
# Binho Supernova USB Host Adapter

# Product Datasheet

Revision 1.5

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binho

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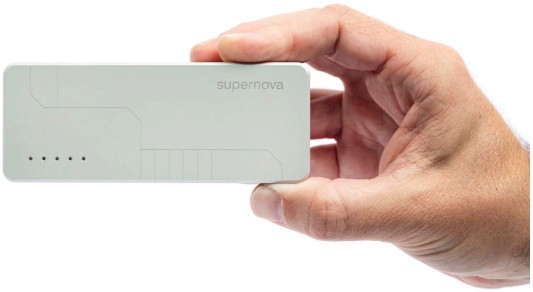
# 1 Key Features

- Support for MIPI I3C Basic
  - v1.0, v1.1.1, and v1.2
  - Controller or Target role
  - SDR mode, HDR-DDR
  - Supports IBI, Hot Join, and all CCCs
  - Voltage range from 0.8V to 3.3V
- Support for SPI protocol
  - SPI Controller
  - All 4 SPI Modes Supported
  - Up to 37.5MHz max clock speed
  - Up to 4 x CS signals
  - Configurable MSB/LSB
  - SPI Peripheral (coming soon)
  - Voltage range from 1.2V to 3.3V
- Support for I2C protocol
  - I2C Controller
  - 1MHz max clock speed
  - 7-bit Addressing, Clock Stretching
  - Configurable Pull-up Resistors
  - 10-bit Addressing (coming soon)
  - I2C Peripheral (coming soon)
  - Voltage range from 1.2V to 3.3V
- Support for UART protocol
  - 115200 max baud
  - Support for Hardware Flow Control
  - Voltage range from 1.2V to 3.3V
- GPIO pins
  - 6 x Digital IO pins
  - Voltage range from 1.2V to 3.3V
  - Configurable as Interrupts
  - PWM Support (coming soon)
- Provides downstream power to DUT
  - Programmable from 1.2V to 3.3V
- Robust Machined Aluminum Enclosure
  - 5 x RGB Status LEDS
  - Integrated mounting holes
  - Silent, Fanless design
- All cables and accessories included
  - Stored in custom zippered case
- Full-featured Software Support
  - Point-and-Click GUI
  - Cross-Platform:  Windows, Mac, Linux
  - Python, C/C#/C++ SDKs
  - Field-Upgradeable Device Firmware

# 2 Target Applications

- Device Driver Development
- Firmware Development & Verification
- Proof of Concept Development
- Automated HW/FW Testing
- FLASH & EEPROM Programming
- NVMe-MI (MCTP over I3C) & JESD300-5 SPD Applications




# 3 Product Introduction

The Binho Supernova USB Host Adapter allows one to interface their computer directly to hardware circuits. Featuring MIPI I3C Protocol v1.1.1 support, the Supernova offers an unmatched value proposition in the test tool market. The Supernova features a modern USB Type-C port for connection to the host PC, 5 x RGB LEDs for visual status indication, and a variety of DUT-facing connections all in a compact, robust machined-aluminum enclosure including integrated mounting holes.

Beyond I3C, the host adapter is able to communicate on several other digital buses: I2C, SPI, and UART. All of these protocols are implemented on their own dedicated pins and can be operated simultaneously. A bank of 6 x dedicated digital GPIO pins can be assigned to other related or unrelated purposes such as GPIO, interrupts, resets, chip selects, etc, as well as operating as digital PWM outputs (coming soon).

# 4 Table of Contents

# 5 Product Description

This section of the document includes detailed information about the Supernova product, starting with an overview of all the included items, followed by a walkthrough of various ports, pinouts, and power domains of the Supernova host adapter.

## 5.1 Included Components

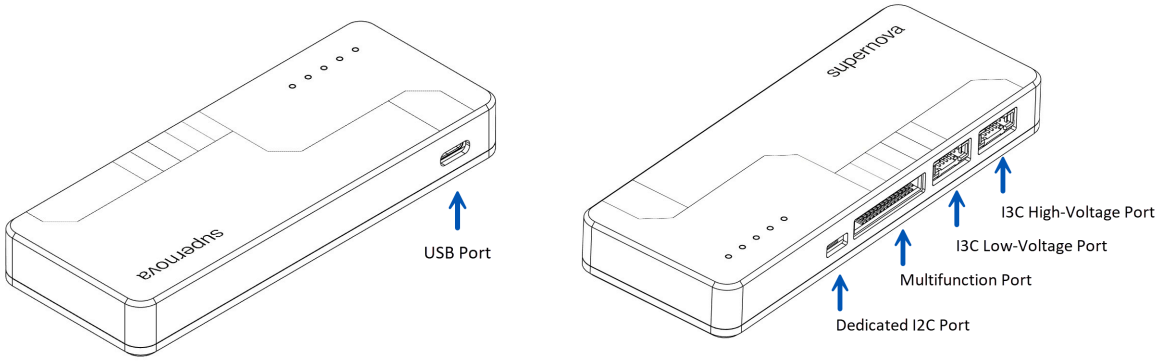
The Binho Supernova comes with everything you need to get up and running. The following items are included in the box.


**Supernova Product Box Contents**

- 1 x Binho Supernova USB Host Adapter
- 1 x I3C Port Kit:
  - 1 x I3C Harness terminated with 2.54mm female headers
  - 6 x 1-position centered male-to-male pin headers
  - 1 x I3C Port to Qwiic Adapter
- 1 x Dedicated I2C Port Kit:
  - 1 x 4 pin JST SH (Qwiic compatible) to 4 pin JST SH cable
  - 1 x 4 pin JST SH (Qwiic compatible) cable with male headers
  - 1 x 4 pin JST SH (Qwiic compatible) cable with female headers
- 1 x Multifunction Port Kit:
  - 1 x 30 conductor IDC ribbon cable
  - 1 x Ribbon cable to 2.54mm pitch header breakout board
- 1 x USB Kit:
  - 1 x USB Type C to Type A Cable
  - 1 x USB Type A to Type C Adapter
- 1 x Mounting Kit:
  - 2 x mounting screws
  - 2 x washers
- 1 x Custom Protective Zippered Carry Case

## 5.2 Ports

The Supernova has a total of five (5) ports, shown in the diagram below.




**Rear View** **Front View**

The rear of the Supernova features a singular port for connecting the device to the Host PC. The front of the Supernova features 4 ports which can be used to interface the host adapter with the DUT. The information in the following subsections provides specific information related to each port.

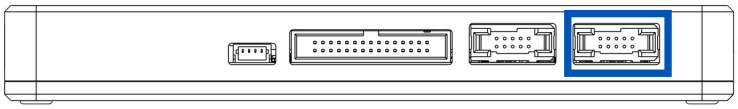
### 5.2.1 USB Port

This USB Type-C  port is used to connect Supernova to the host PC. This can be done with the provided USB Type-C to A cable or any other USB cable. A USB A to Type-C adapter is also included for the user's convenience. Note that The Binho Supernova is a USB 2.0 Full-Speed Device with a 12 Mbps link to the host PC. This connection also provides power to the device - no external power connection is needed.

More information about the USB link to the host PC facilitated over this port can be found in **Section 8.1**. Furthermore, the USB link is also used to update the Supernova device firmware. Details of the firmware update process can be found in **Section 8.2**.

### 5.2.2 I3C High-Voltage Port

This port facilitates communication on an I3C bus within the **I3C HV Power Domain**, which spans from 1.2V to 3.3V. This port uses a TigerEye connector from Semtech to encourage the usage of cable/harnessing solutions that are slightly better than standard flying lead probes. The pinout for this connector can be found in **Section 5.3.1**.

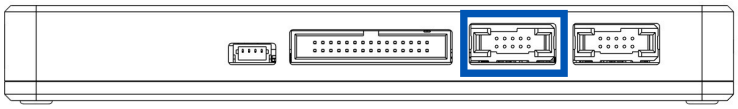


**Front View - I3C High-Voltage Port**

Note that when this port is in use, the I3C Low-Voltage Port is disabled. More information about the MIPI I3C Protocol features supported by Supernova can be found in **Section 7.1**. The wire harness, cables, and adapters that are part of the I3C Port Kit can be used interchangeably with the I3C High-Voltage and I3C Low-Voltage Ports.

### 5.2.3 I3C Low-Voltage Port

This port facilitates communication on an I3C bus within the **I3C LV Power Domain**, which spans from 0.8V to 1.2V. This port uses a TigerEye connector from Semtech to encourage the usage of cable/harnessing solutions that are slightly better than standard flying lead probes. The pinout for this connector can be found in **Section 5.3.1**.

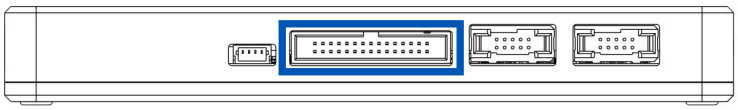


**Front View - I3C Low-Voltage Port**

Note that when this port is in use, the I3C High-Voltage Port is disabled. More information about the MIPI I3C Protocol features supported by Supernova can be found in **Section 7.1**. The wire harness, cables, and adapters that are part of the I3C Port Kit can be used interchangeably with the I3C High-Voltage and I3C Low-Voltage Ports.

### 5.2.4 Multifunction Port

The multifunction port includes I2C, SPI, UART, and GPIO signals on a 2 x 15 pin 1.27mm pitch connector. The Supernova comes with a 30 pin ribbon cable which can be used to interface this port directly with a DUT or with the included Breakout Board which can be used to access the signals with standard 2.54mm jumper wires. This port is part of the **Multifunction Power Domain**, ranging from 1.2V to 3.3V. The pinout for this connector can be found in **Section 5.3.2**.

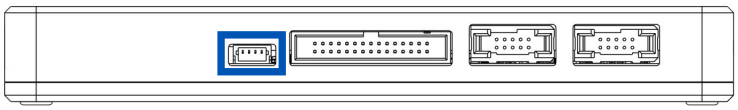


**Front View - Multifunction Port**

Note that the protocols and features available on this port can be used simultaneously with either of the I3C Ports. More information about the I2C, SPI, UART, and GPIO specific features can be found below in **Section 7**.

### 5.2.5 Dedicated I2C Port

The dedicated I2C port includes I2C functionality on a Qwiic-compatible 4-pin JST connector. More details about the Qwiic Ecosystem can be found in section **11.1 Qwiic Ecosystem Overview.** The Supernova comes with a collection of cables to make it fast and easy to interface with other I2C devices using this port. This port is part of the **Multifunction Power Domain**, which ranges from 1.2V to 3.3V. The pinout for this connector can be found in **Section 5.3.3**.



**Front View - Dedicated I2C Port**

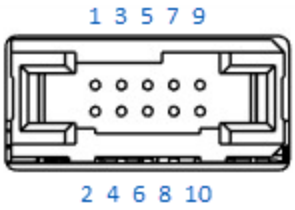
Note that the I2C bus exposed on this port is the same bus that is included in the Multifunction Port. It can be used in parallel with the other protocols of Supernova, including those exposed on the Multifunction port as well as with either of the I3C Ports. More information about the I2C Protocol features supported by Supernova can be found in **Section 7.2**.

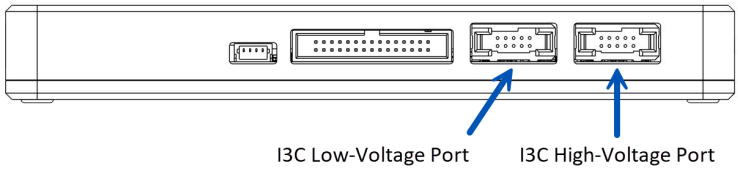
## 5.3 Pinouts

This section of the datasheet provides the pinout information for each of the DUT-facing connectors on the Binho Supernova. The cables and accessories included with the Supernova make it convenient and easy to break out and access the signals. Further information needed for integrating connectors and cabling specifically for Supernova within custom fixtures and test bench setups can be found later in this document in **Section 9.2**.

### 5.3.1 I3C Ports

The figure and accompanying table below show the pinout for the 2 x 5 pin connectors used for the I3C ports. Note that both the I3C High-Voltage Port and the I3C Low-Voltage Port have the same pin assignments.




| Pin Name | Pin Number | Pin Function(s) |
|---|---|---|
| **VTarget** | 1,3,5 | Target Voltage Reference [1] [2] |
| **DETECT** | 2 | Harness Detect Pin [3] |
| **SCL** | 7 | I3C Clock |
| **SDA** | 9 | I3C Data |
| **GND** | 4,6,8,10 | Ground |

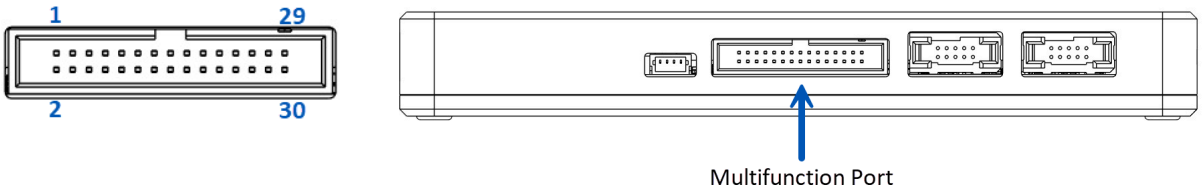
[1]: In the case of a self-powered DUT, the VTarget pin shall operate as an input for the voltage logic level reference for the I3C bus. The Supernova will adjust the voltage level to match the supplied voltage reference. In the case where the DUT is unpowered, the Supernova can operate the VTarget pin as an output and provide downstream power to the DUT. Details of the available power for downstream devices can be found in Section 6.

[2]: The VTarget pin on the I3C High-Voltage Port is connected to the **I3C HV Power Domain**. The VTarget pin on the I3C Low-Voltage Port is connected to the **I3C LV Power Domain**.

[3]: The DETECT pin is used by Supernova to determine (a) the presence of a cable harness plugged into the port and (b) the type of cable harness plugged into the port. This signal does not serve any other purpose and should not be connected to any circuitry on a DUT. The included I3C Coax harness and the Qwiic adapter board can be recognized using this mechanism.

### 5.3.2 Multifunction Port

The figure and accompanying table below show the pinout for the 2 x 15 pin connector of the Multifunction Port.




| Pin Name | Pin Number | Pin Function(s) |
|---|---|---|
| **SCL** | 1 | I2C Clock [1] |
| **SDA** | 3 | I2C Data [1] |
| **RX** | 5 | UART RX Data |
| **TX** | 7 | UART TX Data |
| **RTS** | 9 | UART Ready-To-Send (RTS) Signal for Hardware Flow Control |
| **CTS** | 11 | UART Clear-To-Send (CTS) Signal for Hardware Flow Control |
| **MOSI** | 13 | SPI MOSI |
| **MISO** | 15 | SPI MISO |
| **CLK** | 17 | SPI CLK |
| **CS0** | 19 | SPI Chip Select 0. Can also be used as a General Purpose Digital IO pin. |
| **CS1** | 20 | SPI Chip Select 1. Can also be used as a General Purpose Digital IO pin. |
| **CS2** | 21 | SPI Chip Select 2. Can also be used as a General Purpose Digital IO pin. |
| **CS3** | 22 | SPI Chip Select 3. Can also be used as a General Purpose Digital IO pin. |
| **GPIO1** | 23 | General Purpose Digital IO pin. |
| **GPIO2** | 24 | General Purpose Digital IO pin. |
| **GPIO3** | 25 | General Purpose Digital IO pin. |
| **GPIO4** | 26 | General Purpose Digital IO pin. |
| **GPIO5** | 27 | General Purpose Digital IO pin. |
| **GPIO6** | 28 | General Purpose Digital IO pin. |
| **VTarget** | 29 | Target Voltage Reference / Output [2] [3] |
| **NC** | 30 | Not Connected. Reserved for future usage. |
| **GND** | 2,4,6,8,10,12,14,16,18 | Ground |

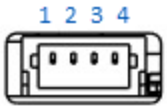
[1]: The SCL and SDA pins of the I2C bus included on the Multifunction Port are also shared with the SCL and SDA pins on the Dedicated I2C Port in the section below.

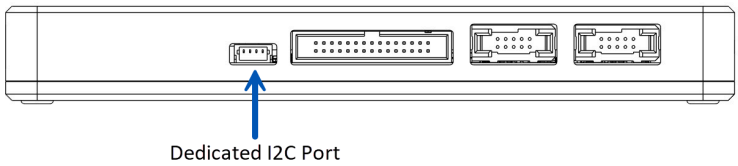
[2]: In the case of a self-powered DUT, the VTarget pin shall operate as an input for the voltage logic level reference for the buses and GPIO pins on the Multifunction Power Domain. The Supernova will adjust the voltage level to match the supplied voltage reference. In the case where the DUT is unpowered, the Supernova can operate the VTarget pin as an output and provide downstream power to the DUT. Details of the available power for downstream devices can be found in Section 6.

[3]: The VTarget pin on the Multifunction Port is connected to the **Multifunction Power Domain**. This is shared with the VTarget pin on the Dedicated I2C Port in the section below.

### 5.3.3 Dedicated I2C Port

The figure and accompanying table below show the pinout for the 4 pin connector used for the Dedicated I2C port.




| Pin Name | Pin Number | Pin Function(s) |
|---|---|---|
| **GND** | 1 | Ground |
| **VTarget** | 2 | Target Voltage Reference / Output [2] [3] |
| **SDA** | 3 | I2C Data [1] |
| **SCL** | 4 | I2C Clock [1] |

[1]: The SCL and SDA pins of the I2C bus included on the Multifunction Port are also shared with the SCL and SDA pins on the Dedicated I2C Port in the section below.

[2]: In the case of a self-powered DUT, the VTarget pin shall operate as an input for the voltage logic level reference for the buses and GPIO pins on the Multifunction Power Domain. The Supernova will adjust the voltage level to match the supplied voltage reference. In the case where the DUT is unpowered, the Supernova can operate the VTarget pin as an output and provide downstream power to the DUT. Details of the available power for downstream devices can be found in Section 6.

[3]: The VTarget pin on the Multifunction Port is connected to the **Multifunction Power Domain**. This is shared with the VTarget pin on the Multifunction Port in the section above.

## 5.4 Power Domains

The Binho Supernova's DUT-facing ports are operating on three separate power domains. While this adds a bit of complexity, it also gives Supernova incredible functionality and versatility to be used in multi-voltage domains that are becoming more and more common, especially for systems with I3C. The settings of each of these power domains are entirely independent of each other.

| | | |
|---|---|---|
| I3C HV Power Domain | → | I3C High-Voltage Port |
| I3C LV Power Domain | → | I3C Low-Voltage Port |
| Multifunction Power Domain | → | Dedicated I2C + Multifunction Port |

The key point to understand is that I3C features of Supernova operate entirely independent of the voltages used for the other protocols. As such, You can have a 1.2V I3C bus and a 1.8V SPI bus, and UART bus all operational at the same time with Supernova. The details of each power domain are further specified in the sections below.

Finally, please note that a common ground is shared between all three power domains. This same ground connection is also connected to the ground of the host PC over the USB cable.

### 5.4.1 I3C HV Power Domain

This power domain is the I3C High-Voltage Port. It supports 1.2 to 3.3V operation. The voltage is configurable programmatically. It can provide downstream power to the DUT, or it can disengage from providing power and instead use the VTarget pin as a voltage reference for the logic level of the bus.

Please note that when the I3C High-Voltage Port is being used, the I3C Low-Voltage Port is not available, meaning that there is no use case in which I3C HV and I3C LV Power Domains are operable at the same time.

### 5.4.2 I3C LV Power Domain

This power domain is the I3C Low-Voltage Port. It supports 0.8  to 1.2V operation. The voltage is configurable programmatically. It can provide downstream power to the DUT, or it can disengage from providing power and instead use the VTarget pin as a voltage reference for the logic level of the bus.

Please note that when the I3C Low-Voltage Port is being used, the I3C High-Voltage Port is not available, meaning that there is no use case in which I3C LV and I3C HV Power Domains are both operable at the same time.

### 5.4.3 Multifunction Power Domain

This is the power domain for the Dedicated I2C Port and Multifunction Port, which collectively cover I2C, SPI, UART, and GPIO functionalities. This domain supports 1.2V to 3.3V. The voltage is configurable programmatically. It can provide downstream power to the DUT, or it can disengage from providing power and instead use the VTarget pin as a voltage reference for the logic level of the bus.

# 6 Electrical Specifications

This section aims to characterize the electrical performance and parameters of the Supernova device.

## 6.1 Absolute Maximum Ratings

Stresses beyond those listed in the tables in this section may cause permanent damage to the device. These are stress ratings only which do not imply functional operation of the device at these conditions. Exposure to absolute-maximum-rated conditions for extended durations may impact device reliability.

| Parameter | Min | Max | Unit |
|---|---|---|---|
| USB Input Voltage | - | 5.5 | V |
| USB Input Current | - | 1000 | mA |
| Operating Temperature | 0 | 70 | ℃ |
| Electrostatic Discharge (ESD) Rating | - | ±4000 | V |

### 6.1.1 I3C High-Voltage Port

| Parameter | Min | Max | Unit |
|---|---|---|---|
| I3C HV Power Domain - Input Voltage | - | 5.5 | V |
| I3C HV Power Domain - Output Current | - | 250 | mA |
| Voltage on SCL, SDA | - | 3.6 | V |

### 6.1.2 I3C Low-Voltage Port

| Parameter | Min | Max | Unit |
|---|---|---|---|
| I3C LV Power Domain - Input Voltage | - | 2.5 | V |
| I3C LV Power Domain - Output Current | - | 400 | mA |
| Voltage on SCL, SDA | - | 2.5 | V |

### 6.1.3 Multifunction & Dedicated I2C Ports

| Parameter | Min | Max | Unit |
|---|---|---|---|
| Multifunction Power Domain - Input Voltage | - | 4.2 | V |
| Multifunction Power Domain - Output Current | - | 250 | mA |
| Voltage on any pin | - | 4.2 | V |

## 6.2 Recommended Operating Conditions

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| USB Input Voltage | 4.5 | 5.0 | 5.5 | V |
| USB Input Current | - | 500 | 1000 | mA |
| Operating Temperature | 0 | 25 | 70 | °C |

### 6.2.1 I3C High-Voltage Port

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| I3C HV Power Domain - Voltage (Input or Output) | 1.2 | 1.8 | 3.3 | V |
| I3C HV Power Domain - Output Current | - | 100 | 200 | mA |
| Voltage on SCL, SDA | 1.2 | 1.8 | 3.3 | V |

### 6.2.2 I3C Low-Voltage Port

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| I3C LV Power Domain - Voltage (Input or Output) | 0.8 | 1.0 | 1.2 | V |
| I3C LV Power Domain - Output Current | - | 100 | 350 | mA |
| Voltage on SCL, SDA | 0.8 | 1.0 | 1.2 | V |

### 6.2.3 Multifunction & Dedicated I2C Ports

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Multifunction Power Domain - Voltage (Input or Output) | 1.2 | 1.8 | 3.3 | V |
| Multifunction Power Domain - Output Current | - | 100 | 200 | mA |
| Voltage on any pin | 1.2 | 1.8 | 3.3 | V |

# 7 Supported Protocols

The Binho Supernova supports MIPI I3C, I2C, SPI, UART, and GPIO. This section provides the specifics of Supernova's capabilities for each of the supported protocols. Note that all the supported protocols have dedicated pins and can be operational at the same time as other protocols. Simultaneous protocol usage is supported and encouraged.

## 7.1 MIPI I3C

Undoubtedly the flagship feature of the Binho Supernova is its support for MIPI I3C protocol.

- v1.0, v1.1.1, and v1.2
- Controller or Target role
- SDR mode, HDR-DDR
- Supports IBI, Hot Join, and all relevant CCCs
- Voltage range from 0.8V to 3.3V

The Supernova is capable of acting as an I3C Controller or as an I3C Target, but only as one of these roles at any given time. It cannot operate in both roles at the same time.

Note that Binho is a MIPI Alliance Contributor Member and actively participates in the I3C Working Group to further develop, enhance, and promote the specification.

### 7.1.1 I3C Controller Mode

The Binho Supernova supports I3C Controller role up to 12.5MHz clock frequency in SDR mode. HDR-DDR mode is also supported. The I3C Controller functionality is available on both the I3C High Voltage Port and I3C Low Voltage Port. The I3C protocol is available for use along with all other supported protocols.

| | |
|---|---|
| Supported Voltage: | 1.2 to 3.3V – I3C High Voltage Port (**I3C HV Power Domain**)<br>0.8 to 1.2V – I3C Low Voltage Port (**I3C LV Power Domain**) |
| Supported Clock Rates: (Open-Drain) | 100kHz, 250kHz, 500kHz, 1.25MHz, 2.5MHz, 3.125MHz, and 4.17MHz |
| Supported Clock Rates: (Push-Pull) | 3.75MHz, 5MHz, 6.25MHz, 7.5MHz, 10MHz, 12.5MHz |
| Supported Protocol Features: | Hot Joins, In-Band Interrupts, Private Read/Write, Group Addressing |
| Max Transfer Length | 2048 Bytes |

I3C Controller support is available in Binho Mission Control Desktop GUI software as well as the Python SDK.

Python API Reference: I3C Controller API

### 7.1.2 I3C Target Mode

The Binho Supernova supports I3C Target role up to 12.5MHz clock frequency in SDR mode.HDR-DDR mode is also supported. The I3C Controller functionality is available on both the I3C High Voltage Port and I3C Low Voltage Port.

The table below shows the possible bus configurations that can be configured in I3C Target mode of operation.

| | |
|---|---|
| Supported Voltage: | 1.2 to 3.3V – I3C High Voltage Port (**I3C HV Power Domain**)<br>0.8 to 1.2V – I3C Low Voltage Port (**I3C LV Power Domain**) |
| I3C Mode: | SDR mode, HDR-DDR mode |
| Default BCR: | 0x00 (user configurable) |
| Default DCR: | 0xC6 (user configurable) |
| Default PID: | 05-47-03-04-75-FF (user configurable) |
| Supported Features: | Private Read/ Write, Hot-Join (coming soon), In-Band Interrupts (coming soon) |
| Memory Emulation Modes: | a) Contiguous 1024 Bytes Buffer with wrap-around<br>b) 512 x 16-bit registers with wrap-around<br>c) 256 x 32-bit registers with wrap-around |
| Max Transfer Length: | 2048 Bytes |

I3C Target support is not available in Binho Mission Control Desktop GUI software and must be configured by using the Python SDK.

Python API Reference: I3C Target API

Note that a common customer use-case for Supernova is to emulate the I3C Target behavior of customer's upcoming semiconductor devices while waiting for custom silicon to become available to the wider software/integration team. While the various emulated memory modes cover many typical use-cases, we are eager and willing to support any modifications or enhancements to our device firmware / APIs that may be needed to support different emulated behaviors. Please reach out to our technical support team with any questions regarding our I3C Target emulation capabilities.

### 7.1.3 I3C Common Command Codes (CCCs)

This section contains a concise list of the currently supported Broadcast and Direct CCC commands. Please reach out to us if there is a need to to support custom CCCs for a particular project or application.

#### 7.1.3.1 Broadcast Commands

Broadcast ENTAS0 (0x02)
Broadcast ENTAS1 (0x03)
Broadcast ENTAS2 (0x04)
Broadcast ENTAS3 (0x05)
Broadcast RSTDAA (0x06)
Broadcast ENTDAA (0x07)
Broadcast SETMWL (0x09)
Broadcast SETMRL (0x0A)
Broadcast SETBUSCON (0x0C)
Broadcast ENDXFER (0x12)
Broadcast ENTHDR0 (0x20)
Broadcast SETXTIME (0x28)
Broadcast SETAASA (0x29) *Note: Not supported by the I3C Target mode.*
Broadcast RSTACT (0x2A)
Broadcast RSTGRPA (0x2C)

#### 7.1.3.2 Direct Commands

Direct SETDASA (0x87)
Direct SETNEWDA (0x88)
Direct SETMWL (0x89)
Direct SETMRL (0x8A)
Direct GETMWL (0x8B)
Direct GETMRL (0x8C)
Direct GETPID (0x8D)
Direct GETBCR (0x8E)
Direct GETDCR (0x8F)
Direct GETSTATUS (0x90)
Direct ENDXFER (0x92)
Direct GETACCCR (0x91) *Note that Supernova as an I3C target, does not support the I3C Secondary Controller role yet.*
Direct GETMXDS (0x94)
Direct GETCAPS (0x95)
Direct SETXTIME (0x98)
Direct GETXTIME (0x99)
Direct RSTACT (0x9A) (write and read mode)
Direct SETGRPA (0x9B)
Direct RSTGRPA (0x9C)

#### 7.1.3.3 Unsupported Commands

Broadcast DEFTGTS (0x08) *This will be supported when supporting I3C Secondary Controller mode.*
Broadcast ENTTM (0x0B)
Broadcast SETAASA (0x29) *Not supported in I3C Target Mode.*
Broadcast DEFGRPA (0x2B *This will be supported when supporting I3C Secondary Controller mode.*
Direct ENTAS0 (0x82)
Direct ENTAS1 (0x83)
Direct ENTAS2 (0x84)
Direct ENTAS3 (0x85)
Direct SETBRGTGT (0x93)
Direct SETROUTE (0x96)
Broadcast ENTHDR1 *The Supernova does not support HDR - TSP mode*
Broadcast ENTHDR2 *The Supernova does not support HDR - TSL mode*
Broadcast ENTHDR3 *The Supernova does not support HDR - BT mode*
Broadcast and Direct MLANE (0x2D) *The Supernova does not support multi-lane*

### 7.1.4 I2C Backwards Compatibility on I3C buses

An increasingly common usage scenario is one with a mix of I3C + Legacy I2C devices on the same bus. Supernova supports this mixed bus use case and can operate in I2C mode on both I3C Ports. It's important to note that there are some backwards compatibility limitations with legacy I2C devices on an I3C bus, in particular that clock stretching is not supported.

### 7.1.5 Known Limitations

Throughout our participation in the MIPI I3C Plugfests and through ample engagement with various customers, we've identified and confirmed a few limitations with Supernova's I3C implementation. These limitations are born out of some ambiguities and differing interpretations of the I3C v1.0 specification which resulted in different vendors implementing V1.0 behaviors in differing ways, both of which can pass the I3C CTS yet result in incompatible behaviors in certain edge cases. Please reach out to our support team if you have any questions as to whether or not these limitations may be relevant to your planned usage.

#### 7.1.5.1 Fixed High-Keeper Logic & Pull-up Resistor Value

Supernova's I3C Controller implementation includes a built-in 1KOhm pull-up resistor that will be automatically engaged/disengaged when needed for Open-Drain mode operation. It is not possible to modify the behavior of the high-keeper logic nor modify the value of the integrated pull-up resistor..

#### 7.1.5.2 IBI Payload Max Bytes

An I3C Target cannot send more than 8 bytes of payload data during an IBI when Supernova is operating as the I3C Controller. Supernova's IBI payload data buffer is limited to a maximum of 8 bytes. In the case that more than 8 bytes are transmitted on an IBI, Supernova will continue to drive the SDA signal low, causing the I3C bus to be stuck.

#### 7.1.5.3 IBI Transfer Cannot Be Aborted

An I3C Target must end the IBI payload data with the nEOD/ T-bit low (zero) on the final byte when Supernova is operating as the I3C Controller. It's not possible to have Supernova's I3C Controller end the transfer after the number of bytes have been received. Combined with the limitation described above in 7.1.3.1, this means that even in the case of an IBI with 8 payload bytes, the I3C target must still end the transfer with the nEOD bit low (zero). Even though the IBI Payload buffer is full, Supernova still cannot terminate the IBI transfer. In the case that nEOD is high after the last payload byte of the IBI, Supernova will continue to drive the SDA signal low, causing the I3C bus to be stuck.

## 7.2 I2C

*Note: The usage of I2C Master/Slave terminology is considered obsolete. Master and Slave are now Controller and Target per the latest release of NXP's I2C Specification in UM10204.*

The Binho Supernova supports I2C protocol in several ways. The first method is for pure I2C bus operation, available on the Dedicated I2C Port and with the I2C bus connection on the Multifunction Port. Recall that these two Ports are wired together – they are the same bus. The second method is via the support for Legacy I2C devices on a mixed I3C/I2C bus. It is our strong suggestion to use the I2C port for all I2C operations unless you are specifically working on an I3C/I2C mixed bus as there are some limitations for I2C protocol features on the I3C mixed bus. These limitations are discussed in detail section **7.1.4 I2C Backwards Compatibility** in the appendix of this document.

The Binho Supernova supports I2C protocol up to 1MHz clock frequency, with 7-bit device addressing and clock stretching. Please note that 10-bit device address support is under development. The I2C protocol pins are exposed on both the Dedicated I2C Port as well as the Multifunction Port and are part of the **Multifunction Power Domain** (1.2V to 3.3V). The I2C protocol is available for use along with all other supported protocols.

### 7.2.1 I2C Controller Mode

The Binho Supernova supports I2C controller mode of operation with digitally-configurable Pull-Up Resistors. The table below shows the possible bus configurations that can be configured in I2C Controller mode of operation.

| | |
|---|---|
| Supported Voltage: | 1.2V to 3.3V – **Multifunction Power Domain** |
| Supported Clock Rates: | 100kHz to 1MHz in 10kHz steps |
| Supported Pull-Up R Values: | OFF, 150, 220, 330, 470, 680, 1K, 1.5K, 2.2K, 3.3K, 4.7K, 10K Ohms |
| Max Transfer Length | 2048 Bytes |

Note that the additional 6 x digital GPIO pins can be utilized for support signals such as RESET, INT, or other functions of connected I2C peripherals as needed.

I2C Controller support is available in Binho Mission Control Desktop GUI software as well as the Python SDK.

Python API Reference: I2C Controller API

### 7.2.2 I2C Target Mode

Support for I2C Target mode of operation is coming soon and will be made available to all existing devices via firmware update.

## 7.3 SPI

*Note: The usage of SPI Master/Slave terminology is considered obsolete. Master and Slave are now Controller and Peripheral. As such, the usage of MOSI/MISO/SS for pin and signal names has been replaced with SDI/SDO/CS.*

The Binho Supernova supports SPI protocol up to 37.5MHz clock frequency, for SPI Modes 0, 1, 2, and 3 (CPOL and CPHA configurations). There are 4 dedicated Chip Select signals to communicate with multiple SPI peripheral devices on the same bus. Data can be configured for MSB or LSB first bit ordering. The SPI protocol pins are exposed on the Multifunction Port and part of the **Multifunction Power Domain** (1.2V to 3.3V). The SPI protocol is available for use along with all other supported protocols.

### 7.3.1 SPI Controller Mode

The Binho Supernova supports SPI controller mode of operation with up to 4 SPI peripheral devices on the bus. The table below shows the possible bus configurations that can be configured in SPI Controller mode of operation.

| | |
|---|---|
| Supported Voltage: | 1.2V to 3.3V – **Multifunction Power Domain** |
| Supported Clock Rates: | 10kHz, 50kHz, 500kHz, 1MHz, 2MHz, 4MHz, 8MHz, 16MHz, 32MHz, 37.5MHz |
| Supported Modes: | 0, 1, 2, and 3 |
| Data Size: | 8 bits |
| Byte Order | MSB-first, LSB-first |
| Number of CS pins: | 4 |
| CS pin polarity: | Configurable Active HIGH, Active Low |
| Max Transfer Length | 1024 Bytes |

Note that the additional 6 x digital GPIO pins can be utilized for support signals such as RESET, INT, or other functions of connected SPI peripherals as needed.

SPI Controller support is available in Binho Mission Control Desktop GUI software as well as the Python SDK.

Python API Reference: SPI Controller API

### 7.3.2 SPI Peripheral Mode

Support for SPI Peripheral operation is coming soon and will be made available to all existing devices via firmware update.

## 7.4 UART

The Binho Supernova supports UART protocol with baud rates up to 115200 baud, with and without hardware flow control. The UART protocol pins are exposed on the Multifunction Port and part of the **Multifunction Power Domain** (1.2V to 3.3V). The UART protocol is available for use along with all other supported protocols. The table below shows the possible bus configurations that can be configured in UART mode of operation.

| | |
|---|---|
| Supported Voltage: | 1.2V to 3.3V – **Multifunction Power Domain** |
| Supported Baud Rates: | 600, 1200, 2400, 4800, 9600, 14400, 19200, 38400, 56000, 57600, and 115200 |
| Supported Parity: | None, Even, Odd |
| Data Size: | 7 bits, 8 bits |
| Hardware Flow Control: | No, Yes |
| Max Transfer Length: | 1024 Bytes |

UART protocol support is available in Binho Mission Control Desktop GUI software as well as the Python SDK.

Python API Reference: UART Protocol API

## 7.5 GPIO

Supernova features 6 dedicated digital GPIO pins which can be used as outputs, inputs, interrupt pins, or for PWM generation. All 6 GPIO pins are part of the **Multifunction Power Domain**. These pins are available for use along with all other supported protocols.

The GPIO features are available in Binho Mission Control Desktop GUI software as well as the Python SDK.

Python API Reference: GPIO API

### 7.5.1 Digital Output

All 6 of the dedicated GPIO pins can be configured to operate as a digital output signal. The logic low level will be 0V and the logic high level will be determined by the voltage configuration of the **Multifunction Power Domain**.

### 7.5.2 Digital Input

All 6 of the dedicated GPIO pins can be configured to operate as a digital input signal. Take care to ensure that the voltage of the input signal is within the suitable range for the configuration of the **Multifunction Power Domain**.

### 7.5.3 Interrupt

All 6 of the dedicated GPIO pins can be configured to raise an interrupt on Rising Edge, Falling Edge, or on both edges.

### 7.5.4 PWM Output

Support for PWM Output is coming soon and will be made available to all existing devices via firmware update. The frequency and duty cycle will be available for user configuration.

# 8 Application Information

***NOTICE***

The best source of the latest and most up-to-date information regarding the features of this product and the very specifics of how to operate the device can be found on our customer support portal. This support portal features a full set of comprehensive documentation and can be found at https://support.binho.io. More details on all of the items below can be found in the support portal.

## 8.1 USB Link to Host PC

The Supernova enumerates as a USB HID device, as such no special device driver needs to be installed. This ensures Supernova is compatible with any platform that has OS-level support for USB HID devices, which includes Windows, MacOS, and many distributions of Linux.

The USB connection with the host PC is a USB 2.0 Full-Speed 12Mbps link.

## 8.2 Device Firmware Update

The Binho Supernova USB Host Adapter features field-upgradeable firmware over USB. This allows for new features to be developed and released to all devices, such as enhancements and customizations, and even support for new protocols. When in device firmware update mode, Supernova will connect to the host PC as a USB Mass Storage Device, and the new firmware file can easily be downloaded by dragging and dropping the updated firmware file onto the drive. Please see the “Device Firmware Update” section of our user guide for more information.

## 8.3 Cross-Platform Support

The Binho Supernova works seamlessly on all modern PC operating systems, such as Windows, Mac OS, and Ubuntu (Linux). This is achieved by implementing the USB connection as a standard USB HID device, and as a mass-storage device while performing a firmware update. This means there is no need to install custom device drivers, allowing the device to be used on any operating system which provides a system driver for these device classes.

## 8.4 Point-and-Click GUI Software

Binho Mission Control, our point-and-click GUI software, available for Windows, MacOS, and Linux, provides an easy, no-code means to quickly get up and running with Supernova (as well as other Binho devices). Binho Mission Control supports performing transactions as an I3C Controller, I2C Controller, a SPI Controller, or on a UART bus. It also features support for GPIO operations. This software also provides the means to update the Supernova device firmware.Additionally, numerous examples and tools are provided as open-source python scripts which can be run on any platform.

## 8.5 Automation API / SDK

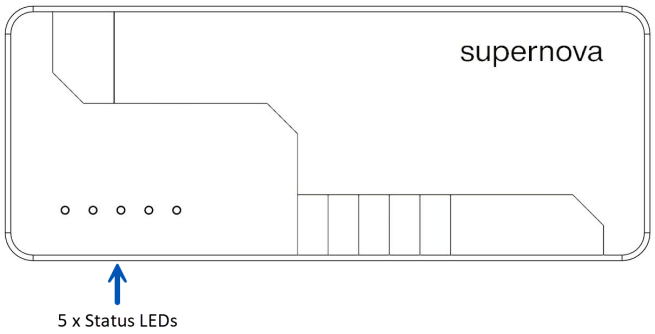
Binho provides cross-platform automation support by means of a fully-featured open-source python library (python 3.10 or later). A C/C#/C++ SDK is also available for Windows and MacOS – Linux support is coming soon..

## 8.6 Multi-Adapter/Gang-able Operation

Binho Supernova devices can be operated in gang-able fashion with many units connected to the same host PC. This allows for making complicated automated test fixtures or custom gang programming stations a breeze. Many examples exist demonstrating how easy it is to work with multiple devices.

## 8.7 RGB Status LEDs

The Binho Supernova features 5 x RGB status LEDs. These can be used to provide clarity to the mode of the device, state of operation, and protocol/bus traffic.

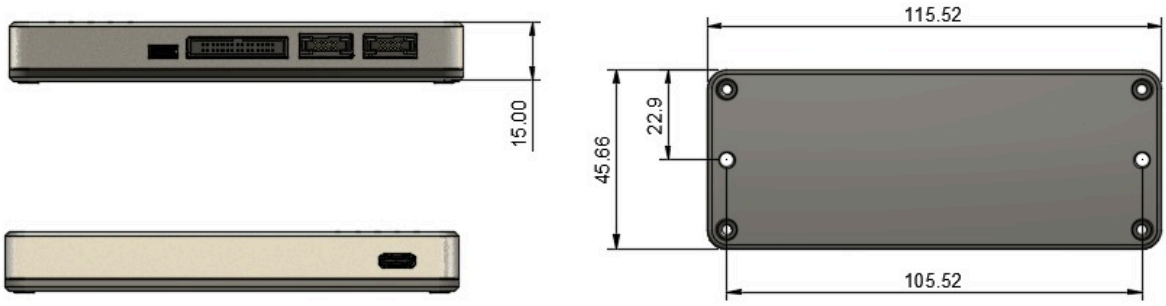


# 9 Integration Support

The Binho Supernova has been designed in a way which lends itself to robust and elegant integration directly into test fixtures and other custom equipment. The information in this section is meant to aid in both the mechanical and electrical integration of the Supernova into your own test stations. In case any additional information is needed for a particular integration, please reach out to techsupport@binho.io for additional assistance.

## 9.1 Mechanical Drawing

The machined aluminum enclosure for Binho Supernova features two integrated mounting holes on the back of the device to facilitate simple and robust installation into test fixtures or other environments. A set of fasteners are included with the product.




Fasteners for 2 x Mounting Holes:
Socket Head Screw M3 x 0.5mm Thread, 10mm Long
McMaster Part Number: 92290A115

All dimensions in mm.
Scale: 1:1
Tolerancing: ISO 286 Grade IT7

**Binho Supernova Mounting Geometry**

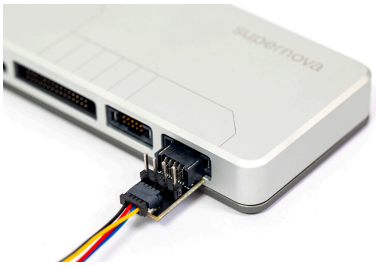
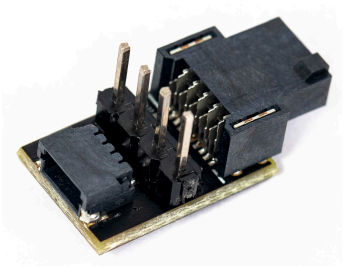
## 9.2 Connectors & Wiring

The Supernova comes with all cables and wire harnesses needed to interface it with the circuit under test. We highly recommend using the provided cables and adapters for interfacing Supernova with the circuitry even when installing it into your custom fixtures and test benches.

### 9.2.1 I3C Port

Given the sensitive nature of I3C, we strongly recommend using the provided cables for all integrations. The provided I3C coax harness balances signal integrity with length, however when possible to use shorter cables, it's possible and encouraged to use the included I3C Port to Qwiic adapter board to break out the I3C signals to standard 2.54mm pitch male headers or a Qwiic connector. In this situation, standard jumper cables can be used to make the connection (note that the length should be kept to a minimum in order to maintain signal integrity). Furthermore, using the Qwiic connector, and of options mentioned in **Section 9.2.3** are also applicable. The photos

on the following page demonstrate the utility of this means of connection to DUT as well as to other test equipment, such as a logic analyzer.


### 9.2.2 Multifunction Port

The Multifunction port is implemented with a generic 2 x 15 pin 1.27mm pitch IDC male header. The included ribbon cable can be used with any equivalent connector. Furthermore, it is simple to source or construct a compatible 30 pin ribbon cable of a custom length if needed.

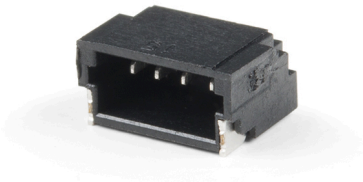
### 9.2.3 Dedicated I2C Port

As noted previously, the dedicated I2C port is implemented using a Qwiic-compatible 4-pin JST connector. More details about the Qwiic Ecosystem can be found in section **11.1 Qwiic Ecosystem Overview.** The connectors and cables shown below provide an excellent way to elegantly interface I2C (and I3C, using the provided adapter board) your custom circuitry directly to Supernova.

**Cables of Various Lengths**

Cable Kit:
Sparkfun / KIT-15081 [**Mouser**]

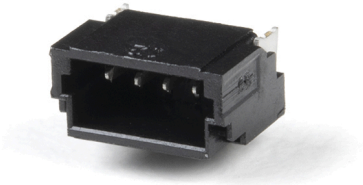
(also sold individually)



**SMT, Right-Angle**

Single connector:
Sparkfun / PRT-14417 [**Mouser**]

10-pack:
Adafruit / 4208 [**Mouser**]



**SMT, Vertical**

Single connector::
Sparkfun / PRT-16766 [**Mouser**]

10-pack:
Adafruit / 4328 [**Mouser**]

# 10 Available Accessories

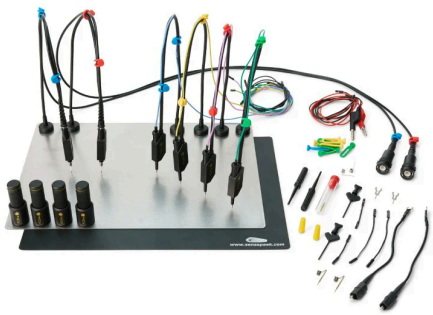
The Supernova comes with everything needed to get up and running, and in many cases, we find our customers are looking for example I3C Targets that they can interact with as they go through their own discovery and R&D phases with the new MIPI I3C Protocol. In an effort to further enhance the productivity of our customers, we offer a number of accessories to aid in the R&D process, which are briefly presented below for consideration. For additional details on these items, please visit our website to learn more.

## 10.1 Hands-Free Probe Kits

Binho has partnered with the experts at **Sensepeek**, makers of the popular PCBite line of hands-free probes in order to develop a custom low-capacitance bidirectional hands-free probe set that is ideally suited for probing an I3C bus. These probes were developed specifically for usage with the I3C Ports on Supernova, and come with a cable adapter to plug them directly into the ports on Supernova.

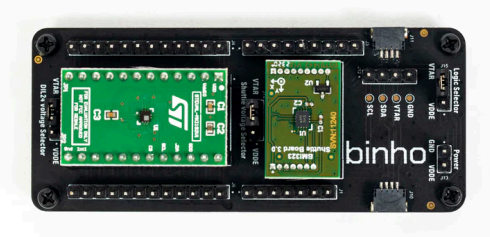

These probes are available either as a set of 2 x low-capacitance probes (for SCL and SDA) + 2 x SQ10 probes (for VTarget and Ground) for customers which already have a PCBKit with base plate and holders. A second kit is available which includes the 4 probes above along with the base plate and PCBite holders.

For usage with other digital protocols such as I2C, SPI, UART, etc,, a variety of general purpose hands-free probes are available for your consideration as well. Binho is an authorized distributor for the full lineup of Sensepeek products.



## 10.2 Demonstration Boards

The following demonstration boards have been developed by the engineering team at Binho and are used extensively in our own internal development and testing of our I3C tools. We have made them available publicly for our customers due to the strong demand for creating a quick-and-easy way to get up and running with I3C Targets devices currently on the market.




I3C Target Demo Board
Model: BIN103

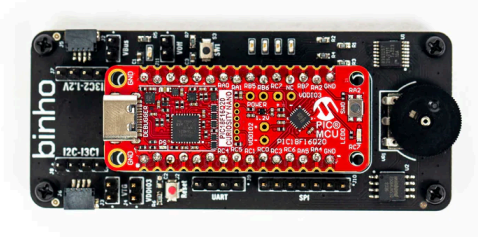
The I3C Target Board makes it quick and easy to get up and running with popular I3C Target devices from Bosch and STMicro. The I3C Target Board can be easily connected to Supernova and supports Bosch Shuttle 3.0 and STMicro's DIL24 form-factor eval boards.

Compatible Bosch I3C Targets available on Shuttle 3.0 eval boards:

- BMI323
- BMM350
- BMP581
- BMP585
- BMA530
- BMA580

Compatible STMicro I3C Targets on DIL24 eval boards:

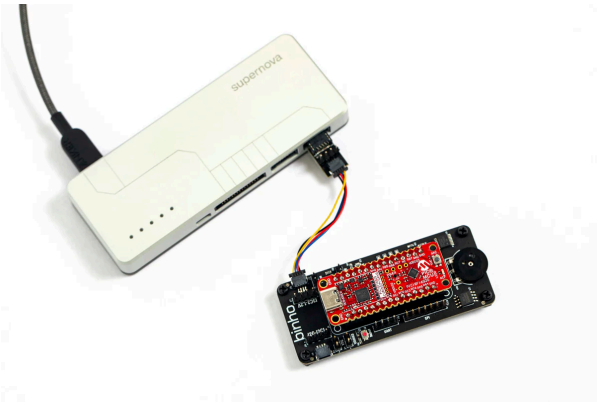
- LPS22HH
- LSM6DSV
- LSM6DSV16B
- LSM6DSV16BX
- LSM6DSV16X
- LSM6DSV32X
- LPS28DFW
- ILPS28QSW
- LIS2DUX12

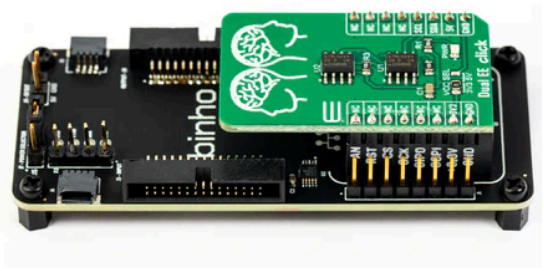



PIC18F16Q20 Curiosity Nano Demo Board
Model: BIN104

This accessory board was designed for use with Microchip's PIC18F16Q20 Curiosity Nano evaluation board (not included) and is perfectly designed to complement their I3C Multi-Protocol Translator example project [Github].

This application example demonstrates the implementation of an I3C Target in their 8 bit PIC microcontroller. As this MCU is an I3C Target-only implementation, the Supernova is a perfect companion for the I3C Controller.



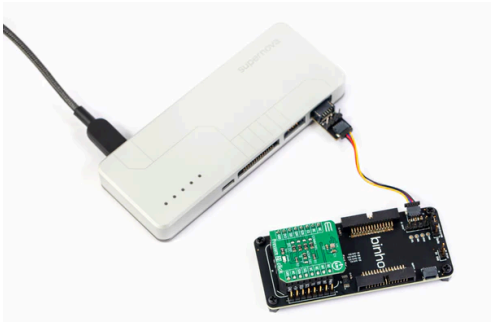


MikroBUS Adapter Board
Model: BIN106

The mikroBUS Adapter Board is a perfect complement to both Supernova and Pulsar host adapters, making it easy to interface with 1700+ Click boards™ from MikroE. Our mikroBUS Adapter Board design breaks out all 18 pins to headers and allows for devices to be communicated with over I3C, I2C, SPI, and UART. GPIO pins are also available as needed.

The I2C/I3C bus is available on QWIIC-compatible connectors. I2C, SPI, UART, and GPIO signals are made available via the 2x15 IDC connector. Pulsar & Supernova host adapters include the ribbon cable needed to make this connection. Each mikroBUS adapter board also comes with an additional 20mm long ribbon cable and qwiic-to-qwiic cable to facilitate daisy-chaining up to 4 boards at a time.

Using multiple SPI devices at the same time is achievable by adjusting the DIP switch to correctly assign the desired INT and CS pins for each SPI Target device.



Compatible boards featuring I3C devices include:

- Bosch Sensortec BMI323: 6DOF IMU 20 Click
- Bosch Sensortec BMP581: Pressure 21 Click
- Bosch Sensortec BMP585: Barometer 13 Click
- TDK ICM-42688PO: 6DOF IMU 14 Click
- TDK ICM-42670-P: 6DOF IMU 22 Click
- ST Microelectronics TSC1641: Current 12 Click
- ST Microelectronics LPS27HHW: Pressure 15 Click
- Bosch Sensortec BMA580: Accel 31 Click
- TDK ICM-42605: 6DOF IMU 18 Click
- ST Microelectronics LPS28DFW: Barometer 10 Click
- ST Microelectronics LSM6DSV16X: Smart DOF 2 Click
- ST Microelectronics LIS2DUX12: Accel&Qvar Click
- ST Microelectronics ST1VAFE6AX: 6DOF IMU 25 Click
- ST Microelectronics ILPS28QSW: PRESS Click
- MEMSIC MMC5633NJL: Compass 7 Click

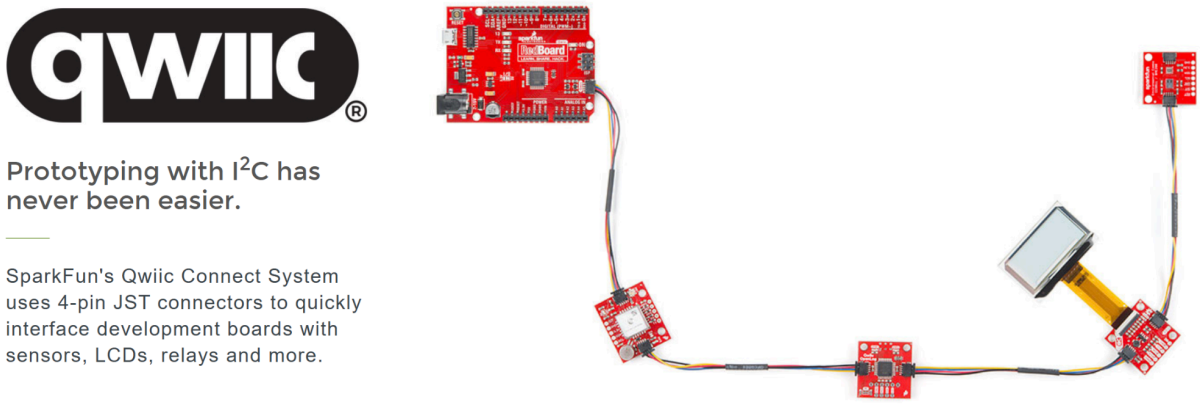
The full set of I3C-capable click boards can be found on MikroE's website here.

# 11 Appendices

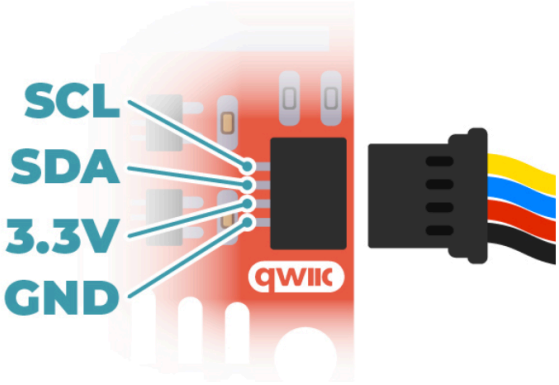
The content in the following section is meant to provide helpful contextual information and additional resources applicable to users of Supernova.

## 11.1 Qwiic Ecosystem Overview

The dedicated I2C port on the Supernova features a **Qwiic** compatible connector. This provides for a convenient means to interface with many evaluation boards and dev kits using this standard. Originally developed by Sparkfun, the Qwiic interface has been widely adopted by many others in the industry. In short, provides a standard pinout for a 4-pin JST connector and common color code for off-the-shelf wire harnesses.




The pinout for this connector can be seen in the graphic below:

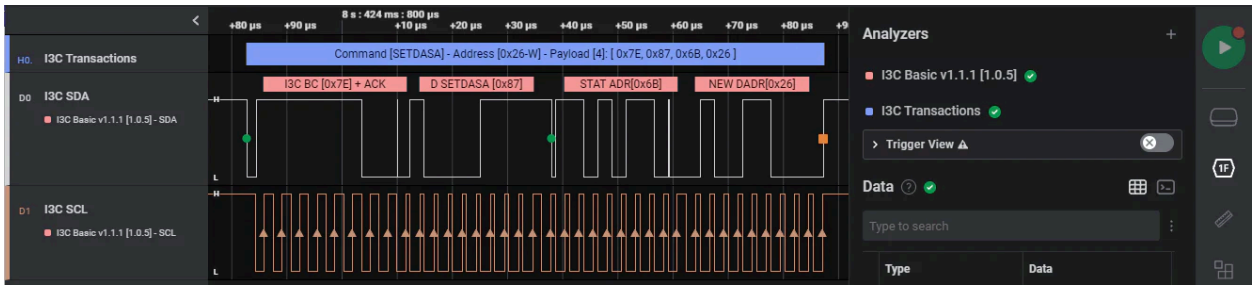



**Sparkfun Electronics**, **Adafruit Industries**, and several others provide a large selection of breakout boards and cables for the Qwiic ecosystem that are also conveniently available for purchase from DigiKey and Mouser.

Note that there's also a convenient adapter accessory included with Supernova that makes it possible to use the Qwiic cables / interconnect system on the I3C ports. While the performance of the qwiic-cables will not match the signal integrity of our I3C Coax Cable Harness, the shorter lengths of the Qwiic cables make up for it.

## 11.2 Saleae Logic I3C Protocol Analyzer Plugin

Many customers are interested in observing the I3C waveform in order to analyze the data being exchanged on the bus. Supernova is a host adapter and does not have the support to act as a protocol analyzer, however Binho has implemented an **I3C Protocol Analyzer Plugin** for the popular and very user friendly software Saleae Logic.




We worked closely with the team at Saleae to develop a premium analyzer for the I3C protocol that comes with full specialized technical support from our team of I3C experts. Our analyzer has been publicly available since June 2022, exercised heavily at the past four MIPI I3C Interop Workshops, and is in daily use by several hundred engineers across the industry's leading tech companies -- we're quite confident that it's one of the most mature I3C test tools available on the market today.

More information can be found in the **analyzer datasheet** and **Getting Started Guide** at these links.
I wanted to point this out as being very helpful: the analyzer supports Saleae HLA's to decode protocols on top of I3C -- inside the analyzer plugin file package, you'll find our 'i3c-transactions-hla' which implements decoding of higher-level protocols on top of I3C, such JESD300-5 SPD and NVMe-MI (MCTP over I3C), and Debug for I3C as well. It's distributed as a python file which also serves as a perfect reference for how to go about implementing the decoding of any proprietary protocol on top of I3C simply by modifying the file. Another powerful feature of our solution is the support for Saleae's Automation API for automating I3C testing.

Several different licensing options are available, enabling us to support the needs of customers large and small. Our most popular solution for large technology and semiconductor companies is our Flex/On-Demand license. Our Flex/On-Demand license can be used from any host PC and with any Saleae Logic device. As such, a single license seat can typically support a team of 2-3 engineers working hands-on with I3C circuits. Our perpetual licenses do not have any additional costs or maintenance fees associated with them, and all updates and enhancements will be made available at no additional costs. We release new features every ~8-12 weeks based on customer requests. Time-based subscriptions and node-locked licenses are also available.

## 12 Revision Log

| Rev | Description of Changes | Date |
|---|---|---|
| 1.0 | Initial Draft | 3/2/24 |
| 1.1 | Significant updates for latest features and capabilities:<br>– Enhanced overall document formatting and organization<br>– Added relevant figures and diagrams<br>– Updated the Electrical Specification Section<br>– Updated the Supported Protocols Section<br>– Updated The Application Information Section<br>– Added Integration Support Section<br>– Added Available Accessories Section<br>– Added Appendices Section | 8/24/24 |
| 1.2 | Cleanup and clarifications:<br>– Clarified Power Domain naming and formatting<br>– Corrected Typos and improved formatting | 9/24/24 |
| 1.3 | Fixed connector pinout details<br>– Signals on the Dedicated I2C were listed in reverse order | 9/30/24 |
| 1.4 | Updated office address<br>Added MikroBUS Adapter Board to section 10 | 2/24/25 |
| 1.5 | Updated I3C support to include latest features:<br>- 2048 Byte transfers<br>- HDR-DDR mode transfers, support for Direct and Broadcast ENTHDR0 CCC<br>- I3C v1.2 support<br>Updated I2C Support:<br>- 2048 Byte transfers<br>Updated list of mikroBUS click boards with I3C support | 8/1/25 |