MODS Grating Tilt Data Sheet

General Description
The MODS Grating Tilt uses a worm drive system to precisely tilt the grating. The grating tilt drive system is equipped with a harmonic drive gear reducer that allows for very fine, precise tilt adjustments.

Topology
Continuous Rotary

Rendering of Grating Tilt Mechanism
Drive Motor
Motor Type  Size 23 Step motor, 200 fullsteps per revolution, double-ended shaft
Part # Superior # KML061F05 - D
Rated Current: 2.7 amps/phase parallel (RMS)
Rated Holding Torque: 170 in#oz
Rated Torque at operating Speed ?????

Motor Connection Diagram (for CW rotation viewed from motor front with positive command)
A Red/White (Pin13)
A Red (Pin12)
B Black (Pin11)
B Black/White (Pin10)

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 = 50 Acceleration Current = 50% ~ 3.5 amps peak
MRC = 30 Run Current = 1.5 amps RMS *1.4 = 2.1 amps peak (2.1/7 = 30% )
MHC = 0 Motor Hold Current is zero
ACLT=1 linear acceleration (default)
ACCL=DECL = 50 acceleration rate (rev/sec^2)
LDECL = 500 limit deceleration rate (rev/sec^2)
Overtravel at Limit = ScrewPitch * VM^2/(2*LDECL) = 0.11mm (“pitch” =0.5mm/rev and VM=15 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= 15 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: not used
I/O 24: not used
I/O 25: not used
I/O 26: not used

Input Sensors
Model P&F # NJ0.8-5GM25-E
5mm Inductive proximity sensor, Normally Open, Sinking output (Type E0), 24 VDC supply
Used for CW Limit, CCW limit
***Sensors are axially mounted

***The raised portion of the stepped detection block should be used for the home sensor. Make sure that the home sensor can be activated without tripping limit sensor. In the event that a home sensor fails the limit should be tripped prior to the home sensor colliding with the detection block.

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

**Output Devices**
None
**Drive Mechanics**

In addition to the drive motor, the grating tilt drive contains the following key components:

- Harmonic Drive Gear Reducer (1/50): Model #HDUC14 CC
- Torque Limiter: Preset to 0.6Nm     Diequa Part #SK2-2-51-w-12-12-0.6-0.2-1.5

Harmonic Gear Ratio = 1/50  
Worm to Bull Gear Ratio = 1/512
Tilt Gear Diameter = 16 inches
Measured Backlash = 0.075mm

1 Full Motor Step = 0.25 microns of Bull Gear Movement @ rim

Full Motor Steps required to overcome backlash ~ 300

Note: The home sensor block will be located near the zeroth order grating position. This will limit grating travel beyond zeroth order in the direction of anamorphic factor less than unity. This is required on all grating tilt drives to prevent an interference between a MODS structural tube and the outside of the blue grating tilt cells.

**Performance**

- Maximum Travel Time ?? seconds
- Typical Travel Time for move of ~ ?? ?? seconds
- Target Repeatability ~ 0.5 pixels
- Home Repeatability ~ 0.09 pixels
- Elastic Windup ~ 33 Steps (Full)
- Backlash ~300 Steps (Full)
- Tilt Gear Wear ~ 0.003” after 9000 cycles. This corresponds to an estimated 2 year maintenance cycle. A MoS2 filled chassis grease should be used for lubrication.

**Software Notes**

The targeting routine must command the motor to the target position and then back off in the opposite direction by approximately 150 steps (Full) to totally disengage the gear mesh. At this point the grating cell will be held in place by the preload friction on the tilt axis. The benefit of this technique is that the elastic windup in the drive mechanics will not affect the motion of the grating cell during the exposure.

**Other Notes**

1. The backlash can be changed by varying the engagement of the gear mesh. The engagement can be adjusted by changing the thickness of the shim stack under the worm drive box.
2. As expected, all tests indicated that the performance increases drastically with more precise alignment between the worm and tilt gear. The worm drive box should be shimmed for proper worm/gear engagement, the tilt gear must be centered along the tilt worm’s axial centerline, and the worm should be parallel to the face of the tilt gear.

**Setup & Calibration Procedure**

1.