LTC6802-2 Battery Monitor

HARDWARE/SOFTWARE USERS GUIDE

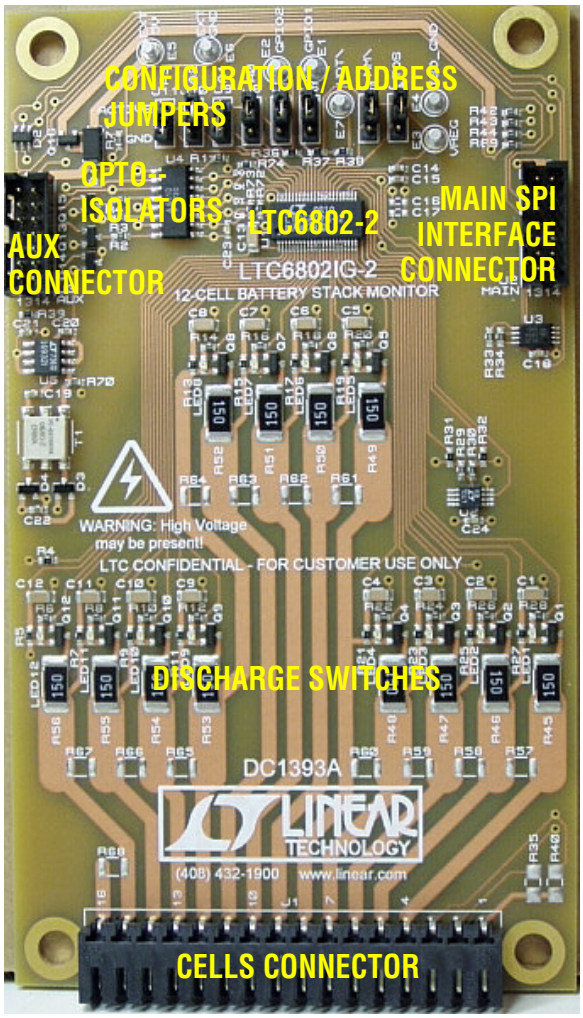
DESCRIPTION

Evaluation circuit DC1393A is a Battery Monitoring System to demonstrate the functional operation of the **LTC6802-2** integrated circuit. The **LTC6802-2** is a complete battery monitoring IC that can measure as many as 12 series connected cells with a total voltage of 60V. A simple SPI serial interface is used to communicate battery state information to a system control processor.

Use of an isolated serial interface allows monitoring of completely separate battery cell packs or a series stack of cells. Stacking of cells permits the monitoring of each individual cell in systems requiring 100's of volts from the battery pack, such as those used in Hybrid Electric Vehicles (HEVs). Each device also has a built in supply voltage regulator.

In addition, each individual cell connection has a software controlled discharge transistor. This allows the implementation of precision cell charging algorithms including charge shedding of over-voltage cells.

A group of up to ten DC1393A boards can be managed through the USB port of a PC using an on screen control panel available from LTC.



LTC6802-2 FEATURES

- 12-bit Accurate Voltage Measurement of 12 Battery Cells (60V maximum/board)
- 4-bit Addressable Serial Interface Enables High Cell Count Systems (16 boards x 12 cells = 192 Cells)
- Fast 13mSec Measurement of All Cell Voltages
- Cell Charge Balancing with Discharge Switches
- Simple 4-Wire SPI Serial Data Interface
- Three Temperature Measurement Channels
- Software and Watchdog Timer Controlled Standby Low Power Mode

DC1393A DEMO FEATURES

- Complete circuitry for monitoring and charge balancing up to 12 cells
- Stackable up to 16 boards with isolated 4-bit addressable serial I/O ports
- Direct connection to a PC through a DC590 Quick Eval board for SPI to USB interface
- Extensive Graphical User Interface (GUI) screen for demonstration of features and program code development
- Click-button implementation of all ten **LTC6802-2** commands
- Set-screw connector for easy wiring harness development to connect cells

GETTING STARTED WITH ONE BOARD CONNECTED

SINGLE BOARD CONNECTION TO PC AND GUI

Step 1. Set jumpers on DC1393A to the default positions indicated in Table 1.

TABLE 1. JUMPER FUNCTIONS

JUMPER	FUNCTION	DEFAULT POSITION	ACTIVE POSITION	GROUND POSITION
J4	Top of Stack (TOS)	Ground	Set to active only on a board with the address of 0x15. Will toggle the SDO line at 1Khz when parallel polled for status and not busy.	For all boards with addresses 0x00 to 0x14. When parallel polled for status will pull the SDO line low if busy, release it if not busy.
J5	Monitor Mode ($\overline{MM}$)	Active (Measure Mode)	Enables measuring of all cell voltages. Allows for normal GPIO pin functions	Monitor Mode. Simple monitoring of cells for over/under voltage conditions. Number of cells monitored is determined by setting of the GPIO pins and the Watchdog Timer pin.
J6	General Purpose I/O (GPIO1)	Active	Pin connected by pull-up resistor to Vreg. Can be programmed as an input or an output.	Pin forced to a logic low level.
J7	General Purpose I/O (GPIO2)	Active	Pin connected by pull-up resistor to Vreg. Can be programmed as an input or an output.	Pin forced to a logic low level.
J11,J10,J9,J8	Board Address Setting J11 is MSB J8 is LSB	Active or Ground (0000 to 1111)	Logic '1' setting	Logic '0' setting

Step 2. Connect the DC590 Quick Eval USB cable to PC/Laptop USB port. Connect a ribbon cable from DC590 to the Main connector of DC1393A (J2).

Step 3. Before running the DC1393 GUI, a DC590 driver must be installed. To do this, install the Quick Eval Software. Quick Eval can be downloaded from:

http://www.linear.com/designtools/software/

After installation **close the DC590 driver program**. Launch the GUI control program:

DC1393_LTC6802_2_GUI_V_mmddyyyy.exe

The month/day/year addition to the file name identifies the version as changes are made. When the DC590 Quick Eval board recognizes the String ID code from the DC1393A board, the program will open and present the control screen. **The program will not open unless DC590 is connected to the computer and the DC1393A board.**

Step 4. Connect the cells to be monitored to the cells connector J1. This connector is in two pieces. The setscrew piece can be unplugged to make it easier to attach a wiring harness from a four to twelve cell battery stack. The **LTC6802-2** is intended to measure from four to twelve individual cells with a total stack voltage of 10V to 60V.

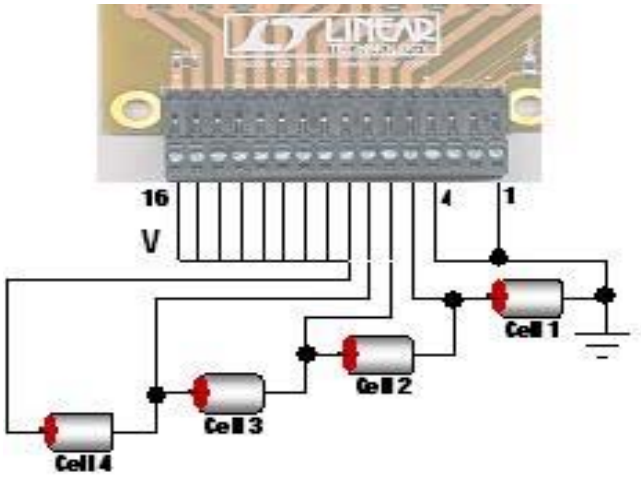
With fewer than 12 cells to be monitored, the bottom cell of the stack should always be connected as Cell 1 between terminals J1-5(+cell contact) and J1-4(-cell contact). Terminals J1-4, and J1-1 are the ground reference point for the battery cell stack and for the DC1393A board. The second cell on the stack connects between terminals J1-6(+cell contact) and J1-5(-cell contact). All higher numbered terminals on J1 not used for cell connections should be shorted together. The V+ positive supply for the DC1393A is the potential at terminal J1-16 and therefore must connect to the top of the battery

stack. Figure 1 Illustrates a connection for fewer than 12 cells.

SPECIAL NOTE FOR DEMONSTRATION PURPOSES

DC1393A and the GUI program are useful to serve as a demonstration tool to highlight the features of the **LTC6802-2**. If actual battery cells are not available, a series string of 150Ω resistors connected between each of the J1 connector terminals can be used instead. Each resistor will serve as a cell voltage. A lab power supply voltage of 10V to 60V can be connected across the resistor string between terminals J1-16(+) and J1-1(-).

If a lab power supply is not available and batteries are used as a portable cell demo power source, a 5KΩ resistor string is available to minimize the load on the batteries.



Step 5. Apply power.

Inserting the setscrew piece into connector J1 will apply power to the board from the battery cell stack. For the demo set up simply turn on the lab power supply preset to a voltage between 10V and 60V.

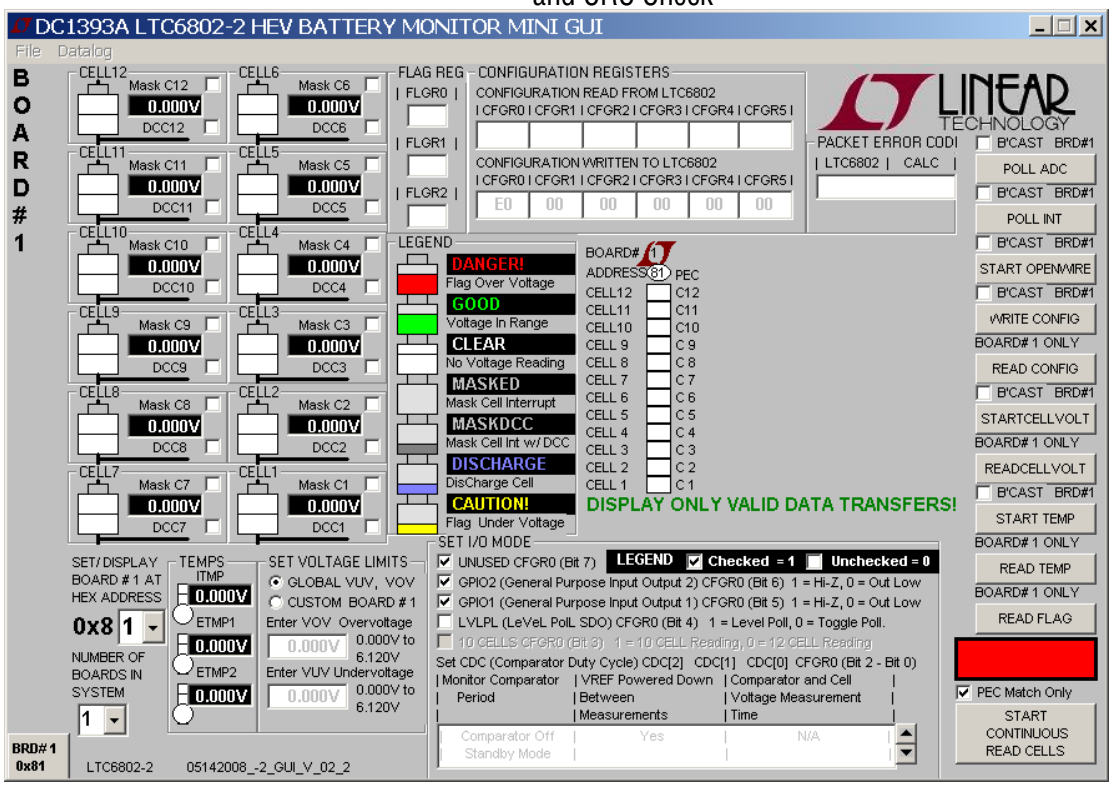
Figure 1. Connection of four cells (cell voltages at least 2.5V)

THE CONTROL PROGRAM

THE GRAPHICAL USER INTERFACE (GUI) SCREENS

Figure 2 shows the control panel that appears on the computer screen. The graphics have been scaled in size for use on Laptop computers. Controls on this panel are used to communicate with the **LTC6802-2**. Commands are issued and information is retrieved and displayed on this screen. This panel is useful not only for demonstrating the operation of the **LTC6802-2**, but also for software developers to observe the Hex codes exchanged with the device.

Figure 2. GUI Control Panel (Start-up Screen)



Hex Code Display for Configuration, System Flags and CRC Check

Cell Voltage Readings for Selected Board

Color Coded Status Panel for All Cells Connected

Click-Button Controls for All Commands

Board Selection Tabs

Set Individual Board Addresses

Temperature Readings

Programmable Over and Under Voltage Thresholds

Configure I/O and Operating Modes

Continuous Reading of All Cells Function

OPERATING THE CONTROL SCREEN

FIRST THINGS FIRST – ONLY ONE BOARD CONNECTED

Figure 2 is the initial start-up screen that appears when the program is launched and the Quick Eval interface card recognizes that the DC1393A board is connected. 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.

EXTERNAL DIGITAL ISOLATOR SUPPLY

Each DC1393A board is electrically isolated from the controlling computer and DC590 interface card. Serial SPI communication is conducted through a digital opto-isolator device. Power for the isolator can be provided through the DC590 connector at J2. The operating current required by the isolator however can exceed the available current from this supply and cause communication problems. An external 5V power supply connected to terminals E5 and E6 (ground) with a current ability of 50mA (50mA for each DC1393A board connected in a multi-board system) will ensure proper data communication.

1: SET BOARD ADDRESS

A feature of the LTC6802-2 is that each device/board is given a unique 4-bit address. Communication between the GUI and a board will occur only when the address set on the board with jumpers J8 through J11 matches the address set in the GUI for that board. The default selected board and address on power up is Board #1 with the address of 0x81. The actual address byte for each board is 8-bits long, but only the 4 LSBs are programmable. Set the jumpers to the address on the GUI or change the GUI to match the board (using the Set Hex Address box in the lower left corner of the GUI) to enable communication with the DC1393A.

2: READ CONFIGURATION

Click the command button labeled **READ CONFIG.** If all is properly connected and operating the start-up default configuration of the **LTC6802-2** (standby mode) 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 LTC6802-2**. The initial configuration bytes should be 0xE0 for configuration register 0 (CNFRG0) and 0x00 for the other five bytes.

In addition the **LTC6802-2** calculates a Packet Error Code, PEC, 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 PEC in the same manner. This byte is compared with the appended byte to check that the data transmission was properly executed. Both PEC bytes are displayed in the top section labeled **PACKET ERROR CODE CHECK** and both bytes should match. The oval located at the top of the color-coded status panel for the one board will turn green if the PEC bytes match. Data transmission errors will produce red warning indications if the PEC bytes do not match.

3: PROGRAM THE CELL MONITORING VOLTAGE THRESHOLDS

In the section labeled **SET VOLTAGE LIMITS** click on the boxes and enter voltage values for the over-voltage and under-voltage thresholds required for the cells being monitored. The voltage value entered will be rounded to the actual value used by the **LTC6802-2** and displayed in the box. The voltage ranges for these thresholds is 0V to 6.12V and the program will not allow the ‘under’ to be greater than the ‘over’ voltage threshold.

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.

4: SELECT AN OPERATING MODE

The power-on operating mode for the LTC6802-2 is Standby. The GUI initializes to this state also to serve as a reminder that the device must be configured before starting operation. Select one of the seven CDC (Comparator Duty Cycle) options from the scroll box in the **SET I/O MODE** section at the bottom of the screen.

5: WRITE CONFIGURATION

Nothing is changed in the LTC6802-2 until the Write Configuration command is executed. Clicking the **WRITE CONFIG** command button does this. When the command is sent, the six Hex bytes shown in the **CONFIGURATION REGISTERS** section in the boxes labeled **CONFIGURATION WRITTEN TO LTC6802-2** will become **bold** type. Software developers can note the exact hex values required by the LTC6802-2 for specific conditions in these boxes to facilitate their control program development.

Clicking the **READ CONFIG** button can provide confirmation that the configuration change was actually made. The six bytes read back should match the six bytes sent and the PEC/CRC check bytes should be a match (green PEC oval above the stack status display).

IMPORTANT NOTE

No configuration changes take effect until the WRITE CONFIG button is clicked.

Consult the LTC6802-2 data sheet for detailed information concerning the variety of software configurable functions possible. The following is a summary of these functions:

- Discharging individual cells
- Changing Over/Under voltage thresholds
- Preventing UV/OV interrupt flags from modifying system operation through masking.
- Systems status polling type; level or toggle polling
- Conversion time for measuring all cells on a stack.
- Monitor comparator time interval
- GPIO pin functions -Inputs or Outputs
- 10cell/12cell conversion mode
- Standby Mode-low current drain

All of these can be implemented from the control panel when selected from various points on the screen then followed by a **WRITE CONFIG** button click.

6: READ TEMPERATURE

The LTC6802-2 has three ADC channels dedicated to measuring temperature. The temperature indications are for the internal die temperature of the LTC6802-2 and two externally connected thermistors. The display returns a voltage measurement.

The internal die temperature sensor produces a voltages that changes at a rate of 8mV/°C relative to absolute zero. To convert the voltage reading to degrees Centigrade, divide the voltage by 8mV then subtract 273°C. For example, 25°C is a reading of 2.384V.

For external temperature measurements connect thermistors across cells connector terminals J1-3 to J1-1 and J1-2 to J1-1. Alternatively thermistors can be connected to the board as resistors R35 and R40 located near connector J1. A thermistor with a 25°C value of 10KΩ will produce a half scale voltage reading at 25°C. Any thermistor value may be used but scaling the voltage measurement may require changing the values of resistors R29 and R30 on the DC1393A circuit board.

To take a temperature reading simply click the **START TEMP** command button to make the LTC6802-2 ADC conversion followed by clicking the **READ TEMP** command button to download the data from the board and display the voltage readings for temperature.

7: READ CELL VOLTAGES

The essential function of the LTC6802-2 is to measure and report the voltage on each battery cell when commanded. Once again this is accomplished from the control screen with two command button clicks. First click on the **START CELL VOLT** button. This commands an A/D conversion of all 12-cell voltages in the time configured from the selected Operating Mode (Set CDC option) in the **SET I/O MODE** box.

NOTE: All 12 cell voltages are converted every time regardless of the number of cells actually connected to the LTC6802-2. Unused cell connections, which should be shorted together, will return voltage readings of 0.000 volts.

The actual cell voltage measurements are not displayed until the **READ CELL VOLT** command button is clicked.

8: READ FLAGS

When any cell in a stack exceeds the programmed over or under voltage threshold limit, one of two flag bits is set in an internal register for that cell to serve as a warning. This is important feedback for battery charging algorithms to know simply when to start or stop charging. To read the state of these warning flags at

any time is a simple click of the **READ FLAG** command button. The Hex code for the three flag bytes appears in the **FLAG REG** section of the control panel at the top of the screen.

One of the configuration options is to mask these flags from appearing in the register bytes that are read from the LTC6802-2. This feature can be used to prevent or allow these flags to interrupt the flow of the control algorithm. A check box is provided for each cell in a stack to select the mask interrupts option for that cell. To implement the masking requires checking the box and then writing the new configuration with a **WRITE CONFIG** button push.

9: DISCHARGE CELLS

Another feature of the LTC6802-2 is the ability to redirect some charge current around individual cells. This can help to distribute the cell charge evenly over a stack of batteries. DC1393A contains a P channel Mosfet in series with a 15Ω resistor across each cell connection. When enabled, a cell is shorted and charge is pulled from the cell and transferred to the next cell below it on the stack.

A check box (DCCx, DisCharge Cell) is provided for each cell. Checking this box and then writing the new configuration with a **WRITE CONFIG** button push will short the cell. A Blue cell status indication will appear for the cells having the discharge transistor activated.

IMPORTANT NOTE: The discharge transistors are automatically turned off momentarily while the A/D converter is measuring the cell voltage. This prevents any voltage drop errors caused by the discharge current flowing through the cell inter-connect wiring. An accurate indication of the true state of charge of the cells is always measured.

OTHER CONTROL FEATURES

Three additional command buttons are provided on the control screen. The **POLL ADC** and **POLL INT** command buttons are used to test if the ADC is busy making conversion and to test if any of the LTC6802-2 devices in a system have an interrupt condition respectively. The result of these commands can be observed by monitoring the serial data output line of the SPI interface at pin 5 of the Main connector, J2. There is no indication provided on the control screen.

The **START OPENWIRE** command button connects the built in open wire detection circuitry to all cells. A **START CELL VOLT** and **READ CELL VOLT** command button click sequence must follow to determine the result. Ideally an open wire connection to any cell will be indicated by a full-scale voltage measurement of approximately 5.2Volts for the cell above the open wire and a 0V measurement for the cell below the open wire. The DC1393A demo board however uses input filtering capacitors (100nF) at each cell that can acquire charge and present a voltage that differs from a true open wire condition. Depending on the timing of the application of the open wire detection circuitry the proper voltage measurements may not be apparent. Repeat application of the Start Open Wire and Start Cell Voltage commands, perhaps five to ten times, will fully deplete any parasitic charge on the input filter capacitor and provide the proper open wire detection voltages.

CONTINUOUS OPERATION

For convenience, the control panel allows for continuous operation of the DC1393A board. The command button labeled **START CONTINUOUS READ CELLS** can be clicked and the board control is placed in a continuous loop executing the following commands automatically in the following sequence:

- Start cell voltage
- Read cell voltage
- Start temp
- Read temp
- Read flags

All values are updated continually. 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 in the lower right hand corner indicates that the system is running continuously. A red box means that the system is stopped and waiting for a new command to be sent.

DISPLAYING VALID DATA TRANSFERS ONLY

Each time data is transferred from the LTC6802-2 by the four READ commands (Cell Voltage, Configuration, Flag Status and Temperature), a Packet Error Code, PEC, is calculated based on the data stream sent. The control program also calculates a PEC value based on the data it receives. If the calculated PEC matches the transmitted value the data transfer is assumed to be error free and therefore the data is valid.

If the two PEC values do not match, the transmitted data stream has been somehow corrupted. This type of data error becomes more of a concern when boards are stacked and the transmit data stream is lengthened. The transmitted and calculated PEC values are displayed on the GUI and turn red when a mismatch occurs.

A small checkbox located in the lower right corner of the GUI, called **PEC Match Only**, is provided as a system control option. When left unchecked the control of the system is normal and all information read from the LTC6802-2 is displayed, even if the transmitted data was corrupted and a PEC mismatch occurred.

Checking this box instructs the control program to automatically retry the READ commands. The only data displayed is that which was transmitted without error. **This setting masks all transmission errors and makes for a smooth running, error free demonstration.**

The state of the PEC Match Only option is indicated below the color-coded status panel.

ADDING BOARDS TO MEASURE MORE CELLS

An important function of the LTC6802-2 is the ability to communicate serial data from devices connected to up to 16 individually addressable battery cell stacks. Likewise 16 DC1393A boards, monitoring up to 12 cells each, can be controlled and read individually. **The control GUI is limited to only 10 boards (120 cells) maximum**. The battery cell stacks can be completely separate from each other, or stacked on top of each other due to the isolated digital control interface. To control more than one board requires the following hardware and software modifications:

HARDWARE ADJUSTMENTS

1. Each board needs a unique 4-bit binary address between 0 (0000) and 15 (1111). The LSB of the address is A0 and is set with jumper J8 (Active=1, Gnd=0). Bits A1 through A3 (the MSB), are set with jumpers J9, J10 and J11. Any address can be used with any board so long as no two are the same. The GUI can also be programmed to match the address of each board.
2. A single external 5V supply to power the opto-isolator circuit is required between terminals E5 and E6 of the board connected to the host controller (the bottom board in a multi-board stack of cells). The current capability of this supply must be at least 50mA for each board connected (50mA x number of boards).
3. The board having address 15 can have J4 (TOS) set to ACTIVE. This will enable toggle polling when all boards are not busy and not in interrupt.
4. To simplify the communication to all boards in a system, the host controller connects to the Main Connector (J2) of just one of the boards (the bottom board in a multi-board stack of cells). A ribbon cable can connect the Aux connector (J3) of this board to the Main connector (J2) of another board. This connects all of the Serial I/O lines together and also provides power for the opto-isolator circuits. Additional boards are added by ribbon cable from J2 to the available J3 connector of another board.

STACKED CELLS OR SEPARATE BATTERY PACKS

Each DC1393A board monitors up to 12 cells in a stack. Multiple cell stacks using multiple boards for monitoring can be completely isolated from each other, or stacked on top of each other.

CAUTION! CAUTION! CAUTION!

As battery cells are stacked on top of each other, great care must be taken to prevent damage and personal injury from the very high voltage potentials that may be present. Do not allow short circuit connections, whether electrical or human, between a high voltage point and the system or chassis ground at the bottom of the stack. Be very careful and respect the potential danger of high voltage!

IMPORTANT NOTE FOR DEMONSTRATION OR EVALUATION WHEN USING RESISTORS INSTEAD OF BATTERY CELLS IN A STACK

When using DC1393A boards in a stacked application where a resistor string is used to simulate cell voltages an extra wire must be added to connect the V+ potential of a lower board to the V- potential of the next board up on the stack. Connector J1, pin 16 of a the lower board must be connected to the connector J1, pin 1 or pin 4 of the next board above it on the stack. The wire making this connection should be kept as short as possible (less then 2 inches or 5 cm). **The ribbon connector does not provide this supply connection.**

An example of use of resistors in a 3-board stack is shown on the next page. If the three resistor stacks (or cells) are separated from each other (not stacked in series) then the V+ to COM connection between the top and bottom of each board is not required. Note also the additional 5V power supply required for opto-isolator power.

Stacking LTC6802-2/DC1393A Boards Using Series Resistors to Simulate Battery Cells

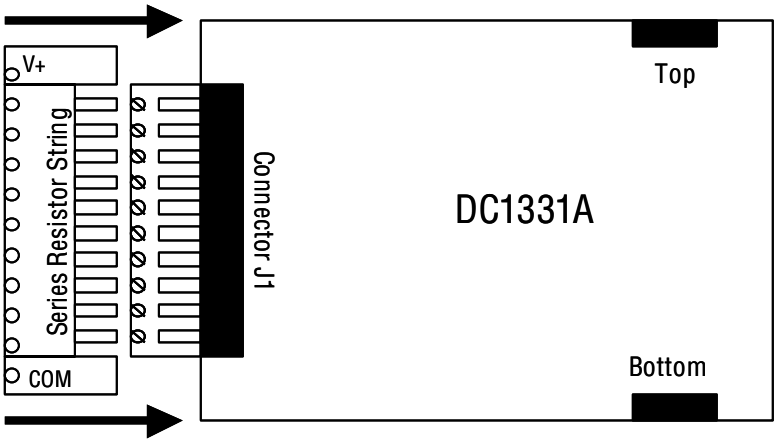


Figure A. Fasten the fingers of the resistor board with the screw terminals on the J1 connector provided with DC1393A. The resistor string provides voltages to simulate 12 cells (Vcell = (V+-Vcom)/12) and 2 temperature sensing thermistors.

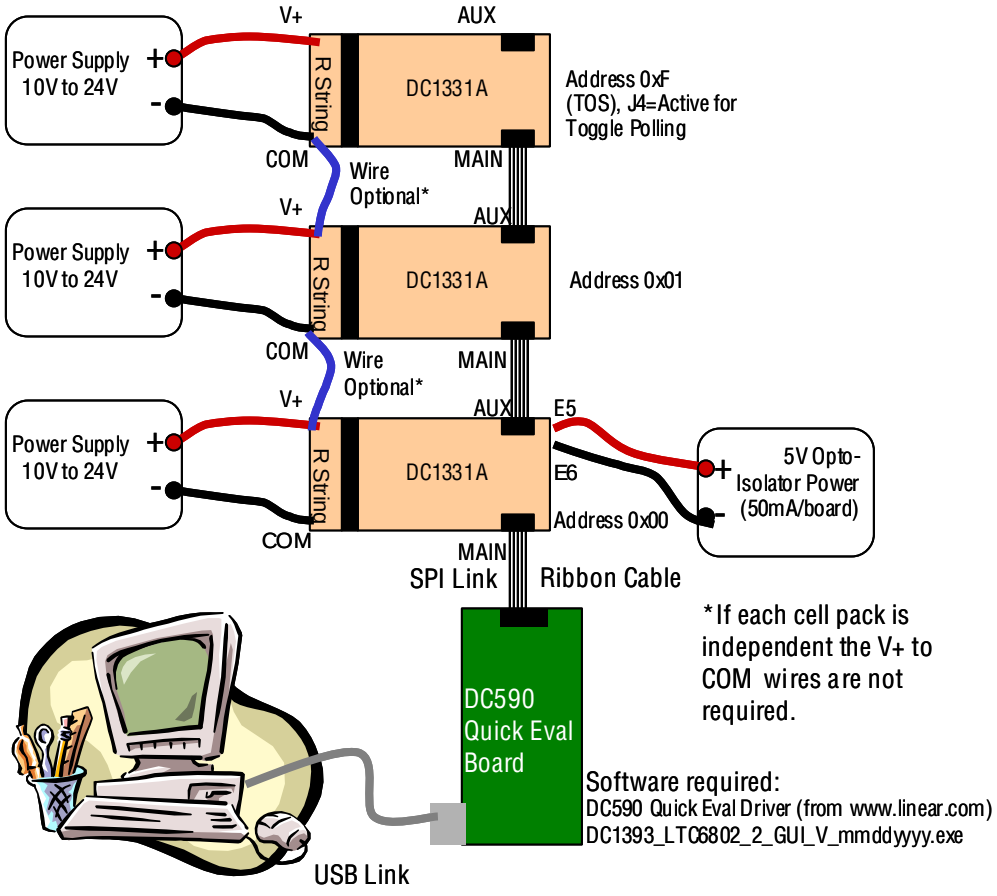


Figure B. A three card stack example. If the power supply voltage across the resistor stack needs to be greater than 24 Volts then the resistor values must be changed from 5K Ω to 150 Ω. In stacked cell demonstrations keep the supply connections between the boards as short as possible to minimize communications errors.

INITIAL SOFTWARE ADJUSTMENTS

The GUI program can control up to ten boards.

Select the number of boards connected from the list box located in the lower left corner of the screen.

A tab will appear on the left edge of the control panel for each board on the stack.

Click each board tab separately and set the following parameters for the selected board:

1. Select the address for each board to match its jumper-set value. Values range from 0 to F. Make sure that each board has a unique address.
2. Select whether the Over/Under voltage thresholds for each board are to be the same (GLOBAL) or different (CUSTOM) and set the voltage limits accordingly. If Global, the limits need to be entered only once.
3. Since the default power up state of the LTC6802-2 is Standby, the GUI starts up this way to serve as a reminder that the device must be configured before any other operations. Select an operating mode from the Set CDC scroll box at the bottom.
4. Click **WRITE CONFIG** to configure the board for basic operation.
5. Click **READ CONFIG** to verify that the proper word was written to the board.
6. Select another board tab on the left and repeat steps 1 to 5.

BROADCAST COMMANDS-BE CAREFUL

Each LTC6802-2 controlling command has the option to be broadcast to all boards in the system simultaneously. This can be quite convenient, but it can also make unintended changes to some of the boards. When the **WRITE CONFIG** command B'Cast check box is checked, the settings currently visible on the screen will be sent to all boards and will change their configuration for voltage monitoring threshold and operating mode. If unpredictable results are seen from a board it could be due to the configuration change. Making a **READ CONFIG** on that board will indicate it's present configuration.

CONTINUOUS READING OF ALL CELLS IN A SYSTEM

When put into continuous mode each board is exercised in succession. The moving LTC logo indicates which board is being measured. The cell voltage and temperature readings are for the Tab selected board only. When stopped, all readings are cleared.

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 meaning of the colors used is explained in the legend on the screen.

Any grayed box indicates that the cell's interrupt flag has been masked so the LTC6802-2 is no longer reporting this status. The cell voltage value measured for this cell however is still accurate.

The schematics for DC1393A follow. Consult the data sheet for detailed information on the operation of the LTC6802-2 battery monitoring system.

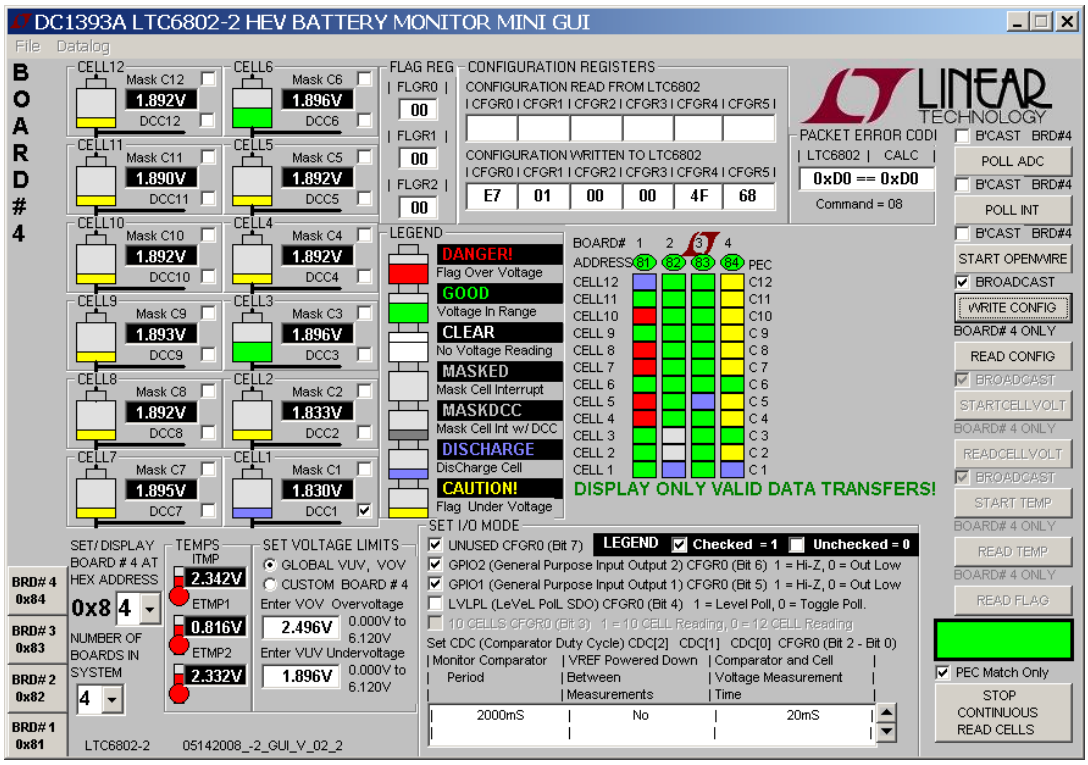


Figure 3. GUI screenshot showing 4 boards being continuously monitored. Cell voltages and Temperature readings are for board 4 only. Color-coded cell status is for all boards connected.

ISO_GND
E4
VREG
E3
GPIO2
E2
GPIO1
E1
WDT\
E7
A3
A2
A1
A0
GPIO2
GPIO1
MM\
TOS
GND / ACTIVE
J11
J10
J9
J8
J7
J6
J5
J4
2MM, 1X3 pin SAMTEC TMM-103-02-L-S
R36 1M
R37 1M
R38 1M
C18 100n
U3
A0 A1 A2 VSS VCC WP SCL SDA
24LC025
R33 4.99k
R34 4.99k
R69 100k
R44 100k
R42 4.99k
R43 100k
J3 AUX
J2 MAIN
VIN GND1 MISO MOSI EESDA EESCK GND3 VCC SCK CS GND2 EEVCC EEGND NC
HD2X7-079-MOLEX 87331-1420
HD2X7-079-MOLEX 87831-1420 QuickEval / SPI / MAIN
R2 330
R3 330
R41 330
Q13 TP0610K
Q14 TP0610K
Q15 TP0610K
U4
ACSL-6410
R72 3.57k
R73 3.57k
R74 3.57k
R1 249
C23 100n
D2
CM1223-04SO
DIGITAL_GND
EXT_GND
E6
TURRET06
Q16
SI2323DS
R71 100k
EXT 5V
E5
D1
CMSH2-20M
C24 100n
R32 100
R31 100
C20 1u
CELL12
R4 100
U1
LTC6802-2
C12FILTER C11FILTER C10FILTER C9FILTER C8FILTER C7FILTER C6FILTER C5FILTER C4FILTER C3FILTER C2FILTER C1FILTER
DC12 DC11 DC10 DC9 DC8 DC7 DC6 DC5 DC4 DC3 DC2 DC1
C13 100n
C15 1u
C14 1u
C16 OPTIONAL
C17 OPTIONAL
D3 BAT54S
D4 BAT54S
C22 1u
U2
LT1636
R29 10.0k
R30 10.0k
R35 OPTIONAL
R40 OPTIONAL
VTEMP1
VTEMP2
U5
LTC1693-2
C21 470p
R39 20.0k
R70 10.0k
C19 33n
T1
PE-68386

LINEAR TECHNOLOGY

1630 McCarthy Blvd.
Milpitas, CA 95035
PH: (408) 432-1900

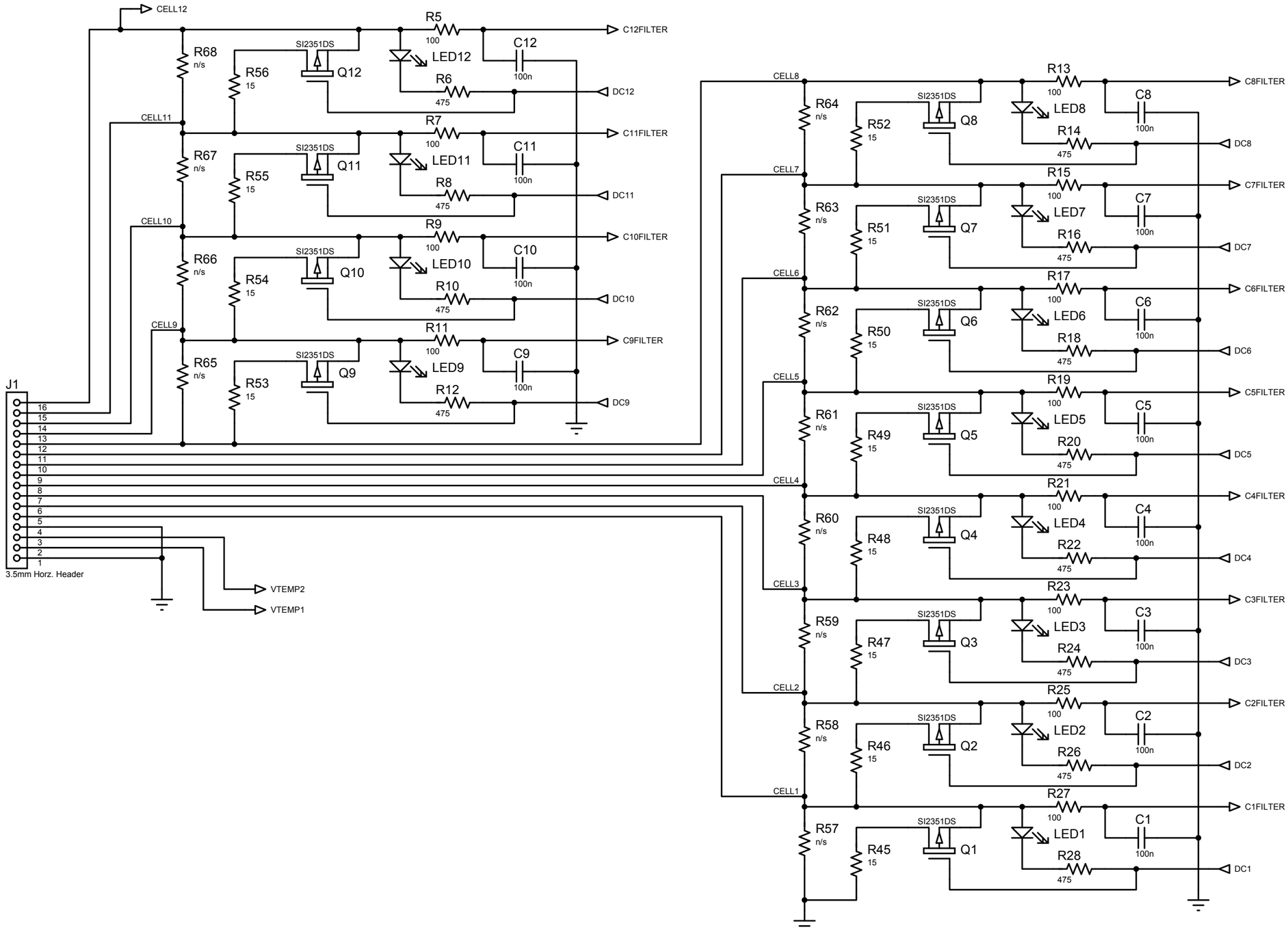
DC1393A SCHEMATIC

LTC6802IG-2 12-CELL BATTERY STACK MONITOR

Sourcefile: DC1393A.DSN

J. Munson 2/28/08

SH 1 of 2



LINEAR TECHNOLOGY

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DC1393A SCHEMATIC

LTC6802IG-2 12-CELL BATTERY STACK MONITOR

Sourcefile: DC1393A.DSN

J. Munson 2/28/08

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