BMS

(Battery Management System)

Manual

Release 1.0

S/W Version 1.0

NTech

2009/07

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PART I . Hardware

1. General Description

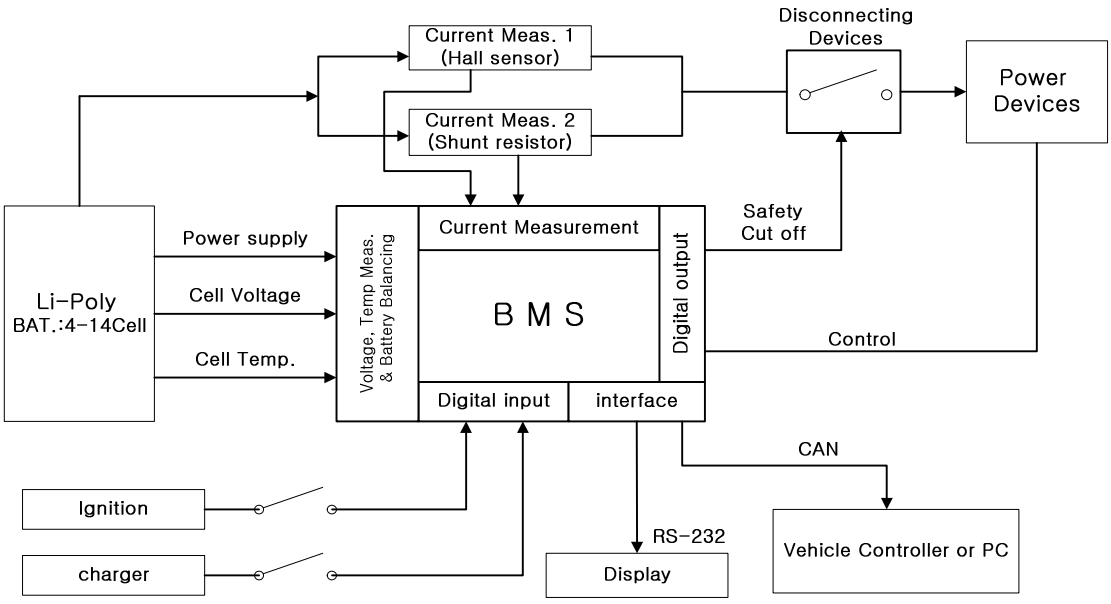
Li-Polymer cells offer great advantages if compared with other battery technologies; they are lighter, more durable can be stored in any state of charge, and they are environmentally benign. However, they require single cell monitor/control in order to be safe and long lasting.

N-Tech battery management system monitors continuously the status of each cell of the battery and helps keeping all the relevant battery parameters such as temperature, cell voltages and battery current, with in their safe limits.

Designed to perform this essential protection and to optimize each cell life,
N-Tech BMS also maximizes the whole battery pack`s performance and ensures it`s safe usage, compatible with most of the commercially available components for electric system, and designed for maximum flexibility Li-Polymer BMS 14 is the ideal choice for a vast range of applications.

2. Overview

A. System Overview



B. Features

- 14 Cells Voltage measurement
- 9ch Temperature measurement ***(BMS module uses Temp1 for itself)***
- Two method current measurement
  (via external shunt resistor or Hall effect transducers)
- Calculation of the state of charge(SOC)
- Cell equalization & Balancing
- Two relays with output for protecting the battery from
  - OVPT(Over Voltage Protection)
  - LVPT(Low Voltage Protection)
- Three digital Opto – isolated outputs
- Three digital Opto – isolated input used for
  - Detection of ignition
  - Detection of charger connection
  - Custom function
- Closed loop charge control
- Closed loop discharge control
- Interface
  - Can bus communication between modules and external components
    (e.g. charger, motor controller)
  - Serial communication(RS-232) for visualization data, setting parameters or data logging
- Power shut down function.
- Compact size[132mm(W) x 72mm(D) X 19mm(H)]

3. Operating Conditions & Specification

A. Operating Conditions

Items	Specification	Remark
Supply Voltage	10V to 60V	Battery Pack Voltage 4Cell~14Cell
Operating Temperature range	-25℃ to 60℃	
Storage Temperature range	-30℃ to 80℃	
ESD Susceptibility	1.5 kV	
Power Consumption	<- 1.5 W	Without External output Voltage 5V, 250mA

B. Specification

Item		Specification		Condition
Cell Voltage	Measuring range	0 ~ 5V		
	Accuracy	F.S ±0.1%		±5mV
	Number of Channel	14 Channel		
Cell Current	Measuring range	Not Fixed		Hall Sensor : 625mV, 1.25V Shunt : 50mV, 80mV
	Accuracy	Shunt Resistor	0.16mV	
		Hall effect transducer	5mV	
	Number of Channel	14 Channel		
Temperature	Measuring range	-30℃ ~ 70℃		10kΩ R T match Thermister(NTC Type)
	Accuracy	F.S ±1℃		Within the range of -10℃ to 50℃
	Number of Channel	9 Channel		

4. Pin Description

A. J9: Cell Voltages & Temperatures

Pin	Function		Pin
1	**Temp1(Internal purpose only)**	TGND	2
3	Temp2	TGND	4
5	Temp3	TGND	6
7	Temp4	TGND	8
9	Temp5	TGND	10
11	Temp6	TGND	12
13	Temp7	TGND	14
15	Temp8	TGND	16
17	Temp9	TGND	18
19	Temp10	TGND	20
21	Cell1-	Cell1-	22
23	Cell1+, Cell2-	Cell1+, Cell2-	24
25	Cell2+, Cell3-	Cell2+, Cell3-	26
27	Cell3+, Cell4-	Cell3+, Cell4-	28
29	Cell4+, Cell5-	Cell4+, Cell5-	30
31	Cell5+, Cell6-	Cell5+, Cell6-	32
33	Cell6+, Cell7-	Cell6+, Cell7-	34
35	Cell7+, Cell8-	Cell7+, Cell8-	36
37	Cell8+, Cell9-	Cell8+, Cell9-	38
39	Cell9+, Cell10-	Cell9+, Cell10-	40
41	Cell10+, Cell11-	Cell10+, Cell11-	42
43	Cell11+, Cell12-	Cell11+, Cell12-	44
45	Cell12+, Cell13-	Cell12+, Cell13-	46
47	Cell13+, Cell14-	Cell13+, Cell14-	48
49	Cell14+	Cell14+	50

★BMS module uses Temp1 for itself that it is not applicable for each individual users.

B. J6: Controls

Pin	Function		Pin
1	Rel2b NO	Rel2b COM	2
3	Rel2b NC	Rel2a NO	4
5	Rel2a COM	Rel2a NC	6
7	Rel1b NO	Rel1b COM	8
9	Rel1b NC	Rel1a NO	10
11	Rel1a COM	Rel1a NC	12
13	Out2 Emitter	Out2 Collector	14
15	Out1 Emitter	Out1 Collector	16
17	PWM2 Out Emitter	PWM2 Out Collector	18
19	PWM1 Out Emitter	PWM1 Out Collector	20
21	+5V(EVCC)	GND(EGND)	22
23	In3+	In3-	24
25	In2+	In2-	26
27	In1+	In1-	28
29	In1+	In1-	30

★In1 in master module receives ignition signal from external terminal, the signal moves to next module one by one using cascade control.

★ Cascade control uses PIN21 and PIN22 to convey the signal to In1 in next module.

C. J2: JTAG

Pin	Function		Pin
1	TCK	GND	2
3	TDO	+5V	4
5	TMS	nRESET	6
7	+5V	NC	8
9	TDI	GND	10

D. J11: RS-232

Pin	Function		Pin
1	NC	NC	2
3	RXD	NC	4
5	TXD	NC	6
7	EVCC(+5V)	EVCC(+5V)	8
9	EGND	EGND	10

★ ***While PC monitoring with RS232 communication is available, LCD display module can be used to monitor the function of each BMS module(Optional).***

E. J7: CAN

Pin	Function		Pin
1	External Reset1	NC	2
3	CAN_L	CAN_H	4
5	CAN_L	CAN_H	6
7	External Reset2	External Reset3	8
9	CVCC(+5V)	CGND	10

F. J8: Current

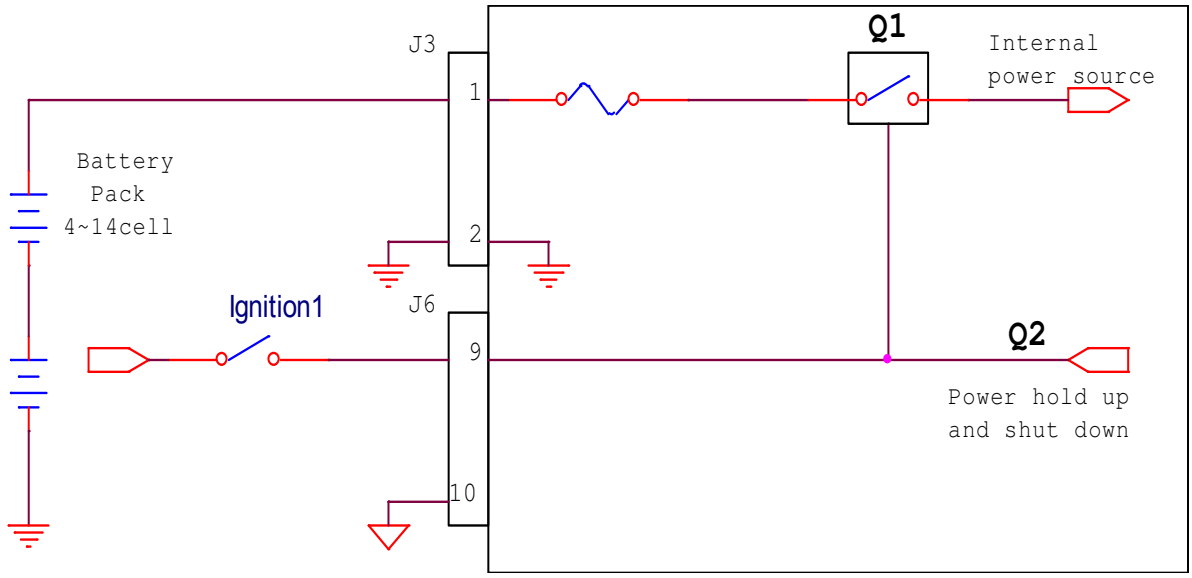
Pin	Function		Pin
1	Shunt+	NC	2
3	Shunt-	Hall_out	4
5	EVCC(+5V)	EGND	6
7	Hall_ref	NC	8
9	NC	EGND	10

G. J3: Power

Pin	Function		Pin
1	VCC	GND	3

5. Functionality

A. Power Up/Down



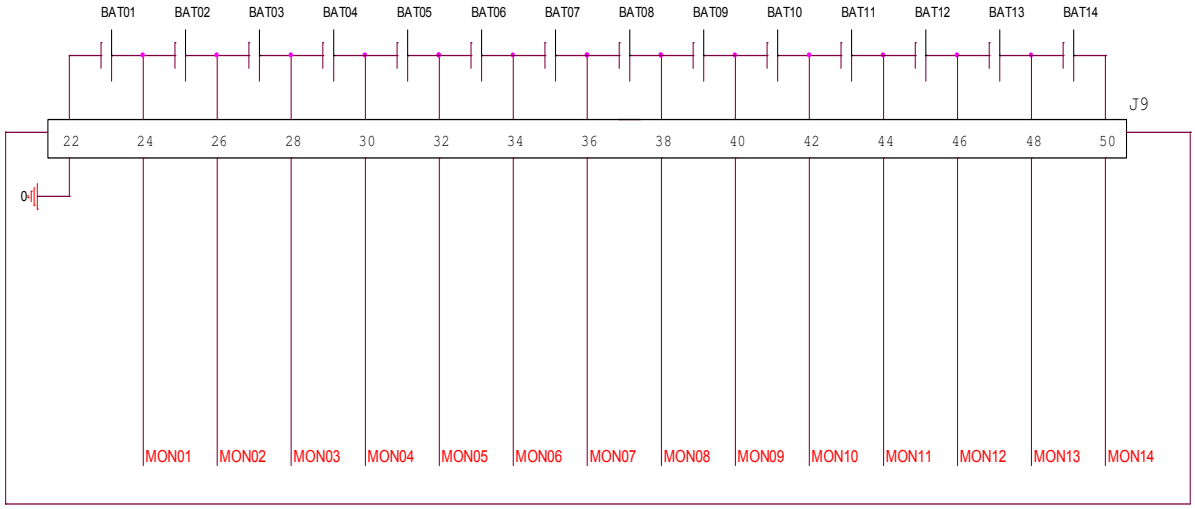
- Power Up

  - BMS input voltage depends on battery pack voltage 4~14 cells(10V~60V). Q1 is initially turned on by signal from External Digital input(Ignition Signal) letting power flow in and Power supply, using signals from Power hold up, continues with Ignition signal.

- Power Down

  - When Ignition is off and the cell balancing finishers according to parameter set value, Q2 is turned off as well as Q1 to Shut down BMS power.

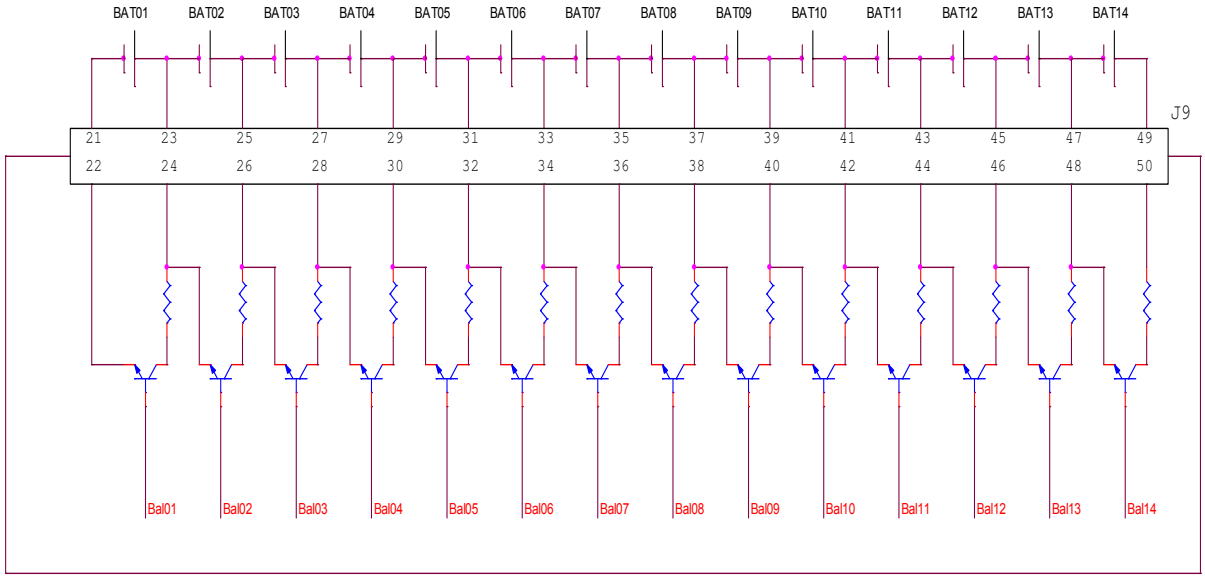
B. Cell Voltage Measurement



- The Cell Voltage Measurement input are also used for cell equalization All connections and cables must be sufficient for carrying current of up to 100mA

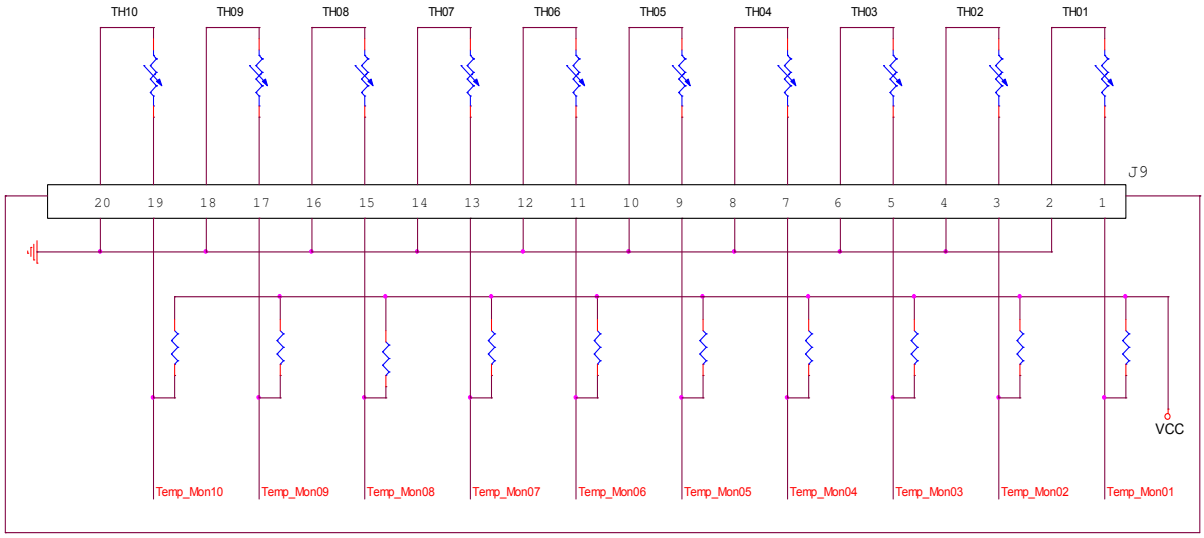
- Use cable with sufficient cross section for good mechanical strength

C. Cell Equalization(Balancing)



- Equalization occurs only during dormant periods(system switch off, charging has finished) and only the cell voltage is higher than the parameter "Min EQ Voltage" Equalization stops as soon as Maximum voltage difference is smaller than 10mV.

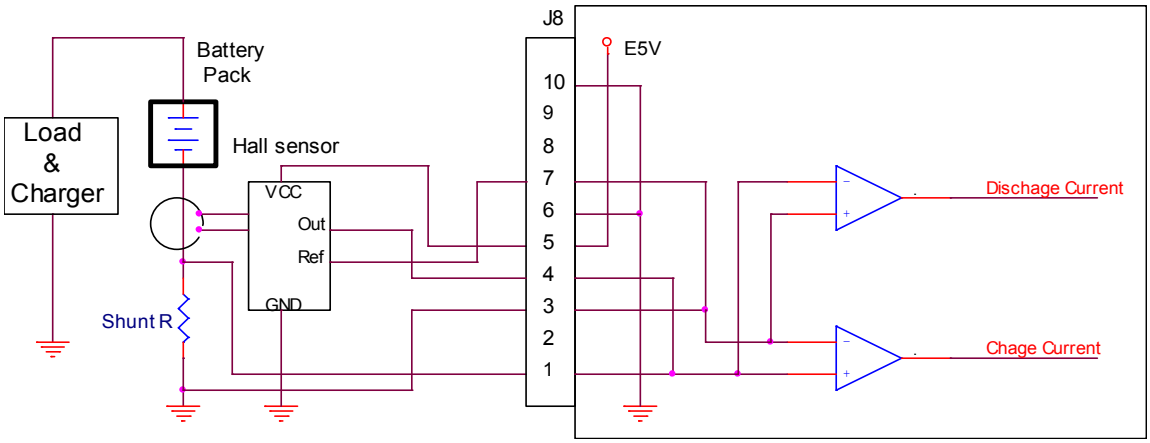
D. Temperature Measurement



- Ten temperatures are measured using a " NTC Thermistor 10kΩ at 25℃ R-T matched

  - The range is -30 ˚C to +70 ˚C
  - The error is smaller than ±1.0˚C within the range of -10˚C to +50˚C
  - 10ch Temperature measurement ***(BMS module uses Temp1 for itself)***

E. Current Measurement

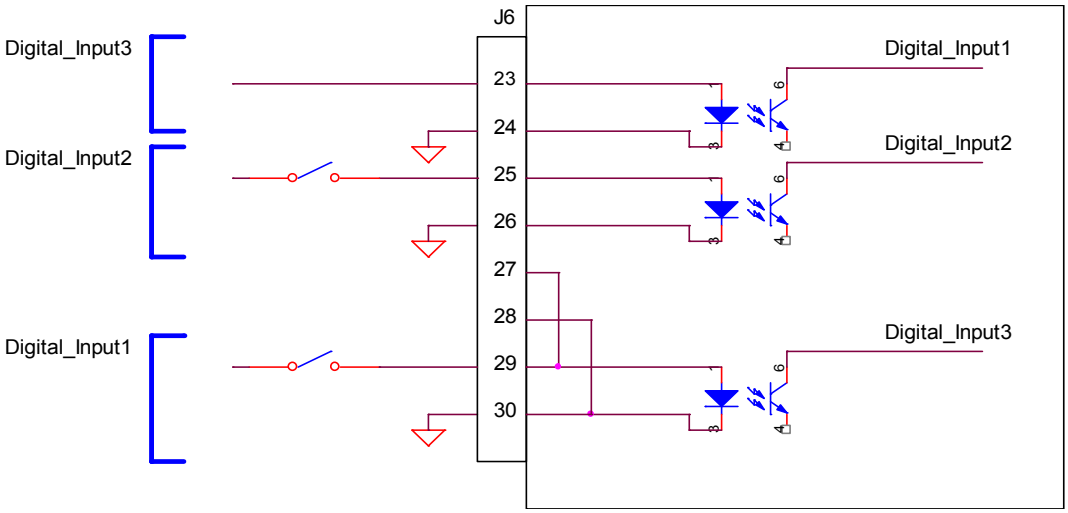


- This BMS provides an interface for measuring two separate Bi-directional current one of them using Hall Effect devices and the other one using a shunt resistor.

- The shunt resistor must be on the low side (-) of managed battery connect the shunt (+) to the battery low side and shunt (-) to the charge/load GND.

- The Hall Effect transducers are non-contact measurement systems which can be utilized anywhere (even to measure the currents in electrically isolated systems), they exhibit fewer EMC problems however; Hall-effect devices exhibit a higher power consumption than shunt resistors. The resolution of current measurements with Hall devices is lower and offset drift can be an issue if the reference output is not being used.

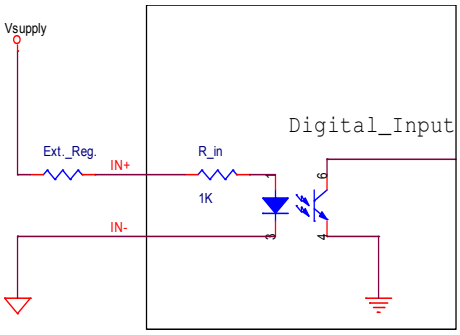
F. Digital inputs



- Digital input 1,2,3 are optically isolated inputs

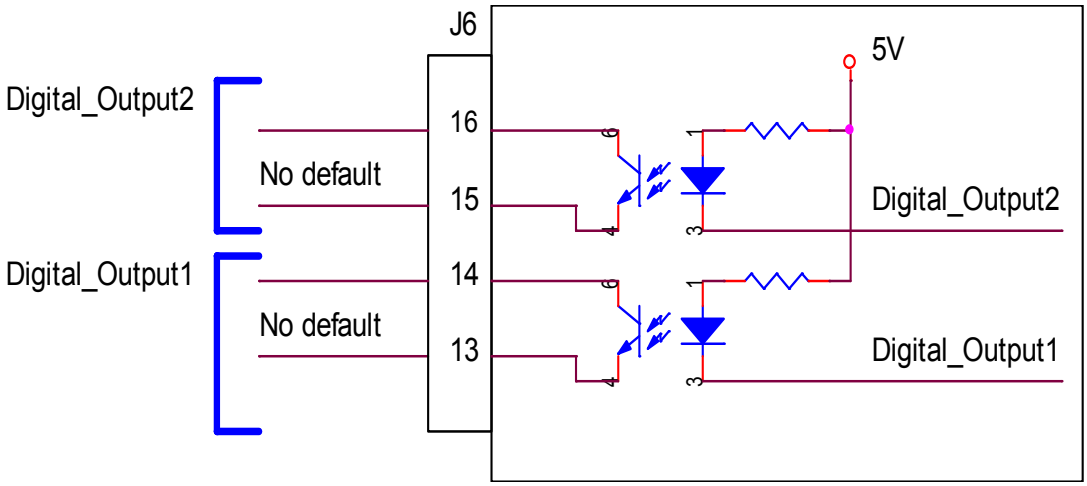
  - The first input is for sensing the "Ignition" input (on/off switch)
  - The second input is for sensing whether a charger is connected and switched on
  - The third input has no default function. This third input according to user requirements and specifications.

- External resistor needs to be applied in accordance with input voltage..



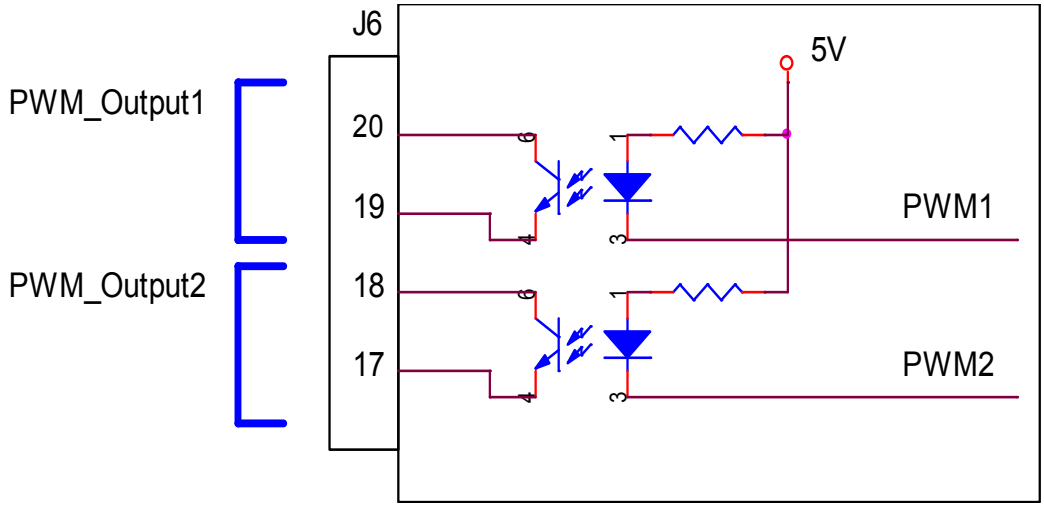
Voltage of battery pack	Number of cells	Resistor[kΩ]
12	3 ... 4	0.56
24	7	1.80
36	10 ... 12	2.70
48	12 ... 14	3.90

G. Digital outputs



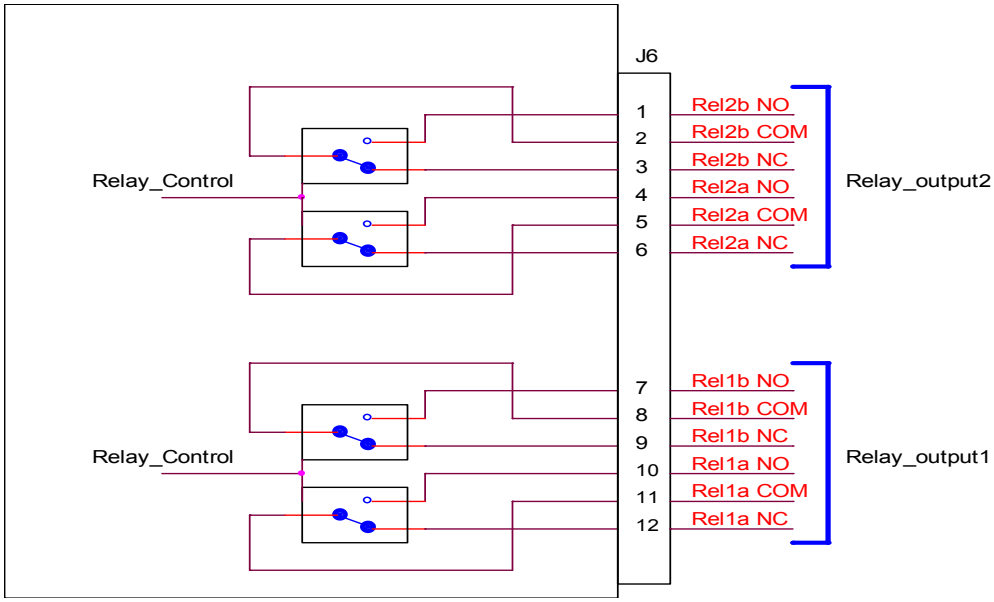
- Two opto-isolated digital outputs are provided.
- These opto-isolated digital outputs can be used by users to interface with external module and other equipments..

H. PWM output



- Two PWM outputs are provided for closed-loop controls.
  - The first output control(limits) the charger output
  - The second output control(limits)the discharger current

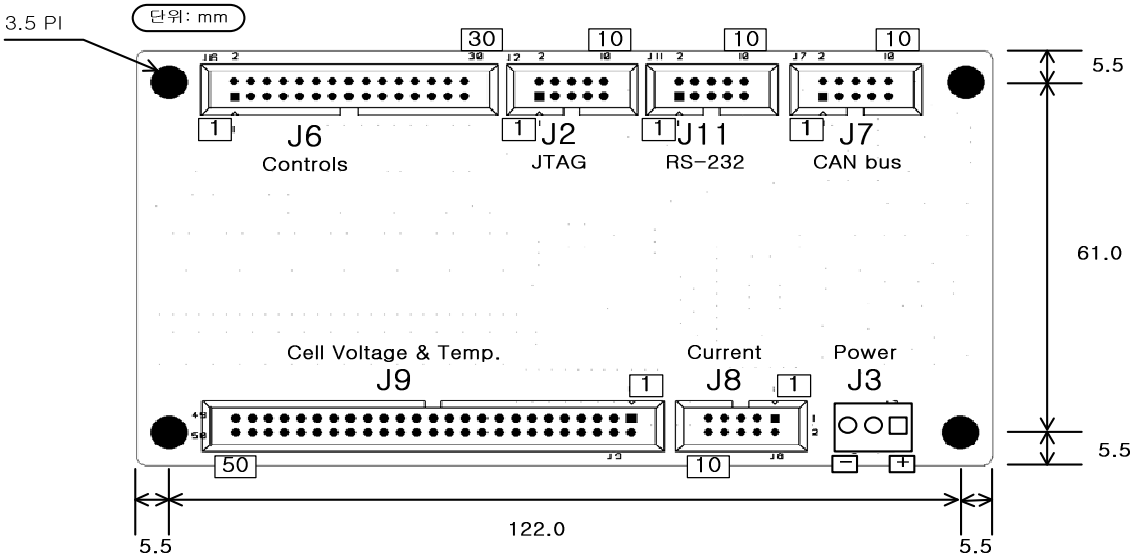
I. Relay output



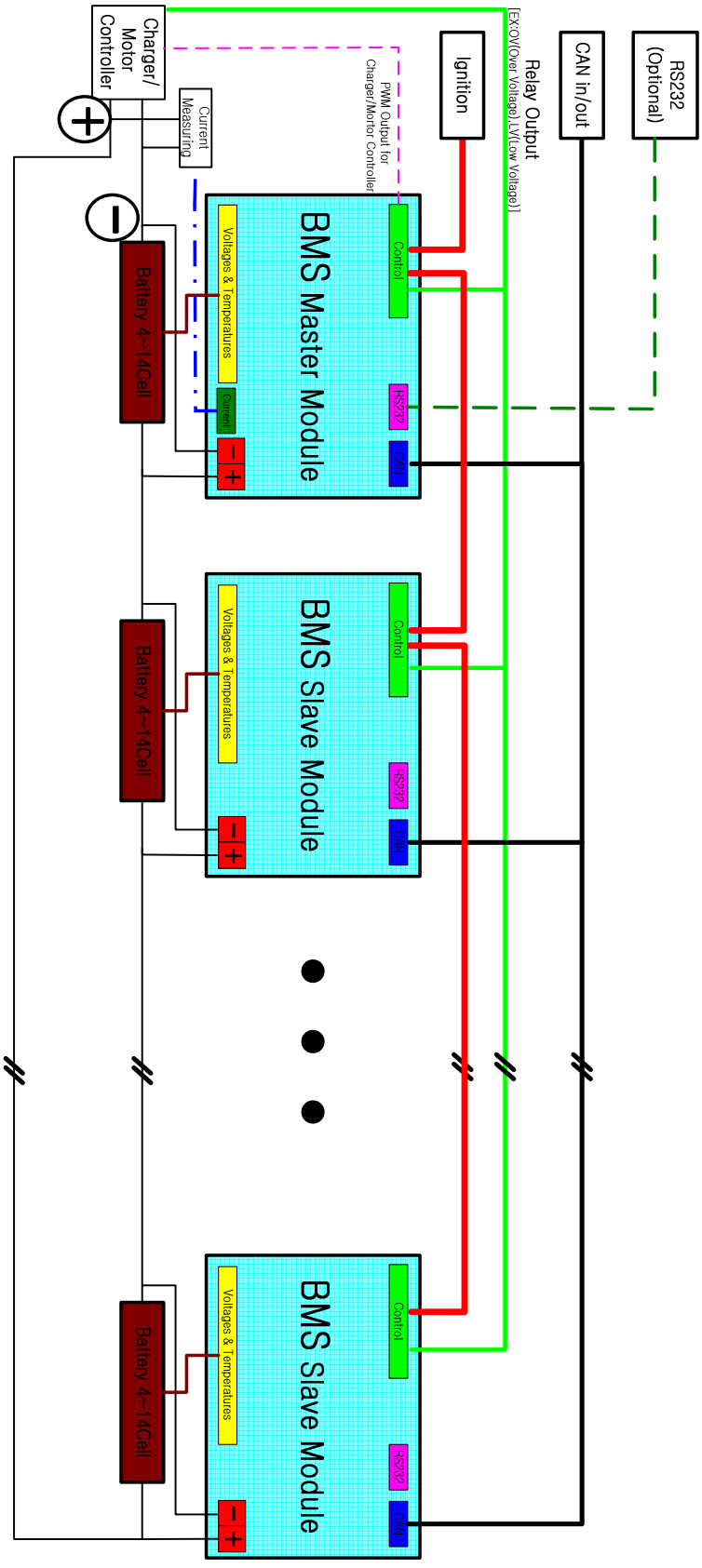
- Two relay output are provided for protection charge/discharge problems.
  - ➢ The relays are controlled by software and also by hardware protection layer they can be used for controlling main contactors as well as additional charge/discharge equipment such as auxiliaries or solar panel chargers
  - ➢ Relay1 switches the charging path and Relay2 switches discharging path each contacts in the relay can switch 1A at 30V. Both contacts in the relay can be paralleled in order to allow switching 2A at 30V.

6. PCB Layout & Dimensions

Shows the dimensions of the BMS printed circuit Board all connectors are labeled and the first and last pin of each connector are numbered

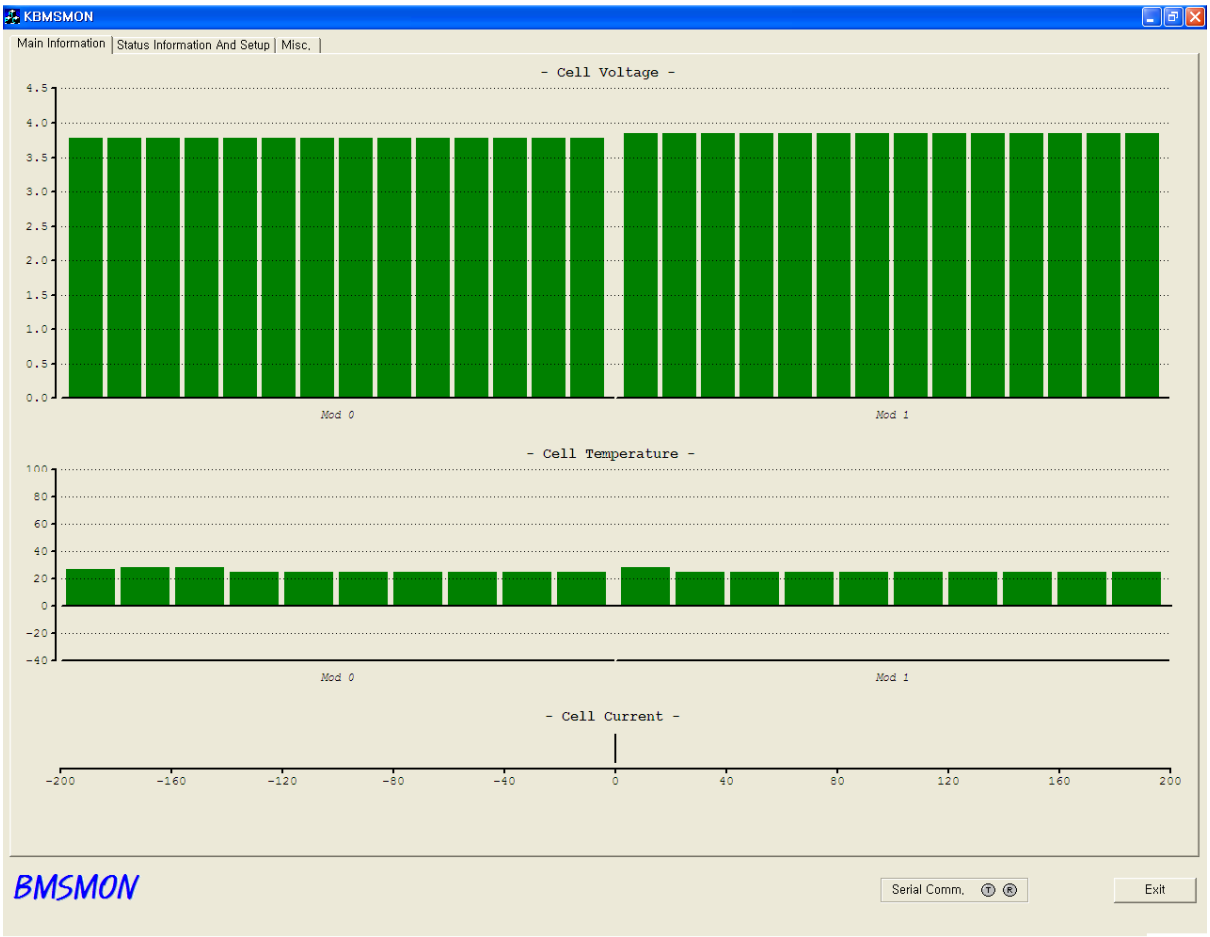


7. BMS System


Charger/
Motor
Controller
Current
Measuring
PWM Output for
Charger/Motor Controller
Ignition
Relay Output
[EX:OV(Over Voltage),LV(Low Voltage)]
CAN in/out
RS232
(Optional)
BMS Master Module
Voltages & Temperatures
Current
Control
RS232
CAN
Battery 4~14Cell
BMS Slave Module
BMS Slave Module

PARTⅡ. Software

1. Main Information



✧ Cell Voltage

- Cell voltage are displayed in a bar graph where users can have a clear look at glance.

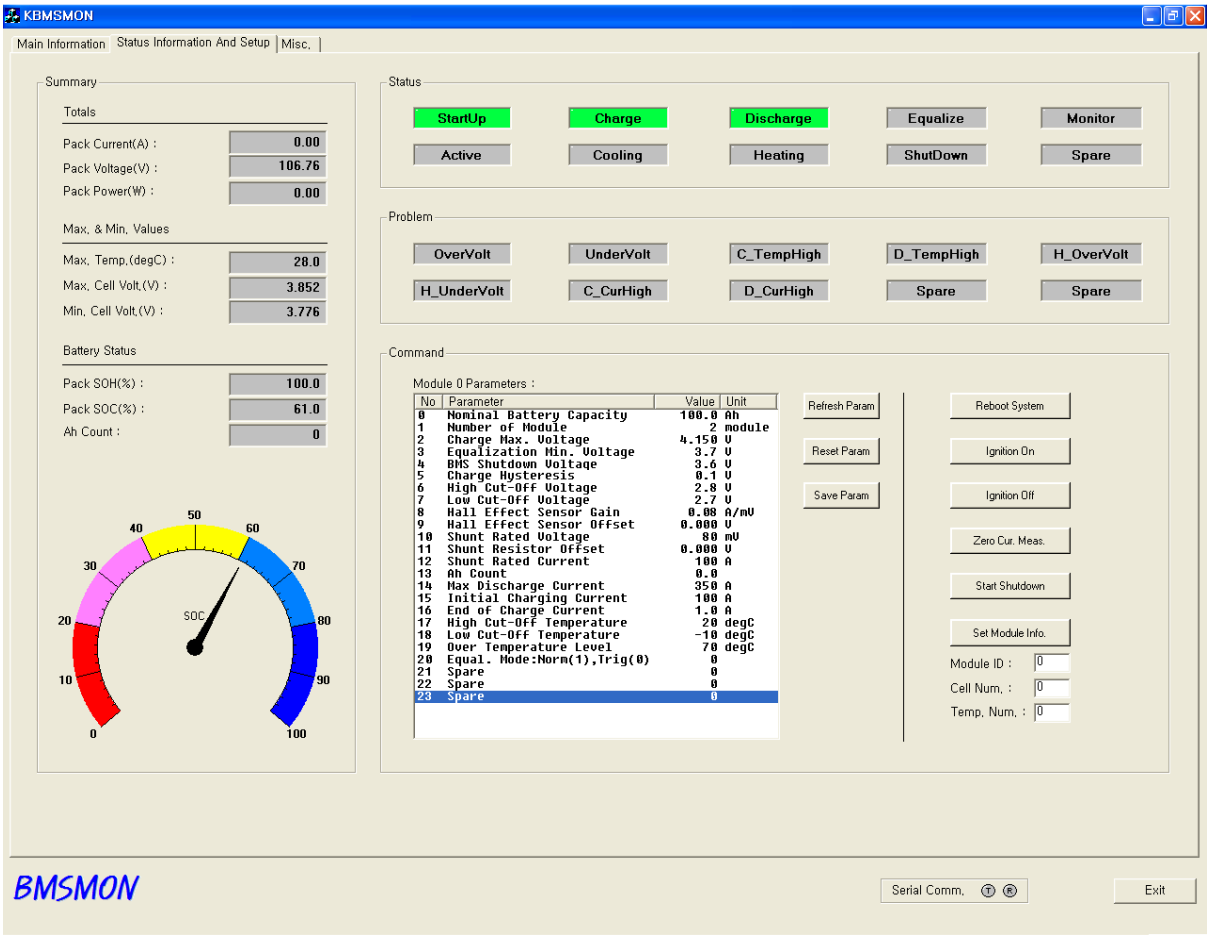
✧ Cell Temperature

- Cell temperatures from 10 checking points are also displayed in a bar graph.

✧ Cell Current

- Current measurements in both charging and discharging are displayed in cell current display.

2. Status Information and Setup



✧ Totals

- Pack Current(A)
- Pack Voltage(V)
- Pack Power(W)

✧ Max. & Min. Values

- Max. Temp.(degC)
  - ➢ Highest temperature among 9 channels.

- Max. Cell Volt.(V)
  - ➢ Maximum voltage among cells in battery pack.

- Min. Cell Volt.(V)
  - ➢ Minimum voltage among cells in battery pack.

✧ Battery Status

- Pack SOH (%)
  - ➢ Battery State of Health
- Pack SOC (%)
  - ➢ Battery State of Charge
- Ah Count

✧ Status

- Startup
- Charge
- Discharge
- Equalize
- Monitor
- Active
- Cooling
- Heating
- Shutdown

✧ Problem

- Over Volt
  - ➢ Over Voltage
- Under Volt
  - ➢ Under Voltage
- C_TempHigh
  - ➢ Charge Over Temperature
- D_TempHigh
  - ➢ Discharge Over Temperature
- H_OverVolt
  - ➢ Hardware Over Voltage
- H_UnderVolt
  - ➢ Hardware Under Voltage

- C_CurHigh
  - Charge Over Current

- D_CurHigh
  - Discharge Over Current

✧ Command

- Nominal Battery Capacity

- Number of Module
  - Parameter which enables master to recognize the number of slave boards connected when CAN communication occurs.

- Charge Max. Voltage
  - **It is crucial that users are aware of battery specification to prevent any events regarding overcharging.**

- Equalization Min. Voltage
  - It is possible to set lowest balancing voltage so that balancing mode won`t function at any level below set voltage by setting parameter.

- BMS Shutdown Voltage
  - Fixed voltage where BMS is shut down not to consume battery voltage when BMS delivers its performances such as checking voltage.

- Charge Hysteresis
  - When the voltage drops below setting value, it starts charging immediately.
    (Charge Voltage – Charge Hysteresis)

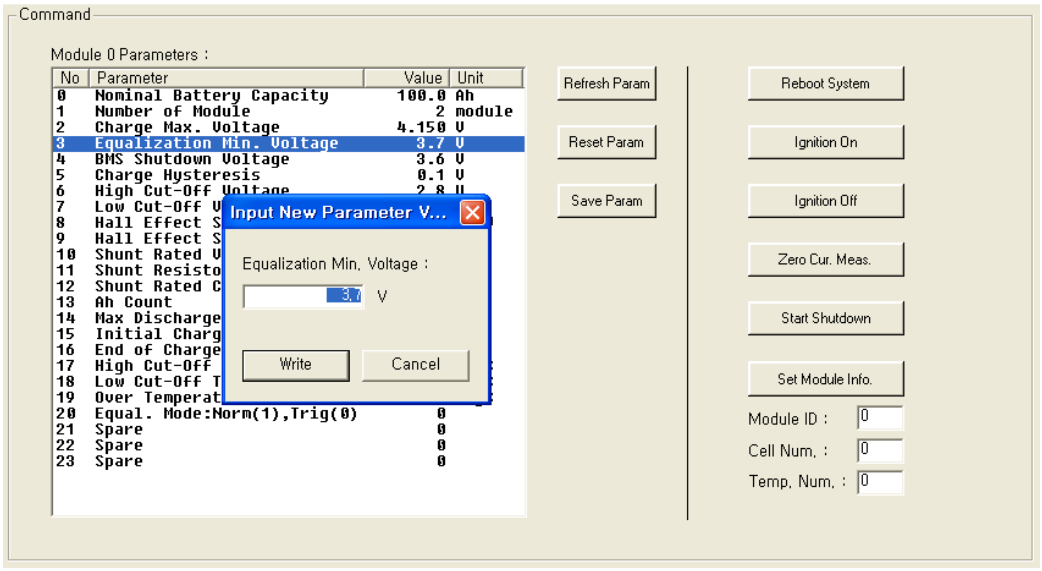
- High Cut-off Voltage(V)

- Low Cut-off Voltage(V)

- Hall Effect Sensor Gain(A/mV)
  - Current variation based on 1mV from Hall sensor.
  - **This value is used to select the Hall Effect Sensor and Shunt.**
    1. **Value is greater then 0 : Hall Effect Sensor using a perception.**
    2. **Value equal to 0 : Shunt using a perception.**

- Hall Effect Sensor Offset
  - Hall sensor value when current is 0
- Shunt Rated Voltage
- Shunt Resistor Offset
- Shunt Rated Current
- Ah Count
- Max Discharge Current
  - Users to set max discharge current in accordance battery capacity and load capacity.
- Initial Charging Current
  - Maximum charging current parameter when the battery pack is being charged.
- End of charge Current
  - Cut-off current in CV(Constant Voltage) period when charging.
- High Cut-off Temperature
- Low Cut-off Temperature
- Over Temperature Level

✧ Functions of buttons in command window and setting parameter.

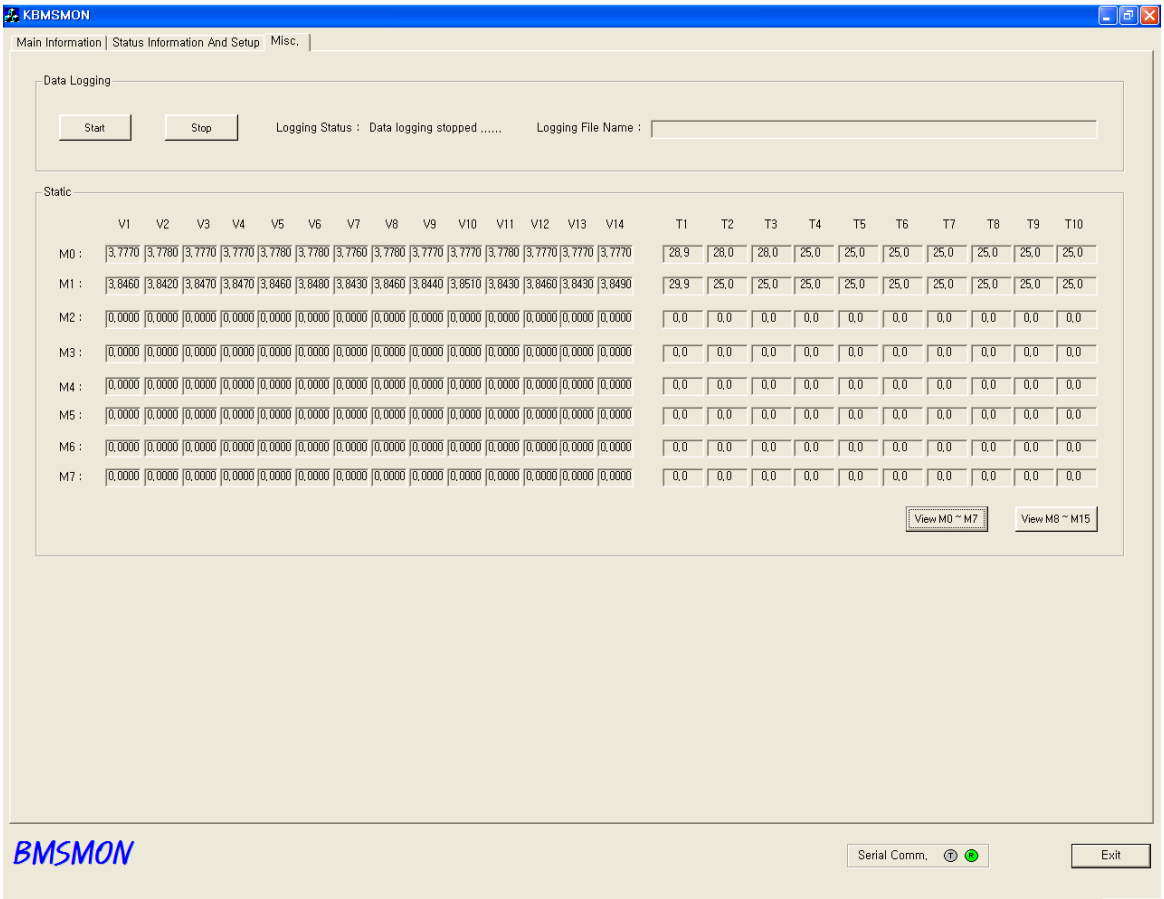


- Refresh Param
  - ➢ Refreshing parameter settings from the board.
- Reset Param
  - ➢ Buttons that sets everything back in parameter to default values.
- Save Param
  - ➢ Sending new parameter value from the screen to board.
- Reboot System
- Ignition On
- Ignition Off
- Zero Cur. Meas.
  - ➢ Button for Zero-in current(Current sensor calibration)
- Start Shutdown
  - ➢ Shut down BMS module.

- Set Module info.
  - ***This command should be entered in each of the modules..***
  - **Module ID : When setting the module ID, should start from master(0) one by one. If misplaced, should put "255" on set module ID to initialize and start again.**
  - Cell Num. : Set the number of battery cells.(MAX. 14 cells)
  - Temp. Num. : Set the number of temperature channels.(MAX. 9ch)
    (10kΩ R-T Match Thermister(NTC Type) should be used.)

- **Parameter setting**
  - Double clicking parameter item will show pop-up window where users can set parameter values.
  - Input parameter value and click write button.
  - When finish parameter settings, click **'save param'** button on the right and parameter value will be sent to BMS modules.

3. Misc.



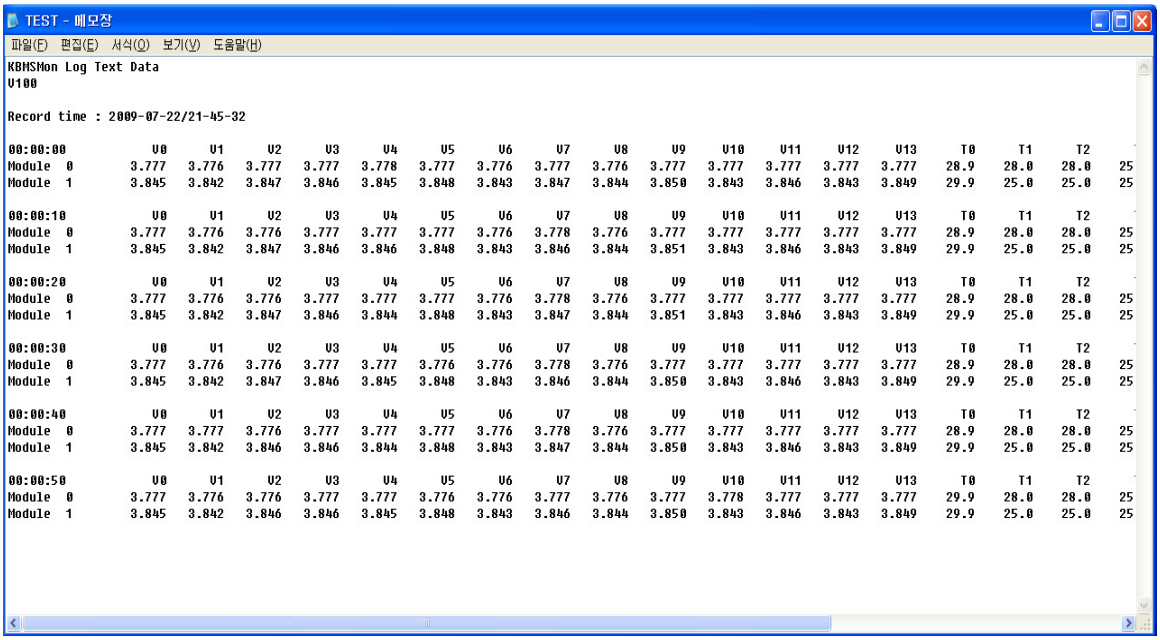
✧ Misc. Window has the following features.

- Voltage & temperature data storage capabilities of the BMS.
- Battery cell voltage monitoring.
- Temperature monitoring..

✧ Voltage & temperature monitoring data storage.

- Click the Start button.
- Set the path and filename of the file..
- When you click the Stop button, the data is stored in the specified file.

✧ **Voltage & temperature monitoring data storage for example (2 BMS module)**



TEST - 메모장

파일(F) 편집(E) 서식(O) 보기(V) 도움말(H)

```
KBMSMon Log Text Data
V100

Record time : 2009-07-22/21-45-32

00:00:00          V0     V1     V2     V3     V4     V5     V6     V7     V8     V9     V10    V11    V12    V13    T0     T1     T2
Module  0      3.777  3.776  3.777  3.777  3.778  3.777  3.776  3.777  3.776  3.777  3.777  3.777  3.777  3.777  28.9   28.0   28.0   25
Module  1      3.845  3.842  3.847  3.846  3.845  3.848  3.843  3.847  3.844  3.850  3.843  3.846  3.843  3.849  29.9   25.0   25.0   25

00:00:10          V0     V1     V2     V3     V4     V5     V6     V7     V8     V9     V10    V11    V12    V13    T0     T1     T2
Module  0      3.777  3.776  3.776  3.777  3.777  3.777  3.776  3.778  3.776  3.777  3.777  3.777  3.777  3.777  28.9   28.0   28.0   25
Module  1      3.845  3.842  3.847  3.846  3.846  3.848  3.843  3.846  3.844  3.851  3.843  3.846  3.843  3.849  29.9   25.0   25.0   25

00:00:20          V0     V1     V2     V3     V4     V5     V6     V7     V8     V9     V10    V11    V12    V13    T0     T1     T2
Module  0      3.777  3.776  3.776  3.777  3.777  3.777  3.776  3.778  3.776  3.777  3.777  3.777  3.777  3.777  28.9   28.0   28.0   25
Module  1      3.845  3.842  3.847  3.846  3.844  3.848  3.843  3.847  3.844  3.851  3.843  3.846  3.843  3.849  29.9   25.0   25.0   25

00:00:30          V0     V1     V2     V3     V4     V5     V6     V7     V8     V9     V10    V11    V12    V13    T0     T1     T2
Module  0      3.777  3.776  3.776  3.777  3.777  3.776  3.776  3.778  3.776  3.777  3.777  3.777  3.777  3.777  28.9   28.0   28.0   25
Module  1      3.845  3.842  3.847  3.846  3.845  3.848  3.843  3.846  3.844  3.850  3.843  3.846  3.843  3.849  29.9   25.0   25.0   25

00:00:40          V0     V1     V2     V3     V4     V5     V6     V7     V8     V9     V10    V11    V12    V13    T0     T1     T2
Module  0      3.777  3.777  3.776  3.777  3.777  3.777  3.776  3.778  3.776  3.777  3.777  3.777  3.777  3.777  28.9   28.0   28.0   25
Module  1      3.845  3.842  3.846  3.846  3.844  3.848  3.843  3.847  3.844  3.850  3.843  3.846  3.843  3.849  29.9   25.0   25.0   25

00:00:50          V0     V1     V2     V3     V4     V5     V6     V7     V8     V9     V10    V11    V12    V13    T0     T1     T2
Module  0      3.777  3.776  3.776  3.777  3.777  3.776  3.776  3.777  3.776  3.777  3.778  3.777  3.777  3.777  29.9   28.0   28.0   25
Module  1      3.845  3.842  3.846  3.846  3.845  3.848  3.843  3.846  3.844  3.850  3.843  3.846  3.843  3.849  29.9   25.0   25.0   25
```