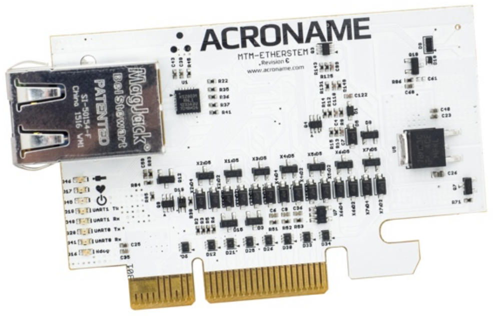


Overview

The MTM-EtherStem, as part of Acroname® MTM (Manufacturing Test Module) product series, is a ruggedized general-purpose automation and IO module for use in MTM-based test systems. The MTM-EtherStem allows MTM system designers a simple way to add digital and analog IO to their designs. Access to all available MTM resources can be implemented through an Ethernet connection.

Ideal for reliability and robustness in manufacturing or R&D environments, the analog and digital outputs on the MTM-EtherStem are protected and against overvoltage, short-circuit and overcurrent events. The low profile and small footprint of the MTM-EtherStem module makes it ideal for direct integration into test fixtures, thereby eliminating the need for external programmable IO cards or DMMs and their associated cabling.

Built using Acroname’s industry-proven and well-adopted BrainStem® technology, resources on the MTM-EtherStem are controlled via Acroname's powerful and extensible BrainStem technology and software APIs.

Typical Application

– Functional test-system instrumentation
– In-circuit testing
– Motion control in manufacturing applications
– General test and measurement

Features

– 15 Digital GPIOs (overvoltage and current protected)
– 3 12-bit ADCs (overvoltage and current protected)
– 1 10-bit DAC (overvoltage and current protected)
– 1 real-time, user-configurable clock
– 1 user-dedicated I²C 400kHz bus
– 1 BrainStem I²C FM+ (1Mbit/s) bus

Description

As part of Acroname's MTM product series, the MTM-EtherStem is used to implement general purpose control and automation functions in an MTM-based test system and also adds an Ethernet connection to the MTM network. Details on the MTM development platform architecture, BrainStem interface, and APIs can be found at https://acroname.com/reference.

The MTM-EtherStem implements an onboard BrainStem controller running a RTOS (Real-Time Operating System), which provides a host connection independent operating capability, the BrainStem interface and the MTM resources identified in this datasheet (GPIO, analog IO, I2C, etc.). These resources can be controlled from a host computer over Ethernet or in a network of MTM modules.

MTM- EtherStem can be used to make measurements, control signal-conditioning circuitry, or for automation control of mechanical systems via servos or other electromechanical systems. This versatile module is an ideal start and core part of any functional test-system.

IMPORTANT NOTE

The MTM-EtherStem utilizes a PCIe connector interface but is for use strictly in MTM-based systems. It should never be installed in a PCI slot of a host computer directly. Insertion into a PC or non-MTM system could cause damage to the PC.

Absolute Maximum Ratings

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.

Voltage Rating	Minimum	Maximum	Units
Input Voltage, V_{supply}	-13.2	13.2	V
I2C0 SDA, SCL	-0.5	13.2	V
UART TX/RX	-0.5	13.2	V
DIO 0-14	-0.5	13.2	V
Module Address 0-3	-0.5	13.2	V
Reset	-0.5	13.2	V
Analog 0-2 – input	-0.5	13.2	V
Analog 3 – output	-0.5	V_{supply}	V

Table 1: Absolute Maximum Ratings

Current Rating	Minimum	Maximum	Units
Input Current, I_{supply}	0.0	5.5	A

Table 2: Absolute Maximum Current Ratings

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 ensure a well-architected current-return path to ground.

Handling Ratings

Parameter	Conditions/Notes	Minimum	Typical	Maximum	Units
Storage Temperature, T_{STG}		-10	-	85	°C
Relative Humidity Range	Non-Condensing	5	-	95	%RH
Electrostatic Discharge, V_{ESD}	IEC 61000-4-2, level 4, contact discharge to edge connector interface	-8	-	+8	kV
Indoor Use Only		-	-	-	-

Table 3: 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
Input Voltage, V_{supply}		6.0	-	12.0	V
Voltage to any IO pin		0	-	3.3	V
Voltage to any I2C pin		0	-	3.3	V
Ambient Operating Temperature, T_A	Non-Condensing	0	25	70	°C
Relative Humidity Range	Non-Condensing	5	-	95	%RH

Table 4: Recommended Operating Ratings

Block Diagram

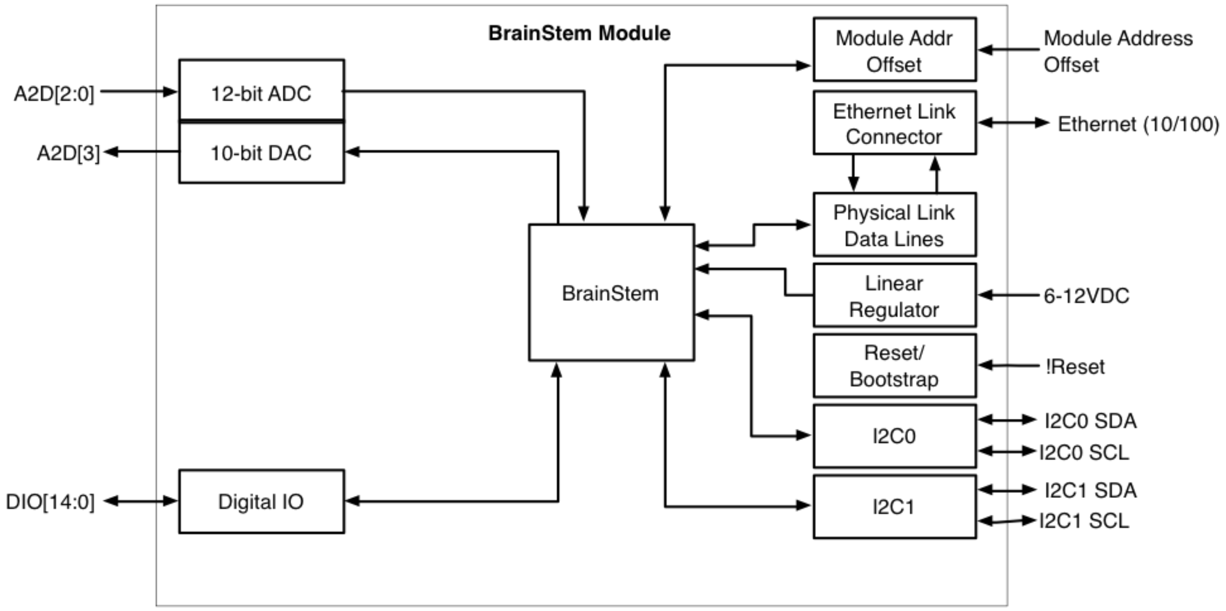


Figure 1: MTM-EtherStem Block Diagram

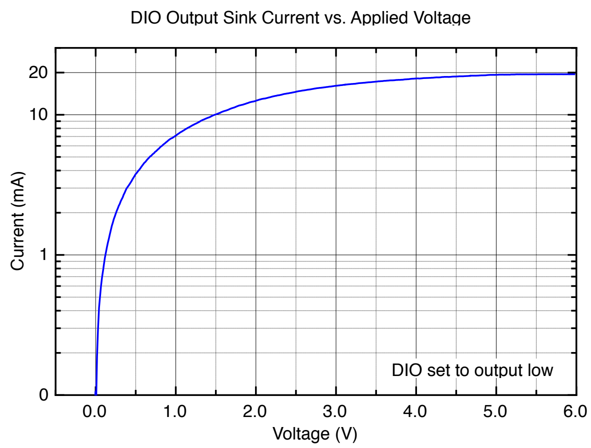
Typical Performance Characteristics

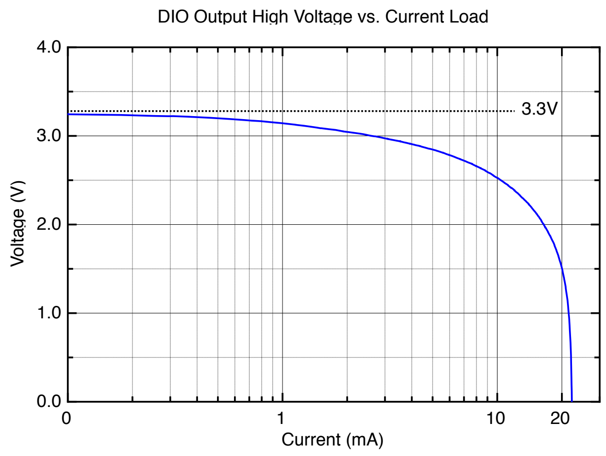
Specifications are valid at 25°C unless otherwise noted. Indoor application use only. Sample rates are typically limited by the Ethernet throughput of the host operating system except where bulk capture is supported.

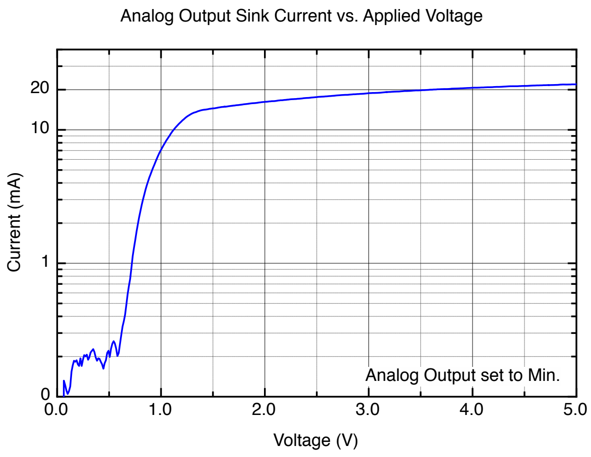
Parameter	Conditions/Notes	Minimum	Typical	Maximum	Units
Base Current Consumption, I_{supply}	V_{supply}=6V V_{supply}=12V	- -	83 102	- -	mA
Reset Low Threshold		-	1.2	-	V
I2C SDA, SCL Pins		0.0	-	3.3	V
Digital Input Logic High, V_{IH}		2.15	-	-	V
Digital Input Logic Low, V_{IL}		-	-	1.1	V
Digital Input Leakage Current	Mode set Input or Hi-Z	-	110	-	µA
Digital Input Resistance	Mode set Input or Hi-Z	-	4.25	4.45	MΩ
Digital Output V_{OH}		-	3.3	-	V
Digital Output Drive Current	Output high; short to GND Output high into 2.97V	- -	20.0 3.15	30.0 -	mA
Digital Output Sink Current	Output low; short to V_{supply}	-	-20.0	-30.0	mA
Digital Output Short Duration	Output high	-	Infinite	-	hours
Digital Output Overvoltage	V_{supply} on pin	-	Infinite	-	hours
Digital Output Sink Current		-	-	-20.0	mA
Digital Output Source Current	Output high; short to GND V_{output} = 0.9* V_{OH}	- -	20.0 3.15	30.0 -	mA
Digital Sample Rate[1]	via TCP/IP link, C++ Reflex	- -	1000 8200	- -	Hz
Analog Output Sink Current		-	-	-20.0	mA
Analog Output Source Current	Set at max. output	-	-	19.0	mA
Analog Output Voltage		0.035	-	3.3	V
Digital Input Resistance	Configuration mode set to both Input and Hi-Z	-	4.25	4.45	MΩ
Digital Input Leakage Current	Configuration mode set to both Input and Hi-Z	-	110	-	µA
Analog Input Leakage Current		-	110	-	µA
Analog Input Resistance		-	4.25	4.45	MΩ

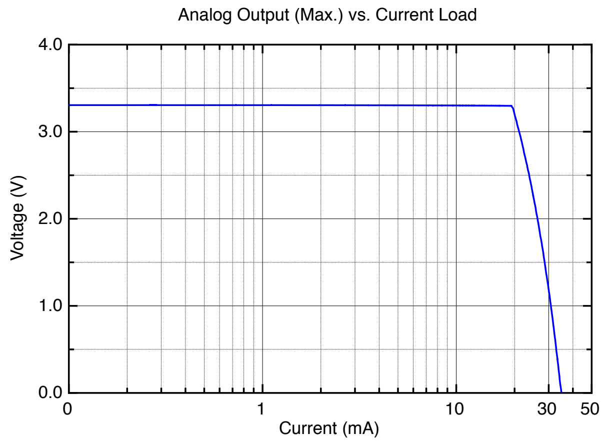
Table 5: Typical Performance Characteristics

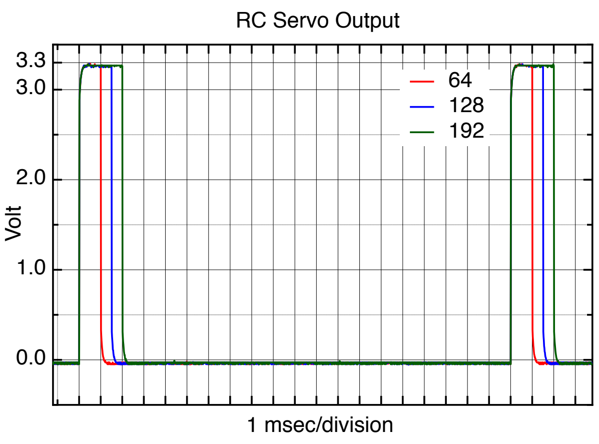
[1] Host dependent, test was done as a single instruction, subsequent instructions may affect performance. Measurements taken using BrainStem Library 2.3.2. The Nyquist frequency should be considered when referring to these values.

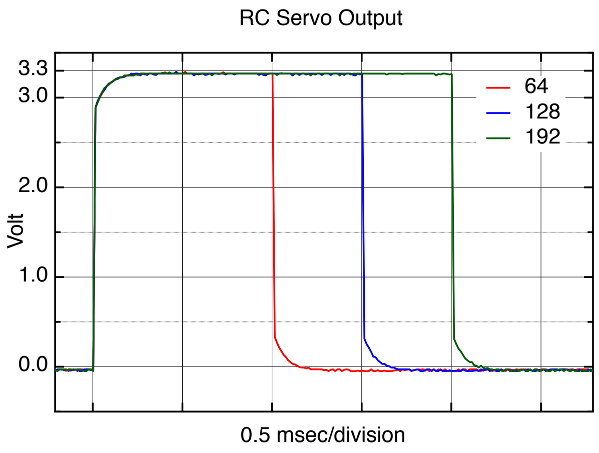

DIO Output Sink Current vs. Applied Voltage
20
10
1
0
Current (mA)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
Voltage (V)
DIO set to output low


DIO Output High Voltage vs. Current Load
4.0
3.0
2.0
1.0
0.0
Voltage (V)
3.3V
0
1
10
20
Current (mA)


Analog Output Sink Current vs. Applied Voltage
20
10
1
0
Current (mA)
0.0
1.0
2.0
3.0
4.0
5.0
Voltage (V)
Analog Output set to Min.


Analog Output (Max.) vs. Current Load
4.0
3.0
2.0
1.0
0.0
Voltage (V)
0
1
10
30
50
Current (mA)

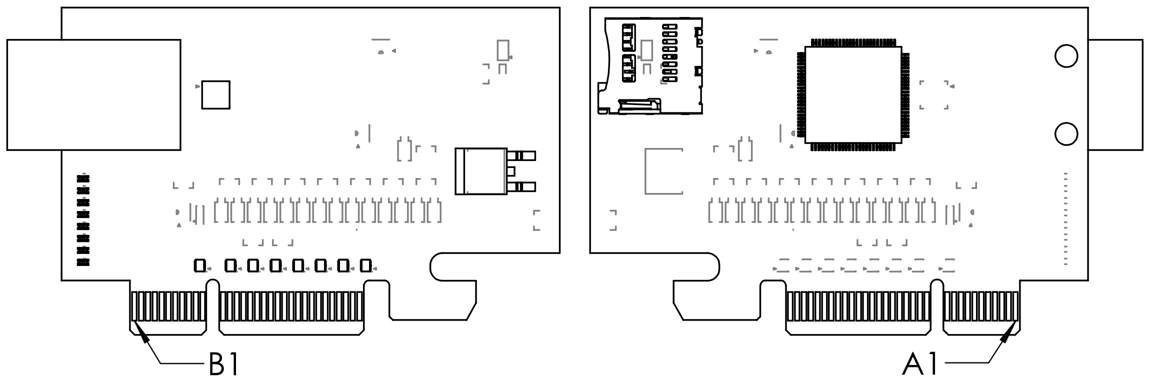

RC Servo Output
3.3
3.0
2.0
1.0
0.0
Volt
64
128
192
1 msec/division


RC Servo Output
3.3
3.0
2.0
1.0
0.0
Volt
64
128
192
0.5 msec/division

Pinout Descriptions

WARNING: MTM modules use a PCIe connector interface that is common in most desktop computers; however, they are NOT intended nor designed to work in these devices. Do NOT insert this product into any PCIe slot that wasn't specifically designed for MTM modules, such as a host PC. Installing this module into a standard PCI slot will result in damage to the module and the PC.

The MTM edge connector pin assignments are shown in the following table. Please refer to Table 4: Recommended Operating Ratings for appropriate signal levels.



Pins Common to all MTM Modules

Side A	Edge Connector Side A Description	Side B	Edge Connector Side B Description
1	GND	1	Input Voltage, V_{supply}
2	GND	2	Input Voltage, V_{supply}
3	GND	3	Input Voltage, V_{supply}
4	GND	4	Input Voltage, V_{supply}
5	Reset	5	Input Voltage, V_{supply}
6	GND	6	Reserved, Do Not Connect
7	GND	7	Reserved, Do Not Connect
8	I^2C0 SCL	8	GND
9	I^2C0 SDA	9	GND
10	GND	10	Reserved, Do Not Connect
11	GND	11	Reserved, Do Not Connect
12	Module Address Offset 0	12	Module Address Offset 2
13	Module Address Offset 1	13	Module Address Offset 3

Table 6: Pins Common to all MTM Modules

Pins Specific to MTM-EtherStem

Side A	Edge Connector Side A Description	Side B	Edge Connector Side B Description
14	Reserved, Do Not Connect	14	Reserved, Do Not Connect
15	Reserved, Do Not Connect	15	Reserved, Do Not Connect
16	Reserved, Do Not Connect	16	Reserved, Do Not Connect
17	I2C1 SCL	17	Reserved, Do Not Connect
18	I2C1 SDA	18	Digital IO 0
19	Reserved, Do Not Connect	19	Digital IO 1

Side A	Edge Connector Side A Description	Side B	Edge Connector Side B Description
20	Reserved, Do Not Connect	20	Digital IO 2
21	Reserved, Do Not Connect	21	Digital IO 3
22	Reserved, Do Not Connect	22	Digital IO 4
23	Reserved, Do Not Connect	23	Digital IO 5
24	Analog 0	24	Digital IO 6
25	Analog 1	25	Digital IO 7
26	Reserved, Do Not Connect	26	Digital IO 8
27	Reserved, Do Not Connect	27	Digital IO 9
28	Reserved, Do Not Connect	28	Digital IO 10
29	Reserved, Do Not Connect	29	Digital IO 11
30	Reserved, Do Not Connect	30	Digital IO 12
31	Analog 2	31	Digital IO 13
32	Analog 3	32	Digital IO 14

Table 7: Pins Specific to MTM-EtherStem

Module Hardware and Software Default Values

Software Control

The MTM-EtherStem module firmware is built on Acroname's BrainStem technology and utilizes a subset of BrainStem entity implementations that are specific to the hardware's capabilities. Table 8 details the BrainStem API entities and macros used to interface to the MTM-EtherStem module. For C and C++ developers, these macros are defined in `aMTMEtherStem.h` from the BrainStem development package. For Python development, the module `MTMEtherStem` class defines the extent of each entity array.

While **Error! Reference source not found.** lists the BrainStem API entities available for this module, not all entity methods are supported by the MTM-EtherStem. For a complete list of supported entity methods, see Table 13. Note that available method options may vary by entity index, as well as by entity, and calling an unsupported entity option will return an appropriate error (e.g.: `aErrInvalidEntity`, `aErrInvalidOption`, `aErrMode`, or `aErrUnimplemented`) as defined in `aError.h` for C and C++ and the `Result` class in Python.

All API example code snippets that follow are pseudocode loosely based on the C++ method calls - Python and Reflex are similar. Please consult the BrainStem Reference for specific implementation details**Error! Bookmark not defined.**

Parameter	Index	Macro Name or Implemented Options	Notes
Module Definitions:			
Module Base Address	4	aMTM_ETHERSTEM_MODULE_BASE_ADDRESS	See aMTMEtherStem.h
Entity Class Definitions:			
`digital` Entity Quantity	15	aMTM_ETHERSTEM_NUM_DIG	
`analog` Entity Quantity	4	aMTM_ETHERSTEM_NUM_A2D	
`i2c` Entity Quantity	2	aMTM_ETHERSTEM_NUM_I2C	
`clock` Entity Quantity	1		
`store` Entity Quantity	3	aMTM_ETHERSTEM_NUM_STORES	
`system` Entity Quantity	1		
`timer` Entity Quantity	8	aMTM_ETHERSTEM_NUM_TIMERS	
`app` Entity Quantity	4	aMTM_ETHERSTEM_NUM_APPS	
`pointer` Entity Quantity	4	aMTM_ETHERSTEM_NUM_POINTERS	
`servo` Entity Quantity	8	aMTM_ETHERSTEM_NUM_SERVOS	

Table 8: MTM-EtherStem Hardware and Software Default Values[2]

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

Capabilities and Interfaces

BrainStem Link and Module Networking

A BrainStem link can be established that will give the user access to the resources available on the MTM-EtherStem. The module can then be controlled via a host running BrainStem APIs or operated independently by running locally embedded, user-defined programs based on Acroname's BrainStem Reflex language in the RTOS.

A BrainStem link to the MTM-EtherStem can be established via one of two (2) interfaces: the onboard Ethernet connection or through another MTM module using the BrainStem protocol (more on this interface below). For the Ethernet connection, once the MTM-EtherStem is attached to a host machine, a user can connect to it via software API:

```
stem.link.discoverAndConnect(linkType,
serialNumber, modelNumber)
```

The MTM-EtherStem can also work within a network of other Brainstem modules, such as in a test fixture, to give access to the capabilities of all networked modules. On the MTM platform, networked modules communicate using the Brainstem protocol, which is transmitted over I^{2}C. Each MTM-EtherStem is uniquely addressable via hardware or software to avoid communication conflicts on the I^{2}C bus. A software offset can be applied as follows:

```
stem.system.setModuleSoftwareOffset(address)
```

Module Address Hardware Offset Configuration

A hardware offset allows a user to modify the module's address on the BrainStem network. Using hardware offset pins is useful when more than one of the same module type is installed on a single BrainStem network. Applying a different hardware offset to each module of the same type in one network allows for all the modules to seamlessly and automatically configure the network for inter-module communication. Further, modules can be simply swapped in and out of the network without needing to pre-configure a module's address before being added to a network. Finally, when a system has more than one of the same module type in a network, the module address hardware offset can be used to determine the module's physical location and thus its interconnection and intended function. For detailed information on BrainStem networking see the BrainStem ReferenceError! Bookmark not defined..

Each hardware offset pin can be left floating or pulled to ground with a 1kΩ resistor or smaller (pin may be directly shorted to ground). Pin states are only read when the module boots, either from a power cycle, hardware reset, or software reset. The hardware offset pin states are treated as a bit state within a 4bit number. This number is multiplied by 2 and added the to the module's base address. The hardware offset calculation is detailed in the following table:

HW Offset Pin				Address Offset	Module Base Address	Final Module Address
3	2	1	0			
NC	NC	NC	NC	0	4	4
NC	NC	NC	1	2	4	6
NC	NC	1	NC	4	4	8
NC	1	NC	NC	8	4	12
1	NC	NC	NC	16	4	20
1	NC	NC	1	(1+8) * 2	4	22

Table 9: Module Address Hardware Offset Examples

Link and TCP/IP Settings

The MTM-EtherStem supports host computer connections over its Ethernet jack via TCP/IP sockets. The MTM-EtherStem is designed to interact on the local network segment only. Typical setup is a direct Ethernet connection between a host test machine and the MTM-EtherStem. The host can run a DHCP server to provide an IP address to the module or, without a DHCP server, the MTM-EtherStem will fall back to a static IP address of 192.168.44.42/24 when it does not receive a response to DHCP requests. In the fallback IP configuration, manually configuring the host machine interface to communicate on this subnet will enable communication to the module. The module features a limited DHCP client which will not function across a network bridge or other gateway mechanism. The MTM-EtherStem will respond to ICMP "ping" requests including broadcast requests.

The brainstem API interface performs a discovery process prior to establishing communication with the MTM-EtherStem. Brainstem discovery over IP is accomplished using a UDP multicast request on port 9888, and a response on the stem to the host UDP port 9889. The MTM-Etherstem listens for socket connections on TCP port 8000. Firewall rules will need to be configured allowing the outgoing multicast request on 9888 and incoming response on 9889, as well as outgoing socket TCP connections to port 8000.

System Entities

Every BrainStem module includes a single System Entity. The System Entity allows access to configuration settings such as the module address and I^{2}C rate, measurements such as input voltage, control over the user LED, and many more.

Saving Entity Settings

Some entities can be configured and saved to non-volatile memory. This allows a user to modify the MTM-EtherStem's startup and operational behavior *away* from the factory default

settings. Saving system settings creates a new default and often requires a reboot of the MTM-EtherStem for changes to take; see Table 10: Entity Values Saved by system.save() for relevant settings. Use the following command to save changes to system settings before reboot:

```
stem.system.save()
```

Saved Configurations	
Software Offset	I2C Rate
Router Address	Boot Slot
Heartbeat Rate	

Table 10: Entity Values Saved by system.save()

Store Entities

Every BrainStem module includes several Store entities and onboard memory slots to load Reflex files (for details on Reflex, see BrainStem Reference[3]). One Reflex file can be stored per slot. Store[0] refers to the internal flash memory, with 12 available slots, and store[1] refers to RAM, with 1 available slot.

Digital Entities

The MTM-EtherStem has fifteen (15) digital input/outputs (DIO) controlled by the digital entity. Each DIO is controllable via software and is independently current limited for both source and sink currents.

All DIO are input and output capable:

```
stem.digital[0].setConfiguration(mode)
stem.digital[0].getConfiguration(mode)
```

The *mode* parameter is an integer that correlates to the following:

Value	Configuration
0	Input
1	Output
2	RC Servo Input
3	RC Servo Output
4	Hi Impedance (Hi-Z)
5	Input with Pull Down

Table 11: Digital IO Configuration Values

Example: If a digital pin is configured as an output, set the digital logic level:

```
stem.digital[0].setState(level)
```

Example: If a digital pin is configured as an input, read the digital logic level:

```
stem.digital[0].getState(level)
```

If a digital pin is configured in Hi-Z mode its internal circuitry has been disconnected to create a high impedance. There are no functions that can act on this configuration.

Configuring a digital pin as an RCServo input or output requires use of the RCServo Entity. The RCServo input and output modes are only available on a subset of the digital pins. Refer to Table 12: Digital IO Pin Configurations for a complete list. **Note**: Signal entity is covered in a subsequent section

Pin	Input	Output	Hi-Z	RCServo
DIO 0	Yes	Yes	Yes	Input
DIO 1	Yes	Yes	Yes	Input
DIO 2	Yes	Yes	Yes	Input
DIO 3	Yes	Yes	Yes	Input
DIO 4	Yes	Yes	Yes	Output
DIO 5	Yes	Yes	Yes	Output
DIO 6	Yes	Yes	Yes	Output
DIO 7	Yes	Yes	Yes	Output
DIO 8	Yes	Yes	Yes	-
DIO 9	Yes	Yes	Yes	-
DIO 10	Yes	Yes	Yes	-
DIO 11	Yes	Yes	Yes	-
DIO 12	Yes	Yes	Yes	-
DIO 13	Yes	Yes	Yes	-
DIO 14	Yes	Yes	Yes	-

Table 12: Digital IO Pin Configurations

Analog Entities

The MTM-EtherStem has three (3) analog inputs (ADC) and one (1) analog output (DAC) all controlled by the analog entity. Each analog is controllable via software and is independently current limited for both source and sink currents.

The analog inputs are connected to a 12-bit ADC, and return a value between 0 and 65535, corresponding to a range of 0-3.3V. The analog inputs can be read back as voltages in microvolts or ADC counts. The analog output is connected to a 10-bit DAC and takes a set value between 0 and 65535, corresponding to a range of 0-3.3V. The analog output may be set in microvolts or DAC counts.

Example: For the analog output (analog[3]), set the DAC value and voltage:

```
stem.analog[0].setValue(counts)
stem.analog[0].setVoltage(microVolts)
```

Example: For the analog inputs (analog[0-2]), read the ADC value:

```
stem.analog[0].getValue(counts)
stem.analog[0].getVoltage(microVolts)
```

The MTM-EtherStem's ADC's are also capable of being captured in bulk based on a user defined sample rate. See *Calculating Bulk Capture Sample Rate*

for additional information on sample rate settings. Configuring and triggering the bulk capture is accomplished by setting the number of samples and the sample rate, then triggering the capture.

To set the number of samples and the sample rate:

```
s.analog[0].setBulkCaptureNumberOfSamples(1)
s.analog[0].setBulkCaptureSampleRate(7000)
```

where the sample rate is samples per second (Hz). The system can capture any number of samples up the size of the RAM_STORE slot 0 (8191). The capture is then triggered with:

```
stem.analog[0].initiateBulkCapture()
```

Results of the capture are stored in the RAM_STORE slot 0. Results are always stored in ADC counts as two little-endian byte pairs with the second byte the most significant. Computing a sample value from the Store read out is:

```
sampleValue = bc[i] + (bc[i+1] << 8)
```

Additional information such as requesting capture status and reading back the captured data can be found in the BrainStem Reference and in the BrainStem SDK examples.

I²C Entities

The MTM-EtherStem includes access to two separate I²C buses: one operating at a set 1Mbit/s rate, and the other at 400kbits/s.

Note: The 1Mbit/s bus, while user-accessible, is also used for BrainStem network communication so there may be other, non-user-initiated traffic when other BrainStem modules are linked.

Example: Sending 2 bytes (0xABCD) through the I²C bus to a device with address 0x42:

```
stem.i2c.write(0x42, 2, 0xABCD)
```

Example: Reading 2 bytes of data from a device with address 0x42:

```
stem.i2c.read(0x42, 2, buffer)
```

Where *buffer* would be a char array in C++.

The maximum data size for individual read and write operations on an I²C bus through the BrainStem API is 20 bytes. Sending more than 20 bytes of information must be done as an iterated sequence.

Each I²C bus also includes 330Ω pull-up resistors on the SDA and SCL lines, disabled by default. When using the MTM-DAQ-2 in a linked system (communicating over the 1Mbit/s bus), only a single set of pull-ups along the bus should be enabled in order for the I²C bus to work properly (if more than one set is enabled, the lines cannot be pulled low for communication). Similarly, when using a single MTM device to communicate with an external device over the I²C bus, either the internal pull-ups can be enabled, or external hardware pull-ups added:

```
stem.i2c.setPullUp(bEnable)
```

RC Servo Entities

The MTM-EtherStem board is equipped with 4 RC servo inputs and 4 RC servo outputs. The RC Servo entity is an overload of the Digital Entity and thus requires proper configuration before this entity can be enabled.

Example: Enabling RC servo input mode for digital pin 0:

```
stem.digital[0].setConfiguration(digitalConfi
gurationRCServoInput)
```

Using the RC servo entity, digital output pins generate pulsed signal based on the RC Servo standard consisting of a period lasting 20ms and high pulse time between 1-2ms. The high time corresponds to a specific position determined by the specific servo being used. RC servo inputs measure this high time and return the corresponding position for a servo.

Example: When operating as an RC servo input, enabling functionality and reading position:

```
stem.RCServo[0].setEnable(bool)
stem.RCServo[0].getPosition(position)
```

Example: When operating as an RC servo output, enabling functionality and setting position:

```
stem.RCServo[4].setEnable(bool)
stem.RCServo[4].setPosition(position)
```

Signal Entities

The MTM-EtherStem board has 5 Signal input and 4 Signal outputs. The Signal entity allows generation of square waves by supplying a period and a time high value. The Signal inputs can also be used as counters.

The Signal entity is an overload of the Digital entity and must first be properly configured before it can be enabled. Using Table 12: Digital IO Pin Configurations, configure the correct digital pin as a Signal input:

```
stem.digital[4].setConfiguration(digitalConfi
gurationSignalInput)
```

Now, configure period (t3 time) and the time high value (t2 time):

```
stem.signal[0].setT3Time(period)
stem.signal[0].setT2Time(timeHigh)
stem.signal[0].setEnable(enable)
```

Note: See the BrainStem Reference[3] guide for timing diagram.

Signal and Digital Entities' indices do not align. Counting for the first Signal Entity starts at the first digital pin that is equipped with a Signal overload (Digital 4 = Signal 0, see Table 12: Digital IO Pin Configurations).

Clock Entities

The MTM-EtherStem includes a real-time, user-configurable clock entity tracking a time object consisting of year, month, day-of-the-month, hour, minute, and second.

Example: Setting values independently:

```
stem.clock.setYear(year)
stem.clock.setSecond(second)
```

Example: Reading values independently:

```
stem.clock.getYear(year)
stem.clock.getSecond(second)
```

Reflex RTOS

Reflex is Acroname's real-time operating system (RTOS) language which runs in parallel to the module's firmware. Reflex allows users to build custom functionality directly into the device. Reflex code can be created to run autonomously on the module or a host can interact with it through BrainStem's Timer, Pointer App and other entities.

Timer Entities

The Timer entity provides simple scheduling for events in the reflex system. The MTM-EtherStem includes 8 timers per reflex. Each timer represents a reflex definition to be executed upon expiration of a running timer. Timers can be controlled from a host, but the reflex code is executed on the device.

Example: Setting up and starting Timer 0 for single use:

```
stem.timer[0].setMode(timeModeSingle)
stem.timer[0].setExpiration(DELAY)
```

Reflex Definition: Timer 0 expiration callback:

```
reflex timer[0].expiration() { //Do Stuff }
```

Pointer Entities

Reflex and the Brainstem module share a piece of memory called the scratchpad which can be accessed via the Pointer Entity. The MTM-EtherStem has 4 pointers per reflex which allow access to the pad in a similar manner as a file pointer.

Example: Configure and access the scratchpad in static mode:

```
stem.pointer[0].setMode(pointerModeStatic)
stem.pointer[0].getByte(byte)
```

Reflex Pad: Single unsigned char definition:

```
pad[0:0] unsigned char byteValue
```

App Entities

Apps are reflex definitions that can be directly trigger by the host. These definitions are also capable of passing a parameter into or out of the app reflex definition. The MTM-EtherStem is equipped with 4 App Entities per reflex.

Example: Triggering App 0:

```
stem.app[0].execute(parameter)
```

Reflex Definition: App 0 callback:

```
reflex app[0](int appParam) { //Do Stuff }
```

MTM-EtherStem Supported Entity Methods Summary

Detailed entity class descriptions can be found in the BrainStem Reference[3]. A summary of MTM-EtherStem class options are shown below. Note that when using Entity classes with a single index (i.e., 0), the index parameter can be dropped. For example:

```
stem.system[0].setLED(1) → stem.system.setLED(1)
```

Entity Class	Entity Option	Variable(s) Notes
`digital[0-14]`	`setConfiguration`	
	`getConfiguration`	
	`setState`	
	`getState`	
`rcservo[0-7]`	`setEnable`	
	`getEnable`	
	`setPosition`	Index 4-7 only
	`getPosition`	
	`setReverse`	Index 4-7 only
	`getReverse`	
`i2c[0-1]`	`write`	
	`read`	
`analog[0-2]`	`getValue`	
	`getVoltage`	
	`setBulkCaptureSampleRate`	
	`getBulkCaptureSampleRate`	
	`setBulkCaptureNumberOfSamples`	
	`getBulkCaptureNumberOfSamples`	
	`initiateBulkCapture`	
	`getBulkCaptureState`	
`analog[3]`	`setValue`	
	`setVoltage`	
`clock[0]`	`setYear`	
	`getYear`	
	`setMonth`	
	`getMonth`	
	`setDay`	
	`getDay`	
	`setHour`	
	`getHour`	
	`setMinute`	
	`getMinute`	
	`setSecond`	
	`getSecond`	
`signal[0-5]`	`setEnable`	
	`getEnable`	
	`setInvert`	
	`getInvert`	
	`setT3Time`	
	`getT3Time`	
	`setT2Time`	
	`getT2Time`	
`store[0-2]`	`getSlotState`	
	`loadSlot`	

Entity Class	Entity Option	Variable(s) Notes
	unloadSlot	
	slotEnable	
	slotDisable	
	slotCapacity	
	slotSize	
system[0]	save	
	reset	
	setLED	
	getLED	
	setBootSlot	
	getBootSlot	
	getInputVoltage	
	getVersion	
	getModuleBaseAddress	
	getModuleSoftwareOffset	
	setModuleSoftwareOffset	
	getModuleHardwareOffset	
	setHBInterval	
	getHBInterval	
	getRouterAddressSetting	
	getModule	
	getSerialNumber	
	setRouter	
	getRouter[3]	
	getModel	
	routeToMe	
timer[0-8]	getExpiration	
	setExpiration	
	getMode	
	setMode	
Pointer[0-3]	getOffset	
	setOffset	
	getMode	
	setMode	
	getTransferStore	
	setTransferStore	
	initiateTransferToStore	
	initiateTransferFromStore	
	getChar	
	setChar	
	getShort	
	setShort	
	getInt	
	setInt	
App[0-3]	execute	

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

Table 13: Supported MTM-EtherStem BrainStem Entity API Methods

LED Indicators

The MTM-EtherStem board has a number of LED indicators to assist with MTM system development, debugging, and monitoring. These LEDs are shown in the diagrams below.

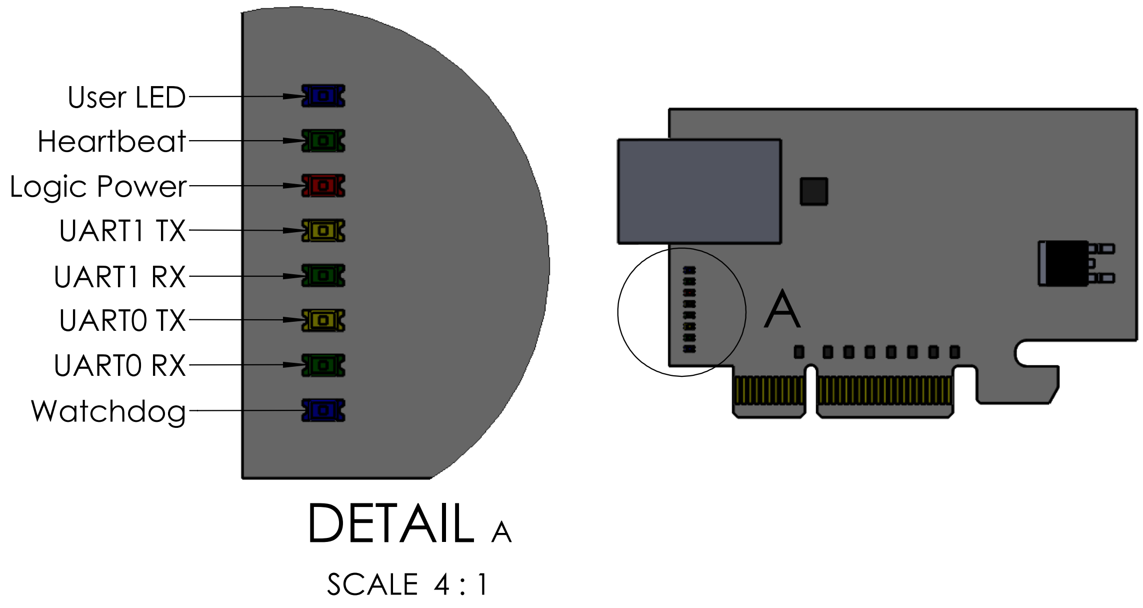


Figure 2: MTM-EtherStem LED Indicators

Edge Connector Interface

All MTM products are designed with an edge connector interface that requires a compatible board-edge connector on the carrier PCB. Acroname recommends the through-hole PCI-Express (PCIe) Vertical Connector. The connectors can be combined with an optional retention clip, as shown below. Representative part numbers are show in Table 14 and equivalent connectors are offered from a multitude of vendors.

Manufacturer	Manufacturer Part Number	Description
Amphenol FCI Samtec	10018784-10201TLF PCIE-064-02-F-D-TH	PCI-Express 64-position vertical connector
Amphenol FCI	10042618-003LF	PCI-Express Retention Clip (optional)

Table 14: PCI-Express Edge Connectors for MTM Products

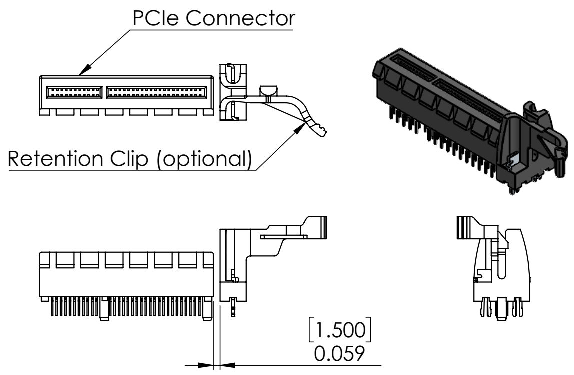


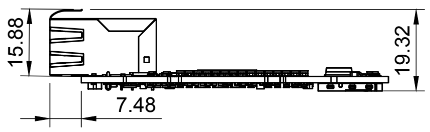
Figure 3: PCIe Vertical Connector with optional Retention Clip

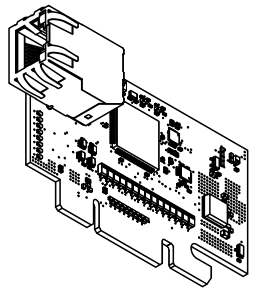
MTM Edge Connector Specifications	Description
Contact Finish	Gold
Card Thickness	0.0625" [1.59mm]
Number of Rows	2
Number of Positions	Variable (see Table 14: PCI-Express Edge Connectors for MTM Products)
Pitch	0.039" (1.00mm)

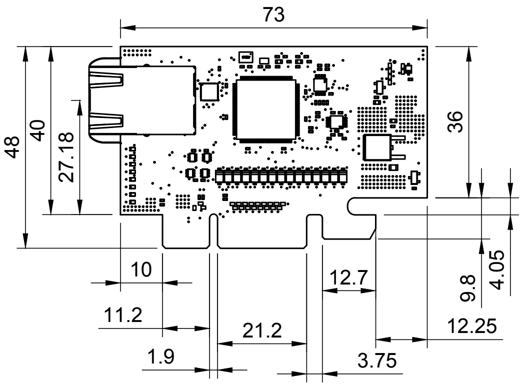
Table 15: MTM Edge Connector Specifications

Mechanical

Dimensions are shown in mm. 3D CAD models are available through the MTM-EtherStem product page's Downloads section. A 3D CAD viewer with many different CAD model formats available for download is available at https://a360.co/3fDUjTD







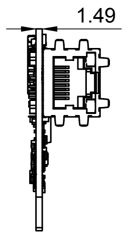


Figure 4: MTM-EtherStem Mechanical

Calculating Bulk Capture Sample Rate

Step 1: Calculate Clock Divisor

Cd = Clock Divisor (This value must be rounded up to the nearest whole number

Cf = Clock Frequency = 96,000,000 Hz

n = Number of cycles required for Analog conversion = 65.

Rf = Requested Frequency in Hz

Cd = Cf / (n * Rf)

Step 2: Calculate Actual Bulk Capture Sample Rate

Sr = Sample Rate

Cf = Clock Frequency = 96,000,000 Hz

n = Number of cycles required for Analog conversion = 65.

Cd = Clock Divisor (Calculated in Step 1)

Sr = Cf / (n * Cd)

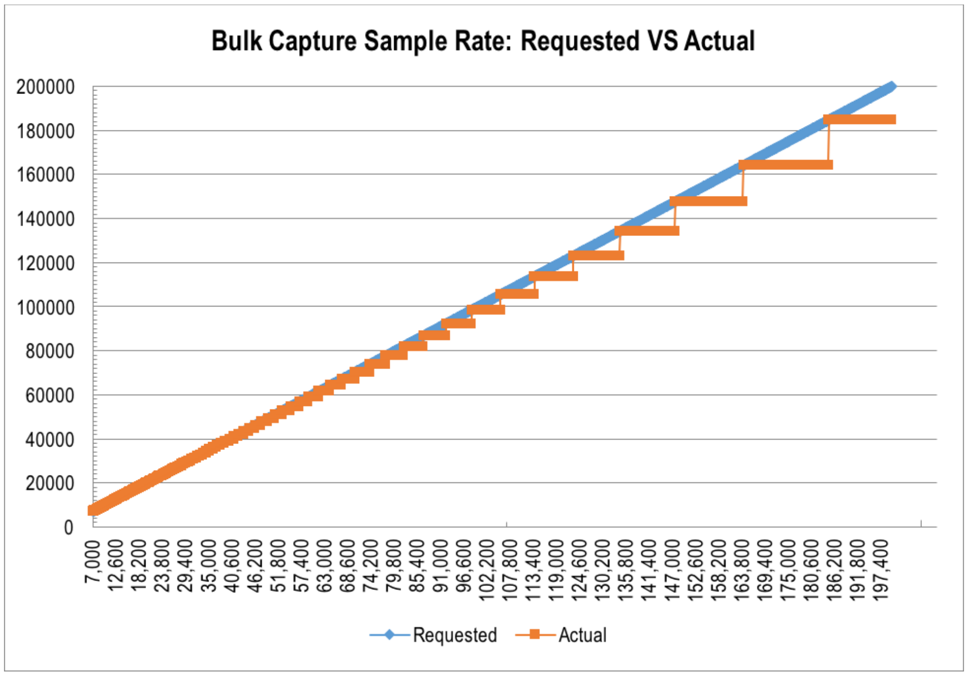


Figure 5: Analog Bulk Capture Actual Sample Rate vs Requested Sample Rate

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
1.0	October 2015	JTD	Initial Revision
1.1	April 206	JTD	Corrected typographical errors
1.2	September 2016	RMN	Formatting, Error checking, updates
1.3	October 2016	LCD	Updated Overview, Features, Description section
1.4	October 2016	RMN	Added Bulk Capture information
1.5	December 2016	JG	Clarified I2C pull-ups; update supported API calls
1.6	July, 2020	ACRO	Formatting, entity updates, diagram updates
1.7	February 2021	MJK	Contact information for technical support.

Table 16: Document Revision History