

LASER RECEIVER

with CANopen®

USER MANUAL

P/N: AX064001

VERSION HISTORY

Version	Date	Author	Modifications
1.0.0	Oct 18, 2021	Antti Keränen	Initial Draft
1.0.0	Oct 18, 2021	Amanda Wilkins	Added technical spec from 12/3/2020
1.0.1	Oct 19, 2021	Antti Keränen	Block diagram, dimensional drawing and firmware reflash instructions updated.
1.0.2	Sep 14, 2023	Kiril Mojsov	Performed Legacy Updates

ACRONYMS

BATT +/-	Battery positive (a.k.a. Vps) or Battery Negative (a.k.a. GND)
DIN	Digital Input used to measure active high or low signals
EMCY	Diagnostic Message (from CANopen® standard)
EA	The Axiomatic Electronic Assistant (A Service Tool for Axiomatic ECUs)
ECU	Electronic Control Unit (from SAE J1939 standard)
GND	Ground reference (a.k.a. BATT-)
RPS	Rotations per Second
UIN	Universal input used to measure voltage, current, frequency or digital inputs
Vps	Voltage Power Supply (a.k.a. BATT+)

Note:

An Axiomatic Electronic Assistant KIT may be ordered as P/N: AX070502, or AX070506K

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REFERENCES

- | | |
|------------|---|
| TDAX064000 | Technical Datasheet, Universal Motor Controller with CAN, Axiomatic Technologies 2020 |
| UMAX07050x | User Manual, Axiomatic Electronic Assistant and USB-CAN, Axiomatic Technologies, 2023 |

1. OVERVIEW OF THE LASER RECEIVER

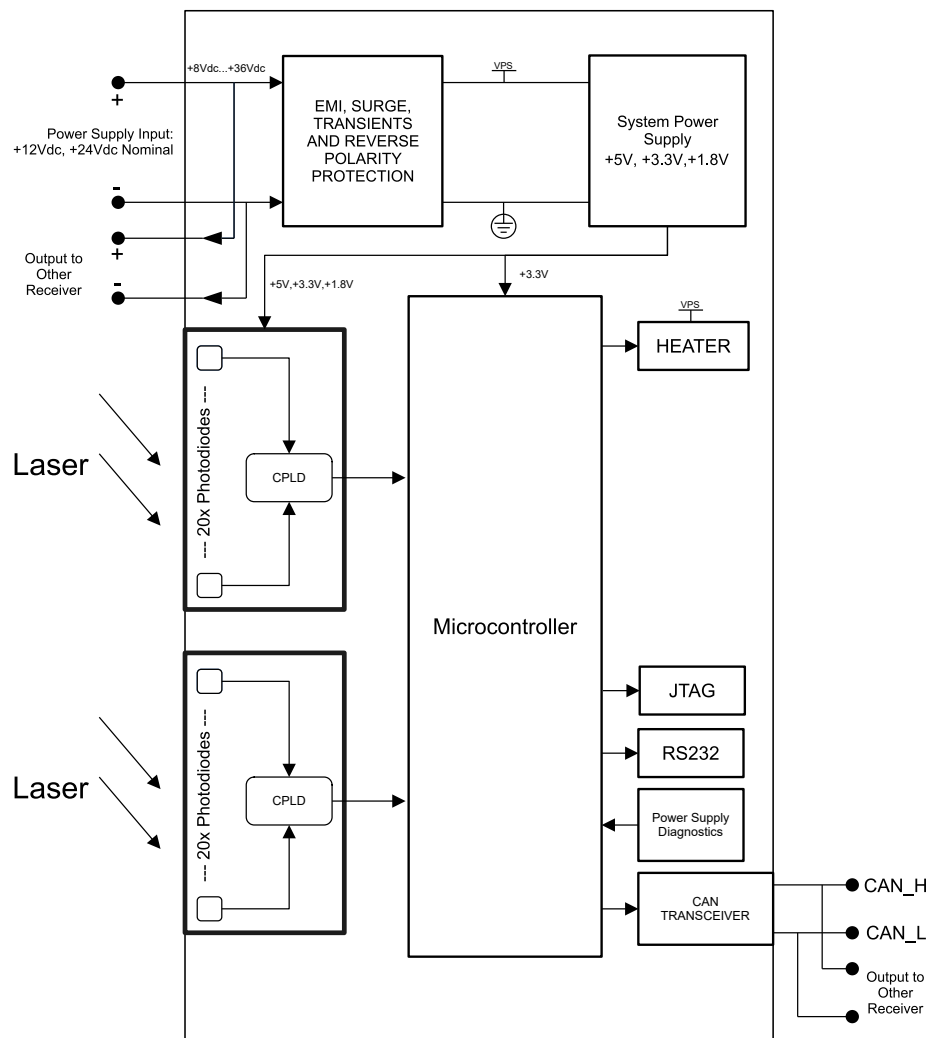


Figure 1 – AX064001 Block Diagram

The Laser Receiver is designed to detect a rotating laser beam and transmit the offset of the detected beam to CAN bus. The Laser Receiver has multiple configuration objects in its CANopen® object dictionary for configuring the detection parameters and the format of data to transmit to the CAN bus.

All CANopen® objects supported by the AX064001 are user configurable using standard commercially available tools that can interact with a CANopen® Object Dictionary via an .EDS file.

1.1. Receiver operation

The Laser receiver is designed to pick up a rotating laser beam. By default the beam detection algorithm filters the detection data from the diode arrays to enhance the resolution and making sure the preferred beam is picked up.

There are various configuration objects available for tuning the operation. The filtering algorithm can be disabled and direct detection based data transmitted using object **300Ah** – *Laser Beam Detection Algorithm Select*. In case the direct detection based transmits is in use, the TPDO #1 transmit events will become dependent of the beam detection.

300Ah – Laser Beam Detection Algorithm Select

Value	Algorithm to use
0	Default filtering algorithm
1	Reserved for future use
2	Direct transmit on receive.

Table 1 – Laser beam detection algorithms

The beam detection filtering algorithm is designed to pick up a rotating beam with rps value defined in **3002h** – *Laser Beam Target RPS*, **3003h** – *Laser Beam Max RPS Error* and **3000h** – *Laser Beam Max RPS*. The rps based detection can be enabled using object **3004h** – *Laser Beam Trace Specific*.

The detection parameters configuration can be done using objects **3006h** – *Laser Beam Autoreset Time*, which defines how long the data is valid in milliseconds and **3007h** – *Laser Beam Detect Threshold Voltage*. The beam detect threshold voltage defines the sensitivity of the receiver. The default value of 50mV is a general setting for most operating environments. Lowering the value will result in increased sensitivity. With increased sensitivity there will be a tradeoff with detection reliability, higher sensitivity can lead into erroneous detection due to other light sources such as sunlight.

The diode arrays also detect the level of ambient light. The object **3009h** – *Laser Beam Saturation Threshold* is used for defining the maximum saturation level before the internal detection gain is switched to lower value allowing detection with higher ambient light conditions, such as excessive sunlight. There is a tradeoff between the gain and detection sensitivity, the default mode of using higher gain yields better sensitivity.

The format of the detected offset level can be configured using object **3008h** – *Laser Beam Offset Polarity*. The laser receiver also contains a built-in heater resistor for enhancing the performance in lower temperatures and higher humidity environments. The heater resistor operation is configurable using object **3100h** – *Heater Settings*, in which subindex 1 defines the low temperature threshold at bootup (in °C) and subindex 2 defines the heater on time in minutes.

The two objects **3005h** – *Laser Beam Trace Multiple* and **3001h** – *Laser Beam Minimum Separation* are reserved for future use. These objects have no implementation in the current receiver firmware.

1.2. Default configuration

By default, the laser receiver transmits the detected beam offset, status and rps values in TPDO #1. The TPDO #3 is also enabled by default, it contains the saturation voltage and gain select info for the two diode arrays.

The TPDOs #1 and #3 have a default transmit interval of 100ms when the laser receiver is in operational mode. In case object **300Ah** – *Laser Beam Detection Algorithm Select* is configured to use direct reception based transmits, the TPDO #1's transmit interval should be configured to 0ms. This is because the TPDO #1 transmit events will be controlled by the reception events and the default timer configuration would yield additional TPDOs on the CAN bus.

1.3. Status information

The received beam offset is reported in object **2200h** – *Laser Beam Offset in Millimeters*. The offset is calculated as defined in object **3008h** – *Laser Beam Offset Polarity*, the options include both ends of the receiver and the middle point of the receiver, data reported with both polarities.

The detected beam status object **2201h** – *Laser Beam Status* contains the info which diode array has detected the beam.

300Ah – *Laser Beam Detection Algorithm* set to 0 (default filtering)

Status index	Possible values	Meaning
1	0 ... 3	0 – no beam(s) detected 1 – beam #1 detected only on array 1 2 – beam #1 detected only on array 2 3 – beam #1 detected on both arrays.
2**	0 ... 3	0 – no beam #2 detected 1 – beam #2 detected only on array 1 2 – beam #2 detected only on array 2 3 – beam #2 detected on both arrays.
3	0	not used in this mode.

** Valid only if **3005h** – *Laser Beam Trace Multiple* is enabled

Table 2 – Laser beam status values

The validity of the detected beam offset data can be determined by monitoring the **2203h** – *Laser Diodes Saturated*. In case the diode arrays have saturated due to excessive ambient light, any detected laser beam offset should be ignored. The current diode voltage created by the ambient light level is reported **2204h** – *Laser Diodes Saturation Threshold*.

The object dictionary also contains some status objects containing lower-level data of the algorithm, such as the **2205h** – *Laser Diodes Gain Select*, **2206h** – *Heater Status* and **2214h** – *DAC Target Voltage*.

The current CPU temperature and detected power supply voltage are reported in **2300h** – *Processor Temperature* and **2301h** – *Power Supply Voltage*. The processor temperature object contains the current CPU temperature in subindex #1 and the CPU temperature at boot up in subindex #2. The Laser Receiver internal temperature and the need for additional heating is determined based on the CPU built-in temperature measurements, and for having more accurate data, the need for additional heating is determined based on the CPU boot-up temperature.

2. INSTALLATION INSTRUCTIONS

2.1. Dimensions and Pinout

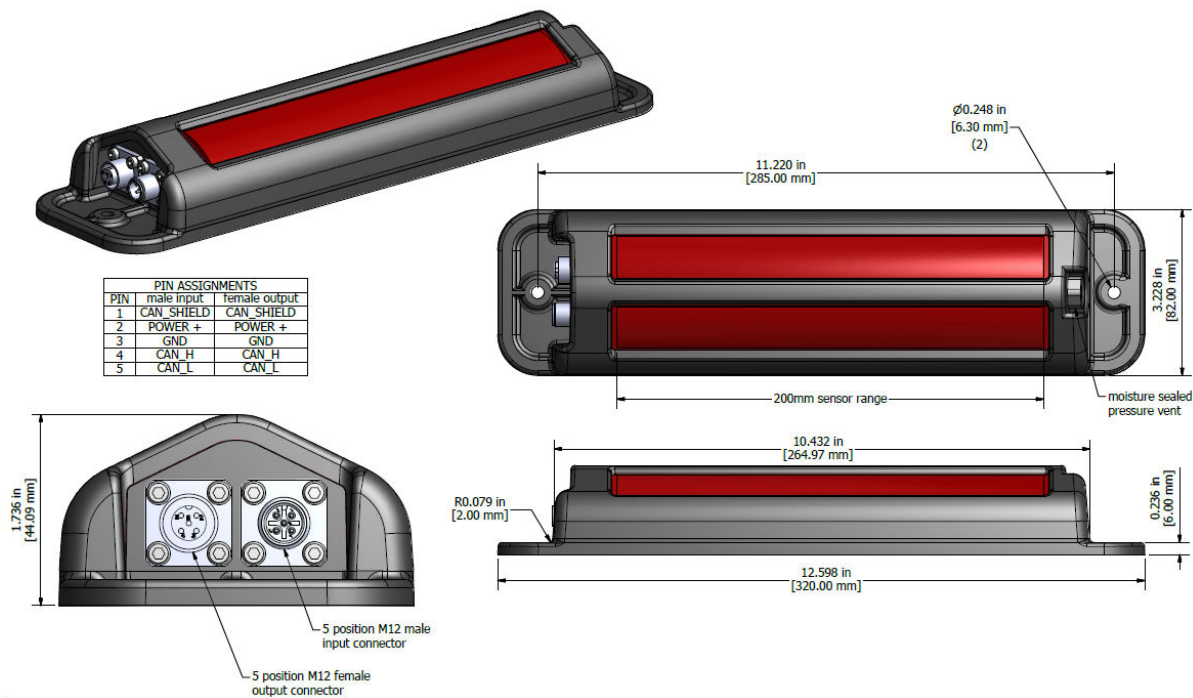


Figure 2 – AX064001 Dimensional Drawing

M12 Male Connector PIN #	Function	M12 Female Connector PIN #	Function
1	CAN Shield	1	CAN Shield
2	Power +	2	Power +
3	GND	3	GND
4	CAN H	4	CAN H
5	CAN L	5	CAN L

Table 3 – AX064001 Connector Pinout

3. CANOPEN® INTERFACE AND OBJECT DICTIONARY

3.1. Node ID and Baud rate

By default, the AX064001 controller ships factory programmed with a

Node ID = 80 (0x50)

and with

Baud rate = 250 kbps.

3.1.1. LSS Protocol to Update

The only means by which the Node-ID and Baud rate can be changed is to use Layer Settling Services (LSS) and protocols as defined by CANopen® standard DS-305.

Follow the steps below to configure either variable using LSS protocol. If required, please refer to the standard for more detailed information about how to use the protocol

3.1.1.1. Setting Node-ID

- Set the module state to LSS-configuration by **sending** the following message:

<i>Item</i>	<i>Value</i>
COB-ID	0x7E5
Length	2
Data 0	0x04 (cs=4 for switch state global)
Data 1	0x01 (switches to configuration state)

- Set the Node-ID by **sending** the following message:

<i>Item</i>	<i>Value</i>
COB-ID	0x7E5
Length	2
Data 0	0x11 (cs=17 for configure node-id)
Data 1	Node-ID (set new Node-ID as a hexadecimal number)

- The module will send the following response (any other response is a failure).

<i>Item</i>	<i>Value</i>
COB-ID	0x7E4
Length	3
Data 0	0x11 (cs=17 for configure node-id)
Data 1	0x00
Data 2	0x00

- Save the configuration by **sending** the following message:

<i>Item</i>	<i>Value</i>
COB-ID	0x7E5
Length	1
Data 0	0x17 (cs=23 for store configuration)

- The module will send the following response (any other response is a failure)

<i>Item</i>	<i>Value</i>
COB-ID	0x7E4
Length	3
Data 0	0x17 (cs=23 for store configuration)
Data 1	0x00
Data 2	0x00

- Set the module state to LSS-operation by **sending** the following message: (Note, the module will reset itself back to the pre-operational state)

<i>Item</i>	<i>Value</i>
COB-ID	0x7E5
Length	2
Data 0	0x04 (cs=4 for switch state global)
Data 1	0x00 (switches to waiting state)

3.1.1.2. Setting Baud rate

- Set the module state to LSS-configuration by sending the following message:

<i>Item</i>	<i>Value</i>
COB-ID	0x7E5
Length	2
Data 0	0x04 (cs=4 for switch state global)
Data 1	0x01 (switches to configuration state)

- Set the baud rate by sending the following message:

<i>Item</i>	<i>Value</i>
COB-ID	0x7E5
Length	3
Data 0	0x13 (cs=19 for configure bit timing parameters)
Data 1	0x00 (switches to waiting state)
Data 2	Index (select baudrate index per Table 32)

Index	Bit Rate
0	1 Mbit/s
1	800 kbit/s
2	500 kbit/s
3	250 kbit/s
4	125 kbit/s (default)
5	reserved (100 kbit/s)
6	50 kbit/s
7	20 kbit/s
8	10 kbit/s

Table 4 – LSS Baud rate Indices

- The module will send the following response (any other response is a failure):

Item	Value
COB-ID	0x7E4
Length	3
Data 0	0x13 (cs=19 for configure bit timing parameters)
Data 1	0x00
Data 2	0x00

- Activate bit timing parameters by sending the following message:

Item	Value
COB-ID	0x7E5
Length	3
Data 0	0x15 (cs=19 for activate bit timing parameters)
Data 1	<delay_lsb>
Data 2	<delay_msb>

The delay individually defines the duration of the two periods of time to wait until the bit timing parameters switch is done (first period) and before transmitting any CAN message with the new bit timing parameters after performing the switch (second period). The time unit of switch delay is 1 ms.

- Save the configuration by sending the following message (on the NEW baud rate):

Item	Value
COB-ID	0x7E5
Length	1
Data 0	0x17 (cs=23 for store configuration)

- The module will send the following response (any other response is a failure):

Item	Value
COB-ID	0x7E4
Length	3
Data 0	0x17 (cs=23 for store configuration)
Data 1	0x00
Data 2	0x00

- Set the module state to LSS-operation by sending the following message: (Note, the module will reset itself back to the pre-operational state)

Item	Value
COB-ID	0x7E5
Length	2
Data 0	0x04 (cs=4 for switch state global)
Data 1	0x00 (switches to waiting state)

The following screen capture (left) shows the CAN data was sent (7E5h) and received (7E4h) by the tool when the baud rate was changed to 250 kbps using the LSS protocol. The other image (right) shows what was printed on an example debug RS-232 menu while the operation took place.

Between CAN Frame 98 and 99, the baud rate on the CAN Scope tool was changed from 125 to 250 kbps.

Net0 | CAN USB331 | 250 - CANscope

File Can Help

Add/Delete ID Area

from to Add > 0x000 <> 0x7FF

Net: 0 - CAN_USB331

Baud rate: 250

☐ IDs decimal ☐ 29 >

Fram...	Absolute Time	RelTime	Id	Atr	L	d1	d2	d3	d4
95	11:42:45.248	6110	07E5		2	04	01		
96	11:42:54.468	9219	07E5		3	13	00	03	
97	11:42:54.468	0	07E4		3	13	00	00	
98	11:42:58.687	4218	07E5		3	15	88	13	
99	11:43:16.579	17891	07E5		1	17			
100	11:43:16.907	328	07E4		3	17	00	00	
101	11:43:23.017	6109	07E5		2	04	00		
102	11:43:23.017	0	0750		1	00			

Send ID: 29-Bit ☐ RTR Len: Data\$:

Fill: 102(10.2%) Bus:ok STARTED

```

===== Main Menu =====
Choose one of the following:
U: View Object Dictionary
D: Default Object Dictionary
T: Toggle RS-232 Stream On/Off
S: Show/Stop Diagnostics
L: Load New Software
M: Main Menu <this>

->Node Id = 80
->Baudrate= 125 [kbps]
CO: PRE-OPERATIONAL
Activating new baud = 250 [kbps]
CO: STOP
Restarting CAN in 5000 [ms]
CO: PRE-OPERATIONAL
Storing ID
Storing Factory Parameters

Storing Baud
Storing Factory Parameters

Storing Communication Parameters

->Node Id = 80
->Baudrate= 250 [kbps]
CO: PRE-OPERATIONAL

```

3.2. Communication Objects (DS-301)

<i>Index (hex)</i>	<i>Object</i>	<i>Object Type</i>	<i>Data Type</i>	<i>Access</i>	<i>PDO Mapping</i>
1000	Device Type	VAR	UNSIGNED32	RO	No
1001	Error Register	VAR	UNSIGNED8	RO	No
1002	Manufacturer Status Register	VAR	UNSIGNED32	RO	No
1003	Pre-Defined Error Field	ARRAY	UNSIGNED32	RO	No
1010	Store Parameters	ARRAY	UNSIGNED32	RW	No
1011	Restore Default Parameters	ARRAY	UNSIGNED32	RW	No
1016	Consumer Heartbeat Time	ARRAY	UNSIGNED32	RW	No
1017	Producer Heartbeat Time	VAR	UNSIGNED16	RW	No
1018	Identity Object	RECORD		RO	No
1020	Verify Configuration	ARRAY	UNSIGNED32	RO	No
1029	Error Behavior	ARRAY	UNSIGNED8	RW	No
1400	RPDO1 Communication Parameter	RECORD		RW	No
1401	RPDO2 Communication Parameter	RECORD		RW	No
1402	RPDO3 Communication Parameter	RECORD		RW	No
1403	RPDO4 Communication Parameter	RECORD		RW	No
1600	RPDO1 Mapping Parameter	RECORD		RO	No
1601	RPDO2 Mapping Parameter	RECORD		RO	No
1602	RPDO3 Mapping Parameter	RECORD		RO	No
1603	RPDO4 Mapping Parameter	RECORD		RO	No
1800	TPDO1 Communication Parameter	RECORD		RW	No
1801	TPDO2 Communication Parameter	RECORD		RW	No
1802	TPDO3 Communication Parameter	RECORD		RW	No
1803	TPDO4 Communication Parameter	RECORD		RW	No
1A00	TPDO1 Mapping Parameter	RECORD		RW	No
1A01	TPDO2 Mapping Parameter	RECORD		RW	No
1A02	TPDO3 Mapping Parameter	RECORD		RW	No
1A03	TPDO4 Mapping Parameter	RECORD		RW	No

3.2.1. 1000h Device Type

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1000	0	UINT32	RO	No	0x0	0x0	Laser receiver

3.2.2. 1001h Error Register

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1001	0	UINT8	RO	No	0, 1	0	Error register

3.2.3. 1002h Manufacturer Status Object

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1002	0	UINT32	RO	No	UINT32	0	Manufacturer debug information

3.2.4. 1003h Pre-Defined Error Field

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1003	0	UINT8	RW	No	15	15	Number of subindexes / reset error codes
	1	UINT32	RO		UINT32	0	EMCY error code #1
	2						EMCY error code #2
	3						EMCY error code #3
	4						EMCY error code #4
	5						EMCY error code #5
	6						EMCY error code #6
	7						EMCY error code #7
	8						EMCY error code #8
	9						EMCY error code #9
	10						EMCY error code #10
	11						EMCY error code #11
	12						EMCY error code #12
	13						EMCY error code #13
	14						EMCY error code #14
	15						EMCY error code #15

3.2.5. 1010h Store Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1010	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		save	1	Write 0x65766173 ('e', 'v', 'a', 's') for storing ALL parameters
	2						Write 0x65766173 ('e', 'v', 'a', 's') for storing Communication parameters
	3						Write 0x65766173 ('e', 'v', 'a', 's') for storing Application parameters
	4						Write 0x65766173 ('e', 'v', 'a', 's') for storing Manufacturer parameters

3.2.6. 1011h Restore Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1011	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		load	1	Write 0x4616F6C ('d', 'a', 'o', 'l') for restoring ALL parameters
	2						Write 0x4616F6C ('d', 'a', 'o', 'l') for restoring Communication parameters
	3						Write 0x4616F6C ('d', 'a', 'o', 'l') for restoring Application parameters
	4						Write 0x4616F6C ('d', 'a', 'o', 'l') for restoring Manufacturer parameters

3.2.7. 1016h Consumer Heartbeat Time

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1016	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		UINT32	0	Consumer heartbeat time bits 31-24: reserved bits 23-16: Node ID bits 15-0: heartbeat time in milliseconds
	2						
	3						
	4						

3.2.8. 1017h Producer Heartbeat Time

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1017	0	UINT16	RW	No	10-65000	0	Producer heartbeat time in milliseconds

3.2.9. 1018h Identity Object

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1018	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32			UINT32	0x55	Vendor ID (Axiomatic Technologies)
	2					0xAA064001	Product Code
	3						Revision Number
	4						Serial Number

3.2.10. 1020h Verify Configuration

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1020	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32			UINT32		Configuration date: DD-MM-YYYY
	2					Configuration time: HH-MM	

3.2.11. 1029h Error Behavior

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1029	0	UINT8	RO	No	6	4	Number of subindexes
	1		RW		0-2	1 (no change)	State transition on Comm. fault
	2		State transition on DI fault				

3.2.12. 1400h RPDO 1 Communication Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1400	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		UINT32	0x4000027F	COB-ID
	2	UINT8			UINT8	0xFF	Transmission type
	3	UINT16			UINT16	0	Inhibit time
	4	UINT8			UINT8	0	Compatibility entry
	5	UINT16			UINT16	0	Event timer

3.2.13. 1401h RPDO 2 Communication Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1401	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		UINT32	0x4000037F	COB-ID
	2	UINT8			UINT8	0xFF	Transmission type
	3	UINT16			UINT16	0	Inhibit time
	4	UINT8			UINT8	0	Compatibility entry
	5	UINT16			UINT16	0	Event timer

3.2.14. 1402h RPDO 3 Communication Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1402	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		UINT32	0xC000047F	COB-ID
	2	UINT8			UINT8	0xFF	Transmission type
	3	UINT16			UINT16	0	Inhibit time
	4	UINT8			UINT8	0	Compatibility entry
	5	UINT16			UINT16	0	Event timer

3.2.15. 1403h RPDO 4 Communication Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1403	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		UINT32	0xC000057F	COB-ID
	2	UINT8			UINT8	0xFF	Transmission type
	3	UINT16			UINT16	0	Inhibit time
	4	UINT8			UINT8	0	Compatibility entry
	5	UINT16			UINT16	0	Event timer

3.2.16. 1600h RPDO 1 Mapping Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1600	0	UINT8	RW	No	0-4	2	Number of subindexes
	1	UINT32			UINT32	0x607E0008	Polarity
	2					0x60FF0020	Target velocity
	3					0	Not used by default
	4					0	Not used by default

3.2.17. 1601h RPDO 2 Mapping Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1601	0	UINT8	RW	No	0-4	4	Number of subindexes
	1	UINT32			UINT32	0x25000110	EC Extra Received PV Value 1
	2					0x25000210	EC Extra Received PV Value 2
	3					0x25000310	EC Extra Received PV Value 3
	4					0x25000410	EC Extra Received PV Value 4

3.2.18. 1602h RPDO 3 Mapping Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1602	0	UINT8	RW	No	0-4	0	Number of subindexes
	1	UINT32			UINT32	0	Not used by default
	2					0	Not used by default
	3					0	Not used by default
	4					0	Not used by default

3.2.19. 1603h RPDO 4 Mapping Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1603	0	UINT8	RW	No	0-4	0	Number of subindexes
	1	UINT32			UINT32	0	Not used by default
	2					0	Not used by default
	3					0	Not used by default
	4					0	Not used by default

3.2.20. 1800h TPDO 1 Communication Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1800	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		UINT32	0x400001FF	COB-ID
	2	UINT8			UINT8	0xFE	Transmission type
	3	UINT16			UINT16	0	Inhibit time
	4	UINT8			UINT8	0	Compatibility entry
	5	UINT16			UINT16	0x64	Event timer

3.2.21. 1801h TPDO 2 Communication Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1801	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		UINT32	0x400002FF	COB-ID
	2	UINT8			UINT8	0xFE	Transmission type
	3	UINT16			UINT16	0	Inhibit time
	4	UINT8			UINT8	0	Compatibility entry
	5	UINT16			UINT16	0x64	Event timer

3.2.22. 1802h TPDO 3 Communication Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1802	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		UINT32	0x400003FF	COB-ID
	2	UINT8			UINT8	0xFE	Transmission type
	3	UINT16			UINT16	0	Inhibit time
	4	UINT8			UINT8	0	Compatibility entry
	5	UINT16			UINT16	0	Event timer

3.2.23. 1803h TPDO 4 Communication Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1803	0	UINT8	RO	No	4	4	Number of subindexes
	1	UINT32	RW		UINT32	0xC00004FF	COB-ID
	2	UINT8			UINT8	0xFE	Transmission type
	3	UINT16			UINT16	0	Inhibit time
	4	UINT8			UINT8	0	Compatibility entry
	5	UINT16			UINT16	0	Event timer

3.2.24. 1A00h TPDO 1 Mapping Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1A00	0	UINT8	RW	No	0-4	4	Number of subindexes
	1	UINT32			UINT32	0x71000110	Universal Input #1 FV
	2					0x71000210	Universal Input #2 FV
	3					0x71000310	Universal Input #3 FV
	4					0x71000410	Universal Input #4 FV

3.2.25. 1A01h TPDO 2 Mapping Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1A01	0	UINT8	RW	No	0-4	2	Number of subindexes
	1	UINT32			UINT32	0x60410010	PDS FSA Status Word
	2					0x606C0020	Velocity Actual Value
	3					0	Not used by default
	4					0	Not used by default

3.2.26. 1A02h TPDO 3 Mapping Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1A02	0	UINT8	RW	No	0-4	2	Number of subindexes
	1	UINT32			UINT32	0x50200020	Processor Temperature Field Value
	2					0x50300020	Power Supply Field Value
	3					0	Not used by default
	4					0	Not used by default

3.2.27. 1A03h TPDO 4 Mapping Parameters

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
1A03	0	UINT8	RW	No	0-4	0	Number of subindexes
	1	UINT32			UINT32	0	Not used by default
	2					0	Not used by default
	3					0	Not used by default
	4					0	Not used by default

3.3. Manufacturer Objects

Index (hex)	Object	Object Type	Data Type	Access	PDO Mapping
2000	RX Data 1	ARRAY	UNSIGNED32	RW	Yes
2001	RX Data 2	ARRAY	UNSIGNED32	RW	Yes
2002	RX Data 3	ARRAY	UNSIGNED32	RW	Yes
2003	RX Data 4	ARRAY	UNSIGNED32	RW	Yes
2100	TX Data 1	ARRAY	UNSIGNED32	RW	Yes
2101	TX Data 2	ARRAY	UNSIGNED32	RW	Yes
2102	TX Data 3	ARRAY	UNSIGNED32	RW	Yes
2103	TX Data 4	ARRAY	UNSIGNED32	RW	Yes
2200	Laser Beam Offset in mm	ARRAY	INTEGER16	RO	No
2201	Laser Beam Status	ARRAY	UNSIGNED8	RO	No
2202	Laser Beam RPS	ARRAY	UNSIGNED8	RO	No
2203	Laser Diodes Saturated	ARRAY	UNSIGNED8	RO	No
2204	Laser Diode Saturation Voltage	ARRAY	UNSIGNED16	RO	No
2205	Laser Diode Gain Select	ARRAY	UNSIGNED8	RO	No
2206	Heater Status	VAR	UNSIGNED8	RO	No
2214	DAC Target Voltage	ARRAY	UNSIGNED16	RO	No
2300	Processor temperature	VAR	FLOAT32	RO	Yes
2301	Power supply voltage	VAR	FLOAT32	RO	Yes
3000	Laser Beam Max RPS	VAR	UNSIGNED16	RW	No
3001	Laser Beam Minimum Separation	VAR	UNSIGNED16	RW	No
3002	Laser Beam Target RPS	VAR	UNSIGNED16	RW	No
3003	Laser Beam Max RPS Error	VAR	UNSIGNED16	RW	No
3004	Trace Specific Laser Beam	VAR	UNSIGNED16	RW	No
3005	Trace Multiple Laser Beams	VAR	UNSIGNED16	RW	No
3006	Laser Beam Autoreset Time	VAR	UNSIGNED16	RW	No
3007	Laser Beam Detect Threshold Voltage	VAR	UNSIGNED16	RW	No
3008	Laser Beam Offset Polarity	VAR	UNSIGNED8	RW	No
3009	Laser Beam Saturation Threshold	VAR	UNSIGNED16	RW	No
300A	Laser Beam Detection Algorithm Sel.	VAR	UNSIGNED8	RW	No
300B	Override Gain Select	ARRAY	UNSIGNED8	RW	Yes
3100	Heater Settings	ARRAY	INTEGER16	RW	No
5555	Start in Operational Mode	VAR	BOOLEAN	RW	No
5556	Start in Operational NMT Delay	VAR	UNSIGNED16	RW	No
5B50	Set Baudrate	VAR	UNSIGNED16	RW	No
5B51	Set NodeID	VAR	UNSIGNED8	RW	No

3.3.1. 2000h RX Data 1

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2000	0	UINT8	RO	No	4	4	Number of subindexes
	1...4	UINT32	RW	Yes	UINT32	0	RX Data

3.3.2. 2001h RX Data 2

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2001	0	UINT8	RO	No	4	4	Number of subindexes
	1...4	UINT32	RW	Yes	UINT32	0	RX Data

3.3.3. 2002h RX Data 3

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2002	0	UINT8	RO	No	4	4	Number of subindexes
	1...4	UINT32	RW	Yes	UINT32	0	RX Data

3.3.4. 2003h RX Data 4

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2003	0	UINT8	RO	No	4	4	Number of subindexes
	1...4	UINT32	RW	Yes	UINT32	0	RX Data

3.3.5. 2100h TX Data 1

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2100	0	UINT8	RO	No	4	4	Number of subindexes
	1...4	UINT32	RW	Yes	UINT32	0	TX Data

3.3.6. 2100h TX Data 2

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2101	0	UINT8	RO	No	4	4	Number of subindexes
	1...4	UINT32	RW	Yes	UINT32	0	TX Data

3.3.7. 2102h TX Data 3

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2102	0	UINT8	RO	No	4	4	Number of subindexes
	1...4	UINT32	RW	Yes	UINT32	0	TX Data

3.3.8. 2103h TX Data 4

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2103	0	UINT8	RO	No	4	4	Number of subindexes
	1...4	UINT32	RW	Yes	UINT32	0	TX Data

3.3.9. 2200h Laser Beam Offset in mm

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2200	0	UINT8	RO	No	2	2	Number of subindexes
	1...2	INT16		Yes	INT16	0	Laser beam #x offset in mm

3.3.10. 2201h Laser Beam Status

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2201	0	UINT8	RO	No	2	2	Number of subindexes
	1...2			Yes	0 ... 3	0	Laser beam #x status

3.3.11. 2202h Laser Beam RPS

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2202	0	UINT8	RO	No	2	2	Number of subindexes
	1...2			Yes	UINT8	0	Laser beam #x rps

3.3.12. 2203h Laser Diodes Saturated

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2203	0	UINT8	RO	No	2	2	Number of subindexes
	1...2			Yes	0, 1	0	Laser diodes saturated in diode array #x

3.3.13. 2204h Laser Diode Saturation Voltage

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2204	0	UINT8	RO	No	2	2	Number of subindexes
	1...2	UINT16		Yes	UINT16	0	Laser diode saturation voltage in array #x

3.3.14. 2205h Laser Diode Gain Select

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2205	0	UINT8	RO	No	2	2	Number of subindexes
	1...2			Yes	0, 1	0	Laser diode gain select in array #x

3.3.15. 2206h Heater Status

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2206	0	UINT16	RO	Yes	UINT8	0	Heater resistor status

3.3.16. 2214h DAC Target Voltage

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2214	0	UINT8	RO	No	2	2	Number of subindexes
	1...2	UINT16		Yes	UINT16	0	DAC target voltage for array #x

3.3.17. 2300h CPU Temperature

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2300	0	UINT8	RO	No	2	2	Number of subindexes
	1	FLOAT32		Yes	-40...150	0	CPU Temperature
	2			CPU Temperature at boot up			

3.3.18. 2301h Power Supply Voltage

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
2301	0	FLOAT32	RO	Yes	VPS	0	Measured VPS

3.3.19. 3000h Laser Beam Max RPS

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3000	0	UINT8	RO	No	2	2	Number of subindexes
	1...2	UINT16	RW		0-4095	20	Max RPS for laser beam #x

3.3.20. 3001h Laser Beam Minimum Separation

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3001	0	UINT8	RO	No	2	2	Number of subindexes
	1...2	UINT16	RW		UINT16	5	Minimum separation for laser beam #x

3.3.21. 3002h Laser Beam Target RPS

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3002	0	UINT8	RO	No	2	2	Number of subindexes
	1...2		RW		UINT8	10	Preferred RPS for laser beam #x

3.3.22. 3003h Laser Beam Max RPS Error

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3003	0	UINT8	RO	No	2	2	Number of subindexes
	1...2		RW		UINT8	1	Maximum RPS error for laser beam #x

3.3.23. 3004h Laser Beam Trace Specific

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3004	0	UINT8	RW	No	0, 1	0	Trace specific laser beam

3.3.24. 3005h Laser Beam Trace Multiple

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3005	0	UINT8	RW	No	0, 1	0	Trace multiple laser beams

3.3.25. 3006h Laser Beam Autoreset Time

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3006	0	UINT16	RW	No	UINT16	200	Laser detection autoreset time in milliseconds

3.3.26. 3007h Laser Beam Detect Threshold Voltage

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3007	0	UINT16	RW	No	0...4095	50	Laser detection threshold voltage in millivolts

3.3.27. 3008h Laser Beam Offset Polarity

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3008	0	UINT8	RW	No	0...3	0	Laser beam detection offset polarity 0 – zero at bottom 1 – zero at top 2 – zero in the middle, positive 3 – zero in the middle, negative

3.3.28. 3009h Laser Diode Saturation Threshold

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3009	0	UINT16	RW	No	0...5000	4500	Laser detection saturation threshold voltage in millivolts

3.3.29. 300Ah Laser Beam Detection Algorithm Select

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
300A	0	UINT8	RW	No	0...2	0	Laser detection algorithm select 0 – Default algorithm 1 – <i>Reserved for future use</i> 2 – Transmit at reception (unfiltered)

3.3.30. 300Bh Override Gain Select

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
300B	0	UINT8	RO	No	2	2	Number of subindexes
	1...2		RW	Yes	0, 1, 255	255	Override gain select 0 – low gain 1 – high gain 255 – automatic gain detection

3.3.31. 3100h Heater Settings

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
3100	0	UINT8	RO	No	2	2	Number of subindexes
	1	INT16	RW		-40 ... 150	10	Heater on threshold temperature at bootup in degrees Celsius
	2				0 ... 10080	5	Heater on duration in minutes

3.3.32. 5555h Start In Operational Mode

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
5555	0	UINT8	RW	No	0-3	0	0 – No action, wait NMT commands 1 – Start directly in operational mode 2 – Start in operational mode and send NMT for starting also other devices 3 – Start in operational mode and set PDS FSA to Enabled Mode.

3.3.33. 5556h Start In Operational Mode NMT Delay

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
5556	0	UINT16	RW	No	0-65000	1000	Delay in milliseconds before sending the NMT message in case object 5555h is set to '2'.

3.3.34. 5B50h Set Baudrate

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
5B50	0	UINT16	RW	No	enum	250	Shows current CAN baud rate, sets a new one on write (enum values accepted, see Table 4)

3.3.35. 5B51h Set Node ID

Index	Subindex	Data Type	Access	PDO Mapping	Value Range	Default Value	Description
5B51	0	UINT8	RW	No	1-127	80	Shows current node ID, sets a new one on write

4. FIRMWARE REFLASHING INSTRUCTIONS



WARNING! The firmware reflashing can be carried out **only** using Axiomatic Technologies' **Electronic Assistant KIT, AX070502/AX070506K** and **250k CAN baud rate**.

DO NOT START THE BOOTLOADER WITHOUT THE KIT!

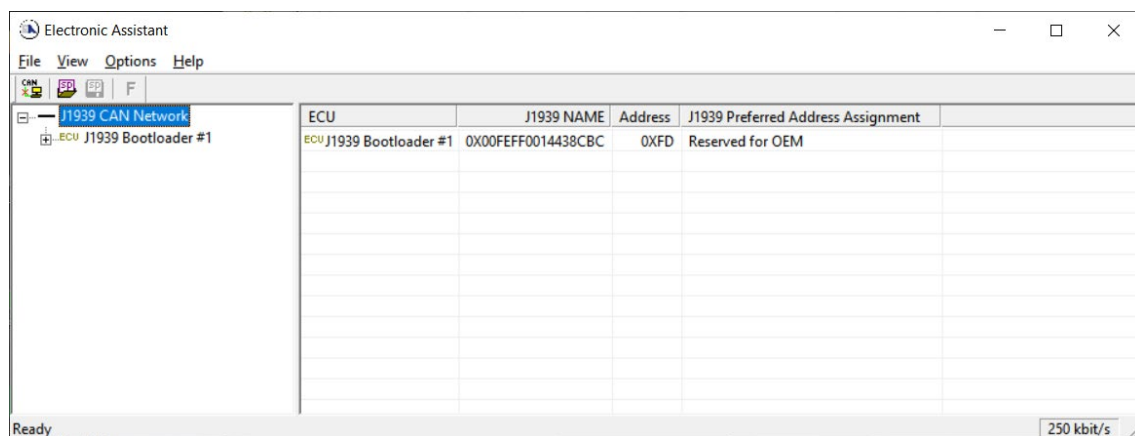
The Axiomatic Electronic Assistant compatible J1939 bootloader can be started by writing '1' to subindex 0 of the object 55AAh:

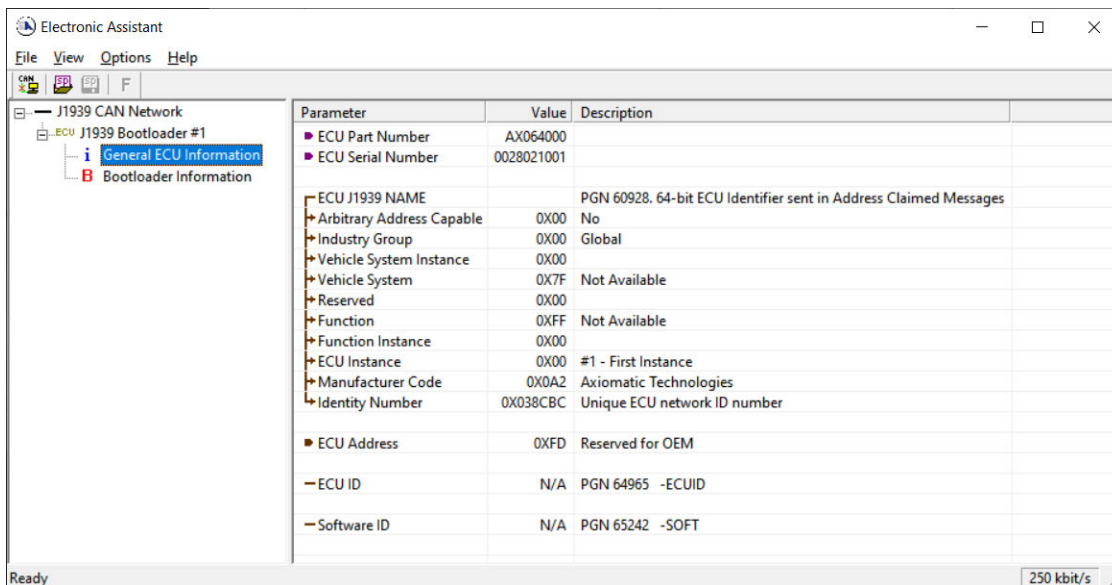
1. To do so, the object 55AAh can be accessed using CANopen® tools or by sending the following SDO write message using CAN Assistant – Scope (assuming default node id of 0x7F):

ID	Len	D0	D1	D2	D3	D4	D5	D6	D7
67F	8	2F	AA	55	00	01	00	00	00

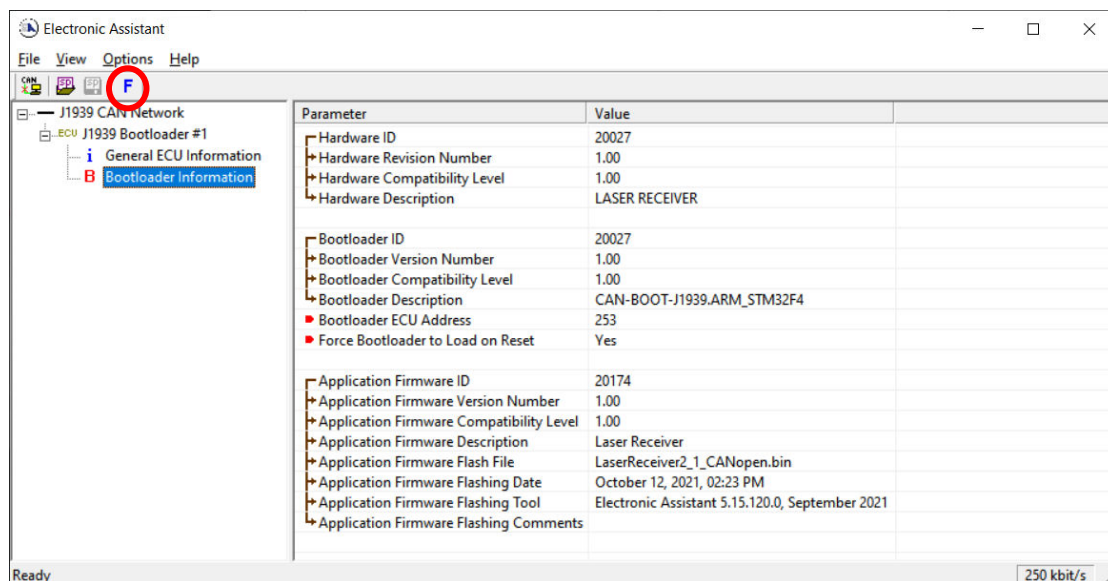
If everything is correct, the controller acknowledges the writing operation and activates software reset after the message is sent.

2. Run the Axiomatic Electronic Assistant (EA) software and connect to the CAN port. **The CAN baud rate needs to be changed to 250k because the bootloader and the Axiomatic EA use J1939 messaging.** The user should see the following screen:





Note that the bootloader is NOT Arbitrary Address Capable. This means that if you want to have multiple bootloaders running simultaneously (not recommended) you would have to manually change the address for each one before activating the next, or there will be address conflicts. And only one ECU would show up as the bootloader. Once the 'active' bootloader returns to regular functionality, the other ECU(s) would have to be power cycled to re-activate the bootloader feature.



3. Select the **F**lashing button and navigate to where you had saved the **AF-20174-x.xx.bin** (or equivalent) file sent from Axiomatic. (Note: only binary (.bin) files can be flashed using the Axiomatic EA tool.)
4. Once the Flash Application Firmware window opens, you can enter comments such as "Firmware upgraded by [Name]" if you so desire. This is not required, and you can leave the field blank if you do not want to use it.

Note: You do not have to date/time-stamp the file, as this is done automatically by the Axiomatic EA tool when you upload the new firmware.

Flash Application Firmware

Flash File Name: AF-20174-1.00.bin

Flashing Comments:
Press CTRL +ENTER to add a new string

Erase All ECU Flash Memory ☒

Flashing Status
Idle

Flash ECU

Cancel Flashing

Exit



NOTE: It is good practice to tick the “Erase All ECU Flash Memory” box. Please note, that selecting this option will **erase ALL data stored in non-volatile flash**. It will also erase any configuration of the setpoints that might have been done to the ECU and reset all setpoints to their factory defaults. In case the controller contains custom settings, those settings need to be saved to PC before reflashing.

A progress bar will show how much of the firmware has been sent as the upload progresses. The more traffic there is on the J1939 network, the longer the upload process will take.

Flash Application Firmware

Flash File Name: AF-20174-1.00.bin

Flashing Comments:
Press CTRL +ENTER to add a new string

Erase All ECU Flash Memory ☒

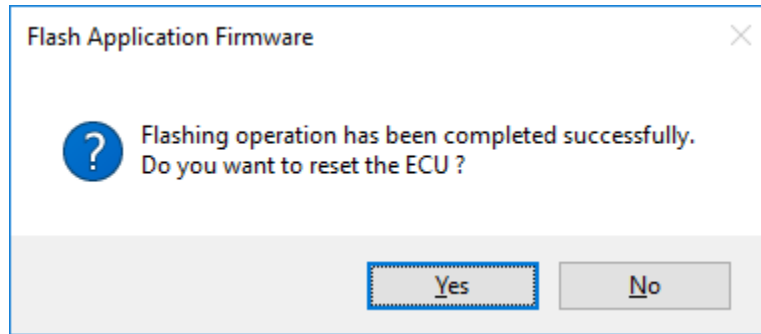
Flashing Status
Flashing Memory...

Flash ECU

Cancel Flashing

Exit

Once the firmware has finished uploading, a message will pop up indicating the successful operation. If you select to reset the ECU, the new version of the AX064001 application will start running, and the ECU will switch back to CANopen communications. Otherwise, the next time the ECU is power-cycled, the AX064001 application will run rather than the bootloader function.



Note: If at any time during the upload the process is interrupted, the data is corrupted (bad checksum) or for any other reason the new firmware is not correct, i.e. bootloader detects that the file loaded was not designed to run on the hardware platform, the bad or corrupted application will not run. Rather, when the ECU is reset or power-cycled the **J1939 Bootloader** will continue to be the default application until valid firmware has been successfully uploaded into the unit.

APPENDIX A - TECHNICAL SPECIFICATION

Technical Specifications:

Specifications are indicative and subject to change. Actual performance will vary depending on the application and operating conditions. Users should satisfy themselves that the product is suitable for use in the intended application. All our products carry a limited warranty against defects in material and workmanship. Please refer to our Warranty, Application Approvals/Limitations and Return Materials Process as described on <https://www.axiomatic.com/service/>.

All specifications are typical at nominal input voltage and 25 degrees C unless otherwise specified.

Power Input	8...36Vdc (12V or 24V nominal)
CAN Port	CANopen®
Interface with laser beam	160 degree beam detection 190 mm (7.5 in.) beam detection height range Detects rotational lasers with rotation speed between 2-20 RPS. Detects rotational lasers within 630 nm – 850 nm and 1m – 150 m Reports RPS of received laser beam Resolution is 2.3 mm. Precision 3 mm (0.1 in.)
User Interface	The Axiomatic Electronic Assistant, P/Ns: AX070502 or AX070506K for SAE J1939 model and to flash new firmware. EDS file for CANopen® model AX064001
Approvals	CE marking
Enclosure	Plexiglass Refer to the dimensional drawing.
Electrical Pinout	2 5-pin M12 connectors
Protection	IP69K
Vibration	MIL-STD-202G, Test 204D and 214A (Sine and Random) 10 g peak (Sine); 7.86 Grms peak (Random)
Shock	MIL-STD-202G, Test 213B; 50 g
Weight	1.00 lb. (0.453 kg)
Temperature Rating	Operating: -40 to 85°C (-40 to 185°F) Storage: -50 to 90°C (-58 to 194°F)

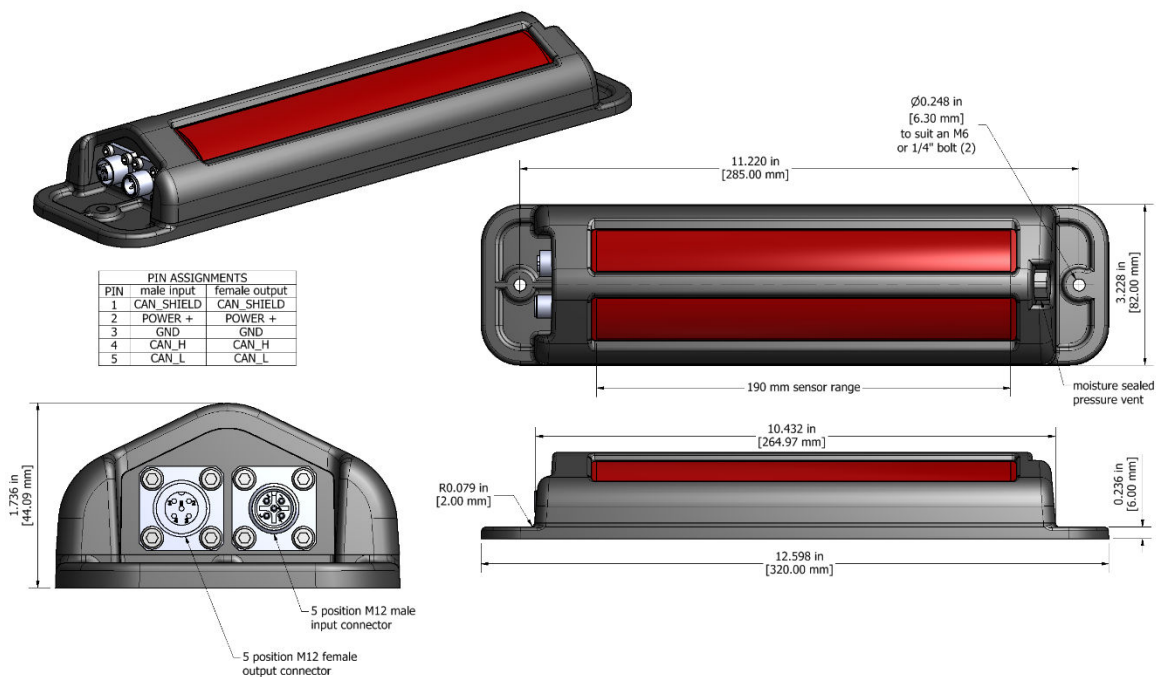


Figure 1.0 – Dimensional Drawing

NOTE: CANopen® is a registered community trademark of CAN in Automation e.V.

OUR PRODUCTS

AC/DC Power Supplies
Actuator Controls/Interfaces
Automotive Ethernet Interfaces
Battery Chargers
CAN Controls, Routers, Repeaters
CAN/WiFi, CAN/Bluetooth, Routers
Current/Voltage/PWM Converters
DC/DC Power Converters
Engine Temperature Scanners
Ethernet/CAN Converters,
Gateways, Switches
Fan Drive Controllers
Gateways, CAN/Modbus, RS-232
Gyroscopes, Inclinometers
Hydraulic Valve Controllers
Inclinometers, Triaxial
I/O Controls
LVDT Signal Converters
Machine Controls
Modbus, RS-422, RS-485 Controls
Motor Controls, Inverters
Power Supplies, DC/DC, AC/DC
PWM Signal Converters/Isolators
Resolver Signal Conditioners
Service Tools
Signal Conditioners, Converters
Strain Gauge CAN Controls
Surge Suppressors

OUR COMPANY

Axiomatic provides electronic machine control components to the off-highway, commercial vehicle, electric vehicle, power generator set, material handling, renewable energy and industrial OEM markets. ***We innovate with engineered and off-the-shelf machine controls that add value for our customers.***

QUALITY DESIGN AND MANUFACTURING

We have an ISO9001:2015 registered design/manufacturing facility in Canada.

WARRANTY, APPLICATION APPROVALS/LIMITATIONS

Axiomatic Technologies Corporation reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. Users should satisfy themselves that the product is suitable for use in the intended application. All our products carry a limited warranty against defects in material and workmanship. Please refer to our Warranty, Application Approvals/Limitations and Return Materials Process at <https://www.axiomatic.com/service/>.

COMPLIANCE

Product compliance details can be found in the product literature and/or on axiomatic.com. Any inquiries should be sent to sales@axiomatic.com.

SAFE USE

All products should be serviced by Axiomatic. Do not open the product and perform the service yourself.



This product can expose you to chemicals which are known in the State of California, USA to cause cancer and reproductive harm. For more information go to www.P65Warnings.ca.gov.

SERVICE

All products to be returned to Axiomatic require a Return Materials Authorization Number (RMA#) from sales@axiomatic.com. Please provide the following information when requesting an RMA number:

- Serial number, part number
- Runtime hours, description of problem
- Wiring set up diagram, application and other comments as needed

DISPOSAL

Axiomatic products are electronic waste. Please follow your local environmental waste and recycling laws, regulations and policies for safe disposal or recycling of electronic waste.

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