

USER'S GUIDE



Ω OMEGA®
<http://www.omega.com>
e-mail: info@omega.com



DPS3300 Series
wall mount Multi-Channel
Process Scanner

TABLE OF CONTENTS

SPECIFICATIONS	3
DESCRIPTION	5
DISPLAYING PARAMETERS	6
Table 1. How to Display Parameters	6
DISPLAY MODES	7
Table 2. Display Modes	7
Elapsed Time Mode	7
Scan Mode	8
High/Low Channel Mode	8
Deviation Mode	9
Types of Deviation Displays	9
Difference Mode	9
SETUP	9
'SYS' Parameter List	10
CH Parameter List	10
CHANNEL CONFIGURATION	11
Setup For Input Type	11
Setup for Voltage or Current Input:	11
Setup For Channel ON/OFF	11
Setup For Decimal Point Position	11
Setup For High Scale	12
Setup For Low Scale	12
Setup For Offset	12
Setup For Tare	12
Setup For Setpoint	13
Setup for Universal Relay (Channel 1 Relay)	13
Setup For Limits	13
Setup For Deadband	13
Setup For Relay Normally Open/Closed	13
Setup For Engineering Units	14
Setup for Thermocouple/ Thermistor/ RTD Inputs:	14
Turning Channels ON/OFF:	14
Temperature units:	14
Setup Examples	15
Example #1: Use of the OFFSET Parameter	15
Example #2: Use of the LOW SCALE Parameter	15
Example #3: Use of the TARE Parameter	15
SYSTEM CONFIGURATION	15
Setup For Display Options	15
Table 3. Display Options	15
Setup For Display Time	16
Setup For Relay Latch/Non-Latch	16
Relay Latched Mode:	16
Relay Non-Latched Mode:	16
Setup for Buzzer	16
Setup For Cold Junction Calibration	16
Setup For Channel Calibration	17
Input Range Setup (for current and voltage):	17
Voltage Range Setup (0-10vdc, 0-5vdc)	17
Voltage Range Setup (for millivolt inputs)	17
Current Range Setup	17
Correct Range Settings	17
Thermocouple Calibration Procedure	17
SAVING PARAMETER:	18
PEAKS	18
PROGRAMMING FLOW CHARTS:	19
RATE	22
LIMITS	22
OUTPUTS	22
Open Collector Option	22
Figure 1. Open Collector Hookup Example	22

TABLE OF CONTENTS

Electro-Mechanical Relay Option	22
Figure 2. Electro-mechanical Relays Hookup Example	22
FIG- 3. DPS3300 Series terminal compartment	23
POWER	24
INPUT CONNECTOR PIN ASSIGNMENT	24
Table 4. DPS3300 Series Output Connector Pin Assignments	24
DIRECT INTERFACE TO UNIVERSAL RELAY MODULE	25
TROUBLE SHOOTING	26
Factory Channel settings:	26
Factory default settings for Thermocouple, voltage, current and milli-volt are:	26
ERROR MESSAGES AND SOLUTIONS	26
MOUNTING	27
Figure - 4. Rear View And Mounting Hole Locations	27
WARRANTY	28

SPECIFICATIONS

(Typical @ 25C and rated supply voltage unless otherwise specified)

STANDARD INPUTS

- * 4-20ma 0-50ma 0-5Vdc 0-10Vdc
- * Thermocouple inputs: J, K, T, E, R, S, and B
- * Cold junction compensation error: +/- 1C (10C to 40C)
- * Open input indication: **HELP** displayed
- * Temperature displayable in Degrees C or F
- * Non-standard inputs available --- consult factory.

ANALOG TO DIGITAL CONVERSION

- * 4-1/2 Digit (20,000) Count) A/D Converter
- * Dual slope integrating converter with 7 conversions /sec. (typical) rate.

SCAN RATE

- * Fixed: two channels per second

DISPLAY

- * Red seven segment displays--0.8" (20mm) digit height
- * Over range indication: **HELP**
- * Display test: Briefly displays 8.8.8.8.8.8.8 on power up.
- * Seven-digit display

SCALE/OFFSET

- * Scale programmable from 1 - 30000 units
- * Offset programmable from 0 - 99.99mA (For mA Input)
- * Offset programmable from 0 - 9.999V (For Voltage Input)
- * Programmable decimal point.

RELIABILITY/ACCURACY

- * Calibration: NIST traceable (for thermocouples)
- * Temperature resolution: 1C/1F
- * Warranty: 1 Year
- * Recalibration recommended at 12-month interval

POWER REQUIREMENT

- * 120Vac --- 60 HZ (Standard)
- * 240Vac --- 50 HZ (optional)
- * 15VDC (optional)

OUTPUT (optional)

- * Open collector outputs -- 50ma maximum sink, limited to 50ma per output
- * Relays: Single pole single throw, 1 Amp @ 28Vdc or 0.5 Amp @ 120Vac resistive
- * Output termination: Euro-style plug-in connector

NOTE

DPS3304 & DPS3314 are four channel units. Therefore, any reference to channel numbers with respect to these models is for channels 1 through 4 only.

DPS3307 and DPS3317 are seven channel units, and therefore, any reference to channel numbers for these models is for channels 1 through 7.

DPS3304 & DPS3307 are base models that accept only one type of transducer signal on all four/seven inputs.

DPS3314 & DPS3317 are enhanced models that have fully programmable inputs and each channel can be configured independently to accept a low voltage signal (T/C, RTD, Thermistor, milliVolt) or a voltage signal (0-5Vdc, 0-10Vdc) or a loop current signal (4-20mA, 0-50mA).

DESCRIPTION

DPS3300 Series instruments are multi-channel scanners that pack a number of functions into one unit. Tasks that require multiple monitors can now be accomplished by using only a single unit. Signals from a number of different transducers can be brought into screw terminals that are conveniently located on the back panel of the instrument. The unit automatically scans through each channel, displaying the channel number and process value. In addition to displaying temperature, pressure, strain, etc. these units also boast some of the most frequently used functions such as process differential between channels, monitoring high and low readings on individual channels, rate of change, tracking channels with highest and lowest readings, comparison of process with a preset set-point, etc.

Signals from thermocouples are linearized and can be displayed in degrees Celsius or Fahrenheit. Transducers that put out 4-20 ma. current loop, 0-5Vdc, or other linear signals can be scaled from the front keys. This gives the flexibility of displaying various parameters directly in engineering units. Channels that do not have signals connected to them may be programmed off by the operator and will not be scanned or displayed.

On power up (check for proper power connections before powering up) the unit will first display 8.8.8.8.8.8. as a display test and then the software revision number. The format is 'rEn x.xx' where x.xx is the revision level.

NOTE: Check model number for input type & display units -- thermocouples, 4-20ma, 0-10Vdc etc...

MODEL NO.	DESCRIPTION
DPS3304 - (a) - (b) - (c)	4 Channel, fixed input scanner
DPS3314 - (a) - (b) - (c)	4 Channel, programmable input scanner
DPS3307 - (a) - (b) - (c)	7 Channel, fixed input scanner
DPS3317 - (a) - (b) - (c)	7 Channel, programmable input scanner

(a)	INPUT TYPE	(a)	INPUT TYPE
TC	J, K, T or E T /C	C	4-20ma current
R	'R' thermocouple		
S	'S' thermocouple		
B	'B' thermocouple	(a)	INPUT TYPE
RTD	RTD (385, 392)	V	0-10 volt DC
TH	Thermistor (400 Series)		
P	100 millivolt		

(b)	POWER	(c)	OUTPUTS
Blank	120VAC Power Input (standard)	5/3	4/7 Relay Outputs (optional)
1	240VAC Power Input (optional)	6/4	4/7 Open Collector Outputs (optional)
2	15Vdc Power Input (optional)	Blank	No Output (standard)

DISPLAYING PARAMETERS

DPS3300 Series keeps track of various parameters and these may be displayed by pushing appropriate keys on the front panel. The parameters that are tracked are:

- a) Channel's high peak
- b) Channel's low peak
- c) Elapsed time
- c) Channel with the highest reading
- d) Channel with the lowest reading
- e) Process deviation of each channel from pre-programmed setpoint
- f) Process differential of a channel with respect to any other channel
- g) Rate of process change per minute for each channel

Table 1 explains how to display the above mentioned parameters.

Table 1. How to Display Parameters

TO DISPLAY	PERFORM FOLLOWING STEPS
1) Channel's high peak	<ul style="list-style-type: none"> a) Select channel whose high peak is desired (push CH SEL key) b) Push HI/LO key once
2) Channel's low peak	<ul style="list-style-type: none"> a) Select channel whose low peak is desired (push CH SEL key) b) Push HI/LO key twice --- 1st push displays high peak, 2nd push , low peak.
3) Rate of process change	<ul style="list-style-type: none"> a) Select channel whose Rate is desired (push CH SEL key) b) Push DATA key once.
4) Channel deviation	<ul style="list-style-type: none"> a) Select desired channel (by pushing CH SEL key) b) Push DATA key twice --- 1st push displays rate, 2nd push, deviation.
5) Channel differentials	<ul style="list-style-type: none"> a) Select desired channel (by pushing CH SEL key). b) Push DATA key three times -- 1st push displays rate, 2nd push: deviation, 3rd push : differential. c) Each additional push moves to the differential between selected channel and the next channel. d) e.g. the sequence for channel 1 is: RATE, CH1-SP, CH1-CH2, CH1-CH3, CH1-CH4, CH1-CH5, CH1-CH6, CH1-CH7
6) Elapsed time	<ul style="list-style-type: none"> a) Push TIME key.
7) Channel with highest process reading	<ul style="list-style-type: none"> a) Push HI/LO key once
8) Channel with lowest process reading	<ul style="list-style-type: none"> a) Push HI/LO key twice ----1st push: high channel 2nd push: low channel.
9) Scan	<ul style="list-style-type: none"> a) If the unit is holding, push the SCN/HLD key once.
10)Hold	<ul style="list-style-type: none"> a) If the unit is scanning, push the SCN/HLD key once.

DISPLAY MODES

DPS3300 Series has multiple display modes and can be programmed to either scan, display the channel with the highest reading, display the channel with the lowest reading, deviation between channel's process variable and a pre-programmed setpoint, difference between any two selected channels or just run as a timer. In the timer mode the unit keeps track of process run time with crystal controlled accuracy. Elapsed Time display format is '**HH.MM.SS**' for hours, minutes, and seconds. The desired display mode is selected during **SYS SETUP** ---- (for details refer to the **SYS CONFIGURATION** section).

Table 2. Display Modes

MODE	FUNCTION PERFORMED
1) Elapsed time	Unit displays elapsed time since power up or last time reset.
2) Scan	All active channels are automatically scanned. Channels that are turned off are not scanned or displayed.
3) High Channel	The unit will compare all active channels against each other and display the one that has the highest process reading.
4) Low Channel	The unit will compare all active channels against each other and display the one that has the lowest process reading.
5) Deviation	The unit scans all active channels and displays the deviation of process variable from a pre-programmed setpoint.
6) Channel Differential	The unit continuously displays the difference of process between any two selected channels.

The following paragraphs give a detailed description and operation of various modes.

Elapsed Time Mode

DPS3300 Series can be programmed to run as timer. In this mode the unit will indicate elapsed time in hours, minutes and seconds. The display format is '**HH.MM.SS**'. This mode is selected during **SYS Setup** by opting for '**ELPSD t**'. The elapsed time is the time passed since the unit was turned on or when the time was last reset. To reset the time, first push the **TIME** key and while keeping it pressed, push the **RESET** key. The display will show '**rESEt**' and on release of the **RESET** key, the display will reset to '**00.00.00**' and begin timing.

The elapsed time can also be momentarily displayed while the unit is operating in any other display mode. This is done by pushing the **TIME** key once. The unit will first display the word '**ELPSd t**' followed by the elapsed time. This will stay in the display window for a brief period and then the unit will revert to the normal display mode.



Scan Mode

When setup for scan mode, individual channels are displayed for a programmed period of time. At the end of that time period the, display automatically switches to the next channel. For ease of reading, the display first shows the channel number (Format: '**CHANEL 1**') and then the process variable along with the programmed three digit engineering units e.g. 23.45 PSI.

Display time for each channel is programmable from 1-999 seconds (16.65 min.). This is useful for adjusting display time to a rate which is consistent with the type of process being monitored. Scan time for each channel is independent of display time. This permits programming long display times without losing track of the process on other channels.

The display can also be put in a hold mode by pushing the **SCN/HLD** key. When this key is pushed, the display will briefly show '**HOLd**' after which the display will stop on the channel it was indicating. Putting the unit in HOLD mode inhibits automatic display scanning and shows only one particular channel. While the display is held on one channel, internally all the enabled channels are continuously scanned for rate, difference, limits and other parameters. Also, during HOLD mode the unit will periodically flash the display '**Cx HOLd**' (x=channel # on hold) to indicate the status of the display mode. If an attempt is made to hold on a channel that has been turned off then the unit will indicate so by displaying in the format '**CHx OFF**' (x=channel # off).

To select another channel for display during hold mode, push the **CH. SEL** key. Each push will increment the channel number. The display will first show the channel number (e.g. '**CHANEL 2**' for channel # 2) followed by the process variable in the form '**0.123 PSI**'. When channel selection is initiated using the **CH. SEL** key, the unit starts with channel #1 and steps thru to channel #7 with each push of the key.

To take the unit out of HOLD mode and back into SCAN mode, push the **SCN/HLD** key. The display will briefly show '**SCAN**' and then start scanning the channels.



High/Low Channel Mode

DPS3300 Series compares all the channels against each other and constantly tracks the channel with the highest and lowest process value. On push of a key, the channel number and the value of process variable can be displayed. Also, during SYS Setup, the unit can be programmed so that instead of scanning all the channels it will only display the channel with highest or lowest process variable. As the process changes, the display automatically switches over to the channel with the highest (or lowest, if so programmed) reading. This is a very useful function for applications involving multi-point monitoring of temperature in a single process. For example, this feature can be used to find hot spots in a kiln. During high or low channel scan mode the display will periodically flash '**HI CHAN**' or '**LO CHAN**' (depending upon the selected mode) to indicate the status of the display mode.

To display high and low channel from any other display mode simply push the **HI/LO** key. Pushing this key once will first display '**HI CHAN**' and then the channel number and the process value will be displayed in the format '**C2 1234**'. The second push on the **HI/LO** key will first show '**LO CHAN**' in the display window, and then the channel with the lowest process value will be displayed.



NOTE: (i) The second push, to display low channel, must be initiated before the display reverts back to the normal display mode.

(ii) If a channel is selected using the **CH. SEL** key prior to the push on the **HI/LO** key, then instead of displaying high and low channels, the unit will display high and low peaks of the active channel. Therefore, if it is desired to display high and low channels and not the peaks, do not select a channel before pushing the **HI/LO** key.

Deviation Mode

In deviation display mode, DPS3300 Series will show the differential between a pre-programmed setpoint and process variable being monitored on each channel by the scanner. Individual setpoint for each channel is programmed during CH Setup and can be any value over the range of selected scale or thermocouple being used.

Types of Deviation Displays

There are two different ways of displaying channel deviation from their setpoint values:

a) The first one is a momentary display in which the deviation is indicated for a short time. Following this brief display time, the unit reverts to its normal mode of operation (scanning, differential, timer etc.). To achieve this, first select the channel whose setpoint deviation is desired. This is done by pushing the **CH. SEL** key. Next, push the **DATA** key twice. The first push displays the rate/minute value. The second push will display the deviation value. Before showing the deviation, the display will read '**CH1 - SP**' (for **CH**annel **1** **S**et**P**oint).

b) The second method of displaying deviation is by selecting the '**dSP dEN**' option when programming the Display Option during the SYS Setup. If this method is selected, the display will scan through all the active channels and display their deviation. The display format is '**d2 1234**' (d stands for deviation).

The unit can also be put on HOLD at any channel by pushing the **SCN/HLD** key. If any other channel's deviation is desired, it may be obtained by pushing the **CH. SEL** key. If an attempt is made to hold the display on a channel that has been turned off, then the unit indicates this by displaying '**CHx OFF**' (x=channel #). DPS3300 Series will keep track of all other parameters while programmed for this mode (i.e. limits, peaks, rate, process value, channel differential etc). All of these may be displayed by pushing the respective keys.



Difference Mode

In this mode the system continuously displays the difference of process variable between any two selected channels. The two active channels are selected during SYS Setup mode. To remind the operator of the current display mode and also the two channels, the display flashes the channel numbers every few seconds (e.g. '**CH1 - CH2**' for displaying difference between channel #1 and channel #2).

If the unit is not programmed for difference mode, the differential between any two of the seven channels can be briefly displayed by pressing the **DATA** key.

The procedure for doing so is to first select the channel whose differential with another channel is desired. This is done by pushing **CH SEL** key. Each push on this key will display the selected channel in the format '**CHANNEL x**' (x=channel #). When the desired channel has been selected, press the **DATA** key three times. The first push will display the rate of process change on that channel. The second push will show the process deviation from the programmed setpoint. The third push will flash a display of the form '**CH1 - CH2**' and then a differential value. Additional pushes on **DATA** key will sequence thru the channels and will be indicated as below:

CH1 - CH3, CH1 - CH4, CH1 - CH5, CH1 - CH6, CH1 - CH7, CH1 - SP



SETUP

Setup mode provides a means to customize the monitor to suit a particular application. It allows programming such parameters as temperature units, limits, display mode, relay deadband, etc.

SETUP mode has 2 sections:

- SYS setup section to set system parameters
- CH setup section to set Channel parameters for each channel.



To get into SETUP mode, push the **SETUP** key twice. The first push displays elapsed time and the second push brings the unit into the SETUP mode. SETUP mode is indicated by '**SETUP**' in the display window (the SETUP LED indicator will also be illuminated) followed by '**ENTR PC**' (for **ENteR PassCode**). The passcode feature has been provided to keep unauthorized personnel from changing any parameters. Each of the five keys on the front panel are labeled with a number in the lower right corner. The pass-code is a four digit combination of these numbers. Enter the pass-code when the displays reads '**ENTR PC**'. **Passcode for DPS3300 Series is 3254.**

Once the correct pass-code has been entered, the display shows '**SYS CH**', with '**CH**' blinking. At this point the operator may choose between making channel settings (CH), or system settings (SYS). Use **▲DIG▼** key to toggle between CH and SYS modes. When the desired mode is blinking, press **SETUP** key to begin setup of parameters for that mode.

'SYS' Parameter List

Following parameters can be setup when blinking '**SYS**' is selected:

- | | |
|---|---|
| <p>1) Display Options</p> <ul style="list-style-type: none"> a) Elapsed Time b) SCAN c) High Channel d) Low Channel e) Deviation f) Channel Difference <p>2) Display Elapsed Time</p> | <p>3) Relay Latch/Non-latch</p> <p>4) Calibration/Range setting</p> <ul style="list-style-type: none"> a) Cold Junction Reference Temperature b) Thermocouple/voltage/current calibration c) Voltage Range d) Current Range |
|---|---|

For more details, refer to the SYSTEM CONFIGURATION section.

CH Parameter List

Following parameters can be setup when blinking '**CH**' is selected:

CURRENT OR VOLTAGE INPUT

- 1) Select Channel
- 2) Input Type
- 3) Channel ON/OFF
- 4) Decimal Point Position
- 5) High Scale
- 6) Low Scale
- 7) Offset
- 8) Tare
- 9) Setpoint
- 10) Limit
- 11) Deadband
- 12) Relay Normally Open/Closed
- 13) Display Units

THERMOCOUPLE, RTD, THERMISTOR INPUT

- 1) Select Channel
- 2) Input type
- 3) Channel ON/OFF
- 4) Temperature units (C or F)
- 5) Setpoint
- 6) Limit
- 7) Deadband
- 8) Relay normally open/closed
- 9) Engineering units

For more details, refer to the CHANNEL CONFIGURATION section.

Three attempts at entering correct pass-code are allowed. '**HELP**' shows up in the display window if attempted pass-code is wrong. If a person fails in three attempts, the system will go back to normal display mode. To make another attempt at this point one has to get into SETUP mode again.

Three keys are used during setup --- **SETUP**, **◀DIG▶** and **▲DIG▼**. If, at any point during SETUP, it is desired to get out of SETUP and back to normal display mode, push and hold the **RESET** key until the display reads '**SAVING**'. The **SETUP** key takes you from one parameter to the next e.g. if you are setting up Channel ON/OFF, then after getting the desired value push **SETUP** key to setup for Degrees C/F. **◀DIG▶** and **▲DIG▼** keys are used for programming values of parameters such as limits, setpoints, etc.



NOTE: To exit from any point during SETUP procedure or to save the newly made changes, simply press and hold the RESET key until the display shows 'SAVING'. When the display shows 'SAVING', it is indicating that the unchanged and the newly made changes are being saved in the EEPROM for permanent storage. **It is important that the above step be performed any time changes are made to the configuration of the unit and before power is removed. If not done so, all the new changes will be lost. The unit will, however, maintain the old settings.**

CHANNEL CONFIGURATION

After entering correct pass-code and selecting the blinking 'CH' (ref. SETUP section), the display shows 'SLCt CH' (for "Select Channel"). Use ▲DIG▼ key to display the desired channel. Selected channel will be displayed in the format 'CHANEL x' (where x=channel#). Once the desired channel # is displayed, push SETUP key to go on to setup parameters for the displayed channel #.

Setup For Input Type

The display will briefly show 'IP TYPE' (for "Input type") after which the present input type for the selected channel will be displayed. Various inputs available are: J T/C, CR.AL T/C (Chromel Alumel, type K T/C), T T/C, E T/C, CURRENT, or VOLTAGE. If the unit has a noble metal thermocouple option, then only one T/C can be selected i.e. B T/C, R T/C, or S T/C. Use the ▲DIG▼ key to display the desired input type. Once the desired input type is displayed, push the SETUP key to enter that input type and go to Setup For Channel ON/OFF.

NOTE : If you have a millivolt input unit (instead of thermocouple), the various types of inputs selectable are **CURRENT**, **HI VOLT** and **LO VOLT** (for millivolt input).

Setup for Voltage or Current Input:

Setup For Channel ON/OFF

After selecting input type, the next parameter for configuration is Channel ON/OFF, which determines whether a channel is scanned or not. If for any reason a channel is not being used, it must be turned OFF. In this way the unit will not spend any time scanning it. This will also prevent the unit from displaying a 'HELP' message on a channel that has nothing hooked up to it. Use ▲DIG▼ key to select the desired setting. If a channel is OFF, the display will show 'CHx OFF', and if the channel is ON the display will show 'CHx ON' (x=channel #).

Use ▲DIG▼ key to display the desired ON/OFF setting, and then push SETUP key to enter that setting and go on to setup Decimal Point Position.

Setup For Decimal Point Position

After turning a channel ON or OFF, the next parameter for configuration is setting the decimal point position. This is indicated by the display showing '9999'. ▲DIG▼ key moves the decimal point through all the possible positions. After '9.999', the display goes to '9999' which indicates a display with no decimal point. Use ▲DIG▼ key to move the decimal point to the desired position, and then push SETUP key to enter that setting and go to setup High Scale.



When this parameter is set for "Normally Open", the relay is open when it is deactivated (readings are below LIMIT), and closes when the channel reading exceeds its LIMIT value. When this parameter is set for "Normally Closed", the relay is closed when it is deactivated (readings are below LIMIT), and open when channel reading exceeds LIMIT value.

The display will show 'rLy N.O.' for relay Normally Open or 'rLy N.C.' for Normally Closed setting. Use ▲DIG▼ key to toggle between the two settings. Once the desired setting is displayed, push SETUP key to enter that value and go on to setting up Engineering Units.



Setup For Engineering Units

After setting a channel's relay for NORMALLY OPEN/CLOSED operation, the next parameter to be set are the 3 letters that follow the process value in the display. These 3 letters represent the measurement units for that particular channel. Any desired combination of the following letters may be programmed:

A,B,C,D,E,F,G,H,I,J,L,N,O,P,Q,R,S,T,U,Y

The letter selection goes up to 'Y' and down to 'A' and from 'A' down to '-' sign. The '-' sign indicates that the particular digit will be blanked e.g. if the desired engineering unit was feet, then the display can be programmed to show 'Ft'. In this case one digit will be blanked out by programming a '-' sign in its location.



Three dots are displayed if no engineering units are programmed for a channel. Whenever the input type is changed from one type to another, the system automatically clears the engineering units. Therefore, it is necessary to re-enter new units after a change in the input type has been made. The only exception in this case is when a thermocouple selection is made. In that case, the unit automatically enters an 'F' or 'C' (Fahrenheit or Centigrade) depending upon the selected display units. However, just like the other inputs, any alternate units may be programmed for thermocouples.

The display will first show 'Cx UNIT' (x=channel #) after which the current UNITS will be displayed. Use ▲DIG▼ key (ref. Setup For High Scale) to setup desired UNITS. Once the desired UNITS are displayed, push SETUP key to enter them and then go back to 'SYS CH' display.

Setup for Thermocouple/ Thermistor/ RTD Inputs:

Turning Channels ON/OFF:

If selected option under 'IP tYPE' is thermocouple, RTD or thermistor, then the next step is turning the channel ON or OFF. This is done by pushing ▲DIG▼ key. Once the desired selection has been made, push SETUP key to go to the next step.

Temperature units:

This step configures the display units to Centigrade or Fahrenheit for the selected input. The display either shows "dEGrE C" or "dEGrE F" depending on previously selected units. Use ▲DIG▼ key to select alternate mode. Once having obtained the desired units, press SETUP key to go on to the next parameter. The following steps (i.e. channel setpoint, Channel limit, relay dead-band and engineering units) are the same as for voltage and current inputs -- refer to appropriate sections and/or flow chart.



Setup Examples

Example #1: Use of the OFFSET Parameter

Setup for a 4-20ma transducer signal corresponding to 0-500 gallons of fluid (reading in 10th of a gallon resolution):

DECIMAL POINT	= 999.9
HIGH SCALE	= 500.0
LOW SCALE	= 000.0
OFFSET	= 4.000
TARE	= 0.000

Example #2: Use of the LOW SCALE Parameter

Setup for a 4-20ma transducer signal corresponding to 500-2000 degrees Fahrenheit temperature i.e. 500 degrees at 4ma and 2000 degrees at 20ma (one degree resolution):

DECIMAL POINT	= 9999
HIGH SCALE	= 2000
LOW SCALE	= 500
OFFSET	= 4.00
TARE	= 0.000

Example #3: Use of the TARE Parameter

Setup for a 0-5Vdc transducer signal corresponding to 0-10.00 pounds of material being packaged in a box weighing 0.50 pounds with display reading in 0.01 lb. increments. DSP3200 should display the weight of the material only (not the box as well):

DECIMAL POINT	= 99.99
HIGH SCALE	= 10.00
LOW SCALE	= 00.00
OFFSET	= 0.00
TARE	= 0.50

SYSTEM CONFIGURATION

After entering the correct pass-code and selecting the blinking 'SYS' (ref. SETUP section), DPS3300 Series goes into SYSTEM CONFIGURATION mode. This mode allows setting up parameters that affect all the channels or the instrument in general.

Setup For Display Options

After pushing **SETUP** key while **SYS** is blinking, the display briefly shows 'dSP OPT' (for display option) and then the present Display Option setting. Table 3 below lists all 6 display options available. Use **▲DIG▼** key to step thru the options. Once the desired Display Option is shown, push **SETUP** key to enter the setting and go to Setup For Display Time.



Table 3. Display Options

DISPLAY OPTION	DISPLAY WINDOW READS
1) Display elapsed time	ELPSEd t
2) Scan active channels	SCAn
3) Display channel with highest reading	HI CHAN
4) Display channel with lowest reading	LO CHAN
5) Display deviation from SETPOINT	dSP dEN
6) Display channel differential	CH1 dIF

Setup For Channel Calibration

After setting the Cold Junction Reference temperature, the next step is a display of channels for calibration purposes. This allows easy calibration of each channel without the instrument scanning to the next channel. The display will show the channel input reading in the form 'x-nnnnn' where x=channel # and nnnnn is the channel reading.

NOTE: ONLY channels that are turned ON will be displayed at this time!

Press **SETUP** key to step the display to the next channel.

Input Range Setup (for current and voltage):

Voltage Range Setup (0-10vdc, 0-5vdc)

After all the enabled channels have been displayed, the VOLTAGE range may be setup. The display will briefly show 'U rAnGE' (for "Voltage Range") followed by the current setting. Use **▲DIG▼** key (ref. Setup For High Scale) to set the desired VOLTAGE value. Once the desired value is displayed, push **SETUP** key to enter that value and go to the next step.

Voltage Range Setup (for millivolt inputs)

For Millivolt input units, the display first shows 'HV rnGE' (for "High Voltage Range"). After the High Voltage range is set, the display shows 'LV rnGE' (for "Low Voltage Range"). Enter values for respective inputs.

Current Range Setup

After VOLTAGE range has been set, the CURRENT range may be set. The display will briefly show 'C RANGE' (for "Current Range") followed by the current setting. Use **▲DIG▼** key (ref. Setup For High Scale) to set the desired CURRENT value. Once the correct CURRENT range is displayed, push **SETUP** key to enter that value and return to 'SYS CH' display.

Correct Range Settings

The following RANGE values should be entered for various inputs:

<u>INPUT</u>	<u>RANGE VALUE</u>
0-5 Vdc	5.000
0-10 Vdc	10.000
0-100 Mv	100.0
4-20 Ma. (loop current)	20.00

Thermocouple Calibration Procedure

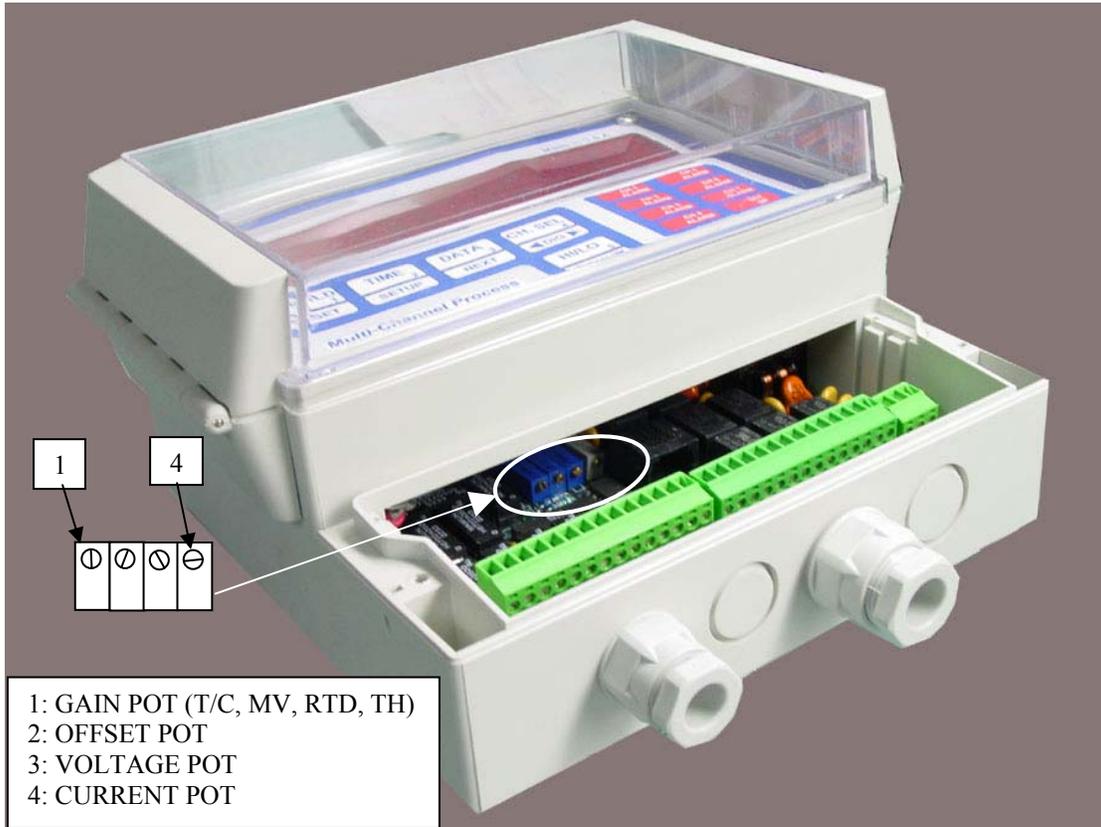
Note: Make sure the unit is reading correct cold-junction temperature before calibrating. If incorrect, adjust as described in the "Setup For Cold Junction" section.

For a thermocouple channel calibration (type J T.C), following steps should be performed. Note that calibrating any channel automatically sets the calibration for all channels. Also, only one type of thermocouple input needs to be calibrated i.e. J,K,T or E. For example, if the calibration is done for a type K thermocouple, types J, T, and E are automatically calibrated.

1. Connect a thermocouple calibration source to channel 1.
2. Dial in 1100 degrees centigrade (Note: unit must be programmed for displaying in centigrade).



3. Adjust the gain pot of the instrument until the display reads '1100'.
4. Short channel #1's input with a wire or shorting bar.
5. Push **DIFF** key. The display will read '0002' --- or some other value.
6. Adjust offset pot of instrument until the display reads '0000'.
7. Push **SETUP** key -- the display will show Cold Junction temperature.
8. Remove the shorting bar from channel one input and connect the thermocouple calibrator again.
9. Repeat steps 2 through 7 till the unit reads proper temperature.



SAVING PARAMETER:

DPS3300 series saves all the programmed parameters in an EEPROM (electrically erasable programmable read only memory). An EEPROM stores the parameters even when power is removed from the unit. However, it is important to note that if the parameters are changed during setup, they must be saved in the EEPROM by pressing reset key as described under setup. If the parameters are not saved and the power is removed from the unit, any newly changed values will be lost (the unit will, however, maintain the old values).

PEAKS

A very useful function of DPS3300 is tracking the highest (peak) and the lowest (valley) point attained by each channel. This is particularly helpful if an operation is not being constantly watched or is left unattended (e.g. overnight). Since high and low points for each channel are monitored and stored separately, the history of changes at various points in the process can be obtained. This can be useful for quality control or for finding properties of a certain process.

The first step in displaying peaks is to select the channel whose peaks are desired. This is done by pushing the 'CH. SEL' key. Each time this key is pushed, the display indicates the selected channel e.g. CHANEL 2, CHANEL 3 and so on.



Once the desired channel has been selected, push **'HI/LO'** key. Pushing it once will show the high peak attained by the selected channel. Pushing it a second time will indicate the low process value (NOTE: The second push, to display valley, must be initiated before the display reverts to normal display mode). Before displaying high peak, the display will read **'CH2 HI'** (for Channel 2 High Peak). Similarly, for low peak the display will indicate **'CH2 LO'** (for Channel2 Low Peak) before showing the value.

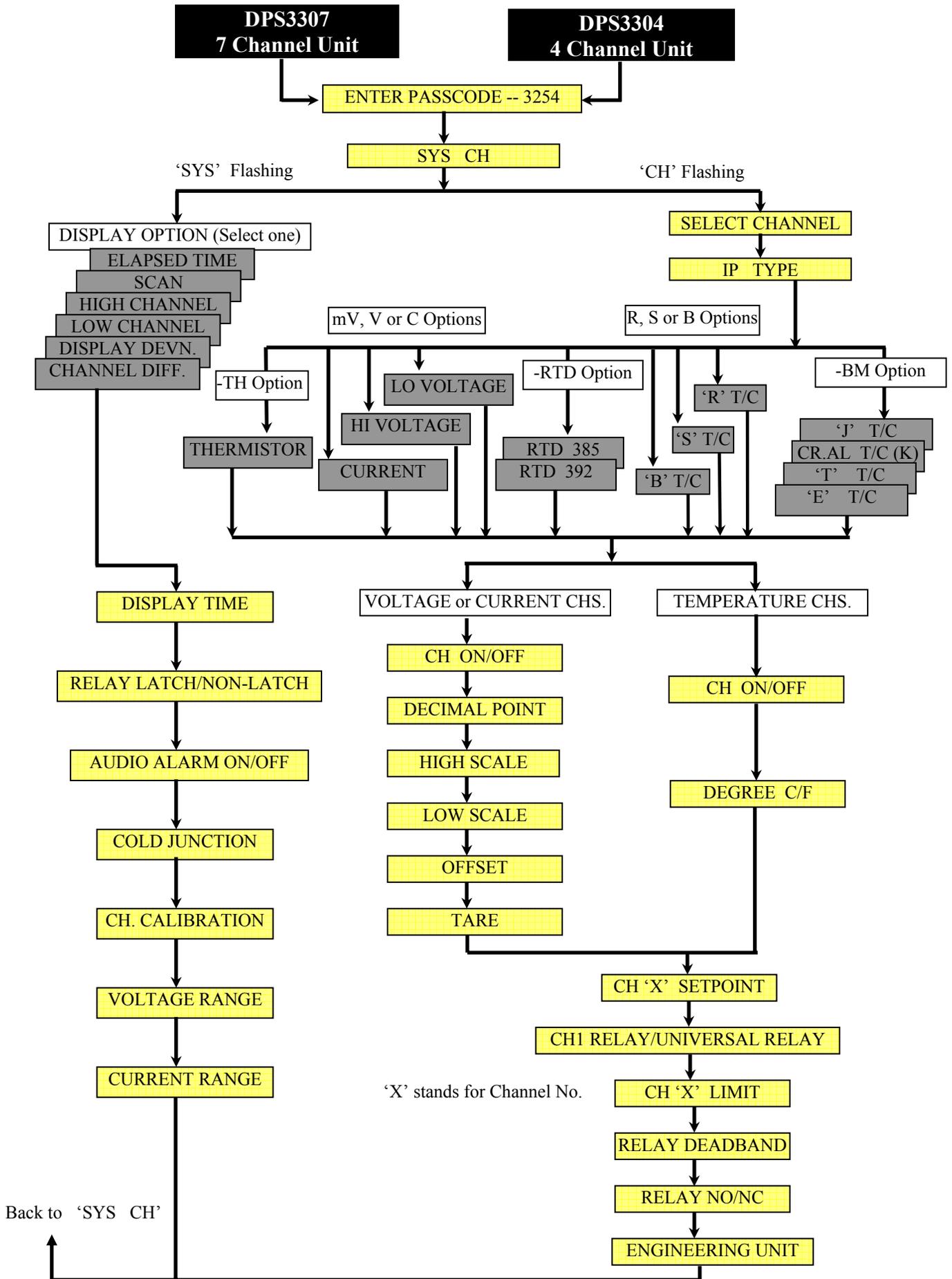
If an attempt is made to display the high or low peak of a channel which has been turned off (in CH Setup), the display will read **'CHx OFF'** (x=channel #) to indicate the channel status.



Peaks can be reset to the present value of process (e.g. if channel 1 is reading 200 C, its peaks can be reset to 200). This will allow tracking the process from present temperature being read by the unit. To reset high peak, first select the channel whose peak is desired to be reset (by pushing the **CH. SEL** key). Once the channel has been selected, push **HI/LO** key and keep it pushed. The display will read **'HI P'** following which the value of high peak will be displayed. With **HI/LO** key still pushed, go on to push the **RESET** key. The display will read **'RESET'** and the unit will then take the present value of process on that channel and enter it as new high peak. To reset low peak, release **HI/LO** key (from high peak display mode) and push it again immediately -- and keep it pushed. The display will read **'LO P'** and then the value of channel's low peak. With **HI/LO** key still pushed, press the **RESET** key. The display will read **'RESET'** and the unit will enter present process value as the channel's new low peak.

PROGRAMMING FLOW CHARTS:

FOLLOWING PAGES SHOW FLOW CHARTS FOR DPS3300 UNITS:



RATE

DPS3300 series tracks the rate of process change/minute for each channel. This rate is displayed by first pushing the CH. SEL key to select the channel whose rate is desired. Once the channel has been selected, push DATA key. The display will briefly read 'cx-rate' (x=channel #), and then the monitored rate for that channel.



LIMITS

DPS3300 series units support limit alarms on all the channels. These limits can be programmed over the entire range of selected thermocouple or scale. Thus, not only can these units be used as monitors but they can also provide control capability on each channel. Limit values are programmed during CH Setup. Also programmed during CH Setup is the dead-band (hysteresis) value. This keeps the relays from chattering when the process is hovering just around the limit.

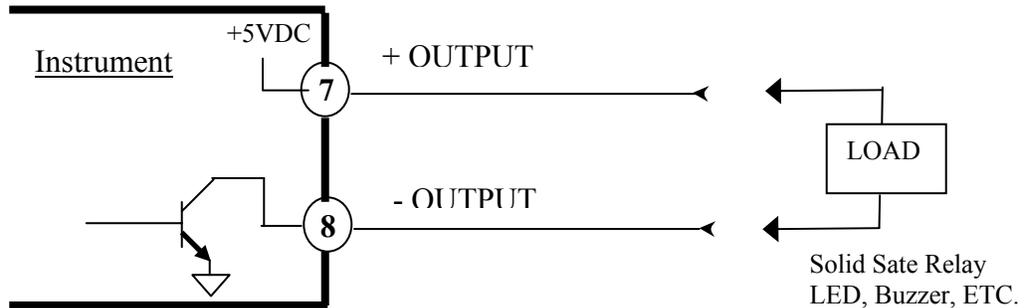
OUTPUTS

DPS3300 Series units can be ordered with either open collector outputs or electro-mechanical relays. Check model number printed on the unit.

Open Collector Option

Whenever a limit is reached an open collector output provides a 5 Vdc signal at 50ma. on the output connector, eg.. Limit #4 provides its 5 volt output signal between pins 7 & 8 of the card edge.

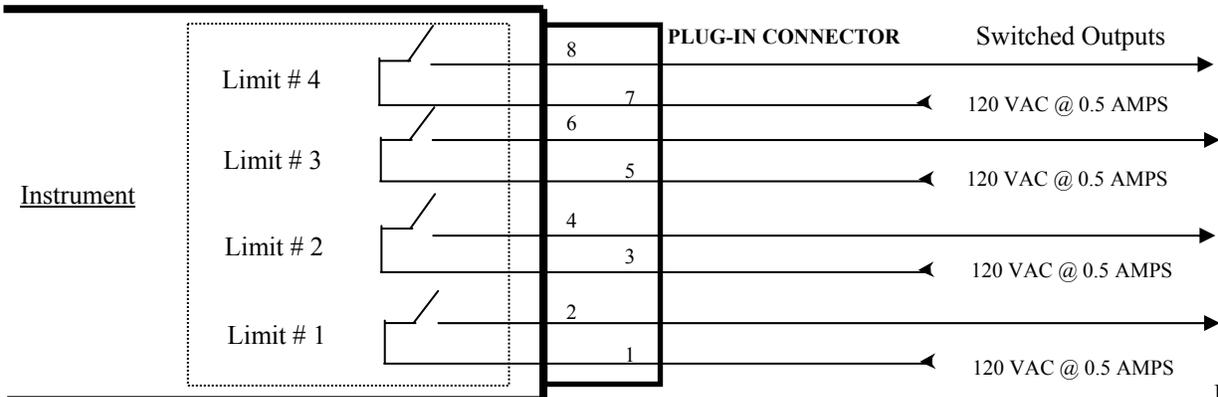
Figure 1. Open Collector Hookup Example



Electro-Mechanical Relay Option

These relays are programmed during CH Setup to operate as either Normally Open (NO) or Normally Closed (NC). The default setting is Normally Open. Each of these limit relays provides a switched output whenever a limit is reached. The maximum rating for a 120Vac unit is 120Vac @ 0.5 amp or 28 Vdc @ 1.0 amp. A 240Vac unit is rated at 240Vac @ 0.25 amp. or 28Vdc @ 1.0 amp.

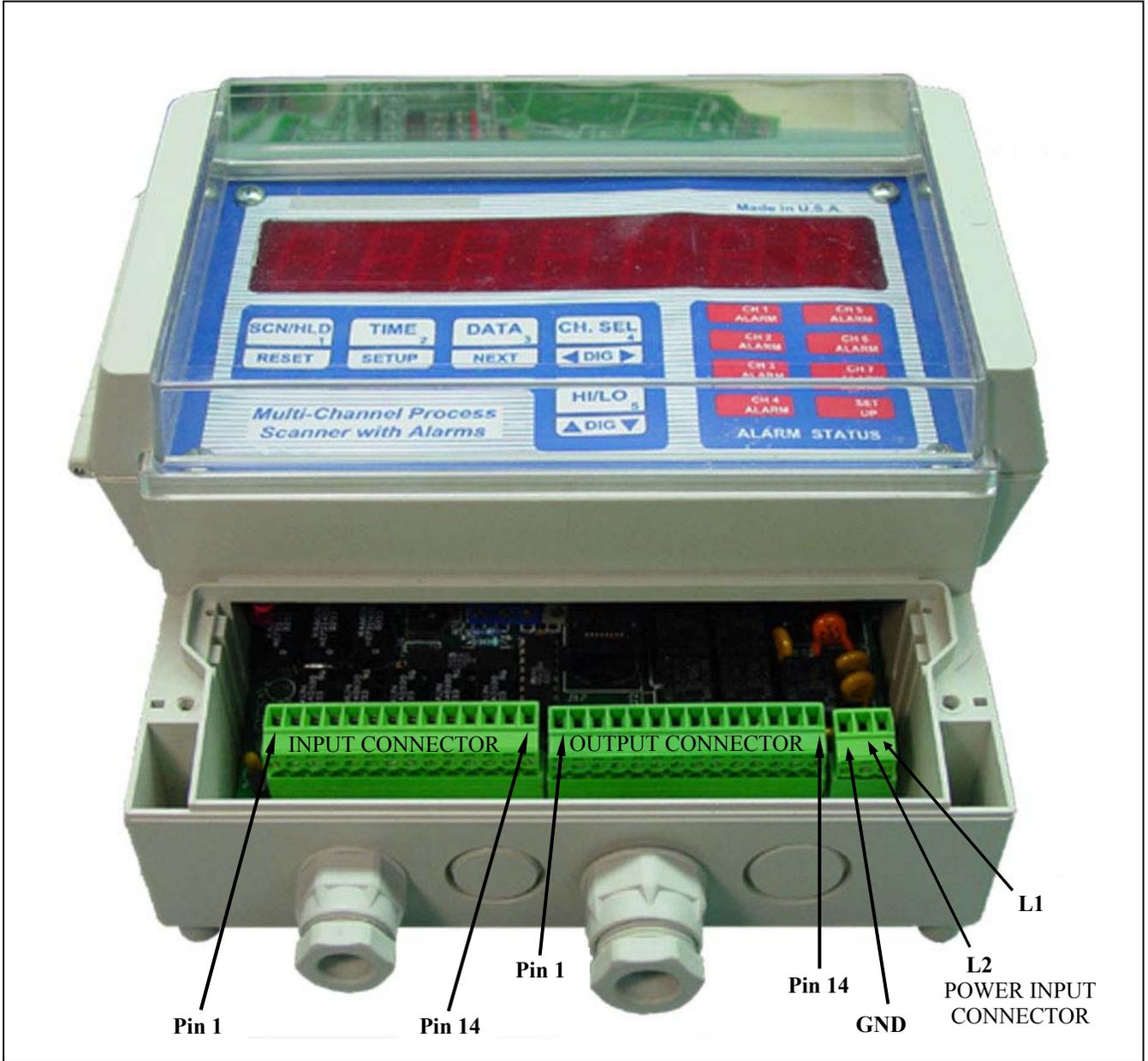
Figure 2. Electro-mechanical Relays Hookup Example



NOTE: LOOK UNDER SPECIFICATIONS FOR THE RATING ON RELAYS AND OPEN COLLECTOR OUTPUTS. UNDER NO CONDITION SHOULD THE RELAYS AND OPEN COLLECTOR OUTPUTS BE OPERATED BEYOND THEIR RATED CAPACITY. DOING SO CAN DAMAGE THE UNIT PERMANENTLY.

The status of the relays for all the channels is indicated on the front panel by a row of LEDs. Whenever the relay is energized, its respective LED is turned on.

FIG- 3. DPS3300 Series TERMINAL COMPARTMENT



POWER

Power connection should be made to the three terminal connector as shown in figure 3. Also, make note that it is very important that the power line inputs and the power ground are not switched. Doing so will permanently damage the instrument. Refer to Figure 3 for proper connections. For convenience, the printed circuit board is labeled L1 L2 GND on the under side of three terminal power connector. For instruments with the 15Vdc power option, L1 = negative supply and L2 = positive supply.

NOTE: WHILE CONNECTING POWER TO THE UNIT, MAKE SURE THAT AC POWER LINE L1 OR L2 IS NOT ACCIDENTALLY CONNECTED TO GROUND (GND) TERMINAL. THIS WILL RESULT IN PERMANENT DAMAGE TO THE INSTRUMENT.

DOUBLE CHECK THE CONNECTIONS BEFORE APPLYING POWER!!

INPUT CONNECTOR PIN ASSIGNMENT

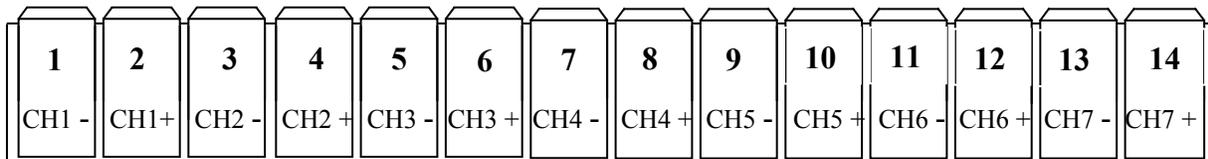


Table 4. DPS3300 Series Output Connector Pin Assignments

<i>OUT-PUT CONNECTOR PIN ASSIGNMENTS</i>			
Pin #	Signal	Relay Output	Open Collector
1	Channel #1 Limit	Common	Positive Output
2	Channel #1 Limit	Normally Open/Closed*	Negative Output
3	Channel #2 Limit	Common	Positive Output
4	Channel #2 Limit	Normally Open /Closed*	Negative Output
5	Channel #3 Limit	Common	Positive Output
6	Channel #3 Limit	Normally Open/Closed*	Negative Output
7	Channel #4 Limit	Common	Positive Output
8	Channel #4 Limit	Normally Open/Closed*	Negative Output
9	Channel #5 Limit	Common	Positive Output
10	Channel #5 Limit	Normally Open/Closed*	Negative Output
11	Channel #6 Limit	Common	Positive Output
12	Channel #6 Limit	Normally Open/Closed*	Negative Output
13	Channel #7 Limit	Common	Positive Output
14	Channel #7 Limit	Normally Open/Closed*	Negative Output

* = Normally Open/Closed is user programmable (Look under Set-up)

NOTE: PROPER RATING, CONNECTION AND CORRECT ORIENTATION OF THE CONNECTOR IS NECESSARY TO AVOID MALFUNCTION OR PERMANENT DAMAGE TO THE UNIT.

DIRECT INTERFACE TO UNIVERSAL RELAY MODULE

A special feature in the DPS3300 series units allows direct interfacing with Universal Relay Module (Model RELAY-URM400/800) – via a serial interface. The serial interface is available at a separate connector (as shown) in the terminal compartment.

RELAY-URM400/800 series relay module is a very versatile instrument that is used for switching up to eight 15 ampere loads. In addition to the DPS3300 serial interface, RELAY-URM400/800 series relay module accepts low level input signals from PLCs, process controllers, indicators, motor starters, etc. Selectable input allows activation of output relays on direct acting or reverse acting signal. In addition to working with control/logic level signals, another very useful feature of RELAY-URM400/800 is activation of output relays on contact closure. The use of the RELAY-URM400/800 allows heavy loads requiring up to 15 amps to be controlled by the DPS3300 with minimal equipment & wiring.

Input and output connections for the RELAY-URM400/800 are made through euro style pluggable connectors which are conveniently located on the top and bottom of the unit. Screw in terminals allow for quick connect/disconnect of wires. The unit is housed in a versatile enclosure that can be configured for mounting on a DIN rail or on a wall. If desired, the same enclosure can be panel mounted with relay, AC and DC supply status visible on the front. LEDs on the front panel turn on when a relay is energized. Two different versions are offered in this series. First one is RELAY-URM400 that has four relay outputs. The second one is RELAY-URM800 that has eight relay outputs. (Future versions will also include 4-15A solid state relays). Both units come with a built-in universal power supply. It operates from 100vac to 240vac. This power supply provides power not only to the internal electronics and relays but has up to 20watts (5, 12 or 24vdc) available for external applications by the user.



DIRECT SERIAL INTERFACE TO RELAY-URM400/800



DPS3300 TERMINAL COMPARTMENT



SERIAL PORT FOR RELAY-URM400/800

TROUBLE SHOOTING

If the meter locks on a particular display, unplug and plug in again to unlock the display. A total reset clears the memory and defaults all values to zero. To perform this reset, re-apply power with **RESET** key pressed in.

Factory Channel settings:

To obtain factory preset values simply re-apply power with **▲DIG▼** key pressed in. This will also clear memory of any erroneous values and is the preferred method of resetting a unit that might be malfunctioning due to corrupted memory.

Factory default settings for Thermocouple, voltage, current and milli-volt are:

<u>PARAMETER</u>	<u>CURRENT INPUT</u>	<u>VOLTAGE. INPUT</u>	<u>MILLIVOLT INPUT</u>	<u>T/C INPUT</u>
HIGH SCALE	20.000	10.000	100.00	J
LOW SCALE	0.000	0.000	0.000	J
OFFSET	0.00	0.00	0.00	J
TARE	0.000	0.000	0.000	J

ERROR MESSAGES AND SOLUTIONS

ERROR MESSAGES AND SOLUTIONS		
ERROR MESSAGE	ERROR CONDITION	SOLUTION
'EE EROR'	The unit was unable to save programmed value in EEPROM -- possible failure of EEPROM.	If the message keeps coming up, unplug the unit and reapply power. If the unit still displays the error message, send it in for repair. If error message followed by 8.8.8.8.8.8.and the revision number are displayed occasionally, it is an indication that power line is very noisy and needs a line filter.
'CARD ER'	Too much noise on input signals or problem with Scanner card.	1. If message shows occasionally, it indicates that input signals have too much high voltage noise. Provide signal filters. 2. Unplug and plug the meter again to recycle power. 3. Scanner card defective -- send in for repair
'HIGH AC NOISE'	High AC noise on input signals or incoming AC line interfering with the operation of the unit	1. If message shows occasionally, it indicates that input signals or AC line has too much high voltage noise. 2. Provide line and signal filters.

MOUNTING

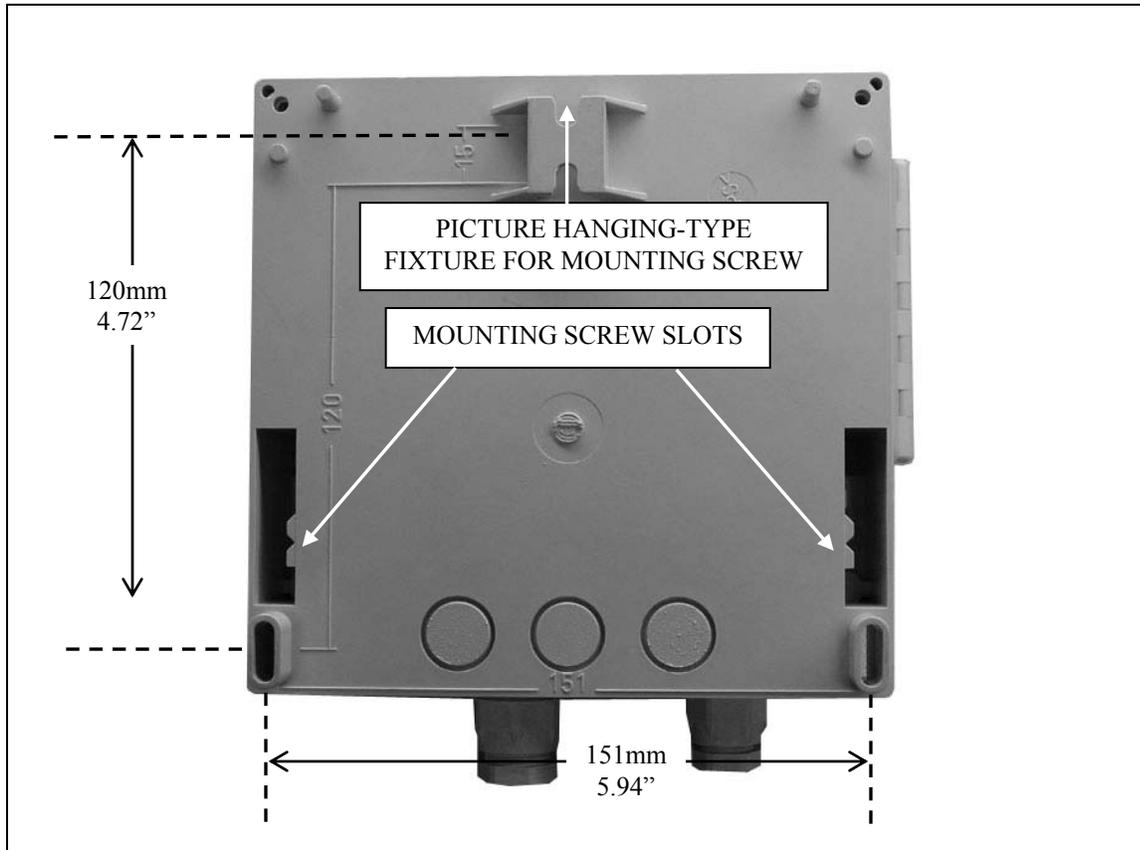
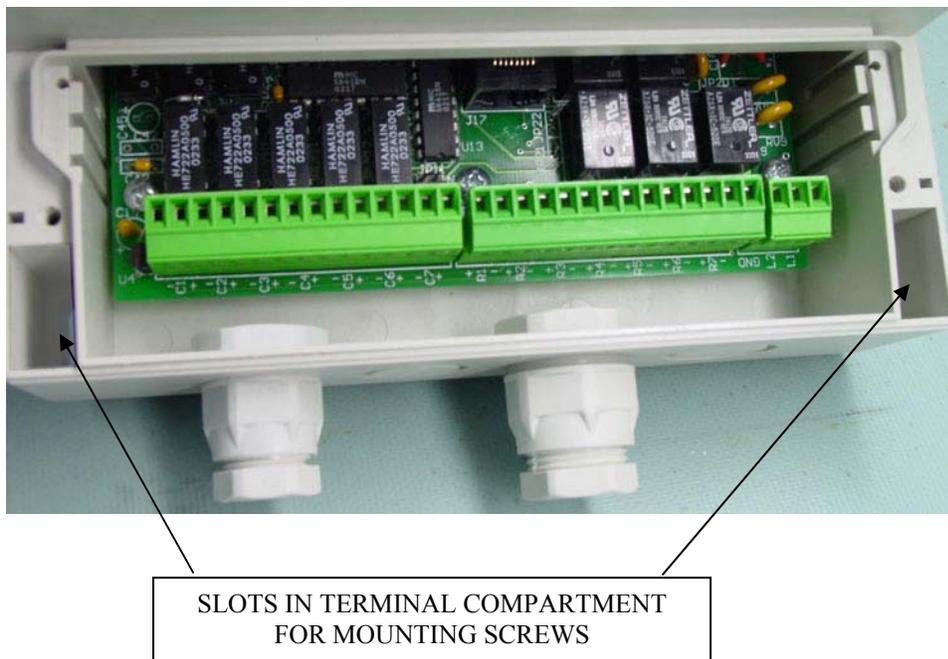


Figure - 4. Rear View And Mounting Hole Locations



MADE IN

USA

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESS OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

OMEGA is a registered trademark of OMEGA ENGINEERING, INC.

© Copyright 1999 OMEGA ENGINEERING, INC. All rights reserved. This document may not be copied, photocopied, reproduced, translated, or reduced to any electronic medium or machine-readable form, in whole or in part, without the prior written consent of OMEGA ENGINEERING, INC.



OMEGAnet® On-Line Service
www.omega.com

Internet e-mail
info@omega.com

Servicing North America:

USA: One Omega Drive, P.O. Box 4047
ISO 9001 Certified Stamford CT 06907-0047
TEL: (203) 359-1660 FAX: (203) 359-7700
e-mail: info@omega.com

Canada: 976 Bergar
Laval (Quebec) H7L 5A1
TEL: (514) 856-6928 FAX: (514) 856-6886
e-mail: info@omega.ca

For immediate technical or application assistance:

USA and Canada: Sales Service: 1-800-826-6342 / 1-800-TC-OMEGA®
Customer Service: 1-800-622-2378 / 1-800-622-BEST®
Engineering Service: 1-800-872-9436 / 1-800-USA-WHEN®
TELEX: 996404 EASYLINK: 62968934 CABLE: OMEGA

Mexico: TEL: (001) 800-826-6342 FAX: (001) 203-359-7807
En Español: (001) 203-359-7803 e-mail: espanol@omega.com
info@omega.com.mx

Servicing Europe:

Benelux: Postbus 8034, 1180 LA Amstelveen, The Netherlands
TEL: +31 (0)20 6418405 FAX: +31 (0)20 6434643
Toll Free in Benelux: 0800 0993344
e-mail: nl@omega.com

Czech Republic: Rudé armády 1868, 733 01 Karviná 8
TEL: +420 (0)69 6311899 FAX: +420 (0)69 6311114
Toll Free in Czech Republic: 0800-1-66342 e-mail: czech@omega.com

France: 9, rue Denis Papin, 78190 Trappes
TEL: +33 (0)130 621 400 FAX: +33 (0)130 699 120
Toll Free in France: 0800-4-06342
e-mail: france@omega.com

Germany/Austria: Daimlerstrasse 26, D-75392 Deckenpfronn, Germany
TEL: +49 (0)7056 3017 FAX: +49 (0)7056 8540
Toll Free in Germany: 0800 TC-OMEGASM
e-mail: germany@omega.com

United Kingdom: One Omega Drive, River Bend Technology Centre
ISO 9002 Certified Northbank, Irlam, Manchester
M44 5EX United Kingdom
TEL: +44 (0)161 777 6611 FAX: +44 (0)161 777 6622
Toll Free in United Kingdom: 0800 488 488
e-mail: sales@omega.co.uk

It is the policy of OMEGA to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

The information contained in this document is believed to be correct, but OMEGA Engineering, Inc. accepts no liability for any errors it contains, and reserves the right to alter specifications without notice.

WARNING: These products are not designed for use in, and should not be used for, patient-connected applications.

Where Do I Find Everything I Need for Process Measurement and Control? OMEGA...Of Course!

TEMPERATURE

- Thermocouple, RTD & Thermistor Probes, Connectors, Panels & Assemblies
- Wire: Thermocouple, RTD & Thermistor
- Calibrators & Ice Point References
- Recorders, Controllers & Process Monitors
- Infrared Pyrometers

PRESSURE, STRAIN AND FORCE

- Transducers & Strain Gages
- Load Cells & Pressure Gages
- Displacement Transducers
- Instrumentation & Accessories

FLOW/LEVEL

- Rotameters, Gas Mass Flowmeters & Flow Computers
- Air Velocity Indicators
- Turbine/Paddlewheel Systems
- Totalizers & Batch Controllers

pH/CONDUCTIVITY

- pH Electrodes, Testers & Accessories
- Benchtop/Laboratory Meters
- Controllers, Calibrators, Simulators & Pumps
- Industrial pH & Conductivity Equipment

DATA ACQUISITION

- Data Acquisition & Engineering Software
- Communications-Based Acquisition Systems
- Plug-in Cards for Apple, IBM & Compatibles
- Datalogging Systems
- Recorders, Printers & Plotters

HEATERS

- Heating Cable
- Cartridge & Strip Heaters
- Immersion & Band Heaters
- Flexible Heaters
- Laboratory Heaters

ENVIRONMENTAL MONITORING AND CONTROL

- Metering & Control Instrumentation
- Refractometers
- Pumps & Tubing
- Air, Soil & Water Monitors
- Industrial Water & Wastewater Treatment
- pH, Conductivity & Dissolved Oxygen Instruments

M4302/0306