Overview

The USBExt3c is a two-port, software-controllable USB Hub and extender designed for high-performance enterprise, communication, industrial, and AV applications. It supports:

- Local USB links of up to 10 Gbps
- Up to 100 m extension of USB 3.2 Gen 1 (5 Gbps) and USB 2.0 over HDBaseT-USB3 using Cat 6A cable.

When powered over the Cat 6A link, the USBExt3c provides up to 60 W total USB-PD output shared across the data and control ports, and 90 W shared when locally powered.

Full software control of the USBExt3c is available using the interactive HubTool App or BrainStem® API, connecting via the upstream-facing host port or a dedicated Control Port (independent of USB data traffic). Acroname AnyPort™ technology allows any USB-C port (0-1), on either end of the extension, to be configured as the upstream-facing host port, enabling automatic host switching.

In addition to USB extension, the USBExt3c provides extensive per-port power and data capabilities, with the ability to:

- Monitor, enable, or disable VBUS on each port
- Independently disconnect USB HS and SS for advanced USB testing
- Source up to 60 W or sink up to 100 W per port via USB-PD
- Set current limits and USB charging modes
- Automate enumeration delays and port resets
- Automate USB port behaviors, set and read PD profiles

The fully bidirectional Power-Over-Ethernet (PoE) system can supply up to 90 W (IEEE 802.3bt Class 8) over the HDBaseT-USB3 link to another USBExt3c or PoE-compliant device, with full software monitoring and control.

Typical applications

- USB-C range extension in enterprise and industrial environments
- Device compatibility test labs
- Industrial and A/V camera extension
- BYOD Video Conferencing systems
- Remote USB-PD monitoring, control and power cycling

Features

Data

- Local USB host/device links up to 10 Gbps (USB 3.2 Gen 2)
- USB 3.2 Gen 1 (5 Gbps) and USB 2.0 extension via HDBaseT-USB3 up to 100 m (Cat 6A)
- Backward compatible with USB 2.0 and USB 1.x devices
- Per-port selective enable/disable of:
  - Hi-Speed (480 Mbps) data lines
  - SuperSpeed (5/10 Gbps) data lines
  - VBUS power lines
- Link speed detection per port
- RS-232 and GPIO signal extension over the link
- Low-latency frame synchronization

Power

- USB Power Delivery per port:
  - Source up to 60 W (60 W max shared limit powered over extension, 90 W local power))
  - Sink up to 100 W
- Programmable per-port current limits
- USB legacy-charging mode support: SDP (Standard Downstream Port) and CDP (Charging Downstream Port)
- Voltage and current measurement on each port's VBUS
- PoE++ (IEEE 802.3bt Class 8) over HDBaseT-USB3 link: up to 90 W to another USBExt3c or compliant device

Control and Management

- Control via interactive HubTool App or BrainStem® API
- Control connections via upstream-facing host port, ethernet, or dedicated USB Control Port (independent of USB data)
- Acroname AnyPort™ software-selectable upstream port for host switching from either end of the extension
- Set enumeration delays for attached downstream devices
- Monitor and manipulate PD profiles
- DIN-rail mountable for industrial installations
- ±15 kV ESD protection (IEC 61000-4-2 Level 4)
- All pins protected against overvoltage and reverse polarity

Absolute Maximum Ratings[1]

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
V_{bus} Power per USB-C Port		100	W
Voltage on any V_{bus}	0.0	24	V
Current on any V_{bus}	-5	5	A
Voltage on any USB SS+/SS-	-0.3	24	V
Voltage on any USB D+/D-	-0.3	5	V
Voltage on CC1 and CC2	-0.3	6	V
Expansion Header Rx/Tx	-25	25	V
Expansion Header IO1	-25	25	V
Altitude		2000	M
Overvoltage		Overvoltage Category II	

Table 1: Absolute Maximum Ratings

Handling Ratings

Parameter	Conditions/Notes	Minimum	Typical	Maximum	Units
Relative Humidity Range	Non-Condensing	5	-	95	%RH
Storage Temperature, T_{STG}		-10.0	-	85.0	°C
Mass		-	602	-	g
Electrostatic Discharge, V_{ESD} Meets IEC 61000-4-2, level 4	Air-discharge	-16	-	16	kV
	Contact-discharge	-8	-	8	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	Units
Ambient Operating Temperature, T_A		0.0	25.0	TBD	°C
Relative Humidity Range	Non-Condensing	5	-	80	%RH
USB V_{bus} on ports	Hub powered; Port power enabled	3.6	5.2	21.0	V

Table 3: Recommended Operating Ratings

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

System Block Diagram

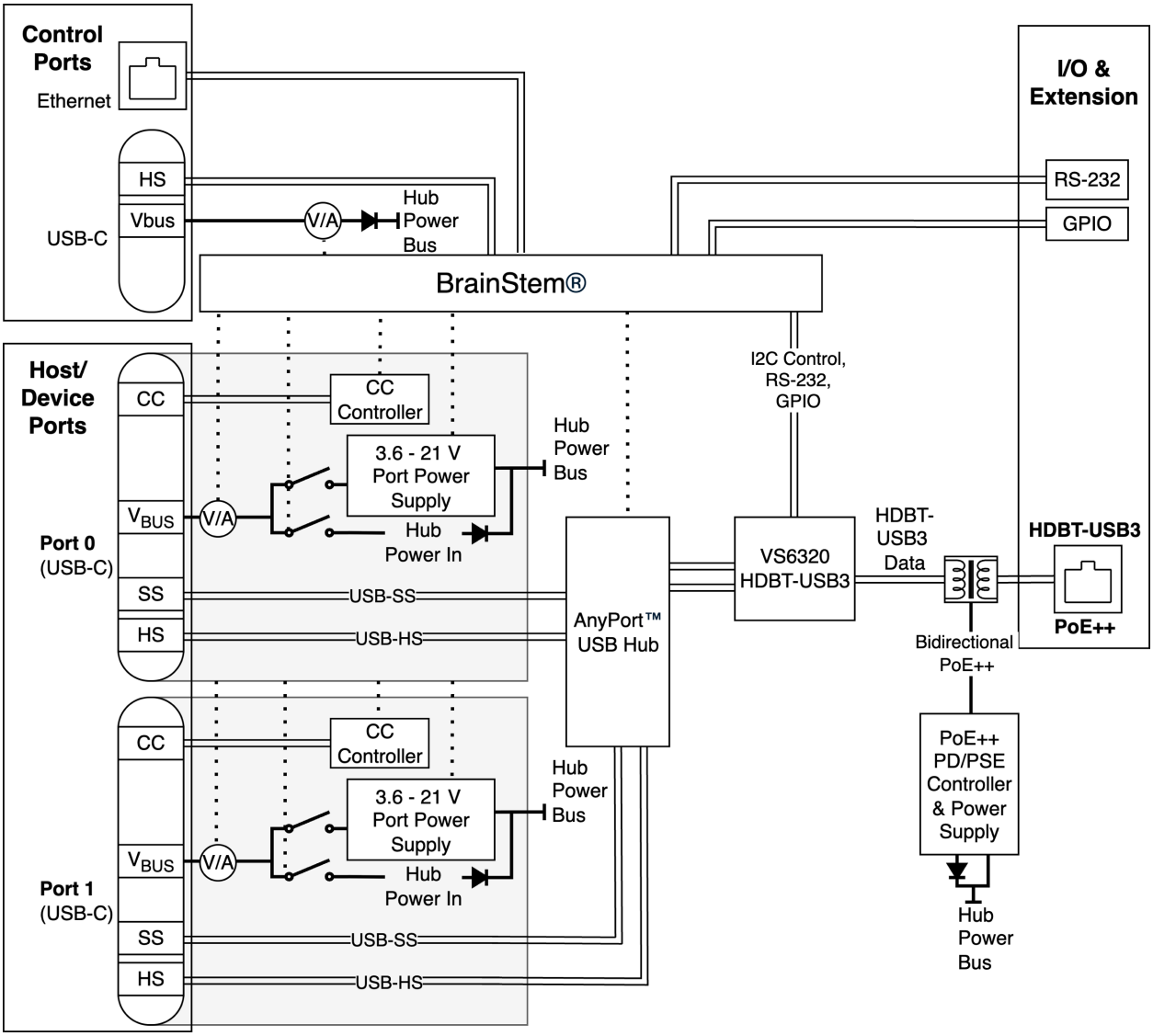


Figure 1: USBExt3c Block Diagram

Typical Performance

System Characteristics

Specifications are valid at 25°C unless otherwise noted. Indoor use only. Sample rates are typically limited by the USB throughput of the host operating system.

Parameter	Conditions/Notes	Min	Typ.	Max	Units
Input Power, W_{vbus}, no downstream devices attached		-	5	-	W
System Input current Type-C port, I_{Vbus}	Dependent upon USB-C supply and Load	100	-	5000	mA
Measurement Sampling Rate			100		Hz

Table 4: Typical Performance Characteristics

USB-C Port Characteristics

Specifications are valid at 25°C unless otherwise noted. Indoor use only.

Parameter	Conditions/Notes	Min	Typ.	Max	Units
V_{bus} Source Power		-	-	60	W
V_{bus} Sink Power		-	-	100	W
V_{bus} Output Voltage		3.6	5.2	21.0	V
V_{bus} Voltage Measurement Full Scale Range		0		32	V
V_{bus} Voltage Measurement Resolution		-	488	-	µV
V_{bus} Voltage Measurement Accuracy		-0.5	-	0.5	%FSR
V_{bus} Voltage Setpoint Resolution		-	100	-	mV
V_{bus} Voltage Ripple	Peak to peak at target V_{bus} voltage	-	-	TBD	V
V_{bus} Current Setpoint Resolution	(0.5, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0)	0.5	-	1.0	A
V_{bus} Current Measurement Full Scale Range		-10	-	10	A
V_{bus} Current Measurement Resolution		-	300	-	µA
V_{bus} Current Measurement Accuracy		-0.5	-	0.5	%FSR
USB SuperSpeed Data Rate	May depend on host or devices	-	-	10	Gbps
USB Hi-Speed Data Rate	May depend on host or devices	-	-	480	Mbps
V_{bus} Current Supply (SDP mode)	USB 2.0 data lines enabled and USB host present, device limited	-	500	-	mA
V_{bus} Current Supply (CDP mode)	USB 2.0 data lines enabled, USB host present, device limited	-	1500	-	mA
V_{bus} Current Supply (DCP mode)	USB 2.0 data lines enabled, no USB host present, device limited	-	5000	-	mA
V_{conn} Output Voltage		4.0	5.2	5.5	V
V_{conn} Output Voltage Ripple	Peak to Peak	-	-	100	mV
V_{conn} Current Output		-	-	400	mA
V_{conn} Line Capacitance		-	25	-	pF

Table 5: Operating specifications

External Header Characteristics

Specifications are valid at 25°C unless otherwise noted. Indoor use only.

Parameter	Conditions/Notes	Min	Typ.	Max	Units
IO1 Output Voltage High V_{OH}	Without external pull-up resistor		5.2		V
IO1 Output Voltage Low V_{OL}	Without external pull-up resistor		0.7		V
IO1 Input Voltage High V_{IH}					V
IO1 Input Voltage Low V_{IL}				2.2	V
Frame Sync					
RS-232 Baud Rate		-	-	1	Mbps

HDBASET-USB3 Port Characteristics (TBD)

Specifications are valid at 25°C unless otherwise noted. Indoor use only.

Parameter	Conditions/Notes	Min	Typ.	Max	Units
HDBT Pins	Compatible with HDBaseT-USB3				
HDBT Extension Distance	POE disabled	-	25	100	m
	POE enabled	-	25	70	m
POE Power[2]	PSE output	25	45	71	W
Galvanic Isolation		2.5	-	-	kV

Table 6: Operating specifications

LAN Port Characteristics (TBD)

Specifications are valid at 25°C unless otherwise noted. Indoor use only.

Parameter	Conditions/Notes	Min	Typ.	Max	Units
LAN Pins	Compatible with IEEE 802.3u standard				

Table 7: Operating specifications

Typical Performance Details

Specifications are valid at 25°C unless otherwise noted. Indoor use only.

TBD – Performance Graphs Thermal derating, input voltage to output power, otherwise look at S99

[2] POE power output has a relation to system thermal characteristics shown in performance characteristics. Compatible with IEEE 802.3bt standard.

Overview

With advanced programmable control features, the USBExt3c is targeted at industrial and production systems requiring software and embedded control of USB devices. It is ideal for manufacturing test of consumer electronics and control of industrial systems.

Power Subsystem

The USBExt3c utilizes internal switch-mode power supplies to allow bidirectional power flow on each USB-C port and the HDBaseT-USB3 port.

Grounding

USB is sensitive to grounding and ground loops. Is important to understand your system's grounding strategy to ensure the USB shield or ground is not the primary ground current return path. The USBExt3c shorts USB shield and ground and provides an earth ground connection point.

Charging Standards

There are multiple overlapping USB charging standards supported by the USBExt3c. All ports support USB Power Deliver 3.0 (PD) and are backward compatible with previous version. All USB-C connectors on the front of the device support sink and source modes.

All numbered USB-C connectors support USB Battery Charge version 1.2 (BC 1.2) in standard downstream port (SDP), charging downstream port CDP, dedicated charging port (DCP) modes.

V_{bus} Power Sourcing and Sinking

The USBExt3c features independent V_{bus} supplies for each front USB-C port.

V_{bus} Measurement Subsystem

The USBExt3c measurement subsystem samples V_{bus} voltage and current for each USB-C port.

HDBaseT-USB3 Power over Ethernet

The USBExt3 is compatible with the IEEE 802.13bt Power Over Ethernet (PoE) standard on the HDBaseT-USB3 port.

The unit can act as a Powered Device (PD) or as Power Sourcing Equipment (PSE). Galvanically isolated supplies separate the PoE power domain from the rest of the USBExt3c and convert the voltages as necessary. The PoE voltages and currents are measured and available to the user.

Device Drivers

The USBExt3c 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 requires the supplied INF to communicate with BrainStem USB devices.

Software Control

Software control of the features of the USBExt3c is performed with the BrainStem API via a BrainStem link. BrainStem links are done over USB and can be established through the selected upstream ports or the Control Port. After one or more of these ports is connected to a host machine, a user can connect to the BrainStem via software API:

```
stem.link.discoverAndConnect(USB)
```

When multiple hubs are connected to a host, connecting to a specific hub can be done by providing the hub serial number. Further, all connected hubs can be found using

```
brainstem.discover.findAllModules(USB)
```

Software Capabilities and Interfaces

The USBExt3c is built on Acroname's BrainStem system, which provides simple high-level APIs, a real-time embedded runtime engine and modular expandability. All shortened code snippets are loosely based on the C++ method calls and meant to be pseudocode. Please consult the BrainStem Reference for implementation details.[3]

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

USB-C Upstream and Downstream Ports

The USBExt3c has two USB-C ports that can be used for connections between a USB host and downstream devices. These ports are numbered 0 and 1 on the case and in software.

Either of these ports or the HDBaseT-USB3 port can be selected as the upstream facing port. The other ports operate as downstream facing ports.

While it is possible to connect separate USB host devices to separate numbered USB-C ports on the USBExt3c, only one port can operate as an upstream facing port. Therefore, it is not possible for multiple USB host devices to simultaneously communicate through the USBExt3c to downstream devices.

The USBExt3c defaults to using CH0 as the upstream port.

BrainStem USB-C Control Port (Add HDBT?)

The USBExt3c USB-C control port carries a high-speed USB 2.0 connection to the BrainStem controller. No USB traffic can flow between the Control Port and the numbered USB-C ports. When a cable is detected in the Control Port USB-C connector, a BrainStem link can only be established through the Control Port, regardless of the selected upstream port.

If no cable is detected in the Control Port USB-C connector, a BrainStem link can be established with a host connected to the active upstream facing port. Additionally, if an HDBaseT-USB3 link is established with another USBExt3c, the remote USBExt3c doesn't have a control port connection, and the remote USBExt3c upstream is set to HDBaseT-USB3, the remote USBExt3c can be controlled via the local USBExt3c connection to a host machine.

The Control Port provides the ability to maintain sofware control of the hub during the process of disconnecting and reconnecting upstream host connections to numbered USB-C ports.

Enabling and Disabling USB-C Ports

The USBExt3c features granular control of each numbered USB-C port, including independent switches for V_{bus}, USB 2 data lines, USB 3 data lines, and CC lines.

A port can be quickly disabled or enabled with a single API call, or more discrete API calls can be used to control specific lines for a port.

Power Paths

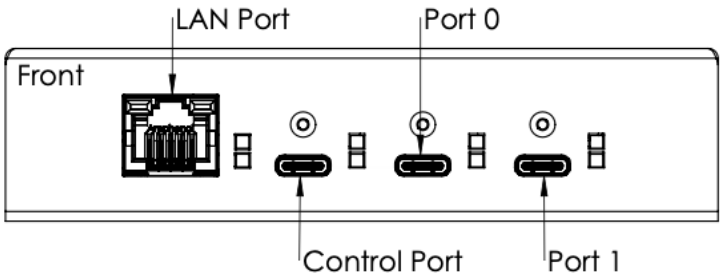
TBD

Connection Interfaces and Indicators

Front Panel

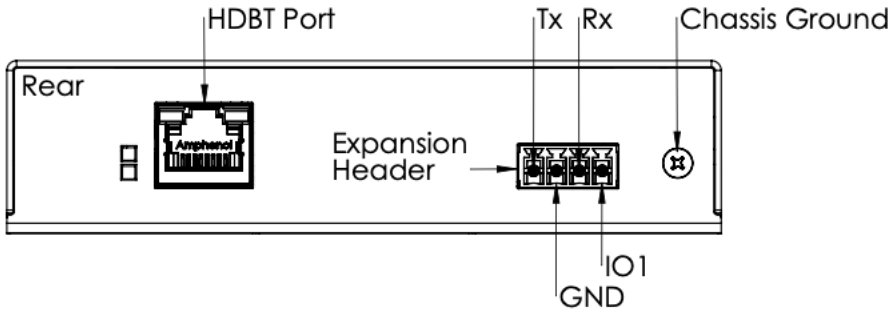
USB-C Connectors

The front of the USBExt3c features an Ethernet port and three USB-C receptacles: Control, Port 0, and Port 1. The Control and Ethernet ports are dedicated for control communication between a computer and the USBExt3c. Port 0 and Port 1 connectors are full-featured hub ports.



Rear Panel

The back of the USBExt3c has an HDBT-USB3 port and external connection header. The HDBT-USB3 port is used for the extension function and the external header is used for RS-232, frame sync, and general purpose IO.



Expansion Connector

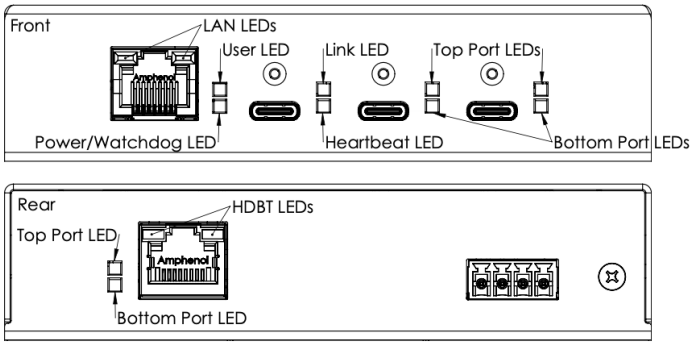
The USBExt3c expansion connector is a 4-pin, 1-row, shrouded male header block with 3.81mm pitch. This interface provides additional mechanisms for expandability and testing scenarios. Table 8 for the connector pinout.

Connection Name	Pin Number	Description
TX	1	RS232 Serial Transmit (data from USBExt3c)
GND	2	Ground
RX	3	RS232 Serial Receive (data to USBExt3c)
IO1	4	General purpose IO, Frame Sync

Table 8: Expansion Connector Pinout

LEDs

Both the front and back panels of the USBExt3c have status LEDs to communicate device status and behavior. The names and meanings of these LEDs are explained in the image and table below.



LED Name	Location	Color	Description
Link Status LED	Front	Yellow	On once a host device has enumerated the BrainStem controller
User LED	Front	Blue	Can be set by the user using the appropriate API
Heartbeat LED	Front	Green	Indicates active BrainStem connection; pulses at a rate determined by the system heartbeat rate
Power/Watchdog LED	Front	Red Magenta	Solid red indicates the system is powered. Alternating between red and magenta is indication the internal watchdog is running and the USBExt3c firmware is running.
LAN LEDs	Front	Yellow Green	Green LED is solid when a link exists. Amber LED will blink during activity.
HDBT-USB3 LEDs	Rear	Yellow Green	Green LED is solid when a USB 3 link exists. Amber LED is solid when an HDBT link exists. Both LEDs will flash during a firmware update.
Top Port LEDs	Front Rear	Yellow Green Blue	USB enumeration speed: blue for SuperSpeed+, green for SuperSpeed; yellow for Hi-Speed or lower USB 2.0 speeds.
Bottom Port LEDs	Front Rear	Purple Red	Port mode for data: Purple for Upstream (UFP) port, Red for Downstream (DFP) port

Table 9: LED indicators

Reset Button

When the unit is powered on the reset button, location shown below, has several functions.

One short press will restart the unit, like a power cycle.

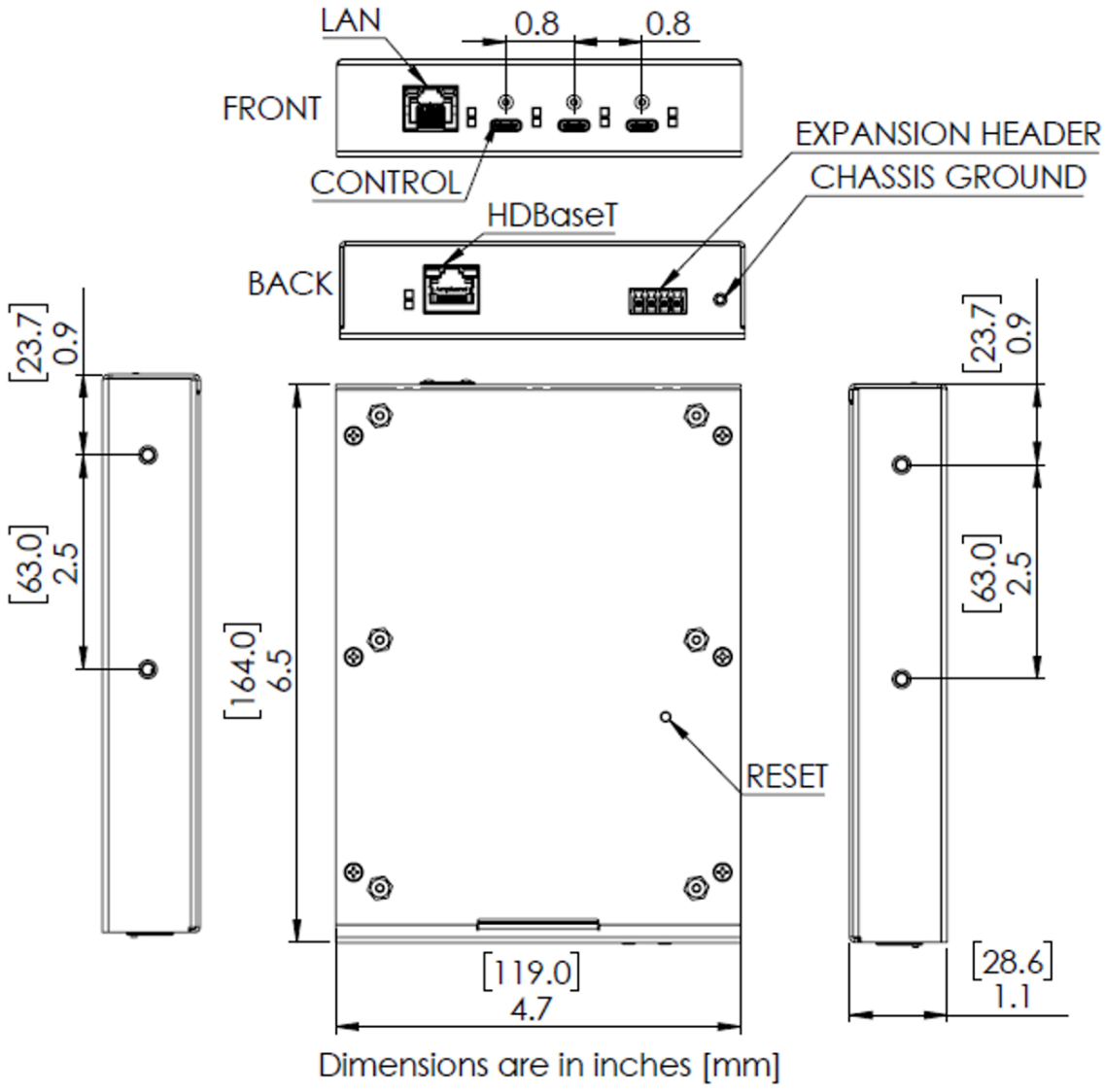
Two short presses within 5 seconds will factory reset the unit, restoring all default settings.

Holding the reset button down for 5 seconds will enable firmware recovery.

Mechanical

3D CAD models available from https://acroname.com.

Figure 2: USBExt3c Mechanical Drawing



Mounting Accessories

Two sets of mounting holes are provided for mounting the USBExt3c to tables or DIN rail. Acroname can provided mounting options as shown below:

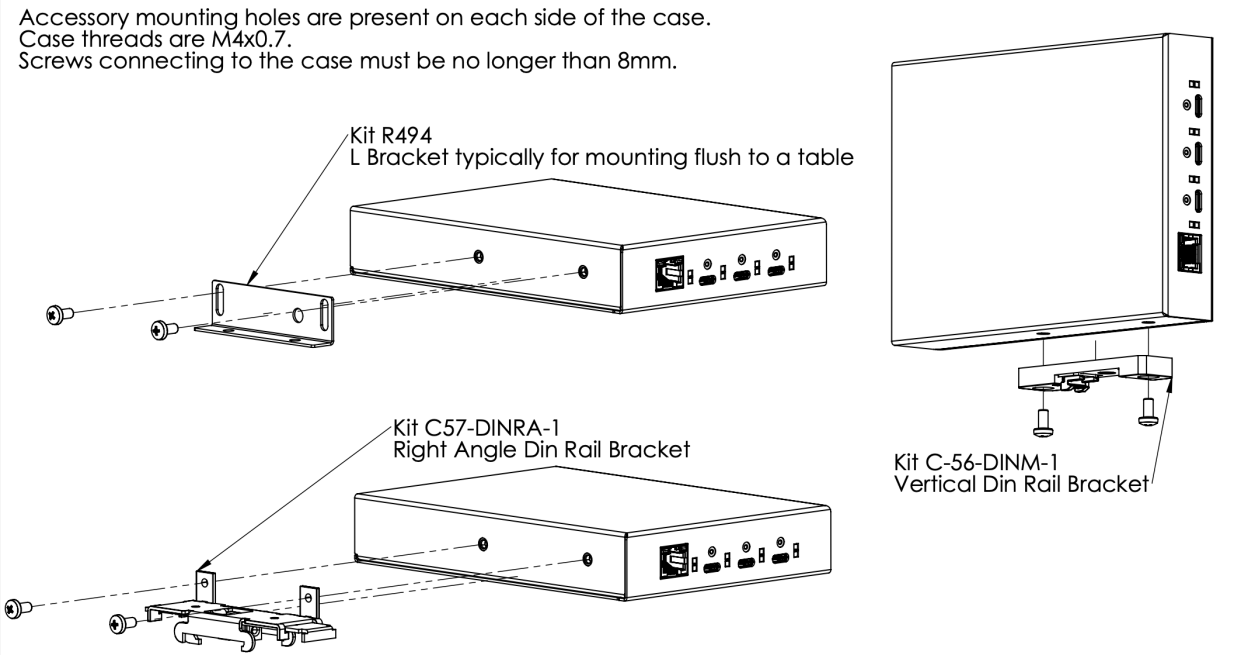


Figure 3: USBExt3c DIN Rail Mount

Markings

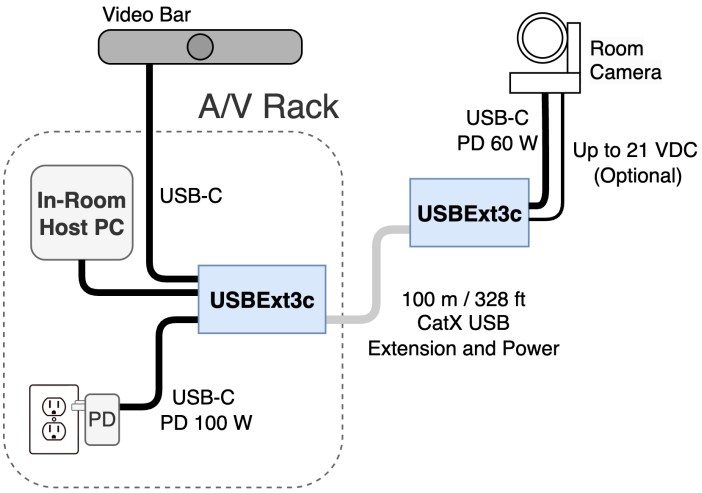
Symbol	Description
	Chassis ground.
	GND return.

Table 10: Case Symbol Markings

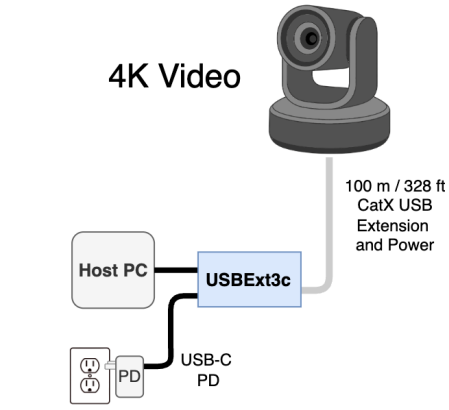
Application Notes

Camera Extension

AV room camera extension

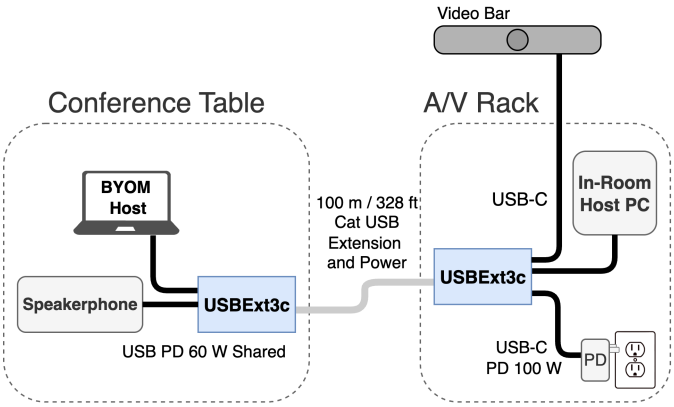


Host interface for VS6320-based cameras with integrated HDBaseT-USB3

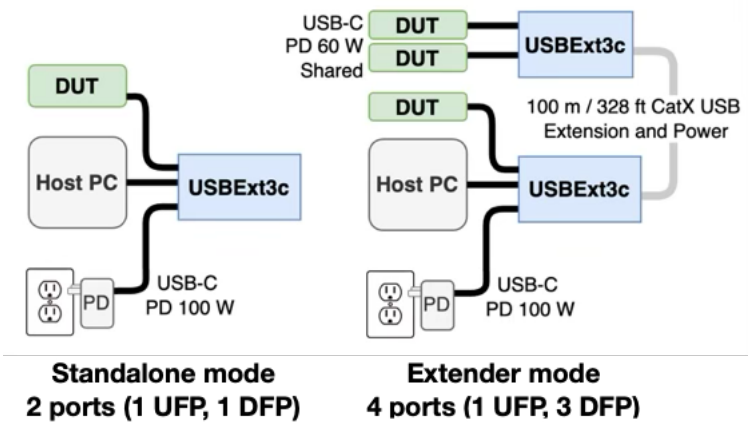


-

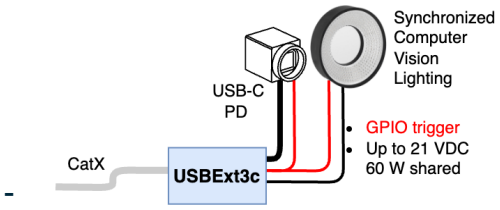
BYOD / BYOM



Industrial extension:



- Standalone mode: one USBExt3c for single host / device testing
    - Most of the features of USBHub3c with fewer ports
    - Ethernet control
- Extender mode: solve power, isolation, cable run limits.
    - Flexible location for host computers / test runners
    - Keep equipment out of work cell safety zones
    -
- Industrial camera extension
    - RS-232, trigger, and variable DC output up to 21 V for lighting synchronization, additional sensing or actuation.



USB-C Connectivity

In general, USB-C connectors are fully functional when inserted in either orientation. However, standard USB-C cables are not symmetric, and the orientation of each USB-C cable is very important in several USBExt3c applications.

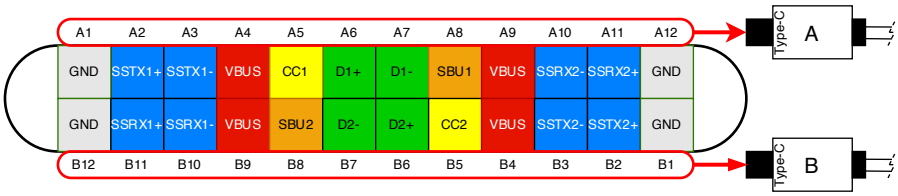


Figure 4: USB-C Connector Detail

- Figure 4 illustrates which CC line is used for Power Delivery negotiation in subsequent application notes and diagrams that specify orientation. For example, diagrams showing connectors with "A" use CC1 for PD communication.
- The CC pin (CC1 or CC2) in the receptacle that is not used for PD communication may instead be used to carry V_{conn} to power additional components once a connection is established between the host and device.
- Standard USB-C cables only include the D+ and D- data lines on the A side of the cable. To overcome the limitations this imposes, Acroname offers a Universal Orientation Cable (UOC) with both D± pairs and employs it in several applications.

The USB-C receptacle is specified for up to 20 V and 5 A. The higher rating of the receptacle enables systems to deliver or receive much more power than USB Type-A or Type-B receptables.

USB-C Device Communication Testing with Flips

The purpose of this application is to test that a USB-C device properly functions using both cable orientations. The USBExt3c enables orientation flips without physically removing and replacing a cable. This application focuses on USB data communication between the device and a host.

The device under test (DUT) is connected to the USBExt3c as a downstream device. A computer serves as a USB host and test station controller. A standard USB-C cable connects the USBExt3c to the host computer, while an Acroname UOC connects the DUT to the USBExt3c. The standard cable is inserted with the "A" side of the cable facing upwards. The host computer cable is connected to the USBExt3c on CH0 and the DUT on CH1, as shown in Figure 5.

Figure 5: DUT with UOC

The Acroname UOC does not determine orientation like a standard USB-C cable, but the USBExt3c can force orientation.

DUT Side A

To test DUT Side A, the test station connects to the USBExt3c and disables CC2 on CH1. The communication between the host and the USBExt3c occurs via CH0, and the command to disable CC2 can be issued either via the graphical user interface or by software API call. Disabling CC2 on CH1 forces the DUT to use CC1 for PD negotiation, D1± for USB 2.0 data, and SSRX1±/SSTX1± for USB 3 data, as shown in Figure 6.

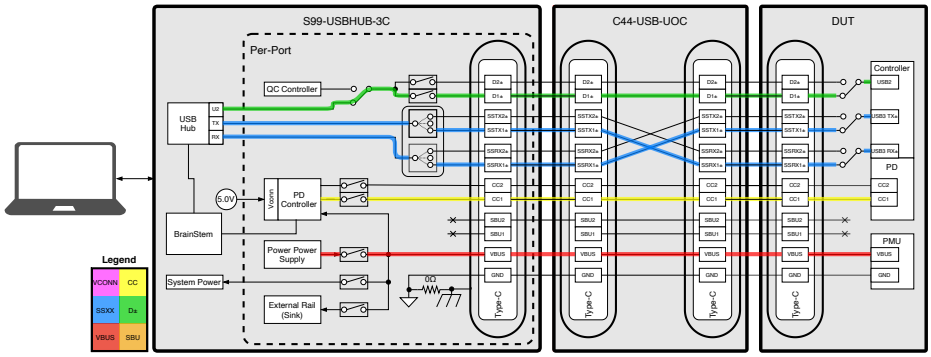


Figure 6: DUT Side A Testing

DUT Side B

To test DUT Side B, the test station disables CC1 and re-enables CC2 on CH1. Disabling CC1 on CH1 forces the DUT to use CC2 for PD negotiation, D2± for USB 2.0 data, and SSRX2±/SSTX2± for USB 3 data, as shown in Figure 7.

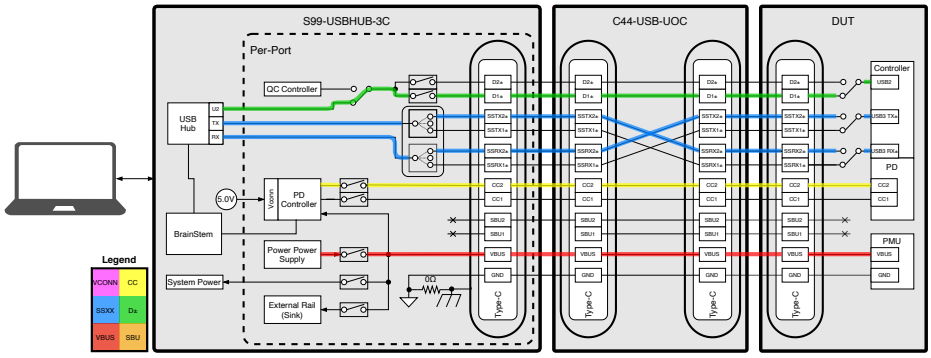


Figure 7: DUT Side B Testing

DUT USB 2

USB downstream devices normally attempt to enumerate as USB 3 devices by default, and only fallback to USB 2 if USB 3 is unavailable or fails. To test DUT USB 2 functionality, the test station disables the USB 3 SuperSpeed (SS±) data lines on CH1. As with CC, the test station can disable data lines connections via software control. With SS± disabled, the DUT can only communicate with the host via the USB 2 High Speed (D±) data lines. The test station can use tools on the computer itself to verify that the DUT is properly communicating using USB 2. This should be completed during both Side A and Side B testing.

DUT USB 3

To test DUT USB 3 functionality, the test station re-enables SS± and possibly disables D±. Again, the test station can use tools on the computer itself to verify USB 3 communications with the DUT, for both DUT Side A and Side B.

Test Coverage

By using the USBExt3c to complete USB 2 and USB 3 testing on DUT Side A and Side B, all the USB data lines and both CC lines in the USB-C receptable have been tested with one cable insertion.

USB-C Device Power Delivery Tests

The purpose of this application is to test that a USB-C device probably sources or sinks power according to power delivery negotiations. The example DUT can either source and sink power, as would be the case with a laptop that can use a USB-C port for charging and peripheral connections.

The DUT is connected to the USBExt3c using an Acroname UOC to CH1. To ensure maximum test coverage, the UOC is rated for 5 A. The test station is connected to CH0 using a standard USB-C Cable. See Figure 5 for connections. As with USB communication testing, the UOC enables one DUT insertion to test both CC lines for successful Power Delivery negotiations.

DUT as Sink PD Rule Negotiation

To test DUT as Sink PD Rule Negotiation, the test station configures USBExt3c CH1 to only act as a source of V_{bus}. This results in a pull-down resistor getting connected to CC, which the DUT should detect. With the PRO edition, the test station can also enable or disable specific PD source rules that are advertised to the DUT. The test station will observe the result of PD negotiations between the USBExt3c and the DUT, as well as collect voltage and current measurements of the V_{bus} current for CH1. The USBExt3c will detect and flag negotiation errors and overcurrent conditions. To expand coverage, one CC line can be disabled to force PD negotiations to occur on the other CC line.

DUT as Source Rule Negotiation

To test DUT as Source PD Rule Negotiation, the test station configures USBExt3c CH1 to only act as a sink of V_{bus}. This results in a pull-up resistor getting connected to CC, which the DUT should detect. The test station can also select specific PD source rules that the USBExt3c requests from the DUT. The USBExt3c will collect V_{bus} measurements and detect errors, all of which will be observed by the test station.

Test Coverage

By using the USBExt3c to complete DUT PD testing, both source and sink capabilities are tested up to 100W in either direction, including PD rule negotiation on each CC line, measurements of V_{bus}, and detection of rule violations. All testing is conducted in a single DUT insertion, which can also include USB data functional testing, as noted in the preceding application note.

FCC Compliance Statement

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.

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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.
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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

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Document Revision History

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

Revision	Date	Engineer	Description
0.9	Aug 2025	RA	Pre-release
1.0	Aug 2025	ACRO	Initial Revision