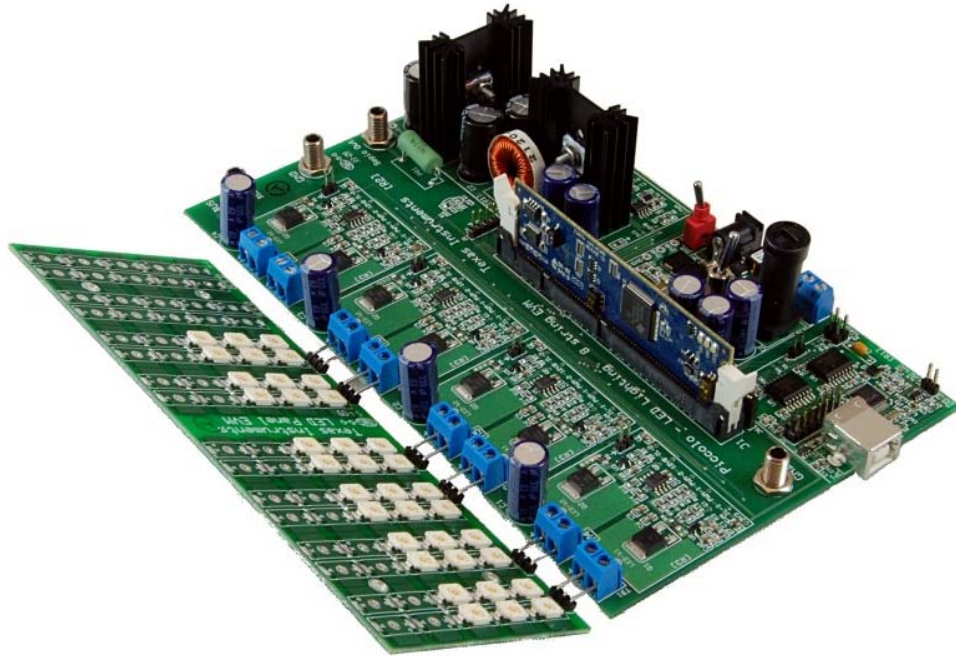


# DC/DC LED Lighting Quick Start Guide

Version 1.1 – April 2010



The document provides instructions to run a GUI that controls the DC/DC LED Lighting Developer's Kit board using the Piccolo F28035 microcontroller.

## **Contents of the DC/DC LED Lighting Developer's Kit:**

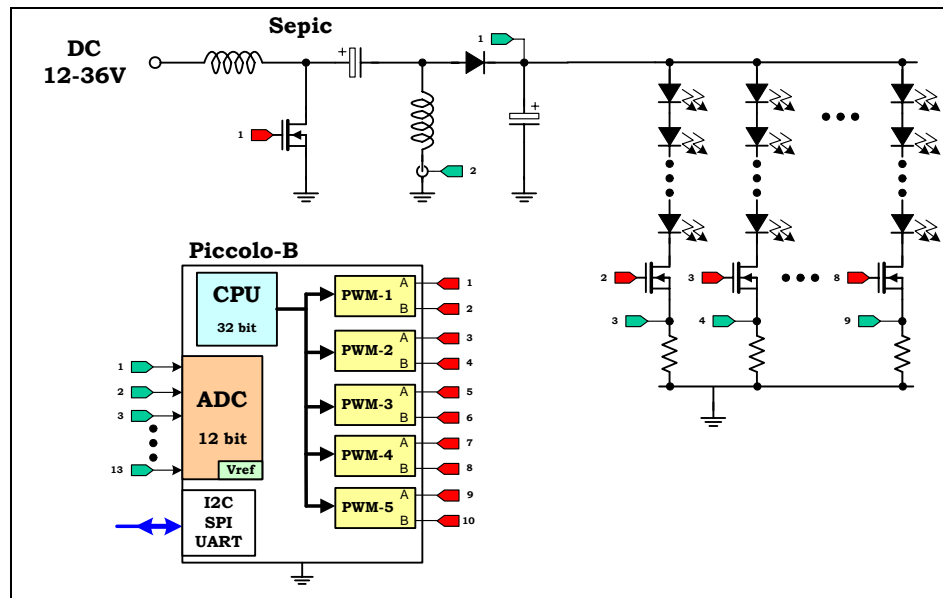
- DC/DC LED Lighting power board
- Piccolo F28035 controlCARD
- LED panel
- 12V power adapter
- Banana Plug Cable
- USB Cable
- USB drive with GUI executable
- CCS4 Installation CD

## **Features of the DC/DC LED Lighting Developer's Kit:**

- Independent closed-loop brightness control of 8 LED strings (6 string included with kit) with PWM dimming
- Closed-loop voltage control of the LED bus using a shared SEPIC stage
- On-board isolated JTAG emulation
- Over-current and over-voltage protection for the SEPIC stage using the F28x trip-zone (TZ) submodule
- UART communication available for host-control
- Hardware Developer's Package is available and includes schematics, bill of materials, Gerber files, etc.

## Overview

The DC/DC LED Lighting Developer's Kit takes in 12 to 36V DC. This voltage is then regulated to a different level by a SEPIC converter. SEPIC, as a buck-boost topology, is able to increase or decrease the input voltage. For our application, we will be setting the SEPIC output voltage to approximately 20V independent of the board input. The SEPIC output is then connected to each of the LED strings. To perform independent LED string dimming, a MOSFET is placed in series with each string and the on-time of this string's MOSFET will control the average current through an LED string. Since the brightness of an LED is roughly proportional to the LED current we use the duty cycle of each string's PWM to control the average current drawn. The figure below illustrates the hardware present on the DC/DC LED Lighting Developer's Kit.



A typical power conversion board is made up of several power stages. On the Lighting\_DCDC board, each of these power stages take the form of a macro section. Each of these macro sections is bounded by its own silkscreen area. Below is a list of all the macro blocks' names and a short description of its function. Refer to the image on the next page for placement of macro areas.

- **Lighting\_DCDC Main Board - [Main]** – consists of controlCARD socket, a few communications jumpers and the routing of signals between the controlCARD and the macro blocks. This section is all of the area outside of the macro blocks.
- **DC-PwrEntry Macro – [M1]** – generates the 15V, 5V, and 3.3V DC rails from a 12V supply included with the kit or an external DC power supply.
- **Isolated-USB-to-JTAG Macro – [M2]** – provides on-board isolated JTAG connection through USB to the host. Is also used to provide isolated SCI (UART) communication for connection with the GUI.
- **Sepic-LV Macro – [M3]** – a SEPIC DC/DC conversion stage, used to increase or decrease the input voltage to the voltage needed by the LED strings.
- **LED-dimming Macro – [M4]-[M7]** – stages used to individually dim an LED string. Each macro consists of the components needed to control two strings.

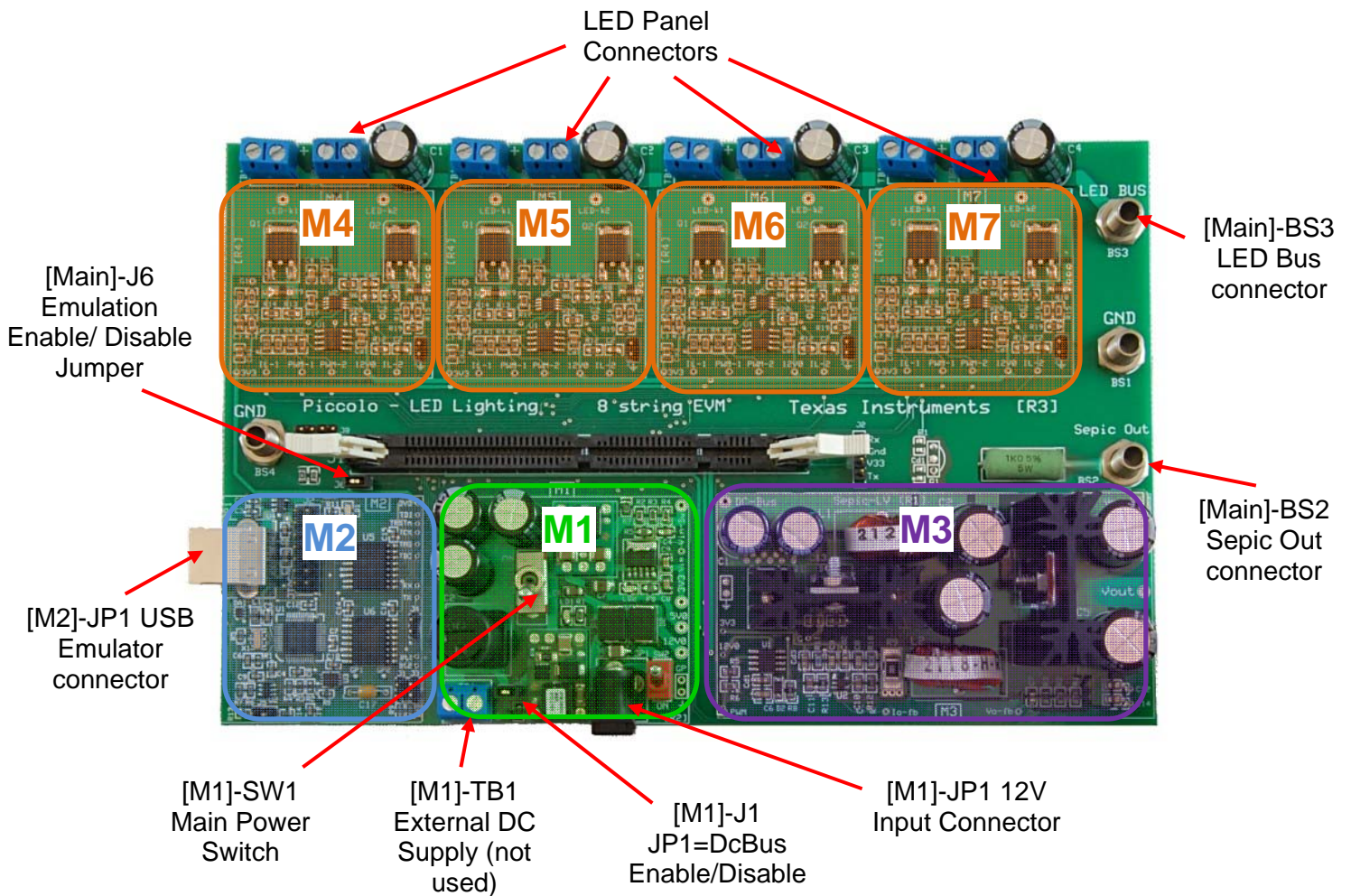
In this guide, each component is named first with their macro number followed by the reference name. For example, [M2]-J1 would refer to the jumper J1 located in the macro M2 and [Main]-J1 would refer to the J1 located on the board outside of the other defined macro blocks.

## Quick Start GUI

This kit comes with a GUI which provides a convenient way to evaluate the functionality of this kit and the F28035 device without having to learn and configure the underlying project software or install Code Composer Studio. The interactive interface using sliders, buttons, and textboxes allows LED lighting with the C2000 device to be demonstrated quickly and easily.

## Hardware Setup

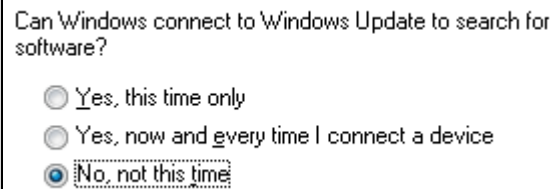
Listed below are some of the major connectors and features of the DC/DC LED Lighting board.



- 1) On the Piccolo F28035 controlCARD, check the following switches:
  - SW1, make sure this switch is in the “off” (down) position
  - SW2, make sure position 1 and 2 are both in the “on” (up) position.
- 2) Put a F28035 control card into the socket on the LED Lighting board and connect a cable from the USB connector on the board to the computer. [M2]-LD1, near the LED Lighting board’s USB connector, should turn on.

**NOTE:** If Code Composer Studio has never been installed, it may be necessary to install drivers to make the board work correctly. If a popup comes up when the USB cable is connected from the board to the computer, have the install wizard install drivers from the XDS100v1 directory of the USB drive included with this kit.

- 1) When Windows asks to search Windows Update, select “No, not at this time” and click Next



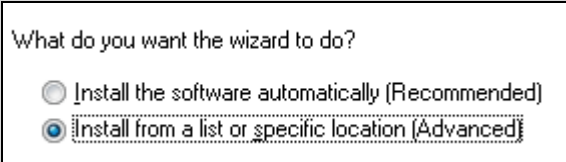
Can Windows connect to Windows Update to search for software?

Yes, this time only

Yes, now and every time I connect a device

No, not this time

- 2) On the next screen select “Install from specific location” and click Next

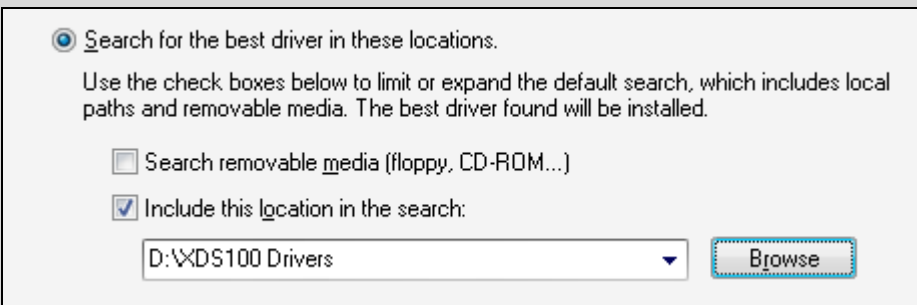


What do you want the wizard to do?

Install the software automatically (Recommended)

Install from a list or specific location (Advanced)

- 3) Select “Search for Best Driver”, uncheck search removable media, and check include specific location and browse to [USB Drive]:\XDS100 Drivers



Search for the best driver in these locations.

Use the check boxes below to limit or expand the default search, which includes local paths and removable media. The best driver found will be installed.

Search removable media (floppy, CD-ROM...)

Include this location in the search:

D:\XDS100 Drivers

- 4) Click next and the drivers will be installed. The driver install screen will appear three times, repeat this procedure each time.

- 3) Connect the LED panel to the LED Lighting board via [Main]-TB1 to TB8.
- 4) Connect or verify the following:
  - Connect a jumper on [M1]-J1.
  - Connect a jumper on [M2]-J4.
  - Remove any jumpers placed on [Main]-J6.
- 5) Connect the banana-to-banana plug wire that came with the kit between the SEPIC out Connector (BS2) and the LED Bus connector (BS3)
- 6) Place [M1]-SW2 into the off position. This switch will not be used in this demonstration.
- 7) Connect a 12V power supply to power up to [M1]-JP1 of the board. Turn [M1]-SW1 to the on position. When on, [M1]-LD1 and [M1]-LD2 should turn on.

## Software Setup

The GUI used to conveniently evaluate the kit can be found on the USB drive that is included with this kit. It is named Lighting\_DCDC.exe. This .exe is all the software necessary to do a quick evaluation of this kit. To explore deeper, the underlying reference software can be found as a Code Composer Studio project within controlSUITE.

**NOTE:** The GUI requires Microsoft .NET framework 3.0 to run. Please ensure that this software is installed prior to running this program.

To install the CCS4 project built to run with this kit, use the most up-to-date software, and find all reference software for the C2000 MCU, please install controlSUITE. It can be downloaded at:

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

Once controlSUITE is installed, the GUI mentioned in this guide can be found at the following location:

*controlSUITE/development\_kits/Lighting\_DCDC\_vX.X/~GUI/Lighting\_DCDC.exe*

The source code for this GUI was written in C# using Microsoft Visual Studio .NET and can be found at:

*controlSUITE/development\_kits/Lighting\_DCDC\_vX.X/~GUI/~Source/*

The kit ships with a F28035 controlCARD that has been pre-flashed with the code that enables it to run with the GUI that comes with this kit. If for any reason, the software needs to be reflashed so that it works with the GUI again, this flash image can be found at:

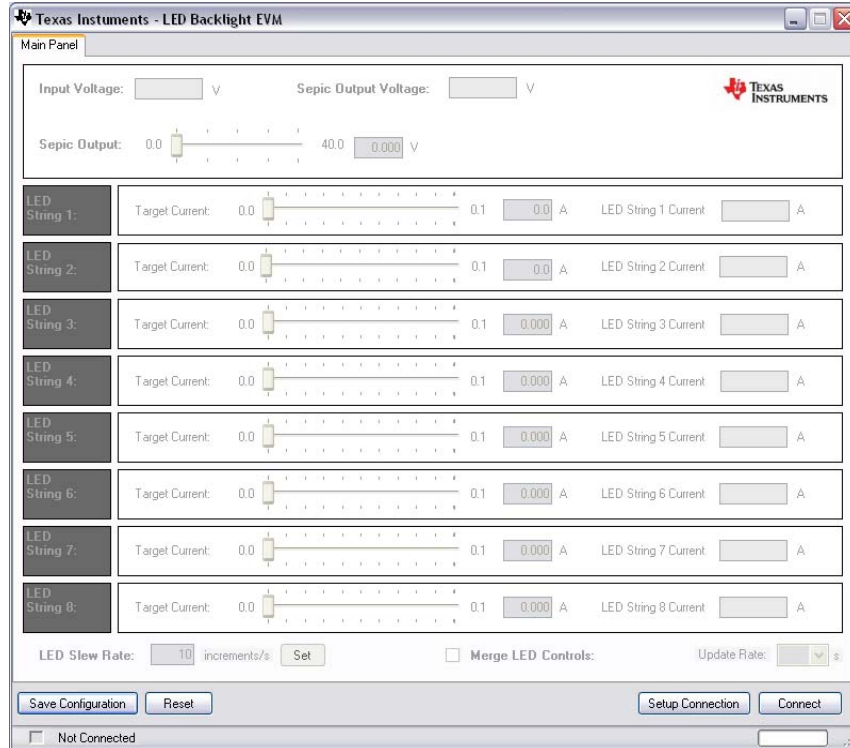
*controlSUITE/development\_kits/Lighting\_DCDC\_vX.X/~GUI/Lighting\_DCDC-FlashImage\_v1.0.out*

The underlying Code Composer Studio 4 project documentation and how to run guide can be found at:

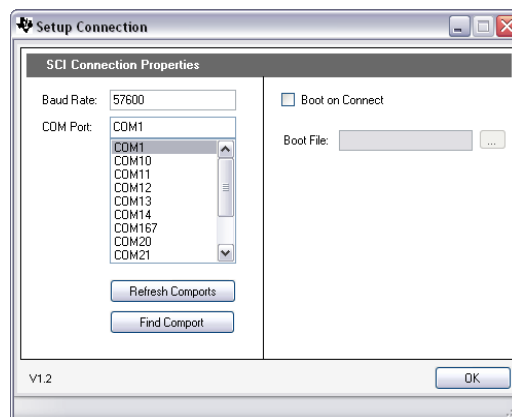
*controlSUITE/development\_kits/Lighting\_DCDC\_vX.X/Lighting\_DCDC/~Docs/Lighting\_DCDC.pdf*

## Running the GUI

- 1) Browse to and double-click on Lighting\_DCDC.exe. If this is the first time that the GUI is run, the GUI will ask the user to read a license agreement. Assuming that the license is accepted, the image below should be seen:



- 2) Click "Setup Connection" on the GUI and ensure the Baud Rate is set to 57600 and that the "Boot on Connect" Box is unchecked.



- 3) Next you will need to select your serial comport. This can be found by going to:

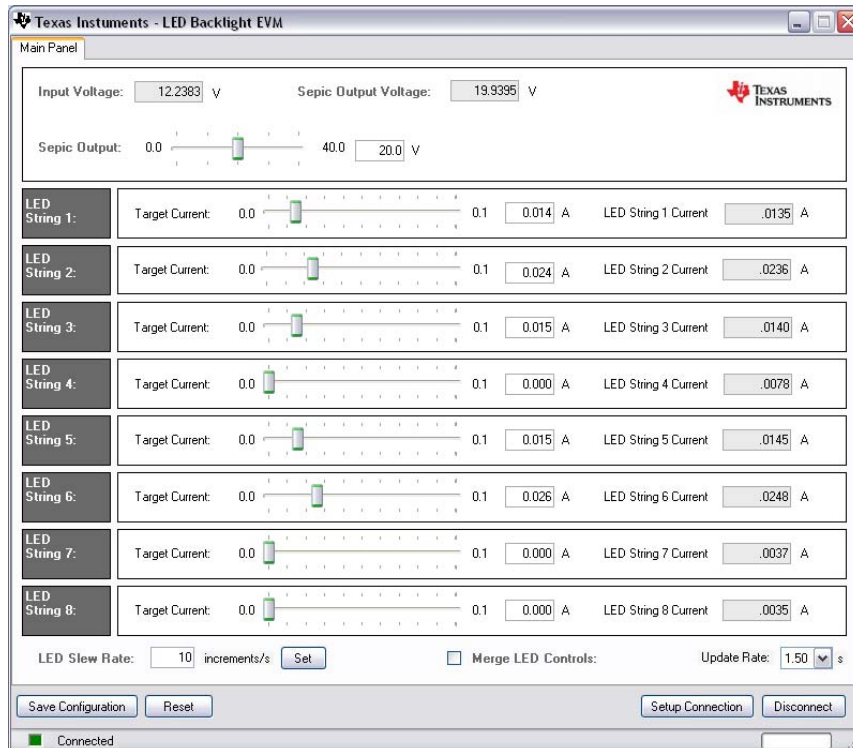
*Control Panel->System->Hardware tab->Device Manager->Ports(COM & LPT)*

Look for the comport that is named "USB Serial Port" or similar, then select this comport in the "Setup Connection" window.

- 4) Click “OK”. This will close the “Setup Connection” window.
- 5) Turn on the board by switching [M1]-SW1 to the “ON” position.
- 6) On the Main Window click “Connect”. When connected the status bar at the bottom left of the GUI should say “Connected”.
- 7) Move the “Sepic Output” slider to approximately 20V. This sets the reference that the controller will try to regulate the output of the Sepic to.
- 8) Change the value of LED string 1’s target current to 0.04A. Note that the “LED String 1 Current” ramps until it reaches approximately 0.04A.
- 9) Edit the other strings’ target currents as desired. Note that average LED current draw is proportional to LED lumen output for most high brightness LEDs. Therefore, in this program, the brightness of the LEDs is being controlled.

**NOTE:** Near the bottom of the GUI there is a checkbox control named “Merge LED controls”. This control enables/disables individual control of each LED string and has the controller try and output the same current for each string. This reference is set by a slider.

**NOTE:** There will be some variation from LED to LED from 0.0 to approximately 0.02A. This is because the LEDs used are not guaranteed, from the manufacturer, to be identical until the LED current is greater than 0.05A.



- 10) When finished, set the “Sepic Output” to 0V then click “Disconnect”.
- 11) Power off the board by switching [M1]-SW1 to the off position.

## References

For more information please see the following guides:

- **Lighting\_DCDC** – provides detailed information on the CCS4 Lighting\_DCDC project within an easy to use lab-style format.  
*C:\TI\controlSUITE\development\_kits\Lighting\_DCDC\_vX.X\Lighting\_DCDC\~Docs\Lighting\_DCDC.pdf*
- **Lighting\_DCDC-HWdevPkg** – a folder containing various files related to the hardware on the Motor Control and PFC Developer's Kit board (schematics, bill of materials, Gerber files, PCB layout, etc).  
*C:\TI\controlSUITE\development\_kits\Lighting\_DCDC\_vX.X\~Lighting\_DCDC-HwdevPkg\*
- **Lighting\_DCDC-HWGuide** – presents full documentation on the hardware found on the Lighting\_DCDC board.  
*C:\TI\controlSUITE\development\_kits\Lighting\_DCDC\_vX.X\~Docs\Lighting\_DCDC-HWGuide.pdf*