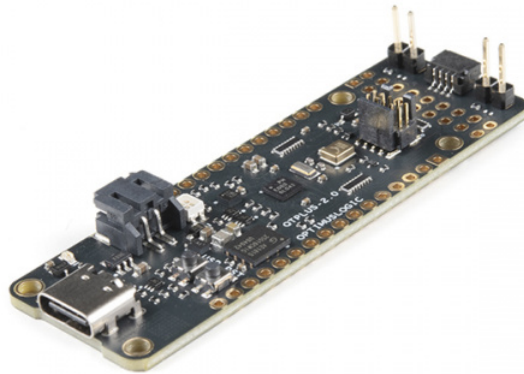


QuickLogic Thing Plus (EOS S3) Hookup Guide

Introduction

Note: Content for this user guide was originally written by QuickLogic.

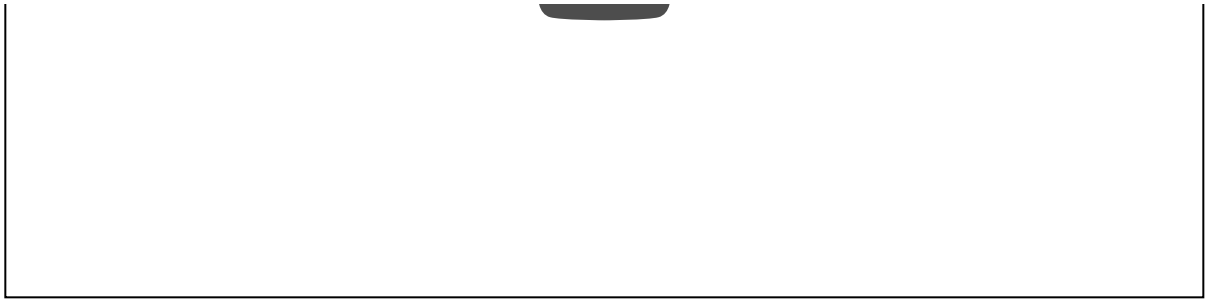
This guide provides users with functional descriptions, configuration options for the QuickLogic Thing Plus EOS S3. It also serves as a “Getting Started” and “How To” guide.



SparkFun QuickLogic Thing Plus - EOS S3
© DEV-17273

Product Showcase: SparkFun QuickLogic Thing Plus





Required Materials

To follow along with this tutorial, you will need the following materials. You may not need everything though depending on what you have. Add it to your cart, read through the guide, and adjust the cart as necessary.



SparkFun QuickLogic Thing Plus - EOS S3

● DEV-17273



Reversible USB A to Reversible Micro-B Cable - 0.8m

○ CAB-15428

You Will Also Need

You will also need a computer with a terminal program or any UART console application. For the scope of this tutorial, we will use PuTTY.

- Computer with Windows 10 OS or Linux OS
 - Serial Terminal

Note: Windows 7, Windows 8 and Virtual Ubuntu machines are not supported.

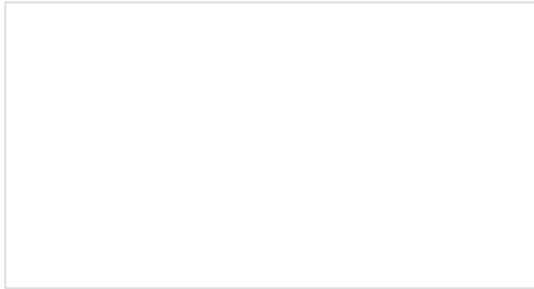
Suggested Reading

If you aren't familiar with the Qwiic system, we recommend reading here for an overview .



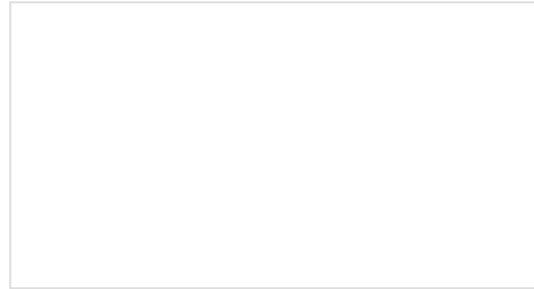
Qwiic Connect System

If you aren't familiar with the following concepts, we also recommend checking out a few of these tutorials before continuing.



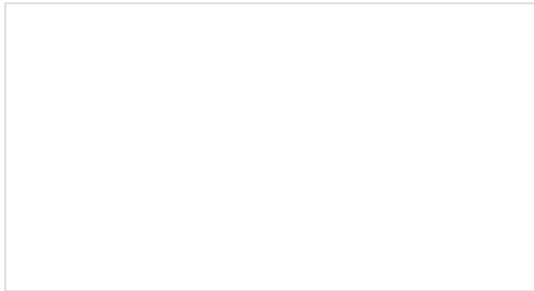
Serial Peripheral Interface (SPI)

SPI is commonly used to connect microcontrollers to peripherals such as sensors, shift registers, and SD cards.



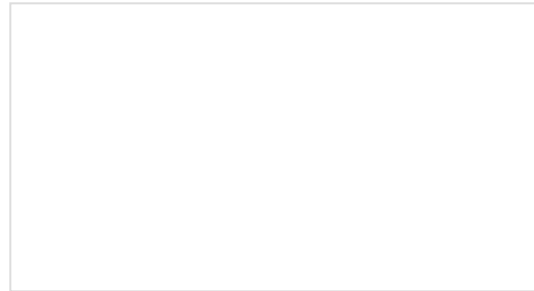
Logic Levels

Learn the difference between 3.3V and 5V devices and logic levels.



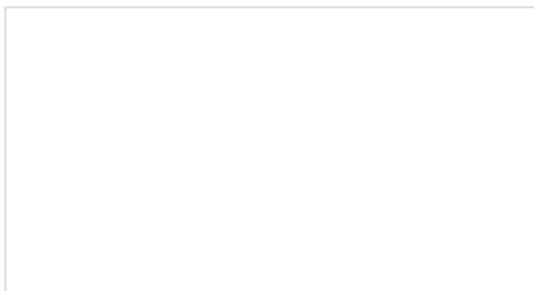
Accelerometer Basics

A quick introduction to accelerometers, how they work, and why they're used.



I2C

An introduction to I2C, one of the main embedded communications protocols in use today.



Serial Terminal Basics

This tutorial will show you how to communicate with your serial devices using a variety of terminal emulator applications.

Hardware Overview

The QuickLogic Thing Plus EOS S3 is a small form factor system ideal for enabling the next generation of low-power Machine Learning (ML) capable Internet of Things (IoT) devices. Unlike other development boards which are based on proprietary hardware and software tools, the QuickLogic Things Plus is based on 100% open source hardware, compatible with the Feather form factor, and is built around 100% open source software (including the Symbiflow FPGA Tools).

The QuickLogic is powered by QuickLogic's EOS™ S3, the first eFPGA-enabled Arm Cortex®-M4F MCU to be fully supported with Zephyr RTOS and FreeRTOS.

Other functionality includes:

- QuickLogic EOS S3 MCU Platform
- ST micro LIS2DH12TR accelerometer
- Vesper VM3011 Adaptive ZeroPower Listening™ Digital Piezoelectric MEMS PDM Microphone
- SparkFun's Qwiic connector to enable easy connection to large number of Qwiic modules
- 16Mbit of on-board flash memory
- User button and RGB LED
- Powered from USB or a single Li-Po battery
- Integrated battery charger
- USB data signals tied to programmable logic
- IO signals routed into general purpose pinheads
- Compatible with standard 0.1" breadboards

Benefits

- QuickLogic Thing Plus EOS S3 is small, Feather compatible, inexpensive, and is 100% supported by open source tools.
- With a Cortex M4F MCU and integrated eFPGA, the EOS S3 lets you innovate with 100% open source hardware and software.

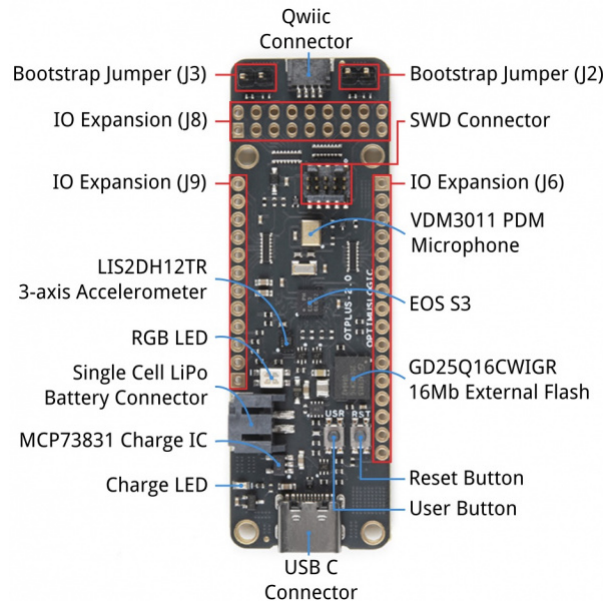
Applications

- Tiny ML applications (such as with SensiML's AI Software Platform and Google's TensorFlow Lite)
- General purpose MCU applications

Board Layout

Below is a quick overview of the board layout and components.

- QuickLogic EOS S3 MCU Platform
- ST micro LIS2DH12TR accelerometer
- SparkFun's Qwiic connector
- Vesper's VM3011 MEMS PDM microphone
- 16Mbit of on-board flash memory
- User button and RGB LED
- Hardware Reset button
- Powered from USB or a single Li-Po battery
- Integrated battery charger
- USB data signals tied to programmable logic
- IO signals break-routed into general purpose pinheads



IO Expansion Connectors EOS S3 MCU IO Map to QuickLogic Thing Plus

Below is the graphical datasheet of the QuickLogic Thing Plus EOS S3 to reference the pins followed by a table listing the EOS S3 pins. Due to the size of the board and components, the silkscreen is printed on the back of the board. You can flip over the board reference the pin name and its respective function as well.

SparkFun QuickLogic Thing Plus - EOS S3
DEV-17273

Power and Logic Levels
VDD: direct to USB (5V)
VBAT: direct to LiPo battery (and Microchip MCP73831 charger)
3V3: output of TI TPS62821 regulator (3.3V/7A)
GPIO logic levels: 3.3V

Notes
• Header pin 1 can be referenced by either the square PIN and polarity marker
†1: Close bootstrap jumper pins when using J-Link programmer, otherwise keep open

EOS S3 MCU + eFPGA SoC
- Arm® Cortex®-M4P Microcontroller
- up to 80 MHz operating frequency
- up to 512 Kb SRAM
- Embedded eFPGA (eFPGA)
- 2400 effective logic cells
- 64 Kb ROM

Storage
- GigaDevice GD25Q16CE06P
- 16 Mb of NOR flash memory

Interfaces
- 1x ADC, 1x UART, 1x I2C, 2x SPI, 1x PS, 1x PDM

Sensors
- STMicro LIS2DH12TR (246011800, 0x18)
- PC-3-axis 12.8k Accelerometer
- Vesper VM3011
- Digital Pulse Density Modulation Mic
- w/ Wake-on-Sound

User Interfaces
- RESET Button
- USB Button (A)
- RGB LED
- Red (E2), Green (E3), Blue (3A)
- Charge LED

QuickLogic
sparkfun
ELECTRONICS

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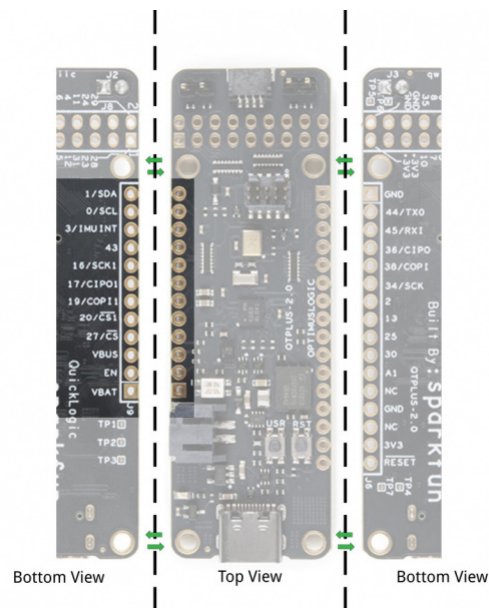
Click image for a closer view.

EOS S3 MCU IO	QuickLogic Thing Plus Function	Additional Function	Expansion
IO_0	I2C0 SCL		J9.11
IO_1	I2C0 SDA		J9.12
IO_2	IO		J6.7
IO_3	Accelerometer LIS2DH12TR Interrupt		J9.10
IO_4	IO		J8.8
IO_5	IO		J8.9

IO_6	User Button Input		J8.10
IO_7	IO		J8.11
IO_8	IO		J8.12
IO_10	IO		J8.13
IO_11	IO		J8.6
IO_12	IO		J8.7
IO_13	IO		J6.8
IO_14	Serial Wire Debug CLK		J6.4
IO_15	Serial Wire Debug DATA		J6.2
IO_16	IO	SPI Peripheral CLK	J9.8
IO_17	IO	SPI Peripheral CIPO (input)	J9.7
IO_18	Blue LED		N/A
IO_19	IO	SPI Peripheral COPI	J9.6
IO_20	IO	SPI Peripheral CSn	J9.5
IO_21	Green LED		N/A
IO_22	Red LED		N/A
IO_23	IO	I2S Peripheral WCLK (Frame)	J8.3
IO_24	IO	I2S Peripheral DATA (dout)	J8.4
IO_25	IO		J6.9
IO_27	IO	SPI Controller CS2	J9.2
IO_28	PDM Data; to isolate, remove R28		J8.1
IO_29	PDM CKO		J8.2
IO_30	IO		J6.10
IO_31	IO	I2S Peripheral CLK (input)	J8.5
IO_32	IO		J9.3
IO_33	IO		J9.4

IO_34	SPI Controller CLK		J6.6
IO_36	SPI Controller CIPO		J6.4
IO_38	SPI Controller COPI (flash)		J6.5
IO_40	IO		N/A
IO_43	IO	Interrupt Output to Host	J9.9
IO_44	IO	UART TX	J6.2
IO_45	IO	UART RX	J6.3

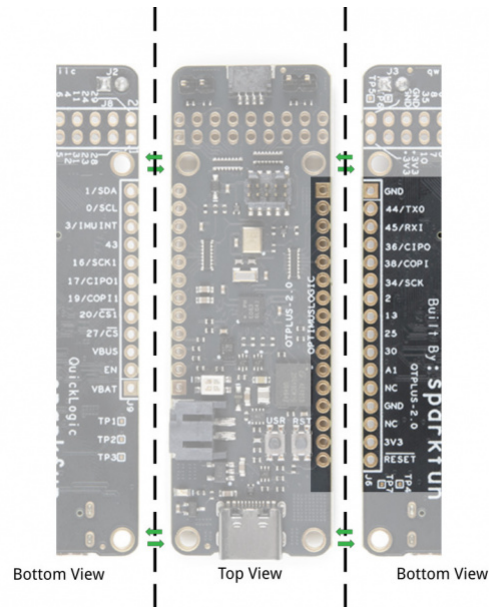
Connector J9



J2	EOS S3 MCU IO	BGA Pin#	Function
1			VBAT
2			3.3V Circuit Enable
3			VBUS
4	IO_27	HS	IO; SPI Controller CSn2
5	IO_20	G8	SPI Peripheral SSn input; EOS S3 boot-strap
6	IO_19	H8	SPI Peripheral COPI input; EOS S3 boot-strap
7	IO_17	D7	SPI Peripheral CIPO output
8	IO_16	E7	SPI Peripheral CLK input

9	IO_43	D1	EOS S3 Interrupt Output
10	IO_3	A2	Accel Interrupt input
11	IO_0	B1	I2C0 SCL
12	IO_1	C1	I2C0 SDA

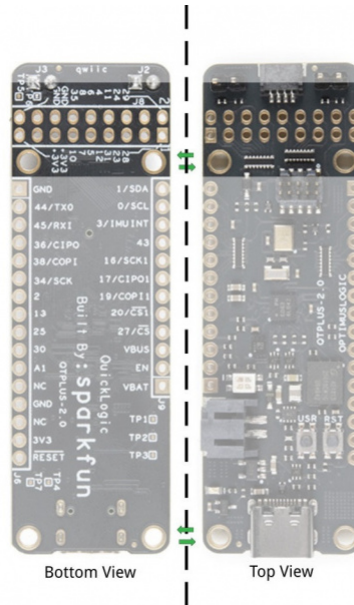
Connector J6



J6	EOS S3 MCU IO	BGA Pin#	Function
1			Ground
2	IO_44	E1	S3 UART TX
3	IO_45	G1	S3 UART RX
4	IO_36	H3	SPI Controller CIPO input
5	IO_38	E2	SPI Controller COPI output
6	IO_34	F3	SPI Controller CLK output
7	IO_2	A1	IO
8	IO_13	D6	IO
9	IO_25	F7	IO
10	IO_30	F4	IO
11	ADC1	C7	ADC1 input

12			No Connect
13			Ground
14			No Connect
15			+3.3V
16	SYS_RSTn	F8	EOS S3 HW reset input

Connector J8



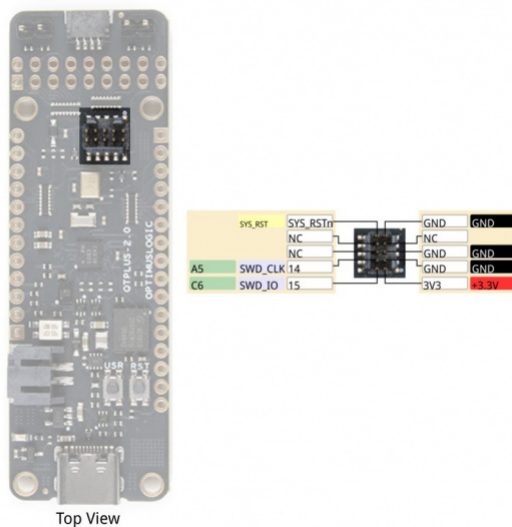
J8	EOS S3 MCU IO	BGA Pin#	Function
1	IO_28	G5	PDM microphone Data
2	IO_29	F5	PDM microphone CLK
3	IO_23	H6	I2S Peripheral WCLK Input
4	IO_24	G6	I2S Peripheral DATA output
5	IO_31	G4	I2S Peripheral CLK input
6	IO_11	C5	IO
7	IO_12	B5	IO
8	IO_4	B2	IO
9	IO_5	C3	IO
10	IO_6	B3	User button input

11	IO_7	A3	IO
12	IO_8	C4	IO
13	IO_10	A4	IO
14	IO_35	F2	IO
15			+3.3V
16			Ground
17			+3.3V
18			Ground

Development Connector

EOS S3 MCU SWD Connector

Below is the SWD connector used to program the board. Taken from the graphical datasheet are the pin labels on the right for reference.

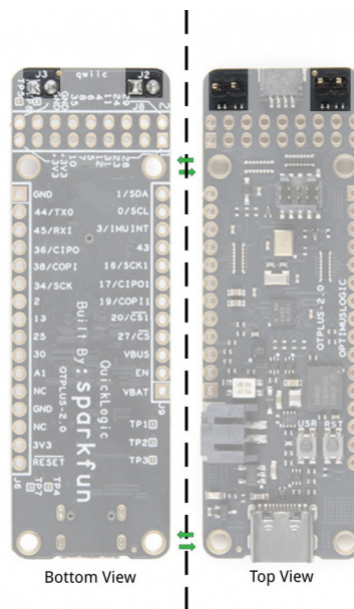


J7	EOS S3 MCU IO	Function
1		+3.3V
2	IO_15	SWD_IO
3		Ground
4	IO_14	SWD_CLK
5		Ground

6		No Connect
7		No Connect
8		No Connect
9		Ground
10	SYS_RSTn	Hardware Reset

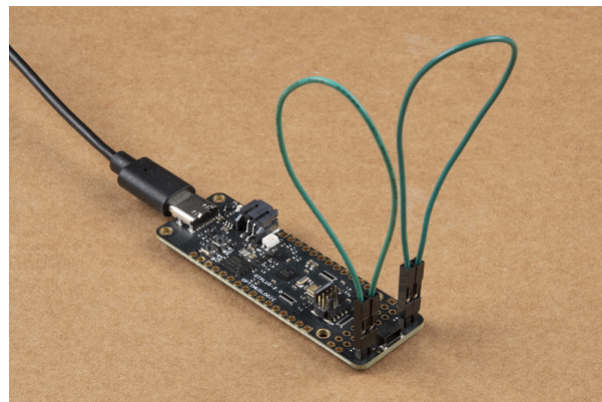
Boot-strap IO_19 & IO_20

There are two pair of IO pins that are reserved for flashing the EOS S3 with a programmer. When booting a program from flash, you'll need to keep these pins open.



- Install both shunts to use SWD Debugger for development
- Remove both shunts for boot-from-flash

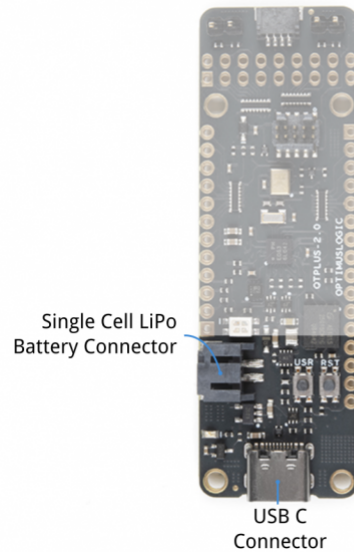
Note: QuickLogic Thing Plus board flash device must contain valid boot image for successful boot from flash.



Power

There are two ways to provide power to the QuickLogic Thing Plus: USB connector (J5) or Battery connector (J4). When both ports are connected at the same time, the USB power activates the battery charging circuit that provide charging current to the battery.

When using a rechargeable battery, the minimum input voltage will determine the maximum currents that the system needs to support. This is important when connecting additional peripherals to the QuickLogic Thing Plus that also requires connection to +3.3V for supplies.



The MCP73831 LiPo charger is set to ~212.76mA for the default charge rate. Before you plug a battery into the charger, you should be aware of your **battery's capacity** and the **charge current** supplied by the charger. To be safe, you should keep the charge current **at or below 1C** of your battery. That means you should connect a LiPo battery that has a capacity of ~212.75mAh or higher to charge safely. For more information on the charge LED's status, check out the LiPo USB Charger breakout board for the MCP73831.

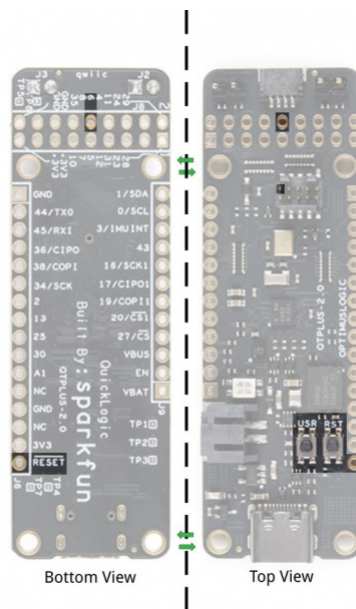
RGB LED

Speaking of LEDs, the board includes a build in RGB LED. As listed earlier in the tutorial, the leds can be controlled using pin 22 (red), pin 21 (green), and pin 18 (blue). Note that the pins are not routed to the edge of the board.



User and Reset Buttons

The board includes a user button and hardware reset button. These are also connected to the edge of the board as well. The reset pin is also connected to the SWD pin when connecting to a programmer.

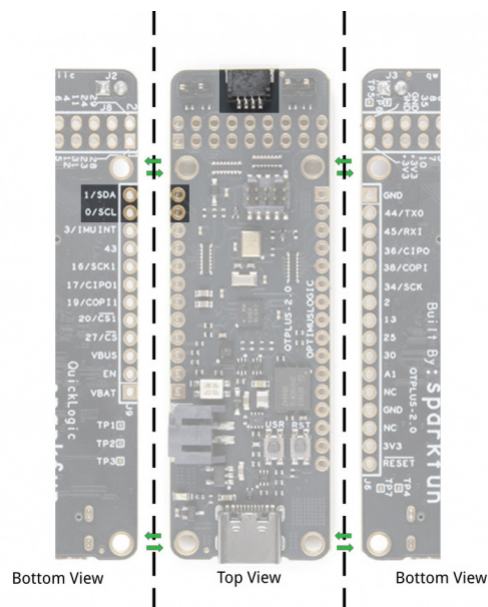


Connecting Additional Peripherals to the QuickLogic Thing Plus

QuickLogic Thing Plus supports direct connection to FeatherWing module (providing that the FeatherWing module has Stack Headers installed) via expansion connector J2 and J3. Refer to AdaFruit's web site for additional information on available FeatherWing modules.

Sensor with I²C Port

QuickLogic Thing Plus board supports connecting to sensor module with I²C peripheral interface via expansion connectors J2. You can also access the pins along the J9 header.



QuickLogic Thing Plus I²C supports I²C Standard mode (100KHz) and Fast mode (400KHz). There is one I²C bus available; additional I²C IP can be implemented in EOS S3 FPGA.

- I2C0 bus: J2 pin 12 (SDA) and J2 pin 11 (SCL); the signals (SCL and SDA) are connected to 4.7K Ω pull-up resistor. This bus is shared with onboard I²C sensor, LIS2DH12TR (b0011000x).

Steps to connect external I²C sensors to QuickLogic Thing Plus board:

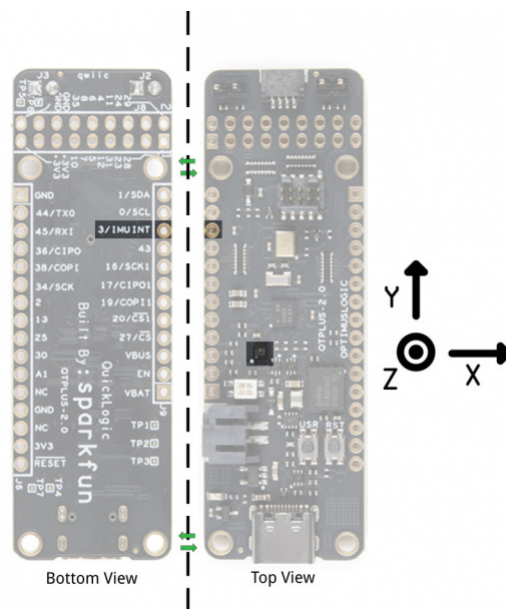
- Ground connection
- Power connection (+3.3V supplies); check supply voltage level meeting connecting module requirement
- Connect SCL and SDA signals; check IO level (> +3.0V IO only)
- Keep connecting wires as short as possible
- Configure the I²C address to avoid LIS2DH12TR assigned address (b0011000x)
- Check SCL and SDA rise time (< 1000 ns for Standard mode and < 300 ns for Fast mode)

Note: You may need to use oscilloscope to validate the rise time for SCL and SDA to stay within rise time specification

Note: Refer to I2C- bus specification for details (UM10204)

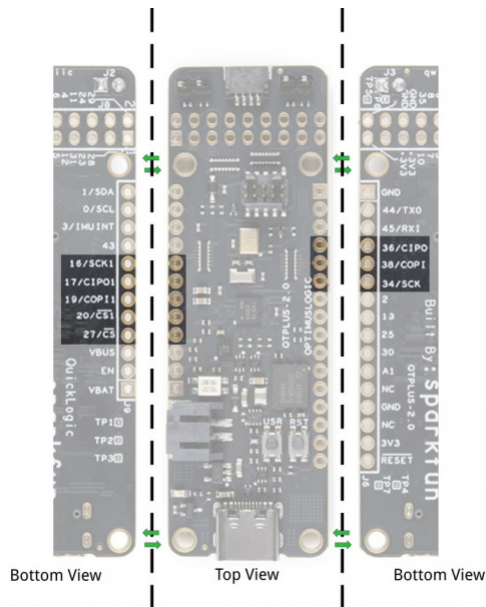
LIS2DH12TR Accelerometer

The board includes the LIS2DH12TR triple axis accelerometer. Below is the reference axis of the IC based on the datasheet. This sensor connected to the I²C bus. The address for the accelerometer is set to 0b0011000 (0x18). The accelerometer INT1 pin is connected to pin 3.



Sensor with SPI Peripheral Port

QuickLogic Thing Plus board supports connecting to sensor module with SPI peripheral interface via expansion connectors J6 and J9: SPI CONTROLLER CLK (J6 pin 6), SPI CONTROLLER CIPO (J6 pin 4), SPI CONTROLLER COPI (J6 pin 5) and SPI CONTROLLER CS2 (J9 pin 4).



The maximum supported SPI clock frequency is 10MHz.

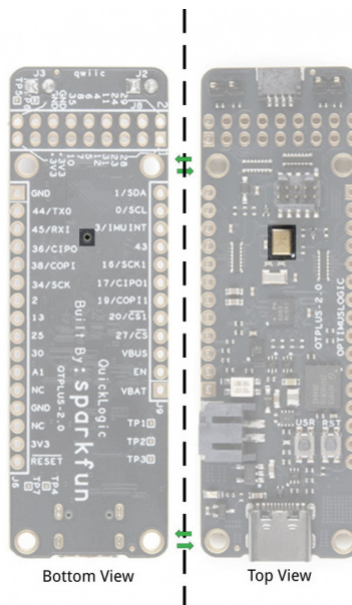
Steps to connect external SPI sensor to QuickLogic Thing Plus board:

- Ground connection
- Power connection (+3.3V supplies check supply voltage level meeting connecting module requirement)
- Connect SPI CONTROLLER signals; check IO level (> +3.0V IO only)
- Keep connecting wires as short as possible
- Check signal quality using scope

PDM Microphones

Single PDM Microphone

The on-board PDM microphone (Vesper VM3011) is configured as left channel output (driving active data on falling edge of PDM CLK). Based on the design of the microphone, there is a drill hit through the board that allows an opening for the sound.



QuickLogic Thing Plus supports external PDM microphone connection via expansion connector J8: PDM CLK (J8 pin 2) and PDM DATA (J8 pin 1).

Steps to connect one external PDM microphone to QuickLogic Thing Plus board:

- Ground connection
- Power connection (+3.3V supplies check supply voltage level meeting connecting module requirement)
- **Remove R28 (100Ω resistor)**
- Connect PDM CLK and PDM DATA signals; check IO level (> +3.0V IO only)
- Keep connecting wires as short as possible
- PDM microphone is configured as right channel microphone; the L/R signal or Channel signal is connected to VDD
- Check signal quality using scope

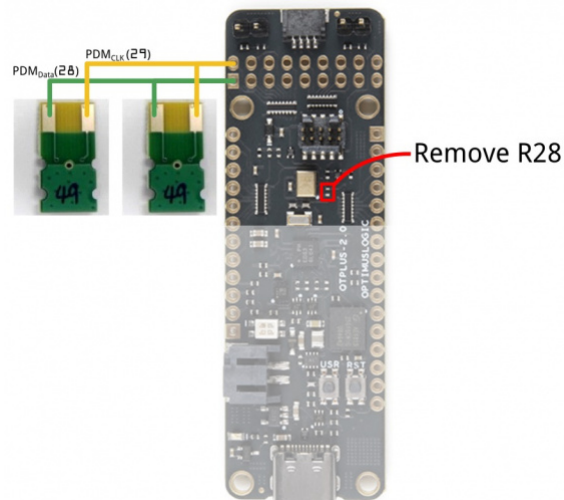
Double PDM Microphone

To support two external PDM microphones configuration, it is required to disable the connection of the on-board PDM microphone.

QuickLogic Thing Plus supports external PDM microphone connection via expansion connector J8: PDM CLK (J8 pin 2) and PDM DATA (J8 pin 1).

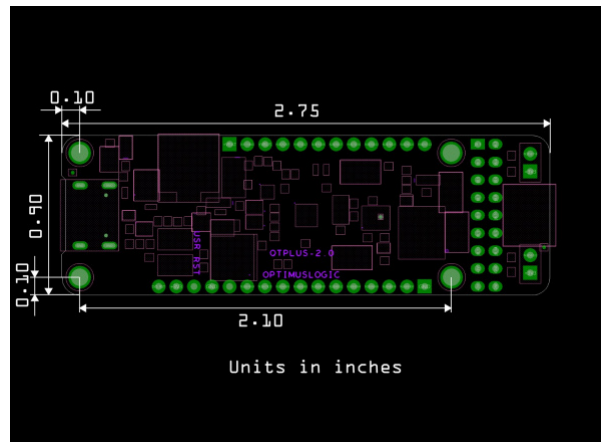
Steps to connect two external PDM microphones to QuickLogic Thing Plus board:

- Ground connection
- Power connection (+3.3V supplies check supply voltage level meeting connecting module requirement)
- **Remove R28 (100Ω resistor)**
- Connect PDM CLK and PDM DATA signals; check IO level (> +3.0V IO only)
- Keep connecting wires as short as possible; avoid star connection scheme (see figure below)
- Configure one PDM microphone as left channel and one PDM microphone as right channel
- Check signal quality using scope



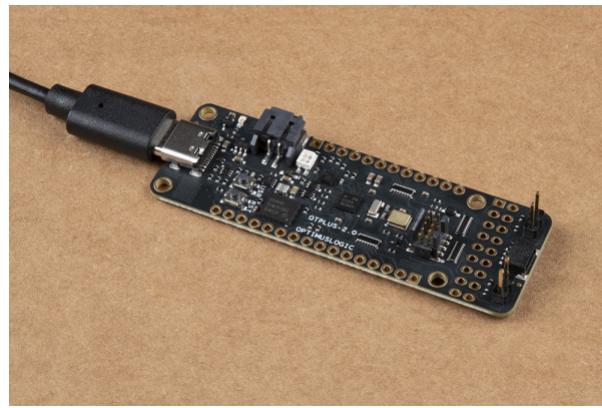
Board Dimensions

The board is 2.75"x2.10". While the board uses the Thing Plus footprint, length of the board is slightly longer than other Thing Plus designs.



Hardware Assembly

To power and output serial data to terminal window, you will need to insert a USB cable to the board.

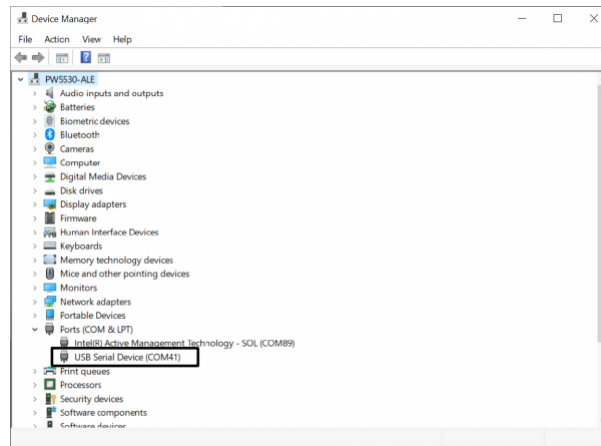


Getting Started

Running Pre-Loaded Program from Flash

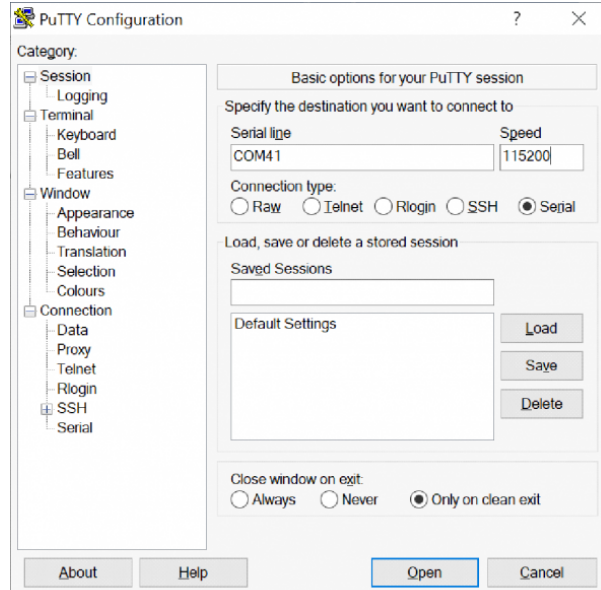
The purpose of the pre-loaded program is to make it very fast and straightforward for a new user to verify the board is functioning correctly. While we do production testing on every QuickLogic Thing Plus before we ship, sometimes things happen during shipping or storage. Running this test takes less than a minute to do, requires no knowledge of the QuickLogic Thing Plus, and will give you peace of mind the QuickLogic Thing Plus is ready for you to start innovating freely.

1. Make sure there is no shunt installed at J2 and J3; if there are shunts installed, remove the shunts; save the shunts for future firmware development
2. Provide power to the QuickLogic Thing Plus using the Type-C USB cable; the power source can be either a PC or wall adapter. When there is power applied to the board, the LED flashes "white" for a short duration
3. Press the "reset" button
4. The LED flashes blue color for 5 seconds and then turns off
5. Wait for 5 seconds
6. On Windows 10 machine, open Device Manager to check for the assign COM port



Note: For Win10 system, the system device manager may not fully configure QuickLogic Thing Plus as COM port when install for the first time, repeat step (3) to (6).

7. Launch PuTTY application and configure for Serial access and select “Open”.



8. Perform the followings in the PuTTY terminal:

- Type: “ diag ” to bring up QuickLogic Thing Plus diagnostic menu
- Type: “ help ” to bring up the menu of commands
- Type: “ red ”; the command shows red color for LED
- Type: “ red ”; the LED turns off the LED
- Try “ green ” and “blue” command

```
COM41 - PuTTY
#####
Sparkfun Thing+ LED / User Button Test
SW Version: qorc-sdk/qt_apps/qt_helloworldsw
May 10 2021 13:43:09
#####

Hello world!!

#####
Command Line Interface
App SW Version: qorc-sdk/qt_apps/qt_helloworldsw
#####
[0] > █
```

```
COM41 - PuTTY
#####
Sparkfun Thing+ LED / User Button Test
SW Version: qorc-sdk/qt_apps/qt_helloworldsw
May 10 2021 13:43:09
#####

Hello world!!

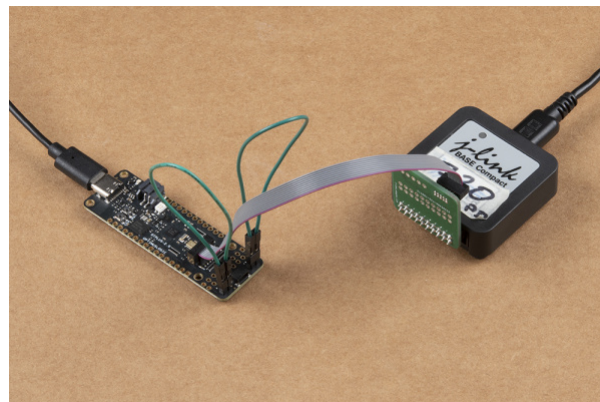
#####
Command Line Interface
App SW Version: qorc-sdk/qt_apps/qt_helloworldsw
#####
[0] > diag
[1] diag > red
[1] diag > red
[1] diag > green
[1] diag > green
[1] diag > blue
[1] diag > blue
[1] diag > █
```

Download Binaries using JLink SWD

QuickLogic Thing Plus supports loading and testing stand-alone eFPGA design or eFPGA + M4 MCU design, using SWD standard tool such as Segger's Jlink SWD or OCD. Below are the instructions for system with Windows 10 OS with Segger Jlink pod.

What you need

- Laptop or PC with Windows 10
- Segger Jlink pod and PC connecting USB cable
- Segger Jlink adapter to 10-pin connector and cable
- QuickLogic Thing Plus board and micro USB cable



Download stand-alone FPGA binaries instructions

- Disconnect QuickLogic Thing Plus power; if USB-to-Serial cable connected to the board, remove the connection from PC
- Install shunts at QuickLogic Thing Plus J2 and J3
- Connect micro USB cable from QuickLogic Thing Plus to PC
- Connect 10-pin cable to QuickLogic Thing Plus connector J6; check connector key for correct alignment

- Press reset button
- Open CMD console
- Type: "Jlink.exe -device cortex-m4 -If SWD -speed 4000 -commandFile "Jlink script"

Note: * Jlink.exe: Link commander – include reference to the location of executable * Jlink script: output file symbiflow for EOS S3 FPGA binaries * Refer to Jlink Commander for more additional information

Download FPGA binaries + M4 MCU binaries instructions

- Disconnect QuickLogic Thing Plus power; if USB-to-Serial cable connected to the board, remove the connection from PC
- Install shunts at QuickLogic Thing Plus J2 and J3
- Connect micro USB cable from QuickLogic Thing Plus to PC
- Connect 10-pin cable to QuickLogic Thing Plus connector J7; check connector key for correct alignment
- Press reset button
- Open CMD console (#1)
- Launch Jlink commander (i.e. type "Jlink.exe") and follow the on-screen instructions to connect to QuickLogic Thing Plus M4 target
- Execute the followings in Link Commander console
 - Type: "r" to reset the EOS S3
 - Type: "loadbin qt_helloworldsw.bin 0x0"
 - Type: "r"
- Open another CMD console (#2)
- Type: "Jlink.exe -device cortex-m4 -If SWD -speed 4000 -commandFile "Jlink script"

Note: * Jlink.exe: Link commander – include reference to the location of executable * Jlink script: Symbiflow's output for EOS S3 FPGA binaries * Refer to Jlink Commander for more additional information * Return to console #1; type: "g"; the M4 binaries in M4 SRAM will start to run and the eFPGA is configured

Resources and Going Further

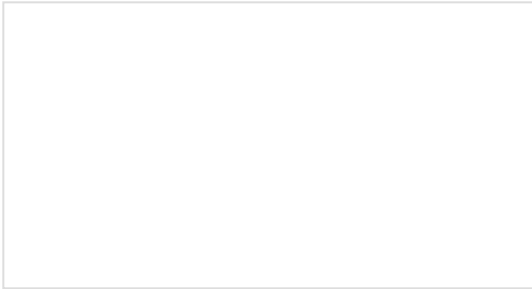
Now that you've successfully got your QuickLogic EOS S3 Thing Plus up and running, it's time to incorporate it into your own project!

For more information, check out the resources below:

- Schematic (PDF)
- Cadence Board File (BRD)
- Board Dimensions (JPG)
- Graphical Datasheet
- QuickLogic EOS E3
 - Datasheet (PDF)
 - Technical Reference Manual (PDF)
 - Whitepaper (PDF)
 - CrowdSupply Tutorial Demos
- Datasheets
 - STMicro LIS2DH12TR (PDF) - triple Axis 12-bit accelerometer
 - Vesper VM3011 (PDF) - digital PDM Microphone w/ wake-on-sound
 - GigaDevice GD25Q16CEIGR (PDF) - 16Mbit SPI NOR flash memory
 - MicroChip MCP73831 (PDF) - single cell LiPo charge IC
- Software
 - Machine Learning

- TensorFlow Lite
- SensiML
- Real-time Operating Systems
 - Zephyr RTOS (QuickLogic Fork)
 - QORC SDK with FreeRTOS
- FPGA Tools
 - SymbiFlow
- GitHub Hardware Repo
- Product Showcase

Need some inspiration for your next project? Check out some of these related tutorials:



Programming an FPGA

Come look at the basics of working with Field Programmable Gate Arrays.