A Platform for Assessing the Performance of Intersil's RTC Devices

Intersil manufactures a line of Real Time Clock IC's that integrate multiple features into a single chip. The main features include a 32.768kHz oscillator, clock/calendar logic, multiple alarms, watchdog timer, power up reset, and EEPROM memory up to 256kb.

The evaluation board provides a platform to test all of these functions, as well as evaluate device performance criteria, such as long-term clock accuracy. Hardware options such as battery and crystal types can also be tested. The software is designed to allow easy setup and monitoring of all the major device functions. The two-piece construction utilizing a motherboard and a daughter card enables the board and software to operate the RTC device residing on a remote board.

Operation of the Intersil RTC Evaluation Board

Hookup and Applying Power

Powering Up - The motherboard should have power hooked up to a suitable +5V source through #24 or better wires to P2. Make sure the +3.3V/5V jumper (J1) is positioned as desired. J1 must have a jumper installed for the RTC device to operate. It is also advisable that the battery/super cap jumper (J2) be removed before initial power-up to avoid oscillator latch up. Once powered up, the jumper can be positioned as desired. If no backup power is desired, then remove J2 (note that for board designs, it is desirable to ground Vback when unused). The board should have the daughter card installed and the serial cable attached to the PC prior to applying the +5V power.

Powering Down - When powering down, the daughter card will operate off the backup source determined by J2 (after the Vcc voltage discharges from the Vcc supply capacitors). If the user wishes to totally power down the RTC device once Vcc is removed, then either the daughter card is removed from the motherboard or J2 is removed. Keep in mind there is a decoupling capacitor on the daughter card (0.1µF) which must discharge fully before the RTC device stops operating. This discharge time can be up to 1 second when using a Vcc of 5V. Note that when powered down, the RTC software cannot monitor the RTC board. If there is valid communication with the RTC software, then Vtrip of the RTC device on the daughter card is lower than that of the battery or super cap, which will reduce backup time.

Using the RTC Software

1. **Initial setup (assuming initial power up of the RTC Motherboard/Daughter card)**

   1.1. Install PC software
   1.1.1. Insert the CD ROM into your PC.
   1.1.2. From the Windows Explorer, open the CD ROM contents. Use the Edit > Copy to Folder command to copy the software to the desired folder. It is also possible to place the program on the PC desktop and can be executed directly from there.

   1.2. After opening the RTC program, you will be viewing the RTC Data Analysis Screen. The RTC device requires an initial write to the clock/calendar registers to begin keeping time.

   1.3. Open the "Set RTC time and date" window as in Section 2.5 of the Software Guide. The quickest way to initialize is to use the "Set date and time from PC clock" button, although the time and date can be manually entered using the calendar and time windows. Also choose the time format, either 12 or 24 hour. When complete, click on "Done", bringing you back to the RTC time and date window.

   1.4. Next, click on the "Poll RTC" button. The PC Time, RTC Time, and RTC Deviation windows should constantly update with their respective information. This is the normal mode for RTC operation/monitoring. If the RTC Time fails to update or is not set correctly, use the following troubleshooting steps.
   1.4.1. RTC Time stuck at 12:00:00 and not advancing. The proper time was not initially written to the RTC registers. Go back to the "Set RTC Time and Date" window and set the time again. Also, be sure to check the PC serial cable hookup and Daughter card connections, as well as the +5Vpower connection to insure these are correct.
   1.4.2. RTC accepted the time setting to the initial PC time, but not advancing. This indicates the serial port is working, but the RTC is not keeping time. The RTC oscillator has most likely failed to start, usually due to the daughter card being installed while a battery was in its socket. The best remedy is to remove the battery (or the jumper, J2) and cycle +5V power (wait until the power LED, LED1 goes out before switching power on), then replace the battery.

   1.5. As the program polls the RTC and updates time, there will be a difference between the RTC time and the PC time due to finite PC communications delays.

This should be a constant +1 or -1 second difference, and the window will alternately display between zero and 1 second error.

1.6. As the RTC or the PC clock drifts, the RTC time window will change color. If the RTC time is faster than PC time, the window will turn blue, first light blue then dark blue as the error increases. If the RTC time is slower than PC time, the window will turn red, first light red then dark red as the error increases.

1.7. The Polling can be turned off by clicking on the polling button again. The RTC device will still be keeping time, and if polled again in the future will display the current time.

2. Modifying RTC Registers

2.1. Open the RTC Register screen using the shortcut key in the menu bar. (section 2.9.3 of the software guide.) The RTC Registers are available using the pull-down menu on the left. Using these registers, the functions of the RTC device can be enabled, modified, or monitored, including

- Watchdog timer interval (X1227, X1228)
- Frequency output (X1226, X1228)
- Alarm settings
- Analog Trimming Registers (ATR)
- Digital Trimming Registers (DTR)

2.2. The clock/calendar registers are available also, but are more easily modified by using the clock/calendar window.

2.3. Once the correct register is located, the byte is displayed in the horizontal window along with its hex value. Changes to the individual bits can be made by clicking on a location. A zero is indicated with a white background, and a one is indicated by yellow background. Once the value of the byte is set, the byte is written to non-volatile memory by clicking on "Write". A register value can be read by clicking on "Read".

3. Using the RTC Deviation/Temperature Recorder (refer to Software Section 2.6)

3.1. The program is able to record continuous time measurements of the RTC deviation from PC Clock and the board temperature. Timeframes of from a few minutes to many days are possible.   From the RTC Data Analysis screen, first select the deviation range from the lower right set of pull-down windows. The Temperature Range and Time Base should also be set as desired from their pull-down windows.

3.2. Set the RTC time from the PC time as described above (section 1.2). This will insure the PC time is close to the RTC time to begin recording.

3.3. To begin recording, select "Start" from the "Record Data" pull-down menu (or from the menu bar). Data will be recorded periodically until the end of the timeframe selected, or until the Stop function is selected.

3.4. The status of the recorder is shown in the windows at the bottom of the RTC Data Analysis screen. These windows will continually update with information on the data recording (see 2.7.8 through 2.7.13 of the software guide).

3.5. Recorded data can be saved to a file, as well as imported from a data file (see 2.7.14 and 2.7.15 of the software guide).

3.6. Note that for long recordings of deviation, it is advisable to use a PC program that automatically updates the PC time, such as that available from AboutTime (http://www.arachnoid.com/abouttime/) or NIST (http://www.boulder.nist.gov/timefreq/service/its.htm)

3.7. Compensation for crystal frequency variation over temperature is accomplished using the temperature compensation window. See section 4 of the software guide for more information.

Hardware and Software Detailed Descriptions

Intersil Real Time Clock (RTC) Evaluation Board

1. Intersil RTC Evaluation Board – General Description

The Evaluation Board consists of the motherboard and daughter card. The motherboard contains all the main support functions for the RTC device, including:

- Microcontroller for communicating with the PC and the RTC using serial interfaces
- RS-232 interface IC for translating the PC serial port interface to the CMOS microcontroller.
- Temperature sensor for monitoring the ambient temperature
- Regulator to produce 3.3V from the 5V board supply
- Connectors for the serial port interface and the daughter card.
- A 0.22µF super capacitor and a 3V lithium battery for backup power
- Jumpers for selecting the backup battery or super capacitor, and also for selecting the Vcc voltage of 5V or 3.3V.

The daughter card contains just the Intersil RTC device, the crystal, and a decoupling capacitor and pull-up resistor for the open drain output.

2. Evaluation Board – Functional description (see diagram, Figure 1 and schematic, Figure 3)

2.1. Power Supply. The board requires a single power supply of 5V and ground. This supply should be regulated to 5V ±5%, and capable of at least 100mA. There is an on-board regulator, which produces 3.3V, which is available to the Intersil RTC chip as well as the serial interface pull-up resistors. The Intersil RTC device supply is selectable via a 3.3V/5V jumper.

The power/ground are connected via screw terminals on the board (see Figure 1).

2.2. Backup Supply. There are two sources of backup supply (Vback) available. A 0.22µF super capacitor is on the board. It will provide enough backup power for the typical RTC chip to last for 3 to 5 days at room temperature when Vcc is set to 5V. There is also a CR2032 battery included in a socket to allow removal/replacement without soldering. This battery will last from 6-10 years in normal backup operation. The (Vback) supply is selectable via a jumper as shown in Figure 1. The jumper may be removed altogether and an alternative source for Vback can be attached to the board via the exposed header. The center pin of the header goes to the Vback supply (See J2, Figure 2).

2.3. Microcontroller. The microcontroller used is the PIC16C63. It has a dedicated I/O port, which connects, to the serial interface from the RS-232 device. There is another dedicated I/O port for the 2-wire serial interface to the Intersil RTC device and the temperature sensor. The power for the microcontroller comes from the 5V Vcc input, so the microcontroller will always be powered from 5V. Note that the RB0 to RB4 I/O pins for the microcontroller are available at the daughter card connector, J3. This is to facilitate any extra functionality should a user choose to write special code for a particular application. The device is in a socket to allow removal/replacement for development activity and software upgrades with newly programmed devices.

2.4. Temperature Sensor. There is an LM76 temperature sensor on the board, which measures ambient temperature, digitizes it and provides it to the microcontroller when prompted. Since this temperature sensor is not physically on the RTC daughter card, the temperature reported may be slightly different from the RTC/crystal temperature in a thermally changing environment. When performing temperature testing keep in mind that the motherboard and daughter card, although connected, should have time to settle to the same temperature for best results.

2.5. Daughter card Connector (J3). This connector provides power and interface signals to the daughter card containing the Intersil RTC device. Specifically, power (3.3V or 5V), ground, the SCL and SDA serial interface signals, and the Vback supply voltage are available at this connector. This configuration allows these signals to be used to control the Intersil device on an external board by connecting the serial interface and ground, available at the connector. Also available are the RB0 to RB4 I/O signals from the microcontroller (see Section 2.3).

2.6. Serial Port Connector (P2). This connector is a standard DB-9 connector which goes to the serial port of a PC using a serial port cable.

2.7. LED's. There are 3 surface mounted LED's on the board for various functions. LED2 and LED3 monitor the TX and RX functions of the serial port. They should be observed to insure that communication is taking place with the serial port. LED1 monitors the power supply and will light when the +5V power is applied.
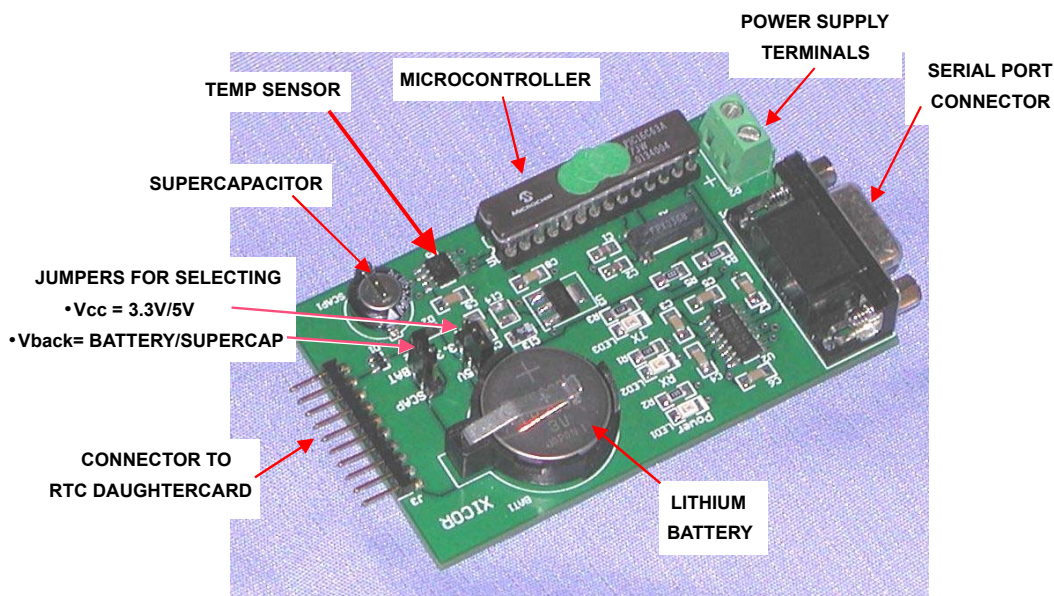

TEMP SENSOR
MICROCONTROLLER
POWER SUPPLY TERMINALS
SERIAL PORT CONNECTOR
SUPERCAPACITOR
JUMPERS FOR SELECTING
•Vcc = 3.3V/5V
•Vback= BATTERY/SUPERCAP
CONNECTOR TO RTC DAUGHTERCARD
LITHIUM BATTERY

FIGURE 1. RTC EVALUATION BOARD MOTHERBOARD

intersil

3. Daughter card – functional description (see schematic, Figure 2)

3.1. The Daughter card contains the Intersil RTC device; crystal, decoupling capacitor and a 10kΩ pull-up resistor for the open drain output.

3.2. Open Drain output. The open drain output of the X1226 is the PHZ/IRQ- signal, and for the X1227 it is the RESET- signal. There is test point available to monitor that signal, and the pull-up resistor has a jumper (J2) to disconnect the pull-up and also enable hooking up a different value externally.

3.3. Crystal. A standard 32.768kHz tuning-fork through-hole mounted cylindrical crystal is supplied on the Daughter card. There are also pads provided for standard surface mount crystals. The through-hole crystal must be removed before the surface mount crystal is installed.

3.4. Measurements. The only signal that is recommended to measure on the Daughter card is the open-drain output. It is possible to probe the X2 oscillator output with a scope probe, but this is not recommended as it will either slow the oscillator down or possibly stop it due to introduction of a transient. If it is absolutely necessary to monitor the oscillator output, use a low-capacitance probe (<2pF) or an active probe and note that the absolute frequency monitored will be higher than that without the probe. This can be verified by monitoring the RTC time in the software window (see RTC software manual).
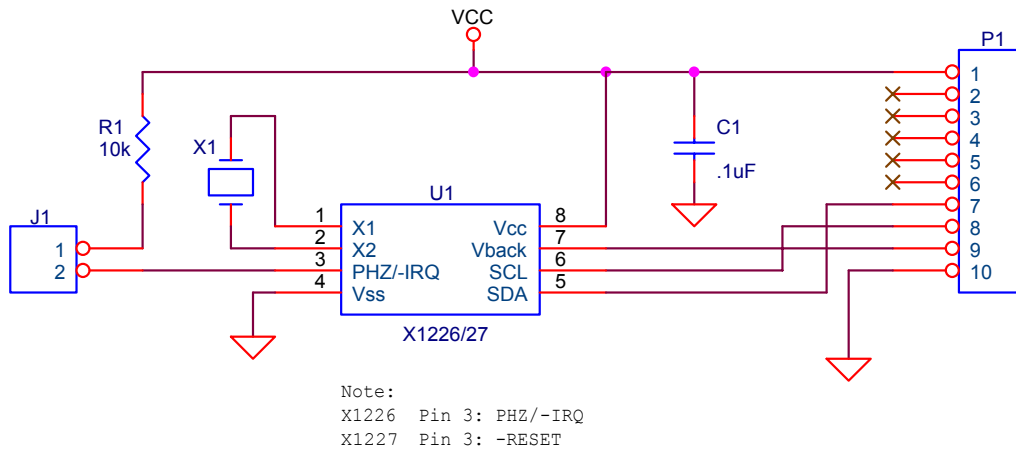

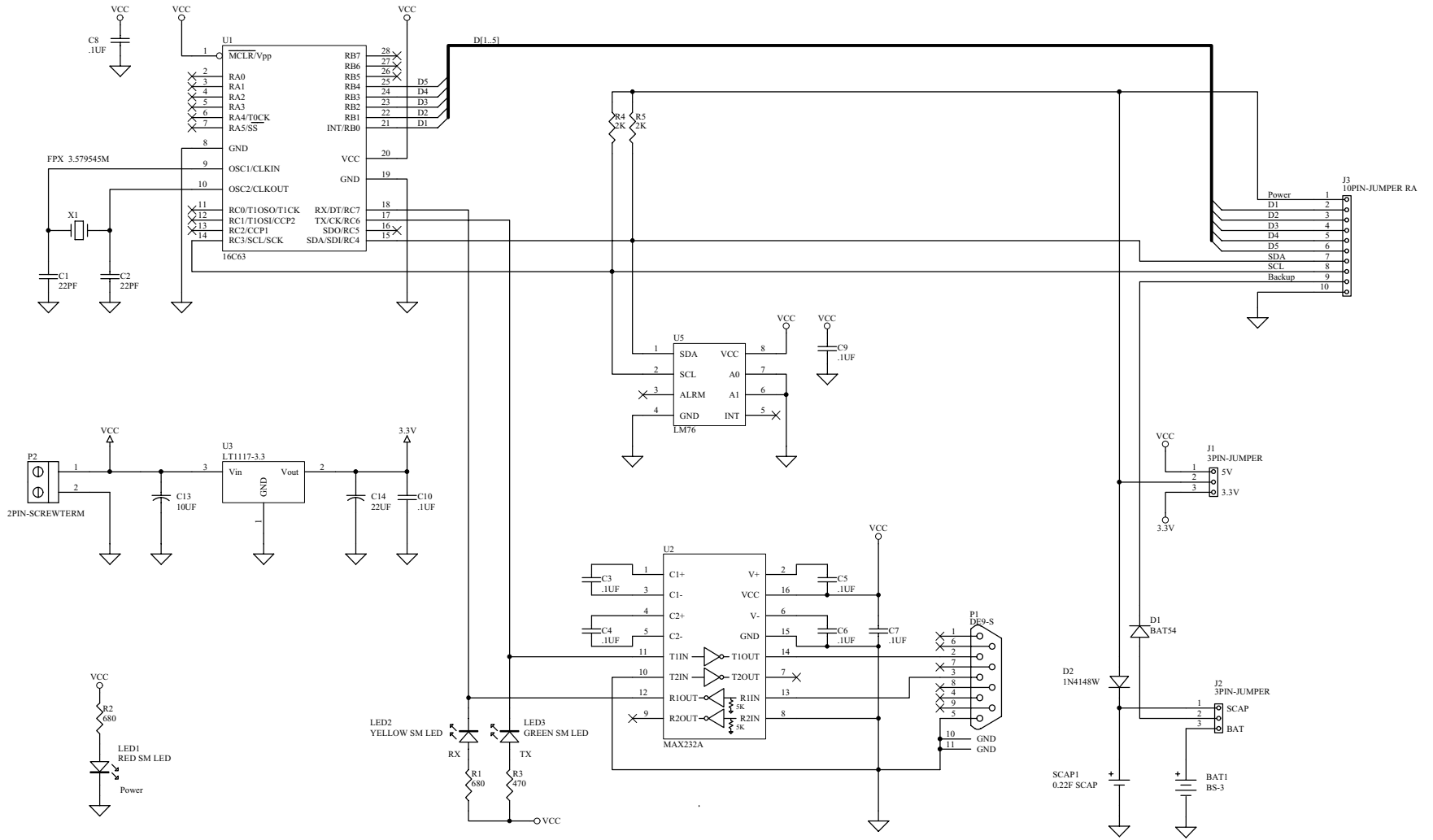**FIGURE 2. RTC DAUGHTER CARD SCHEMATIC (SHOWING THE X1226/27 RTC DEVICE)**

FIGURE 3. RTC MOTHERBOARD SCHEMATIC

Intersil RTC Evaluation Board Software Users Guide

Software Guide

The following sections guide you through the functions of the software and show the screen icons and menus used to perform the tasks.

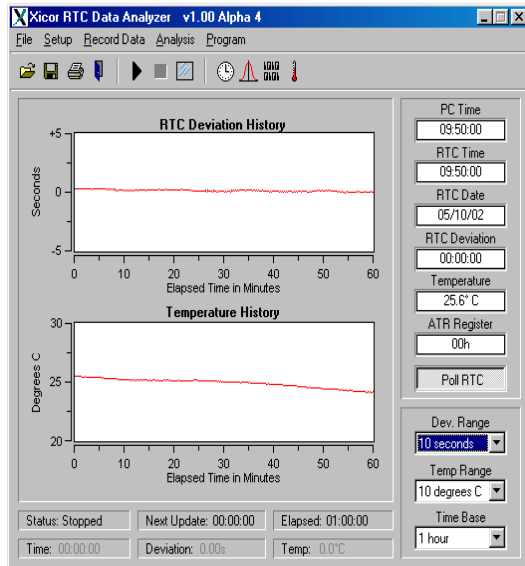**1. Opening Screen: Intersil RTC Data Analysis Screen:**

FIGURE 4. INTERSIL RTC DATA ANALYSIS SCREEN

1.1. The Intersil RTC Data Analysis opening screen displays the following windows and pull-down menus.
   • PC Time: Time of the PC clock
   • RTC Time: Time of the RTC under test when polling
   • RTC Date: Date in the RTC registers
   • RTC Deviation: Deviation of the RTC under test to the PC clock
   • Temperature: Temperature of the RTC evaluation main board
   • ATR Register: Analog Trimming Register (ATR) setting
   • Poll RTC: Button to start polling and to stop polling the RTC under test. Note that the watchdog functions, if enabled, will not time out while polling is enabled. Note: The following windows and pull-down menus are used when recording and are discussed in the recording section: Section 2.7
   • RTC Deviation History
   • Temperature History
   • Deviation Range
   • Temperature Range
   • Time Base
   • Status
   • Next Update

• Elapsed time
• Time (Current time)
• Deviation
• Temperature (current temperature)

1.2. Toolbar: The Intersil RTC Analysis screen has five pull-down menus in the tool bar.
   • File
   • Setup
   • Record Data
   • Analysis
   • Program

1.3. Shortcut Bar: The Intersil RTC Analysis screen has 11 buttons in the shortcut bar.
   • These buttons are used for features that appear in the pull-down menus and will be referred to under the pull-down menu descriptions.
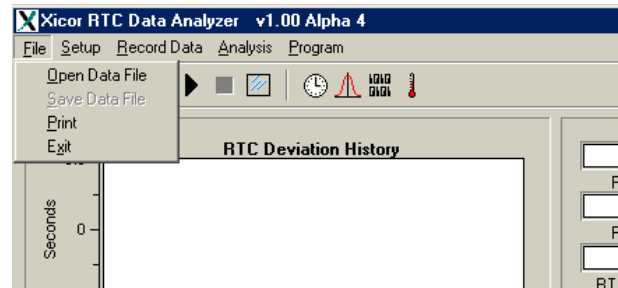
2. File Pull-Down Menu:

FIGURE 5. FILE PULL-DOWN MENU SCREEN

2.1. The File pull-down menu has the following four selections:
   2.1.1. Open Data File:Open a previously saved data file. (See the section on recording: Section 2.7.)
   2.1.2. Save Data File:Save current data file. (See the section on recording: Section 2.7.)
   2.1.3. Print Print current screen.
   2.1.4. Exit:Exit the program.

NOTE: The first 4 buttons in the shortcut bar are shortcuts to each of these selections.
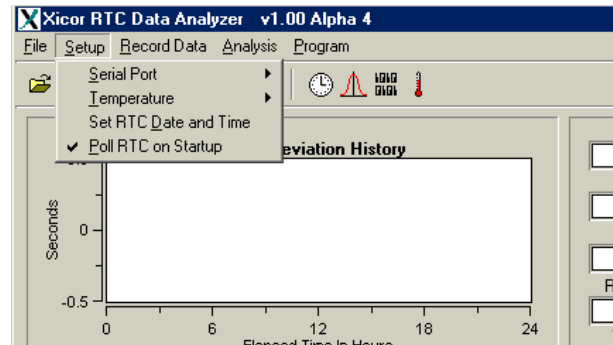
2.2. Setup Pull-Down Menu

FIGURE 6. SETUP PULL-DOWN MENU SCREEN

2.2.1. The Setup pull-down menu has the following four selections:
- Serial Port
- Temperature
- Set RTC Date and Time
- Poll RTC on Startup

NOTE: The clock button in the shortcut bar is a shortcut for the Set RTC Date and Time screen.
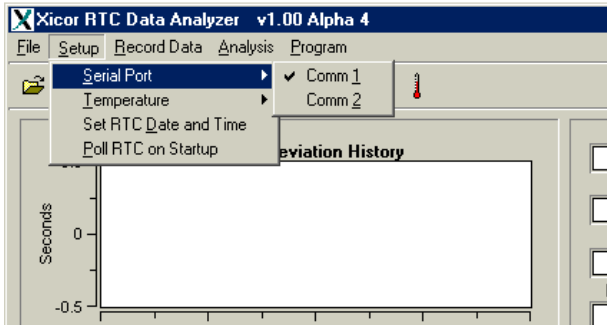
2.3. Serial Port Selection

FIGURE 7. SERIAL PORT SELECTION SCREEN

2.3.1. Com1 or Com2 may be selected for the serial communication port.
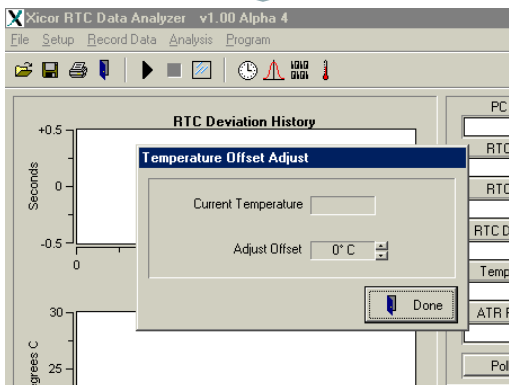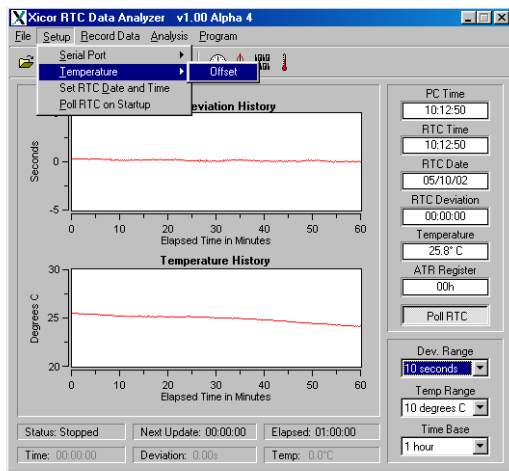
2.4. Temperature Offset Adjustment

FIGURE 8. TEMPERATURE OFFSET ADJUSTMENT SCREEN

2.4.1. A temperature offset from +20°C to -20°C may be applied to the temperature for both the current temperature reading and when recording temperature.

2.5. Set RTC Date and Time. It is a good idea to set the PC time and date using an accurate source. A handy way to do this if your PC is Internet connected is with a program such as AboutTime (http://www.arachnoid.com/abouttime/) which will automatically update your PC time periodically, essentially making it a reference clock.
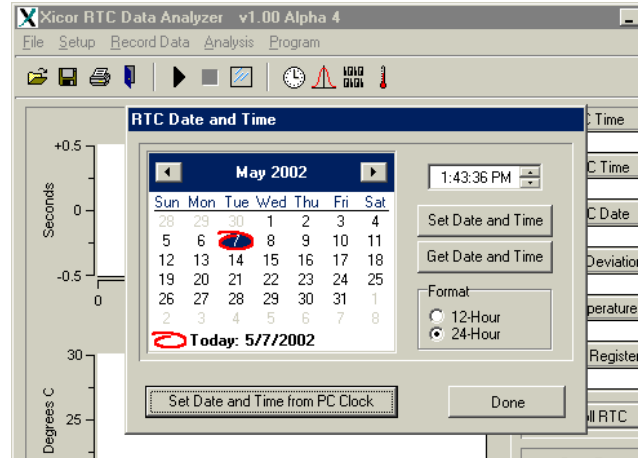

FIGURE 9. RTC DATE AND TIME SCREEN

2.5.1. Set Date and Time from PC Clock button. Clicking on the Set Date and Time from PC Clock button will write the time and date that is in the PC to the registers of the RTC under test.

2.5.2. Set Date and Time button: Clicking on the Set Date and Time button will write the time shown in the time window and the date shown on the calendar to the registers of the RTC under test.

2.5.3. Get Date and Time button: Clicking on the Get Date and Time button will read the date and time stored in the RTC under test registers to the calendar and the time windows.

2.5.4. Format: 12 Hour, 24 Hour radio button. 12 Hour or 24 Hour time format can be selected by clicking on the radio button for the desired format. Changing the format also writes to the MIL bit of the HR register of the RTC under test.

2.5.5. Calendar: The Month can be changed by using the forward and back arrows above the calendar. The day is selected by clicking on the desired day.

NOTE: Polling and Recording must be stopped in order to set a date and time other than the PC date and time.

2.6. Poll RTC on Startup:

  2.6.1. Polling on startup can be selected by clicking on Poll RTC on Startup selection on Startup pull down menu. Note: the watchdog function cannot be analyzed while polling since constant serial bus activity will not allow it to time out.

2.7. Record Data: The RTC test software is able to record time data for both RTC deviation from PC clock and for temperature. There is a pull-down menu for these functions and windows to display the graphical result. The Record Data pull-down menu has the following three selections:
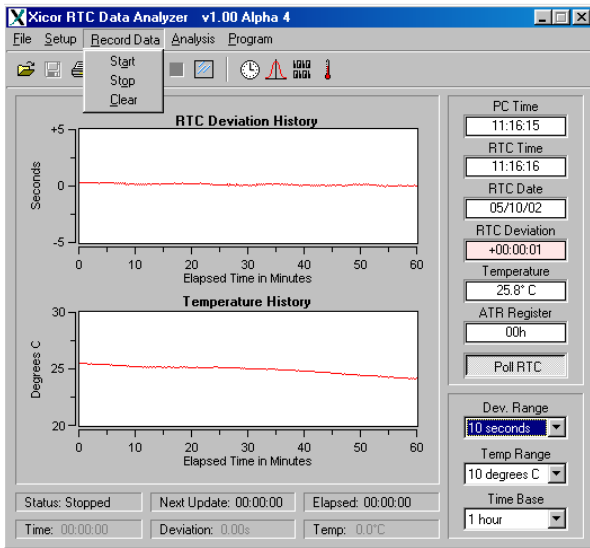

FIGURE 10. RECORD DATA PULL-DOWN SCREEN

  2.7.1. Start: Start the data recorder.
  2.7.2. Stop: Stop the data recorder.
  2.7.3. Clear: Clear the data currently displayed in the RTC Deviation History chart window and in the Temperature History chart window.

NOTE: The 5th, 6th and 7th buttons in the shortcut bar are shortcuts to Start, Stop, and Clear selections of the Record Data pull-down menu.

  2.7.4. RTC Deviation History Window: This window is a chart of the RTC Deviation History when recording, or for a data file that is loaded. Note that the chart begins writing right to left, and the first reading is to the right, and the last reading is to the left on the chart.

  2.7.5. Temperature History Window: This window is a chart of the temperature history when recording, or for a data file that is loaded. Again, the first reading is to the right, and the last reading is to the left on the chart.
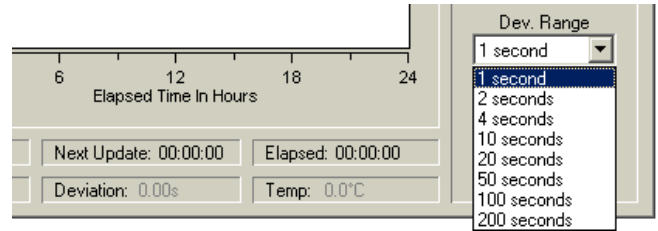

FIGURE 11. DEV. RANGE PULL-DOWN MENU SCREEN

  2.7.6. The Deviation Range pull-down menu is used to control the y-axis of the RTC Deviation History Chart window. The y-axis can range from 1 second to 200 seconds. When set to a range value, the axis will automatically be set to plus half and minus half that value (i.e. 1 second will show as +1/2 second to –1/2 second.)
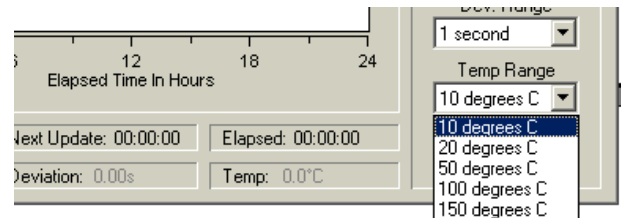

FIGURE 12. TEMP. RANGE PULL-DOWN MENU SCREEN

  2.7.7. The Temperature Range pull-down menu is used to change the y-axis range for the Temperature History chart window. The y-axis can range from 10°C to 150°C.
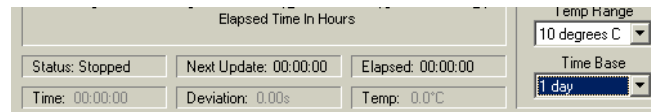

FIGURE 13. STATUS, NEXT UPDATE, ELAPSED TIME, TIME, DEVIATION AND TEMP WINDOWS

  2.7.8. Status: The Status window indicates whether the Data Recorder is running or is stopped.
  2.7.9. Next Update: The Next Update window indicates when the next update will occur to the Deviation History chart as well as the Temperature History chart.
  2.7.10. Elapsed: Shows the time elapsed since starting the recorder.
  2.7.11. Time: By placing the cursor in the RTC Deviation Chart window or the Temperature History Chart window, the time of the cursor crosshatch, or the x-axis, will be displayed in the Time window.
  2.7.12. Deviation: By placing the cursor in the RTC Deviation Chart window, the Deviation at the cursor crosshatch, or y-axis, will be displayed in the Deviation window.

2.7.13. Temp: By placing the cursor in the Temperature History Chart window, the temperature at the cursor crosshatch, or y-axis, will be displayed in the Temp. Window.

2.7.14. Data previously recorded can be loaded to the RTC Deviation History Chart and the Temperature History chart by using the Open Data File selection in the File pull-down menu.

2.7.15. Using the Save Data File in the File pull-down menu in the tool bar can save the RTC Deviation History chart, as well as the Temperature History Chart.
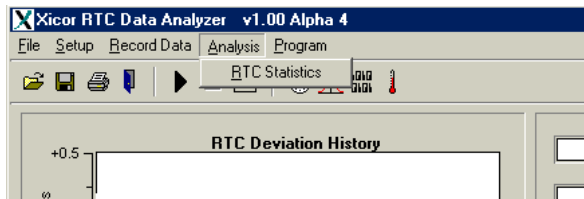
2.8. Analysis Pull-Down Menu

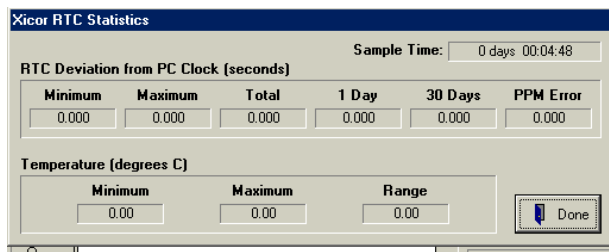**FIGURE 14. INTERSIL RTC STATISTIC PULL DOWN MENU SCREEN**

FIGURE 15. INTERSIL RTC STATISTICS SCREEN

The RTC Statistics screen shows RTC deviations from the PC clock as well as PPM Error for the recorded data shown in the RTC Deviation History Screen. It will also display the Minimum, Maximum and Range for the Temperature History chart. This can be for the data that is currently being recorded, or for a data file that has been loaded.

NOTE: If the Watchdog Timer is active when using I^2C serial communication, the write must be completed during the time out period of the Watchdog timer or the high time.
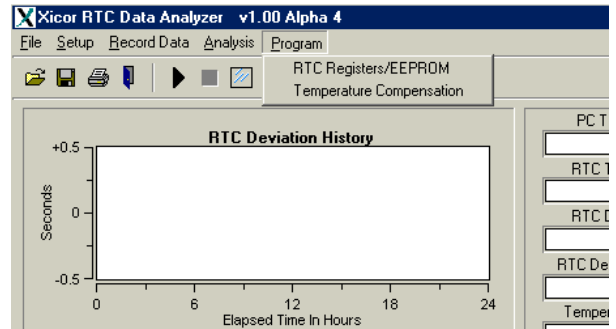
2.9. Program pull-down menu:

FIGURE 16. PROGRAM PULL-DOWN MENU SCREEN

The Program pull-down menu has the following two selections

• RTC Registers/EEPROM

• Temperature Compensation

NOTE: The 10th button in the shortcut bar is a shortcut to the RTC Register/EEPROM selection. The thermometer is a shortcut to the Temperature Compensation selection.

2.9.1. Intersil RTC Register /EEPROM Access
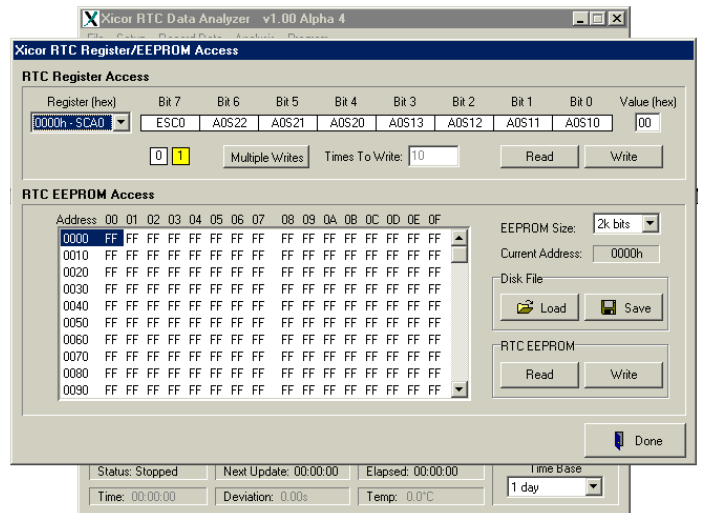
FIGURE 17. INTERSIL RTC REGISTER/EEPROM SCREEN

2.9.2. The RTC Register /EEPROM Access screen allows reading and writing to all of the Clock/Control registers as well as the EEPROM array.

2.9.3. RTC Register Pull Down Menu. This menu allows access to the Clock/Control registers. The desired register is selected in the pull-down window and each bit is displayed across the top of the window. The current contents can be read by clicking the read button. Changes can be made by setting the bits individually and writing to the register with the write button. You may also use the multiple write option. Enter the number of

writes desired by entering the number into the Times to Write window.

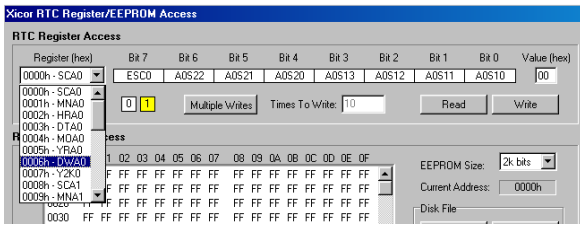**FIGURE 18. INTERSIL RTC REGISTER PULL DOWN MENU SCREEN**

NOTE: If the Watchdog Timer is active when using I2C serial communication, the write must be completed during the time out period of the Watchdog timer, or the high time.

3. RTC EEPROM Access Window

3.1. The RTC EEPROM Access window displays the contents of the memory buffer the contents of the memory buffer may be edited in this window.
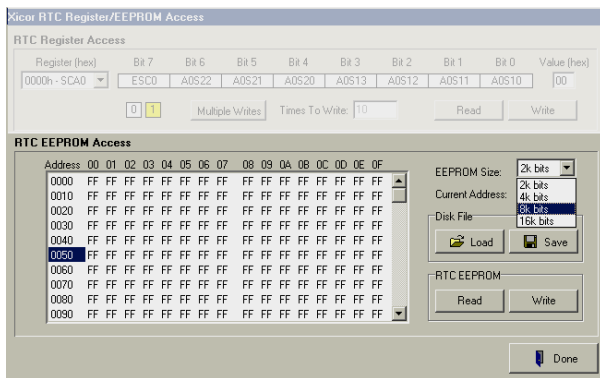

FIGURE 19. RTC EEPROM SIZE SCREEN

3.2. The EEPROM Size pull-down menu changes the size of the EEPROM array that is addressed. The size should agree with the size of the EEPROM array of the RTC under test.

3.3. The Disk File Load button will fill the buffer with a data file in hex format. The Disk File Save Button will save the buffer to a desired file.

3.4. Data may be read from the EEPROM array to the buffer by using the RTC EEPROM Read button.

3.5. The data displayed in the data window can be edited directly by clicking on the desired location and editing. The entire contents of the data window can then be written to the EEPROM array by using the RTC EEPROM Write button.

4. Intersil RTC Temperature Compensation.

4.1. Intersil RTCs have on-chip oscillator compensation. The six analog trimming bits (ATR5 to ATR0) are used for adjusting the on-chip loading capacitors.

The loading capacitors are used to adjust the frequency of the crystal. The on-chip capacitance allows for oscillator compensation from +116ppm to –37ppm by changing the on-chip capacitor from 5.00pF to 19.75pF.

4.2. The temperature compensation window (see Figure 20) is opened from the RTC Data Analyzer screen by selecting the Program pull-down menu, and then selecting Temperature Compensation. In order for temperature compensation to be active, the "Temperature Compensation Enabled" button must be selected in the lower right corner of the window.

A Practical Example of Temperature Compensation

There are six slide bars each for a different temperature range as indicated on the top of each slide bar. The slide bars allow adjusting the on-chip capacitance for the 6 different temperature ranges. This is done by writing to the ATR register. The window just below the slide bar indicates the on-chip capacitance. The window below that indicates the expected PPM change (calculated based on load capacitance change from 12.5pF). The next window down indicates the ATR register setting required for the on-chip capacitance and the PPM setting.

The microcontroller temperature sensor located on the Evaluation Board allows active temperature monitoring and compensation. As the temperature of the Evaluation Board changes from one range to the next range, the new ATR register setting is written to the RTC under test.
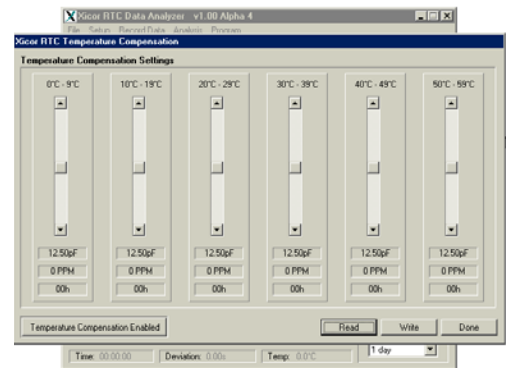
FIGURE 20. INTERSIL RTC TEMPERATURE COMPENSATION SCREEN

Using a typical 32.768kHz crystal such as that used on the evaluation platform, compensation values can be calculated using the error equation for the crystal:

PPM Error = $k(T-T_0)^2$ where k = -0.040ppm/°C, and T_0 is the "turnover temperature" for the crystal, typically 25°C (note both k and T_0 have manufacturing tolerances)

Use the center temperature for each of the six ranges as follows:

0-10°C (5) = -16.0ppm (use +17ppm compensation)

10-20°C (15) = -3.5ppm (use +4ppm)

20-30°C (25) = 0ppm

30-40°C (35) = -3.5ppm (use +4ppm)

40-50°C (45) = -16ppm (use +17ppm)

50-60°C (55) = -36ppm (use +35ppm)

The recorder must be running or the program set to polling mode, in addition to selecting the "Temperature Compensation Enabled" button in order for RTC Temperature Compensation to work. See section 2.7 for recording data. Also, see Intersil AN154 for details on the ATR registers and crystal compensation.

Appendix

Calculations for Intersil RTC Data Analyzer Software

Basic Calculations

Time Base

All time is converted from hours, minutes and seconds to a single value for calculations. This value represents the total number of seconds in a 24-hour (1 day) time period. This value will range from 0 at 00:00:00 to 86,399 at 23:59:59.

The Time Base value is calculated as follows:

`TimeBase = (Hours * 3600) + (Minutes * 60) + Seconds;`

RTC Deviation from PC Time

This value is of primary interest for this project. In order to measure the accuracy of any given RTC we must have an accurate time source to compare with. Using a readily available utility such as AboutTime, the PC's clock can be calibrated to within about ±100ms of the correct time.

To find the deviation of an RTC's time from the PC's calibrated time we subtract the RTC's time from the PC's time.

RTC deviation from PC's time is calculated as follows:

`RTC_PCTimeDeviation = RTC_TimeBase - PC_TimeBase;`

Improving Measurement Accuracy

The Basic Calculations are our building blocks but there is a problem. The RTC only provide the time to the nearest second therefore the Basic Calculations are only accurate to 1 second. We need to do better than that!

It was observed that the RTC's time will bounce 1 second ahead or behind the PC's time creating a duty cycle for lack of a better term. If the RTC's time is 500ms ahead of the nearest PC time second, the RTC time will exhibit a 50% duty cycle. If the RTC's time is 750ms ahead of the nearest PC time second, the RTC time will exhibit a 75% duty cycle and so on.
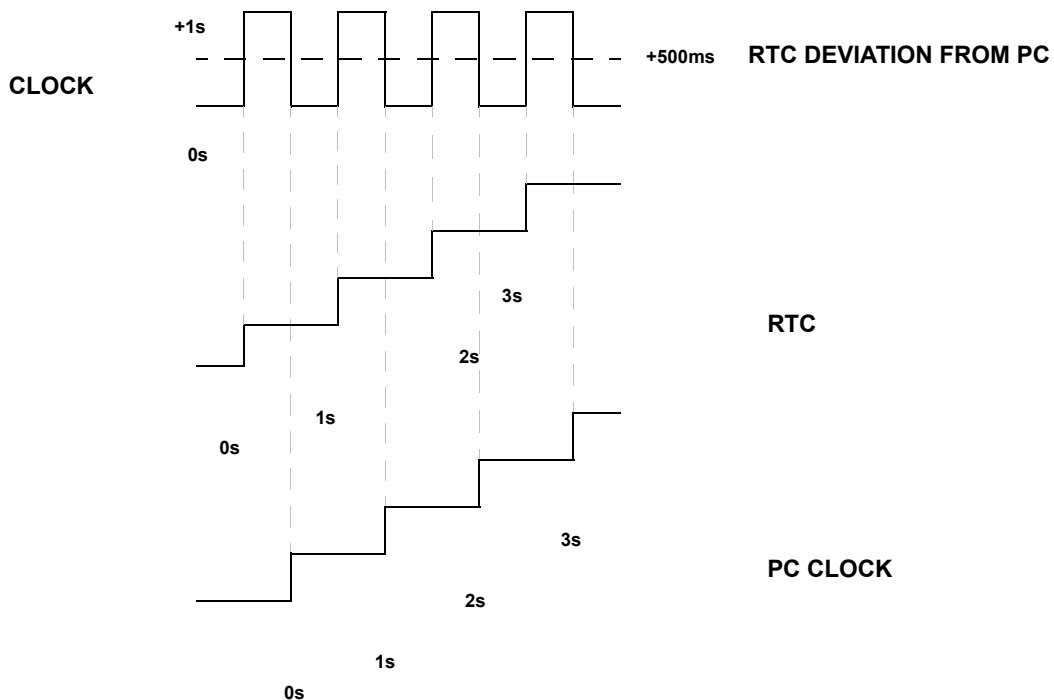
This effect allows us to use averaging to produce very accurate measurements. 2 samples a second over a 144 second sample period (288 samples) appear to yield an error of only ±0.05s. Of coarse, the longer the sample period, the better the results.

Recording RTC Data

What we've done so far is nice but it doesn't tell us much unless we can observe the results over time. We have implemented a strip chart type display, which graphically presents the data collected over a preselected time period.
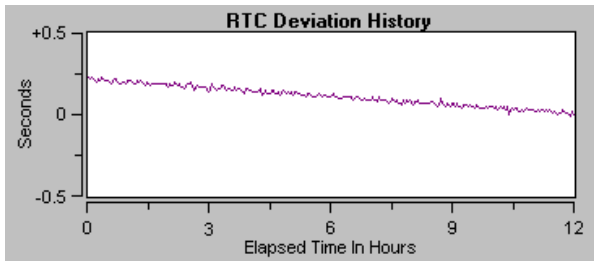

FIGURE 21. 12 HOUR RTC SAMPLE WITH +0.236S DEVIATION FROM PC CLOCK

Each pixel on the chart's x-axis represents 1 sample period of which there are 300 total.

Sample Period 1	Sample Period 2	Sample Period 3	…	Sample Period 298	Sample Period 299	Sample Period 300
Time Period							

The selected time period determines how long each sample period is and how many samples within each sample period. There are 9 time periods to choose from.

TIME PERIOD	SAMPLE PERIOD	NUMBER OF SAMPLES PRE SAMPLE PERIOD	NUMBER OF SAMPLES PER TIME PERIOD
1 hour	12s	24	7,200
3 hours	36s	72	21,600
6 hours	72s	144	43,200
12 hours	144s	288	86,400
1 day	288s	576	172,800
3 days	864s	1,728	518,400
7 days	2,016s	4,032	1,209,600
14 days	4,032s	8,640	2,592,000
30 days	8,640s	17,280	5,184,000

Averaging the Data

Data is collected from the Accuracy Board Test Platform 2 times per second for the duration of the sample period. Each sample is added to the previous samples during the current sample period. When the sample period is over, the sum of all samples are divided by the total number of samples yielding the averaged result. By averaging the data in blocks (sample periods), a floating average scheme is created that provides smooth plots and also responds quickly to sudden changes.

The averaged data is calculated as follows:

Do this when a new sample is acquired:

```
// New RTC Sample

RTC_PCTimeDeviationSum =
RTC_PCTimeDeviationSum + RTC_PCTimeDeviation;
```

Do this when Sample Period is done:

```
// Average RTC data

RTC_PCTimeDeviationAverage =
RTC_PCTimeDeviationSum/NumberOfSamples;
```

Then plot this data on the strip chart.

Appendix 2

Intersil Evaluation Board Bill of Materials

```
Bill of Material for: Xicor CPU Board Rev. 0.0

Used Part Type       Designator       Manuf.                    Part Number     Description
==== ==============  ===============  ======================    =============== ========================================
8    .1UF            C10 C3 C4 C5 C6 C7 AVX                     12065C104KAT2A  CAP - 0.1uF 50V X7R Ceramic
                     C9 C9
1    0.22F SCAP      SCAP1            Panasonic                 EEC-SOHD224H    BAT - 0.22F 5.5V Super Cap
1    10PIN-JUMPER RA J3               Samtec                    BCS-110-L-S-HE  CON - 10-pin single row square header RA 0.1"
1    10UF            C13              Panasonic                 ECS-T1AY106R    CAP - 10uF 10v Tantalum Surface Mount
1    16C63           U1               Microchip                 PIC16C63-04/SP  IC  - PIC 16C63 8-bit CMOS Microcontroller
1    1N4148W         D2               Diodes Inc.               1N4148W-7       DIO - Small Signal Vr=75V 350mA SOD-123
2    22PF            C1 C2            AVX                       08055A220KAT2A  CAP - 22pF 50V NCO Ceramic
1    22UF            C14              Panasonic                 ECS-T1AX226R    CAP - 22uF 10v Tantalum Surface Mount
2    2.2K            R4 R5                                      2.2K Ohm        RES - 1/8W 5% Carbon Comp.
1    2PIN-SCREWTERM  P2               Phoenix                   1729128         CON - 2-pin RA 0.2" Screw Terminal
2    3PIN-JUMPER     J1 J2            Sullins                   S1021-03-ND     CON - 3-pin single row square header 0.1"
1    470             R3                                         470 Ohm         RES - 1/8W 5% Carbon Comp.
2    680             R1 R2                                      680 Ohm         RES - 1/8W 5% Carbon Comp.
1    BAT54A          D1               Zetex                     BAT54AJA        DIO - Shottky Barrier Vr=30V 200mA SOT-23
1    BS-3            BAT1             Memory Protection Devices BS-3            BAT - 3V Lithium Battery Socket
1    DE9-S           P1                                         09R-K           CON - 9-pin D-sub RA Female 7.2mm
1    FPX  3.579545M  X1               FOX                       FPX0368S        XTL - 3.579545MHz 18pF Crystal
1    GREEN SM LED    LED3             Lumex                     SML-LX23GC-TR   LED - Green Low Current SM LED
1    LM76            U5               National Semi.            LM76CIM-5       IC  - Digital Temp. Sensor
1    LT1117-3.3      U3               Linear Tech.              LT1117CST-3.3   IC  - 3.3V LDO 800mA Regulator
1    MAX232A         U2               MAXIM                     MAX232ACSE      IC  - RS-232 Transceiver
1    RED SM LED      LED1             Lumex                     SML-LX23IC-TR   LED - Red Low Current SM LED
1    YELLOW SM LED   LED2             Lumex                     SML-LX23YC-TR   LED - Yellow Low Current SM LED

End of Schematic References

1    28-pin Socket                    Augat                     328-AG10DC      SKT - 28-pin 0.3" IC Socket
1    3V Battery                       Panasonic                 CR2032          BAT - 3V 220mAh Lithium Coin Battery
1    Printed Circuit Board                                                      PCB - Xicor CPU Board Rev. 0
2    Programming Shunt                Sullins Elec. Corp.       STC02SYAN       CON - 0.1" Tin Programming Shunt
```

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