QA TECHNICAL MEMO

TEST: PIT STATION BATTERY CELLS CHARGING QA MEMO

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TESTERS: _____

WITNESS: _____

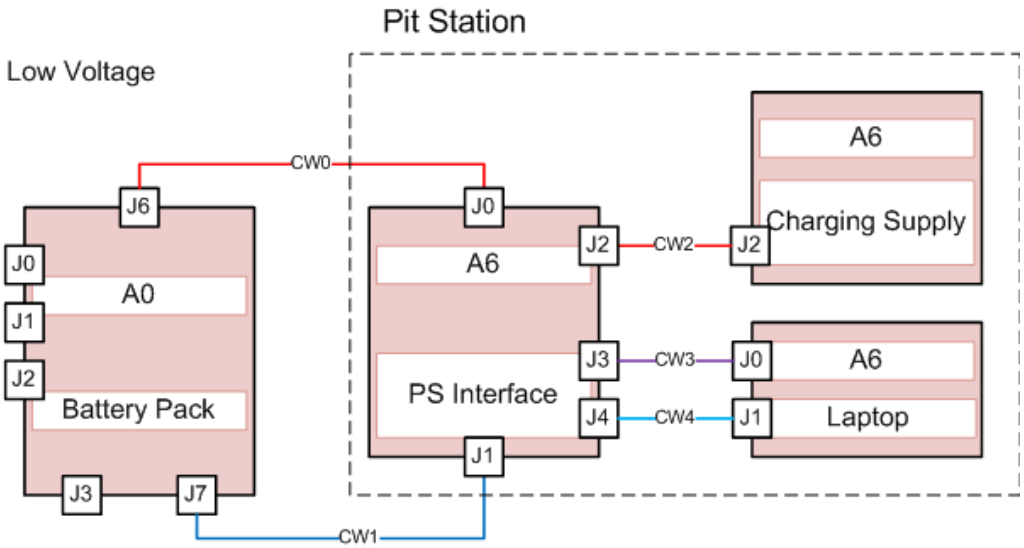
DATE: 05/05/13

TEST DESCRIPTION

This test is intended to prove that the pit station is capable of charging one pack properly. The pack can consist of 1-8 cells. During the charging process, individual cells needs to be bypassed strictly according to the cell balancing algorithm. When the pack is done charging, the isolation relays in the charging circuits needs to be switched open by the Pit Station Software in order to produce an open circuit so that the battery can be protected from overcharging.

TEST SETUP

1. Change the power supply to constant current mode. Turn the power supply output to be off.
2. The charging circuit needs to set up according to the physical layout displayed below.



The Ports used by the charging circuit are:

Component Name	Port Label	Port Name
Battery Pack	J6	Battery's Power and Ground(Anderson Connector)
	J7	I2C Databus(I2C connector)
PS Interface Board	J0	Battery's Power and Ground (Anderson Connector)
	J1	I2C Databus(I2C connector)
	J2	AC Power(AC Receptacle)
	J3	Serial Data (USB) from BMS
	J4	Serial Data (USB) from Arduino
Charging Supply	J2	Power Supply's Power and Ground
Laptop	J0	The USB port closest to the power supply port
	J1	The USB port furthest from the power supply port

*Red mark indicates that the corresponding port is for a bus.

Wiring Instructions:

CW0: Charging Cable. 10 AWG.

CW1: I2C cable. 24 AWG.

CW2(This is already inside the box): Charging Cable. 10 AWG

CW3 & CW4: One USB male to male USB cable is needed from the labtop to the Pit Station Interface Box

3. Start the Cell Charging Software. Please refer to the Software User Manual here.

Test 1

The purpose of the following tests in this section is to verify that the software can be correctly launched and trouble shoot instructions are properly provided to the user if any exceptions occur.

Precondition: At least one cells/BMS boards needs to be connected to the I2C databus. The power supply is not required for the tests in this section.

Test #	Test Procedure	Passes if	Passed?
1	Disconnect the Arduino board. Launch the Charger Program by double clicking on the charger icon shortcut.	A pop-up window should be displayed. The warnings displayed in the window should tell the user that the Arduino board is not connected and what the user should do(restart the program)	
2	Disconnect the BMS board by unplug the I2C wire or the USB wire. Launch the Charger Program.(Please don't launch the program before unplugging the I2C wire, it may corrupts the board)	A pop-up window should be displayed. The warnings displayed in the window should tell the user that the BMS board is not connected and what the user should do(restart the program)	
3	Launch the Charger Program. Wait for at least one minute.	No pop-up window should be displayed.	
4		The number of cells displayed should be updated with the number of BMS boards	
5	Launch the Charger Program. Click on the "Tools" in the menu bar, and hover over "BMS Port" and "Arduino Port" sub-menu	Under "BMS Port" submenu, the menu item has a valid port name displayed (i.e. anything other than "Unknown Port")	

6		Under “Arduino Port” submenu, the menu item has a valid port name displayed (i.e. anything other than “Unknown Port”)	
7	Launch the Charger program. After one minute. Unplug the wire from Computer to I2C Adaptor *Make sure to connect the wire back together and restart the program after this test is done since the port name may have changed. Also, the BMS board might need to be reprogrammed	Warning Message displayed, indicating the communication to The BMS board is down. The warning message should also inform the user what to do next	
8	Launch the Charger program. After one minute. Unplug the wire from Computer to Arduino board. *Make sure to connect the wire back together and restart the program after this test is done since the port name may have changed	Warning Message displayed, indicating the communication to The Arduino board is down. The warning message should also inform the user what to do next.	
9	Open the ErrorLog.txt file in the local directory with a text editor (such as “Notepad” or “Sublime Text 2”).	It should display all the errors that were encountered previously in this set of tests, along with a time stamp for each error.	
10	Open the DatabaseLog.xml file in the local directory with a text editor (such as “Notepad” or “Sublime Text 2”).	It should be populated with information about cell number, cell voltage, cell temperature, whether or not the cell is bypassed, and how long the cell has bypassed. It should be recorded in XML format, an example of which is included in the system design file as well as at the end of this file.	

11	Launch the Charger Program. Click on the “Tools” in the menu bar, and then hover over “set bypass switch with board address:” sub-menu. Try hover over all the board addresses one by one.	For all the board addresses, the “off” Radio button is selected, and the “on” Radio button is not selected	
12		The bypass switch on the BMS boards should be turned off. This is true as long as the Red LED on the BMS boards are not blinking	
13	Launch the Charger Program. Click on the “Tools” in the menu bar, and then hover over “set bypass switch with board address:” sub-menu. Try hover over all the board addresses one by one. Click on the “off” button for each one.	On the BMS board with the corresponding board address, the Red LED on the BMS boards should start blinking for a short period (This is turned off by the program since bypass should only be closed during charging when certain conditions are met).	
14	Before Launching the Charger Program, manually turn on the Relay by performing the following procedures: 1. Open the Arduino Software IDE 2. Open the Serial Monitor(under Tools) 3. Try one of the Serial port in the selection window(for selecting port) 4. type “a” in the text field and click “send” button 5. If the Relay is not turned on(the Red LED is not on), start from step (3) Now launch the Charger Program.	The Relay should be switched off after a few seconds (the Relay LED should turn off if the Relay has any LED).	

15	Launch the Charger Program, and observe the Relay LED in the Pit Station Interface Board, the System state on the screen, and the current reading on the screen	Relay LED turns off(This wouldn't apply if Relay without LED is used)	
16		System State is "IDLE"	
17		Current Reading should be 0A	
18	Disconnect the Arduino and start up the Charging Program	No warning should be thrown.	
		Go to "Mode" menu and Hover over "Charging Mode" and without Arduino is selected	
19	Start up the Charging Program. Go to "Mode" and hover over "Charging Mode" and select "Without Arduino". Now wait for at least 12 seconds. Disconnect the Arduino Board	No warnings should be thrown.	

Ran by: _____

Witnessed by:_____

Test 2

The purpose of the following tests in this section is to verify that the software can properly collect data, parse the information collected, and convert it back to analog values to be displayed on the screen.

Precondition: At least three cells/BMS boards needs to be connected to the I2C databus. The power supply is not required for the tests in this section.

<table>
<tr><th>Test #</th><th>Test Procedure</th><th>Passed if</th><th>Passed?</th></tr>
<tr><td>1</td><td>Use RealTerm, collect 10 current readings from the pack by following the guidelines for real-term and I2C protocol. Record all the values, convert them to analog current values using the conversion tables and calculate the average current I_1 and the tolerance T_1.

Launch the Software, wait for five minutes. Go into DatabaseLog.xml and check for the first 10 current readings and calculate the average I_2 and the tolerance T_2

<table><tr><td>I_1</td><td>T_1</td><td>I_2</td><td>T_2</td></tr><tr><td></td><td></td><td></td><td></td></tr></table></td><td>I_1 and I_2, T1 and T_2 are close to each other.</td><td></td></tr>
<tr><td>2</td><td>Use RealTerm, collect 10 voltage readings from each cell in the pack by following the guidelines for real-term and I2C protocol. Record all the values, convert them to analog voltage values using the conversion tables and calculate the average voltage V_{11} V_{12} V_{13} and the tolerance T_{11}, T_{12}, T_{13}.

Launch the Software, wait for five minutes. Go into DatabaseLog.xml and check for the first 10 voltage readings for each cell and calculate the voltage average V_{21} V_{22} V_{23} and the tolerance T_{21}, T_{22}, T_{23}.

<table><tr><td>V_{11}</td><td>V_{12}</td><td>V_{13}</td><td>T_{11}</td><td>T_{12}</td><td>T_{13}</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td></tr></table></td><td>V_{11} and V_{21}, V_{12} and V_{22}, V_{13} and V_{23}, T_{11} and T_{21}, T_{12} and T_{22}, T_{13} and T_{23} are close to each other.</td><td></td></tr>
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</table>
</td><td></td><td></td></tr>
<tr><td>3</td><td>Use RealTerm, collect 10 temperature readings from each cell in the pack by following the guidelines for real-term and I2C protocol. Record all the values, convert them to analog voltage values using the conversion tables and calculate the average voltage t_{11} t_{12} t_{13} and the tolerance T_{11}, T_{12}, T_{13}.

Launch the Software, wait for five minutes. Go into DatabaseLog.xml and check for the first 10 temperature readings for each cell and calculate the voltage average t_{21} t_{22} t_{23} and the tolerance T_{21}, T_{22}, T_{23}.
<table>
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Test 3

The purpose of the following tests in this section is to verify that the software is capable of performing charging algorithm and communicating with both the cells and the charging relay.

Precondition: At least three cells/BMS boards needs to be connected to the I2C databus. The power supply needs to be connected, set to output constant 20A current and turned on.

Test #	Test Procedure	Passed if	Passed?
1	Launch the program. Make sure nothing is beyond the default parameters (Otherwise, go to "configure" menu and click on "Change Parameters" to change the parameters). Press the "Start Charging" button.	"Start Charging" button faded	
2		User should be prompted with the Charging Parameters to confirm	
3	Following the previous test case, click on "Change Parameters".	The parameter confirm screen disappears and a Parameter Setup screen should appear	
4	Following the previous setup, in the "Parameter Setup" page, enter an invalid voltage upper limit value such as 6 V. Now click on the "Set Parameter" button.	User should be prompted with the warning, saying that the voltage upper limit that the user is trying to set is out of range	
5	Following the previous test case (in the "Parameter Setup" page), enter an invalid temperature upper limit value such as 1000C. Now click on the "Set Parameter" button.	User should be prompted with the warning, saying that the temperature upper limit that the user is trying to set is out of range	
6	Following the previous test case (in the "Parameter Setup" page), enter an invalid current upper limit value such as 100A. Now click on the "Set Parameter" button.	User should be prompted with the warning, saying that the current upper limit that the user is trying to set is out of range	
7	Following the previous test case (in the "Parameter Setup" page), enter an invalid bypass threshold value such as -10mV.	User should be prompted with the warning, saying that the bypass threshold that the user is	

	Now click on the “Set Parameter” button.	trying to set is out of range	
8	Following the previous test case (in the “Parameter Setup” page), enter an invalid bypass time value such as -10min. Now click on the “Set Parameter” button.	User should be prompted with the warning, saying that the bypass timeout that the user is trying to set is out of range	
9	In the “Parameter Setup” page, enter a set of valid parameter values (within the given range). Now press the “Save Parameter to File” and enter the desired name to save	A “.txt” file was saved in the desired directory.	
10	In the same “Parameter Setup” page, load an existing parameter file that has different parameter values than the ones that were entered in the previous test. Click on the “Choose File” button and select the file that was saved in the previous test in the file browser.	All the parameters used in the previous test are loaded in the corresponding field	
11	Adjust the power supply to output 20A (constant current). Following the previous test, press the “Set Parameter” button in the “Parameter Setup” page.	The Parameter Setup Page should disappear and the main Charging Monitor screen should be displayed	
12		System State should now change to CHARGING.	
13		Current Reading should no longer be 0A(should be around 20A)	
14		“Start Charging” Button should now fade	

15		The Charging Relay should now be switched on	
16	Following the previous test, wait for a few minutes. Open the ChargingCharacteristics.txt file in the local directory	System time in seconds should be logged in the first column; Voltage values should be logged in the second column in volts; System time in readable format should be logged in the third column	
17	Now click on “Stop” button	“Start Charging” button becomes available	
18		“Stop” button no longer available	
19		System state changed to “IDLE”	
20		Charging Relay is switched off(Current is now 0)	
21	Discharge one of the cells more than others. Voltage difference between the more discharged cell and the less discharged cell needs to be at least 0.05V. Launch the Charging Program. Click on the “Start Charging” and set a relatively high voltage upper limit (such as 3.8V) and a valid value for the rest of the parameters before start charging. Then click on “Start Charging”.	“Bypass Status” column of the corresponding row showing that the cell has been bypassed	
22		“Bypass Time” column of the corresponding row showing is increasing until the bypass time you set	
23	Following the previous test. Stop Charging by click on “Stop button”, and start charging again, but set the bypass time to	Wait until one of the cells is bypassed, check if the bypass time goes up till the bypass time	

	a different value	you specified	
23	Following the previous test, hover over the "Mode" menu, hover over the "Data Collection" submenu and click on Manual Mode" Radio button. Now go to "Configure" menu and click on Manual Update submenu. Adjust the cell voltages for all the cells to be close to each other and within the upper limit. Then close the "Manual Update". Click on "Start Charging" button and set up a set of reasonable parameters (at least valid). Then open the "Manual Update" window again, manually adjust the current value to be larger than the current upper limit	A warning message should be prompted to let the user know that this exception has occurred.	
		After Clicking "OK" button on the warning window. The user should be guided back to the main Charging Monitor screen. The system state should now be "IDLE"	
24		Charging Relay switches off(Measure the conductance if LED is not available)	
25	Launch the Charging Program, open the "Manual Update" window and adjust the cell voltages for all the cells to be close to each other and within the upper limit. Then close the "Manual Update". Click on "Start Charging" button and set up a set of reasonable parameters (at least valid). Then open the "Manual Update" window again, manually adjust the temperature value to be larger than the temperature upper limit.	A warning message should be prompted to let the user know that this exception has occurred.	
26		After Clicking "OK" button on the warning window. The user should be guided back to the main Charging Monitor screen. The system state should now be "IDLE"	
27		Charging Relay switches off(Measure the conductance if LED is not available)	
28	Launch the Charging Program, open the "Manual Update" window and adjust the cell voltages for all the cells to be close to each other and within the upper limit. Then close the "Manual Update". Click on "Start Charging" button and set up a set of reasonable parameters (at least valid).	A warning message should be prompted to let the user know that this exception has occurred.	
29		After Clicking "OK" button on the warning window. The user should be guided back to the main Charging Monitor screen.	

	Then open the “Manual Update” window again, manually adjust the voltage value to be larger than the voltage upper limit.	The system state should now be “IDLE”	
30		Charging Relay switches off(Measure the conductance if LED is not available)	

Ran by: _____

Witnessed by:_____