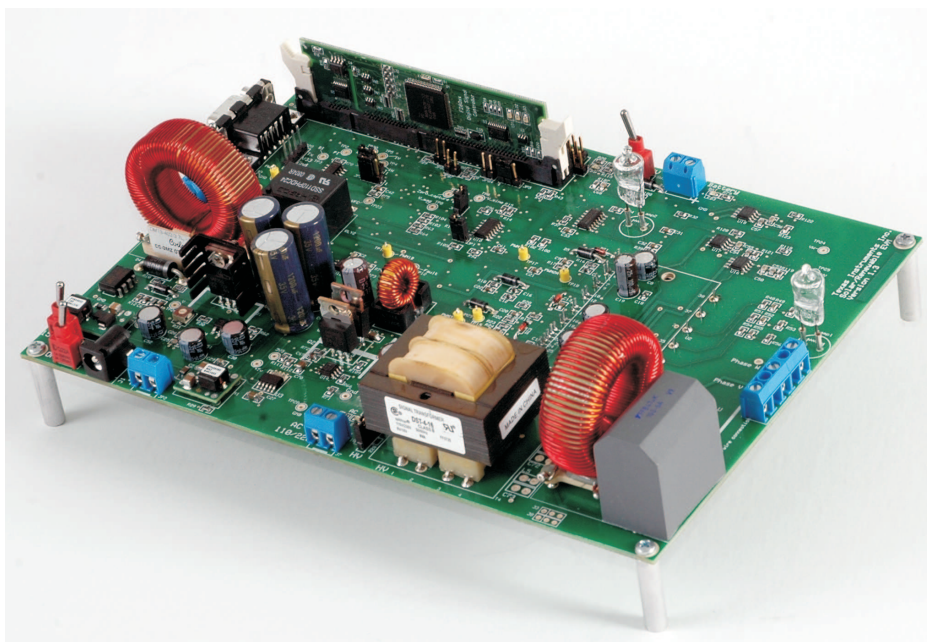


Renewable Energy Developer's Kit Overview

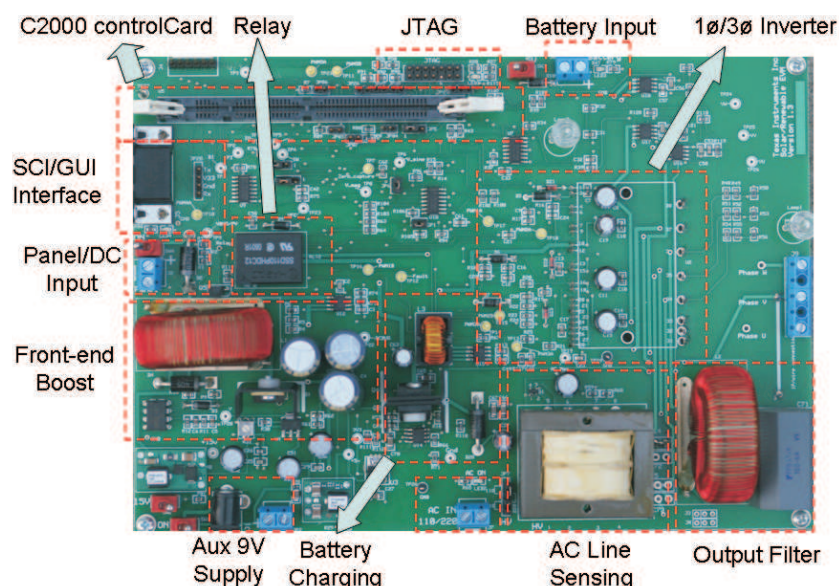


This document describes the Renewable Energy Developer's Kit evaluation board designed to work with Texas Instruments C2000™ microcontrollers. This kit is a part of TI's digital power tools package designed to give customers an opportunity to quickly evaluate TI C2000 products for power conversion applications at a safe input voltage and power level. The Renewable Energy Developer's Kit contains a motherboard which accepts any of the plug-in controlCARDS™. This system allows implementing all the major functions of a solar and/or a renewable energy system. These functions include front-end DC to DC conversion, three or single phase inverter operation, synchronizing inverter output with the AC line, and DC to DC buck operation for possible battery charging. This board offers all the voltage and current measurement hooks so that one can create and test new topologies, techniques etc. Features of the Renewable Energy Developer's Kit include:

- Compatibility with any of the plug-in C2000 controlCARDS.
- Front-end DC/DC boost converter.
- Three phase or single phase inverter output.
- DC/DC buck converter for battery charging.
- Hardware relay to switch between panel/DC source and battery supply.
- AC line (110 V or 220 V) synchronization for the inverter output.
- Voltage and current measurements via ADC.
- Closed loop digital control with feedback using F28x on-chip ePWM and ADC.
- UART communications header available for host control.
- A learning platform allowing the user to easily probe the most significant wave forms within a board that is laid out conservatively and contains many test points.
- 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.

1 Hardware Overview

Shown below is a picture of the Renewable Energy board that identifies the key components.



Auxiliary Supply	A 9 V auxiliary supply (included) connection at J1 to power the control and drive circuit. Optional 5-V supply connection at J1 to only power the control circuit
DC-DC Boost Section	Front-end single phase DC/DC boost converter
Panel/DC Input	Input Panel/DC voltage up to 20 V at J2.
12-V Battery	12-V Battery connection at J6.
Charging Section	DC/DC buck converter for battery charging.
Inverter Section	Single-phase or three-phase inverter operation. Output filter provided for single phase output.
110/220-V AC I/P	110/220-V _{ac} input for line sensing/synchronization at connector J7. Default jumper setting at JP7 selects 110-V _{ac} input configuration.
Boot Jumpers	Controls how the F280x will boot. (J34) <ul style="list-style-type: none"> If no jumpers are placed the target will boot from flash. If a jumper is placed the target will boot from the SCI.

2 Hardware Setup

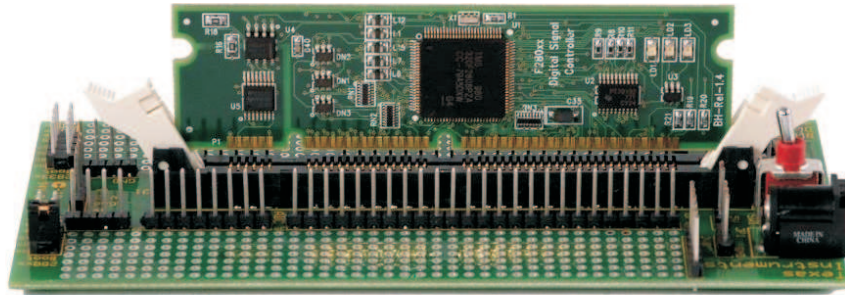
To be able to run the various software builds for the projects included in this package, a 12/20-V DC regulated bench power supply and an emulator are required apart from the hardware included in this package (suggested emulators are listed near the end of this document). The application-specific motherboard provided in this kit can be used in one of two ways:

- **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 graphing features during emulation in the second mode.
- **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.

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

1. Unpack the DIMM style controlCARD.
2. Spread open the winged retaining clips on controlCARD U5 connector.
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).

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).



Test Drive with GUI – (skip this if you need only emulation support)

1. Plug in the provided DB9 serial cable to connector J5.
2. Insert a jumper at JP34 to Boot from SCI.
3. Plug the DB9 connector into your PC using either a serial port or a serial-to-USB converter dongle.
4. Turn on the power once you are done with the TI software download, see Software Setup GUI-TestDrive.

CCStudio Software Development Platform Emulation - additional steps

1. Connect the JTAG emulator cable to the JTAG connector.
2. See Software Setup CCS-Development.

Note: For full details (schematics, pin-out table, etc) of the hardware please refer to the Hardware Developer's Package, Renewable-HWdevPkg. See [Section 3](#) for download location.

3 Software Setup

The Renewable Energy Kit application software example, GUI, documentation, and other useful soft collateral can all be found 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 HW setup 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. Please follow the steps below for either case.

To run any of the application-specific software in CCStudio, you will first need to install the baseline code that contains the header files, libraries, etc. If you already have the base-line software installed, skip the base-line install steps and go to the Renewable Energy Kit section.

Baseline soft collateral and hardware documents (skip this if you already have this software installed). To download the free TI soft collateral follow these steps:

1. On an Internet browser type: <http://www.ti.com/c2000tools>
2. At the C2000 collateral page choose the "Renewable Energy Developer's Kit Baseline Software" link.
3. Save the .zip file to the directory of your choice.
4. Unzip the file and run the install program Baseline Software Setup.
5. The installer will create the following default directories:

C:\TI_F28xxx_SysSW

~Docs

~GeneralPurposeGUI

~HexConverterUtility

~SupportFiles

FlashingLeds

C:\TI_F28xxx_SysHW

CC280xxHWdevPkg

CC2833xHWdevPkg

DockingStnHWdevPkg

Renewable Energy Kit soft collateral and hardware documents

1. On an Internet browser type: <http://www.ti.com/c2000tools>
2. Then choose the “Renewable Energy Kit Board Specific Software” link.
3. Save the .zip file to the directory of your choice.
4. Unzip the file and run the install program Renewable Energy Software Setup.
5. The installer will create the following default directories:

C:\TI_F28xxx_SysSW

~SupportFiles

lib

PowerLib

Renewable

~Docs

~GUI

C:\TI_F28xxx_SysHW

Renewable-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.

1. TestDrive-GUI

- Open the GUI Quick Start Guide, QSG-Renewable-GUI.pdf, found in:
C:\TI_F28xxx_SysSW\Renewable\~Docs\
- Browse to the directory: C:\TI_F28xxx_SysSW\Renewable\~GUI
- Open Renewable-GUI.exe
- Follow the step-by step instructions found in the Quick Start Guide

2. CCS-Development

- If you have emulation tools and Code Composer Studio (CCS) already installed and active, load the project file “Renewable.pjt” found in: C:\TI_F28xxx_SysSW\Renewable\
- Please refer to the corresponding (Renewable.pdf) user guide for a step-by-step walk through of how to compile and run the various labs. This document can be found in the corresponding documents folder for the project ...\\~Docs\

5 Emulators

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

Blackhawk™

USB2000 Controller (Blackhawk part number BH-USB-2000, TI part number TMDSEMU2000U)

<http://www.blackhawk-dsp.com>

<http://www.ti.com/c2000tools>

\$299

Spectrum Digital

XDS510LC JTAG Emulator (part number 701902)

<http://www.spectrumdigital.com>

\$249

6 References

For more information please see the following guides:

- Renewable – provides detailed information on the Renewable Energy project within an easy to use lab-style format. C:\TI_28xxx_SysSW\ Renewable\~Docs\ Renewable.pdf
- QSG-Renewable-GUI – gives an overview on how to quickly demo the Renewable Energy project using an intuitive GUI interface. C:\TI_28xxx_SysSW\ Renewable\~Docs\QSG-Renewable-GUI.pdf
- Renewable-HWdevPkg – a folder containing various files related to the hardware on the Renewable Energy Kit board (schematics, bill of materials, Gerber files, PCB layout, etc). C:\TI_28xxx_SysHW\ Renewable-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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Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
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