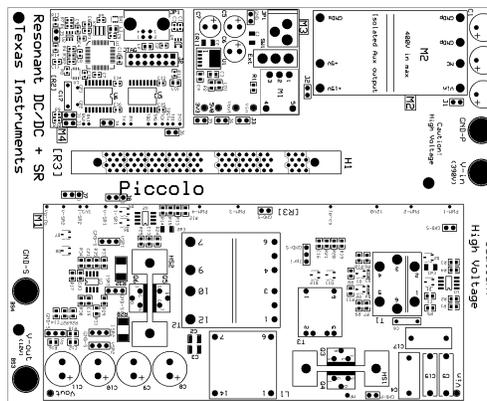


# Resonant LLC Half-Bridge DC/DC Converter Quick Start Guide

## 1 System Description

The document provides instructions to run a GUI that controls the High-Voltage Half-Bridge LLC Resonant DC/DC Converter with Synchronous Rectification Kit board using the F28027 microcontroller.



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## General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines



Always follow TI's setup and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and those working around you. Contact TI's Product Information Center <http://support/ti.com> for further information.

**Save all warnings and instructions for future reference.**

**Failure to follow warnings and instructions may result in personal injury, property damage, or death due to electrical shock and burn hazards.**

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is **intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments.** If you are not suitable qualified, you should immediately stop from further use of the HV EVM.

### 1. Work Area Safety

- (a) Keep work area clean and orderly.
- (b) Qualified observer(s) must be present anytime circuits are energized.
- (c) Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
- (d) All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding 50Vrms/75VDC must be electrically located within a protected Emergency Power Off EPO protected power strip.
- (e) Use stable and nonconductive work surface.
- (f) Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.

### 2. Electrical Safety

As a precautionary measure, it is always a good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.

- (a) De-energize the TI HV EVM and all its inputs, outputs and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
- (b) With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment connection, and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
- (c) After EVM readiness is complete, energize the EVM as intended.

**WARNING: WHILE THE EVM IS ENERGIZED, NEVER TOUCH THE EVM OR ITS ELECTRICAL CIRCUITS AS THEY COULD BE AT HIGH VOLTAGES CAPABLE OF CAUSING ELECTRICAL SHOCK HAZARD.**

### 3. Personal Safety

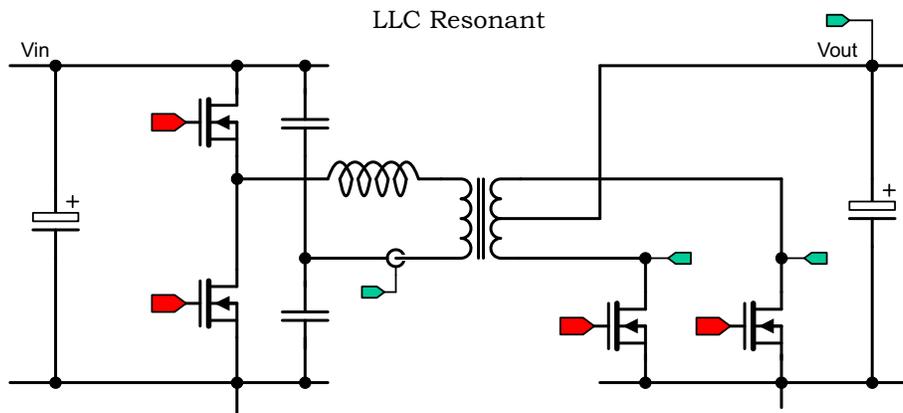
- (a) Wear personal protective equipment (for example, latex gloves or safety glasses with side shields) or protect EVM in an adequate lucent plastic box with interlocks to protect from accidental touch.

### Limitation for safe use:

EVMs are not to be used as all or part of a production unit.

## 2 Hardware Overview

The High-Voltage Half-Bridge LLC Resonant DC/DC Converter with Synchronous Rectification Kit board regulates the output voltage using 2P2Z/PID closed-loop control.. [Figure 1](#) shows the circuit diagram.

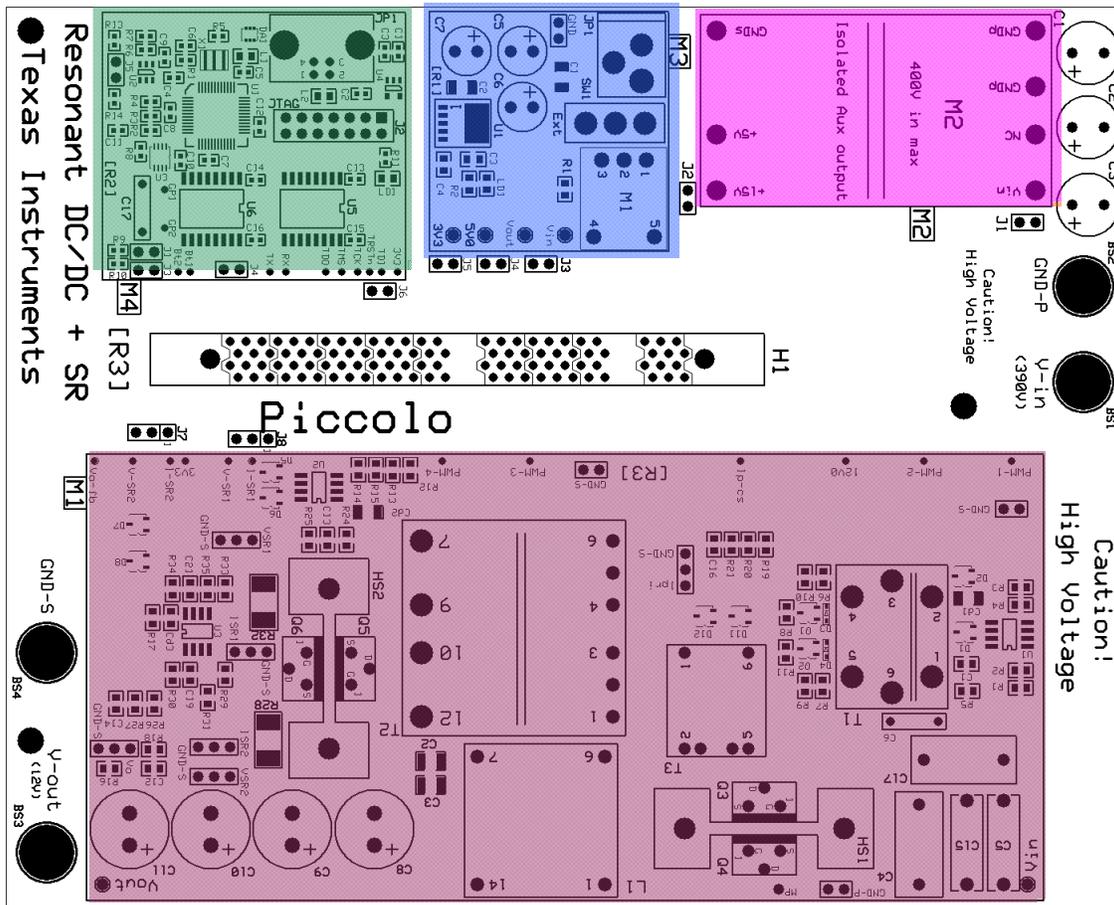


**Figure 1. TMDSHVRESLLCKIT Circuit Diagram**

The High-Voltage Half-Bridge LLC Resonant DC/DC Converter with Synchronous Rectification Kit 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 brief descriptions of each:

- **Main Board Area – [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.
- **Aux-DC-Power macro – [M3]** – Generates the 12-15V, 5V, and 3.3V DC power rails from a 12V DC supply included with the kit, an external DC power supply, or the on-board 400V-to-15V DC/DC module.
- **Isolated-USB-to-JTAG macro– [M4]** – Provides an on-board isolated JTAG connection through USB to the host as well as isolated SCI (UART) communication.
- **LLC Resonant + SR macro – [M1]** – Isolated Resonant LLC DC/DC power stage with Synchronous Rectification.
- **400V-to-15V DC/DC macro – [M2]** – Generates an isolated 15V from the 400V input voltage.

Refer to [Figure 2](#) for placement of each macro block.



- (1) [Main] – Main Board area
- (2) [M3] – Aux-DC-Power macro
- (3) [M4] – Isolated-USB-to-JTAG macro
- (4) [M1] – LLC Resonant + SR macro
- (5) [M2] – 400V-to-15V DC/DC macro

**Figure 2. TMDSHVRESLLCKIT Macro Block Locations**

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.

## Hardware Setup

Perform or verify the following steps to prepare the High-Voltage Half-Bridge LLC Resonant DC/DC Converter with Synchronous Rectification Kit for use with the included GUI.

1. Insert a F28027 control card into socket [Main]-H1.
2. Connect your computer to the board using a USB cable. [M4]-LD1 should turn on.
3. Verify the following jumper settings:
  - Jumpers are placed on [Main]-J1, J2, J3, J4, J5.
  - Jumpers are placed on pins 1-2 on [Main]-J7, J8.
  - A jumper is placed on [M4]-J4.
  - No jumpers are placed on [Main]-J6.
4. Verify that the power switch [M3]-SW1 is in the “OFF” position.
5. Verify that no DC power supply is connected to [M3]-JP1.
6. Connect a 390VDC, 1A (max), power supply across [Main]-BS1, BS2.
7. Connect a 300W (max) load across [Main]-BS3, BS4.

**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 zip file 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:

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

## Quick Start GUI

This kit comes with a GUI which provides a convenient way to evaluate the functionality of this kit and the F28027 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 the High-Voltage Half-Bridge LLC Resonant DC/DC Converter with Synchronous Rectification Kit and C2000 device to be demonstrated quickly and easily.

The GUI for evaluating this kit is named "HVLLC-GUI[R3].exe" and can be found on the USB drive that is included in the kit box. This GUI is all the software necessary to do a quick evaluation of this kit. To explore deeper, the underlying reference software can be found within controlSUITE.

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**NOTE:** To obtain the most recent version of the CCS4 project for this kit, reference material, and other software for the C2000 MCU, please download the controlSUITE installer from:

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

Once controlSUITE is installed, the project files can be found in the following directory:

```
controlSUITE\development_kits\TMDSHVRESLLCKIT_v1.0\
```

The GUI mentioned in this guide can be found at:

```
\TMDSHVRESLLCKIT_v1.0\~GUI\HVLLC-GUI[R3].exe
```

The kit ships with a F27027 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 controlCARD needs to be reflashed so that it works with the GUI again, the flash image can be found at:

```
\TMDSHVRESLLCKIT_v1.0\~GUI\HVLLC-FLASH[R3].out
```

The Code Composer Studio 4 project and source code can be found at:

```
\TMDSHVRESLLCKIT_v1.0\HVLLC\
```

The documentation can be found at:

```
\TMDSHVRESLLCKIT_v1.0\~Docs\
```

The hardware development package can be found at:

```
\TMDSHVRESLLCKIT_v1.0\~HVLLC-HWdevPkg[R3]\
```

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

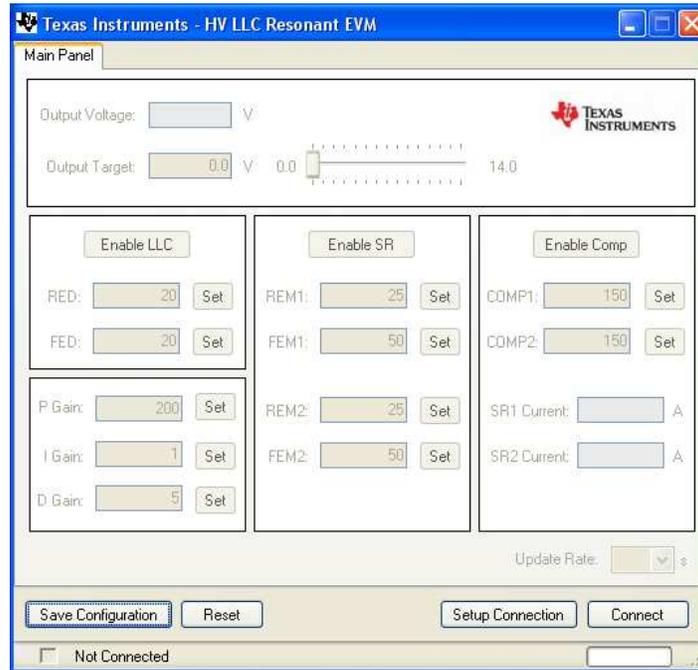
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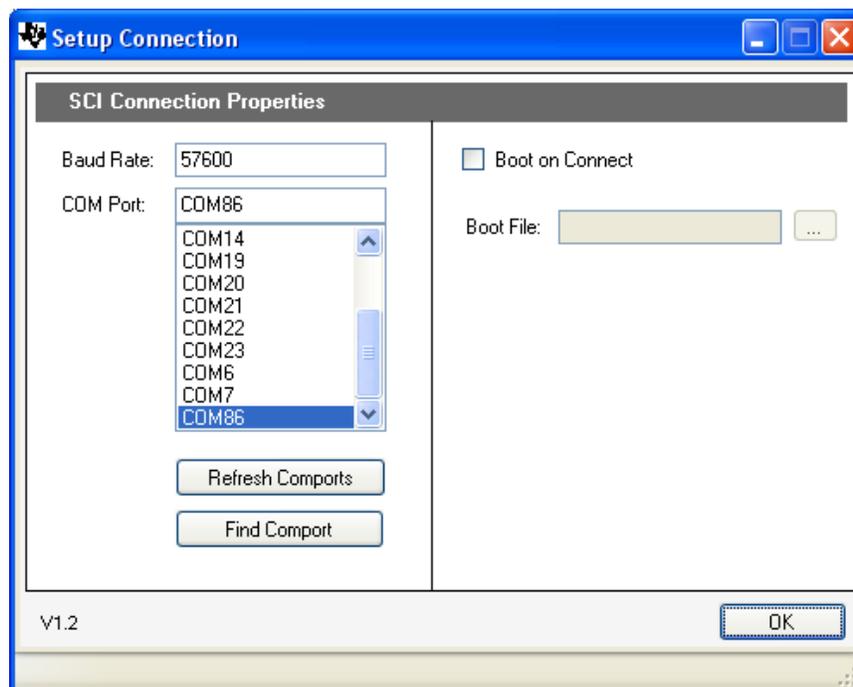
Follow these instructions to run the GUI included:

1. Browse to and run the “HVLLC-GUI[R3].exe” GUI. The program is shown in [Figure 3](#).



**Figure 3. TMDSHVRESLLCKIT GUI**

2. Click “Setup Connection” and make sure the Baud Rate is set to 57600 and that the “Boot on Connect” box is unchecked.



**Figure 4. The GUI "Setup Connections" Window**

3. Next you will need to select your serial COM port. This can be found by going to:  
`Control Panel->System->Hardware tab->Device Manager->Ports(COM & LPT)`  
Look for the COM port that is named "USB Serial Port" or similar and note the number. Select this COM port in the "Setup Connection" window and click "OK" to close the window. Hint: Try selecting the largest number or refreshing the list while connecting/disconnecting the USB cable to/from the board to see which one changes.
4. Set the power switch [M3]-SW1 so that it is pointed away from "Ext" label.
5. Turn on the 390VDC, 1A (max), power supply. [M3]-LD1 should turn on and a red LED should begin blinking on the controlCARD.
6. Click "Connect" in the GUI main window. The status bar at the bottom left corner of the GUI should turn green and say "Connected" once the GUI is connected.
7. Click "Enable LLC" to enable the LLC Resonant power stage.
8. Click "Enable SR" to enable Synchronous Rectification.
9. Click "Enable Comp" to enable SR MOSFET current-level based turn-off via the on-chip analog comparators.
10. When finished, set "Target Output" to 0.00V and disable the LLC Resonant power stage.
11. Press "Disconnect" to terminate the connection.
12. Turn off the board by turning off the 390VDC power supply.

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