NATIONAL RADIO ASTRONOMY OBSERVATORY
GREEN BANK, WEST VIRGINIA

ELECTRONICS DIVISION INTERNAL REPORT NO. 149

NRAO 45-FOOT TELESCOPE
DIGITAL POSITION CONTROL AND READOUT SYSTEM

J. RAY HALLMAN

NOVERMBER 1974

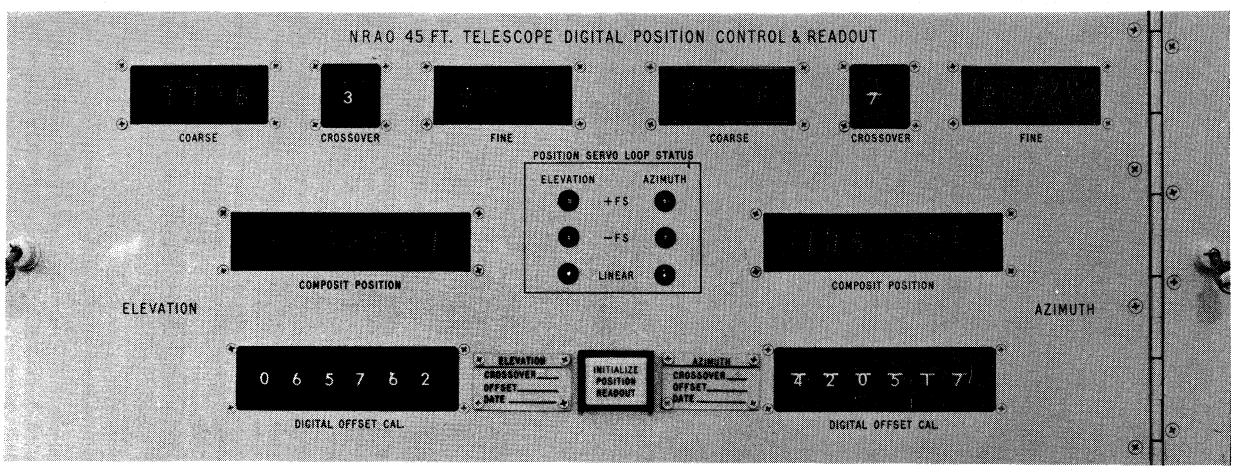
NUMBER OF COPIES: 150

NRAO 45-FOOT TELESCOPE DIGITAL POSITION CONTROL AND READOUT SYSTEM

J. Ray Hallman

The digital position control and readout (DPCAR) electronic system provides the 45-ft telescope position control and monitor facilities used to accurately point the telescope. The basic system contains the stand-alone calculator control circuit cards 24, 25, and 26 (described in EDIR #128), the inductosyn position readout system cards 27 and 28 (contributed by Ron Weimer), and the digital position servo control cards 29, 30, 31, and 32. Also described in this EDIR is a test fixture (useful in testing the telescope response) and the analog control panel circuits that were added to permit monitoring of the telescope drive motor currents.

A picture of the DPCAR front panel is presented below.

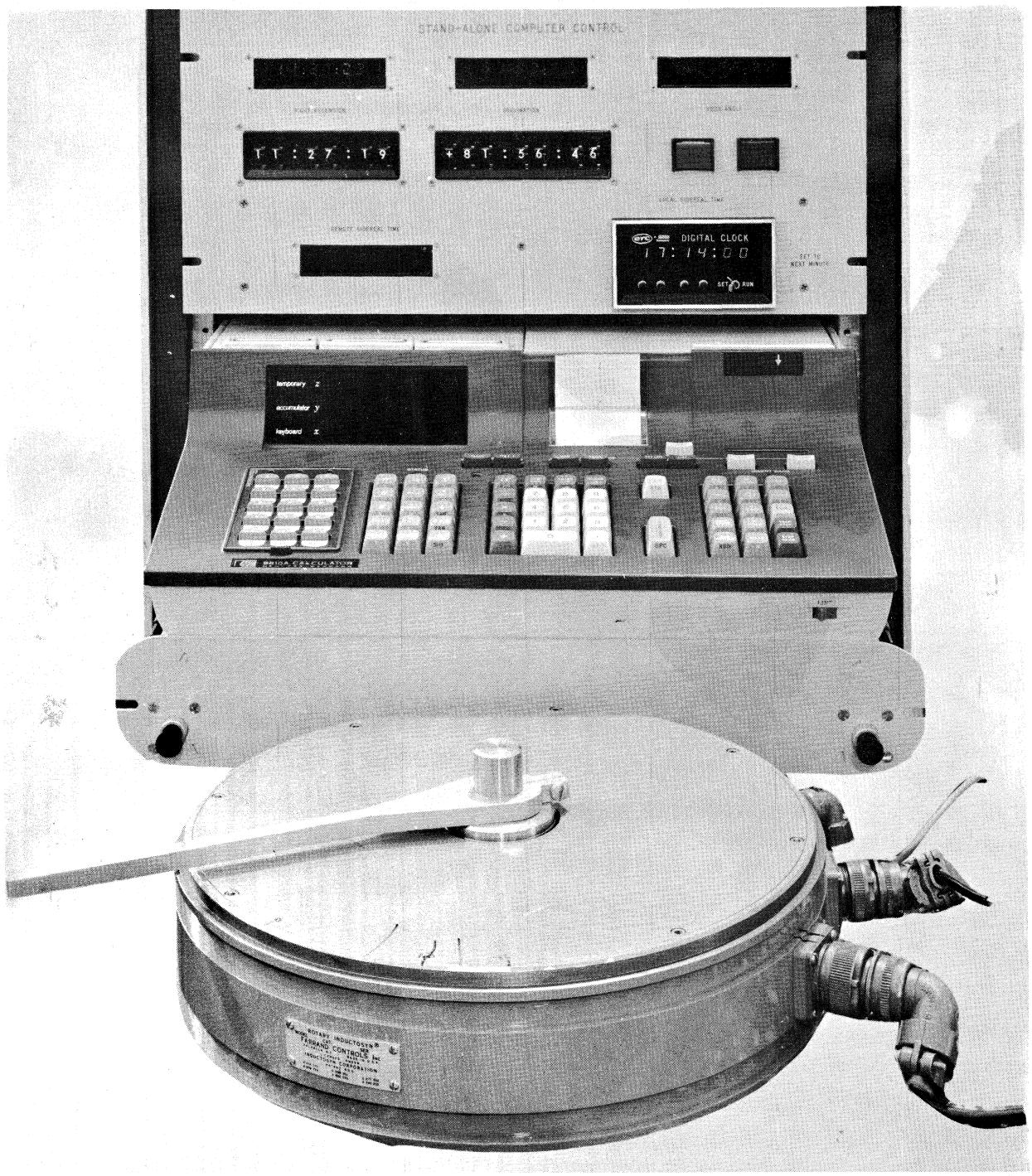


In the pix, coarse and fine indicators display the actual 11 and 12 bits respectively of the inductosyn converter logic outputs when the cross-over control is in position "0". The "crossover"control provides an electronic means of adjusting the offset between the "fine" and "coarse" (1 speed and 256 speed) resolvers. The crossover control adds the displayed value to the most significant

octal digit of the "fine" outputs. The "composite" position displays indicate the octal value of the position readout after logical combination of the "fine" and "coarse" values and after a digital offset calibration value is added to the position values. The "offset cal" enables electronically the azimuth and elevation position readout inductosyns to be zeroed without the necessity of adjusting, mechanically, the resolvers. The yellow "initialize position readout" push-button resets the inductosyn converter counting system. This is done automatically whenever a computer update error occurs via the digital data link system. The button lights during a reset sequence.

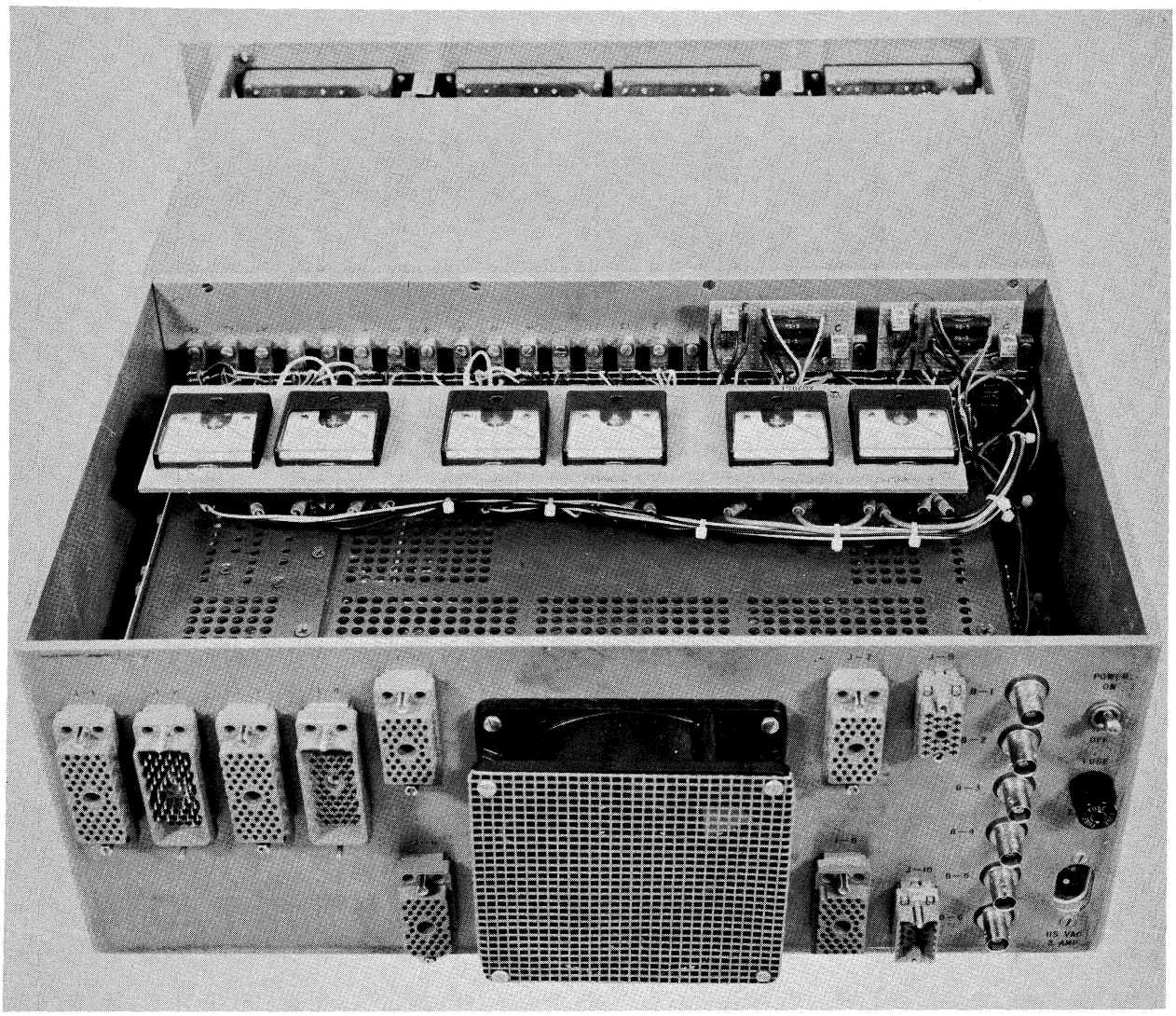
The position servo loop status indicators display the mode of the digital servo control circuits which may be either + full scale, - full scale, or linear (D/A) mode. Normal operation is "linear" but during observing source changes, usually the mode changes to full scale during slew. This digital control is connected via DAC's to the analog servo control system described in EDIR #127.

A picture of the "stand alone" computer control is shown on the next page.



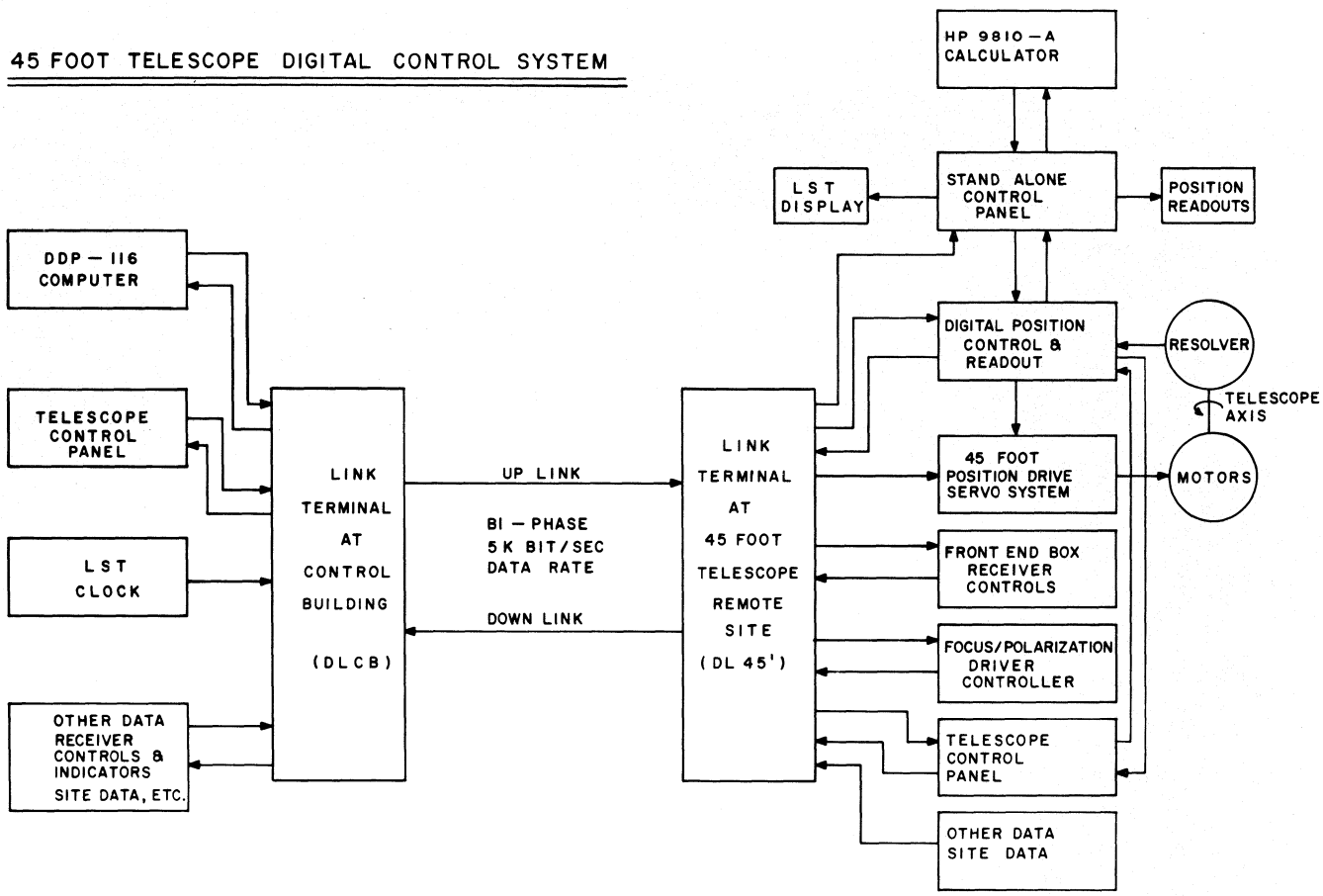
Also, in the pix at the bottom, is the rotary inductosyn package employed in the telescope position monitor system.

The DPCAR logic circuits are assembled in the top-most 7-inch rack-mounted drawer, a picture of which is presented showing the "insides".



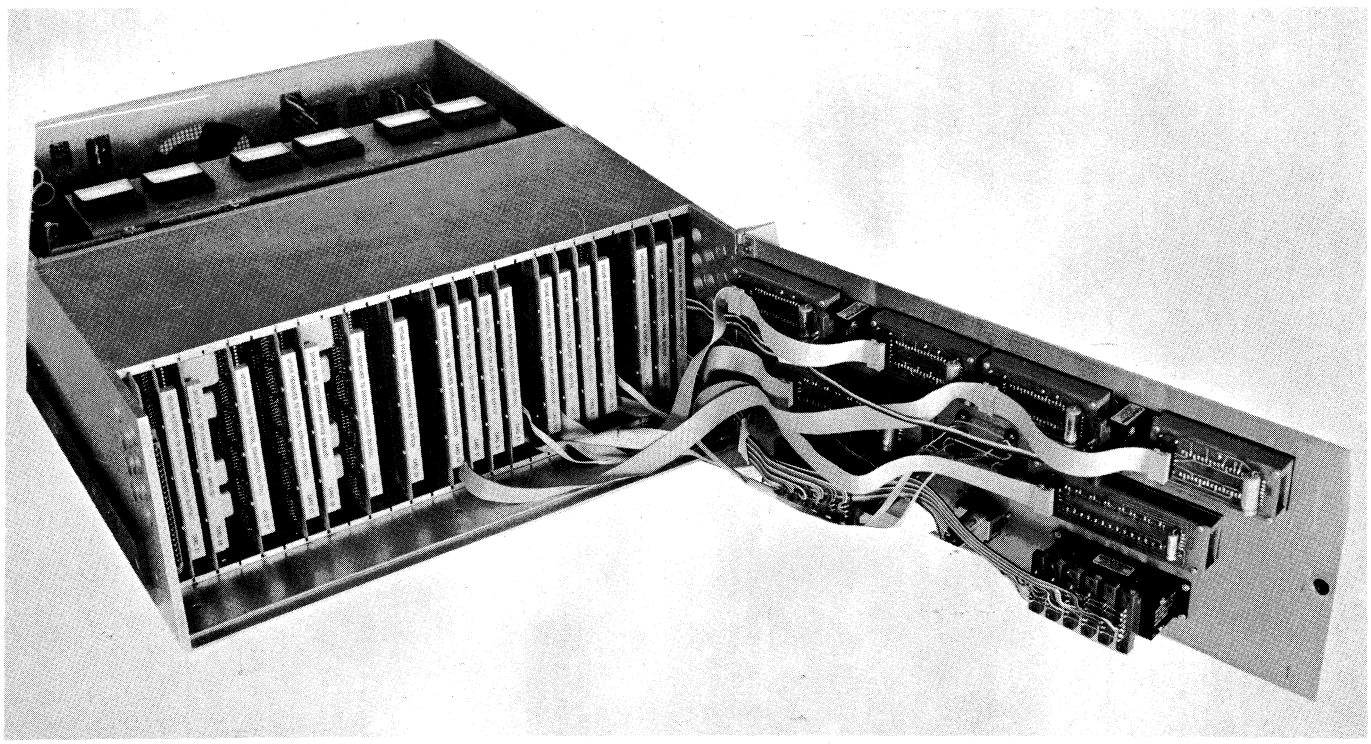
The "box" rolls out on slides when careful attention is given to the rear cables. The meters provide monitoring facilities of the ± 15 V DC and +5 V DC power supplies.

A block diagram showing the basic functions of the 45-ft control system interconnected with the DPCAR is presented.



The link terminals are described in EDIR #150.

A picture of the DPCAR card file is presented showing the electronic card complement and locations.



There are 26 slots of which 18 are used. There is some redundancy resulting in only 9 different logic cards required for spares. Note the digital display wiring in the pix. The displays are connected using a multiplexing scheme resulting in great saving of cabling and wiring.

45-FT DIGITAL POSITION CONTROL AND READOUT (DPCAR)

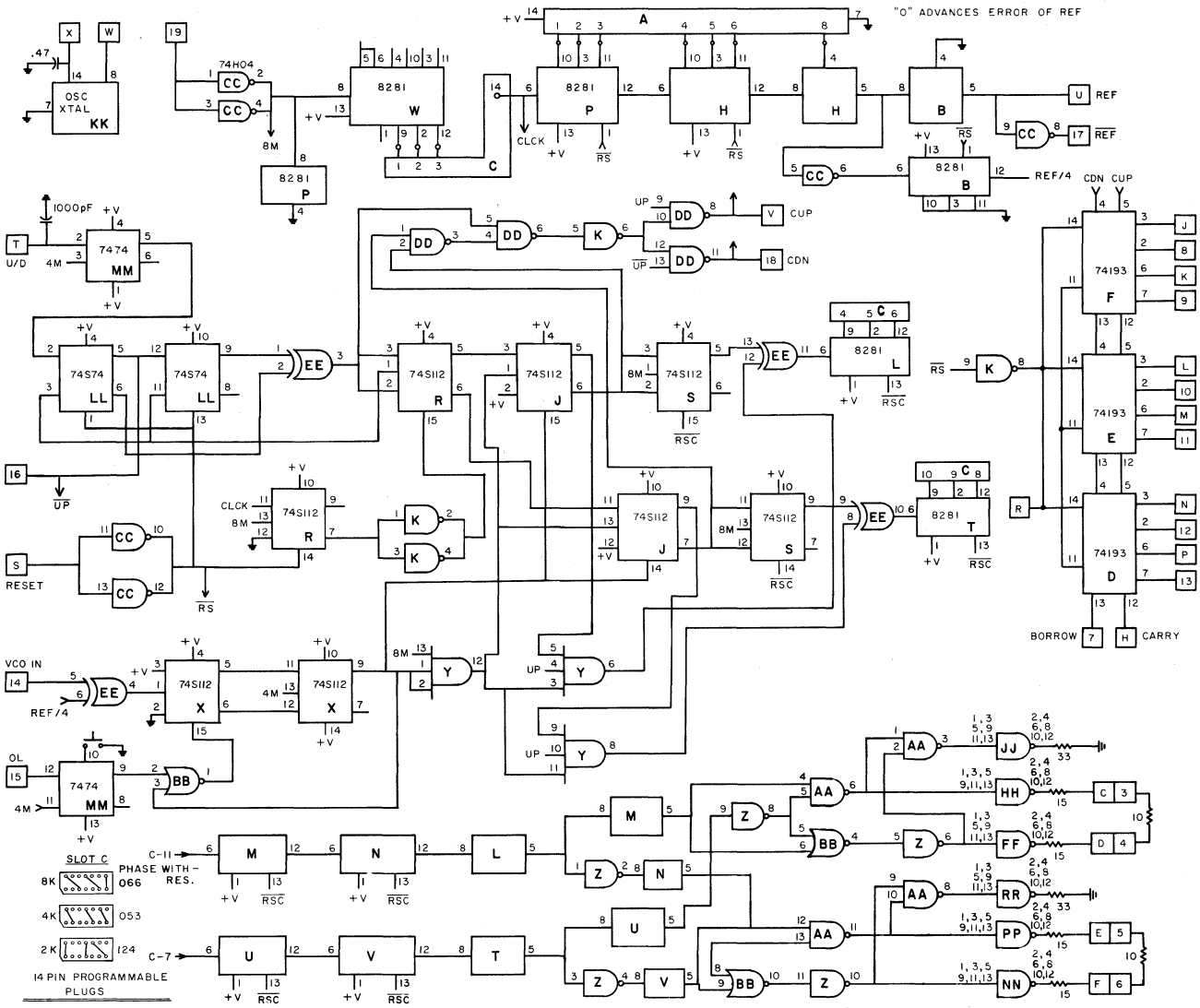
CARD SLOT ASSIGNMENTS

Slot					
1	Spare				
2	DPCAR	Resolver to digital converter (digital)	Card 27		(C)
3	DPCAR	Sync det/error amp/VCO (analog)	Card 28	El	
4	Not usable				
5	DPCAR	Resolver to digital converter (digital)	Card 27		(F)
6	Spare				
7	DPCAR	Resolver to digital converter (digital)	Card 27		(C)
8	DPCAR	Sync det/error amp/VCO (analog)	Card 28	Az	
9	Not usable				
10	DPCAR	Resolver to digital converter (digital)	Card 27		(F)
11	Spare				
12	DPCAR	System timing generator/Az MSB synth	Card 29		
13	Spare				
14	DPCAR	Coarse/fine resolver displays/crossover	Card 30		
15	DPCAR	Digital offset cal/output reg buffer	Card 31		
16	DPCAR	Digital offset cal/output reg buffer	Card 31	El	
17	DPCAR	Composit display/servo error control	Card 32		
18	Spare				
19	DPCAR	Coarse/fine resolver displays/crossover	Card 30		
20	DPCAR	Digital offset cal/output reg buffer	Card 31		
21	DPCAR	Digital offset cal/output reg buffer	Card 31	Az	
22	DPCAR	Composit display/servo error control	Card 32		
23	Spare				
24	DPCAR	Stand alone position readout input	Card 24		
25	DPCAR	Stand alone position command output	Card 25	Calc	
26	DPCAR	Stand alone position command output	Card 26		

Description of Circuits

Cards #24, 25, and 26: EDIR #128 describes these circuits.

Card #27: The schematic showing the inductosyn converter digital logic is presented below.



45' POSITION READOUT, RESOLVER TO DIGITAL CONVERVTER CARD No. 27
DIGITAL COUNTER / DRIVER CIRCUITS

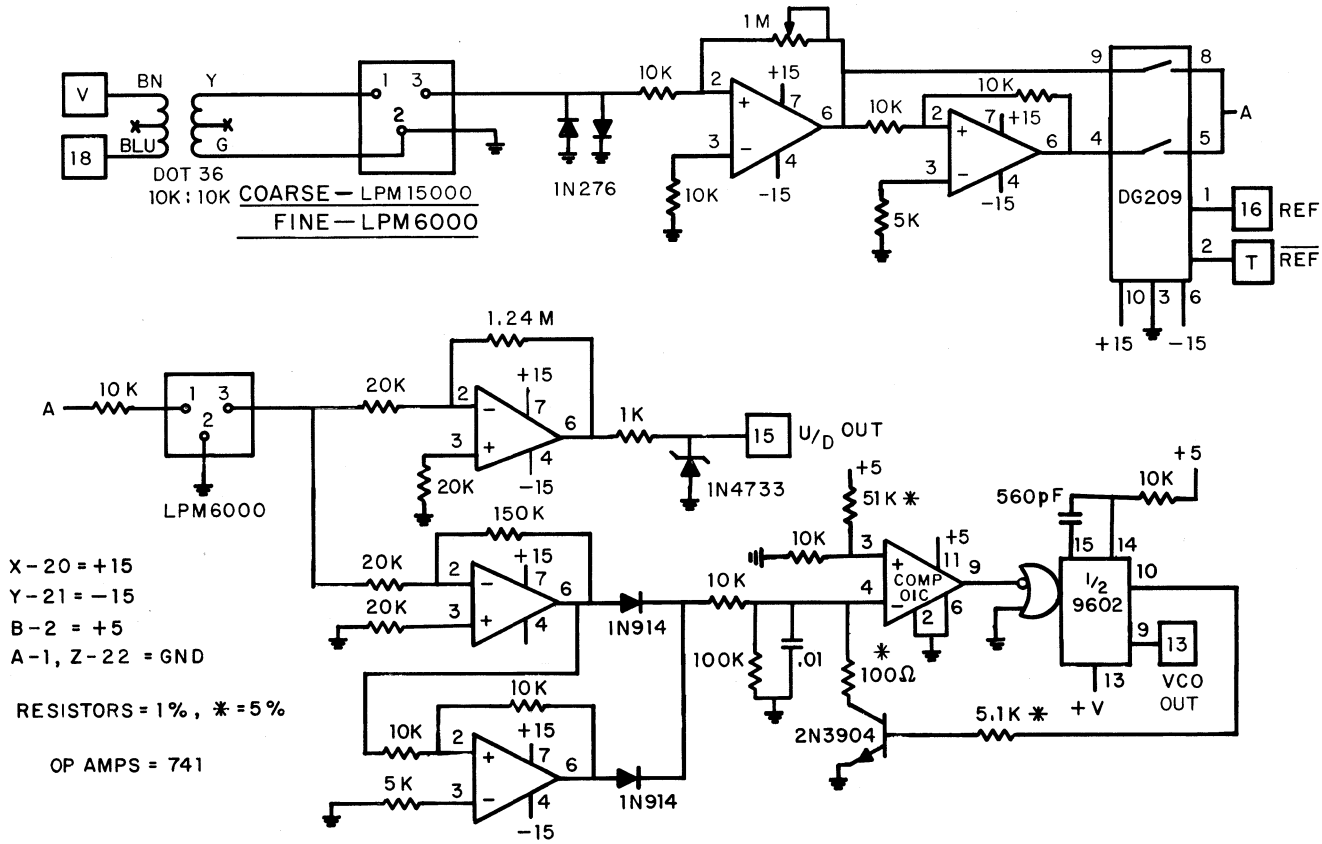
The converter system crystal time base is in the upper left corner. The reference counter string which drives the synchronous detector (card 28) is along the top.

The synchronizing (reset) logic is in the middle left side of the drawing. The VCO input logic is in the lower left which drives the sin and cos generator counters in the middle and lower middle of the schematic. The counters control the sin and cos inductosyn winding drivers in the lower right corner. Calibration circuits comprising two balance pots are mounted in the chassis behind the card sockets. The binary output is generated by the up/down counters in the middle right side of the schematic which count incrementally and synchronously with the sin and cos counters.

Position resolution is adjusted by changing the straps on a programmable plug located in slot "C" on the digital card #27.

The basic principle of operation is as follows: Proportional sin and cos signals are generated by the digital counting logic of card #27 which drive the rotary inductosyn in a reverse (non-conventional) direction. A single output from the inductosyn rotor is filtered, amplified, synchronously detected, filtered, and amplified providing error magnitude and direction signals which control the above-mentioned digital counting logic, resulting in a negative feedback loop circuit. A VCO with it's "dead zone" thresholds operates from the magnitude signal to "speed up" the converter counting logic during position slewing. Also, an up/down counter operates incrementally from these error signals via control logic providing the 12-bit position output data for "outside world" utilization circuits.

Card 28: The principles of the analog card #28 are discussed under card #27. The schematic shows the input port (upper left) for the inductosyn rotor signal. The transformer provides common mode noise rejection. Along the top,

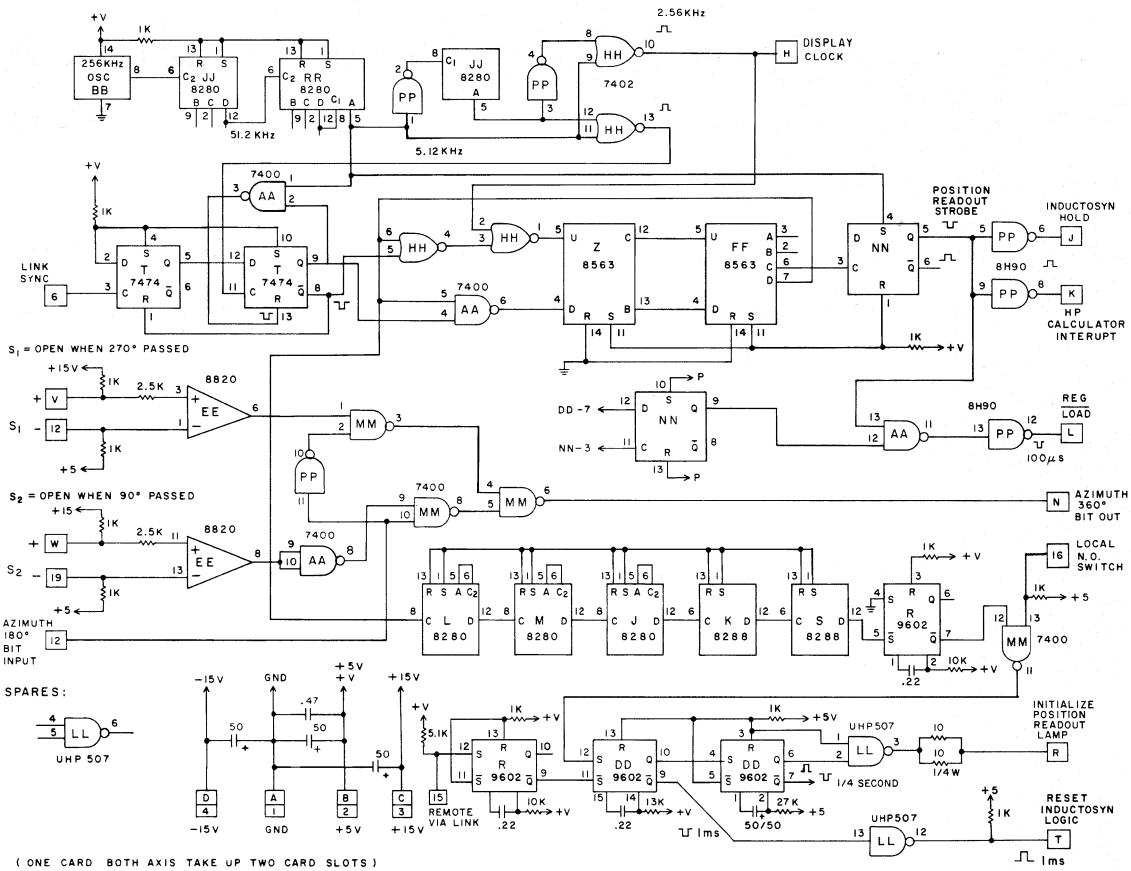


45' POSITION READOUT, RESOLVER TO DIGITAL COMPUTER CARD No. 28
ANALOG CIRCUITS / SYNC. DET. / ERROR AMP. / VCO

the filter and amplifier string drive the synchronous detector (upper right) which is filtered (lower left) and sliced, providing the up/down output pin 7 (middle drawing). The VCO threshold and amplifier circuits (lower middle) and VCO (lower right) provide a frequency output aiding in converting a rapidly changing position input to the inductosyn.

A complete position readout conversion system for one axis requires two digital logic cards #27 and one analog card #28.

Card 29: The DPCAR system timing generator and "extra" logic card #29 is drawn below.



DIGITAL POSITION COMMAND & CONTROL
SYSTEM TIMING GENERATOR / AZIMUTH MSB SYNTHESIZER CARD NO. 29 - SLOT NO. 12

The system time base (upper left corner) drives the timing generator string (top) which provides the display clock (pin H) to the front panel mounted digital displays. Also the "assured" readout system strobe logic (upper middle of drawing)

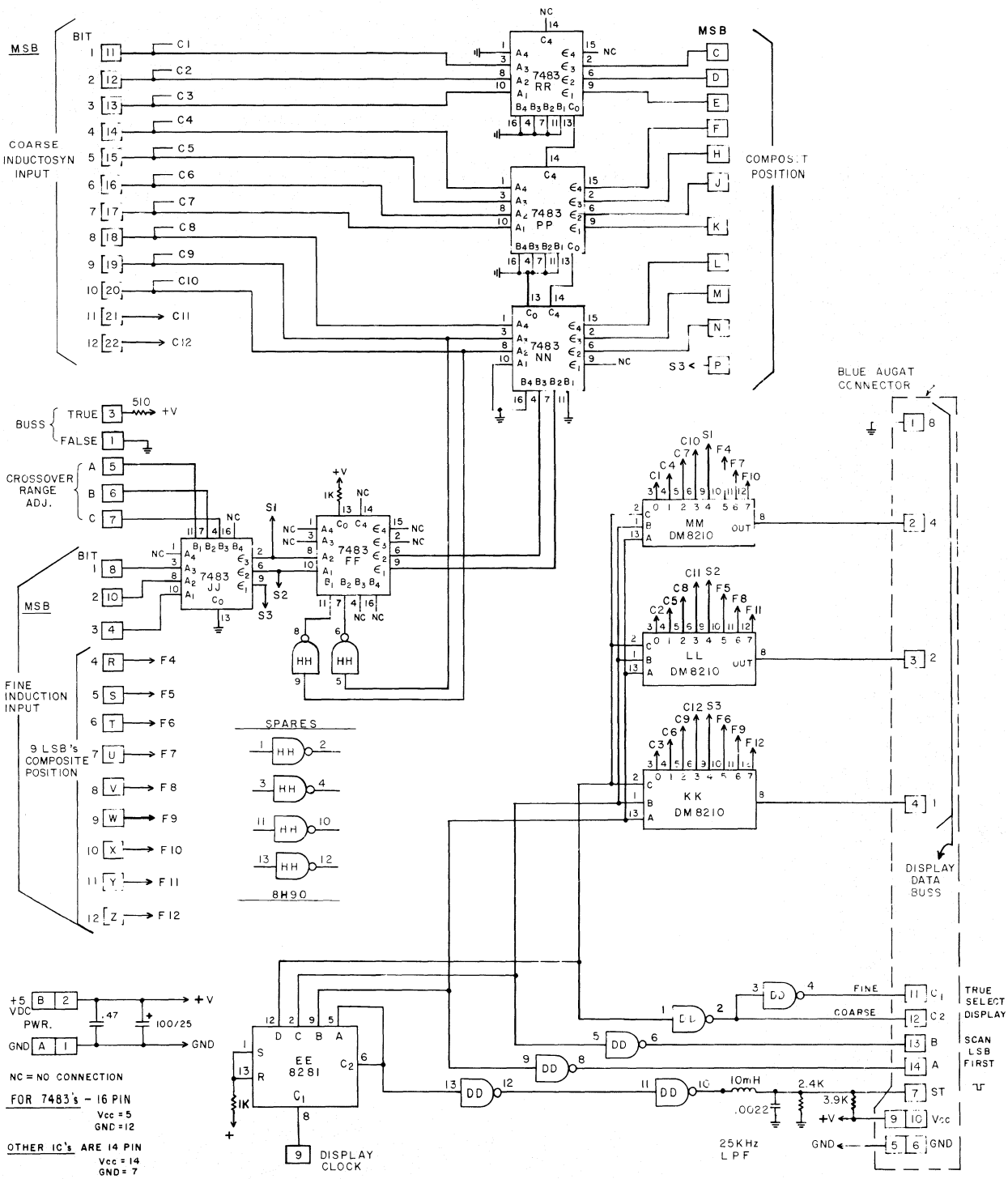
is synchronized to the data link which is synchronized to the control building sidereal clock. Pin 6 is the link sink input to the assured strobe which operates at 10 Hz with output at pin J. Also an interrupt signal to the "stand alone" calculator signals it when position data is valid. Pin L strobes the position readout data register located on card #31.

The telescope azimuth axis travels through a position range greater than 360° of travel and therefore requires an indicator bit to signal when the telescope has passed 360° of travel. The bit is "synthesized" synchronously with the position encoder 180° bit by means of two micro rocker switches mounted on the telescope pedestal. The logic associated with the 360° bit is in the left middle of the drawing with the output at pin N.

A divider chain providing a reset (initialize signal to the inductosyn system) every 10 minutes is in the lower middle of the drawing with an output at pin "R-7", which is "ORed" with the local yellow "initialize" switch on the front panel with signal input at pin 16.

The logic in the lower middle of the schematic receives the "computer update error signal" from the data link and updates the position readout via the "one shots" and driver circuits in the lower digit of the drawing.

Card 30: The electronics in card 30 provide automatic crossover correction for the "coarse" and "fine" functions of the two speed position readout system, thus providing a single composite montonic position output. As shown in schematic #30, the crossover logic comprises binary adders at the top of the drawing which add the three most signficant bits of the "fine" data to the "coarse" position data.



DIGITAL POSITION CONTROL & READOUT

COARSE/FINE DISPLAYS & CROSSOVER CONTROL CARD NO. 30

The adder chip "FF" subtracts the two least significant bits of "coarse" data from the two most significant bits of "fine" data. The net result is that any variation due to relative error between the coarse and fine speed resolver is cancelled. Adder chip "JJ" calibrates the crossover circuits to the most optimum range of operation by adding an offset (selected by the crossover adjust switch) to the "fine" position data which zero's the "fine" resolver to the "coarse" resolver.

The circuits in the lower right corner of the drawing provide multiplexed character serial data to the "coarse" and "fine" digital displays on the front panel.

TABLE I

CROSSOVER VALUES TO ADD TO C TO FORCE = TO F = 200 CTS COMPOSITE

0.5 = 1000 CTS fine or (2 CTS) coarse on the respective display.
(No odd CTS on coarse.)

Optimum Range Chosen

$C_9C_{10} - F_1F_2$ ERROR →	-3.5	-2.5	-1.5	-0.5	+0.5	+1.5	+2.5	+3.5
$F_1F_2 = C_9C_{10}$ DIFF ↓								
+3	+3	+3			-1	-1		
+2		+2	+2			-2	-2	
+1			+1	+1			-3	-3
0	+4			0	0			-4
-1	+3	+3			-1	-1		
-2		+2	+2			-2	-2	
-3			+1	+1			-3	-3
-4	+4			0	0			-4
-5	+3	+3			-1	-1		
-6		+2	+2			-2	-2	
-7			+1	+1			-3	-3

1 Period of Fine Equivalent

8000 CTS Fine (octal)
1000 CTS Composite (octal)
10)$_8$ Coarse

(Relative) Counts

	Fine	Coarse
$F_1 = C_9$	4000	- 10
$F_2 = C_{10}$	2000	- 4
$F_3 = C_{11}$	1000	- 2

DFN Display

Fine = Fine + Crossover
1 Crossover CT =
1000 CTS of Fine
= 200 CTS of Composite

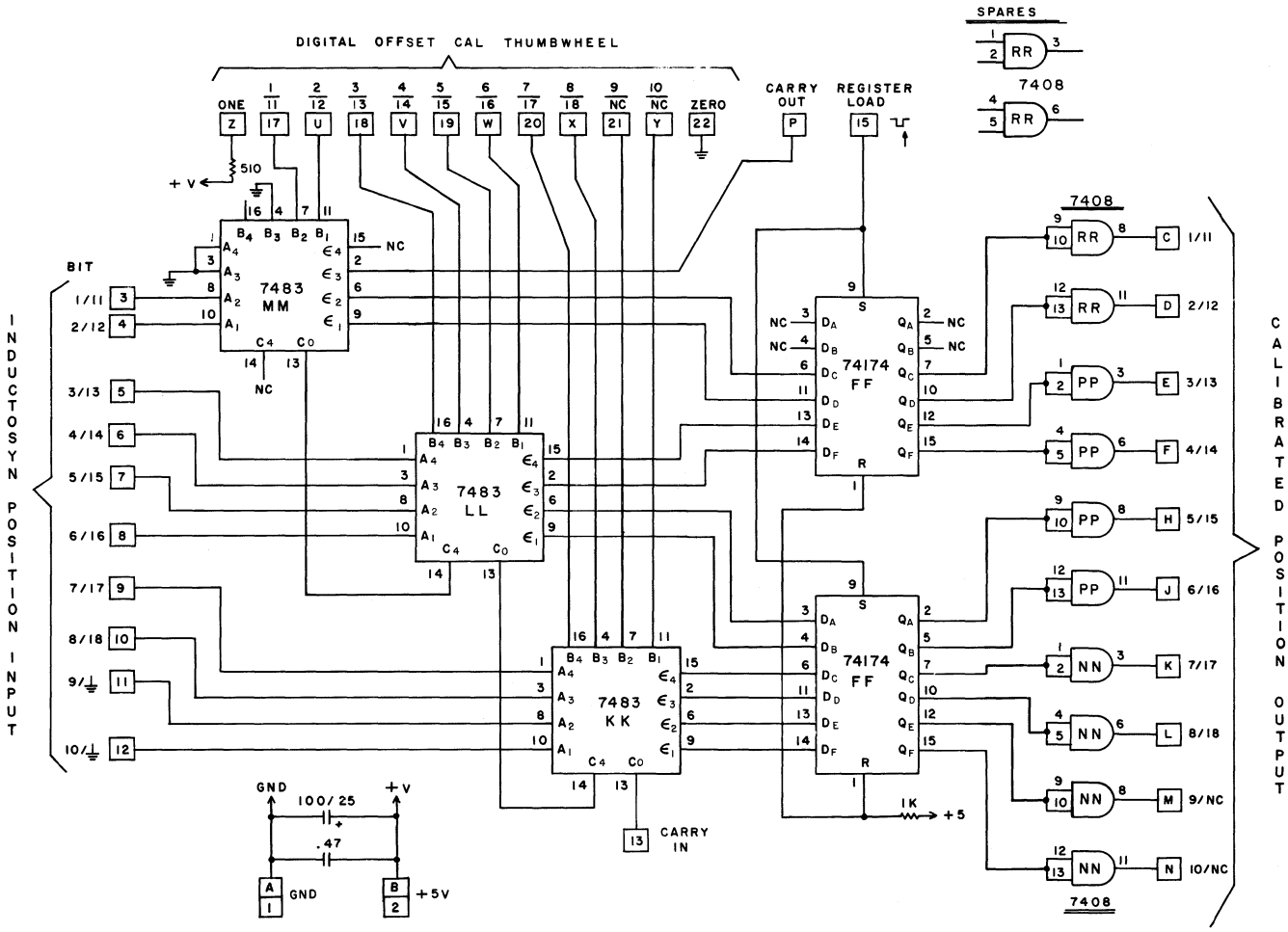
Coarse = Coarse

[Composite = Coarse + (Fine + Crossover - Coarse) + Coarse]

VALUES BELOW AND TO RIGHT OF DOTTED LINE ARE REDUNDANT.

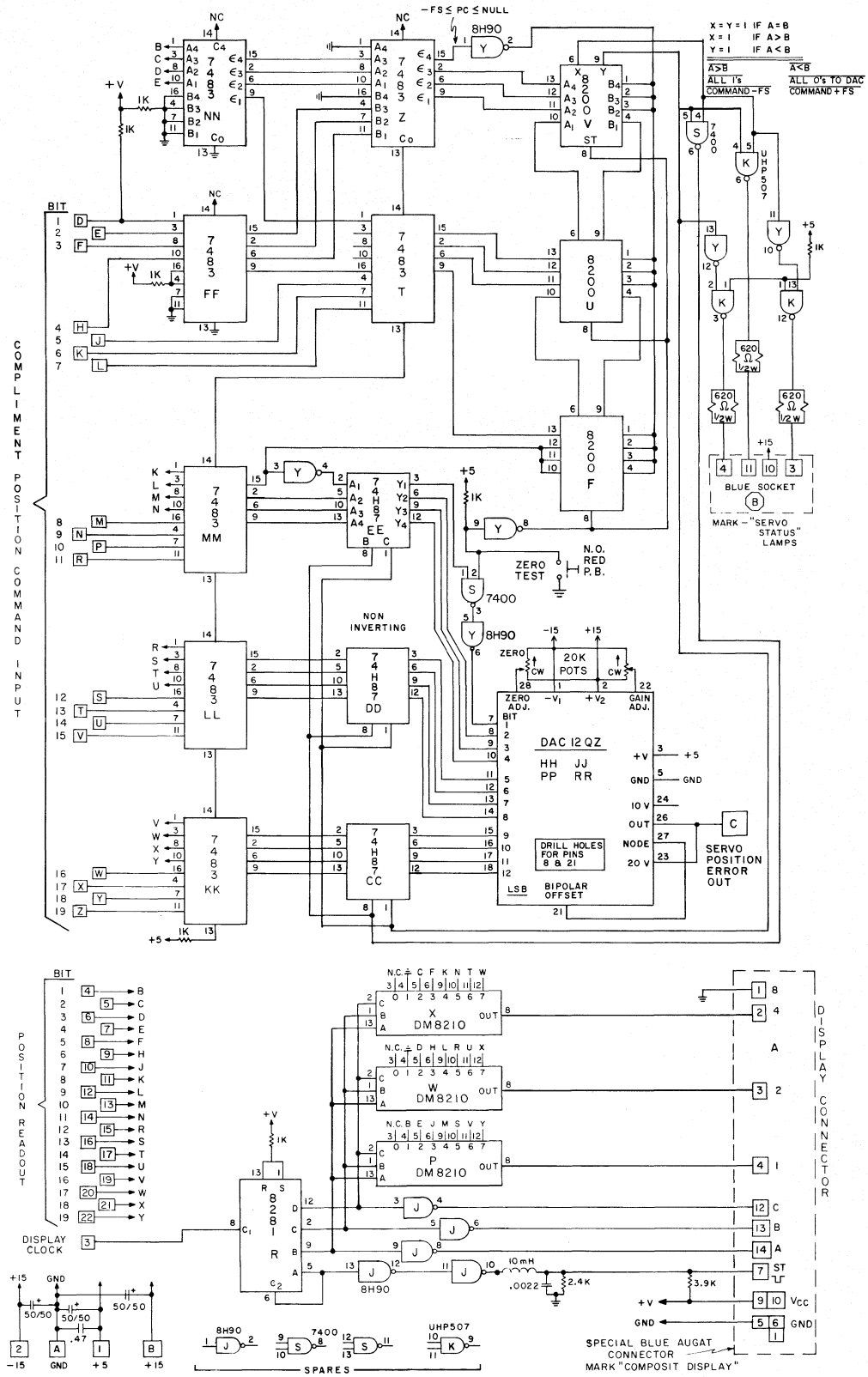
To adjust the crossover control, move telescope until coarse readout is changing from XX76 → XX00 and adjust crossover control for the nearest fine indication of 2400. The crossover control causes an increment of 1000 counts of fine for each increment of the crossover switch. Adjustment of the crossover may alter the digital offset cal of the encoders. This should be rechecked.

Card 31: The position readout electronic zeroing circuits and register circuits are shown in schematic #31.



DIGITAL OFFSET CAL / OUTPUT REGISTER BUFFER CARD NO. 31
45' DIGITAL POSITION CONTROL & READOUT

Two cards are required for each axis which provide calibrated position data. The "digital offset cal" thumbwheel value is added to the uncalibrated composite readout data from card #30 by adders KK, LL, and MM and latched into registers EE and FF for utilization by the digital servo nulling circuits of card #32.

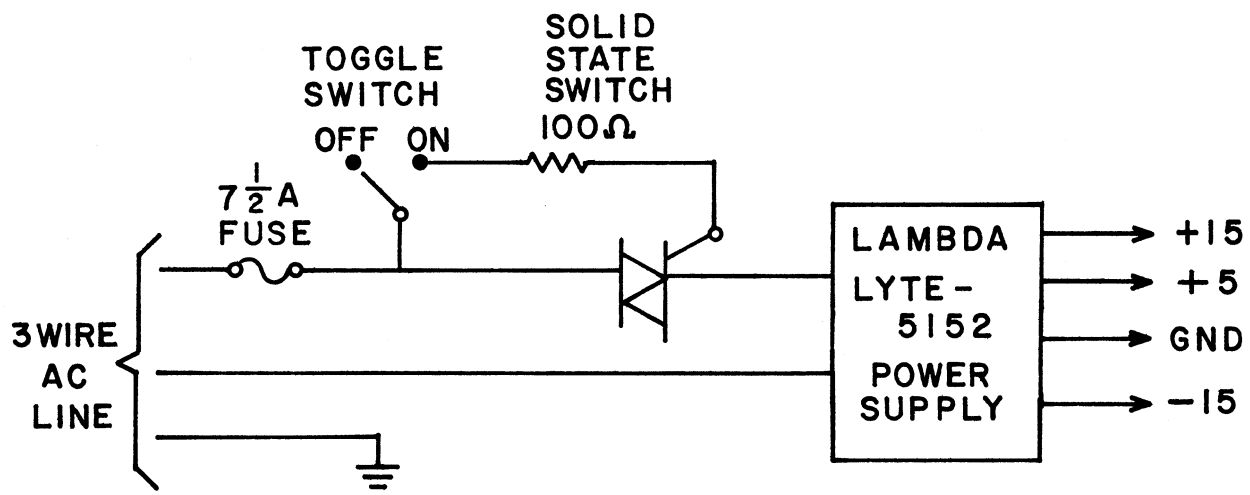


COMPOSITE DISPLAY AND SERVO ERROR CONTROL CARD 32

Card 32: Card 32 is a digital subtractor circuit which provides high gain, thus limiting the output providing a linear output via a D/A converter (DAC 12 QZ) over a narrow range of difference between the position command and position readout inputs.

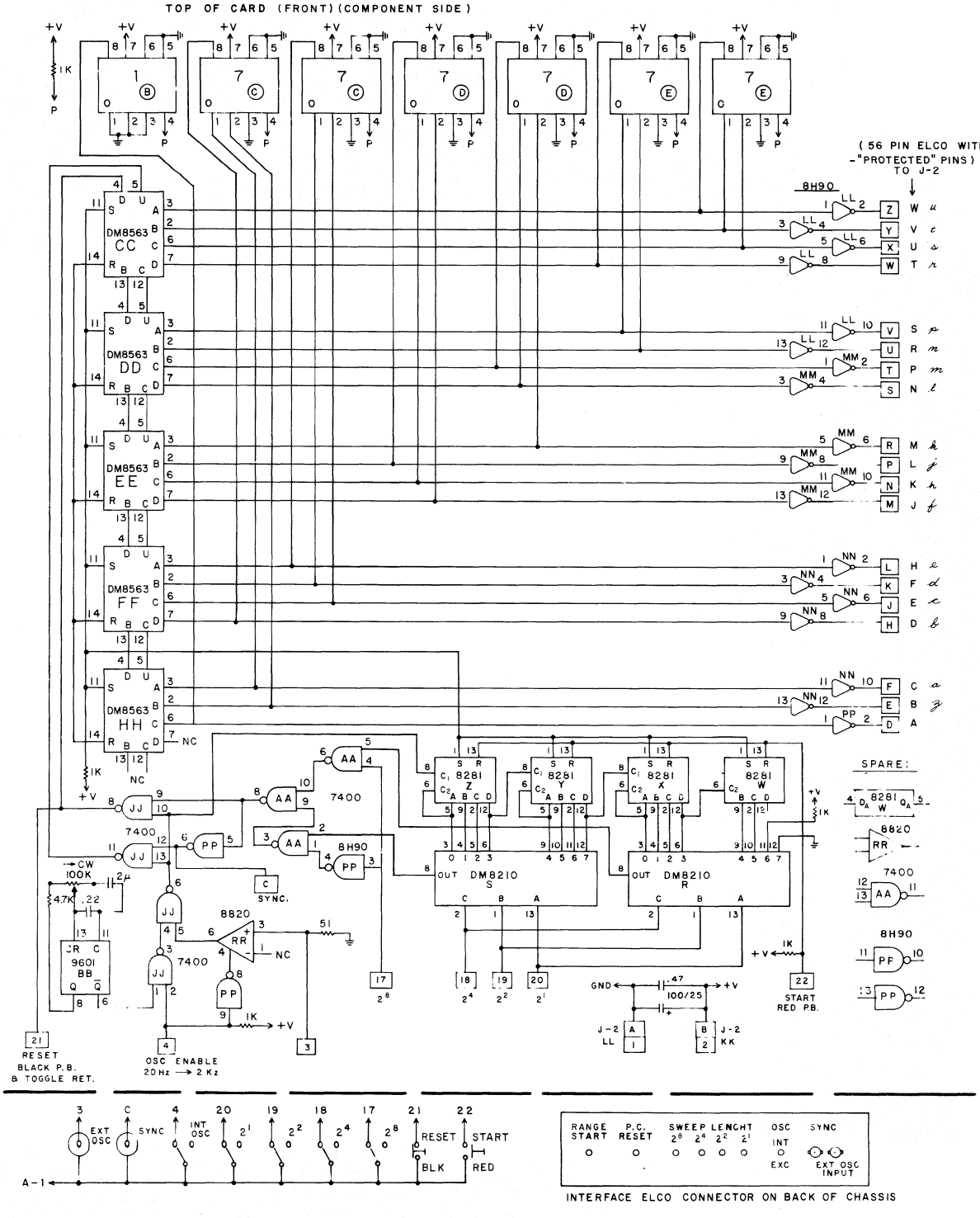
Also, circuits on the card (bottom of drawing) provide multiplexed octal data to the composite displays on the front panel. The circuit at the middle right controls the servo status indicators.

The Power Control Circuit: The power supplies used in this project are the switching regulator type which employ a full wave rectifier bridge directly across the primary power line. The bridge feeds a large capacitor such that under certain conditions when the power switch is turned on the contacts stick (weld), thus rendering the power switch ineffective. The power control circuit eliminates the problem since the triac is able to withstand the "inrush" current.



POWER CONTROL CIRCUIT

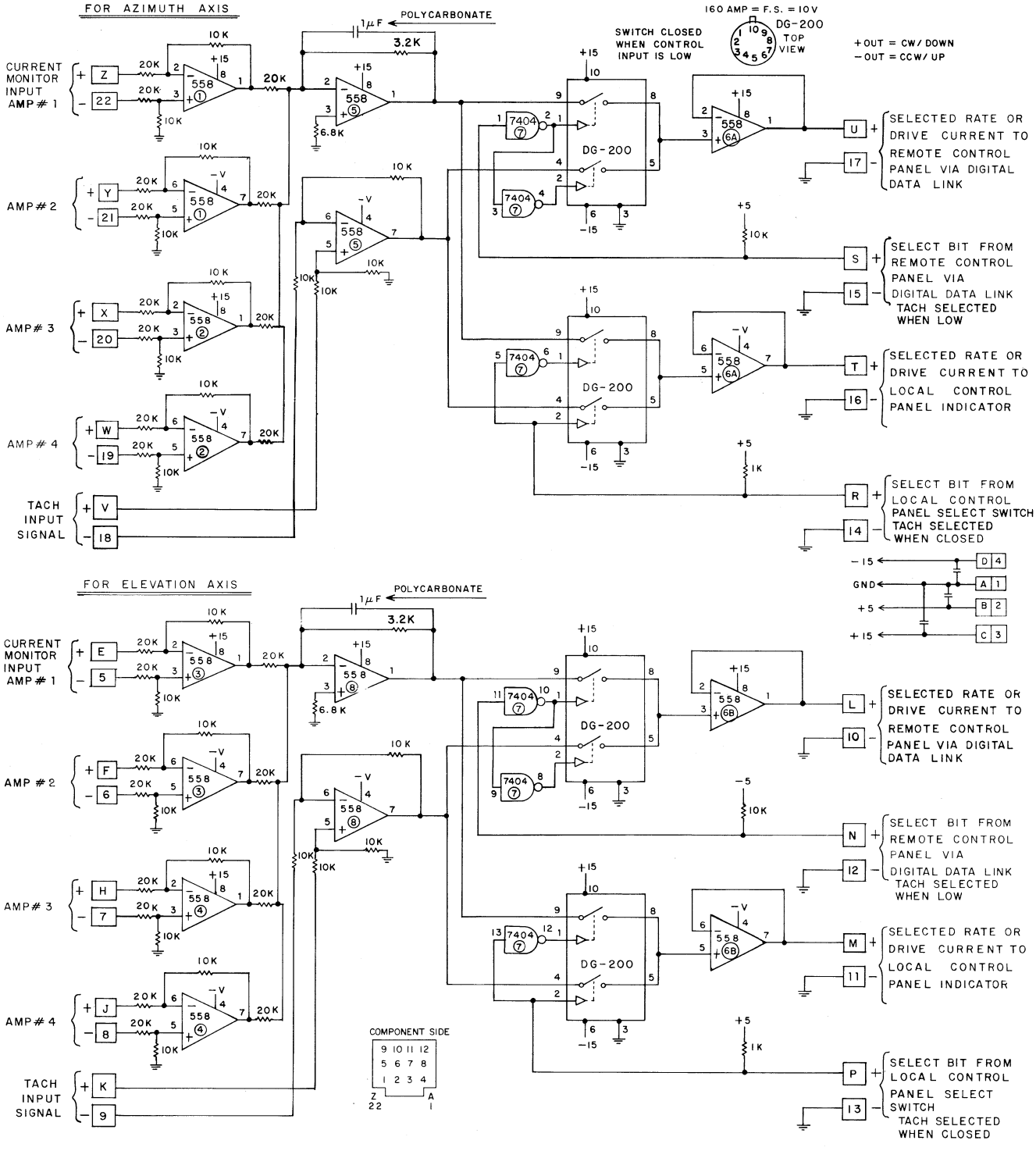
A schematic of a test fixture which generates digital position command functions for testing the servo is shown. The test set is connected to J-2 on the DPCAR via one of the short Elco cables used in the system.



45' POSITION SERVO/READOUT TEST FIXTURE

45-ft Drive Motor Current Monitor and Display System:

Circuits were added to allow the servo motor drive effort to be monitored. The circuit schematics are presented below.



45 Ft. DRIVE MOTOR CURRENT MONITOR & DISPLAY ADDITIONS R. HALLMAN 12/73

- 21a -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 27

Slot 2

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	
D			4	
E			5	
F			6	
H	NC		7	NC
J	S14-21	2^0	8	S14-20 2^1
K	S14-19	2^2	9	S14-18 2^3
L	S14-17	2^4	10	S14-16 2^5
M	S14-15	2^6	11	S14-14 2^7
N	S14-13	2^8	12	S14-12 2^9
P	S14-11	2^{10}	13	NC
R	NC		14	S3-13
S	S5-S		15	S5-15
T	S3-15		16	NC
U	S3-T		17	S3-16
V	NC		18	NC
W	NC		19	S5-19
X	NC		20	NC
Y	S2-21		21	S2-2
Z	S3-22		22	S2-1 - Buss pin 22 thru slots 2, 3 & 4 and 7, 8 & 9.

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 21b -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 28

Slot 3

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C	NC		3	NC
D			4	
E	NC		5	NC
F	S5-U		6	S5-17
H	NC		7	S5-T
J	NC		8	NC
K	NC		9	NC
L	NC		10	NC
M	NC		11	NC
N	NC		12	S5-14
P	NC		13	
R	NC		14	NC
S	NC		15	
T			16	
U	NC		17	NC
V			18	
W	NC		19	NC
X	+15 V DC (power supply)		20	+15
Y	-15 V DC (power supply)		21	-15
Z	S5-22		22	S3-Z

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 21c -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 27

Slot 5

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	
D			4	
E			5	
F			6	
H	NC		7	NC
J	S14-Z		8	S14-Y
K	S14-X		9	S14-W
L	S14-V		10	S14-U
M	S14-T		11	S14-S
N	S14-R		12	S14-4
P	S14-10		13	S14-8
R	NC		14	
S	S7-5		15	S7-15
T			16	NC
U			17	
V	NC		18	NC
W	S5-19		19	
X	S5-Y		20	NC
Y	S5-21		21	S2-Y
Z	S5-22		22	S2-22

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 21d -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 27

Slot 7

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	
D			4	
E			5	
F			6	
H	NC		7	NC
J	S19-21		8	S19-20
K	S19-19		9	S19-18
L	S19-17		10	S19-16
M	S19-15		11	S19-14
N	S19-13		12	S19-12
P	S19-11		13	NC
R	NC		14	S8-13
S	S10-S		15	S10-15
T	S8-15		16	NC
U	S8-T		17	S8-16
V	NC		18	NC
W	S7-19		19	S10-19
X	NC		20	NC
Y	S7-21		21	S7-2
Z	S7-22		22	S7-1

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 22a -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 28

Slot 8 —

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C	NC		3	NC
D			4	
E	NC		5	NC
F	S10-U		6	S10-17
H	NC		7	S10-T
J	NC		8	NC
K	NC		9	NC
L	NC		10	NC
M	NC		11	NC
N	NC		12	S10-14
P	NC		13	
R	NC		14	NC
S	NC		15	
T			16	
U			17	NC
V			18	
W			19	
X	+15		20	+15 S3-X
Y	-15		21	-15 S3-Y
Z	S10-22		22	S8-Z

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 22b -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 27

Slot 10 —

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	
D			4	
E			5	
F			6	
H	NC		7	NC
J	S19-Z		8	S19-Y
K	S19-X		9	S19-W
L	S19-V		10	S19-U
M	S19-T		11	S19-S
N	S19-R		12	S19-4
P	S19-10		13	S19-8
R	NC		14	
S	S12-T		15	S12-J
T			16	NC
U			17	
V	NC		18	NC
W	S10-19		19	
X	S10-Y		20	NC
Y	S10-21		21	S7-Y
Z	S10-22		22	

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 22c -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 29

Slot 12 —

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C	S12-3		3	S8-X +15
D	S12-4		4	S8-Y -15
E	NC		5	NC
F	NC		6	
H			7	NC
J			8	NC
K			9	NC
L			10	NC
M	NC		11	NC
N			12	
P	NC		13	NC
R			14	NC
S	NC		15	
T			16	
U	NC		17	NC
V			18	
W			19	
X	NC		20	NC
Y	NC		21	NC
Z	NC		22	NC

S12-B
Br & Yel

Initialize position read-out lamp in orange button on front panel.

S12-1
Red

Or

3

6

Initialize Position Readout Button

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 22d -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 30

Slot 14 —

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	F Bk
D			4	B Yel
E			5	E Br
F			6	D Red
H			7	C Or
J			8	
K			9	S12-H
L			10	
M			11	
N			12	
P			13	
R			14	
S			15	
T			16	
U			17	
V			18	
W			19	
X			20	
Y	NC		21	
Z	NC		22	S14-1

MSB

20 Bit Composite Position Readout Without Digital Offset Cal

LSB

Elevation Cross-Over Switch Pin

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 23a -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 31

Slot 15 —

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	S14-C
D			4	S14-D
E			5	S14-E
F			6	S14-F
H			7	S14-H
J			8	S14-J
K			9	S14-K
L			10	S14-L
M			11	S14-M
N			12	S14-N
P	NC		13	S16-P
R	NC		14	NC
S	NC		15	S12-L
T	NC		16	NC
U	8^6 - D		17	8^6 - C
V	8^5 - C		18	8^6 - E
W	8^5 - E		19	8^5 - D
X	8^4 - D		20	8^4 - C
Y	8^3 - C		21	8^4 - E
Z	All Pin E Bussed		22	All Pin F Bussed

All below line to digital off-set cal switch elevation.

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 23b -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 31

Slot 16 —

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	S14-P
D			4	S14-R
E			5	S14-S
F			6	S14-T
H			7	S14-U
J			8	S14-V
K			9	S14-W
L			10	S14-X
M			11	S16-1
N			12	S16-11
P			13	S16-1
R	NC		14	NC
S	NC		15	S15-15
T	NC		16	NC
U	8^3 - E		17	8^3 - D
V	8^2 - D		18	8^2 - C
W	8^1 - C		19	8^2 - E
X	8^1 - E		20	8^1 - D
Y	S16-21		21	S16-1
Z	NC		22	NC

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 23c -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 32

Slot 17 —

	From	To	From	To
A	Gnd B-1 Shell		1	5 V - Remove power buss Pins A, B, 1, 2
B	S12-C +15 V	Elevation Position Error Analog Out	2	S12-D -15 V
C	B-1 - Center Pin		3	S14-9
D	NC		4	S17-A
E			5	S15-C
F			6	S15-D
H			7	S15-E
J			8	S15-F
K			9	S15-H
L			10	S15-J
M		Elevation Compliment	11	S15-K
N		Posi-tion	12	S15-L
P		Position Command Input	13	S15-M
R		Read-out	14	S15-N
S			15	S16-C
T			16	S16-D
U			17	S16-E
V			18	S16-F
W			19	S16-H
X			20	S16-J
Y			21	S16-K
Z			22	S16-L

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 23d -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 30

Slot 19 —

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	Azimuth Cross-Over Switch Pin F
D			4	B
E			5	E
F			6	D
H			7	C
J			8	NC
K			9	S17-3
L			10	NC
M			11	
N			12	
P			13	
R			14	
S			15	
T			16	
U			17	
V			18	
W			19	
X			20	
Y	NC		21	
Z	NC		22	S19-1

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 24a -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 31

Slot 20

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	S19-C
D			4	S19-D
E			5	S19-E
F			6	S19-F
H			7	S19-H
J			8	S19-J
K			9	S19-K
L			10	S19-L
M			11	S19-M
N			12	S19-N
P	NC		13	S21-P
R	NC		14	NC
S	NC		15	S21-15
T	NC		16	NC
U	8^6 - D	Azimuth	17	8^6 - C
V	8^5 - C	Position	18	8^6 - E
W	8^5 - E	Digital	19	8^5 - D
X	8^4 - D	Offset	20	8^4 - C
Y	8^3 - C	Cal	21	8^4 - E
Z	All pin E bussed.		22	All pin F bussed.

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 24b -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 31

Slot 21

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	S19-P
D			4	S19-R
E			5	S19-S
F			6	S19-T
H			7	S19-U
J			8	S19-V
K			9	S19-W
L			10	S19-X
M			11	S21-1
N			12	S21-11
P			13	S21-1
R	NC		14	NC
S	NC		15	S16-15
T	NC		16	NC
U	8^3 - E		17	8^3 - D
V	8^2 - D		18	8^2 - C
W	8^1 - C		19	8^2 - E
X	8^1 - E		20	8^1 - D
Y	S21-21		21	S21-1
Z	NC		22	NC

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 24c -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 32

Slot 22

	From	To	From	To
A	Gnd B-2 Shell		1	+5 Remove power
B	S17-B		2	S17-2 buss pin A B 1 2
C	B-2 - Center Pin		3	S19-9
D			4	S12-N
E			5	N20-C
F			6	S20-D
H			7	S20-E
J			8	S20-F
K			9	S20-H
L			10	S20-J
M			11	S20-K
N			12	S20-L
P			13	S20-M
R			14	S20-N
S			15	S21-C
T			16	S21-D
U			17	S21-E
V			18	S21-F
W			19	S21-H
X			20	S21-J
Y			21	S21-K
Z			22	S21-L

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 24d -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 24

Slot 24

	From	To	From	To
A	Gnd		1	Gnd
B	S21-J		2	+5
C			3	S15-C
D	S20-N		4	S15-K
E	S20-F		5	S15-F
F	S20-C		6	S21-E
H	S20-K		7	S16-E
J	S15-N		8	S15-L
K	S21-K		9	S16-J
L	S16-C		10	S21-C
M	S16-F		11	S16-K
N	S25-C		12	S15-H
P	S15-D		13	S25-H
R			14	S21-F
S	S20-D		15	S20-H
T	S20-L		16	S16-L
U	S16-D		17	S15-M
V	S15-J		18	S16-H
W	S15-E		19	S21-L
X	S21-D		20	S21-H
Y	S20-E		21	
Z	S20-J		22	S20-M

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 25a -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 25

Slot 25 —

	From	To	From	To
A	+5		1	Gnd
B			2	S26-3
C			3	
D			4	
E			5	S22-D
F			6	S12-K
H			7	S26-D
J	S26-C		8	
K			9	S26-T
L	S26-M		10	S26-H
M			11	
N			12	
P			13	S26-R
R	S26-N		14	S26-S
S	S26-L		15	S26-P
T	S26-K		16	
U	S22-L		17	S22-T
V	S22-K		18	S22-S
W	S22-J		19	S22-R
X	S22-H		20	S22-P
Y	S22-F		21	S22-N
Z	S22-E		22	S22-M

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 25b -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 26

Slot 26 —

	From	To	From	To
A	Gnd		1	Gnd
B	+5		2	+5
C			3	
D			4	
E	NC		5	S17-Z
F	NC		6	S17-Y
H			7	S17-X
J			8	S17-W
K			9	S17-V
L			10	S17-U
M			11	S17-T
N			12	S17-S
P			13	S17-R
R			14	S17-P
S			15	S17-N
T			16	S17-M
U	S22-Z		17	S17-L
V	S22-Y		18	S17-K
W	S22-X		19	S17-J
X	S22-W		20	S17-H
Y	S22-V		21	S17-F
Z	S22-U		22	S17-E

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 26a -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 24

Slot 24 —

	From	To	From	To
	A	Gnd	1	Gnd
	B	A16	2	VCC
	C	J3-Z	3	E1
	D	A10	4	E7
	E	A4	5	E4
	F	A1	6	A13
	H	A7	7	E13
	J	E10	8	E8
	K	A17	9	E16
	L	E11	10	A11
	M	E14	11	E17
	N	S2-C	12	E5
	P	E2	13	S2-H
	R	J3-Y	14	A14
	S	A2	15	A5
	T	A8	16	E18
	U	E12	17	E9
	V	E6	18	E15
	W	E3	19	A18
	X	A12	20	A15
	Y	A3	21	J3-X
	Z	A6	22	A9

A1 = M.S.B. and A18 = L.S.B. of the Azimuth Position Readout.

E1 = M.S.B. and E18 = L.S.B. of the Elevation Position Readout

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 26b -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 25

Slot 25 —

	From	To	From	To
	A	V_{CC}	1	Gnd
	B	J3-B	2	S26-3
	C	S1-N	3	J3-A
	D	J3-F	4	J3-E
	E	J3-H	5	A0
	F	J3-C	6	20 Hz Control Signal Input
	H	S1-13	7	S3-D
	J	S3-C	8	J3-d
	K	J3-b	9	S3-T
	L	S3-M	10	S3-H
	M	J3-S	11	J3-R
	N	J3-P	12	J3-N
	P	J3-M	13	S3-R
	R	S3-N	14	S3-S
	S	S3-L	15	S3-P
	T	J3-L, S3-K	16	J3-T
	U	A6	17	A12
	V	A5	18	A11
	W	A4	19	A10
	X	A3	20	A9
	Y	A2	21	A8
	Z	A1	22	A7

A0 = M.S.B. of the Azimuth Position Command

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 26c -

CARD SLOT WIRING LIST

FOR: BOX DPCAR CARD 26

Slot 26 —

	From	To	From	To
	A	Gnd	1	Gnd
	B	V_{CC}	2	V_{CC}
	C	S2-J	3	S25-2
	D	S2-7	4	Calculator Inhibit
	E	NC	5	E18
	F	NC	6	E17
	H	S2-10	7	E16
	J	NC	8	E15
	K	S2-T, J3-L	9	E14
	L	S2-S	10	E13
	M	*S2-L	11	E12
	N	S2-R	12	E11
	P	S2-15	13	E10
	R	S2-13	14	E9
	S	S2-14	15	E8
	T	S2-9	16	E7
	U	A18	17	E6
	V	A17	18	E5
	W	A16	19	E4
	X	A15	20	E3
	Y	A14	21	E2
	Z	A13	22	E1

A18 is the L.S.B. of the Azimuth Position Command

E1 is the M.S.B. of the Elevation Position Command

Abbreviations:

Ex: S 25-22
Slot 25, Pin 22

J9-MM
Elco J9, Pin MM

BNC Connectors: B1, B2, B3, etc.
Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B, -22, etc.

- 27a -

ELCO CONNECTOR LIST FOR BOX/RACK/DRAWER DPCAR

CONNECTOR: DESIGNATION J-1 ; TYPE Elco ; 56 PINS

SMALL KEY _____, LARGE KEY _____; PANEL P CABLE E

Pin	To	Function	Pin	To	Function
A	S12-N	Az Pos Bit 1 MSB	u	S16-L	Elevation Position Bit 19 LSB
B	S20-C	Az Pos Bit 2	v	S16-A	Logic Common
C	S20-D	Az Pos Bit 3	w	S12-6	Link Sync
D	S20-E	Az Pos Bit 4	x	S12-1	Logic Common
E	S20-F	Az Pos Bit 5	y		
F	S20-H	Az Pos Bit 6	z		
H	S20-J	Az Pos Bit 7	AA		
J	S20-K	Az Pos Bit 8	BB		
K	S20-L	Az Pos Bit 9	CC		
L	S20-M	Az Pos Bit 10	DD		
M	S20-N	Az Pos Bit 11	EE	S22-C	Az Pos Error + Out
N	S21-C	Az Pos Bit 12	FF	S22-A	Az Pos Error - Out
P	S21-D	Az Pos Bit 13	HH	S17-C	El Pos Error + Out
R	S21-E	Az Pos Bit 14	JJ	S17-A	El Pos Error - Out
S	S21-F	Az Pos Bit 15	KK		
T	S21-H	Az Pos Bit 16	LL		
U	S21-J	Az Pos Bit 17	MM		
V	S21-K	Az Pos Bit 18	End 56 Pin NN		
W	S21-L	Az Pos Bit 19			
End 20 Pin → X	S21-A	Logic Common Gnd →			
Y	S15-A	El Pos Bit 1 MSB			
Z	S15-C	El Pos Bit 2			
AA a	S15-D	El Pos Bit 3			
BB b	S15-E	El Pos Bit 4			
CC c	S15-F	El Pos Bit 5			
DD d	S15-H	El Pos Bit 6			
EE e	S15-J	El Pos Bit 7			
FF f	S15-K	El Pos Bit 8			
HH h	S15-L	El Pos Bit 9			
JJ j	S15-M	El Pos Bit 10			
KK k	S15-N	El Pos Bit 11			
LL l	S16-C	El Pos Bit 12			
MM m	S16-D	El Pos Bit 13			
NN n	S16-E	El Pos Bit 14			
PP p	S16-F	El Pos Bit 15			
RR r	S16-H	El Pos Bit 16			
SS s	S16-J	El Pos Bit 17			
TT t	S16-K	El Pos Bit 18			
End 38 → Pin					

Abbreviations:
Ex: S25-22 Slot 25, Pin 22 | J9-MM Elco J9, Pin MM | Elco Connectors: J1, J2, J3, etc. Slot Connectors: S1, S2, S3, etc. Pin No.'s -3, -X, -B,

- 27b -

ELCO CONNECTOR LIST FOR BOX/RACK/DRAWER DPCAR

CONNECTOR: DESIGNATION J-2 ; TYPE Elco ; 56 PINS

SMALL KEY _____, LARGE KEY _____; PANEL E CABLE P

Pin	To	Function	Pin	To	Function
A	S22-D	Az Pos Com Bit 1(MSB)	u	S17-Z	El Pos Com Bit 19 (LSB)
B	E	2	v	S17-Z	Logic Common Gnd
C	F	3	w	S26-4	HP/116 Control Select
D	H	4	x	S26-1	Logic Common Gnd
E	J	5	y	S12-15	Initialize P.R. Comp U/D Error
F	K	6	z	S12-1	Logic Common
H	L	7	AA		
J	M	8	BB		
K	N	9	CC		
L	P	10	DD		
M	R	11	EE		
N	S	12	FF		
P	T	13	HH		
R	U	14	JJ		
S	V	15	KK	→	+5 Volts
T	W	16	LL	→	Ground
U	X	17	MM		
V	Y	18	End 56 Pin NN		
End 20 Pin → W	S22-Z	19			
X	S22-A	Logic Common Gnd →			
Y	S17-D	El Pos Com Bit 1 (MSB)			
Z	E	2			
AA a	F	3			
BB b	H	4			
CC c	J	5			
DD d	K	6			
EE e	L	7			
FF f	M	8			
HH h	N	9			
JJ j	P	10			
KK k	R	11			
LL l	S	12			
MM m	T	13			
NN n	U	14			
PP p	V	15			
RR r	W	16			
SS s	X	17			
TT t	S17-Y	18			
End 38 → Pin					

Abbreviations:
Ex: S25-22 Slot 25, Pin 22 | J9-MM Elco J9, Pin MM | Elco Connectors: J1, J2, J3, etc. Slot Connectors: S1, S2, S3, etc. Pin No.'s -3, -X, -B,

- 27c -

ELCO CONNECTOR LIST FOR BOX/RACK/DRAWER DPCAR

CONNECTOR: DESIGNATION J-3 ; TYPE Elco ; 56 PINS

SMALL KEY _____, LARGE KEY _____; PANEL P CABLE E

Pin	To	Function	Pin	To	Function
A	S25-3	Encoder Output	u		
B	S25-B	Clock Pair	v		
C	S25-1	Gnd	w		
D	S25-1	Gnd	x		
E	S25-4	Position Command	y		
F	S25-D	Strobe Pair	z		
H	S25-E	Encoder Protect	AA		
J	S25-A	+5	BB		
K	S25-A	+5	CC		
L	T	Output Blk	DD		
M	P	Br	EE		
N	12	R	FF		
P	N	O	HH		
R	11	Y	JJ		
S	M	Grn	KK		
T	S25-16	Output Blue	LL		
U	S24-2	+5	MM		NC
V	S24-2	+5	End 56 Pin NN		NC
W	A	Gnd			
End 20 Pin → X	21	Input Blk			
Y	R	Input Br			
Z	C	Input R			
AA a	S24-A	Gnd			
BB b	S25-K	Counter 4			
CC c	S25-F	Counter 2			
DD d	S25-8	Counter 1			
EE e					
FF f					
HH h					
JJ j					
KK k					
LL l					
MM m					
NN n					
PP p					
RR r					
SS s					
TT t					
End 38 → Pin					

Abbreviations:
Ex: S25-22 Slot 25, Pin 22 | J9-MM Elco J9, Pin MM | Elco Connectors: J1, J2, J3, etc. Slot Connectors: S1, S2, S3, etc. Pin No.'s -3, -X, -B,

- 27d -

ELCO CONNECTOR LIST FOR BOX/RACK/DRAWER DPCAR

CONNECTOR: DESIGNATION J3 ; TYPE Elco ; 56 PINS

SMALL KEY _____, LARGE KEY _____; PANEL P CABLE E

Pin	To	Function	Pin	To	Function
A	1-H 5-3	Encoder Output	u		
B	1-N 5-B	Clock (twisted pr)	v		
C		Gnd	w		
D		Gnd	x		
E	1-16 5-4	Position Command	y		
F	1-V 5-D	Strobe (twisted pr)	z		
H	1-17 5-E	Encoder Protect	AA		
J		V_{CC}	BB		
K		V_{CC}	CC		
L	1-13 5-T	Output Blk	DD		
M	1-D 5-P	Lines Br	EE		
N	1-M 5-12	R	FF		
P	1-E 5-N	O	HH		
R	2-R 5-11	Y	JJ		
S	1-R 5-M	G	KK		
T	1-14 5-16	B	LL		
U		V_{CC}	MM		
V		V_{CC}	End 56 Pin NN		
W		Gnd			
End 20 Pin → X	2-K 4-21	Input Blk			
Y	2-L 4-R	Lines Br			
Z	2-Z 4-C	R			
AA a	24A	Gnd			
BB b	3-22 5-K	Counter '4'			
CC c	3-W 5-F	Lines '2'			
DD d	3-16 5-8	'1'			
EE e	25				
FF f		Cable wired			
HH h		through t			
JJ j		in twisted pairs			
KK k					
LL l					
MM m					
NN n					
PP p					
RR r					
SS s					
TT t					
End 38 → Pin					

Abbreviations:
Ex: S25-22 Slot 25, Pin 22 | J9-MM Elco J9, Pin MM | Elco Connectors: J1, J2, J3, etc. Slot Connectors: S1, S2, S3, etc. Pin No.'s -3, -X, -B,

- 28a -

ELCO CONNECTOR LIST FOR BOX/RACK/DRAWER DPCAR

CONNECTOR: DESIGNATION J-5 ; TYPE Elco ; 38 PINS

SMALL KEY _____, LARGE KEY _____ ; PANEL P CABLE E

Pin	To	Function	Pin	To	Function
A	S2-3	Coarse Sine +	u		
B	S2-4	Coarse Sine -	v		
C	S2-A	Shield	w		
D	S2-6	Coarse Cosine +	x		
E	S2-5	Coarse Cosine -	y		
F	S2-A	Shield	z		
H	S3-V	Coarse Error +	AA		
J	S3-18	Coarse Error -	BB		
K	S3-22	Shield	CC		
L	S3-4	Fine Error -	DD		
M	S3-D	Fine Error +	EE		
N	S3-A	Shield	FF		
P	S5-5	Fine Cosine -	HH		
R	S5-6	Fine Cosine +	JJ		
S	S5-A	Shield	KK		
T	S5-4	Fine Sine -	LL		
U	S5-3	Fine Sine +	MM		
V	S5-A	Shield	End 56 Pin → NN		
W	S3-A				
End 20 Pin → X	S3-A				
Y	S3-A				
Z	S3-X	+15 Volts			
AA a	S3-A				
BB b	S3-A				
CC c		NC			
DD d					
EE e					
FF f					
HH h					
JJ j					
KK k					
LL l					
MM m					
NN n					
PP p					
RR r					
SS s					
TT t		NC			
End 38 → Pin					

Thru balance adjust board mounted behind card slots nos. 2-5.

See balance board schematic.

Abbreviations:
Ex: S25-22 | J9-MM
Slot 25, Pin 22 | Elco J9, Pin MM

Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B,

- 28b -

ELCO CONNECTOR LIST FOR BOX/RACK/DRAWER DPCAR Position Azimuth

CONNECTOR: DESIGNATION J-6 ; TYPE Elco ; 38 PINS

SMALL KEY _____, LARGE KEY _____ ; PANEL P CABLE E

Pin	To	Function	Pin	To	Function
A	S7-3	Coarse Sine +	u		
B	S7-4	Coarse Sine -	v		
C	S7-A	Shield	w		
D	S7-6	Coarse Cosine +	x		
E	S7-5	Coarse Cosine -	y		
F	S7-A	Shield	z		
H	S8-V	Coarse Error +	AA		
J	S8-18	Coarse Error -	BB		
K	S8-22	Shield	CC		
L	S7-4	Fine Error -	DD		
M	S8-D	Fine Error +	EE		
N	S8-A	Shield	FF		
P	S10-5	Fine Cosine -	HH		
R	S10-6	Fine Cosine +	JJ		
S	S10-A	Shield	KK		
T	S10-4	Fine Sine -	LL		
U	S10-3	Fine Sine +	MM		
V	S10-A	Shield	End 56 Pin → NN		
W	S8-A				
End 20 Pin → X	S8-A				
Y	S8-A				
Z	S8-X	+15 V DC			
AA a	S8-A				
BB b	S8-A				
CC c		NC			
DD d					
EE e					
FF f					
HH h					
JJ j					
KK k					
LL l					
MM m					
NN n					
PP p					
RR r					
SS s					
TT t		NC			
End 38 → Pin					

Through balance adjust board mounted behind card slots nos. 7-10.

See balance board schematic.

Abbreviations:
Ex: S25-22 | J9-MM
Slot 25, Pin 22 | Elco J9, Pin MM

Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B,

- 28c -

ELCO CONNECTOR LIST FOR BOX/RACK/DRAWER DPCAR

CONNECTOR: DESIGNATION J-7 ; TYPE Elco ; 38 PINS

SMALL KEY _____, LARGE KEY _____ ; PANEL P CABLE E

Pin	To	Function	Pin	To	Function
A	S12-V	Az MSB S_1 +	u		
B	S12-18	Az MSB S_1 -	v		
C	S12-1	Shield	w		
D	S12-W	Az MSB S_2 +	x		
E	S12-19	Az MSB S_2 -	y		
F	S12-A	Shield	z		
H			AA		
J			BB		
K			CC		
L			DD		
M			EE		
N			FF		
P			HH		
R			JJ		
S			KK		
T			LL		
U			MM		
V			End 56 Pin → NN		
W					
End 20 Pin → X					
Y					
Z					
AA a					
BB b					
CC c					
DD d					
EE e					
FF f					
HH h					
JJ j					
KK k					
LL l					
MM m					
NN n					
PP p					
RR r					
SS s					
TT t					
End 38 → Pin					

Abbreviations:
Ex: S25-22 | J9-MM
Slot 25, Pin 22 | Elco J9, Pin MM

Elco Connectors: J1, J2, J3, etc.
Slot Connectors: S1, S2, S3, etc.
Pin No.'s -3, -X, -B,

- 29a -

Elevation		J-5 Elco	Bendix	Stub
Coarse +	S2-3	A	A	J2-A
Sine -	S2-4	B	B	J2-B
Shield	S2-A	C	C	
Coarse +	S2-5	D	D	J2-C
Cosine -	S2-6	E	E	J2-D
Shield	S2-A	F	F	
Coarse +	S3-V	H	G	J2-E
Error -	S3-18	J	H	J2-F
Shield	S3-22	K	J	
Fine -	S3-4	L	K	J4-A
Error +	S3-D	M	L	J4-B
Shield	S3-A	N	M	J4-C
Fine -	S5-6	P	N	J1-C
Cosine +	S5-5	R	P	J1-J
Shield	S5-A	S	Q	
Fine -	S5-4	T	R	J1-A
Sine +	S5-3	U	S	J1-B
Shield	S5-A	V	T	
Spare	S3-A	W	U	
Ground	S3-A	X	V	
	S3-A	Y	W	
Preamp +15	S3-X	Z	X	J4-D
Power	S3-A	a	Y	J4-E
Shield	S3-A	b	Z	J4-F
				J1-D
				J1-E
				J1-F
				J1-G
				J1-H
				J1-I

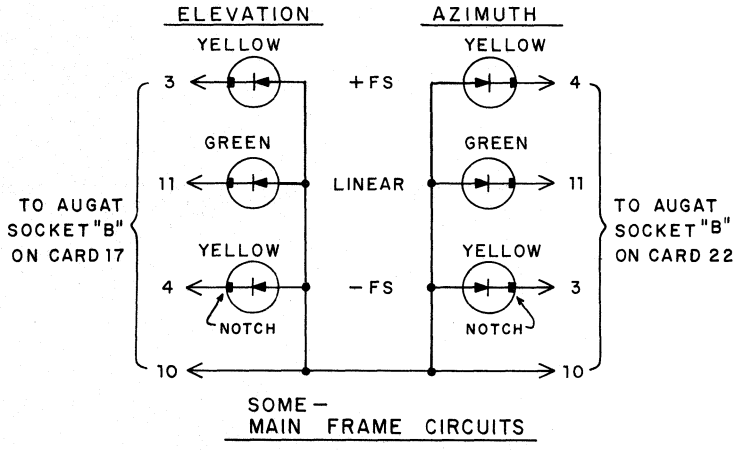
J1 = MS3108A-18-1S
J2 = MS3108A-16S-1S
J3 = MS3108A-12S-3P
J4 = MS3102A-14S-6S
J5 = MS3106A-14S-7S

Azimuth same except
Elco = J6
S2 = S7
S3 = S8
S5 = S10

Preamp Stub

J3-A	J5-A
J3-B	J5-B
Connector Body	J5-C

- 29b -



- 29c -

PHYSICAL LAYOUT - INDUCTOSYN STUB