Digital Power Experimenter Kit

1 Overview

A great way to experiment and learn about digital power control, the Digital Power Experimenter Kit contains a power motherboard which accepts any of the plug-in controlCARDs. It is based on the TI PowerTrain™ modules, small and efficient 10-Amp synchronous buck power stages, which are directly interfaced with and controlled by the TMS320F28x digital signal controller (DSC). The kit is self-contained, providing a static or an active (switched) load. Voltage measurements of both outputs can be taken with the built-in digital voltmeter. 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.

Features of the Digital Power Experimenter Kit include:

- 10-Amp SyncBuck DC/DC power stages (no heat-sink required) with built in MOSFET drivers
- Active load for transient response testing (switching timing controlled by ECAP peripheral)
- 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
- Closed loop digital control with voltage feedback using F28x on-chip ePWM and ADC
- Optional looped back ePWM signals, allowing ADC inputs to provide a simple scope to view waveforms in Code Composer Studio
- 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.

For more information and ordering info, visit www.ti.com/f28xkits

CAUTION

During experimentation the power resistors (Load1 – see Hardware overview) may become very HOT if Ch-1 output voltage is left running for extended time (avoid if possible). Injury may result if you touch the resisters before allowing them to cool down first.

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PowerTrain is a trademark of Texas Instruments.

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2 Getting Started

2.1 Hardware Components

The Digital Power Experimenter Kit consists of two identical buck power stages. The input bus voltage for both stages is 9 V. Figure 1 is a diagram of the Digital Power Experimenter board and some key features.

Figure 1. Hardware Components

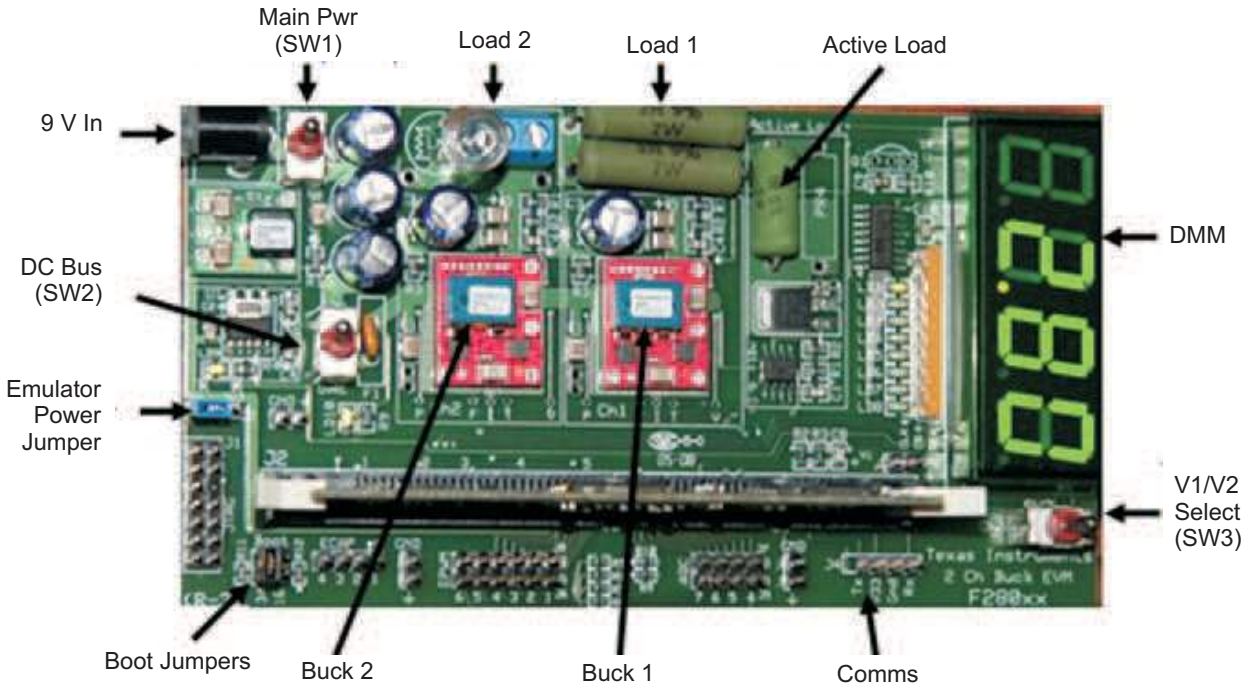


Table 1. Hardware Components

Component	Description
9 V In	DC power supply from plug pack (12-V supply may be used as well)
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, 2	Buck power stage modules with temperature/current measurement and over current protection
Load 1	Buck converter output for Channel 1 is tied to two 2 Ω resistors in parallel. If desired, load 1 can be desoldered and a terminal block as in Channel 2 can be reinstalled.
Load 2	Load terminals and/or buck converter output - next to each terminal block is a light bulb or “visual” load (these draw approx 250 mA hot)
Active Load	Software controlled switched load (connected to output of buck 1 only)
DMM	Digital Multi-Meter has a range of 0~20 V, with resolution of 10 mV and is used to measure output voltage of buck converters)
V1/V2 Select	SW3 - selects the display of the DMM between output voltage of buck 1 and 2
Comms	Serial communications UART (connects to an optional GUI, not used in lab exercises)
Emulator Power Jumper	Sets the voltage sent to power the emulator. No jumper means no power will be sent to an emulator, a jumper at 5V powers 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 boots from flash. If a jumper is placed at 34, the target boots from the SCI If a jumper is placed at 29 and 34, the target boots from RAM

2.2 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™ (CCStudio) 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 CCStudio Watch Window and slider features during emulation in the second mode.
2. CCStudio Software Development Platform – With the project code provided, the application can be modified, compiled, loaded and run in a development environment. CCStudio 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.

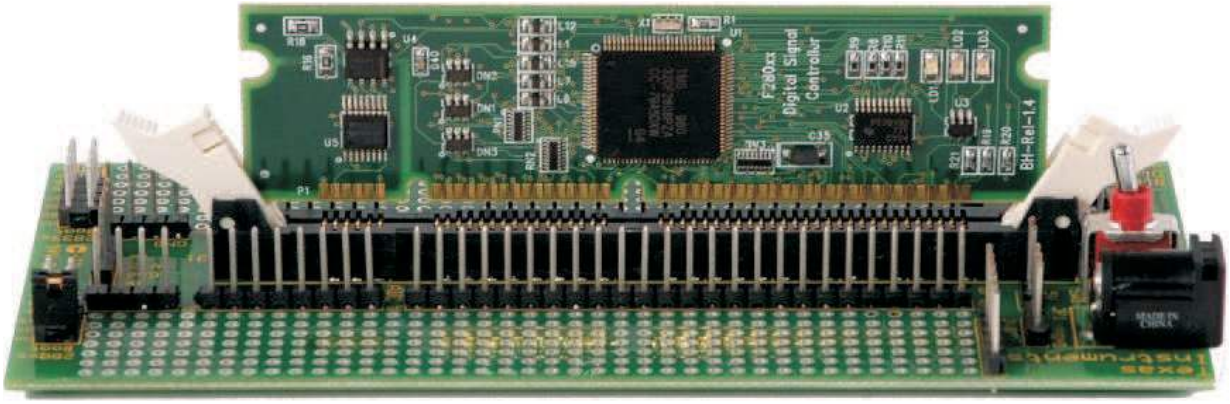
Step 2. Spread open the winged retaining clips on connector J2.

Step 3. Sit the DIMM card loosely in the connector slot. Make sure to align the 2 keyed notches 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. (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.

Figure 2. Card Retaining Clips



2.2.1 Test Drive With GUI

If you need only emulation support, you can skip this set of steps.

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 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 Setup GUI-TestDrive.

2.2.2 CCStudio 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 Setup CCS-Development.

Note: For full details (schematics, pin-out table, etc) of the hardware, see the Hardware Developer's Package, TwoChBuck-HWdevPkg. See Section 2.3 for download location.

2.3 Software Set Up

The Digital Power Experimenter Kit application software example, GUI, step-by-step lab style documentation, and other useful soft collateral can all be found on the TI website. If you already have your own software project and don't require this collateral skip this section. As explained in the HW set-up section, the target mother board can be run either with the GUI or CCStudio. 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 CCStudio, first you must install the baseline code that contains the header files, libraries, etc. If you already have the baseline software installed, skip the baseline install steps and go to the Digital Power Experimenter 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 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 Setup.
f. The installer will create the default directories shown in Figure 3.

Figure 3. Directory Structure

```
C:\TI_F28xxx_SysSW
  ~ Docs
  ~ GeneralPurposeGUI
  ~ SupportFiles
  FlashingLeds

C:\TI_F28xxx_SysHW
    CC280xxHWdevPkg
    CC2833xHWdevPkg
    DockingStnHWdevPkg
```

Step 2. Digital Power Experimenter Kit soft collateral and hardware documents

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

Figure 4. Directory Structure

```
C:\TI_F28xxx_SysSW
    ~ SupportFiles
        lib
            PowerLib

        TwoChannelBuck
            ~ Docs
            ~ GUI
C:\TI_F28xxx_SysHW
    TwoChBuck-HWdevPkg
```

2.4 Running the Application

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

1. TestDrive-GUI
   a. Open the GUI Quick Start Guide, QSG-TwoChannelBuck-GUI.pdf, found in: C:\TI_F28xxx_SysSW\TwoChannelBuck\~Docs\
   b. Browse to the directory: C:\TI_F28xxx_SysSW\TwoChannelBuck\~GUI
   c. Open TwoChannelBuck-GUI.exe
   d. Follow the step-by step instructions found in the Quick Start Guide
2. CCS-Development
   a. If you have emulation tools and Code Composer Studio (CCS) already installed and active, load the project file “TwoChannelBuck.pjt” found in: C:\TI_F28xxx_SysSW\TwoChannelBuck\
   b. See the TwoChannelBuck.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\TwoChannelBuck\~Docs\

2.5 Emulators

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

Blackhawk®	USB2000 Controller (part number BH-USB-2000) http://www.blackhawk-dsp.com $299
Spectrum Digital	XDS510LC JTAG Emulator (part number 701902) http://www.spectrumdigital.com $249

3 References

For more information, see the following guides:

- TwoChannelBuck – provides detailed information on the TwoChannelBuck project within an easy to use lab-style format.
  C:\TI_28xxx_SysSW\TwoChannelBuck\~Docs\TwoChannelBuck.pdf
- QSG-TwoChannelBuck-GUI – gives an overview on how to quickly demo the TwoChannelBuck project using an intuitive GUI interface.
  C:\TI_28xxx_SysSW\TwoChannelBuck\~Docs\QSG-TwoChannelBuck-GUI.pdf
- TwoChBuck-HWdevPkg – a folder containing various files related to the hardware on the Digital Power Experimenter 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\TwoChBuck-HWdevPkg\
- System Framework Overview Guide – presents more information on the system framework found in F28xxx EVM projects.
  C:\TI_28xxx_SysSW\~Docs\SystemFrameworkOverview.pdf
- F28xxx User’s Guides :
  http://www.ti.com/f28xuserguides

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