

M1 Control System Actuators, Sensors, and Electronics

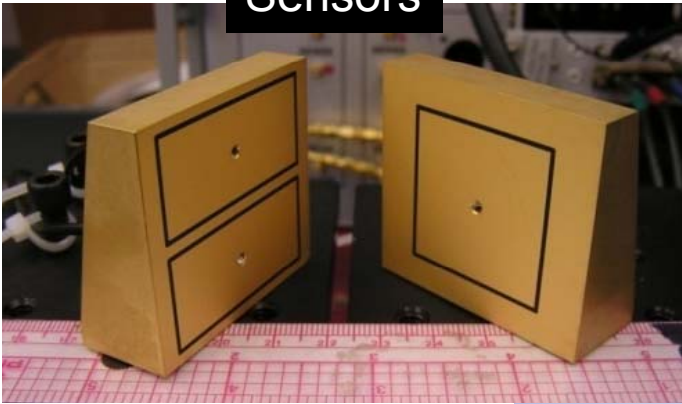
November, 2009

Mark Sirota

TMT.CTR.PRE.09.138.REL01

M1CS Summary

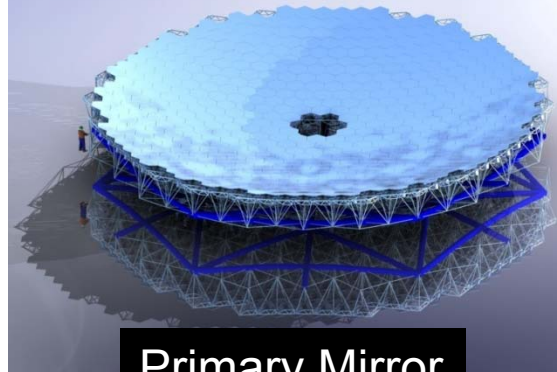
Sensors



Primary Segment Assembly



Primary Mirror



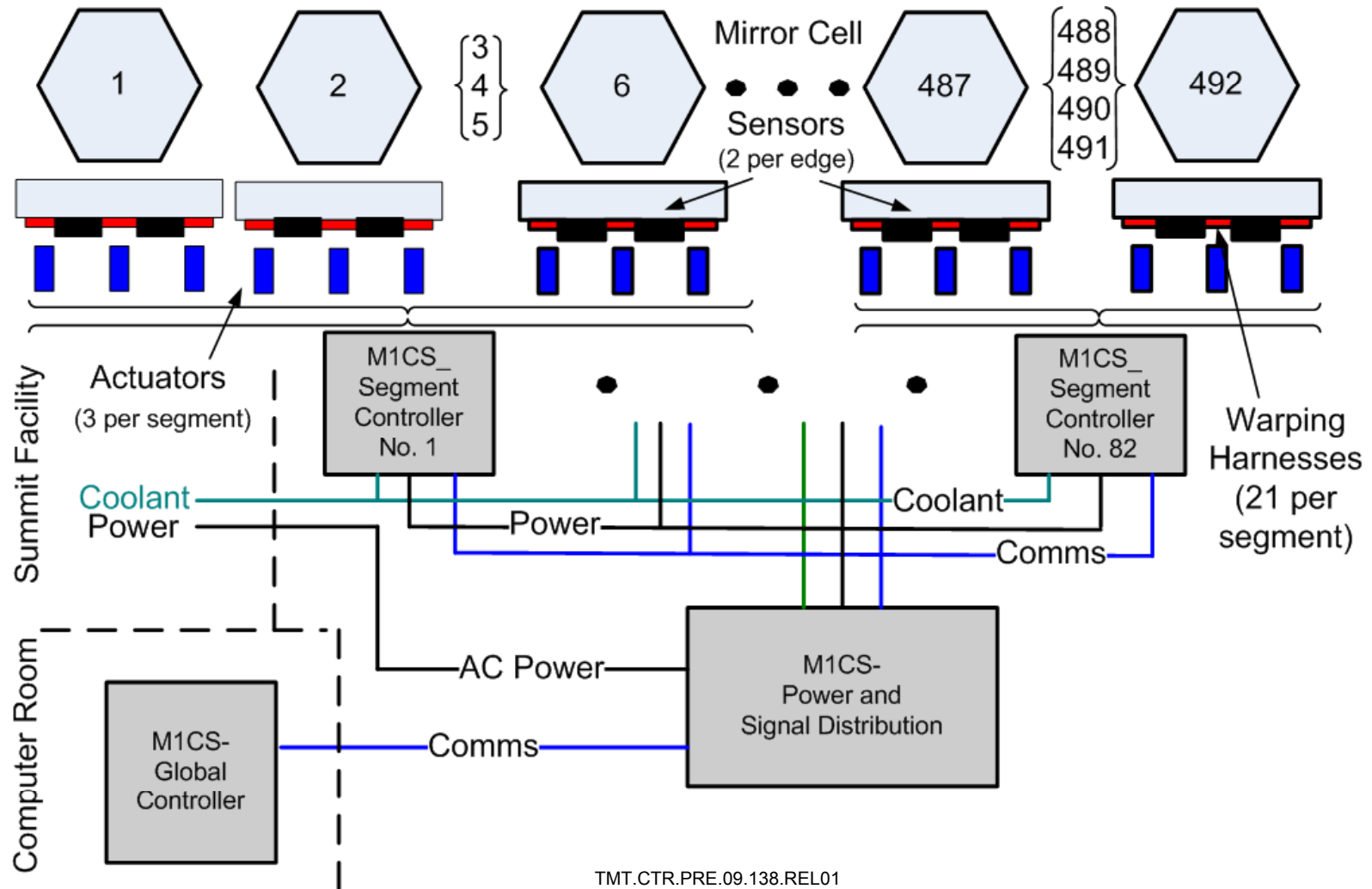
Actuators



Segments



M1CS Decomposition



M1CS Components

● Actuators

- 1476 for 492 segments
- 100 spares
- 1576 total

● Sensors

- 2772 for 492 segments
- 462 for 82 spare segments
- 200 spares
- ~ 3500 total

● Distributed Control Electronics

- 82 Node Boxes
 - Insulated and liquid cooled
- 574 segment cable harnesses (492 + 82 segments)
- ~4400 PCB assemblies (printed circuit board assemblies)

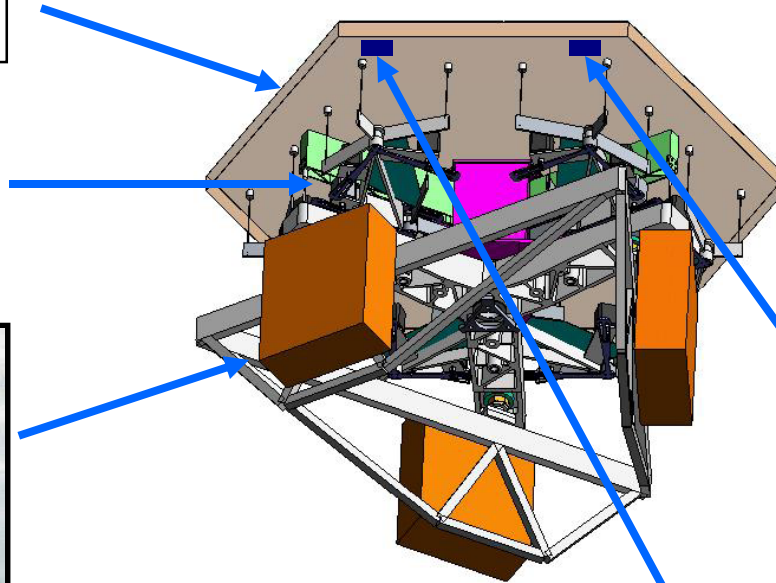
TMT M1CS Components

Segment 1.4 m

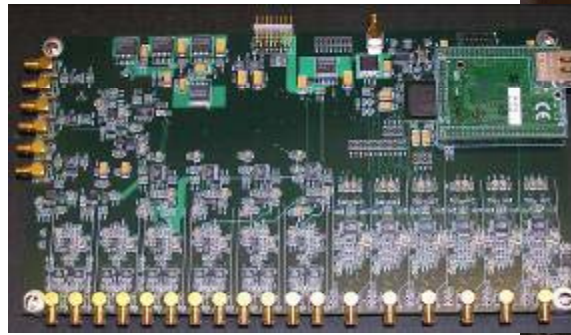
Segment Support Assembly



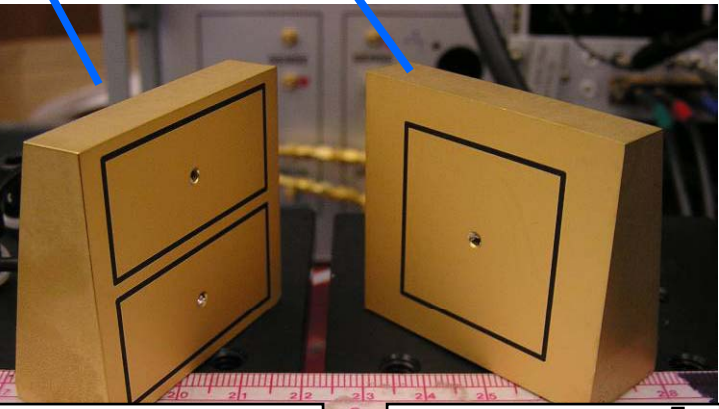
Actuators
3 per segment



Sensor Preamp



Sensor Control Bd.



Drive half

Sense half

Keck Analogies to TMT

Node Boxes



Segment and mirror cell cabling



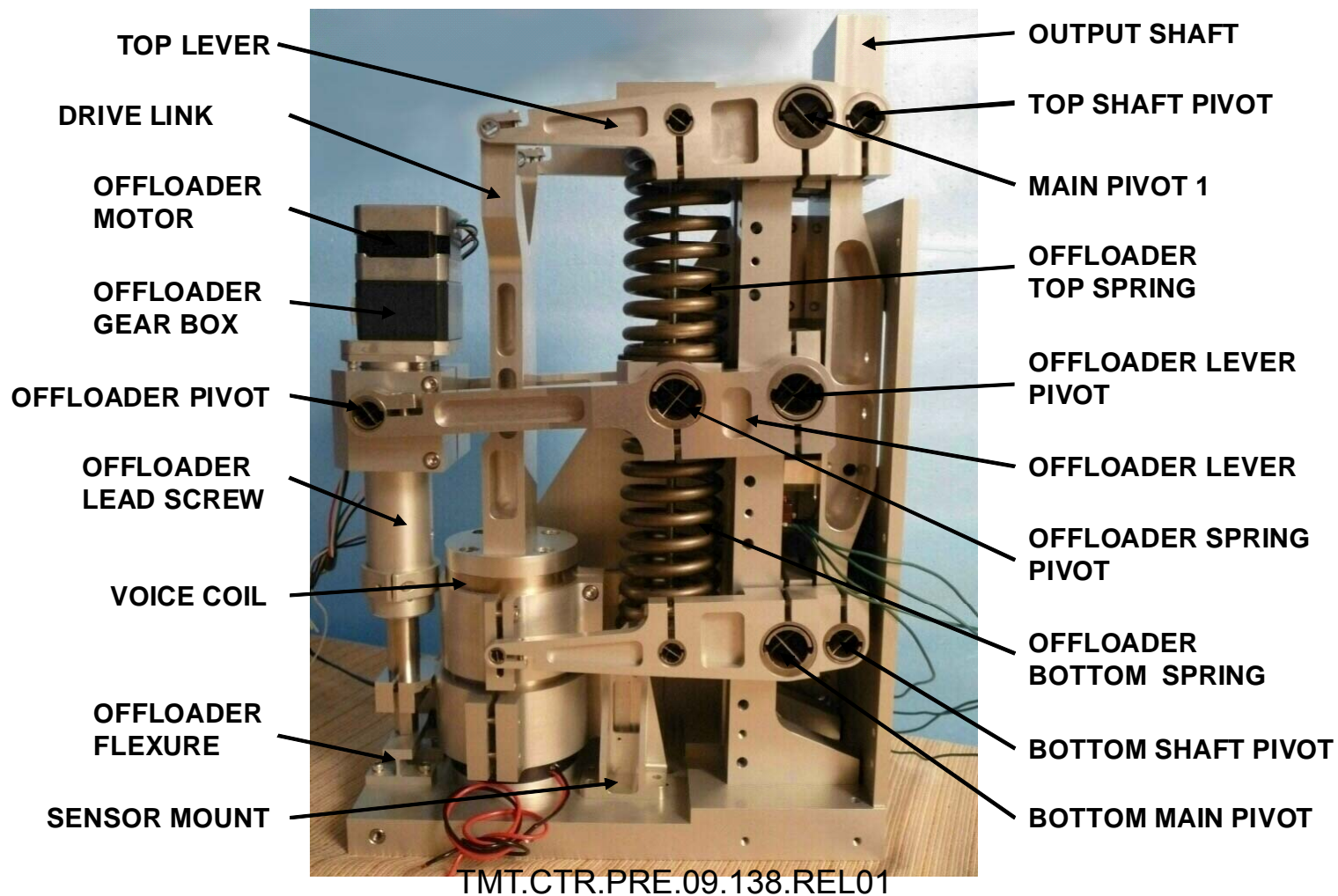


THIRTY METER TELESCOPE

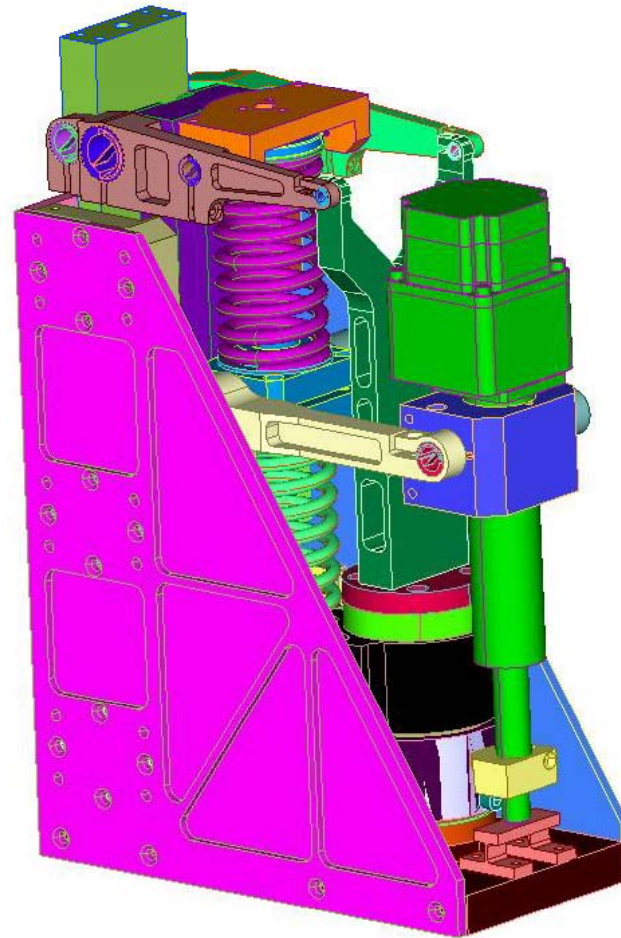
Summary of Actuator and Sensor Requirements

Actuators	
Mass	$\leq 10\text{Kg}$
Load (Performance)	0 to 850 N
Range	$\geq 5\text{ mm}$
Noise	$\leq 4.4\text{ nm RMS}$
Peak error	$\leq 50\text{ nm}$
DC Stiffness	$\geq 20\text{ N}/\mu\text{m}$
Stiffness at 1 Hz	$\geq 10\text{ N}/\mu\text{m}$
Power	$\leq 1\text{ Watt}$
Survive -2000 N to +3000 N	3g earthquake survival
Design for 50 year life time with preventative maintenance	
Sensors	
Edge Sensor Noise (Height)	$\leq 2.8\text{ nm}/\sqrt{\text{Hz}}\text{ RMS}$
Edge Sensor Noise (Gap)	$\leq 1\text{ }\mu\text{m RMS}$
Edge Sensor Noise (dihedral angle)	$\leq 330\text{ nRad RMS}$
Quasi Static Mean Sensor Error	$< \sim 2\text{nm}$
Non Interlocking	
In-plane sensitivities	Various
Mass (to be confirmed)	$\leq 115\text{ grams}$
Dimensions (to be confirmed)	55 mm x 60 mm x 20 mm
Design for 50 year life time with preventative maintenance	

Actuator 1



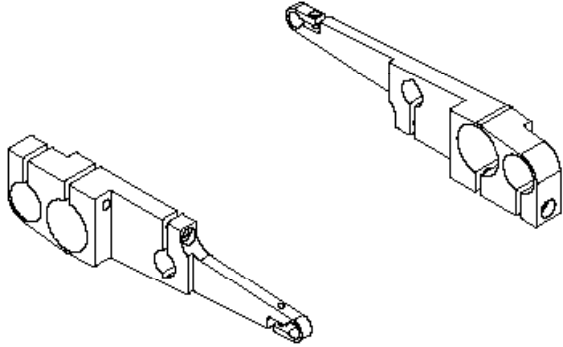
Actuator 2





THIRTY METER TELESCOPE

Actuator 3

<p>MANUFACTURING NOTES:</p> <p>1. MATERIAL: ALUMINUM 6061, CLEAR ANODIZE</p> <p>2. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.</p> <p>3. PART SHALL BE DELIVERED CLEAN, FREE OF COOLANT OR CUTTING OIL.</p> <p>4. DRAWING DIMENSION TOLERANCE, UNLESS OTHERWISE NOTED: X.XXX: +/- 0.010 X.XX : +/- 0.015 X.X : +/- 0.025</p>		↓																																					
		<table border="1"> <thead> <tr> <th colspan="5">REVISIONS</th> </tr> <tr> <th>ZONE</th> <th>REV</th> <th>DESCRIPTION</th> <th>DATE</th> <th>APPROVED</th> </tr> </thead> <tbody> <tr> <td colspan="5" style="height: 100px;"> </td> </tr> </tbody> </table>				REVISIONS					ZONE	REV	DESCRIPTION	DATE	APPROVED																								
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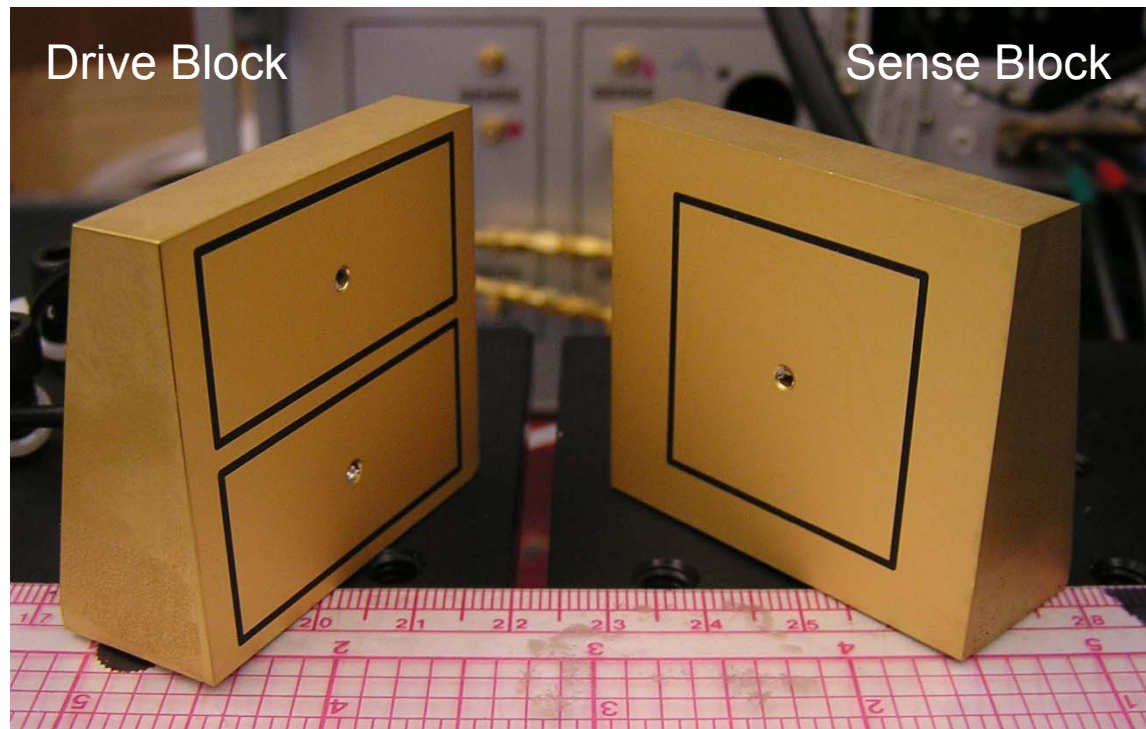
TMT.CTR.PRE.09.138.REL01

Actuator

Summary Statement of Work

- Third generation prototype
 - Procurement, fabrication, assembly, and test
 - 10 to 20 actuators
 - Design for manufacturability
 - To be used for reliability tests
 - To be used for final evaluation
 - To be used to evaluate test and quality control equipment and procedures
 - Ideally fabricated, assembled, and tested at supplier for production units
- Production build
 - Pre-production procurement, fabricate, assembly, test, and evaluate
 - Production procurement, fabrication, and assembly
 - Acceptance testing
 - Repair and test of rejected units
 - Quality control
 - Pack and ship

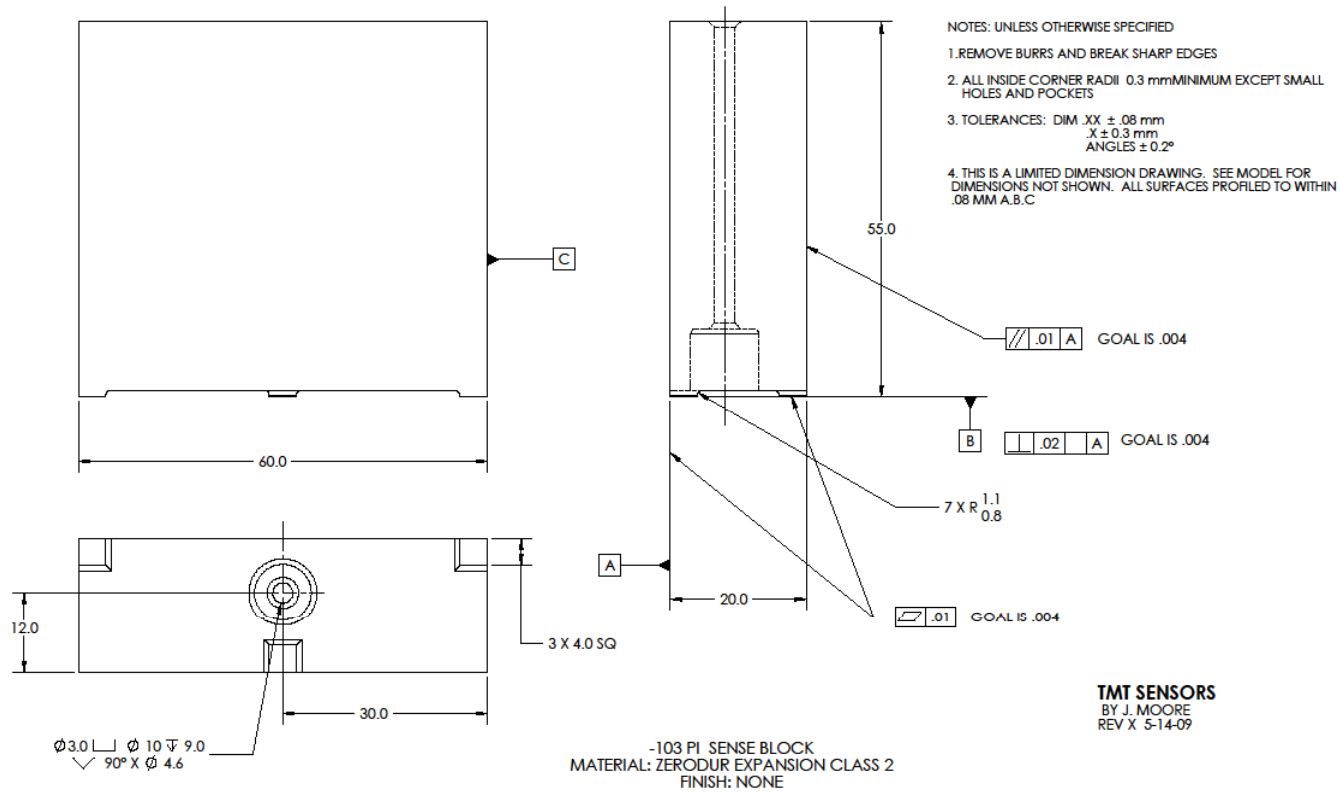
Capacitive Sensor





THIRTY METER TELESCOPE

Sense Block

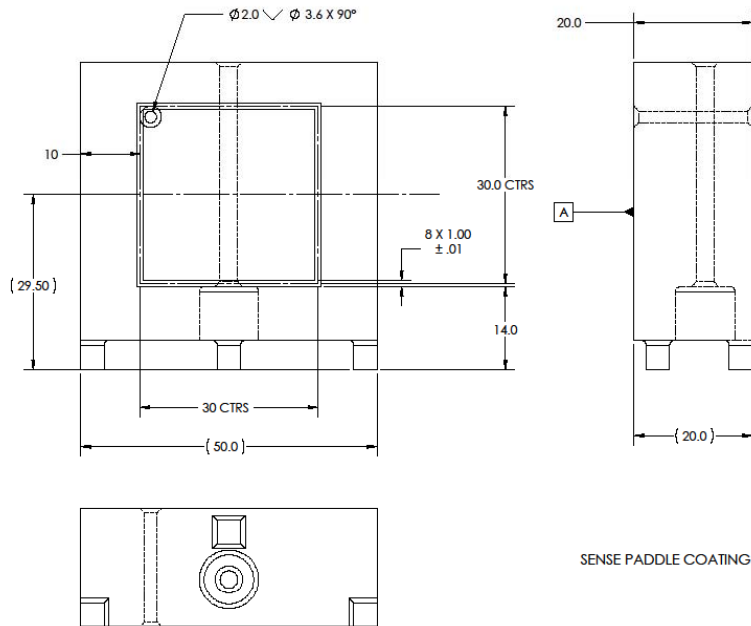


TMT.CTR.PRE.09.138.REL01



THIRTY METER TELESCOPE

Sense Block Coating



SENSE PADDLE COATING DIMS

COATING NOTES

1. COATINGS ARE .5 μ M GOLD OVER .05 μ M CHROMIUM
2. SPUTTERING APPLICATION PREFERRED TO INSURE COATING INSIDE COUNTERSINKS
3. SUBSTRATE TEMPERATURE MAY NOT EXCEED 150 DEG C DURING COATING OR PROCESSING
4. FRONT AND BACK (50 X 45 mm) COATING THICKNESS FACES $\pm 10\%$
5. SIDES MAY BE $+100\%/-50\%$
6. ETCHED UNCOATED PATTERNS ARE 1 mm WIDE. ETCHED PATTERN SIZE TOLERANCE $\pm .01$ mm
7. ETCHED PATTERN IS LOCATED ± 0.1 MM FROM SIDES OF BLOCK

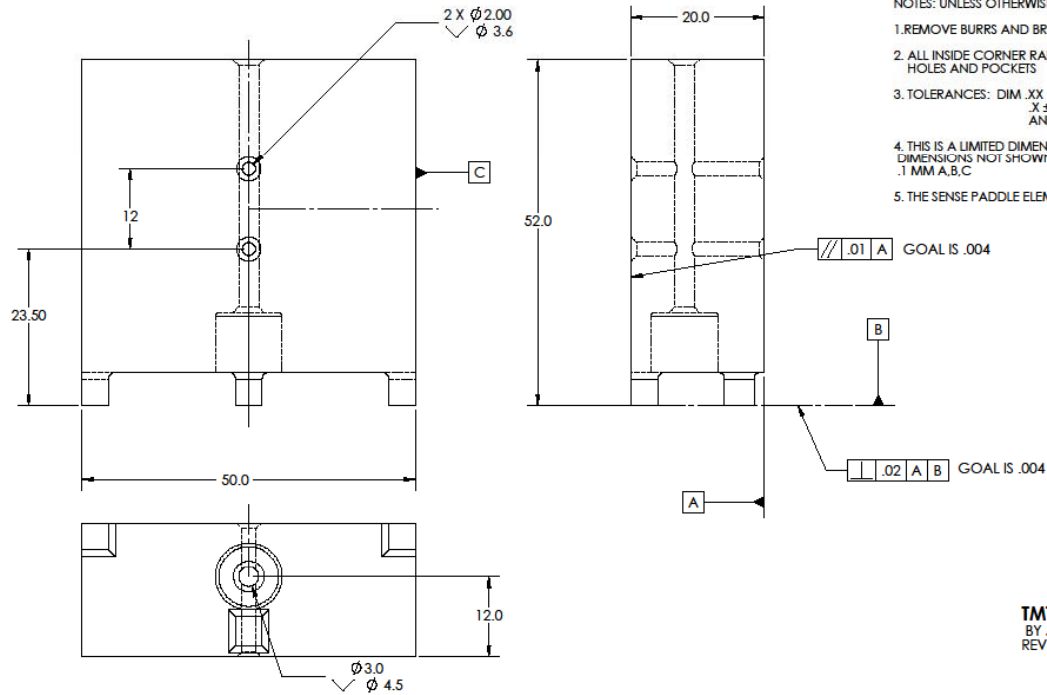
- MINIMUM COATING
- DEG C
- THICKNESS FACES $\pm 10\%$
- ETCHED PATTERN SIZE
- LOCATED ± 0.1 MM FROM SIDES OF BLOCK

TMT SENSORS
BY J. MOORE
REV X 4-2-09



THIRTY METER TELESCOPE

Drive Block

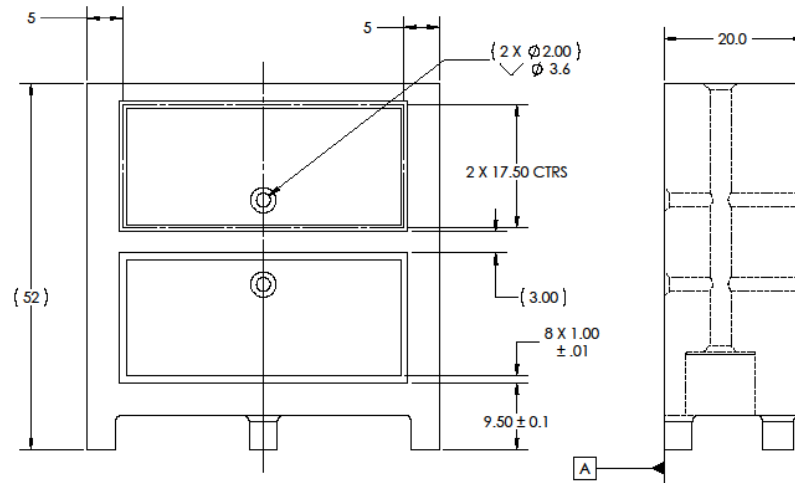


- NOTES: UNLESS OTHERWISE SPECIFIED
- 1.REMOVE BURRS AND BREAK SHARP EDGES
 2. ALL INSIDE CORNER RADII 0.3mm MINIMUM EXCEPT SMALL HOLES AND POCKETS
 3. TOLERANCES: DIM .XX $\pm .08$ mm
 X ± 0.15 mm
 ANGLES $\pm 0.2^\circ$
 4. THIS IS A LIMITED DIMENSION DRAWING. SEE MODEL FOR DIMENSIONS NOT SHOWN. ALL SURFACES PROFILED TO WITHIN .1 MM A,B,C
 5. THE SENSE PADDLE ELEMENT SHALL BE MOUNTED ON SURFACE A

TMT SENSORS
 BY J. MOORE
 REV X 4-2-09

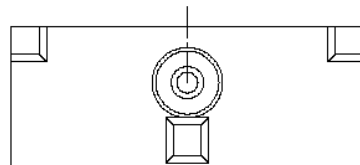
-102 PI DRIVER PADDLE
 MATERIAL: ZERODUR EXPANSION CLASS 2
 FINISH: NONE

Drive Block Coating



COATING NOTES

1. COATINGS ARE .5 μ M GOLD OVER .05 μ M CHROMIUM
2. SPUTTERING APPLICATION PREFERRED TO INSUR COATING INSIDE COUNTERSINKS
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5. SIDES MAY BE +100%/-50%
6. ETCHED UNCOATED PATTERNS ARE 1 mm WIDE. ETCHED PATTERN SIZE TOLERANCE \pm .01 mm
7. ETCHED PATTERN IS LOCATED \pm 0.1 MM



COATING DIMENSIONS- DRIVE PADDLE

TMT SENSORS
BY J. MOORE
REV X 5-20-09

Sensor

Summary Statement of Work

- Third generation prototype
 - Procurement, fabrication, assembly, and test
 - 10 to 20 sensors
 - Design for manufacturability
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- Production build
 - Pre-production procurement, fabricate, assembly, test, and evaluate
 - Production procurement, fabrication, and assembly
 - Acceptance testing
 - Repair and test of rejected units
 - Quality control
 - Pack and ship

Electronics

Summary Statement of Work

- Parts procurement
- Printed Circuit Board (PCB) fabrication (bare board)
- PCB assembly
- PCB assembly testing
- Cable harness fabrication and test
- Node Box assembly and test
- Quality control
- Pack and ship