Curiosity PIC32MZ EF 2.0 Development Board User's Guide

Introduction

The Microchip Technology Curiosity PIC32MZ EF 2.0 Development Board (DM320209) includes an integrated programmer and debugger, hence additional hardware is not required to get started. Users can expand functionality through MikroElectronika mikroBUS™ Click™ adapter boards, add Ethernet connectivity with the Microchip PHY Daughter Board, add Wi-Fi® connectivity capability using the Microchip expansions boards, and add audio input and output capability with Microchip audio daughter boards.

With or without expansion boards, the Curiosity PIC32MZ EF 2.0 Development Board provides the freedom to develop a variety of applications, including Bluetooth Audio, CAN, Graphics/UI, Internet of Things (IoT), robotics development, and proof-of-concept designs.

Curiosity PIC32MZ EF 2.0 Development Board Features

The Curiosity PIC32MZ EF 2.0 Development Board has the following features:

- PIC32MZ2048EFM144, 200 MHz, 2 MB Flash, 512 Kb SRAM
- On-Board debugger (PKoB4)
  - Real time Programming & Debugging
  - Virtual COM port (VCOM)
  - Data Gateway Interface (DGI)
- Two mikroBUS interfaces
- Two X32 Audio interfaces supporting Bluetooth® and Audio
- Ethernet interface
- Graphics interface
- Xplained pro extension compatible interface
- CAN interface
- User buttons
- User LEDs
- 8 MB QSPI memory
- Arduino Uno R3 compatible interface

Kit Contents

The kit contains one Curiosity PIC32MZ EF 2.0 Development Board (DM320209).

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

Curiosity PIC32MZ EF 2.0 Development Board

The Curiosity PIC32MZ EF 2.0 Development Board (DM320209) is shown in the following figure:

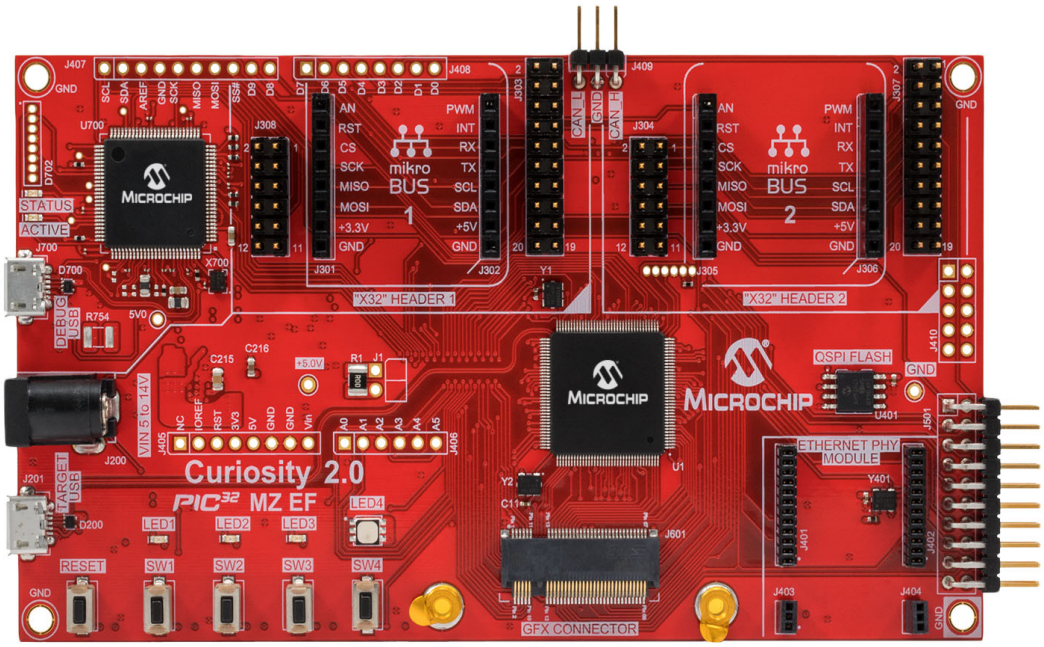

Curiosity 2.0
PIC32 MZ EF
"X32" HEADER 1
"X32" HEADER 2
mikro BUS 1
mikro BUS 2
QSPI FLASH
ETHERNET PHY MODULE
GFX CONNECTOR
DEBUG USB
TARGET USB
VIN 5 to 14V
STATUS
ACTIVE
RESET
SW1
SW2
SW3
SW4
LED1
LED2
LED3
LED4
CAN_L
CAN_H
MICROCHIP

Table of Contents

1. Development Board Functionality and Features

1.1 Board Feature Location

Figure 1-1. Curiosity PIC32MZ EF 2.0 Development Board Layout (Top View)

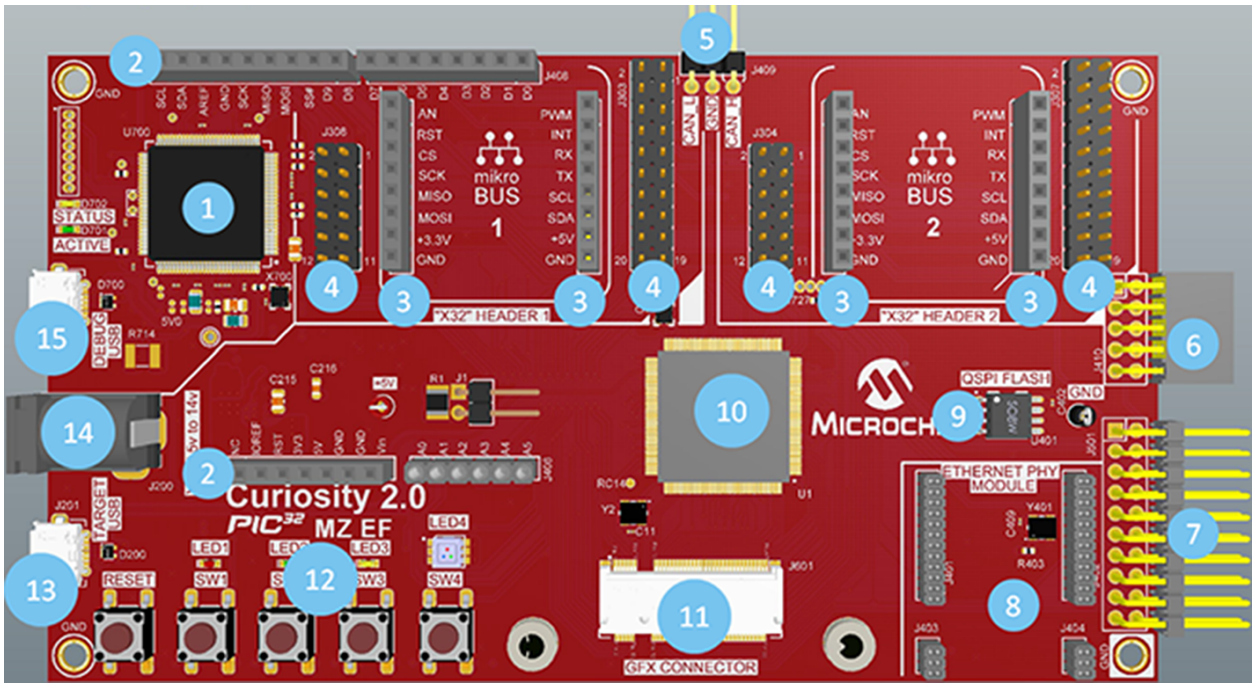


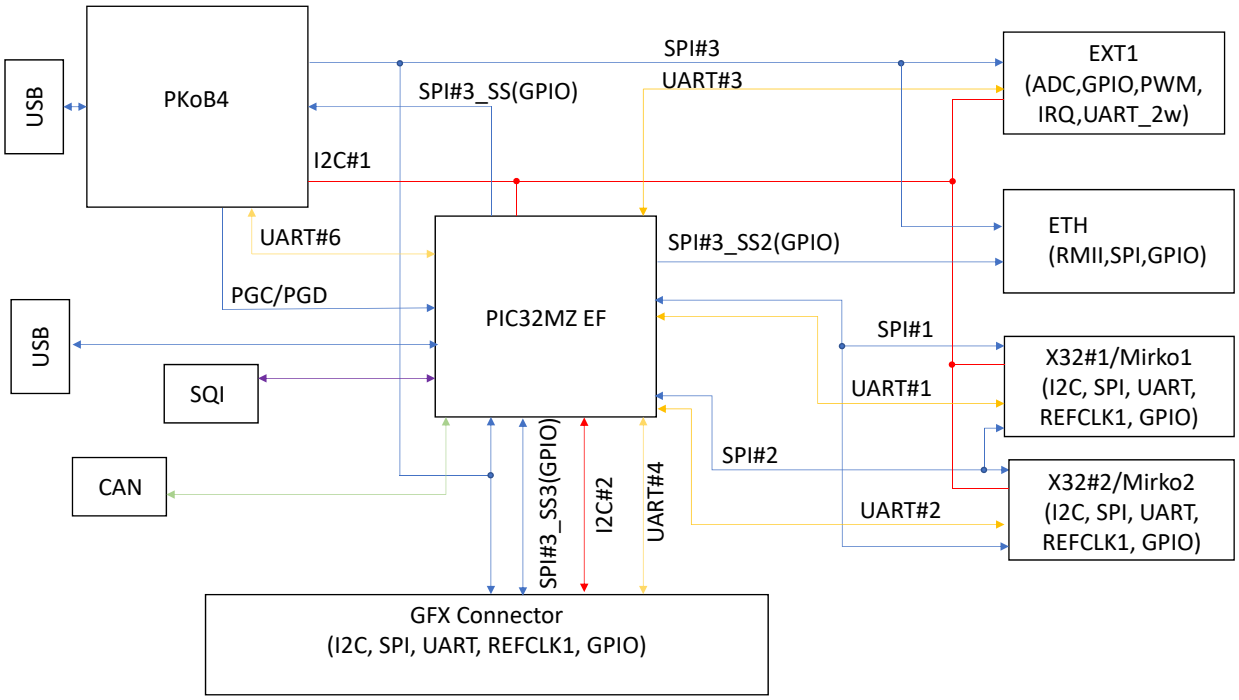
Table 1-1. Board Features and Locations

Number	Description of Item
1	PICKit on Board 4 (PKoB4)
2	Arduino Uno interface. Headers not populated
3	mikroBUS Click interface. 2 per board
4	X32 Audio interface. 2 per board. Bluetooth and audio codecs sold separately
5	CAN interface
6	Authentication interface. Header is not populated
7	Xplained pro expansion compatible interface
8	Ethernet interface (RMII, SPI, GPIO). Ethernet PHY is not included.
9	Quad SPI Memory 256 Mb
10	PIC32MZ2048EFM144
11	Graphics Interface
12	Programmable user buttons and LEDs
13	USB to PIC32MZ EF
14	2.5 mm barrel jack power input
15	USB to PKoB4 for debugging, power, virtual COM port

1.2 System Block Diagram

The following high-level block diagram shows data bus routing.

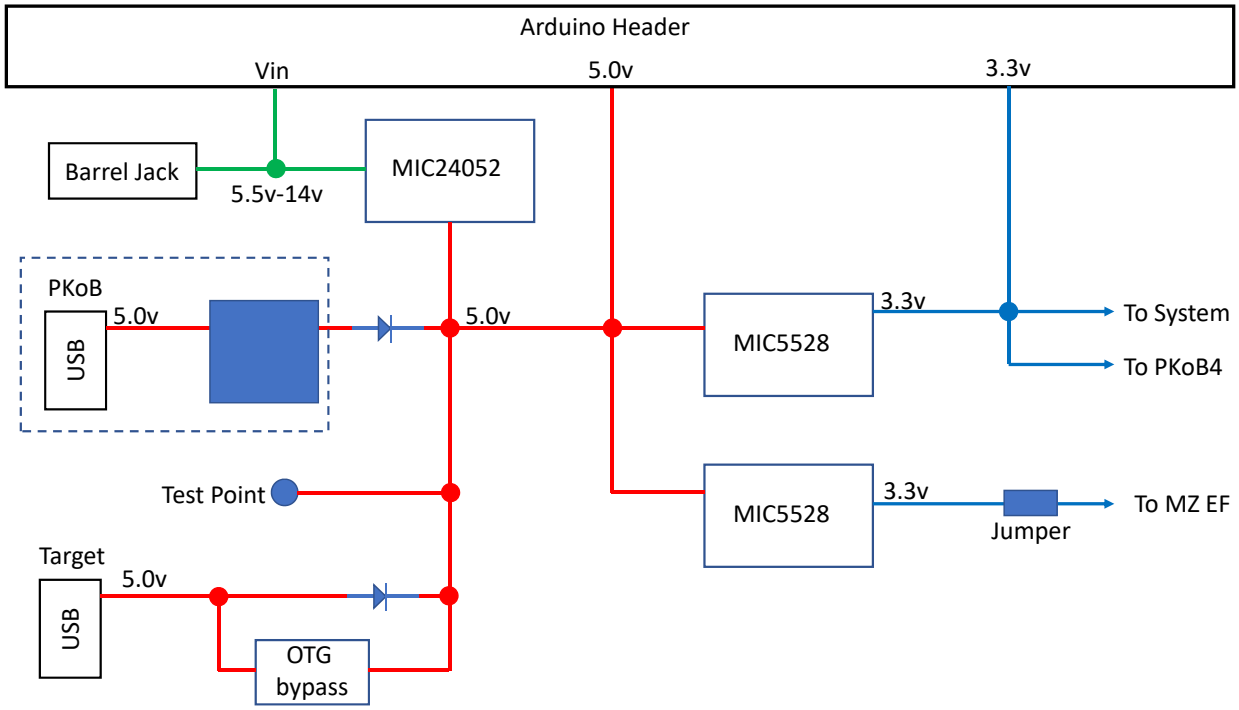
Figure 1-2. System Block Diagram



1.3 Power Block Diagram

The following figure shows a block diagram of the power system on the Curiosity PIC32MZ EF 2.0 Development Board. The Curiosity PIC32MZ EF 2.0 Development Board has several power sub systems that allow it to accept up to 16V. The barrel jack is a 2.1 mm center positive connector. The power in can also be connected through the Arduino header, this input is before the reverse voltage protection.

Figure 1-3. Power Block Diagram



1.4 PICKit On-Board 4

The MPLAB® PICkit™ On-Board 4 (PKoB4) is a new generation of In-Circuit Debugger. The MPLAB PKoB4 programs faster than its predecessor, and is designed to use a high-speed 2.0 USB interface and provide a feature rich debugging experience through one USB cable. The PKoB4 is intended to support programming debugging and a Data Gateway interface.

The MPLAB PKoB4 In-Circuit Debugger is compatible with these platforms:

- Microsoft Windows® 7 or later version
- Linux®
- macOS™

The MPLAB PKoB4 In-Circuit Debugger system provides the following advantages:

Features and Capabilities:

- Connects to computer through high-speed USB 2.0 (480 Mbits) cable
- Programs devices using MPLAB X IDE or MPLAB Integrated Programming Environment (IPE)
- Supports multiple hardware and software breakpoints, stopwatch, and source
- Code file debugging
- Debugs user 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
- Adds new device support and features by installing the latest version of MPLAB X IDE (available as a free download at www.microchip.com/mplabx/)
- Indicates debugger status through on-board LEDs

Performance and Speed:

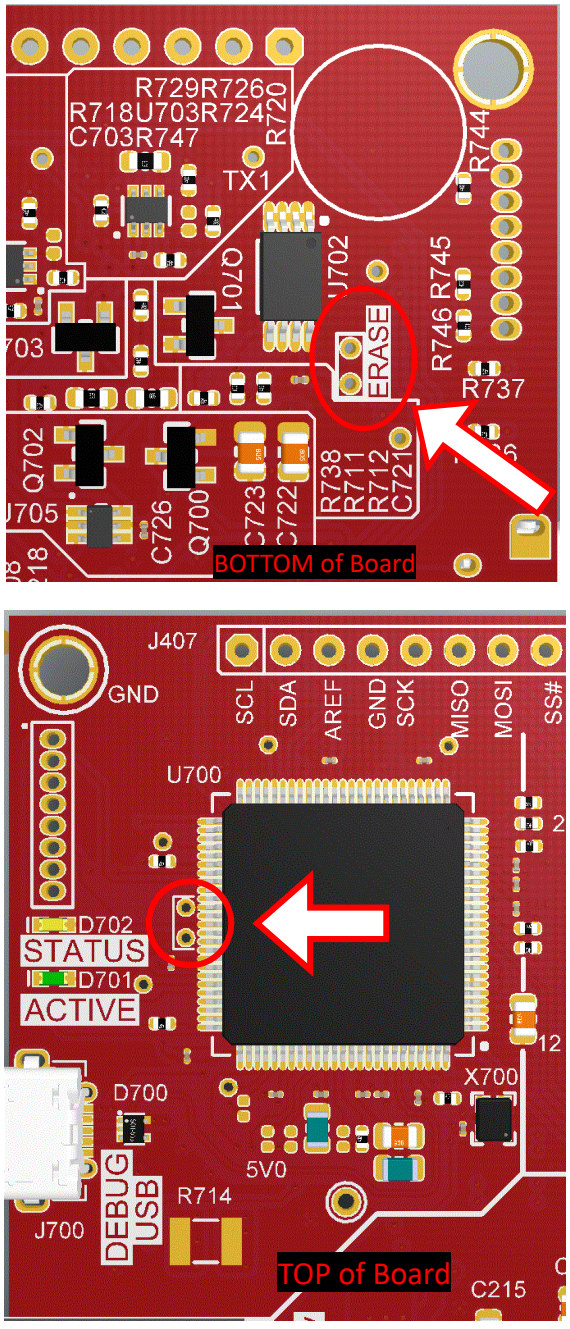
- More and faster memory
- A Real-Time Operating System (RTOS)
- No firmware download delays incurred when switching devices
- A 32-bit MCU running at 300 MHz

1.4.1 Recovery Method

When MPLAB PICkit On-Board 4 is not responding, users can recover it by following these steps:

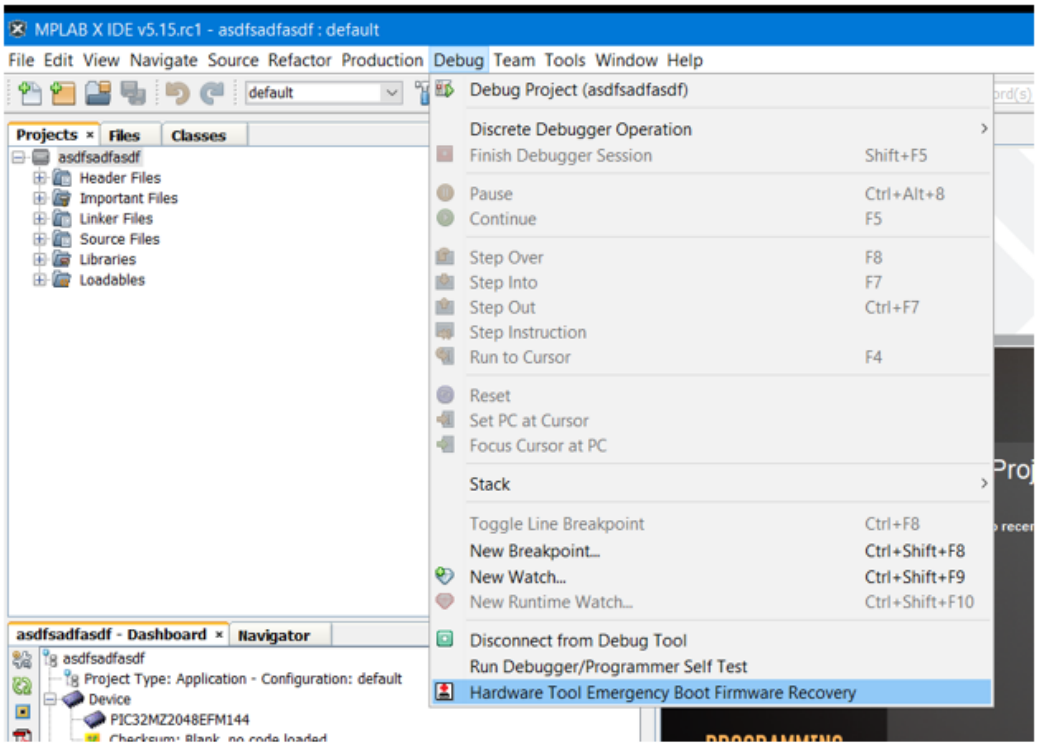
1. With the Curiosity PIC32MZ EF 2.0 Development Board is still powered, short the two pads for approximately 10 seconds, see figure below.

Figure 1-4. Location of Pads to Short



2. Open the latest version of MPLAB X IDE.
3. From Debug, select Hardware Tool Emergency Boot Firmware Recovery.

Figure 1-5. Debugging Window



4. Follow the instructions prompted on the screen to bring the tool back to the factory conditions.

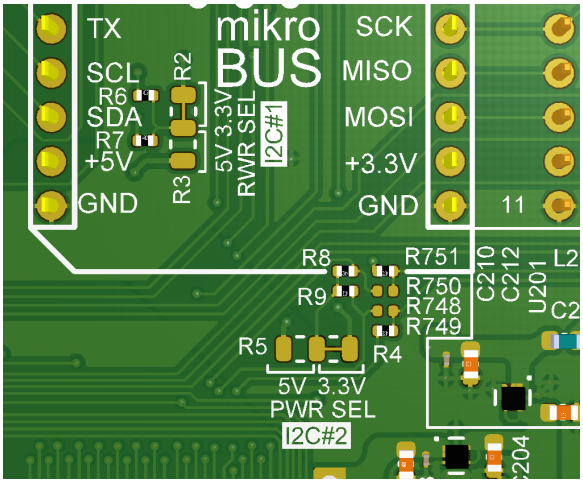
For additional information on PKoB4, refer to the *"MPLAB® PICkit™ 4 In-Circuit Debugger User's Guide"* (DS50000251), which is available for download at http://ww1.microchip.com/downloads/en/DeviceDoc/MPLAB%20PICkit%204%20ICD%20Users%20Guide%20DS50002751C.pdf.

1.5 I²C Voltage Selection

The I²C voltage is defaulted to 3.3V pull ups. A 5.0V option is possible, to do this the trace must be cut and a resistor of 0 ohm or a bus bar must be installed. A 0805 SMD footprint has been provided, which can be located on the back side of the board.

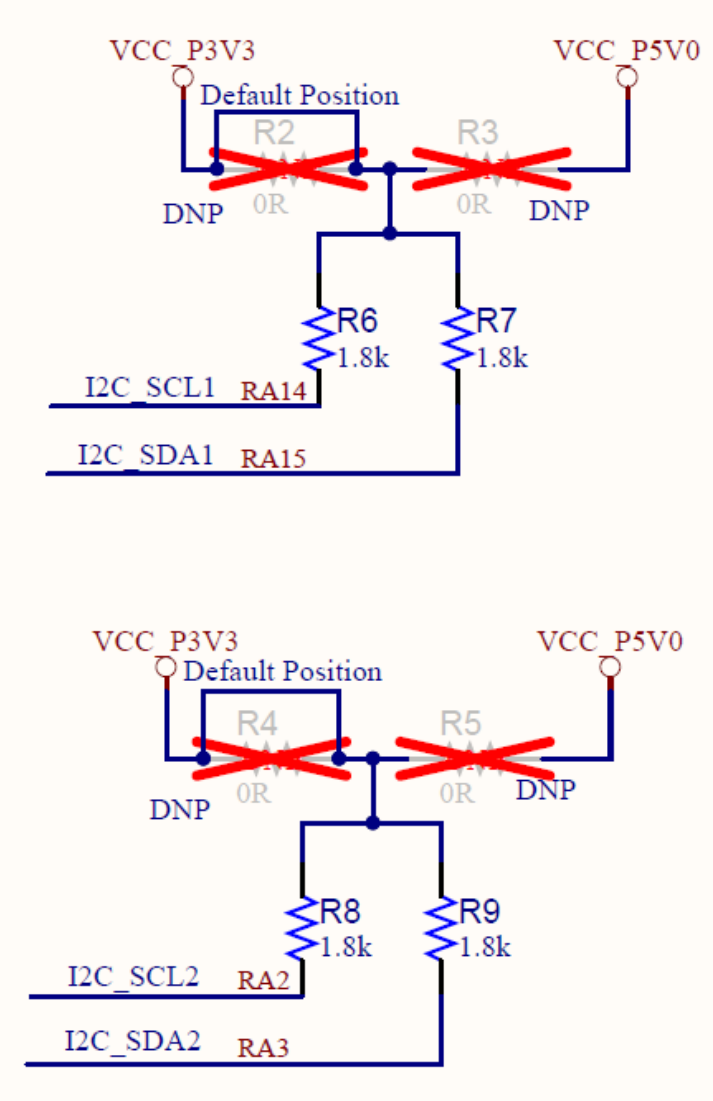
The following figure shows the I²C jumper in the trace:

Figure 1-6. I²C Jumper



The following figure shows the schematic representation:

Figure 1-7. Schematic Representation



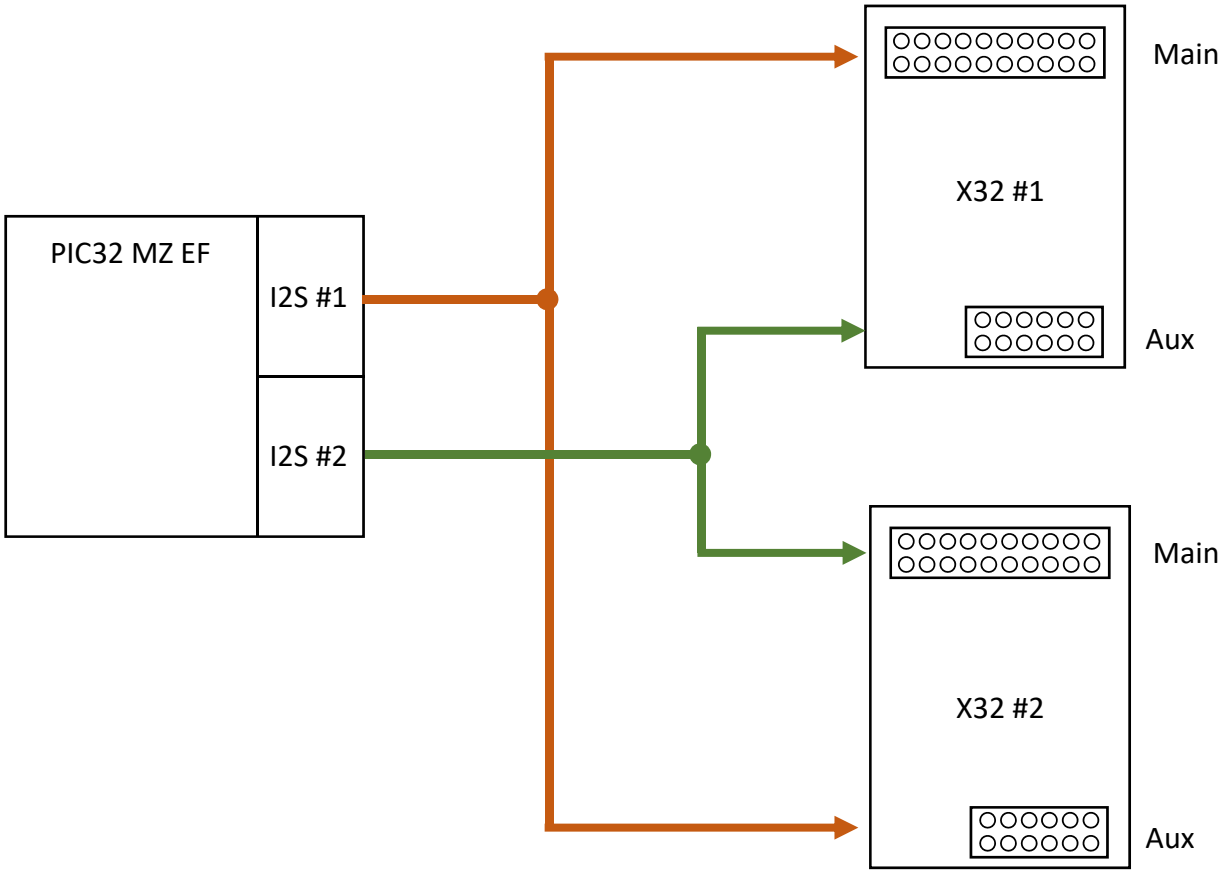
1.6 X32 Audio Interface

The X32 audio interface is a 32-pin interface to the board which supports audio codec, DACs, and Bluetooth® radios. The X32 audio interface has audio supply I^2S, other control lines, and data interfaces.

1.6.1 Block Diagram

The Curiosity PIC32MZ EF 2.0 Development Board has two X32 interfaces that share two I^2S signals. The following figure shows the relation between the I^2S signals and the X32 daughter board interface.

Figure 1-8. X32 Interface Block Diagram



1.6.2 Pinout

The following table shows the pinout and description for the X32 Audio interface. Refer to the Schematics for additional information.

Table 1-2. X32 Audio Interface Pinout

Pin Number	Name	Description	Interface
1	GND	Ground	Power
2	GND	Ground	Power
3	UART RX	UART RX, receive to MCU from DB	UART
4	UART CTS	UART Clear to send	UART
5	UART TX	UART TX, transmit from MCU to DB	UART

.....continued

Pin Number	Name	Description	Interface
6	UART RTS	UART Ready to send	UART
7	I²C SCL	Clock line for I²C interface.	I²C
8	STBY/RST	Standby/Reset control	GPIO
9	I²C SDA	Data line for I²C interface.	I²C
10	Audio WS/LRCLK	Audio Word Select/Left Right Clock	I²S
11	Audio In	Audio into MCU, out from CODEC	I²S
12	Audio CLK	Audio clock	I²S
13	Audio out	Audio out of MCU, in to CODEC/DAC	I²S
14	REFCLK/MCK	Reference clock #1	REFCLK
15	GND	Ground	Power
16	GND	Ground	Power
17	NC	Legacy hold over	-
18	+3.3v	VDD	Power
19	NC	Legacy hold over	-
20	+5.0v	VDD	Power
21 (1)	Audio WS/ Audio LRCLK	Audio Word Select/Left Right Clock	I²S
22 (2)	Card ID pin	Communication line to the daughter card and PKoB4.	Connected to PKoB4
23 (3)	Audio CLK	Audio Clock	I²S
24 (4)	NC		
25 (5)	Audio IN	Audio into MCU, out from CODEC	I²S
26 (6)	NC		
27 (7)	Audio OUT	Audio out of MCU, in to CODEC/DAC	I²S
28 (8)	NC		
29 (9)	REFCLK2/MCK2	Reference clock #2	REFCLK
30 (10)	NC		
31 (11)	GND	Ground	Power
32 (12)	GND	Ground	Power

1.6.3 Port Connections

The following table provides port connections to the X32 audio interface. The I²S signals listed are the main signals, and both of these signals are available at each interface, refer to the X32 Interface Block Diagram for additional information.

Table 1-3. Port Connections

Interface	X32#1	X32#2
UART RX	RPC4	RPE9
UART TX	RPC1	RPG9

.....continued		
Interface	**X32#1**	**X32#2**
UART RTS	RPE8	RPF5
UART CTS	RPF12	RPD10
I^2C SDA	RA3	RA3
I^2C SCL	RA2	RA2
Reset	RJ12	RJ10
REFCLK	RPD15	RPD15
I^2S Clock	RPD1	RPG6
I^2S Audio Out (MOSI)	RPD7	RPG8
I^2S Audio In (MISO)	RPD14	RPG7
I^2S LRCLK	RPD9	RPC2

1.7 mikroBUS

The mikroBUS interface enables using the additional click™ boards. For additional information and to see the boards which can be used with this development board, refer to https://www.mikroe.com/.

Table 1-4. mikroBUS™ Pinout

Pin Number	Name	Function
1	GND	Ground
2	+5V	+5.0V
3	SDA	I^2C SDA
4	SCL	I^2C SCL
5	TX	UART TX
6	RX	UART RX
7	INT	Interrupt request line
8	PWM	Pulse-Width Modulation
9	GND	Ground
10	+3.3V	Ground
11	MOSI	**M**aster **O**ut **S**lave **I**n line of serial peripheral interface.
12	MISO	**M**aster **I**n **S**lave **O**ut line of serial peripheral interface.
13	SCK	Clock for serial peripheral interface
14	CS	Chip Select for serial peripheral interface. (Active low)
15	RST	Reset
16	ADC	Analog-to-digital converter.

1.7.1 Port Connections

The following table provides the port connections to the mikroBUS interface. The mikroBUS is nested inside of the X32 Audio interface. Due to mechanical interference, a mikroBUS or Audio interface can be used in the same socket.

The mikroBUS interface shares signals with the X32 Audio interface, refer to Pinout for additional information on pinout or signal probing.

Table 1-5. Port Connections for the mikroBUS Interface

Interface	mikroBUS™ #1	mikroBUS™ #2
UART RX	RPC4	RPE9
UART TX	RPC1	RPG9
INT/IRQ	RPF12	RPD10
I^2C SDA	RA3	RA3
I^2C SCL	RA2	RA2
Reset	RJ12	RJ10
PWM	RPD15	RPD15
SPI Clock	RPD1	RPG6
SPI MOSI	RPD7	RPG8
SPI MISO	RPD14	RPG7
SPI SS	RPD9	RPC2
ADC	AN5	AN6

1.8 Control Area Network (CAN) Bus Interface

The Curiosity PIC32MZ EF 2.0 Development Board provides access to a CAN interface that is post transceiver. The on-board CAN transceiver is an ATA6561, which allows the application to be used with any CAN bus compliant interface.

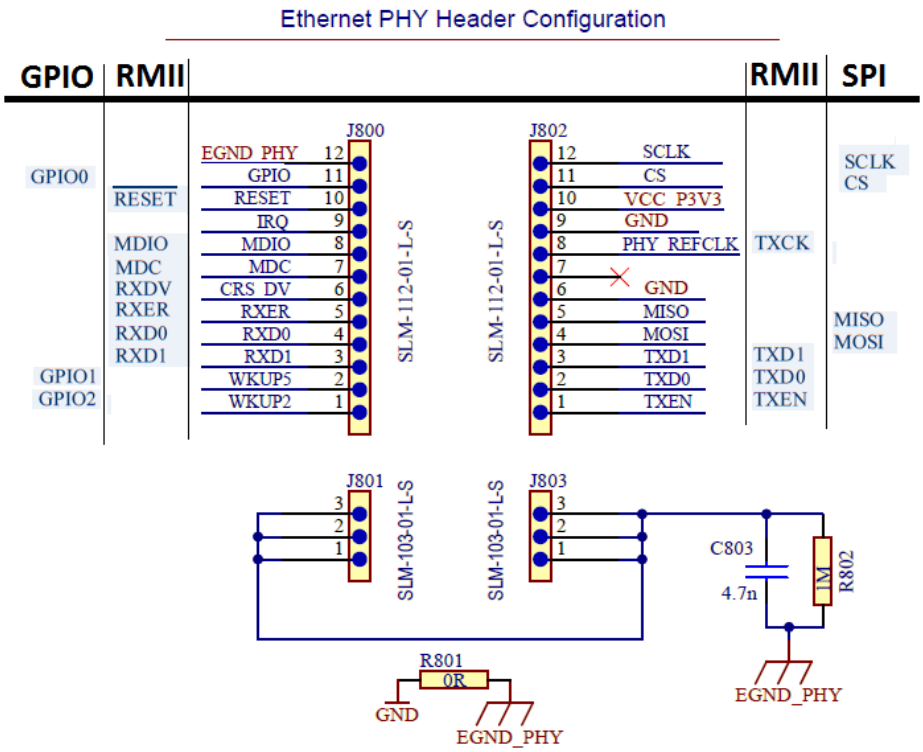
Table 1-6. CAN Bus Interface

Pin Number	Name	Description	Port
1	CAN_H	CAN High Signal	-
2	GND	Ground	-
3	CAN_L	CAN Low Signal	-
-	CAN2_TX	CAN Transmit	RPD5
-	CAN2_RX	CAN Receive	RPF5

1.9 Ethernet

The Curiosity PIC32MZ EF 2.0 Development Board has a modular Ethernet PHY system that enables different PHYs to be plugged into the board. This interface is set up to use a Reduced Media-Independent Interface (RMII interface) and a SPI bus interface with GPIO.

Figure 1-9. Ethernet PHY Header Configuration



The following table provides the pinout and description of the Ethernet interface:

Table 1-7. Pinout and Description for the Ethernet Interface

Pin Number	Name	Description	Port
1	GPIO	General purpose I/O	RH15
2	GPIO	General purpose I/O	RH14
3	RXD1	Receive Data 1	RH5
4	RXD0	Receive Data 0	RH8
5	RXER	Receive Error	RH4
6	RXDV	Receive Data Valid	RH13
7	MDC	Ethernet Management Data Clock	RD11
8	MDIO	Ethernet Management Data	RJ1
9	IRQ	Interrupt request line	RJ2
10	RESET	Reset control to the Ethernet PHY	RJ0
11	GPIO	General purpose I/O	RH12
12	EGND	Shield Ground	-
13 (1)	TXEN	Transmit Enable	RD6
14 (2)	TXD0	Transmit Data	RJ8
15 (3)	TDX1	Transmit Data	RJ9
16 (4)	MOSI	**M**aster **O**ut **S**lave **I**n line of serial peripheral interface.	RB3

.....continued			
Pin Number	**Name**	**Description**	**Port**
17 (5)	MISO	**M**aster **I**n **S**lave **O**ut line of serial peripheral interface	RB5
18 (6)	GND	Ground	-
19 (7)	NC	No Connect	-
20 (8)	REFCLK (in)	Reference Clock input (50MHz)	RJ11
21 (9)	GND	GND	-
22 (10)	+3.3v VDD	+3.3V VDD	-
23 (11)	CS	Chip Select for serial peripheral interface	RH3
24 (12)	SCK	Clock for serial peripheral interface	RB14
25 -30	EGND	Shield Ground	-

1.10 Xplained Pro Extension Standard Header

The Curiosity PIC32MZ EF 2.0 Development Board has an Xplained Pro extension compatible interface that enables using the existing extension boards. This interface consists of a dual row, 20-pin, 100 mil, 90 degree extension male header. Xplained Pro extensions have their female counterparts. The extension headers can be used to connect a variety of Xplained Pro extension boards or to access the pins of the target MCU directly. All connected pins follow the defined pinout description as shown in the following table.

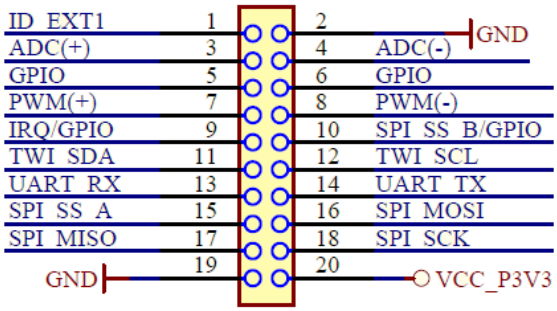
Note: All pins are not always connected.

Table 1-8. Interface Pinout

Pin number	Name	Description	Port
1	ID	Communication line to the ID chip on an extension board	Connected to PKoB4
2	GND	Ground	-
3	ADC(+)	Analog-to-digital converter, alternatively positive part of differential ADC	RB2/AN2
4	ADC(-)	Analog-to-digital converter, alternatively negative part of differential ADC	RB12/AN7
5	GPIO1	General purpose I/O	RK4
6	GPIO2	General purpose I/O	RK5
7	PWM(+)	Pulse width modulation, alternatively positive part of differential PWM	No Connect
8	PWM(-)	Pulse width modulation, alternatively negative part of differential PWM	No Connect
9	IRQ/INT/GPIO	Interrupt request line and/or general purpose I/O	RK0
10	SPI SS B/GPIO	SPI Slave Select or General purpose I/O	RK6
11	I^2C SDA	Data line for I^2C interface. Always implemented, bus type	RA15
12	I^2C SCL	Clock line for I^2C interface. Always implemented, bus type.	RA14

.....continued			
Pin number	**Name**	**Description**	**Port**
13	UART RX	Receiver line of target device UART	RPD15
14	UART TX	Transmitter line of target device UART.	RPF4
15	SPI SS A/GPIO	SPI Slave Select or General purpose I/O	RPB15
16	SPI MOSI	**M**aster **O**ut **S**lave **I**n line of serial peripheral interface. Always implemented, bus type.	RPB3
17	SPI MISO	**M**aster **I**n **S**lave **O**ut line of serial peripheral interface. Always implemented, bus type.	RPB5
18	SPI SCK	Clock for serial peripheral interface. Always implemented, bus type	RPB14
19	GND	Ground	-
20	VCC	Power for extension boards (3.3V)	-

Figure 1-10. Pinout Schematic



1.11 Graphics Connector/GFX Card Interface

The Curiosity PIC32MZ EF 2.0 Development Board has a new graphics interface that enables using different graphics cards to support different graphics models.

Table 1-9. Graphics Pinout

Pin Number	Name	Description	Port
1	GND	Ground	-
2	GND	Ground	-
3	$\overline{\text{MCLR}}$	Master Clear, controlled by the debuggers. allows for a complete system reboot	-
4	IRQ1 (LCD Touch)	Interrupt request line for cap touch device	RD0
5	5.0V VCC	5.0V	-
6	IRQ2 (Q Touch)	Interrupt request line for Q touch devices	RH9
7	LCDEN	LCD Data Enable	RK3
8	IRQ3 (Display Controllers)	Interrupt request line for external display controllers	RH10

.....continued

Pin Number	Name	Description	Port
9	LCDHSYNC/NCS3	LCD Horizontal Sync	RK1
10	IRQ4 (Resistive touch)	Interrupt request line for resistive touch controllers	RH11
11	LCDVSYNC/nWE	LCD Vertical Sync or Write enable (active-low)	RK2
12	5.0V VCC	+5.0V	-
13	LCDPCK/nRD	LCD pixel Clock or Read Enable (active-low)	RC3
14	I^2C SDA	Data line for I^2C interface. Always implemented, bus type	RA3
15	LCD D0	LCD Data bit 0	RE0
16	I2C SCL	Clock line for I^2C interface. Always implemented, bus type.	RA2
17	LCD D1	LCD Data bit 1	RE1
18	SPI SCK	Clock for serial peripheral interface. Always implemented, bus type	RPB14
19	LCD D2	LCD Data bit 2	RE2
20	SPI MOSI	**M**aster **O**ut **S**lave **I**n line of serial peripheral interface.	RPB3
21	LCD D3	LCD Data bit 3	RE3
22	SPI MISO	**M**aster **I**n **S**lave **O**ut line of serial peripheral interface.	RPB5
23	LCD D4	LCD Data bit 4	RE4
24	SPI SS	SPI Slave Select	RH2
25	LCD D5	LCD Data bit 5	RE5
26	UART RX	Receiver line of target device UART (Not Implemented on this design)	No Connect
27	LCD D6	LCD Data bit 6	RE6
28	UART TX	Transmitter line of target device UART. (from MCU to GFX card) (Not Implemented on this design)	No Connect
29	LCD D7	LCD Data bit 7	RE7
30	UART RTS	UART Ready To Send (from MCU to GFX card) (Not Implemented on this design)	No Connect
31	LCD D8	LCD Data bit 8	RG0
32	UART CTS	UART Clear To Send (from MCU to GFX card) (Not Implemented on this design)	No Connect
333	LCD D9	LCD Data bit 9	RG1
34	LCD PWM	LCD PWM back light control	RPB6/OC1
35	LCD D10	LCD Data bit 10	RF1
36	PWM2	Pulse width modulation,	RPD15
37	LCD D11	LCD Data bit 11	RF0

.....continued

Pin Number	Name	Description	Port
38	GPIO1	General purpose I/O	RK4
39	LCD D12	LCD Data bit 12	RD12
40	GPIO2	General purpose I/O	RK5
41	LCD D13	LCD Data bit 13	RD13
42	GPIO3	General purpose I/O	RA4
43	LCD D14	LCD Data bit 14	RD2
44	STBY/RST/GPIO4	Standby/reset or General purpose I/O. for resetting devices attached to the GFX connector	RJ14
45	LCD D15	LCD Data bit 15	RD3
46	STBY/RST/GPIO5	Standby2/Reset2 or General purpose I/O	RJ15
47	LCD D16	LCD Data bit 16 (Not implemented on this design)	No Connect
48	ID pin	Communication line to the ID chip on an extension board	Connected to PKoB4
49	LCD D17	LCD Data bit 17 (Not implemented on this design)	No Connect
50	ADC 0	Analog-to-digital converter (ADC) to MCU	AN23
51	LCD D18	LCD Data bit 18 (Not implemented on this design)	No Connect
52	ADC1	ADC to MCU	AN24
53	LCD D19	LCD Data bit 19 (Not implemented on this design)	No Connect
54	ADC2	ADC to MCU	AN27
55	LCD D20	LCD Data bit 20 (Not implemented on this design)	No Connect
56	ADC3	ADC to MCU	AN28
57	LCD D21	LCD Data bit 21 (Not implemented on this design)	No Connect
58	ADC4	ADC to MCU	AN34
59	LCD D22	LCD Data bit 22	No Connect
60	ADC5	ADC to MCU (Not implemented on this design)	No Connect
61	LCD D23	LCD Data bit 23 (Not implemented on this design)	No Connect
62	ADC6	ADC to MCU (Not implemented on this design)	No Connect
63	3.3V VCC	+3.3V VCC	-
64	ADC7	ADC to MCU (Not implemented on this design)	No Connect
65	GND	Ground	-
66	3.3V VCC	+3.3V VCC	-
67	GND	Ground	-
68	GND TAB	Mounting Tab	-
69	GND TAB	Mounting Tab	-

1.12 Buttons and LEDs

The Curiosity PIC32MZ EF 2.0 Development Board offers several user buttons and LEDs. Some of the LEDs can be used with PWM (Output Compare). The following table provides the function, description, and port on the MCU.

Table 1-10. Functions for Buttons and LEDs

Function	Description	Type	Port
SW1	Users switch	Input	RJ4
SW2	Users switch	Input	RJ5
SW3	Users switch	Input	RJ6
SW4	Users switch	Input	RC15
RESET	Hard reset of the PIC32	Input	-
LED1	User programmable LED. Single color	GPIO Output	RJ7
LED2	User programmable LED. Single color	GPIO Output	RK7
LED3	User programmable LED. Single color	GPIO Output	RJ3
LED4 (Red)	RGB LED Red channel	GPIO or PWM	RPB7 or OC8
LED4 (Green)	RGB LED Green Channel	GPIO or PWM	RPB8 or OC5
LED4 (Blue)	REB LED Blue Channel	GPIO or PWM	RPB9 or OC3

1.13 USB

The Curiosity PIC32MZ EF 2.0 Development Board has a high-speed USB 2.0 connection for user application. This port can act as a device class or host class.

For device class, use the USB cable which can be plugged into the target USB. Refer to 1.1 Board Feature Location for additional information.

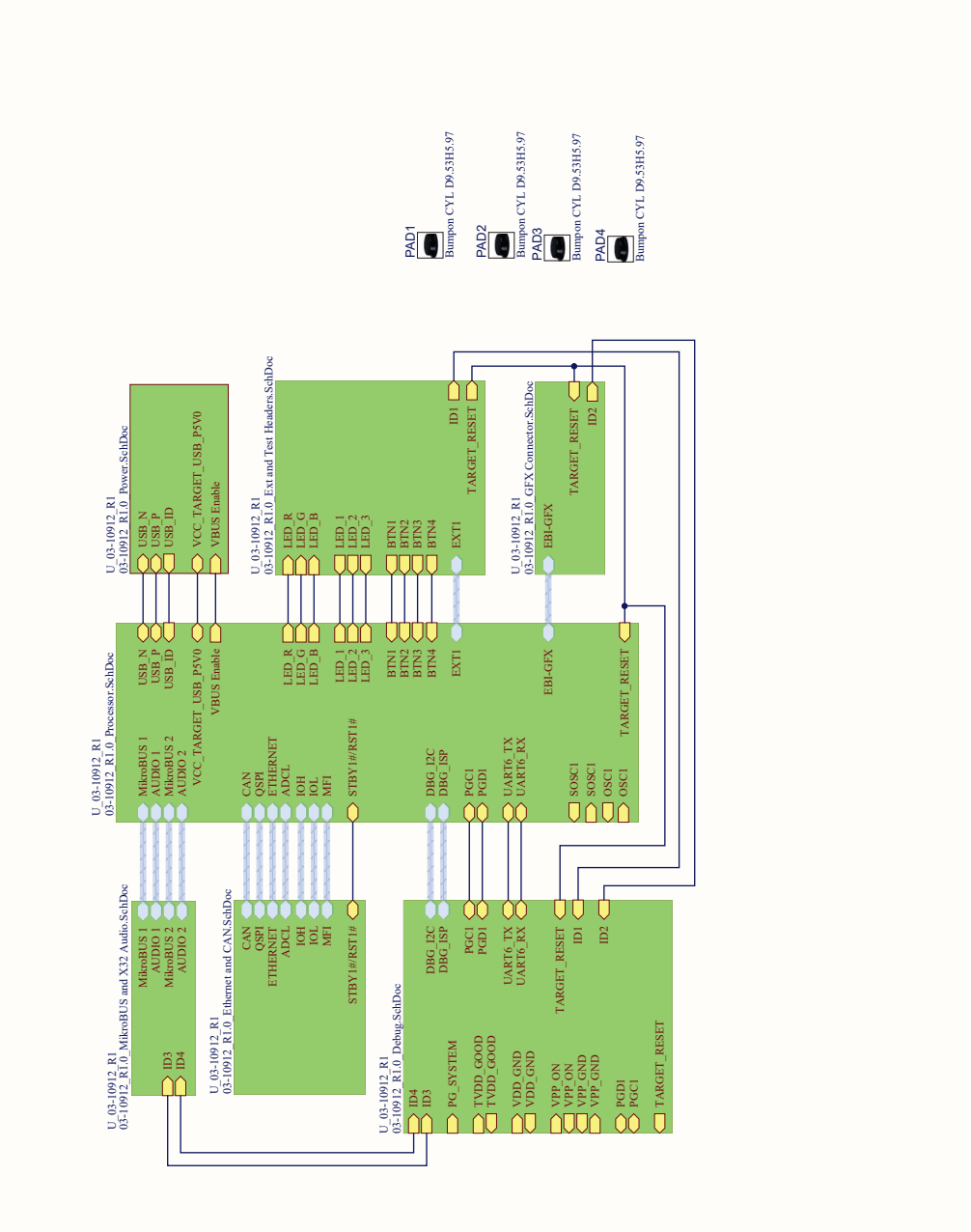
For host class, a USB OTG cable is needed. To enable power from the Curiosity PIC32MZ EF 2.0 Development Board, the user must control the VBUS Enable pin. The Curiosity PIC32MZ EF 2.0 Development Board must be powered through an external source, Vin, PKoB4, or barrel jack.

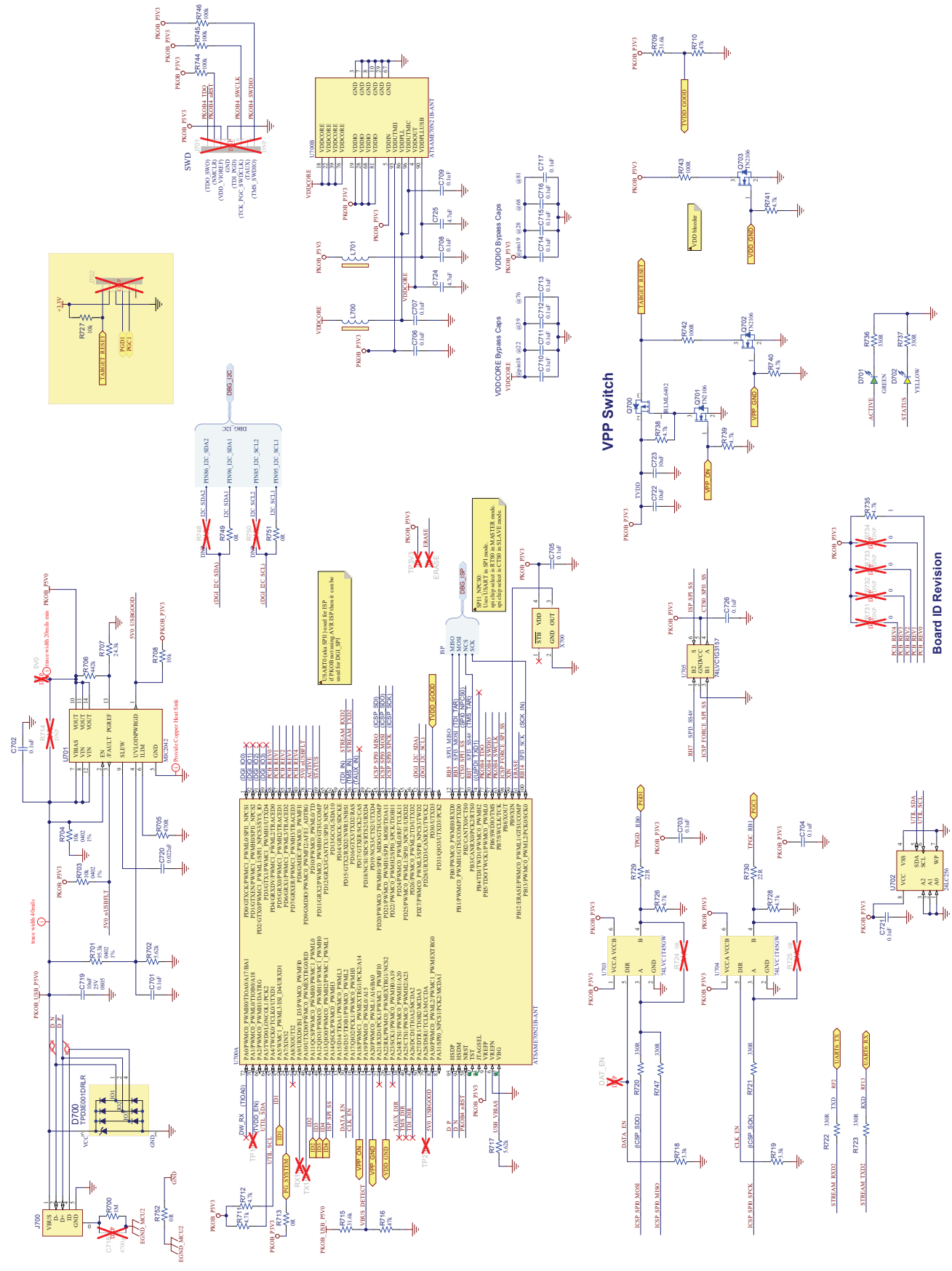
Table 1-11. VBUS Enable Pin Description

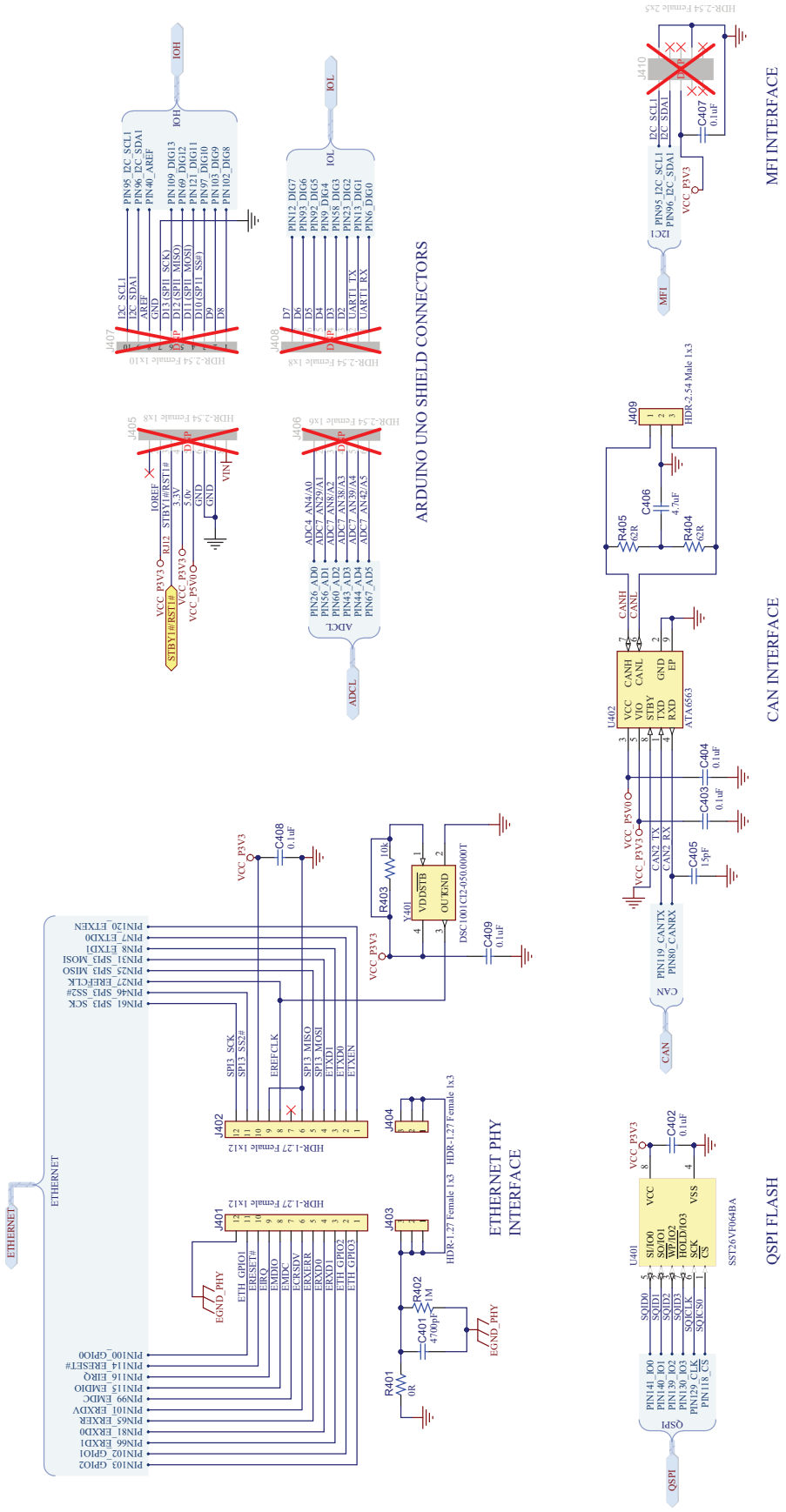
Function	Description	Port
VBUS Enable	Enable power control to USB devices attached to the Curiosity PIC32MZ EF 2.0 Development Board.	RJ13

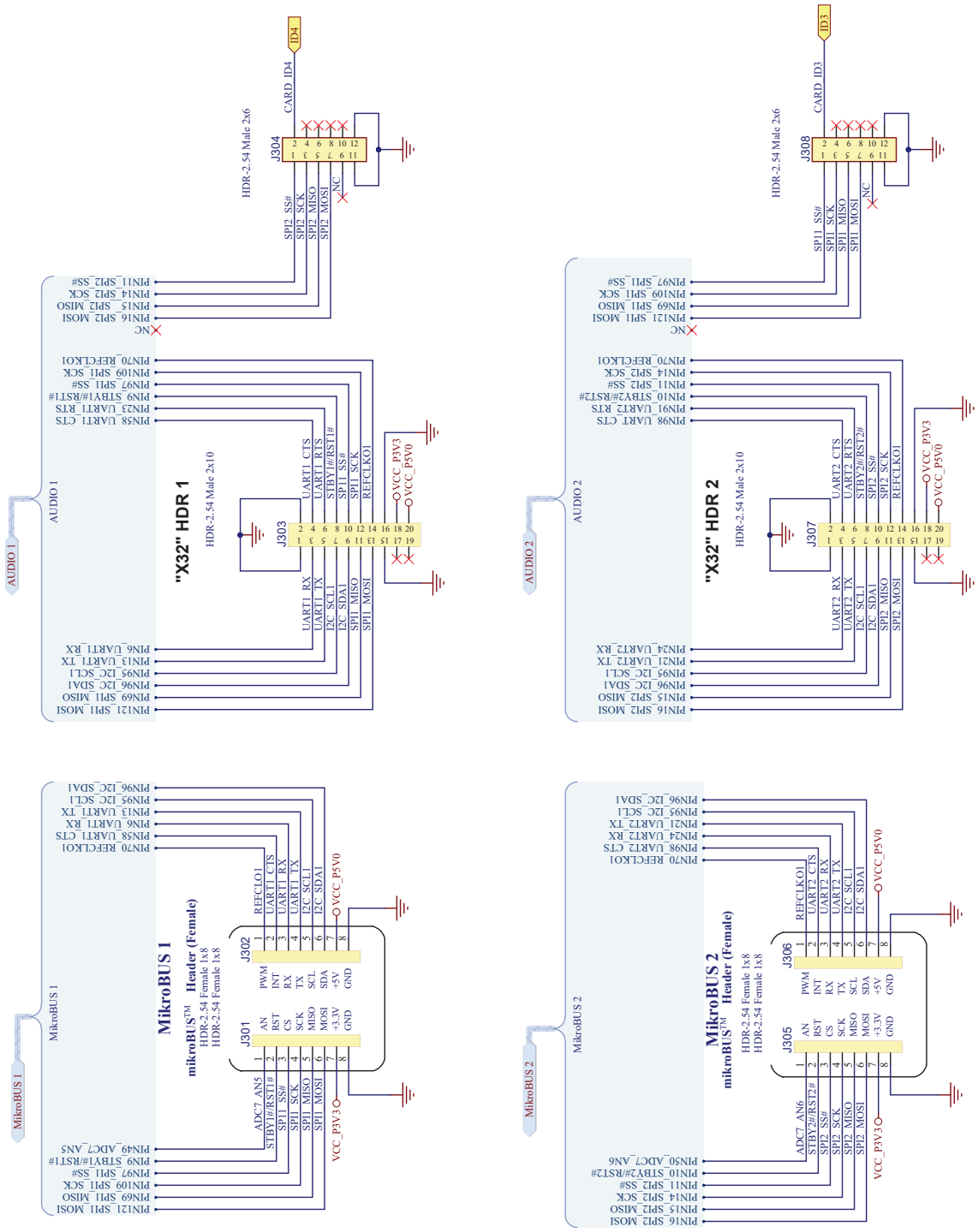
2. Hardware

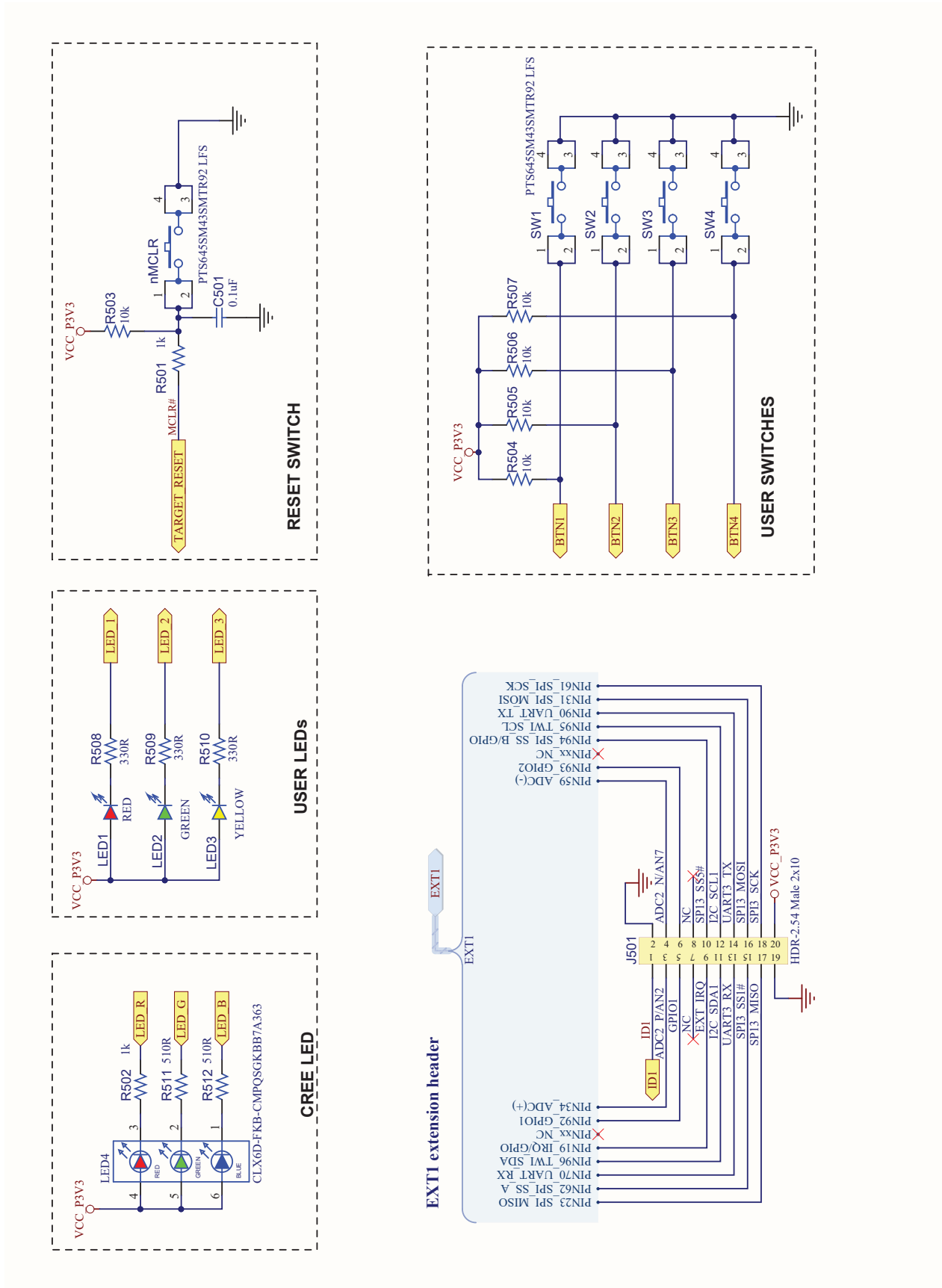
2.1 Schematics

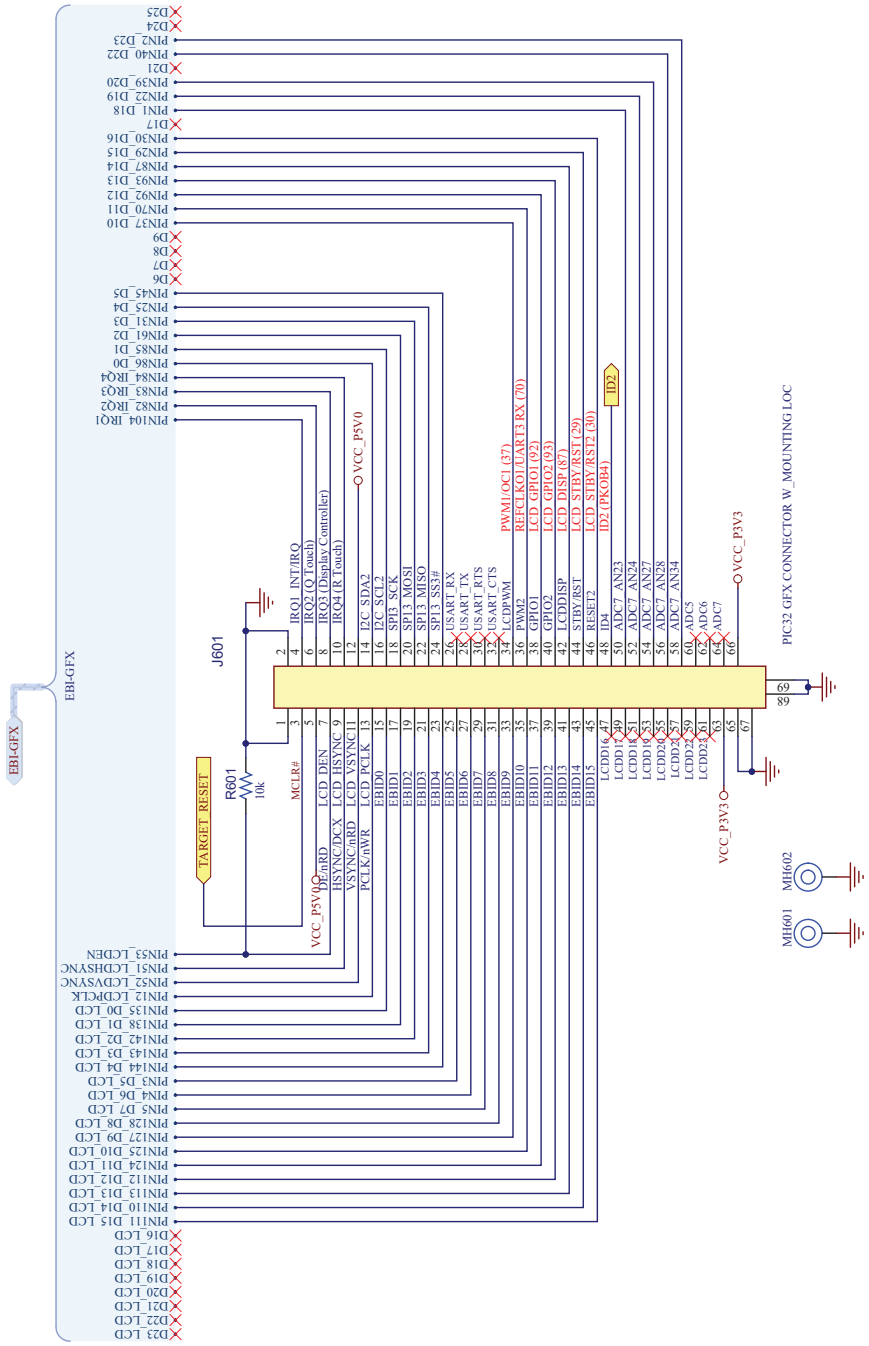


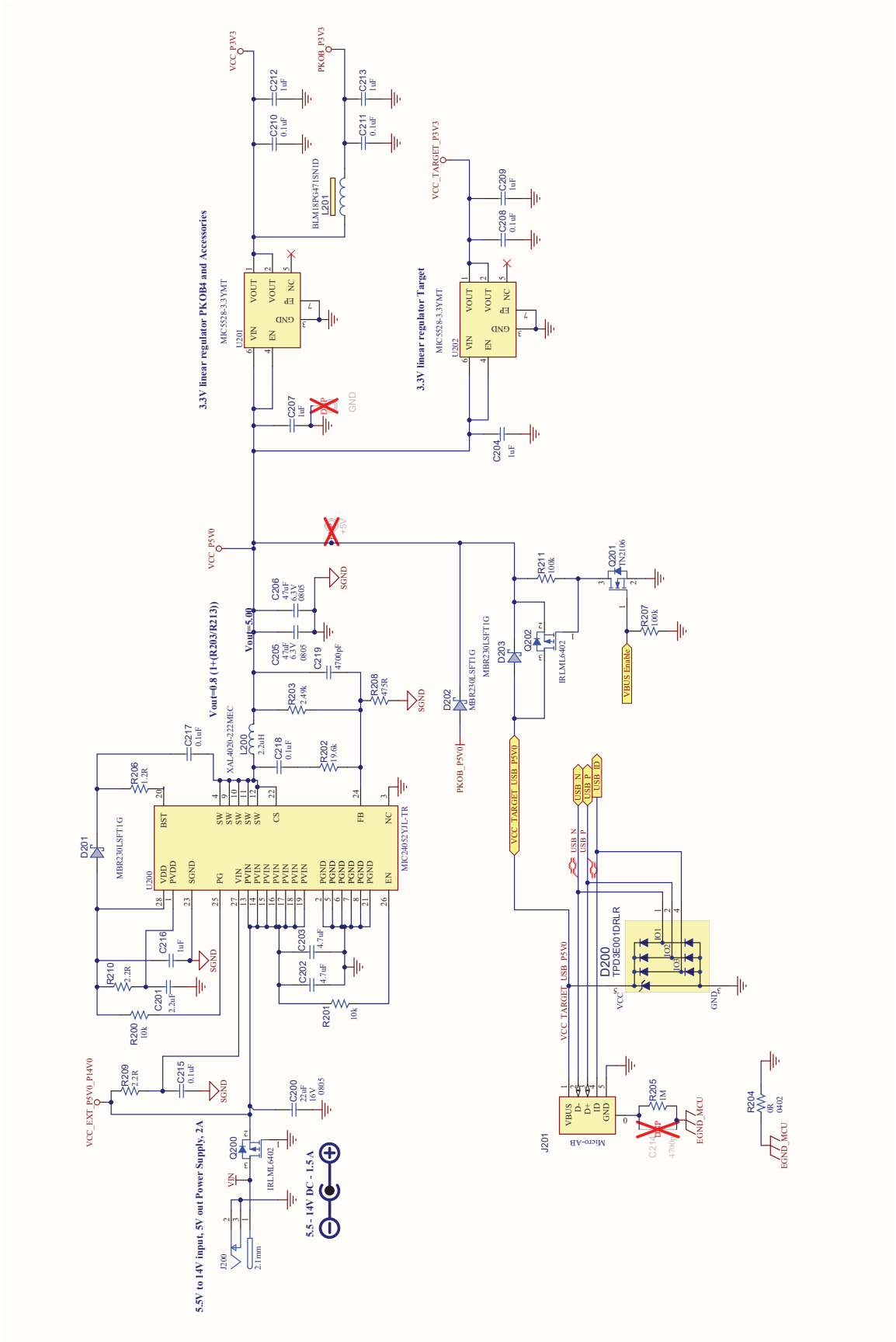

VPP Switch
Board ID Revision
SWD
VDDCORE Bypass Caps
VDDIO Bypass Caps
TARGET_RESET
VPP_ON
VPP_GND
TVDD_GOOD
VDD_GOOD
DBG_I2C
DBG_ISP
ERASE
DAT_EN
CLK_EN
ICSP SPD MOSI
ICSP SPD MISO
ICSP SPD SPCK
STREAM_RXD2
STREAM_TXD2
UART2_TX
UART2_RX
PKOB_USB_P3V0
PKOB_P3V3
ATSAME70N21B-ANT
MIC5042
TPD2E001DRLR
24LC256

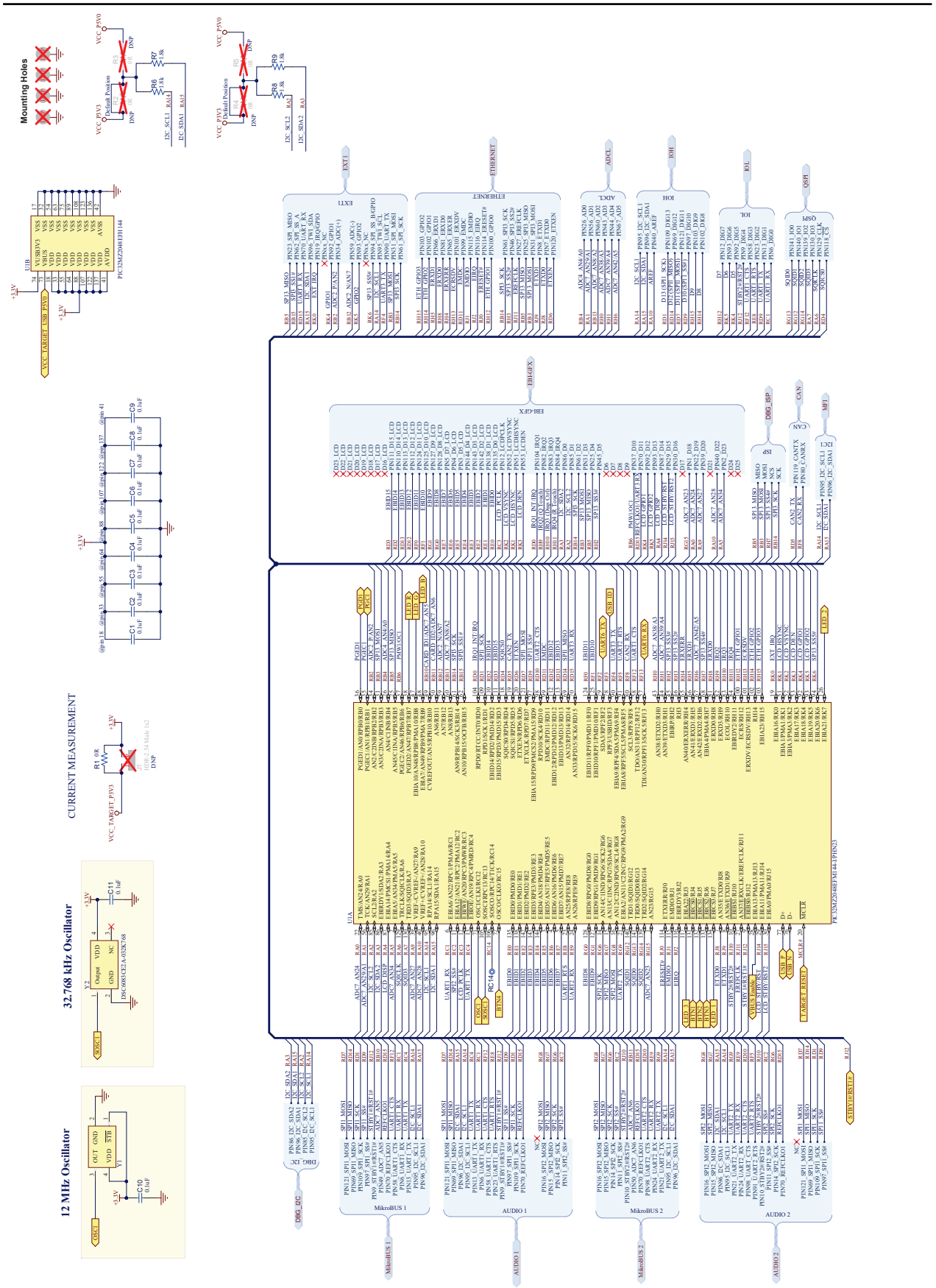

ARDUINO UNO SHIELD CONNECTORS
MFI INTERFACE
CAN INTERFACE
QSPI FLASH
ETHERNET PHY INTERFACE
ETHERNET
CAN
QSPI
MFI
ADCL
IOH
IOL
J407
J408
J405
J406
J409
J410
J401
J402
J403
J404
U401
U402
Y401
R401
R402
R403
R404
R405
C401
C402
C403
C404
C405
C406
C407
C408
C409
HDR-2.54 Female 1x10
HDR-2.54 Female 1x8
HDR-2.54 Female 1x6
HDR-2.54 Male 1x3
HDR-1.27 Female 1x12
HDR-1.27 Female 1x3
SST26VF064BA
ATA6563
DSC1001CI2-050.0000T
PIN95_I2C_SCL1
PIN96_I2C_SDA1
PIN40_AREF
PIN109_DIG13
PIN69_DIG12
PIN121_DIG11
PIN97_DIG10
PIN103_DIG9
PIN102_DIG8
PIN12_DIG7
PIN93_DIG6
PIN92_DIG5
PIN9_DIG4
PIN58_DIG3
PIN23_DIG2
PIN13_DIG1
PIN6_DIG0
PIN26_AD0
PIN56_AD1
PIN60_AD2
PIN43_AD3
PIN44_AD4
PIN67_AD5
PIN19_CANTX
PIN80_CANRX
PIN141_IO0
PIN140_IO1
PIN139_IO2
PIN130_IO3
PIN129_CLK
PIN118_CS
PIN120_ETXEN
PIN7_ETXD0
PIN8_ETXD1
PIN31_SPI3_MOSI
PIN25_SPI3_MISO
PIN27_EREFCLK
PIN46_SPI3_SS2#
PIN61_SPI3_SCK
PIN103_GPIO2
PIN102_GPIO1
PIN66_ERXD1
PIN81_ERXD0
PIN65_ERXER
PIN101_ERXDV
PIN99_EMDC
PIN115_EMDIO
PIN116_EIRQ
PIN114_ERESET#
PIN100_GPIO0

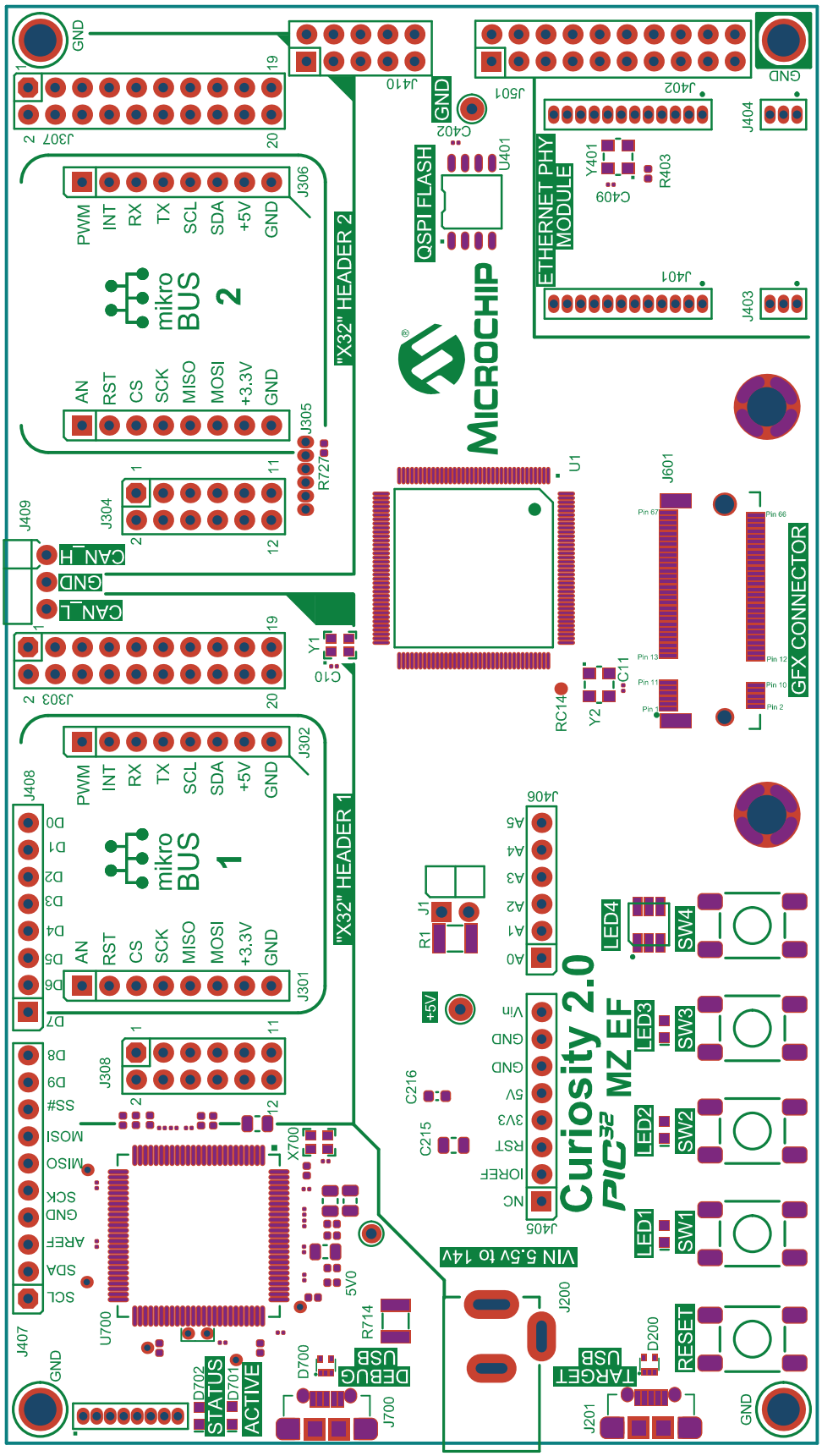

"X32" HDR 1
HDR-2.54 Male 2x10
J303
AUDIO 1
HDR-2.54 Male 2x6
J304
CARD_ID4
ID4
"X32" HDR 2
J307
AUDIO 2
J308
CARD_ID3
ID3
MikroBUS 1
MikroBUS™ Header (Female)
HDR-2.54 Female 1x8
J301
J302
MikroBUS 2
J305
J306
VCC_P5V0
VCC_P3V3
NC

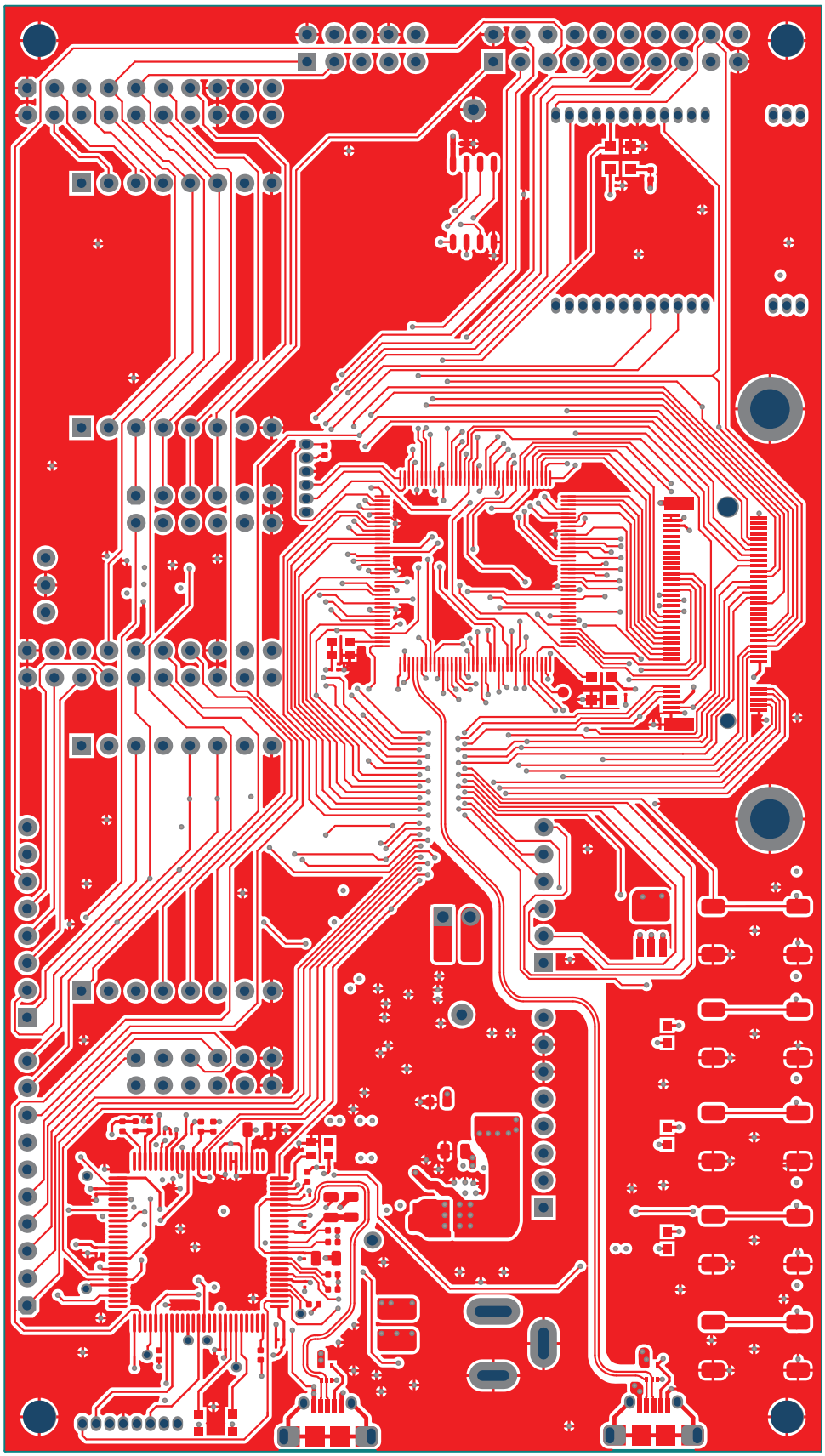

RESET SWITCH
VCC_P3V3
R503
10k
nMCLR
PTS645SM43SMTR92 LFS
C501
0.1uF
R501
1k
MCLR#
TARGET_RESET
USER SWITCHES
PTS645SM43SMTR92 LFS
SW1
SW2
SW3
SW4
R507
10k
R506
10k
R505
10k
R504
10k
VCC_P3V3
BTN1
BTN2
BTN3
BTN4
USER LEDs
LED 1
LED 2
LED 3
R508
330R
R509
330R
R510
330R
LED1
LED2
LED3
RED
GREEN
YELLOW
VCC_P3V3
CREE LED
LED R
LED G
LED B
R502
1k
R511
510R
R512
510R
LED4
CLX6D-FKB-CMPQSGKBB7A363
RED
GREEN
BLUE
VCC_P3V3
EXT1 extension header
EXT1
J501
HDR-2.54 Male 2x10
ID1
ADC2_P/AN2
GPIO1
NC
EXT_IRQ
I2C_SDA1
UART3_RX
SPI3_SS1#
SPI3_MISO
ADC2_N/AN7
NC
SPI3_SS#
I2C_SCL1
UART3_TX
SPI3_MOSI
SPI3_SCK
VCC_P3V3
PIN34_ADC(+)
PIN92_GPIO1
PINxx_NC
PIN19_IRQ/GPIO
PIN96_TWI_SDA
PIN70_UART_RX
PIN62_SPI_SS_A
PIN23_SPI_MISO
PIN59_ADC(-)
PIN93_GPIO2
PINxx_NC
PIN94_SPI_SS_B/GPIO
PIN95_TWI_SCL
PIN90_UART_TX
PIN31_SPI_MOSI
PIN61_SPI_SCK

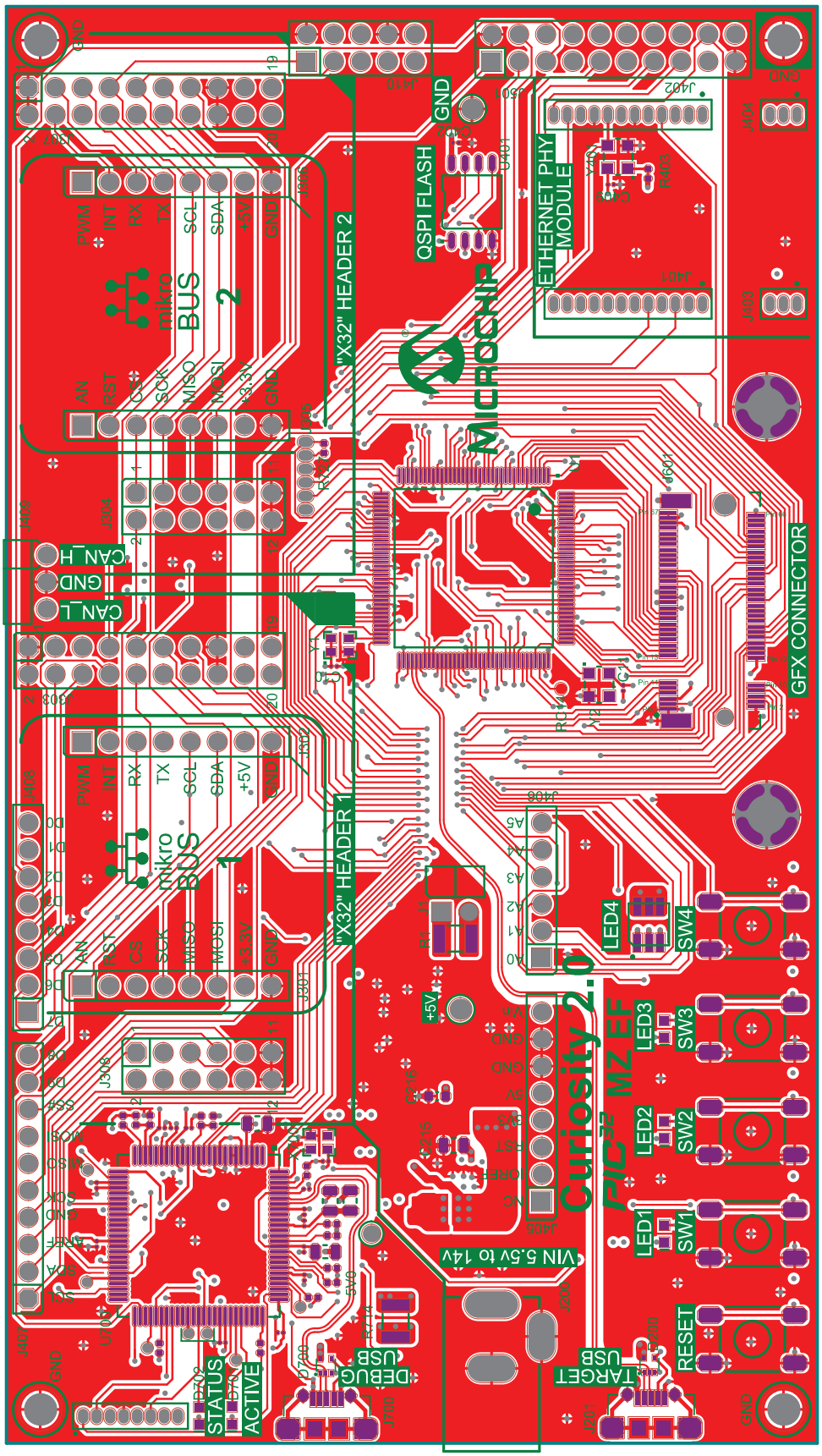

EBI-GFX
J601
PIC32 GFX CONNECTOR W_MOUNTING LOC
TARGET_RESET
R601
10k
MCLR#
VCC_P5V0
VCC_P3V3
MH601
MH602
ID2
IRQ1_INT/JRQ
IRQ2_(Q Touch)
IRQ3_(Display Controller)
IRQ4_(R Touch)
I2C_SDA2
I2C_SCL2
SPI3_SCK
SPI3_MOSI
SPI3_MISO
SPI3_SS#
USART_RX
USART_TX
USART_RTS
USART_CTS
LCDPWM
PWM2
GPIO1
GPIO2
LCD_D/SP
LCD_STBY/RST
LCD_STBY/RST2
ID2_(PIC32MJ)
RESET2
ID1
ADC3
ADC6
ADC7
AN23
AN24
AN27
AN28
AN34
PWM1/OC1 (37)
REFCLKO1/UART3 RX (70)
LCD_GPIO1 (92)
LCD_GPIO2 (93)
LCD_D/SP (87)
LCD_STBY/RST (29)
LCD_STBY/RST2 (30)
LCD_VSYNC
LCD_HSYNC
LCD_DEN
LCD_PCLK
PCLK/nWR
HSYNC/DCX
VSYNC/nRD
EBID0
EBID1
EBID2
EBID3
EBID4
EBID5
EBID6
EBID7
EBID8
EBID9
EBID10
EBID11
EBID12
EBID13
EBID14
EBID15
LCDD16
LCDD17
LCDD18
LCDD19
LCDD20
LCDD21
LCDD22
LCDD23
PIN53_LCDEN
PIN51_LCDHSYNC
PIN52_LCDVSYNC
PIN12_LCDPCLK
PIN135_D0_LCD
PIN138_D1_LCD
PIN142_D2_LCD
PIN143_D3_LCD
PIN144_D4_LCD
PIN3_D5_LCD
PIN4_D6_LCD
PIN5_D7_LCD
PIN128_D8_LCD
PIN127_D9_LCD
PIN125_D10_LCD
PIN124_D11_LCD
PIN112_D12_LCD
PIN113_D13_LCD
PIN110_D14_LCD
PIN111_D15_LCD
PIN104_IRQ1
PIN82_IRQ2
PIN83_IRQ3
PIN84_IRQ4
PIN86_D0
PIN85_D1
PIN61_D2
PIN31_D3
PIN25_D4
PIN45_D5
PIN37_D10
PIN70_D11
PIN92_D12
PIN93_D13
PIN87_D14
PIN29_D15
PIN30_D16
PIN22_D19
PIN39_D20
PIN40_D22
PIN2_D23

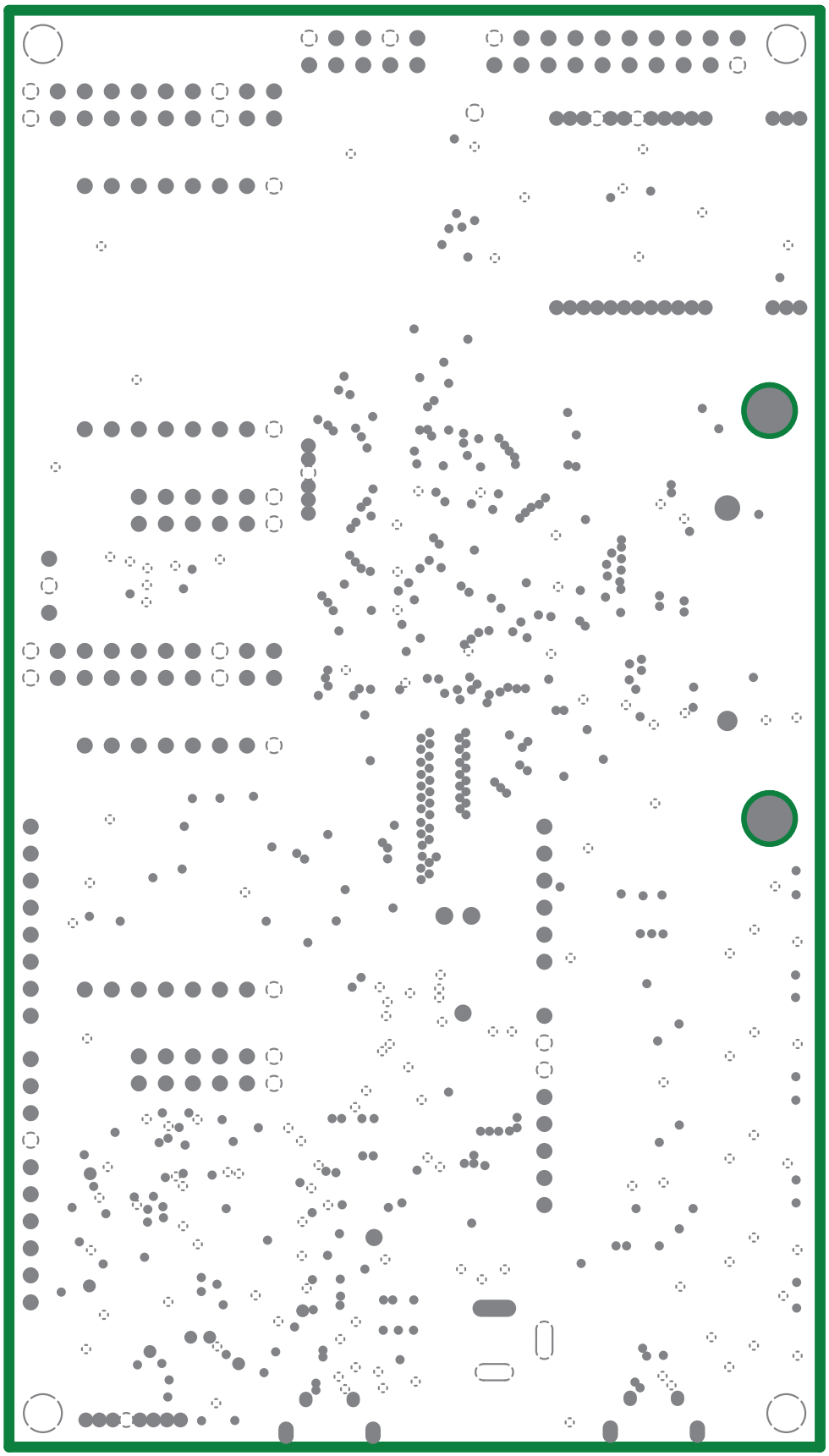

3.3V linear regulator PKOB4 and Accessories
3.3V linear regulator Target
MIC5528-3.3YMT
BLM18PG471SN1D
MBR230LSFT1G
MBR230LSFT1G
MBR230LSFT1G
XAL4020-222MEC
MIC24052YFL-TR
IRLML6402
IRLML6402
TN2106
TPD3E001DRLR
Micro-AB
5.5V to 14V input, 5V out Power Supply, 2A
5.5 - 14V DC - 1.5A
Vout=0.8 (1+(R203/R213))
Vout=5.00
VCC_P3V3
PKOB_P3V3
VCC_TARGET_P3V3
VCC_P5V0
VCC_EXT_P5V0_P14V0
VCC_TARGET_USB_P5V0
PKOB_P5V0
VBUS Enable
USB_N
USB_P
USB_ID
EGND_MCU
SGND
GND

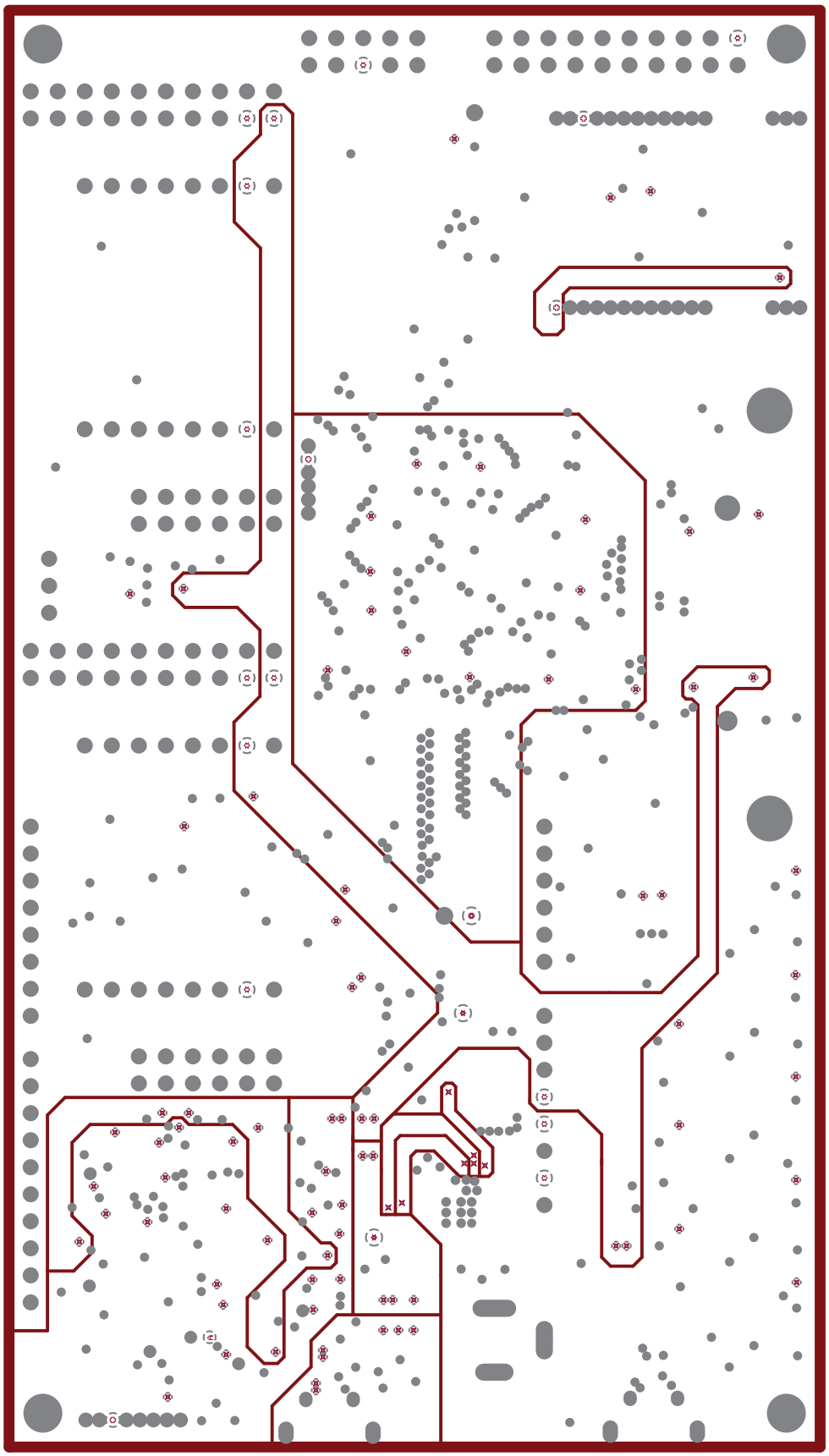


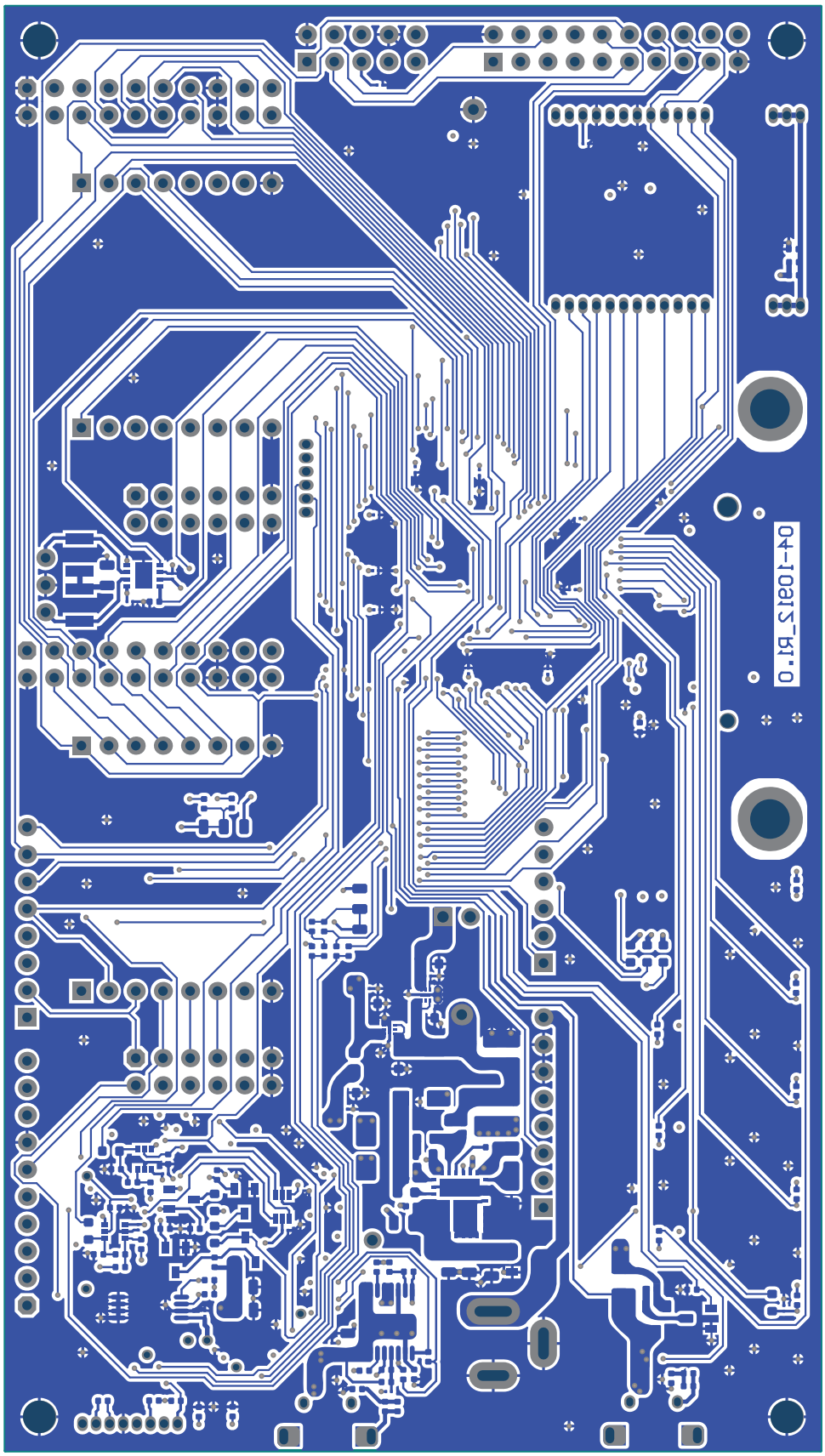

Curiosity 2.0
PIC32 MZ EF
MICROCHIP
"X32" HEADER 1
"X32" HEADER 2
mikro BUS 1
mikro BUS 2
PWM
INT
RX
TX
SCL
SDA
+5V
GND
AN
RST
CS
SCK
MISO
MOSI
+3.3V
QSPI FLASH
ETHERNET PHY MODULE
GFX CONNECTOR
CAN_H
CAN_L
VIN 5.5V to 14V
DEBUG USB
TARGET USB
STATUS
ACTIVE
LED1
LED2
LED3
LED4
SW1
SW2
SW3
SW4
RESET

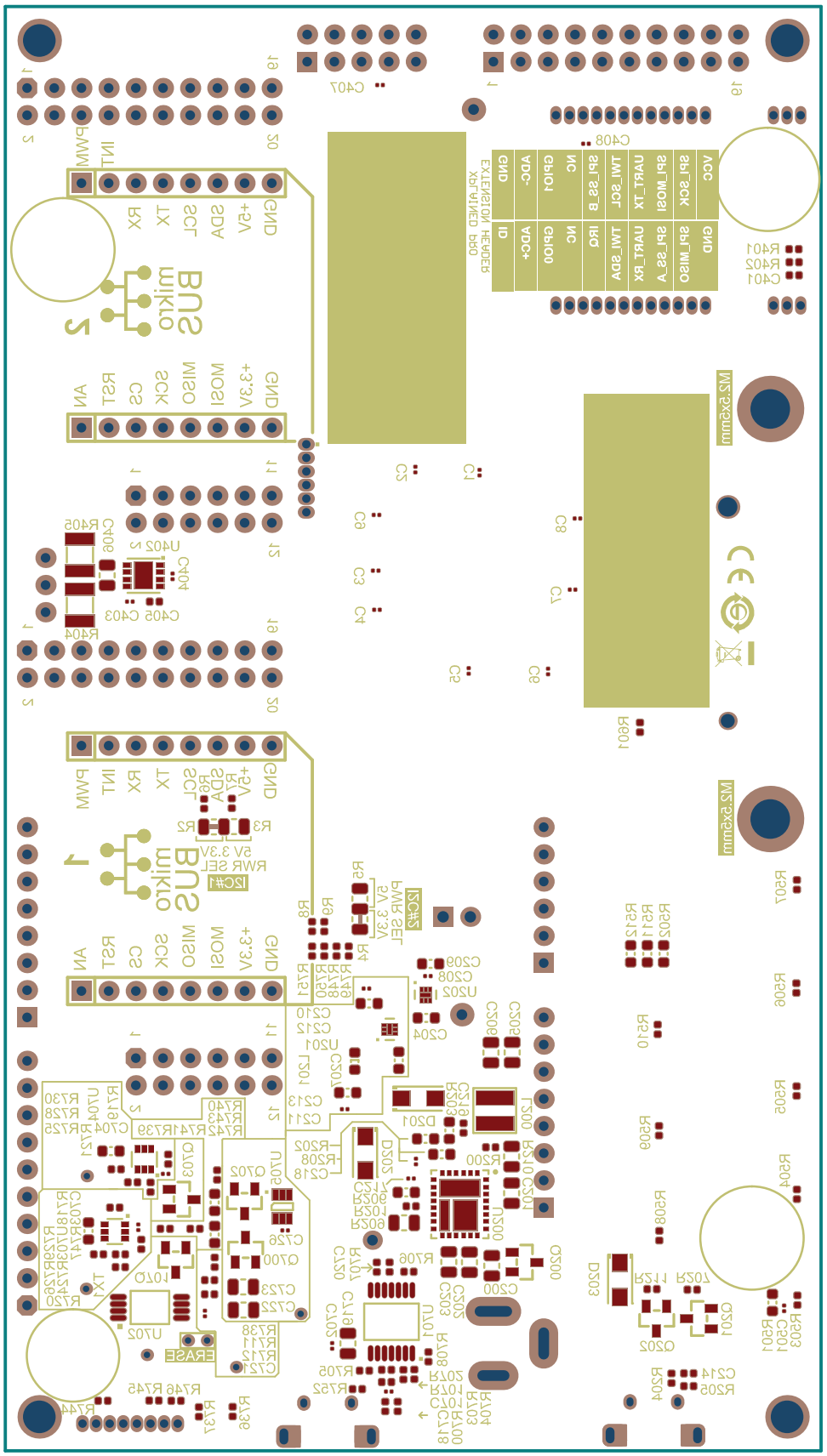


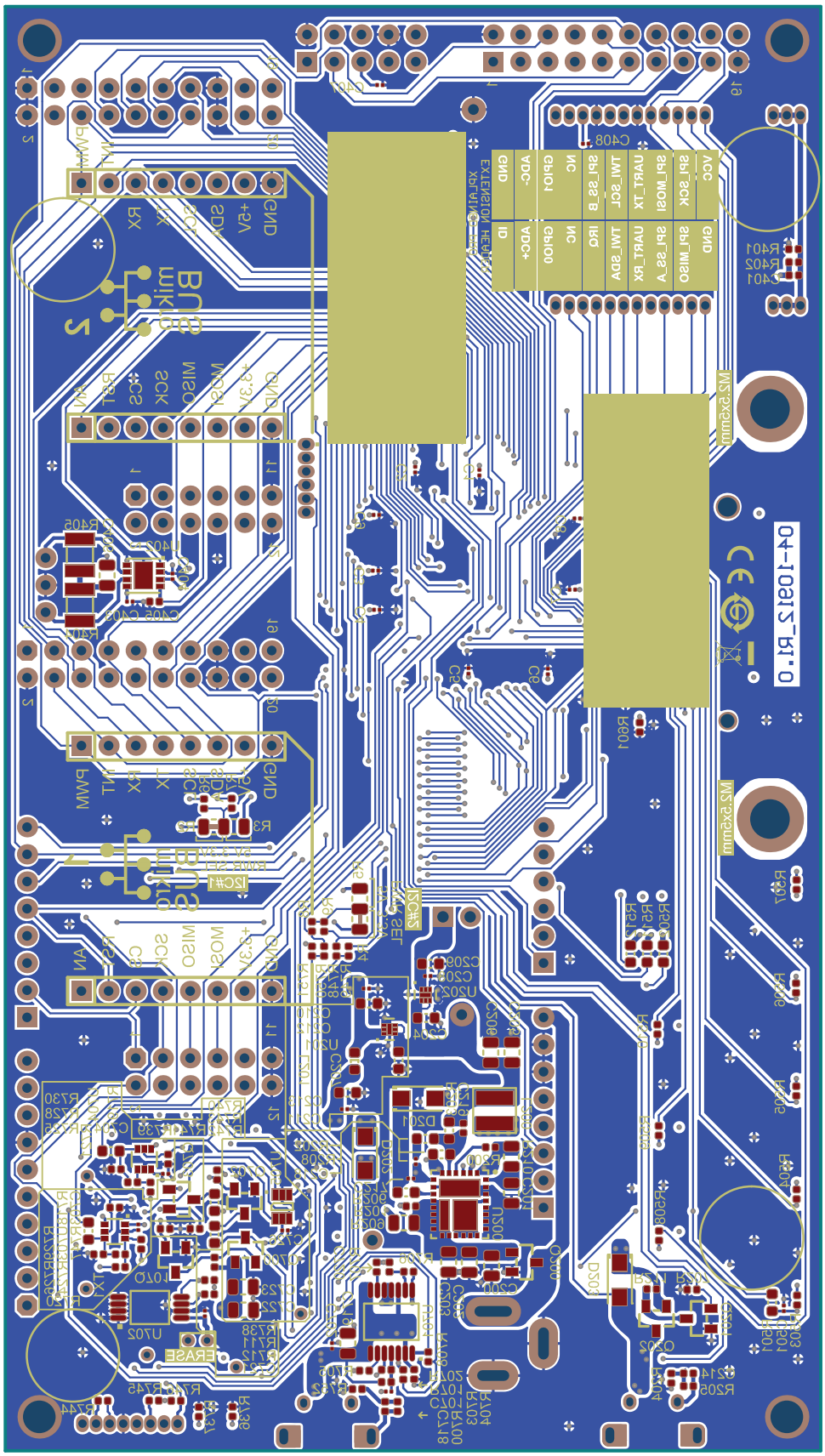

"X32" HEADER 2
"X32" HEADER 1
QSPI FLASH
ETHERNET PHY MODULE
GFX CONNECTOR
mikro BUS 2
mikro BUS 1
CAN_H
CAN_L
GND
LED1
LED2
LED3
LED4
SW1
SW2
SW3
SW4
RESET
STATUS
ACTIVE
DEBUG USB
TARGET USB
VIN 5.5V to 14V
Curiosity 2.0
PIC32 M7 EF
MICROCHIP






04-10812_R1.0





2.2 Bill of Materials

Quantity	Designator	Description
42	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C208, C210, C211, C217, C218, C402, C403, C404, C407, C408, C409, C501, C701, C702, C703, C704, C705, C706, C707, C708, C709, C710, C711, C712, C713, C714, C715, C716, C717, C721, C726	CAP CER 0.1µF 16V 10% X5R SMD 0201
1	C200	CAP CER 22uF 25V 20% X5R SMD 0805
1	C201	CAP CER 2.2uF 16V 10% X7R SMD 0805
5	C202, C203, C406, C724, C725	CAP CER 4.7uF 25V 10% X5R SMD 0805
6	C204, C207, C209, C212, C213, C216	CAP CER 1uF 16V 10% X7R SMD 0603
2	C205, C206	CAP CER 47uF 10V 20% X5R 0805
2	C219, C401	CAP CER 4700pF 50V 10% X7R SMD 0402
1	C215	CAP CER 0.1uF 25V 10% X7R SMD 0805
1	C405	CAP CER 15pF 50V 5% NP0 SMD 0402
3	C719, C722, C723	CAP CER 10uF 25V 10% X5R SMD 0805
1	C720	CAP CER 0.022uF 16V 10% X7R SMD 0402
2	D200, D700	DIO TVS ARRAY TPD3E001DRLR 11V 90W SMD SOT-553
3	D201, D202, D203	DIO SCTKY MBR230LSFT1G 430mV 2A 30V SMD SOD-123FL
2	D701, LED2	DIO LED GREEN 2V 30mA 35mcd Clear SMD 0603
2	D702, LED3	DIO LED YELLOW 2.1V 20mA 6mcd Clear SMD 0603
1	J200	CON POWER 2.1mm 5.5mm Switch Slotted TH R/A
2	J201, J700	CONN RCPT USB MICRO AB SMD
4	J301, J302, J305, J306	CON HDR-2.54 Female 1x8 Tin TH VERT
2	J303, J307	CON HDR 2.54 MALE 2x10 3u" GOLD IN CONTACT AREA MATTE TIN ON TAIL 5.84MH TH VERT
2	J304, J308	CON HDR-2.54 Male 2x6 Gold 5.84MH TH VERT
2	J401, J402	CON STRIP-1.27 Female 1x12 Gold TH VERT
2	J403, J404	CON STRIP-1.27 Female 1x3 Gold TH VERT
1	J409	CON HDR-2.54 Male 1x3 Tin 6.2MH TH R/A
1	J501	CON HDR-2.54 Male 2x10 Gold 5.84MH TH R/A
1	J601	CONN EDGE DUAL FEMALE 67POS 0.5mm SMD R/A
1	L200	INDUCTOR 2.2uH 5.5A 20% SMD L4W4H2.1
1	L201	FERRITE 470R@100MHz 1A SMD 0603
2	L700, L701	FERRITE 2A 600R SMD 0805
1	LED1	DIO LED RED 1.8V 40mA 10mcd Clear SMD 0603
1	LED4	DIO LED TRI RED, GREEN, BLUE 2V, 3.2V, 3.2V 20mA, 20mA, 20mA SMD 6-PLCC
2	MH601, MH602	MECH RND STNDFF M2.5X0.45 STEEL H2.5
5	nMCLR, SW1, SW2, SW3, SW4	SWITCH TACT SPST 24V 50mA KSR231GLFS SMD 6X3.5mm
3	Q200, Q202, Q700	TRANS FET P-CH IRLML6402 -20V -3.7A 1.3W SOT-23-3
1	R1	RES TKF 0R 1/3W SMD 1210
4	R6, R7, R8, R9	RES TKF 1.8k 1% 1/10W SMD 0402
13	R200, R201, R403, R503, R504, R505, R506, R507, R601, R703, R704, R708, R727	RES TKF 10k 1% 1/10W SMD 0402

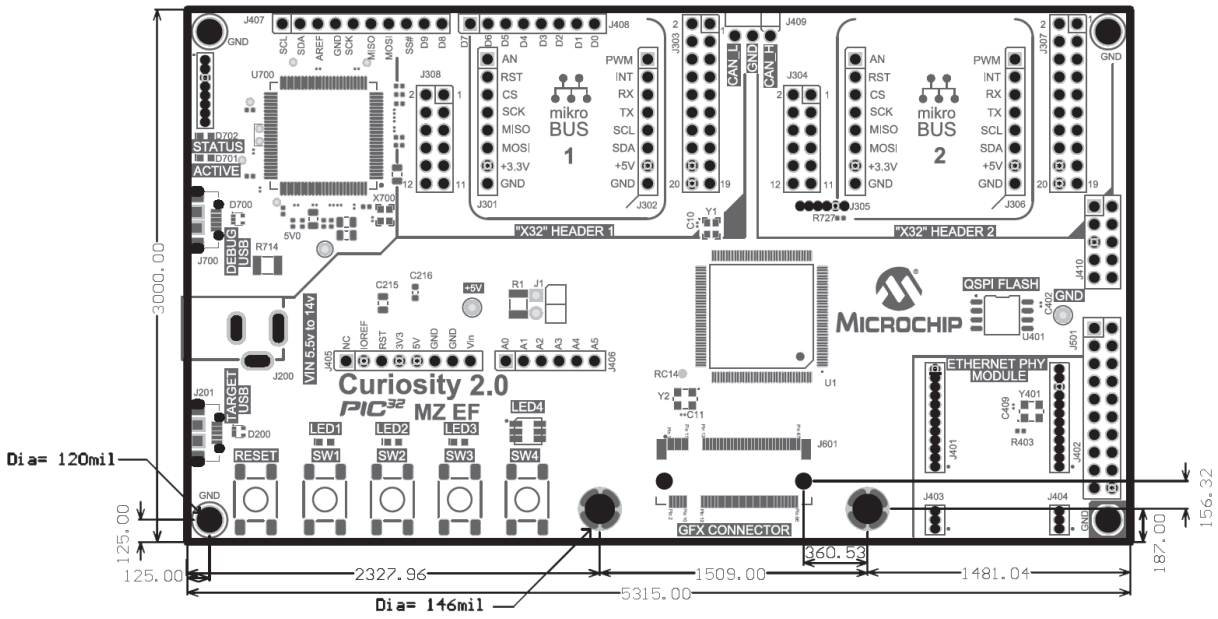
.....continued

Quantity	Designator	Description
1	R202	RES TKF 19.6k 1% 1/10W SMD 0603
1	R203	RES TKF 2.49k 1% 1/10W SMD 0603
6	R204, R401, R713, R749, R751, R752	RES TKF 0R 1/16W SMD 0402
3	R205, R402, R700	RES TKF 1M 1% 1/10W SMD 0402
2	R209, R210	RES TKF 2.2R 1% 1/8W SMD 0805 AEC-Q200
5	R207, R211, R744, R745, R746	RES TKF 100k 1% 1/10W SMD 0402
11	R208	RES TKF 475R 1% 1/10W SMD 0603
1	R214	RES TKF 1.2R 1% 1/10W SMD 0603
2	R404, R405	RES TKF 62R 1% 1/2W SMD 1210
2	R501, R502	RES TKF 1k 1% 1/10W SMD 0603
10	R508, R509, R510, R720, R721, R722, R723, R736, R737, R747	RES TKF 330R 1% 1/16W SMD 0402
2	R511, R512	RES TKF 510R 1% 1/10W SMD 0603
1	R701	RES TKF 95.3k 1% 1/16W SMD 0402
2	R702, R717	RES TKF 5.62k 1% 1/16W SMD 0402
1	R705	RES TKF 470R 1% 1/16W MF 0402
1	R706	RES TKF 442k 1% 1/16W SMD 0402
1	R707	RES TKF 24.3k 1% 1/16W SMD 0402
2	R709, R715	RES TKF 31.6k 1% 1/10W SMD 0402
2	R710, R716	RES TKF 47k 5% 1/10W SMD 0402
9	R711, R712, R726, R728, R735, R738, R739, R740, R741	RES TKF 4.7k 1% 1/16W SMD 0402
2	R718, R719	RES TKF 3.3k 5% 1/10W SMD 0402
2	R729, R730	RES TKF 22 OHM 1% 1/10W SMD 0603
2	R742, R743	RES TKF 100R 5% 1/10W SMD 0603
2	U703, U704	IC TRANSCEIVER 74LVC1T45GW Single Bit Voltage Translator SOT-363
1	U705	IC SWITCH SPDT 74LVC1G3157 SC-70-6
4	Q701, Q702, Q703, Q201	MCHP ANALOG MOSFET N-CH TN2106 60V 280mA 360mW 2.5R SOT23-3
1	U1	MCHP MCU 32-BIT 2MB 512kB PIC32MZ2048EFH144-I/PH TQFP-144
1	U200	MCHP BUCK REGULATOR 12V 6A MIC24052 QFN-28
2	U201, U202	MCHP ANALOG LDO 3.3V MIC5528-3.3YMT-TR 6-TDFN
1	U401	MCHP MEMORY SERIAL FLASH 64M 104MHz SOIJ8
1	U402	MCHP INTERFACE CAN ATA6563-GBQW1 VDFN-8
1	U700	MCHP MCU 32-BIT 300MHz 2MB 384kB ATSAME70N21B-ANT LQFP-100
1	U701	MCHP ANALOG POWER SWITCH 5.5V 3A MIC2042-1YTS TSSOP-14
1	U702	MCHP MEMORY SERIAL EEPROM 256k I2C 24LC256-E/ST TSSOP-8
2	X700, Y1	MCHP CLOCK OSCILLATOR SINGLE 12.000MHZ DSC6011JI1A-012.0000 VLGA
1	Y2	MCHP CLOCK OSCILLATOR SINGLE 32.768Hz DSC6083CE2A-032K768 SMD DFN-4
1	Y401	MCHP CLOCK OSCILLATOR 50MHz DSC1001CI2-050.0000T DFN-4
4	PAD1, PAD2, PAD3, PAD4	MECH HW RUBBER PAD CYLINDRICAL D9.53H5.97
DNP	J701	CON HDR-1.27 Female 1x8 TH VERT
DNP	J1	CON HDR-2.54 Male 1X2 Gold 6mm MH TH R/A

.....continued

Quantity	Designator	Description
DNP	J405, J408	CON HDR-2.54 Female 1x8 Tin TH VERT
DNP	J406	CON HDR-2.54 Female 1x6 Gold TH
DNP	J407	CON HDR-2.54 Female 1x10 Gold TH VERT
DNP	J410	CON HDR-2.54 Female 2x5 GOLD TH R/A
DNP	R724, R725, R748, R750	RES TKF 0R 1/16W SMD 0402
DNP	C214, C718	CAP CER 4700pF 50V 10% X7R SMD 0402
DNP	GND	MISC, TEST POINT MULTI PURPOSE MINI BLK
DNP	+5V	MISC, TEST POINT MULTI PURPOSE MINI RED
DNP	J702	CON HDR-1.27 Female 1x6 Gold TH VERT
DNP	R2, R3, R4, R5	RES TKF 0R 1/16W SMD 0805
DNP	R731, R732, R733, R734	RES TKF 4.7k 1% 1/16W SMD 0402
DNP	DAT_EN, ERASE, MH1, MH2, MH3, MH4, RX1, TP1, TP2, TP3V3, TX1, 5V0	Non-populated Test Points

2.3 Board Dimensions



2.4 Hardware Revision History

Rev 1.0
Known issue: J407 and J408 in Arduino header section are 180 degrees out. Arduino Headers will not be compatible with shields.

Rev 2.0
J407 and J408 are corrected to work with Arduino header interface.

3. Revision History

Revision B - February 2021
Added a new section titled Hardware Revision History to detail updates that have been done to the board.

Revision A - July 2019
This is the initial release of this document.

The Microchip Web Site

Microchip provides online support via our web site at www.microchip.com/. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, 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 (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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/. Under "Support", click on "Customer Change Notification" and follow the registration instructions.

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: www.microchip.com/support

Microchip Devices Code Protection Feature

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.

Legal Notice

Trademarks

ISBN: 978-1-5224-7596-5

Quality Management System Certified by DNV

ISO/TS 16949

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

Worldwide Sales and Service

AMERICAS	ASIA/PACIFIC	ASIA/PACIFIC	EUROPE
Corporate Office 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Fax: 480-792-7277 Technical Support: http://www.microchip.com/support Web Address: www.microchip.com **Atlanta** Duluth, GA Tel: 678-957-9614 Fax: 678-957-1455 **Austin, TX** Tel: 512-257-3370 **Boston** Westborough, MA Tel: 774-760-0087 Fax: 774-760-0088 **Chicago** Itasca, IL Tel: 630-285-0071 Fax: 630-285-0075 **Dallas** Addison, TX Tel: 972-818-7423 Fax: 972-818-2924 **Detroit** Novi, MI Tel: 248-848-4000 **Houston, TX** Tel: 281-894-5983 **Indianapolis** Noblesville, IN Tel: 317-773-8323 Fax: 317-773-5453 Tel: 317-536-2380 **Los Angeles** Mission Viejo, CA Tel: 949-462-9523 Fax: 949-462-9608 Tel: 951-273-7800 **Raleigh, NC** Tel: 919-844-7510 **New York, NY** Tel: 631-435-6000 **San Jose, CA** Tel: 408-735-9110 Tel: 408-436-4270 **Canada - Toronto** Tel: 905-695-1980 Fax: 905-695-2078	**Australia - Sydney** Tel: 61-2-9868-6733 **China - Beijing** Tel: 86-10-8569-7000 **China - Chengdu** Tel: 86-28-8665-5511 **China - Chongqing** Tel: 86-23-8980-9588 **China - Dongguan** Tel: 86-769-8702-9880 **China - Guangzhou** Tel: 86-20-8755-8029 **China - Hangzhou** Tel: 86-571-8792-8115 **China - Hong Kong SAR** Tel: 852-2943-5100 **China - Nanjing** Tel: 86-25-8473-2460 **China - Qingdao** Tel: 86-532-8502-7355 **China - Shanghai** Tel: 86-21-3326-8000 **China - Shenyang** Tel: 86-24-2334-2829 **China - Shenzhen** Tel: 86-755-8864-2200 **China - Suzhou** Tel: 86-186-6233-1526 **China - Wuhan** Tel: 86-27-5980-5300 **China - Xian** Tel: 86-29-8833-7252 **China - Xiamen** Tel: 86-592-2388138 **China - Zhuhai** Tel: 86-756-3210040	**India - Bangalore** Tel: 91-80-3090-4444 **India - New Delhi** Tel: 91-11-4160-8631 **India - Pune** Tel: 91-20-4121-0141 **Japan - Osaka** Tel: 81-6-6152-7160 **Japan - Tokyo** Tel: 81-3-6880- 3770 **Korea - Daegu** Tel: 82-53-744-4301 **Korea - Seoul** Tel: 82-2-554-7200 **Malaysia - Kuala Lumpur** Tel: 60-3-7651-7906 **Malaysia - Penang** Tel: 60-4-227-8870 **Philippines - Manila** Tel: 63-2-634-9065 **Singapore** Tel: 65-6334-8870 **Taiwan - Hsin Chu** Tel: 886-3-577-8366 **Taiwan - Kaohsiung** Tel: 886-7-213-7830 **Taiwan - Taipei** Tel: 886-2-2508-8600 **Thailand - Bangkok** Tel: 66-2-694-1351 **Vietnam - Ho Chi Minh** Tel: 84-28-5448-2100	**Austria - Wels** Tel: 43-7242-2244-39 Fax: 43-7242-2244-393 **Denmark - Copenhagen** Tel: 45-4450-2828 Fax: 45-4485-2829 **Finland - Espoo** Tel: 358-9-4520-820 **France - Paris** Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79 **Germany - Garching** Tel: 49-8931-9700 **Germany - Haan** Tel: 49-2129-3766400 **Germany - Heilbronn** Tel: 49-7131-67-3636 **Germany - Karlsruhe** Tel: 49-721-625370 **Germany - Munich** Tel: 49-89-627-144-0 Fax: 49-89-627-144-44 **Germany - Rosenheim** Tel: 49-8031-354-560 **Israel - Ra'anana** Tel: 972-9-744-7705 **Italy - Milan** Tel: 39-0331-742611 Fax: 39-0331-466781 **Italy - Padova** Tel: 39-049-7625286 **Netherlands - Drunen** Tel: 31-416-690399 Fax: 31-416-690340 **Norway - Trondheim** Tel: 47-72884388 **Poland - Warsaw** Tel: 48-22-3325737 **Romania - Bucharest** Tel: 40-21-407-87-50 **Spain - Madrid** Tel: 34-91-708-08-90 Fax: 34-91-708-08-91 **Sweden - Gothenberg** Tel: 46-31-704-60-40 **Sweden - Stockholm** Tel: 46-8-5090-4654 **UK - Wokingham** Tel: 44-118-921-5800 Fax: 44-118-921-5820