# 2002 - ALM
# DUAL TRIP AMPLIFIER

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# 1.0 INTRODUCTION

The 2002-ALM range is a family of configurable trip amplifiers capable of accepting a wide variety of electrical input types and providing two trip action relay outputs.

The family comprises three different products each accepting an input from a different type of sensor. Input signal, trip configuration and power supply information are required to define any unit exactly. This information, together with a unique serial number is printed on the side label of each unit; records of the exact configuration of every product shipped are maintained at the factory.

## 1.1 Input Types And Ranges:

1.1.1 IIR 2002-ALM-HL

Accepts either DC voltage or current (i.e. high level) inputs.

In general the limits on signals that can be handled with the accuracy specified in section 8 are:

| FULL SCALE INPUT | MIN | MAX | MIN SPAN | NOTES |
|---|---|---|---|---|
| DC CURRENT | 50μA | 10A | 50% FULL SCALE | MAX VOLTAGE DROP = 0.33V |
| DC VOLTAGE | 100mV | 300V | 50% FULL SCALE | 10K ohm ≤ R in ≤ 10M ohm<br>USE 2002-TC FOR Vin<100mV |

All the standard process ranges such as 0-10mA, 4-20mA, 0-20mA, 1-5V and 0-10V are of course covered.

1.1.1.1 Reconfigurable input option

A user reconfigurable version of the product can be specified, covering 0-20mA, 4-20mA and 0-10V inputs (see section 5).

1.1.2 IIR 2002-ALM-TC

Accepts inputs directly from the following thermocouple types: J, K, N, T, R, B, E, U, L and S. Alternatively a mV input may be specified.

All specified ranges are zero referred - i.e. 0°F, 0°C or 0mV, although negative inputs will not damage the unit. Automatic cold junction compensation will be fitted to thermocouple units, for which either upscale or downscale drive on break detection are link selectable (see section 4) - factory default setting is upscale. The process signal is not linearised. For standard thermocouples the operating range will be specified in °C or °F, as required.

In general, the limits on signals that can be handled with the accuracy specified in section 8 are:

| FULL SCALE INPUT | MIN | MAX | NOTES |
|---|---|---|---|
| mV | 4mV | 100mV | |
| J (L) | 80°C | 1200°C | |
| K | 100°C | 1372°C | |
| T (u) | 95°C | 400°C | |
| E | 65°C | 1000°C | |
| N | 150°C | 1300°C | |
| R | 460°C | 1768°C | |
| S | 480°C | 1760°C | |
| B | 910°C | 1820°C | COLD JUNCTION COMPENSATION WILL NOT BE FITTED |

1.1.2.1 Reconfigurable input option.

A user reconfigurable version of the product can be specified covering any 4 thermocouple type / range combinations (see section 5). Note: all ranges must be in the same units (e.g. °C).

1.1.3 IIR 2002-ALM-RTD

Accepts inputs from resistance thermometers such as the PT100 type in 2 or 3 wire configuration. Additionally 2 wire potentiometers less than 1K ohm can be accommodated.

In general the measured resistance can be anywhere between zero and 1Kohm and standard curves such as PT100 can be linearised. The minimum span must be 10 ohm for the accuracy specified in section 8, which corresponds to roughly 30°C for a PT100 sensor. For standard RTD sensor types, the operating range will be specified in °C and the process signal will be linearised; otherwise the range will be specified in ohms without linearisation. 2 or 3 wire connection is link selectable (see section 4) - factory default setting is 3 wire. Downscale drive on wire break detection is standard - upscale drive can be specially requested from the factory but is only possible with a 2 wire connection.

1.1.3.1 Reconfigurable input option

A user reconfigurable version of the product can be specified covering any 4 RTD / resistance combinations (see section 5).

**1.2 Description of operation**

The input stage of the 2002 ALM produces an internal process signal of 0 - 1V DC corresponding to the input span. This signal can be measured between terminals 12 and 9 of the HL unit and may be available for the TC and RTD units, dependent on configuration (see section 4).

The trip set point potentiometers produce set point signals of 0 - 1V DC corresponding to the input span. These signals can be measured between terminal 12 and the relevant front panel brass terminal.

Internal circuitry compares the process signal with each of the set point levels and changes the state of the output relays and indicator LED's as the signal passes through the set point, the exact action being factory or user configurable (see section 4).

A hysteresis band (typically 1% of span unless specifically requested) below each set point ensures chatter-free trip operation.

A block schematic diagram of the 2002-ALM is shown in Figure 1.

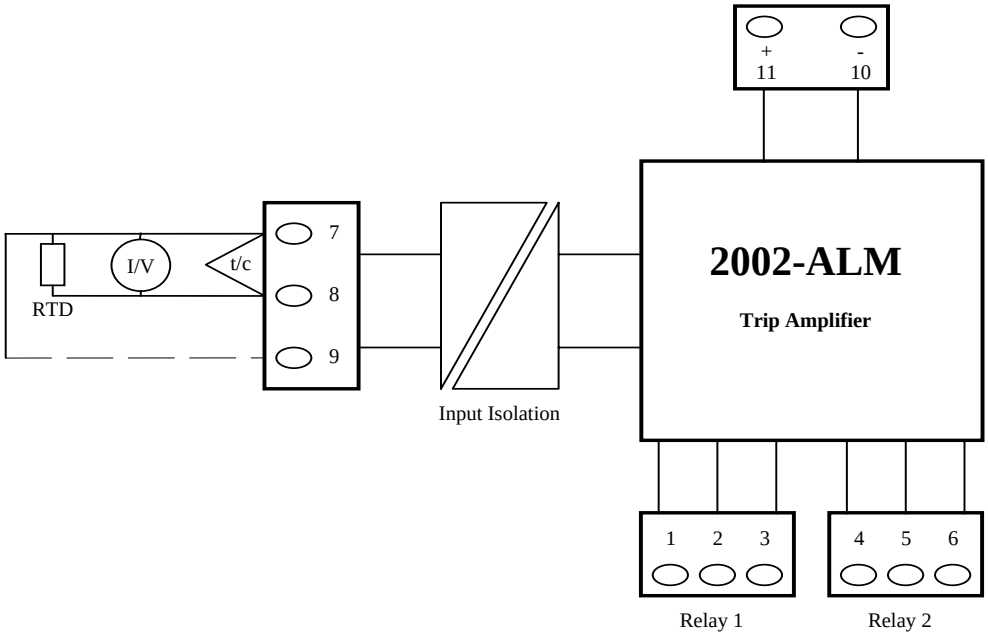


FIG. 1 - BLOCK SCHEMATIC DIAGRAM FOR THE IIR-2002-ALM TRIP AMPLIFIER

## 2.0 UNPACKING

Please inspect the instrument carefully for signs of shipping damage. The unit is packaged to give maximum protection but we can not guarantee that undue mishandling will not have damaged the instrument. In the case of this unlikely event, please contact your supplier immediately and retain the packaging for our subsequent inspection.

### 2.1 Checking the Unit Type

Each unit has a unique serial number label on which full details of the configuration are given (see Figure 2 for example). These details should be checked to ensure conformance with your requirement.

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| | |
|---|---|
| PART NUMBER | 2002-TC |
| INPUT | TYPE 'K'; RANGE 0-150°C |
| OUTPUT | RLY 1 > SP 1 < LED 1 |
| SUPPLY | 24v DC |
| OPTIONS | SINGLE TRIP |
| | |
| NATO STOCK No. | |
| SERIAL No. | T193-160 |

Fig. 2 - Serial Number Label

## 3.0 CONNECTIONS

This section details the instrument connection information. These details are also shown on the connections side label on each unit (see figure 3).

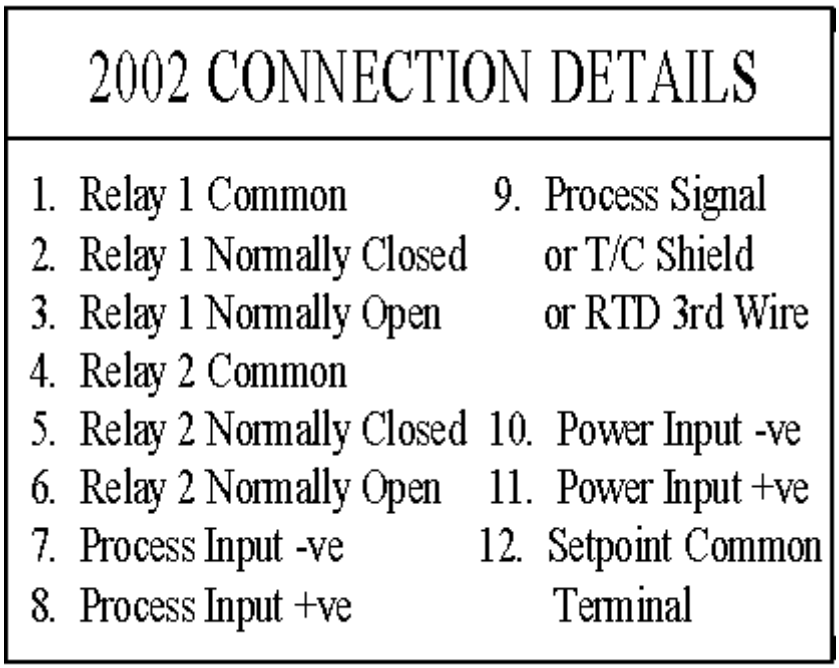



Fig. 3 - 2002-ALM Connection Details

**3.1 Power Supply**

The power supply is connected into terminals 10 (negative) and 11 (positive). The supply voltage is indicated on the serial number label (Figure 2)

APPLICATION OF VOLTAGES HIGHER THAN THAT STATED FOR THE SUPPLY MAY CAUSE DAMAGE TO THE INSTRUMENT.

**3.2 Sensor Connections**

All sensor connections are made to terminals numbered 7, 8 and 9 on the instrument.
The inputs are connected as described below.

3.2.1 DC Voltage Inputs

This applies to the high level input device only (IIR-2002-ALM-HL). The signal should be connected between pins 8 (positive) and 7(negative).

3.2.2 DC Current Inputs

This applies to the high-level input device only (IIR-2002-ALM-HL). The signal should be connected between pins 8 (positive) and 7 (negative).

3.2.3 Thermocouple Inputs

This applies to the thermocouple input device only, (IIR-2002-ALM-TC). Thermocouples or mV sources are connected to input terminals 7 (negative) and 8 (positive). The cold junction compensation, where appropriate, is performed by an integral sensor located close, and thermally connected to, the input terminal.

3.2.4 RTD Inputs

This applies to the resistance thermometer input device only, (IIR-2002-ALM-RTD). RTD's should be connected using three identical wires in order that measurement errors due to lead wire resistances can be eliminated. The sensor common wires should be connected to terminals 7 & 9, the remaining wire going to terminal 8. If it is necessary to use a two wire sensor then it should be connected between terminals 7 and 8 and internal link 22 should be fitted (see section 4.0 Trip Configuration).

## 4.0 TRIP CONFIGURATION

### 4.1 Standard (non latching) operation

The action of each trip can be simply described by considering the state of the relevant relay and LED indicator with process signal either side of the trip set point. The options for each trip are as follows:

| | | |
|---|---|---|
| a) | Relay energised for process signal above set point | LED on for process signal above set point |
| b) | Relay energised for process signal above set point | LED off for process signal above set point |
| c) | Relay energised for process signal below set point | LED on for process signal below set point |
| d) | Relay energised for process signal below set point | LED off for process signal below set point |

Thus any combination of fail safe or non fail safe options can be catered for.

4.1.2 Factory Pre-Configured Units

Where the unit is required for a preset trip configuration this can be requested at time of order and will be carried out free of charge at the factory. In this case the following convention, corresponding to option a to d above, is used for specifying operation:

| | | | |
|---|---|---|---|
| a) | RLY x > SP x < LED x | | |
| b) | RLY x > SP x > LED x | Where | x = 1 for trip 1 |
| c) | RLY x < SP x > LED x | | x = 2 for trip 2 |
| d) | RLY x < SP x < LED x | | |

This information will appear on the serial number side label on pre-configured units (figure 2). It is helpful if this convention is used by the customer when specifying units.

4.1.3 Default Configuration

In the event that pre-configuration information is not available, units will be shipped in default configuration as follows:

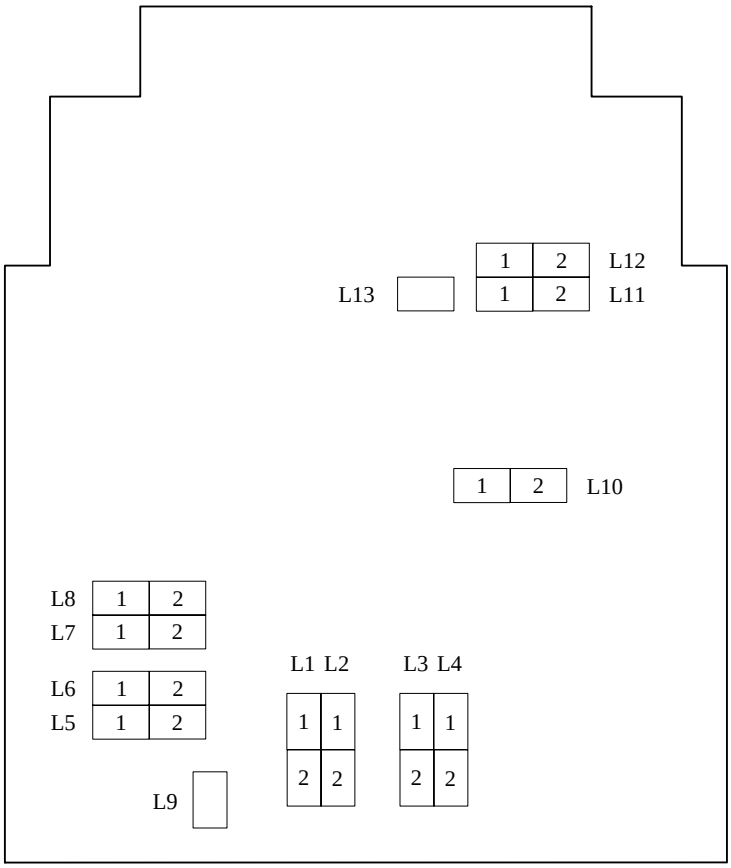
| | |
|---|---|
| RLY 1 > SP 1 < LED 1 | (case a, section 4.1) |
| RLY 2 < SP 2 > LED 2 | (case c, section 4.1) |

4.1.4 User Configuration

If it is necessary to change the trip action of the instrument, or to change the wire break detection (2002-ALM-TC only) or 2/3 wire sensor connection (2002-ALM-RTD only), the instrument must be removed from the plastic enclosure. This is achieved by gently prising apart both sides of the grey plastic box, next to the connection terminals, and withdrawing the circuit board with the black terminal blocks.

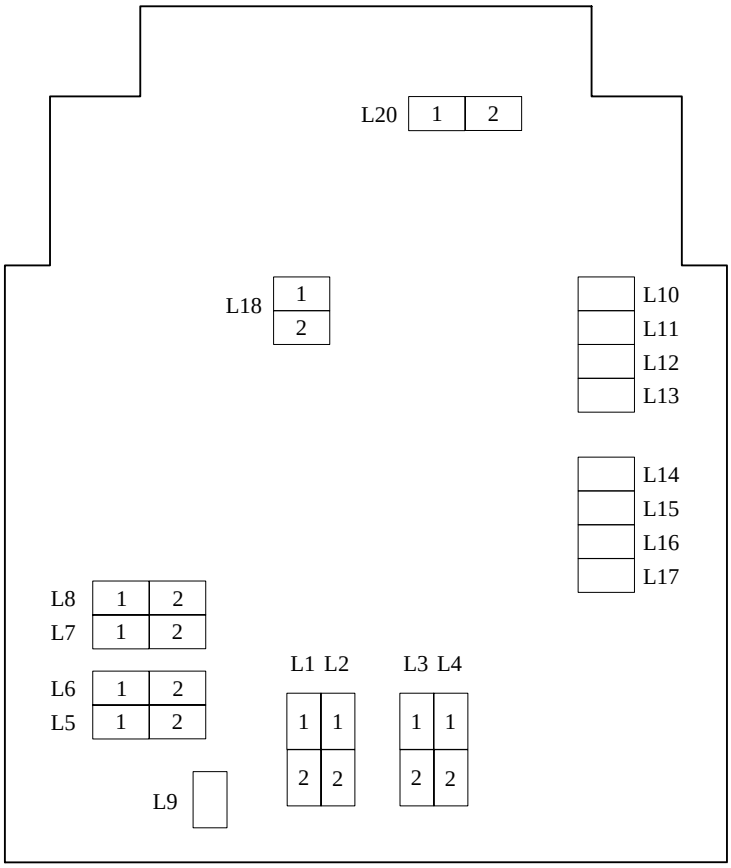
The units may then be configured by changing the handbag links with reference to the appropriate one of the following diagrams:

**Fig. 4 - 2002-ALM-HL Link Settings**



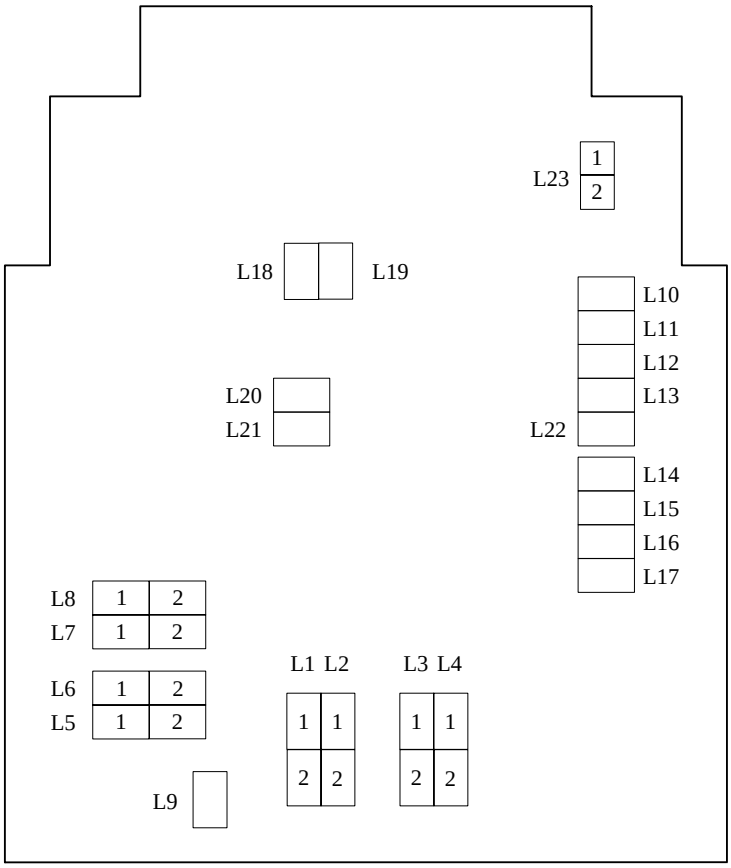

| LINK SET NO | POSITION | FUNCTION DESCRIPTION | |
|---|---|---|---|
| Links 1 and 2 | 1 | Relay 1 energised Above Setpoint | |
| Links 1 and 2 | 2 | Relay 1 energised Below Setpoint | |
| Links 3 and 4 | 1 | Relay 2 energised Below Setpoint | |
| Links 3 and 4 | 2 | Relay 2 energised Above Setpoint | |
| Links 5 and 6 | 1 | LED2 on when Relay 2 energised | |
| Links 5 and 6 | 2 | LED2 Off when Relay 2 energised | |
| Links 7 and 8 | 1 | LED1 Off when Relay 1 energised | |
| Links 7 and 8 | 2 | LED1 On when Relay 1 energised | |
| Link 9 | fitted | Relay Latching Function | |
| Link 10 | 1 | 0-20mA/0-10v | } |
| Link 10 | 2 | 4-20mA | } Reconfigurable Input |
| Links 11 and 12 | 1 | Current (mA) Input | } Option Only |
| Links 11 and 12 | 2 | Voltage Input | } |
| Link 13 | fitted | 0-20mA Input | } |

**Fig. 5 - 2002-ALM-TC Link Settings**




| LINK SET NO | POSITION | FUNCTION DESCRIPTION | |
|---|---|---|---|
| Links 1 and 2 | 1 | Relay 1 energised Above Setpoint | |
| Links 1 and 2 | 2 | Relay 1 energised Below Setpoint | |
| Links 3 and 4 | 1 | Relay 2 energised Below Setpoint | |
| Links 3 and 4 | 2 | Relay 2 energised Above Setpoint | |
| Links 5 and 6 | 1 | LED2 On when Relay 2 energised | |
| Links 5 and 6 | 2 | LED2 Off when Relay 2 energised | |
| Links 7 and 8 | 1 | LED1 Off when Relay 1 energised | |
| Links 7 and 8 | 2 | LED1 On when Relay 1 energised | |
| Link 9 | fitted | Relay Latching Function | |
| Links 10-13 | | Thermocouple Type Selection | }Reconfigurable Input |
| Links 14-17 | | Thermocouple Input Range | } Option Only |
| Link 18 | 1 | Downscale Burnout | |
| Link 18 | 2 | Upscale Burnout | |
| Link 20 | 1 | Terminal 9 measures Process (0-1V) | |
| Link 20 | 2 | Terminal 9 used for t/c screen conn. | |

**Fig. 6 - 2002-ALM-RTD Link Settings**




| LINK SET NO | POSITION | FUNCTION DESCRIPTION | |
|---|---|---|---|
| Links 1 and 2 | 1 | Relay 1 energised Above Setpoint | |
| Links 1 and 2 | 2 | Relay 1 energised Below Setpoint | |
| Links 3 and 4 | 1 | Relay 2 energised Below Setpoint | |
| Links 3 and 4 | 2 | Relay 2 energised Above Setpoint | |
| Links 5 and 6 | 1 | LED2 On when Relay 2 energised | |
| Links 5 and 6 | 2 | LED2 Off when Relay 2 energised | |
| Links 7 and 8 | 1 | LED1 Off when Relay 1 energised | |
| Links 7 and 8 | 2 | LED1 On when Relay 1 energised | |
| Link 9 | fitted | Relay Latching Function | |
| Links 10-13 | | RTD Range Zero Selection | } |
| Links 14-17 | | RTD Range Span Selection | } Reconfigurable Input |
| Links 18-21 | | RTD Range Gain Selection | } Option only |
| Link 22 | fitted | For 2-wire RTD Operation | |
| Link 22 | not fitted | For 3-wire RTD Operation | |
| Link 23 | 1 | Process O/P on terminal 9 (0-1V) | |
| Link 23 | 2 | 3-wire connection to terminal 9 | |

## 4.2 Latching Operation

Latching operation of relay 1 can be achieved by connecting link 9. Note that, where latching operation is specified, trip set point 2 is used to set the unlatch threshold such that Relay 2 is not independent. Latching operation is not possible with relay 2.

With Link 9 fitted, Relay 1 can be set to energise when the process signal rises above or falls below trip set point 1, in the normal fashion. At the same time LED 1 can be set to be on above or below set point 1. Once relay 1 has become energised it will remain energised so long as either the initial condition which caused the trip is sustained, or whilst relay 2 is de-energised, or both. i.e. relay 1 can only be latched whilst relay 2 is de-energised and can only be unlatched whilst relay 2 is energised. (Note that LED1 denotes whether the process signal is above or below trip set point 1, not whether relay 1 is energised.)

By way of example the latching mode of operation is likely to be used to maintain the process signal between an upper and a lower limit (for instance tank level control) as shown in Figure 7:

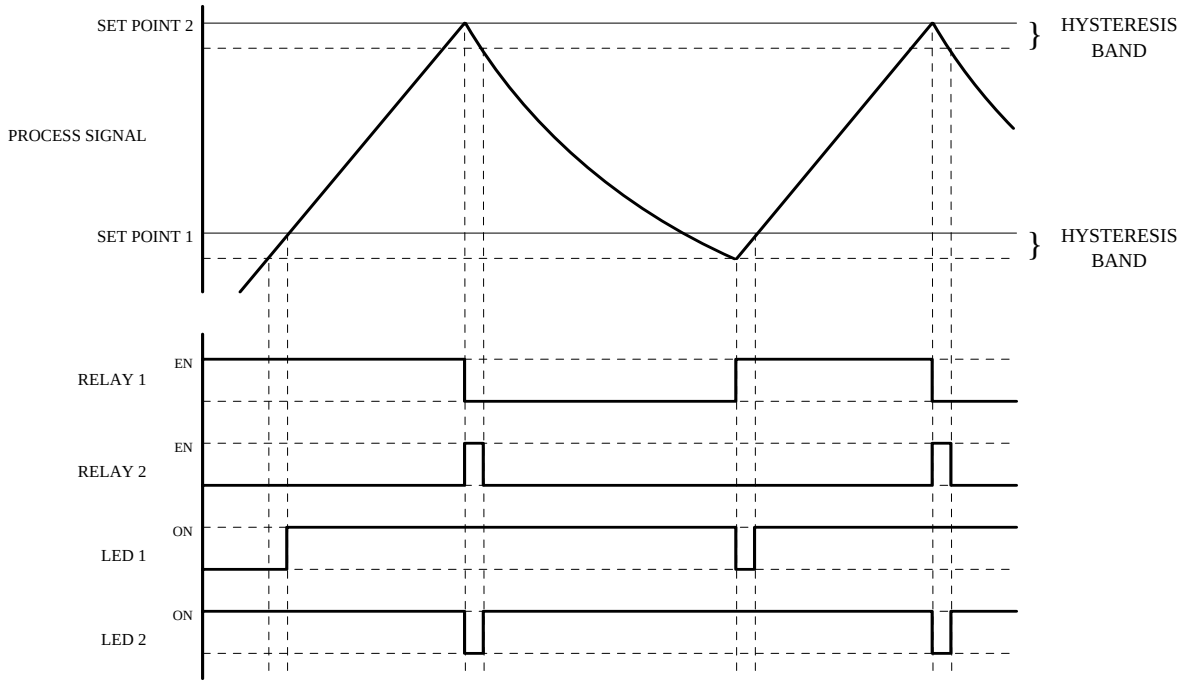



Fig. 7 - Timing Diagram - Latching Operation Of 2002-ALM

Trip 1 is set to option d) (section 4.1)
Trip 2 is set to option b) (section 4.1)
Trip set point 1 is set to the lower allowable limit
Trip set point 2 is set to the upper allowable limit

When the process signal is below set point 1 relay 1 is energised (latched) and will remain energised until the signal reaches set point 2. At this point relay 1 is unlatched (by relay 2 energising). As the process signal reduces relay 2 de-energises. As the signal falls below set point 1 relay 1 is energised (latched) again and the cycle repeats.

The LEDs can be used to indicate the status as follows:

| LED1 | LED2 | STATUS |
|---|---|---|
| OFF | OFF | Power Fail |
| OFF | ON | At or below bottom unit |
| ON | OFF | At or above top limit |
| ON | ON | Within limits |

## 5.0 INPUT RECONFIGURATION (RECONFIGURABLE UNITS ONLY) AND CALIBRATION

If the 2002-ALM has a reconfigurable input option reconfiguration can be carried out by changing handbag links and, for greatest accuracy, recalibrating the 0-1V process signal.

### 5.1 2002-ALM-HL Reconfiguration and Calibration

(i) Referring to 2002-ALM-HL link setting diagram (figure 4), set links 10 through 13 as required

(ii) Connect voltmeter between connector terminals 12 (-ve) and 9 (+ve)

iii) Connect a current or voltage source as appropriate to input terminals 7 (-ve) and 8 (+ve)

(iv) Adjust VR4 to give 0.00V on voltmeter at zero scale for 4-20mA range only - zero is automatic for other ranges

(v) Adjust VR3 to give 1.00V on voltmeter at full scale

(vi) Repeat (iv) and (v) as necessary.

### 5.2 2002-ALM-TC Reconfiguration and Calibration

(i) Referring to 2002-ALM-TC link setting diagram (figure 5), select range 1, 2, 3 or 4, as detailed on unit side label, as follows:

| RANGE | LINKS FITTED |
|---|---|
| 1 | 13 and 17 |
| 2 | 12 and 16 |
| 3 | 11 and 15 |
| 4 | 10 and 14 |

(ii) Make sure that link 20 is in position 1

(iii) Connect voltmeter between connector terminals 12 (-ve) and 9 (+ve)

(iv) Ensuring that the cold junction compensation temperature is equal to the 2002-TC terminal temperature, connect a thermocouple simulator to terminals 7 (-ve) and 8 (+ve)

(v) Adjust VR4 to give 1.00V on voltmeter at full scale

(vi) Adjust VR3 to give 0.00V on voltmeter at zero scale (NB ensure that voltage increases with small input to check that unit is in its linear range - this signal will not go negative)

(vii) Repeat (v) and (vi) as necessary

(viii) Replace link 20 if screen connection is used.

### 5.3 2002-ALM-RTD Reconfiguration and Calibration

(i) Referring to the 2002-ALM-RTD link setting diagram (figure 6), select range 1, 2, 3 or 4, as detailed on unit side label, as follows:

| RANGE | LINKS FITTED |
|---|---|
| 1 | 13, 17, 21 |
| 2 | 12, 16, 20 |
| 3 | 11, 15, 19 |
| 4 | 10, 14, 18 |

(ii) Make sure that link 23 is in position 1 and that link 22 is fitted

(iii) Connect voltmeter between connector terminals 12 (-ve) and 9 (+ve)

(iv) Ensuring that lead resistance is minimised (since this is a 2 wire connection), connect an RTD simulator or resistance box to terminals 7 and 8

(v) Adjust VR3 to give 1.00V on voltmeter at full scale

(vi) Adjust VR4 to give 0.00V on voltmeter at zero scale (NB ensure that voltage increases with a small input to check that unit is on its linear range - this signal will not go negative)

(vii) Repeat (v) and (vi) as necessary

(viii) Check for voltmeter reading of 0.50V at half scale input

(ix) Return link 23 to position 2 and remove link 22 if 3 wire connection is to be used.

## 6.0 SETTING TRIP POINTS

The trip points can be measured between connection terminal 12 and the set 1 or set 2 brass terminals on the front panel. The measured signal is a voltage between 0 and 1 V corresponding to the input range of the unit.

### 6.1 2002-ALM-HL Trip Points

Since the 0-1V process signal is linear for this device the trip point is equal to 100% of span multiplied by the set point voltage

e.g. 4-20mA input
trip at 16mA input = 75% of span
therefore trip set point = 0.75V

### 6.2 2002-ALM-TC Trip Points

Since the 0-1V process signal is linear with respect to thermocouple voltage and not degrees, the set point must be calculated as follows:

(i) Look up full scale thermocouple millivolts from table - X

(ii) Look up millivolt output for required trip point - Y

(iii) Set 0-1V indication for Y/X volts

e.g. a) 0-1200 ° C type K 1200°C = 48.828mV
b) Require trip above 900 ° C; 900 ° C = 37.325mV
c) Set point will be $\frac{37.325}{48.828}$ = 0.764V

Unit will then trip on at 900 ° C and off at (900 - Z) ° C, where Z is hysteresis band. (Hysteresis is typically 1% of span, unless otherwise specified)

### 6.3 2002-ALM-RTD Trip Points

Since the 0-1V process signal is linear for this device the trip point is equal to 100% of span multiplied by the set point voltage

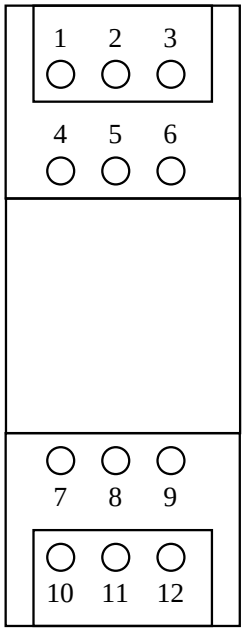
e.g. -100 to 200°C PT 100 input
trip at 100°C = 67% of span
therefore trip set point = 0.67V

## 7.0 INSTALLATION

**Fig. 8 - Installation Data & Terminal Positions For 2002-ALM**

Installation Data_____

| | |
|---|---|
| Mounting | DIN Rail T35 |
| Orientation | Any (Vertical Preferred) |
| Connections | Screw Clamp With Pressure Plate |
| Conductor Size | 0.5mm - 4.0 mm |
| Insulation Stripping | 10mm |
| Screw Terminal Torque | 0.4Nm Max. |
| Weight | 120g (approx.) |




| Terminal No | Function | | |
|---|---|---|---|
| | **2002-ALM-HL** | **2002-ALM-TC** | **2002-ALM-RTD** |
| 1 | Relay 1 common | Relay 1 common | Relay 1 common |
| 2 | Relay 1 n/c | Relay 1 n/c | Relay 1 n/c |
| 3 | Relay 1 n/o | Relay 1 n/o | Relay 1 n/o |
| 4 | Relay 2 common | Relay 2 common | Relay 2 common |
| 5 | Relay 2 n/c | Relay 2 n/c | Relay 2 n/c |
| 6 | Relay 2 n/o | Relay 2 n/o | Relay 2 n/o |
| 7 | Process input -ve | T/C -ve | RTD common |
| 8 | Process input +ve | T/C +ve | RTD +ve |
| 9 | Process signal +ve | Process +ve/shield | Process +ve/RTD common (3 wire) |
| 10 | Power supply -ve | Power supply -ve | Power supply -ve |
| 11 | Power supply +ve | Power supply +ve | Power supply +ve |
| 12 | Setpoint/Process -ve | Setpoint/Process -ve | Setpoint/Process -ve |

### 7.1 Installation onto Rails

The instrument is designed to mount directly onto the "Top hat" TS35 standard assembly rail to DIN46277 part 3/EN 50022/BS5584.

### 7.2 Mounting Arrangements

Ideally the unit should be mounted in a vertical position, i.e. on a horizontal rail. This is the optimum orientation to minimise temperature rise within the unit. However successful operation is possible in any orientation.

Ensure the maximum ambient temperature is less than 55°C.

Good airflow around the unit will maximise reliability.

### 7.3 Wiring Precautions

These units can accept a variety of sensor inputs, some of which produce very small voltages. Therefore it is advisable to adhere to the following rules of good installation practice:

(i) Do not install close to switchgear, electromagnetic starters, connectors, power units or motors.

(ii) Do not have power or control wiring in the same loom as sensor wires.

(iii) Use screened cable for sensor wiring with the screen earthed at one end only.

(iv) Take care not to allow cut pieces of wire to fall onto the unit as they might enter via the ventilation holes and cause electrical short circuits. If in doubt, remove the units from the rail until wiring is complete.

(v) Use bootlace ferrules on all bare wires.

**IMPORTANT**: **The connection terminals are designed for a maximum torque of 0.4Nm. Exceeding this figure is unnecessary and will result in unwarrantable damage to the unit.**

# 8.0 SPECIFICATIONS

All specifications are at 20 ° C operating ambient unless otherwise stated.

## 8.1 Accuracy and Response

### 8.1.1 2002-ALM-HL

| | |
|---|---|
| Process signal linearity | +/- 0.1% full scale |
| Trip point accuracy | +/- 0.25% range |
| Hysteresis | -1% full scale standard |
| Process signal drift | +/- 100ppm full scale/°C |
| Trip point drift | +/- 100ppm/°C |
| Signal Response Time (90% of step change) | 2ms typical |
| Relay response time | 10ms typical |

### 8.1.2 2002-ALM-TC

| | | |
|---|---|---|
| Process signal linearity (with respect to thermocouple voltage) | +/- 0.1% full scale | |
| Trip point accuracy | +/- 0.25% range | |
| Hysteresis | -1% full scale standard | span ≥ 10mV |
| | -2% full scale standard | span < 10mV |
| Cold junction compensation accuracy | +/- 2 ° C over operating temperature range 0-55 °C | |
| Process signal drift | +/- 100ppm full scale/°C | |
| Trip point drift | +/- 100ppm/°C | |
| Signal response time (90% of step change) | 300ms typical | |
| Relay response time | 10ms typical | |

### 8.1.3 2002-ALM-RTD

| | | |
|---|---|---|
| Process signal linearity | +/- 0.1% range | |
| Trip point accuracy | +/- 0.25% range | |
| Hysteresis | - 1% full scale standard | span ≥ 10Ω |
| | -2% full scale standard | span < 10Ω |
| Process signal drift | +/- 100ppm full scale/° C | |
| Trip point drift | +/ 100ppm/° C | |
| Signal response time (90% of step change) | 10ms typical | |
| Relay response time | 10ms typical | |

## 8.2 Power Supply Isolation and Operating Ambient (all types)

| | |
|---|---|
| Operating Voltage | 24V DC +/- 10% |
| Current consumption * | 45mA typical |
| Input to power supply isolation | 1kV DC |
| Input and power supply to relay contact isolation | 2kV RMS AC |
| Operating temperature range | 0-55°C |
| Storage temperature range | -40 - 100°C |
| Operating and storage humidity range | 0 - 90% RH |

* Both relays energised

### 8.3 RFI Immunity

All members of the 2002-ALM family have been tested for RFI immunity to IEC 801-3 as follows:

Pass condition: No false trips with signal ≥ 1% of span from set point for high and low trip action, any field orientation.

8.3.1 2002-ALM-HL

| Field Strength Immunity Level/$Vm^{-1}$ | Frequency Range/MHz |
|---|---|
| 10 | 27-37; 47-60; 72-500 |
| 3 | 27-500 |

8.3.2 2002-ALM-TC

| Field Strength Immunity Level/$Vm^{-1}$ | Frequency Range/MHz |
|---|---|
| 3 | 27-500 |

8.3.3 2002-ALM-RTD

| Field Strength Immunity Level/$Vm^{-1}$ | Frequency Range/MHz |
|---|---|
| 3 | 27-500 |