EVM User's Guide: AMC7908EVM

AMC7908 Evaluation Module

Description

The AMC7908EVM is an easy-to-use platform to evaluate the functionality and performance of the AMC7908 device. The AMC7908EVM has optional circuits and jumpers to configure the device for different applications.

The AMC7908 is a highly integrated power-amplifier monitor and control device with eight 13-bit digital-to-analog converters (DAC) and a 12-bit analog-to-digital converter (ADC). The DACs can be switched on and off through dedicated clamping software and hardware triggers.

Get Started

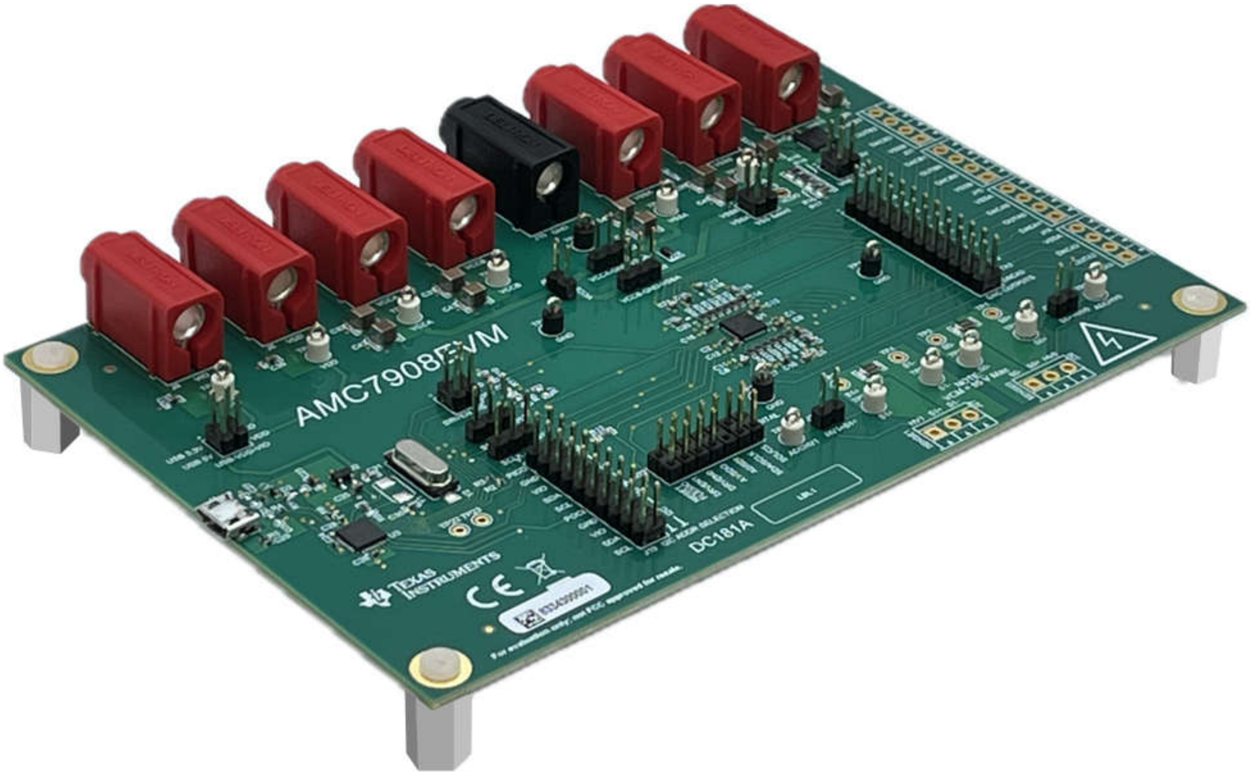
1. Order the EVM.
2. Configure EVM jumpers.
3. Install the AMC7908EVM GUI from ti.com.
4. Download the latest libraries.
5. Connect USB and external power supplies.
6. Launch the AMC7908EVM GUI.

Features

- Configurable circuit to evaluate the AMC7908
- Onboard VDD (5V) and VIO (3.3V) support via USB
- Onboard VSSA and VSSB (−10.5V or −7V) support
- FT4222 easily writes to the AMC using the AMC7908EVM GUI
- External SPI and I^2C connections available

Applications

- Macro remote radio unit (RRU)
- Active antenna system mMIMO (AAS)
- Outdoor backhaul unit
- Radar



1 Evaluation Module Overview

1.1 Introduction

The AMC7908 is a highly integrated power-amplifier monitor and control device capable of temperature, current, and voltage supervision. The AMC7908 bias controller features eight digital-to-analog converters (DAC) with programmable output ranges. The eight gate bias outputs are switched on and off through dedicated control pins.

The AMC7908 supervisor also features a highly accurate multichannel analog-to-digital converter (ADC). The device integrates two high-voltage inputs, two high-side current-sense amplifiers, and an on-chip temperature sensor.

The function integration and wide operating temperature range make the AMC7908 an excellent choice for an all-in-one, bias control circuit for the power amplifiers found in RF communication systems.

This user's guide describes the characteristics, operation, and recommended use cases of the AMC7908EVM. This document provides examples and instructions on how to use the AMC7908EVM board and included software. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the AMC7908EVM. This document also includes schematics, the reference printed circuit board (PCB) layouts, and a complete bill of materials (BOM).

1.2 Kit Contents

Table 1-1 details the contents of the EVM kit. Contact the TI Product Information Center at (972) 644-5580 if any component is missing. Download the latest versions of the related software on the TI website, www.ti.com.

Table 1-1. AMC7908EVM Kit Contents

Item	Quantity
AMC7908EVM board	1
USB micro-B plug to USB-A plug cable	1

1.3 Specification

The EVM is intended to provide basic functional evaluation of the device. The layout is not intended to be a model for the target circuit, nor laid out for electromagnetic compatibility (EMC) testing. The EVM consists of a printed-circuit board (PCB), which has the AMC7908 installed.

1.4 Device Information

The documents in Table 1-2 provide information regarding Texas Instruments integrated circuits used in the assembly of the AMC7908EVM. This user's guide is available from the TI web site under literature number SLAU883. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions are available from the TI web site at www.ti.com, or call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Table 1-2. Related Device Documentation

Document	Literature Number
AMC7908 product data sheet	SBASAG5

2 Hardware

2.1 Hardware Setup

This section describes the overall system setup for the EVM. A PC runs software that communicates with the FTDI controller onboard using I^{2}C or SPI protocols. External power supplies are required for certain EVM inputs, such as the VCCA and VCCB supplies.

2.1.1 Hardware Theory of Operation

The AMC7908EVM is connected to the computer through the on-board FTDI digital controller using the USB cable that is supplied with the EVM. The evaluation board features connectors and test points for all communication lines, DAC outputs, supplies, and the ADC inputs. Figure 2-1 shows a block diagram of the AMC7908EVM.

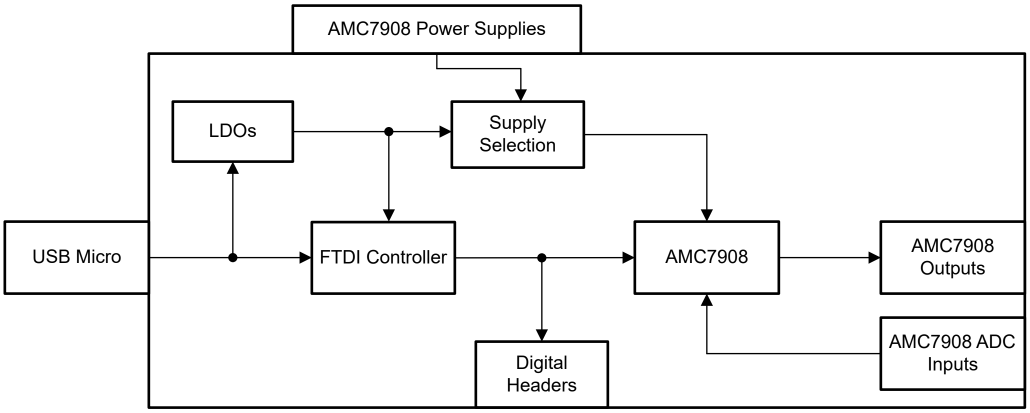


Figure 2-1. Theory of Operation Block Diagram

The USB connection provides the 5V supply to the EVM. A voltage regulator generates 3.3V from the USB 5V supply. These 5V and 3.3V supplies are used to power the FTDI controller.

The AMC7908 VDD supply can use the on-board 5V supply depending on the J13 pins 3-4 setting. By default, the VDD supply is connected to the on-board 5V supply. Alternatively, VDD can be supplied externally through banana jack J5. Remove the jumper connector on J13 pins 3-4 before connecting external supplies to VDD.

The AMC7908 VIO supply can use the on-board 3.3V supply depending on the J13 pins 1-2 setting. By default, the VIO supply is connected to the on-board 3.3V supply. Alternatively, VIO can be supplied externally through banana jack J8. Remove the jumper connector on J13 pins 1-2 before connecting external supplies to VIO.

The AMC7908 VCCA and VCCB supplies are used to configure the device to operate in the positive output range. If using the positive range, then power VCCA and VCCB externally using banana jacks J3 and J11, respectively. If using the negative range, then place a shunt on pins 1-2 of J2 and J9 to connect VCCA and VCCB to ground. Jumper J6 can be used to connect VCCA and VCCB together, allowing for the use of one external supply to power both VCCA and VCCB. Remove the jumper connections on pins 1-2 of J2 and J9 before connecting external supplies to VCCA or VCCB, respectively.

The AMC7908 VSSA and VSSB supplies are used to configure the device to operate in the negative output range. If using the negative range, then VSSA and VSSB can be powered externally using banana jacks J4 and J12, respectively. Alternatively, an on-board voltage regulator is available to provide negative voltage to the supplies. The regulator is powered by an external negative power supply, VNEG, and can output either –7 V or –10.5 V depending on the position of jumper J28. Jumper J29 connects the on-board negative voltage to the VSSA and VSSB supplies. If using the positive range, place a shunt on pins 2-3 of J2 and J9 to connect VSSA and VSSB to ground. Remove the jumper connections on J29 and pins 1-2 of J2/J9 before connecting external supplies to VSSA and VSSB.

There are multiple unpopulated components on the EVM that can be populated to change the configuration of the EVM:

- R7 and R9 are I^{2}C pull-ups to VIO. When using a communication source other than the FTDI controller for I^{2}C communication, R7 and R9 can be populated for pull-ups to VIO.
- C6, C11, C18, and C20 are 0603 footprints to allow for larger capacitance loads on the DACA1, DACA3, DACB1, and DACB3, respectively.
- J14, J15, J20, J21, J26, and J27 are optional terminal blocks. See Table 2-4 for more information.

2.1.2 Jumper Definitions

Table 2-1 provides the details of the configurable jumper settings of the AMC7908EVM. Figure 2-2 shows the default jumper connections on the board.

Table 2-1. Jumper Definitions

Designator	Name	Positions
J2	VCCA-GND-VSSA	**SHORT 1-2** - VCCA is grounded. **SHORT 2-3** - VSSA is grounded (default).
J6	VCCB = VCCA	**SHORT 1-2** - VCCA and VCCB are connected (default). **OPEN** - VCCA and VCCB are not connected.
J9	VCCB-GND-VSSB	**SHORT 1-2** - VCCB is grounded. **SHORT 2-3** - VSSB is grounded (default).
J13	USB-VDD-VIO	**SHORT 1-2** - VIO is connected to on-board 3.3V (default). **SHORT 3-4** - VDD is connected to on-board 5V (default). **OPEN** - VDD and VIO are powered by external supplies. No other jumper orientation allowed.
J17	CS - SCL	**SHORT 1-2** - Uses the FTDI $\overline{\text{CS}}$ pin for SPI mode (default). **SHORT 2-3** - Uses the FTDI SCL pin for I^{2}C Mode. **OPEN** - Open if external communication is used.
J18	SCLK - SDA	**SHORT 1-2** - Uses the FTDI SCLK pin for SPI mode (default). **SHORT 2-3** - Uses the FTDI SDA pin for I^{2}C Mode. **OPEN** - Open if external communication is used.
J19	I^{2}C ADDR SELECTION	**SHORT 1-2 and 11-12** - SPI configuration (default). **SHORT all else** - I^{2}C configuration, see Table 2-7 for jumper configurations. **OPEN** - Open if external communication is used.
J23	DRVEN DIS	**SHORT 1-2** - Connects DRVEN0 to FTDI controller. **SHORT 3-4** - Connects DRVEN1 to FTDI controller. **OPEN** - DRVEN0 and DRVEN1 are pulled up to VIO (default).
J24	S0+ = HV0	**SHORT 1-2** - Connects ADCHV0 and SENSE0+ together. **OPEN** - ADCHV0 and SENSE0+ are separate (default).
J25	HV1 = S1+	**SHORT 1-2** - Connects ADCHV1 and SENSE1+ together. **OPEN** - ADCHV1 and SENSE1+ are separate (default).
J28	VNEG Select	**SHORT 1-2** - VNEG regulator output is –10.5 V. **SHORT 3-4** - VNEG regulator output is –7 V. **OPEN** - VNEG regulator is not used (default).
J29	VSS Select	**SHORT 1-2** - VSSB is connected to the VNEG regulator output. **SHORT 1-3** - VSSA and VSSB are connected. **SHORT 3-4** - VSSA is connected to the VNEG regulator output. **OPEN** - VSSA and VSSB are powered externally (default).

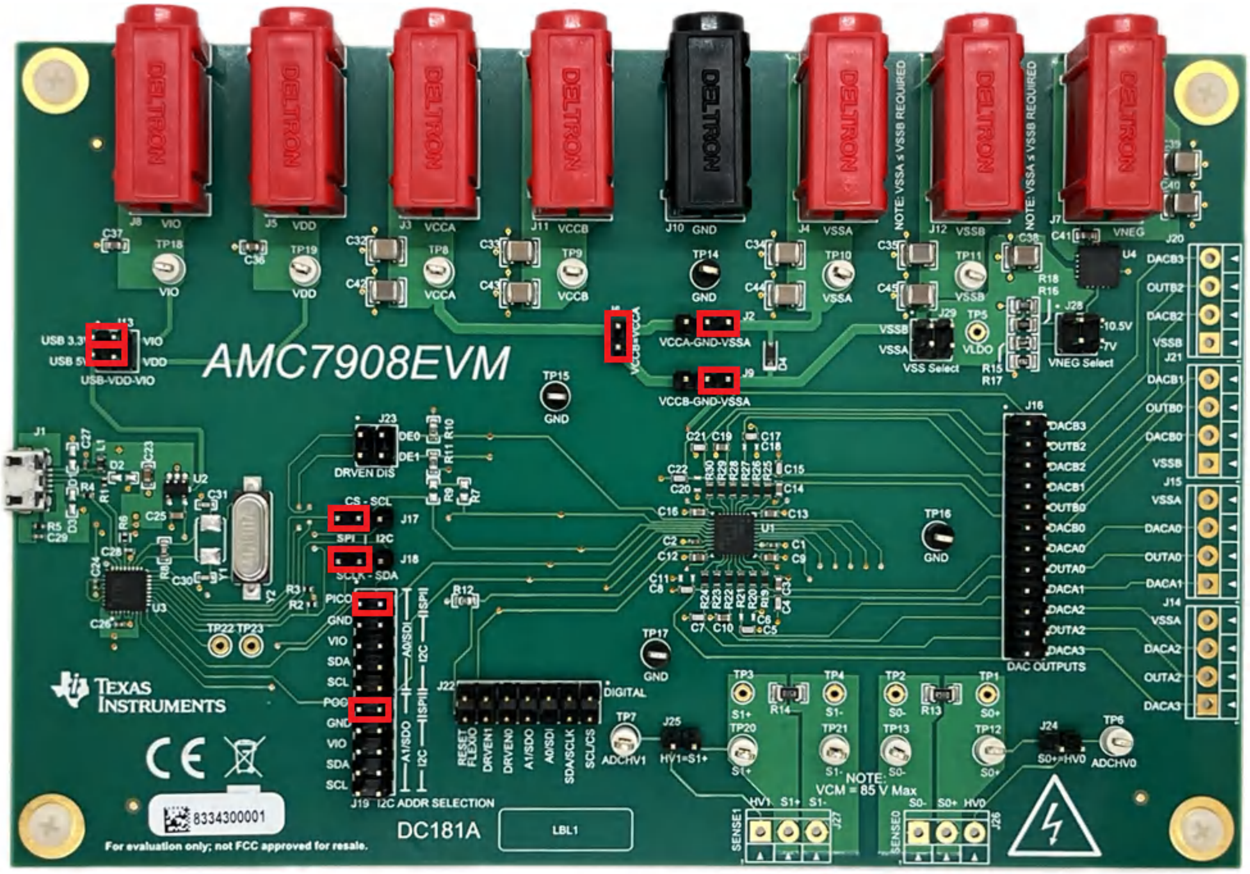

DELTRON
J8 VIO
J5 VDD
J3 VCCA
J11 VCCB
J10 GND
J4 VSSA
J12 VSSB
J7 VNEG
NOTE: VSSA ≤ VSSB REQUIRED
TP18 VIO
TP19 VDD
TP8 VCCA
TP9 VCCB
TP14 GND
TP10 VSSA
TP11 VSSB
TP5 VLDO
U4
J20
DACB3
OUTB2
DACB2
VSSB
J21
DACB1
OUTB1
DACB0
VSSB
J15
VSSA
DACA0
OUTA0
DACA1
J14
VSSA
DACA2
OUTA2
DACA3
USB 3.3V
USB 5V
J13
VIO
VDD
USB-VDD-VIO
AMC7908EVM
VCCB=VCCA
J2
VCCA-GND-VSSA
J9
VCCB-GND-VSSA
VSSB
VSSA
J29
VSS Select
J28
10.5V
7V
VNEG Select
TP15 GND
J1
J23
DE0
DE1
DRVEN DIS
J16
CS - SCL
J17
SPI
I2C
J18
SCLK - SDA
U1
U2
U3
TP16 GND
DAC OUTPUTS
PICO
GND
VIO
SDA
SCL
POCI
A0/SDI
I2C
SPI
A1/SDO
J19 I2C ADDR SELECTION
TP22 TP23
TP17 GND
J22
DIGITAL
RESET
FLEXIO
DRVEN1
DRVEN0
A1/SDO
A0/SDI
SDA/SCLK
SCL/CS
TP7 ADCHV1
J25 HV1=S1+
TP3 TP4 TP2 TP1
S1+ S1- S0- S0+
TP20 TP21 TP13 TP12
NOTE: VCM = 85 V Max
J24 S0+=HV0
TP6 ADCHV0
SENSE1 HV1 S1+ S1- J27
SENSE0 S0- S0+ HV0 J26
TEXAS INSTRUMENTS
CE
8334300001
For evaluation only; not FCC approved for resale.
DC181A
LBL1

Figure 2-2. AMC7908EVM Default Jumpers

2.1.3 Connector Definitions

Table 2-2 shows the power connector definitions of the AMC7908EVM.

Table 2-2. Power Connector Definitions

Designator	Definition
J1	USB connector
J3	AMC7908 VCCA supply (3V to 11V)
J4	AMC7908 VSSA supply (−11V to −3V)
J5	AMC7908 VDD supply (3V to 5.5V)
J7	VNEG supply (−10V to −33V)
J8	AMC7908 VIO supply (1.65V to 3.6V)
J10	AMC7908 Ground
J11	AMC7908 VCCB supply (3V to 11V)
J12	AMC7908 VSSB supply (−11V to −3V)

When powering the EVM, follow these guidelines:

- Choose between onboard power or external power for VIO and VDD using the J13 jumper. Do not short this jumper and use external power at the same time.
- The VNEG supply can be used in place of the VSSA and VSSB supplies. Do not short the J29 jumper and use external supplies for VSSA and VSSB at the same time.
- The VSSA voltage must always be less than (more negative) or equal to the VSSB voltage.
- To operate the group A DACs in the positive range, apply a positive voltage to VCCA and ground VSSA. To operate the group A DACs in the negative range, apply a negative voltage to VSSA and ground VCCA.
- To operate the group B DACs in the positive range, apply a positive voltage to VCCB and ground VSSB. To operate the group B DACs in the negative range, apply a negative voltage to VSSB and ground VCCB.
- To operate in the mixed voltage range, the group B DACs must be positive and the group A DACs must be negative. Apply a positive voltage to VCCB and ground VSSB for the group B DACs, and apply a negative voltage to VSSA and ground VCCA for the group A DACs.

Table 2-3 shows the DAC output header J16 definitions for the AMC7908EVM.

Table 2-3. DAC Output Header J16 Definitions

Pin	Definition
2	DACB3 Output
4	OUTB2 Output
6	DACB2 Output
8	DACB1 Output
10	OUTB0 Output
12	DACB0 Output
14	DACA0 Output
16	OUTA0 Output
18	DACA1 Output
20	DACA2 Output
22	OUTA2 Output
24	DACA3 Output
1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23	Ground

Table 2-4 shows other connector definitions for the AMC7908EVM. All of these terminal blocks are unpopulated by default.

Table 2-4. Terminal Block Connector Definitions

Designator	Definition
J14	Connector for DACA3, OUTA2, DACA2, and VSSA
J15	Connector for DACA1, OUTA1, DACA0, and VSSA
J20	Connector for DACB3, OUTB2, DACB2, and VSSB
J21	Connector for DACB1, OUTB1, DACB0, and VSSB
J26	Connector for current sense pins SENSE0-, SENSE0+, and ADCHV0
J27	Connector for current sense pins SENSE1+, SENSE1-, and ADCHV1

2.1.4 Test Points

The AMC7908EVM has a variety of test points available for measuring and debugging purposes. Table 2-5 explains the purpose of each test point.

Table 2-5. AMC7908EVM Test Points

Test Point	Net	Description
TP1	SENSE0+	High side of SENSE0 resistor
TP2	SENSE0-	Low side of SENSE0 resistor
TP3	SENSE1+	High side of SENSE1 resistor
TP4	SENSE1-	Low side of SENSE1 resistor
TP5	VLDO	Output of VNEG regulator
TP6	ADCHV0	ADCHV0 test point
TP7	ADCHV1	ADCHV1 test point
TP8	VCCA	AMC7908 VCCA supply
TP9	VCCB	AMC7908 VCCB supply
TP10	VSSA	AMC7908 VSSA supply
TP11	VSSB	AMC7908 VSSB supply
TP12	SENSE0+	SENSE0+ test point
TP13	SENSE0-	SENSE0- test point
TP14, TP15, TP16, TP17	GND	Ground connections
TP18	VIO	AMC7908 VIO supply
TP19	VDD	AMC7908 VDD supply
TP20	SENSE1+	SENSE1+ test point
TP21	SENSE1-	SENSE1- test point
TP22	FTDI_IO2	FTDI GPIO2 test point. Can be connected to DRVEN0 by shorting positions 1-2 on J23 with a jumper
TP23	FTDI_IO3	FTDI GPIO3 test point. Can be connected to DRVEN1 by shorting positions 3-4 on J23 with a jumper

2.2 Hardware Overview

This section details how to configure the EVM for and voltage outputs using I^2C and SPI. The following subsections provide detailed information on the EVM hardware and jumper positions for the two communication modes (see also Section 2.1.2).

2.2.1 Electrostatic Discharge Caution

CAUTION

Many of the components on the AMC7908EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

2.2.2 Connecting the FTDI Digital Controller

To connect the FTDI digital controller on the EVM board to the PC, align and firmly connect the USB connector to the J3 connector. Verify the connection is snug; a loose connection can cause intermittent operation. A 100 mil header (J22) is available for external communication. Table 2-6 lists the J22 pin definitions. To use external communication, disconnect jumpers J17 and J18 to remove the connection to the FTDI controller. Jumpers on J19 must be removed for SPI, but can remain for I^2C to select the device address. Resistors R7 and R9 can be populated for pullups for I^2C. These resistors do not need to be populated for the FTDI driver.

Table 2-6. Digital Header J22 Pin Definitions

Designator	Definition
2	AMC7908 SCL/$\overline{\text{CS}}$
4	AMC7908 SDA/SCLK
6	AMC7908 A0/SDI
8	AMC7908 A1/SDO
10	AMC7908 DRVEN0
12	AMC7908 DRVEN1
14	AMC7908 $\overline{\text{RESET}}$
1, 3, 5, 7, 9, 11, 13	Ground

2.2.3 SPI Configuration

Figure 2-3 shows the AMC7908EVM configured for SPI communication.

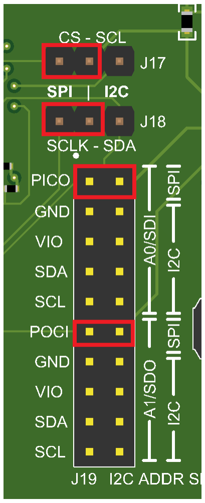


Figure 2-3. AMC7908EVM Configuration for SPI

2.2.4 I^{2}C Configuration

Figure 2-4 shows the AMC7908EVM configured for I^{2}C communication.

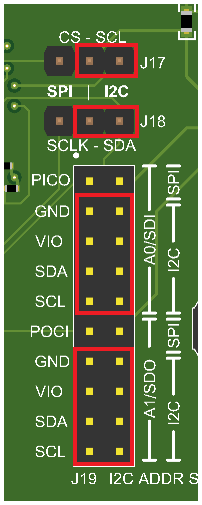

CS - SCL
J17
SPI | I2C
J18
SCLK - SDA
PICO
GND
VIO
SDA
SCL
POCI
GND
VIO
SDA
SCL
A0/SDI
SPI
I2C
A1/SDO
SPI
I2C
J19
I2C ADDR S

Figure 2-4. AMC7908EVM Configuration I^{2}C

The jumper connections on J19 determine the device address of the AMC7908. Table 2-7 shows the required configuration of the A1 and A0 jumpers for specific device addresses.

Table 2-7. I^{2}C Device Address Map

A1	A0	[A6:A0]
GND	GND	101 0000
GND	VIO	101 0001
GND	SDA	101 0010
GND	SCL	101 0011
VIO	GND	101 0100
VIO	VIO	101 0101
VIO	SDA	101 0110
VIO	SCL	101 0111
SDA	GND	101 1000
SDA	VIO	101 1001
SDA	SDA	101 1010
SDA	SCL	101 1011
SCL	GND	101 1100
SCL	VIO	101 1101
SCL	SDA	101 1110
SCL	SCL	101 1111

3 Software

3.1 Software Setup

This section provides the procedure for EVM software installation.

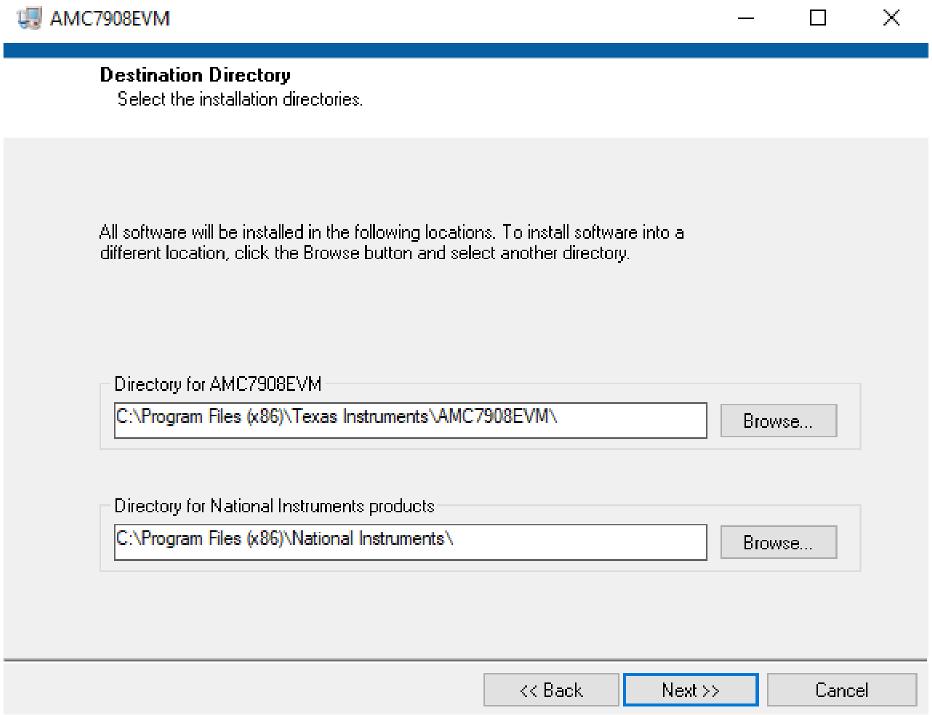
3.1.1 Software Installation

Note

Do not connect the EVM to the PC when the software is installing.

Download the latest version of the EVM graphical user interface (GUI) installer from the *Order and start development* subsection of the AMC7908EVM tool folder on TI.com. Run the GUI installer to install the AMC7908EVM GUI software on your PC. The software installation automatically copies the required LabVIEW™ software files and drivers to the PC.

When the AMC7908EVM GUI is launched, an installation dialog window opens and prompts the user to select an installation directory. If left unchanged, Figure 3-1 shows that the software location defaults to *C:\Program Files (x86)\Texas Instruments\AMC7908EVM.*



Destination Directory
Select the installation directories.

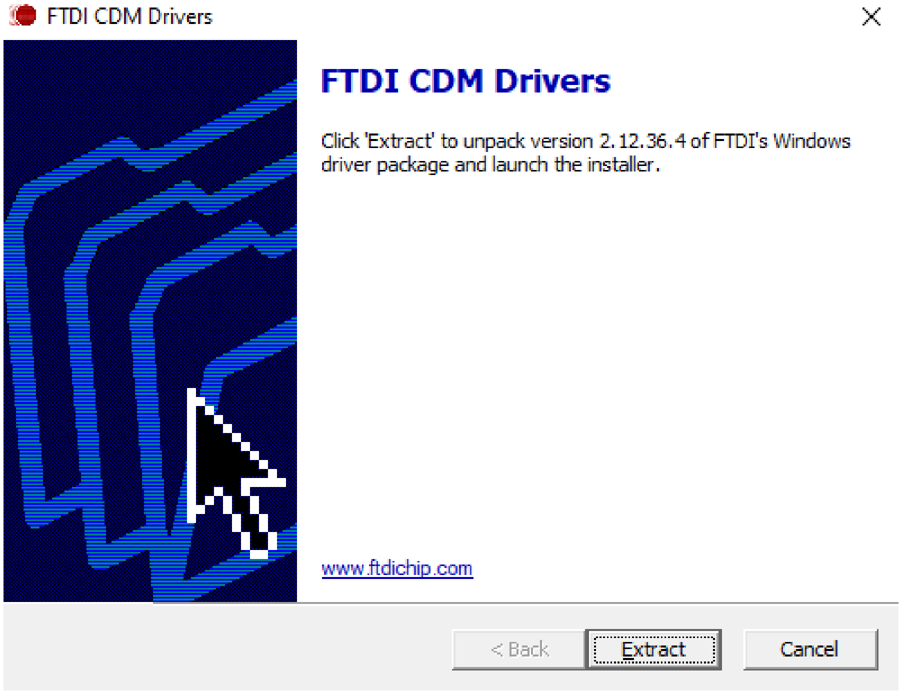
All software will be installed in the following locations. To install software into a different location, click the Browse button and select another directory.

Directory for AMC7908EVM
C:\Program Files (x86)\Texas Instruments\AMC7908EVM\

Directory for National Instruments products
C:\Program Files (x86)\National Instruments\

Figure 3-1. Software Installation Path

The EVM software also installs the Future Technology Devices International Limited (FTDI) USB drivers using a separate executable file. Figure 3-2 shows the FTDI USB drivers installation window that is automatically launched after the AMC7908EVM software installation is complete. Restart the PC to finish installation.



FTDI CDM Drivers

Click 'Extract' to unpack version 2.12.36.4 of FTDI's Windows driver package and launch the installer.

www.ftdichip.com

Figure 3-2. FTDI USB Drivers

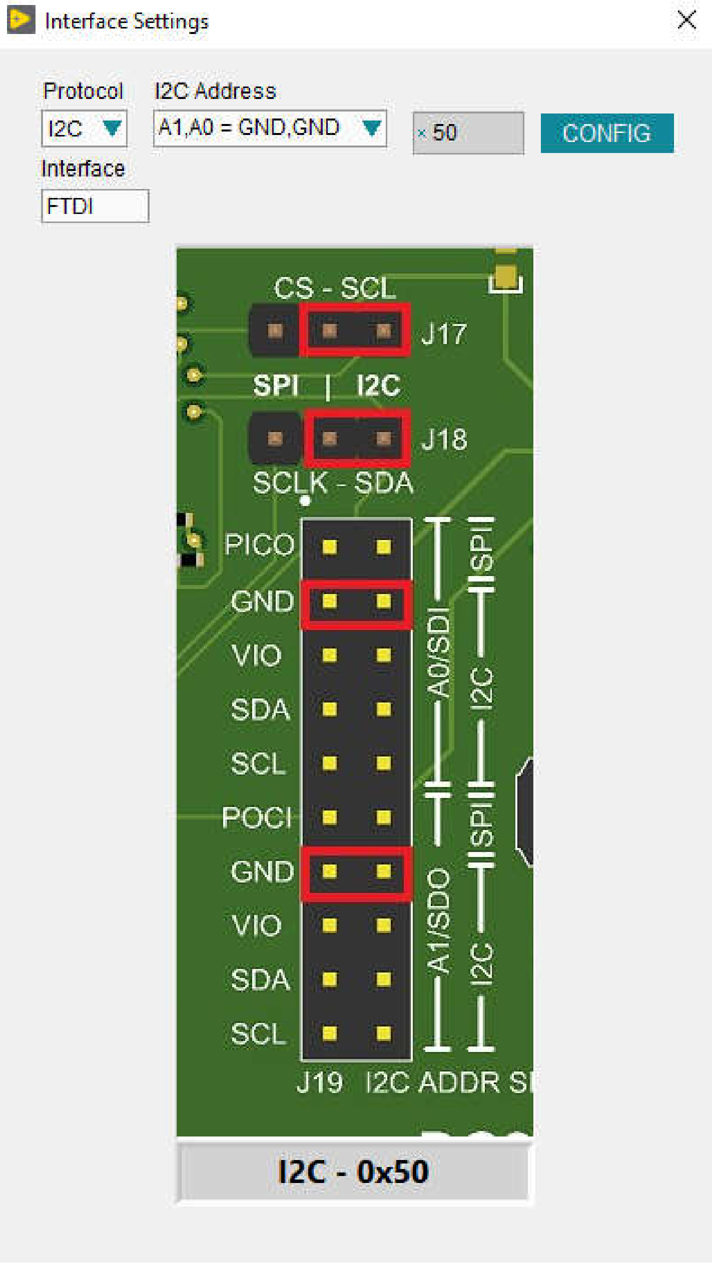
3.2 Software Overview

This section discusses how to use the AMC7908EVM software.

3.2.1 Launching the Software

If installed in the default directory, launch the AMC7908EVM software by searching for "AMC7908EVM" in the Windows® *Start* menu.

Figure 3-3 shows the initial configuration menu that is present when the GUI is launched. From this menu, select the interface protocol, as well as the I^{2}C address, if desired. Select the **CONFIG** button to save the current settings and launch the main GUI.

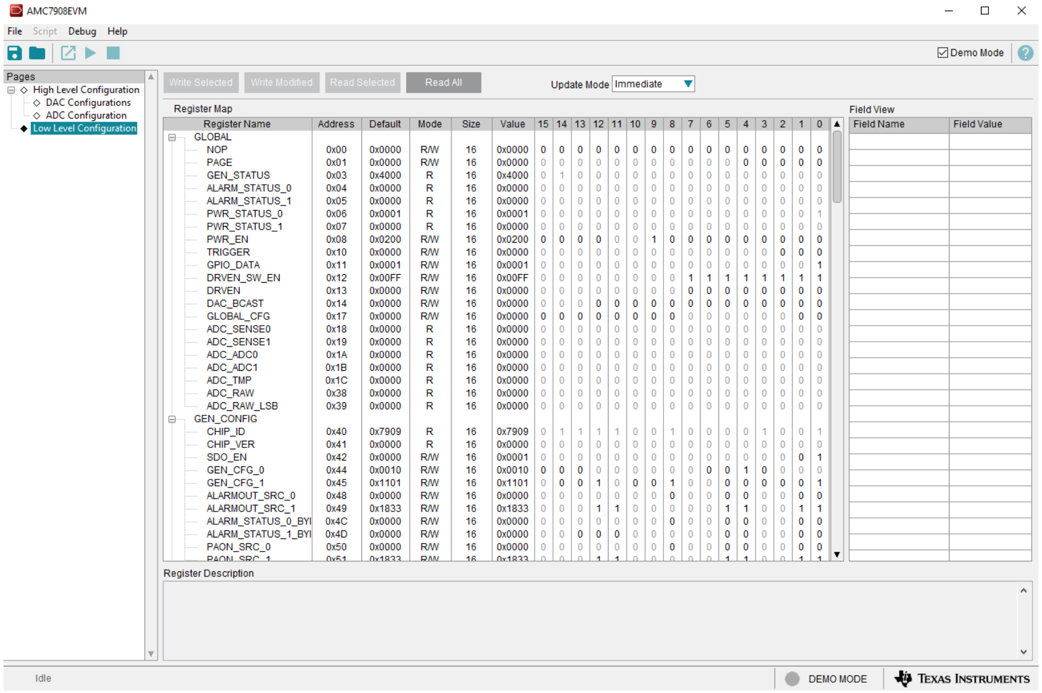

Interface Settings
CONFIG
CS - SCL
J17
SPI | I2C
J18
SCLK - SDA
PICO
GND
VIO
SDA
SCL
POCI
GND
VIO
SDA
SCL
A0/SDI
A1/SDO
SPI
I2C
SPI
I2C
J19
I2C ADDR SE

Protocol: I2C
I2C Address: A1,A0 = GND,GND
x 50
Interface: FTDI

I2C - 0x50

Figure 3-3. AMC7908EVM Interface Settings at Launch

Figure 3-4 shows the GUI after launch.


AMC7908EVM
File
Script
Debug
Help
Demo Mode
Pages
High Level Configuration
DAC Configurations
ADC Configuration
Low Level Configuration
Write Selected
Write Modified
Read Selected
Read All
Register Map
Field View
Register Description
Idle
DEMO MODE
TEXAS INSTRUMENTS

☑ Demo Mode

Update Mode: Immediate

Register Name	Address	Default	Mode	Size	Value	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
GLOBAL																					
NOP	0x00	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAGE	0x01	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GEN_STATUS	0x03	0x4000	R	16	0x4000	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALARM_STATUS_0	0x04	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALARM_STATUS_1	0x05	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PWR_STATUS_0	0x06	0x0001	R	16	0x0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
PWR_STATUS_1	0x07	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PWR_EN	0x08	0x0200	R/W	16	0x0200	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
TRIGGER	0x10	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GPIO_DATA	0x11	0x0001	R/W	16	0x0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
DRVEN_SW_EN	0x12	0x00FF	R/W	16	0x00FF	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
DRVEN	0x13	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAC_BCAST	0x14	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLOBAL_CFG	0x17	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_SENSE0	0x18	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_SENSE1	0x19	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_ADC0	0x1A	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_ADC1	0x1B	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_TMP	0x1C	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_RAW	0x38	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_RAW_LSB	0x39	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GEN_CONFIG																					
CHIP_ID	0x40	0x7909	R	16	0x7909	0	1	1	1	1	0	0	1	0	0	0	0	1	0	0	1
CHIP_VER	0x41	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SDO_EN	0x42	0x0000	R/W	16	0x0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
GEN_CFG_0	0x44	0x0010	R/W	16	0x0010	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
GEN_CFG_1	0x45	0x1101	R/W	16	0x1101	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1
ALARMOUT_SRC_0	0x48	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALARMOUT_SRC_1	0x49	0x1833	R/W	16	0x1833	0	0	0	1	1	0	0	0	0	0	1	1	0	0	1	1
ALARM_STATUS_0_BYI	0x4C	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALARM_STATUS_1_BYI	0x4D	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAON_SRC_0	0x50	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAON_SRC_1	0x51	0x1833	R/W	16	0x1833	0	0	0	1	1	0	0	0	0	0	1	1	0	0	1	1

Field Name	Field Value

Figure 3-4. AMC7908EVM GUI at Launch

If the FTDI controller is not connected to the PC when the software is launched, then the GUI defaults to *demo* mode. Figure 3-5 illustrates the bottom-left corner of the GUI that shows the hardware connection status: DEMO MODE or CONNECTED. After the FTDI controller is properly connected to the PC, restart the AMC7908EVM software to detect the device.

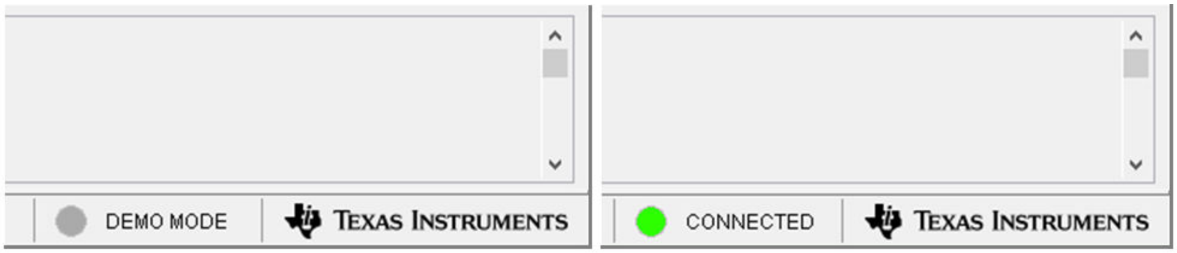

DEMO MODE
TEXAS INSTRUMENTS
CONNECTED
TEXAS INSTRUMENTS

Figure 3-5. FTDI Digital Controller Connection Status

3.2.2 Software Features

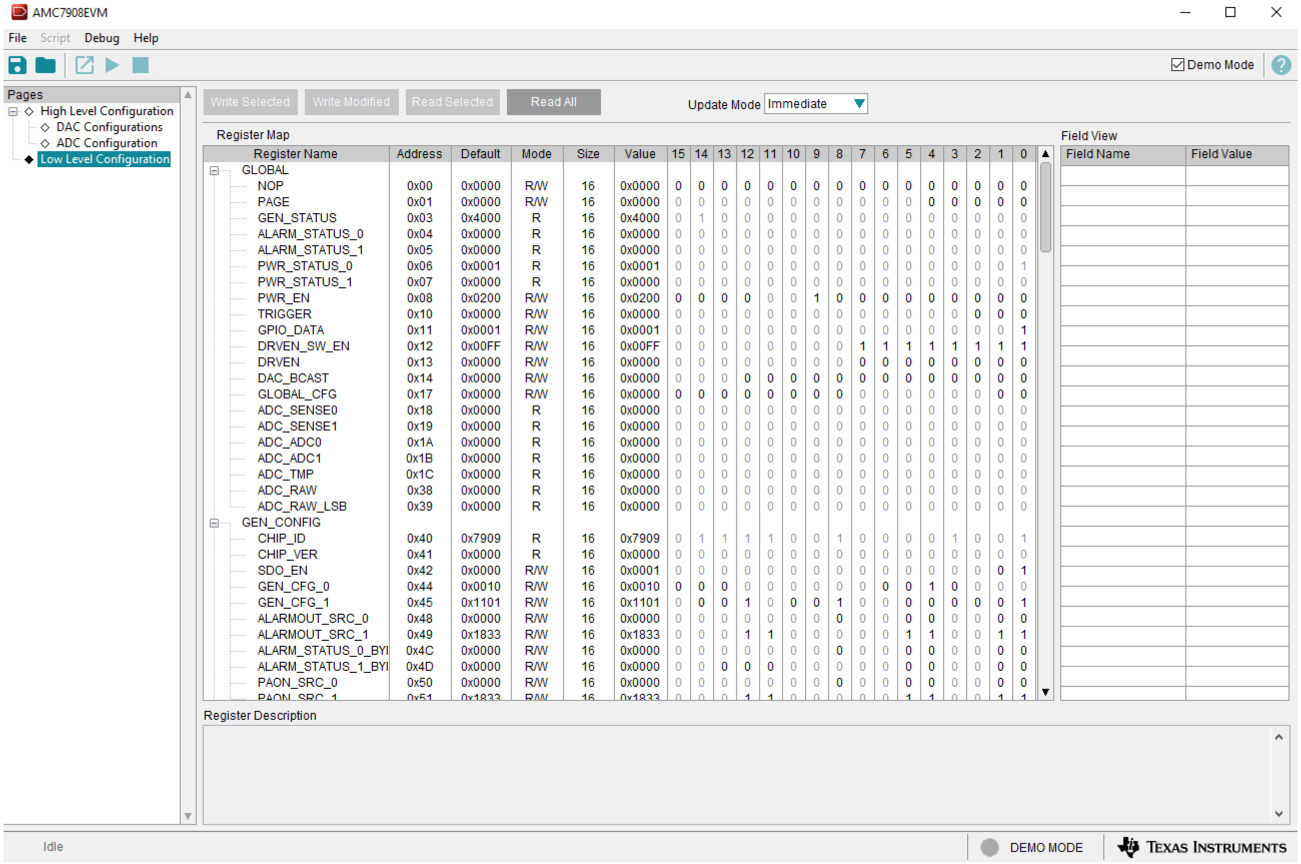
The AMC7908EVM GUI allows for I^{2}C or SPI communication to the AMC7908 and control of the digital pins. Although the entire register map is available for use, some features have been abstracted into user controls in the *High-Level Configuration* page for easy operation.

3.2.2.1 Low Level Configuration Page

Figure 3-6 shows the AMC7908EVM *Low Level Configuration* page of the AMC7908EVM GUI. This page allows direct access to all registers on the AMC7908. The GUI handles page address management, allowing seamless access to registers.

The *Register Map* section in the center of the page lists all the registers, grouped by the pages in the device. Directly above the *Register Map* section are four buttons that allow for read and write access to all registers.

Select a register on the Register Map list to show a description of the values in that register, as well as information on the register address, default value, size, and current value. Data are written to the registers by entering a value in the value column of the GUI.



☑ Demo Mode

Update Mode: Immediate

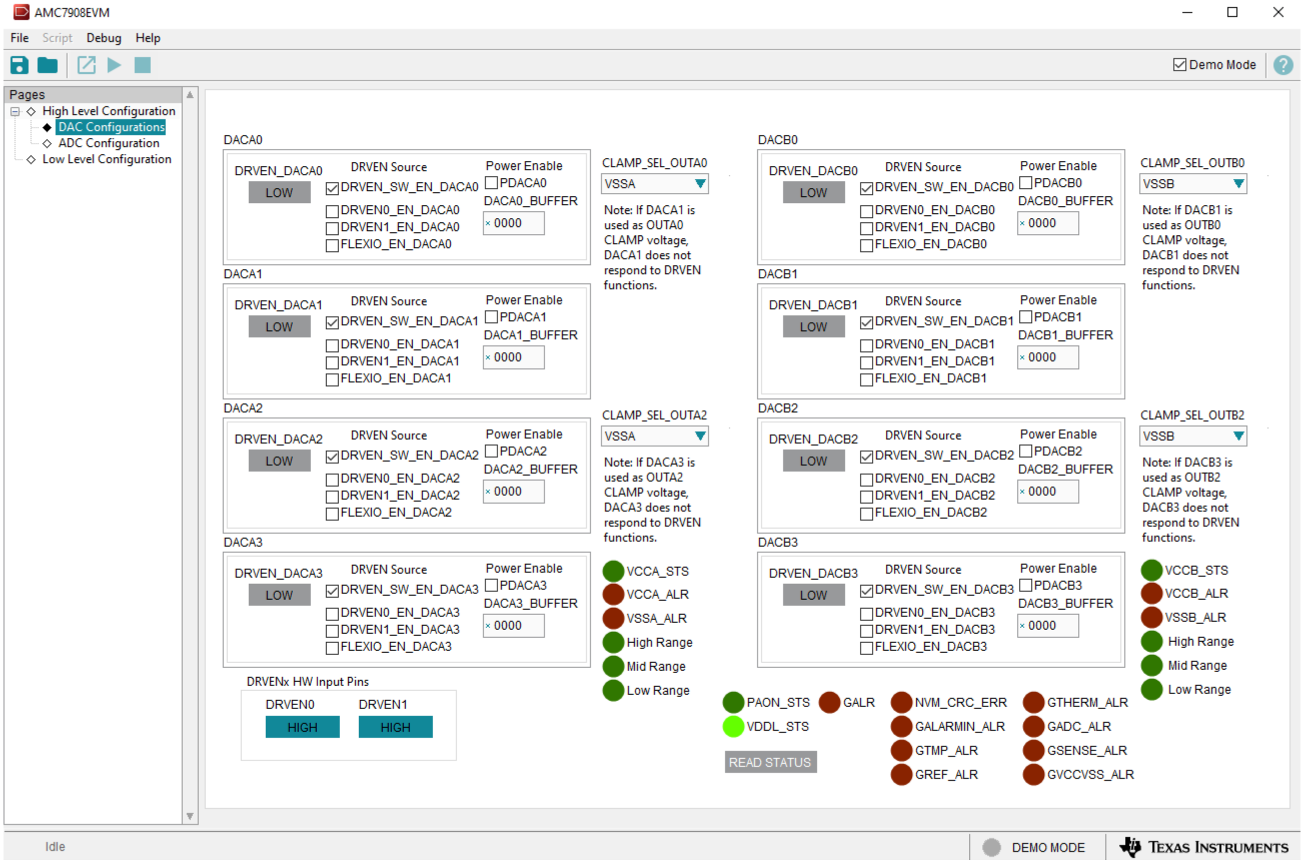
Register Name	Address	Default	Mode	Size	Value	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
GLOBAL																					
NOP	0x00	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAGE	0x01	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GEN_STATUS	0x03	0x4000	R	16	0x4000	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALARM_STATUS_0	0x04	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALARM_STATUS_1	0x05	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PWR_STATUS_0	0x06	0x0001	R	16	0x0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
PWR_STATUS_1	0x07	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PWR_EN	0x08	0x0200	R/W	16	0x0200	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
TRIGGER	0x10	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GPIO_DATA	0x11	0x0001	R/W	16	0x0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
DRVEN_SW_EN	0x12	0x00FF	R/W	16	0x00FF	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
DRVEN	0x13	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DAC_BCAST	0x14	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLOBAL_CFG	0x17	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_SENSE0	0x18	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_SENSE1	0x19	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_ADC0	0x1A	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_ADC1	0x1B	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_TMP	0x1C	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_RAW	0x38	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ADC_RAW_LSB	0x39	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GEN_CONFIG																					
CHIP_ID	0x40	0x7909	R	16	0x7909	0	1	1	1	1	0	0	1	0	0	0	0	1	0	0	1
CHIP_VER	0x41	0x0000	R	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SDO_EN	0x42	0x0000	R/W	16	0x0001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
GEN_CFG_0	0x44	0x0010	R/W	16	0x0010	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
GEN_CFG_1	0x45	0x1101	R/W	16	0x1101	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1
ALARMOUT_SRC_0	0x48	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALARMOUT_SRC_1	0x49	0x1833	R/W	16	0x1833	0	0	0	1	1	0	0	0	0	0	1	1	0	0	1	1
ALARM_STATUS_0_BYI	0x4C	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALARM_STATUS_1_BYI	0x4D	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAON_SRC_0	0x50	0x0000	R/W	16	0x0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAON_SRC_1	0x51	0x1833	R/W	16	0x1833	0	0	0	1	1	0	0	0	0	0	1	1	0	0	1	1

Figure 3-6. Low Level Configuration Page

3.2.2.2 High Level Configuration Page

The *High Level Configuration* page is used to set the configuration of the AMC7908EVM GUI. The page is comprised of two tabs: *DAC Control* and *ADC Control*. These two tabs act as shortcuts to configure the AMC7908 for basic functionality and testing.

Figure 3-7 shows the *DAC Control* tab of the *High Level Configuration* page. This tab is used to set the range and outputs for the DACs. Alarms and status information is also displayed on this tab.


AMC7908EVM
File Script Debug Help
Demo Mode
Pages
High Level Configuration
DAC Configurations
ADC Configuration
Low Level Configuration
DACA0
DRVEN_DACA0
LOW
DRVEN Source
DRVEN_SW_EN_DACA0
DRVEN0_EN_DACA0
DRVEN1_EN_DACA0
FLEXIO_EN_DACA0
Power Enable
PDACA0
DACA0_BUFFER
0000
CLAMP_SEL_OUTA0
VSSA
DACA1
DRVEN_DACA1
LOW
DRVEN_SW_EN_DACA1
DRVEN0_EN_DACA1
DRVEN1_EN_DACA1
FLEXIO_EN_DACA1
PDACA1
DACA1_BUFFER
0000
DACA2
DRVEN_DACA2
LOW
DRVEN_SW_EN_DACA2
DRVEN0_EN_DACA2
DRVEN1_EN_DACA2
FLEXIO_EN_DACA2
PDACA2
DACA2_BUFFER
0000
CLAMP_SEL_OUTA2
VSSA
DACA3
DRVEN_DACA3
LOW
DRVEN_SW_EN_DACA3
DRVEN0_EN_DACA3
DRVEN1_EN_DACA3
FLEXIO_EN_DACA3
PDACA3
DACA3_BUFFER
0000
VCCA_STS
VCCA_ALR
VSSA_ALR
High Range
Mid Range
Low Range
DRVENx HW Input Pins
DRVEN0
HIGH
DRVEN1
HIGH
DACB0
DRVEN_DACB0
LOW
DRVEN_SW_EN_DACB0
DRVEN0_EN_DACB0
DRVEN1_EN_DACB0
FLEXIO_EN_DACB0
PDACB0
DACB0_BUFFER
0000
CLAMP_SEL_OUTB0
VSSB
DACB1
DRVEN_DACB1
LOW
DRVEN_SW_EN_DACB1
DRVEN0_EN_DACB1
DRVEN1_EN_DACB1
FLEXIO_EN_DACB1
PDACB1
DACB1_BUFFER
0000
DACB2
DRVEN_DACB2
LOW
DRVEN_SW_EN_DACB2
DRVEN0_EN_DACB2
DRVEN1_EN_DACB2
FLEXIO_EN_DACB2
PDACB2
DACB2_BUFFER
0000
CLAMP_SEL_OUTB2
VSSB
DACB3
DRVEN_DACB3
LOW
DRVEN_SW_EN_DACB3
DRVEN0_EN_DACB3
DRVEN1_EN_DACB3
FLEXIO_EN_DACB3
PDACB3
DACB3_BUFFER
0000
VCCB_STS
VCCB_ALR
VSSB_ALR
High Range
Mid Range
Low Range
PAON_STS
GALR
VDDL_STS
READ STATUS
NVM_CRC_ERR
GALARMIN_ALR
GTMP_ALR
GREF_ALR
GTHERM_ALR
GADC_ALR
GSENSE_ALR
GVCCVSS_ALR
Idle
DEMO MODE
TEXAS INSTRUMENTS

Note: If DACA1 is used as OUTA0 CLAMP voltage, DACA1 does not respond to DRVEN functions.

Note: If DACA3 is used as OUTA2 CLAMP voltage, DACA3 does not respond to DRVEN functions.

Note: If DACB1 is used as OUTB0 CLAMP voltage, DACB1 does not respond to DRVEN functions.

Note: If DACB3 is used as OUTB2 CLAMP voltage, DACB3 does not respond to DRVEN functions.

Figure 3-7. DAC Control Tab of the High Level Configuration Page

DACs

DACs DACA0, DACA2, DACB0, and DACB2 are powered on by checking the respective PDACxx box. DACs DACA1, DACA3, DACB1, and DACB3 are powered on by checking the respective PDACxx box and by clicking the DRVEN_DACxx box. Write to the DAC buffers by entering hex values into the DACxx_BUFFER boxes.

DRIVE ENABLE

By default, all of the DACs are connected to the software drive enable. To enable the DRVEN hardware pins, deselect the software DRVEN and select one of the hardware DRVEN options (DRVEN0, DRVEN1, or FLEXIO). The DRVEN0 and DRVEN1 hardware pins can be controlled by the GUI if jumper J23 1-2 and 3-4 are shorted.

OUT PINS

By default, OUTA0, OUTA2, OUTB0, and OUTB2 are connected to the VSSA/VSSB power supply. The CLAMP_SEL_OUTxx box sets the OUTxx pins to the respective DACxx pin. Table 3-1 shows the Output pin configurations.

Table 3-1. Output Pin CLAMP Configuration

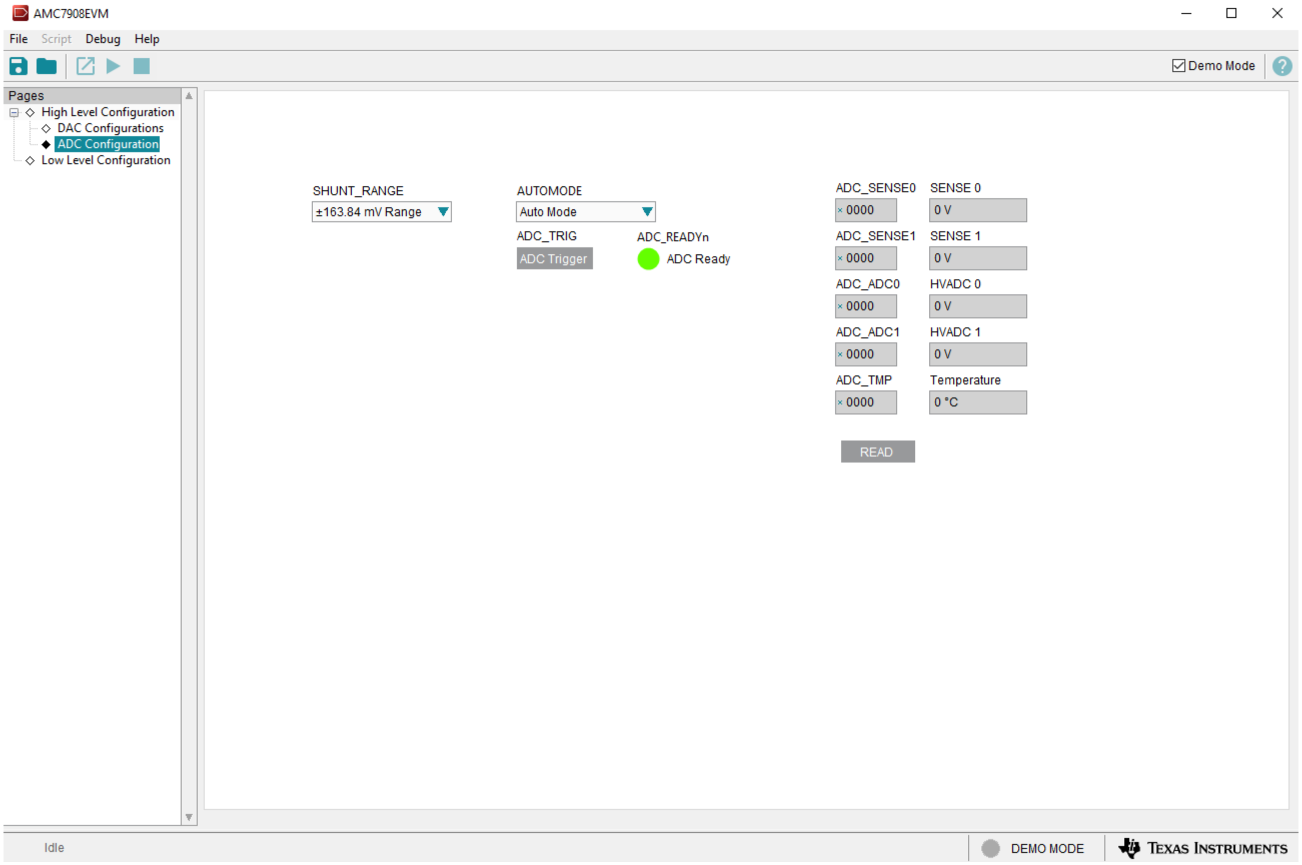
Output Pin	CLAMP Bit	CLAMP_SEL = 0	CLAMP_SEL = 1
OUTA0	CLAMP_SEL_OUTA0	VSSA	DACA1
OUTA2	CLAMP_SEL_OUTA2	VSSA	DACA3
OUTB0	CLAMP_SEL_OUTB0	VSSB	DACB1
OUTB2	CLAMP_SEL_OUTB2	VSSB	DACB3

Furthermore, the output pins can switch between the respective CLAMP and DACs using the even DAC's DRVEN bit. Table 3-2 shows the DRVEN configurations.

Table 3-2. Output Pin DRVEN Configuration

Output Pin	DRVEN Bit	DRVEN = 0	DRVEN = 1
OUTA0	DRVEN_DACA0	DACA1/VSSA	DACA0
OUTA2	DRVEN_DACA2	DACA3/VSSA	DACA2
OUTB0	DRVEN_DACB0	DACB1/VSSB	DACB0
OUTB2	DRVEN_DACB2	DACB3/VSSB	DACB2

Figure 3-8 shows the *ADC Control* tab from the *High Level Configuration* page. This tab configures and reads data from the ADC in the AMC7908.


AMC7908EVM
File
Script
Debug
Help
☑ Demo Mode
Pages
High Level Configuration
DAC Configurations
ADC Configuration
Low Level Configuration
ADC Trigger
READ
Idle
DEMO MODE
TEXAS INSTRUMENTS

SHUNT_RANGE: ±163.84 mV Range
AUTOMODE: Auto Mode
ADC_TRIG
ADC_READYn: ● ADC Ready
ADC_SENSE0: x 0000
SENSE 0: 0 V
ADC_SENSE1: x 0000
SENSE 1: 0 V
ADC_ADC0: x 0000
HVADC 0: 0 V
ADC_ADC1: x 0000
HVADC 1: 0 V
ADC_TMP: x 0000
Temperature: 0 °C

Figure 3-8. ADC Control Tab of the High Level Configuration Page

4 Hardware Design Files

4.1 Schematics

The AMC7908EVM schematics are shown in Figure 4-1 through Figure 4-3.

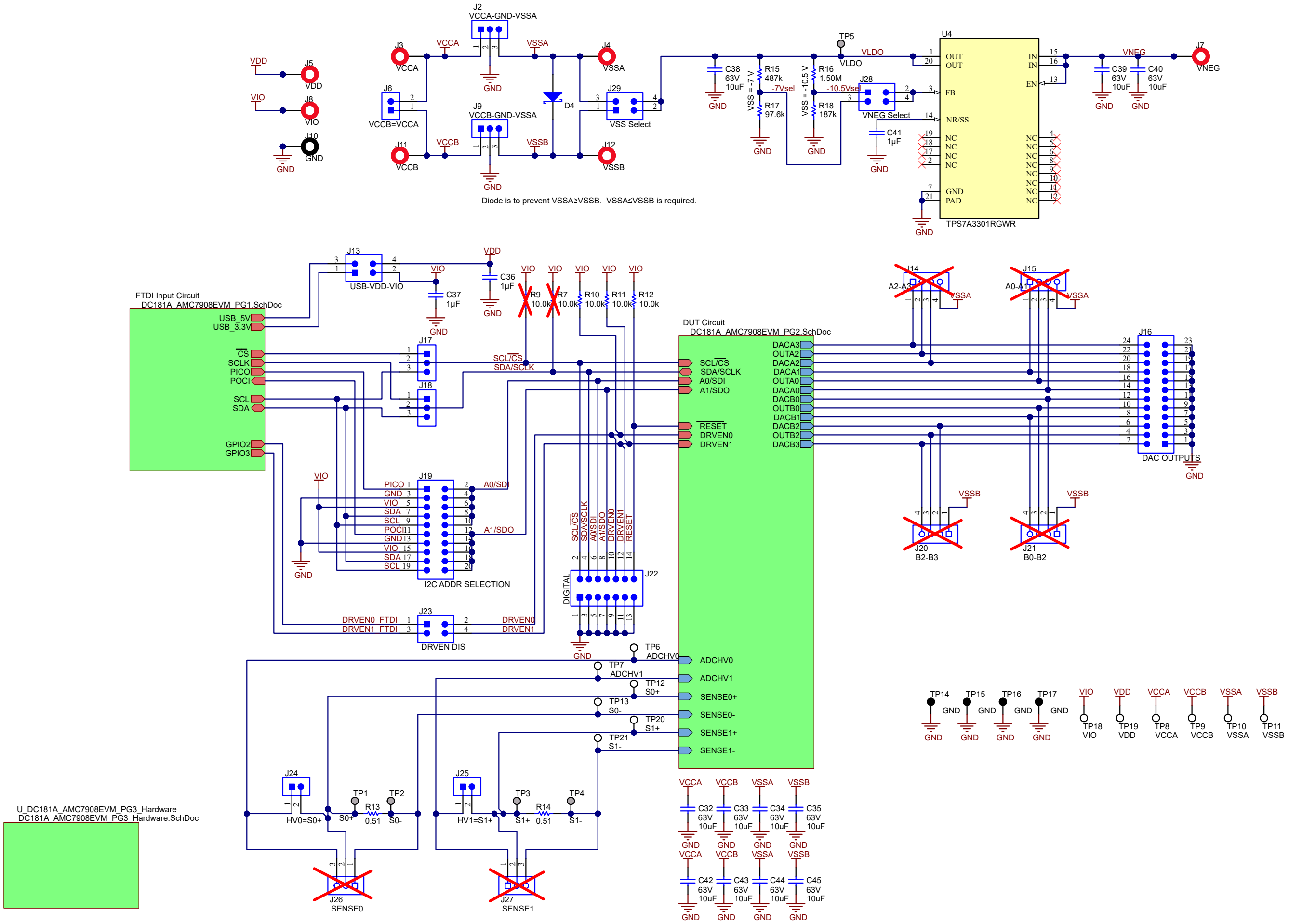

TPS7A3301RGWR
FTDI Input Circuit
DC181A_AMC7908EVM_PG1.SchDoc
DUT Circuit
DC181A_AMC7908EVM_PG2.SchDoc
U_DC181A_AMC7908EVM_PG3_Hardware
DC181A_AMC7908EVM_PG3_Hardware.SchDoc
Diode is to prevent VSSA≥VSSB. VSSA≤VSSB is required.
I2C ADDR SELECTION
DAC OUTPUTS
DRVEN DIS
VNEG Select
VSS Select
USB-VDD-VIO
VCCB=VCCA
SENSE0
SENSE1

Figure 4-1. AMC7908EVM Schematic Page 1

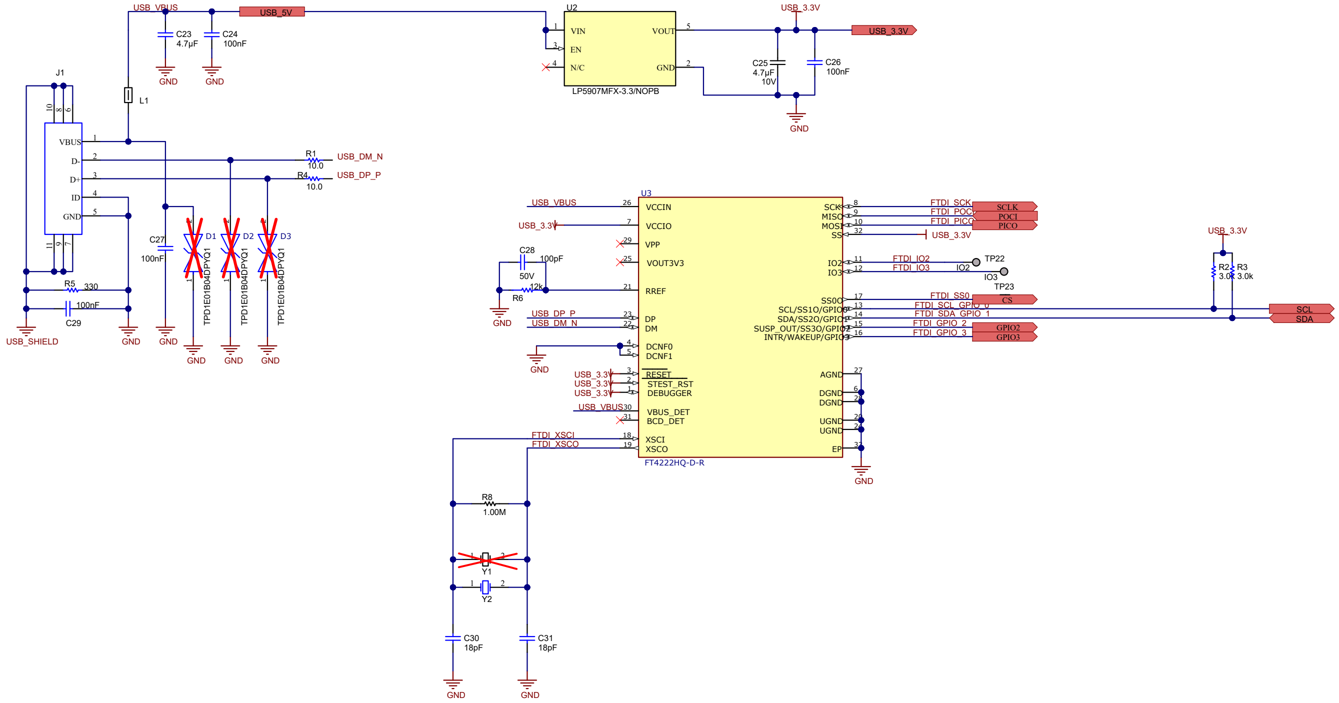

USB_VBUS
USB_5V
U2
VIN
EN
N/C
VOUT
GND
LP5907MFX-3.3/NOPB
USB_3.3V
C23
4.7µF
C24
100nF
C25
4.7µF
10V
C26
100nF
GND
J1
L1
VBUS
D-
D+
ID
GND
R1
10.0
R4
10.0
USB_DM_N
USB_DP_P
C27
100nF
D1
D2
D3
TPD1E01B04DPYQ1
R5
330
C29
100nF
USB_SHIELD
U3
VCCIN
VCCIO
VPP
VOUT3V3
RREF
DP
DM
DCNF0
DCNF1
RESET
STEST_RST
DEBUGGER
VBUS_DET
BCD_DET
XSCI
XSCO
FT4222HQ-D-R
C28
100pF
50V
R6
12k
SCK
MISO
MOSI
SS
IO2
IO3
SS0O
SCL/SS1O/GPIO0
SDA/SS2O/GPIO1
SUSP_OUT/SS3O/GPIO2
INTR/WAKEUP/GPIO3
AGND
DGND
UGND
EP
FTDI_SCK
FTDI_POCI
FTDI_PICO
SCLK
POCI
PICO
FTDI_IO2
FTDI_IO3
TP22
TP23
IO2
IO3
FTDI_SS0
CS
FTDI_SCL_GPIO_0
FTDI_SDA_GPIO_1
FTDI_GPIO_2
FTDI_GPIO_3
GPIO2
GPIO3
R2
3.0k
R3
3.0k
SCL
SDA
FTDI_XSCI
FTDI_XSCO
R8
1.00M
Y1
Y2
C30
18pF
C31
18pF

Figure 4-2. AMC7908EVM FTDI Schematic

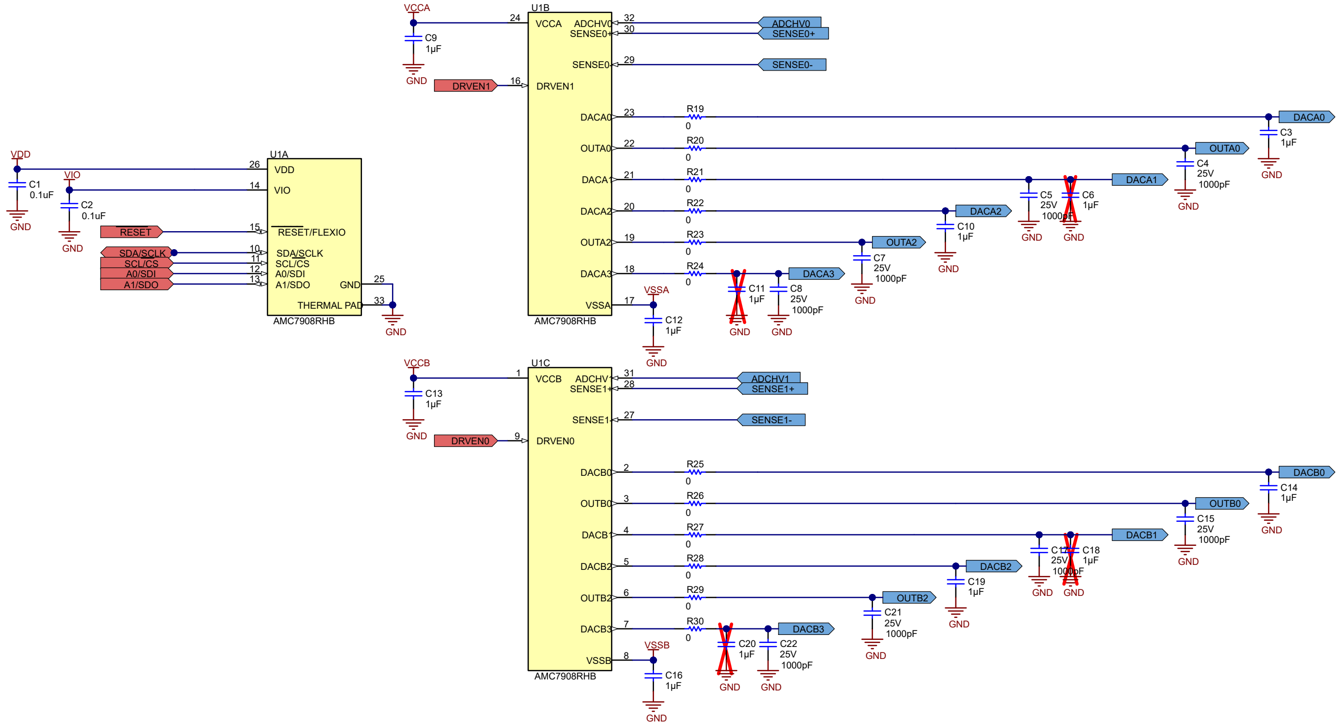

VCCA
C9
1µF
U1B
VCCA
ADCHV0
SENSE0+
SENSE0-
DRVEN1
DACA0
OUTA0
DACA1
DACA2
OUTA2
DACA3
VSSA
AMC7908RHB
R19
R20
R21
R22
R23
R24
0
C3
1µF
C4
25V
1000pF
C5
25V
1000pF
C6
1µF
C10
1µF
C7
25V
1000pF
C11
1µF
C8
25V
1000pF
C12
1µF
VDD
C1
0.1uF
VIO
C2
0.1uF
U1A
VDD
VIO
RESET/FLEXIO
SDA/SCLK
SCL/CS
A0/SDI
A1/SDO
GND
THERMAL PAD
RESET
VCCB
C13
1µF
U1C
VCCB
ADCHV1
SENSE1+
SENSE1-
DRVEN0
DACB0
OUTB0
DACB1
DACB2
OUTB2
DACB3
VSSB
R25
R26
R27
R28
R29
R30
C14
1µF
C15
25V
1000pF
C17
25V
1000pF
C18
1µF
C19
1µF
C21
25V
1000pF
C20
1µF
C22
25V
1000pF
C16
1µF
GND

Figure 4-3. AMC7908EVM DUT Schematic

4.2 PCB Layout

Figure 4-4 through Figure 4-7 show the board layout for the AMC7908EVM.

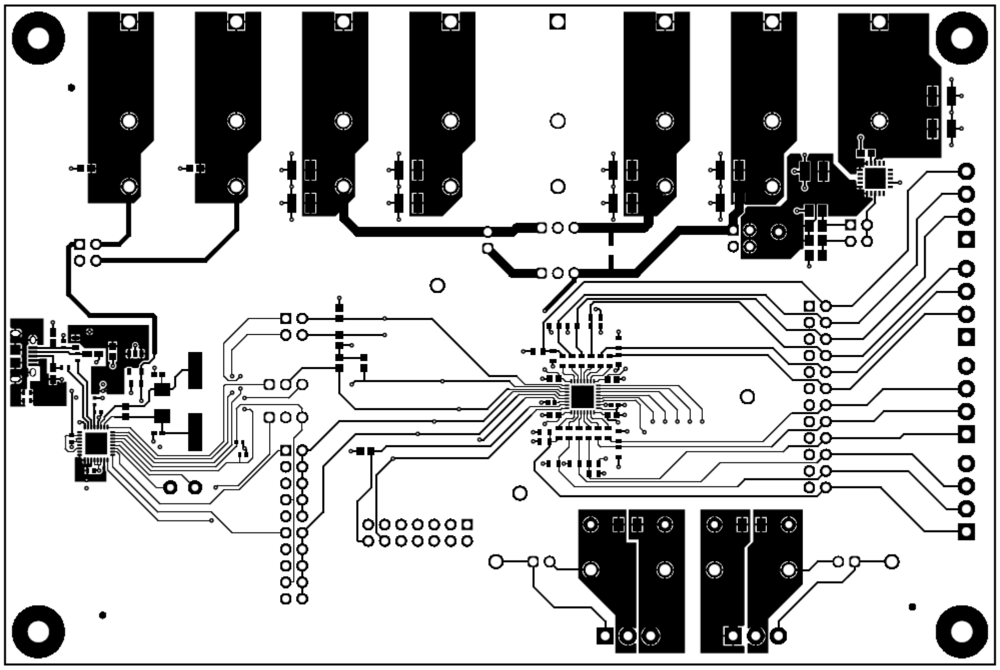


Figure 4-4. AMC7908EVM PCB Top Layer Layout

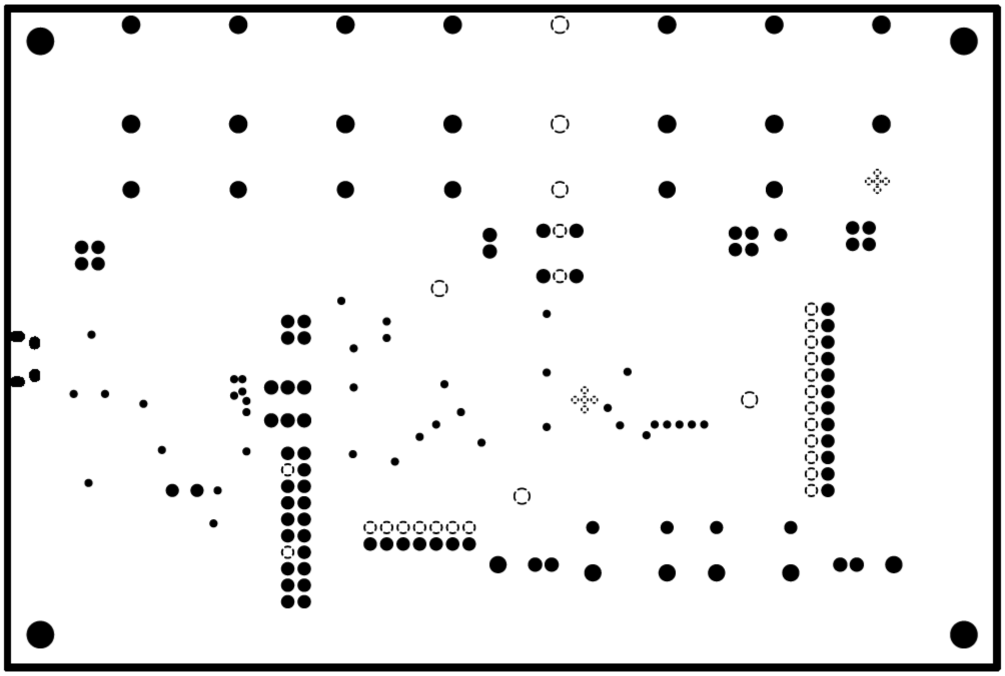


Figure 4-5. AMC7908EVM PCB Mid Layer 1 Layout (Ground Plane)

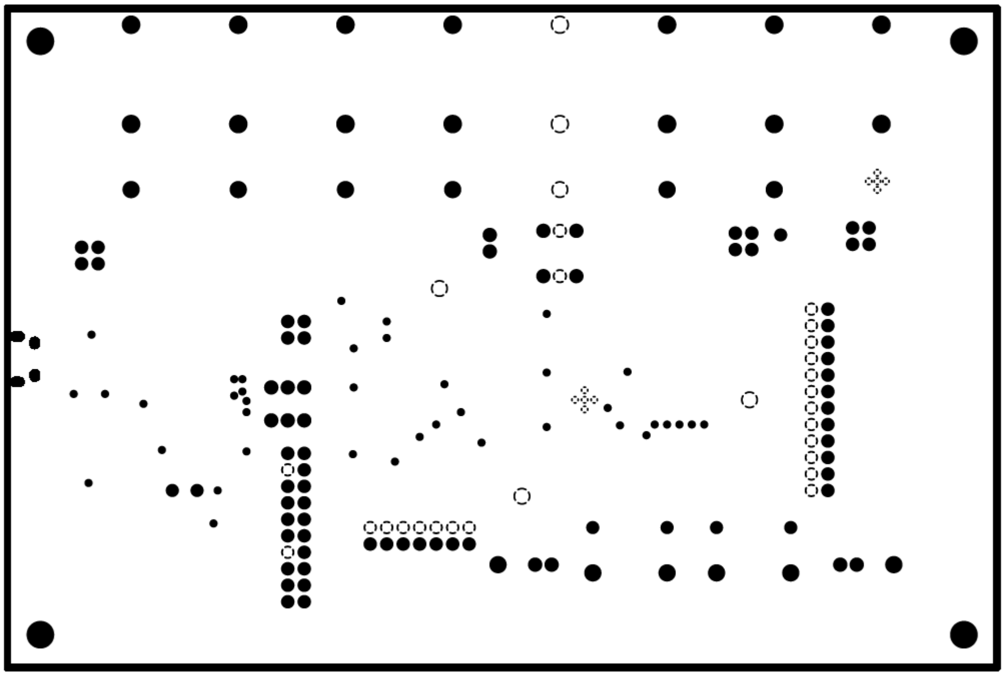


Figure 4-6. AMC7908EVM PCB Mid Layer 2 Layout (Ground Plane)

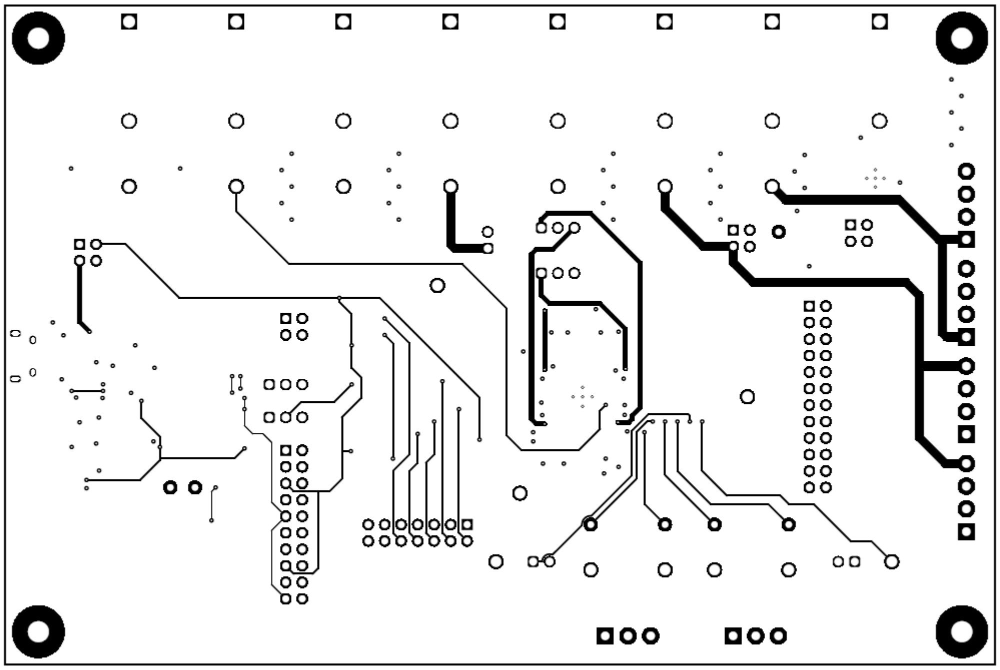


Figure 4-7. AMC7908EVM PCB Bottom Layer Layout

4.3 Bill of Materials

Table 4-1 lists the AMC7908EVM bill of materials (BOM).

Table 4-1. Bill of Materials for the AMC7908EVM

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C1, C2	2	0.1µF	CAP, CERM, 0.1µF, 25V, +/- 20%, X7R, 0402	402	C1005X7R1E104M050BB	TDK
C3, C9, C10, C12, C13, C14, C16, C19, C36, C37, C41	11	1µF	CAP, CERM, 1µF, 25V, +/- 10%, X7R, 0603	603	C0603C105K3RACTU	Kemet
C4, C5, C7, C8, C15, C17, C21, C22	8	1000pF	CAP, CERM, 1000pF, 25V,+/- 1%, C0G/NP0, 0603	603	C0603C102F3GACTU	Kemet
C23, C25	2	4.7µF	CAP, CERM, 4.7µF, 10V, +/- 20%, X7R, 0603	603	GRM188Z71A475ME15D	MuRata
C24, C26, C27, C29	4	0.1µF	CAP, CERM, 0.1µF, 25V,+/- 10%, X7R, 0402	402	CC0402KRX7R8BB104	Yageo
C28	1	100pF	CAP, CERM, 100pF, 50V, +/- 10%, X7R, 0402	402	8.85012E+11	Wurth Elektronik
C30, C31	2	18pF	CAP, CERM, 18pF, 50V, +/- 5%, C0G/NP0, 0402	402	GRM1555C1H180JA01D	MuRata
C32, C33, C34, C35, C38, C39, C40, C42, C43, C44, C45	11	10µF	CAP, CERM, 10µF, 63V, +/- 10%, X7R, 1210	1210	GRM32ER71J106KA12L	MuRata
D4	1	20V	Diode, Schottky, 20V, 1A, SOD-323	SOD-323	CUS10S30,H3F	Toshiba
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1	1		Receptacle, USB 2.0, Micro-USB Type B, R/A, SMT	USB-micro B USB 2.0, 0.65mm, 5 Pos, R/A, SMT	10118194-0001LF	FCI
J2, J9, J17, J18	4		Header, 2.54mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH	61300311121	Wurth Elektronik
J3, J4, J5, J7, J8, J11, J12	7		Standard Banana Jack, insulated, 10A, red	571-0500	571-0500	DEM Manufacturing
J6, J24, J25	3		Header, 2.54mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Wurth Elektronik
J10	1		Standard Banana Jack, insulated, 10A, black	571-0100	571-0100	DEM Manufacturing

Table 4-1. Bill of Materials for the AMC7908EVM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
J13, J23, J28, J29	4		Header, 100mil, 2x2, Gold, TH	2x2 Header	TSW-102-07-G-D	Samtec
J16	1		Header, 100mil, 12x2, Gold, TH	12x2 Header	TSW-112-07-G-D	Samtec
J19	1		Header, 100mil, 10x2, Gold, TH	10x2 Header	TSW-110-07-G-D	Samtec
J22	1		Header, 2.54mm, 7x2, Gold with Tin tail, TH	7x2 Header	TSW-107-07-L-D-006	Samtec
L1	1	600Ω	Ferrite Bead, 600Ω at 100MHz, 1A, 0603	603	782633601	Wurth Elektronik
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1, R4	2	10Ω	RES, 10.0Ω, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	RMCF0402JT10R0	Stackpole Electronics Inc
R2, R3	2	3.0 Ωk	RES, 3.0 Ωk, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04023K00JNED	Vishay-Dale
R5	1	330Ω	RES, 330Ω, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	402	ERJ-2RKF3300X	Panasonic
R6	1	12kΩ	12kΩ ±1% 0.1W, 1/10W Chip Resistor 0402 (1005 Metric) Automotive AEC-Q200 Thick Film	402	ERJ-2RKF1202X	Panasonic ECG
R8	1	1.00MΩ	RES, 1.00MΩ, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06031M00FKEA	Vishay-Dale
R10, R11, R12	3	10.0kΩ	RES, 10.0kΩ, 1%, 0.1 W, 0603	603	ERJ-3EKF1002V	Panasonic
R13, R14	2	0.51Ω	RES, 0.51Ω, 1%, 0.5 W, 1206	1206	CRM1206-FX-R510ELF	Bourns
R15	1	487kΩ	RES, 487kΩ, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	ERJ-6ENF4873V	Panasonic
R16	1	1.50MΩ	RES, 1.50MΩ, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	ERJ-6ENF1504V	Panasonic
R17	1	97.6kΩ	RES, 97.6kΩ, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	ERJ-6ENF9762V	Panasonic
R18	1	187kΩ	RES, 187kΩ, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	ERJ-6ENF1873V	Panasonic
R19, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30	12	0Ω	RES, Ω, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	603	PMR03EZPJ000	Rohm

Table 4-1. Bill of Materials for the AMC7908EVM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP18, TP19, TP20, TP21	12		Test Point, Compact, White, TH	White Compact Testpoint	5007	Keystone Electronics
TP14, TP15, TP16, TP17	4		Test Point, Compact, Black, TH	Black Compact Testpoint	5006	Keystone Electronics
U1	1		AMC7908	RHB0032E	AMC7908RHB	Texas Instruments
U2	1		250mA Ultra-Low-Noise, Low-IQ LDO, DBV0005A (SOT-23-5)	DBV0005A	LP5907MFX-3.3/NOPB	Texas Instruments
U3	1		USB Bridge, USB to I²C/SPI USB 2.0 I²C, SPI 32-VQFN (5x5)	VQFN32	FT4222HQ-D-R	FTDI
U4	1		Vin -3V to -36V, -1A, Ultra-Low-Noise, High-PSRR, Low-Dropout Linear Regulator, RGW0020A (VQFN-20)	RGW0020A	TPS7A3301RGWR	Texas Instruments
Y2	1		Crystal, 12MHz, 30ppm, 18pF, SMD	11.4x4.7mm	ABLS2-12.000MHZ-D4Y-T	Abracon Corporation
C6, C11, C18, C20	0			603		
J14, J15, J20, J21	0		Terminal Block, 3.5mm Pitch, 4x1, TH	14x8.2x6.5mm	ED555/4DS	On-Shore Technology
J26, J27	0		Terminal Block, 3.5mm Pitch, 3x1, TH	10.5x8.2x6.5mm	ED555/3DS	On-Shore Technology
R7, R9	0			603		

5 Additional Information

5.1 Trademarks

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6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (March 2024) to Revision A (June 2024)	Page
• First public release	1

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1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d’usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 *Notice for Users of EVMs Considered “Radio Frequency Products” in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry’s Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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2. 実験局の免許を取得後ご使用いただく。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

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8. *Limitations on Damages and Liability:*
    8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.
    8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.
9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.
10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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