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LTC6811-2 Addressable isoSPI Battery- Stack Monitor

DESCRIPTION

Demonstration circuit 2260A is an Addressable isoSPI Battery-Stack Monitor featuring the LTC6811-2. Multiple boards can be linked through a 2-wire isolated serial interface to monitor any number of cells on a stack.

Communication to a PC uses a DC2026 Linduino® One as a USB interface. The DC2026 comes preloaded with a legacy DC590 emulator function (the DC590 can also still be used¹). A control program for up to ten stacked boards has a Graphical User Interface (GUI) to implement the device command set.

To control more than one DC2260A, the DC1941B isoSPI adapter and RJ45 (Ethernet) patch cables are also required.

HARDWARE SETUP

When connected to a battery stack, power for the DC2260A is provided by the cell group being monitored. Separate the screw-terminal section from J1 and wire cell voltage connections or resistors into the clamping contacts to provide the input stimulus for the ADC.

Cell voltages are wired from position 4 (most negative potential of the group) with increasing potentials up to position 16 (most positive potential).

Design files for this circuit board are available at <http://www.linear.com/demo/DC2260A>

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¹A DC590 is a USB data acquisition board that serves to interface the DC2259 to a PC's USB port. This board is not necessary with a DC2026.

Alternatively, for a simple demo, connect twelve 100Ω resistors between each contact from position 4 to position 16 as shown in Figure 1. Then, provide a “stack-equivalent” power supply connection to position 16 (positive) and position 4 (return). The supply may be adjusted to provide the desired nominal cell voltage (e.g., 43.2V will be 3.6V/cell). **Note that cell discharge cannot be demonstrated properly with a resistor string stimulus.**

Photo 1 shows the following connections for one board interfaced to a PC:

1. Set jumpers on the board per Figure 1.
2. Connect a USB cable from the PC USB port to DC2026.
3. Connect a 14-pin ribbon from DC2026 to the SPI connector (J2) on DC2260A.
4. Mate the J1 cell-voltage connector. The blue LED will illuminate when power is applied. The brightness reflects the supply current.



Photo 1. Connecting a Board to a PC

DESCRIPTION

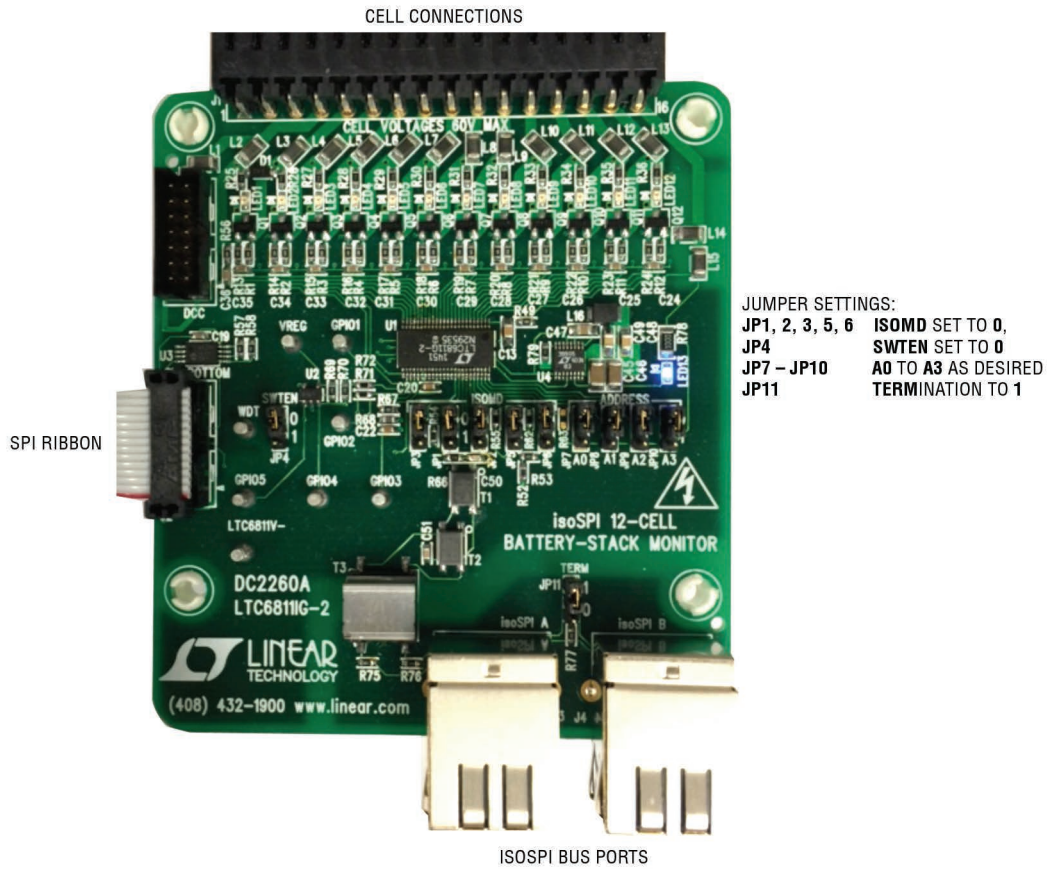


Photo 2. Connections and Jumpers

DESCRIPTION

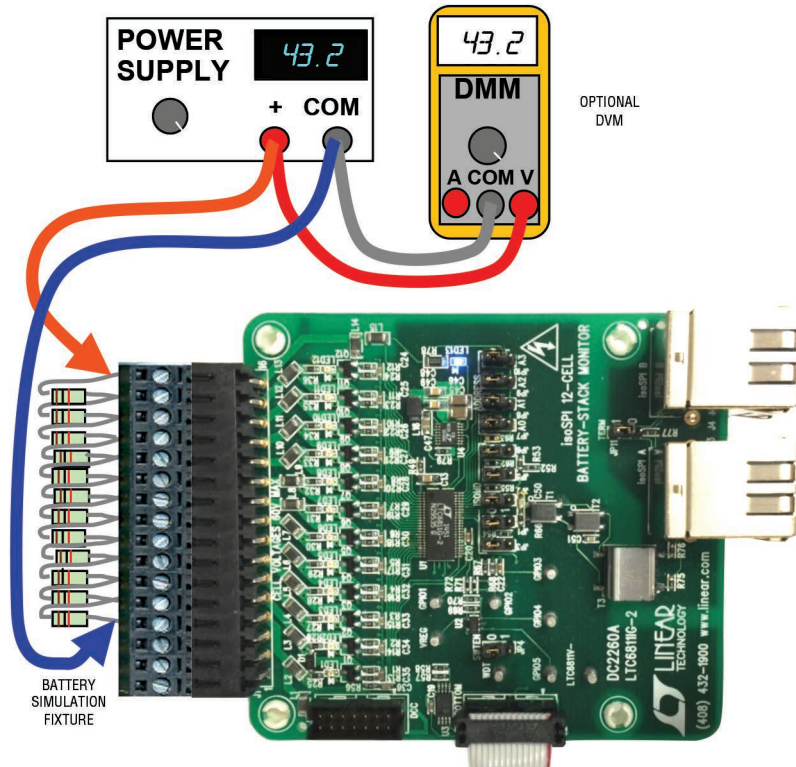


Figure 1. Simple Cell Simulator Using Resistors

DESCRIPTION

ISOLATING THE HOST AND ADDING BOARDS

The LTC6811-2 can be operated using the isoSPI ports (J3 and J4) rather than the conventional SPI port (J2), if desired. To operate more than one DC2260A, it is actually necessary to use the isoSPI feature to create the communication bus. To operate with isoSPI, the following is necessary:

- ADC1941 isoSPI adapter board (to provide the LTC6820 interface IC) that provides the conversion from the 14-contact ribbon cable connection to an RJ45 isoSPI port. With large numbers of isoSPI devices on a bus, the DC1941 may require slight hardware modifications to optimize the bus performance.
- Reconfiguration of all DC2260A ISOMD jumpers to the “1” position (JP1, 2, 3, 5, 6).
- Interconnection of isoSPI ports with RJ45 patch cables (J3 and J4 are interchangeable).

- TERMination jumpers (JP11) on DC2260A should all be set to “0” except for the unit electrically furthest from the DC1941 (JP11 set to “1”).

SOFTWARE SETUP

To use the DC2026 USB interface board, download the free driver for a program called QuikEval™ from <http://www.linear.com/designtools/software>.

The separate GUI program is provided in a zipped file (LTC6804_6811_GUI_Vxx.zip):

1. Unzip this folder
2. Run the setup.exe file to start installation
3. Ignore the Security Warning by selecting Install

The GUI control panel appears immediately after installation. Subsequent starts of the GUI are done through the Windows Start menu or the optional Windows Desktop shortcut icon.

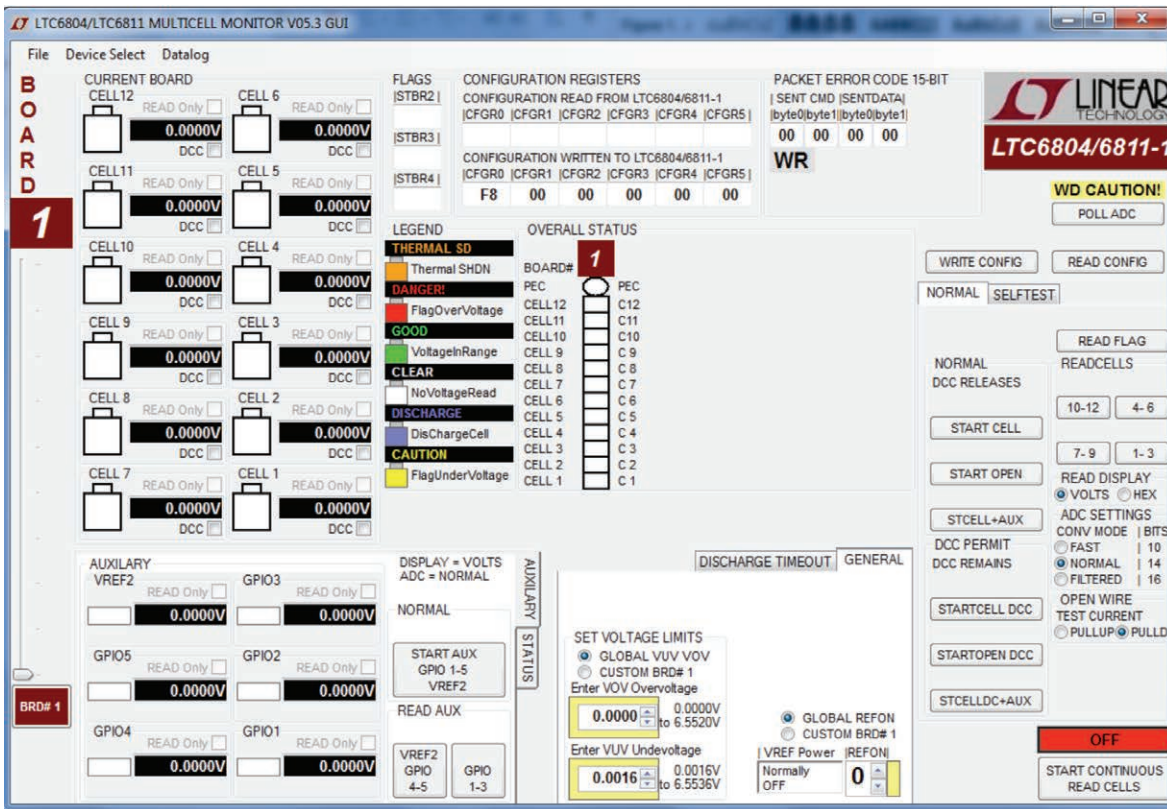


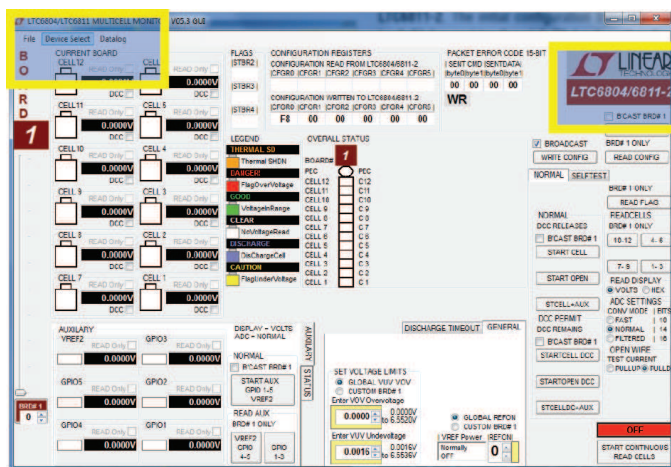
Figure 2. GUI Control Panel Start-Up Screen

OPERATING THE CONTROL SCREEN

GUI STARTUP

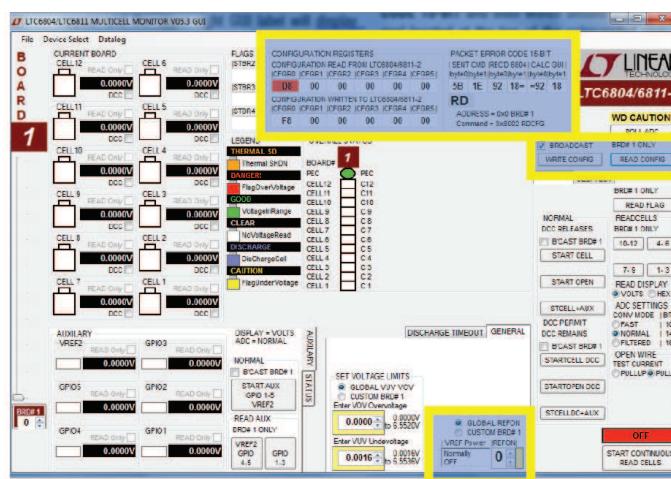
Figure 2 is the initial start-up screen that appears when the program is launched. Once power is supplied to the board from a stack of cells or a power supply, the communication between the PC and the board can be checked.

1. Set Device Mode



Click the Device Select menu, upper left of the GUI, then click LTC6804/6811-2 Addressable to set the correct GUI mode. Additional controls will appear and the upper right GUI label will display LTC6804/6811-2.

2. Read Configuration



Click the command button labeled READ CONFIG. If all is properly connected and operating, the start-up default configuration of the LTC6811-2 will be read from the board. The Hex codes for the six bytes of configuration setting will appear in the CONFIGURATION REGISTERS section in the boxes labeled CONFIGURATION READ FROM LTC6804/6811-2. The initial configuration bytes should be 0xD8 for register 0 and 0x00 for the other five bytes. This default configuration is the sleep mode for the LTC6811-2 on DC2260A.

The LTC6811 calculates a 15-bit Packet Error Code, PEC15, as a 16-bit word and appends it to the data stream each time it sends out data. For the six bytes sent by this command and received by the GUI, the control program calculates a PEC15 in the same manner. This 16-bit word is compared with the appended received 16-bit word to check that the data transmission was properly executed. The received PEC15 word and the calculated PEC15 word from the received data are displayed in the top section labeled PACKET ERROR CODE 15-BIT and both words should match. The oval located at the top of the color-coded status panel for the one board will turn green if the PEC15 words match. Data transmission errors will produce red warning indications when the PEC15 words do not match. There is also a display of the PEC15 that was sent with the most recent command to the LTC6811.

3. Write Configuration

Nothing is changed within the LTC6811 until the Write Configuration command is executed. Clicking the WRITE CONFIG command button sends the command and then the six Hex bytes shown in the CONFIGURATION REGISTERS section in the boxes labeled CONFIGURATION WRITTEN TO LTC6804/6811-2 will become bold type. Software developers can note the exact hex values required by the LTC6811 for specific conditions in these boxes to facilitate their control program development.

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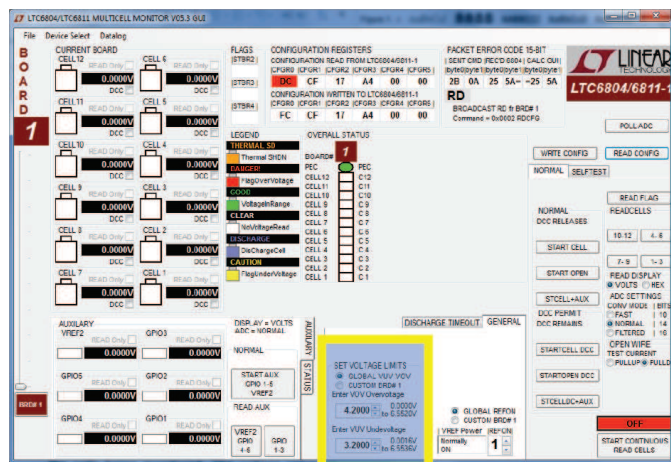
Clicking the READ CONFIG button can give confirmation that the configuration change was actually made. Five of the six bytes read back should match the bytes sent and the PEC15/CRC15 check 16-bit words should be a match (green PEC oval on stack display).

When any configuration information is changed on the screen, the WRITE CONFIG command button will be illuminated, serving as a reminder that this command still needs to be executed.

Set REFUP to 1 followed by a WRITE CONFIG command. The Watchdog Timer (WDT) will now be prevented from expiring by issuing a repeating POLL ADC command, and the stack is ready to be monitored.

NOTE: No configuration changes take effect until the WRITE CONFIG button is clicked. Leaving REFUP at the default setting of 0, the WDT times out in 2 seconds and all configuration information is reset.

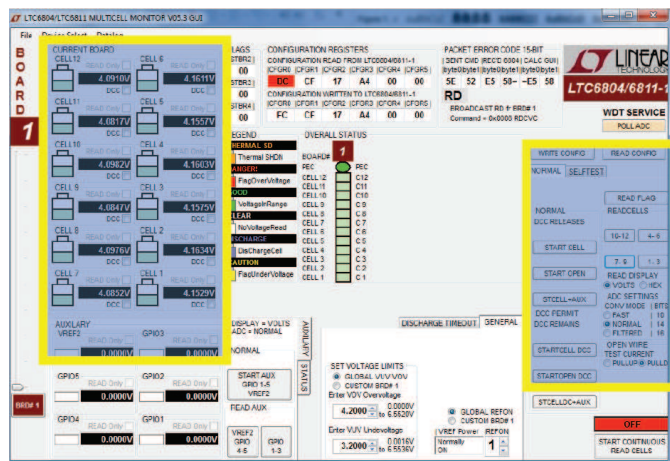
4. Program the Cell Monitoring Voltage Thresholds



In the section labeled SET VOLTAGE LIMITS, click on the boxes and enter voltage values for the overvoltage and undervoltage thresholds appropriate for the cells being monitored. The voltage value entered will be rounded to the actual value used by the LTC6811 and displayed in the box. The voltage ranges for these thresholds is 0V to 6.5520V.

These monitor thresholds can be applied globally to each and every cell in the system or customized for the cells connected to an individual board by clicking the desired option button. Individual boards are selected for programming by the left hand tabs in multiple board systems. Click the WRITE CONFIG button to send the data and then a READ CONFIG to verify it.

5: Read Cell Voltages



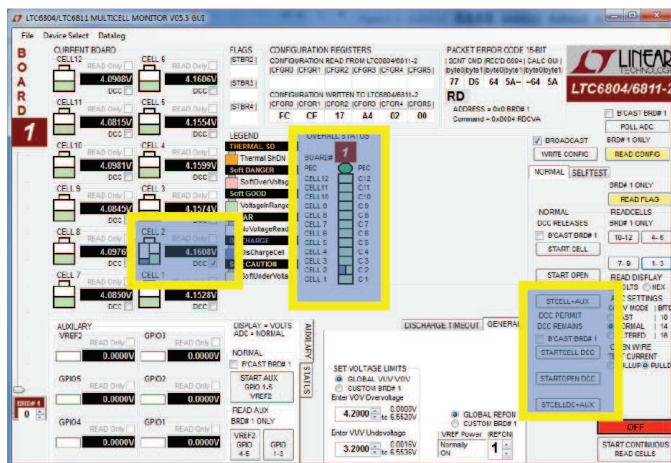
The essential function of the LTC6811 is to measure and report the voltage on each battery cell when commanded. First click on the STARTCELL button. This commands an A/D conversion of all 12-cell voltages in the bit-resolution configured from the selected CONV MODE (Conversion Mode) in the ADC SETTINGS box. The actual cell voltage

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measurements are displayed in groups of 3 when each command button inside the READ CELLS box is clicked.

NOTE: The READ DISPLAY box has options to display Cell Voltages in VOLTS or HEX. First select VOLTS or HEX then click on one of the command buttons inside READ CELLS box. Every time a command button inside the READ CELLS box is clicked; new data is downloaded from the board and displayed as selected in VOLTS or HEX.

6: Discharge Cells



The LTC6811 includes the ability to remove charge from individual cells to help equalize cell charges within a stack of batteries. DC2260A contains a P-channel MOSFET in series with a 33Ω resistor across each cell connection. When enabled, a cell is loaded and charge is pulled from the cell with energy dissipated in the switch and resistor.

A check box is provided for each cell to be discharged. Checking this box (Cell 2 in the above example screen shot) and then writing the new configuration with a WRITE CONFIG button push will load the cell.

The discharge transistors are automatically turned off momentarily while the A/D converter is measuring the cell voltage using the normal STARTCELL command. This prevents any voltage drop errors caused by the discharge current flowing through the cell inter-connection wiring. An accurate indication of the true cell voltage is then obtained.

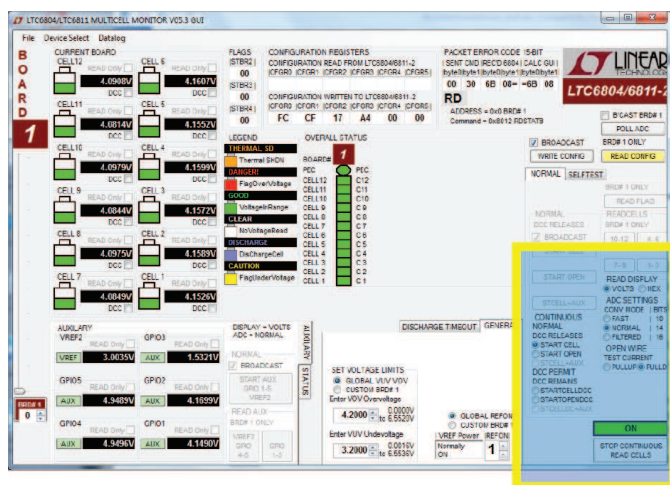
The LTC6811 offers the option of keeping the discharge transistors on while measuring the cell voltages. This is done using the STARTCELL DCC command button. The command button is illuminated blue when this command has been executed. This lower voltage reading also includes I•R errors introduced by cabling and connectors.

7. Other Control Features

Additional command buttons are provided on the control screen. The POLL ADC command button is used to test if the ADC is busy making conversions of any LTC6811 devices in a system. The result of this command can be observed by monitoring the serial data output line of the SPI interface to the Bottom Port, J2. There is no indication provided on the control screen.

The START OPEN (WIRE) command button connects the built in open wire detection circuitry to all cells. This command must be followed by any command buttons inside the READ CELLS box click to see the result. The OPEN WIRE TEST CURRENT box provides options to use either PULLUP or PULLDOWN Open Wire Test Currents. An open wire connection to any cell will be indicated by an abnormally high voltage measurement for the cell above the open wire and a near zero measurement for the cell with the open wire in the PULLDOWN case.

8. Continuous Operation



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For convenience, the control panel allows for continuous operation of the DC2260A board. When the command button labeled START CONTINUOUS READ CELLS is selected, the GUI operates in a continuous loop executing the following command sequence automatically:

- Start cell voltage
- Read cell voltage groups A (1 – 3) , B (4 – 6), C (7 – 9), and D (10 – 12)
- Read flags

Options available are the READ DISPLAY box, ADC SETTINGS box, OPEN WIRE TEST CURRENT box, and the CONTINUOUS box. The CONTINUOUS box allows the selection of STARTCELL, STARTOPEN, STARTCELL DCC, and STARTOPEN DCC commands to be executed during continuous operation. The options are useful for monitoring the cell voltage measurements under different ADC Test Conditions.

All values are updated continually (update rate is ~500ms). While running, the configuration can be changed on the fly. Simply changing a configuration item (Discharge cells for example) and clicking the WRITE CONFIG button will implement the new configuration and return to continuous operation.

A green box with the label ON in the lower right corner of the GUI indicates that the system is running continuously. A red box with the label OFF means that the system is stopped and waiting for a new command to be sent.

DATALOGGING OPERATION

The GUI program can “datalog” or store cell voltage results in a CSV (Comma Separated Value *.csv) file. This feature is useful in characterizing cell voltages over time. Datalogging operates similarly to continuous operation but has the added functionality of storing results in a CSV file.

1. At the upper left of the GUI, click on the Datalog Menu then Enable Datalog.



Datalog Mode is enabled when a maroon box appears to the left of the START CONTINUOUS READ CELLS command button and the red box label changes from OFF to DATALOG OFF. Datalog Mode is disabled when the maroon box disappears and the red box label reverts to OFF.

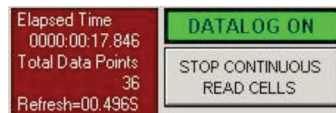
NOTE: The *.csv filenames include the time created and are stored by default into the “C:\Datalog6804_6811\” folder. More details are in the file “AboutCurrentVersion.txt” inside the GUI’s installation folder (normally “C:\Program Files\LTC\MultiCellBatteryMonitor\LTC6804”).

2. Click on the START CONTINUOUS READ CELLS command button to start datalogging onto a new CSV file.



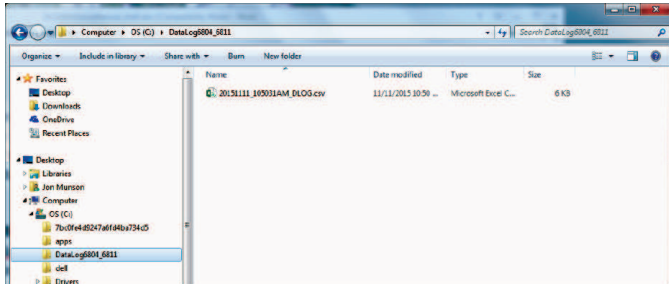
Elapsed Time = Total time of Datalog from start to finish. Total Data Points = Total data points of Datalog from start to finish. Refresh = Time in seconds (S) between each Read Cells command; also known as Sample or Update Rate.

3. Click on the STOP CONTINUOUS READ CELLS command button to stop datalogging and close the CSV file.

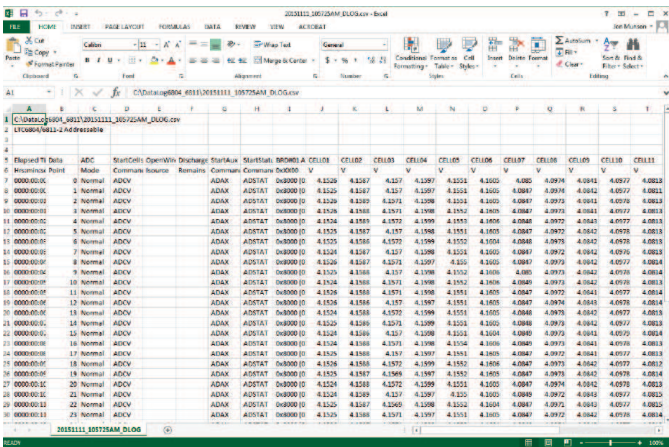


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4. The CSV file is ready to view. Go to “C:\Data-Log6804_6811” folder and open file.



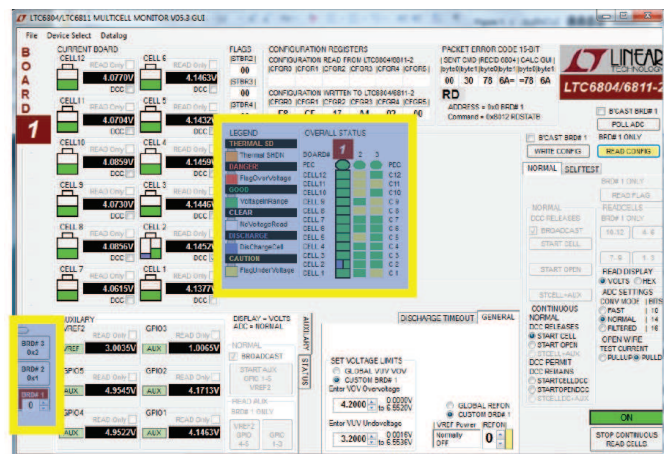
5. View the CSV file in a compatible spreadsheet software program such as MS Excel.



SOFTWARE ADJUSTMENTS

The GUI program can control up to ten boards on a stack.

1. Select the number of boards on the stack by sliding the track bar up or down; located at the bottom left of the screen.



2. A tab will appear on the left edge of the control panel for each board on the stack. Clicking on any of these tabs will transfer control commands and data to and from the display screen to that selected board.

3. Select whether the ADC’s Voltage Reference Powered State (Ref Up) and Over-/Undervoltage thresholds for each board are to be the same (GLOBAL) or different for each board (CUSTOM) and set the Ref Up and voltages accordingly.

COLOR CODED STATUS PANEL

The color-coded status panel will expand to include all boards connected in a stack. Each small square in this array represents an individual battery in the stack of boards. The intent of this display is to provide a way to see the status of all cells at a glance. The significance of the colors used is explained in the legend on the screen.

Consult the data sheet for detailed information concerning the operation of the LTC6811-2.

COMMANDS SUPPORTED (V05 VERSION):

POLLADC

WRITE CONFIG (REFUP, VUV, VOV, Discharge selected cells)

READ CONFIG

START CELL and OPEN WIRE conversions with and without discharge connected (ADC Settings: Conversion Mode, Open Wire Test Current)

READ CELL GROUPS (A, B, C and D. Read Volts/Hex)

START CONTINUOUS reads all cells every ~500ms.

COMMANDS NOT SUPPORTED (V05 VERSION):

SELFTEST

GPIO Logic Functions

READ FLAGS

READ AUX

DEMO MANUAL DC2260A

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