
E-Solution Line

Software CAN protocol

ESAGV4860



Release Date: 22-02-23

Table of Contents

General Information	5
Overview	5
Scope.....	5
Acronyms	5
Reference Documents	5
CANopen	6
Overview	6
CANopen Network Management (NMT)	7
NMT Node Control Protocol.....	7
CANopen Broadcast Messages (TPDO)	8
Transmit Process Data Object 1 (TPDO1)	8
Transmit Process Data Object 2 (TPDO2)	9
Transmit Process Data Object 3 (TPDO3)	10
Transmit Process Data Object 4 (TPDO4)	11
Transmit Process Data Object 5 (TPDO5)	13
Transmit Process Data Object 6 (TPDO6)	14
CANopen Request Messages (SDO)	15
Service Data Object (SDO): Read Request	15
Service Data Object (SDO): Read Response	15
Service Data Object (SDO): Write Request.....	16
Service Data Object (SDO): Write Response	16
Service Data Object (SDO): Abort Response	17
CANopen Object Dictionary	18
Update Node ID and CAN Bit Timing	21
Switch State Global Service	21
Configure Node ID Request.....	22
Configure Node ID Response	22
Configure CAN Bit Timing Request	22
Configure CAN Bit Timing Response.....	22
Activate Bit Timing Request.....	23

Store Configuration Request.....	23
Store Configuration Response	23
Layer Setting Services (LSS).....	24
Emergency Object.....	25

General Information

Overview

The purpose of this document is to detail the CANopen communication interface for the ESAGV4860 battery.

Scope

The scope of this document specifies the controller area network (CAN) interface of the ESAGV4860 BMS to other devices on the CAN network.

Acronyms

CAN – Controller Area Network
BMS – Battery Management System
MSB – Most Significant Byte
LSB – Least Significant Byte
TPDO – Transmit Process Data Object
SDO – Service Data Object

Reference Documents

CiA. (21 February 2011). *CiA 301 CANopen application layer and communication profile* (Version 4.2.0) [PDF file]. Retrieved from <https://www.can-cia.org/groups/specifications/>

CiA. (8 May 2013). *CiA 305 Layer setting services (LSS) and protocols* (Version 3.0.0) [PDF file]. Retrieved from <https://www.can-cia.org/groups/specifications/>

CiA. (27 April 2012). *CiA 418 CANopen device profile for battery modules* (Version 1.2.0) [PDF file]. Retrieved from <https://www.can-cia.org/groups/specifications/>

CANopen

Overview

CANopen is a CAN-based protocol that was originally created for embedded systems used in automation however this protocol is used widely today in other applications as such as medical equipment and off-road vehicles.

The protocol consists of several different objects which are essentially different messages on the CAN bus. One type of messages is a transmit process data object (TPDO) which is a message that is cyclically put onto the CAN bus without having to request it. The specific TPDO messages that have been implemented on the ESAGV4860 battery are TPDO1 through TPDO6. Each TPDO contains unique information about the battery pack which is detailed in the following sections. Each battery pack on the CAN bus uses a unique CAN ID to transmit this information. This CAN ID can be calculated by adding the TPDO base address to the node ID of the battery pack. ESAGV4860 battery packs use node IDs between the range of 0x31-0x3A inclusive. The master battery pack will always have the node ID of 0x31. Below is the base address of each TPDO message. So, the master battery pack would use a CAN ID of $0x180+0x01 = 0x181$ to transmit TPDO1.

TPDO	Base Address
TPDO1	0x180
TPDO2	0x280
TPDO3	0x380
TPDO4	0x480
TPDO5	0x190
TPDO6	0x290

The protocol also provides a method for requesting or modifying specific pieces of information from a specific battery pack. These messages are called service data objects (SDO).

Note: To translate the received value into an actual physical value, first the bytes need to be combined. In many cases, the value is represented by a 16-bit (2 byte) value, so those values need to be combined to form the total value. Next, the value needs to be multiplied by the "units" value which is specified in each PGN section. Please note the order of the bytes when converting values into their physical units. Make sure the raw value is reconstructed considering the significance of each byte. Here is an example of how to convert the temperature:

Example:

Received values: MSB – 0x02; LSB – 0x30.

Combined value (0x02 is most significant so it is put in the higher value position): $0x0230 = 560$

Final Temperature value = $560 * 0.125C = 70C$

CANopen Network Management (NMT)

The CANopen NMT state can be controlled by using the command below. For more information, please refer to the CiA301 spec. The battery pack will automatically enter operational mode.

NMT Node Control Protocol

COB ID: 0x000

D0	D1
CS	Node-ID

Name	Position	Size (bits)	Description
Command Specifier	D0	8	0x01 – Start, go to operational mode 0x02 – Stop, go to stopped mode 0x80 – Go to pre-operational mode 0x81 – Reset node 0x82 – Reset communication
Node-ID	D1	8	Node-ID command is targeted for otherwise use 0x00 for global broadcast

CANopen Broadcast Messages (TPDO)

Transmit Process Data Object 1 (TPDO1)

Transmission Rate: 400ms

COB ID: 0x180+node ID

D0	D1	D2	D3	D4	D5	D6	D7
NUM BATT	VB SOC	VB CAP (LSB)	VB CAP (MSB)	VB DSG TIME (LSB)	VB DSG TIME (MSB)	VB CHG TIME (LSB)	VB CHG TIME (MSB)

Name	Position	Size (bits)	Units	Description
Number of Batteries	D0	8	%	Number of batteries in parallel
Virtual Battery SOC	D1	8	%	Average SOC of all non-faulted batteries
Virtual Battery Current Stored Capacity	D2-D3	16	Ah	Sum of the remaining capacity of all non-faulted batteries
Virtual Battery Remaining Run Time	D4-D5	16	min	Remaining run time of all non-faulted batteries
Virtual Battery Remaining Charge Time	D6-D7	16	min	Remaining timeto full charge of all non-faulted batteries

Transmit Process Data Object 2 (TPDO2)

Transmission Rate: 400ms

COB ID: 0x280+node ID

D0	D1	D2	D3	D4	D5	D6	D7
VB PACK VLT (LSB)	VB PACK VLT (MSB)	VB CURR (LSB)	VB CURR (MSB)	VB DSG CUR LIM (LSB)	VB DSG CUR LIM (MSB)	VB CHG CUTOFF CURR (LSB)	VB FULL CHARGE (MSB)

Name	Position	Size (bits)	Units	Description
Virtual Battery Pack Voltage	D0-D1	16	mV	Average voltage of all non-faulted battery packs
Virtual Battery Current	D2-D3	16	+/-100mA	Combined current value of all non-faulted battery packs. Charge/regen current (+), Discharge current (-)
Virtual Battery Discharge Current Limit	D4-D5	16	100mA	Combined discharge current limit of all non-faulted battery packs
Virtual Battery Charge Cutoff Current	D6	8	100mA	Combined taper current of all non-faulted battery packs when nearing charge cutoff voltage
Virtual Battery Full Charge Flag	D7	8		0 – All non-faulted battery packs not at charge termination voltage 1 – All non-faulted battery packs at charge termination voltage

Transmit Process Data Object 3 (TPDO3)

Transmission Rate: 400ms

COB ID: 0x380+node ID

D0	D1	D2	D3	D4	D5	D6	D7
VB TEMP (LSB)	VB TEMP (MSB)	VB DSG CUTOFF VLT (LSB)	VB DSG CUTOFF VLT (MSB)	MAX CHG CURR (LSB)	MAX CHG CURR (MSB)	MAXCHG VLT (LSB)	MAXCHG VLT (MSB)

Name	Position	Size (bits)	Units	Description
Virtual Battery Temp	D0-D1	16	+/-0.125C	Average temperature of all non-faulted battery packs
Virtual Battery Discharge Cutoff Voltage	D2-D3	16	mV	Voltage at which a battery pack will open FETs to stop discharging
Virtual Battery Charge Current Limit	D4-D5	16	100mA	Combined charge current limit of all non-faulted battery packs
Virtual Battery Max Charge Voltage	D6-D7	16	mV	Maximum allowed charging voltage

Transmit Process Data Object 4 (TPDO4)

Transmission Rate: 400ms

COB ID: 0x480+node ID

D0	D1	D2	D3	D4	D5	D6	D7
VB SOH (LSB)	NUM FAULT BATT	NUM ACT BATT	VB OP MODE	CHG FLT (LSB)	CHG FLT (MSB)	DSG FLT (LSB)	DSG FLT (MSB)

Name	Position	Size (bits)	Units	Description
Virtual Battery State of Health	D0	8	%	Average state of health of all non-faulted battery packs
Number of Faulted Batteries	D1	8		Number of batteries in the system that are faulted
Number of Active Batteries	D2	8		Number of batteries in the system that are not faulted
Virtual Battery OperationalMode	D3	8	Table Below	Operational mode of all non-faulted battery packs. This value will only show "fault mode" if all battery packs in the system are faulted.

Operational Modes

Value	Mode	Description
1	Module Balancing	Pack to pack balancing is active
2	Ship	Very low power consumption. MOSFETs open (disabled), analog pins disabled
3	Pre-Discharge	Battery system is bringing up voltage of the system
4	Standby	Pack operational, MOSFETs open (disabled)
5	Discharge	Pack fully operational, MOSFETs closed (enabled)
6	Charge	Pack fully operational, MOSFETs closed (enabled)
7	Fault	Entered when safety check fails
8	Pre-Charge	Charger is bringing up the voltage of the battery system

Charge Faults (1=least significant bit)

Bit	Fault
1	High Temp
2	Low Temp
3	Over Current
4	Over Voltage
5	Short Circuit
6	Other Charge Fault
7	MOSFET Temp
8	Severe Undervoltage
9	Com AFE Failed
10	HW Second OVP
11	Reserved
12	Pre-charge Failed
13	Pack Parallel Error
14	Charge OPC
15	Pre-discharge Failed
16	Internal Comm Failure

Discharge Faults (1=least significant bit)

Bit	Fault
1	High Temp
2	Low Temp
3	Over Current
4	Under Voltage
5	Short Circuit
6	Other Discharge Fault
7	MOSFET Temp
8	Severe Undervoltage
9	Com AFE Failed
10	HW Second OVP
11	Reserved
12	Reserved
13	Pack Parallel Error
14	Reserved
15	Pre-discharge Failed
16	Internal Comm Failure

Transmit Process Data Object 5 (TPDO5)

Transmission Rate: 400ms

COB ID: 0x190+node ID

D0	D1	D2	D3	D4	D5	D6	D7
VB REGEN CUR LIM (LSB)	VB REGEN CUR LIM (MSB)	VB MIN CELL VOLT (LSB)	VB MIN CELL VOLT (MSB)	VB MAX CELL VOLT (LSB)	VB MAX CELL VOLT (MSB)	CELL BAL STATUS (LSB)	CELL BAL STATUS (MSB)

Name	Position	Size (bits)	Units	Description
Virtual Battery Gegen Current Limit	D0-D1	16	100mA	Combined regen current limit of all non-faulted battery packs
Virtual Battery Min Cell Voltage	D2-D3	8	mV	Min cell voltage of all non-faulted battery packs
Virtual Battery Max Cell Voltage	D4-D5	8	mV	Max cell voltage of all non-faulted battery packs
Cell Balance Status_ALL	D6-D7	8		Cell balance status of all battery packs. Each bit will represent one battery, bit0 will represent battery pack#1, bit1 will represent battery pack #2, and so on. Bit = 1 means cell balance of this battery pack is enabling. Bit = 0 means cell balance of this battery pack is Idle.

Transmit Process Data Object 6 (TPDO6)

Transmission Rate: 400ms

COB ID: 0x290+node ID

D0	D1	D2	D3	D4	D5	D6	D7
VB Pack Voltage_ALL (LSB)	VB Pack Voltage_ALL (MSB)	VB SOC_ALL	VB Temperature_ALL (LSB)	VB Temperature_ALL (MSB)	HEATER STATUS (LSB)	HEATER STATUS (MSB)	Master NodeID

Name	Position	Size (bits)	Units	Description
Virtual Battery Pack Voltage_ALL	D0-D1	16	mV	Average pack voltage of all battery packs
Virtual Battery SOC_ALL	D2	8	%	Average SOC value of all battery packs
Virtual Battery Temperature_ALL	D3-D4	8	+/- 0.125C	Average temperature of all battery packs
Heater Status	D5-D6	16		Heater status of all battery packs. Each bit will represent one battery, bit0 will represent battery pack#1, bit1 will represent battery pack #2, and so on. Bit = 1 means heater of this battery pack is enabling. Bit = 0 means heater of this battery pack is Idle.
Master NodeID	D7	8		The node ID of master pack

CANopen Request Messages (SDO)

The protocol detailed in this section only covers the read and write requests for data of sizes between 1 and 4 bytes which covers most of the entries in the object dictionary. For details on how to read objects greater than 4 bytes refer to the CiA301 document referenced in the beginning of this document.

Service Data Object (SDO): Read Request

COB ID: 0x600+node ID

Description: This message is for requesting the value of an object from a specific battery pack (depending the node ID in the COB ID). Use the index and sub-index in the following sections to complete the message.

D0	D1	D2	D3	D4	D5	D6	D7
0x40	Index(LSB)	Index(MSB)	Sub Index	0x00	0x00	0x00	0x00

Name	Position	Size (bits)	Description
Index	D1-D2	16	Index of the requested data
Sub Index	D3	8	Sub-index of the requested data

Service Data Object (SDO): Read Response

COB ID: 0x580+node ID

Description: This message is the response from the battery pack when it receives a valid SDO request message. There are two types of responses depending on the size of the data requested.

8-bit

D0	D1	D2	D3	D4	D5	D6	D7
0x4F	Index(LSB)	Index(MSB)	Sub Index	D0	0x00	0x00	0x00

16-bit

D0	D1	D2	D3	D4	D5	D6	D7
0x4B	Index(LSB)	Index(MSB)	Sub Index	D0(LSB)	D1(MSB)	0x00	0x00

32-bit

D0	D1	D2	D3	D4	D5	D6	D7
0x43	Index(LSB)	Index(MSB)	Sub Index	D0(LSB)	D1	D2	D3(MSB)

Name	Position	Size (bits)	Description
Index	D1-D2	16	Index of the requested data
Sub Index	D3	8	Sub-index of the requested data
Requested Data	D4-D7	16-32	Requested data which is either 16-bits or 32-bits in length

Service Data Object (SDO): Write Request

COB ID: 0x600+node ID

Description: This message is for requesting to modify an object in a battery pack. There are two types of requests depending on the size of the data.

8-bit

D0	D1	D2	D3	D4	D5	D6	D7
0x2F	Index(LSB)	Index(MSB)	Sub Index	D0	0x00	0x00	0x00

16-bit

D0	D1	D2	D3	D4	D5	D6	D7
0x2B	Index(LSB)	Index(MSB)	Sub Index	D0(LSB)	D1(MSB)	0x00	0x00

32-bit

D0	D1	D2	D3	D4	D5	D6	D7
0x23	Index(LSB)	Index(MSB)	Sub Index	D0(LSB)	D1	D2	D3(MSB)

Name	Position	Size (bits)	Description
Index	D1-D2	16	Index of the object to write to
Sub Index	D3	8	Sub-index of the object that was written to
Data	D4-D7	8-32	Data to write to battery pack

Service Data Object (SDO): Write Response

COB ID: 0x580+node ID

Description: This message is the response from the battery pack if the write request was successfully completed.

D0	D1	D2	D3	D4	D5	D6	D7
0x60	Index(LSB)	Index(MSB)	Sub Index	0x00	0x00	0x00	0x00

Name	Position	Size (bits)	Description
Index	D1-D2	16	Index of the object that was written to
Sub Index	D3	8	Sub-index of the object that was written to

Service Data Object (SDO): Abort Response

COB ID: 0x580+node ID

Description: This is the message that will be transmitted in the case that the SDO read or write request was not able to be successfully completed.

D0	D1	D2	D3	D4	D5	D6	D7
0x80	Index(LSB)	Index(MSB)	Sub Index	Abort Code (LSB)	Abort Code	Abort Code	Abort Code (MSB)

Name	Position	Size (bits)	Description
Index	D1-D2	16	Index of the object that was written to
Sub Index	D3	8	Sub-index of the object that was written to
Abort Code	D4-D7	32	0x06020000 – Object does not exist 0x06070010 – Object length does not match 0x06010002 – Object is a read-only object 0x06090011 – Sub-index does not exist Note: Abort code in CAN message is listed in reverse order so for example abort code 0x06090011 will show up as D4: 0x11; D5: 0x00; D6: 0x09; D7: 0x06

CANopen Object Dictionary

The following is a listing of all the information that can be requested from the battery pack using the SDO read request messages listed earlier in the document. The index and sub-index which needs to be put into the request messages is listed in the table below. Please refer to CiA 301 and CiA 418 documents for more information on each object.

CiA 301

Name	Index	Sub-index	Length	Units	References
Device Type	0x1000	0x00	4		CiA301
Error Register	0x1001	0x00	1		CiA301
Manufacturer Device Name	0x1008	0x00	14		CiA301
Manufacturer Hardware Version	0x1009	0x00	4		CiA301
Manufacturer Software Version	0x100A	0x00	8		CiA301
COB-ID Emergency	0x1014	0x00	4		CiA301
Inhibit Time Emergency	0x1015	0x00	2	100us	CiA301
Consumer Heartbeat Time	0x1016	0x00	4	ms	CiA301
Producer Heartbeat Time	0x1017	0x00	2	5ms	CiA301
Vendor ID	0x1018	0x01	4		CiA301
Product Code	0x1018	0x02	4		CiA301
Revision Number	0x1018	0x03	4		CiA301
Serial Number	0x1018	0x04	4		CiA301
COB ID Client to Server	0x1200	0x01	4		CiA301
COB ID Server to Client	0x1200	0x02	4		CiA301
Node ID of SDO Client	0x1200	0x03	1		CiA301

CiA 418

Name	Index	Sub-index	Length	Units	References
Battery Status	0x6000	0x00	1		CiA418
Charger Status	0x6001	0x00	1		CiA418
Temperature	0x6010	0x00	2	+/-0.125C	CiA418
Battery Type	0x6020	0x01	1		CiA418
Capacity	0x6020	0x02	2	Ah	CiA418
Max Charge Current	0x6020	0x03	2	A	CiA418
Number of Cells	0x6020	0x04	2		CiA418
Battery Serial Number Chars 1-4	0x6030	0x01	4		CiA418
Battery Serial Number Chars 5-8	0x6030	0x02	4		CiA418
Cumulative Total Ah Charge	0x6050	0x00	4	Ah	CiA418
Ah Expended Since Last Charge	0x6051	0x00	2	0.125Ah	CiA418
Ah Returned During Last Charge	0x6052	0x00	2	0.125Ah	CiA418
Battery Voltage	0x6060	0x00	4	1/1024V	CiA418
Charge Current Requested	0x6070	0x00	2	1/16A	CiA418
Battery SOC	0x6081	0x00	1	%	CiA418

Inventus Power Proprietary

Name	Index	Sub-index	Length	Units
SOH	0x4800	0x00	1	%
Operational Mode	0x4801	0x00	2	Same as VB op mode
Charge Fault	0x4802	0x00	2	Table Below
Discharge Fault	0x4803	0x00	2	Table Below
Current	0x4804	0x00	2	+/-100mA
Regen Current Limit	0x4805	0x00	2	100mA
Charge Current Limit	0x4806	0x00	2	100mA
Discharge Current Limit	0x4807	0x00	2	100mA
Min Cell Temperature	0x4808	0x00	2	+/-0.125C
Max Cell Temperature	0x4809	0x00	2	+/-0.125C
Min Cell Voltage	0x480A	0x00	2	mV
Max Cell Voltage	0x480B	0x00	2	mV
System SOC	0x480C	0x00	1	%
Pack Balancing Status	0x480D	0x00	1	0-off 1-on
Pack Voltage	0x480E	0x00	2	mV
Remaining Run Time	0x480F	0x00	2	min
Heater Status	0x4810	0x00	2	0-off 1-on
Remaining Charge Time	0x4811	0x00	2	min
Remaining Capacity	0x4812	0x00	2	Ah
Full Charge Capacity	0x4813	0x00	2	Ah
VB NumberOfBatteries	0x4850	0x00	1	N/A
VB SOC	0x4851	0x00	1	%
VB Current Stored Ah	0x4852	0x00	2	Ah
VB Remaining Run Time	0x4853	0x00	2	Min
VB Remaining Charge Time	0x4854	0x00	2	Min
VB Pack Voltage	0x4855	0x00	2	mV
VB Current	0x4856	0x00	2	+/-100mA
VB Discharge Current Limit	0x4857	0x00	2	100mA
VB Charge Cut Off Current	0x4858	0x00	1	100mA
VB FullyCharged	0x4859	0x00	1	1-fullcharged
VB Temperature	0x485A	0x00	2	+/-0.125C
VB Discharge Cut Off Voltage	0x485B	0x00	2	100mA
VB Charge Current Limit	0x485C	0x00	2	mV
VB Max Allowed Charge Voltage	0x485D	0x00	2	mV
VB SOH	0x485E	0x00	1	%
VB Number Of Batteries Fault	0x485F	0x00	1	N/A
VB Number Of Active Batteries	0x4860	0x00	1	N/A
VB Operational Mode	0x4861	0x00	1	N/A
VB Charge Fault	0x4862	0x00	2	See below table
VB Discharge Fault	0x4863	0x00	2	See below table
VB Regen Current Limit	0x4864	0x00	2	100mA
VB min cell voltage	0x4865	0x00	2	mV
VB max cell voltage	0x4866	0x00	2	mV
VB Cell Balance Status_ALL	0x4867	0x00	2	Bit0 means pack1, and so on 1-on; 0-off
VB Pack Voltage_ALL	0x4868	0x00	2	mV
VB SOC %_ALL	0x4869	0x00	1	%
VB Temperature_ALL	0x486A	0x00	2	+/-0.125C
VB Heater Status	0x486B	0x00	2	Bit0 means pack1, and so on 1-on; 0-off
Master node ID	0x486C	0x00	1	N/A
Charger taper/cut off current	0x4880	0x00	2	100mA
Maximum Pack charge voltage	0x4881	0x00	2	mV
Maximum Cell charge voltage	0x4882	0x00	2	mV
Pack charge voltage requested (CV)	0x4883	0x00	2	mV
BQ8050 SMBus Data	0x4900	0x00	2	N/A
Set broadcast node ID	0x4901	0x00	1	N/A

Note: Virtual Battery Pack Data, only available in master pack, other slave battery pack will read as 0.

Charge Faults (1=least significant bit)

Bit	Fault
1	High Temp
2	Low Temp
3	Over Current
4	Over Voltage
5	Short Circuit
6	Other Charge Fault
7	MOSFET Temp
8	Severe Undervoltage
9	Com AFE Failed
10	HW Second OPV
11	Reserved
12	Pre-charge Failed
13	Pack Parallel Error
14	Charge OCP
15	Pre-discharge Failed
16	Internal Comm Failure

Discharge Faults (1=least significant bit)

Bit	Fault
1	High Temp
2	Low Temp
3	Over Current
4	Under Voltage
5	Short Circuit
6	Other Discharge Fault
7	MOSFET Temp
8	Severe Undervoltage
9	Com AFE Failed
10	HW Second OVP
11-12	Reserved
13	Pack Parallel Error
14	Reserved
15	Pre-discharge Failed
16	Internal Comm Failure

Update Node ID and CAN Bit Timing

The node ID and CAN bit timing of each battery pack can be updated according to the protocol laid out in the CiA305 specification. Below is a summary of the protocol. For more information, please refer to the CiA305 spec.

Sequence for Updating Node ID

1. Change state of the battery pack to "Configuration state"
2. Send the "Configure Node ID Request" with desired node ID (sets pending ID)
3. Send the NMT command to reset communication (sets active ID)
4. Send the "Store Configuration Request" to store the new node ID into flash memory
5. Change state of the battery pack to "Waiting state"

Sequence for Updating CAN Bit Timing

1. Change state of the battery pack to "Configuration state"
2. Send the "Configure CAN Bit Timing Request" with desired CAN bit timing
3. Send the "Activate CAN Bit Timing Request" to switch to new bit timing
4. Send the "Store Configuration Request" to store the new bit timing into flash memory
5. Change state of the battery pack to "Waiting state"

Switch State Global Service

COB ID: 0x7E5

D0	D1	D2	D3	D4	D5	D6	D7
0x04	State	0x00	0x00	0x00	0x00	0x00	0x00

Name	Position	Size (bits)	Description
State	D1	8	0x00 – Waiting state 0x01 – Configuration state

Configure Node ID Request

COB ID: 0x7E5

D0	D1	D2	D3	D4	D5	D6	D7
0x11	Node ID	0x00	0x00	0x00	0x00	0x00	0x00

Name	Position	Size (bits)	Description
Node ID	D1	8	Value to set the pending node ID of the battery pack. The store command must be sent in order to make the node ID permanent otherwise this value will revert back to previous value upon resetting the battery pack. This value can be set to any value between 0x01-0x7F and 0xFF.

Configure Node ID Response

COB ID: 0x7E4

D0	D1	D2	D3	D4	D5	D6	D7
0x11	Error Code	0x00	0x00	0x00	0x00	0x00	0x00

Name	Position	Size (bits)	Description
Error Code	D1	8	0x00 – Success 0x01 – node ID out of range

Configure CAN Bit Timing Request

COB ID: 0x7E5

D0	D1	D2	D3	D4	D5	D6	D7
0x13	0x00	Table Indx	0x00	0x00	0x00	0x00	0x00

Name	Position	Size (bits)	Description
Table Index	D2	8	Use the following values to specify the CAN bit timing to set the battery pack to: 0x0 – 1000 kbit/s 0x1 – 800 kbit/s 0x2 – 500 kbit/s 0x3 – 250 kbit/s

Configure CAN Bit Timing Response

COB ID: 0x7E4

D0	D1	D2	D3	D4	D5	D6	D7
0x13	Error Code	0x00	0x00	0x00	0x00	0x00	0x00

Name	Position	Size (bits)	Description
Error Code	D1	8	0x00 – Success 0x01 – Bit timing not supported

Activate Bit Timing Request

COB ID: 0x7E5

D0	D1	D2	D3	D4	D5	D6	D7
0x15	0x00	0x00	0x00	0x00	0x00	0x00	0x00

Store Configuration Request

COB ID: 0x7E5

D0	D1	D2	D3	D4	D5	D6	D7
0x17	0x00	0x00	0x00	0x00	0x00	0x00	0x00

Store Configuration Response

COB ID: 0x7E4

D0	D1	D2	D3	D4	D5	D6	D7
0x17	Error Code	0x00	0x00	0x00	0x00	0x00	0x00

Name	Position	Size (bits)	Description
Error Code	D1	8	0x00 – Success 0x01 – Operation not supported 0x02 – Storage media access error

Layer Setting Services (LSS)

The battery pack will respond to all inquiry and identification (including fastscan) requests as specified in the CiA305 document. Please refer to the CiA305 specification for more details.

Emergency Object

COB ID: 0x80+node ID

Emergency objects are transmitted by a battery pack upon detection of a fault. Each battery pack will transmit its own emergency object only once per error event.

D0	D1	D2	D3	D4	D5	D6	D7
ERR CODE (MSB)	ERR CODE (LSB)	ERR REG	0x00	0x00	0x00	0x00	0x00

Name	Position	Size (bits)	Description
Error Code	D0-D1	16	Specific error detected (see table)
Error Register	D2	8	Generic error category (see table)

Error Codes

Fault	Error Code
Charge Low Temp	0x4200
Charge High Temp	0x4201
Discharge Low Temp	0x4202
Discharge High Temp	0x4203
Over Current	0x2000
Short Circuit	0x2001
Over Voltage	0x3000
Under Voltage	0x3001
Severe Under Voltage	0x3002
End-of-life	0xFF00
Pre-discharge	0xFF01
Communication with BQ Failed	0xFF02
Miscellaneous Charge Fault	0xFF03
Miscellaneous Discharge Fault	0xFF04
Pack Parallel Error	0xFF05

Error Register (1-least significant bit)

Bit	Fault
1	Generic Error
2	Current
3	Voltage
4	Temperature
5	Communication error
6	Device Profile Specific