PIC32MZ Embedded Connectivity (EC) Starter Kit 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 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

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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.

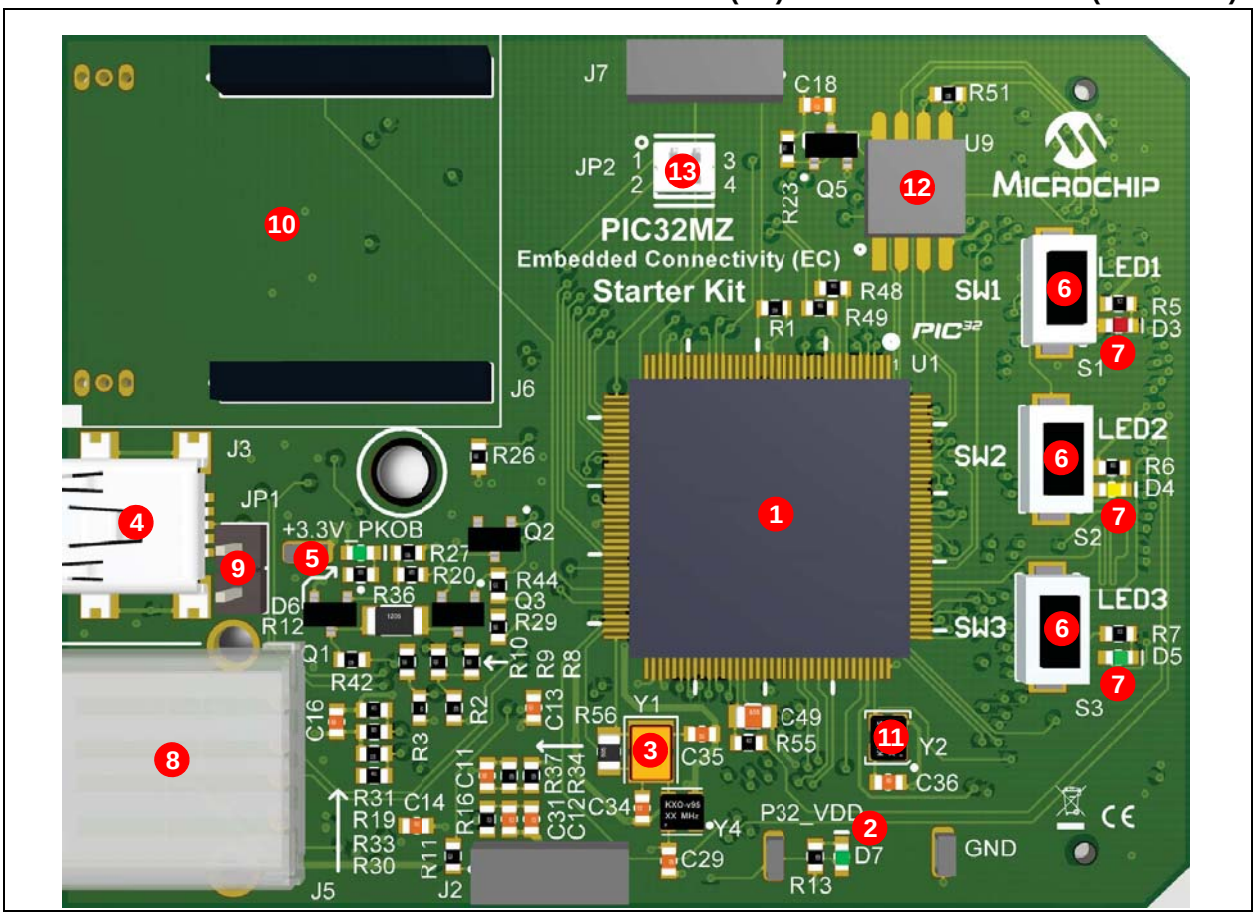
The top assembly of the board includes these key features, as indicated in Figure 1-1:

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"**.

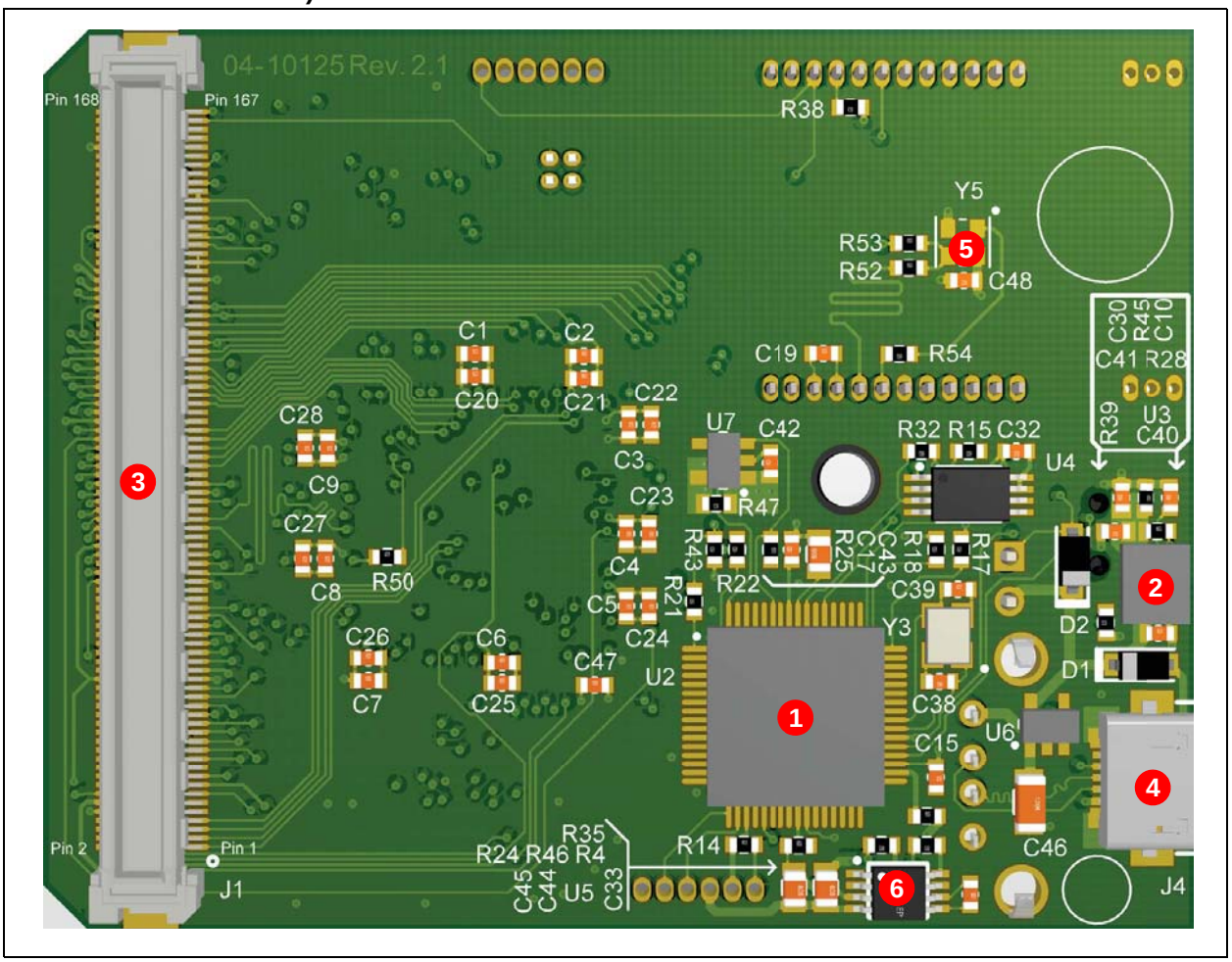
FIGURE 1-1: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT LAYOUT (TOP VIEW)



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:

Chapter 2. Hardware

This chapter describes the hardware features of the PIC32 Ethernet Starter Kit.

2.1 HARDWARE FEATURES

The key features of the PIC32MZ Embedded Connectivity (EC) Starter Kit are listed below. They are presented in the order given in **Section 1.2 "Starter Kit Functionality and Features"**. You can refer to Figure 1-1 for their locations on the board.

2.1.1 Processor Support

The PIC32MZ Embedded Connectivity (EC) Starter Kit is designed with a permanently mounted (i.e., soldered) PIC32MZ2048ECM144 processor.

2.1.2 Power Supply

There are two ways to supply power to the PIC32MZ Embedded Connectivity (EC) Starter Kit:

- USB bus power connected to USB debug connector J1
- An external application board with a regulated DC power supply that provides +5V can be connected to the J2 application board connector that is provided on the bottom side of the board

One green LED (D3) is provided to indicate the PIC32 microcontroller is powered up.

2.1.3 Debug USB Connectivity

The PIC32MZ Embedded Connectivity (EC) Starter Kit includes a PIC24FJ256GB106 USB microcontroller that provides debugger connectivity over USB. The PIC24FJ256GB106 is hard-wired to the PIC32 device to provide protocol translation through the I/O pins of PIC24FJ256GB106 to the ICSP™ pins of the PIC32.

If MPLAB REAL ICE™ or MPLAB ICD 3 are used with the starter kit, it is necessary to disconnect the on-board debugger from the PIC32 device. To do this, remove the JP2 jumper. When the on-board debugger is required, replace the JP2 jumper. When the JP2 jumper is installed, pin 1 must be connected to pin 3 and pin 2 must be connected to pin 4.

2.1.4 PIC32 USB Connectivity

There are three possible ways to connect to the PIC32 USB microcontroller:

- HOST Mode – Connect the device to the Type A connector J4, which is located on the top side of the starter kit. If using the Debug USB port to power the Host port, install jumper JP1 to short the back-power prevention diode. Note that a maximum of ~400 mA can be supplied from the Debug USB port to the Host port using this method. If the full 500 mA supply is needed, an external supply must be connected to the application board and jumper JP1 must be removed to prevent back-powering the Debug USB port.

- 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.

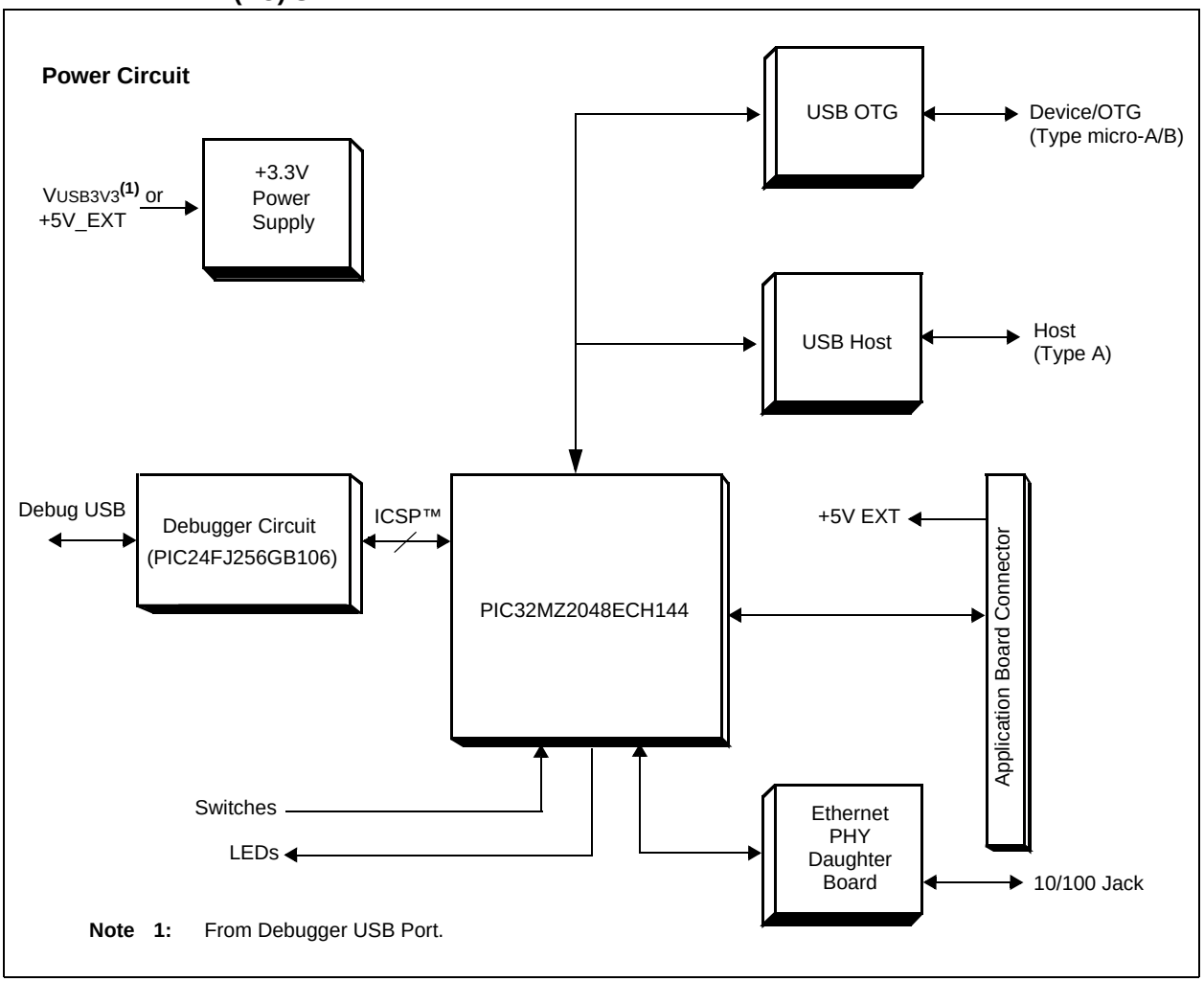
To use a different Ethernet PHY other than what is offered, visit the microchipDIRECT website (www.microchipdirect.com) for the list of alternate options.

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



Note 1: From Debugger USB Port.

A.2 BOARD LAYOUT

FIGURE A-2: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT LAYOUT (TOP ASSEMBLY)

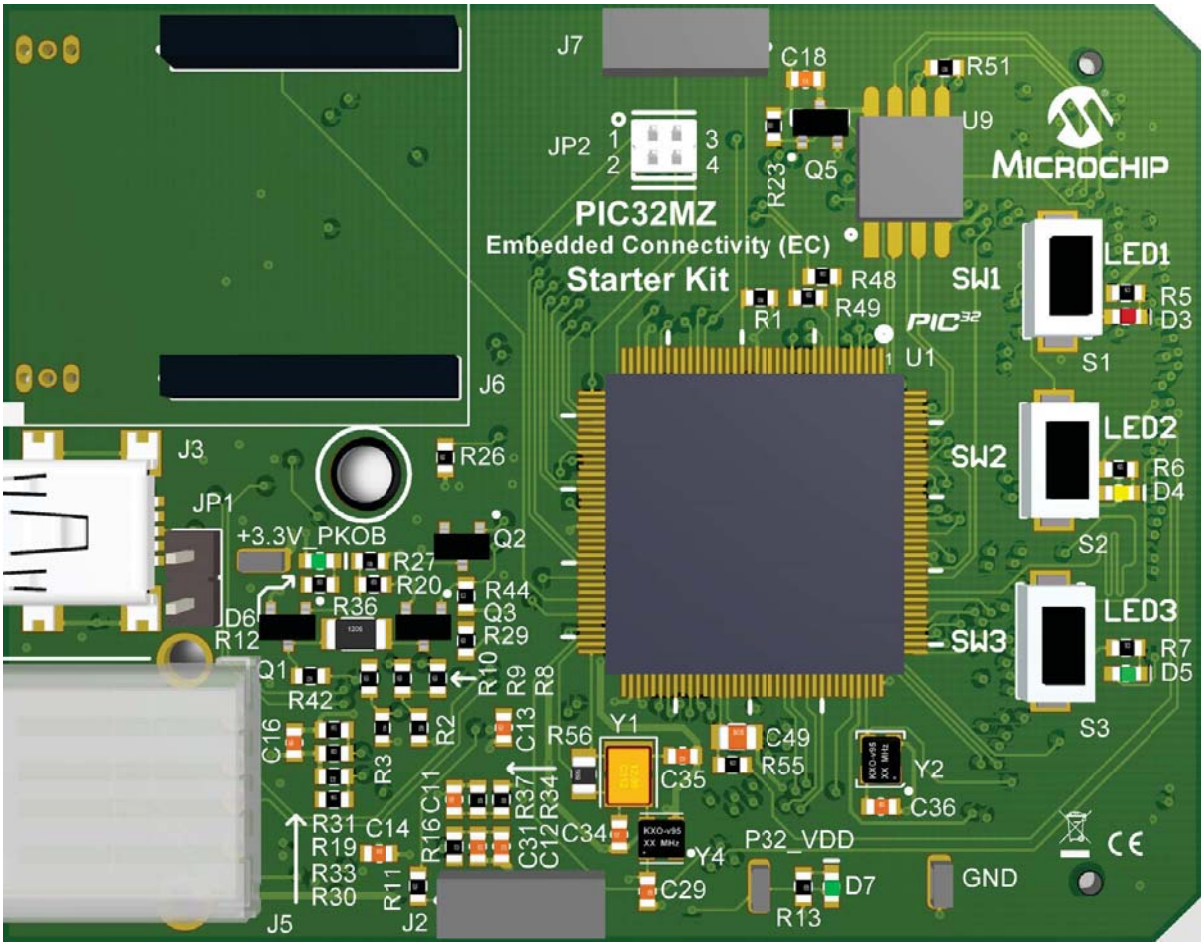
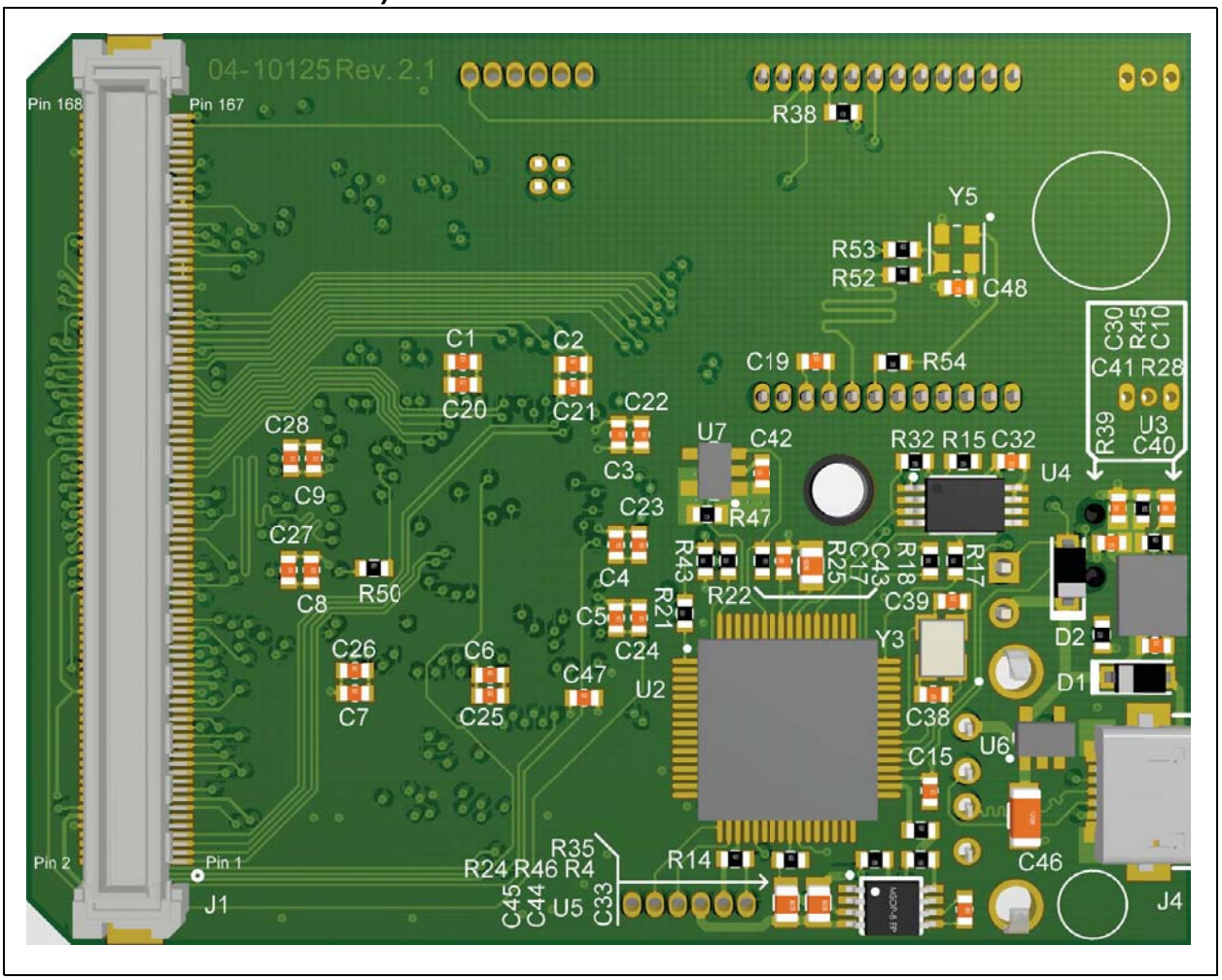


FIGURE A-3: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT LAYOUT (BOTTOM ASSEMBLY)



A.3 SCHEMATICS

FIGURE A-4: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT (PIC32MZ EC FAMILY DEVICE)

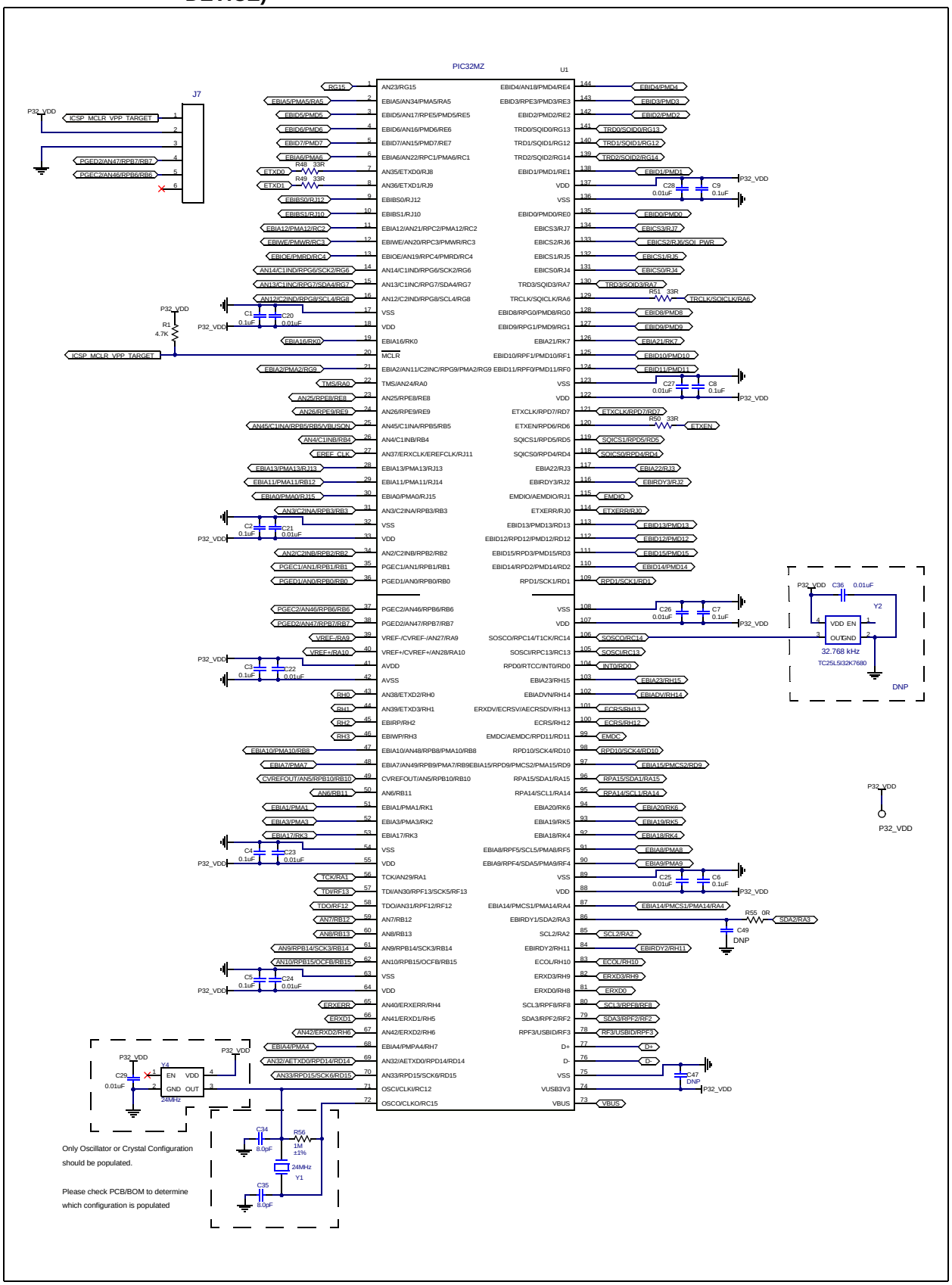


FIGURE A-5: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT (USB HOST AND OTG POWER SUPPLIES)

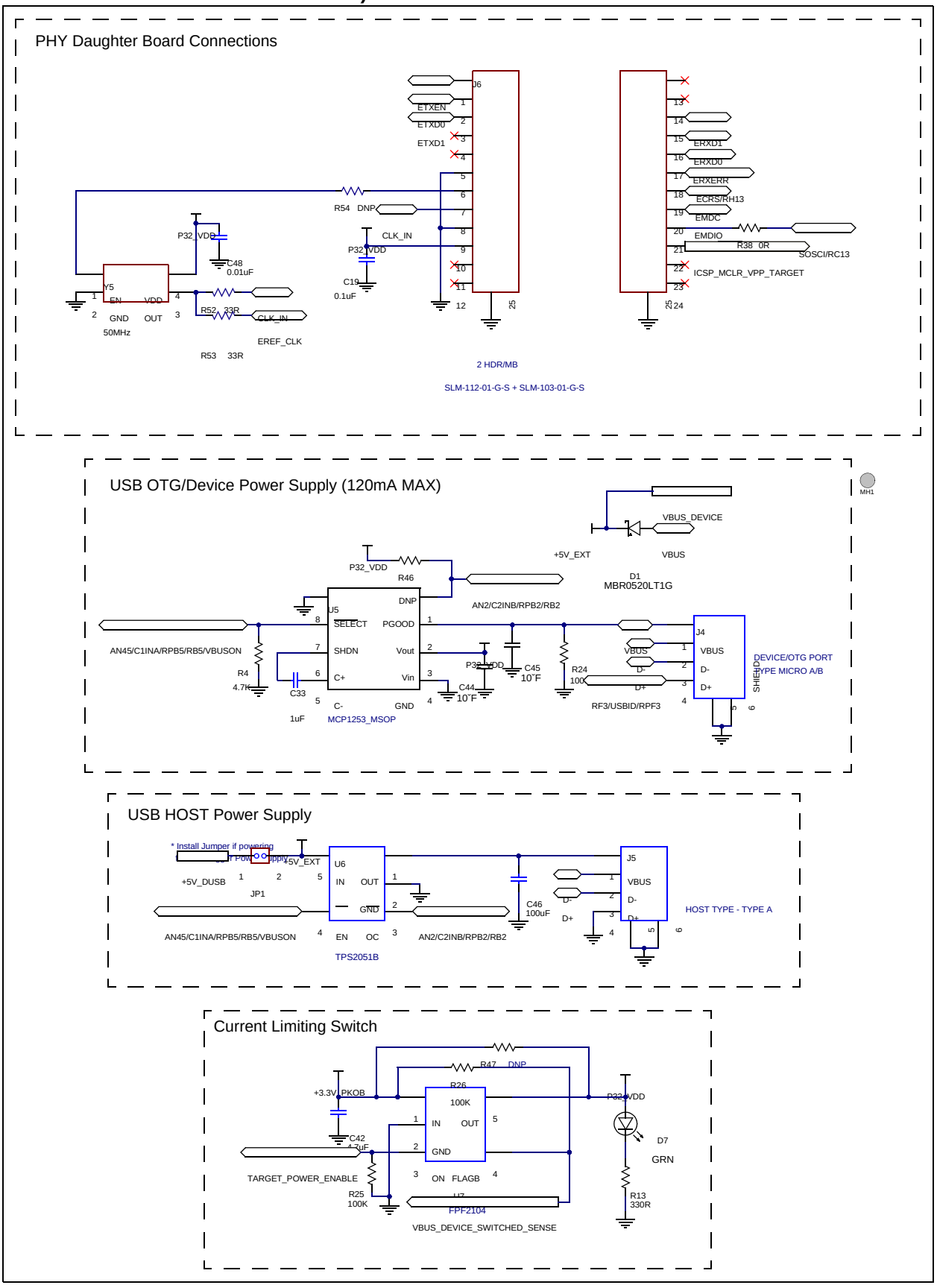


FIGURE A-6: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT (DEBUGGER)

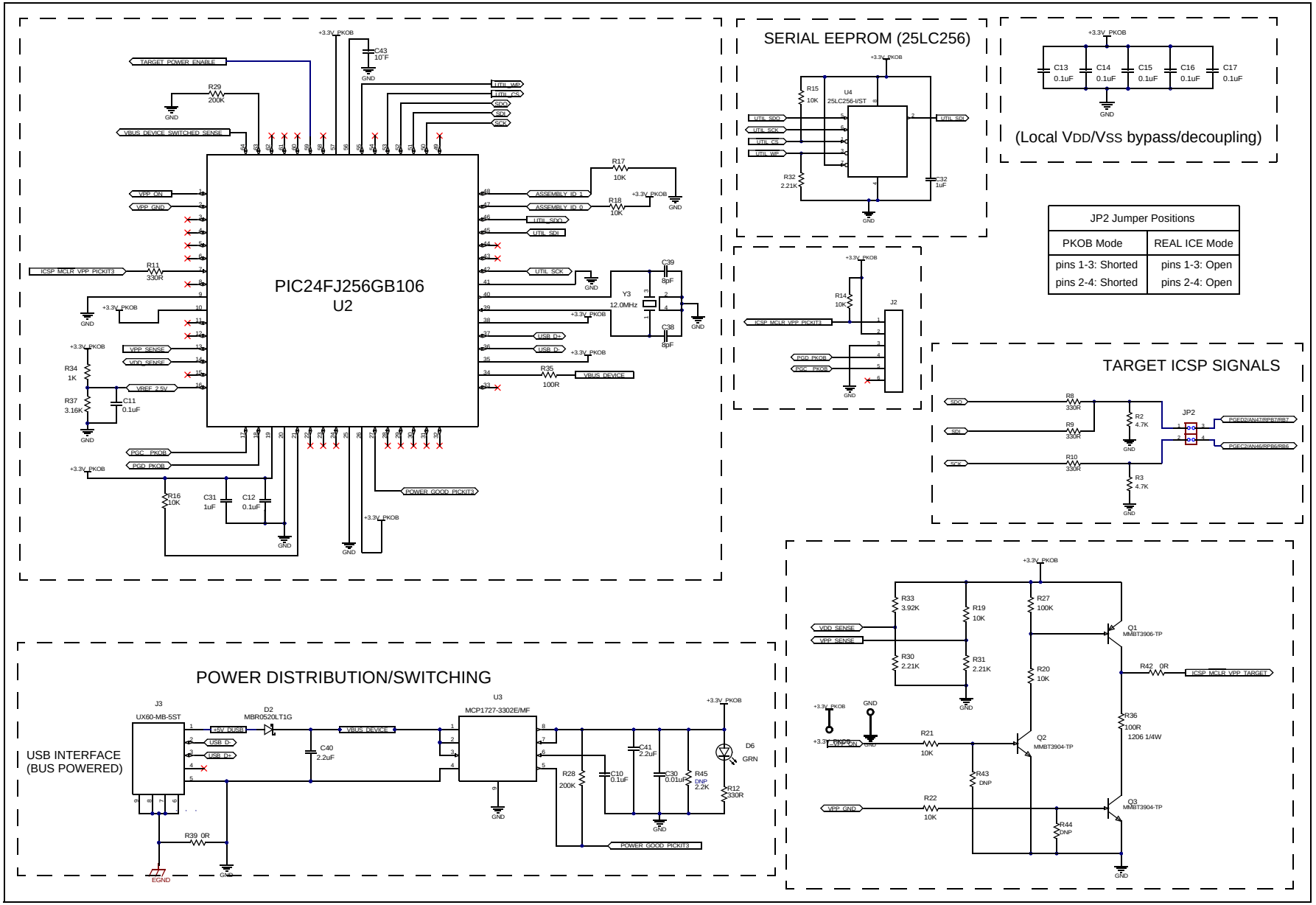
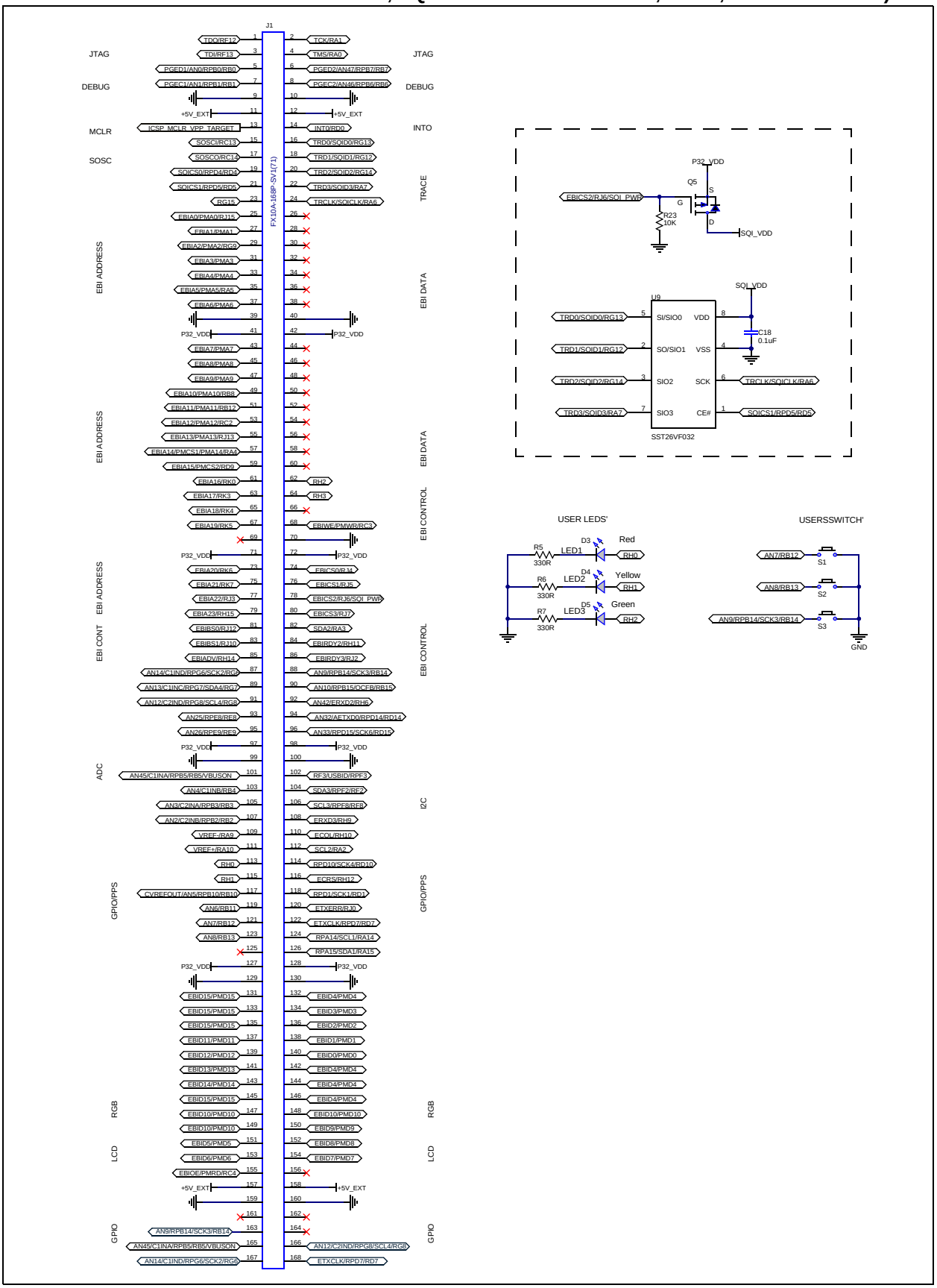


FIGURE A-7: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT (APPLICATION BOARD CONNECTOR, SQI MEMORY AND POWER, LEDS, AND SWITCHES)



NOTES:

Appendix B. Bill of Materials

TABLE B-1: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT BILL OF MATERIALS

Reference	Description	Manufacturer	Part No.
C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19	CAP CER .10 µF 50V X7R 0603	TDK Corporation	C1608X7R1H104M
C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C48	CAP CER 10000 pF 50V X7R 0603	TDK Corporation	C1608X7R1H103M
C31, C32, C33	CAP CER 1.0 µF 16V X5R 10% 0603	TDK Corporation	C1608X5R1C105K
C38, C39	CAP CER 8 pF 50V NP0 0603	Murata	GRM1885C1H8R0DZ01D
C40, C41	CAP CER 2.2 µF 16V X5R 0603	TDK Corporation	C1608X5R1C225K
C42	CAP CER 4.7 µF 6.3V 10% X5R 0603	Taiyo Yuden	JMK107BJ475KA-T
C43, C44, C45	CAP CER 10 µF 16V Y5V 0805	Murata	GRM21BF51C106ZE15L
C46	CAP CER 100 µF 6.3V Y5V 1206	Murata	GRM31CF50J107ZE01L
D1, D2	DIODE SCHOTTKY 20V 0.5A SOD123	ON Semiconductor	MBR0520LT1G
D3	LED, SMD, RED, 0603 package	Kingbright Corp	APT1608EC
D4	LED, SMD, YEL, 0603 package	Kingbright Corp	APT1608YC
D5, D6, D7	LED, SMD, GRN, 0603 package	Kingbright Corp	APT1608SGC
J1	Hirose FX10_ 168-pin Header	Hirose Electric Co Ltd	FX10A-168P-SV1(71)
J7	CONN HEADER .050" 6 POS PCB GOLD	Samtec	TMS-106-01-G-S
J3	CONN RECEPT MINI USB 2.0 5 POS	Hirose Electric Co Ltd	UX60-MB-5ST
J4	CONN USB TYPE MICRO_A/B	Hirose Electric Co Ltd	ZX62-AB-5PA(11)
J5	CONN USB TYPE A R/A BLACK	On Shore Technology Inc	USB-A1HSB6
J6	12 POS 0.05" SINGLE ROW TH HEADER	Samtec	SLM-103-112-L-S
@J6	3POS 0.05" SINGLE ROW TH HEADER	Samtec	SLM-103-103-L-S
JP2	2X2 (0.05"x 0.05") TH HEADER	Samtec	FTS-102-01-L-D
installed @ JP2	SHUNT 2POS (0.05" x 0.05")	SULLINS	NPB02DVFN-RC
JP1	CONN HEADER .100" SNGL STR 2POS	SULLINS	PRPC002SAAN-RC

TABLE B-1: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT BILL OF MATERIALS (CONTINUED)

Reference	Description	Manufacturer	Part No.
Q1	TRANS SS PNP 40V 300MW SOT23	Micro Commercial Co.	MMBT3906-TP
Q2, Q3	TRANSISTOR NPN GP 40V SOT23	Micro Commercial Co.	MMBT3904-TP
Q5	MOSFET P-CH 8V 3.7A SOT23-3	ON Semiconductor	NTR2101PT1G
R1, R2, R3, R4	RES 4.7K OHM 1/10W 1% 0603 SMD	Stackpole Electronics Inc.	RMCF0603FT4K70
R5, R6, R7, R8, R9, R10, R11, R12, R13	RES 330 OHM 1/10W 1% 0603 SMD	Stackpole Electronics Inc.	RMCF0603FT330R
R14, R15, R16, R17, R18, R19, R20, R21, R22, R23	RES 10K OHM 1/10W 1% 0603 SMD	Stackpole Electronics Inc.	RMCF0603FT10K0
R24, R25, R26, R27	RES 100K OHM 1/10W 1% 0603 SMD	Stackpole Electronics Inc.	RMCF0603FT100K
R28, R29	RES 200K OHM 1/10W 1% 0603 SMD	Stackpole Electronics Inc.	RMCF0603FT200K
R30, R31, R32	RES 2.21K OHM 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF2211V
R33	RES 3.92K OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-073K92L
R34	RES 1K OHM 1/10W 1% 0603 SMD	Stackpole Electronics Inc.	RMCF0603FT1K00
R35	RES 100 OHM 1/10W 5% 0603 SMD	Yageo	RC0603JR-07100RL
R36	RES 100 OHM 1/4W 1% 1206 SMD	Yageo	RC1206FR-07100RL
R37	RES 3.16K OHM 1/10W 1% 0603 SMD	Yageo	RC0603FR-073K16L
R38, R39, R42, R55	RES 0.0 OHM 1/10W 0603 SMD	Rohm Semiconductor	MCR03EZPJ000
R48, R49, R50, R51, R52, R53	RES 33 OHM 1/10W 1% 0603 SMD	Stackpole Electronics Inc.	RMCF0603FT33R0
S1, S2, S3	Switch, Tact, PB MOM SMT, Series TL3302	C&K	PTS635SK25SMTR LFS
U1	PIC32MZ2048ECH144-I/PH	Microchip Technology Inc.	PIC32MZ2048ECH144-I/PH
U2	IC PIC MCU FLASH 256K 64-TQFP	Microchip Technology Inc.	PIC24FJ256GB106-I/PT
U3	IC REG LDO 1.5A 3.3V 8DFN	Microchip Technology Inc.	MCP1727-3302E/MF
U4	IC EEPROM 256 KBIT 10 MHz 8TSSOP	Microchip Technology Inc.	25LC256-I/ST
U5	IC MULT CONFIG 3.3/5V .12A 8MSOP	Microchip Technology Inc.	MCP1253-33X50I/MS
U6	IC PWR DIST SWITCH SNGL SOT23-5	Texas Instruments	TPS2051BDBVR
U7	IC SWITCH LOAD FULL FUNC SOT23-5	Fairchild Semiconductor	FPF2104
U9	IC FLASH 32 MBIT 8-pin SOIC	Microchip Technology Inc.	SST26VF032-80-5I-S2AE
Y3	CRYSTAL 12.000000 MHZ 8 pF SMD	NDK	NX3225SA-12.000000MHZ
Y4	OSC MEMS 24.000 MHz SMD	Abracon Corporation	ASDMB-24.000MHZ-LC-T
Y5	OSC MEMS 50.000 MHz_1.8V ~3.3V SMD	Abracon Corporation	ASEMB-50.000MHZ-LC-T
+3.3V_P-KOB, GND	PC TEST POINT MINIATURE SMT	Keystone Electronics	5015

TABLE B-1: PIC32MZ EMBEDDED CONNECTIVITY (EC) STARTER KIT BILL OF MATERIALS (CONTINUED)

Reference	Description	Manufacturer	Part No.
bottom of board	BUMPON CYLINDRICAL .375X.135 BLK	3M	SJ61A8
Y1	CRYSTAL 24 MHz 8 pF SMD	AVX	CX3225GA24000D0PTVZ1
Y2	OSCILLATOR 32.768 kHz 3.3V SM	Abracon Corporation	TC25L5I32K7680
C34, C35	CAP CER 8 pF 50V NPO 0603	TDK Corporation	C1608C0G1H080D080AA
C36	CAP CER 10000 pF 50V X7R 0603	TDK Corporation	C1608X7R1H103M
R56	RES 1M OHM 1/8W 1% 0805 SMD	Vishay Dale	RMCF0805FT1M00

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