

VLA TECHNICAL REPORT No. 66

Temperature Sensor Array

for Antenna No. 6

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TECHNICAL REPORT No. 66

VLA Antenna Temperature Sensor Array

I. Overview

An array of temperature sensors is installed on antenna 6 at this writing for use in measuring temperature differences across the antenna structure. Tilt sensors are already installed on this antenna as reported in references 1 and 2. The theory is that temperature differences on the structure will cause antenna tilts that are not corrected by the pointing coefficients. It may be possible to predict the uncorrected antenna tilt by measuring the temperatures, and thereby permit more precise pointing corrections.

The array consists of semiconductor sensors connected to an electronic module in the pedestal room.

II. The Temperature Sensors

The temperature sensor is an Analog Devices semiconductor temperature transducer part no. AD590KH. The device was selected because it is easy to use, accurate, and simple to mount. The AD590's are linear to $\pm 0.8^\circ\text{C}$ and repeatable to $\pm 0.1^\circ\text{C}$ over the rated performance range of -55°C to $+155^\circ\text{C}$. The output current is proportional to temperature so that the device is independent of power supply voltage variations. The device is calibrated to be within $\pm 2.5^\circ\text{C}$ of absolute at 25°C . With the external calibration provided at startup, the absolute error at any temperature can be as much as $\pm 2.5^\circ \pm 0.8^\circ \pm 0.1^\circ$ (drift) = $\pm 3.6^\circ\text{C}$. The sensing element is mounted in a two-element TO-52 can.

Installation of the sensing device demands careful attention to insure accurate measurement of the structure temperature. Where ever possible, a mating sensor was mounted on an opposing side, for verification and for more accurate determination of temperatures at beam midpoints.

We drilled holes in the structure and bonded the devices to the structure with temperature conducting electrical insulating epoxy. Each device was then sealed with RTV. In the case of the subreflector support legs, the base support beams, and the concrete piers, we covered each sensor with a plastic electrical box which we covered in turn with a layer of self-adhering insulating tape followed by a layer of self-adhering aluminum foil. About 8" of cable was formed into a loop inside the box to reduce the effect of sensor heating via thermal conductance along the cable. We decided the use of thermally-insulating Manganin wire was not necessary for this project. The boxes were caulked to keep out moisture.

Sensors on the tubes that run from each pier to the torque box were also mounted in holes drilled in the structure. An access hole was cut through the insulation with a hole saw, the sensor was mounted to the structure, and then the hole was filled back in with insulation and caulked. The patch was covered with the sticky-backed aluminum tape. A single turn of the cable was tucked under the insulation, again to reduce thermal migration to the sensor.

The sensors inside the yoke are mounted in holes, bonded with adhesive and coated with RTV, but are otherwise not insulated. Each sensor is located approximately halfway between left and right and upper and lower boundaries.

2 Temperature Sensors

On the concrete piers, we mounted the sensors in 1" deep holes and back-filled with thermally-conductive putty. The entry to the holes are sealed with RTV, and the installations covered with boxes as explained earlier. Only the concrete piers at pad CN7 are instrumented.

The shielded twisted pair cables from each sensor lead to a junction box in the upper pedestal room. Each line to the box is protected by a surge suppressor at this termination. A single multiconductor cable connects the box to the module in the electronics crate.

III. The M25 Module

The M25 module houses the electronics to convert the current from the temperature transducers to a proportional voltage, multiplexers to switch the selected sensor to the output, and a 5 VDC power supply. ± 15 VDC is provided by the Data Set utility module. Altogether, the module will support up to 32 temperature sensing channels. The module is located in the C rack in the pedestal room in the same bin as the F/R modules.

The AD590 will pass 1 μ Amp. of current per $^{\circ}$ K of sensed temperature. To scale the temperature for a convenient operational amplifier output of 0 V - 0° C and 4 V - 40° C, a current equal to 273.2 μ Amp. is produced using a 10V AD581 precision voltage source and two resistors in series, a 35.7k resistor and a 2k trimpot: $10V/36.6k = 273.2 \mu A$. Remember that $273.2^{\circ}K = 0^{\circ}C$. To hold the "-" input of the op amp at 0 V, the output voltage of the device will change so that the sum of 273.2 μ A. and the current through the op amp feedback resistor is equal to the current through the AD590 to the -15VDC power supply. For instance, at $40^{\circ}C$, the current through the AD590 must be 313.2 μ A. by definition: 313.2 μ A. at $313.2^{\circ}K$. $313.2 \mu A - 273.2 \mu A = 40 \mu A$. feedback current. A 4 V op amp output voltage dropped across the feedback resistors of 97.6k and the 5k trimpot provides 40 μ A. to the summing junction: $4V/100k = 40 \mu A$. In that way, the output voltage of the op amp is proportional to the temperature sensed by the AD590.

The 27k resistor leading to the noninverting op amp input "+" is equal to $(100k)(36.6k)/(100k + 36.6k)$, and is intended to offset the input bias current at the inverting input. The 0.1 μ f capacitor in the feedback loop limits the frequency bandpass of the op amp.

MUX addresses for the temperature channels are listed with sensor locations in Appendix A. Appendix B lists further information on how to access the data.

IV. Parts List and Costs

Analog Devices temperature transducer AD590KH, 32 at \$7.65 each
Hoffman ABS enclosure, 19 at \$7.99 each
Adhesive, insulating tape, cable clamps, hardware \$85
Belden 9501 twisted shielded 24 AWG cable, 3000' at \$90/M
Belden 9545 40 conductor 24AWG cable, 40' at \$246/C
Hoffman NEMA 12 enclosure for junction box \$97.89
Phoenix mounting rail, 3 tier terminals, mounting blocks \$325.28
Siemens SVP 74 at \$2 each
M24 module \$805

Approximate total: \$2300

3 Temperature Sensors

V. Schematics and Drawings

C13720S32 M25 Schematic (3 sheets)
M25 Wire list (3 sheets)
M25 Special Assemblies (5 sheets)
Connector P1
connector P2
J-Box wiring (2 sheets)

Others not included:

C13720AB03 M25 PCB (2 sheets)
C12720M03 M25 PCB
C13720M06 M25 front panel
C13720M12 M25 rear panel

VI. Manufacturer's Literature

Analog Devices AD590

VII. Bibliography:

1. DCS Manual, VLA Operators, updated periodically.

4 Temperature Sensors

Appendix A

MUX Addresses for Temperature Sensor Array

Data Set 3

Probe MUX	Location
1	'60 Inner side, center, of top leg of subreflector support leg
2	'61 Ambient air temperature sensor above center of elevation axle
3	'62 Outer side, center, of e-side subreflector support leg
4	'63 Inner side, center, of e-side subreflector support leg
5	'64 Outer side, center, of bottom subreflector support leg
6	'65 Inner side, center, of bottom subreflector support leg
7	'66 Outer side, center, of w-side subreflector support leg
8	'67 Inner side, center, of w-side subreflector support leg
9	'70 Back of waveguide yoke arm
10	'71 Center of back of yoke base
11	'72 Back of encoder yoke arm
12	'73 Front of waveguide yoke arm
13	'74 Center of front of yoke base
14	'75 Front of encoder yoke arm
15	'76 Top center of front support tube to pier
16	'77 Bottom center of front support tube to pier
17	'100 Top center of south support tube to pier
18	'101 Bottom center of south support tube to pier
19	'102 Top center of north support tube to pier
20	'103 Bottom center of north support tube to pier
21	'104 Outside center of I-beam between south and north piers
22	'105 Inside center of I-beam between south and north piers
23	'106 Outside center of I-beam between front and south piers
24	'107 Inside center of I-beam between front and south piers
25	'110 Outside center of I-beam between front and north piers
26	'111 Inside center of I-beam between front and north piers
27	'112 North side of front pier, CN7, or test
28	'113 South side of front pier, CN7, or test
29	'114 North side of north pier, CN7, or test
30	'115 South side of north pier, CN7, or test

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31	'116	North side of south pier, CN7, or test
32	'117	South side of south pier, CN7, or test

Utility:

'120	Ground
'121	-5 VDC
'122	+15/2 VDC
'123	-15/2 VDC
'124	+5 VDC
'125	+5 VDC
'126	+5 VDC
'127	+5 VDC

Notes:

1. Subreflector support leg orientations refer to encoder side as e-side and waveguide side as w-side.
2. Support tube and pier orientations refer to the pier furthest from the railroad track as the "front" pier. Pier sensors are only available at pad CN7. The sensors at these mux addresses are available for tests at other locations on the antenna.
3. Ambient sensor 2 is mounted in a box with grill work to permit free air passage fastened to the vertex room support structure above the elevation axle.
4. MUX address are in octal.
5. Multiply sensor readings by 10 for data in Celsius.

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Appendix B:

How to Access Data from MODCOMP computer

1. Access VLA DDS. If you are at Socorro, type "VLA" at the DDS prompt.
2. Select the MODCOMP computer by entering "MONTY" or "BACCHUS".
3. Wake the computer up with ^A. (^ indicates the CTRL key.)
4. Switch to CAPS LOCK for entering commands to MONTY and BACCHUS. Lower case does not map to upper case in these computers.
5. If you receive the ">" prompt, enter "RUN BATCH".
A ^Q or /A command can sometimes gain control of the computer
at this point.
6. With the "\$" prompt, enter "EXE MONLST".
7. Once in MONLST, type "HELP" for detailed instructions. Basically, you must specify the points to be monitored with the command "MONPOINT":
 - a. Example: MONPOINT 1;6:3:'60;V will access the value of octal mux address 60_8 for data set 3 on antenna 6. Although 10 points may be specified, only 6 will be printed on the screen and are transferrable using KERMIT or other data transfer routines.
 - b. Specify the TIMERANGE in the format shown. Data older than 6 days is not accessible.
 - c. To honor the time range specified, specify "YES" for the honor time inquiry.
 - d. Choose octal, hex, or decimal. Choose "array" or "list" for format.
 - e. Choose CO for output; TTY will print on the VLA printer and no data will show on your monitor screen.
 - f. Use the command "IN" to check your parameters.
8. Type "GO" to begin listing data from the mux points specified, during the timerange given. To save the data, use data transfer software like KERMIT to write files to your disk. Follow instructions for your software. With KERMIT, it is necessary to open the file with ^R and close with ^A.
9. To exit MONLST (*), type "QUIT". To exit BATCH (\$), type "DIE", then "ALT-BREAK". To abort data taking, enter "^A". At the MONTY prompt >, type "/A". The implementation of XON/XOFF uses ^S, ^Q.
10. See Appendix A and C for scaling information.

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Appendix C:

MUX address for Tilt Sensors, Weather Sensors, and Antenna Positions

Tilts: Antenna 6 and 22 DS 2

MUX Parameter

'60	Tilt Ey	(y axis parallel to EL axis, encoder side)
'61	Tilt Ex	(x axis perpendicular to EL, encoder side)
'62	Tilt Wy	(y axis, waveguide side)
'63	Tilt Wx	(x axis, waveguide side)
'64	Temp Ey	(temperature of Tilt Ey heat controller)
'65	Temp Ex	(note: all temperatures should be 40 C)
'66	Temp Wy	
'67	Temp Wx	

Multiply tilt data by 100 for data in arcseconds.

Multiply temperature data by 10 for data in Celsius.

Utility

'70	-15V/2
'71	+10V
'72	ground
'73	+15V/2
'74	+5V
'75	ground
'76	ground
'77	ground

Antenna position: DS 0

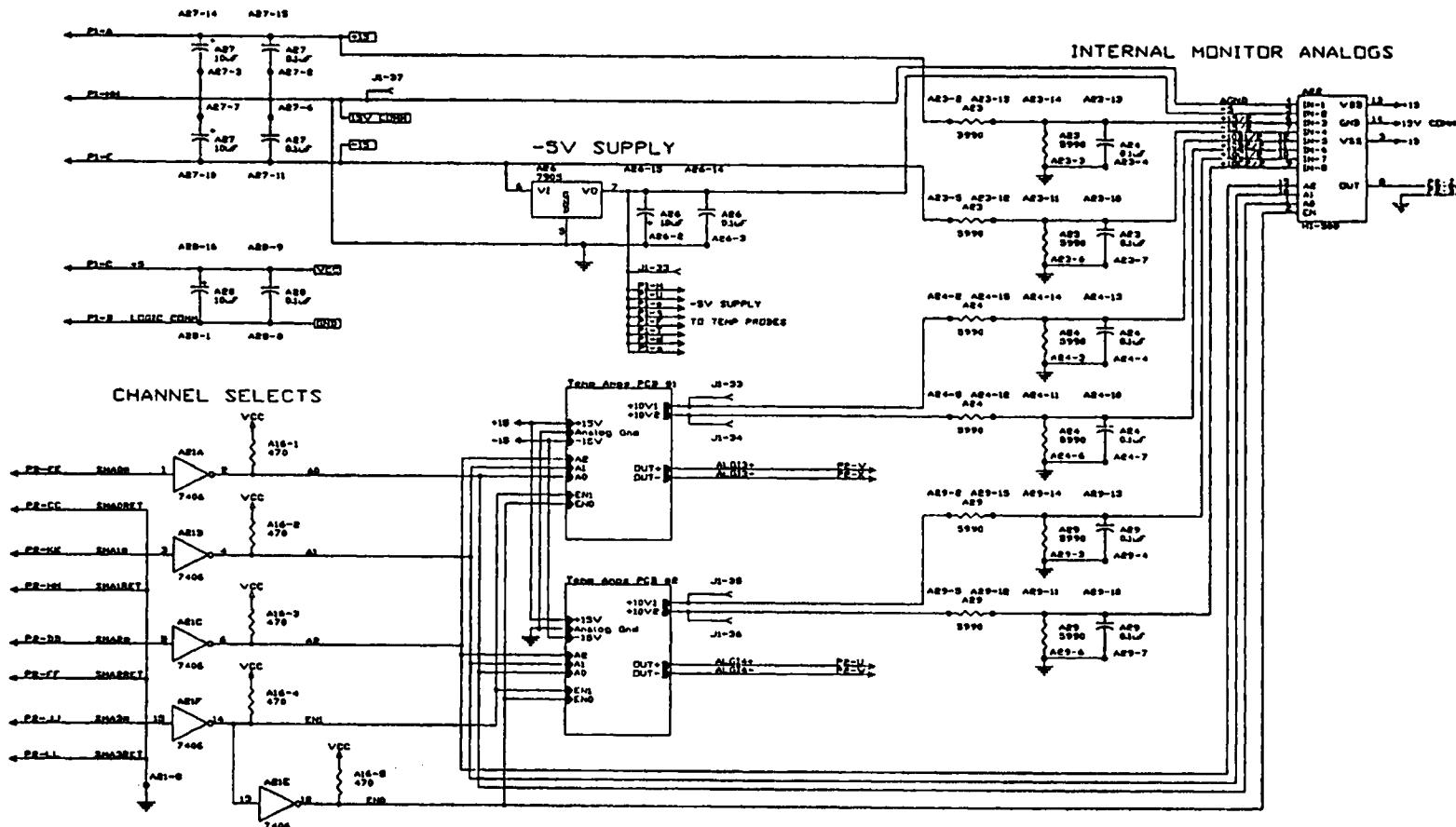
MUX Parameter

'210	Azimuth position where LSB = 1.24 arcseconds
'212	Elevation position where LSB = 1.24 arcseconds

Weather data: Antenna 0, DS 0

MUX Parameter

2	Wind speed where 1V = 1 meter per second.
3	Wind direction where 1V = 36 degrees azimuth, 10V = 360 degrees azimuth.
4	Ambient temperature where Temp = (21 * data in volts) - 45 in °C.



ACAD : M25SK-1
REF : ORCAD

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES		M25 TEMP/PROBE INTERFACE M25 TEMP/PROBE INTERFACE MULTIPLEX 16 TEMP CHANNEL PCB SCHEMATIC	NATIONAL RADIO ASTRONOMY OBSERVATORY SOCORRO, NEW MEXICO 87801		
REFERENCE : ANGLE 0	—		DRAWN BY	DATE	
3 PLATE INTERNAL L400 0	—		DESIGNED BY	DATE	
4 PLATE INTERNAL L400 0	—		APPROVED BY	DATE	
MATERIAL : —					
FINISH : —					
SHEET NUMBER	1 of 3	DRAWING NUMBER	C13720S32	REV	SCALE
C13720P22 ASSEMBLY					
C13720M03 DRILL DWG					
C13720A03 ARTWORK					
NEXT ASSEMBLY DWG. TYPE					

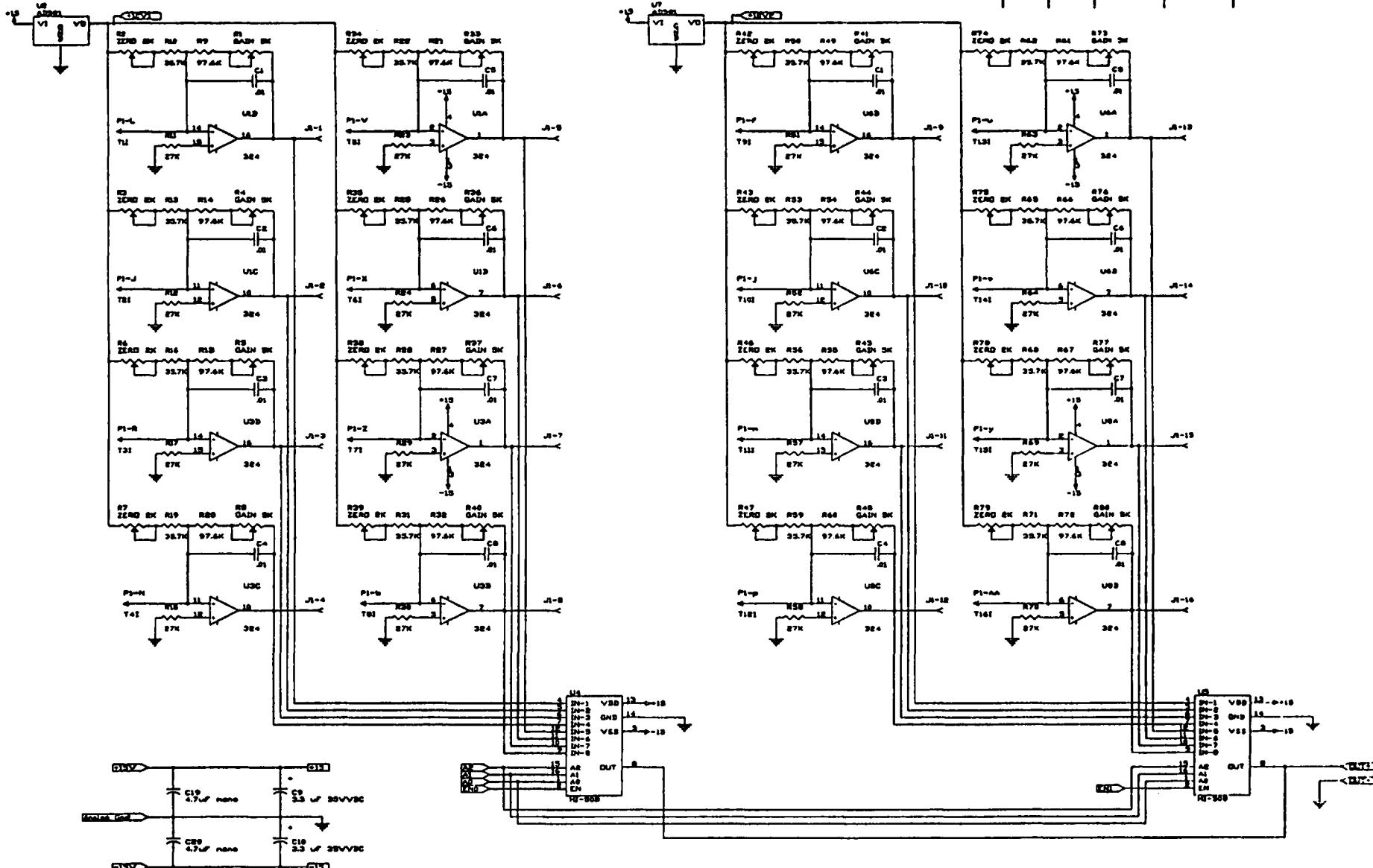
4

3

2

1

REV	DATE	DRAWN BY	APPRVD BY	DESCRIPTION



TEMPERATURE PROBE CHANNELS 1-16

ACAD : M25SK-2
REF : ORCAD

NEXT ASSEMBLY		DWG. TYPE	
B13720P22	ASSEMBLY		
C13720M03	DRILL DVG		
C13720AB03	ARTWORK		

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

REFERENCE : AIAA-6
2 PLANE SYMBOLIC LINES : _____
3 PLANE SYMBOLIC LINES : _____
4 PLANE SYMBOLIC LINES : _____

MATERIAL : _____

FINISH : _____

**M25
TEMP/PROBE
INTERFACE**
**M25 TEMP/PROBE
INTERFACE MULTIPLEX**
**16 TEMP CHANNEL
PCB SCHEMATIC**

NATIONAL RADIO
ASTRONOMY
OBSERVATORY
SOCORRO, NEW MEXICO 87801

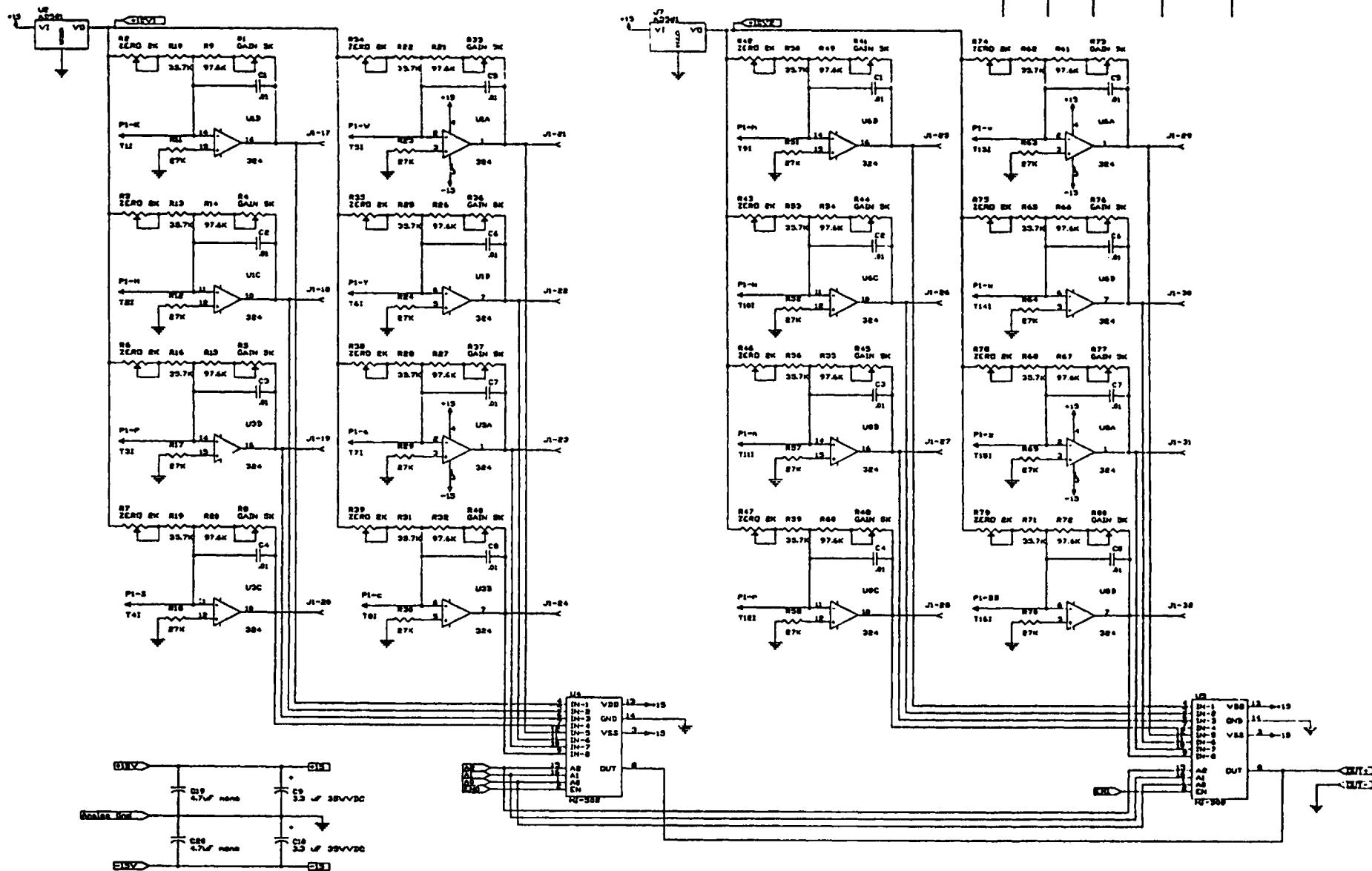
DRAWN BY DATE 1-91

DESIGNED BY DATE 3-90

APPROVED BY DATE

SHEET NUMBER 2 of 3 DRAWING NUMBER C13720S32 REV A SCALE _____

REV	DATE	DRAWD BY	APPRVD BY	DESCRIPTION



TEMPERATURE PROBE CHANNELS 17-32

DI3720P22	ASSEMBLY
C13720M03	DRILL DWG
C13720A03	ARTWORK
NEXT ASSEMBLY	DWG. TYPE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	MATERIAL :	FINISH :
BALANCED : UNBALANCED : _____	_____	_____
3 PLATE SIGNALS (1500) : _____	_____	_____
5 PLATE SIGNALS (100) : _____	_____	_____
7 PLATE SIGNALS (40) : _____	_____	_____

M25 TEMP/PROBE INTERFACE MULTIPLEX 16 TEMP CHANNEL PCB SCHEMATIC	
SHEET NUMBER	3 of 3
DRAWING NUMBER	C13720S32
REV	S-A1

DESIGNED BY	DATE
DR	1-91
APPROVED BY	DATE
DR	3-90

NATIONAL RADIO ASTRONOMY OBSERVATORY SOCORRO, NEW MEXICO 87801

M25 Wire List

PROJ=DCS
 JOB=M25 TEMPERATURE PROBE INTERFACE
 REV=0
 DATE=07/31/90
 MASTERD=XXXXXXXXXXXX
 MACHINED=XXXXXXXXXXXX
 HANDD=XXXXXXXXXXXX
 CONND=A1
 PUNCH=BOTH
 TYPEPATH=SHORTEST
 TYPEWIRE=BOTH
 TYPECON=NONE
 DO DCS

S M +10VB		XA24-15	XA24-14	XA24-13	XA22-10	
S M +10VC		XA24-11	XA24-10	XA24-09	XA22-09	
S M +15V			XA27-15	XA27-14		/ +15V DECOUPLING/
			XA22-13			
			XA23-02			/ +15V MONITOR/
S H +15VIN	P1-A		XA27-15	B-15+	C-15+	/#26AWG,RED WW/
S M -15V			XA27-10	XA27-11	XA26-06	
			XA22-03			
			XA23-05			/ -15V MONITOR/
S H -15VIN	P1-E		XA27-10	B-15-	C-15-	/#26AWG,YELLOW WW/
S M -5V	XA26-07		XA26-15	XA26-14		/ DECOUPLING HEADER A26
			XA22-07			/ -5V MONITOR/
S H -5VOUT	XA26-07	P1-H		P1-U	P1-e	P1-t /#26AWG,YEL/
		P1-F		P1-T	P1-d	P1-S /#26AWG,YEL/
			J1-33			/#26AWG,YEL/
S M 15MON+	XA23-15	XA23-14	XA23-13	XA22-12		
S M 15MON-	XA23-11	XA23-10	XA23-09	XA22-11		
S H A+10V	C10V	XA24-05	J1-35			/#26AWG,RED/
S M A0	XA21-02	XA16-01	XA22-01			
S H A0OUT	XA21-02			B-A0	C-A0	
S M A1	XA21-04	XA16-02	XA22-16			
S H A1OUT	XA21-04			B-A1	C-A1	
S M A2	XA21-06	XA16-03	XA22-15			
S H A2OUT	XA21-06			B-A2	C-A2	
S M AA2108	A21-08	XA21-07	/ GROUND FOR 7406 A21/			
S M AA2808	XA28-08	XA28-01	/ +5V DECOUPLING HEADER A28 /			
			XA22-05	/ DIGITAL GROUND MONITOR/		
S M AA2816	XA28-16	XA28-09	/ +5V DECOUPLING HEADER A28/			
			XA22-06	/ +5V MONITOR/		
S M AGND		XA27-07	XA27-06	XA27-02	XA27-03	
		XA24-06	XA24-07	XA24-03	XA24-04	
		XA23-06	XA23-07	XA23-03	XA23-04	
		XA22-14	XA22-01			
		XA26-05	XA26-02	XA26-03		
S H AGNDIN	P1-HH	XA27-07	B-GND	C-GND		/#26AWG,BLACK/
S H AGNDOT	C-GND	J1-37				/#26AWG,BLACK/
S H ALGI3+	B-OUT+	P2-V	/TP5,	#30AWG,WHT/		

M25 Wire List

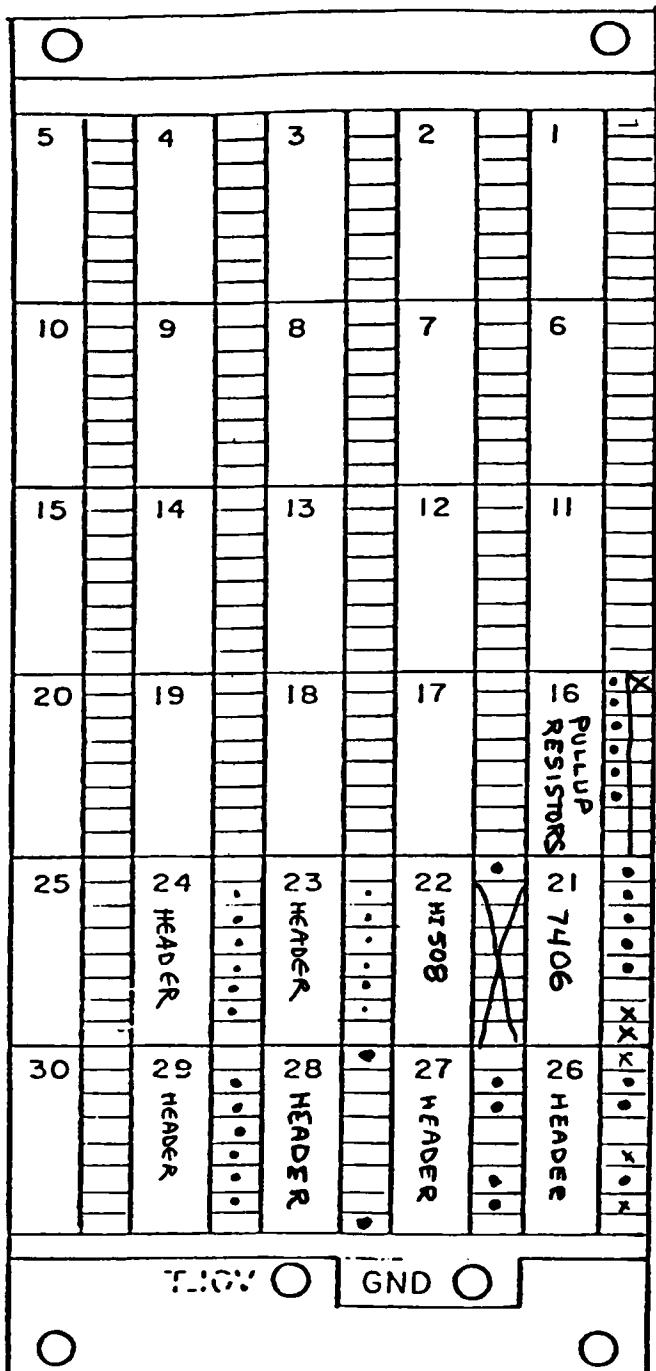
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S H ALGI4+	C-OUT+	P2-U	/TP6,#30AWG,WHT/		
S H ALGI4-	C-OUT-	P2-W	/TP6,#30AWG,BLK/		
S H ALGI5+	XA22-08	P2-Z	/TP7,#30AWG,WHT/		
S H ALGI5-	XA22-14	P2-BB	/TP7,#30AWG,BLK/		
S H B+10V	B10V	XA24-02	J1-34 /#26AWG,RED/		
S H DGNDIN	P1-B	A-GND	/#16AWG,BLACK /		
S M ENO	XA21-12	XA16-05	XA22-02		
S H ENOOUT	XA21-12			B-ENO	C-ENO
S M EN1	XA21-14	XA16-04			XA21-13
S H EN1OUT	XA21-14			B-EN1	C-EN1
S H SMA0-	P2-EE	XA21-01	/TP1,30AWG,WHT/		
S H SMA0-R	P2-CC	XA21-07	/TP1,30AWG,BLK/		
S H SMA1-	P2-KK	XA21-03	/TP2,30AWG,WHT/		
S H SMA1-R	P2-HH	XA21-07	/TP2,30AWG,BLK/		
S H SMA2-	P2-DD	XA21-05	/TP3,30AWG,WHT/		
S H SMA2-R	P2-FF	XA21-08	/TP3,30AWG,BLK/		
S H SMA3-	P2-JJ	XA21-15	/TP4,30AWG,WHT/		
S H SMA3-R	P2-LL	XA21-08	/TP4,30AWG,BLK/		
S H TEMP1V	BT1V	J1-1	/#26AWG,BLU/		
S H TEMP2V	BT2V	J1-2	/#26AWG,BLU/		
S H TEMP3V	BT3V	J1-3	/#26AWG,BLU/		
S H TEMP4V	BT4V	J1-4	/#26AWG,BLU/		
S H TEMP5V	BT5V	J1-5	/#26AWG,BLU/		
S H TEMP6V	BT6V	J1-6	/#26AWG,BLU/		
S H TEMP7V	BT7V	J1-7	/#26AWG,BLU/		
S H TEMP8V	BT8V	J1-8	/#26AWG,BLU/		
S H TEMP9V	BT9V	J1-9	/#26AWG,BLU/		
S H TMP10V	BT10V	J1-10	/#26AWG,BLU/		
S H TMP11V	BT11V	J1-11	/#26AWG,BLU/		
S H TMP12V	BT12V	J1-12	/#26AWG,BLU/		
S H TMP13V	BT13V	J1-13	/#26AWG,BLU/		
S H TMP14V	BT14V	J1-14	/#26AWG,BLU/		
S H TMP15V	BT15V	J1-15	/#26AWG,BLU/		
S H TMP16V	BT16V	J1-16	/#26AWG,BLU/		
S H TMP17V	CT1V	J1-17	/#26AWG,BLU/		
S H TMP18V	CT2V	J1-18	/#26AWG,BLU/		
S H TMP19V	CT3V	J1-19	/#26AWG,BLU/		
S H TMP20V	CT4V	J1-20	/#26AWG,BLU/		
S H TMP21V	CT5V	J1-21	/#26AWG,BLU/		
S H TMP22V	CT6V	J1-22	/#26AWG,BLU/		
S H TMP23V	CT7V	J1-23	/#26AWG,BLU/		
S H TMP24V	CT8V	J1-24	/#26AWG,BLU/		
S H TMP25V	CT9V	J1-25	/#26AWG,BLU/		
S H TMP26V	CT10V	J1-26	/#26AWG,BLU/		
S H TMP27V	CT11V	J1-27	/#26AWG,BLU/		
S H TMP28V	CT12V	J1-28	/#26AWG,BLU/		
S H TMP29V	CT13V	J1-29	/#26AWG,BLU/		
S H TMP30V	CT14V	J1-30	/#26AWG,BLU/		
S H TMP31V	CT15V	J1-31	/#26AWG,BLU/		

M25 Wire List

S H TMP32V CT16V J1-32 /#26AWG, BLU/

Loc A

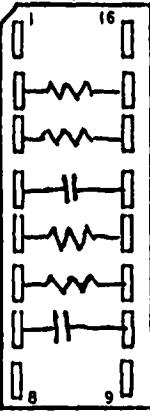
SPECIAL SUB ASSY'S



NATIONAL RADIO ASTRONOMY
OBSERVATORY
SOCORRO, NEW MEXICO 87801

PROJECT
TITLE M25 TEMP PROBE INTERFACE
DWG NO. SHEET 1 OF 5

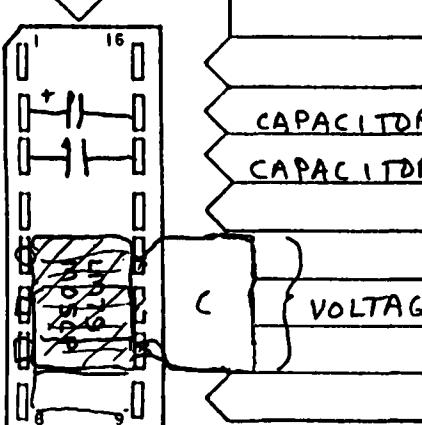
DESCRIPTION	VALUE	MFG	MFG P/N
DIP HEADER			
RESISTOR	4.99K 1%		
RESISTOR	4.99K 1%		
CAPACITOR	0.1 μ F mono		
RESISTOR	4.99K 1%		
RESISTOR	4.99K 1%		
CAPACITOR	0.1 μ F mono		

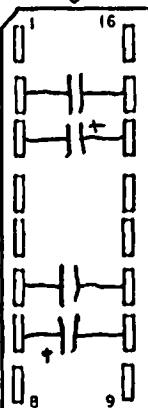


MODULE: M25

BOARD LOCATION: A23, A24, A29

DESCRIPTION	VALUE	MFG	MFG P/N
DIP HEADER			
CAPACITOR	3.3 μ F 35V elect		
CAPACITOR	0.1 μ F 50V mono		
VOLTAGE REGULATOR	-5V LM79M05CP	NATIONAL	

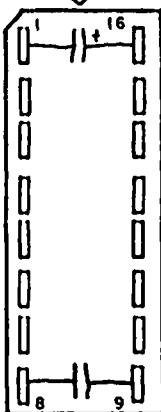

DWG.
NO.SHEET
3
of 5
REV.MODULE: M25BOARD LOCATION: A26

DESCRIPTION	VALUE	MFG	MFG P/N
DIP HEADER			
			
CAPACITOR	0.1 μ F mono		
CAPACITOR	3.3 μ F electrolytic 35V		
CAPACITOR	0.1 μ F mono		
CAPACITOR	3.3 μ F 35V elect.		

MODULE: M25

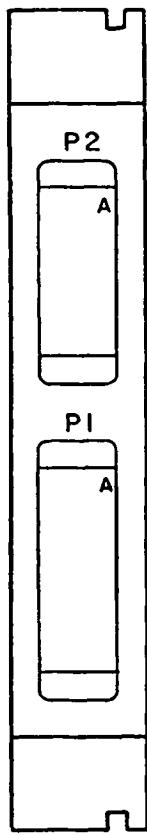
BOARD LOCATION: A27

DESCRIPTION	VALUE	MFG	MFG P/N
DIP HEADER			
CAPACITOR	3.3 μ F 35V		
CAPACITOR	0.1 μ F mono. 50V		

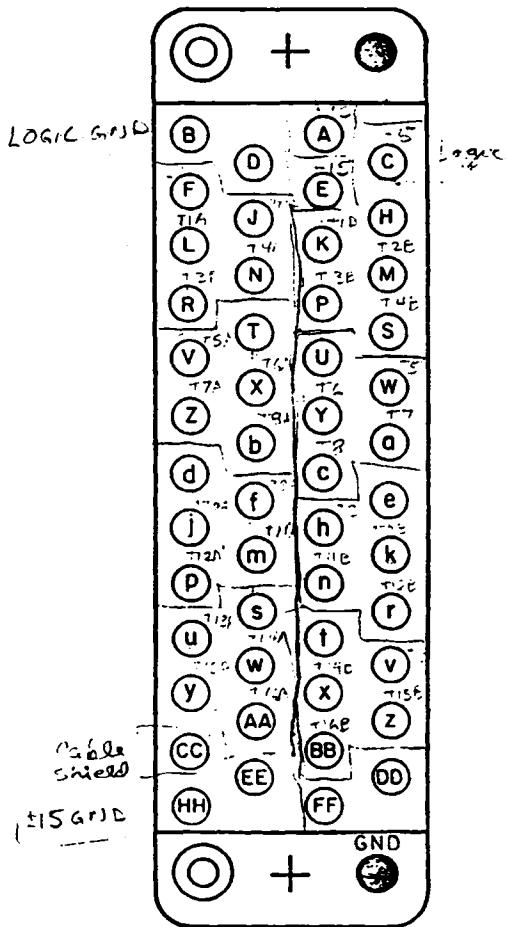


MODULE: M25

BOARD LOCATION: A28



SINGLE WIDE MODULE
(REAR VIEW)

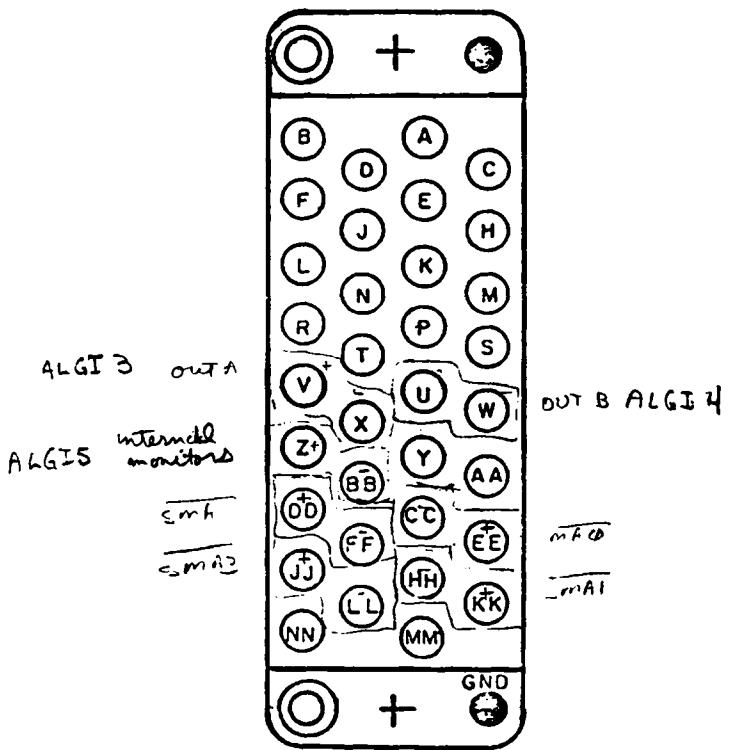


P1 (REAR VIEW)

P1

PIN	FUNCTION	WIRE COLOR	PIN	FUNCTION	WIRE COLOR
A	+ 15 VOLTS	RED	d	-5 To T9A - T16A	BLK/Gr/wh
B	GND LOGIC GND	BLK	e	-5 To T9B - T12B	gr/wh/blk or
C	+ 5 VOLTS	ORN	f	T9A	blk/rd
D	-		h	T9B	bl/rd
E	- 15 VOLTS	YEL	j	T10A	or/blk
F	-5 To T1A - T4A	Or/Gr/Blk	k	T10B	wh/blk/gr
H	-5 To T1B - T4B	rd/or/blk	m	T11A	rd/wh/blk
J	T2A	gr/blk/or	n	T11B	wh/blk/gr
K	T1B	wh/rd/gr	p	T12A	rd/wh/blk
L	T1A	Blk/wh/or	r	T12B	blk/rd/wh
M	T2B	blk/rd/gr	s	-5 To T13A - T16A	
N	T4A	wh/rd/or	t	-5 To T13B - T16B	wh
P	T3B	rd/wh	u	T13A	rd/gr
R	T3A	Or/wh/Bl	v	T13B	gr/blk
S	T4B	Bl	w	T14A	wh/blk
T	-5 To T5A - T8A	Blk/wn	x	T14B	rd/blk
U	-5 To T5B - T8B	Bl/wh	y	T15A	rd/wh/gr
V	T5A	Wh/rd/bl	z	T15B	blk/blk
W	T5B	Bl/blk/wh	AA	T16A	blk/wh/rd
X	T6A	wh/rd	BB	T16B	wh/rd/blk
Y	T6B	Or/wh	CC	CABLE SHIELD	
Z	T7A	Or/rd	DD		
a	T7B	bl/or/wh	EE		
b	T8A	Or	FF		
c	T8B	rd	HH	ANALOG GND (±15COM)	BLK

* INDICATES A FUNCTION NOT FOUND IN THIS MODULE

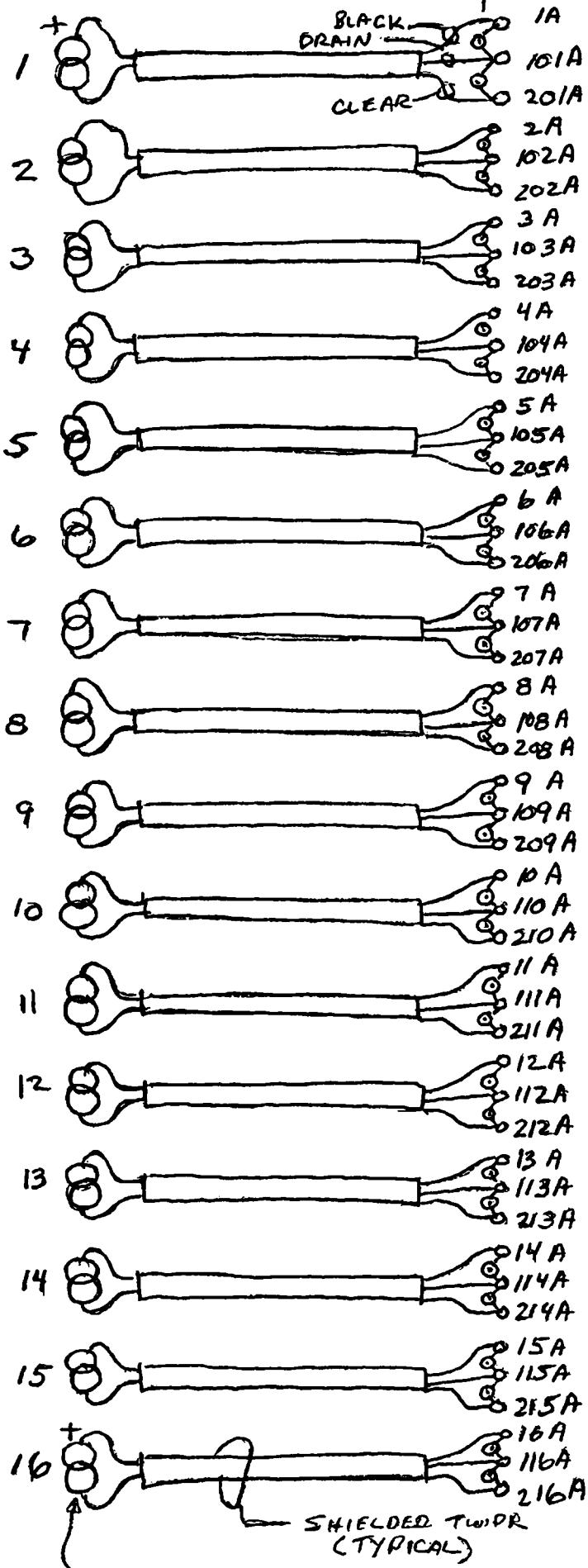


P2 (REAR VIEW)

P2

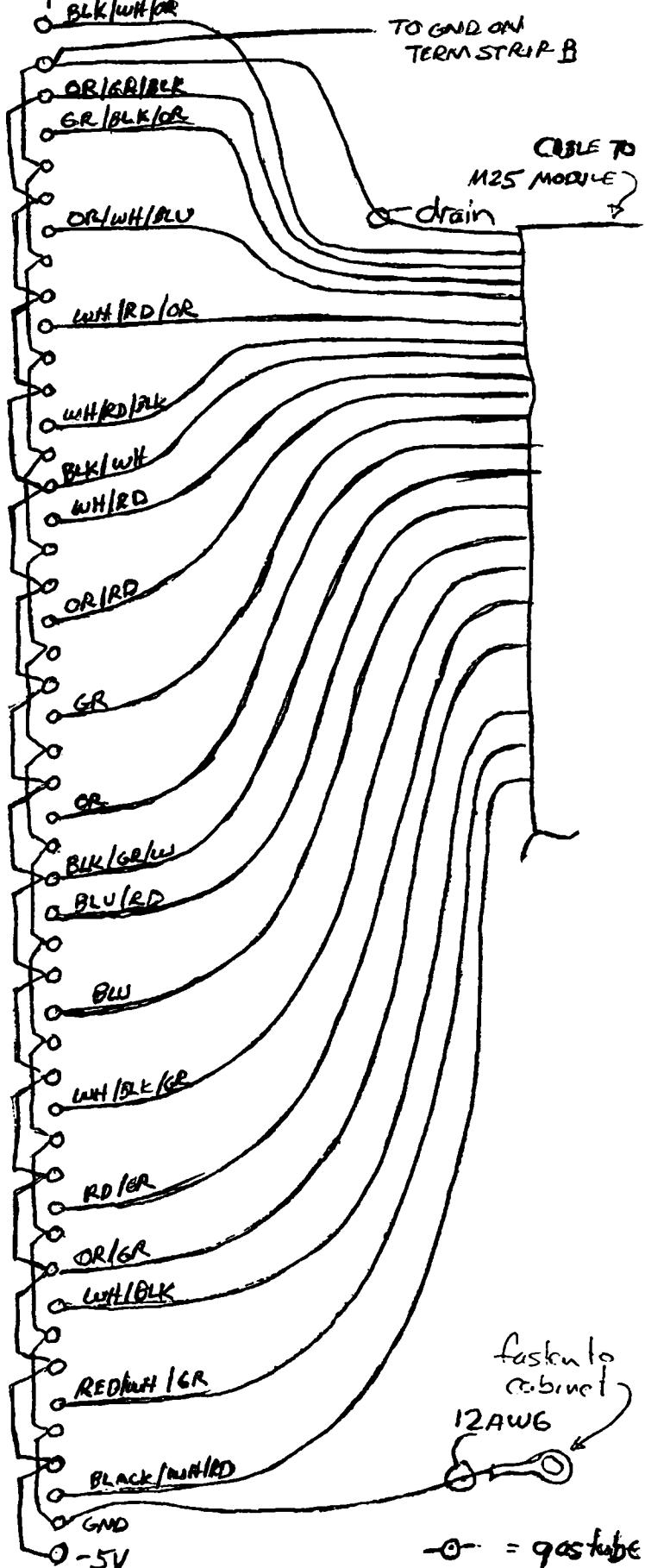
PIN	FUNCTION	WIRE COLOR	PIN	FUNCTION	WIRE COLOR
A			V	ALGI 3 +	
B			W	ALGI 4 -	
C			X	ALGI 3 -	
D			Y		
E			Z	ALGI 5 +	
F			AA		
H			BB	ALGI 5 -	
J			CC	SMA1 net	
K			DD	SMA2	
L			EE	SMA3	
M			FF	SMA3 net	
N			HH	SMA1 net	
P			JJ	SMA2	
R			KK	SMA1	
S			LL	SMA3 1.	
T			MM		
U	ALGI 4 +		NN		

3-TIER TERMINAL BLOCK ON DIN RAIL



AD590 SENSOR (TYP)

R=RED, G=GREEN, BL=BLUE, B=BLACK, W=WHITE, O=ORANGE, CCJ



-o- = gas tube suppressor

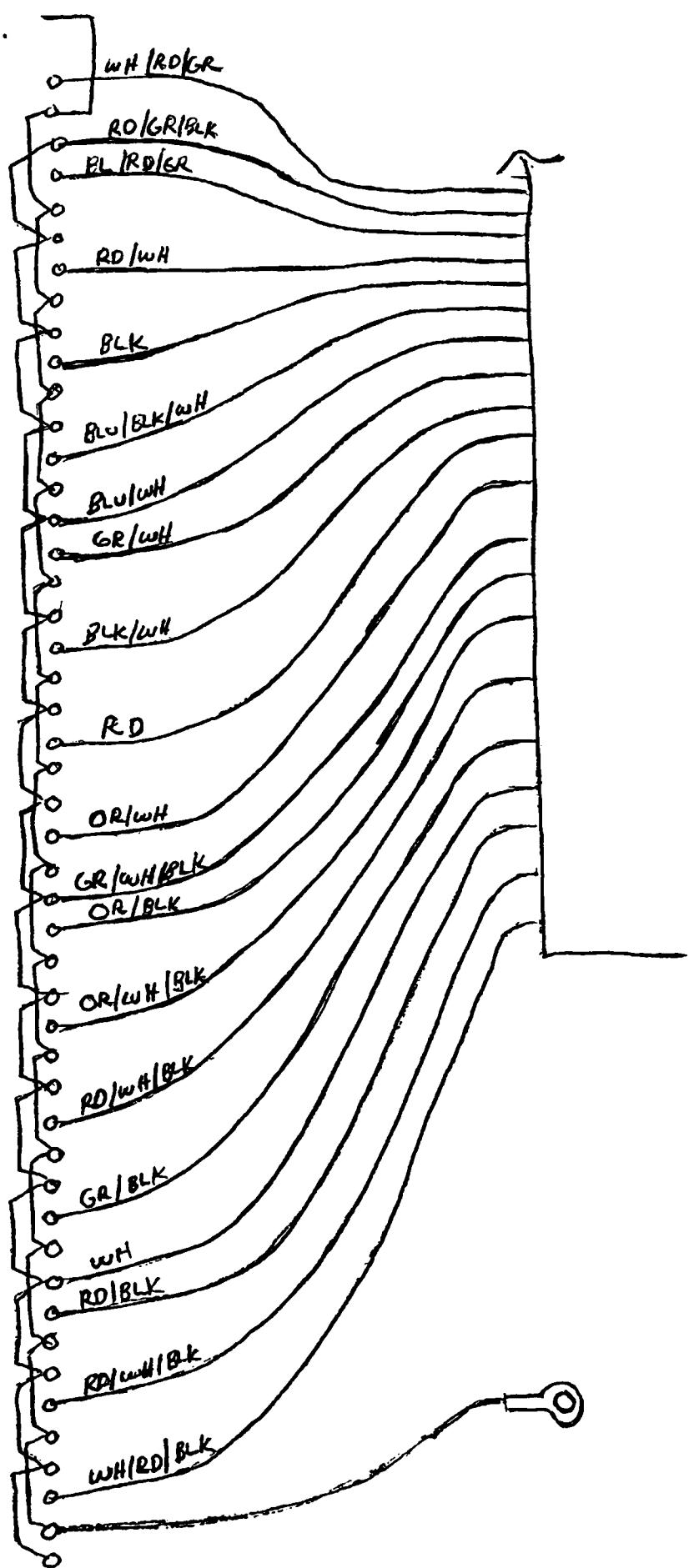
JBOX
VLATEMPSENSE ARRAY

7/26/90

SH 1/2

TO GND
ON TERM A.

- 17 1B
- 18 10B
- 19 20B
- 20 2B
- 21 102B
- 22 202B
- 23 3B
- 24 103B
- 25 203B
- 26 4B
- 27 104B
- 28 204B
- 29 5B
- 30 105B
- 31 205B
- 32 6B
- 22 106B
- 23 206B
- 24 7B
- 25 107B
- 26 207B
- 27 8B
- 28 108B
- 29 208B
- 30 9B
- 31 109B
- 32 209B
- 26 10B
- 27 11B
- 28 211B
- 29 12B
- 30 112B
- 31 212B
- 29 113B
- 30 213B
- 31 13B
- 32 214B
- 30 14B
- 31 114B
- 32 214B
- 31 15B
- 32 215B
- 30 115B
- 31 215B
- 32 16B
- 31 116B
- 32 216B



VIA-TO-GND-TERM A

J BOX

CCIT

7/25/10

SH 2/2



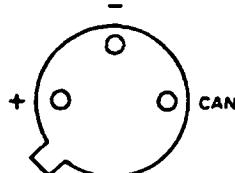
Two-Terminal IC Temperature Transducer

AD590*

FEATURES

- Linear Current Output: $1\mu\text{A}/\text{K}$
- Wide Range: -55°C to $+150^\circ\text{C}$
- Probe Compatible Ceramic Sensor Package
- Two-Terminal Device: Voltage In/Current Out
- Laser Trimmed to $\pm 0.5^\circ\text{C}$ Calibration Accuracy (AD590M)
- Excellent Linearity: $\pm 0.3^\circ\text{C}$ Over Full Range (AD590M)
- Wide Power Supply Range: $+4\text{V}$ to $+30\text{V}$
- Sensor Isolation from Case
- Low Cost

AD590 PIN DESIGNATIONS



BOTTOM VIEW

PRODUCT DESCRIPTION

The AD590 is a two-terminal integrated circuit temperature transducer which produces an output current proportional to absolute temperature. For supply voltages between $+4\text{V}$ and $+30\text{V}$ the device acts as a high impedance, constant current regulator passing $1\mu\text{A}/\text{K}$. Laser trimming of the chip's thin film resistors is used to calibrate the device to $298.2\mu\text{A}$ output at 273.2K ($+25^\circ\text{C}$).

The AD590 should be used in any temperature sensing application below $+150^\circ\text{C}$ in which conventional electrical temperature sensors are currently employed. The inherent low cost of a monolithic integrated circuit combined with the elimination of support circuitry makes the AD590 an attractive alternative for many temperature measurement situations. Linearization circuitry, precision voltage amplifiers, resistance measuring circuitry and cold junction compensation are not needed in applying the AD590.

In addition to temperature measurement, applications include temperature compensation or correction of discrete components, biasing proportional to absolute temperature, flow rate measurement, level detection of fluids and anemometry. The AD590 is available in chip form making it suitable for hybrid circuits and fast temperature measurements in protected environments.

The AD590 is particularly useful in remote sensing applications. The device is insensitive to voltage drops over long lines due to its high impedance current output. Any well-insulated twisted pair is sufficient for operation hundreds of feet from the receiving circuitry. The output characteristics also make the AD590 easy to multiplex: the current can be switched by a CMOS multiplexer or the supply voltage can be switched by a logic gate output.

*Covered by Patent No. 4,123,698

PRODUCT HIGHLIGHTS

1. The AD590 is a calibrated two terminal temperature sensor requiring only a dc voltage supply ($+4\text{V}$ to $+30\text{V}$). Costly transmitters, filters, lead wire compensation and linearization circuits are all unnecessary in applying the device.
2. State-of-the-art laser trimming at the wafer level in conjunction with extensive final testing insures that AD590 units are easily interchangeable.
3. Superior interference rejection results from the output being a current rather than a voltage. In addition, power requirements are low (1.5mW 's @ 5V @ $+25^\circ\text{C}$). These features make the AD590 easy to apply as a remote sensor.
4. The high output impedance ($>10\text{M}\Omega$) provides excellent rejection of supply voltage drift and ripple. For instance, changing the power supply from 5V to 10V results in only a $1\mu\text{A}$ maximum current change, or 1°C equivalent error.
5. The AD590 is electrically durable: it will withstand a forward voltage up to 44V and a reverse voltage of 20V . Hence, supply irregularities or pin reversal will not damage the device.



SPECIFICATIONS

($\theta = +25^\circ\text{C}$ and $V_s = 5\text{V}$ unless otherwise noted)

Model	AD590J			AD590K			Units
	Min	Typ	Max	Min	Typ	Max	
ABSOLUTE MAXIMUM RATINGS							
Forward Voltage ($E_+ - E_-$)			+44			+44	Volts
Reverse Voltage ($E_+ - E_-$)			-20			-20	Volts
Breakdown Voltage (Case to E_+ or E_-)			± 200			± 200	Volts
Rated Performance Temperature Range ¹	-55	+150		-55	+150		$^\circ\text{C}$
Storage Temperature Range ¹	-65	+155		-65	+155		$^\circ\text{C}$
Lead Temperature (Soldering, 10 sec)			+300			+300	$^\circ\text{C}$
POWER SUPPLY							
Operating Voltage Range	+4	+30		+4	+30		Volts
OUTPUT							
Nominal Current Output ($+25^\circ\text{C}$ / 295.2K)		295.2			295.2		
Nominal Temperature Coefficient	1			1			$\mu\text{A/K}$
Calibration Error ($+25^\circ\text{C}$)			± 5.0			± 2.5	$^\circ\text{C}$
Absolute Error (over rated performance temperature range)							
Without External Calibration Adjustment			± 10			± 5.5	$^\circ\text{C}$
With $+25^\circ\text{C}$ Calibration Error Set to Zero			± 3.0			± 2.0	$^\circ\text{C}$
Nonlinearity			± 1.5			± 0.8	$^\circ\text{C}$
Repeatability			± 0.1			± 0.1	$^\circ\text{C}$
Long Term Drift ²			± 0.1			± 0.1	$^\circ\text{C}$
Current Noise		40			40		$\mu\text{A} \sqrt{\text{Hz}}$
Power Supply Rejection							
$+4\text{V} \leq V_s \leq +5\text{V}$		0.5			0.5		μAV
$+5\text{V} \leq V_s \leq +15\text{V}$		0.2			0.2		μAV
$+15\text{V} \leq V_s \leq +30\text{V}$		0.1			0.1		μAV
Case Isolation to Either Lead		10^{10}			10^{10}		MΩ
Effective Shunt Capacitance		100			100		pF
Electrical Turn-On Time		20			20		μs
Reverse Bias Leakage Current ³			10			10	pA
PACKAGE OPTION⁴							
TO-52 (II-03A)		AD590JH			AD590KH		
Flat Pack (F-2A)		AD590JF			AD590KF		

NOTES

¹The AD590 has been used at -100°C and $+200^\circ\text{C}$ for short periods of measurement with no physical damage to the device. However, the absolute errors specified apply to only the rated performance temperature range.

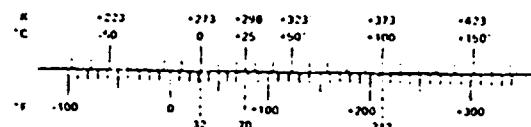
²Maximum deviation between $+25^\circ\text{C}$ readings after temperature cycling between -55°C and $+150^\circ\text{C}$; guaranteed not tested.

³Conditions: constant $+5\text{V}$, constant $+125^\circ\text{C}$, guaranteed, not tested.

⁴Leakage current doubles every 10°C .

⁵See Section 10 for package outline information.
Specifications subject to change without notice.

Specifications shown in boldface are tested on all production units at final electrical test. Results from those tests are used to calculate outgoing quality levels. All min and max specifications are guaranteed, although only those shown in boldface are tested on all production units.



TEMPERATURE SCALE CONVERSION EQUATIONS

$$^\circ\text{C} = \frac{5}{9} \cdot (\text{°F} - 32) \quad K = ^\circ\text{C} + 273.15$$

$$\text{°F} = \frac{9}{5} \cdot ^\circ\text{C} + 32 \quad ^\circ\text{R} = \text{°F} + 459.7$$

Model	AD590L			AD590M			
	Min	Typ	Max	Min	Typ	Max	Units
ABSOLUTE MAXIMUM RATINGS							
Forward Voltage E + to E -			+ 44			+ 44	Volts
Reverse Voltage E - to E +			- 20			- 20	Volts
Breakdown Voltage (Case to E + or E -)			± 200			± 200	Volts
Limited Performance Temperature Range ¹	- 55		+ 150	- 55		+ 150	°C
Storage Temperature Range ²	- 65		+ 155	- 65		+ 155	°C
Lead Temperature Soldering, 10 sec ³			+ 300			+ 300	°C
POWER SUPPLY							
VOperating Voltage Range	- 4		+ 30	- 4		+ 30	Volts
CURRENT							
Nominal Current Output at + 25°C (298.2K)		298.2			298.2		
Nominal Temperature Coefficient	1		1				µA/K
Calibration Error at + 25°C			± 1.0			± 0.5	°C
Absolute Error (over rated performance temperature range)							
Without External Calibration Adjustment			± 3.0			± 1.7	°C
With + 25°C Calibration Error Set to Zero			± 1.6			± 1.0	°C
Nonlinearity			± 0.4			± 0.3	°C
Repeatability ⁴			± 0.1			± 0.1	°C
Long Term Drift ⁵			± 0.1			± 0.1	°C
Current Noise	40			40			pA/Hz
Power Supply Rejection							
+ 4V < V _{CC} < + 5V		0.5			0.5		µAV
+ 5V < V _{CC} < + 15V		0.2			0.2		µAV
+ 15V < V _{CC} < + 30V		0.1			0.1		µAV
Case Isolation to Either Lead		10 ¹⁰			10 ¹⁰		Ω
Effective Shunt Capacitance	100			100			pF
Electrical Turn-On Time	20			20			ns
Reverse Bias Leakage Current ⁶							
Reverse Voltage = 10V	10			10			pA
PACKAGE OPTION⁷							
TO-52-H-03A ⁸		AD590LJ			AD590MH		
Flat Pack (F-2A)		AD590LF			AD590MF		

