BiSON Birmingham Solar-Oscillations Network

TECHNICAL REPORT NO. 379

Schematics for the 60-foot/150-foot tower auto-guider at Mount Wilson Observatory

Steven J. Hale

The University of Birmingham, Edgbaston, Birmingham B15 2TT

2016 May 30

This technical report series is published by:

THE UNIVERSITY OF BIRMINGHAM

High-Resolution Optical-Spectroscopy Group

School of Physics and Astronomy
The University of Birmingham
Edgbaston, Birmingham B15 2TT, United Kingdom
Telephone: +44-121-414-4551

Schematics for the 60-foot/150-foot tower auto-guider at Mount Wilson Observatory

Steven J. Hale

The University of Birmingham, Edgbaston, Birmingham B15 2TT

2016 May 30

Abstract

Electrical schematics for the 60-foot/150-foot tower auto-guider at Mount Wilson Observatory.

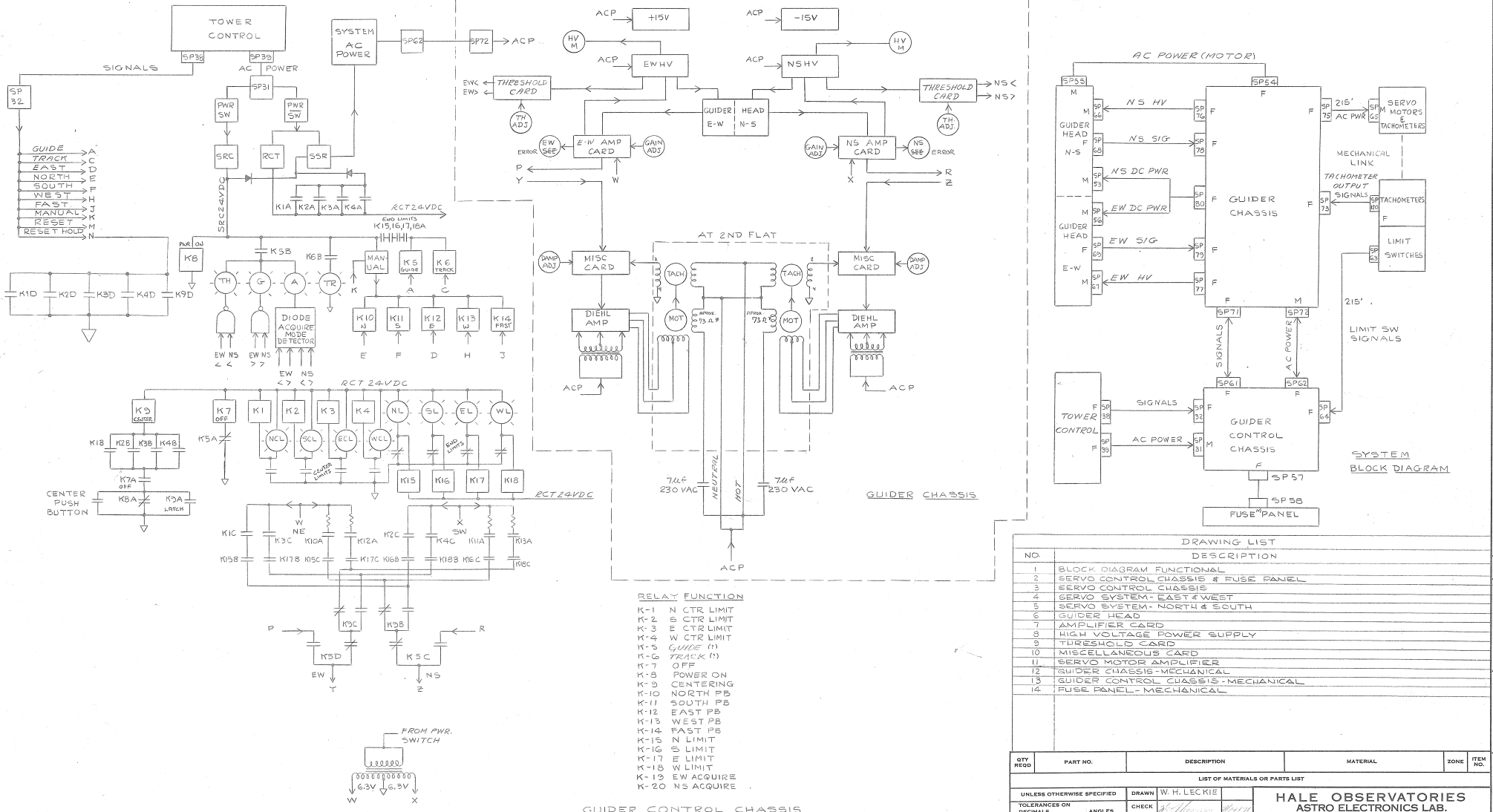
Contents

1 Introduction

The second-flat auto-guider at the 60-foot tower has been misbehaving. A previous site visit in 2014 April [1] identified some corroded and possibly broken cables from the second-flat motors to the patch-panel below the mirror mount. These were replaced, producing some improvement in performance. The guider module itself was not inspected due to lack of electrical schematics and little knowledge of how it was supposed to operate. Subsequently, a selection of schematics were found and scanned.

2 Guider Schematics

Schematics for the tower auto-guider are presented below.



REVISIONS					
SYM	ZONE	DESCRIPTION	CHK	DATE	APPR
B		UPDATED AUGUST 14, 1980 M.K.C. LSW 7-APR-98		11-19-98	

RELAY FUNCTION

K-1	N CTR LIMIT
K-2	S CTR LIMIT
K-3	E CTR LIMIT
K-4	W CTR LIMIT
K-5	GUIDE (?)
K-6	TRACK (?)
K-7	OFF
K-8	POWER ON
K-9	CENTERING
K-10	NORTH PB
K-11	SOUTH PB
K-12	EAST PB
K-13	WEST PB
K-14	FAST PB
K-15	N LIMIT
K-16	S LIMIT
K-17	E LIMIT
K-18	W LIMIT
K-19	EW ACQUIRE
K-20	NS ACQUIRE

GUIDER CONTROL CHASSIS

* NOTE: DC RESISTANCES ACROSS MOTORS:
5 WATT - ≈ 130 Ω
10 WATT - ≈ 73 Ω

DRAWING LIST

NO.	DESCRIPTION
1	BLOCK DIAGRAM FUNCTIONAL
2	SERVO CONTROL CHASSIS & FUSE PANEL
3	SERVO CONTROL CHASSIS
4	SERVO SYSTEM - EAST & WEST
5	SERVO SYSTEM - NORTH & SOUTH
6	GUIDER HEAD
7	AMPLIFIER CARD
8	HIGH VOLTAGE POWER SUPPLY
9	THRESHOLD CARD
10	MISCELLANEOUS CARD
11	SERVO MOTOR AMPLIFIER
12	GUIDER CHASSIS - MECHANICAL
13	GUIDER CONTROL CHASSIS - MECHANICAL
14	FUSE PANEL - MECHANICAL

QTY REQD	PART NO.	DESCRIPTION	MATERIAL	ZONE	ITEM NO.

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS .XX ± .02 .XXX ± .010 ANGLES ± 0° 30'
FINISH

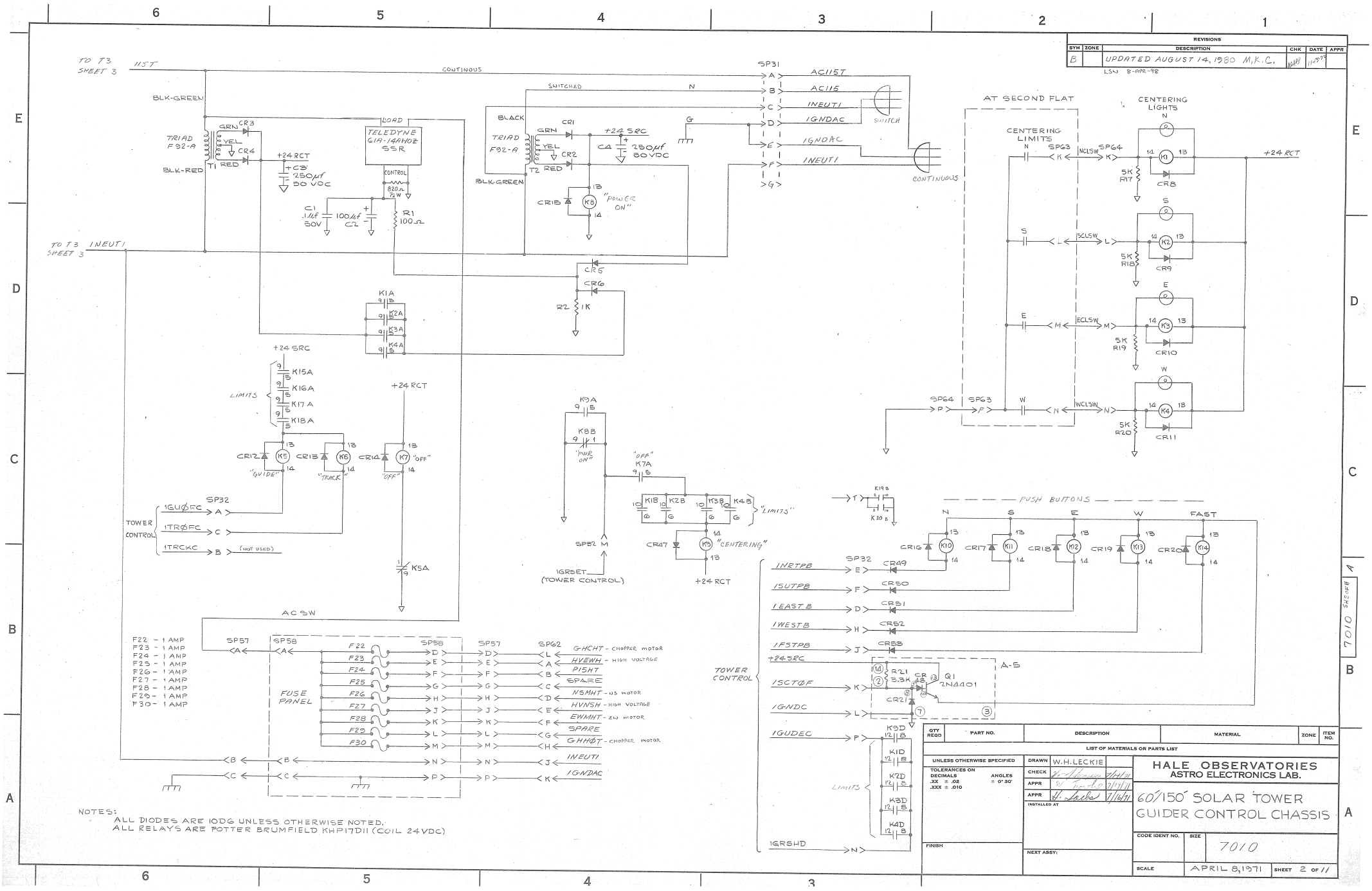
DRAWN	W. H. LECKIE	
CHECK		
APPR		7/11/71
APPR		7/16/71
INSTALLED AT		
NEXT ASSY:		

HALE OBSERVATORIES
ASTRO ELECTRONICS LAB.

60'/150' SOLAR TOWER
BLOCK DIAGRAM - FUNCTIONAL
GUIDER SYSTEM

CODE IDENT NO.	SIZE	
		7010
SCALE	APRIL 8, 1971	SHEET 1 OF 11

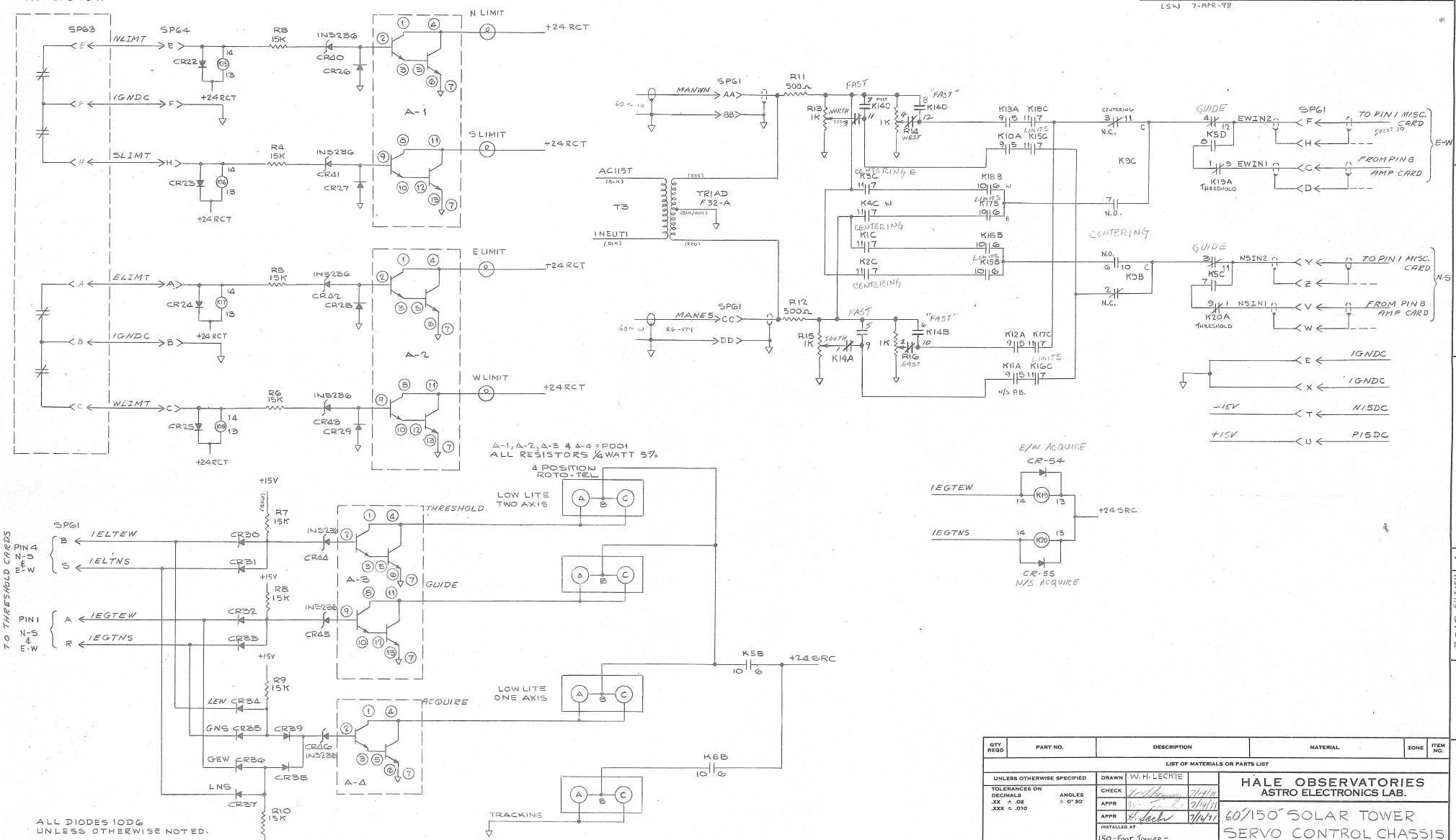
7010 SH 1 OF 11 A


REVISIONS
SYM ZONE DESCRIPTION CHK DATE APPR
B UPDATED AUGUST 14, 1980 M.K.C. 11-8-79
LSW 8-APR-98
TO T3 SHEET 3
115T
CONTINOUS
SWITCHED
BLK-GREEN
TRIAD F32-A
T1 RED
BLK-RED
GRN CR3
YEL CR4
+24 RCT
C3 250µf 50 VDC
LOAD
TELEDYNE G1A-1A4H02 SSR
CONTROL
820Ω 1/2W
C1 .1µf 50V
C2 100µf
R1 100Ω
BLACK
TRIAD F32-A
T2 RED
GRN CR1
YEL CR2
+24 SRC
C4 250µf 50VDC
G
CR1B K8 "POWER ON"
SP31
A 115T
B AC115
C INEUT1
D IGNDAC
E IGNDAC
F INEUT1
G
SWITCH
CONTINUOUS
TO T3 SHEET 3 INEUT1
CR5
CR6
R2 1K
K1A
K2A
K3A
K4A
AT SECOND FLAT
CENTERING LIMITS
CENTERING LIGHTS
N SP63 K SP64 K NCLSW 14 13 K1 CR8 5K R17 +24 RCT
S L SCLSW L 14 13 K2 CR9 5K R18
E M ECLSW M 14 13 K3 CR10 5K R19
W N WCLSW N 14 13 K4 CR11 5K R20
SP64 P SP63 P
+24 SRC
K15A
K16A
K17A
K18A
LIMITS
+24 RCT
CR12 K5 "GUIDE"
CR13 K6 "TRACK"
CR14 K7 "OFF"
K5A
K9A
K8B "PWR ON"
"OFF" K7A
K1B K2B K3B K4B "LIMITS"
CR47 K9 "CENTERING"
+24 RCT
SP82 M
IGRSET (TOWER CONTROL)
K19B
K20B
PUSH BUTTONS
N S E W FAST
CR16 K10 CR17 K11 CR18 K12 CR19 K13 CR20 K14
SP32
1GUØFC A
1TRØFC C
1TRCKC B (NOT USED)
TOWER CONTROL
AC SW
F22 - 1 AMP
F23 - 1 AMP
F24 - 1 AMP
F25 - 1 AMP
F26 - 1 AMP
F27 - 1 AMP
F28 - 1 AMP
F29 - 1 AMP
F30 - 1 AMP
SP57 A
SP58 A
FUSE PANEL
F22 F23 F24 F25 F26 F27 F28 F29 F30
SP58 D E F G H J K L M
SP57 D E F G H J K L M
SP62 L A B C D E F G H
GHCHT - CHOPPER MOTOR
HVEWH - HIGH VOLTAGE
PISHT
SPARE
NSMHT - NS MOTOR
HVNSH - HIGH VOLTAGE
EWMHT - EW MOTOR
SPARE
GHHØT - CHOPPER MOTOR
B B N N J INEUTI
C C P P K IGNDAC
SP32 E F D H J
INETPB CR49
ISUTPB CR50
IEASTB CR51
IWESTB CR52
IFSTPB CR53
+24SRC
ISCTØF K
IGNDC L
IGUDEC P
IGRSHD N
TOWER CONTROL
R21 3.3K
Q1 2N4401
CR21
A-5
K9D K1D K2D K3D K4D
LIMITS
NOTES:
ALL DIODES ARE 100G UNLESS OTHERWISE NOTED.
ALL RELAYS ARE POTTER BRUMFIELD KHP17D11 (COIL 24VDC)
QTY REQD PART NO. DESCRIPTION MATERIAL ZONE ITEM NO.
LIST OF MATERIALS OR PARTS LIST
UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS .XX ± .02 .XXX ± .010 ANGLES ± 0° 30'
DRAWN W.H. LECKIE
CHECK
APPR 7/14/71
APPR 7/16/71
INSTALLED AT
FINISH
NEXT ASSY:
HALE OBSERVATORIES
ASTRO ELECTRONICS LAB.
60'/150' SOLAR TOWER
GUIDER CONTROL CHASSIS
CODE IDENT NO.
SIZE 7010
SCALE
APRIL 8, 1971
SHEET 2 OF 11
7010 SHEET 4 B

REVISIONS					
SYM	ZONE	DESCRIPTION	CHK	DATE	APPR
B		UPDATED AUGUST 14, 1980 M.K.C.			

LSW 7-APR-98

AT 2ND FLAT



QTY REQD	PART NO.	DESCRIPTION	MATERIAL	ZONE	ITEM NO.

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS .XX ± .02 .XXX ± .010 ANGLES ± 0° 30'
FINISH

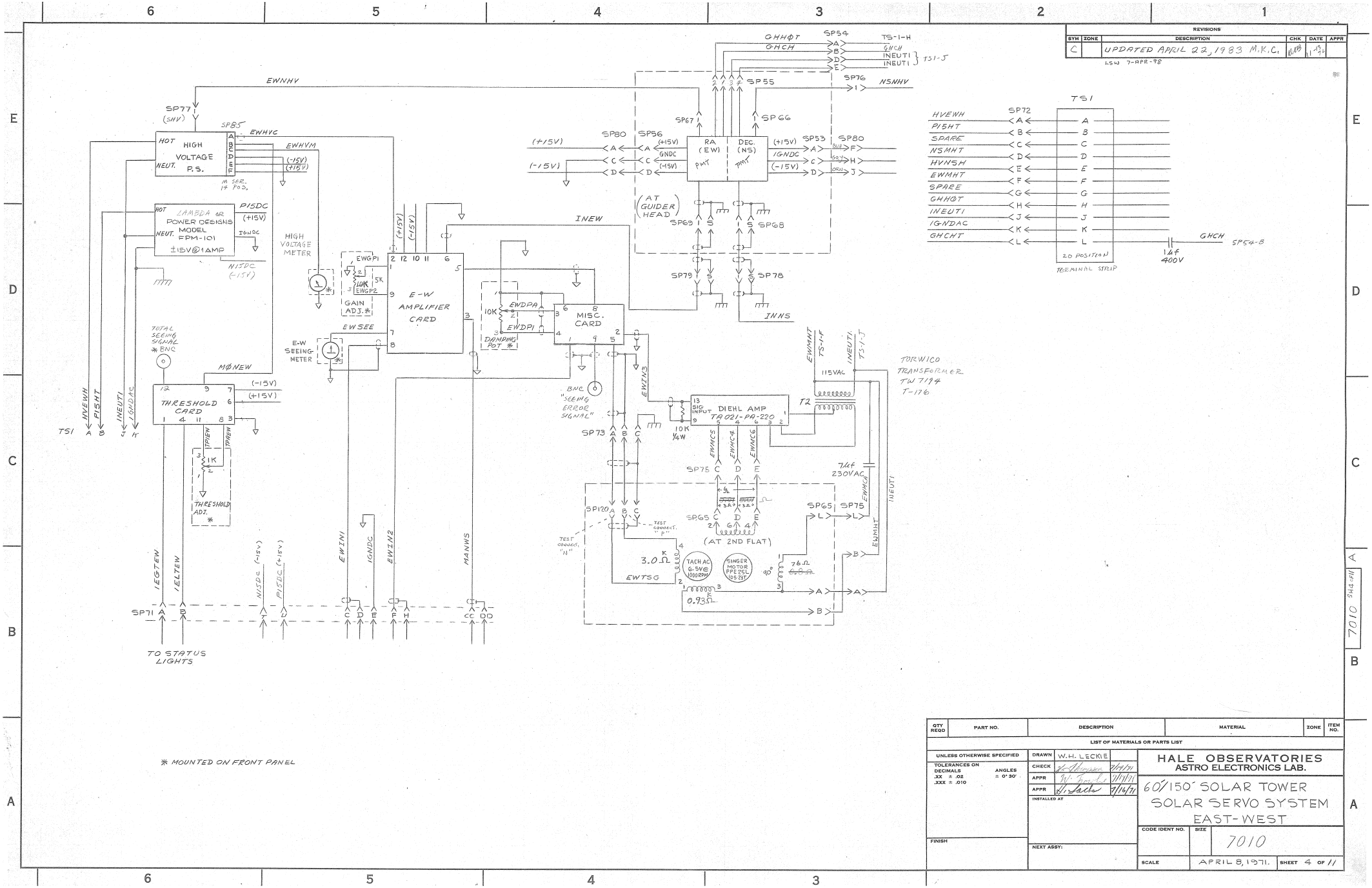
DRAWN W. H. LECKIE
CHECK 7/14/71
APPR 7/14/71
APPR 7/14/71
INSTALLED AT 150-Foot Tower-
NEXT ASSY:

HALE OBSERVATORIES
ASTRO ELECTRONICS LAB.

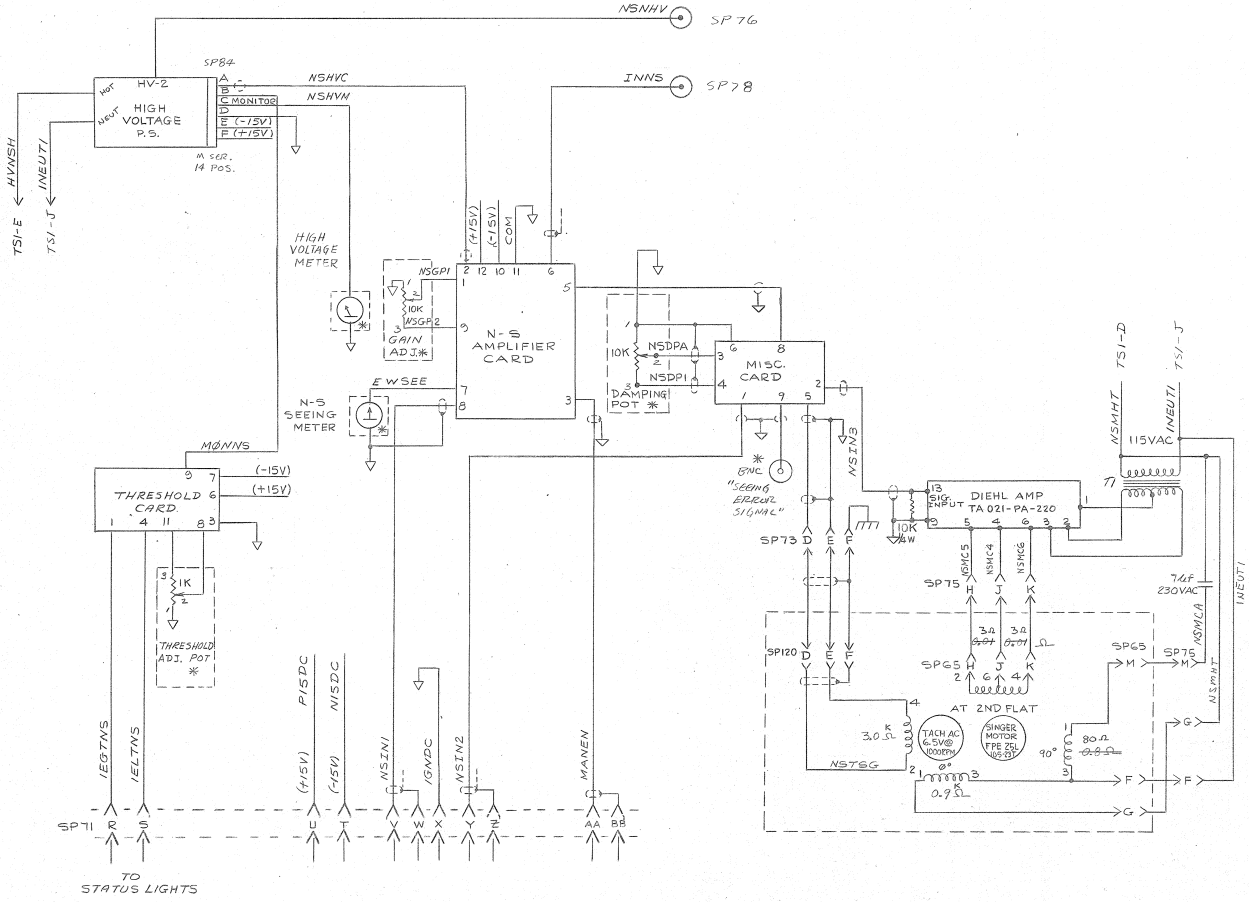
60'/150' SOLAR TOWER
SERVO CONTROL CHASSIS

CODE IDENT NO. | SIZE 7010
SCALE | APRIL 8, 1971 | SHEET 3 OF 11

7010 SH 3 OF 11


REVISIONS
SYM | ZONE | DESCRIPTION | CHK | DATE | APPR
C | | UPDATED APRIL 22, 1983 M.K.C. | | |
LSW 7-APR-98
HIGH VOLTAGE P.S.
LAMBDA OR POWER DESIGNS MODEL FPM-101 ±15V@1AMP
HIGH VOLTAGE METER
E-W AMPLIFIER CARD
MISC. CARD
E-W SEEING METER
GAIN ADJ. *
DAMPING POT *
THRESHOLD CARD
THRESHOLD ADJ. *
TOTAL SEEING SIGNAL * BNC
"SEEING ERROR SIGNAL" BNC
DIEHL AMP TA021-AA-220
TORWICO TRANSFORMER TW 7194 T-176
(AT GUIDER HEAD)
RA (EW) PMT
DEC. (NS) PMT
TACH AC 6.5V@1000RPM
SINGER MOTOR FPE25L 05231
EWTSG
3.0Ω
0.93Ω
76Ω
TS1
TERMINAL STRIP
20 POSITION
1.4f 400V
TO STATUS LIGHTS
* MOUNTED ON FRONT PANEL
QTY REQD | PART NO. | DESCRIPTION | MATERIAL | ZONE | ITEM NO.
LIST OF MATERIALS OR PARTS LIST
UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS .XX ± .02 .XXX ± .010 ANGLES ± 0° 30'
FINISH
DRAWN W.H. LECKIE
CHECK H. Johnson 7/14/71
APPR W. Epps 7/14/71
APPR D. Lacke 7/16/71
INSTALLED AT
NEXT ASSY:
HALE OBSERVATORIES
ASTRO ELECTRONICS LAB.
60/150' SOLAR TOWER
SOLAR SERVO SYSTEM
EAST-WEST
CODE IDENT NO.
SIZE
7010
SCALE
APRIL 8, 1971.
SHEET 4 OF 11
7010 SH4 REV A

REVISIONS					
SYM	ZONE	DESCRIPTION	CHK	DATE	APPR
C		UPDATED APRIL 23, 1983 M.K.C.			



NOTES:
* MOUNTED ON FRONT PANEL

QTY REQD	PART NO.	DESCRIPTION	MATERIAL	ZONE	ITEM NO.

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS .XX ± .02 .XXX ± .010 ANGLES ± 0° 30'
FINISH

DRAWN	W. H. LECKIE	
CHECK	[illegible]	7/14/71
APPR	W. Jacobs	7/14/71
APPR	H. Jacobs	7/16/71
INSTALLED AT		
NEXT ASSY:		

HALE OBSERVATORIES
ASTRO ELECTRONICS LAB.

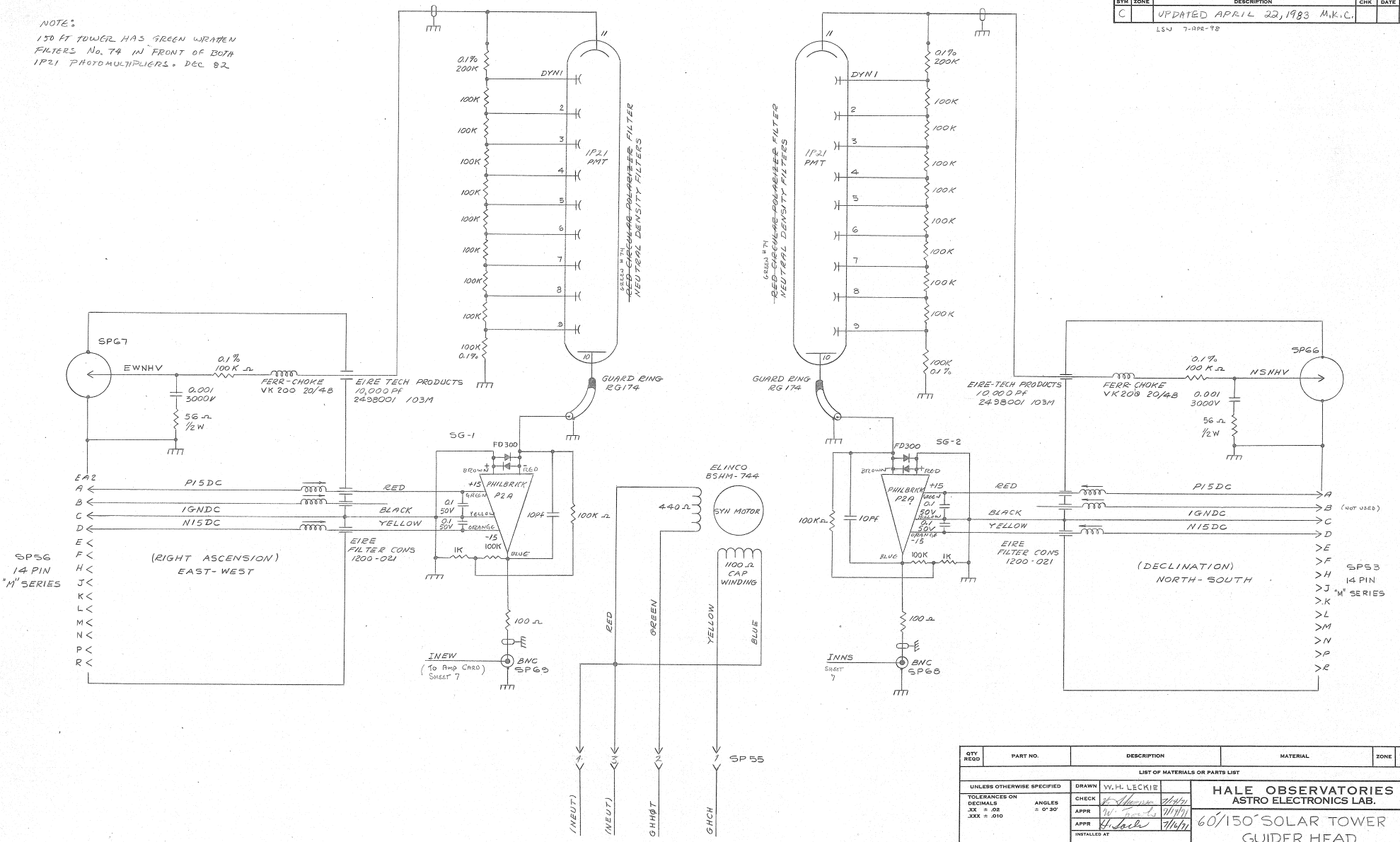
60'/150' SOLAR TOWER
SOLAR SERVO SYSTEM
NORTH-SOUTH

CODE IDENT NO.	SIZE	
		7010
SCALE	APRIL 8, 1971	SHEET 5 OF 11

7010 SHEET 5

NOTE:
150 FT TOWER HAS GREEN WRATTEN FILTERS No. 74 IN FRONT OF BOTH IP21 PHOTOMULTIPLIERS. DEC 82

REVISIONS					
SYM	ZONE	DESCRIPTION	CHK	DATE	APPR
C		UPDATED APRIL 22, 1983 M.K.C.			
		LSN 7-APR-98			



QTY REQD	PART NO.	DESCRIPTION	MATERIAL	ZONE	ITEM NO.

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS .XX ± .02 .XXX ± .010 ANGLES ± 0° 30'
FINISH

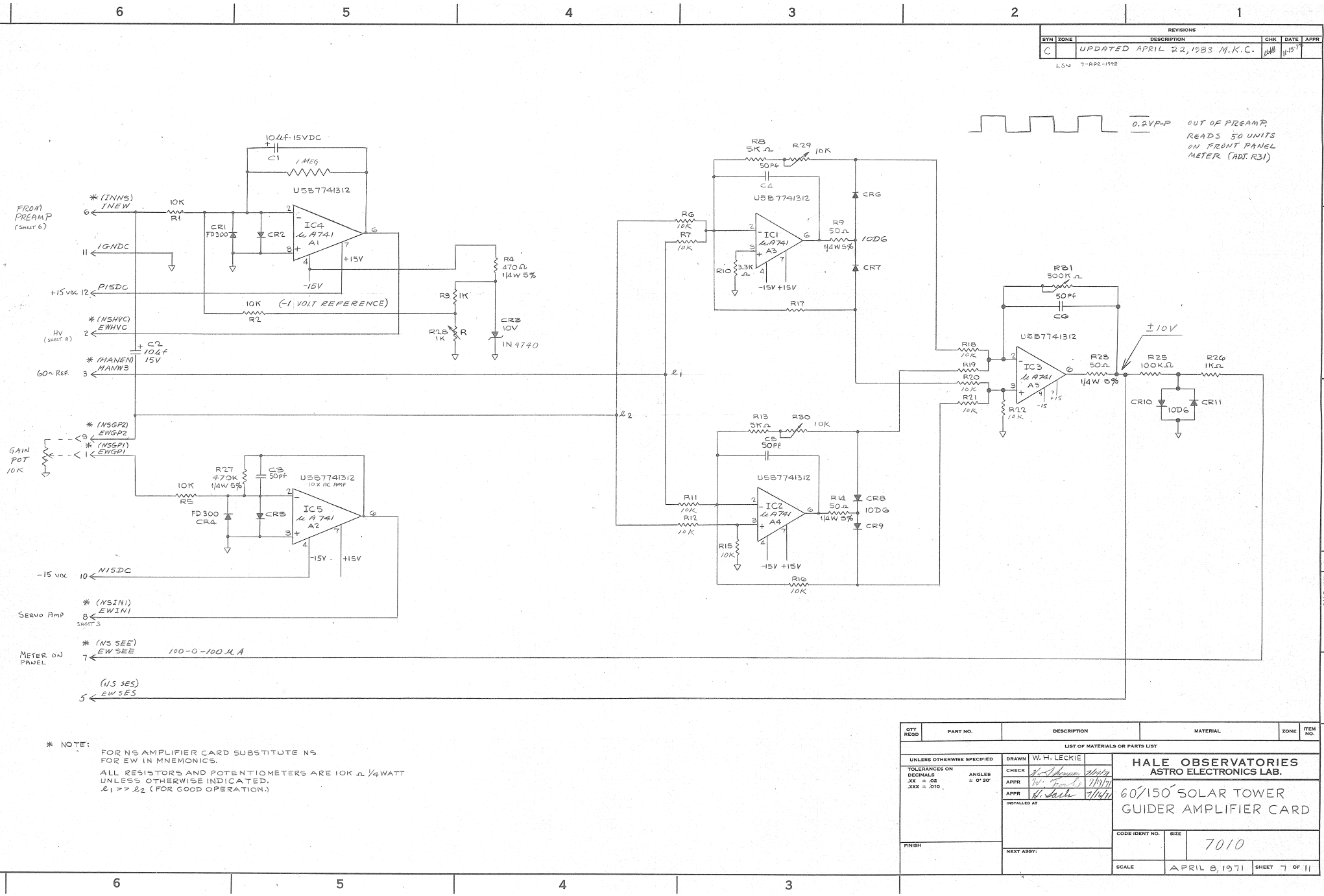
DRAWN	W.H. LECKIE	
CHECK		
APPR		
APPR		
INSTALLED AT		
NEXT ASSY:		

HALE OBSERVATORIES
ASTRO ELECTRONICS LAB.

60/150' SOLAR TOWER GUIDER HEAD

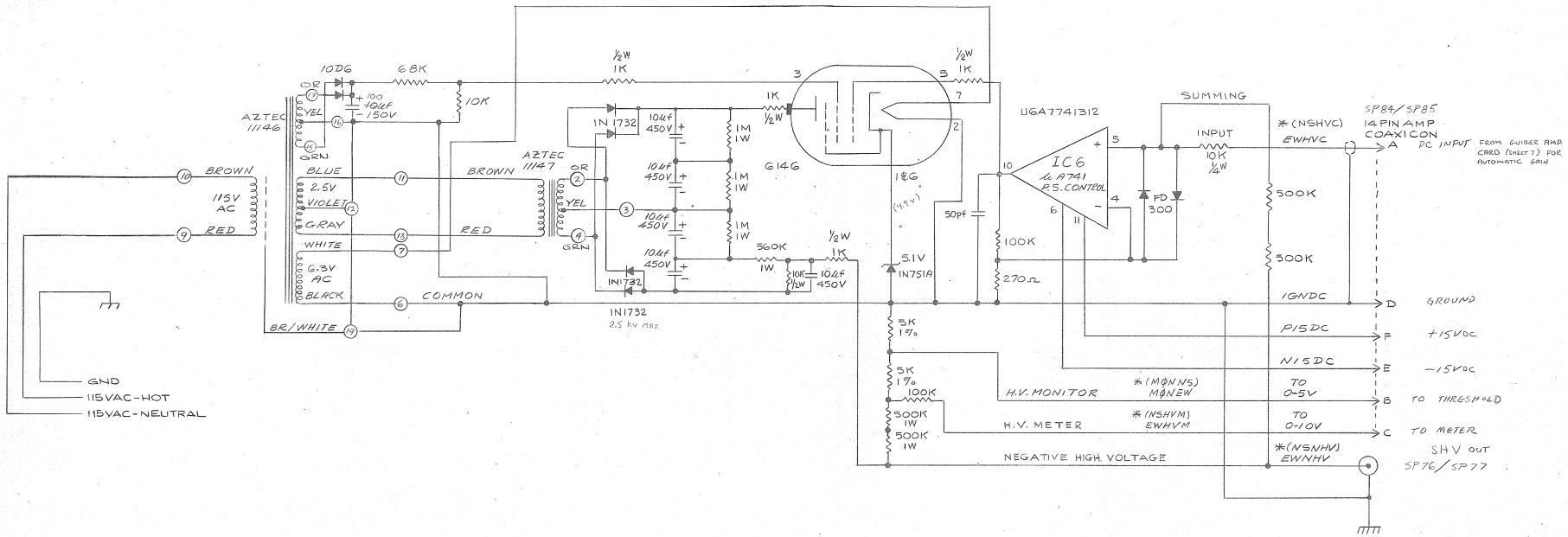
CODE IDENT NO. | SIZE 7010
SCALE | APRIL 8, 1971 | SHEET 6 OF 11

7010 SHEET B


REVISIONS
SYM ZONE DESCRIPTION CHK DATE APPR
C UPDATED APRIL 22, 1983 M.K.C.
LSG 7-APR-1998
0.2VP-P OUT OF PREAMP. READS 50 UNITS ON FRONT PANEL METER (ADJ. R31)
FROM PREAMP (SHEET 6)
* (INNS) INEW
10K R1
10UF-15VDC C1
1 MEG
USB7741312
IC4 µA741 A1
CR1 FD300
CR2
+15V
-15V
10K R2 (-1 VOLT REFERENCE)
R4 470Ω 1/4W 5%
R3 1K
R28 1K R
CR3 10V IN4740
11 IGNDC
+15 VDC 12 P15DC
* (NSHVC) EWHVC
HV (SHEET 8)
C2 10µF 15V
* (MANEN) MANW3
60Δ REF. 3
* (NSGP2) EWGP2
* (NSGP1) EWGP1
GAIN POT 10K
R27 470K 1/4W 5%
C3 50PF
USB7741312 10X AC AMP
10K R5
FD300 CR4
CR5
IC5 µA741 A2
-15V +15V
-15 VDC 10 N15DC
* (NSINI) EWINI
SERVO AMP 8
SHEET 3
* (NS SEE) EW SEE
METER ON PANEL 7
100-0-100 µA
(NS SES) EW SES 5
R8 5K Ω
R29 10K
50PF C4
USB7741312
IC1 µA741 A3
R6 10K
R7 10K
R10 3.3K Ω
R9 50Ω 1/4W 5%
CR6
CR7
10DG
-15V +15V
R17
R31 500K Ω
50PF C6
USB7741312
IC3 µA741 A5
R18 10K
R19 10K
R20 10K
R21 10K
R22 10K
R23 50Ω 1/4W 5%
±10V
R25 100KΩ
R26 1KΩ
CR10
CR11
10DG
R13 5K Ω
R30 10K
C5 50PF
USB7741312
IC2 µA741 A4
R11 10K
R12 10K
R15 10K
R14 50Ω 1/4W 5%
CR8
CR9
10DG
-15V +15V
R16 10K
ℓ1
ℓ2
* NOTE:
FOR NS AMPLIFIER CARD SUBSTITUTE NS FOR EW IN MNEMONICS.
ALL RESISTORS AND POTENTIOMETERS ARE 10K Ω 1/4WATT UNLESS OTHERWISE INDICATED.
ℓ1 >> ℓ2 (FOR GOOD OPERATION.)
QTY REQD | PART NO. | DESCRIPTION | MATERIAL | ZONE | ITEM NO.
LIST OF MATERIALS OR PARTS LIST
UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS .XX ± .02 .XXX ± .010 ANGLES ± 0° 30'
FINISH
DRAWN W. H. LECKIE
CHECK 7/14/71
APPR 7/14/71
APPR 7/14/71
INSTALLED AT
NEXT ASSY:
HALE OBSERVATORIES
ASTRO ELECTRONICS LAB.
60/150' SOLAR TOWER
GUIDER AMPLIFIER CARD
CODE IDENT NO. SIZE 7010
SCALE APRIL 8, 1971 SHEET 7 OF 11
7010 SH 7 OF 11

REVISIONS					
SYM	ZONE	DESCRIPTION	CHK	DATE	APPR
B		UPDATED 7 AUGUST 1980 M.K.C.			

LSW 7-APR-1998



* NOTE:
FOR NS HIGH VOLTAGE POWER SUPPLY SUBSTITUTE NS FOR EW IN MNEMONICS.
IN1732 DIODES ARE SARKES TARZIAN.
ENCIRCLED LETTERS (L) DENOTE PINS ON 26 PIN "M" SERIES CONNECTORS
EVEN NUMBERED CONNECTORS ARE ON NORTH-SOUTH HV UNIT

QTY REQD	PART NO.	DESCRIPTION	MATERIAL	ZONE	ITEM NO.

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS .XX ± .02 .XXX ± .010 ANGLES ± 0° 30'
FINISH

DRAWN	W.H. LECKIE	
CHECK	[signature]	7/14/71
APPR	[signature]	7/14/71
APPR	[signature]	7/16/71
INSTALLED AT		
NEXT ASSY:		

HALE OBSERVATORIES
ASTRO ELECTRONICS LAB.

60/150' SOLAR TOWER
GUIDER HIGH VOLTAGE POWER SUPPLY

CODE IDENT NO. | SIZE | 7010

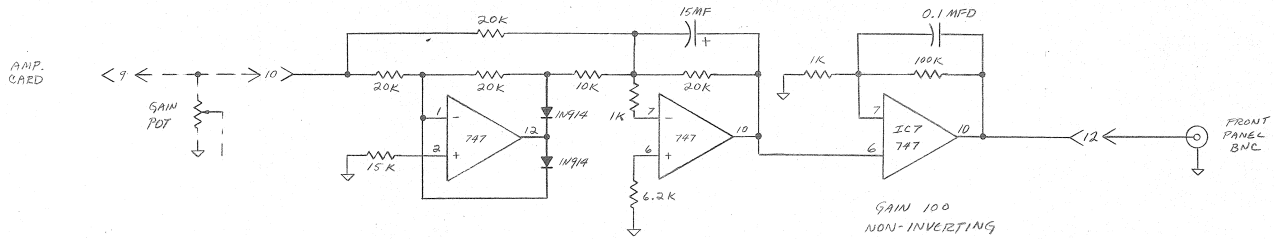
SCALE | APRIL 8, 1971 | SHEET 8 OF 11

7010 SHEET 11

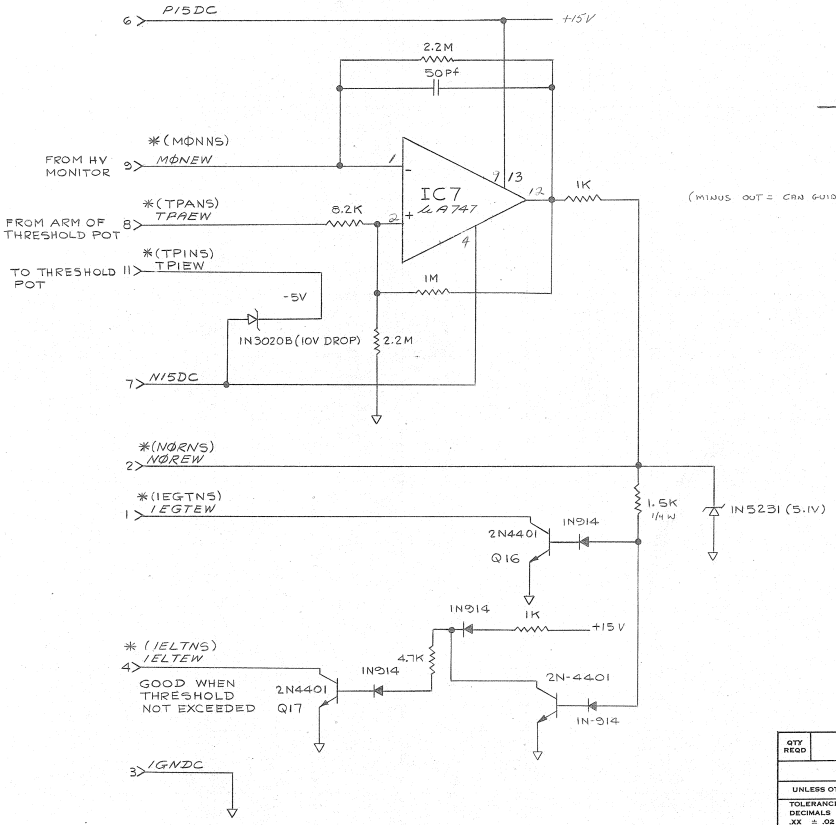
REVISIONS					
SYM	ZONE	DESCRIPTION	CHK	DATE	APPR
C		UPDATED 7 MARCH 1985 M.K.C.			
		LSW 7-APR-1998			

SEEING MONITOR

FULL-WAVE PRECISION RECTIFIER



GAIN 100
NON-INVERTING



0.2 VP-P

OUT OF PREAMP
GIVES 1.0 VDC
OUT OF FRONT
PANEL BNC

* NOTE:
FOR NS THRESHOLD CARD SUBSTITUTE
NS FOR EW IN MNEMONICS.

QTY REQD	PART NO.	DESCRIPTION	MATERIAL	ZONE	ITEM NO.

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS .XX ± .02 .XXX ± .010 ANGLES ± 0° 30'
FINISH

DRAWN	W.H. LECKIE	
CHECK		7/14/71
APPR		7/17/71
APPR		7/16/71
INSTALLED AT		
NEXT ASSY:		

HALE OBSERVATORIES
ASTRO ELECTRONICS LAB.

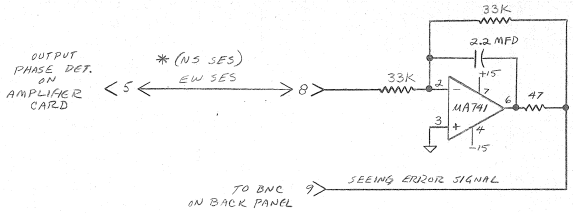
60/150' SOLAR TOWER
GUIDER THRESHOLD CARD

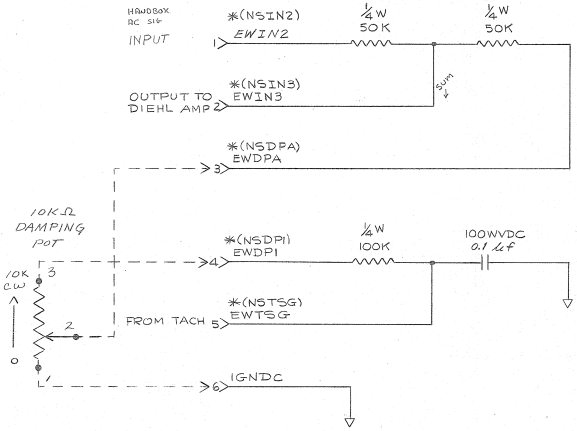
CODE IDENT NO.	SIZE	
		7010
SCALE	APRIL 8, 1971	SHEET 3 OF 11

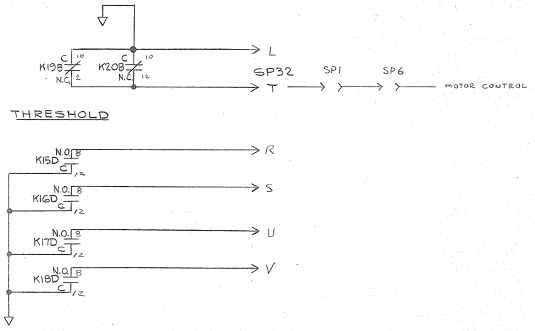
7010 SH 3 of 11

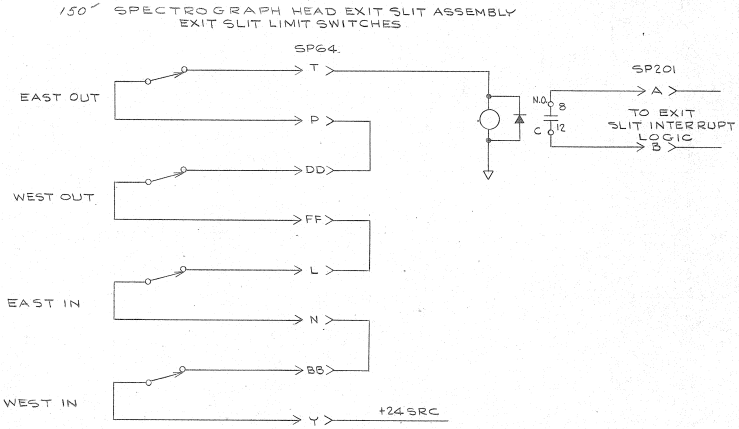
REVISIONS					
SYM	ZONE	DESCRIPTION	CHK	DATE	APPR
B		UPDATED AUGUST 14, 1980 M.K.C.		1-15-79	

LSW 7-APR-1998









* NOTE:
FOR NS MISCELLANEOUS CARD SUBSTITUTE NS FOR EW IN MNEMONICS.

QTY REQD	PART NO.	DESCRIPTION	MATERIAL	ZONE	ITEM NO.

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS .XX ± .02 .XXX ± .010 ANGLES ± 0° 30'
FINISH

DRAWN	W. H. LECKIE	
CHECK	R. Thompson	7/14/71
APPR	W. Tyler	7/14/71
APPR	H. Sachs	7/16/71

INSTALLED AT
NEXT ASSY:

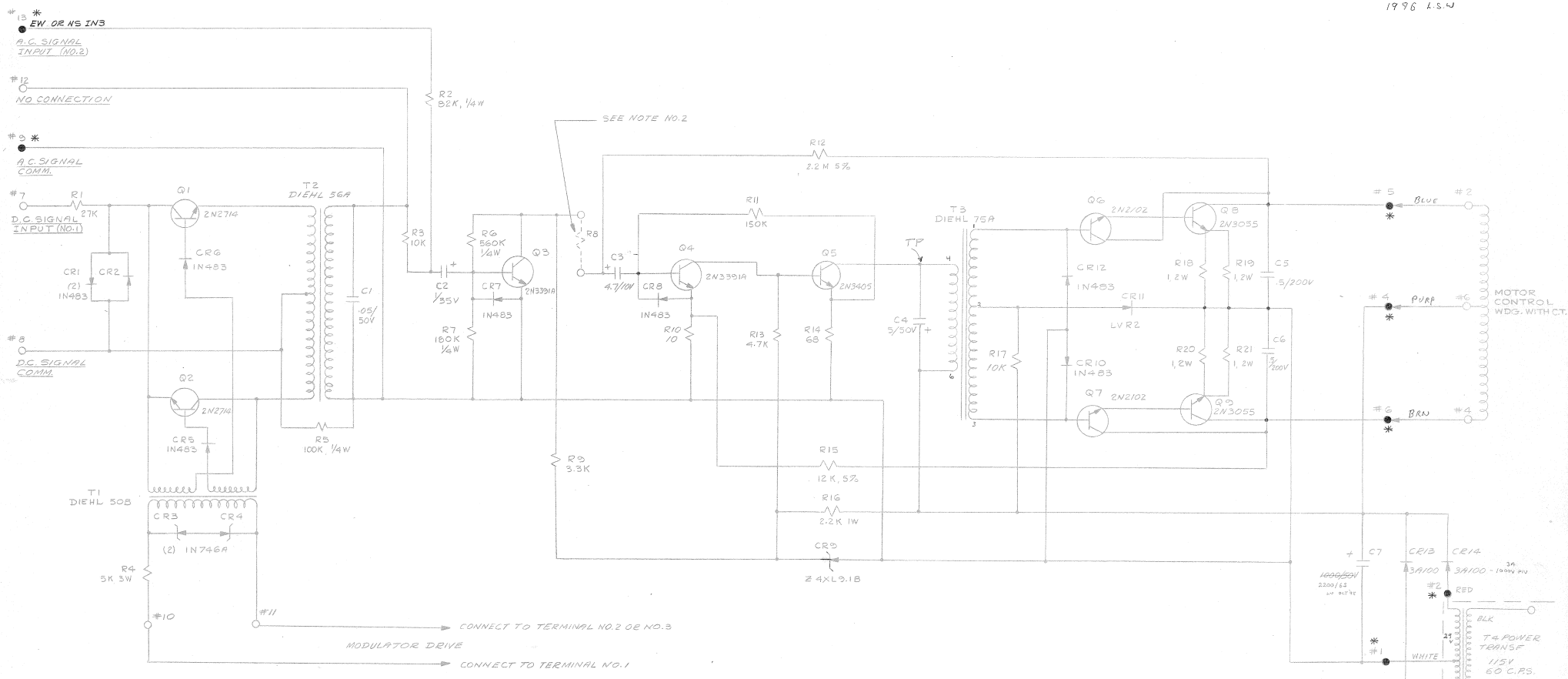
HALE OBSERVATORIES
ASTRO ELECTRONICS LAB.

60/150' SOLAR TOWER
GUIDER MISCELLANEOUS CARD & EXTERNAL INTERRUPT RELAY

CODE IDENT NO.	SIZE	
		7010
SCALE	APRIL 8, 1971	SHEET 10 OF 11

7010 3410-11 A

REVISIONS					
SYM	ZONE	DESCRIPTION	CHK	DATE	APPR
B		UPDATED NOV. 11, 1980 W.H.L.		11-13-80	
		1996 A.S.W.			



T4 TRANSFORMER
DIEHL #176: FOR 10 WATT MOTOR OPERATION.
DIEHL #180: FOR 20 WATT MOTOR OPERATION.

NOTE:

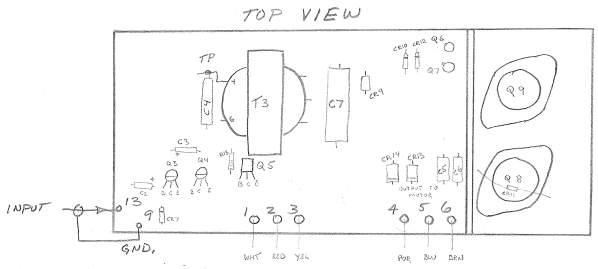
(1) UNLESS OTHERWISE SPECIFIED
(a) CAPACITANCE VALUES IN M.F.D.
(b) RESISTANCE VALUES IN OHMS 1/2W 10%

(2) FOR NOMINAL GAIN OF 1000 D.C. INPUT TO P.M.S. OUTPUT R B IS 27K, 1/4W. NOMINAL GAIN MAY BE ADJUSTED UPWARDS BY REDUCING RESISTANCE OF R B. MINIMUM VALUE FOR RB IS 5.6K.

(3) NUMBERS (#1-#13) DENOTES TERMINAL IDENTIFICATION FOR EXTERNAL CONNECTIONS. (SEE OUTLINE AND CONNECTION DIAGRAM (A-00157-10)

* CONNECTIONS TO BE USED IN M.W. SOLAR TOWER GUIDER SYSTEMS

TOP VIEW



QTY. REQD	PART NO.	DESCRIPTION	MATERIAL	ZONE	ITEM NO.
LIST OF MATERIALS OR PARTS LIST					

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS XX ± .02 XXX ± .010 ANGLES ± 0° 30'
FINISH

DRAWN	W.H.LECKIE	
CHECK		
APPR		7/11/67
APPR		7/16/67
INSTALLED AT		
NEXT ASSY:		

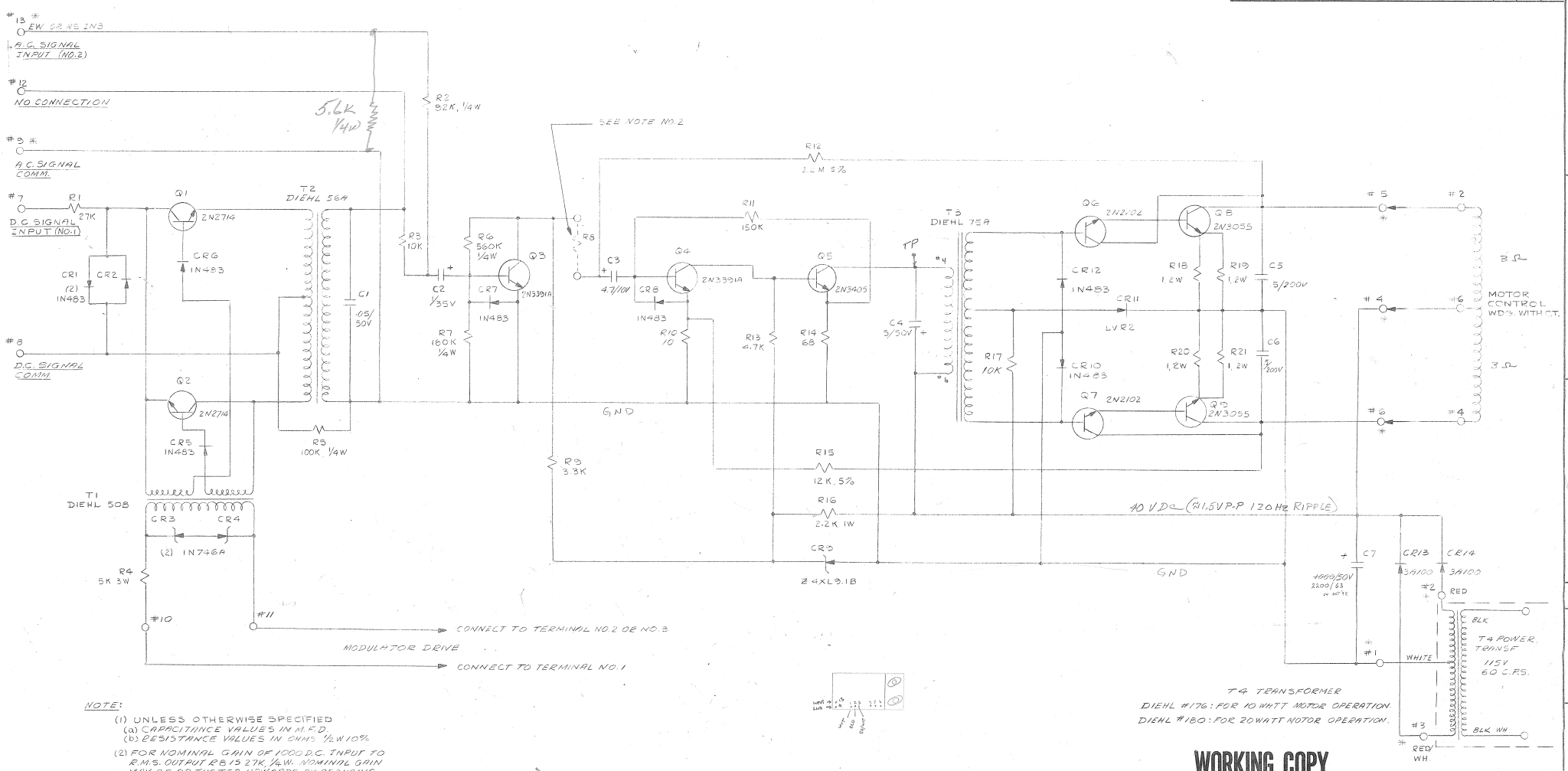
MT. WILSON & PALOMAR OBSERVATORIES
ASTRO ELECTRONICS LAB.

SERVO AMPLIFIER
THE SINGER COMPANY
DIEHL DIVISION
CAT. NO. TA061-PD-222 (9-788652-01)

CODE IDENT NO.	SIZE	7010
SCALE	OCTOBER 16, 1969	SHEET 11B OF 11

7010 SHT OF 11

REVISIONS					
SYM	ZONE	DESCRIPTION	CHK	DATE	APPR
		UPDATED NOV. 11, 1970 W.H.L.			



NOTE:

(1) UNLESS OTHERWISE SPECIFIED
(a) CAPACITANCE VALUES IN M.F.D.
(b) RESISTANCE VALUES IN OHMS ½W 10%

(2) FOR NOMINAL GAIN OF 1000 D.C. INPUT TO R.M.S. OUTPUT R8 IS 27K, ¼W. NOMINAL GAIN MAY BE ADJUSTED UPWARDS BY REDUCING RESISTANCE OF R8. MINIMUM VALUE FOR R8 IS 5.6K.

(3) NUMBERS (#1-#13) DENOTES TERMINAL IDENTIFICATION FOR EXTERNAL CONNECTIONS. (SEE OUTLINE AND CONNECTION DIAGRAM (A-00157-10)

* CONNECTIONS TO BE USED IN 150' SOLAR TOWER GUIDER SYSTEM.

T4 TRANSFORMER
DIEHL #176: FOR 10 WATT MOTOR OPERATION.
DIEHL #180: FOR 20 WATT MOTOR OPERATION.

WORKING COPY
MAR 8 1972

QTY REQD	PART NO.	DESCRIPTION	MATERIAL	ZONE	ITEM NO.

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DECIMALS XX ± .02 XXX ± .010 ANGLES ± 0° 30'
FINISH

DRAWN	W.H. LECKIE	
CHECK		
APPR		11/1/71
APPR		11/1/71

INSTALLED AT
NEXT ASSY:

MT. WILSON & PALOMAR OBSERVATORIES
ASTRO ELECTRONICS LAB.

SERVO AMPLIFIER
THE SINGER COMPANY
DIEHL DIVISION
CAT. NO. TA061-PD-222 (9-788652-01)

CODE IDENT NO. | SIZE

SCALE | OCTOBER 16, 1969 | SHEET 1/8 OF 14

References

[1] Hale, S. J. Autoguider repairs at Mount Wilson in 2014 April. *BiSON Technical Report Series,* Number 365, High-Resolution Optical-Spectroscopy Group, University of Birmingham, UK, 2014. URL `http://epapers.bham.ac.uk/2060/`. [page 1]