

VANN-Guard 70-Series

Power Management System With CAN Capable Smart Monitor™



Table of Contents

Introduction.....	3
Specifications.....	4
Theory of Operation.....	5
Typical Applications.....	8
Installation Instructions.....	10
Testing and Troubleshooting.....	13

Notes

Introduction

Thank you for purchasing a Vanner *VANN-Guard CAN Power Management System*. We are confident that you will be very pleased with its performance because our 70-Series are designed and manufactured by skilled professionals using the highest standards in workmanship. With minimum maintenance and care, you can be assured of many years of trouble free service.

General Description

The Vanner *VANN-Guard CAN Power Management System* is an efficient and highly reliable method of obtaining a 12 volt DC power source from a 24 volt DC electrical system. The *VANN-Guard* makes the batteries look like they are in series and parallel at the same time. In addition to providing regulated 12 volt power, the system ensures that battery voltages remain equal which significantly extends battery life. Ideally suited for vehicle and alternate energy applications, the *VANN-Guard* is designed to save your batteries and the money you would spend replacing them. Users of the Vanner *VANN-Guard* know that it is the most cost effective and dependable solution for dual voltage systems.

The CAN (Controller Area Network) Capable Smart Monitor is a device designed to monitor and report the status of several critical functions in the vehicle electrical system. This unit provides real-time fault signals over the CAN bus to the vehicle electrical system controller. Fault indications can then be given from the vehicle's electrical system controller.

A typical system would include a 24VDC power source, such as an alternator or solar array, two 12 volt battery banks in series, and the *VANN-Guard*. The *VANN-Guard* connects to the 24 volt, 12 volt and ground terminals of the battery system. When the 12 volt loads require power, the *VANN-Guard* ensures that the current is taken equally from both batteries, and that the voltages of the two batteries are kept equal. This equalization ensures extended battery life and provides a stable 12 volt supply for operating accessories.

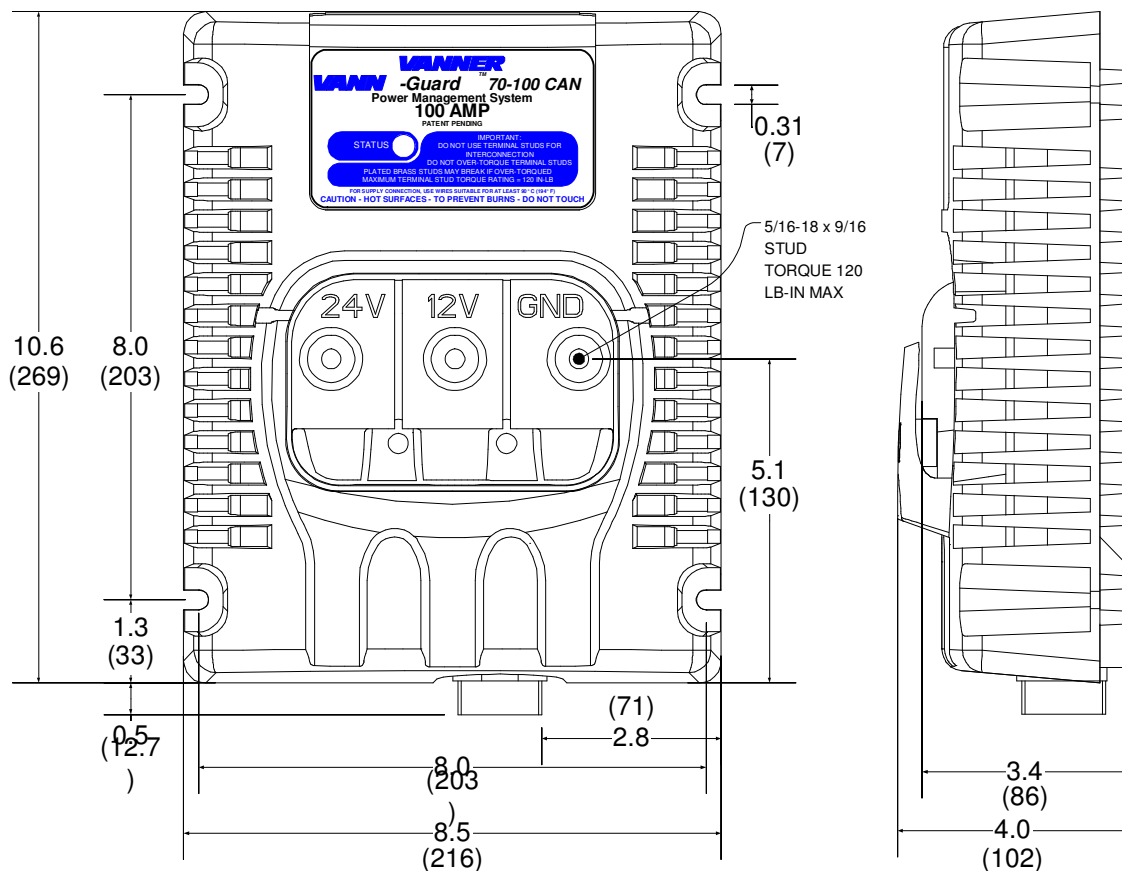
Paralleling VANN-Guard: Models are available which provide 60, 80 and 100 amps of 12 volt DC power. *VANN-Guard* may also be operated in parallel to provide more power. For example, two 60 amp units can be installed to provide 120 amps of 12 volt DC power.

NOTE: The Vanner *VANN-Guard CAN Power Management System* is an extremely reliable device and, when installed according to the instructions, will provide reliable operation for an indefinite period of time. However, if a system abnormality should develop that would cause a *VANN-Guard* malfunction, damage to the battery system could result if 12 volt loads are present.

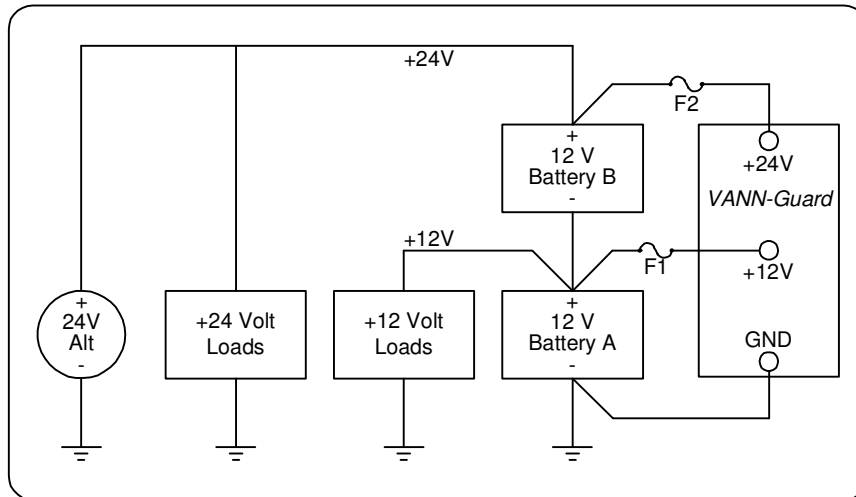
Specifications

70-Series CAN Equalizers			
Model Number	70-60M	70-80M	70-100M
Input Voltage 24v	18 to 32 v		
Efficiency (Peak)	>97%	>97%	>97%
Max 24v Input Amps	32	43	53
Output Voltage	(Input Voltage/2) ±2%		
Output Amps (12v)	0-60	0-80	0-100
Standby Current	20 milliamps nominal at 28.4V		
Smart Monitor	Alarm Low/High Voltage, Imbalance, Undervoltage protect override, Vann-Guard fault -Low/High Temperature available if Vanner Smart Sensor present		
Operating Temp.	-40°C to +75°C (-40°F to 167°F)		
Storage Temp.	-54°C to +95°C (-65°F to 203°F)		
Serviceable	Yes	Yes	Yes
Environmental Considerations	Cast aluminum enclosure provides protection against salt, fungus, dust, water, fuel vapors and all fluids associated with commercial and off-highway vehicle operations.		
Mounting Location	Mount on a flat surface close to the batteries to allow short cable runs. Location should be protected from battery acid and gases.		
Weights	7.0 lbs.	7.3 lbs.	7.3 lbs.

70M-Series Dimensional Specifications



Theory of Operation



In many 24 volt electrical systems it is desirable to tap into the battery system to obtain power for 12 volt loads. This method, while seemingly simple, causes a charge imbalance resulting in Battery B (see diagram) being overcharged, and possibly boiling, while Battery A discharges.

To solve this application problem the Vanner *VANN-Guard* is connected to the battery system at the +24 volt, +12 volt, and ground points. The *VANN-Guard* makes the batteries look like they are in series and in parallel at the same time. The *VANN-Guard* maintains the voltage balance and therefore the charge acceptance rate of each battery. The *VANN-Guard* holds the Battery A and B voltages to within 0.05 volts under light loads and to within 0.1 volts at full rated load.

When the voltage of Battery A is higher than or equal to Battery B the *VANN-Guard* is in the standby mode, i.e., it is not transferring power from its 24 volt input to its 12 volt output. When a 12 volt load is present, and Battery A's voltage decreases to just below the voltage of Battery B, the *VANN-Guard* activates and transfers sufficient current from Battery B to Battery A to satisfy the load and maintain an equal voltage and charge in both batteries.

A key advantage of a system containing a Vanner *VANN-Guard*, compared to a DC to DC converter, is that if the 12 volt load requires a momentary surge current which exceeds the rated capacity of the *VANN-Guard*, Battery A will supply the extra current to the load. The *VANN-Guard* will then replenish the energy to Battery A after the surge has passed.

The following scenarios describe the *VANN-Guard CAN Power Management System* operation.

Scenario #1 - 24 volt load present, no 12 volt load present. The system operates as a system would without the *VANN-Guard* whether the alternator is ON or OFF. The *VANN-Guard* is in the standby mode except for making small adjustments to keep the batteries in balance.

Scenario #2 - Both 24 volt and 12 volt loads present, alternator is OFF. The *VANN-Guard* will insure that both batteries will discharge at the same rate even if different loads are present.

Scenario #3 - Both 24 volt and 12 volt loads present, alternator is ON. The alternator provides 24 volt power to the battery system and to the 24 volt loads. The *VANN-Guard* transfers power from the 24 volt source to the 12 volt load by converting 24 volt power to 12 volts. It will supply sufficient 12 volt power to satisfy the 12 volt load and to maintain battery voltage balance.

Smart Monitor functionality

All functionality described in this section requires that the Monitor Ignition Input (Terminal B) be connected to +24v in order to be active.

A. Switched Sensor Supply Output

This output is used to provide +12v for the Vanner Smart Sensor™ and current sensors. The +12v output is switched for low power shutdown and sleep mode operation.

B. Smart Monitor Ignition (Enable) Input

This input powers the equalizer monitor. When this pin is taken to +24V the monitor becomes active.

C. CAN Shield

This connection is used to make common the shield on the CAN cable. This is required for noise considerations in vehicle electrical systems.

D. Public CAN Low

This is the connection for the vehicle's public CAN bus. The Smart Monitor will communicate faults to the vehicle's electrical system controller via the CAN bus.

E. Public CAN High

This is the connection for the vehicle's public CAN bus. The Smart Monitor will communicate faults to the vehicle's electrical system controller via the CAN bus.

F. Private CAN Low

This is the connection for the Smart Monitor's private CAN bus. The Vanner Smart Sensor communicates with the monitor on this CAN line.

G. Private CAN High

This is the connection for the Smart Monitor's private CAN bus. The Vanner Smart Sensor communicates with the monitor on this CAN line.

H. Sensor Ground

Connect ground for current sensors and Smart Sensors here.

J. Current Sensor 1 (+24v) Signal Input

The monitor can record incoming and outgoing battery current on the upper battery. The output from the current sensor monitoring the +24v output line should be terminated here.

K. Current Sensor 2 (+12v) Signal Input

The monitor can record incoming and outgoing battery current on the lower battery. The output from the current sensor monitoring the +12v output line should be terminated here.

L. Pilot Remote Sense

The Smart Monitor provides this additional single ended voltage sense input for remote sense of other critical system points. This sense line operates the same as the other remote sense lines detailed below.

M. +24V Battery Remote Sense

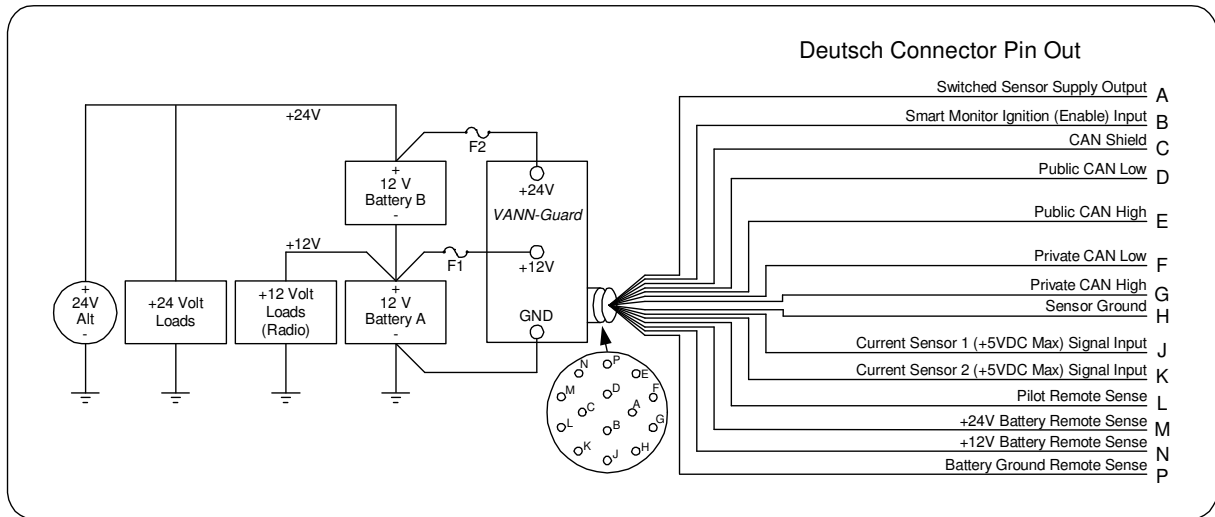
If this pin is connected directly to the +24V battery positive by a separate line, it will improve the accuracy of the Equalizer balance of the batteries when load current is drawn. See below for more information.

N. +12V Battery Remote Sense

If this pin is connected directly to the +12V battery positive by a separate line, it will improve the accuracy of the Equalizer balance of the batteries when load current is drawn. See below for more information.

P. Battery Ground Remote Sense

If this pin is connected directly to the battery ground by a separate line, it will improve the accuracy of the Equalizer balance of the batteries when load current is drawn. See below for more information.



The monitor output from the unit is a through a Deutsch brand connector P/N: HDP20-18-14PN. The mating connector is the Deutsch P/N: HDP26-18-14SN housing with Deutsch P/N: 1062-16-0622 socket contact.

Remote Sense (Terminals M, N, and P)

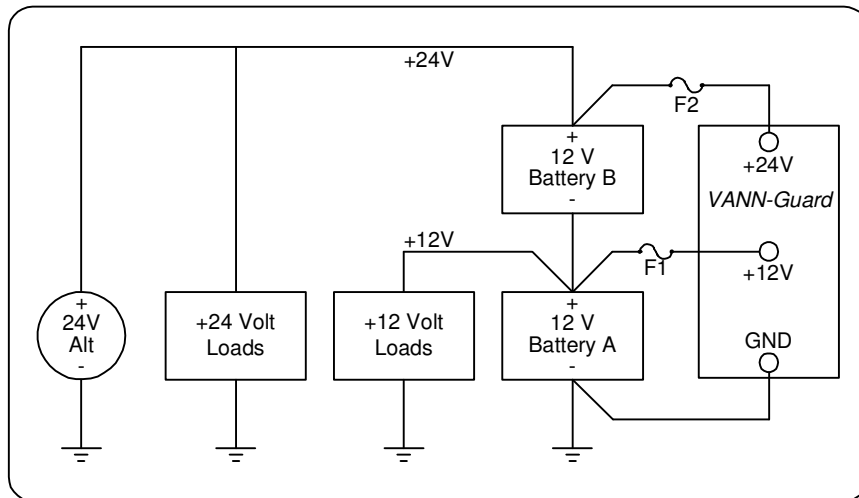
There are three inputs for this function, +24, +12, and ground. They are for remote sense of the battery voltage. This makes the Equalize function insensitive to wire, fuse and connection voltage drops. All three sense lines must be connected for this function to work properly. It is usual for the battery connections to be brought to a distribution point from where connections are made to the rest of the vehicle. Since the battery charge current is the only current which the battery cables carry for most of the time it is convenient to connect the sense wires to these distribution points. This should not introduce a significant error. In fact, when the system stabilizes and the batteries are charged there will be almost no error.

The sense wires can be 16 or 18AWG as the input impedance is high, and the wire gauge can be set for mechanical strength requirements. This allows cost savings and freedom of configuration in the Equalizer power connection wiring, and more freedom in Equalizer location. The equalizer current carrying wire gauge can be the minimum size listed in this manual's wire size table for a given Equalizer rating, up to four times the distance listed. This sets a maximum voltage drop of 0.4V which is reasonable from efficiency and fault detection considerations.

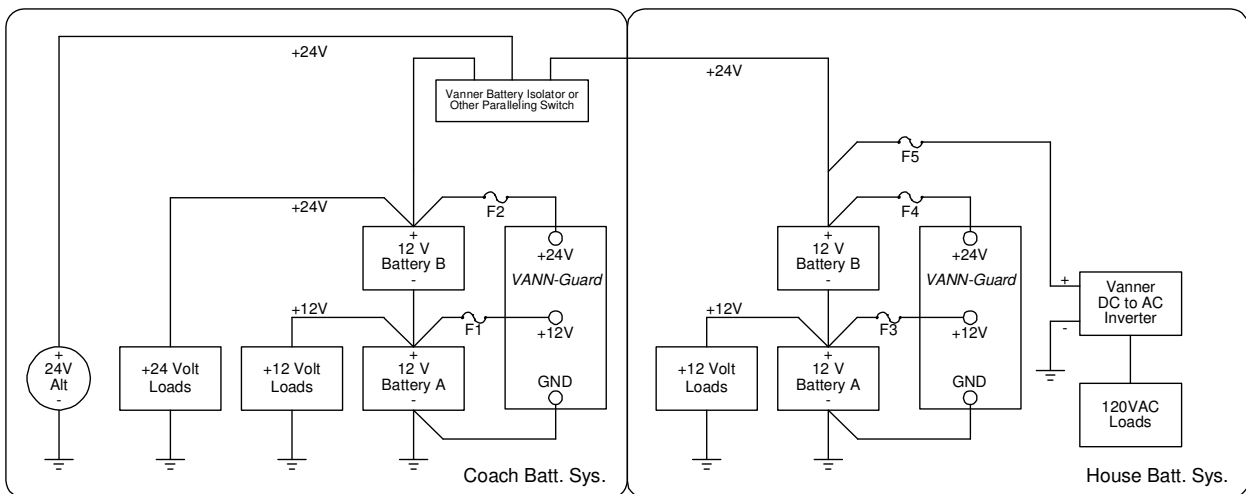
Typical Applications

Vanner VANN-Guard CAN Power Management Systems are used in many types of applications including transit and tour buses, private coaches, heavy trucks and off highway equipment, yachts, and alternative energy systems such as solar powered homes. In addition to VANN-Guards, Vanner manufactures a wide range of complementary products such as DC to DC converters, DC to AC inverters, battery charger/conditioners, and battery isolators. The following system diagrams illustrate how these products are used in various applications.

TRANSIT BUS

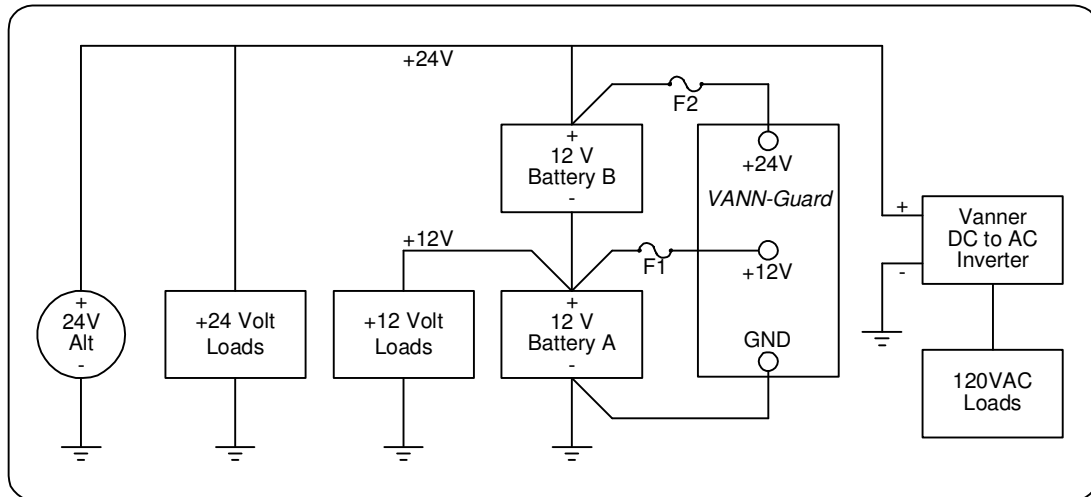


PRIVATE COACH

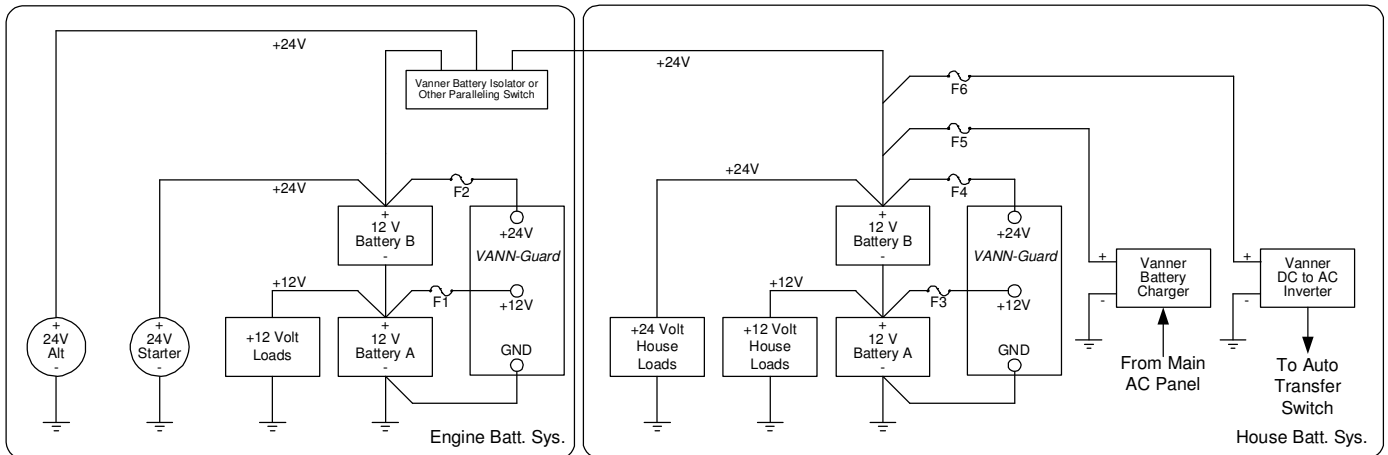


Applications Continued:

TOUR/CHARTER COACH



MARINE



Installation Instructions

Do not exceed the specified torque of 120 in-lbs. when connecting cables to the terminal posts (+24, GND, +12) during installation of all the VANN-Guard Models. Torque values higher than specified may damage the product, reduce performance, and/or create hazardous conditions. Products damaged by improper torque are not covered by the warranty.

Do not connect more than one conductor per terminal post on any Vanner VANN-Guard. Multiple wires and cables may overstress internal components, resulting in poor performance or creating hazardous conditions. Products damaged by the installation of multiple conductors per post are not covered by the warranty.

Fault protection devices must be installed between the VANN-Guard and the power source (battery). A fault protection device would be any fuse or circuit breaker properly rated for the maximum DC current obtainable. This advisory is in accordance with SAE, NEC and UL, for mobile power applications. Install per applicable codes or within 18" of the battery. See Wire and Fuse Sizing Chart on page 10 of this manual or contact Vanner at 1-800-227-6937 or pwrsales@vanner.com if assistance is needed in sizing fault protection devices.

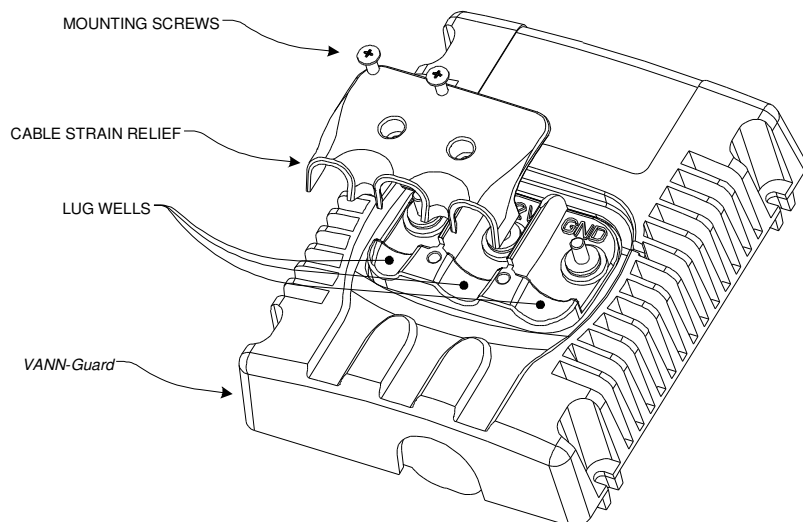
Caution: This equipment tends to produce arcs and sparks during installation. To prevent fire or explosion, compartments containing batteries or flammable materials must be properly ventilated. Safety goggles should always be worn when working near batteries

Mounting Location –The VANN-Guard may be mounted in any orientation, on a flat mounting surface suitable to support the VANN-Guard during application. Do not mount in zero-clearance compartment that may result in the VANN-Guard overheating. Locate so that contact by people is unlikely.

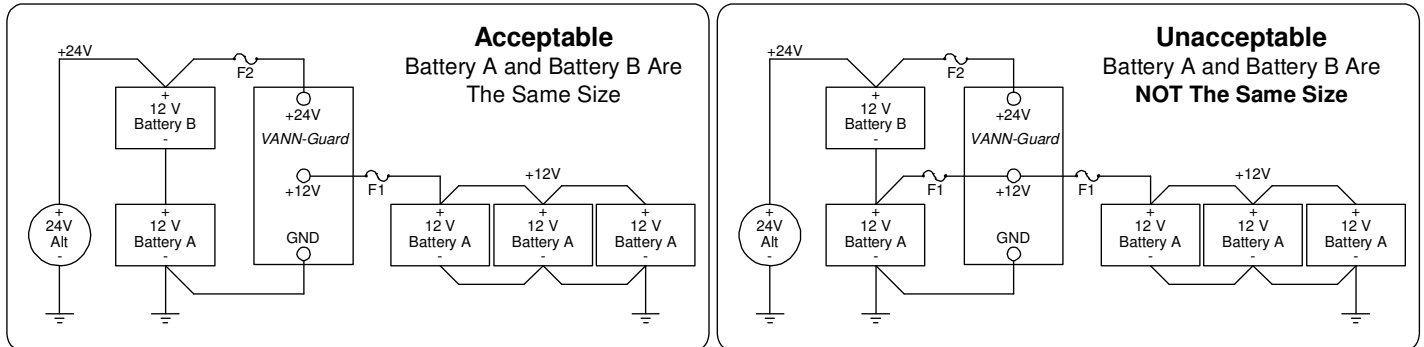
Environmental Protection – Your VANN-Guard has been designed to withstand direct exposure to rain and moisture. The VANN-Guard has also been tested for exposure to direct pressure spray, but continual exposure to direct pressure spraying may reduce the VANN-Guard serviceable life. Any damage due to water contamination is covered by Vanner only through the terms of our factory warranty.

Wiring Sequence– The VANN-Guard is internally protected for reverse polarity. The wiring sequence is not an issue with the VANN-Guard products.

Strain Relief – The VANN-Guard has an integral strain relief. The VANN-Guard is designed with wells for the lug to sit into to resist bolt loosening from cable movement, and the strain relief is designed to further inhibit cable movement. The diagram below shows the proper orientation for the attachment of the strain relief and the #10-32 mounting hardware that is supplied.



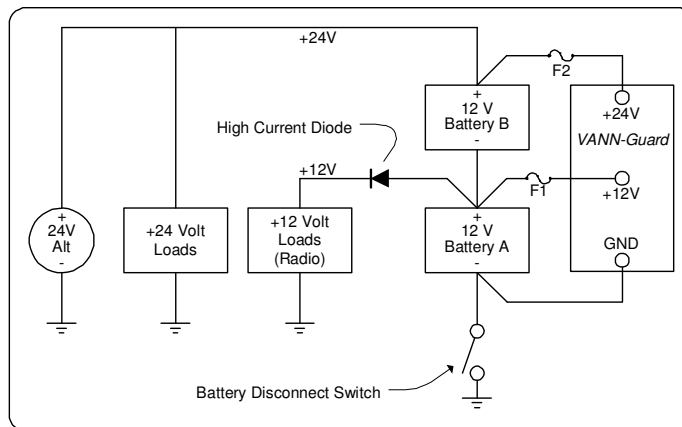
Caution adding 12volt batteries



In certain applications, such as private coach or alternate energy applications, it may be desirable to have additional 12 volt “House Batteries” to operate heavy 12 volt (inverter) loads. Use the *VANN-Guard* to charge the additional batteries.

Connect the *VANN-Guard* 12V terminal to the additional batteries only. Do not connect the *VANN-Guard* 12V terminal to both battery banks as this would make Battery A larger than Battery B. **Damage to Battery B may occur during charging** due to overcharging, if the *VANN-Guard* cannot keep up with the charging system.

Caution using a Ground-Side Battery Disconnect Switch



The system must be wired as shown to prevent Reverse Polarity Damage to polarity sensitive 12 volt loads while the ground-side disconnect switch is open. The *VANN-Guards* GND terminal must be wired to the battery side of the ground-side disconnect switch circuit for the *VANN-Guard* to work properly.

Install the external High Current Diode, such as Vanner Model 52-75 (45 amp continuous rating) to protect polarity sensitive 12 volt loads if these loads do not already contain input diode protection. This prevents a reverse polarity on the 12 volt equipment when the battery switch is open. The reverse polarity does not come from the *VANN-Guard*, but from any 24 volt equipment that may be turned ON.

Wire Size and temperature rating

Cables connecting the *VANN-Guard* to the batteries must be sufficiently sized to prevent unwanted voltage drops. These voltage drops (loss) must be less than 0.05 VDC between the *VANN-Guard's* +24 volt terminal and the battery +24 volt terminal (Battery B positive terminal), less than 0.10 VDC between the *VANN-Guard's* +12 volt terminal and the battery +12 volt terminal (the jumper between Battery A and Battery B), and less than 0.05 VDC between the *VANN-Guard's* GND terminal and the battery ground terminal (Battery A negative terminal that is connected to chassis ground). In most installations, the *VANN-Guard's* terminals are wired directly to the battery terminals (reference fault protection) to prevent voltage loss that could occur in switch contacts, connections, and long wire runs. Since the *VANN-Guard* can be operated in temperatures up to 75°C, use wire rated at least 90°C. See Wire and Fuse Size Chart.

Wire and Fuse Size Chart

Wire Size AWG	Ring Terminal AMP or UL recognized equal	Max wire length, in feet, between <i>VANN-Guard</i> and battery to keep voltage drop under 0.1 volt. The chart assumes wire carries no other load and wire temperature is below 80°C.			
		70-60M	70-80M	70-100M	2 X 70-100M
#8	33462	2.1	XXX	XXX	XXX
#6	33466	3.2	2.4	XXX	XXX
#4	33470	5.9	4.4	3.5	XXX
#2	322870	8.7	6.5	5.2	2.6
#1	321867	10.9	8.2	6.5	3.3
#1/0	321867	13.8	10.4	8.3	4.1
#2/0	321870	17.6	13.2	10.5	5.3
Fuse F1		80 amp	100 amp	125 amp	250 amp
Fuse F2		40 amp	50 amp	80 amp	150 amp

Crimp the ring terminals using **AMP** ROTA-CRIMP 600850 (2/0 - 8ga).

AMP Product Information Center: 800-522-6752

AMP Tooling Assistance Center: 800-722-1111

Note: The wire gages listed are for use without remote sense; see the monitor section for applications using the remote sense capability.

Testing and Troubleshooting

CAUTION

Servicing of electrical systems should only be performed by trained and qualified technical personnel.

Equipment Required

VoltMeter having 0.01 volt resolution. (Fluke Model 87 Multimeter recommended).
Clamp-on current meter (Fluke Model 36 Clamp-on Meter recommended).

Vanner Repair Service

Vanner offers a quick turn around factory repair service. Send the unit to the address below with a note instructing us to repair it. Include your name, phone number, shipping address (not a P.O. Box Number), and your purchase order number.

Test Procedure for *VANN-Guard* 70-Series CAN Power Management Systems

The *VANN-Guard* is working properly if:

1. The 12 volt DC loads are being operated continuously and are within the rated capacity of the *VANN-Guard* and;
2. Battery A voltage is lower than Battery B by no more than 0.05 to 0.10 volts (measured at the *VANN-Guard*'s +24, +12 and GND terminals).

Vanner *VANN-Guards* are electronically protected against reverse polarity damage therefore the DC connection sequence is not an issue.

Vanner *VANN-Guards* will not function properly unless all three battery connections are made. Battery A and Battery B voltages both must be above 8 volts for the unit to turn ON.

Vanner *VANN-Guards* may be used in parallel with other *VANN-Guards* and Vanner Equalizer models.

Please note that the 24V, 12V and GND stud position and orientation are different on *VANN-Guard* 70-Series than on other Vanner Equalizers.

VANN-Guard Test Procedure:

1. Field-test the equalizer while fully connected to the vehicle batteries. For bench testing, two 12 volt batteries, or two 12 volt power supplies are required. The *VANN-Guard* must be connected to the batteries at GND, 12V and 24V to function properly.
2. If battery voltage is below 24 volts start the vehicle or apply a 24 volt battery charger to the batteries.
3. Turn ON 12 volt DC loads up to the *VANN-Guard*'s rated capacity. Measure DC current on the *VANN-Guard* +12V cable to verify load current.
4. **At the *VANN-Guard*** measure and record:
 - a. Battery A voltage (voltage between the *VANN-Guard*'s +12 and GND terminals)
 - b. Battery B voltage (voltage between the *VANN-Guard*'s +24 and +12 terminals)
5. Subtract Battery A voltage from Battery B voltage and compare readings.

Voltage Comparison		VANN-Guard Status	
a.	Battery A is lower than Battery B but within 0.05 volt.	OFF	Stand-by Mode. The <i>VANN-Guard</i> will not turn ON until Battery A is lower than Battery B by more than 0.05 volts.
b.	Battery A is lower than Battery B by 0.05 to 0.10 volts.	ON	Normal Operating Mode
c.	Battery A is lower than Battery B by more than 0.10 volts	ON	Self-Protection Mode due to Overload Condition. See below.
d.	Battery A is lower than Battery B by more than 0.10 volts	OFF	The <i>VANN-Guard</i> is not functioning properly.
e.	Battery A is <u>higher</u> than Battery B	Abnormal condition. Suspect Battery B is defective or a 12 volt load is connected to Battery B.	

Overload Condition

An overload condition exists when the 12 volt loads exceed the *VANN-Guard's* rated capacity. The overload condition will not damage the *VANN-Guard*, but may cause damage to the batteries.

During the overload, the *VANN-Guard's* output is limited by internal protection circuits to its Rated Output Amps. The 12 volt amps exceeding the *VANN-Guard's* output are drawn from Battery A which will begin to draw the batteries out of balance. The *VANN-Guard's* full Rated Output Amps are maintained as long as Battery A and Battery B remain balanced within 0.10 volt. The internal protection circuits will reduce the *VANN-Guard's* output as the batteries become further out-of-balance. If Battery A voltage falls below approximately 8 volts the *VANN-Guard* will shut itself OFF.

To correct the overload condition the 12 volt load must be reduced or the *VANN-Guard's* rated capacity must be increased.

Trouble Shooting an Engine No-Start Situation**Situation:**

A coach has dead batteries and won't start while jump starting. The coach is equipped with a 24 volt starting and charging system, a 12 volt electronic diesel engine control, a *VANN-Guard*, and a moderate 12 volt load which cannot be turned OFF. The coach sits for several days and the batteries run completely dead. During jump-starting the engine cranks but does not start due to low voltage on the 12 volt supply. Electrical testing reveals there is no 12 volt output from the *VANN-Guard* while jump starting even though the *VANN-Guard* separately tests OK.

Cause:

The 12 volt load which could not be turned OFF first ran both batteries down until the *VANN-Guard* shut itself OFF due to low voltage. (The *VANN-Guard* will shut OFF if system voltage falls below 16 volts or if voltage on either battery falls below 8 volts.) Then Battery A alone was drained to near zero volts. As the bus is being jumped, 12 volt loads hold Battery A voltage too low for the *VANN-Guard* to turn ON and Battery A is too weak to support the 12 volt electronic engine control.

Solution:

Turn OFF all 12 volt loads (turning the battery disconnect switch OFF may accomplish this). Connect the jumper cables but do not crank the engine for two or three minutes. (Both batteries must rise above 8 volts.) The battery disconnect switch can then be turned ON and the bus should have adequate 12 volt power to start.

NOTES

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Part Number D912674A
November 1, 2005 Printed in U.S.A.



70 Series Equalizer CAN Bus Specification

The CAN Bus Interface PGN Description

The Equalizer CAN Bus interface allows for reception of messages for control of the Equalizer and transmission of messages that reflect Equalizer status, as well as gathering data from external devices. There are two CAN Bus interfaces on the Equalizer: the public interface, which allows communication with the main vehicle bus, and the private interface, which may optionally be used to connect to devices that communicate only with the equalizer. The CAN protocol used for the Equalizer is SAE J1939. The Parameter Group Numbers (PGNs) assigned to the equalizer are proprietary and are in PDU2 Format. Currently, there are two Parameter Group Numbers (PGNs) assigned that provide for CAN control from the Equalizer and four that provide for CAN status. Both the control and status messages use priority 6. Additional PGNs have been identified for future expansion.

The data format within the J1939 CAN data frames adhere to the following convention: each CAN message consists of 8 bytes (defined 1-8) of data, and each byte is defined as bits 0-7. Values are normally given in decimal, but may also be indicated in hexadecimal or binary. A 0x preceding the number indicates a hexadecimal value, and a 0b preceding indicates a binary value

PGN criteria for the messages in this document is as follows:

- PGN range: 65490 (0xFFD2) to 65499 (0xFFDB)
- Source address of messages from the Equalizer: 30 (0x1E)
- Source address of messages to the Equalizer: 216 (0xD8)
- Source addresses of messages from the Smart Sensors are 16 (0x10) to 23 (0x17), depending on the wiring of the address bits for the sensor.
- Commands to the Equalizer: 65490 (0xFFD2), 65491 (0xFFD3)
- Data from the Equalizer: 65492 (0xFFD4) to 65499 (0xFFDB)



CAN Bus PGN Definitions and Data Formats

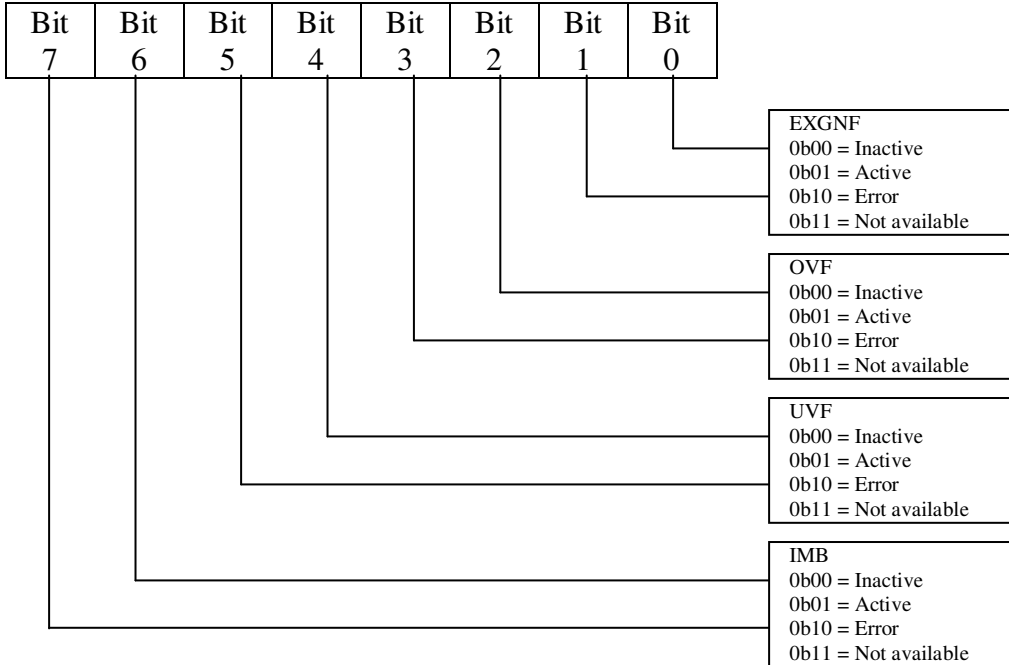
<u>PGN</u>		<u>Description</u>	<u>Source Address</u>		<u>Priority</u>	<u>Message ID (Hex)</u>	<u>Transmit Interval</u>
<u>Decimal</u>	<u>HEX</u>		<u>Decimal</u>	<u>HEX</u>			
65490	0xFFD2	Control Message 1	216	0xD8	6	0xFFD2D8	1 second
65491	0xFFD3	Control Message 2	216	0xD8	6	0xFFD3D8	1 second
65492	0xFFD4	Status	30	0x1E	6	0xFFD41E	3 second
65493	0xFFD5	Heartbeat and Control	30	0x1E	6	0xFFD51E	3 second
65494	0xFFD6	Interface Voltages 1	30	0x1E	6	0xFFD61E	3 seconds
65495	0xFFD7	Smart Sensor Temperatures	30 or Smart Sensor	0x1E or Smart Sensor	6	0xFFD71E	5 seconds
65496	0xFFD8	Smart Sensor Voltages	30 or Smart Sensor	0x1E or Smart Sensor	6	0xFFD81E	5 seconds
65497- 65499	0xFFD9- 0xFFDB	Future Expansion					

Table 1 - CAN BUS Parameter Group Definitions

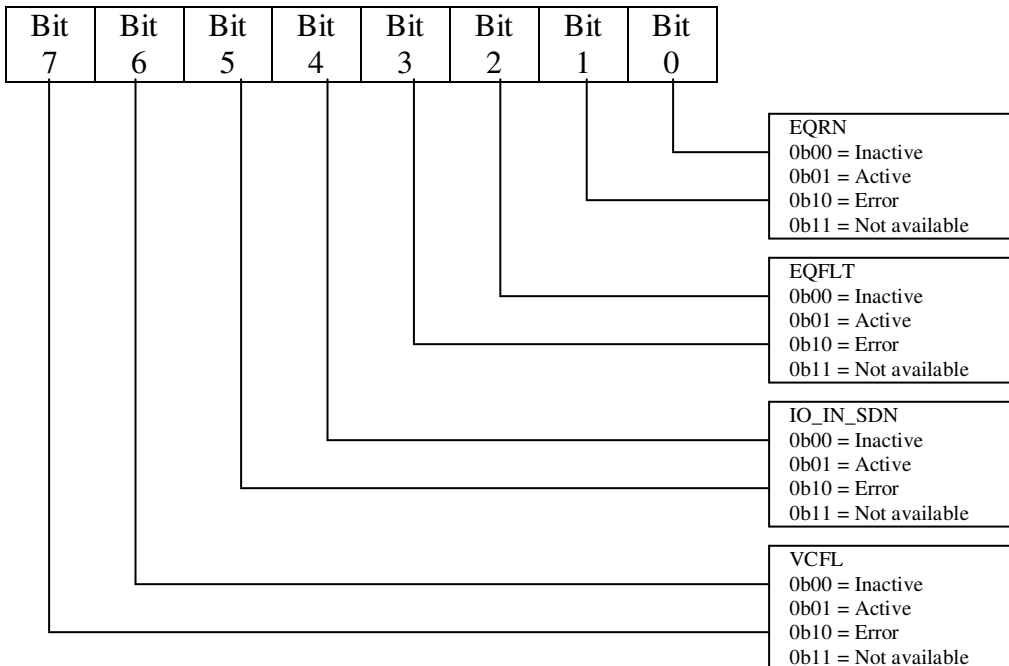
PGN 65490 – Equalizer Control 1

Message: PGN 65490 (0xFFD2h)
 Message Type: Broadcast
 Source Address: System controller, 216 (0xD8)
 Intended Recipient: Equalizer, 30 (0x1E)
 Priority: 6
 29 Bit identifier: 0x18FFD2D8
 Transmission repetition rate: 1 second
 Data length: 8 bytes

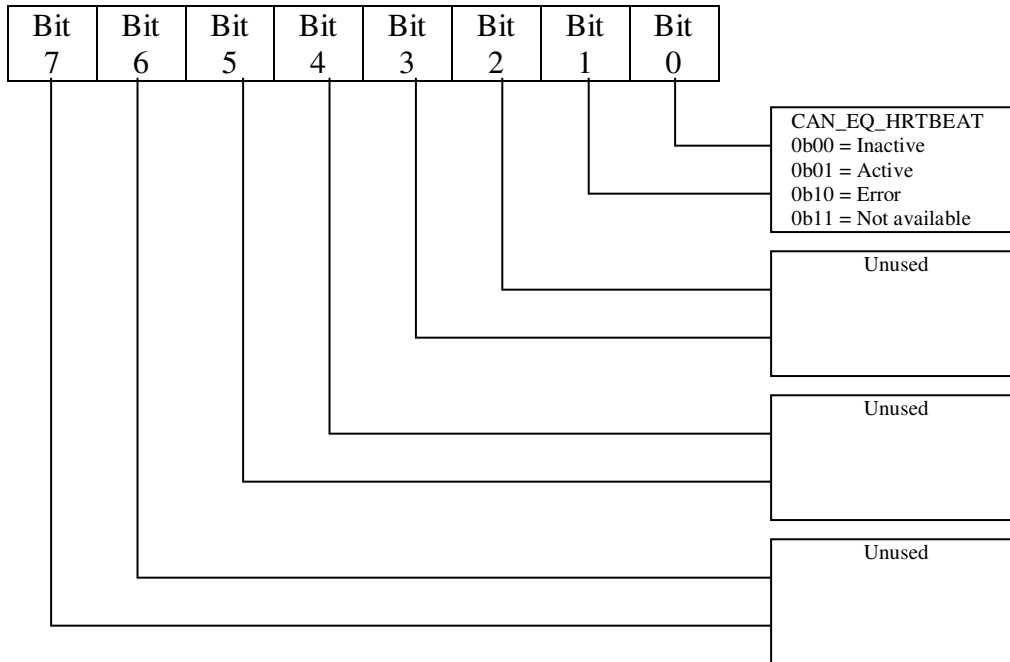
Byte 2: Bit 0,1 EXGNF – external ground fault
 Bit 2,3 OVF – over voltage fault
 Bit 4,5 UVF – under voltage fault
 Bit 6,7 IMB – battery string imbalance



Byte 3: Bit 0,1 EQRN – equalizer running
 Bit 2,3 EQFLT – equalizer fault
 Bit 4,5 IO_IN_SDN – equalizer shutdown
 Bit 6,7 VCFL – voltage compensation fault low



Bit 0,1 CAN_EQ_HRTBEAT– Two bits that indicate a heartbeat message. The value of these two bits will alternate between 0b00 and 0b01
 Bits 2-7 are not used



PGN 65494 – Equalizer Interface Voltages 1

Message: PGN 65494 (0xFFD6)
 Message Type: Broadcast
 Source Address: Equalizer, 30 (0x1E)
 Intended Recipient: System Controller, 216 (0xD8)
 Priority: 6
 29 Bit identifier: 0x18FFD61E
 Transmission repetition rate: 1 second
 Data length: 8 bytes

V12: Equalizer DC Potential, +12V

Bytes 0,1: 16 bit unsigned integer, byte 1 the most significant byte
 Resolution: 0.005 V/bit gain, 0V offset, no sign bit
 Data Range: 0 to 327.675 V

V24: Equalizer DC Potential, +24V

Bytes 2,3: 16 bit unsigned integer, byte 3 is the most significant byte
 Resolution: 0.005 V/bit gain, 0V offset, no sign bit
 Data Range: 0 to 327.275 V

Bytes 4-8: Presently unused

PGN 65495 – Smart Sensor Temperatures

The transmission of PGN 65495 may be enabled or disabled utilizing the CAN_SS_MSG_EN command bits available in PGN 65490, Equalizer Control 1. See **PGN 65490 – Equalizer Control 1 for** details. The messages for Smart Sensor Temperatures can come from the Equalizer (Source Address = 0x1E), from the Smart Sensors themselves, or from both. The Smart Sensors may be located on either the public or private CAN Bus, and the Equalizer determines on which bus the Smart Sensors are located by monitoring for the appropriate messages.

The Equalizer and Smart Sensors use the same PGN for transmission of temperatures, but with different Source Addresses. The Source Address for the message from the Equalizer is 30 (0x1E0). See Appendix A for more information on the PGN, Source Address and data formats for the Smart Sensor.

The Equalizer and Smart Sensors may be used in any one of three configurations:

- Smart Sensors are on the private CAN Bus, and the Equalizer is enabled to collect the Smart Sensor temperatures from the private CAN BUS and transmit them on the public CAN Bus. The Smart Sensor CAN messages PGN 65495 are available only on the private CAN Bus, and the temperatures are available on the public CAN Bus through the Equalizer message only.
- Smart Sensors are on the public CAN Bus, and the Equalizer is enabled to collect the Smart Sensor temperatures from the public CAN Bus and transmit them on the public CAN Bus. The Smart Sensor temperatures are available to devices on the public CAN Bus through PGN 65495 messages, as well as through messages from the Equalizer for the same PGN.
- Smart Sensors are on the public CAN Bus, and the Equalizer is NOT enabled to collect and transmit Smart Sensor temperatures. For this case, the Smart Sensor temperatures are available only through the CAN messages transmitted by the Smart Sensors.

The details for the PGN 65495 messages from the Equalizer are:

Message:	PGN 65495 (0xFFD7)
Message Type:	Broadcast
Source Address:	Equalizer, 30 (0x1E)
Intended Recipient:	System Controller, 216 (0xD8)
Priority:	6
29 Bit identifier:	0x18FFD71E
Transmission repetition rate:	5 second
Data length:	8 bytes

There are up to eight system temperatures collected by the equalizer from the Smart Sensors on the private or public CAN Bus. The collected temperature

values are transmitted in PGN 65495 messages, with the Source Address of 30 (0x1E), and each value occupies one byte in that message. The presence of a sensor is indicated by a nonzero value. The single byte temperature values follow the format defined below:

Byte: 8 bit unsigned integer
 Resolution: 1 °C /bit gain, -128 Degrees offset, sign bit;
 0 = no sensor present, 1=-127 °C , 128 = 0°C,
 255 = 127 °C
 Data Range: -127 to 127 °C

The three address bits, ADDR3-ADDR1, on pins 3-5 of connector P3 determine the Smart Sensor number. When one of these address bits is grounded, it is assigned a value of 0, and when it is left open it is assigned a value of 1. The Smart Sensor number assignments as defined by the address bits, determine the data field assignments in the CAN data message. The data field assignments are defined in Table 2. See Appendix A for the data formats for the Smart Sensor messages.

<u>Data Byte</u>	<u>Temperature Parameter</u>	<u>ADDR3</u> (P3 pin 5)	<u>ADDR2</u> (P3 pin 4)	<u>ADDR1</u> (P3 pin 3)
0	Temperature Sensor 1	No jumper	No jumper	No jumper
1	Temperature Sensor 2	No jumper	No jumper	Jumper to ground
2	Temperature Sensor 3	No jumper	Jumper to ground	No jumper
3	Temperature Sensor 4	No jumper	Jumper to ground	Jumper to ground
4	Temperature Sensor 5	Jumper to ground	No jumper	No jumper
5	Temperature Sensor 6	Jumper to ground	No jumper	Jumper to ground
6	Temperature Sensor 7	Jumper to ground	Jumper to ground	No jumper
7	Temperature Sensor 8	Jumper to ground	Jumper to ground	Jumper to ground

Table 2 - Byte Positions of System Temperatures for PGN 65495

PGN 65496 – Smart Sensor Voltages

The transmission of PGN 65496 may be enabled or disabled utilizing the CAN_SS_MSG_EN command bits available in PGN 65490, Equalizer Control 1. See **PGN 65490 – Equalizer Control 1** for details. The messages for Smart Sensor Temperatures can come from the Equalizer (Source Address = 0x1E), from the Smart Sensors themselves, or from both. The Smart Sensors may be located on either the public or private CAN Bus. See **PGN 65495 – Smart Sensor Temperatures** for more details concerning the use of Smart Sensors on the public or private CAN Bus. Also see **Appendix A for** details of Smart Sensor data formats and PGN assignments.

Message: PGN 65496 (0xFFD8)
Message Type: Broadcast
Source Address: Equalizer, 30 (0x1E)
Intended Recipient: System Controller, 216 (0xD8)
Priority: 6
29 Bit identifier: 0x18FFD81E
Transmission repetition rate: 5 second
Data length: 8 bytes

There are up to eight system voltages collected by the equalizer from up to eight Smart Sensors. The voltage values are transmitted in PGN 65496 messages using an indexed scheme, where the byte 1 of the message is the index, and three voltages reside in bytes 3-8. Each voltage value occupies two bytes, and their format is defined below. The presence of a sensor is indicated by a nonzero value. The integer voltage values follow the format defined below:

Byte 1: Index indicating for which sensors voltage values are present.
Byte 2: Presently not used
Bytes 3, 4: 16 bit unsigned integer, byte 4 is the most significant byte
Resolution: 0.004 Volts /bit gain, no offset
Data Range: 0 (0x0000) to 262.14 V (0xFFFF)
Bytes 5, 6: See bytes 3, 4 above
Bytes 7, 8: See bytes 3, 4 above

The indexing scheme for the Smart Sensor voltages is described below in Table 3. The first byte of the message contains the index, which defines the sensor numbers for which voltages are present in the message. For example, if byte 1's value is 0x01, the voltage for sensor 0 is present in bytes 3 and 4, sensor 1 voltage is in bytes 5 and 6, and sensor 2 voltage is in bytes 7 and 8.

<u>Index Value (Byte 1)</u>	<u>Bytes 3 and 4 Voltage</u>	<u>Bytes 5 and 6 Voltage</u>	<u>Bytes 7 and 8 Voltage</u>
1	Sensor 0	Sensor 1	Sensor 2
2	Sensor 3	Sensor 4	Sensor 5
3	Sensor 6	Sensor 7	N/A
4 - 255	Reserved for future use		

Table 3 - Assignment of Sensor Voltages

PGN 65497 – 65499

No commands are presently implemented for PGNs 65497-65499.

Appendix A - Smart Sensor Private Bus CAN Bus PGN Definitions and Data Formats

<u>PGN</u>		<u>Description</u>	<u>Source Address</u>		<u>Priority</u>	<u>Message ID (Hex)</u>	<u>Transmit Interval</u>
<u>Decimal</u>	<u>HEX</u>		<u>Decimal</u>	<u>HEX</u>			
65495	0xFFD7	Smart Sensor 1	16	0x10	6	0xFFD710	5 seconds
65495	0xFFD7	Smart Sensor 2	17	0x11	6	0xFFD711	5 seconds
65495	0xFFD7	Smart Sensor 3	18	0x12	6	0xFFD712	5 seconds
65495	0xFFD7	Smart Sensor 4	19	0x13	6	0xFFD713	5 seconds
65495	0xFFD7	Smart Sensor 5	20	0x14	6	0xFFD714	5 seconds
65495	0xFFD7	Smart Sensor 6	21	0x15	6	0xFFD715	5 seconds
65495	0xFFD7	Smart Sensor 7	22	0x16	6	0xFFD716	5 seconds
65495	0xFFD7	Smart Sensor 8	23	0x17	6	0xFFD717	5 seconds

Table 4 – J1939 CAN Bus Parameter Group Definitions for Smart Sensors

Notes:

- PGNs and source addresses for Smart Sensors are assigned so that the sensors may reside on the public or private CAN Bus of the Equalizer.
- The base source address for a group of Smart Sensors is 16 (0x10). Source addresses number for 16 to 23 (0x10 to 0x17). Smart Sensors with the same address on a given CAN Bus can confuse the Equalizer and should be avoided.
- The source address for the Equalizer is 30 (0x1E), whether it is located on the public or private CAN Bus. Future enhancements, such as power management commands transmitted from the equalizer to the Smart Sensors, require that the Equalizer use this source address.
- Priority for all messages is 6.

The three address bits, ADDR3-ADDR1, on pins 3-5 of connector P3 (pins PT5/IOC5, PT6/IOC6, PT7/IOC7) determine the Smart Sensor number. When one of these address bits is grounded, it is assigned a value of 0, and when it is left open it is assigned a value of 1. The Smart Sensor number and base PGN assignments are determined by the address bits as defined in Table 2.

<u>PGN Base Identifier</u>	<u>Temperature Parameter</u>	<u>ADDR3</u> (P3 pin 5)	<u>ADDR2</u> (P3 pin 4)	<u>ADDR1</u> (P3 pin 3)
0x18FFD710	Smart Sensor 1	No jumper	No jumper	No jumper
0x18FFD711	Smart Sensor 2	No jumper	No jumper	Jumper to ground
0x18FFD712	Smart Sensor 3	No jumper	Jumper to ground	No jumper
0x18FFD713	Smart Sensor 4	No jumper	Jumper to ground	Jumper to ground
0x18FFD714	Smart Sensor 5	Jumper to ground	No jumper	No jumper
0x18FFD715	Smart Sensor 6	Jumper to ground	No jumper	Jumper to ground
0x18FFD716	Smart Sensor 7	Jumper to ground	Jumper to ground	No jumper
0x18FFD717	Smart Sensor 8	Jumper to ground	Jumper to ground	Jumper to ground

Table 5 – PGN assignments based on Smart Sensor address pins

Data Format for System Temperatures

Message: PGN 65280 - 65392 (0xFF00 – 0xFF70)
 Message Type: Broadcast
 Source Address: Temperature Sensor 1 - 8, 16 - 23 (0x10 – 0x17)
 Intended Recipient: System Controller, 128 (0x80)
 Priority: 6
 29 Bit identifier: See Table 4
 Transmission repetition rate: 5 seconds
 Data length: 8 bytes

Temperature Sensor Status

Bytes 1, 2: These bytes are reserved for use in reporting status in the future.

Measured Temperature

Byte 3: The measured temperature occupies one byte. The single byte temperature values follow the format defined below:

Byte: 8 bit unsigned integer
 Resolution: 1 °C /bit gain, -128 Degrees offset, sign bit;
 0 = no sensor present, 1 = -127°C , 128 = 0°C, 255 = 127 °C

Data Range: -127 to 127 °C

Byte 4: Reserved

Measured Voltage

Bytes 5, 6: DC voltage measured at the temperature sensor's terminal,
Byte 6 is most significant.

Resolution: 0.04 V/bit gain, 0V offset

Data Range: 0 to 3212.75 V

Bytes 7, 8: Reserved