
RNBD451 Add On Board User's Guide

Introduction

The RNBD451 Add On Board is an efficient low-cost development platform to evaluate and demonstrate the features, capabilities and interfaces of Microchip's Bluetooth® Low Energy RF module RNBD451PE, compliant to the mikroBUS™ Add On Bus Standard. It also includes an on-board MCP2200 USB-to-UART converter enabling out-of-box evaluation with no other hardware requirements.

The RNBD451 Add On Board offers:

1. Easy-to-use platform to speed up design concepts to revenue with the Bluetooth Low Energy RF Module:
 - a. Host board supporting mikroBUS Socket
 - b. Host PC via USB Type-C® interface
2. No need for external hardware tools
3. Small low-cost form factor

The RNBD451 Add On Board supports a wide range of applications. The following are a few of them:

- Wireless lighting
- Home automation
- Internet of Things (IoT)
- Industrial automation
- General purpose Bluetooth data

Features

- RNBD451PE Bluetooth Low Energy RF Module
- USB or Host Board-Powered at 3.3V Power Supply
- Control Interface Over UART and Additional Functionality Provided by Other Event/Status Indication Pins
- USB-to-UART Converter with MCP2200 Enables Fast Evaluation with No Other Hardware Requirement
- mikroBUS Add On Bus Standard, Enables Support with Host Boards with mikroBUS Socket
- User LEDs for Status/Event Indication
- Green Power LED
- PTA Header to Support Bluetooth Low Energy-Wi-Fi Co-Existence Applications

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1. Quick References

1.1 Reference Documentation

For further details, refer to the following:

- *MCP1727 1.5A, Low Voltage, Low Quiescent Current LDO Regulator Data Sheet* ([DS21999](#))
- *Universal Serial Bus Specification and Associated Documents* (www.usb.org)
- *mikroBUS™ Specification* (www.mikroe.com/mikrobus)
- *RNBD451 Bluetooth® Low Energy Module Data Sheet* (DS70005514)

1.2 Hardware Prerequisites

- RNBD451 Add On Board
- USB Type-C cable
- Bluetooth-enabled Smartphone:
 - Android™ device
 - iOS® – iPhone®
- Host Board with mikroBUS socket support

1.3 Software Prerequisites

- MPLAB® Integrated Development Environment ([MPLAB X IDE](#)) tool

1.4 Acronyms and Abbreviations

Table 1-1. Acronyms and Abbreviations

Acronyms and Abbreviations	Description
BOM	Bill of Material
GPIO	General Purpose Input Output
IoT	Internet of Things
LDO	Low-Dropout
LED	Light Emitting Diode
MCU	Microcontroller
NC	Not Connected
RX	Receiver
TX	Transmitter
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus

2. Kit Overview

The RNBD451 Add On Board contains an RNBD451PE module. The signals required for control interface and other status/event indicators are connected to the on-board features of the Add On Board for flexibility and rapid prototyping.

Figure 2-1. RNBD451 Add On Board (EV25F14A) – Top View

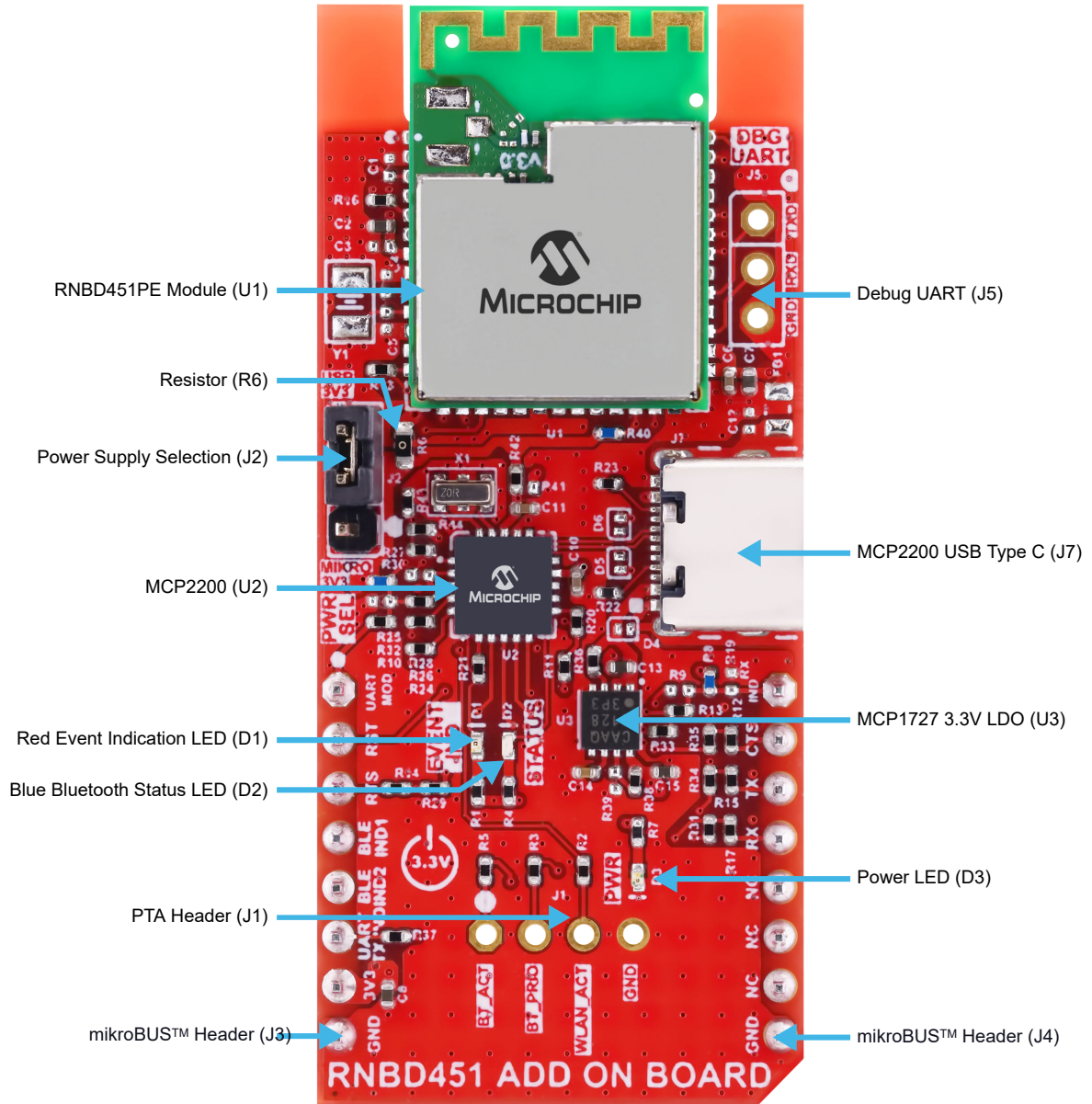
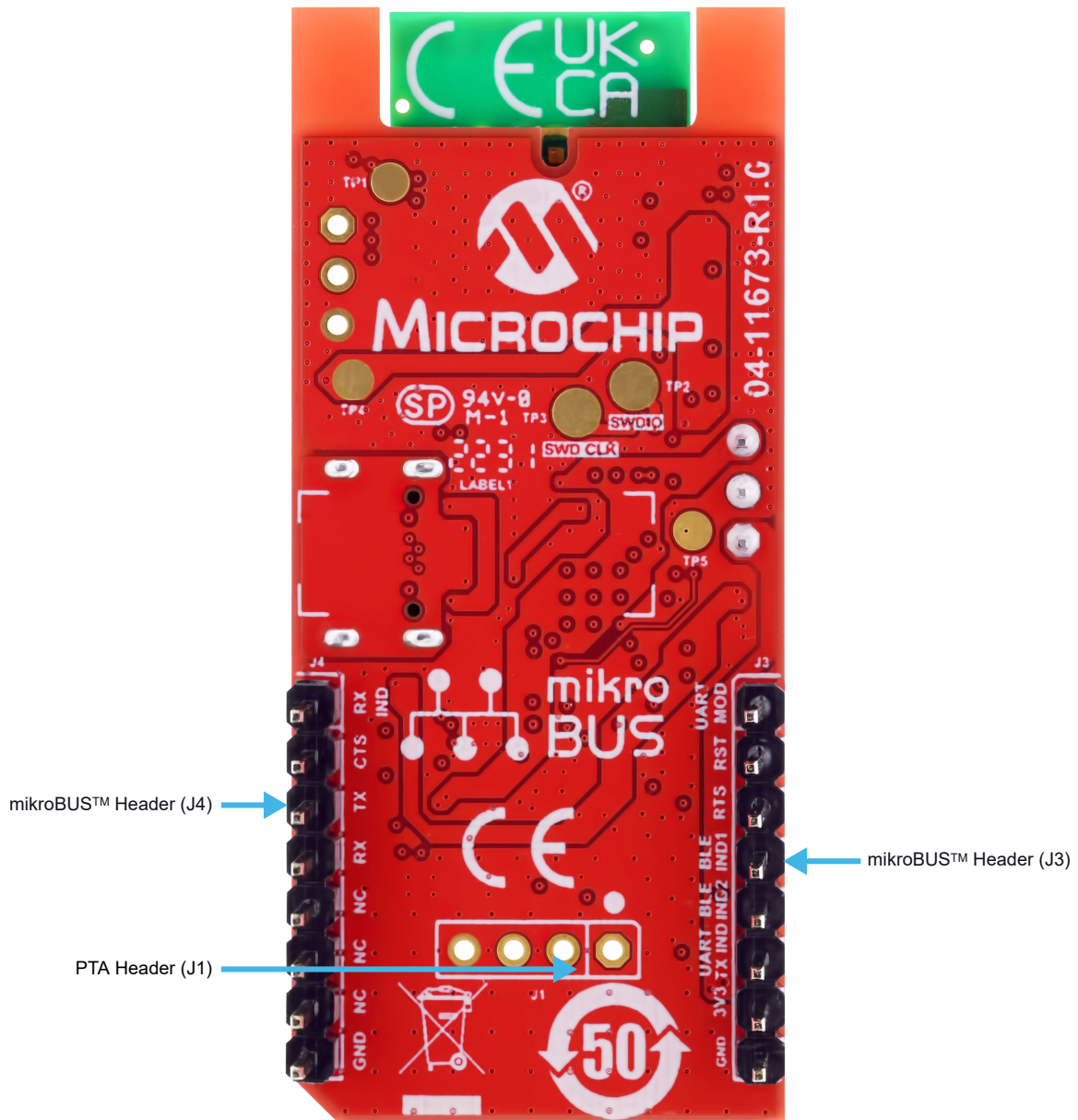


Figure 2-2. RNBD451 Add On Board (EV25F14A) – Bottom View



2.1 Kit Contents

The EV25F14A (RNBD451 Add On Board) kit contains the following:

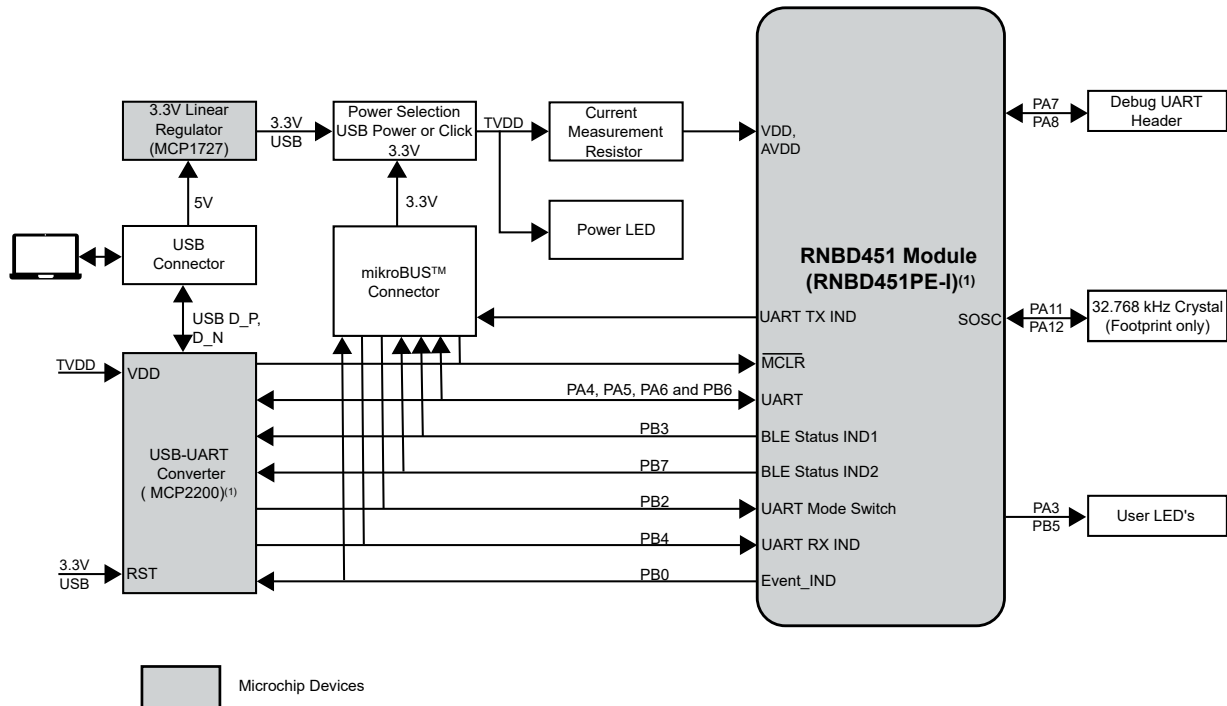
- An RNBD451PE module mounted on the RNBD451 Add On Board

Note: If any of the above items are missing in the kit, go to support.microchip.com or contact your local Microchip Sales office. In this user guide, there is a list of Microchip offices for sales and services provided on the last page.

3. Hardware

This chapter describes the hardware features of the RNBD451 Add On Board.

Figure 3-1. RNBD451 Add On Board Block Diagram



Note:

- Using Microchip's total system solution, which includes complementary devices, software drivers and reference designs, is highly recommended to ensure the proven performance of the RNBD451 Add On Board. For more details, go to support.microchip.com or contact your local Microchip Sales office.

3.1 Power Supply

The RNBD451 Add On Board can be powered using any of the following sources depending on the use case scenario:

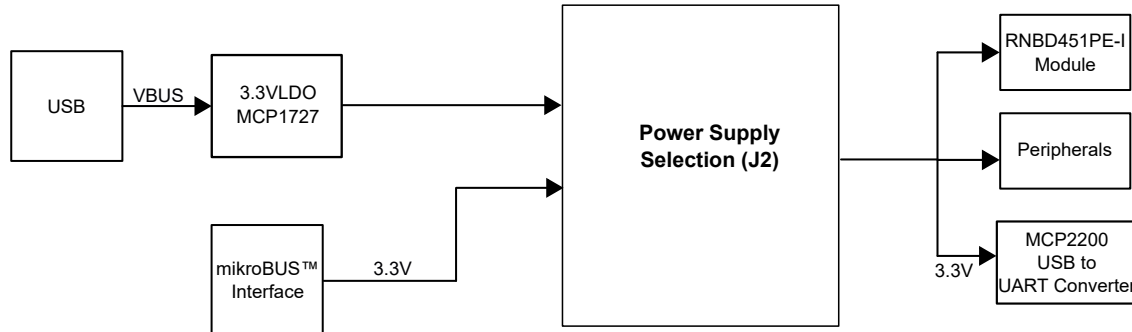
- USB supplies power to the RNBD451 Add On Board using a USB Type-C cable connected to the USB Type-C Connector (**J7**). The module and the peripherals are powered by 3.3V generated from the on-board 3.3V linear regulator.
- The RNBD451 module and the peripherals are powered by 3.3V at **J3**, the mikroBUS interface when plugged into a host board.

Power selection between USB power supply or the 3.3V from the mikroBUS interface is done by mounting a jumper cap JP1 on **J2**.

Table 3-1. Jumper Cap JP1 Position to Select Power Supply Using J2 Power Supply Selection Header

3.3V generated from USB Power Supply	3.3V from mikroBUS interface
JP1 on J2-3, J2-2	JP1 on J2-1, J2-2

Figure 3-2. RNBD451 Add On Board Power Supply Block Diagram



To measure the current consumed by the RNBD451PE module alone, remove R6 and connect an ammeter across it.

3.2 RNBD451PE Module Control Interface

The RNBD451PE Add On Board supports two modes of operation:

1. Using a host PC with on-board MCP2200 USB-to-UART converter
2. Using a host MCU board with mikroBUS socket via mikroBUS interface

3.2.1 Host PC with On-Board MCP2200 USB-to-UART Converter

The simplest method to use the RNBD451 Add On Board is to connect it to a PC host that supports USB CDC virtual COM (serial) ports using the on-board MCP2200 USB-to-UART Converter. The user can send simple ASCII commands to the RNBD451 module by using a terminal emulator application. In this situation, the PC acts as the host device. In addition to UART, status and other control GPIOs from the RNBD451PE module are also connected to MCP2200 GPIO pins.

The MCP2200 is configured in Reset condition until the USB supply is plugged in.

Table 3-2. RNBD451PE Connection to MCP2200 USB-to-UART Converter

Pin on MCP2200	Pin on RNBD451PE Module	Description
TX	PB6, UART RXD	RNBD451PE module UART RXD
RX	PA5, UART TXD	RNBD451PE module UART TXD
RTS	PA6, UART CTS	RNBD451PE module UART CTS
CTS	PA4, UART RTS	RNBD451PE module UART RTS
GP0	—	—
GP1	—	—
GP2	NMCLR	RNBD451PE module reset pin
GP3	PA3, EVENT INDICATION	Event indication
GP4	PB3, BT_STATUS_IND1	Bluetooth Low Energy status indication 1

.....continued

Pin on MCP2200	Pin on RNBD451PE Module	Description
GP5	PB7, BT_STATUS_IND2	Bluetooth Low Energy status indication 2
GP6	PB2, UART MODE SWITCH	UART mode switch
GP7	PB4, UART RX INDICATION	UART RX indication

3.2.2 Host MCU Board with mikroBUS Socket via mikroBUS Interface

The RNBD451 Add On Board can also be used by host MCU boards with mikroBUS sockets using the control interface. The following table shows how the pinout on the RNBD451 Add On Board mikroBUS interface corresponds to the pinout on the mikroBUS socket.

Table 3-3. RNBD451PE Connection to mikroBUS Interface

Pin No on mikroBUS	Standard Pin on mikroBUS	Pin on RNBD451PE Module	Description
1	AN	PB2, UART MODE SWITCH	UART mode switch
2	RST	NMCLR	RNBD451PE module reset pin
3	CS	PA4, UART RTS	RNBD451PE module UART RTS
4	SCK	PB3, BT_STATUS_IND1	Bluetooth Low Energy status indication 1
5	MISO	PB7, BT_STATUS_IND2	Bluetooth Low Energy status indication 2
6	MOSI	PA2, UART_TX_IND	UART transmit indication from the RNBD451PE module
7	3.3V	—	3.3V from host MCU socket
8	GND	GND	GND
9	GND	GND	GND
10	5V	—	NC
11	SDA	—	NC
12	SCL	—	NC
13	RX	PB6, UART RXD	RNBD451PE module UART RXD
14	TX	PA5, UART TXD	RNBD451PE module UART TXD
15	INT	PA6, UART CTS	RNBD451PE module UART CTS
16	PWM	PB4, UART RX INDICATION	UART RX indication to RNBD451PE module

3.3 LEDs

3.3.1 Red Event Indication LED (D1)

Use the Red Event Indication LED (D1), to indicate the changes in the monitoring indicators.

For more details, refer to the *RNBD451 Bluetooth® Low Energy Module User's Guide* (DS50003467).

3.3.2 Blue Bluetooth Status LED (D2)

The Blue Bluetooth Status LED (D2) indicates Bluetooth Low Energy connection status by specific LED Flash pattern.

Standby mode:

- No Bluetooth Low Energy connection
- RNBD451 is in Advertisement or Scan state
- Flash one time for every three seconds
- ON: 50 ms, OFF: 2950 ms

Linked mode:

- Bluetooth Low Energy ACL link is connected whether central or peripheral role
- Flash two times for every 1.5 seconds
- ON: 50 ms, OFF: 150 ms, ON: 50 ms, OFF: 1050 ms

Note: By default, the Bluetooth status LED is turned OFF. The user can enable this feature by using the `SR` command. For more details, refer to the *RNBD451 Bluetooth® Low Energy Module User's Guide* (DS50003467).

3.4 Debug UART (J5)

Use the Debug UART (J5) to monitor the debug logs from the RNBD451PE module. The pinout of the Debug UART header J5 is as follows. For more details, refer to the *RNBD451 Bluetooth® Low Energy Module User's Guide* (DS50003467).

Table 3-4. RNBD451PE Connection to Debug UART Header

Pin No	Pin on RNBD451PE Module	Description
1	PA7	Debug UART TXD
2	PA8	Debug UART RXD
3	GND	—

4. RNBD451 Add On Board Out-of-Box Demo

The RNBD451PE module provides the control interface based on ASCII commands sent over UART. Using the on-board USB-to-UART converter MCP2200, users can quickly get started with the board and evaluate the Bluetooth Low Energy connectivity capability of the wireless module with minimal effort.

For more details for the Out-of-Box (OOB) demo and demo guide, refer to the section *RNBD451 Bluetooth® Low Energy Module User's Guide* (DS50003467).

5. Appendix A: Reference Circuit

5.1 RNBD451 Add On Board Reference Schematics

Figure 5-1. Power Supply Selection

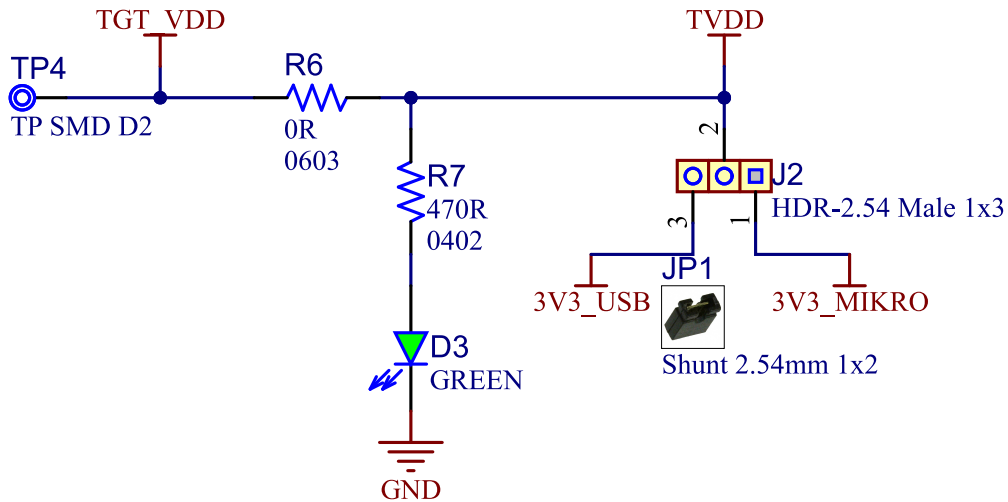


Figure 5-2. Debug UART

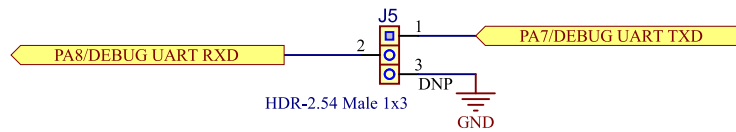


Figure 5-3. Target 3.3V Regulator

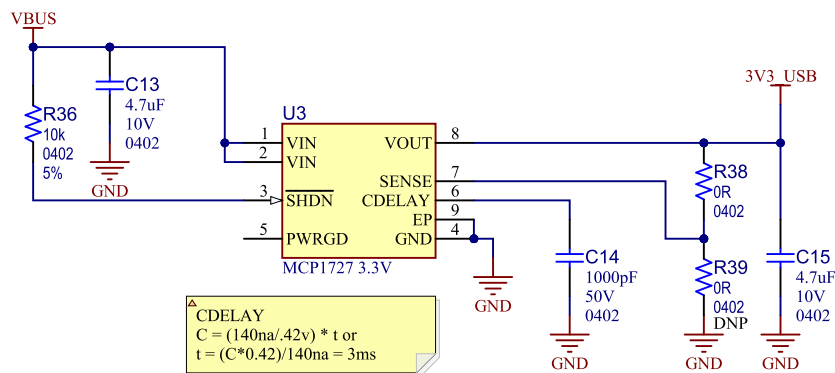


Figure 5-4. MCP2200 USB UART Converter

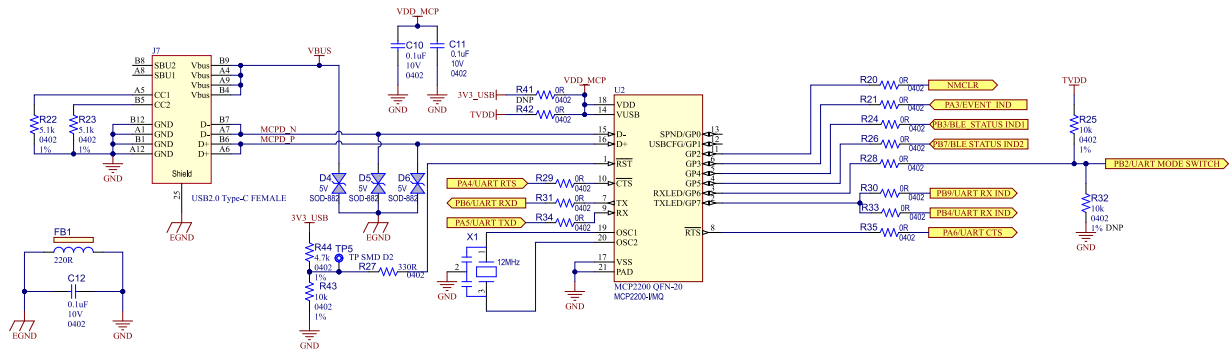


Figure 5-5. mikroBUS

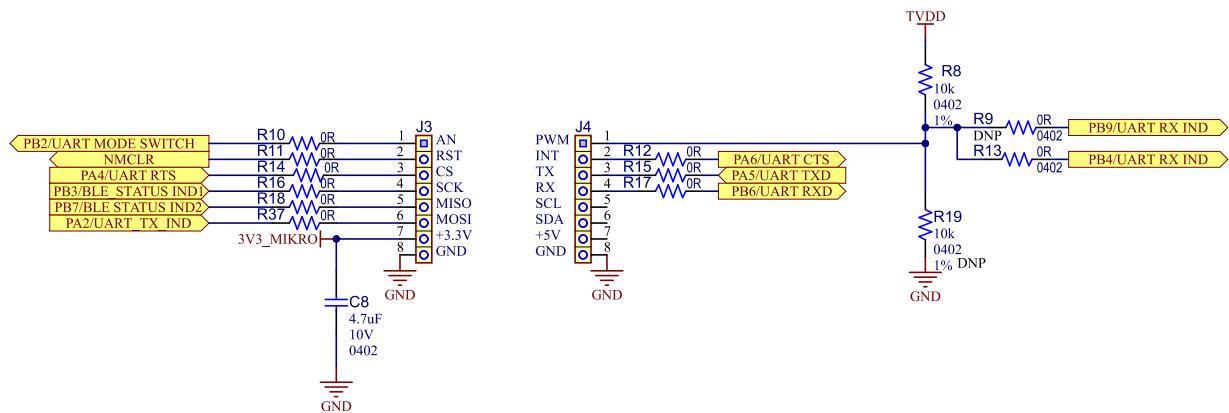
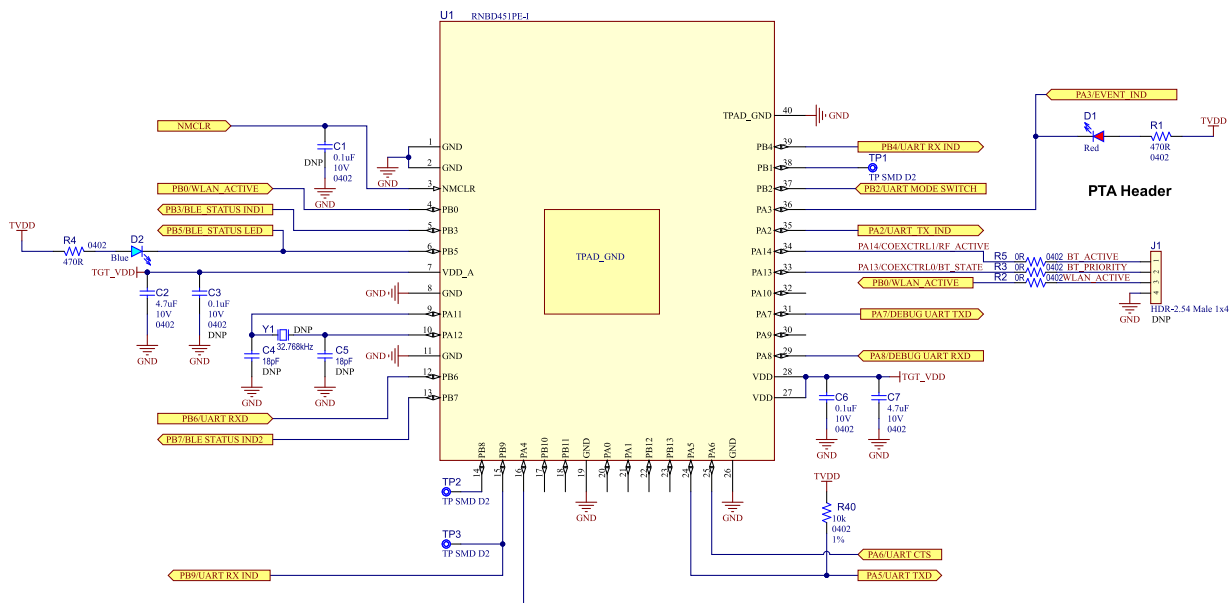


Figure 5-6. RNBD451PE Module Connection



5.2 RNBD451 Add On Board Bill of Materials

The following table provides the Bill of Materials (BOM) for the RNBD451 Add On Board.

Table 5-1. Bill of Materials

Reference	Description	Manufacturer	Part Number
C1, C3, C12	CAP CER 0.1uF 10V 10% X5R SMD 0402	KEMET	C0402C104K8PACTU
C2, C7, C8, C13, C15	CAP CER 4.7uF 10V 10% X5R SMD 0402	TDK Corporation	C1005X5R1A475K050BC
C4, C5	CAP CER 18 pF 50V 2% NP0 SMD 0402	Murata Electronics®	GRM1555C1H180GA01D
C6, C10, C11	CAP CER 0.1uF 10V 10% X5R SMD 0402	KEMET	C0402C104K8PACTU
C14	CAP CER 1000pF 50V 10% X7R SMD 0402	Murata Manufacturing Co., Ltd.	GRM155R71H102KA01D
D1	DIO LED RED 2V 20mA 120mcd Clear SMD 620nm	QT-Brightek Corporation	QBLP595-R
D2	DIO LED BLUE 2.85V 5mA 49.5mcd Diffuse SMD 470nm	OSRAM Opto Semiconductors GmbH.	LB QH9G-N100-35-1
D3	DIO LED GREEN 1.9V 1mA 2.1mcd CLEAR SMD 0402	ROHM Semiconductor	SML-P11MTT86
D4, D5, D6	DIO ZENER PESD5V0X1BL 5V SMD SOD-882	NXP Semiconductors	PESD5V0X1BL,315
FB1	FERRITE 2A 220R SMD 0805	Murata Electronics North America, Inc.	BLM21PG221SN1D
J1	CON HDR-2.54 Male 1x4 Tin 5.84MH TH VERT	FCI	68002-404HLF
J2	CON HDR-2.54 Male 1x3 Tin 5.84MH TH VERT	Samtec, Inc.	TSW-103-07-T-S
J3, J4	CON HDR-2.54 Male 1x8 Gold 5.84MH TH VERT	Nextron	211-081A7-0021-400
J5	CON HDR-2.54 Male 1x3 Tin 5.84MH TH VERT	Samtec, Inc.	TSW-103-07-T-S
J7	CONN USB2.0 TYPE-C Female SMD/TH R/A	GCT	USB4105-GF-A
JP1	MECH HW JUMPER 2.54mm 1x2 GOLD	Würth Elektronik	60900213421
R1, R4, R7	RES TKF 470R 5% 1/16W SMD 0402	Panasonic Industry Co., Ltd.	ERJ-2GEJ471X
R2, R3, R5, R10, R11, R12, R13, R14, R15, R16, R17, R18, R20, R21, R24, R26, R28, R29, R31, R33, R34, R35, R37, R38, R42	RES TKF 0R 1/16W SMD 0402	Yageo Corporation	RC0402JR-070RL
R6	RES TKF 0 OHM 1/10W 0603	Bourns®, Inc.	CR0603-J/-000ELF

.....continued

Reference	Description	Manufacturer	Part Number
R8, R25, R40, R43	RES TF 10k 1% 1/10W SMD 0402 AEC-Q200	Vishay Beyschlag	MCS0402MC1002FE000
R9, R30, R39, R41	RES TKF 0R 1/16W SMD 0402	Yageo Corporation	RC0402JR-070RL
R19, R32	RES TF 10k 1% 1/10W SMD 0402 AEC-Q200	Vishay Beyschlag	MCS0402MC1002FE000
R22, R23	RES TKF 5.1k 1% 1/10W SMD 0402	Panasonic Industry Co., Ltd.	ERJ-2RKF5101X
R27	RES TKF 330R 1% 1/16W SMD 0402	Yageo Corporation	RC0402FR-07330RL
R36	RES TKF 10k 5% 1/16W SMD 0402	Vishay	CRCW040210K0JNED
R44	RES TKF 4.7k 1% 1/16W SMD 0402	Yageo Corporation	RC0402FR-074K7L
U1	MOD BLE/ZIGBEE RNBD451PE-I	Microchip Technology	RNBD451PE-I
U2	MCHP INTERFACE USB UART MCP2200-I/MQ QFN-20	Microchip Technology	MCP2200-I/MQ
U3	MCHP ANALOG LDO 3.3V MCP1727-3302E/MF	Microchip Technology	MCP1727-3302E/MF
X1	RESONATOR 12MHz 0.07% SMD CSTNE 3-SMD	Murata Manufacturing Co., Ltd.	CSTNE12M0GH5L000R0
Y1	CRYSTAL 32.768kHz 12.5pF SMD ABS07	Seiko Instruments	SC32S-12.5PF20PPM

6. Appendix: B Regulatory Approval

This equipment (RNBD451 Add On Board/EV25F14A) is an evaluation kit and not a finished product. It is intended for laboratory evaluation purposes only. It is not directly marketed or sold to the general public through retail; it is only sold through authorized distributors or through Microchip. Using this requires a significant engineering expertise towards understanding of the tools and relevant technology, which can be expected only from a person who is professionally trained in the technology.

Regulatory compliance settings have to follow the RNBD451PE module certifications. The following regulatory notices are to cover the requirements under the regulatory approval.

6.1 United States

The RNBD451 Add On Board (EV25F14A) contains the RNBD451PE module, which has received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C “Intentional Radiators” single-modular approval in accordance with Part 15.212 Modular Transmitter approval.

Contains FCC ID: 2ADHKWBZ451

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



Important: FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for uncontrolled environment. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 8 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. This transmitter is restricted for use with the specific antenna(s) tested in this application for certification.



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

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

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

6.2 Canada

The RNBD451 Add On Board (EV25F14A) contains the RNBD451PE module, which has been certified for use in Canada under Innovation, Science and Economic Development Canada (ISED, formerly Industry Canada) Radio Standards Procedure (RSP) RSP-100, Radio Standards Specification (RSS) RSS-Gen and RSS-247.

Contains IC: 20266-WBZ451

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference;
2. This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage;
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.



This equipment complies with radio frequency exposure limits set forth by Innovation, Science and Economic Development Canada for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 cm between the device and the user or bystanders.

Cet équipement est conforme aux limites d'exposition aux radiofréquences définies par d'Innovation, Sciences et Développement économique Canada pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre le dispositif et l'utilisateur ou des tiers.

6.3 Europe

This equipment (EV25F14A) has been assessed under the Radio Equipment Directive (RED) for use in European Union countries. The product does not exceed the specified power ratings, antenna specifications and/or installation requirements as specified in the user manual. A Declaration of Conformity is issued for each of these standards and kept on file as described in Radio Equipment Directive (RED).

Simplified EU Declaration of Conformity

Hereby, Microchip Technology Inc. declares that the radio equipment type [EV25F14A] is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at www.microchip.com/en-us/development-tool/EV25F14A (See *Conformity Documents*).

7. Document Revision History

Revision	Date	Section	Description
A	02/2023	Document	Initial revision

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