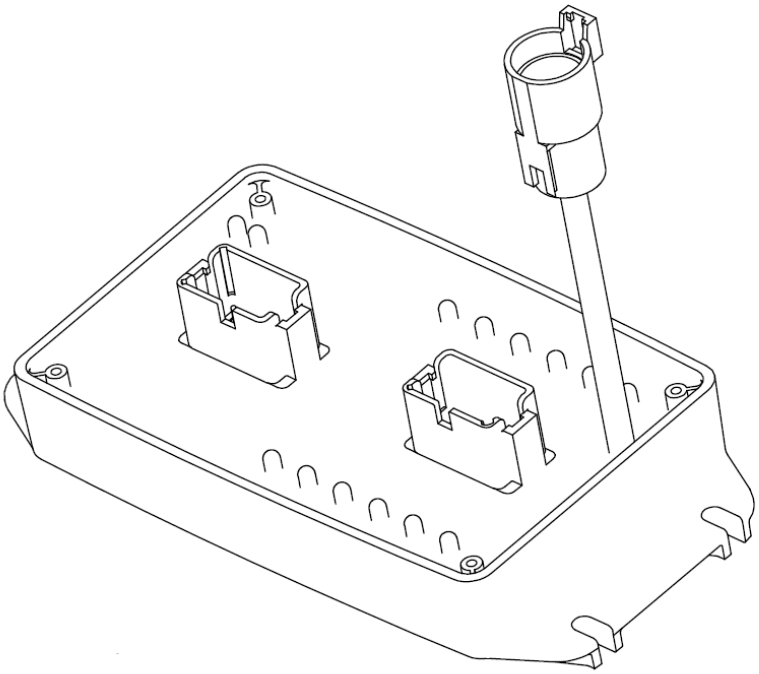
Trombetta P/N: 99-0530

J1939 High Current Output Module Messaging Specification



Specification Revision History:

Rev	Rev Date	Modified by	Description
A	2/24/2016	ALG	Original Release
B	2/2/2017	ALG	Fix P/N, was 115-0010, corrected to be 117-0010, changed to 99-0530 for general purpose modules.
C	6/18/2019	ALG	Updated specification document form, updated names to reflect Trombetta, fixed oversight in example(current) configuration, adjusted for max 13 amps current. Added 0x94 system current messages. Updated for general J1939 proprietary communications structure.
D	7/12/2019	AM	Updated title to include J1939. Updated communication example messages to set 50Hz frequency.
E	2/25/2020	AM	Changed Wake-Up broadcast PGN(was point-point EF now broadcast FF). Updated the data description for the wake-up broadcast; data is hexadecimal format and must be converted to decimal for proper dates. Adjusted functional example to send request for info message after module power up and for new broadcast PGN. Fixed small grammatical oversights in messaging section.
F	11/13/2020	AM	Updated the specification with findings from DVP&R testing. Fixed some small grammatical oversights.

Table of Contents

1. GENERAL DESCRIPTION: 3
2. COMMUNICATION INTERFACE REQUIREMENTS: 3
3. COMMUNICATION PROTOCOLS: 3
4. SUPPORTED MESSAGES: 5
5. FUNCTIONAL EXAMPLE: 13

1. GENERAL DESCRIPTION:

i. This specification includes messaging format, sequence, and content applicable to devices utilizing the Power module type in a J1939 system.

ii. **LEDS:** The green LED indicates that the module is powered and has normal functionality. The red LED next to the green LED is the communication LED. When the red LED is flashing, good CAN communication is present, and messages are being directed at the module. If communications fail, such as no messages are being sent to the unit, the red LED will extinguish. The 12 red status LEDs indicate the statuses of individual outputs, when a LED is on, the output has been activated and is operating normally. If the LED is blinking, then that output has a fault condition present and has been turned off.

2. COMMUNICATION INTERFACE REQUIREMENTS:

a. Vehicle Network Capability

i. All devices utilizing this specification shall comply with the following network interfaces. All network interfaces shall meet all environmental specifications and be isolated to the maximum extent practical.

b. CAN 2.0b Physical Bus/J1939 Superset

i. Quantity 1
ii. ISO 11898 physical layer (copper media)
iii. Primary Network Interface

3. COMMUNICATION PROTOCOLS:

a. Definition

i. This section describes proper communication message protocols to interface with the controller.

b. Module Type

i. The module type shall be: Power Module 0x6_

c. CAN Address

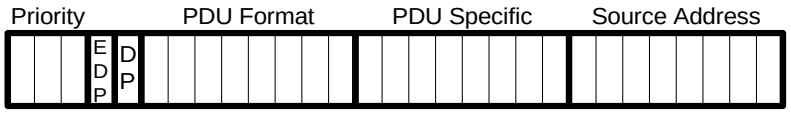
i. The CAN address is generated from the module type and the harness ground pin matrix ID such that the module type composes of the upper nibble and the 1's complement of the harness ground matrix ID composes of the lower nibble.

d. Harness Ground Matrix ID

i. The Matrix ID can be changed to enable multiple output modules to be used on a single CAN bus by connecting ground to one or more address pins. The address pins and Matrix ID follow a basic binary format, if ground is attached to the ADD0 pin the ID will change to 0x01, if ground is attached to the ADD1 pin the ID will change to 0x02, if ground is attached to both ADD0 and ADD1 pins the ID will change to 0x03, and so on. Please note that if the ID is changed the output module will only accept messages directed at its current combination of CAN address and Matrix ID.

e. Message Identifier

J1939 uses the 29-bit extended frame format identifier. The 29 identifier bits are defined as follows:



The Priority (P) Bits fields (are ignored).
The Extended Data Page (EDP) Bit.
The Data Page (DP) bit.
The Proprietary PDU1 Format (PF) byte is 239 (0xEF) for point-to-point and 255 (0xFF) for broadcast messages. (Section 5.3 J1939-21)
The PDU Specific (PS) byte is the Destination Address (DA) for point-to-point messages.
The Source Address (SA) byte is the Node Address and is the concatenation of the Module Type ID (high nibble) and the Node ID (low nibble). The Node Address shall be used as the module's Source Address as part of the message identifier as identified in SAE J1939-21.

Example Message ID: 0x00EF600C would be a point-to-point message from the Controller 0x0C to the Power Module 0x60.

4. SUPPORTED MESSAGES:

Wake-up Message: Broadcast Message from the Specified Module.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Month	Day	Year(MSB)	Year(LSB)	Major REV	Minor REV	Module Status
0x01	0x??	0x??	0x??	0x??	0x??	0x??	0x??

Byte 0	**COMMAND**	Command Byte – For Device Wake Up Response, the command byte is 0x01.
Byte 1	**MONTH**	The month of the software version date in hexadecimal format(convert to decimal for date). e.g. for '12', MONTH = 0x0C = 12d
Byte 2	**DAY**	The day of the software version date in hexadecimal format(convert to decimal for date). e.g. for '31', DAY = 0x1F = 31d
Byte 3	**YEAR (MSB)**	The first two digits of the year of the software version date in hexadecimal format(convert to decimal for date). e.g. for '2006', YEAR (MSB) = 0x14 = 20d
Byte 4	**YEAR (LSB)**	The last two digits of the year of the software version date in hexadecimal format(convert to decimal for date). e.g. for '2006', YEAR (LSB) = 0x06 = 6d
Byte 5	**MAJOR REV**	The major revision number of the software version in hexadecimal format(convert to decimal for revision number).
Byte 6	**MINOR REV**	The minor revision number of the software version in hexadecimal format(convert to decimal for revision number).
Byte 7	**MODULE STATUS**	Status: 0x00 = Needs Configuration 0x01 = Configuration OK 0x02 = Configuration Unknown (after initial power up or hard reset) 0x03 = Reserved 0x04 = Reserved 0x05 = No Comm. 0x06 = Active Run Mode 0x07 = Reserved

Comm-Fail timeout Configuration: Point to Point Message from CONTROLLER to Specified Module

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	My Time	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0x10	0x??	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

My Time: If module does not get a message within this amount of time, it goes into comm-fail.
Time = (Value sent *100msec). Default = 7 seconds, Maximum = 25.5 seconds.

Reset any module: Point to Point Message from CONTROLLER to Specified Module							
BYTE 0	**BYTE 1**	**BYTE 2**	**BYTE 3**	**BYTE 4**	**BYTE 5**	**BYTE 6**	**BYTE 7**
Command	Hard Reset Key						Reserved
0x11	0x01	0xA5	0x5A	0x49	0x94	0x01	0xFF

Hard Reset: The module shall transition from the current mode to the device power up mode. All inputs and outputs are disabled (Off), then the module will behave as if just powered up. The wake-up message(s) will be sent to the CONTROLLER and the module will be configurable.

CONTROLLER Wake-up Message: Point to Point Message from CONTROLLER to Specified Module							
BYTE 0	**BYTE 1**	**BYTE 2**	**BYTE 3**	**BYTE 4**	**BYTE 5**	**BYTE 6**	**BYTE 7**
Command	Module Serial Number				Reserved	Echo Runtime	Echo Configuration
0x12	0x??	0x??	0x??	0x??	0xFF	0x??	0x??

Module Serial Number: Compared to the saved module serial for loading a saved configuration.
NOTE: The Module Serial Number (bytes [1-4]) cannot all be 0xFF or all 0x00. The message will be ignored if that is the case.
Echo Runtime: If enabled, specified runtime messages shall be echoed by the module after a runtime command is received.

Byte 6 Data: 0x00 or 0xFF = echo disabled
Byte 6 Data: 0x01 = echo enabled

Echo Configuration: If enabled, specified configuration messages shall be echoed by the module after a configuration command is received.

Byte 7 Data: 0x00 or 0xFF = echo disabled
Byte 7 Data: 0x01 = echo enabled

Save Configuration Message: Point to Point Message from CONTROLLER to Specified Module							
BYTE 0	**BYTE 1**	**BYTE 2**	**BYTE 3**	**BYTE 4**	**BYTE 5**	**BYTE 6**	**BYTE 7**
Command	Module Serial Number				Reserved	Reserved	Reserved
0x13	0x??	0x??	0x??	0x??	0xFF	0xFF	0xFF

Module Serial Number: Serial number used to compare against the CONTORLLER Wake-Up message(0x12) serial number. If the two serial numbers match, then configuration values of specified messages shall be saved to non-volatile memory upon receipt of the save configuration message(0x13) from the controller. The saved values will be loaded when the SAME serial number is entered in the CONTORLLER Wake-Up message(0x12) during the next device power up/configuration cycle.

Output Configuration Message 1: Point to Point Message from CONTROLLER to Specified Module. This message **IS** required for each configured output

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Output Number	Mode / Slew Type	PWM Frequency	Over-Current Limit	Over-Current Delay Time	ON Slew Rate	OFF Slew Rate
0x60	0x??	0x??	0x??	0x??	0x??	0x??	0x??

Output Number: The output number that is being configured
Output Numbering: [1 – 12]

Mode / Slew Type: The high nibble is for the mode; the low nibble is slew type of the output being configured.
Mode: 0x00 = Disabled (default)
0x01 = PWM
Slew Type: 0x00 = Linear (default)

PWM Frequency: The frequency rate for the PWM of the output being configured.
Minimum = 50Hz (0x32)
Maximum = 250Hz (0xFA)

Over-Current Limit: The current set point for the over-current condition of the output being configured.
Over-Current Limit = (Value sent * 100mA)
Outputs [1-8] are hard coded and default with a maximum limit of 13 Amps
Outputs [9-12] are hard coded and default with a maximum limit of 3 Amps

Over-Current Delay Time: Delay for current limit. (Value sent * 10 msec)
Minimum delay time is 0.5 seconds(0x32), if less the entire message is ignored.
Maximum delay time is 25.5 seconds (0xFF).

ON Slew Rate: The rate at which the ON value is ramped to. (Value sent * 10 msec)
Maximum ON Slew Rate = 25.5 seconds (0xFF)

OFF Slew Rate: The rate at which the OFF value is ramped to. (Value sent * 10 msec)
Maximum OFF Slew Rate = 25.5 seconds (0xFF)

Note 1: These configuration values shall be saved to non-volatile memory after the module receives the save configuration message(0x13) from the controller. If the save config is not sent on that power-cycle, the configuration values shall revert to the last saved configuration upon the next power cycle.

Note 2: This message shall be returned from the Specified Module to the Controller upon receipt of this message if the Echo Configuration byte of the Wake-Up message(0x12) was configured. This acts as a confirmation “echo” of the proper configuration.

Output Configuration Message 2: Point to Point Message from CONTROLLER to Specified Module. This message **IS NOT** required for each configured output.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	State			Reserved	Reserved	Reserved	Reserved
0x64	0x?? (Outputs 1-4)	0x?? (Outputs 5-8)	0x?? (Outputs 9-12)	0xFF	0xFF	0xFF	0xFF

State: When the module enters comm-fail (module status 0x05 is present), the designated output(s) will transition to the following state depending on their assigned value…

0x00 = Output to turn **OFF** if module enters comm-fail
0x01 = Output to turn **ON** if module enters comm-fail
0x02 = Output to maintain current state if module enters comm-fail

Outputs not configured for comm-loss state default to **OFF** when the module enters comm-loss.

Comm-Fail (0x05 module status) conditions must be met for the state to be implemented

Byte 1.1 - 1.2 is output # 1
Byte 1.3 - 1.4 is output # 2
Byte 1.5 - 1.6 is output # 3
Byte 1.7 - 1.8 is output # 4
Byte 2.1 - 2.2 is output # 5
Byte 2.3 - 2.4 is output # 6
Byte 2.5 - 2.6 is output # 7
Byte 2.7 - 2.8 is output # 8
Byte 2.1 - 3.2 is output # 9
Byte 2.3 - 3.4 is output # 10
Byte 2.5 - 3.6 is output # 11
Byte 2.7 - 3.8 is output # 12

Note 1: These configuration values shall be saved to non-volatile memory after the module receives the save configuration message(0x13) from the controller. If the save config is not sent on that power-cycle, the configuration values shall revert to the last saved configuration upon the next power cycle.

Note 2: This message shall be returned from the Specified Module to the Controller upon receipt of this message if the Echo Configuration byte of the Wake-Up message(0x12) was configured. This acts as a confirmation “echo” of the proper configuration.

Output Runtime Data 1: Point to Point Message from CONTROLLER to Specified Power Module
This message is used to control the **DUTY CYCLE** of the PWM output being configured.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Subset	Reserved	Output (4+Offset)	Output (3+Offset)	Output (2+ Offset)	Output (1+Offset)	Reserved
0x65	0x??	0xFF	0x??	0x??	0x??	0x??	0xFF

Subset:

0x00 = Outputs 1-4
0x01 = Outputs 5-8
0x02 = Outputs 9-12

*If any subset received is greater than 0x02, the entire message shall be ignored.

Offset: This is used for output numbering due to multiple subsets.

Offset = (subset * 4)

Output #: This value is for percent of PWM period that is ON. If value is greater than 100, output is clipped to 100. If an output is not configured, the respective output field value shall be ignored.

Minimum: 0x00 (0d = OFF)
Maximum: 0x64 (100d = ON)

Note 1: This message shall be returned from the Specified Module to the Controller upon receipt of this message if the Echo Configuration byte of the Wake-Up message(0x12) was configured. This acts as a confirmation "echo" of the proper configuration.

Request for Information: Point to Point Message from CONTROLLER to Specified Power Module

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Data Set	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0x7F	0x??	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

Data Set: The data set that the CONTROLLER desires to receive as a response.

0x00 = Output Diagnostic (0x90 message)
0x01 = Current draw of outputs 1-6 (0x91 message response)
0x02 = Current draw of outputs 7-12 (0x92 message response)
0x03 = Return messages 0x90, 0x91, 0x92
0x04 = Output Duty Cycle (0x93 message response)
0x05 = Total system current draw (0x94 message response)

*If any other value is requested, a message does not report back, but the comm. fail message timer is reset.

Output Diagnostic Data: Point to Point Message from Specified Power Module to CONTROLLER.
This message is an answer to a request (0x7F) from the CONTROLLER

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Reserved	Outputs1,2	Outputs3,4	Outputs5,6	Outputs7,8	Outputs9,10	Outputs11,12
0x90	0xFF	0x??	0x??	0x??	0x??	0x??	0xFF

Output #: Odd output number is the MSN (Most Significant Nibble) and Even output number is the LSN (Least Significant Nibble) of that data byte.
Value for each Nibble

- 0 = Okay
- 1 = Open Load
- 2 = Shorted Ground
- 3 = Shorted Battery
- 4 = Over Current Limit

Current Draw 1: Point to Point Message from Specified Power Module to CONTROLLER
This message is an answer to a request (0x7F) from the CONTROLLER.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Reserved	Output 1	Output 2	Output 3	Output 4	Output 5	Output 6
0x91	0xFF	0x??	0x??	0x??	0x??	0x??	0x??

Output #: The current draw of this output.
Current Draw = (Value sent * 100 MilliAmps)

Current Draw 2: Point to Point Message from Specified Power Module to CONTROLLER
This message is an answer to a request (0x7F) from the CONTROLLER.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Reserved	Outputs 7	Outputs 8	Outputs 9	Outputs 10	Output 11	Output 12
0x92	0xFF	0x??	0x??	0x??	0x??	0x??	0x??

Output #: The current draw of this output.
Current Draw = (Value sent * 100 MilliAmps)

Output Duty Cycle: Point to Point Message from Specified Power Module to CONTROLLER.
This message is an answer to a request (0x7F) from the CONTROLLER.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Subset	Reserved	Output (4 + Offset)	Output (3 + Offset)	Output (2 + Offset)	Output (1 + Offset)	Reserved
0x93	0x??	0xFF	0x??	0x??	0x??	0x??	0xFF

Subset:

0x00 = Outputs 1-4
0x01 = Outputs 5-8
0x02 = Outputs 9-12

Offset: This is used for output numbering due to multiple subsets.
Offset = (subset * 4)

Output #: This value is the duty cycle percentage(PWM period that is ON). (Value is **0** (OFF) to **100** (ON))
Minimum: 0x00 (0d = OFF)
Maximum: 0x64 (100d = ON)

Total System Current: Point to Point Message from Specified Power Module to CONTROLLER
This message is an answer to a request (0x7F) from CONTROLLER.

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Subset	System Overcurrent	System Current	Reserved	Reserved	Reserved	Reserved
0x94	0x00	0x??	0x??	0xFF	0xFF	0xFF	0xFF

Subset: 0x00

System Overcurrent:

0x00 – System current ok
0x01 – System faulted, overcurrent

System Current: Total system current draw **(A)**

Output Configuration Message 7: Point to point message from CONTROLLER to Specified Power Module.
This message **IS NOT** required for each Module

BYTE 0	BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5	BYTE 6	BYTE 7
Command	Diagnostic Control	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0x96	0x??	0xFF	0xFF	0xFF	0xFF	0xFF	0xFF

This message is used to turn off the open load diagnostic check circuit.

Diagnostic Control: The Diagnostic Circuit Control applies to all outputs. The circuit is either on for all outputs or off for all outputs.

0 (or any other value) = Turn off the open load diagnostic check
1 = Turn on the open load diagnostic check

Note 1: The module shall default to the check is off for all outputs.

Note 2: These configuration values shall be saved to non-volatile memory upon receipt of the save configuration message(0x13) from the controller. If the save config is not sent on that power-cycle, the configuration values shall revert to the last saved configuration upon the next power cycle.

Note 3: This message shall be returned from the Specified Module to the Controller upon receipt of this message if the Echo Configuration byte of the Wake-Up message(0x12) was configured. This acts as a confirmation "echo" of the proper configuration.

5. FUNCTIONAL EXAMPLE:

1. With battery power off, connect an output module, verify power, ground, load, and CAN communication are properly connected.
    a. Battery power provided must be within range of 8 – 16 VDC.
    b. CAN communication is set to 250k baud rate
    c. Please note values for data sent are always sent in hexadecimal format
    d. For this example, the output module will have the CAN ID of 0x00EF__60, no address pins have been connected to ground therefore the Source Address is 0x60
    e. For this example, the address used to control the output module will be 0x00EF600C, the Source Address of this controller will be 0x0C.
    f. It is recommended a message is sent directly to the module at a frequency of once per second to prevent the module from going into communication loss status. A request for information message such as “Output Diagnostic” is recommended to be sent. Once a wake-up message has been sent this request will also provide output information from the module.

2. Turn on battery power and provide communication directed to the output module.
    a. Verify the green power LED is on and the red communication LED continues to blink (red LED will turn off when in comm loss)
    b. Verify the output module is broadcasting the Wake-up Message:
        i. Address 0x00FFFF60
        ii. Data (Bytes 0-7): 0x01 0x02 0x04 0x20 0x16 0x00 0x01 0x02
    c. Request for information message (Outputs Diagnostic):
        i. Send address: 0x00EF600C (0x60 is directing the message to the output module and the 0x0C is the node address of the requesting controller)
        ii. Send data (Bytes 0-7): 0x7F 0x00 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
        iii. Byte 0: 0x7F, must be sent for this specific request
        iv. Byte 1: 0x00, identifies the Data Set for this request
        v. Byte 2 – 7: please fill remaining unused bytes with 0xFF’s

3. Send Controller Wake-up message
    a. This message must be sent before configuring outputs.
    b. This message will set the module serial number to 01 01 01 01
    c. This message will turn ON the echo back Runtime and Configuration messages
    d. Controller Wake-up Message:
        i. Send address: 0x00EF600C
        ii. Send data (Bytes 0-7): 0x12 0x01 0x01 0x01 0x01 0xFF 0x01 0x01
    e. Output module response (echo back has been turned on in the Wake-up message):
        i. Address 0x00EF0C60
        ii. Data (Bytes 0-7): 0x12 0x01 0x01 0x01 0x01 0xFF 0x01 0x01
    f. Verify the output module Wake-up Message status (Byte 7) has changed to Needs Configuration (0x00).
        i. Address: 0x00FFFF60
        ii. Data (Bytes 0-7): 0x01 0x02 0x04 0x20 0x16 0x00 0x01 **0x00**

4. Send Output Configuration Message (for output1):
    a. Please note that all configuration values must be within the specified ranges, if a single value is out of its given range this will void the configuration and no echo back reply will be sent.
    b. Please note the Wake-up message containing the serial number must be sent and accepted before outputs and be configured.
    c. Send address: 0x00EF600C
    d. Send Data (Bytes 0-7): 0x60 0x01 0x10 0x32 0x82 0xFF 0xFF 0xFF
        i. Byte 0: 0x60, the command which notifies the module what data is being sent
        ii. Byte 1: 0x01, output 1 is being configured
        iii. Byte 2: 0x10, enables the PWM of the output being configured
        iv. Byte 3: 0x32, sets the PWM frequency to 50hz
        v. Byte 4: 0x82, sets the Current Limit to 13 amps.
        vi. Byte 5: 0xFF, sets the Current Delay Time to 2.55 seconds
        vii. Byte 6: 0xFF, sets the ON Slew Rate to 2.55 seconds
        viii. Byte 7: 0xFF, sets the OFF Slew Rate to 2.55 seconds
    e. Output module response:
        i. Address 0x00EF0C60
        ii. Data (Bytes 0-7): 0x60 0x01 0x10 0x32 0x82 0xFF 0xFF 0xFF

f. Verify Module Status has changed to 0x01 (Configuration OK).
   i. Address 0x00FFFF60
   ii. Data (Bytes 0-7): 0x01 0x02 0x04 0x32 0x16 0x00 0x01 **0x01**
g. Now Output 1 is ready to accept a duty cycle
h. Please note that if the configuration is not saved (via the Save Configuration Message 0x13) the module will revert to its last saved configuration on power up and will need to be reconfigured.

5. Send Output Duty Cycle (for Output 1):
   a. Please note that the output must be configured before a duty cycle can be accepted and duty cycles must be within a range of 0-100 or the message will be ignored.
   b. Send address 0x00EF600C
   c. Send Data (Bytes 0-7): 0x65 0x00 0xFF 0x00 0x00 0x00 0x32 0xFF
      i. Byte 0: 0x65, the command which notifies the module what data is being sent
      ii. Byte 1: 0x00, the subset for the data being received
      iii. Byte 2: 0xFF, UNUSED
      iv. Byte 3-5: 0x00, duty cycles for outputs 2-4 which are not being set currently
      v. Byte 6: 0x32, Sets output 1 to 50% duty cycle
      vi. Byte 7: 0xFF, UNUSED
   d. Output module echo response and Module Status (0x06 “Active Run”):
      i. Address: 0x00EF0C60
      ii. Data (Bytes 0-7): 0x65 0x00 0xFF 0x00 0x00 0x00 0x32 0xFF
      iii. Address: 0x00FFFF60
      iv. Data (Bytes 0-7): 0x01 0x02 0x04 0x20 0x16 0x00 0x01 **0x06**

6. Output 1 will now be activated, its status LED will turn on immediately, and the output will slew on to 50% duty cycle at 50hz frequency in 2.55 seconds.

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