

Real-Time Digital Signal Processors

DSP tools for projects and teaching

Signal Processing is a core subject in any electronics degree, but it is not always taught at a practical level. Including real hands-on experience dramatically enhances student learning, and is now easy to do!

TI's University Programme started in 1994 with a simple goal: **to enable the widest possible use of real-time signal processing to be achieved in the classroom using industry standard TI processors and software.**



C5505 eZDSP USB Stick Development Tool
Part#: TMDX5505EZDSP \$49



The "Beagle Board" based on OMAP3530
<http://beagleboard.org/> \$149

TI provides universities with teaching materials, workshops, technical support and special pricing. There are three DSP processor families to choose from: C6000, C5000 and OMAP™ Processors.

The focus of the C6000 DSP family is high-performance. Typical applications include professional audio, video and image processing, and software defined radio (SDR). There are both fixed (C64xx) and floating-point (C67xx) CPUs. Latest developments include the "DaVinci" processors (C64x+) optimised for video applications.

The TMS320C5000™ DSP platform provides a broad portfolio of the most power-efficient DSPs with standby power as low as 0.12 mW and performance up to 600 MIPs. They are optimized for power- and cost-efficient embedded signal processing solutions, including portable electronics in consumer, communications, medical, security and industrial applications.

OMAP-L1x Applications Processors include ARM9 and ARM9-plus-C6747 DSP architectures and offer a variety of peripherals for networking and run Linux or the DSP/BIOS™ real-time kernel for operating system flexibility. Power consumption ranges from 8 mW in standby to 400 mW total power.

The OMAP 3 platform is based on the first catalog offering of the ARM® Cortex™A8 core. With more than four times the processing power of today's 300MHz ARM9 devices. The OMAP3530 is available in two versions: 600MHz ARM/430MHz DSP and 720MHz ARM/520MHz DSP to deliver advanced user interfaces, improved graphics, plus video & connectivity for portable and multimedia applications.

C6000 for Teaching

C6000 Teaching ROM

This is TI's most comprehensive set of teaching materials and programs. Comprising twenty two chapters, the material describes the C6000 architecture in detail, introduces Code Composer Studio (CCS), the Operating System (DSP/BIOS), Software Optimisation and also provides common DSP applications implemented on the C6713 and C6416 DSK platforms.
Written by: Author and Lecturer Dr. Naim Dahnoun, Bristol University, UK.

“From MATLAB(c) and SIMULINK(c) to Real-time Using TI DSP” - Teaching ROM

This teaching ROM focuses on work-flow and application-based teaching rather than individual DSP algorithms implementation. The idea is that you start from algorithm development and show how easily an idea is prototyped step-by-step, and then deployed on the hardware. The CD-ROM contains a suite of example applications in various fields such as Audio, Video, Imaging, Communications and Control Advanced level examples are also included, where the basic tools are integrated with external dedicated hardware and/or software modules.

Written by: Author Jacob Fainguelernt, the engineering supervisor of the Signal Processing and Communication labs at the School of Electrical Engineering at Tel-Aviv University, Israel.

You can request any of our Teaching ROMs for free at: https://www-a.ti.com/apps/dspuniv/teaching_rom_request.asp

C6416 / C6713 DSKs

Part#: TMDSDSK6416-TE

\$455

<http://focus.ti.com/docs/toolsw/folders/print/tmdsdsk6416.html>

Part#: TMDSDSK6713

\$355

<http://focus.ti.com/docs/toolsw/folders/print/tmdsdsk6713.html>

The 6713 DSK is the most popular choice of academia. The C6416 and C6713 DSKs are the easiest DSKs to get started with, and link closely with simulation tools like MatLab. Many application notes, guides and other materials are available on the web for these boards.

Typical Applications: Teaching DSP with real hardware gives the added benefit of allowing students to interact with the algorithms they are creating, enabling them to really understand the power of the mathematics behind DSP. For many students, this is their “Eureka moment”, and often leads to enthusiastic team projects. These boards are well suited to teaching audio processing, and complex filtering.

Features:

- C64x CPU at 1GHz or C67x CPU at 225MHz
- High-quality 24-bit stereo codec
- 3.5mm jacks for mic, line in/out & speaker
- Onboard JTAG controller with USB interface
- 16MB SDRAM and 512kB Flash
- Compatible with 5-6K Analog Interface Board for easy connection to TI Data Converters

Related Workshop Materials:

- DSP/BIOS OS Design Workshop (4-day, C6416)
- C6000 DSP Optimization Workshop (4-day C6416)



C6000 for Projects

C6455 DSK

Part#: TMDSDSK6455

\$595

<http://focus.ti.com/docs/toolsw/folders/print/tmdsdsk6455.html>

The C6455 DSK includes TI's most powerful DSP, with 9600 MIPS. This is the only DSK to feature Serial RapidIO®, an interface allowing users to implement high-speed multi-DSP & FPGA projects.

Typical Applications: Multi-DSP processing, video and voice transcoding, wireless base station transceivers, SDR, HD radio, medical imaging, and photo labs and printing.

Features:

- C64x+ 1.2GHz CPU (9600 MIPS/MMACS)
- Four 1x Serial RapidIO® Links (or One 4x),
- 10/100 Mb/s Ethernet MAC
- High-quality 24-bit stereo codec
- 3.5mm jacks for mic, line in/out & speaker
- Onboard embedded IEEE 1149.1 JTAG controller with USB interface
- 128MB Memory and 8MB Flash
- Compatible with 5-6K Analog interface board for easy connection to TI Data Converters



C5000 for Teaching

C5000 Teaching ROM

Including 23 chapters, which cover both the hardware part of the 'C5000 platform (Architecture, description of each peripheral) and the implementation (FIR and IIR filters, image compression, Fast Fourier Transform, Polyphase filters, Frequency modulation, GMSK modulation, and more). Most chapters come with associated source files that have developed for the C5416 and C5510 DSP Starter Kits. In addition to the laboratories, applications, such as an audio sweep generator and various audio effects, are included.

Written and designed by Genevieve Baudoin, Olivier Venard and Ferial Virolleau of ESIEE (Ecole Supérieure d'Ingenieurs en Electrotechnique et Electronique), Paris, France, with additional applications and code from Richard Sikora.

Request your Teaching ROM at: https://www-a.ti.com/apps/dspuniv/teaching_rom_request.asp

TMS320VC5510 DSP Starter Kit (DSK)

Part#: TMDSDSK5510

\$316

<http://focus.ti.com/docs/toolsw/folders/print/tmdsdsk5510.html>

Typical Applications: Portable internet, high speed wireless communications, digital audio players, digital still cameras, electronic books, portable medical devices, voice recognition, GPS receivers, fingerprint/pattern recognition, wireless modems, headsets and biometrics.

Features:

- Embedded JTAG support via USB
- High-quality 24-bit stereo codec
- Four 3.5mm audio jacks for microphone, line in, speaker and line out
- 256K words of Flash and 8 MB SDRAM
- Expansion port connector for plug-in modules
- On-board standard IEEE JTAG interface
- **The C5000 Teaching ROM come with associated source code files that have been developed for the C5510 DSK.**



TMS320VC5505 DSP Evaluation Module

Part#: TMDXEV5505

\$395

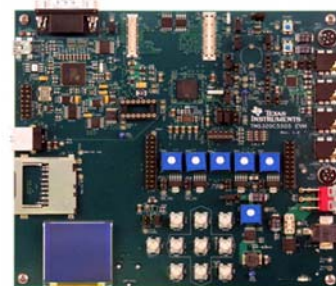
<http://focus.ti.com/docs/toolsw/folders/print/tmdxevm5505.html>

The TMS320VC5505 EVM is a low cost fixed point low power DSP, feature rich development platform designed to speed the evaluation process with low power technology. You can get started immediately with innovative product designs by utilizing the EVM's full-featured Code Composer Studio™ integrated development environment (IDE) and eXpressDSP™ software which includes the DSP/BIOS™ kernel. The combination of standby and active power help to conserve energy at exceptional levels and enables longer battery life. It also includes a hardware accelerator for FFT computation.

Typical Applications: Signal processing applications, voice recorder, musical instruments, portable medical solutions and other consumer electronics in industrial and security applications.

Features:

- On board embedded JTAG emulation to enable the plug-and-play functionality through just an A-to-mini B USB cable and compatibility of external JTAG emulation interface
- TLV320AIC3254 32-bit programmable low power stereo codec
- OLED colour LCD display (128x128 pixels)
- Stereo line in (2) /out (1), headphone out (1) and microphone in (L/R)
- Analog front end connectors
- I2C and SPI EEPROMs
- High speed USB 2.0 slave port
- MMC/SD slot, CE-ATA connector, RS232 interface
- 10 user defined push button switches
- Two expansion connectors for memory cards
- External oscillator socket
- Battery Holder (For 2 AAA, not included)



In addition, there are three medical development kit front end modules available for the C5505:

- **Digital Stethoscope (DS)** Analog Front End Module for the C5505 DS Medical Development Kit
Part #: TMDXMDKDS3254 \$375 <http://focus.ti.com/docs/toolsw/folders/print/tmdxmdkds3254.html>
- **Electrocardiogram (ECG)** Analog Front End Module for the C5505 ECG Medical Development Kit
Part #: TMDXMDKEK1258 \$449 <http://focus.ti.com/docs/toolsw/folders/print/tmdxmdkek1258.html>
- **Pulse Oximeter (PO or SpO2)** Analog Front End Module for the C5505 PO or SpO2 Medical Development Kit
Part #: TMDXMDKPO8328 \$395 <http://focus.ti.com/docs/toolsw/folders/print/tmdxmdkpo8328.html>

C5505 eZDSP
Part#: TMDX5505eZDSP
\$49
USB Stick Development Tool <http://focus.ti.com/docs/toolsw/folders/print/tmdx5505ezdsp.html>

The TMDX5505eZDSP is a low cost USB-powered DSP development tool which includes all hardware and software needed to evaluate the industries lowest power 16-bit DSP. The USB port provides enough power so no external power supply is required. This ultra low cost tool allows quick and easy evaluation of the advanced capabilities of the C5505 and C5504 processors. This tool has embedded XDS510 emulator for full source level debug capability and supports Code Composer Studio™ Rev. 4.0 integrated development environment (IDE) and eXpressDSP™ software which includes the DSP/BIOSv kernel.

Features:

- TMS320C5505 fixed point low power DSP
- Embedded XDS100 emulator
- I2C EEPROM
- TLV320AIC3204 32-bit programmable low power stereo codec



- Line In, Headphone Out Connectors
- Expansion connector
- Removable USB stick enclosure
- Includes Code Composer Studio 4.0
- Full documentation on CD-ROM

OMAP for Teaching

**OMAP-L137/TMS320C6747
Floating Point Starter Kit**
Part#: TMDXOSKL137BET
\$395
<http://focus.ti.com/docs/toolsw/folders/print/tmdxoskl137bet.html>

This starter kit includes both a 300 MHz fixed/floating-point C674x DSP core and a 300 MHz ARM9 processor. The C674x DSP generation is designed for applications that require floating-point precision and fixed-point performance for energy-efficient, connected applications, such as audio, medical and industrial.

Typical Applications: Teaching ARM Linux Based architecture and the high performance C674x DSP professional audio processing and industrial control, USB networking and high-speed encoding.

Features:

Other hardware features of the SK include the following:

- Embedded JTAG support via USB
- High-quality 24-bit stereo codec
- Four 3.5mm audio jacks for microphone, line in, speaker and line out



- 4MB Serial Flash and 64MB SDRAM
- Expansion port connector for plug-in modules
- On-board standard IEEE JTAG interface

OMAP for Projects

Beagle Board
<http://beagleboard.org/>
\$149

For OMAP projects we recommend the Beagle Board which is based on OMAP3530 technology and features ARM CortexA8 and TMS320C64x+™ DSP. Information and supplies of the Beagle Board come from Digi-Key© (www.digikey.com), with support through the thriving online community at www.beagleboard.org

**Code Composer Studio
Version 4**
<http://focus.ti.com/docs/toolsw/folders/print/ccstudio.html>

Code Composer Studio v4 is a major new release of Code Composer Studio (CCS) that is based on the Eclipse open source software framework. We have chosen to base CCSv4 on Eclipse as it offers an excellent software framework for building software development environments and is becoming a standard framework used by many embedded software vendors. CCSv4 combines the advantages of the Eclipse software framework with advanced embedded debug capabilities from TI resulting in a rich development environment for embedded developers.

 Prices Valid as of 1st August 2009

For more information about the University Program
www.ti.com/university

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