**MODS Calibration System Data Sheet**

**General Description**
The MODS Calibration System consists of a fixed section of baffle tube with an integrating sphere attached to the end and a retractable calibration tower that contains a fold mirror and calibration lens. In the inserted mode, the calibration tower is moved into the science beam where it blocks the incoming light and connects to the baffle tube/integrating sphere. The inserted mode is used for calibration. In the retracted mode, the calibration tower is moved away from the baffle tube until the science beam is unobstructed. The retracted mode is used for normal operation of MODS.

**Topology**
Two Position Linear
Calibration System – Retracted Position

**Drive Motor**
Motor Type: Size 23 Step motor, 200 fullsteps per revolution, double-ended shaft
Part #: Applied Motion #HT23-401D
Rated Current: 4.24 amps/phase parallel (RMS)
Rated Holding Torque: 264 in oz

Motor Connections
A Orange & Black/Wht (pin13)
A Orange/Wht & Black (pin12)
B Yellow & Red/Wht (pin10)
B Red & Yellow/Wht (pin11)

**Motor Controller Specifications**
Manufacturer & Model: IMS MicroLYNX 7 (#MX-CS100-701)
Rated Current: 5amps RMS/phase, 7 amps peak/phase
Rated Voltage: 24 to 75 VDC
Daughterboards: None

**Motor Controller Settings**
MSEL = 10
10usteps/fullstep = 2000 microsteps/rev
MUNIT = 2000 sets units to (2000 usteps/rev) gives velocity and accelerations in rev/sec
MAC = 70 Acceleration Current = 70% ~ 4.9 amps peak
MRC = 70 Run Current = 3.5 amps * 1.4 = 4.9 amps peak (4.9/7 = 70%)
MHC = 0 Motor Hold Current is zero

ACLT = 1 linear acceleration (default)
ACCL = DECL = 10 acceleration rate (rev/sec^2)
LDECL = 500 limit deceleration rate (rev/sec^2)

Overtravel at Limit = ScrewPitch * VM^2/(2*LDECL) = 0.006mm (pitch = 6mm and VM = 1
rev/sec, LDECL = 500 rev/sec^2)
Beware overtravel when seeking limits, must not decelerate hard into limits
Maximum Permitted Overtravel ~ 0.5mm ~ 0.020"

VM = 1.0 running speed (rev/sec)
VM = 0.5 Homing speed to assert limits

Motor Controller I/O Connections
Vpull: not used
GND: 24 volt Gnd
I/O 21: CW LIMIT sensor (CW shaft rotation as viewed from motor front)
I/O 22: CCW LIMIT sensor
I/O 23: FRONT AGW CW Limit (second copy) Used as Calibration Tower ENABLE
I/O 24: not used
I/O 25: not used
I/O 26: Brake relay coil (internal pull-up switch opened)
Output defaults to NO, Brake is wired to NO contacts on relay
Brake is applied with power off and default state of drive output

Input Sensors
Model P&F # NBB1.5-8GM50-E0-V3
8mm Inductive proximity sensor, Normally Open Sinking output (Type E0), 24 VDC supply
Used for CW Limit, CCW limit, and ??HOME sensors

Note: A stainless steel clip is used for detection on position sensors ??????????????????????,
the limit sensors directly detect the aluminum calibration tower baseplate. The difference in
detection materials is used to create a larger activation gap between “In Position” and “Limit
Activated” states, reducing the chance for Limits being tripped at inappropriate instances.

Sensor Setup: The spacing between the position sensor and the limit sensor should allow the
position sensor to be activated without tripping the limit. However, if the position sensor fails to
activate and a limit is encountered, the limit should be asserted prior to the potential collision
between the calibration tower baseplate and the position sensor.

Connection for P&F E0 Sensors (3 wire)
Brown +24 volts
Blue  24 volt ground
Black to input of controller

Output Devices
Failsafe Brake
Electroid # BFSB-7-4 24 volt, 0.25 amps
Holding Torque 112 in*oz.

**Drive Mechanics**
The calibration system uses a THK Model KR33 06 A + 600-00000 linear actuator with a 6mm screw lead. The calibration tower is supported on one side by the KR33 linear actuator and on the opposite side by 2 THK HSR20 Bearing Blocks (Style A) that are mounted on a THK HSR20 Rail (820mm long). The actuator side is driven by the HT23-401D motor and the opposite side is used as an additional guide rail that provides stability and support to the calibration tower.

Position Datum ?? (??CW End of Travel)
Range of Motion ?? mm
Axis Resolution 30 microns per motor fullstep = (6mm)*(1/200)

**Performance**
Maximum Travel Time ?? seconds
Position Repeatability ?? micron error
Position Hysteresis ?? micron

**Software Notes**
- The calibration tower must remain in its fully retracted position during normal MODS science operations

**Software Interlocks**
- FRONT AGW- CALIBRATION TOWER Interlock
  - The calibration tower must be inhibited from insertion into the optical path unless the FRONT AGW “Y” axis is fully retracted. A copy of the Y axis CW Limit sensor is routed directly to Input 23 of the Calibration Tower. This sensor is then routed to the MicroLynxx for use by the Calibration Tower Software as a MOTION ENABLE sensor. This input is also used to control a relay mounted on the Calibration Tower Mechanism which Enables/Inhibits motor operation.

**Other Notes**
A) The weight of the calibration tower, including the base plate, rails, tower (with optics) is approximately 50 pounds.

B) The measured torque required to move the tower in the vertical orientation was 52 oz-in.

C) In the design, a 2.8mm gap was left between the base plate and the ADC frame to allow for shims and epoxy.