LiFePO$_4$ Battery Module for Telecom

48NPFC100

BATTERY MANAGEMENT SYSTEM

Operation Manual

Version: 1.0

NARADA POWER SOURCE CO., LTD

Contents

1.   Overview

Smart BMS technology is adopted for battery modules of NPFC series to assure smart automatic management for batteries. Features of BMS are shown as below:

- There is a centralized monitoring unit in BMS. Functions such as monitoring, protection and communication are available. Battery modules can be controlled remotely by staffs in control center. NPFC series are in line with the requirements of the development of modern communications technology.

- It is combined by technologies of power source and computer. Parameters and status of rectifiers and AC/DC distributions can be detected and controlled.

- Excellent electromagnetic compatibility. BMS used for battery modules of NPFC series can comply with the outdoor power plants during operation, no interfere with each other.

- BMS can provide protections against overcharge, over-discharge, over-temperature, overcurrent, short circuit, etc., to assure reliable safety and operation life.

- With patented cell balancing technology, BMS provide high efficiency for cell balancing and prolong system operate life.

- Configuration flexibility, support parallel connection expansion

2.   BMS appearance

Fig. 2.1 BMS PCB Front side

3.   BMS functions

3.1. Voltage measuring, monitoring and protection

Measuring and Monitoring:
- ✓ Single cell voltage, error ≤ 0.5%, resolution: 1mV
- ✓ Module (pack) voltage, error ≤ 0.5%, resolution: 10mV

Protection:
- ✓ Single cell charge over voltage protection
- ✓ Single cell discharge under voltage protection
- ✓ Module charge over voltage protection
- ✓ Module discharge under voltage protection

3.2. Current measuring, monitoring and protection

Measuring and Monitoring:
- ✓ Charge current monitoring, show as positive value, error ≤ 2% (charge @0.5C), resolution: 10mA
- ✓ Discharge current monitoring, show as negative value, error ≤ 2% (discharge @0.5C), resolution: 10mA

Protection:
- ✓ Charge over current protection
- ✓ Discharge over current protection

3.3. Temperature measuring, monitoring and protection

Measuring and Monitoring:
- ✓ Group of cells (≤ 4 cells) temperature, error ≤ 3°C, resolution: 1°C
- ✓ Battery charge temperature, error ≤ 3°C, resolution: 1°C
- ✓ Battery discharge temperature, error ≤ 3°C, resolution: 1°C
- ✓ BMS PCB temperature, error ≤ 3°C, resolution: 1°C
- ✓ Ambient temperature, error ≤ 3°C, resolution: 1°C

Protection:
- ✓ Charge over temperature protection
- ✓ Charge under temperature protection
- ✓ Discharge over temperature protection
- ✓ Discharge under temperature protection

3.4. SOC (State Of Charge) measuring, monitoring

Measuring and Monitoring:
- ✓ State Of Charge (full capacity, remaining capacity), error ≤ 5% (charge/discharge @0.2C)

3.5. SOH (State Of Health) measuring, monitoring

Measuring and Monitoring: State Of Health, error ≤ 5%

3.6. Life cycles (finished cycles) counting, and monitoring

Detail algorithm:

✓ If the discharge DOD reaches to the 80%DOD, it will be 1 cycle.

✓ If one-time discharge is not reach to the 80%DOD, it will be accumulated to 80%DOD, then it will count one cycle.

3.7. Total discharge capacity (or energy) measuring and monitoring

Measure and store the accumulated discharge capacity (Ah) or energy (Wh) in whole battery life, error < 5%.

Ampere integral method is applied: the current and discharge time will be monitor by BMS, then calculate the discharge capacity by ampere integral method.

3.8. Cell voltage balancing

Control and balance the voltage between cells together during charging

Detail algorithm: When the one cell reaches to the 3.5V, cell voltage deviation ≥ 20mV, and when charging the battery, the balance function will start, then charging current will be limited to 60-100mA

3.9. Charge current limitation

Control and self-limit the battery charging current when charging current exceeds allowed value

Detail algorithm: If the current is exceeded than allowed value, the MOSFET wil turn off, then charge self-limit function will start, the current will be limited to about 10A.

3.10. Short-circuit protection

Short-circuit detection and protection

3.11. Polarity reverse protection

Polarity reverse detection and protection

3.12. RS232/RS485 communication

Communicate with computer or other devices.

✓ RS232: Used for BMS firmware update. It is adopting RS-232 series port to upload data. Contents of data transmit include BMS parameters, battery running status, alarms, etc. Generally, speed rate of RS-232 is 1200bps.

✓ RS485: Use for communication. It is adopting RS485 series port communication pattern to upload data. Communication of modules connected in parallel (Slave PACKs) is available through RS 485.
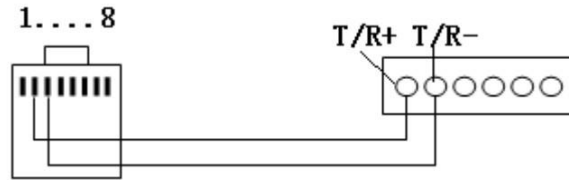
RJ45 Pins	Definition	Sketch
1	GND	
2	RS485_A	
3	RS485_B	
4,5,6,7,8	No connection	

3.13. LED indicator

SOC indicator: Four green LED lights in front panel indicating SOC. SOC is short for state of charge. Each SOC LED light represents 25% of rated capacity. Detailed information is shown in table 3.1.

Table 3.1. SOC indicators description

Capacity	LED Status			
	●	●	●	●
	LED1	LED2	LED3	LED4
0-25%	ON	OFF	OFF	OFF
25%-50%	ON	ON	OFF	OFF
50%-75%	ON	ON	ON	OFF
75%-100%	ON	ON	ON	ON

Run LED indicator: one green LED light in front panel indicating running status. Detailed information is shown in table 3.2.

Table 3.2. Run indicator description

LED Status	Module Condition
Flash1 (ON-0.25S, OFF-3.75S)	Register successfully, but neither charge nor discharge
Flash2(ON-0.5S, OFF-0.5S)	Charging state
Flash3(ON-0.15S, OFF-0.15S)	Register failed
Continuous ON	Discharging state
Continuous OFF	Dormant state

Alarm LED indicator: one red LED light in front panel indicating alarms. Detailed information is shown in table 3.3.

Table 3.3. Alarm indicator description

LED Status	Module Condition
Flash1 (ON-0.25S, OFF-3.75S)	Reserved
Flash2 (ON-0.5S, OFF-0.5S)	Faulty alarm
Flash3 (ON-0.15S, OFF-0.15S)	Reserved
Continuous ON	Failed alarm
Continuous OFF	Reserved

3.14. ADD switch dip function:

ADD is applicable to modules connected in parallel. ADD consists of four binary bits. Detailed information is shown in Fig 3.2.

Fig. 3.2 ADD switch dip

Up to 16 batteries can be connected in parallel with the max deviation of current should be 40A and total charge/discharge current for the whole string must be in below range:

✓ 1 module: 1C (max.100A);
✓ 2~5 modules: 0.5C (max.100A~max.250A)
✓ 6~8 module: 0.3C (max.180A~max.240A)
✓ 8~10 module: 0.2C (max.160A~max.240A)
✓ 10~16 module: 0.2C (max.160A~max.240A)

The new batteries also can be connected with old batteries (different SOH) then properly work if the below conditions are met:

✓ Same nominal voltage and capacity (48V100Ah)
✓ Same cell material (LFP)
✓ Maximum 3 old batteries when 10 batteries in total.
✓ Old modules have been in use for no more than 1 year.

Note: This scheme is just based on theoretical calculation. With this configuration, the life time of new batteries will be affected. Moreover, the capacity of new batteries is less than nominal because they can only be discharged the capacity as old ones, can not full discharge themselves.

3.15. Dry contact function:

Two pcs of normal close dry contact:

• Failure Alarm: Indicate BMS or battery fail including but not limited to charge and discharge MOS fail, cell voltage under 1.75V, module voltage under 26V, NTC disconnect.

• Fault Alarm: Output short circuit, charge and discharge over current, charge and discharge over temperature/low temperature, polarity reverse, battery shutdown

4. BMS parameters

4.1. Basic function parameters

Table 4.1. Basic function parameters

Item	Description	Value
Charge Over-Current	Current limitation value	10±2A
Dormant Voltage	Battery sleep voltage value	3.1±0.05V
Power Consumption	Working (Fan ON)	≤100mA
	Dormant (Fan OFF)	≤40mA
Charge Balancing	Balancing open voltage	3.5V
	Balancing open voltage gap	20mV
	Balancing current	20-200mA
Dimension	W*H*D (mm)	260.0*100.0*48.0

4.2. Protection parameters

Table 4.2. Protection parameters

Item	Description	Val
Single cell over-voltage protection	Cell over-voltage voltage	3.80±0.05V
	Cell over-voltage protection delay time	1.0-
	Cell over-voltage recovery voltage	3.34±0.05V
Single cell under-voltage protection	Cell under-voltage voltage	2.50±0.05V
	Cell under-voltage protection delay time	1.0-
	Cell under-voltage recovery voltage	Charge recovery
Battery over-voltage protection	Battery over-voltage voltage	56.0±0.5V
	Battery over-voltage protection delay time	1.0-
	Battery over-voltage recovery voltage	51.0±0.5V
Battery under-voltage protection	Under-voltage voltage	40.5±0.5V
	Under-voltage protection delay time	1.0-
	Under-voltage recovery voltage	Charge recovery
Overcurrent protection	Charge over-current level1	105±
	Charge over-current level1 delay time	4.0±
	Discharge over-current level1	105±
	Discharge over-current level1 delay time	5.0±
	Charge over-current level2	120±
	Charge over-current level2 delay time	300±10ms
	Discharge over-current level2	120±
	Discharge over-current level2 delay time	500±50ms
Short-circuit	Short circuit current	210±1
	Short circuit protection delay time	≤500

Item	Description	Value
	Protection recovery	Disconnect with loads and 1. Reset 2. Charge recovery
Temperature protection	Charging over temperature protection	65±3℃
	Charging over temperature protection recovery	55±3℃
	Discharging over temperature protection	70±3℃
	Discharging over temperature protection	65±3℃
	Charging under temperature protection	-10±3℃
	Charging under temperature recovery	0±3℃
	Discharging under temperature protection	-20±3℃
	Discharging under temperature recovery	-10±3℃

4.3. Alarm parameters

Table 4.3. Alarm parameters

Item	Description	Value
Single cell over-voltage alarm	Cell over-voltage voltage	3.60±0.05V
	Cell over-voltage alarm delay time	1.0-2.5s
	Cell over-voltage recovery voltage	3.50±0.05V
Single cell under-voltage alarm	Cell under-voltage voltage	2.80±0.05V
	Cell under-voltage alarm delay time	1.0-2.5s
	Cell under-voltage recovery voltage	3.10±0.05V
Battery over-voltage alarm	Battery over-voltage voltage	54.5±0.5V
	Battery over-voltage alarm delay time	1.0-2.5s
	Battery over-voltage recovery voltage	53.2±0.5V
Battery under-voltage alarm	Under-voltage voltage	45.0±0.5V
	Under-voltage alarm delay time	1.0-2.5s
	Under-voltage recovery voltage	50.0±0.5V
Over-current alarm	Charge over-current level1	80±2A
	Charge over-current level1 delay time	1.0±2s
	Discharge over-current level1	70±2A
	Discharge over-current level1 delay time	1.0±2s
	Charge over-current level2	90±2A
	Charge over-current level2 delay time	100±10ms
	Discharge over-current level2	80±2A
	Discharge over-current level2 delay time	200±50ms
Short-circuit	Short circuit current	130±10A
	Short circuit alarm delay time	≤500us

Temperature alarm	Charging over temperature alarm	55±3℃
	Charging over temperature protection recovery	45±3℃
	Discharging over temperature alarm	50±3℃
	Discharging over temperature alarm recovery	45±3℃
	Charging under temperature alarm	-10±3℃
	Charging under temperature recovery	0±3℃
	Discharging under temperature alarm	-20±3℃
	Discharging under temperature recovery	-10±3℃

5. Guideline of PC software
5.1. Installation of PC software driver

Step 1:

Connect USB to RS485 cable to laptop or PC.

Step 2:

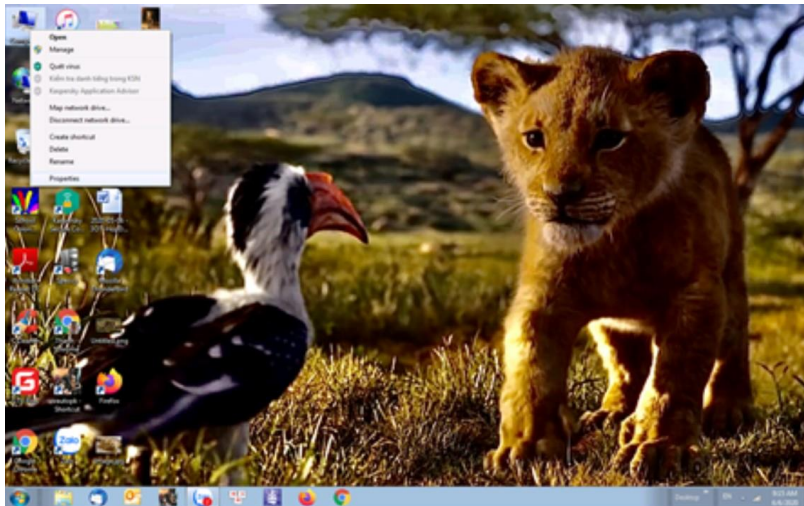Right click on 'My computer' icon, choose "Properties"

Fig. 5.1 Open 'Properties" in computer

Step 3:

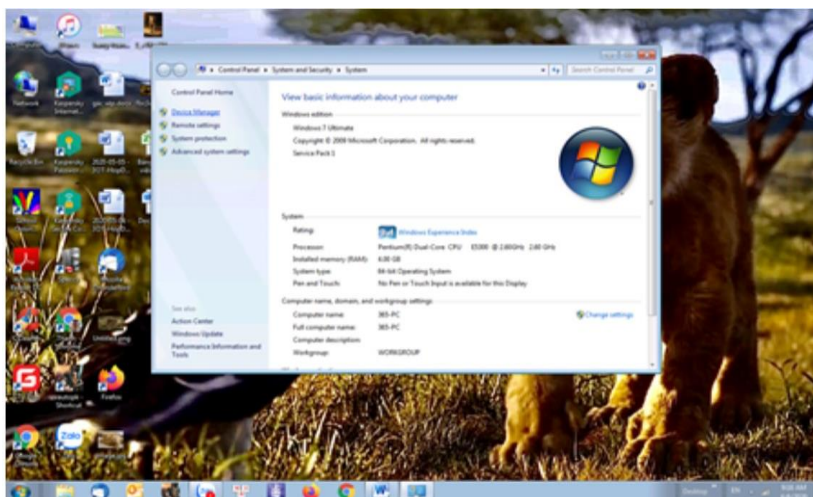Open 'Device manager'.

Fig. 5.2 Open 'Device Manager' in computer

Step 4:

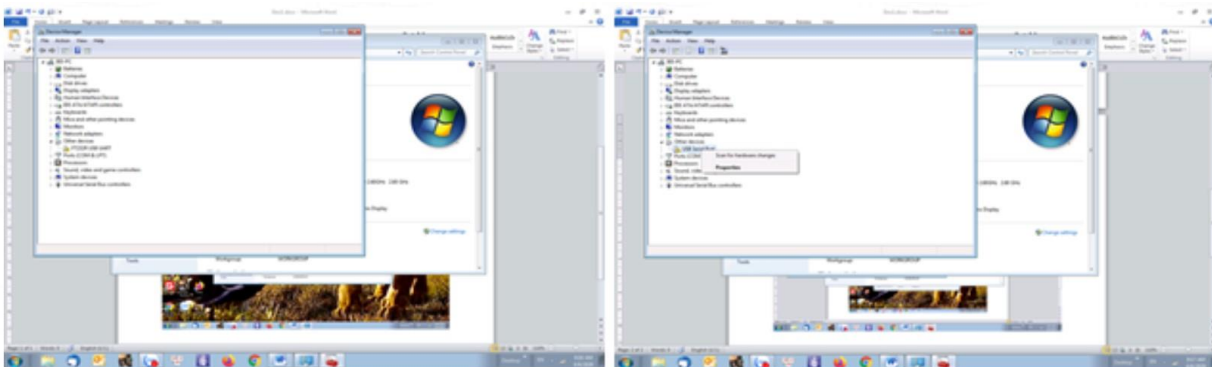RS485 cable (FT232R USB UART) driver is automatically updated by Window

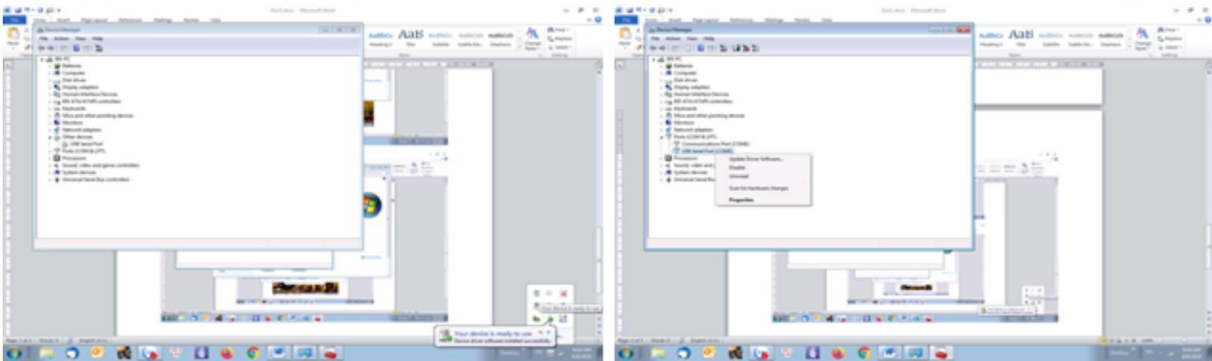Fig. 5.3 Window automatically update driver for RS485 cable

It is ready for use now:

Fig. 5.4 RS485 cable is ready for use (COM3)

5.2. Installation of PC software

Step 1:

Using Narada RS485 to USB communication cable as shown in the figure bellowing. The cable converts 485 signals to USB signal to PC. Connect USB to RS485 communication cable to laptop.
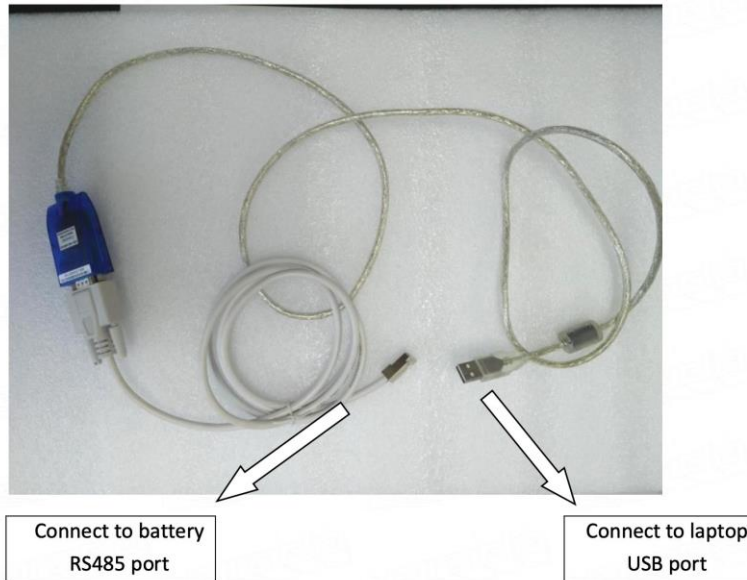

Fig. 5.5 photo of USB to 485 cables
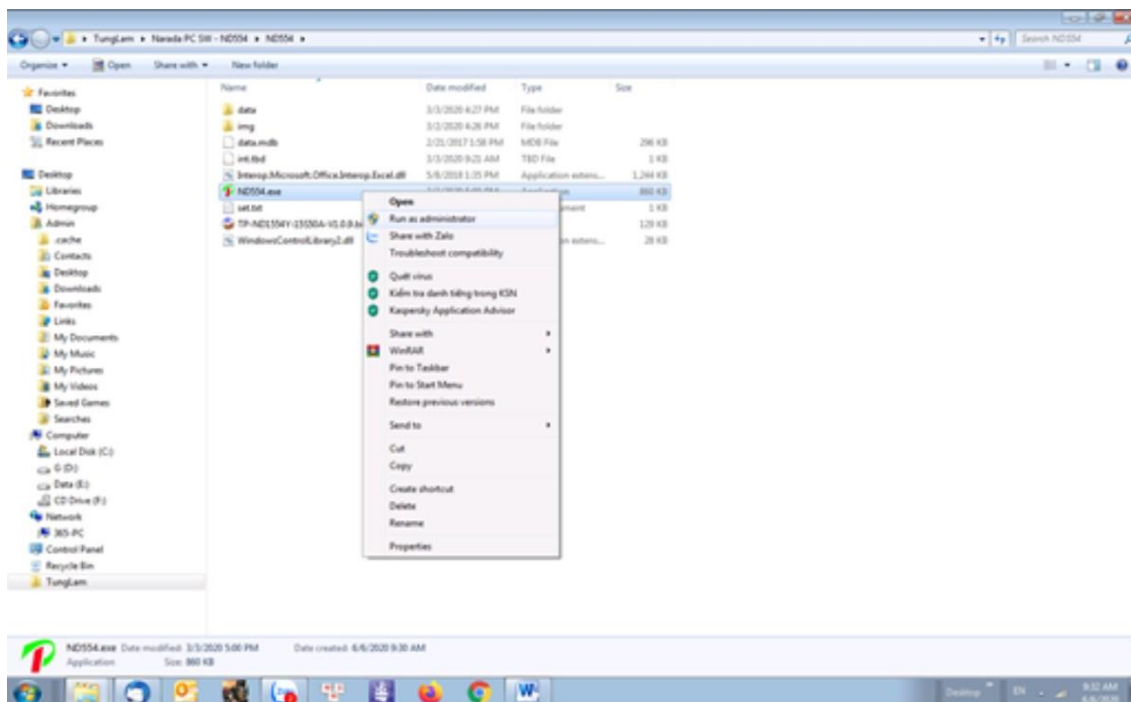
Step 2:

Open PC software

Fig. 5.6 PC software for monitoring BMS

Step 3:

Select language

Fig. 5.7 Select English
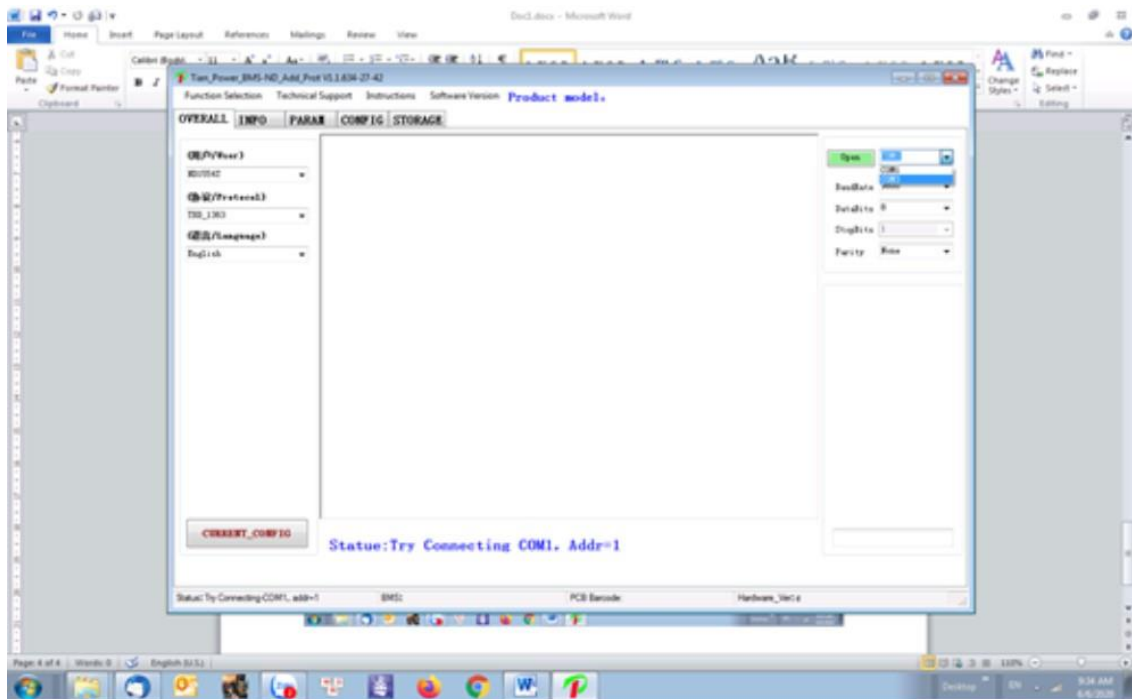
Step 4:

Select COM port

Fig. 5.8 Select COM port (COM3)
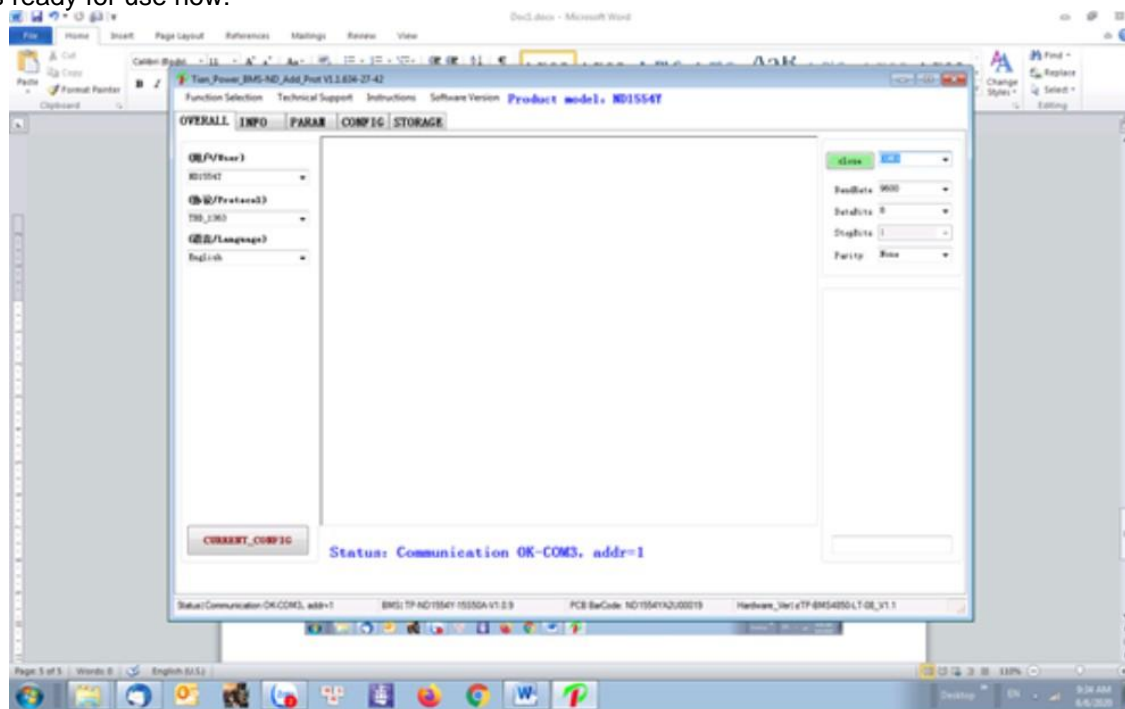
It is ready for use now:

Fig. 5.9 Communication OK, PC software is ready for use

5.3. Introduction of PC software

PC software include 5 General Tabs: including 'OVERALL', 'INFO', 'PARAM', 'CONFIG', 'STORAGE'.

1. OVERALL page: Basic information of BMS and PC software

   ✓ Manufacture name and PC software version;

   ✓ Communication data information: COM port, Baud rate, Data bits, Stop bits, Parity Check;

   ✓ Communication status: show battery communicate with PC is OK or not.

2. INFO page --- single pack

   ✓ Shows 15 Cell voltage;
   ✓ V_SUM: module voltage;
      V_AVG: average cell voltage;
      V_MAX: maximum cell voltage;
      V_MIN: minimum cell voltage;
      V_DIFF: gap voltage between
      V_MAX and V_MIN;
      Loop count: finished cycles
      Capacity_Full: fully capacity;
      Capacity_Surplus: remaining capacity;
      Remain_Chg_Time: remaining charging time;
      Remain_Disg_Time: remaining discharging time;
      Total_DSG_Capa: total discharged capacity (Ah)
      CELL_TEMP1-4: 1-4 Cell sub-packs terminal temperature; PCB_TEMP: BMS temperature;
      ENV_TEMP: ambient temperature inside battery;
      Current: charge/discharge current, positive current means charging, negative current means discharging.
   ✓ Protect Status:

      Show protection information

   ✓ Alarm Status:

      Show alarming information

   ✓ Normal Status:

      Show battery SOC and SOH

   ✓ Communication: Connect to PC software is OK or not;

   ✓ Communication port:

      RS232: apply to single battery communication RS485:

      apply to multiple batteries communication Pack_Count:

      numbers of battery paralleling connection

      DIP_Addr: Choose the address number same as battery accordingly

3. INFO page --- Multipacks

    Show all real-time batteries information, including cell voltage, module voltage, current, temperature.

4. INFO page --- Record

    Display: Click display button, show battery information.

    Clear: Click clear button, remove battery information.

    Save: Click save button, save shown battery information on the screen as '.xls' format.

    Auto save: Click auto save button, save battery information automatically for every 1/10/50/100/200/400… up to 10,000 items.

    Data export: Click export data button, export all battery information to .xls file

5. PARAM page

    Parameter column: shows all protection/alarm threshold and recovery values.

    LoadBak Params: load '.xml' parameter setting.

    BackUP Params: save the current parameter setting as '.xml' format.

    Export Params Data: Export all parameters read to .xls format

    Load Origin: load factory parameter settings.

    Read: read current protection and alarm parameter. If the value is different with factory parameter settings, it will display in red color.

6. CONFIG page

    For operation and maintenance staff debugging and testing purposes only.

7. STORAGE page

    For operation and maintenance staff debugging and testing purposes only.

6. Maintenance

6.1. Procedure of installation the BMS：λ

- ✓ Fix BMS on battery container λ
- ✓ Connect B+ and B- λ
- ✓ Connect FAN on BMS λ
- ✓ Connect 18Pin connector λ
- ✓ Connect P+ and P_6.2

6.2. Procedure of disassemble the BMS：

Reverse the procedure as 6.1.

Annex 1– LCD Menu Instruction (Optional)

Press "MENU" to enter the following interface

Welcome

Battery manage system

Press "MENU" next

Press "MENU" to enter the following interface

Battery parameters query

Battery status Battery

parameter settings Version

Information

1.   The "Battery Parameters" subdirectory

——Voltage: xxxx V

——Current: xxxx A (charge: +, discharge: -)

2.   The "Battery Temperature" Subdirectory

——Temperature01: xx℃

——Temperature02: xx℃

——Temperature03: xx℃

——Temperature04: xx℃

——PCB Temperature: xx℃

——Environment Temperature: xx℃

——The "Cell Voltages" Subdirectory

——Cell01: xxxx mV

——Cell02: xxxx mV

——Cell03: xxxx mV

——Cell04: xxxx mV

——Cell05: xxxx mV

——Cell06: xxxx mV

——Cell07: xxxx mV

——Cell08: xxxx mV

——Cell09: xxxx mV

——Cell10: xxxx mV

——Cell11: xxxx mV

——Cell12: xxxx mV

——Cell13: xxxx mV

——Cell14: xxxx mV

——Cell15: xxxx mV

——Cell16: xxxx mV

——SOC: xxxx%

——Nominal Capacity: xxxx Ah

——Remaining Capacity: xxxx Ah

——Battery Cycles: xxxx

The "Battery Status" Subdirectory

——Status: IDLE/CHARGE/DISCHARGE

——the "alarm status" Subdirectory

——Overvoltage alarm YES/NO

——under voltage alarm YES/NO

——Over temperature YES/NO

——under voltage alarm YES/NO

——under capacity alarm YES/NO

——Difference voltage YES/NO

——Overcurrent YES/NO

——Charger Reverse alarm YES/NO

——the "protection status" Subdirectory

——Overvoltage protect YES/NO

——under voltage protect YES/NO

——over temperature protect YES/NO

——under temperature protect YES/NO

——over current protect YES/NO

——Short current protect YES/NO

——the "Fail alarm" Subdirectory

——Sampling line: OK/ERROR

——Charge MOSFET: OK/ERROR

——Discharge MOSFET: OK/ERROR

——Sampling chip: OK/ERROR

——Short current times: xxxx

——Temperature protect times: xxxx

——over protect times: xxxx

——Over current times: xxxx

——under voltage times: xxxx

The "Battery parameter settings" Subdirectory Non-manufacturers cannot enter 10 NPFC series LiFePO4 Battery System for Telecommunication Operation manual V1.0

The "Version Information" Subdirectory

——the "BMS version" Subdirectory

——BMS software version

——BMS hardware version

——the "LCD version" Subdirectory

——LCD software version:

——LCD hardware version:

LCD Instructions BMS under sleep mode please press "MENU" wake the BMS and LCD With in one minute without operating LCD into turn off: Please press "MENU" wake the BMS and LCD