




**GREEN CUBES**  
TECHNOLOGY

# **03C-069 BATTERY SYSTEM: CAN MESSAGE DEFINITION & TEST SETUP**

**GCT Doc. Control No.: 711323**

**Doc. Rev.: 1.4**


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## Revision History

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DATE	REVISION	PREPARED BY	CHECKED BY	DESCRIPTION
6/9/2015	1.0	Cooper		Initial Release
6/17/2015	1.1	Jannu	Cooper	Update CAN messaging to include Battery ID, and Vehicle serial, ID; correct status and warning message explanation
6/22/2015	1.2	Jannu	Cooper	Added normal operation section to explain status messages seen.
06/05/2019	1.3	Raghu		Added all the CAN signals supported by BMS, updated the BMS Object Dictionary
08/01/2023	1.4	Florek		Changed descriptions to represent IBMS


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# 1 Introduction

## 1.1 Purpose

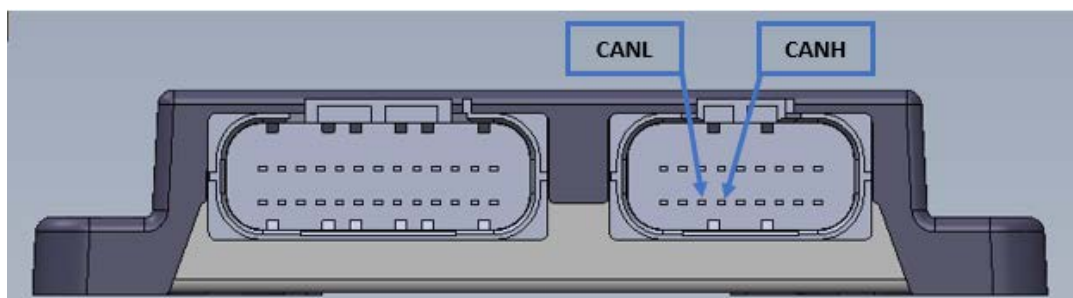
The purpose of this document is to explain the CAN Protocol and Interface implemented in the Green Cubes Battery Management System.

## 1.2 Scope

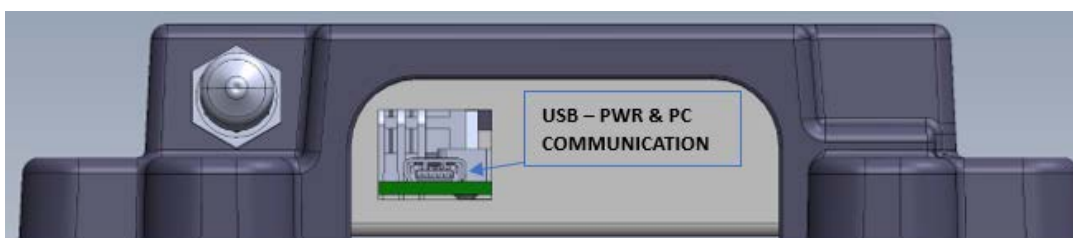
This document only covers the CAN signals implemented in the BMS, along with the method to configure the CAN signals implemented in the BMS. This document is intended for anyone who wants to interface the Green Cubes Technology BMS with their system.

# 2 Overview


For testing purposes, the Industrial BMS will be connected to the CAN serial bus via the CAN LOW (Pin 16) & CAN HIGH (Pin 15) lines, seen in **Figure 1**. Power and PC communications for the BMS is via the Mini USB connection, seen in **Figure 2**



**Figure 1 – CAN Connection Diagram**



**Figure 2 – Mini USB Connection**

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## 3 Equipment/Software/Firmware List

### 3.1 Equipment

- *TBD*

### 3.2 Software

- *TBD*

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## 4 CAN Interface and Protocol

The CAN messages are based on the CiA 418/419/301 standards with custom additions to the Object Dictionary.

### 4.1 General

BMS is implemented as a CANOpen Slave Node. As soon as the BMS is woken up, the device is automatically put into Operational mode.

The Node ID of the BMS can be configured using the BMS software.

BMS supports multiple baud rate's which can be configured using the BMS Software.

GCT BMS is a Heartbeat Producer. The Heartbeat rate is configurable via the BMS software.

BMS supports 6 TPDO's and 6 RPDO's which are configurable using the BMS Software.

BMS supports multiple chargers. The BMS SW provides an option to select the charger support.

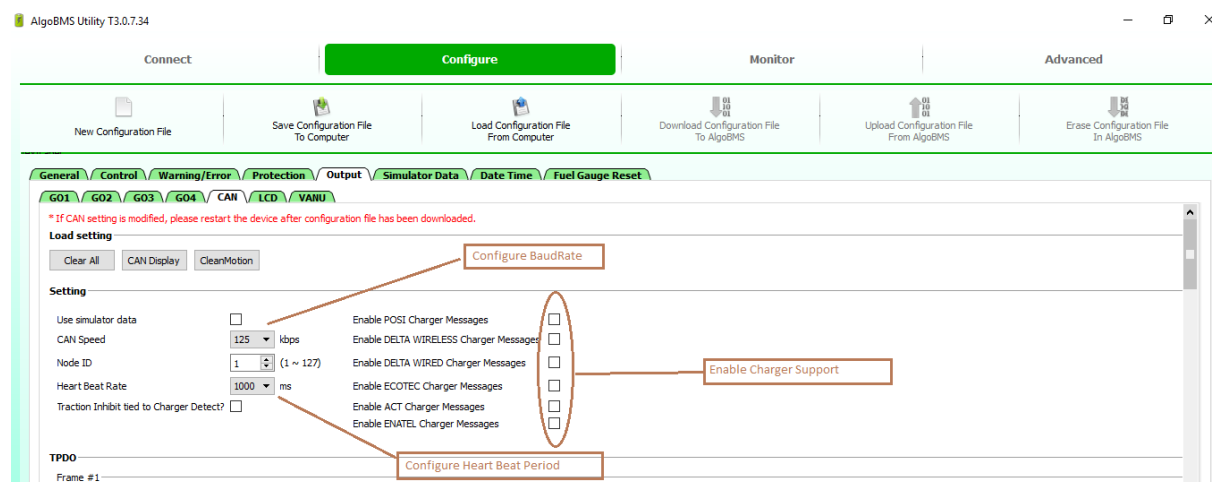



Figure 1 – CAN Configuration Tab in BMS Software


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## 4.2 Object Dictionary

The object dictionary provides the list of parameters which are supported by the BMS, which can be read via CAN using PDO or SDO mapping.

Index [hex]	Sub Index	Data Type	Access	Data Value Min	Data Value Max	Data Value Units	PDO Mapping	Description
6000	0	U8	RO	0	1		No	Battery Status 0 – Not Ready 1- Ready
6001	0	U8	RO	0	1		No	Charger Status 0 – Not Ready 1 - Ready
6002	0	U8	RO	0	255		Yes	BMS Status 1 (*)
6002	1	U8	RO	0	255		Yes	BMS Status 2 (*)
6002	2	U8	RO	0	255		Yes	BMS Status 3 (*)
6003	0	U16	RO	0	65535		Yes	Warnings (*)
6004	0	U16	RO	0	65535		Yes	Alarms (#)
6005	0	U16	RO	0	100	%	No	State of Charge
6010	0	S16	RO	-40	125	1/8 Deg C	No	Temperature3
6011	0	S16	RO	-40	125	1/8 Deg C	Yes	Average Battery Temperature
6012	0	S16	RO	-40	125	1/8 Deg C	Yes	Lowest Battery Temperature
6013	0	S16	RO	-40	125	1/8 Deg C	Yes	Highest Battery Temperature
6014	0	U8	RO	0	255		Yes	GO1 and GO2 Output (*)
6015	0	U16	RO	0	1000	0.1 %	Yes	GO3 Output
6015	1	U16	RO	0	1000	0.1%	Yes	GO4 Output
6016	0	U16	RO	0	65535	1/10 A	Yes	Max Allowed Charge Current
6017	0	U16	RO	0	65535	1/10 A	Yes	Max Allowed Discharge Current
6018	0	U8	RO	0	255		Yes	Fan Status (*)
6019	0	U8					Yes	Park Brake Status (\$)
601A	0	U16	RO	0	65535	1/16 A	Yes	Max Allowed Charge Current
601B	0	U16	RO	0	65535	1/16 A	Yes	Max Allowed Discharge Current
601C	0	U16	RO	0	65535	1/16A	Yes	Battery Current




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601D	0	S16	RO	-40	125	Deg C	Yes	Average Battery Temperature
6050	0	U32	RO	0	MAX(U32)	Ah	No	Total Cumulative Charge Ah
6055	0	U8	RO	0	255		Yes	Charger Enable 0 – Disable 1 – Enable
6060	0	U32	RO	0	MAX(U32)	1/1024 V	Yes	Battery Voltage
6061	0	S16	RO	0	32767	1/1024 V	Yes	Lowest Cell Voltage
6062	0	S16	RO	0	32767	1/1024 V	Yes	Highest Cell Voltage
6063	0	U16	RO	0	65535	1/10 V	Yes	Battery Voltage
6064	0	U16	RO	0	65535	1/10 V	Yes	Discharge Voltage Limit
6065	0	U16	RO	0	65535	1/10 V	Yes	Charge Voltage Limit
6067	0	U32	RO	0	MAX(U32)	1/1024 V	Yes	Discharge Voltage Limit
6068	0	U32	RO	0	MAX(U32)	1/1024 V	Yes	Charge Voltage Limit
6069	0	U16	RO	0	65535		Yes	Charge Cycle Count
6081	0	U8	RO	0	100	%	Yes	Battery State of Charge
6091	0	S16	RO	-32767	32767	1/10 A	Yes	Battery Current
6092	0	U16	RO	0	65535	1/8 Ah	No	Battery Remaining Capacity
6093	0 – 16	U16	RO	0	65535	1/1024 V	Yes	Battery Cell Voltage 0 to 16
6094	0	U16	RO	0	65535	1/8 Ah	Yes	Battery Full Capacity
6095	0	U8	RO	0	100	%	Yes	Battery State of Health
6096	0	U8	RO	0	65535		Yes	Charge Fault (*)
6096	1	U8	RO	0	65535		Yes	Discharge Fault (*)

(\*) See Data Dictionary for Detailed Object Description

(#) Future Implementation

(\$) Information obtained from other interfaced nodes

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## 5 Data Dictionary

This section provides detailed description of select Data Dictionary Objects.

### 5.1 BMS Status 1

CAN Data Description	
<b>BMS Status 1</b>	
Size: 1 byte	
Bit	Meaning
0	Reserved
1	Reserved
2	Reserved
3	Battery Full
4	Battery Low
5	Battery balancing
6	Charge Voltage Reached
7	Reserved


### 5.2 BMS Status 2

CAN Data Description	
<b>BMS Status 2</b>	
Size: 1 byte	
Bit	Meaning
0	Power On
1	Main Charger Detected
2	Discharging Allowed
3	Main Charging Allowed
4	Alternative Charger Detected
5	Alternative Charging Allowed
6	Reserved
7	Reserved

```

; Message Number
; |
; | Time Offset (ms)
; | Type
; | ID (hex)
; | Data Length Code
; | Data Bytes (hex) ...
; +-----+-----+-----+-----+-----+-----+
; 1)      227.4  Rx      0701  1  05
; 2)      756.1  Rx      0181  8  DD D4 FF FF 64 BB 00 35
; 3)      756.6  Rx      0281  2  00 00
; 4)     1226.4  Rx      0701  1  05

```

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0x35 -> 0011 0101

## 5.3 BMS Status 3

CAN Data Description	
<b>BMS Status 3</b>	
Size: 1 byte	
Bit	Meaning
0	Inhibit Operation
1	Immediate Shutdown
2	Limited Operation
3	Traction Inhibit
4	Lift Lockout
5	Reserved
6	Reserved
7	Reserved

## 5.4 Warnings

CAN Data Description	
<b>Warnings</b>	
Size: 2 bytes	
Bit	Meaning
0	Cell Under Voltage
1	Cell Over Voltage
2	Battery Under Temperature
3	Battery Over Temperature
4	Battery Over Current
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved
<b>Alarms</b>	


Example:

```

; Message Number
; | Time Offset (ms)
; | | Type
; | | | ID (hex)
; | | | | Data Length Code
; | | | | | Data Bytes (hex) ...

```



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## 5.6 G01 and G02 Output

G01_G02 Output	
Size: 1 byte	
Bit	Meaning
0	G01 Output
1	G02 Output
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved

## 5.7 Battery Voltage:

- Size: 2 Bytes
- Unit: (1/1024) V

Example:

```

; Message Number
; |           Time Offset (ms)
; |           |           Type
; |           |           |           ID (hex)
; |           |           |           |           Data Length Code
; |           |           |           |           |           Data Bytes (hex) ...
; |           |           |           |           |           |
; ---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
;      8)      4701.9  Rx      0181  8  66 C2 80 04 32 C8 00 02

```

0xC266 -> 49766 ; divide by 1024 = 48.6V

## 5.8 Battery Current:


- Size: 2 Bytes
- Unit: (1/16) A

Example:

```

; Message Number
; |           Time Offset (ms)
; |           |           Type
; |           |           |           ID (hex)

```

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```

;      |      |      |      |      |      |      |      |      |      |
;      |      |      |      |      |      |      |      |      |      |
;      |      |      |      |      |      |      |      |      |      |
;-----+-----+-----+-----+-----+-----+-----+-----+-----+
      8)      4701.9  Rx      0181  8  66 C2 80 04 32 C8 00 02

```

0x480 -> 1152 ; divide by 16 = 72A

## 5.9 Battery SOC:

- Size: 1 Byte
- Unit: 1 %

Example:

```

;      Message Number
;      |      Time Offset (ms)
;      |      |      Type
;      |      |      |      ID (hex)
;      |      |      |      |      Data Length Code
;      |      |      |      |      |      Data Bytes (hex) ...
;      |      |      |      |      |      |
;-----+-----+-----+-----+-----+-----+-----+-----+
      8)      4701.9  Rx      0181  8  66 C2 80 04 32 C8 00 02

```

0x32 -> 50 ; 50%

## 5.10 High Temperature:

- Size: 2 Bytes
- Unit: (1/8) °C


Example:

```

;      Message Number
;      |      Time Offset (ms)
;      |      |      Type
;      |      |      |      ID (hex)
;      |      |      |      |      Data Length Code
;      |      |      |      |      |      Data Bytes (hex) ...
;      |      |      |      |      |      |
;-----+-----+-----+-----+-----+-----+-----+-----+
      8)      4701.9  Rx      0181  8  66 C2 80 04 32 C8 00 02

```

0x00c8 -> 200 ; divide by 8 = 25 °C

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## 5.11 Battery Parameters:

- Size:  
1byte Battery type, 2 bytes Ah Capacity, 2 bytes Max charge current and 2 bytes number of cells

;	Message Number		Time Offset (ms)		Type		ID (hex)		Data Length	Code		Data Bytes (hex) ...
;												
;												
;												
;												
;												
;												
;												
5)	3472.4	Tx	0601	8	40	20	60	01	00	00	00	00
6)	3483.0	Rx	0581	8	4F	20	60	01	A0	00	00	00
8)	4904.6	Tx	0601	8	40	20	60	02	00	00	00	00
9)	4911.2	Rx	0581	8	4B	20	60	02	40	01	00	00
3)	2176.2	Tx	0601	8	40	20	60	03	00	00	00	00
4)	2203.1	Rx	0581	8	4B	20	60	03	40	01	00	00
15)	7944.5	Tx	0601	8	40	20	60	04	00	00	00	00
16)	7970.9	Rx	0581	8	4B	20	60	04	10	00	00	00

0xA0 = 1010 0000 → Refers to Li-ion Battery type

0x140 = 320; multiply with 0.125 = 40 Ah → Capacity


0x140 = 320; multiply by (1/16) = 20A → Max charge current

0x10 = 16 → number of cells.

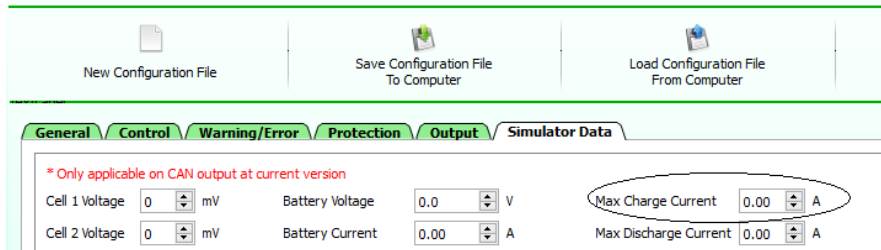
The above parameters can be set from the SW using the configure → General tab

### Battery Information

Number of Battery Cell	<input type="text" value="16"/>	Cell (4 ~ 16)
Battery Capacity	<input type="text" value="40"/>	Ah (1 ~ 8000)
Battery Chemistry	<input type="text" value="Lithium Ion"/>	

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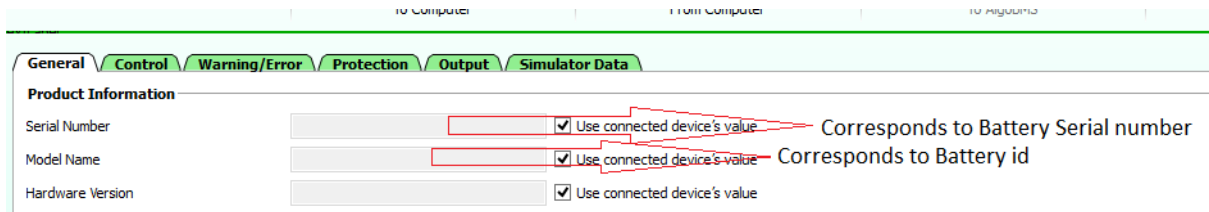
The Max charge current can be set from SW using configure→simulator tab (make sure the use simulator data is selected in CAN tab)



## 5.12 Battery Serial number and Battery Id:

- Size: 8 characters for Battery Serial number and 20 characters for Battery Id

This parameter can be set from SW using configure→General tab



Battery Serial Number Example Trace:

```

; Message Number
; | Time Offset (ms)
; | Type
; | ID (hex)
; | Data Length Code
; | Data Bytes (hex) ...
; |
; ---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
1) 96.9 Rx 0701 1 05
2) 1065.9 Rx 0701 1 05
3) 2085.9 Rx 0701 1 05
4) 3096.3 Tx 0601 8 40 30 60 01 00 00 00 00
5) 3106.5 Rx 0581 8 43 30 60 01 31 54 43 47 -->
1TCG
6) 3106.9 Rx 0701 1 05
7) 4074.9 Rx 0701 1 05
8) 4720.2 Tx 0601 8 40 30 60 02 00 00 00 00
9) 4738.4 Rx 0581 8 43 30 60 02 35 34 33 32 -->
5432
10) 5095.0 Rx 0701 1 05

```


Actual Battery serial number set in SW is "GCT12345"

Battery ID Example Trace:





```
; Message Number
; | Time Offset (ms)
; | Type
; | ID (hex)
; | Data Length Code
; | Data Bytes (hex) ...
; +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+ +---+
; 1) 844.8 Rx 0701 1 05
; 2) 1864.8 Rx 0701 1 05
; 3) 2704.7 Tx 0601 8 40 31 60 01 00 00 00 00
; 4) 2732.3 Rx 0581 8 43 31 60 01 41 54 43 47 -->
ATCG
; 5) 2833.8 Rx 0701 1 05
; 6) 3680.4 Tx 0601 8 40 31 60 02 00 00 00 00
; 7) 3701.2 Rx 0581 8 43 31 60 02 42 4F 47 4C -->
BOGL
; 8) 3853.8 Rx 0701 1 05
; 9) 4592.3 Tx 0601 8 40 31 60 03 00 00 00 00
; 10) 4622.8 Rx 0581 8 43 31 60 03 00 00 53 4D -->
00SM
; 11) 4873.8 Rx 0701 1 05
; 12) 5624.3 Tx 0601 8 40 31 60 04 00 00 00 00
; 13) 5639.6 Rx 0581 8 43 31 60 04 00 00 00 00 -->
0000
; 14) 5842.7 Rx 0701 1 05
; 15) 6537.0 Tx 0601 8 40 31 60 05 00 00 00 00
; 16) 6557.3 Rx 0581 8 43 31 60 05 00 00 00 00 -->
0000
; 17) 6862.7 Rx 0701 1 05
; 18) 7831.8 Rx 0701 1 05
```

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## 5.13 Vehicle Serial number and Vehicle Id:

- Size: 20 Characters for each

These parameters can be set from SW using configure → General tab


Vehicle Information	
Vehicle Serial Number	<input type="text"/>
Vehicle ID	<input type="text"/>

```

; Message Number
; Time Offset (ms)
; Type
; ID (hex)
; Data Length Code
; Data Bytes (hex) ...
;
;-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
; 1)      46.8   Rx      0701  1  05
; 2)     1066.7  Rx      0701  1  05
; 3)     1504.8  Tx      0601  8  40 40 60 01 00 00 00 00
; 4)     1526.2  Rx      0581  8  43 40 60 01 31 54 43 47 -- >
1TCG
; 5)     2035.7  Rx      0701  1  05
; 6)     2408.8  Tx      0601  8  40 40 60 02 00 00 00 00
; 7)     2444.2  Rx      0581  8  43 40 60 02 35 34 33 32 -- >
5432
; 8)     3055.7  Rx      0701  1  05
; 9)     3272.0  Tx      0601  8  40 40 60 03 00 00 00 00
; 10)    3314.8  Rx      0581  8  43 40 60 03 00 5A 59 58 -- >
0ZYX
; 11)    4048.0  Tx      0601  8  40 40 60 04 00 00 00 00
; 12)    4076.3  Rx      0581  8  43 40 60 04 00 00 00 00 -- >
0000
; 13)    4076.7  Rx      0701  1  05
; 14)    4976.4  Tx      0601  8  40 40 60 05 00 00 00 00
; 15)    4994.2  Rx      0581  8  43 40 60 05 00 00 00 00 -- >
0000
; 16)    5044.7  Rx      0701  1  05
; 17)    6064.7  Rx      0701  1  05

```

Actual Vehicle Serial number set in SW is "GCT12345XYZ"


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```

; Message Number
; |
; | Time Offset (ms)
; | |
; | | Type
; | | |
; | | | ID (hex)
; | | | |
; | | | | Data Length Code
; | | | | | Data Bytes (hex) ...
; | | | | | |
; ---+---+-----+---+---+---+---+---+---+---+---+---+---+---+---+---+
1)      943.5 Rx      0701 1 05
2)     1912.5 Rx      0701 1 05
3)     2592.0 Tx      0601 8 40 41 60 01 00 00 00 00
4)     2627.0 Rx      0581 8 43 41 60 01 34 33 32 31 --> 4321
5)     2932.5 Rx      0701 1 05
6)     3901.5 Rx      0701 1 05
7)     4016.5 Tx      0601 8 40 41 60 02 00 00 00 00
8)     4055.0 Rx      0581 8 43 41 60 02 38 37 36 35 --> 8765
9)     4921.5 Rx      0701 1 05
10)    5192.6 Tx      0601 8 40 41 60 03 00 00 00 00
11)    5228.3 Rx      0581 8 43 41 60 03 54 43 47 39 --> TCG9
12)    5941.5 Rx      0701 1 05
13)    6232.4 Tx      0601 8 40 41 60 04 00 00 00 00
14)    6248.1 Rx      0581 8 43 41 60 04 00 00 00 00 --> 0000
15)    6910.6 Rx      0701 1 05
16)    7385.1 Tx      0601 8 40 41 60 05 00 00 00 00
17)    7421.0 Rx      0581 8 43 41 60 05 00 00 00 00 --> 0000
18)    7930.5 Rx      0701 1 05
19)    8899.5 Rx      0701 1 05

```

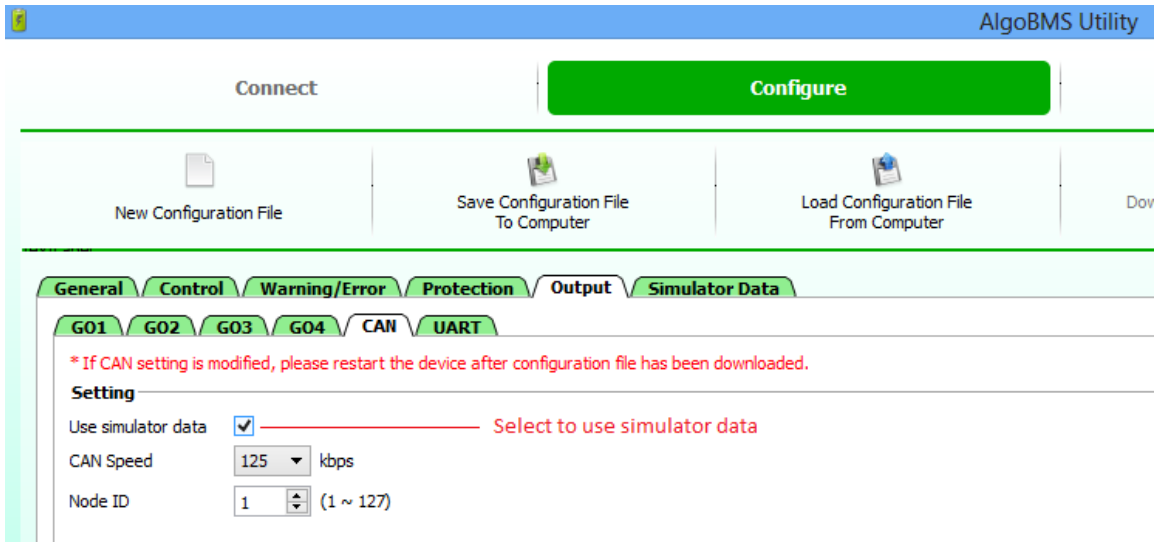
Actual Vehicle Id set in SW is "123456789GCT

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**Note:**

To vary parameters using the SW please use config → output → CAN tab.

Here make sure to select the “Use simulator data”



AlgoBMS Utility

Connect | **Configure**

New Configuration File | Save Configuration File To Computer | Load Configuration File From Computer | Download Configuration File To Computer

General | **Control** | Warning/Error | Protection | Output | Simulator Data

G01 | G02 | G03 | G04 | **CAN** | UART

\* If CAN setting is modified, please restart the device after configuration file has been downloaded.

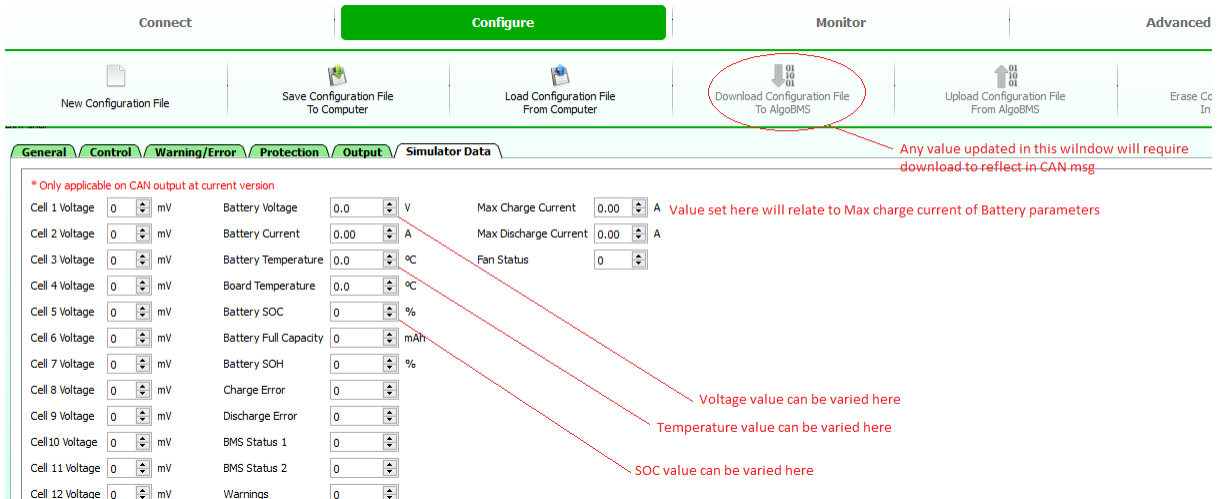
**Setting**

Use simulator data ☒ Select to use simulator data

CAN Speed: 125 kbps

Node ID: 1 (1 ~ 127)

Then to vary parameters using the SW please use config → simulator tab.



Connect | **Configure** | Monitor | Advanced

New Configuration File | Save Configuration File To Computer | Load Configuration File From Computer | **Download Configuration File To AlgoBMS** | Upload Configuration File From AlgoBMS | Erase Configuration File

General | **Control** | Warning/Error | Protection | Output | **Simulator Data**

\* Only applicable on CAN output at current version

Cell 1 Voltage: 0 mV | Battery Voltage: 0.0 V | Max Charge Current: 0.00 A | Value set here will relate to Max charge current of Battery parameters

Cell 2 Voltage: 0 mV | Battery Current: 0.00 A | Max Discharge Current: 0.00 A

Cell 3 Voltage: 0 mV | Battery Temperature: 0.0 °C | Fan Status: 0

Cell 4 Voltage: 0 mV | Board Temperature: 0.0 °C

Cell 5 Voltage: 0 mV | Battery SOC: 0 % | SOC value can be varied here

Cell 6 Voltage: 0 mV | Battery Full Capacity: 0 mAh

Cell 7 Voltage: 0 mV | Battery SOH: 0 %

Cell 8 Voltage: 0 mV | Charge Error: 0

Cell 9 Voltage: 0 mV | Discharge Error: 0

Cell 10 Voltage: 0 mV | BMS Status 1: 0

Cell 11 Voltage: 0 mV | BMS Status 2: 0

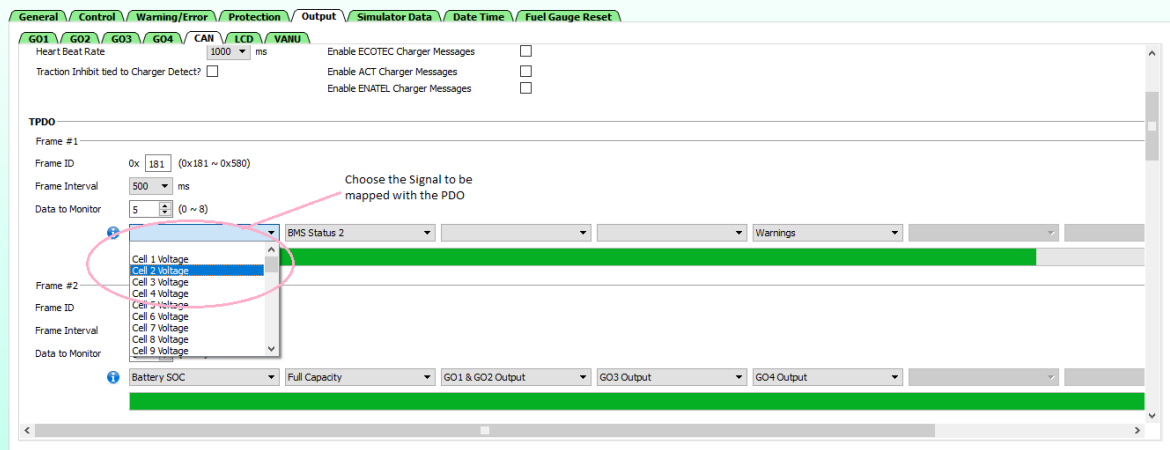
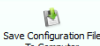
Cell 12 Voltage: 0 mV | Warnings: 0

Voltage value can be varied here

Temperature value can be varied here

Any value updated in this window will require download to reflect in CAN msg

Normal messages or the PDO's can be configured using the BMS SW. Below is an image of the configuration tab.




The following are examples of the typical CAN message which are translated by the BMS

	Message Number	Time Offset (ms)	Type	ID (hex)	Data Length	Code	Data Bytes (hex)	...
17)	5479.1	Rx	0701	1	05			
18)	5982.9	Rx	0181	8	AC D4	00 00	4B B8	00 0B
19)	5983.4	Rx	0281	2	00 00			
20)	6465.0	Rx	0701	1	05			
21)	6982.8	Rx	0181	8	AC D4	00 00	4B B8	00 0F
22)	6983.3	Rx	0281	2	00 00			
23)	7522.8	Rx	0701	1	05			
24)	7982.7	Rx	0181	8	AC D4	00 00	4B B8	00 0F
25)	7983.2	Rx	0281	2	00 00			

To ensure proper Charger Operation, the Status 2 Information can relay when Charger should be turned off. The Status 2 information will turn Charging Allowed to OFF (0) when cell voltages have reached full charge.

Status: 0x0B -> 0001011 : Normal status when key OFF, Charging allowed

 <b>GREEN CUBES</b> TECHNOLOGY	<b>03C-069 BATTERY SYSTEM: CAN MESSAGE DEFINITION &amp; TEST SETUP</b>	GCT Doc. Control No.:	711323
		Doc. Rev.:	1.4

*(Note since Charger & Discharge share single contactor, battery output will still be on)*

Status: 0x0F -> 00001111 : Normal status when key ON, Charging allowed

Status: 0x06 -> 00000111 : Main Chrg Allow OFF, Should be used to turn off charger

*(Note since Charger & Discharge share single contactor, battery output will still be on If charger continue to operate, battery will open contactor to shut down power when individual cell voltage reaches 3.8V for safety control.)*