DS323X Evaluation Kit

General Description

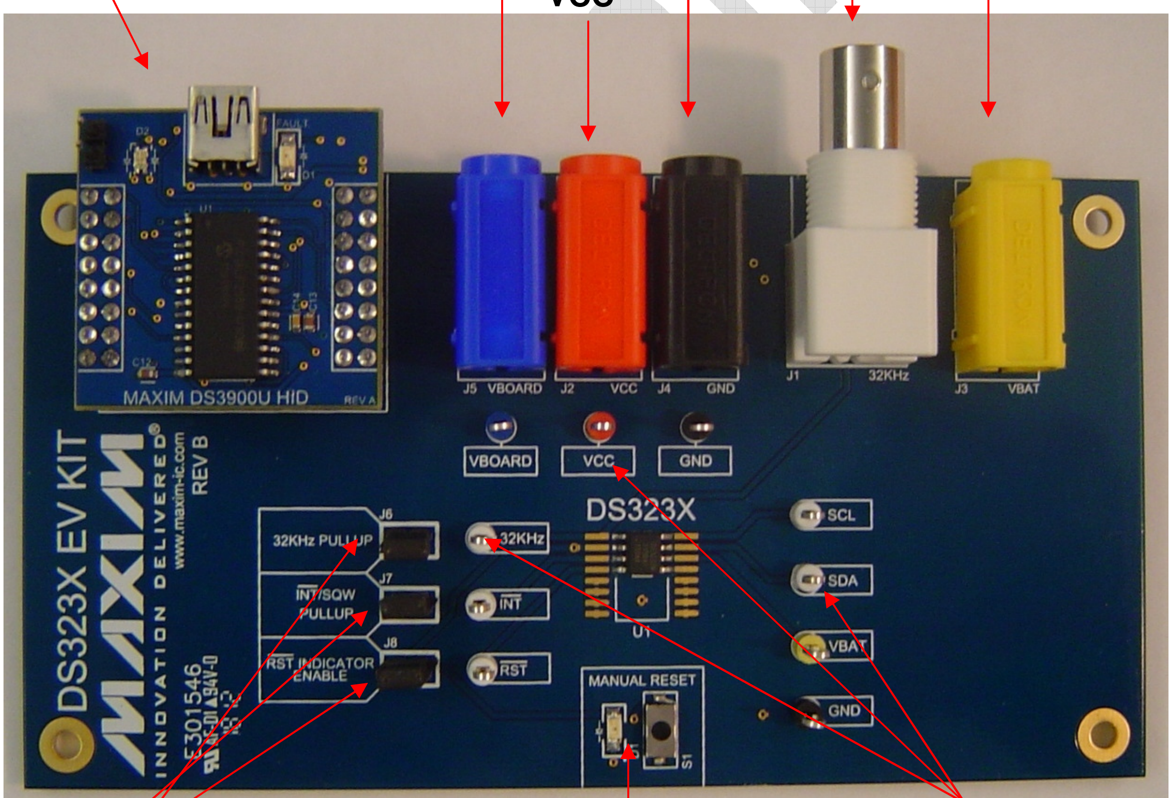
The DS323X evaluation kit (EV Kit) is a fully-assembled and tested circuit board with an accompanying application program that demonstrate the operation of the DS3231 or DS3232M real-time clocks. The DS3231 I^2C Real-Time Clock contains an internal quartz crystal for a timekeeping reference, while the DS3231M and DS3232M I^2C Real-Time Clocks contain an internal silicon (MEMS) resonator for its timekeeping reference. All three components constantly monitor the operating temperature, periodically adjusting the internal oscillator frequency to maintain highly accurate time information.

The kit includes a demonstration board, a USB I/O module (DS3900H2), and the CD containing the application program and instructions. System requirements are a Windows-compatible PC running Windows XP or later, and a USB port.

The kit allows for optional user configuration to a single power supply operation, and the accompanying I^2C interface and application program provide easy access to manipulate register settings while observing the various component functions of timekeeping and real-time alarm-initiated interrupts.

The kit also allows the user to connect their I^2C Master to our sample component for operational verification and/or code generation.

DS3900H2 I/O Module **VBOARD** **VCC** **GND** **32KHZ** **VBAT**



Pull-Up Resistor Jumpers J6-J8 **$\overline{\text{RST}}$ Pushbutton and LED** **Test Points**

Quick Start

Note: The Quick Start section assumes that the user will provide at least two power sources (VCC and VBAT) for a dual-voltage operational demonstration. A third power source (VBOARD) may optionally be used to provide a unique I/O power rail reference.

If single-supply operation is desired, see the appropriate set-up requirements under *Single-Supply Operation*, prior to performing any connections to the EV Kit.

Recommended Equipment

5V, 1A power supply (PS1 = VBOARD optional I/O power)
5V, 1A power supply (PS2 = VCC device power)
5V, 1A power supply (PS3 = VBAT backup power)
PC with USB capability
USB A to Mini B Cable
Oscilloscope (optional)

The DS323X EV Kits are fully assembled and tested. Follow these steps to verify the DS323X EV Kit dual-supply board operation. <u>Do not enable the power supply until all connections are completed</u>.

1) Verify that jumpers J6, J7, and J8 are installed (where noted). J6 and J7 connect the 32kHz and $\overline{\text{RST}}$ /SQW output pin pull-up resistors (respectively/if populated) to the VBOARD bias. J8 connects the $\overline{\text{RST}}$ (active-low) LED anode to the VCC bias.

2) If using a separate VBOARD (I/O) power supply, connect the PS1 power supply across the VBOARD (J5) and GND (J4) connectors. If I/O power is to be derived from the VCC supply, connect a banana jumper from VBOARD (J5) to VCC (J2).

3) Connect the PS2 power supply across the VCC (J2) and GND (J4) connectors.

4) Connect the PS3 power supply across the VBAT (J3) and GND (J4) connectors.

5) Set PS3 for +3V, 100mA, and enable the PS3 output.

6) Set PS2 for +3.3V, 200mA, and enable the PS2 output. The RESET LED (D1) will illuminate for ~250mS.

7) If using separate VBOARD power, set PS1 for +3.3V, 200mA, and enable the PS1 output.

8) Connect the USB cable (not provided) from the PC to the DS3900H2 Mini B USB connector. The D2 LED will illuminate red/blinking. Please allow Windows time to recognize the new USB device and load the device driver before proceeding.

9) See *Software Procedure*.

Software Procedure

DS3900 USB to I^{2}C Set Up Procedure (REQUIRED PROCEDURE)

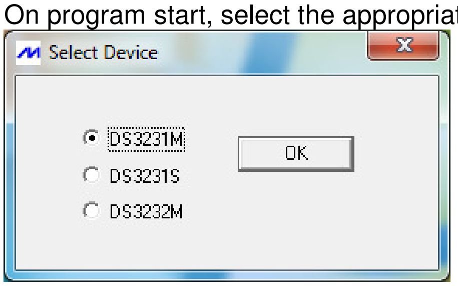
User Note: The DS3900H2 is the small daughter card located on top-left of the EV kit. It converts USB to I^{2}C and allows the GUI to communicate to the DS323X. ***It is important to allow Windows the time necessary to install the device driver, prior to first use.***

When initially connecting the USB cable, Windows should auto-recognize this new USB device. Please wait until you see the message that the device is ready for use.

The application is a self-contained exe, and may now be executed from the CD or copied to any directory on the PC that is desired. No installation script is required, nor included.

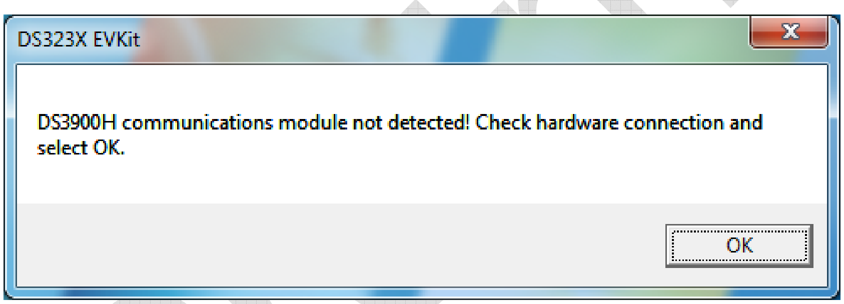
Device Prompt

On program start, select the appropriate device type and hit 'OK'.



If I/O is operational, the D2 LED will turn green and the application will automatically proceed to the Monitor Tab display.

If I/O initialization fails, an error message will be presented:



For ***Demo Mode***, simply click OK to proceed to view the Tabs. *No component or I/O operations will be active in Demo mode.*

For ***Operating Mode***, power off all supplies, recheck the connections, exit and subsequently restart the application.

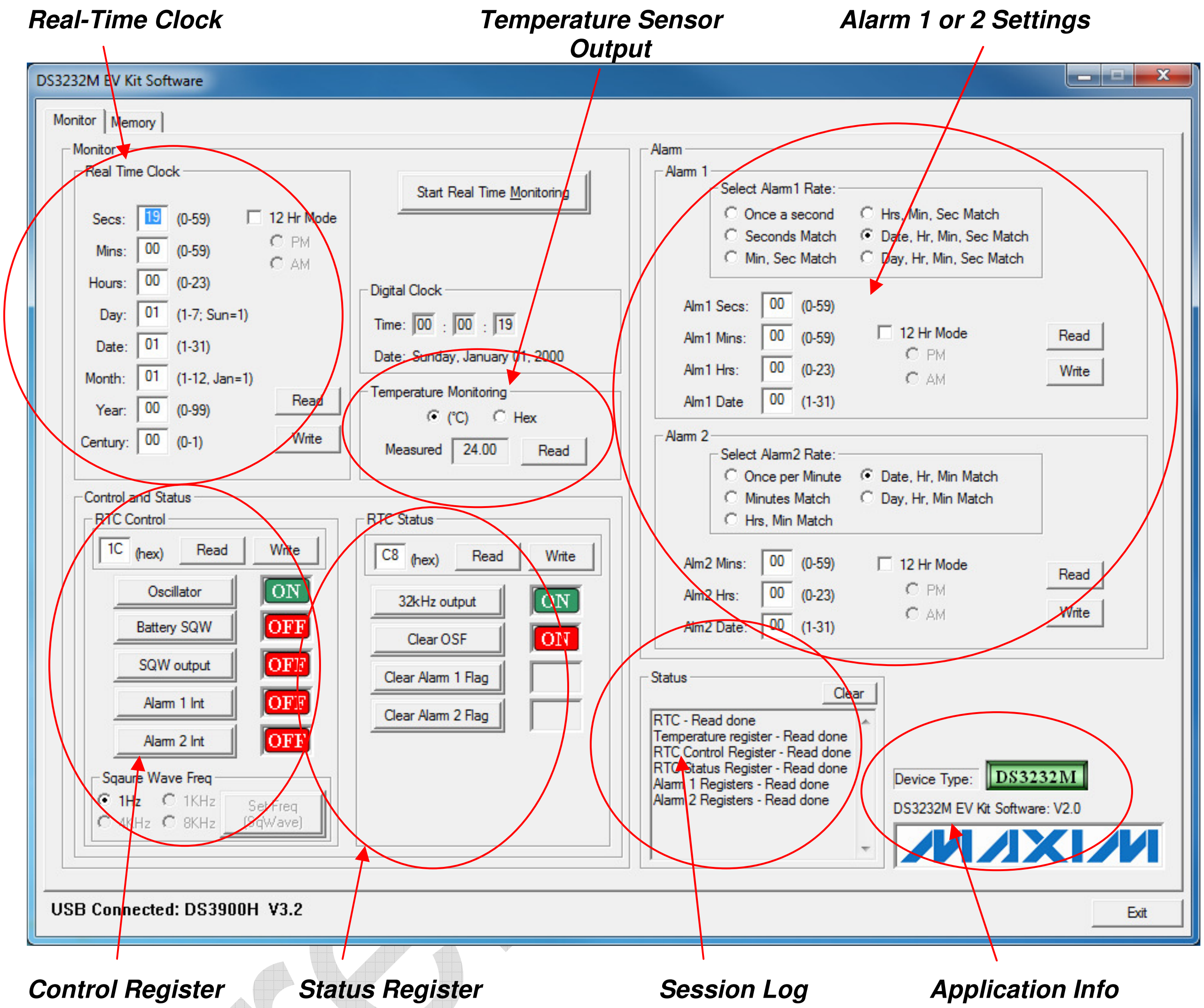
Monitor Tab

The Monitor Tab display is organized into several basic sections, as highlighted below.

When entering the Monitor Tab, an I/O read of the component registers is automatically executed to display the present contents in a human-formatted graphical display.

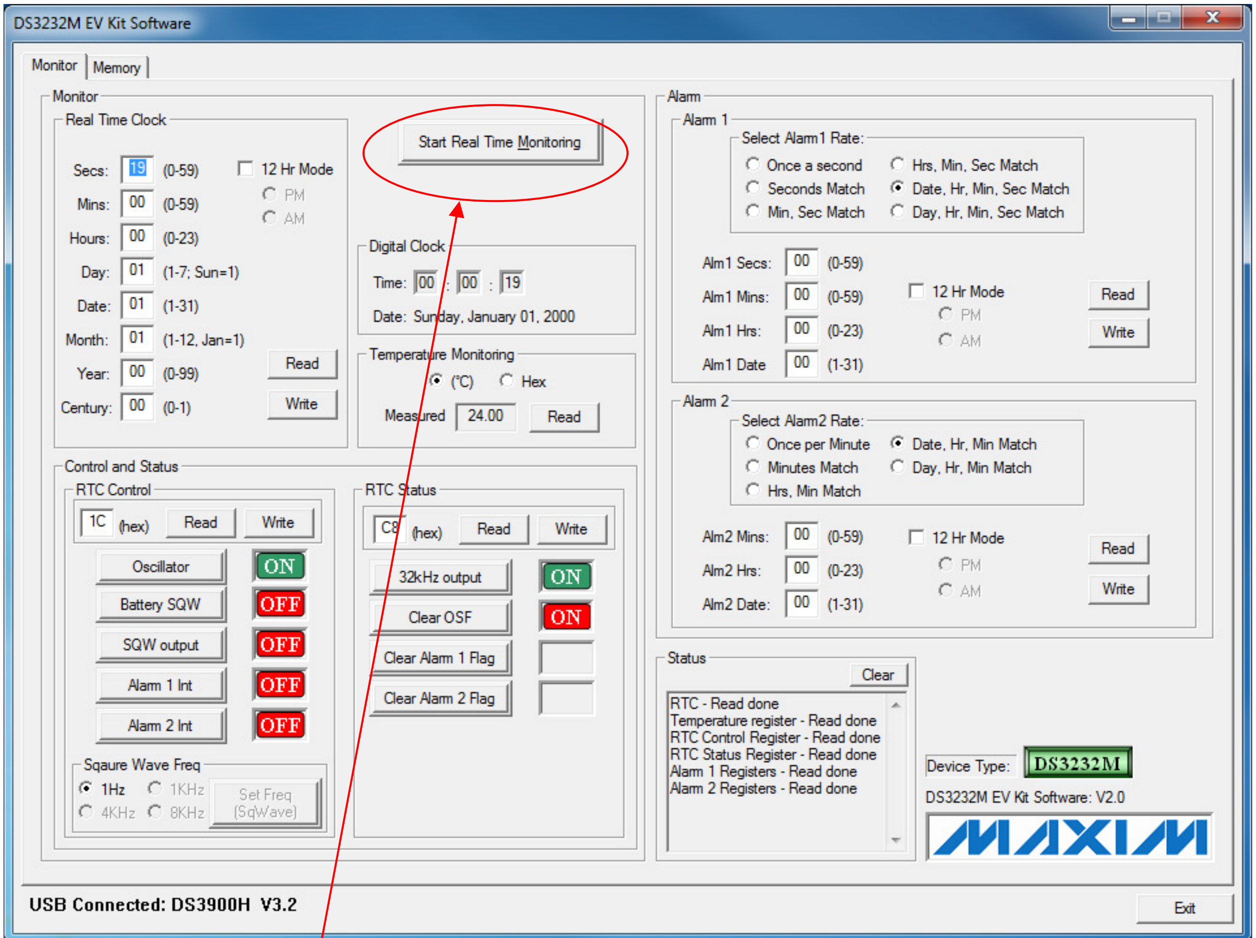
New register values can be entered into the appropriate registers, *by field*, using the Monitor Tab, or alternatively *by hexadecimal register address*, using the Memory Tab.

In each section of the Monitor Tab display, the component settings can be manually written or read using the 'Read' or 'Write' buttons provided in that section. Double-click in the field desired to enter new data. A <Tab> then moves the cursor to the next dialog box.



Monitor Tab Notes:
Unused dialog boxes will display "--".
Day Register (classic calendar arrangement) defines Sunday = "1", Monday = "2", etc.
Digital Clock display: Century bit value 0 will display "20"; Century bit value 1 will display "21".

Device Polling



Depressing the 'Start Real Time Monitoring' button puts the application into a continuous-read loop, updating the real-time, alarm, status, control, and temperature sensor register contents. Once started, this button renames itself to 'Stop Real Time Monitoring', and the green LED (D2) on the DS3900H2 will blink red upon each component read.

If looping, depressing the 'Stop Real Time Monitoring' button halts the read loop and returns I/O control to the application. Once stopped, this button renames itself to 'Start Real Time Monitoring'.

Access to all other buttons is inhibited during real-time monitoring.

Power Switching

In the dual-voltage configuration, and to facilitate testing the battery-related timekeeping or alarm functions, follow these steps:

With the power supplies enabled and the application running, stop any real time monitoring.
Load and verify time and/or alarm values, as needed.
Do not exit the application.

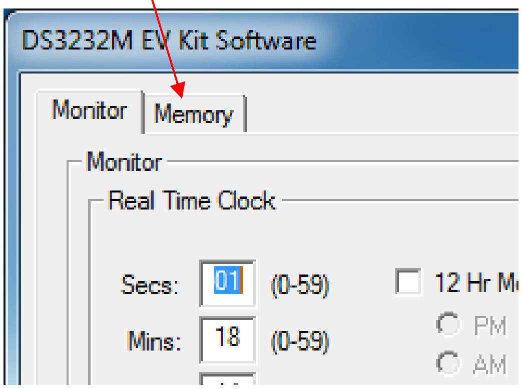
Set PS1 (VBOARD) to 0V
Set PS2 (VCC) to 0V
The Reset LED will illuminate momentarily as the supply voltage falls below V_{PF}.
The component is now being powered by PS3 (VBAT).

To restore I/O, restore PS2 (VCC) and PS1 (VBOARD) to their valid conditions (in that order) and return to the desired application operation.

Changing Tabs

To go to the desired tab, simply click on that tab (upper left).

To select 'Memory Tab' (for an example), click on Memory.



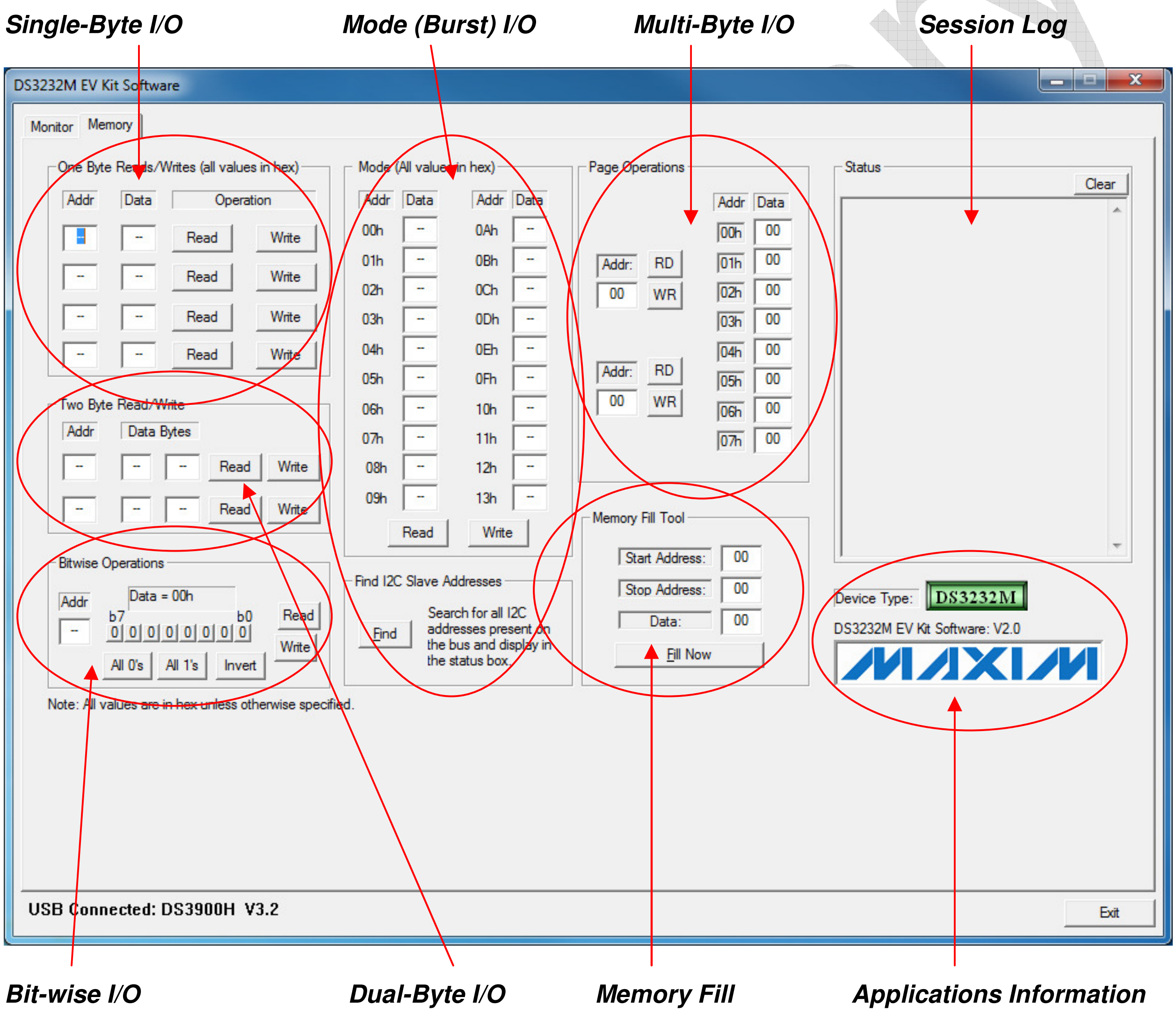
Memory Tab

The Memory Tab is a series of manual dialog boxes, providing basic I^{2}C communication strings to be passed to and from the EV Kit.

Buttons have been provided to execute four (4) unique Single-Byte Write or Read instructions, two (2) Dual-Byte Write or Read instructions, a singular bit-wise modification tool, a Burst Write or Read of the component's RTC registers, two (2) Multi-byte (8 byte) Write or Read instructions, and (if DS3232M is selected) a Memory Fill Tool for the NV SRAM. Additionally, a session log and application information is also presented.

Unused dialog boxes will display "--" until some user-initiated action has occurred in that Write or Read dialog.

Double-click in the *Addr* box to enter a hex register address; Tab to the *Data* box to enter new data. Click the appropriate Write or Read button to execute the I/O transmission.



Making Register Content Changes

As previously noted the Monitor Tab read or write buttons are assigned and function within the predefined section of the targeted component under evaluation. For example, depressing the Read button in the Real Time Clock section will execute a device read of strictly the seven RTC registers (00h-06h), and display the result in a human-formatted eight-field display.

On the Memory Tab, the general-purpose single-byte and dual-byte write and read functions are not predefined for any specific register or component function. The user must enter a register address, as well as the new data to be written (if applicable), and then manually initiate the I/O transfer by depressing the Read or Write button.

Whenever a Write button is depressed, the new data is sent to the component, and a subsequent verification read is automatically executed. The Data field will then display *the verified contents* of that register.

Examples:

Read Register 0Eh *using a 'One Byte Read'*

Place the cursor on any one of the four optional Addr boxes in the One Byte Read/Write section. Left-click to open the box and enter the hexadecimal address (in this case, "E" is sufficient, preceding zeros may be omitted).

Click on the Read button to the right of that Addr box, and the Data field will display the content of the register (in hexadecimal). The Session Log will also record a transaction.

Write 04h to Control Register (0Eh) *using a 'One Byte Write'*

Place the cursor on any one of the four optional Addr boxes in the One Byte Read/Write section. Left-click to open the box and enter the hexadecimal address (in this case, "E" is sufficient, preceding zeros may be omitted). Tab to the next field (or move the cursor manually), and enter the new data ("4" is sufficient in this case).

Click on the Write button to the right of that Addr box, and the Data field will display the new, verified content of the register (in hexadecimal). The Session Log will also record a transaction.

Read Registers 0Eh& 0Fh *using a 'Two Byte Read'*

Utilizing the internal address auto-increment feature of the component, we can read two *adjacent* registers in one I/O transaction.

Place the cursor on either one of the two optional Addr boxes in the Two Byte Read/Write section. Left-click to open the box and enter the *first* register address ("E" is the first and preceding zeros may be omitted).

Click on the Read button to the right of that Addr box, and the two Data fields will display the contents of the registers (in hexadecimal) in the order of their addressing. The Session Log will also record a transaction.

Write 01h to Day and 23h to Date Registers (03h-04h) *using a 'Two Byte Write'*

Utilizing the internal address auto-increment feature of the component, we can write two *adjacent* registers in one I/O transaction.

Place the cursor on either one of the two optional Addr boxes in the Two Byte Read/Write section. Left-click to open the box and enter the *first* register address ("3" is the first and preceding zeros may be omitted). Tab to the first data field and enter the data for the *first* register ("1"). Tab to the second data field and enter the new data for the *second* register ("23").

Click on the Write button to the right of that Addr box, and the Data field will display the new, verified content of the registers (in hexadecimal). The Session Log will also record a transaction.

Bitwise Operations to Toggle OSF bit in the Status Register (0Fh)

One single-byte window has been designated for bitwise operations.

Place the cursor on the Addr box in the Bitwise Operations section. Left-click to open the box and enter the hexadecimal address (in this case, "F" is sufficient, preceding zeros may be omitted).

Click on the Read button to the right of that Addr box, and the Data box will display the content of the register (in hexadecimal) and directly below that box, each bit will be represented in it's weighted position by 1's or 0's.

Assuming the register contents were initially found to be 83h (OSF, A2F, & A1F), the display should show "Data = 83" (hex) and "10000011" respectively. Our desire is to only clear bit7, so pressing the bit7 button should invert the content of only that specific bit.

Click on the Write button, and the Data field will display the updated and verified content of the registers (in hexadecimal). The Session Log will also record a transaction.

"Mode" = Burst Write or Read

Read or Write buttons have been provided to load or read all component RTC registers, in sequential address order.

"Memory Fill Tool"

To facilitate loading of the DS3232M NV SRAM data space (14h-FFh), a user-definable Memory Fill Tool is provided to sequentially load memory space bounded by the START and STOP addresses.

Example: To fill the entire NV SRAM area with AAh, enter a Start Address of "14" (hex), a Stop Address of "FF" (hex), Data of "AA" (hex), and click on the Fill Now button.

Verification (reads) can be accomplished using either single, dual, or multiple (8) byte reads.

Component Features

Oscillator Start-Up and Control

On the initial application of VCC, the DS323X device oscillator enable bit ($\overline{\text{EOSC}}$) should default to 0 and the oscillator will be running.

Upon entering the Monitor Tab, the present status of the $\overline{\text{EOSC}}$ bit is displayed in the Control register section, with a green **ON** indication if the oscillator is enabled. Depressing the ***Oscillator*** button toggles the bit state and the displayed condition.

Oscillator Stop Flag (OSF)

The Oscillator Stop Flag (OSF) resides in the Status register (0Fh bit7), and will become a 1 when one of the following actions occurs:

1) the first time power was applied,
2) the voltages present on both VCC and VBAT are insufficient to support the oscillator,
3) the $\overline{\text{EOSC}}$ bit was a 1 when the device switched to battery-backup,
4) external influences upon the oscillator (i.e.: noise, leakage, etc.).

Upon entering the Monitor Tab, the present status of the OSF bit is displayed in the Control register section, with a red **ON** indication if the Oscillator Stop Flag was detected. Depressing the ***Clear OSF*** button clears the bit state and, if previously set, inverts the displayed condition.

Oscillator Frequency Monitoring

The DS3231 has two options for oscillator frequency output:

1) 32kHz square-wave from the 32KHZ output (pin 1), or
2) a square-wave output* from the $\overline{\text{INT}}$/SQW output (pin 3).

* DS3231M and DS3232M $\overline{\text{INT}}$/SQW output frequency is fixed at 1Hz. DS3231 SQW output frequency is user-selectable for 1Hz, 1kHz, 4kHz, or (default) 8kHz; for more information, see the explanation of the RS_ bits in register 0Eh in the DS3231 product specification.

Upon initial application of power, the DS323X 32KHZ output enable bit (EN32KHZ) is automatically set to 1, and the 32KHZ output will produce a 32kHz waveform, viewable at either the 32KHZ Test Point or at the J1 BNC connector (50Ω).

The application Monitor Tab displays a green **ON** indication if the 32kHz output is enabled. Depressing the ***32kHz output*** button toggles the EN32KHZ bit, and the output state changes from drive to high-impedance (or vice versa).

Upon initial application of power, the DS323X INTCN bit is automatically set to 1, which forces the $\overline{\text{INT}}$/SQW output to be the interrupt output from the clock. Clearing the INTCN bit will cause the square-wave to be output on $\overline{\text{INT}}$/SQW, viewable at the $\overline{\text{INT}}$ Test Point. If the BBSQW bit (register 0Eh bit6) is 1, the SQW signal will also be presented during battery back-up operation when VBOARD is referenced to VBAT.

The application Monitor Tab displays a green **ON** indication if a SQW output is selected. Depressing the ***SQW output*** button toggles the INTCN bit, and the output data changes from a square-wave to a RTC interrupt (or vice versa).

On the DS3231, the $\overline{\text{INT}}$/SQW output frequency options are user-selectable (lower left).

Real-Time Clock and Calendar

The DS323X clock is comprised of 16 8-bit registers that contain all timekeeping, alarm, and control information. The clock, calendar, and alarm register contents are stored in binary-coded decimal (BCD) format. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information, with automatic compensation for months containing fewer than 31 days, as well as leap years corrections valid through the year 2099. The clock operates in either the 24-hour format or 12-hour format with an AM/PM indicator.

The application Monitor Tab displays the real-time register values in *register-oriented dialog boxes*, as well as a *digital clock* format.

The Status and Control registers (0Eh-0Fh) are used to control and monitor the operation of the oscillator, and alarm functions.

Alarms

Two time-of-day alarms are provided for user-initiated interrupt purposes:

1) Alarm1 can be configured to one of six combinations of time-of-day events (up to once-per-second), or
2) Alarm2 can be configured for one of five combinations of time-of-day events (up to once-per-minute).

Each alarm circuit is fully independent from the other, except for sharing the $\overline{\text{INT}}$/SQW output.

As a normal sequence of operation, alarm settings should be loaded and the associated alarm flag should be cleared *prior to enabling that alarm*. Refer to the product specification for more details on alarm programming.

The application Monitor Tab displays a green **ON** indication if that alarm circuit has been enabled, as well as a red **ON** indication if an Alarm Flag was detected.

Temperature Sensor

The DS323X contains an internal temperature sensor to periodically monitor the environmental conditions of operation. As the temperature changes, the oscillator frequency and the SQW output is automatically compensated to maintain the highly accurate time base.

The DS3231M and DS3232M measures the temperature once per-second when operating on VCC, or once every ten seconds when operating on VBAT.

The DS3231 measures the temperature once every sixty-four seconds. Additional user-initiated thermal sampling can also be performed, without interrupting the normal sixty-four second intervals, by writing the CONV bit and monitoring the BSY bit. See the product specification for more details.

The application Monitor Tab will display the latest temperature result in either °C or hex format.

Pushbutton Reset Detection

The DS323X provides support for an external pushbutton switch to be connected to the $\overline{\text{RST}}$ output pin. When not in a reset cycle, the $\overline{\text{RST}}$ signal is continuously monitored for a low-going edge. If an edge is detected, the DS323X debounces the switch by pulling the $\overline{\text{RST}}$ line low. After the internal timer has expired, the DS323X continues to monitor the $\overline{\text{RST}}$ line looking for a high-going edge. Upon detecting a release, the DS323X forces the $\overline{\text{RST}}$ line low and holds it low for one more reset interval.

Whenever VCC is valid, depressing switch S1 will momentarily pull the reset line to ground and illuminate D1 (Red LED) for ~250ms from the release of the pushbutton.

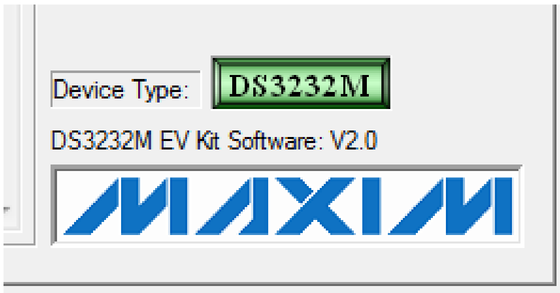
The $\overline{\text{RST}}$ output and D1 LED are not available when component power is provided from VBAT.

Applications Information

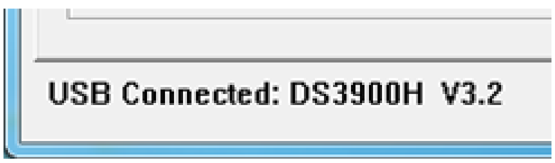
On either the Monitor or Memory Tabs, in the lower right corner, the application will display:

1) the Device Type selected when the program was started,

2) the software revision identity.



In the lower left corner, the USB Identity and Firmware version is displayed.



Single-Supply Operation

The DS323X can operate using three unique power-supply configurations:

1) dual-supply (VCC for operation, VBAT for backup)
2) single-supply (VCC only)
3) single-supply (VBAT only)

The DS323X EV Kit is preassembled for use in dual-supply mode. Refer to the *Quick Start* section.

Single-Supply using VCC-only

To utilize the DS323X EV Kit in VCC-only mode, connect a banana cable from VBAT (J3) to GND (J4); do not use PS3.

1) Verify that jumpers J6, J7, and J8 are installed (where noted). J6 and J7 connect the 32kHz and $\overline{\text{INT}}$/SQW output pin pull-up resistors (respectively) to the VBOARD bias. J8 connects the $\overline{\text{RST}}$ (active-low) LED anode to the VCC bias.

2) If using a separate VBOARD (I/O) power supply, connect the PS1 power supply across the VBOARD (J5) and GND (J4) connectors. If I/O power is to be derived from the VCC supply, connect a banana jumper from VBOARD (J5) to VCC (J2).

3) Connect the PS2 power supply across the VCC (J2) and GND (J4) connectors.

4) Verify that a USB cable (not provided) is properly connected from the PC to the DS3900H2 Mini-USB connector.

5) Set PS2 for +3.3V, 200mA, and enable the PS2 output. The Reset LED will illuminate for ~250mS.

6) If using separate VBOARD power, set PS1 for +3.3V, 200mA, and enable the PS1 output.

7) See *Software Procedure*.

Single-Supply using VBAT-only

To utilize the DS323X EV Kit in VBAT-only mode, connect a banana cable from VCC (J2) to GND (J4); do not use PS2.

1) Verify that component C3 (0.1µF 0805 SMT capacitor) is placed (from VBAT to GND) on the pads labeled C3 (bottom side of EV Kit board).

2) Verify that jumpers J6 and J7 are installed (where noted). J6 and J7 connect the 32kHz and $\overline{\text{INT}}$/SQW output pin pull-up resistors (respectively) to the VBOARD bias. J8 is not used; *the $\overline{\text{RST}}$ output is not operational in the VBAT-only power configuration*.

3) If using a separate VBOARD (I/O) power supply, connect the PS1 power supply across the VBOARD (J5) and GND (J4) connectors. If I/O power is to be derived from the VBAT supply, connect a banana jumper from VBOARD (J5) to VBAT (J3).

4) Connect the PS3 power supply across the VBAT (J3) and GND (J4) connectors.

5) Verify that a USB cable (not provided) is connected from the PC to the DS3900H2 Mini-USB connector.

6) Set PS3 for +3V, 100mA, and enable the PS3 output.

7) If using separate VBOARD power, set PS1 for +3.3V, 200mA, and enable the PS1 output.

8) See *Software Procedure*.

User-Provided I2C Bus Master

If desired, the user can configure the DS323X EV Kit to operate from an existing I^2C Bus Master, providing that external pull-up resistors already exist on that communications bus.

1) Power off all supplies.

2) Disconnect the USB cable. Remove the DS3900H2 sub-assembly from the EV Kit by lifting the module vertically from its headers.

3) Connect VBOARD to the desired I/O power reference (from the customer's board).

4) Connect GND to the ground reference from the customer's board.

5) Jumper the SDA signal from the SDA Test Point to SDA on the customer's board.

6) Jumper the SCL signal from the SCL Test Point to SCL on the customer's board.

7) If using dual-supply mode, power-on the VBAT supply.

8) Power-on the VCC supply.

9) Power-on the customer's board.

10) See *Software Procedure*.

DS323X EV Kit Board

Component List

DESIGNATION	QTY	DESCRIPTION
C1, C3, C6	3	0.1µF Capacitor, 0805, Xicon #CC501B104K-RC
C2	1	0.01µF Capacitor, 0805, Venkel #C0805X7R101-103KNP
C4	1	47µF Capacitor, C-SMT, Venkel #TA010TCM476KCR
C5	1	1.0µF Capacitor, 0805, Venkel #C0805X5R250-105KNE
D1	1	Red LED, 1206, Kingbright #APT3216SURCK
J1(32KHZ)	1	RA BNC, Tyco Electronics # 5227161-1
J2(VCC)	1	Red Banana Jack, Deltron #571-0500
J3(VBAT)	1	Yellow Banana Jack, Deltron #571-0700
J4(GND)	1	Black Banana Jack, Deltron #571-0100
J5(VBOARD)	1	Blue Banana Jack, Deltron #571-0200
J6(P1), J7(P3), J8($\overline{RST}$)	3	2pin Header
R1, R2	2	10K Resistor, 0805, Venkel #CR0805-10W-1002FT
R3	1	499ohm Resistor, 0805, Venkel # CR0805-10W-4990FT
S1	1	Switch, SPST, Momentary, C&K Components #KSR231GLFS
U1	1	DS3231S+, DS3231M+, DS3231MZ+, or DS3232MZ+ (as populated)
U3	1	DS3900H2 I/O Communications Module
None	10	Test Points
None	1	DS323X EV Kit board

If you have any questions, email MixedSignal.Apps@maxim-ic.com.