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## FEATURES

- Demonstrates the capabilities of the DS2438 Smart Battery Monitor, including:
  - Temperature measurement
  - Voltage measurement
  - Current measurement
  - Current accumulation
  - Elapsed time
  - Information storage
  - Identification
- Provides small-volume DS2438 programming support
- Interfaces to the serial port of a PC running Windows 95, Windows 98 or Windows NT

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## INTRODUCTION

The DS2438K Evaluation Kit makes performance evaluation, software development, and prototyping with the DS2438 Smart Battery Monitor easy. The evaluation board interfaces to an IBM-compatible PC through a DS9123 Serial Port Adapter and RJ-11 cable connection. Two floppy disks contain the DS2438K software, which can be run under Windows 95, Windows 98 or Windows NT.

Resistor R1 on the evaluation board is a 50 mΩ current sense resistor. Resistor R2 and capacitor C1 implement the VSENS– low-pass filter recommended by the DS2438 data sheet. Component site R3, which is intentionally unpopulated, allows another sense resistor to be soldered down in parallel with or in place of resistor R1. Component site C3, intentionally unpopulated, allows a capacitor to be connected to the VAD input if needed.

# DS2438K Smart Battery Monitor Evaluation Kit



## EVALUATION KIT CONTENTS

- 1 pc. DS2438K evaluation board
- 2 pcs DS2438K software diskettes (3.5" format)
- 1 pc. DS9123 Serial Port Adapter
- 1 pc. RJ-11 phone cable
- 1 pc. DS2438K data sheet
- 1 pc. DS2438 data sheet

## EQUIPMENT NEEDED

1. An IBM-compatible PC running Windows 95, Windows 98 or Windows NT with a 3.5" floppy drive and an available serial port
2. A battery or power supply and cabling to interface to the evaluation board



The evaluation board can be connected to a power supply and an external load in configurations that simulate either charging or discharging for the DS2438. Figure 1a below illustrates the charging configuration while Figure 1b shows the discharging configuration.

## CONNECTIONS TO SIMULATE CHARGING OR DISCHARGING Figure 1

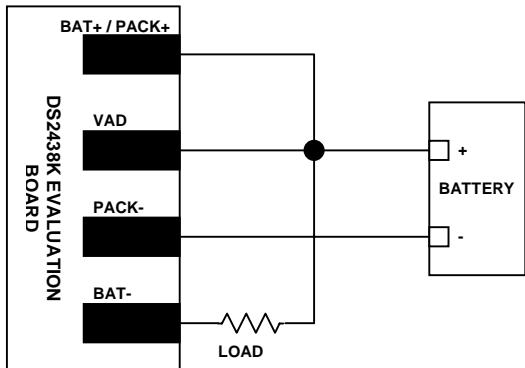


Figure 1a Charging

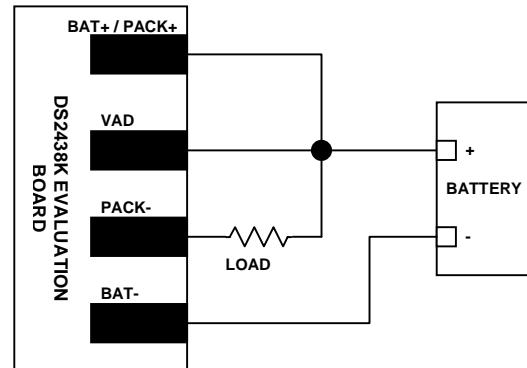


Fig 1b Discharging

## SETUP AND INSTALLATION

Before starting the demonstration, connect the evaluation board to a power supply and a load as shown in Figure 1a or Figure 1b. Also, be sure that the evaluation board is connected to the DS9123 through the RJ-11 cable and that the DS9123 is plugged into an unused serial port on the computer.

To install the DS2438K software, exit all programs currently running and insert Installation Disk 1. Run SETUP.EXE and the installation process is launched. Follow the prompts to complete the installation. The DS2438K software can be uninstalled in the Add/Remove Programs tool in the Control Panel. After the installation is complete, open the DS2438K folder and run DS2438K.EXE. A splash screen containing information about the evaluation kit appears as the program is being loaded.

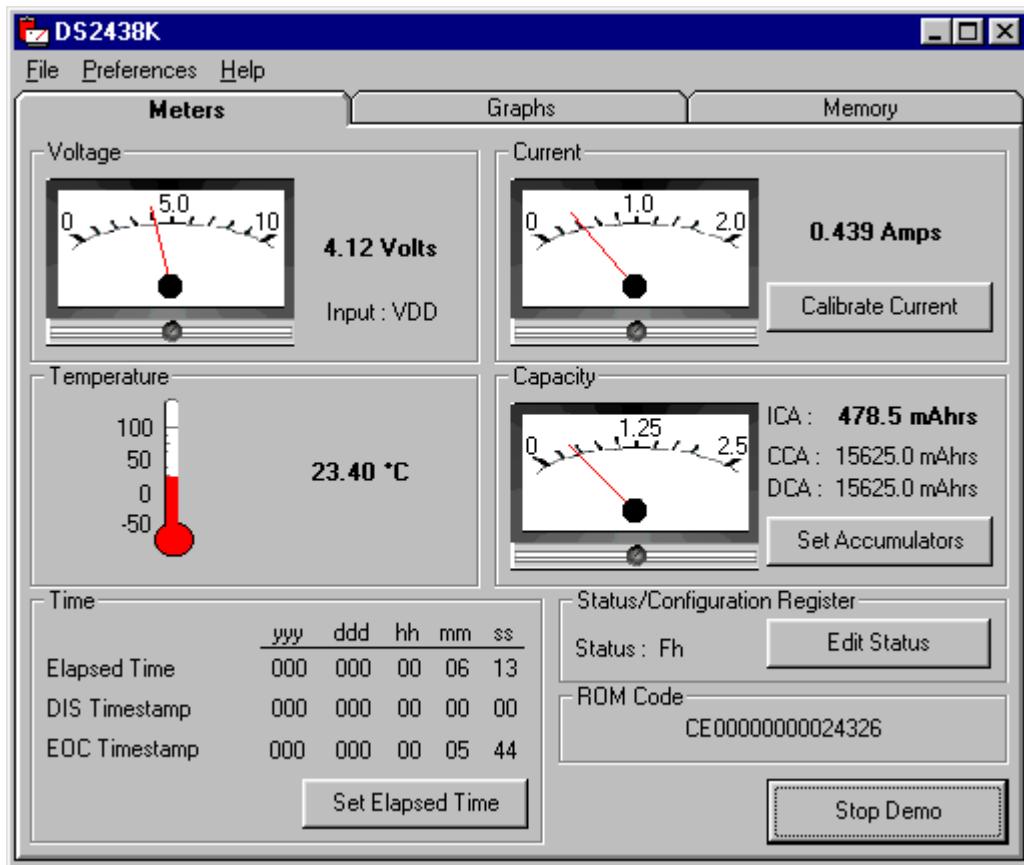
## SELECTING THE COM PORT

The first time the software runs, the Serial Port Settings window appears. In this window, select the COM port to which the DS9123 is attached and then hit OK. The DS2438K software saves this COM port selection and automatically uses the selection each time the program starts. To change the COM port later, click the Preferences option on the menu bar, select Serial Port Settings, and then select the appropriate port.

## REAL-TIME METERS

The Meters Screen displays the latest real-time measurements of battery voltage, temperature, current and remaining capacity (ICA) with both analog meter readouts and digital values. Also displayed on the Meters Screen are the values in the Charge Current Accumulator (CCA), Discharge Current Accumulator (DCA), Elapsed Time Meter, Disconnect (DIS) Timestamp Register, End-of-charge (EOC) Timestamp Register and Status Register. The 64-bit ROM ID of the DS2438 is also displayed at the bottom of this screen. The Meters Screen is shown in Figure 2. To begin reading and displaying real-time data from the DS2438, click the Start Demo button.

## METERS SCREEN – Figure 2



### SETTING THE ELAPSED TIME METER

The Elapsed Time Meter (ETM) in the DS2438 is a 32-bit seconds counter that starts counting from zero when a power supply is connected to the part. The DS2438K software reads this 32-bit value and formats it into years, days, hours, minutes and seconds. To set the ETM, press the Set Elapsed Time button and then enter the appropriate years, days, hours, minutes and seconds information in the Set Elapsed Time window. The evaluation kit software reformats this information into a 32-bit binary value and writes that value to the DS2438. Pressing the Reset button in the Set Elapsed Time window clears ETM fields.

### END-OF-CHARGE AND DISCONNECT TIMESTAMPS

To demonstrate the DS2438's end-of-charge timestamp, wire the evaluation board in the charging configuration shown in Figure 1a, start the demonstration, and then disconnect one side of the load resistor (BAT- or PACK-). As soon as this is done, the end-of-charge timestamp register updates to reflect the end-of-charge time. To demonstrate the disconnect timestamp feature, simply unplug the RJ-11 cable from the evaluation board. During the time the cable is unplugged, the displayed values of the Elapsed Time Meter and both timestamp registers become invalid because the software is not able to communicate with the DS2438. When the RJ-11 cable is plugged back in, the software updates the displayed values to reflect the contents of the DS2438, including the new Disconnect Timestamp register value.

## CURRENT MEASUREMENT CALIBRATION

The Calibrate Current button on the Meters Screen opens the Calibrate Current Measurement window. This window gives a real-time demonstration of how current measurements are acquired, corrected and reported using the DS2438. First, the DS2438 takes an uncorrected measurement of the voltage drop across the current sense resistor. The DS2438 then adds the contents of the Offset Register to the uncorrected current measurement and writes the corrected result to the Current Register. The host system then divides the voltage value in the Current Register by the value of the sense resistor to obtain the measured current.

To calibrate DS2438 current measurements for offset error, follow these steps:

1. Press the Calibrate Current button in the Meters Screen.
2. Reduce the actual current driven through the sense resistor to zero.
3. Set the Offset Register value to 0 and press the Apply button.
4. Set the Offset Register value to  $-1$  times the observed Uncorrected Current value and press the Apply button. This uncorrected current value is the DS2438's offset error.
5. The Current Register line should now be reporting 0 LSb, 0 mV.

To calibrate DS2438 current measurements for sense resistor variation and the effects of trace resistance, follow these steps:

1. Force a known current through the sense resistor.
2. Enter a different sense resistor value and click the Apply button.
3. Repeat step 7 until the Current reading shown by the software equals the actual current being forced.
4. Click the OK button to leave the Calibrate Current Measurement window. The DS2438 should now be correctly calibrated, and the Current Meter on the Meters Screen should now show the actual current flowing through the sense resistor.

## SETTING THE CURRENT ACCUMULATORS

The Set Accumulators button on the Meters Screen opens the Set Accumulators window. This window allows the user set the values of the ICA, CCA and DCA registers and configure accumulator-related items. The value entered in the Nominal Battery Capacity field becomes the full-scale reading of the Capacity Meter on the Meters Screen. The Threshold Register setting configures the DS2438 to only accumulate currents above a particular threshold.

To set the values of the ICA, CCA and DCA, enter the decimal value to be stored in the register and then press the Apply button. The DS2438K software multiplies the entered value by the value of an LSb in units of mAh (calculated from the sense resistor value entered in the Calibrate Current Measurement window) to obtain the value of the register in units of mAh. If any of the ICA, CCA or DCA registers are disabled by Status Register settings, their values cannot be set in the Set Accumulators window.

## STATUS/CONFIGURATION REGISTER

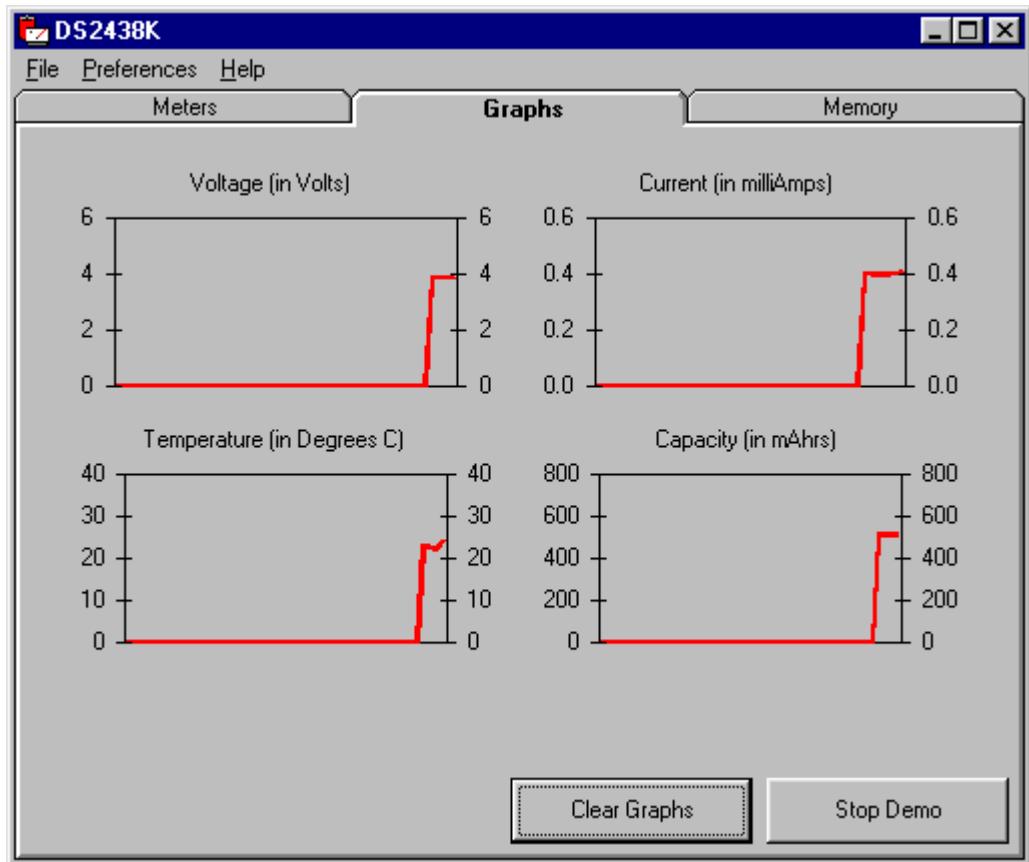
The DS2438 has four bits in its Status/Configuration Register that can affect the operation of the part. To change the values of the bits, press the Edit Status button to open the Status/Configuration Register window. When the Current A/D Control Bit (IAD) is set to "Disabled," Current, ICA, CCA and DCA functions are disabled in the DS2438 and on the Meters Screen. When the Current A/D Control Bit is set to "Enabled" and the Current Accumulator Configuration Bit (CA) is set to "Disabled," only the CCA and DCA registers are disabled in the DS2438 and on the Meters Screen. The Current Accumulator Shadow Selector Bit (EE) controls whether or not the DS2438 copies changes in the CCA and DCA registers to EEPROM memory or not. The Voltage A/D Input Select Bit (AD) configures the DS2438 to

use either the VDD pin or the VAD pin as input for voltage A/D conversion. The currently selected input is indicated next to the Voltage Meter on the Meters Screen.

## REAL-TIME GRAPHS

The Graphs Screen in the DS2438K software displays the last 50 seconds of real-time measurements of battery voltage, temperature, current and remaining capacity, as illustrated in Figure 3. The Clear button erases all the data in the graphs.

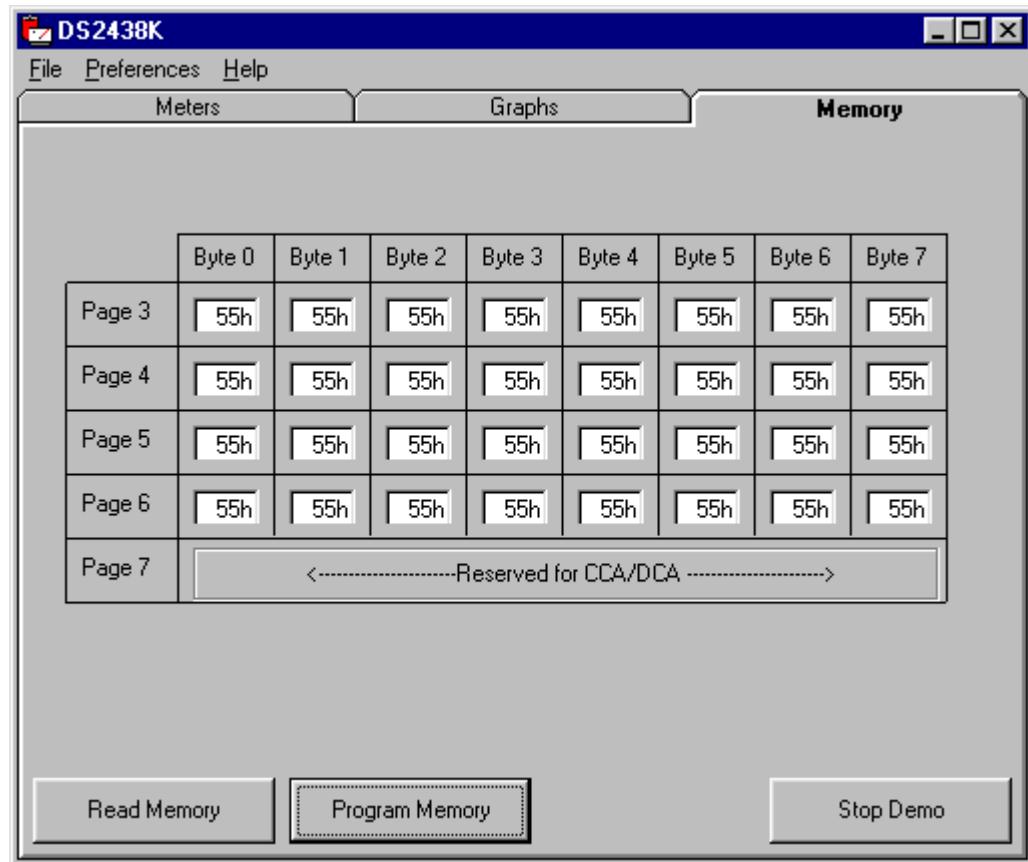
### GRAPHS SCREEN – Figure 3



## NONVOLATILE MEMORY

The Memory Screen in the DS2438K software (shown in Figure 4) allows the user to read and program the EEPROM memory in the DS2438. Memory pages 3 through 6 are general purpose data storage that can be programmed and read at any time. Page 7 is only accessible when the CCA and DCA are disabled via the IAD or CA bits in the Status/Configuration Register. To display the contents of DS2438 memory, press the Read Memory button. To program DS2438 memory, enter the desired data and press the Program Memory button.

**Saving and Opening Data Sets.** To save a particular set of data to a file for future use, click File in the menu bar, select Save, and specify a file name. To load a data set from a file, click File in the menu bar, select Open, and select the file.

**MEMORY SCREEN – Figure 4****EVALUATION BOARD SCHEMATIC – Figure 5**