



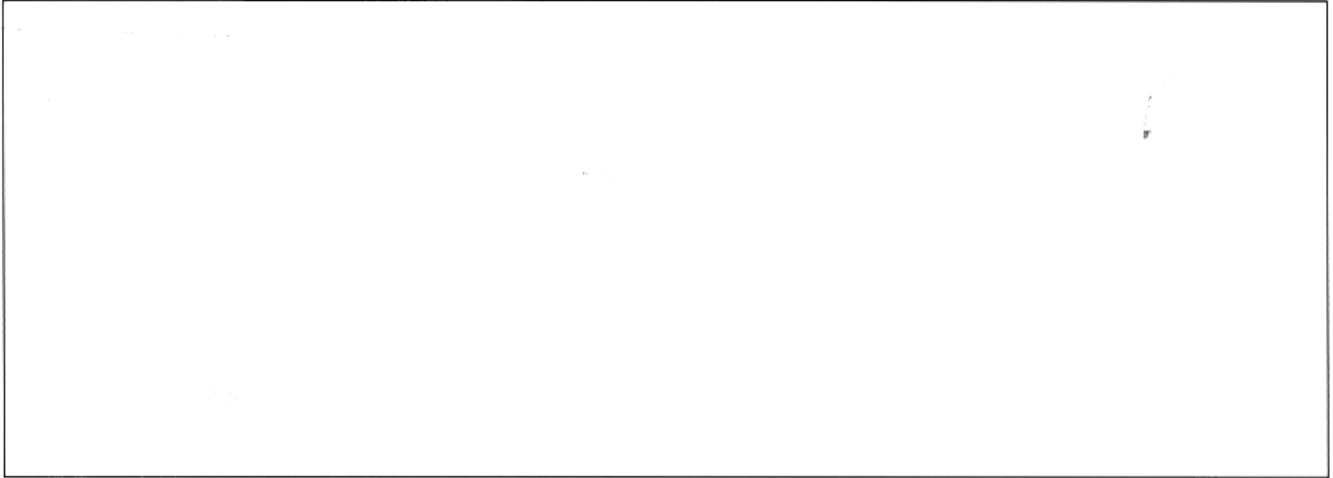
INSTRUCTION MANUAL

DAI

Direct Analog Interface

Form 112-751-00D

October 1986



GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This manual contains operating and maintenance information for the Direct Analog Interface (DAI), manufactured by Moore Industries Inc., Sepulveda, California. The manual consists of six sections, as follows:

Section 1, General Information, introduces the equipment function and describes the equipment's physical appearance, its specifications and any options available for the unit.

Section 2, Calibration, provides the information necessary to adjust and calibrate the unit. This section contains a list of the tools and test equipment necessary for calibrating the equipment, and illustrates the test setup.

Section 3, Installation and Operation, supplies the information needed to install and operate the equipment. This section contains figures that specify the installation requirements for the unit, and text that informs the user of recommended wiring practices for the equipment.

Section 4, Functional Operation, provides an explanation of the internal functional operation of the unit. The description is based on a simplified schematic diagram showing the basic signal flow through the unit.

Section 5, Maintenance, provides guidance in determining whether or not the unit is malfunctioning. This unit is not field repairable due to its complexity and therefore it is necessary only to determine whether it is malfunctioning.

Section 6, Unit Documentation, provides the user with the Moore Industries schematic diagrams and printed circuit assembly drawing, showing the location of all components.

The terms NOTE, CAUTION, and WARNING are each used with a specific meaning throughout this manual. A NOTE provides additional information that makes it easier to perform a particular task, a step in wiring or disassembly, for example. Failure to follow a NOTE may result in some inconvenience or needless expense, but the unit will not be damaged, nor is the instrument technician likely to be injured. A CAUTION stresses important details to follow, when making electrical connections or cleaning PC board contacts, for example. Failure to heed a CAUTION may damage the unit, void the Moore Industries warranty, or even result in minor physical injury to the instrument engineer. A WARNING provides vital safety information which must not be ignored on any account. WARNINGS deal with proper ground-

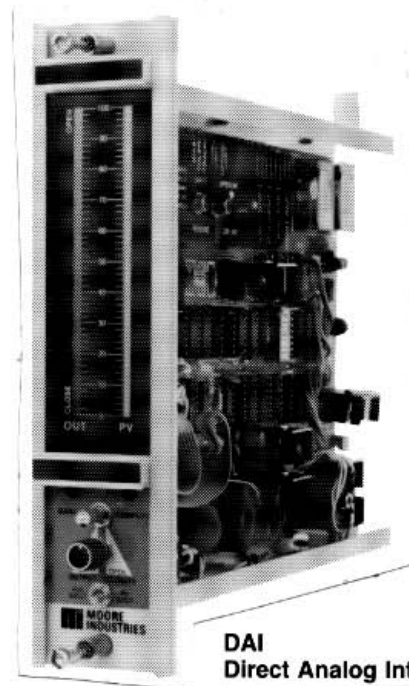
ing of equipment, use of solvents, etc. More important than the damage that will certainly result to the unit, the instrumentation engineer risks serious personal injury, even death, if the WARNINGS are not obeyed.

1.2 EQUIPMENT DESCRIPTION

The Direct Analog Interface, Model DAI, is a computer/manual control and display station designed to interface a process control computer, or a programmable controller, with a valve or other final control element in an analog loop.

It can be ordered either as a fail-safe, 4 to 20mA single control loop BACKUP STATION or as a single channel, 1 to 5V input, DEMULTIPLEXER STATION.

In the BACKUP STATION configuration, the unit can be operated as a manual control station or as a computer (or programmable controller) interface with an analog control loop. When operated in computer



DAI
Direct Analog Interface

mode, the control signal passes through the station, unmodified, to the external control element terminals. The DAI tracks the computer input signal and generates an equivalent signal which is maintained on standby as long as the computer indicates that operation is normal. Should a computer failure occur, the computer may disconnect by activating MANUAL REQUEST MR1, causing the DAI to take over and hold the output signal constant at the last value present before the failure was indicated. The manual mode will then be indicated by the front panel MANUAL LED. The operator may then manually adjust the control signal as required.

When configured as a 1-5V input DEMULTIPLEXER STATION, the DAI can be used in groups, controlled from a single computer output channel, on a time-shared basis. When a specific DAI is enabled by the computer SELECT line, its output signal tracks the computer control signal until it is de-selected. It then holds the last value as a control output until it is re-selected for an update by the computer. The output can be manipulated by the operator while in manual mode, if required. A bias signal of up to $\pm 50\%$ of the signal range can be added to the output signal to compensate for possible dc level shifts in the computer control signal.

update

etc

Two 4" high bar graph indicators display, on a continuous basis, both the control function and a process variable of the user's choice. An auxiliary variable can also be displayed, on a momentary basis, instead of the process variable by actuating a front panel switch. The left bar graph indicator, which monitors the control signal, is red to distinguish it from the process variable indicator, which is orange.

Adjustable upper and lower limits may be imposed on the output control signal, ranging from 0 to 100% of full scale when in computer mode. (Limiting is also available in manual mode as an option.) Limiting values may be displayed on the control signal bar graph indicator by a side panel selector switch. If the signal amplitude exceeds the maximum indicator value, the associated bar graph will flash at a 2Hz rate. When the alarm input for either indicator is made active, the selected indicator will flash at a 4Hz rate.

1.3 PHYSICAL DESCRIPTION

The DAI consists of a single printed circuit board and a front panel control and display section, mounted to a frame assembly. The circuit board contains the electronic components required to perform the DAI functions and uses a rear edge connector for power and input/output signals.

CALIBRATION PROCEDURES

2.1 GENERAL INFORMATION

This section provides information about unit adjustment and calibration. Units with standard input and output levels are adjusted at the factory. After the unit is unpacked, general operating level checks are recommended. Usually these checks, specified in this section, require little or no adjustment.

2.2 CONTROLS, DESCRIPTION & LOCATION

The potentiometers used require 22 turns of the shaft to move the wiper from one end of the range to the other and are equipped with a slip clutch at

either end of the travel to prevent damage if turned beyond the wiper stop. Usually, a slight change in the feel will be noticed when the clutch is slipping. However, either end can be reached by turning the shaft 22 turns in the desired direction. Controls are connected so that turning the shaft clockwise increases the quantity or makes it more positive, and turning the shaft counterclockwise has the opposite effect.

Controls, switches and indicators, are listed in Table 2-1. Unit specifications are found in Table 2-2.

No.	NOMENCLATURE	DESCRIPTION
1.	MODE SWITCH	Protected spring return toggle, allows the operator to switch to MANUAL OUTPUT control or request COMPUTER control.
2.	MANUAL OUTPUT CONTROL	Push-to-activate knob ramps manual output at a continuously variable rate from -20% to +20% per second.
3.	DISPLAY SELECTOR SWITCH	Spring return toggle normally displays process variable or momentarily displays auxiliary variable and provides momentary contact closure output.
4.	DIRECT/REVERSE SWITCH	Reverses action of output bar graph & front panel output control for reverse action control loops.
5.	UPPER/LOWER SWITCH	Selects upper limit, lower limit, or control output for display on output bar graph.
6.	UPPER/LOWER LIMIT ADJUSTMENT	Sets respective limits on station's output range from 0 to 100% when in computer mode. (Also available in manual mode with -LIM option.) Both limits may be displayed on the output bar graph.
7.	DIP SWITCH	Selects value that output will assume when power is first applied. Range: -25% to 102.5% in 0.5% steps.
8.	BIAS ADJUSTMENT	Adds up to $\pm 50\%$ to station output signal.
9.	TOLERANCE ADJUSTMENT	Sets maximum allowable difference between computer signal and station's present output to enable transfer to computer mode.
10.	INDICATORS	Vertical ionized gas tube display. Height: 4 inches Resolution: 0.5% Right Bar: Orange for PROCESS VARIABLE (PV) or AUXILIARY INPUT display. Left Bar: Red for control output or control limits display (switch selectable). Flashing: Displays flash at 2Hz rate when range is over 100% and flash at a 4Hz rate for alarm indication.
11.	INDICATOR, LED	Dual LED, red/green signal match indicator.
12.	INDICATOR, LED	Single LED, glows red when in COMPUTER mode or "Transfer Request Pending."
13.	INDICATOR, LED	Single LED, glows red when in MANUAL mode or "Transfer Request Pending."

Table 2-1 Operator Controls, Switches and Indicators

ANALOG INPUTS

Control Signal:

Back-up Station

4-20mA (100 ohm series load)
Common mode voltage range: > 50V
with respect to control signal return
Common mode rejection ratio: > 56 dB
(Errors due to common mode voltage can be minimized if the output load resistance is specified at time of purchase.)

Demultiplexer Station

1-5V (250K ohms, single-ended)

Process and Auxiliary Variables:

1-5V (200K ohms differential, 400K ohms common mode)
1-5mA (1K ohms)
4-20mA (250 ohms)
10-50mA (100 ohms)
Common mode voltage range > 50V with respect to control signal return
Common mode rejection ratio > 56dB

DISCRETE SIGNALS: Select, Manual Request, & Alarm

(Accommodates TTL, Open Collector, and Contact Closure inputs)

OFF: +3.0Vdc min. @ 20 μ A

ON: +0.8Vdc max. @ 500 μ A

ANALOG OUTPUTS

Current: 4-20mA (1200 ohm max. load)

Voltage: 1-5V (10K ohm minimum load)

DISCRETE OUTPUTS: Status and NO

Blocking Voltage: 60Vdc or 120Vac

Current Rating: 1A max., nonreactive loads only

TRACKING FUNCTION

Output Slew Rate: 0.2%/ms

Bumpless Transfer Accuracy: 0.5% of signal
(100 ohm load on current output)

Meter Display Accuracy: 1% of full scale

TRACK AND HOLD TIMING

Analog Signal Setup Time: 0ms.

Select (tracking) Pulse Width: 1.0ms minimum

Analog Signal Hold Time: 0ms minimum

CONTROLS

Front Panel:

MODE SWITCH: Protected spring return toggle allows the operator to switch to manual output control or request computer control.

MANUAL OUTPUT CONTROL: Push-to-activate knob ramps manual output at a continuously variable rate from -20 to +20% per second.

DISPLAY SELECTOR SWITCH: Spring return toggle normally displays process variable or momentarily displays auxiliary variable and provides momentary contact closure output.

Side Panel:

DIRECT/REVERSE SWITCH: Reverses action of output bar graph and front panel manual output control for reverse action control loops.

UPPER/LOWER SWITCH: Selects UPPER LIMIT, LOWER LIMIT, or CONTROL OUTPUT for display on output bar graph.

UPPER/LOWER LIMIT ADJUSTMENT: Sets respective limits on station's output range from 0 to 100% when in computer mode. (Also available in manual mode with -LIM option.) Either limit may be displayed on the output bar graph.

DIP SWITCH: Selects value that output will assume when power is first applied. Range: -25% to +102.5% in 0.5% steps.

BIAS ADJUSTMENT: Adds $\pm 50%$ to station output signal.

TOLERANCE ADJUSTMENT: Sets maximum allowable difference between host's signal and station's present output to enable transfer to computer mode. Range: 0.5% to 10%.

INDICATOR: Vertical ionized gas tube display

Height: 4 inches

Resolution: 0.5%

Right Bar: Orange for PROCESS VARIABLE (PV) OR AUXILIARY (AUX) INPUT display.

Left Bar: Red for CONTROL OUTPUT or CONTROL LIMITS display (switch selectable)

Flashing: Displays flash at 2Hz rate when range is over 100% and flash at 4Hz rate for alarm indication.

ENVIRONMENTAL

Ambient Temperature:

Operating: 0° to 55° C (32° to 131° F)

Storage: -29° to +82° C (-20° to +186° F)

Relative Humidity:

Operating: 10 to 90%, noncondensing

Storage: 5 to 90%, noncondensing

Weight:

Power: 24 \pm 2Vdc, 0.75A typical in manual mode and 0.7A typical in computer mode.

OPTIONS:

-LIM Manual output limited to same values as those in selected computer control.

For demultiplexer only, -NM or -NT may be selected:

-NM No Match. Input/output match not required to transfer to computer mode or track input signal.

-NT No Track. In computer mode, output will not track input if difference exceeds tolerance setting

-SS Special scale placed to the right of the PV display bar indicating customer-specified engineering units and range.

CERTIFICATION: CSA approval pending.

ORDERING INFORMATION:

Specify the following:

1. Analog input ranges
2. Analog output ranges
3. Options
4. Enclosure

SAMPLE MODEL NUMBER

DAI/DMX1-5V4-20MA/4-20MA/24DC/-LIM [PC]

Table 2-2 Unit Specifications

2.3 TEST EQUIPMENT & TOOLS REQUIRED

Test equipment and tools required for calibration are described in Table 2-3. They are not supplied and must be provided by the user.

2.4 TEST EQUIPMENT SETUPS

Off-line calibration for all units requires the same test equipment setup regardless of option or physical configuration. The following paragraphs define the general test setup and identify the hookup requirements for the unit.

The test equipment setup required for calibration is shown in Figure 2-3.

2.5 ADJUSTMENT AND CALIBRATION

The approach used in testing is to apply inputs and measure appropriate station response to decide whether the DAI station requires readjustment. In addition, when process system parameters, such as bias and input signal limits, change, further adjustments may be necessary. The location of switches, potentiometers and indicators referred to in the adjustment and calibration procedure, is shown in Figures 2-1 and 2-2.

2.5.1 Preliminary

It is necessary to remove the plexiglass safety shield in order to reach Pin #1 of IC1 and Pin #1 of IC6. Signal level measurements taken at these points are recommended as a part of the adjustment verification process described below. To remove this shield, disconnect the DAI at the edge connector and lay the unit on a work bench, component side up.

Loosen and remove the toggle switch bushing hex nuts on the DIRECT/REVERSE and LIMIT switches and remove the safety shield. Keep it handy to refer to locations of switches and pots whose functions are printed on the shield. *CAUTION: Avoid contact with the high voltage section of the power supply as it may be hazardous to human beings.* Leave the DIRECT/REVERSE switch in the DIRECT position. Set DIP switch S3 to -25% of full scale (all switches open) and short +IN to AR. Using the test set up shown in Figure 2-3, insert the DAI edge connector into the mating test receptacle and turn on the primary power supply and all test equipment. Allow a 10-minute stabilization period before taking measurements. Current drain on the 24Vdc supply should be equal to or less than 0.8 Amperes.

2.5.2 Left Bar Indicator, ZERO and SPAN Adjustment

Use the oscilloscope to measure the voltage at PIN #1 of IC1. If necessary, adjust the offset pot to obtain a reading of $0 \pm 1\text{mVdc}$ on the oscilloscope. Also measure the voltage at IC6, Pin #1. If necessary, adjust Ref bias pot to obtain a reading of 0Vdc.

The Left Bar Indicator should have only the first segment illuminated. If necessary, adjust the LEFT BAR ZERO pot to achieve this condition. Verify that Vout and Iout both indicate $1\text{Vdc} \pm 2\text{mV}$. Adjust the respective ZERO pots to achieve this condition if necessary.

Using the precision current source, identified in Table 2-3, as a simulated computer signal, set +IN to 100% and set the DIP switch to 100% (1,2,3,4,5, & 7 to ON). Turn the 24Vdc power off and then on

NOMENCLATURE	CHARACTERISTICS	FUNCTION
Adjustable Voltage Source	0-7Vdc @ 100mA	Discrete input simulator
Power Supply	24Vdc @ 1A	Station Power Source
Digital Voltmeter	5½ Digit, Accuracy $\pm .05\%$	Output Signal Monitoring
DC Milliammeter	0-20mA, Accuracy $\pm .05\%$	Output Signal Monitoring
DAI Test Fixture	Simulates System Hookup	Facilitates Bench Testing
Oscilloscope	Input Sensitivity 2MVdc per cm	Measure Offset & Bias Voltage
Precision Current Source	0-20mA, Accuracy $\pm .05\%$	Simulates Process Current Signal

Table 2-3 Test Equipment Required

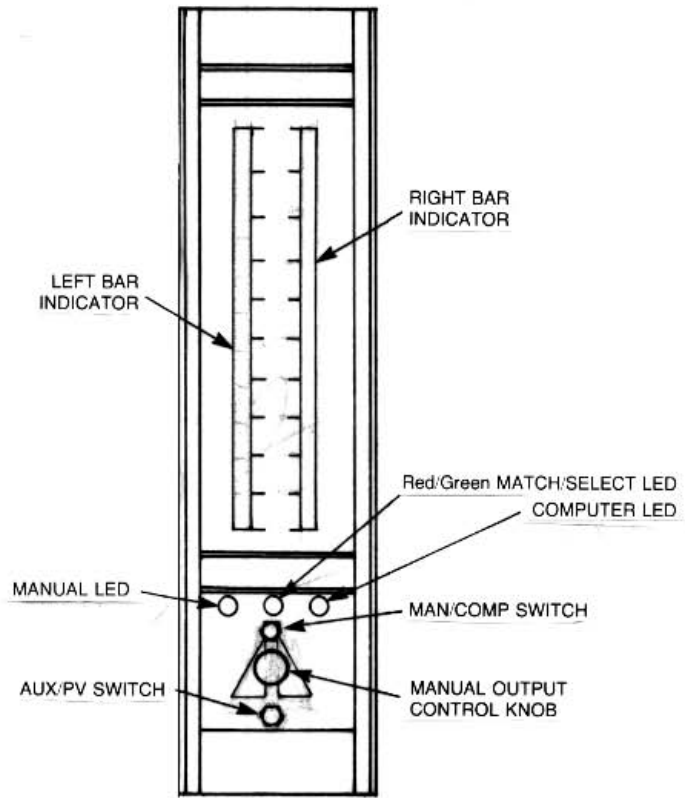


Figure 2-1 Control Locations, Front Panel

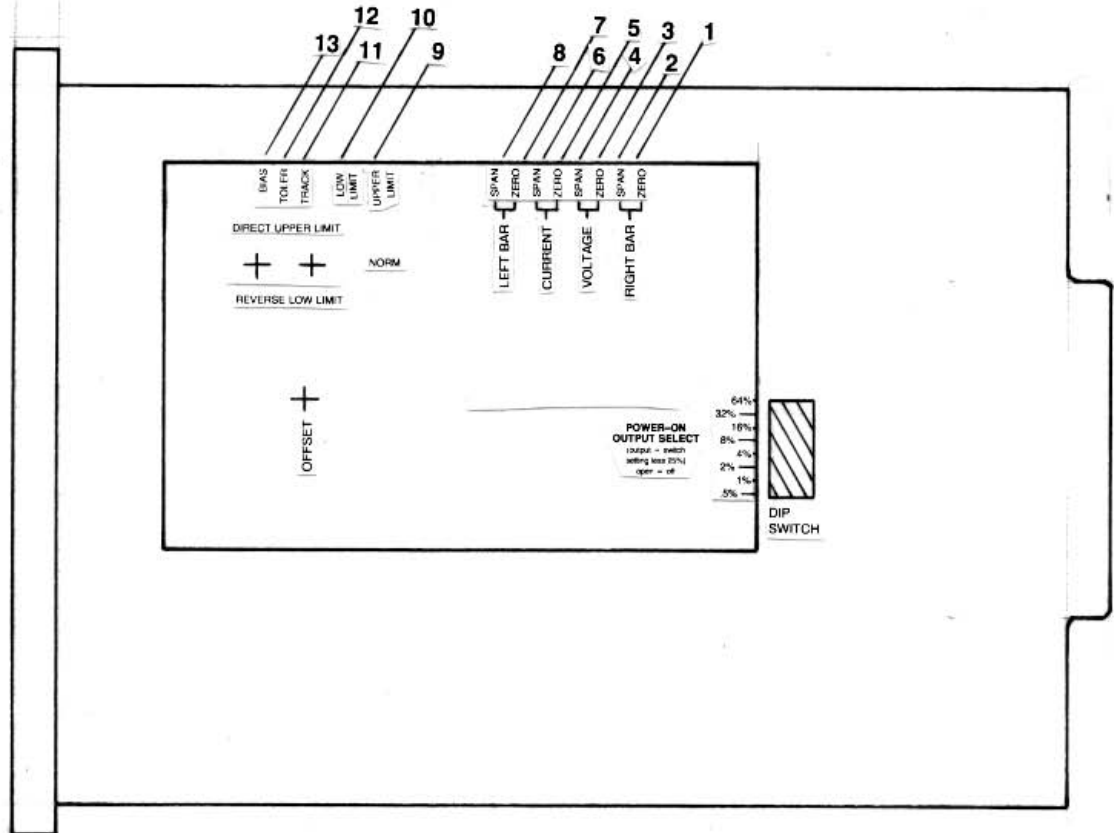


Figure 2-2 Control Locations, Side Panel

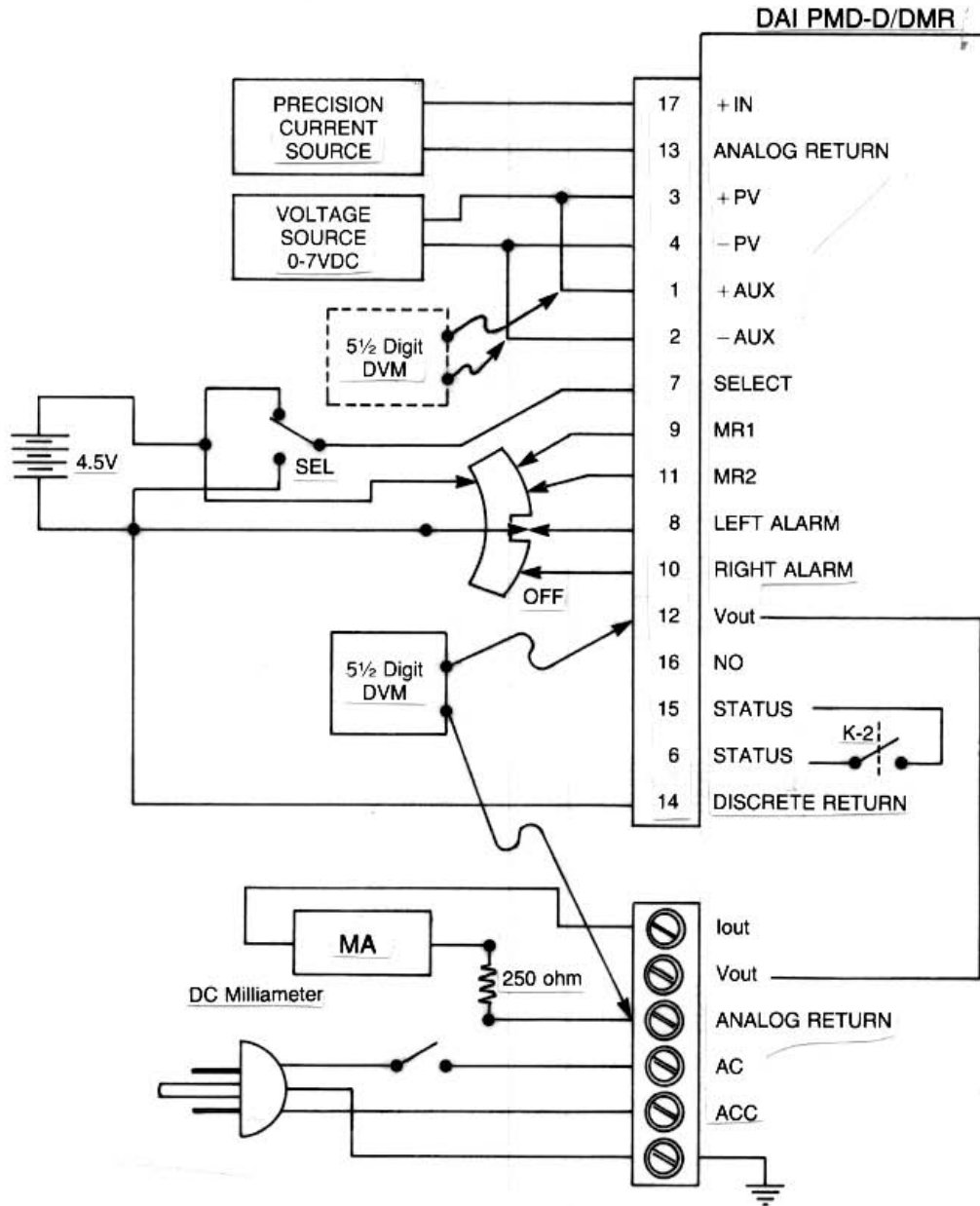


Figure 2-3 Test Equipment Set-Up For Adjustment And Calibration

again, thereby resetting the DAC to the value selected by the DIP switch. Adjust TRACK GAIN to reduce the signal level at Pin 1 of IC1 to $0\text{mV} \pm 1\text{mV}$.

Verify that the LEFT BAR indicator reads $100\% \pm 0.5\%$, and both Vout and Iout read $5\text{Vdc} \pm 2\text{mV}$. If any of the three outputs are out of specification limits, adjust the corresponding SPAN pot located as shown in Figure 2-2. *NOTE: ZERO and SPAN pots are interactive.* If it becomes necessary to adjust a ZERO or SPAN pot, both the related ZERO and SPAN pots must be alternately adjusted while being provided with proper inputs, until no further adjustments are required.

2.5.3 Limit Adjust

Set switch S2 on the DAI printed circuit board, to the LOW LIMIT position and adjust the LOW LIMIT pot, if necessary, so that only the first segment of the LEFT BAR indicator is illuminated.

Set S2 to UPPER LIMIT position and adjust the UPPER LIMIT pot until the LEFT BAR indicator moves up to just over 100%. The indicator should flash at a 2Hz rate to signal an overrange condition.

If more restrictive limits on the computer signal excursion (or both the computer and the manual signal with the -LIM option) are desired, they can be adjusted as described in the paragraph above. Set the UPPER and LOWER LIMIT pots to the required values using switch S2 to display the settings on the LEFT BAR indicator. The flashing 2Hz alarm is activated only when the signal exceeds 0% or 100% on the Bar Graph Display.

2.5.4 Right Bar Indicator, ZERO and SPAN Adjustment

Using the precision current source identified in Table 2-3, connected to the PV signal input, set the current to 4mA. The RIGHT BAR INDICATOR should have only the first segment illuminated. Adjust the RIGHT BAR ZERO pot, if required.

Adjust the current source to 20.0mA and the RIGHT BAR INDICATOR should display $100\% \pm 0.5\%$. Adjust the RIGHT BAR INDICATOR SPAN pot if required. If either the ZERO or SPAN pot requires adjustment, it will be necessary to repeat the steps above until no further adjustment is required.

2.5.5 Track and Transfer (Backup Station Only)

With the 24Vdc power on, set the DAI station to MANUAL and use the output control knob to sweep the LEFT BAR INDICATOR through its full range. Set the computer signal simulator current source to 50% of full scale (12mA). Hold the transfer switch to COMPUTER position and use the DAI front panel output control knob to adjust the LEFT BAR INDICATOR toward the 50% level. When the MANUAL OUTPUT signal matches the simulated computer signal within 1%, the front panel green (MATCH) LED

should illuminate if the TOLERANCE POT is set fully counterclockwise. Release the transfer switch. The station is now in the TRACKING mode. The LEFT BAR INDICATOR, which is driven by the station's DAC, will follow the simulated computer input signal within 1%, or better. Verify by adjusting the input signal and comparing its value with Vout, which is also driven by the station's DAC.

Initiate a MANUAL REQUEST by activating MR1 or MR2. Observe that the COMPUTER LED on the front panel extinguishes while the MANUAL LED illuminates and the MATCH LED changes from green to red when the MANUAL output control knob is used to deviate the control signal from the value present at time of transfer. Verify that the DAI cannot be transferred to COMPUTER while the MATCH LED shows red.

SELECT/DESELECT and TRACK-AND-HOLD (DEMULTIPLEXER STATION). Conduct the first test as described in paragraph 2.5.5 for BACKUP STATION with SELECT line active (low state), and MR1 and MR2 inactive. Verify that Iout and the LEFT BAR INDICATOR correspond to Vout on the digital voltmeter. Vary the computer signal simulator and verify that the LEFT BAR INDICATOR follows the input signal variations. Observe the station output, then Deselect the station and change the simulated computer signal by approximately 10%. Verify that the LEFT BAR INDICATOR and the station Iout signal hold the same value that existed at the time of Deselect.

2.5.6 LEFT and RIGHT BAR INDICATOR Alarm

With 24Vdc power applied to the station, activate the LEFT ALARM (LOW STATE) and verify that the LEFT BAR INDICATOR flashes at a 4Hz rate.

Repeat this test with the RIGHT ALARM and verify that the RIGHT BAR INDICATOR flashes at a 4Hz rate.

2.5.7 LEFT and RIGHT BAR OVER-RANGE

With 24Vdc power applied to the station, provide a simulated computer over-range input signal of +102% from the test fixture and verify that the LEFT BAR INDICATOR flashes at a 2Hz rate for the over-range input signal.

With 24Vdc power applied to the station, provide a simulated PROCESS VARIABLE (PV) over-range input signal of +102% and verify that the RIGHT BAR INDICATOR flashes at a 2Hz rate for the over-range input signal.

2.5.8 DIRECT/REVERSE SWITCH

Set the LEFT BAR INDICATOR to exactly 75%, using the simulated computer input signal from the test fixture and then change the DIRECT/REVERSE switch to the REVERSE position. Both the LEFT BAR INDICATOR and the Vout/Iout signals should indicate $25\% \pm 5\%$ of full scale.

INSTALLATION & OPERATION

3.1 GENERAL INFORMATION

The DAI is designed for either panel mounting, using the PMD enclosure, or rack mounting, using the DMR multiple rack frame enclosure. Mechanical dimensions for the PMD enclosure are shown in Figure 3-1, and dimensions for the DMR are shown in Figure 3-2.

3.2 ELECTRICAL CONNECTIONS

For the PMD-TB, nickel plated brass screws (6-32) are used for connections on the terminal block at the rear of the panel mount enclosure. Connections to the unit should be made with #6 spade lugs, using 24 AWG insulated conductor. To avoid induced transient noise, twisted conductors are recom-

mended. Figure 3-3 shows the terminal block nomenclature assigned to the PMD-TB enclosure. Electrical connections for the PMD-D are made through the cable assembly described below in 3.2.1. Figures 3-4 and 3-5 show pin and terminal functions for the PMD-D and the 8 position DMR enclosure, respectively.

3.2.1 Cable Assembly

Cable assemblies are available for each DAI unit when the DMR rack mount configuration is used and when the -D option is specified for the PMD panel mount configuration. Figure 3-6 shows the cable assembly, and Table 3-1 identifies the pin numbers and the function assignments of the connector.

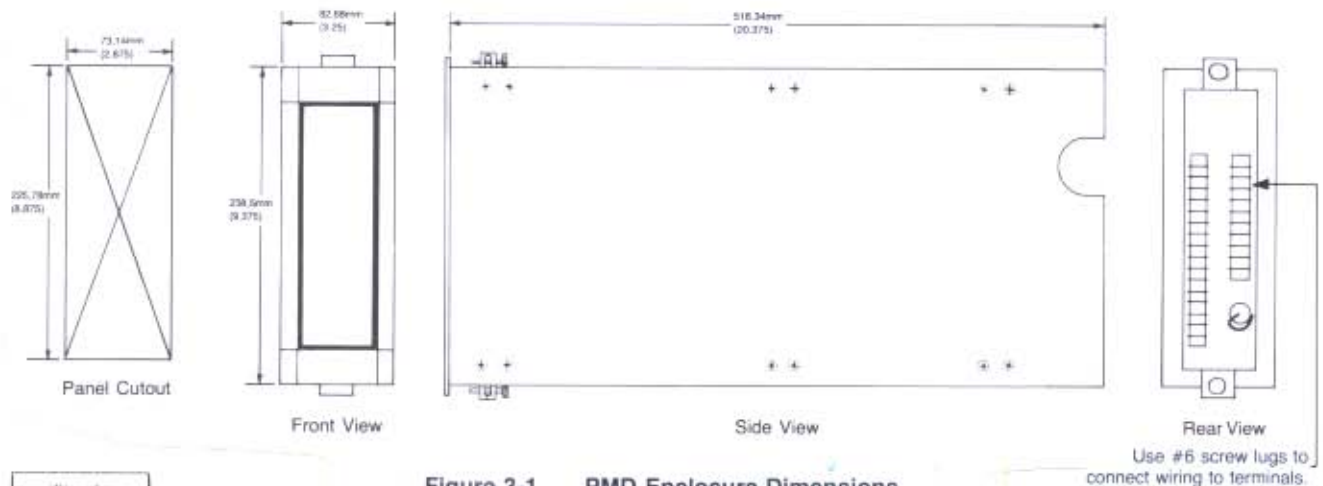


Figure 3-1 PMD Enclosure Dimensions

millimeters
inches

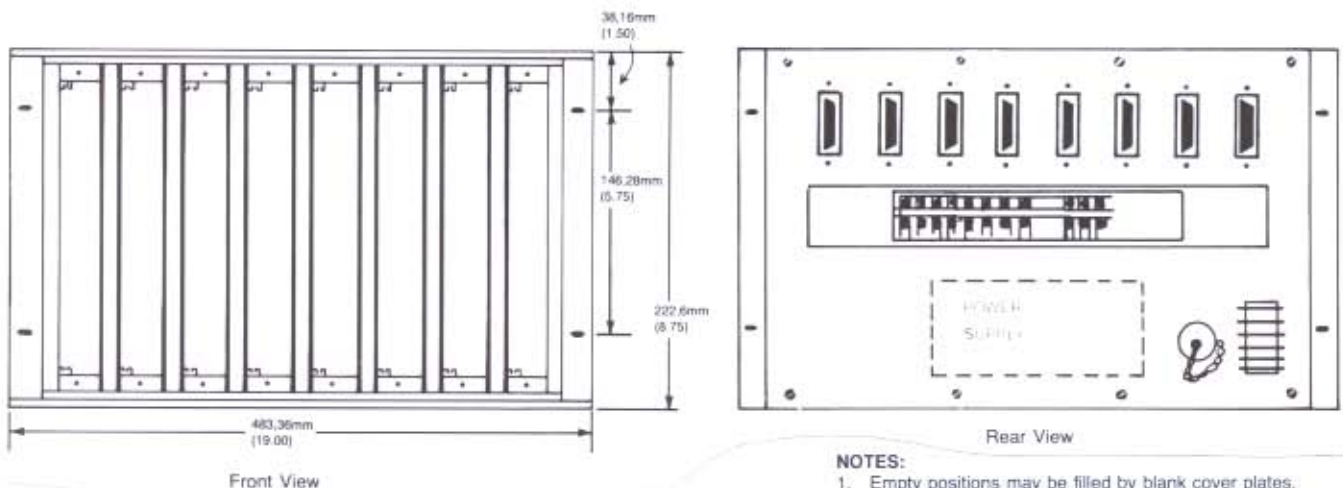


Figure 3-2 DMR Enclosure Dimensions

SIGNAL SYMBOL	FUNCTION	PMD-TB TERM.	PMD-D & DMR PIN #
+PV -PV	Differential inputs for process variable signal displayed on right bar graph.	+PV -PV	3 4
+Aux -Aux	Differential inputs for Auxiliary signal displayed on right bar graph.	+AUX -AUX	1 2
+Stat -Stat	Operation mode. In manual mode, contacts are closed; in computer mode, open.	+Stat -Stat	15 6
SEL SEL Ret	Active when low. In computer mode, allows DAI to track computer signal.	SEL DR	7 14
MR1 MR1 Ret	Manual Request line, active when low. Forces DAI into MANUAL mode.	MR1 DR	9 14
MR2 MR2 Ret	Manual Request line, active when low. Forces DAI into MANUAL mode.	MR2 DR	11 14
LA LA Ret	Left Bar display alarm, active when low. Flashes at a 4Hz rate when active.	LA DR	8 14
RA RA Ret	Right Bar display alarm, active when low. Flashes at a 4Hz rate when active.	RA DR	10 14
NO	A switched connection to DR. Is open when PV is displayed & closed for AUX.	NO	16
+IN +IN Ret	Computer control signal input.	+IN AR	17 13
Vout Vout Ret	DAI voltage mode output signal	+V AR	12 13
		TERMINAL STRIP	
Iout Vout	DAI current output signal. DAI voltage output signal.	+I +V	+I V
AR	Analog Return.		AR
AC ACC GND	110 Vac, 60Hz Power AC Power Common Equipment Ground	AC ACC GND	AC ACC GND

NOTE: For DC powered units, the last three terminals become: DC, DCC, and GND.

Table 3-1 Hookup Information, Pin And Terminal Assignments

3.3 INSTALLATION

The panel mount enclosure is designed for installation in panels up to one-half inch thick, within an opening of 2.875 inches wide, and 8.875 inches high. The enclosure is held in position by top and bottom mounted screw assemblies that are adjusted from the rear to draw the enclosure flange up against the mounting panel.

3.4 DMR INSTALLATION

The rack mount enclosure may contain up to eight DAI assemblies that slide into assigned positions

using top- and bottom-mounted printed circuit card guides. The enclosure is designed for flush mounting within a rack frame that meets EIA standards, and is held in position by four 10-32 screws.

3.5 INTERCONNECT DIAGRAM

Figure 3-7 shows the interconnection of the DAI interface and a typical process loop. Alarm signal inputs have been configured such that an alarm OFF condition is represented by a dc voltage within the range of +3 to +5 volts, and an ON condition is represented by the range of 0 to +0.8 volts.

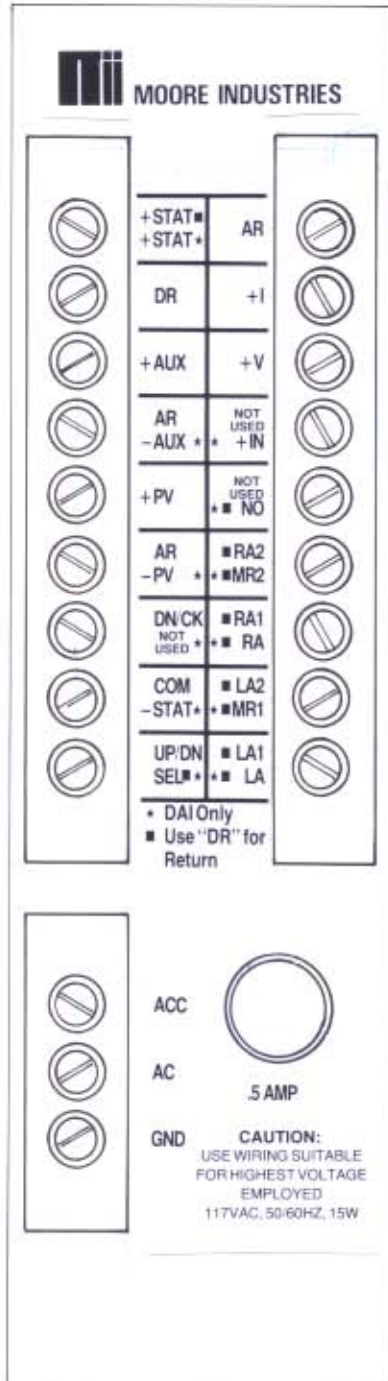


Figure 3-3 PMD Terminal Block For Panel Mount Configuration

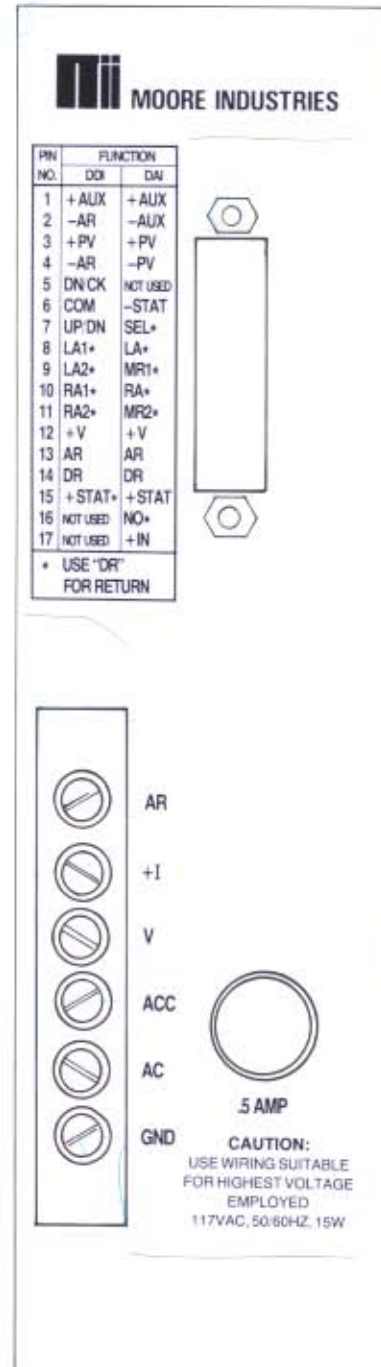


Figure 3-4 PMD-D Terminal Block & "D" Connector Pin Functions

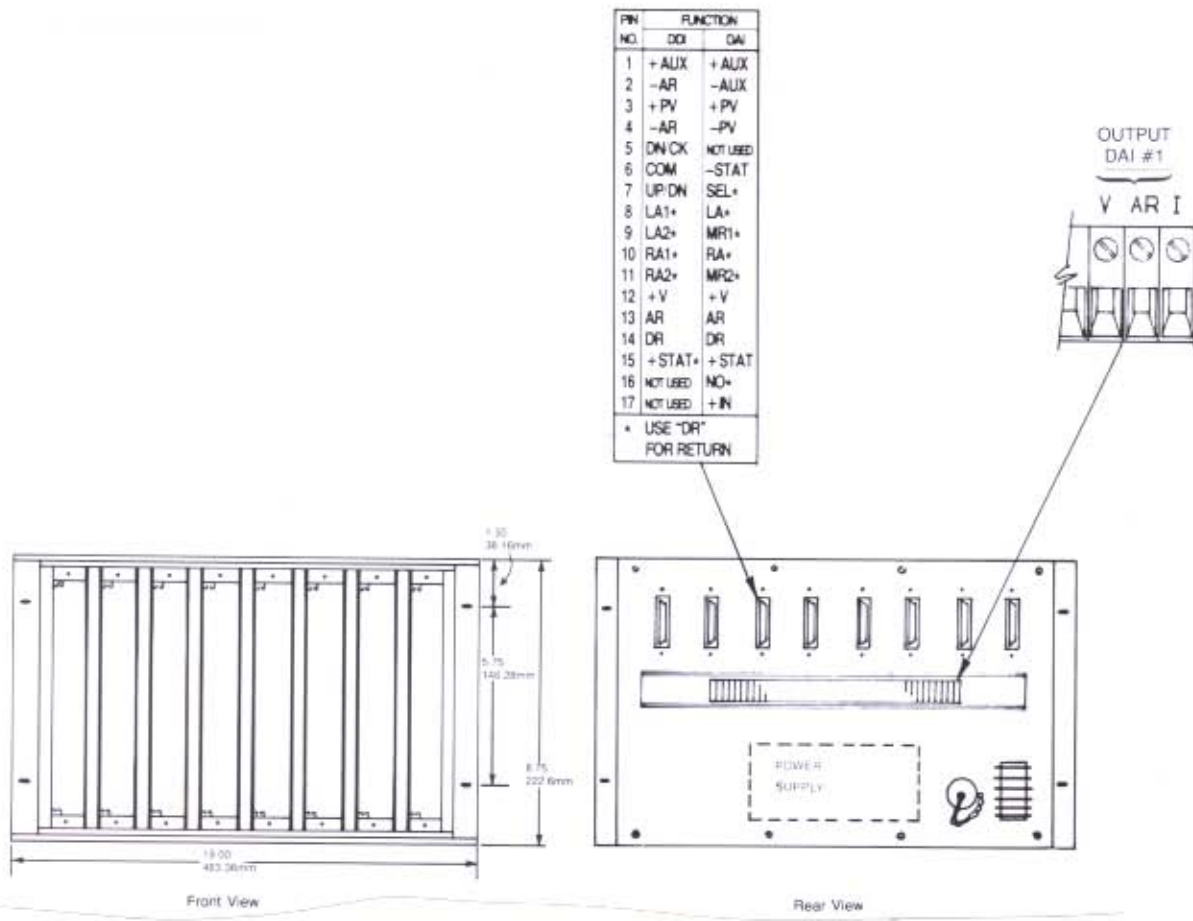


Figure 3-5 8 Position DMR

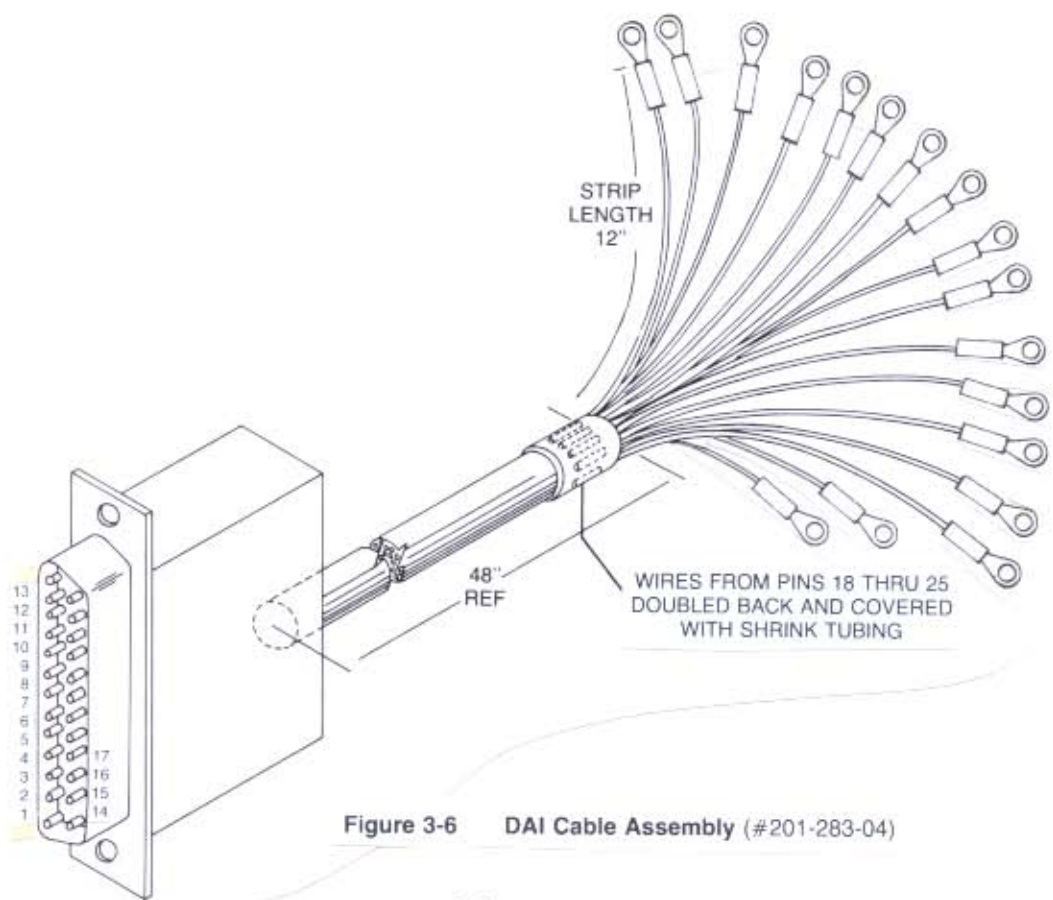


Figure 3-6 DAI Cable Assembly (#201-283-04)

3.6 GENERAL OPERATIONAL CHARACTERISTICS

The following sections describe the operational characteristics of the DAI as a backup station and as a demultiplexer station. These sections assume that the proper loads and signals are connected to the DAI housing.

3.6.1 Backup Station

When power is first applied to the DAI backup station, the unit is initialized to manual mode. This is indicated by illumination of the Manual LED (see Figure 2-1) on the front panel. The Computer LED will be off. The output of the unit is displayed on the left (red) bar graph and is determined by the setting of the Power-On Output Select dip switch (see Figure 2-2). While the DAI is in manual mode, the output may be adjusted with the Manual Output Control knob located on the front panel. When the knob is depressed, it may be rotated to set the rate of change of the DAI output.

The DAI continually monitors the input control signal coming from the host computer. When the DAI is selected and there is a match, within a tolerance determined by the Tolerance pot (#12 in Figure 2-2), between the control signal and the DAI's output, the red/green LED on the front panel glows green. (In a typical application, the DAI is permanently selected by connecting SEL to DR.) At this point, a transfer from manual mode to computer mode is possible. This transfer is achieved by toggling the Manual/Computer switch on the front panel to "computer." When the transfer to computer mode takes place, the manual LED extinguishes, the computer LED lights, and internal relay contacts close, directing the host control signal through the DAI to the +I terminal on the DAI housing and, ultimately, to the final control element in the field. The control signal then sees a load consisting of the impedance of the final control element plus a 100 ohm series load in the DAI.

If a transfer from manual mode to computer mode is requested at a time when such a request cannot be honored (i.e., when there is no match between input and output and/or the unit is not selected), the DAI enters a "Transfer Request Pending" mode. This mode is indicated by the illumination of both the manual and computer LEDs on the front panel. When the DAI is in this mode, the output may not be manually adjusted. (In order to adjust the output, manual mode must be entered.) As soon as the transfer request to computer mode can be honored

(i.e., as soon as there is a match and the unit is selected), the manual LED extinguishes, the computer LED remains lit, and the relay contacts close to direct the control input signal to the +I output terminal, thereby completing the transfer to computer mode.

While the DAI is in computer mode, its internal current source tracks the host control signal. When the DAI is transferred from computer mode to manual mode, its relay contacts open, thereby disconnecting the host control signal from the current output terminal (+I) and connecting the internal current source to the output terminal. Since the internal current source has been tracking the control signal, this transfer is bumpless. Whenever the DAI is in manual mode, the host control signal is connected to analog return (AR) through a 100 ohm resistor.

A transfer from computer mode to manual mode may be achieved in one of two ways: either by toggling the manual/computer front panel switch to "manual," or by bringing MR1 or MR2 active. (These inputs are designed to accommodate contact closures.) A manual request, while the DAI is in "Transfer Request Pending" mode, also forces the DAI into manual mode. As soon as manual mode is entered, the DAI holds its output at the value present when the transfer took place. Manual adjustment of the output is then allowed. In a typical application, a normally-closed relay, the contacts of which are connected to MR1 or 2 and DR, is held open as long as the host computer is functioning properly. Upon computer failure, the contacts close, generating a manual request to the DAI which causes the DAI to hold its output value and suspend tracking.

The DAI allows for the display of one of two signals on the right bar graph display. Normally, the signal applied to the +PV and -PV differential inputs is displayed. However, actuation of the momentary PV/AUX toggle switch on the front panel causes the signal applied to the +AUX and -AUX inputs to be displayed instead.

3.6.2 Demultiplexer Station

When power is first applied to the DAI demultiplexer station, the unit is initialized to manual mode. This is indicated by illumination of the Manual LED (see Figure 2-1) on the front panel. The Computer LED will be off. The output of the unit is displayed on the left (red) bar graph and is determined by the setting of

the Power-On Output Select dip switch (see Figure 2-2). While the DAI is in manual mode, the output may be adjusted with the Manual Output Control knob located on the front panel. When the knob is depressed, it may be rotated to set the rate of change of the DAI output.

As a demultiplexer, the DAI may be transferred into computer mode only when the unit is selected and there is a match, within a tolerance determined by the Tolerance pot (#12 in Figure 2-2), between the DAI output and the signal present at the +IN terminal of the housing. (In a typical application, the Select signal is toggled on and off by the programmable controller supplying the multiplexed control signal.) If the NM (No Match) option is installed, transfer to computer mode may be achieved at any time, regardless of the match condition. Transfer is effected by toggling the manual/computer front panel switch to "computer." When the transfer is complete, the manual LED extinguishes and the computer LED lights. If a transfer to computer mode is requested when it cannot be honored (e.g., when there is no match and/or the unit is not selected), the DAI will remain in manual mode.

While the DAI is selected and in computer mode, its

outputs track the input signal applied to the +IN terminal of the DAI housing. If the NT (No Track) option is installed, however, the outputs will not track the input if the difference between the signals exceeds the tolerance setting. When the select signal to the DAI becomes inactive, the unit suspends tracking and holds its outputs (current and voltage) at the value present when the select signal become inactive. (A transfer to manual mode, achieved by toggling the manual/computer switch to "manual" or by activating either manual request input MR1 or MR2, also suspends tracking.) In a typical application, several DAIs are connected to one multiplexed analog control line. Each DAI is selected in succession when the appropriate signal is valid on the control line. In this way, the signals are demultiplexed and directed to the final control elements. (See Figure 3-8.)

The DAI allows for the display of one of two signals on the right bar graph display. Normally, the signal applied to the +PV and -PV differential inputs is displayed. However, actuation of the momentary PV/AUX toggle switch on the front panel causes the signal applied to the +AUX and -AUX inputs to be displayed instead.

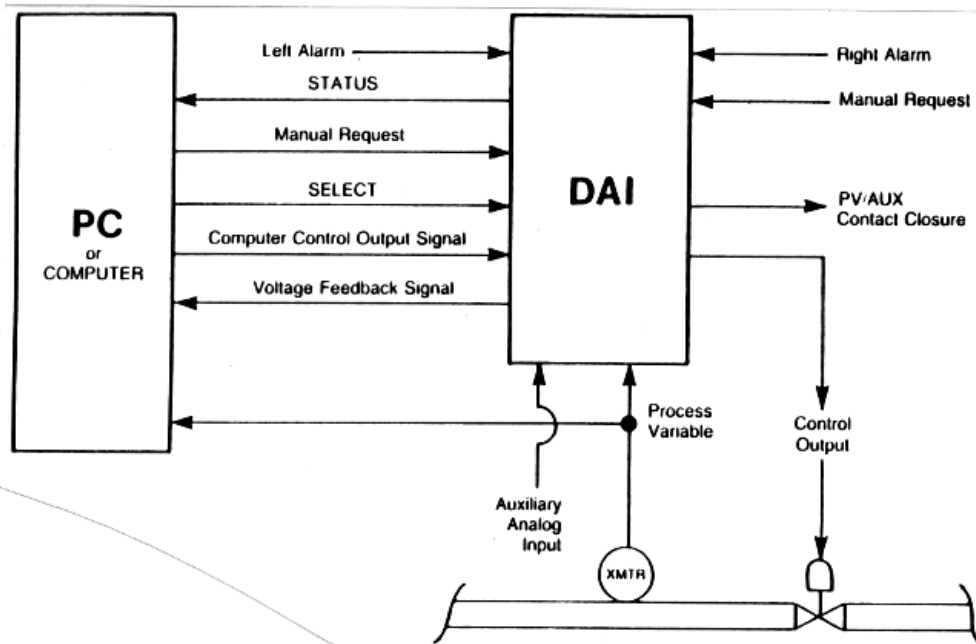


Figure 3-7 Interconnection Of DAI Interface

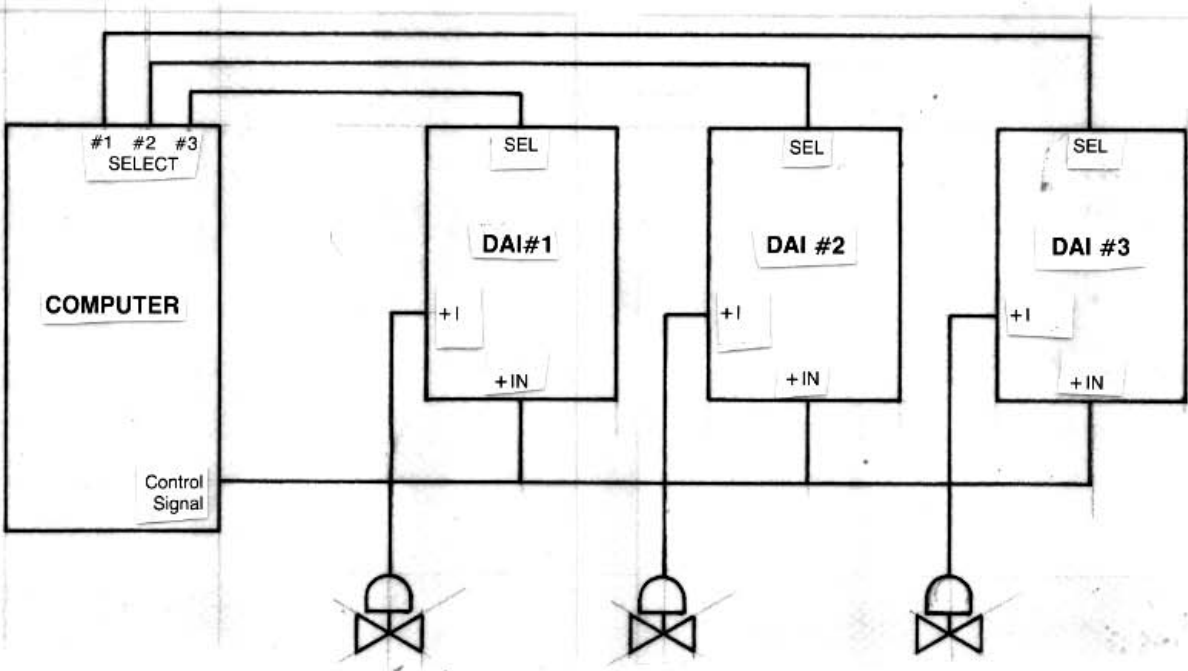


Figure 3-8 Typical Demultiplexor DAI Interconnections

THEORY OF OPERATION

4.1 GENERAL

This section describes the functional operation as an aid in troubleshooting the unit. The description is presented in terms of information flow through the unit to provide ease of problem identification should a malfunction occur. Figure 4-1 is a simplified schematic diagram which illustrates the primary signal paths through the unit. This method of circuit description is intended to aid in rapidly evaluating circuit functional performance without requiring intensive study of design details of the complete circuit.

4.2 FUNCTIONAL DESCRIPTION

4.2.1 Backup Station

When the DAI is configured as a back-up station for a computer or programmable controller, it provides a fail-safe channel for the computer or programmable controller signal through a Normally Closed Contact. It thereby retains continuity with the output terminal even if the DAI

experiences a power failure. The 4-20mA input signal goes through a 100 ohm resistor and then directly to pin 6 on the output relay, K-1. A differential buffer amplifier is connected across the 100 ohm resistor to provide an analog of the computer control signal for use in the DAI internal circuits. This signal, for example, is used by the up/down comparator to generate directional commands for the digital-to-analog converter (DAC). This makes it possible for the DAI to become the back-up signal source, should a computer failure occur. The same signal is also used in the MATCH DETECTOR to illuminate the MATCH INDICATOR LED on the front panel when the computer input and the DAC signal are matched within the tolerance set by the operator. This allows "bumpless" transfer between MANUAL mode and COMPUTER mode. It is then routed to a three-position switch which selects one of three possible signals for output display: DAC output; upper output limit; or lower output limit. The DAC composite signal is then routed to the "zero" and "span" operational amplifier pair, each

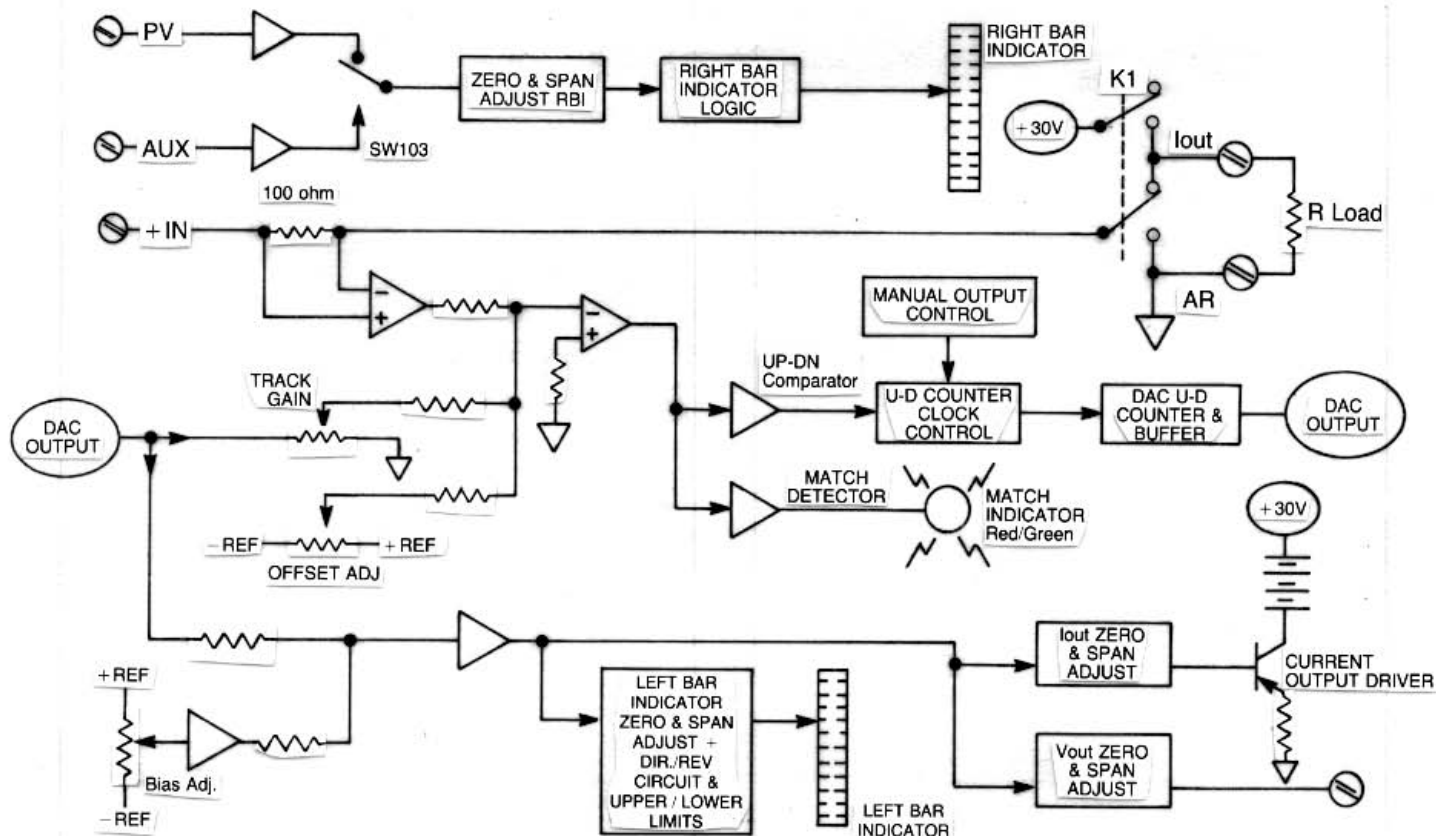


Figure 4-1 DAI Simplified Schematic Diagram

output limit. The DAC composite signal is then routed to the "zero" and "span" operational amplifier pairs, each of which produces exactly the same signal but with opposite polarity. The Left Bar Display is controlled by either one of these output signals, depending on the position of the DIRECT/REVERSE switch.

The composite DAC signal is also routed to an output current driver circuit and an output voltage driver circuit. They each have separate ZERO and SPAN adjust controls. The current driver circuit regulates the current through the external output load resistor in exact proportion to the incremental DAC composite signal when in the manual mode as a BACKUP STATION. Control is effected by having the output transistor stage in series with the external load resistor and the 30Vdc current loop section of the power supply. The output voltage driver circuit provides an output voltage equivalent to the current output, capable of driving a 10K ohm load.

4.2.2 Demultiplexer Station

When the DAI is configured as a DEMULTIPLEXER station, it provides a sample-and-hold interface between a computer or programmable controller and a final control element. When the unit is powered up, its output is determined by the preset switch setting and it can be operated as a MANUAL control station much the same as the BACKUP station version. In this configuration, the green MATCH LED will be illuminated when the SELECT line is active, and there is a match between the input and output signals. When the unit is transferred to COMPUTER mode, the red COMPUTER mode LED is illuminated. As soon as the computer or PC activates the SELECT line, assuming that the front panel selector switch has been momentarily placed in the COMPUTER position, the DAC is enabled and will generate an output signal that is proportional to the computer input signal. The bias generator provides an adjustable voltage that is summed with the DAC signal. This is provided in case it is necessary to compensate for an offset that may be caused by the individual control loops. This can occur when a single computer channel is being used to control a number of valves or similar control element on a time shared basis. This configuration does not use relay K-1 and therefore the DAI current output circuit is permanently wired to the output terminal.

4.2.3 Power Supply

All units are powered by 24Vdc, using a dc to dc converter to generate the necessary circuit voltage levels. DC input power is applied to circuit board pins 21 and 22 where CR50 protects against overvoltage and CR49 prevents damage in the event that the polarity is accidentally reversed. A 1-Ampere fuse is provided in the input circuit.

Five different electronic voltages are provided as follows: $\pm 15V$, 5V, isolated 5V and 30V. A separate transformer, rectifier, and filter section provides 250Vdc excitation to the gas tube bar graph displays. If necessary, these voltages can be monitored by applying voltmeter leads directly across the appropriate section output filter capacitor.

CAUTION

WHEN MEASURING 250VDC, AVOID CONTACTING THIS PART OF THE CIRCUIT WITH THE BARE HANDS AS THIS VOLTAGE CAN BE HAZARDOUS TO HUMAN BEINGS.

The $\pm 15V$ is used to energize the CMOS integrated circuits and op amps, +5V is applied to the logic chips as V_{cc} , the isolated +5V is used to energize the discrete functions, and +30V is used to power the output current loop.

Referring to the schematic diagram, an inverter circuit using Q9 and Q10 develops a 36V peak to peak square wave at approximately 2000Hz and applies it to the primary of both transformers T-1 and T-2. The 250V and 30V outputs are generated by full wave bridge rectifiers and capacitor filters. The $\pm 15V$ and +5V power for discrete signals is regulated and completely isolated from the +5V logic power section. These power supply sections use all conventional designs and therefore functional principles will be apparent from the schematic drawings. No adjustments to the power supply section are required.

MAINTENANCE & TROUBLESHOOTING

5.1 INTRODUCTION AND GENERAL INFORMATION

This section contains information to aid in the maintenance of the unit including a table of symptoms and probable causes for general purpose troubleshooting.

5.2 TROUBLESHOOTING

The schematic diagrams include flagged numbers at output points in the power supply circuits. Table 5-1 gives the voltages at these points. The assembly drawing shows the physical locations of the parts on the circuit board. Bear in mind that the circuit board is protected with a moisture-resistant coating and it may not be possible to measure a voltage at a specific point without removing the coating or piercing it with a sharp pointed test lead.

In general, troubleshooting is carried out by establishing specific input conditions and observing both the front panel indicators and the output terminals for an appropriate response. The intent of troubleshooting in this section is to determine whether or not a malfunction exists in the DAI station rather than in some other part of the system. If it is determined that the DAI is defective, it must be returned to the factory for repair. The complexity of the circuitry makes field diagnosis and repair inadvisable.

Test Point	Level
1	+250 ± 20volts DC
2	+15Vdc ± 5%
3	-15Vdc ± 5%
4	+5Vdc ± 5% isolated
5	26 to 30Vdc measured between D and E
6	+5Vdc ± 5% at C

Table 5-1 Test Point Signal Levels

The following listing of symptoms and recommendations is provided to help determine whether or not a malfunction exists in the DAI:

SYMPTOM	PROBLEM/SOLUTION
No lights on	Fuse blown, no power
No display	Apply signal to PV or AUX inputs or set preset output to 100% and observe bar graph indicator. No display indicates DAI malfunction.
No output	Set preset output to 100% and measure output current and voltage in MANUAL mode. No output indicates DAI malfunction.
Will not transfer to computer mode	Apply signal to +IN, adjust tolerance to maximum, manually set output for match (if BACKUP STATION) and toggle MAN/COMP switch. No transfer indicates DAI malfunction.
Station does not track input signal	Ground SELECT line, apply signal to +IN, put into COMPUTER mode and observe output for proper response.
Output signal range restricted	Check high and low limit settings.
Match occurs in MANUAL mode but disappears when transfer to COMPUTER mode takes place. Voltage output & LEFT BAR indicator also disappear.	Ensure that proper load is connected to current output and analog return.

5.3 PRINTED CIRCUIT BOARD CONNECTOR CLEANING

Modules which have been in service for a long period of time may develop resistive coatings on the gold plated contacts of the plug-in boards. These coatings, if allowed to build up, can cause malfunctions by decreasing the noise margin of a circuit. Another form of contamination results from careless handling: Organic substances--mainly fingerprints, salts, and oils--are deposited when the plug-in boards are handled by the gold-plated contacts. Contamination by organic substances can be reduced by careful handling.

Although rack connectors are usually of the self-cleaning type, it may become necessary to clean the module contacts to ensure reliable connection. When module contacts are in need of cleaning, the following procedures are recommended:

- a) Immerse contacts only in trichloroethane for at least 30 seconds. Do *not* allow the solvent to come into contact with the printed circuit protective coating.

CAUTION

NEVER USE AN ERASER ON THE CONTACTS. THE USE OF ABRASIVE CLEANERS OR ERASERS ON PLUG-IN BOARD CONTACTS IS CONSIDERED A PHYSICAL ABUSE TO THE UNIT AND MAY VOID THE WARRANTY.

- b) Let contacts air-dry or wipe them with a very fine, nonabrasive material such as K-Dry towels or equivalent.
- c) Test the unit for proper operation and, if necessary, recalibrate by the procedure given in Section 2. When the performance of the unit is known to be satisfactory, apply clear acrylic to reseal the unit where required. Check that all leads are clear of the board edge before reinstalling the board into its case.
- d) Before reinstalling the unit, mount the front and rear plastic covers. Be sure to use the same screws (or screws of the same size) and spacers, since longer screws will damage the unit.

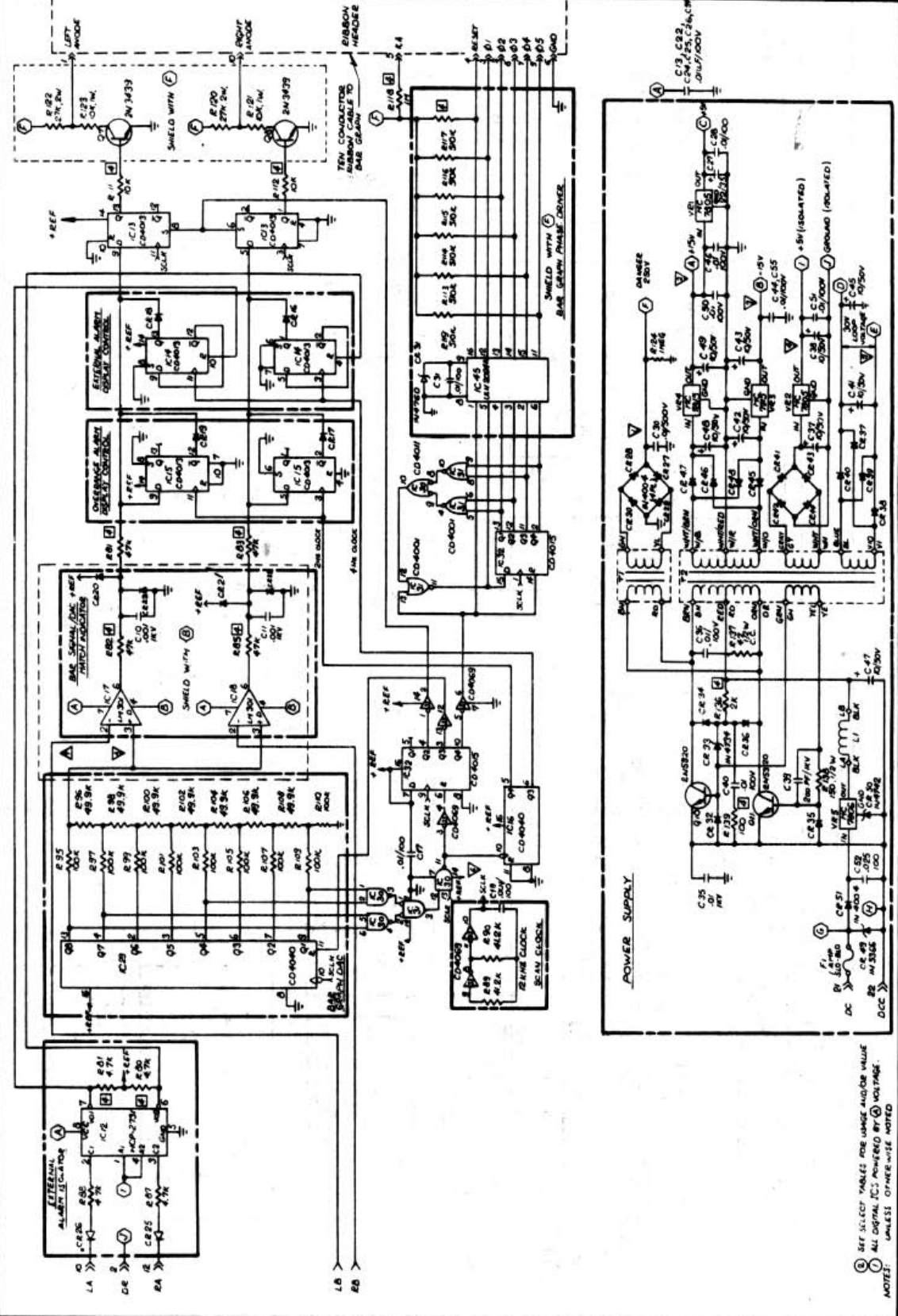
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DO NOT SCALE DRAWING

TOLERANCES	UNLESS NOTED	UNLESS NOTED	UNLESS NOTED
X	±.1	A. PAPUC	9/2/83
XX	±.03	DESIGNED	
XXX	±.010	DRAWN	
		CHECKED	
		SCALE	1/1

DAI
SCHEMATIC
PC 1
(SHEET 1 OF 3)

DATE	112-451-00	REVISED	5/11/83	BY	SM/10/83
CATEGORY	SCHEMATIC	REVISION		DATE	
REVISION	ECO 10/82	BY	SM/10/83	DATE	
REVISION		BY		DATE	
REVISION		BY		DATE	



NOTE: SET SELECT VALUES FOR USAGE AND/OR VALUE.
ALL DIGITAL IC'S POWERED BY (A) VOLTAGE.
UNLESS OTHERWISE NOTED.

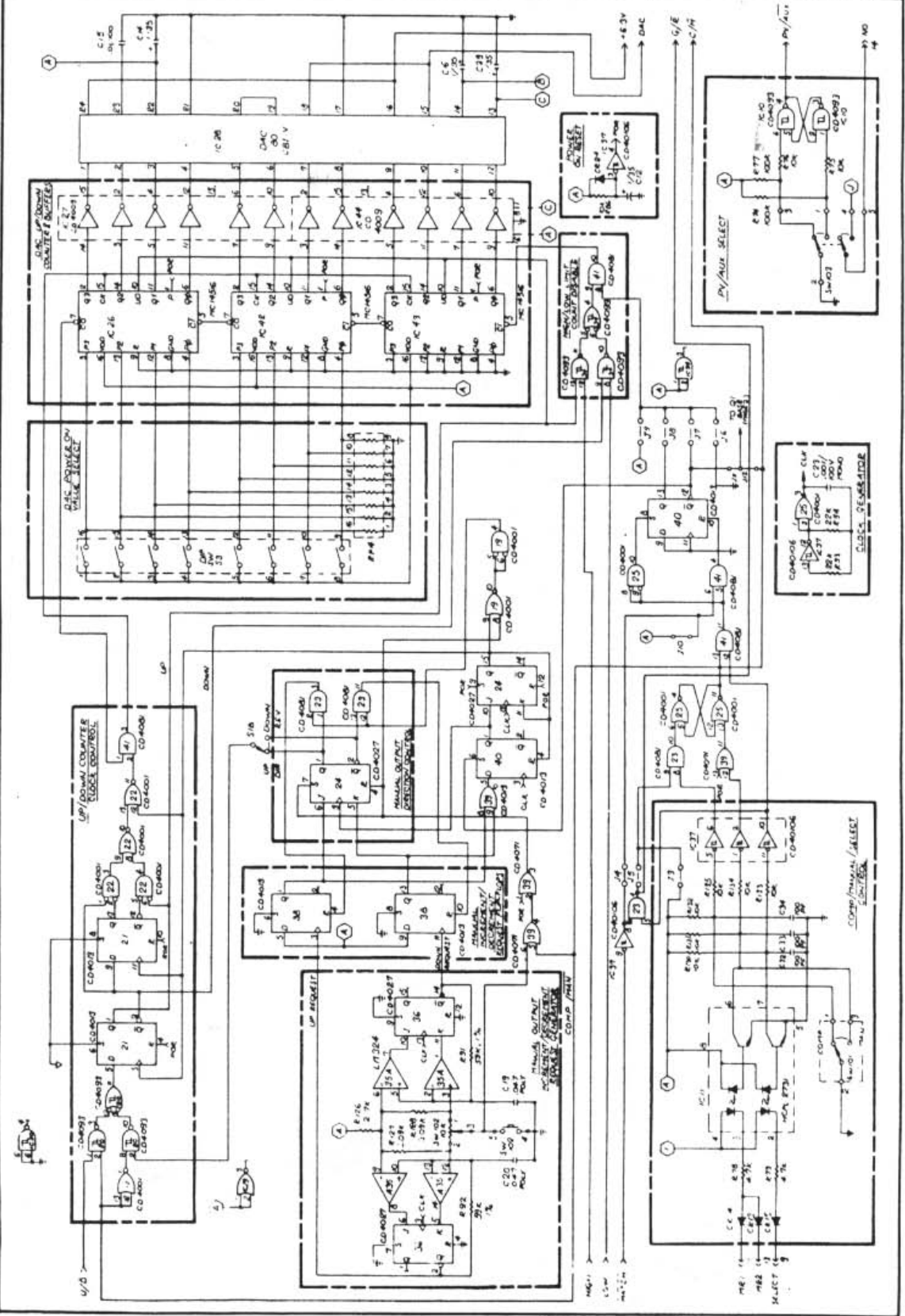
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18650 Schoenborn Street
Sepulveda, California 91343

DO NOT SCALE DRAWING

TOLERANCES UNLESS NOTED	DRAWN	DATE
X ±.1	A. PAPUC	9/6/83
XX ±.03	CHECKER	
XXX ±.010	ENGINEER	
ANGLES ±30°	SCALE	A

DAI
SCHEMATIC
PC 1
(SHEET 3 OF 3)

DRAWING NUMBER	112-451-00	REVISED BY	(SEE NEXT)
CATEGORY	SCHEMATIC	DATE	
BY		DATE	
CHKD BY		DATE	



RETURN PROCEDURES

To return equipment to Moore Industries for repair, follow these four steps:

1. Call Moore Industries and request a Returned Material Authorization (RMA) number.

Warranty Repair –

If you are unsure if your unit is still under warranty, we can use the unit's serial number to verify the warranty status for you over the phone. Be sure to include the RMA number on all documentation.

Non-Warranty Repair –

If your unit is out of warranty, be prepared to give us a Purchase Order number when you call. In most cases, we will be able to quote you the repair costs at that time. The repair price you are quoted will be a "Not To Exceed" price, which means that the actual repair costs may be less than the quote. Be sure to include the RMA number on all documentation.

2. Provide us with the following documentation:
 - a) A note listing the symptoms that indicate the unit needs repair
 - b) Complete shipping information for return of the equipment after repair
 - c) The name and phone number of the person to contact if questions arise at the factory
3. Use sufficient packing material and carefully pack the equipment in a sturdy shipping container.
4. Ship the equipment to the Moore Industries location nearest you.

The returned equipment will be inspected and tested at the factory. A Moore Industries representative will contact the person designated on your documentation if more information is needed. The repaired equipment, or its replacement, will be returned to you in accordance with the shipping instructions furnished in your documentation.

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RETURN POLICY

For a period of thirty-six (36) months from the date of shipment, and under normal conditions of use and service, Moore Industries ("The Company") will at its option replace, repair or refund the purchase price for any of its manufactured products found, upon return to the Company (transportation charges prepaid and otherwise in accordance with the return procedures established by The Company), to be defective in material or workmanship. This policy extends to the original Buyer only and not to Buyer's customers or the users of Buyer's products, unless Buyer is an engineering contractor in which case the policy shall extend to Buyer's immediate customer only. This policy shall not apply if the product has been subject to alteration, misuse, accident, neglect or improper application, installation, or operation. THE COMPANY SHALL IN NO EVENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.



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