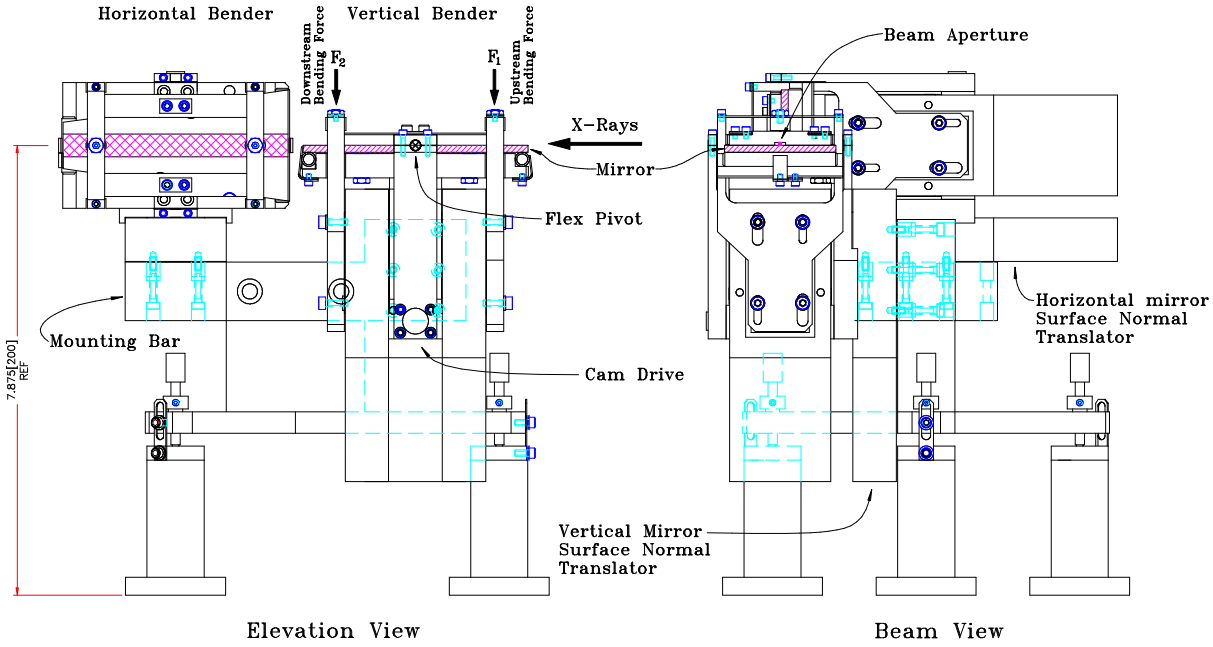
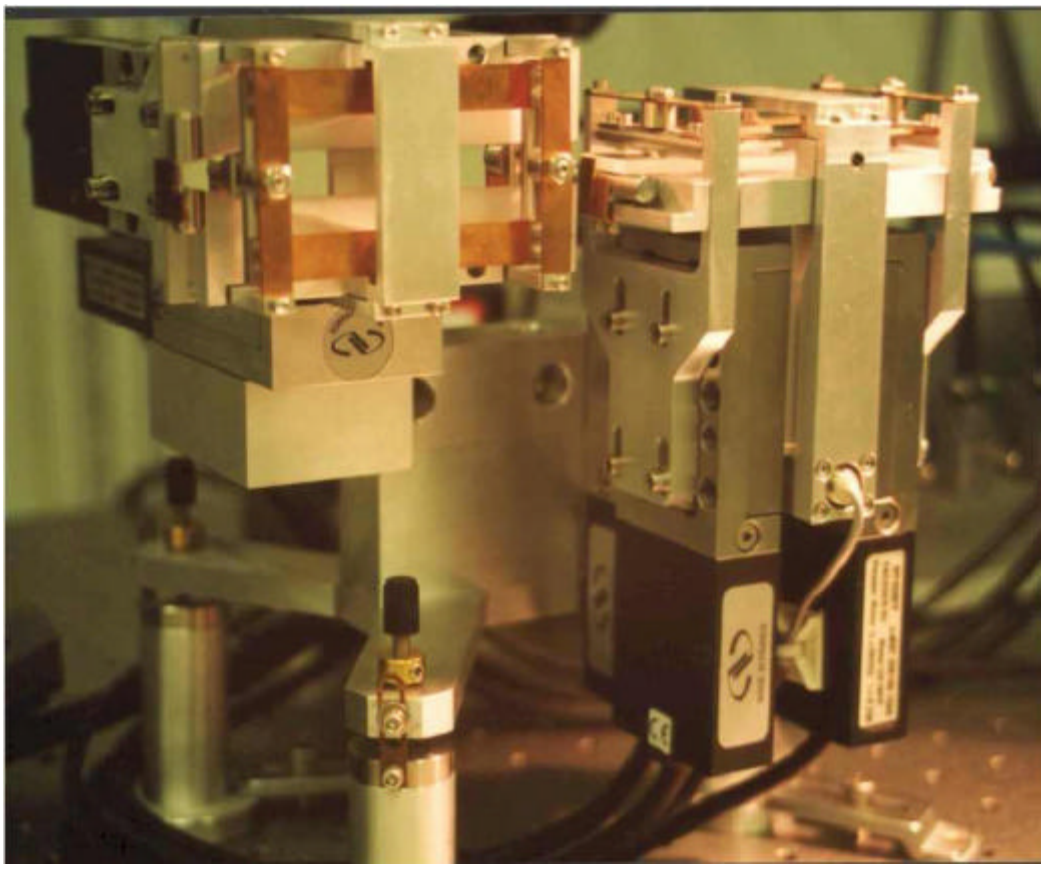
Center for Advanced Radiation Sources,
University of Chicago,
Kirkpatrick Baez
X-Ray Micro-Focusing Optics





I. Installation of Mirrors into the KB Bender

II. Small KB Bender Motor Setup Parameters

III. Cam Driven KB Mirror Tilt Angle

IV. Circuit Diagrams for the BP8000 and Transition Board

I. Installation of Mirrors into the KB Bender

Installation of Mirrors into the KB Bender

Installing the Horizontal mirror

1) Remove the vertical bender from mirror support (see figure 1):
    a. The benders are held in place with two screws and two dowel pins (see figure 2).
    b. By removing the two screws shown in figure 3 the vertical bender can than be pulled of to allow access for the installation of the horizontal mirror.
2) Check the centering of the downstream outer rod to making sure that it is 0.6" from the edge of the bender (see figure 4). It is important that this rod be centered since it is sitting on top of a pivot.
3) Place a spacer under the downstream leaf spring (see figure 5) (pic 5 label spacer) so that the downstream inner bending rod is lifted away from the mirror surface during installation.
4) With one hand pulling the upstream leaf spring (see figure 6), so that the upstream bending rod is lifted away from the mirror surface, carefully slide the mirror (pointy side first) (see figure 7) under the bending rods taking care to not scratch the mirror surface on the bending rods and it slides into place.
5) Once the mirror is over the downstream outer rod release the upstream spring so that there is a light pressure from the upstream bending rod holding the mirror it in place.
6) Remove the downstream spacer so that the downstream bending rod applies a light holding force on the mirror surface.
7) Check the position of the mirror in the bender:
    a. The ends of the mirror should line up with the edges of the outer rods.
    b. The width of the mirror should be centered between the upstream and downstream bending forks. Carefully check that the wide end of the mirror is not touching the bending fork (see figure 8).
8) Push down on the downstream inner bending rod to make sure that the pivoting downstream outer rod is lined up with the back of the mirror.
9) Reinstall the vertical bender by lining up the dowel pin with the mount and tightening the two screws.

Installing the Vertical Mirror

1) Follow steps 2 through 8 of the Horizontal mirror installation.

Note: Before starting focusing it is a good idea to apply maximum force to the mirrors so that they are fully seated.

Connector information

The two round connectors are hermetic with an o-ring and a jam nut (see figure 9). These connectors allow the connection to the benders to easily pass into a gas enclosure.

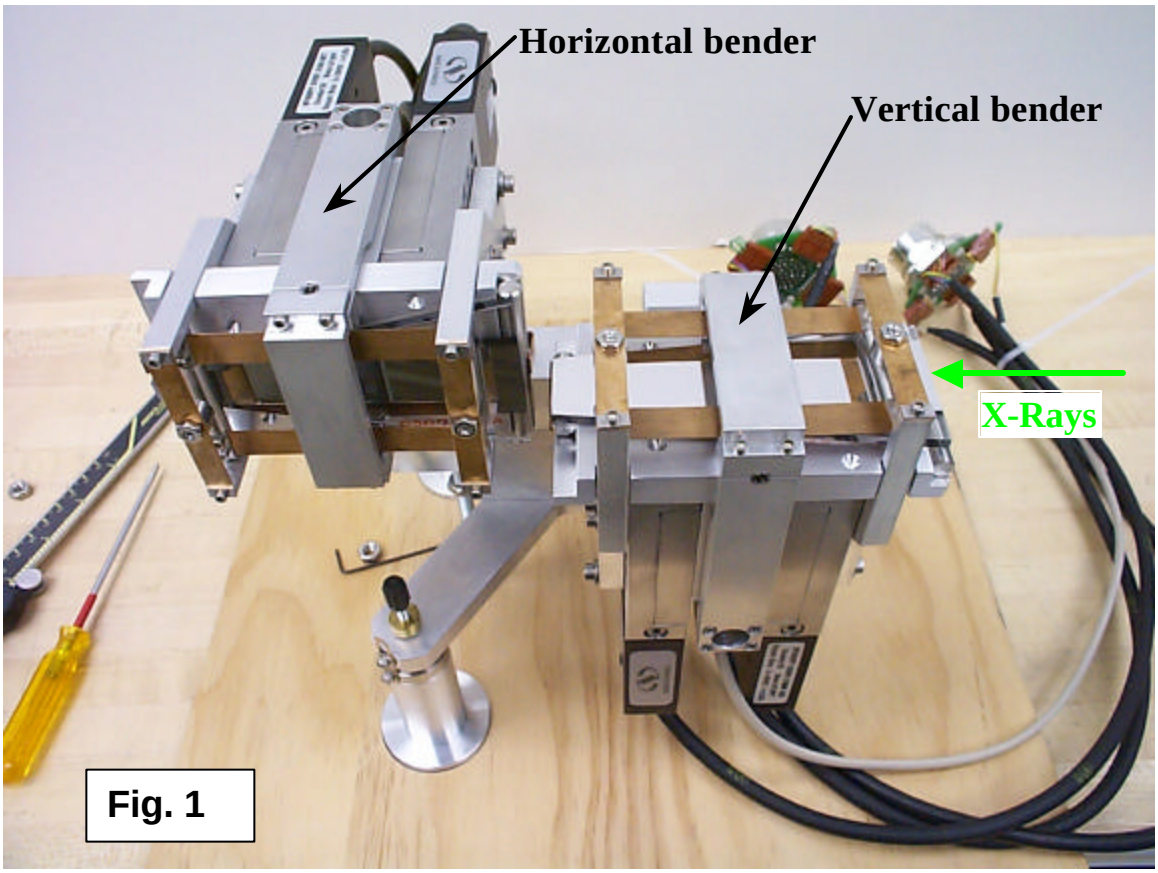

Horizontal bender
Vertical bender
X-Rays

Fig. 1

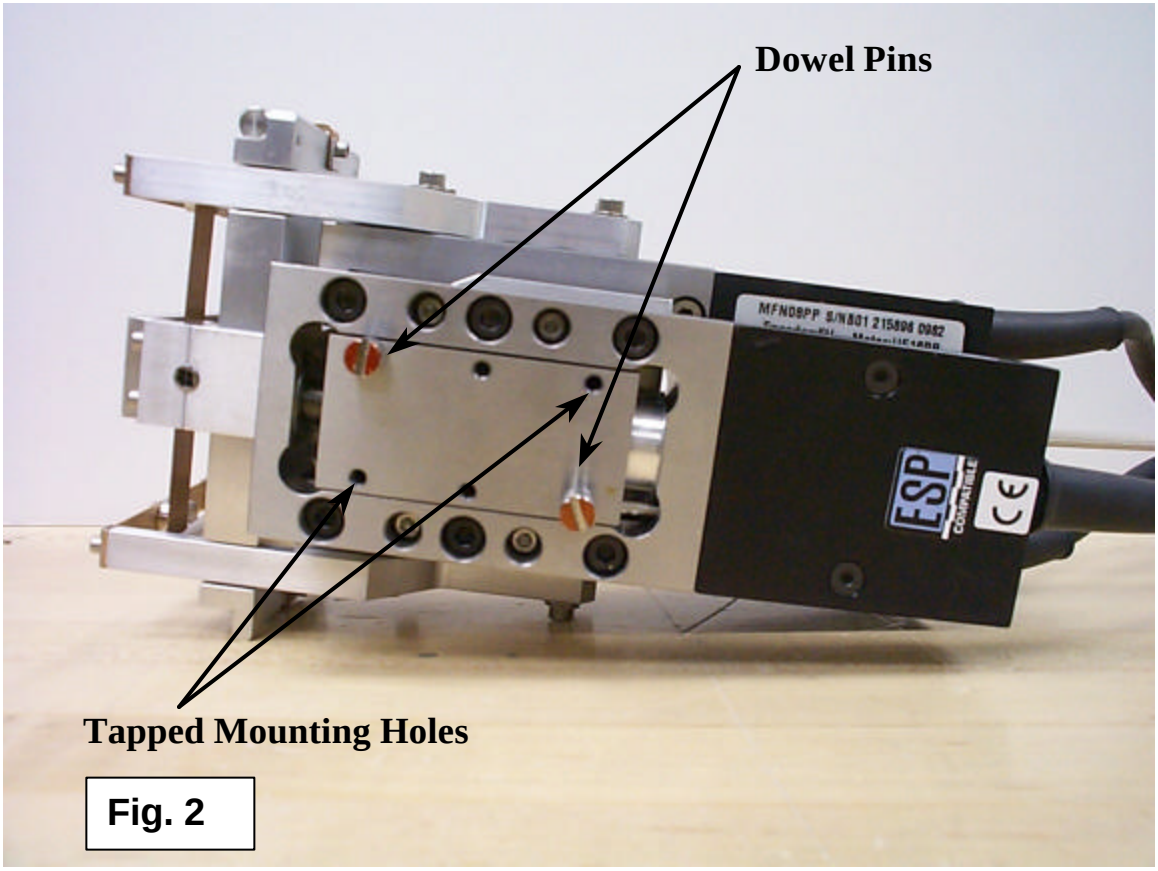

Dowel Pins
Tapped Mounting Holes
ESP

Fig. 2

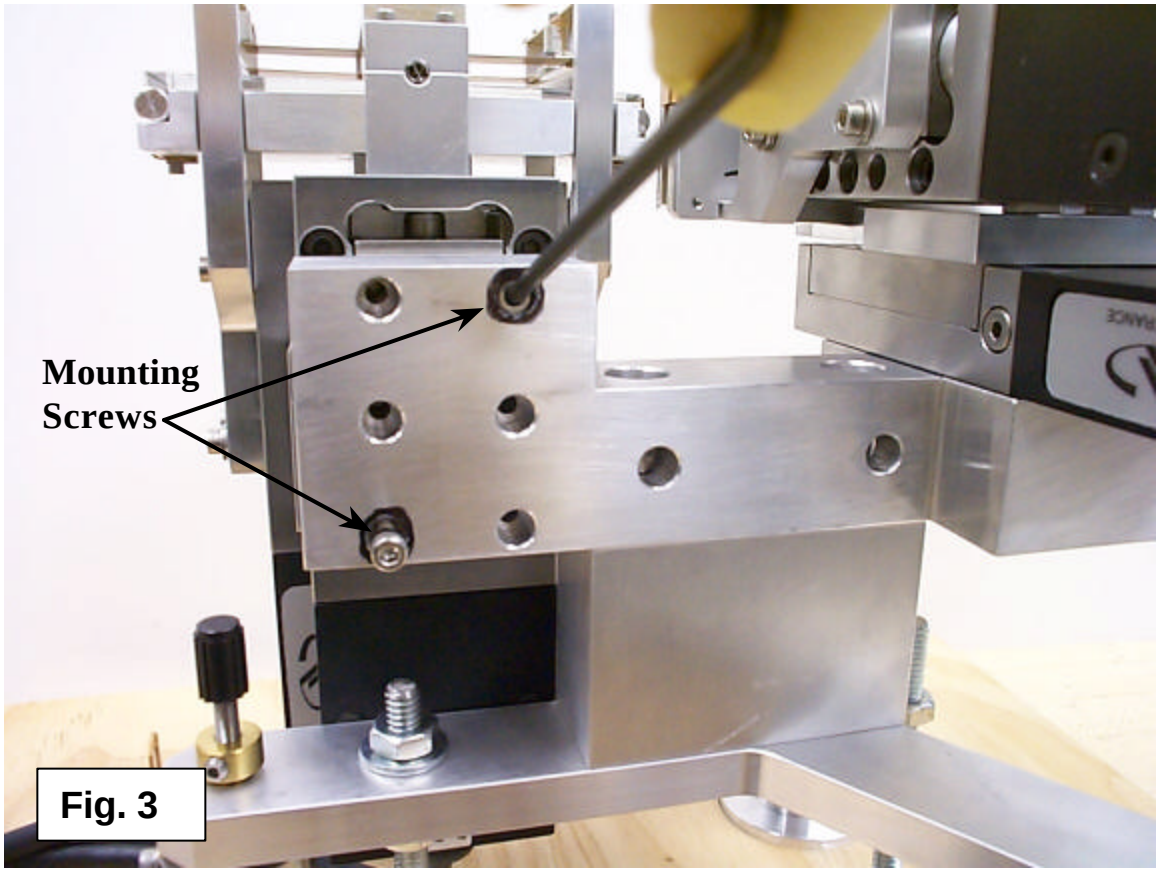

Mounting
Screws

Fig. 3

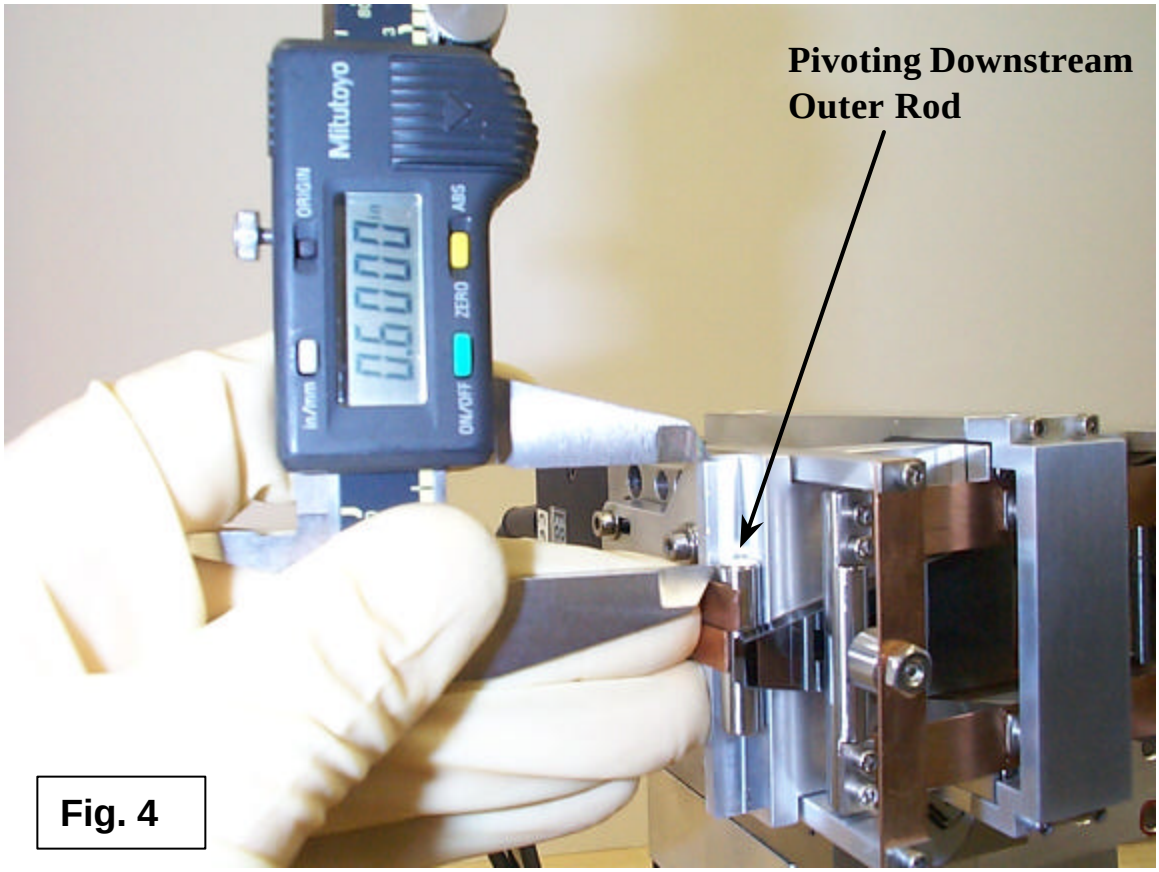

Pivoting Downstream
Outer Rod
Mitutoyo
ORIGIN
ABS
ZERO
ON/OFF

Fig. 4

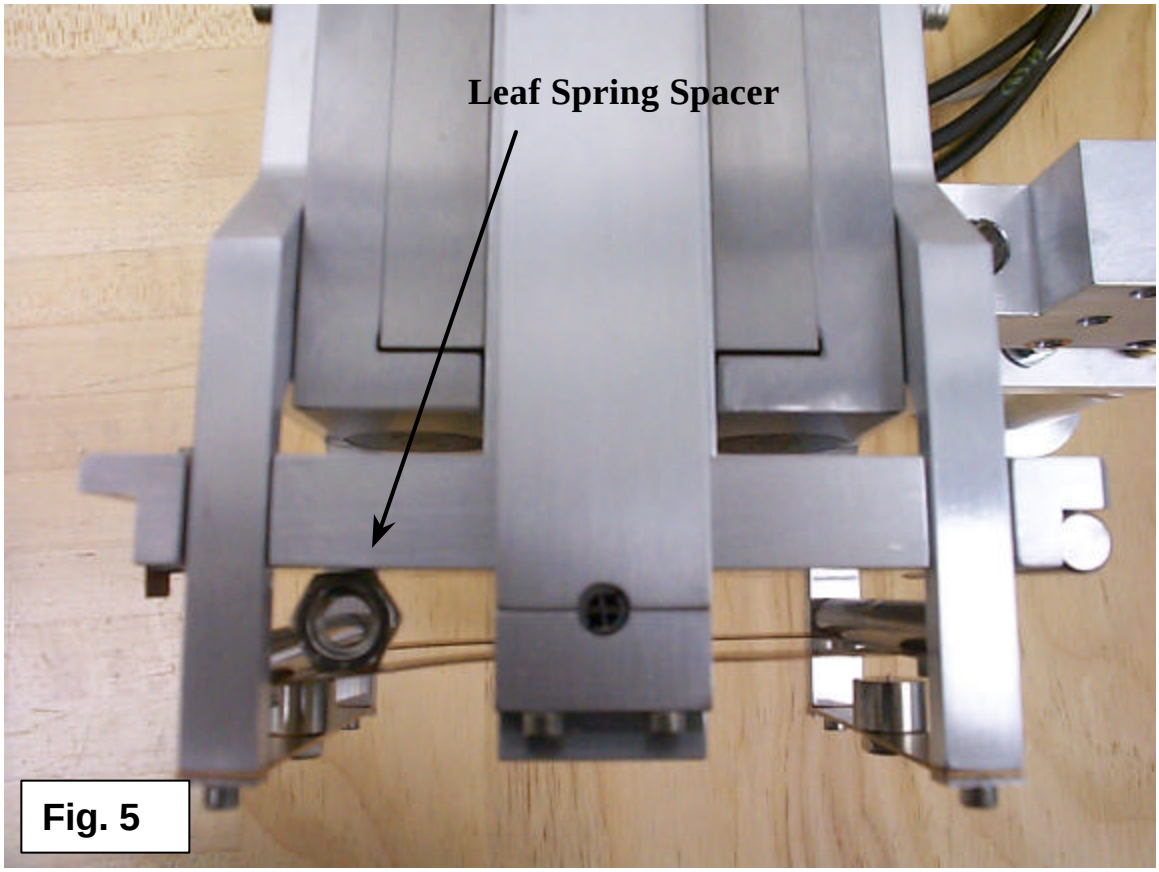


Fig. 5

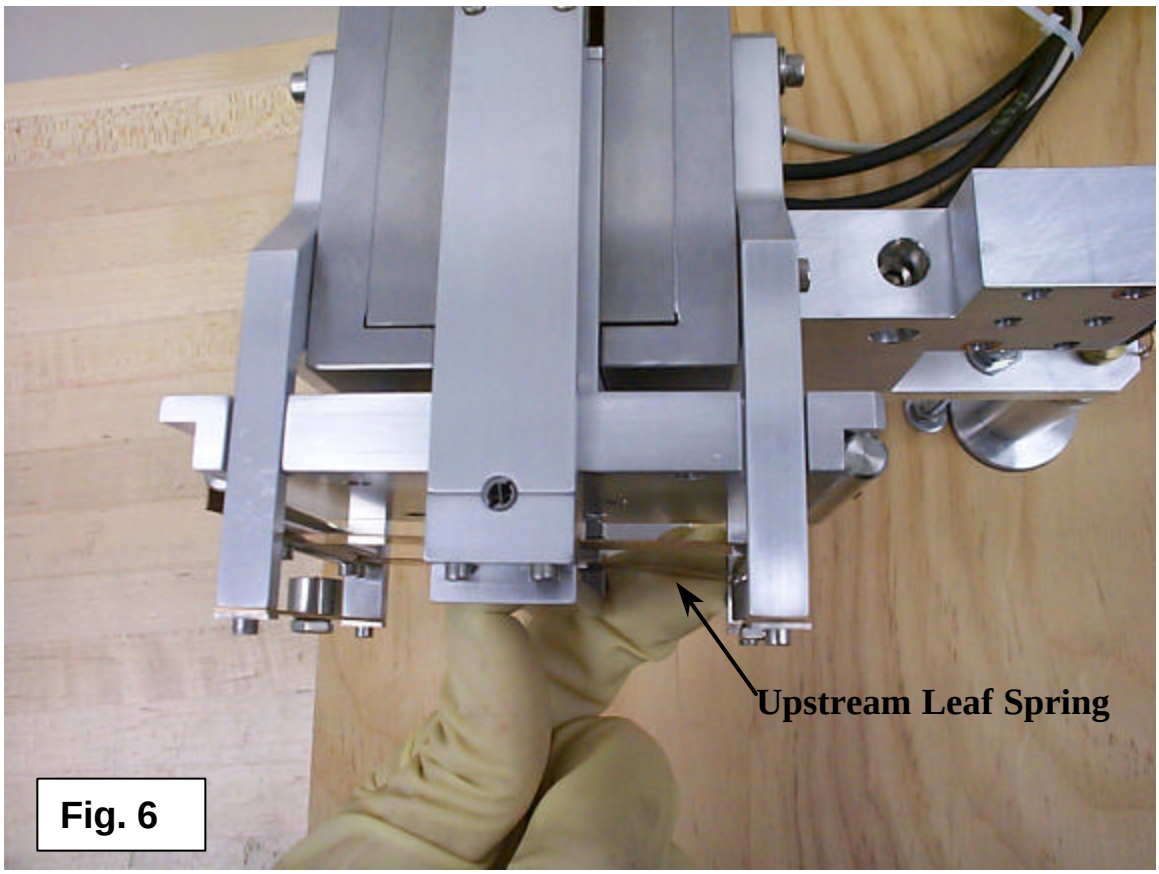


Fig. 6

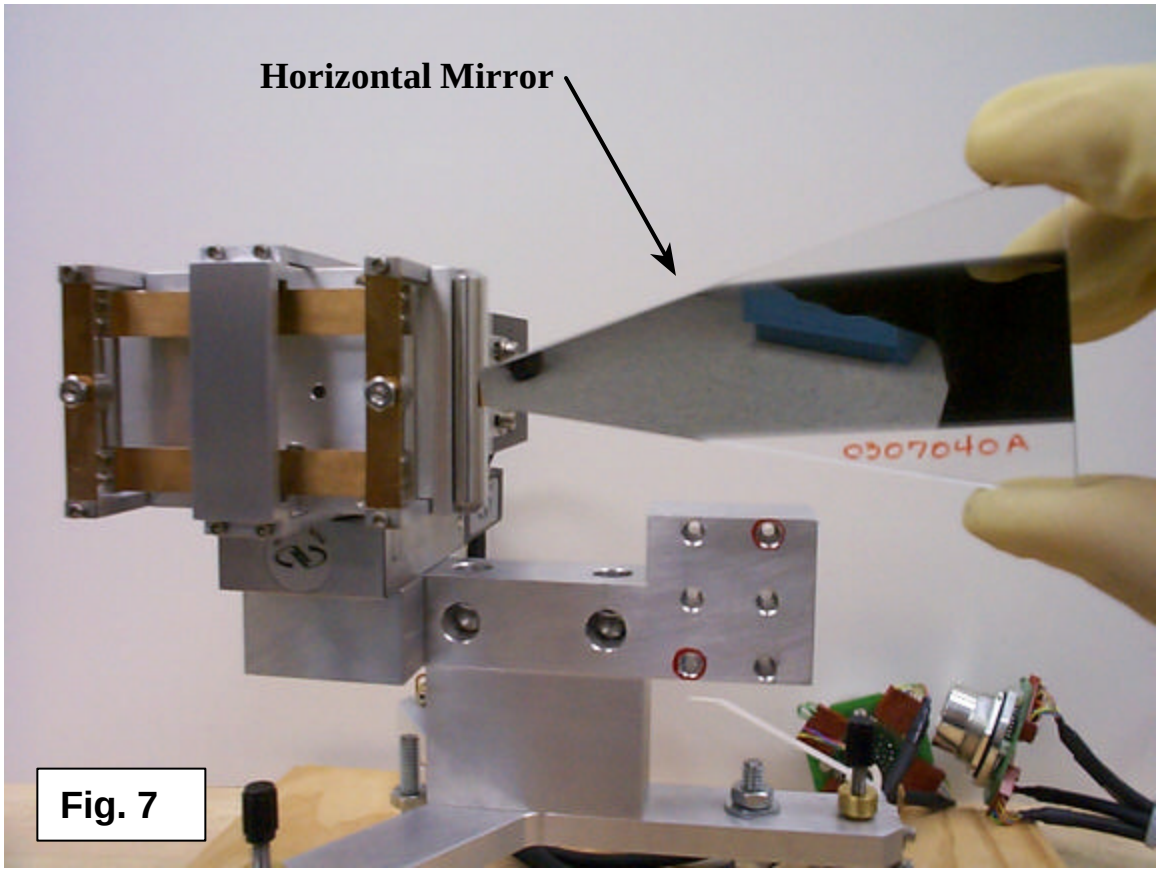

Horizontal Mirror
0307040A

Fig. 7

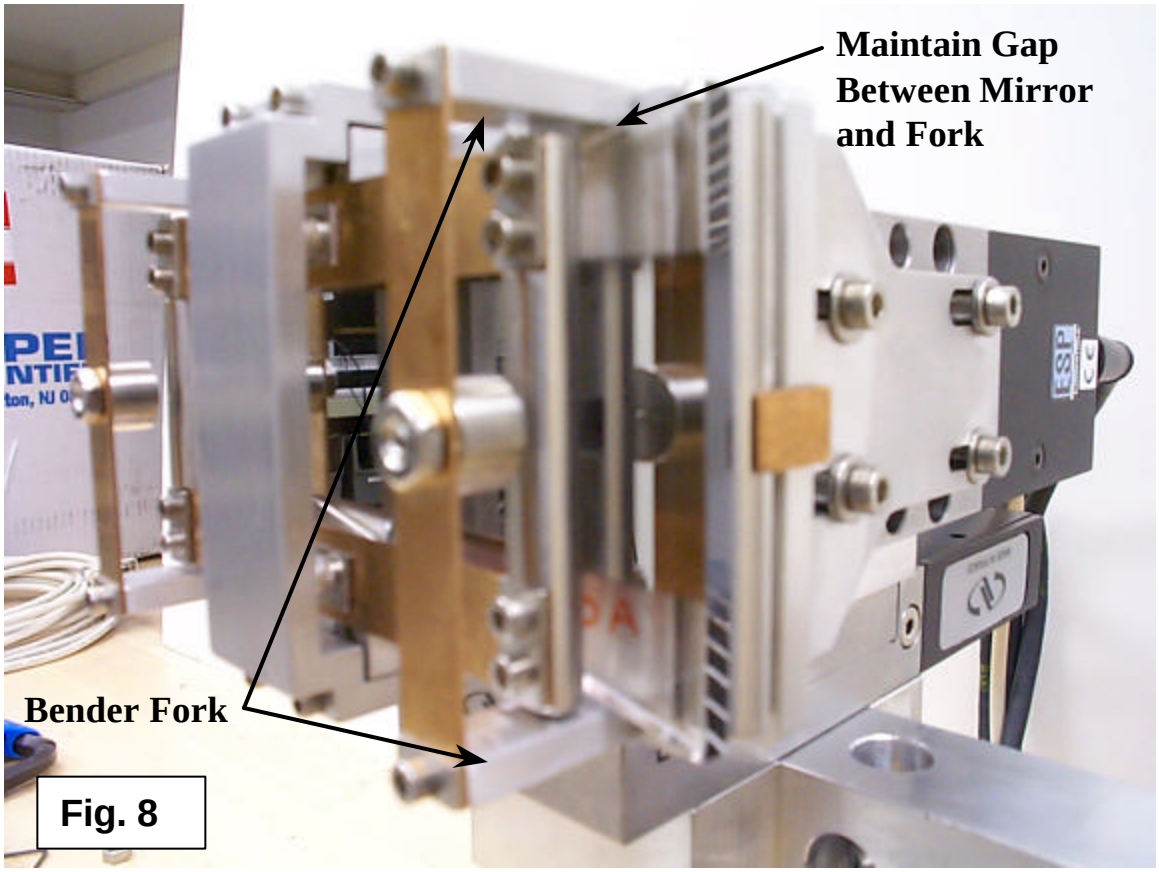

Maintain Gap
Between Mirror
and Fork
Bender Fork

Fig. 8

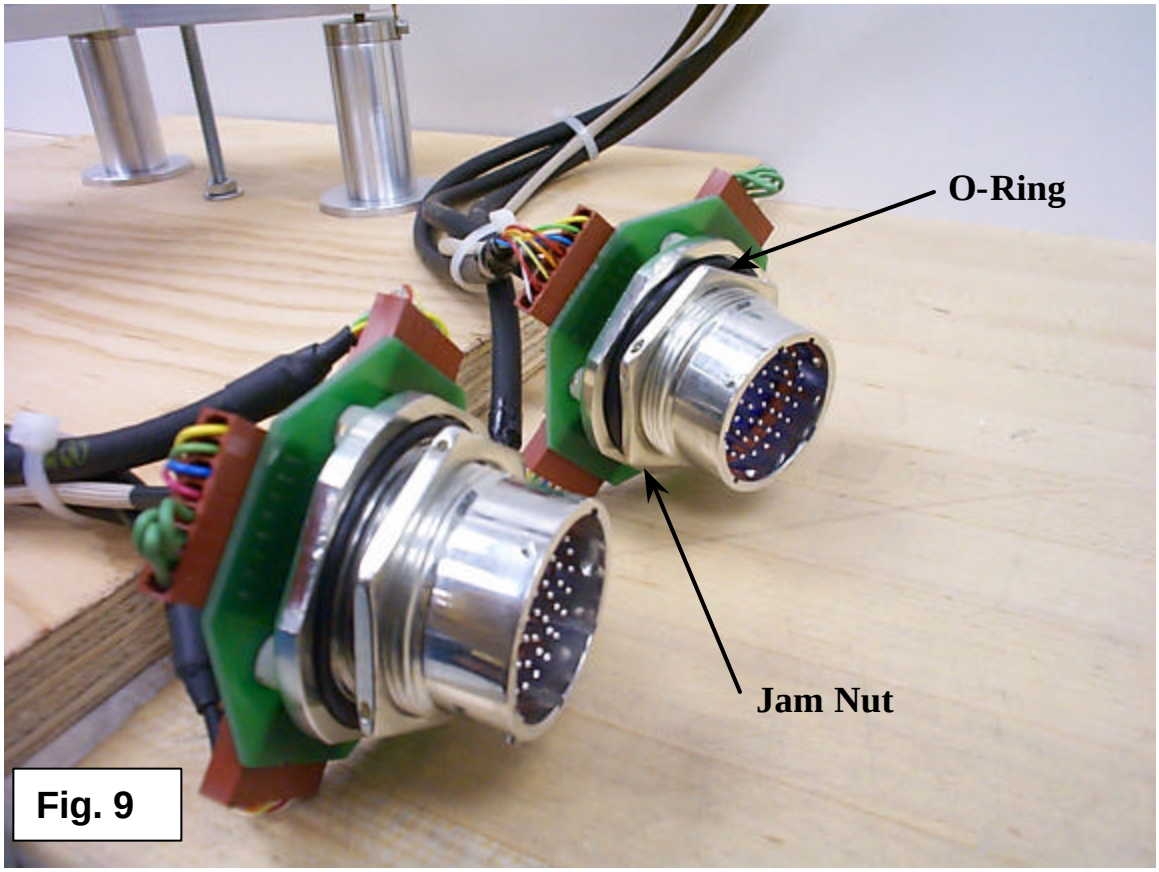


Fig. 9

II. Small KB Bender Motor Setup Parameters

Small KB Bender Motor Setup Parameters

Name	Units	Speed [Units/sec]	Base Speed [Units/sec	Acceleration Time [sec]	Steps per Revolution of Motor	Units per Motor Revolution
Vert. mirror normal	microns	150.0	10	0.2	48	3.546
Vert. mirror rotation	mrad	10	0.1	0.2	48	0.8868
Vert. force UpStream.	microns	150.0	10	0.2	48	3.546
Vert. force DownStream.	microns	150.0	10	0.2	48	3.546
Hor. mirror normal	microns	150.0	10	0.2	48	3.546
Hor. mirror rotation	mrad	10	0.1	0.2	48	0.8868
Hor. force UpStream	microns	100.0	10	0.2	48	3.546
Hor. force DownStream	microns	100.0	10	0.2	48	3.546

III. Cam Driven KB Mirror Tilt Angle

Cam Driven KB Mirror Tilt Angle

The tilt angle is given by:

$$\mathrm{Tilt}(\delta,\theta,L) := \frac{\delta\cdot\sin(\theta)}{L}$$

Where L is the distance from the pivot to the bearing and delta is distance the motor shaft is offset from the center of the cam bearing.

The micromo motor in half step mode has 48 steps per rev. and the gear head is 141:1

There are then:

$$48\cdot 141 = 6.768\cdot 10^{3}$$

motor steps for one output shaft rotation.

One step is then:

$$\frac{1}{48}\cdot\frac{1}{141}\cdot 2\cdot\pi = 9.28367\cdot 10^{-4}$$

radians

or

$$\frac{1}{48}\cdot\frac{1}{141}\cdot 360 = 0.05319$$

deg

Output shaft rotation as a function of steps is then:

$$\theta(\mathrm{step}) := \frac{1}{48}\cdot\frac{1}{141}\cdot 2\cdot\pi\cdot\mathrm{step}$$

So with:

$$L := 3.015$$

and

$$\delta := .060$$

the incident angle as a function of motor steps is:

$$\mathrm{Incident}(\mathrm{step}) := \mathrm{Tilt}(\delta,\theta(\mathrm{step}),L)$$

The fist steps around zero give:

$$\mathrm{Incident}(1) = 1.8475\cdot 10^{-5}$$

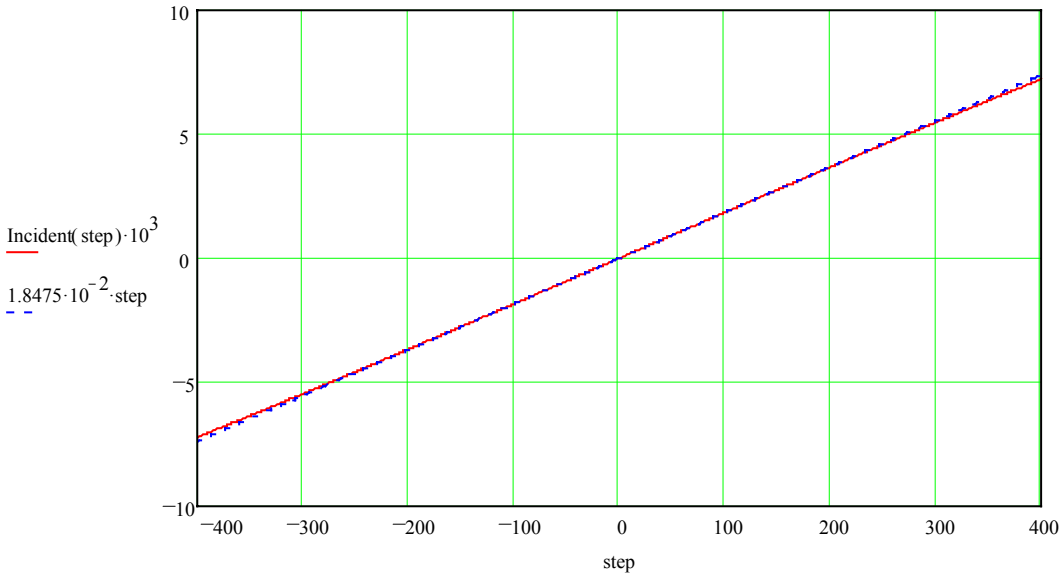
radians

i.e. if it was linear we would have

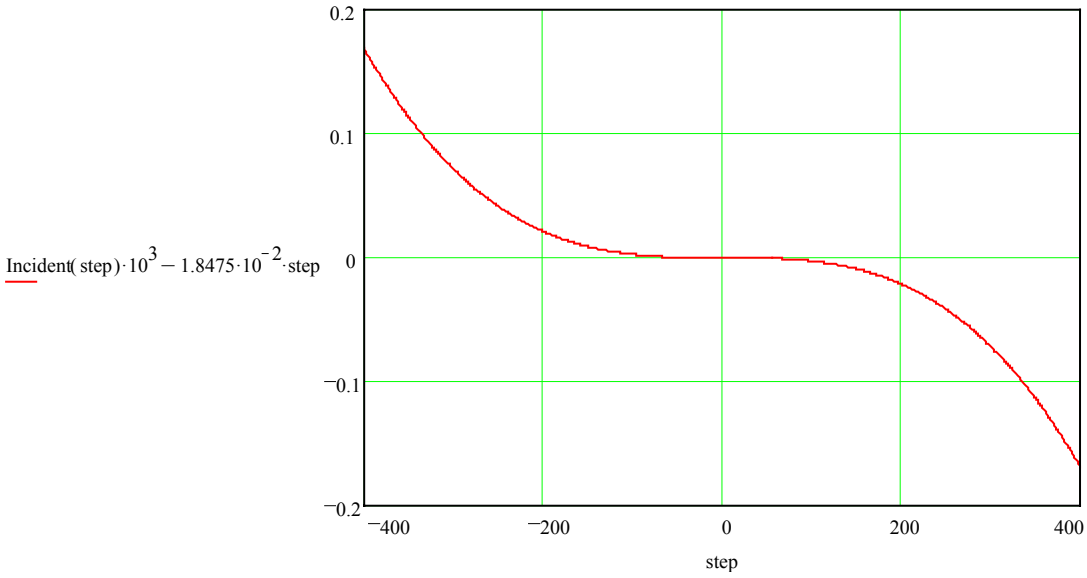
$$18.475$$

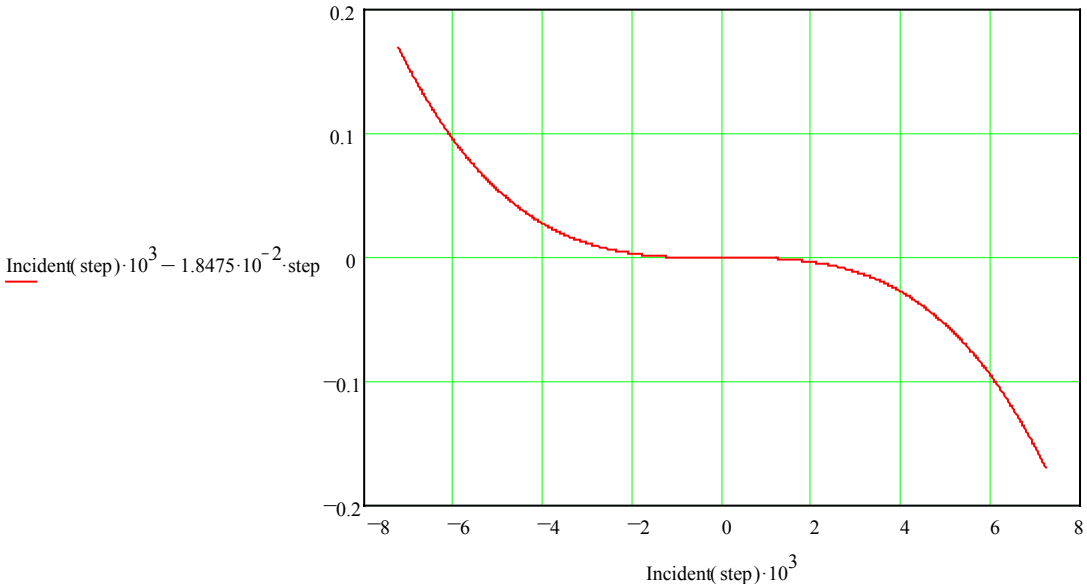
urad/step

$$\mathrm{step} := -400..400$$



The deviation from linear for +/- 8 mrad is:





For the OMS motor record we put in the number of steps per motor rev and user units for one turn of the motor. For our case assuming linearity we have:

$1.8475\,10^{-5}\cdot 48 = 8.8$

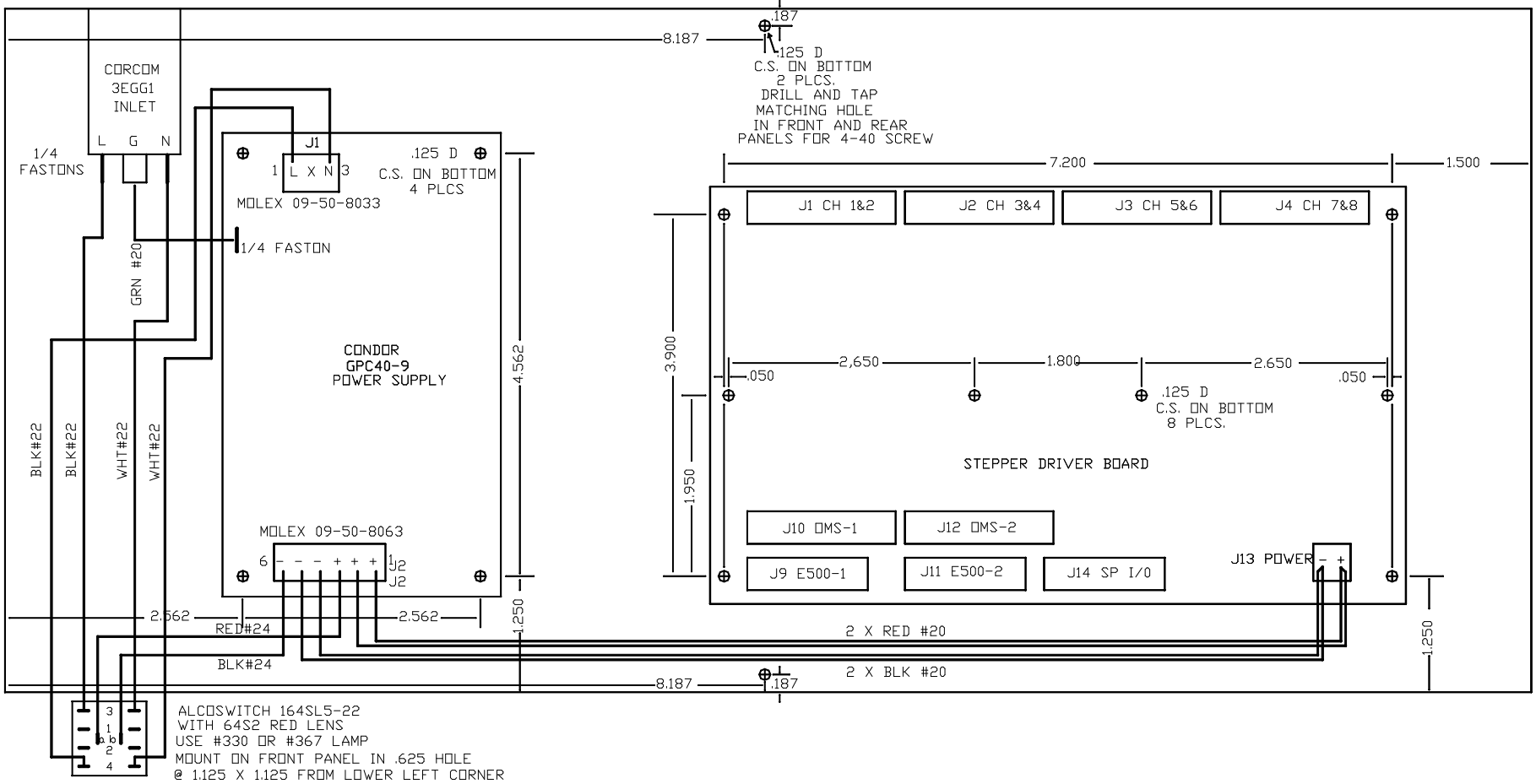
or

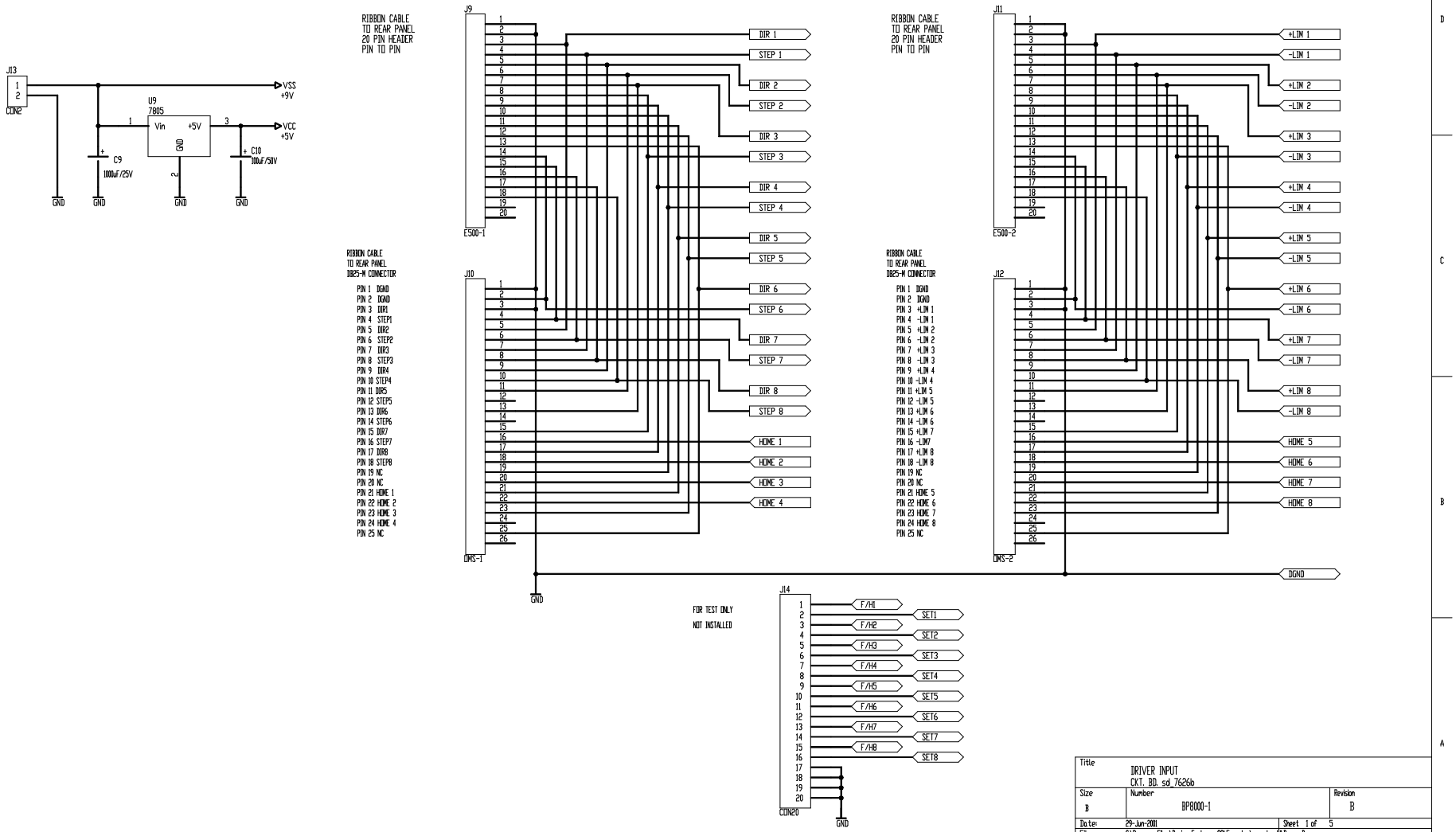
.8868

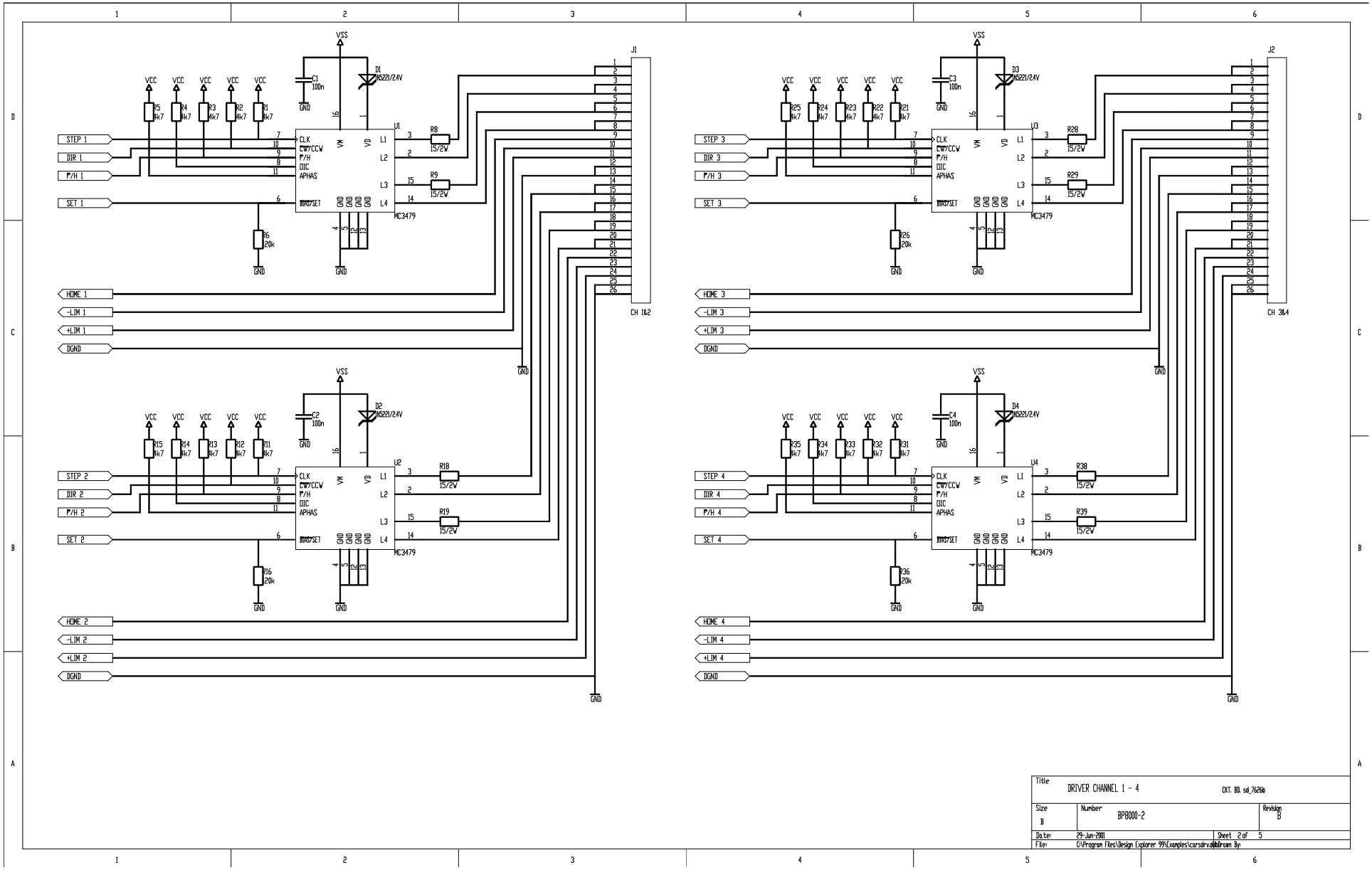
mrad/motor turn

IV. Circuit Diagrams for the BP8000 and Transition Board

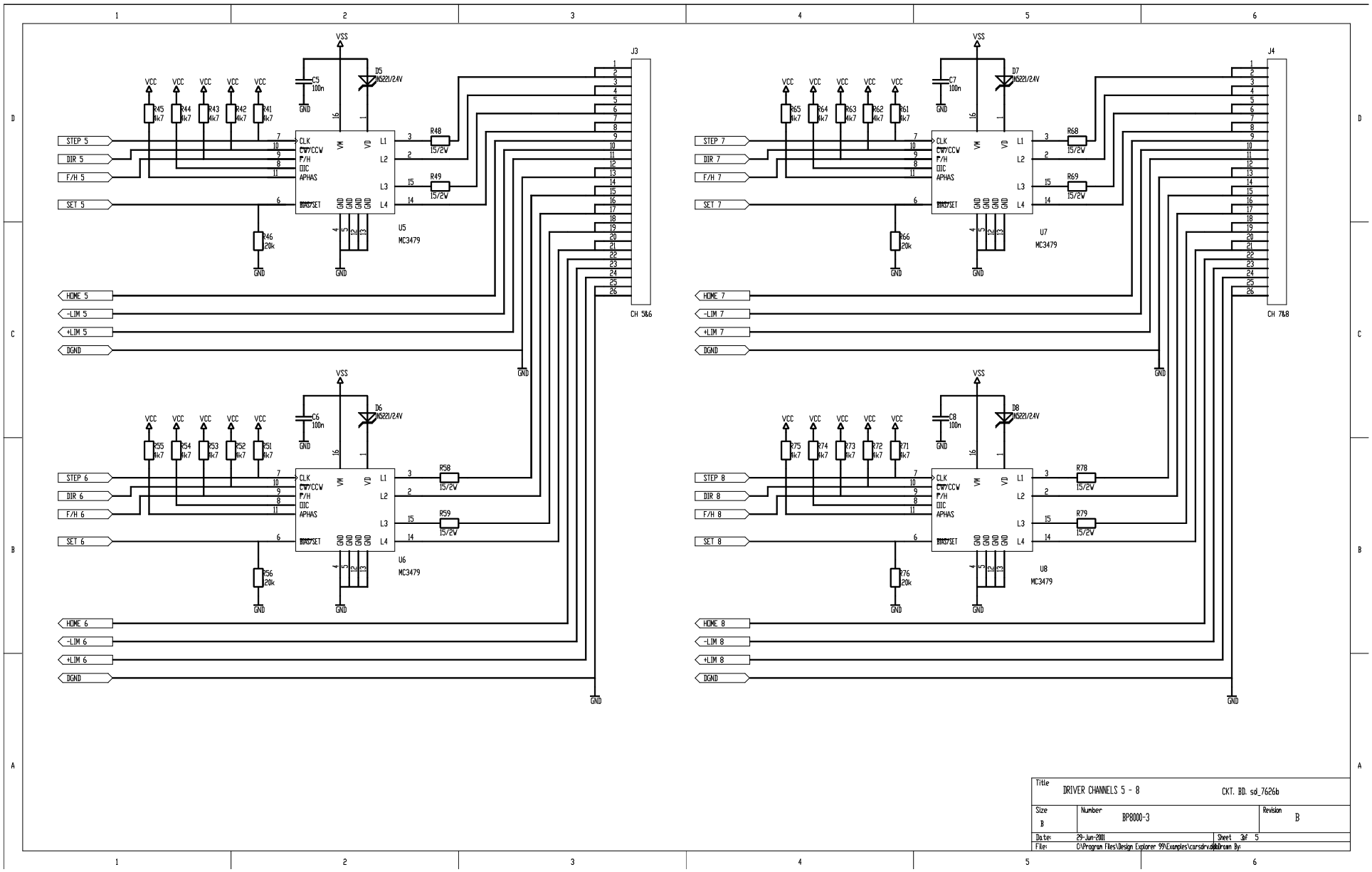
STEPPER DRIVER BOTTOM PANEL
STEPPER DRIVER INTERIOR WIRING — ANSING B2F08-001A ENCLOSURE TOP VIEW 05/04/01 05/04/01




J13
CON2
U9
7805
Vin
+5V
GND
C9
1000uF/25V
C10
100uF/50V
VSS
+9V
VCC
+5V
RIBBON CABLE
TO REAR PANEL
20 PIN HEADER
PIN TO PIN
J9
E500-1
DIR 1
STEP 1
DIR 2
STEP 2
DIR 3
STEP 3
DIR 4
STEP 4
DIR 5
STEP 5
DIR 6
STEP 6
DIR 7
STEP 7
DIR 8
STEP 8
HOME 1
HOME 2
HOME 3
HOME 4
RIBBON CABLE
TO REAR PANEL
DB25-M CONNECTOR
PIN 1 DGND
PIN 2 DGND
PIN 3 DIR1
PIN 4 STEP1
PIN 5 DIR2
PIN 6 STEP2
PIN 7 DIR3
PIN 8 STEP3
PIN 9 DIR4
PIN 10 STEP4
PIN 11 DIR5
PIN 12 STEP5
PIN 13 DIR6
PIN 14 STEP6
PIN 15 DIR7
PIN 16 STEP7
PIN 17 DIR8
PIN 18 STEP8
PIN 19 NC
PIN 20 NC
PIN 21 HOME 1
PIN 22 HOME 2
PIN 23 HOME 3
PIN 24 HOME 4
PIN 25 NC
J10
DMS-1
GND
J11
E500-2
+LIM 1
-LIM 1
+LIM 2
-LIM 2
+LIM 3
-LIM 3
+LIM 4
-LIM 4
+LIM 5
-LIM 5
+LIM 6
-LIM 6
+LIM 7
-LIM 7
+LIM 8
-LIM 8
RIBBON CABLE
TO REAR PANEL
DB25-M CONNECTOR
PIN 1 DGND
PIN 2 DGND
PIN 3 +LIM 1
PIN 4 -LIM 1
PIN 5 +LIM 2
PIN 6 -LIM 2
PIN 7 +LIM 3
PIN 8 -LIM 3
PIN 9 +LIM 4
PIN 10 -LIM 4
PIN 11 +LIM 5
PIN 12 -LIM 5
PIN 13 +LIM 6
PIN 14 -LIM 6
PIN 15 +LIM 7
PIN 16 -LIM7
PIN 17 +LIM 8
PIN 18 -LIM 8
PIN 19 NC
PIN 20 NC
PIN 21 HOME 5
PIN 22 HOME 6
PIN 23 HOME 7
PIN 24 HOME 8
PIN 25 NC
J12
DMS-2
HOME 5
HOME 6
HOME 7
HOME 8
DGND
FOR TEST ONLY
NOT INSTALLED
J14
CON20
F/H1
F/H2
F/H3
F/H4
F/H5
F/H6
F/H7
F/H8
SET1
SET2
SET3
SET4
SET5
SET6
SET7
SET8
GND
Title
DRIVER INPUT
CKT. BD. sd_7626b
Size
B
Number
BP8000-1
Revision
B
Date: 29-Jun-2001
Sheet 1 of 5
File: C:\Program Files\Design Explorer 99\Examples\carsdrv.ddb
Drawn By:



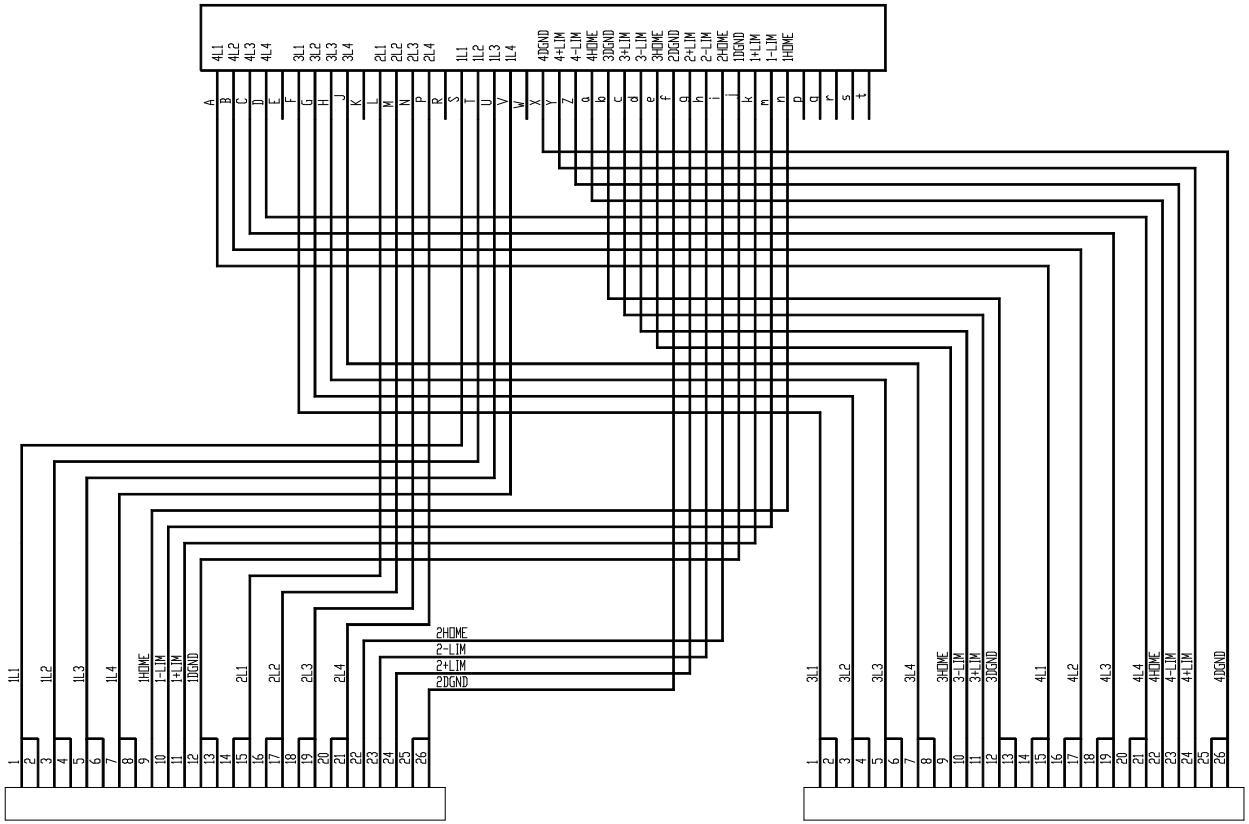
Title: DRIVER CHANNEL 1 - 4	CKT. BD. sd_7626b	
Size: B	Number: BP8000-2	Revision: B
Date: 29-Jun-2001	Sheet 2 of 5	
File: C:\Program Files\Design Explorer 99\Examples\carsdrv.ddb	Drawn By:	



Title: DRIVER CHANNELS 5 - 8		CKT. BD. sd_7626b
Size: B	Number: BP8000-3	Revision: B
Date: 29-Jun-2001	Sheet 3of 5	
File: C:\Program Files\Design Explorer 99\Examples\carsdrv.ddb	Drawn By:	

CONNECTOR TECHNOLOGIES 851-02E20-41S50
MOTOR OUT - MOTORS 1-4 OR 5-8

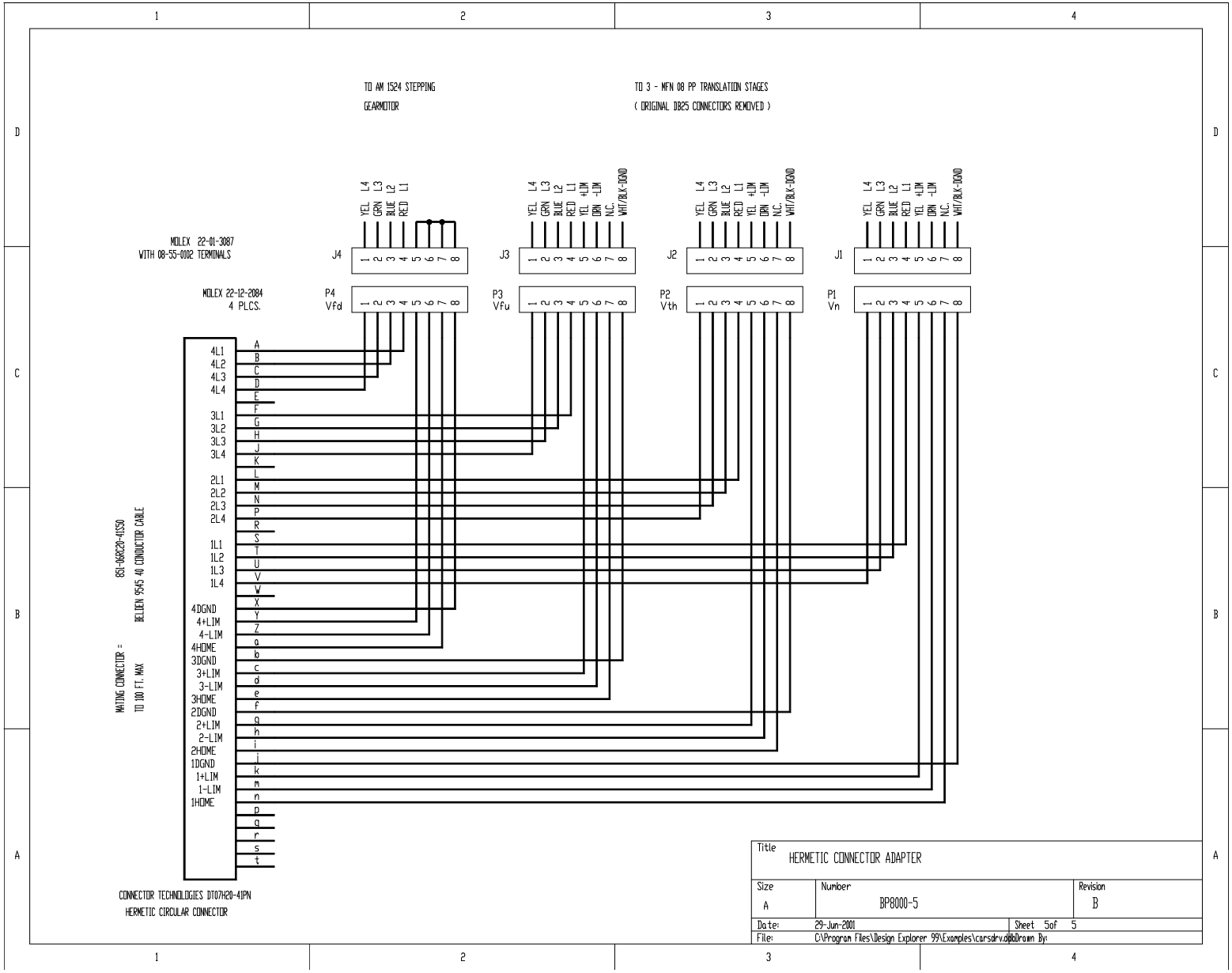
MATING CONNECTOR = CTI 851-06RC20-41P50
TO 100FT. MAX BELDEN 9545 40 CONDUCTOR CABLE

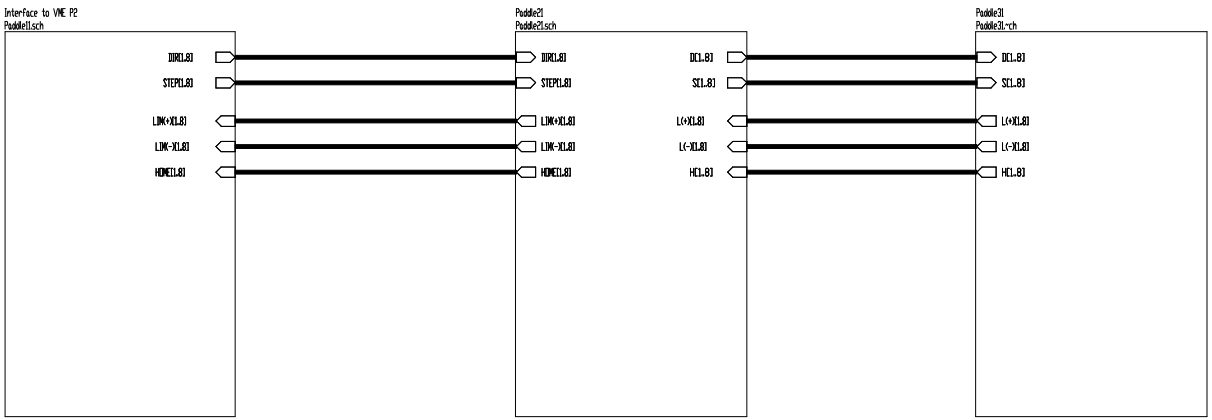


J1/3
CHANNELS 1&2 OR 5&6
26 PIN IDC

J2/4
CHANNELS 3&4 OR 7&8
26 PIN IDC

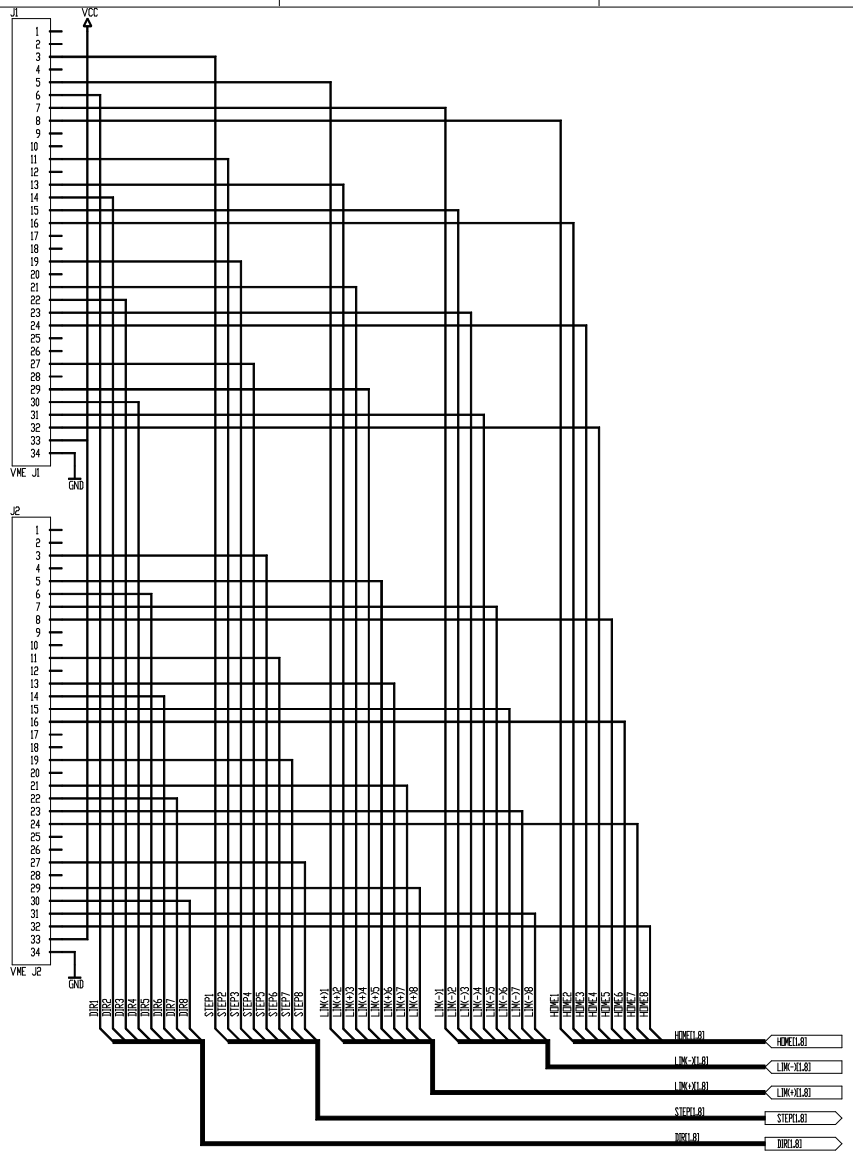
Title: IDC CABLE TO CIRCULAR ADAPTER CKT. BD FO_7626B		
Size: A	Number: BP8000-4	Revision: B
Date: 29-Jun-2001		Sheet 4 of 5
File: C:\Program Files\Design Explorer 99\Examples\carsdrv.ddb	Drawn By:	


TO AM 1524 STEPPING
GEARMOTOR
TO 3 - MFN 08 PP TRANSLATION STAGES
(ORIGINAL DB25 CONNECTORS REMOVED)
MOLEX 22-01-3087
WITH 08-55-0102 TERMINALS
MOLEX 22-12-2084
4 PLCS.
J4
J3
J2
J1
P4
Vfd
P3
Vfu
P2
Vth
P1
Vn
YEL L4
GRN L3
BLUE L2
RED L1
YEL +LIM
ORN -LIM
N.C.
WHT/BLK-DGND
4L1
4L2
4L3
4L4
3L1
3L2
3L3
3L4
2L1
2L2
2L3
2L4
1L1
1L2
1L3
1L4
4DGND
4+LIM
4-LIM
4HOME
3DGND
3+LIM
3-LIM
3HOME
2DGND
2+LIM
2-LIM
2HOME
1DGND
1+LIM
1-LIM
1HOME
MATING CONNECTOR =
TO 100 FT. MAX
BELDEN 9545 40 CONDUCTOR CABLE
85I-466226-A1S30
CONNECTOR TECHNOLOGIES DT07H20-41PN
HERMETIC CIRCULAR CONNECTOR
Title
HERMETIC CONNECTOR ADAPTER
Size
A
Number
BP8000-5
Revision
B
Date: 29-Jun-2001
Sheet 5of 5
File: C:\Program Files\Design Explorer 99\Examples\carsdrv.ddb
Drawn By:



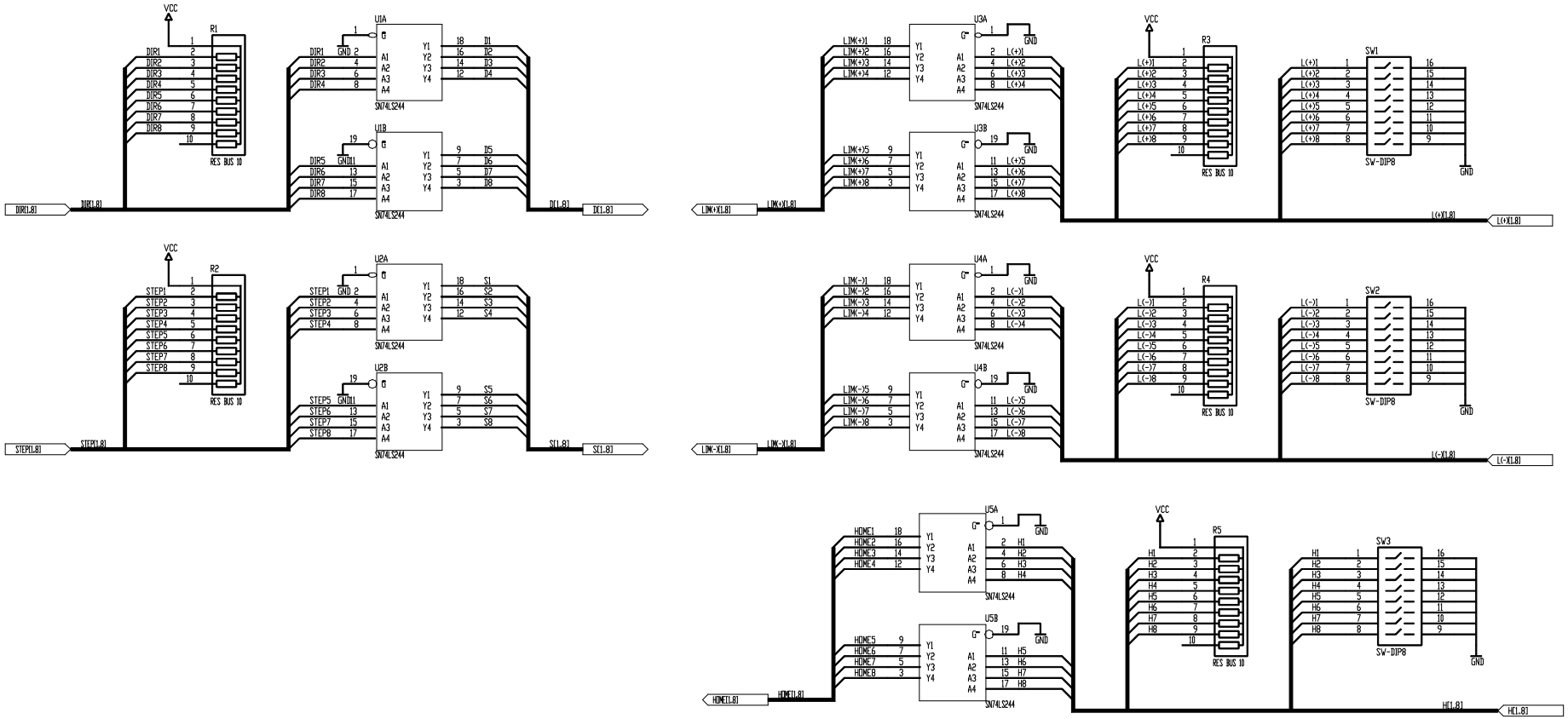
Title: Paddle Board			CARS University of Chicago 5734 S. Ellis Ave. Chicago, IL 60637 USA
Size: B	Number:	Revision: A	
File: C:\Program Files\Design Explorer 99\Examples\carsdrv.ddb - Paddle Main1.sch			Sheet 1 of 4
Date: 29-Jun-2001		Drawn by:	Checked by:

CARS



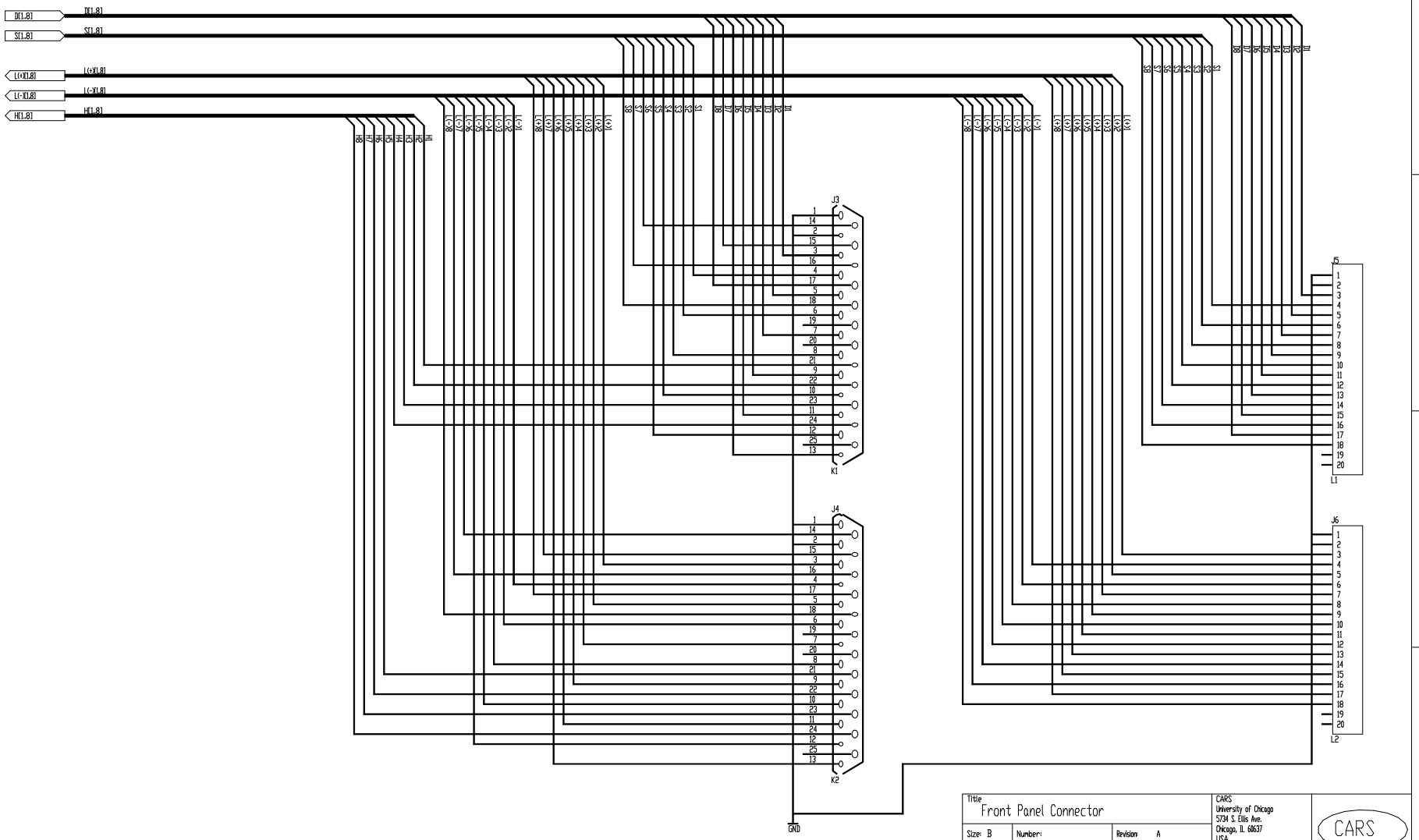
Title: Interface to VME P2			CARS University of Chicago 5734 S. Ellis Ave. Chicago, IL 60637 USA
Size: B	Number:	Revision: A	
File: C:\Program Files\Design Explorer 99\Examples\carsdrv.ddb - paddle11.sch			Sheet 2 of 4
Date: 29-Jun-2001		Drawn by:	Checked by:

CARS



Title: Buffer Section			CARS University of Chicago 5734 S. Ellis Ave. Chicago, IL 60637 USA
Size: B	Number:	Revision: A	
File: C:\Program Files\Design Explorer 99\Examples\carsdrv.ddb - paddle2.sch			Sheet 3 of 4
Date: 29-Jun-2001		Drawn by:	Checked by:

CARS



Title: Front Panel Connector			CARS University of Chicago 5734 S. Ellis Ave. Chicago, IL 60637 USA
Size: B	Number:	Revision: A	Sheet 4 of 4
File: C:\Program Files\Design Explorer 99\Examples\carsdrv.ddb - paddle3l.sch			Checked by:
Date: 29-Jun-2001		Drawn by:	

CARS