Overview

The S62-MTM-IO-SERIAL is a software controlled USB 2.0 hub designed for use in manufacturing and validation environments. Along with a USB hub with individually controlled data and power (VBUS) lines, the MTM-IO-Serial module features adjustable logic voltage levels, and high current drivers for supplying custom circuitry, and high-speed driverless serial UART ports. All features are controlled by Acroname's proven, extensible and well adopted BrainStem® technology and software API.

Features

- 2 banks of 4 adjustable rail GPIO ports
- All GPIOs overvoltage and overcurrent protected
- 1 fixed, high-current 5.0V output, current limited to 100mA
- 2 independent 1.8V-5.0V adjustable high-current outputs, current limited to 100mA
- 4 downstream USB 2.0 ports, software controlled Hi-Z disable
- 1 downstream USB 2.0 port type-A connector, always on for daisy chaining multiple modules
- 1 downstream USB 2.0 port on edge connector, always on for daisy chaining multiple modules
- 4 adjustable rail serial UART ports (2 per adjustable rail, software controlled Hi-Z disable)
- 1 BrainStem® I^2C FM+ (1 Mbit/s) bus

Description

As part of Acroname's MTM series, the MTM-IO-Serial module is a key component for manufacturing test for electronic devices using a USB 2.0 interface, serial UARTs and one or more interface voltages.

During manufacturing of electronic devices with embedded microcontrollers, it is common to load firmware via serial UART interface with voltage levels the same as a microcontroller's supply voltage. At the same time, other parts of the product need to interface at other voltages, e.g. to provide proper bootstrapping signal. After the proper firmware is loaded, further functional testing and validation testing may be conducted via a USB interface. With the MTM-IO-Serial module, USB power and data lines are individually controlled via a high-level or embedded programming interface. This allows for full testing of a device's USB and stand-alone capabilities. With four controllable USB 2.0 high-speed channels, the MTM-IO-Serial module can easily handle four devices-under-test (DUT) simultaneously. Each USB bus channel can supply up to 500mA. With dedicated USB downstream and upstream channels, the MTM-IO-Serial module can scale with simple daisy chaining via cables or PCB traces; only one cable is needed to connect up to 100 devices.

The MTM-IO-Serial module also provides four high-speed serial UART interfaces which require no specialized driver or kernel extensions on Windows, Linux and MacOS X. Serial UART data rate limits vary with the host operating system, but most systems support up to 230400bps. The serial UARTs are placed into two groups of independent, software adjustable voltage rails which track associated digital input/output (DIO) pin interface voltages. This configuration allows the MTM-IO-Serial module to be used to interface to DUTs which use two different voltage planes. For example, many modern cell phones have application-processors running at one voltage and a radio or baseband processor running at a different voltage. The MTM-IO-Serial module allows these types of complex devices to be tested without complicated, rate limited, unreliable level shifters in the test fixture control board. The serial UART lines can be disabled and put into a "Hi-Z" state to prevent back-powering or browning-out a device-under-test (DUT).

With four digital input/output pins connected to each adjustable rail, the MTM-IO-Serial module is the "central hub" for controlling and interfacing with DUTs in automated functional test (FCT) and in-circuit test (ICT). Each DIO group (DIO0-3, DIO4-7) can drive or sink up to 20mA per bank. There are also auxiliary 100mA current-limited voltage supplies from the two adjustable rails and a fixed 5.0V rail. These rails may be used to ensure the exact equality of interface voltage planes or to even supply power to low-power DUTs or test circuitry.

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 and may permanently damage the device.

Parameter	Minimum	Typical	Maximum	Units
Input Voltage, V_{supply}	6.0	-	14.0	V
V_{supply} current	0.0	-	3200.0	mA
Voltage to any IO pin[1]	0.0	-	V_{supply}	
Voltage to any USB pin	0.0	-	6.0	V

The MTM system is designed to be used in a system where V_{supply} is the highest voltage connected to all MTM modules. Each module is designed to withstand V_{supply} continuously connected to all IOs, excepting those specified above, including accidental reverse polarity connection between V_{supply} and ground (0V). As with all products, care should be taken to properly match interface voltages and use a well architected current-return path to ground for the targeted application.

Handling Ratings

Parameter	Conditions/Notes	Minimum	Typical	Maximum	Units
Ambient Operating Temperature, T_A	Non-condensing	0.0	25.0	70.0	°C
Storage Temperature, T_{STG}		-10	-	+85	°C
Electrostatic discharge, V_{ESD}	IEC 61000-4-2, level 4, contact discharge	0	-	±8000	V

Recommended Operating Ratings

The values presented apply over the full operating temperature, otherwise specifications are at T_A = 25 °C.

Parameter	Conditions/Notes	Min	Typical	Max	Units
Input Voltage, V_{supply}		6.0	-	12.0	V
Current Draw, I_{supply}		10	50	3200	mA
Reset Low Threshold		-	1.15	-	V
I^2C SDA, SCL pins		-	3.3	-	V
UART Tx/Rx Logic High, V_{IH}		0.65 × V_{rail}	-	-	V
UART Tx/Rx Logic Low, V_{IL}		-	-	0.35 × V_{rail}	V
Digital Input Logic High, V_{IH}		0.65 × V_{rail}	-	-	V
Digital Logic Low, V_{IL}		-	-	0.35 × V_{rail}	V
Rail 0 Output Voltage, V_{rail0}	±2%	4.9	5.0	5.1	V
Rail 0 Switched Output Current	Current limited	100	150	200	mA
Rail 1-2 Output Voltage, V_{rail1}, V_{rail2}	Software controlled; ±2%	1.8	-	5.0	V
Rail 1-2 Switch Output Current	Current limited	100	150	200	mA
Rail 1-2 Voltage Error	$V_{rail} \geq 2.5V$	-	-	1	%
Rail 1-2 Voltage Error	$V_{rail} < 2.5V$	-	-	2	%
Rail 1-2 Voltage	$V_{rail} = 1.8V$; ±2%	1.764	1.800	1.836	V
Rail 1-2 Voltage	$V_{rail} = 3.3V$; ±1%	3.267	3.300	3.333	V
Rail 1-2 Voltage	$V_{rail} = 5.0V$; ±1%	4.950	5.000	5.050	V
Digital output drive current[1]	Output set high; Shorted to GND	-	20	30	mA
Digital output sink current[1]	Output set low; connected to V_{rail}	-	-10	-30	mA
USB V_{bus} current limit		500.0	500.0	800.0	mA

[1] It is not recommended to continuously apply more than V_{rail} to any DIO or UART pin.
[2] Internal I^2C 330Ω pull-up resistors to 3.3V are enabled by firmware when module is the bus router.

Block Diagram

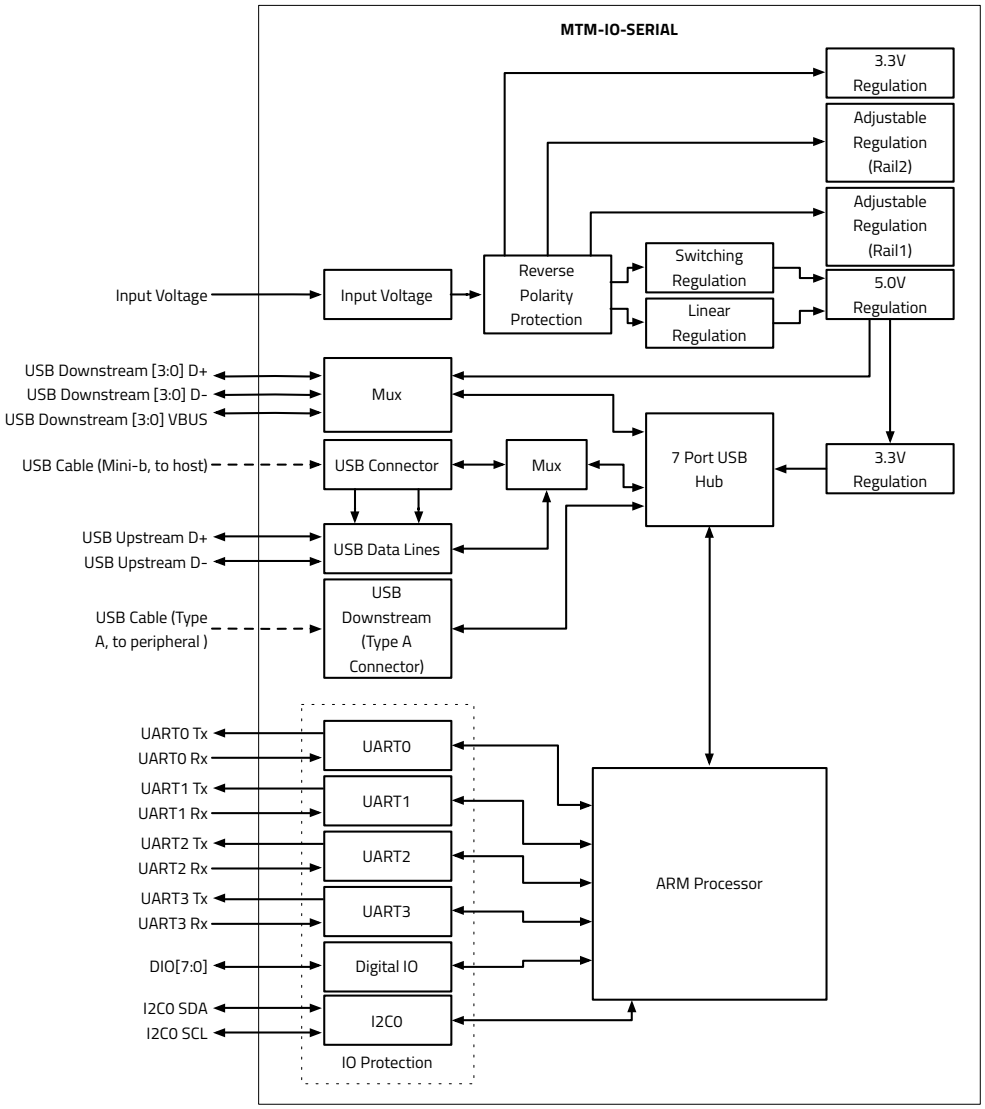
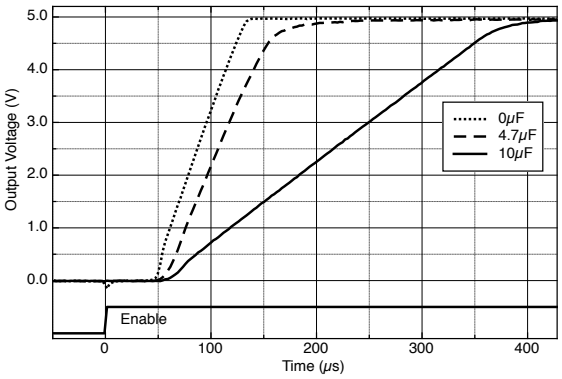


Figure 1: MTM-IO-Serial module system block diagram

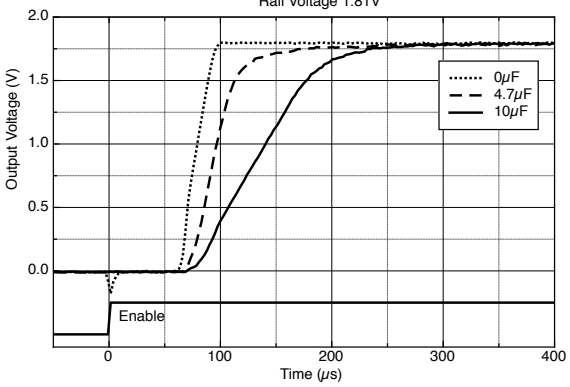
Typical Performance Characteristics

Representative of typical performance and conditions at 25°C ambient, 6.0V input supply, unless otherwise noted.

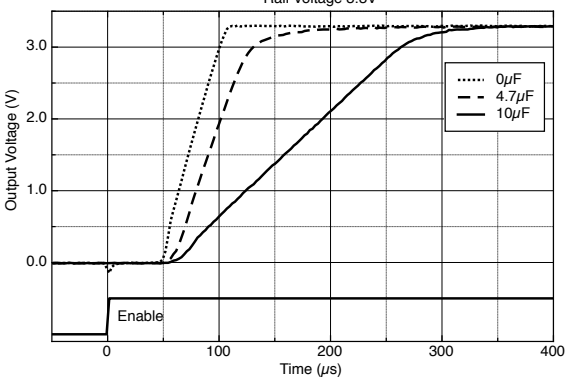
Fixed 5.0V Rail Enable Voltage vs Time



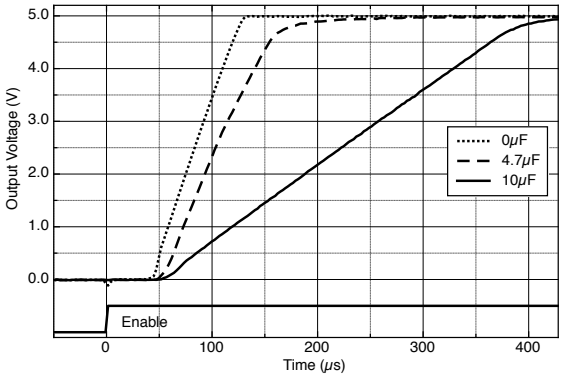
Adjustable Rail Enable Voltage vs Time
Rail Voltage 1.81V



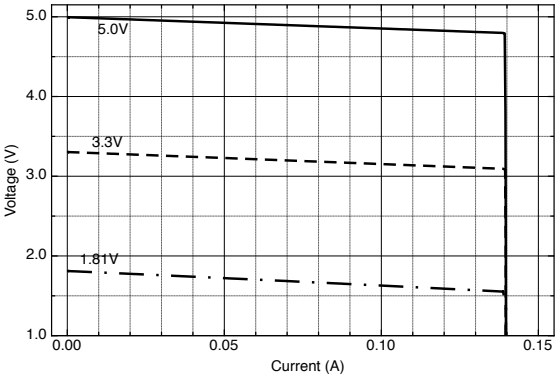
Adjustable Rail Enable Voltage vs Time
Rail Voltage 3.3V



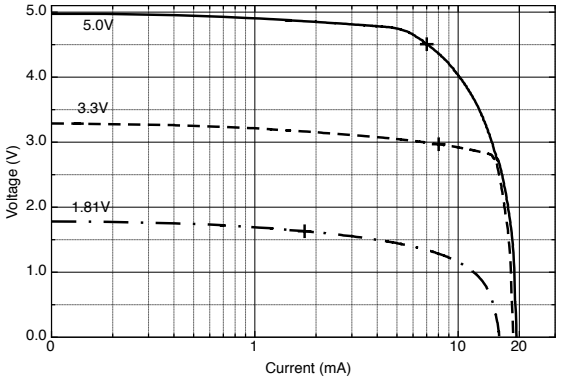
Adjustable Rail Enable Voltage vs Time
Rail Voltage 5.0V

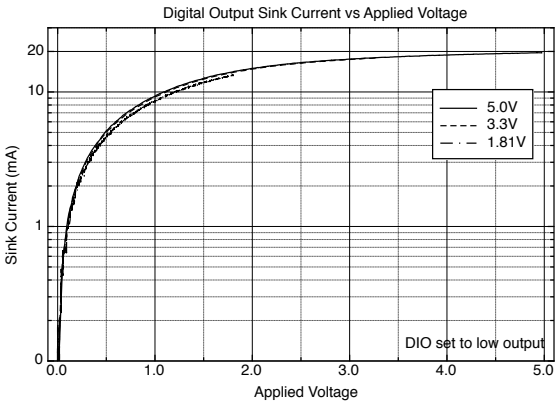


Adjustable Rail Output Voltage vs Output Load Current



Digital Output High Voltage vs Current Load




Digital Output Sink Current vs Applied Voltage
Sink Current (mA)
20
10
1
0
0.0
1.0
2.0
3.0
4.0
5.0
Applied Voltage
5.0V
3.3V
1.81V
DIO set to low output

Pin Functionality

Edge connector pin designators may be omitted if no functionality is present.

Side A	Description	Notes	Side B	Description	Notes
A1	Ground		B1	Input Voltage	
A2	Ground		B2	Input Voltage	
A3	Ground		B3	Input Voltage	
A4	Ground		B4	Input Voltage	
A5	Reset	Pull to ground to assert	B5	Input Voltage	
A6	Ground		B6	Reserved	Do not connect
A7	Ground		B7	Reserved	Do not connect
A8	I^2C0 SDA[3]	Module includes a 330 kΩ pull-up resistor	B8	Ground	
A9	I^2C0 SCL[3]	Module includes a 330 kΩ pull up resistor	B9	Ground	
A10	Ground		B10	UART0 Tx	
A11	Ground		B11	UART0 Rx	
A12	Module Offset[0]	Pull to ground to set	B12	Module Offset[2]	Pull to ground to set
A13	Module Offset[1]	Pull to ground to set	B13	Module Offset[3]	Pull to ground to set

Table 1: Pin position mappings common to all BrainStem® Link modules

[3] This I^2C bus is usually reserved for BrainStem functionality. Consult with Acroname if you'd like to attach other devices to this bus.

Side A	Description	Notes	Side B	Description	Notes
A14	Reserved	Do not connect	B14	USB Upstream D+	Software selectable[4]
A15	UART2 Transmit	Rail2 voltage; output	B15	USB Upstream D-	Software selectable[4]
A16	UART2 Receive	Rail2 voltage; input	B16	UART1 Transmit	Rail1 voltage; output
A17	UART3 Transmit	Rail2 voltage; output	B17	UART1 Receive	Rail1 voltage; input
A18	UART3 Receive	Rail2 voltage; input	B18	Digital 0	Rail1 voltage
A19			B19	Digital 1	Rail1 voltage
A20			B20	Digital 2	Rail1 voltage
A21			B21	Digital 3	Rail1 voltage
A22			B22	Digital 4	Rail2 voltage
A23			B23	Digital 5	Rail2 voltage
A24			B24	Digital 6	Rail2 voltage
A25			B25	Digital 7	Rail2 voltage
A31	Rail1 output	Adj. voltage; 100mA limit	B31	Rail2 output	Adj. voltage; 100mA limit
A32			B32	Rail0 output	Fixed 5.0V; 100mA limit
A33	Ground		B33	USB2 V_{BUS}	Default disabled.[5]
A34	USB0 D+	Default disabled.[5]	B34	USB2 D-	Default disabled.[5]
A35	USB0 D-	Default disabled.[5]	B35	USB2 D+	Default disabled.[5]
A36	USB0 V_{BUS}	Default disabled.[4]	B36	Ground	
A37	Ground		B37	USB3 V_{BUS}	Default disabled.[5]
A38	USB1 D+	Default disabled.[5]	B38	USB3 D-	Default disabled.[5]
A39	USB1 D-	Default disabled.[5]	B39	USB3 D+	Default disabled.[5]
A40	USB1 V_{BUS}	Default disabled.[4]	B40	Ground	
A42			B42	USB Edge D+	Always ON.[4]
A43			B43	USB Edge D-	Always ON.[4]
A45	V_{supply}		B45	Ground	
A46	V_{supply}		B46	Ground	
A47	V_{supply}		B47	Ground	
A48	V_{supply}		B48	Ground	
A49	V_{supply}		B49	Ground	

Table 2: Pin position mappings specific to MTM-IO-Serial module

[4]The always on downstream and upstream USB connections on the edge connector are intended to be used for daisy chaining multiple MTM modules.
[5]See operation section.

Module Hardware and Software System Default Values

The MTM-IO-Serial module utilizes a subset of BrainStem entity implementations that are specific to the hardware's capabilities. The table below details the BrainStem API entities and macros used to interface to the MTM-IO-Serial module.

Parameter	Value	Implementation Macro Name	Notes
Module Definitions:			
Module Base Address	8	aMTMIOSERIAL_MODULE_BASE_ADDRESS	See Page 9
UART Entity Quantity	4	aMUX_UART_NUM_CHANNELS	Passthrough to host
Entity Definitions:			
Digital Entity Quantity	8	aMTMIOSERIAL_NUM_DIGITALS	See Page 9
Rail Entity Quantity	3	aMTMIOSERIAL_NUM_RAILS	See Page 9
5.0V Rail (RAIL0)	0	aMTMIOSERIAL_5VRAIL	
Adjustable Rail (RAIL1)	1	aMTMIOSERIAL_ADJRAIL1	
Adjustable Rail (RAIL2)	1	aMTMIOSERIAL_ADJRAIL2	
Minimum Rail Voltage	1800000	aMTMIOSERIAL_MIN_MICROVOLTAGE	
Maximum Rail Voltage	5000000	aMTMIOSERIAL_MAX_MICROVOLTAGE	
Mux Entity Quantity	2	aMTMIOSERIAL_NUM_MUX	See Page 10
USB Mux Quantity	9	aMUX_USB_NUM_CHANNELS	
Downstream Channels			See Page 10
USB CH0 Power	0	aMUX_USBA_POWER	Disabled by default
USB CH0 Data	1	aMUX_USBA_DATA	Disabled by default
USB CH1 Power	2	aMUX_USBB_POWER	Disabled by default
USB CH1 Data	3	aMUX_USBB_DATA	Disabled by default
USB CH2 Power	4	aMUX_USBC_POWER	Disabled by default
USB CH2 Data	5	aMUX_USBC_DATA	Disabled by default
USB CH3 Power	6	aMUX_USBD_POWER	Disabled by default
USB CH3 Data	7	aMUX_USBD_DATA	Disabled by default
Upstream Channel			See Page 10
USB Upstream	8	aMUX_USB_UPSTREAM	Enabled by default
Upstream Cfg Auto	0	aMUX_USB_UPSTREAM_CONFIG_AUTO	Default mode
Upstream Cfg Edge	1	aMUX_USB_UPSTREAM_CONFIG_EDGE	
Upstream Cfg Connector	2	aMUX_USB_UPSTREAM_CONFIG_ONBOARD	

Capabilities and Interfaces

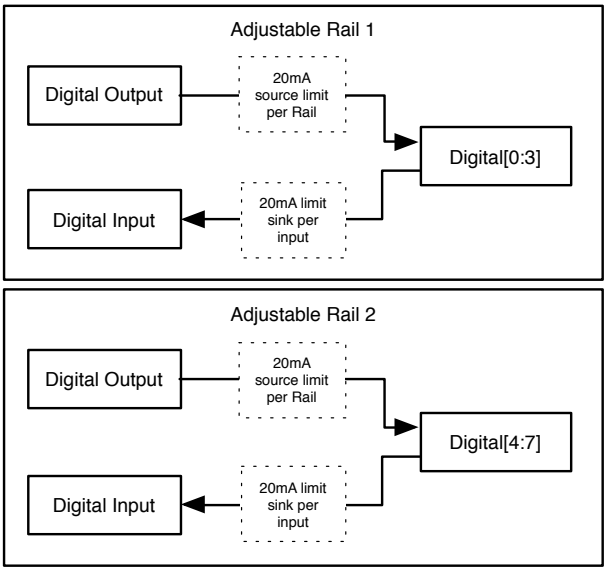
The MTM-IO-Serial module software is built on BrainStem® technology. The module adheres to the BrainStem protocol on I^2C and uses BrainStem software APIs. Each functional capacity that is available on the MTM-IO-Serial module is described in the following sections.

Module Default Address

All BrainStem modules come with a specific default network I^2C base address for identification on the I^2C bus. The default module base address is factory defaulted to value 8, which is defined in the source file aMTMIOSerialDefs.h.

Digital Entities

Digital inputs and outputs are unique in the sense that each digital input/output (DIO) is voltage adjustable via software and current limited. Each DIO pin has a current limiting circuit allowing 20mA of current to be sourced or sinked by each pin. When a digital line is configured as an output, the whole bank (0-3, 4-7) is limited in total to 20mA sourcing capability. Page 4 shows a plot of expected output voltage for different voltage rail values as a function of current draw. It is not recommended to apply more than the configured rail voltage to any DIO pin.



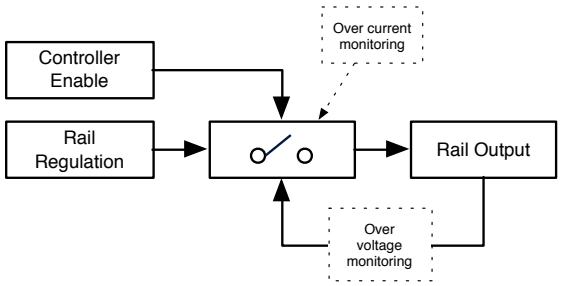
The supported digital operating modes, and how they correspond to voltage rails, are as shown in the digital operational modes table. DIO capabilities may change with future firmware revisions. Please contact Acroname to request specific pin capabilities.

Digital	Input	Output	Rail	PWM	Match
DIO0	Yes	Yes	1	No	No
DIO1	Yes	Yes	1	No	No
DIO2	Yes	Yes	1	No	No
DIO3	Yes	Yes	1	No	No
DIO4	Yes	Yes	2	No	No
DIO5	Yes	Yes	2	No	No
DIO6	Yes	Yes	2	No	No
DIO7	Yes	Yes	2	No	No

Table 3: Digital operational modes

Rail Entities

Rails allow other devices and peripherals to consume power from the MTM-IO-Serial module in a controlled fashion. Three (3) different rails are available for use in a variety of applications. A fixed 5.0V rail (RAIL0) and two (2) adjustable voltage rails (RAIL1, RAIL2) can be switched on or off through software control. Each rail is current limited to 150mA and an overcurrent condition will disable the power. Once the overcurrent condition is appropriately removed, the rail power can be turned back on through software by disabling and then re-enabling the rail.

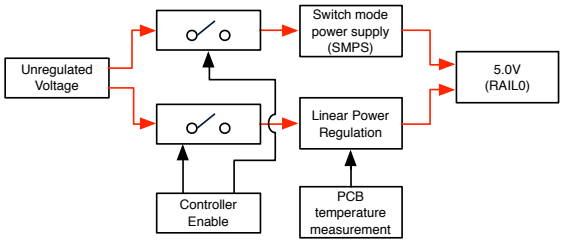


Overvoltage conditions occur when a voltage above the rail's setpoint will also disable the rail's output. After the overvoltage condition is safely removed, the voltage rail will resume desired operation without any software intervention.

The 5.0V fixed regulation stage is unique since it can be configured to operate in either a switch mode power supply or linear regulation mode. For applications such

as RF system testing, one might want to operate only in linear regulation mode to eliminate any potential EMI sources. While operating in linear mode, one must be aware of power dissipation through the linear regulation stage. A higher input voltage will result in higher power dissipation. When linear mode is desired and high current operation is desired it is recommended to run the input voltage close to the MTM-IO-Serial module's minimum input voltage. Switch mode power supply operation will allow a broader range of input voltages while maintaining high current demand limits. Default behavior is to auto-switch to switch mode power supply if an input voltage greater than 7.25V is applied.

A simplified block diagram for the 5.0V regulation stage shows the two different power paths.



Printed circuit board (PCB) temperature can be monitored at the 5.0V rail (RAIL0) linear regulation stage. Reading this value is possible through the API. Temperature monitoring is also used internally to prevent the power regulation stage from over heating and self preserving the power stage. If an overtemperature condition occurs, then the MTM-IO-Serial module will disable the linear regulator until safe operating temperatures are reached.

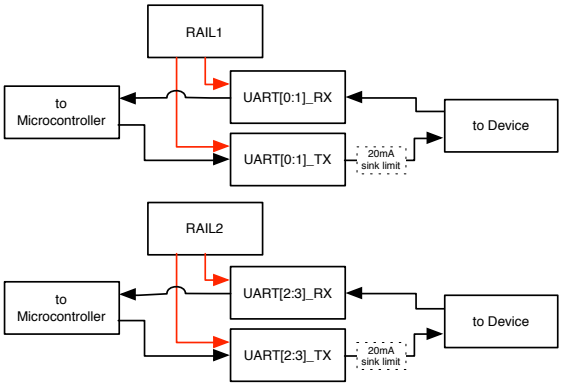
Mux Entities

Mux entities provide a mechanism to enable and disable UART data lines as well as USB connections. Mux entities for the MTM Software Controlled USB Hub can simulate cable disconnect events.

UART Mux Channels

All of the UARTs that are passed down from the MTM-IO-Serial module can be turned off through software control. If a voltage is applied that is higher than the current RAIL voltage setpoint, each UART transmit line is current limited to 20mA sinking. Therefore, only a small amount of current will flow into the device, preventing any damage to the MTM Software Controlled USB Hub's hardware.

UARTs are grouped in two with a corresponding voltage rail. UART0 and UART1 share RAIL1's voltage reference. UART2 and UART3 share RAIL2's voltage reference.



When a UART is disabled by means of the cmdMUX, all exposed UART data lines will be discharged by being pulled to Ground through a 10kΩ resistor.

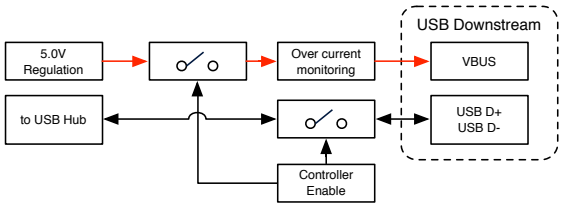
USB Upstream Mux Channel

Two different USB Upstream connections are available for use on the MTM-IO-Serial module - the physical mini-b USB connector on the board and also through the edge connector. The default operation mode is to have the USB upstream (to a host computer) enable and auto detect which USB port to use. Automatic detection is performed by the presence of a VBUS connection coming through the mini-b USB connector. Otherwise, the connection to the edge connector will be the default input.

USB upstream datelines D+ and D- to the host can be set to a Hi-Z state through software control. Caution should be taken with this capability as it can prevent any host level communication without being re-enabled either by a Reflex routine or a reset event.

USB Downstream Mux Channel

Both data lines and power (VBUS) can be manipulated independently to each downstream USB port.



If an overcurrent condition is detected in hardware on a downstream VBUS line, then the software enable control will be disabled automatically. Once the overcurrent condition is removed, one can safely enable the VBUS line. If the overcurrent condition still exists, the VBUS will be disabled.

Additional Downstream USB Ports

Also included onboard the MTM-IO-Serial module is an “always on” downstream USB port through a Type A USB connector. This port cannot be controlled through software and is current limited to 500mA by the hub.

Another “always on” downstream USB port connection is also included on the edge connector. Connection to this port requires proper trace impedance matching at 90Ω differential. Trace width and spacing will depend on one’s printed circuit board design.

Mechanical

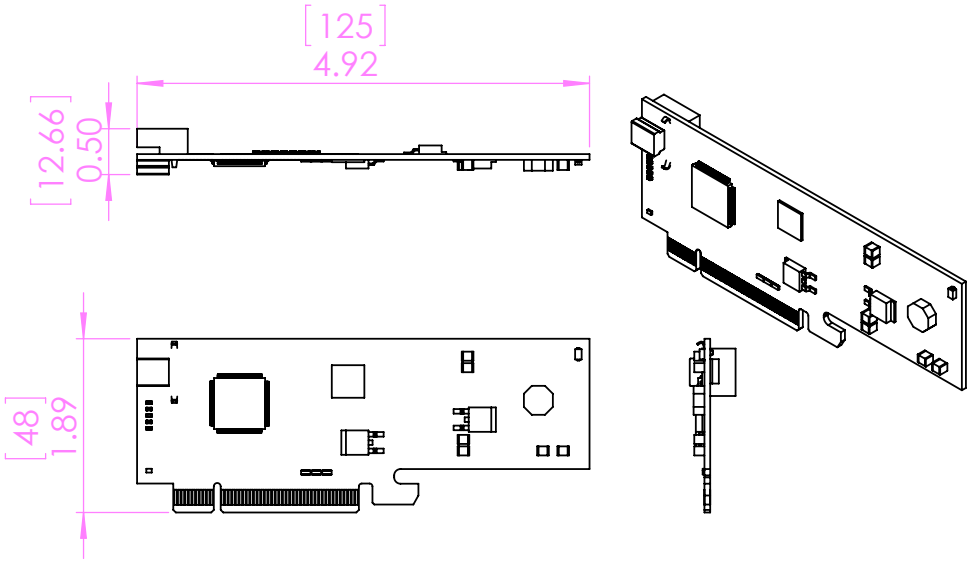


Figure 2: MTM Software Controlled USB Hub mechanical dimensions shown in inches [mm].

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	February 26, 2015	MJK	Added information about class entities, module specifics
1.2	March 3, 2015	JLG	Updated performance data
1.3	April 16, 2015	MAB	Corrected typographical errors