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PIC32MZ Embedded Connectivity (EC) Starter 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.

- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.

- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.

- Microchip is willing to work with the customer who is concerned about the integrity of their code.

- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

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PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT USER'S GUIDE

Table of Contents

NOTES:

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 web site (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 PIC32MZ Embedded Connectivity (EC) Starter Kit. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the PIC32MZ Embedded Connectivity (EC) Starter Kit (also referred to as "starter kit") as a development tool to emulate and debug firmware on a target board. This user's guide is composed of the following chapters:

- **Chapter 1. "Introduction"** provides a brief overview of the starter kit, highlighting its features and uses.
- **Chapter 2. "Hardware"** provides the hardware descriptions of the starter kit.
- **Appendix A. "Board Layout and Schematics"** provides a block diagram, board layouts, and detailed schematics of the starter kit.
- **Appendix B. "Bill of Materials"** provides the bill of materials for the components used in the design and manufacture of the starter kit.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
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
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
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)`
		`{ ...`
		`}`

Notes	A Note presents information that we want to re-emphasize, either to help you avoid a common pitfall or to make you aware of operating differences between some device family members. A Note can be in a box, or when used in a table or figure, it is located at the bottom of the table or figure.	**Note:** This is a standard note box. **CAUTION** **This is a caution note.** **Note 1:** This is a note used in a table.

RECOMMENDED READING

This user's guide describes how to use the starter kit. The following Microchip documents are available and recommended as supplemental reference resources.

PIC32MZ Embedded Connectivity (EC) Family Data Sheet (DS60001191)

Refer to this document for detailed information on PIC32MZ EC family devices. Reference information found in this data sheet includes:

- Device memory maps
- Device pinout and packaging details
- Device electrical specifications
- List of peripherals included on the devices

MPLAB® XC32 C/C++ Compiler User's Guide (DS50001686)

This document details the use of Microchip's MPLAB XC32 C/C++ Compiler to develop an application.

MPLAB® X IDE User's Guide (DS50002027)

Refer to this document for more information pertaining to the installation and implementation of the MPLAB X IDE software, as well as the MPLAB SIM Simulator software that is included with it.

Universal Serial Bus Specification and Associated Documents

The Universal Serial Bus is defined by the USB 2.0 specification and its associated supplements and class-specific documents. These documents are available from the USB Implementers Forum. See their web site at: http://www.usb.org

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at http://www.microchip.com. This web site makes files and information easily available to customers. Accessible by most Internet browsers, the web site 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 listings
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listings of seminars and events; and listings of Microchip sales offices, distributors and factory representatives

DEVELOPMENT SYSTEMS CUSTOMER CHANGE NOTIFICATION SERVICE

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, access the Microchip web site at www.microchip.com, click on Customer Change Notification and follow the registration instructions.

The Development Systems product group categories are:

• **Compilers** – The latest information on Microchip C compilers and other language tools

• **Emulators** – The latest information on the Microchip in-circuit emulator, MPLAB REAL ICE™

• **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 3

• **MPLAB X IDE** – The latest information on Microchip MPLAB X IDE, the Windows® Integrated Development Environment for development systems tools

• **Programmers** – The latest information on Microchip programmers including the PICkit™ 3 development programmer

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 web site at: http://support.microchip.com

DOCUMENT REVISION HISTORY

Revision A (November 2013)

This is the initial release of this document.

NOTES:

Chapter 1. Introduction

Thank you for purchasing a Microchip Technology PIC32MZ Embedded Connectivity (EC) Starter Kit. This board provides a low-cost, modular development system for Microchip's line of 32-bit microcontrollers.

The starter kit comes preloaded with demonstration software for the user to explore the new features of the PIC32MZ EC family of devices. It is also expandable through a modular expansion interface, which allows the user to extend its functionality. The starter kit also supplies on-board circuitry for full debug and programming capabilities.

This chapter covers the following topics:

• Kit Contents
• Starter Kit Functionality and Features

The preprogrammed example code on the PIC32MZ EC family MCU is available for download from the Microchip web site at http://www.microchip.com. All project files have been included so that the code may be used directly to restore the PIC32MZ EC family MCU on the starter kit to its original state (i.e., if the sample device has been reprogrammed with another program) or so you can use the tutorial code as a platform for further experimentation.

1.1   KIT CONTENTS

The PIC32MZ Embedded Connectivity (EC) Starter Kit contains the following items:

• PIC32MZ Embedded Connectivity (EC) Starter Kit development board
• SMSC 8870A Ethernet PHY daughter board
• USB mini-B to full-sized A cable – USB debug cable to debug and power the starter kit development board
• USB micro-B to full-sized A cable – PIC32 USB cable to communicate with the PIC32 USB port
• RJ-45 CAT5 Ethernet patch cable – Ethernet CAT5 cable to communicate with the PIC32 Ethernet port

> **Note:**   If you are missing any part of a kit, contact a Microchip sales office for assistance. A list of Microchip offices for sales and service is provided on the back page of this document.

1.2   STARTER KIT FUNCTIONALITY AND FEATURES

Representations of the layout of the PIC32MZ Embedded Connectivity (EC) Starter Kit are shown in Figure 1-1 and Figure 1-2.
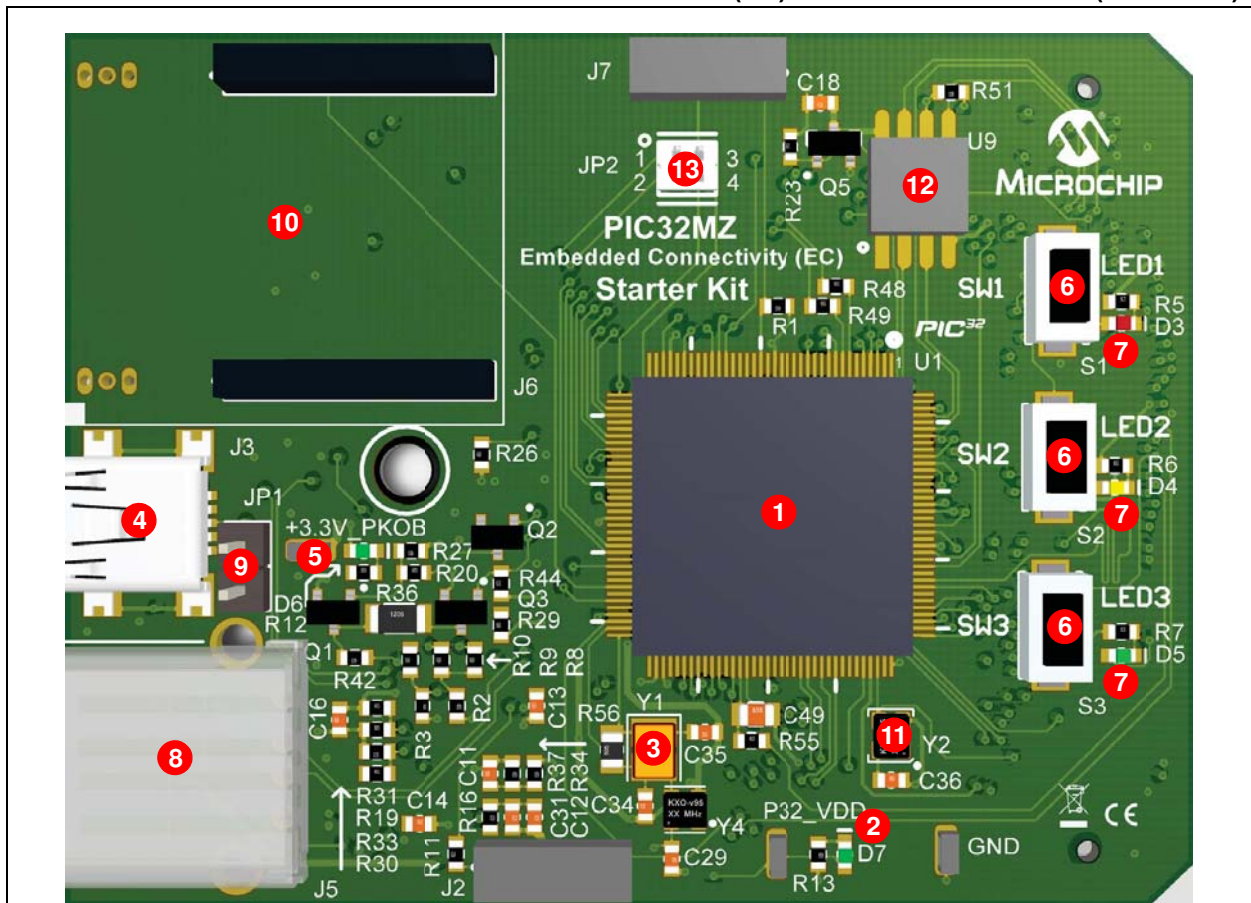
The top assembly of the board includes these key features, as indicated in Figure 1-1:

1. PIC32MZ2048ECH144-I/PH (non-crypto) or PIC32MZ2048ECM144-I/PH (crypto) 32-bit microcontroller.
2. Green power indicator LED.
3. On-board crystal or oscillator for precision microcontroller clocking (12 MHz).
4. USB connectivity for on-board debugger communications.
5. Green debug indicator LED.
6. Three push button switches for user-defined inputs.
7. Three user-defined indicator LEDs.
8. USB Type A receptacle connectivity for PIC32 host-based applications.
9. HOST mode power jumper.
10. Daughter board connectors for flexible Ethernet PHY options.
11. 32 kHz oscillator for RTCC and Timer1 (optional).
12. External 2 GB SQI memory for expanded memory applications.
13. Jumper for using or disconnecting the on-board debugger.

> **Note:** When running self-powered USB device applications, open the jumper JP1 to prevent possibly back-feeding voltage onto the VBUS from one port on the host to another (or from one host to another).

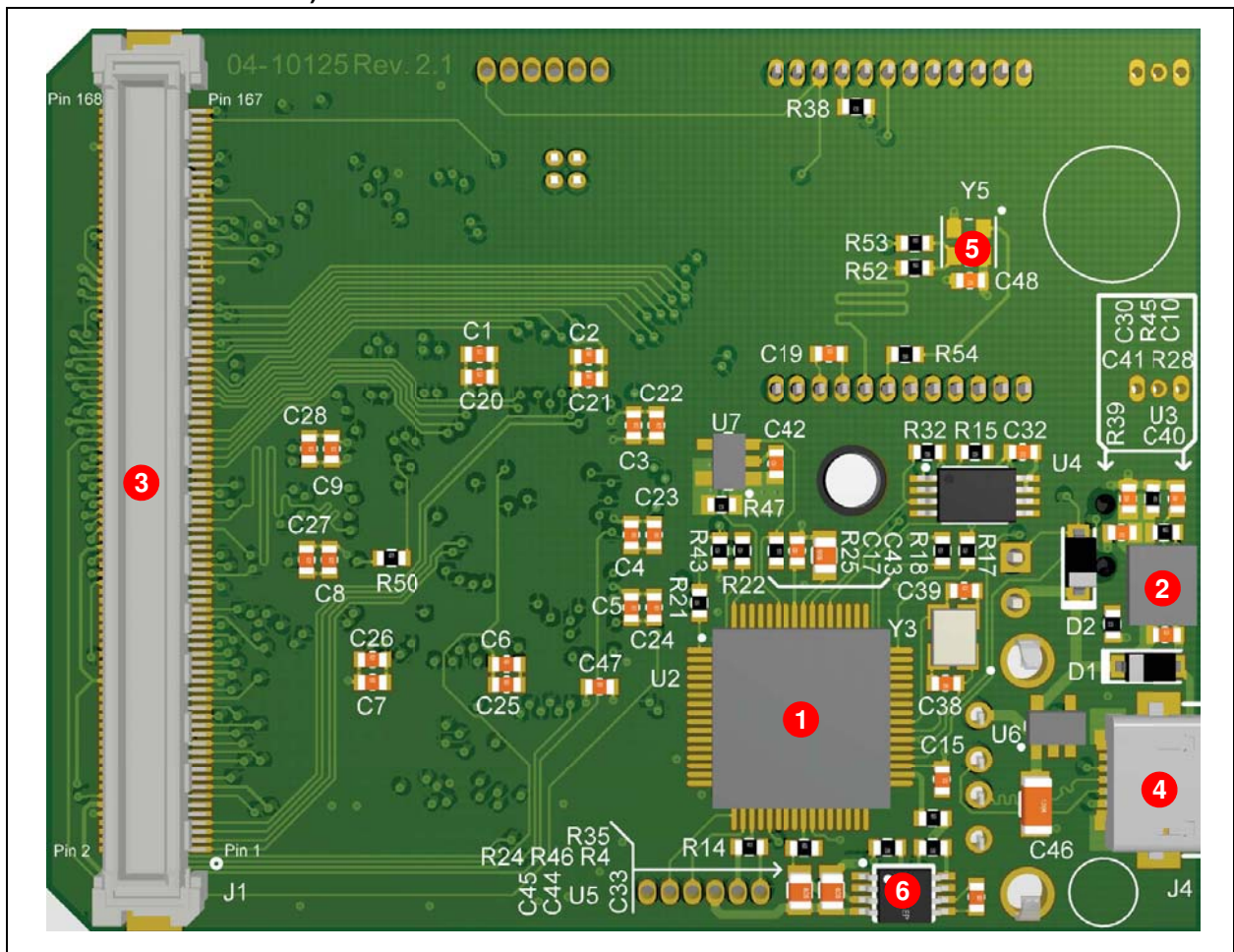For details on these features, refer to **Chapter 2. "Hardware"**.

FIGURE 1-1: **PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT LAYOUT (TOP VIEW)**

Introduction

The bottom assembly of the board includes these key features, as indicated in Figure 1-2:

1. PIC24FJ256GB106 USB microcontroller for on-board debugging.
2. Regulated +3.3V power supply for powering the starter kit through USB or expansion board.
3. Connector for various expansion boards.
4. USB Type micro-AB receptacle for OTG and USB device connectivity for PIC32 OTG/device-based applications.
5. 50 MHz Ethernet PHY oscillator.
6. USB Host and OTG power supply for powering PIC32 USB applications.

FIGURE 1-2: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT LAYOUT (BOTTOM VIEW)

NOTES:

- DEVICE Mode – Connect the debug mini-B USB cable to port J1 and then connect the starter kit to the host using a cable with a Type-B micro-connector to the starter kit's micro-A/B port J5, which is located on the bottom side of the board. The other end of the cable must have a Type-A connector. Connect it to a USB host. Jumper JP1 should be removed.

- OTG Mode – Connect the starter kit to the OTG device using an OTG micro-A/B cable to the micro-A/B port J5, which is located on the bottom side of the board. The starter kit provides an on-board power supply capable of providing 120 mA Max. This supply is controlled by the PIC32MZ2048ECH144 microcontroller. Jumper JP1 should be removed.

2.1.5   Switches

Push button switches provide the following functionality:
- SW1: Active-low switch connected to RB12
- SW2: Active-low switch connected to RB13
- SW3: Active-low switch connected to RB14

The switches do not have any debounce circuitry and require the use of internal pull-up resistors; this allows you to investigate software debounce techniques. When Idle, the switches are pulled high (+3.3V). When pressed, they are grounded.

2.1.6   LEDs

The RH0 through RH2 LEDs are connected to PORTH of the processor. The PORTH pins are set high to light the LEDs.

2.1.7   Oscillator Options

The installed microcontroller has an oscillator circuit connected to it. The main oscillator uses an 12 MHz crystal (Y1) and functions as the controller's primary oscillator. Depending on which is populated on the starter kit board, a 12 MHz external oscillator (Y4) may be used instead of Y1. Use of an external crystal is required to develop USB applications. The USB specification dictates a frequency tolerance of ±0.25% for high speed. Non-USB applications can use the internal oscillators. The starter kit also has provisions for an external secondary 32 kHz oscillator (Y2); however, this is not populated. A suitable oscillator, the ECS-3X8, can be obtained from Digi-Key: Part no. X801-ND CMR200TB32.768KDZFTR.

The PIC24FJ256GB106 is independently clocked and has its own 12 MHz crystal.

2.1.8   168-Pin Modular Expansion Connector

The PIC32MZ Embedded Connectivity (EC) Starter Kit has been designed with a 168-pin modular expansion interface, which allows the board to provide basic generic functionality and easy extendability to new technologies as they become available.

TABLE 2-1:   STARTER KIT CONNECTOR PART NUMBERS

Connector	HIROSE Electric PN
Starter Kit Connector	FX10A-168P-SV1(71)
Application Board Connector	FX10A-168S-SV

2.1.9   Ethernet PHY

The PIC32MZ Embedded Connectivity (EC) Starter Kit has been designed to use a wide variety of Ethernet PHYs through the Reduced Media Independent Interface (RMII). The starter kit comes with a daughter board that is populated with a SMSC 8720A Ethernet PHY. The RMII has been isolated from the expansion connector.

To use a different Ethernet PHY other than what is offered, visit the microchipDIRECT website (www.microchipdirect.com) for the list of alternate options.

NOTES:

Appendix A. Board Layout and Schematics

A.1   BLOCK DIAGRAM

FIGURE A-1:   **HIGH-LEVEL BLOCK DIAGRAM OF THE PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT**
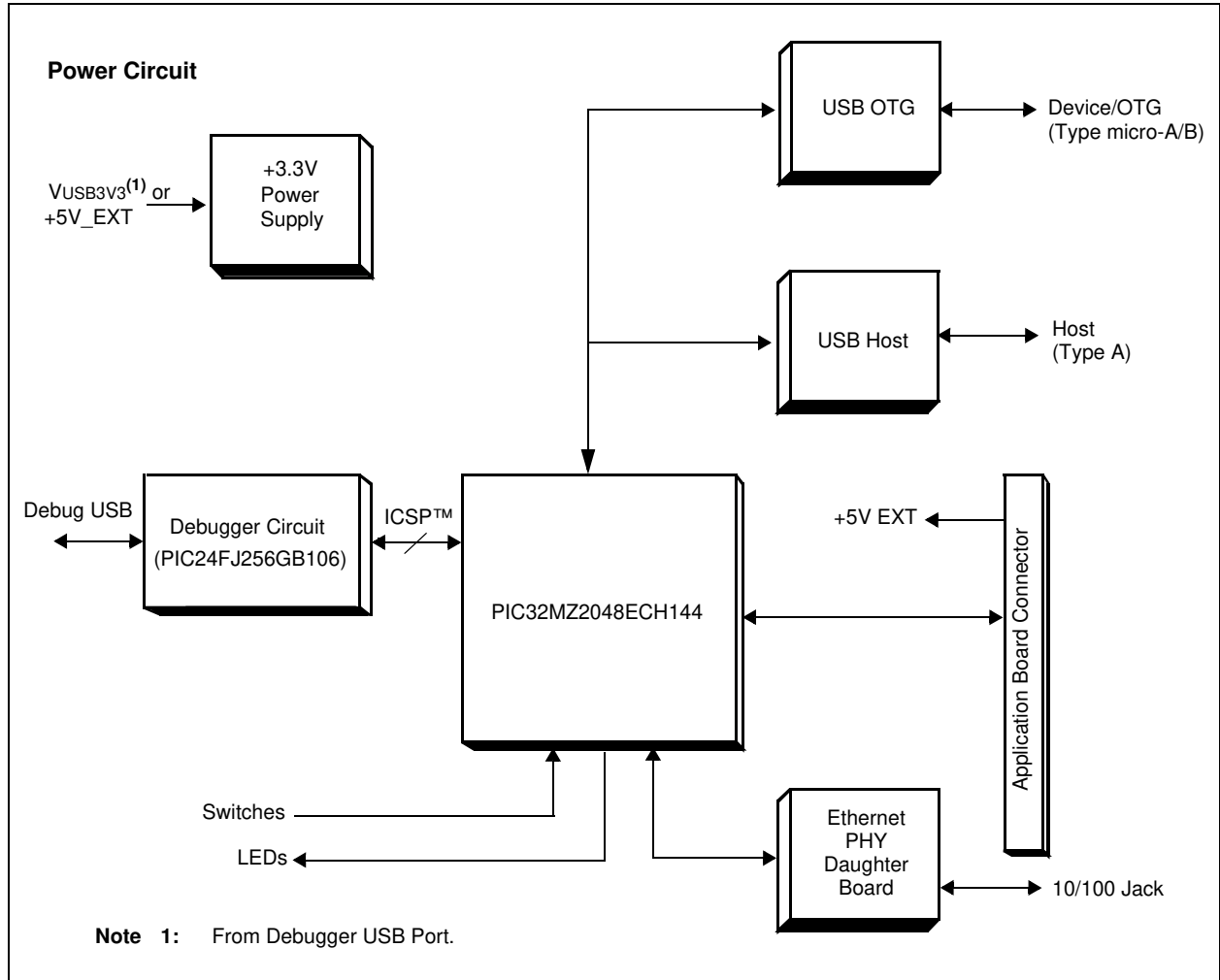
A.2   BOARD LAYOUT

FIGURE A-2:   PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT LAYOUT (TOP ASSEMBLY)
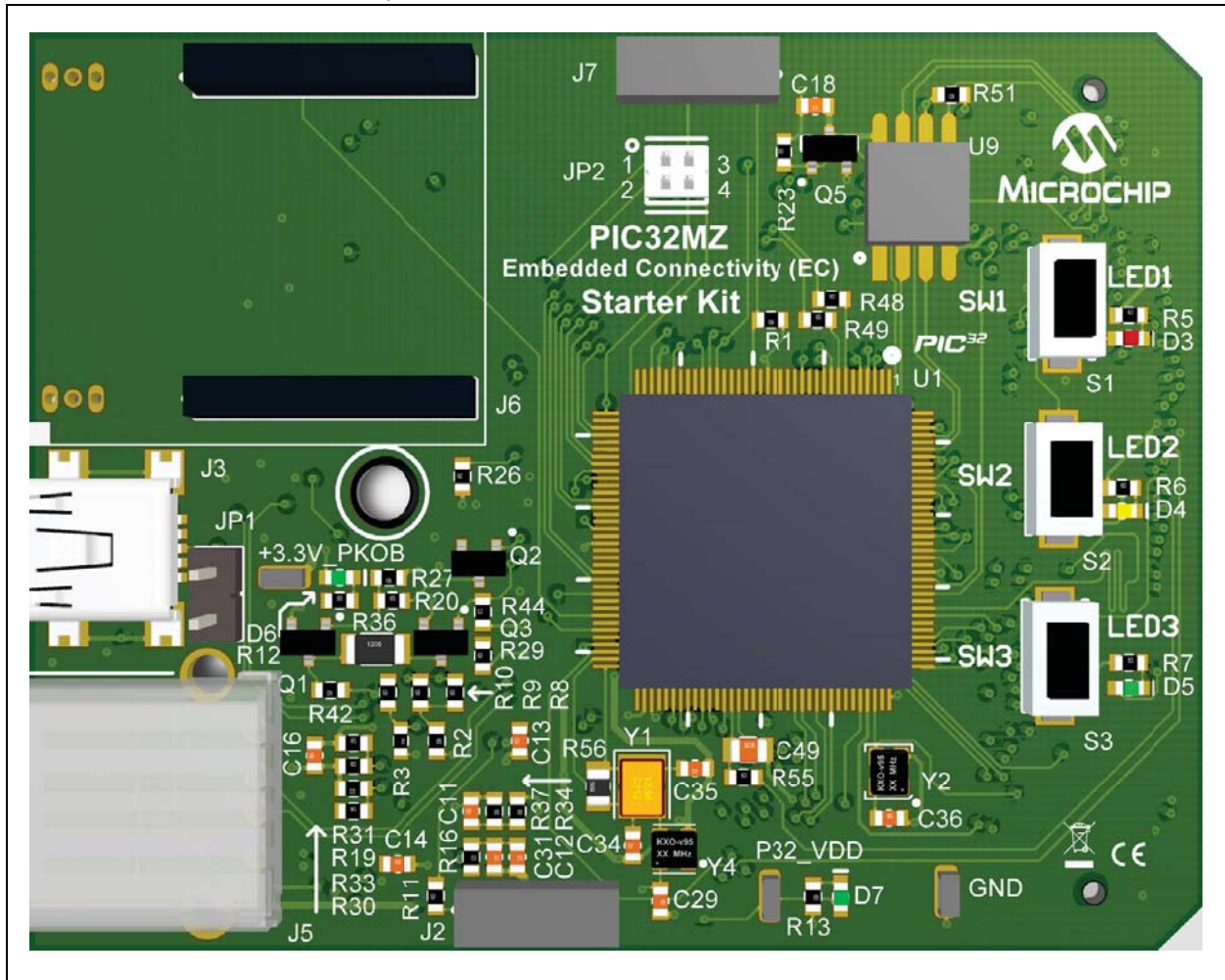
FIGURE A-3: **PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT LAYOUT (BOTTOM ASSEMBLY)**
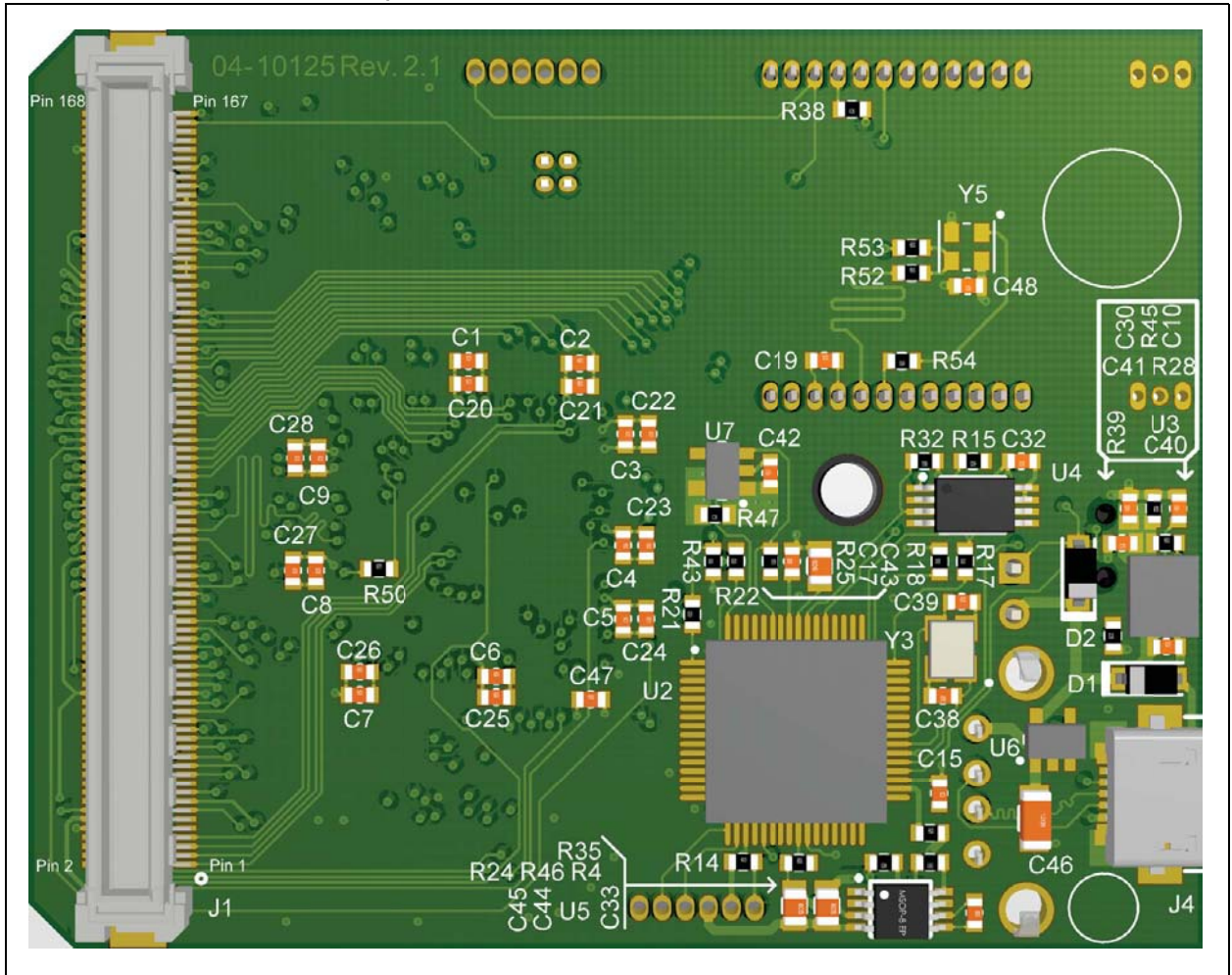
A.3 SCHEMATICS

FIGURE A-4: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT (PIC32MZ EC FAMILY DEVICE)
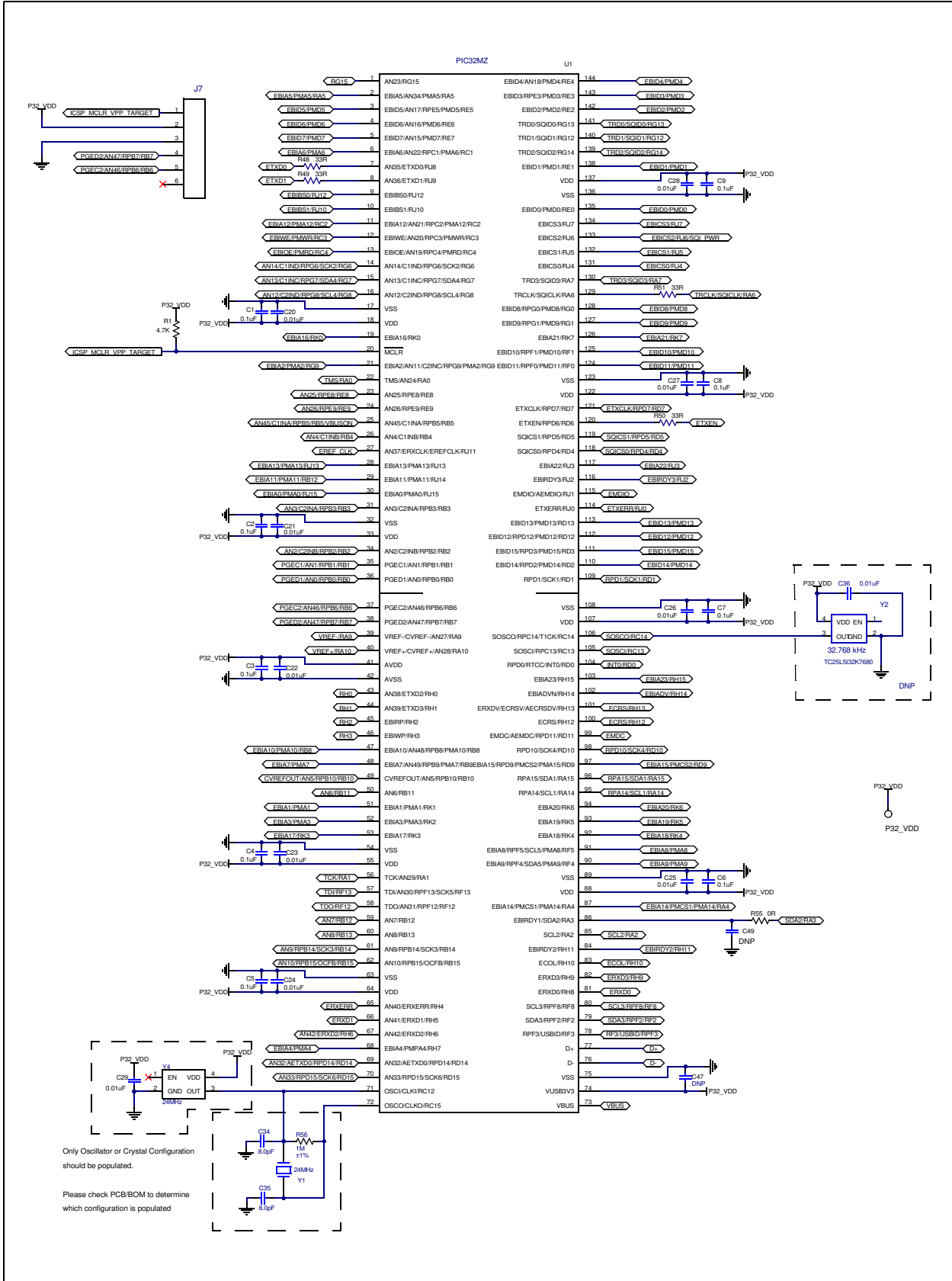
FIGURE A-5: **PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT (USB HOST AND OTG POWER SUPPLIES)**

FIGURE A-6: **PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT (DEBUGGER)**

SERIAL EEPROM (25LC256)

+3.3V_PKOB

C13 0.1uF C14 0.1uF C15 0.1uF C16 0.1uF C17 0.1uF

GND

(Local V_DD/V_SS bypass/decoupling)

TARGET POWER ENABLE

C43 10'F

GND

UTIL_WP
UTIL_CS
SDO
SDI
SCK

R29 200K
GND

VBUS DEVICE SWITCHED SENSE

R15 10K U4 25LC256-I/ST

UTIL SDO
UTIL SCK
UTIL CS
UTIL WP

UTIL SDI

R32 2.21K

C32 1uF

GND

JP2 Jumper Positions	
PKOB Mode	REAL ICE Mode
pins 1-3: Shorted	pins 1-3: Open
pins 2-4: Shorted	pins 2-4: Open

VPP_ON
VPP_GND

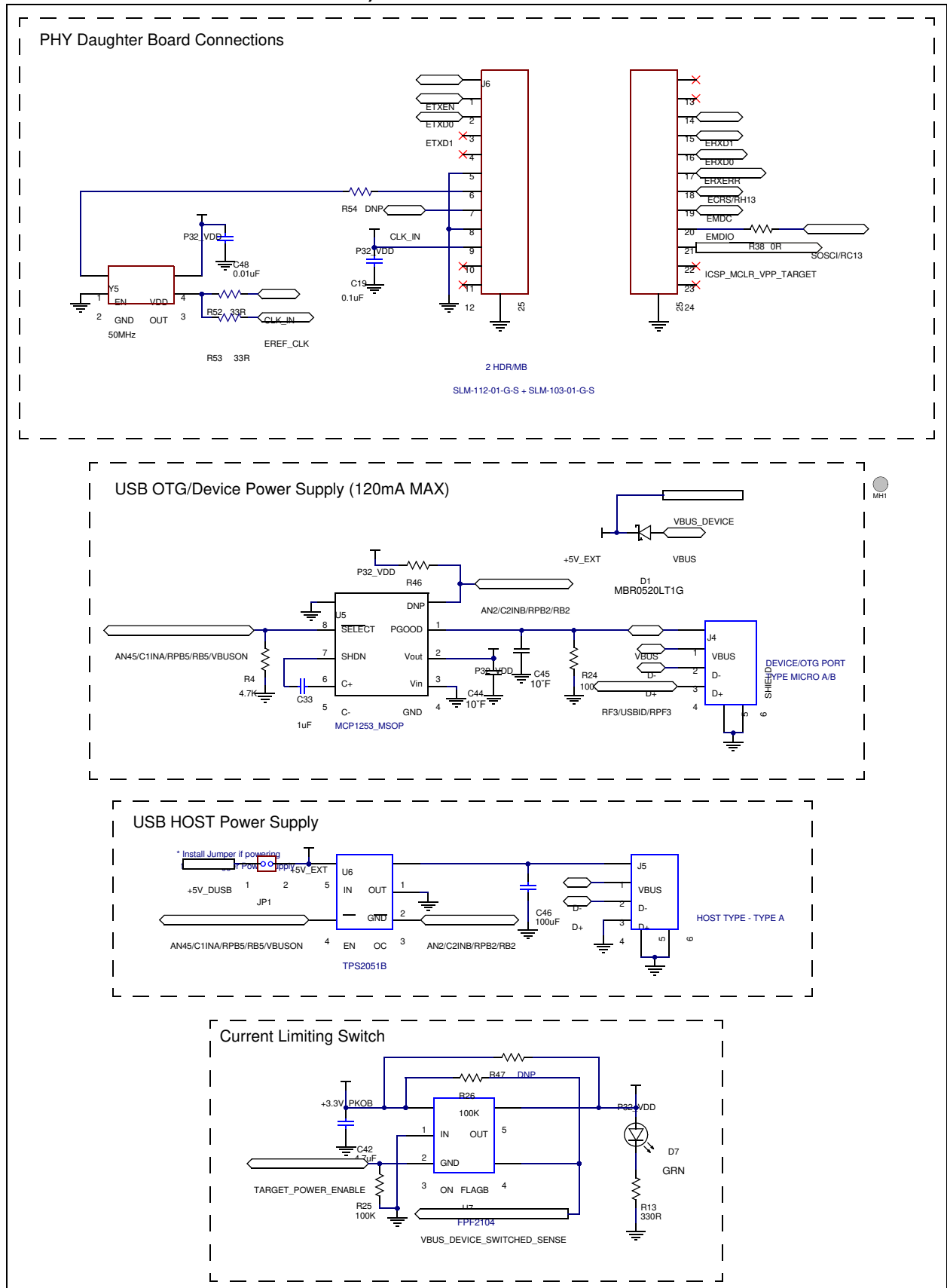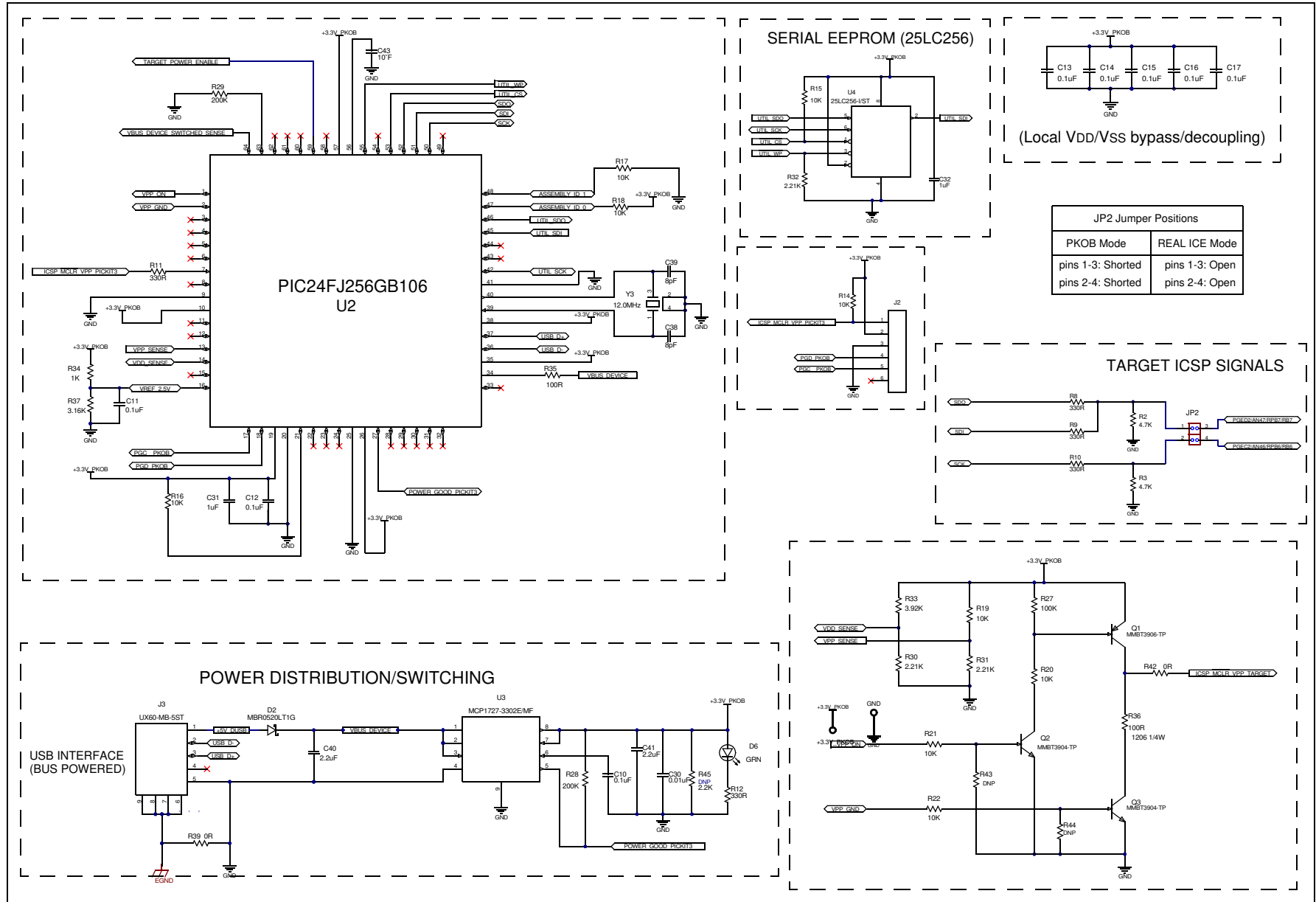R17 10K
ASSEMBLY ID 1
ASSEMBLY ID 0
R18 10K
+3.3V_PKOB
GND

ICSP MCLR VPP PICKIT3
R11 330R

UTIL SDO
UTIL SDI

PIC24FJ256GB106
U2

UTIL SCK

C39 8pF

Y3 12.0MHz

C38 8pF

+3.3V_PKOB
GND

USB D+
USB D-
+3.3V_PKOB

+3.3V_PKOB
GND

+3.3V_PKOB
VPP SENSE
VDD_SENSE

R34 1K

VBEF 2.5V

R37 3.16K

C11 0.1uF

GND

VBUS DEVICE
R35 100R

+3.3V_PKOB
R14 10K J2

ICSP MCLR VPP PICKIT3

PGD_PKOB
PGC_PKOB

GND

TARGET ICSP SIGNALS

SDO R8 330R
SDI R9 330R
R2 4.7K JP2
SCK R10 330R
GND
R3 4.7K
GND

PGED2/AN47/RPB7/RB7
PGEC2/AN46/RPB6/RB6

PGC_PKOB
PGD_PKOB
+3.3V_PKOB

R16 10K C31 1uF C12 0.1uF

+3.3V_PKOB
GND

POWER GOOD PICKIT3

GND

R33 3.92K R19 10K R27 100K +3.3V_PKOB

VDD SENSE
VPP SENSE

Q1 MMBT3906-TP

R30 2.21K R31 2.21K

GND

R20 10K

R42 0R ICSP MCLR VPP TARGET

+3.3V_PKOB GND

+3.3V VPP_ON GND

R21 10K Q2 MMBT3904-TP

R36 100R 1206 1/4W

R43 DNP

POWER DISTRIBUTION/SWITCHING

VPP GND R22 10K

Q3 MMBT3904-TP

R44 DNP

GND

J3 UX60-MB-5ST

D2 MBR0520LT1G VBUS DEVICE U3 MCP1727-3302E/MF +3.3V_PKOB

USB INTERFACE (BUS POWERED)

+5V_VUSB
USB D-
USB D+

C40 2.2uF

R28 200K C10 0.1uF C41 2.2uF C30 0.01uF R45 DNP 2.2K R12 330R

D6 GRN

GND GND GND

R39 0R

EGND GND

POWER GOOD PICKIT3

FIGURE A-7: **PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT (APPLICATION BOARD CONNECTOR, SQI MEMORY AND POWER, LEDS, AND SWITCHES)**