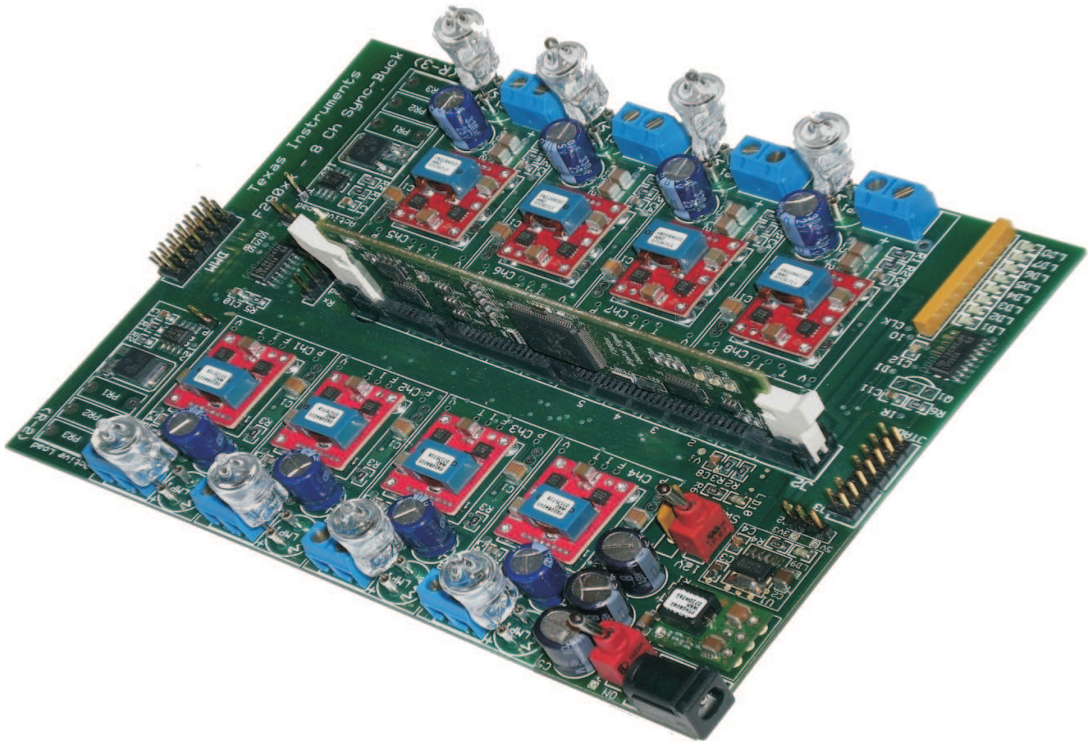
Quick Start Guide

SPRUFR7–July 2008

TMS320C2000 DSC DC/DC Developer's Kit



Providing a great way to experiment and learn about digital power control, the TMS320C2000™ DC/DC Developer's Kit highlights the TMS320C28x™ digital signal controller (DSC) as a multi-rail controller for multi-phase applications. This kit contains a power motherboard which has eight TI PowerTrain™ modules, small and efficient 10 Amp synchronous buck power stages, and can interface with any of the TI plug-in controlCARDs. The board requires a single 9-V DC supply and has a separately switched and fused rail as the input voltage bus to the Buck modules. This allows for safe, convenient software experimentation and debug without the risk of hardware damage. The software package for this kit uses the TMS320F28x DSC to digitally control the output voltage, ramp rates and sequence timing for each of the eight DC/DC voltage rails.

Features of the DC/DC Developer's Kit include:

- Eight non-isolated 10-Amp SyncBuck DC/DC power stages (no heat-sink required) with built in MOSFET drivers
- Closed loop digital control with voltage feedback using F28x on-chip ePWM and ADC
- Sequencing and ramp rate parameters in software allow DC/DC rails to be controlled independently and in an organized manner
- Voltage input and output measurements via ADC
- Temperature measurement for each channel monitored by ADC
- Current measurement for each channel monitored by ADC
- Over-current protection and fault flag detection via GPIO
- 8 x LED indicators for diagnostics and fault status
- UART communications header available for host control
- Host GUI, a friendly way to control / demo the application, based on open source C# freeware
- Hardware Developer's Package is available and includes schematics, bill of materials, Gerber files,…etc

CAUTION

During experimentation the lamp loads (LMP1-LMP8 – see Hardware Overview) may become HOT if output voltages are left running for an extended time (avoid if possible). DO NOT TOUCH until the loads cool down.

1 Hardware Overview

The DC/DC Developer's Kit consists of eight identical buck power stages. The input bus voltage for all stages is 9 V. Shown below is a diagram of the DC/DC Developer's Kit board and some key features.

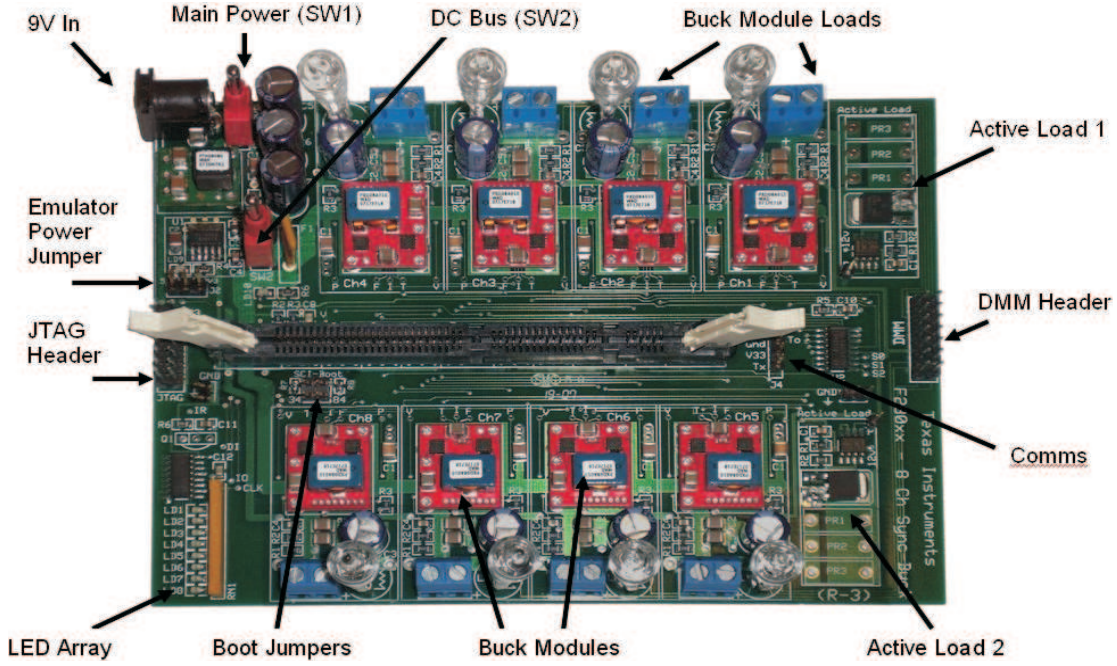


Table 1. Hardware Components

Component	Description
9V In	DC power supply from plug pack (12V supply may also be used)
Main Pwr	SW1 – Master power switch for entire EVM
DC Bus	SW2 – Power switch for Vin to buck stages only. When off the DIMM controller card will still operate (next to the DC bus switch is a resettable fuse)
Buck 1-8	Buck power stage modules with temperature/current measurement and over current protection
Load 1-8	Load terminals and/or buck converter output - next to each terminal block is a light bulb or "visual" load (these draw approx 300 mA hot)
Active Load 1/2	Switched loads controlled by the ECAP peripheral via software. These loads are connected to the output of buck 1 & 5 respectively. PR1, PR2, or PR3 will need to be populated for each active load module to function correctly. (ECAP peripheral not available on F28044)
DMM Header	Provides convenient access to the outputs of the eight buck converters
Emulator Pwr	Sets the voltage sent to power the emulator. No jumper means no power will be sent to an emulator, a jumper at 5V will power the emulator with 5 V, and a jumper at 3V3 will power the emulator with 3.3 V.
Boot Jumpers	Controls how the F280x will boot. • If no jumpers are placed the target will boot from flash. • If a jumper is placed at 34, the target will boot from the SCI. • If a jumper is placed at 29 and 34, the target will boot from RAM.
Comms	Serial communications UART (allows connection to the external GUI)

2 Hardware Set Up

All the hardware needed to get started (except the emulator) is included in this package (suggested emulators are listed near the end of this document). The application-specific motherboard provided in this kit can be used in one of two ways:

1. Test Drive – Using the provided GUI application, the user does not require Code Composer Studio™ software or emulation tools. This provides a great way to run or demo the application code quickly and see what functionality the hardware offers. Note: exactly the same functionality can be achieved by using the Code Composer Studio Watch Window and slider features during emulation in the second mode.
2. Code Composer Studio Software Development Platform – With the project code provided, the application can be modified, compiled, loaded and run in a development environment. Code Composer Studio and Emulation HW tools are required for this.

Follow these steps to set up the hardware for either the GUI or Software Development Platform:

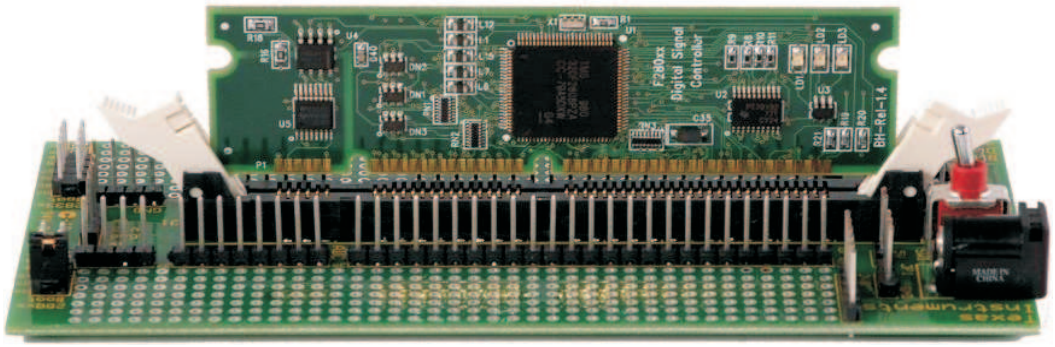
Step 1. Unpack the DIMM style controlCARD.

Step 2. Spread open the winged retaining clips on connector J2.

Step 3. Sit the DIMM card loosely in the connector slot. Align the 2 keyed notches carefully and position the card bottom corners inside the retaining clips (see picture below).

Step 4. Push vertically down using even pressure from both ends of the card until the clips snap and lock. (note: to remove or eject the card simply spread open the retaining clips with thumbs).

Step 5. Be sure switch 1 (SW1) is in the off position and connect the included power supply to the power jack.



2.1 Test drive with GUI – (skip if you need only emulation support)

Step 1. Plug in the serial cable provided to connector J4 making sure the red wire aligns with the Rx pin on EVM.

Step 2. Insert a jumper in position 34 on the board's boot pins.

Step 3. Plug the DB9 connector into your PC using either a serial port or a serial-to-USB converter dongle.

Step 4. Turn on the power once you are done with the TI Software download (see Software Set Up GUI-TestDrive).

2.2 Code Composer Studio Software Development Platform Emulation - Additional Steps

Step 1. Depending on your emulator type, place the jumper at J2 to either the 3.3-V or 5-V position.

Step 2. Connect the JTAG emulator cable to connector J1.

Step 3. Turn on power once you are done with the TI Software download, see Software Set Up - Code Composer Studio Development. For full details (schematics, pin-out table, etc) of the hardware see the Hardware Developer's Package, EightChBuck-HWdevPkg. See Software Set Up for the download location.

3 Software Set Up

The DC/DC Developer's Kit application software example, GUI, step-by-step lab style documentation, and other useful soft collateral is available on the TI website. If you already have your own software project and do not require this collateral, skip this section. As explained in the hardware set up section, the target mother board can be run either with the GUI or Code Composer Studio. The GUI executable file is found as part of the main software download. Follow the steps below for either case.

To run any of the application-specific software in Code Composer Studio, first you must install the baseline code, which contains the header files, libraries, etc. If you already have the baseline software installed, skip the baseline install steps and go to the DC/DC Developer's Kit section.

To download the free TI soft collateral follow these steps:

Step 1. Baseline soft collateral and hardware documents (skip this if you already have this software installed)

a. On an Internet browser type: http://www.ti.com/f28xkits
b. At the C2000™ DSP collateral page, choose the *Experimenter's Kit download* link
c. When prompted, fill in the TI customer registration details and click ok
d. Save the .zip file to the directory of your choice
e. Unzip the file and run the install program Baseline Software Set Up
f. The installer will create the following default directories:

C:\TI_F28xxx_SysSW
~Docs
~GeneralPurposeGUI
~SupportFiles
FlashingLeds

C:\TI_F28xxx_SysHW
CC280xxHWdevPkg
CC2833xHWdevPkg
DockingStnHWdevPkg

Step 2. DC/DC Developer's Kit soft collateral and hardware documents

a. On an Internet browser type: http://www.ti.com/f28xkits
b. Then choose the DC/DC Developer's Kit link.
c. When prompted, fill in the TI customer registration details and click ok.
d. Save the .zip file to the directory of your choice.
e. Unzip the file and run the install program Eight Channel Buck Software Set Up.
f. The installer will create the following default directories:

C:\TI_F28xxx_SysSW
EightChannelBuck
~Docs
~GUI

C:\TI_F28xxx_SysHW
EightChBuck-HWdevPkg

4 Running the Application

To run the application specific hardware, choose either *TestDrive-GUI* or *CCS-Development* options below and follow the appropriate steps.

Step 1. TestDrive-GUI

a. Open the GUI Quick Start Guide, QSG-EightChannelBuck-GUI.pdf, found in:
   C:\TI_F28xxx_SysSW\EightChannelBuck\~Docs\
b. Go to directory C:\TI_F28xxx_SysSW\EightChannelBuck\~GUI
c. Open EightChannelBuck-GUI.exe
d. Follow the step-by step instructions found in the Quick Start Guide

Step 2. Code Composer Studio - Development

a. If you have emulation tools and Code Composer Studio already installed and active, load the project file EightChannelBuck.pjt found in:
   C:\TI_F28xxx_SysSW\EightChannelBuck\
b. See the *EightChannelBuck.pdf* for a step-by-step walk through of how to compile and run the various labs. This document can be found in
   C:\TI_F28xxx_SysSW\EightChannelBuck\~Docs\.

5 Emulators

The following companies provide low cost, full featured emulators designed specifically for C2000™ controllers:

Blackhawk™	USB2000 Controller (part number TMDSEMU2000U)
	http://www.blackhawk-dsp.com
	$299
Spectrum Digital	XDS510LC JTAG Emulator (part number 701902)
	http://www.spectrumdigital.com
	$249

6 References

For more information, see the following guides:

- *EightChannelBuck* – provides detailed information on the EightChannelBuck project within an easy to use lab-style format.
  C:\TI_28xxx_SysSW\EightChannelBuck\~Docs\EightChannelBuck.pdf
- *QSG-EightChannelBuck-GUI* – gives an overview on how to demo the EightChannelBuck project quickly using an intuitive GUI interface.
  C:\TI_28xxx_SysSW\EightChannelBuck\~Docs\QSG-EightChannelBuck-GUI.pdf
- *EightChBuck-HWdevPkg* – a folder containing various files related to the hardware on the DC/DC Developer's Kit board (schematics, bill of materials, Gerber files, PCB layout, etc). All schematics and PCB files created with the freeware ExpressPCB package.
  C:\TI_28xxx_SysHW\EightChBuck-HWdevPkg\
- F28x User's Guides http://www.ti.com/f28xuserguides

Trademarks

TMS320C2000, TMS320C28x, PowerTrain, Code Composer Studio, C2000 are trademarks of Texas Instruments.

Blackhawk is a trademark of EWA Technologies, Inc.

All other trademarks are the property of their respective owners.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Clocks and Timers	www.ti.com/clocks	Digital Control	www.ti.com/digitalcontrol
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated