Multi-DC/DC Color LED Kit Hardware

This reference guide goes over kit contents and the kit hardware details and explains the functions and locations of jumpers and connectors present on the board. This document supersedes all of the documents available for the hardware of this kit.

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1 Introduction

The multi-DC/DC color LED kit provides a great way to learn and experiment with using a single MCU to accurately control a series of LED strings and efficiently control the power stages needed to make the LEDs work.

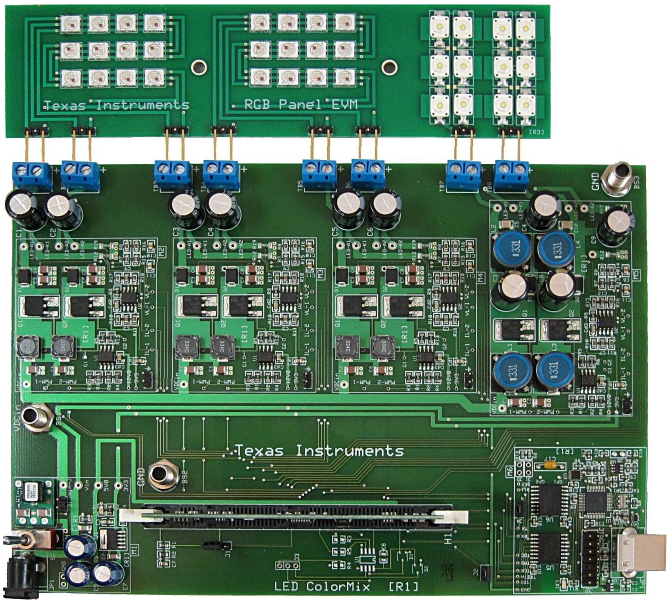

Figure 1. Picture of the Multi-DC/DC Color LED Kit Board (TMDSRGBLEDKIT)

WARNING

This evaluation module (EVM) is meant to be operated in a lab environment only and is not considered by TI to be a finished end-product fit for general consumer use.

This equipment operates at voltages and currents that can result in electrical shock, fire hazard and personal injury if not properly handled or applied. Use equipment with the necessary caution and appropriate safeguards employed to avoid personal injury or property damage.

2 Getting Familiar With the Kit

2.1 Kit Contents

The kit consists of:

- Multi-DC/DC Color LED Kit power board
- Piccolo™ F28027 controlCARD
- Color RGB LED panel with diffuser cover
- 12-V power adapter
- USB cable
- USB drive with graphical user interface (GUI) executable and Code Composer Studio™ (CCS) v4 software

The board can accept any of the C2000™ series controlCARDs. An F28027 control card is shipped with the kit. Some software changes may be necessary to have the board work with a different controlCARD.

2.2 Kit Features

The kit has the following features:

- Power board with eight independently controlled power stages (6×Boost, 2×SEPIC), each capable of providing both voltage and current feedback
- LED panel with two RGB LED strings and two white LED strings
- Onboard isolated JTAG emulation
- Isolated universal asynchronous receiver/transmitter (UART) communication through the serial communications interface (SCI) peripheral and FTDI chip
- Hardware developer's package is available and includes schematics, bill of materials (BOM), Gerber files, and so on

2.3 Kit Specifications

The multi-DC/DC color LED kit has the following specifications: (1)

(1) Hardware component-based limitations.

Table 1. Power Board Specifications (at Maximum(1))

INPUT	OUTPUT
36-V DC 350 mA per stage	50-V DC 650 mA per stage

(1) The DC input for the board should be chosen based on the specifications of the attached LED panel. When using the LED panel included in the kit, if the demo-mode jumper [M1]-J1 is not populated, a DC input range of 12 to 18 V is recommended. If the demo-mode jumper is populated, use a 12-V DC input to prevent damage to board components.

Table 2. LED Panel Specifications

RGB LED STRINGS	WHITE LED STRINGS
12 LEDs 400 mA per color (max)	6 LEDs 1 A (max)

3 Hardware Overview

Figure 2 illustrates an LED lighting system running from DC power.

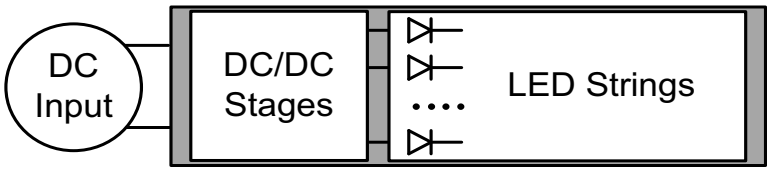

Figure 2. Block Diagram for an LED Lighting Application

There are multiple ways of controlling LEDs. On this board, use the C2000 to control a separate DC supply for each of the LED strings. Control the brightness by using the C2000 by varying the output power of each DC/DC stage independently, which allows us to control the average current passing through each LED string. Since average current is roughly proportional to lumen output, each LED string's brightness is controlled.

3.1 Macro Blocks

The multi-DC/DC color LED board is divided into functional groups referred to as macro blocks. The following is a list of the macro blocks present on the board and a brief description of each:

Main board [Main]— Contains the controlCARD socket, power connectors, jumpers, and the routing of signals between the controlCARD and the macro blocks. This section includes any area outside of other defined macro blocks.

DC-PwrEntry macro [M1]— Generates the 12-V, 5-V, and 3.3-V DC power rails from a 12-V DC supply included with the kit or an external DC power supply.

Dual boost macro [M2],[M3], and [M4]— Consists of two independent boost DC/DC conversion stages with voltage and output current feedback, per macro instance.

Isolated-USB-to-JTAG macro [M6]— Provides an onboard isolated JTAG connection through USB to the host as well as isolated SCI (UART) communication.

Dual SEPIC macro [M5]— Consists of two independent SEPIC DC/DC conversion stages with voltage and output current feedback.

Figure 3 illustrates the position of these macro blocks on the board. The use of a macro block approach for different power stages enables easy debug and testing of one stage at a time. All of the pulse width modulator (PWM) and analog-to-digital converter (ADC) signals have designated test points on the board, which makes it easy for an application developer to not only debug but try out new algorithms and strategies.

Nomenclature: A component on the board is referred to with a macro number in the brackets followed by a dash and the reference number. For example, [M2]-J1 refers to the jumper J1 located in the macro M2, and [Main]-J1 refers to the jumper J1 located on the board outside of the defined macro blocks.

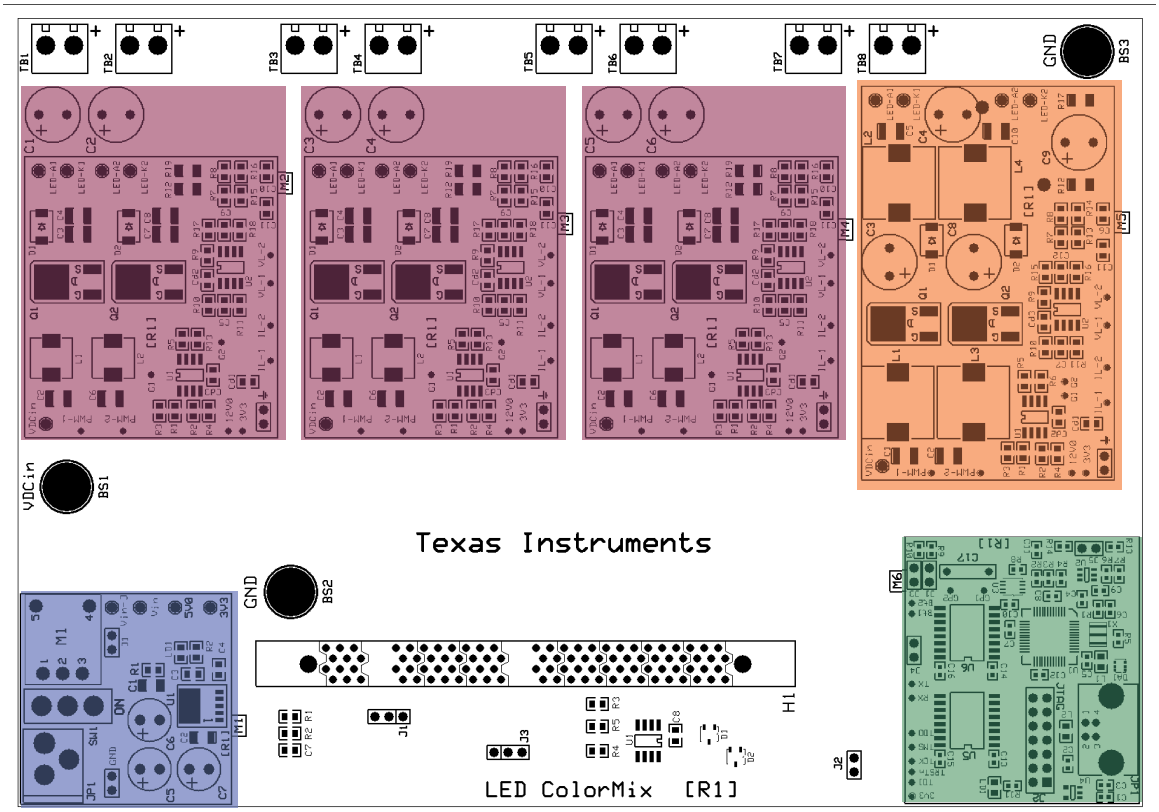

Figure 3. Multi-DC/DC Color LED Board Macro Block Locations

Table 3. Macro Block Locations Legend

[Main] – controlCARD socket, power connectors, and jumpers
[M1] – 12-V, 5-V, and 3.3-V DC power rails
[M6] – Isolated JTAG and SCI (UART) communication via USB
[M2],[M3], and [M4] – Two independent Boost stages, per macro instance
[M5] – Two independent SEPIC stages

3.2 Powering the Board

The DC/DC LED Lighting board has two separate power domains and two major modes of operation. The two power domains are the primary power rail, which feeds the eight DC/DC power stages, and the auxiliary power rail, which powers all of the support chips along with the MCU. The question of which mode of operation to use depends on if the board is being used to evaluate or experiment.

WARNING

Always use caution when using the board's electronics.

- Demo Mode – used to quickly show how the boards functions. All power used by the board is provided from a single 12-V DC power supply. The CE marked, 12-V, 2-A power supply that is included with the Multi-DC/DC Color LED Kit is ideal for this mode.
  - Demo-mode enable jumper [M1]-J1 should be populated
  - A 12-V DC supply should be connected to either [M1]-JP1 or [Main]-BS1, but not both
- Experimentation Mode – uses two different power supplies to minimize the risk of damage caused while experimenting. The primary and auxiliary power rails will each use a separate power supply. This mode allows the user to verify PWM output and ADC feedback signals before energizing the DC/DC power stages and helps protect the MCU if a fault occurs on the primary power rail. This mode also allows for more experimentation with how the eight DC/DC power stages work under different input voltages.
  - Demo-mode enable jumper [M1]-J1 should not be populated
  - A 12-V DC supply should be connected to [M1]-JP1
  - A separate 12-18V DC supply (or some other voltage chosen based on desired input/output power), should be connected to [Main]-TB1
  - [M1]-SW1 controls power to the MCU and support chips

3.3 Boot Modes

Table 4 describes the jumper and switch settings that are needed for booting from Flash and SCI for the board.

Table 4. Boot Options

DEVICE	BOOT FROM FLASH	BOOT FROM SCI (USING ISO JTAG MACRO)
F2802x	SW1 on controlCARD • Position 1 = 1 • Position 2 = 1 Remove the jumper [Main]-J2	SW1 on controlCARD • Position 1 = 1 • Position 2 = 0 Depopulate R10 on controlCARD Remove the jumper [Main]-J2 Populate the jumper [M6]-J4
F2803x	SW2 on controlCARD • Position 1 = 1 • Position 2 = 1 Remove the jumper [Main]-J2	SW2 on controlCARD • Position 1 = 1 • Position 2 = 0 SW3 on controlCARD should be off Remove the jumper [Main]-J2 Populate the jumper [M6]-J4

3.4 GUI Connection

The FTDI chip present on the board can be used as an isolated SCI for communicating with a host (for example, a PC). The following jumper settings must be done to enable this connection:

1. Populate jumper [M6]-J4.
2. Remove jumper [Main]-J2.
3. For F28035, put SW3 on the F28035 controlCARD to the *OFF* position. For F28027, verify that R10 on the controlCARD is removed.
4. Connect a USB cable from [M6]-JP1 to the host.

NOTE: To boot from Flash and connect using the GUI, use the proper *Boot from Flash* settings described in Table 4.

3.5 Ground Levels and Safety

Do not touch any part of the board or components connected to the board while energized.

The power stages on the board are individually rated. Make sure that these ratings (such as the voltage, current and power levels) are well understood and complied with prior to connecting these power blocks together and energizing the board or simulation.

4 Hardware Resource Mapping

4.1 Resource Allocation

Figure 4 shows the various stages of the board in a circuit diagram format and illustrates the major connections and feedback values being mapped to the C2000 MCU. Table 5 lists these resources. It is important to note that not all resources are available on every C2000 MCU. For example, Piccolo F28027 devices only have 13 ADC channels, so not all feedback signals are available for use even if they are routed to the DIM100 controlCARD socket. For more detailed information, see the schematics and device-specific data sheets.

Table 5. PWM and ADC Resource Allocation

MACRO NAME			SIGNAL NAME	PWM/ADC CHANNEL	DESCRIPTION
Main Board	[Main]	VDCin- meas	VDCin- meas	ADC-B4	Input voltage sense muxed with V-Led-4B
Dual Boost	[M2]	PWM-1	PWM-1A	PWM-1A	Boost 1 PWM signal
		PWM-2	PWM-1B	PWM-1B	Boost 2 PWM signal
		Vfb-1	V-Led-1A	ADC-B1	Boost 1 output voltage sense
		Vfb-2	V-Led-1B	ADC-B2	Boost 2 output voltage sense
		Ifb-1	I-Led-1A	ADC-A2	Boost 1 output current sense
		Ifb-2	I-Led-1B	ADC-A0	Boost 2 output current sense
Dual Boost	[M3]	PWM-1	PWM-2A	PWM-2A	Boost 3 PWM signal
		PWM-2	PWM-2B	PWM-2B	Boost 4 PWM signal
		Vfb-1	V-Led-2A	ADC-B3	Boost 3 output voltage sense
		Vfb-2	V-Led-2B		Boost 4 output voltage sense
		Ifb-1	I-Led-2A	ADC-A4	Boost 3 output current sense
		Ifb-2	I-Led-2B	ADC-A1	Boost 4 output current sense

Table 5. PWM and ADC Resource Allocation (continued)

MACRO NAME			SIGNAL NAME	PWM/ADC CHANNEL	DESCRIPTION
Dual Boost	[M4]	PWM-1	PWM-3A	PWM-3A	Boost 5 PWM signal
		PWM-2	PWM-3B	PWM-3B	Boost 6 PWM signal
		Vfb-1	V-Led-3A	ADC-B5	Boost 5 output voltage sense
		Vfb-2	V-Led-3B		Boost 6 output voltage sense
		Ifb-1	I-Led-3A	ADC-A6	Boost 5 output current sense
		Ifb-2	I-Led-3B	ADC-A3	Boost 6 output current sense
Dual SEPIC	[M5]	PWM-1	PWM-4A	PWM-4A	SEPIC 1 PWM signal
		PWM-2	PWM-4B	PWM-4B	SEPIC 2 PWM signal
		Vfb-1	V-Led-4A	ADC-B7	SEPIC 1 output voltage sense
		Vfb-2	V-Led-4B	ADC-B4	SEPIC 2 output voltage sense muxed with VDCin-meas
		Ifb-1	I-Led-4A	ADC-B6	SEPIC 1 output current sense
		Ifb-2	I-Led-4B	ADC-A7	SEPIC 2 output current sense

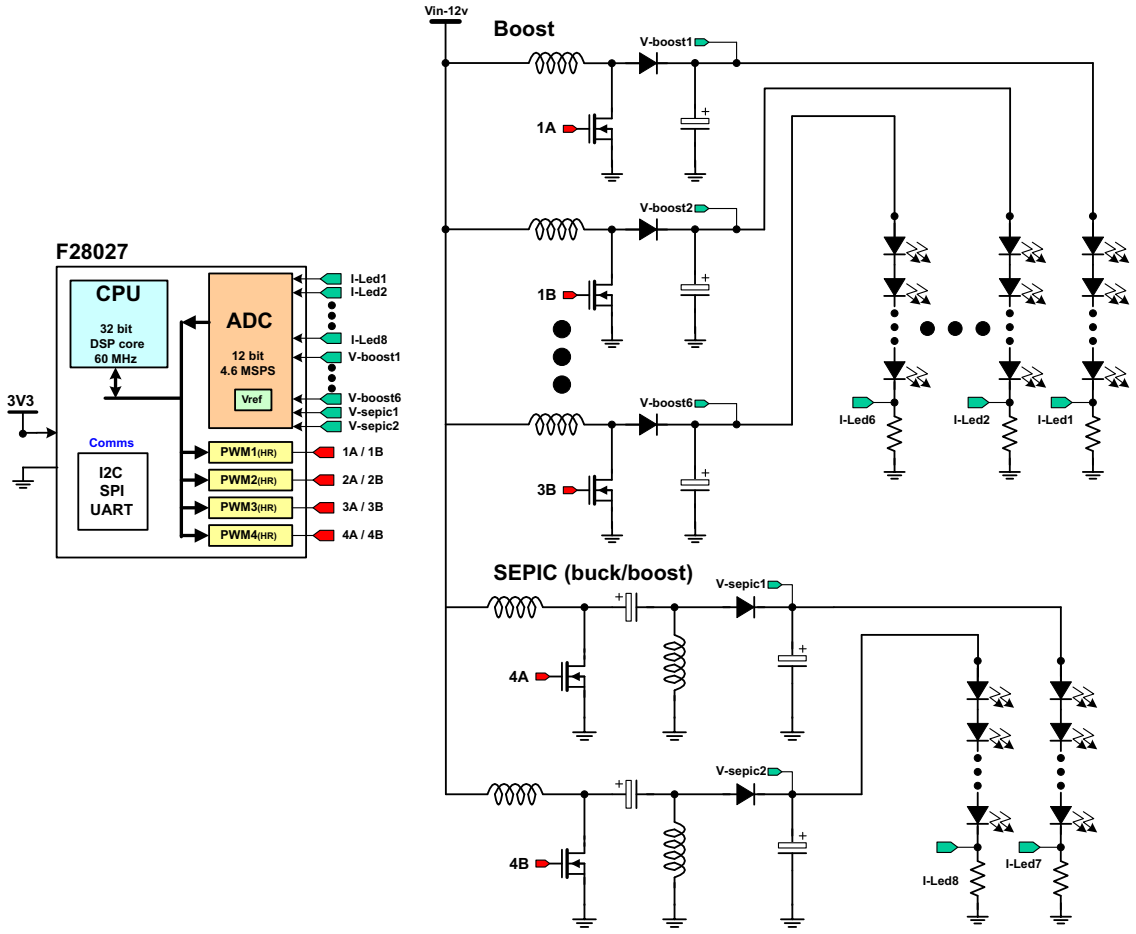

Figure 4. Multi-DC/DC Color LED Kit Circuit Diagram

4.2 Jumpers, Connectors, and Switches

Table 6 lists the jumpers, connectors, and switches available on the board. Figure 5 shows the location of these items with help of a board image.

Table 6. Description of Jumpers, Connectors, and Switches

COMPONENT	DESCRIPTION
[Main]-BS1	Banana jack for primary power rail DC input
[Main]-BS2, BS3	Banana jack for ground connection
[Main]-H1	100-pin DIM100 controlCARD socket
[Main]-J1	ADC-B4 Mux, used to select the input signal for ADC-B4. Place a jumper across pins 1-2 to select V-Led-4B. Place a jumper across pins 2-3 to select VDCin-meas.
[Main]-J2	JTAG enable jumper, populating the jumper enables JTAG connection to the microcontroller. The jumper needs to be unpopulated when booting from Flash, SCI, or another medium.
[Main]-TB1-TB8	Terminal blocks used to connect the output of the DC/DC power stages to a load, such as an LED panel.
[M1]-J1	Demo-mode enable jumper. This jumper connects the primary and auxiliary power rails together to allow board operation from a single 12-V DC supply. For more information, see Section 3.2.
[M1]-JP1	Auxiliary 12-V DC input. This connector is designed to connect up with the 12-V power supply included with this kit and supplies power to the auxiliary power rail powering the C2000 MCU and support chips.
[M1]-SW1	Power switch for the auxiliary 12-V DC input. This switch determines whether power is passed to the auxiliary power stage from the auxiliary 12-V DC input. The auxiliary power rail can still be powered from the primary power rail if the demo mode enable jumper, [M1]-J1, is populated.
[M6]-J2	External JTAG connector. This connector gives access to the JTAG emulation pins. If external emulation is desired, place a jumper across [M6]-J5 and connect the emulator to the board. However, a USB connector still needs to be connected to [M2]-JP1 to power the emulation logic.
[M6]-J4	FTDI UART enable jumper. Populate this jumper when using the FTDI chip as a UART (for example, when using a GUI to interact with the MCU).
[M6]-J5	Onboard emulation disable jumper: Place a jumper here to disable the onboard emulator and give access to the external interface.
[M6]-JP1	USB connector for on-board JTAG emulation and SCI (UART) communication.

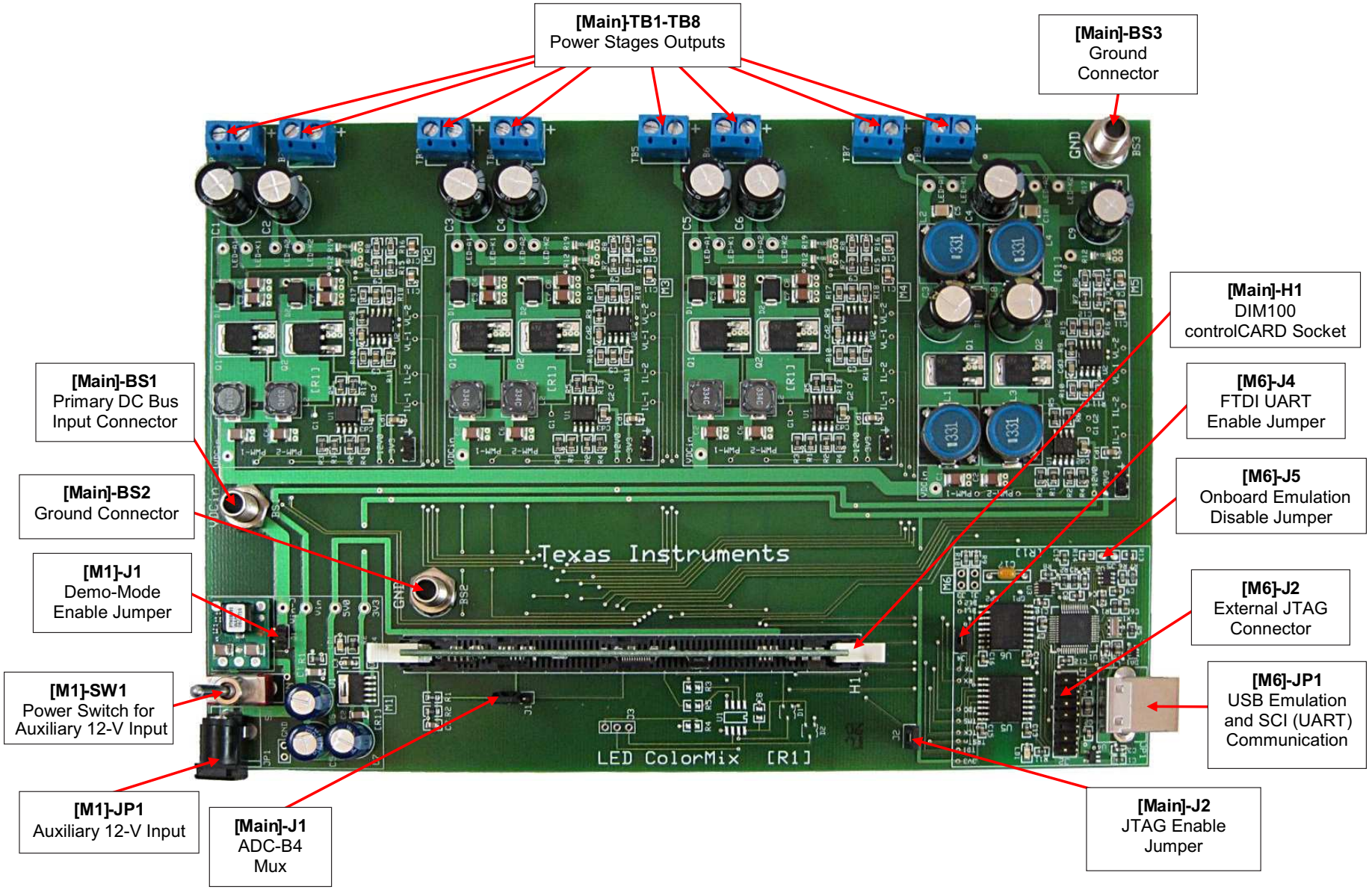

Figure 5. Multi-DC/DC Color LED Board Jumpers, Connectors, and Switches Locations

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- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
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