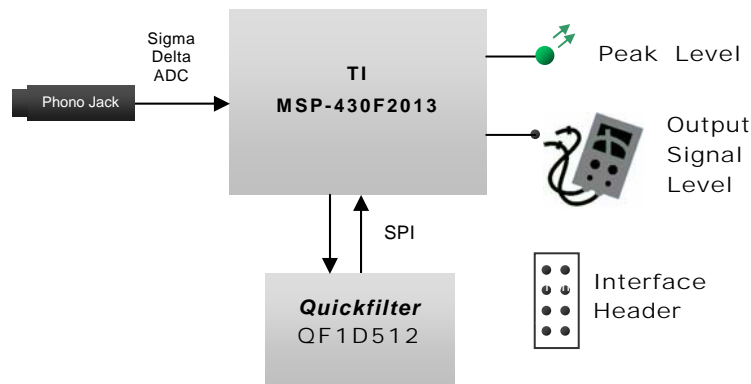


QF1D512 Coprocessor Example Using an MSP-430

1) Introduction

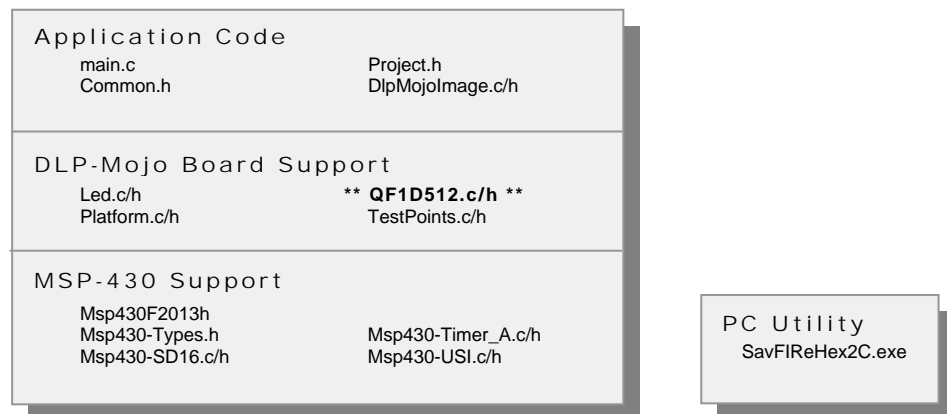
This application note describes the software used with the QF1D512-eZ430 “DLP-MSP-Mojo” Demo Board (called MSP-Mojo here) from DLP Designs. The structure of the MSP-Mojo board is as shown below.

Figure 1 – MSP-Mojo Board Structure



The software for the MSP-Mojo provides a detailed working example of the Quickfilter QF1D512, acting as a coprocessor that filters the samples from the MSP-430’s on-chip ADC. The structure of the software in this example is as follows.

Figure 2 – Software Structure



A .zip archive, named **eZ430 Release Content (Ver x.x.xxx).zip**, contains the technical content for this Application Note. For detailed information, see **Source Code Documentation.chm** in the root folder of the .zip file.

2) Capabilities

As shipped, this program's filtering characteristics are -

Figure 3 – Filter Parameters

Type:	Parks-McLellan Bandpass
Sampling Frequency:	20 KHz
Passband Center Frequency:	1 KHz
Passband Bottom Bandwidth:	400 Hz
Passband Top Bandwidth:	100 Hz
Passband Ripple:	1 dB
Stopband attenuation:	60 dB
Number of Taps:	337 (folded, 169 coefficients)

The filter is specified in the configuration file for the PC software - **PcSoftwareConfig.q1d2**. Its output is in **DlpMojolImage.c/h** in the source code.

Of course, alternative filter parameters may be used by following the design flow in the Build & Debug section below. The SD16CTL register can be manipulated to get up to 61.5 K samples/s on the MSP430F2013 device.

To observe filtering behavior, connect a function generator to the audio jack and start the target per the instructions below. Then set the function generator to 5.0 Vpp and sweep from 100 Hz to 2 KHz in 100 Hz steps. The Level LED should only light at the 1KHz mark.

Sampling activity can be observed by probing TP4 (U1, pin 11). TP4 goes high on entry to the ADC interrupt service routine. It is set low on exit from that routine. It should occur every 50us (1/ 20 KHz) with the default configuration. Note - the MSP-430 clock intentionally introduces dither that may affect the time between two samples, however the average time should be maintained to within 1% of 50us.

Power Management

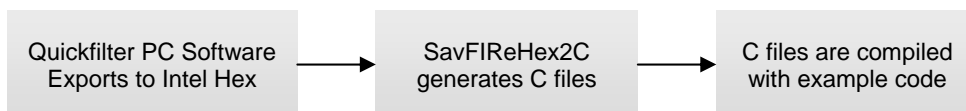
This software is designed for low power consumption. There are no idle loops. The core is either processing or it is in Low Power Mode 0. In that mode the CPU clock is off, but peripherals and all interrupt sources are still active.

3) Build & Debug

To debug this example, install the eZ430-F2013 per TI's instructions, including the IAR Workbench. Then start IAR Workbench and select **File→Open→Workspace...** Navigate to **IAR.eww** (in this project) and open it. Then select **Project→Debug** to load the image on the target device and **Debug→Go** to run the program.

To rebuild this example, load **IAR.eww** then select **Project→Rebuild All** from the menu. It should compile with no warnings or errors.

Figure 4 – Design Flow



To integrate a filter created on the Quickfilter Pro PC software, create the configuration then export it to an Intel hex file by selecting **File→Export Image...** Next, run the **SavFIREHex2C.exe** utility (provided in the source code zip file) on the hex file to produce a C file pair (.c/.h). Finally, build and debug the new configuration per the instructions above.

4) Stand-Alone Operation

After the USB debugging adapter has loaded an image for debug, that image will persist in the MSP430 flash even when power is removed. The MSP-Mojo may be run stand-alone by unplugging the debugging adapter from USB, separating the MSP-Mojo board from the programming adapter, and re-applying power on pins 10 and 12 of H1, the Interface Header.

5) Other

The **Assert()** macro, and macros built upon it (**AssertNonNull()**, etc.), are used to instrument the code in the **Debug** build configuration when **USE_ASSERTIONS** is defined. These statements are ignored in Release builds, and have no effect on code size or bandwidth in that case. When used, they do consume code space and runtime bandwidth. The tradeoff is an improvement in the ability to catch many types of bugs earlier in the debug process (see `assert.h` in the C library documentation).

The 2K flash memory size of the MSP430F2013 prohibits project-wide use of assertions. Assertions can be turned on locally by defining **USE_ASSERTIONS** as a custom build setting for a particular file or files.

Please send any comments, bug reports, etc. about this example to apps@quickfilter.com.

6) References

1. "QF1D512 Single Channel Programmable Digital Filter", Rev A1, June 06, Quickfilter Technologies, Inc., www.quickfiltertech.com
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7. "doxygen", Version 1.4.6, Dimitri van Heesch, doxygen.org

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