Web Data Logging Example

Cam Thompson, February, 2012

The original plan for this project was to develop a simple data logging example that would take readings from various sensors, and log the information to a storage device of some type. The dual-core capabilities of NXP's LPC43xx provided some more interesting possibilities. The LPC43xx has two ARM cores: a Cortex-M4 with digital signal processing and hardware floating point capabilities designed for number crunching, and a Cortex-M0 that can offload the data movement and I/O handling. This offered an alternative for the project: use the Cortex-M4 to collect and process the data, and use the Cortex-M0 to run a web server for supplying data to web clients. This allows data to be viewed on any web browser, including portable devices such as smart phones and tablets.

The web data logging example was implemented using the Hitex LPC4300 evaluation board, which has all the necessary components. The LPC43xx has a built-in Ethernet controller accessible by either core, and the Hitex evaluation board provides the physical layer. An on-board 128x32 pixel Chip-on-Glass (COG) LCD display, four touch sensors, and several LEDs that were used to develop a simple user interface. The LPC43xx contains a Real-Time Clock (RTC) which is used to record the date and time of data samples.

The first step of the project was to develop code to sample data from some on-board devices. The Hitex board has a temperature sensor, and a potentiometer connected to ADC channel 0. Support routines were written to provide text and graphic support for the COG LCD, access to the touch keys, LEDs, and temperature sensor. The drivers provided by NXP are used to read the ADC. (Note: A new release of the NXP LPC driver software includes text-only support for the COG LCD and access to the touch keys).

The next step was to port the EasyWeb web server developed by Andreas Dannenberg. The port is designed to run on either the M0 or M4 processor. It provides a simple HTTP server with limited services. The EasyWeb server must be located in the same subnet as the web browser being used. The IP address is located in the *tcpip.h* file and must be changed to match the local subnet you will be using. The IP address is displayed on the COG LCD.

The final step was implementing the inter-process communication (IPC) between the M4 and M0. The LPC43xx has shared memory space and interrupts for IPC, and support is available through system drivers for cyclic buffers and message queues, but this example uses a simple shared memory method for exchanging data. Data is written to shared memory by one processor and read from shared memory by the other processor.

The program flow for the M4 and M0 code is briefly described below.

M4 processor

The M4 processor is responsible for loading the M0 execution image and starting the M0 processor. It then configures the peripherals and prompts the user to enter the correct date and time using the COG LCD and touch keys. The RTC is initialized to generate sample interrupts every second, and an alarm interrupt at the 15 second mark of every minute.

At each sample event, the date, time, temperature, and ADC value is stored in shared memory and the sample count is incremented. The date, time, temperature and ADC values are displayed on the COG LCD.

At each alarm event, the date and time is stored in shared memory and the alarm count is incremented. An example of the COG LCD screen is shown in Figure 1. The LED located beside the USB1 connector flashes at 1 Hz when the M4 processor is running.

Figure 1: COG LCD Screen

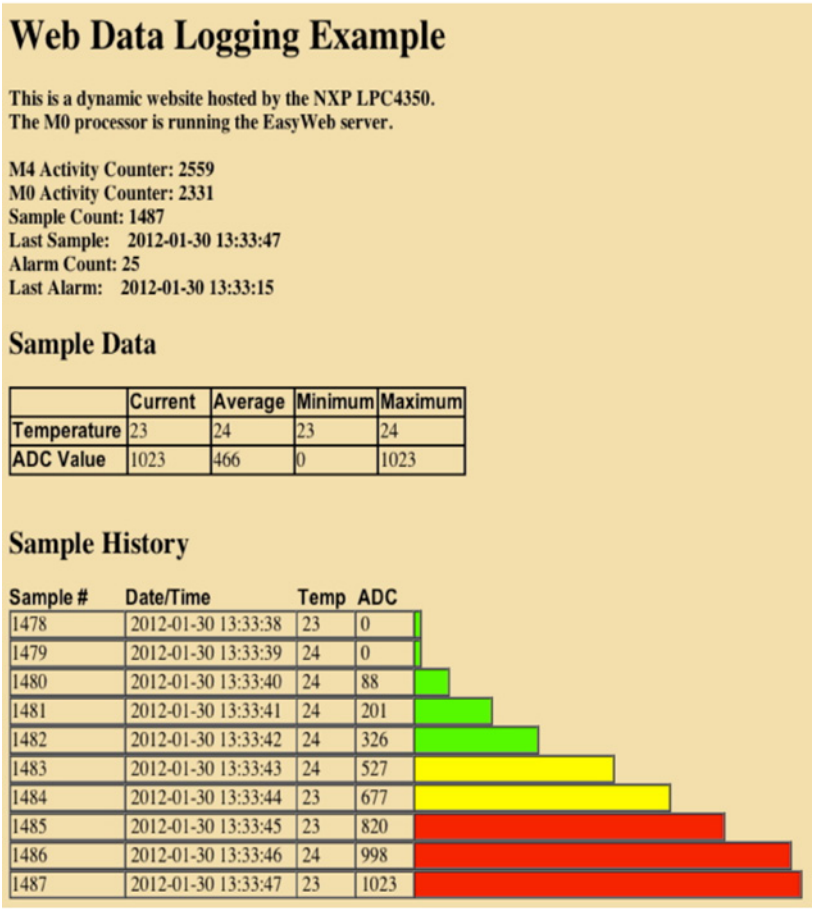
M0 processor

The M0 processor runs the EasyWeb web server and monitors shared memory to watch for new data samples. When a new sample is available, the average, minimum and maximum values are calculated, and the sample values are stored in a history buffer.

When the HTTP server receives a request from a web client, it serves up an HTML page containing various individual data values, a table showing the current sample summary, and a table showing the sample history. The sample history includes a bar graph of the ADC values. Values in the lower third of the ADC range are displayed in green, values in the middle third are displayed in yellow, and values in the upper third are displayed in red. The dynamic content is inserted into the HTML by replacing special string tokens with the relevant dynamic content. An example of the page displayed by a web browser is shown in Figure 2. The LED located beside the USB0 connector flashes at 1Hz when the M0 processor is running.

The web data logging example was tested with web browsers on various desktop computers and on the iPhone and iPad.

The NXP LPC43xx dual-core capability is well suited to web server applications. With an impressive amount of processing power and access to large amounts of memory, a fully featured



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This is a dynamic website hosted by the NXP LPC4350.
The M0 processor is running the EasyWeb server.

M4 Activity Counter: 2559
M0 Activity Counter: 2331
Sample Count: 1487
Last Sample: 2012-01-30 13:33:47
Alarm Count: 25
Last Alarm: 2012-01-30 13:33:15

Sample Data

	Current	Average	Minimum	Maximum
Temperature	23	24	23	24
ADC Value	1023	466	0	1023

Sample History

Sample #	Date/Time	Temp	ADC
1478	2012-01-30 13:33:38	23	0
1479	2012-01-30 13:33:39	24	0
1480	2012-01-30 13:33:40	24	88
1481	2012-01-30 13:33:41	24	201
1482	2012-01-30 13:33:42	24	326
1483	2012-01-30 13:33:43	24	527
1484	2012-01-30 13:33:44	23	677
1485	2012-01-30 13:33:45	23	820
1486	2012-01-30 13:33:46	24	998
1487	2012-01-30 13:33:47	23	1023

Figure 2: Sample Web Page

web server can easily be supported. The dual-core capability means the M4 is free of web server overhead and can fully utilize its extensive capabilities for data processing and number crunching.

The NXP LPC43xx is a very powerful processor with extensive peripheral support. The system driver code and examples supplied by NXP provide an excellent starting point for code development.

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