VLA TECHNICAL REPORT NO. 43

WAVEGUIDE PRESSURE SENSING SYSTEM
(PART OF ANTENNA ZERO)

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1.0 INTRODUCTION

This technical manual was prepared to encompass operation, theory of operation and maintenance viewpoints of the WCC Pressure Sensing System. This system, a one-of-a-kind device, essentially monitors the pressurization of the three waveguides and acts as a DCS system interface in making this pressure information available to the Monitor and Control System, and, hence, the computer overlays for monitoring.

The WCC Pressure Sensing System is a part of the Antenna Zero System and, hence, a part of the Monitor and Control System. Upon initial installation it also became a part of the Waveguide Pressurization and Charging System in a passive role, as it offers no control functions over the charging system. Hence, it also is a responsibility of the Waveguide Group. It is for the latter that this documentation was specially prepared.

2.0 GENERAL DESCRIPTION

2.1 Waveguide Pressurization/Charging System

"The VLA waveguide system is pressurized with dry nitrogen gas supplied from a tank of liquid nitrogen (LN_2). The pressurization with nitrogen is required in order to provide a low-loss transmission medium in the bandwith 27 to 52 GHz. Nitrogen does not have any natural resonant frequencies in this bandwidth."[1] This pressurization of the waveguide system also tends to protect the waveguide from water in the event of rupture or poor seal.

The charging system consists of a 1500 gallon tank of LN_2, heat exchangers to insure a dry gaseous state, the various control, vent and relief valves required, and the pressure regulators to keep this nitrogenated pressure at the desired pressure. The charging system has the capability to pressurize the system at any level from 1 to 22 psi. Currently, 2.0±0.1 psi is used for the system pressure.

This pressure is maintained by the actions of two series regulators. A nominal pressure of 15 psig (above atmosphere) is reduced to 5 psig by the first regulator. This 5 psig will, of course, vary with the atmospheric pressure. The waveguide pressure is to be maintained at a constant pressure, isolated from atmospheric pressure variations. This is accomplished by the 2 psia regulator, which is referenced to a vacuum. It maintains an output of 2 psi above the normalized atmospheric pressure of 780 mb, or nearly 13 psi absolute. Thus, the pressurization is maintained at this level and independent of atmospheric pressure fluctuations.

Because each waveguide arm is an independent subsystem (separate regulators, etc.), it is a mandate to monitor each arm as a separate entity. This is illustrated by the fact that a leak

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[1] "Waveguide Pressurization System and Procedures", Bill delGiudice, VLA

in the waveguide (or intentional venting), will only effect one waveguide and not influence the other two waveguide pressures.

Figure 1 shows the piping arrangement of this charging system and is included herein for reference purposes only. The charging station is located about 50 metres north of the Control Building.

CAUTION: Waveguide pressurization should be controlled, adjusted or modified by authorized personnel only.

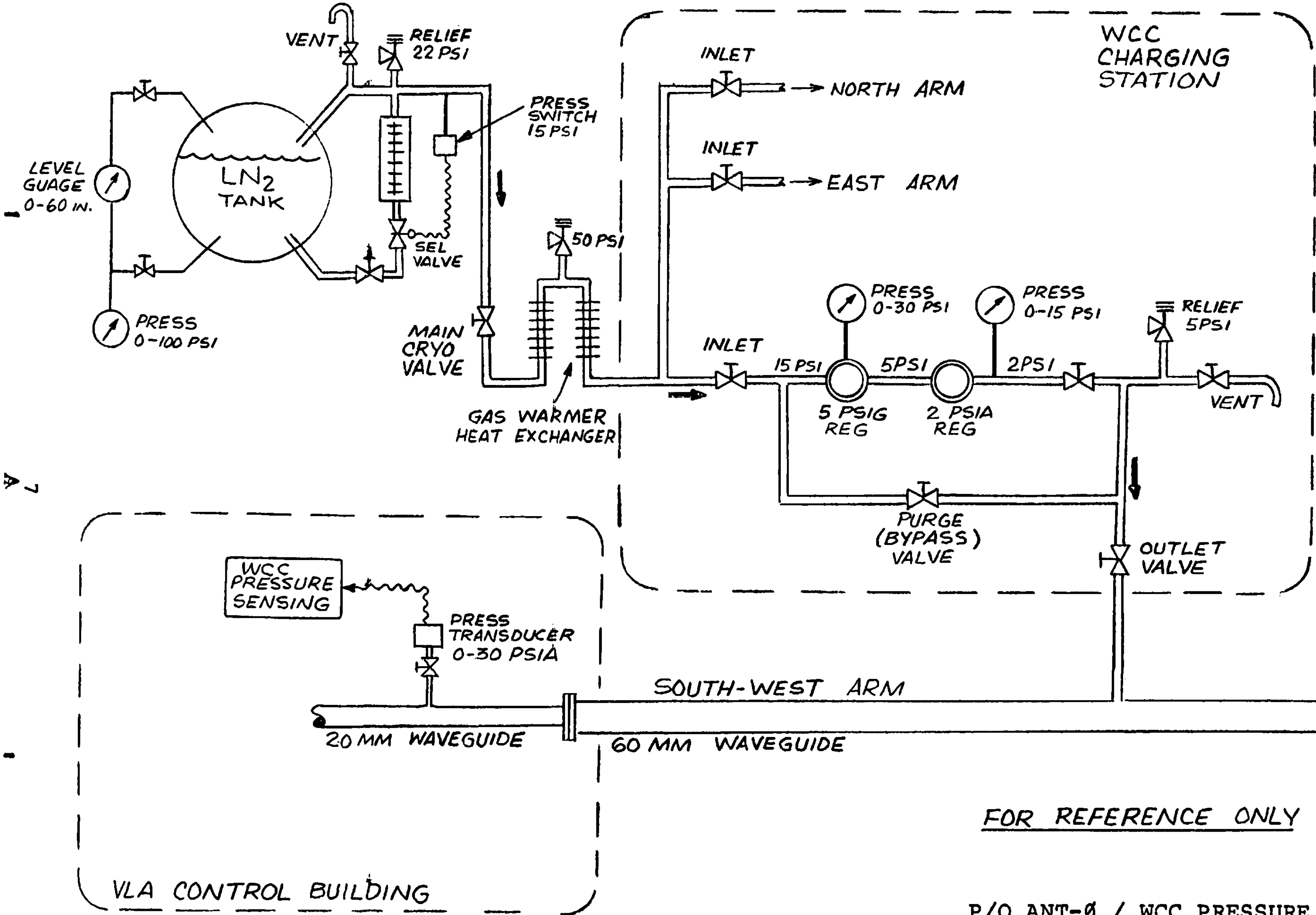


FIG. 1 – PRESSURIZATION SYSTEM PIPING

P/O ANT-Ø / WCC PRESSURE SYSTEM

WAVEGUIDE PRESSURIZATION SYS. PIPING-TAB	national radio astronomy observatory vla project • n.m.
dsg by [redacted] d	sht dwg no.

sht of

2.2 LX1703A Pressure Tranducers

"The (LX1700) series of pressure transducers (National Semiconductor Corporation) are hybrid IC devices with internal operational amplifiers, temperature compensation, signal conditioning and voltage regulation to provide a linear and accurate voltage output corresponding to the applied pressure."[2]

The LX1703A is a 0-30 psia (absolute) pressure transducer mounted in a rugged die cast zinc housing with a 1/8" NPT fitting. This meets both the electrical and physical requirements of the WCC Pressure Sensing System. There is a LX1703A transducer for each of the three waveguide arms mounted on the 20-mm waveguide sections immediately after the 60 mm-to-20 mm waveguide transition. An isolation valve separates the transducer from the pressurized waveguide.

An electronic pressure transducer was chosen due to the requirement of providing the waveguide pressures as a monitoring point through the Monitor and Control System. These pressures are thus available on the "MW1 Overlay" (MW1 DCS-Ø Data Set 5) and to the computerized monitor logging features of MONTY. Local gauge readings are also provided on the amplifier and control unit at the waveguide station.

These transducers require +12 V excitation.

Refer to the LX1703A data sheets in the Appendix for additional information.

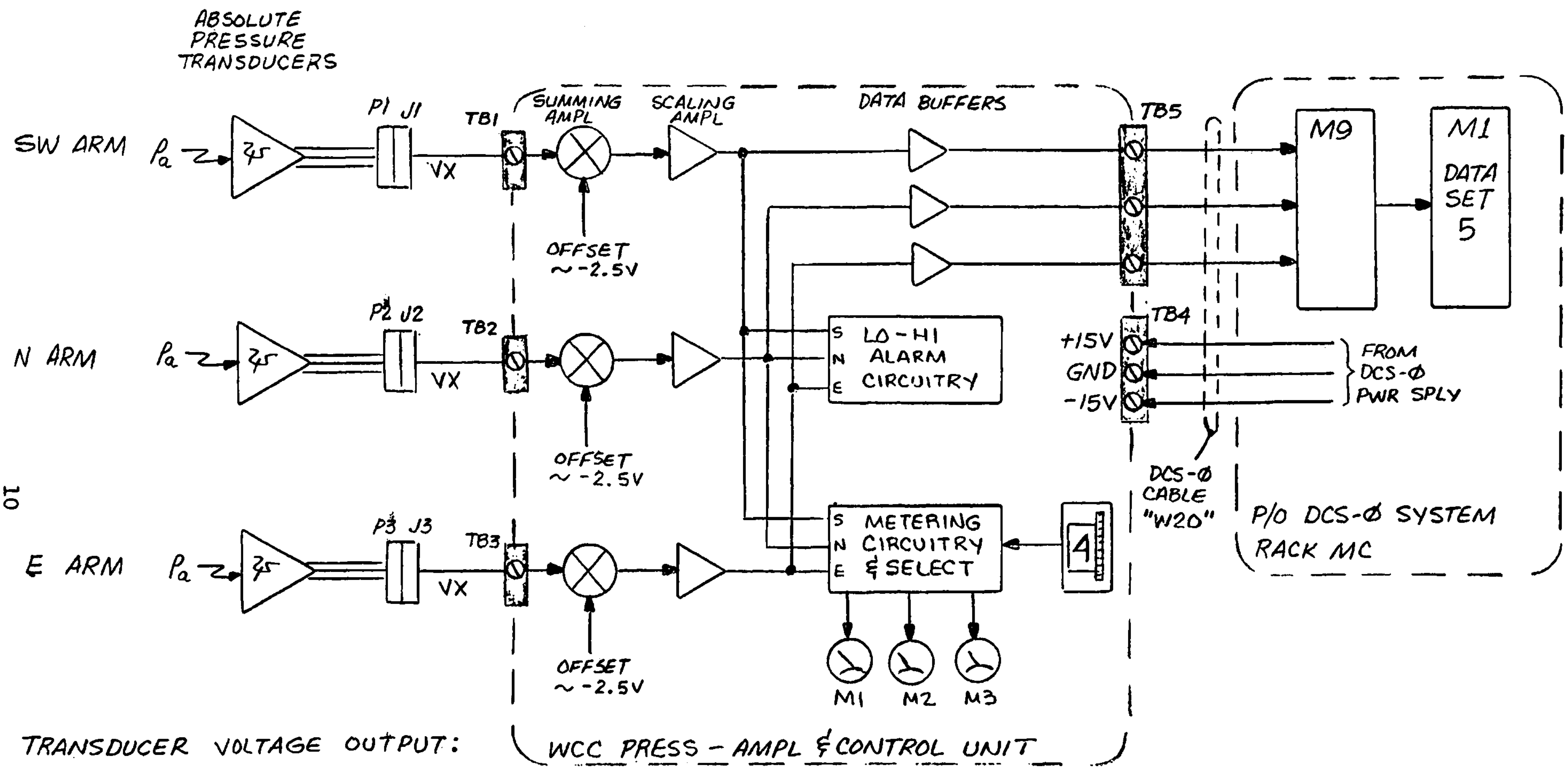
[2]"Pressure Transducer Handbook", National Semiconductor, 1977.

2.3 Amplifier and Control Unit

The output of the pressure transducers must supply this pressure information to local gauges (meters) and to the Monitor and Control System. Also, the voltage outputs of the transducers, though linear, contain voltage offsets (bias) that render the output voltages difficult to implement for direct monitoring of volts-to-pounds of pressure. Hence, the amplifier and control unit conditions the transducer output voltage (V_x), provides the "scaling factor" necessary for volts-to-pounds conversion, and makes this pressure output voltage (V_p) available to the local pressure meters and to the Monitor and Control System as a Data Set analog input.

Additionally, the control unit provides the +12 V excitation to the transducers, provides internal monitoring (power supply voltages, etc.) and alarm circuitry. The alarm circuitry consists of voltage comparators that sense when the three waveguide pressures exceed their respective HI- and LO-PRESSURE limits, and when activated provides a visual alarm of the condition. The alarm condition is also "latched", that is "stored" until manually cleared, to indicate that an alarm condition had occurred. The alarm set points (HI- and LO-PRESSURE) are adjustable and may be changed at any time. They are currently set at 1.8 psi (LO) and 2.2 psi (HI).

Refer to Figure 2, Overall Block Diagram.



TRANSDUCER VOLTAGE OUTPUT:

$$V_X = V_0 + (S \cdot P_a)$$

where:

V_X = XDUCER OUTPUT VOLTS

V_0 = OFFSET BIAS VOLTAGE ≈ +2.5v ±.5

S = PRESSURE SENSITIVITY ≈ 333mV/PSIA

P_a = APPLIED PRESSURE ≈ 11-12 PSIA

∴ AT 11 PSIA (2 PSI ABOVE ATMOSPHERE)

$$V_X = 2.5v + (333mV \cdot 11psi) \approx 5.1V$$

FIGURE 2

P/O ANT-Ø / WCC PRESSURE SYSTEM

OVERALL BLOCK DIAGRAM	national radio astronomy observatory vla project • n.m.
dsg by P. HARDEN d	sht / dwg no

sht ___ of ___

2.4 DCS Interface

The three pressure outputs of the three waveguide pressures are sent to DCS-Ø (Antenna Zero) Data Set 5 as analog inputs. These analog signals are routed through DCS-Ø cable "W105B".

These analog signals (VP_s, VP_n, VP_e) are buffered by unity gain op-amps as a cable driver to prevent any loading effects to the scaling amplifiers. Empirical measurements show a nominal 5 mV voltage loss in this drive scheme, which relates to a ±2 bit error in the Data Set analog-digital converter, (including the ±1 bit analog-digital accuracy), or in terms of pressure, a ±0.010 psi error.

To eliminate lengthy cable runs of analog lines and Data Set sub-MUX address lines (SMA), the analog multiplexer that sequentially selects the proper waveguide pressure (under Data Set 5 control) is actually located in module M9 of the Antenna Zero System.

The resulting monitor points are:

WCC Pressure,	S Arm	MUX 020	DCS-Ø	DS 5
	N Arm	MUX 021		
	E Arm	MUX 022		

The Data Set 5 PROM selects this data, and consequently is part of the monitor word one (MW1) overlay.

Refer to Figure 3, MW1 Overlay Presentation.

```
OPERATOR GENERATED COPY: 178 23:16:01

<A000>   -0.040  -0.165  -7.295   7.440 -10.160   6.395
<A010>
<A020>    2.105   2.030   2.115   2.180   1.415   4.085
<A030>
<A040>
<A050>
<A060>
<A070>
<A100>
<A110>
<A120>
<A130>
<A140>
<A150>
<A160>
<A170>
<D200> FFFFFF          1010100
<D210>
<D220>
<D230>
<D240>
<D250>
<D260>
HCD270>
HCD270>
```

SW ARM PRESS — N ARM PRESS — E ARM PRESS

OVERLAY OF: MW1 DCS Ø DS 5

COMPUTER ENTRY "MW 1 'Ø 5" (RETURN)

FIGURE 3

ILLUSTRATION COMPUTER OVERLAY

3.0 DETAILED CIRCUIT ANALYSIS

3.1 Transducer Scaling Amplifiers

(Refer to Schematic Diagram, sheet 1.) There are three separate scaling amplifier channels that are exactly identical except for component location. The following discussion and references are based on "Channel 1 - SW Arm."

The input voltage from the transducer may be expressed as:

$$V_x = V_o + (S \cdot P_a)$$

where; V_x = transducer output voltage
V_o = offset calibration voltage
S = sensitivity (mV/psi)
P_a = applied pressure (psia).

For the LX1703A transducer and the VLA application, these parameters are:

V_o = +2.5±0.5 V bias offset
S = 333±3 mV/psia
P_a = 11-12 psia (typ).

This yields a typical input voltage of: (at 13 psia)*

$$V_x = V_o + (S \cdot P_a)$$
$$= 2.5\ \text{V} + (333\ \text{mV/psia} \cdot 13\ \text{psia})$$
$$= 2.5\ \text{V} + 4.33$$
$$V_x = 6.83\ \text{V}$$

The waveguide pressurization is currently specified for "2 psi", which in reality means "2 psi above the normalized

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*The normal, average atmospheric (barometric) pressure at the VLA Site is 780 mb (~11.4 psi) + 2.0 psi WCC pressure ≈ 13 psia.

atmospheric pressure". Since this 2 psi is the pressure of interest, all other pressures and offset voltages from the transducer must be eliminated. This is performed primarily by TRANSDUCER OFFSET AMPL, U1A. Resistors Z4R1 and Z4R5 form a summing junction. Of the +6.83 V (nom.) transducer input, about +6.2 V is attributable to the offset bias and atmospheric pressure of the transducer, and, hence, "subtracted" by inserting -6.2 V from Z4R5, the OFFSET BIAS adjustment. The resulting output of amplifier U1A is zero volts with the transducer exposed to an atmospheric pressure of 780 mb. A 100 k ohm pot was chosen for Z4R5 to provide a wide range of offset bias (0 to -15 V) should future requirements call for a higher waveguide pressure or for a true absolute pressure reading.

The output of amplifier U1A now represents only the sensitivity of the transducer: 333 mV/psi above atmosphere. The WCC Pressure Sensing output was specified to be scaled such that 2.00 V = 2.00 psi to simplify "software" requirements of MONTY in developing the pressure "overlays". SCALING AMPL, U1B, provides a gain of ~3.33 (adjustable) to convert the 333 m V/psi sensitivity of the transducer (and offset amplifier) to 1.000 V/psi. The output of SCALING AMPL, U1B, therefore, is scaled volts-per-pound of pressure.

MONITOR DATA BUFFER, U4A, is a noninverting, unity gain buffer amplifier providing the scaled transducer output to the Monitor and Control System.

3.2 Alarm Circuitry

(Refer to Schematic Diagram, sheet 4.) Since the purpose of the WCC Pressure Sensing System is to monitor for the proper pressurization of the three waveguides, the means of detecting a pressure abnormalty is also essential.

The alarm circuitry constantly monitors the three waveguide pressures and if any of these pressures should exceed a preset HI-PRESSURE point, or fall below the LO-PRESSURE point, an alarm condition is considered to be present. When this alarm state occurs, an alarm LED indicator on the control unit is illuminated to indicate which one of the three waveguides exhibits improper pressure. In addition, an alarm latch is set to store the alarm indication until manually reset. In the event the alarm condition is temporary and restores to normal pressure, the alarm latch will continue to indicate that an alarm condition had occurred, and to indicate which of the three waveguides was affected.

The basic alarm detecting element is the LM319 voltage comparator, U10 (south arm channel). Resistor U14-2 establishes the HI-PRESSURE threshold and U15-2 the LO-PRESSURE threshold. The pressure input (2 psi nom.) is constantly compared to these two thresholds, and when either threshold is reached, or exceeded, the comparator output will go from HI (+12 V CMOS) to LO (OV). Inverter U16 will illuminate the SW ARM ALARM LED for the duration of the alarm condition.

When the comparator goes LO (alarm), the input logic is satisfied to set alarm latch U19A, CD4044 R-S LATCH. This latch will illuminate the SW ARM LATCH LED until manually reset (application of logic LO on the R inputs).

Note that the HI- and LO-PRESSURE threshold voltages are adjustable and may be set to any desired "pressure" within the range of the transducers. These voltages are also made available to the metering/select circuitry.

3.3 Metering/Select Circuitry

(Refer to Schematic Diagram, sheet 5.) Local indication of the waveguide pressures is desired for regular operation and maintenance purposes. The front panel thumbwheel switch METER CHAN SELECT, selects the parameter to be displayed on the three meters. The parameters and select numbers are:

Select	Meter M1	Meter M2	Meter M3
0	PSIA-S	PSIA-N	PSIA-E
1	+15 V Monitor	+5 V Monitor	+12 V Excitation
2	HI-PRESS-S	HI-PRESS-N	HI-PRESS-E
3	LO-PRESS-S	LO-PRESS-N	LO-PRESS-E
4	VX-S	VX-N	VX-E

where,

PSIA = scaled pressure output, 2 psi nom.
+15 V Monitor = +15 V ÷ 2, +7.5 V nom.
+5 V Monitor = +5 V power supply
+12 V Excitation = +12 V CMOS and transducer drive ÷ 2, +6 V nom.
HI-PRESS = alarm HI-PRESSURE set points
LO-PRESS = alarm LO-PRESSURE set points
VX = actual transducer output voltage; +6.8 V nom.
-S, -N, -E = south, north, east arms, respectively.

It should be emphasized that the local meters are for local monitoring only, i.e., as a quick check for proper operation. These meters are simple vane-movement types with a 15% accuracy. The TEST POINTS should be used in conjunction with an external VOM or DVM for precise measurements of the selected parameter, or for driving a chart recorder.

The analog selection is performed by two analog multiplexers, U17 and U18, an HI-1828A CMOS multiplexer. The input channel to be selected as the output is controlled by the digital inputs, AØ and A1, a 0 V to +12 V CMOS LO-HI input from the thumbwheel SELECT switch.

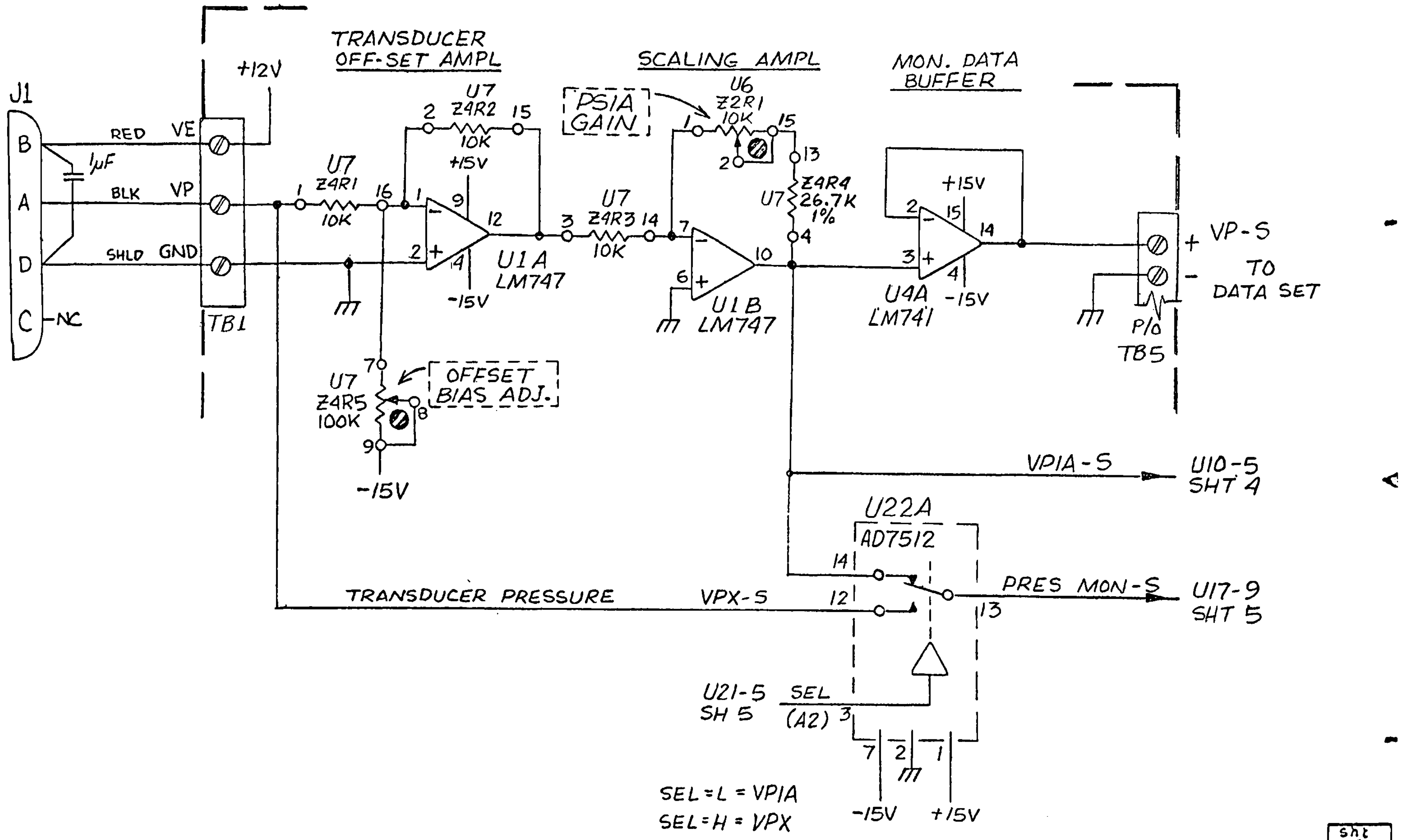
As these multiplexers are 4-channel switches, and five parameters are selectable, further multiplexing is accomplished by analog switches U22 and U23, an AD7512 SPST switch. These switches are used to select either the TRANSDUCER PRESSURE (Select 4) or the PSIA scaled pressure (Select Ø). Consequently, the PRES MON input to the HI-1828A MUX's may be either the XDUCER or PSIA values, depending upon the state of the AD7512 switches. The PRES MON inputs are displayed on the meters when the SELECT switch is selected to 0 or 4. The "4 bit" on the select switch further selects the AD7512 switches to the proper pressure desired.

The outputs of U17 and U18 MUX's are buffered by U24, an RC4558 quad op-amp, to form a noninverting, unity gain buffer, to drive the front panel meters and the TEST POINTS.

3.4 Power Supplies

(Refer to Schematic Diagram, sheet 6.) The amplifier and control unit requires -15 V, +5 V, +12 V, and +15 V. Transducer excitation requires +12 V. Input voltage, ±15 V, is derived from the ±15 V power supply in Rack MC, a part of the DCS-Ø System. This ±15 V is made available to the amplifier and control unit circuitry. Device VR-1, LM7812, is a positive 12 V regulator IC, which forms the regulated +12 V CMOS logic drive and the transducers +12 V input excitation. VR-2, LM7805, is a positive 5 V regulator IC, which forms the regulated +5 V logic and LED drive.

Resistors Z5R1 and Z5R2 form a voltage divider network to divide the +15 V to +7.5 V for monitoring.

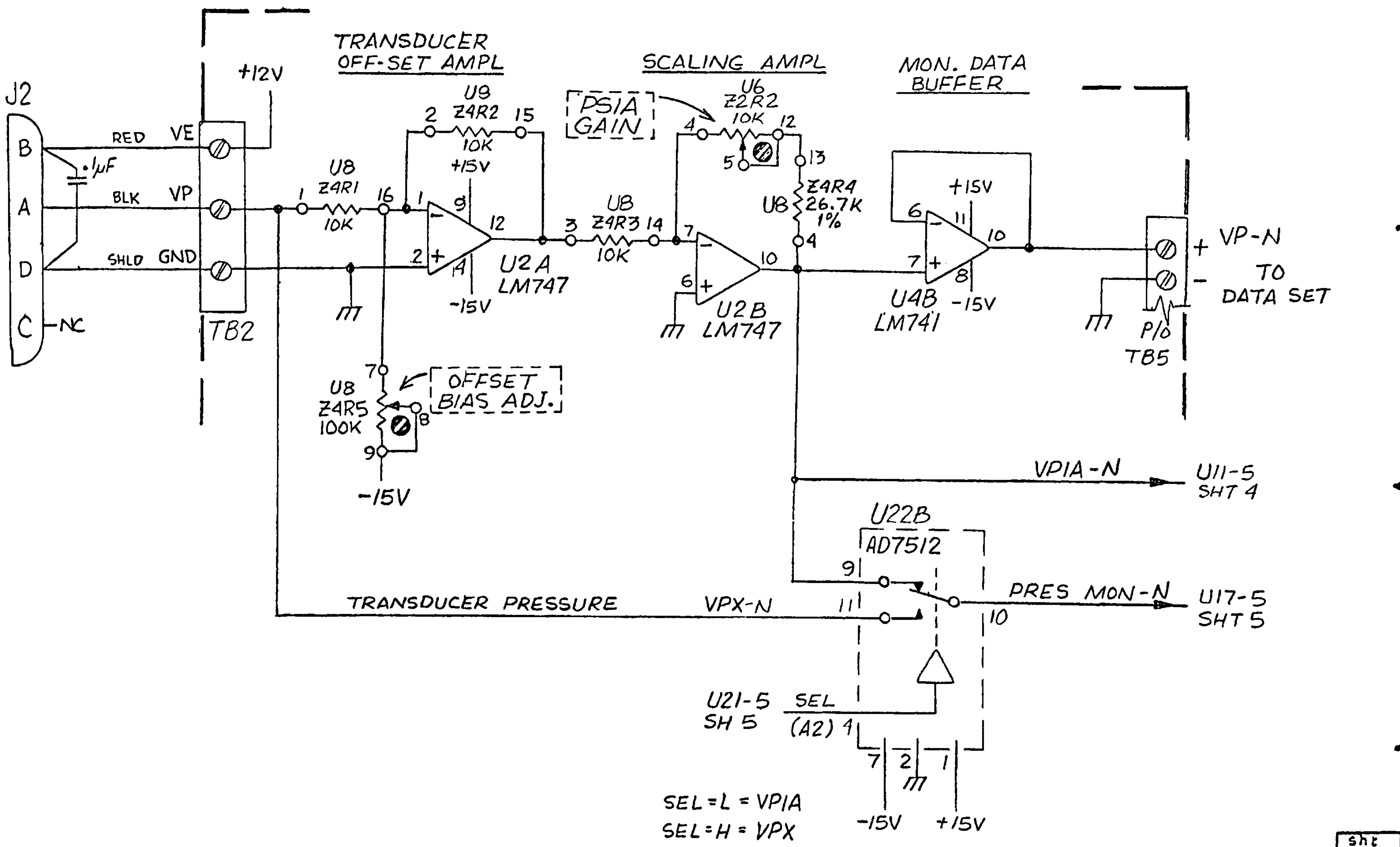


P/O ANT-Ø / WCC PRESSURE SYSTEM

sht 1 of ___

PRESSURE TRANSDUCER SCALING AMPL. CHAN 1 - SW ARM	national radio astronomy observatory vla project • n.m.
dsg by P. HARDEN	d
sht	dwg no.

FIGURE 4 (SHEETS 1-6)



sht 2 of

P/O ANT-Ø / WCC PRESSURE SYSTEM

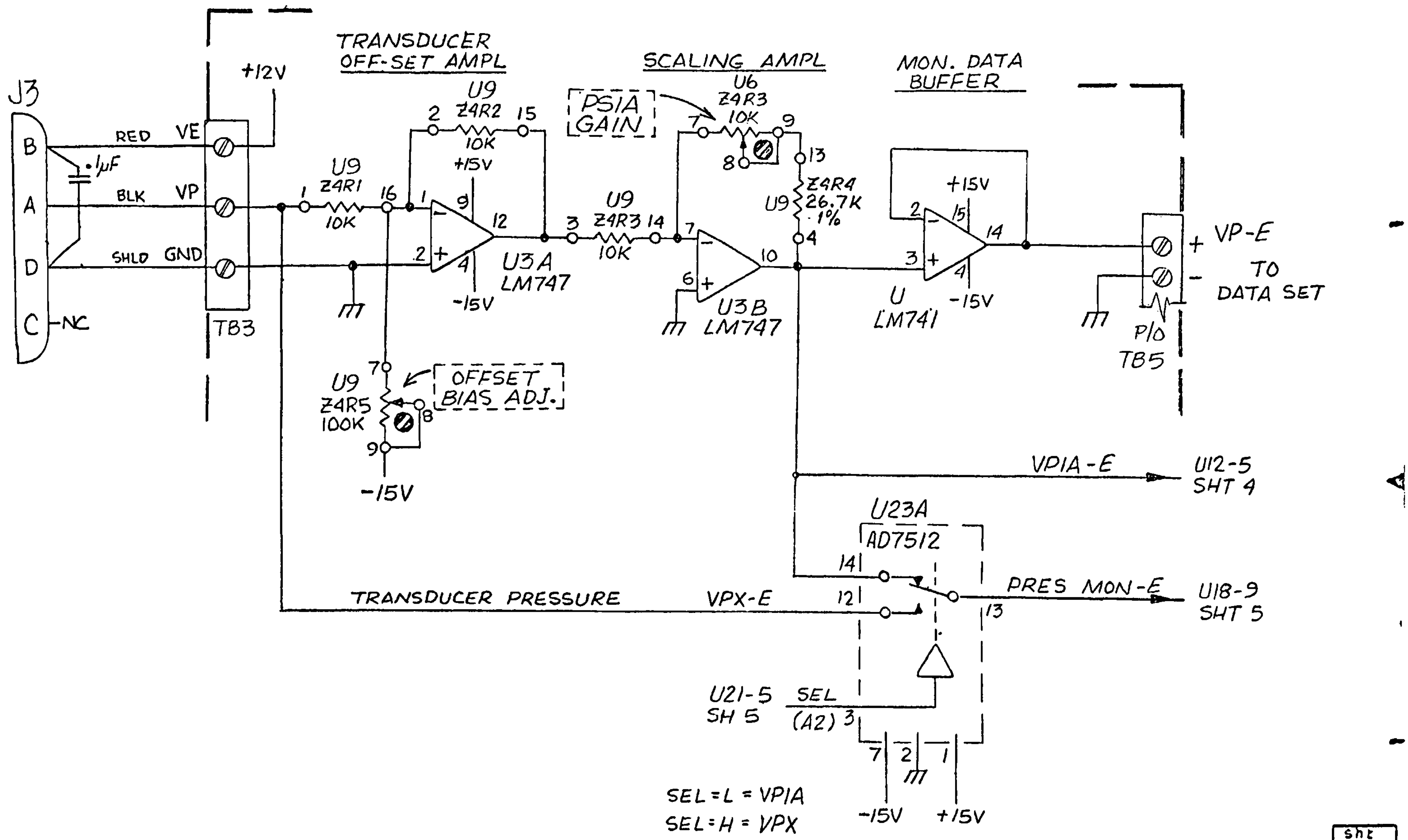
PRESSURE TRANSDUCER SCALING AMPL.

CHAN 2 - N ARM

national radio astronomy observatory vla project • n.m.

dsg P. HARDEN [redacted] d

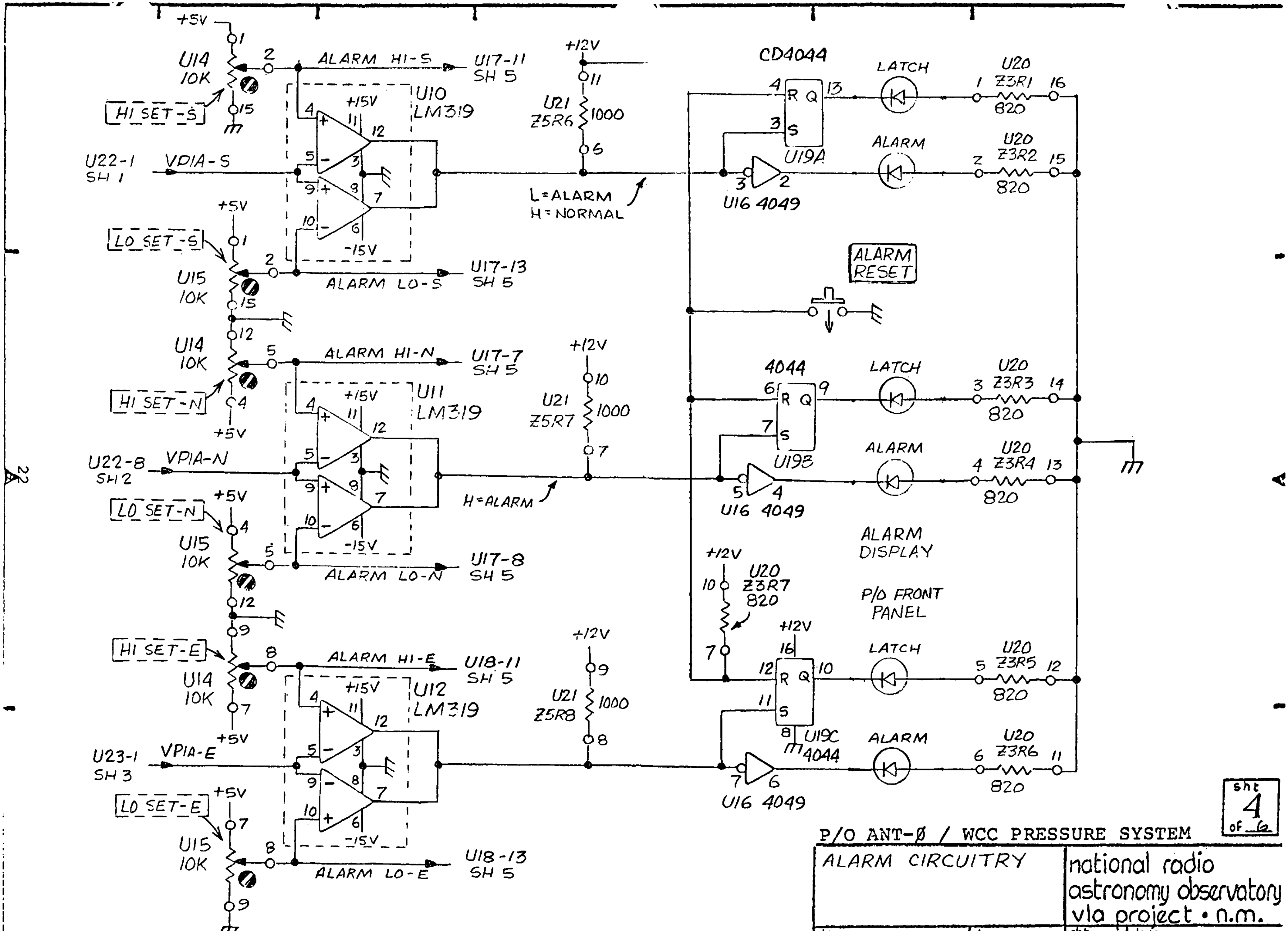
sht [redacted] dwg no [redacted]



sht 3 of

P/O ANT-Ø / WCC PRESSURE SYSTEM

PRESSURE TRANSDUCER SCALING AMPL. CHAN 3 – E ARM	national radio astronomy observatory vla project • n.m.
dsg by P. HARDEN	d
sht	dwg no.



P/O ANT-Ø / WCC PRESSURE SYSTEM

ALARM CIRCUITRY

national radio astronomy observatory vla project • n.m.

dsg P. HARDEN

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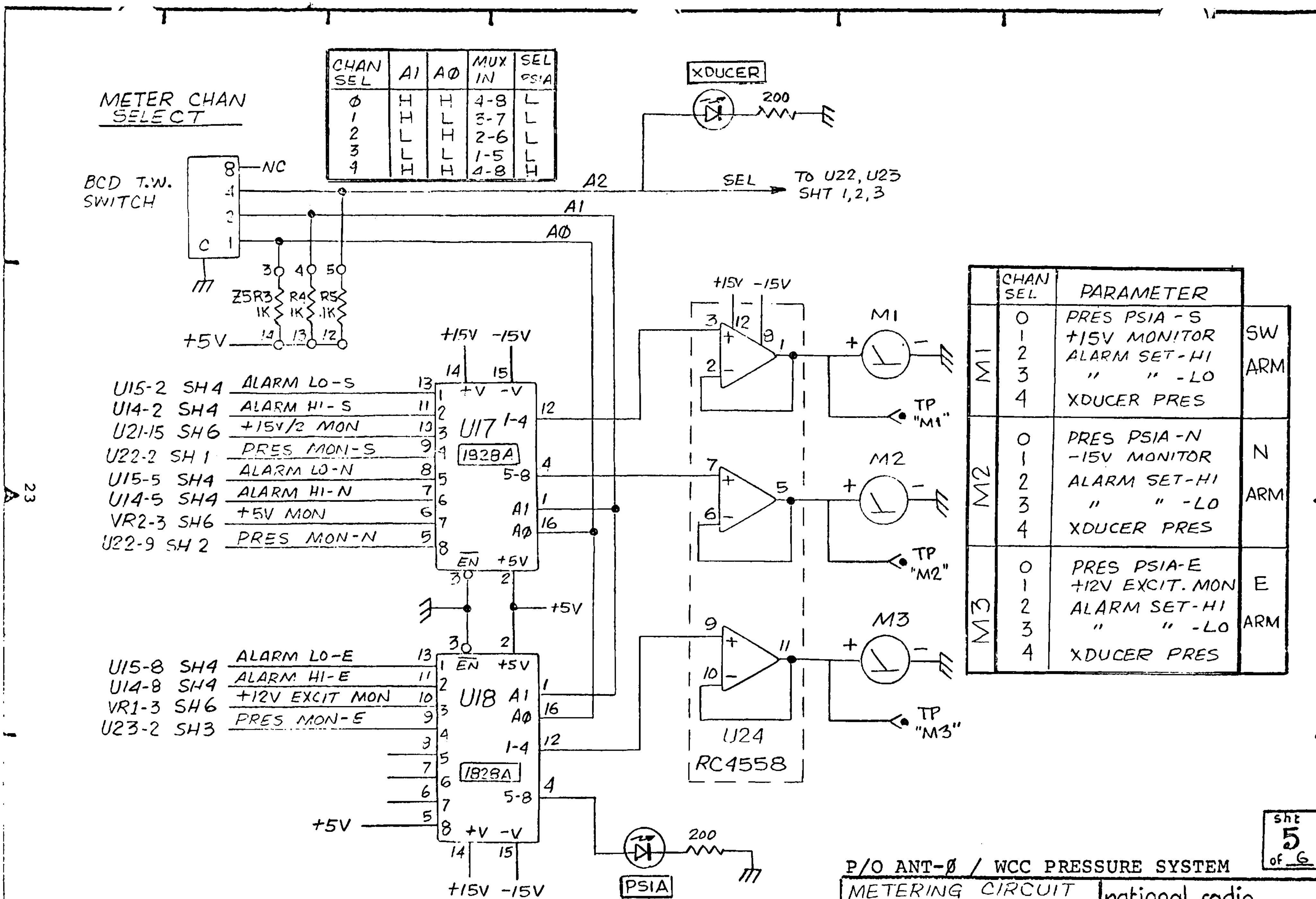


CHAN SEL	A1	AØ	MUX IN	SEL PSIA
Ø	H	H	4-8	L
1	H	L	3-7	L
2	L	H	2-6	L
3	L	L	1-5	L
4	H	H	4-8	H

	CHAN SEL	PARAMETER	
M1	0	PRES PSIA - S	SW ARM
	1	+15V MONITOR	
	2	ALARM SET-HI	
	3	" " -LO	
	4	XDUCER PRES	
M2	0	PRES PSIA - N	N ARM
	1	-15V MONITOR	
	2	ALARM SET-HI	
	3	" " -LO	
	4	XDUCER PRES	
M3	0	PRES PSIA-E	E ARM
	1	+12V EXCIT. MON	
	2	ALARM SET-HI	
	3	" " -LO	
	4	XDUCER PRES	

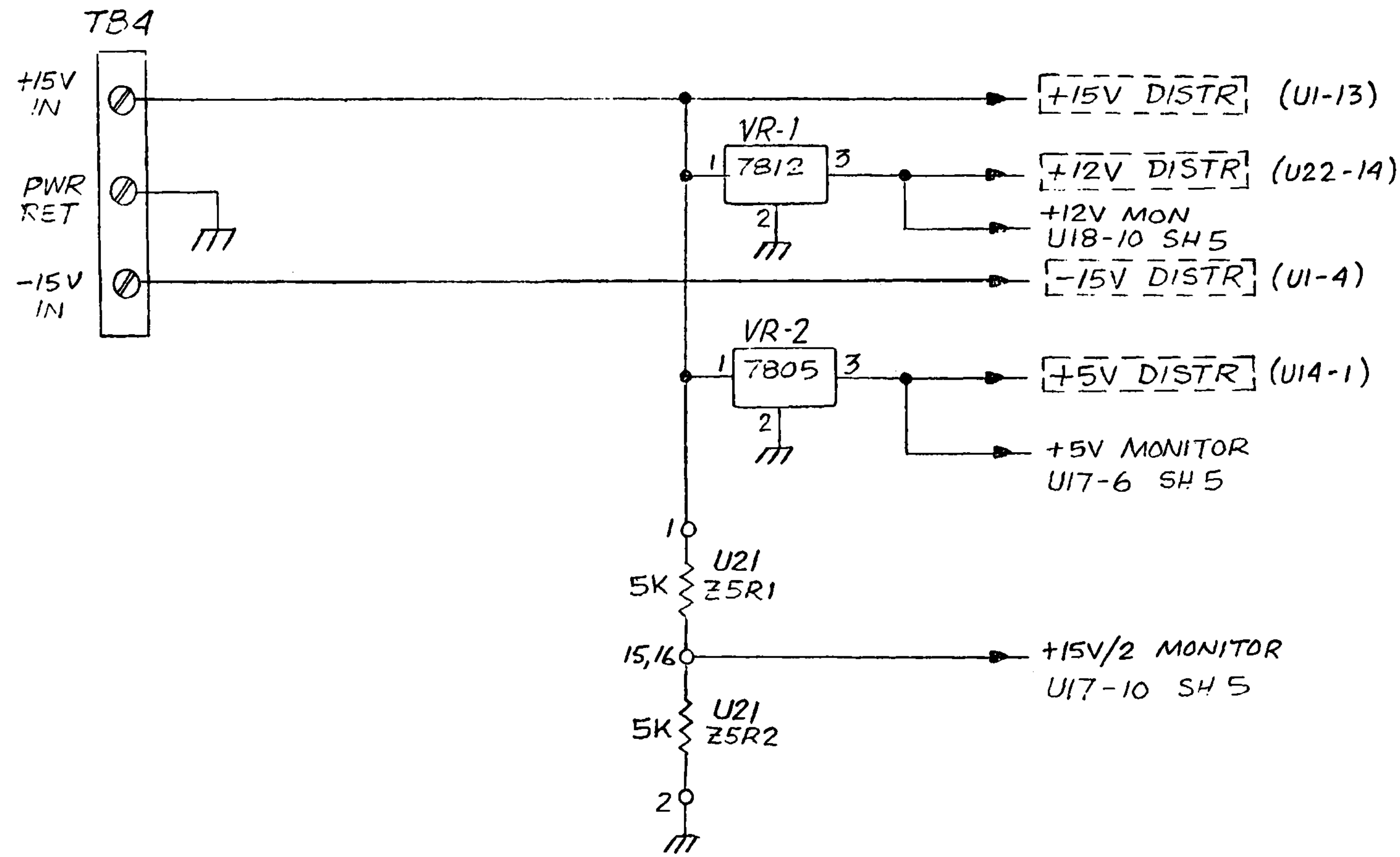
P/O ANT-Ø / WCC PRESSURE SYSTEM

sht 5 of 6

METERING CIRCUIT

national radio astronomy observatory vla project • n.m.

dsg by P. HARDEN | d | sht | dwg no.



sht 6 of 6

P/O ANT-Ø / WCC PRESSURE SYSTEM

DC POWER DISTR.	national radio astronomy observatory vla project • n.m.
dsg by P. HARDEN	d
sht	dwg no

4.0 OPERATION

Operation of the amplifier and control unit is very straightforward. Since input power is derived from the Antenna Zero System, input and derived voltages should be occasionally checked by SELECT CHAN 1 and insuring the meter readings are in the "green" areas.

Waveguide pressure is monitored by SELECT Ø. The scaled pressure is sent to DCS-Ø Data Set 5 continuously, regardless of what select channel is being displayed.

In event of alarm condition, the <u>actual</u> pressure should be determined by observing the proper computer overlay or by using an external DVM applied to the meter channel in question. If the latched alarm needs to be cleared, simply depress the RESET push button. If the alarm immediately returns, the alarm condition still exists. Meter Select 4 will verify the proper output of the transducer (+6.8 V±0.4 V nom.). Select channels 2 and 3 will show the pressure limit set points, and if the alarm is justified (V LO-PRESS < VP < V HI-PRESS).

5.0 MAINTENANCE

The circuit descriptions given in Sections 2.0 and 3.0 in conjunction with the schematic diagrams (Figure 4, sheets 1-6) should be sufficient to perform any required maintenance. The logic board layout, dip header details and special device data sheets are also provided in the Appendix.

In the event that replacement of the LX1703 transducer(s) is required, see Section 6.0, INSTALLATION/REPLACEMENT, for proper mechanical and electrical procedures.

Input/output cabling details are presented in Figure 6.

6.0 INSTALLATION/REPLACEMENT

Initial installation was performed in June 1979.

In the event of removal of a transducer requiring reinstallation, or replacement of same, the following guidelines are provided.

6.1 Removal of Transducer

1. Disconnect connectors P1, P2, P3 from J1, J2, J3 on the ribbon cable from the transducer.
2. Do not exert any force (pulling) on the ribbon cable.
3. Close isolation valve to remove transducer pressure.
4. Remove transducer housing from the waveguide and valve assembly.
5. Do not let dirt or grease enter the pressure access fitting. Do not blow into fitting, as moisture can cause damage to pressure sensor.

6.2 Installation of Transducers (and Alignment)

1. Install transducer pressure fitting into waveguide valve access and tighten firmly with wrench. Apply Teflon tape to insure good pressure seal.
2. Connect ribbon cable connector P1, P2, P3 to respective J1, J2, J3, without stressing cable. Insure sufficient flex (loop) in the cable.
3. Refer to Figure 5 for proper orientation and installation scheme.
4. With power applied, take transducer reading in volts and record. With external DVM, measure output pressure (Select 1). Adjust appropriate OFFSET BIAS ADJ for zero volts (0 psi atmospheric). Every transducer exhibits a different offset value, making this adjustment necessary upon replacement.
5. Open isolation valve to transducer.
6. Measure transducer output voltage with applied pressure. Subtract to find difference voltage from atmospheric pressure obtained in step 4. Divide difference by 0.333 V to verify applied pressure is producing correct output.

$$\begin{array}{ll} \text{VX with pressure} = & \text{VX (step 4)} \\ \underline{-\text{VX atmospheric}} & \underline{-\text{VX (step 6)}} \\ = \Delta\text{VX} & = \Delta\text{VX} \end{array}$$

$$\text{psi} = \frac{\Delta \text{VX}}{0.333\ \text{V}}$$

for 2 psi ΔVX $\approx$ 666 mV = 0.666 V

$$\text{psi} = \frac{0.666\ \text{V}}{0.333\ \text{V}} = 2\ \text{psi}.$$

7. Adjust appropriate GAIN control for an output pressure reading equal to the psi calculated in step 6.

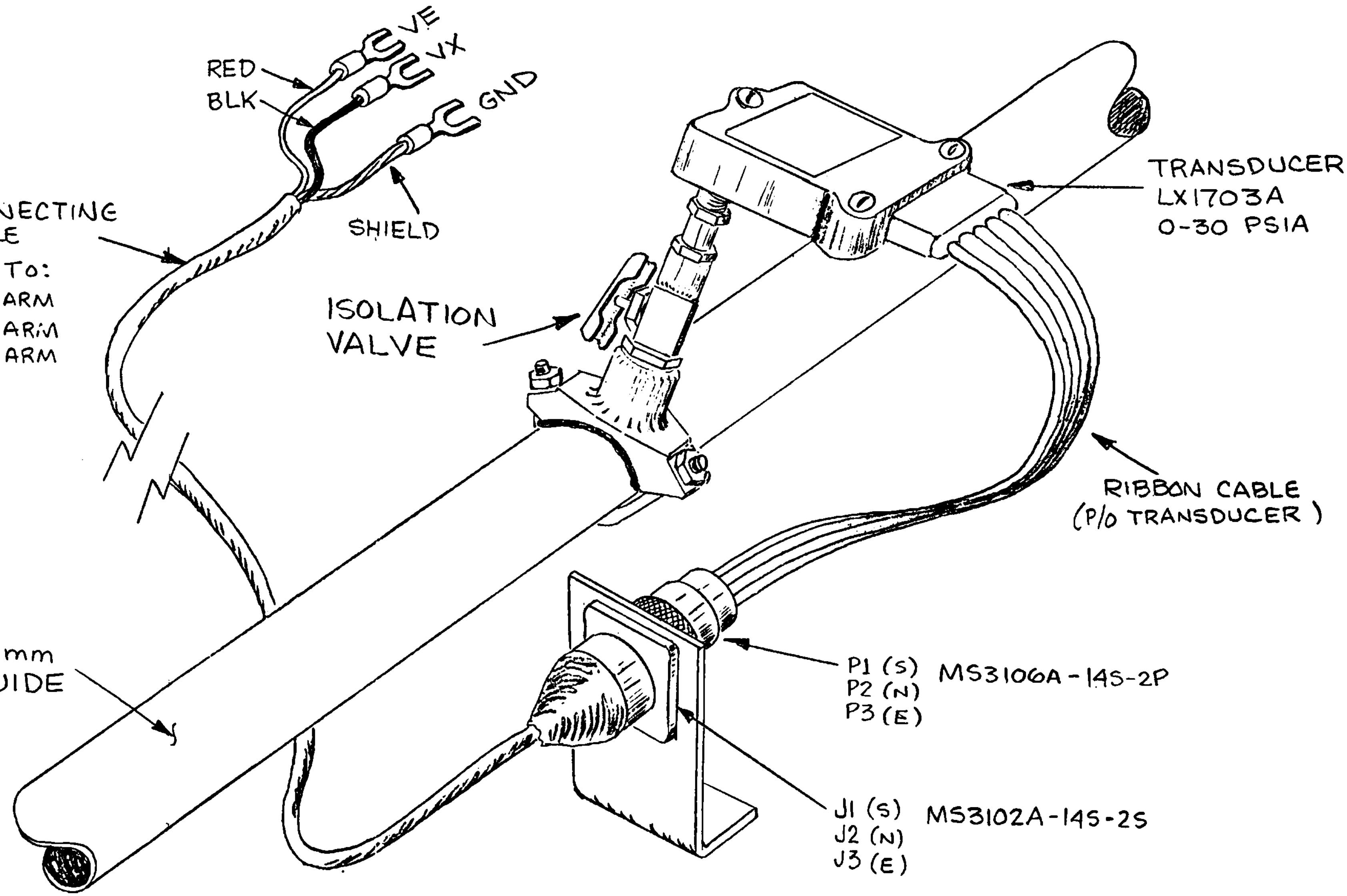


FIG. 5 TRANSDUCER INSTALLATION

P/O ANT-Ø / WCC PRESSURE SYSTEM			
TRANSDUCER & WIRING INSTALLATION DIAGRAMME		national radio astronomy observatory vla project • n.m.	
dgg by P. HARDEN	d	sht	dwg no.

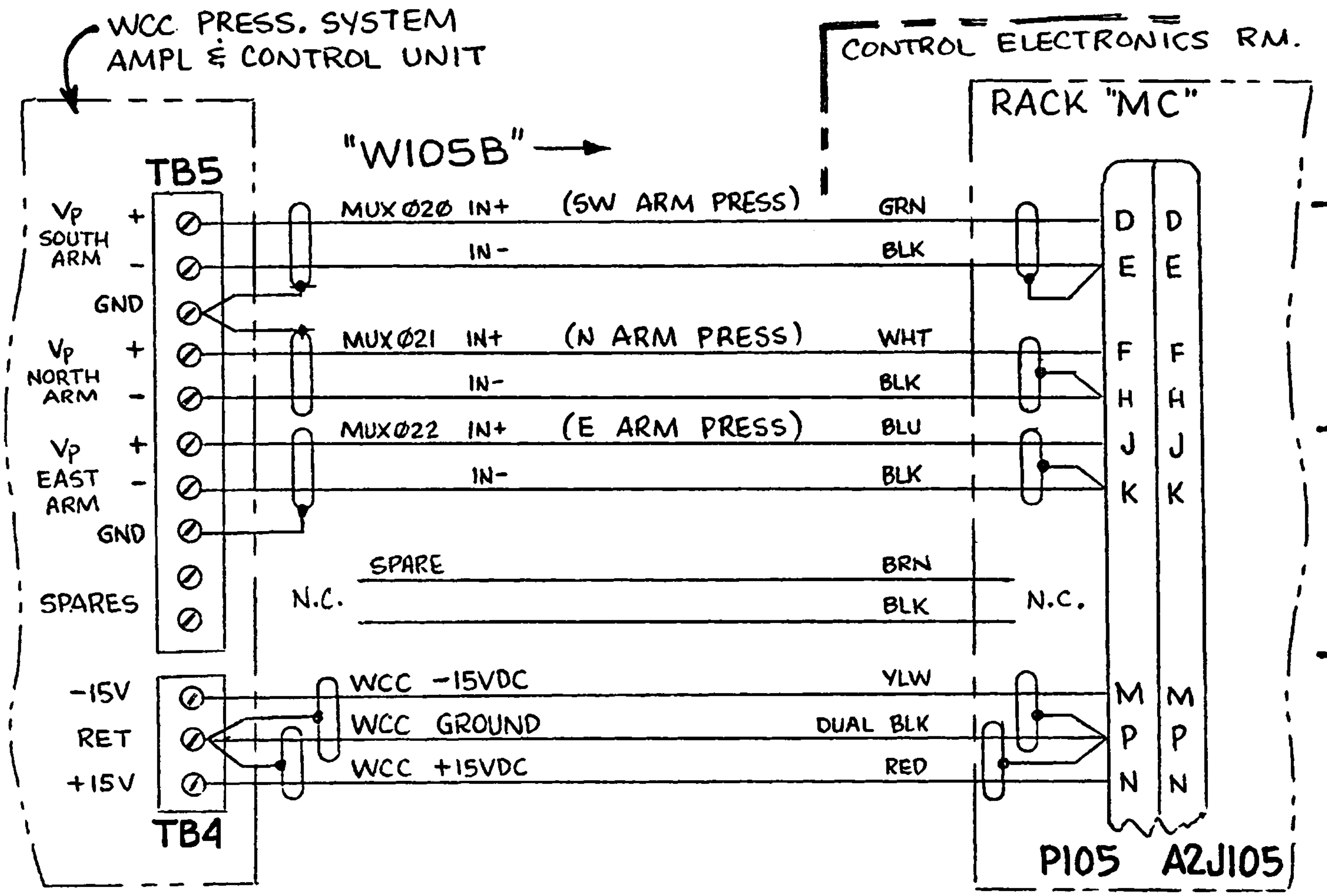
sht of

6.3 Interconnecting Wiring

The transducers are connected to the amplifier and control unit via TB1, TB2 and TB3. Refer to Figure 4 for color coding of wires to proper TB terminals.

The voltage inputs and analog outputs to Antenna Zero are done through DCS-Ø cable "W105B". Refer to Figure 6 for proper color coding and connections to TB4 and TB5 on the amplifier and control unit. Alterations to the wiring at the Antenna Zero end-of-things should be performed by the DCS Lab only.

Terminal board details of TB1 and TB5 are given in the Appendix.



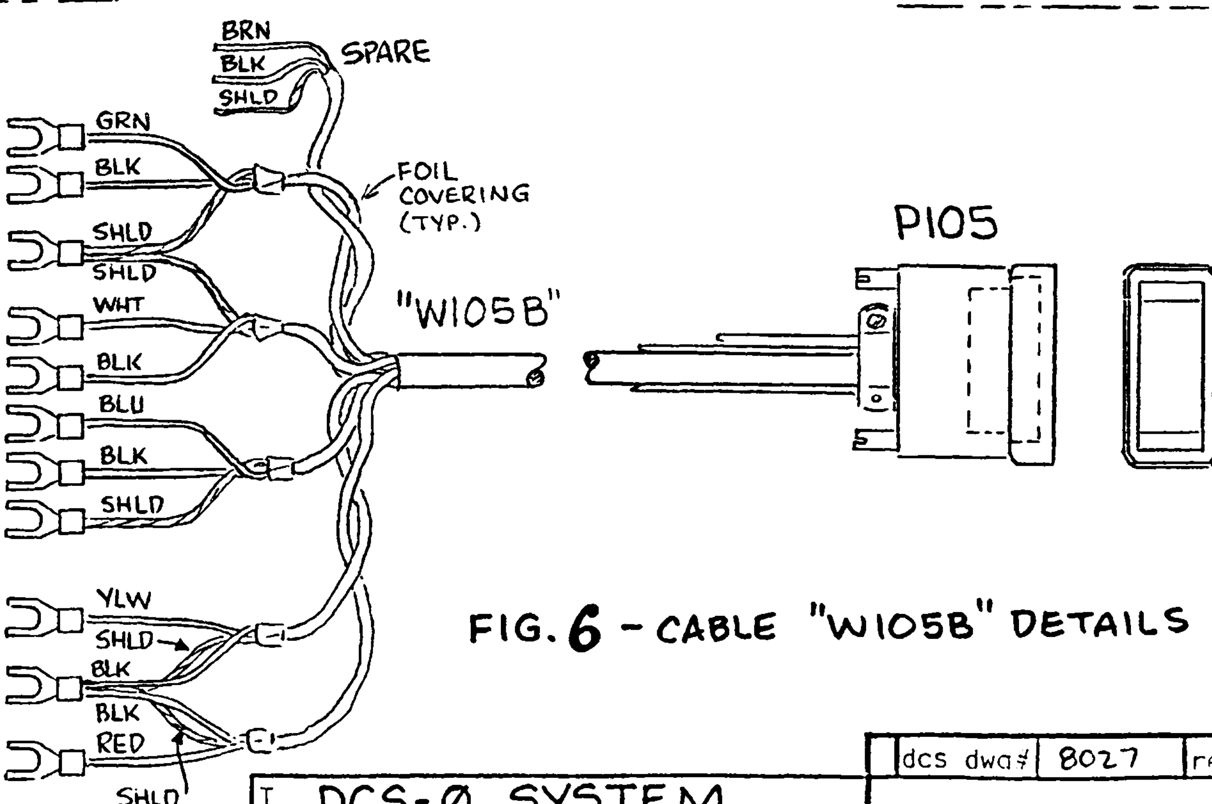


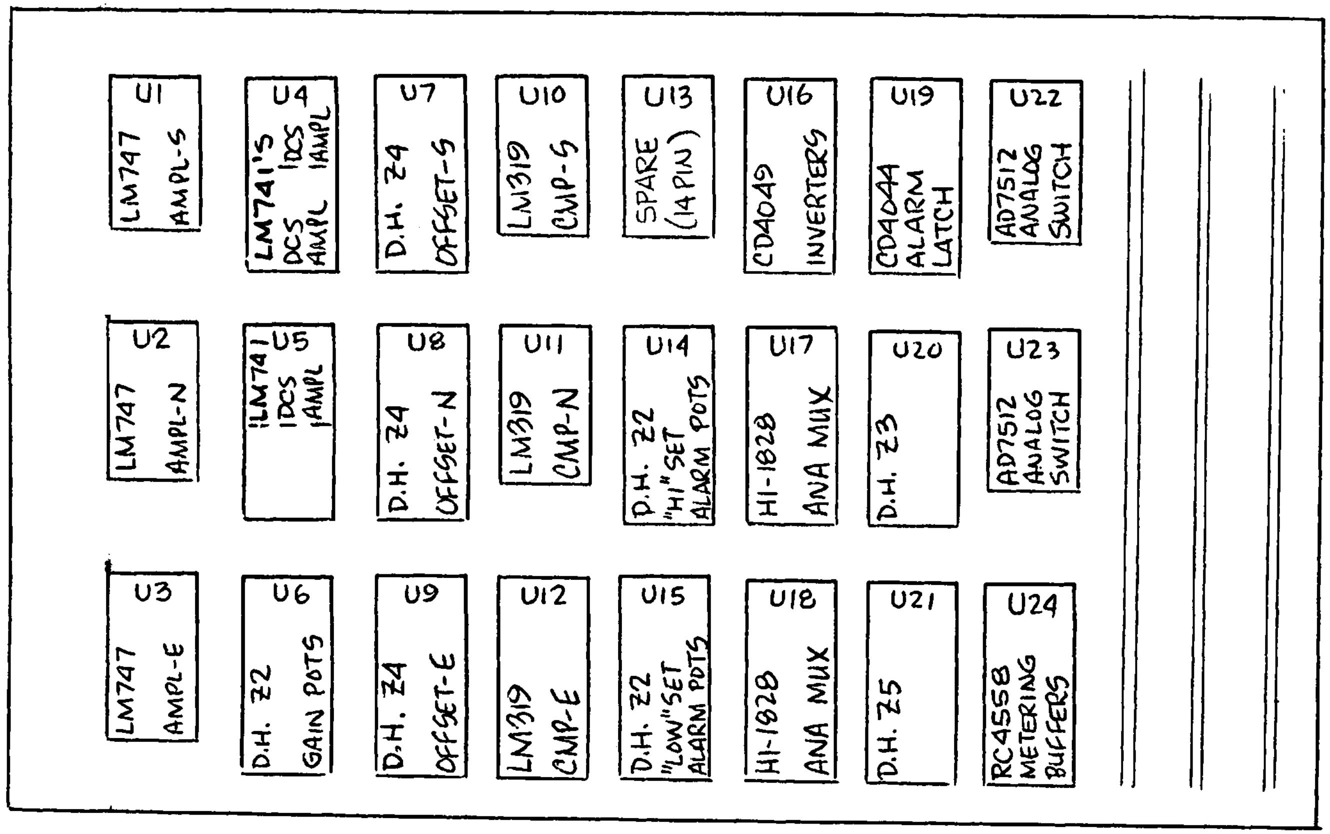
FIG. 6 - CABLE "W105B" DETAILS

		dcs dwg # 8027	rev B
TITLE: DCS-Ø SYSTEM CABLE ASSY - "W105B" INTERFACE TO THE WAVEGUIDE PRESSURE SENSING SYSTEM		NATIONAL RADIO ASTRONOMY OBSERVATORY VLA PROJECT POST OFFICE BOX O SOCORRO, NEW MEXICO 87801	
DRN BY:	DATE 2JAN1980	DWG NO. A13720W74	SHT NO.

7.0 APPENDIX

This Section contains miscellaneous data and drawings useful for maintenance and troubleshooting. Special device data sheets are also included for reference.

FIG. 7 - LOGIC BOARD LAYOUT, (I.C. LOCATIONS)



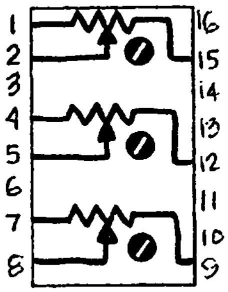
P/O ANT-Ø / WCC PRESSURE SYSTEM

LOGIC BOARD LAYOUT (I.C. LOCATIONS)	national radio astronomy observatory vla project • n.m.
dsg P. HARDEN	d
sht	dwg no

sht of

"Z1" REMOVED; NO LONGER USED.

"Z2"

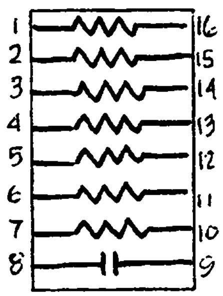


GAIN ADJ. & PRES. ALARM SET POTS

DESCR	VALUE	MFG	MFG P/N
POT	10KΩ 4T	BOURNES	3339P-1-103
		↓	↓
POT	10KΩ 4T		
POT	10KΩ 4T		

QTY: 3 LOC: U6, U14, U15

"Z3"

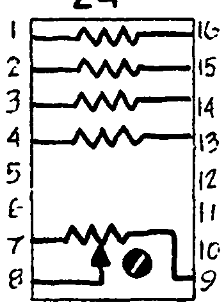


L.E.D. "PULL-UPS"

RES	820Ω 1/4W	A-B	RCR-821J
RES	↓		↓
RES			
RES			
RES			
RES			
RES			
CAP	.01μF 50V	ERIE	8121-050-651-103M

QTY: 1 LOC: U20

"Z4"

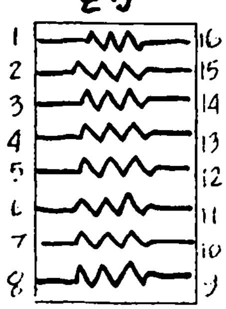


AMPL. DISCRETES & BIAS OFFSET ADJ.

RES	10K 1/8W 5%	A-B	RCR-103J
RES	10K 1/8W 5%		RCR-103J
RES	10K 1/8W 5%		RCR-103J
RES	22K 1/8W 5%		RCR-223J
POT	100KΩ 4T	BOURNES	3339P-1-104

QTY: 3 LOC: U7, U8, U9

"Z5"



MISC. DISCRETES

RES	5K 1/4W 5%	A-B	RCR-502J
RES	5K 1/4W 5%		RCR-502J
RES	1K 1/4W 5%		RCR-103J
RES	1K ↓		↓
RES	1K		
RES	1K		
RES	1K		
RES	1K		

QTY: 1 LOC: U21

FIG. 8 - DIP HEADER DETAILS

DWG # 7708-1

National Semiconductor

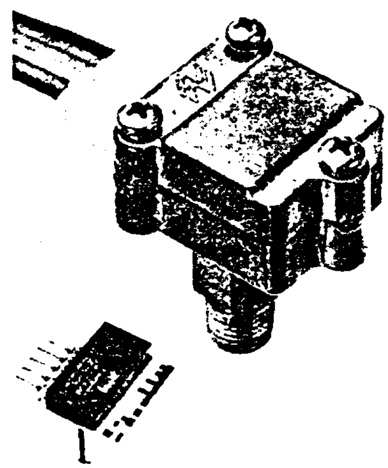
Backward Gage Pressure Transducers

LX16XXGB, LX17XXGB SERIES

DESCRIPTION

The LX16XXGB and LX17XXGB Series are backward gage pressure transducers with operating pressure ranges of ±5 psig to 0–300 psig. These units provide superior protection against corrosive and conductive working fluids by applying the pressure to the back side of the sensor diaphragm. For each operating pressure range, the transducer is available either in the basic PX6B hybrid IC package for easy PC board mounting or in the compact, rugged PX7B zinc alloy housing with 1/8" NPT fitting for systems requiring mechanical isolation from extraneous forces.

Like other National IC pressure transducers, these units are designed to provide high accuracy and excellent stability. They are field interchangeable and can be easily interfaced with auto-reference, control and display systems. Each device includes internal temperature compensation, voltage regulation and full signal conditioning by an operational amplifier with a low-impedance 10V output.



LX17XXGB (LX16XXGB Inset)

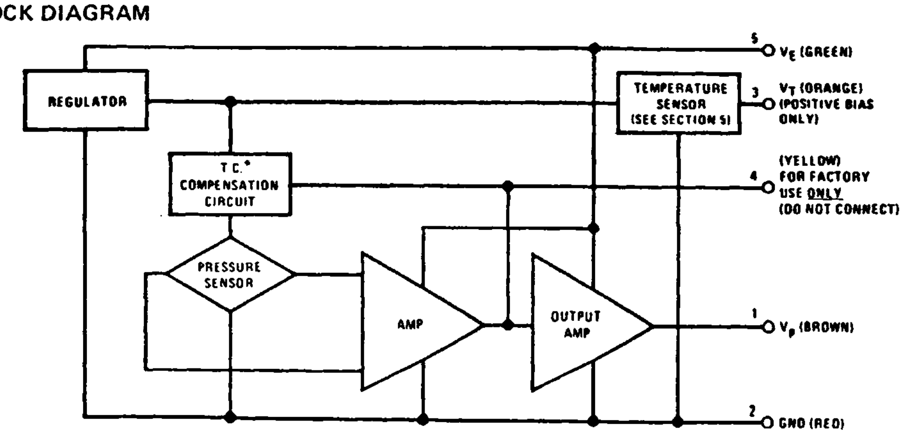
FEATURES

- ±5 psig to 0–300 psig
- Backward gage construction
- Hostile working fluid protection
- Hybrid IC package for PC board mounting
- Ruggedly housed versions
- Temperature sensor
- High accuracy
- Easy auto-reference interface
- Temperature compensation
- Excellent stability
- Field interchangeability
- Available from National distributors

APPLICATIONS

- Saline solutions
- Sewage
- Petro-chemical systems
- Aqueous solutions
- Process fluids
- Medical dialysis
- Water management
- Cooling systems
- Fuel management
- Liquid head

BLOCK DIAGRAM



*National patents 3836796, 3886799, 3899695

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FIG. 9 - LX1703 DATA SHEETS

MAXIMUM RATINGS

Excitation Voltage	30V
Output Current	
Source	20 mA
Sink	10 mA
Transducer Bias Current	20 mA
Operating Temperature Range	0°C to 85°C
Storage Temperature Range	−40°C to +105°C
Lead Soldering Temperature (10 seconds)	260°C

TYPICAL CHARACTERISTICS

Output Voltage Sensitivity to Excitation Voltage	0.5%
Output Impedance	<50Ω
Electrical Noise Equivalent ($0 \leq f \leq 1$ kHz)	0.04% Span
Natural Frequency of Sensor Diaphragm	> 50 kHz
Transducer Bias Current	11–15 mA

BACKWARD GAGE PRESSURE DEVICES– GUARANTEED SPECIFICATIONS*

DEVICE TYPE	OPERATING PRESSURE RANGE	MAXIMUM OVER PRESSURE	REFERENCE TEMPERATURE = 25°C REFERENCE PRESSURE = 0 psi				EXCITATION VOLTAGE, V_E = 15 V_{DC} (NOTE 2) OPERATING TEMPERATURE = 0°C to 85°C			
			OFFSET SPECIFICATIONS				SPAN SPECIFICATIONS			
			OFFSET CALIBRATION V	TEMP. COEFFICIENT ± psi/°C	REPEATABILITY ± psi	STABILITY ± psi	SENSITIVITY CALIBRATION mV/psi	TEMP. COEFFICIENT ± psi/°C	L·H·R (NOTE 1) ± psi	STABILITY ± psi
LX1601GB, LX1701GB	−5 to +5 psig	40 psig	7.5 ±0.5	0.0054	0.05	0.3	1,000 ±20	0.0054	0.05	0.05
LX1611GB, LX1711GB	−5 to +5 psig	100 psig	7.5 ±0.5	0.0054	0.05	0.3	1,000 ±20	0.0054	0.05	0.05
LX1602GB, LX1702GB	0 to 15 psig	40 psig	2.5 ±0.3	0.0072	0.06	0.3	670 ±13	0.0072	0.07	0.06
LX1603GB, LX1703GB	0 to 30 psig	60 psig	2.5 ±0.25	0.009	0.1	0.3	333 ±6	0.009	0.16	0.10
LX1604GB, LX1704GB	−15 to +15 psig	40 psig	7.5 ±0.25	0.009	0.1	0.3	333 ±6	0.009	0.16	0.10
LX1610GB, LX1710GB	0 to 60 psig	100 psig	2.5 ±0.25	0.018	0.2	0.6	167 ±3.3	0.018	0.36	0.24
LX1620GB, LX1720GB	0 to 100 psig	150 psig	2.5 ±0.2	0.0216	0.4	1.0	100 ±2	0.0216	0.60	0.40
LX1730GB	0 to 300 psig	450 psig	2.5 ±0.2	0.063	1.0	2.0	33.3 ±0.67	0.063	2.0	1.0

Note 1: L·H·R combines linearity, hysteresis and repeatability of span.

Note 2: Operation is possible with excitation voltage as low as 10V. Output voltage will saturate at excitation voltage less 2V.

*See Section 3 for definition of specifications

PX7 SERIES HOUSINGS

The LX17XX series transducer is provided in a rugged outer housing with 1/8" NPT fitting(s) and a 10-inch ribbon cable with a connector for use with a zero-insertion-force mating connector. This connector can be used for incoming inspection, calibration and testing but should be cut off for permanent installation (since there is no mating connector suitable for field installation).

PX7 SERIES MECHANICAL INTERFACE

Single-Port: The single-port housings (PX7, PX7F, PX7N, PX7FN) each have a single 1/8" NPT male fitting. The housing must be anchored by this fitting and the connection sealed with teflon tape as shown in *Figure 9*. It is especially important to use teflon tape between the two fittings when the zinc housing (PX7) is fit to a dissimilar metal. The nylon NPTS fitting (PX7N) should be used for a gasket or O-ring seal when it is inserted in a metallic female fitting and the system must work over a large temperature range. In either case, the female fitting must be rigidly held to minimize vibration. A typical PX7 installation is shown in *Figure 10*.

Dual-Port: The dual-port housings (PX7D and PX7DF) each have 2 in-line 1/8" NPT female fittings for pipe mounting and 2 1/4-20 threaded female screw holes for optional panel mounting. The housing is made of brass for extra strength and can be mounted either in-line as shown in *Figure 11* or on a panel as shown in *Figure 12*. As with the single-port versions, it is good practice to seal the PX7D pressure connections with teflon tape and use a rigidly held mount to minimize vibration.

Cable Support: The cable is connected directly to the transducer pins and must be secured near the transducer to minimize stress on the pins *(Figures 9 through 12)*. The section of cable between the cable support and the transducer should be short and firm.

Moisture Protection: The PX7 housing is environmental, not hermetic, and must be protected from moisture seepage into the cable-transducer interface. Moisture on the leads causes metallic plating while power is applied to the transducer. *Do not pot the transducer.* For operation in humid environments a separate hermetic outer enclosure should be used.

PX7 ELECTRICAL INTERFACE

Pins 3 and 4 should never be grounded, and no connection at all should be made to pin 4. Pin 3 is the temperature sensor output and, if used, should only be connected to a high impedance amplifier (see temperature sensor discussion). The transducer output signal (pin 1) should be connected only to an impedance of not less than 1k. A V_E-to-ground bypass capacitor (0.22 μF ceramic or 1 μF tantalum) must be connected on the cable to prevent oscillation in noisy electrical environments. As shown in *Figure 13*, the capacitor is connected between the green (V_E) and red (ground) wires no more than 4 inches from the transducer. The power supply leads must never be reversed, and the operating voltage V_E should *always* be at least 10V. With this voltage the maximum output signal is 8V. The recommended minimum normal operating voltage V_E is 15V. This provides the full signal output of up to 13V.

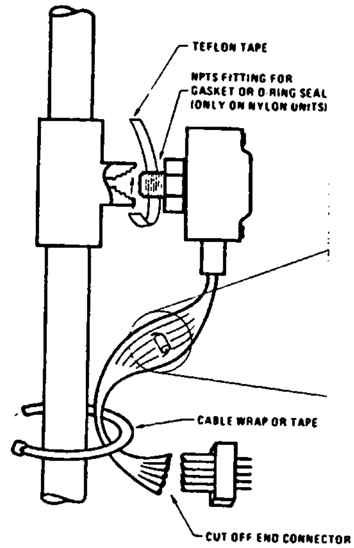


FIGURE 9. PX7 Housing Interface

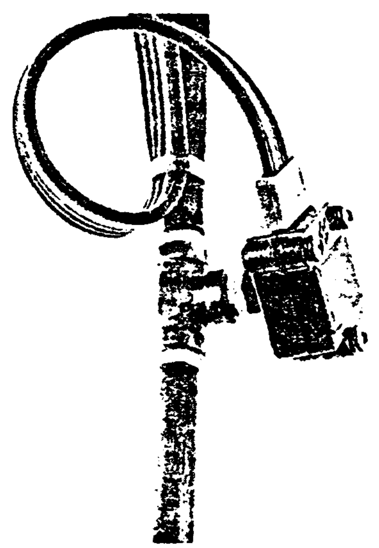


FIGURE 10. Typical Single-Port PX7 Installation

PX7 SERIES "DO'S AND DON'T'S"

DO

- Anchor by pipe threads into a rigid fitting.
- Use teflon tape to seal connection.
- Use NPTS thread on nylon PX7N package to make gasket or O-ring seal when metal fitting is used and system has wide temperature range.
- Use threaded holes for optional panel mounting of PX7D or PX7DF.
- Use separate outer hermetic enclosure in humid environments.
- Anchor cable close to transducer for stress relief.
- Use cable end connector with zero-insertion-force connector for incoming inspection and other testing.
- Cut off end connector for permanent installation.
- Install V_E-to-ground bypass capacitor (0.22 μF ceramic or 1 μF tantalum) in noisy electrical environments.

DON'T

- Screw zinc housing into dissimilar metal fitting unless teflon tape is used for chemical isolation.
- Allow catenary loop in cable.
- Seek mating connector for permanent installation (doesn't exist).
- Allow moisture to enter cable-transducer interface (seal is environmental, not hermetic).
- Submerge transducer in water.
- Pot the cable-transducer interface.
- Attempt to measure water or other corrosive fluid without backward gage or fluidic isolation.
- Connect pin 3 and 4 to ground.
- Make connection to pin 4.
- Connect signal output to less than 1k impedance.
- Reverse power supply leads or allow V_E below 10V.
- Operate with V_E higher than 30V.

PX4 SERIES HOUSINGS

The LX14XX Series transducer is provided in a concentric brass (PX4) or stainless steel (PX4S) housing with a 1/4" NPTS male fitting (female on PX4F or PX4FS) and three flying leads. The lead-transducer interface is epoxy-sealed for hermetic protection, which allows the PX4 to be used in extremely humid environments. With fluidic isolation (PX4F or PX4FS) the LX14XX Series transducer can be submerged in water without damage, but an outer hermetic enclosure is recommended if it is to be submerged in a saline solution or in water for an extended period (see next section). The PX4 series housing is ruggedly built for easy interfacing in any pressure-flow system, and it will provide high performance and reliable, trouble-free service if the following simple rules are adhered to in its electromechanical interface.

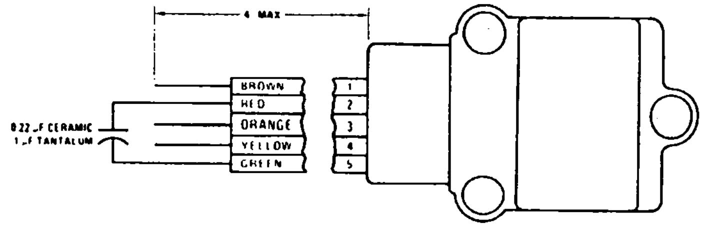


FIGURE 13. Capacitor Connection for PX7 (LX17XX) Series Packages

FIG. 10 LX1703 APPLICATION NOTES

FIG. 11 - PRESSURE UNIT CONVERSION TABLE

17-3

PRESSURE UNIT CONVERSION FACTORS

	lb./in.²*	oz./in.²	lb./ft.²	ton/in.²	ton/ft.²	in. H²O	ft. H_2O	in. Hg.	A_n	dyne/cm.²**	g/cm.²	kg./cm.²	cm. H_2O	m. H_2O	mm. Hg.***	μ Hg.
ENGLISH																
1 Pound/sq. in.* =	1.0000	16.000	144.00	5.0000×10^{-4}	7.2000×10^{-2}	27.680	2.3067	2.0360	6.8045×10^{-2}	68947.	70.306	7.0306×10^{-2}	70.308	0.7031	51.715	51715.
1 Ounce/sq. in. =	0.0625	1.0000	9.0000	3.1250×10^{-5}	4.5000×10^{-3}	1.7300	0.1442	0.1272	4.2528×10^{-3}	4309.2	4.3941	4.3941×10^{-3}	4.3942	4.3942×10^{-2}	3.2322	3232.2
1 Pound/sq. ft. =	6.9445×10^{-3}	0.11111	1.0000	3.4723×10^{-6}	5.0000×10^{-3}	0.19223	1.6019×10^{-2}	1.4139×10^{-2}	4.7254×10^{-4}	478.80	0.4882	4.8824×10^{-4}	0.4882	4.8825×10^{-3}	0.3591	359.13
1 Ton/sq. in. =	2000.0	32000.	2.8800×10^{5}	1.000	144.00	55361.	4613.4	4072.0	136.09	1.3789×10^{8}	1.4061×10^{5}	140.61	1.4062×10^{5}	1406.2	1.0343×10^{5}	1.0343×10^{8}
1 Ton/sq. ft. =	13.889	222.22	2000.0	6.9445×10^{-3}	1.0000	384.45	32.038	28.278	0.9451	9.5760×10^{5}	976.48	0.9765	976.51	9.7651	718.26	7.1826×10^{5}
1 Inch water 39°F. =	3.6127×10^{-2}	0.5780	5.2022	1.8063×10^{-5}	2.6011×10^{-3}	1.0000	8.3333×10^{-2}	7.3554×10^{-2}	2.4582×10^{-3}	2490.8	2.5399	2.5399×10^{-3}	2.5400	2.5400×10^{-2}	1.8683	1868.3
1 Foot water 39°F. =	0.43352	6.9363	62.427	2.1676×10^{-4}	3.1213×10^{-2}	12.000	1.0000	0.8826	2.9499×10^{-2}	29890.	30.479	3.0479×10^{-2}	30.480	0.3048	22.419	22419.
1 In mercury 32°F. =	0.49116	7.8586	70.727	2.4558×10^{-4}	3.5363×10^{-2}	13.596	1.1330	1.0000	3.3421×10^{-2}	33864.	34.532	3.4532×10^{-2}	34.532	0.3453	25.400	25400.
INT'L																
1 Normal Atm'ere =	14.696	235.14	2116.2	7.3480×10^{-3}	1.0581	406.79	33.900	29.921	1.0000	1.0132×10^{6}	1033.2	1.0332	1033.3	10.333	760.00	7.6000×10^{5}
1 Dyne/sq. cm.** 1 Microbar =	1.4504×10^{-5}	2.3206×10^{-4}	2.0886×10^{-3}	7.2519×10^{-9}	1.0443×10^{-6}	4.0147×10^{-4}	3.3456×10^{-5}	2.9530×10^{-5}	9.8692×10^{-7}	1.0000	1.0197×10^{-3}	1.0197×10^{-6}	1.0197×10^{-3}	1.0197×10^{-5}	7.5006×10^{-4}	0.7501
METRIC																
1 Gram/sq. cm. =	1.4224×10^{-2}	0.2276	2.0482	7.1117×10^{-6}	1.0241×10^{-3}	0.3937	3.2809×10^{-2}	2.8959×10^{-2}	9.6784×10^{-4}	980.66	1.0000	0.0010	1.00003	1.00003×10^{-2}	0.7356	735.56
1 Kilogram/sq. cm. =	14.224	227.58	2048.2	7.1117×10^{-3}	1.0241	393.71	32.809	28.959	0.9678	9.8060×10^{5}	1000.0	1.0000	1000.03	10.0003	735.56	7.3556×10^{5}
1 Cm. water at 4°C. =	1.4223×10^{-2}	0.2276	2.0481	7.1115×10^{-6}	1.0240×10^{-3}	0.3937	3.2808×10^{-2}	2.8958×10^{-2}	9.6781×10^{-4}	980.64	0.99997	9.9997×10^{-4}	1.0000	0.0100	0.7355	735.54
1 Meter water 4°C. =	1.4223	22.767	204.81	7.1116×10^{-4}	0.1024	39.370	3.2808	2.8958	9.6781×10^{-2}	98064.	99.997	9.9997×10^{-2}	100.00	1.0000	73.554	73554.
1 Mm. Hg. at 0°C.*** =	1.9337×10^{-2}	0.3094	2.7845	9.6684×10^{-6}	1.3922×10^{-3}	0.53525	4.4605×10^{-2}	3.9370×10^{-2}	1.3158×10^{-3}	1333.2	1.3595	1.3595×10^{-3}	1.3595	1.3595×10^{-2}	1.0000	1000.0
1 Micron Hg. 0°C. =	1.9337×10^{-5}	3.0939×10^{-4}	2.7845×10^{-3}	9.6684×10^{-9}	1.3922×10^{-6}	5.3525×10^{-4}	4.4605×10^{-5}	3.9370×10^{-5}	1.3158×10^{-6}	1.3332	1.3595×10^{-3}	1.3595×10^{-6}	1.3595×10^{-3}	1.3595×10^{-5}	0.0010	1.0000

*1 lb./in.² = 1 psi

**1 dyne/cm.² = 1 microbar = 10^{-4}K Pa = 0.1 Pa (Pascal)

***1 mm. Hg. = 1 torr

HARRIS
SEMICONDUCTOR
A DIVISION OF HARRIS CORPORATION

HI-1818A/1828A

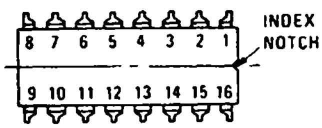
8 Channel Analog Multipexers

FEATURES

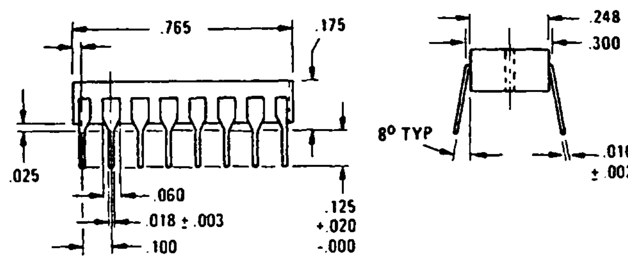
- SIGNAL RANGE ±15V
- "ON" RESISTANCE 250 Ω TYP.
- INPUT LEAKAGE AT +125°C 20nA TYP.
- ACCESS TIME 350ns TYP.
- POWER CONSUMPTION 5mW TYP.
- DTL/TTL COMPATIBLE ADDRESS
- -55°C TO +125°C OPERATION

PACKAGE

CODE 1W 16 LEAD CERAMIC D.I.P.



ALL DIMENSIONS IN INCHES
ALL DIMENSIONS ± .010
UNLESS OTHERWISE SHOWN.

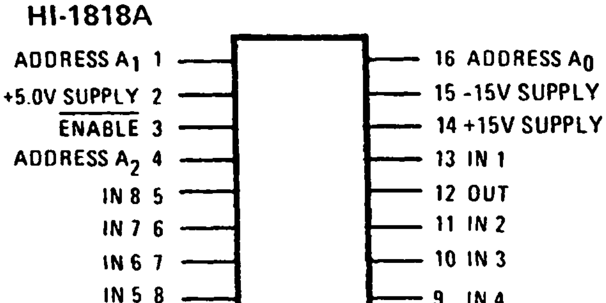


GENERAL DESCRIPTION

The Harris HI-1818A and HI-1828A Analog Multiplexers represent a significant breakthrough in analog switch performance. Vastly superior characteristics are obtained through the unique process of forming complementary MOS transistors in a dielectrically isolated substrate. These devices are useful as multiplexers, signal selectors, and choppers over a wide range of signal levels and switching frequencies. The HI-1818A is a single 8 channel multiplexer while the HI-1828A is a differential 4 channel version. The devices are packaged in a standard 16 pin dual in-line hermetic case and are available in the full military or commercial temperature ranges.

PIN OUT/TRUTH TABLE

HI-1818A

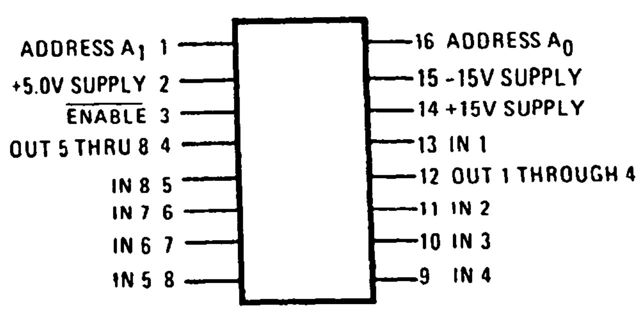


ADDRESS A_2	A_1	A_0	EN	"ON" CHANNEL
L	L	L	L	1
L	L	H	L	2
L	H	L	L	3
L	H	H	L	4
H	L	L	L	5
H	L	H	L	6
H	H	L	L	7
H	H	H	L	8
X	X	X	H	NONE

PIN OUT/TRUTH TABLE

HI-1828A

ADDRESS A_1	A_0	EN	"ON" CHANNELS
L	L	L	1 and 5
L	H	L	2 and 6
H	L	L	3 and 7
H	H	L	4 and 8
X	X	H	NONE



LINEAR

FIG. 12 - HI-1828A DATA SHEET

ABSOLUTE MAXIMUM RATINGS (NOTE 1)

Supply Voltage Between Pins 14 and 15	40.0V	Digital Input Voltage	V-Supply to V+ Supply
Logic Supply Voltage, Pin 2	30.0V	Total Power Dissipation (Note 2)	780mW
Analog Input Voltage: V^{+}_{Supply} +2V		Storage Temperature Range	-65°C to +150°C
V^{-}_{Supply} -2V			

ELECTRICAL CHARACTERISTICS

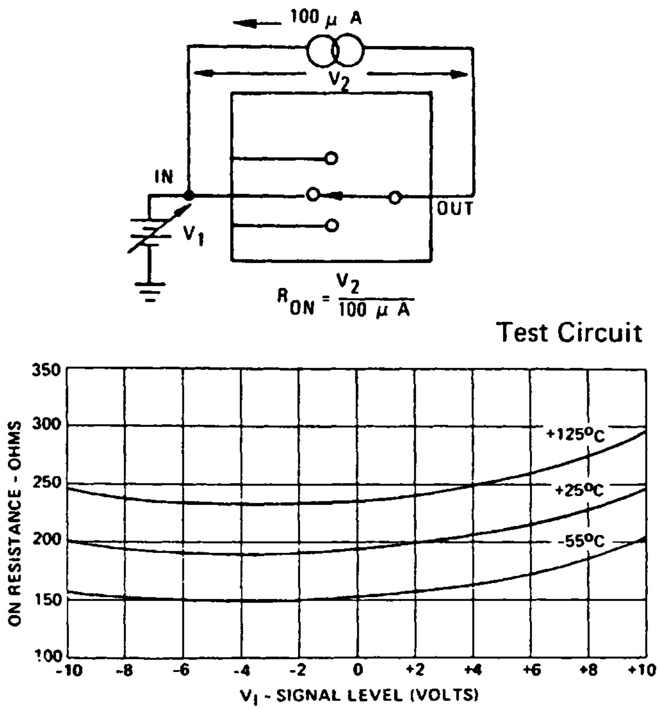
Supplies = +15V, -15V, +5V

PARAMETER	TEMP.	HI-1818A-2/1828A-2 -55°C to +125°C MIN.	TYP.	MAX.	HI-1818A-5/1828A-5 0°C to +75°C MIN.	TYP.	MAX.	UNITS
ANALOG CHANNEL CHARACTERISTICS								
* V_{IN}, Analog Signal Range	Full	-15		+15	-15		+15	V
* R_{ON}, ON Resistance (Note 3)	+25°C		250	400		250	400	Ω
	Full		300	500		300	500	Ω
* I_S(OFF), Input Leakage Current	Full		20	50		20	50	nA
* I_D(ON), On Channel Leakage Current (HI-1818A)	Full		100	250		100	250	nA
(HI-1828A)	Full		50	125		50	125	nA
* I_D(OFF) Output Leakage Current (HI-1818A)	Full		100	250		100	250	nA
(HI-1828A)	Full		50	125		50	125	nA
DIGITAL INPUT CHARACTERISTICS								
V_{IL}, Input Low Threshold	Full			0.4			0.4	V
V_{IH}, Input High Threshold (Note 4)	Full	4.0			4.0			V
* I_{IN}, Input Leakage Current	Full		.01	1		.01	1	μA
SWITCHING CHARACTERISTICS								
T_S, Access Time (Note 5)	+25°C		350			350		ns
Break-Before-Make Delay	+25°C		100			100		ns
C_{IN}, Channel Input Capacitance	+25°C		4			4		pF
C_{OUT}, Channel Output Capacitance (HI-1818A)	+25°C		20			20		pF
(HI-1828A)	+25°C		10			10		pF
C_D, Digital Input Capacitance	+25°C		5			5		pF
POWER REQUIREMENTS								
P_D, Power Dissipation	Full		5			5		mW
P_{DS}, Standby Power (Note 6)	Full		5			5		mW
* I_+, Current Pin 14	Full		0.1	0.5		0.1	1	mA
* I_-, Current Pin 15	Full		0.3	1		0.3	2	mA
* I_L, Current Pin 2	Full		0.3	1		0.3	2	mA

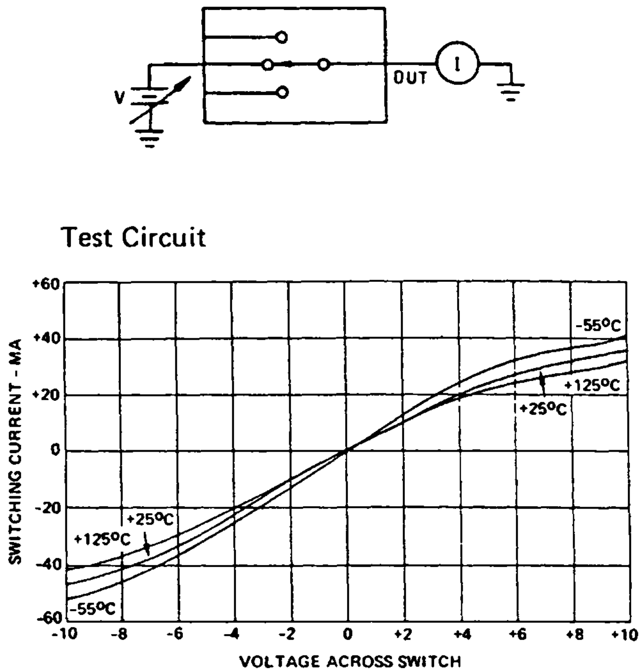
NOTES:
1. Voltage ratings apply when voltages at all other pines are within their nominal operating ranges.
2. Derate 9.25 mW/°C above 75°C
3. V_{OUT} = ± 10V I_{OUT} = -100μ A
4. To drive from DTL/TTL circuits, 1K Ω pullup resistors to +5.0V supply are recommended.
5. Time measured to 90% of final output level; V_{OUT} = - 5.0V to +5.0V, Digital Inputs = 0V to +4.0V.
6. Voltage at Pin 3, $\overline{ENABLE}$ = +4.0V.

*100% Tested For DASH 8

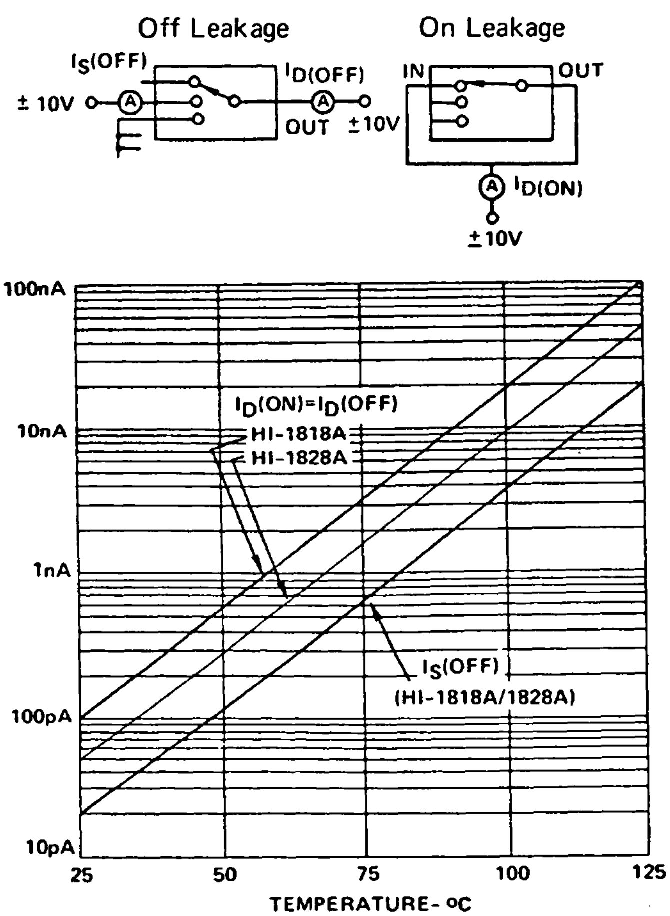
ON RESISTANCE vs ANALOG SIGNAL LEVEL



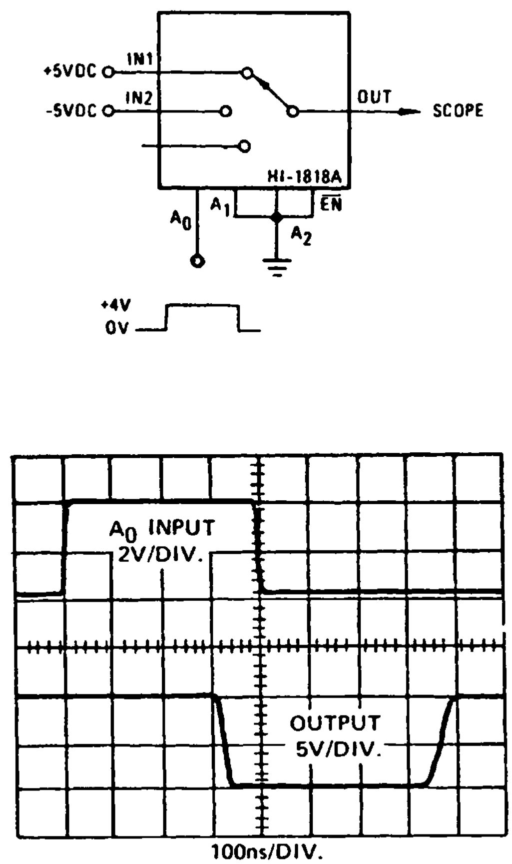
ON CHANNEL CURRENT vs VOLTAGE



ON/OFF LEAKAGE CURRENTS vs TEMPERATURE

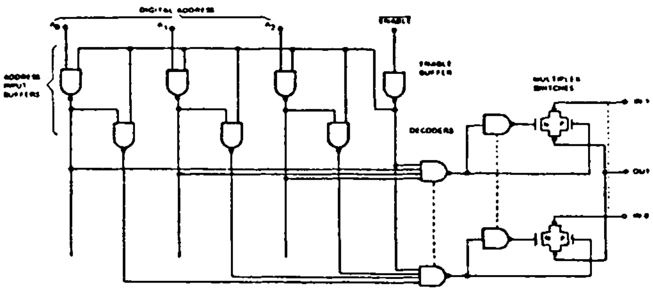


ACCESS TIME

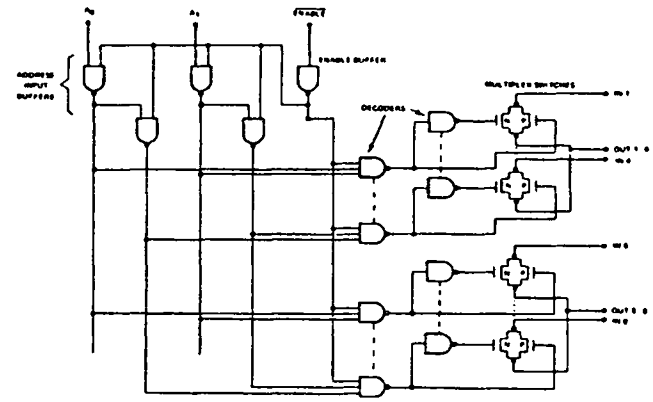


SCHEMATIC DIAGRAM

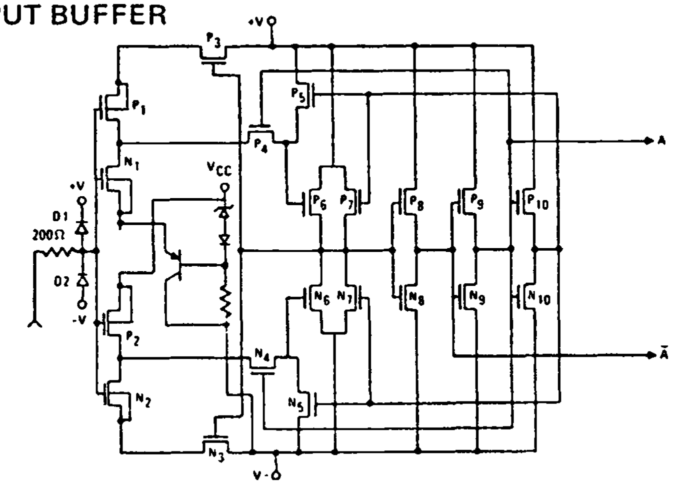
BLOCK DIAGRAM HI-1818A



BLOCK DIAGRAM HI-1828A



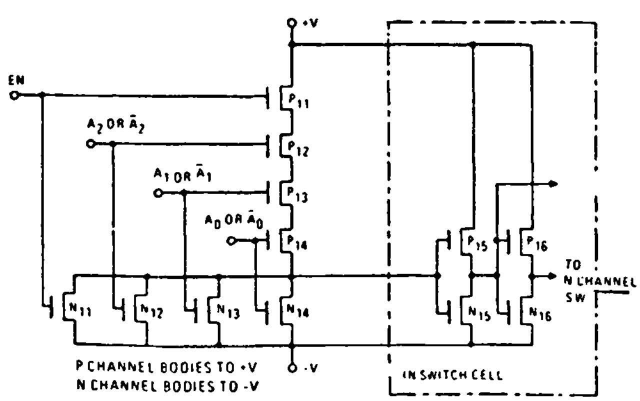
ADDRESS INPUT BUFFER



ALL N-CHANNEL BODIES TO V-

ALL P-CHANNEL BODIES TO V+ UNLESS OTHERWISE INDICATED.

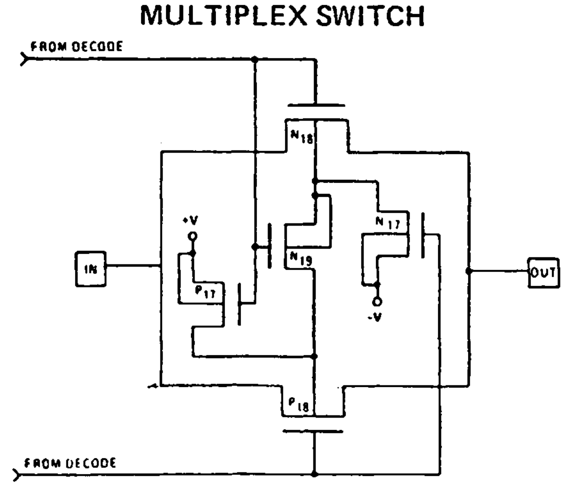
DECODER GATE



P CHANNEL BODIES TO +V
N CHANNEL BODIES TO -V

A2 OR Ā2 NOT USED FOR HI-1828A

MULTIPLEX SWITCH



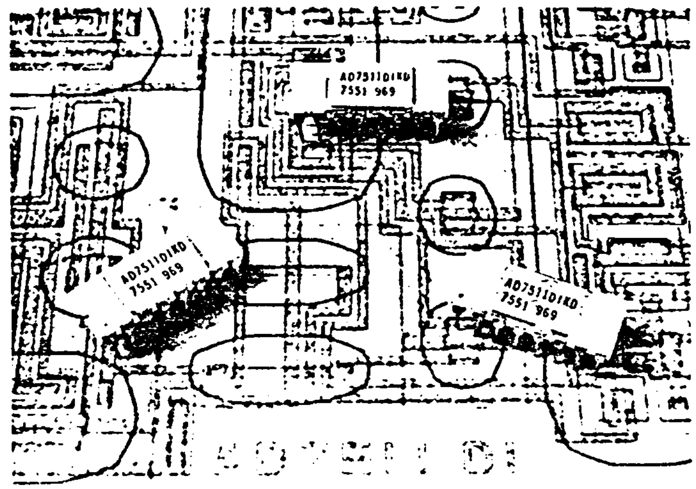
LINEAR

ANALOG DEVICES

DI CMOS Protected Analog Switches

AD7510DI AD7511DI AD7512DI

FEATURES
Latch-Proof
Overvoltage-Proof: ±25V
Low R_{ON}: 75Ω
Low Dissipation: 3mW
TTL/CMOS Direct Interface
Silicon-Nitride Passivated
Monolithic Dielectrically-Isolated CMOS



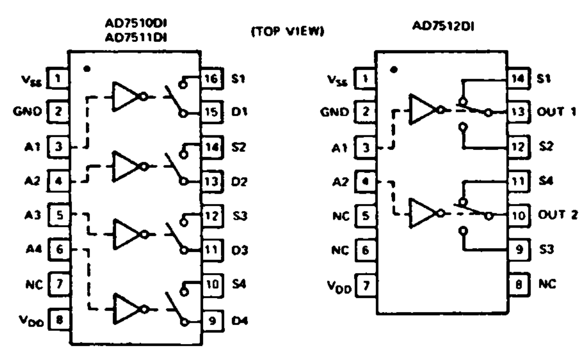
GENERAL DESCRIPTION

The AD7510DI, AD7511DI and AD7512DI are a family of latch proof dielectrically isolated CMOS switches featuring overvoltage protection up to ±25V above the power supplies. These benefits are obtained without sacrificing the low "ON" resistance (75Ω) or low leakage current (400pA), the main features of an analog switch.

The AD7510DI and AD7511DI consist of four independent SPST analog switches packaged in a 16-pin DIP. They differ only in that the digital control logic is inverted. The AD7512DI has two independent SPDT switches packaged in a 14-pin DIP.

Very low power dissipation, overvoltage protection and TTL/CMOS direct interfacing are achieved by combining a unique circuit design and a dielectrically isolated CMOS process. Silicon nitride passivation ensures long term stability while monolithic construction provides reliability.

PIN CONFIGURATIONS



ORDERING INFORMATION

Plastic (Suffix N)	Ceramic (Suffix D)	Operating Temperature Range
AD7510DIJN AD7510DIKN AD7511DIJN AD7511DIKN AD7512DIJN AD7512DIKN		0 to +70°C
	AD7510DIJD AD7510DIKD AD7511DIJD AD7511DIKD AD7512DIJD AD7512DIKD	−25°C to +85°C
	AD7510DISD AD7511DISD AD7511DITD AD7512DISD AD7512DITD	−55°C to +125°C

CONTROL LOGIC

AD7510DI: Switch "ON" for Address "HIGH"

AD7511DI: Switch "ON" for Address "LOW"

AD7512DI: Address "HIGH" makes S1 to Out 1 and S3 to Out 2

FIG. 13 - AD7512 DATA SHEET

SPECIFICATIONS (V_{DD} = +15V, V_{SS} = −15V unless otherwise noted)

COMMERCIAL VERSIONS (J, K)

PARAMETER	MODEL	VERSION	+25°C	0 to +70°C (N) -25°C to +85°C (D)	TEST CONDITIONS
ANALOG SWITCH					
R_{ON} [1]	All	J, K	75Ω typ, 100Ω max	175Ω max	-10V ≤ V_D ≤ +10V
R_{ON} vs V_D (V_S)	All	J, K	20% typ		I_{DS} = 1.0mA
R_{ON} Drift	All	J, K	+0.5%/°C typ		
R_{ON} Match	All	J, K	1% typ		V_D = 0, I_{DS} = 1.0mA
R_{ON} Drift Match	All	J, K	0.01%/°C typ		
I_D (I_S) OFF [1]	All	J, K	0.5nA typ, 5nA max	500nA max	V_D = -10V, V_S = +10V and V_D = +10V, V_S = -10V
I_D $(I_S)_{ON}$ [2]	All	J, K	10nA max		V_S = V_D = +10V V_S = V_D = -10V
I_{OUT} [1]	AD7512DI	J, K	15nA max	1500nA max	V_{S1} = V_{OUT} = ±10V, V_{S2} = ∓10V and V_{S2} = V_{OUT} = ±10V, V_{S1} = ∓10V
DIGITAL CONTROL					
V_{INL} [1]	All	J, K		0.8V max	
V_{INH} [1]	All	J		3.0V min	
	All	K		2.4V min	
C_{IN}	All	J, K	3pF typ		
I_{INH} [1]	All	J, K	10nA max		V_{IN} = V_{DD}
I_{INL} [1]	All	J, K	10nA max		V_{IN} = 0
DYNAMIC CHARACTERISTICS					
t_{ON}	AD7510DI	J, K	180ns typ		
	AD7511DI	J, K	350ns typ		V_{IN} = 0 to +3.0V
t_{OFF}	AD7510DI	J, K	350ns typ		
	AD7511DI	J, K	180ns typ		
$t_{TRANSITION}$	AD7512DI	J, K	300ns typ		
C_S (C_D)OFF	All	J, K	8pF typ		
C_S (C_D)ON	All	J, K	17pF typ		
C_{DS} (C_{S-OUT})	All	J, K	1pF typ		V_D (V_S) = 0V
C_{DD} (C_{SS})	All	J, K	0.5pF typ		
C_{OUT}	AD7512DI	J, K	17pF typ		
Q_{INJ}	All	J, K	30pC typ		Measured at S or D terminal. C_L = 1000pF, V_{IN} = 0 to 3V, V_D (V_S) = +10V to -10V
POWER SUPPLY					
I_{DD} [1]	All	J, K	500μA max		All digital inputs = V_{INH}
I_{SS} [1]	All	J, K	100μA max		
I_{DD} [1]	All	J, K	100μA max		All digital inputs = V_{INL}
I_{SS} [1]	All	J, K	100μA max		

NOTES:
[1] 100% tested.
[2] Guaranteed, not production tested.
[3] A pullup resistor, typically 1-2kΩ is required to make "J" versions TTL compatible.

Specifications subject to change without notice.

MILITARY VERSIONS (S, T)					
PARAMETER	MODEL	VERSION	+25°C	-55°C to +125°C	TEST CONDITIONS
ANALOG SWITCH					
R_{ON}[1]	All	S, T	100Ω max	175Ω max	$-10V \leq V_D \leq +10V$ $I_{DS} = 1mA$
$I_D (I_S)_{OFF}$[1]	All	S, T	3nA max	200nA max	$V_D = -10V, V_S = +10V$ and $V_D = +10V, V_S = -10V$
$I_D (I_S)_{ON}$[2]	All	S, T	10		$V_S = V_D = +10V$ and $V_S = V_D = -10V$
I_{OUT}[1]	AD7512DI	S, T	9nA max	600nA max	$V_{S1} = V_{OUT} = \pm 10V$ $V_{S2} = \mp 10V$ and $V_{S2} = V_{OUT} = \pm 10V$ $V_{S1} = \mp 10V$
DIGITAL CONTROL					
V_{INL}[1]	All	S, T		0.8V max	
V_{INH}[1,3]	AD7510DI	S		2.4V min	
	AD7511DI	T		2.4V min	
	AD7512DI	T		2.4V min	
	AD7511DI	S		3.0V min	
	AD7512DI	S		3.0V min	
I_{INH}[1]	All	S, T	10nA max		$V_{IN} = V_{DD}$
I_{INL}[1]	All	S, T	10nA max		$V_{IN} = 0$
DYNAMIC CHARACTERISTICS					
t_{ON}[2]	AD7510DI	S, T	1.0μs max		$V_{IN} = 0$ to $+3V$
	AD7511DI	S, T	1.0μs max		
t_{OFF}[2]	AD7510DI	S, T	1.0μs max		
	AD7511DI	S, T	1.0μs max		
$t_{TRANSITION}$[2]	AD7512DI	S, T	1.0μs max		
POWER SUPPLY					
I_{DD}[1]	All	S, T		800μA max	All digital inputs = V_{INH}
I_{SS}[1]	All	S, T		800μA max	
I_{DD}[1]	All	S, T		500μA max	All digital inputs = V_{INL}
I_{SS}[1]	All	S, T		500μA max	

NOTES:
[1] 100% tested.
[2] Guaranteed, not production tested.
[3] A pullup resistor, typically 1-2kΩ is required to make AD7511DISD and AD7512DISD TTL compatible.
Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS

V_{DD} to GND . . . . +17V
V_{SS} to GND . . . . -17V
Overvoltage at V_D (V_S)
(1 second surge) . . . . V_{DD} +25V
or V_{SS} -25V
(Continuous) . . . . V_{DD} +20V
or V_{SS} -20V
Switch Current (I_{DS}, Continuous) 50mA
Switch Current (I_{DS}, Surge)
1ms Duration, 10% Duty Cycle 150mA
Digital Input Voltage Range . . . . 0V to V_{DD}
Power Dissipation (Package)
14 & 16 pin Ceramic Dip
Up to +75°C. 450mW
Derates above +75°C by . . . . .6mW/°C
14 & 16 pin Plastic Dip
Up to +70°C. 670mW
Derates above +75°C by . . . . .8.3mW/°C
Storage Temperature . . . . -65°C to +150°C
Operating Temperature
Plastic (J, K Versions) . . . . 0 to +70°C
Ceramic (J, K Versions) . . . . -25°C to +85°C
Ceramic (S, T Versions) . . . . -55°C to +125°C

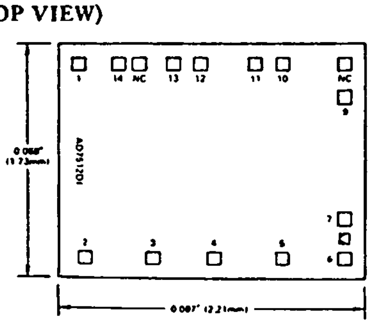
CAUTION: The digital control inputs are zener protected; however, permanent damage may occur on unconnected units under high electrostatic fields. Keep unused units in conductive foam at all times. Prior to pulling the devices from the conductive foam, ground the foam to deplete any accumulated charge.

TERMINOLOGY

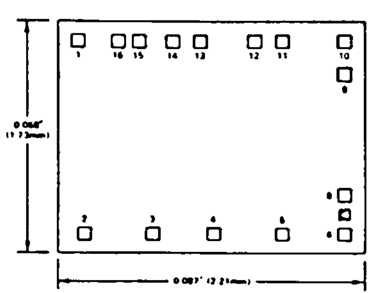
R_{ON}:	Ohmic resistance between terminals D and S.
R_{ON} Drift Match:	Difference between the R_{ON} drift of any two switches.
R_{ON} Match:	Difference between the R_{ON} of any two switches.
I_D $(I_S)_{OFF}$:	Current at terminals D or S. This is a leakage current when the switch is "OFF."
I_D $(I_S)_{ON}$:	Leakage current that flows from the closed switch into the body. (This leakage will show up as the difference between the current I_D going into the switch and the outgoing current I_S.)
V_D (V_S):	Analog voltage on terminal D (S).
C_S (CD):	Capacitance between terminal S (D) and ground. (This capacitance is specified for the switch open and closed.)
C_{DS}:	Capacitance between terminals D and S. (This will determine the switch isolation over frequency.)
C_{DD} (C_{SS}):	Capacitance between terminals D (S) of any two switches. (This will determine the cross coupling between switches vs. frequency.)
t_{ON}:	Delay time between the 50% points of the digital input and switch "ON" condition.
t_{OFF}:	Delay time between the 50% points of the digital input and switch "OFF" condition.
$t_{transition}$:	Delay time when switching from one address state to another.
V_{INL}:	Threshold voltage for the low state.
V_{INH}:	Threshold voltage for the high state.
I_{INL} (I_{INH}):	Input current of the digital input.
C_{IN}:	Input capacitance to ground of the digital input.
V_{DD}:	Most positive voltage supply.
V_{SS}:	Most negative voltage supply.
I_{DD}:	Positive supply current.
I_{SS}:	Negative supply current.

BONDING DIAGRAMS (TOP VIEW)

AD7512DI



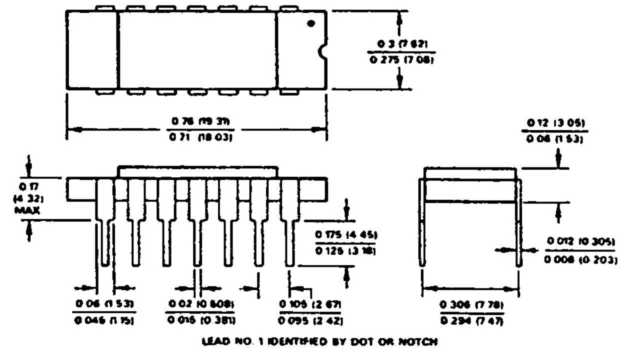
AD7510DI, AD7511DI



OUTLINE DIMENSIONS

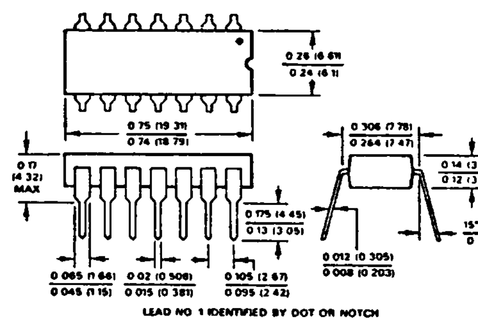
Dimensions shown in inches and (mm).

14-PIN CERAMIC DIP



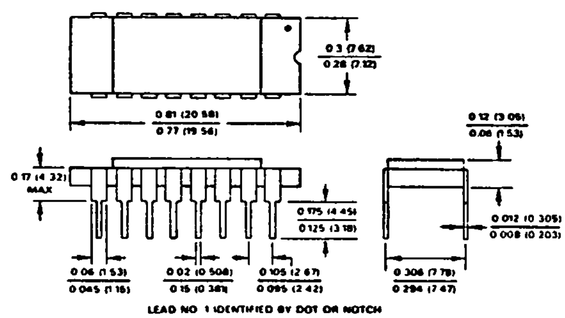
AD7512DI

14-PIN PLASTIC DIP



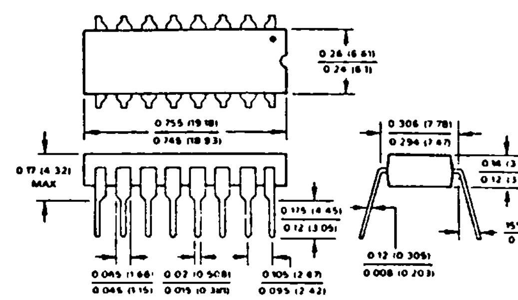
AD7512DI

16-PIN CERAMIC DIP



AD7510DI, AD7511DI

16-PIN PLASTIC DIP



AD7510DI, AD7511DI