MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit User's Guide

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.

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MCP331X1 16/14/12-BIT 1 MSPS SAR ADC EVALUATION KIT 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 MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit. 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 MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit to demonstrate the performance of the MCP331x1 device family. The manual layout is as follows:

- **"Quick Start Guide"**– Provides quick, step-by-step information on setting up the MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit.
- **Chapter 1. "Product Overview"** – Important information about the MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit.
- **Chapter 3. "Firmware"** - Includes information about the firmware that is included with the MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit.
- **Appendix A. "Schematic and Layouts"** – Refer to the board's web page for the complete Schematics and Layouts.
- **Appendix B. "Bill of Materials (BOM)"** – Refer to the board's web page for the complete Bill of Materials.

MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit User's Guide

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 MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource.

- **MCP331x1 Data Sheet –** *"1 Msps 16/14/12-Bit Differential Input SAR ADC"* **(DS20005947)**

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

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 (April 2018)

- Initial release of this document.

NOTES:

Quick Start Guide

Steps 1-9 below provide a quick start for setting up the MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit:
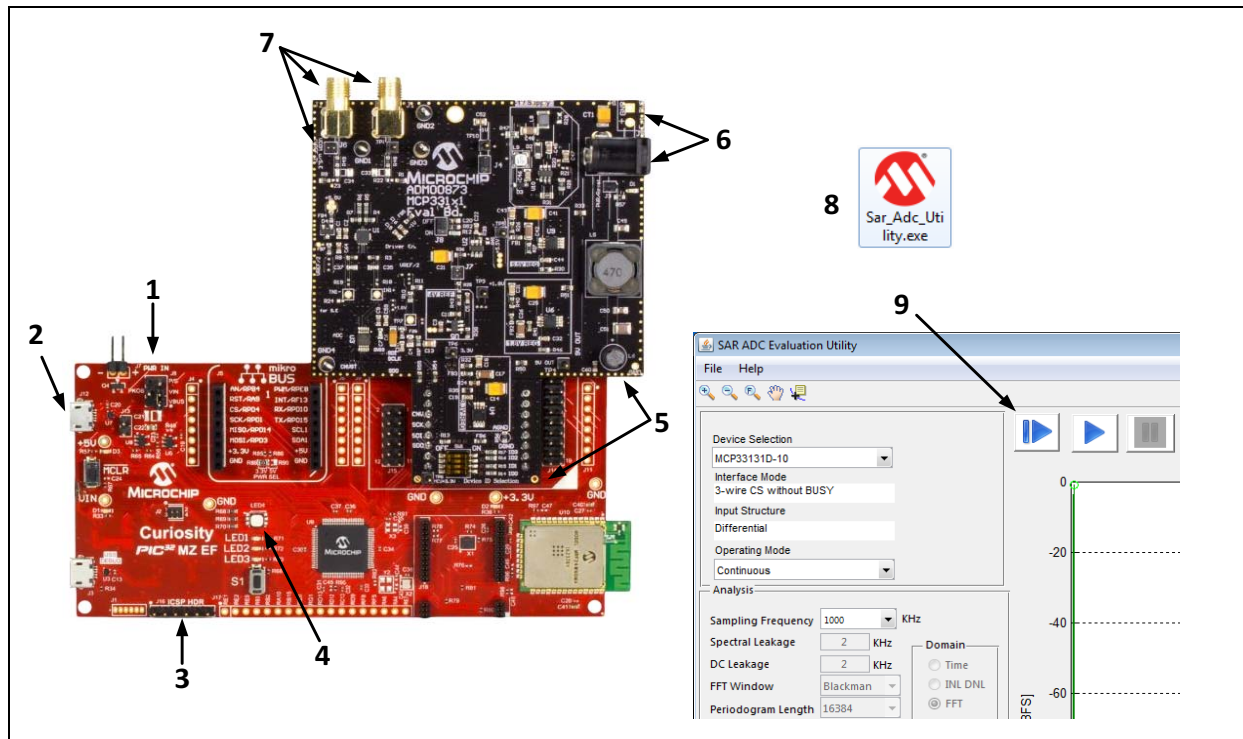
1. Move the PWR IN jumper to connect pins VIN and VBUS.
2. Connect micro USB cable from PC to J12 on the PIC32MZ Curiosity board. This USB is used for both power and data transfer for the Curiosity board.
3. Program the PIC32MZ with the latest MCP331x1_EVB.X firmware (available on Microchip.com) using an external programmer (ICD, PICKit, etc) connected to the ICSP HDR (J16).
4. Once the firmware is loaded, remove the programmer and wait for LED4 to illuminate with a solid red light. A solid red lit LED indicates that the firmware is loaded and the board is working as intended.
5. Connect the MCP331x1 EVB (ADM00872/ADM00873) to the top right mikroBUS header (J10).
6. Connect a 9V power supply to the barrel jack connection point using either the supplied 9V wall power supply, or alternatively connect 9V from an external power source to the H1 headers. D1 directly below the barrel jack will illuminate to confirm that 9V is being supplied to the EVB.
7. Connect a fully differential signal source to the SMA connectors at J1 (positive input) only, and place a jumper on J6 to connect the negative input to Vref/2.
8. Install and launch SAR_ADC_Utility.exe (available on Microchip.com). The software will automatically recognize the plugged in device and launch the GUI.
9. Once the GUI is open, use the blue 'play' buttons to run single or continuous acquisitions. The GUI will display all performance analysis data related to the acquired signal.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board and covers the following topics:

- MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board Features
- MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board Overview
- SAR ADC Device Configuration
- Curiosity PIC32MZEF Development Board (DM320104) Overview
- SAR ADC Utility Software Overview
- What the MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit Contains
- MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit Requirements

1.2 MCP331X1 16/14/12-BIT 1 MSPS SAR ADC EVALUATION BOARD FEATURES

This MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit is a fully-assembled, programmed and tested solution to evaluate and demonstrate the MCP331x1 operating performance.

The MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit features:

- Full-Scale Analog Input Range: $-V_{REF}$ to $+V_{REF}$
  - ADM00872 with MCP33131D/21D/11D: $-5\ V_{PP}$ to $+5\ V_{PP}$
  - ADM00873 with MCP33131D/21D/11D: $-4\ V_{PP}$ to $+4\ V_{PP}$
- Dynamic Performance Monitoring
- Evaluation of Performance Metrics, such as: SNR, SFDR, INL, DNL, and so on
- Ability to Save and Load Software Configurations
- Ability to Save and Load Raw Data for User Post-Processing

For information about the device features, refer to the MCP331x1 data sheet.

1.3 MCP331X1 16/14/12-BIT 1 MSPS SAR ADC EVALUATION BOARD OVERVIEW

The MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board is intended to demonstrate the performance of the MCP331x1 device family. This evaluation board is used together with:

• Curiosity PIC32MZEF Development Board (DM320104)
• SAR ADC Utility Software

Figure 1-1 displays the system setup.
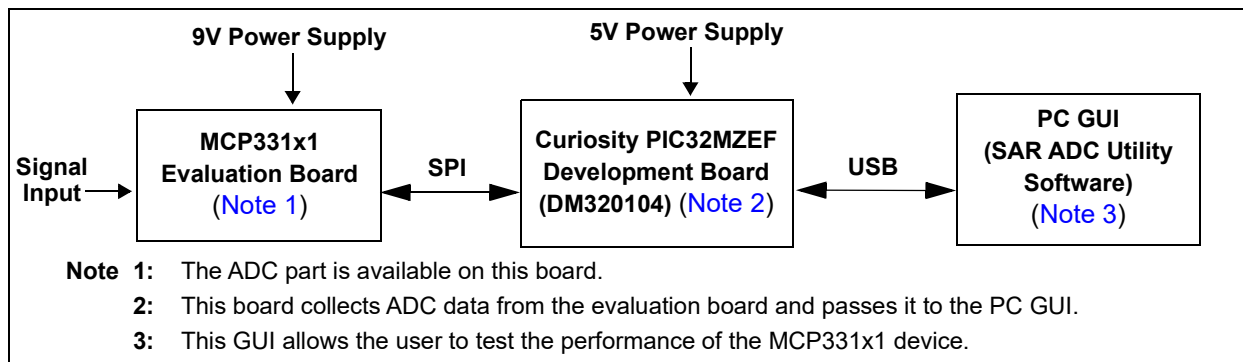
FIGURE 1-1: *MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Kit System Setup.*

This evaluation board supports the MCP331x1 device family, which is Microchip Technology Inc.'s baseline single-channel 12/14/16-bit 1 Msps SAR Analog-to-Digital Converter (ADC).

The MCP331x1 Evaluation Board comes with the MCP331x1 device on board. All conditions and features can be evaluated using this evaluation board. Refer to Figure 1-2 and Figure 1-3 for photos of the evaluation boards, and refer to Table 1-1 for our currently available device offerings.

TABLE 1-1: DEVICE OFFERING [1]

Part Number	Resolution	Sample Rate	SNR [2]	SFDR [2]	Input Configuration
MCP33131D-10	16-bit	1 Msps	91.3 dBFS	103.5 dB	Differential
MCP33121D-10	14-bit	1 Msps	85.1 dBFS	103.5 dB	Differential
MCP33111D-10	12-bit	1 Msps	73.9 dBFS	99.3 dB	Differential

Note 1: Contact Microchip Technology Inc. for availability.

2: SNR and SFDR are measured with f_{IN} = 10 kHz, V_{IN} = −1 dBFS, V_{REF} = 5V
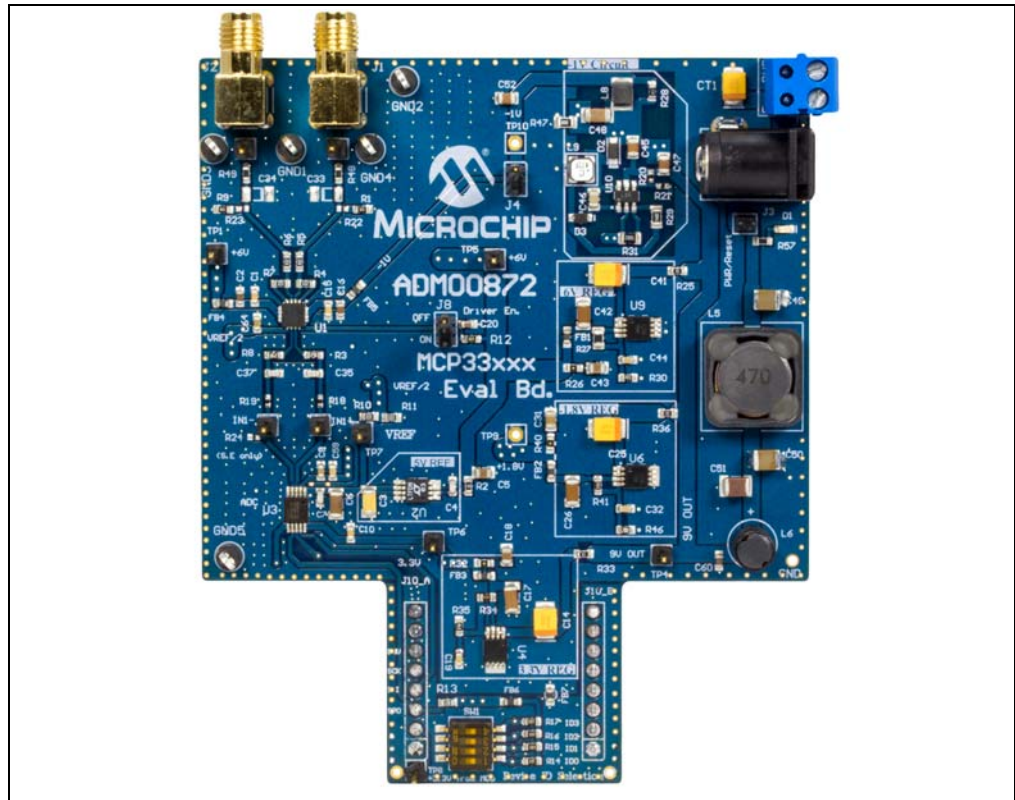
FIGURE 1-2: MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board, 5V Reference.
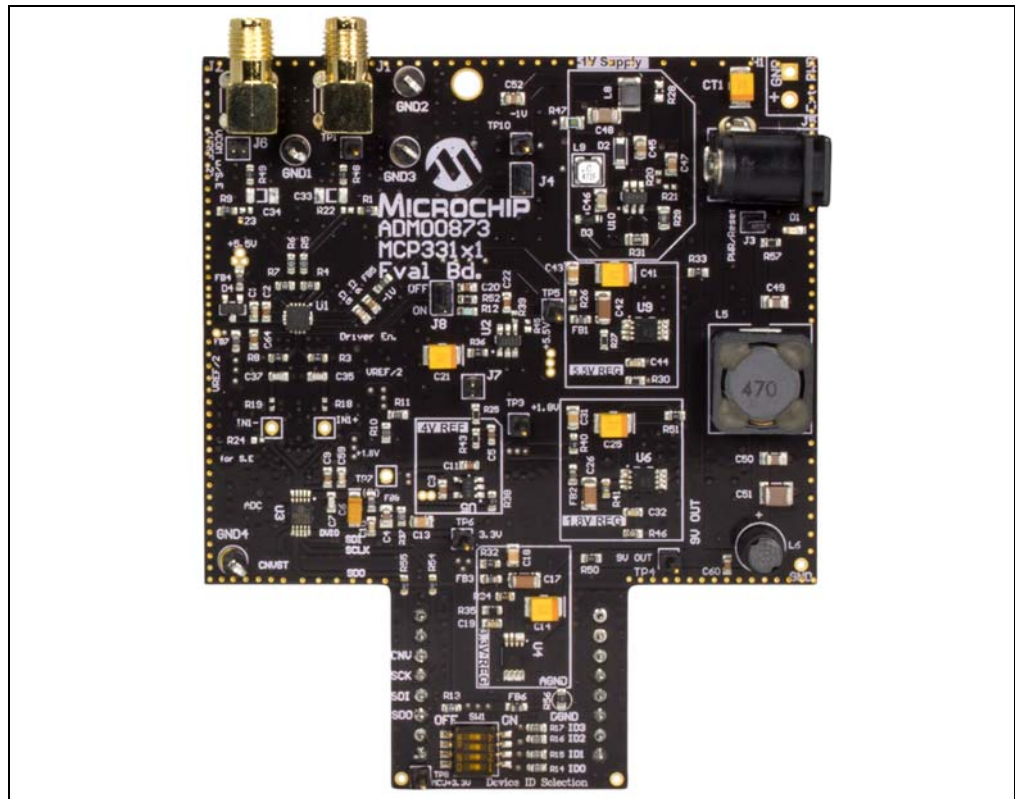
FIGURE 1-3: MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board, 4V Reference.

1.4   SAR ADC DEVICE CONFIGURATION

Each evaluation board features a 4-way SPST DIP switch (schematic designator: SW1) that allows the user to manually configure the board for a variety of available devices, as well as configure the input, resolution and speed for each device. Table 1-2 lists each available switch setting. Refer to Figure 2-1 from **Chapter 2. "Installation and Operation"** to view the location of SW1.

TABLE 1-2:   SW1 DEVICE CONFIGURATION SETTINGS

Part Number	Resolution	Speed	Input Configuration	SW1 Setting: (ID3:ID2:ID1:ID0)	Notes
MCP33111-05	12	500 ksps	Single-Ended	0-0-0-0	
MCP33111D-05	12	500 ksps	Differential	0-0-0-1	
MCP33121-05	14	500 ksps	Single-Ended	0-0-1-0	
MCP33121D-05	14	500 ksps	Differential	0-0-1-1	
MCP33131-05	16	500 ksps	Single-Ended	0-1-0-0	
MCP33131D-05	16	500 ksps	Differential	0-1-0-1	
MCP33141-05	18	500 ksps	Single-Ended	0-1-1-0	Future Use
MCP33141D-05	18	500 ksps	Differential	0-1-1-0	Future Use
MCP33141-10	18	1 Msps	Single-Ended	1-0-0-0	Future Use
MCP33141D-05	18	1 Msps	Differential	1-0-0-1	Future Use
MCP33111-10	12	1 Msps	Single-Ended	1-0-1-0	
MCP33111D-10	12	1 Msps	Differential	1-0-1-1	
MCP33121-10	14	1 Msps	Single-Ended	1-1-0-0	
MCP33121D-10	14	1 Msps	Differential	1-1-0-1	
MCP33131-10	16	1 Msps	Single-Ended	1-1-1-0	
MCP33131D-10	16	1 Msps	Differential	1-1-1-1	Default

1.5   CURIOSITY PIC32MZEF DEVELOPMENT BOARD (DM320104) OVERVIEW

The Curiosity PIC32MZEF Development Board (DM320104) is a fully-integrated 32-bit development platform featuring the high-performance PIC32MZ EF Series PIC$^®$ Microcontroller (PIC32MZ2048EFM100), which is utilized for capturing the digital data received from the MCP331x1 Analog-to-Digital Converter (ADC) evaluation board. Figure 1-1 shows the connection of the Curiosity Development Board (DM320104) directly between the MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board and the SAR ADC Utility Software.

The Curiosity Development Board (DM320104) connects to the PC through a USB cable, providing the user with two functionalities:

• The ability to send user commands directly to the device from the SAR ADC Utility Software.
• The ability to collect data from the evaluation board and send it to the SAR ADC Utility Software.

Refer to Figure 1-4 for close-up photos of the Curiosity PIC32MZEF Development Board (DM320104). More information, including user guides and other resources for the Curiosity Development Board, can be found by visiting www.microchip.com.
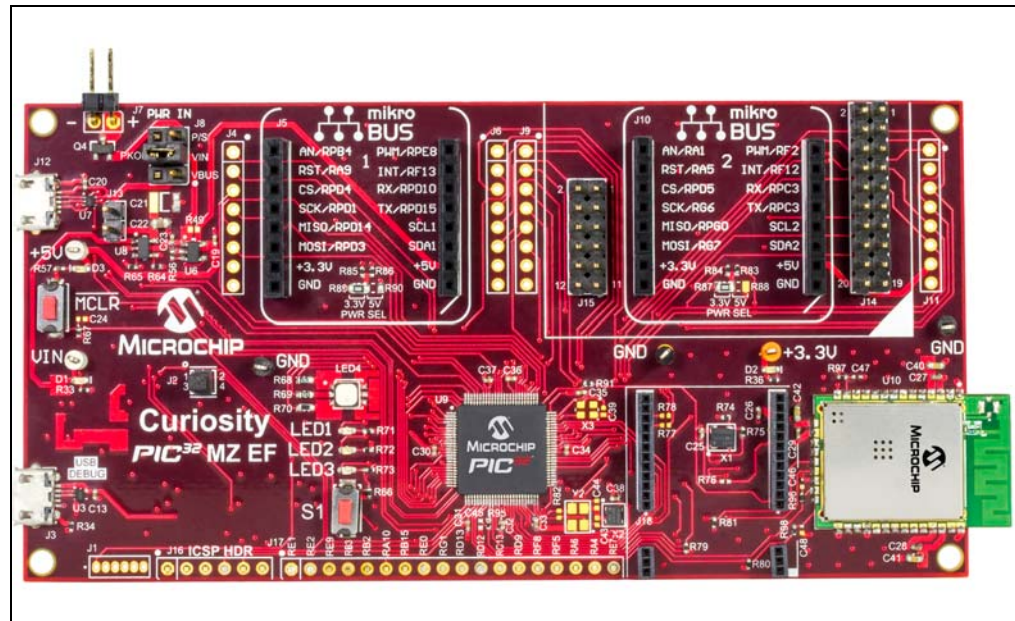
FIGURE 1-4:   *Curiosity PIC32MZEF Development Board (DM320104).*

1.6   SAR ADC UTILITY SOFTWARE OVERVIEW

The SAR ADC Utility Software is the graphical user interface (GUI) used to communicate with the device and to configure its operating parameters. The software communicates with the part through the Curiosity PIC32MZEF Development Board and a USB cable, allowing the user to program the internal ADC registers. When the user interacts with the software (for example, by updating the registers), the user's commands are passed to the MCP331x1 device through the Curiosity PIC32MZEF Development Board. Once the commands are executed by the MCP331x1 Evaluation Board, the software receives the requested data from the Curiosity PIC32MZEF Development Board. The software will then analyze the data, perform a FFT or other analysis, and display the results. Refer to Figure 1-1 for a diagram of the system setup. Figure 1-5 shows a screen shot of the GUI with FFT display while running in Continuous operating mode. Figure 1-6 shows a screen shot of the GUI while running in Single-Shot mode 16-bit digital output display.
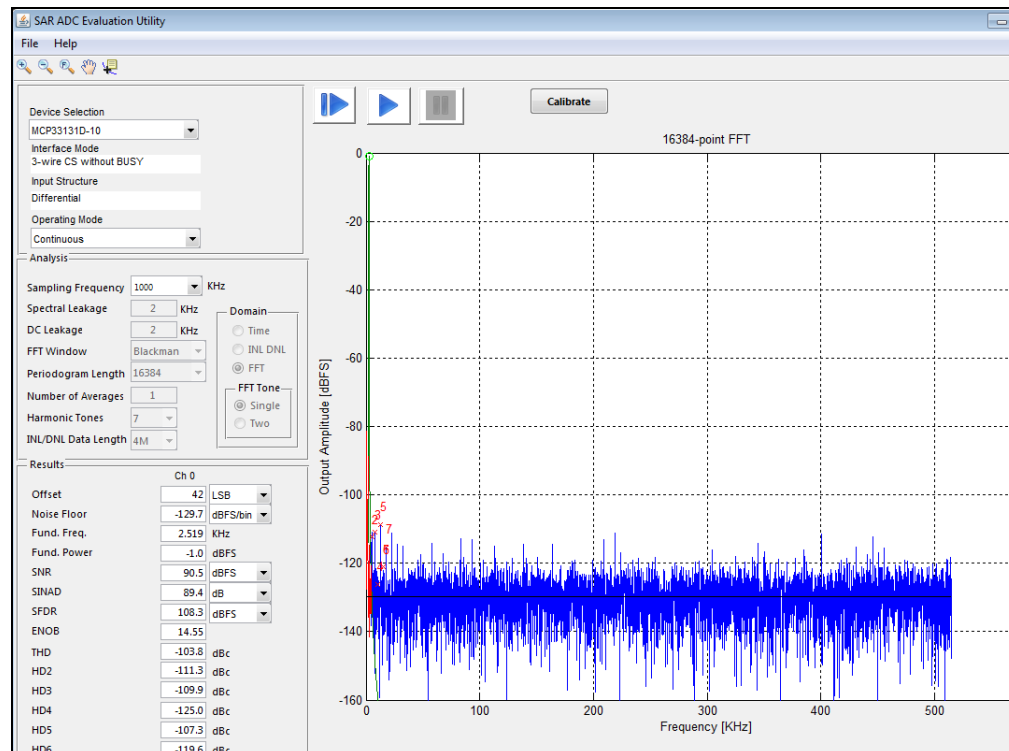
FIGURE 1-5:   *SAR ADC Utility Software Displaying a Typical FFT Waveform.*
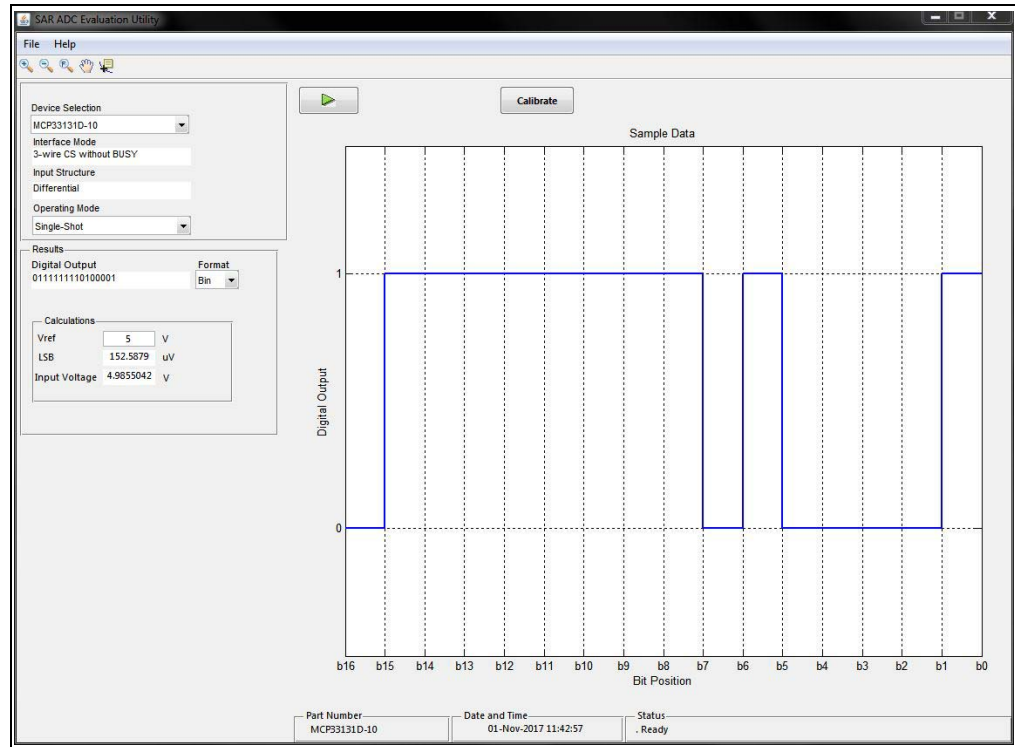
FIGURE 1-6: *SAR ADC Utility Software Displaying a Single Acquisition Bit Position Digital Output.*

The SAR ADC Utility Software is available for download at www.microchip.com. For instructions on using the GUI, refer to the software's supporting documentation included with the installation file, as well as within the application Help menu.

1.7 WHAT THE MCP331X1 16/14/12-BIT 1 MSPS SAR ADC EVALUATION KIT CONTAINS

The MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board includes the following items:

- MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board in two options:
  - $4V_{REF}$, (ADM00873), **or**
  - $5V_{REF}$, (ADM00872)
- 9V wall plug-in power supply
- Important Information Sheet

1.8 MCP331X1 16/14/12-BIT 1 MSPS SAR ADC EVALUATION KIT REQUIREMENTS

MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board requires:

- Curiosity PIC32MZEF Development Board (DM320104)
  - Sold separately
- Type A male-to-micro-B USB cable
  - Not provided with the kit
- External signal input
  - Supplied by the user
- SAR ADC Utility Software
  - Available on the Microchip website

Chapter 2. Installation and Operation

2.1 CONFIGURATION REQUIREMENTS

To power-up and run the evaluation kit, the following are required:

- SAR ADC Utility Software
- MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board
- Curiosity PIC32MZEF Development Board (DM320104)
- Type A Male-to-Micro-B USB cable
- External Signal Source, differential or single-ended output (see **Section 2.2.1 "Input Optimization"**)

2.1.1 Power Input Connection

This MCP331x1 Evaluation Board comes with a 9V wall plug-in switching power supply (Trident: WSU090-2000-13). This power supply is able to provide a 9V, 2A maximum output. It can be connected to an AC wall outlet rated between 100V AC and 240V AC, at a frequency of 50 Hz to 60 Hz. The other end of the power supply is a 2.1 mm barrel plug that connects to the MCP331x1 Evaluation Board (see Figure 2-1). If the user chooses to connect a different external power supply, a minimum output of *500 mA is required*, with a voltage output between 6V-12V. There is no on-board 9V regulator, so the 9V OUT pin (TP4) will read a voltage equal to the voltage input value selected by the user.

WARNING
Avoid connecting a power supply with a voltage greater than what is recommended in this user guide. Doing so can damage the voltage regulators, requiring them to be replaced.

2.2 EVALUATION KIT SETUP

1. Connect the MCP331x1 Evaluation Board and the Curiosity PIC32MZEF Development Board as shown in Figure 2-1.
2. Connect the Curiosity PIC32MZEF Development Board to a computer using a type A male-to-micro-B USB cable. In order to power the Curiosity Board through USB, the USB cable must be plugged-in to the USB connection located at J12. In addition to this, the headers located at J8 need to have the jumper connecting the V_{BUS} pin to V_{IN}. Figure 2-1 shows the component locations.
3. Power-up the MCP331x1 Evaluation Board using the provided 9V power supply.
4. Connect a differential or single-ended analog input signal to the MCP331x1 Evaluation Board SMA terminals. For single-ended operation, populate jumper J6 (see Figure 2-1 for jumper location). By populating this jumper, the negative signal input will be tied to $V_{REF/2}$ (V_{COM}). Another option is to terminate the negative signal input using a 50Ω termination.
5. Run the SAR ADC Utility Software. See **Section 1.6 "SAR ADC Utility Software Overview"**.
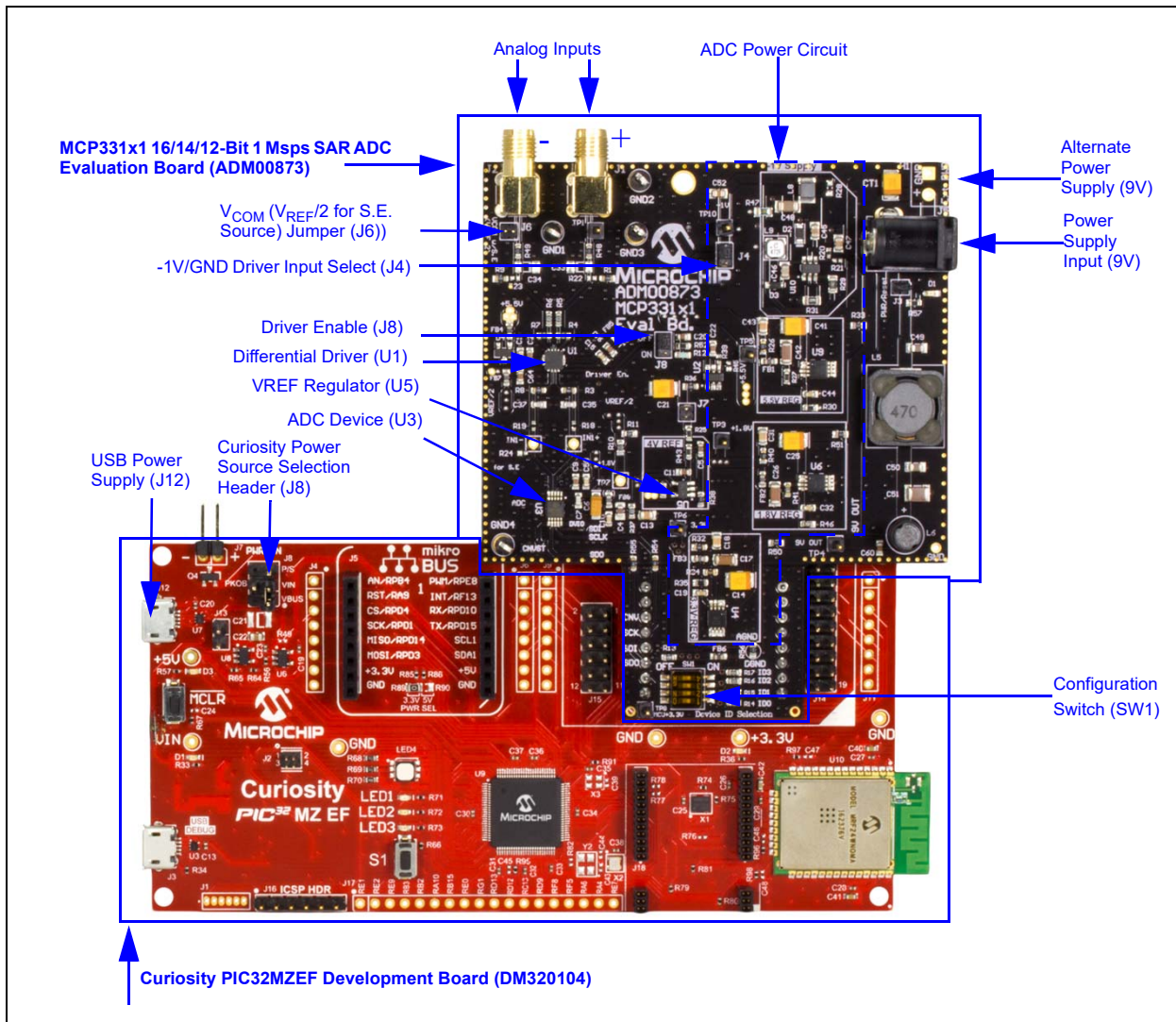
FIGURE 2-1: *The MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board (ADM00873), connected to the Curiosity PIC32MZEF Development Board (DM320104).*

2.2.1   Input Optimization

The best way to evaluate the MCP331x1 device is to use a clean analog input signal with as little noise as possible, and no harmonic contents. The AP2722, for example, can be used to generate a clean analog signal for evaluation purposes. If using a less pure signal source, a filter can be added between the signal source and EVB to remove any noise outside of the desired frequency.

Chapter 3. Firmware

3.1 PIC32MZ2048EFM100 INITIALIZATION

MPLAB® X IDE and MPLAB® Harmony were used to develop the firmware for the PIC32MZ2048EFM100 on the Curiosity Development Board (DM320104).

The frequency of the PIC32MZ2048EFM100 was decreased under its maximum capabilities in order to achieve maximum SPI clock. The MCU runs at 130 MHz, and the SPI prescaler is set to perform a division by 2 in order to obtain an SPI clock frequency of 65 Mhz. This is the minimum SPI speed required to successfully read 16-bits of data out of the ADC at 1 Msps.

In the firmware for this demo, a USB stack was used to achieve communication with the GUI. Direct Memory Access (DMA) was used together with SPI and Output Compare in order to acquire data and to gate the clock during acquisition.

3.2 DATA ACQUISITION

In this demonstration, the ADC acquisition is triggered by the CONV pulse (RPD5), which is generated by the OC2. The OC2 is generated by Timer3 (OCTSEL = 1). Timer 3 is also used to generate OC1 which triggers the DMA SPI transfer. Because both the SPI transfer and CONV pulse are generated by the same timer, they are synchronous. Figure 3-1 displays the timing diagram between CONV pulse and SPI transfer.
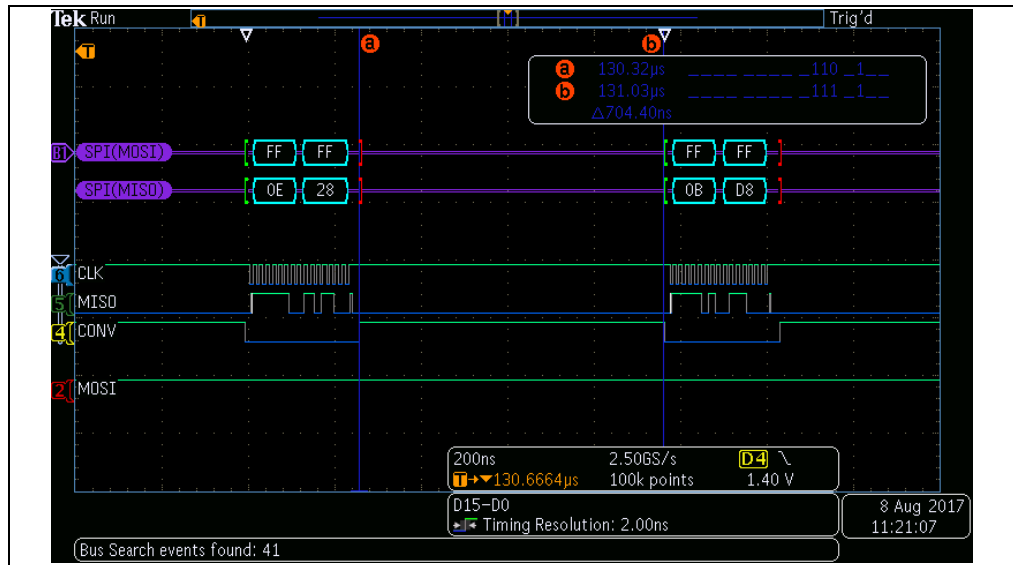
FIGURE 3-1:   *SPI Transfer and CONV Pulse.*

The reason for using OC2 and not SS is related to Electromagnetic Interference (EMI). By using OC2, the user can control the timing between falling edge of the CONV pulse and SPI transfer, and also the timing between the transfer and CONV rising edge-ADC conversion start. For best EMI performance, it is recommended to keep a few nanoseconds between SPI transfer and ADC start.

There are moments during the ADC operation where SPI transfer can affect the output results. There are two main periods during ADC operation: SAR register settling and sample and hold capacitor charging. Time intervals T1 and T2 from Figure 3-2 are the least recommended time intervals for SPI transfer. During T1, the SAR ADC is settling its lower bits and is most easily affected by noise. During T2, the sample and hold capacitor voltage needs to be as clean as possible for accurate conversion. By performing data read out in the recommended time interval, the maximum value of SNR can be achieved.
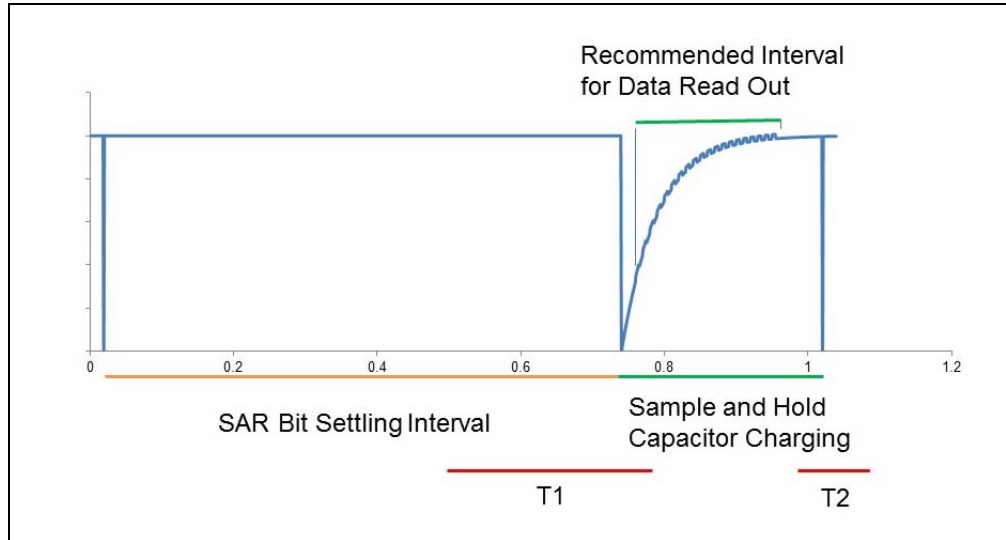
FIGURE 3-2: *Recommended Period for Data Read Out.*

Once the data is transfered from the ADC to SPI, the DMA will place it in a 8192 word buffer (`ADC_BUFFER[]`). Since the sampling speed is 1 Msps, this buffer will be updated every 8.1 ms, making timing less critical for other tasks.

The GUI requires a larger amount of data to be processed in order to indicate accurate performance characteristics: FFT, THD, SINAD, etc. Because of this, a larger data buffer is created in RAM (`storage[]`), with a length of 262144bytes. 32 DMA transfers are required to fill this buffer. The flow chart in Figure 3-3 provides a simple overview of the sample acquisition process, and an overview of the entire firmware process.
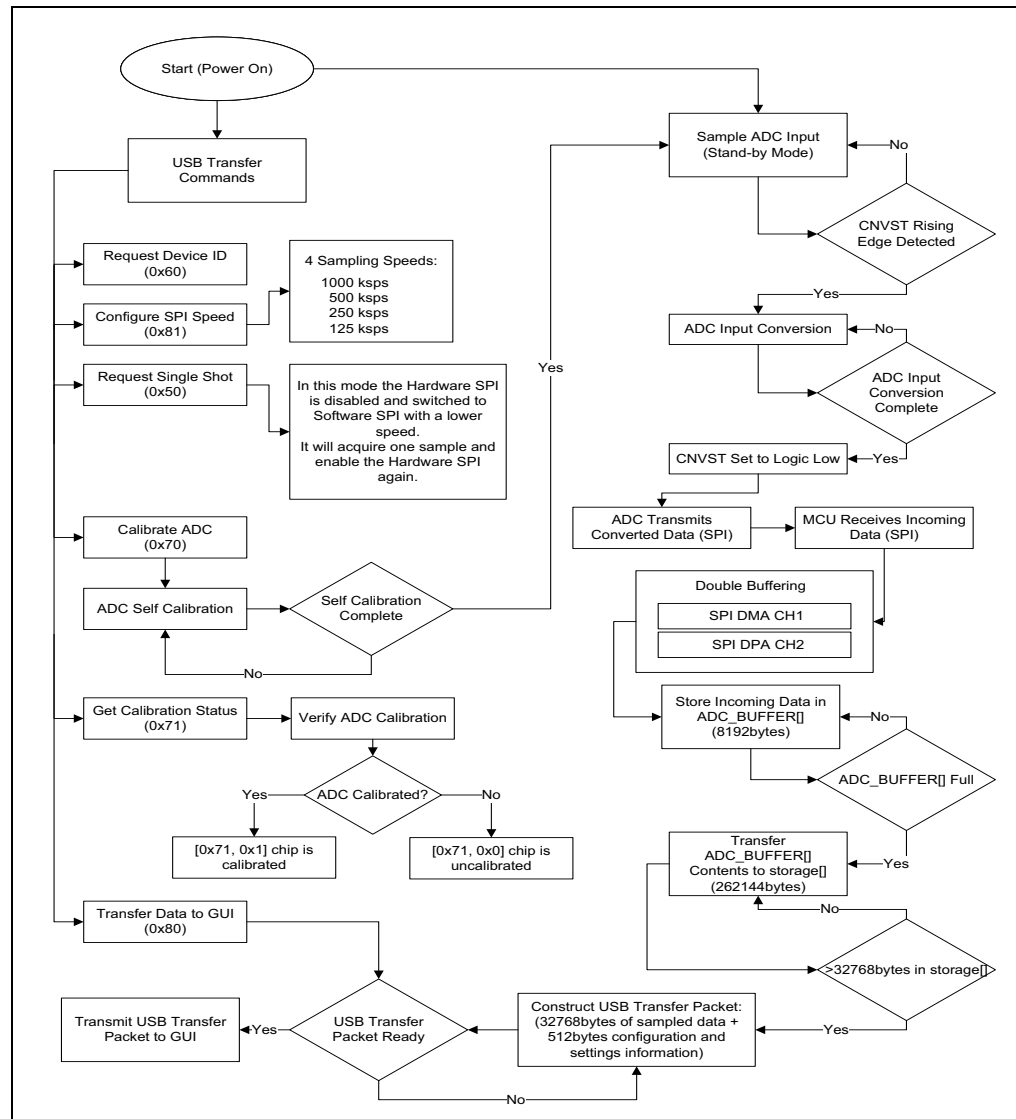
FIGURE 3-3: *Firmware and ADC Samples Acquisition Flowchart.*

3.3 USB TRANSFER

The MCU firmware implements a WinUSB device to handle the data transfer between the USB host (a PC for example) and the USB device (evaluation board).

Each USB transfer has a length of 33280 bytes out of which first 512 bytes are configuration and setting bytes. The remaining 32768 bytes will contain samples. This will require 8 logical transfers to be executed (Figure 3-4). The physical USB layer will split the 33280 byte packets into 512 byte chunks before transmitting on the USB bus.

512 bytes for configuration	32768 bytes – samples
33280 bytes USB transfer packet	
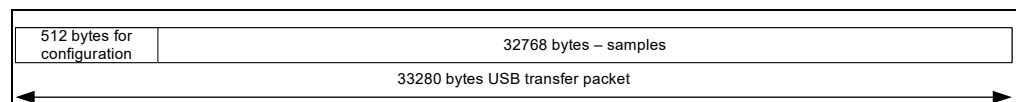
FIGURE 3-4: *USB Transfer Frame.*

3.4 ADC FUNCTIONS

In addition to the actual sample transfer from MCU to PC, there are other ADC functions available: Calibration, Read Device ID, and Sampling Speed Change.

The PC not only receives data from the EVB, but it also sends 512 bits of data back to the MCU. The 512 length size is required because of the USB high-speed endpoint size. Out of these, only the first 5 are meaningful.

The first element: receivedDataBuffer[0] is indicating to the MCU the desired function. For 0x80, the MCU will send samples. For 0x81, the transfer is stopped and MCU RAM is filled with samples from the ADC. The code will not perform transfers in the same time as the acquisition of ADC samples.

The Calibration function is executed when value 0x70 is received. Calibration status function has code 0x71. Table 3-1 provides the command structure byte values sent to and the responses from the PIC32MZ2048EFM100 on the Curiosity Development Board (DM320104). Figure 3-5 displays the timing diagram of the calibration process.

TABLE 3-1: COMMAND STRUCTURE BYTE VALUES

Command	receivedDataBuffer[x]			transmitDataBuffer[x]				Description
	Byte[0]	Byte[1] Byte[2]	Byte[3]	Byte[0]	Byte[1]	Byte[2]	Byte [3] Byte [4] Byte [5]	
Send Samples	0x80	—	[0 to 7] Package Index	0x80	0x00	—	—	33280 Byte reply [0-511] – Irrelevant [512 – 33279] – Data samples Combine the read data into a 16b signed value as follows: dataH: dataL = read[odd index]: read[even index]
Change Sampling Speed	0x81	—	1-4 Sampling speed	0x81	0x01	—	—	Select sampling speed from Byte[3] and change transmitDataBuffer[1] = 0x80 to start send data
				0x80	0x01	—	—	
Calibrate ADC	0x70	—	—	0x70	0x01	—	—	[0x70, 0x01] – Command received successfully [0x70, 0x00]– Error
Calibration Status	0x71	—	—	0x71	0x01	—	—	[0x71, 0x01] – Calibration successful [0x71, 0x00] – Calibration failed
Acquire Single Sample	0x50	—	—	0x50	MSb	LSb	—	[0x50, ADCHighByte, ADCLowByte]
Read Device ID	0x60	—	—	0x60	—	—	—	[0x60, chip ID]
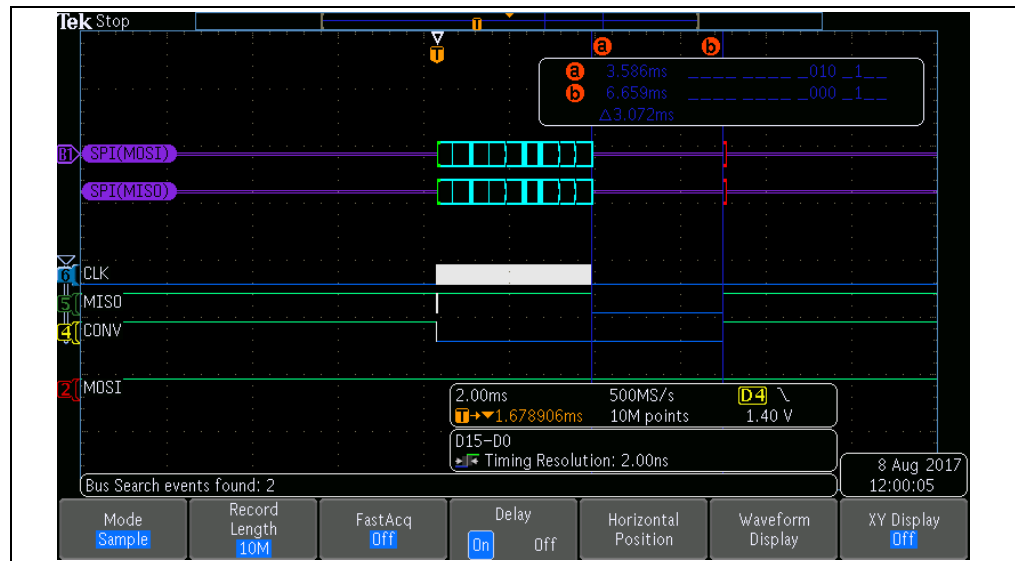
FIGURE 3-5: *ADC Calibration.*

Read Device ID code is 0x60. In order to retrieve the chip ID, more read registers are required. Figure 3-6 describes the read register command format.

To retrieve the samples, the GUI will send to the MCU information on the packet required to be received as an index, which is a number from 0 to 7. This index is sent to the MCU in `receivedDataBuffer[4]`.

Another function controlled by the GUI is the sampling speed change. There are four available sampling speeds. These are selected in accordance with the value received in `receivedDataBuffer[3]`. The sampling speed is controlled by changing the prescaler of the reference system clock.
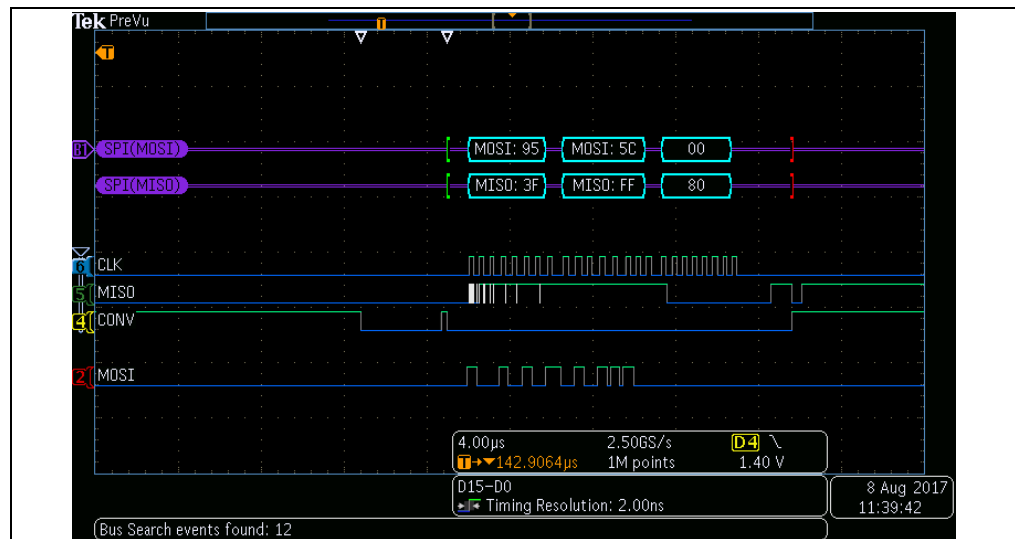
FIGURE 3-6: *Read Register from ADC.*

NOTES:

Appendix A. Schematic and Layouts

A.1   INTRODUCTION

This appendix contains the following schematics and layouts for the MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board (4V$_{REF}$, ADM00873 and 5V$_{REF}$, ADM00872).

A.2   ADM00872

- Board ADM00872 – Schematic
- Board ADM00872 – Schematic Regulators
- Board ADM00872 – Top Silk Layer
- Board ADM00872 – Top Copper and Silk Layer
- Board ADM00873 – Top Copper Layer
- Board ADM00873 – Bottom Copper Layer
- Board ADM00873 – Bottom Copper and Silk Layer
- Board ADM00872 – Bottom Silk Layer

A.3   ADM00873

- Board ADM00873 – Schematic
- Board ADM00873 – Schematic Regulators
- Board ADM00873 – Top Silk Layer
- Board ADM00873 – Top Copper and Silk Layer
- Board ADM00873 – Top Copper Layer
- Board ADM00873 – Bottom Copper Layer
- Board ADM00873 – Bottom Copper and Silk Layer
- Board ADM00873 – Bottom Silk Layer

A.4 BOARD ADM00872 – SCHEMATIC

+6V

ENABLE_ADA4940

FB4
1k

R12
0603
10k
5%

JP1
Shunt 1.27mm 1x2 W/ Handle

C1
0.1uF
GND

C2
1uF
GND

C20
1uF
GND

J8
HDR-1.27 Male 1x3

GND

Connector Shunt PN: 952-1732 ND
Connector PN: M50-3530342

Differential Input

GND

R1
20R 1%
0603

TP1

VIN1+

DNP R22
0R 0402 DNP

DIFF DRIVER

ENABLE_ADA4940

IN1+
DNP

right angle
J1

R48
0R
0603
GND

C33
0.062uF
DNP
GND

R4
1k

R5
1k ±0.1%

U1
ADA4940-1ACPZ-R7

FB-
IN+
IN-
FB+

V+ V+ V+
DISABLE

OUT- 11

OUT+ 10

VOCM

* C_filter >20 x C_sample. * Keep fc < 500 kHz

R3
24R

C35
2.2nF
50V0603
NP0
GND

R18
0R
0402

C12
DNP DNP

+1.8V

C9
1uF

C59
0.1uF
16V
GND

C6
10uF
16V
TANT-A
GND

C7
100pF
25V
GND

VREF

VIO_3.3V

DNP +5V
TP7
DNP

Tie Pins 6 & 7 at the le

C3
22µF
25V 1206
GND

right angle
J2

R49
0R
0603
DNP
GND

C34
0.062uF
DNP
GND

R23
0R 0402
DNP
GND

R6
1k

R7
1k

R8
24R

C37
2.2nF
50V0603
NP0
GND

R19
0R
0402

IN1-
DNP DNP

R24
0R 0402
DNP DNP

Connect when Single-Ended is used
GND

SAR ADC
U3

VREF
AVdd
Ain+
Ain-
VSS

VIO
SDI
SCK
SDO
CNV

10
9
8
7
6

MCP33131

C10
0.1uF
GND

R37
0R
0603

VIO_3.3V

R38 33R 0603
DNP R39 33R
R42 33R
R43 33R
DNP

CNV
SCK
SDI
SDO

DGND

VIN1-
J6
HDR-1.27 Male 1x2

R9
20R0603
1%

Connect when Single-Ended Source is used
GND

VREF

R10
10k 0.1%
0603

FB5
1k

C15
0.1uF
GND

C16
1uF
GND

-1V_Out

VIO_3.3V

R13
30k
0603
1%

This connec

Do not populate R39

Connector Shunt PN: 952-1732 ND
Connector PN: M50-9530242

C8
1uF
25V 0603
GND

C11
100pF
25V
GND

Vcom

FB7
1k

C64
1uF
25V 0603
GND

VREF/2

R11
10k 0.1%
0603
GND

VIO_3.3V
FB6
1k

R14
10k
0603
5%

R15
10k
0603
5%

R16
10k
0603
5%

R17
10k
0603
5%

DEVICE ID0
DEVICE ID1
DEVICE ID2
DEVICE ID3

SW1

DIP 4 SPST

Device ID Programming SW.

DGND

R44
0R
0603

GND   DGND

GND1 GND2   GND3 GND4

GND

Test GND Points

A.5   BOARD ADM00872 – SCHEMATIC REGULATORS

H1 2 1 TERMINAL 1x2
GND

J5
+9V IN
Power Jack 2.5mm
GND
CT1
10uF
20V
TANT-B
GND

J3 2 1 HDR-1.27 Male 1x2
JP2 Shunt 1.27mm 1x2 W/ Handle

R57
2k
0603
1%

D1
Green
Changed to Green LED
GND

L5
47UH 2A

C49
22uF
16V
0805
GND

C50
22uF
16V
0805
GND

C51
10uF
50V
GND

L6
1 mH

TP4
1

+9V OUT

C60
1uF
16V
GND

+9V OUT
R25
0R

C41
10uF
20V
TANT-B
GND

6V ADJ REGULATOR
U9 MIC5219 ADJ
2 IN   OUT 3
1 EN   BYP/ADJ 4
   GND
   5,6,7,8
GND

R27
82K
0805
±1%

C44
470pF
50V
GND

R30
348k 1%
0603
GND

C42
2.2uF
50V
GND

FB1
1k

TP5
1
+6V
To ADC Driver, Reference

R26
1R
1%

C43
10uF
25V
0805
GND

+9V OUT
R33
0R

C14
10uF
20V
TANT-B
GND

3.3V ADJ REGULATOR
U4 MIC5219 ADJ
2 IN   OUT 3
1 EN   BYP/ADJ 4
   GND
   5,6,7,8
GND

R34
143k
0603
±1%

C19
470pF
50V
GND

R35
237k ±1%
0603
GND

C17
2.2uF
50V
GND

FB3
1k

TP6
1
VIO_3.3V
To DVIO

Vout = 1.24 * (1+R2/R1)

R32
1R
1%

C18
10uF
25V
0805
GND

+9V OUT
R36
0R

C25
10uF
20V
TANT-B
GND

1.8V ADJ REGULATOR
U6 MIC5219 ADJ
2 IN   OUT 3
1 EN   BYP/ADJ 4
   GND
   5,6,7,8
GND

R41
348k
1%
0603

C32
470pF
50V
GND

R46
158k ±1%
0603
GND

C26
2.2uF
50V
GND

FB2
1k

TP9
1
+1.8V
To ADC VDD

Vout = 1.24 * (1+R2/R1)

R40
1R
1%

C31
10uF
25V
0805
GND

-1V Circuit

+9V OUT

C45
4.7uF
25V0805

C47
4.7uF
25V
0805
EARTH

R20
0R0402

R21
0R
0402
DNP
DNP
EARTH
GND

MCP16301/2V to 15V
U10
5 VIN   SW 6
4 EN   VFB 3
   BOOST 1
   GND 2

C46
0.1uF
50V0805

D3
1N4148
DNP **DNP**

L9
4.7 uH
GND

R29
14K
0805
1%

R31
56k
0805
1%

D2
30V 1A

R47
0R
0805

C48
22uF
16V
EARTH

L8
1uH

R2
DNP **DNP**

Earth GND is tied @ Layer 3
Signal GND is tied to C48

U10 is pin-to-pin compatible with ADP2301AUJZ-R7

WARNING - R20 and R21 must never be populated at the same time.
R20: Enables -1V Circuit
R21: Disables -1V Circuit

A.6   BOARD ADM00872 – TOP SILK LAYER

A.7   BOARD ADM00872 – TOP COPPER AND SILK LAYER

A.8   BOARD ADM00872 – TOP COPPER LAYER

A.9   BOARD ADM00872 – BOTTOM COPPER LAYER

A.10   BOARD ADM00872 – BOTTOM COPPER AND SILK LAYER

A.11 BOARD ADM00872 – BOTTOM SILK LAYER

A.12 BOARD ADM00873 – SCHEMATIC

Reference: 4.096V

+5.5V
FB4 1k
D4 MMBD1503A
+4.54 Vmax
C1 0.1uF
C2 1uF

+5.5V
R12 10k 0603 1%
R52 47k 0603 1%
C20 1uF
JP3 ON
J8 HDR-1.27 Male 1x3
ENABLE_ADA4940
Shunt 1.27mm 1x2 W/ Handle OFF
Shunt for Connector: PN: 952-1732 ND
Connector PN: M50-3530342, CON1672
GND

VREF
TP7 **DNP**
FB8 1k
DNP if not needed
fc = 1/(2pi RC) = 16Hz
C4 1uF 16V
R37 1k
C13 10µF 25V
R38 0R 0603

C5 2.2uF 16V 0603
2nd Order LP: fc = 1
U5 MCP6286
VSS Vin+
VOUT
VDD Vin-
+5.5V
R43 13.3k 0603
C11 1uF 25V 0603
Option: MIC920
To by-pass U5:
C3 1uF
GND

Differential Input
TP1
VIN1+
right angle J1
R48 0R
Capacitor NP
C33 0.062uF **DNP**
GND

GND
R1 20R 1% 0603
R22 DNP 0R 0402 **DNP**

DIFF DRIVER
R4 1k
R5 1k ±0.1%
R6 1k
R7 1k
U1 ADA4940-1ACPZ-R7
FB- IN+ IN- FB+ VOCM
V+ V+ V+ DISABLE
OUT- OUT+
V- V- V- EP

ENABLE_ADA4940

* C_filter >20 x C_sample.   * Keep fc < 500 kHz
R3 24R
C35 2.2nF 50V0603 NP0
R18 0R 0402
IN1+ **DNP**
C12 0.1uF **DNP**
R8 24R
C37 2.2nF 50V0603 NP0
R19 0R 0402
-1V_Out
FB5 1k
GND
DNP IN1- **DNP**
R24 DNP 0R 0402
GND

+1.8V
C9 1uF
C59 0.1uF 16V
C6 10µF 16V TANT-A
C7 100pF 25V
GND

VIO_3.3V
C10 0.1uF
R42 0R

SAR ADC
U3
VREF VIO
AVdd SDI
Ain+ SCK
Ain- SDO
VSS CNV
MCP33131

+5.5V
MCP1501/4.096V
U2
VDD OUT
GND SHDN
2,3,5
C22 1uF 16V
GND

J1
CNV
SCK
SDI
SDO
R44 0603 33R
R53 33R 0603
R54 33R 0603
R55 33R 0603
DGND

right angle J2
VIN1-
R49 0R
Capacitor NP
C34 0.062uF **DNP**
GND
R23 DNP 0R 0402 **DNP**
R9 20R0603 1%
GND

J6 HDR-1.27 Male 1x2
Shunt for Connector: PN: 952-1732 ND
Connector PN: M50-3530242, CON1673

C15 0.1uF
C16 1uF
GND

VIO_3.3V
R13 30k 0603 5%

R56 0R
GND

This conn
To Mother board

VCOM
FB7 1k
C64 1uF 25V 0603
R10 10k 0603 0.1%
2.048V
R11 10k 0603 0.1%
VREF
VREF/2

C8 1uF
C23 100pF 25V
GND

VIO_3.3V
FB6 1k

R14 10k 0603 5%
R15 10k 0603 5%
R16 10k 0603 5%
R17 10k 0603 5%

DEVICE ID0
DEVICE ID1
DEVICE ID2
DEVICE ID3
SW1
DIP 4 SPST
DGND

Note: Device ID can be also read out from Registers

Optional. BW = 50 kHz with 50 ohms//0.062 uF

GND1 GND2 GND3 GND4
GND
Test GND Points

A.13   BOARD ADM00873 – SCHEMATIC REGULATORS

A.14   BOARD ADM00873 – TOP SILK LAYER

A.15   BOARD ADM00873 – TOP COPPER AND SILK LAYER

A.16   BOARD ADM00873 – TOP COPPER LAYER

A.17   BOARD ADM00873 – BOTTOM COPPER LAYER

A.18   BOARD ADM00873 – BOTTOM COPPER AND SILK LAYER
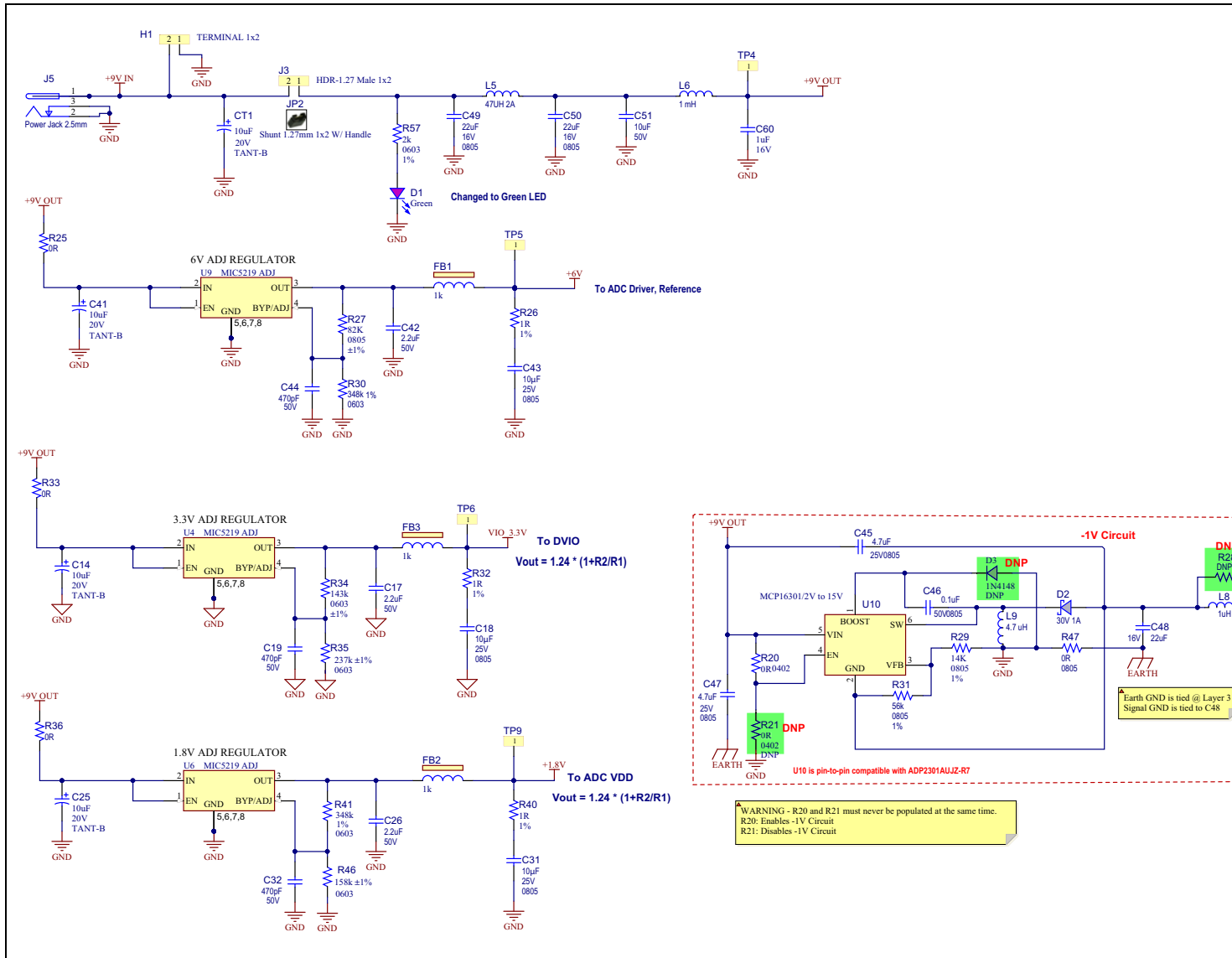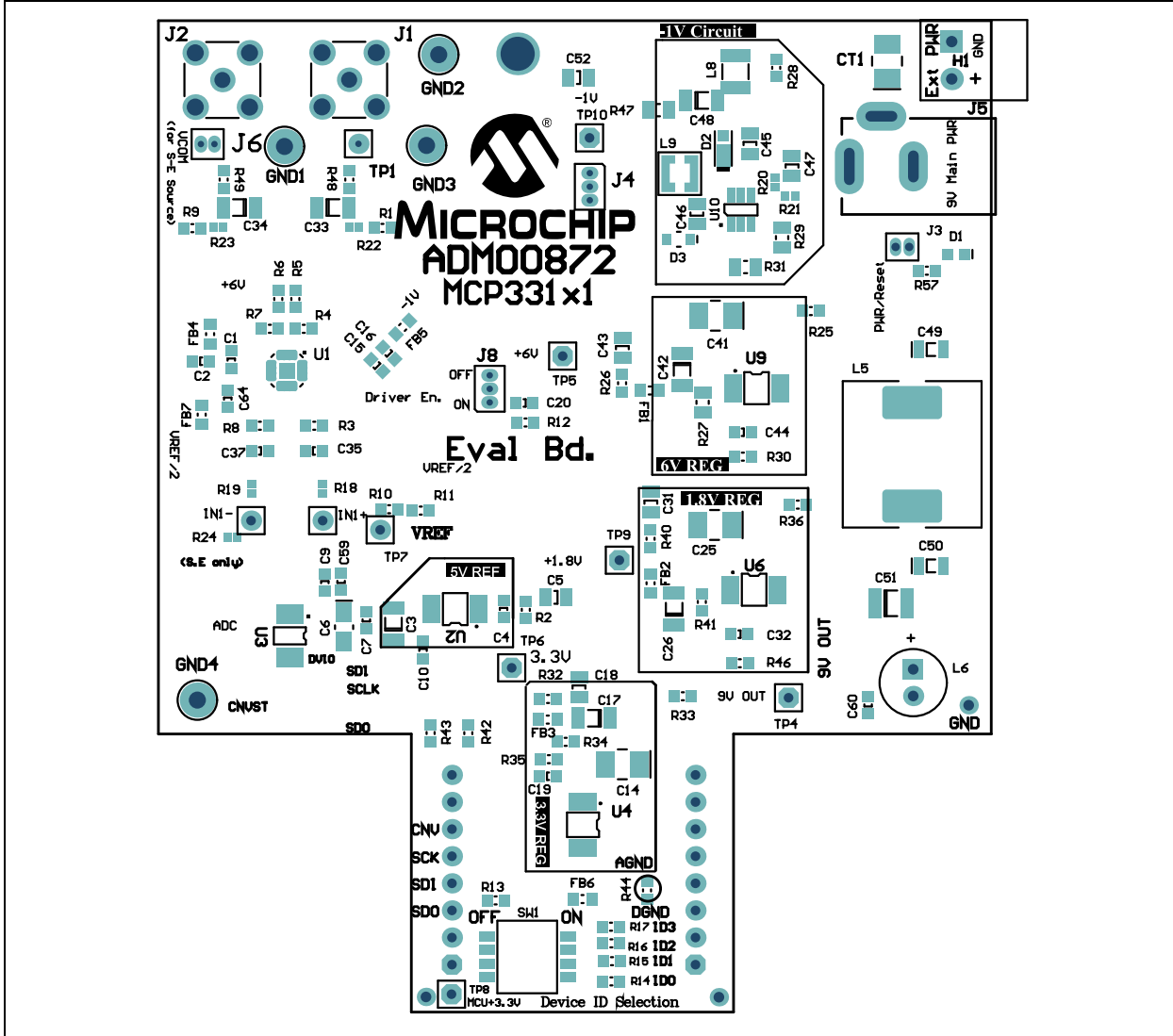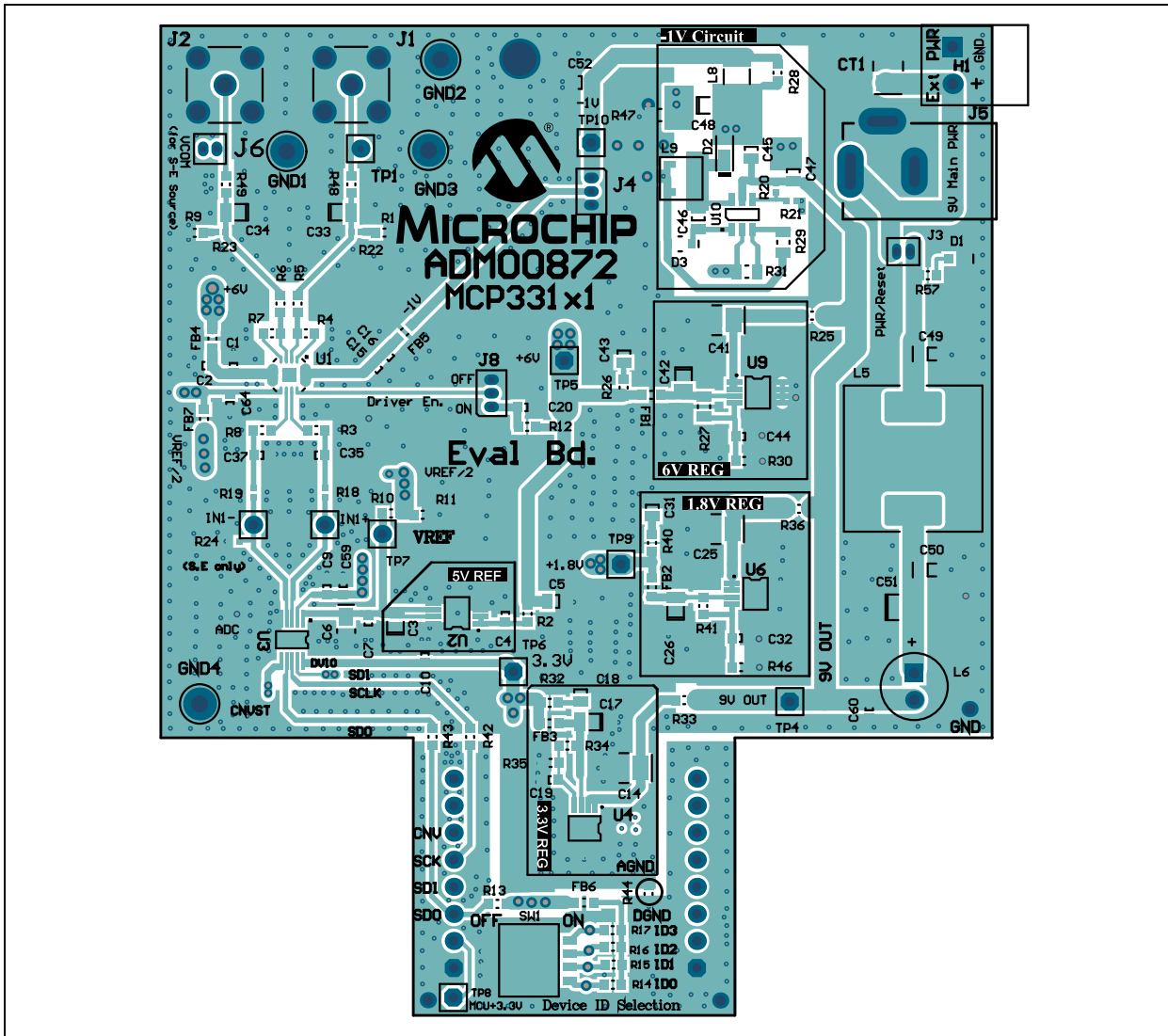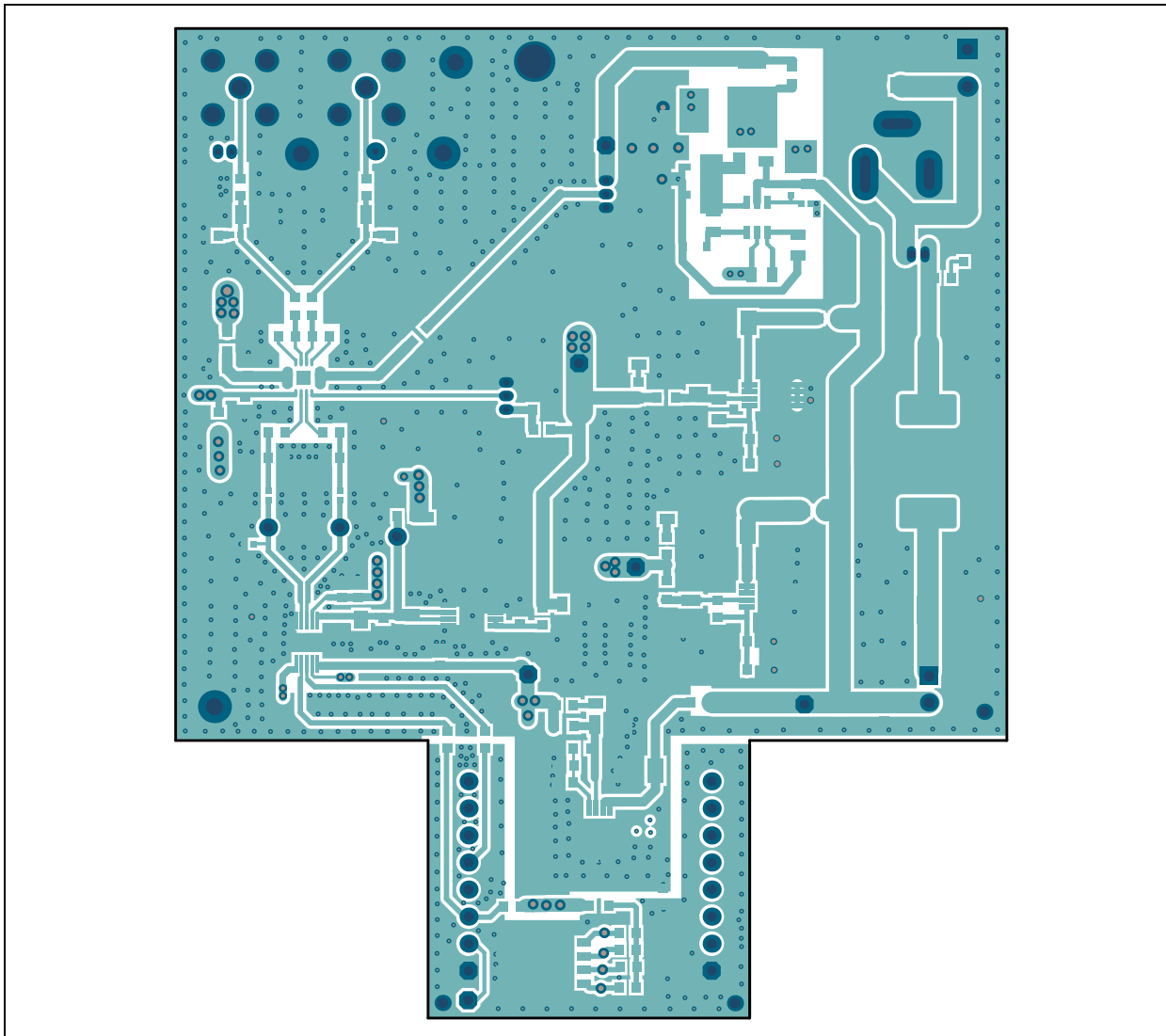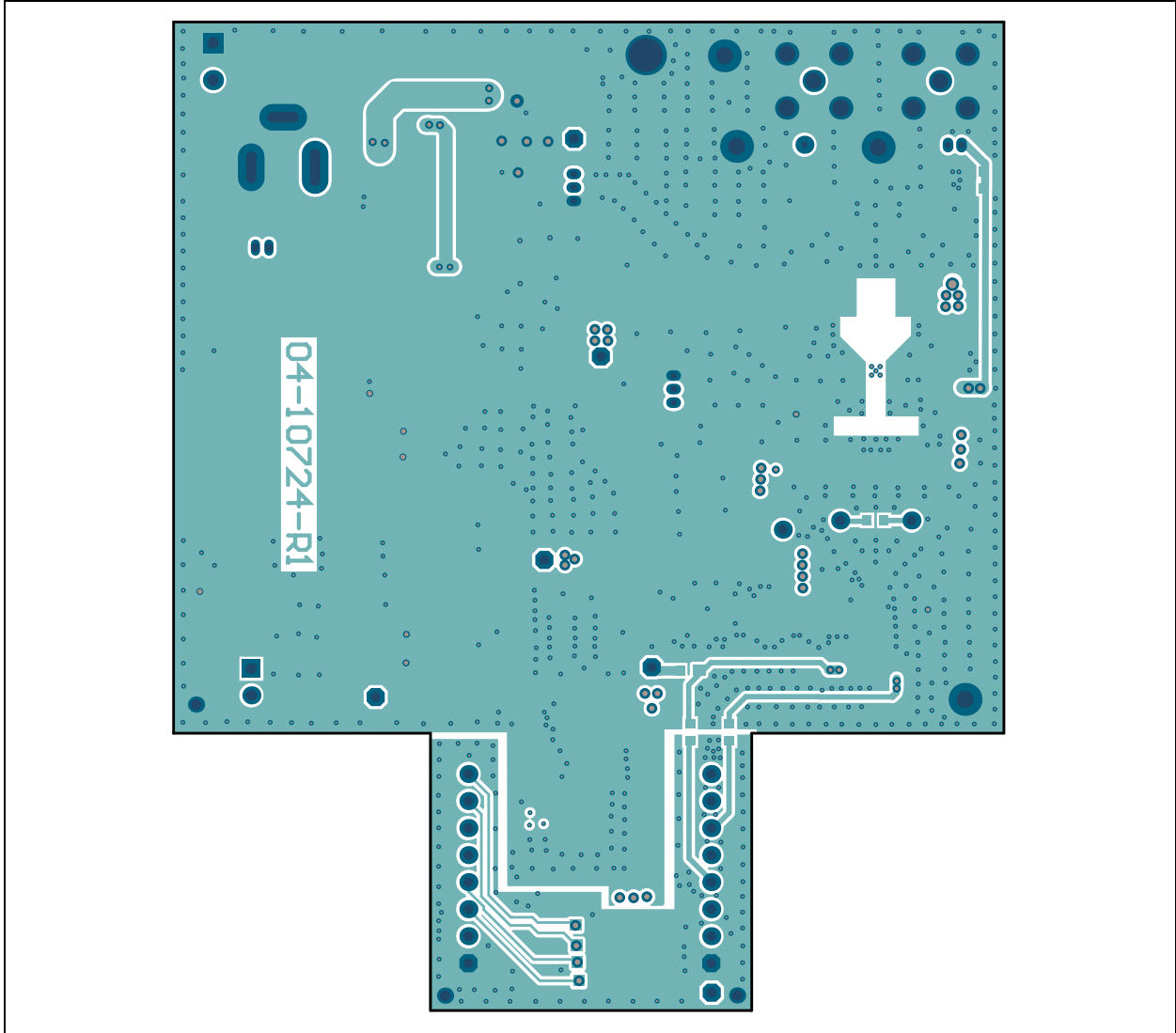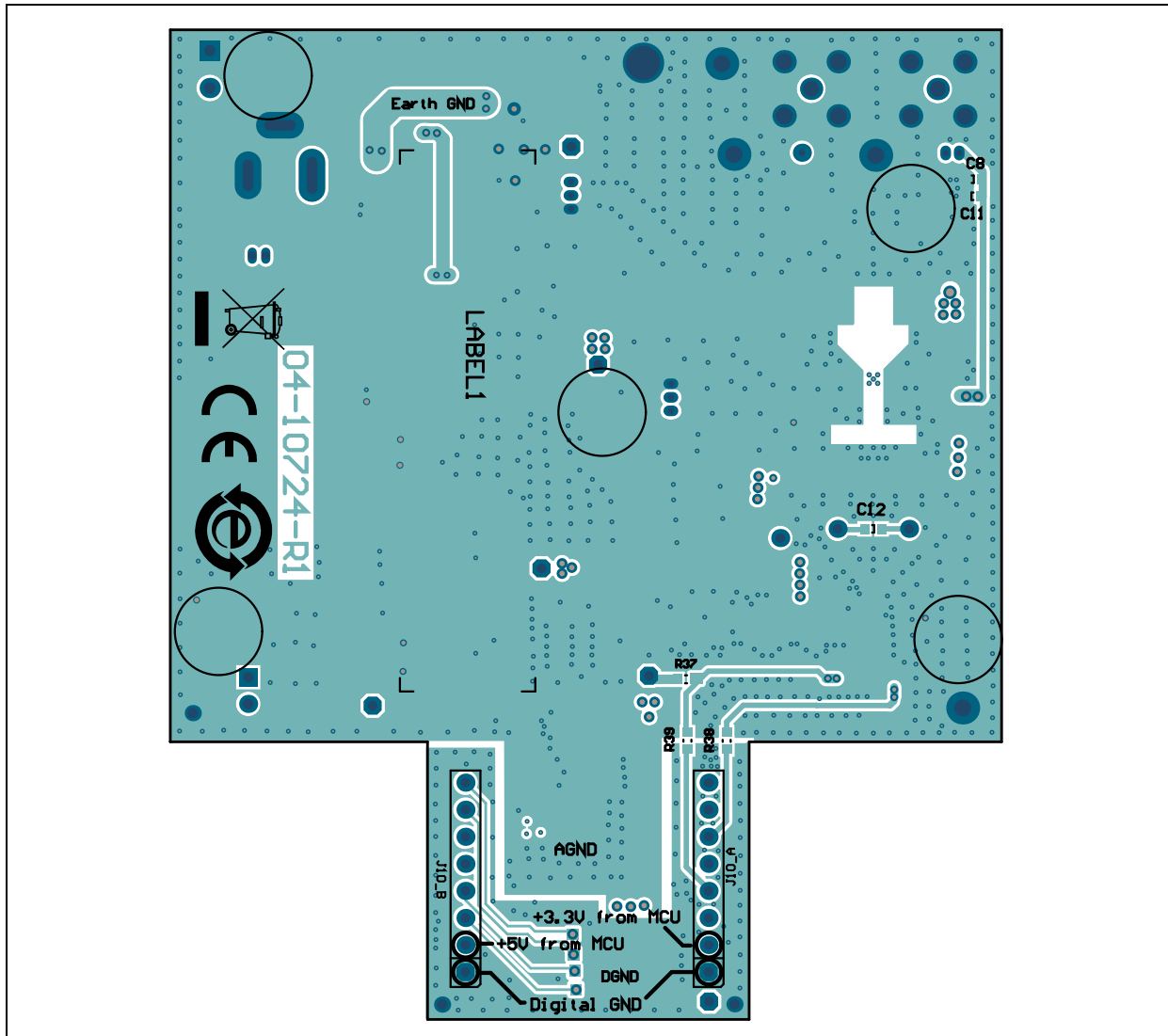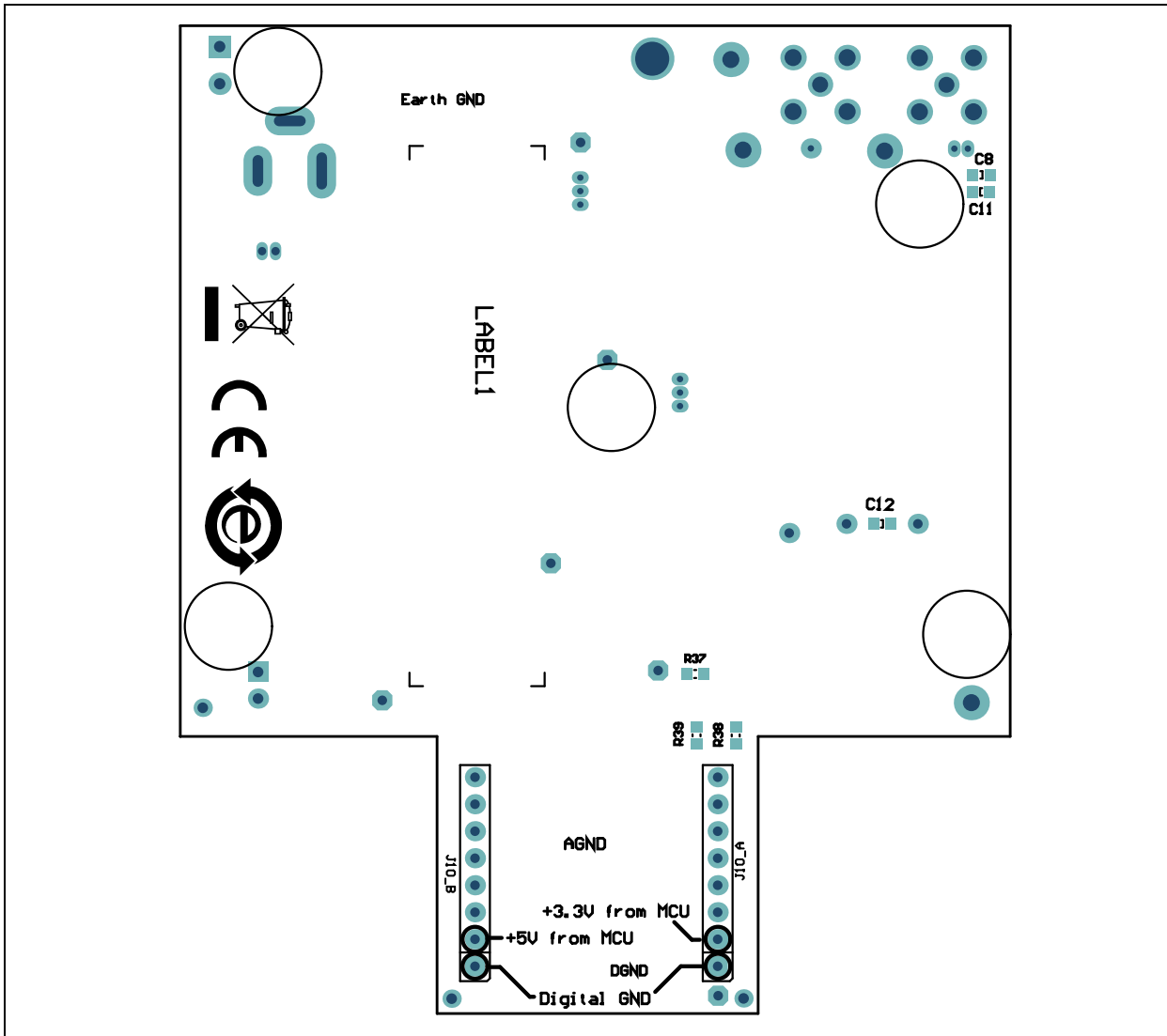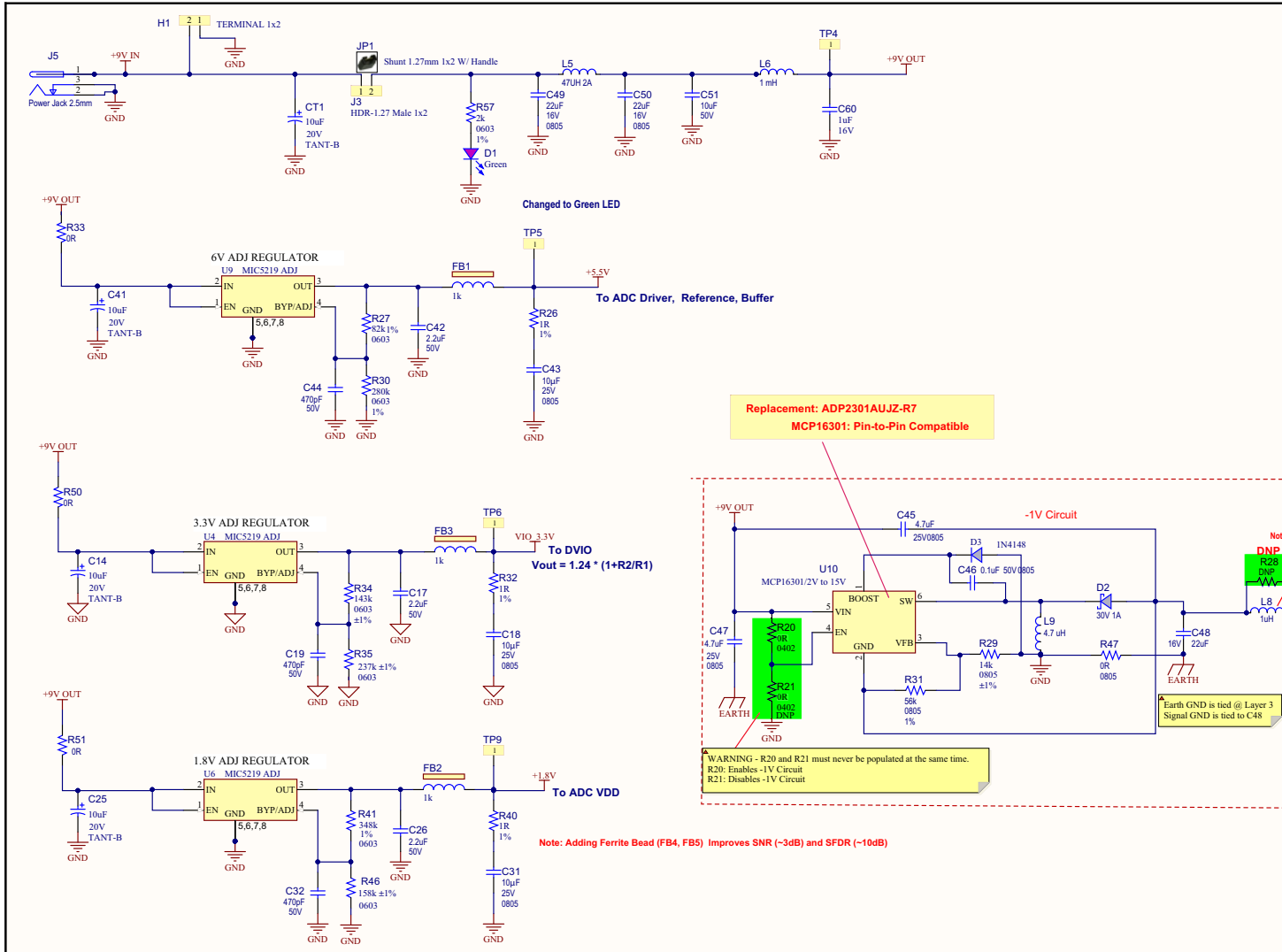
A.19   BOARD ADM00873 – BOTTOM SILK LAYER

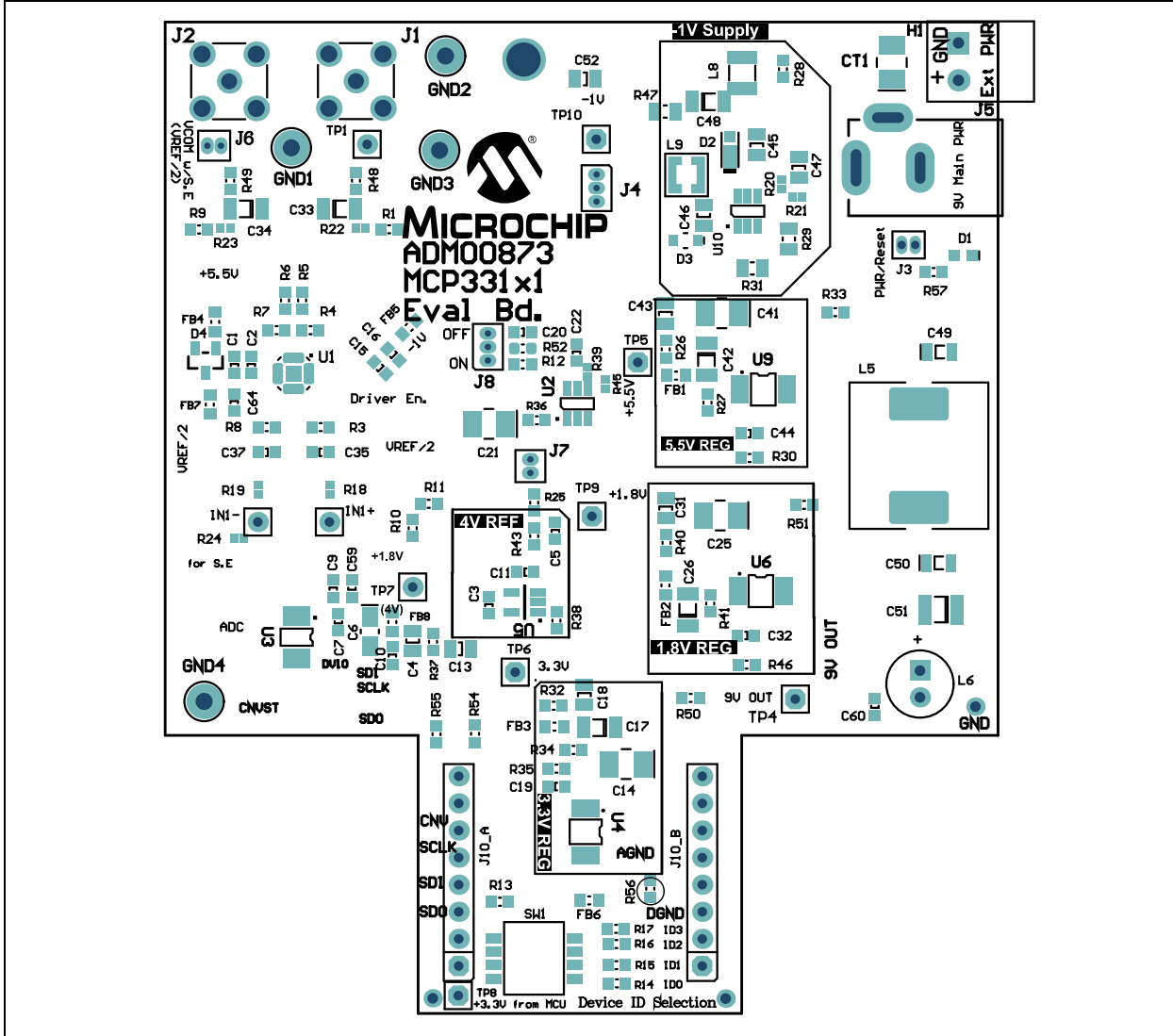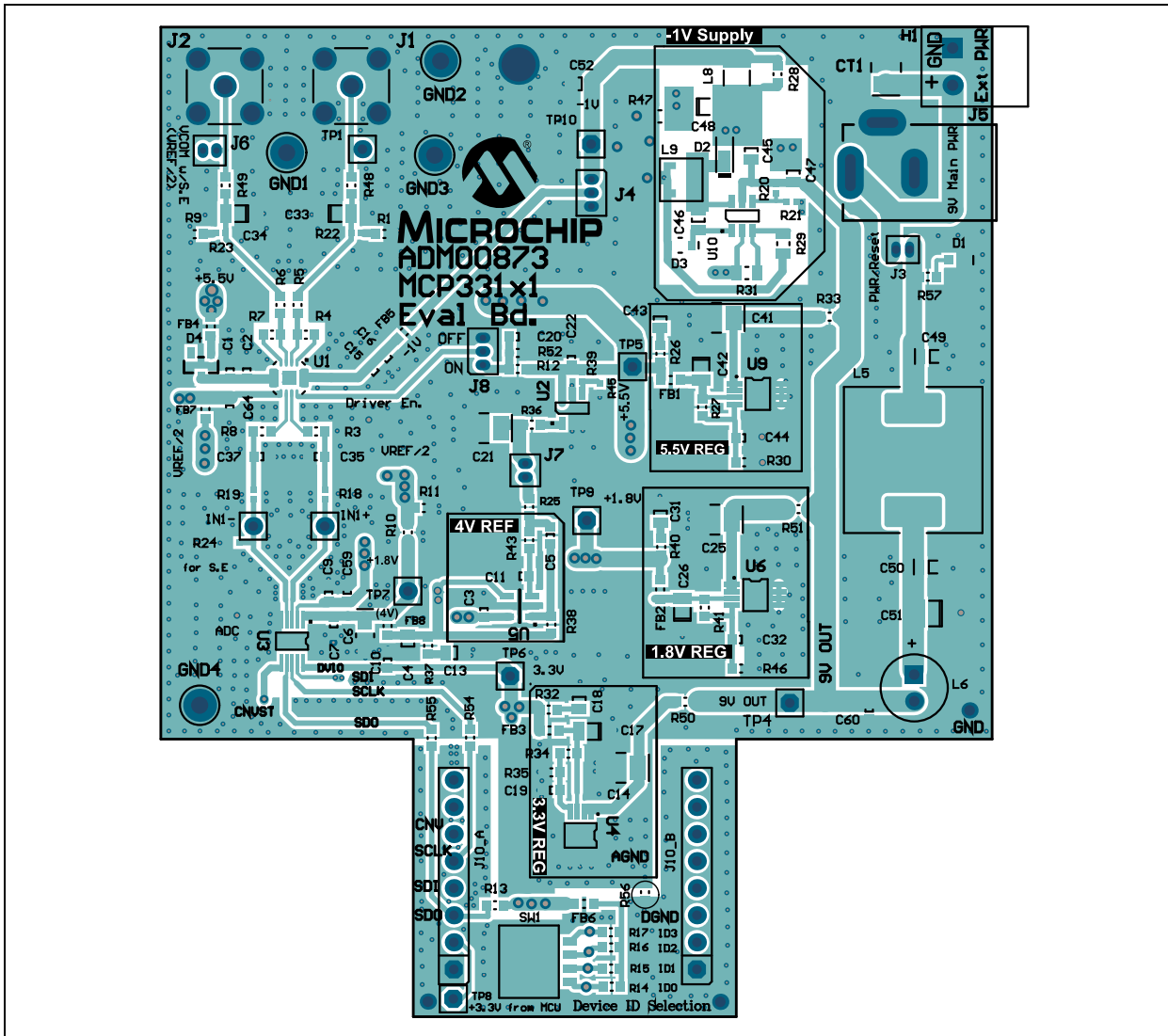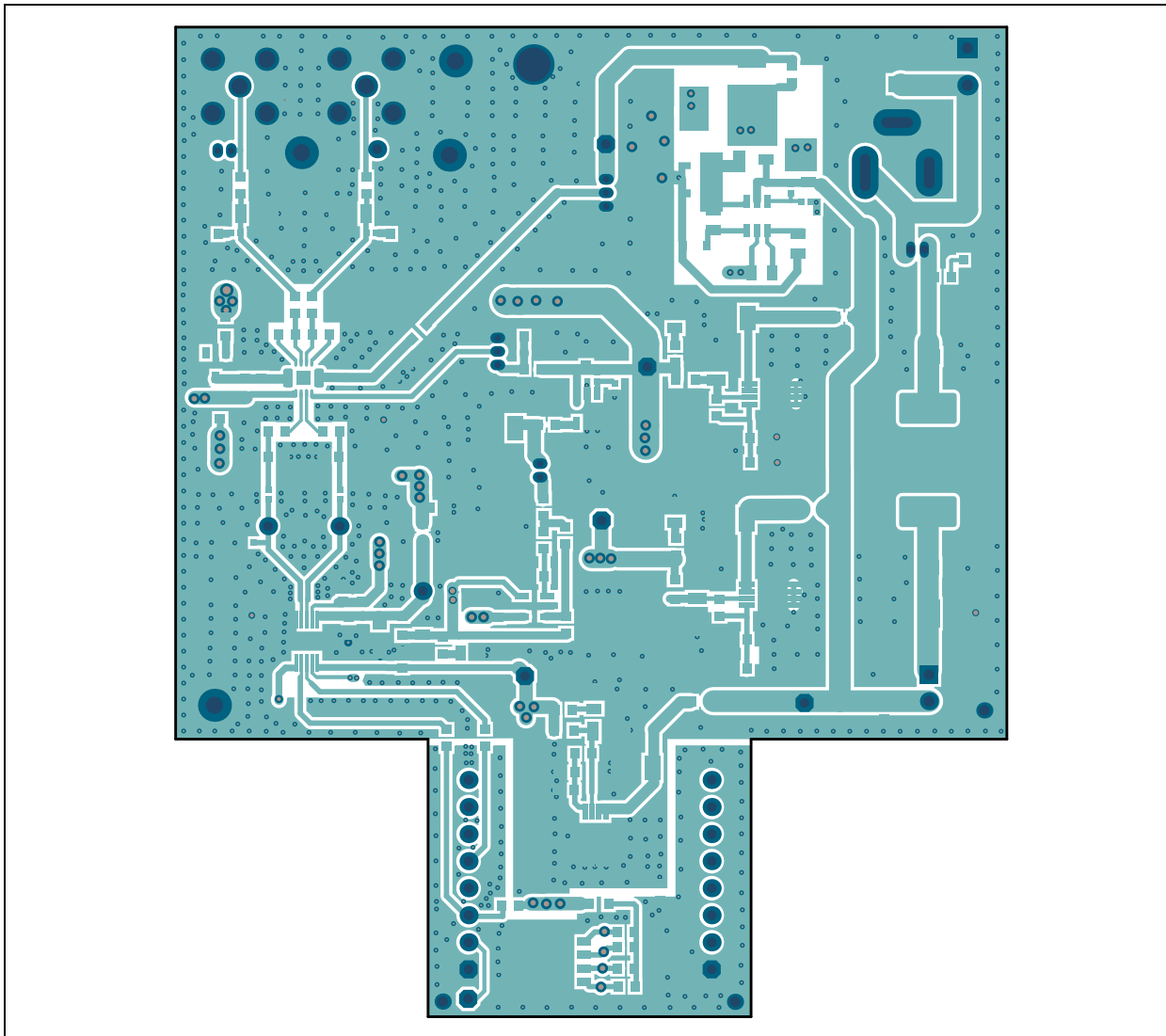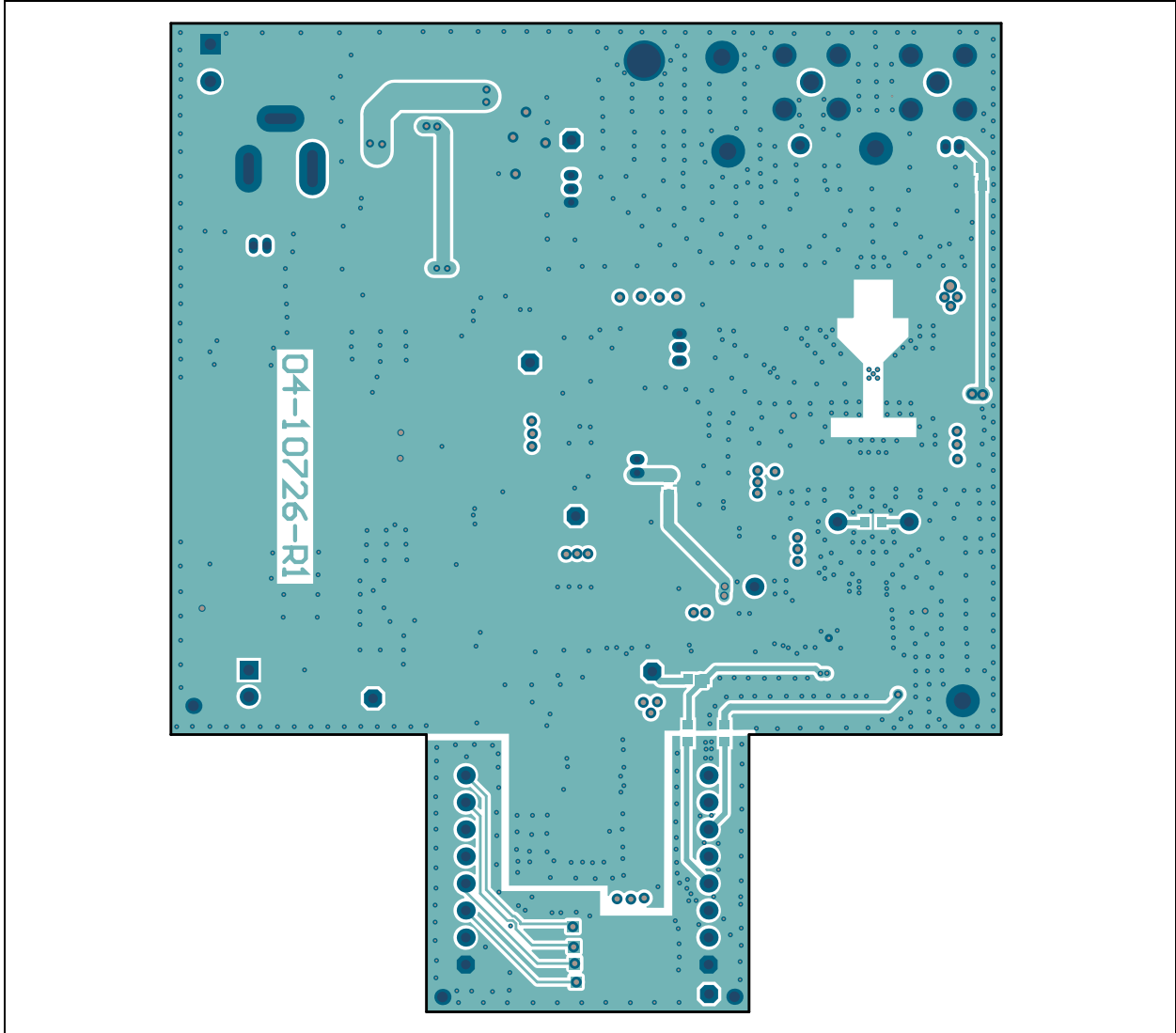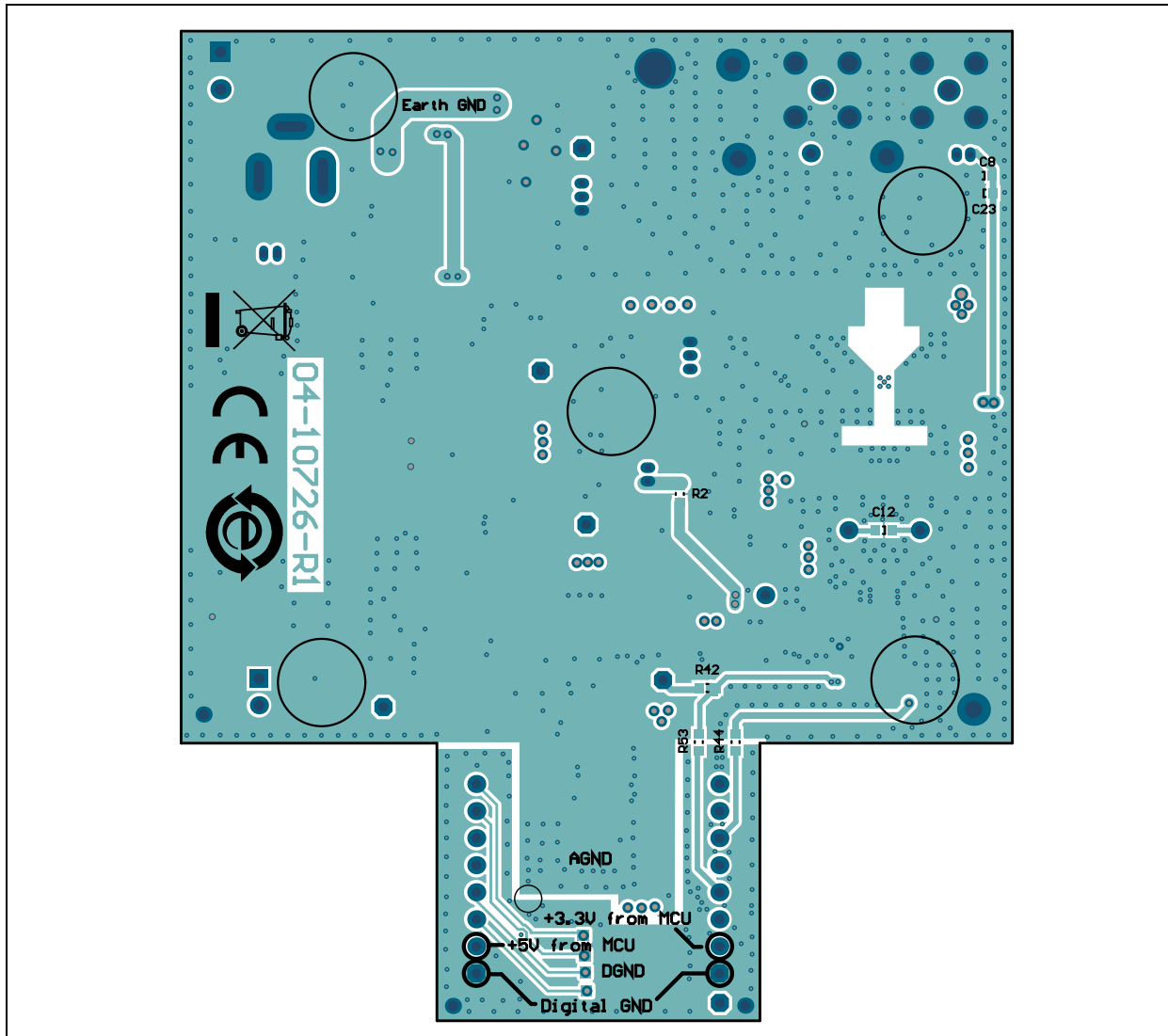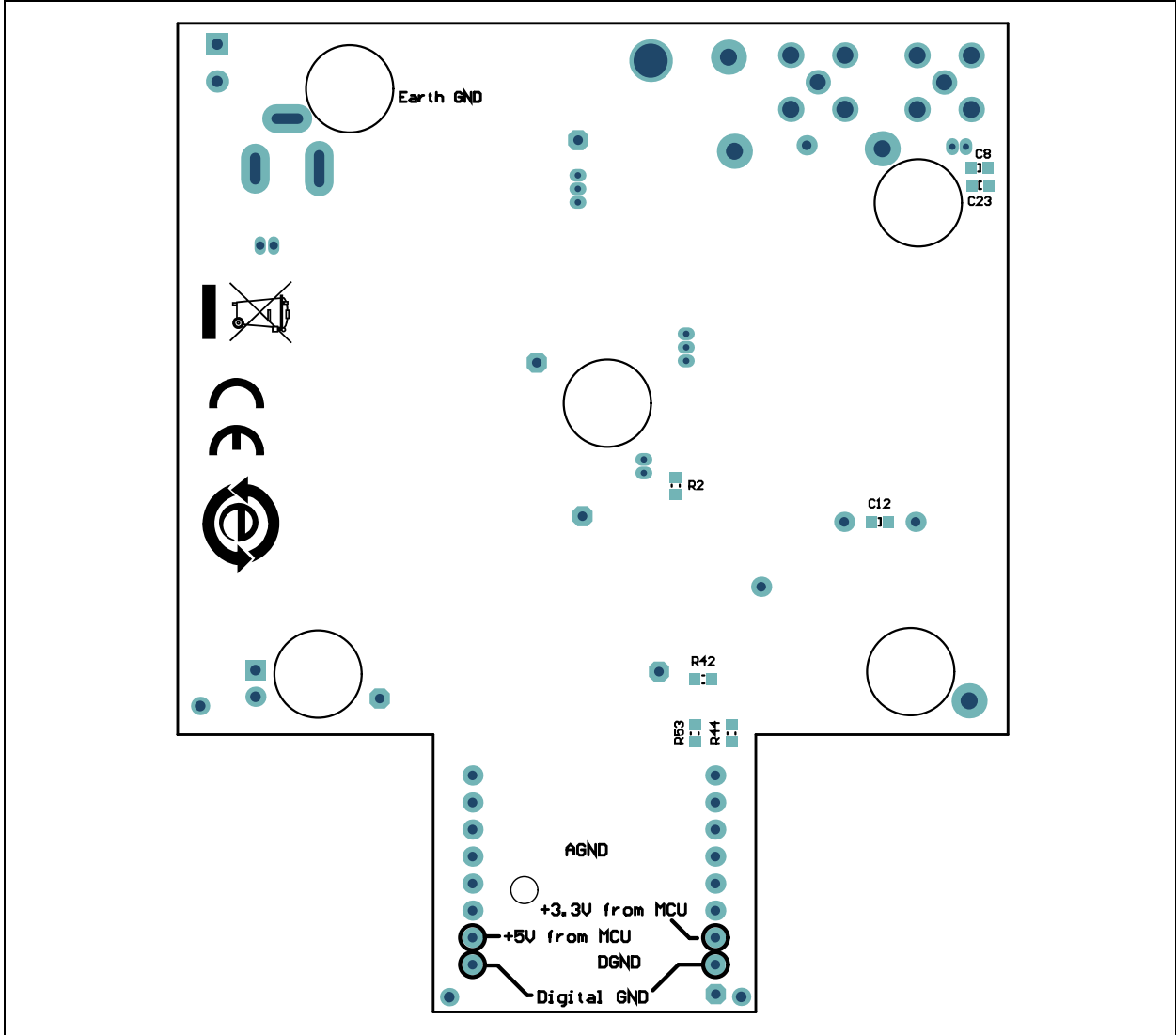**NOTES:**

Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM) FOR ADM00872[1]

Qty.	Reference	Description	Manufacturer	Part Number
4	C1, C10, C15, C59	Capacitor ceramic 0.1 µF, 16V, 10%, X7R, SMD, 0603	AVX Corporation	0603YC104KAT2A
1	C12	Capacitor ceramic, 0.1 µF, 16V, 10%, X7R, SMD, 0603 **DO NOT POPULATE**	AVX Corporation	0603YC104KAT2A
4	C14, C25, C41, CT1	Capacitor tantalum 10 µF, 20V, 10%, 2.1Ω, SMD, 1210	AVX Corporation	TAJB106K020RNJ
3	C17, C26, C42	Capacitor ceramic 2.2 µF, 50V, 10%, X7R, SMD, 1206	TDK Corporation	CGA5L3X7R1H225K160AB
3	C19, C32, C44	Capacitor ceramic 470 pF, 50V, 10%, X7R, SMD, 0603	Johanson Dielectrics	500R14W471KV4T
6	C2, C8, C9, C16, C20, C64	Capacitor ceramic 1 µF, 16V, 10%, X7R, SMD, 0603	Samsung Electro-Mechanics America, Inc.	CL10B105KA8NNNC
1	C3	Capacitor ceramic 22 µF, ±10%, 25V, X5R, 1206	Murata Electronics North America, Inc.	GRM31CR61E226KE15L
2	C33, C34	Capacitor ceramic, 0.062 µF, 1206, CER, 50V, 5%, COG **DO NOT POPULATE**	Murata Electronics North America, Inc.	GRM31C5C1H623JA01L
2	C35, C37	Capacitor ceramic 2200 pF, 50V, C0G, NP0, 0603 (1608 Metric) 0.063" L x 0.031	Murata Electronics North America, Inc.	GRM1885C1H222FA01D
3	C4, C7, C11	Capacitor ceramic, 100 pF, 25V, 10%, NP0, SMD, 0603	AVX Corporation	06033A101KAT2A
3	C45, C47, C52	Capacitor ceramic 4.7 µF, 25V, 10%, X7R, SMD, 0805	TDK Corporation	C2012X7R1E475K125AB
1	C46	Capacitor ceramic 0.1 µF, 50V, 10%, X7R, SMD, 0805	Yageo Corporation	CC0805KRX7R9BB104
1	C48	Capacitor ceramic 22 µF, 16V, 20%, X5R, SMD, 1206	Samsung Electro-Mechanics America, Inc.	CL31A226KOCLFNC
2	C49, C50	Capacitor ceramic 22 µF, 16V, X5R, 0805	TDK Corporation	C2012X5R1C226K125AC
4	C5, C18, C31, C43	Capacitor ceramic 10 µF, ±10%, 25V, X5R, MLCC, 0805	Murata Electronics North America, Inc	GRM219R61E106KA12D
1	C51	Capacitor ceramic 10 µF, 50V, 20%, X7S, SMD, 1210	TDK Corporation	C3225X7S1H106M
1	C6	Capacitor tantalum 10 µF, 16V, 20%, 8Ω, SMD, A	KEMET	T491A106M016AT
1	C60	Capacitor ceramic 1 µF, 16V, 10%, X7R, SMD, 0603	Yageo Corporation	CC0603KRX7R7BB105
1	D1	Diode LED Red, 2V, 30 mA, 2 mcd, clear, SMD, 0603	Lite-On®, Inc.	LTST-C190EKT

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

TABLE B-1: BILL OF MATERIALS (BOM) (CONTINUED)FOR ADM00872[1]

Qty.	Reference	Description	Manufacturer	Part Number
1	D2	Diode schottky, 30V, 1A, POWERDI323	Diodes Incorporated®	PD3S130L-7
1	D3	Diode rectifier, 1N4148, 855 mV, 300 mA, 75V, SOD-323 **DO NOT POPULATE**	Diodes Incorporated	1N4148WS-7-F
7	FB1, FB2, FB3, FB4, FB5, FB6, FB7	Ferrite bead, 1 kΩ, 0603, 1LN	Wurth Elektronik	742792662
4	GND1, GND2, GND3, GND4	Connector TP, Loop, Black, TH	Keystone Electronics Corp.	5011
1	H1	Connector terminal, 3.5 mm, 6A Female, 1 x 2 TH, R/A	Keystone Electronics Corp.	8722
3	IN1+, IN1-, TP7	Connector header-2.54, Male, 1x1, Gold, 5.97MH, TH, Vertical **DO NOT POPULATE**	Samtec, Inc.	TSW-101-07-L-S
2	J1, J2	Connector radio frequency, Coaxial, SMA Female, TH, R/A	TE Connectivity, Ltd.	5-1814400-1
2	J10_A, J10_B	Connector header-2.54 Male, 1x8, Gold, 5.84MH, TH	FCI	68001-108HLF
2	J3, J6	Connector header, 1.27 mm, T/H, Gold, 2 POS	Harwin Plc.	M50-3530242
2	J4, J8	Connector header, 1.27 mm, T/H, AU, 3 POS	Harwin Plc.	M50-3530342
1	J5	Connector power, Jack Male, 2.5 mm, CLSD	CUI Inc.	PJ-002B
1	L5	Fixed inductor, 47 µH, 2A, 135 mΩ, SMD	Bourns®, Inc.	SRR1240-470M
1	L6	Fixed inductor, 1 mH, 250 mA 6Ω, TH	Wurth Elektronik	7447462102
1	L8	Fixed inductor, 1 µH, 1A, 60 mΩ, SMD	Murata Electronics North America, Inc	QH32CN1R0M33L
1	L9	Fixed Shielded Power Inductor, 4.7 µH	Coilcraft	LPS3015-472MRB
1	PCB1	MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board Printed Circuit Board	Microchip Technology Inc.	**04-10724-R1**
2	R1, R9	Resistor TF, 20R, 1%, 1/16W, SMD, 0603	Stackpole Electronics, Inc.	RNCP0603FTD20R0
2	R10, R11	Resistor TF, 10k, 0.1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERA-3AEB103V
5	R12, R14, R15, R16, R17	Resistor TKF, 10k, 5%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3GEYJ103V
1	R13	Resistor TKF, 30k, 1%, 1/10W, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603FT30K0
2	R18, R19	Resistor TKF, 0R, SMD, 0402	Panasonic - ECG	ERJ-2GE0R00X
8	R2, R25, R33, R36, R37, R44, R48, R49	Resistor TKF, 0R, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3GSY0R00V
1	R20	Resistor TKF, 0R, 1/16W, SMD, 0402	Yageo Corporation	RC0402JR-070RL

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

TABLE B-1:   BILL OF MATERIALS (BOM) (CONTINUED)FOR ADM00872[1]

Qty.	Reference	Description	Manufacturer	Part Number
1	R21	Resistor TKF, 0R, 1/16W, SMD, 0402 **DO NOT POPULATE**	Yageo Corporation	RC0402JR-070RL
3	R22, R23, R24	Resistor TKF, 0R, SMD, 0402 **DO NOT POPULATE**	Panasonic - ECG	ERJ-2GE0R00X
3	R26, R32, R40	Resistor TKF, 1R, 1%, 1/10W, SMD, 0603	ROHM Semiconductor	KTR03EZPF1R00
1	R27	Thick Film Resistors, SMD, 0805, 82 kΩ, 1%, Anti-Surge, AEC-Q200	Panasonic - ECG	ERJ-P6WF8202V
1	R28	Resistor, TFK, 35.7 kΩ, 1%, 1/10W, SMD, 0603 **DO NOT POPULATE**	Vishay/Dale	CRCW060335K7FKEA
1	R29	Resistor, SMD, 14 kΩ, 1%, 1/8W, 0805	Panasonic - ECG	ERJ-6ENF1402V
2	R3, R8	Resistor TKF, 24R, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-0724RL
2	R30, R41	Resistor, TKF, 348k, 1/10W, 1%, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603FT348K
1	R31	Resistor TKF, 56k, 1%, 1/8W, SMD, 0805	Vishay/Dale	CRCW080556K0FKEA
1	R34	Resistor, SMD, 143 kΩ, 1%, 1/10W, 0603	Bourns, Inc.	CR0603-FX-1433ELF
1	R35	Resistor, SMD, 237 kΩ, 1%, 1/10W, 0603	Stackpole Electronics, Inc.	RMCF0603FT237K
3	R38, R42, R43	Resistor TKF, 33R, 5%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3GEYJ330V
1	R39	Resistor, TKF, 33R, 5%, 1/10W, SMD, 0603 **DO NOT POPULATE**	Panasonic - ECG	ERJ-3GEYJ330V
4	R4, R5, R6, R7	Resistor TF, 1k, 0.1%, 1/10W, SMD, 0603	Panasonic - ECG	ERA-3AEB102V
1	R46	Resistor TKF, 158k, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-07158KL
1	R47	Resistor TKF, 0R, 1/8W, SMD, 0805	Panasonic - ECG	ERJ-6GEY0R00V
1	R57	Resistor TKF, 2k, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF2001V
1	SW1	Switch DIP, 4-POS, SLIDE, SMD, 6V	Nidec Copal Electronics, Inc.	CHS-04TB
7	TP1, TP4, TP5, TP6, TP8, TP9, TP10	Connector header-2.54 Male, 1x1, Gold, 5.97MH, TH, Vertical	Samtec, Inc.	TSW-101-07-L-S
1	U1	IC OP-AMP, Differential, RRO LFCSP-16	Analog Devices Inc.	ADA4940-1ACPZ-R7
1	U2	IC POWER, VREF, MSOP-8	Linear Technology Corporation	LTC6655BHMS8-5#PBF
1	U3	MCP33131D-10-I/MS	Microchip Technology Inc.	MCP33131D-10-I/MS
3	U4, U6, U9	Microchip Analog LDO, 2.5V-5V, MSOP-8	Microchip Technology Inc.	MIC5219YMM
1	U10	Microchip Analog Switcher, Buck 2V to 15V, SOT-23-6	Microchip Technology Inc.	MCP16301T-E/CH

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

TABLE B-2: BILL OF MATERIALS (BOM) - MECHANICAL PARTS FOR ADM00872[1]

Qty.	Reference	Description	Manufacturer	Part Number
3	JP1, JP2, JP3	1.27 mm Jumper at Pins 1 and 2 of J8 1.27 mm Jumper at Pins 1 and 2 of J3 1.27 mm Jumper at Pins 1 and2 of J4	Harwin Plc.	M50-2000005
1	LABEL1	Microchip Technology Product Label		
5	PAD1, PAD2, PAD3, PAD4, PAD5	Mechanical Hardware Rubber Pad, Cylindrical, D7.9, H5.3, Black	3M	SJ61A11
1	PS1	100-240V, Wall Plug-in, Power Supply	Triad Magnetics	WSU090-2000-13
1	SCR1	Mechanical Hardware Machine Screw, PAN Phillips, 4-40, Nylon	Digi-Key® Electronics	H544-ND
	STANDOFF1	Mechanical HW Standoff, #4-40 x 3/4", F/F, HEX, Nylon	Keystone Electronics Corp.	1902D

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

TABLE B-3: BILL OF MATERIALS (BOM) FOR ADM00873[1]

Qty.	Reference	Description	Manufacturer	Part Number
4	C1, C10, C15, C59	Capacitor ceramic 0.1 µF, 16V, 10%, X7R, SMD, 0603	AVX Corporation	0603YC104KAT2A
1	C12	Capacitor ceramic, 0.1 µF, 16V, 10%, X7R, SMD, 0603 **DO NOT POPULATE**	AVX Corporation	0603YC104KAT2A
4	C13, C18, C31, C43	Capacitor ceramic 10 µF, ±10%, 25V, X5R, MLCC, 0805	Murata Electronics North America, Inc.	GRM219R61E106-KA12D
4	C14, C25, C41, CT1	Capacitor tantalum 10 µF, 20V, 10%, 2.1Ω, SMD, B	AVX Corporation	TAJB106K020RNJ
3	C17, C26, C42	Capacitor ceramic 2.2 µF, 50V, 10%, X7R, SMD, 1206	TDK Corporation	CGA5L3X7R1H225K160AB
3	C19, C32, C44	Capacitor ceramic 470 pF, 50V, 10%, X7R, SMD, 0603	Johanson Dielectrics	500R14W471KV4T
11	C2, C3, C4, C8, C9, C11, C16, C20 C22, C60, C64	Capacitor ceramic 1 µF, 25V, X7R, 0603	Samsung Electro-Mechanics America, Inc.	CL10B105KA8NNNC
1	C21	Capacitor tantalum 22 µF, 16V, 10%, 2.3Ω, SMD, B	AVX Corporation	TAJB22226K016R
2	C33, C34	Capacitor ceramic, 0.062 µF, 1206, CER, 50V, 5%, COG **DO NOT POPULATE**	Murata Electronics North America, Inc.	GRM31C5C1H623-JA01L
2	C35, C37	Capacitor ceramic 2200 pF, 50V, C0G, NP0, 0603 (1608 Metric) 0.063" L x 0.031	Murata Electronics North America, Inc.	GRM1885C1H222-FA01D
3	C45, C47, C52	Capacitor ceramic 4.7 uF, 25V, 10%, X7R, SMD, 0805	TDK Corporation	C2012X7R1E475K125AB
1	C46	Capacitor ceramic 0.1 uF, 50V, 10%, X7R, SMD, 0805	Yageo Corporation	CC0805KRX-7R9BB104
1	C48	Capacitor ceramic 22 uF, 16V, 20%, X5R, SMD, 1206	Samsung Electro-Mechanics America, Inc.	CL31A226KOCLFNC
2	C49, C50	Capacitor tantalum 100 uF, 20V, 10%, 140 mΩ, SMD, R	Vishay/Dale	595D107X9020R2T

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

TABLE B-3:   BILL OF MATERIALS (BOM) FOR ADM00873[1] (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
1	C5	Capacitor ceramic 2.2 uF, 16V, 10%, X5R, SMD, 0603	TDK Corporation	C1608X5R1C225K
1	C51	Capacitor ceramic 10 µF, 50V, 20%, X7S, SMD, 1210	TDK Corporation	C3225X7S1H106M
1	C6	Capacitor tantalum 10 µF, 16V, 20%, 8Ω, SMD, A	KEMET	T491A106M016AT
2	C7, C23	Capacitor ceramic 100 pF, 25V, 10%, NP0, SMD, 0603	AVX Corporation	06033A101KAT2A
1	D1	Diode LED Red, 2V, 30 mA, 2 mcd, clear, SMD, 0603	Lite-On®, Inc.	LTST-C190EKT
1	D2	Diode schottky, 30V, 1A, POWERDI323	Diodes Incorporated®	PD3S130L-7
1	D3	Diode rectifier, 1N4148, 855 mV, 300 mA, 75V, SOD-323	Diodes Incorporated®	1N4148WS-7-F
1	D4	Diode array, 1.1V, 200 mA, 200V, SMD, SOT-23-3	Fairchild Semiconductor®	MMBD1503A
8	FB1, FB2, FB3, FB4, FB5, FB6, FB7, FB8	Ferrite bead, 1 kΩ, 0603, 1LN	Wurth Elektronik	742792662
4	GND1, GND2, GND3, GND4	Connector TP, Loop, Black, TH	Keystone Electronics Corp.	5011
1	H1	Connector terminal, 3.5 mm, 6A Female, 1 x 2 TH, R/A	Keystone Electronics Corp.	8722
3	IN1+, IN1-, TP7	Connector header-2.54, Male, 1x1, Gold, 5.97MH, TH, Vertical **DO NOT POPULATE**	Samtec, Inc.	TSW-101-07-L-S
2	J1, J2	Connector radio frequency, Coaxial, SMA, Female, TH, R/A	TE Connectivity, Ltd.	5-1814400-1
2	J10_A, J10_B	Connector header-2.54 Male, 1x8, Gold, 5.84MH, TH	FCI	68001-108HLF
3	J3, J6, J7	Connector header-1.27 Male, 1x2, Gold, TH, Vertical	Harwin PI	M50-3530242
2	J4, J8	Connector header, 1.27 mm, T/H, AU, 3 POS	Harwin Plc.	M50-3530342
1	J5	Connector Power, Jack Male, 2.5 mm, CLSD	CUI Inc.	PJ-002B
1	L5	Fixed inductor, 47 µH, 2A, 135 mΩ, SMD	Bourns®, Inc.	SRR1240-470M
1	L6	Fixed inductor, 1 mH, 250 mA 6Ω, TH	Wurth Elektronik	7447462102
1	L8	Fixed inductor, 1 µH, 1A, 60 mΩ, SMD	Murata Electronics North America, Inc	LQH32CN1R0M33L
1	L9	Fixed Shielded Power Inductor, 4.7 µH	Coilcraft	LPS3015-472MRB
1	PCB1	MCP331x1 16/14/12-Bit 1 Msps SAR ADC Evaluation Board Printed Circuit Board	Microchip Technology Inc.	**04-10726-R1**
2	R1, R9	Resistor TF, 20R, 1%, 1/16W, SMD, 0603	Stackpole Electronics, Inc.	RNCP0603FTD20R0
2	R10, R11	Resistor TF, 10k, 0.1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERA-3AEB103V

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

TABLE B-3: BILL OF MATERIALS (BOM) FOR ADM00873[1] (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
1	R12	Resistor TF, 10k, 1%, 1/16W, SMD, 0603	TE Connectivity, Ltd.	5-1879337-9
1	R13	Resistor TKF, 30k, 5%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3GEYJ303V
4	R14, R15, R16, R17	Resistor TKF, 10k, 5%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3GEYJ103V
2	R18, R19	Resistor TKF, 0R, SMD, 0402	Panasonic® - ECG	ERJ-2GE0R00X
1	R2	Resistor TKF, 0R, 1/10W, SMD, 0603 **DO NOT POPULATE**	Panasonic® - ECG	ERJ-3GSY0R00V
1	R20, R39	Resistor TKF, 0R, 1/16W, SMD, 0402	Yageo Corporation	RC0402JR-070RL
2	R21, R45	Resistor TKF, 0R, 1/16W, SMD, 0402 **DO NOT POPULATE**	Yageo Corporation	RC0402JR-070RL
1	R25	Resistor TKF, 7.15K, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF7151V
3	R22, R23, R24	Resistor TKF, 0R, SMD, 0402 **DO NOT POPULATE**	Panasonic® - ECG	ERJ-2GE0R00X
3	R26, R32, R40	Resistor TKF, 1R, 1%, 1/10W, SMD, 0603	ROHM Semiconductor	KTR03EZPF1R00
1	R27	Resistor TKF, 82K, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF8202V
1	R28	Resistor, TFK, 35.7 kΩ, 1%, 1/10W, SMD, 0603 **DO NOT POPULATE**	Vishay/Dale	CRCW060335K7FKEA
1	R29	Resistor TKF, 14k, 1%, 1/8W, SMD, 0805	Panasonic® - ECG	ERJ-6ENF1402V
2	R3, R8	Resistor TKF, 24R, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-0724RL
1	R30	Resistor TKF, 280k, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF2803V
1	R31	Resistor TKF, 56k, 1%, 1/8W, SMD, 0805	Vishay/Dale	CRCW080556K0FKEA
8	R33, R38, R42, R48, R49, R50, R51, R56	Resistor TKF, 0R, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3GSY0R00V
1	R34	Resistor, SMD, 143 kΩ, 1%, 1/10W, 0603	Bourns®, Inc.	CR0603-FX-1433ELF
1	R35	Resistor, SMD, 237 kΩ, 1%, 1/10W, 0603	Stackpole Electronics, Inc.	RMCF0603FT237K
1	R36	Resistor TKF, 10.5R, 1%, 1/10W, SMD, 0603	Vishay/Dale	CRCW060310R5FKEA
1	R39	Resistor, TKF, 33R, 5%, 1/10W, SMD, 0603 **DO NOT POPULATE**	Panasonic® - ECG	ERJ-3GEYJ330V
5	R4, R5, R6, R7, R37	Resistor TF, 1k, 0.1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERA-3AEB102V
1	R41	Resistor TKF, 348k, 1/10W, 1%, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603FT348K
1	R43	Resistor TKF, 13.3k, 1%, 1/10W, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603FT13K3

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

TABLE B-3:   BILL OF MATERIALS (BOM) FOR ADM00873[1] (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
4	R44, R53, R54, R55	Resistor TKF, 33R, 1%, 1/10W, SMD, 0603	ROHM Semiconductor	MCR03EZPFX33R0
1	R46	Resistor TKF, 158k, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-07158KL
1	R47	Resistor TKF, 0R, 1/8W, SMD, 0805	Panasonic® - ECG	ERJ-6GEY0R00V
1	R52	Resistor TKF, 47k, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF4702V
1	R57	Resistor TKF, 2k, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF2001V
1	SW1	Switch DIP, 4-POS, SLIDE, SMD, 6V	Copal Electronics Inc.	CHS-04TB
7	TP1, TP4, TP5, TP6, TP8, TP9, TP10	Connector header-2.54 Male, 1x1, Gold, 5.97MH, TH, Vertical	Samtec, Inc.	TSW-101-07-L-S
1	U1	IC OP-AMP, Differential, RRO LFCSP-16	Analog Devices Inc.	ADA4940-1ACPZ-R7
1	U2	Microchip Analog, VREF, 4.096V, SOT-23-6	Linear Technology Corporation	MCP1501T-40E/CHY
1	U3	MCP33131D-10-I/MS	Microchip Technology Inc.	MCP33131D-10-I/MS
3	U4, U6, U9	Microchip Analog LDO, 2.5V-5V, MSOP-8	Microchip Technology Inc.	MIC5219YMM
1	U5	IC Op Amp GP, 3.5 MHz, RRO, SOT23-5	Microchip Technology Inc.	MCP6286T-E/OT
1	U10	Microchip Analog Switcher, Buck 2V to 15V, SOT-23-6	Microchip Technology Inc.	MCP16301T-I/CHY

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

TABLE B-4:   BILL OF MATERIALS (BOM) - MECHANICAL PARTS FOR ADM00873[1]

Qty.	Reference	Description	Manufacturer	Part Number
3	JP1, JP2, JP3	1.27 mm Jumper at Pins 1 and 2 of J8 1.27 mm Jumper at Pins 1 and 2 of J3 1.27 mm Jumper at Pins 1 and 2 of J4	Harwin Plc.	M50-2000005
1	LABEL1	Microchip Technology Product Label		
5	PAD1, PAD2, PAD3, PAD4, PAD5	Mechanical Hardware Rubber Pad, Cylindrical, D7.9, H5.3, Black	3M	SJ61A11
1	PS1	100-240V, Wall Plug-in Power Supply	Triad Magnetics	WSU090-2000-13
1	SCR1	Mechanical Hardware Machine Screw, PAN Phillips, 4-40, Nylon	Digi-Key® Electronics	H544-ND
	STANDOFF1	Mechanical HW Standoff, #4-40 x 3/4", F/F, HEX, Nylon	Keystone Electronics Corp.	1902D

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

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