



Overview

The [USBStem module](#) is one of a family of 40-pin BrainStem modules which share a common IO interface meant for docking to breakout boards, prototyping boards and OEM solutions on a 0.1" inch spaced header. The only difference in functionality and form-factor is the link transport which is through a USB connection.

simple programming interface to enable use with a wide range of input and output devices. There is also a powerful host-side C/C++ API which enables host-PC interactions with the module and subordinate hardware devices. All Acroname software and APIs are full featured on all host platforms (Mac, Windows, Linux).

Features

- 3 Analog (ADC) Inputs at 12-bit resolution
- ADC sampling up to 200kS/s
- ADC bulk capture to RAM up to 3kS
- 15 GPIO Digital Input/Outputs (3.3 V)
- 1 DAC, 10-bit resolution
- I²C Fast Mode Plus (Fm+, 1Mbit) intended for BrainStem bus
- I²C Fast Mode (Fm, 400kbit) user peripheral applications
- User, Link status, Power, Heartbeat LEDs
- 2 Serial Ports (UARTs) with TX and RX Traffic Indication
- 48kB persistent internal storage (4kB slots)
- 1 Internal 8kB RAM Storage Slot
- μ SD Card Interface (max 255 slots of 64kB slots)
- Small size footprint (50.8 mm x 30.48 mm x 14.03 mm)

Applications

The BrainStem USBStem Module is a modular power supply subsystem designed for supplying software controllable voltage power rail to a device under test (DUT) in automated testing environments and research and development. Accurate voltage, temperature and current rail measurements can be read through the BrainStem API.

Description

The BrainStem USBStem Module is a core BrainStem microcontroller module intended for general purpose applications. The BrainStem USBStem Module can be easily integrated into any system in order to provide a collection of IO functions for automation systems, embedded control systems and remote data collection. It supports GPIO, I2C, A2D, and DAC. The module provides a flexible embedded virtual machine runtime with



Absolute Maximum Ratings

Stresses beyond those listed under ABSOLUTE MAXIMUM RATINGS 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.

Parameter	Conditions	Minimum	Typical	Maximum	Units
Input Voltage (Vsupply)		-0.5	-	4.6	V
Supply Current (per pin)		0.0	-	100.0	mA
Ground Current (per pin)		0.0	-	100.0	mA
Input Voltage (all pins)		-0.5	-	4.6	V
Operating Temperature		0.0	25.0	80.0	C



Recommended Operating Ratings

The values presented apply over the full operating temperature, otherwise specifications are at $T_A = 25\text{ }^\circ\text{C}$.

Parameter	Conditions	Minimum	Typical	Maximum	Units
Input Voltage (VCC)		2.4	3.3	3.6	V
RTC Supply Voltage (VRTC)		2.1	3.3	3.6	V
Nominal Supply Current	Operating at 25C with 3.3V input voltage	-	72.2	-	mA
Supply Current (Deep sleep)	Operating at 25C with 3.3V input voltage	-	180.0	-	uA
ADC Maximum Input Voltage		-0.5	-	4.6	V
ADC Usable Input Voltage Range		0.0	-	3.3	V
DAC Voltage Output		0.0	-	3.3	V
Digital Input Voltage		0.0	-	5.5	V
GPIO Current, per pin		18.0	20.0	22.0	mA
GPIO Input Logic Low Threshold		-	-	1.0	V
GPIO Input Logic High Threshold		2.3	-	-	V
GPIO Output Voltage		0.0	-	3.3	V
Operating Temperature		0.0	-	80.0	C
Unregulated Voltage Input Measurement		0.0	-	32.76	V



Block Diagram

The BrainStem USBStem Module is composed of a many different subsystems carefully linked together.

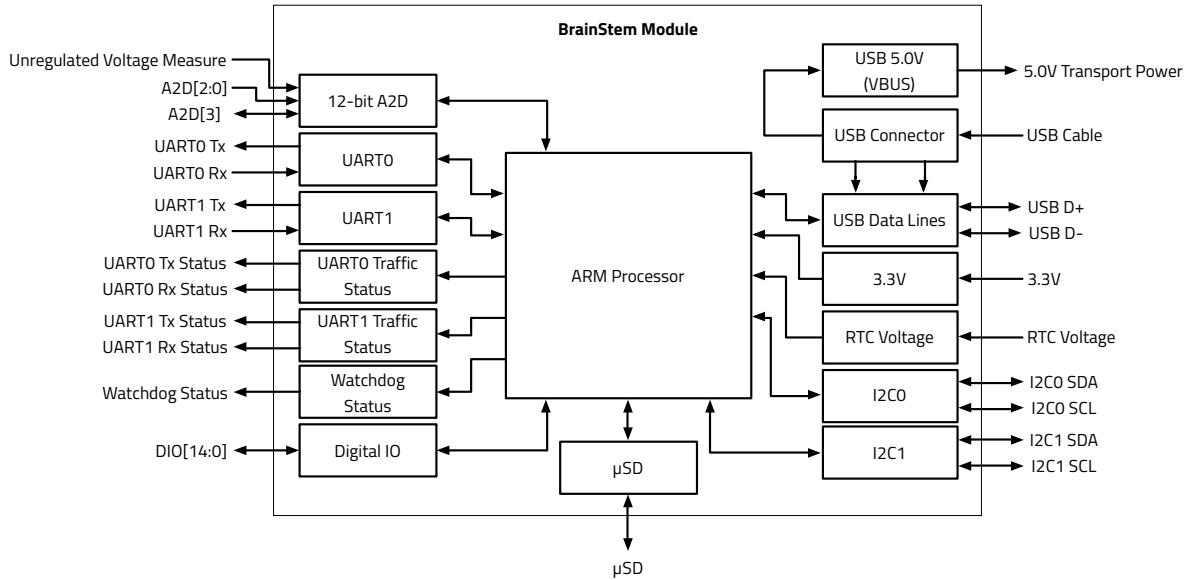


Figure 1: System block diagram



Pin Functionality

All pin mapping functionality is described in the following table.

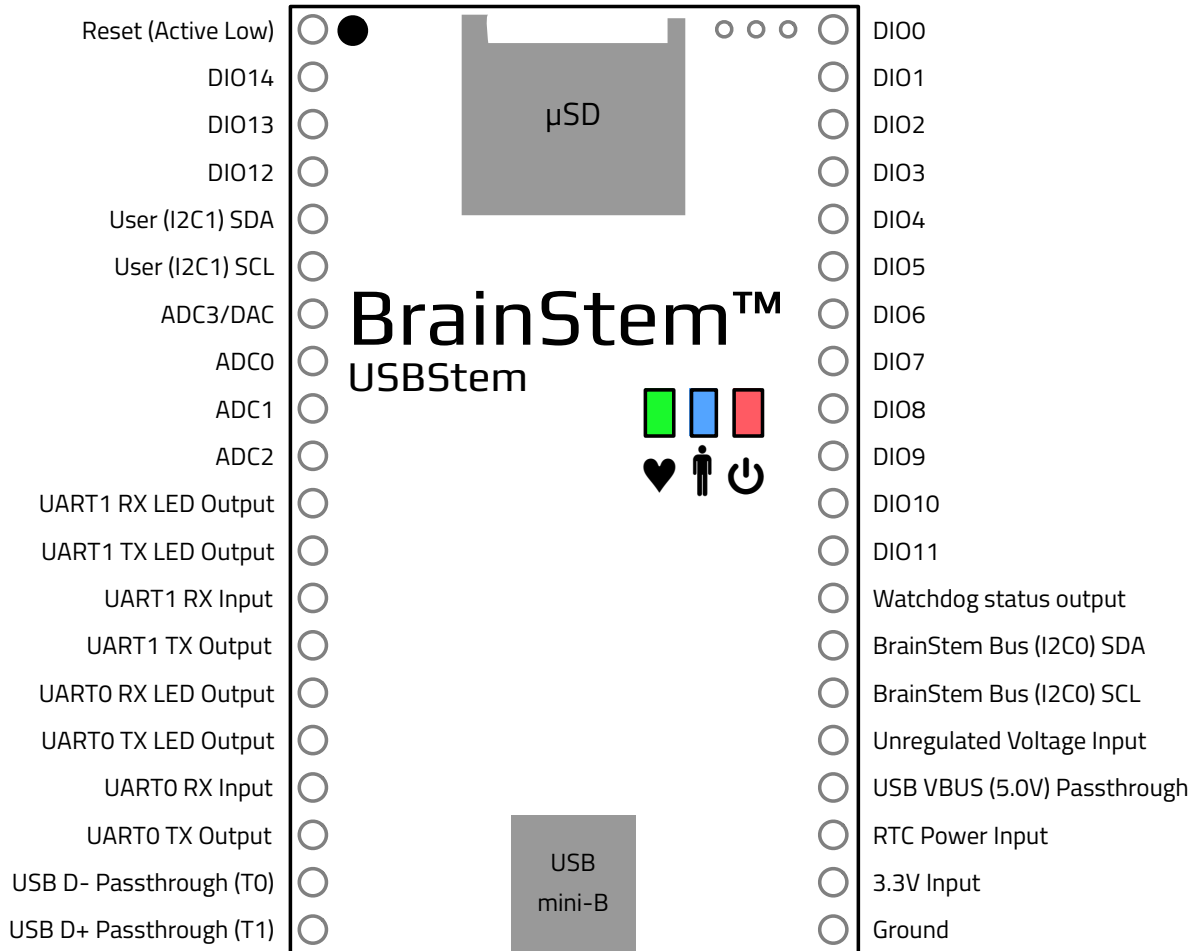


Figure 2: BrainStem USBStem Module pinout drawing.



Connector	Description	Notes
1	Reset	Logic low asserts reset
2	DIO 14	
3	DIO 13	
4	DIO 12	
5	I2C1 SDA	Hardware pull up is included
6	I2C1 SCL	Hardware pull up is included
7	ADC3/DAC	Analog input and output capable
8	ADC0	Analog input only
9	ADC1	Analog input only
10	ADC2	Analog input only
11	UART1 Rx LED status indication	
12	UART1 Tx LED status indication	
13	UART1 Rx	
14	UART1 Tx	
15	UART0 Rx LED status indication	
16	UART0 Tx LED status indication	
17	UART0 Rx	
18	UART0 Tx	
19	USB D+ passthrough	
20	USB D- passthrough	
21	Ground	
22	VCC	Recommended 3.3V. See electrical characteristics
23	RTC Voltage input	Recommended 3.3V. See electrical characteristics
24	Voltage Transport	5.0V from USB VBUS is passed through from mini-b connector.
25	Voltage Unregulated Measure	
26	I2C0 SCL	Hardware pull up is included. This is primarily used as BrainStem network bus.
27	I2C0 SDA	Hardware pull up is included. This is primarily used as BrainStem network bus.
28	Watchdog status pin	
29	DIO 11	
30	DIO 10	
31	DIO 9	
32	DIO 8	
33	DIO 7	
34	DIO 6	
35	DIO 5	
36	DIO 4	
37	DIO 3	
38	DIO 2	
39	DIO 1	
40	DIO 0	



Operation

I2C Interface

The module supports I2C communication up to fast-mode plus (Fm+, 1MHz). This I2C bus is normally dedicated to communication between other BrainStem and BrainStem Spindle modules, but may also be used for user specific applications. The I2C interface allows the module to operate as a master or slave on the bus, and can support multi-master busses. 330Ω pull-up resistors to 3.3V are incorporated into the module. SCL and SDA lines are 5.0V tolerant.

Module Power

Regulated 3.3V is required to run the BrainStem USBStem Module. When all GPIO and analog functions are disabled (default configuration), the module draws the nominal current defined in the ratings table. Current from enabling these functions is additive to the nominal current and the supply should be capable of sourcing the required current without dropping below the minimum input voltage.

Note that the module is not directly powered from the USB 5V VBUS. An unregulated voltage output pin passes the USB VBUS power allowing a subordinate board to regulate and provide the required 3.3V for the module.

Alternatively, 3.3V power may be generated from a source independent from the USB connection, such as a battery. Note that direct connection to standard lithium polymer (LiPo) or lithium ion (LIB) battery voltages will likely allow the module to power on. However, these voltages exceed the recommended input voltage range and doing so voids the warranty.

A measurement of the unregulated system input voltage is available through the programming interface. Measurement granularity is approximately 8mV across the specified input range. It is recommended to have a minimum of 1nF of capacitance on the unregulated voltage measurement to reduce noise on this measurement.

LED Indicators

The core module has a bank of four LED indicators with specific utility.

Color	Name	Description
Yellow	Link LED	Shows the module has established communication with a host processor. Drivers will need to be installed for the BrainStem USBStem Module for this to happen. Drivers are available through the Acroname Download Center.
Green	Heartbeat LED	Cycles on and off when a host application is communicating with the module.
Blue	User LED	User application controllable LED. Please see the BrainStem Reference manual for programming interfacing details.
Red	Power LED	Shows the core module is receiving 3.3 V power. See the section on Input Power for more details.

Power Saving Modes

Significant power consumption reduction can be realized by operating in a low power mode. Using power-saving mode put the microcontroller into a deep sleep state while maintaining the real time clock. The real time clock may be powered by an independent power source through the interface header, such as a standard coin-cell battery. When a single power source is used, it is recommended to tie the RTC Voltage input pin to the 3.3 V input power. Leaving the RTC Voltage pin unconnected will disable the use of any power savings modes.

Transport Interface

Pins T0 and T1 are dedicated to passing through link transport pins when possible. The BrainStem USBStem Module connects the T0 line to the USB D+ and the T1 to the USB D-. Both lines pass through a built ESD line protection on the BrainStem USBStem Module. Other modules may have different uses or no connection to these transport-specific T0 and T1 pins. These pins do support USB hubbing. I.e. devices cannot be daisy-chained from the USB connector to the transport interface pins. Only one USB connection should be used at any one time: either the USB connector or the transport pins. If using the transport pins



to supply a host transport connection, care should be taken to ensure proper signal integrity of the USB signal on the external board.



Mechanical

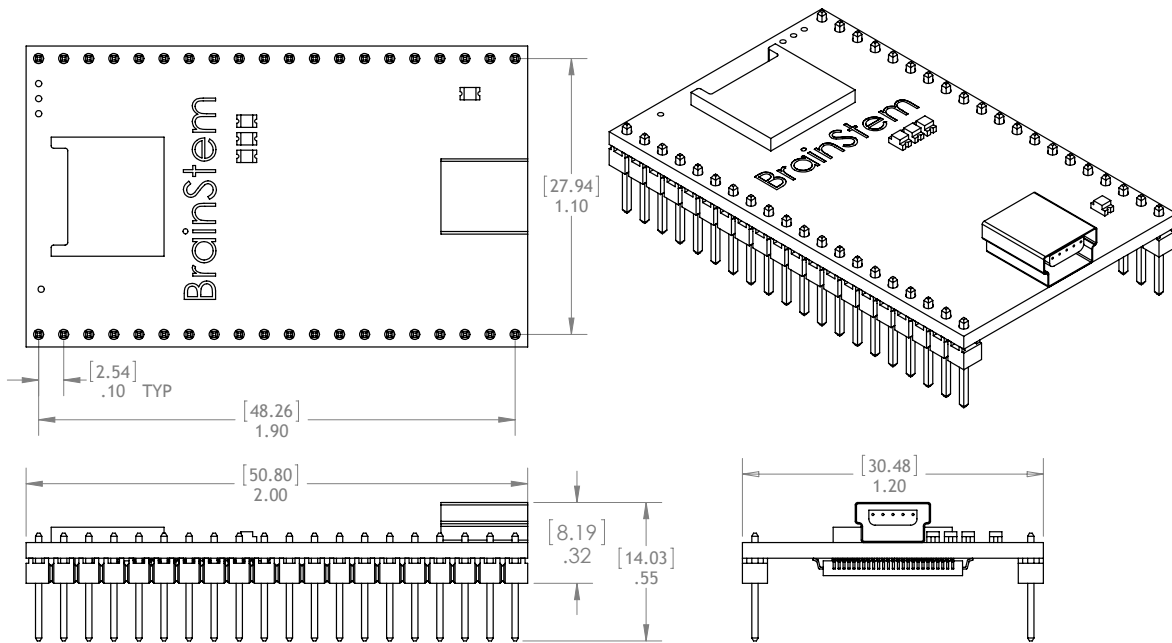


Figure 3: BrainStem USBStem Module mechanical dimensions shown in inches [mm].



Document Revision History

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

Revision	Date	Engineer	Description
1.0	July 7, 2014	MJK	Initial revision
1.1	August 27, 2014	ECM	Updated pin mapping, absolute and recommend rating tables