

CREATED	B.BERTOLASI	DATE 12/14/20
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Marlin CAN-Bus I/O Module Protocol

Marlin I/O modules are designed to operate in CAN-Bus based Input/Output fashion and communicate status over a Controller Area Network (CAN) using the industry standard J1939 messaging protocol. Outputs are controlled via CAN messages from the master control unit (MCU). Input status and Module status are reported via “Proprietary A” PGN’s at user selected intervals.

The I/O modules are very versatile, and the Inputs and Outputs can be user configured for many different operating modes to fit the needs of the user. Configuration is made by downloading the XML instruction file designed for the target application.

The module has CAN auto bit rate detection on power up (future update) and will operate at bus speeds of 250K, 500K and 1M bits per second. The CAN network must be active.

This specification is specific to the 505004 4-In/4-Out module. (It does mirror a lot of the same information from 11697S_ specification for the 505000 8-in/8-out module)

Output Configurations

The 505004 has 4 outputs which are individually configurable for various modes of operation. The table below indicates the modes available to each output channel. *Factory default in **bold**.

OUTPUT TYPE	#1	#2	#3	#4
00 *Disabled	●	●	●	●
01 Digital Active High	●	●	●	●
02 Digital Active Low	●	●	●	●
03 High Side PWM – Closed Loop	●	●	●	●
04 High Side PWM – Open Loop	●	●	●	●
05 Low Side PWM – Closed Loop	●	●	●	●
06 Low Side PWM – Open Loop	●	●	●	●

Output Command Messages

PGN 61184 (0xEfddss) Proprietary A Command

The I/O module uses a single PDU1 format, Proprietary A, CAN message ID to control all the outputs. 'dd' is the module source address and 'ss' is the senders address. Outputs will change only if the message ID and command identifier are compatible with the current output configuration. The message Data Field contains the command identifiers, output channel and data format.

Data Field: 60 FF 00 00 xx xx xx xx 2 bit command output 1-4

This command identifier will drive outputs configured as digital type. Outputs not configured as digital type will ignore the contents of this message.

Byte 1.1	2 bytes	command identifier	0xFF60	(2 bit command data)
Byte 3.1	1 byte	reserved	0x00	
Byte 4.1	1 byte	data page	0	
Byte 5.1	2 bits	Output Command, Output 01 (00 = low, 01 = high, 1x = ignored)		
Byte 5.3	2 bits	Output Command, Output 02 (00 = low, 01 = high, 1x = ignored)		
Byte 5.5	2 bits	Output Command, Output 03 (00 = low, 01 = high, 1x = ignored)		
Byte 5.7	2 bits	Output Command, Output 04 (00 = low, 01 = high, 1x = ignored)		

Data Field: 61 FF 00 00 xx xx xx xx 8 bit command output 1-4

This command identifier will drive outputs configured as Open Loop PWM type. Outputs not configured for this mode will ignore the contents of this message.

Byte 1.1	2 bytes	command identifier	0xFF61	(8 bit command data)
Byte 3.1	1 byte	reserved	0x00	
Byte 4.1	1 byte	data page	0	
Byte 5.1	8 bits	Output Duty Cycle, Output 01 (refer SPN 520200 for scaling factor)		
Byte 6.1	8 bits	Output Duty Cycle, Output 02 (refer SPN 520200 for scaling factor)		
Byte 7.1	8 bits	Output Duty Cycle, Output 03 (refer SPN 520200 for scaling factor)		
Byte 8.1	8 bits	Output Duty Cycle, Output 04 (refer SPN 520200 for scaling factor)		

Data Field: 62 FF 00 00 xx xx xx xx 16 bit command output 1-2

This command identifier will drive outputs configured as Open or Closed Loop PWM. Outputs not configured for PWM modes will ignore the contents of this message.

Byte 1.1	2 bytes	command identifier	0xFF62	(16 bit command data)
Byte 3.1	1 byte	reserved	0x00	
Byte 4.1	1 byte	data page	0	
Byte 5.1	16 bits	PWM Output 01 (refer SPN 520201 for scaling factor)		
Byte 7.1	16 bits	PWM Output 02 (refer SPN 520201 for scaling factor)		

Data Field: 62 FF 00 01 xx xx xx xx 16 bit command output 3-4

This command identifier will drive outputs configured as Open or Closed Loop PWM. Outputs not configured for PWM modes will ignore the contents of this message.

Byte 1.1	2 bytes	command identifier	0xFF62	(16 bit command data)
Byte 3.1	1 byte	reserved	0x00	
Byte 4.1	1 byte	data page	1	
Byte 5.1	16 bits	PWM Output 03 (refer SPN 520201 for scaling factor)		
Byte 7.1	16 bits	PWM Output 04 (refer SPN 520201 for scaling factor)		

Input Configurations

The 505004 has 4 inputs of which all various modes of operation are available all the time (no configuration is required). The table below indicates which modes are available to each input channel.

INPUT TYPE	#1	#2	#3	#4
Digital Active High - Threshold	●	●	●	●
Digital Active Low - Threshold	●	●	●	●
Analog 0 - 37v	●	●	●	●
PWM Active High	●	●		
Frequency	●	●		

Input Status Messages

The I/O module uses a priority 6, Proprietary PDU2 format CAN message ID to send Input status information. In the following PGN descriptions, '**xx**' is the I/O module source address. The message Data Field contains the status of the respective input channels.

PGN 65344 (0x18FF40xx) Digital Inputs

2 bit status

inputs 1-4

This CAN message will broadcast the status of inputs as measured as a digital type.

Transmission Repetition Rate: User defined (default = 0/Not sent)

Byte 1.1	2 bits	Digital High Status, Input 01 (00 = low, 01 = high, 10 = error, 11 = not applicable)
Byte 1.3	2 bits	Digital High Status, Input 02 (00 = low, 01 = high, 10 = error, 11 = not applicable)
Byte 1.5	2 bits	Digital High Status, Input 03 (00 = low, 01 = high, 10 = error, 11 = not applicable)
Byte 1.7	2 bits	Digital High Status, Input 04 (00 = low, 01 = high, 10 = error, 11 = not applicable)
Byte 2.1	2 bits	Digital Low Status, Input 01 (00 = low, 01 = high, 10 = error, 11 = not applicable)
Byte 2.3	2 bits	Digital Low Status, Input 02 (00 = low, 01 = high, 10 = error, 11 = not applicable)
Byte 2.5	2 bits	Digital Low Status, Input 03 (00 = low, 01 = high, 10 = error, 11 = not applicable)
Byte 2.7	2 bits	Digital Low Status, Input 04 (00 = low, 01 = high, 10 = error, 11 = not applicable)

PGN 65345 (0x18FF41xx) Analog Inputs

16 bit status

inputs 1-4

This CAN message will broadcast the status of inputs as measured as an analog type.

Transmission Repetition Rate: User defined (default = 0/Not sent)

Byte 1.1	16 bits	Value, Input 01 (refer SPN 520197 for scaling factor)
Byte 3.1	16 bits	Value, Input 02 (refer SPN 520197 for scaling factor)
Byte 5.1	16 bits	Value, Input 03 (refer SPN 520197 for scaling factor)
Byte 7.1	16 bits	Value, Input 04 (refer SPN 520197 for scaling factor)

PGN 65347 (0x18FF43xx) Frequency Inputs

16 bit status

inputs 1-2

This CAN message will broadcast the status of inputs as measured as a digital frequency type.

Transmission Repetition Rate: User defined (default = 0/Not sent)

Byte 1.1	16 bits	Value, Input 01 Frequency (refer SPN 520197 for scaling factor)
Byte 3.1	16 bits	Value, Input 02 Frequency (refer SPN 520197 for scaling factor)
Byte 5.1	16 bits	Value, Input 01 Duty Cycle (refer SPN 520197 for scaling factor)
Byte 7.1	16 bits	Value, Input 02 Duty Cycle (refer SPN 520197 for scaling factor)

Module Status Messages

PGN 65376 (0x18FF60xx) Module Status

This CAN message to broadcast the general module status.

Transmission Repetition Rate: User defined (default = 0/Not sent)

Byte 1.1	16 bits	Supply voltage	(refer SPN 520202 for scaling factor)
Byte 3.1	16 bits	System Temperature	(refer SPN 520202 for scaling factor)
Byte 5.1	16 bits	System Vref	(refer SPN 520202 for scaling factor)
Byte 7.1	16 bits	HWID	(refer SPN 520202)

PGN 65377 (0x18FF61xx) Output Faults

8 bit status

outputs 1-4

The 505000 uses this CAN message to broadcast output fault status.

Transmission Repetition Rate: User defined (default = 0/Not sent)

Byte 1.1	8 bits	Status Output 1	(refer SPN 520203 for scaling factor)
Byte 2.1	8 bits	Status Output 2	(refer SPN 520203 for scaling factor)
Byte 3.1	8 bits	Status Output 3	(refer SPN 520203 for scaling factor)
Byte 4.1	8 bits	Status Output 4	(refer SPN 520203 for scaling factor)

PGN 65379 (0x18FF63xx) Output Current Control Status

16 bit status

outputs 1-4

This CAN message to broadcast output control status in closed loop PWM mode.

Transmission Repetition Rate: User defined (default = 0/Not sent)

Byte 1.1	16 bits	Output 1 Setpoint	(refer SPN 520209 for scaling factor)
Byte 3.1	16 bits	Output 2 Setpoint	(refer SPN 520209 for scaling factor)
Byte 5.1	16 bits	Output 3 Setpoint	(refer SPN 520209 for scaling factor)
Byte 7.1	16 bits	Output 4 Setpoint	(refer SPN 520209 for scaling factor)

PGN 65380 (0x18FF64xx) Output Current Feedback Status

16 bit status

outputs 1-4

This CAN message to broadcast output feedback status in closed loop PWM mode.

Transmission Repetition Rate: User defined (default = 50ms)

Byte 1.1	16 bits	Output 1 Feedback	(refer SPN 520210 for scaling factor)
Byte 3.1	16 bits	Output 2 Feedback	(refer SPN 520210 for scaling factor)
Byte 5.1	16 bits	Output 3 Feedback	(refer SPN 520210 for scaling factor)
Byte 7.1	16 bits	Output 4 Feedback	(refer SPN 520210 for scaling factor)

Module Configuration Messages

Configuration messages are only accepted from the Source Address reserved for Service Tools (0xF9). The 505004 module currently has all of the Configuration disabled via the CAN messages and instead supports configuration through the XML Configuration File. The only exception is the ability to turn Beacon Mode On/Off so that you can identify the controller if more than one is present on the CAN-Bus.

PGN 61184 (0xEFddss) Proprietary A Command

The I/O module uses a single PDU1 format, Proprietary A, CAN message ID for all configuration commands. '*dd*' is the module source address. The senders address must be service tool source address 0xF9. The message Data Field contains configuration command identifiers, channel and setup data.

Data Field: 01 02 03 04 05 06 07 08

Byte 1	Function Byte	(reference SPN 520192)
Byte 2	Action Byte	(reference SPN 520193)
Byte 3-8	Data Bytes	(varies by function) <i>Fill all unused bytes with 0xFF</i>

Control Functions

Data Field: Function 0x15 - Enable Locator Beacon (Power LED flashes)

Byte 1.1	8 bits	Function	0x15
Byte 2.1	8 bits	Action	0xFF
Byte 3.1	8 bits	Service Tool Address	0xF9
Byte 4.1	8 bits	Module Source Address	0xB0
Byte 5.1	32 bits	Security Key	0x77665544

Data Field: Function 0x16 - Disable Locator Beacon

Byte 1.1	8 bits	Function	0x16
Byte 2.1	8 bits	Action	0xFF
Byte 3.1	8 bits	Service Tool Address	0xF9
Byte 4.1	8 bits	Module Source Address	0xB0
Byte 5.1	32 bits	Security Key	0x77665544

All other Control Functions are handled by the XML configuration.

CAN J1939 Configuration

All CAN J1939 Configurations are handled by the XML configuration.

Module Configuration

All Module Configurations are handled by the XML configuration.

APPENDIX: Suspect Parameter Numbers (SPN)

SPN 520192 – Function Byte

Data Field position: Byte 1, 8 bits

Used to define the configuration Function is to perform

Control Functions

0x10	Enter Configuration Mode – Run Mode Suspended, all outputs shut off
0x11	Save Changes and Exit Configuration Mode – Restart in Run Mode
0x12	Reset to Factory Default Settings – Restart in Run Mode
0x13	Cancel Changes and Exit Configuration – Restart in Run Mode
0x14	Configure Power Saving Operation – Not implemented at this time
0x15	Enable Locator Beacon (green power LED will pulse red)
0x16	Disable Locator Beacon

CAN J1939 Configuration

0x20	J1939 Source Address
0x21	J1939 NAME (Identity Number)
0x22	J1939 NAME (Manufacturer Code)
0x23	J1939 NAME (ECU Instance)
0x24	J1939 NAME (Function Instance)
0x25	J1939 NAME (Function)
0x26	J1939 NAME (Reserved)
0x27	J1939 NAME (Vehicle System)
0x28	J1939 NAME (Vehicle System Instance)
0x29	J1939 NAME (Industry Group)
0x2A	J1939 NAME (Arbitrary Address Capable Bit)
0x2B	J1939 NAME (Alternate Address Count)
0x2C	J1939 NAME (Alternate Address List)

Module Configuration

0x30	Input Configuration (Threshold, Hysteresis)
0x31	Output Configuration (Proportional Gain, Integral Gain)
0x32	Output Configuration (Derivative Gain, PWM Frequency)
0x33	Output CAN Receive Timeout (CAN Timeout, Fault State, Driver)
0x34	Input CAN Transmit Rates (PGN, Rate, Offset)

SPN 520193 Action Byte**Data Field position: Byte 2, 8 bits**

Used to define the action the Function is to perform

Tx: As a Command

0x10	Read Operation
0x11	Write Operation
0xFF	Not Applicable

Rx: As a Response

0x12	Read Operation completed successfully
0x13	Write Operation completed successfully
0x14	Operation failed due to incorrect message format
0x15	Operation failed due to unsupported hardware
0x16	Operation failed due to a configuration access error

SPN 520194 Input Type**Data Field position: Byte 4, 8 bits**

Used to define input type. (NOTE: Not all configurations are available for each Input. See Input Configurations)

0x00	Off - Disabled (factory default)
0x05	Digital Active High - Threshold
0x06	Digital Active Low - Threshold
0x09	Analog - 37V Range
0x0C	PWM Active High – 0.0 to 100.0% Duty Cycle
0x0D	PWM Active Low – 0.0 to 100.0% Duty Cycle
0x0E	Frequency – 0 to 10,000 Hz

**Quadrature encoders require a pair of inputs, the next input (INPUTxx +1) will automatically be configured as a quadrature encoder input to complete the pair.*

SPN 520195 Output Type**Data Field position: Byte 4, 8 bits**

Used to define output type. (NOTE: Not all configurations are available for each Output. See Output Configurations)

0x00	Off - Disabled
0x01	Digital Active High (factory default)
0x02	Digital Active Low
0x03	High Side PWM – Closed Loop Current Control
0x04	High Side PWM – Open Loop Duty Cycle Control
0x05	Low Side PWM – Closed Loop Current Control
0x06	Low Side PWM – Open Loop Duty Cycle Control

SPN 520197 16 Bit Input Status**Data Field position: Byte 5, 16 bits (Input N)****Data Field position: Byte 7, 16 bits (Input N+1)**

Input signal conversion method

Analog voltage input configuration:

Range: 0x0000–0xAA2B 0-43563 1mv/bit (0-43,563 mV*)

Frequency input configuration:

Range: 0x0000-0xFFFF 0-65535 0.1 Hz/bit (0-6535.5 Hz*)

PWM duty cycle input configuration:

Range: 0x0000-0x03E8 0-1000 0.1 %/bit (0.0-100.0 %)

range & accuracy limited by hardware capability of ECU*SPN 520200 8-bit Output Data****Data Field position: Byte 5, 8 bits (Output N)****Data Field position: Byte 6, 8 bits (Output N+1)****Data Field position: Byte 7, 8 bits (Output N+2)****Data Field position: Byte 8, 8 bits (Output N+3)**

Used to command duty cycle percentage for outputs configured as open loop PWM type

PWM Duty Cycle

Range: 0x00-0xFA 0-250 0.4% /bit (0.0-100.0 %)

SPN 520201 16-bit Output Data**Data Field position: Byte 5, 16 bits (Output N)****Data Field position: Byte 7, 16 bits (Output N+1)**

Used to command duty cycle percentage for outputs configured as open loop PWM type

Range: 0x0000-0x03E8 0-1000 0.1% /bit (0.0-100.0 % duty cycle)

Used to command current setpoint for outputs configured as closed loop PWM type

Range: 0x0000-0x0BBF, 0-3000 1 mA / bit (0-3000 mA)

SPN 520202 Module Status**Data Field position: Byte 1, 16 bits**

Used to report Module supply voltage

Range: 0x0000-0xAA2B 0-43563 1 mV / bit (0-43,563 mV)

Data Field position: Byte 3, 16 bits

Used to report Module core temperature

Range: 0x0000-0x07D0 0-2000 0.1 °C / bit (0.0-200.0 °C)

Data Field position: Byte 5, 16 bits

Used to report Module System Voltage ADC raw value

Range: 0x0000-0x0FFF 0-4095 1 bit (0-4095 bits)

Note: ADC reading is about 10.63335 mV/bit nominally

Data Field position: Byte 7, 16 bits

Used to report the Module Hardware Identification Number

SPN 520203 8-bit Output Status

Used to indicate output fault status

0x00	No Fault	
0x01	Over Current	(channels 1-4)
0x02	DRV_OTW	(channels 1-4)
0x04	DRV_OTSD	(channels 1-4)
0x08	DRV_PVDD_UV	(channels 1-4)
0x10	DRV_GVDD_UV	(channels 1-4)
0x20	DRV_GVDD_OV	(channels 1-4)
0x40	DRV_FF	(channels 1-4)
0x80	Command Timeout	(channels 1-8)
0xFF	Inactive	

SPN 520209 16 Bit Output Control Setpoint Status

Data Field position: Byte 1, 16 bits (Output 1)

Data Field position: Byte 3, 16 bits (Output 2)

Data Field position: Byte 5, 16 bits (Output 3)

Data Field position: Byte 7, 16 bits (Output 4)

Command current setpoint for outputs configured as closed loop PWM type

Range: 0x0000-0x0BBF 0-3000 1 mA /bit (0-3000 mA)

SPN 520210 16 Bit Output Control Feedback Status

Data Field position: Byte 1, 16 bits (Output 1)

Data Field position: Byte 3, 16 bits (Output 2)

Data Field position: Byte 5, 16 bits (Output 3)

Data Field position: Byte 7, 16 bits (Output 4)

Measured load current setpoint for outputs configured as closed loop PWM type

Range: 0x0000-0x1068 0-4200 1 mA /bit (0-4200 mA)