Comparison of DSP Boards (updated July 2013)

We are firm believers in the need for a working knowledge of real-time DSP to be part of a complete EE/ECE curriculum. Such a working knowledge cannot come only through books, lectures, or MATLAB demos; students need to use actual DSP hardware and get real-time applications to run successfully before they can acquire a practical working knowledge of real-time DSP. Throughout the years, we've used a number of boards in our labs for this purpose using both fixed- and floating-point Texas Instruments (TI) processors, such as the C50, C31, C6201, C6211, C6711, C6713, and most recently the multi-core OMAP-L138 (which includes both a C6748 core and an ARM926 core). Of these boards, several are now only of historical interest, while the boards based on the C6713 and the OMAP-L138 remain our primary targets of interest.

The Spectrum Digital C6713 DSK, Logic PD OMAP-L138 Zoom Experimenters Kit (ZEK), and the relatively new Texas Instruments OMAP-L138 Low Cost Development Kit (LCDK) can all be used effectively with our book, *Real-Time Digital Signal Processing: from MATLAB to C with theTMS320C6x DSPs*, 2nd edition, by Welch, Wright, and Morrow (CRC Press 2012). How do these three boards compare?

	Spectrum Digital/TI C6713 DSK	**Logic PD OMAP-L138 Zoom Experimenter Kit**	**TI OMAP-L138 Low Cost Development Kit**
Processor	C6713 DSP	OMAP-L138 dual core, C6748 VLIW DSP and ARM926 RISC GPP on a SOM	OMAP-L138 dual core, C6748 VLIW DSP and ARM926 RISC GPP
Processor Clock Freq.	225 MHz (fixed)	375 MHz (max)	456 MHz (max)
RAM	16 MB of SDRAM	128 MB mDDR SDRAM*	128 MB DDR2 SDRAM
Flash memory	512 KB	8 MB SPI-NOR Flash	128 MB NAND Flash
Audio codec	TLV320AIC23	TLV320AIC3106 (access to line in and line out only)	TLV320AIC3106 (access to line in, microphone in, and line out)
Other I/O	None, but an available HPI interface board from eDSP provides parallel port, USB, serial RS-232, and digital input/output ports as user selectable resources available to the DSK software	USB, SATA, Ethernet (RJ-45), MMC/SD card slot, serial (RS-232), Integrated (LCD, touch, and backlight) Connector for optional Zoom Display Kits, JTAG Note: XDS100 emulation is built into the board.	USB, SATA, Ethernet (RJ-45), MMC/SD card slot, Composite Video (NTSC/PAL) input, VGA output, Leopard Imaging Camera Sensor input, LCD Port (Beagleboard XM connectors) output, two user push button inputs, JTAG**
Suggested retail price	$395	$495	$195***

* Older boards shipped with 64 MB of mDDR SDRAM

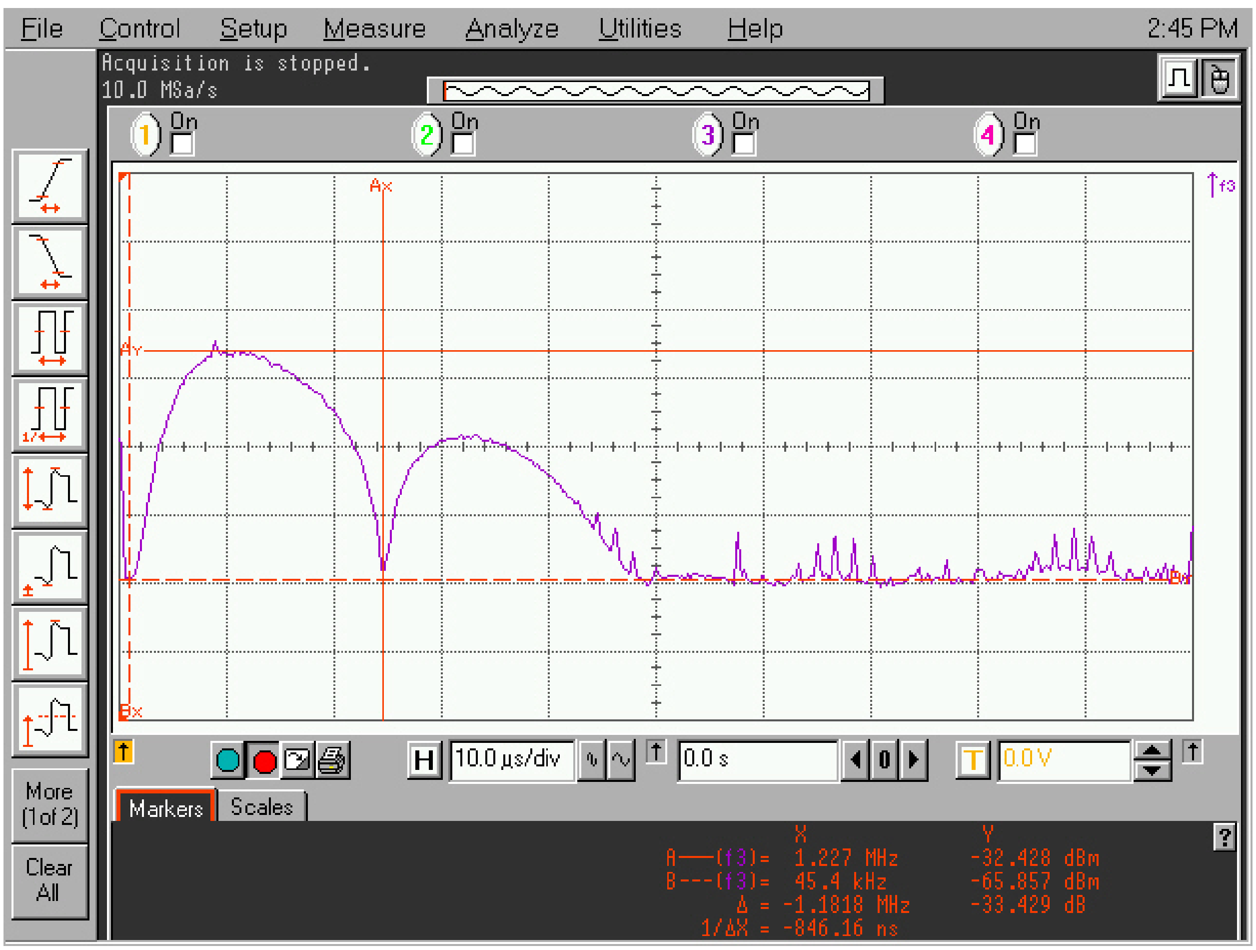
** Early versions of the LCDK included an Authentec fingerprint swipe sensor, but since Authentec has recently discontinued production of this sensor, newer LCDKs do not include a fingerprint reader.

*** Note: to program the LCDK in C (using Code Composer Studio from TI), you will also need an inexpensive XDS100 emulator, since it isn't part of the main board. These are available at a suggested retail price of $79, from TI's estore or a variety of third-party vendors.

We provide support for the C6713 DSK in the latest edition of our book mainly for legacy purposes, as many universities have labs populated with these boards. For those just getting started, populating new labs, or for those wanting to upgrade existing labs, one of the two OMAP-L138 boards seems to make more sense. Using basic criteria such as price and available I/O, the new LCDK appears to be the better choice. The only slight disadvantage to the LCDK is the need for an external XDS100 emulator, but this is a minor issue. After using both boards, we now prefer the LCDK. Beyond price and I/O, the comparison of OMAP boards gets a bit more interesting, if you start to consider more subtle issues.

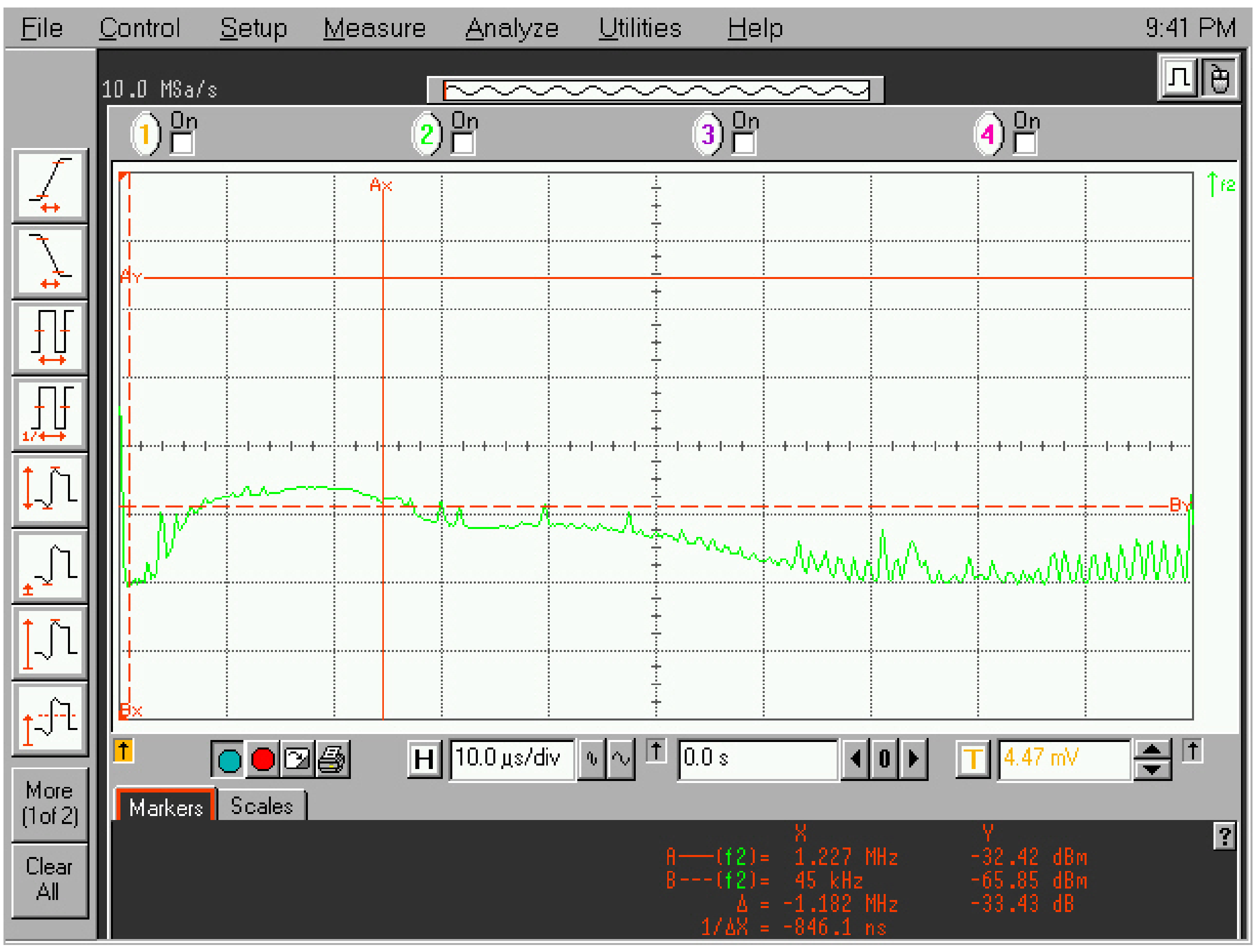
For example, while both OMAP-L138 boards use the identical audio codec chip, the two manufacturers chose to integrate that codec into the overall board design in different ways. The ZEK only makes available line in and line out, whereas the LCDK also makes available an amplified microphone input (handy for commonly available non-powered microphones). Furthermore, the power supply decoupling of the codec chip is very different between the two boards, and this is important to some applications.

It can be seen from the board schematics that the codec on the ZEK connects directly to the “noisy” switching DC power supply, whereas the LCDK uses LC filtering on the power connection. From a design standpoint, the better board is the LCDK, since power supply noise is not coupled into the codec as it is in the ZEK. One could argue that such power supply noise is well above the audio range intended for the audio codec, so why “waste” money on filter components? But such high-frequency noise can still be problematic in a laboratory setting where processed signals are routinely analyzed using traditional test and measurement equipment. This unnecessary high-frequency noise can be clearly seen in the screen capture below, which shows the average spectrum of the ZEK’s audio codec output.



In this figure, the “Bx” marker is placed at the first spectral null near 45 kHz, so the energy shown is all well above the audio frequencies. But it can still cause a problem. Often, the system’s output is analyzed by test and measurement equipment (e.g., an oscilloscope, spectrum analyzer, or a vector signal analyzer) that is usually of the high-speed sampled type (e.g., a digital sampling oscilloscope or DSO). Such test equipment typically does not incorporate antialiasing filters in the front end, meaning that aliasing of this “out of the audio band energy” can end up in the audio range and become a huge problem for certain DSP applications. This problem could easily have been avoided by a more prudent circuit design. The design used in the LCDK clearly shows this via its quieter code output.

The figure below shows the average spectrum of the LCDK’s audio codec output. Compare this to the previous figure showing the ZEK codec output. The LCDK uses exactly the same AIC3106 codec chip that is used in the ZEK, and the sample frequency, scales, and markers for the two figures are as close to identical as we could get them. The figure of the LCDK’s output clearly shows a substantial reduction (approximately 30 dB) in the “out of audio band noise” compared to the ZEK.



In conclusion, based on price, available I/O, and the noise characteristics of the codec output, the better of the two OMAP-L138 boards seems to be the LCDK. That being said, our book fully supports all three: the Spectrum Digital C6713 DSK, the Logic PD Zoom OMAP-L138 Experimenters Kit (ZEK), and the Texas Instruments OMAP-L138 Low Cost Development Kit (LCDK).