QCIOT-USB2SERDEMOZ

USB-to-Serial Converter

Description

The QCIOT-USB2SERDEMOZ evaluation board is a highly flexible USB-to-Serial converter that supports UART, SPI, I^{2}C, and I3C. The evaluation board allows users to connect the device to the desired serial communication protocol, then communicate via a PC using a simple terminal interface. In addition to transparent mode, the UART-to-USB channel supports an AT commands interface that enables querying the connectivity status of a sensor with the supported serial communication protocols.

The QCIOT-USB2SERDEMOZ evaluation board is an all-in-one solution that supports multiple common serial communication, along with the ability to evaluate and quickly prototype a broad portfolio of Pmod™ boards.

Board Contents

- RA4E2 Entry-Line 100MHz Arm® Cortex®-M33 general purpose microcontroller
- SLG46538V GreenPAK™ programmable dual supply mixed-signal matrix
- RAA2142504 20V, 500mA low-dropout linear regulator
- SLG59H1401C High Voltage GreenFET™ load switch for OR'ing or manual power MUX applications

Features

- Direct USB to UART converter
- SPI, I^{2}C, I3C master and slave operation
- AT command controlled terminal interface
- GreenPAK-based on-the-fly configurable interface MUX
- Integrated level shifter for UART, SPI (master or slave, hereby referred to as controller and target, respectively), I^{2}C controller
- Digilent Pmod compatible interface
- Selectable Pmod power supply (3.3V or 5V)
- Integrated low noise LDO 3.3V regulator
- Overcurrent protection
- Configurable GPIOs

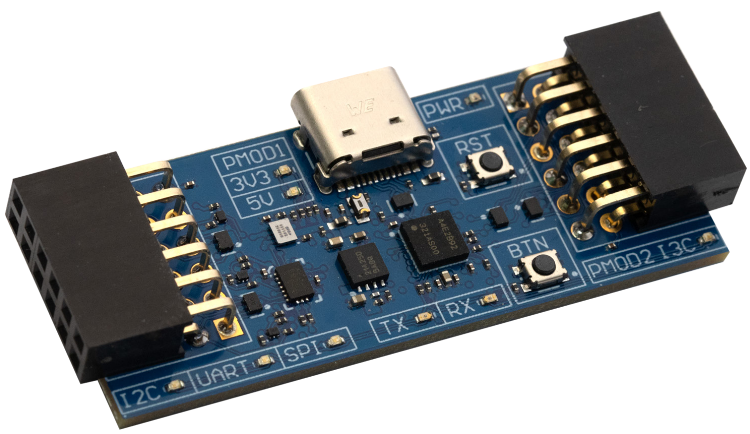


Figure 1. QCIOT-USB2SERDEMOZ USB to Serial Converter Board

Contents

Figures

1. Functional Description

The design of QCIOT-USB2SERDEMOZ board leverages a proven block diagram from Renesas' Universal USB Converter Winning Combination solution (see Figure 2), emphasizing the RA4E2 Entry Line Arm Cortex M33; a general purpose microcontroller containing a set of peripheral interfaces for this application.

To save board space, the design highlights the use of the Renesas GreenPAK portfolio. In addition to its small footprint, the design utilizes the GreenPAK mixed-signal matrix to multiplex the signals and enable the Digilent Pmod-compatible interface.

The 5V level converter capitalizes on the dual-voltage of the GreenPAK, and the GreenFET load switch is used for the power supply switch for the Pmod connector.

For more detailed schematics, see section 2.1.

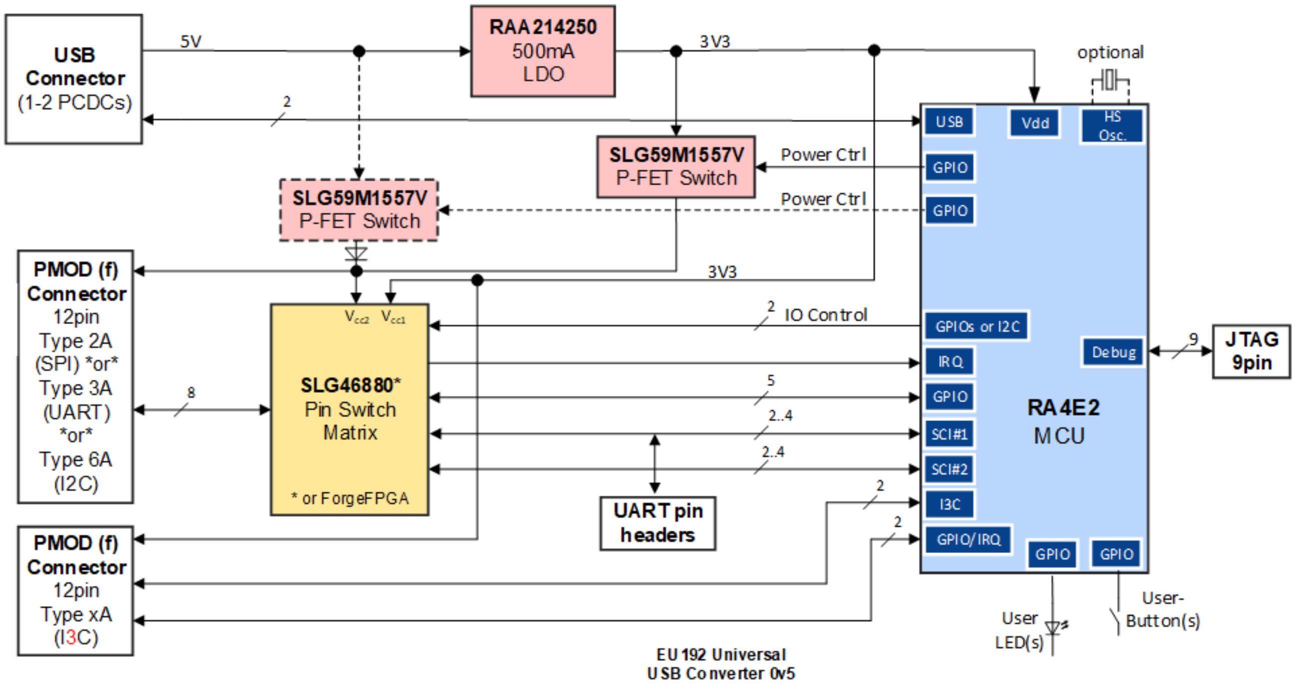


Figure 2. Universal USB Converter Solution Block Diagram

1.1 Board Overview

The board operates as a USB Communication Device Class (CDC) device that provides communication capabilities similar to a traditional serial port while simultaneously supporting one serial interface conversion to USB. The PMOD1 and PMOD2 connectors host different interfaces. The Interface/Connector selection matrix is shown in Table 1.

Table 1. Interface/Connector Selection Matrix

	UART	SPI Controller	SPI Target	I²C Controller	I²C Target	I3C Controller	I3C Target
PMOD1	X	X	X	X			
PMOD2				X	X	X	x

The board connectors and key components are shown in Figure 3, followed by a functional description of each.

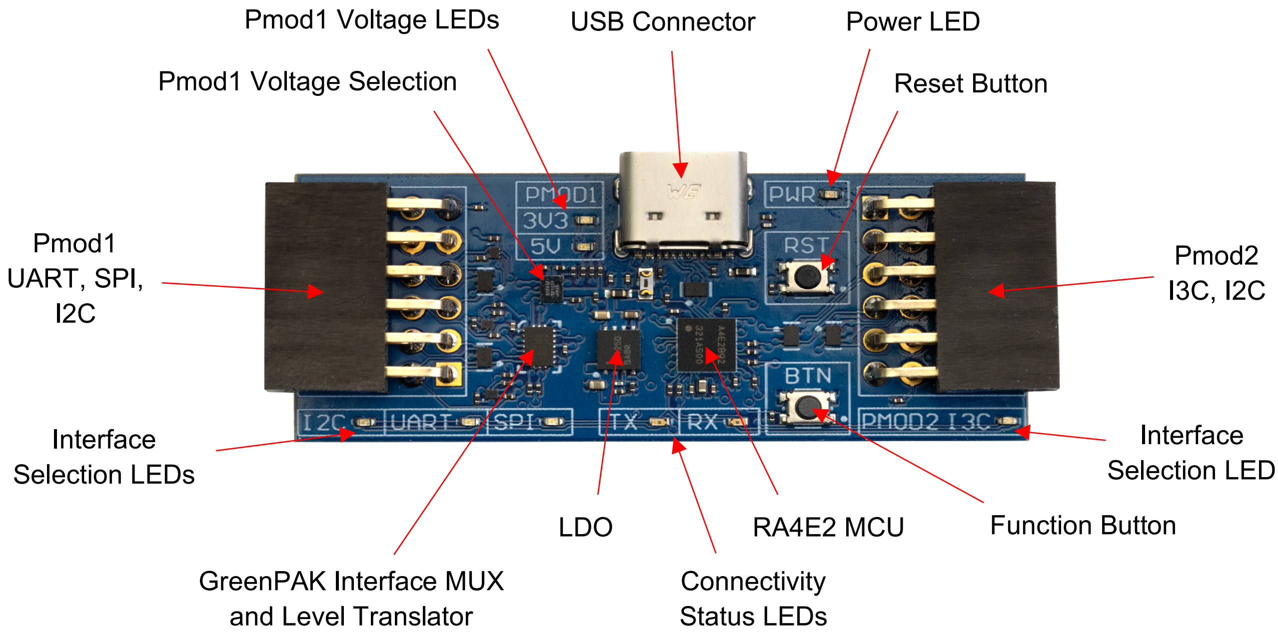


Figure 3. QCIOT-USB2SERDEMOZ Board Connectors and Components

Buttons

- **RST** – Board reset button.
- **BTN** – Button for operating mode selection and to restore factory defaults.

LEDs

- **PWR** – shows that the board is powered on. It will stay on as long as it is powered through USB connector.
- **I2C / UART / SPI** – LEDs that distinguish the interface mode. For UART transparent mode, the **UART** LED will be blinking. A solid light on the interface LED indicates which interface is opened.
- **TX / RX** – LEDs blink when data is being transferred between one of the Pmod connectors and USB.
- **PMOD1 3V3 / 5V** – displays if PMOD1 is 3V3 or 5V compatible.
- **PMOD2 I3C** – displays when PMOD2 is in I3C mode.

Connectors

There are three connectors on the board:

- **USB** – USB Type-C connector for connectivity and powering the board.
- **PMOD1/PMOD2** – Connectors are dynamically reconfigured depending on the chosen interface. Physically they do not comply with the Digilent Pmod Interface specification, but different interface selections are compatible with the corresponding Pmod standard.

1.2 Board Operation

After performing a reset, the board enters the initialization process and checks if a factory reset is needed.

Important: If the button labeled '**BTN**' is pressed during the reset for longer than 3 seconds, the factory parameters restoring procedure is initiated. Note that the LEDs will blink simultaneously.

Upon successful initialization, all interface selection LEDs (see Figure 3) will blink one after another, indicating the end of the process.

The device can be operating in two modes:

- **Transparent mode** – this is a default mode in which the board acts as a USB to UART bridge.
- **Command mode** – Special AT commands are needed to configure the interface and to send/receive data.

See Figure 4 for a basic board operation flow.

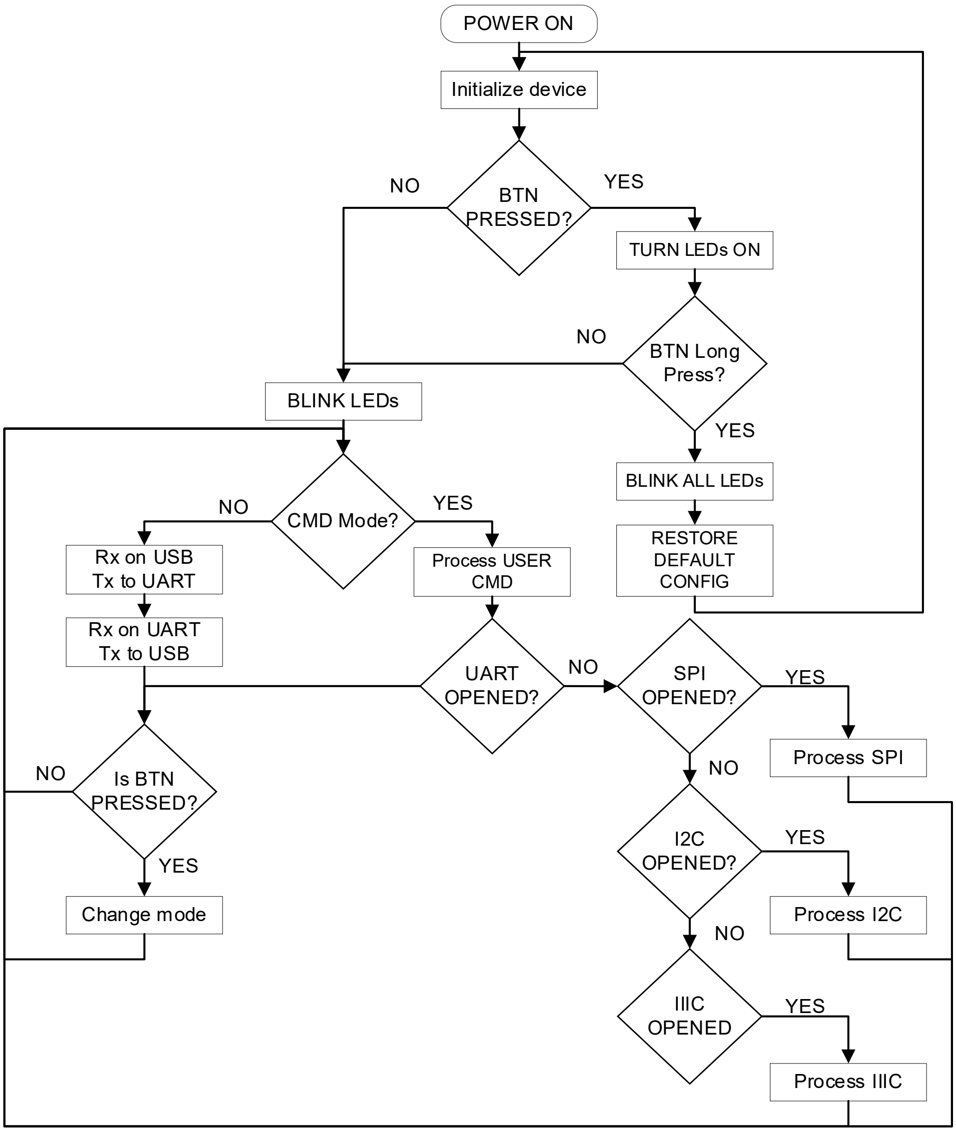


Figure 4. Board Operation Flow Diagram

1.3 Operational Characteristics

Parameter	Value	Unit
UART on PMOD1		
Baud Rate (supports all standard baud rates up to maximum value)	Max 912600	bps
Level Shifter	3.3 or 5	V
Supports all Standard UART Settings		
SPI on PMOD1		
Maximum Frequency	5 [1]	MHz
Level Shifter	3.3 or 5	V
Supports Controller (master) and Target (slave) Modes		
Different CPOL and CPHA Configuration done using AT Commands		
I^2C on PMOD1		
Frequency	100	kHz
Level Shifter	3.3 or 5	V
Controller Mode Only [2]	-	-
I^3C on PMOD2		
In I3C mode it can act as controller or target.	-	-
In I^2C mode it can act as controller or target.	-	-
I^2C Clock	100	kHz

1. Maximum SPI frequency is limited by GreenPAK. If two QCIOT-USB2SERDEMOZ boards are connected together, then maximum frequency drops to 4MHz.
2. I^2C on PMOD1 is running on the SCI peripheral that supports only I^2C master mode. If I^2C mode is needed, please check PMOD2.

1.4 Electrical Characteristics

Parameter	Symbol	Typical Value	Unit
USB Power supply			
Input Voltage	V_{USB}	5	V
Supply Current [1]	I_{USB}	500	mA
PMOD1			
PMOD1 Output Voltage	V_{PMOD1}	3.3 or 5	V
PMOD1 Output Current [2]	I_{PMOD1}	500	mA
GPIO Voltage	V_{IO}	3.3 or 5	V
PMOD2			
PMOD2 Output Voltage	V_{PMOD2}	3.3	V
PMOD2 Output Current	I_{PMOD2}	500	mA
GPIO Voltage	V_{IO}	3.3	V

1. The supply current is limited by a resettable fuse. 500mA is the maximum total current that can be drawn from the USB. For more information, refer to the schematics in section 2.1.
2. I^2C on PMOD1 is running on the SCI peripheral that supports only I^2C master mode. If I^2C mode is needed, please check PMOD2.

1.5 Setup and Configuration

The board can only be configured in command mode. For more information, see section 1.2.

1.5.1 Out-of-the-Box Configuration

By default, the QCIOT-USB2SERDEMOZ board is configured in Transparent Mode. Verify the UART LED indicator is flashing. Data from the host PC will be transferred via UART.

1.5.2 Entering Command Mode

Ensure the board is in **Transparent Mode**. To enter **Command Mode**, press and hold the '**BTN**' button for 3 seconds. Verify that the UART LED stops flashing and the device configuration is printed on the terminal screen. In this mode, you can use AT Commands to configure the device as needed. For more details, see section 5.

1.6 Factory Reset

Factory Reset or default settings can be restored in two ways:

1. Press and hold the **BTN** button during the power-up process until all LEDs are off.
2. Use the **AT+FACTORY** command as described in section 5.13.

1.7 GreenPAK Design

1.7.1 UART an SPI Controller (Master)

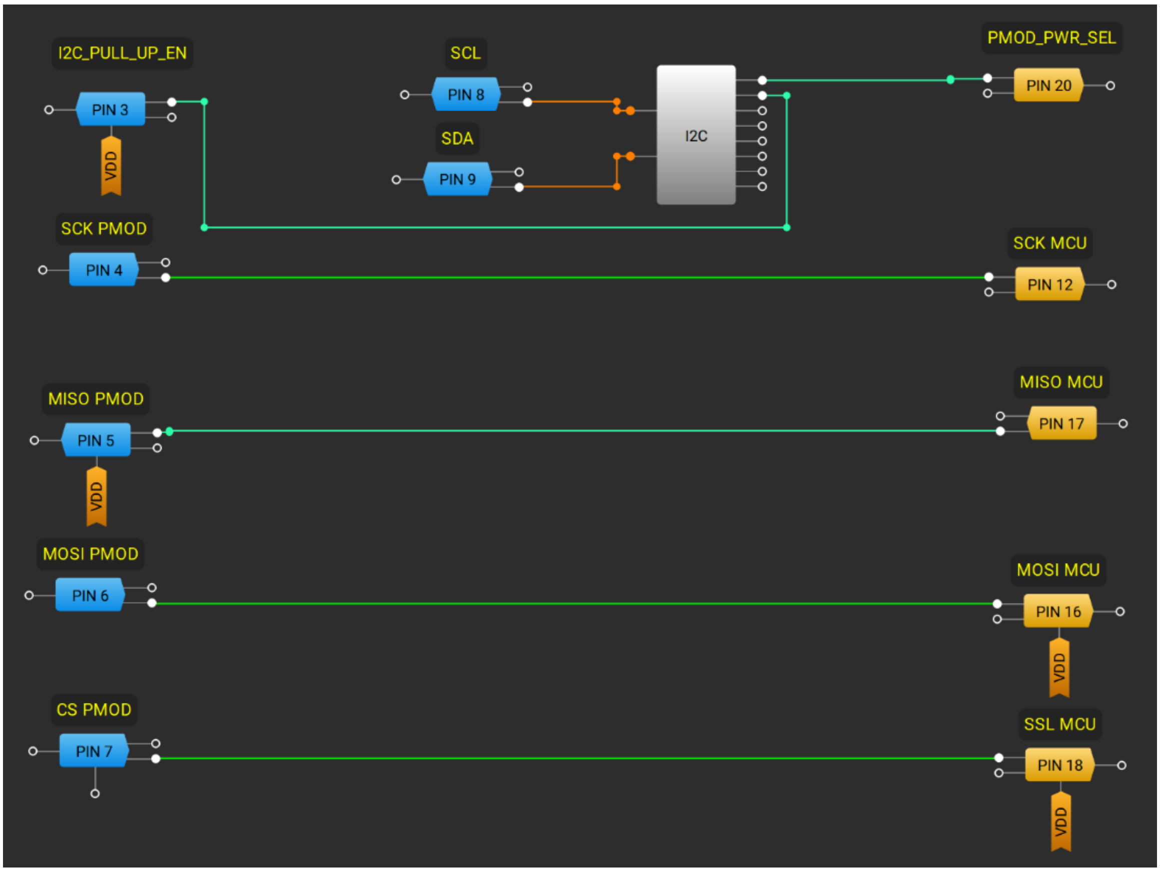


Figure 5. UART and SPI Controller Mode Level Converter GreenPAK Design

1.7.2 SPI Target (Slave) Converter

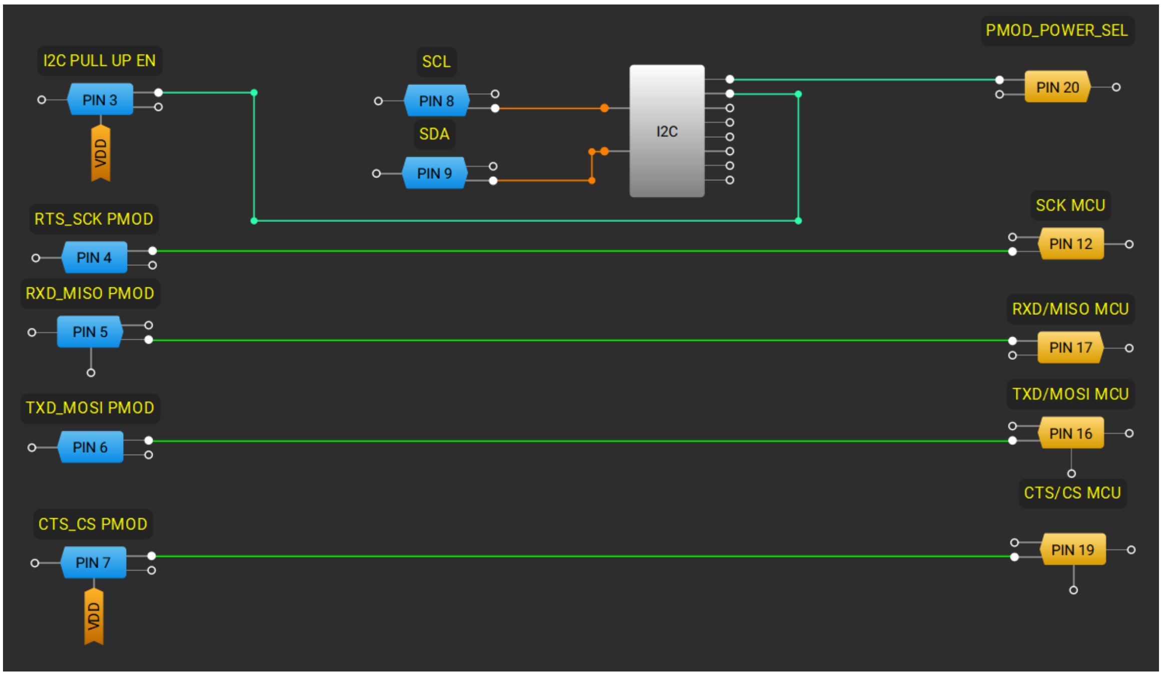


Figure 6. SPI Target Level Converter GreenPAK Design

1.7.3 I^{2}C Level Converter

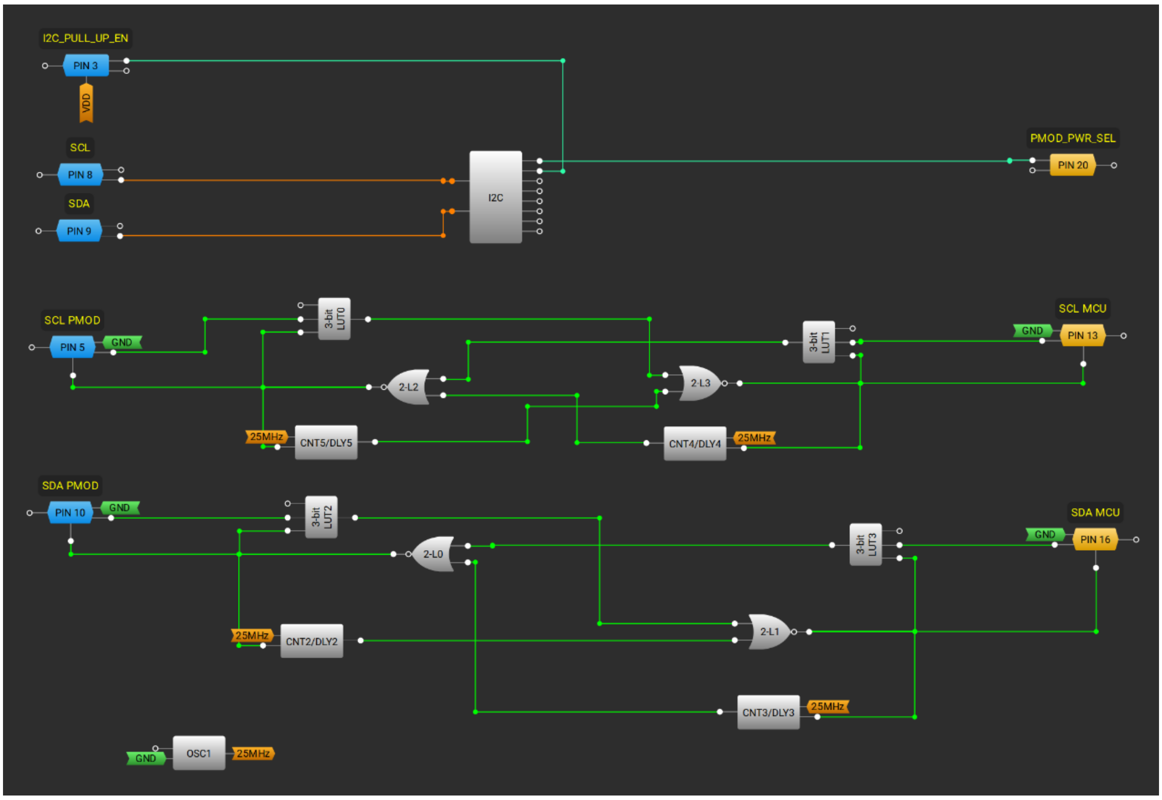


Figure 7. I^{2}C Level Converter GreenPAK Design

2. Board Design

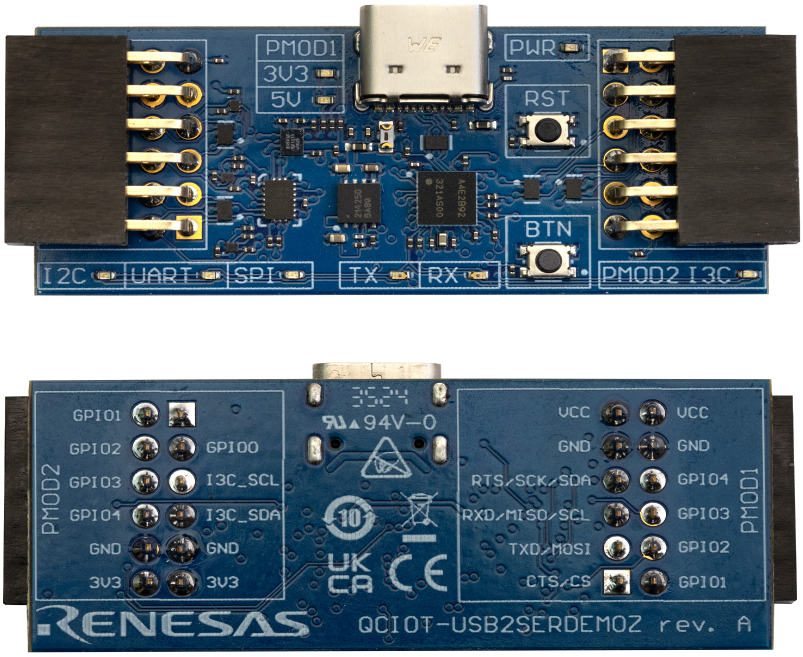


Figure 8. QCIOT-USB2SERDEMOZ USB to Serial Converter Board (Top and Bottom)

2.1 Schematic Diagrams

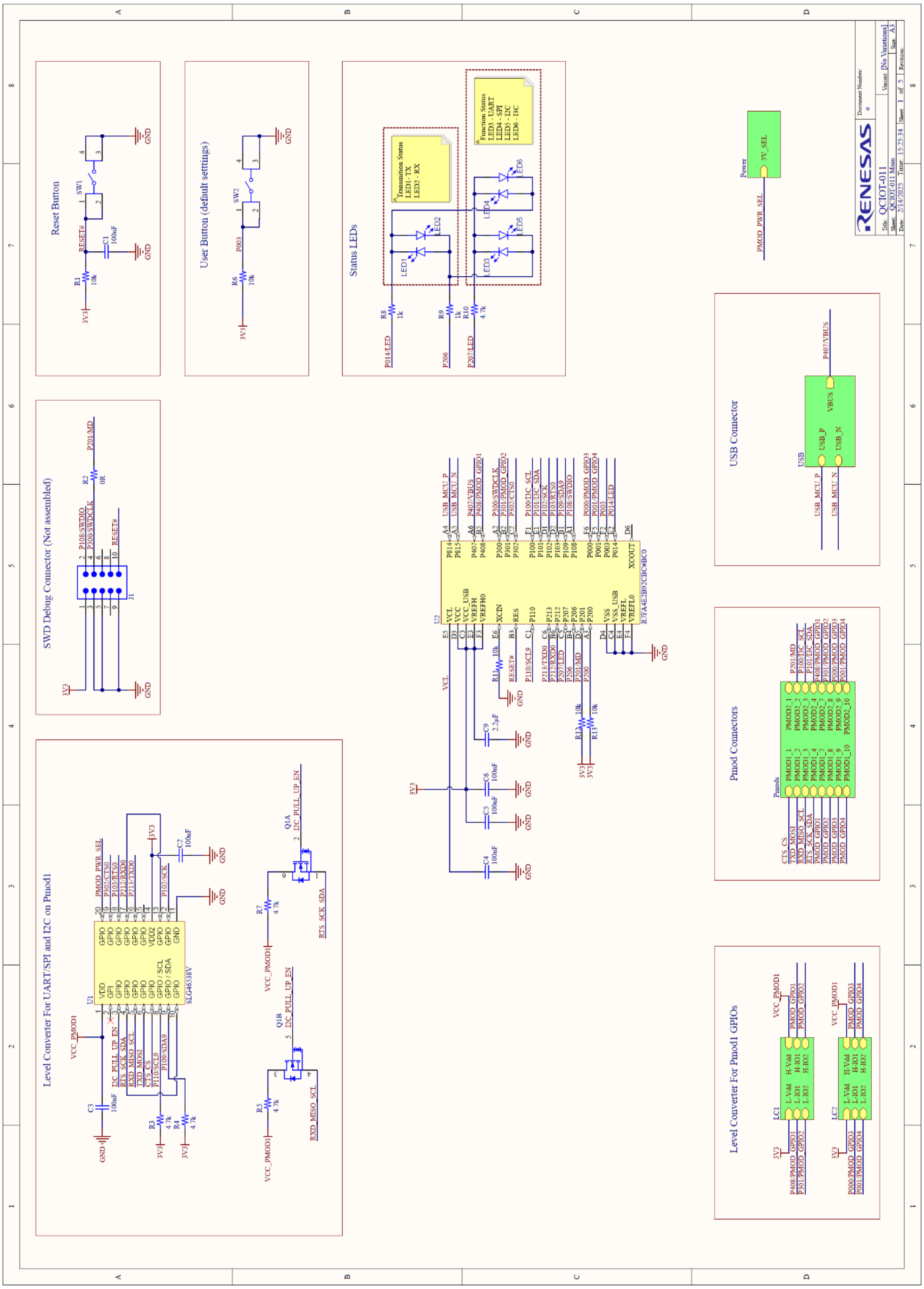


Figure 9. Schematic Diagram – Page 1

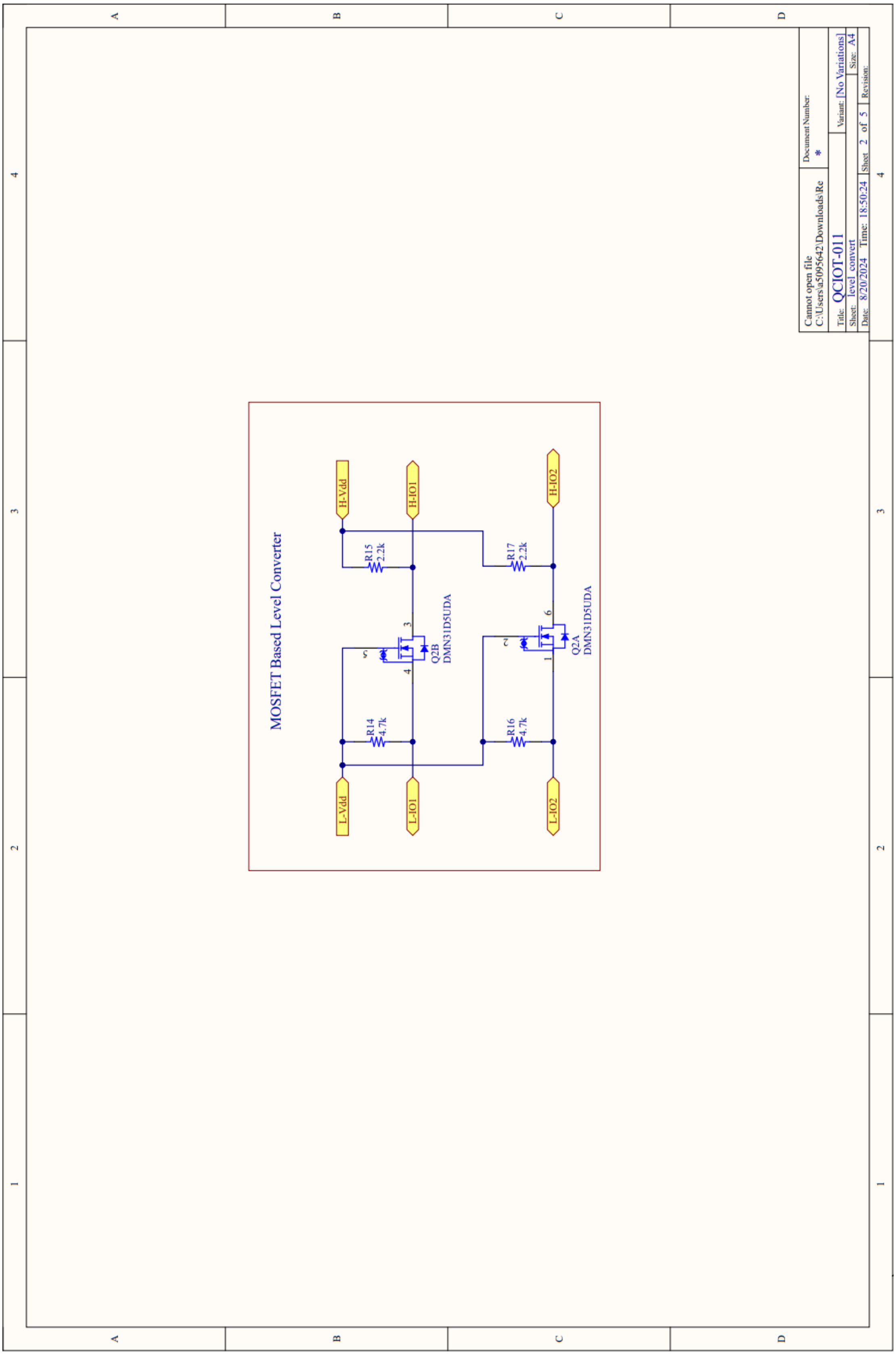


Figure 10. Schematic Diagram – Page 2

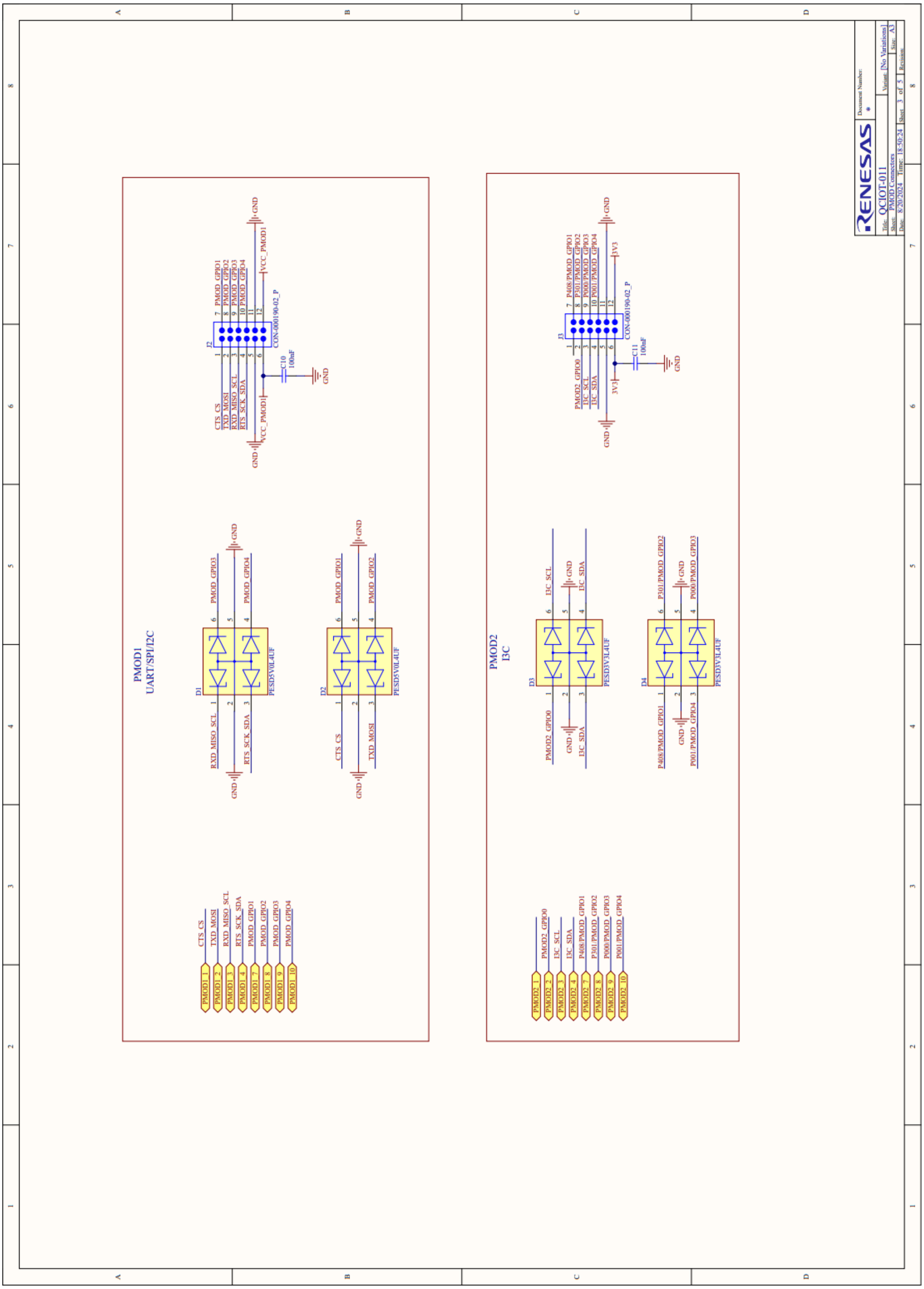


Figure 11. Schematic Diagram – Page 3

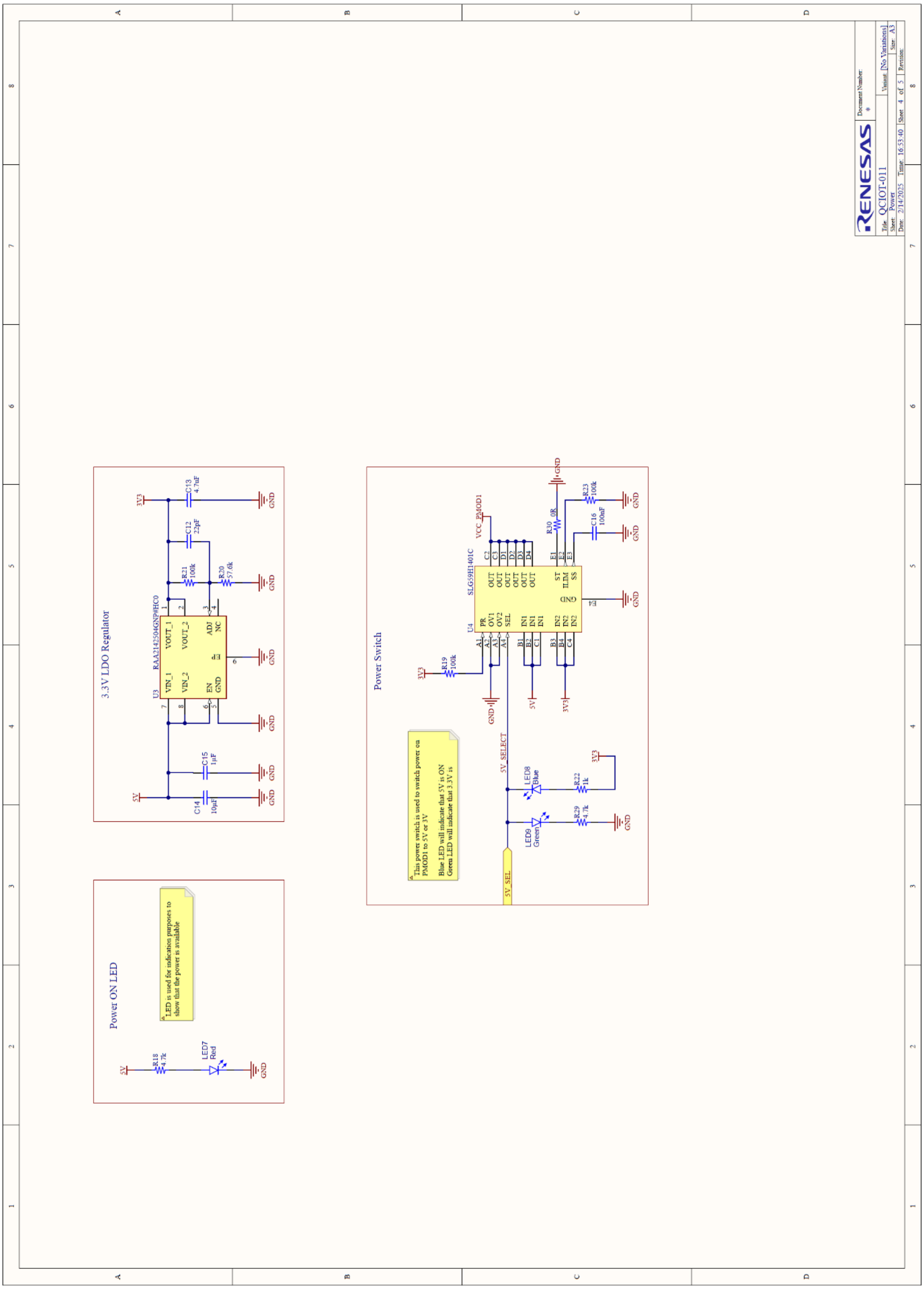


Figure 12. Schematic Diagram – Page 4

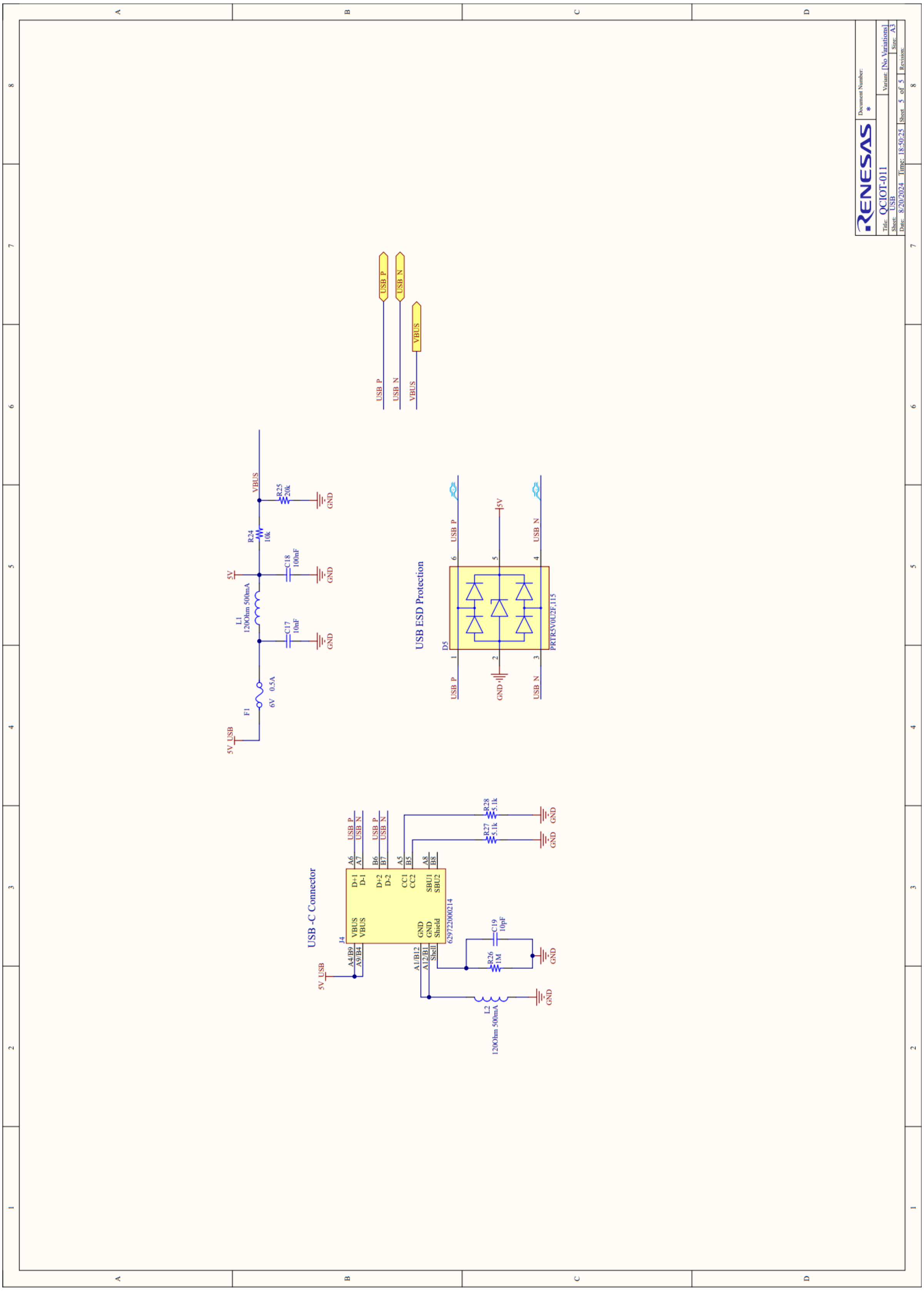


Figure 13. Schematic Diagram – Page 5

2.2 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
10	C1, C2, C3, C4, C5, C6, C10, C11, C16, C18	CAP CER 0.1µF 25V X5R 0201	Würth Elektronik	885012104005
1	C9	CAP CER 2.2µF 10V X5R 0402	Würth Elektronik	885012105013
1	C12	CAP CER 10pF 50V C0G/NP0 0201	Würth Elektronik	885012004011
1	C13	CAP CER 4.7µF 10V X5R 0402	Samsung	CL05A475MP5NRNC
1	C14	CAP CER 10µF 6.3V X5R 0402	Würth Elektronik	885012105020
1	C15	CAP CER 1µF 10V X5R 0402	Würth Elektronik	885012105012
1	C17	CAP CER 0.01vF 25V X7R 0201	Würth Elektronik	885012204004
1	C19	CAP CER 10pF 50V C0G/NP0 0201	Würth Elektronik	885012004011
2	D1, D2	TVS DIODE 5VWM 13VC 6XSON	Nexperia	PESD5V0L4UF,115
2	D3, D4	TVS DIODE 3.3VWM 12VC 6XSON	Nexperia	PESD3V3L4UF,115
1	D5	TVS DIODE 5.5V 6XSON SOT886	Nexperia	PRTR5V0U2F,115
1	F1	PTC RESET FUSE 6V 500MA 0603	Bourns	MF-FSMF050X-2
1	J4	Connector USB 2.0 Type C Horizontal SMT	Würth Elektronik	629722000214
2	L1, L2	Ferrite Bead WE-CBF, Z = 120 Ohm, 0402	Würth Elektronik	74279271
3	LED1, LED2, LED7	LED RED CLEAR 0402 SMD	Würth Elektronik	150040RS73240
5	LED3, LED4, LED5, LED6, LED9	LED GREEN CLEAR 0402 SMD	Würth Elektronik	150040GS73240
1	LED8	LED BLUE CLEAR 0402 SMD	Würth Elektronik	150040BS73240
3	Q1, Q2_LC1, Q2_LC2	MOSFET 2N-CH 0.4A 6DFN	Diodes	DMN31D5UDA-7B
6	R1, R6, R11, R12, R13, R24	RES 10K Ohm 1% 1/20W 0201	Yageo	RC0201FR-0710KL
2	R2, R30	RES 0 Ohm JUMPER 1/20W 0201	Yageo	RC0201JR-070RL
11	R3, R4, R5, R7, R10, R14_LC1, R14_LC2, R16_LC1, R16_LC2, R18, R29	RES 4.7K Ohm 1% 1/20W 0201	Yageo	RC0201FR-074K7L
3	R8, R9, R22	RES 1K Ohm 1% 1/20W 0201	Yageo	RC0201FR-071KL
4	R15_LC1, R15_LC2, R17_LC1, R17_LC2	RES 2.2K Ohm 1% 1/20W 0201	Yageo	RC0201FR-072K2L
3	R19, R21, R23	RES 100K Ohm 1% 1/20W 0201	Yageo	RC0201FR-07100KL
1	R20	RES 57.6K Ohm 1% 1/20W 0201	Yageo	RC0201FR-0757K6L
1	R25	RES 20K Ohm 1% 1/20W 0201	Yageo	RC0201FR-0720KL
1	R26	RES 1M Ohm 5% 1/20W 0201	Yageo	RC0201JR-071ML
2	R27, R28	RES 5.1K Ohm 1% 1/20W 0201	Yageo	RC0201FR-075K1L
2	SW1, SW2	SWITCH TACTILE SPST-NO 0.05A 12V	Yageo	PTS830GM140SMTRLFS
1	U1	GreenPAK Programmable Mixed-signal Matrix with Asynchronous State Machine and Dual Supply	Renesas	SLG46538V

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
1	U2	RA4E2 ARM Cortex-M33, 100MHz, 128KB, 40KB, 36 Pins, LFBGA	Renesas	R7FA4E2B92CBC#BC0
1	U3	500mA 20V Wide Input Voltage Range LDO Linear Regulator	Renesas	RAA2142504GNP#HC0
1	U4	Dual Input Single Output, 3A Power Multiplexer, 6V Maximum	Renesas	SLG59H1401C

2.3 Board Layout

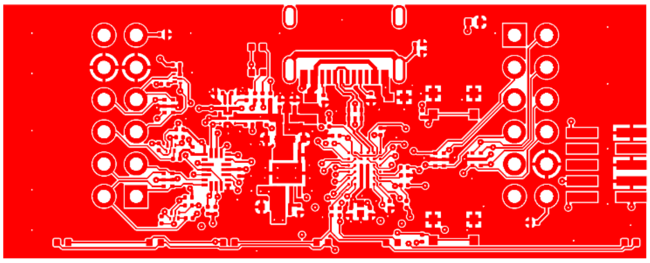


Figure 14. Top Layer

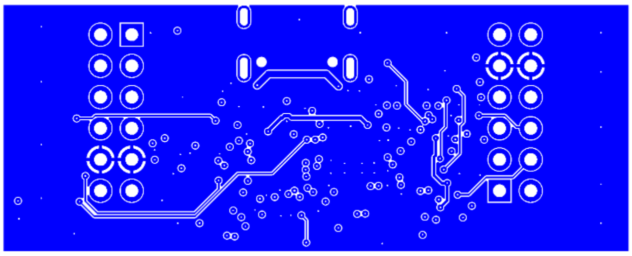


Figure 15. Bottom Layer

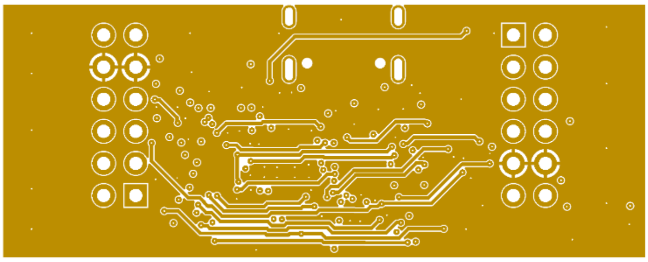


Figure 16. INT1 Layer

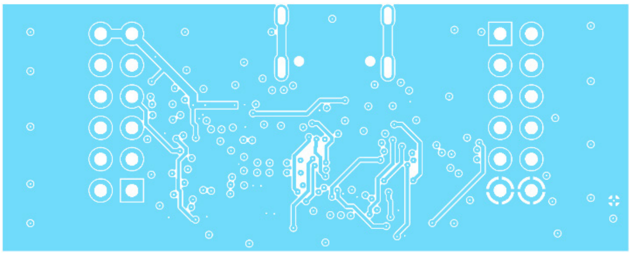


Figure 17. INT2 Layer

3. Quick Start

By default, the device is in USB-to-UART mode. Everything transferred on USB COM port will be forwarded to UART and vice versa.

To use a board other than USB-to-UART converter, you must enter Command Mode. Follow the procedure described in section 1.5.2.

3.1 Setting up the Device as SPI Controller

Command	Description
AT	Test connectivity.
AT+SPIOPEN OK	Open SPI.
AT+SPICFG = ? +SPICFG: 1,0,1,4000000 OK	Configure SPI Controller, CPOL = 0, CPHA = 1,4MHz ***Note:*** 4MHz is due to GreenPAK that is not able to switch faster.
AT+SPIWRITE = 16,57 0 11 22 33 44 55 66 77 88 99 AA OK	Write 12 bytes to SPI when data is entered in hex.
AT+SPIREAD = 12,16 +SPIREAD: 99 aa 11 22 33 44 55 66 77 88 OK	Read 12 bytes from SPI and show data in hex.

3.2 Setting up the Device as I^2C Controller on PMOD1

Command	Description
AT	Test connectivity.
AT+I2COPEN OK	Open I^2C. ***Note:*** On PMOD1 connector only I^2C master is supported.
AT+I2CSADDR = 21 OK	Set 7-bit target address which is entered in hex.
AT+I2CWRITE = 10,7 50 OK	Write 2 bytes to I^2C when data is entered in decimal form.
AT+I2CREAD = 10,16 +I2CREAD: 5 21 0 bf 0 0 0 ff 5 2c OK	Read 10 bytes from I^2C and show data in hex.

3.3 Setting up the Device as I²C Controller on PMOD2

Command	Description
AT	Test connectivity.
AT+IIICOPEN	Open I3C.
AT+IIICCFG = 0	Configure I3C as I^2C master.
AT+IIICSADDR = 21	Set 7-bit Slave address which is entered in hex.
AT+IIICWRITE = 10,7 50 OK	Write 2 bytes to I^2C when data is entered in decimal form
AT+IIICREAD = 10,16 +IIICREAD: 5 21 0 bf 0 0 0 ff 5 2c OK	Read 10 bytes from I^2C and show data in hex

4. Firmware Update

The device firmware update is executed using the Renesas Flash Programmer which can be downloaded from Renesas website.

To use The Renesas Flash Programmer tool, you must place the USB2SERIAL board to boot mode. This can be executed by pulling the MD pin low during the boot process. The following steps outline the procedure:

1. MD pin can be found on the PMOD2 connector, J3 pin 2. For more details, refer to the schematics in section 2.1.
2. Place a jumper wire connecting J3-2 (GPIO0) and J3-5 (GND) as shown in Figure 18.

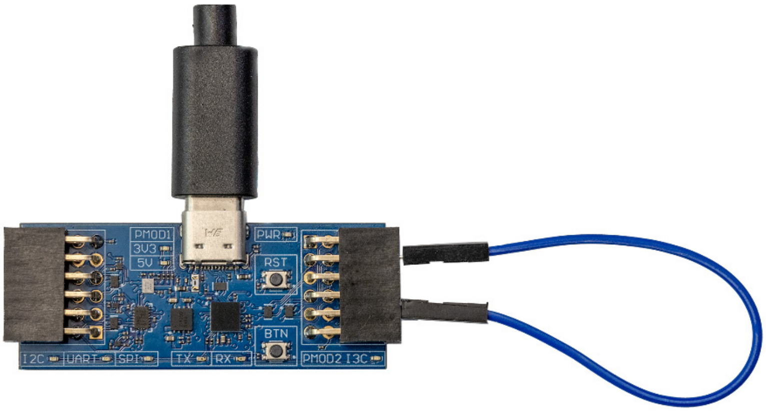
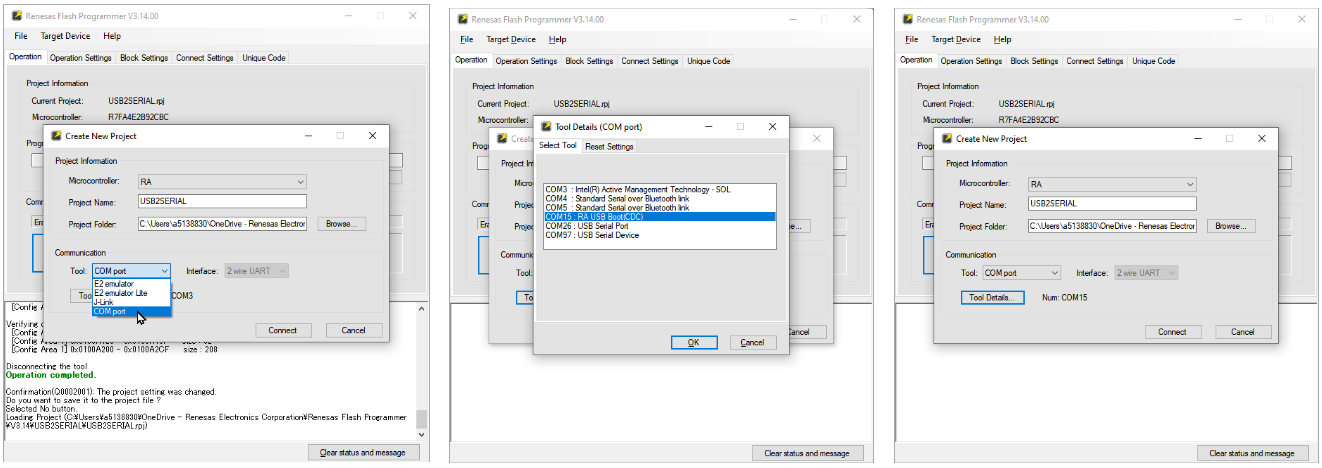


Figure 18. Jumper on PMOD2 Placing MD Pin Low

3. Connect USB cable to J4 connector to see the RA USB Boot (CDC) device in the Device manager.

Use the following steps and refer to Figure 19 to start and configure the Renesas Flash Programmer:

1. Enter Project name (Figure 19-a).
2. Select COM port as a tool (Figure 19-a).
3. Select RA USB Boot (CDC) COM Port in Tool Details (Figure 19-b).
4. Connect to the board (Figure 19-c).

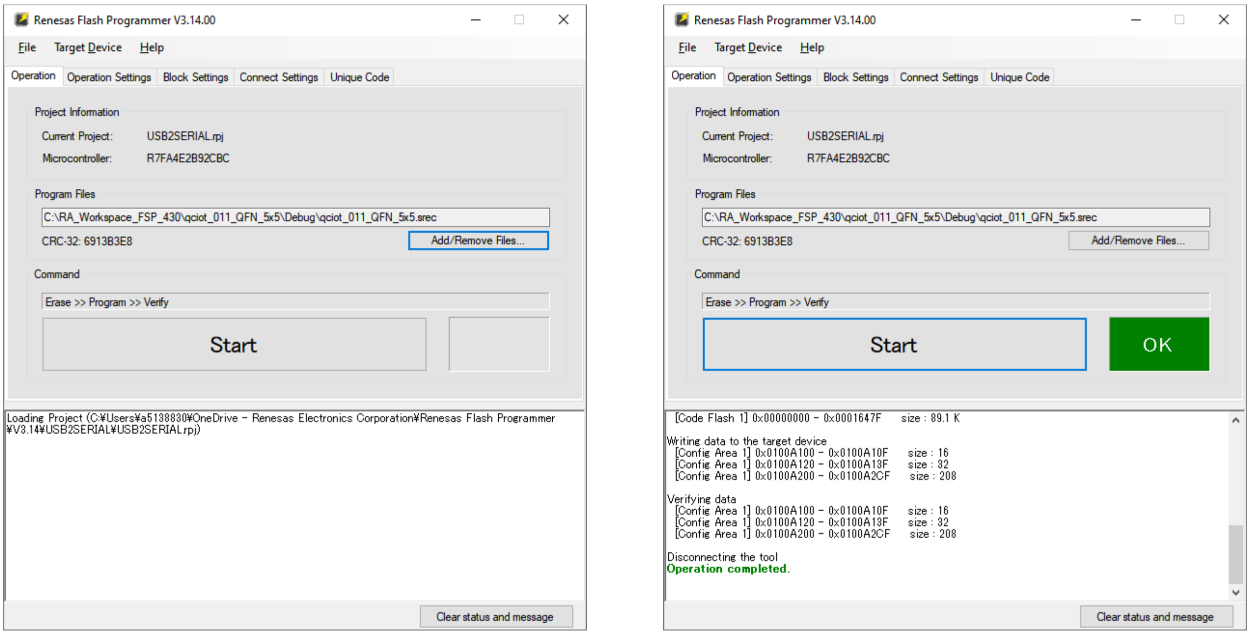


a. Create project and select tool
b. Change Tool Details
c. Connect

Figure 19. Configuring the Renesas Flash Programmer

After successfully connecting the Renesas Flash Programmer to the board, select the firmware file and press *Start* (see Figure 20).

If an error is received, reboot the board by pressing the **RST** button. This may be required due to the RA MCU exiting boot mode after the single operation has been completed.



a. Select firmware file and press Start
b. View after successful update

Figure 20. Updating the Firmware

After achieving a successful firmware upgrade, the “Operation completed“ message displays as shown in Figure 20-b.

5. AT Commands

5.1 Test: AT

If the device is working in command mode, the board will always answer with *OK* to this command. This is used to check if the system is working. It is recommended to use it before sending any other command.

5.1.1 Syntax: AT

Command	Response
AT	OK

5.2 Help: AT+HELP

Prints all available commands.

5.2.1 Syntax: HELP

Command	Response
AT+HELP	<AT COMMANDS LIST>

5.3 UART on PMOD1

In every communication mode, the PMOD1 has a slightly different pinout. For UART mode, the pinout is shown in Table 2.

Table 2. PMOD1 Pinout in UART Mode

Pin	Signal	Direction	Description
1	CTS	In	Host is clear to send.
2	TXD	Out	Data from host to peripheral.
3	RXD	In	Data from peripheral to host.
4	RTS	Out	Host request to send.
5	GND	-	-
6	VCC	-	-
7	GPIO1	Out	General purpose output 1.
8	GPIO2	Out	General purpose output 2.
9	GPIO3	In	General purpose input 3.
10	GPIO4	In	General purpose input 4.
11	GND	-	-
12	VCC	-	-

5.3.1 UART Open: AT+UARTOPEN

Open UART with the settings received during CDC initialization phase.

5.3.1.1 Syntax: AT+UARTOPEN

Command	Response
AT+OPEN	OK

5.3.2 UART Command Mode: AT+UARTCMD

Change UART mode.

UART is working in two modes:

1. Transparent (UART LED is blinking). In this mode, everything that is written to the CDC device will be sent to the UART Command mode.
2. Command mode (UART LED is constantly on). In this mode, AT command mode is enabled.

5.3.2.1 UARTCMD Syntax

Command	Response
AT+UARTCMD = <MODE>	OK
AT+UARTCMD = ?	+UARTCMD: <MODE> OK

5.3.2.2 UARTCMD Parameters

Parameter	Description
MODE	AT Command mode: 0 = Disabled (UART works as transparent channel) 1 = Enabled

5.3.2.3 UARTCMD Examples

Command	Description
AT+UARTCMD = ? +UARTCMD: 1 OK	Get current UART Command mode status.
AT+UARTCMD = 0 OK	Disable UART Command mode and enable transparent mode. Note that to return to command mode, use only the BTN button.
AT+UARTCMD? AT+UARTCMD	Get help on a command.

5.4 SPI on PMOD1

In every communication mode, the PMOD1 has a slightly different pinout. For SPI mode, the pinout is shown in Table 3.

Table 3. PMOD1 Pinout in SPI Mode

Pin	Signal	Direction	Description
1	CS	Out (controller) / In (target)	Active low to enable slave device.
2	MOSI	Out (controller) / In (target)	Data from master to slave.
3	MISO	In (controller) / Out (target)	Data from slave to master.
4	SCK	Out (controller) / In (target)	Master provides the clock to shift the data.
5	GND	-	-
6	VCC	-	-
7	GPIO1	Out	General purpose output 1.
8	GPIO2	Out	General purpose output 2.
9	GPIO3	In	General purpose input 3.
10	GPIO4	In	General purpose input 4.
11	GND	-	-
12	VCC	-	-

5.4.1 Open SPI: AT+SPIOPEN

Open SPI interface.

5.4.1.1 SPIOPEN Syntax

Command	Response
AT+SPIOPEN	OK

5.4.2 Configure SPI: AT+SPICFG

Configure SPI interface on PMOD1.

Configuration will be applied after *OK* answer has been received. There is no need to reinitialize the peripheral.

5.4.2.1 SPICFG Syntax

Command	Response
AT+SPICFG = <MODE>,<CPOL>,<CPHA>,<FREQ>	OK
AT+SPICFG = ?	+SPICFG=<MODE>,<CPOL>,<CPHA>,<FREQ> OK

5.4.2.2 SPICFG Parameters

Parameter	Description
MODE	SPI Mode: 0 = Controller 1 = Target
CPOL	Clock Polarity when idle: 0 = Low 1 = High
CPHA	Data is valid on clock: 0 = leading edge 1 = trailing edge
FREQ	Clock frequency 5000000Hz Maximum.

5.4.2.3 SPICFG Examples

Command	Description
AT+SPICFG = ? +SPICFG: 0,0,1,400000 OK	Get current SPI Configuration
AT+SPICFG = 0,0,1,4000000 OK	Configure SPI as controller, low clock polarity when idle, data valid on trailing clock edge, set frequency to 4MHz.
AT+SPICFG = 1,0,1 OK	Configure SPI as target, low clock polarity when idle, data valid on trailing clock edge.
AT+SPICFG?	Print help on the command.

Note: If two QCIOT-USB2SER boards are connected and they are used as target and controller, the maximum bitrate is 4000000.

5.4.3 Read SPI: AT+SPIREAD

Read data on the PMOD1 connector.

5.4.3.1 SPIREAD Syntax

Command	Response
AT+SPIREAD = <LEN>,<FORMAT>	+SPIREAD: <DATA> OK

5.4.3.2 SPIREAD Examples

Set	Description
AT+SPIREAD = 10,16 +SPIREAD: 5 21 0 bf 0 0 0 ff 5 2c OK	Read 10 bytes and show them in Hex format.
AT+SPIREAD = 10,10 +SPIREAD: 5 33 0 191 0 0 0 255 5 44 OK	Read 10 bytes and show them in Dec format.
AT+SPIREAD = ? AT+SPIREAD? AT+SPIREAD	Get help on the command.

5.4.4 Write SPI: AT+SPIWRITE

SPI Write data on the PMOD1 connector.

5.4.4.1 SPIWRITE Syntax

Command	Response
AT+SPIWRITE = <FORMAT>,<DATA>	OK

5.4.4.2 SPIWRITE Parameters

Parameter	Description
FORMAT 10 = decimal 16 = hexadecimal	Data format used to display bytes array that will be read out from the target. All other values besides 10 and 16 will be ignored and hexadecimal representation is used as a default.
DATA	Data bytes in format that has been set in <FORMAT> parameter and separated by spaces.

5.4.4.3 SPIWRITE Examples

Command	Description
AT+SPIWRITE = 16,4 55 45 ff ff OK	Write 5 bytes in Hex format.
AT+SPIWRITE = 10,4 32 44 250 255 OK	Write 5 bytes in decimal format.
AT+I2CWRITE = ? AT+I2CWRITE? AT+I2CWRITE	Print help on the command with possible parameters values.

5.4.5 Write and Read SPI: AT+SPIWR

Single command that sends data to the SPI target and then reads the number of bytes defined by LEN.

5.4.5.1 SPIWR Syntax

Command	Response
AT+SPIWR = <LEN>,<FORMAT>,<DATA>	OK

5.4.5.2 SPIWR Parameters

Parameter	Description
LEN 0–255 bytes	Number of bytes that will be read in decimal format.
FORMAT 10 = decimal 16 = hexadecimal	Data format that is used to interpret sending data and to display bytes array and read out from the target: All other values besides 10 and 16 will be ignored and hexadecimal representation is used as a default.
DATA	Data bytes in format that has been set in <FORMAT> parameter and separated by spaces.

5.4.5.3 SPIWR Examples

Set	Description
AT+SPIWR = 5,16,10 +SPIWR: b d4 62 41 5a OK	Write one byte and read 5 bytes in hex format.
AT+SPIWR = 5,10,16 +SPIWR: 11 212 98 65 85 OK	Write one byte and read 5 bytes in decimal format.
AT+SPIWR = ? AT+SPIWR? AT+SPIWR	Print help on the command with parameters values.

5.4.6 SPI Target

When the device is configured as SPI target, the SPI external controller can write or read to the internal 256 memory buffer – XBUF.

SPI target does not support sequential write/read.

Initially, there should be a written command setting read address or writing data to the XBUF.

5.4.6.1 Protocol

Every SPI Write sequence should include a command byte followed by the address byte and write data if needed, as shown in Figure 21. Supported Write commands are described in section 5.4.6.2.

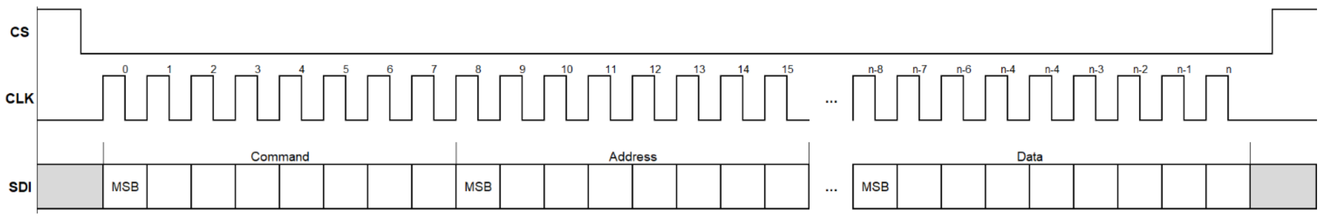


Figure 21. Write to SPI Target Protocol

Start Reading after the SPI Write has completed (see Figure 22).

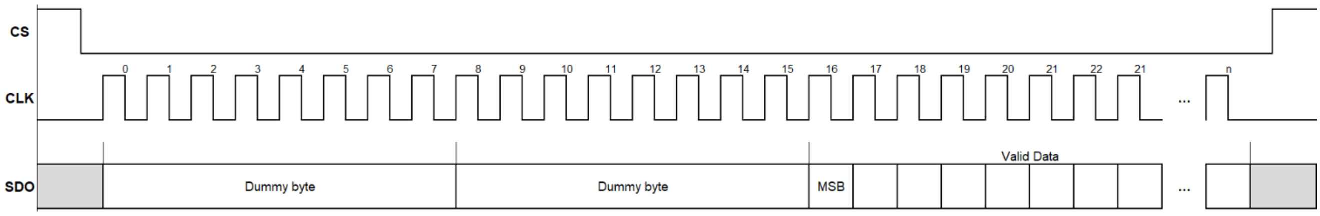


Figure 22. Read from SPI Target Protocol

The SPI target read sequence is shown in Figure 22. Read from SPI Target Protocol Reading data from the SPI target is described in section 0.

5.4.6.2 SPI Target Write Commands

Command	Address				Description
82 (52h)	0..255				Sets the address from which the data will be read.
87 (57h)	0.255	D0	D1	D2	Write data to XBUF starting at the defined address.

Note: If writing more data than the XBUF length (255 bytes), the overlapping data is ignored.

5.4.6.3 SPI Target Read

D0	D1	D2	..	Dn	Description
dummy	dummy	Valid data D0	Valid data	Valid data Dn	The first two bytes are dummy bytes and should be ignored.

Before starting a read cycle, it is recommended to write the 54h command that sets the buffer to the desired position.

Note that after sending the command, the board should be deselected (chip select pulled up). Only then the pointer is moved to requested position.

5.5 I²C on PMOD1

In every communication mode, PMOD1 has a slightly different pinout. For SPI mode, the pinout is shown in

Table 4. PMOD1 Pinout in I²C Mode

Pin	Signal	Direction	Description
1	NC	-	-
2	NC	-	-
3	SCL	In / Out	Serial Clock.
4	SDA	In / Out	Serial Data.
5	GND	-	-
6	VCC	-	-
7	GPIO1	Out	General purpose output 1.
8	GPIO2	Out	General purpose output 2.
9	GPIO3	In	General purpose input 3.
10	GPIO4	In	General purpose input 4.
11	GND	-	-
12	VCC	-	-

5.5.1 Open I²C: AT+I2COPEN

Open I²C controller interface on PMOD1 connector. Note that only the I²C controller is available on PMOD1.

5.5.1.1 I2COPEN Syntax

Command	Response
AT+I2COPEN	OK

5.5.2 Pull-Up on I²C Lines: AT+I2CPULLUP

Command	Response
AT+I2CPULLUP = <ENABLE>	OK
AT+I2CPULLUP = ?	+I2CSADDR: <ENABLE> OK

5.5.2.1 I2CPULLUP Syntax

Command	Response
AT+I2CPULLUP = <ENABLE>	OK
AT+I2CPULLUP = ?	+I2CSADDR: <ENABLE> OK

5.5.2.2 I2CPULLUP Parameters

Parameter	Description
ENABLE	Enable or disable pull-ups on I^2C lines: 0 = disabled 1 = enabled

5.5.2.3 I2CPULLUP Examples

Set	Description
AT+I2CPULLUP = 1 OK	Enable pull-ups on I^2C lines.
AT+I2CPULLUP = ? +I2CPULLUP: 1 OK	Get pull-up status.
AT+I2CPULLUP? AT+I2CPULLUP	Get help on the command.

5.5.3 Set I^2C Target Address on PMOD1: AT+I2CSADDR

Sets the 7-bit I^2C target address in hex format for the controller to access.

5.5.3.1 I2CSADDR Syntax

Command	Response
AT+I2CSADDR = <ADDR>	OK
AT+I2CSADDR = ?	+I2CSADDR: <ADDR> OK

5.5.3.2 I2CSADDR Parameters

Parameter	Description
ADDR	7-bit I^2C slave address in hexadecimal format.

5.5.3.3 I2CSADDR Examples

Set	Description
AT+I2CSADDR = 5 OK	Sets I^2C Slave address. ***Note:*** Address is 7-bit and entered in hexadecimal format.
AT+I2CSADDR = ? +I2CSADDR: 5 OK	Get current I^2C slave address.
AT+I2CSADDR? AT+I2CSADDR	Get help on the command.

5.5.4 Read I^{2}C: AT+I2CREAD

Reads data from the I^{2}C target.

5.5.4.1 I2CREAD Syntax

Command	Response
AT+I2CREAD = <LEN>,<FORMAT>	+I2CREAD: <DATA> OK

5.5.4.2 I2CREAD Parameters

Parameter	Description
LEN	Number of bytes that are read in decimal format.
FORMAT 10 = decimal 16 = hexadecimal	Data format that is used to display bytes array read out from the target: All other values besides 10 and 16 are ignored and hexadecimal representation is used as a default.
DATA	Data bytes in format set in <FORMAT> parameter and separated by spaces.

5.5.4.3 I2CREAD Examples

Set	Description
AT+I2CREAD = 10,16 +I2CREAD: 5 21 0 bf 0 0 0 ff 5 2c OK	Read 10 bytes and show them in hexadecimal format.
AT+I2CREAD = 10,10 +I2CREAD: 5 33 0 191 0 0 0 255 5 44 OK	Read 10 bytes and show them in decimal format.
AT+I2CREAD = ? AT+I2CREAD? AT+I2CREAD	Get help on the command.

5.5.5 Write I^{2}C: AT+I2CWRITE

Writes data to the I^{2}C target.

5.5.5.1 I2CWRITE Syntax

Command	Response
AT+I2CWRITE = <FORMAT>,<DATA>	OK

5.5.5.2 I2CWRITE Parameters

Parameter	Description
FORMAT 10 – decimal 16 – hexadecimal	Data format used to display bytes array read out from the target: All other values besides 10 and 16 are ignored and hexadecimal representation is used as a default.
DATA	Data bytes in format set in <FORMAT> parameter and separated by spaces.

5.5.5.3 I2CWRITE Examples

Command	Description
AT+I2CWRITE=16,4 55 45 ff ff OK	Write 5 bytes in hexadecimal format.
AT+I2CWRITE = 10,4 32 44 250 255 OK	Write 5 bytes in decimal format.
AT+I2CWRITE = ? AT+I2CWRITE? AT+I2CWRITE	Print help on the command and parameters.

5.5.6 Write and Read I^{2}C: AT+I2CWR

Single command that writes data to the I^{2}C target, then reads the number of bytes defined by LEN.

5.5.6.1 I2CWR Syntax

Command	Response
AT+I2CWR = <LEN>,<FORMAT>,<DATA>	OK

5.5.6.2 I2CWR Parameters

Parameter	Description
LEN 0–255 bytes	Number of bytes read in decimal format.
FORMAT 10 – decimal 16 – hexadecimal	Data format used to interpret sending data and to display bytes array that read out from the target. All other values besides 10 and 16 are ignored and hexadecimal representation is used as a default.
DATA	Data bytes in format set in <FORMAT> parameter and separated by spaces.

5.5.6.3 I2CWR Examples

Set	Description
AT+I2CWR = 5,16,10 +I2CWR: b d4 62 41 5a OK	Write one byte and read 5 bytes in hexadecimal format.
AT+I2CWR = 5,10,16 +I2CWR: 11 212 98 65 85 OK	Write one byte and read 5 bytes in decimal format.
AT+I2CWR = ? AT+I2CWR? AT+I2CWR	Print help on the command and parameters.

5.6 I3C On PMOD2

I3C is a peripheral device on the RA4E2 MCU that is dedicated to I^2C and I3C communication. This peripheral device can be configured as:

- I^2C Controller
- I^2C Target
- I3C Controller
- I3C Target

Note: The Pmod specification is not yet defined to use I3C.

See Table 5 for PMOD2 connector pinout.

Table 5. PMOD2 Connector Pinout

Pin	Signal	Direction	Description
1	NC	-	-
2	GPIO0	Out	General purpose output 0.
3	SCL	In / Out	Serial Clock.
4	SDA	In / Out	Serial Data.
5	GND	-	-
6	VCC	-	-
7	GPIO1	Out	General purpose output 1.
8	GPIO2	Out	General purpose output 2.
9	GPIO3	In	General purpose input 3.
10	GPIO4	In	General purpose input 4.
11	GND	-	-
12	VCC	-	-

5.6.1 Open I3C module on PMOD2: AT+IIICOPEN

Opens the I3C module.

5.6.1.1 I3COPEN Syntax

Command	Response
AT+IIICOPEN	OK

5.6.2 Set I3C Mode: AT+IIICMODE

After successfully setting the mode, the module is reinitialized automatically. There is no need to reopen or restart the board.

5.6.2.1 I3CMODE Syntax

Command	Response
AT+IIICMODE = <MODE>	OK
AT+IIICMODE = ?	+IIICMODE: <MODE> OK

5.6.2.2 I3CMODE Parameters

Parameter	Description
MODE 0 – I^2C Master 1 – I^2C Slave 2 – I3C Master 3 – I3C Slave`	Describes the working mode for the device.

5.6.2.3 I3CMODE Examples

Command	Description
AT+IIICMODE = 1 OK	Configure peripheral as I^2C target.
AT+IIICMODE = ? +IIICMODE: 1 OK	Get current I3C mode.
AT+IIICMODE? AT+IIICMODE	Get help on the command.

5.6.3 Set I3C Slave Address: AT+IIICSADDR

Sets the I3C slave address that the controller will be accessing in hex format.

5.6.3.1 I3CSADDR Syntax

Command	Response
AT+IIICSADDR = <ADDR>	OK
AT+IIICSADDR = ?	+IIICSADDR: <ADDR> OK

5.6.3.2 I3CSADDR Parameters

Parameter	Description
ADDR	7-bit I^2C slave address in hexadecimal format.

5.6.3.3 I3CSADDR Examples

Set	Description
AT+ IIICSADDR = 5 OK	Set I3C target address in hexadecimal format. ***Note***: For I3C, Address is 7-bit.
AT+IIICSADDR = ? +IIICSADDR: 5 OK	Get current I3C slave address.
AT+IIICSADDR? AT+IIICSADDR	Get help on the command

5.6.4 Read I3C: AT+IIICREAD

Reads data using I3C on PMOD2.

5.6.4.1 I3CREAD Syntax

Command	Response
AT+IIICREAD = <LEN>,<FORMAT>	+IIICREAD: <DATA> OK

5.6.4.2 I3CREAD Parameters

Parameter	Description
LEN	Number of bytes read in decimal format.
FORMAT 10 – decimal 16 – hexadecimal	Data format used to display bytes array read out from the target. All other values besides 10 and 16 are ignored and hexadecimal representation is used as default.
DATA	Data bytes in format set in <FORMAT> parameter and separated by spaces

5.6.4.3 I3CREAD Examples

Set	Description
AT+IIICREAD = 10,16 +IIICWR: 5 21 0 bf 0 0 0 ff 5 2c OK	Read ten bytes and display them in hexadecimal format.
AT+IIICREAD = 10,10 +IIICWR: 5 33 0 191 0 0 0 255 5 44 OK	Read ten bytes and display them in decimal format.
AT+IIICREAD = ? AT+IIICREAD? AT+IIICREAD	Print help on the command and parameters.

5.6.5 Write I3C: AT+IIICWRITE

Writes data to I3C target.

5.6.5.1 I3CWRITE Syntax

Command	Response
AT+IIICWRITE = <FORMAT>,<DATA>	OK

5.6.5.2 I3CWRITE Parameters

Parameter	Description
FORMAT 10 – decimal 16 – hexadecimal	Data format used to display bytes array read out from the target. All other values besides 10 and 16 are ignored and hexadecimal representation is used as default.
DATA	Data bytes in format set in <FORMAT> parameter and separated by spaces.

5.6.5.3 I3CWRITE Examples

Command	Description
AT+IIICWRITE = 16,4 55 45 ff ff OK	Write 5 bytes in hexadecimal format.
AT+IIICWRITE=10,4 32 44 250 255 OK	Write 5 bytes in decimal format.
AT+IIICWRITE = ? AT+IIICWRITE? AT+IIICWRITE	Print help on the command and parameters.

5.6.6 Write Read I3C on PMOD2: AT+IIICWR

Single command that writes data to the I3C target, then reads the number of bytes defined by LEN.

5.6.6.1 I3CWR Syntax

Command	Response
AT+IIICWR = <LEN>,<FORMAT>,<DATA>	+IIICWR: <DATA> OK

5.6.6.2 I3CWR Parameters

Parameter	Description
LEN 0–255 bytes	Number of bytes read in decimal format.
FORMAT 10 – decimal 16 – hexadecimal	Data format used to interpret sending data and to display bytes array read out from the target. All other values besides 10 and 16 are ignored and hexadecimal representation is used as default.
DATA	Data bytes in format set in <FORMAT> parameter and separated by spaces.

5.6.6.3 I3CWR Examples

Set	Description
AT+IIICWR = 5,16,10 +IIICWR: b d4 62 41 5a OK	Write one byte and read 5 bytes in hexadecimal format
AT+IIICWR = 5,10,16 +IIICWR: 11 212 98 65 85 OK	Write one byte and read 5 bytes in decimal format.
AT+IIICWR = ? AT+IIICWR? AT+IIICWR	Print help on the command and parameters.

5.6.7 I3C Module in I^2C Target Mode

The I3C module can be configured as an I^2C target using the AT+IIICMODE command.

Note: There are no pull-up resistors available. Ensure that the controller contains pull-up resistors.

5.7 Read GPIO: AT+GPIOGET

Reads input on the Pmod connectors.

5.7.1.1 GPIOGET Syntax

Command	Response
AT+GPIOGET = <GPIONUMBER>	+GPIOGET: <LEVEL> OK

5.7.1.2 GPIOGET Parameters

Parameter	Description
GPIONUMBER	GPIO Number. Check the board pinout in the schematics in section 2.1.
LEVEL 0 – Low Level 1 – High Level	Defines pin level.

5.7.1.3 GPIOGET Examples

Set	Description
AT+GPIOGET = 3 +GPIOGET: 1 OK	Read GPIO3.
AT+GPIOGET = ? AT+GPIOGET? AT+GPIOGET	Print help on the command with parameters values.

5.8 SET GPIO: AT+GPIOSET

Sets the outputs on the Pmod connectors.

5.8.1.1 GPIOSET Syntax

Command	Response
AT+GPIOSET = <GPIONUMBER>,<LEVEL>	OK

5.8.1.2 GPIOSET Parameters

Parameter	Description
GPIONUMBER	GPIO number. Output pins 0..2. Check the board pinout in the schematics in section 2.1.
LEVEL 0 – Low Level 1 – High Level	Defines pin level.

5.8.1.3 GPIOSET Examples

Set	Description
AT+GPIOSET = 1, 0 OK	Set GPIO1 value to 0
AT+GPIOSET = ? AT+GPIOSET? AT+GPIOSET	Print help on the command and parameters.

5.9 Internal Data Exchange Buffer XBUF

Internal 256 bytes buffer can be accessed if the board is in I^2C/SPI/I3C target mode. Buffer control commands are described in following sections.

5.9.1 Print XBUF to Screen: AT+XBUF

Prints the entire buffer to the screen in readable format.

5.9.1.1 XBUF Syntax

Command	Response
AT+XBUF	<XBUF DATA> OK

5.9.1.2 XBUF Example

Set	Description
AT+XBUF 00 01 02 03 04 05 06 07 08 09 0a 0b 0c 0d 0e 0f 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ff c8 96 64 32 19 14 0f 0a 05 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 OK	Print buffer to the screen.

5.9.2 Read XBUF: AT+XBUFREAD

Prints the entire buffer to the screen in readable format.

5.9.2.1 XBUFREAD Syntax

Command	Response
AT+XBUFREAD = <LEN>,<FORMAT>,<ADDR>	+XBUFREAD: <DATA> OK

5.9.2.2 XBUFREAD Parameters

Parameter	Description
LEN	Number of bytes read in decimal format.
FORMAT 10 – decimal 16 – hexadecimal	Data format used to display bytes array read out from the target. All other values besides 10 and 16 are ignored and hexadecimal representation is used as default.
ADDR	Address index to start reading the buffer.
DATA	Data bytes in format set in <FORMAT> parameter and separated by spaces.

5.9.2.3 XBUFREAD Example

Set	Description
AT+XBUFREAD = 10,16,0 +I2CREAD: 5 21 0 bf 0 0 0 ff 5 2c OK	Read 10 bytes read starting index 0 and show them in hexadecimal format.
AT+XBUFREAD = 10,10,0 +I2CREAD: 5 33 0 191 0 0 0 255 5 44 OK	Read 10 bytes and show them in decimal format.
AT+XBUFREAD = ? AT+XBUFREAD? AT+XBUFREAD	Get help on the command.

5.9.3 Write to XBUF: AT+XBUFWRITE

Writes data to the internal exchange buffer XBUF.

5.9.3.1 XBUFWRITE Syntax

Command	Response
AT+XBUFWRITE = <FORMAT>,<ADDR>,<DATA>	OK

5.9.3.2 XBUFWRITE Parameters

Parameter	Description
FORMAT 10 – decimal 16 – hexadecimal	Data format used to display bytes array read out from the target. All other values besides 10 and 16 are ignored and hexadecimal representation is used as default.
ADDR	Buffer index where the data is written. It is given in decimal or hexadecimal format as defined in <FORMAT> parameter.
DATA	Data bytes in format set in <FORMAT> parameter and separated by spaces.

5.9.3.3 XBUFWRITE Examples

Command	Description
AT+XBUFWRITE = 16,0,4 55 45 ff ff OK	Write 5 bytes in hexadecimal format starting at 0 index.
AT+XBUFWRITE = 10,4,0 32 44 250 255 OK	Write 5 bytes in decimal format starting at 0 index.
AT+XBUFWRITE = ? AT+XBUFWRITE? AT+XBUFWRITE	Print help on the command and parameters.

5.10 Console Configuration: AT+CONSCFG

5.10.1 CONSCFG Syntax

Command	Response
AT+CONSCFG = <ECHO>,<INFO>,<PRINTOK>, <PRINTATRESP>	OK
AT+CONSCFG = ?	+CONSCFG: <ECHO>,<INFO>,<PRINTOK>,<PRINTATRESP>OK

5.10.2 CONSCFG Parameters

Parameter	Description
ECHO	Print echo.
INFO	Print INFO after connection.
PRINTOK	Print OK after successful command.
PRINTATRESP	Print AT command as response before sending data.

5.10.3 CONSCFG Examples

Command	Description
AT+CONSCFG = 0,0,1,0 OK	Disable ECHO, No INFO, Print OK; no AT command response before sending data.
AT+CONSCFG = ? OK	Get configuration.
AT+CONSCFG? AT+CONSCFG	Print help on the command.

5.11 Device INFO: AT+INFO

Prints device configuration in readable format.

5.11.1 INFO Syntax

Command	Response
AT+INFO	<Device Configuration>

5.12 Reset: AT+RESET

Reboots the board.

5.12.1 RESET Syntax

Command	Response
AT+RESET	No response. The board is rebooted immediately.

5.13 Factory Reset: AT+FACTORY

Restores default settings.

5.13.1 FACTORY Syntax

Command	Response
AT+FACTORY	Confirm board reset to factory defaults (Y/N).

6. Ordering Information

Part Number	Description
QCIOT-USB2SERDEMOZ	QCIOT-USB2SERDEMOZ Evaluation Board

7. Revision History

Revision	Date	Description
1.00	Mar 18, 2025	Initial release.

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