MCP251XFD CAN FD Motherboard 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 "DSXXXXXXXA", where "XXXXXXX" 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 MCP251XFD CAN FD Motherboard. 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 MCP251XFD CAN FD Motherboard as a demonstration board to evaluate the MCP25xxFD devices. The manual layout is as follows:

- **Chapter 1. "MCP251XFD CAN FD Motherboard"** – Provides important information about the MCP251XFD CAN FD Motherboard.
- **Chapter 2. "Hardware"** – Includes a detailed description of the demonstration board and instructions on how to use it.
- **Chapter 3. "Software"** – Helps getting started on firmware development.
- **Appendix A. "Schematics and Layout"** – Schematics and layout diagrams of the MCP251XFD CAN FD Motherboard.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP251XFD CAN FD Motherboard.
- **Appendix C. "MCP2517FD click Board Schematics"** – Schematics and layout diagrams of the MCP2517FD click 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 MCP251XFD CAN FD Motherboard. The following Microchip documents are available and recommended as supplemental reference resources:

- **MCP2517FD Data Sheet - *"External CAN FD Controller with SPI Interface" (DS20005688)***
- **MCP2518FD Data Sheet - *"External CAN FD Controller with SPI Interface" (DS20006027)***

These data sheets provides detailed information regarding the MCP25xxFD devices.

- **MCP25xxFD FRM - *"MCP25xxFD Family Reference Manual" (DS2005678)***

This FRM provides even more detailed information regarding the MCP25xxFD.

THE MICROCHIP WEBSITE

Microchip provides on-line 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, on-line 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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- 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://support.microchip.com.

DOCUMENT REVISION HISTORY

Revision B (May 2018)

- Added MCP2518FD support.

Revision A (September 2017)

- Initial release of this document.

NOTES:

Chapter 1. MCP251XFD CAN FD Motherboard

1.1 INTRODUCTION

The MCP251XFD CAN FD Motherboard provides a simple, low-cost board to evaluate the MCP25xxFD family of devices. The board features one mikroBUS™ socket to accommodate the MCP25xxFD click boards.

The MCP251XFD CAN FD Motherboard together with the MCP25xxFD click boards can be used to implement a CAN FD node.

The MCP251XFD CAN FD Motherboard supports the following click boards:

* MCP2517FD click

* MCP2518 click

The MCP251XFD CAN FD Motherboard contains a PIC32MX470F512H microcontroller with a Serial Peripheral Interface (SPI) peripheral. The microcontroller controls the MCP25xxFD via the SPI interface.

A firmware Application Program Interface (API) is available for rapid application development, which is written in C programming language for MPLAB Harmony Integrated Software Framework. It can be easily ported to other microcontrollers.

1.2 RECOMMENDED ITEMS TO IMPLEMENT A CAN FD NODE

In order to implement a CAN FD node using the MCP25xxFD, the following items are recommended:

- MCP251XFD CAN FD Motherboard (ADM00576)
- MCP2517FD or MCP2518FD click Board (**NOT** included)
- Mini-USB Cable (**NOT** included)

1.3 KIT CONTENTS

The MCP251XFD CAN FD Motherboard kit includes:

- MCP251XFD CAN FD Motherboard (ADM00576)
- Information Sheet

1.4 MCP251XFD CAN FD MOTHERBOARD FEATURES

Figure 1-1 illustrates the main features of the MCP251XFD CAN FD Motherboard:

1. PIC32MX470F512H microcontroller
2. mikroBUS socket
3. Debug headers for monitoring the MCP25xxFD I/O
4. DSC1121 8 MHz MEMS Clock Generator
5. USB connector to supply regulated +5V DC to the LDO and mikroBUS socket
6. Test loops to supply regulated +5V DC to the LDO and mikroBUS socket
7. Jumper to select between USB and test loop power source
8. 3.3V LDO to supply microcontroller and mikroBUS socket, and power indicator LEDs
9. Push button switches for user-defined inputs
10. Eight indicator LEDs
11. Microcontroller Reset push button
12. Six-pin interface for the PICkit™ 3 Programmer/Debugger

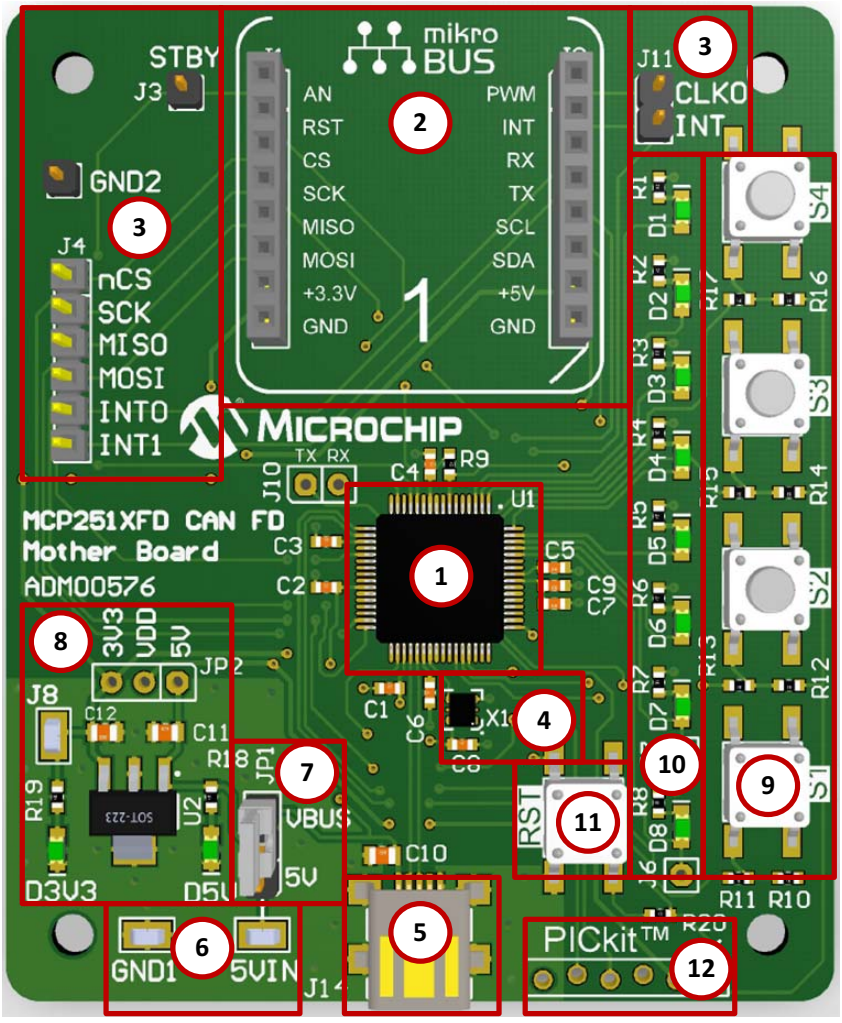


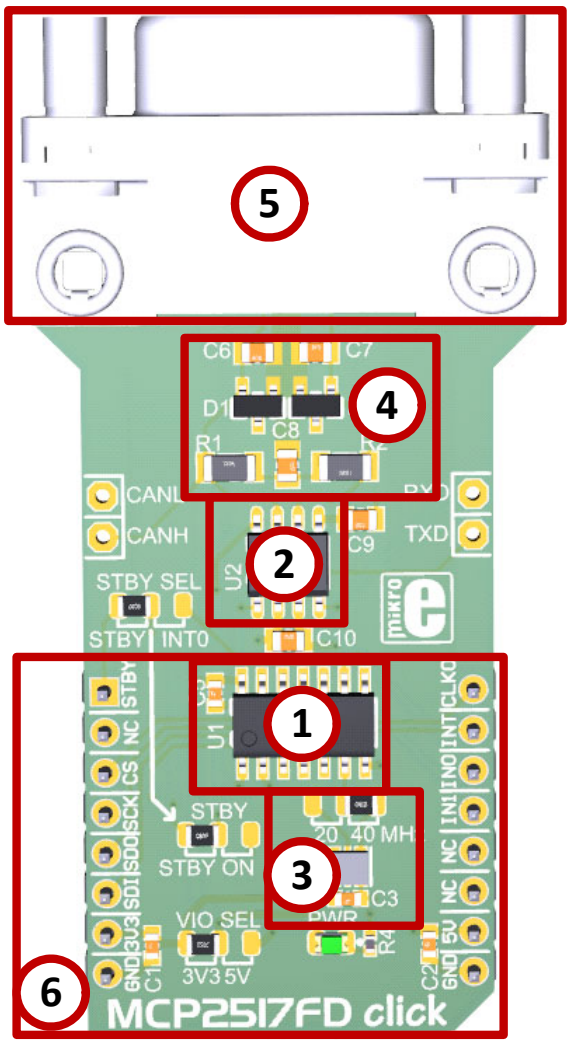
FIGURE 1-1: *MCP251XFD CAN FD Motherboard.*

1.5 MCP2517FD CLICK BOARD FEATURES

The MCP2517FD click Board contains the MCP2517FD and a CAN FD transceiver. The board can be connected to the CAN FD bus using a DB9 connector. The click board is available for purchase from https://shop.mikroe.com/mcp2517fd-click.

Figure 1-2 illustrates the main features of the MCP2517FD click Board:

1. MCP2517FD CAN FD Controller with SPI Interface
2. ATA6563 CAN FD Transceiver
3. DSC2311 20/40 MHz Dual MEMS Clock Generator
4. ESD protection and termination
5. DB9 CAN connector
6. mikroBUS click connector with MCP2517FD specific I/O pin assignment



The ATA6563 may not require the ESD protection diodes and capacitors.

FIGURE 1-2: *MCP2517FD click Board.*

NOTES:

Chapter 2. Hardware

2.1 HARDWARE FEATURES

2.1.1 Microcontroller

The MCP251XFD CAN FD Motherboard accommodates a PIC32MX470F512H microcontroller with a 120 MHz/150 DMIPS MIPS32® M4K® core. The microcontroller controls the MCP25xxFD through the SPI interface. The interrupt pins of the MCP25xxFD are connected to the microcontroller input pins. The microcontroller can control the standby pin of the CAN FD transceiver on the MCP25xxFD click Board using the STBY output.

2.1.2 Clock Generator

The MCP251XFD CAN FD Motherboard uses the DSC1121, which is a Microchip MEMS clock generator, as the default clock source into the microcontroller. The DSC1121 on this board has been programmed to generate an output frequency of 8 MHz and is offered in a small 2.5 x 2.0 mm package.

2.1.3 Switches

Five push button switches provide the following functions:

- S1: Active-low switch
- S2: Active-low switch
- S3: Active-low switch
- S4: Active-low switch
- RST (S5): Active-low $\overline{\text{MCLR}}$ switch to hard reset the microcontroller

When Idle, the switches are pulled high; when pressed, they are grounded.

2.1.4 LEDs

Eight LEDs (D1 through D8) are available. Set the corresponding microcontroller output pins high to light the LEDs.

2.1.5 PICkit™ 3 In-Circuit Debugger connector

Connector J11 provides the footprint for a 6-pin PICkit™ 3 interface.

2.1.6 MikroBUS interface

Figure 2-1 shows the signal assignment to the mikroBUS connector. The MCP251XFD CAN FD Motherboard is targeted to be used with the MCP25xxFD click Board, but it could also be used with a variety of other click boards.

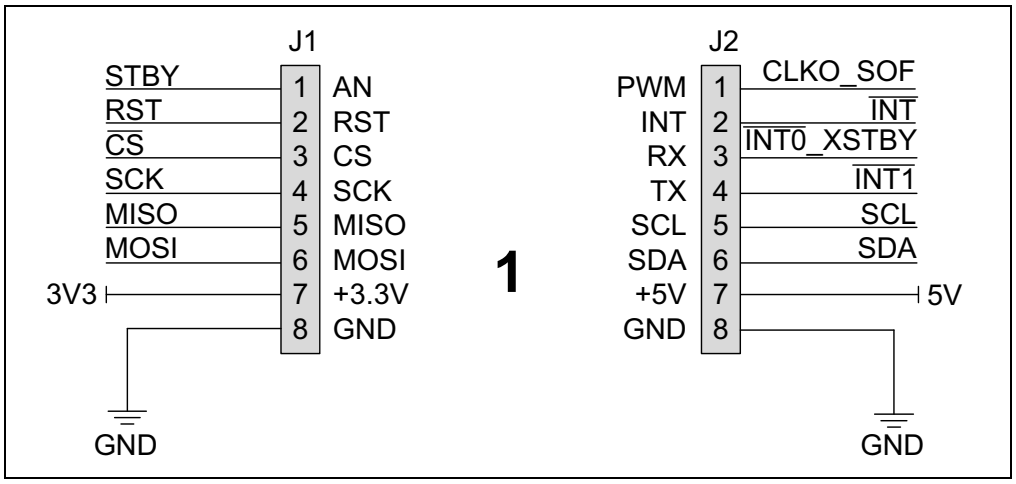


FIGURE 2-1: *mikroBUS Interface.*

2.2 POWER SOURCES

The MCP251XFD CAN FD Motherboard must be powered using a +5V DC regulated power source. The user has two options to connect the power:

- USB connector (J14), or
- Test loops: 5VIN and GND1.

The jumper (JP1) is used to select between the power sources, see Table 2-1.

TABLE 2-1: POWER SOURCE JUMPERS

Index	Description	Default Configuration
JP1	• Powers-up the MCP251XFD CAN FD Motherboard from USB or an external 5V power supply between 5VIN and GND1. • Short-circuit pins 2 and 3 (top and middle) to select VBUS, or pins 1 and 2 (middle and bottom) to select the external power supply.	V_{BUS}
JP2(1)	Could be used to select 5V V_{DD} for a different microcontroller. U1 is a 3.3V microcontroller.	

Note 1: Jumper JP3 is not populated, however, it is short-circuited on the bottom layer (back) of the board. The trace can be cut in order to disconnect it.

2.3 RESISTOR JUMPER SETTING ON MCP25XXFD CLICK BOARD

Table 2-2 briefly describes the functions of all the boards' resistor jumpers.

TABLE 2-2: JUMPER DESCRIPTIONS

Index	Description	Default Configuration
V_{IO}_SEL	Selects 3.3V or 5V for V_{IO} of the CAN FD transceiver.	3.3V
20/40 MHz	The OSC1 of the MCP25xxFD can be connected to the 20 or 40 MHz clock output of U3.	40 MHz
STBY	The STBY pin of the CAN FD transceiver can be grounded (transceiver always in Normal mode) or controlled by the microcontroller or MCP25xxFD.	Grounded (Normal mode)
STBY_SEL	Selects between the STBY output of the microcontroller or the $\overline{INT0}$/XSTBY pin of the MCP25xxFD.	Microcontroller (STBY header)

2.4 CONNECTING THE BOARD

Figure 2-2 illustrates an example CAN FD network. The MCP2517FD click Board is plugged into the MCP251XFD CAN FD Motherboard. A CAN FD tool from K2L is connected to the MCP2517FD click Board by using twisted pair wires.

The demonstration board is powered using a Mini-USB cable. Alternatively, the board can be powered using a 5V power supply connected between $5V_{IN}$ and GND1.

There are two terminations on the CAN bus:

- Two 60 Ohm resistors in series on the MCP2517FD click Board.
- A 120 Ohm termination resistor at the connector of the K2L OptoLyzer® MOCCA FD tool.

2.5 OPERATION

The user can write firmware for the MCU in order to create a custom CAN FD node. Check the MCP25xxFD product pages for the firmware API and for code examples.

The RST button can be used to reset the MCU. Switches S1-S4 can be used to trigger the transmission of CAN FD messages to the CAN FD tool. LEDs D1-D8 can be controlled by the CAN FD tool using CAN FD messages.

All I/O pins of the MCP25xxFD are easily accessible through pin headers.

The differential CAN bus signals, CAN_H and CAN_L, are accessible on the MCP25xxFD click Board or on the DB9 connector: CAN_H on pin 7 and CAN_L on pin 2.

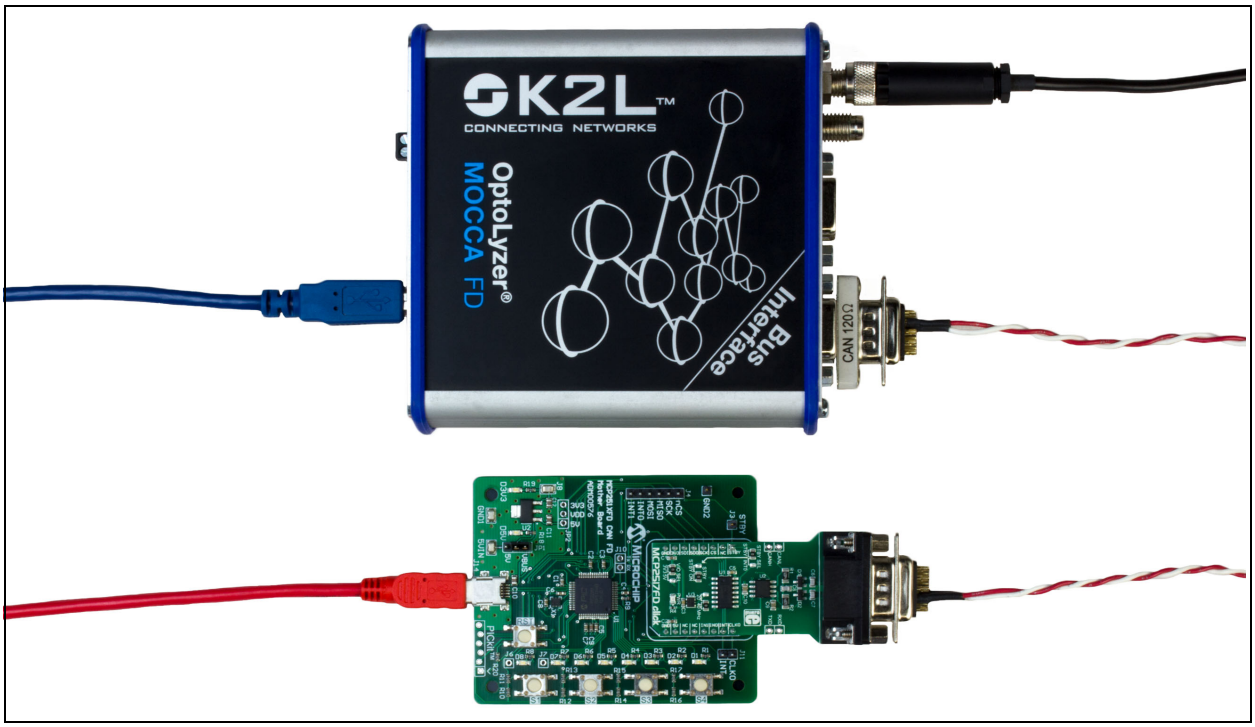


FIGURE 2-2: *Connecting the MCP251XFD CAN FD Motherboard.*

NOTES:

Chapter 3. Software

3.1 INTRODUCTION

The MCP251xFD CAN FD Motherboard can be used with MPLAB X Integrated Development Environment (IDE), which is available free on Microchip's website at https://www.microchip.com/mplab/mplab-x-ide. This software is used for programming and debugging the PIC32MX470F512H on the MCP251xFD CAN FD Motherboard.

3.2 SOFTWARE OVERVIEW

The PICkit™ 3 through MPLAB X, is a low-voltage in-circuit debugger, as well as a low-voltage programmer, for the PIC32MX470F512H. In-circuit debugging allows the user to run, examine and modify programs for the microcontroller embedded in the board hardware. This facilitates the debugging of firmware and hardware concurrently. Use the in-circuit debugger with MPLAB X IDE to run, stop and single-step through programs; breakpoints can be set and the microcontroller can be reset. When the microcontroller stops, the contents of the registers are available for examination and modification.

NOTES:

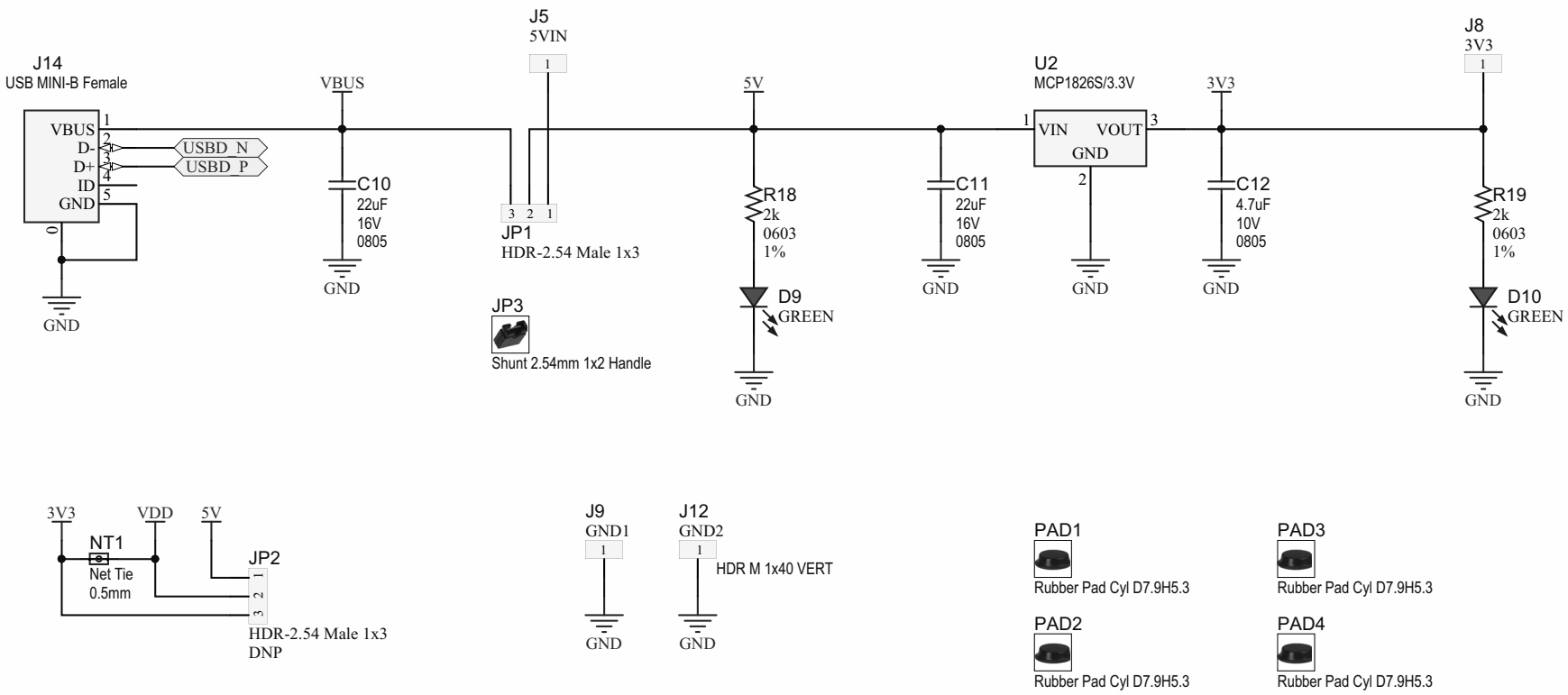
Appendix A. Schematics and Layout

A.1 INTRODUCTION

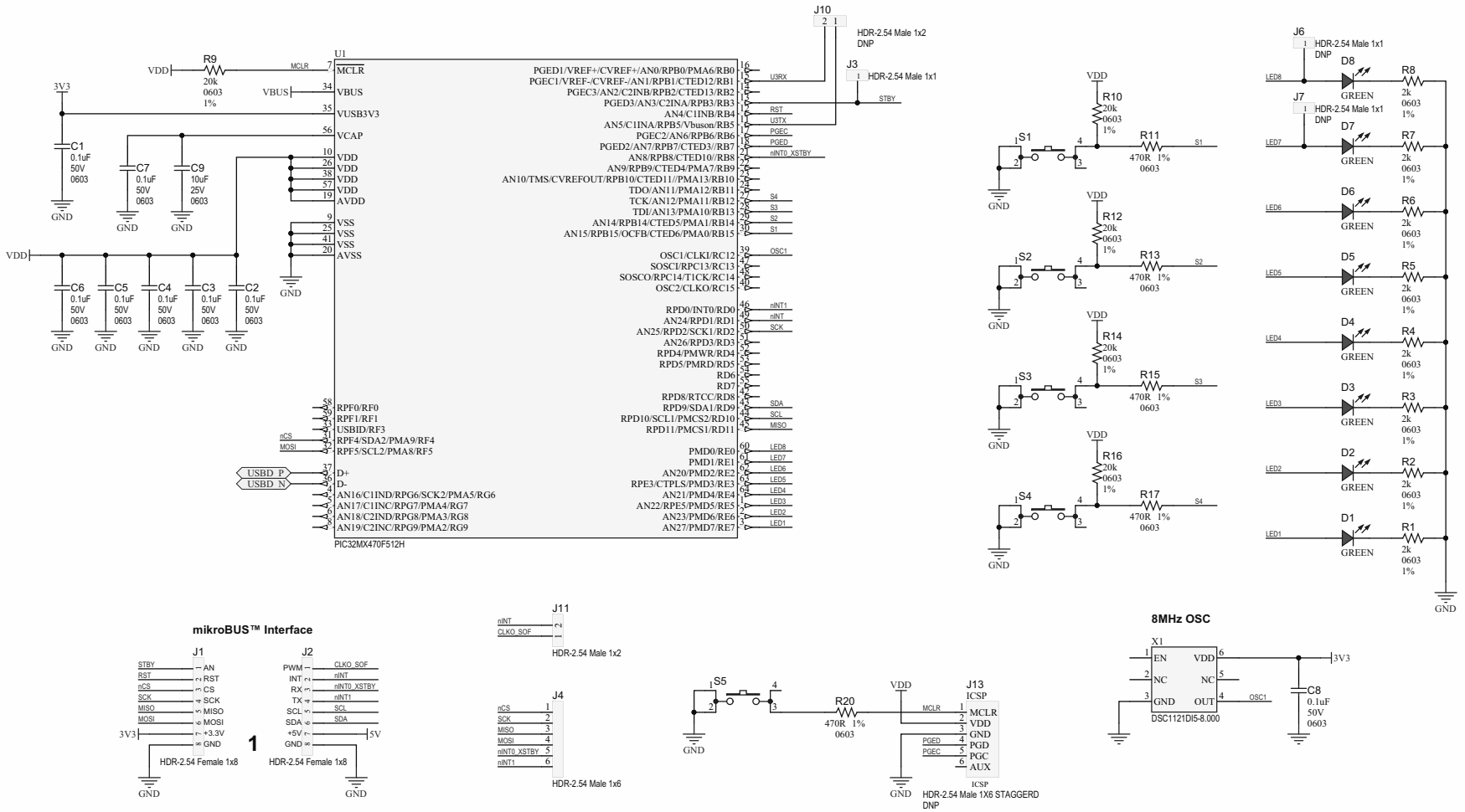
This appendix contains the following schematics and layout of the MCP251XFD CAN FD Motherboard:

- Schematics - Power Supply
- Schematics - Microcontroller
- Board – Top View
- Board – Bottom View
- Board – Top Silk
- Board – Top Copper and Silk
- Board – Top Copper
- Board – Bottom Copper
- Board – Bottom Copper and Silk
- Board – Bottom Silko

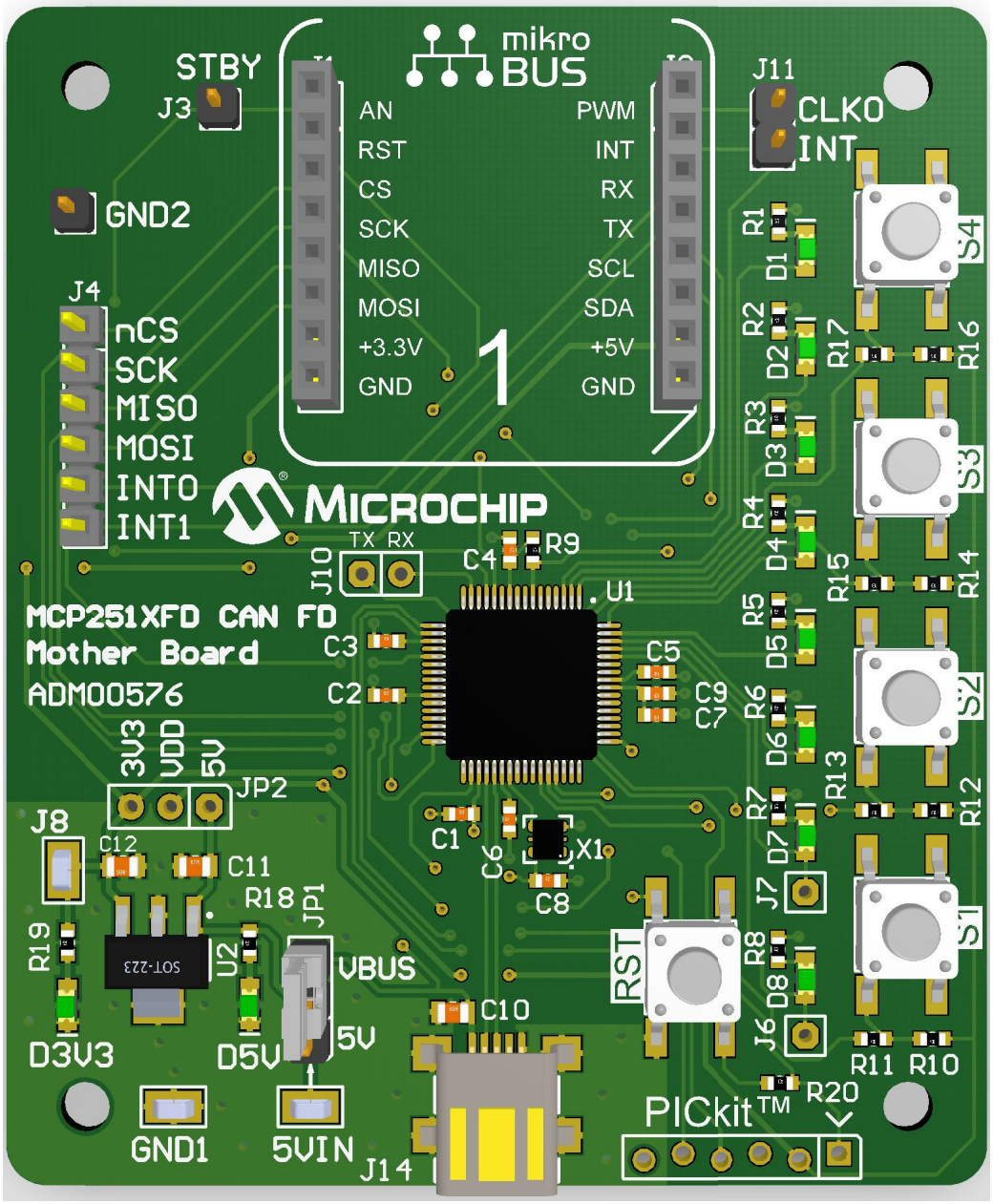
A.2 SCHEMATICS - POWER SUPPLY



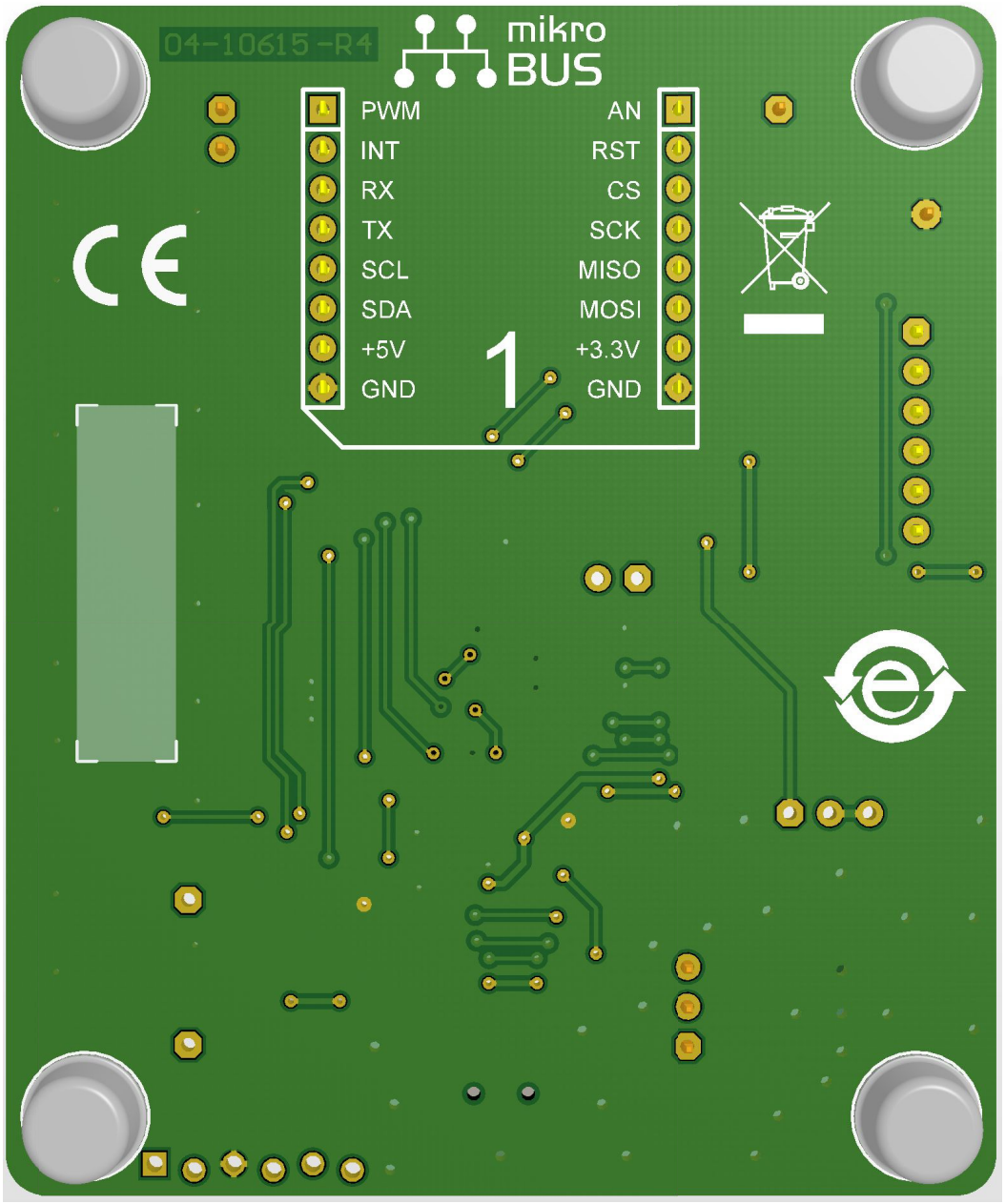
A.3 SCHEMATICS - MICROCONTROLLER



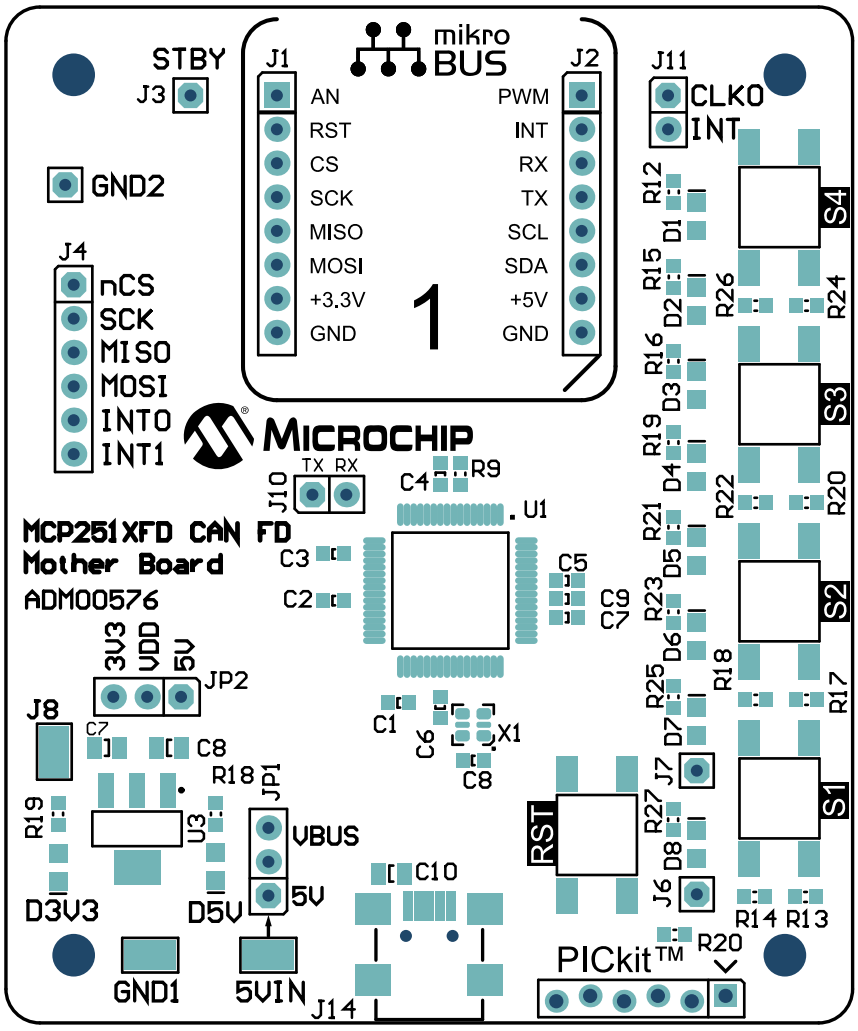
A.4 BOARD – TOP VIEW



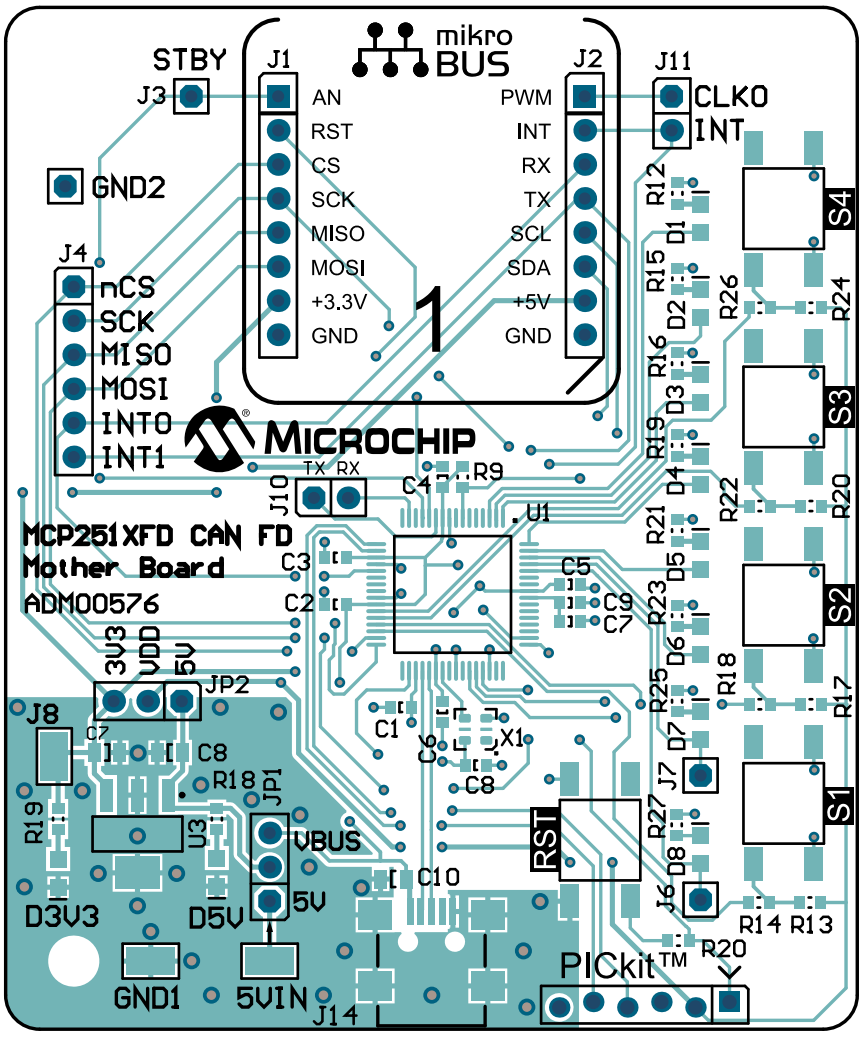
A.5 BOARD – BOTTOM VIEW



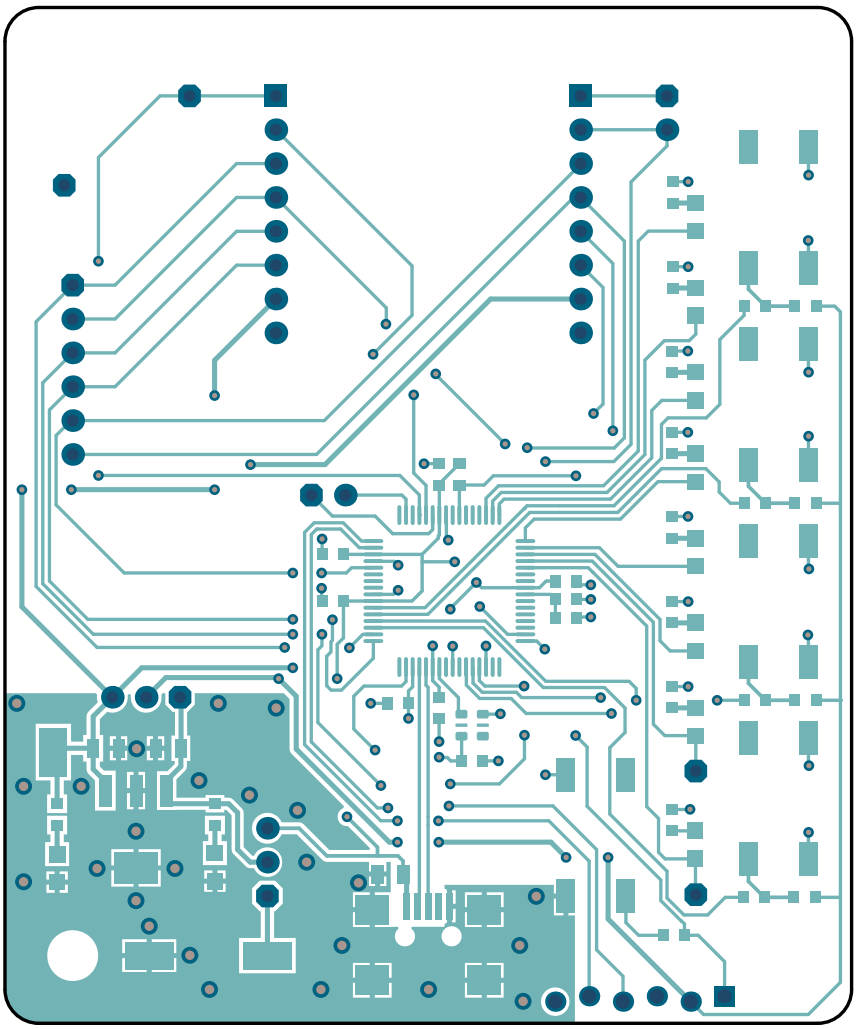
A.6 BOARD – TOP SILK



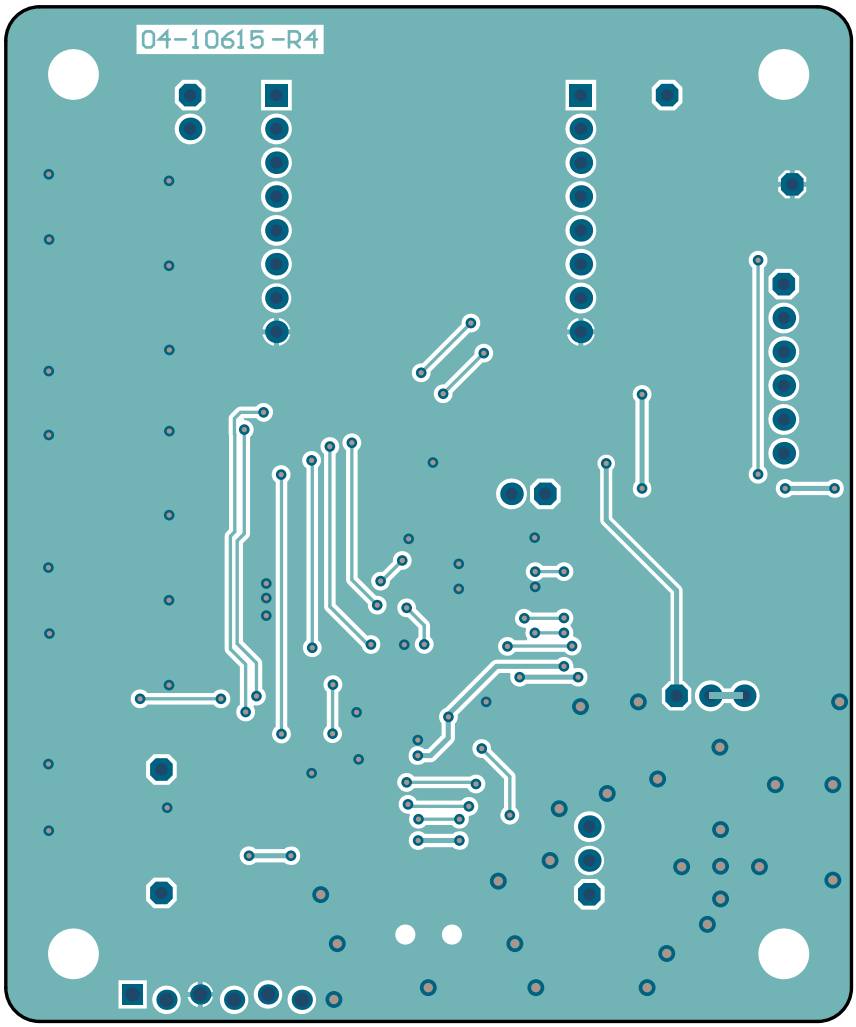
A.7 BOARD – TOP COPPER AND SILK



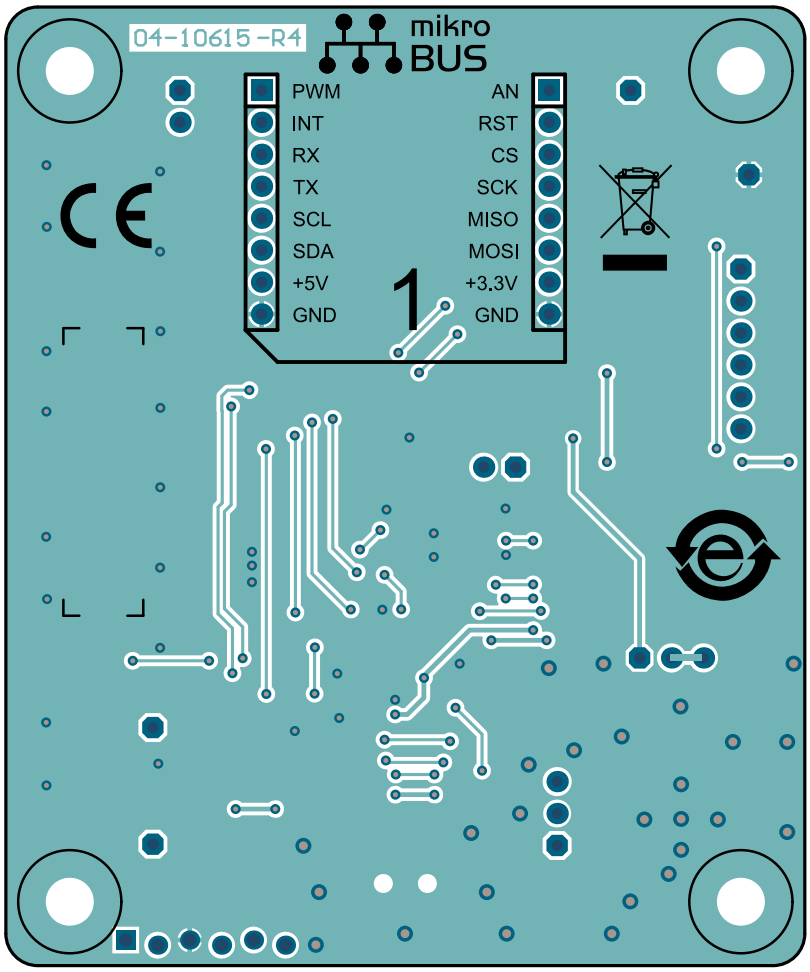
A.8 BOARD – TOP COPPER



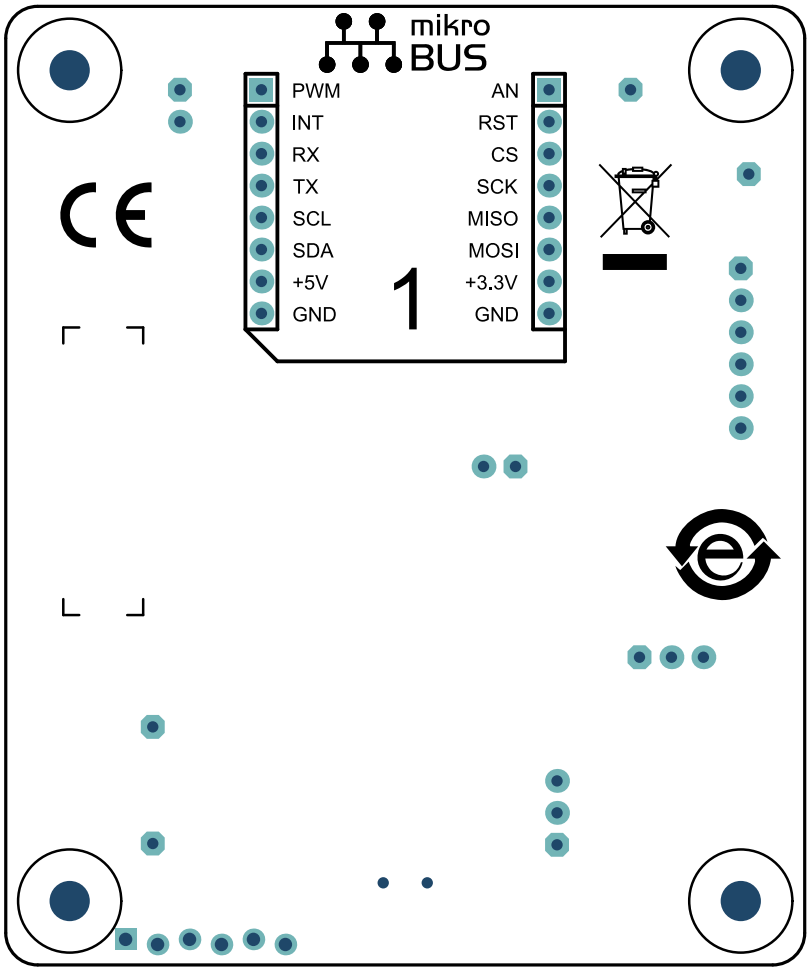
A.9 BOARD – BOTTOM COPPER



A.10 BOARD – BOTTOM COPPER AND SILK



A.11 BOARD – BOTTOM SILK



NOTES:

Appendix B. Bill of Materials (BOM)

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

Qty.	Reference	Description	Manufacturer	Part Number
8	C1, C2, C3, C4, C5, C6, C7, C8	Capacitor, ceramic, 0.1 µF, 50V, 10%, X7R, SMD, 0603	Murata Electronics®	GRM188R71H104KA93D
1	C9	Capacitor, ceramic,10 µF, 25V, 20%, X5R, SMD, 0603	Murata Electronics®	GRM188R61E106MA73D
2	C10, C11	Capacitor, ceramic, 22 µF, 16V, 10%, X5R, SMD, 0805	TDK Corporation	C2012X5R1C226K
1	C12	Capacitor, ceramic, 4.7 µF, 10V, 10%, X5R, SMD, 0805	Panasonic® - ECG	ECJ-GVB1A475M
10	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10	LED, 0805, green, 525, NM, 400, MCD, 20, MA	QT-Brightek Corporation	QBLP631-IG
2	J1, J2	Connector, hdr.-2.54 female, 1x8, tin, TH. vertical	Sullins Connector Solutions	PPTC081LFBN-RC
1	J3	Connector, hdr.-2.54 male, 1x1, gold, 5.84, MH, TH. vertical.	TE Connectivity Alcoswitch	5-146280-1
1	J4	Connector, hdr.-2.54, male, 1x6, tin, 5.84, MH, TH. vertical	Sullins Connector Solutions	PEC06SAAN
3	J5, J8, J9	Connector, TP, loop, tin, SMD	Harwin Plc.	S1751-46R
1	J11	Connector, hdr.-2.54 male, 1x2, tin, 5.84, MH, TH. vertical	Sullins Connector Solutions	PREC002SAAN-RC
1	J12	Connector, hdr. breakaway, 100, 40, pos. vertical	TE Connectivity, Ltd.	4-103239-0
1	J14	Connector, USB, mini-B, female, SMD, R/A	Hirose Electric Co. Ltd.	UX60-MB-5ST
1	JP1	Connector, hdr.-2.54, male, 1x3, tin, 5.84, MH, TH. vertical	Samtec, Inc.	TSW-103-07-T-S
10	R1, R2, R3, R4, R5, R6, R7, R8, R18, R19	Resistor, TKF, 2 kΩ, 1%, 1/10W, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603FT2K00
5	R9, R10, R12, R14, R16	Resistor, TKF, 20 kΩ, 1%, 1/10W, SMD, 0603	Yageo Corporation	9C06031A2002FKHFT
5	R11, R13, R15, R17, R20	Resistor, TKF, 470R, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-07470RL
5	S1, S2, S3, S4, S5	Switch, tact. spst. 12V, 50 mA, TL3301NF160QG/TR, SMD	E-Switch®, Inc.	TL3301NF260QG/TR
1	U1	PIC32MX470F512H	Microchip Technology Inc.	**PIC32MX470F512H-120/PT**

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)[1]

Qty.	Reference	Description	Manufacturer	Part Number
1	U2	Microchip Analog, LDO, 3.3V, MCP1826S-3302E/DB, SOT-223-3	Microchip Technology Inc.	**MCP1826S-3302E/DB**
1	X1	Microchip Analog, Oscillator, 8 MHz, DSC1121DI5-8.000, L2.5W2H0.85	Microchip Technology Inc.	**DSC1121DI5-8.000**

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.

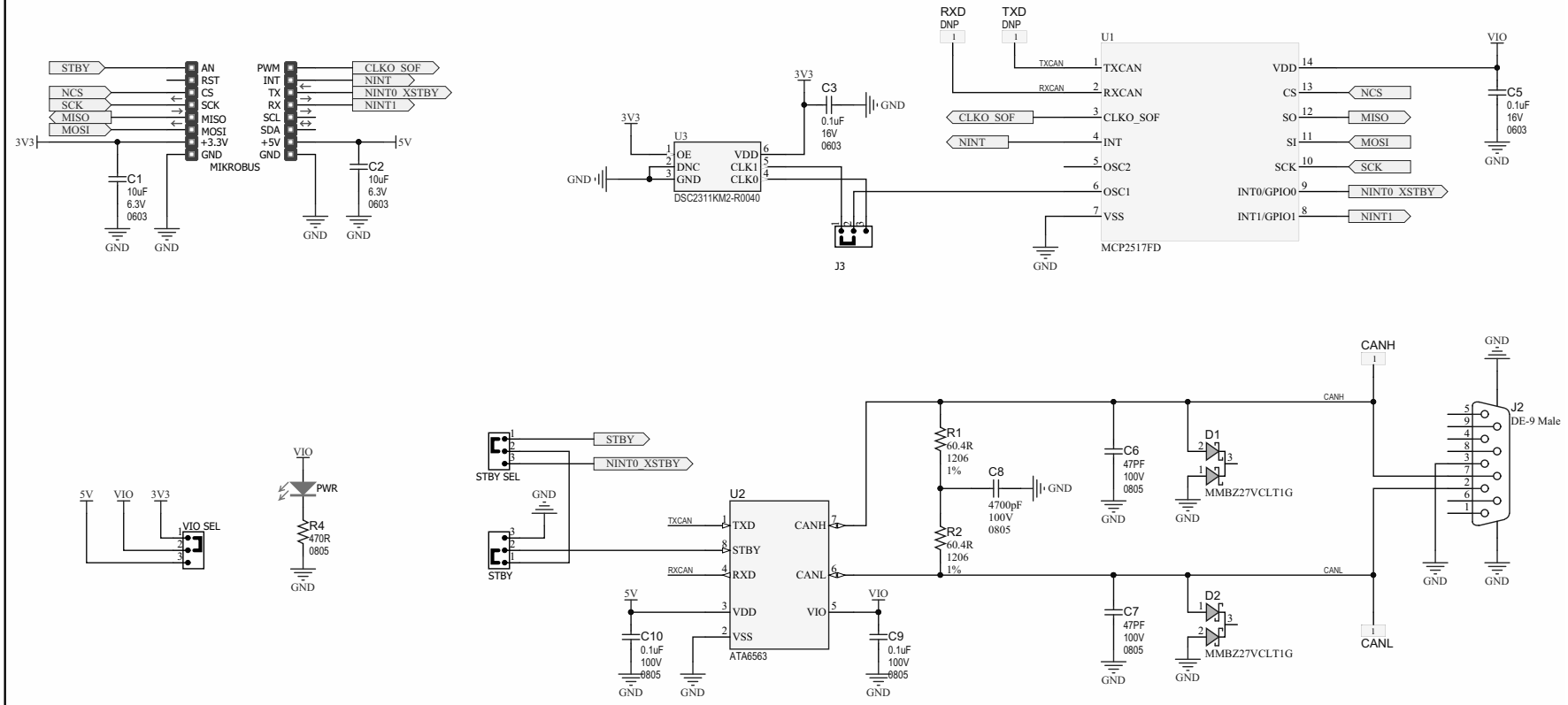
Appendix C. MCP2517FD click Board Schematics

C.1 INTRODUCTION

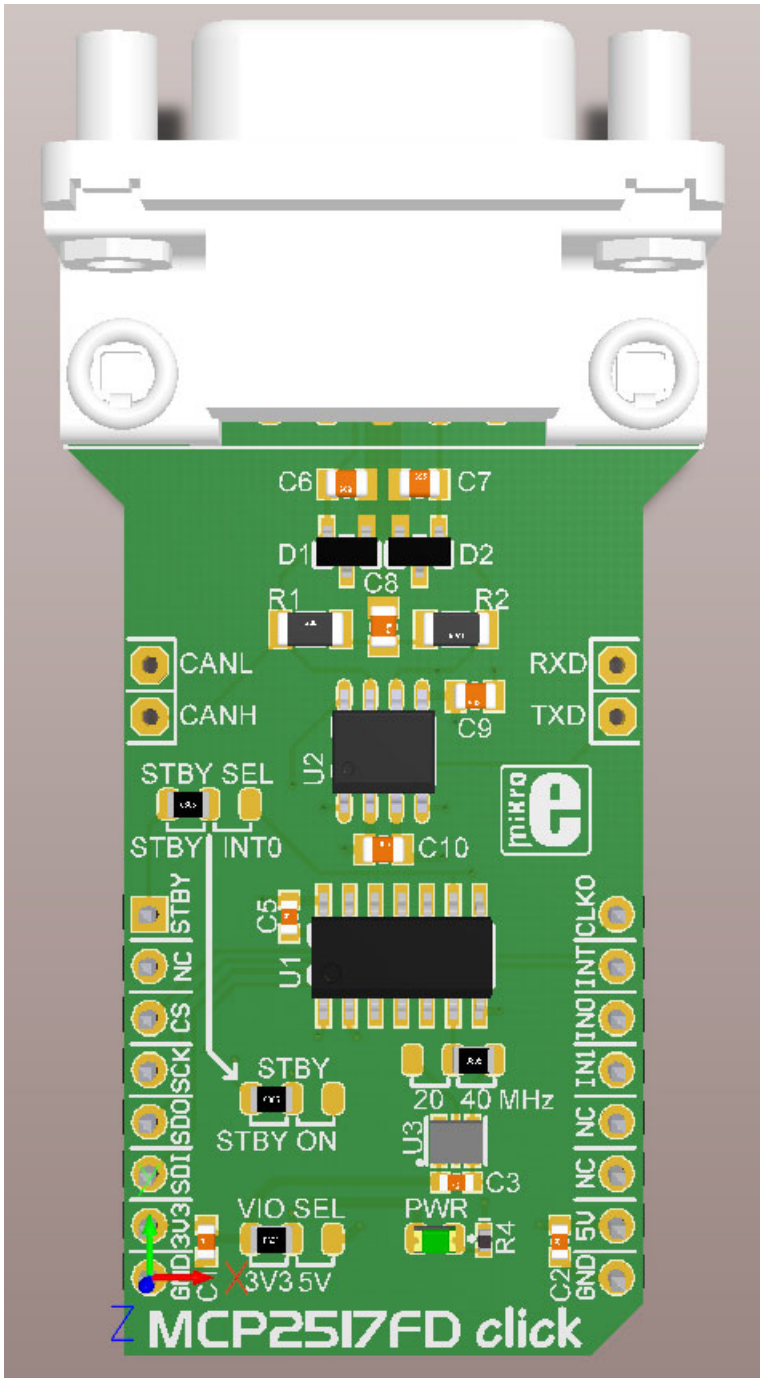
This appendix contains the schematics and layout of the MCP2517FD click Board:

- **Schematics - MCP2517FD click Board**
- **Board – Top View**
- Board – Bottom View

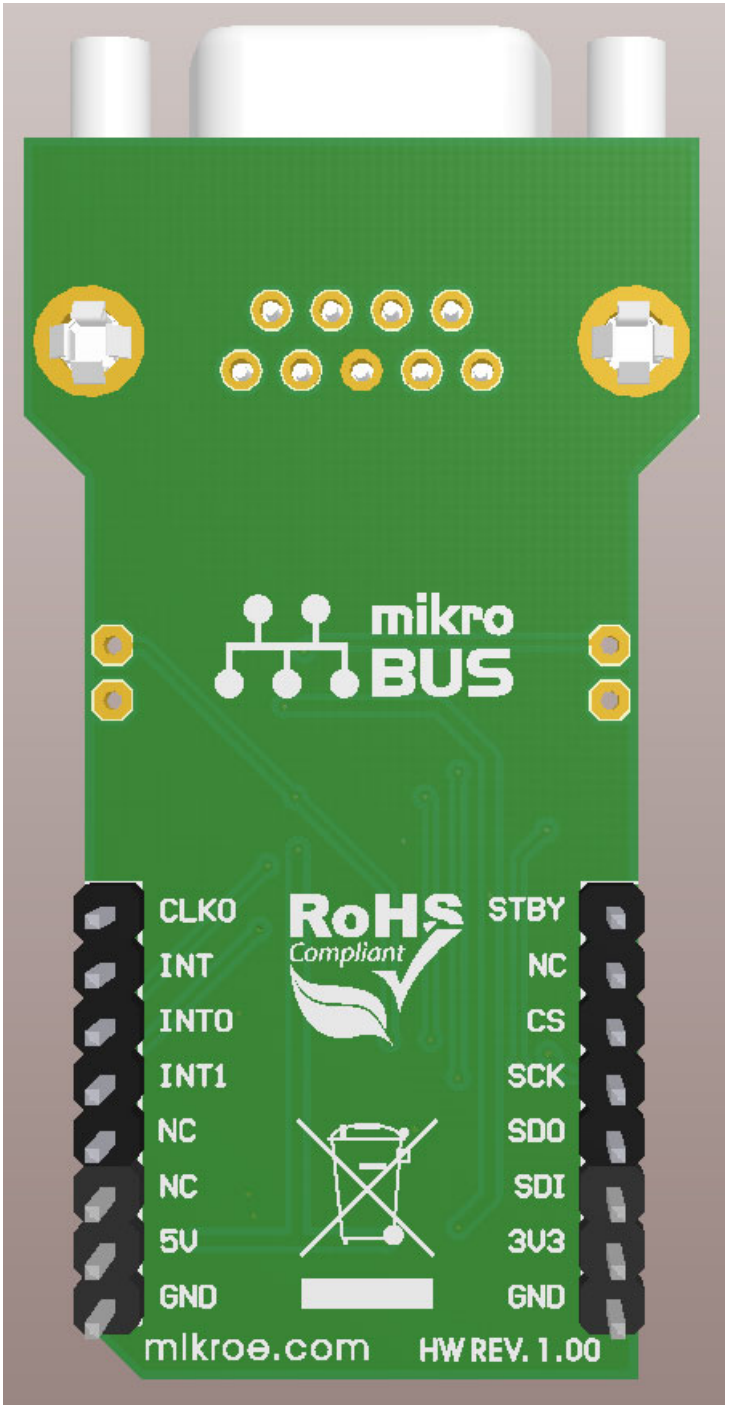
C.2 SCHEMATICS - MCP2517FD CLICK BOARD



C.3 BOARD – TOP VIEW



C.4 BOARD – BOTTOM VIEW



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