HV2916 Analog Switch Evaluation Board User's Guide

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HV2916 ANALOG SWITCH EVALUATION BOARD USER'S GUIDE

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our website (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXXXXA", where "XXXXXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics, to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the HV2916 Analog Switch Evaluation Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Website
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the HV2916 Analog Switch Evaluation Board as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the HV2916 device.
- **Chapter 2. "Installation and Operation"** – This chapter includes instructions for how to begin using the HV2916 Analog Switch Evaluation Board.
- **Chapter 3. "GUI Description"** – This chapter describes the features of the GUI PC software.
- **Chapter 4. "PCB Design and Layout Notes"** – This chapter explains important points of the PCB design of the HV2916 Analog Switch Evaluation Board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the HV2916 Analog Switch Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the HV2916 Analog Switch Evaluation Board.
- **Appendix C. "Demo Board Waveforms"** – Describes the various demo waveforms for the HV2916 Analog Switch Evaluation Board.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

RECOMMENDED READING

This user's guide describes how to use the HV2916 Analog Switch Evaluation Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource:

- **HV2815/HV2915/HV2916 Data Sheet – *"Single 5V Bias, Low Harmonic Distortion, 32-Channel, High-Voltage Analog Switch"* (DS20006551)**

THE MICROCHIP WEBSITE

Microchip provides online support via our website at www.microchip.com. This website is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the website contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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To register, access the Microchip website at www.microchip.com, click on **Product Change Notification** and follow the registration instructions.

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the website at:
http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (May 2021)

- Initial release of this document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

The HV2916 Analog Switch Evaluation Board (EV07D36A) works with the Microchip HV MUX Controller Board (ADM00825) to provide single 5V bias, low harmonic distortion, 32-channel, high-voltage analog switch demonstration, including basic switch on/off operation, and 2:1 MUX operation to transmit ±100V high-voltage pulse burst from two built-in MD1822 and TC6320 pulser circuits.

1.2 HV2916 DEVICE SHORT OVERVIEW

The HV2916 device is a single 5V bias, low harmonic distortion, 32-channel, high-voltage analog switch (with bleed resistors in SWT pins). It is designed to be used in applications requiring high-voltage switching, controlled by low-voltage control signals, such as medical ultrasound imaging, driving piezoelectric transducers and printers. Each analog switch has a typical 6Ω on-resistance and can conduct currents up to ±2.9A. The switches can withstand ±100V (at the SWS pins) and can conduct pulses with widths up to 2.5 µs without the need for high voltage supplies. It requires only a +5V single bias voltage supply at V_{DD} and V_{LL} for the switch operation. The user can also use +3.3V instead of +5V for the logic voltage, V_{LL}, in order to reduce power consumption.

The HV2916 device has a digital serial interface to control the 32 analog switches individually. The digital interface clock operates at frequencies up to 66 MHz.

The HV2916 has an asymmetric topology which is smaller in size compared to a no-high-voltage-bias analog switch with symmetric topology. A switch in HV2916 has an SWT terminal and an SWS terminal. Since the HV2916 has asymmetric topology, the SWT pin and the SWS pin are not interchangeable. The SWT pin can pass a high-voltage pulsed signal applied to the SWS pin, when the switch is ON state. When the switch is OFF state, high-voltage should not be applied to the SWT pin. In a medical ultrasound system, the SWS pin is connected to Tx/Rx and the SWT pin is connected to a single piezoelectric transducer element in order to avoid high-voltage at the SWT pin during the switch OFF state.

1.3 HV2916 ANALOG SWITCH EVALUATION BOARD FEATURES

- HV2916 Single 5V Bias, Low Harmonic Distortion, 32-Channel, High-Voltage Analog Switch with Bleed Resistors in SWT Pin
- Designed to work with the Microchip HV MUX Controller Board (ADM00825)
- Two 2:1 MUX channels with built-in MD1822 and TC6320 Pulsers
- 5 MHz 3-Level High-Voltage Pulse Burst Outputs
- On-Board 330 pF//2.5 kΩ Dummy Load on SW8T, SW9T, SW24T, SW25T Pins
- Pulser ON/OFF and Time Domain Control through the PC GUI (Graphic User Interface) and the HV MUX Controller Board

1.4 WHAT IS THE HV2916 ANALOG SWITCH EVALUATION BOARD?

The HV2916 Analog Switch Evaluation Board can control the HV2916 device and built-in pulsers that are connected to the two 2:1 MUX switches for demonstration using the HV MUX Controller Board and GUI. Four switch outputs (SWT pins) from two 2:1 MUXes have SMA connectors which can be connected to four transducer elements. The other side of the 2:1 MUX (SWS pins) is connected to the outputs of two built-in MD1822 and TC6320 pulsers. The HV2916 Analog Switch Evaluation Board can drive four transducer elements with 5 MHz, ±100V pulse signals.

The HV2916 Analog Switch Evaluation Board features one HV2916/AJA 10 x 10 x 1.1 mm 121-Ball TFBGA packaged integrated circuit, two MD1822K6-G 3 x 3 x 1 mm 16-Lead QFN packaged integrated circuits and four TC6320K6-G 4 x 4 x 1 mm 8-Lead DFN packaged NMOS and PMOS paired integrated circuits.

The HV2916 Analog Switch Evaluation Board uses two high-speed 20-signal pairs, carrying capable right-angle backplane connectors, which are designed to work with the HV MUX Controller Board as a control signal source.

The HV MUX Controller Board has an FPGA that generates pulser waveform and logic control signals, and a USB bridge IC that connects the control board to a PC. By using a Microsoft® Windows®-operated PC and the GUI software, the user can control the HV2916 device and two built-in pulsers on the HV2916 Analog Switch Evaluation Board.

Four switch terminals, consisting of two 2:1 MUX configurations on the PCB, have SMA connectors to which the user can connect loads. The jumpers close to the SMA connectors are for connecting the on-board dummy R-C load (330 pF//2.5 kΩ) optionally to the switch outputs.

WARNING

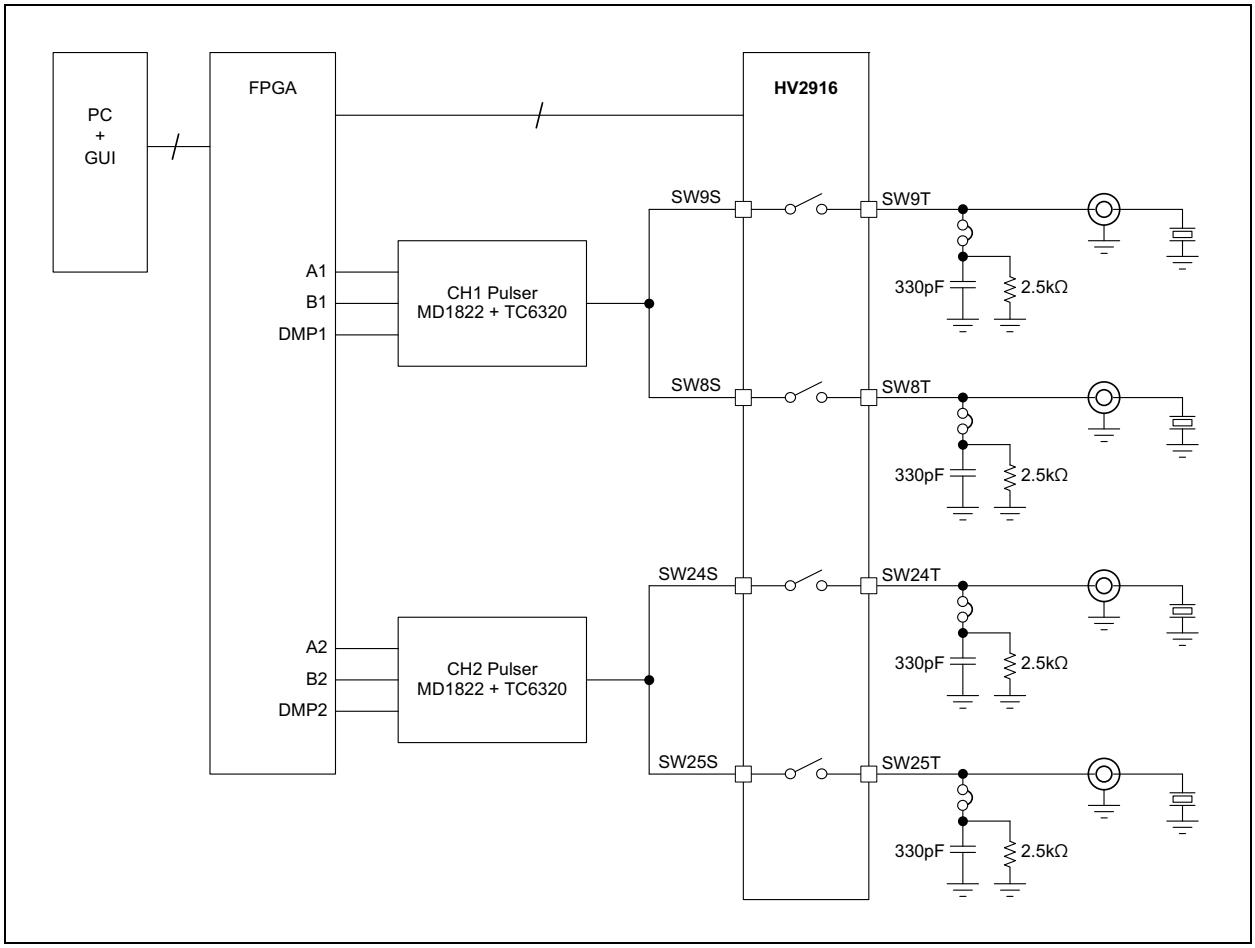
Risk warning of electrical shock. This board uses multiple hazardous high voltages. Disconnect all high-voltage supplies before working on it. Electrical safety precautions must be taken when working on or using this board.

1.5 HV2916 ANALOG SWITCH EVALUATION BOARD TECHNICAL PARAMETERS

TABLE 1-1: HV2916 ANALOG SWITCH EVALUATION BOARD TECHNICAL PARAMETERS

Parameter	Value
Pulser Frequency	5 MHz
Number of Pulses in the Burst	1 to 90
T_{OFF} Time Between Pulse Bursts	5 to 30 ms
Pulse Peak Voltage and Current	0 to ±100V and ±2.9A (typical)
Interface of FPGA Control Signals and USB PC-GUI Software	J1 and J2 Connects to ADM00825 Controller Interface Board
Pulser R-C Test Load and User's Transducer Interface	Built-in, 330 pF//2.5 kΩ per Channel with jumper and 50Ω SMA
PCB Board Dimension	115 mm x 110 mm

FIGURE 1-1: HV2916 ANALOG SWITCH EVALUATION BOARD SIMPLIFIED BLOCK DIAGRAM



1.6 HV2916 ANALOG SWITCH EVALUATION BOARD KIT CONTENTS

The HV2916 Analog Switch Evaluation Board includes:

- HV2916 Analog Switch Evaluation Board (EV07D36A)
- Important Information Sheet

NOTES:

Chapter 2. Installation and Operation

2.1 GETTING STARTED

The HV2916 Analog Switch Evaluation Board is fully assembled and tested. The board requires five power supply voltage rails: +5V for HV2916 and +3.3V,+10V and ±100V for the pulser.

2.1.1 Additional Tools Required for Operation

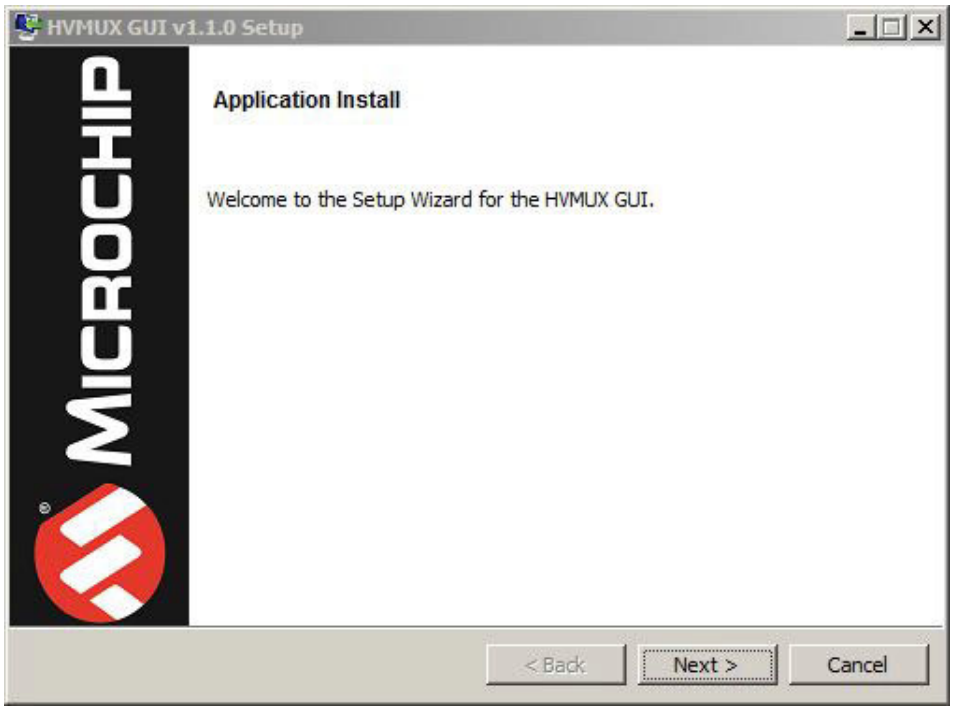
1. An oscilloscope with a minimum of 500 MHz bandwidth and two high-impedance probes. Make sure the grounds of the power supply sources are correctly connected to the same ground as the testing oscilloscope ground.
2. A Microchip HV MUX Controller Board (ADM00825)
3. A Microsoft® Windows® 7 or higher PC with the HV MUX Controller Board GUI software installed and running
4. J1 and J2 connected to the HV MUX Controller Board
5. HV MUX Controller Board connected through the USB port to the PC

2.2 HV MUX GUI INSTALLATION

The HV MUX GUI software installer can be downloaded from the Microchip website at www.mircochip.com. Search for the evaluation board on the website by the part number: **EV07D36A**.

1. Open the `HVMUXGUI-v1.0.0-windows-installer.exe`.
2. Initiate the HV MUX GUI software installer by launching the Application Install dialog box.

FIGURE 2-1: HV MUX GUI – APPLICATION INSTALL DIALOG BOX



3. Click **Next** to start the installation.

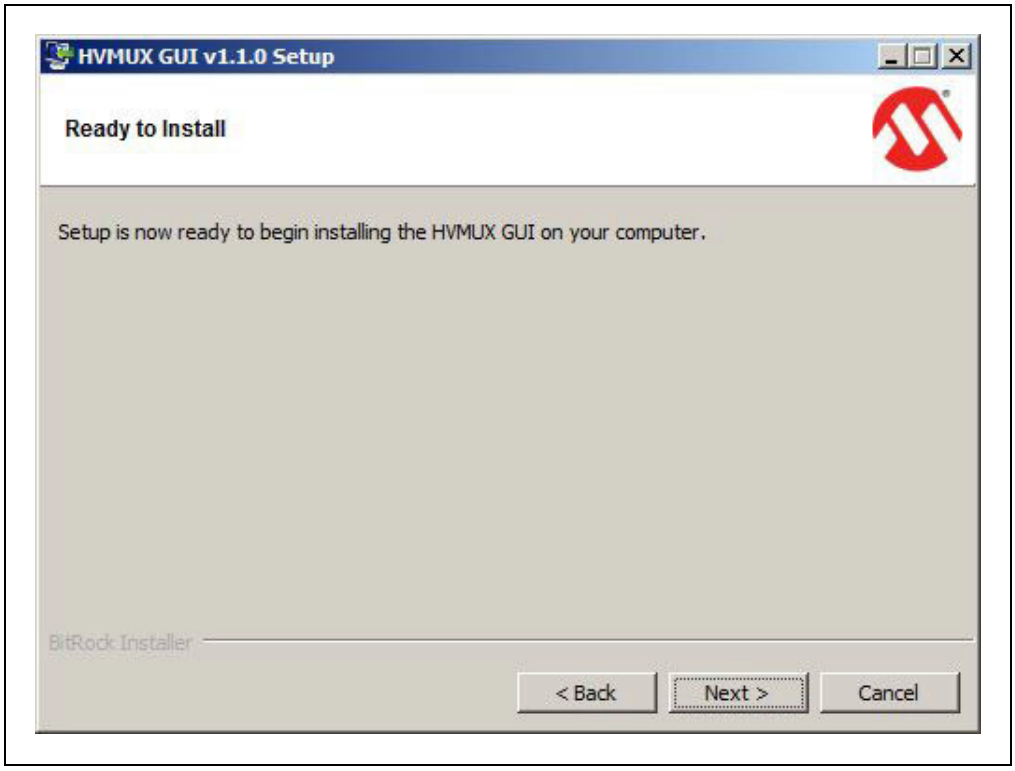
FIGURE 2-2: HV MUX GUI – LICENSE AGREEMENT DIALOG BOX

4. Read the License Agreement and accept it by checking the box corresponding to "I accept the agreement". Click **Next** to proceed with the installation.

FIGURE 2-3: HV MUX GUI – INSTALLATION DIRECTORY DIALOG BOX

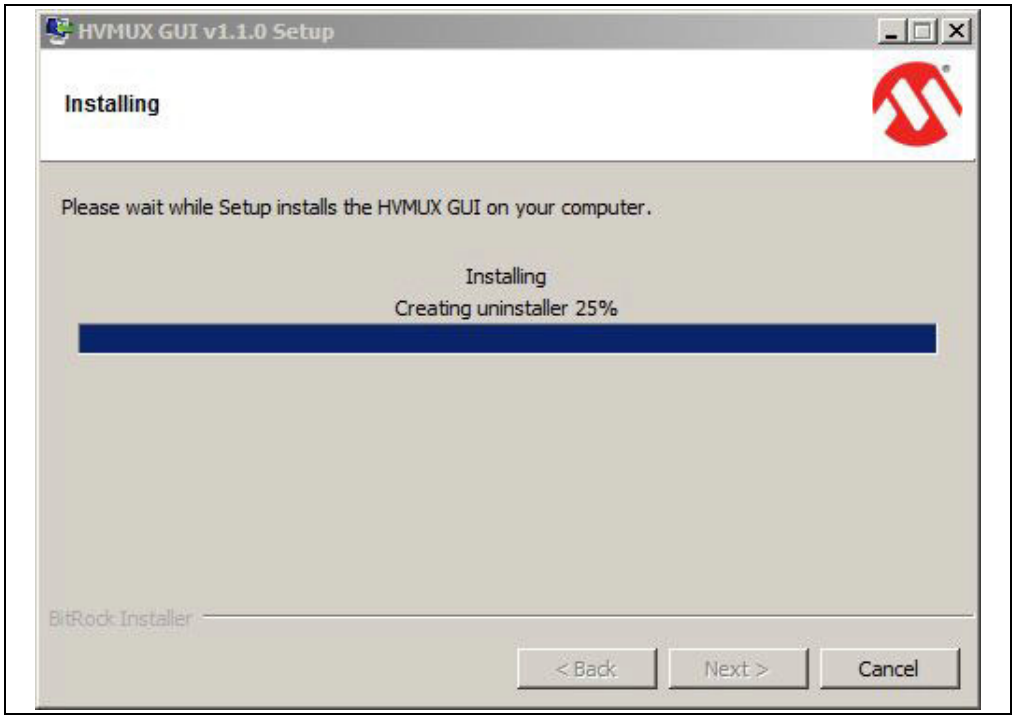
5. On the Installation Directory dialog box, browse for the desired location or click **Next** to install in the default location.

FIGURE 2-4: HV MUX GUI – READY TO INSTALL DIALOG BOX



6. Once the installation path is chosen, the software is ready to install. Click **Next**.

FIGURE 2-5: HV MUX GUI – INSTALLATION STATUS DIALOG BOX



7. The Installation Status window appears, showing the installation progress.
8. After the installation has completed, click **Next**.

FIGURE 2-6: HV MUX GUI – INSTALLATION COMPLETE DIALOG BOX

9. Once the Installation Complete dialog box appears, click the **Finish** button to exit the installer.

2.3 HV2916 ANALOG SWITCH EVALUATION BOARD SETUP PROCEDURE

To operate the HV2916 Analog Switch Evaluation Board, the following steps must be completed:

1. Attach the HV2916 Analog Switch Evaluation Board to the HV MUX Controller Board (ADM00825) with the J1 and J2 connectors.
2. Connect all the jumpers on J5, J6, J7 and J11 for the on-board R-C load.
3. Connect all the power supplies to the voltage supply input connectors J3 and J4, as indicated in Table 2-1, by observing the polarity.

CAUTION

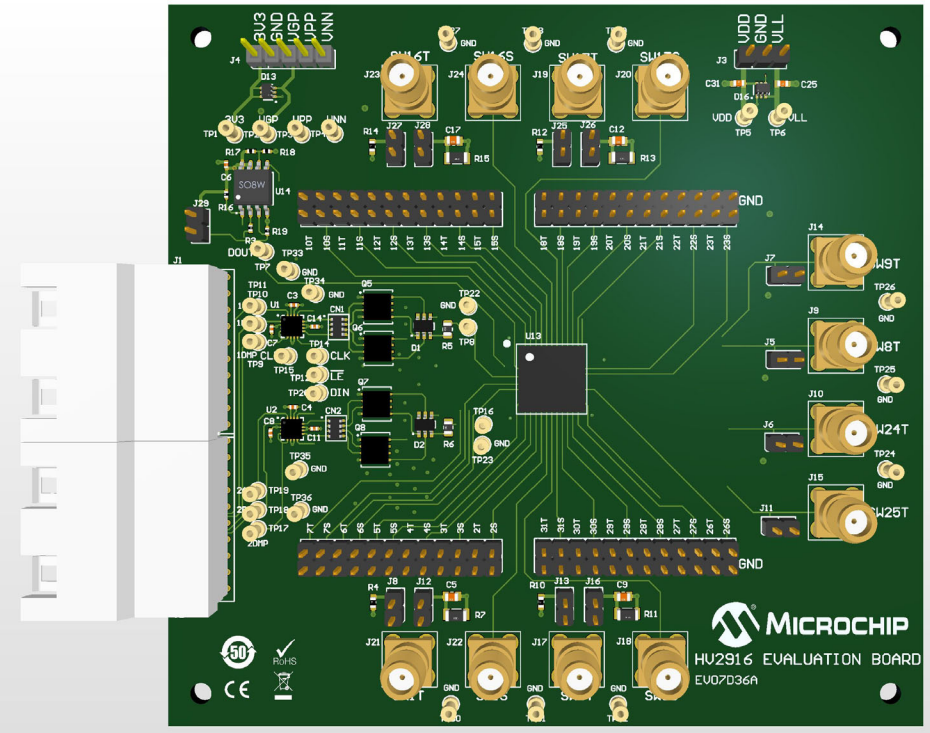
Observe the polarity of each power supply rail and set the voltage and current limit carefully.

4. Turn on the V_{LL} first and then turn on the V_{DD}.
5. Turn on the 3V3.
6. Turn on the V_{GP} and V_{PP}/V_{NN}.
7. Connect a USB cable from the HV MUX Controller Board to the PC.
8. Connect +12V/1A power to the HV MUX Controller Board and turn on OFF/ON switch.
9. Run the HV MUX GUI software on the PC.
10. Click the **Initialize HV MUX Controller** button in the GUI. This causes the status window at the bottom of the screen to display an “Initialization Complete” message.
11. Clear the $\overline{\text{STBY}}$ check box and select the MODE check box. (Do not change these states. Not used for the HV2916 Analog Switch Evaluation Board.)
12. Click the **Set HV MUX** button. All digital control signals are applied to the HV2916 device.
13. Set the number of pulses and T_{OFF} time of the pulser.
14. Select CH1 or CH2 to set the Channel 1 pulser or the Channel 2 pulser, respectively.
15. Click the **Start** button for the selected pulser to generate pulse bursts.
16. Click the **Stop** button for the selected pulser to stop generating pulse bursts.

TABLE 2-1: POWER SUPPLY VOLTAGES AND CURRENT LIMIT SETTINGS

Terminal	Rail Name	Voltage	Average Current Limit
J3-1	V_{DD}	+5V	+20 mA
J3-2	GND	0V	—
J3-3	V_{LL}	+3.3V or +5V	+2 mA
J4-1	3V3	+3.3V	+150 mA
J4-2	GND	0V	—
J4-3	V_{GP}	+5V to +11.5V	+10 mA
J4-4	V_{PP}	+100V	+5 mA
J4-5	V_{NN}	-100V	-5 mA

FIGURE 2-7: HV2916 ANALOG SWITCH EVALUATION BOARD FRONT VIEW



2.3.1 Recommended Power-Up and Power-Down Sequences

Table 2-2 shows the recommended power-up and power-down sequences of the HV2916 Analog Switch Evaluation Board.

TABLE 2-2: HV2916 ANALOG SWITCH EVALUATION BOARD POWER-UP AND POWER-DOWN SEQUENCES

Step	Power-up Description	Step	Power-Down Description
1	V_{LL} ON	1	V_{PP} and V_{NN} OFF
2	V_{DD} ON	2	V_{GP} OFF
3	3V3 ON with Logic Signal Static	3	3V3 OFF with Logic Signal Static
4	V_{GP} ON	4	V_{DD} OFF
5	V_{PP} and V_{NN} ON	5	V_{LL} OFF

2.4 INTERFACE CONNECTIONS

TABLE 2-3: J2 CONTROL INTERFACE SIGNALS

Pin No.	Name	Test Point	I/O Type	Signal Direction
J2-A2	SCK	—	LVCMOS-2.5V Input	EEPROM Serial Clock Input
J2-B2	CSB	—	LVCMOS-2.5V Input	EEPROM Chip Select Input
J2-A3	MISO	—	LVCMOS-2.5V Output	EEPROM Serial Data Output
J2-B3	MOSI	—	LVCMOS-2.5V Input	EEPROM Serial Data input
J2-A5	CLR	TP15	LVCMOS-3.3V Input	HV2916 Latch Clear Logic Input
J2-B5	CLK	TP14	LVCMOS-3.3V Input	HV2916 Clock Logic Input
J2-C5	$\overline{LE}$	TP12	LVCMOS-3.3V Input	HV2916 Latch Enable Logic Input
J2-A6	DIN	TP20	LVCMOS-3.3V Input	HV2916 Data In Logic Input
J2-C6	1_A	TP11	LVCMOS-3.3V Input	Ch1 Pulser input for NMOS to V_{NN}
J2-D6	1_B	TP10	LVCMOS-3.3V Input	Ch1 Pulser input for PMOS to V_{PP}
J2-A7	1_DMP	TP9	LVCMOS-3.3V Input	Ch1 Pulser Damp Input for PMOS/NMOS to GND
J2-B7	2_A	TP19	LVCMOS-3.3V Input	Ch2 Pulser input for NMOS to V_{NN}
J2-C7	2_B	TP18	LVCMOS-3.3V Input	Ch2 Pulser input for PMOS to V_{PP}
J2-D7	2_DMP	TP17	LVCMOS-3.3V Input	Ch2 Pulser Damp Input for PMOS/NMOS to GND

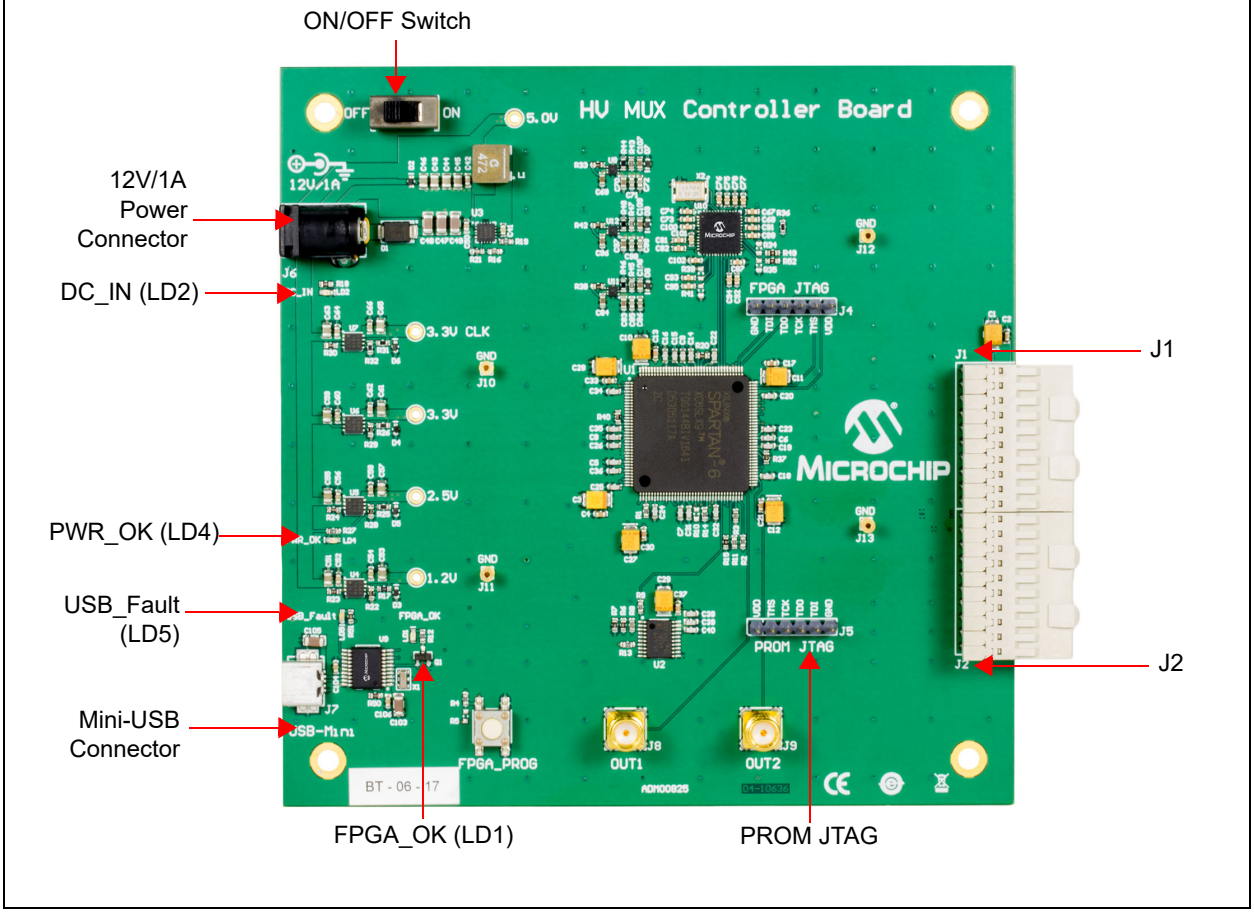
2.5 HV MUX CONTROLLER BOARD SETUP PROCEDURE

The HV MUX Controller Board generates 3.3V control signals for the HV2916 Analog Switch Evaluation Board and features a Spartan-6 XC6SLX9 FPGA.

1. Before powering up the HV2916 Analog Switch Evaluation Board and the HV MUX Controller Board, make sure that the latest GUI software is installed on the PC.
2. Start the GUI program. If the board is not connected, a "Not Connected" message is displayed in the Status bar, located at the bottom left of the screen.
3. Connect the appropriate power supply and turn on the power switch to power-up the HV MUX Controller Board. The FPGA_OK(LD1), DC_IN (LD2) and PWR_OK(LD4) on the HV MUX Controller Board should light up green. A "Connected" message is displayed on the bottom left of the Status bar of the GUI.

The HV MUX Controller Board is now ready to control the HV2916 Analog Switch Evaluation Board.

FIGURE 2-8: HV MUX CONTROLLER BOARD (ADM00825) – FRONT VIEW



2.6 TESTING THE HV2916 ANALOG SWITCH EVALUATION BOARD

The user can turn on/off each of the 32 switches through the USB connected PC GUI software program by following the next steps:

1. Click the **Initialize HV MUX Controller** button, located at the top left corner.
2. Clear $\overline{\text{STBY}}$.
3. Select MODE.
4. Put 32-bit data in DIN to set switches ON and OFF. Data 1 means the switch is ON and data 0 means the switch is OFF.
5. Click the **Set HV MUX** button. The GUI and controller board now generate 32-bit data and 32 clocks, followed by one $\overline{\text{LE}}$ negative pulse and the switches are ON and OFF according to DIN in the GUI.
6. Select CLR and click the **Set HV MUX** button to set all switches to OFF.

Note: The typical voltage and waveforms are provided in **Appendix C. "Demo Board Waveforms"**.

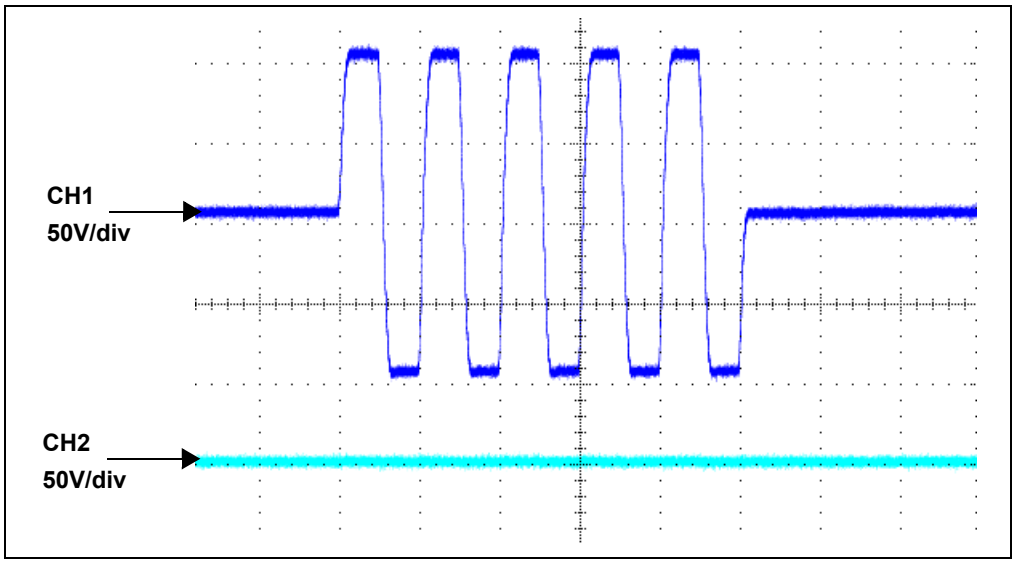
2.7 GENERATION OF PULSER OUTPUT AT SW8T OF HV2916

This section provides the simple step-by-step procedure to make the Ch1 pulser output at the SW8T SMA connector with dummy loads by configuring the GUI.

1. Before powering up the HV2916 Analog Switch Evaluation Board, make sure that the latest GUI software is installed on the PC.
2. Start the GUI program. If the board is not connected, a "Not Connected" message is displayed in the Status bar located at the bottom left of the screen.
3. Power up the HV MUX Controller Board and HV2916 Analog Switch Evaluation Board as described in the previous sections. The prompt "Connected", is displayed in the Status bar.
4. Click the **Initialize HV MUX Controller** button and check the message window to see "Initialization Complete".
5. Clear $\overline{\text{STBY}}$.
6. Select MODE.
7. Clear CLR.
8. Change the DIN to Bit 8 from '0' to '1' to set SW8 ON (DIN = 00000000 00000000 00000001 00000000).
9. Click the **Set HV MUX** button to turn on the HV2916 SW8.
10. Change the Pulses to 10.
11. Select CH1.
12. Click the **Start** button. CH1 pulser starts to generate pulse bursts with 10 pulses (5 cycles) and 30 ms T_{OFF} time.

The Ch1 and Ch2 of the oscilloscope in Figure 2-9 show the SW8T and the SW9T.

FIGURE 2-9: TYPICAL WAVEFORM OF 2:1 MUX CONNECTED TO PULSER



Chapter 3. GUI Description

3.1 HV2916 ANALOG SWITCH EVALUATION BOARD GUI DESCRIPTION

Figure 3-1 displays a screen capture of the HV MUX Controller Board GUI.

Table 3-1 provides a detailed description of every item numbered in the screen capture. The selection of the check box, binary data in the DIN entry box and number in the Pulses and T_{OFF} entry box are just settings and don't change the operation of the HV2916 device and built-in pulsers immediately. By clicking the **Set HV MUX**, **Start** and **Stop** buttons, and the control data set by the user in the GUI change operation of the HV2916 device and turns on/off the built-in pulsers in the HV2916 Analog Switch Evaluation Board. Follow the explanation for each corresponding item.

FIGURE 3-1: HV MUX CONTROLLER BOARD GUI SCREEN CAPTURE

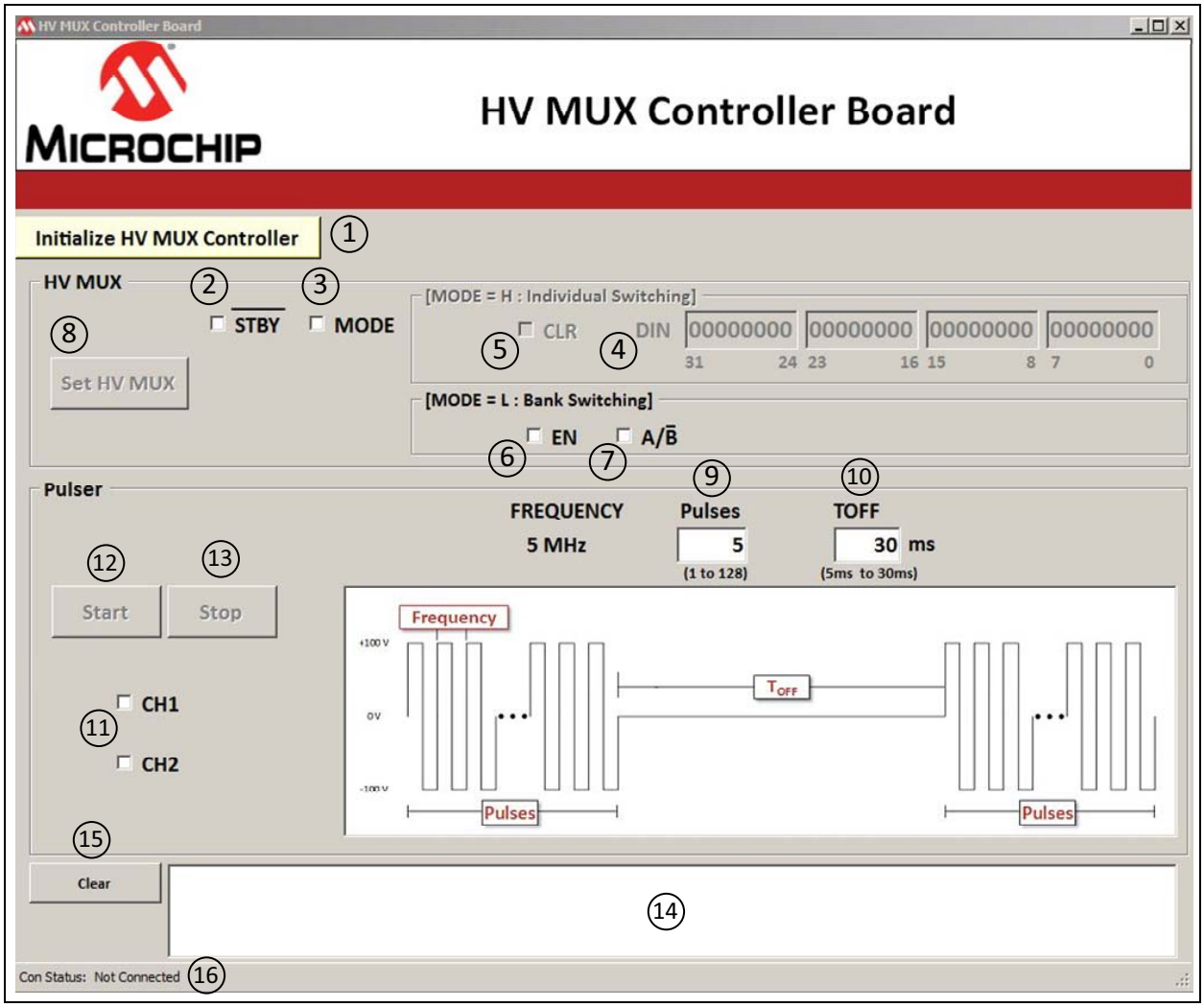


TABLE 3-1: HV2916 ANALOG SWITCH EVALUATION BOARD GUI DESCRIPTION

Item No.	Item Name	Item Description
1	**Initialize HV MUX Controller**	When this button is clicked, the GUI starts the initialization of FPGA on the HV MUX Controller Board and the communication between the GUI and the HV MUX Controller Board. If there is no error, the "Initialization Complete" message is displayed in the Message window.
2	$\overline{\text{STBY}}$	Stays unselected. Not used for the HV2916 Analog Switch Evaluation Board.
3	MODE	Stays selected. Not used for the HV2916 Analog Switch Evaluation Board.
4	DIN	32-bit data entry boxes. Each bit in the boxes is related to each analog switch. If data entry is `1`, the associated switch is set to ON. If data entry is `0`, the associated switch is set to OFF.
5	CLR	When this check box is selected, the CLR logic input is set to high and all the switches of the HV2916 device are set to off. When cleared, the CLR logic input is set to low and the 32 switches of HV2916 are set to ON/OFF states according to the DIN data entry.
6	EN	Deactivated when MODE is selected. Not used for the HV2916 Analog Switch Evaluation Board.
7	A/$\overline{\text{B}}$	Deactivated when MODE is selected. Not used for the HV2916 Analog Switch Evaluation Board.
8	**Set HV MUX**	When this button is clicked, the data described in Items 2 through 7 is applied to the HV2916 device. Note that the 32-bit DIN data, 32 clocks and one negative $\overline{\text{LE}}$ pulse are applied only once.
9	Pulses	This text box defines the number of pulses in the pulse burst generated by the selected pulser. A pulse is half of the cycle and the pulse burst always starts the positive pulse first.
10	TOFF	This text box defines the interval between pulse bursts generated by the selected pulser.
11	Ch1/Ch2	When one of these check boxes is selected, the respective pulser is set to generate 5 MHz pulse bursts defined in items 9 and 10 by the user.
12	**Start**	When this button is clicked, the selected pulser starts generating the pulse burst.
13	**Stop**	When this button is clicked, the selected pulser stops generating the pulse burst.
14	Message Window	This window displays information from the GUI program.
15	**Clear**	This button clears the messages in the Message window.
16	Connection Status	This window displays the status of the connection between the GUI and the HV MUX Controller Board.

Chapter 4. PCB Design and Layout Notes

4.1 PCB LAYOUT TECHNIQUES FOR HV2916

The HV2916 Analog Switch Evaluation Board has an analog switch to pass high-voltage, high-current and high-frequency pulses. Good PCB design and layout are important to ensure the success of the implementation.

4.1.1 High-Voltage and High-Speed Grounding and Layout Techniques

The user must pay attention to the connecting traces, since the analog switches pass high-voltage and high-speed signals. In particular, a controlled impedance of 50Ω to the ground plane and more trace spacing needs to be applied in this situation.

High-speed PCB trace design practices are used for the HV2916 Analog Switch Evaluation Board PCB layout. The internal circuitry of the HV2916 device can operate at a high frequency, with load capacitance as the primary speed limitation. Because of these high-speed and high-transient currents that result from driving capacitive loads, the supply voltage bypass capacitors should be located as close to the power supply pins as possible.

All the GND pins should have low-inductance feed through connections that are connected directly to a solid ground plane of the PCB. It is recommended to minimize the trace length to the ground plane and to insert a ferrite bead in the power supply lead to the capacitor to prevent resonance in the power supply lines. It is important to minimize trace lengths and use sufficient trace width to reduce inductance. Surface mount components are highly recommended.

The use of a solid ground plane and good power and signal layout practices prevent any possible parasitic capacitance coupling. The user should also ensure that the circulating ground return current from a capacitive load does not react with common inductance to create noise voltages in the input logic circuitry.

4.1.2 Decoupling Capacitors Selection

The V_{LL} and V_{DD} supply voltage rails are able to provide fast transient current. Therefore, they should have a low-impedance bypass capacitor close to each of the power supply pins. Use a surface-mounted ceramic capacitor of 0.1 to 2.2 µF capacitance with an appropriate voltage rating.

It is important to verify what type of ceramic capacitor is selected for these bypass capacitors. Low impedance means low-ESR/ESL impedance within the frequency bandwidth range of ultrasound pulses transmitted, including the very fast dV/dt of the pulse's rising and falling edges. A capacitor with low-temperature coefficient and low-voltage coefficient is also recommended. The type of X7R and X5R or other more advanced multilayer-ceramic types should be selected for these purposes.

NOTES:

Appendix A. Schematics and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the HV2916 Analog Switch Evaluation Board (EV07D36A) and the HV MUX Controller Board (ADM00825).

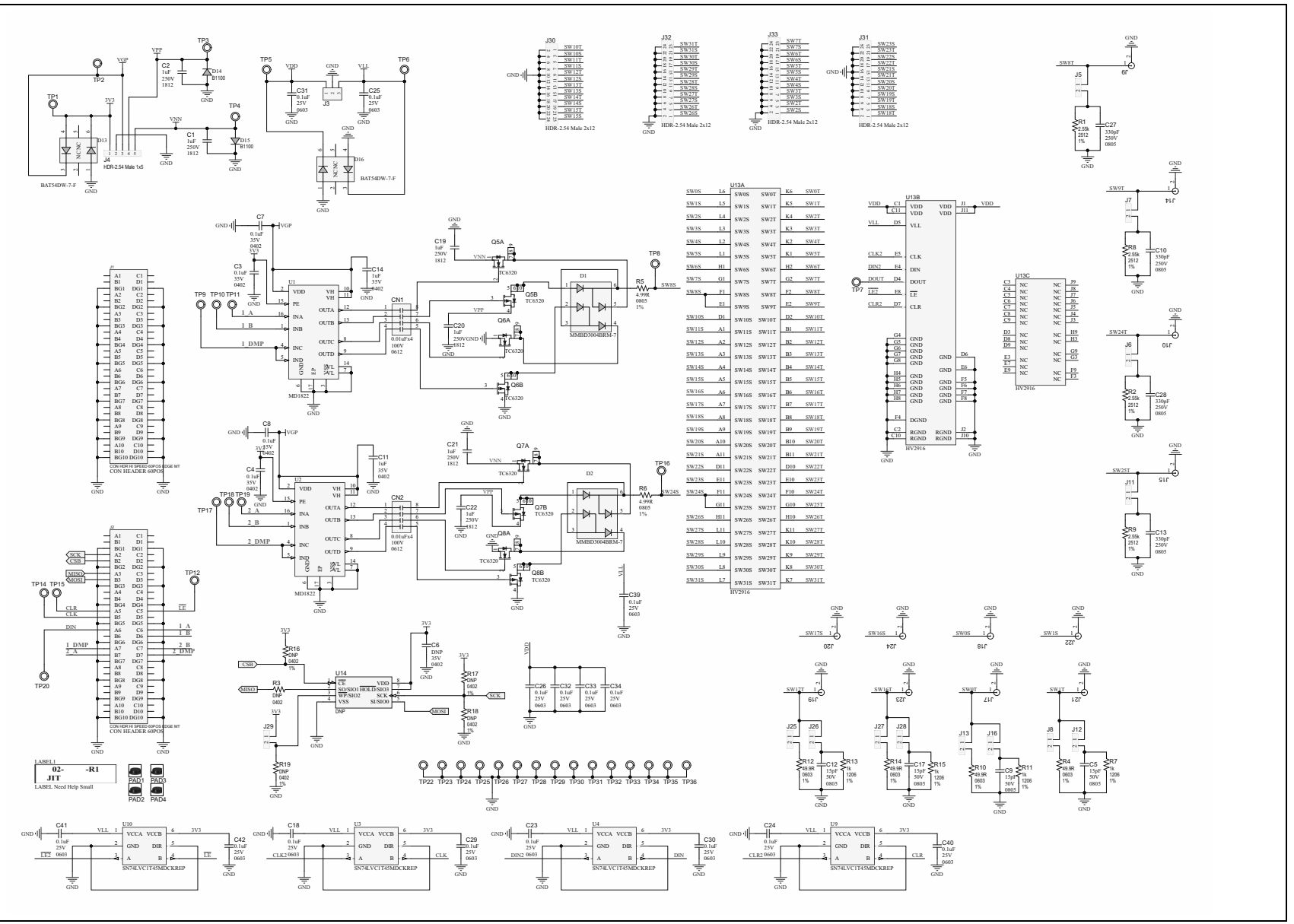
1. HV2916 Analog Switch Evaluation Board (EV07D36A):

- EV07D36A – Schematic
- EV07D36A – Top Silk
- EV07D36A – Top Copper and Silk
- EV07D36A – Top Copper
- EV07D36A – Inner 1 and 4
- EV07D36A – Inner 2
- EV07D36A – Inner 3
- EV07D36A – Bottom Copper
- EV07D36A – Bottom Copper and Silk
- EV07D36A – Bottom Silk

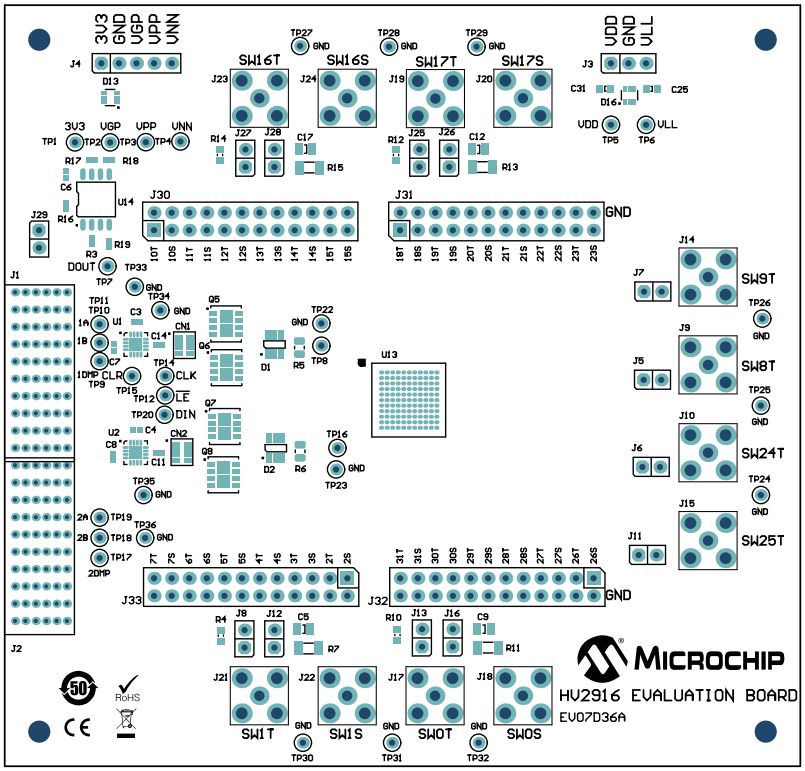
2. HV MUX Controller Board (ADM00825):

- ADM00825 – Schematic (Connection)
- ADM00825 – Schematic (Power Supply)
- ADM00825 – Schematic (USB to SPI)
- ADM00825 – Schematic (Programmable Clock)
- ADM00825 – Schematic (FPGA)
- ADM00825 – Schematic (FPGA Decoupling Capacitors)
- ADM00825 – Schematic (Connectors)
- ADM00825 – Top Silk
- ADM00825 – Top Copper and Silk
- ADM00825 – Top Copper
- ADM00825 – Inner 1
- ADM00825 – Inner 2
- ADM00825 – Inner 3
- ADM00825 – Inner 4
- ADM00825 – Bottom Copper
- ADM00825 – Bottom Copper and Silk
- ADM00825 – Bottom Silk

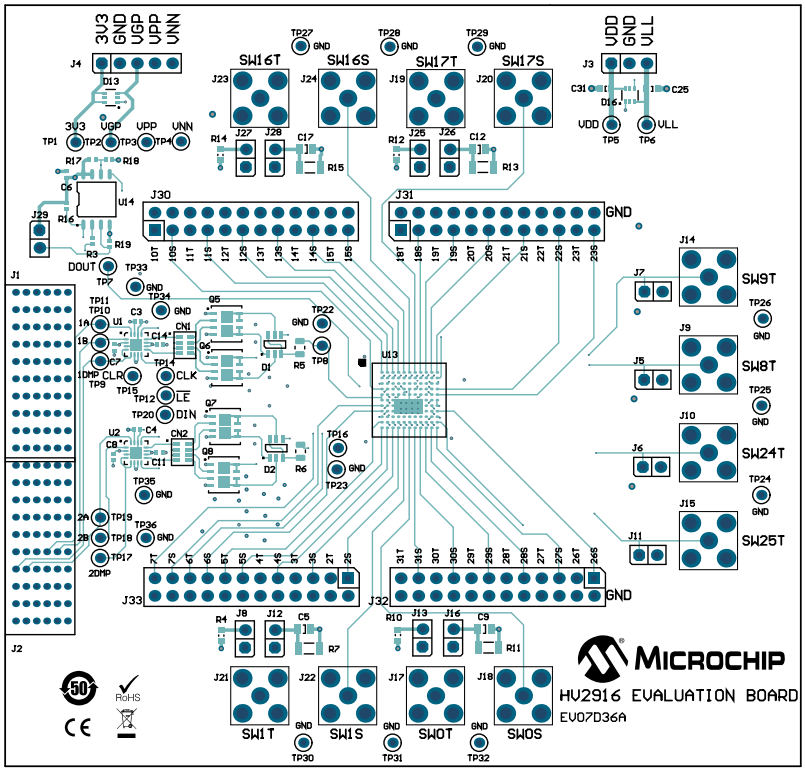
A.2 EV07D36A – SCHEMATIC



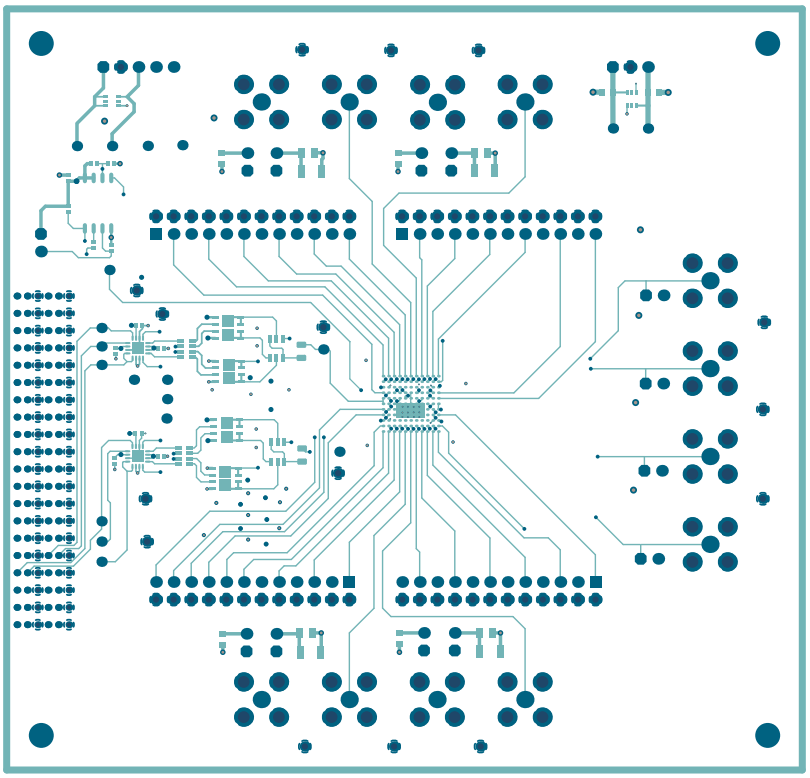
A.3 EV07D36A – TOP SILK



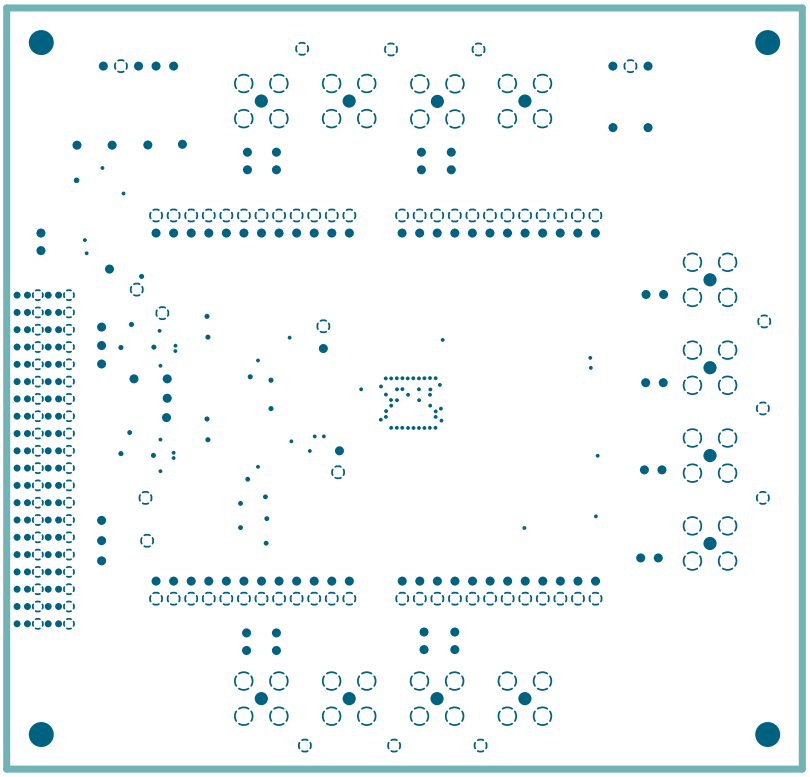
A.4 EV07D36A – TOP COPPER AND SILK



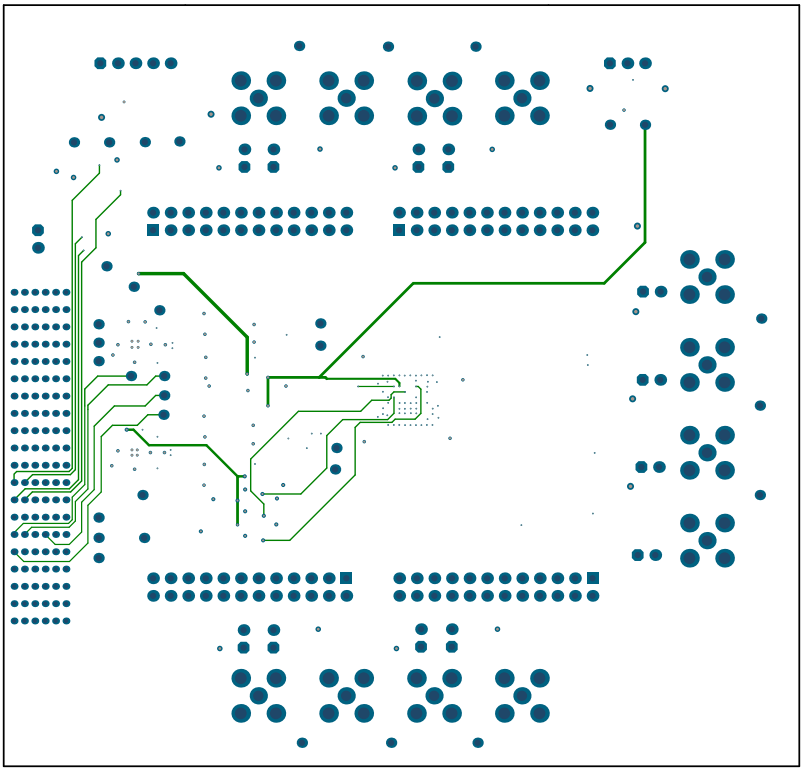
A.5 EV07D36A – TOP COPPER



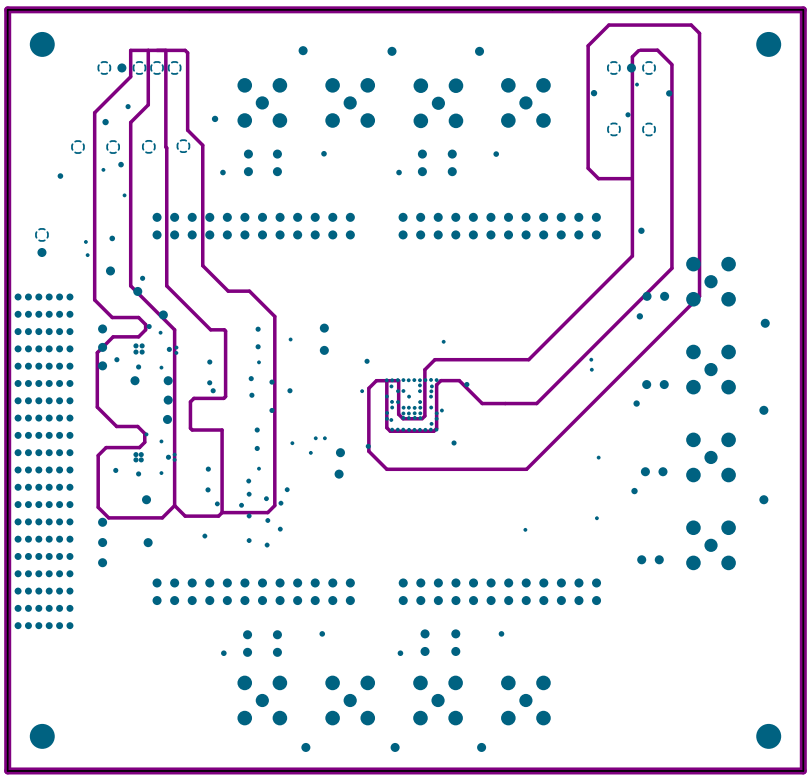
A.6 EV07D36A – INNER 1 AND 4



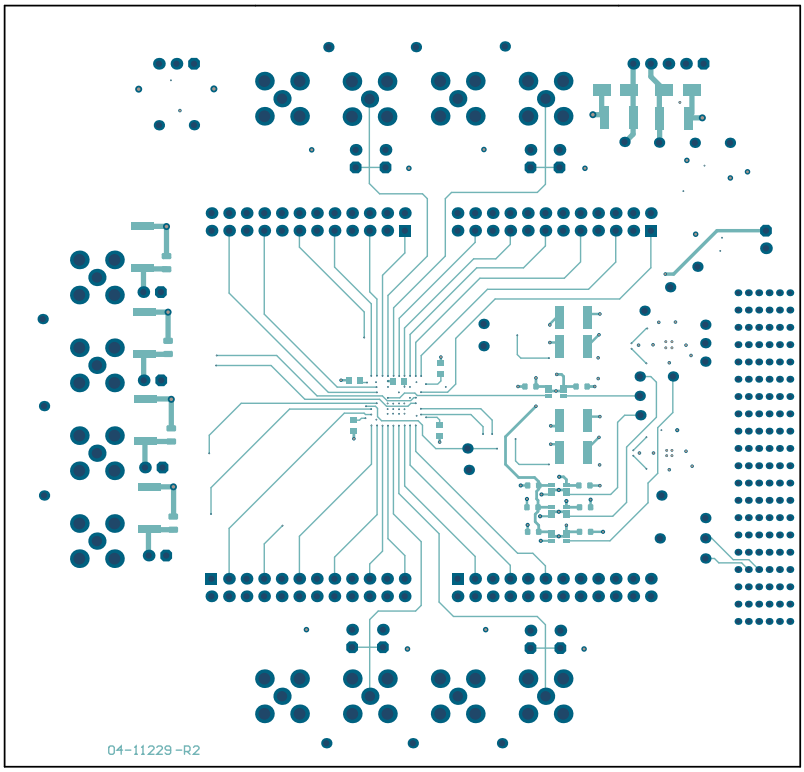
A.7 EV07D36A – INNER 2



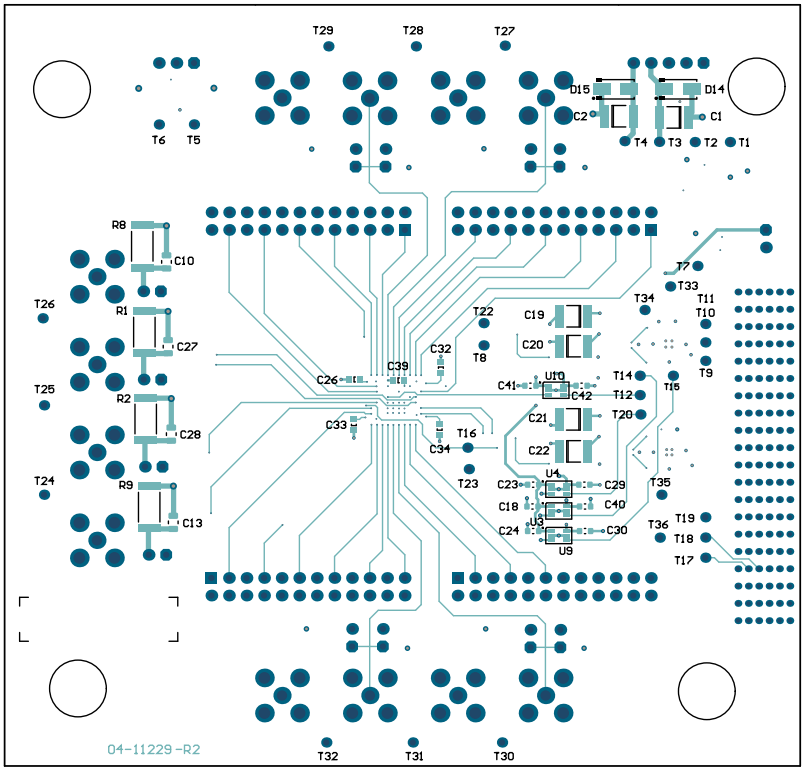
A.8 EV07D36A – INNER 3



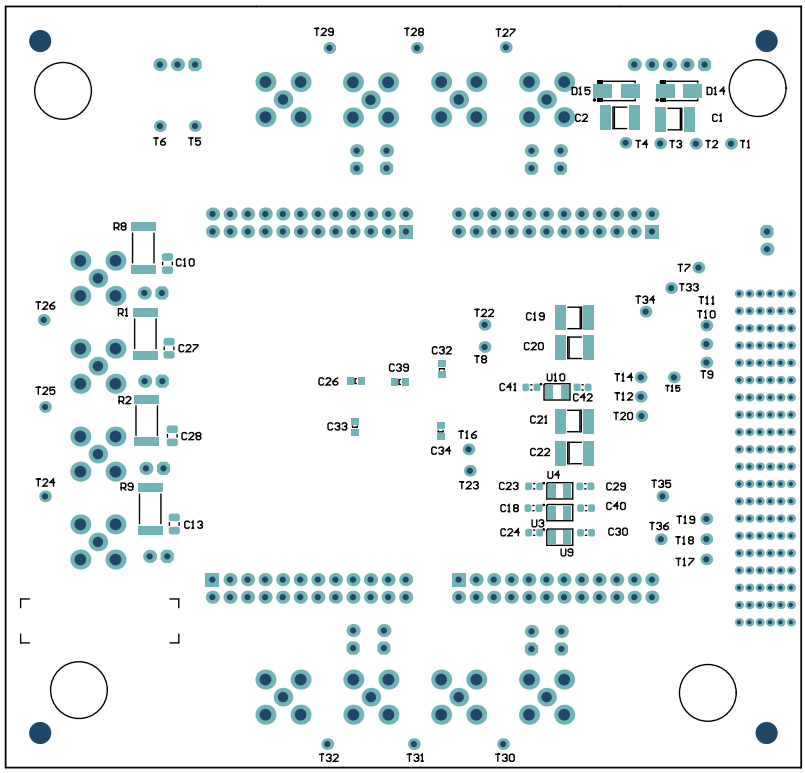
A.9 EV07D36A – BOTTOM COPPER



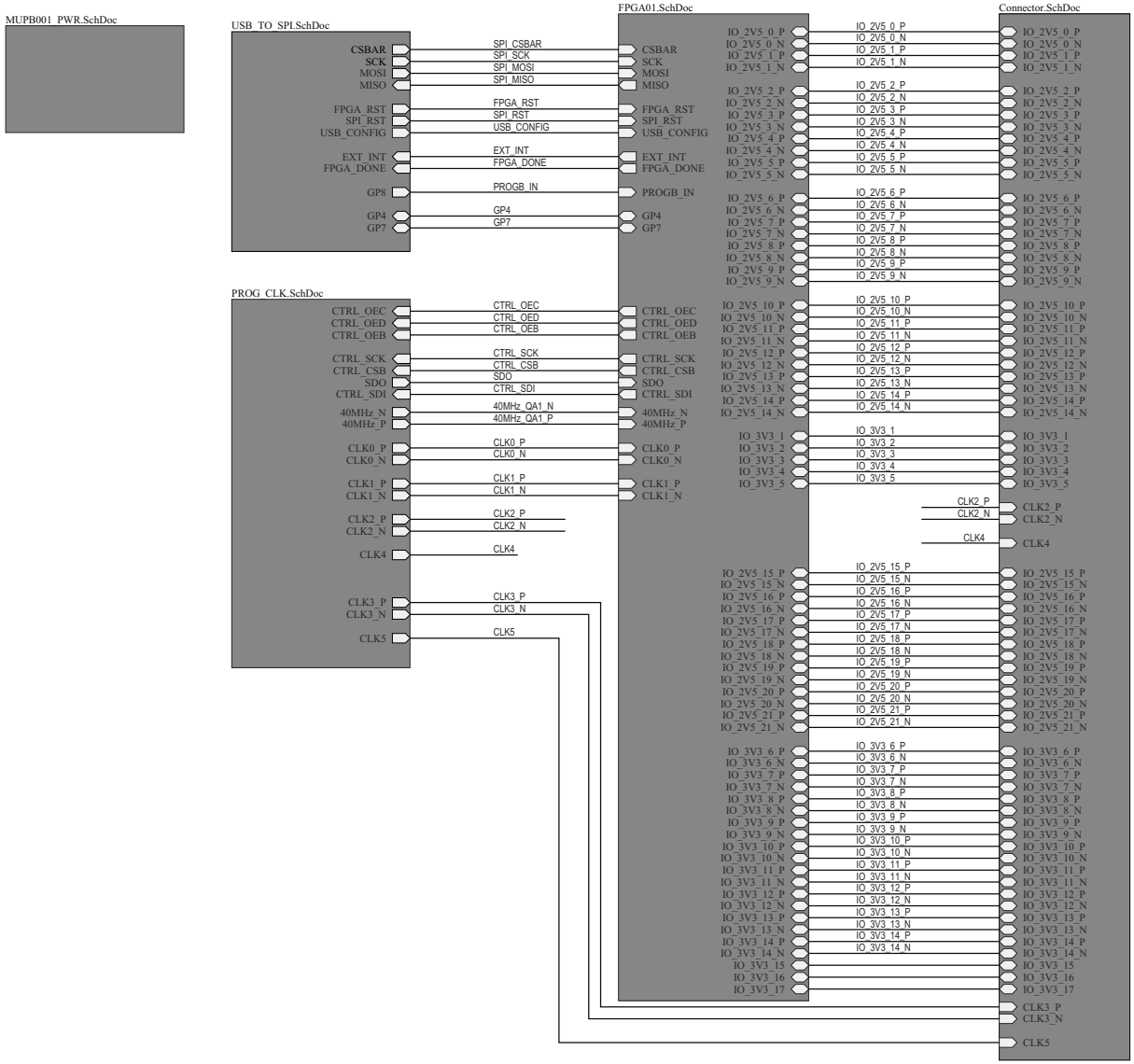
A.10 EV07D36A – BOTTOM COPPER AND SILK



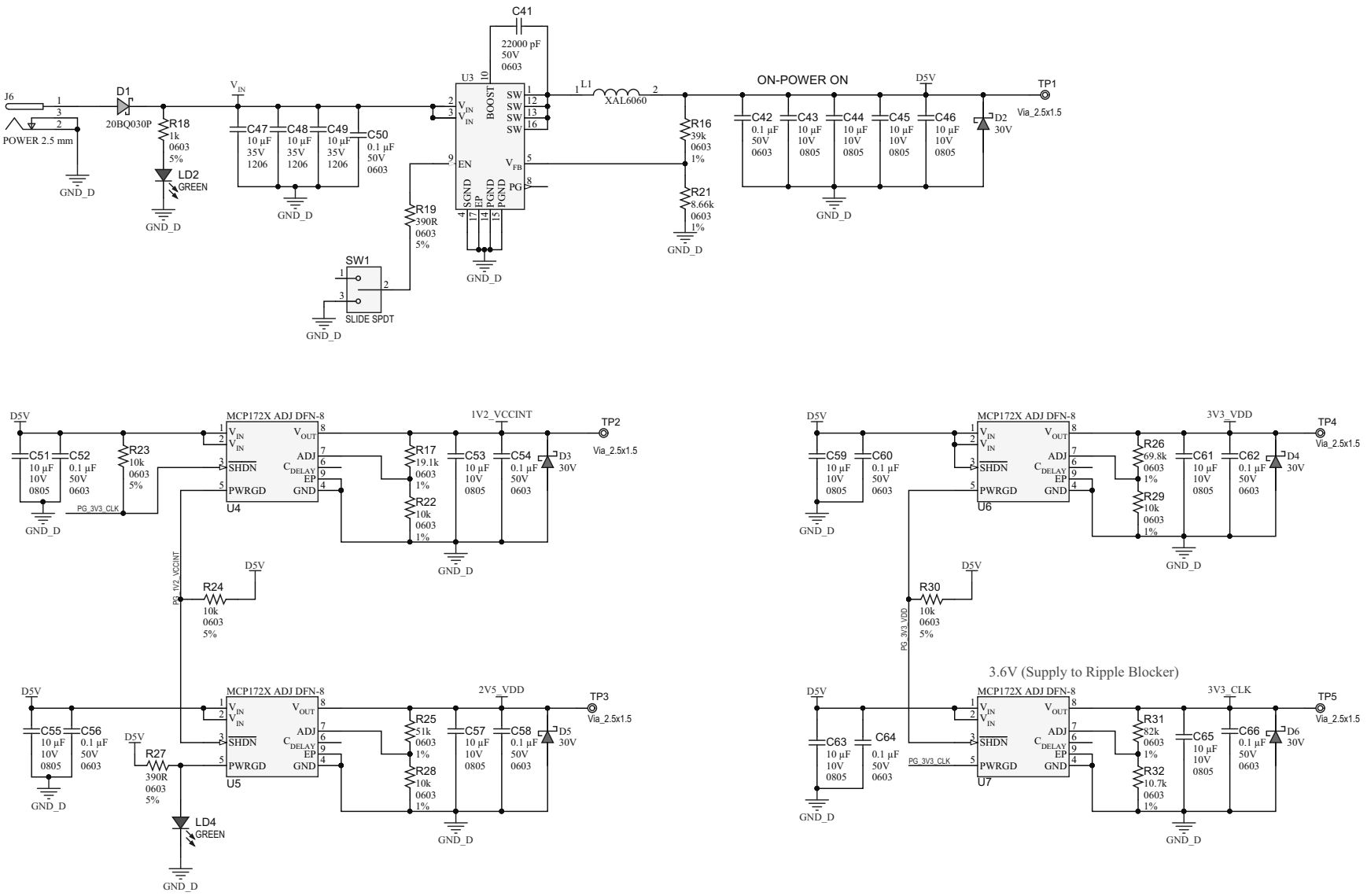
A.11 EV07D36A – BOTTOM SILK



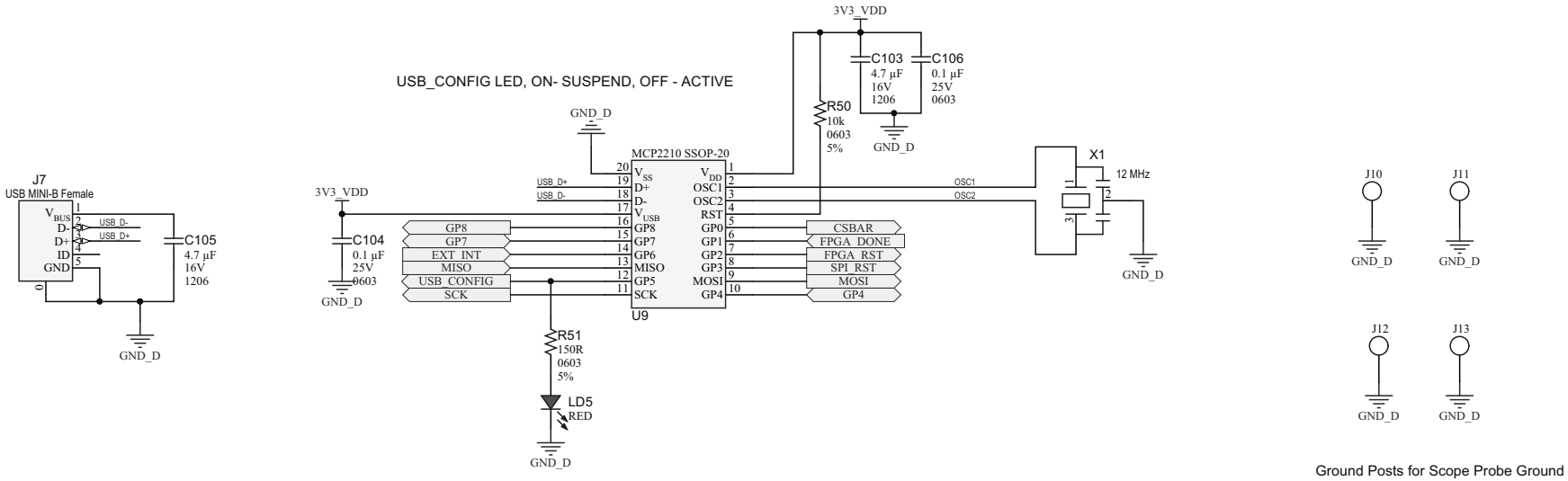
A.12 ADM00825 – SCHEMATIC (CONNECTION)



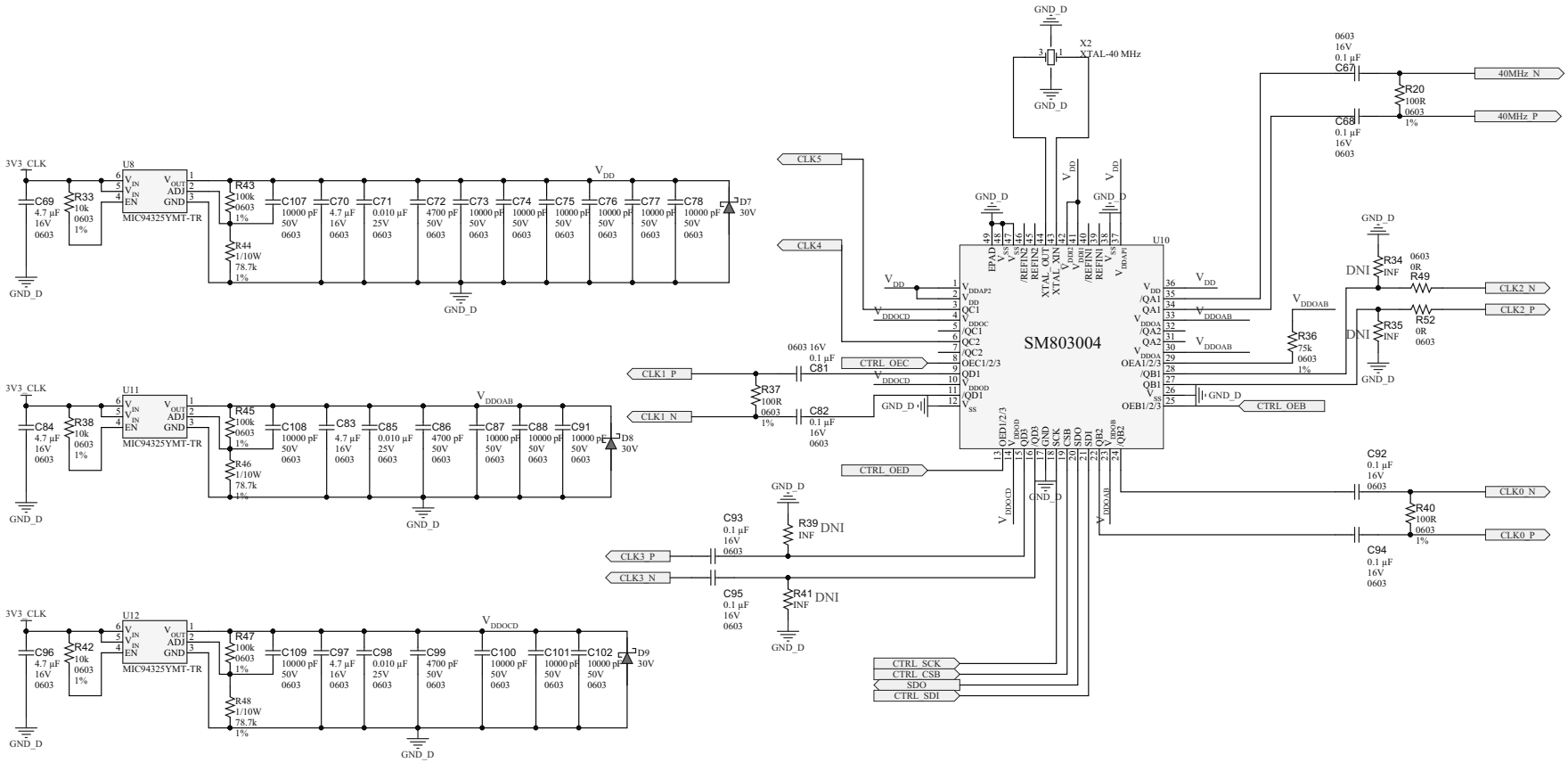
A.13 ADM00825 – SCHEMATIC (POWER SUPPLY)



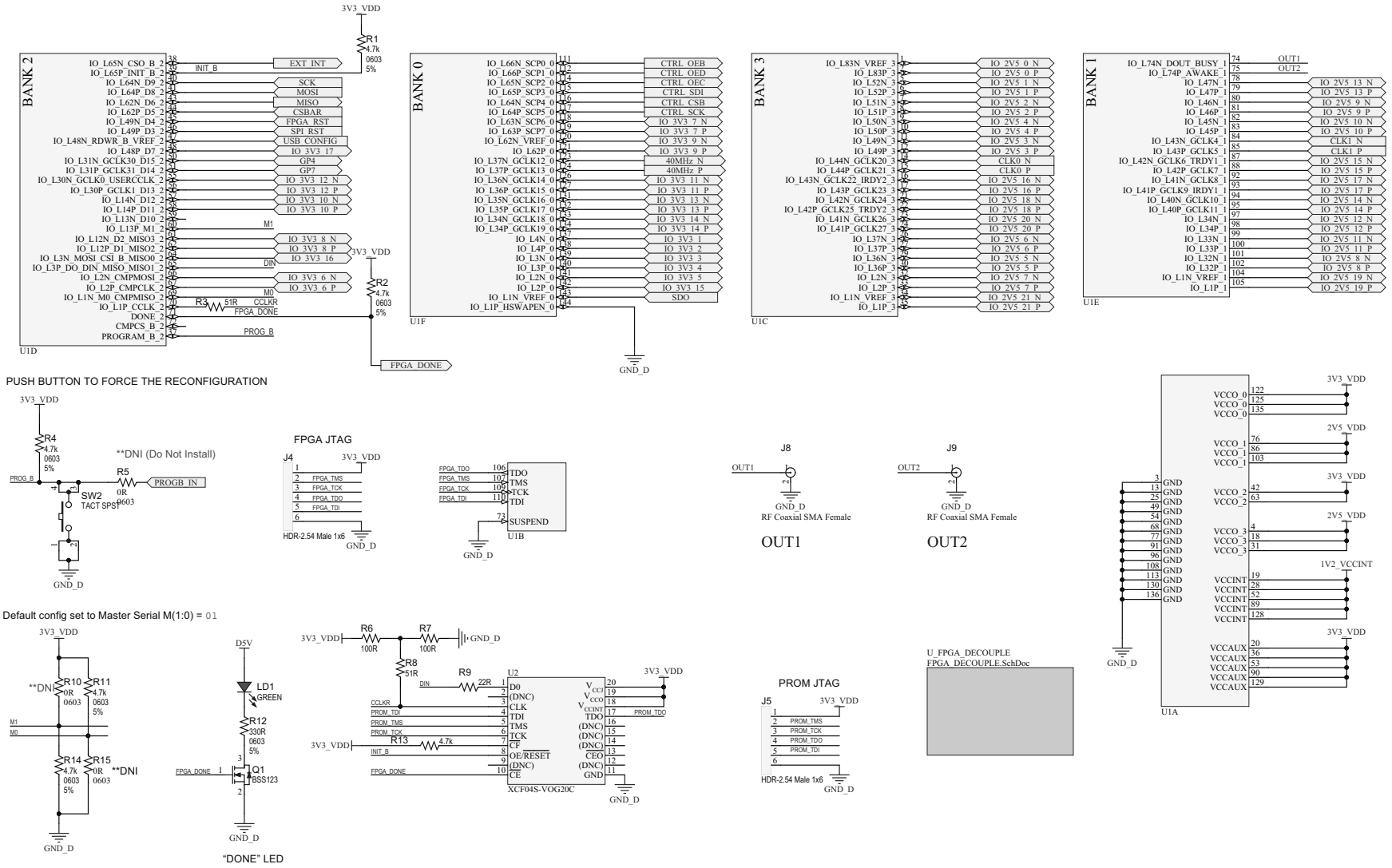
A.14 ADM00825 – SCHEMATIC (USB TO SPI)



A.15 ADM00825 – SCHEMATIC (PROGRAMMABLE CLOCK)

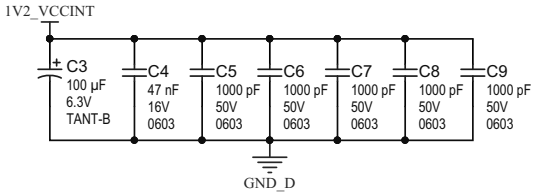


A.16 ADM00825 – SCHEMATIC (FPGA)

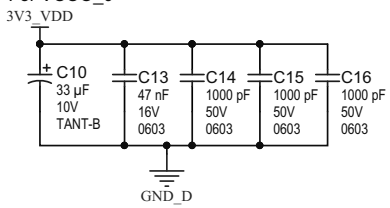


A.17 ADM00825 – SCHEMATIC (FPGA DECOUPLING CAPACITORS)

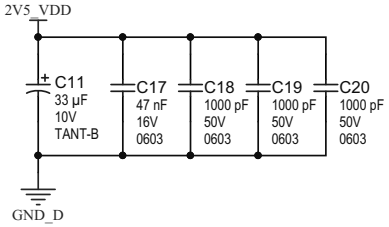
For 1V2_VCCINT



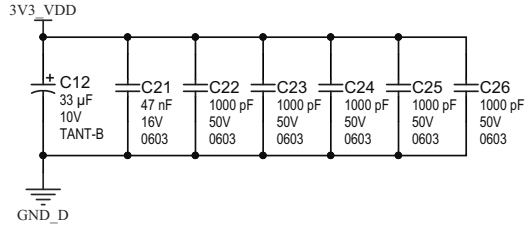
For VCCO_0



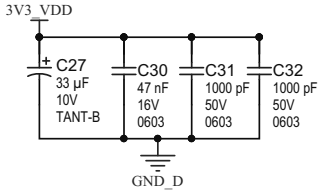
For VCCO_1



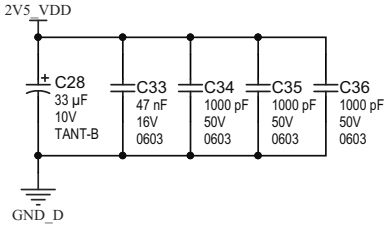
For VCCAUX



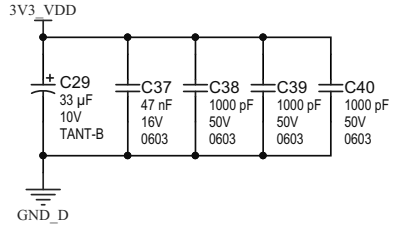
For VCCO_2



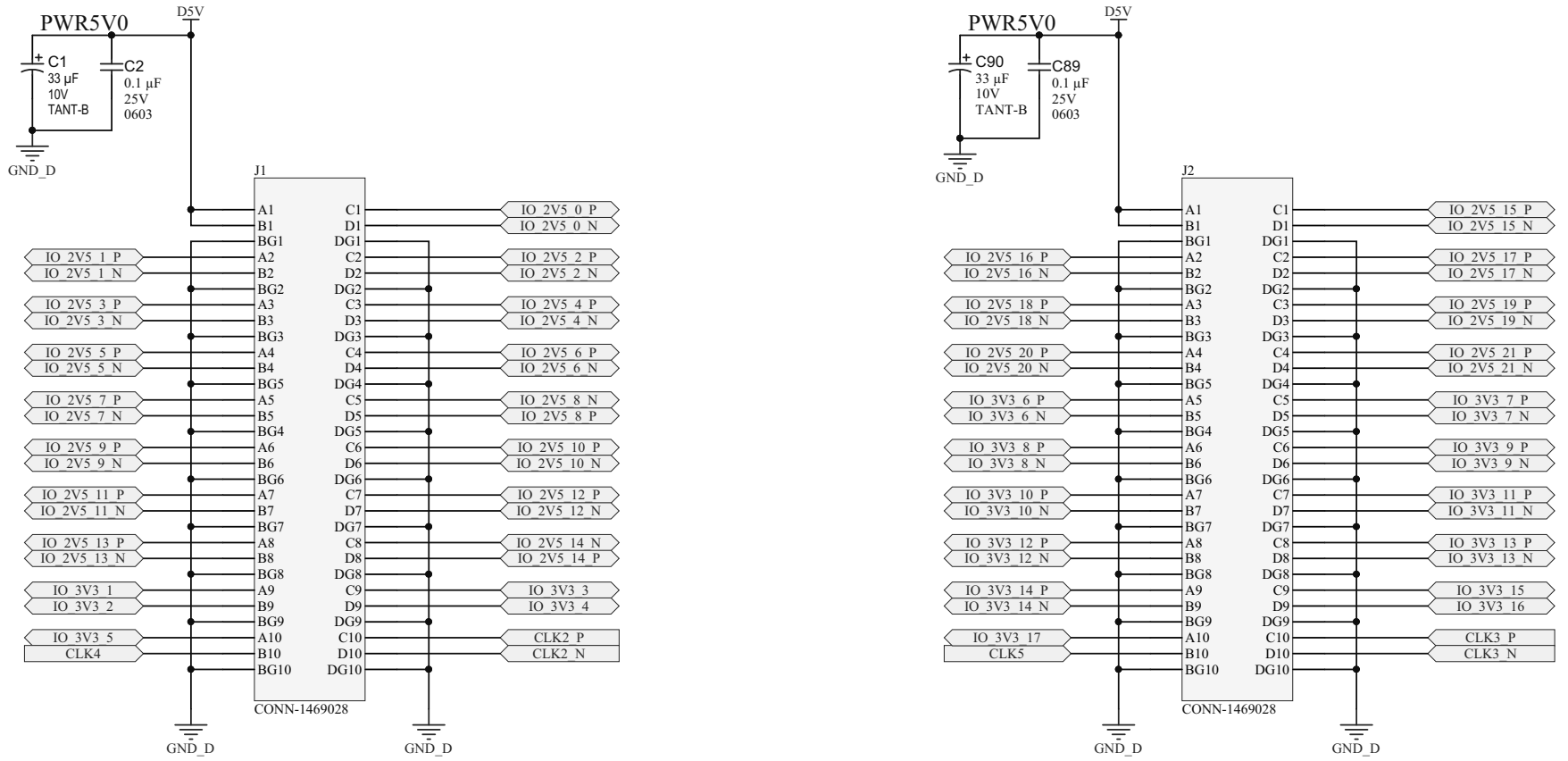
For VCCO_3



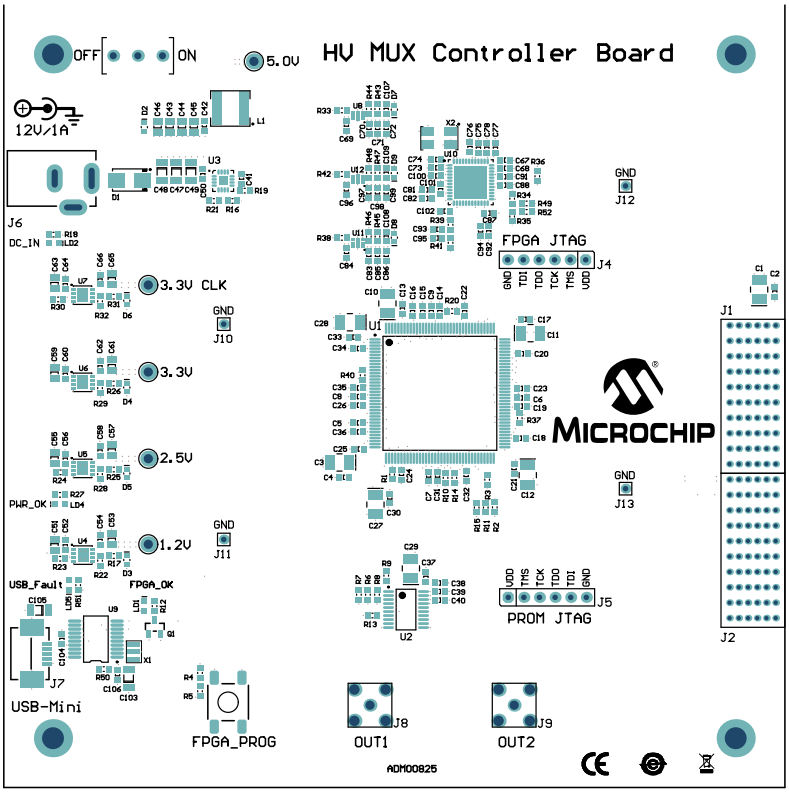
For XCF04S



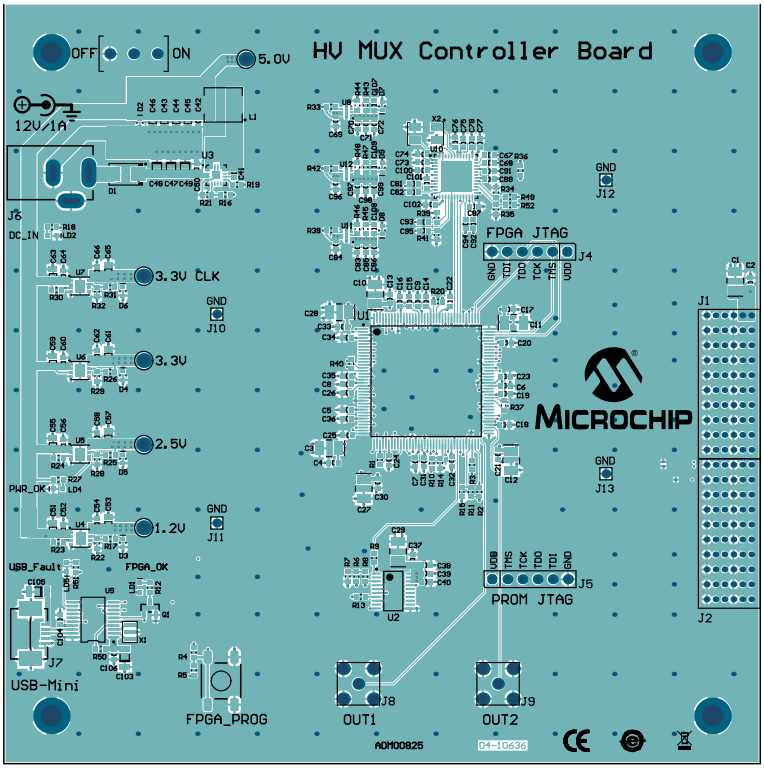
A.18 ADM00825 – SCHEMATIC (CONNECTORS)



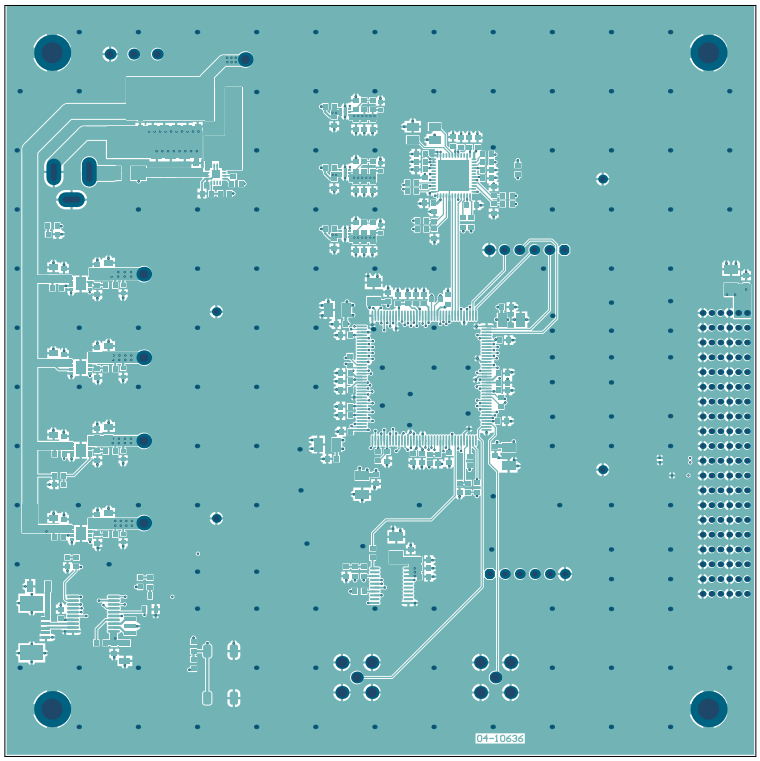
A.19 ADM00825 – TOP SILK



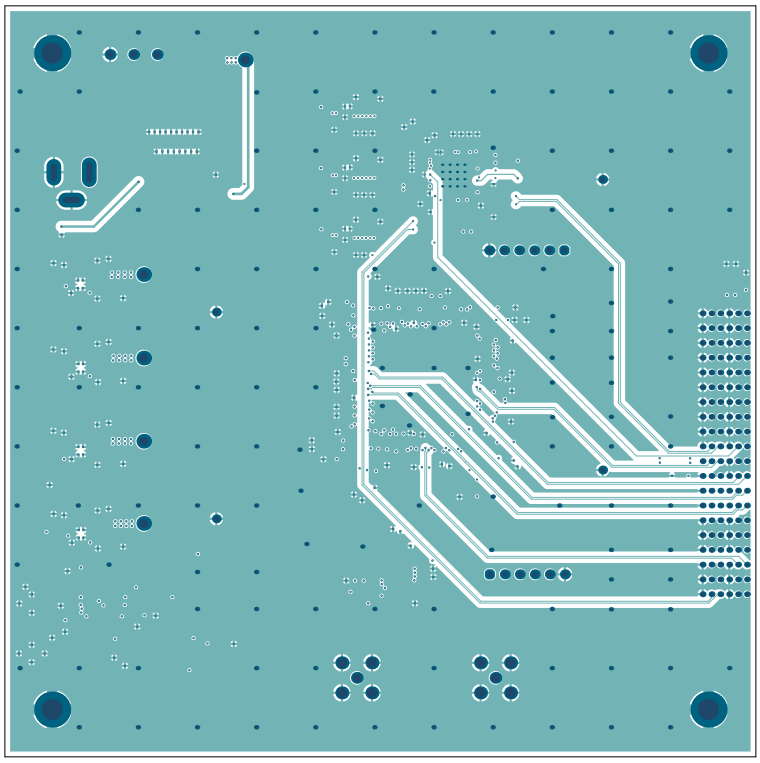
A.20 ADM00825 – TOP COPPER AND SILK



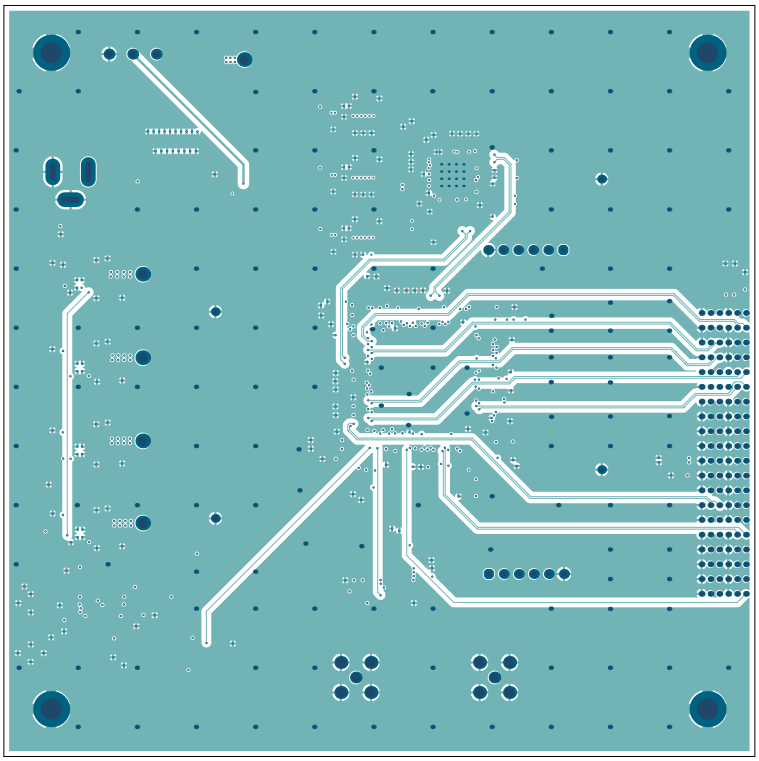
A.21 ADM00825 – TOP COPPER



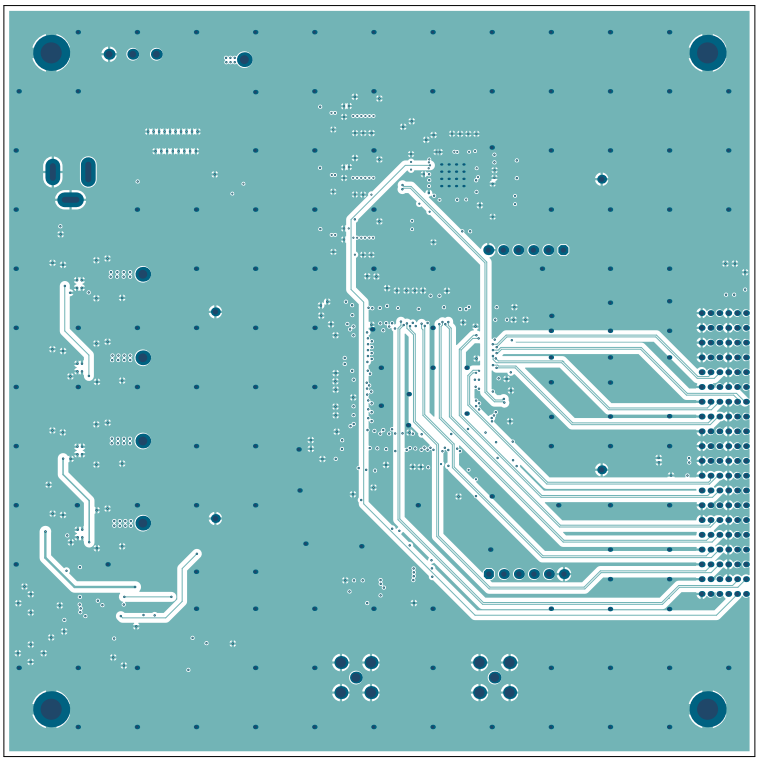
A.22 ADM00825 – INNER 1



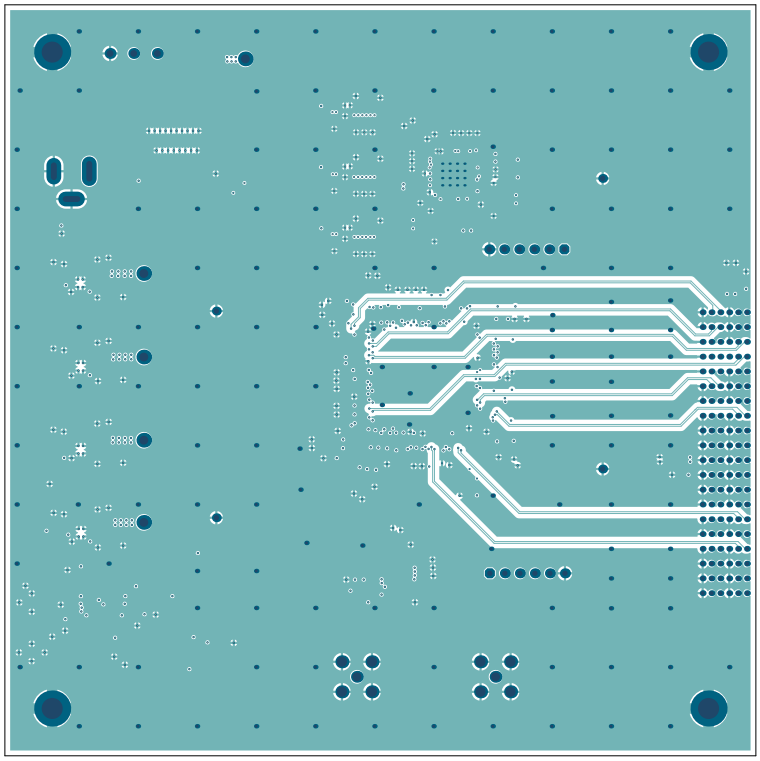
A.23 ADM00825 – INNER 2



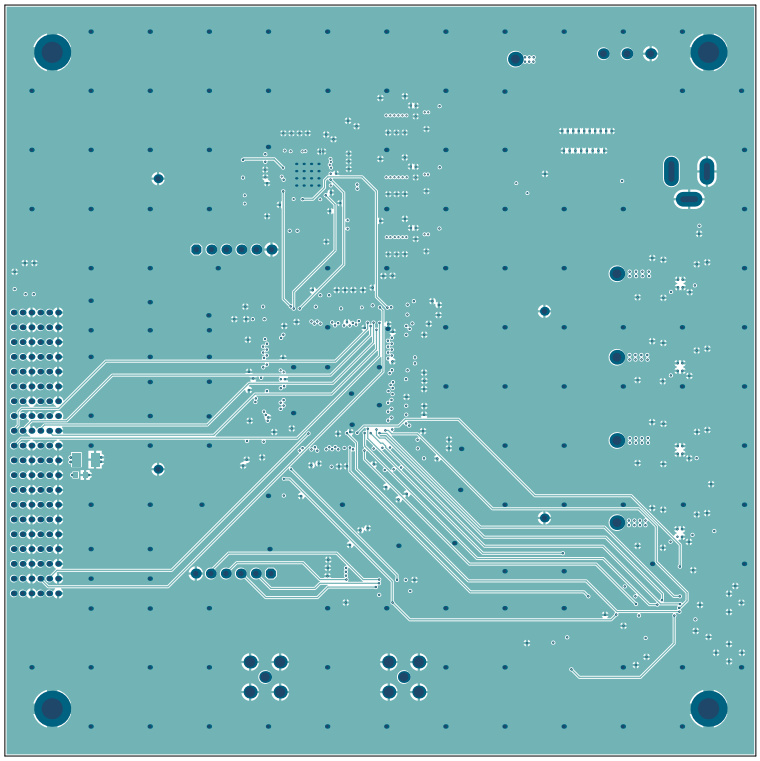
A.24 ADM00825 – INNER 3



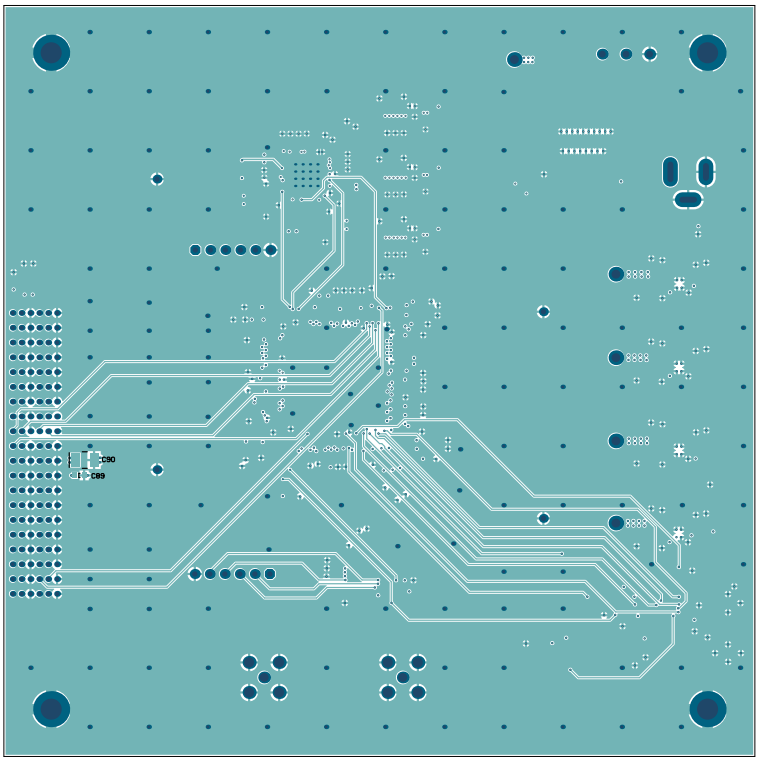
A.25 ADM00825 – INNER 4



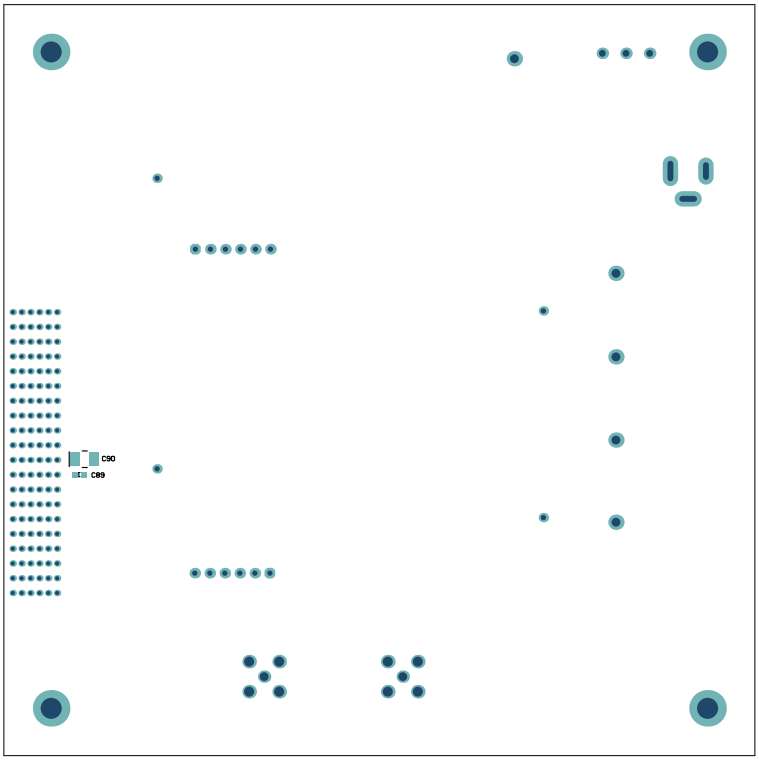
A.26 ADM00825 – BOTTOM COPPER



A.27 ADM00825 – BOTTOM COPPER AND SILK



A.28 ADM00825 – BOTTOM SILK



NOTES:

Appendix B. Bill of Materials (BOM)

B.1 HV2916 ANALOG SWITCH EVALUATION BOARD – BOM

TABLE B-1: HV2916 ANALOG SWITCH EVALUATION BOARD – BILL OF MATERIALS

Qty.	Reference	Description	Manufacturer	Part Number
6	C1, C2, C19, C20, C21, C22	Capacitor, Ceramic, 1 µF, 250V, 20%, X7T, SMD, 1812	TDK Corporation	C4532X7T2E105M250KA
4	C3, C4, C7, C8	Capacitor, Ceramic, 0.1 µF, 35V, 10%, X7R, SMD, 0402	TDK Corporation	CGA2B3X7R1V104K050BB
4	C5, C9, C12, C17	Capacitor, Ceramic, 15 pF, 50V, 5%, C0G, SMD, 0805	Kyocera Electronic Components and Devices	08055A150JAT2A\4K
1	C6	Capacitor, Ceramic, 0.1 µF, 35V, 10%, X7R, SMD, 0402 – DO NOT POPULATE	TDK Corporation	CGA2B3X7R1V104K050BB
4	C10, C13, C27, C28	Capacitor, Ceramic, 330 pF, 250V, 5%, C0G/NP0, SMD, 0805	Murata Electronics® North America, Inc.	GRM21A5C2E331JW01D
2	C11, C14	Capacitor, Ceramic, 1 µF, 35V, 10%, X5R, SMD, 0402	Murata Electronics® North America, Inc.	GRM155R6YA105KE11D
15	C18, C23, C24, C25, C26, C29, C30, C31, C32, C33, C34, C39, C40, C41, C42	Capacitor, Ceramic, 0.1 µF, 25V, 20%, X7R, SMD, 0603	KEMET	C0603C104M3RACTU
2	CN1, CN2	Capacitor, Array, 0.01 µFx4 100V, 20%, X7R, SMD, 0612	Kyocera Electronic Components and Devices	W3A41C103MAT2A
2	D1, D2	Diode, Rectifier, Array, MMBD3004BRM, 1V, 225 mA, 350V, SMD, SOT-23-6	Diodes Incorporated®	MMBD3004BRM-7-F
2	D13, D16	Diode, Schottky, Array, BAT54DW-7-F, 1V, 200 mA, 30V, SMD, SOT363	Diodes Incorporated®	BAT54DW-7-F
2	D14, D15	Diode, Schottky, B1100, 790 mV 1A, 70V, DO-214AC_SMA	Diodes Incorporated®	B1100-13-F
2	J1, J2	Connector, Header-0.098, Male, 4x10+20GND, Press-Fit, TH, R/A	TE Connectivity, Ltd.	6469169-1
1	J3	Connector, Header-2.54, Male, 1x3, Tin, 5.84 MH, TH, Vertical	Samtec, Inc.	TSW-103-07-T-S
1	J4	Connector, Header-2.54, Male, 1x5, Gold, 5.84 MH, TH, Vertical	Samtec, Inc.	TSW-105-07-S-S
12	J5, J6, J7, J8, J11, J12, J13, J16, J25, J26, J27, J28	Connector, Header-2.54, Male, 1x2, Gold, 5.84 MH, TH, Vertical	Amphenol ICC (FCI)	77311-118-02LF

Note: 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 B-1: HV2916 ANALOG SWITCH EVALUATION BOARD – BILL OF MATERIALS

Qty.	Reference	Description	Manufacturer	Part Number
12	J9, J10, J14, J15, J17, J18, J19, J20, J21, J22, J23, J24	Connector, RF, Coaxial, SMA, Female, 2P, TH, Vertical	Adam Equipment	RF2-04A-T-00-50-G
1	J29	Connector, Header-2.54, Male, 1x2, Gold, 5.84 MH, TH, Vertical – DO NOT POPULATE	Amphenol ICC (FCI)	77311-118-02LF
4	J30, J31, J32, J33	Connector, Header-2.54 Male, 2x12, Gold, 5.84 MH, TH, Vertical	Samtec, Inc.	TSW-112-07-G-D
1	LABEL1	Label, Assembly w/Rev Level (Small Modules) per MTS-0002	—	—
4	PAD1, PAD2, PAD3, PAD4	Mechanical Hardware Rubber Pad, Cylindrical, D7.9, H5.3, Black	3M	70006431483
1	PCB1	HV2916 Analog Switch Evaluation Board – Printed Circuit Board	Microchip Technology Inc.	**04-11229-R2**
4	Q5, Q6, Q7, Q8	Microchip Analog MOSFET Dual, P-N-CH, 200V, 2A, TC6320K6-G, DFN-8	Microchip Technology Inc	**TC6320K6-G**
4	R1, R2, R8, R9	Resistor, Thick Film, 2.55k, 1%, 1W, SMD, 2512	Panasonic® - BSG	ERJ-1TNF2551U
1	R3	Resistor, Thick Film, 0R 1/16W, SMD, 0402 – DO NOT POPULATE	Mepco Philips	RC0402JR-070RL
4	R4, R10, R12, R14	Resistor, Thick Film, 49.9R, 1%, 1/4W, SMD, 0603	Vishay/Dale	CRCW060349R9FKEAHP
2	R5, R6	Resistor, Thick Film, 4.99R, 1%, 1/2W, SMD, 0805, AEC-Q200	Vishay/Dale	CRCW08054R99FKEAHP
4	R7, R11, R13, R15	Resistor, Thick Film, 1k, 1%, 1/4W, SMD, 1206	Yageo Corporation	RC1206FR-071KL
2	R16, R19	Resistor, Thick Film, 4.7K, 1%, 1/10W, 0402 – DO NOT POPULATE	KOA Speer Electronics, Inc.	RK73H1ETTP4701F
2	R17, R18	Resistor, Thick Film, 100R, 1%, 1/10W, SMD, 0402 – DO NOT POPULATE	Panasonic® - BSG	ERJ-2RKF1000X
34	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP35, TP36	Connector, TP, Pad, MILL, MAX, 3132, PCB, 1.5x0.9, TH, AU	Mill-Max Mfg. Corporation	3132-0-00-15-00-00-08-0
2	U1, U2	Microchip Analog FET Driver Quad-Two Inverting-Two Noninverting, MD1822K6-G, 16-Lead, QFN	Microchip Technology Inc.	**MD1822K6-G**
4	U3, U4, U9, U10	IC Special, SN74LVC1T45MDCKREP Voltage Level Translator Bidirectional, SC70-6	Texas Instruments	SN74LVC1T45MDCKREP

Note: 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 B-1: HV2916 ANALOG SWITCH EVALUATION BOARD – BILL OF MATERIALS

Qty.	Reference	Description	Manufacturer	Part Number
1	U13	Microchip Analog Switch, HV2916, HV, 100V, BGA-121	Microchip Technology Inc.	**HV2916/AJA**
1	U14	Microchip Memory Serial Flash 16M 104MHz SST26VF016B-104I/SM SOIJ-8 – DO NOT POPULATE	Microchip Technology Inc.	**SST26VF016B-104I/SM**

Note: 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.

B.2 HV MUX CONTROLLER BOARD – BOM

TABLE B-2: HV MUX CONTROLLER BOARD – BILL OF MATERIALS

Qty.	Reference	Description	Manufacturer	Part Number
8	C1, C10, C11, C12, C27, C28, C29, C90	Capacitor, Tantalum, 33 µF, 10V, 10%, 1.4Ω, Surface Mount	KEMET	T494B336K010AT
2	C103, C105	Capacitor, Ceramic, 4.7 µF, 16V, 10%, X7R, Surface Mount, 1206	KEMET	C1206C475K4RACTU
4	C2, C89, C104, C106	Capacitor, Ceramic, 0.1 µF, 25V, 10%, X7R, Surface Mount, 0603	Murata® Manufacturing Co., Ltd.	GRM188R71E104KA01D
1	C3	Capacitor, Tantalum, 100 µF, 6.3V, 10%, 400 mΩ, Surface Mount	AVX Corporation	TPSB107K006R0400
7	C4, C13, C17, C21, C30, C33, C37	Capacitor, Ceramic, 47 nF, 16V, 10%, X7R, Surface Mount, 0603	Murata Manufacturing Co., Ltd.	GRM188R71C473KA01D
1	C41	Capacitor, Ceramic, 22000 pF, 50V, 5%, X7R, Surface Mount, 0603	AVX Corporation	06035C223JAT2A
10	C42, C50, C52, C54, C56, C58, C60, C62, C64, C66	Capacitor, Ceramic, 0.1 µF, 50V, 20%, X7R, Surface Mount, 0603	TDK Corporation	C1608X7R1H104M
12	C43, C44, C45, C46, C51, C53, C55, C57, C59, C61, C63, C65	Capacitor, Ceramic, 10 µF, 10V, 10%, X7R, Surface Mount, 0805	Murata Manufacturing Co., Ltd.	GRM21BR71A106KE51L
3	C47, C48, C49	Capacitor, Ceramic, 10 µF, 35V, 10%, X5R, Surface Mount, 1206	Taiyo Yuden Co., Ltd.	GMK316BJ106KL-T
24	C5, C6, C7, C8, C9, C14, C15, C16, C18, C19, C20, C22, C23, C24, C25, C26, C31, C32, C34, C35, C36, C38, C39, C40	Capacitor, Ceramic, 1000 pF, 50V, 10%, X7R, Surface Mount, 0603	NIC Components Corp.	NMC0603X7R102K50TRPF

Note: 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 B-2: HV MUX CONTROLLER BOARD – BILL OF MATERIALS (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
8	C67, C68, C81, C82, C92, C93, C94, C95	Capacitor, Ceramic, 0.1 µF, 16V, 10%, X7R, Surface Mount, 0603	Samsung Electro-Mechanics America, Inc.	CL10B104KO8NNNC
9	C69, C70, C83, C84, C96, C97,107,108,109	Capacitor, Ceramic, 4.7 µF, 16V, 10%, X5R, Surface Mount, 0603	TDK Corporation	C1608X5R1C475K080AC
3	C71, C85, C98	Capacitor, Ceramic, 0.010 µF, 25V, 10%, X7R, Surface Mount, 0603	Yageo Corporation	CC0603KRX7R8BB103
3	C72, C86, C99	Capacitor, Ceramic, 4700 pF, 50V, 10%, X7R, Surface Mount, 0603	KEMET	C0603C472K5RACTU
12	C73, C74, C75, C76, C77, C78, C87, C88, C91, C100, C101, C102	Capacitor, Ceramic, 10000 pF, 50V, 10%, X7R, 0603	AVX Corporation	06035C103KAT2A
1	D1	Diode, Schottky, 20BQ030P, 470 mV, 2A, 30V, DO-214AA (SMB)	ON Semiconductor®	MBRS130LT3G
8	D2, D3, D4, D5, D6, D7, D8, D9	Diode, Schottky, 30V, 200 MA, SOD523	Micro Commercial Components (MCC)	BAT54WX-TP
2	J1, J2	Connector, Receptacle, 40 Positions, 2-Row, Right Angle, Through-Hole	TE Connectivity, Ltd.	1469028-1
4	J10, J11, J12, J13	Connector, PC, Pin, Circular, 0.030 Diameter, Gold	Mill-Max Mfg. Corporation	3132-0-00-15-00-00-08-0
2	J4, J5	Connector Header-2.54, Male, 1x6, Tin, 5.84 mm, Through-Hole, Vertical	Sullins Connector Solutions	PEC06SAAN
1	J6	Connector, Power, 2.5 mm, 5.5 mm, Switch, Through-Hole, Right Angle	CUI Inc.	PJ-002B
1	J7	Connector, USB, Mini-B, Female, Surface Mount, Right Angle	Hirose Electric Co., Ltd.	UX60SC-MB-5ST(80)
2	J8, J9	Connector, RF Coaxial, SMA, Female, 2P, Through-Hole, Vertical	TE Connectivity, Ltd.	5-1814832-1
1	L1	Inductor, 4.7 µH, 11A	Coilcraft	XAL6060-472MEB
3	LD1, LD2, LD4	Diode, LED, Green, 2.2V, 25 mA, 15 mcd, Clear, Surface Mount, 0603	Kingbright Electronic Co., Ltd.	APT1608SGC
1	LD5	Diode, LED, Red, 2V, 25 mA, 104 mcd, Diffuse, Surface Mount, 0603	OSRAM Opto Semiconductors GmbH.	LS Q976-NR-1-0-20-R18
1	PCB	HV2916 Analog Switch Evaluation Board – Printed Circuit Board	Microchip Technology Inc.	**04-10636**

Note: 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 B-2: HV MUX CONTROLLER BOARD – BILL OF MATERIALS (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
1	Q1	Transistor, MOSFET, N-Channel, BSS123, 100V, 170 mA, 300 mW, 3-Lead SOT-23	Diodes Incorporated	BSS123-7-F
6	R1, R2, R4, R11, R13, R14	Resistor, Thick Film, 4.7 kΩ, 5%, 1/10W, Surface Mount, 0603	Panasonic® - ECG	ERJ-3GEYJ472V
1	R12	Resistor, Metal Film, 330R, 5%, 1/16W, Surface Mount, 0603	Panasonic - ECG	ERA-V33J331V
1	R16	Resistor, Thick Film, 39 kΩ, 1%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3EKF3902V
1	R17	Resistor, Thick Film, 19.1 kΩ, 1%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3EKF1912V
1	R18	Resistor, Thick Film, 1 kΩ, 5%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3GEYJ102V
2	R19, R27	Resistor, Thick Film, 390R, 5%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3GEYJ391V
3	R20, R37, R40	Resistor, Thick Film, 100R, 1%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3EKF1000V
1	R21	Resistor, Thick Film, 8.66 kΩ, 1%, 1/10W, Surface Mount, 0603	Yageo Corporation	RC0603FR-078K66L
6	R22, R28, R29, R33, R38, R42	Resistor, Thin Film, 10 kΩ, 1%, 1/8W, Surface Mount, 0603	Vishay Beyschlag	MCT06030C1002FP500
4	R23, R24, R30, R50	Resistor, Thick Film, 10 kΩ, 5%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3GEYJ103V
1	R25	Resistor, Thick Film, 51 kΩ, 1%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3EKF5102V
1	R26	Resistor, Thick Film, 69.8 kΩ, 1%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3EKF6982V
2	R3, R8	Resistor, Thick Film, 51R, 5%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3GEYJ510V
1	R31	Resistor, Thick Film, 82 kΩ, 1%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3EKF8202V
1	R32	Resistor, Thick Film, 10.7 kΩ, 1%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3EKF1072V
4	R34, R35, R39, R41	Resistor, Thick Film, 150R, 1%, 1/10W, Surface Mount, 0603	Stackpole Electronics, Inc.	RMCF0603FT150R
1	R36	Resistor, Thick Film, 75 kΩ, 1%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3EKF7502V

Note: 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 B-2: HV MUX CONTROLLER BOARD – BILL OF MATERIALS (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
3	R43,R45,R47	Resistor, Thick Film, 100 kΩ, 1%, 1/10W, Surface Mount, 0603	Panasonic - ECG	—
3	R44, R46, R48	Resistor, 78.7 kΩ, 1%, 1/10W, Surface Mount, 0603	Yageo Corporation	RC0603FR-0778K7L
2	R49,R52	Resistor, Surface Mount, 0.0Ω, Jumper, 1/10W, 0603	Panasonic - ECG	ERJ-3GEY0R00V
3	R5, R10, R15	Resistor, Thick Film, 0R, 1/10W, Surface Mount, 0603	NIC Components Corp.	NRC06Z0TRF
1	R51	Resistor, Thick Film, 150R, 5%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3GEYJ151V
2	R6, R7	Resistor, Thick Film, 100R, 5%, 1/10W, Surface Mount, 0603	Vishay® Intertechnology, Inc.	CRCW0603100RJNEA
1	R9	Resistor, Thick Film, 22R, 5%, 1/10W, Surface Mount, 0603	Panasonic - ECG	ERJ-3GSYJ220V
1	SW1	Switch Slide, SPDT, Mini, 50V, 0.5A, G4050X-R, Through-Hole	Jameco® Electronics	G4050X-R
1	SW2	Switch Tactical, SPST, 12V, 50 mA, TL3301NF160QG/TR, Surface Mount	E-Switch®, Inc.	TL3301NF260QG/TR
1	U1	IC, FPGA, 102, I/O, 144-Lead TQFP	Xilinx Inc.	XC6SLX9-2TQG144C
1	U10	Flexible Ultra-Low Jitter Clock Generator	Microchip Technology Inc.	**SM803234**
1	U2	IC, PROM, SRL for 4M Gate	Xilinx Inc.	XCF04SVOG20C
1	U3	3A Buck, 5V, 16-Lead QFN	Semtech	TS30013-M000QFNR
4	U4, U5, U6, U7	Microchip Analog LDO, 0.8V-5V, MCP1727T-ADJE/MF, 8-Lead DFN	Microchip Technology Inc.	**MCP1727-ADJE/MF**
3	U8, U11, U12	Adjustable LDO Ripple Blocker	Microchip Technology Inc.	**MIC94325YMT-TR**
1	U9	Microchip Interface, USB, SPI, MCP2210-I/SS, 20-Lead SSOP	Microchip Technology Inc.	**MCP2210T-I/SS**
1	X1	Resonator, 12 MHz, 0.1%, Surface Mount, CSTCE-G	Murata Manufacturing Co., Ltd.	CSTCE12M0G15L99-R0
1	X2	40 MHz, ±30 ppm, Crystal, 12 pF, 40Ω, -20°C, ~70°C, Surface Mount	TXC Corporation	7B-40.000MAAE-T

Note: 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.

Appendix C. Demo Board Waveforms

C.1 BOARD TYPICAL WAVEFORMS

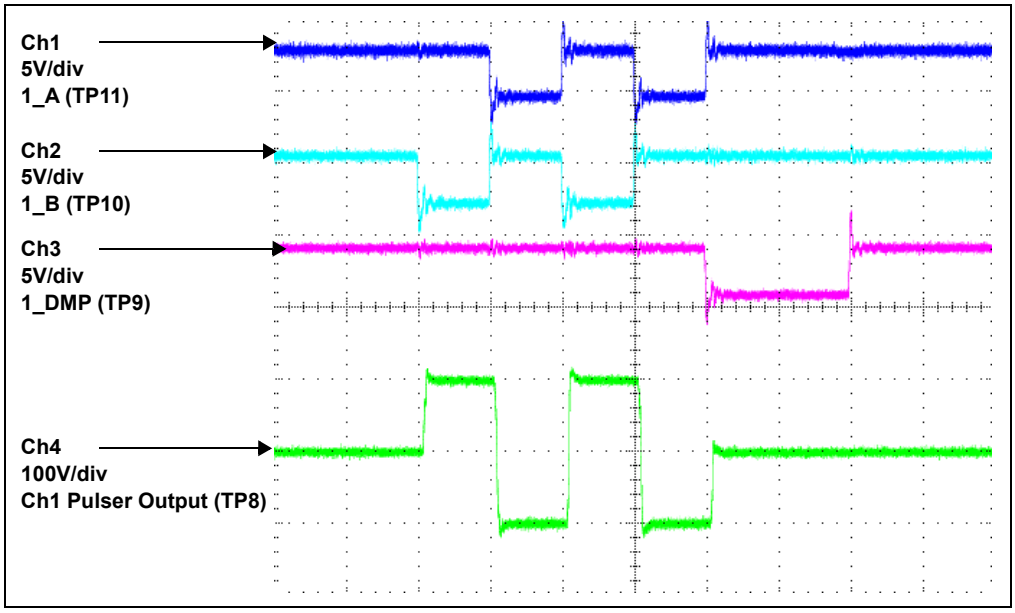


FIGURE C-1: *5 MHz, 4 Pulses, Ch1 Pulser Input and Output when All SW Off.*

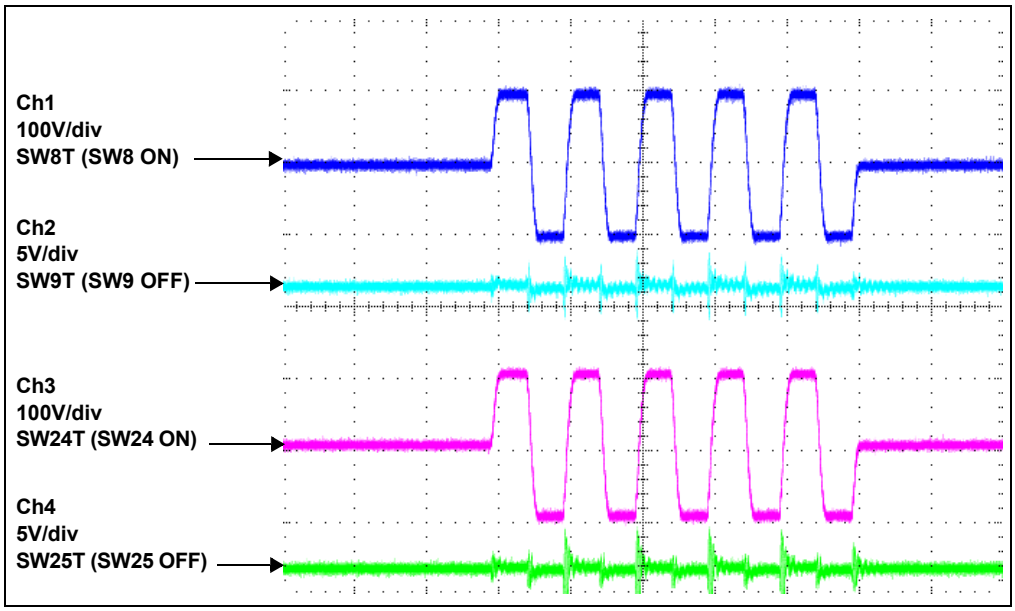


FIGURE C-2: *5 MHz, 10 Pulses, V_{PP}/V_{NN} = ±100V, V_{DD} = +5V, VGP = 10V, 330 pF//2.5 kΩ Load.*

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