Overview

The USBHub2x4 is a 4-port software-programmable USB 2.0 (480Mbps) hub that is designed for demanding industrial environments where advanced control and monitoring of USB ports is required. This is very useful in testing or development environments where standard "always-on" behavior of a consumer-grade USB hub is not desirable.

Software control of the USBHub2x4 is established and maintained over the selected one of the two available host-facing ports.

The USBHub2x4 can be used to enable/disable individual USB ports, measure current or voltage on downstream USB ports, set programmable current limits, set USB charging protocol behavior and otherwise automate USB port behaviors in development and testing.

Typical applications include:

- USB device manufacturing
- USB device validation and development
- Functional testing
- Camera control
- Battery charging
- USB device resets
- USB monitoring
- Sequential firmware load/updates

Features

- Individually enable/disable any of 4 downstream ports
- Data and power lines can be separately enabled for each downstream port
- Measure voltage and current on each downstream port
- Set programmable current limits for each downstream port (500mA to 2.5A)
- Automatic or programmed selection for either of 2 host port connections
- All ports support USB link speeds up to 480Mb/s
- Selectively enable USB charging mode behaviors: SDP (Standard Downstream Port) or CDP (Charging Downstream Port) modes[1]
- Deliver up to 2.5A per port (in CDP mode)
- Set enumeration delay for discovery of attached downstream devices
- Boost USB upstream and downstream data signal levels
- DIN-rail mountable
- Certified to withstand +/- 30kV ESD strikes (IEC6100-4-2 level 4)

Description

The USBHub2x4 gives engineers advanced flexibility and configurability over USB ports in testing and development applications.

Each downstream USB channel implements separately and independently switched data lines and 2500mA current-limited power lines. USB power and data can be independently disconnected for advanced USB testing applications. Pin interfaces are protected against reverse polarity and over-voltage, and connections are designed to operate from 0°C to 50°C ambient with no external cooling or fans.

Each USBHub2x4 is uniquely addressable and controllable from a host PC via the selected USB host input. Acroname's BrainStem™ link is then established over the USB input and allows a connection to the on-board controller in the USBHub2x4. USBHub2x4 can be controlled via a host running BrainStem APIs or alternately, it can operate independently by running locally embedded, user-defined programs based on Acroname's BrainStem Reflex language.

[1] See http://www.usb.org/developers/docs/devclass_docs/ under the category Battery Charging for full details.

Absolute Maximum Ratings[2]

Stresses beyond those listed under ABSOLUTE MAXIMUM RATINGS can cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under RECOMMENDED OPERATING CONDITIONS is not implied. Exposure to absolute-maximum rated conditions for extended periods affects device reliability and may permanently damage the device.

Parameter	Minimum	Maximum	Units
Input Voltage, V_{supply}	6.0	26.0	V
V_{supply} current	0.0	14.0	A
Input Power		85	W
V_{bus} Ouput Power		50	W
Voltage on V_{bus} inputs	0.0	24.0	V
Voltage on V_{bus} outputs	0.0	6.0	V
Voltage on any USB D+/D- inputs and outputs	-0.3	5.3	V
Altitude	-	2000	M
Overvoltage	-	Overvoltage Category II	-

Table 1: Absolute Maximum Ratings

Handling Ratings

Parameter	Conditions/Notes	Minimum	Typical	Maximum	Units
Ambient Operating Temperature, T_A	Non-Condensing	0.0	25.0	50.0	°C
Relative Humidity Range	Non-Condensing	5	-	95	%RH
Storage Temperature, T_{STG}		-10.0	-	85.0	°C
Electrostatic Discharge, V_{ESD}	Exceeds IEC 61000-4-2, level 4, air and contact discharge	0.0	-	±30	kV

Table 2: Handling Ratings

Recommended Operating Ratings

Specifications are valid at 25°C unless otherwise noted. Intended for indoor use only.

Parameter	Conditions/Notes	Minimum	Typical	Maximum	Unit
Input Voltage, V_{supply}		9.0	12	24.0	V
Input Current, I_{supply}		0.15	-	11.0	A
Voltage on V_{bus} inputs and outputs		4.5	5.0	5.5	V
Relative Humidity Range	Non-Condensing	5	-	95	%RH

Table 3: Recommended Operating Ratings

[2] If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Block Diagram

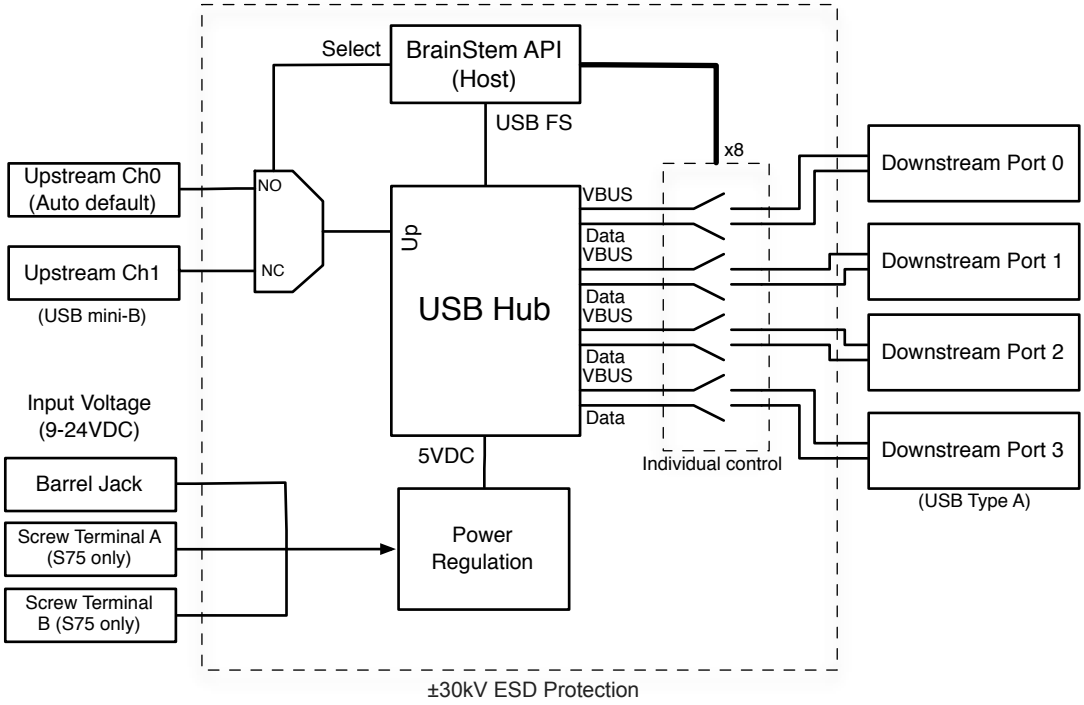


Figure 1: USBHub2x4 Block Diagram

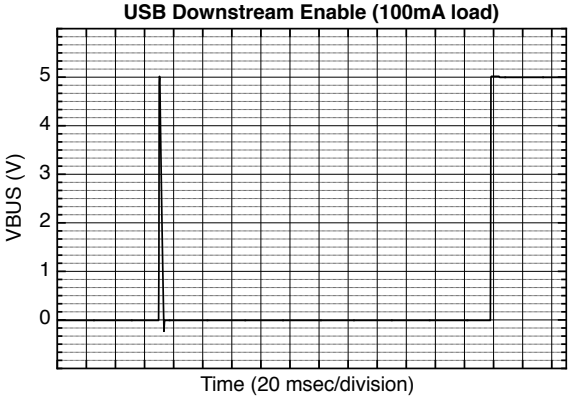
Typical Performance Characteristics

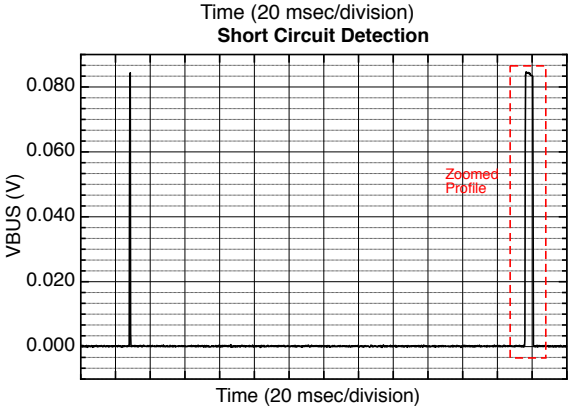
Specifications are valid at 25°C unless otherwise noted. Indoor application use only. Sample rates are typically limited by the USB throughput of the host operating system except where bulk capture is supported.

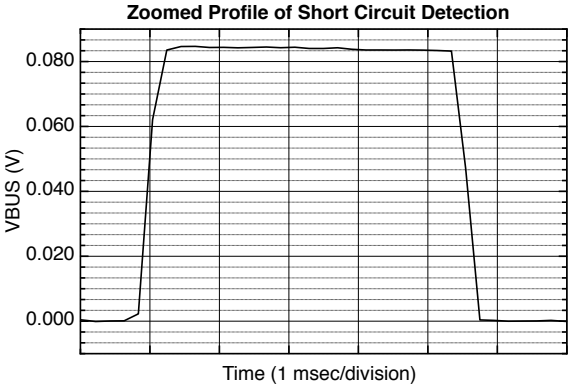
Parameter	Conditions/Notes	Minimum	Typical	Maximum	Unit
USB Downstream (V_{bus})		4.5	5.0	5.5	V
USB Downstream Current	I_{LIM}=2.5A	0.0	-	2.5	A
System Efficiency	@12.0V input, nominal 6.5A load[3]	84	-	86	%
Current Measurement Range		6.4	-	2500	mA
Current Measurement Resolution		-	9.76	-	mA
Current Measurement Accuracy	I_{LIM} not exceeded		±2		%
V_{bus} Voltage Measurement		0.0	-	5.5	V
V_{bus} Voltage Resolution		-	1.2	-	mV
V_{bus} Output Rise Time	I_{LIM} = 1.0A	-	-	1.0	ms
V_{supply} Measurement Resolution		-	8	-	mV
Selectable Current Limits I_{LIM}	I_{LIM} = 500mA I_{LIM} = 900mA I_{LIM} = 1000mA I_{LIM} = 1200mA I_{LIM} = 1500mA I_{LIM} = 1800mA I_{LIM} = 2000mA I_{LIM} = 2500mA	- - - - - - - -	480 850 950 1130 1400 1720 1910 2370	500 900 1000 1200 1500 1800 2000 2500	mA
Short Circuit Response Time	Time from detection of short to current limit applied.	-	-	1.5	µs
Short Circuit Detection Time	Time from detection of short to port power switch disconnect.	-	-	6.0	ms
USB Downstream V_{bus} Current Supply (SDP mode)	USB 2.0 data lines disabled or no USB host present	-	-	100	mA
USB Downstream V_{bus} Current Supply (SDP mode)	USB 2.0 data lines enabled and USB host must be present	-	-	500	mA
USB Downstream V_{bus} Current Supply (DCP mode)	USB 2.0 data lines must be enabled	-	-	1500	mA
USB Downstream V_{bus} Current Supply (CDP mode)	USB 2.0 data lines enabled and USB host must be present	-	-	2500	mA

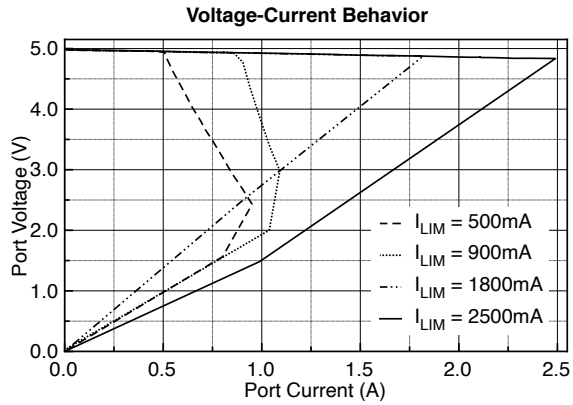
Table 4: Electrical Characteristics

[3] 6.5A selected as representative load based on 4 USB downstream devices running in CDP mode consuming approximately 1.5A each.









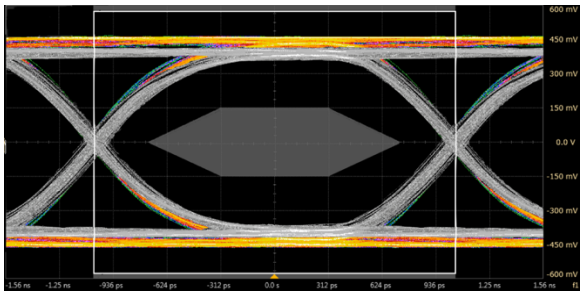


Figure 2: Upstream USB Eye diagram through USB Mini-B to host with 0.3m cable. Boost 0% in greyscale; Boost 12% in color.

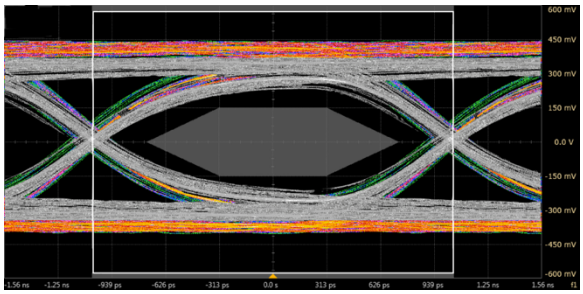


Figure 3: Upstream USB eye diagram USB Mini-B to host with 3.2m cable. Boost 0% in greyscale; Boost 12% in color.

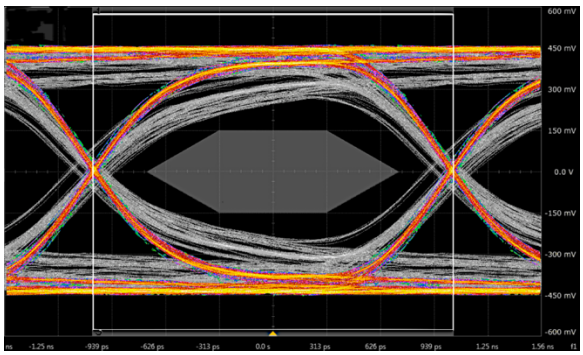


Figure 4: Downstream USB eye diagram USB A to device. 3.2m cable in greyscale; 0.3m cable in color.

Module Hardware and Software Default Values

The USBHub2x4 leverages a hardware-specific subset of BrainStem Entity implementations. The `aUSBHub2x4.h` C++ header file includes macro definitions for many parameters specific to the USBHub2x4. Table 5: USBHub2x4 Hardware and Software Default Values provides an overview of these values.

Parameter	Index	Macro Name or Implemented Options	Notes
Module Definitions:			
Module Base Address	6	`aUSBHUB2X4_MODULE_ADDRESS`	
Router Base Address	6		
Entity Class Definitions:			
`timer` Entity Quantity	8	`aUSBHUB2X4_NUM_TIMERS`	
`usb` Entity Quantity	1	`aUSBHUB2X4_NUM_USB`	
`store` Entity Quantity	2	`aUSBHUB2X4_NUM_STORES`	
`system` Entity Quantity	1		
`app` Entity Quantity	4	`aUSBHUB2X4_NUM_APPS`	
`pointer` Entity Quantity	4	`aUSBHUB2X4_NUM_POINTERS`	

Table 5: USBHub2x4 Hardware and Software Default Values[4]

[4] Refer to `aUSBHub2x4.h` within the BrainStem Development Kit download for actual file.

Device Drivers

USBHub2x4 leverages operating system user space interfaces that do not require custom drivers for operation on modern operating systems.

Some older operating systems may require the installation of a BrainStem USB driver to enable software control. Installation details on installing USB drivers can be found within the BrainStem Development Kit under the "drivers" folder. For example, Windows 7 the supplied INF to communicate with BrainStem USB devices.

Capabilities and Interfaces

The USBHub2x4 is built on Acroname's BrainStem system, which provides simple high level APIs, a real-time embedded runtime engine and modular expandability. Functionality details unique to the USBHub2x4 are described in the following sections. A complete list of available API functionality specific to USBHub2x4 is listed in Table 10. All shortened code snippets are loosely based on the C++ method calls and meant to be Psuedocode like – Python and Reflex are virtually the same. Please consult the online BrainStem Reference for implementation details[5].

LED Indicators

Built into the board are a number of LED indicators to assist in system troubleshooting using the USBHub2x4.

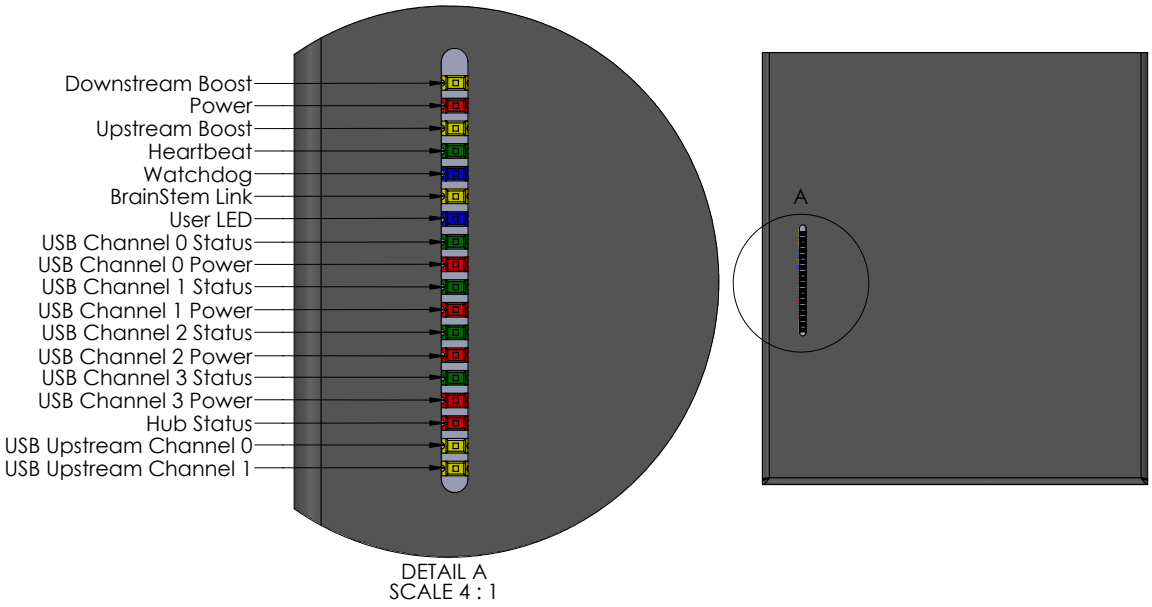


Figure 5: USBHub2x4 LED Indicators

[5] See BrainStem software API reference at https://acroname.com/reference/ for further details about all BrainStem API methods and information.

The BrainStem Link LED will illuminate when the BrainStem USB interface is created on a host computer.

The Heartbeat indicator informs the user when communication is occurring with the BrainStem module, including a periodic heartbeat signal and response. Additional details on Heartbeats can be found in the BrainStem Terminology section of the Reference Manual.

The Logic Power indicator shows that a 3.3V voltage regulation system is up and running properly.

The User LED is a software controllable indicator accessed via the System BrainStem Entity. Detailed information can be found in the System Entity section of the reference manual.

Each downstream USB connection has LED indicators for status and power. The red LED labeled USB Channel X Power indicates an error on USB power (V_{bus}) such as overcurrent. This LED will automatically turn-off approximately 5 seconds after the error condition occurs. Additionally, a green LED, labeled USB Channel X Status, indicates whether the downstream device has enumerated on the host computer.

The Hub Status indicator illuminates when the USB hub communicates with a host computer.

Using Multiple Hosts with USBHub2x4

The two upstream-facing host ports can be connected to two different host computers. Due to limitations of USB specification and architecture, only one host computer can access downstream USB ports at any time. Through the BrainStem APIs, the upstream port used can be specifically selected, or the system can automatically select the upstream port.

The BrainStem controller connection is available only through the actively selected host port. Because of this, it is important to keep in mind that when a host upstream connection is changed, the software connection to the BrainStem module should follow the upstream connection appropriately.

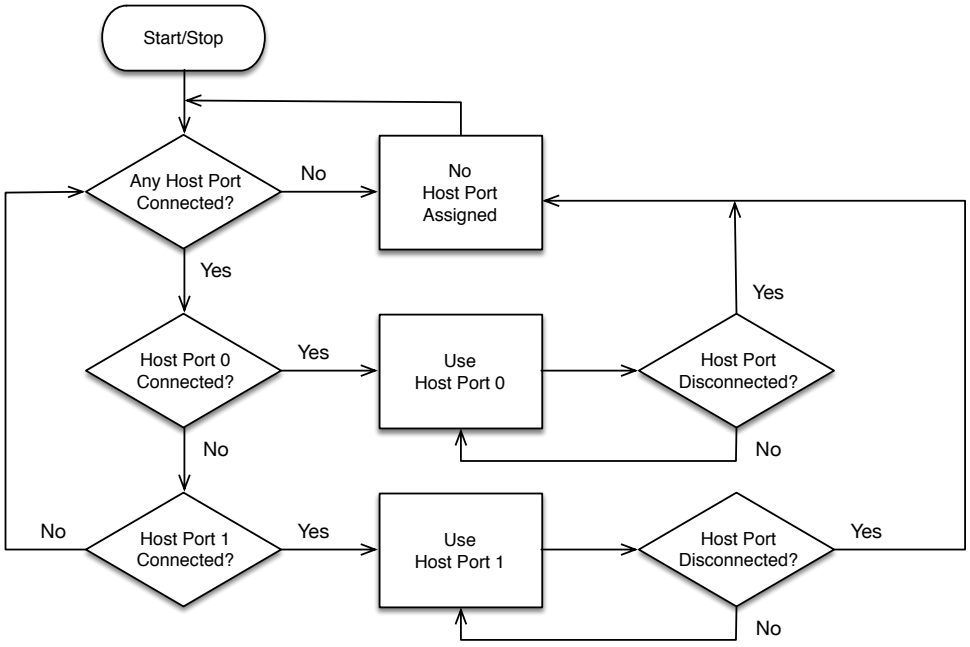


Figure 6: Determining connection used for BrainStem communications

Mechanical

Dimensions are shown in inches [mm]. 3D CAD models are available through the USBHub2x4 product page's Downloads section

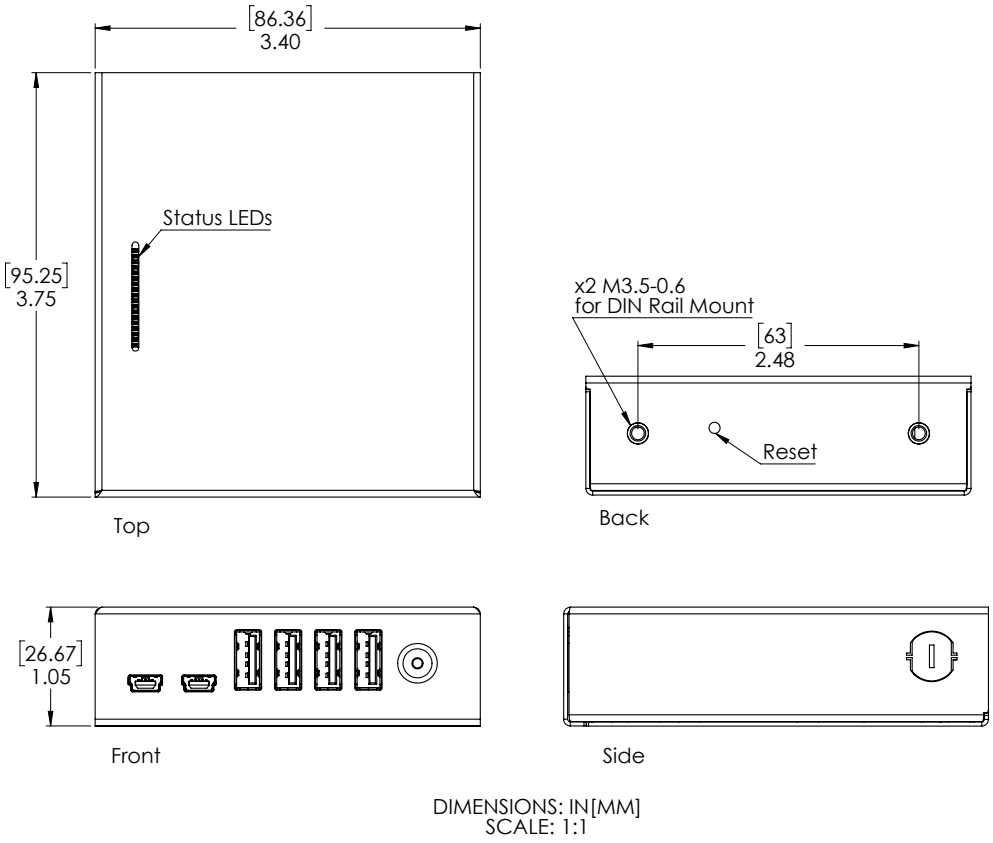


Figure 7: USBHub2x4 Mechanical

Housing Markings

Symbol	Description
	*DC barrel connector polarity marking*
	*DC line voltage*

Table 6: Case Symbol Markings

Input Power Connections

The USBHub2x4 can be powered through the DC barrel-jack on the front of the unit.

Certifications and specifications are only valid with the Acroname provided power supply. Other power supplies can result in unspecified behaviors. Contact Acroname support for guidance on alternative power supplies. Replacement power supplies and AC mains cords are available from Acroname. Acroname recommends against replacing detachable AC Mains supply cord provided with the inadequately rated cords. Replacement power supplies are available Acroname part number: R469-PS-3 (https://acroname.com/store/r469-acdc-ps-3).

The DC barrel-jack is a standard 5.5mm outside diameter, 2.5mm inside diameter, 9.5mm mating length connector. Many manufacturers make compatible mating plug connectors; one example is the DC barrel plug from CUI: part number PP3-002B (https://www.cui.com/product/resource/pp3-002b.pdf).

DIN Rail Mounting

DIN rail mounting provisions have been designed into the USBHub2x4 case. Holes for a DIN rail clip/adapter are provided to allow mounting of the USBHub2x4 to standard DIN rails. Mounting clip hardware is available separately in a kit from Acroname: part number C31-DINM-1. The diagrams below illustrate USBHub2x4 mounted in two orientations:

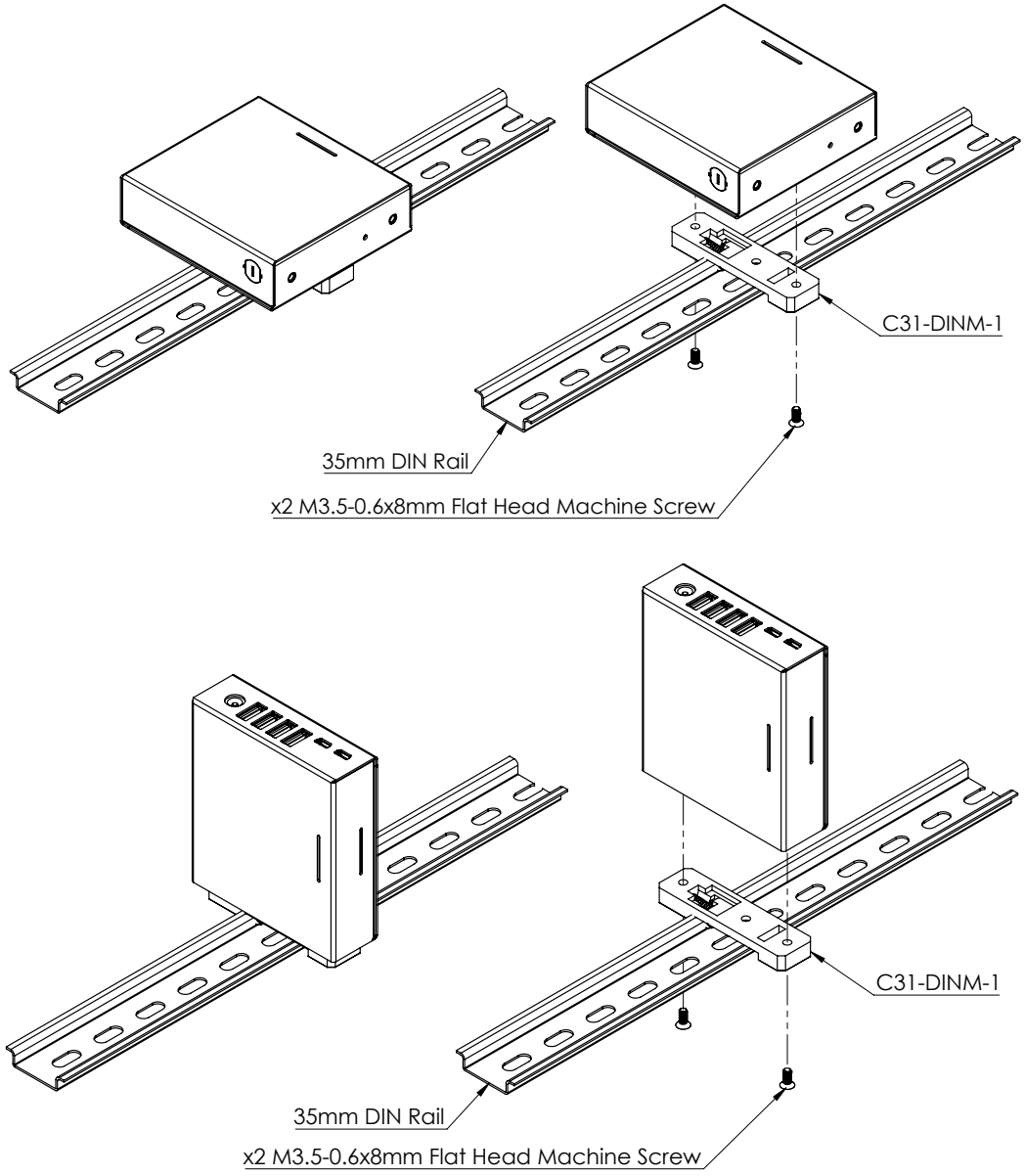


Figure 8: USBHub2x4 DIN Rail Mount

FCC Compliance Statement

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

```
This device complies with part 15 of
FCC Rules.  Operation is subject to the
following two conditions; (1) This
device may not cause harmful
interference, and (2) this device must
accept any interference received,
including interference that may cause
undesired operation.
```

Compliance Information

Acroname

S77-USBHUB-2X4
Programmable Industrial USB 3.0 Hub (8 Ports)

Input: 6-26 V⎓ 85W
Output: 5V⎓ 2.5A

Country of Origin: United States of America

NOM NYCE

Product Support

Questions about the product operation or specifications are welcome through Acroname's contact portals. Software downloads, reference API and application examples are available online at:

https://acroname.com/support

Direct communication and additional technical support are available at:

https://acroname.com/contact-us

2741 Mapleton Avenue

Boulder, CO, USA 80304-3837

720-564-0373 (phone)

Document Revision History

All major documentation changes will be marked with a dated revision code

Revision	Date	Engineer	Description
1.0	April 2015	MJK	Initial Revision
1.1	September 2015	JTD	Reformatted. Added Entity Section Specifics, DIN rail mounting
1.2	November 2015	JTD	Updated DIN rail mounting
1.3	December 2015	JTD	Updated ESD rating
1.4	January 2016	JLG	Typographical and formatting fixes
1.6	February 2016	JLG	Update part number for DIN rail mount; FCC Compliance; add block diagram
1.7	February 2016	JLG	Update Electrical Characteristics table
1.8	March 2016	JTD	Updated CAD to v2
1.9	September 2016	JTD	Updated formatting
1.10	October 2016	LCD	Updated Overview, Features, Description sections
1.11	March 2017	JTD	Updated DIN mount screw spec
1.12	April 2018	RMN	Swapped hubState for portState
1.13	November 2018	LCD	Updated for BrainStem API changes
1.14	July 2020	ACRO	Formatting update
1.15	Jan 2021	JLG	Add V-I behavior plot, clarify current-limit behavior, correct getPortState bitfield
1.16	February 2021	MJK	Contact information for technical support.
1.17	August 2021	MJK	Added case symbol markings, information on AC power cords and replacement options, updated absolute specifications.
1.18	August 2021	MJK	Added footnote under absolute maximum ratings.
1.19	January 2022	TDH	Fix incomplete sentence explaining VBUS toggle during data toggle.
1.20	January 2022	TDH	Removed section for getDownstreamDataSpeed
1.21	February 2022	RMN	Update SDP/CDP/DCP information
1.22	April 2022	FEC	Included NOM label
1.23	August 2022	CJD	Removed API Entities
1.24	February 2023	MJK	Image consistency with other documentation