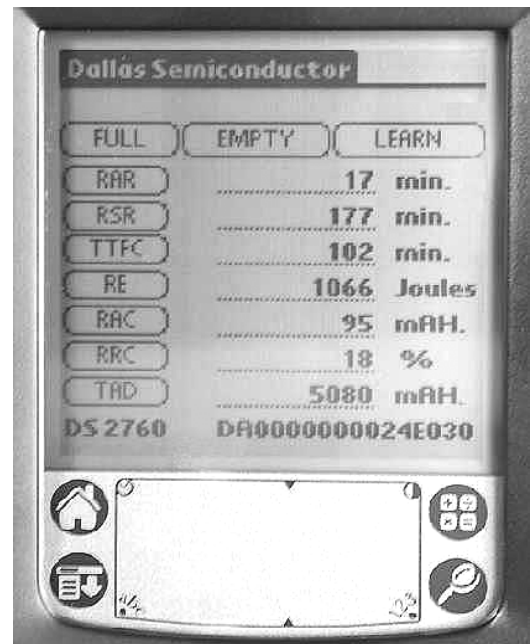


INTRODUCTION

Dallas Semiconductor's battery management support products allow the user to validate fuel gauging and power control within their product without committing significant resources to the task. Fuel gauging software is available for evaluation purposes on both the PC and PALM platforms as well as ANSI C source code capable of running within the target application. Developing a typical DS2760-based application usually involves the integration of the DS2760 into the battery pack, configuration of the device using the DS2760K Li⁺ Battery Monitor Evaluation Kit, and performance evaluation using the DS2760K software on the PC or PALM handheld. The final phase of the development involves the integration of the fuel gauging function into the end equipment.

The PALM platform is a convenient vehicle for portably monitoring state-of-charge of the user's target rechargeable system. The DS2760 Fuel Pack software runs on either Palm III or Palm m100 PDAs and communicates to a DS2760 through the Palm's Hotsync port using a specially modified DS9123. It then displays relevant cell information to the user.



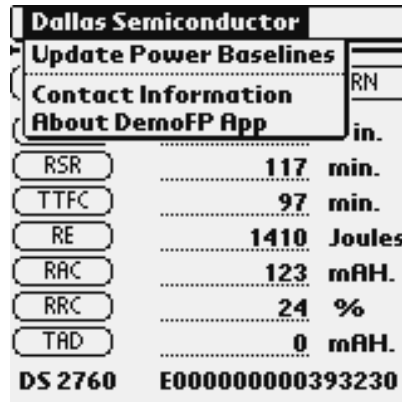
PARAMETER DISPLAY Figure 1

SETUP AND INSTALLATION

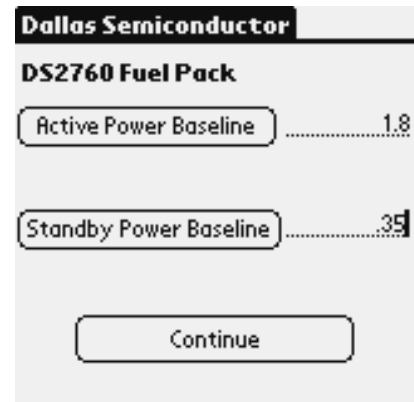
The DS2760 Fuel Pack is a standard Palm-executable that can be downloaded through either the Hotsync port or infrared link of the PDA. For proper operation, the program must communicate to a DS2760 through a specially modified DS9123 brick attached to the Hotsync port (See the appendix for modification details), and characterization data for the monitored cell must already be stored in the DS2760's EEPROM. Cell characterization data is discussed in detail in Application Note 131: Lithium-Ion Fuel Gauging with Dallas Semiconductor Devices, and a memory map of how the cell data is stored can be found in the DS2760K demonstration kit datasheet. Once Fuel Pack is loaded onto the PDA and a DS2760 is connected through a DS9123 to the Hotsync port, tap the Fuel Pack icon to execute the program. Cell characterization data is read from the DS2760 only at the start of the program; therefore, to ensure accurate readings, the program must be restarted each time the cell pack being monitored is changed.

OPERATION

Upon execution of the program, the Dallas Semiconductor logo screen will appear for several seconds showing the program revision and date. At this time, the program will attempt to initialize the DS9123. If unsuccessful, an error message will be displayed warning of a communication problem. Once the DS9123 is initialized, the program will proceed to the fuel gauge display screen. In order for the fuel gauging algorithms to report the remaining active and standby runtimes accurately, the user must enter a power consumption reference. To do this, select the Update Power Baselines option from the menu (Figure 2). Next, enter the device's active and standby power consumption in watts into the two blanks provided and tap **CONTINUE** (Figure 3). Failure to enter either of these values correctly will cause the corresponding runtime value to not be displayed during program operation.



MENU OPTIONS Figure 2



POWER BASELINE ENTRY Figure 3

| FuelPack | | Parametric | Memory |
|----------|------------------|------------|--------|
| FULL | EMPTY | LEARN | |
| RAR | 11 | min. | |
| RSR | 117 | min. | |
| TTFC | 97 | min. | |
| RE | 1410 | Joules | |
| RAC | 123 | mAh. | |
| RRC | 24 | % | |
| TAD | 0 | mAh. | |
| DS 2760 | E000000000393230 | | |

FUEL GAUGING DATA Figure 4

Once the power baselines have been entered, the program moves on to its active display screen where it will continuously report fuel-gauging parameters. During this time, communication to the DS2760 takes place continuously as real-time values of cell temperature, voltage, current, and accumulated current are updated. Real-time information is displayed on the right-hand side of the screen directly across from the corresponding parameter (Figure 4). Tapping on any of the parameters located on the left-hand side of the screen will bring up a display window showing the parameter name and the units in which the reported value is displayed. These parameters are summarized as follows:

RAR: Remaining Active Runtime in minutes – Calculated from the remaining energy (RE) value and the active power baseline entered by the user. Predicts when the cell will reach full discharge when the handset is in the active mode of operation. Figure 4 shows 11 minutes remaining.

RSR: Remaining Standby Runtime in minutes – Calculated from the RE value and the standby power baseline entered by the user. Predicts when the cell will reach full discharge when the handset is left in the standby mode of operation. Figure 4 shows 117 minutes remaining.

TTFC: Time Remaining to Full Charge in minutes – An estimation of time required to fully charge the cell based on characterization data and the cell's present state of charge. Figure 4 shows 97 minutes remaining.

RE: Remaining Energy in joules – An estimation of remaining energy in the cell based on the active power baseline and the present temperature. Figure 4 shows 1410 joules remaining.

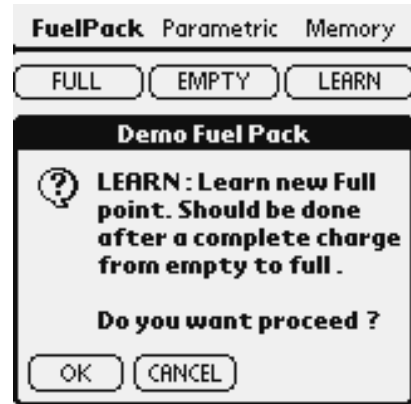
RAC: Remaining Absolute Capacity in milliamp-hours – An estimation of remaining charge in the cell based on active power baseline, present temperature, and cell characterization data. Figure 4 shows 123 milliamp-hours remaining.

RRC: Remaining Relative Capacity in percentage – The remaining absolute capacity (RAC) expressed as a percentage of the cell’s full capacity. Figure 4 shows 24 percent remaining.

TAD: Total Accumulated Discharge in milliamp-hours – A cumulative total of all charge measured leaving the cell over its operating life. Figure 4 shows 0 accumulated milliamp-hours of discharge.

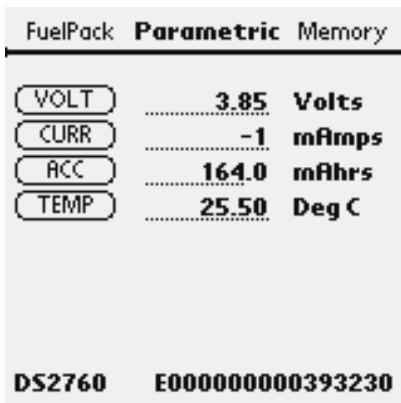
DS2760: The final parameter displayed at the bottom of the screen is the unique, 64-bit net address of the DS2760. Figure 4 shows the net address of the DS2760 as E000000000393230.

The **FULL**, **EMPTY**, and **LEARN** buttons at the top of the screen (Figure 4) are present to allow the user to remove long term error accumulation from the system. Each time the cell is fully discharged, the user should tap the **EMPTY** button. This will reset the fuel gauge to 0%, the expected empty point for the present operating conditions. Each time the cell is fully charged, the user should tap the **FULL** button. This resets the fuel gauge to 100% or the expected full point based on present conditions. Finally, the **LEARN** function will alter the characterization data stored inside the DS2760 to reflect present RAC value. **LEARN** should be used *only* after a known good charge from completely empty to completely full has taken place, as these changes will affect the accuracy of the fuel gauge for all future readings. The user should select either **LEARN** or **FULL** after a charge, not both; taping both will have a negative effect on the accuracy of the fuel gauge. Because an accidental press of any of these buttons will cause the fuel gauge to become inaccurate, a pop up window will appear prompting the user to confirm or cancel the action.



LEARN OPTION Figure 5

The parametric tab at the top of the screen will bring the user to the parametric data page. This page displays all real time measurements made by the DS2760. The displayed values are automatically updated with each poll from the software. These values are as follows:



REAL-TIME DATA Figure 6

- VOLT:** Cell voltage measured directly from the Vin pin of the DS2760 displayed in volts.
- CURR:** Current flow measured across the sense resistor in milliamps. Positive current is flowing into the pack, negative current is flowing out.
- ACC:** Accumulated current value integrated over time by the DS2760 and stored in milliamp-hours.
- TEMP:** Temperature of the DS2760 in degrees Celsius.

The memory tab at the top of the screen will bring the user to the last page of data. The memory page displays all data inside the DS2760 including user registers, real time data, user EEPROM, and user SRAM. The data is displayed in hexadecimal format eight bytes at a time. To view the next eight bytes of data by address, tap the **NEXT** button. To view the previous eight bytes of data by address, tap the **PREV** button. Finally, the **UPDATE** button will refresh the displayed data with new readings from the DS2760. The memory page is read only to protect the parametric data for the fuel gauge stored in EEPROM.

| FuelPack | Parametric | Memory |
|---------------|-------------------------|----------------|
| | | Address |
| | | Data |
| | | 20 02 |
| | | 21 16 |
| Prev | | 22 07 |
| Update | | 23 05 |
| Next | | 24 07 |
| | | 25 08 |
| | | 26 34 |
| | | 27 00 |
| DS2760 | E000000000393230 | |

MEMORY DATA Figure 7

APPENDIX

The standard DS9123 communication brick is designed to interface from a computer's serial port through a male DB9 connector to a 1-Wire bus through an RJ-11 connector. The Palm's Hotsync cable connection is different from a standard serial port; the DS9123 must therefore be modified to interface to the Palm.

Refer to the following steps to modify a DS9123:

1. Remove female DB9 connector and circuit board from plastic housing.
2. Unsolder female DB9 connector from circuit board and discard.
3. Replace with a male DB9 connector using the following pin to pad assignments. All other pins and pads are no connects.

| DB9 Connector Pin | Circuit Board Pad |
|-------------------|-------------------|
| 1 | 1 |
| 3 | 2 |
| 5 | 5 |
| 6 | 4 |
| 8 | 7 |

4. Reinsert circuit board and male DB9 connector into plastic housing.