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Revision History

November 2001 – Revision 0.1 (ALPHA)
March 2002 – Revision 0.8 (BETA)
April 2002 – Revision 1.0
May 2002 – Revision 1.1
June 2002 – Revision 1.2
October 2003 – Revision 2.0
April 2005 – Revision 2.1 (added Analog Interfacing – Mod 6.5)
August 2005 – Revision 3.1a (update to CCS 3.1, SIO/IOM, errata fixes)

Mailing Address

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Dallas, Texas 75251-1903
Workshop Introduction

What Will You Accomplish This Week?

When you leave the workshop at the end of the week, you should be able to perform certain tasks and make critical assessments and decisions about the C6000s’ capabilities. We developed this list based on customer feedback over the past 5 years and our own workshop design experience spanning the past 25 years. All of the modules exercises and labs support these accomplishments (as you’ll see when we discuss the workshop’s agenda).

The first two accomplishments are really the overall objectives of the entire workshop. Many students attend the workshop to meet these two needs. The rest of the list supports these two objectives and provides more insight into the expected outcomes. We hope this list meets or exceeds most of your expectations. If you think about it, we’re going through the equivalent of a college semester course in 4 days! We obviously can’t discuss everything given the time limitations, but we have provided the fastest path toward understanding, using and becoming confident in these activities.

What Will You Accomplish?

When you leave the workshop, you should be able to…

- **Evaluate** C6000’s ability to meet your system requirements
- **Use development tools** to compile, optimize, assemble, link, debug and benchmark code on the C6713 and C6416 DSKs
- **Control response to real-time events using interrupts**
- **Configure peripherals** to communicate with various devices
- **Use DSP/BIOS APIs** to perform various tasks in the system as well as analyze results
- **Integrate an XDAIS algorithm** into your system
- **Use the bootloader and flash programming tools** to create a standalone system
- **Understand other C6000 capabilities**: EMIF, cache, HPI

So, if you’re need falls “inside the box”, be prepared to ask questions when the topic comes up. If your need falls “outside the box”…
What We Won’t Cover

It’s very important to set the expectations of our student’s right up front. This includes analyzing what we intend to discuss (accomplishments) as well as what we won’t have time to cover. This leads us to the next discussion. We have chosen, based on time constraints, to explicitly not cover certain topics. Not only do we expect a certain level of knowledge coming into the workshop (pre-requisites such as some C programming, basic assembly, understanding basic engineering terms and system concepts, etc), we also want to specifically state what won’t be covered during the week. This list includes DSP Theory, algorithms, and specific applications.

Regarding DSP Theory, we will not cover topics such as IIR/FIR filters, convolution, FFTs, and the rest of the topics addressed by the numerous DSP theory books and college courses. We assume that you know this theory if need to apply it. Our job is to show you how to use the device to accomplish these tasks (i.e. the CPU and peripherals) – instead of spending time showing the theory. We do not have time to dive into any one specific algorithm – such as PID, servo, VSELP, GSM, Viterbi, etc. If we did, it’d probably not be the one you wanted. We do provide details about on-chip hardware peripherals, which you can apply to the various hardware/software applications, required by your system – we just don’t intend to show the details of any specific application.

What We Won’t Cover and Why...

Issues “outside the box”:

- DSP Theory / Algorithms
- Specific hardware and software applications
- Detailed ASM programming and Code Optimization
- Architectural details

What Will You Accomplish?

When you leave the workshop, you should be able to...

- Evaluate C600x's ability to meet your system requirements
- Use development tools to compile, optimize, assemble, link, debug and benchmark code on the C6711 DSK
- Control response to real-time events using interrupts
- Configure communication interfaces with various devices
- Use C6000 API’s to perform various tasks in the system as well as OOTB
- Integrate an existing application into your system
- Use the bootstrapper and boot loader tools to create a standalone system
- Understand other C600x capabilities: DMF, cache, HPI

C6000 IW Workshop Scope and Depth

- In 4 days, it is impossible to cover everything. However, we do cover an equivalent of a college semester course on the C6000.
- We’ve chosen the “Accomplishments” list based on customer feedback and years of workshop experience.
- Many app notes have been written to address specific topics not covered in the workshop (check out the TI website).
- If you have a need that falls “outside the box”, please inform your instructor. Often, they can offer answers/ideas before or after class.

We’ve had to make some decisions about the material in the workshop based on time and what makes sense for all users. Many app notes have been written (and are available on the TI web site at http://www.dspvillage.com) which cover, in detail, many of the topics we cannot here. So, if you’re need falls “outside the box” (i.e. in addition to the accomplishment list discussed previously), then you have two options: (1) ask the instructor if a manual or app note is available which addresses your specific issue; or, (2) let the instructor know before or after class time – we might be able to shed some light or direct you to other resources. If you communicate your need then we will do our best to fulfill it.
Workshop Outline

On the first day of the workshop, you will be developing an audio application that requires you to set up the C6000 DMA and McBSP to send and receive audio from the PC. So, you get to hear “something” in the speakers by the end of the day. On Day 2, you will increase the complexity of the system by modifying your application to use a double-buffer instead of a single buffer. You will also be adding other threads to the system beyond the audio path and integrating a fully compliant XDAIS algorithm. On Days 3 and 4, we will cover many other system issues including EMIF, boot, cache, HPI. By the end of the workshop, you will be able to burn your application into the DSK’s flash memory and boot from power-on reset disconnected from CCS. Wow!

Workshop Outline

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
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<td>1. Introduction</td>
<td>5. Hardware Interrupts (HWI)</td>
<td>9. DSP/BIOS Scheduling</td>
</tr>
<tr>
<td>3. Basic Memory Management</td>
<td>6.5 Analog Interfacing</td>
<td>11. Integrating a XDAIS Compliant Algorithm</td>
</tr>
<tr>
<td>4. Using the EDMA (Intro to CSL)</td>
<td>7. Channel Sorting using EDMA</td>
<td>12. Using Reference Frameworks and IOM Device Drivers</td>
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<td>Day 4</td>
<td></td>
<td>13. External Memory Interface</td>
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<tr>
<td>14. Creating a Stand-alone System (Flash, Boot)</td>
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<td>15. Using the Cache</td>
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<tr>
<td>15. Using the Cache</td>
<td></td>
<td>16. Using the HPI</td>
</tr>
<tr>
<td>16. Using the HPI</td>
<td></td>
<td>17. Wrap Up</td>
</tr>
</tbody>
</table>

Note: The outline describes which day each module should fall within. Please understand, though, that each class moves at it’s own pace, therefore, you may find the daily breakout differs in your workshop from that described above.
Introductions

Learning more about you, your application, and your experience will help your instructor tailor the materials to the class needs. This is important since there is more information than can be taught during a single week.

Introduce Yourself

Briefly, a little about your application:
- Name & Company
- Application
- Which C6000 DSP do you plan to use?

And, a little about your experience:
- Do you have experience with:
  - TI DSP’s (TMS320)
  - Another DSP
  - Other microprocessors
- C, Assembly, or both
- Have you used an OS or RTOS?
TI DSP and ‘C6x Family Positioning

Applications / System Needs

DSP systems today face a host of system needs:

- Performance
- Interfacing
- Power
- Size
- Ease-of Use
  - Programming
  - Interfacing
  - Debugging
- Cost
  - Device cost
  - System cost
  - Development cost
  - Time to market
- Integration
  - Memory
  - Peripherals

These needs challenge the designer with a series of tradeoffs. For example, while performance is important in a portable MP3 player, more important would be efficiency of power dissipation and board space. On the other hand, a cellular base station might require higher performance to maximize the number of channels handled by each processor.

Wouldn’t it be nice if the fastest DSP consumed the lowest amount of power? While TI is working on providing this (and making it software compatible), it provides you with a broad assortment of DSP families to cover a varying set of system needs. Think of them as different shoes for different chores …
TI DSP Families

TI provides a variety of DSP families to handle the tradeoffs in system requirements.

Different Needs? Multiple Families.

Lowest Cost
Control Systems
- Segway
- Motor Control
- Storage
- Digital Ctrl Systems

Efficiency
Best MIPS per Watt / Dollar / Size
- Wireless phones
- Internet audio players
- Digital still cameras
- Modems
- Telephony
- VoIP

Max Performance with Best Ease-of-Use
- Multi Channel and Multi Function App's
- Wireless Base-stations
- DSL
- Imaging & Video
- Home Theater
- Performance Audio
- Multi-Media Servers
- Digital Radio

The TMS320C2000 (‘C2000) family of devices is well suited to lower cost, microcontroller-oriented solutions. They are well suited to users who need a bit more performance than today’s microcontrollers are able to provide, but still need the control-oriented peripherals and low cost.

The ‘C5000 family is the model of processor efficiency. While they boast incredible performance numbers, they provide this with just as incredible low power dissipation. No wonder they are the favorites in most wireless phones, internet audio, and digital cameras (just to name a few).

Rounding out the offerings, the ‘C6000 family provides the absolute maximum performance offered in DSP. Couple this with its phenomenal C compiler and you have one fast, easy-to-program DSP. When performance or time-to-market counts, this is the family to choose. It also happens to be the family the course was designed around, thus, the rest of the workshop will concentrate only on it.
‘C6000 Roadmap

The ‘C6000 family has grown considerably over the past few years. With the addition of the 2nd generation of devices (‘C64x), performance has increased yet again.

Yet, the ease of design within the ‘C6000 architecture has not been abandoned with its growing family of devices. Software compatibility is addressed by the architecture, rather than by the hard-work of the programmer. With both the ‘C67x and ‘C64x devices being able to run ‘C62x object code, upgrading DSP’s is much easier.
Fixed- and Floating-pt Roadmaps

**C6000™ DSP Platform Fixed-Point Roadmap**

- **Production**
- **90nm Production**
- **2Q 2005 Announcement**
- **In Development**
- **Future**

**Increasing Performance, Memory & Peripherals**

- **C6201**
- **C6203**
- **C6205**
- **C6211**
- **C6411**
- **C64x+™ Next**
- **100% Software Compatible**

**C64x+™ Next**

- **C6412**
- **C6414**
- **C6415**
- **90nm Production**

**Breakthrough Performance**

- **C6416**
- **C6418**
- **C6410**
- **C6413**

- **Up to 720 MHz**
- **720, 850 MHz and 1+ GHz**

**Floating-Point Platform Roadmap**

**Software Compatible**

- **Production**
- **2Q 2005 Announcement**
- **Future**

**First Generation**

- **C6701 167 MHz**
- **C6711 150 MHz**
- **C6712 100 MHz**
- **C31 80 MHz**
- **C31/C32 60 MHz**
- **VC33 60/75 MHz**

**Second Generation**

- **C6713 200 MHz**
- **C6712D 200 MHz**
- **C6713D 225 MHz**

**Third Generation**

- **C6711D 200 MHz**
- **C6712D 225 MHz**
- **C6722 250MHz**
- **C6726 250MHz**
- **C6727 300MHz**

**Future**

- **C6713 300 MHz**
Additional Information

For More Information and Support

For support we suggest you try TI’s web site first. Then call your local support – either your local TI representative or Authorized Distributor Sales/FAE. Finally, here are a few other places to go for support and information:

**For More Information . . .**

<table>
<thead>
<tr>
<th>Internet</th>
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<tbody>
<tr>
<td><strong>Website:</strong> <a href="http://www.ti.com">http://www.ti.com</a></td>
</tr>
<tr>
<td><a href="http://www.dspvillage.com">http://www.dspvillage.com</a></td>
</tr>
<tr>
<td><strong>FAQ:</strong></td>
</tr>
<tr>
<td><a href="http://www-k.ext.ti.com/sc/technical_support/knowledgebase.htm">http://www-k.ext.ti.com/sc/technical_support/knowledgebase.htm</a></td>
</tr>
<tr>
<td>• Device information</td>
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<tr>
<td>• Application notes</td>
</tr>
<tr>
<td>• Technical documentation</td>
</tr>
<tr>
<td><strong>Enroll in Technical Training:</strong></td>
</tr>
<tr>
<td><a href="http://www.ti.com/sc/training">http://www.ti.com/sc/training</a></td>
</tr>
</tbody>
</table>

**USA - Product Information Center (PIC)**

| Phone: 800-477-8924 or 972-644-5580 |
| Email: support@ti.com               |
| • Information and support for all TI Semiconductor products/tools |
| • Submit suggestions and errata for tools, silicon and documents |

**In Europe . . .**

**European Product Information Center (EPIC)**

| Web: http://www-k.ext.ti.com/sc/technical_support/pic/euro.htm |
| Phone: **Language** | **Number** |
| Belgium (English)   | +32 (0) 27 45 55 32 |
| France              | +33 (0) 1 30 70 11 64 |
| Germany             | +49 (0) 8161 80 33 11 |
| Israel (English)    | 1800 949 0107 (free phone) |
| Italy               | 800 79 11 37 (free phone) |
| Netherlands (English)| +31 (0) 546 87 95 45 |
| Spain               | +34 902 35 40 28 |
| Sweden (English)    | +46 (0) 8587 555 22 |
| United Kingdom      | +44 (0) 1604 66 33 99 |
| Finland (English)   | +358 (0) 9 25 17 39 48 |
| Fax:                | +49 (0) 8161 80 2045 |
| Email: epic@ti.com  |
| • Literature, Sample Requests and Analog EVM Ordering |
| • Information, Technical and Design support for all Catalog TI Semiconductor products/tools |
| • Submit suggestions and errata for tools, silicon and documents |
### For More Generic DSP Information

#### Looking for Literature on DSP?

- “A Simple Approach to Digital Signal Processing”  
  by Craig Marven and Gillian Ewers;  
  ISBN 0-4711-5243-9

- “DSP Primer (Primer Series)”  
  by C. Britton Rorabaugh;  
  ISBN 0-0705-4004-7

- “A DSP Primer : With Applications to Digital Audio and Computer Music”  

- “DSP First : A Multimedia Approach”  
  James H. McClellan, Ronald W. Schafer, Mark A. Yoder;  
  ISBN 0-1324-3171-8

#### Looking for Books on ‘C6000 DSP?’

- “Digital Signal Processing Implementation using the TMS320C6000TM DSP Platform”  
  by Naim Dahnoun;  
  ISBN 0201-61916-4

- “C6x-Based Digital Signal Processing”  
  by Nasser Kehtarnavaz and Burc Simsek;  

- “Real-Time Digital Signal Processing: Based on the TMS320C6000” by Nasser Kehtarnavaz;  
  Newnes; Book & CD-Rom (July 14, 2004)  

- “Digital Signal Processing and Applications with the C6713 and C6416 DSK (Topics in Digital Signal Processing)”  
  Wiley-Interscience; Book & CD-Rom (December 3, 2004)  
  by Rulph Chassaing;  
  ISBN 0-4716-9007-4
Key TI Manuals

Key C6000 Manuals

**Hardware**
- SPRU189 - CPU and Instruction Set Ref. Guide
- SPRU190 - Peripherals Ref. Guide
- SPRZ122 - SPRU190 Manual Update Sheet (important!)
- SPRU401 - Peripherals Chip Support Lib. Ref.
- SPRU609 - C67x Two-Level Internal Memory Reference
- SPRU610 - C64x Two-Level Internal Memory Reference
- SPRU656 - Cache Memory Users Guide

**Software**
- SPRU198 - Programmer’s Guide
- SPRU423 - C6000 DSP/BIOS User’s Guide
- SPRU403 - C6000 DSP/BIOS API Guide

**Code Generation Tools**
- SPRU186 - Assembly Language Tools User’s Guide

Refer to the C6000 Product Update handout for full list.
TI DSP Workshops

DSP Workshops Available from TI

◆ Attend another workshop:
  - 4-day C2000 Workshops
  - 4-day C5000 Integration Workshops
  - 4-day C6000 Integration Workshop
  - 4-day C6000 Optimization Workshop
  - 4-day DSP/BIOS Workshop
  - 4-day OMAP Software Workshop
  - 1-day Workshops (C2000, C5000, C6000)
  - 1-day Reference Frameworks and XDAIS

◆ Sign up at:
  http://www.ti.com/sc/training

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C6000 Workshop Comparison

<table>
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<tr>
<th>Audience</th>
<th>IW6000</th>
<th>OP6000</th>
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<tbody>
<tr>
<td>Algorithm Coding and Optimization</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>System Integration (data I/O, peripherals, real-scheduling, etc.)</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

C6000 Hardware

| CPU Architecture & Pipeline Details | ✓ |
| Using Peripherals (EDMA, McBSP, EMIF, HPI, XBUS) | ✓ |

Tools

| Compiler Optimizer, Assembly Optimizer, Profiler, PBC | ✓ |
| CSL, Hex6x, Absolute Lister, Flashburn, BSL | ✓ |

Coding & System Topics

| C Performance Techniques, Adv. C Runtime Environment | ✓ |
| Calling Assembly From C, Programming in Linear Asm | ✓ |
| Software Pipelining Loops | ✓ |
| DSP/BIOS, Real-Time Analysis, Reference Frameworks | ✓ |
| Creating a Standalone System (Boot), Programming DSK Flash | ✓ |
Administrative Details

Administrative Topics

- What you have in front of you
- Name Cards
- Sign-in Sheet
- Refreshments
- Facilities
- Phones
- Lunch
- Cell Phones – please silence them
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