ioBLOC 6 Expansion Module

2 Input | 4 Output

Part Number

PN 100001264 (58-0160)

Product Manual

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20220630_v1.3 (L-20220623)

Contents

Overview & Specifications:

This module uses a 12-pin sealed Deutsch connector (DT04-12PA equivalent). All outputs on this module may be configured as a sourcing digital output or a PWM Output. All inputs on this module may be configured as a sourcing digital input, a 32V analog input, a 4-20mA current-reading analog input, or 0-5V ratiometric input. This module uses J1939 Proprietary Peer-to-Peer Messaging.

Electrical/Mechanical/Environmental Specifications (58-0160 2-Input/4-Output Module)

Parameter	Min	Nominal	Max	Notes
Functional Battery Voltage	8VDC	24VDC	32VDC	12VDC or 24VDC supply supported.
Reverse Battery Protection	-	-	-32VDC	
Unit Current Consumption	-	-	34.8mA	All I/O turned off, 12VDC Supply.
Output Current	-	3.0A	3.75A	Overcurrent trips after 1.5 seconds of current exceeding 3.75A (Assuming digital output or 100% duty cycle).
Module Max Current	-	-	13A	The sum of all output currents must be less than 13A.
PWM Output Frequency	5Hz	-	1kHz	+/- 5% Accuracy.
PWM Output Duty Cycle	0%	-	100%	+/- 0.5% Accuracy.
ESD Protection		8KV	15KV	15KV air discharge, 8KV contact discharge on all pins.
Storage Temperature	-40°C	-	125°C	
Operating Temperature	-40°C	-	105°C	SAE J1455 Section 4.1.3, 8hr cycle.
CAN Baud Rate		250kbps		J1939 Proprietary Peer-to-Peer and Broadcast Messaging.
Digital Input Logic High Threshold	-	7.0VDC	32.0VDC	+7VDC at any input is a guaranteed logic high in the digital input configuration.
Digital Input Logic Low Threshold	0.0VDC	5.5VDC	-	+5.5VDC at any input is a guaranteed logic low in the digital input configuration.
4-20mA Input Accuracy	0mA	-	22mA	+/- 3% Accuracy.
0-32V Analog Input Accuracy	0VDC	-	32.0VDC	+/- 3% Accuracy.
0-5V Ratiometric Input	0VDC	-	5.0VDC	+/- 3% Accuracy.
Frequency Inputs	20Hz	-	20kHz	+/- 3% Accuracy.
Frequency Input “High” Threshold	3.25VDC	-	32VDC	+3.25VDC min at any input is registered as a signal “high” in the frequency reading input configuration.

Frequency Input "Low" Threshold	-	-	1.75VDC	+1.75VDC max at any input is registered as a signal "low" in the frequency reading input configuration.

Parameter	Test
Thermal Shock, Thermal Shock Immersion	ISO 16750-4 Section 5.3.2, 5.4.3
Humidity and Temperature Cycle	SAE J1455 Section 4.2.3, 4A, 8-hour cycle
Ingress Protection	IP67 IEC 60519
Mechanical Shock	50g Operational
Fluid Compatibility	SAE J1455 Section 4.4, ISO16750-5 Engine Compartment Fluids

Connector Specification and Pinout

All connectors shall be rated to IP67 standards. The recommended mating connector to this module is the DT04-12PA or any equivalent part. The recommended socket for this mating connector is the TE Connectivity/Deutsch 0462-201-16141.

Mating Connector
DT04-12PA

1 – OUTPUT 1
2 – OUTPUT 2
3 – OUTPUT 3
4 – OUTPUT 4
5 – INPUT 1
6 – INPUT 2
7 – ADDR1
8 – ADDR2
9 – CAN L
10 – CAN H
11 – GND
12 – +BATT

Description of Operation

Indicators & Lighting

Green (Power) LED

The green LED will illuminate when the module has been connected to 8-32VDC Power. It will remain on until the unit has been disconnected from its power supply.

Red CAN LED

The CAN LED will flash for 10 seconds by default when it is powered on and connected to the CAN bus. It will turn off once the CAN timeout value has been reached. This indicates that the I/O module has not received a message within the CAN timeout period. The CAN Timeout may be configured by the user via a message to the module.

Red Input/Output LED's

There are six I/O LEDs on this module. When one of these LEDs is solidly on, it indicates that the corresponding input or output is configured and on. If the LED is off, the corresponding I/O is unconfigured or off. If the I/O LED is blinking, the module has detected an overcurrent or short circuit fault.

Normal Output Operation and Output Faults

Outputs can be configured in one of two different ways by the user.

Digital Sourcing Output

When configured as a sourcing digital output, battery voltage will be supplied at the output. These outputs are rated for 3A each (Sum of output currents may not exceed 13A). If the current at the output exceeds 3.75A for more than 1.5 seconds, the output may fault for overcurrent. The corresponding output LED will blink at a rate of 0.75Hz when an output has tripped for an overcurrent fault. Fault states may be requested via (0xD5) CAN message. To reset an overcurrent fault, either turn the output off (Digital Output) or set the duty cycle to zero (PWM Output).

This module protects against short circuits. If a short circuit is detected, the corresponding LED will blink at a rate of 2Hz. To clear any fault, the controller may send the “Clear Faults” message which will be outlined in the CAN messaging section of this specification.

20Hz-1kHz PWM Output

The PWM output configuration on this output module supports duty cycles from 0-100%, and frequencies from 20Hz to 1kHz. Duty cycle and frequency may be read via CAN. The same digital output faults apply to the PWM Outputs. PWM Outputs have the same fault detection as the digital outputs do.

Note: Short Circuit protection is **NOT** available if the duty cycle is set below 10%.

Output Current Feedback

Each individual output can provide averaged current feedback readings (tolerance +/-150mA) upon request with the Output Current Reading Request (0xD3) message. The unit will reply with the Output Current Reading Reply (0x43). Accuracy of current readings can be negatively affected by certain factors including driving outputs at high frequencies, low duty cycles, and/or low current loads.

Normal Input Operation and Input Faults

Inputs can be configured in one of four different ways by the user.

Digital Sourcing Inputs

This input mode is a typical logic high/logic low input used to read the state of the input. The input will be high when the voltage at the sourcing digital input is between +7-32VDC. The input will report low when the voltage at the sourcing digital input is below +5.5VDC. Values between +5.6VDC and +6.9VDC are a “Do Not Care” condition and High/Low values are not guaranteed to be accurate in this range.

32V Analog Inputs

This input mode reads the voltage at an input and converts for the controller. Do not exceed 32V at this input. The scaling factor for an input configured in this mode is 0.13515V/unit. This means that the controller should multiply the decimal value of the data received from the module by the scaling factor to get the voltage at the input. See the functional example at the end of this specification for a practical example.

4-20mA Analog Inputs

This input mode reads currents between 4mA and 20mA. The scaling factor for an input configured in this mode is 0.087625mA/unit. This means that the controller should multiply the decimal value of the data received from the module by the scaling factor to get the current (mA) at the input. Currents below 4mA are read accurately and do not trigger a fault.

This mode has over-current protection. If the module reads a current higher than 22mA, the input will turn off and its corresponding LED will begin blinking. To reset the input, the user must disable the input and reconfigure it to 4-20mA Input Mode. See the 0xAC "Reset Faults" Message.

Ratiometric (0-5V) Inputs

This input mode is used to read a ratio of the measured input voltage compared to the reference voltage of 5.0V. The scaling factor for an input configured in this mode is 0.0012207V/unit. This means that the controller should multiply the decimal value of the data received from the input module by the scaling factor to get the voltage (V) at the input.

20Hz to 20kHz Frequency Inputs

This input mode allows the user to read frequencies up to 20kHz at an input. Frequencies that fall below 20Hz cannot be read. The input signal "low" level is +1.75VDC **MAX** and input signal "high" level is +3.25VDC **MIN**.

Addressing Input Table (CAN ID)

Pins 7 and 8 are reserved as addressing input pins. There are four possible CAN-IDs for this module that range from 0x54 to 0x57. To set the desired ID, reference the table below:

Addressing Input Table

ADDR 1	ADDR 2	CAN ID:
0	0	0x57
0	1	0x56
1	0	0x55
1	1	0x54

Key:
0 = Pin grounded
1 = Pin floating

J1939 Proprietary Messaging – Configuration Messages

Broadcast Message

This message is Broadcasted from the module every second until a configuration message is received (0xA1, 0xA4, or 0xA5). It contains the software date and revision.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Month	Day	MSB Year	LSB Year	Major Revision	Minor Revision	Reserved
0x01	0x??	0x??	0x??	0x??	0x??	0x??	0xFF

Parameter	Parameter Description
Month	Indicates the month the software revision was completed: 0x01 Jan 0x07 Jul 0x02 Feb 0x08 Aug 0x03 Mar 0x09 Sep 0x04 Apr 0x0A Oct 0x05 May 0x0B Nov 0x06 Jun 0x0C Dec
Day	Indicates the day the software revision was completed: 0x01-0x1F (1-31)
Year	Separated into two bytes, this data indicates the year the software revision was released: 0x07 0xE5 (2021)
Major Revision	Major Revision starts at 0x01
Minor Revision	Minor Revision starts at 0x00

Output Configuration

This message is sent from the controller to module and allows the controller to configure any of the 4 outputs as a digital or PWM output. The controller may set only one output at a time.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Mode	Output	Frequency**	Frequency**	Reserved	Reserved	Reserved
0xA1	0x??	0x??	0xFF**	0xFF**	0xFF	0xFF	0xFF

Parameter	Parameter Description
Mode	Sets the configuration of each output: 0x01 Configure as Digital Output 0x02 Configure as PWM Output 0x03 Set PWM Frequency
Output	This byte contains the output that is being configured: 0x00 Output 1 0x01 Output 2 0x02 Output 3 0x03 Output 4
Frequency	Only use bytes 3 and 4 if configuring the output frequency. Values from 5Hz-1kHz supported (0x00 0x05)-(0x03 0xE8). ****Note: The user must configure the output as a PWM Output before setting the output frequency. For example: A1 02 03 FF FF FF FF FF followed by A1 03 03 00 64 FF FF FF sets up output 4 as a PWM Output with a frequency of 100Hz. The user should ignore the Frequency bytes when configuring a digital output. See the functional example for clarification.**

Control Digital Outputs

This message is sent from the controller to the module and is used to turn on and off digital outputs.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Output	State	Reserved	Reserved	Reserved	Reserved	Reserved
0xA2	0x??	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Output	This byte contains the output that is being configured: 0x00 Output 1 0x01 Output 2 0x02 Output 3 0x03 Output 4
State	0x00 Digital OFF 0x01 Digital ON

Control Output Duty Cycle

This message is sent form the controller to the module and is used to turn on and off PWM outputs to the specified duty cycle. A duty cycle of zero turns off the output.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Output	Duty Cycle	Reserved	Reserved	Reserved	Reserved	Reserved
0xA3	0x??	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Output	This byte contains the output that is being configured: 0x00 Output 1 0x01 Output 2 0x02 Output 3 0x03 Output 4
Duty Cycle	Byte[2] contains the duty cycle the specified output will turn on with 0x00-0x64h (0-100%)

Input Configuration

This message is sent from the controller to module and allows the controller to configure either of the 2 inputs. The controller may configure only one input at a time in any of the five input configurations. This is also the message used to disable or turn an input off.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Mode	Input	Reserved	Reserved	Reserved	Reserved	Reserved
0xA4	0x??	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Mode	Sets the configuration of each input: 0x00 Input Disabled (Turns input off if already configured) 0x01 Sourcing Digital Input 0x02 32V Analog Input 0x03 4-20mA Current-Reading Input 0x04 0-5VDC Ratiometric Input 0x05 20Hz-20kHz Frequency-Reading Input Note: To change an input from one configuration to another, **you MUST DISABLE the input first**, then you can re-configure the input as desired.
Input	This byte contains the input that is being configured: 0x00 Input 1 0x01 Input 2

Reset Input Faults

This message is sent from the controller to the module and allows the controller to reset the fault status of all the inputs. If an input is on and does not have a fault, this message will not have an effect on the input. In order for the input to be operational after having a fault reset, the input must be disabled/re-enabled or the module must be power cycled.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xAC	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Multiplex	Resets Overcurrent faults when an input is in 4-20mA mode. Note: Input must be disabled and then re-enabled to be operational (or unit must be power cycled).

CAN Timeout Configuration

This message is sent from the controller to the module and allows the controller to set the CAN communication timeout.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Timeout Mode	Timeout Value	Reserved	Reserved	Reserved	Reserved	Reserved
0xA5	0x??	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Timeout Mode	0x00 Turns inputs/outputs off when CAN Message has not been received within the Timeout Value 0x01 Inputs/outputs stay in last configured state when CAN Message has not been received within the Timeout Value
Timeout Value (seconds)	The value transmitted to the module in this byte sets the CAN Timeout in seconds. Range: 0x00-0xFF (0 seconds – 255 seconds) Note: Default timeout value is 10 seconds

J1939 Proprietary Messaging – Requests to Module and Replies from Module

Output Configuration Request

This is a message sent from the controller to the module. This message is used to check the configurations of the module's outputs. When this message is received by the module, it will reply with the "Output Configurations Reply" message (0x21).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xB1	0x00	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	This module only has one subset of outputs 0x00 Subset 1 (Outputs 1-4)

Output Configuration Reply

This is a message sent from the module to the controller as a response to the 0xB1 message. The data in this message contains the output configuration of each output.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Output 1 Config	Output 2 Config	Output 3 Config	Output 4 Config	Reserved	Reserved
0x21	0x00	0x??	0x??	0x??	0x??	0xFF	0xFF

Parameter	Parameter Description
Subset	This module only has one subset of outputs: 0x00 Subset 1
Output Configuration	Bytes[2-7] contain the output configuration of each output: 0xFF Unconfigured 0x01 Digital Output 0x02 PWM Output

Input Configurations Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Input Configurations Reply" message (0x23).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xB3	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Input Configurations Reply

This is a message sent from the module to the controller and is response to the 0xB3 message. The data in this message contains the configuration of each input.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Input 1 Configuration	Input 2 Configuration	Reserved	Reserved	Reserved	Reserved	Reserved
0x23	0x??	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description	
Configuration Status	0x00	Input Disabled or Turned Off
	0x01	Sourcing Digital Input
	0x02	32V Analog Input
	0x03	4-20mA Current-Reading Input
	0x04	0-5VDC Ratiometric Input
	0x05	20Hz-20kHz Frequency-Reading Input

Module Configuration Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Module Configuration" message (0x20). A module will only report as unconfigured if no output configuration messages have been received yet.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xBB	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Module Configuration Reply

This is a message sent from the module to the controller as a response to the 0xBB message. This message contains the module's configuration state. If any configuration message is successfully received, this message will reply configured.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Configuration Status	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0x20	0x00	0x??	0x??	0x??	0x??	0x??	0x??

Parameter	Parameter Description
Configuration Status	0x00 No Configuration 0x01 Configured

Request CAN Timeout

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "CAN Timeout Value Reply" message (0x24).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xB4	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Reply CAN Timeout Value

This is a message sent from the module to the controller and is response to the 0xB4 message. The data in this message contains the timeout configuration of the module.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	CAN Timeout Value	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0x24	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
CAN Timeout Value	Timeout duration Note: Possible range of values is [0x00 - 0xFF] or [0-255] seconds.

Battery Voltage Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Battery Voltage Reply" message (0x36).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xC6	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Battery Voltage Reply

This is a message sent from the module to the controller and is response to the (0xC6) message. The data in this message contains the Battery Voltage as a 8-bit measurement.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Battery Voltage	Battery Voltage	Reserved	Reserved	Reserved	Reserved	Reserved
0x36	0x??	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Battery Voltage	0-255 Possible Range of values for battery voltage. **Note:** The scaling factor for the battery voltage reading is 0.00792. This reading is an 12-bit measurement, Byte[2] LSB & Byte[1] MSB. **Example:** The values Byte[1] = 0x05 Byte[2] = EB is transmitted to the controller, 0x05EB value is 1515 in decimal. (1515 * 0.007392) = 12V being supplied to the module.

Digital Input State Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Digital Input States Reply" message (0x30).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xC0	0x00	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	This module only has one subset of inputs 0x00 Subset 1 (Inputs1-6)

Digital Input State Reply

This is a message sent from the module to the controller and is response to the 0xC0 message. The data in this message contains the digital input states of each input.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Input 1 Digital State	Input 2 Digital State	Input 3 Digital State	Input 4 Digital State	Input 5 Digital State	Input 6 Digital State
0x30	0x00	0x??	0x??	0x??	0x??	0x??	0x??

Parameter	Parameter Description
Subset	This module only has one subset of inputs: 0x00 Subset 1
Input State	Bytes[2-7] contain the digital input state of each input: 0x00 LOW 0x01 HIGH

Output State Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Output State Reply" message (0x40).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xD0	0x00	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	This module only has one subset of outputs: 0x00 Subset 1

Output State Reply

This is a message sent from the module to the controller and is response to the 0xD0 message. The data in this message contains the output state of each output.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Output 1 State	Output 2 State	Output 3 State	Output 4 State	Reserved	Reserved
0x40	0x00	0x??	0x??	0x??	0x??	0xFF	0xFF

Parameter	Parameter Description
Subset	This module only has one subset of outputs: 0x00 Subset 1
Output State	Bytes[2-7] contain the state of each output: 0x00 Output is OFF 0x01 Output is ON

Output Frequency Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Output Frequency Reply" message (0x41).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Output	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xD1	0x??	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Output	Specify the output frequency to report: 0x00 Output 1 0x01 Output 2 0x02 Output 3 0x03 Output 4

Output Frequency Reply

This is a message sent from the module to the controller and is response to the 0xD1 message. The data in this message contains the output state of each output.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Output	Frequency	Frequency	Reserved	Reserved	Reserved	Reserved
0x41	0x??	0x??	0x??	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Output	Specifies the output frequency the modules will respond with: 0x00 Output 1 0x01 Output 2 0x02 Output 3 0x03 Output 4
Frequency	Bytes[2,3] contain the frequency data from the specified output. Frequencies of 5Hz-1kHz or 0005h-03E8h are supported.

Output Duty Cycle Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Output Duty Cycle Reply" message (0x42).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Output	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xD2	0x??	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Output	Specify the output duty cycle to report: 0x00 Output 1 0x01 Output 2 0x02 Output 3 0x03 Output 4

Output Duty Cycle Reply

This is a message sent from the module to the controller and is response to the 0xD2 message. The data in this message contains the duty cycle of the specified output.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Output	Duty Cycle	Reserved	Reserved	Reserved	Reserved	Reserved
0x42	0x??	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Output	Specifies the output duty cycle the modules will respond with: 0x00 Output 1 0x01 Output 2 0x02 Output 3 0x03 Output 4
Frequency	Byte[2] contains the duty cycle of the specified output (00h-64h)

Output Fault Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Output Fault Reply" message (0x45).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xD5	0x00	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	This module only has one subset of outputs: 0x00 Subset 1

Output Fault Reply

This is a message sent from the module to the controller and is response to the 0xD5 message. The data in this message contains the fault status of each output.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Output 1 Fault Status	Output 2 Fault Status	Output 3 Fault Status	Output 4 Fault Status	Reserved	Reserved
0x45	0x00	0x??	0x??	0x??	0x??	0xFF	0xFF

Parameter	Parameter Description
Subset	This module only has one subset of outputs: 0x00 Subset 1
Output # Fault Status	0x00 No Fault 0x01 Short Circuit Fault 0x02 Overcurrent Fault 0x03 CAN Timeout Occurred, Output Turned Off

Input Fault State Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Input Fault State Reply" message (0x35).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xC5	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Input Fault State Reply

This is a message sent from the module to the controller and is response to the 0xC5 message. The data in this message contains the fault state of each input.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Input 1	Input 2	Reserved	Reserved	Reserved	Reserved	Reserved
0x35	0x??	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Fault Condition	0x00 No Fault 0x01 Short Circuit Fault 0x02 Overcurrent Fault

Digital Input State Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Digital Input States Reply" message (0x30).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xC0	0x00	0x??	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	This module only has one subset of inputs 0x00 Subset 1 (Inputs 1-2)

Digital Input State Reply

This is a message sent from the module to the controller and is response to the 0xC0 message. The data in this message contains the digital input states of each input.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Input 1 Digital State	Input 2 Digital State	Reserved	Reserved	Reserved	Reserved
0x30	0x00	0x??	0x??	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	This module only has one subset of inputs: 0x00 Subset 1
Input State	Bytes[2-3] contain the digital input state of each input: 0x00 LOW 0x01 HIGH

Analog Input Value Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Analog Input Value Reply" message (0x31).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Input	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xC1	0x??	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Input	This byte denotes the input for which the analog input data is being requested: 0x00 Input 1 0x01 Input 2

Analog Input Value Reply

This is a message sent from the module to the controller and is response to the 0xC1 message. The data in this message contains the analog input value of the specified input.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Input	MSB Data	LSB Data	Reserved	Reserved	Reserved	Reserved
0x31	0x??	0x00	0x??	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	This byte denotes the input for which the analog input data is being sent: 0x00 Input 1 0x01 Input 2
MSB/LSB Input Data	Bytes [2,3] contain the analog input value for the requested input: 0x0000-0x0FFF (0-4095) **Note:** The scaling factor for these 32V Analog inputs is 0.008416V/unit. The analog input value is a 12-bit measurement. **Example:** The value 0x0A 0x7C is transmitted to the controller, 0x0A7C is 2684 in decimal. (2684 x 0.008416V) = 22.59V at the requested input.

4-20mA Current-Reading Analog Input Value Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "4-20mA Current Reading Input Reply" message (0x32).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Input	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xC2	0x??	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Input	This byte denotes the input for which the current-reading analog input data is being requested: 0x00 Input 1 0x01 Input 2

4-20mA Current-Reading Analog Input Value Reply

This is a message sent from the module to the controller and is response to the 0xC2 message. The data in this message contains the current reading of the requested input.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Input	MSB Data	LSB Data	Reserved	Reserved	Reserved	Reserved
0x32	0x00	0x??	0x??	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	This byte denotes the input for which the current value is being sent: 0x00 Input 1 0x01 Input 2
MSB/LSB Input Data	Bytes [2,3] contain the current reading value for the requested input: 0x0000-0x0FFF (0-4095) **Note:** The scaling factor for these 4-20mA Current-Reading Analog inputs is 0.00548mA/unit. The input value is a 12-bit measurement. **Example:** The value 0x08 0xD1 is transmitted to the controller, 0x08D1 is 2257 in decimal. (2257 x 0.00548mA) = 12.36mA at the requested input.

0-5V Ratiometric Analog Input Value Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Ratiometric Analog Input Value Reply" message (0x33).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Input	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xC3	0x??	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Input	This byte denotes the input for which the ratiometric analog input data is being requested: 0x00 Input 1 0x01 Input 2

0-5V Ratiometric Analog Input Value Reply

This is a message sent from the module to the controller and is response to the 0xC3 message. The data in this message contains the 0-5V analog input value.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Input	MSB Data	LSB Data	Reserved	Reserved	Reserved	Reserved
0x33	0x00	0x??	0x??	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	This byte denotes the input for which the ratiometric analog input data is being sent: 0x00 Input 1 0x01 Input 2
MSB/LSB Input Data	Bytes [2,3] contain the ratiometric analog input data for the requested input: 0x0000-0x0FFF (0-4095) **Note:** The scaling factor for these 0-5V Ratiometric Analog inputs is 0.0012207V/unit. The input value is a 12-bit measurement. **Example:** The value 0x0D 0x8C is transmitted to the controller, 0x0D8C is 3468 in decimal. (3468 x 0.0012207V) = 4.23V at the requested input.

Frequency Reading Input Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Frequency Reading Input Reply" message (0x34).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Input	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0xC4	0x??	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Input	This byte denotes the input for which the frequency is being requested: 0x00 Input 1 0x01 Input 2

Frequency Reading Input Reply

This is a message sent from the module to the controller and is response to the 0xC4 message. The data in this message contains the frequency at the requested input.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Input	MSB Data	LSB Data	Reserved	Reserved	Reserved	Reserved
0x34	0x00	0x??	0x??	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	This byte denotes the input for which the frequency data is being sent: 0x00 Input 1 0x01 Input 2
MSB/LSB Input Data	Bytes[2,3] contain the frequency at the requested input: 0x0000-0xFFF0 (0-65,520) **Note:** These frequency inputs cannot read frequencies under 20Hz. **Example:** The value 0x30 0xD4 is transmitted to the controller, 0x30D4 is 12,500 in decimal. This means that the frequency at the input is 12.5kHz.

Output Current Reading Request

This is a message sent from the controller to the module. When this message is received by the module, it will reply with the "Output Current Reading Reply" message (0x43).

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Unused	Unused	Unused	Unused	Unused	Unused
0xD3	0x00	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	List of subset - outputs: 0x00 Output[1] 0x01 Output[2] 0x02 Output[3] 0x03 Output[4]

Output Current Reading Reply

This is a message sent from the module to the controller and is response to the 0xD3 message. The data in this message contains the averaged current reading of each output.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Multiplex	Subset	Output Current	Output Current	Unused	Unused	Unused	Unused
0x43	0x00	0x??	0x??	0xFF	0xFF	0xFF	0xFF

Parameter	Parameter Description
Subset	List of subset - outputs: 0x00 Output[1] 0x01 Output[2] 0x02 Output[3] 0x03 Output[4]
Output # Current Reading	Byte[2] MSB & Byte[3] LSB, current ratio 0.004884, Example: Byte[2] = 0x02 & Byte[3] = 0x84, 0x0284 is 644 decimal, (644 * 0.004884) = 3.145 amps current draw for the output.

Functional Example – Configuring and Turning on a PWM Output

1. **With power off, connect the I/O Module to power (pin 12) and ground (pin 11). Connect pin 10 to CAN_H and pin 9 to CAN_L. Leave Addr1 (pin 7) and Addr2 (pin 8) unconnected (floating). Connect Output 2 (pin 2) to a resistive load greater than 10 ohms.**
    a. Power provided must be in the range of 8-32VDC, 24VDC used in this example.
    b. CAN Communication is 250k baud rate for this module.
    c. Addr1 and Addr2 connected to battery sets the I/O Module Address to 0x**54**.
2. **Turn power on and verify the CAN LED starts blinking; Broadcast message (0x01) should be transmitted once per second.**
    a. The default CAN timeout is 10 seconds.
    b. Verify the module is broadcasting the software revision.
        i. CAN ID: 0x10FF0054
        ii. Data (Bytes 0-7): 0x01 0x02 0x11 0x07 0xE5 0x01 0x01 0x00. (Note: the data will be different if a SW revision has been updated after this example was written)
3. **Configure the CAN timeout of the module with the (0xA5) message.**
    a. Send the CAN Configuration Timeout data (0xA5). It will be configured for 10 seconds in this example.
        i. CAN ID: 10EF5400
        ii. Data (Bytes 0-7): 0xA5 0x00 0x0A 0xFF 0xFF 0xFF 0xFF 0xFF
    b. Verify the CAN LED blinks for 10 seconds, and then turns off. When the CAN LED goes turns off, it indicates a message has not been received in last 10 seconds.
4. **Configure output and verify configuration with (0xA1) and (0xB1) messages.**
    a. This message is sent from the controller to the output module to configure an output. In this example, output 2 will be configured as a PWM Output.
        i. CAN ID: 10EF5400
        ii. Data (Bytes 0-7): 0xA1 0x02 0x01 0xFF 0xFF 0xFF 0xFF 0xFF
    b. Verify the output configuration by sending the Output Configuration Message.
        i. CAN ID: 10EF5400
        ii. Data (Bytes 0-7): 0xB1 0x00 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
    c. Verify the module replies with the Output Configuration Reply message.
        i. CAN ID: 10EF0054
        ii. Data (Bytes 0-7): 0x21 0x00 0xFF 0x02 0xFF 0xFF 0xFF 0xFF

5. **Send the Frequency Configuration Message (0xA1) to the module.**
    a. This message is sent from the controller to the output module to set the output frequency.
        i. CAN ID: 10EF5400
        ii. Data (Bytes 0-7): 0xA1 0x03 0x01 0x00 0xFA 0xFF 0xFF 0xFF (message sets the frequency of the output to 250Hz when the output is turned on).
6. **Send the Control Duty Cycle Message (0xA3) to the module to turn on the output.**
    a. This message is sent from the controller to the module and sets the duty cycle at output 2, turning it on to 250Hz and a duty of 50%.
        i. CAN ID: 10EF5400
        ii. Data (Bytes 0-7): 0xA3 0x01 0x32 0xFF 0xFF 0xFF 0xFF 0xFF (message sets the duty cycle of the output to 50%).
        iii. The output should now be on.
7. **Send the Output Frequency Request Message (0xD1) to the module.**
    a. This message is sent from the controller to the module to request the frequency of output 2.
        i. CAN ID: 10EF5400
        ii. Data (Bytes 0-7): 0xD1 0x01 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
    b. Verify the Module responds with the Output Frequency Reply Message
        i. CAN ID: 10EF0054
        ii. Data (Bytes 0-7): 0x41 0x01 **0x00 0xFA** 0xFF 0xFF 0xFF 0xFF.
8. **Send the Output Duty Cycle Request Message(0xD2) to the module.**
    a. This message is sent from the controller to the module to request the duty cycle of output 2.
        i. CAN ID: 10EF5400
        ii. Data (Bytes 0-7): 0xD2 0x01 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
    b. Verify the Module responds with the Output Duty Cycle Reply Message
        i. CAN ID: 10EF0054
        ii. Data (Bytes 0-7): 0x42 0x01 **0x32** 0xFF 0xFF 0xFF 0xFF 0xFF.
9. **Send the Output State Request Message (0xB1)**
    a. This message is sent from the controller to the module to request the on/off state of the module's outputs.
        i. CAN ID: 10EF5400
        ii. Data (Bytes 0-7): 0xB1 0x00 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
    b. Verify the Module responds with the Output State Reply Message
        i. CAN ID: 10EF0054
        ii. Data (Bytes 0-7): 0x21 0x00 0x00 **0x01** 0x00 0x00 0x00 0x00.

10. Send the Control Duty Cycle Message (0xA3) to the module to turn off the output.

a. This message is sent from the controller to the module and sets the duty cycle of output 2 to zero, turning off the output.
   i. CAN ID: 10EF5400
   ii. Data (Bytes 0-7): 0xA3 0x01 **0x00** 0xFF 0xFF 0xFF 0xFF 0xFF (message sets the duty cycle of the output to 0%).
   iii. The output should now be off. Resend the message from step 8(0xD2) and verify byte 3 is now 0x00 (OFF).

Functional Example – Configuring and Turning on an Analog Input

1. **With power off, connect the I/O Module to power (pin 12) and ground (pin 11). Connect pin 10 to CAN_H and pin 9 to CAN_L. Connect Addr1 (pin 7) and Addr2 (pin 8) to ground.**
    a. Power provided must be in the range of 8-32VDC, 24VDC used in this example.
    b. CAN Communication is 250k baud rate for this module.
    c. Addr1 and Addr2 connected to ground sets the I/O Module Address to **57**.
2. **Turn power on and verify the CAN LED starts blinking; Broadcast message (0x01) should be transmitted once per second.**
    a. The default CAN timeout is 10 seconds.
    b. Verify the I/O Module is broadcasting the software revision.
        i. CAN ID: 0x10FF0057
        ii. Data (Bytes 0-7): 0x01 0x02 0x11 0x07 0xE5 0x01 0x01 0xFF. (Note: the data will be different if a SW revision has been updated after this example was written)
3. **Configure the CAN timeout from the controller to the input module.**
    a. Send the CAN Configuration Timeout message (0xA5). It will be configured for 10 seconds in this example.
        i. CAN ID: 10EF5700
        ii. Data (Bytes 0-7): 0xA5 0x00 0x0A 0xFF 0xFF 0xFF 0xFF 0xFF
    b. Verify the CAN LED blinks for 10 seconds, and then turns off. When the CAN LED turns off, it indicates a message has not been received in last 10 seconds.
4. **Send the input configuration message to the input module.**
    a. This message is sent from the controller to the input module to configure an input. In this example, input 1 will be configured as a 32V analog input. Do not connect input 1 to anything yet.
        i. CAN ID: 10EF5700
        ii. Data (Bytes 0-7): 0xA4 0x02 0x00 0xFF 0xFF 0xFF 0xFF 0xFF
    b. Verify the Input 1 LED turns on and stays on.

5. **Send the Analog Input Value Request message to the input module.**
    a. This request message is sent from the controller to the input module and will cause the input module to reply to the controller.
        i. CAN ID: 10EF5700
        ii. Data (Bytes 0-7): 0xC1 **0x00** 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF (0x00 in byte[1] specifies input 1 is being requested).
    b. The Analog Input Value Response message will be sent back to the controller.
        i. CAN ID: 10EF0057
        ii. Data (Bytes 0-7): 0x31 **0x00 0x00** 0xFF 0xFF 0xFF 0xFF 0xFF
        iii. Since the analog input is not connected to anything, a value of zero is observed.
6. **Connect input 1 to the 24V power supply and send the Analog Input Value Request message again.**
    a. Connect Input 1 (pin 4) to the +24VDC power supply.
    b. Send the Analog Input Value Request message
        i. CAN ID: 10EF5700
        ii. Data (Bytes 0-7): 0xC1 **0x00** 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF (0x00 in byte[1] specifies input 1 is being requested).
    c. The Analog Input Value Response message will be sent back to the controller.
        i. CAN ID: 10EF0057
        ii. Data (Bytes 0-7): 0x31 **0x?? 0x??** 0xFF 0xFF 0xFF 0xFF 0xFF
        iii. Now that the analog input is connected to battery, the controller will get non-zero data back in bytes[1,2].
        iv. A hex value of 0x00 0x4E is exactly 24.0VDC.
7. **Disable the input**
    a. Send the Input Configuration message (0xA4) to disable input 1.
        i. CAN ID: 10EF5700
        ii. Data (Bytes 0-7): 0xA4 **0x00** 0x00 0xFF 0xFF 0xFF 0xFF 0xFF (0x00 in byte[1] disables the input specified in byte[2])
    b. The Input 1 LED should turn off once this message is sent.
    c. If the Analog Input Value Request message is sent again, the Analog Input Value Response message will report 0x00 0x00 in the data bytes for analog value.