MCP164GX1000 Evaluation Board User Guide

EV22R85A

Introduction

The MCP164GX1000 is a Power Management Integrated Circuit (PMIC) dedicated to the PIC64 MPU line. The MCP164GX1000 supports commercial and industrial applications.

The MCP164GX1000 integrates eight parallelable DC-DC Buck regulators, four auxiliary LDOs and one low-input/low-output voltage LDO Controller using an external MOSFET. It also features an interrupt flag that signals faults and a 3.4 MHz I^2C interface.

The Buck channels support loads up to 1.5A. All low-voltage Bucks are 100% duty cycle capable. They can be operated either independently or paralleled into groups of four to support higher currents.

Four 300 mA LDOs are provided so that sensitive analog loads can be supported. The LDOs can also be cascaded (in groups of two) to the output of a DC-DC channel, thus improving overall conversion efficiency.

The MCP164GX1000 power management settings allow for the implementation of low-power mode commanded by a GPIO pin (MODE input of MCP164GX1000). Any channel can also be selectively and permanently set in Auto PFM or FPWM.

The device has a programmable NVM with write password protection and stores a default power-up configuration in the EEPROM. The MCP164GX1000 is preconfigured with a suitable configuration in two available architecture options: DDR4 (MCP164GX1000AB) and LPDDR4 (MCP164GX1000AA).

Active discharge resistors are provided on each output. All Buck channels and LDOs support soft start-up. A programmable, windowed Watchdog Timer with uncommitted open-drain output (nWDO) is also available.

The MCP164GX1000 is available in a 64-pin, 8 mm x 8 mm VQFN package with an operating junction temperature range from -40°C to +105°C.

Figure 1. Typical MCP164GX1000AB with PIC64 MPU Application for DDR4

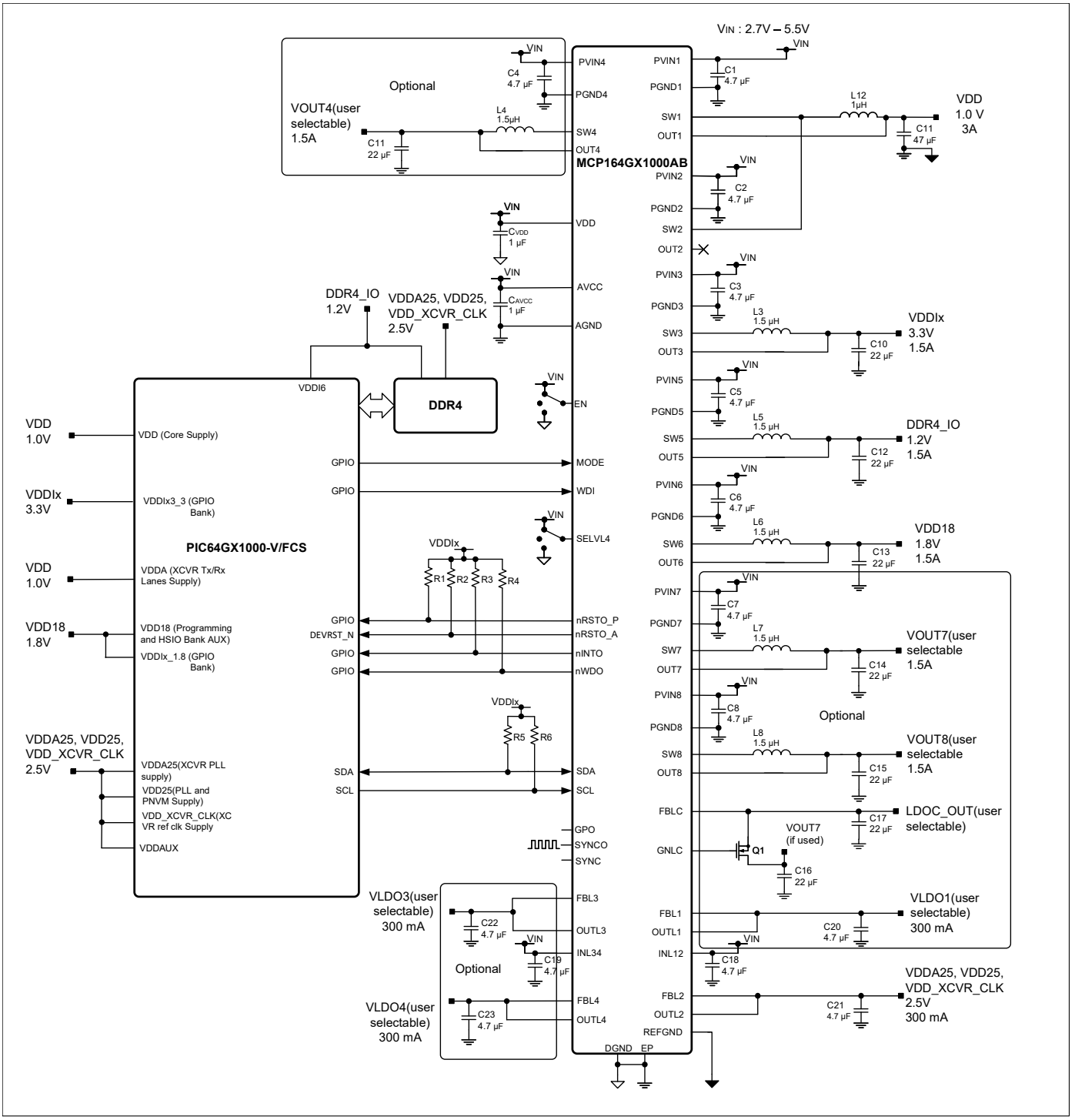
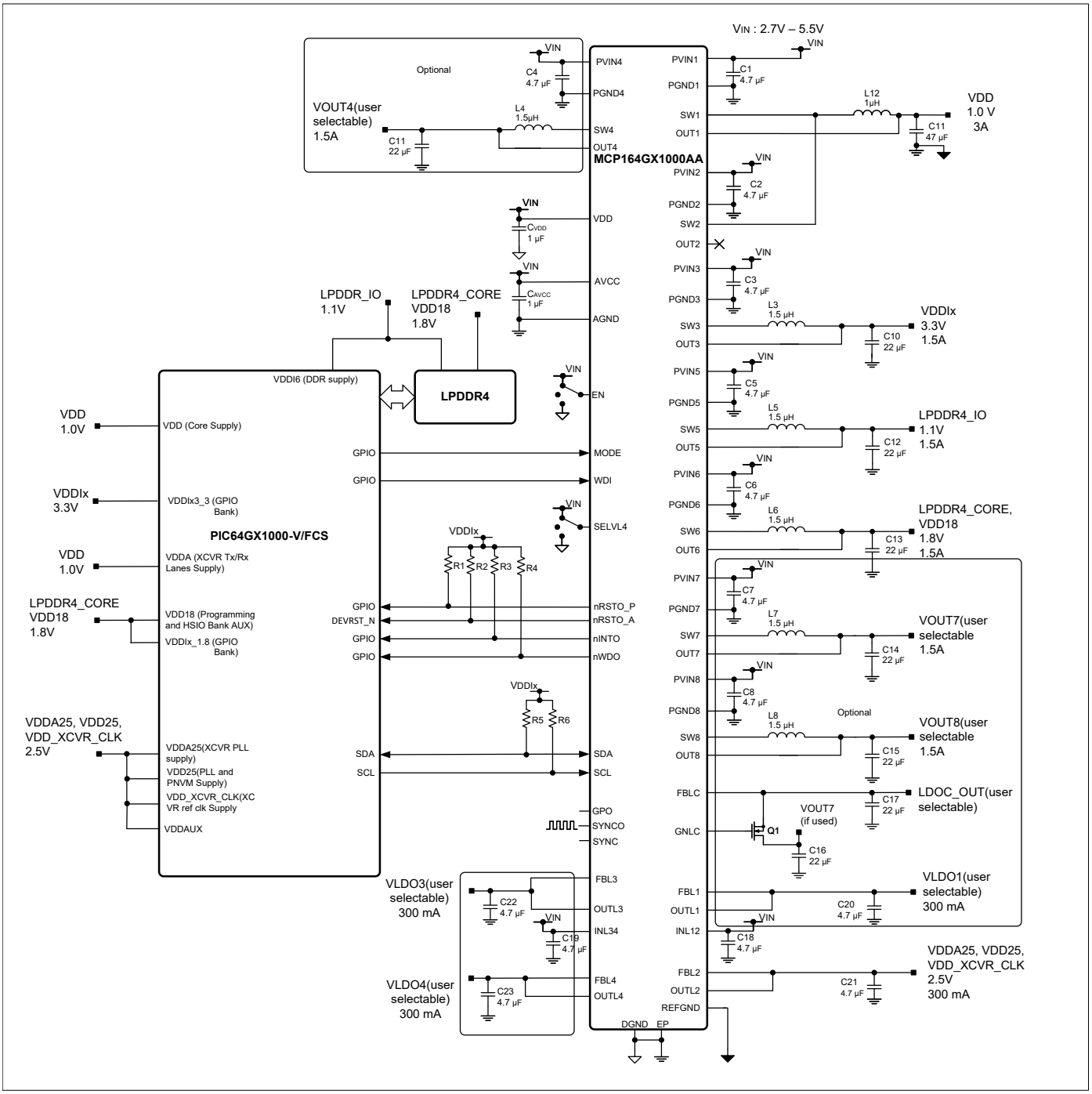


Figure 2. Typical MCP164GX1000AA with PIC64 MPU Application for LPDDR4

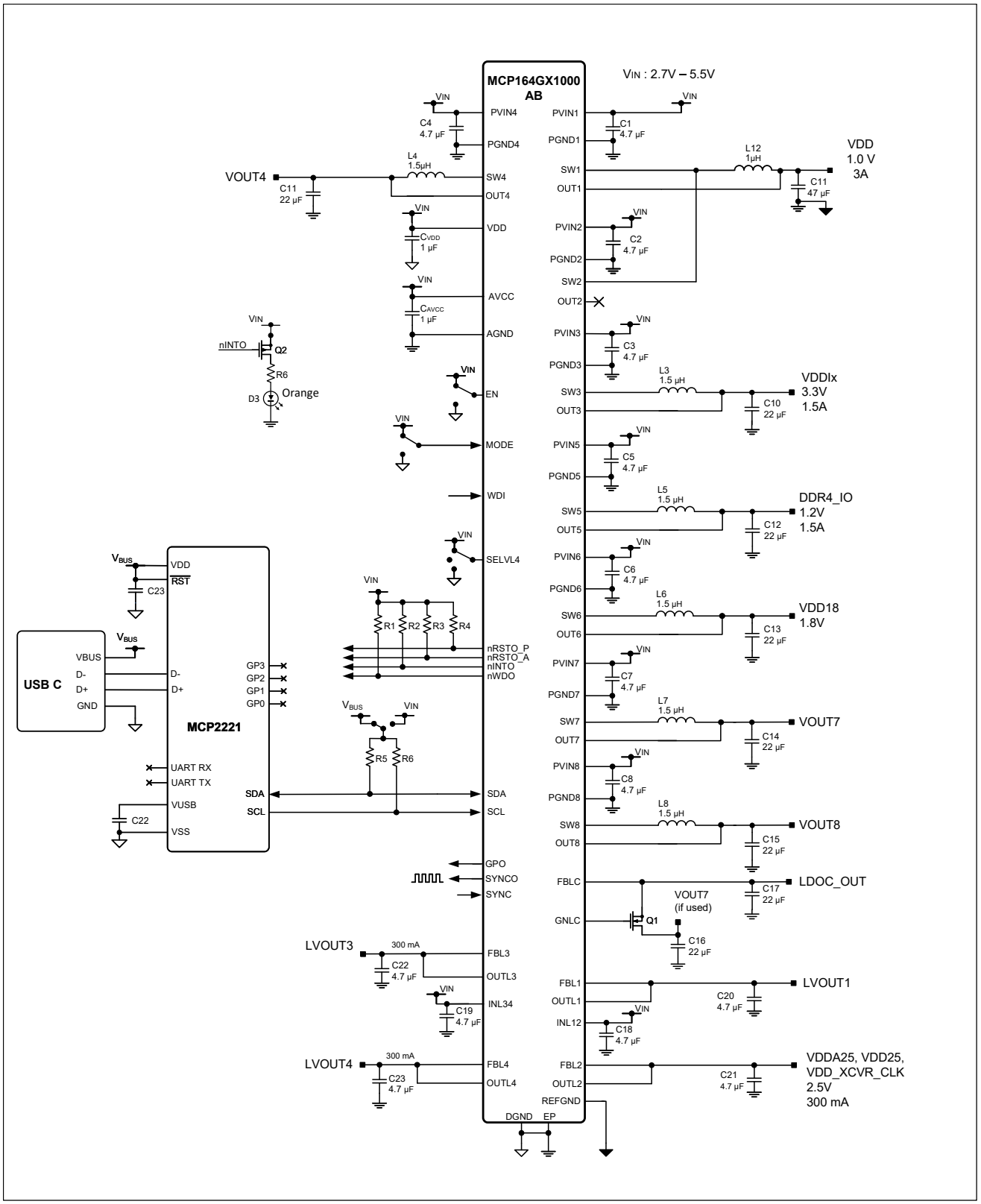


Features

The MCP164GX1000 (EV22R85A) Evaluation Board has the following features:

- Input Voltage: 2.7V to 5.5V
- Eight 1.5A Buck DC-DC Channels
- Four 300 mA High-Accuracy LDOs
- One High-Accuracy, High-PSRR LDO Controller Using External N-Channel MOSFET(Q1)
- Output Voltage of 1V for Paralleled Bucks12 and Current Capability of Up to 3A (VDD Core Supply)
- Output Voltage of 3.3V for Buck3 and Current Capability Up to 1.5A (VDDIx GPIO Banks Supply)
- Output Voltage of 1.2V for Buck5 and Current Capability of 1.5A (VDDIODDR (VDDI6) and Memory IO's Supply)
- Output Voltage of 1.8V for Buck6 and Current Capability of 1.5A (VDD18 and VDDIx_1.8 Supply)
- Output Voltage of 2.5V for LDO2 and Current Capability of 0.3A (VDD25, VDDA25, VDD_XCVR_CLK and DDR4 Core Supply)
- All Other Regulators Available on the Board Are Optional and Turned Off by Default (Buck4, Buck7, Buck8, LDO1, LDO3, LDO4 and the LDO Controller)
- 100% Duty Cycle Capability of Buck Channels
- Reference Ground (REFGND) is Routed to Bucks12 for an Improved Accuracy of the Output Voltage
- Low-Noise Forced-PWM and Light-Load High-Efficiency Mode Available (Pin-Selectable or Bit Control)
- External Synchronization of Switching Frequency; This Feature Can be Active or Disabled in Registry
- Selectable Phase (0°, 90°, 180° or 270°) for Buck Channels
- Global RESET (nRSTO_A) With Programmable Deassertion Delay
- User-Defined RESET (nRSTO_P) With Programmable Deassertion Delay
- 1 MHz MCP2221 I^2C Interface; the PMIC Has a Maximum of 3.4 MHz Frequency
- Dedicated VDD Supply Pin for NVM and Interface Allows Programming Without Powering-Up the Application
- Reconfigurable During Run Time
- Hiccup-Mode Current Limit for Buck Channels (Can be Disabled)
- Programmable Thermal Early Warning and Thermal Shutdown Protection
- LED Visual Indicator for the nINTO Pin (Interrupt Flag) With Selectable Interrupt Masking for Each Channel
- On-Board Load Transient Generator for VOUT12 and LDOC_OUT
- Test Points and Headers for All Available Outputs and Input
- Test Points for Switch Nodes
- Headers for Ease of Access to All Digital Signals
- USB-C Connector for Easy Connection With Host PC
- General Purpose Output (GPO)

Figure 3. MCP164GX1000AB (EV22R85A) Evaluation Board with MCP2221 I²C Bridge



MCP164GX1000 (EV22R85A) Evaluation Board Overview

The MCP164GX1000 (EV22R85A) Evaluation Board is designed to simplify the evaluation and testing of the MCP164GX1000 capabilities. The V_{IN} supply has a 2.7V - 5.5V range, while the V_{OUT} has a 0.6V - 3.8V range for Bucks and LDOs, and 0.6V – 1.6V for the LDO Controller.

The chosen configuration of the evaluation board for the Buck converters is as follows: Bucks12 in parallel and Bucks 3 through 8 independent. The LDO Controller is powered by VOUT7.

An on-board MCP2221, which is a USB 2.0 to I^2C/UART protocol converter with GPIO, is placed on the board to simplify the configuration of the MCP164GX1000.

The PMIC's mode change can be done with either the 3-pin jumper on the MODE pin or by using the I^2C Monitor GUI to change registry settings.

The on-board load transient generator circuit can be used with an external signal generator to evaluate the load step response of Bucks12 and the LDO Controller.

An on-board LED will signal the state of the nINTO signal. Upon nINTO assertion, the orange LED present on the board will turn ON.

Kit Contents

The MCP164GX1000 (EV22R85A) Evaluation Board kit includes:

- MCP164GX1000 Evaluation Board (EV22R85A)
- Important Information

1. Setup and Configuration

The MCP164GX1000 (EV22R85A) Evaluation Board was developed to test the MCP164GX1000's capabilities, monitoring features and control settings through the USB interface (via the I^2C Monitor GUI).

1.1. Getting Started

The MCP164GX1000 (EV22R85A) Evaluation Board comes fully assembled and tested to evaluate and demonstrate the MCP164GX1000.

This board requires a power supply at VSYST with at least 7A current capability if multiple channels are tested under load. Furthermore, the MCP164GX1000 (EV22R85A) Evaluation Board can be powered directly from the USB connector by connecting jumper J5.

Note that in this configuration, the amount of power that can be supplied at the outputs is limited by the USB connection and R11. This is only meant to test the sequencing and change register settings using the GUI.

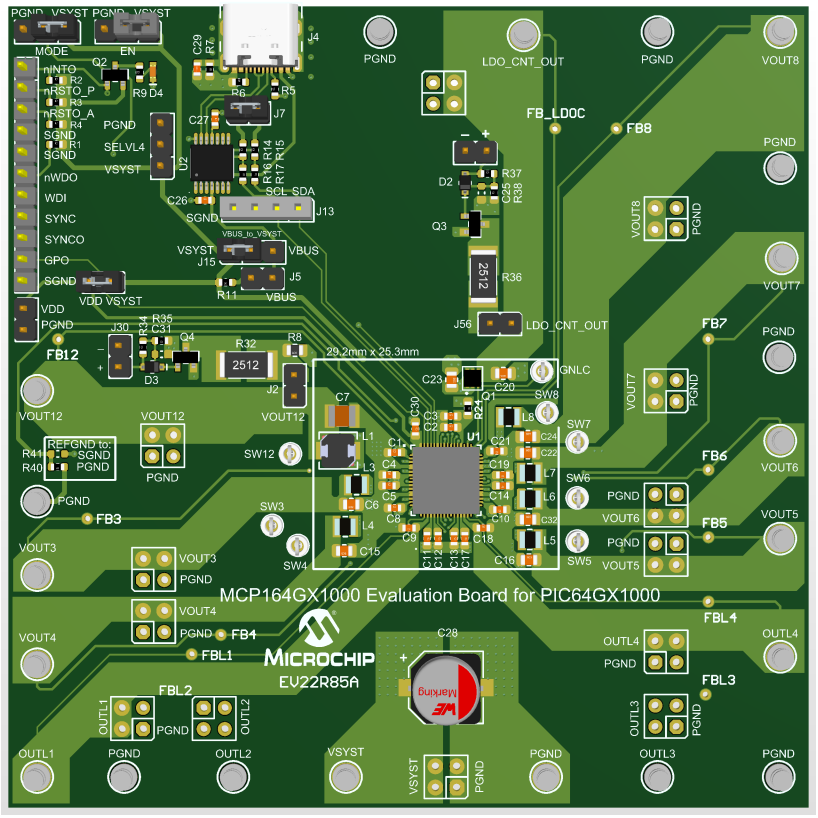
1.1.1. Power Input and Output Connections

To power up the MCP164GX1000, follow the steps below:

1. Connect a power supply to the VSYST and PGND terminals. An ammeter may be placed between the input supply and the VSYST terminal of the evaluation board to monitor the input power. Ensure that the supply voltage is monitored at the VSYST terminal. The ammeter and/or power lead resistance can reduce the voltage supplied to the input.

   Note: Keep the power supply disabled; do not apply power before Step 5.

Figure 1-1. MCP164GX1000 (EV22R85A) Evaluation Board Connections



2. Connect the loads to the VOUTx for Buck converters, OUTLx for LDOs or LDOC_OUT for LDO Controller and PGND terminals. The load can be either passive (resistive) or active (electronic load). An ammeter can be placed between the load and each output terminal to monitor the power rails' current consumption. Ensure that the output voltage is monitored at the output terminals. Alternatively, for high-speed load transient testing of Bucks12 or the LDO Controller, the on-board load transient generator can be used.
3. Make sure the jumpers are connected as shown in Figure 1-1 (MODE = EN = VDD = HIGH).
4. At this step, the GUI is needed to start up the regulators. By default, the evaluation board is preconfigured with the correct registry settings with some regulators enabled and others disabled.
5. Set the power supply to 5V and turn it on. Alternatively, if no power supply is available, connect a jumper to J5 to power the board from the USB connection.
6. Verify that the output voltages are regulated to the desired V_{OUT} setting for each channel.

1.2. On-Board Load Transient Generator

The MCP164GX1000 (EV22R85A) Evaluation Board provides circuitry to enable load transient testing with fast current rise time and fast, yet controlled, fall time. This is achieved by using fast turn-on and controlled turn-off MOSFET switches (Q3 and Q4). The MOSFETs must be driven by an external signal generator, connected at J30 for Bucks 1 and 2 or at J58 for the LDO Controller, using a square wave (suggested low level is 0V, high level is 5V-6V). Drive levels can be adjusted to modify the switching speed of Q3/Q4, but it is recommended to always ensure complete turn-on and turn-off of the MOSFET after settling, without exceeding its VGS ratings. By default, resistor R32 is 0.33Ω, with a power dissipation rating of 1W for Bucks 1 and 2. The R36 resistor for the LDO Controller is 2Ω with a power dissipation rating of 1W. It is very important not to exceed the power dissipation limit of the resistors. When using the 2512 resistor (1W rating), the constraint is:

Equation 1-1.

$$D \times \frac{V_{OUT}^2}{R} < 1W$$

Where:

D	=	The on-time duty cycle of MOSFET
V_{OUT}	=	The selected output voltage

Note: Considerations before performing a load step at the Bucks12 output: V_{OUT12} is set to 1V. In the standard configuration with R32 at 0.33Ω and a power dissipation rating 1W, the maximum duty cycle from the signal generator is calculated based on the equation below.

Equation 1-2.

$$D_{12MAX} < \frac{R}{V_{OUT\_12}^2} \times PowerRating = \frac{0.33\Omega}{1V^2} \times 1W = 33.3\,\%$$

Considerations before performing a load step at the LDO Controller: in the standard configuration with R36 at 2Ω with a power dissipation rating of 1W, the maximum duty cycle can be reached with V_{LDOC_OUT} = 1.05V. However, if the LDO Controller's output voltage increases, up to the maximum value of 1.6V, the duty cycle from the signal generator is calculated based on Equation 1-3.

Equation 1-3.

$$D_{LDOC\_MAX} < \frac{R}{V_{LDOC\_OUT}^2} \times PowerRating = \frac{2\Omega}{1.6V^2} \times 1W = 78.1\,\%$$

The open-drain transient generators are especially useful when testing at very low output voltages, because not many active loads can perform well under those conditions. Additionally, the current rise times achievable with external load boards are limited by stray inductance.

1.3. Layout Considerations

The MCP164GX1000 PMIC requires at least 25 vias from the IC's Exposed Pad to the ground (GND) plane for a good heat dissipation. The GND plane can be increased or decreased based on the ambient temperature, airflow or other devices that generate heat. As a general rule, the GND plane must be as large as possible.

The MCP164GX1000 also features Power Ground (PGND) pins that must be connected to the power components (power input and output capacitors) and to a low impedance return path, such as a dedicated plane or copper pour. It is also recommended to connect the input and output capacitors GND connections, as well as the PGND pins, on the same layer (thus, avoiding vias inductance) and the same continuous copper plane for optimal performance.

Connecting the PGND pins and GND planes at the Exposed Pad is recommended (see Board Design for a PCB layout example). For low Electromagnetic Interference (EMI) emissions, it is recommended to route the switching node of the Buck regulators on an internal plane is recommended, surrounded/enclosed by input supply voltage distribution or GND planes.

The REFGND is a reference to all the regulators and gives better performance to the rail that it is tied close to, but the others have a slight disadvantage. For FPGAs, the core rail is the most important; therefore, it is recommended that REFGND go directly to the core supply GND. For the MCP164GX1000 Evaluation Board, V_{OUT12} is suited for the core rail.

2. GUI Installation and Operation

To install, use and evaluate the product, several software and hardware tools are required.

2.1. Required Software

- I^2C Monitor Graphical User Interface version 10.0.0.0 or higher
- Microsoft®.NET Framework 4.5 or higher
- Adobe® Reader
- Windows® 10 or later

2.2. Required Hardware

- MCP164GX1000 (EV22R85A) Evaluation Board
- USB-to-USB-C Cable of USB-to-USB type C

2.3. Graphical User Interface Installation

The following steps describe how to install the I^2C Monitor Graphical User Interface:

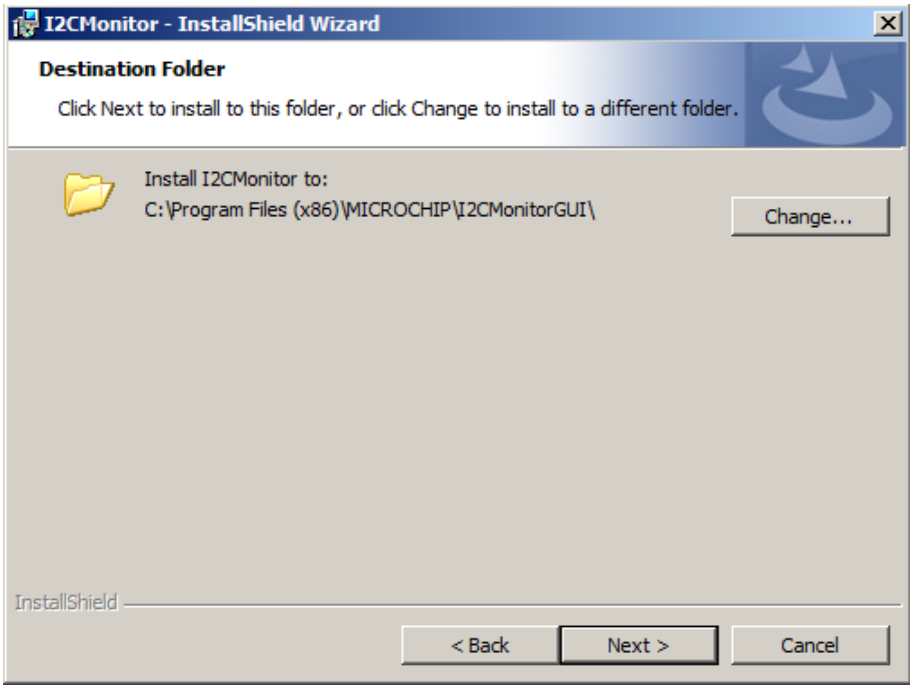
1. If Microsoft .NET Framework is already installed, go to Step 3. If not, download Microsoft .NET Framework from www.microsoft.com and follow the installation instructions.
2. If Adobe Reader is already installed, go to Step 3. If not, download Adobe Reader from http://get.adobe.com/reader/ and follow the installation instructions.
3. Download the I^2C Monitor Graphical User Interface archive from the product web page under “Documentation”.
4. Unzip the I^2C Monitor Graphical User Interface archive, which contains the `setup.exe` file.
   Note: If an older version or a corrupted version of the current I^2C Monitor Graphical User Interface is already installed on the computer, see I2C Monitor Graphical User Interface Uninstall before proceeding with the installation.
5. Double-click the `setup.exe` file to open the Install Shield Wizard window and wait for the extraction to complete. If required, the installation can be stopped by pressing the **Cancel** button.

6. In the Welcome to the Install Shield Wizard for I2CMonitor window, click **Next** to start the installation.

Figure 2-1. Starting the I²C Monitor Graphical User Interface Installation

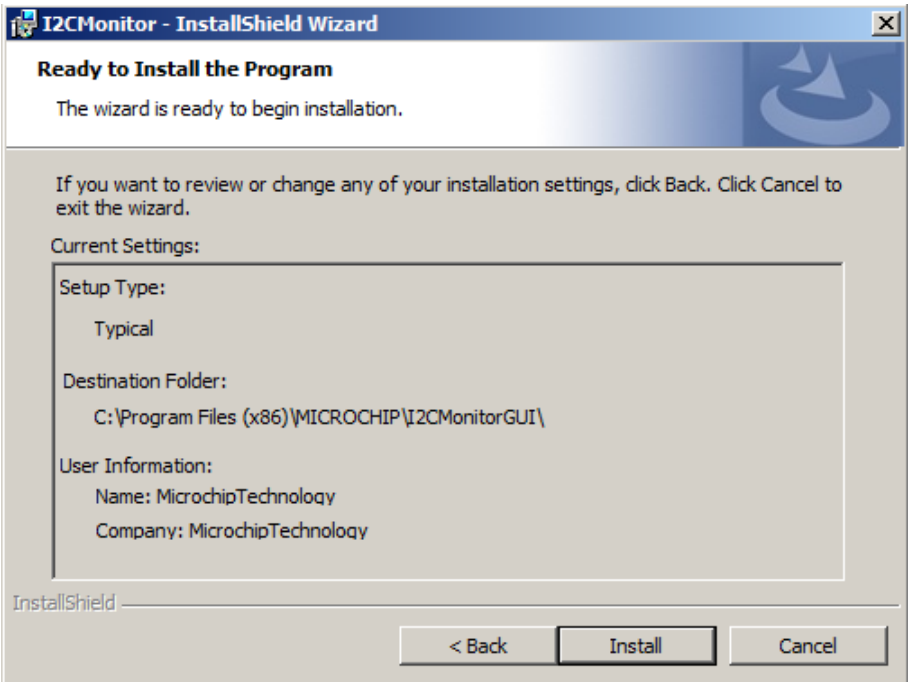
7. The installation path can be changed, although it is recommended to keep the default path. Click **Next** to continue.

Figure 2-2. Selecting the Destination Folder



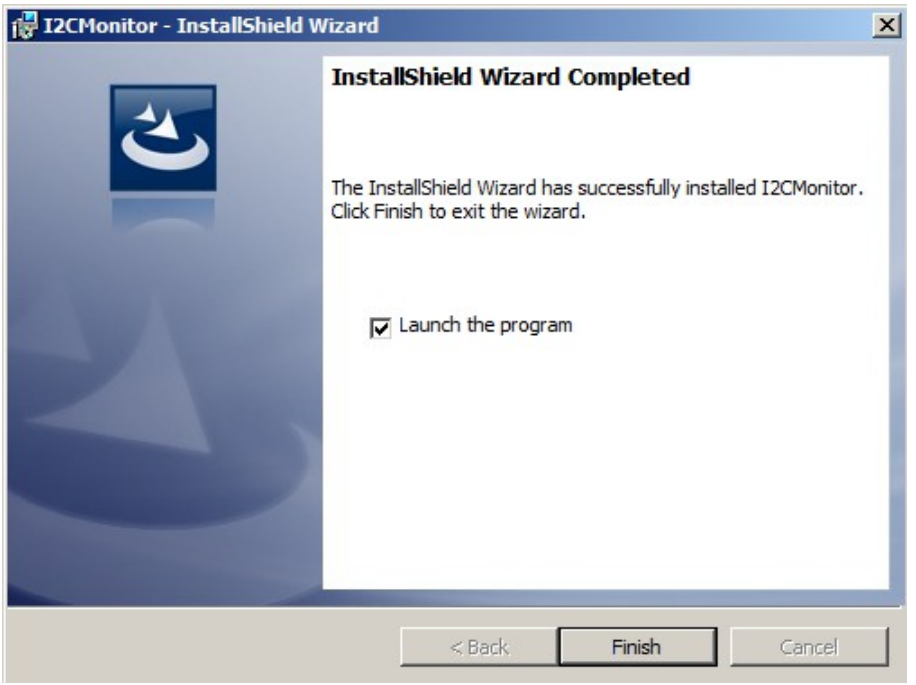
8. In the Ready to Install the Program window, click **Install** and wait for the application to proceed with the installation.

Figure 2-3. Installing the I²C Monitor Graphical User Interface



9. Once the installation is complete, click **Finish** to end the installation. To start the GUI, either click the desktop icon or browse to *Windows Start>All Programs>Microchip>I2C Monitor*.

Figure 2-4. InstallShield Wizard Completed Window

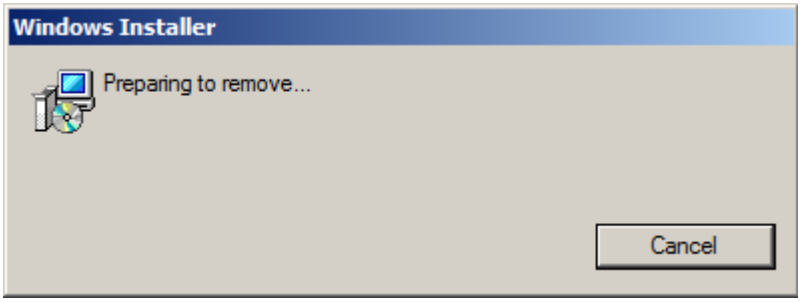


2.4. I²C Monitor Graphical User Interface Uninstall

To install a new version of the I²C Monitor Graphical User Interface, any previous or corrupted version must be removed from the computer.

To uninstall it, go to *Windows Start>Control Panel>Uninstall a program>I2C Monitor*. The I²C Monitor will automatically close once the process is complete.

Figure 2-5. Uninstalling the I²C Monitor Graphical User Interface



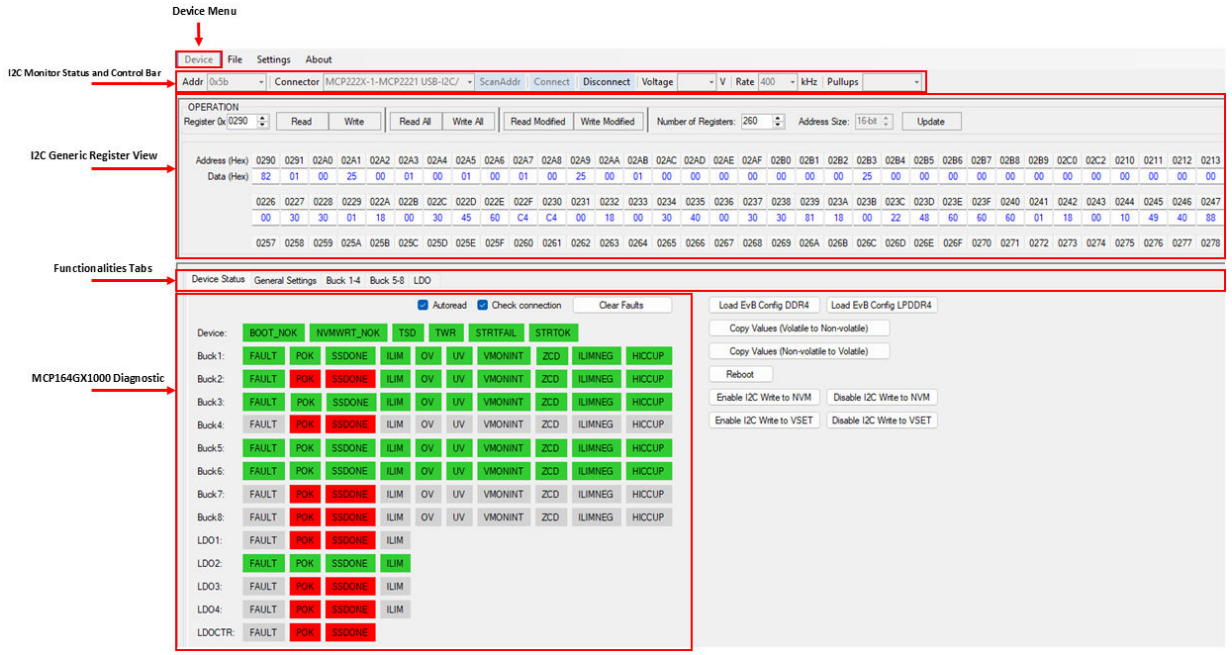
3. Graphical User Interface (GUI)

3.1. Introduction

This chapter describes how to use the I²C Monitor Graphical User Interface with the MCP164GX1000 (EV22R85A) Evaluation Board.

NOTICE This chapter provides information on how to use the GUI with the MCP164GX1000. For other devices using the I²C Monitor Graphical User Interface, see their specific data sheets and user guides.

Figure 3-1. I²C Monitor Graphical User Interface Main Window - MCP164GX1000 View



All the changes to register values are made in the Volatile Register Map. For these changes to be present after a repowering of the PMIC, follow these steps:

1. Enable I2C Write to VSET and Enable I2C Write to NVM by pressing the corresponding buttons.
2. Copy the values (Volatile to Non-Volatile) by pressing the corresponding button.
3. Write all registers values by pressing the corresponding button.

3.2. Graphical User Interface

3.2.1. Device Menu

The Device drop-down menu allows the user to select the device to be evaluated.

3.2.2. I²C Monitor Status and Control

The *Status and Control* bar includes the items listed in Table 3-1.

Figure 3-2. I²C Monitor Status and Control Bar

Table 3-1. Monitor Status And Control Bar

Item	Description
Addr	This drop-down menu shows the addresses of the available devices.
Connector	This drop-down menu shows the type of connector used to connect the board.
ScanAddr	This button scans for a valid address.
Connect/Disconnect	These buttons connect or disconnect the currently selected device.
Voltage	This drop-down menu selects the voltage level for communication when using the PICkit™ Serial Analyzer.
Rate	This drop-down menu selects the appropriate communication rate for the device.
Pullups	This drop-down menu activates the internal pull-ups of the PICkit Serial Analyzer.

In the *Status and Control* bar, users can select the hardware tool for communicating with the device and configure its settings.

To connect to a device, users must first complete the first three steps outlined in the Getting Started section. After connecting the USB-USB-C cable, users must scan for a valid address. Once a valid address is detected, clicking the **Connect** button will initialize the connection with the device, making the registers available for read and write operations.

3.2.3. I²C Generic Register View

The I²C Generic Register View area includes items listed in Table 3-2. This section of the I²C Monitor GUI is standard for any device being evaluated.

Figure 3-3. Generic Register View Area

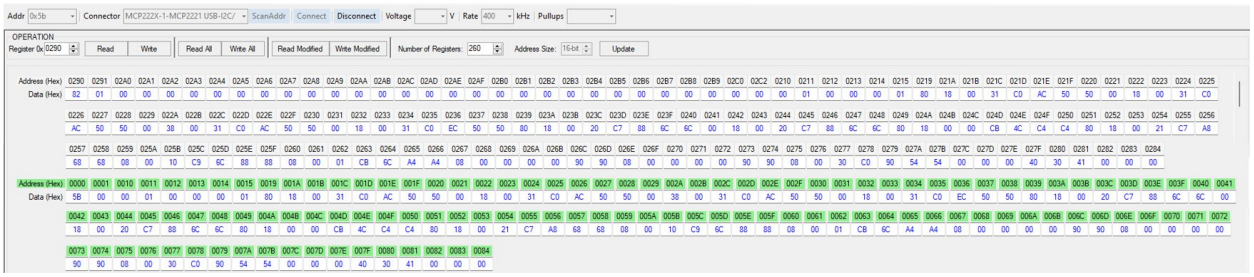


Table 3-2. I²C Generic Register View Items

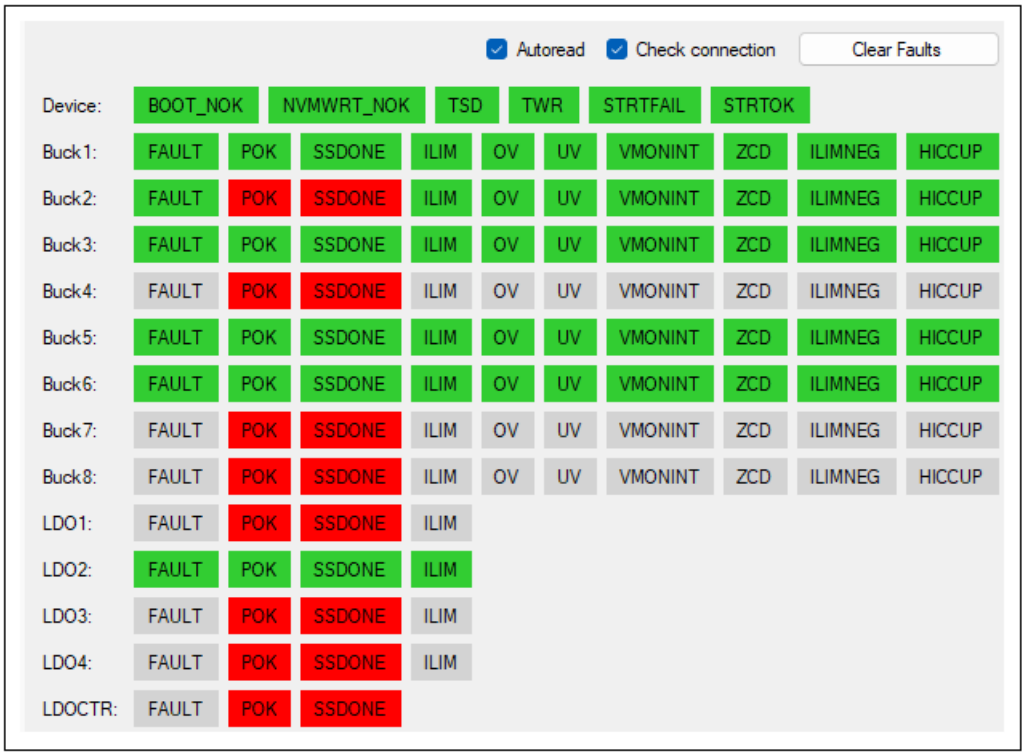
Panel	Item	Description
Operation	Register	This section shows the registers available for read/write operations.
	Read/Write	These buttons are used for single register read/write operations.
	Read All/Write All	These buttons are used for reading/ writing all the available registers.
	Number of Registers	In this section, the user can set the number of available registers for read/ write operations.
	Address Size	In this section, the user can set the registers' address size.
	Update	This button sets the number of available registers for read/write operations in the Register Area.
Register Area		This section shows the current status of the registers' address and the content.

The MCP164GX1000 specific registers are described in the MCP164GX1000 Data Sheet.

3.2.4. MCP164GX1000 I²C Diagnostic

The MCP164GX1000 I²C Diagnostic part of the GUI summarizes the information contained in the STATUS register.

Figure 3-4. I²C Diagnostic Area



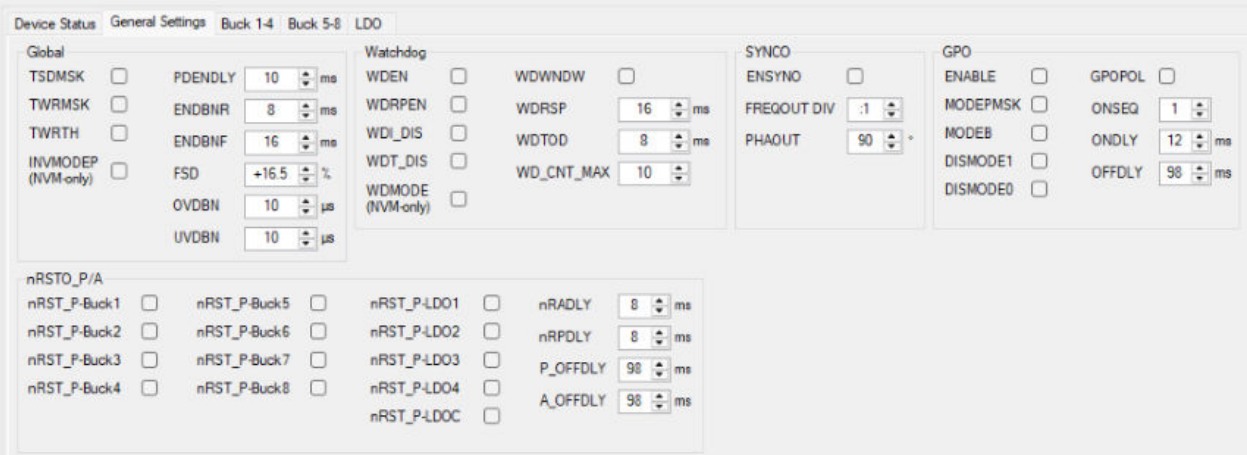
This region marks the status and faults of each corresponding bits in the registers. For the SSDONE, STRTOK and POK status flags, green signals a '1' condition and red signals a '0' condition. For the TSD, TWR, BOOT_NOK, NVMWRT_NOK, VMONINT, FAULT, HICCUP, ZCD, OV, UV, STRTFAIL, ILIM, and fault flags, green signals a '0' condition and red signals a '1' condition, indicating an active fault.

If the "Autoread" box is checked, all the information is refreshed automatically. All fault flags are reset on read, so the GUI memorizes the appearance of a Fault. To clear them from the GUI, the **Clear Faults** button must be clicked.

3.2.5. MCP164GX1000 I²C General Settings

This area of the GUI allows the user to modify the general related features of the PMIC.

Figure 3-5. General Settings



nRSTO_P is an individual POK monitor; it must be enabled for each channel that needs to be monitored at start-up/shutdown. When all the I/O rails have successfully powered on (POK threshold is reached), the monitored rails are fully working and nRSTO_P will deassert with a default or user-defined delay. For the MCP164GX1000 Evaluation Board, the default configuration does not enable POK monitoring for any channels.

nRSTO_A is the global reset; it will deassert after all regulators have started correctly.

3.2.5.1. MCP164GX1000 Global

The MCP164GX1000 Global area in General Settings contains the items listed in Table 3-3.

Figure 3-6. Global Settings

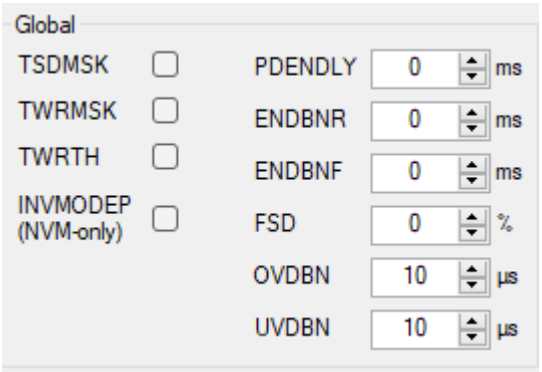


Table 3-3. Global

Panel	Item	Description
Global	TSDMSK	If the TSDMSK box is ticked, nINTO assertion at Thermal Shutdown is masked.
	TWRMSK	If the TWRMSK box is ticked, nINTO assertion during Thermal Early Warning is masked.
	TWRTH	If the TWRTH box is ticked, Thermal Early Warning Threshold is set to 1.
	INVMODEP (NVM-only)	If the INVMODEP box is ticked, MODE polarity is inverted.
	PDENDLY	This spin box allows Power-Down Enable Delay for the Enable L-to-H transition to be ignored until the delay has expired.
	ENDBNR	This spin box allows for debounce time for the L-to-H transition of Enable.
	ENDBINF	This spin box allows for debounce time for the H-to-L transition of Enable.
	FSD	This spin box allows for Switching Frequency Displacement.
	OVDBN	This spin box allows for Overvoltage comparator debouncing delay.
	UVDBN	This spin box allows for Undervoltage comparator debouncing delay.

3.2.5.2. MCP164GX1000 Watchdog

The MCP164GX1000 Watchdog area in General Settings contains the items listed in Table 3-4.

Figure 3-7. Watchdog Settings

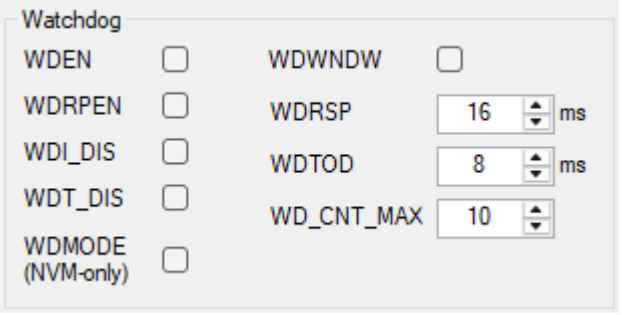


Table 3-4. Watchdog

Panel	Item	Description
Watchdog	WDEN	If the WDEN box is ticked, the Watchdog is enabled.
	WDRPEN	If the WDRPEN box is ticked, the Watchdog is enabled on nRSTO_P deassertion.
	WDI_DIS	If the WDI_DIS box is ticked, the Watchdog counter will not be incremented during H-to-L transitions.
	WDT_DIS	If the WDT_DIS box is ticked, the Watchdog counter will not be incremented during watchdog timer timeout.
	WDMODE (NVM-only)	If the WDMODE box is ticked, the Watchdog is in MODE 1.
	WDWNDW	If the WDWNDW box is ticked, the Watchdog is windowed.
	WDRSP	This spin box allows the change of Watchdog pulse width.
	WDTOD	This spin box allows for different time-out delays for the Watchdog.
	WD_CNT_MAX	This spin box allows the change of the maximum number of time-outs.

3.2.5.3. MCP164GX1000 SYNCO

The MCP164GX1000 SYNCO area in General Settings contains the items listed in Table 3-5.

Figure 3-8. SYNCO Settings

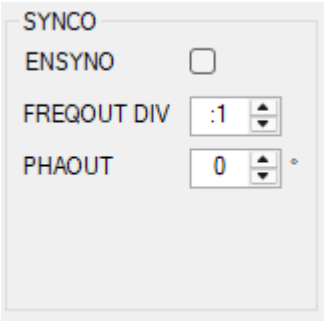


Table 3-5. SYNCO

Panel	Item	Description
SYNCO	ENSYNO	If the ENSYNO box is ticked, Synchronization Output is enabled.
	FREQOUT DIV	This spin box allows for different division ratios for external synchronization.
	PHAOUT	This spin box allows for the synchronization signal to have a different phase.

3.2.5.4. MCP164GX1000 GPO

The MCP164GX1000 GPO area in General Settings contains the items listed in Table 3-6.

Figure 3-9. GPO Settings.

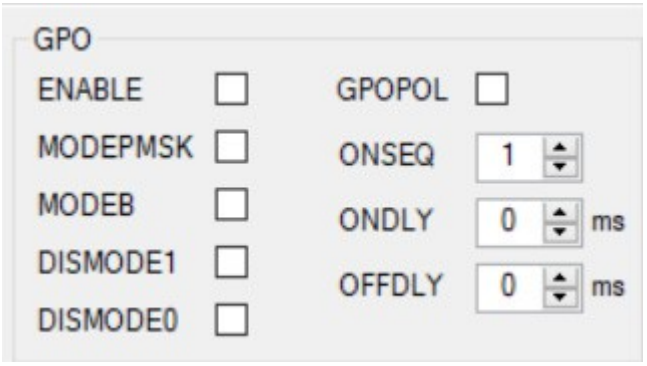


Table 3-6. GPO

Panel	Item	Description
GPO	ENABLE	If the ENABLE box is ticked, GPO is enabled during start-up.
	MODEPMSK	If the MODEPMSK box is ticked, the MODE pin is masked.
	MODEB	If the MODEB box is ticked, the MODE pin value is irrelevant.
	DISMODE1	If the DISMODE1 box is ticked, the channel will be disabled when MODE is 1 even if ENABLE is 1.
	DISMODE0	If the DISMODE0 box is ticked, the channel will be disabled when MODE is 0, even if ENABLE is 1.
	GPOPOL	If the GPOPOL box is ticked, the polarity of GPO is inverted.
	ONSEQ	This spin box assigns GPO to a certain ON sequence step.
	ONDLY	This spin box programs the delay between the end of the previous sequence and the assertion of GPO.
	OFFDLY	This spin box programs the delay between the deassertion of ENABLE and the deassertion of GPO.

3.2.5.5. MCP164GX1000 nRSTO_P/A

The MCP164GX1000 nRSTO_P/A area in General Settings contains the items listed in Table 3-7.

Figure 3-10. nRSTO_P/A Settings

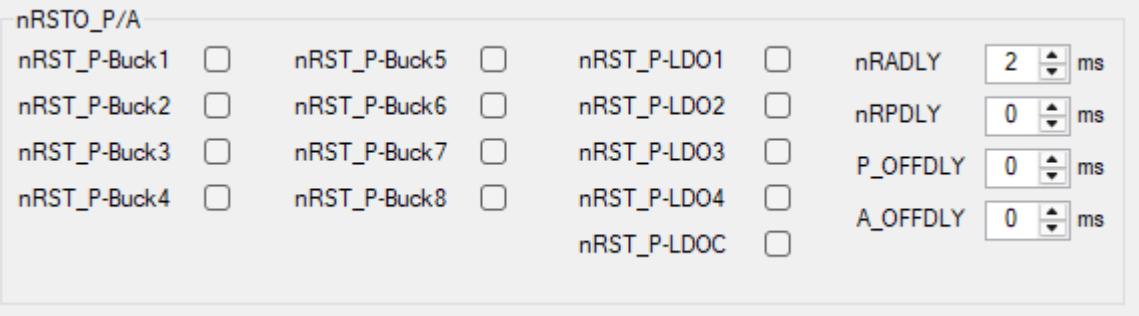


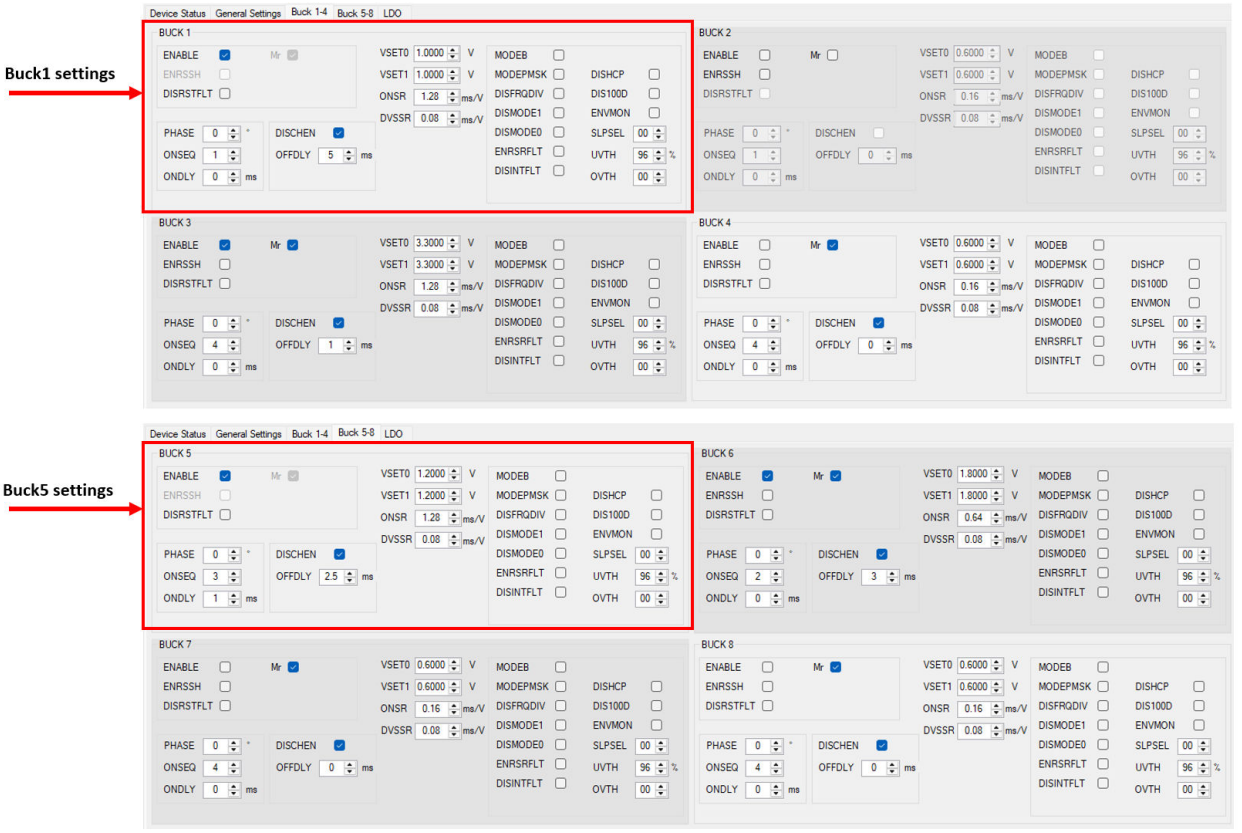
Table 3-7. nRSTO_P/A

Panel	Item	Description
nRSTO_P/A	nRST_PBUCKs 1 to 8	If the nRST_P for BUCKS 1 to 8 box is ticked, the channel will be taken into consideration for nRSTO_P deassertion.
	nRST_PLDOs 1 to 4 and LDOC	If the nRST_P for LDOs 1 to 4 and LDOC box is ticked, the channel will be taken into consideration for nRSTO_P deassertion.
	nRADLY	This spin box sets the delay of deassertion of nRSTO_A.
	nRPDLY	This spin box sets the delay of deassertion of nRSTO_P.
	P_OFFDLY	This spin box sets the delay between the deassertion of the ENABLE input and the assertion of nRSTO_P.
	A_OFFDLY	This spin box sets the delay between the deassertion of the ENABLE input and the assertion of nRSTO_A.

3.2.6. MCP164GX1000 I²C Buck Channel Settings

This area of the GUI allows the user to modify the Buck-related features individually for each of the eight Buck channels. There are two tabs for the Buck channels, the first tab is for Bucks 1 to 4, and the second tab is for Bucks 5 to 8.

Figure 3-11. I²C Buck Channel Settings



3.2.6.1. MCP164GX1000 BUCKS 1 to 8 General

The MCP164GX1000 General area in BUCKS 1 to 8 contains the items listed in Table 3-8.

Figure 3-12. General Buck Channel Settings

Table 3-8. General

Panel	Items	Description
General	ENABLE	If the ENABLE box is ticked, the channel will activate at start-up.
	DISRSTFLT	If the DISRSTFLT box is ticked, nRSTO_A/P will not deassert upon a channel fault during run time.
	ENRSSH	If the ENRSSH box is ticked, a replica channel is disabled with the ENABLE bit.
	Mr	If the Mr box is ticked, the channel will be set to Main. Bucks 1 and 5 are always Main and cannot be replicas.
	VSET0	This spin box changes the output voltage of the channel when MODE is '0'.
	VSET1	This spin box changes the output voltage of the channel when MODE is '1'.

3.2.6.2. MCP164GX1000 BUCKS 1 to 8 Start-Up, Shutdown and Dynamic Voltage Scaling

The MCP164GX1000 Start-Up, Shutdown and Dynamic Voltage Scaling area in BUCKS 1 to 8 contains the items listed in Table 3-9.

Figure 3-13. Start-up, Shutdown and Dynamic Voltage Scaling Settings for Buck Channels.

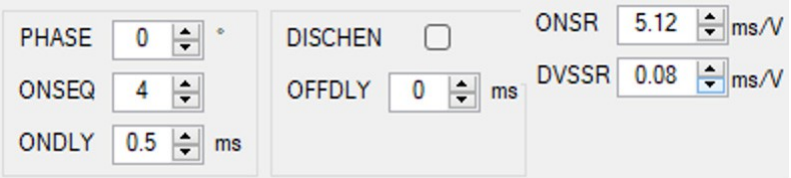


Table 3-9. Start-Up, Shutdown and Dynamic Voltage Scaling

Panel	Item	Description
Start-Up, Shutdown and DVSR	PHASE	This spin box sets the phase displacement of the Buck converter switch turn-on edge.
	ONSEQ	This spin box assigns the Buck to a certain ON sequence.
	ONDLY	This spin box sets the delay between the end of the previous sequence and the beginning of the converter turn-on.
	DISCHEN	If the DISCHEN box is ticked, the discharge resistor is enabled at turn-off.
	OFFDLY	This spin box sets the delay between the deassertion of ENABLE and the converter turn-off.
	DVSSR	This spin box set the slew-rate for DVS transitions.

3.2.6.3. MCP164GX1000 BUCKS 1 to 8 Features

The MCP164GX1000 Features area in Bucks 1 to 8 contains the items listed in Table 3-10.

Figure 3-14. Features Settings of Buck Channels

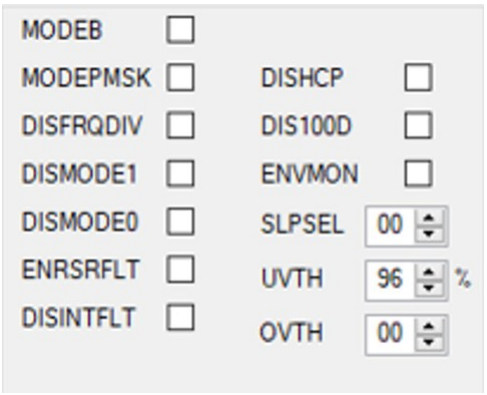
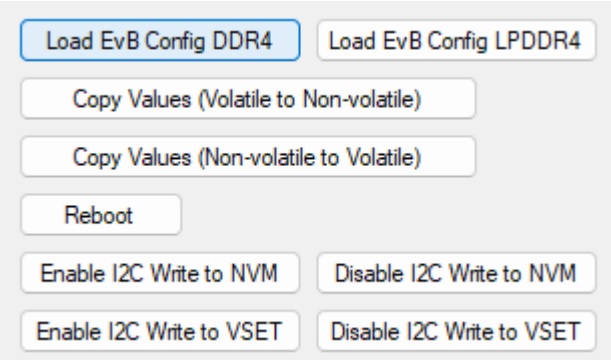


Table 3-10. Features

Panel	Item	Description
Features	MODEB	If the MODEB box is ticked when MODEMSK = 1, the MODE pin is irrelevant and only the MODEB value is taken into account.
	MODEPMSK	If the MODEMSK box is ticked, the MODE pin is not taken into consideration for a MODE change.
	DISFRQDIV	If the DISFRQDIV box is ticked, the frequency division algorithm in light-load efficiency is disabled.
	DISMODE1	If the DISMODE1 box is ticked, when a channel is ENABLED, it will be disabled when MODE = 1.
	DISMODE0	If the DISMODE0 box is ticked, when a channel is ENABLED, it will be disabled when MODE = 0.
	ENRSRFLT	If the ENRSRFLT box is ticked, when a channel has a fault, an automatic restart will be invoked after 100 ms.
	DISINTFLT	If the DISINTFLT box is ticked, nINTO will not deassert upon a channel fault during run time.
	DISHCP	If the DISHCP box is ticked, Hiccup mode overcurrent protection is disabled for the channel.
	DIS100D	If the DIS100D box is ticked, the duty cycle of the channel will be limited to 75%.
	ENVMON	If the ENVMON box is ticked, nINTO will deassert when an OV/UV condition is detected.
	SLPSEL	This spin box changes the slope compensation.
	UVTH	This spin box changes the threshold of undervoltage monitoring.
	OVTH	This spin box changes the threshold of overvoltage monitoring.

3.2.6.4. MCP164GX1000 Special Commands

Figure 3-15. Special Commands



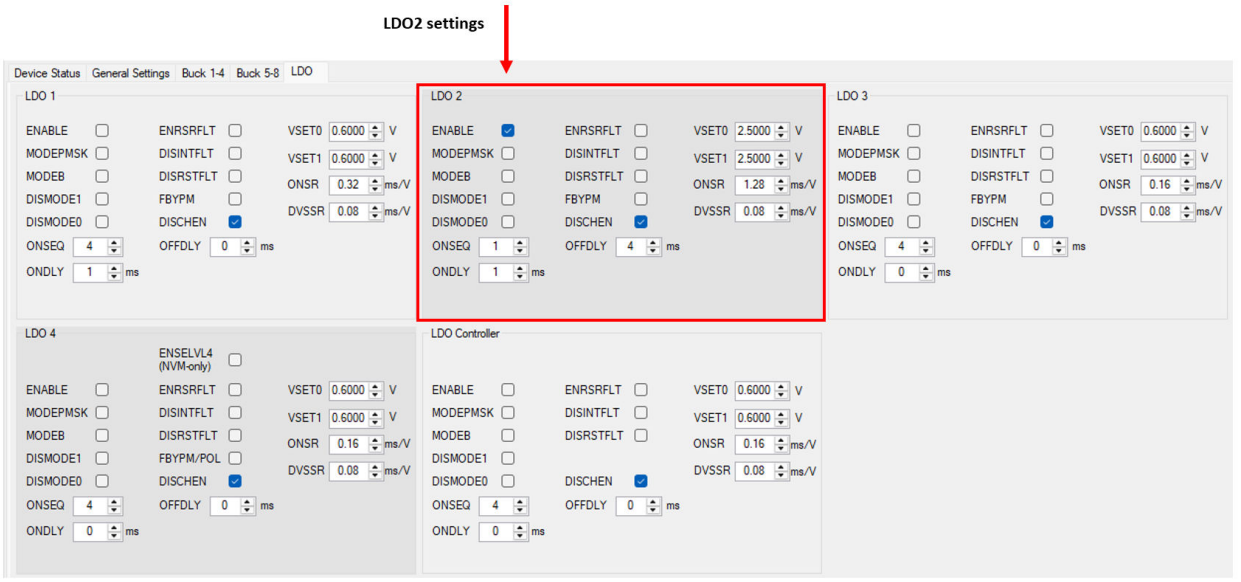
MCP164GX1000 has a list of special commands:

- **Load EvB Config DDR4** and **Load EvB Config LPDDR4** will load the typical application registry settings for the evaluation board to the appropriate values for either memory type. After loading the configuration, click the **Write All** button to make the changes effective.
- **REBOOT** is equivalent to a device turn-off. It reloads all values from the EEPROM content to volatile registers, followed by a new start-up sequence.
- **Enable I2C Write to NVM** is required to change the settings of the registers located in the non-volatile memory. **Disable I2C Write to NVM** revokes write access in the non-volatile memory.
- To change the output voltages, **Enable I2C Write to VSET** is required; otherwise, any changes to VSET settings will not be taken into account. **Disable I2C Write to VSET** revokes write access to VSET settings to avoid accidental changes in the VOUT settings.

3.2.7. MCP164GX1000 I²C LDO Channel Settings

This area of the GUI allows the user to modify the LDO-related features individually for each of the four LDO channels and LDO Controller.

Figure 3-16. I²C LDO Channel Settings



3.2.7.1. MCP164GX1000 LDOs 1 to 4 and LDO Controller General

The MCP164GX1000 General area in LDO contains the items listed in Table 3-11.

Figure 3-17. General Settings for the LDOs

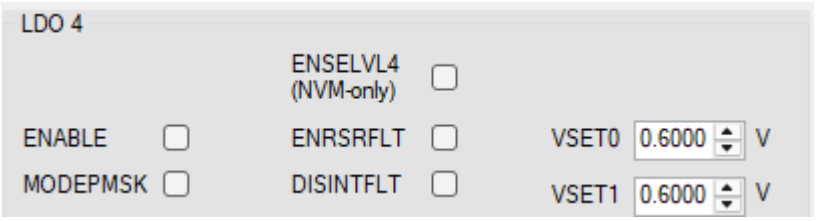


Table 3-11. General

Panel	Item	Description
General	ENABLE	If the ENABLE box is ticked, the channel will activate at start up.
	MODEPMSK	If the MODEMSK box is ticked, the MODE pin is not taken into consideration for a MODE change.
	ENRSRFLT	If the ENRSRFLT box is ticked, when a channel has a fault, an automatic restart will be invoked after 100 ms.
	DISINTFLT	If the DISINTFLT box is ticked, nINTO will not deassert upon a channel fault during run time.
	VSET0	This spin box changes the output voltage of the channel when MODE is 0.
	VSET1	This spin box changes the output voltage of the channel when MODE is 1.
	ENSELVL4	(LDO4 only) If the ENSELVL4 box is ticked, it enables SELVL4 to control the LDO4 voltage between 1.8V and 3.3V.

3.2.7.2. MCP164GX1000 LDOs 1 to 4 and LDO Controller Start-Up, Shutdown and Dynamic Voltage Scaling

The MCP164GX1000 LDOs 1 to 4 and LDO Controller Start-Up, Shutdown and Dynamic Voltage Scaling area contains the items listed in Table 3-12.

Figure 3-18. Start-Up, Shutdown and Dynamic Voltage Scaling for LDOs

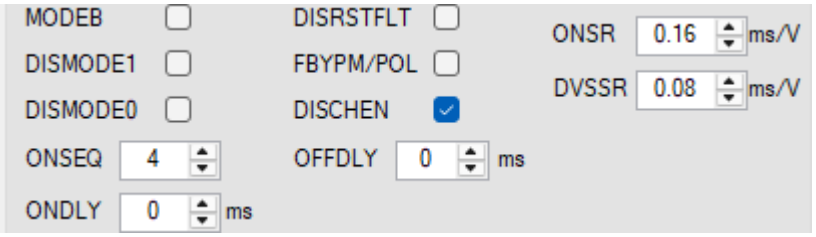


Table 3-12. Start-Up, Shutdown And Dynamic Voltage Scaling

Panel	Item	Description
Start-Up, Shutdown and DVSR	ONSEQ	This spin box assigns the LDO to a certain ON sequence.
	ONDLY	This spin box sets the delay between the end of the previous sequence and the beginning of the LDO turn-on.
	DISCHEN	If the DISCHEN box is ticked, the discharge resistor is enabled at turn-off.
	OFFDLY	This spin box sets the delay between the deassertion of ENABLE and the LDO turn-off.
	ONSR	This spin box sets the slew-rate for the soft-start ramp.
	DVSSR	This spin box set the slew-rate for DVS transitions.

3.2.7.3. MCP164GX1000 LDOs 1 to 4 and LDO Controller Features

The MCP164GX1000 LDOs 1 to 4 and LDO Controller Features area contains the items listed in Table 3-13.

Figure 3-19. Features Settings for LDOs.

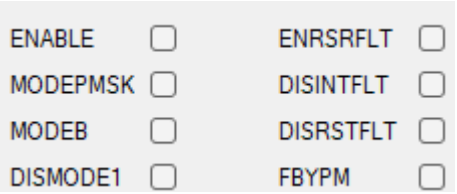


Table 3-13. Features

Panel	Item	Description
Features	MODEB	If the MODEB box is ticked when MODEMSK = 1, the MODE pin is irrelevant and only the MODEB value is taken into account.
	DISRSTFLT	If the DISRSTFLT box is ticked, nRSTO_A/P will not deassert upon a channel fault during run time.
	DISMODE1	If the DISMODE1 box is ticked, when a channel is ENABLED, it will be disabled when MODE = 1.
	DISMODE0	If the DISMODE0 box is ticked, when a channel is ENABLED, it will be disabled when MODE = 0.
	FBYPM/POL	(FBYPM exclusive LDOs 1 to 4) Forces LDOs in Load-Switch mode.
		(POL LDO4 only) If this box is ticked and ENSELVL4 = 1, it selects the polarity of SELVL4 logic.

3.2.8. Status Bar

The status bar provides information on the status of the device connected to the PC.

Figure 3-20. Status Bar

Table 3-14. Status Bar Items

Item	Description
Status Label	The label shows if there is any device connected to the board. Refer to Table 3-15 for a list of possible labels.
Progress Bar	This bar shows the level of completion for a given command.

Table 3-15. Status Labels

Status Label	Description
STATUS: Connected!	This message is shown when the GUI connects to a device.
STATUS: Disconnected!	This message is shown when the GUI does not detect a connected device.

The specific settings for all control areas are detailed in the register map available in the MCP164GX1000 Data Sheet.

4. Board Design

This chapter contains the following schematics and layout for the MCP164GX1000 (EV22R85A) Evaluation Board:

- Board– Schematic 1
- Board– Schematic 2
- Board– Top Silk
- Board– Top Copper and Silk
- Board– Top Copper
- Board– Mid-Layer 1
- Board– Mid-Layer 2
- Board– Bottom Copper
- Board– Bottom Copper and Silk
- Board– Bottom Silk

4.1. Schematic

Figure 4-1. Board - Schematic 1

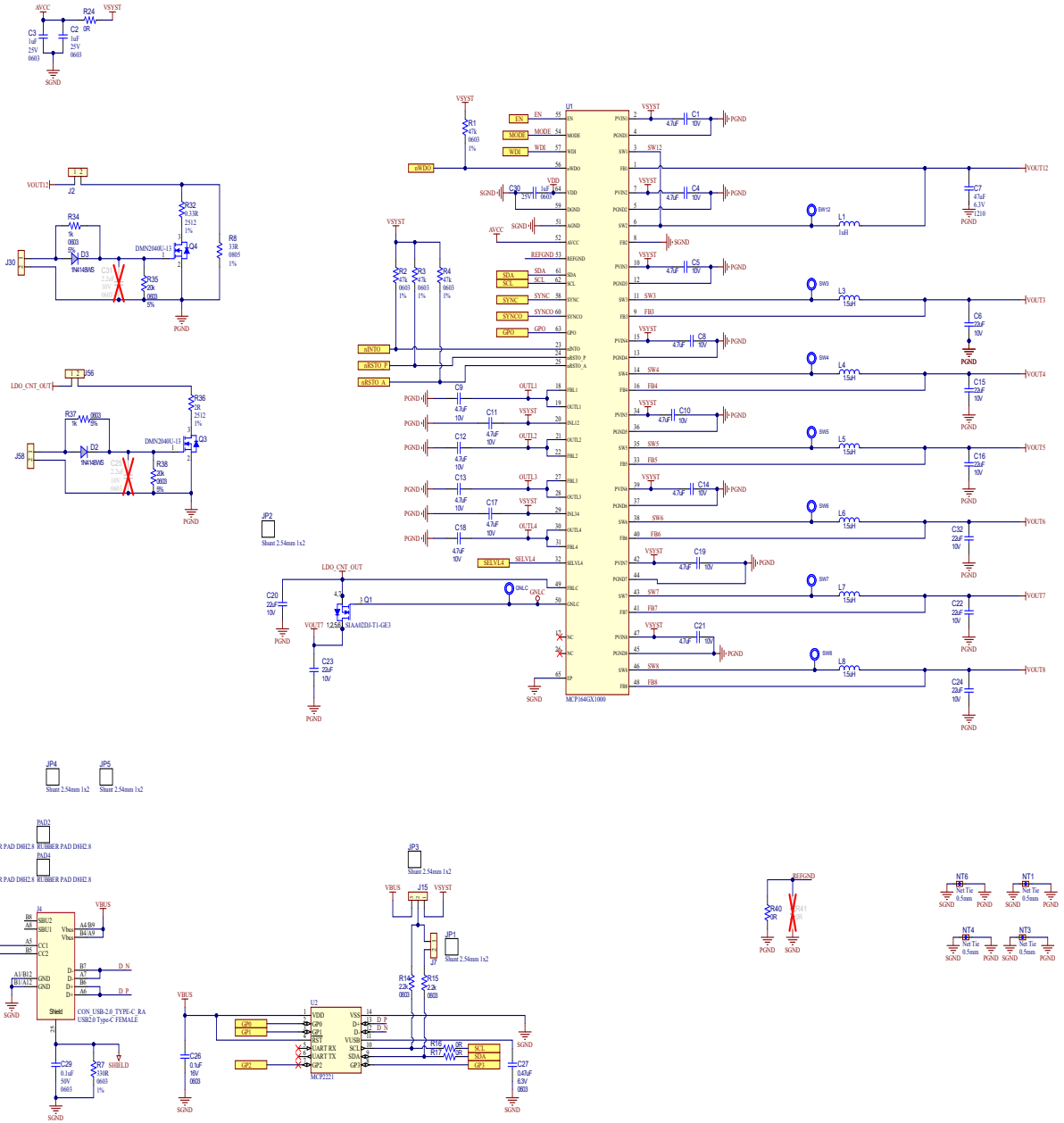
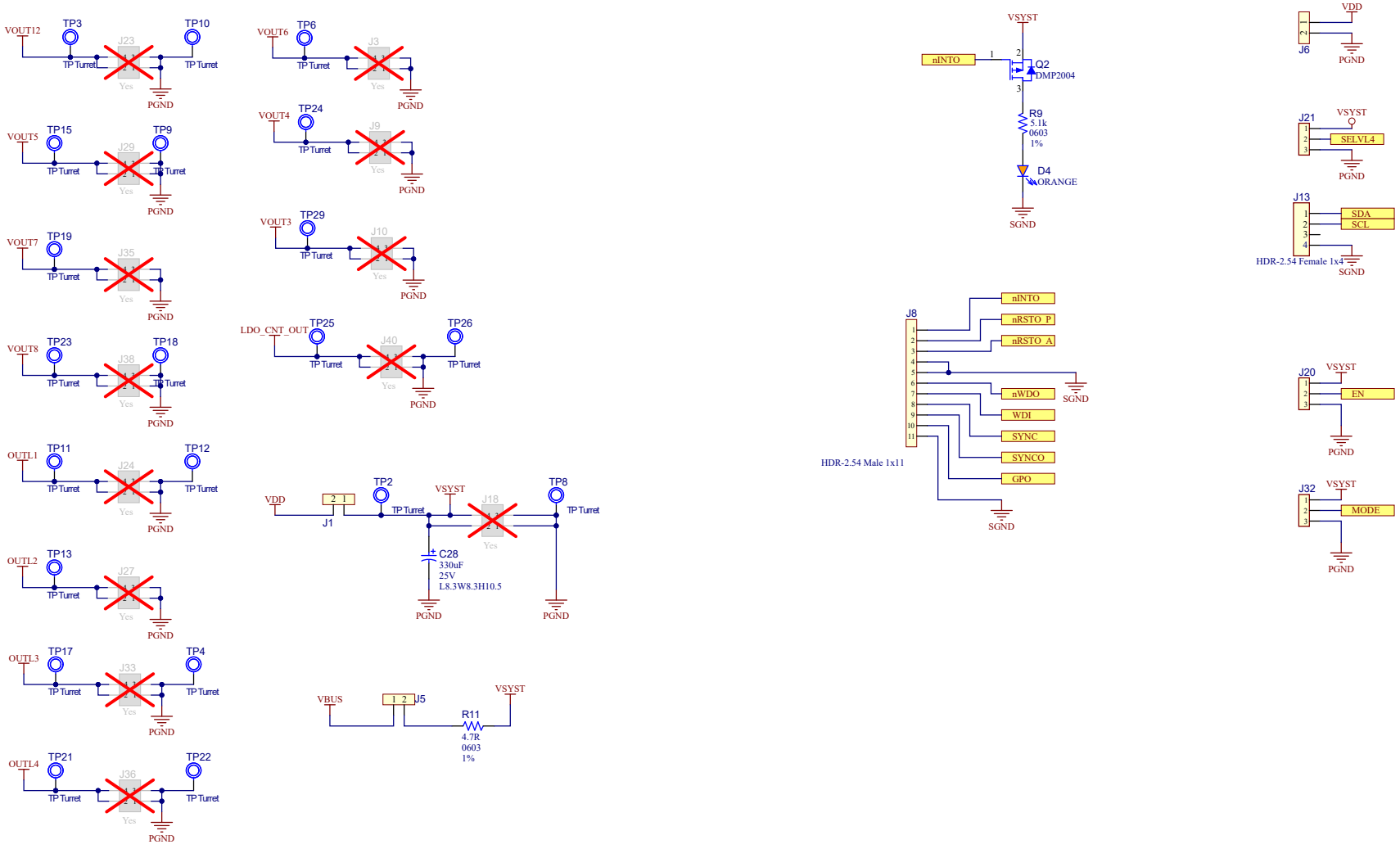


Figure 4-2. Board - Schematic 2



4.2. Layout

Figure 4-3. Board – Top Silk

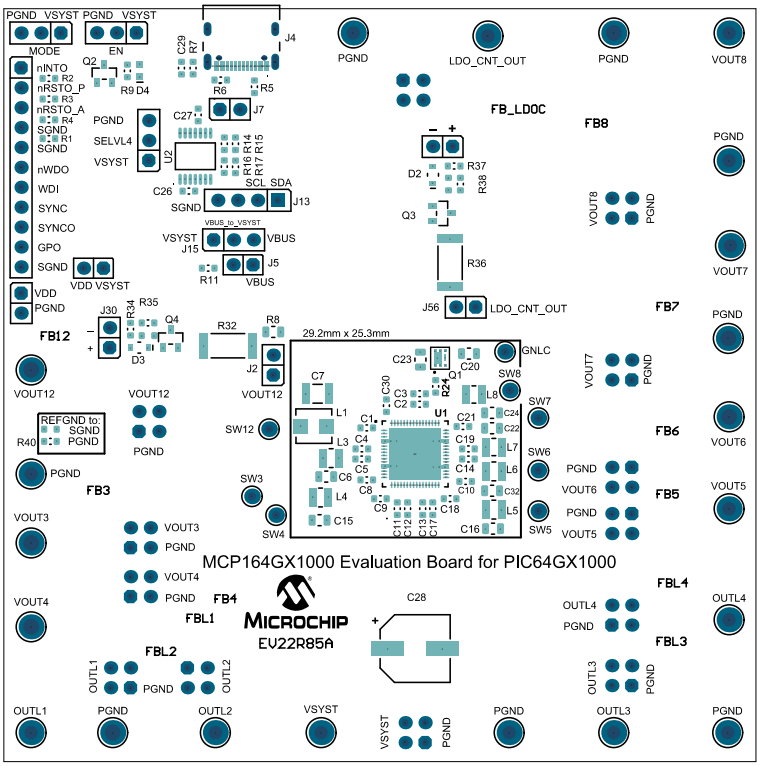


Figure 4-4. Board – Top Copper and Silk

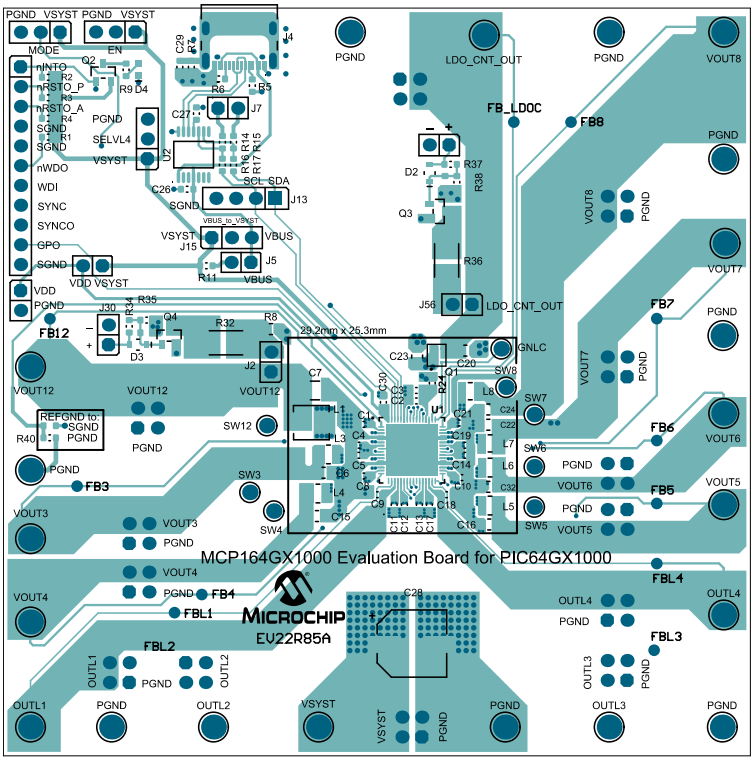


Figure 4-5. Board – Top Copper

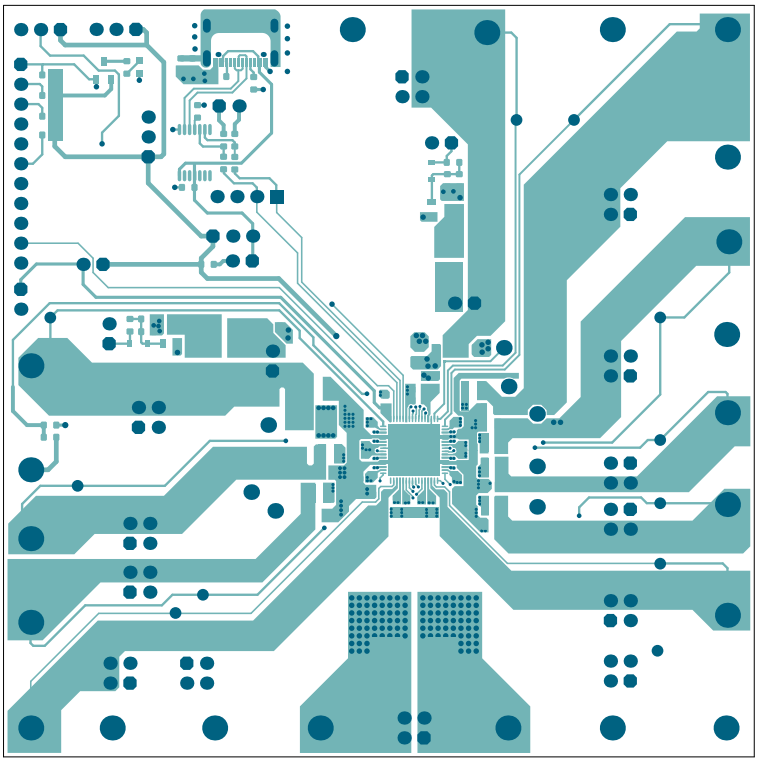


Figure 4-6. Board – Mid-Layer 1

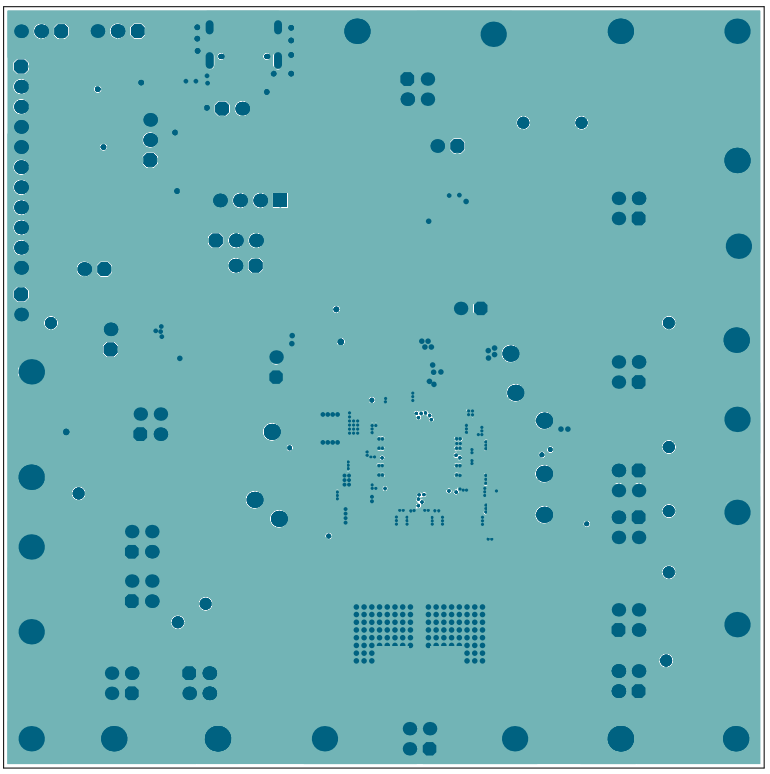


Figure 4-7. Board – Mid-Layer 2

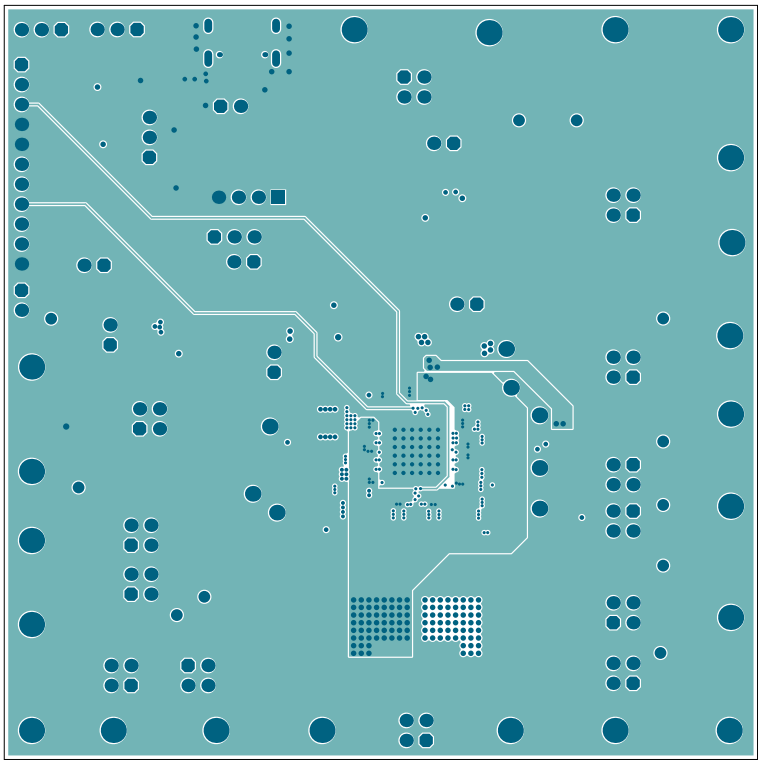


Figure 4-8. Board – Bottom Copper

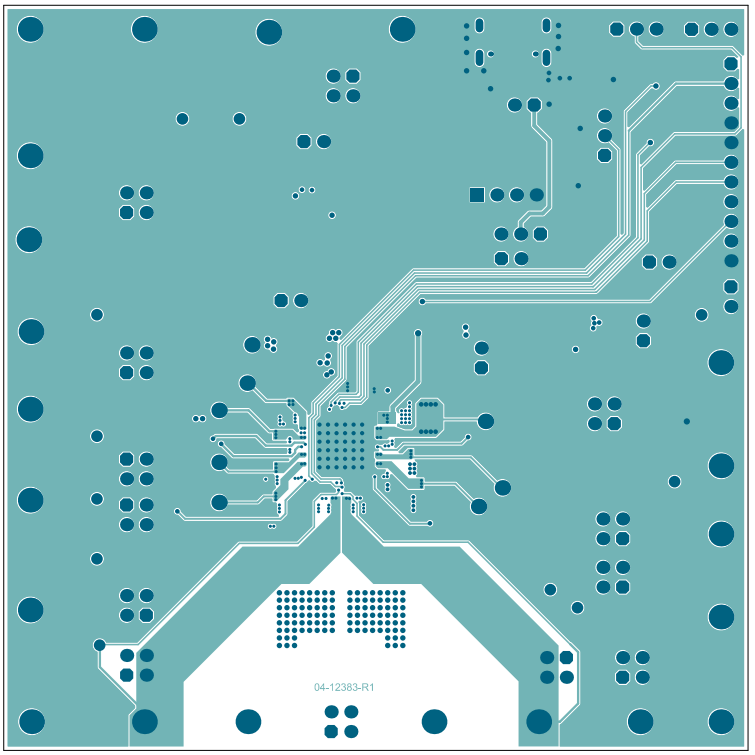


Figure 4-9. Board – Bottom Copper and Silk

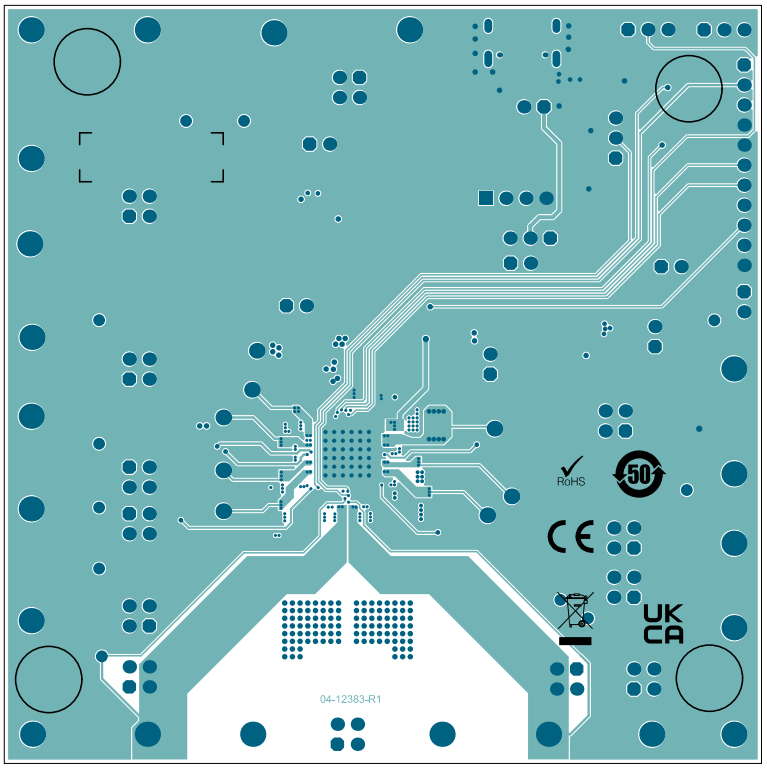
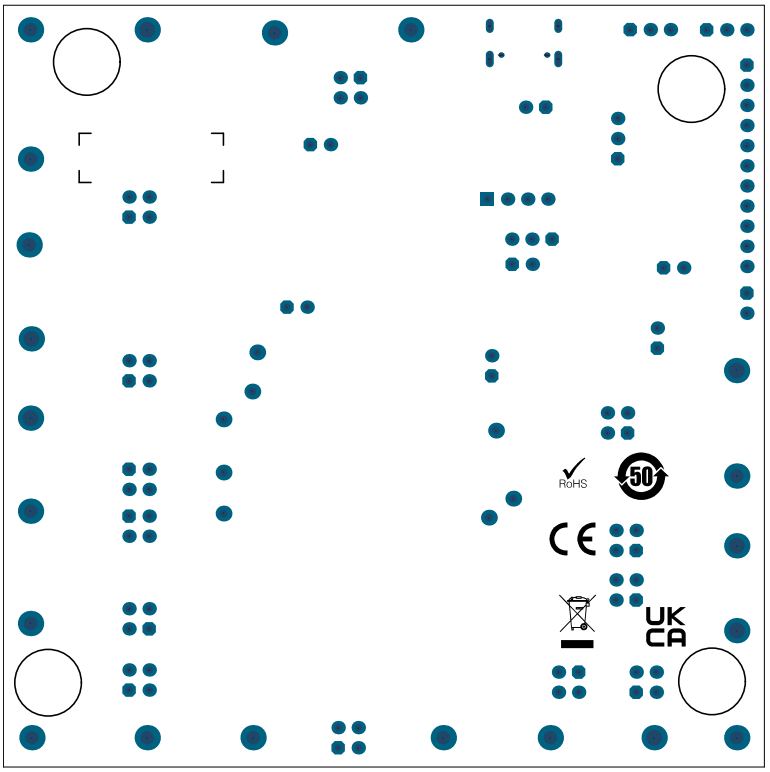


Figure 4-10. Board – Bottom Silk



5. Bill of Materials (BOM)

Table 5-1. Bill of Materials (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
14	C1, C4, C5, C8, C9, C10, C11, C12, C13, C14, C17, C18, C19, C21	Ceramic Capacitor, 4.7 µF, 10V, 10%, X7S, SMD, 0603	TDK Corporation	C1608X7S1A475K080AC
2	C2, C3	Ceramic Capacitor, 1 µF, 25V, 10%, X7R, SMD, 0603	TDK Corporation	C1608X7R1E105K080AB
8	C6, C15, C16, C20, C22, C23, C24, C32	Ceramic Capacitor, 22 µF, 10V, 20%, X7S, SMD, 0805	TDK Corporation	C2012X7S1A226M125AC
1	C7	Ceramic Capacitor, 47 µF, 6.3V, 20%, X7S, SMD, 1210	TDK Corporation	C3225X7S0J476M250AC
1	C26	Ceramic Capacitor, 0.1 µF, 16V, 10%, X7R, SMD, 0603	Wurth Elektronik	885012206046
1	C27	Ceramic Capacitor, 0.47 µF, 6.3V, 10%, X5R, SMD, 0603	Murata Electronics®	GRM188R60J474KA01D
1	C28	Aluminum Capacitor, 330 µF, 25V, 20%, SMD, L8.3W8.3H,10.5, AEC-Q200	Wurth Elektronik	865080453014
1	C29	Ceramic Capacitor, 0.1 µF 50V, 20%, X7R, SMD, 0603	TDK Corporation	C1608X7R1H104M080AA
1	C30	Ceramic Capacitor, 1 µF, 25V, 10%, X7R, SMD, 0603	Yageo Corporation	CC0603KRX7R8BB105
2	D2, D3	Diode Rectifier, 1.25V, 150 mA, 75V, SOD-323	Diodes Incorporated®	1N4148WS-7-F
1	D4	Diode LED, Orange, 2V, 20 mA, 90 mcd, Clear, SMD, 0603	Lite-On®,Inc.	LTST-C191KFKT
8	J1, J2, J5, J6, J7, J30, J56, J58	Connector Header, 2.54, Male, 1x2, Gold, 5.84 MH, Through Hole, Vertical	FCI	77311-118-02LF
1	J4	Connector, USB, 2.0, Type-C, Female, SMD/Through Hole, R/A	GCT® Inc.	USB4105-GF-A
1	J8	Connector Header, 2.54, Male, 1x11, Gold, 5.84MH, Through Hole, Vertical	Sullins Connector Solutions	PBC11SAAN
1	J13	Connector Header, 2.54, Female, 1x4, Gold, Through Hole, Vertical	Samtec, Inc.	SSW-104-01-G-S
4	J15, J20, J21, J32	Connector Header, 2.54, Male, 1x3, Tin, 5.84MH, Through Hole, Vertical	Samtec, Inc.	TSW-103-07-T-S
1	L1	Inductor, 1 µH, 8A, 20%, SMD, L4.2W4H3.0	TDK Corporation	SPM4030T-1R0M
6	L3, L4, L5, L6, L7, L8	Inductor, 1.5 µH, 3.5A, 20%, SMD, 1008	Murata Electronics	DFE252012P-1R5M=P2
1	Q1	Transistor MOSFET, N-Channel, 20V, 22A, 3.5W, (Ta)PowerPAK SC-70-6	Vishay® Siliconix	SIAA02DJ-T1-GE3
1	Q2	Transistor MOSFET, P-Channel, 20V, 0.6A, 0.9R, 0.55W, SOT-23-3	Diodes Incorporated	DMP2004K-7
2	Q3, Q4	Transistor, MOSFET, N-Channel, 20V, 6A, 800 mW, SOT23-3	Diodes Incorporated	DMN2040U-13
4	R1, R2, R3, R4	Resistor, Thick Film, 47 kΩ, 1%, 1/4W, SMD, 0603	Vishay Intertechnology®	CRCW060347K0FKEAHP
3	R5, R6, R9	Resistor, Thick Film, 5.1 kΩ, 1%, 1/10W, SMD, 0603	Panasonic®	ERJ-3EKF5101V

Table 5-1. Bill of Materials (BOM) (continued)

Qty.	Reference	Description	Manufacturer	Part Number
1	R7	Resistor, Thick Film, 330Ω, 1%, 1/10W, SMD, 0603	Panasonic	ERJ-3EKF3300V
1	R8	Resistor, Thick Film, 33Ω, 1%, 1/8W, SMD, 0805, AEC-Q200	Vishay Intertechnology	CRCW080533R0FKEA
1	R11	Resistor, Thick Film, 4.7Ω, 1%, 1/10W, SMD, 0603	Panasonic	ERJ-3RQF4R7V
2	R14, R15	Resistor, Thick Film, 2.2 kΩ, 1%, 1/10W, SMD, 0603	Panasonic	ERJ-3EKF2201V
4	R16, R17, R24, R40	Resistor, Thick Film, 0Ω, 1/10W, SMD, 0603	Panasonic	ERJ-3GSY0R00V
1	R32	Resistor, Thick Film, 0.33Ω, 1%, 1W, SMD, 2512	Vishay Intertechnology	WSL2512R3300FEA
2	R34, R37	Resistor, Thick Film, 1 kΩ, 5%, 1/10W, SMD, 0603	Panasonic	ERJ-3GEYJ102V
2	R35, R38	Resistor, Thick Film, 20 kΩ, 5%, 1/10W, SMD, 0603	Panasonic	ERJ-3GSYJ203
1	R36	Resistor, Thick Film, 2Ω, 1%, 2W, SMD, 2512	Bourns®,Inc.	CRM2512-FX-2R00ELF
8	TP1, TP5, TP7, TP27, TP31, TP32, TP33, TP34	Miscellaneous,Test Point, Multi Purpose, Miniature, White	Keystone® Electronics Corp.	5002
21	TP2, TP3, TP4, TP6, TP8, TP9, TP10, TP11, TP12, TP13, TP15, TP17, TP18, TP19, TP21, TP22, TP23, TP24, TP25, TP26, TP29	Connector, Test Point, PIN, Tin, Through Hole	Harwin Plc.	H2121-01
1	U1	Analog PMIC Switcher, Buck, ADJ, VQFN-64	Microchip Technology Inc.	MCP164GX1000TAB-K/CX
1	U2	Interface USB, I^2C, UART, TSSOP-14	Microchip Technology Inc.	MCP2221-I/ST
1	PCB1	MCP164GX1000 (EV22R85A) Evaluation Board – Printed Circuit Board	Microchip Technology Inc.	04-12135-R1

Note:

1. The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

Table 5-2. Bill of Materials (BOM) - Mechanical Parts

Qty.	Reference	Description	Manufacturer	Part Number
5	JP1,JP2, JP3, JP4, JP5	Mechanical, HW Jumper,2.54 mm, 1 x 2	FCI	63429-202LF
1	LABEL1	Label, PCBA, 18 x 6 mm, Data- matrix Assy# /Rev/Serial/ Date	ACT Logimark AS	505462
4	PAD1, PAD2, PAD3, PAD4	Mechanical, HW Rubber Pad Cylindrical flat top D8H2.8 Black	3M	SJ5076BLACK

Note:

1. The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

Table 5-3. Bill of Materials (BOM) - DO NOT POPULATE PARTS

Qty.	Reference	Description	Manufacturer	Part Number
0	C25,C31	Ceramic Capacitor, 2.2 µF, 10V, 10%, X7R, SMD, 0603	Murata Electronics	GRM188R71A225KE15D
0	J3, J9, J10, J18, J23, J24, J27, J29, J33, J35, J36, J38, J40	Connector Header, 2.54, Male, 2x2, Gold, 5.84 MH, Through Hole, Vertical	Samtec, Inc.	HTSW-102-07-G-D
0	R41	Resistor, Thick Film, 0Ω, 1/10W, SMD, 0603	Panasonic	ERJ-3GSY0R00V

6. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Revision	Date	Section	Description
A	05/2025		Initial Revision

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