



**EV34C35A  
DAC-Based  
4-20 mA Current Loop  
Evaluation Board  
User's Guide**

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# EV34C35A DAC-BASED 4-20 mA CURRENT LOOP EVALUATION BOARD USER'S GUIDE

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## Preface

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### NOTICE TO CUSTOMERS

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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 EV34C35A DAC-Based 4-20 mA Current Loop 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 EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board to demonstrate the performance of the MCP48CMD2X device family. The manual layout is as follows:

- **Chapter 1. “Product Overview”** – Important information about the EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board.
- **Chapter 2. “Installation and Operation”** – Includes instructions on how to get started with the EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board.
- **Appendix A. “Schematic and Layouts”** – Shows the schematic and layout diagrams for the EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board.
- **Appendix B. “Bill of Materials (BOM)”** – Lists the parts used to build the EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board.

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

Description	Represents	Examples
<b>Arial font:</b>		
Italic characters	Referenced books	<i>MPLAB® IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> 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	<u>File&gt;Save</u>
Bold characters	A dialog button	Click <b>OK</b>
	A tab	Click the <b>Power</b> 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>
<b>Courier New font:</b>		
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	<i>file.o</i> , where <i>file</i> can be any valid filename
Square brackets [ ]	Optional arguments	mcc18 [options] <i>file</i> [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 EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource.

- **DAC-Based 4-20 mA Current Loop Reference Design (DS50003623A)**

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- Embedded System Engineer (ESE)
- Technical Support

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

## DOCUMENT REVISION HISTORY

### Revision A (December 2023)

- Initial release of this document.

NOTES:



## Chapter 1. Product Overview

### 1.1 INTRODUCTION

This chapter provides an overview of the EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board and covers the following topics:

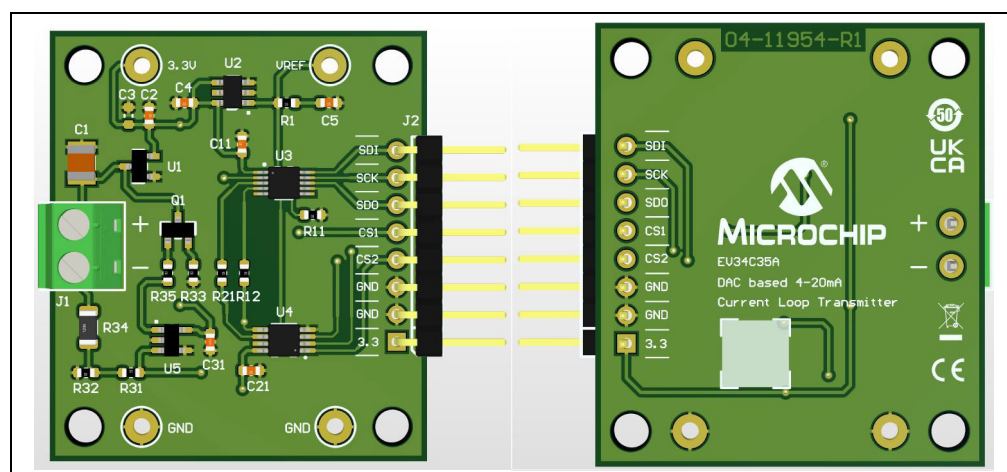
- Overview
- Features
- Contents
- Requirements

### 1.2 OVERVIEW

The EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board is designed to regulate the loop current according to the changes in the process variable value. Sensor output computed by the host controller (MCU) is provided through MCP48CMD21 a 12-bit 1 LSB DAC as an input to current loop transmitter. MCP4152 is an 8-bit digipot that provides an offset trimming option at 4 mA. The MCP1501 external voltage reference provides the precise output to DAC reference and helps to improve accuracy.

Loop current flows through the return wire in two-wire systems and it is necessary that the quiescent current of the transmitter and other devices in the loop is less than the minimum loop current. Appropriate current budgeting allows users to allocate alarms for system failures.

The following figures show the top and bottom side of the EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board.



**FIGURE 1-1:** Top Side and Bottom Side of EV34C35A.

J2 connector provides user an option to mount this small board at sensor side controller set up. This board can be a quick plug-in solution to transmit process variables like pressure, temperature, flow, etc. over a long distance.

## 1.3 FEATURES

The EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board features:

- Highly-accurate 4-20 mA current signal
- Current budgeting with room to allocate different system level alarms
- Offset adjustment
- Cost-effective solution

## 1.4 CONTENTS

The EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board includes the following devices:

- MCP1792-3302: 3.3V, 100 mA high-voltage LDO to convert 24V supply into 3.3V which is used as an on-board  $V_{DD}$
- MCP1501-25: 2.5V high-precision buffered voltage reference which acts as an external reference for DAC
- MCP48CMD21: Single channel, 1 LSb INL, 12-bit DAC which provides 0 to 2.5V output
- MCP4152-503: 8-bit single-channel digipot to adjust and precisely set low scale current of 4 mA when DAC output is 0V
- MCP6021: Single-channel, Rail-to-Rail Input/Output, 10 MHz op amp
- 2N7002: N-Channel Enhancement-Mode Vertical DMOS FET

## 1.5 REQUIREMENTS

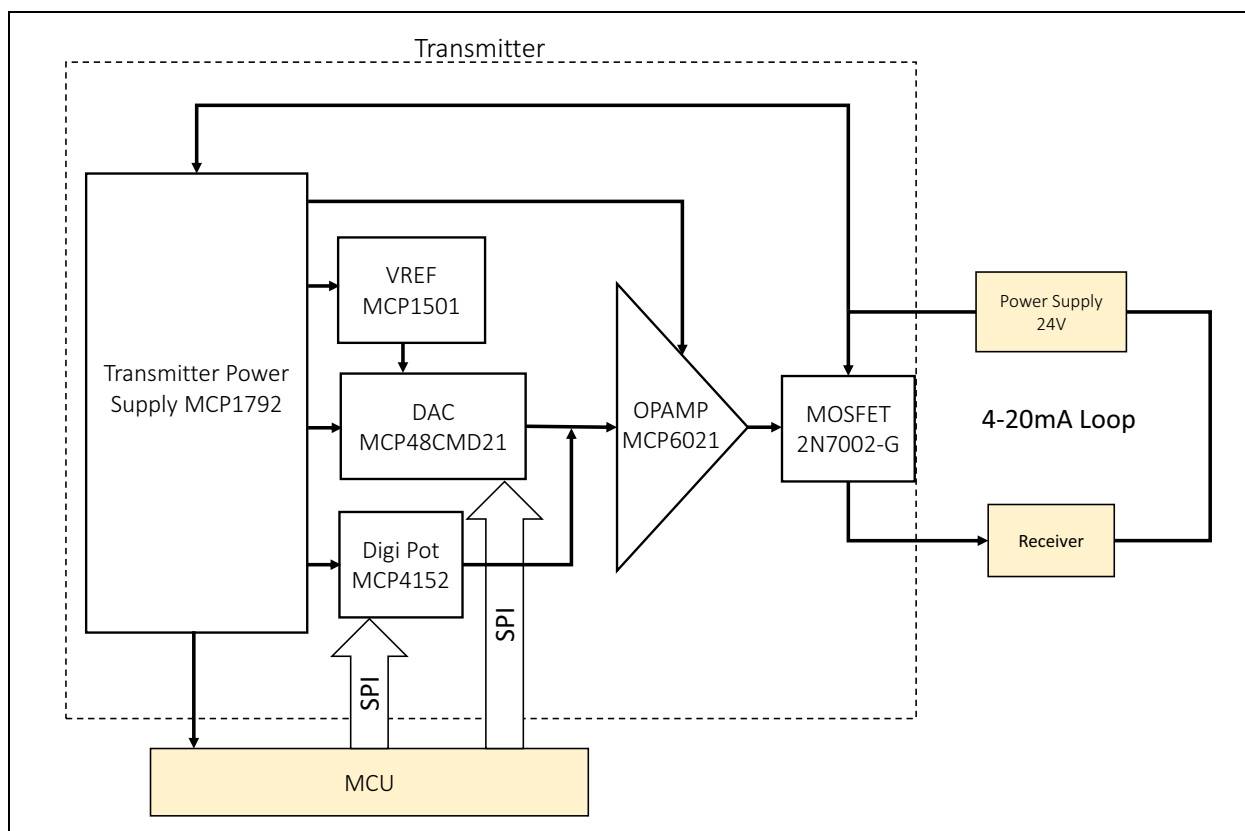
The EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board requires:

- External +24V DC Power Supply
- Two-wire loop
- External controller board

## Chapter 2. Installation and Operation

### 2.1 OPERATION

The EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board is intended to demonstrate the performance of 4-20 mA current loop with MCP48CMD21 DAC. Block diagram of the 4-20 mA current loop transmitter is shown below.

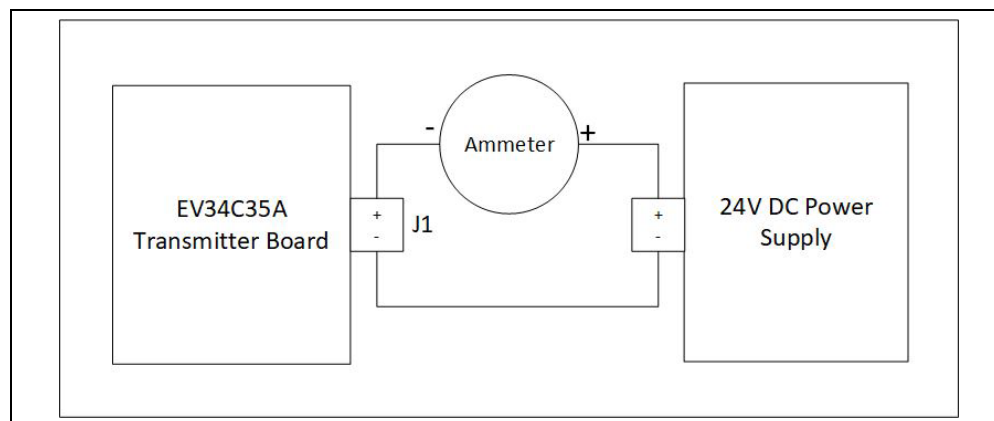


**FIGURE 2-1:** Block Diagram.

DAC based 4-20 mA current loop transmitter accepts DAC voltage and converts it to a current in such a way that relation between input process variable and output loop current is linear. Sensor output is converted into digital signal and provided through 12-bit 1 LSb DAC as an input to current loop transmitter. 8-bit digipot provides an offset trimming option at the lower end of current. External voltage reference provides the precise output to DAC reference and helps to improve accuracy. All the devices including voltage regulator, voltage reference, DAC, digipot and op amp return paths are connected to the on-board local ground which is different than the 24V power supply ground. For two-wire systems, it is necessary that the quiescent current of the transmitter and other devices in the loop is less than the minimum required loop current. Appropriate current budgeting allows users to allocate alarms for system failures.

## 2.2 CONFIGURATION REQUIREMENTS

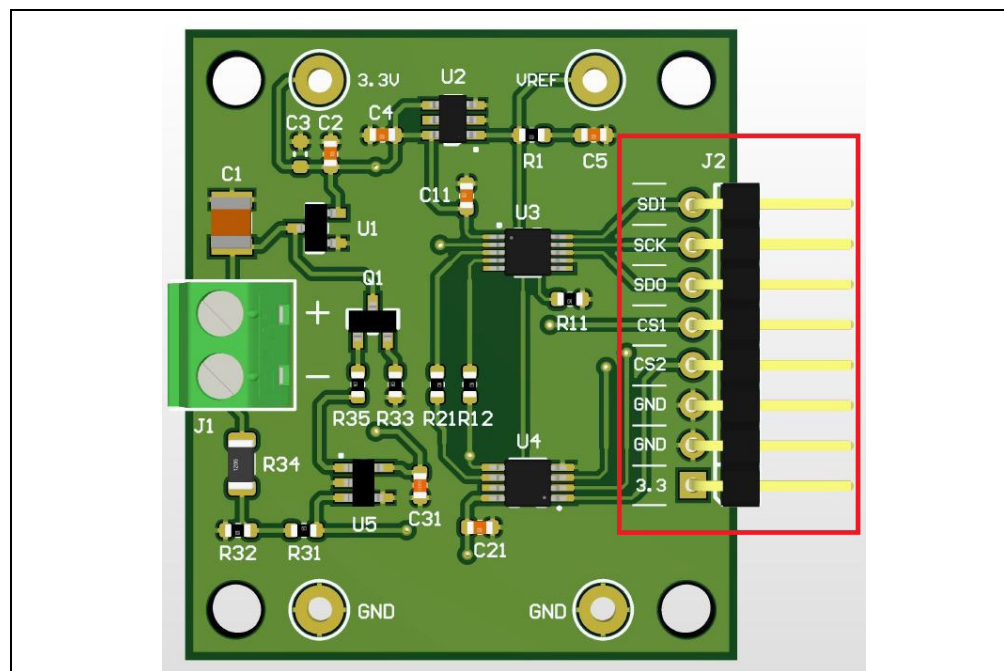
In two-wire loop configurations, an ammeter can be placed in series with power supply to measure the loop current. Users can apply the 4-20 mA current to the receivers or display modules as per the need of applications. The following figure shows a test set up for the EV34C35A.



**FIGURE 2-2:** 4-20 mA Current Loop Transmitter Board System Setup.

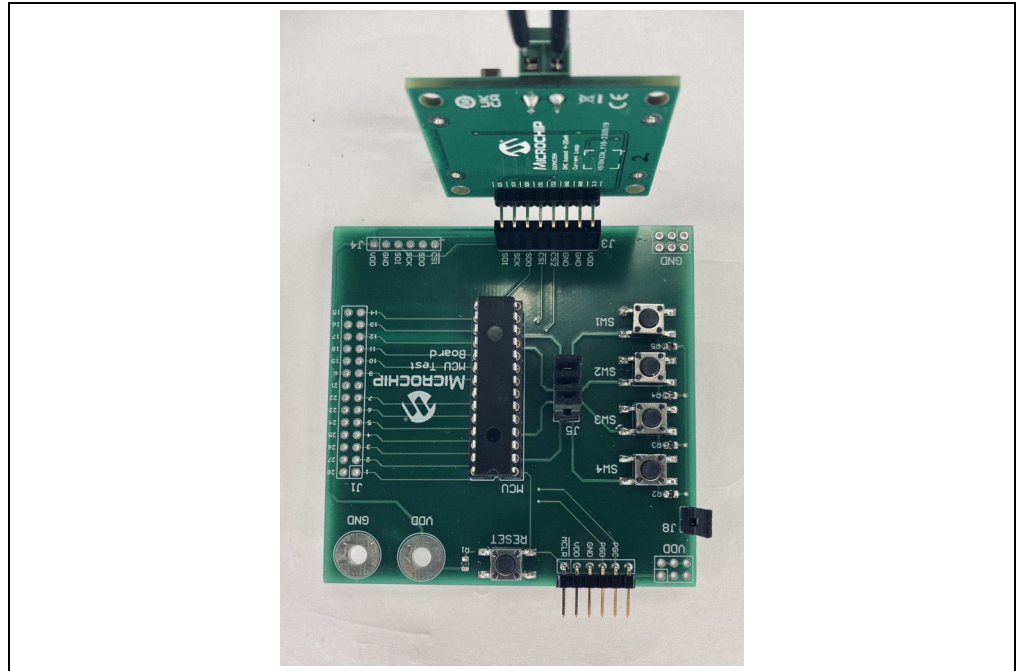
Performance of two-wire 4-20 mA current loop using EV34C35A board can be demonstrated with the following steps:

1. Connect +24V DC supply in series connection with Ammeter to the EV34C35A board as shown in [Figure 2-2](#), making sure that DC power supply is OFF,
2. Connect the SDI, SCK, SDO, CS1, CS2, GND, 3.3 pins of J2 connector on EV34C35A to microcontroller board.



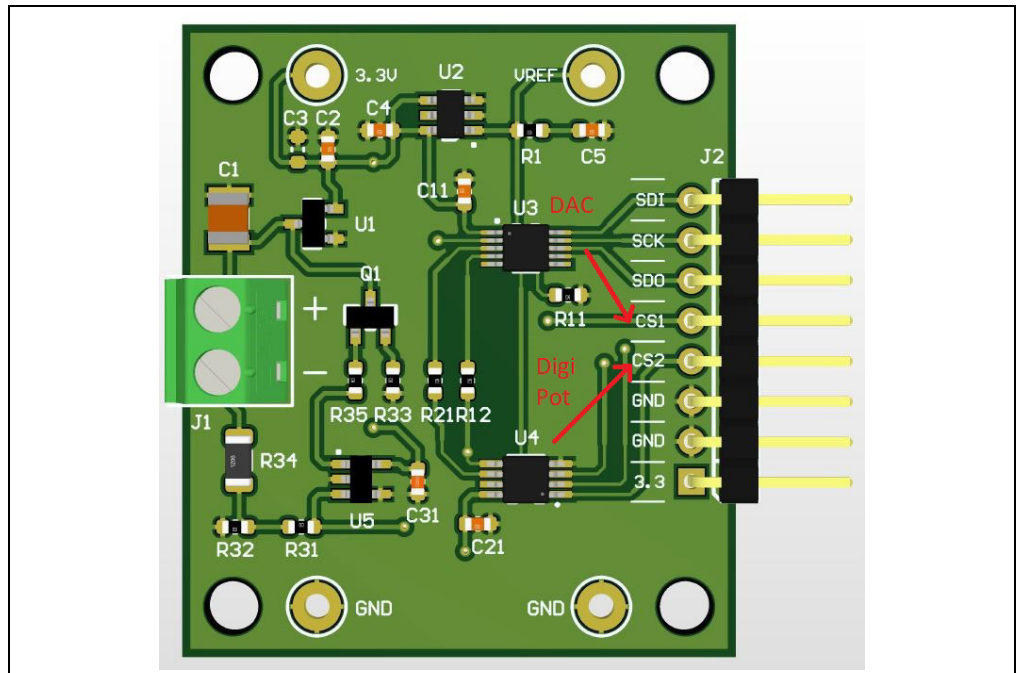
**FIGURE 2-3:** J2 Connector.

3. For example, the following image shows the EV34C35A connection to MCU test board.



**FIGURE 2-4:** MCU Transmitter.

4. Program the controller to communicate with the DAC and digipot of EV34C35A board using SPI communication protocol.
5. Chip select CS1 is used for communicating with DAC and chip select CS2 is used for communicating with digipot.



**FIGURE 2-5:** Chip Select.

6. DAC output range is from 0V - 2.5V to get 4 mA - 20 mA current respectively.
7. Digipot is used for trimming the current at 4 mA to get precise output.

NOTES:



# EV34C35A DAC-BASED 4-20 mA CURRENT LOOP EVALUATION BOARD USER'S GUIDE

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## Appendix A. Schematic and Layouts

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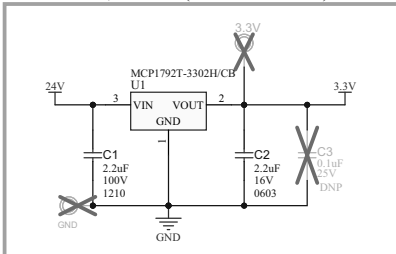
### A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the EV34C35A DAC-Based 4-20 mA Current Loop Evaluation Board:

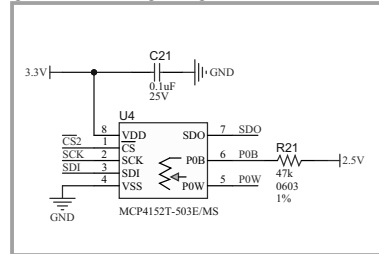
- [Board – Schematic](#)
- [Board – Top Silk](#)
- [Board – Top Copper and Silk](#)
- [Board – Top Copper](#)
- [Board – Bottom Copper](#)
- [Board – Bottom Copper and Silk](#)
- [Board – Bottom Silk](#)
- [Board – Top View](#)
- [Board – Bottom View](#)

## A.2 BOARD – SCHEMATIC

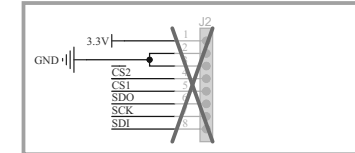
LDO: 3.3V, 100mA (3 lead SOT-23A)



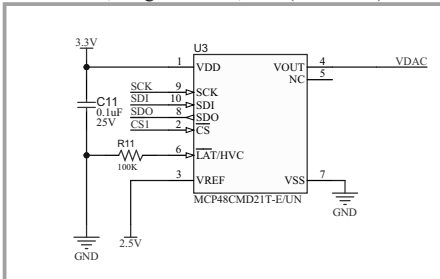
Digi Pot: 8-Bit Single Digital POT with NVM and SPI (DFN-8)



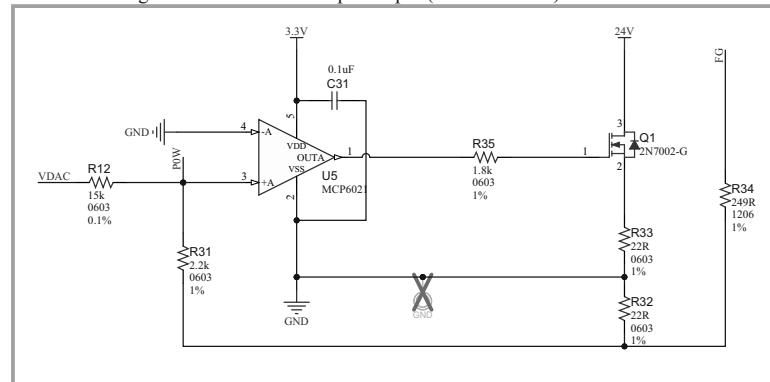
MCU Connector



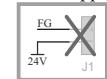
DAC: 12-bit, Single channel, SPI (MSOP-10)



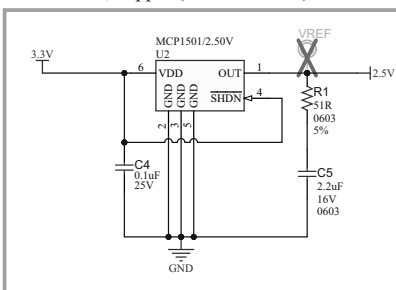
OPAMP: Single channel rail to rail input/output (5 lead SOT-23)



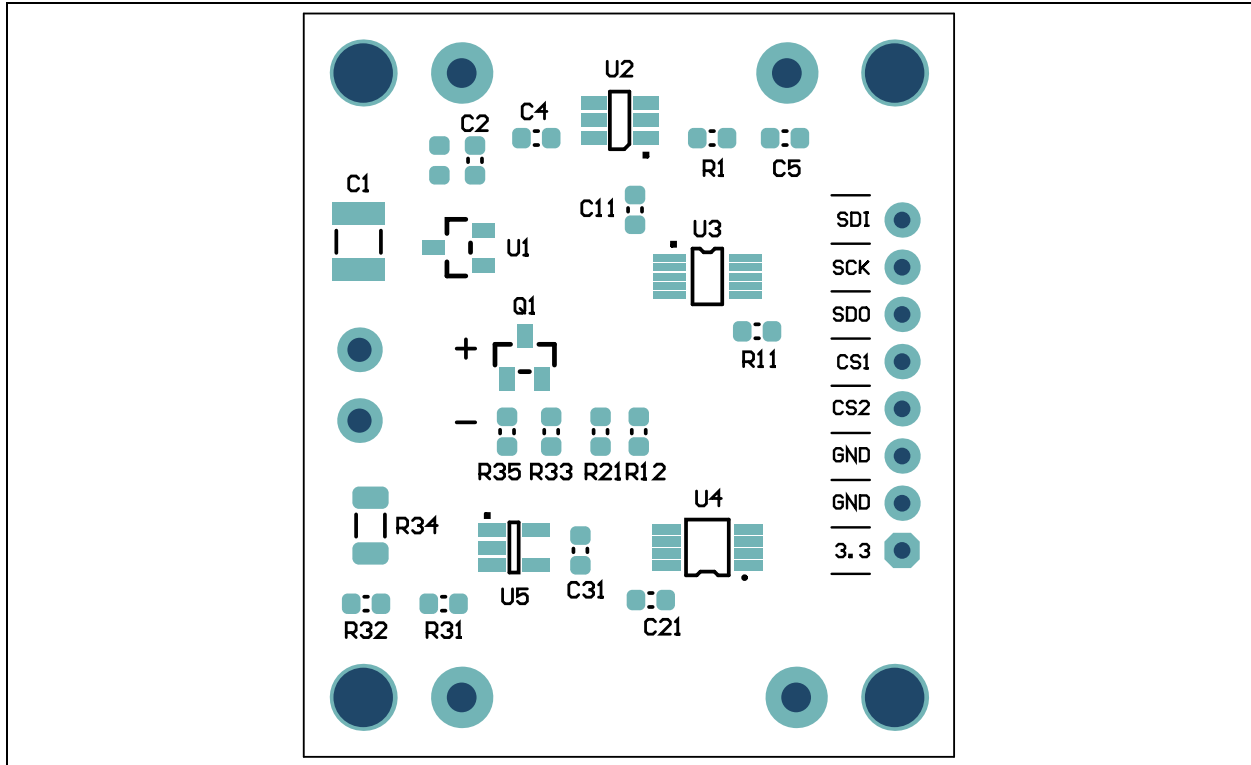
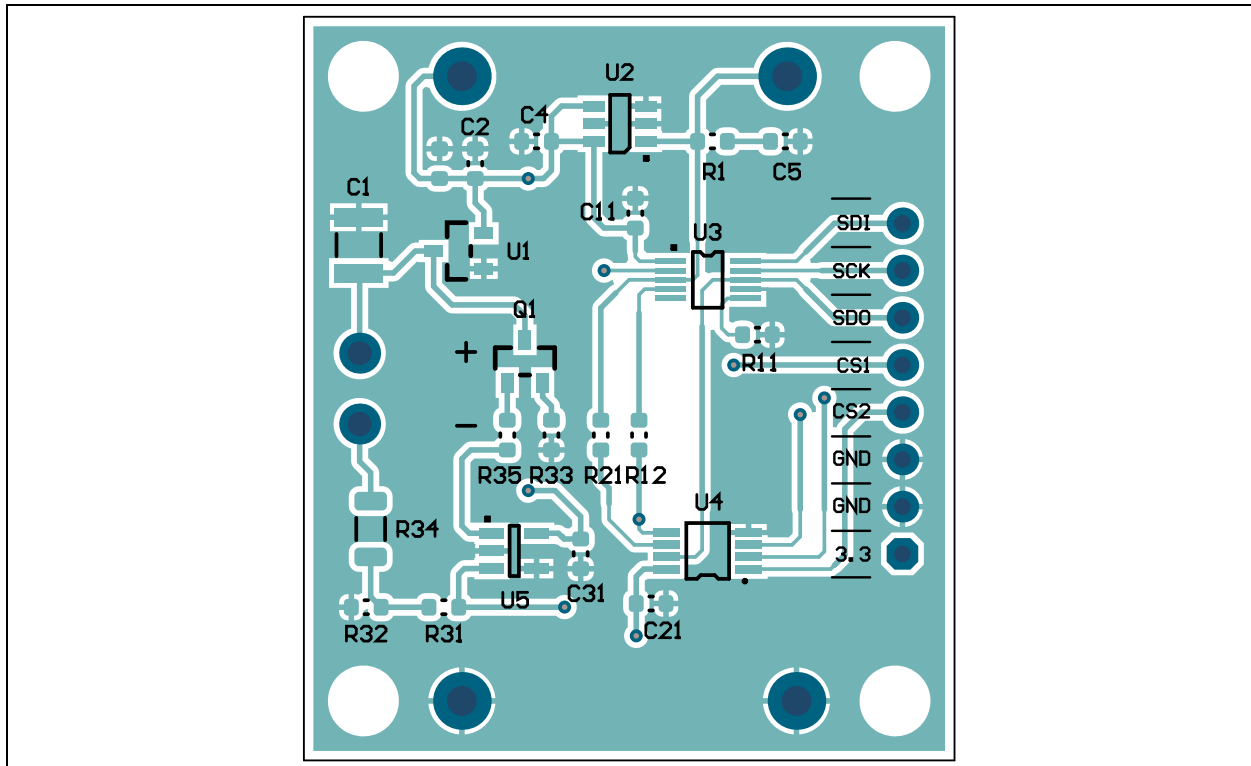
24V Supply



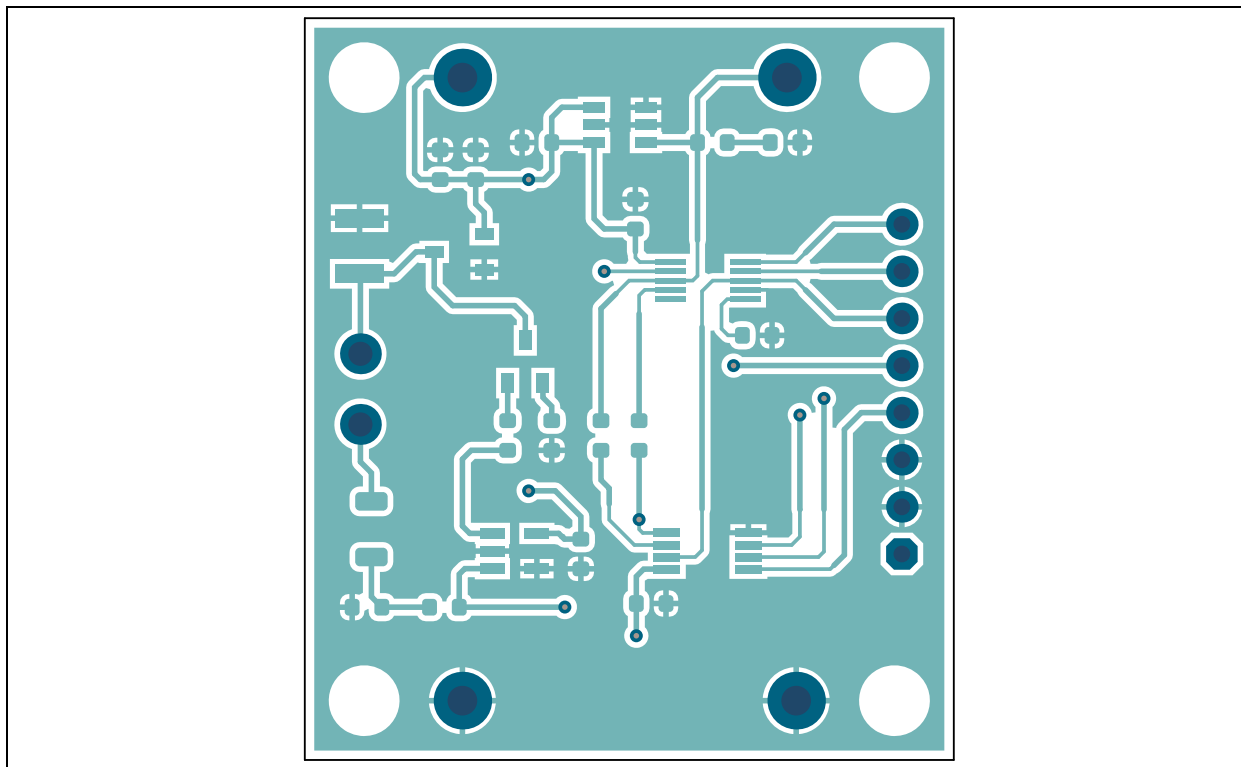
VREF: 2.5V, 50ppm (6 lead SOT-23)



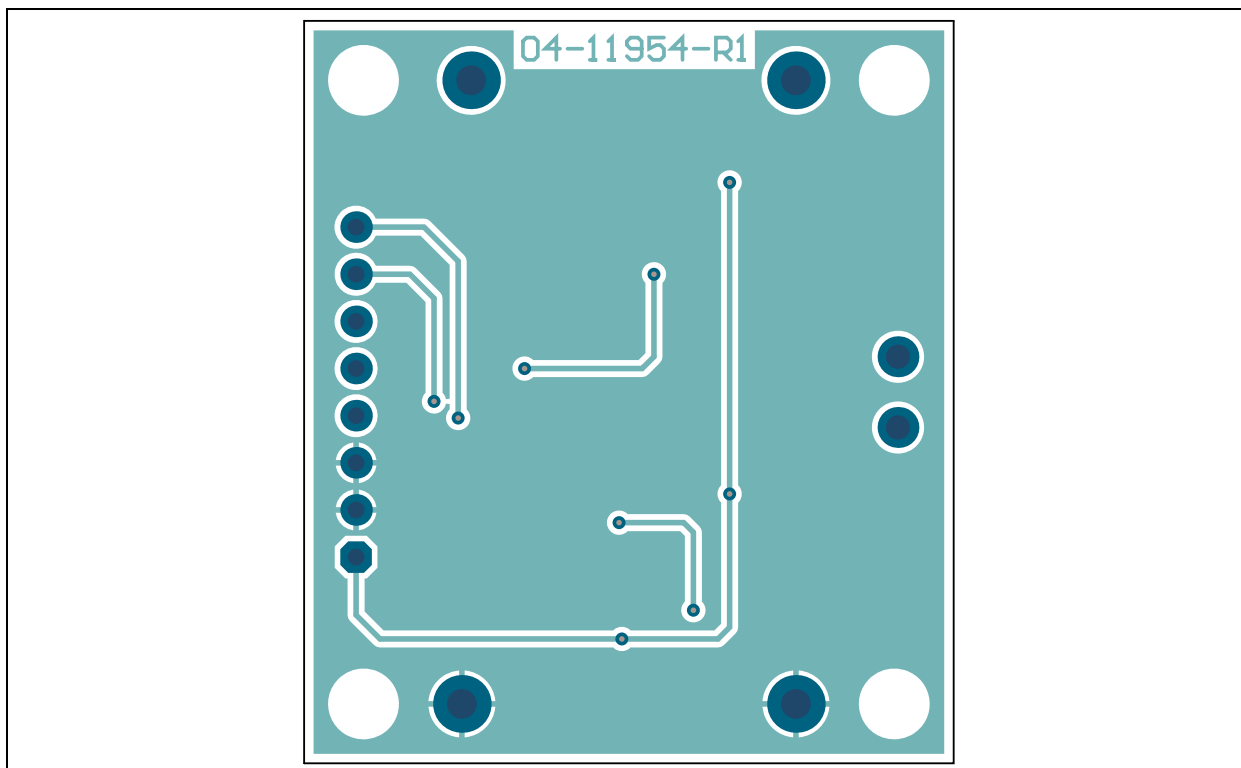


**A.3 BOARD – TOP SILK****A.4 BOARD – TOP COPPER AND SILK**

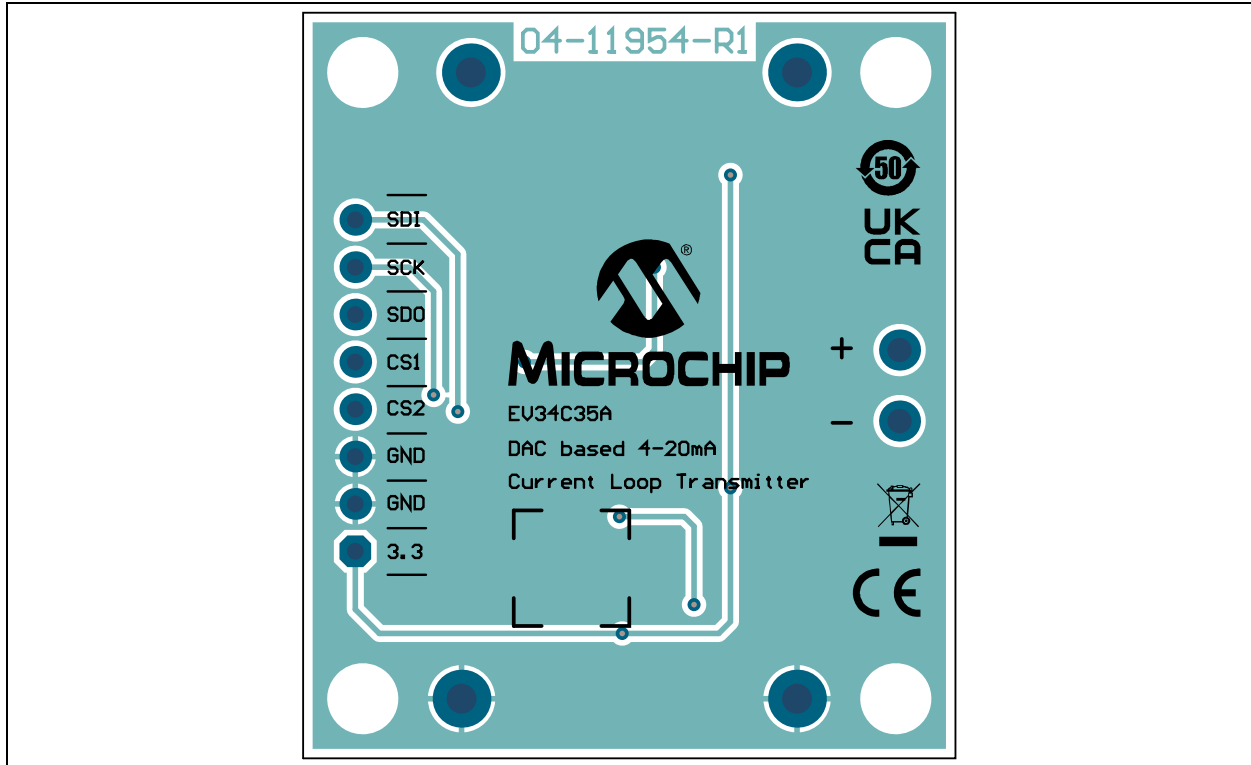
**A.5 BOARD – TOP COPPER**



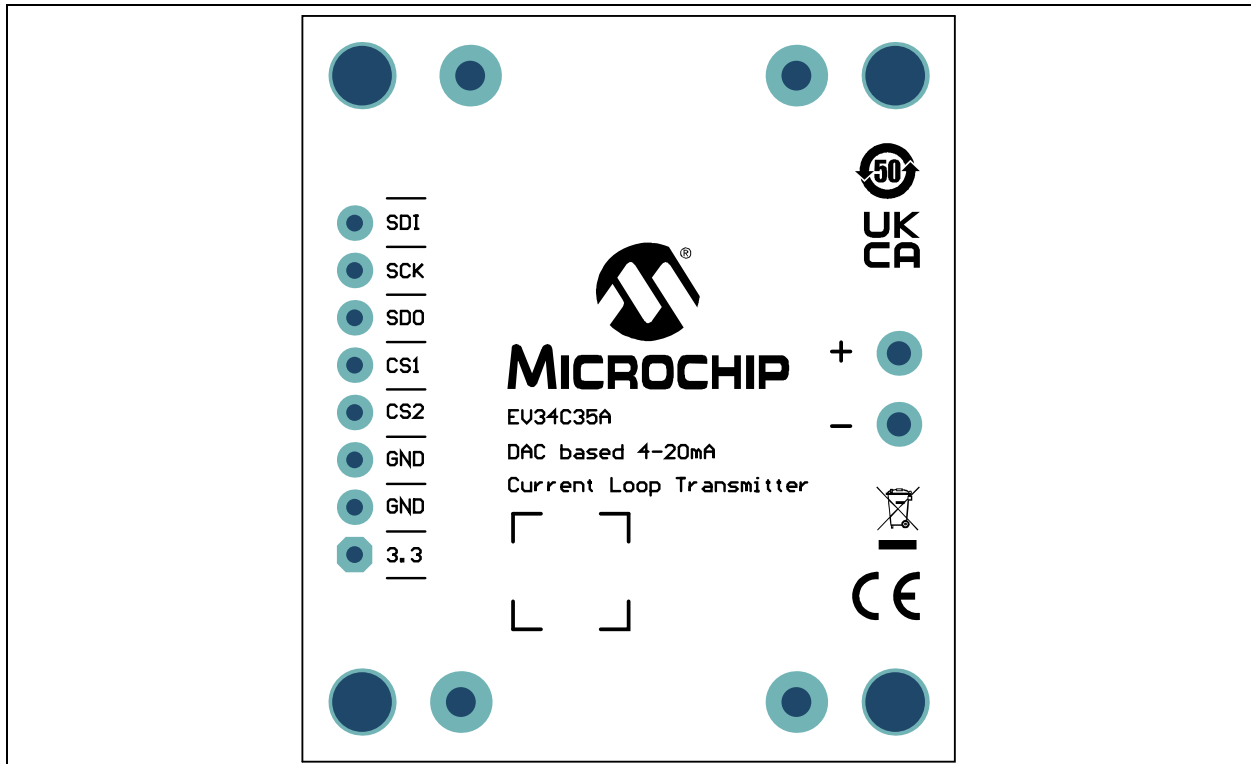
**A.6 BOARD – BOTTOM COPPER**



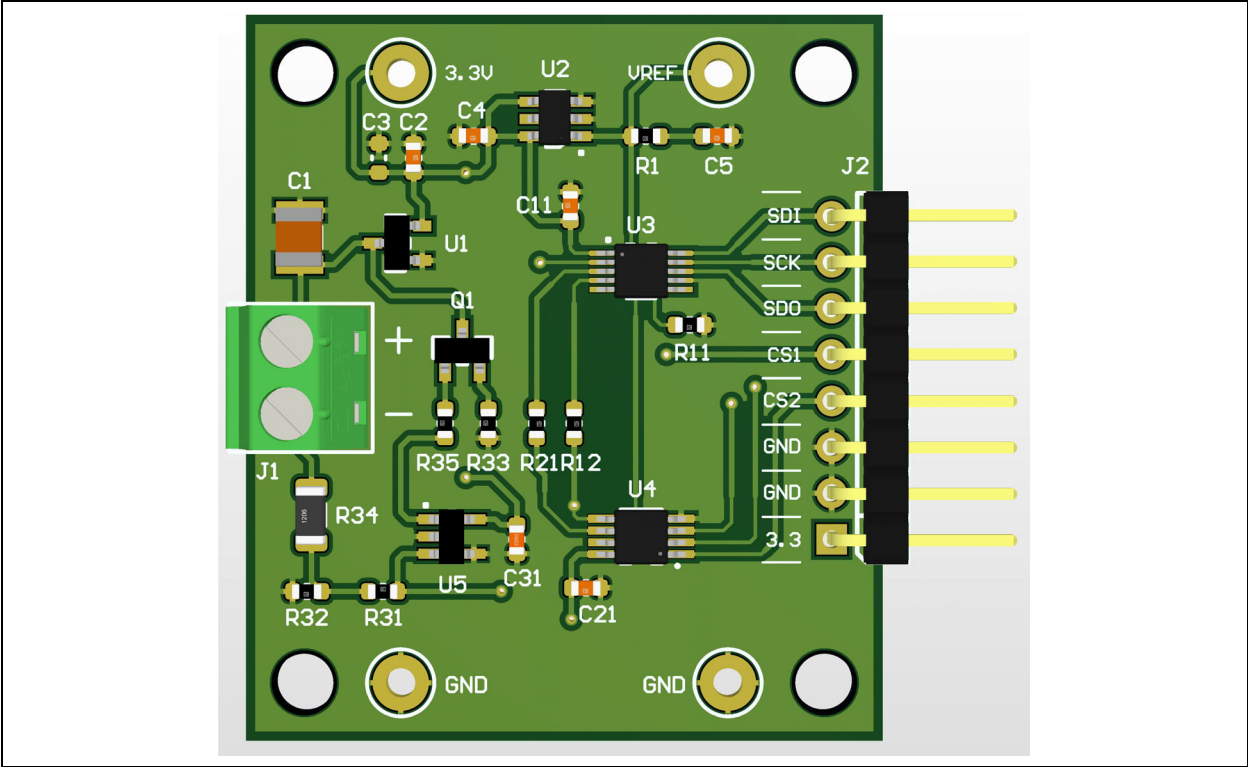
## A.7 BOARD – BOTTOM COPPER AND SILK



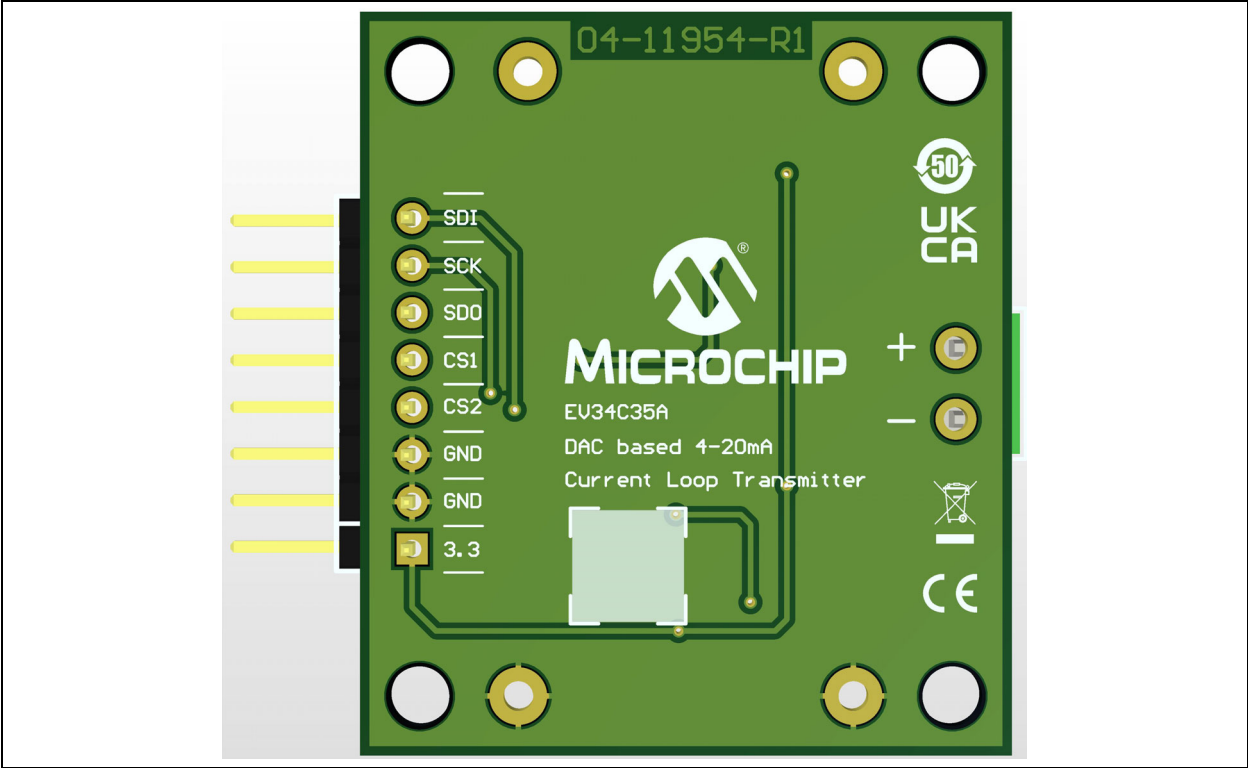
## A.8 BOARD – BOTTOM SILK



A.9 BOARD – TOP VIEW



A.10 BOARD – BOTTOM VIEW



### Appendix B. Bill of Materials (BOM)

**TABLE B-1: BILL OF MATERIALS (BOM)**

Qty.	Reference	Description	Manufacturer	Part Number
1	C1	Capacitor, ceramic, 2.2 $\mu$ F, 100V, 10%, X7R, SMD, 1210	Samsung Electro-Mechanics America, Inc.	CL32B225KCJSNNE
2	C2, C5	Capacitor, ceramic, 2.2 $\mu$ F, 16V, 10%, X5R SMD 0603	TDK Corporation	C1608X5R1C225K080AB
0	C3	Capacitor, ceramic, 0.1 $\mu$ F, 25V, 10%, X7R SMD 0603 – <b>Do Not Populate</b>	KEMET	C0603C104K3RAC7013
4	C4, C11, C21, C31	Capacitor, ceramic, 0.1 $\mu$ F, 25V, 10%, X7R, SMD, 0603	KEMET	C0603C104K3RAC7013
1	J1	Connector, terminal, 3.81mm, 1x2 female, 16-30AWG, 13.5A, TH, R/A	Phoenix Contact	1727010
1	J2	Connector, header-2.54, Male, 1x8, gold, 5.84MH, TH, R/A	Sullins Connector Solutions	PBC08SBAN
1	LABEL	Label, PCBA, 6x6mm, info, text	ACT Logimark AS	505462
1	PCB1	Printed Circuit Board – EV34C35A DAC Based 4-20 mA Current Loop Evaluation Board	Microchip Technology Inc.	<b>04-11954-R1</b>
1	Q1	Microchip, Analog, MOSFET, N-Channel, 2N7002-G, 60V, 115mA, SOT-23-3	Microchip Technology Inc.	2N7002-G
1	R1	Resistor, TKF, 51R, 5%, 1/10W, SMD, 0603	Panasonic® – ECG	ERJ-3GEYJ510V
1	R11	Resistor, TKF, 100 k $\Omega$ , 5%, 1/10W, SMD, 0603, AEC-Q200	Panasonic – ECG	ERJ-3GEYJ104V
1	R12	Resistor, TKF, 15 k $\Omega$ , 0.1%, 1/10W, SMD 0603	Panasonic – ECG	ERA-3AEB153V
1	R21	Resistor, TKF, 47 k $\Omega$ , 1%, 1/10W, SMD, 0603	Panasonic – ECG	ERJ-3EKF4702V
1	R31	Resistor, TKF, 2.2 k $\Omega$ , 1%, 1/10W, SMD, 0603	Panasonic – ECG	ERJ-3EKF2201V
2	R32, R33	Resistor, TKF, 22R, 1%, 1/10W, SMD, 0603	Panasonic – ECG	ERJ-3EKF22R0V
1	R34	Resistor, TKF, 249R, 1%, 1/4W, SMD, 1206	ROHM Semiconductor	MCR18EZH2490
1	R35	Resistor, TKF, 1.8 k $\Omega$ , 1%, 1/10W, SMD, 0603	Panasonic – ECG	ERJ-3EKF1801V
0	3.3V, TP1, TP2, VREF	C0nnecter, TP loop, red, TH – <b>Do Not Populate</b>	Keystone® Electronics Corp.	5010
1	U1	Microchip, Analog, voltage regulator, 3.3V, 3 Lead, MCP1792T-3302H/CB, SOT-23A-3	Microchip Technology Inc.	<b>MIC9136</b>
1	U2	Microchip, Analog, VREF, 2.50V, MCP1501T-25E/CHY, SOT-23-6	Microchip Technology Inc.	<b>MCP1501T-25E/CHY</b>
1	U3	Microchip, Analog, DAC, 1-Channel, 12-bit, MCP48CMD21T-E/UN, MSOP-10	Microchip Technology Inc.	<b>MCP48CMD21T-E/UN</b>
1	U4	Microchip, Analog, Digipot, 50 K Ohm, 257TAP, 8MSOP	Microchip Technology Inc.	<b>MCP4152T-503E/MS</b>
1	U5	Microchip, Analog, Op Amp, 1-Channel, 10 MHz, MCP6021T-E/OT, SOT-23-5	Microchip Technology Inc.	<b>MCP6021T-E/OT</b>

NOTES:

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