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# User's Manual

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DIN EN ISO 9001  
Certificate: 01 100 98505



## LIMIT CONTROL L41 Microprocessor Based Limit Controller

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UMOL411B

**BrainChild**

## Warning Symbol

The Symbol calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury or damage to or destruction of part or all of the product and system. Do not proceed beyond a warning symbol until the indicated conditions are fully understood and met.

## Use the Manual

- Installers                      Read Chapter 1, 2
- System Designer              Read All Chapters
- Expert User                    Read Page 12

### NOTE:

**It is strongly recommended that a process should incorporate a LIMIT CONTROL like L41 which will shut down the equipment at a preset process condition in order to preclude possible damage to products or system.**

Information in this user's manual is subject to change without notice.

**This manual is applicable for the products with software version 11 and later version.**

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# Chapter 1 Overview

## 1-1 General

The limit control **L41** is an over temperature protection or a high limit safety device with a latching output, that removes power in an abnormal condition during the process is higher than the high limit set point or lower than the low limit set point.

The unit is powered by 11-26 or 90-250 VDC/VAC supply, incorporating a 3 amp. form C relay for limit control, an universal input which is fully programmable for PT100, thermocouple types J, K, T, E, B, R, S, N, L, C, P and 0~60mV, an option port available for one of the following functions: RS-232, RS-485 communication interface and Retransmission. Alternative output options include SSR drive and triac . The input signal is digitized by using a **18-bit A to D** converter. Its **fast sampling rate** (5 times/second) allows the L41 to control fast process such as pressure and flow.

Digital communication RS-485 is available as an additional option. This option allows L41 to be integrated with supervisory control system. An alarm output is another option. A variety of alarm function and alarm mode can be programmed for a specific application. The DC power supply output option is used for an external sensor or transmitter. The standard event input can be programmed for remote reset or remote lock signal input. The limit annunciator can be used to control an alarm buzzer.

**Three kinds** of method can be used to program L41. **1.** use keys on front panel to program the unit manually, **2.** Use a PC and setup software to program the unit via RS-485 port and **3.** Use a pc and configuration software to program the unit via **programming port**.

**High accuracy, maximum flexibility, fast response and user friendly** are the main features of L41.

# 1-2 Ordering Code

L41—☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

1 2 3 4 5 6 7 8

## Power Input

- 4: 90-250 VAC, 47-63 HZ  
5: 11 - 26 VAC or VDC, SELV, Limited Energy

## Signal Input

- 1: Standard Input  
Thermocouple: J, K, T, E, B, R, S, N, L, C, P  
RTD: PT100 DIN, PT100 JIS  
mV: 0~60 mV  
2: Voltage: 0-1 V  
3: Voltage : 0-10 V  
4: Current: 0-20mA  
5: Voltage : 0-5 V  
9: Special Order

## Output 1

- 0: None  
1: Form C relay rated 2A/240VAC  
2: Pulsed voltage to drive SSR, 5V/30mA  
6: Triac Output 1A / 240VAC, SSR  
C: Pulsed voltage to drive SSR, 14V/40mA  
9: Special order

## Accessories

- OM94-6 = Isolated 1A/240VAC Triac Output Module (SSR)  
OM94-7 = 14V/40mA SSR Drive Module  
DC94-1 = Isolated 20V / 25mA DC Output Power Supply  
DC94-2 = Isolated 12V / 40mA DC Output Power Supply  
DC94-3 = Isolated 5V / 80mA DC Output Power Supply  
CM94-1 = Isolated RS-485 Interface Module  
CM94-2 = Isolated RS-232 Interface Module  
CM94-3 = Isolated 4-20mA / 0-20mA Retransmission Module  
CM94-4 = Isolated 1-5V / 0-5V Retransmission Module  
CM94-5 = Isolated 0-10V Retransmission Module  
CC91-3 = Programming port cable for L41

**Standard leave blank  
Special Order AA-ZZ**

## Options

- 0: IP50 standard  
1: IP65 water resistant rubber installed

## Communication

- 0: None  
1: RS-485 interface  
2: RS-232 interface  
3: Retransmit 4-20mA/0-20mA  
4: Retransmit 1-5V/0-5V  
5: Retransmit 0-10V  
9: Special Order

## Output 2

- 0: None  
1: Form C Relay 2A/240VAC  
2: Pulsed voltage to drive SSR, 5V / 30mA  
6: Triac Output, 1A / 240VAC, SSR  
7: Isolated 20V / 25mA DC Output Power Supply  
8: Isolated 12V / 40 mA DC Output Power Supply  
9: Isolated 5V / 80mA DC Output Power Supply  
C: Pulsed voltage to drive SSR, 14V/40mA  
H: Special order

## Related Products

SNA10A = Smart Network Adaptor for Third Party Software,  
Converts 255 channels of RS-485 or RS-422 to  
RS-232 Network

SNA12A = Smart Network Adaptor for programming port to RS-232  
interface.

BC-Set = Configuration Software

Standard model without option : L41-411000

## 1-3 Programming Port and DIP Switch

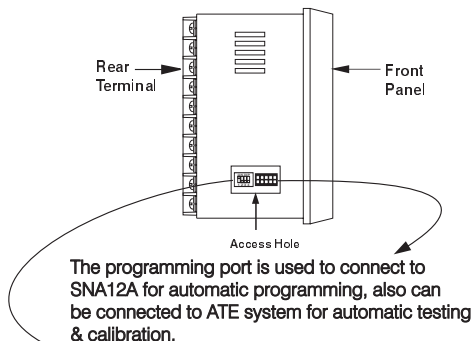


Figure 1.1 Access Hole Overview

|              |             | DIP Switch |   |   |   |
|--------------|-------------|------------|---|---|---|
|              |             | 1          | 2 | 3 | 4 |
| Input Select | TC, RTD, mV | ■          | □ |   |   |
|              | 0-1V, 0-10V | □          | ■ |   |   |
|              | 0-20 mA     | ■          | ■ |   |   |

Table 1.1 DIP Switch Configuration

A special connector can be used to touch the programming port which is connected to a PC for automatic configuration, also can be connected to an ATE system for automatic calibration and testing. The programming port is used for off-line automatic setup and testing procedures only. Don't attempt to make any connection to these pins when the unit is used for a normal control purpose.

## 1-4 Keys and Display

### KEYPAD OPERATION

SCROLL KEY 

This key is used to:

1. Select a set point to be displayed.
2. Select a parameter to be viewed or adjusted.
3. Advance display from a parameter code to the next parameter code

ENTER KEY  4 seconds, 6 seconds

Press the scroll key for 4 seconds the display will enter the setup menu. Press this key for 6 seconds to enter the calibration mode.

UP KEY 

This key is used to increase the selected parameter value during the lock indicator is off.

DOWN KEY 

This key is used to decrease the selected parameter value during the lock indicator is off.

RESET KEY 

This key is used to:

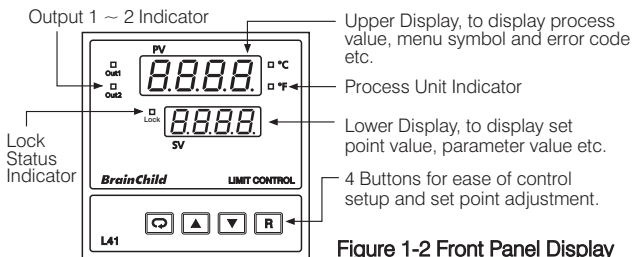
- 1.Reset the limit condition after the process is within the limit.
- 2.Revert the display to the normal display.
- 3.Reset the latching alarm, once the alarm condition is removed.
- 4.Reset the limit annunciator.

**Note:** If the RESET key is left pressed, only ONE reset operation will occur. If the unit subsequently goes into a state where reset is required again, the RESET key (or remote reset contacts) must be released (opened) and pressed (closed) again.

UNLOCK KEY  4 seconds

Press the RESET key for 4 seconds to enable up/down key function, and the lock indicator will be extinguished. However, this function is disabled when the EI input pins are closed and remote lock is selected for EIFN (Event input function). **See section 3-11.**

The reference data are reset as long as the reset key is pressed for 4 seconds. **See section 3-13.**



**Figure 1-2 Front Panel Display**

## DISPLAY FORM

Table 1-2 Display Form of Characters

|   |          |   |          |   |          |   |          |   |          |   |          |
|---|----------|---|----------|---|----------|---|----------|---|----------|---|----------|
| A | <i>A</i> | E | <i>E</i> | I | <i>I</i> | N | <i>N</i> | S | <i>S</i> | X |          |
| B | <i>b</i> | F | <i>F</i> | J | <i>J</i> | O | <i>O</i> | T | <i>t</i> | Y | <i>Y</i> |
| C | <i>C</i> | G | <i>G</i> | K | <i>K</i> | P | <i>P</i> | U | <i>u</i> | Z |          |
| c | <i>c</i> | H | <i>H</i> | L | <i>L</i> | Q |          | V | <i>v</i> | ? | <i>?</i> |
| D | <i>d</i> | h | <i>h</i> | M | <i>M</i> | R | <i>r</i> | W |          | = | <i>=</i> |

►: These characters are displayed differently.

### How to display a 5-digit number :

For a number with decimal point the display will be shifted one digit right:

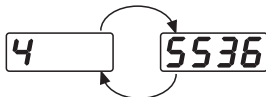
-199.99 will be displayed as -199.9, 4553.6 will be displayed as 4553

For a number without decimal point the display will be divided into two alternating phases:

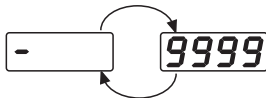
-19999 will be displayed as:



45536 will be displayed as:



-9999 will be displayed as:



### NORMAL DISPLAY

During normal operation, the unit will display the process value, and the word SAFE.

### ABNORMAL DISPLAY

Whenever the process is outside the normal range, the lower display will display the limit set point value instead of displaying the word SAFE.

## SENSOR BREAK DISPLAY

If a break is detected in the sensor circuit, the display will show:

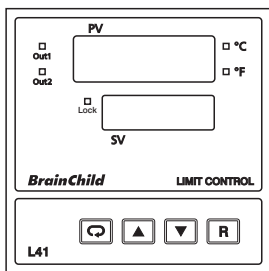
*SEn.b*

## A-D FAILURE DISPLAY

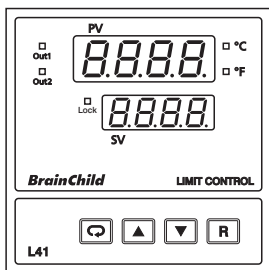
If failure is detected in the A-D converter circuit, the display will show:

*AdEr*

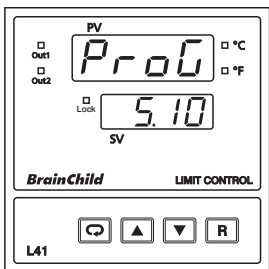
## POWER UP SEQUENCE



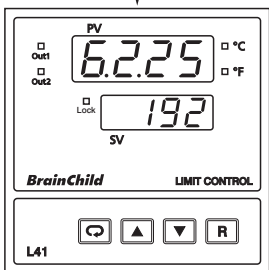
All segments of display and indicators are left off for 0.5 second.



All segments of display and indicators are lit for 1.5 seconds.

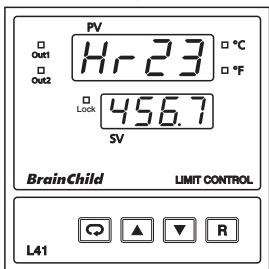


Display program code of the product for 1.5 seconds. The left diagram shows program no.5 with version 10.



Display Date Code for 1.5 seconds. The left diagram shows Year 2006, Month February (2), Date 25<sup>th</sup>. This means that the product is produced on February 25<sup>th</sup>, 2006. Note that the month code **A** is for **October**, **B** is for **November** and **C** is for **December**.

Display the serial number ( 001~999 ) for 1.5 seconds.



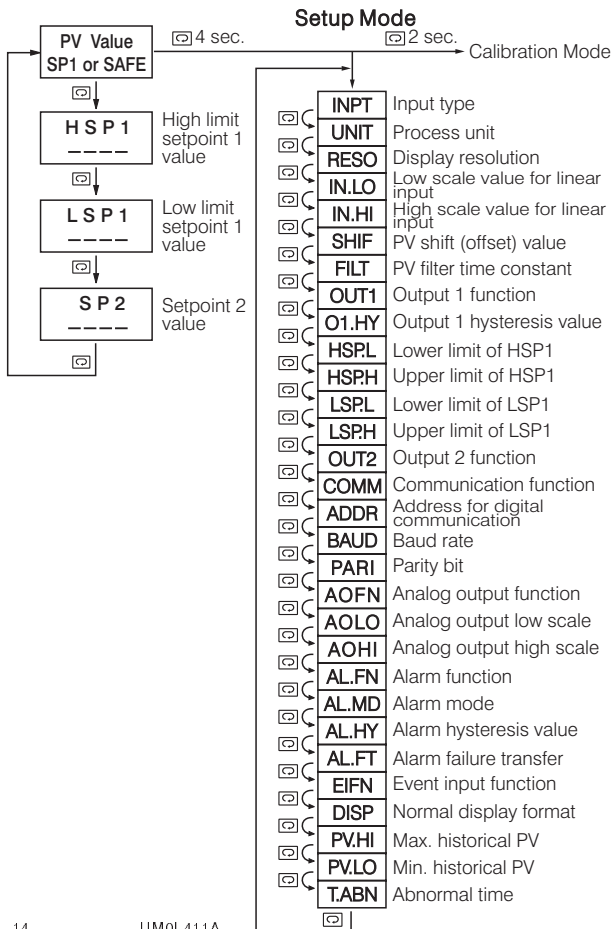
Display the hours used for 1.5 seconds. The left diagram shows that the unit has been used for 23456.7 hours since production.

Figure 1-3 Power Up Sequence

Verify all electrical connections have been properly made before applying power to the unit.

During power up, a self-test procedure is performed within 6.5 seconds. During self-test period all outputs are left off. When the self-test procedure is complete, the unit reverts to normal operation.

# 1-5 Menu Overview



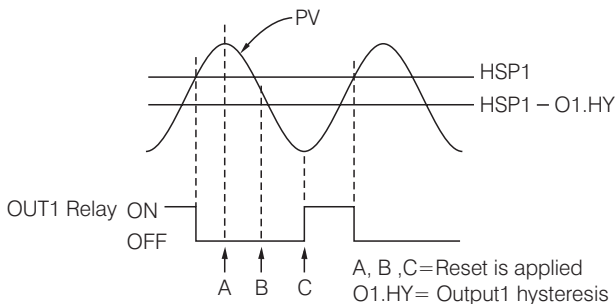
**Note 1.** The flow charts show a complete listing of parameters. For actual application the number of available parameters is dependent on the setup conditions, and should be less than that shown in the flow charts.

**Note 2.** Press **[R]** key for 4 seconds to enable up/down key function, and the LOCK indicator will be extinguished.

## 1-6 Limit Control Operation

### HIGH LIMIT OPERATION

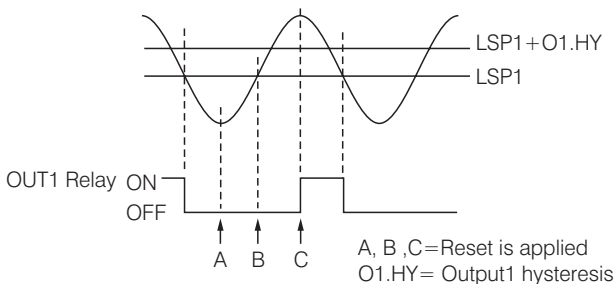
If Hi. is selected for OUT1, the unit will perform high limit control. When power is applied the OUT1 relay is de-energized. After 6.5 seconds self-test period, if the process is below the high limit set point (HSP1), the output 1 relay will be energized and OP1 indicator will go off. If the process goes above the high limit set point, the relay will be de-energized, the OP1 indicator will go on and the display will show the process value. After the process falls below the high limit set point and the RESET key is pressed or the remote reset input is applied, the relay will be energized and the OP1 indicator will go off.



**Figure 1-4 High Limit Operation**

## LOW LIMIT OPERATION

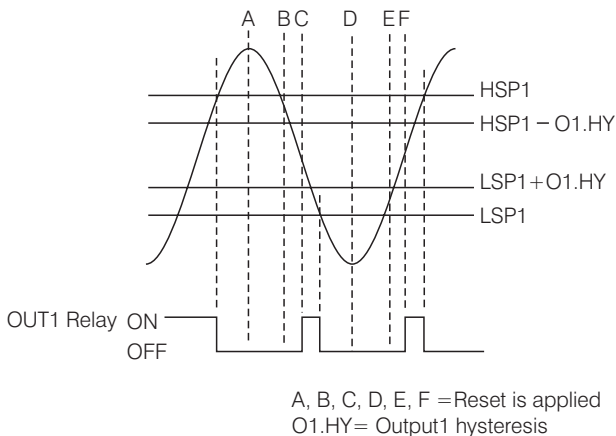
If Lo. is selected for OUT1, the unit will perform low limit control. When power is applied the OUT1 relay is de-energized. After 6.5 seconds self-test period, if the process is above the low limit set point (LSP1), the output 1 relay will be energized and OP1 indicator will go off. If the process goes below the low limit set point, the relay will be de-energized, the OP1 indicator will go on and the display will show the process value. After the process rises above the low limit set point and the RESET key is pressed or the remote reset input is applied, the relay will be energized and the OP1 indicator will go off.



**Figure 1-5 Low Limit Operation**

## HIGH/LOW LIMIT OPERATION

If Hi.Lo is selected for OUT1, the unit will perform high/low limit control. When power is applied the OUT1 relay is de-energized. After 6.5 seconds self-test period, if the process is below the high limit set point (HSP1) and above the low limit set point (LSP1), the output 1 relay will be energized and OP1 indicator will go off. If the process goes above the high limit set point or below the low limit set point, the relay will be de-energized, the OP1 indicator will go on and the display will show the process value. After the process is within the normal operation range, and the RESET key is pressed or the remote reset input is applied, the relay will be energized and the OP1 indicator will go off.



**Figure 1-6 High/Low Limit Operation**

## 1-7 Parameter Descriptions

| Parameter Notation | Parameter Description          | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Default Value          |
|--------------------|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| HSP1               | High Limit Set point 1         | Low: HSP.L<br>High: HSP.H                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 100.0 °C<br>(212.0 °F) |
| LSP1               | Low Limit Set point 1          | Low: LSP.L<br>High: LSP.H                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0 °C<br>(32.0 °F)      |
| SP2                | Set point 2 Value for Output 2 | Low: -19999<br>High: 45536                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 90.0 °C<br>(194.0 °F)  |
| INPT               | Input Type Selection           | 0 J _ t C : J type thermocouple<br>1 K _ t C : K type thermocouple<br>2 T _ t C : T type thermocouple<br>3 E _ t C : E type thermocouple<br>4 B _ t C : B type thermocouple<br>5 R _ t C : R type thermocouple<br>6 S _ t C : S type thermocouple<br>7 N _ t C : N type thermocouple<br>8 L _ t C : L type thermocouple<br>9 C _ t C : C type thermocouple<br>10 P _ t C : P type thermocouple<br>11 P t . d n : PT100 ohms DIN curve<br>12 P t . J S : PT100 ohms JIS curve | 1<br>(0)               |

| Parameter Notation | Parameter Description            | Range                                                                                                                                                                                                                                                                                             | Default Value |
|--------------------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| INPT               | Input Type Selection             | 13 <b>4-20</b> : 4~20 mA linear current<br>14 <b>0-20</b> : 0~20 mA linear current<br>15 <b>0-60</b> : 0~60 mV linear voltage<br>16 <b>0-1V</b> : 0~1 V linear voltage<br>17 <b>0-5V</b> : 0~5 V linear voltage<br>18 <b>1-5V</b> : 1~5 V linear voltage<br>19 <b>0-10</b> : 0~10V linear voltage | 1<br>(0)      |
| UNIT               | Process Unit                     | 0 <b>°C</b> : Degree C unit<br>1 <b>°F</b> : Degree F unit<br>2 <b>Pu</b> : Process unit                                                                                                                                                                                                          | 0<br>(1)      |
| RESO               | Display Resolution               | 0 <b>no.dP</b> : No decimal point<br>1 <b>1-dP</b> : 1 decimal point<br>2 <b>2-dP</b> : 2 decimal point<br>3 <b>3-dP</b> : 3 decimal point                                                                                                                                                        | 1             |
| IN.LO              | Low Scale Value for Linear Input | Low: -19999<br>High: IN.HI                                                                                                                                                                                                                                                                        | 0             |

| Parameter Notation | Parameter Description             | Range                                                                                                                                                                                                                                                                                                                                                                                                                    | Default Value |
|--------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| IN.HI              | High Scale Value for Linear Input | Low: IN.LO<br>High: 45536                                                                                                                                                                                                                                                                                                                                                                                                | 100.0         |
| SHIF               | PV Shift ( offset ) Value         | Low: -200.0 °C (-360.0 °F)<br>High: 200.0 °C (360.0 °F)                                                                                                                                                                                                                                                                                                                                                                  | 0.0           |
| FILT               | PV Filter Time Constant           | 0 <b>0</b> : 0 second time constant<br>1 <b>0.2</b> : 0.2 second time constant<br>2 <b>0.5</b> : 0.5 second time constant<br>3 <b>1</b> : 1 second time constant<br>4 <b>2</b> : 2 seconds time constant<br>5 <b>5</b> : 5 seconds time constant<br>6 <b>10</b> : 10 seconds time constant<br>7 <b>20</b> : 20 seconds time constant<br>8 <b>30</b> : 30 seconds time constant<br>9 <b>60</b> : 60 seconds time constant | 2             |
| OUT1               | Output 1 Function                 | 2 <b>H<sub>i</sub></b> : High limit control<br>3 <b>L<sub>o</sub></b> : Low limit control<br>4 <b>H<sub>i</sub> . L<sub>o</sub></b> : High/Low limit control                                                                                                                                                                                                                                                             | 2             |

| Parameter Notation | Parameter Description     | Range                                                                                                                                                                                                                                                                                                                  | Default Value            |
|--------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| O1.HY              | Output 1 Hysteresis Value | Low: 0.1<br>High: 10.0 °C (18.0 °F)                                                                                                                                                                                                                                                                                    | 0.1                      |
| HSP.L              | Lower Limit of HSP1       | Low: -19999<br>High: HSP.H                                                                                                                                                                                                                                                                                             | 0 °C<br>(32.0 °F)        |
| HSP.H              | Upper Limit of HSP1       | Low: HSP.L<br>High: 45536                                                                                                                                                                                                                                                                                              | 1000.0 °C<br>(1832.0 °F) |
| LSP.L              | Lower Limit of LSP1       | Low: -19999<br>High: LSP.H                                                                                                                                                                                                                                                                                             | -100.0 °C<br>(-148.0 °F) |
| LSP.H              | Upper Limit of LSP1       | Low: LSP.L<br>High: 45536                                                                                                                                                                                                                                                                                              | 0 °C<br>(32.0 °F)        |
| OUT 2              | Output 2 Function         | 0 <i>nonE</i> : No function<br>1 <i>dCPS</i> : DC power supply output<br>2 <i>ALn</i> : Alarm output<br>3 <i>L_An</i> : Limit annunciator                                                                                                                                                                              | 2                        |
| COMM               | Communication function    | 0 <i>nonE</i> : No communication<br>1 <i>rtu</i> : Modbus RTU mode protocol<br>2 <i>4-20</i> : 4-20mA retransmission output<br>3 <i>0-20</i> : 0-20mA retransmission output<br>4 <i>0-5V</i> : 0-5V retransmission output<br>5 <i>1-5V</i> : 1-5V retransmission output<br>6 <i>0-10</i> : 0-10V retransmission output | 1                        |

| Parameter Notation | Parameter Description              | Range                                                                                                                                                                                                                                                                                                                                                                                                                | Default Value     |
|--------------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| ADDR               | Address Assignment of Digital COMM | Low: 1<br>High: 255                                                                                                                                                                                                                                                                                                                                                                                                  | 1                 |
| BAUD               | Baud Rate of Digital COMM          | 0 <b>0.3</b> : 0.3 Kbits/s baud rate<br>1 <b>0.6</b> : 0.6 Kbits/s baud rate<br>2 <b>1.2</b> : 1.2 Kbits/s baud rate<br>3 <b>2.4</b> : 2.4 Kbits/s baud rate<br>4 <b>4.8</b> : 4.8 Kbits/s baud rate<br>5 <b>9.6</b> : 9.6 Kbits/s baud rate<br>6 <b>14.4</b> : 14.4 Kbits/s baud rate<br>7 <b>19.2</b> : 19.2 Kbits/s baud rate<br>8 <b>28.8</b> : 28.8 Kbits/s baud rate<br>9 <b>38.4</b> : 38.4 Kbits/s baud rate | 5                 |
| PARI               | Parity Bit of Digital COMM         | 0 <b>EVEN</b> : 8 bit even parity<br>1 <b>odd</b> : 8 bit odd parity<br>2 <b>none</b> : 8 bit none parity                                                                                                                                                                                                                                                                                                            | 0                 |
| AOFN               | Analog Output Function             | 0 <b>PU</b> : Process value<br>1 <b>HSP1</b> : High Limit Set point 1<br>2 <b>LSP1</b> : Low Limit Set point 1                                                                                                                                                                                                                                                                                                       | 0                 |
| AOLO               | Analog Output Low Scale Value      | Low: -19999<br>High: 45536                                                                                                                                                                                                                                                                                                                                                                                           | 0 °C<br>(32.0 °F) |

| Parameter Notation | Parameter Description                      | Range                                                                                                                                     | Default Value           |
|--------------------|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| AOHI               | Analog Output High Scale Value             | Low: -19999<br>High: 45536                                                                                                                | 100.0 °C<br>(212.0 °F ) |
| AL.FN              | Alarm function                             | 6 <i>PV.HA</i> : Process value high alarm<br>7 <i>PV.LA</i> : Process value low alarm                                                     | 6                       |
| AL.MD              | Alarm mode                                 | 0 <i>non</i> : Normal alarm action<br>1 <i>Latch</i> : Latching alarm action                                                              | 0                       |
| AL.HY              | Alarm hysteresis value                     | Low: 0.1<br>High: 10 °C (18.0 °F )                                                                                                        | 0.1                     |
| AL.FT              | Alarm failure transfer                     | 0 <i>off</i> : Alarm output goes off as unit fails<br>1 <i>on</i> : Alarm output goes on as unit fails                                    | 1                       |
| EIFN               | Event input function                       | 0 <i>none</i> : No event function<br>1 <i>reset</i> : Remote reset for output 1, output 1 on.<br>2 <i>lock</i> : Remote lock for the unit | 0                       |
| DISP               | Normal display format                      | 0 <i>SAFE</i> : Display SAFE<br>1 <i>HSP I</i> : Display the value of HSP1<br>2 <i>LSP I</i> : Display the value of LSP1                  | 0                       |
| PV.HI              | Historical Max. value of PV                | Low: -19999<br>High: 45536                                                                                                                | —                       |
| PV.LO              | Historical Min. value of PV                | Low: -19999<br>High: 45536                                                                                                                | —                       |
| T.ABN              | Accumulated time during abnormal condition | Low: 0<br>High: 6553.5 minutes                                                                                                            | —                       |

# Chapter 2 Installation



Dangerous voltages capable of causing death are sometimes present in this instrument. Before installation or beginning any troubleshooting procedures the power to all equipment must be switched off and isolated. Units suspected of being faulty must be disconnected and removed to a properly equipped workshop for testing and repair. Component replacement and internal adjustments must be made by a qualified maintenance person only.



To minimize the possibility of fire or shock hazards, do not expose this instrument to rain or excessive moisture.



Do not use this instrument in areas under hazardous conditions such as excessive shock, vibration, dirt, moisture, corrosive gases or oil. The ambient temperature of the areas should not exceed the maximum rating specified in Chapter 6.

## 2 - 1 Unpacking

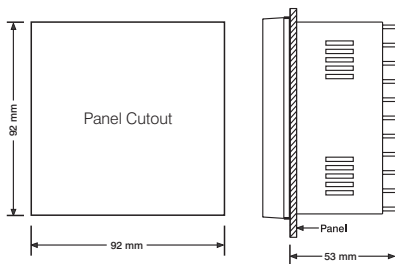
Upon receipt of the shipment remove the unit from the carton and inspect the unit for shipping damage.

If any damage due to transit, report and claim with the carrier. Write down the model number, serial number, and date code for future reference when corresponding with our service center. The serial number (S/N) and date code (D/C) are labeled on the box and the housing of the unit.

## 2 - 2 Mounting

Make panel cutout to dimension shown in Figure 2-1.

Install both mounting clamps and insert the housing into panel cutout.



**Figure 2-1 Mounting Diagram**

## **2 - 3 Wiring Precautions**

- ✱ Before wiring, verify the label for correct model number and options. Switch off the power when checking.
- ✱ Care must be taken to ensure that maximum voltage rating specified on the label are not exceeded.
- ✱ It is recommended that power of these units to be protected by fuses or circuit breakers rated at the minimum value possible.
- ✱ All units should be installed inside a suitably grounded metal enclosure to prevent live parts being accessible from human hands and metal tools.
- ✱ All wiring must conform to appropriate standards of good practice and local codes and regulations. Wiring must be suitable for maximum voltage, current, and temperature rating of the system.
- ✱ Beware not to over-tighten the terminal screws. The torque should not exceed 1N-m (8.9 Lb-in or 10.2 KgF-cm).

- ★ Unused control terminals should not be used as jumper points as they may be internally connected, causing damage to the unit.
- ★ Verify that the ratings of the output devices and the inputs as specified in Chapter 6 are not exceeded.
- ★ Except the thermocouple wiring, all wiring should use stranded copper conductor with maximum gauge 18 AWG.

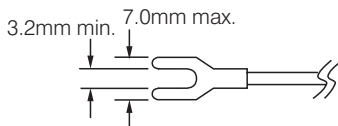


Figure 2-2 Lead Termination

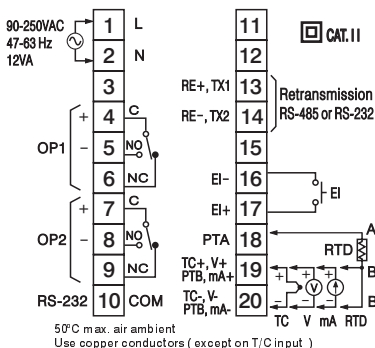


Figure 2-3  
Rear Terminal  
Connection Diagram

## 2-4 Power Wiring

The controller is supplied to operate at 11-26 VAC / VDC or 90-250 VAC. Check that the installation voltage corresponds with the power rating indicated on the product label before connecting power to the controller. Near the controller a fuse and a switch rated at 2A/250VAC should be equipped as shown in the following diagram.

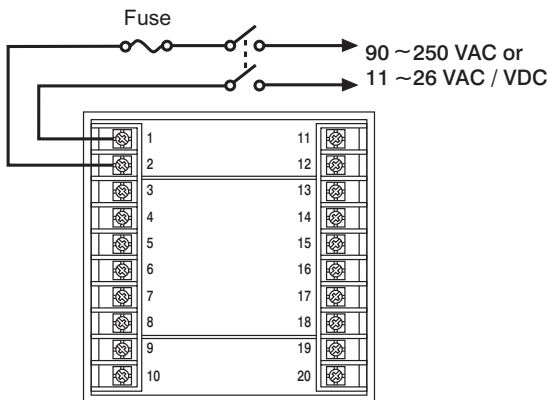


Figure 2-4 Power Supply Connections



This equipment is designed for installation in an enclosure which provides adequate protection against electric shock. The enclosure must be connected to earth ground.

Local requirements regarding electrical installation should be rigidly observed. Consideration should be given to prevent from unauthorized person access to the power terminals.

## 2-5 Sensor Installation Guidelines

Proper sensor installation can eliminate many problems in a control system. The probe should be placed so that it can detect any temperature change with minimal thermal lag. In a process that requires fairly constant heat output, the probe should be placed closed to the heater. In a process where the heat demand is variable, the probe should be closed to the work area. Some experiments with probe location are often required to find this optimum position.

In a liquid process, addition of a stirrer will help to eliminate thermal lag. Since the thermocouple is basically a point measuring device, placing more than one thermocouple in parallel will provide an average temperature readout and produce better results in most air heated processes.

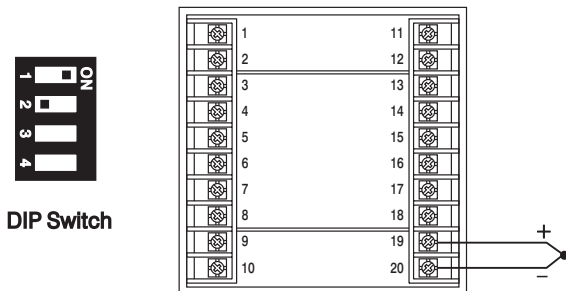
Proper sensor type is also a very important factor to obtain precise measurements. The sensor must have the correct temperature range to meet the process requirements. In special processes the sensor might need to have different requirements such as leak-proof, anti-vibration, antiseptic, etc.

Standard thermocouple sensor limits of error are  $\pm 4$ degrees F ( $\pm 2$ degrees C ) or 0.75% of sensed temperature (half that for special ) plus drift caused by improper protection or an over-temperature occurrence. This error is far greater than controller error and cannot be corrected at the sensor except by proper selection and replacement.

## 2-6 Thermocouple Input Wiring

Thermocouple input connections are shown in Figure 2-5. The correct type of thermocouple extension lead-wire or compensating cable must be used for the entire distance between the unit and the thermocouple, ensuring that the correct polarity is observed throughout. Joints in the cable should be avoided, if possible.

If the length of thermocouple plus the extension wire is too long, it may affect the temperature measurement. A 400 ohms K type or a 500 ohms J type thermocouple lead resistance will produce approximately 1 degree C temperature error .

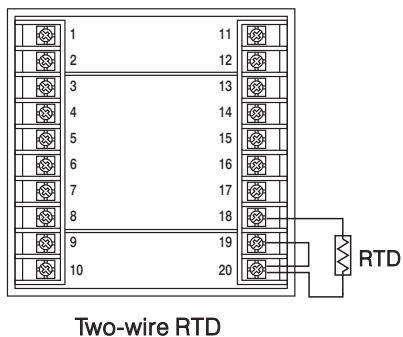
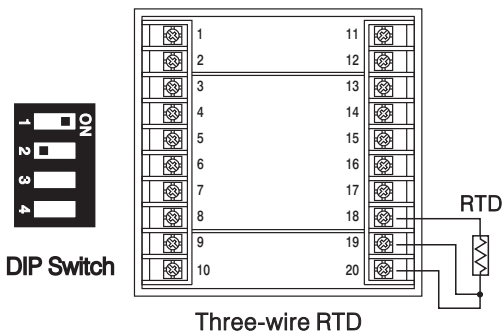


**Figure 2-5**  
**Thermocouple Input Wiring**

## 2-7 RTD Input Wiring

RTD connection are shown in Figure 2-6, with the compensating lead connected to terminal 19. For two-wire RTD inputs, terminals 19 and 20 should be linked. The three-wire RTD offers the capability of lead resistance compensation provided that the three leads are of same gauge and equal length.

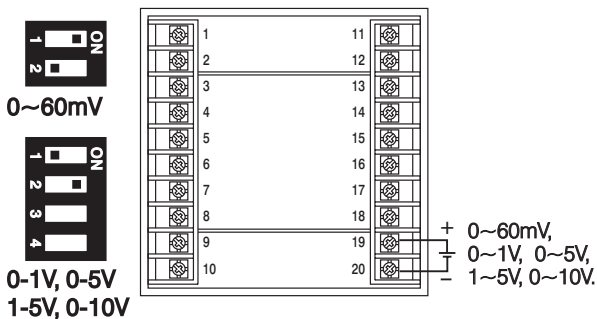
Two-wire RTD should be avoided, if possible, for the purpose of accuracy. A 0.4 ohm lead resistance of a two-wire RTD will produce 1 degree C temperature error.



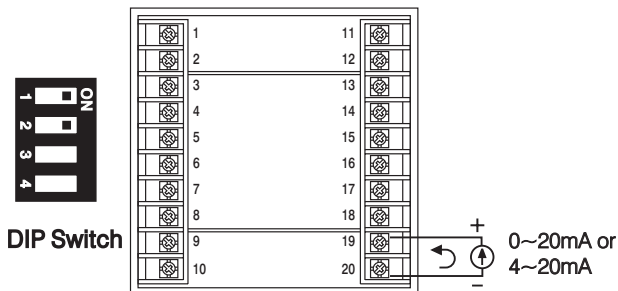
**Figure 2-6**  
**RTD Input Wiring**

## 2-8 Linear DC Input wiring

DC linear voltage and linear current connections are shown in Figure 2-7 and 2-8.

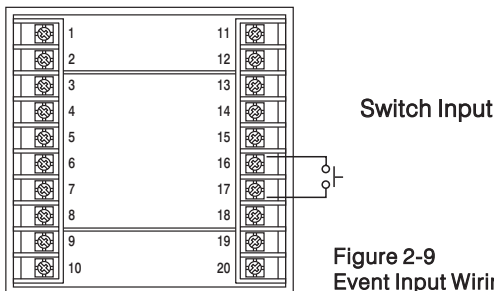
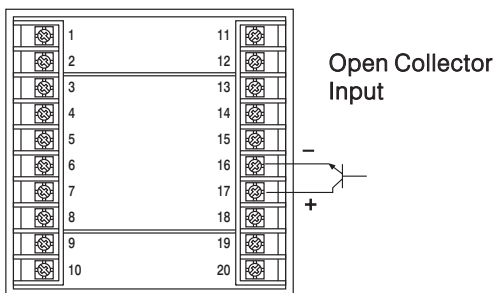


**Figure 2-7**  
**Linear Voltage Wiring**



**Figure 2-8**  
**Linear Current Wiring**

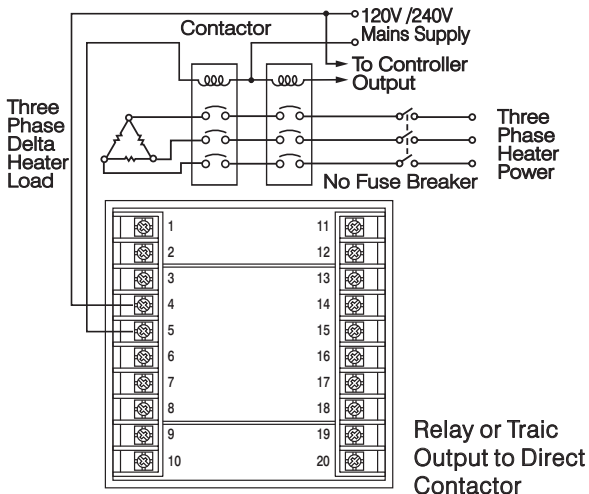
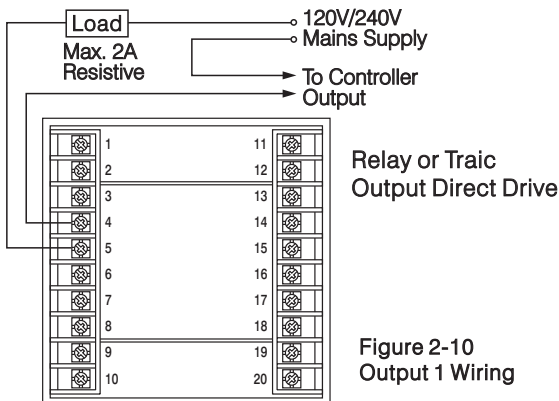
## 2-9 Event Input wiring

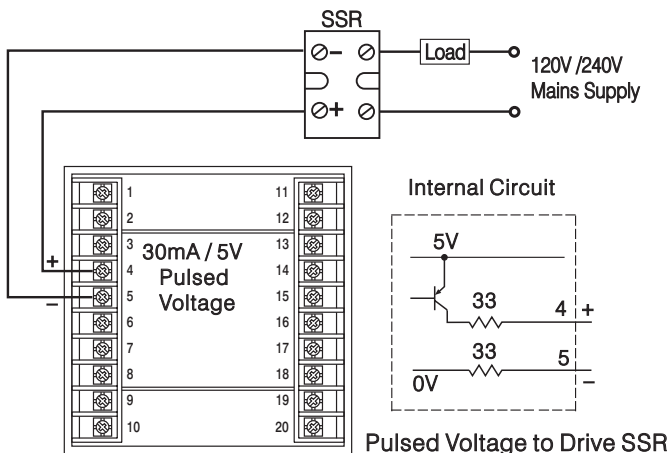


**Figure 2-9**  
**Event Input Wiring**

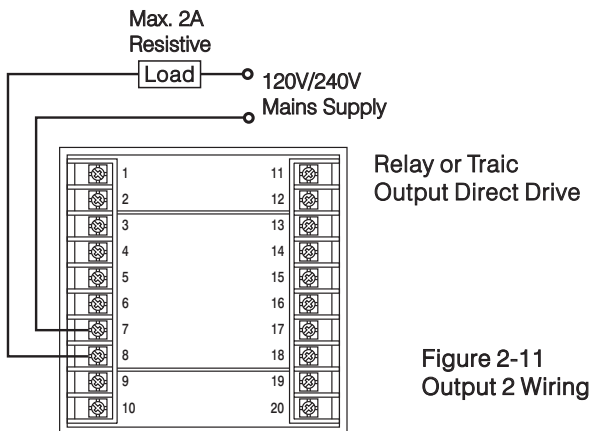
The event input can accept a switch signal as well as an open collector signal. The event input function (EIFN) is activated as the switch is closed or an open collector (or a logic signal ) is pulled down.

## 2-10 Output 1 Wiring

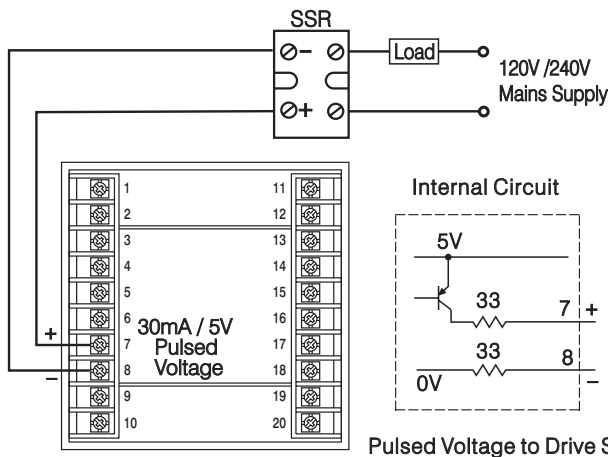
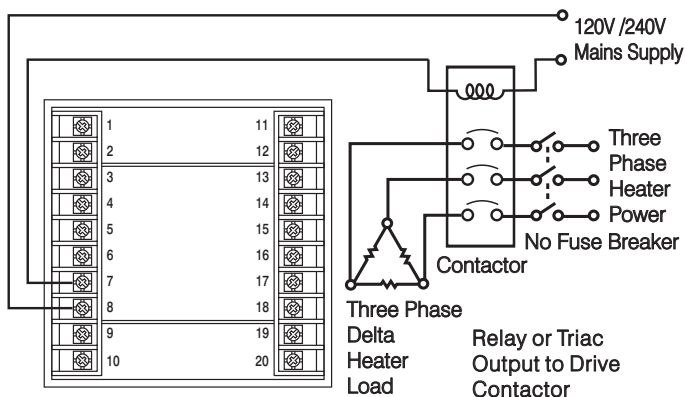




## 2-11 Output 2 Wiring



**Figure 2-11  
Output 2 Wiring**



# 2-12 RS-485

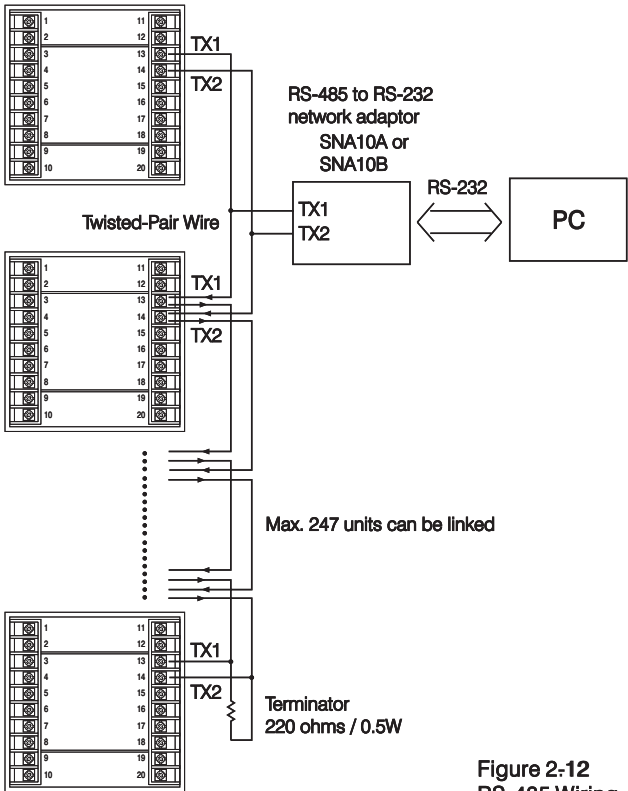


Figure 2-12  
RS-485 Wiring

## 2-13 RS-232

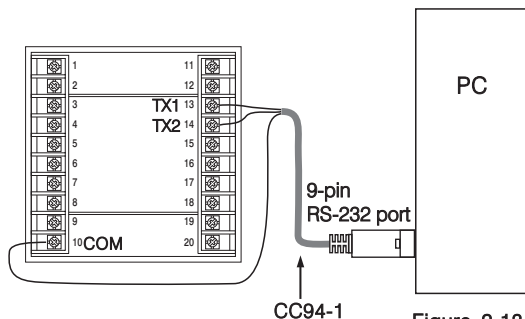


Figure 2-13  
RS-232 Wiring

If you use a conventional 9-pin RS-232 cable instead of CC94-1, the cable must be modified according to the following circuit diagram.

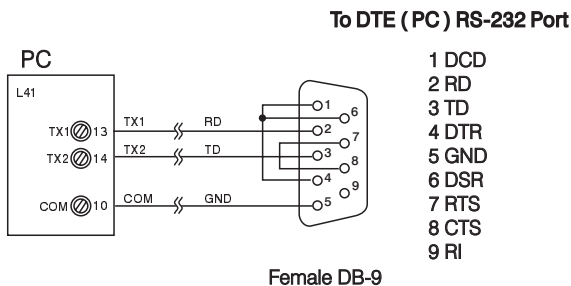


Figure 2-14  
Configuration of RS-232 cable

## 2-14 Retransmission

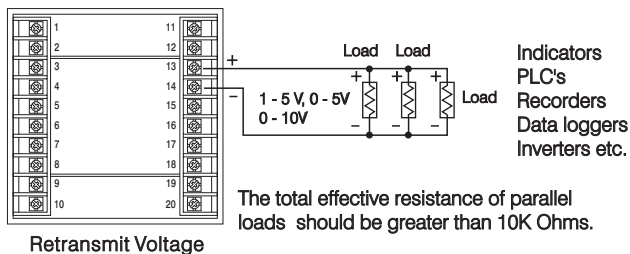
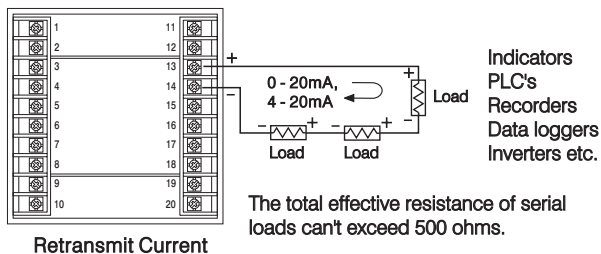


Figure 2-15  
Retransmission Wiring

# Chapter 3 Programming

## 3-1 Process Input

Press  for 4 seconds to enter setup mode. Press  to select parameter. The display will indicate the parameter symbol and the value ( or selection ) for that parameter.

**INPT:** Selects the sensor type and signal type for the process input.

**UNIT:** Selects the process unit.

**RESO:** Selects the location of the decimal point (Resolution) for most (not all) process related parameters.

**IN.LO:** Selects the low scale value for the Linear type input  
**Hidden if:** T/C or RTD type is selected for INPT

**IN.HI:** Selects the high scale value for the Linear type input  
**Hidden if:** T/C or RTD type is selected for INPT

### How to use IN.LO and IN.HI:

If 4-20mA is selected for INPT, let SL specifies the input signal low (ie. 4mA), SH specifies the signal high (ie. 20mA), S specifies the current input signal value, the conversion curve of the process value is shown as follows:

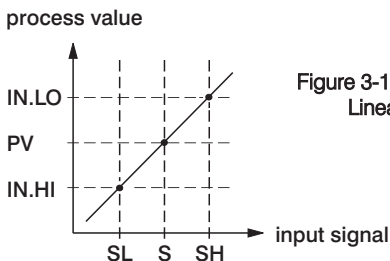


Figure 3-1 Conversion Curve for Linear Type Process Value

**Formula:** 
$$PV = IN.LO + (IN.HI - IN.LO) \frac{S - SL}{SH - SL}$$

**Example:** a 4-20 mA current loop pressure transducer with range 0 - 15 kg/cm<sup>2</sup>, is connected to input, then perform the following setup:

|                |              |
|----------------|--------------|
| INPT = 4-20 mA | IN.LO = 0.0  |
| UNIT = PU      | IN.HI = 15.0 |
| RESO = 1-DP    |              |

Of course, you may select other value for RESO to alter the resolution.

## 3-2 Limit Control

**OUT1:** Selects the output 1 function. The available output 1 functions are: High Limit Control, Low Limit Control and High/Low Limit Control. Refer to **Section 1-6** for the limit control operation.

**O1.HY:** Output 1 hysteresis value. The hysteresis value is adjusted to a proper value to eliminate the relay jitter in a noisy environment.

## 3-3 Set Point Range

**HSPL :** Lower limit of HSP1  
Hidden if LO is selected for OUT1

**HSPH :** Upper limit of HSP1  
Hidden if LO is selected for OUT1

**LSPL :** Lower limit of LSP1  
Hidden if HI is selected for OUT1

**LSPH :** Upper limit of LSP1  
Hidden if HI is selected for OUT1

HSPL and HSPH in setup menu are used to confine the adjustment range of HSP1. LSPL and LSPH are used to confine the adjustment range of LSP1.

### 3-4 PV Shift

In certain application it is desirable to shift the indicated value from its actual value. This can be easily accomplished with this unit by using the PV shift function.

Cycle the unit to the SHIF parameter by using the scroll key. The number you adjust here, either positive or negative, will be added to the actual value. The SHIF function will **alter PV only**.

**SHIF:** PV shift (offset) value

### 3-5 Digital Filter

In certain applications the process value is too unstable to be read. To Improve this a programmable low pass filter incorporated in the L41 can be used. This is a first order filter with time constant specified by FILT parameter which is contained in setup menu. The FILT is defaulted to 0.5 sec. before shipping. Adjust FILT to change the time constant from 0 to 60 seconds. 0 second represents no filter is applied to the input signal. The filter is characterized by the following diagram.

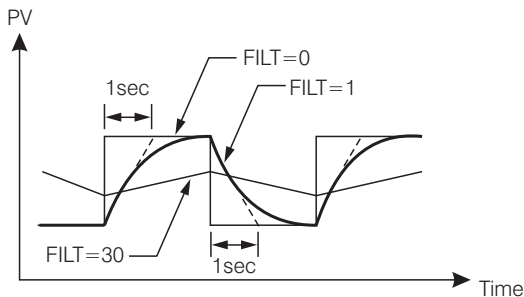


Figure 3-2 Filter Characteristics

## 3-6 Process Alarms

The output 2 will perform process alarm function and PV.H.A or PV.L.A for AL.FN. If PV.H.A is selected the alarm will perform process high alarm. If PV.L.A is selected the alarm will perform process low alarm. The process alarm sets an absolute trigger level. When the process exceeds that absolute trigger level an alarm occurs. The trigger level is determined by SP2 (Set point 2 value) and AL.HY (Alarm hysteresis value). The hysteresis value is introduced to avoid interference action of alarm in a noisy environment. Normally AL.HY can be set with a minimum value(0.1).

Trigger levels for process high alarm are SP2 and  $SP2 - AL.HY$ .  
Trigger level for process low alarm are  $SP2 + AL.HY$  and Sp2.

There are two types of alarm mode can be selected, these are: normal alarm and latching alarm.

### **Normal Alarm: AL.MD= NORM**

When a normal alarm is selected, the alarm output is de-energized in the non-alarm condition and energized in an alarm condition.

### **Latching Alarm: AL.MD= LTCH**

If a latching alarm is selected, once the alarm output is energized, it will remain unchanged even if the alarm condition has been cleared unless the power is shut off or the RESET key (or remote reset button) is pressed.

### **Failure Transfer: AL.FT = OFF or ON**

In case of **Sensor Break** or **A-D Failure** occurs, the alarm output will be on or off according to the selection of AL.FT.

### **Examples:**

|              |                |
|--------------|----------------|
| SP2 = 200    | AL.HY = 10.0   |
| AL.MD = NORM | AL.FN = PV.H.A |

Examples:

Process proceeds →

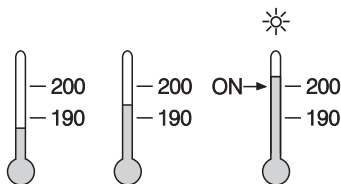
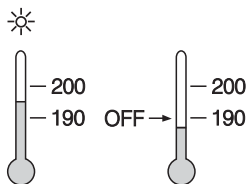


Figure 3-3  
Normal Process Alarm



SP2 = 200

AL.MD = LTCH

AL.HY = 10.0

AL.FN = PV.H.A

Process proceeds →

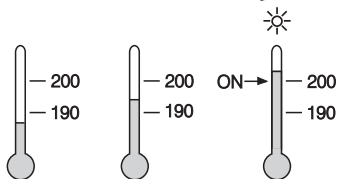
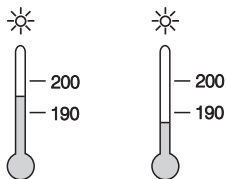


Figure 3-4  
Latching Process Alarm



## 3 - 7 Data Communication

The controllers support **RTU** mode of **Modbus** protocol for the data communication. Other protocols are not available for the series.

Two types of interface are available for Data Communication. These are RS-485 and RS-232 interface. Since RS-485 uses a differential architecture to drive and sense signal instead of a single ended architecture which is used for RS-232, RS-485 is less sensitive to the noise and suitable for a longer distance communication. RS-485 can communicate without error over 1 km distance while RS-232 is not recommended for a distance over 20 meters.

Using a PC for data communication is the most economic way. The signal is transmitted and received through the PC communication Port ( generally RS-232 ). Since a standard PC can't support RS-485 port, a network adaptor ( such as SNA10A, SNA10B ) has to be used to convert RS-485 to RS-232 for a PC if RS-485 is required for the data communication. But there is no need to be sad. Many RS-485 units ( up to 247 units ) can be connected to one RS-232 port, therefore a PC with 4 comm ports can communicate with 988 units. It is quite economic.

### Setup

Enters the setup menu.

Select RTU for COMM . Set individual address as for those units which are connected to the same port.

Set the Baud Rate ( BAUD ), Data Bit ( DATA ), Parity Bit ( PARI ) and Stop Bit ( STOP ) such that these values are accordant with PC setup conditions.

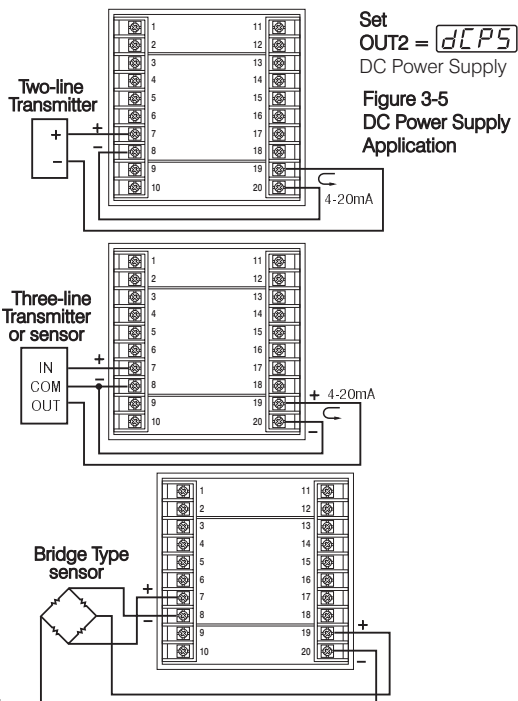
If you use a conventional 9-pin RS-232 cable instead of CC94-1, the cable should be modified for proper operation of RS-232 communication according to Section 2-9.

## 3-8 PV Retransmission

The controller can output (retransmit) process value via its retransmission terminals RE+ and RE- provided that the retransmission option is ordered. A correct signal type should be selected for COMM parameter to meet the retransmission option installed. AOLO and AOHI are adjusted to specify the low scale and high scale values of retransmission.

### 3-9 Signal Conditioner DC Power Supply

Three types of isolated DC power supply are available to supply an external transmitter or sensor. These are 20V rated at 25mA, 12V rated at 40 mA and 5V rated at 80 mA. The DC voltage is delivered to the output 2 terminals by selecting DCPS for OUT2 in setup menu.



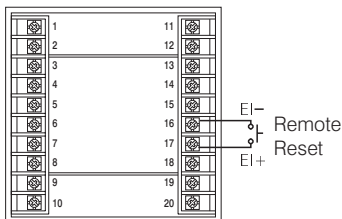
#### Caution:

Don't use the DC power supply beyond its rating current to avoid damage.

Purchase a correct voltage to suit your external devices. See ordering code in section 1-2.

### 3-10 Remote Reset

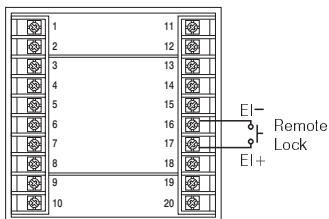
If REST is selected for EIFN, terminals 16 & 17 will act as remote reset input. Pressing remote reset button will perform the same function as pressing the RESET key. Refer to **section 1-4** for RESET key function.



**Figure 3-6 Remote Reset Application**

### 3-11 Remote Lock

If LOCK is selected for EIFN, terminals 16 & 17 will act as remote lock input. Turning the remote lock switch on will keep all the parameter setting from been changed. If the switch is opened the lock indicator is extinguished and the up/down key is enabled.



**Setup**  
**EIFN = LOCK**

**Figure 3-7 Remote Lock Application**

### 3-12 Limit Annunciator

If L\_AN (Limit annunciator) is selected for OUT2, the output 2 will act as a Limit Annunciator. If the limit is or has been reached and the RESET key (or remote reset contacts) has not been pressed since the limit was reached, then the limit annunciator output will be energized and the OP2 indicator will be lit and remain unchanged until the RESET key or remote reset input is applied.

### 3-13 Reference Data

There are three reference data contained in setup menu. The reference data are read only data. The maximum historical PV, displayed by *PV.HI*, which shows the maximum process value since the last UNLOCK operation. The minimum historical PV, displayed by *PV.LO*, which shows the minimum process value since the last UNLOCK operation. The abnormal time, displayed by *T.ABN*, which shows the total accumulated time (minutes) during the process has been in abnormal condition since the last UNLOCK operation.

The values of reference data will be initiated as soon as the RESET key is pressed for 4 seconds (UNLOCK operation). After UNLOCK operation, the PV.HI and PV.LO values will start from the current process value and T.ABN value will start from zero.

## Chapter 4 Application

An oven uses a single phase heater to heat the process. A single loop temperature control C91 is used to regulate the temperature. A limit control L41 is used to protect the process from being over heated. The wiring diagram is shown below.

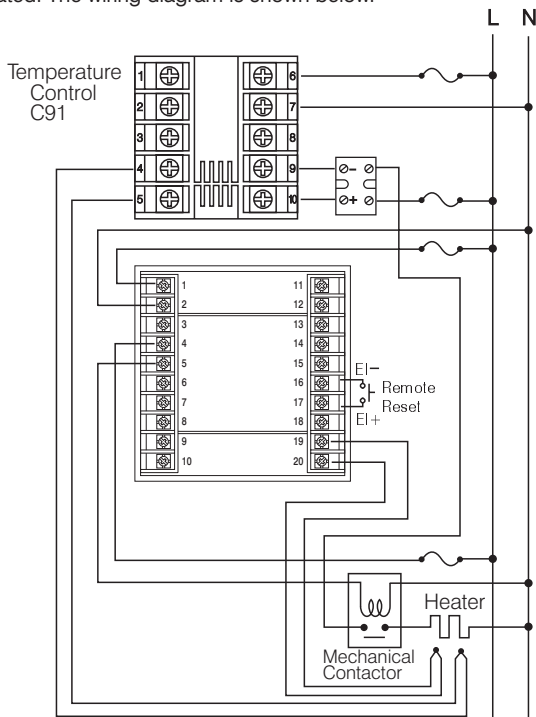


Figure 4-1 Over Temperature Protection with Remote Reset

## Chapter 5 Calibration



Do not proceed through this section unless there is a definite need to re-calibrate the controller. Otherwise, all previous calibration data will be lost. Do not attempt re-calibration unless you have appropriate calibration equipment. If calibration data is lost, you will need to return the unit to your supplier who may charge you a service fee to re-calibrate the unit.



Entering calibration mode will break the control loop. Make sure that if the system is allowable to apply calibration mode.

Equipments needed for calibration:

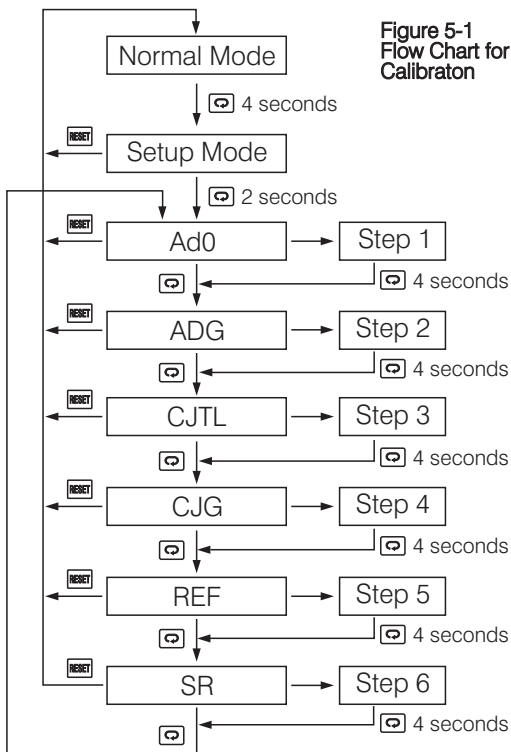
- (1) A high accuracy calibrator ( Fluke 5520A Calibrator recommended ) with following function:
  - 0 - 100 mV millivolt source with  $\pm 0.005$  % accuracy
  - 0 - 10 V voltage source with  $\pm 0.005$  % accuracy
  - 0 - 20 mA current source with  $\pm 0.005$  % accuracy
  - 0 - 300 ohm resistant source with  $\pm 0.005$  % accuracy
- (2) A test chamber providing 25 °C - 50 °C temperature range
- (3) A switching network ( SCANNER 80, optional for automatic calibration )
- (4) A calibration fixture equipped with programming units ( optional for automatic calibration )
- (5) A PC with calibration software BC-Net and Smart Network Adaptor SNA10B ( optional for automatic calibration )

Since each unit needs 30 minutes to warm up before calibration, calibrating one unit each is inefficient. An automatic calibration system for small quantity well as for unlimited quantity is available upon request.

The calibration procedures described in the following are a step by step manual procedures.

Apply Enter Key ( press  for 6 seconds ) to enter the calibration mode. see figure 5-1.

**Figure 5-1**  
Flow Chart for Manual  
Calibration



Step1: Calibrate **Zero** of A to D converter.

Short terminal 4 and 5, then press  for at least 4 seconds.

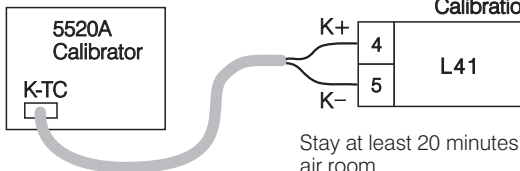
The display will blink a moment. If the display didn't blink, then the calibration fails.

Step 2: Calibrate **Gain** of A to D converter.

Send a span signal to terminal 4 and 5 with correct polarity. The span signal is 60 mV for thermocouple input, 1V for 0-1V input, 10V for 0-10V input and 20mA for 0-20 mA input. Press  for at least 4 seconds. The display will blink a moment. If the display didn't blink, then the calibration fails.

Step 3: Calibrate **offset** of cold junction.

Setup the equipment according to the following diagram for calibrating the cold junction compensation. Note that a K type thermocouple must be used.



**Figure 5-2**  
**Cold Junction**  
**Calibration Setup**

Stay at least 20 minutes in still-air room  
room temperature  $25 \pm 3^{\circ}\text{C}$

The 5520A calibrator is configured as K type thermocouple output with internal compensation. Send a  $0.00^{\circ}\text{C}$  signal to the unit under calibration.

The unit under calibration is powered in a still-air room with temperature  **$25 \pm 3^{\circ}\text{C}$** . Stay at least 20 minutes for warming up.

Press  for at least 4 seconds. The display will blink a moment. If the display didn't blink, then the calibration fails.



| Input Function   | R62  |
|------------------|------|
| T/C, RTD, 0~60mV | 300K |
| 0 ~ 1 V          | 28K  |
| 0 ~ 5V, 1 ~ 5V   | 150K |
| 0 ~ 10 V         | 300K |

2. Perform **Step 1** to calibrate the linear input zero.
3. Perform **Step 2** but send a span signal to the input terminals instead of 60mV. The span signal is 1V for 0~1V input, 5V for 0~5V or 1~5V input, 10V for 0~10V input and 20mA for 0~20mA or 4~20mA input.

# Chapter 6 Specifications

## Power

90-250 VAC, 47-63 Hz, 10 VA, 5W maximum

11-26 VAC/VDC, SELV, Limited Energy, 10 VA, 5W maximum

## Input

**Resolution:** 18 bits

**Sampling:** 5 times/second

**Maximum Rating:** -2 VDC minimum, 12 VDC maximum  
(1 minute for mA input)

**Temperature Effect:**  $\pm 1.5 \mu\text{V} / ^\circ\text{C}$

**Sensor Lead Resistance Effect:**

T/C:  $0.2 \mu\text{V}/\text{ohm}$

3-wire RTD:  $2.6 ^\circ\text{C}/\text{ohm}$  of resistance difference of two leads

2-wire RTD:  $2.6 ^\circ\text{C}/\text{ohm}$  of resistance sum of two leads

**Burn-out Current:** 200nA

**Common Mode Rejection Ratio (CMRR):** 120db

**Sensor Break Detection:**

Sensor open for TC, RTD and mV inputs,  
below 1 mA for 4-20 mA input,  
below 0.25V for 1-5 V input,  
unavailable for other inputs.

**Sensor Break Responding Time:**

Within 4 seconds for TC, RTD and mA inputs,  
0.1 second for 4-20 mA and 1-5V inputs.

## Characteristics:

| Type           | Range                            | Accuracy<br>@ 25 °C     | Input<br>Impedance |
|----------------|----------------------------------|-------------------------|--------------------|
| J              | -120°C-1000°C<br>(-184°F-1832°F) | ±2 °C                   | 2.2 MΩ             |
| K              | -200°C-1370°C<br>(-328°F-2498°F) | ±2 °C                   | 2.2 MΩ             |
| T              | -250°C-400°C<br>(-418°F-752 °F)  | ±2 °C                   | 2.2 MΩ             |
| E              | -100°C-900°C<br>(-148°F-1652°F)  | ±2 °C                   | 2.2 MΩ             |
| B              | 0°C-1820°C<br>(-32°F-3308°F)     | ±2 °C<br>(200°C-1820°C) | 2.2 MΩ             |
| R              | 0°C-1767.8°C<br>(-32°F-3214°F)   | ±2 °C                   | 2.2 MΩ             |
| S              | 0°C-1767.8°C<br>(-32°F-3214°F)   | ±2 °C                   | 2.2 MΩ             |
| N              | -250°C-1300°C<br>(-418°F-2372°F) | ±2 °C                   | 2.2 MΩ             |
| L              | -200°C-900°C<br>(-328°F-1652°F)  | ±2 °C                   | 2.2 MΩ             |
| C              | 0°C-2315°C<br>(32°F-4199°F)      | ±2 °C                   | 2.2 MΩ             |
| P              | 0°C-1395°C<br>(32°F-2543°F)      | ±2 °C                   | 2.2 MΩ             |
| PT100<br>(DIN) | -210°C-700°C<br>(-346°F-1292°F)  | ±0.4 °C                 | 1.3 KΩ             |
| PT100<br>(JIS) | -200°C-600°C<br>(-328°F-1112°F)  | ±0.4 °C                 | 1.3 KΩ             |
| mV             | -8mV-70mV                        | ±0.05 %                 | 2.2 MΩ             |
| mA             | -3mA-27mA                        | ±0.05 %                 | 70.5 Ω             |
| V              | -1.3V-11.5V                      | ±0.05 %                 | 302 KΩ             |

Table 6-1 Input Characteristics

## Event Input

**Logic Low:** -10V minimum, 0.8V maximum.

**Logic High:** 2V minimum, 10V maximum.

**Functions:** Remote reset, remote lockout.

## Output 1 / Output 2

**Relay Rating:** 2A/240 VAC, life cycles 200,000 for resistive load.

**Pulsed Voltage:** Source Voltage 5V, current limiting resistance 66 ohms.

## Triac (SSR) Output

**Rating:** 1A/240 VAC

**Inrush Current:** 20A for 1 cycle

**Min. Load Current:** 50 mA rms

**Max. Off-state Leakage:** 3 mA rms

**Max. On-state Voltage:** 1.5 V rms

**Insulation Resistance:** 1000 Mohms min. at 500 VDC

**Dielectric Strength:** 2500 VAC for 1 minute

## DC Voltage Supply Characteristics ( Installed at Output 2 )

| Type | Tolerance    | Max. Output Current | Ripple Voltage | Isolation Barrier |
|------|--------------|---------------------|----------------|-------------------|
| 20 V | $\pm 1$ V    | 25 mA               | 0.2 Vp-p       | 500 VAC           |
| 12 V | $\pm 0.6$ V  | 40 mA               | 0.1 Vp-p       | 500 VAC           |
| 5 V  | $\pm 0.25$ V | 80 mA               | 0.05 Vp-p      | 500 VAC           |

## Data Communication

**Interface :** RS-232 (1 unit), RS-485 ( up to 247 units )

**Protocol :** Modbus Protocol RTU mode

**Address :** 1 - 247

**Baud Rate :** 0.3 ~ 38.4 Kbits/sec

**Data Bits :** 8 bits

**Parity Bit :** None, Even or Odd

**Stop Bit :** 1 or 2 bits

**Communication Buffer :** 50 bytes

## Analog Retransmission

**Output Signal :** 4-20 mA, 0-20 mA, 0 - 5V,  
1 - 5V, 0 - 10V

**Resolution :** 15 bits

**Accuracy :**  $\pm 0.05$  % of span  $\pm 0.0025$  %/ °C

**Load Resistance :**

0 - 500 ohms ( for current output )

10 K ohms minimum ( for voltage output )

**Output Regulation :** 0.01 % for full load change

**Output Settling Time :** 0.1 sec. (stable to 99.9 % )

**Isolation Breakdown Voltage :** 1000 VAC min.

**Integral Linearity Error :**  $\pm 0.005$  % of span

**Temperature Effect :**  $\pm 0.0025$  % of span/ °C

**Saturation Low :** 0 mA ( or 0V )

**Saturation High :** 22.2 mA ( or 5.55V, 11.1V min. )

**Linear Output Range :** 0-22.2mA(0-20mA or 4-20mA)

0-5.55V ( 0 - 5V, 1 - 5V )

0 - 11.1 V ( 0 - 10V )

## User Interface

**Dual 4-digit LED Displays**

**keypad:** 4 keys

**Programming Port:** For automatic setup, calibration and testing.

**Communication Port:** Connection to PC for supervisory control.

**Limit Control:** High Limit, Low limit and High/Low Limit  
programmable

## Digital Filter

**Function:** First order

**Time Constant:** 0, 0.2, 0.5, 1, 2, 5, 10, 20, 30, 60 seconds  
programmable

## Environmental & Physical

Operating Temperature : -10 °C to 50 °C

Storage Temperature : -40 °C to 60 °C

Humidity : 0 to 90 % RH ( non-condensing )

Altitude: 2000 m maximum

Pollution: Degree 2

Insulation Resistance : 20 Mohms min. ( at 500 VDC )

Dielectric Strength : 2000 VAC, 50/60 Hz for 1 minute

Vibration Resistance : 10 - 55 Hz, 10 m/s<sup>2</sup> for 2 hours

Shock Resistance : 200 m/s<sup>2</sup> ( 20 g )

Moldings : Flame retardant polycarbonate

Dimensions: 96 mm(W) X 96 mm(H) X 65 mm(D),  
53 mm depth behind panel

Weight : 250 grams

## Approval Standards

Safety : FM Class 3545 (Oct. 1998)

UL61010C-1

CSA C22.2 No. 24-93

EN61010-1 ( IEC1010-1 )

Protective Class :

IIP65 for panel with additional option

IP50 for panel without additional option

IP20 for terminals and housing with protective cover.

All indoor use.

EMC EN61326

# Chapter 7 Modbus Communications

This chapter specifies the Modbus Communications protocol as RS-232 or RS-485 interface module is installed. Only RTU mode is supported. Data is transmitted as eight-bit binary bytes with 1 start bit, 1 stop bit and optional parity checking (None, Even or Odd). Baud rate may be set to 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 28800 and 38400.

## 7-1 Functions Supported

Only function 03, 06 and 16 are available for this series of controllers. The message formats for each function are described as follows:

### Function 03: Read Holding Registers

| Query ( from master )                              | Response ( from slave ) |
|----------------------------------------------------|-------------------------|
| Slave address (0-255)                              | ←                       |
| Function code (3)                                  | ←                       |
| Starting address of register Hi (0)                | Byte count              |
| Starting address of register Lo (0-61,<br>128-143) | Data 1 Hi               |
|                                                    | Data 1 Lo               |
| No. of words Hi (0)                                | Data 2 Hi               |
| No. of words Lo (1-22)                             | Data 2 Lo               |
| CRC16 Hi                                           | ⋮                       |
| CRC16 Lo                                           | ⋮                       |
|                                                    | CRC16 Hi                |
|                                                    | CRC16 Lo                |

### Function 06: Preset single Register

| Query ( from master )               | Response ( from slave ) |
|-------------------------------------|-------------------------|
| Slave address (0-255)               | ←                       |
| Function code (6)                   | ←                       |
| Register address Hi (0)             | ←                       |
| Register address Lo (0-61, 128-143) | ←                       |
| Data Hi                             | ←                       |
| Data Lo                             | ←                       |
| CRC16 Hi                            | ←                       |
| CRC16 Lo                            | ←                       |

## Function 16: Preset Multiple Registers

| Query ( from master )                              | Response ( from slave ) |
|----------------------------------------------------|-------------------------|
| Slave address (0-255)                              | ←                       |
| Function code (16)                                 | ←                       |
| Starting address of register Hi (0)                | ←                       |
| Starting address of register Lo (0-61,<br>128-143) | ←                       |
| No. of words Hi (0)                                | ←                       |
| No. of words Lo (1-18)                             | ←                       |
| Byte count (2-36)                                  | CRC16 Hi                |
| Data 1 Hi                                          | CRC16 Lo                |
| Data 1 Lo                                          |                         |
| Data 2 Hi                                          |                         |
| Data 2 Lo                                          |                         |
| •                                                  |                         |
| •                                                  |                         |
| •                                                  |                         |
| •                                                  |                         |
| CRC16 Hi                                           |                         |
| CRC16 Lo                                           |                         |

## 7-2 Exception Responses

If the controller receives a message which contains a corrupted character (parity check error, framing error etc.), or if the CRC16 check fails, the controller ignores the message.

However, if the controller receives a syntactically correct message which contains an illegal value, it will send an exception response, consisting of five bytes as follows:

slave address + offset function code + exception code + CRC16 Hi + CRC16 Lo

Where the offset function code is obtained by adding the function code with 128 (ie. function 3 becomes H'83), and the exception code is equal to the value contained in the following table:

| Exception Code | Name                 | Cause                                                                     |
|----------------|----------------------|---------------------------------------------------------------------------|
| 1              | Bad function code    | Function code is not supported by the controller                          |
| 2              | Illegal data address | Register address out of range                                             |
| 3              | Illegal data value   | Data value out of range or attempt to write a read-only or protected data |

## 7-3 Parameter Table

| Register Address | Parameter Notation | Parameter                                  | Scale Low | Scale High | Notes |
|------------------|--------------------|--------------------------------------------|-----------|------------|-------|
| 0                |                    | Reserved                                   |           |            |       |
| 1                | HSP1               | High limit set point 1                     | *1        | *1         | R/W   |
| 2                | LSP1               | Low limit set point 1                      | *1        | *1         | R/W   |
| 3                | SP2                | Set point 2 value for output 2             | *1        | *1         | R/W   |
| 4                |                    | Reserved                                   |           |            |       |
| 5                |                    | Reserved                                   |           |            |       |
| 6                | PV.HI              | Historical max. value of PV                | *1        | *1         | R     |
| 7                | PV.LO              | Historical min. value of PV                | *1        | *1         | R     |
| 8                |                    | Reserved                                   |           |            |       |
| 9                | INPT               | Input type selection                       | 0         | 65535      | R/W   |
| 10               | UNIT               | Process unit                               | 0         | 65535      | R/W   |
| 11               | RESO               | Display resolution                         | 0         | 65535      | R/W   |
| 12               | IN.LO              | Low scale value for linear input           | *1        | *1         | R/W   |
| 13               | IN.HI              | High scale value for linear input          | *1        | *1         | R/W   |
| 14               | SHIF               | PV shift (offset) value                    | *1        | *1         | R/W   |
| 15               | FILT               | PV filter time constant                    | 0         | 65535      | R/W   |
| 16               | T.ABN              | Accumulated time during abnormal condition | 0         | 6553.5     | R     |
| 17               | OUT1               | Output 1 function                          | 0         | 65535      | R/W   |
| 18               |                    | Reserved                                   |           |            |       |
| 19               |                    | Reserved                                   |           |            |       |
| 20               | O1.HY              | Output 1 hysteresis value                  | *2        | *2         | R/W   |
| 21               |                    | Reserved                                   |           |            |       |
| 22               |                    | Reserved                                   |           |            |       |
| 23               |                    | Reserved                                   |           |            |       |
| 24               |                    | Reserved                                   |           |            |       |
| 25               |                    | Reserved                                   |           |            |       |
| 26               |                    | Reserved                                   |           |            |       |
| 27               |                    | Reserved                                   |           |            |       |
| 28               | HSPL               | Lower limit of HSP1                        | *1        | *1         | R/W   |
| 29               | HSP.H              | Upper limit of HSP1                        | *1        | *1         | R/W   |

| Register Address | Parameter Notation | Parameter                                  | Scale Low | Scale High | Notes |
|------------------|--------------------|--------------------------------------------|-----------|------------|-------|
| 30               | LSPL               | Lower limit of LSP1                        | *1        | *1         | R/W   |
| 31               | LSPH               | Upper limit of LSP1                        | *1        | *1         | R/W   |
| 32               |                    | Reserved                                   |           |            |       |
| 33               |                    | Reserved                                   |           |            |       |
| 34               | AOFN               | Analog output function                     | 0         | 65535      | R/W   |
| 35               | OUT2               | Output 2 function                          | 0         | 65535      | R/W   |
| 36               |                    | Reserved                                   |           |            |       |
| 37               |                    | Reserved                                   |           |            |       |
| 38               |                    | Reserved                                   |           |            |       |
| 39               | COMM               | Communication function                     | 0         | 65535      | R/W   |
| 40               | ADDR               | Address                                    | 0         | 65535      | R/W   |
| 41               | BAUD               | Baud rate                                  | 0         | 65535      | R/W   |
| 42               | PARI               | Parity bit                                 | 0         | 65535      | R/W   |
| 43               | AOLO               | Analog output scale low                    | *1        | *1         | R/W   |
| 44               | AL.FN              | Alarm function                             | 0         | 65535      | R/W   |
| 45               | AL.MD              | Alarm mode                                 | 0         | 65535      | R/W   |
| 46               | AL.HY              | Alarm hysteresis value                     | *2        | *2         | R/W   |
| 47               | AL.FT              | Alarm failure transfer                     | 0         | 65535      | R/W   |
| 48               | EIFN               | Event input function                       | 0         | 65535      | R/W   |
| 49               | DISP               | Normal display format                      | 0         | 65535      | R/W   |
| 50               | AOHI               | Analog output scale high                   | *1        | *1         | R/W   |
| 51               | AD0                | mV calibration low coefficient             | -1999.9   | 4553.6     | R/W   |
| 52               | ADG                | mV calibration high coefficient            | -1999.9   | 4553.6     | R/W   |
| 53               | CJTL               | Cold junction calibration low coefficient  | -199.99   | 455.36     | R/W   |
| 54               | CJG                | Cold junction calibration high coefficient | -1999.9   | 4553.6     | R/W   |
| 55               | REF                | RTD calibration low coefficient            | -1999.9   | 4553.6     | R/W   |
| 56               | SR                 | RTD calibration high coefficient           | -1999.9   | 4553.6     | R/W   |
| 57               |                    | Reserved                                   |           |            |       |
| 58               | DATE               | Manufacturing date of the product          | 0         | 65535      | R/W   |
| 59               | NO                 | Serial number of the product               | 0         | 65535      | R/W   |
| 60               | HOUR               | Working hours of the product               | 0         | 65535      | R/W   |
| 61               | HRLO               | Fractional value of hour                   | 0         | 65535      | R/W   |

| Register Address | Parameter Notation | Parameter                                  | Scale Low | Scale High | Notes |
|------------------|--------------------|--------------------------------------------|-----------|------------|-------|
| 128              | PV                 | Process value                              | *1        | *1         | R     |
| 129              | HSP1               | High limit set point 1                     | *1        | *1         | R     |
| 130              | LSP1               | Low limit set point 1                      | *1        | *1         | R     |
| 131              | TABN               | Accumulated time during abnormal condition | 0         | 6553.5     | R     |
| 132              | ALM                | Output 1 status *4                         | 0         | 65535      | R     |
| 140              | PROG               | Program code *3                            | 0.00      | 655.35     | R     |
| 142              | CMND               | Command code                               | 0         | 65535      | R/W   |
| 143              | JOB                | Job code                                   | 0         | 65535      | R/W   |

\*1: The scale high/low values are defined in the following table for the parameters HSP1, LSP1, SP2, PV.HI, PV.LO, IN.LO, IN.HI, SHIF, HSP.L, HSP.H, LSP.L, LSP.H, PV, AOLO and AOHI:

| Conditions | Non-linear input | Linear input<br>RESO = 0 | Linear input<br>RESO = 1 | Linear input<br>RESO = 2 | Linear input<br>RESO = 3 |
|------------|------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Scale low  | -1999.9          | -19999                   | -1999.9                  | -199.99                  | -19.999                  |
| Scale high | 4553.6           | 45536                    | 4553.6                   | 455.36                   | 45.536                   |

\*2: The scale high/low values are defined in the following table for the parameters O1.HY and AL.HY :

| Conditions | Non-linear input | Linear input<br>RESO = 0 | Linear input<br>RESO = 1 | Linear input<br>RESO = 2 | Linear input<br>RESO = 3 |
|------------|------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Scale low  | 0.0              | 0                        | 0.0                      | 0.00                     | 0.000                    |
| Scale high | 6553.5           | 65535                    | 6553.5                   | 655.35                   | 65.535                   |

\*3: The PROG code is defined by 5.XX, where XX denotes the software version number. For example : PROG=5.10 means the product is L41 with software version 10.

\*4: The least significant bit (LSB) of ALM shows the status of output 1. LSB=1 if output 1 is ON (normal condition). The second bit of ALM shows the status of output2.

## 7-4 Data Conversion

The word data are regarded as unsigned ( positive ) data in the Modbus message. However, the actual value of the parameter may be negative value with decimal point. The high/low scale values for each parameter are used for the purpose of such conversion.

Let M = Value of Modbus message  
A = Actual value of the parameter  
SL = Scale low value of the parameter  
SH = Scale high value of the parameter

The conversion formulas are as follows:

$$M = \frac{65535}{SH-SL} \cdot (A - SL)$$

$$A = \frac{SH-SL}{65535} \cdot M + SL$$

## 7-5 Communication Examples :

### Example 1: Down load the default values via the programming port

The programming port can perform Modbus communications regardless of the incorrect setup values of address, baud, parity, stop bit etc. It is especially useful during the first time configuration for the controller. The host must be set with 9600 baud rate, 8 data bits, even parity and 1 stop bit.

The Modbus message frame with hexadecimal values is shown as follows:

### (1) Unlock the controller

|       |       |            |    |            |    |       |    |
|-------|-------|------------|----|------------|----|-------|----|
|       | 06    | 00         | 8E | 68         | 2C | HI    | LO |
| Addr. | Func. | Reg. Addr. |    | CMND=26668 |    | CRC16 |    |

### (2) Preset the first group of the parameters

|       |       |                |    |              |    |       |        |    |        |    |
|-------|-------|----------------|----|--------------|----|-------|--------|----|--------|----|
|       | 10    | 00             | 09 | 00           | 07 | 0E    | 00     | 01 | 00     | 00 |
| Addr. | Func. | Starting Addr. |    | No. of words |    | Bytes | INPT=1 |    | UNIT=0 |    |

|        |    |         |    |             |    |          |    |        |    |       |    |
|--------|----|---------|----|-------------|----|----------|----|--------|----|-------|----|
| 00     | 01 | 4E      | 1F | 52          | 07 | 4E       | 1F | 00     | 02 | HI    | LO |
| RESO=1 |    | IN.LO=0 |    | IN.HI=100.0 |    | SHIF=0.0 |    | FILT=2 |    | CRC16 |    |

### (3) Preset the second group of the parameters

|       |       |                |    |              |    |       |            |    |          |    |          |    |       |    |
|-------|-------|----------------|----|--------------|----|-------|------------|----|----------|----|----------|----|-------|----|
|       | 10    | 00             | 01 | 00           | 03 | 06    | 52         | 07 | 4E       | 1F | 51       | A3 | HI    | LO |
| Addr. | Func. | Starting Addr. |    | No. of words |    | Bytes | HSP1=100.0 |    | LSP1=0.0 |    | SP2=90.0 |    | CRC16 |    |

### (4) Preset the third group of the parameters

|       |       |                |    |              |    |       |        |    |          |    |          |    |           |    |
|-------|-------|----------------|----|--------------|----|-------|--------|----|----------|----|----------|----|-----------|----|
|       | 10    | 00             | 11 | 00           | 13 | 26    | 00     | 02 | 00       | 00 | 00       | 00 | 00        | 01 |
| Addr. | Func. | Starting Addr. |    | No. of words |    | Bytes | OUT1=2 |    | Reserved |    | Reserved |    | O1.HY=0.1 |    |

|          |    |          |    |          |    |          |    |          |    |          |    |          |    |        |
|----------|----|----------|----|----------|----|----------|----|----------|----|----------|----|----------|----|--------|
| 00       | 00 | 00       | 00 | 00       | 00 | 00       | 00 | 00       | 00 | 00       | 00 | 00       | 00 | 00     |
| Reserved |    | Reserved |    | Reserved |    | Reserved |    | Reserved |    | Reserved |    | Reserved |    | HSPL=0 |

|             |    |             |    |        |    |          |    |          |    |        |    |        |    |       |    |
|-------------|----|-------------|----|--------|----|----------|----|----------|----|--------|----|--------|----|-------|----|
| 75          | 2F | 4A          | 37 | 4E     | 1F | 00       | 00 | 00       | 00 | 00     | 00 | 00     | 02 | HI    | LO |
| HSPH=1000.0 |    | LSPL=-100.0 |    | LSPH=0 |    | Reserved |    | Reserved |    | AOFN=0 |    | OUT2=2 |    | CRC16 |    |

### (5) Preset the rest parameters

|       |       |                |    |              |    |       |        |    |        |    |        |    |        |    |
|-------|-------|----------------|----|--------------|----|-------|--------|----|--------|----|--------|----|--------|----|
|       | 10    | 00             | 27 | 00           | 0C | 18    | 00     | 01 | 00     | 01 | 00     | 05 | 00     | 00 |
| Addr. | Func. | Starting Addr. |    | No. of words |    | Bytes | COMM=1 |    | ADDR=1 |    | BAUD=5 |    | PARI=0 |    |

|        |    |         |    |         |    |           |    |         |    |        |    |        |    |    |
|--------|----|---------|----|---------|----|-----------|----|---------|----|--------|----|--------|----|----|
| 4E     | 1F | 00      | 06 | 00      | 00 | 00        | 01 | 00      | 01 | 00     | 00 | 00     | 00 | 00 |
| AOLO=0 |    | AL.FN=6 |    | AL.MD=0 |    | AL.HY=0.1 |    | AL.FT=1 |    | EIFN=0 |    | DISP=0 |    |    |

|            |    |       |    |
|------------|----|-------|----|
| 52         | 07 | HI    | LO |
| AOHI=100.0 |    | CRC16 |    |

### Example 2: Read the process value (PV)

Send the following message to the controller via the COMM port or the programming port :

Query

|       |       |                |              |    |       |    |    |
|-------|-------|----------------|--------------|----|-------|----|----|
|       | 03    | 00             | 80           | 00 | 01    | HI | LO |
| Addr. | Func. | Starting Addr. | No. of words |    | CRC16 |    |    |

### Example 3: Perform reset function ( same effect as pressing key ):

Query

|       |       |                |              |    |       |    |    |
|-------|-------|----------------|--------------|----|-------|----|----|
|       | 06    | 00             | 8E           | 68 | 25    | HI | LO |
| Addr. | Func. | Starting Addr. | CMND = 26661 |    | CRC16 |    |    |

### Example 4: Read 22 parameters at most one time

Query

|       |       |                |              |    |       |    |    |
|-------|-------|----------------|--------------|----|-------|----|----|
|       | 03    |                |              | 00 | 16    | HI | LO |
| Addr. | Func. | Starting Addr. | No. of words |    | CRC16 |    |    |

### Example 5: Modify the calibration coefficient

Preset the CMND register with 26665 before attempting to change the calibration coefficient.

|       |       |                |              |    |       |    |    |
|-------|-------|----------------|--------------|----|-------|----|----|
|       | 06    | 00             | 8E           | 68 | 29    | HI | LO |
| Addr. | Func. | Register Addr. | CMND = 26665 |    | CRC16 |    |    |

**Table A.1 Error Codes and Corrective Actions**

| Error Code | Display Symbol | Error Description                                                                                                          | Corrective Action                                                     |
|------------|----------------|----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| 10         | <i>Er 10</i>   | Communication error: bad function code                                                                                     | Correct the communication software to meet the protocol requirements. |
| 11         | <i>Er 11</i>   | Communication error: register address out of range                                                                         | Don't issue an over-range register address to the slave.              |
| 14         | <i>Er 14</i>   | Communication error: attempt to write a read-only data or a protected data                                                 | Don't write a read-only data or a protected data to the slave.        |
| 15         | <i>Er 15</i>   | Communication error: write a value which is out of range to a register                                                     | Don't write an over-range data to the slave register.                 |
| 39         | <i>SEnb</i>    | Input sensor break, or input current below 1 mA if 4-20 mA is selected, or input voltage below 0.25V if 1 - 5V is selected | Replace input sensor.                                                 |
| 40         | <i>AdEr</i>    | A to D converter or related component(s) malfunction                                                                       | Return to factory for repair.                                         |

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