# ELEO 48V BATTERY PACK CAN PROTOCOL

## Controller

Confidential

Version 18-02-2021

# General:

**Message type:** Extended frame (configurable)
**CANOFFSET**[1] : 0x684 (configurable)
**Bit rate:** 250kHz (configurable)
**Byte Order:** big-endian

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[1] The starting CAN address

| CAN message | CAN ID | Data0 | Data1 | Data2 | Data3 | Data4 | Data5 | Data6 | Data7 |
|---|---|---|---|---|---|---|---|---|---|
| BOOT_RX | CANOFFSET | - | - | - | - | - | - | - | - |
| BOOT_TX | CANOFFSET + 1 | - | - | - | - | - | - | - | - |
| SERVICE_ID | CANOFFSET +2 | - | - | - | - | - | - | - | - |
| MASTER_TX_STATUS | CANOFFSET + 3 | MSG 0x01 | STAT | SAFA | ERRA | ERRB | ERRC | ERRD | COND |
| MASTER_TX_WARNING | CANOFFSET + 3 | MSG 0x02 | WARNA | WARNB | WARNC | WARND | - | - | - |
| MASTER_TX_SUM | CANOFFSET + 3 | MSG 0x03 | SOC | VMINM | VMINL | VMAXM | VMAXL | TMIN | TMAX |
| MASTER_TX_DCTOTAL | CANOFFSET + 3 | MSG 0x04 | DCTOTM | DCTOT | DCTOT | DCTOTL | - | - | - |
| MASTER_TX_CURR | CANOFFSET + 3 | MSG 0x05 | CURRM | CURR | CURR | CURRL | - | - | - |
| MASTER_TX_CHARGE | CANOFFSET + 3 | MSG 0x10 | CHRGA | CHRGS | - | - | - | - | - |
| MASTER_TX_SLAVECMD | CANOFFSET + 3 | MSG 0x81 | SLVID | CMD | ARG0 | ARG1 | ARG2 | ARG3 | ARG4 |
| MASTER_RX_CMD | CANOFFSET + 4 | MSG 0x01 | CMD | ARG0 | ARG1 | ARG2 | ARG3 | ARG4 | ARG5 |

| MASTER_TX_STATUS | | |
|---|---|---|
| **CAN ID** | **Length** | **Cycle time (ms)** |
| CANOFFSET + 3 | 8 | 1000 |
| **Data** | | |
| **Byte number/ name** | **Data description** | **Details** |
| 0. MSG | Byte specifying the message type | 0x01 |
| 1. STAT | Byte specifying the status for all modules | Bit 0 – Operational[2]<br>Bit 1 – -<br>Bit 2 – Error Present[3]<br>Bit 3 – Regenerative charging (Negative current in non charge mode)<br>Bit 4&5 – 0: not in charging mode<br>    1: charging mode[4] (not charging active or charging done)<br>    2: charging active (in charging mode and negative current, could be charging done)<br>    3: charging done (in charging mode and not charging active)<br>Bit 6&7 – 0: not in balancing mode<br>    1: balancing mode (not balancing active or balancing done)<br>    2: balancing active (one of the modules is in balancing mode and and actively balancing) |

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[2] For modules the operational bit is equal to the error present bit. For the battery controller if the operational bit is high the relays are closed and the battery can be used. If the operational bit is low the battery should not be used.

[3] If no safety error or normal error has been set by any of the modules the error present bit will be set. Otherwise the error present bit is cleared.

[4] The modules should be set to charge mode before charging (when not using a charger provided by SPIKE) by continuously sending MasterRX (0x01) before charging or by setting input pin 2 high if a battery controller is connected. This sets different parameters and allows the modules to balance.

| | | 3: balancing done (in balancing mode and not actively balancing and balancing is completed (only when battery is fully charged)) |
|---|---|---|
| 2. SAFA | Byte specifying safety errors for all modules | Bit 0 – Over Voltage<br>Bit 1 – Under Voltage<br>Bit 2 – Over Temperature Cell<br>Bit 3 – Under Temperature Cell<br>Bit 4 – Charge Current<br>Bit 5 – Task Timeout<br>Bit 6 – Watchdog Timeout |
| 3. ERRA | Byte specifying errors for all modules | Bit 0 – Over Voltage<br>Bit 1 – Under Voltage<br>Bit 2 – Over Temperature Cell<br>Bit 3 – Under Temperature Cell<br>Bit 4 – Over Temperature Balancing<br>Bit 5 – Over Temperature PCB<br>Bit 6 – Under Temperature PCB<br>Bit 7 – Discharge peak current |
| 4. ERRB | Byte specifying errors for all modules | Bit 0 – Charge peak current<br>Bit 1 – Discharge continuous current<br>Bit 2 – Charge continuous current<br>Bit 3 – Disbalance voltage between cells<br>Bit 4 – Disbalance temperature<br>Bit 5 – -<br>Bit 6 – Communication timeout<br>Bit 7 – Watchdog triggered |
| 5. ERRC | Byte specifying errors for all modules | Bit 0 – Task timeout<br>Bit 1 – Incorrect customer configuration<br>Bit 2 – Incorrect factory configuration |
| 6. ERRD | Byte specifying errors for all modules (BC ONLY) | Bit 0 – HVIL        (HV BC ONLY)<br>Bit 1 – HVIL device   (HV BC ONLY)<br>Bit 2 – Insulation P  (HV BC ONLY)<br>Bit 3 -  Insulation N (HV BC ONLY) |
| 7. COND | Byte specifying conditions that need to hold for the relay to open (BC ONLY) | Bit 0 – no input 1<br>Bit 1 – no initial module communication<br>Bit 2 – no initial HVIL measurement          (HV BC ONLY)<br>Bit 3 -  no initial insulation measurement       (HV BC ONLY) |

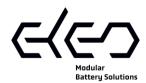| MASTER_TX_WARNING | | |
|---|---|---|
| **CAN ID** | **Length** | **Cycle time (ms)** |
| CANOFFSET + 3 | 8 | 1000 |
| **Data** | | |
| **Byte number/ name** | **Data description** | **Details** |
| 0. MSG | Byte specifying the message type | 0x02 |
| 1. WARNA | Byte specifying warnings for all modules | Bit 0 – Over Voltage<br>Bit 1 – Under Voltage<br>Bit 2 – Over Temperature Cell<br>Bit 3 – Under Temperature Cell<br>Bit 4 – Over Temperature Balancing<br>Bit 5 – Over Temperature PCB<br>Bit 6 – Under Temperature PCB<br>Bit 7 – Discharge peak current |
| 2. WARNB | Byte specifying warnings for all modules | Bit 0 – Charge peak current<br>Bit 1 – Discharge continuous current<br>Bit 2 – Charge continuous current |

| | | |
|---|---|---|
| | | Bit 3 – Disbalance voltage between cells<br>Bit 4 – Disbalance temperature<br>Bit 5 – low SOC<br>Bit 6 – Communication timeout<br>Bit 7 – Watchdog triggered |
| 3. WARNC | Byte specifying warnings for all modules | Bit 0 – Task timeout |
| 3. WARND | Byte specifying warnings for all modules | Bit 0 – Insulation P (HV BC ONLY)<br>Bit 1 – Insulation N (HV BC ONLY)<br>Bit 2 – Precharge no load<br>Bit 3 – Precharge timeout<br>Bit 4 – Precharge device |

## MASTER_TX_SUM

| CAN ID | Length | Cycle time (ms) |
|---|---|---|
| CANOFFSET + 3 | 8 | 1000 |

| Data | | |
|---|---|---|
| **Byte number/ name** | **Data description** | **Details** |
| 0. MSG | Byte specifying the message type | 0x03 |
| 1. SOC | Byte stating average SOC of all modules | Unsigned 8bit<br>0-100% with 0.5%/LSB |
| 2. VMINM | Minimum cell voltage of all modules MSB | Unsigned 16bit<br>0.1mV /LSB |
| 3. VMINL | Minimum cell voltage of all modules LSB | |
| 4. VMAXM | Maximum cell voltage of all modules MSB | Unsigned 16bit<br>0.1mV /LSB |
| 5. VMAXL | Maximum cell voltage of all modules LSB | |
| 6. TMIN | Minimum temperature of all modules | Unsigned 8bit<br>-40 .. 215 °C with 1°C/LSB  (offset -40°C) |
| 7. TMAX | Maximum temperature of all modules | Unsigned 8bit<br>-40 .. 215 °C with 1°C/LSB  (offset -40°C) |

## MASTER_TX_DCTOTAL

| CAN ID | Length | Cycle time (ms) |
|---|---|---|
| CANOFFSET + 3 | 8 | 1000 |

| Data | | |
|---|---|---|
| **Byte number/ name** | **Data description** | **Details** |
| 0. MSG | Byte specifying the message type | 0x04 |
| 1. DCTOTM | DC total voltage of all modules MSB | Unsigned 32bit<br>0.1mV /LSB |
| 2. DCTOT | DC total voltage of all modules | |
| 3. DCTOT | | |
| 4. DCTOTL | DC total voltage of all modules LSB | |

## MASTER_TX_CURR

| CAN ID | Length | Cycle time (ms) |
|---|---|---|
| CANOFFSET + 3 | 8 | 1000 |

| Data | | |
|---|---|---|

| Byte number/ name | Data description | Details |
|---|---|---|
| 0. MSG | Byte specifying the message type | 0x05 |
| 1. CURRM | Current through battery pack MSB | 32bit signed two's complement 0.001A/LSB Positive: discharging Negative: charging |
| 2. CURR | Current through battery pack | |
| 3. CURR | | |
| 4. CURRL | Current through battery pack LSB | |

## MASTER_TX_CHARGE

| CAN ID | Length | Cycle time (ms) |
|---|---|---|
| CANOFFSET + 3 | 8 | 1000 (when charge mode is externally set) |

| Data | | |
|---|---|---|

| Byte number/ name | Data description | Details |
|---|---|---|
| 0. MSG | Byte specifying the message type | 0x10 |
| 1. CHRGA | Byte specifying if charging is allowed | 0x00 = charging not allowed 0x01 = charging is allowed[5] |
| 2. CHRGS | Byte specifying the state of charging | Bit 0 – In charging mode Bit 1 – Charging Active Bit 2 – Charging Done Bit 3 – - Bit 4 – In balancing mode Bit 5 – Balancing Active Bit 6 – Balancing Done Bit 7 – - |
| 3. - | - | - |
| 4. - | - | - |
| 5. - | - | - |
| 6. - | - | - |
| 7. - | - | - |

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[5] When the charging is handled externally (not by the BMS itself) the allow charging value will indicate when the modules are allowed to be charged when in charge mode. The value will be 0 when the modules are full or an error has occurred.

| MASTER_TX_SLAVECMD | | |
|---|---|---|
| **CAN ID** | **Length** | **Cycle time (ms)** |
| CANOFFSET + 3 | 4-8 | - |
| **Data** | | |
| **Byte number/ name** | **Data description** | **Details** |
| 0. MSG | Byte specifying the message type | 0x81 |
| 1. SLVID | ID of the slave receiving the message | 0x00 – 0xFE target 1 specific slave in order<br>0xFF – broadcast to all slaves |
| 2. CMDID | The command ID for the slave modules | See slave commands |
| 3. ARG0 | Argument 0 | See slave commands |
| 4. ARG1 | Argument 1 | See slave commands |
| 5. ARG2 | Argument 2 | See slave commands |
| 6. ARG3 | Argument 3 | See slave commands |
| 7. ARG4 | Argument 4 | See slave commands |

| **Slave command** | **Command ID** | **length** |
|---|---|---|
| CHARGING_MODE_SLAVE | 0x01 | 4 |
| **Byte number/ name** | **Data description** | **Details** |
| 3. ARG0 | State | Bit 0 - Set charging (1 = on, 0 = off) |

| **Slave command** | **Command ID** | **length** |
|---|---|---|
| BALANCING_MODE_SLAVE | 0x02 | 6 |
| **Byte number/ name** | **Data description** | **Details** |
| 3. ARG0 | State | Bit 0 - Set balancing (1 = on, 0 = off) |
| 4. ARG1 | Balancing voltage MSB | |
| 5. ARG2 | Balancing voltage LSB | Unsigned 16bit<br>0.1mV /LSB |

| **Slave command** | **Command ID** | **length** |
|---|---|---|
| SET_LED_SLAVE | 0x03 | 7 |
| **Byte number/ name** | **Data description** | **Details** |
| 3. ARG0 | R (set the value for the red led) | Unsigned 8 bit<br>0-255 1/LSB |
| 4. ARG1 | G (set the value for the green led) | Unsigned 8 bit<br>0-255 1/LSB |
| 5. ARG2 | B (set the value for the blue led) | Unsigned 8 bit<br>0-255 1/LSB |
| 6. ARG3 | A (set the value for the brightness of the led) | Unsigned 8bit<br>0-100 1/LSB (higher values rounded to 100) |

| MASTER_RX_CMD | | |
|---|---|---|
| **CAN ID** | **Length** | **Cycle time (ms)** |
| CANOFFSET + 4 | 2-8 | - |
| **Data** | | |
| **Byte number/ name** | **Data description** | **Details** |
| 0. CMDID | Command ID for the master module | See master command |
| 1. ARG0 | Argument 0 | See master command |
| 2. ARG1 | Argument 1 | See master command |
| 3. ARG2 | Argument 2 | See master command |
| 4. ARG3 | Argument 3 | See master command |
| 5. ARG4 | Argument 4 | See master command |
| 6. ARG5 | Argument 5 | See master command |
| 7. ARG6 | Argument 6 | See master command |

| **Master command** | **Command ID** | **length** |
|---|---|---|
| CHARGING_MODE_MASTER | 0x01 | 2 |
| **Byte number/ name** | **Data description** | **Details** |
| 1. ARG0 | State | Bit 0 – charging (1 = go to /stay in charge mode, 0 = go out charge mode) |

| **Master command** | **Command ID** | **length** |
|---|---|---|
| SET_LED_MASTER | 0x02 | 6 |
| **Byte number/ name** | **Data description** | **Details** |
| 1. ARG0 | ID of the targeted module | 0x00 – 0xFE target 1 specific module in order (0x00 = master)<br>0xFF – broadcast to all modules |
| 2. ARG1 | R (set the value for the red led) | Unsigned 8 bit<br>0-255 1/LSB |
| 3. ARG2 | G (set the value for the green led) | Unsigned 8 bit<br>0-255 1/LSB |
| 4. ARG3 | B (set the value for the blue led) | Unsigned 8 bit<br>0-255 1/LSB |
| 5. ARG4 | A (set the value for the brightness of the led) | Unsigned 8bit<br>0-100 1/LSB (higher values rounded to 100) |

# Examples:

Assuming CANOFFSET = 0x684

| CANID | DATA0 | DATA1 | DATA2 | DATA3 | DATA4 | DATA5 | DATA6 | DATA7 | Definition |
|---|---|---|---|---|---|---|---|---|---|
| 0x687 | 0x01 | 0xB4 | 0x01 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | There is an error present in one of the modules. The battery pack is done charging and currently actively balancing. Additionally, there is an over-voltage safety error. |
| 0x687 | 0x02 | 0x64 | 0x61 | 0xA8 | 0xA4 | 0x10 | 0x1E | 0x41 | The SOC of all modules is 50% The min voltage of all modules is 2.5V The max voltage of all modules is 4.2V The min temperature of the batteries is -10°C The max temperature of the batteries is 25°C |
| 0x687 | 0x04 | 0x00 | 0x3D | 0x09 | 0x00 | 0x00 | 0x00 | 0x00 | The total voltage of all the modules is 400V |
| 0x688 | 0x01 | 0x01 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | 0x00 | Set all modules to charge mode (only necessary if charging not handled by the BMS) |

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