-Down Resistors (cont.)

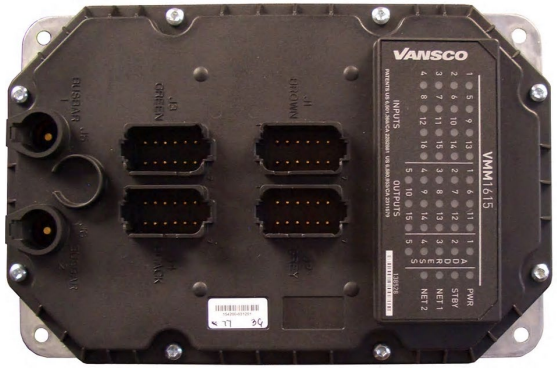
- Depending on the device, this could lead to an undefined operation of the input, oscillation between states, high power consumption, or even physical damage to the device.

VMM1615 Diagnostic LEDs

- **Input LED**
  - Off = input inactive
  - On = input active
- **Output LED**
  - Off = output off
  - On solid = output on
  - Flashing = output faulted
- **Address Input LED**
  - Off = address input inactive
  - On = address input active

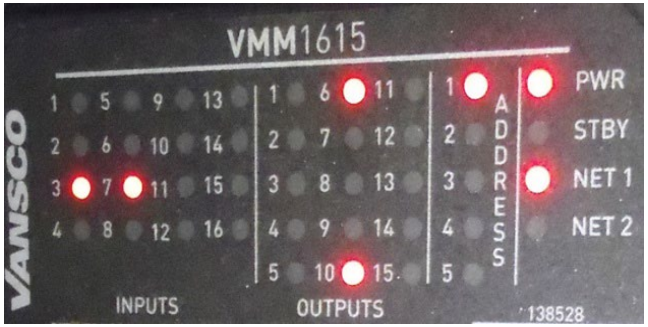
Note: Must consult with the specific SR Electrical Schematics.





VMM1615 Diagnostic LEDs (cont.)

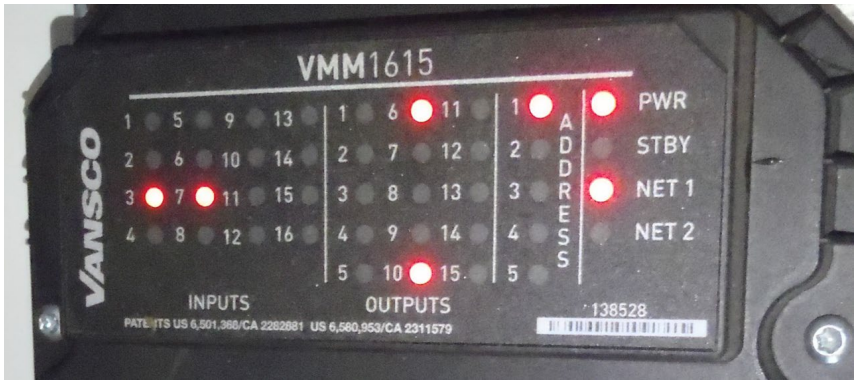
- **Power LED**
  - Off = Sleep mode
  - On solid = Module operating normally
  - Flashing = Programming Mode (1Hz)
    = System Fault (not 1Hz)
- **Standby LED**
  - Off = Standby mode not active
  - On = Standby mode active
- **Network LED (NET 1, NET 2) (CAN1, CAN2)**
  - On or Flickering = CAN Activity
  - Off = CAN Inactive



Note: Must consult with the specific SR Electrical Schematics.
Depending on the electrical specification, the Net 1 and Net 2 network will be used.

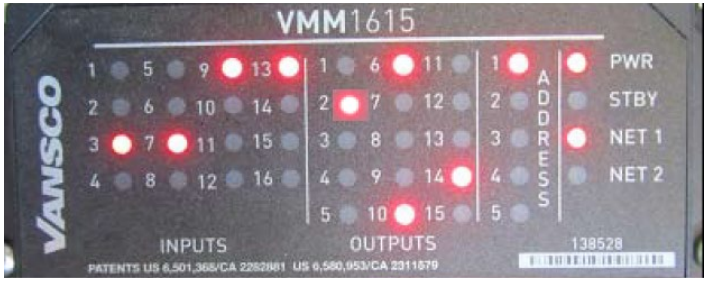
VMM1615 Inputs

- The digital inputs are active high or active low .
- When the input is configured as active high, the input will be active when it is switched to battery voltage.
- When the input is configured as active low, the input will be active when it is switched to ground.



VMM1615 Inputs (cont.)

- The 1615 Module has sixteen inputs of different configuration.
  - Five of the inputs are used for reading active high/low signals. (configurable).
  - One input is used for reading active high signals.
  - One input is used for active high-power control.
- The 1615 module has eight inputs capable of reading analog voltages.
- The 1615 module has one DC frequency input. Input 8. This input is used mainly for Fire Suppression Systems.



VMM1615 Reading Inputs

Reading Inputs:

- Inputs are sampled at a rate of 40 Hz (40 times per second).
- Input readings are based on filtering of the most recent samples that are broadcasted over CAN, to indicate the current state of the VMM.
- The minimum digital input pulse that is guaranteed to be detected by the VMM 1615 is 50ms when filtering is considered.
- Analog and frequency input reading are based on the most recent 16 samples (which are configurable). In addition, at least four samples must be taken on subsequent state change updates. i.e., analog and frequency state messages are generated at a maximum rate of 10 times a second.

VMM1615 Inputs Wetting Current

- All digital inputs have their wetting current configured according to the following:
  - 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 is based on battery voltage and on the value of the pull-down resistor.
  - Wetting current is determined by the value of the resistor. The maximum wetting on a VMM 1615 is 10 mA at 7.5 vdc.

VMM1615 Outputs

- The 1615 module have fifteen output of different configurations.
- The 1615 module has 12 high-side outputs capable of Pulse Width Modulation (PWM), with a maximum frequency of 500 Hz., four of these outputs are capable of accurate current sensing.
- The 1615 module has one low-side output that is capable of current sensing with a maximum PWM frequency of 1500 Hz.
- The 1615 module has two solid state relay outputs. (Low-Side Outputs).

VMM1615 Outputs (cont.)

The Output Configurations on a 1615 module.

- Outputs 1 - 6 10 Amp High Side .
- Outputs 7 and 9 5 Amp High Side.
- Outputs 8,10,11,12 2.5 Amp High Side.
- Output 13 2.5 Amp Low Side.
- Outputs 14,15 Solid state relay A and B Low Side.
- Maximum module output amperage 80A.
- Maximum module output for each Bus Bar 40A.

Note: Currently only using 30A Circuit Breakers for each Bus Bar.

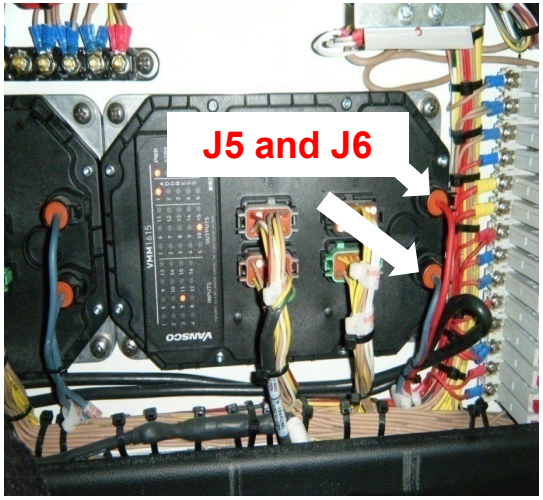
VMM1615 Outputs (cont.)

- The high-side outputs are used for switching voltage to loads, using either a pulse width modulated (PWM) signal, or an on/off signal.
- High-side outputs can also test for various fault conditions, which can be used for software diagnostics.
- When a high-side output is PWM'd, the output switches the percentage of time that the output is “on” vs. “off” , this is determined by the duty cycle of the signal.
- When a high-side output is switched on and off, the output provides battery voltage when in the "on" state and goes high impedance when in the “off” state.

VMM1615 Output Power

- There are two main power connections for the high current bus bar battery power inputs:
  - BUSBAR1, BUSBAR2
- The bus bar inputs are separated into two connectors:
  - J5 and J6
- Bus Bar # 1 powers odd output circuits 1-11.
- Bus Bar # 2 powers even output circuits 2-12 & outputs 13-15 (LS) grounds.
- Bus bar current flow will be limited to 40 Amps. maximum, for each bus bar.

Note: Currently using 30 Circuit Breakers for each bus bar.



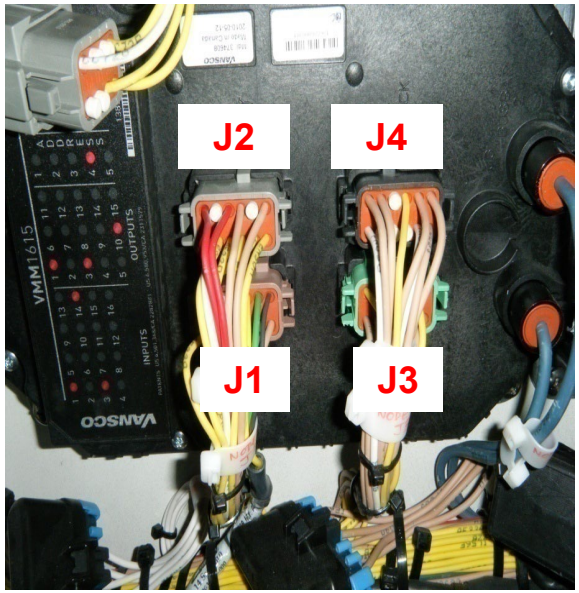
VMM1615 Connectors

Power

- The VMM1615 is powered by the vehicle battery.
- The VMM1615 operates in a system and can operate down to 6VDC and up to 32VDC, with protection.
- The VMM1615 has various pins on the 6 colored connectors that are used for different types of power.
  - Brown (J1) Input/Output/Network
  - Grey (J2) Input/Output
  - Green (J3) Input/Output
  - Black (J4) Input/Output/Addressing inputs
  - Black (J5) 12/24 volts
  - Black (J6) 12/24 volts

VMM1615 Connectors (cont.)

- The VMM1615 has four 12-pin Deutsch DT connectors responsible for input/output/network connections, as follows:
  - Brown (J1): Input/Output/Network
  - Grey (J2): Input/Output
  - Green (J3): Input/Output
  - Black (J4): Input/Output/Addressing



VMM1615 J3 Connector

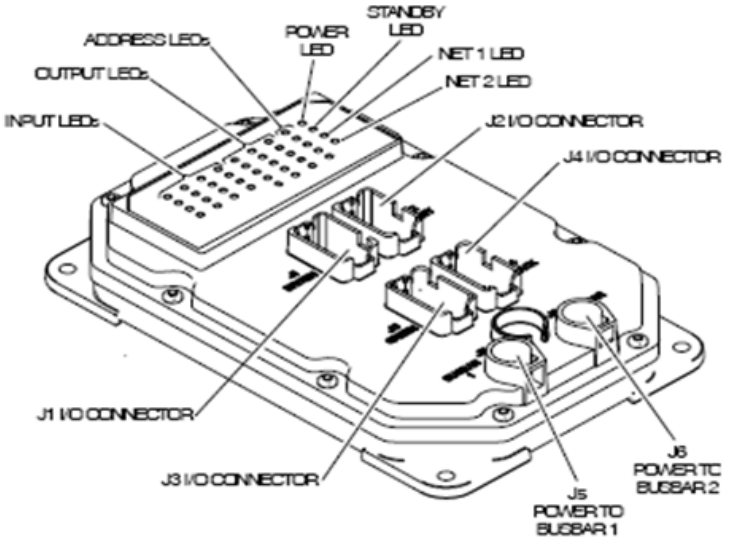
- Pin out of Connector (J3) Green: input/output.

Connector pin	Name	Function
1	OUT7_5A_HS_CS	5A High-side output with current sense
2	OUT5_10A_HS	10A High-side output
3	IN1_DIN_WAKE	Digital input, power control
4	ADDR_5	Address digital input
5	OUT9_5A_HS	5A High-side output
6	OUT3_10A_HS	10A High-side output
7	IN2_DIN	Digital input
8	IN13_ATN_AIN	Attenuated analog input
9	IN14_ATN_AIN	Attenuated analog input
10	IN5_DIN	Digital input
11	IN6_DIN	Digital input
12	OUT11_2A5_HS_CS	2.5A High-side output with current sense

J3 connector

VMM1615 - Output Power Connectors

- The VMM1615 also has two 1-pin Deutsch DTHD connectors for bus bar power (power for High-side outputs):
  - Black (J5): 12/24 Volts
  - Black (J6): 12/24 Volts



VMM1615 Logic Power

- The VMM1615 has 1 pin dedicated to providing power for logic circuitry, called VBATT (J1-3).
- There is 3 pins dedicated to grounding the VMM1615, called GROUND (J1-2) (J2-6) (J4-2).

Note: Must refer to the electrical schematics for details.

VMM1615 Logic Power (cont.)

Logic Power Capabilities

- The VMM1615 is powered by the vehicle battery.
- The VMM1615 operates in a 12V or 24V system, and can operate from 6V up to 32V, with overvoltage protection at 36V.
- The VMM1615 has various pins on the connectors that are used for different types of power, as detailed in the following sections.
- Logic power provides power to the logic circuit, which consists of the microprocessor, RAM, etc.
- The logic circuit can draw 200-250 mA, depending on the size of the logic file.

VMM1615 Sensor Power

- The VMM1615 has one pin dedicated to providing power to external sensors called:
  - SENSOR SUPPLY (J2-11).

Connector J2 Pin 11

VMM1615 Sensor Power (cont.)

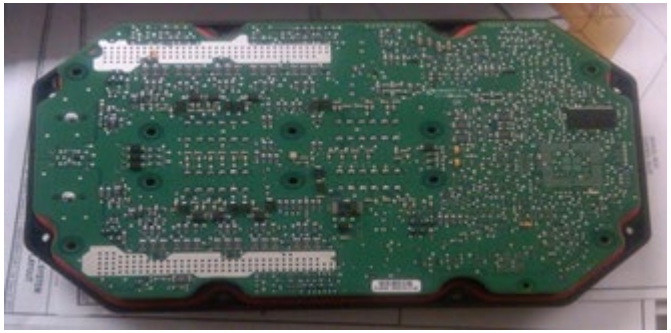
Sensor Power Capabilities

- The Sensor Supply offers two software programmable output voltages of either 5V or 8V.
- 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 VMM1615 must be 7V or greater to ensure that the Sensor Supply can provide 5V. The voltage provided to the product must be 10V or greater to ensure the sensor supply can provide 8V.

VMM1615 Software

- Each VMM has three pieces of embedded software on board during normal operation.
  - Boot Code
  - Application Code
  - Ladder Logic



VMM1615 Software - Boot Code

- Acts as a base operating system for the VMM.
- Provides the ability to download other applications (such as ladder logic or application code) to the VMM via the CAN/J1939 port.
- Boot Code is downloaded to the product at the factory and is typically not upgradable by the end customer.

Logic Version	Application Version	Boot Version
V158511.1	V4.1 Build 38	V3.0
V158511.1	V4.1 Build 38	V2.0
V158511.1	V4.1 Build 38	V2.0
V158511.1	V4.1 Build 38	V3.0
V158511.1	V4.1 Build 38	V3.0
V158511.1	V4.1 Build 38	V3.0

VMM1615 Software - Application Code

- Acts as the second level operating system for the VMM.
- Provides the I/O scanning functions, the I/O state transmission functions, the plug and play functions and the ladder logic processing functions.
- Application Code is upgradable by the customer.
- Can be downloaded to VMMs via the VMM Software package through the CAN/J1939 network.

Logic Version	Application Version	Boot Version
V158511.1	V4.1 Build 38	V3.0
V158511.1	V4.1 Build 38	V2.0
V158511.1	V4.1 Build 38	V2.0
V158511.1	V4.1 Build 38	V3.0
V158511.1	V4.1 Build 38	V3.0
V158511.1	V4.1 Build 38	V3.0

VMM1615 Software - Ladder Logic

- Ladder Logic is the main operating program for the VMM, which allows the VMM to perform tasks based on the users' requirements.
- Ladder Logic is written using the VMM Software package, a powerful user-friendly windows-based application.
- Ladder Logic is drawn on the graphical user interface and compiled, that is, converted into a format readable by the VMM.

Logic Version	Application Version	Boot Version
V158511.1	V4.1 Build 38	V3.0
V158511.1	V4.1 Build 38	V2.0
V158511.1	V4.1 Build 38	V2.0
V158511.1	V4.1 Build 38	V3.0
V158511.1	V4.1 Build 38	V3.0
V158511.1	V4.1 Build 38	V3.0

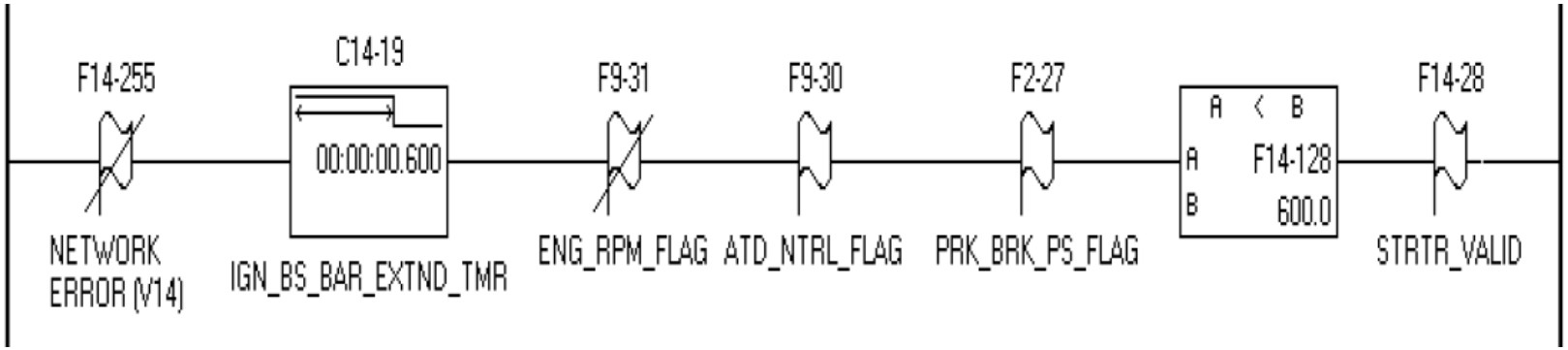
VMM1615 - Processing Ladder Logic

Processing Ladder Logic:

- The VMM continuously processes the portion of ladder logic in a ladder logic file that it addresses, based on the last known state of the VMMs (including itself) and other J1939 devices connected to the same CAN bus.
- Ladder logic rungs are processed alphabetically as shown in the logic rungs by module group, (which is part two of the ladder logic handout) i.e., timers (Cx-y) then flags (Fx-y), then logs (Lx-y), then CAN messages (Mx-y), then outputs (Ox-y), then SPNs (Sx-y) and finally telltales (Tx-y).
- After processing the last rung, the first rung is processed again.

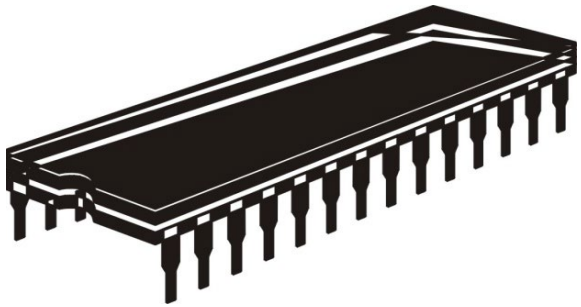
VMM1615 Modules - Ladder Logic

- The modules process ladder logic. The ladder logic defines which inputs or arrangement of inputs turns on which outputs on the module.
- The inputs and outputs in the ladder logic can be from one or more modules connected together in a system via the J1939 network.



VMM1615 Memory

- Each VMM contains a EEPROM (Electrically Erasable Programmable Read-Only Memory) chip and contains a copy of the ladder logic file.
- The EEPROM chip is re-programmable on the bus.
- The EEPROM retains its contents even when the power is turned off.
- Any changes to the program state (Log files) is automatically saved to the VMM's every 15 minutes.



The CAN Bus

- The CAN protocol is an ISO standard (ISO 11898) for serial data communication.
- The protocol was developed aiming at automotive applications. Today CAN has gained widespread use.
- The CAN standard includes a physical layer and a data-link layer which defines different message types, arbitration rules for bus access and methods for fault detection and fault confinement.
- CAN PROTOCOL
  - The physical layer uses differential transmission on a twisted pair of wires.
  - A non-destructive bit-wise arbitration is used to control access to the bus.
  - The messages are small (at most eight data bytes) and are protected by a checksum.

The CAN Bus (cont.)

- There is no explicit address in the message, instead, each message carries a numeric value which controls its priority on the bus and may also serve as an identification of the contents of the message.
- An elaborate error handling scheme that results in retransmitted messages when they are not properly received.
- There are effective means for isolating faults and removing faulty nodes from the bus.

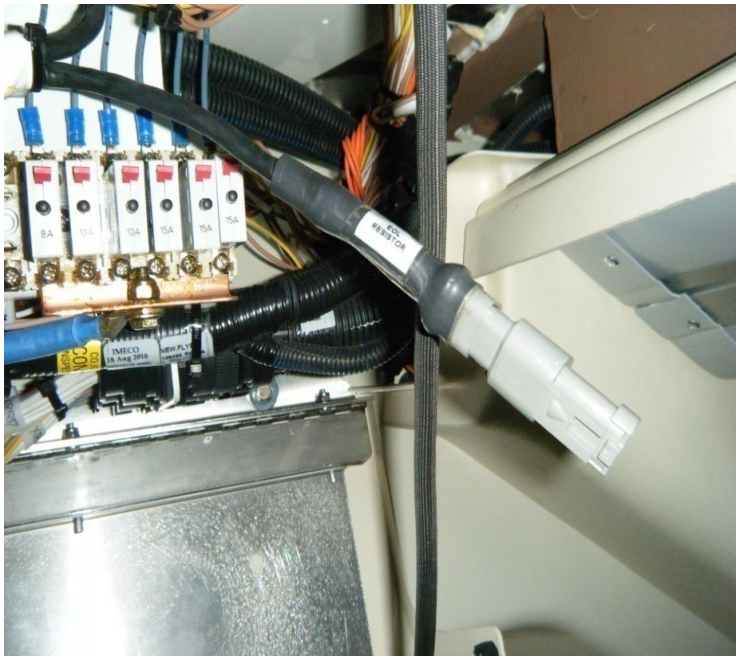
CAN J1939 Communication

Vansco J1939 Capabilities

- The Vansco CAN communicates information at a rate of 250 kbps (kilobytes per second).
- 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.
- The VMM continuously receives CAN messages from other VMMs (including itself) and other J1939 devices sharing the CAN bus.
- Received CAN messages are periodically processed and buffered to provide logic processing with the latest state information.
- In general, received messages are processed every 5m.

VMM1615 - CAN Communication

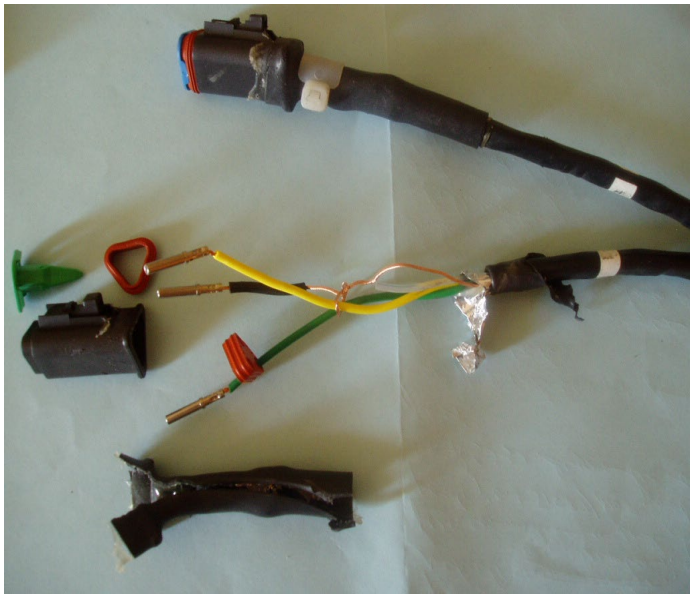
- The VMM1615 uses the Controller Area Network (CAN) communication when communicating with other modules on the vehicle, or with a personal computer.



VMM1615 - CAN Communication (cont.)

Controller Area Network (CAN)

- The VMM1615 hardware provides CAN communication according to the SAE J1939 specification, making the VMM1615 compatible with any CAN-based protocol through software.
- CAN communication is used to communicate the status of multiple modules that are connected in the same network.



CAN Communication Connectors & Harness

CAN Connectors:

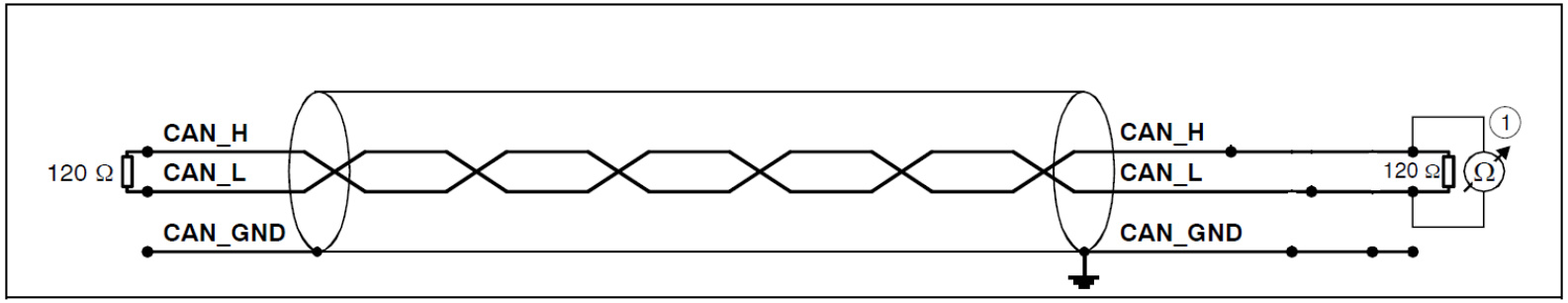
- Industry-approved CAN connectors are manufactured by ITT Canon and Deutsch.
- The connectors, come in either “T” or “Y” configurations.

CAN Harness:

- The CAN harness, is the “main backbone” cable that is used to connect the CAN network.
- Cannot be longer than 40 meters. If the CAN Network is longer than 40 meters, a CAN REPEATER is used, e.g., 60Ft. Coaches.
- Must have a 120 ohms terminator resistor at each end of the network cable.
- Two 120 ohm terminating resistors eliminate bus reflections and ensure proper idle state voltage levels.

CAN Termination Resistors

- The termination is used to match impedance of a node to the impedance of the transmission line being used.
- When impedance is mismatched, the transmitted signal is not completely absorbed by the load and a portion is reflected back into the transmission line.
- If the source, transmission line and load impedance are equal these reflections are eliminated.



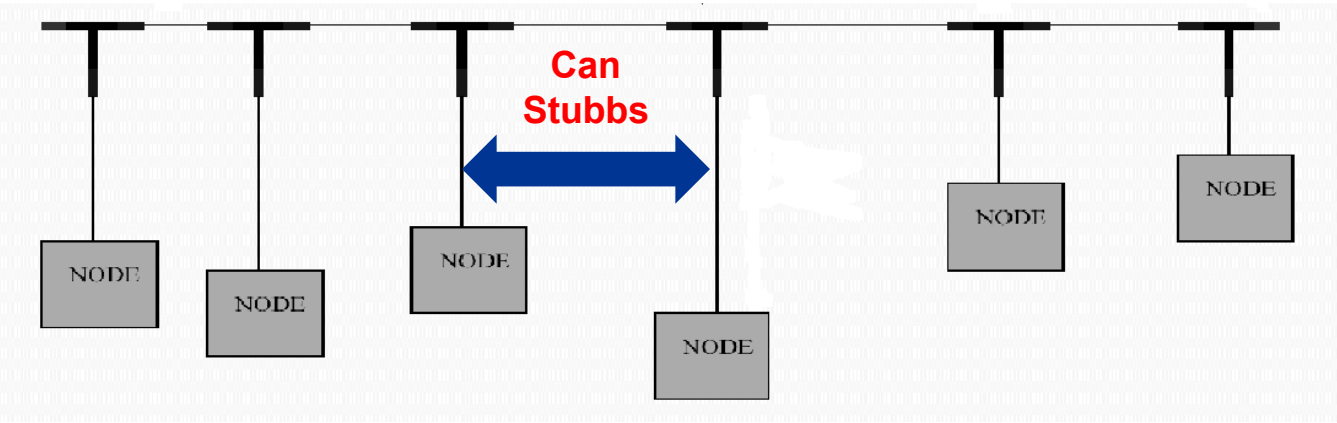
CAN Communication Stubs

CAN Stubs

- Cannot be longer than 1 meter.
- Should vary in length to eliminate bus reflections and ensure proper idle state voltage levels.

Max Number of Modules in a System

- Can handle a maximum of 30 modules in a system at one time.

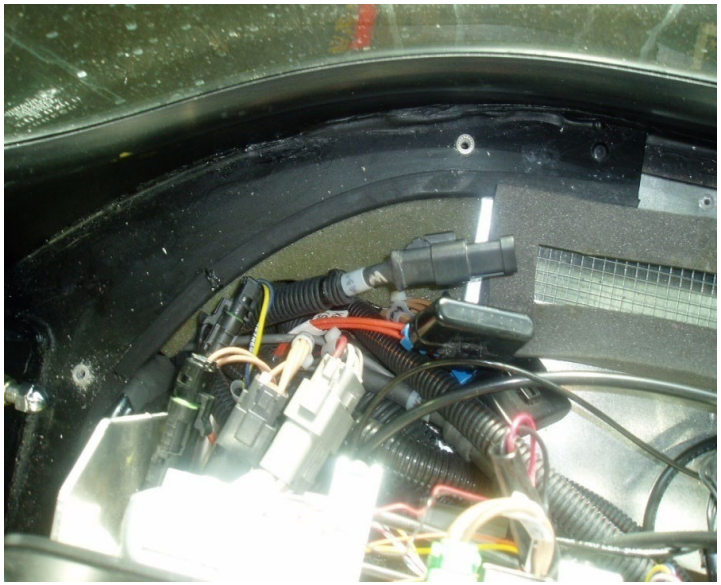


J1939 CAN Configuration

J1939 CAN Configuration

- Standard configuration:
  - All NF VMM1615 Modules & CAN interface configurations have two external resistors.

Note: Refer to Electrical Schematics for details



J1939 CAN Configuration (cont.)

- The CAN cable is very susceptible to system noise.
- The CAN drain must be connected according to the following:
  - To the point of least electrical noise on the CAN bus.
  - As close to the center of the CAN bus as possible.
  - Use the lowest impedance connection possible.
  - Refer to the electrical system schematics, for the specific SR, for the CAN Drain location.

The CAN Bus (cont.)

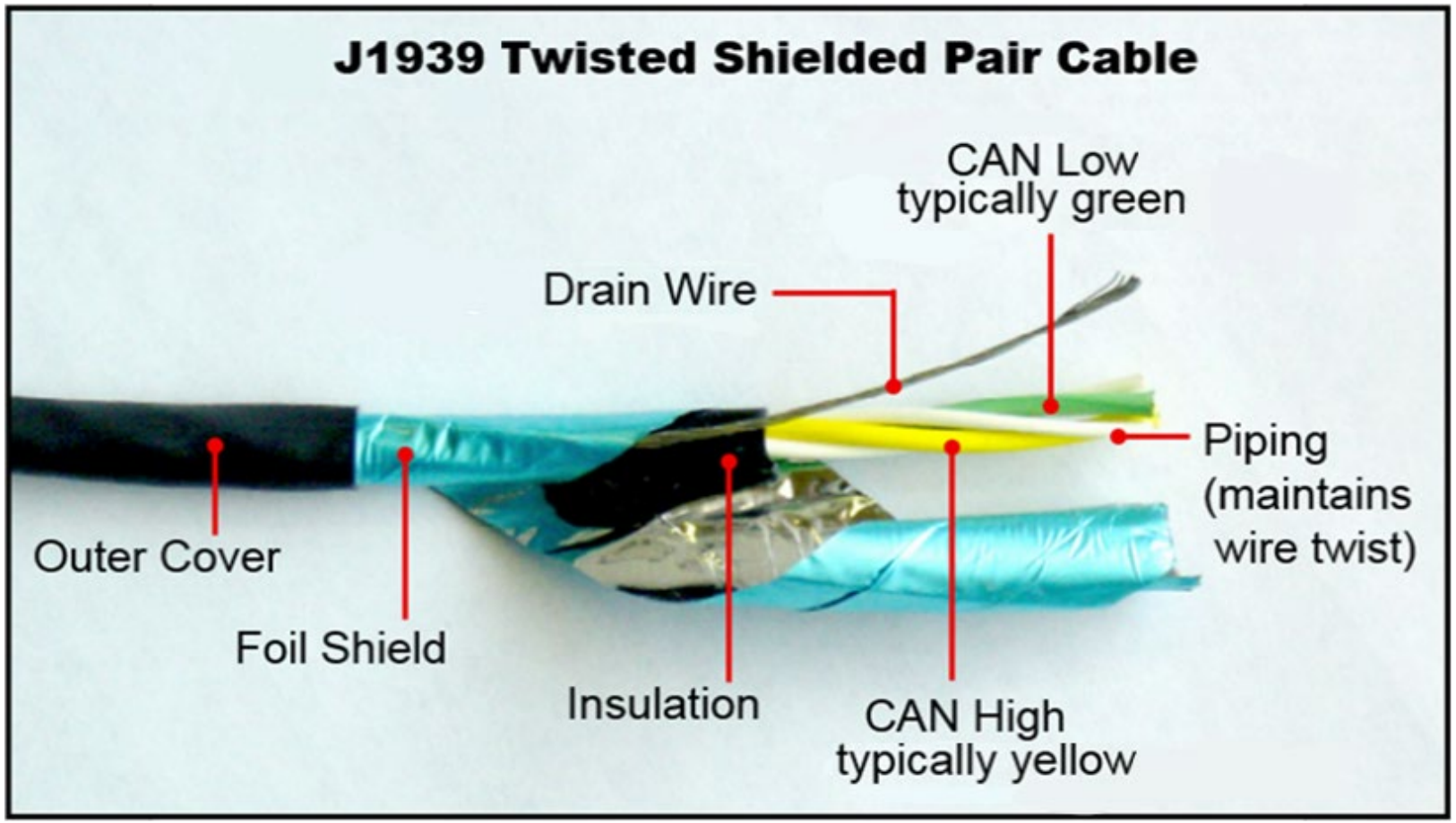
- There is no explicit address in the message, instead, each message carries a numeric value which controls its priority on the bus and may also serve as an identification of the contents of the message.
- An elaborate error handling scheme that results in retransmitted messages when they are not properly received.
- There are effective means for isolating faults and removing faulty nodes from the bus.

J1939 CAN Configuration (cont.)

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

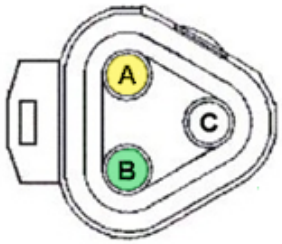
- CAN Cable: A shielded twisted-pair cable should be used when connecting multiple modules to the CAN bus.
- The cable for the J1939 CAN bus has three wires: CAN High, CAN Low, and CAN Drain (which connect to the corresponding CAN_HIGH, CAN_LOW, and CAN_ Drain pins on the connector).
- J1939 connection to each 1615 module J1-10, J1-11, J1-12.
- J1939 connection to IP Cluster Connector J1- 6,7,8.
- The CAN cable must have an impedance of 60 ohms with both resistors installed.

J1939 CAN Wiring Configuration

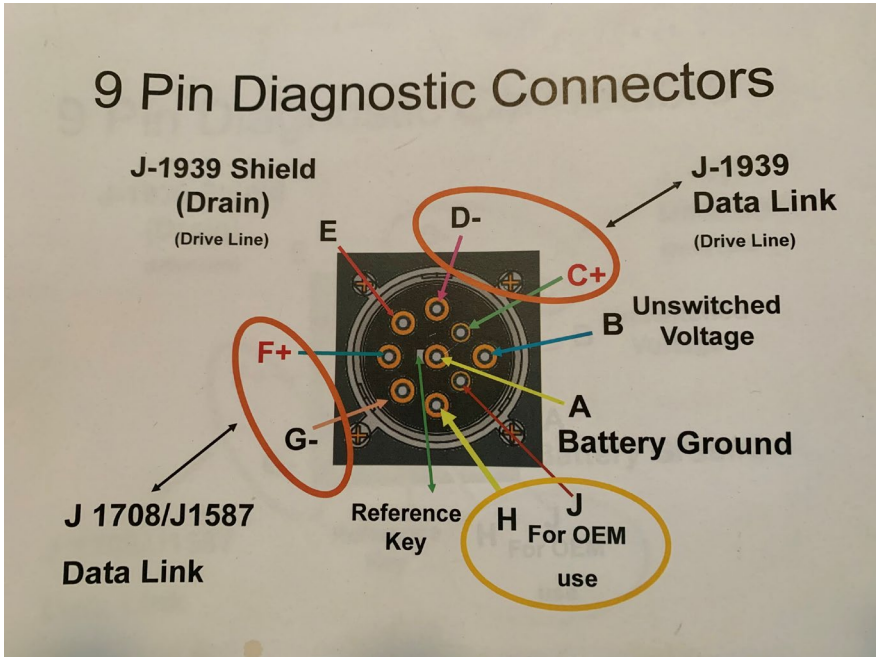


J1939 CAN Wiring Configuration (cont.)

Pin	Value
A	CAN/J1939 Hi
B	CAN/J1939 Lo
C	Ground V-



Typical 3 pin
Deutsch Connector



Typical 9 pin Deutsch Connector

SAE J1939

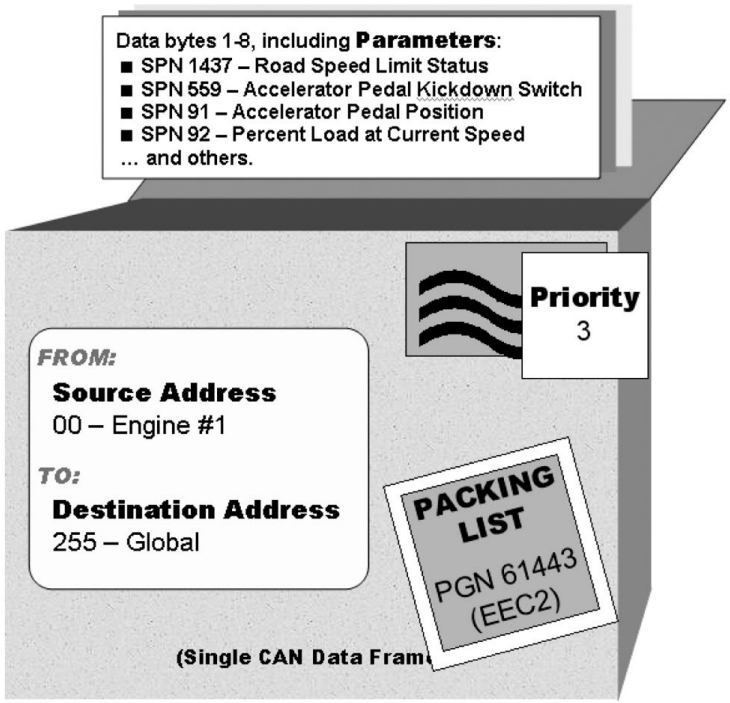
- Established by SAE.
- Based on the Bosch CAN 2.0B.
- J1939 is a series of documents defining everything about the protocol.
- In many ways, J1939 is similar to the older J1708 and J1587 standards, but J1939 is built on CAN.
- The physical layer (J1939/11) describes the electrical interface to the bus.
- The data link layer (J1939/21) describes the rules for constructing a message, accessing the bus, and detecting transmission errors.
- The application layer (J1939/71 and J1939/73) defines the specific data contained within each message sent across the network.

SAE J1939 (cont.)

- Most messages defined by the J1939 standard are intended to be broadcasted. This means that the data is transmitted on the network without a specific destination. This permits any device to use the data without requiring additional request messages. This also allows future software revisions to easily accommodate new devices (address assignments).
- When a message must be directed to a particular device, a specific destination address can be included within the message identifier.
- J1939 uses a 29-bit identifier defined within the CAN 2.0B protocol.
- Key benefits:
  - 25 times faster baud rate (250,000 vs. 9600 Kbit/s).
  - Message arbitration (no destructive collision).
  - Intelligent error detection by hardware.

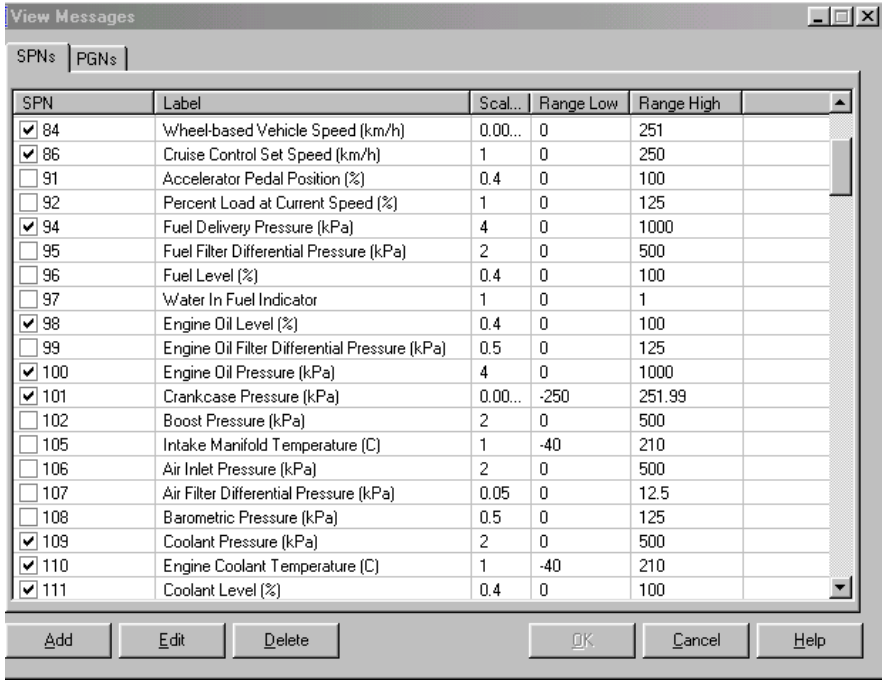
SAE J1939 Message

- Messages sent over J1939 are very similar to mail delivery and include information about who sent the message, where the message is going, how quickly the message must arrive, and the message contents.



J1939 Messages

- J1939 Messages are standard messages for different functions.
- Message S100 is Engine Oil Pressure regardless if it is a Cummins, Detroit or CAT Engine.
- Refer to the bus program and the Vansco software to access specific SR J1939 message list.



Parker Vehicle System Gateway (PVSG)

- The PVSG (Parker Vehicle System Gateway) platform is a gateway family providing routing and gateway interfacing between various communication ports.
- There is a Basic model with USB interface for use as a CAN router/repeater/gateway and an Advanced model with added Wi-Fi, Ethernet and LIN interfaces.

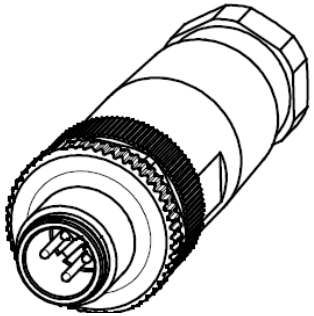
- The PVSG is ideal for balancing CAN loading and isolating CAN Devices to best utilize complex vehicle CAN Bus architectures. Its multiple CAN buses can route, repeat or block messages as configured through the PVSG Config. Tool.

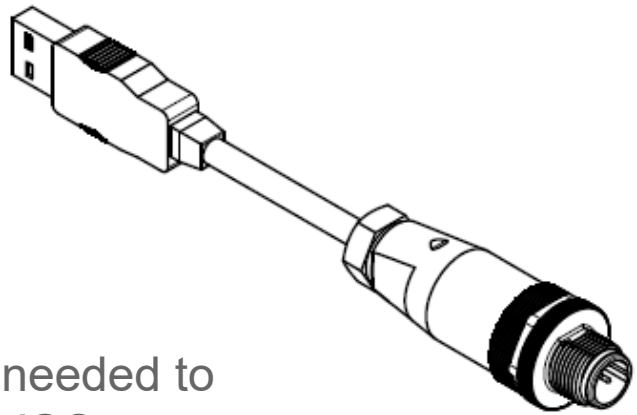
PVSG Features

- The PVSG (Parker Vehicle System Gateway) Service Kit is a replacement to the DLA Kit.
- The PVSG has 5 CAN buses, and each can do 250k/500k/1M baud. The PVSG Service Kit, will be set up for 2 CAN Buses.
- The PVSG Service Kit is WIFI capable, which means, once properly configured, one can connect to the vehicle wirelessly. The PVSG is also fully backwards compatible.
- A PVSG Service Tool Kit will be available from NF Parts.

PVSG Communication Cable

- There is 1 x USB (M12-5 pin), and depending on configuration, 1x Ethernet (M12-4 pin) and 1x SMA Wi-Fi antenna connector.





- Communication Cable needed to program & diagnose PVGS

Plug & Play Feature

- The VMM has a powerful "plug and play" feature, which allows a single module to be replaced in a system with a VMM that contains different ladder logic, application or is blank (no logic and/or no application code) without the need for reprogramming equipment.
- **How it Works:**
  - Each VMM, upon every wake up with master power active will request ladder logic version, system version, application code version and application family version from all the other VMMs in the system.
  - The responses will be sorted to identify mismatches in each application family.
  - The VMM with the lowest address in the lowest application family containing a single mismatch will update the odd VMM in its' application family.

Plug & Play Feature - Update Steps

- **There are three steps to an update:**
  - The requesting VMM puts all VMMs (except itself) into reprogram mode.
  - The requesting VMM then downloads a copy of its' application code into the odd VMM.
  - The requesting VMM puts all VMMs into run mode and then it performs a software reset.

None Existing Odd Module

- If the system does not determine that an odd module exists, the ladder logic version responses are sorted by the requesting VMM.
- If one of the responding VMMs mismatches the majority, and the requesting VMM has the lowest address from the majority, the requesting VMM will update the odd VMM.
- Refer to the three steps to update on previous slide.

Successful Plug & Play

- **The result of plug and play is considered successful when:**
  - All VMMs have the same ladder logic version.
  - All VMMs within an application family have the same application version.
  - All VMMs across all application families have the same system version (i.e., all application families are compatible).
- If one or more of these conditions fail, the network error fault (flag 255) is activated.

Vansco Multiplexing Module Input and Output Circuits

VMM1615 modules mounted inside the side console.

Vansco Circuit Definitions

- **Active-High**
  - Input type that is considered "on" when it reads a battery voltage level and "off“ when it is floating or grounded.
- **Active-Low**
  - Input type that is considered "on" when it reads a ground voltage level and "off“ when it is floating or connected to battery voltage.
- **Analog Input**
  - An input that allows a voltage level to be read and converted to discrete digital values within a microprocessor.
- **Attenuation**
  - Decreasing the voltage level of an input signal to maximize the resolution of an input.

Vansco Circuit Definitions (cont.)

- **Gain**
  - Increasing the voltage level of an input signal to maximize the resolution of an input.
- **CAN**
  - Controller Area Network
- **CAN High**
  - One of the wires used in the shielded twisted-pair cable, which provides the positive signal that, when connected with CAN Low, provides a complete CAN differential signal.
- **CAN Low**
  - One of the wires used in the shielded twisted-pair cable, which provides the negative signal that, when connected with CAN High, provides a complete CAN differential signal.

Vansco Circuit Definitions (cont.)

- **CAN Shield**
  - A shielding that wraps around the CAN High and CAN Low wires (twisted-pair), completing the shielded twisted-pair cable.
- **Current Sensing**
  - When an analog input reads the amount of current flowing through an output driver circuit.
- **DC-coupled**
  - A circuit used with signals that have minimal DC offset. The signal being read by this circuit must fall within the detection threshold range specified for the input.
- **Digital Input**
  - An input that is typically controlled by an external switch that makes the input either active (on), or inactive (off).

Vansco Circuit Definitions (cont.)

- **Frequency Input**
  - An input that allows a frequency value to be read from an oscillating input signal.
- **Half-Bridge**
  - When a high-side and low-side switch are used together to provide a load with both a battery voltage and a ground.
- **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.
- **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.

Vansco Circuit Definitions (cont.)

- **High-Side Output**
  - An output that provides switched battery voltage to an external load
- **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.
- **Power Control Input**
  - A digital input that is used to turn on the product. When the input is active, the product "turns on" and operates in normal mode, and when the input is inactive, the product “powers down” and will not operate.

Vansco Circuit Definitions (cont.)

- **Short-to-Battery**
  - A fault state that occurs when an input or output pin on the product is connected to battery power, potentially resulting in high current flow.
- **Short-to-Ground**
  - A fault state that occurs when an input or output pin on the product is connected to system ground, potentially resulting in high current flow.
- **Pulse Width Modulation (PWM)**
  - A type of square wave frequency signal where the ratio of “on” time vs. “off” time is determined by the duty cycle of the signal. The duty cycle refers to the percent of time the square wave is “on” vs. “off”. PWM signals are typically used to drive varying amounts of current to loads, or to transmit data.

Vansco Circuit Definitions (cont.)

- **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.
- **Wetting Current**
  - The amount of current that flows into, or out of, a digital input. The current helps eliminate oxidation on the contacts of digital switches and relays. Switches with gold or silver contacts typically require much less wetting current than standard tinned contacts.
- **Sensor Power**
  - A regulated voltage output that provides a set voltage level for analog sensors attached to the product.

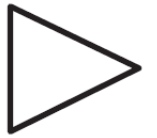
Vansco Circuit Definitions (cont.)

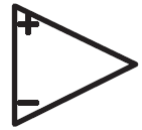
- **Field Effect Transistor (FET)**
  - An electronic device used either as a power switch, or amplifier in electronic circuitry. FETs are typically used as drivers.
- **Pull-Down**
  - A resistor that connects an input to a ground reference so that an open circuit can be recognized by the microprocessor, which is typically used on active-high digital inputs or analog inputs.
- **Pull-Up**
  - A resistor that connects an input to a voltage reference so that an open circuit can be recognized by the microprocessor, which is typically used on active-low digital inputs or analog inputs.

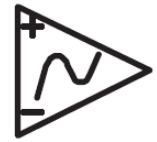
VMM1615 Inputs

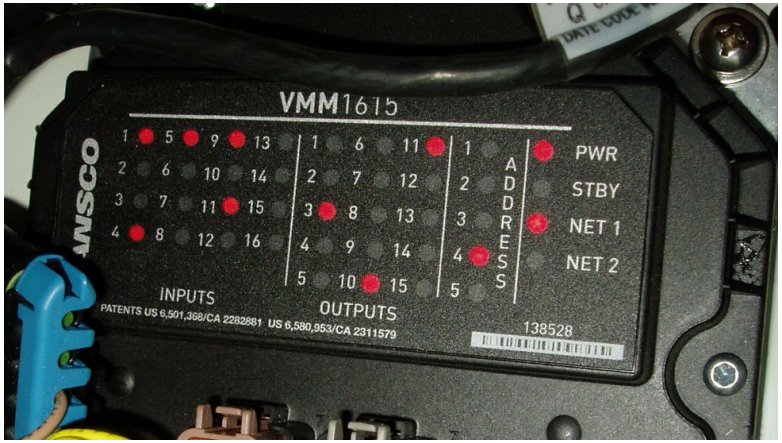
VMM1615 Inputs

- The VMM1615 has three types of inputs:
  - Digital
  - Analog
  - Frequency









VMM1615 Digital Inputs

- The VMM 1615 has 16 inputs of various configurations.
- Digital inputs are typically used with electrical signals and switches that are either on or off.
- There are 3 types of digital inputs in the VMM1615:
  - Programmable Digital Inputs.
  - Addressing Digital Input.
  - Power Control Digital Inputs

VMM1615 Programmable Digital Inputs

Programmable Digital Inputs

- Programmable Digital inputs are configured as active high or active low by using pull-up or pull-down resistors internal to the module. A digital input is typically connected to a switch that is either open or closed.

Active High

- When the switch is open, the pull-down resistor will ensure no voltage exists on the input signal, which will be interpreted by the VMM1615 as inactive. When the switch is closed, the input is connected to battery voltage, which will be interpreted by the VMM1615 as active.

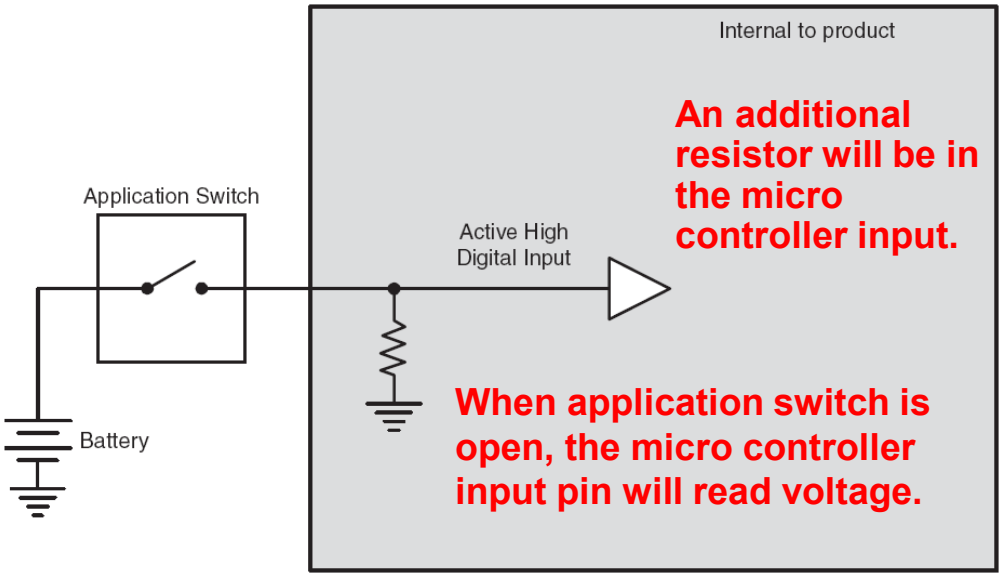
Active Low

- The active-low input must be connected to ground to ensure there is a ground connection when the state of the input changes.
- The VMM1615 has 5 programmable digital inputs input 3 through input 7.

Programmable Digital Input Active High

- Must be connected to battery power to ensure there is a battery connection when the state of the input changes.
- The following shows a typical active high digital input connection:

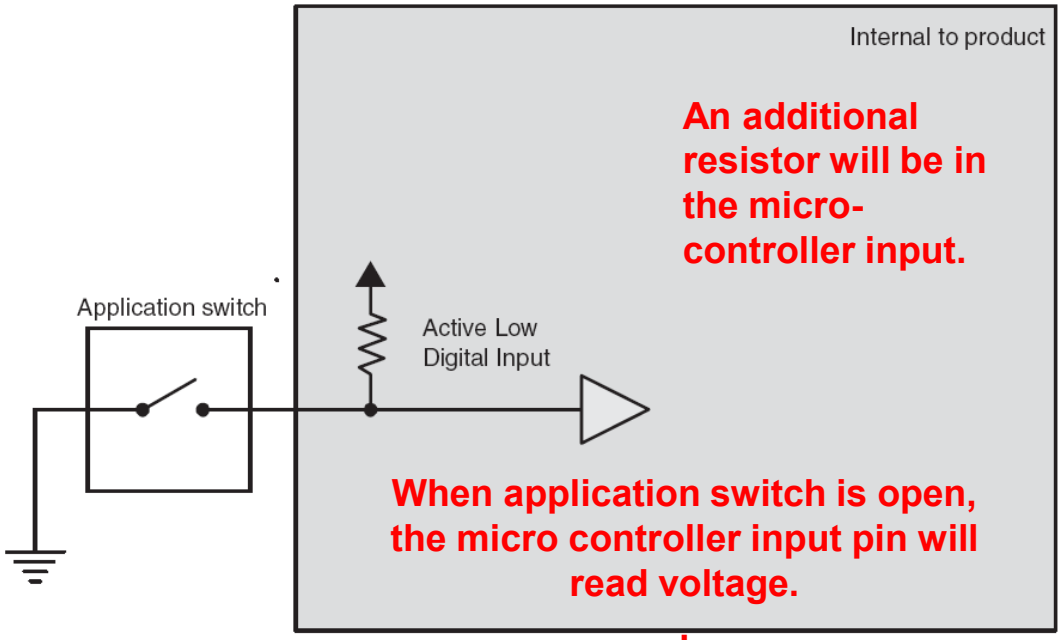
When application switch closes, voltage from battery, is sent into VMM input (path of lease resistance).



Programmable Digital Input Active Low

- Must be connected to ground to ensure there is a ground connection when the state of the input changes.

When the application switch closes, the micro controller will read 0 volts. Because of the impedance on the input pin resistor, electricity will take the path of lease resistance and flow to ground. This will provide a ground signal to the Microcontroller.



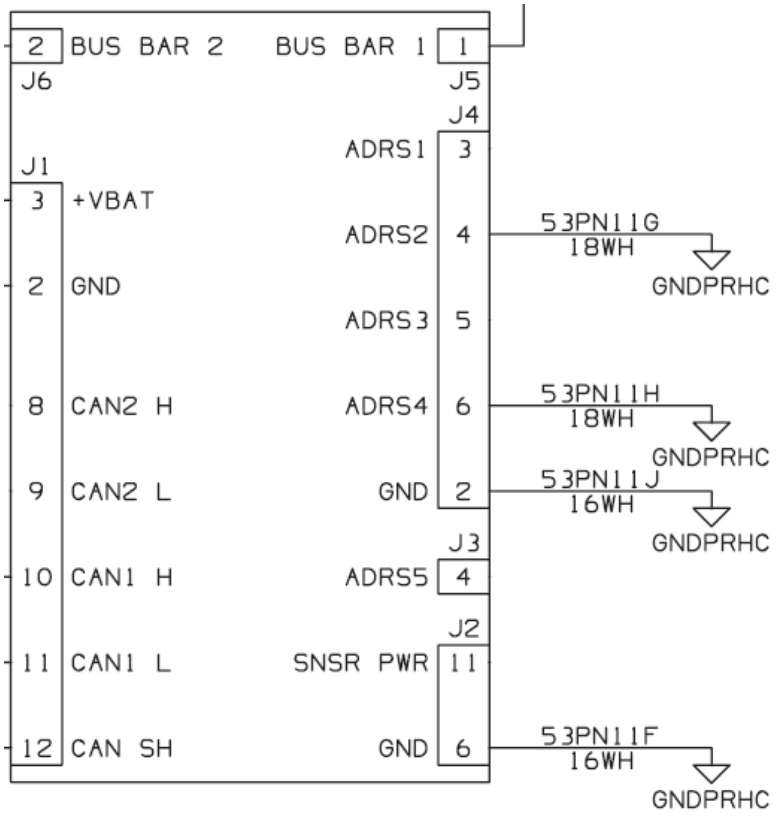
Addressing Digital Inputs

- Digital inputs ADDR1, ADDR2, ADDR3, ADDR4 and ADDR5 are dedicated address inputs .
- These inputs are used to set the system address on the module such that it is unique among all other modules in the system. The maximum allowable addresses in a VMM system is 31 including all devices on the bus (VMMs, PGM, LIMs, etc.).
- The addressing arrangement is shown in the following table, which identifies the required inputs that need to be active and floating (active shown as 1, floating shown as 0).
- The address for the VMMs will be set in the hard wiring of the bus.
- This allows modules to be swapped out and the address will automatically set when the module connectors are reinstalled.

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

VMM1615 Module Addressing (cont.)

- See drawing indicating the module addressing in the illustration.
- Note: Address 2 & 4 are connected to ground, the other address locations are not connected.
- In this arrangement (SR#), this represents node 11 above the exit door.

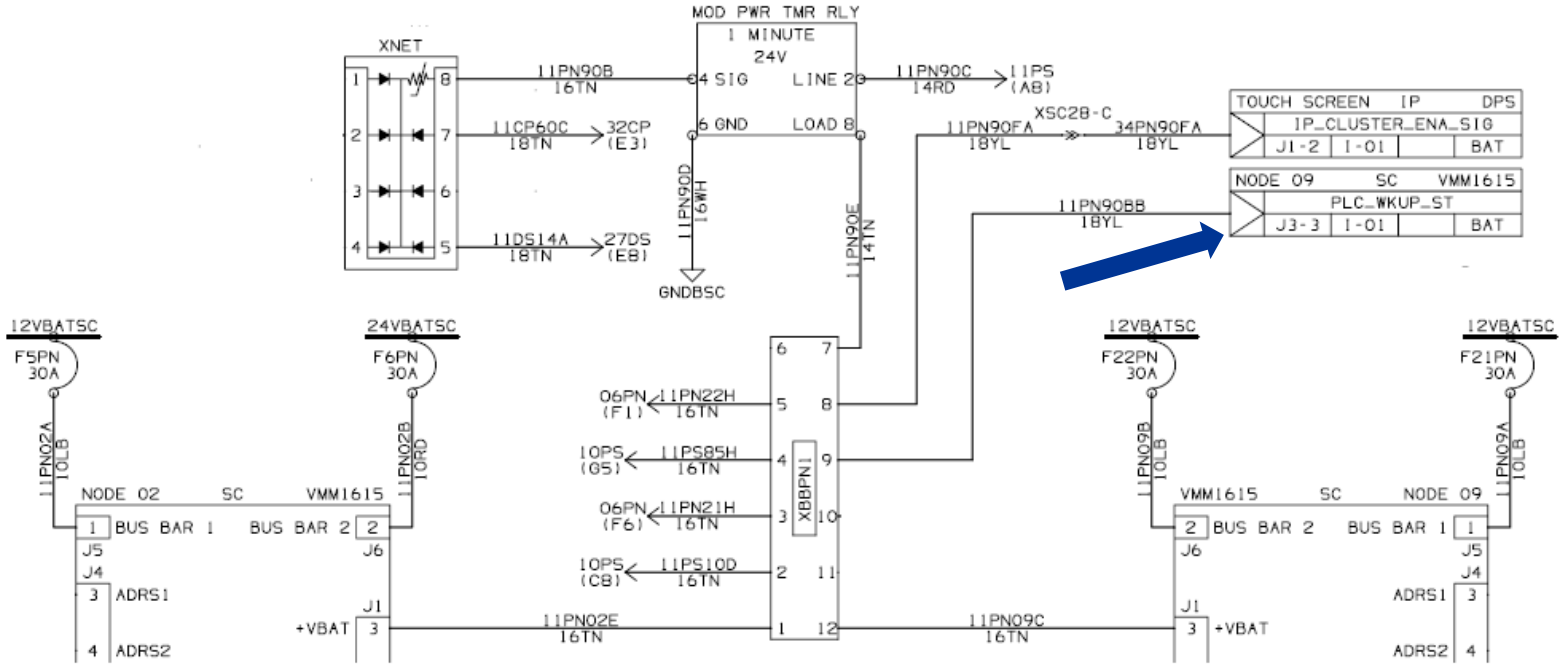


VMM1615 Power Control Digital Input

- The VMM1615 Module # 9 has one active-high power control digital input that is used for waking up (turning on). Input 1-01 Wake Up Signal.
- The power control digital input wakes-up the VMM1615 when switched high to a voltage of 3.9 V or greater, and turns the VMM1615 off when switched low to a voltage less than 1.4 V.
- The VMM1615 will also shut off when an open circuit condition occurs on the power control digital input.
- The power control digital input is usually connected to the vehicle ignition.
- Refer to next slide.

VMM1615 Power Control Digital Input (cont.)

- The Input to Node 9 is used to wake up (via software) all the modules on the system.



VMM1615 Analog Inputs

- Analog inputs are typically used to read electrical signals that span a voltage range. The VMM1615 has 8 analog inputs: Input 9 through Input 16 AD (analog digital).
- Two of the analog inputs (Input 9 AD and Input 10 AD) are type 1 amplified, and the remaining analog inputs (Input 11AD through Input 16 AD) are type 2 attenuated.
- Type 1 analog inputs have programmable gain and are driven through an amplifier to provide a wider array of input range options. These inputs have programmable pull-up or pull-down resistor values, including a resistor that can be used for 4 to 20mA sensor readings.
- Type 2 analog inputs have programmable attenuation and are driven directly into the module analog to digital converter (ADC). These inputs have programmable pull-up or pull-down resistor values, including a resistor that can be used for 4 to 20mA sensor readings.

VMM1615 Analog Inputs (cont.)

- Gain: a measure of the ability of a circuit (often an amplifier) to increase the power or amplitude of a signal from the input to the output.
- Attenuation: the gradual loss in intensity.
- Below is an example of type 1 analog inputs as noted in the IO assignment pages of the electrical schematics.
- The ones listed below are for the alternator charging status and the fuel level sender unit.

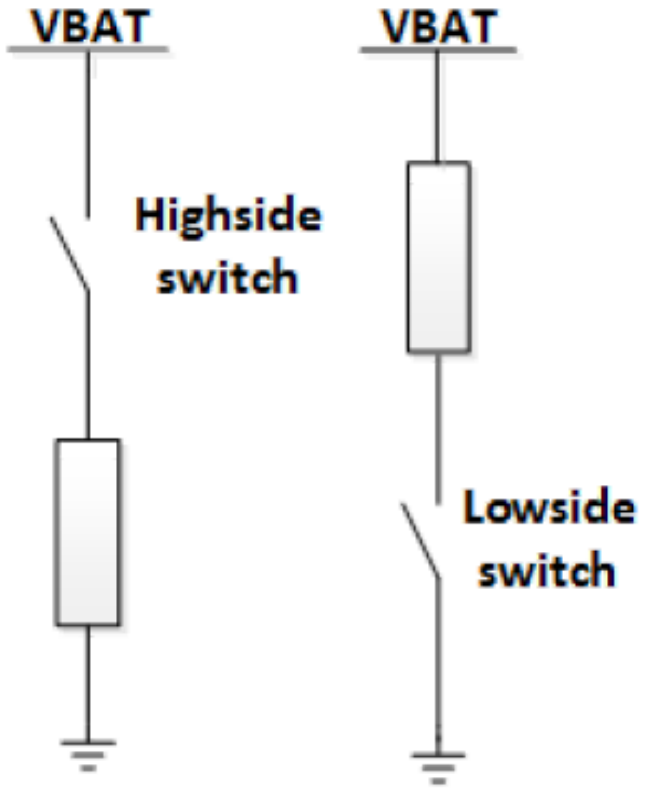
A17-9	ALT_CHRGNG_ST	J2-2B	PS32E	ANALOG
A17-10	FUEL_LVL_SNDR	J2-2D	IP27B	ANALOG

VMM1615 DC Coupled Frequency Input

- There is one type of frequency input in the VMM1615, DC-coupled frequency input.
- DC-coupled frequency inputs are typically used to read pulse signals.
- The VMM1615 has one DC-coupled frequency input: Input 8.
- DC-coupled frequency inputs allow one to read the frequency of external signals that switch between system ground, and sensor or battery power.
- These inputs are ideal for use with hall-effect type sensors.
- The DC-coupled frequency inputs use a pull-up or pull-down resistor.
- This type of input is used to capture fast changing state of the input.
- Example: Amerex fire suppression system provides a pulse. This input type is the most reliable method of capturing it.

VMM1615 High Side & Low Side Connections

- In general terms high side means the power supply or Vehicle Control Current side of the load.
- A high side driver is one in which the switching element is between Vehicle Control Current and the load.
- A low side driver is one in which the switching element is between the load and common ground.



High Side Output Fault Protection

High-Side Output Diagnostics and Fault Protection

- Each high-side output can report many different fault conditions.

Note: The types of faults that are reported are determined by the configuration of the high-side outputs and coach specification.

Short Circuit

- Short-circuit faults occur when a high-side output pin is shorted to ground.

Software Overcurrent

- Software overcurrent faults occur when the current through a high-side output pin exceeds a threshold for a period of 1 second.

High Side Output Fault Protection (cont.)

Back Driven Fault

- Back driven 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.

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. The open load configuration is dependent on the specification of the coach.

Note: The open load check is only enabled per coach specification.

VMM1615 Outputs

The VMM1615 has 12 solid-state outputs.

- Output currents can range from 1.0 up to 10.0 Amps.
- The VMM1615 has 4 types of outputs:
  - High-side outputs.
  - High-side outputs with current sense.
  - Low-side outputs
  - Solid state relay outputs.

VMM1615 High Side Output

The VMM has a total of 12 high-side outputs.

- 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.
- There is 6 outputs that are rated for 10 Amps.
  - Output 1 to Output 6 (10 Amp high side).
- There is 2 of the outputs that are rated for 5 A with current sensing:
  - Output 7 to Output 8 (5 Amp high side).
- There is 2 of the outputs that are rated for 5 A.
  - Output 9 to Output 10 (5 Amp high side).
- There is 2 of the outputs that are rated for 2.5 A with current sensing.
  - Output 11 to 12 (2.5 Amp high side).

VMM1615 High Side Outputs (cont.)

High Side Outputs Examples

O-01	RR_DR_MV	J1-1	DC70F	12V
O-02	RR_DR_ENA_LP	J2-12	DC60T	12V
O-03	FRT_DR_MV	J3-6	DC71M	12V
O-04	FRT_DR_LPS	J4-7	L120A	12V
O-05	RR_DR_LPS	J3-2	L141A	12V
O-06	FRT_DR_DUMP_MV	J4-11	DC71P	12V
O-07	RMP_KNL_WRN_LP	J3-1	LK56F	12V
O-08	-	J4-12		-
O-09	AVM_AC_FAIL_SIG	J3-5	CP61C	12V
O-10	AVM_ESTRK_EVENT_SIG	J4-8	CP61R	12V
O-11	AVM_ABS_FLT_SIG	J3-12	CP61E	12V
O-12	AVM_LO_AIR_SIG	J4-1	CP61F	12V

VMM1615 10 AMP High Side Output Circuits (cont.)

On 10A High-Side Output:

- These outputs provide 10A maximum continuous current with a less accurate current sensing function.
- The current sensing is used to detect over current and provide short circuit protection.

VMM1615 10 AMP High Side Output Circuits (cont.)

Fixed Output Protection:

- **Over temperature** – If the temperature of the driver IC reaches the thermal trip point, the output is disabled. The output will be re-enabled when the driver cools down to an acceptable level.
- **Short circuit** – The output is protected from short circuits.
- **Software fuse** – The software samples the measured current at a predefined rate and compares this value to a set of current ranges. In these ranges multipliers are specified which either increment or decrement the fuse value by a multiplier. If the fuse value reaches the trip point, the output is shut off. The fuse value cannot be decremented below the minimum fuse value. This mechanism is disabled in the event of a hard short circuit. Simulates a mechanical fuse and will trip between 200ms and 1000ms for currents above 10A.
- Refer to 10A High Side Output Specification Chart

VMM1615 5 AMP HS Output Circuits With Current Sense

On 5A High-Side Output with Current Sense Capabilities

- These outputs provide 5A maximum continuous current with accurate current sensing.
- The current sensing provides accurate readings to detect single load disconnect on parallel driven load applications (configurable in software).
- HS = High Side

VMM1615 5 AMP HS Output Circuits With Current Sense (cont.)

Fixed Output Protection

- **Software fuse** – The software samples the measured current at a predefined rate and compares this value to a set of current ranges. In these ranges multipliers are specified which either increment or decrement the fuse value by a multiplier. If the fuse value reaches the trip point, the output is shut off. The fuse value cannot be decremented below the minimum fuse value. This mechanism is disabled in the event of a hard short circuit. Simulates a mechanical fuse and will trip between 200ms and1000ms for currents above 5A.
- **Software short circuit** – The output has software short circuit detection.
- **Over temperature** – If the temperature of the driver IC reaches the thermal trip point, the output is disabled. The output will be re-enabled when the driver cools down to an acceptable level.

VMM1615 5 AMP HS Output Circuits With Current Sense (cont.)

- **Hardware overcurrent protection** – The output has hardware overcurrent protection which will disable the output. The tripping threshold of the circuit is a function of both current and time. The output will trip immediately when subjected to inrush currents above 32A +/- 30%.

VMM1615 5 AMP HS Output Circuits With Current Sense (cont.)

Examples of 5A Output Circuits with current sense

O-07	RR_DR_LPS	J3-1	LI41A	12V
O-08	CLNT_PMP_ENA_SIG	J4-12	EP12D	24V

VMM1615 5 AMP HS Output Circuits Without Current Sensing

On 5A High Side Output Capabilities

- These outputs provide 5A maximum continuous current with a less accurate current sensing function.
- The current sensing is used to detect over current and provide short circuit protection. The circuit is either on or off, does not measure current.
- HS = High Side

VMM1615 5 AMP HS Output Circuits Without Current Sensing (cont.)

Fixed Output Protection

- **Software fuse** – The software samples the measured current at a predefined rate and compares this value to a set of current ranges. In these ranges multipliers are specified which either increment or decrement the fuse value by a multiplier. If the fuse value reaches the trip point, the output is shut off. The fuse value cannot be decremented below the minimum fuse value. This mechanism is disabled in the event of a hard short circuit. Simulates a mechanical fuse and will trip between 200ms and 1000ms for currents above 5A.
- **Software short circuit** – The output has software short circuit detection.
- **Over temperature** – If the temperature of the driver IC reaches the thermal trip point, the output is disabled. The output will be re-enabled when the driver cools down to an acceptable level.

VMM1615 5 AMP HS Output Circuits Without Current Sensing (cont.)

- **Hardware overcurrent protection** – The output has hardware overcurrent protection which will disable the output when a potentially damaging current situation is detected. The output will trip immediately when subjected to inrush currents above 32A +/- 30%.

VMM1615 5 AMP HS Output Circuits Without Current Sensing (cont.)

Examples of 5A Output Circuits without current sense

O-09	AVM_AC_FAIL_SIG	J3-5	CP61C	12V
O-10	AVM_ESTRK_EVENT_SIG	J4-8	CP61R	12V

VMM1615 2.5 AMP High Sided Output Circuits With Current Sensing

On 2.5A High-Side Output with Current Sense Capabilities.

- These outputs provide 2.5A maximum continuous current with accurate current sensing.
- The current sensing provides accurate readings to detect single load disconnect on parallel driven load applications. The current sensing can also be used for regulating current control of hydraulic coils.

VMM1615 2.5 AMP HS Output Circuits With Current Sensing (cont.)

Fixed Output Protection

- **Software fuse** – The software samples the measured current at a predefined rate and compares this value to a set of current ranges. In these multipliers are specified which either increment or decrement the fuse value by a multiplier. If the fuse value reaches the trip point, the output is shut off. The fuse value cannot be decremented below the minimum fuse value. This mechanism is disabled in the event of a hard short circuit. Simulates a mechanical fuse and will trip between 200ms and1000ms for currents above 2.5A.
- **Software short circuit** – The output has software short circuit detection.
- **Over temperature** – If the temperature of the driver IC reaches the thermal trip point, the output is disabled. The output will be re-enabled when the driver cools down to an acceptable level.
- HS = High Side

VMM1615 2.5 AMP HS Output Circuits With Current Sensing (cont.)

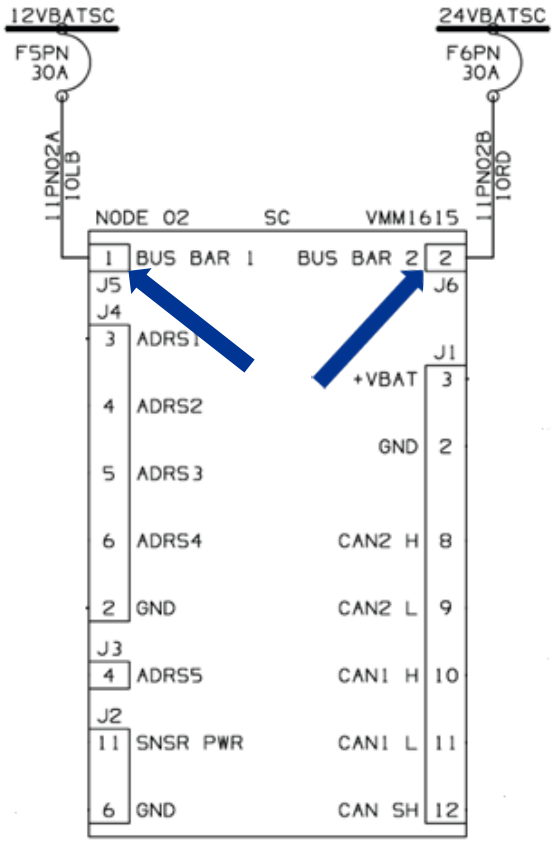
Examples High Sided Output Circuits with Current Sensing

O-11	AVM_ABS_FLT_SIG	J3-12	CP61E	12V
O-12	AVM_LO_AIR_SIG	J4-1	CP61F	12V

VMM1615 Buss Bars Connection On High Side Output Circuits

High Side Output Connections

- High-side outputs are connected to one of two internal bus bars, which can be connected to a +12 V or +24 V battery.
- Each busbar powers 3 x 10Amp, 2 x 5Amp and 1 x 2.5Amp outputs.
- Maximum load on each busbar is 40A.
- High-side outputs can provide switched battery power to a variety of load types in a vehicle.



VMM1615 Low Side Output With Current Sensing (cont.)

- This output provides 2.5A maximum continuous current with accurate current sensing.
- The current sensing provides accurate readings to detect single load disconnect on parallel driven load applications.

VMM1615 Low Side Output With Current Sensing (cont.)

- The low-side output with current sense is used for switching ground to load, using either a pulse width modulated (PWM) signal, or an on/off signal. It also can sense current that is provided to the load, through an amplifier circuit.
- The VMM1615 has 1 low-side output :
  - Output 13 - 2.5 Amps Low Side
- 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".

VMM1615 Low Side Output With Current Sensing (cont.)

Fixed Output Protection

- **Hardwire overcurrent protection** - The output has hardware overcurrent protection which will disable the output when a potentially damaging overcurrent situation is detected. The tripping threshold of the circuit is a function of both current and time. The output will trip immediately when subjected to inrush currents above 13.8A.
- **Software fuse** - The software samples the measured current at a pre defined rate and compares this value to a set of current ranges. In these ranges multipliers are specified which either increment or decrement the fuse value by a multiplier. If the fuse value reaches the trip point, the output is shut off. Simulates a mechanical fuse and will trip between 200ms and 1000ms for currents above 2.5A.
- **Short circuit** – The output is protected from short circuits.

VMM1615 Low Side Output With Current Sensing Faults

Low-Side Outputs with Current Sense Diagnostics

- The VMM1615'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.

The types of faults that are reported are determined by the configuration of the low side outputs.

VMM1615 Solid State Relay Circuits

- The solid-state relays are used for switching currents in either direction as an on/off signal. There are two contacts associated with each of this type of output, which act like the two contacts of a normally open mechanical relay.

VMM1615 Solid State Relay Circuits (cont.)

The VMM1615 has 2 solid state relays:

- Output 14 SSR A / Output14 SSR B.
- Output 15 SSR A / Output15 SSR B.

- When solid state relays are used as an on/off signal, the output provides a low impedance path between the “A” and “B” terminals in the “on” state, (the application software is responsible for switching solid state relays "on" and "off").
- These outputs support 1.0 Amp maximum continuous current between their terminals.
- Each solid-state relay has the ability, to report one type of fault condition.
- **Hardware overcurrent protection-** faults occur when a solid-state relay senses a short from battery to ground across its terminals. The output will trip immediately when subjected to inrush currents above 13.8A.

VMM1615 Solid State Relay Circuits (cont.)

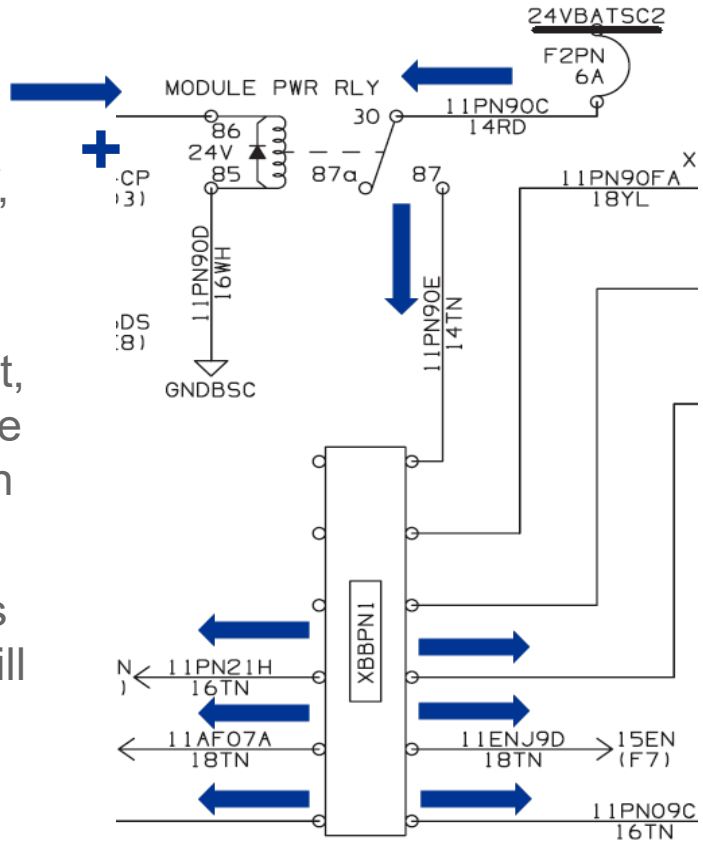
Example Solid State Relay Circuit

O-14A	CMRA_LH_TRN_SIG	J1-7	AF19F	24V
O-14B	CMRA_LH_TRN_SIG	J2-7	AF19FA	24V

VMM1615 Power

- The VMM1615 is powered by the vehicle battery.
- The VMM1615 operates in a 12 V or 24 V system and can operate from 6 V up to 32 V, with overvoltage protection at 36 V protection.
- When the Module Power Relay is fed current, the relay will close and switch power from the 24Volt Battery Side Console Bus Bar and pin 87a will contact pin 87.
- Power will now flow from the bus battery bus bar and feed the Bus Bar XBBPN1, which will supply current to all the modules on the bus.

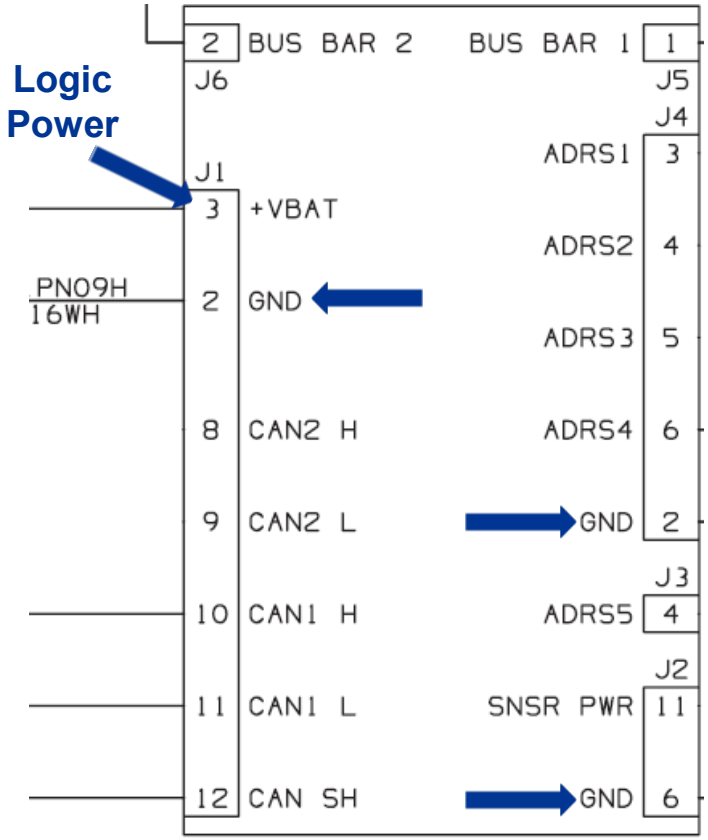
Note: Refer to the SR schematics for specific power arrangement, as there is variations.



VMM1615 Logic Power

Logic Power

- The VMM1615 has 1 pin dedicated to providing power for logic circuitry, called VBatt Logic, and 3 pins dedicated to grounding the VMM1615, called Ground.
- Logic power provides power to the logic circuit, which consists of the microprocessor, RAM, etc.
- The VMM1615 is protected against reverse battery connections by an internal high-current conduction path that goes from ground to power.



VMM1615 Sensor Power

Sensor Power:

- The VMM1615 has one pin dedicated to providing power to external sensors called Sensor Supply.
- Sensor Supply is a 5 V or 8 V linear power supply that is capable of continuously providing 300 mA to external sensors.
- The voltage provided to the VMM1615 must be 7 V or greater to ensure the Sensor Supply can provide 5 V.
- The voltage provided to the VMM 1615 must be 10.5 V or greater to ensure the Sensor Supply can provide 8 V.
- The Sensor Supply is designed to survive short-to-battery, short-to-ground, and overcurrent events. If these events occur, the circuit will recover as described in the following table on the next slide .

VMM1615 Sensor Power (cont.)

Sensor Power Event & Recovery Chart

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.

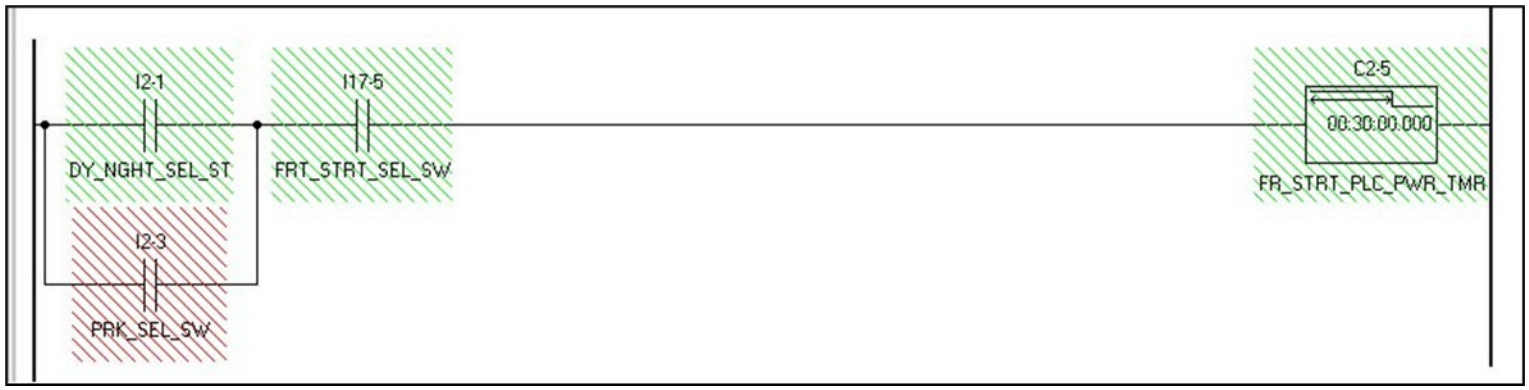
Vansco Diagnostics
Vansco Multiplexing Module Software (VMMS)

- Parker's VMMS Ladder Logic Software makes the configuration of your VMM controller module quick and easy. The user-friendly software lets you make changes quickly and allows you to easily keep track of your software changes. When you are tuning or troubleshooting a machine, VMMS allows you to perform real time diagnostics. VMMS is the perfect software tool for any machine application in mobile markets.

  There are 3 access levels of VMMS:
  • Creative
  Full access to create and edit applications
  • Productive-Most Common
  Advanced diagnostics, log access, I/O forcing, viewing, up/download capabilities
  • Active
  Basic diagnostics, viewing, up/download capabilities

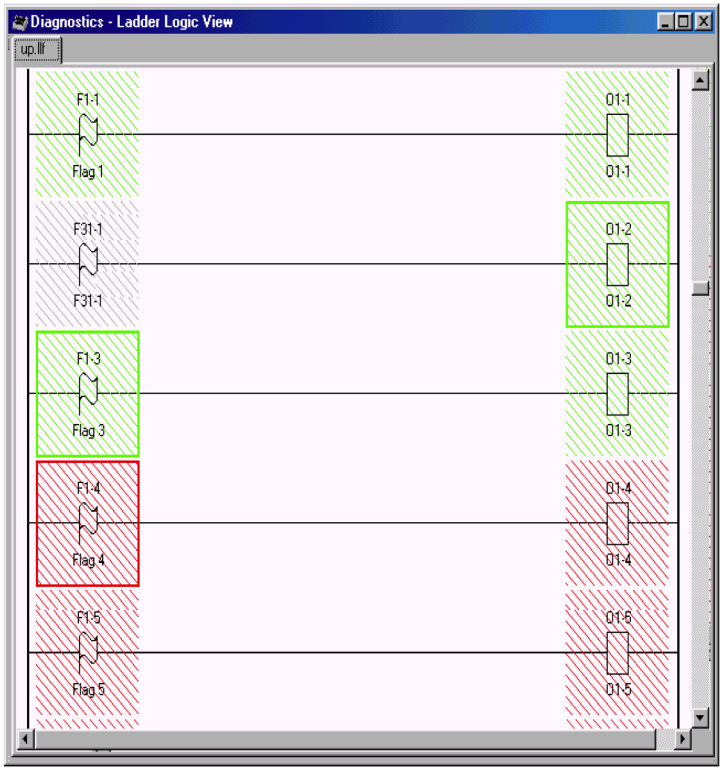
Vansco Diagnostics
Vansco Multiplexing Module Software (VMMS) (cont.)

- In this mode/view (Diagnostic Mode) the ladder logic and can be viewed interactively.
- Active addresses are shown in Green and Inactive addresses are RED.



Vansco Diagnostics
Vansco Multiplexing Module Software (VMMS) (cont.)

- Symbols shown with grey shading are unknown (F31-1).
- Symbols shown with green shading without a solid green border are active (F1-1, O1-1, O1-3).
- Symbols shown with green shading with a solid green border are forced active (F1-3, O1-2).
- Symbols shown with red shading without a solid red border are inactive (F1-5, O1-4, O1-5).
- Symbols shown with red shading with a solid red border are forced inactive (F1-4).



Vansco Diagnostics (cont.)
DPS70 Dash Display

Components and Operation

Note: Arrangement of Icons & colors may vary depending on the coach specification.

Vansco Diagnostics (cont.)
DPS70 Dash Display

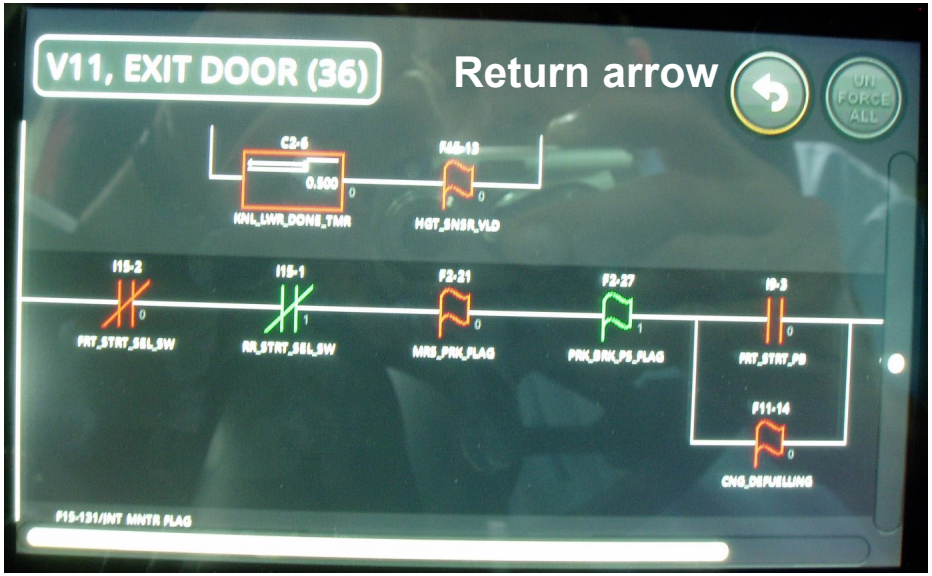
- Parker’s DPS70 (Display Panel Standard with 7" LCD touch screen) instrument cluster is an innovative user interface that makes complete vehicle information accessible in a single centralized location. By incorporating the DPS70 cluster, a wide range of transportation vehicles can be operated more efficiently for greater productivity.
- This versatile instrument cluster supports 3 CAN communication channels, as well as Ethernet and USB. The DPS70 has inputs to measure analog, digital and frequency signals and outputs suited for hydraulic control, or general electrical control.

Vansco Diagnostics (cont.)
DPS70 Dash Display

- The DPS70 instrument cluster is ideal for various transportation vehicle applications, with 4 backlit gauges, up to 26 positions for status LEDs (tell-tales), and an 800x480 LCD screen with a Projected Capacitive (PCAP) touch capability. The 5 video inputs provide blind spot monitoring and backup camera feeds. The robust enclosure has environmentally sealed, Molex MX150 type connectors and is designed to be used in rugged environments.
- Features/Benefits:
  - Monitors up to 21 inputs - analog, digital or frequency
  - 4 gauges supported
  - 26 status LEDs
  - 7" LCD touch screen
  - 3 CAN buses

Vansco Diagnostics (cont.)
DPS70 Dash Display

- The ladder logic screen will provide real time diagnostics.
- In ladder logic one can apply forces, access other sub routines, etc.
- One can perform the same functions as with a laptop.
- The side and bottom bars are used to move the screen to read additional information.



Conclusion

Thank you for you time and questions regarding the New Flyer Multiplexing System. If you have any further questions, feel free to email your New Flyer representative