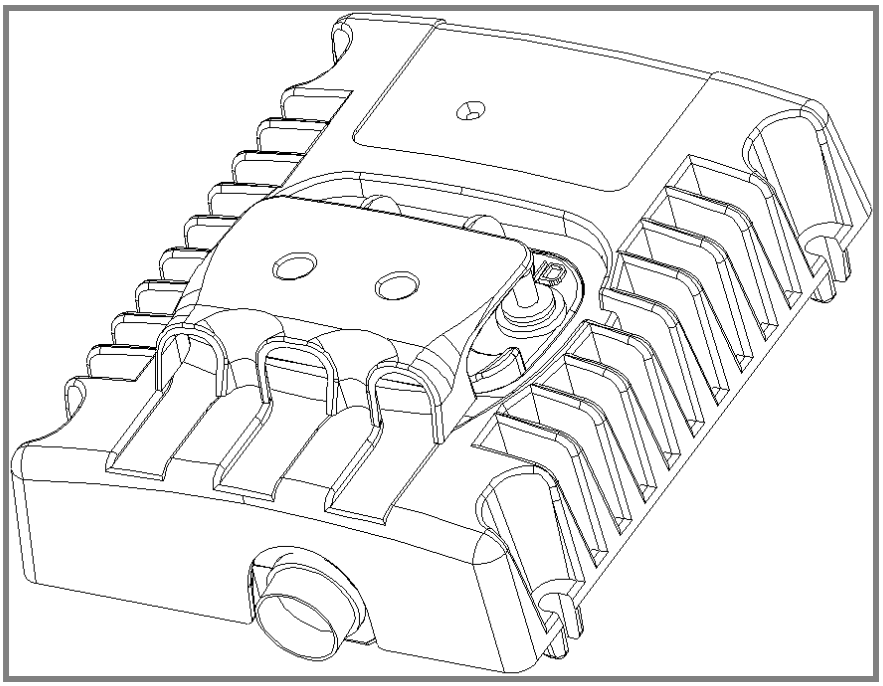
VANN-Bus 90-Series

Converter-Isolator System
With CAN Capable Smart Monitor ™



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Introduction

Thank you for purchasing a Vanner *90-60 Converter-Isolator*. We are confident that you will be very pleased with its performance because our 90-Series Converters 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 *VAN-Bus CAN Power Management System* is an efficient and highly reliable method of maintaining isolation between your 24-Volt DC starting system and your 24-Volt DC auxiliary system. In addition to providing regulated 24-Volt power, the system provides charging to the 24-Volt auxiliary battery, when conditions permit, which significantly extends battery life. Ideally suited for vehicle and alternate energy applications, the *VAN-Bus* is designed to save your batteries and the money you would spend replacing them. Users of the Vanner *VAN-Bus* know that it is the most cost effective and dependable solution for 24-Volt 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. Battery-monitoring algorithms have been incorporated into the 90-60 Series *VAN-Bus*, transmitting real time battery state of charge, state of health, and run time messages over CAN.

A typical system would include a 24-Volt DC-starting system, a 24-Volt DC auxiliary system, and the *90-Series*. The *90-Series* connects to the 24-Volt starting system, 24-Volt auxiliary system and ground terminals of the battery system. When the auxiliary battery requires charging, the *VAN-Bus* ensures that the current is transferred from the starting batteries, when conditions permit, and that the auxiliary batteries can not drain the starting batteries when loads are left on. This isolation between the two 24-Volt systems ensures that the starting batteries will maintain the power required to start the vehicle, and provides a stable 24-Volt supply for operating accessories.

NOTE: The Vanner *VAN-Bus 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 *VAN-Bus* malfunction, damage to the battery system could result if 24-Volt loads are present.

Specifications

90-Series Converter-Isolator	
Model Number	90-60CAN
Input Voltage 24v	18 to 32 v
Efficiency (Peak)	>97%
Max 24v Input Amps	32
Output Voltage	Programmed via CAN
Output Amps (24v)	0-62
Standby Current	20 milliamps nominal at 28.4V
Smart Monitor	Alarm Low/High Voltage, Imbalance, Under voltage protect override, VAN-Bus fault Battery Monitoring
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
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.

90-Series CAN Dimensional Specifications

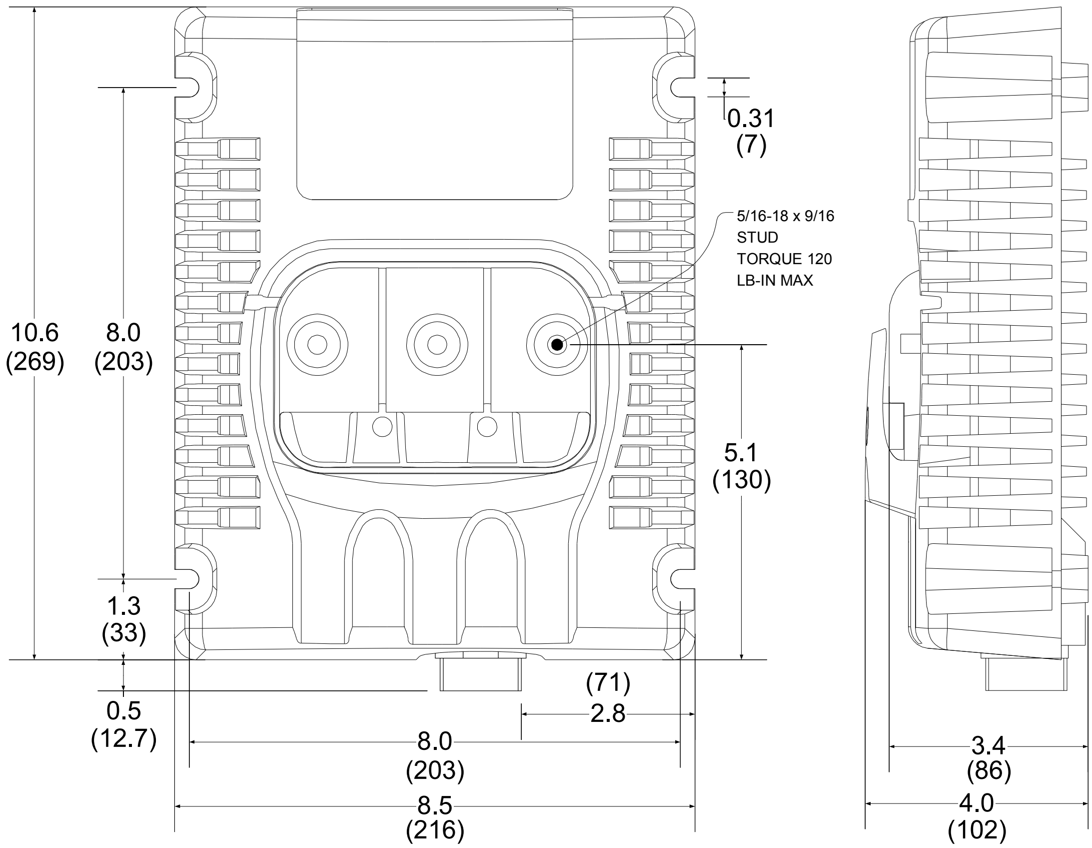


Figure 1 - 90-60 Dimensions

Theory of Operation

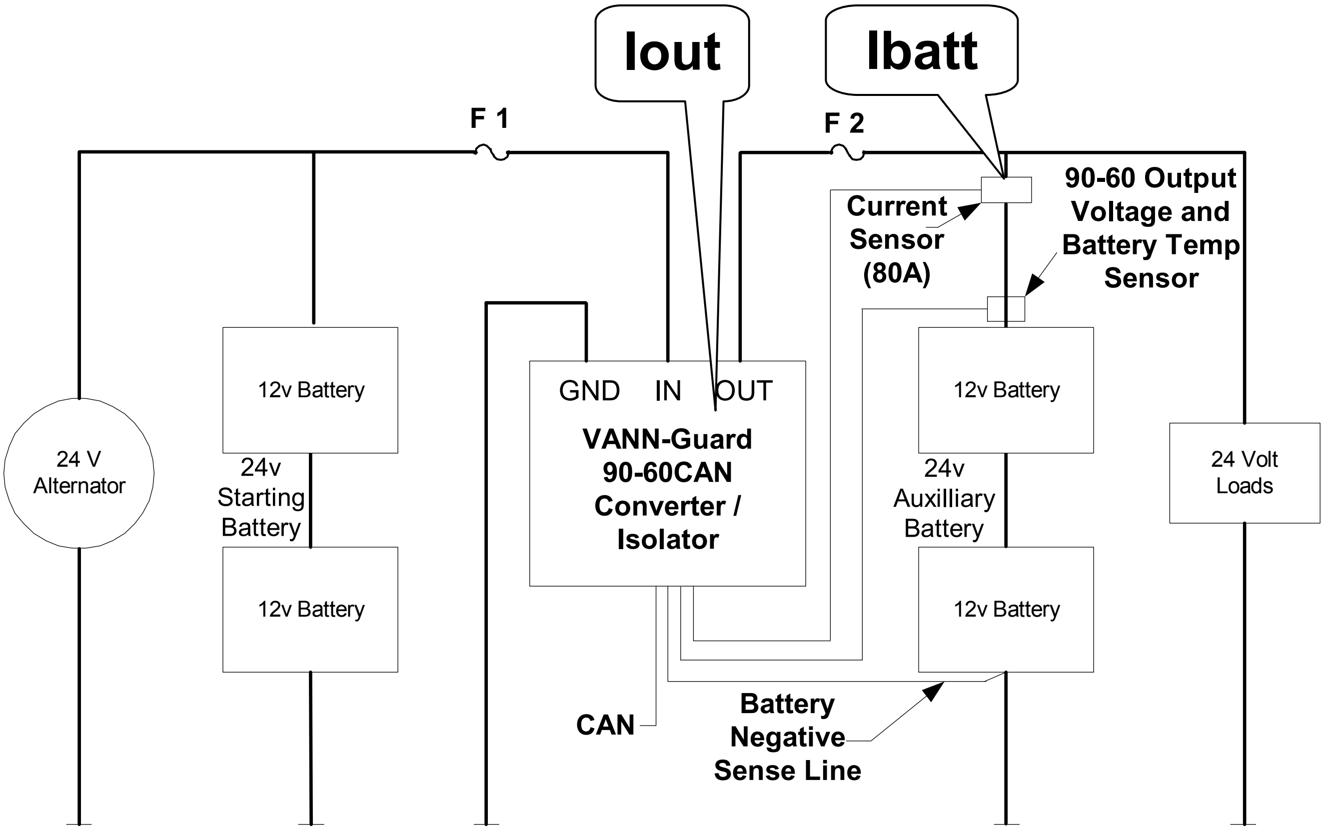


Figure 2 - 90-60 Stand Alone System

The Converter-Isolator is a state of the art device that implements software controlled power management. When the unit has been installed and the system is engaged, the 90-Series will look at the input voltage line to determine if there is sufficient voltage to turn the unit on. If there is not, then the unit does not turn on. If there is then the unit performs a "soft start" cycle that will ramp up the output current to the default setpoint of 60-Amps DC. If at some point during the soft start cycle the output voltage plateaus at a lower value than 20-Volts, then the Output current limits to a lower value than 60-Amps. If the Output Voltage climbs to the default setpoint of 20-Volts, then the unit will continue operation, regulating the output voltage to the default values.

The 90-Series is also capable of being controlled by the CAN Bus. Through CAN communication (J1939 Standard) the unit can have many of its operating parameters adjusted. The adjustments are:

1. Input Voltage Setpoint
2. Output Voltage Setpoint
3. Current Limit Setpoint
4. Battery Type
5. Bulk Charge Voltage
6. Float Charge Voltage
7. Battery Temperature Coefficient

If during normal operations the unit should have an output voltage dip, below 20-Volts, again the unit will limit the current below the 60-Amp Default. If the unit's output voltage rises above 30-Volts then the unit will power off for 10 seconds and perform a restart procedure including the soft start sequence. Furthermore, if the unit experiences an over temperature condition, it will also enter into a current limit (a 10% reduction in the output current capacity) to reduce internal temperatures. If this condition persists, the unit will again reduce current output, until the unit gets out of the internally monitored thermal danger zone. If the temperature continues to rise, the unit will again power off for 10 seconds and attempt a restart. If the temperature remains high, then the unit will NOT operate until the temperature is within the rated operating temperatures.

Converter-Isolator functionality

All functionality described in this section requires that the Monitor Ignition Input (Terminal B) be connected to +24v in order to be active. Please see the above figure for placement of the current and temperature sensors.

A. Switched Sensor Supply Output
This output is used to provide +5v for Vanner VSS Series current sensors and temperature sensor. The +5v output is switched for low power shutdown and sleep mode operation.

B. Ignition (Enable) Input
This input powers the Converter-Isolator. When this pin is taken to +24V the Converter-Isolator 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. 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. 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. Not Connected
This pin is not currently used.

G. Not Connected
This pin is not currently used.

H. Sensor Ground
Connect ground for current sensors and Smart Sensors here.

J. Single Current Sensor (+24V) Signal Input
The monitor can record incoming and outgoing battery current on the upper (+24V) battery. The output from the current sensor monitoring the +24v battery line should be connected to this input. ****Note that the arrow on the current sensor should pointed toward the battery if it is connected to the positive terminal of the battery.****

K. Not Connected
This pin is not currently used.

L. Temperature Sensor
The monitor can record the temperate of the batteries. The output from the Vanner temperature sensor should be connected to this input.

M. +24V Battery Input Sense
If this pin is connected directly to the +24V battery positive by a separate line, it will improve the accuracy of the Converter–Isolator input voltage when load current is drawn. See below for more information.

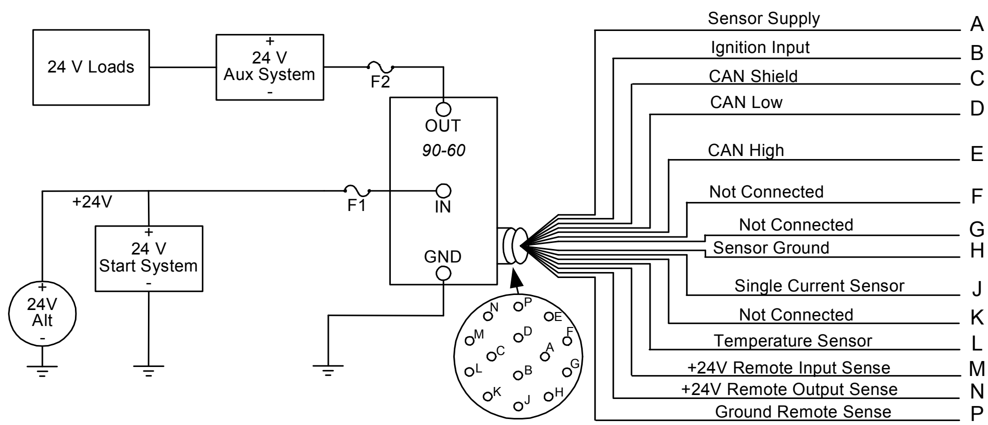
N. +24V Battery Output Sense

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

Deutsch Connector Pin Out



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 Input, +24 Output, and Ground. They are for remote sense of the battery voltage. This makes the Conversion 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. Should the external sense lines be removed, or operating improperly, the Converter will default to internal readings.

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 Converter power connection wiring, and more freedom in Converter location. The Converter current carrying wire gauge can be the minimum size listed in this manual's wire size table for a given Converter 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.

Installation Instructions

Do not exceed the specified torque of 120 in-lbs. *when connecting cables to the terminal posts (Input, Output, and GND) during installation of all the VAN-Bus 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 VAN-Bus*. 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 VAN-Bus 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.*

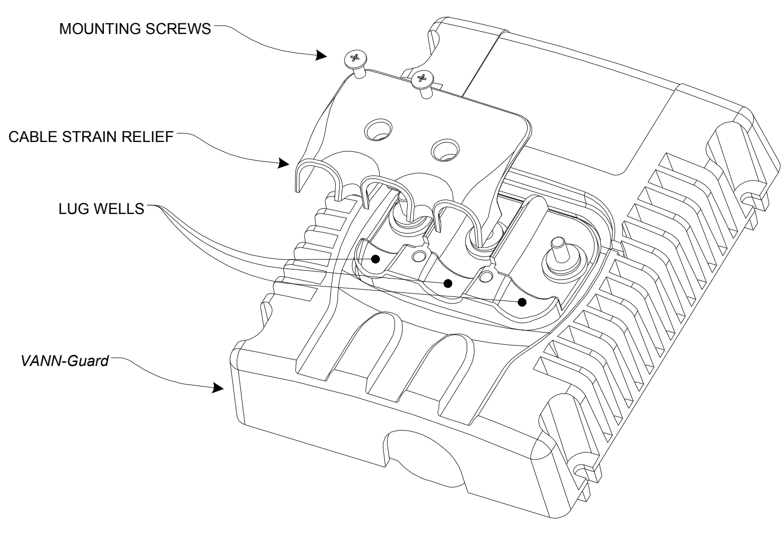
Caution: This equipment tends to produce arcs and sparks during installation. To prevent fire or explosion, compartments containing batteries or flammable materials must be properly ventilated. Safety goggles should always be worn when working near batteries

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

Environmental Protection – Your *VAN-Bus* has been designed to withstand direct exposure to rain and moisture. The *VAN-Bus* has also been tested for exposure to direct pressure spray, but continual exposure to direct pressure spraying may reduce the *VAN-Bus* serviceable life. Vanner covers any damage due to water contamination only through the terms of our factory warranty.

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

Strain Relief – The *VAN-Bus* has an integral strain relief. The *VAN-Bus* 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.



Wire Size and temperature rating

Cables connecting the *VAN-Bus* 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 *VAN-Bus's* +24 volt terminal and the battery +24 volt terminal (Battery B positive terminal), less than 0.10 VDC between the *VAN-Bus's* Input terminal and the battery +24 volt terminal (the jumper between Battery A and Battery B), and less than 0.05 VDC between the *VAN-Bus's* GND terminal and the battery ground terminal (Battery A negative terminal that is connected to chassis ground). In most installations, the *VAN-Bus'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 *VAN-Bus* can be operated in temperatures up to 75ºC, use wire rated at least 90ºC. 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 *VAN-Bus* and battery to keep voltage drop under 0.1 volt. The chart assumes wire carries no other load and wire temperature is below 80ºC.
		90-60CAN
#8	33462	2.1
#6	33466	3.2
#4	33470	5.9
#2	322870	8.7
#1	321867	10.9
#1/0	321867	13.8
#2/0	321870	17.6
Fuse F1		120 amp
Fuse F2		100 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, or higher, 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 *VAN-Bus* 90-Series CAN Power Management Systems

The VAN-Bus is working properly if:

1. The 24 volt DC loads are being operated continuously and are within the rated capacity of the VAN-Bus and;

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

Vanner *VAN-Buss* 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 *VAN-Buss* may be used in parallel with other *VAN-Buss* and Vanner Equalizer models.

Please note that the Input, Output and GND stud positions and orientation are different on *VAN-Bus* 90-Series than on other Vanner Equalizers.

Vanner J1939 CAN Bus Isolator-Converter Specification

The CAN Bus Interface PGN Description

The Isolator-Converter CAN Bus interface allows for reception of messages for control of the unit and transmission of messages that reflect its status. The CAN Bus protocol used for the Isolator is SAE J1939. The Parameter Group Numbers (PGN's) assigned to the Isolator are proprietary and are in PDU2 Format. Currently, there is 1 Parameter Group Number (PGN) assigned that provide for CAN control for the Isolator-Converter and three that provide for status. Both the control and status messages use priority 6. Additional PGN's 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:

- 13 PGN's
- PGN range: 65492 (0xFFD4) to 65497 (0xFFD9)
- Source address of messages from the Isolator: 176 (0xB0)
- Source address of messages to the Isolator: Any
- Commands to the Isolator: 65498 (0xFFDA)
- Data from the Isolator: 65492 (0xFFD4) to 65494 (0xFFD6)

Control messages to the Converter-Isolator are indexed, which means that byte 1 of the data fields indicates the functional content of the other seven bytes. For example, if byte 1 contains a value of 1, the message is Control Message 1, a value of 2 indicates the message is Control Message 2 – Controlled Interface Voltages, etc.

All control values for the Isolator-Converter are volatile and will be reset to their defaults at power. If the system software requires values other than default, then it must set the values for the by sending J19329 CAN message(s) to the Isolator-Converter.

CAN Bus PGN Definitions and Data Formats

PGN		Description	Index (Byte 1 of Data)	Source Address		Priority	Message ID (Hex)	Transmit Interval
Decimal	HEX			Decimal	HEX			
65492	0xFFD4	Converter-Isolator Status	N/A	176	0xB0	6	0xFFD4B0	3 seconds
65493	0xFFD5	Converter-Isolator Heartbeat and Control	N/A	176	0xB0	6	0xFFD5B0	3 seconds
65494	0xFFD6	Converter-Isolator Interface Voltages and Currents	N/A	176	0xB0	6	0xFFD6B0	3 seconds
65497	0xFFD9	Battery States1	N/A	176	0xB0	6	0xFFD9B0	3 seconds
65497	0xFFD9	Battery States2	N/A	176	0xB0	6	0xFFD9B0	3 seconds
65498	0xFFDA	Converter-Isolator Control 1	1	Any	Any	6	0xFFDAxx	1 second or as needed
65498	0xFFDA	Converter-Isolator Control 2	2	Any	Any	6	0xFFDAxx	1 second or as needed
65498	0xFFDA	Converter-Isolator Control 3	3	Any	Any	6	0xFFDAxx	1 second or as needed
65526	0xFECA	DM1 Message	N/A	176	0xB0	6	0xFECA1E	1 second when active
59904	0xEA00	Request Message	N/A	Any	Any	6	0xEA00xx	User Defined
65259	0xFEEB	Component Identification	N/A	176	0xB0	6	0xFEEBB0	User Defined
65242	0xFEDA	Software Identification	N/A	176	0xB0	6	0xFEDAB0	User Defined
60416	0xEC00	BAM Connection Management Message	N/A	176	0xB0	6	0xEC00B0	As required by multi-packet DM1 messages
60160	0xEB00	BAM Data Transfer Message	N/A	176	0xB0	6	0xEB00B0	As required by multi-packet DM1 messages

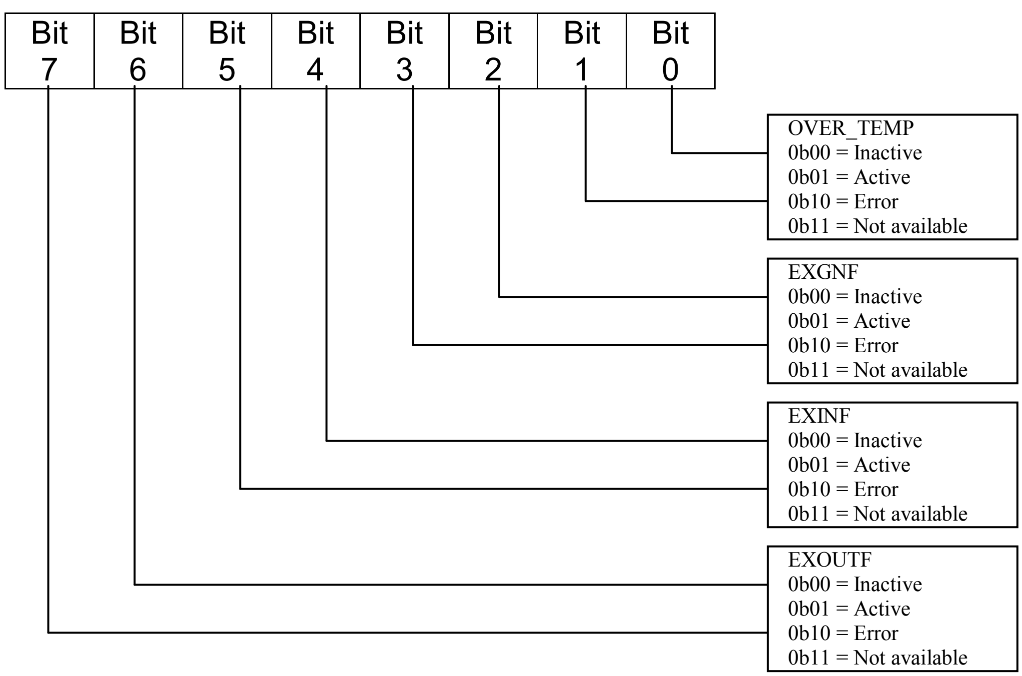
Table 1 - CAN BUS Parameter Group Definitions

PGN 65492 – Converter Isolator Status

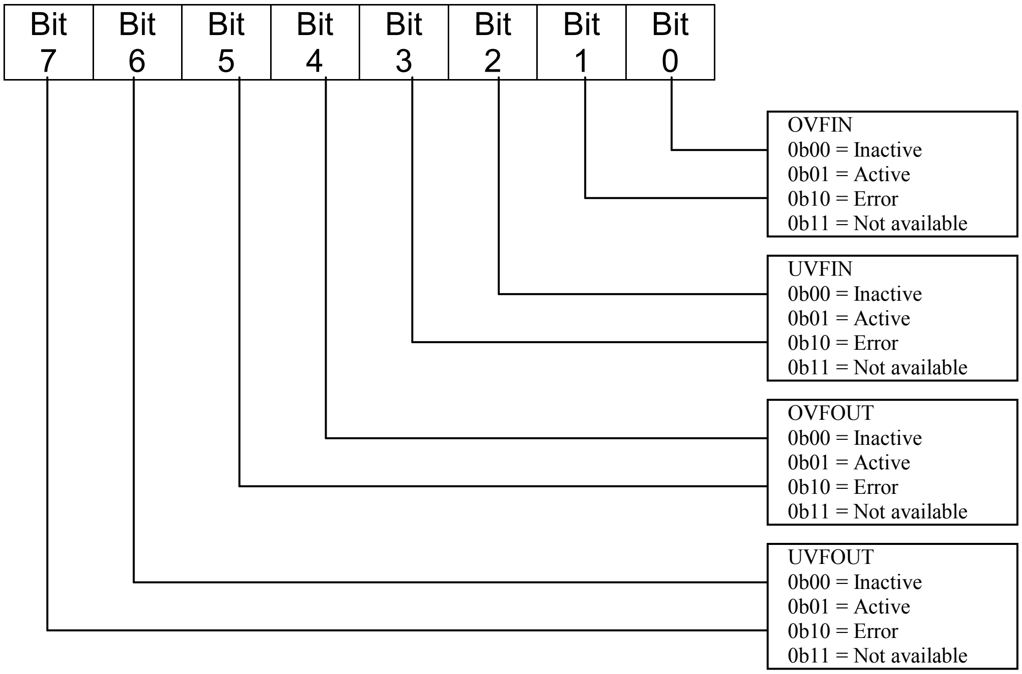
Message:	PGN 65492 (0xFFD4)
Message Type:	Broadcast
Source Address:	Isolator, 176 (0xB0)
Intended Recipient:	System Controller, 216 (0xD8)
Priority:	6
29 Bit identifier:	0x18FFD4B0
Transmission repetition rate:	3 seconds
Data length:	8 bytes

Isolator Status

Byte 1: Bit 0,1 OVER_TEMP – indicates that an over temperature condition has occurred on the Isolator
Bit 2,3 EXGNF – external ground fault, if (EXGND > 0.75) this condition is true
Bit 4,5 EXINF – External 24 V input fault, if (|VIN_INT-VIN_EXT| > 0.75) this condition is true.
Bit 6,7 EXOUTF – External 24 V output fault, if (|VOUT_INT-VOUT_EXT| > 0.75) this condition is true.

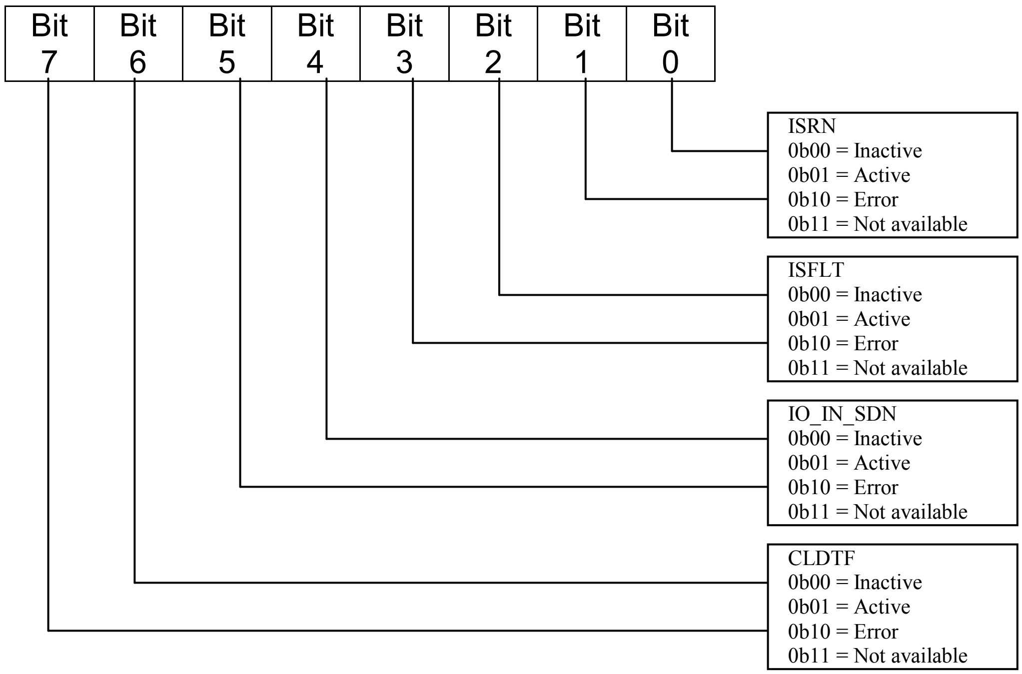


Byte 2: Bit 0,1 OVFIN – over voltage fault for input
Bit 2,3 UVFIN – under voltage fault for input
Bit 4,5 OVFOUT – over voltage fault for output
Bit 6,7 UVFOUT – under voltage fault for output

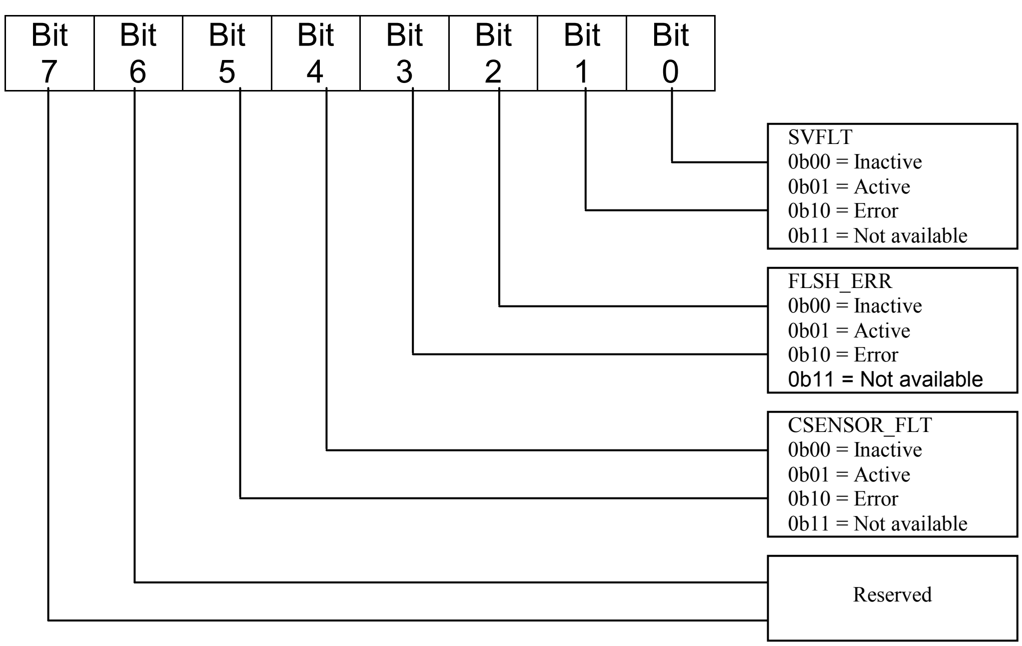


Note: Over voltage fault for the inputs and outputs is defined as the voltage exceeding 30 V. Under voltage fault for the output is defined as 20 V or less. Under voltage fault for the input is defined as a voltage that is 0.75 V less than the Isolator Input Voltage Limit.

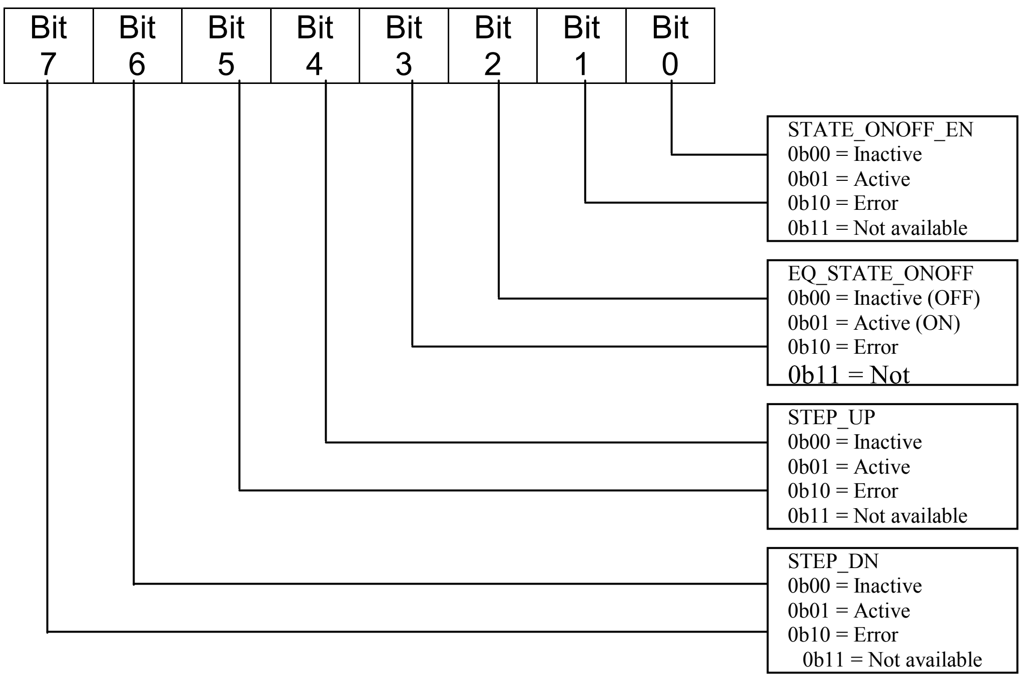
Byte 3: Bit 0,1 ISRN – Isolator is on and running.
Bit 2,3 ISFLT – Isolator fault. The Isolator is running and is expecting output current, but the output current is 0.
Bit 4,5 IS_SDN – Isolator shutdown
Bit 6,7 CLDTF – Current Limit Due to Temperature. Isolator internal temp is between 90 and 100 degrees C.



Byte 4: Bit 0,1 SVFLT – Sensor Voltage Fault. Sensor Supply is 5V and flags Active if it falls below 3V.
Bit 2,3 FLSH_ERR – Error in reading or writing to/from flash memory
Bit 4,5 CSENSOR_FLT – Fault with battery current sensor and its value is not to be trusted.
Bit 6,7 Reserved



Byte 5: Bit 0,1 IS_STATE_EN - Indicates whether the Isolator is enabled to be turned on and off using Isolator Control Message 1
Bit 2,3 IS_STATE_ONOFF – Indicates whether the Isolator is on or off. Note that the Isolator can be turned on or off via the CAN Bus only when STATE_ONOFF_EN is active.
Bit 4,5 STEP_UP – indicates that the Converter-Isolator is in step up mode (output voltage is greater than input voltage)
Bit 6,7 STEP_DN – Indicates that the Converter- Isolator is in step own mode (input voltage is greater than output voltage)



Bytes 6 – 7: Unused

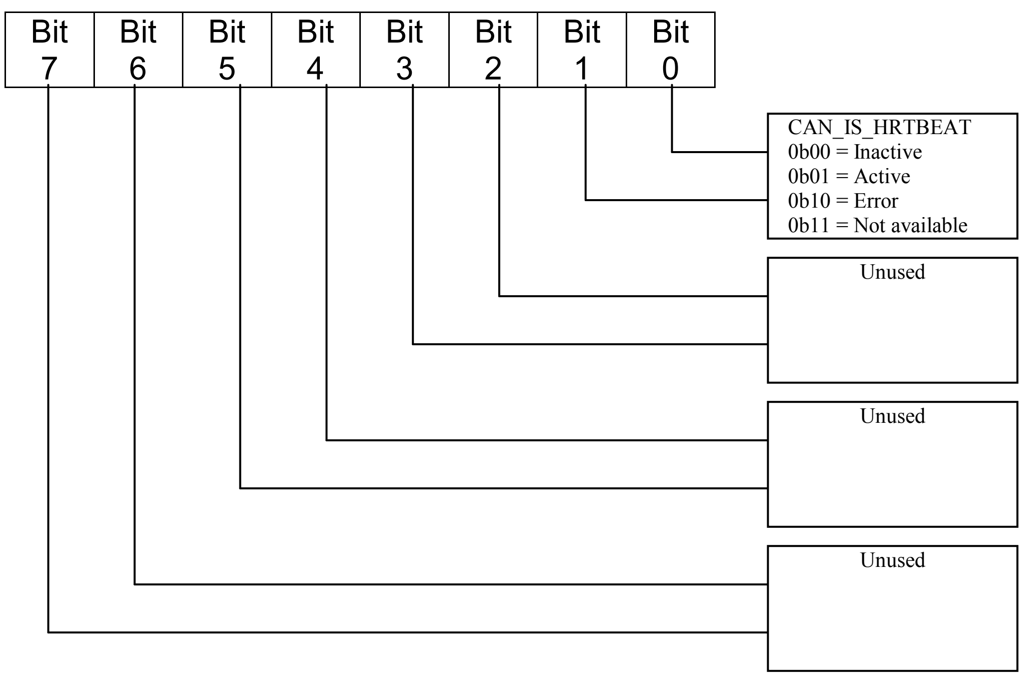
Byte 8: BATTERY TEMPERATURE – One degree per bit with a 40-degree offset to be able to handle –40 degrees.

PGN 65493 – Converter Isolator Heartbeat

Message:	PGN 65493 (0xFFD5)
Message Type:	Broadcast
Source Address:	Isolator, 176 (0xB0)
Intended Recipient:	System Controller, 216 (0xD8)
Priority:	6
29 Bit identifier:	0x18FFD5B0
Transmission repetition rate:	3 seconds
Data length:	8 bytes

Isolator Heartbeat

Byte 1: Bit 0,1 CAN_IS_HRTBEAT – Two bits that indicate a heartbeat message. The value of these two bits will alternate between 0b00 (inactive) and 0b01 (active) for each message transmitted to indicate the Converter-Isolator is still functioning correctly.
Bits 2-7 are not used



Bytes 2-8: unused

PGN 65494 – Isolator Interface Voltages and Currents

Message:	PGN 65494 (0xFFD6)
Message Type:	Broadcast
Source Address:	Isolator, 176 (0xB0)
Intended Recipient:	System Controller, 216 (0xD8)
Priority:	6
29 Bit identifier:	0x18FFD6B0
Transmission repetition rate:	1 second
Data length:	8 bytes

VIN: Converter-Isolator DC Input Potential

Bytes 1,2: 16 bit unsigned integer, byte 2 is the most significant byte
Resolution: 0.05 V/bit gain, 0V offset, no sign bit
Data Range: 0 to 3276.75 V

VOUT: Converter-Isolator DC Output Potential

Bytes 3,4: 16 bit unsigned integer, byte 4 is the most significant byte
Resolution: 0.05 V/bit gain, 0V offset, no sign bit
Data Range: 0 to 3272.75 V

IOUT: Converter-Isolator DC Output Current

Bytes 5-6: 16 bit unsigned integer, byte 6 is the most significant byte
Resolution: 0.05 A/bit gain, 0A offset, no sign bit
Data Range: 0 to 3272.75 A

IBOUT: Converter-Isolator DC Battery Current

Bytes 7-8: 16 bit signed integer, byte 8 is the most significant byte
Resolution: 0.05 A/bit gain, -1600 A offset
Data Range: -1600 to 1612.75 A

Note: If value is "0" then there is a sensor ERROR

PGN 65497 – Index Byte Value = 1 - Battery States 1

PGN 65497 messages contain information that pertains to the battery states as determined by the battery monitoring algorithms. The messages are indexed so that the first byte of the message indicates the message contents.

Message:	PGN 65497 (0xFFD9)
Message Type:	Broadcast
Source Address:	Isolator, 176 (0xB0)
Intended Recipient:	System Controller, 216 (0xD8)
Priority:	6
29 Bit identifier:	0x18FFD9B0
Transmission repetition rate:	5 seconds or as needed
Data length:	8 bytes

Index Byte

Byte 1: Must be 1 (0x01) for the Equalizer 12V Battery Parameters 1 message.

Q: Performance Index in Percent

Bytes 2,3: 16 bit unsigned integer, byte 3 the most significant byte
Resolution: 0.1 %/bit gain, 0% offset, no sign bit
Data Range: 0 to 100.0 %, any value greater than 100.0% is invalid.

SOH: State of Health in Percent

Bytes 4,5: 16 bit unsigned integer, byte 5 the most significant byte
Resolution: 0.1 %/bit gain, 0% offset, no sign bit
Data Range: 0 to 100.0 %, any value greater than 100.0% is invalid.

U: Predicted Time to Run

Bytes 6,7: 16 bit unsigned integer, byte 7 the most significant byte
Resolution: 0.5 minute/bit gain, 0 minute offset, no sign bit
Data Range: 0 to 32675.5 minutes

PGN 65497 – Index Byte Value = 2 - Battery States 2

PGN 65497 messages contain information that pertains to the battery states as determined by the battery monitoring algorithms. The messages are indexed so that the first byte of the message indicates the message contents.

Message:	PGN 65497 (0xFFD9)
Message Type:	Broadcast
Source Address:	Equalizer, 30 (0x1E)
Intended Recipient:	System Controller, 216 (0xD8)
Priority:	6
29 Bit identifier:	0x18FFD91E
Transmission repetition rate:	5 seconds or as needed
Data length:	8 bytes

Index Byte

Byte 1: Must be 2 (0x02) for the Equalizer 12V Battery Parameters 2 message.

Up: Predicted Time to Run, Adjusted for Battery Temperature

Bytes 2,3: 16 bit unsigned integer, byte 2 the most significant byte
Resolution: 0.5 minute/bit gain, 0 minute offset, no sign bit
Data Range: 0 to 32675.5 minutes

Dd: Depth of Discharge in Percent

Bytes 4,5: 16 bit unsigned integer, byte 4 the most significant byte
Resolution: 0.1 %/bit gain, 0% offset, no sign bit
Data Range: 0 to 100.0 %, any value greater than 100.0% is invalid.

SOC: State of Charge in Percent

Bytes 6,7: 16 bit unsigned integer, byte 6 the most significant byte
Resolution: 0.1 %/bit gain, 0% offset, no sign bit
Data Range: 0 to 100.0 %, any value greater than 100.0% is invalid.

PGN 65497 – Index Byte Value = 3 - Battery States 3

PGN 65497 messages contain information that pertains to the battery states as determined by the battery monitoring algorithms. The messages are indexed so that the first byte of the message indicates the message contents.

Message:	PGN 65497 (0xFFD9)
Message Type:	Broadcast
Source Address:	Equalizer, 30 (0x1E)
Intended Recipient:	System Controller, 216 (0xD8)
Priority:	6
29 Bit identifier:	0x18FFD91E
Transmission repetition rate:	5 seconds or as needed
Data length:	8 bytes

Index Byte
Byte 1: Must be 3 (0x03) for the Equalizer 12V Battery Parameters 3 message.

SMajor: Major State of Battery
Byte 2: 8 bit unsigned integer

SMinor: Minor State of Battery
Byte 3: 8 bit unsigned integer

Bytes 4-8: Unused (reserved)

PGN 65497 – Isolator Control 1

Message:	PGN 65498 (0xFFDA)
Message Type:	Broadcast
Source Address:	Any
Intended Recipient:	Isolator, 176 (0xB0)
Priority:	6
29 Bit identifier:	0x18FFD9D8B0
Transmission repetition rate:	1 second or as needed
Data length:	8 bytes

Index Byte

Byte 1: Must be 1 (0x01) for the Isolator Control 1 message.

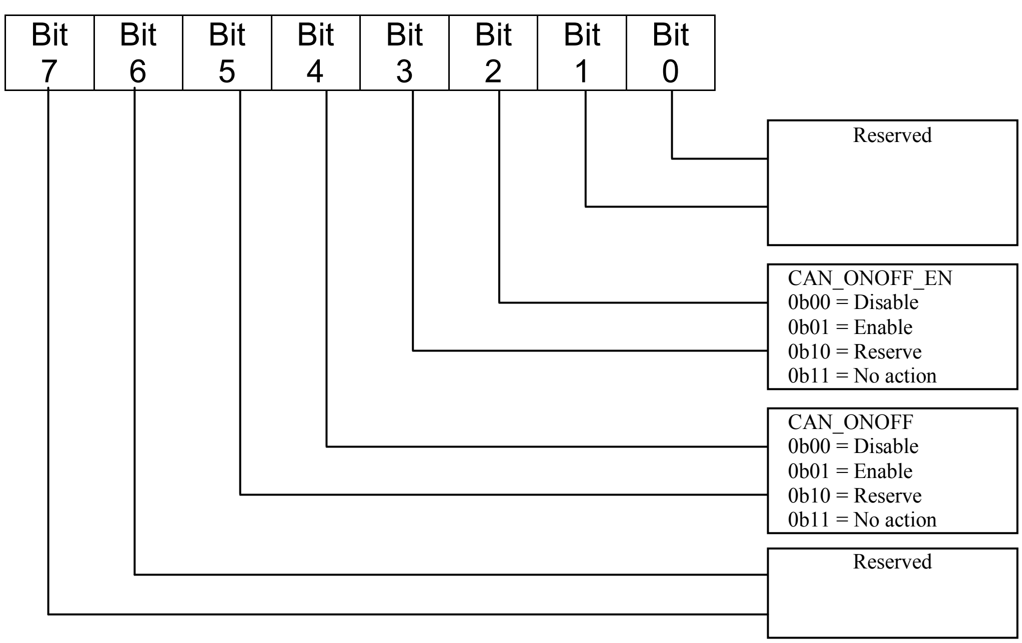
Control Byte

Byte 2: Bit 0,1 Reserved

Bit 2,3 CAN_ONOFF_EN – Enables or disables the capability of the Isolator to be turned on and off using the CAN Bus command bits CAN_ONOFF. If this feature is disabled, the Isolator cannot be turned on or of by a CAN Bus message. 0x11 will cause no action to be taken. Disabled at power-up.

Bit 4,5 CAN_ONOFF – Command that turns the Isolator on (Enable. 0b01) or off (Disable, 0b00). This bit field is valid only when CAN_ONOFF_EN is enabled. A 0x11 will cause no action to be taken.

Bit 6,7 Reserved



PGN 65497 – Isolator Control 2 – Controlled Interface Voltages

Message:	PGN 65498 (0xFFDA)
Message Type:	Broadcast
Source Address:	Any
Intended Recipient:	Isolator, 176 (0xB0)
Priority:	6
29 Bit identifier:	0x18FFD9D8
Transmission repetition rate:	1 second or as needed
Data length:	8 bytes

Index Byte

Byte 1: Must be 2 (0x02) for the Isolator Control 2 message.

Isolator Input Voltage Limit

The input voltage limit is the threshold at which the isolator begins to operate. If the input voltage is below the threshold, the isolator does not convert power.

Bytes 3,4: 16 bit unsigned integer, byte 2 the least significant byte, byte 3 is most significant

Resolution: 0.05 V/bit gain, 0V offset, no sign bit

Data Range: 20 to 28 V

Notes: Default value at power up is 27V. The minimum voltage value is 20V, and the maximum is 28V. For values below the minimum, the assumed value is 20V, and for values above the maximum, the assumed value is 28V. If the value is "0", then there is NO change.

Isolator Output Current Limit

The output current determines the maximum current limit provided to the load. When the output current exceeds the limit, the output voltage decreases to compensate. The converter output operates down to 0V.

Bytes 5,6: 16 bit unsigned integer, byte 6 the least significant byte, byte 7 is most significant

Resolution: 0.05 A/bit gain, 0A offset, no sign bit

Data Range: 20 to 70 A

Notes: Default value at power up is 60 A. The minimum current value is 20 A, and the maximum is 70 A. For values below the minimum, the assumed value is 20 A, and for values above the maximum, the assumed value is 70 A. If the value is "0", then there is NO change.

Isolator Output Voltage

The Isolator Output Voltage is the voltage at which the isolator operates at its output when not current limited.

Bytes 7,8: 16 bit unsigned integer, byte 2 the least significant byte, byte 3 is most significant

Resolution: 0.05 V/bit gain, 0V offset, no sign bit

Data Range: 25 to 29 V

Notes: Default value at power up is dependant on the battery parameters. If the battery is not 0, then the output voltage is not affected by the value in this field. The output voltage is determined by the battery parameters. The output voltage be changed by this message field only if the battery type is 0. Also, if the value is “0”, then there is NO change. The minimum voltage value is 25V, and the maximum is 29V. For values below the minimum, the assumed value is 25V, and for values above the maximum, the assumed value is 29V.

PGN 65497 – Isolator Control 3 – Battery Charging Voltages

Message:	PGN 65498 (0xFFDA)
Message Type:	Broadcast
Source Address:	Any
Intended Recipient:	Isolator, 176 (0xB0)
Priority:	6
29 Bit identifier:	0x18FFD9D8
Transmission repetition rate:	1 second or as needed
Data length:	8 bytes

Index Byte

Byte 1: Must be 3 (0x03) for the Isolator Control 3 message.

Battery Type

A single byte integer value defines the battery type. This information is used by the battery charging algorithm to determine previously defined parameters.

Byte 2: 8 bit unsigned integer

Data Range: 0 to 255

Defined values:

0 - Indicates that no charge algorithm is used and the output voltage is held at the value indicated by the Isolator Bulk Charge Voltage field of Isolator Control 2 message. There is no bulk or float phase for battery charging, and the Float Charge Voltage is ignored.

With this battery type, the Isolator Output Voltage can change.

1 - Indicates that the battery charge algorithm incorporates the Bulk Charge Voltage, the Float Charge Voltage, and the Battery Temperature Coefficient as programmed by this message. If the value of this field is greater than 1, then the three parameters are inferred by the field's value.

2 - Battery is of Type 2 **IS THE DEFAULT** and has the following parameters:
<u>Bulk Charge Voltage = 28.6 V</u>
<u>Float Charge Voltage = 26.8 V</u>
Battery Temperature Coefficient = -72 mV/°C

Other Battery Types may be defined in the future.

Bulk Charge Voltage

<u>The output voltage the Isolator supplies to the batteries when it is in Bulk Charge mode. Bulk charge mode occurs when the battery charge current is greater than 5 A.</u>

Bytes 3,4: 16 bit unsigned integer, byte 3 the least significant byte, byte 4 is most significant

Resolution: 0.05 V/bit gain, 0V offset, no sign bit

Data Range: 25 to 29 V

Notes: Default value at power up is 27 V. The minimum voltage value is 20 V, and the maximum is 29V. For values below the minimum, the assumed value is 20 V, and for values above the maximum, the assumed value is 29 V.

Float Charge Voltage

<u>The output voltage the Isolator supplies to the batteries when it is in Float Charge mode. Float charge mode occurs when the battery charge current is less than 5 A.</u>

Bytes 5,6: 16 bit unsigned integer, byte 5 the least significant byte, byte 6 is most significant

Resolution: 0.05 V/bit gain, 0V offset, no sign bit

Data Range: 25 to 29 V

Notes: Default value at power up is 27 V. The minimum voltage value is 25 V, and the maximum is 29 V. For values below the minimum, the assumed value is 24 V, and for values above the maximum, the assumed value is 29 V.

Battery Temperature Coefficient

The Battery Temperature Coefficient provides for compensating the measured battery voltage based on temperature. The battery voltage is normalized for 25 °C and the measured voltage is compensated for temperatures above and below 25 °C. It is typically a negative number. The equation for compensation is:

$$V_{Comp} = V_{Out} + (T - 25) * C_{Comp}$$

where

V_{Comp} is the compensated voltage
V_{Meas} is the measured voltage
T is the temperature in °C
C_{Comp} is the Battery Temperature Coefficient

Bytes 7,8:	16 bit unsigned integer, byte 7 the least significant byte, byte 8 is most significant
Resolution:	1 mV/bit gain, 0V offset, no sign bit
Data Range:	-32768 to 32767 mV
Notes:	Default value at power up is -72 mV.

DM1 Diagnostic Message Support

The Isolator Converter Can Bus Interface supports SAE J1939 Diagnostic Message 1 (DM1) for active Diagnostic Trouble Codes. The DM1 message contains information that indicates currently active Diagnostic Trouble Codes (DTC), preceded by the diagnostic lamp status. See section 5.7.1 of J1939-73 (Application Layer – Diagnostics) for an explanation of the format and data fields of a DM1 message. The intended recipient for DM1 messages is the Information System Controller #1, which is defined as a J1939 Preferred Address. The Address for Information System Controller #1 is 65 (0x41).

DM1 message criteria are:

- A DM1 message is transmitted using Parameter Group Number 65226, with PDU Format = 254 and PDU Specific = 202.
- A DM1 message is not normally transmitted when there are no active DTC's.
- A DM1 message is transmitted when one or more DTC's become active, and at one second intervals thereafter.
- If a fault has been active for 1 second or longer, and then becomes inactive, a single DM1 message is transmitted to reflect this state change.
- If a different DTC changes state within the 1-second update period, a new DM1 message is transmitted immediately to reflect the new DTC. However, to prevent a high message rate due to intermittent faults with a very high

frequency, there will be no more than one state change per DTC per second transmitted.

- A DM1 message may be transmitted in response to a Request Message. If there are no active DTC's when the CAN Interface receives the request, it transmits the DM1 message with the data fields set at values that indicate there are no active DTC's. See SAE J1939-21, section 5.4.2 for more details on Request messages.
- When more than one active DTC exists, transmitting the DM1 message requires the use of the "Multi-packet Transport" Parameter Group, specifically the Broadcast Announce Message. See SAE J1939-21, section 5.10 for a complete definition of the Transport Protocol. For Broadcast Announce Message (BAM) details see 5.10.3.5 of J1939-73.

The conditions that cause active Diagnostic Trouble Codes and the associated SPN's and FMI are for the Isolator Converter is show below in Table-6. The SPN's for the over and under voltage faults are defined in J19 39. The SPN's for imbalance and Isolator Converter Fault are proprietary. All DM1 messages for the Isolator Converter use the SPN Conversion Method = 0, which conforms to Version 4. See J1939-73, section 5.7.1.7 for a description of SPN Conversion Methods.

DTC	SPN	FMI	FMI Description
Over Voltage Fault on Output (OVFOUT)	168 (0x000A8)	0	Data valid, but above normal operating range – Most Severe
Under Voltage Fault on Output (UVFOUT)	168 (0x000A8)	1	Data valid, but below normal operating range – Most Severe
Over Temperature (OVER_TEMP)	520450 (0x7F102)	0	Data valid, but above normal operating range – Most Severe
Isolator Fault (ISFLT)	520451 (0x7F103)	1	Data valid, but below normal operating range – Most Severe
Sensor Voltage Fault (SVFLT)	520452 (0x7F104)	1	Data valid, but below normal operating range – Most Severe

Table 2 - DTC Defnitions, SPN's and FMI values

PGN 65226 – Active Diagnostic Codes (DM1) Data Formats

Message:	PGN 65526 (0xFECA)
Message Type:	Broadcast
Source Address:	Isolator Converter, 176 (0xB0)
Intended Recipient:	Clever Devices, 65 (0x41)
Priority:	6
29 Bit identifier:	0x18FECA1E
Transmission repetition rate:	Upon Change in DTC, upon request, or 1 second
Data length:	Variable

DM1 Data Field Format – No Active DTC's

When there are no active DTC's, the Isolator Converter does not normally transmit DM1 messages. However, in response to a Request PGN message, the Isolator Converter will transmit a single frame DM1 message that indicates no active DTC's. In addition, when the Isolator Converter transitions from a state where is has active DTC's to a state where it has no active DTC's, it will transmit the same message. The data fields for the DM1 message with no active DTC's is:

Byte 1: 0x00 – All Lamp Status Codes are off
Byte 2: 0xFF – All bits reserved
Byte 3: 0x00 – Recommended setting for not active DTC's
Byte 4: 0x00 – Recommended setting for not active DTC's
Byte 5: 0x00 – Recommended setting for not active DTC's
Byte 6: 0x00 – Recommended setting for not active DTC's
Byte 7: 0xFF – Not used
Byte 8: 0xFF – Not used

Data length is 8.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte6	Byte 7	Byte 8
0x00	0xFF	0x00	0x00	0x00	0x00	0xFF	0xFF

DM1 Data Field Format – Single Frame Message, Active DTC is Over Voltage Fault on Output

Byte 1: 0x08 Amber Warning Lamp is on.
Byte 2: 0x00 All bits reserved.

Byte 3: 0xA8 8 least significant bits of SPN
Byte 4: 0x00 Second byte of SPN
Byte 5: 0x00 Bits 8-6 = 3 most significant bits of SPN
Bits 5-1 = FMI (0)
Byte 6: OC Bit 8 = SPN Conversion Method (0)
Bits 7-1 = Occurrence Count, OC.
Byte 7: 0xFF Not used.
Byte 8: 0xFF Not used

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte6	Byte 7	Byte 8
0x08	0x00	0xA8	0x00	0x00	OC	0x00	0x00

DM1 Data Field Format – Single Frame Message, Active DTC is Under Voltage Fault on Output

Byte 1: 0x08 Amber Warning Lamp is on.
Byte 2: 0x00 All bits reserved.
Byte 3: 0xA8 8 least significant bits of SPN
Byte 4: 0x00 Second byte of SPN
Byte 5: 0x01 Bits 8-6 = 3 most significant bits of SPN
Bits 5-1 = FMI (1)
Byte 6: OC Bit 8 = SPN Conversion Method (0)
Bits 7-1 = Occurrence Count, OC.
Byte 7: 0xFF Not used.
Byte 8: 0xFF Not used

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte6	Byte 7	Byte 8
0x08	0x00	0xA8	0x00	0x01	OC	0x00	0x00

DM1 Data Field Format – Single Frame Message, Active DTC is Over Temperature

Byte 1: 0x08 Amber Warning Lamp is on.
Byte 2: 0x00 All bits reserved.
Byte 3: 0x02 8 least significant bits of SPN
Byte 4: 0xF1 Second byte of SPN
Byte 5: 0xE0 Bits 8-6 = 3 most significant bits of SPN
Bits 5-1 = FMI (1)
Byte 6: OC Bit 8 = SPN Conversion Method (0)
Bits 7-1 = Occurrence Count, OC.
Byte 7: 0xFF Not used.
Byte 8: 0xFF Not used

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte6	Byte 7	Byte 8
0x08	0x00	0x02	0xF1	0xE0	OC	0x00	0x00

DM1 Data Field Format – Single Frame Message, Active DTC is Isolator Fault

Byte 1: 0x08 Amber Warning Lamp is on.
Byte 2: 0x00 All bits reserved.
Byte 3: 0x03 8 least significant bits of SPN
Byte 4: 0xF1 Second byte of SPN
Byte 5: 0xE1 Bits 8-6 = 3 most significant bits of SPN
Bits 5-1 = FMI (1)
Byte 6: OC Bit 8 = SPN Conversion Method (0)
Bits 7-1 = Occurrence Count, OC.
Byte 7: 0xFF Not used.
Byte 8: 0xFF Not used

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte6	Byte 7	Byte 8
0x08	0x00	0x03	0xF1	0xE1	OC	0xFF	0xFF

DM1 Data Field Format – Single Frame Message, Active DTC is Sensor Voltage Fault

Byte 1: 0x08 Amber Warning Lamp is on.
Byte 2: 0x00 All bits reserved.
Byte 3: 0x04 8 least significant bits of SPN
Byte 4: 0xF1 Second byte of SPN
Byte 5: 0xE2 Bits 8-6 = 3 most significant bits of SPN
Bits 5-1 = FMI (1)
Byte 6: OC Bit 8 = SPN Conversion Method (0)
Bits 7-1 = Occurrence Count, OC.
Byte 7: 0xFF Not used.
Byte 8: 0xFF Not used

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte6	Byte 7	Byte 8
0x08	0x00	0x04	0xF1	0xE1	OC	0xFF	0xFF

DM1 Data Field Format – Multiple Frame Messages, Multiple Active DTC's

In the event that multiple active DTC's occur at once on the Isolator Converter, the DM1 message must be transmitted in multiple frames. The multiple frames are broadcast using the Transport Protocol with a connection management type of Broadcast Announce Message (BAM). The frame data fields for the BAM connection management and for the BAM data transfer messages are addressed in this section.

PGN 59904 – Request PGN

The Request PGN provides the capability to request information globally or from a specific destination.

Message:	PGN 59904 (0xEA00)
Message Type:	Broadcast
Source Address:	Any device, for DM1 messages Clever Devices AVM system will have Source Address of 65 (0x41)
Intended Recipient:	Isolator Converter, 216 (0xD8)
Priority:	6
29 Bit identifier:	0x18FFD5(SA), where SA = source address
Transmission repetition rate:	as needed
Data length:	8 bytes

PGN Being Requested

Byte 1:	Most significant byte of the full PGN being requested, usually all 0's
Byte 2:	PDU Format Field of PGN being requested
Byte 3:	PDU Specific Field of PGN being requested.
Bytes 4-8:	Not used

Presently, the Request Message supports requests for DM1 messages, but will be expanded as needed to support requests for other PGNs.

PGN 65259 – Component Identification

Message:	PGN 65259 (0xFEEB)
Message Type:	Broadcast
Source Address:	Isolator, 176 (0xB0)
Intended Recipient:	System Controller, 216 (0xD8)
Priority:	6
29 Bit identifier:	0x18FEEBB0
Transmission repetition rate:	User Requested
Data length:	8

Make

This field of 1 byte is delimited by an ASCII "*"

Byte 1:	0x2A	"*"

Model

This field is filled with the ASCII characters "IC90xx" where the "xx" is the model number of the unit. For the FIRST revision it will be "01" for version "1". This field is delimited by an ASCII "*".

Byte 2:	0x39	"9"
Byte 3:	0x30	"0"
Byte 4:	0x36	"6"
Byte 5:	0x30	"0"
Byte 6:	0x30	"0"
Byte 7:	0x31	"1"
Byte 8:	0x2A	"*"

PGN 65242 – Software Identification

Message:	PGN 65242 (0xFEDA)
Message Type:	Broadcast
Source Address:	Isolator, 176 (0xB0)
Intended Recipient:	System Controller, 216 (0xD8)
Priority:	6
29 Bit identifier:	0x18FEDAB0
Transmission repetition rate:	User Requested
Data length:	8

Message

For the Isolator Converter, the software ID will read as follows: "IC90xx" where the "xx" will be the software version number. For the first version it will be "01" for version 1. This means that there will be 7 Data bytes outside of the first byte including the delimiter "*".

Byte 1:	0x01	Number of Software ID Fields
Byte 2:	0x39	"9"
Byte 3:	0x30	"0"
Byte 4:	0x36	"6"
Byte 5:	0x30	"0"
Byte 6:	0x30	"0"
Byte 7:	0x31	"1"
Byte 8:	0x2A	"*"

PGN 60146 – BAM Connection Management Message

Message:	PGN 60416 (0xEC00)
Message Type:	Broadcast
Source Address:	Isolator Converter, 176 (0xB0)
Intended Recipient:	Broadcast, 255 (0xFF)
Priority:	6
29 Bit identifier:	0x18ECFF1E
Transmission repetition rate:	When required. 1 second when active.
Data length:	8 bytes

Byte 1:	0x20	Control Byte = BAM
Byte 2:	Variable	DM1 message size in bytes, low byte
Byte 3:	Variable	DM1 message size in bytes, high byte
Byte 4:	Variable	DM1 message number of packets
Byte 5:	0xFF	Reserved
Byte 6:	0xCA	DM1 PGN low byte
Byte 7:	0xFE	DM1 PGN middle byte
Byte 8:	0x00	DM1 PGN high byte

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte6	Byte 7	Byte 8
0x20	Var	Var	Var	0xFF	0xCA	0xFE	0x00

PGN 60160 – BAM Data Transfer Message

Message: PGN 60160 (0xEB00)
Message Type: Broadcast
Source Address: Isolator Converter, 176 (0xB0)
Intended Recipient: Broadcast, 255 (0xFF)
Priority: 7
29 Bit identifier: 0x18EBFF1E
Transmission repetition rate: When required. 1 second when active.
Data length: 8 bytes

First Frame:
Byte 1: 0x01 Packet Sequence Number
Byte 2: 0 or 0x08 DM1 Lamp Status
Byte 3: 0x00 Reserved
Byte 4: DTC 1 SPN low bits
Byte 5: DTC1 SPN middle bits
Byte 6: DTC1 SPN upper 3 bits, FMI
Byte 7: DTC1 CM, occurrence count
Byte 8: DTC2 SPN low bits

Second Frame:
Byte 9: 0x02 Packet Sequence Number
Byte 10: DTC2 SPN middle bits
Byte 11: DTC2 SPN upper 3 bits, FMI
Byte 12: DTC2 CM, occurrence count
Byte 13: DTC3 SPN low bits or 0xFF
Byte 14: DTC3 SPN middle bits or 0xFF
Byte 15: DTC3 SPN upper 3 bits, FMI or 0xFF
Byte 16: DTC3 CM, occurrence count

Third Frame:
Byte 17: 0x03 Packet Sequence Number
Byte 18: DTC4 SPN low bits or 0xFF
Byte 19: DTC4 SPN middle bits or 0xFF
Byte 20: DTC4 SPN upper 3 bits, FMI or 0xFF
Byte 21: DTC4 CM, occurrence count
Byte 22: DTC5 SPN low bits or 0xFF
Byte 23: DTC5 SPN middle bits or 0xFF
Byte 24: DTC5 SPN upper 3 bits, FMI or 0xFF

Fourth Frame:

Byte 25:	0x04	Packet Sequence Number
Byte 26:		DTC5 CM, occurrence count
Byte 27:		DTC6 SPN low bits or 0xFF
Byte 28:		DTC6 SPN middle bits or 0xFF
Byte 29:		DTC6 SPN upper 3 bits, FMI or 0xFF
Byte 30:		DTC6 CM, occurrence count
Byte 31:		DTC7 SPN low bits or 0xFF
Byte 32:		DTC7 SPN middle bits or 0xFF

Additional packets may be transmitted if there are more active DTC's. Also, only one DM1 Lamp Status is transmitted if more than once DTC is active.

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