UG10208

Multimode Bidirectional AC-DC Reference Solution

Rev. 1.0 — 10 February 2025 **User guide**

Document information

Information	Content
Keywords	UG10208, multimode bidirectional AC-DC reference solution, AC-DC reference, bidirectional
Abstract	The multimode bidirectional AC-DC reference platform is designed as an evaluation prototype providing a hardware reference design and a system enablement software. This document details the steps to set up and tests this platform.

1 Introduction

The multimode bidirectional AC-DC reference platform is designed as an evaluation prototype providing a hardware reference design and a system enablement software.

This document details the steps to set up and tests this platform.

2 Getting started

This section lists the kit contents with other hardwareSection "Other hardware" and software requirements.

2.1 Kit contents

The hardware kit consists of the bidirectional AC-DC power board and the HVP-56F83783 expansion card. The HVP-56F83783 expansion card is plugged into the expansion card socket on the power board. The DSC MC56F83783 on the HVP-56F83783 expansion card is used as the main controller for the digital power system. The board schematic and layout are available on the bidirectional AC-DC reference design webpage.

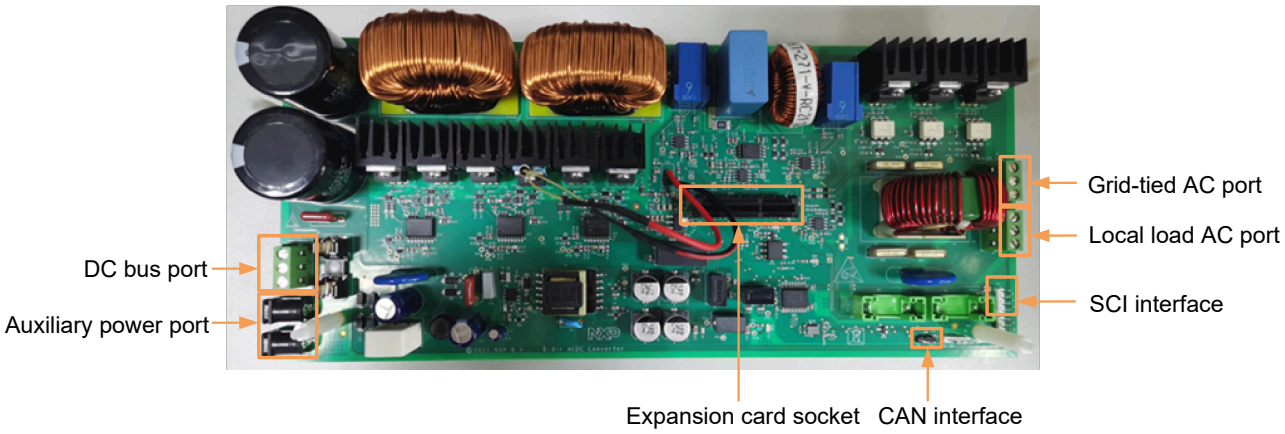

Figure 1. Bidirectional AC-DC power board

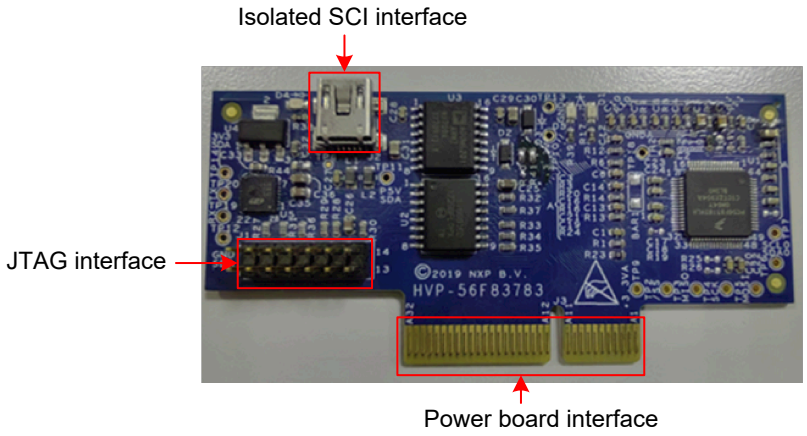

Figure 2. MCU control expansion card (HVP-56F83783)

2.2 Other hardware

In addition to the kit contents, the following hardware is necessary or is beneficial when working with this platform.

1. Power supply, AC source up to 220 V, 5 A for PFC mode, DC source up to 400 V, 2.5 A for inverter mode.
2. Load.
3. Cable assembly, double row wire cable.
4. A PC to run the graphical user interface (GUI) and USB to serial cable for GUI connection.
5. A Universal Multilink or DSC Multilink to program the controller.

2.3 Software

Installing software is recommended to work with this platform.

1. CodeWarrior IDE v11.1, for editing, compiling, and debugging of source code designs.
   Note: *Update4 for CodeWarrior V11.1 is needed. Download (via the above link) CodeWarrior for MCU 11.1 Update4, the installation instructions are available at: How to install CodeWarrior service pack for DSC guide.*
2. MCUXpresso Config Tools V13.1, for graphical display of pin, clock, and peripheral configurations to facilitate modification.
3. Software Development Kit (SDK_2_13_1_MC56F83783), is complimentary and includes full source code under a permissive open source license for all hardware abstraction and peripheral driver software.
4. FreeMASTER 3.2, for measurement visualization and runtime configuration and tuning of the embedded software.
   Note: *To use the CP210x USB to UART bridge virtual COM port communication on HVP-56F83783, download, and install the CP210x drivers.*

3 Platform assembly and operation

As a bidirectional AC-DC converter, electric energy could be transferred from AC port to DC port (AC_TO_DC), or from DC port to AC port (DC_TO_AC). In DC_TO_AC mode, the working mode is divided into the GRIDCONNECTED and OFFGRID mode based on if the power grid is connected. The hardware configurations and parameter configurations are different for different operating modes.

The following section describes how to run the converter in all working modes.

3.1 AC_TO_DC mode

Note: *In AC_TO_DC mode, the converter must be supplied by the AC source instead of the power grid. Otherwise, distortion in the power grid can damage the current limiting circuit.*

Note: *Load the electronic load after the DC bus reaches the voltage reference (380 V).*

- **Hardware connections:**
  1. Plug HVP-56F83783 into the expansion card socket on the power board.
  2. Connect the high-voltage AC source on the grid-tied AC port and supply a single phase AC voltage.
  3. Connect the load on the DC port.
  4. Connect isolated SCI interface J2 on HVP-56F83783 to the PC through a USB-Mini-B cable.

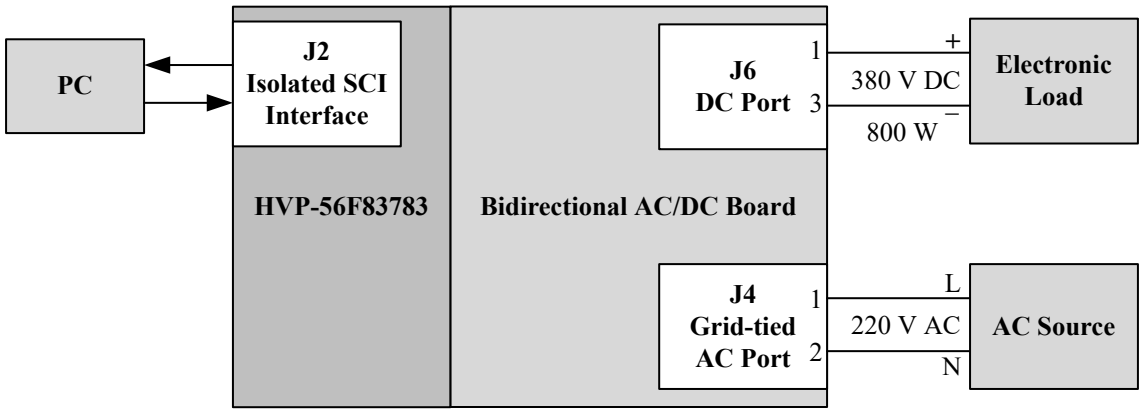

Figure 3. Hardware connections for AC_TO_DC mode

- **Powering the boards:** Powers the platform by powering up the AC source.
- **Control and monitor the system with FreeMASTER:**
  1. Open the FreeMASTER project (`Multimode_Bidir_DCAC_LCL_MC56F83783.pmpx`) with the latest FreeMASTER. Figure 4 illustrates the FreeMASTER window.

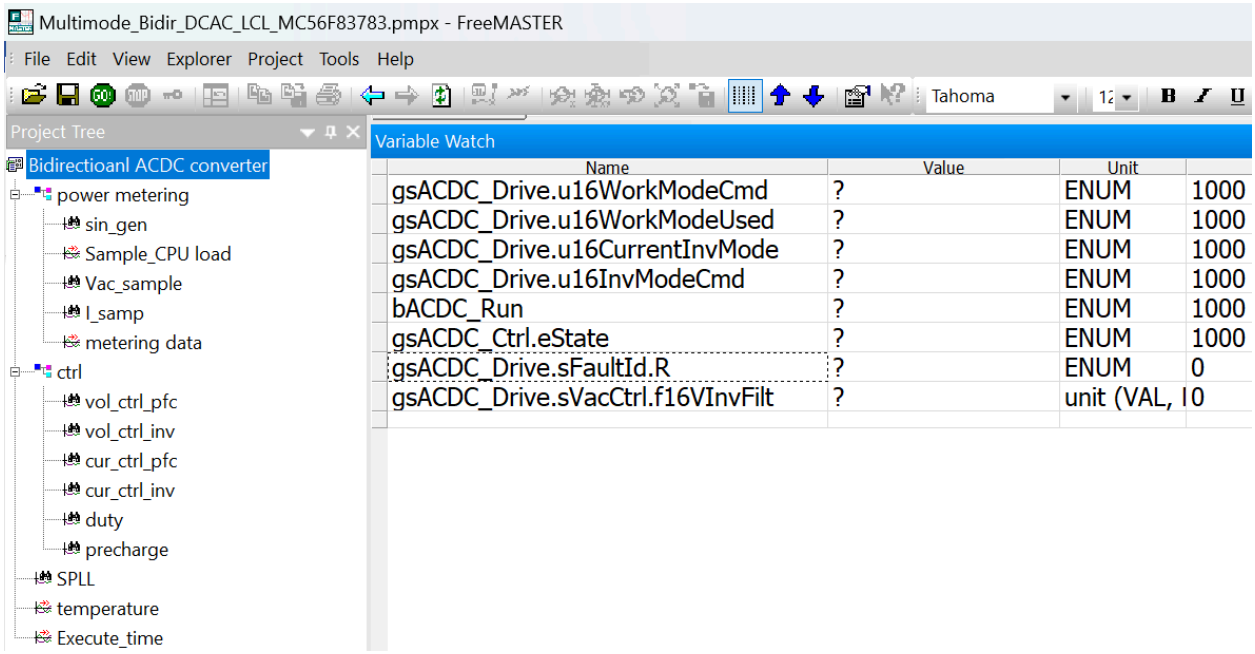

Figure 4. FreeMASTER window

  2. Enable the communication between the PC and the HVP-56F83783 expansion card.
  3. Set up the communication parameters by selecting **Project > Options**.
  4. Under the **Comm** tab, select the port used by the CP210x and set the baud rate as 115200.

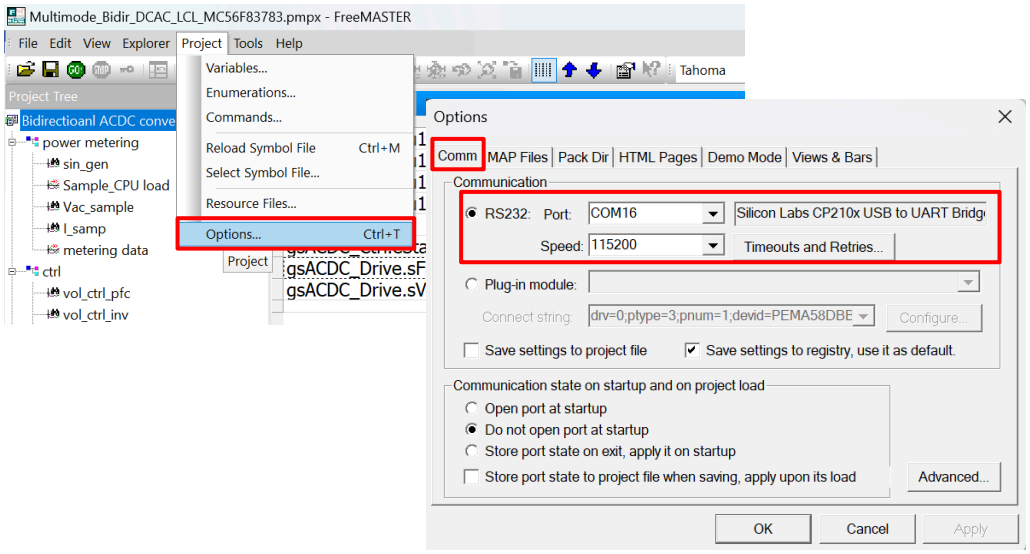

Figure 5. FreeMASTER communication options

5. Under the **MAP Files** tab, click the **...** button and select the correct symbol file.

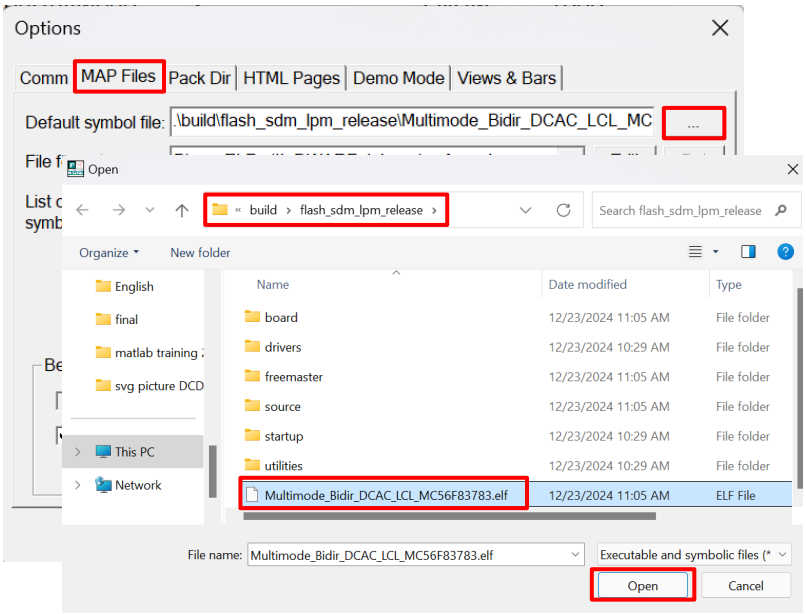

Figure 6. FreeMASTER symbol files options

6. Click **OK** and save the configuration.

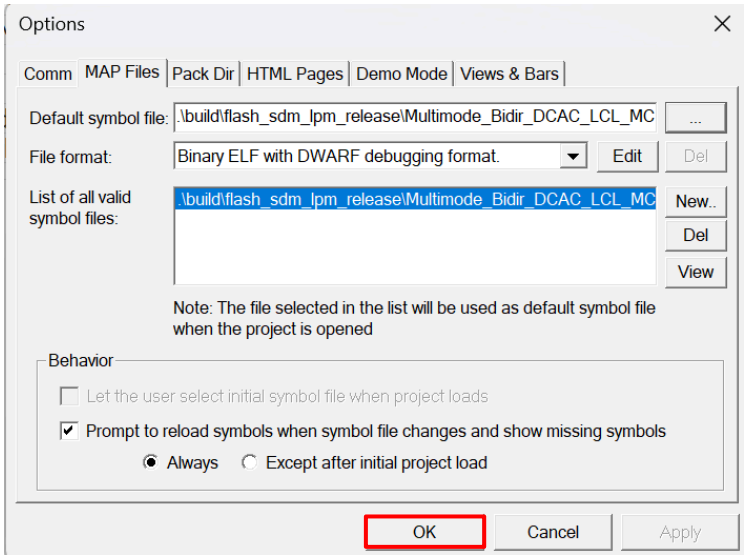

Figure 7. Save the configuration

7. Click the **Go** icon and start the communication. Once the communication is established, the communication port can be closed by clicking the **Stop** icon.

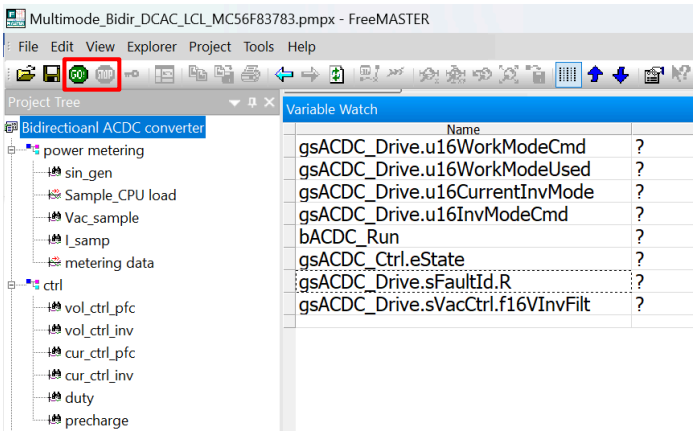

Figure 8. Open/close the communication port

8. After the FreeMASTER communication is established, click the drop-down menu of the `gsACDC_Drive.gu16WorkModeCmd` command to choose the AC_TO_DC.

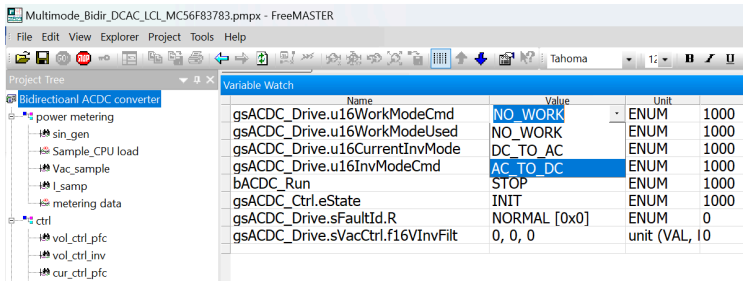

Figure 9. AC_TO_DC mode selection

9. Click the drop-down menu of the `bACDC_Run` command and start/stop the converter.

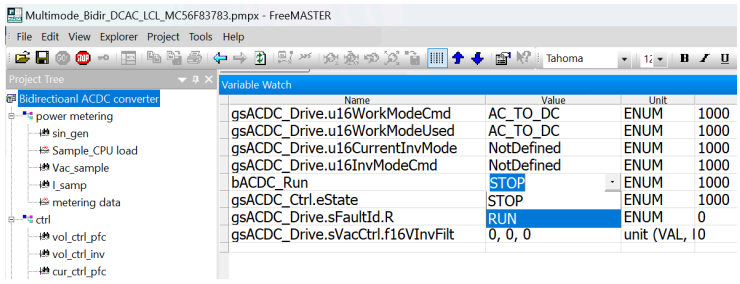

Figure 10. Start/stop converter

3.2 OFFGRID DC_TO_AC mode

Note: *Uncommont the `CLOSE_SW_LOAD()` command in the `ACDC_TransStopRun` function to enable load connection. Otherwise the load switch is open and no output on the J3 port. Comment out the `CLOSE_SW_LOAD()` command in the `ACDC_TransStopRun` function to prevent any hardware damage when the converter operates in standalone inverter mode and the grid-connected AC port is connected to the grid. In the original software, the `CLOSE_SW_LOAD()` is commented.*

- **Hardware connections**
  1. Plug HVP-56F83783 into the expansion card socket on the power board
  2. Connect the high voltage DC supply positive and negative connections on the DC bus port
  3. Connect the load on the local load AC port
  4. Connect isolated SCI interface J2 on HVP-56F83783 to the PC through a USB-Mini-B cable

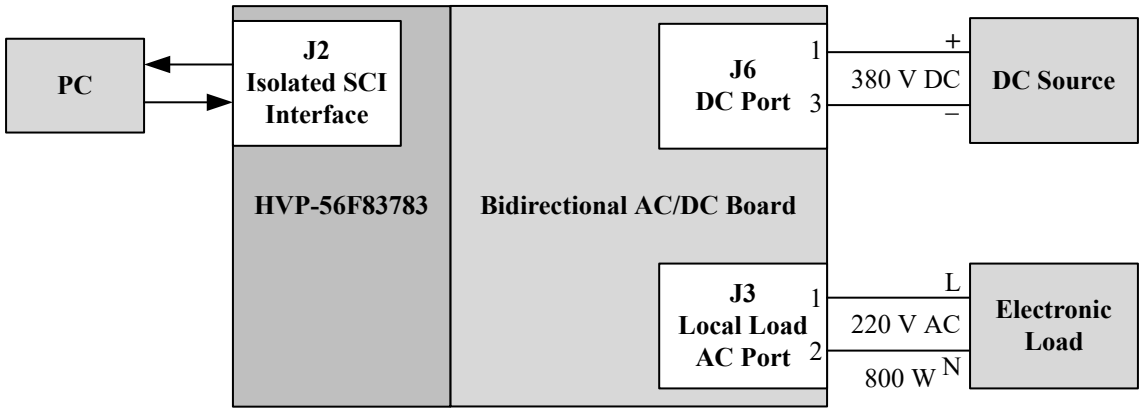

Figure 11. Hardware connections for OFFGRID DC_TO_AC mode

- **Powering the boards:** powers the platform by powering up the DC source
- **Control and monitor the system with FreeMASTER**
  1. Open the FreeMASTER project (`Multimode_Bidir_DCAC_LCL_MC56F83783.pmpx`) with latest FreeMASTER and enable the communication between the PC and HVP-56F83783.
  2. After the communication is established, click the drop-down menu of the `gsACDC_Drive.gu16WorkModeCmd` command to choose the DC_TO_AC.

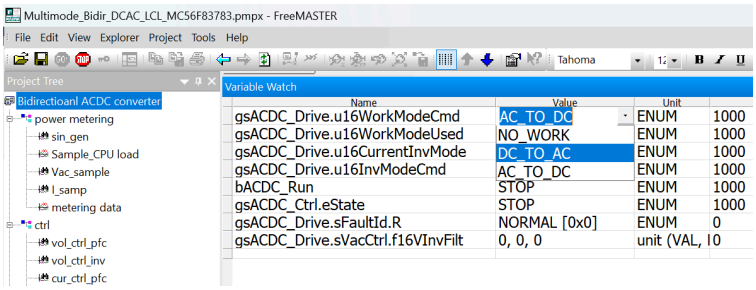

Figure 12. DC_TO_AC mode selection

3. Click the drop-down menu of the `gsACDC_Drive.u16InvModeCmd` command and choose the `OFFGRID` mode.

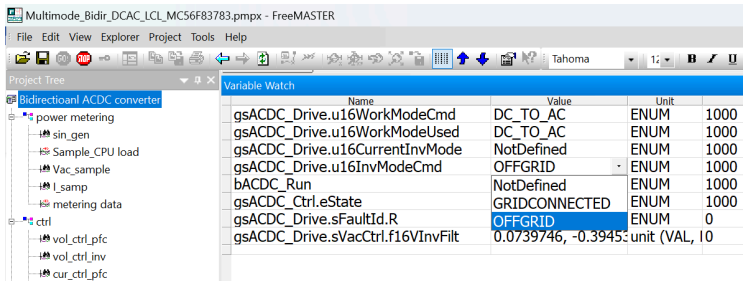

Figure 13. OFFGRID mode selection

4. Click the drop-down menu of the `bACDC_Run` command and start/stop the converter.

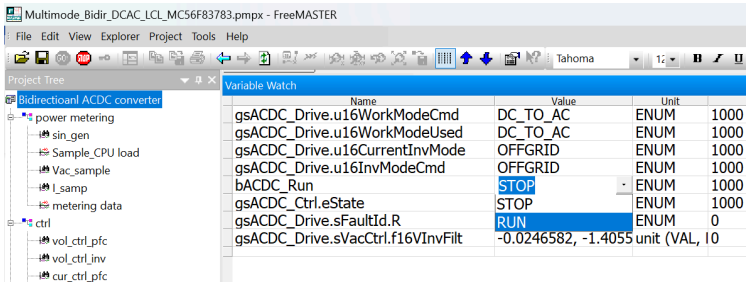

Figure 14. Start/stop converter

3.3 GRIDCONNECTED DC_TO_AC mode

- **Hardware connections:**
  1. Plug HVP-56F83783 into the expansion card socket on the power board.
  2. Connect the high voltage DC supply positive and negative connections on the DC bus port.
  3. Connect the grid-tied AC port to a power frequency transformer. The other side of the transformer is connected to the power grid with a transformation ratio of 1:1.
  4. Connect isolated SCI interface J2 on HVP-56F83783 to the PC through a USB-Mini-B cable.

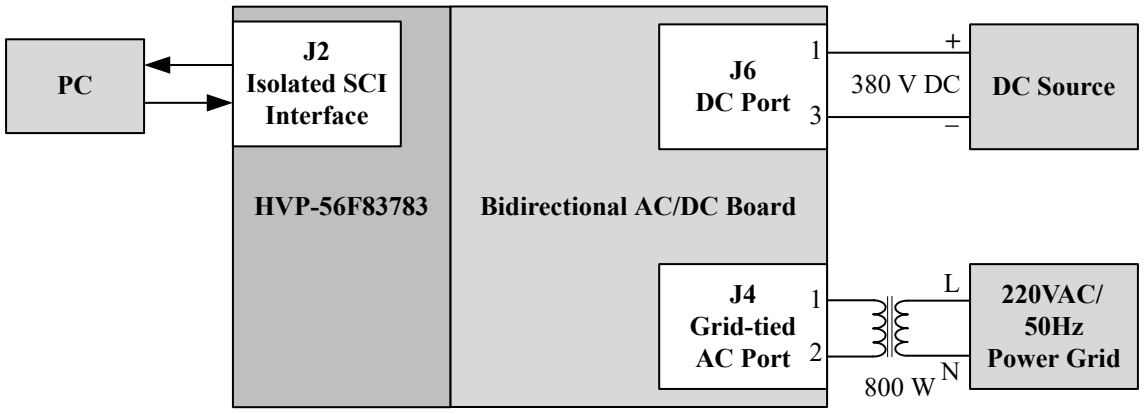

Figure 15. Hardware connections for GRIDCONNECTED DC_TO_AC mode

- **Powering the boards:** Powering the DC source.
- **Control and monitor the system with FreeMASTER:**
  1. Open the FreeMASTER project (`Multimode_Bidir_DCAC_LCL_MC56F83783.pmpx`) with latest FreeMASTER and enable the communication between the PC and the HVP-56F83783 expansion card.
  2. After the communication is established, click the drop-down menu of the `gsACDC_Drive.gu16WorkModeCmd` command and choose `DC_TO_AC`.
  3. Click the drop-down menu of the `gsACDC_Drive.u16InvModeCmd` command and choose the `GRIDCONNECTED` mode.

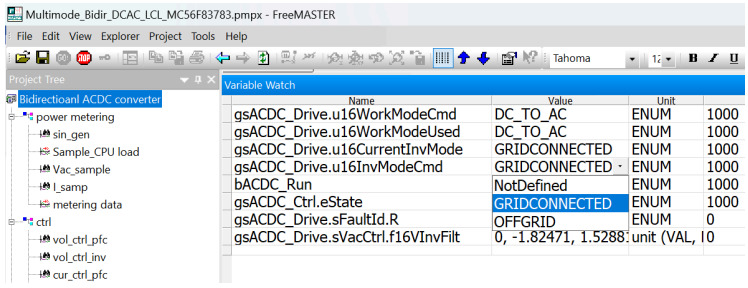

Figure 16. GRIDCONNECTED mode selection

4. Click the drop-down menu of the `bACDC_Run` command and start/stop the converter.

3.4 Mode switching

Note: *When the converter operates in the standalone inverter mode and the grid-connected AC port is connected to the grid, the hardware can get damaged. To avoid any hardware damage, comment out the* `CLOSE_SW_LOAD()` *command in the* `ACDC_TransStopRun` *function.*

3.4.1 Mode switching between DC_TO_AC and AC_TO_DC modes

Assuming that the converter first operates in the AC_TO_DC mode, mode switching can be done as follows:

1. To start the converter in the AC_TO_DC mode, follow the steps provided in Section 3.1.
2. Change the value of the gsACDC_Drive.u16WorkModeCmd command in FreeMASTER from AC_TO_DC to DC_TO_AC. After making this change, the converter stops.
3. Power down the AC power source.
4. Disconnect the AC source from the AC port, and remove the load from the DC port.
5. Connect the DC power source to the DC port and power up the DC source.
   Note: *During this process, the DSC remains powered from the host computer through the USB port.*

6. To choose the desired inverter mode, use the **Value** drop-down menu of the `gsACDC_Drive.u16InvModeCmd` command in the **Variable Watch** window of the bidirectional AC-DC converter block.
7. To start the converter, use the **Value** drop-down menu of the `bACDC_Run` command.

3.4.2 Mode switching between OFFGRID and GRIDCONNECTED modes

Assuming that the converter first operates in the OFFGRID mode, mode switching to the GRIDCONNECTED mode can be done as follows:

1. To start the converter in the OFFGRID mode, follow the steps provided in Section 3.2.
2. When the converter is working, click the drop-down menu of the `gsACDC_Drive.u16InvModeCmd` command to choose the GRIDCONNECTED mode. Then the converter mode changes automatically from the OFFGRID mode to the GRIDCONNECTED mode.
3. When the converter is working in GRIDCONNECTED mode, click the drop-down menu of the `gsACDC_Drive.u16InvModeCmd` command to choose the OFFGRID mode. Then the converter mode changes automatically from the GRIDCONNECTED mode to the OFFGRID mode.

4 Reference

For more information on the AC-DC converter design using MC56F83783, refer to the following documents:

- Multimode Bidirectional AC-DC Converter Design using MC56F83783 (AN14354)
- Getting started with the Bidirectional AC-DC converter

5 Revision history

Table 1 lists the revisions to this document.

Table 1. Revision history

Document ID	Release date	Description
UG10208 v.1.0	10 February 2025	Initial public release

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