Two Module Development Kit
Installation and User Instructions
For Model No. ED-GV15/30

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Introduction

The DC Rider Development Kit is designed to allow users to explore potential applications for DC (direct current) power line communication in 12V and 24V vehicle environments. Based on DC Power Line Network (DPN) technology, the DC Rider Modules in this Kit format CAN-Bus (Controller Area Network) data received from inputs and they transmit command and control signals over power wiring to control outputs. With this Kit, users will be able experiment with the DPN technology and test capabilities for their specific application(s) where communicating over discrete wiring or other digital communication wiring (i.e. CAN-Bus) is not feasible or is impractical.

IMPORTANT! Prior to using the DC Rider Kit to develop and demonstrate power line communication, read all Installation and User Instructions. To fully utilize this Kit and understand the Instructions, a background in electrical engineering and CAN-Bus messaging is beneficial.

DC Rider

The DC Rider system is configured to enable vehicle communications over the DC power bus for a wide range of applications. A DC Rider Module takes CAN-Bus inputs from items such as switches and sensors and transmits over power wiring to other Modules to control outputs such as lights, motors, actuators, controls and gauges. In this way, DC Rider simplifies the design, layout and installation of a vehicle communication bus. Only power is required between modules and by reducing the wiring needed to control electrical loads, DC Rider eliminates the use of bulky harnesses and also decreases the need for expensive wire and complex connectors.

The Modules contain hardware and software to interface to a CAN-Bus, a microprocessor, and a radio modem with analog front end to connect directly to power lines. The software in the Modules interprets J1939-style CAN messages and forwards them to the power lines. Two to eight modules may be networked to demonstrate data transfer and control. Each Module contains three input lines to set the Module address and two output lines to control loads up to 15 amps.

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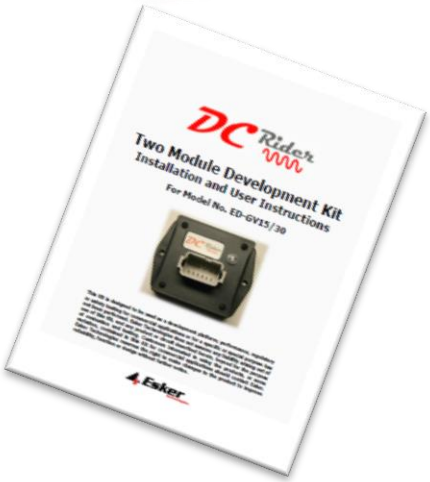
Features

- Up to 8 Modules can be used in a peer to peer configuration and each Module can control two outputs for a maximum total of 16 outputs per system
- Modules accept SAE J1939 compatible commands to control outputs and obtain Module status and feedback
- Compatible with 12 and 24 volt DC vehicle electrical systems
- Module connector (Deutsch DTF15-12PA) supports up to 15 amps to outputs
- Modules have 3 inputs available for module addressing
- Modules are protected against transient voltage spikes and are tolerant to high levels of radio frequency interference
- Module status is indicated by a status indicator light on the enclosure case
- Enclosure is potted and rated at IP67

Contents of the Kit

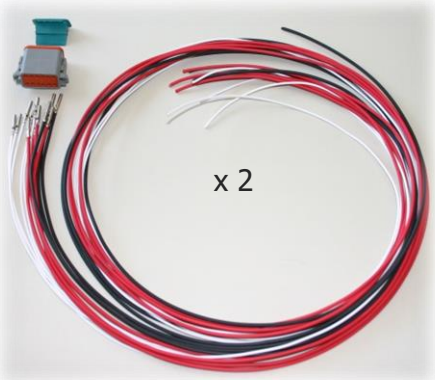
The Development Kit consists of ED-GV15 Modules and connector pigtails as pictured. A minimum of two Modules are required to form a power line network. Each Module can control up to two outputs with CAN commands but the power line interface cannot be utilized without another Module to communicate with.

The Development Kit includes the following items:



(2) DC Rider Modules with 12-pin Deutsch Connector (DTF15-12PA)

(2) Amphenol Connectors (AT06-12SA) including Connector Pins (AT62-16-0122) crimped with 3-foot pigtails



(1) Installation and Users Instructions

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Additional Required Items

Users are responsible for providing the following items:

(1) CAN Tool to transmit and receive CAN messages.
(1) DC Power source of 12V or 24V, minimum current rating of 1A plus total load current.
(1) Fused 20A power lead, or laboratory supply limited at 20A maximum.
(4) 12V or 24V lamps or other loads if output indicators are desired.

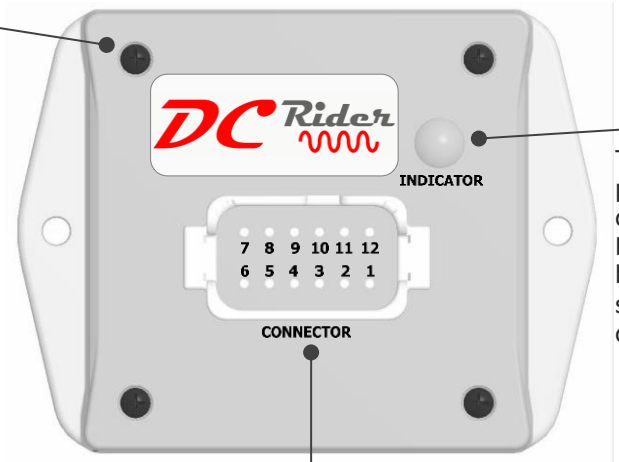
Additional Resources

The DC Rider ED-GV15/30 Product Data Sheet contains background information as well as ranges and limits for module I/O. If you are not familiar with the particular CAN tool being used, please refer to applicable documentation.

Kit Hardware Modules

Housing

The kit module is housed in an ABS plastic enclosure. Module temperature limits are mainly based on characteristics of the ABS plastic and not the circuit board assembly inside. Wider temperature range applications using other housings are possible. The CU-1935-MB drawing http://www.budind.com/pdf/hb1935.pdf from Bud Industries contains the basic module dimensions.



Indicator

The indicator lamp blinks if power line communication cannot be established, or if a Module with address 0 cannot be found. The lamp will be on solid while normal power line communication is taking place.

Connector

The module connector, a 12-pin Deutsch DTF15-12PA, mates with the supplied Amphenol AT06-12SA plug. A drawing is available at http://www.amphenol-sine.com/pdf/datasheet/AT06-12SA.pdf

Amphenol connector-pin and wedge part numbers are AT62-16-0122 and AW12S. Similar Deutsch items are also compatible. Plugs for waterproofing unused connector cavities should be used when applicable.

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Connector Pin Description

PIN	NAME	FUNCTION
1	VDPN	The VDPN lines carry both power and communication signals between modules. Do not make any other connections to these lines. For best EMC performance, use matched wires in convoluted tubing or two-wire zip cord.
2	VDPN_RTN	
3	IN1	These analog inputs are used as module address inputs A0-A2. They are internally pulled high when open. Connect to I/O_GND to obtain a low state.
4	IN2	
5	IN3	
6	OUT1	These high-side outputs are controlled by CAN messages. Ground loads to I/O_GND or VBAT_RTN
7	OUT2	
8	I/O_GND	This line is internally connected to VBAT_RTN
9	CANH	These are J1939 compatible CAN lines. The module does not contain a termination resistor.
10	CANL	
11	VBAT	Connect the lines of one module to a 12 or 24 volt DC power source through a 20 ampere fuse. A protection diode in the module will cause a blown fuse if DC polarity is reversed. These lines are used as a power source at the other modules.
12	VBAT_RTN	

I/O Parameters

Inputs

The three inputs in the Development Kit Modules are pulled up to 3.3V with an internal 47k resistor. The pin voltages at power-up determine the Module address. One of the Modules in the network must have address 0 with all pins tied to ground. A maximum of eight Modules can be addressed. Other Module configurations requiring analog inputs are possible.

Outputs

The two outputs are configured to drive up to 10 amps each. They are current limited to protect the connector pins. An internal diode will clamp inductive load voltages to 1 volt or less during turn-off. A current limit time delay during turn-on allows tungsten filament lamps and capacitive loads to be driven. Further, voltage hold-up capacitors in the module allow operation during brief brownout periods that may be caused by these types of loads. Load current may be returned through I/O_GND or VBAT_RTN lines. Chassis ground may be used if other options are not available.

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CAN Lines

Connect lines to a suitable CAN tool such as PCAN. A switch panel or any other device may be used as long as it can be configured to output the proper messages to communicate with the module. Be sure that the CAN bus has at least one termination resistor.

Kit Software

The module is pre-programmed with evaluation software implementing a CAN API (application programming interface) to provide a link between the CAN bus and power line networks. Up to eight modules are time division multiplexed giving each module a slot within which to transmit. Time slot synchronization is provided by the module with address 80h. The other uniquely addressed modules transmit only within those assigned slots to prevent destructive transmission collisions.

The first two CAN message data bytes are used by the API as a header that supplies module commands, sources, and destinations. Below is a summary of the commands. See appendix A for complete API information.

HEADER BYTE 0 BITS <3:0>	COMMAND	RESPONSE
0	Get software information	Software ID and version
1	Get module status	On-line status bit and VBAT voltage
2	Get IN1-IN3	Voltage at input pin
3	Get output status	Enable status, Fault status, Output current
4	Set outputs	Two-byte response header
5	Set outputs without response	None
15	Rebroadcast from destinations as response	Two-byte response header to source module and Two-byte response header with up to six user defined data bytes to another module

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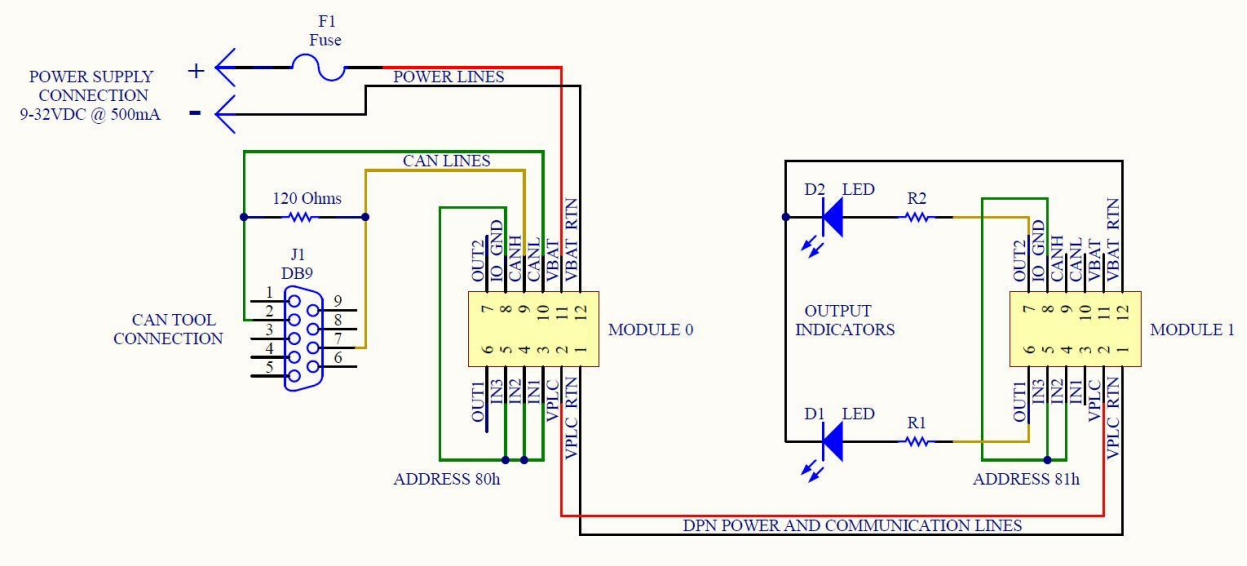
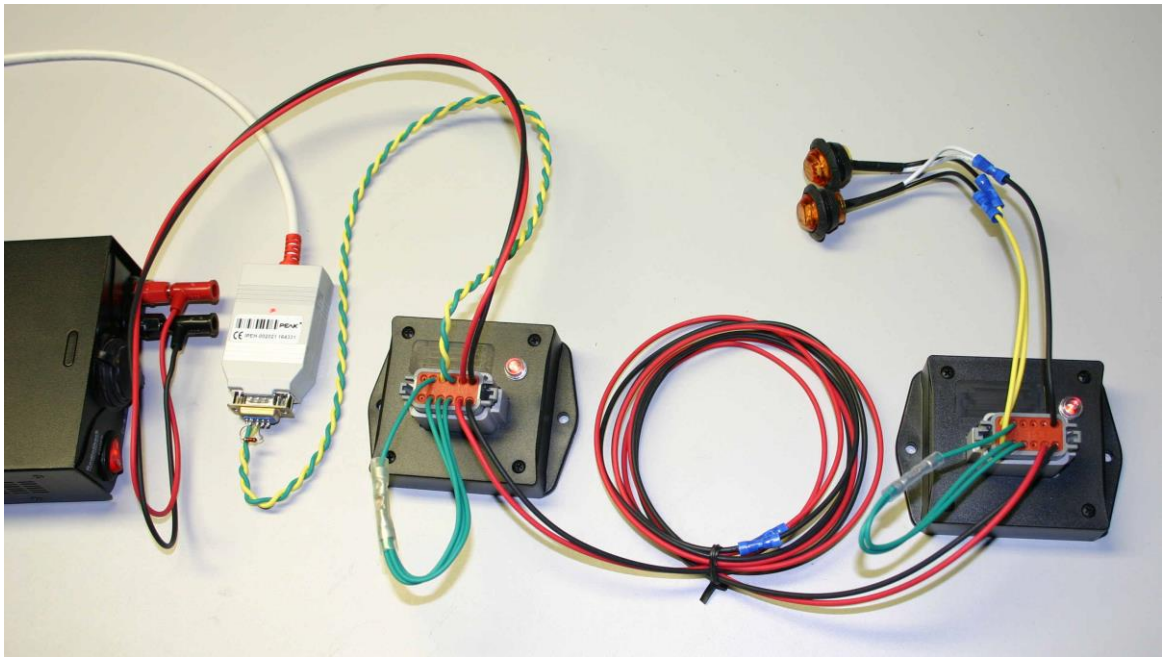
Connecting the Modules - Example Test Set-Up

This schematic and photo below show a simple setup to demonstrate output control.





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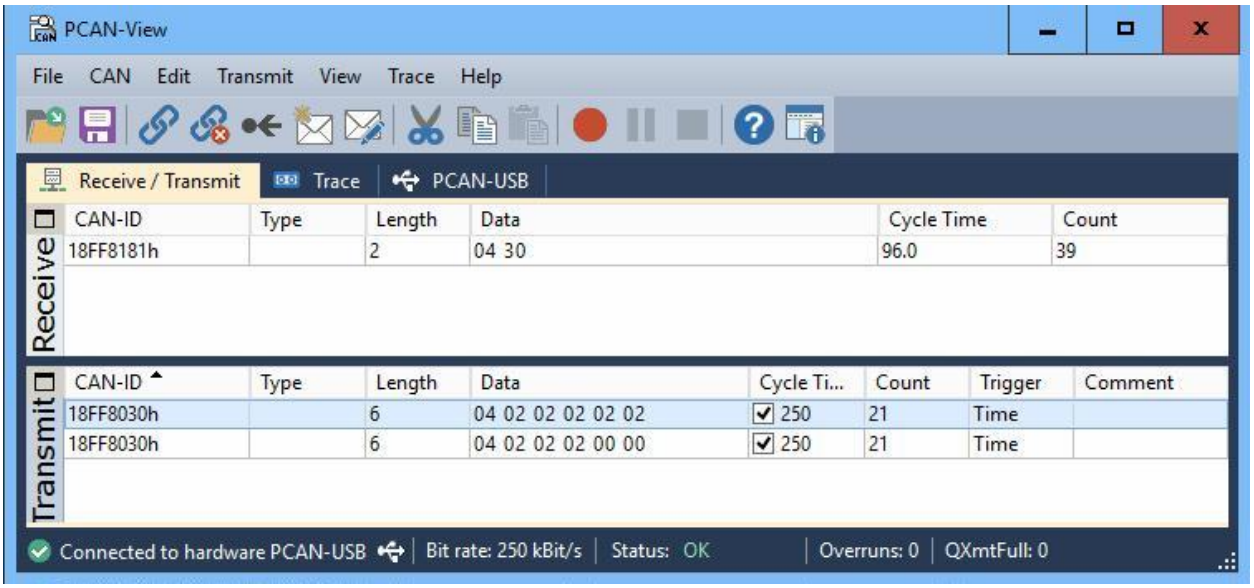
Follow these steps to turn the outputs on and off.

1. Apply power and observe that both indicator lamps are illuminated solid and not flashing.
2. Set the CAN tool to send SAE j1939 messages at 250kbps.
3. Send PGN/SPN hex characters 18FF8030 with data 04 02 02 02 02 02.
4. Both LED's should light up. If the message is not repeated, the LED's will turn off.
5. Send alternate data of 04 02 02 02 02 02 and 04 02 02 02 00 00 to blink the lamps on and off.

When using PCAN, this is what the message setup should look like:



Messages sent every 50mS or more will be processed immediately. Experiment further by referring to the CAN API to construct messages for reading various Module parameters.

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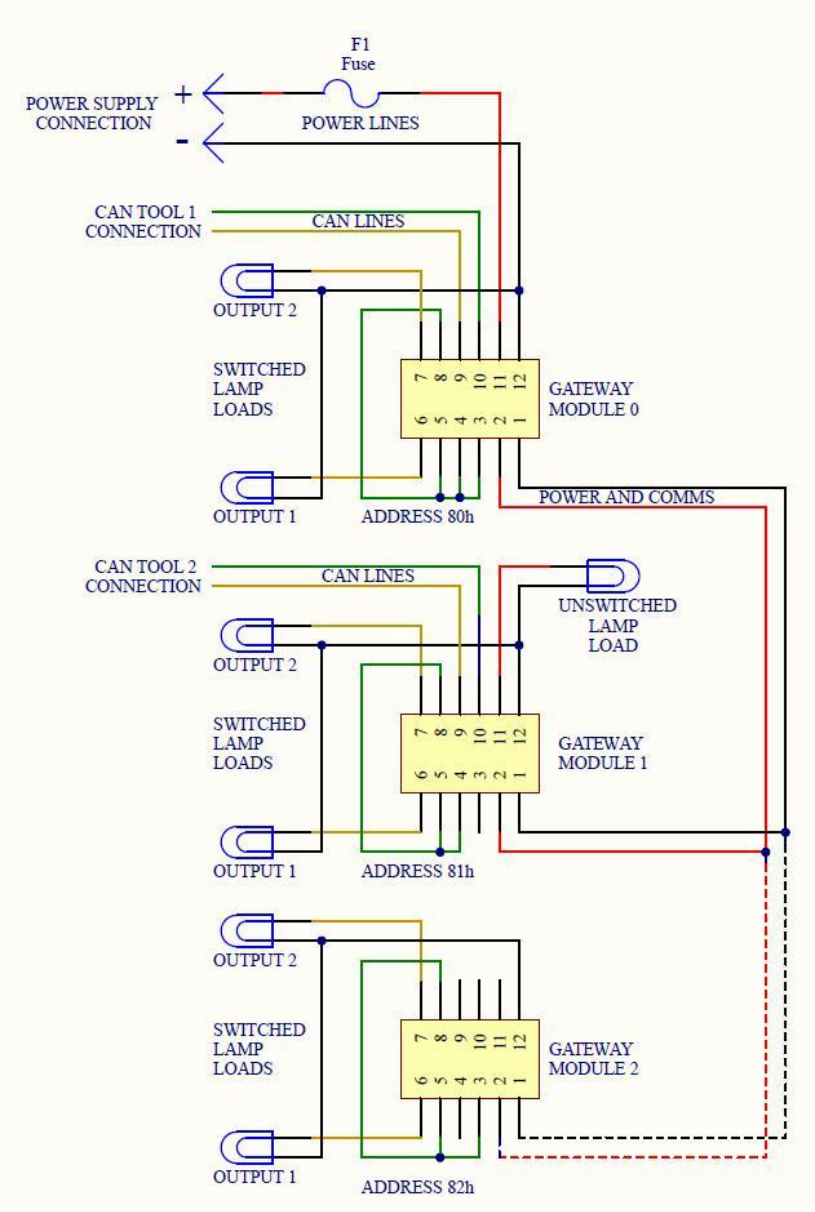
The schematic below shows how three or more DC Rider Modules may be connected to exercise some additional features:

1. Control any output from any CAN port.
2. Forward a message from one module to another.
3. Drive loads up to 10A and measure load currents.
4. Power additional non-switched loads from remote VBAT lines.



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Potential Applications

The DC Rider is ideal for use in challenging environments such as high-wear applications with excessive wire flexing and bending where a single robust pair of power lines can carry multiple control signals. The DC Rider is also suited for routing power lines through retractable reels or small conduits or openings where it is not possible to run communication wire bundles.

As this Kit is provided specifically to allow customers to explore potential new applications, Esker Technologies welcomes input, questions and suggestions on how the DC Rider, or variations of the product, would be of benefit to the customer.

Warranty

The Development Kit sold by Esker Technologies is intended for evaluation use only and performance, regulatory or safety testing for a specific or special purpose or commercial application has not been performed. The Development Kit is supplied with a limited warranty covering defects in materials and workmanship; if any of the contents in the Kit do not function in accordance with Esker's specifications during such evaluations, they will be repaired or replaced at Esker's discretion (*see Esker's published Terms and Conditions*).

Questions or Comments?

If you have a commercial application that you would like to use the DC Rider, or some variation, or if you have any comments or suggestions on ways to improve the performance of the DC Rider, please contact Esker Technologies at:

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www.eskertech.com
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262-674-1433

If you have any questions or need support, please contact Esker Technologies at:

Esker Product Support
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6340 West Industrial Drive
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Appendix A: Development Kit Software Specification

Overview

DC Rider Development Kit Modules are pre-programmed with a software feature set which demonstrates the Modules' base capabilities. This software is intended to be used for product evaluation, functional testing, and loosely tailored systems. The Development Kit Software allows for communication and control of up to 8 modules on the DPN bus through a CAN API which can be exercised on any module. Messages can be routed from CAN to the DPN bus and back to CAN according to the routes specified in message headers.

CAN API

The CAN bus is configured for a bit rate of 250kbps with SAE J1939-11 compatible bit timing parameters. Extended CAN frames with SAE J1939-21 compatible identifiers are used. All messages are in the PDU2 format with Proprietary B PGNs of 65408 ($00FF80_{16}$) for commands and 65409 ($00FF81_{16}$) for responses. The module determines the impedance to ground of the IN1-IN3 inputs upon power up and assigns itself a node address based on the state of the inputs. Once assigned, the state of the inputs does not affect the assigned address until another power cycle is performed. Each module in a system must be assigned a unique address in order to properly forward the data to and from the DPN bus. The address values are assigned according to the following table:

Termination			Address
IN3	**IN2**	**IN1**	
Short to GND	Short to GND	Short to GND	128 (80_{16})
Short to GND	Short to GND	Open circuit	129 (81_{16})
Short to GND	Open circuit	Short to GND	130 (82_{16})
Short to GND	Open circuit	Open circuit	131 (83_{16})
Open circuit	Short to GND	Short to GND	132 (84_{16})
Open circuit	Short to GND	Open circuit	133 (85_{16})
Open circuit	Open circuit	Short to GND	134 (86_{16})
Open circuit	Open circuit	Open circuit	135 (87_{16})

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The module will only transmit CAN frames in response to received command frames. The priority field of the command frame identifier is copied to the response identifier priority field but is otherwise ignored. Frames with a data length less than what is required to fully process the command are ignored. Additional data bits of command frames with a data length greater than what is required to fully process the frame are also ignored. The data of each command and response frame begins with a header according to the following formats:

Command Header Data

Byte(s)	Bit(s)	Type	Parameter
0	0-3	uint4	0: Get software information
			1: Get module status
			2: Get IN1-IN3
			3: Get output status
			4: Set outputs
			5: Set outputs without response
			6-14: Reserved
			15: Rebroadcast from destinations as response
	4-7	uint4	0: Forward to DPN using address 128 (80_{16}) module
			1: Forward to DPN using address 129 (81_{16}) module
			2: Forward to DPN using address 130 (82_{16}) module
			3: Forward to DPN using address 131 (83_{16}) module
			4: Forward to DPN using address 132 (84_{16}) module
			5: Forward to DPN using address 133 (85_{16}) module
			6: Forward to DPN using address 134 (86_{16}) module
			7: Forward to DPN using address 135 (87_{16}) module
			8-13: Reserved
			14: Process locally
			15: Forward to DPN using any available module

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Byte(s)	Bit(s)	Type	Parameter
1	0	bool	Include address 128 (80_{16}) in destination
	1	bool	Include address 129 (81_{16}) in destination
	2	bool	Include address 130 (82_{16}) in destination
	3	bool	Include address 131 (83_{16}) in destination
	4	bool	Include address 132 (84_{16}) in destination
	5	bool	Include address 133 (85_{16}) in destination
	6	bool	Include address 134 (86_{16}) in destination
	7	bool	Include address 135 (87_{16}) in destination

Response Header Data

Byte(s)	Bit(s)	Type	Parameter
0	0-3	uint4	0: Software information
			1: Module status
			2: IN1-IN3
			3: Output status
			4: Set outputs response
			5-14: Reserved
			15: Rebroadcast
	4-7	:	Reserved
1	:	uint8	Command source address

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Get Software Information

Retrieves identifying information about the module software. The software ID is a guaranteed-unique identifier for the software feature set. The version is a revision identifier for the specified feature set.

Command Data

Byte(s)	Bit(s)	Type	Parameter
0-1	:	uint8[2]	Command header

Response Data

Byte(s)	Bit(s)	Type	Parameter
0-1	:	uint8[2]	Response header
2-3	:	uint16	Software ID
4-7	:	uint32	Software version

Get Module Status

Retrieves the module DPN status and battery voltage

Command Data

Byte(s)	Bit(s)	Type	Parameter
0-1	:	uint8[2]	Command header

Response Data

Byte(s)	Bit(s)	Type	Parameter
0-1	:	uint8[2]	Response header
2	0	bool	DPN online
	1-7	:	Reserved
3-4	:	uint16	VBAT voltage (mV)

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Get IN1-IN3

Retrieves the module input voltages

Command Data

Byte(s)	Bit(s)	Type	Parameter
0-1	:	uint8[2]	Command header

Response Data

Byte(s)	Bit(s)	Type	Parameter
0-1	:	uint8[2]	Response header
2-3	:	uint16	IN1 voltage (mV)
4-5	:	uint16	IN2 voltage (mV)
6-7	:	uint16	IN3 voltage (mV)

Get Output Status

Retrieves the fault status and output current of the module outputs

Command Data

Byte(s)	Bit(s)	Type	Parameter
0-1	:	uint8[2]	Command header

Response Data

Byte(s)	Bit(s)	Type	Parameter
0-1	:	uint8[2]	Response header
2	0	bool	OUT1 enabled
	1	bool	OUT2 enabled
	2-3	:	Reserved
	4	bool	OUT1 faulted
	5	bool	OUT2 faulted
	6-7	:	Reserved

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Byte(s)	Bit(s)	Type	Parameter
3-4	:	uint16	OUT1 current (mA)
5-6	:	uint16	OUT2 current (mA)

Set Outputs

Controls the Boolean output of all module outputs. Each output will automatically disable if an enable command is not re-applied within 10s.

Command Data

Byte(s)	Bit(s)	Type	Parameter
0-1	:	uint8[2]	Command header
2	0	bool	Apply address 128 (80_{16}) OUT1 enable value
	1	bool	Apply address 129 (81_{16}) OUT1 enable value
	2	bool	Apply address 130 (82_{16}) OUT1 enable value
	3	bool	Apply address 131 (83_{16}) OUT1 enable value
	4	bool	Apply address 132 (84_{16}) OUT1 enable value
	5	bool	Apply address 133 (85_{16}) OUT1 enable value
	6	bool	Apply address 134 (86_{16}) OUT1 enable value
	7	bool	Apply address 135 (87_{16}) OUT1 enable value
3	0	bool	Apply address 128 (80_{16}) OUT2 enable value
	1	bool	Apply address 129 (81_{16}) OUT2 enable value
	2	bool	Apply address 130 (82_{16}) OUT2 enable value
	3	bool	Apply address 131 (83_{16}) OUT2 enable value
	4	bool	Apply address 132 (84_{16}) OUT2 enable value
	5	bool	Apply address 133 (85_{16}) OUT2 enable value
	6	bool	Apply address 134 (86_{16}) OUT2 enable value
	7	bool	Apply address 135 (87_{16}) OUT2 enable value

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Byte(s)	Bit(s)	Type	Parameter
4	0	bool	Enable address 128 (80_{16}) OUT1 value
	1	bool	Enable address 129 (81_{16}) OUT1 value
	2	bool	Enable address 130 (82_{16}) OUT1 value
	3	bool	Enable address 131 (83_{16}) OUT1 value
	4	bool	Enable address 132 (84_{16}) OUT1 value
	5	bool	Enable address 133 (85_{16}) OUT1 value
	6	bool	Enable address 134 (86_{16}) OUT1 value
	7	bool	Enable address 135 (87_{16}) OUT1 value
5	0	bool	Enable address 128 (80_{16}) OUT2 value
	1	bool	Enable address 129 (81_{16}) OUT2 value
	2	bool	Enable address 130 (82_{16}) OUT2 value
	3	bool	Enable address 131 (83_{16}) OUT2 value
	4	bool	Enable address 132 (84_{16}) OUT2 value
	5	bool	Enable address 133 (85_{16}) OUT2 value
	6	bool	Enable address 134 (86_{16}) OUT2 value
	7	bool	Enable address 135 (87_{16}) OUT2 value

Response Data

Byte(s)	Bit(s)	Type	Parameter
0-1	:	uint8[2]	Response header

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DPN Requirements

In addition to each module being assigned a unique node address using the IN1-IN3 inputs according to the CAN API, the module with a node address of 128 (80_{16}) synchronizes the DPN bus to prevent data collisions in a deterministic manner. Thus, one module with this address must be present in a system for the DPN bus to function properly.

The DPN bus is time division multiplexed allowing each of up to 8 modules transmit one message every 50ms. When a module has more than one message to transmit, messages are queued in a first-in-first-out queue and the module will transmit a message from the queue in subsequent 50ms periods. Such is the case if multiple modules transmit a command requesting response to the same module in the same 50ms period. The DPN message queue can hold at most 20 messages at any given time; additional messages will be dropped. System design should consider these rate limitations to prevent lost messages.

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