Bibliography

Carroll, Bradley W., & Ostlie, Dale A. (1996) Modern Stellar Astrophysics. New York: Addison-Wesley Publishing Company, Inc.

Franco, Sergio (1995). Electric Circuits Fundamentals. New York: Saunders College Publishing.

Guidelines for the Preparation and Submission of Theses and Written Creative Works. (1993). San Francisco State University Graduate Division Office. San Francisco, Ca.

Hardy, John W. (1998). Adaptive Optics for Astronomical Telescopes. New York: Oxford University Press.

Houp, Kenneth W., Pearsall, Thomas E., & Tebeaux, Elizabeth. (1998). Reporting Technical Information (9th ed.). Needham Heights, Ma: Allyn & Bacon.

Melles Griot 1997-98: Optics, Fiber Optics, Tables & Hardware, Lasers, Instruments & Lab Accessories. (1997). Irvine, Ca: Melles Griot.

Mohan, Ned, Undeland, Tore M., & Robbins, William P. (1989). Power Electronics (2nd ed.). New York: John Wiley & Sons, Inc.

Montgomery, Douglas C., & Runger, George C. (1999). Applied Statistics and Probability for Engineers (2nd ed.). New York: John Wiley & Sons, Inc.

Nanomotion II. 11 NCS 101/IEEE User Manual. (1998). Irvine, Ca: Melles Griot.

New Focus, Inc. 1997/98 Catalog, Vol. 8. (1997). Santa Clara, Ca: New Focus, Inc.

Nise, Norman S. (1995). Control Systems Engineering (2nd ed.). Redwood City, Ca: The Benjamin/Cummings Publishing Company, Inc.

PCI-20093W-1 Analog Output Board and PCI-20369S Master Link Software Libraries Manual. (1993). Arizona: Intelligent Instrumentation, Inc.

PCI-20428W-1A, -2A, -3A Multifunction Boards and Master Link Software Libraries Manual. (1997). Arizona: Intelligent Instrumentation, Inc.

Physik Insrumente: Nano Positioning, 1998 Waldbronn, Germany: Physik Instrumente.

Rohlf, James W. (1994). Modern Physics from α to Z^0. New York : John Wiley & Sons, Inc.

Sen, P.C. (1997). Principles of Electric Machines and Power Electronics (2nd ed.). New York : John Wiley & Sons, Inc.

Tipler, Paul A. (1995). Physics For Scientists and Engineers (3rd ed.). New York: Worth Publishers.

Visual Designer 4.0 User Manual. (1998). Arizona: Intelligent Instrumentation, Inc.

Wangness, Roald K. (1986). Electromagnetic Fields (2nd ed.). New York: John Wiley & Sons, Inc.

APPENDICES

A1: Specifications

Optical Table

Average Mirror Reflectance	>98% for λ>400nm
Average Total Light Transmission	>96% for λ>400nm
Tip/Tilt Range/Axis	3 degrees
Tip/Tilt Resolution/Axis	0.25 nanoradians
Maximum Angular Velocity of Tip/Tilt Mirror	62.5 mrad/s
Maximum bandwidth for arcsecond corrections	70Hz

Beamsplitter

First Surface Reflectance	Avg 4% in Visible Wavelengths
Second Surface Reflectance	Avg 0.5% in Visible Wavelengths
Total Light Transmission	~94%
Incedence Angle	45 degrees
Angular Range of Mount	10 degrees/axis
Angular Resolution of Mount	6 arcseconds/axis

PMT

Peak Quantum Effeciency	20% (400nm)
Peak Spectral Response	60mA/W (350-450nm)

Supply Voltage	800VDC
Dark Current	0.065nA/anode
Gain	1.8×10^7

PMT Supply Amplifier

Input Voltage	9.9VDC
Output Voltage	800VDC
Voltage Ripple	0.025%

PMT Preamplifiers

Input Impedance	1kΩ
Input Signal Range	1pA-1uA per 1V output
Input Range Selector	Remote via 3 logic lines
Output Range	±10V
Output Impedance	100Ω
Power Requirements	±15V, 50mA

Data Acquisition Board

Bus Compatability	PC/XT/AT and EISA
Analog Input	
No. of Channels	16 Single ended 8 differential
Resolution	12 bits
Voltage ranges (jumper selectable)	±5V, ±10V, 0-5V, 0-10V
Selected Range	0-10V

Gain Ranges (jumper Selectable)	1, 10, 100
Selected Gain	1
Offset Voltage	±2.44mV max
Bias Current	500pA
Input Impedance	$10^9\Omega$/10pF
Noise (Gain=1)	0.5 LSB RMS max
Analog Output	
No. of Channels	2
Resolution	12 bits
Voltage Ranges (jumper selectable)	±5V, ±10V, 0-10V
Selected Voltage Range	0-10V
Offset Voltage	±2.44mV max
Output Current	±5mA
Digital I/O	
No. of 8 bit Ports	2 (1 input, 1 output)
Digital I/O levels	TTL Compatible
System Throughput	
Multi-Channel Analog Input or Analog Output Under DMA Control	0-100kHz
DMA Channels	
Number supported	2 (1 Input, 1 Output)
PC Channels Supported (jumper selectable)	DMA 1, DMA 3
Input Mode	Start on trigger or start on

	command, using a linear or circular buffer
Output Mode	Start on command, using a linear or circular buffer

PC

Processor	Pentium 166MHz
RAM	32Mbytes
Hard Drive Capacity	1.6Gbytes
Operating System	Windows 95
Control Software	Visual Designer 4.0 by Intelligent Instrumentation

Overall System Specifications

Total Light Transmission	88.5% in the visible spectrum
Bandwidth	25Hz
Field of View (largest correction due to position sensor active area limitations)	±11 Arcseconds
Range of Motion at Slit	±72.1mm
Resolution	1.3 milliarcseconds
Maximum Slew Rate	326.8 Arcseconds/second
Stellar Range	V=0-9 stellar magnitudes

A2: Operating Instructions

Setup for an Observing Run

1. Boot up PC and open the Visual Designer software by clicking Start → Programs → Visual Designer → Visual Designer - Run.
2. Power up tip/tilt driver (black box next to PC).
3. Run program TIPTILTALIGN.DGM in the C:tiptilt directory. Follow the runtime instructions of this program as summarized in 4-26.
4. Install laser into polar axis mount.
5. Adjust laser until beam passes through the slit and is aligned with the center of the collimator.
6. Install link between optical table and polar quartz lamp.
7. Install beamsplitter.
8. Adjust pick-off mirror #1 until laser hits the center of the tip/tilt mirror.
9. Adjust pick-off mirror #2 until laser passes through the slit and hits the center of the collimator. If this cannot be achieved, it may be necessary to re-adjust the home position of the tip/tilt mirror and the position of pick-off mirror #2 simultaneously. The home position of the tip/tilt mirror can be adjusted by entering new values in the x-home and y-home fields of the run time screen. The final values must be recorded and changed in the TIPTILTRUN.DGM program. Do not change these values unless absolutely necessary.
10. Very Important!! Insert Neutral density filter on face of laser to avoid overexposing the PMT.
11. Plug in BNC and DB-15 cables between PC and PMT signal converter located in the rack next to the slit room doorway.
12. Turn on power switch located in the bottom, left hand corner of the Signal converter.
13. Turn off lights in slit room.
14. Open both diaphragms in PMT baffle tube.
15. Close control loop by clicking the switch on the display screen and shut off monitor.
16. Adjust beamsplitter until laser is centered on the slit.
17. Turn on monitor and open control loop by clicking switch on display back to open loop position.
18. Close diaphragms in PMT baffle tube.
19. Laser should still be centered on the slit.
20. Remove optical table - polar quartz link.
21. Remove laser from polar axis.

22. Re-install optical table - polar quartz link.
23. Stop TIPTILTALIGN.DGM program.
24. Run TIPTILTRUN.DGM.
25. Turn off monitor.
26. Follow Nightly Setup instructions.

Nightly Setup

1. Open diaphragms in PMT Baffle Tube.
2. Close loop on first star.
3. If star does not go to the slit, adjust beamsplitter mount until the desired position is reached.
4. System is now aligned.

Run Time Operations

1. When Star is within a couple arcseconds of slit, enable tip/tilt by moving "tip/tilt" switch to "enabled".
2. When observation is complete, disable "tip/tilt" switch.

- Should star be lost or tip/tilt seems to fail, disable "tip/tilt switch, complete observation and check status display on the monitor in the slit room for further instructions.
- It may be necessary to slightly re-adjust the beamsplitter position if the star is not centered perfectly on the slit during tip/tilt operation.

3. At end of night, just make sure tip/tilt switch is in the "disabled" position and close PMT baffle tube diaphragms.

System Shutdown and Removal Procedures at end of Run

1. Shut down Visual Designer program.
2. Shut down PC.
3. Remove beamsplitter and store properly.

4. Close diaphragms in PMT baffle tube.
5. Power off tip/tilt driver.
6. Power off signal converter.
7. Remove optical table - polar quartz link and slide optical table out of light path.
8. Cover optical table mirrors.
9. Unplug PC to signal converter cables and store under PC desk.

A3: Parts List

Part	Vendor	P/N	Total Cost ($)
Optical Table			
Pick-Off Mirrors	UCO/Lick Optical Shop	N/A	N/A
Tip/Tilt Mirror	Melles Griot	02MPQ011/038	198.00
Mirror Coatings	Denton Vacuum	FSS-99	650.00
Base Plates	UCO/Lick Machine Shop	N/A	N/A
Pick-Off Mirror Mounts (2)	Edmund Scientific	J36-482	256.00
Mirror Clips	UCO/Lick Machine Shop	N/A	N/A
Tip/Tilt Actuator	Melles Griot	07MCD015	3,295.00
Tip/Tilt Actuator Mounting Plates	UCO/Lick Machine Shop	N/A	N/A
Optical Table Link		N/A	N/A
Rubber Stopper	UCO/Lick Machine Shop	N/A	N/A
Misc. Hardware	UCO/Lick Machine Shop	N/A	N/A
	N/A		
Beamsplitter and PMT Assy.			
Beamsplitter	OptoSigma	03-2480	170.00
Beamsplitter Mount	Melles Griot	07MHT037	91.00

Mounting Plates	UCO/Lick Machine Shop	N/A	N/A
PMT Baffle Tube			
Iris Diaphragm	Edmund Scientific	J36-623	42.25
48mm Ring Mount (2)	Edmund Scientific	J52-304	115.50
Double Female Thread	Edmund Scientific	J03-630	19.00
Ring	Edmund Scientific	J03-632	115.50
Iris Diaphragm Barrel	Edmund Scientific	J54-630	42.00
15mm Extension (2)	Edmund Scientific	J53-483	33.75
C-to-T Thread Adapter	Edmund Scientific	J52-298	19.00
Double Male Thread Ring	Edmund Scientific	J52-295	42.00
25mm Extension (2)	Edmund Scientific	J52-292	63.00
25mm Holder (2)	N/A	N/A	N/A
PMT Housing	Hamamatsu	R5900-01-M4	1,345.00
PMT	Hamamatsu	E7083	335.00
PMT Socket	UCO/Lick Observatory	N/A	N/A
Misc. Hardware			
PMT Signal Converter			
PMT Supply Amp	EMCO High Voltage	L10W	77.00
	Advanced Research	PMT-5R	3,240.00

PMT Preamplifiers (4) Preamplifier power supply Misc. Hardware	Instruments Corporation Jameco Electronics N/A	123490 N/A	39.95 N/A
Controller PC Visual Designer 4.0 Multifunction I/O Board Termination Panel PCI/GPIB Interface W/ Software & Cable PMT Power Supply Tip/Tilt Driver Misc. Hardware	 Hi-Tech USA Intelligent Instrumentation Intelligent Instrumentation Intelligent Instrumentation National Instruments UCO/Lick Electronics Shop Melles Griot N/A	 N/A PCI-20909S-1 PCI-20428W-1 PCI-20428K-1 777158-51 N/A 11NCS101/IEEE N/A	 560.47 695.00 445.00 60.00 570.00 N/A 4,400.00 N/A

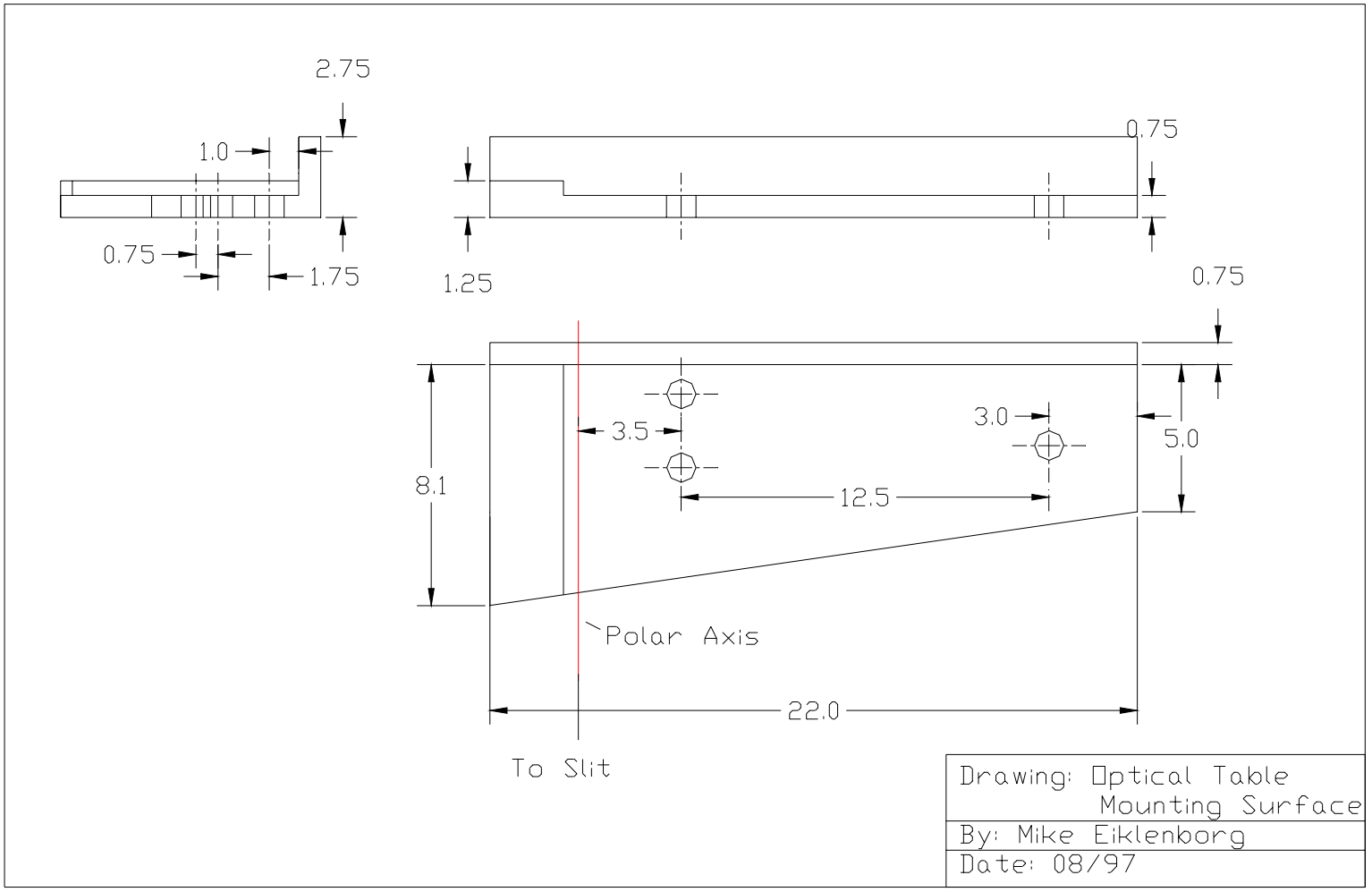
A4: Component Datasheets and Mechanical Drawings

Optical Table Mechanical Drawings

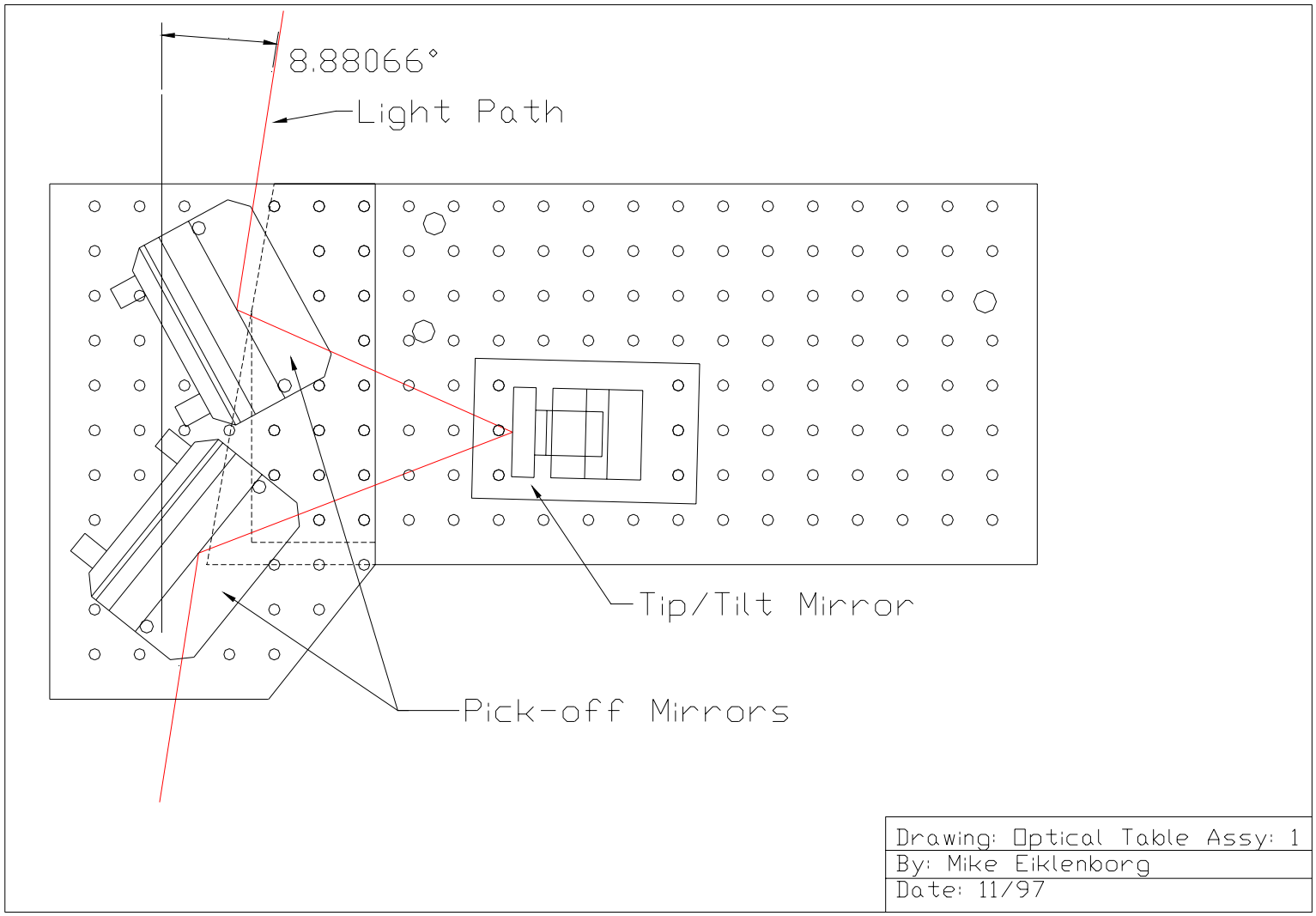
- Optical Table Mounting Surface
- Assembled Optical Table
- Optical Table Assembly Drawing
- Mirror Layout
- Pick-off Mirror Mounts
- Tip/Tilt Mirror Mounting Plate #1
- Tip/Tilt Mirror Mounting Plate #2
- Baseplate #1
- Baseplate #2
- Baseplate #3

Optical Table Datasheets

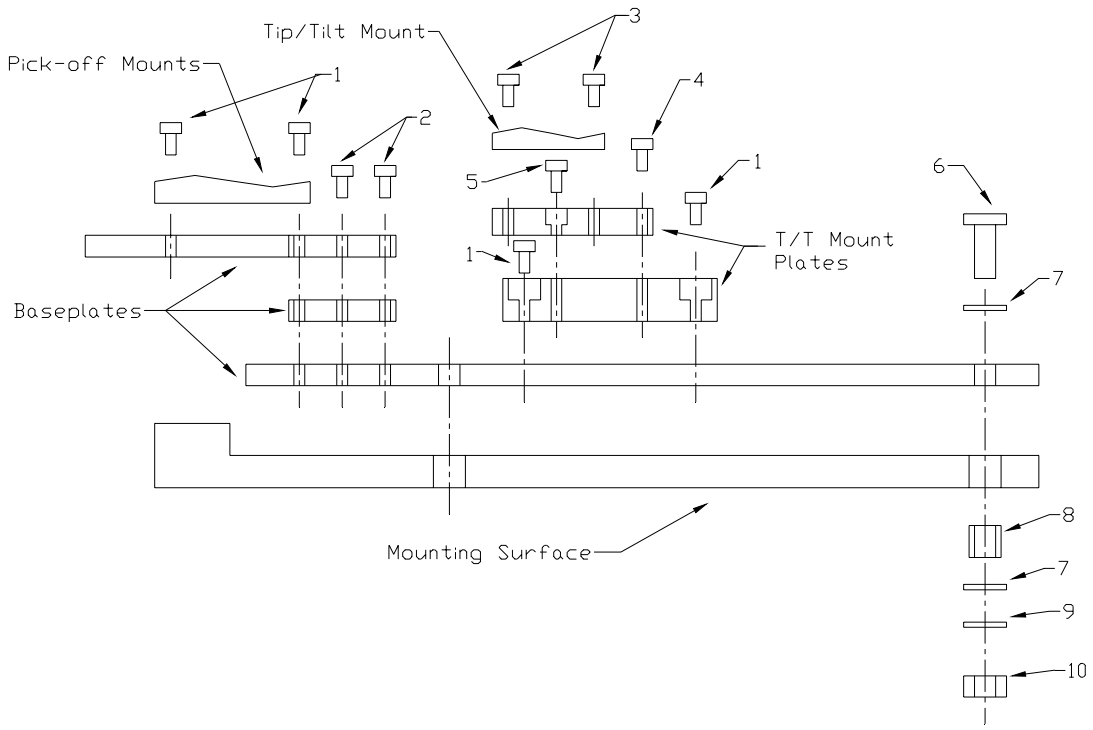
- Nanomover Actuators
- Nanomover 1 Calibration Graph
- Nanomover 2 Calibration Graph
- Nanomover Gimbal Mount Kit
- Sample FSS-99 Ag Coating Curve



Drawing: Optical Table Mounting Surface
By: Mike Eiklenborg
Date: 08/97

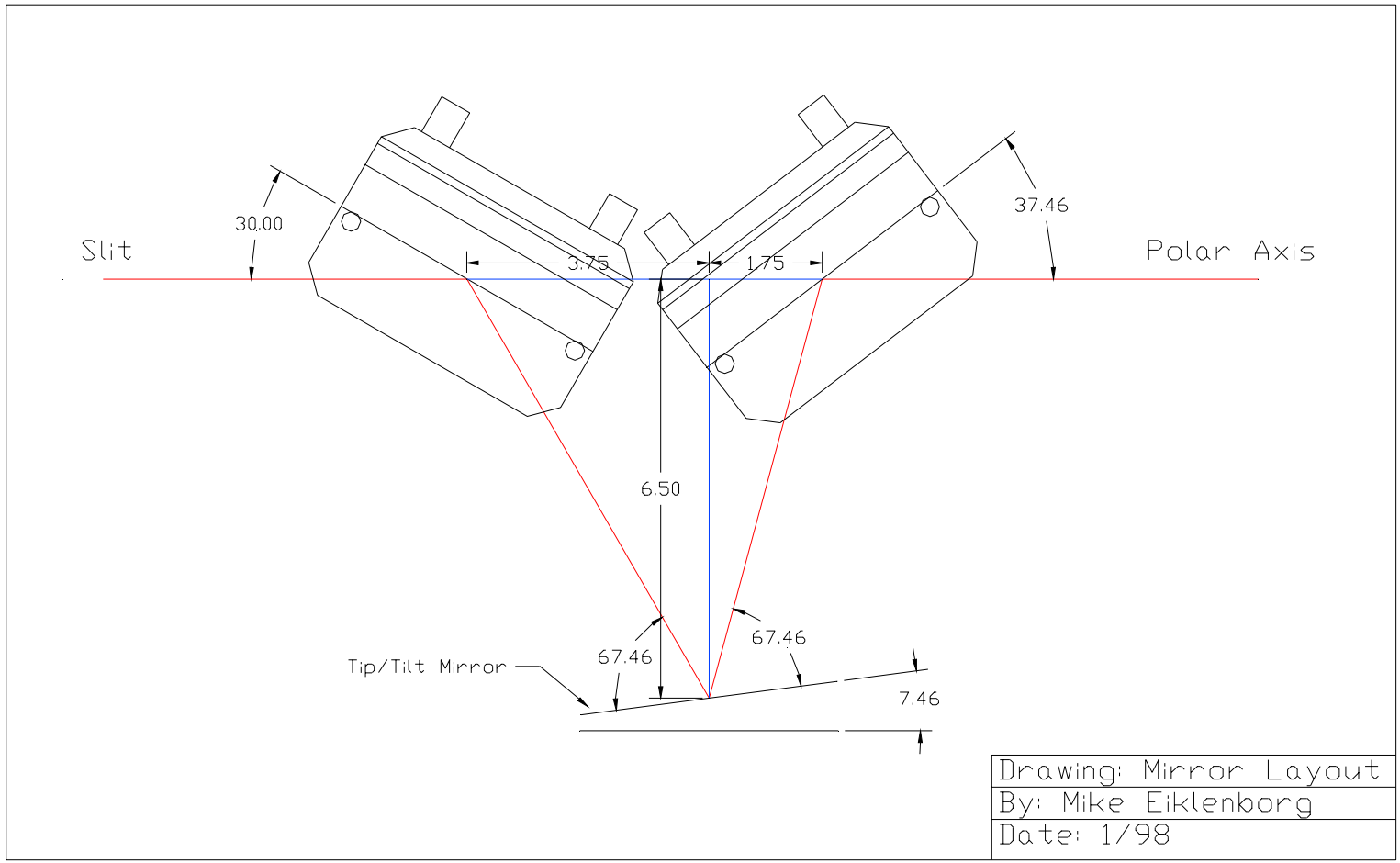


Drawing: Optical Table Assy: 1
By: Mike Eiklenborg
Date: 11/97

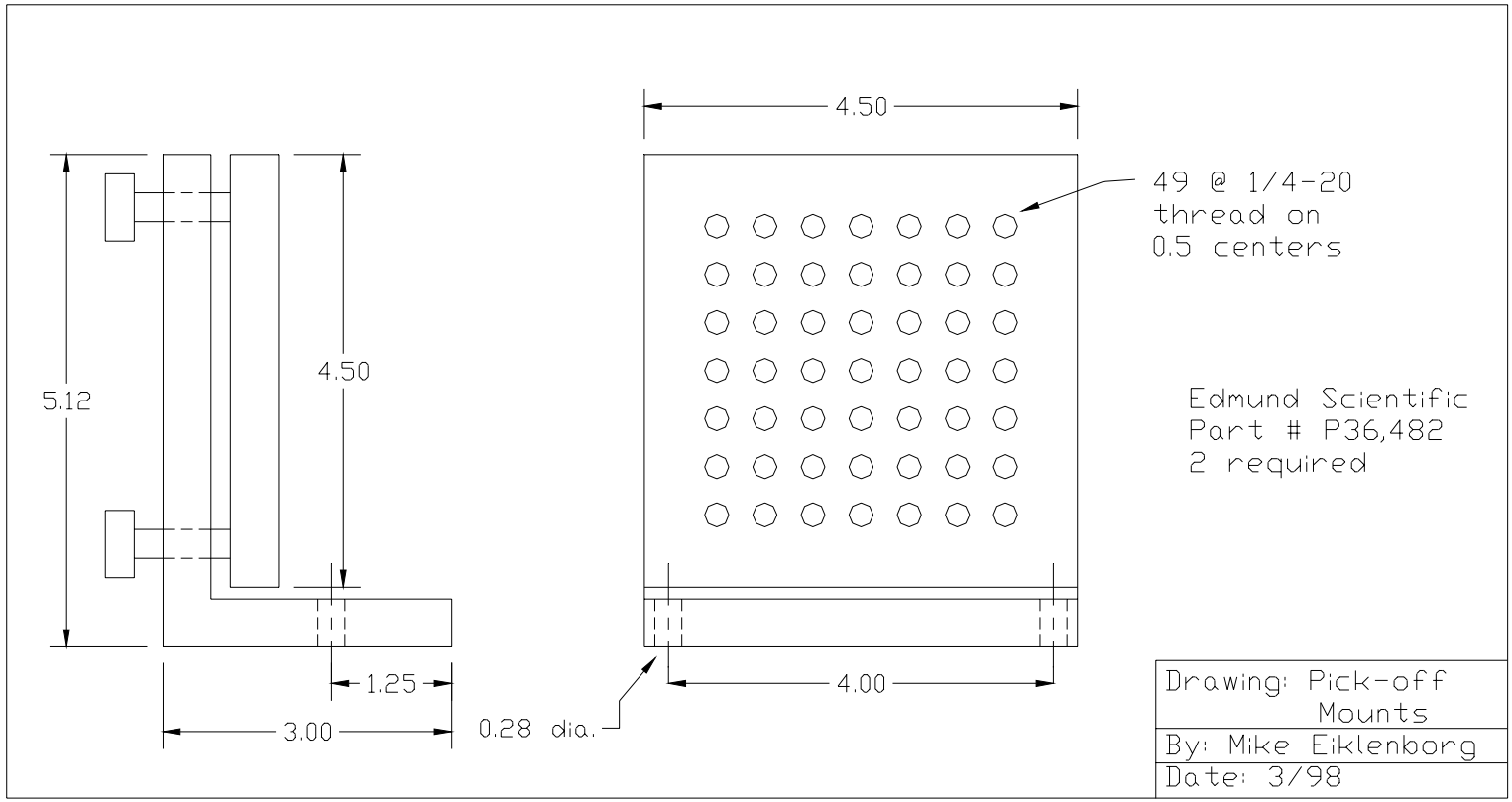


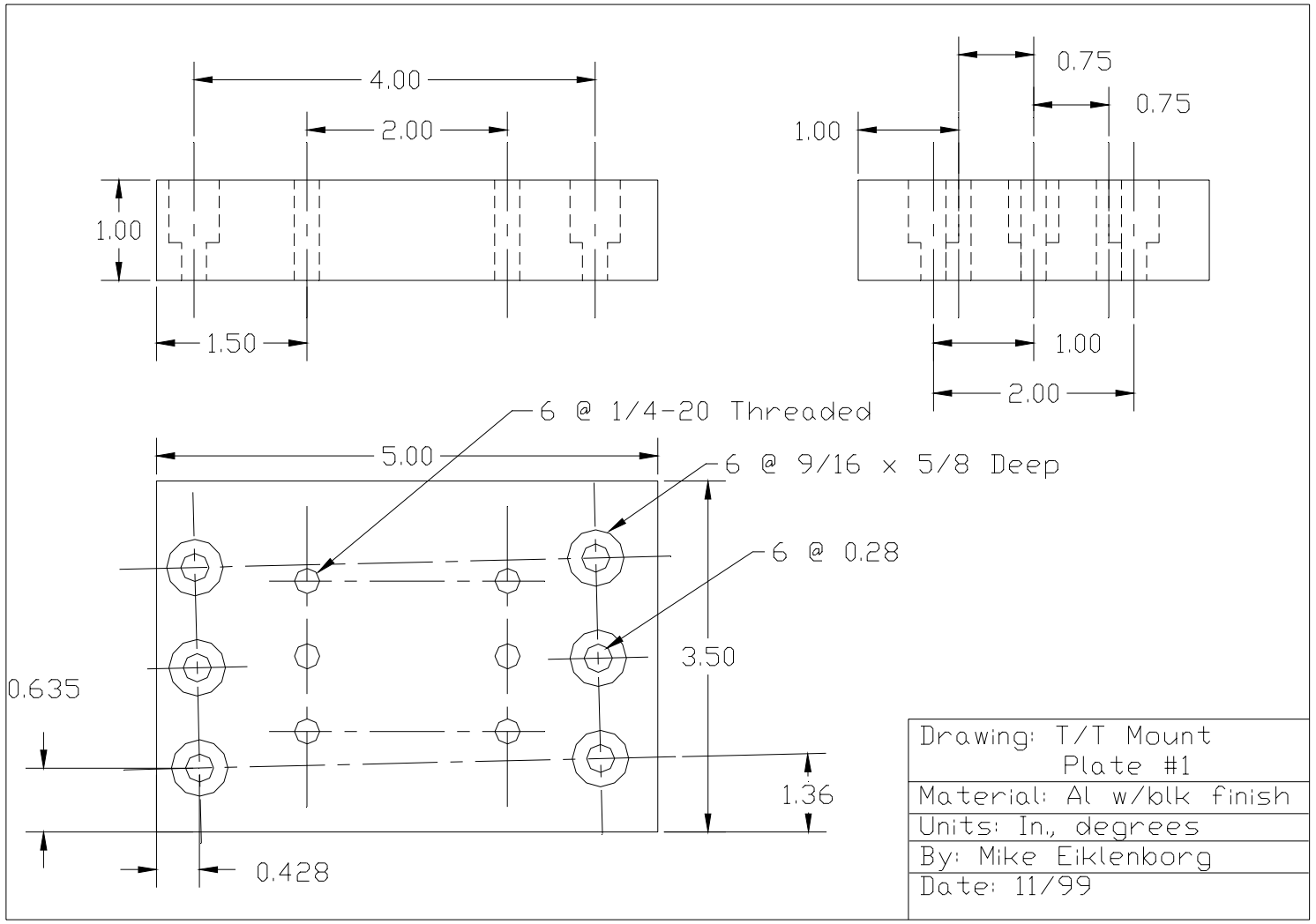
1. 1/4x0.75 Socket Head. Qty: 10
2. 1/4x1.25 Hex Head. Qty: 9
3. 1/4x3/8 Socket Head. Qty: 4
4. 1/4x1 Socket Head. Qty: 3
5. 1/4x5/8 Socket Head. Qty: 3
6. 7/16x1.75 Shoulder Bolt. Qty: 3
7. 7/16 Flat Washer Qty: 6
8. Bushing. L=.5, ID=.5, □D=.675. Qty: 3
9. 7/16 Lock Washer
10. 7/16 Nut

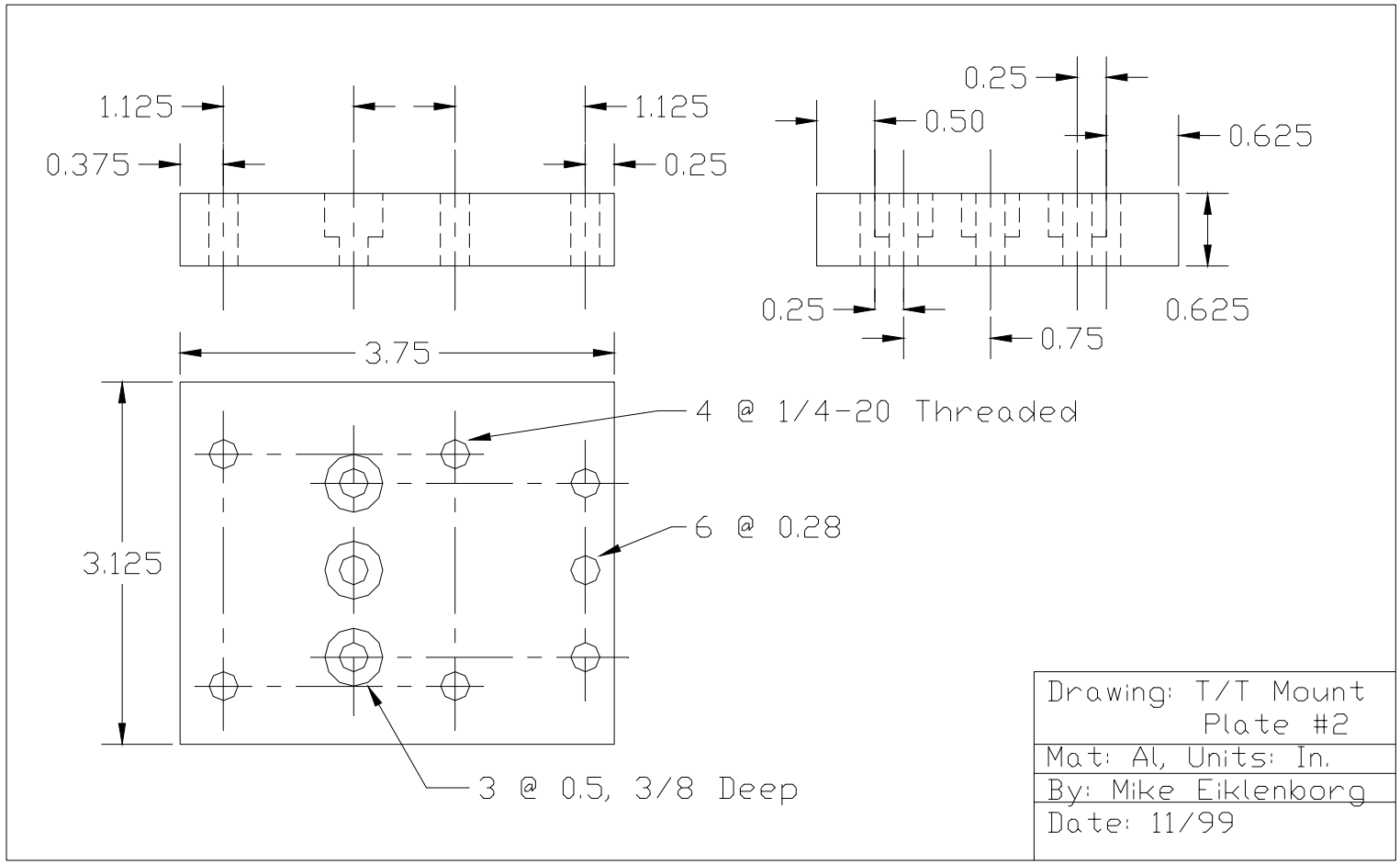
Drawing: □ptical Table Assembly
By: Mike Eiklenborg
Date: 11/99

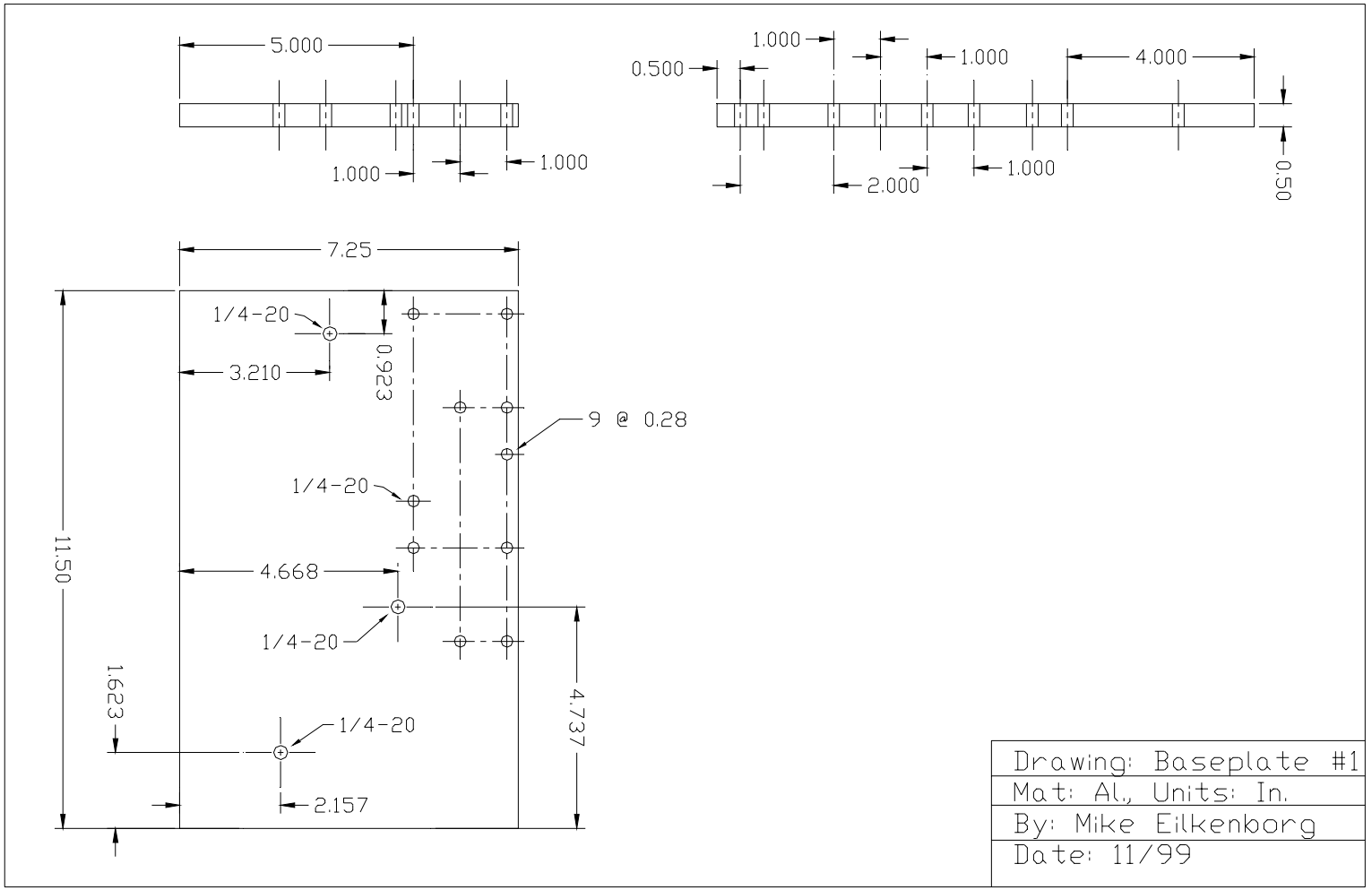


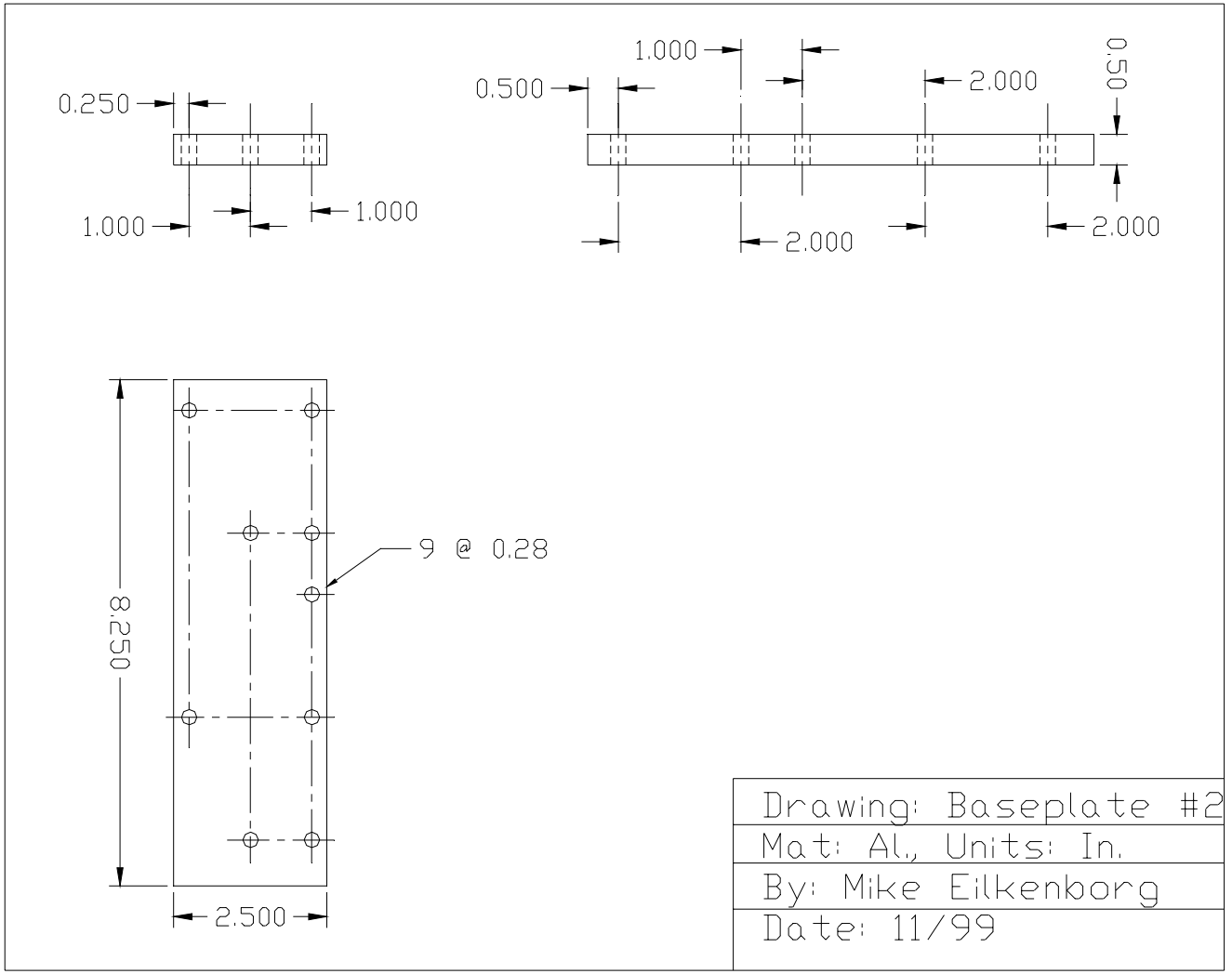
Drawing: Mirror Layout
By: Mike Eiklenborg
Date: 1/98

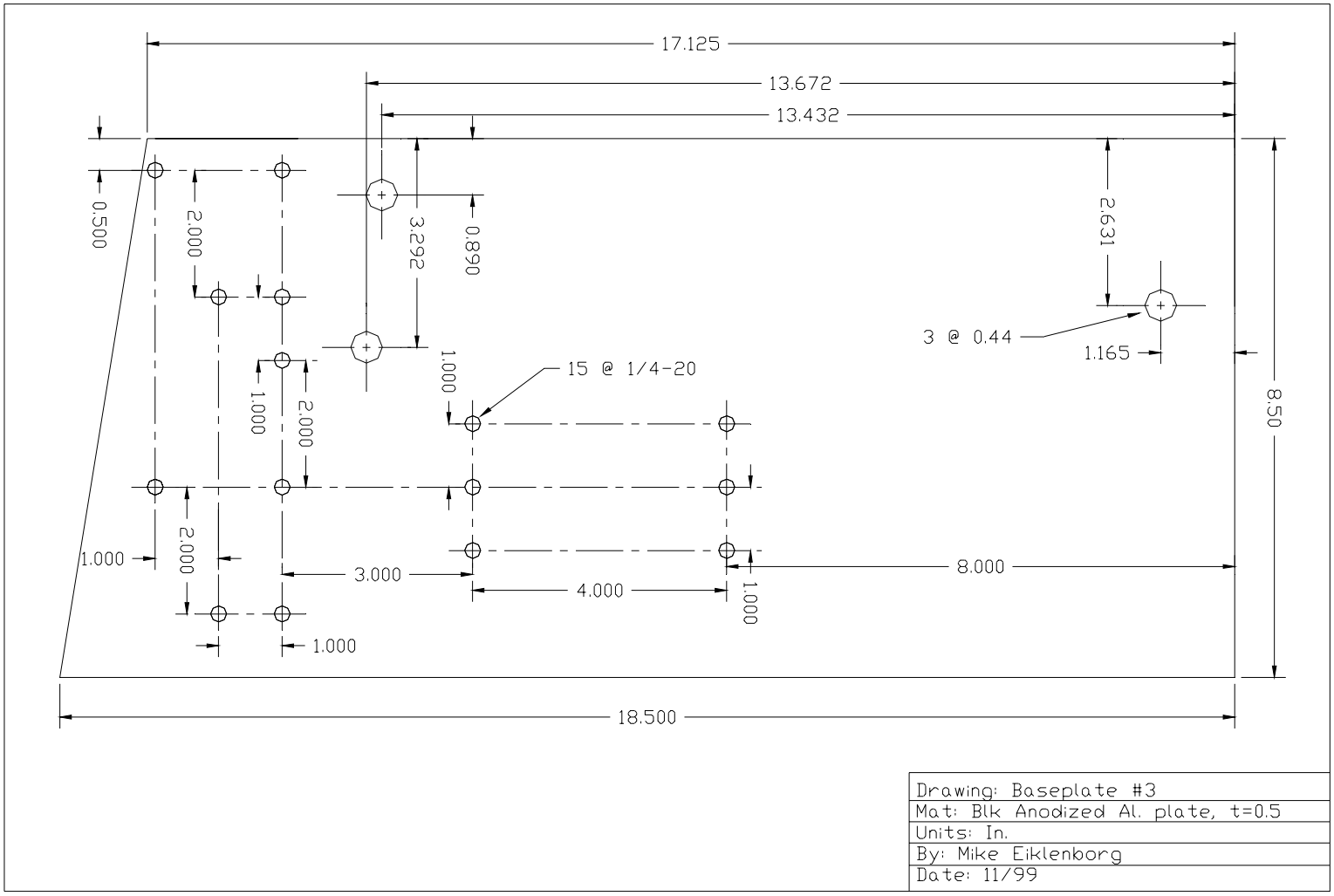

4.50
49 @ 1/4-20
thread on
0.5 centers
5.12
4.50
Edmund Scientific
Part # P36,482
2 required
1.25
3.00
0.28 dia.
4.00
Drawing: Pick-off
Mounts
By: Mike Eiklenborg
Date: 3/98


4.00
2.00
1.00
1.50
0.75
0.75
1.00
1.00
2.00
6 @ 1/4-20 Threaded
5.00
6 @ 9/16 x 5/8 Deep
6 @ 0.28
3.50
0.635
1.36
0.428
Drawing: T/T Mount Plate #1
Material: Al w/blk finish
Units: In., degrees
By: Mike Eiklenborg
Date: 11/99

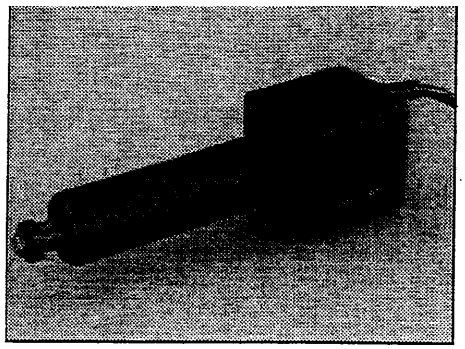

1.125
1.125
0.375
0.25
3.75
3.125
4 @ 1/4-20 Threaded
6 @ 0.28
3 @ 0.5, 3/8 Deep
0.25
0.50
0.625
0.25
0.625
0.75
Drawing: T/T Mount Plate #2
Mat: Al, Units: In.
By: Mike Eiklenborg
Date: 11/99


5.000
1.000
1.000
1.000
0.500
1.000
1.000
4.000
2.000
1.000
0.50
7.25
1/4-20
0.923
3.210
9 @ 0.28
1/4-20
11.50
4.668
1/4-20
1.623
4.737
1/4-20
2.157
Drawing: Baseplate #1
Mat: Al., Units: In.
By: Mike Eilkenborg
Date: 11/99


0.250
1.000
1.000
1.000
0.500
2.000
0.50
2.000
2.000
9 @ 0.28
8.250
2.500
Drawing: Baseplate #2
Mat: Al., Units: In.
By: Mike Eilkenborg
Date: 11/99



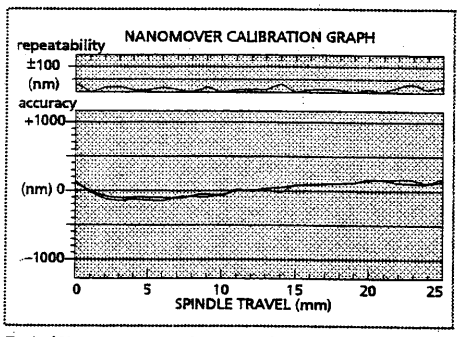
Drawing: Baseplate #3
Mat: Blk Anodized Al. plate, t=0.5
Units: In.
By: Mike Eiklenborg
Date: 11/99



Nanomover™ Actuators

The Nanomover™ actuator consists of the finest micrometer leadscrew driven through a direct linkage (to minimize backlash) by a two phase, 400 steps/revolution stepper motor. Although somewhat larger than a typical micrometer, Nanomovers are designed as a direct replacement for a manual micrometer. Three versions of Nanomover are available: standard (11 NCM 001), high torque (11 NCM 005), and the spherically tipped (11 NCM 007).

- All actuators have a 25 mm travel.
- Directly replaces manual micrometers with 9.5 mm (.375 in.) shafts.
- High torque model is perfect for vertical stages.
- Available driver allows complete software control.
- Individually tested actuators come with inspection data sheet.
- Up to 10 nm resolution, repeatable to within ±100 nm.



Typical Nanomover™ performance showing the bidirectional repeatability and accuracy (measured using a Hewlett Packard laser interferometer 5508A) over the range of travel.

SPECIFICATIONS: Nanomover™ ACTUATORS

Resolution: 10 nm

Bidirectional Repeatability: ±100 nm

Absolute Accuracy: ±1 μm

Range of Travel: 25 mm

Maximum Velocity: 2.5 mm/sec.

Maximum Acceleration: 1.25 m/sec^2

Maximum Load:
11 NCM 001, 11 NCM 007: 10 kg
11 NCM 005: 20 kg

Stepping Current:
11 NCM 001, 11 NCM 007: 0.90 A
11 NCM 005: 1.20 A

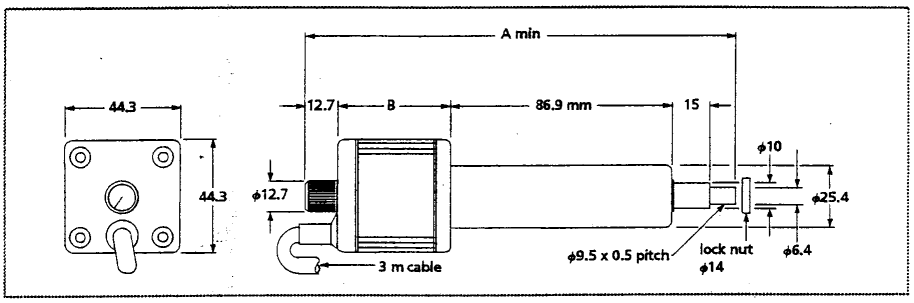
Holding Current:
11 NCM 001, 11 NCM 007: 0.45 A
11 NCM 005: 0.60 A

Shaft Length:
11 NCM 001, 11 NCM 007: 370 mm
11 NCM 005: 500 mm

Standard Cable Length: 3 m

Dimensions:
11 NCM 001: 44×44×160 mm
11 NCM 005: 44×44×174 mm
11 NCM 007: 44×44×160 mm

Weight:
11 NCM 001: 370 gm
11 NCM 005: 500 gm
11 NCM 007: 370 gm

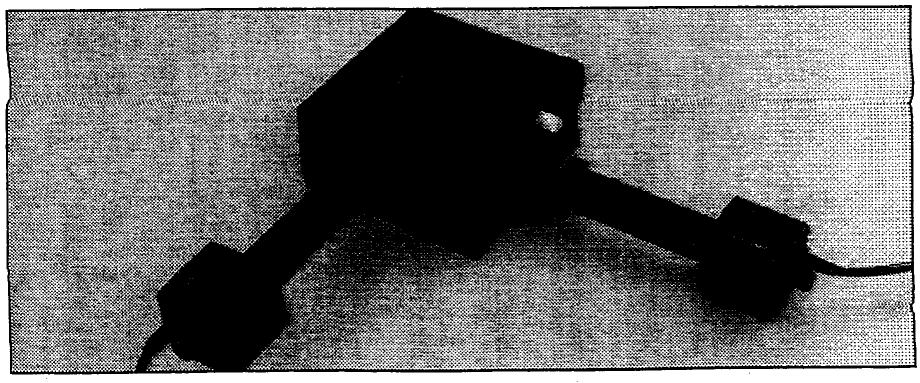


Nanomover™ actuator outline

Nanomover Actuators

Motor	Tip	A (mm)	B (mm)	Range of Travel (mm)	Maximum Load (kg)	PRODUCT NUMBER
Standard	Flat	159.9	43.6	25	10	11.NOM.001
Hi Torque	Flat	173.9	57.6	25	20	11.NOM.005
Standard	Spherical	159.9	54.8	25	10	11.NOM.007

For quantity pricing please contact your sales representative.

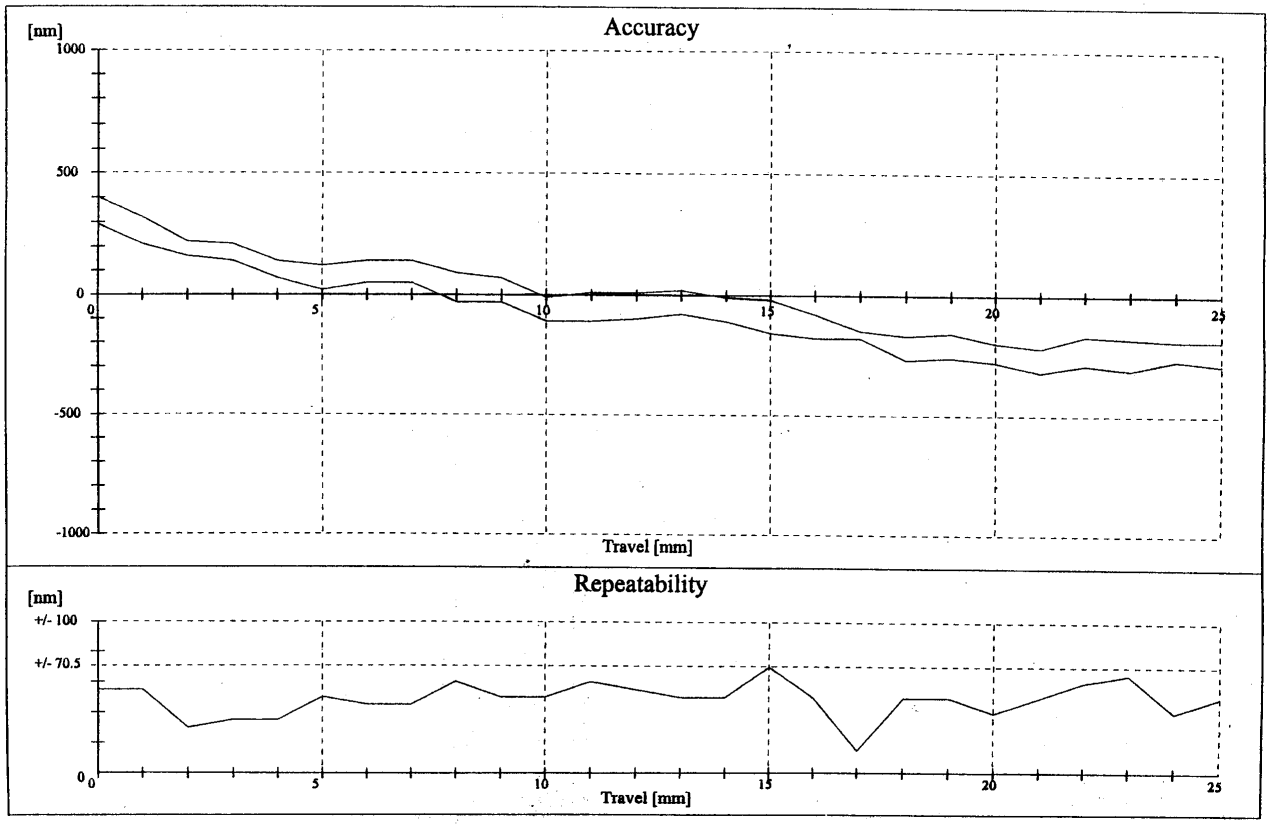


Nanomover Calibration Graph

Model: 11 NCM 001
Load: 1.5 kg
Test: final +5

LMC: 5
Date: 08-11-1998
Time: 07:19:16

Serial Number: mg2813
Temperature: 19.9 C

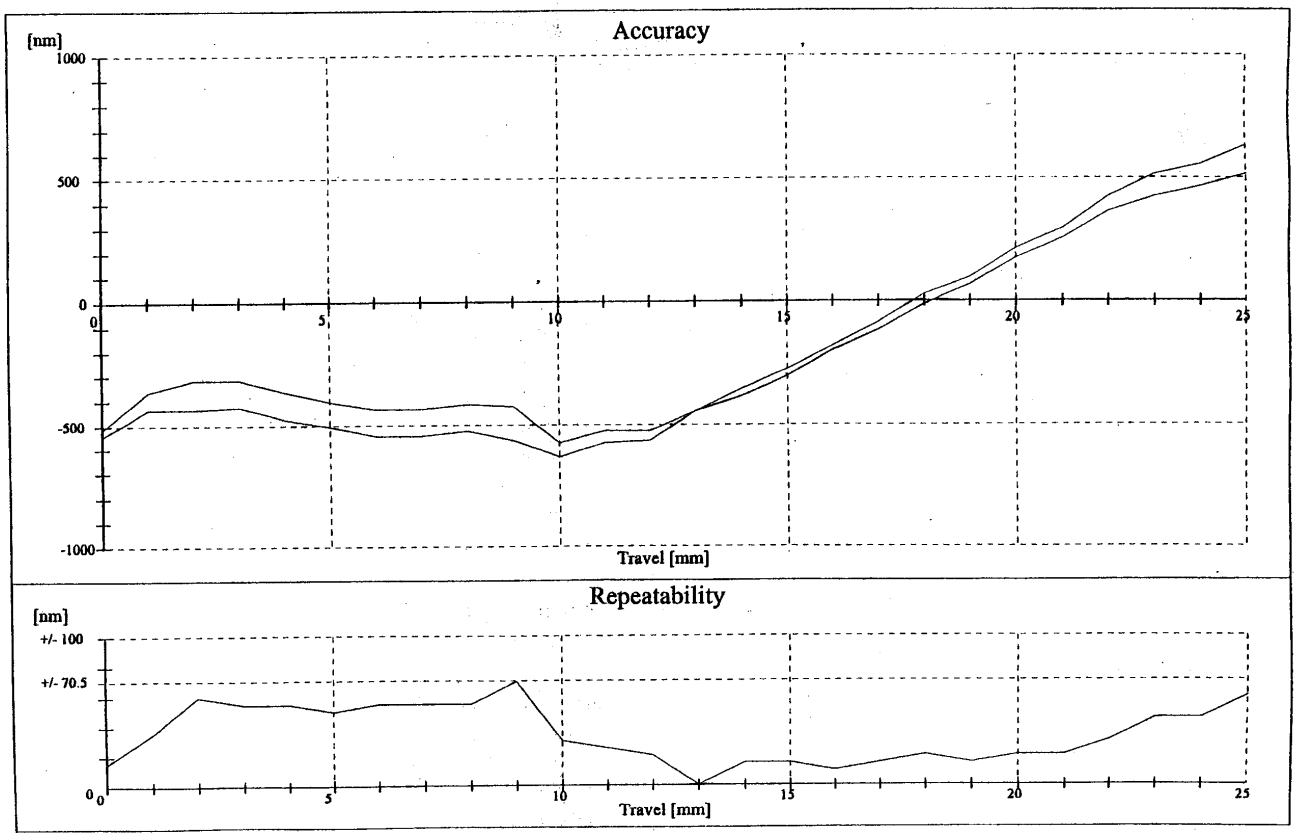


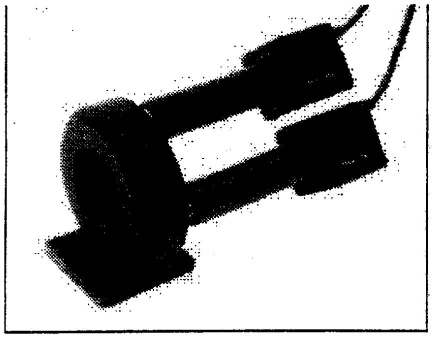
Nanomover Calibration Graph

Model: 11 NCM 001
Load: 1.5 kg
Test: final +5

LMC: 5
Date: 08-17-1998
Time: 09:46:03

Serial Number: mg2829
Temperature: 19.9 C





Nanomover™ Gimbal Mirror Mount Kits

This gimbal type mirror holder is designed so the two orthogonal axes of rotation intersection on the front surface of the mirror. As a result, the optical path length will remain constant with angular changes in mirror position.

- Easily assembled.
- Solid steel construction.
- Universal inch/metric base plate provided with both ¼-20 and M6 cap screws.
- Holds optics up to 50.8 mm (2 in.) in diameter.
- Comes with two Nanomover™ drives.
- Angular resolution of better than 0.5 arc seconds.

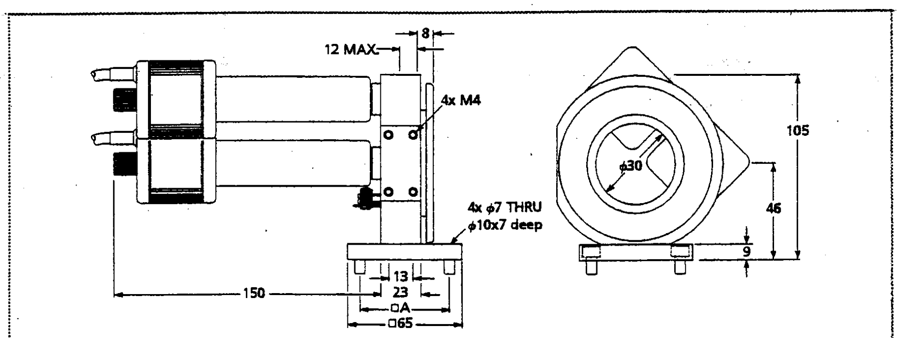
SPECIFICATIONS:
Nanomover™ GIMBAL MIRROR MOUNT KITS

Angular Range: 6°
Mirror Diameter: 50.8 mm
Maximum Mirror Thickness: 12 mm
Angular Sensitivity: >0.5 arc seconds
Material: Solid steel with stainless steel motion components
Finish: Flat black paint
Nanomover™ Actuators: 2, 11 NCM 001 standard actuators

Nanomover™ Gimbal Mirror Mount Kits

	PRODUCT NUMBER
Inch/metric compatible mounting	07 MCD 025

**Available fully assembled and tested.*

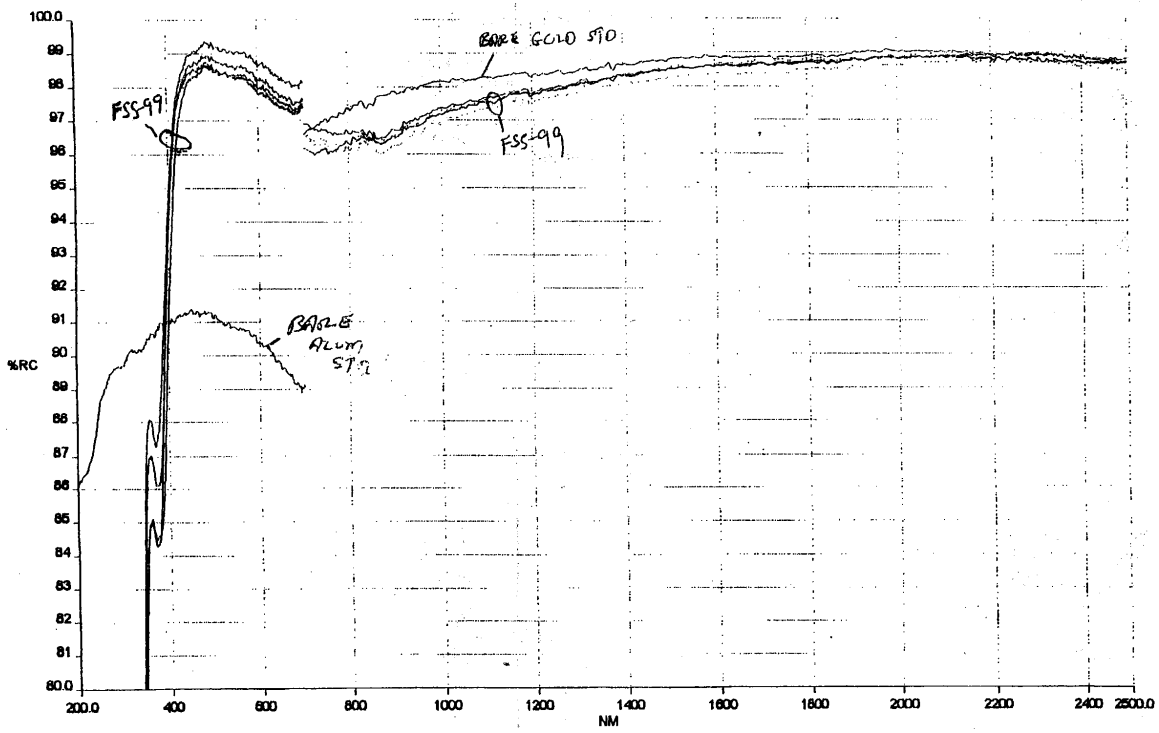


07 MCD 025 assembled kit

Date: 10/1/98

DENTON VACUUM, L.L.C.

LAMBDA 900



FSS-99 - UNIT 11 - 45 DEG

AL1-45AV.SP - 10/1/98 - AL STANDARD @ 45 Deg
H8D71RGB.SP - 10/1/98 - FSS-99, 45 DEG, Glass Witness
H8F12RGB.SP - 10/1/98 - FSS-99, 45 DEG, Glass Witness
H8G12RGB.SP - 10/1/98 - FSS-99, 45 DEG, Glass Witness
H8H11RGB.SP - 10/1/98 - FSS-99, 45 DEG, Glass Witness

AURIAV45.SP - 10/1/98 - GOLD STANDARD @ 45 DEG
H8D71RGC.SP - 10/1/98 - FSS-99, 45 DEG, Glass Witness
H8F12RGC.SP - 10/1/98 - FSS-99, 45 DEG, Glass Witness
H8G12RGC.SP - 10/1/98 - FSS-99, 45 DEG, Glass Witness
H8H11RGC.SP - 10/1/98 - FSS-99, 45 DEG, Glass Witness

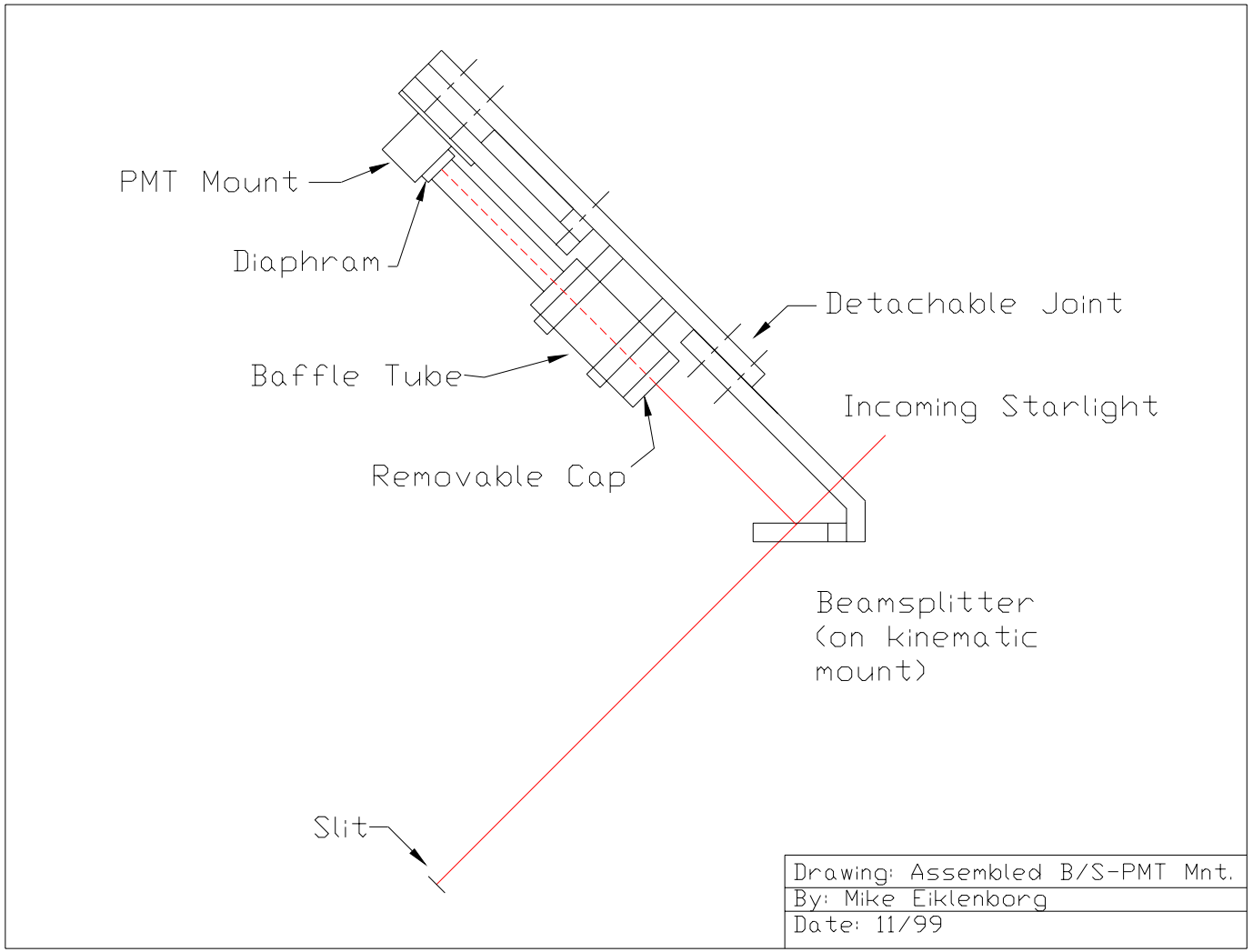
FSS9911C

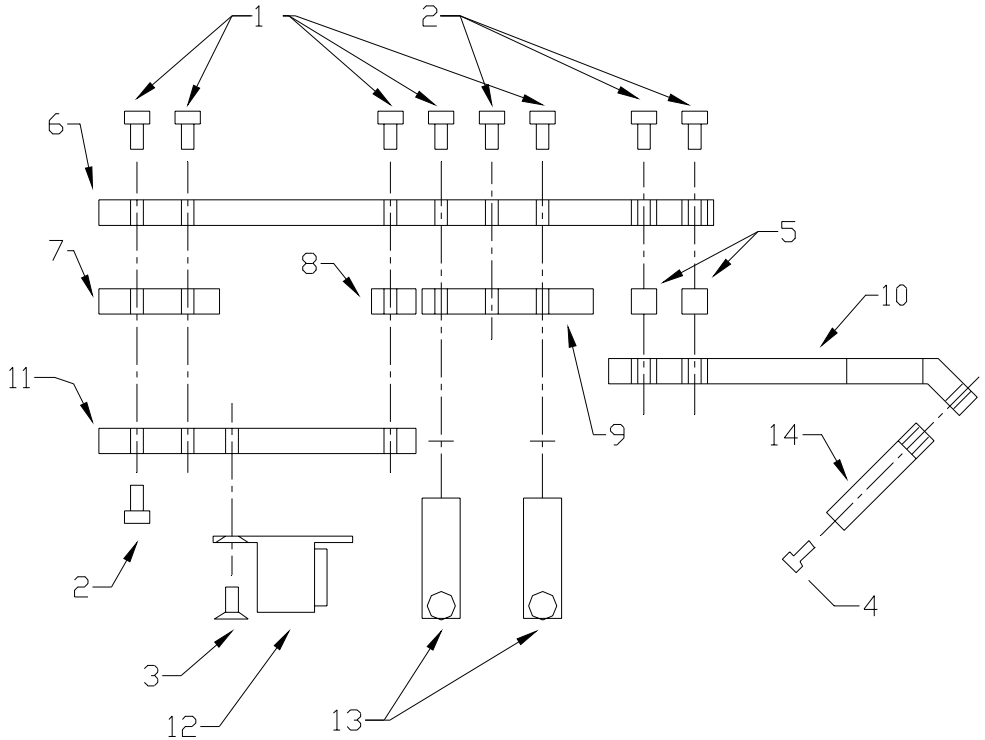
Beamsplitter and PMT Mount Assembly Drawings

- Assembled PMT-B/S Mount
- Beamsplitter and PMT Mount Assembly
- B/S-PMT Mounting Plate #1
- B/S-PMT Mounting Plate #2
- B/S-PMT Mounting Plate #3
- B/S-PMT Mounting Plate #4
- B/S-PMT Mounting Plate #5
- B/S-PMT Mounting Plate #6
- PMT Housing
- PMT Baffle Tube

Beamsplitter and PMT Mount Assembly Datasheets

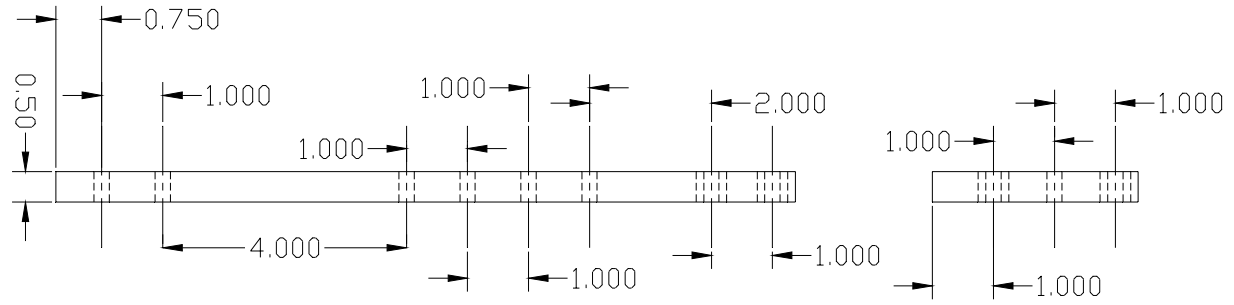
- Kinematic Beamsplitter Mount
- Beamsplitter
- PMT & Socket

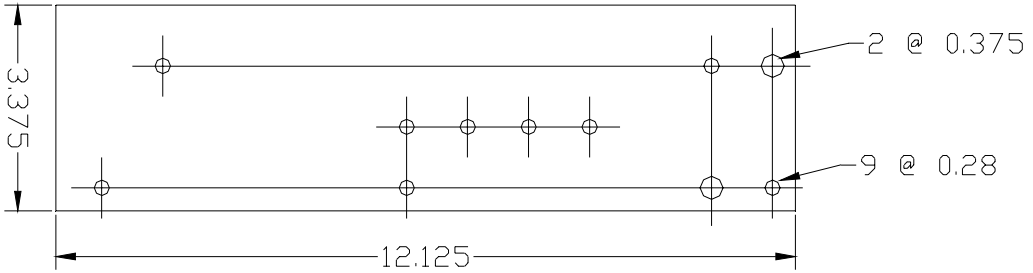

PMT Mount
Diaphram
Detachable Joint
Baffle Tube
Incoming Starlight
Removable Cap
Beamsplitter
(on kinematic
mount)
Slit
Drawing: Assembled B/S-PMT Mnt.
By: Mike Eiklenborg
Date: 11/99



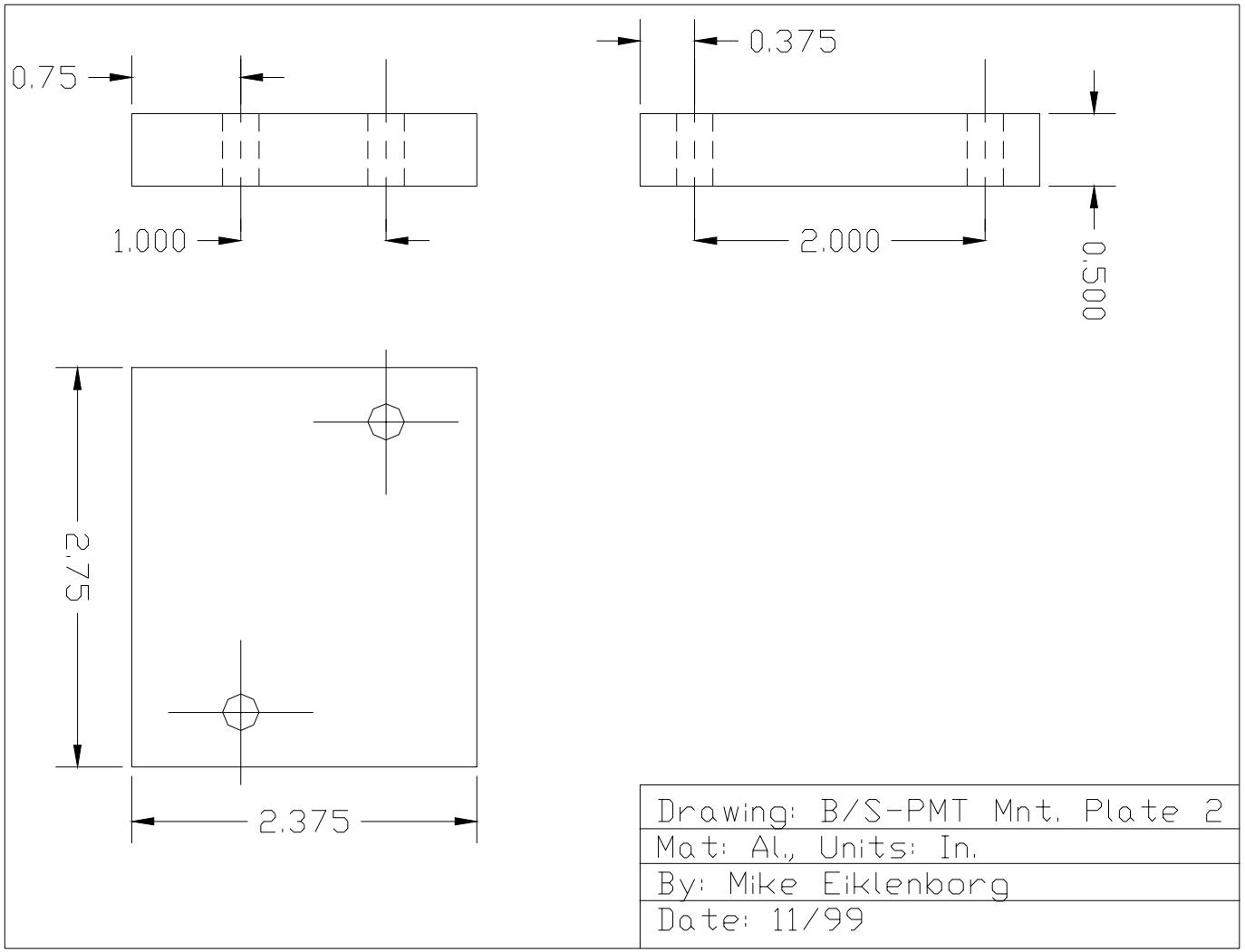
1. 1/4x1.25 Socket Head. Qty. 6
2. 1/4x3/4 Socket Head. Qty. 4
3. 1/4x3/8 Counter Sink. Qty. 1
4. 1/4x3/8 Socket Head. Qty. 1
5. 3/8x1 Pin. Qty. 2
6. Mnt. Plate #1
7. Mnt. Plate #2
8. Mnt. Plate #3
9. Mnt. Plate #4
10. Mnt. Plate #5
11. Mnt. Plate #6
12. PMT Housing
13. Baffle Tube Clamps. Qty. 2
14. Beamsplitter Mnt.

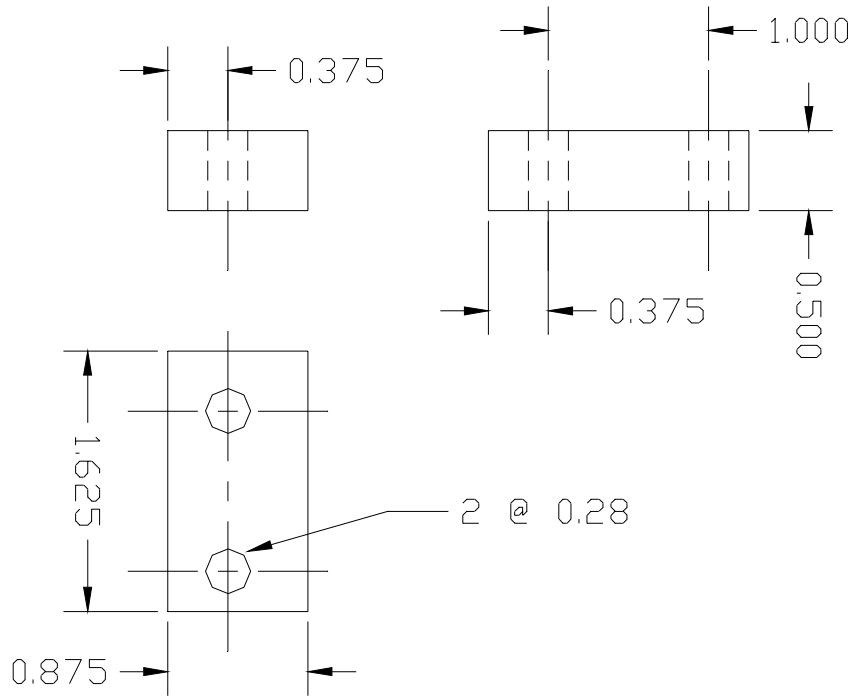
Drawing: B/S-PMT Mnt. Assy.
By: Mike Eiklenborg
Date: 11/99



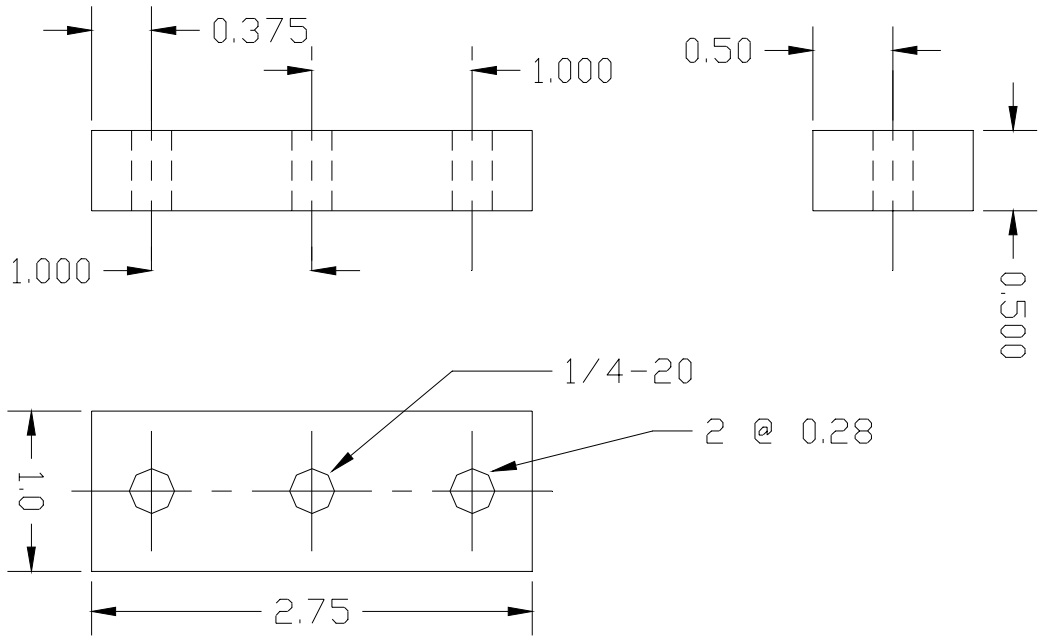


Drawing: B/S-PMT Mnt. Plate 1
Mat: Al., Units: In.
By: Mike Eiklenborg
Date: 11/99

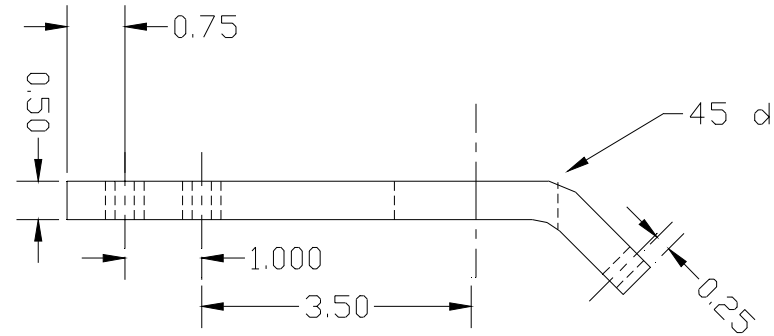

0.75
1.000
0.375
2.000
0.500
2.75
2.375
Drawing: B/S-PMT Mnt. Plate 2
Mat: Al., Units: In.
By: Mike Eiklenborg
Date: 11/99

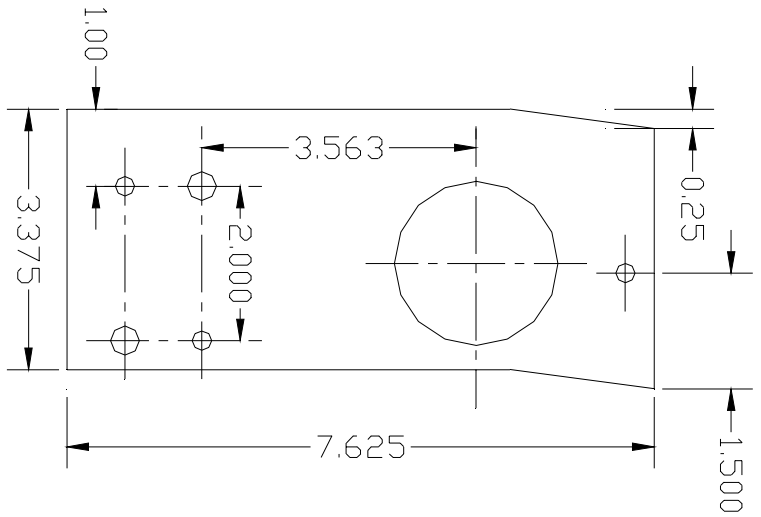


Drawing: B/S-PMT Mnt. Plate 3
Mat: Al., Units: In.
By: Mike Eiklenborg
Date: 11/99

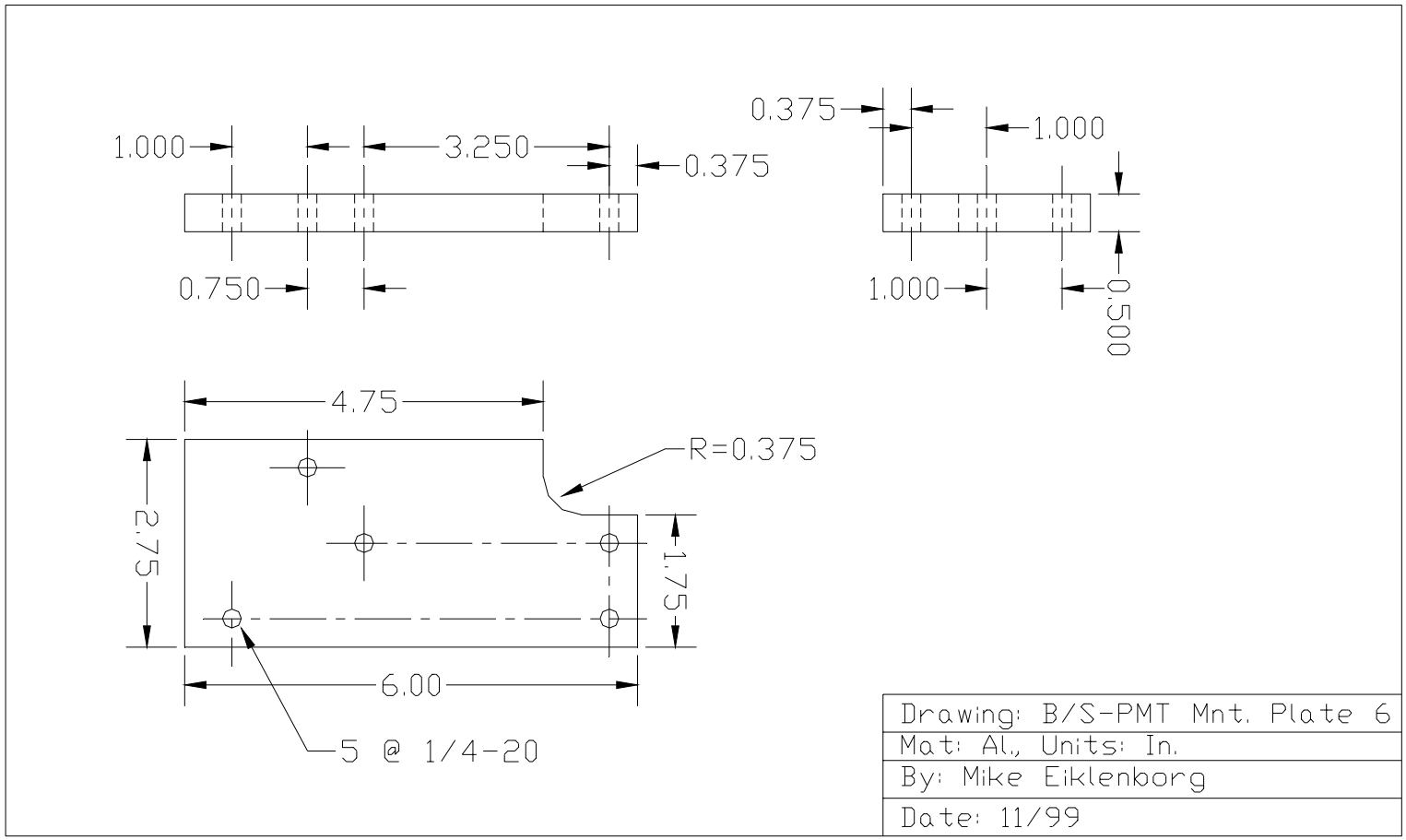


Drawing: B/S-PMT Mnt. Plate 4
Mat: Al., Units: In.
By: Mike Eiklenborg
Date: 11/99

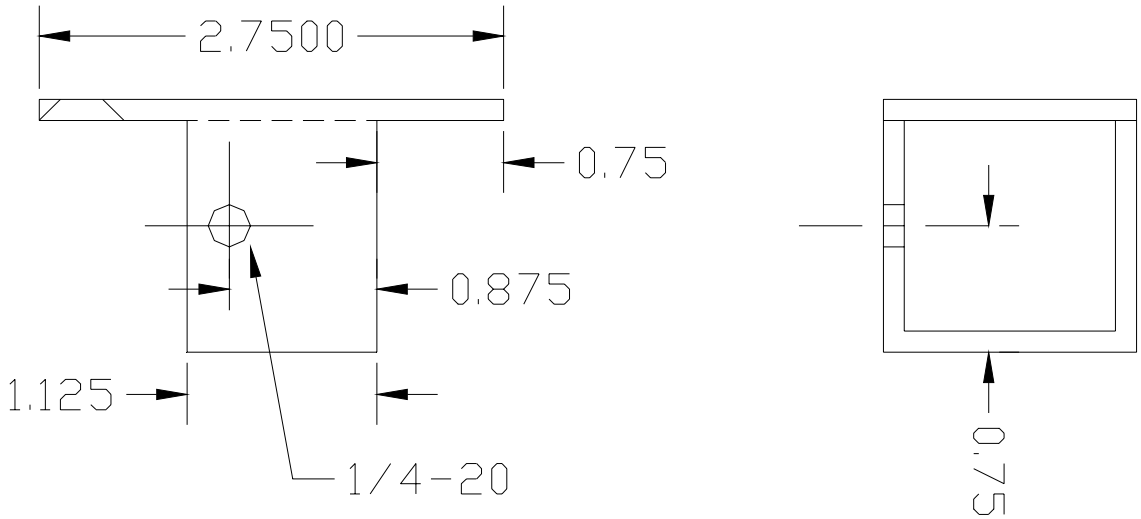




Drawing: B/S-PMT Mnt. Plate 5
Mat: Al., Units: In.
By: Mike Eiklenborg
Date: 11/99

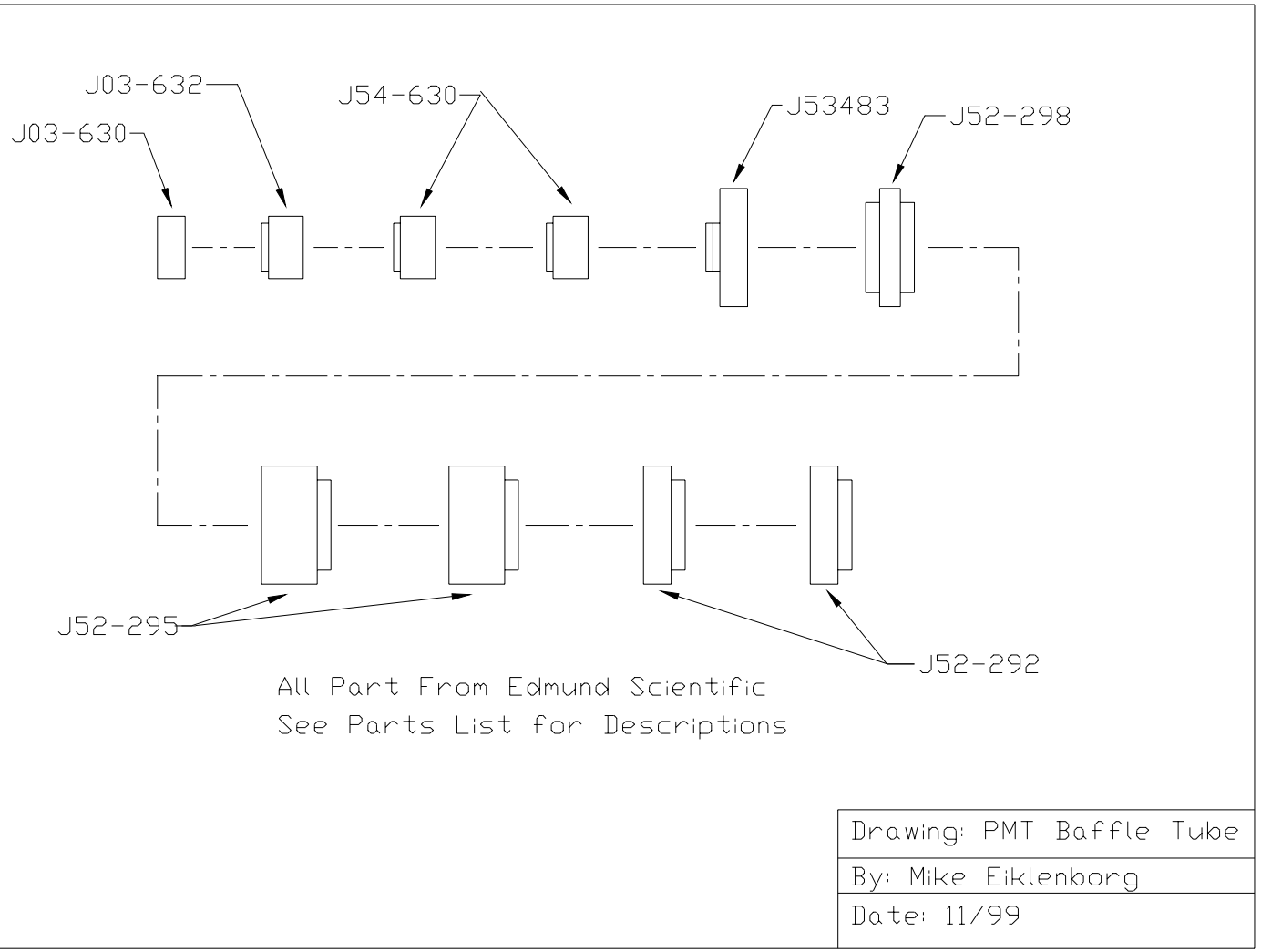


Drawing: B/S-PMT Mnt. Plate 6
Mat: Al., Units: In.
By: Mike Eiklenborg
Date: 11/99



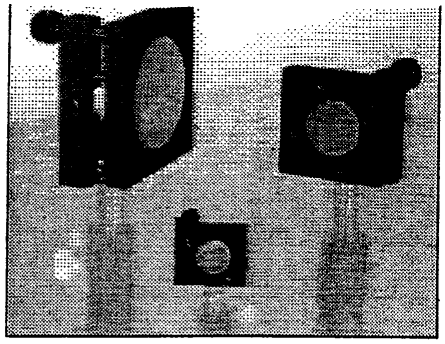
Cut From 1.5" Al Sq.
Tubing W/1.25" I.D.

Drawing: PMT Housing
Units: In.
By: Mike Eiklenborg
Date: 11/99



All Part From Edmund Scientific
See Parts List for Descriptions

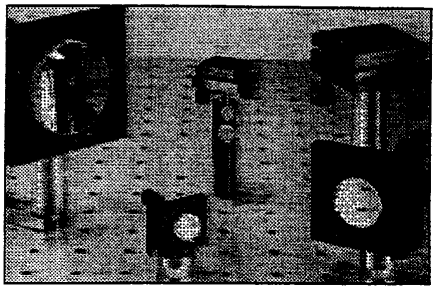
Drawing: PMT Baffle Tube
By: Mike Eiklenborg
Date: 11/99

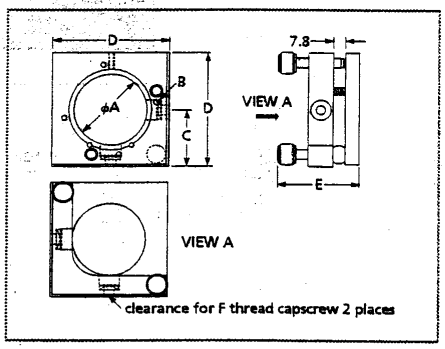


Kinematic Mirror/Beamsplitter Mounts

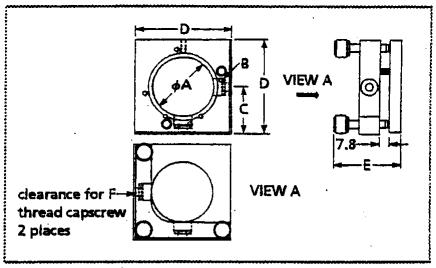
Kinematic mirror/beamsplitter mounts are an ideal low cost solution for two axes tilt. The kinematic design includes hardened surfaces to resist wear and increase stability.

- Precision stainless steel adjustment screws with brass threaded inserts provide exceptionally smooth adjustment.
- Triple-drive option provides translation.
- Counter bored holes provided for easy "top down" mounting to mounting posts (page 404) and pillars (page 415).
- Angular range of 10°.
- M6 and ¼-20 cap screws provided.





07 MHT 02X kinematic mount with two adjusters



07 MHT 03X kinematic mounts with three adjusters

07 MHT Mirror Mounts

	ϕA Optic Diameter	Angular* Resolution	Number of Adjusters	B Hole Pattern	C Optical Axis Height (mm)	D (mm)	E (mm)	F (mm)	PRODUCT NUMBER
□	10	20 arc sec	2	M3 on 20 mm center	15	27.5	28	M4/8-32	07 MHT 021
▣	12.5	20 arc sec	2	M3 on 20 mm center	15	27.5	28	M4/8-32	07 MHT 023
▤	25	10 arc sec	2	M4 on 38 mm bolt circle	25	50	43	M6/1/4-20	07 MHT 025**
▥	50	6 arc sec	2	M4 on 38 mm bolt circle	37.5	75	53	M6/1/4-20	07 MHT 027
▦	10	20 arc sec	3	M3 on 20 mm center	15	27.5	28	M4/8-32	07 MHT 031
□	12.5	20 arc sec	3	M3 on 20 mm center	15	27.5	28	M4/8-32	07 MHT 033
▤	25	10 arc sec	3	M4 on 38 mm bolt circle	25	50	43	M6/1/4-20	07 MHT 035
▥	50	6 arc sec	3	M4 on 38 mm bolt circle	37.5	75	53	M6/1/4-20	07 MHT 037

*Angular resolution calculated from 2° rotation of adjuster. **07 MHT 025 replaces 07 MHT 001.

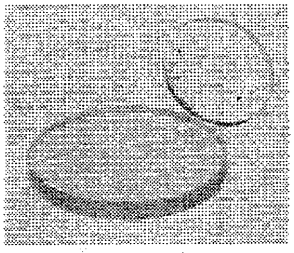
OptoSigma

Beam Samplers

Ordering Details

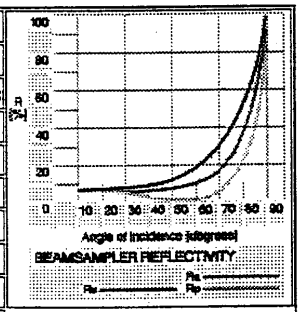
- Provides a 4% reflected sample of the entire beam
- Highly efficient AR coating on the second surface to eliminate ghosts
- Available in four standard diameters
- Wedged second surface also available for highly demanding applications
- Surfaces finished to λ/10 flatness

About 4% of a beam incident at 45 degrees is reflected from one surface of these BK7 beam samplers. The faces are parallel to within 5arcsec with a highly effective anti-reflection coating on the second surface. This coating eliminates virtually all ghost image problems. The 4% reflected beam is useful for diagnostic sampling or monitoring of the optical beam.



Specifications & Tolerances

Substrate flatness:	λ/10
Surface quality:	40-20
Reflectance:	Rav =4% at 45degrees
Thickness:	±0.2mm
Parallelism:	±5arcsec or 1° wedge
Diameter:	+0, -0.2mm
Bevel:	0.2mmx45°
Usable aperture:	>90% diameter
Material:	BK7, grade A
Wedge (optional):	1°



Beam Samplers

International Pricing: Prices for the United States are listed. For export orders shipped outside the United States simply add 5% to the US price.

Diameter, D		Thickness, t	New Lower Price	Delivery	Product Number
(inches)	(mm)	(mm)			
1.00	25.4	3.0	$85.00	from stock	038-2450
1.18	30.0	3.0	$90.00	from stock	038-2460
1.97	50.0	5.0	$160.00	from stock	038-2470
2.00	50.8	5.0	$170.00	from stock	038-2480

For a 1° **wedged substrate** append -W to product number and add $20 to the price.
Note: Wedged substrates are thicker.

OptoSigma®

Beamsplitters

- **Laser and Broadband Plate Beamsplitters** (with multilayer dielectric coatings)
- **Non-polarizing Laser Cube Beamsplitters** (with special all-dielectric coatings)
- **Broadband Cube Beamsplitters** (with dielectric coatings)
- New **Low-polarizing Cube Beamsplitters** (with hybrid coatings)
- **Metallized Plate Beamsplitters** (with inexpensive metallic coatings)
- **Metallized Cube Beamsplitters** (with internal metal film coatings)
- **Harmonic Separators** (for separating YAG laser harmonics)
- **Pellicle Beamsplitters** (coated for a range of intensity splits)

OptoSigma®
Ordering & Technical Support
(949) 851-5881
Fax (949) 851-5058
E-MAIL: optosigm@ix.netcom.com

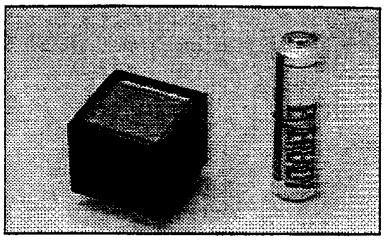
HOME | Mirrors | Beamsplitters | Windows | Lenses | Prisms | Polarizers | Filters | Apertures | Minisystem | Linear Drivers
Coatings | Optical Bases | Optic Holders | Mirror Mounts | Positioning Stages

HAMAMATSU

PRELIMINARY DATA

MAR. 1997

MULTIANODE PHOTOMULTIPLIER TUBE R5900U-00-M4



FEATURES

- 2 × 2 multianode
- Newly developed "metal channel dynode"
- High speed response
- Low cross - talk

GENERAL

Parameter		Description / Value	Unit
Spectral Response		~~300 to 650~~ 280 - 700	nm
Wavelength of Maximum Response		420	nm
Photocathode	Material	~~Bialkali~~ MULTIALKALI	–
	Minimum Effective Area	18 × 18	mm²
Window Material		Borosilicate glass	–
Dynode	Structure	Metal channel dynode	–
	Number of Stages	10	–
Weight		Approx. 26	g
Suitable Socket		E678-32B (option)	–

MAXIMUM RATINGS (Absolute Maximum Values)

Parameter		Value	Unit
Supply Voltage	Between Anode and Cathode	900	Vdc
Average Anode Current		0.1	mA

CHARACTERISTICS (at 25 °C)

Parameter		Min.	Typ.	Max.	Unit
Cathode Sensitivity	Luminous (2856 K)	50	70	–	µA/lm
	Blue (CS - 5 - 58 filter)	6	8	–	µA/lm-b
Anode Sensitivity	Luminous (2856 K)	25	140	–	A/lm
Gain		5×10^5	2×10^6	–	–
Anode Dark Current per Channel (after 30min. storage in darkness)		–	0.5	–	nA
Time Response	Anode Pulse Rise Time	–	1.2	–	ns
	Transit Time Spread (FWHM)	–	0.32	–	ns
Pulse Linearity per Channel (±2 % deviation)		–	5(30ⓑ)	–	mA
Cross - talk (9 × 9 mm² Aperture)		–	2	4	%
Uniformity Between Each Anode		–	1:1.5	1:3	–

NOTE : Anode characteristics are measured with the voltage distribution ration A shown below.

ⓑ : Measured with the special voltage distribution ratio B (Tapered Bleeder) shown below.

VOLTAGE DISTRIBUTION RATIO AND SUPPLY VOLTAGE

Electrodes	K	Dy1	Dy2	Dy3	Dy4	Dy5	Dy6	Dy7	Dy8	Dy9	Dy10	P
Ratio A	1.5	1.5	1.5	1	1	1	1	1	1	1	1	1
Ratio B (Tapered Bleeder)	1.5	1.5	1.5	1	1	1	1	1	1	2	3.6	

Supply Voltage: 800 Vdc, K: Cathode, Dy: Dynode, P: Anode

MULTIANODE PHOTOMULTIPLIER TUBE R5900U-00-M4

Figure 1: Typical Spectral Response

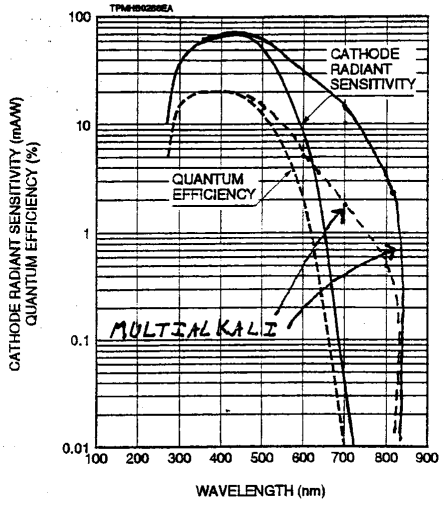


Figure 2: Typical Gain and Anode Dark Current

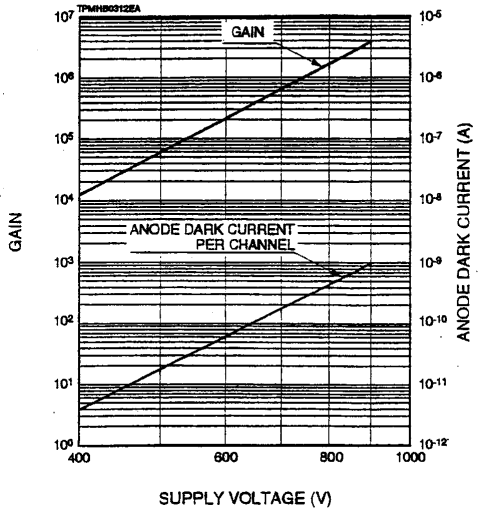


Figure 3: Typical Time Response

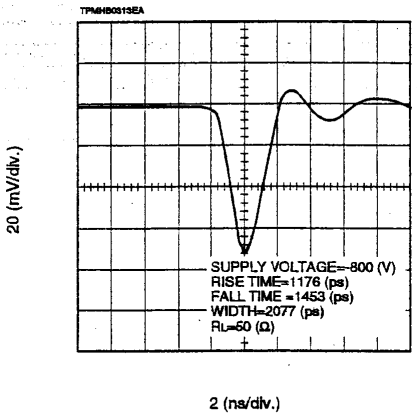


Figure 4: Typical T.T.S. Characteristic

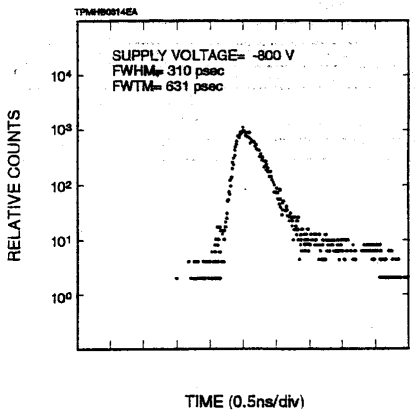


Figure 5: Pulse Linearity per Channel

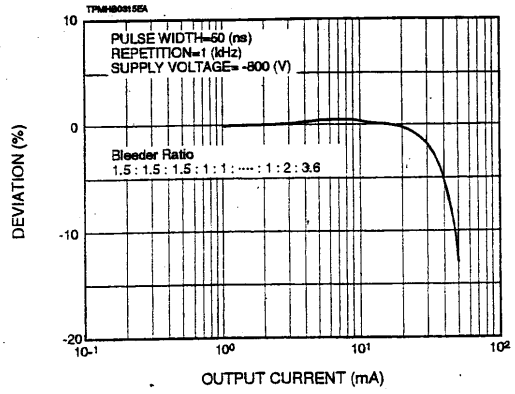


Figure 6: Anode Uniformity (Example)

82	95
97	100

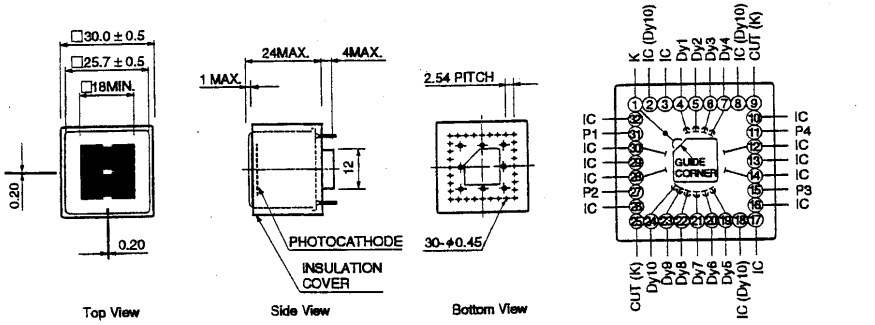
Supply Voltage : 800 V
Light Source : Lamp(uniform DC light)
Full Illumination

Figure 7: Anode Cross Talk (Example)

0.1	0.9
1.3	100

Supply Voltage : 800 V
Light Source : Lamp(uniform DC light)
Spot Illumination : 9 × 9 mm²

Figure 8: Dimensional Outline and Basing Diagram (Unit: mm)



K : Photocathode
Dy : Dynode
P : Anode
CUT : Short Pin
IC : Internal Connection (Don't Use)

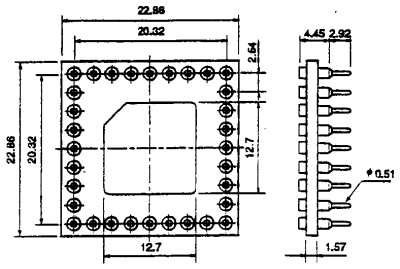
Basing Diagram

TPMHB0077ED

MULTIANODE PHOTOMULTIPLIER TUBE R5900U-00-M4

[ACCESSORIES]

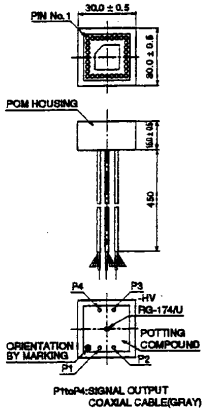
● Socket E678-32B OPTION



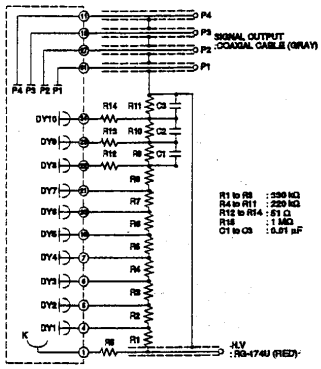
MATERIAL: Glass Epoxy

TACCA0084ED

● D Type Socket Assembly E7083



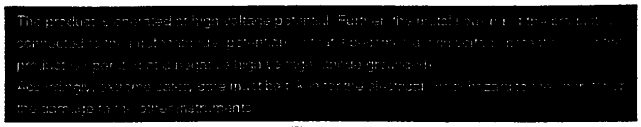
P1toP4:SIGNAL OUTPUT
COAXIAL CABLE(GRAY)



*For a stable operation, all of anodes should be connected to ground potential through load resistors such as 100 k ohm or so, even if they are not used.

⚠ WARNING ~ High Voltage ~

TACCA0162EA



* PATENT: USA Pat. No. 5410211 PATENT PENDING: JAPAN11, USA1, EUROPE2

HAMAMATSU

HAMAMATSU PHOTONICS K.K., Electron Tube Center
314-5, Shimokanzo, Toyooka-village, Iwata-gun, Shizuoka-ken, 438-0193 Japan, Telephone:(81)539/62-5248, Fax:(81)539/62-2205
U.S.A.: Hamamatsu Corporation: 360 Foothill Road, P.O.Box 6910, Bridgewater, N.J. 08807-0910, U.S.A., Telephone:(1)908-231-0960, Fax:(1)908-231-1218
Germany: Hamamatsu Photonics Deutschland GmbH: Arzbergerstr. 10, D-82211 Herrsching am Ammersee, Germany, Telephone:(49)8152-375-0, Fax:(49)8152-2658
France: Hamamatsu Photonics France: S.A.R.L.: 8, Rue du Saule Trapu, Parc du Moulin de Massy, 91882 Massy Cedex, France, Telephone:(33)1 69 53 71 00, Fax:(33)1 69 53 71 10
United Kingdom: Hamamatsu Photonics UK Limited: Lough Point, 2 Gladbeck Way, Windmill Hill, Enfield, Middlesex EN2 7JA, United Kingdom, Telephone:(44)181-367-8560, Fax:(44)181-367-6384
North Europe: Hamamatsu Photonics Norden AB: Färögatan 7, S-164 40 Kista, Sweden, Telephone:(46)8-703-29-50, Fax:(46)8-750-58-95
Italy: Hamamatsu Photonics Italia S.R.L.: Via della Moia, 1/E 20020 Arese, (Milano), Italy ,Telephone: (39)2 935 81 733 Fax: (39)2 935 81 741

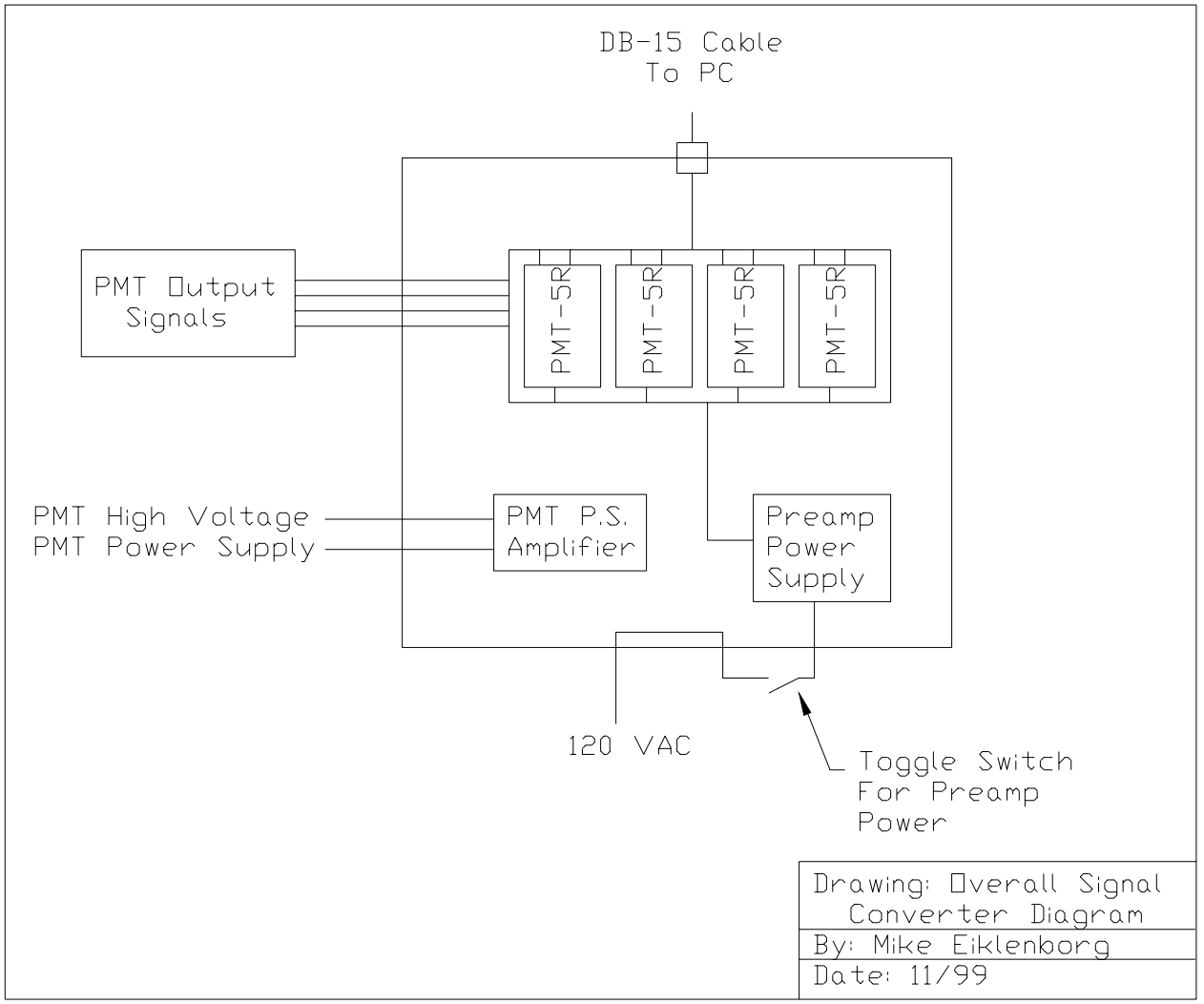
TPMH1128E05
JUN. 1997 (9703)

PMT Signal Converter Drawings

- Signal Converter Diagram

PMT Signal Converter Datasheets

- PMT Preamplifiers
- PMT Supply Amplifier


DB-15 Cable
To PC
PMT Output
Signals
PMT-5R
PMT-5R
PMT-5R
PMT-5R
PMT High Voltage
PMT Power Supply
PMT P.S.
Amplifier
Preamp
Power
Supply
120 VAC
Toggle Switch
For Preamp
Power
Drawing: Overall Signal
Converter Diagram
By: Mike Eiklenborg
Date: 11/99

ADVANCED
RESEARCH INSTRUMENTS
CORPORATION

PMT-5R CURRENT TO VOLTAGE AMPLIFIER

SPECIFICATIONS

Input Impedance	1kΩ
Input Signal Range	1pA to 1μA per 1V output
Input Range Selector	Remote via 3 logic lines
Output Range	±10V
Output Impedance	100Ω
Power Requirements	±15V, 50mA
Physical Size	2.5 x 5 x 2 inches
Output Connector	BNC and 9 pin sub miniature D

9 Pin Sub Miniature D Connector Pin Out

1	N/U
2	Bit 0 LSB
3	+15VDC
4	Bit 1
5	Bit 2 MSB
6	Signal GND
7	Power GND
8	-15VDC
9	Output

Range Selection

Range (A/V)	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}
Bit 0	0	1	0	1	0	1	0
Bit 1	0	0	1	1	0	0	1
Bit 2	0	0	0	0	1	1	1

TTL = Positive Logic
1 = +5V 0 = 0V

FEATURES

- Low Noise
- Wide Sensitivity Range
- Small Size
- Stabilized Power Conditioning
- Low Cost

APPLICATIONS

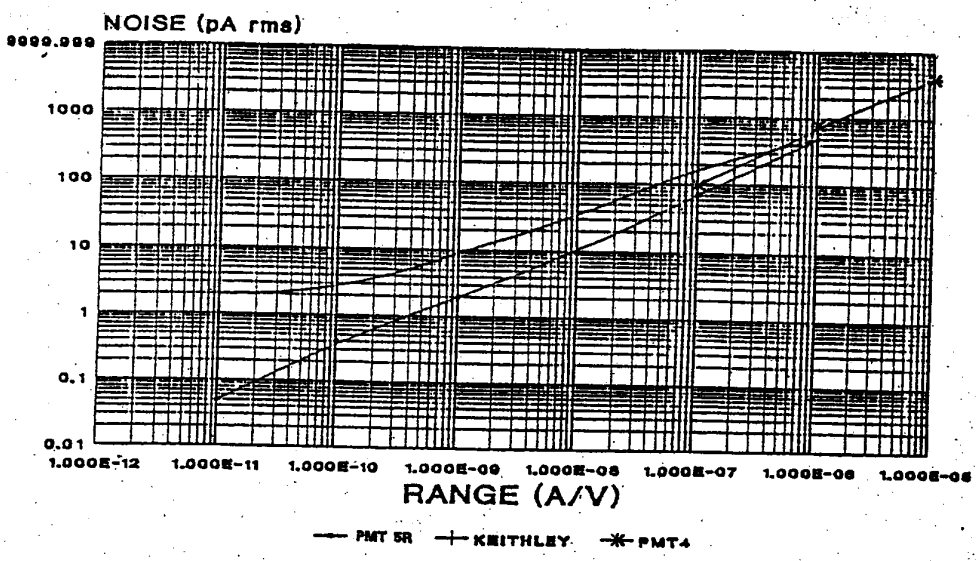
- Spectroscopy
- PMT or Photo Diode Preamplifier
- Low Light Level Detection
- Detection of Currents in the Pico Ampere Range

Bandwidth and noise comparison with similar amplifiers is on the reverse side of this data sheet

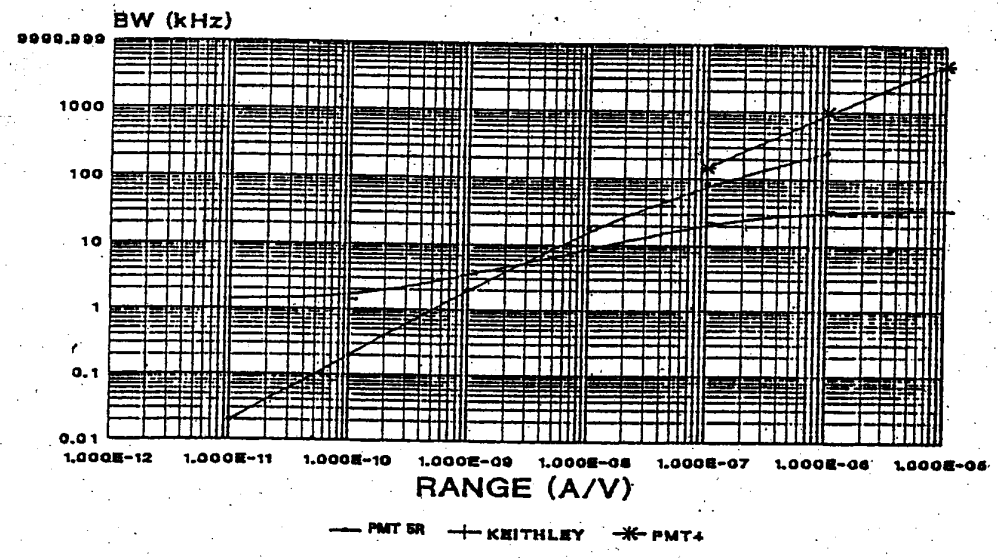
February 1995

(303) 449-2288 • FAX (303) 449-9376
2434 30th Street • Boulder, CO 80301, USA

PMT 5R/KEITHLEY 428



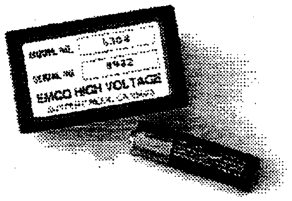
PMT 5R/KEITHLEY 428



Low Noise, Proportional High Voltage Modules

0 to + or - 300 through 0 to + or - 3,000 VDC @ 1.5 Watts
L Series

EMCO
High Voltage Corporation



The L Series is a line of small, versatile, component level building blocks that provide up to 3,000 VDC, positive or negative, in a compact PC mount package. The isolated output is directly proportional to the input. Either output may be grounded to generate positive or negative high voltage. Excellent filtering techniques and a low noise sinewave oscillator provide clean, reliable DC to HV DC conversion with low ripple, noise, and EMI/RFI. Two pin-out options are available in this series; add an "A" or "B" for your choice (see below). An external metal enclosure is also available, just add an "AB" to the model number (i.e. L30BAB).

FEATURES
Low Ripple
Proven Reliability
Extensive Filtering and Shielding
Proportional Input/Output
Low Cost/High Performance

OPTIONS
External Metal Enclosure
Two Pin-Patterns

APPLICATIONS
Photomultiplier Tubes
Mass Spectrometers
Avalanche Photo Diodes
Microchannel Plates

PHYSICAL CHARACTERISTICS
SIZE: 2.5" x 1.5" x 0.85 "
WEIGHT: 3 Ounces Approx.
PACKAGING: Fully Encapsulated
CASE MATERIAL: Glass-filled Epoxy
MOUNTING: Four PC Pins
Holes (A model only)

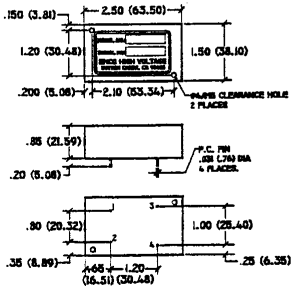
ELECTRICAL SPECIFICATIONS
INPUT VOLTAGE: 0 to 12 Volts
TYPICAL TURN-ON VOLTAGE: <2 Volts
OUTPUT VOLTAGE: *See Table*
OUTPUT CURRENT: *See Table*
RIPPLE: *See Table*
REGULATION: 10% (No Load to Full Load)
ISOLATION: 3,500 Volts
OPERATING TEMP: -10° to +60° C

MODEL	OUTPUT VOLTAGE	OUTPUT CURRENT	RIPPLE
L03*	0 to 300	5.00 mA	0.025%
L05*	0 to 500	3.00 mA	0.025%
L10*	0 to 1,000	1.50 mA	0.025%
L12*	0 to 1,200	1.25 mA	0.025%
L15*	0 to 1,500	1.00 mA	0.030%
L20*	0 to 2,000	0.75 mA	0.025%
L25*	0 to 2,500	0.60 mA	0.200%
L30*	0 to 3,000	0.50mA	0.200%

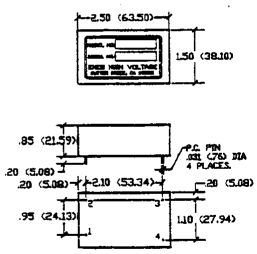
* Pin-out pattern "A"or "B" must be specified with model number

Pin #	Function
1	(+) Input
2	(-) Input
3	(-) Output
4	(+) Output

PIN-OUT PATTERN "A"



PIN-OUT PATTERN "B"



e-mail sales@emcohighvoltage.com
Web site www.emcohighvoltage.com

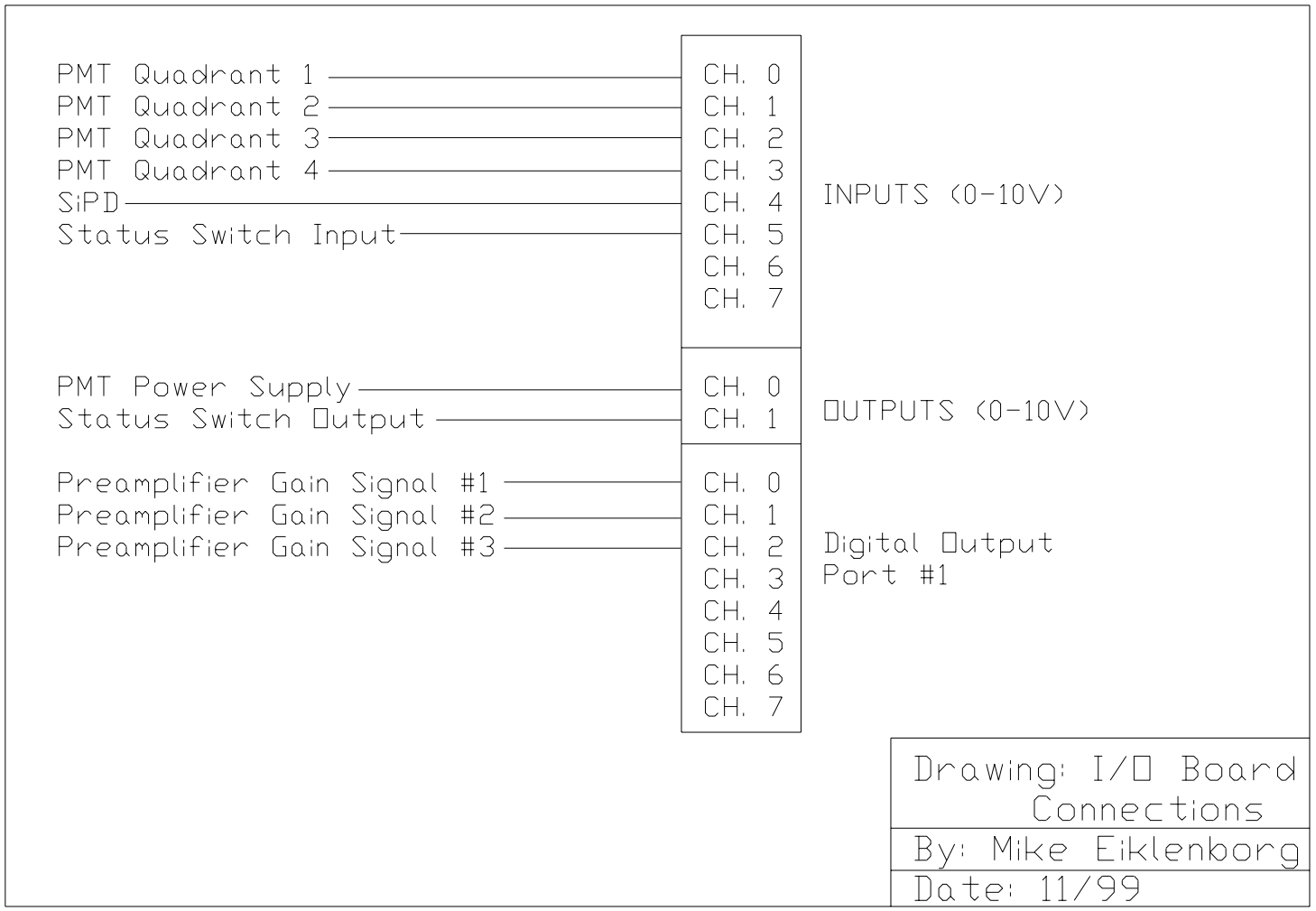
Phone (209) 223-3626 Fax (209) 223-2779
11126 Ridge Road, Sutter Creek CA 95685

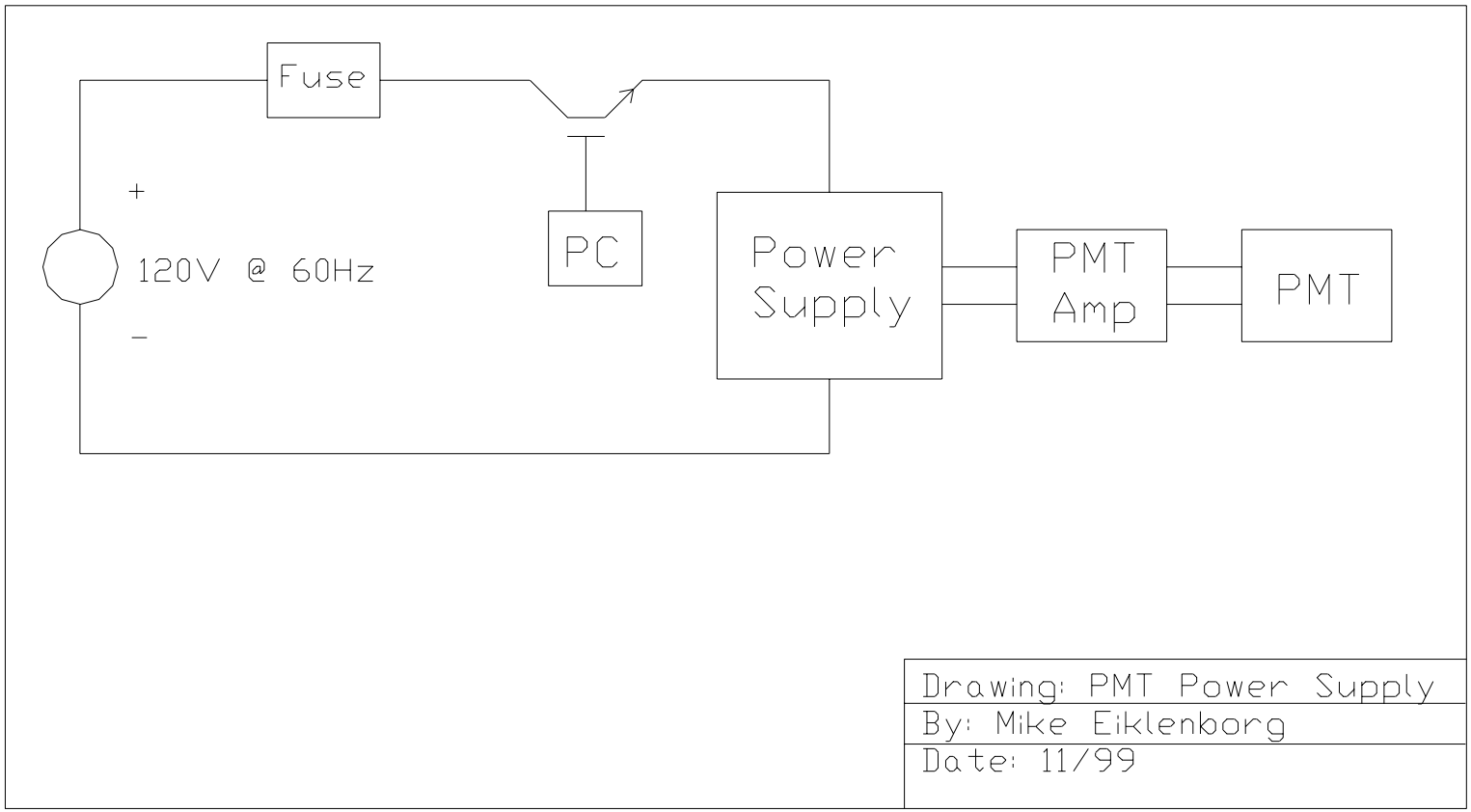
Controller Drawings

- Controller I/O Wiring Diagram
- PMT Power Supply Schematic

Controller Datasheets

- PC
- Multifunction I/O Board
- PCI/GPIB Interface
- Nanomover System II Tip/Tilt Driver
- Nano Micropositioning Systems


PMT Quadrant 1
PMT Quadrant 2
PMT Quadrant 3
PMT Quadrant 4
SiPD
Status Switch Input
CH. 0
CH. 1
CH. 2
CH. 3
CH. 4
CH. 5
CH. 6
CH. 7
INPUTS (0-10V)
PMT Power Supply
Status Switch Output
CH. 0
CH. 1
OUTPUTS (0-10V)
Preamplifier Gain Signal #1
Preamplifier Gain Signal #2
Preamplifier Gain Signal #3
CH. 0
CH. 1
CH. 2
CH. 3
CH. 4
CH. 5
CH. 6
CH. 7
Digital Output
Port #1
Drawing: I/O Board Connections
By: Mike Eiklenborg
Date: 11/99


Fuse
+
120V @ 60Hz
–
PC
Power Supply
PMT Amp
PMT
Drawing: PMT Power Supply
By: Mike Eiklenborg
Date: 11/99

SA
el: (415) 753-6888
ax: (415) 753-8848

SI-102060 09/19/98

PC

Customer	Contact	Ship To
UNIVERSITY OF CA - SANTA CRUZ GLORIA PLOSS 1156 HIGH STREET SANTA CRUZ, CA 95064 Tel: (831) 459-5168, (415) 731-3982 xMIK Fax: (831) 459-5244	SF STATE UNIV MIKE EIKLENBORG Tel: (415) 731-3982 xPU	

Account	Terms	Due Date	Sales Rep	Schedule Date
63342	NET 30 DAYS	10/19/98	RAYMOND L.	09/15/98

Sales Order	PO #	Reference	Ship VIA	Page	Printed
SO-107203	P0085773		*WILL CALL PICK UP	1	09/19/98

Item	Description	Order	Ship	Price	Disc	UM	Amount
P5SYST	** INTEL PENTIUM SYSTEM **	1	1			EA	
MB-P5/5-TRIT-TX	INTEL TRITON TX MB W/512K S/N : 383916, MFG : P5586003695	1	1	64.00		EA	64.00
CPU-586-166-INT	INTEL PENTIUM 166 CPU S/N : 444599	1	1	62.00		EA	62.00
MEM-16MB-EDO	4*32-60 EDO (16MB EDO), 72PIN S/N : 397594 S/N : 397614	2	2	16.00		EA	32.00
CASE-MINI-MP	MINI TOWER CASE W/POWER SUPPLY	1	1	18.00		EA	18.00
MS-CFANP5	PENTIUM COOLING FAN	1	1	7.00		EA	7.00
VGA-9680-TRI	TRIDENT 9680 1MB PCI W/ MPEG S/N : 438049, MFG : TV571327300	1	1	20.00		EA	20.00
FLPY-1.44-MITS	MITSUMI 1.44MB FD	1	1	16.00		EA	16.00
HD-2.1GBIDE-WES	W. D. 2.1GB ULTRA IDE HD S/N : 448848, MFG : WM3801091027	1	1	122.00		EA	122.00
PARTS	***** PARTS ONLY DO NOT INSTALL *****	1	1			EA	
KB-104-QTRONIX	QTRONIX SCORPLUS 104 K/B (AT)	1	1	9.00		EA	9.00
MICE-3B	3 BUTTOM SERIAL MOUSE	1	1	5.00		EA	5.00
MON-14-DIGIVIEW	** DIGIVIEW 14" SVGA MONITOR ** S/N : 444078, MFG : 3LX48471305200	1	1	108.00		EA	108.00
LAB-SD	SYSTEM DIAGNOSTICS	2:00	2:00	40.00		HR	80.00
PF	PROCESSING FEE	1	1	17.47		EA	17.47
	******						
	SALES:CHARLIE						

Taxable	0.00
Tax	0.00
Exempt	560.47
Total	560.47
Paid	0.00
Tr Disc	0.00
Balance	560.47

Thank You

X

All system sales include one year parts and labor warranty. All part sales include six months parts and labor warranty. All CPU sales are covered under a seven day parts and labor warranty. Any discrepancy must be reported within 48 hours. All return is subjected to a 15% restocking fee within 30 days with original packaging and conditions. No return or instant replacement after 30 days on systems or parts. No returns or exchanges on CPU's once outside the CPU warranty period. No return on monitor, notebook computer, printer, software and any special ordered item. Shipping & handling charge, rush order fee, deposit, wire transfer fee and check processing fee is non refundable. Refer to back page for more terms and conditions.

PCI-20428W BOARD ELECTRICAL SPECIFICATIONS

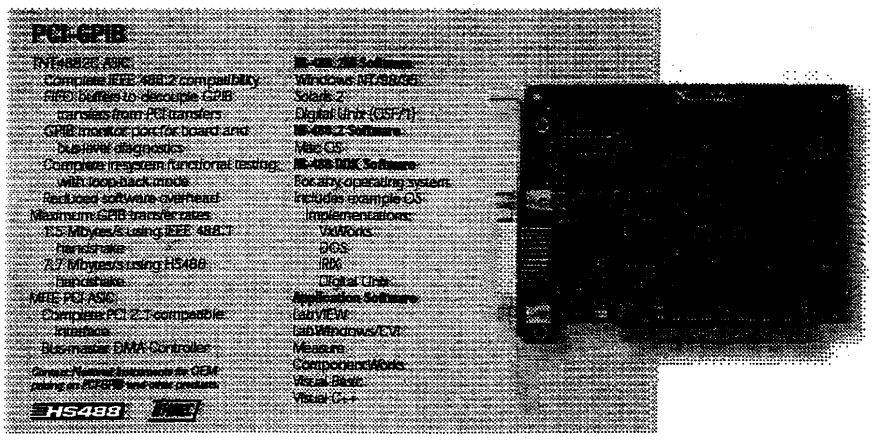
(All specifications are typical at 25°C unless otherwise noted.)

PARAMETER	CONDITIONS	SPECIFICATION
Bus Compatibility		PC/XT/AT and EISA
Analog Input		
Number of Channels		
PCI-20428W-1,-2	Single-ended/Differential	16/8
PCI-20428W-3	Single-ended	16
Resolution		12 bits (1 part in 4096)
Voltage Ranges		
PCI-20428W-1	Gain = 1	±5V, ±10V, 0-5V, 0-10V
	Gain = 10	±0.5V, ±1V, 0-0.5V, 0-1V
	Gain = 100	±50mV, ±0.1V, 0-50mV, 0-0.1V
PCI-20428W-2	Gain = 1	±5V, ±10V, 0-5V, 0-10V
	Gain = 2	±2.5V, ±5V, 0-2.5V, 0-5V
	Gain = 4	±1.25V, ±2.5V, 0-1.25V, 0-2.5V
	Gain = 8	±625mV, ±1.25V, 0-625mV, 0-1.25V
PCI-20428W-3	Gain = 1	±5V, ±10V, 0-5V, 0-10V
Overvoltage Protection	Power on/ Power off	±35V/±20V
Gain Accuracy		
PCI-20428W-1, -2	Gain = 1	0.02% max
	Gain = 2, 4, 8, 10	0.07% max
	Gain = 100	0.25% max
PCI-20428W-3	Gain = 1	0.02% max
Offset Voltage	RTI	±2.44mV max
Bias Current		500pA
Input Impedance		10^9Ohms/10pF
Common Mode		
Range	Vcm = Vrange - (Vdiff *Gain)/2	±10V (DC + Peak AC) min
Rejection	60Hz, 100ohm imbalance	
PCI-20428W-1, -2	Gain ≤ 10	80dB / 0.04LSB/V min
	Gain = 100	90dB / 1.3LSB/V min
Noise	Input grounded at connector; RMS / p-p	
PCI-20428W-1, -2	Gain = 1	0.5 LSB RMS max
PCI-20428W-3	Gain = 1	0.5 LSB RMS max
Monotonicity	No missing codes	12 bits
Linearity Error		
PCI-20428W-1, -2		±0.024%, ±1 LSB max
PCI-20428W-3		±0.024%, ±1 LSB max
Analog Output		
PCI-20428W-1, -2		
Number of Channels		2
Resolution		12 bits (1 part in 4096)
Voltage Ranges		±5V, 0-10V, ±10V
Accuracy		
Gain		±1LSB
Linearity Error		0.024%
Offset Voltage		±2.44 mV max
Monotonicity		11 bits
Output Current		±5mA
Digital I/O		
Number of Ports	8 channels (bits) each	2 (1 input , 1 output)
Input Levels		TTL compatible (Schmitt-trigger)
Input Current, High-Level		20uA
Input Current, Low-Level		200uA
Output Levels		TTL compatible
Source Current	Vout = high	400uA
Sink Current	Vout = low	8mA
External Input		
Input Level		TTL compatible (Schmitt-trigger)
Input Current, High-Level		20uA
Input Current, Low-Level		200uA

(Continued on next page)

PARAMETER	CONDITIONS	SPECIFICATION
Timebase Generators		
Number of Channels		2
PCI-20428W-1, -2		1
PCI-20428W-3		Rate Generator
Type	crystal-based	125ns
Resolution		
Output Frequency		122Hz to 4MHz
16-bit Operation		0.002Hz to 2MHz
Prescaled		
Output Levels		TTL compatible
Source Current	Vout = high	15mA
Sink Current	Vout = low	24mA
Counters		
Number of Channels	16 bits	1
Clock Speed		8MHz max
Input Levels		TTL compatible (Schmitt-trigger)
Input Current, High-Level		20uA
Input Current, Low-Level		200uA
Output Levels		TTL compatible
Source Current	Vout = high	400uA
Sink Current	Vout = low	8mA
Interrupts		
PCI-20428W-1, -2		
Sources	Jumper Selected	One of 3: Analog Input EOC, Analog Input RateGenerator, Analog Output Rate Generator
PCI-20428W-3		
Sources	Jumper Selected	One of 2: Analog Input EOC, Analog Input RateGenerator,
PC Levels	Jumper Selected	IRQ2, IRQ3 and IRQ5
System Throughput		
Multi-Channel Analog Input or Analog Output Under DMA control		100 kHz
DMA Channels		
Number supported		2 (1 input, 1 output)
PC Channels supported	Jumper Selected	DMA 1, DMA 3
Modes	Single Transfer DMA mode only	
Input		Start on trigger or Start on Command, using a Linear or Circular buffer
Output		Start on Command, using a Linear or Circular buffer
Power Requirements		+5V, 1A
Power Available	Connector pins P1-26 and P1-48 combined	+5V, 0.25A fused
Physical Characteristics		
Size	Length x Height	9.0" x 4.2" (22.9cm x 10.7cm)
Operating Temperature Range		0-70°C

High-Performance GPIB Interface for PCI



Overview

The PCI-GPIB is a high-performance Plug and Play IEEE 488 interface for personal computers and workstations equipped with PCI expansion slots. You can use the PCI-GPIB in PCs running Windows NT/98/95, Power Macintosh computers, Sun Ultra Workstations, and DEC Alpha Workstations.

The National Instruments MITE and TNT4882C ASICs make the PCI-GPIB a maximum-performance IEEE 488.2 interface board for the PCI bus. The MITE ASIC, a complete PCI interface, is compliant with the PCI Specification 2.1. The hardware is completely software-configurable and compatible with the Plug and Play standard for easy hardware installation. The TNT4882C chip performs the basic IEEE 488 Talker, Listener, and Controller functions required by all versions of the IEEE 488 standard, including IEEE 488.2. The PCI-GPIB can sustain data transfer rates up to 1.5 Mbytes/s using the IEEE 488.1 3-wire handshake. The PCI-GPIB also implements the high-speed HS488 GPIB protocol, for benchmarked data transfers up to 7.7 Mbytes/s.

HS488

The PCI-GPIB can use the high-speed GPIB protocol (HS488). HS488, patented by National Instruments, increases the maximum data transfer rate of ANSI/IEEE Standard 488.1-1987 up to 8 Mbytes/s. HS488 is a superset of the IEEE 488.1 protocol that attempts to conduct data transfers with the new higher speed protocol. If all active Listeners are not capable of HS488 transfers, the protocol automatically uses the IEEE 488.1 3-wire handshake protocol. Maximum data transfer rates obtainable using HS488 depend on the host computer architecture and system configuration. The PCI-GPIB has

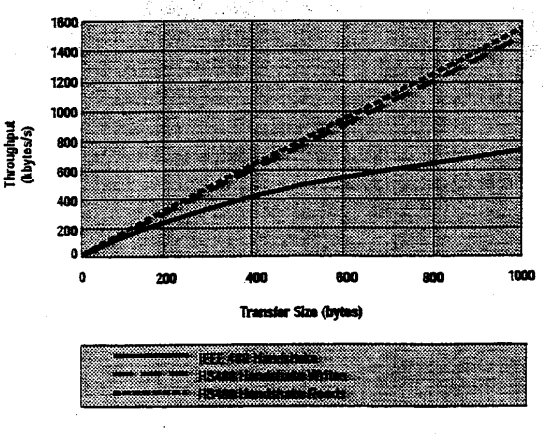


Figure 1. PCI-GPIB Data Transfer Benchmarks using Windows NT (small data blocks)

Phone: (512) 794-0100 • Fax: (512) 683-8411 • info@natinst.com • www.natinst.com

High-Performance GPIB Interface for PCI

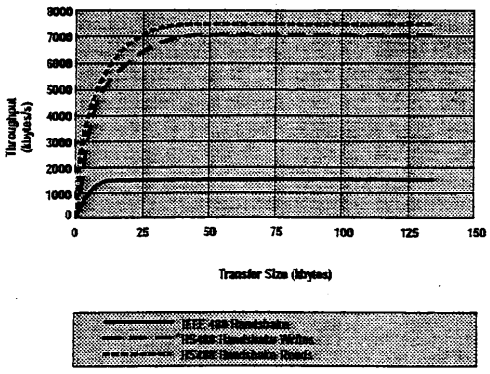


Figure 2. PCI-GPIB Data Transfer Benchmarks Using Windows NT

been benchmarked at transfer rates up to 7.7 Mbytes/s.

The TNT4882C completely and transparently handles the HS488 protocol without additional circuitry. Because HS488 is a superset of IEEE 488.1, you can mix existing GPIB devices with devices that have high-speed capability without changing your application programs. The TNT4882C can implement high-speed data transfers automatically. Thus, devices that have the TNT4882C chip can transparently communicate using HS488 if the corresponding Talker or Listener can also use HS488.

Transfer Rates

The PCI-GPIB hardware and software provide maximum performance, even when the data block is small. Figures 1 and 2 describe performance under Windows NT. Figures 3 and 4 describe performance under Solaris 2. Figures 1 and 3 illustrate the data transfer performance of the PCI-GPIB for transfers smaller than 1 kbyte. Figures 2 and 4 extend the plot up to 32 kbyte data transfers. Actual obtainable data transfer rates depend on host computer system configuration, and device capability.

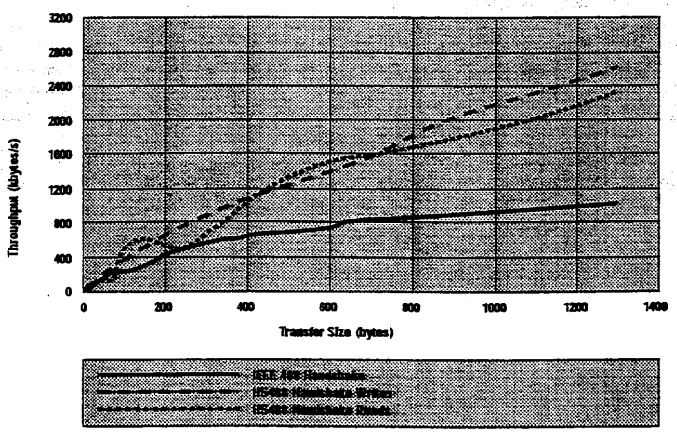


Figure 3. PCI-GPIB Data Transfer Benchmarks Using Sun Solaris 2 (small data blocks)

Phone: (512) 794-0100 • Fax: (512) 683-8411 • info@natinst.com • www.natinst.com

High-Performance GPIB Interface for PCI

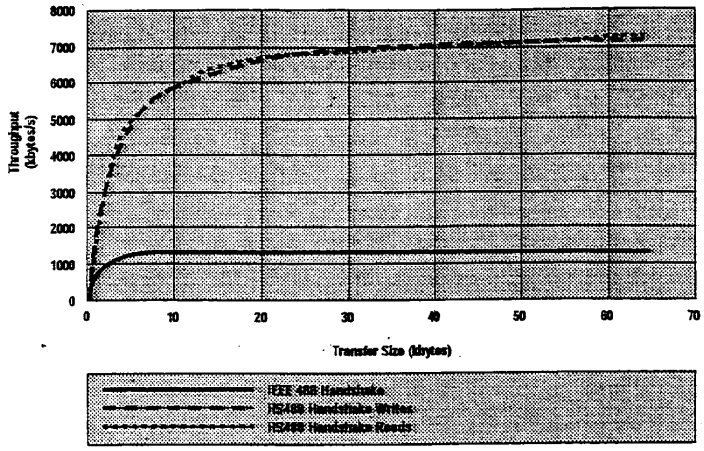


Figure 4. PCI-GPIB Data Transfer Benchmarks Using Sun Solaris 2

Hardware

The key functional components of the PCI-GPIB include:

MITE

The PCI interface logic is integrated in the MITE ASIC, a high-performance, single-chip PCI interface. All PCI-defined configuration registers and additional control and status registers are implemented in the MITE. The address and control signals of the PCI bus are decoded by the MITE to provide access to the PCI-GPIB registers, the onboard ROM, and the TNT4882C ASIC.

The MITE provides bus mastering using a sophisticated DMA Controller to enhance overall performance during data transfers. The DMA Controller automatically provides several modes of operation, including link chaining, to maximize data transfer performance.

TNT4882C

The TNT4882C ASIC is the first maximum performance single-chip IEEE 488.2 Talker, Listener, and Controller interface with integrated IEEE 488.1-compatible transceivers. The TNT4882C also implements the HS488 mode of operation for high-speed GPIB data transfers. The transfer functions implement Automatic Handshake Holdoff on the last byte of a GPIB read, and Automatic END transmission on the last byte of a GPIB write. Because the PCI-GPIB performs these functions in hardware, you save significant CPU time relative to performing the same functions in software.

GPIB Transceivers

Transceivers interface the PCI-GPIB to the IEEE 488 bus, which provide power-up/power-down bus protection (glitch-free). The transceivers are integrated into the TNT4882C circuitry.

NI-488DDK

The NI-488 Driver Development Kit (DDK) is a comprehensive source code package for developing applications for operating systems other than those supported by a standard NI-488.2 driver. NI-488DDK consists of over 20 board-level functions provided in source code to give you a head start when you must design your own GPIB driver. The NI-488DDK, a subset of our NI-488 driver, uses the same syntax so that migration of applications between the NI-488DDK and our NI-488 driver software is straightforward.

High-Performance GPIB Interface for PCI

Ordering Information

PCI-GPIB and NI-488.2 Software

Windows NT* 777073-01
Windows NT (2 m cable)* 777073-51
Windows 98/95* 777158-01
Windows 98/95 (2 m cable)* 777158-51
Solaris 2 777462-01
Solaris 2 (2 m cable) 777462-51
Digital Unix (OSF/1) 777260-01
Mac OS* 777075-01
Mac OS (2 m cable)* 777075-51
*CD only – for 3.5 in. floppy disks, also order 777780-01
†Includes XA adapter (see page 769)

Software Only

NI-488.2M for Digital Unix 777065-01
Provided on DAT and 3.5 in. disk.
NI-488DDK 777430-01

GPIB Cables

X2 cable (double-shielded)
1 m 763061-01
2 m 763061-02
4 m 763061-03
8 m 763061-04

Specifications

IEEE 488 Device Facility

Complies with IEEE 488.1 and IEEE 488.2

Capability Code	Description
SH1	Source Handshake
AH1	Acceptor Handshake
T5, TE5	Talker, Extended Talker
L3, LE3	Listener, Extended Listener
SR1	Service Request
PP1, PP2	Local/Remote Parallel Poll
RL1	Remote/Local
C1, C2, C3, C4, C5	Controller
E1, E2	Three-state bus drivers with automatic switch to open collector during parallel poll

IEEE 488 Data Transfer Rates (Preliminary)

Maximum IEEE 488 transfers ..... 1.5 Mbyte/s
HS488 transfers ..... Up to 7.7 Mbyte/s
Actual rate dependent upon system configuration and application

Power Requirements from PCI Bus

+5 VDC ..... 700 mA typical
450 mA max

Physical Characteristics

Dimensions ..... 17.3 cm by 10.7 cm (6.3 in. by 4.2 in.)
I/O connector ..... IEEE 488 standard 24-pin

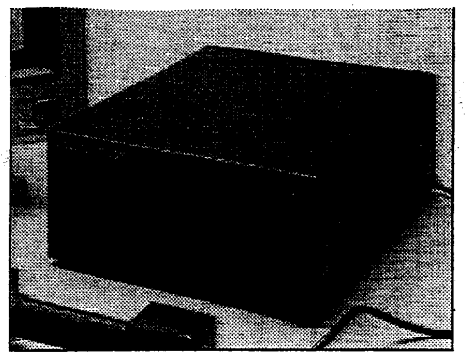
Operating Environment

Ambient temperature ..... 0 to 45 °C
Relative humidity ..... 10% to 90%, noncondensing

Storage Environment

Ambient temperature ..... -20 to 70 °C
Relative humidity ..... 5% to 95%, noncondensing

Phone: (512) 794-0100 • Fax: (512) 683-8411 • info@natinst.com • www.natinst.com



Nanomover™ Control System II

The Nanomover™ Control System II (NCSII) consists of a power supply, a two channel Nanomover control card and two board slots that can be configured for either an IBM-ISA bus or an IEEE-488/RS-232 interface for communication to the host computer. The block diagram of the NCSII is shown in the figure on page 469.

- Computer control via IBM-ISA bus or IEEE 488/RS 232.
- Additional pairs of actuators can be driven by linking control units together. Only one control unit needs to be configured for computer control.
- Interface for two mechanical limit switches per actuator.
- Optional joystick for simple control of individual actuators without a host computer.
- Can be used with any two phase stepper motor requiring less than 1.25 amps per phase.

SPECIFICATIONS:
NANOMOVER CONTROLLER SYSTEM II

Nanomovers per chassis: 2

Maximum Current per Phase: 1.25 amps

Input power: 85–240 VAC, 50/60 Hz

Fuse: 2 amps slow blow

Safety Ratings:
Designed per U/L, CSA, TUV, and VDE specifications

Limit Switches:
Supported Opto-Interuppter or contact
(open during operation)

Dimensions (W × L × H): 215 × 326 × 100 mm

Weight: 4.4 kg

Operating Temperature: 10°C–40°C

Storage Temperature: −40°C–70°C

HOW TO ORDER

The modular nature of the Nanomotion System makes it easy to create optimized solutions for your specific application.

If the host computer is an IBM compatible machine and you wish to operate directly from the ISA bus, then order:

a. 11 NCS 101/IBM for two actuators.
b. one 11 NCS 101 for each additional pair of actuators.

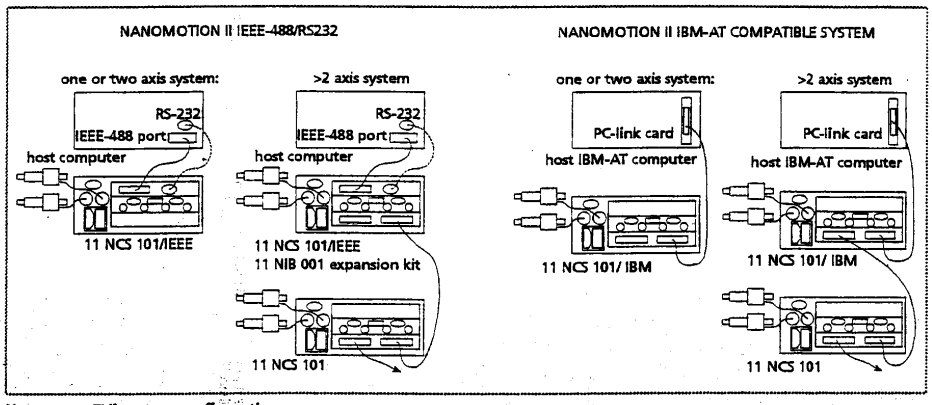
If the system is controlled from either an RS-232 serial port, or an IEEE-488 interface, then you order:

a. 11 NCS 101/IEEE for two actuators.
b. For additional actuators:
– one 11 NIB 001 expansion kit and,
– one 11 NCS 101 for each additional pair of actuators.

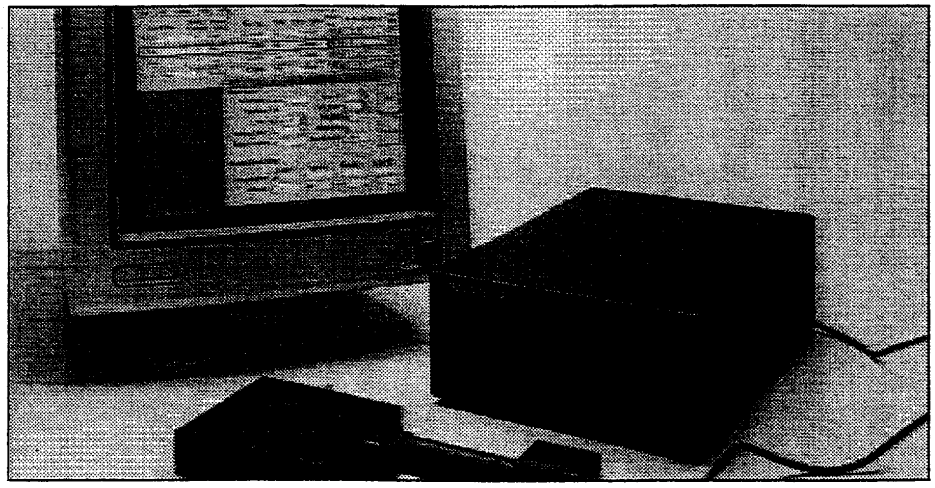
Nanomover™ Control System II

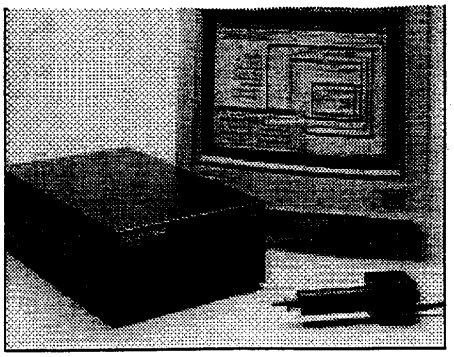
	PRODUCT NUMBER
Controller with IBM-PC Unit Card/Cable	11 NCS 101/IBM
Controller with IEEE-488 & RS-232	11 NCS 101/IEEE
IBM Bus Expanded Board/Cable	11 NIB 001
Joystick	11 NCA 101
Expansion Controller Cable	11 NCS 101

For special controller configurations, please contact Melles Griot



Nanomover™ II system configurations





Nanomover™ Micropositioning Systems

A Nanomover™ micropositioning system can be constructed to control from 1 to 16 actuators simultaneously. The Nanomover actuators perform to specified levels of precision when operated with Nanomover software and the Nanomover Control System II (NCSII) electronics assembly. The actuators can be controlled through an IBM ISA bus, RS-232 or IEEE-488 interface. Each NCSII chassis can control two actuators. Up to 8 such units can be cascaded for a capacity of 16 actuators. The Nanomover software package is based upon a series of clear menu and self help screens. Only a cursory knowledge of personal computers is necessary to execute relatively complex maneuvers.

RESOLUTION

The ultimate resolution of the Nanomover™ is ± 1 microstep. With 50,000 microsteps per revolution and a 2 threads per mm precision micrometer lead screw, this is a resolution of 10 nanometers.

REPEATABILITY

In most applications, the most important feature of a micropositioning device is the ability to return to a position with consistently high accuracy. The Nanomover has an unsurpassed repeatability (both unidirectional and bidirectional) of 100 nanometers. Using the ***Park*** function, the system can be powered down and left overnight and will still return to the same position within 100 nanometers.

ACCURACY

Good accuracy is hard to achieve but is rarely as important as repeatability, since, in principle, compensation can always be made for systematic deviations. The Nanomover has an absolute accuracy of travel of ± 1 micron, which arises from minute variations in the micrometer thread pitch and inherent inaccuracies present in the stepper motor. For applications requiring even higher accuracy, a software routine to compensate for the errors in an individual lead screw can be supplied by Melles Griot on special request.

RANGE

The Nanomover actuators are able to achieve their high degree of resolution, accuracy, and repeatability over a total range of 25 mm.

SYSTEM CONFIGURATION

A Nanomover system can be operated directly from an IBM PC or industry standard IEEE-488 or RS-232 interfaces. Systems with more than two actuators can be created by cascading in one of three ways: via the IBM-ISA bus, the parallel IEEE-488 bus, or the RS 232 serial interface.

The Nanomover software and associated algorithms are vital in achieving specified performance. The IBM-compatible system can be controlled using Nanomover application software and can be programmed using any Windows compatible programming language using Nanomotion dynamically linkable library (DLL). The Nanomotion IEEE-488 system can be controlled using the LabVIEW™ drivers or by programming directly with IEEE-488 commands. The Nanomover RS-232 system can be controlled with ASCII text. These commands can be sent using LabVIEW drivers, standard communications packages, or custom programs.

The Nanomover™

Products in this catalog are in stock and ready for shipment. If you require special positioning or if you prefer multiple axes control in a single chassis, please discuss your needs with your local Melles Griot applications engineer.

A5: Experimental Data

9-25-99 TEST #1/OPEN LOOP: dn = 2900
TEST #2/CLOSED LOOP: dn = 5000

Hamilton Spectrograph Observing Log

Observer: Fischer/Butler Tape:B97 Telescope:3m
UT Date: Sept 25/26 1999 Chip:#6 Mask:OCM
Windowing: Rows: 1000 Cols: 1851 Col. offset: 97
Grating: 493631 Ht:499811 slit:640mu "l"
CCD Focus:500399

d*.ccd number	Object Name	I2 (Y/N)	Mid-Time(UT)	Exp. time	Comments
185	HD195019	Y	03:23:31	380	2600dn
186	HD194035	Y	03:32:27	420	3kdn
187	HD199598	Y	03:42:23	420	3kdn
188	HD202108	Y	03:53:24	600	2500dn
189	HD208313	Y	04:05:56	600	2500dn
190	HR8382	Y	04:16:13	300	2500dn
191	HD209779	Y	04:28:28	900	1kdn
192	HD209875	Y	04:46:31	600	2300dn
193	HD213575	Y	04:57:53	520	3800dn
194	HD217107	Y	05:07:46	420	4kdn
195	HD217877	Y	05:17:53	600	4kdn
196	HR8729	Y	05:28:19	280	6kdn
197	HD214557	Y	05:36:28	420	4kdn
198	GL873	Y	05:56:34	900	300dn
199	HD217618	Y	06:15:02	900	3kdn
200	HD218868	Y	06:30:43	600	3kdn
201	HD221830	Y	06:41:21	420	3kdn
202	HD222033	Y	06:50:18	420	2500dn
203	HD218133	Y	06:59:56	420	2kdn
204	GL908	Y	07:15:02	900	1kdn
205	HR8969	Y	07:26:36	90	5kdn
206	HD217813	Y	07:33:56	420	4kdn
207	HIP113084	N	07:51:29	180	5kdn,Kgiant
208	HIP114449	N	07:58:17	180	5kdn,Kgiant
209	HIP113622	N	08:04:52	280	4kdn,Kgiant
210	HIP113686	N	08:12:51	280	6kdn,Kgiant
211	junk	Y	08:39:29	27	saturated Bstar
212	HR8781	Y	08:41:45	27	10Kdn,Bstar
213	HR8781	Y	08:57:46	25	10kdn,Bstar
214	HIP117567	Y	09:01:05	360	5kdn,Kgiant
215	HIP117567	N	09:08:27	300	5kdn,Kgiant
216	HIP117756	N	09:16:34	300	6kdn,Kgiant
217	HD4903	Y	09:28:11	720	4kdn
218	HD8262	Y	09:46:28	600	4kdn
219	HD10126	Y	10:00:55	900	2600dn
220	HD8673	Y	10:15:50	480	5kdn
221	HR458	Y	10:24:03	120	6kdn
222	HR458	Y	10:27:31	90	4kdn
223	HR493	Y	10:33:25	240	4kdn
224	HR509	Y	10:49:06	180	5kdn
225	HR509	Y	10:53:51	180	5kdn
226	HD11226	Y	11:08:59	1200	1kdn
227	HR582	Y	11:29:36	600	2kdn
228	HR1729	Y	11:54:46	720	2500dn,tip/tilt!
229	HR1165	Y	12:17:04	120	1900dn,open loop
230	HR1165	Y	12:21:07	120	4800dn,closed loop
231	HR1165	Y	12:31:12	120	4000dn,no t/t
232	HR1165	Y	12:37:46	120	1200dn,open loop
233	HR1165	Y	12:41:42	120	2500dn,closed loop
234	HR1165	Y	12:45:23	120	1300dn,open loop
235	HR1165	Y	12:49:09	120	3500dn,closed loop
236	HR1165	Y	12:52:48	120	2300dn,open loop
237	HR1165	Y	12:56:48	120	2800dn,closed loop
238	HR1165	Y	13:00:52	120	850dn,open loop

Hamilton Spectrograph Observing Log

Observer: Fischer/Butler Tape:B97 Telescope:3m
UT Date: Sept 26/27 1999 Chip:#6 Mask:OCM
Windowing: Rows: 1000 Cols: 1851 Col. offset: 97
Grating: 493631 Ht:499818 slit:640mu "1"
CCD Focus:500398

d*.ccd number	Object Name	I2 (Y/N)	Mid-Time(UT)	Exp. time	Comments
260-265	Wideflat	N	03:04:00	5	64:5,bg13 focus:
266	ThAr	N	03:05:00	3	64:2
267	I2	Y	03:06:00	5	64:2,bg13
268	HR7602	Y	03:10:41	70	5400dn t/t, clear skies
269	HR7602	Y	03:17:19	70	3100dn t/t
270	HR7602	Y	03:24:34	70	10Kdn no ttoptics
271	HD177153	Y	03:33:59	600	3100dn
272	HD193017	Y	03:53:46	600	1300dn
273	HD194766	Y	04:10:57	900	2kdn
274	HD194765	Y	04:28:13	600	1700dn
275	HD194035	Y	04:47:55	1200	2kdn
276	HD195019	Y	05:10:05	1150	3kdn
277	HD213575	Y	05:32:59	1150	2500dn
278	HD217107	Y	05:54:14	900	
279	HR864	N	06:00:00	60	1700dn,t/t
280	HR864	N	06:20:00	60	900dn no t/t
281	HR864	N	06:25:00	60	1800dn,t/t
282	HR864	N	06:30:00	60	1280dn,,no t/t
283	HR864	N	06:35:00	60	1900,t/t
284	HR864	N	06:40:00	60	560,t/t
285	junk8729	Y	07:33:09	600	1700,no t/t
286	HR8729	Y	07:45:03	600	4600,t/t
287	HD221830	Y	08:00:37	720	2kdn,t/t
HD222033	Y				
HD218730	Y				
HD221146	Y				
HD224156*	Y				
HD223084	Y				
HD4915	Y				
HD5133*	Y				
HD4903	Y				
HD7228*	Y				
HD9224	Y				
HD8262*	Y				
HD8574*	Y				
HD5065	Y				
HD6611	Y				
HR458	Y				
HD8673*	Y				
HD10126*	Y				
HD8941	Y				
HR493	Y				
HR509	Y				
HD11226	Y				
HD11505	Y				
HD10086*	Y				
HD12661*	Y				
HD12846	Y				
HD17230*	Y				
HD18144	Y				
HR937	Y				
HD25918	Y				
HD33632	Y				
HD10780	5mir*				

239	HR1165	Y	13:04:08	120	1600,closed loop
240	I2	Y	13:20:00	5	64:2,bg13
241	ThAr	Y	13:40:00	3	64:2
242-257	wideflat	N	13>50:00	5	64:5,bg13

Date: Tue, 28 Sep 1999 12:16:25 -0700 (PDT)
From: Debra Fischer <fischer@serpens.berkeley.EdU>
To: paul@dtm.ciw.edu, gmarcy@etoile.Berkeley.EDU, meiklenb@stars.sfsu.edu,
jones@ucolick.org, tony@ucolick.org, vogt@ucolick.org
Cc: fischer@serpens.berkeley.EdU
Subject: Re: Lick Errors

Hello,

I thought I'd supplement Mike's report on t/t with my observations.

I checked the spectra of HR7602 with and without t/t (series of observations to test). The velocities are identical and the Svalues from the IR triplet are identical for all 3 observations (2 with and one without t/t). These observations were taken at the beginning of our last night when the seeing was just under 2" and we lost a factor of 2 in counts with t/t.

I also checked hd221830 which is a new standard star with no apparent velocity variation. This star was observed at the end of the night in nearly hopeless conditions. Between bad seeing and telescope shake, we were down by a factor of 4 in counts when I started the exposure. Mike rolled in t/t and had everything aligned in about 15 minutes and I started another exposure. In these bad conditions, we gained back a factor of 2, making it reasonable to try to work. The velocity and S values all look consistent with the previous observations of this star.

HR8729 (good ol' 51 Peg) was also observed in extremely bad conditions. Again, all indications are that t/t increased s/n to a workable level and the spectra produce the expected velocity and S_IR value.

So, t/t is basically working. The optics need to be recoated to reduce losses and then we need to again evaluate the throughput performance of t/t. We also need a faster/easier way to align the star on the slit - Mike has suggested motorizing the beam splitter so we could adjust it remotely with a joystick. That would be ideal and I think that should be an immediate/early upgrade. Finally, once the optics are resurfaced, we need to spend some time evaluating the performance as a function of magnitude. Will we have to adjust the gain? What is the faintest star that the PMT can sense? I think we'll need a different sensing mechanism to make this an observatory instrument that will look at fainter than about V=9.

Best,
Debra