WBZ450 Curiosity Board User's Guide

EV22L65A

Introduction

The WBZ450 Curiosity Board is an efficient and modular development platform that supports rapid prototyping and demonstrates the features, capabilities and interfaces of Microchip's Bluetooth® Low Energy and Zigbee® RF Module (WBZ450PE).

The WBZ450 Curiosity Board:

- Offers integrated programming/debugging features using the PICkit™ On-board 4 (PKOB4) debugger interface
- Requires only a Micro-USB cable to power-up and program the board

The WBZ450 Curiosity Board supports a variety of applications:

- Wireless lighting
- Home automation or Internet of Things (IoT)
- Industrial automation
- Other Bluetooth Low Energy or Zigbee-related applications

Features

- WBZ450PE Bluetooth Low Energy and Zigbee RF Module
- USB or Li-Po Battery Powered
- On-Board Programmer/Debug Circuit Using PKoB4 Based on Microchip SAME70 MCU
- Microchip MCP73871 Li-Ion/LiPo Battery Charger with Power Path Management
- RGB LED Connected to Pulse Width Modulation (PWM)
- One Reset Switch
- One User-Configurable Switch
- One User LED
- 32.768 kHz Crystal
- Microchip MCP9700A, Low Power Analog Voltage Temperature Sensor
- 10-Pin ARM Serial Wire Debug (SWD) Header for External Programmer/Debugger

For more details, refer to 3. Hardware.

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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)
- *MCP9700A, Low-Power Linear Active Thermistor IC Data Sheet* (DS20001942)
- *MPLAB® XC32 C/C++ Compiler User's Guide* (DS50001686)
- *MPLAB® X IDE User's Guide* (DS50002027)
- *MPLAB® PICkit™ 4 In-Circuit Debugger User's Guide User Guide* (DS50002751)
- *MPLAB® Snap In-Circuit Debugger Information Sheet* (DS50002787)
- *PIC32CX Software User's Guide* (DS50003034)
- *PIC32CX-BZ2 and WBZ45 Family Data Sheet* (DS70005504)
- *Stand-Alone System Load Sharing and Li-Ion/Li-Polymer Battery Charge Management Controller Data Sheet* (DS20002090)
- *Universal Serial Bus Specification and Associated Documents* (www.usb.org)

1.2 Hardware Prerequisites

- WBZ450 Curiosity Board kit
- Type-A male to Micro-B USB cable
- Lithium Ion (Li-Ion) Polymer Battery – 4.2V for battery-powered application
- Bluetooth-enabled Smartphone:
  - Android™ device
  - iOS® – iPhone®

1.3 Software Prerequisites

- MPLAB Integrated Development Environment (MPLAB X IDE) tool (version 6.15 or later)
- MPLAB XC32 Compiler (version 4.35 or later)
- PKOB4 Tool Pack (version 1.10.1023 or later)
- Out of Box (OOB) demo

1.4 Acronyms and Abbreviations

Table 1-1. Acronyms/Abbreviations

Acronyms/Abbreviations	Description
ADC	Analog-to-Digital Converter
BOM	Bill of Material
GPIO	General Purpose Input Output
I^2C	Inter-Integrated Circuit
ICD	In-Circuit Debugger
IoT	Internet of Things
LDO	Low-Dropout
LED	Light Emitting Diode
MCU	Microcontroller
NC	Not Connected
OOB	Out-of-Box

.....continued	
Acronyms/Abbreviations	**Description**
PCB	Printed Circuit Board
PKOB	PICKit On-Board
PPS	Peripheral Pin Select
PWM	Pulse Width Modulation
RTCC	Real Time Clock and Calendar
RX	Receiver
SCL	Serial Clock
SDA	Serial Data
SMD	Surface Mount Device
SoC	System-on-Chip
SPI	Serial Peripheral Interface
SWD	Serial Wire Debug
TX	Transmitter
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus

2. Kit Overview

The WBZ450 Curiosity Board contains a WBZ450PE Module. All the signals from the WBZ450PE Module are connected to on-board features of the Curiosity Board for flexibility and rapid prototyping.

Figure 2-1. WBZ450 Curiosity Board (EV22L65A) – Top View

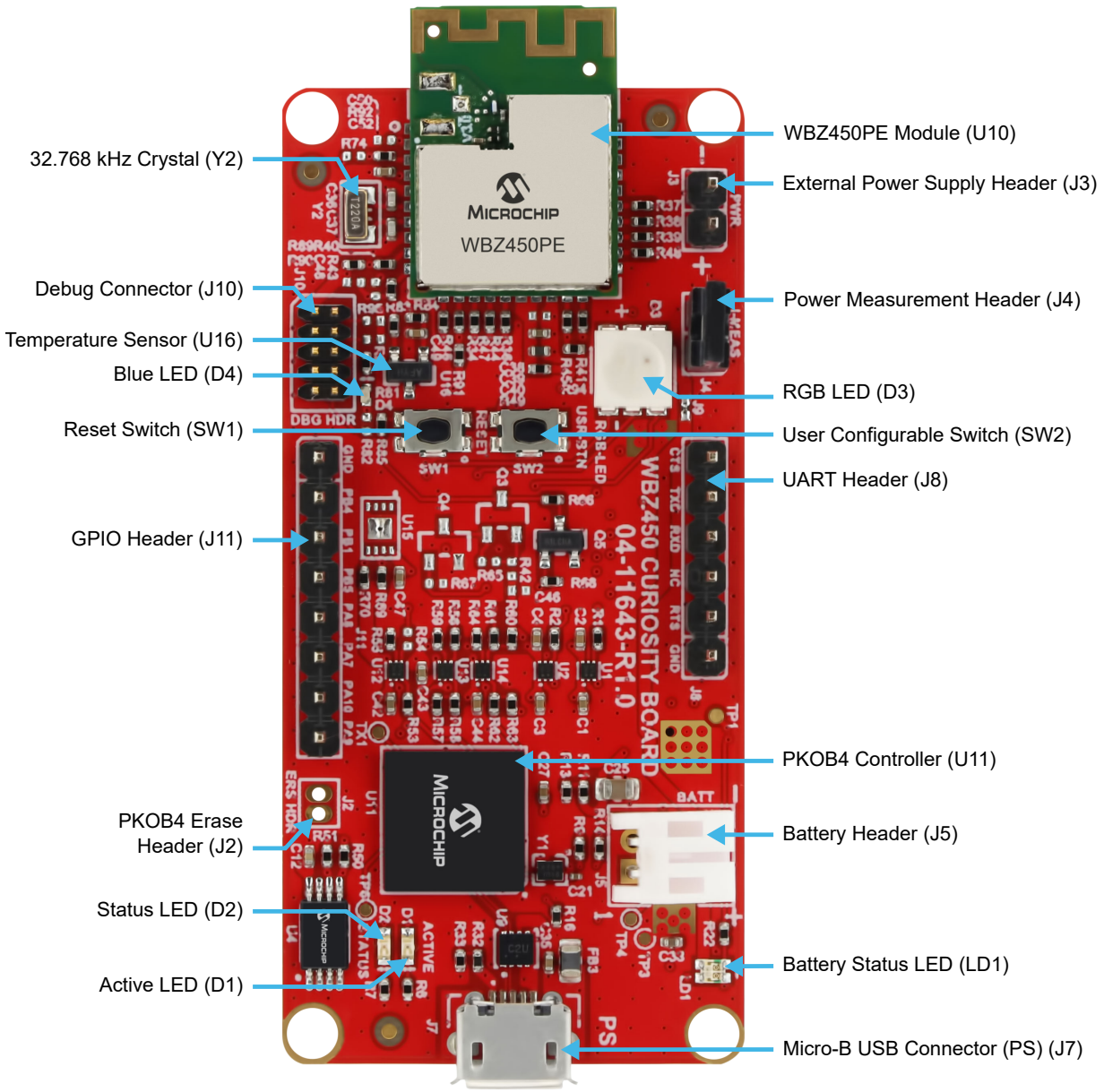
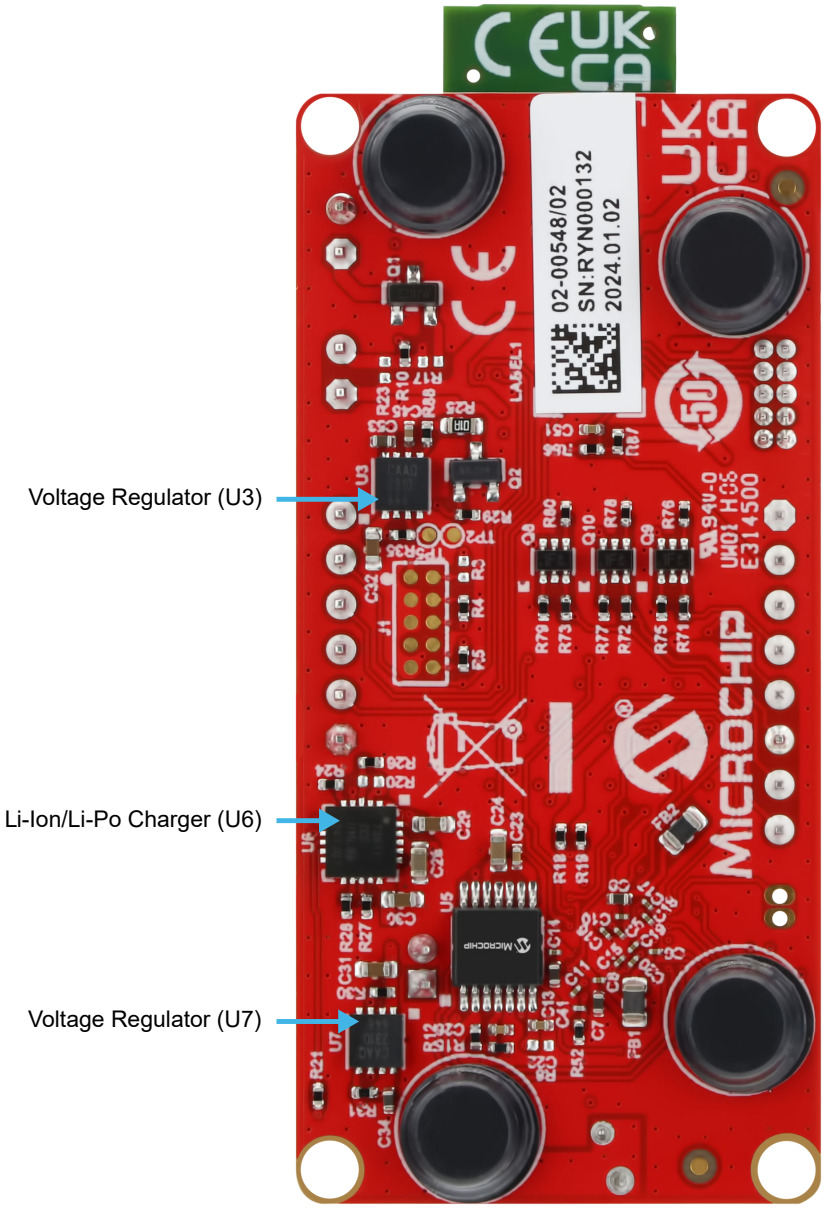


Figure 2-2. WBZ450 Curiosity Board (EV22L65A) – Bottom View



2.1 Kit Contents

The EV22L65A (WBZ450 Curiosity Board) kit contains the following:

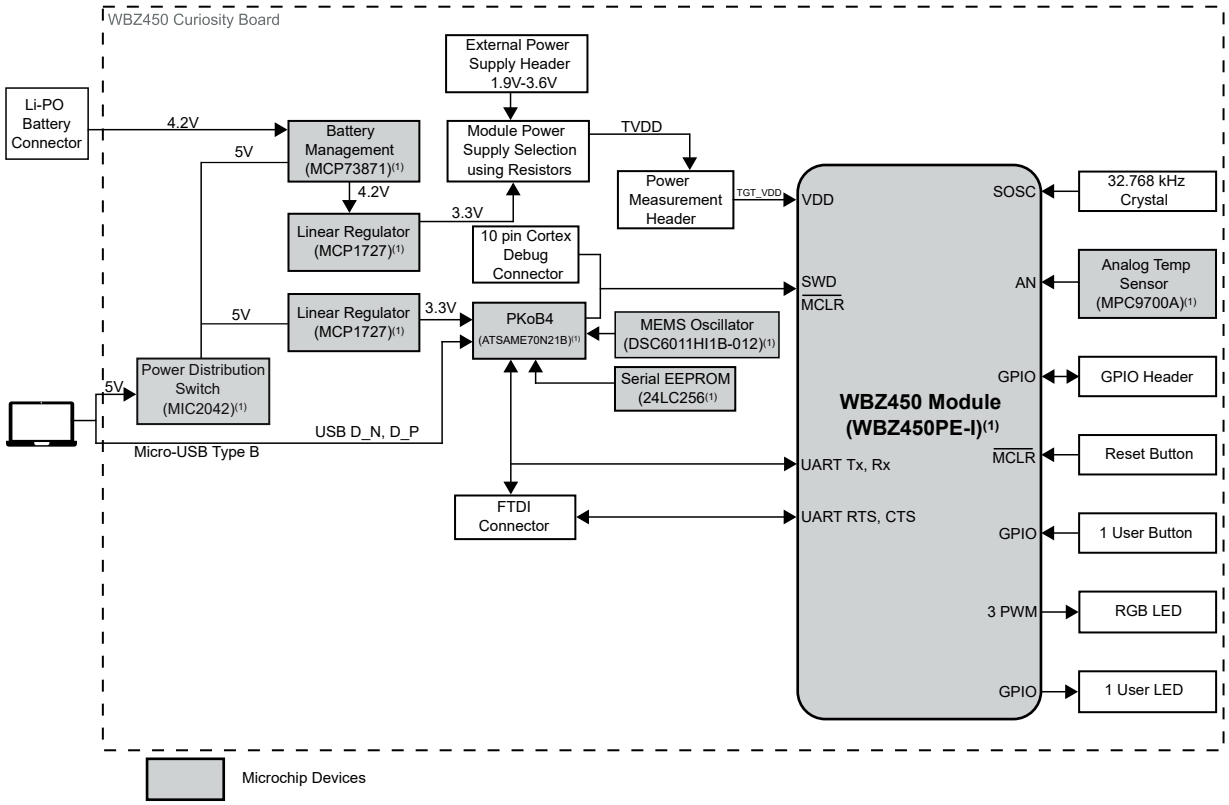
- A WBZ450PE Module mounted on the WBZ450 Curiosity Board
- A Type-A male to Micro-B USB cable

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 WBZ450 Curiosity Board.

Figure 3-1. WBZ450 Curiosity Board Block Diagram



Note:

1. 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 WBZ450 Curiosity Boards. For more details, go to support.microchip.com or contact your local Microchip Sales office.

Table 3-1. Microchip Components used in the WBZ450 Curiosity Board

S.No.	Designator	Manufacturer Part Number	Description
1	Q2, Q4, Q5	TN2106K1-G	Analog MOSFET N-CH TN2106 60V 280 mA 360 mW 2.5R SOT23-3
2	U3, U7	MCP1727-3302E/MF	Analog LDO 3.3V MCP1727-3302E/MF
3	U4	24LC256T-E/ST	Memory Serial EEPROM 256k I2C 24LC256T-E/ST TSSOP-8
4	U5	MIC2042-1YTS	Analog Power Switch 5.5V 3A MIC2042-1YTS TSSOP-14
5	U6	MCP73871-2CCI/ML	Analog Battery Charger MCP73871-2CCI/ML QFN-20
6	U10	WBZ450PE-I	MOD Bluetooth Low Energy/ZIGBEE WBZ450PE-I
7	U11	ATSAME70N21B-CNT	MCU 32-BIT 300 MHz 2 MB 384K x 8 ATSAME70N21B-CNT TFBGA-100
8	U16	MCP9700AT-E/TT	Analog Temperature Sensor -40C to +150C MCP9700AT-E/TT SOT-23-3
9	Y1	DSC6011HI1B-012.0000	CMOS Oscillator 12 MHz DSC6011HI1B-012.0000 SMD VFLGA-4

3.1 Power Supply

The WBZ450 Curiosity Board can be powered using any of the following sources:

1. The USB supplies power to the WBZ450 Curiosity Board using a Type-A male to Micro-B USB cable connected to the Micro-B USB connector (PS) (J7).
2. 4.2V Li-ion/Li-Po battery kit as follows:
   - Connected to J5, JST PH, 2-pin, 2 mm pitch and right-angle male battery header
   - Crimp style connector, battery polarity according to ± marking on the Curiosity Board
   - Battery is not part of the kit
   - Minimum recommended battery capacity is 400 mAh with a battery charge voltage of 4.2V

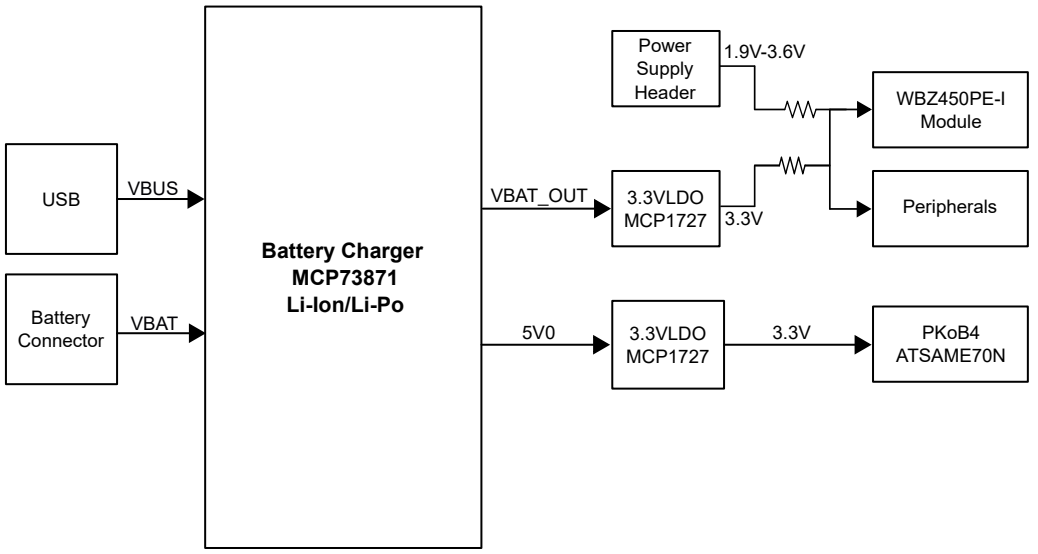
Battery management circuit automatically handles selection between USB power supply and battery supply.

The following are the two on-board MCP1727 voltage regulators on the WBZ450 Curiosity Board that power the circuitry on-board.

- U3 – Generates 3.3V that powers the WBZ450PE Module along with the associated circuits
- U7 – Generates 3.3V that powers the PKOB4 controller (U11), along with the associated circuits that connect the PKOB4 debugger to a host PC

For more details on the U3 and U7 voltage regulators, refer to the *MCP1727 1.5A, Low Voltage, Low Quiescent Current LDO Regulator Data Sheet* (DS21999).

Figure 3-2. WBZ450 Curiosity Board Power Supply Block Diagram



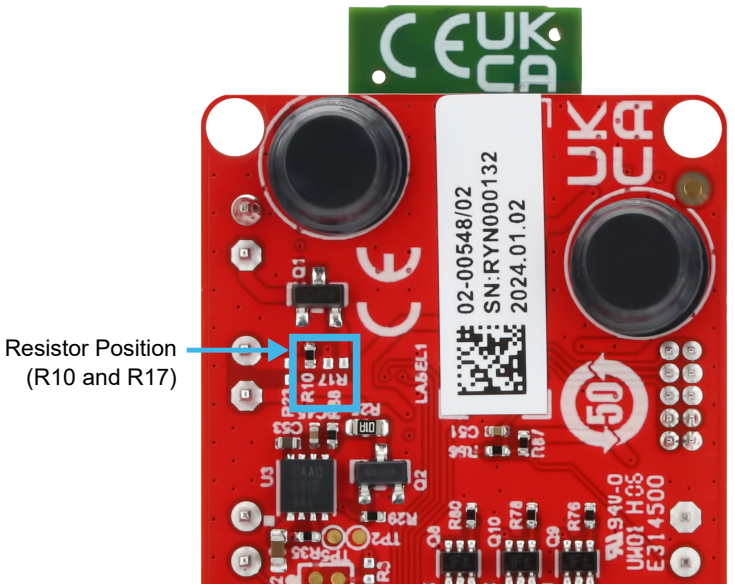
The WBZ450PE Module and associated peripherals can also be powered from:

- External power supply header (J3) using external power supply (1.9-3.6V) for testing at different voltage levels apart from the default supply of 3.3V from on-board regulator. To use the external power supply header, disconnect the on-board 3.3V supply according to the following table:

Table 3-2. Resistor Option to Select the WBZ450PE Module Power Supply

On-board 3.3V Regulator	External Power Supply
Mount R10	Do not mount R10
Do not mount R17	Mount R17

Figure 3-3. Resistor Position to Select the WBZ450 Module Power Supply



Note: The maximum available current from the Micro-B USB Connector (PS) (J7) is limited to 500 mA. The current is shared between charging the external battery (if connected) and the target application section.

3.2 Li-Po Battery Charger

A 4.2V, Li-Po battery connected to the 2-pin, 2 mm pitch right-angle male battery header can be charged using Battery Management IC MCP73871-2CC (U6) from the USB power supply at 100 mA fast charge current.

The battery management circuit automatically handles selection between the USB power supply and battery supply. The current is shared between charging the battery (if connected) and the target application section. For more details on the MCP73871 Li-ion/Li-Po battery charger, refer to the *Stand-Alone System Load Sharing and Li-Ion/Li-Polymer Battery Charge Management Controller Data Sheet* (DS20002090).

Table 3-3. LD1 Battery Charger Status LED

LED Color	Function
Red (charging)	The battery is charged by the USB when USB is plugged-in.
Red (discharging)	The battery voltage is low. Triggers if the voltage is under 3.1V.
Green	Fully charged

3.3 USB Connectivity using PKOB4

The WBZ450 Curiosity Board includes an integrated programmer and debugger MPLAB PICkit On-Board 4 (PKOB4), which is a new generation of In-Circuit Debugger that requires no additional programming/debugging tool to get started.

The following are the features and capabilities of PKOB4:

- Connects to computer through high-speed USB 2.0 (480 Mbits/s) cable
- Programs devices using MPLAB X IDE or MPLAB IPE
- Supports multiple hardware and software breakpoints, stopwatch and source code file debugging

- Debugs your application in real time
- Sets breakpoints based on internal events
- Monitors internal file registers
- Debugs at full speed
- Configures pin drivers
- Field-upgradeable through an MPLAB X IDE firmware download
- Indicates debugger status through on-board LEDs development board functionality and features
- Virtual COM port (VCOM)

PKOB4 on the WBZ450 Curiosity Board is intended to support programming and debugging the target device, WBZ450PE Module through the Micro-B USB Connector (PS) (J7) from the host PC and to act as a USB to UART converter using PICKIT4 On-board virtual COM port.

3.4 Debugger/Programmer

By default, the on-board debugger (PKOB4) is connected to the programming pins (SWDIO and SWDCLK) of the WBZ450PE Module.

The voltage level translators are provided on signals between PKOB4 and WBZ450PE Module for supporting target voltage from 1.9-3.6V.

Two PKOB4 LEDs indicate:

- Green (D1) – ACTIVE indicator
- Yellow (D2) – STATUS indicator

In addition, the WBZ450 Curiosity Board supports external debuggers, such as MPLAB ICD4, MPLAB PICKIT4 and MPLAB SNAP by connecting to the debug connector (J10).

The debug connector (J10) follows the standard ARM SWD 10. MPLAB ICD4 can be connected to the DBG header using the debugger adapter board (AC102015). For more details, refer to the *Debugger Adapter Board* (AC102015).

Table 3-4. SWD Debug Connector Details

Pin Number of DBG Header	Pin Name	Description
1	VCC	RF module power supply
2	SWDIO	PB9, SWD programming data
3	GND	Ground
4	SWCLK	PB8, SWD programming clock
5	GND	Ground
6	SWO	PB7, optional trace output
7	NC	No connection
8	NC	No connection
9	GND	Ground
10	RESET	RF module reset NMCLR pin

3.5 PKOB4 Virtual COM Port

The PKOB4 on the WBZ450 Curiosity Board acts as a USB-to-UART converter through the Micro-B USB (PS) connector (J7) from the host PC. Voltage level translators are provided on signals between MCP2200 and the WBZ450PE Module for supporting target voltage from 1.9-3.6V when powered externally.

Table 3-5. USB Serial Converter Pin Assignment

Pin on PKOB4	Pin on WBZ450PE Module	Description
TX	PA6, SERCOM0_PAD1	UART RX pin of the WBZ450PE Module
RX	PA5, SERCOM0_PAD0	UART TX pin of the WBZ450PE Module

3.6 UART with Hardware Flow Control

The following table provides details about the 1x6 UART header (J8) that supports UART with hardware flow control with pinout.

Table 3-6. UART Header (J8) Pin Details

Pin on J8	Pin on WBZ450PE Module	Description
1	GND	Ground
2	PB6, SERCOM1_PAD2	UART RTS pin
3	NC	No connection
4	PA6(2), SERCOM1_PAD1	UART RX pin
5	PA5(1), SERCOM1_PAD0	UART TX pin
6	PB0, SERCOM1_PAD3	UART CTS pin

Notes:

1. In J8, PA5 is also shared with PKOB4. Depopulate R1 to isolate the connection to PKOB4.
2. In J8, PA6 is also shared with PKOB4. Depopulate R2 to isolate the connection to PKOB4.

3.7 Switches

The following switches are available on the WBZ450 Curiosity Board:

- Reset switch (SW1)
- User configurable switch (SW2)

In the Idle state, the level of the Reset switch is pulled high using the external pull up resistor and, when the switch is pressed, it drives the level of the switch to low and resets the WBZ450PE Module.

The user-configurable switch is also pulled high using the external pull up resistor and, when the switch is pressed, it drives the level of the switch to low.

Table 3-7. Switches Description

Switch Name	Pin on WBZ450PE Module	Description
Reset (SW1)	NMCLR	Reset switch (SW1) connected to NMCLR pin
USR-BTN (SW2)	PB4	User-configurable switch (SW2)

3.8 LEDs

3.8.1 User LED (D4)

One user-programmable user LED (D4) is available on the WBZ450 Curiosity Board. This LED can be turned ON or OFF using the connected GPIO pin PB7. Drive the pin to a high level to turn OFF the LED, and drive the pin to a low level to turn ON the LED.

3.8.2 RGB LED (D3)

Three PWM signals from the WBZ450PE Module are connected to RGB LED (D3) on the WBZ450 Curiosity Board.

Table 3-8. RGB LED Pin Description

Color	Pin on WBZ450
Red	PA9
Green	PA10
Blue	PB5

3.9 Temperature Sensor (U16)

Analog output from the temperature sensor (2.3-5.5V Microchip MCP9700A, U16) is connected to one of the analog pins (PB1, AN5) of the WBZ450PE Module's ADC channel. For more details, refer to the *MCP9700A, Low-Power Linear Active Thermistor IC Data Sheet* (DS20001942).

3.10 Power Measurement Header (J4)

To measure the power going to the WBZ450PE Module, 1x2, 2.54 mm male pin header with shunt connector (I-MEAS, J4) is provided. The user must ensure to populate the shunt connector on the power measurement header (J4) under normal conditions.

3.11 32.768 kHz Secondary Oscillator (Y2)

The 32.768 kHz crystal (Y2) connected to SOSC pins (PA4 and PA3) of the WBZ450PE Module.

3.12 WBZ450PE Module

For more details on the WBZ450PE Module pinout details, refer to the *High-performance 2.4 GHz Multi-protocol Wireless MCUs and Modules, supporting Bluetooth Low Energy and 802.15.4 protocols with 32-bit ARM® Cortex®-M4F, 2 Msps 12-bit ADC Data Sheet.*

Note: The user can configure the Peripheral Pin Select (PPS) pins for any of the supported peripheral functions based on the end user application.

3.13 Limitations of Using Battery and External Power Supply

Battery Power:

The battery management circuit is designed for a 4.2V battery going to a downstream 3.3V regulator. When the battery voltage is near to the required minimum input voltage of the regulator, it can affect the regulated output. It is advised to use a fully charged battery for evaluation and to recharge the battery as soon as the low battery output indicator is turned ON.

External Power Supply Header:

The WBZ450 Curiosity Board is designed by default for evaluating the WBZ450PE Module and associated peripherals with an on-board 3.3V regulator. The following limitations apply for the circuitry if the WBZ450PE Module and associated circuitry is powered from external power supply header at other voltages:

- Temperature Sensor MPC9700A (U16) – Standard operating voltage for the temperature sensor is 2.3-3.6V operation
- User LED (D4) – Designed for 3.3V operation; LED brightness at lower voltages will be dull or no glow. To increase the emitted light level, the value of the series resistor (R42) can be lowered.
- RGB Lighting LED (D3) – RGB lightning LED is powered from VBAT net. It requires either USB or battery power supply to be plugged in to be functional.

4. WBZ450 Curiosity Board Out of Box Demo

The ble_zigbee_light_prov demo application is pre-programmed on the WBZ450 Curiosity Board.

This application brings several Bluetooth Low Energy, Zigbee and multiprotocol (Bluetooth Low Energy and Zigbee) concepts to practice.

For more details for the Out-of-Box (OOB) demo source code and demo guide, go to ble_zigbee_light_prov_wbz450.

5. Appendix A: Reference Circuit

5.1 WBZ450 Curiosity Board Reference Schematics

Figure 5-1. USB

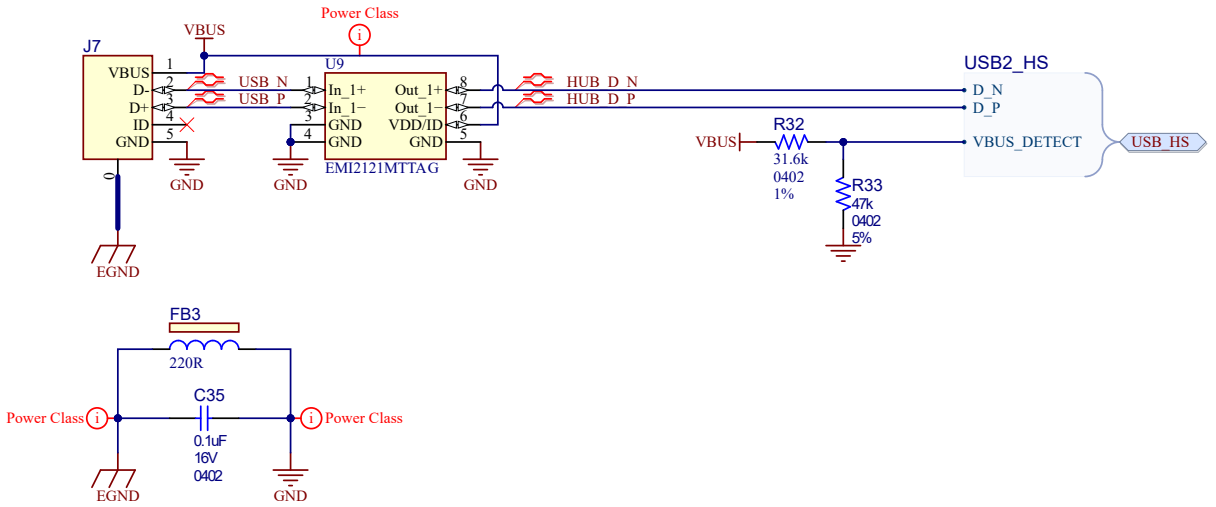


Figure 5-2. Power Distribution Switch for PKoB4

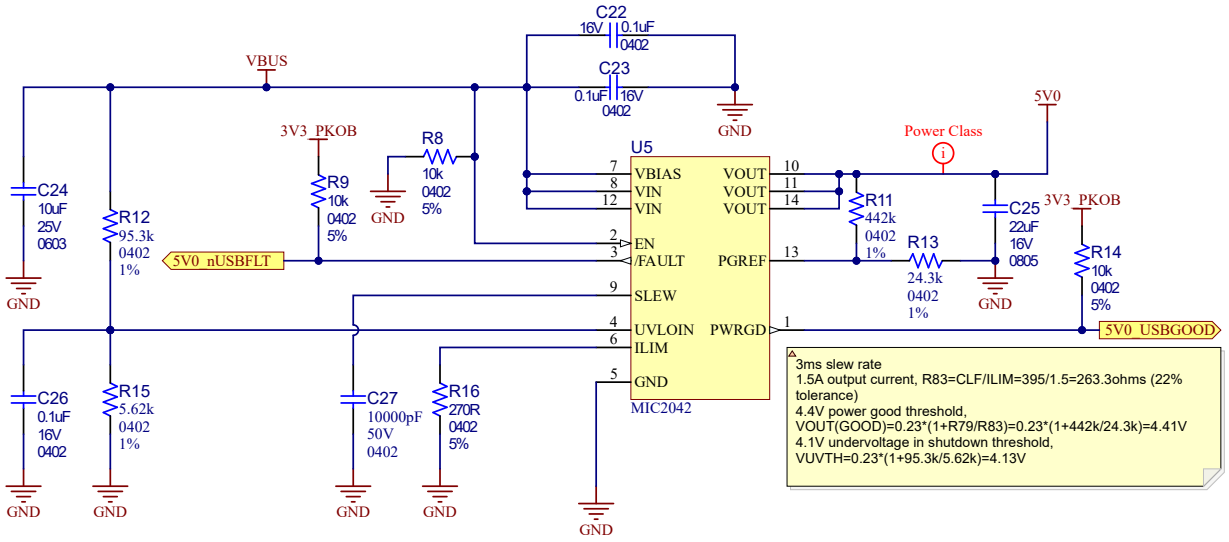


Figure 5-3. Li-Po Battery Connector/Charger

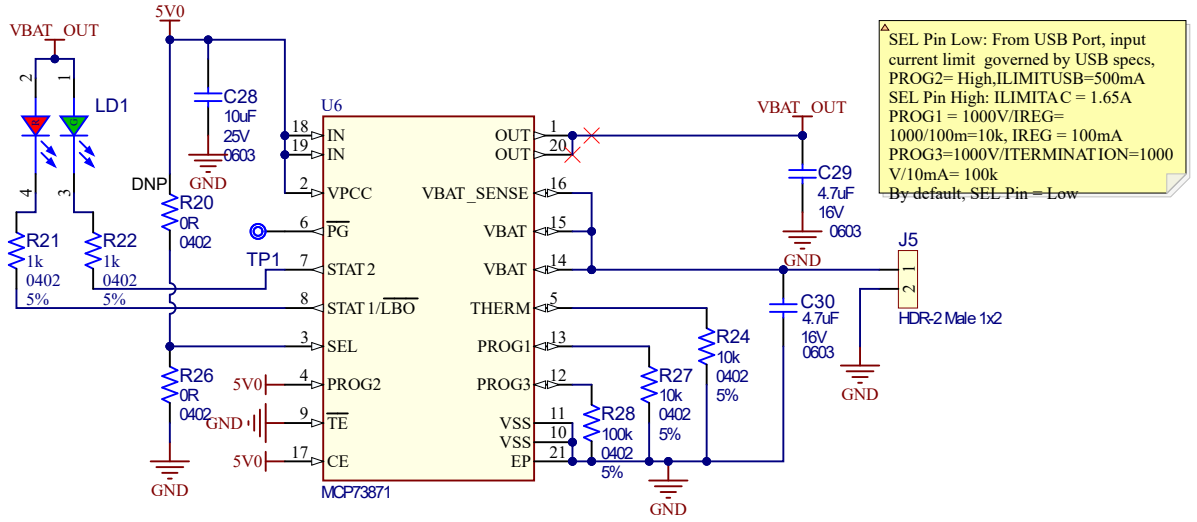


Figure 5-4. 3.3V Target Regulator

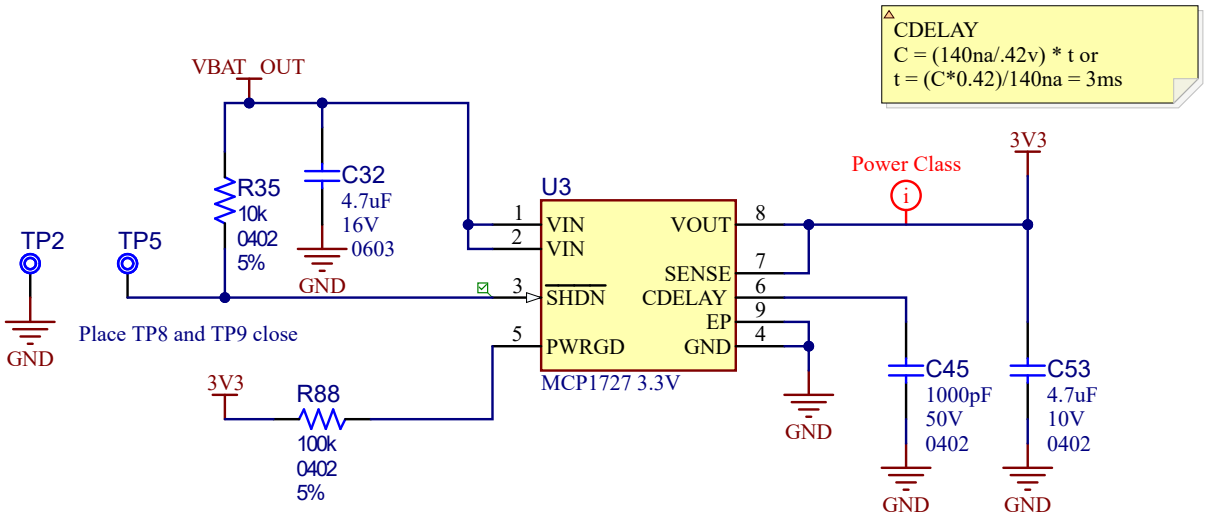


Figure 5-5. External Power Supply

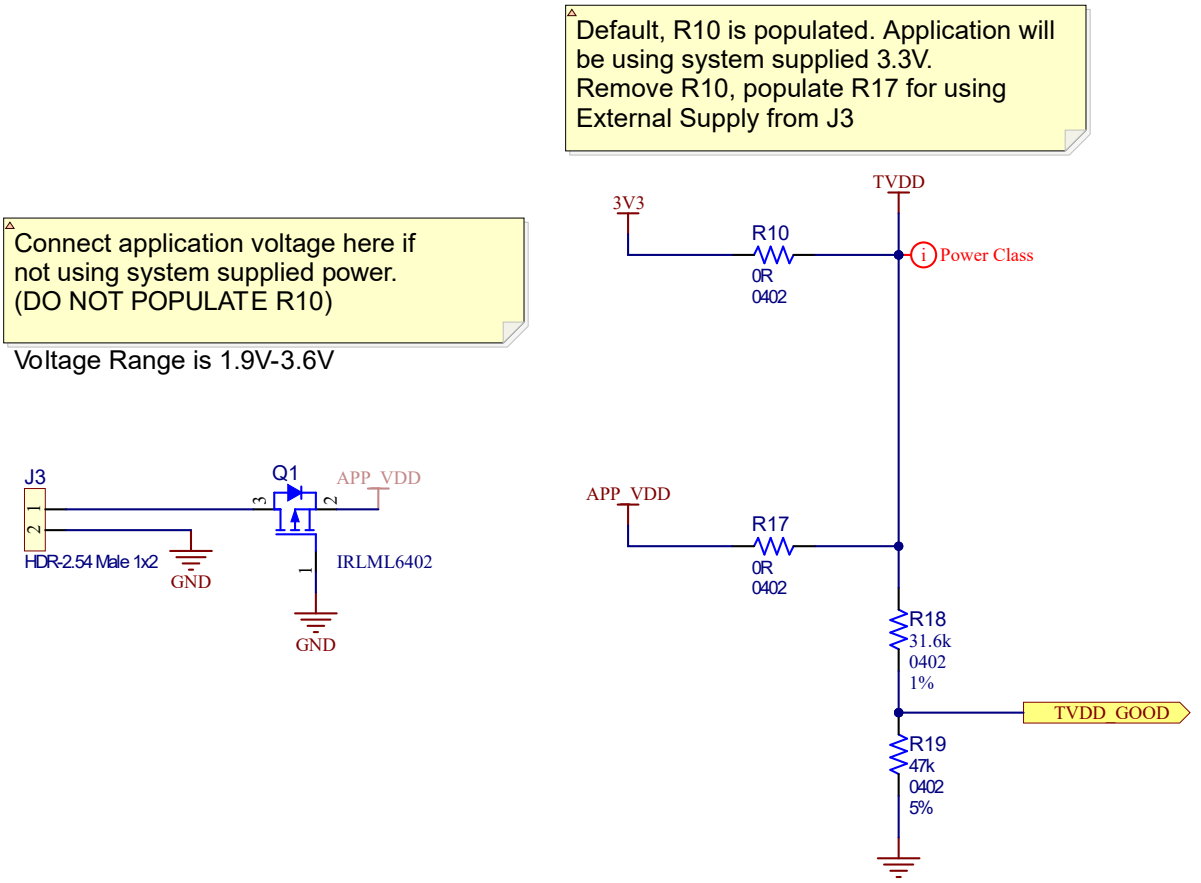


Figure 5-6. TGT Current Measurement Header

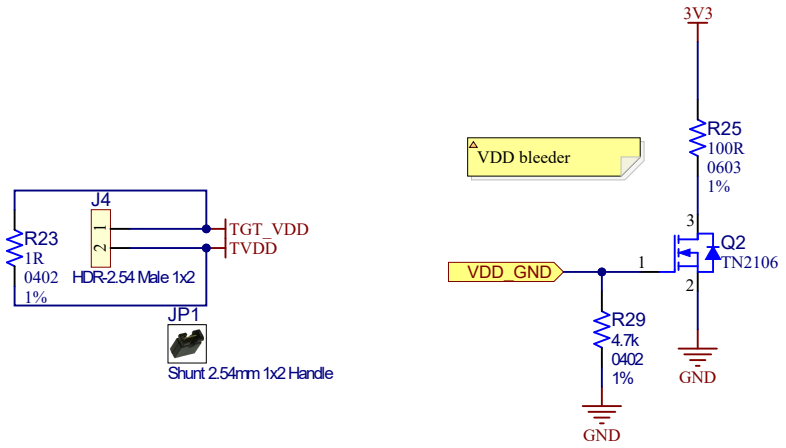


Figure 5-7. 3.3V Regulator for PKOB

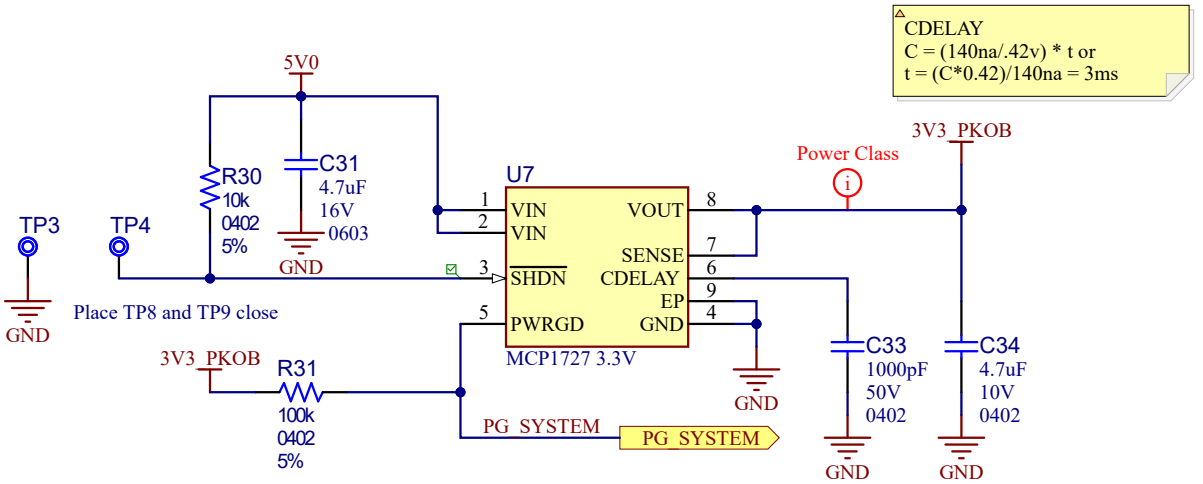


Figure 5-8. PKoB4 Main Micro 1 of 2

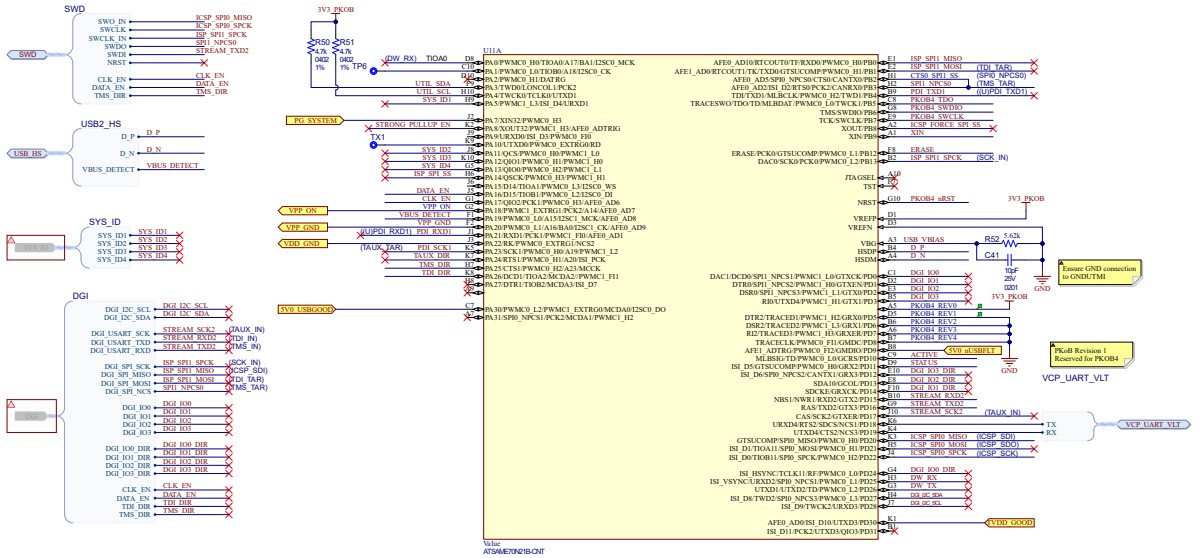


Figure 5-9. PKoB4 Main Micro 2 of 2

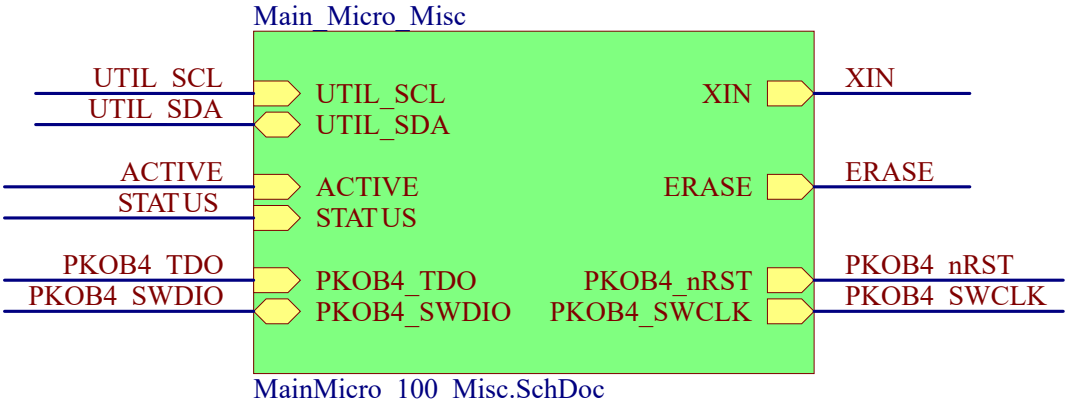


Figure 5-10. PKoB4 Debug Header Misc 1 of 2

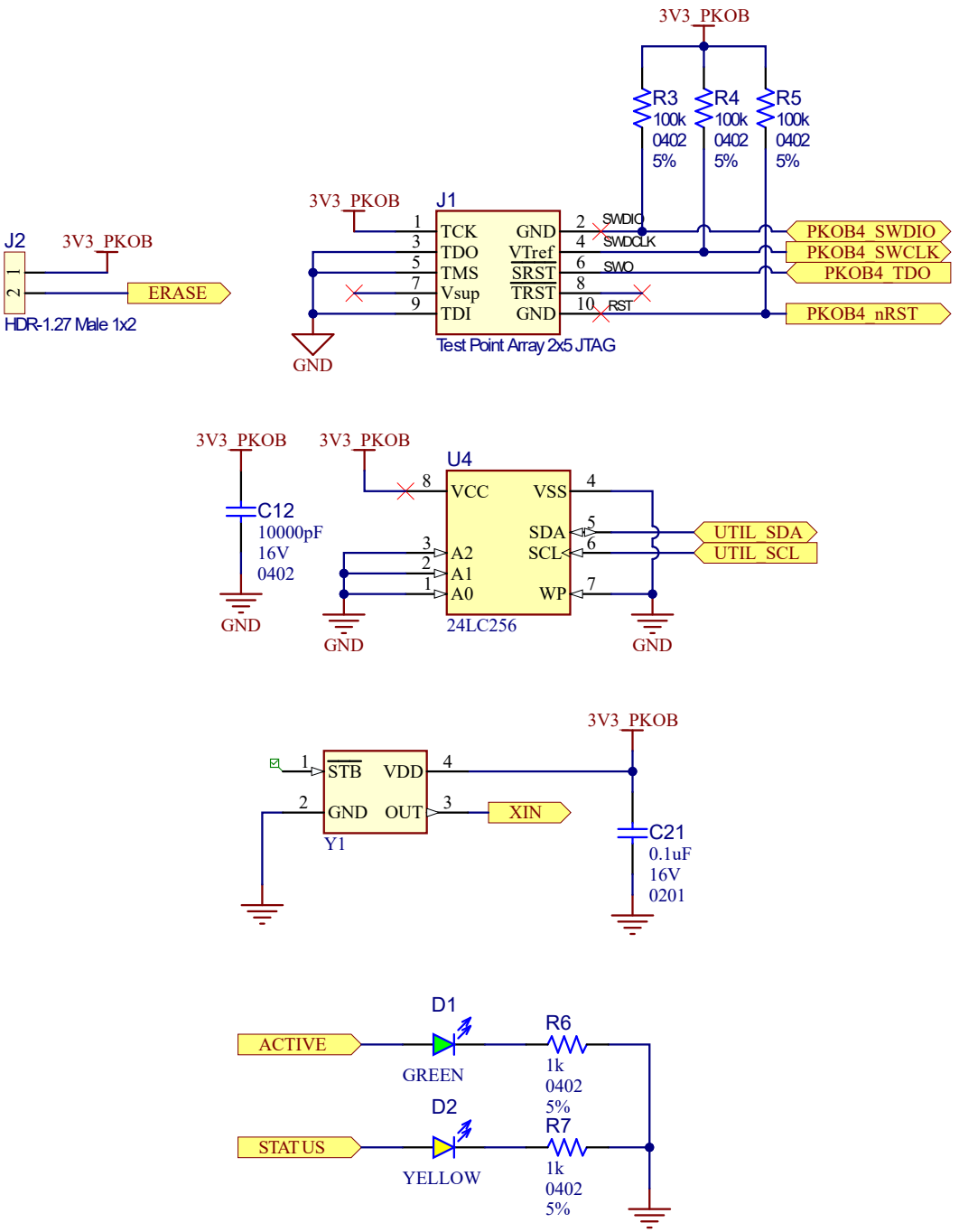


Figure 5-11. PKoB4 Debug Header Misc 2 of 2

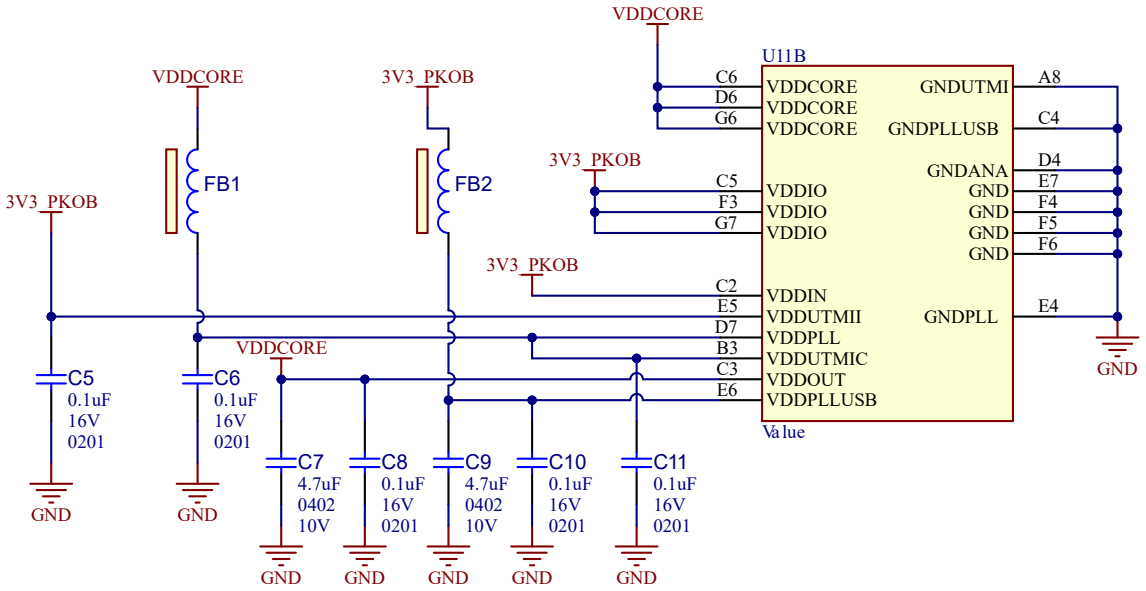


Figure 5-12. VDDIN Cap

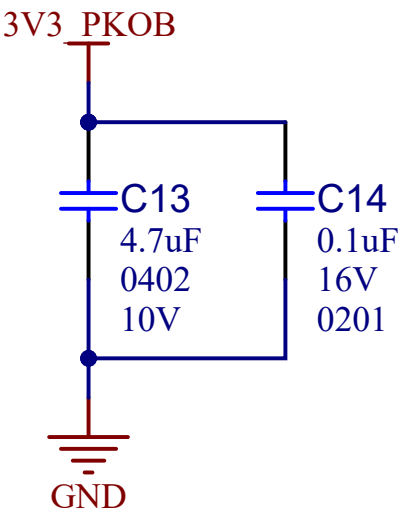


Figure 5-13. VDDIO Bypass Caps

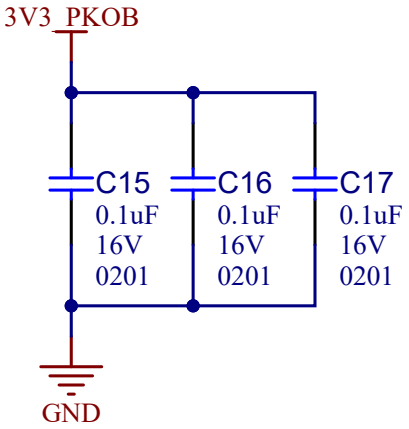


Figure 5-14. VDDCORE Bypass Caps

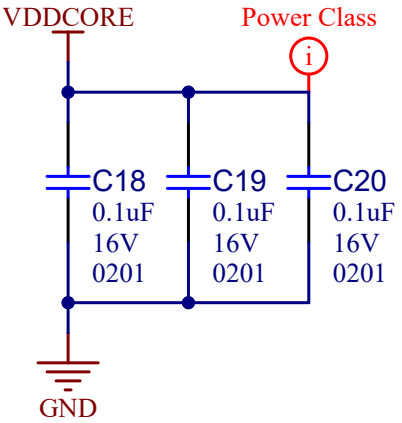


Figure 5-15. Serial Wire Debug

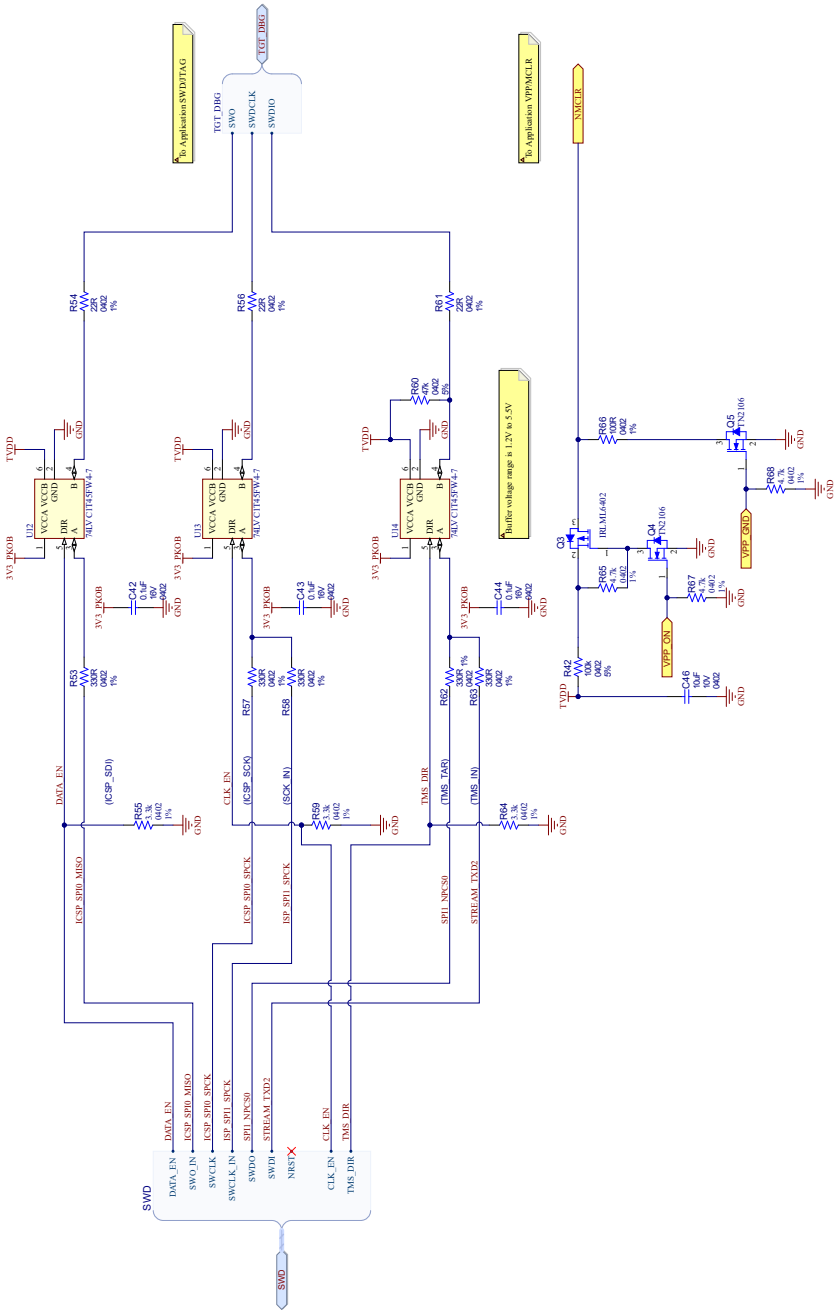


Figure 5-16. Application Virtual Comm Port

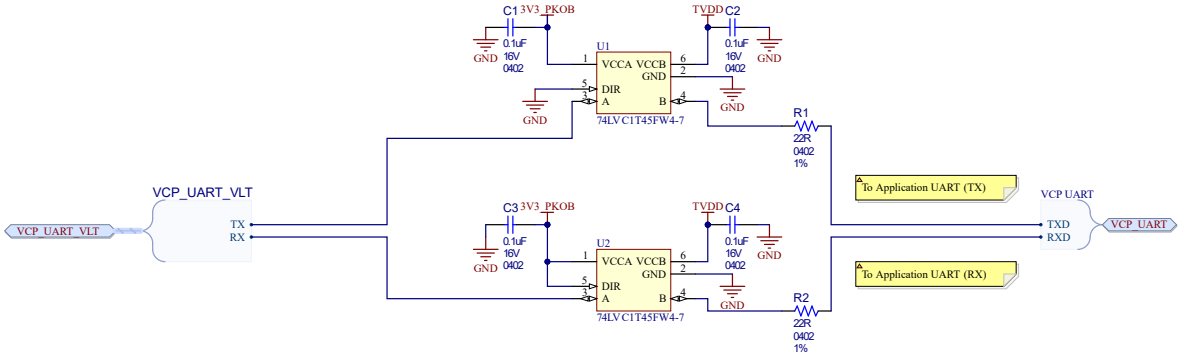


Figure 5-17. WBZ450PE-I Module

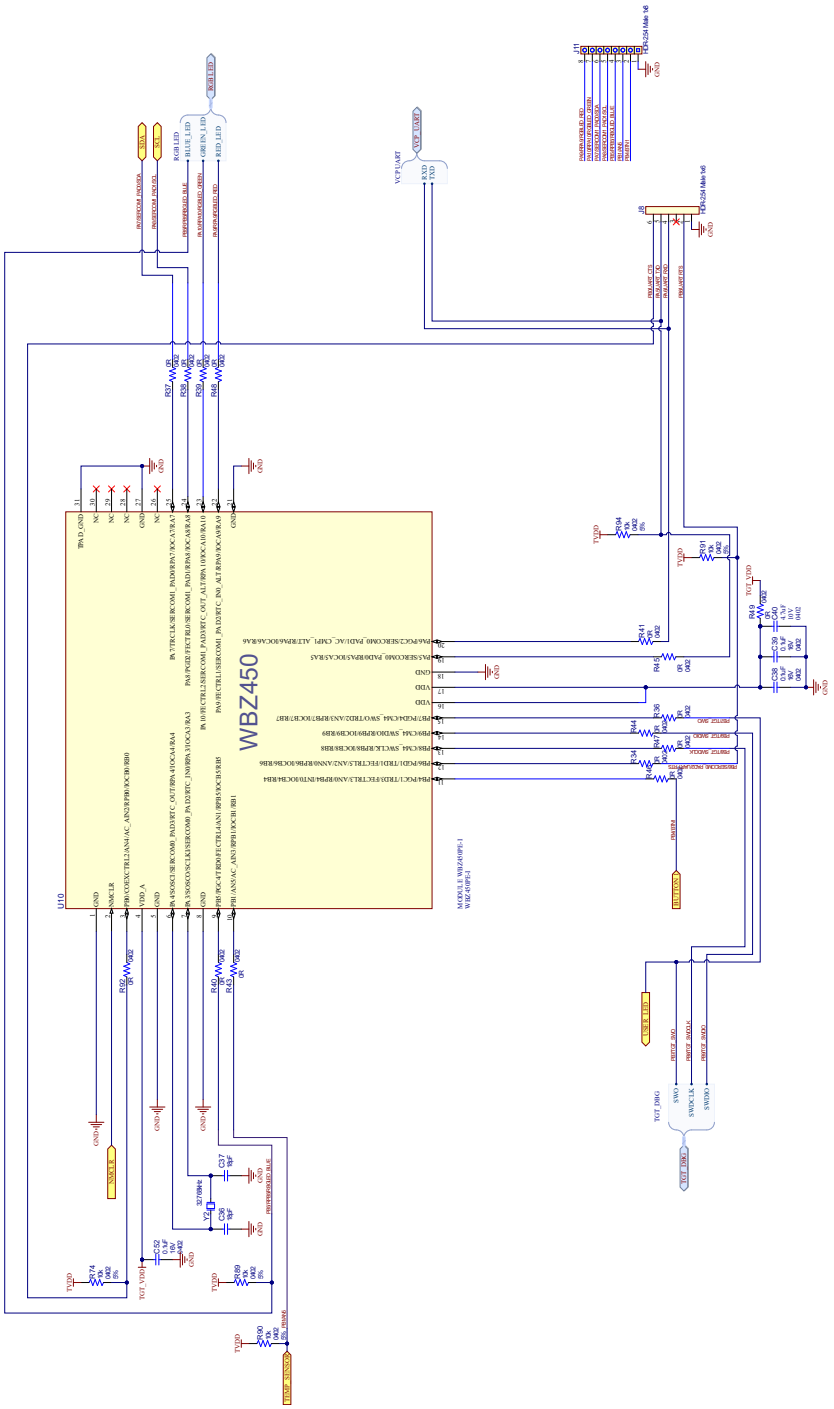


Figure 5-18. Crypto IC

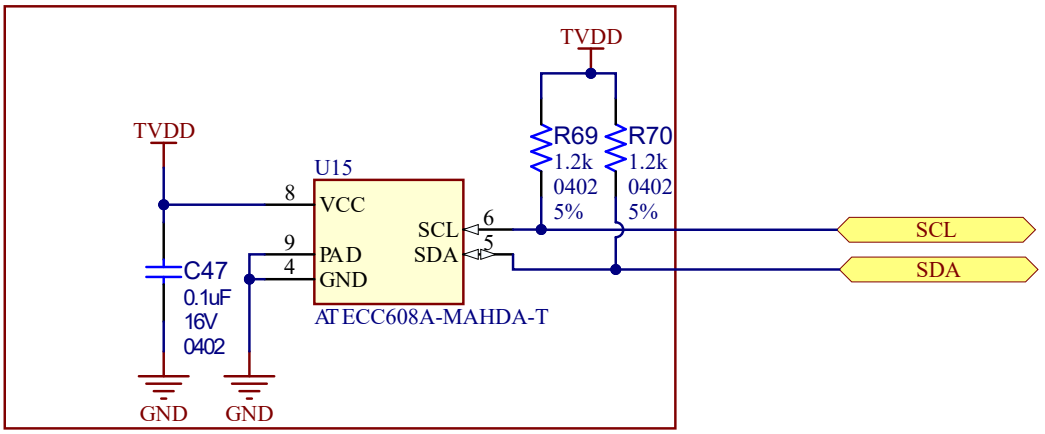


Figure 5-19. Debug Header Interface and Reset Button

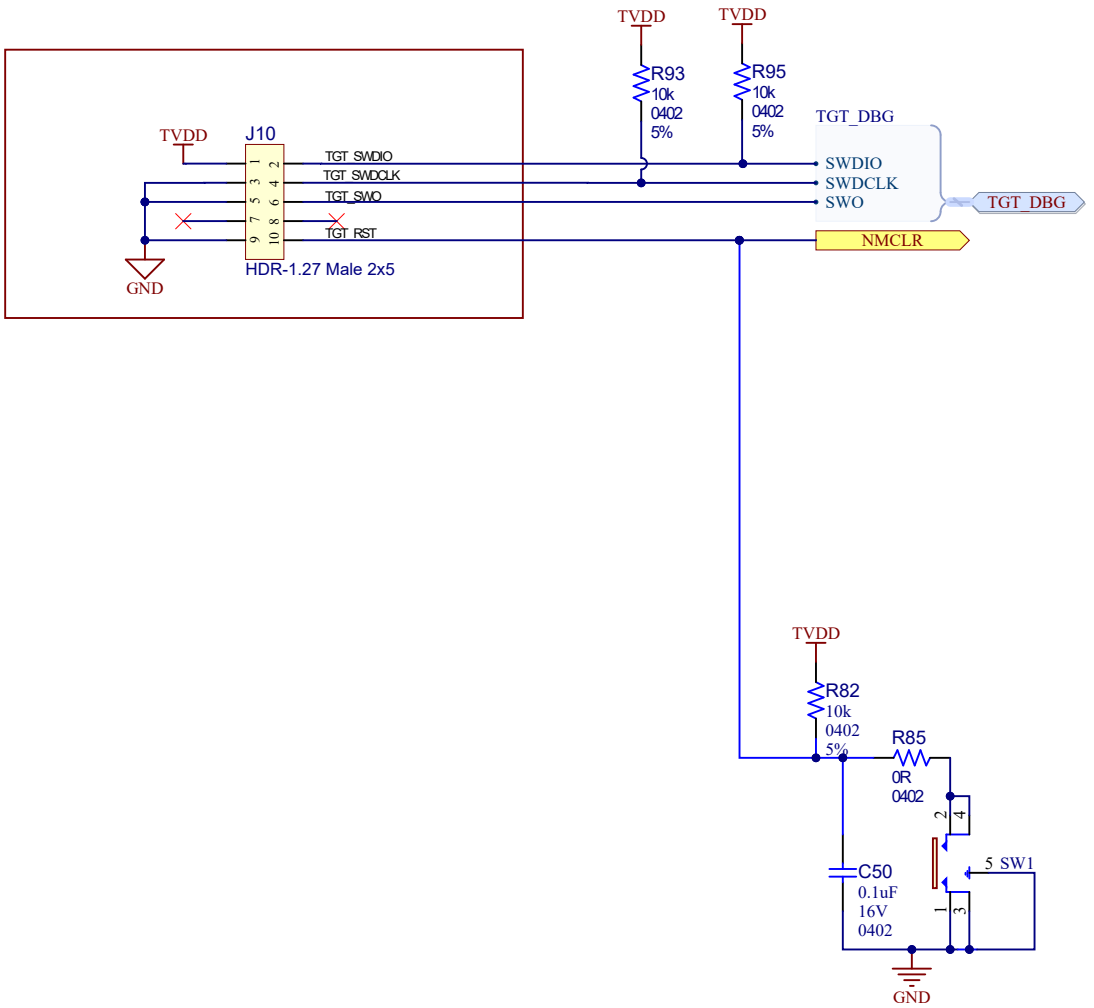


Figure 5-20. Temperature Sensor

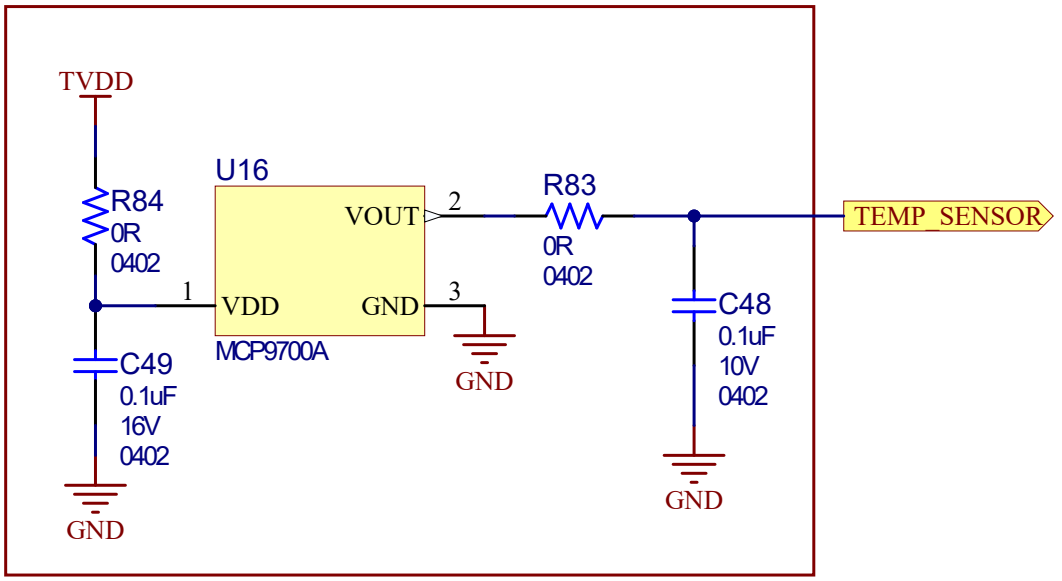


Figure 5-21. RGB LED

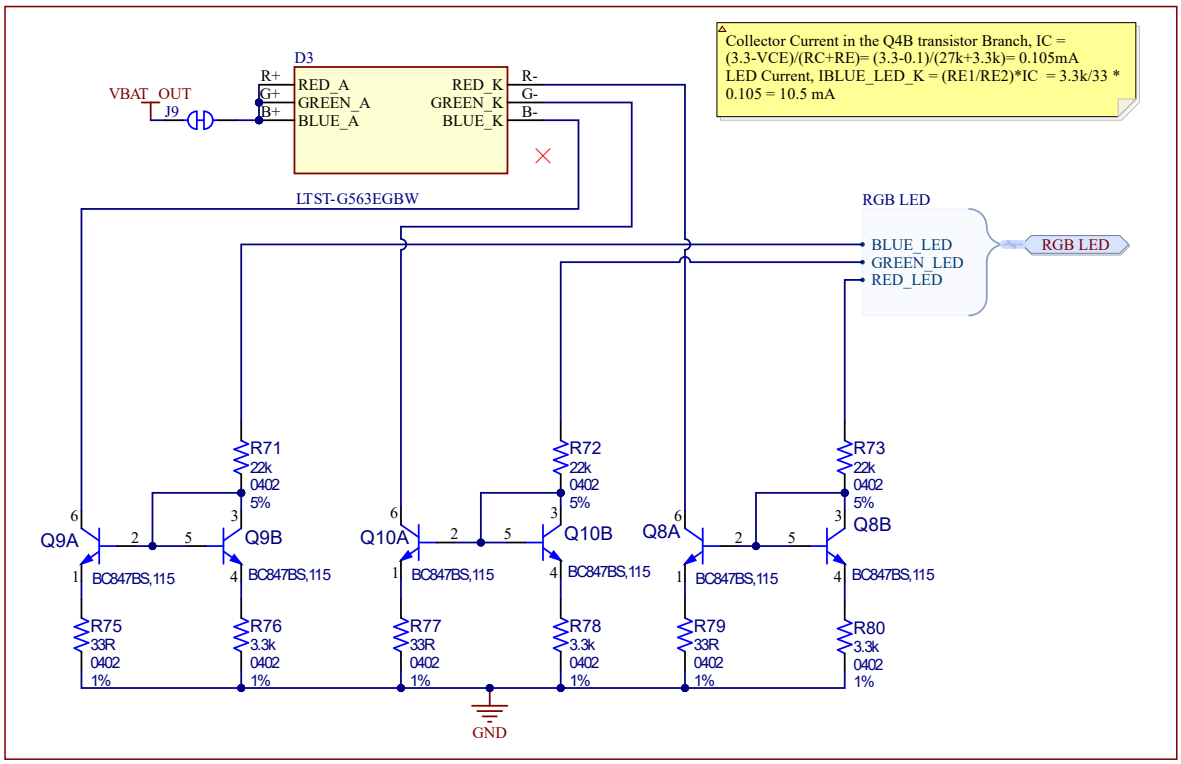


Figure 5-22. User LED

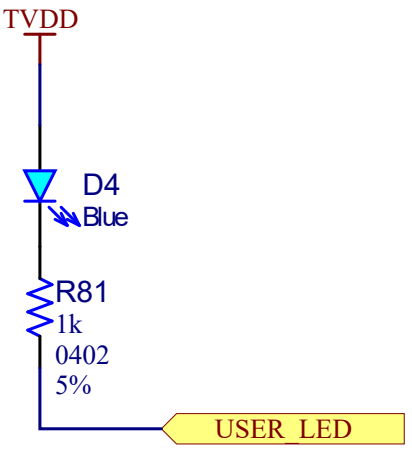
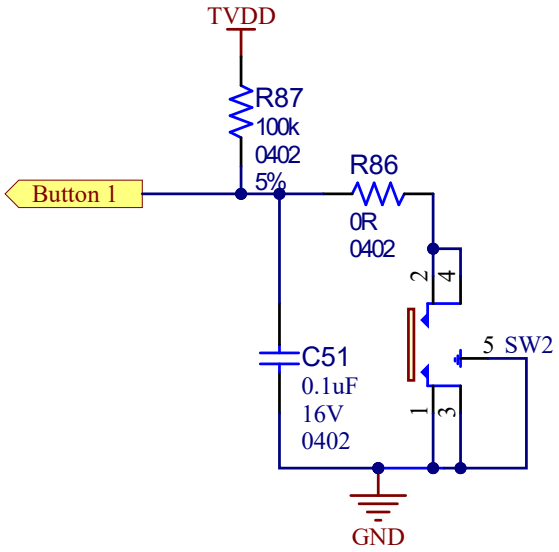


Figure 5-23. User Button



6. Appendix: B Regulatory Approval

This equipment (WBZ450 Curiosity Board/EV22L65A) 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 WBZ450PE module certifications. The following regulatory notices are to cover the requirements under the regulatory approval.

6.1 United States

The WBZ450 Curiosity Board (EV22L65A) contains the WBZ450PE 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: 2ADHKWBZ450

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.

CAUTION 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 WBZ450 Curiosity Board (EV22L65A) contains the WBZ450PE 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-WBZ450

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.

⚠ WARNING

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 (EV22L65A) 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 [EV22L65A] is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at *EV22L65A* (See *Conformity Documents*).

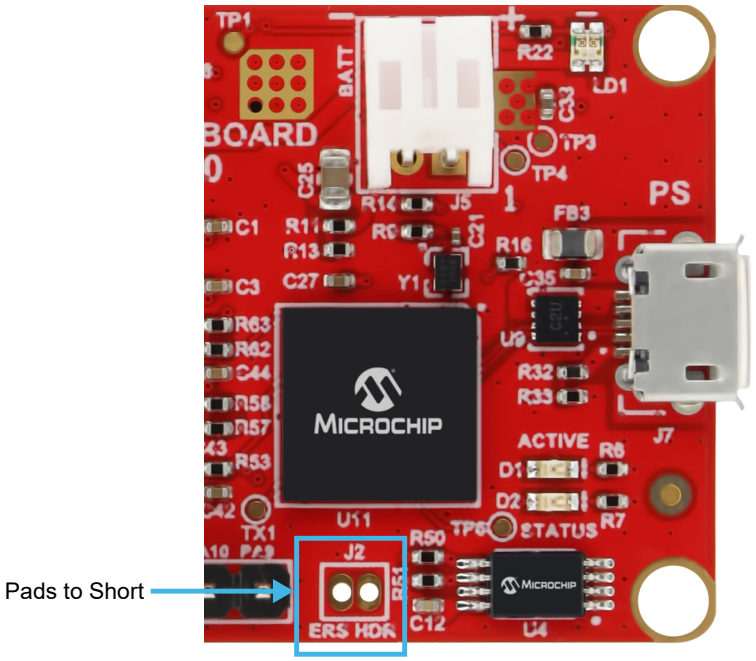
7. Appendix C: PKOB4 Recovery Method

When the MPLAB PICkit On-Board 4 is not responding, in rare cases, the user can recover its operation by following these steps:

WARNING Only use this utility to restore the hardware tool boot firmware to its factory state. Use only if the hardware tool no longer functions on any machine.

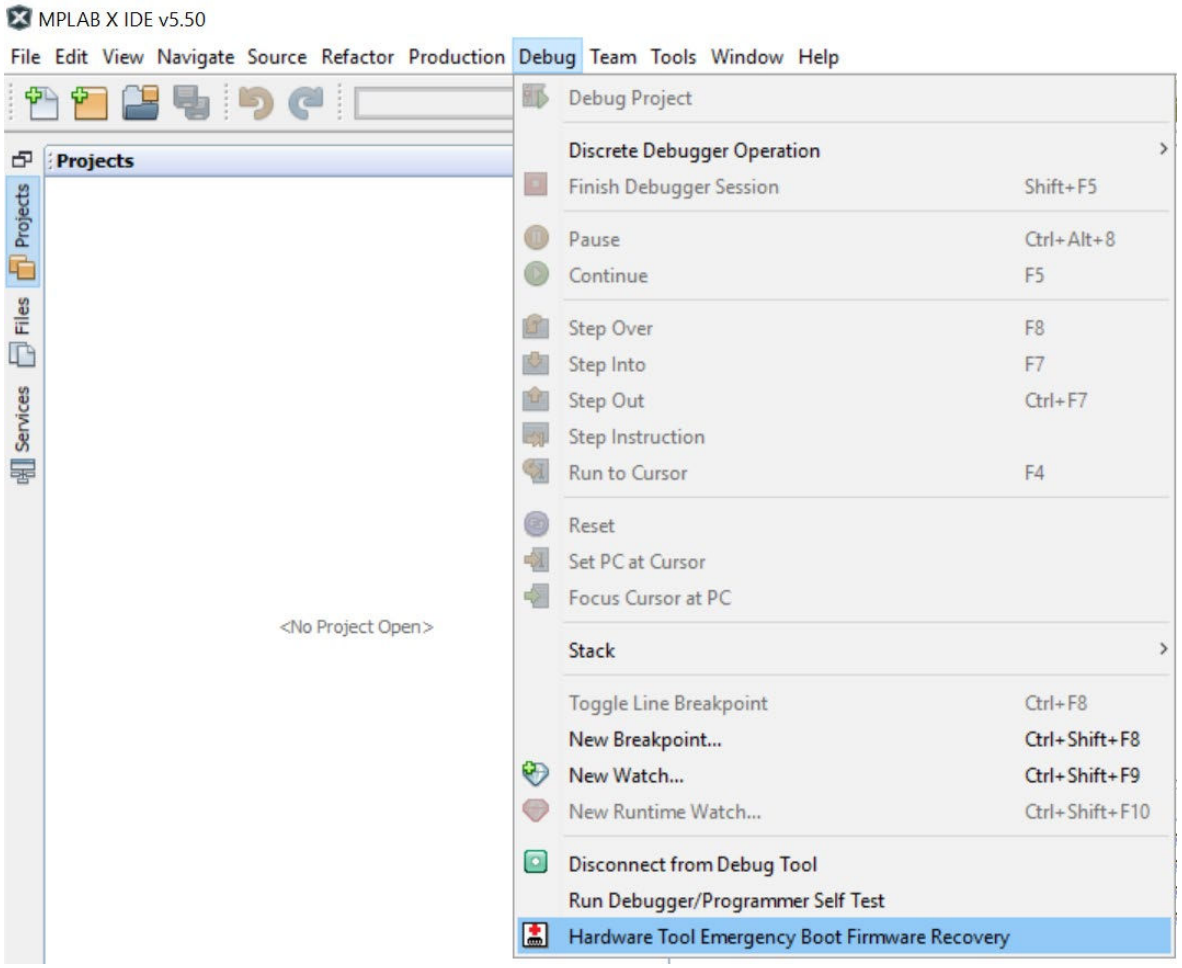
1. With the WBZ450 Curiosity Board still being powered, short the two pads for approximately ten seconds.

Figure 7-1. Location of Pads to Short



2. Open the latest version of MPLAB X. For more details, refer to the 1.3. Software Prerequisites.
3. Click **Debug** > **Hardware Tool Emergency Boot Firmware Recovery**.

Figure 7-2. Hardware Tool Emergency Boot Firmware Recovery



4. Follow the directions on the screen. This resets the tool back to the factory conditions.
   Note: For additional information on the MPLAB PKOB4, refer to the *MPLAB® PICkit™ 4 In-Circuit Debugger User's Guide* (DS50002751) and *MPLAB® Snap In-Circuit Debugger User's Guide* (DS50002787).

8. Document Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Table 8-1. Document Revision History

Revision	Date	Section	Description
A	02/2024	Document	Initial Revision

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