



DM4000A

SMART

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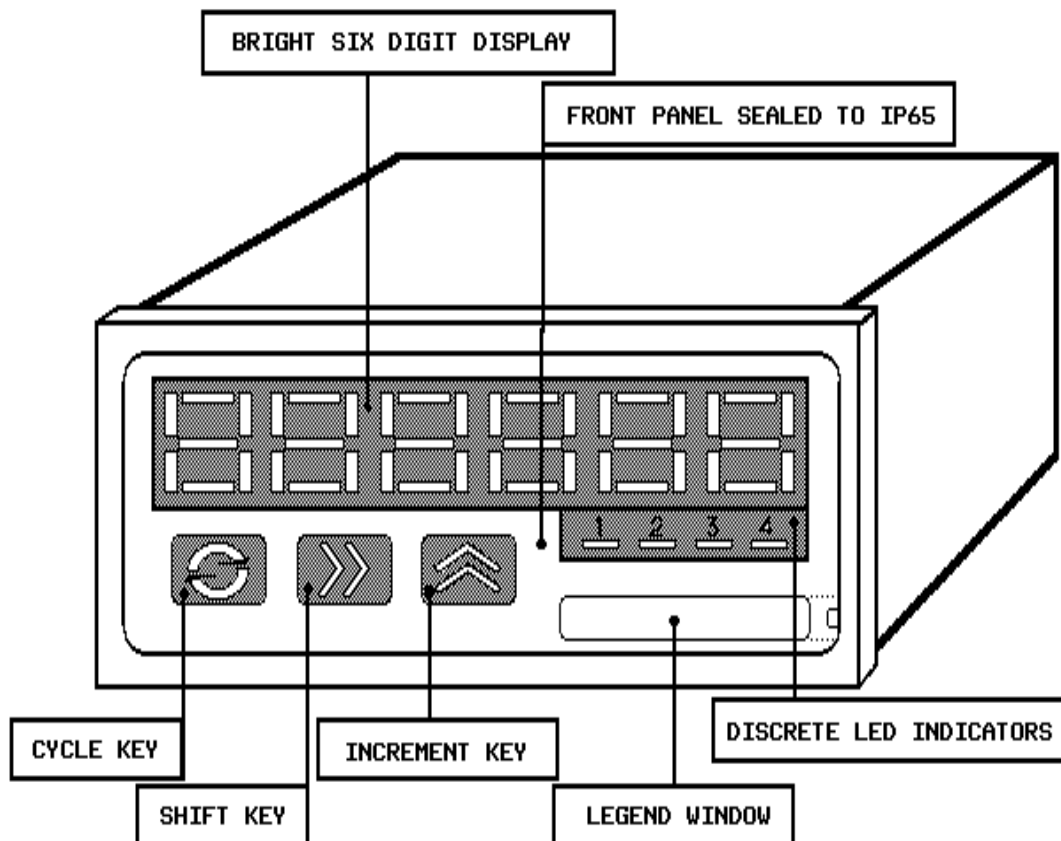
GETTING STARTED

1.0 INTRODUCTION

This instrument is a combined Rate indicator and Totaliser designed to accept a wide range of Voltage and Current inputs.

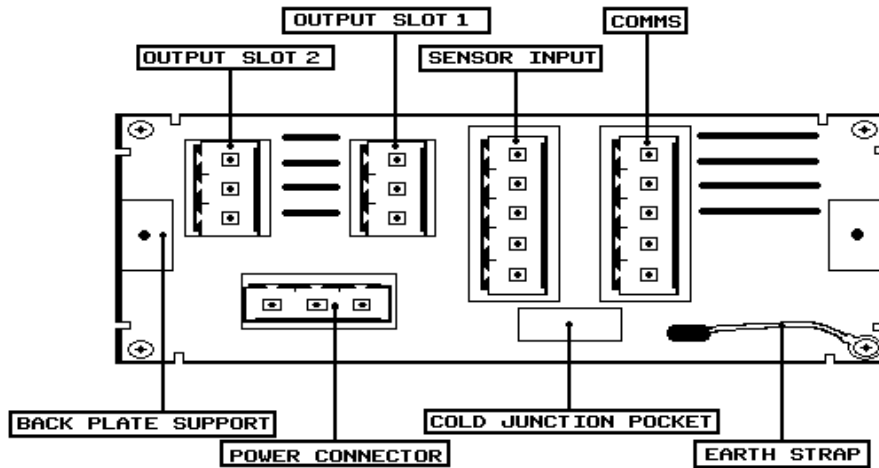
A great advantage with the unit is its ability to adapt to a wide variety of applications. A comprehensive set of programming menus allow the instrument to be entirely re-configured from the keypad.

The diagram below identifies features on the front panel.

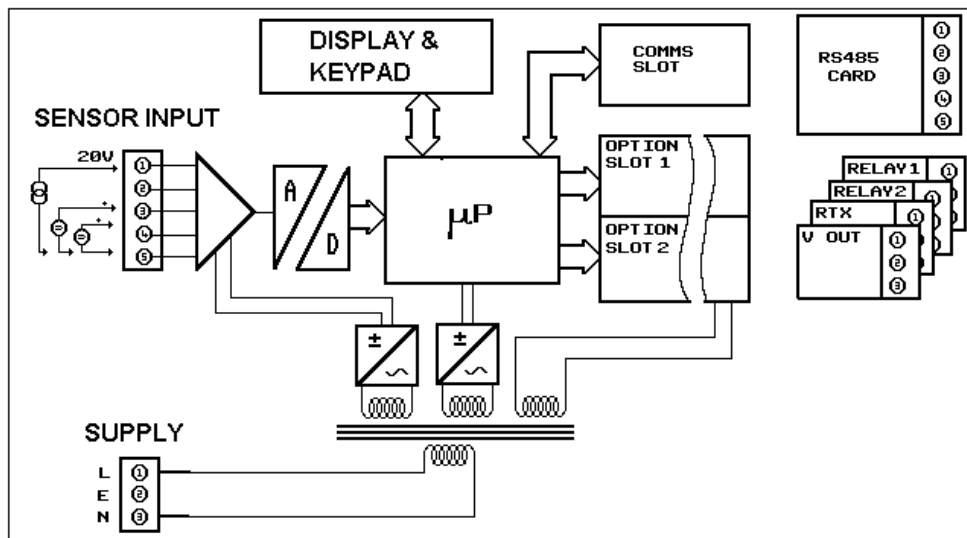


Relay, Current Re-transmission, Programmable Voltage Supply and Communications option boards are available to be fitted to the standard unit as required.

The diagram of the rear panel below shows the slot positions for all electrical connections. The output option slots and communications will only be populated if specifically ordered. These may be retrospectively fitted by the user if required at a later date.



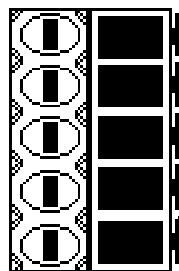
A schematic of the unit showing internal power supplies and possible options is shown below.



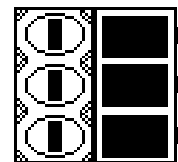
2.0 UNPACKING

Please inspect the instrument carefully for signs of shipping damage. The packaging has been designed to afford maximum protection, however, 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.

Check that the following items are included with the instrument. Note that if there are output options included there will be additional connectors.

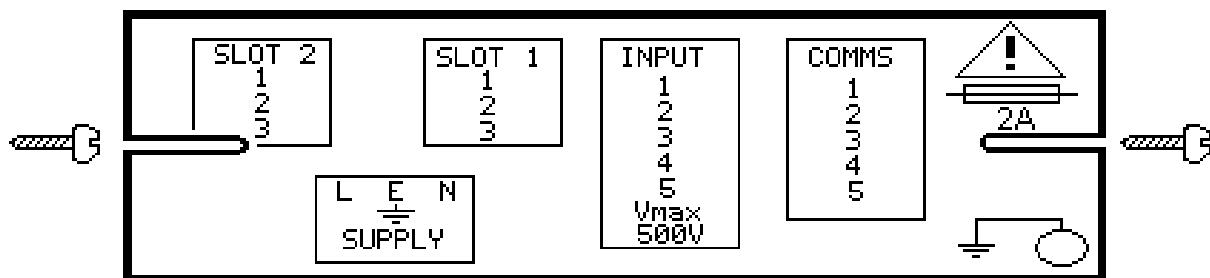


**SENSOR
INPUT
SOCKET**



POWER SOCKET

BACKPLATE AND FIXING SCREWS



INSTALLATION

SAFETY INFORMATION

THIS SECTION FOR USE BY COMPETENT PERSONNEL ONLY

- **WARNING** **READ SAFETY INFORMATION BELOW BEFORE INSTALLATION**
- **WARNING** Hazardous voltages may be present on the terminals - the equipment must be installed by suitably qualified personnel and mounted on an enclosure providing protection to at least IP20.
- **ISOLATION** The power supply terminals and associated internal circuitry are isolated from all other parts of the equipment in accordance with BS EN61010-1 for connection to a Category II supply (pollution degree 2)

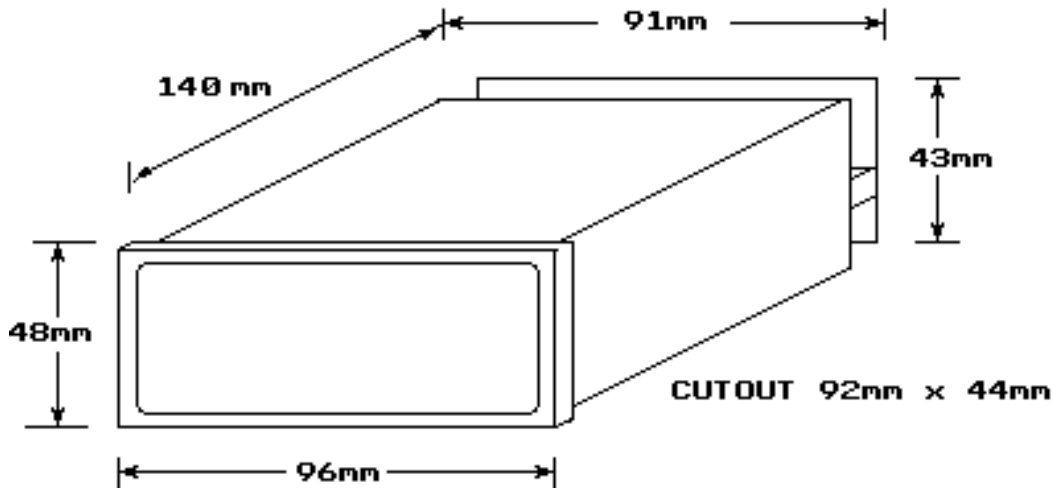
Functional isolation (500v max) is provided between input and output circuits, and between inputs and communications (where fitted).

Any terminals or wiring connected to the input, output or communications terminals which are **accessible in normal operation** must **ONLY** be connected to signals complying with the requirements for **Safety extra low voltage (SELV)** circuits.

- **WARNING** If not installed in accordance with these instructions, protection against hazards may be impaired
- Installation overvoltage category - 2 (as per BS EN61010-1)
- (If this equipment is to be used in environments with overvoltage category 3, transient suppressors should be installed on wiring greater than 50VAC or 75VDC).
- The Mains supply to the equipment must be protected by a 1Amp fuse and a suitable switch or circuit breaker which should be near the equipment.
- The equipment contains no user serviceable parts.

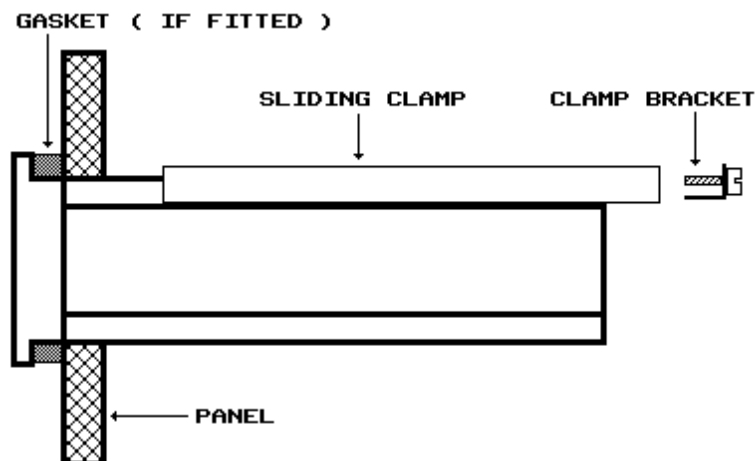
MECHANICAL INSTALLATION

When installing the instrument into the panel, the following dimensions should be taken into account.



The unit is held in the Panel by two metal clamp bars, on diagonally opposite corners, fitted from the rear. A gasket is available, and should be fitted wherever sealing of the instrument is required. See diagram below.

The maximum panel thickness is 3.5mm with a gasket and 4.5mm without. The gasket has a self adhesive side which should be stuck to the panel around the cutout. The instrument may then be inserted and tightened against the gasket to form a seal. The panel should be clean and smooth for the seal to be effective.



3.0 WIRING

This section describes how the instrument should be wired for the Power Supply, Input Sensor or any Output options that may be fitted. All connections are made to three or five way sockets which are removable for ease of wiring.

The unit 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.

- Do not have power or control wiring in the same loom as sensor wires.
- Use screened cable for sensor wiring with the screen earthed at one end only.

Installation should be undertaken in accordance with relevant sections of BS6739 - British Standards code of practice for "Instrumentation in Process Control Systems: Installation design and practice".

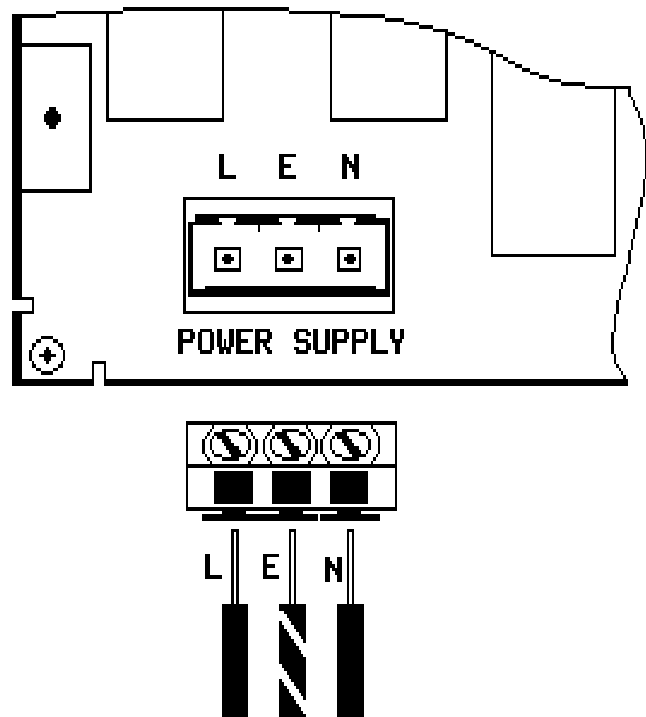
See important safety information on page 8

3.1 POWER SUPPLY

The Power supply rating will be indicated on the top of the instrument. **Ensure that this is correct for the voltage that is to be connected.**

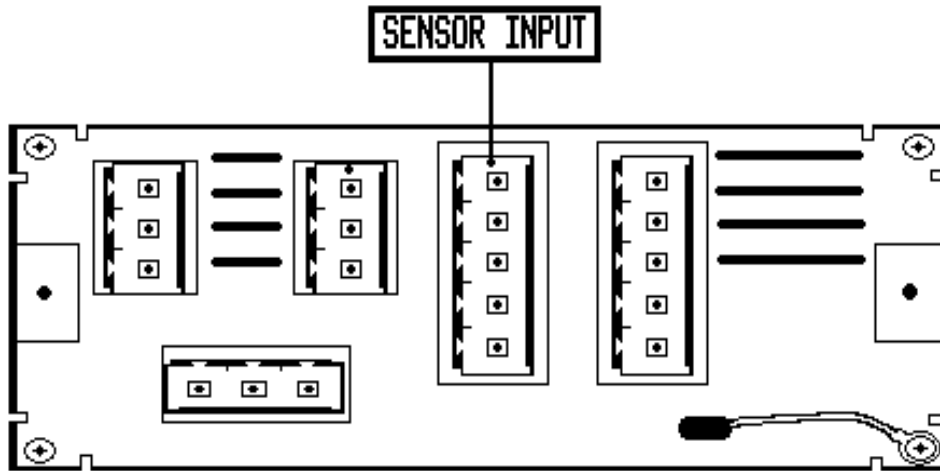
Note that the power supply socket has had polarisation keys fitted to prevent insertion into any other plug at the rear of the instrument.

The connection is made as shown. Ensure that no bare wire protrudes from the rear of the power connector risking a short circuit.

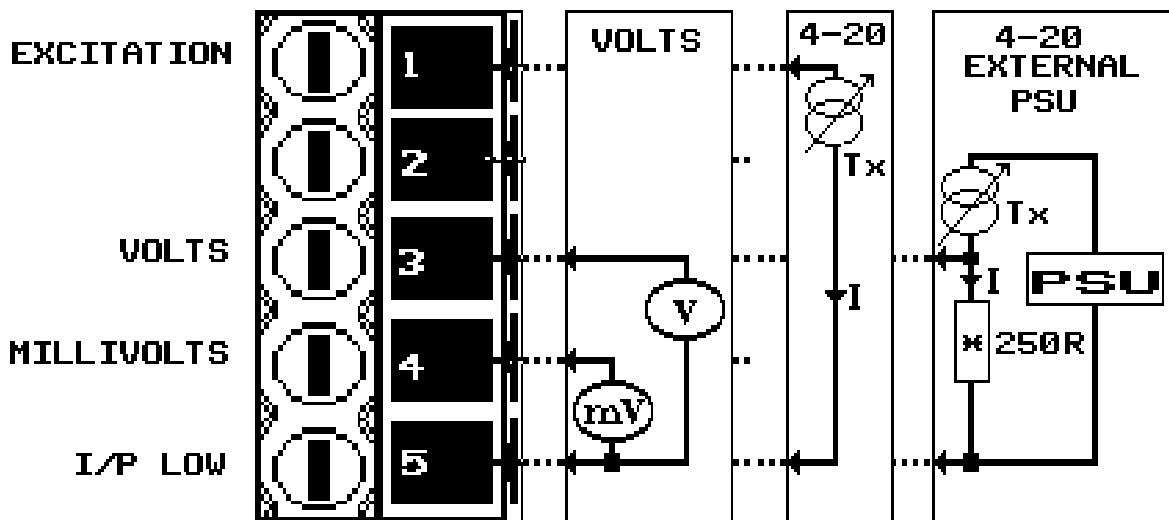


3.2 SENSOR CONNECTIONS

All sensor connections are made via the five way socket at the rear of the unit as shown below.



All sensor connections are summarised in the diagram below.



* EXTERNAL RESISTOR

3.2.1 VOLTAGE INPUTS

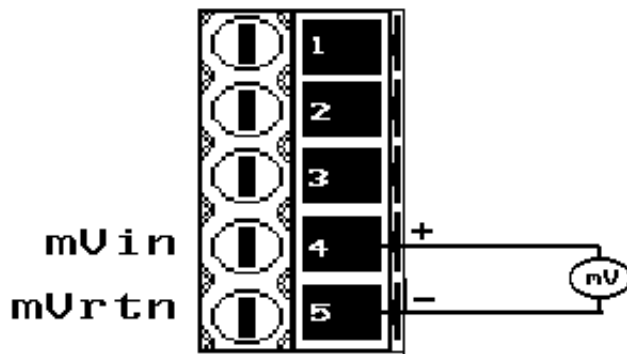
The instrument has two individual voltage inputs. One supports millivolt inputs up to 100mV , and the other voltage inputs up to 10 volts.

If the voltage input to be measured is to be no greater than 100mV it is connected to the millivolts input. If the signal is less than 10 volts but greater than 100mV, it is connected to the Voltage input. Any voltages greater than 10V may still be measured, but must be divided down first. The input signal may exceed the maximum rated voltage by 7% and still be measured correctly.

Each pin is overload protected to 250V.

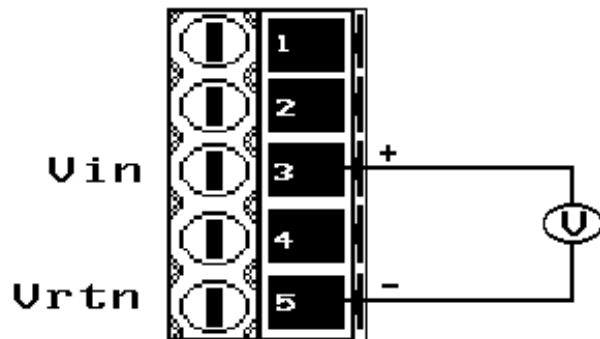
3.2.1.1 MILLIVOLTS INPUT

This input accepts signals up to +/-100mV in normal operation. The signal source must be connected to pins 4 and 5 as shown opposite.



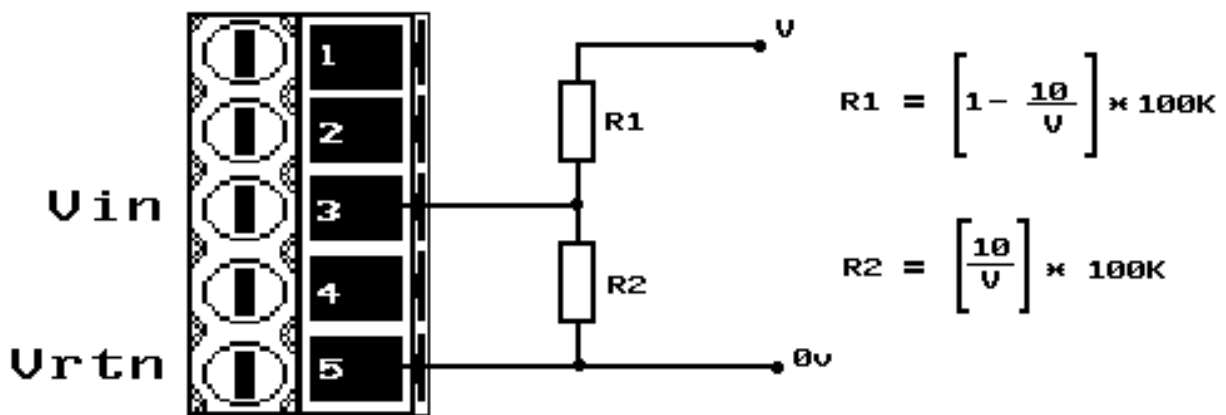
3.2.1.2 VOLTAGE INPUT

This input pin can take voltages up to 10 volts. The signal should be connected between pins 3 and 5 as indicated.



3.2.1.3 VOLTAGES GREATER THAN 10 VOLTS

In order for these to be measured correctly, it is necessary to connect some simple external circuitry outside the unit to divide down the voltage to a nominal maximum of 10volts. This is done using a resistor divider chain as shown in the diagram below. The choice of resistors are given as the nearest preferred values to those calculated in the equations for R1 and R2 below. It is possible to correct for any errors in the divide down chain by making R2 a trimmer, or correct by adjustment of scale range. Care must be taken to insulate any high voltages to protect from electric shocks or damage to any other equipment.

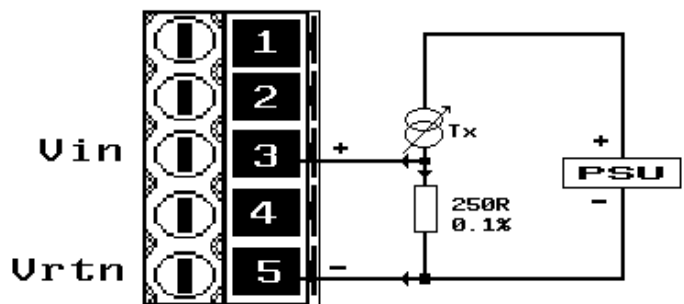


3.2.2 CURRENT INPUTS

There are two types of current measurement possible, the first type measures the current of an external loop, that is, a current that has been generated from an external power supply, or from another instrument. The second type measures current generated from the units own 20V excitation supply. Before connecting up a current input it is important to establish which one of these two groups apply.

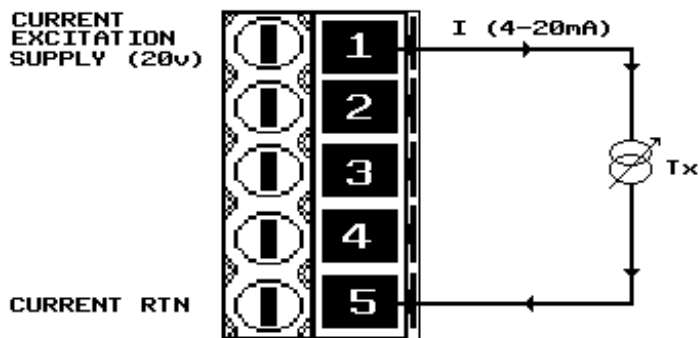
3.2.2.1 EXTERNALLY GENERATED LOOP

In order to measure the current in an externally generated loop, it is necessary to insert a resistor in-circuit and use the instrument to measure the resultant voltage drop. Note that the instrument will need to be configured as a 1-5V input and not a 4-20mA input; this is described later in the programming section. The diagram shows the necessary connections.



3.2.2.2 INTERNALLY GENERATED LOOP

The instrument has an excitation supply which can be used for generating a current loop. If this is used, the circuit is connected in the following way. Note that the current input has an internal impedance of 50 ohms.



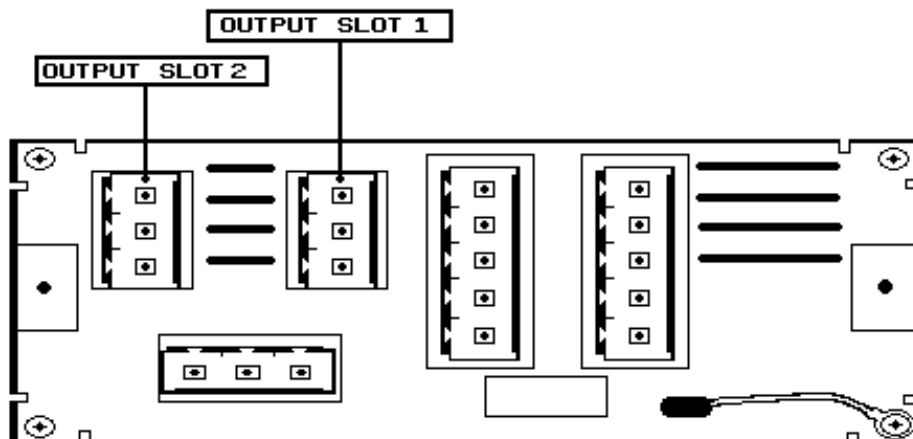
3.3 WIRING THE OUTPUT OPTIONS

This section applies to optional outputs fitted to the instrument. There are four types of output option available; Change-Over Relay, Dual Relay, Current Retransmission and Programmable voltage Output. These options may be fitted to either slot in any combination.

There is, however, a restriction when using Programmable Voltage Output with the Current Retransmission card or another Voltage Output. The combined maximum current should not exceed 50mA; the supply capacity of the Output options. Another consideration with a pair of analogue output options (Voltage or Current) is that although there is 500V * isolation from the Input, there is no isolation between output slots.

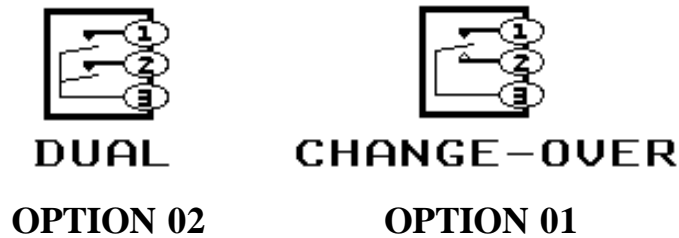
* See safety information on page 8

The position of the Output slots as viewed from the back are shown in the following diagram.

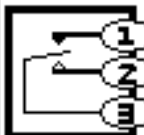
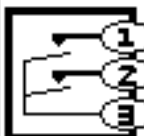


3.3.1 RELAY OUTPUTS

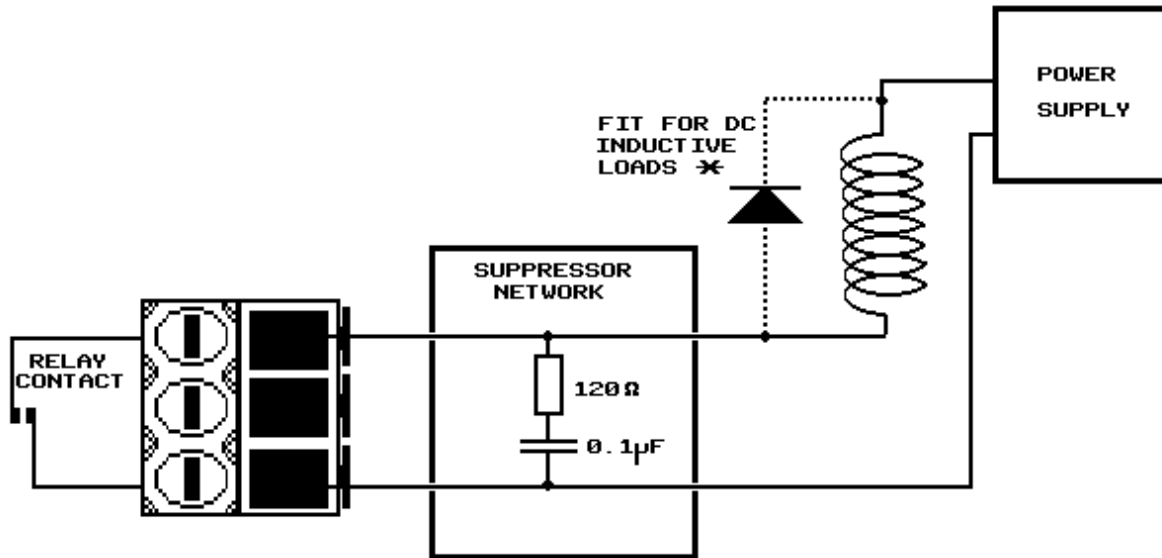
There are two types of relay outputs available, Dual relay and Change-Over relay. The dual relay board has two **independent** contacts sharing the same common. The Change-over relay has a single contact with a Normally Open and Normally Closed output available. These are shown schematically below.



The contact states for both these types of Relays are summarised in the table below. At the wiring stage, it is possible that all that is required is the power-off or fail-safe state. All power on states may be manipulated in software and is dealt with in the programming section.

	ALARM OPTION	POWER OFF	POWER ON	
			NO ALARM	IN ALARM
	NON INV	1:3 CLOSED 2:3 OPEN	1:3 CLOSED 2:3 OPEN	1:3 OPEN 2:3 CLOSED
	INV	1:3 CLOSED 2:3 OPEN	1:3 OPEN 2:3 CLOSED	1:3 CLOSED 2:3 OPEN
	NON INV	1:3 CLOSED 2:3 CLOSED	1:3 CLOSED 2:3 CLOSED	1:3 OPEN 2:3 OPEN
	INV	1:3 CLOSED 2:3 CLOSED	1:3 OPEN 2:3 OPEN	1:3 CLOSED 2:3 CLOSED

If the relay is to switch inductive loads, the contact should be suppressed as shown below.

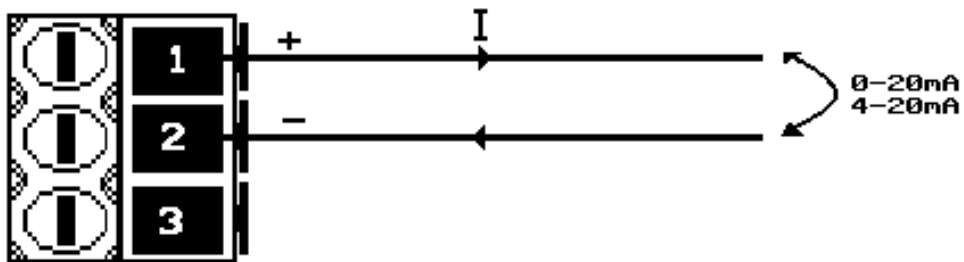
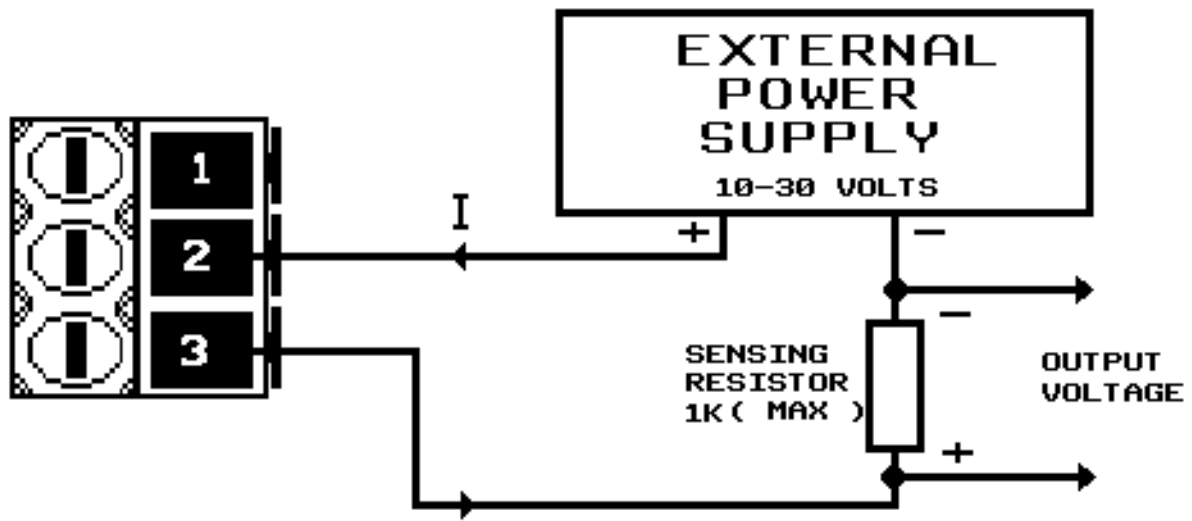


It is recommended that a proprietary suppressor network is fitted as close as possible to the inductive load. DC inductive loads should also have a reversed biased diode connected as shown.

3.3.2 CURRENT RETRANSMISSION,option 03

3.3.2.1 CURRENT OUTPUT

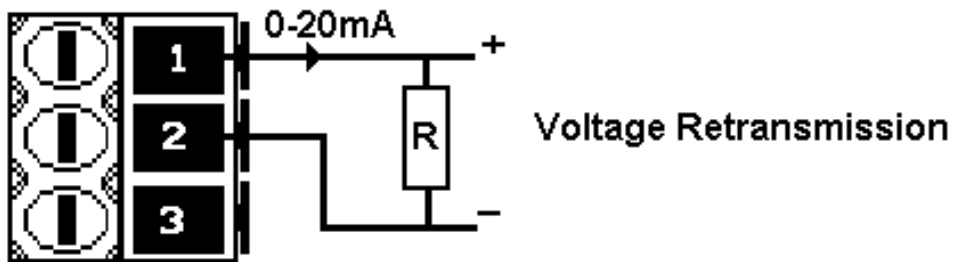
The Current output board can support current loops generated from an external power supply, or generate a loop source from the instrument itself. Both of these cases are shown in the diagrams below.



Note that connecting directly across pins 1& 3 may cause damage to the output card.

3.3.2.2 VOLTAGE RETRANSMISSION

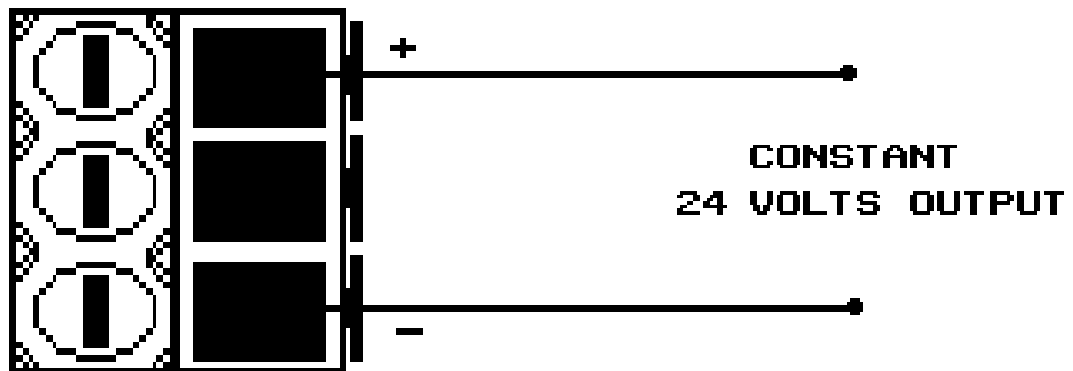
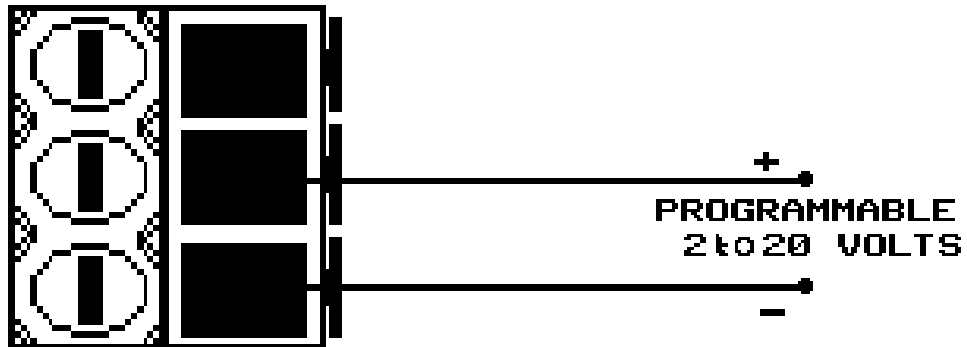
The current retransmission board may be used to retransmit a voltage signal. It is important that the impedance into which the signal drives is large in comparison to the load resistor 'R'.



'R' should be less than 700Ω
If 'R' is 50Ω , Voltage range is 0-1V

3.3.3 Voltage Output (Bridge Excitation),option 04

There are two options. Either a programmable 2 to 20 volt output or a fixed 24 volt output. The connections for both cases are shown below.

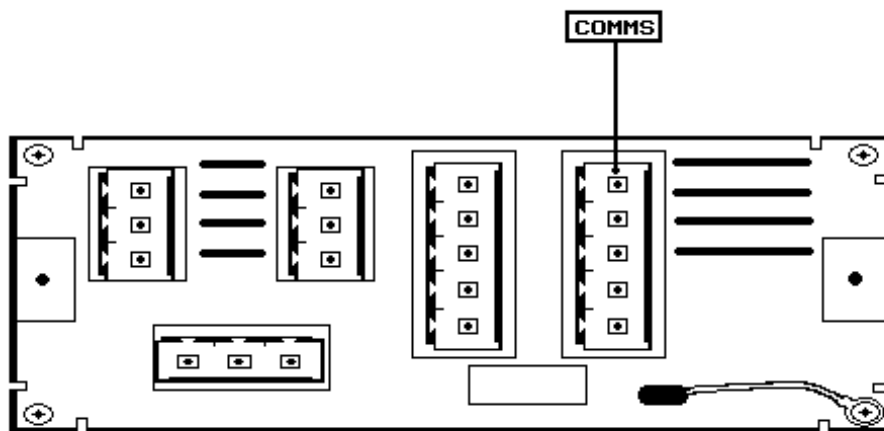


3.4 COMMS BOARD

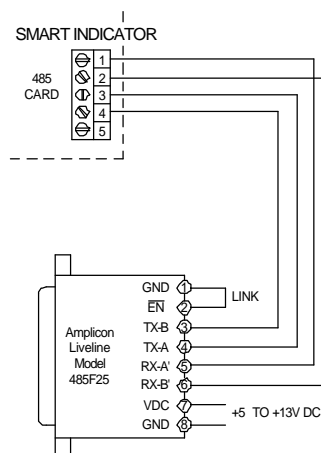
This section explains how the instrument may be connected to a Host computer, either individually or as part of a multidrop network. Although a Personal Computer is shown as the host device, any computer capable of generating RS485 may be used.

The electrical communications standard, RS485 is used instead of the commonly available RS232 as its robustness is more suitable for process instrumentation.

The Comms board is fitted in its own dedicated slot accessible from the rear of the instrument as identified below.

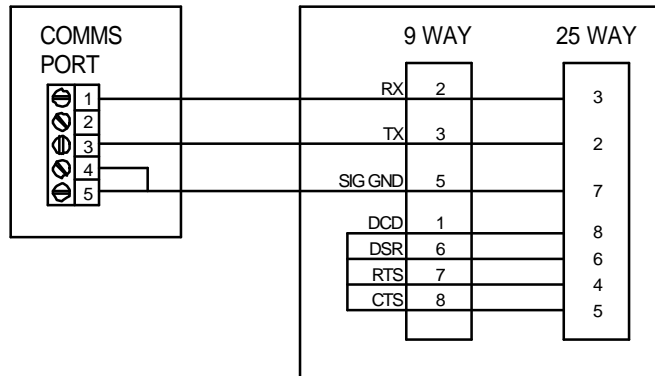


Although RS485 is the recommended interface, RS232 has been found to operate satisfactorily on some PCs over short distances. This is not a recommended arrangement, but if required for evaluation, should be wired as follows.

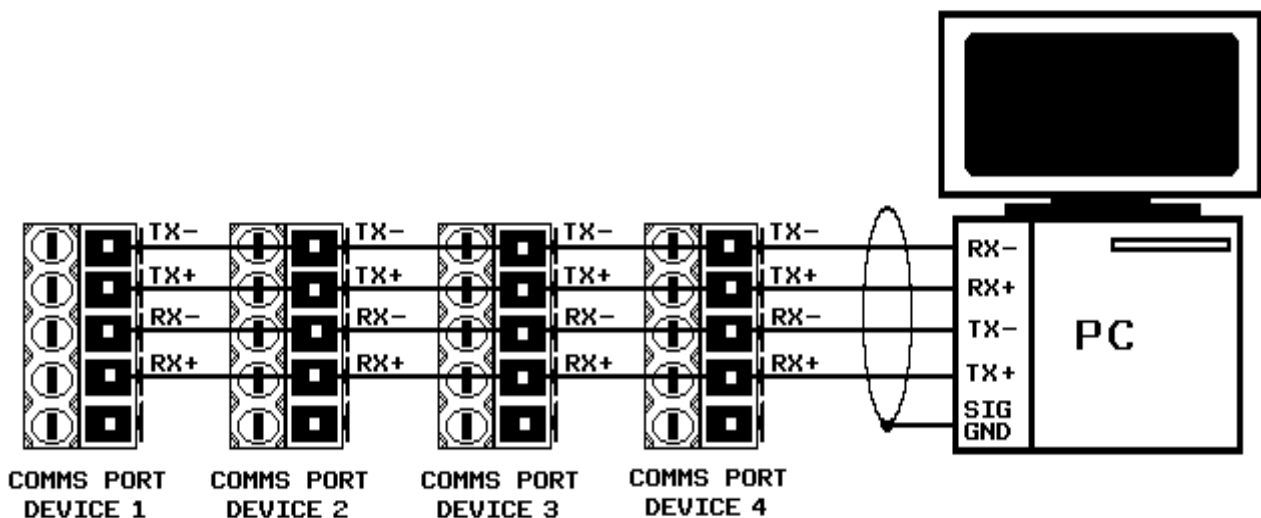


3.4.1 BASIC CONNECTIONS

The diagram below shows the basic connections between the instrument and a Host PC. The Tx and Rx signals are both differential, therefore they should be twisted wires for best operation over long distances.

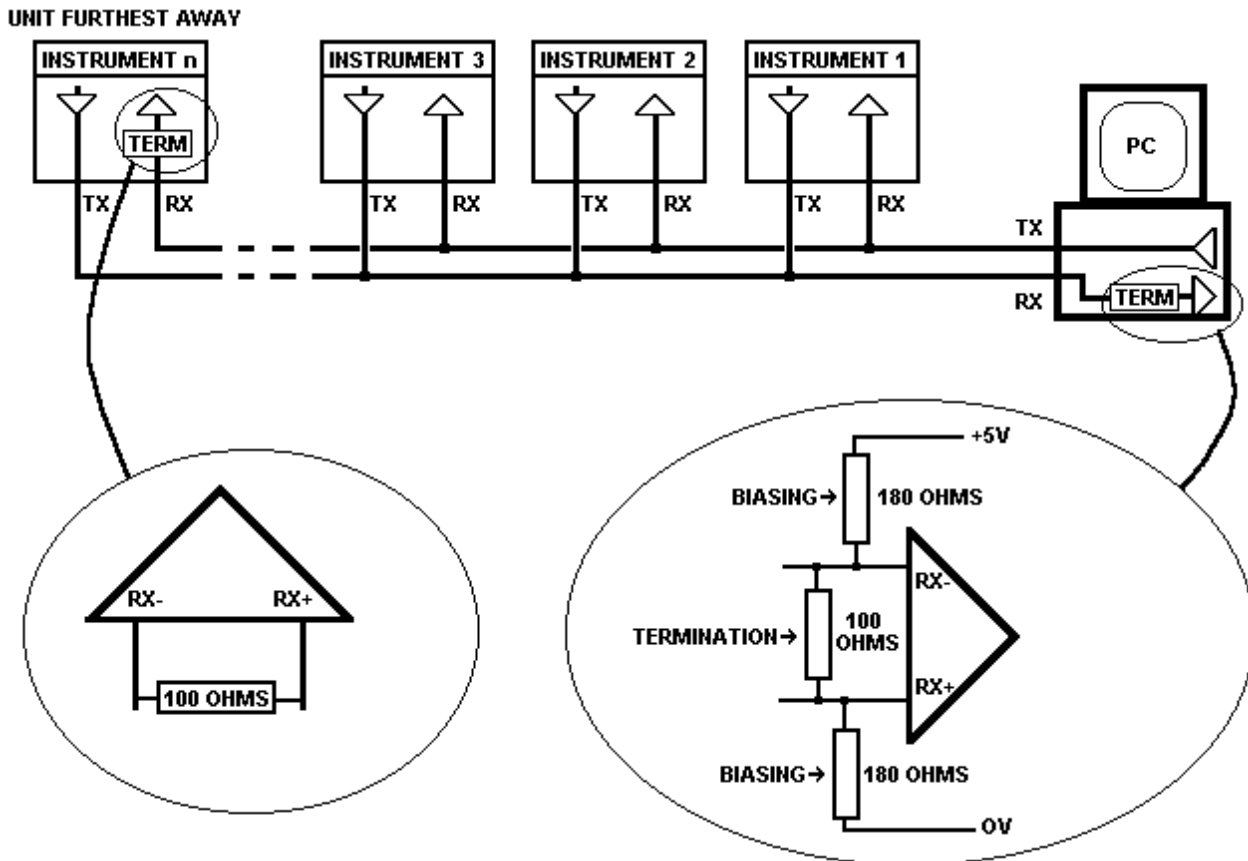


For multidrop operation, the instruments should be connected as shown below. As only one instrument can transmit at a time. It is possible to connect all of the transmit lines together, this does depend upon each unit being given a unique 'address' or device number, a subject which is dealt with in the programming section of this manual. It may be necessary to screen the communications wiring if installed in a very noisy electrical environment. The screen should be grounded at one point only.



3.4.2 LINE TERMINATION

Termination resistors should be put on the receive inputs of the Host PC and the instrument furthest away from it. This is shown schematically below.

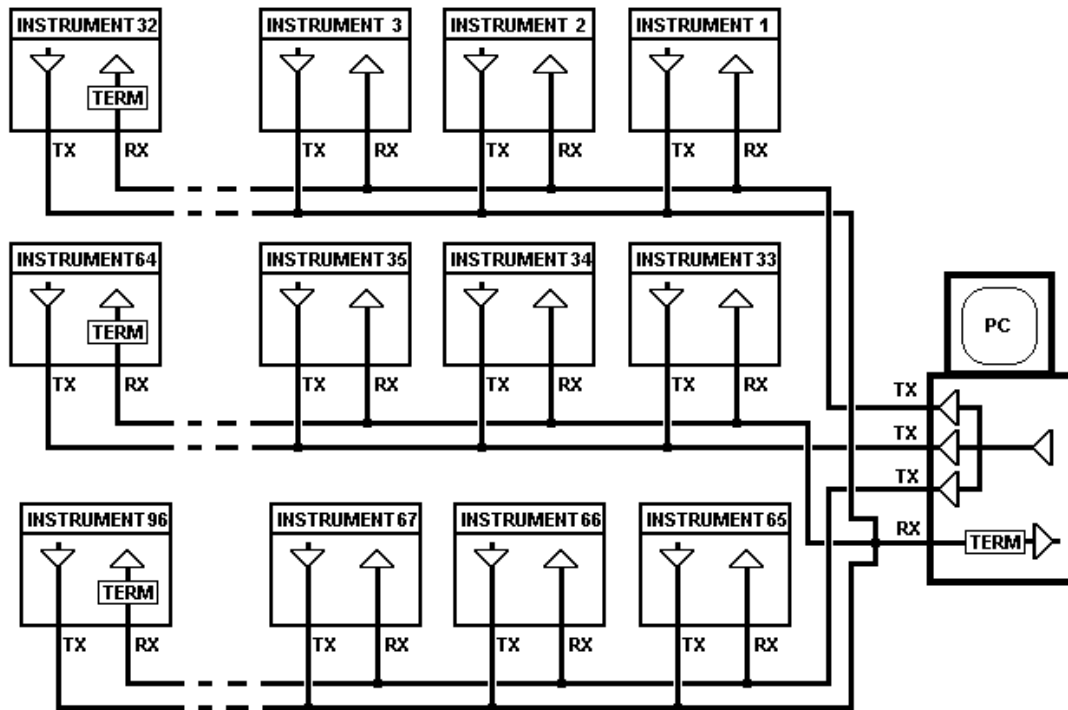


The instrument has a 100 ohm termination on the comms board which may be connected in-circuit by moving a user selectable link. The normal position, when the unit leaves the factory is with the resistor disconnected. See service manual for details.

Termination at the Host PC receiver, the additional resistors ensure that when all units are tri-state, the differential line rest in an 'idle' state and therefore do not risk detection of spurious data due to noise or slight offsets in the differential inputs.

3.4.3 CONNECTING MORE THAN 32 UNITS

RS485 has a drive limitation of 32 receivers. If additional instruments are required (there is a logical maximum of 99 units) it is necessary to buffer the Host PC transmitter as shown in the diagram below.



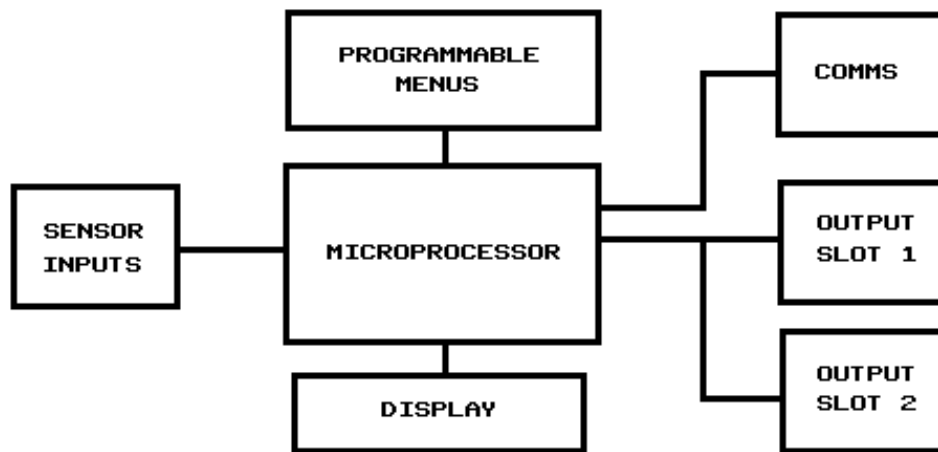
3.4.4 GROUNDING PROBLEMS

Each instrument has an internal link which connects the comms 0v to unit ground. If this causes any problems, it may be removed. See Service Manual for the location of the ground link.

USER GUIDE

4.0 PROGRAMMING THE INSTRUMENT

The unit is a microprocessor based instrument which enables it to satisfy a wide variety of applications through re-programming. The diagram below shows schematically, the operation of the instrument.



The programming of the instrument is central to its operation, effecting the way the inputs are processed, how the outputs are handled and what is displayed.

This section is divided into two parts, the first is a tutorial guide to show how to use the programming menus, the second documents the complete menu contents.

4.1 PROGRAMMING TUTORIAL GUIDE

Before starting with the Tutorial, it is useful to understand that the unit has three operating modes. These are :-

DISPLAY PROCESS VARIABLE MODE

MENU MODE

EDIT MODE









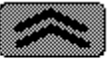









THE DISPLAY PROCESS VARIABLE MODE is the principal mode of operation. From here, the Process Variable is displayed and all other modes are accessed. The unit will always time-out back to this mode from any other mode of operation.

THE MENU MODE gives the user access to the programmable parameters within the unit. It is called a Menu Mode because the parameters are arranged in lists according to their type.

THE EDIT MODE is entered into from the Menu Mode and allows the user to inspect or modify a parameter value.

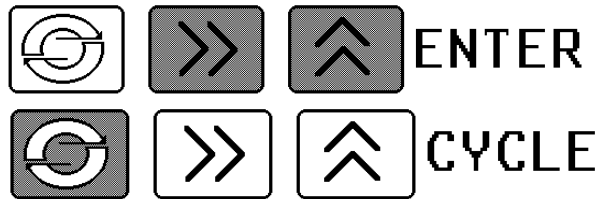
4.1.1 KEY DEFINITIONS

All programming is done using the three front panel keys. How these keys are used to program the instrument is shown in this tutorial. The functions of the keys are summarised as follows. The black symbols indicate the keys to press. Shaded keys indicate that the keys should be pressed simultaneously.

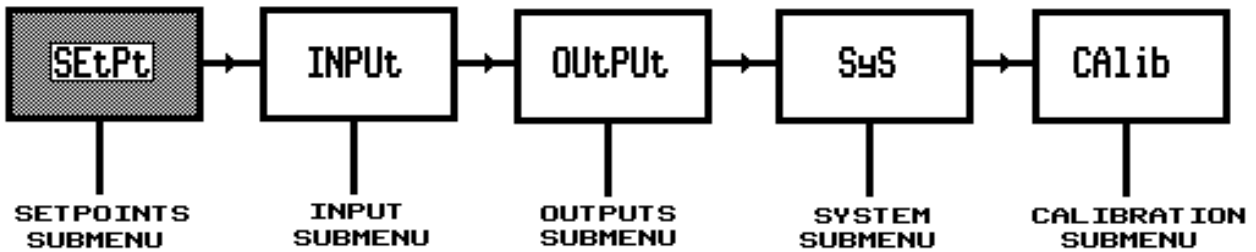
			CYCLE
			SHIFT
			INC
			ESCAPE
			ENTER
			CLEAR

4.1.2 GETTING INTO MENU MODE

The Menu mode is accessed from the Display PV mode by pressing the following sequence of keys.



The display will now show SETPt. In order to understand what this means, the following diagram shows where we are within the basic or Root menu structure.



4.1.2.1 MOVING AROUND THE MENU

We can browse through the other items in the Root menu by pressing

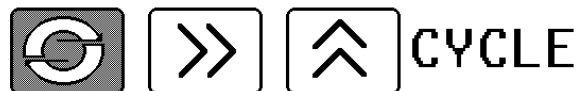


Subsequent presses of Cycle moves the menu position from right to left on the previous diagram of the root menu. Notice that after reaching CALIB, the menu position wraps around to the start. This principle of menu operation is applied throughout the system.

4.1.2.2 GETTING INTO A SUBMENU

Up to now we have simply moved within the Root menu, in order to get into a submenu, we must first cycle around the Root menu until the required submenu is displayed.

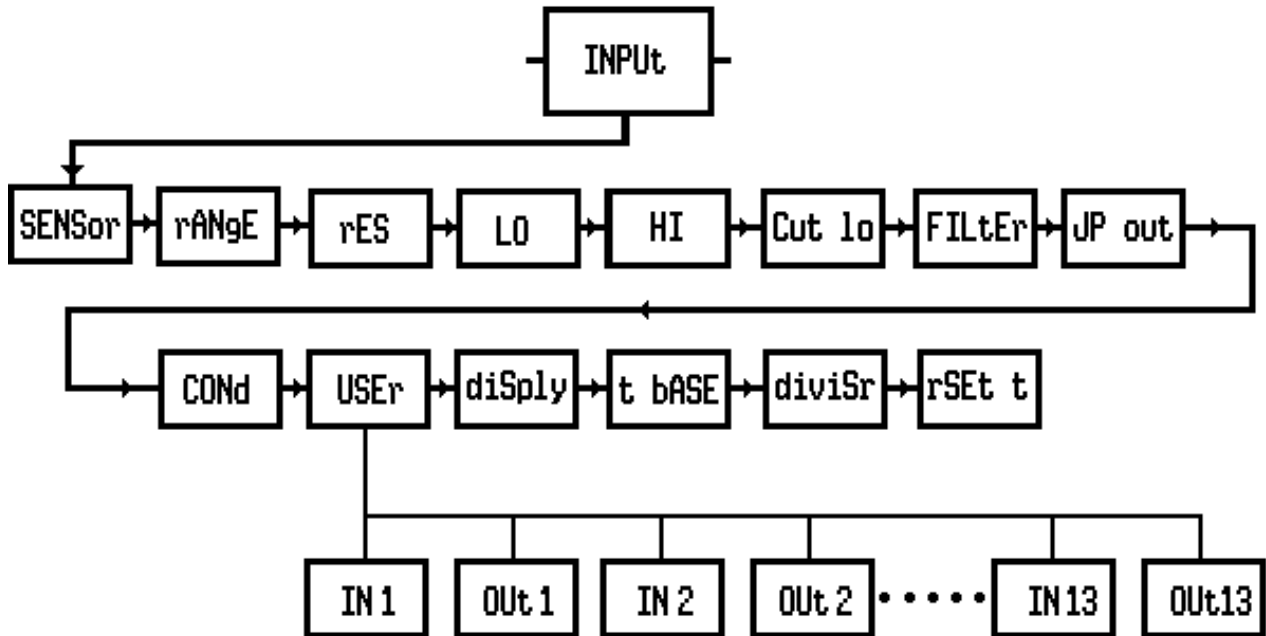
For the purposes of this tutorial press the CYCLE key until InPut is displayed.



In order to get into the INPUT menu simply press the SHIFT key.



SENSor will now be displayed; we are now in the Input submenu. The diagram below shows our position in relation to other items in the menu.



As before, pressing the **CYCLE** moves the menu position from left to right, wrapping around at the end. Do not worry if the contents of the menu as shown above is not exactly as you find; the unit alters items in the menu list depending upon settings made.

4.1.3 EDITING A PARAMETER

Although the items displayed in the menu can either be submenus or parameters, most of the items in the Inputs menu are parameters. This means that they can be edited.

Press the CYCLE key until **SENSOR** is displayed,



and then press SHIFT.

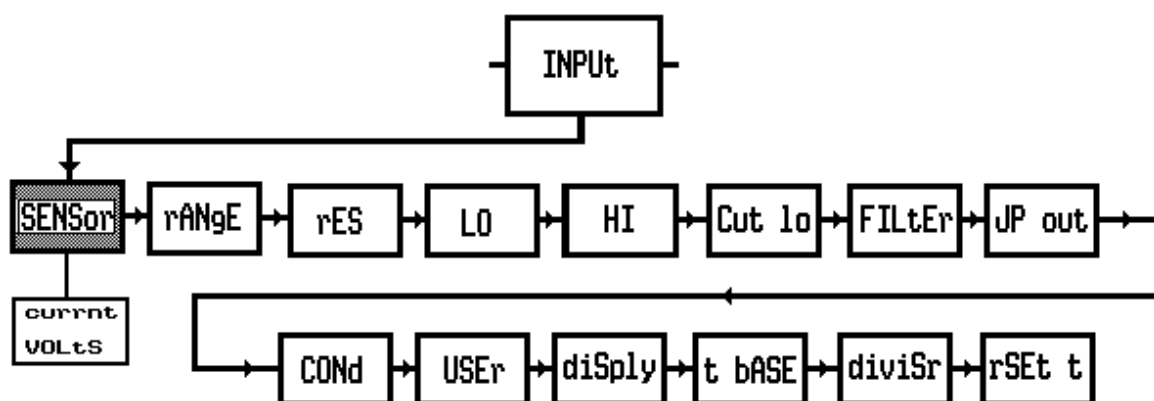


We are now in EDIT mode. This mode is indicated by a flashing display. The display shows the contents of the parameter being edited. The flashing entry is most likely to be **currnt**. This means that the Input sensor type was previously set to monitor current inputs.

This item is changed by pressing the INC key.



The choice of options available will be found to be as follows:-

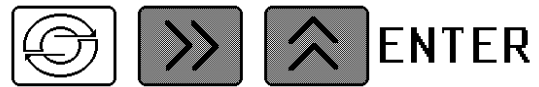


INCrement the edit options around until **Volts** is displayed flashing.

Note that whilst the display is flashing, the option on the display has not been saved to memory.

To select an option, the ENTER key sequence is used.

Now press ENTER.



The display will be seen to stop flashing momentarily before returning to Menu mode. Instead of returning back to the **SENsOr** entry, **rANgE** will now be displayed. The system has automatically stepped on to the next entry to speed the process of programming.

This method of editing parameters is repeated broadly throughout the menu structure, with the exception of programming number fields which will be dealt with next.

The method of editing a field is a bit different, though as easy as for any other entry. As before, we will see it through an example.

Cycle around the Inputs menu until **Hi** is displayed.



This is the engineering high range value, although its function is unimportant in the tutorial, it simply provides a numeric field to edit.

As before pressing SHIFT takes us into the edit mode.



The value on the display will have its most significant digit flashing and represents the value previously entered for the engineering units high range.

As before, the INC key modifies the editable value, but this time, this will only be the digit flashing. This digit is said to be under the edit cursor.



To move the edit cursor, press the



The edit cursor moves one digit to the right. If the SHIFT key is repeatedly pressed, the edit cursor will be seen to wrap around to the most significant digit once more.

Therefore it can be seen how a number may be programmed in this field by selective use of the INC and SHIFT keys. We could enter the edited value as done in the previous example, but for the purposes of this tutorial we shall abandon the edit.

This is done using the ESCAPE key sequence.



Pressing this returns us to the MENU mode, showing **FiltEr**, the next item in the Input menu.

We could go on and program other items within this or other menus using the same principles as we have done in the previous examples. Instead, we shall return to the Root menu, and then back to the DISPLAY PV mode.

4.1.4 RETURNING FROM SUBMENUS

It has been shown that the method of getting into a submenu is pressing the SHIFT key on a submenu item. The reverse operation is to press the ESCAPE key.

This may be done anywhere in a menu. Pressing the ESCAPE key from our current position in the Inputs menu takes us back to the Root menu.



OUtPUt will now be displayed, as the menu position has automatically stepped on to the menu item.

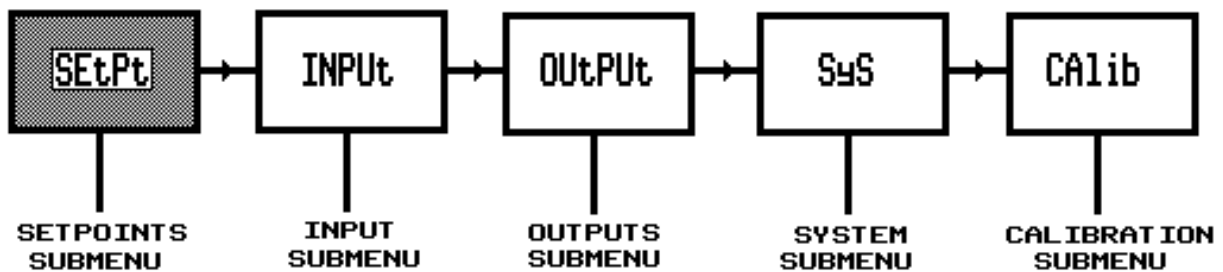
The Root menu, as its name suggests is not a submenu. Pressing the ESCAPE key sequence whilst in the Root menu will take the user out of MENU mode and into the DISPLAY PV mode. Thus the monitored process variable will be shown on the display.

Note that escaping to DISPLAY PV mode saves all programmed data to non-volatile memory, retaining it during switch off.

4.2 THE MENUS

The previous section explained how to get into program mode, to move around the menus and how to edit. This section details the contents of the menus and explains how to program the unit for your own particular application.

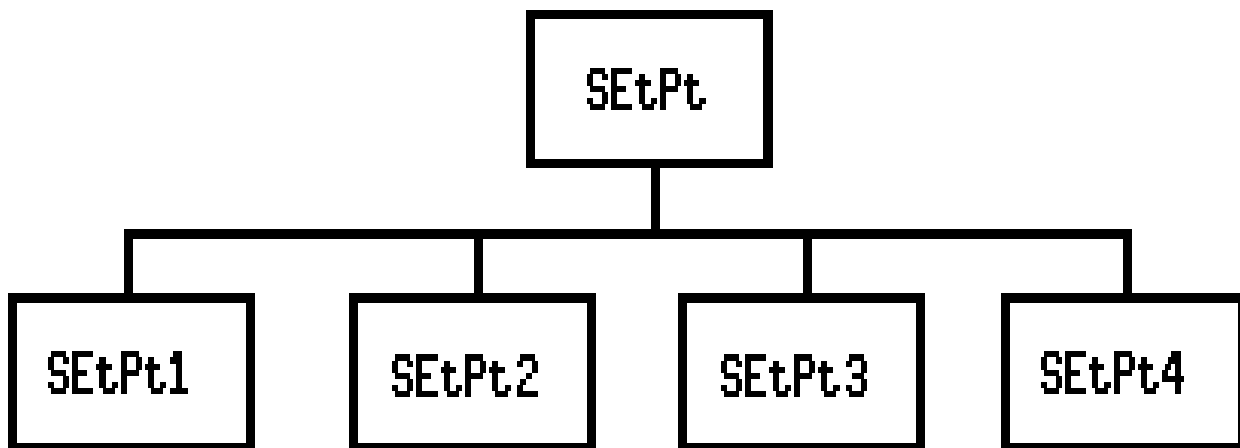
As described before, Program mode is entered by pressing ENTER then CYCLE from the process variable display. This takes the system into the Root menu. The Root menu is divided into five submenus: SETPOINTS, INPUTS, OUTPUTS and CALIBRATION.



Note: If there are analog output options fitted (Current output or Voltage output) in both output slot positions, there will not be any setpoints available and the SETPOINT submenu will be removed from the Root menu.

4.2.1 The SEtP (SETPOINTS) submenu

This submenu is provided as a quick means of modifying setpoints. Only the setpoint values are available to be changed. The availability of the setpoints depends upon the output options fitted. The logic directing this is discussed in detail in section 4.2.3, under the Output submenu section. With this in mind, it should be taken that any or all of the setpoints (1 to 4) could be unavailable and therefore removed from the submenu. If all setpoints are unavailable then the entire submenu is occulted. The submenu is represented as follows:-



The setpoint can apply to either the Rate value or the totalised value; this is something selected within the Outputs submenu. If the setpoint has been designated a Rate setpoint, five digits are available to be programmed, if the setpoint applies to total, a six digit value may be programmed. Note that these six digits apply to the least significant portion of the twelve digit totalise count.

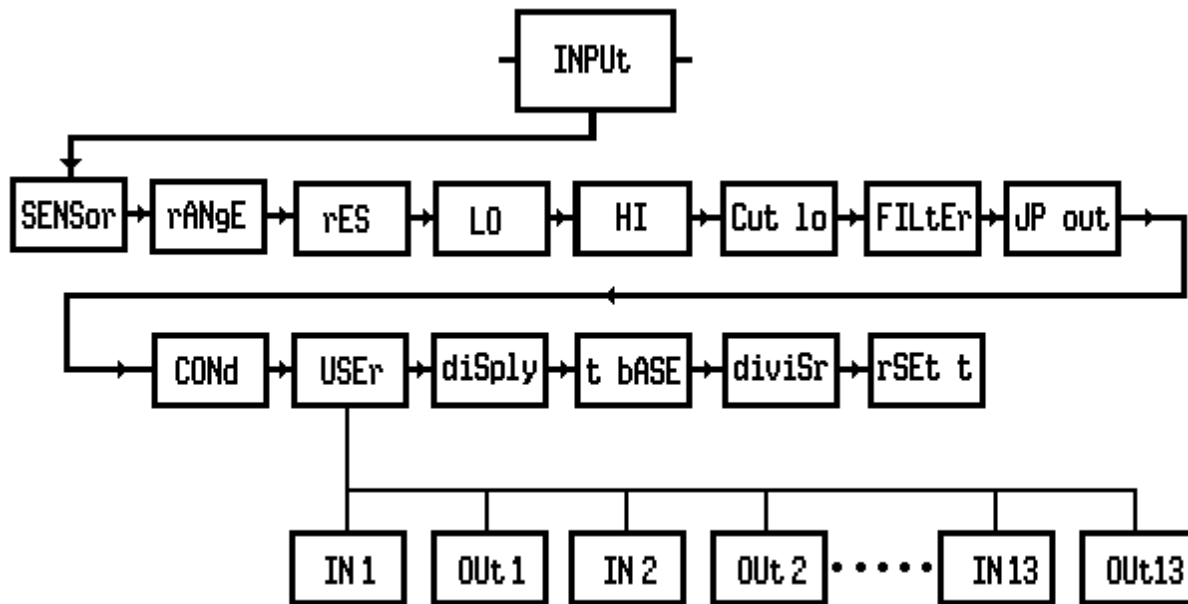
If the setpoint applies to a rate, the editable value is the setpoint in engineering units. The number of decimal places for this field is defined by ``rES'' in the Inputs menu.

The default value for all setpoints is **zero**.

4.2.2 The INPUT submenu

This submenu is used to program all the characteristics of the input sensor and any signal conditioning that may be required. The selection of an option in the list may effect items further down. Therefore, during programming, the user should start at the top of the menu and work down, to avoid setting an option which may later become obsolete.

The structure of the Input menu is represented in the following diagram.



4.2.2.1 SENSOR (Type of sensor connected)

This parameter defines the type of electrical sensor connected.

There are two options.

currnt	(Current inputs, internally generated loop)
VoltS	(Voltage input, including millivolts)

default setting: **currnt**

4.2.2.2 rANgE (electrical range)

This parameter will define the electrical range that the instrument will operate on.

The options available will vary between these two settings.

4.2.2.2.1 rANgE [SENSOR=currnt]

If the sensor type has been set to current, the following options are available.

4-20	(Internally generated 4-20mA)
0-20	(Internally generated 0-20mA)
0-10	(Internally generated 0-10mA)

default setting: **4-20**.

4.2.2.2.2 rANgE [SENSOR=VOLTs]

If the sensor type has been set to voltage, the following options are available.

0.100	(100mV on the millivolt input)
1	(1 Volt on the voltage input)
1-5	(1 to 5 volts on the voltage input)
10	(10 volts on the voltage input)

default setting: **0.100**

4.2.2.3 rES (Engineering units resolution)

This option defines the number of decimal places displayed for the Rate value.

There are four options:

8888	No places of decimal (integer value)
888.8	One place of decimal
88.88	Two places of decimal
8.888	Three places of decimal

Note that the Low and High engineering range adopts this resolution, as do the Rate setpoints, so consideration needs to be given to appropriate resolution for the required application. There are five digits allocated for all engineering Rate values, so the number of significant figures must fit within this field. It is advised that the number of decimal places is set before the engineering range is programmed. There are five digits allocated for all engineering values, so the number of significant figures must fit within this field.

If there are more significant digits than can be displayed, the number will be right justified.

default setting: **888.8** (One place of decimal)

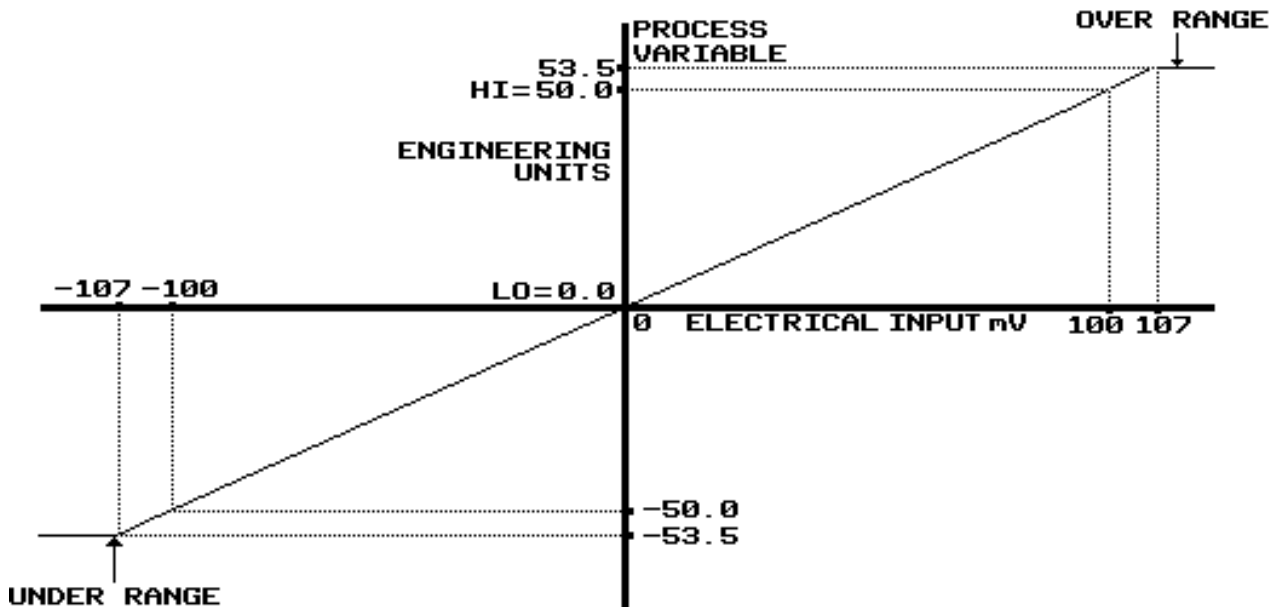
4.2.2.4 LO and HI (Rate Engineering range)

LO and HI are used to define the engineering range for Rate.

This range applies to low and high electrical inputs being monitored by the unit. For example, if the electrical input has been set to Volts, on the 100mV range, and it is required that the Rate value be 0.0 at 0mV input and read 50.0 at 100mV, LO and HI are set to the following values:

LO = 0.0 HI = 50.0

The Rate value will increase linearly from 0.0 to 50.0 as the millivolts increase from 0 to 100. Similarly as the millivolts reduce from 0 to -100 the Rate falls from 0.0 to -50.0. This relationship is shown on the following diagram.



On all ranges, a 7% overhead is allowed on the scale before the unit detects an out-of-range signal. If the input signal is out of range at the positive end of the scale, **OVER** is displayed instead of the Rate display. If out-of-range at the negative end, **Under** is displayed.

Note that the maximum value that may be entered is **64000**.

default setting: **LO: 0.0; HI: 100.0**

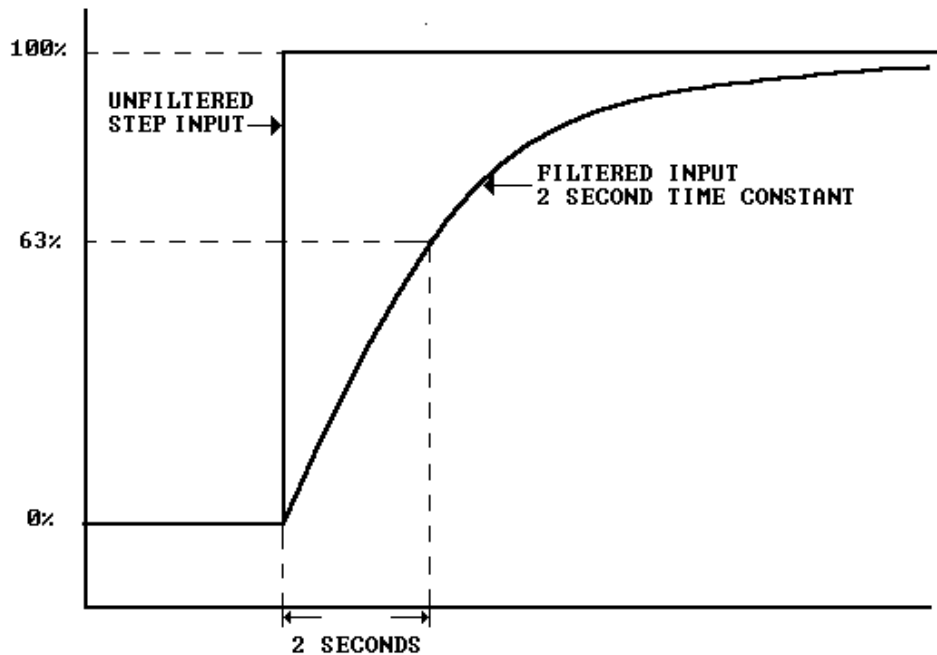
4.2.2.5 Cut Lo (Rate input cut off)

This parameter, scaled in electrical units forces the Rate value to the low engineering range when the electrical input is below this value. It is particularly useful to disregard inputs too small to be regarded as valid. Forcing these Rates to zero, tidies up a reading that would otherwise be spurious. The Totaliser does not accumulate in this region. If the Cut Lo feature is not required, it should be set to the minimum electrical input value.

default setting: **4.00 mA**

4.2.2.6 FilteR (Input filtering or smoothing)

If an input is particularly noisy, it is possible to filter out noise using this programmable feature. There are eight filter values which may be selected. These filter factors represent the time it would take a step change in an input value to reach approximately 63% of its final value. See diagram below for illustration.



The following filter factors are available:

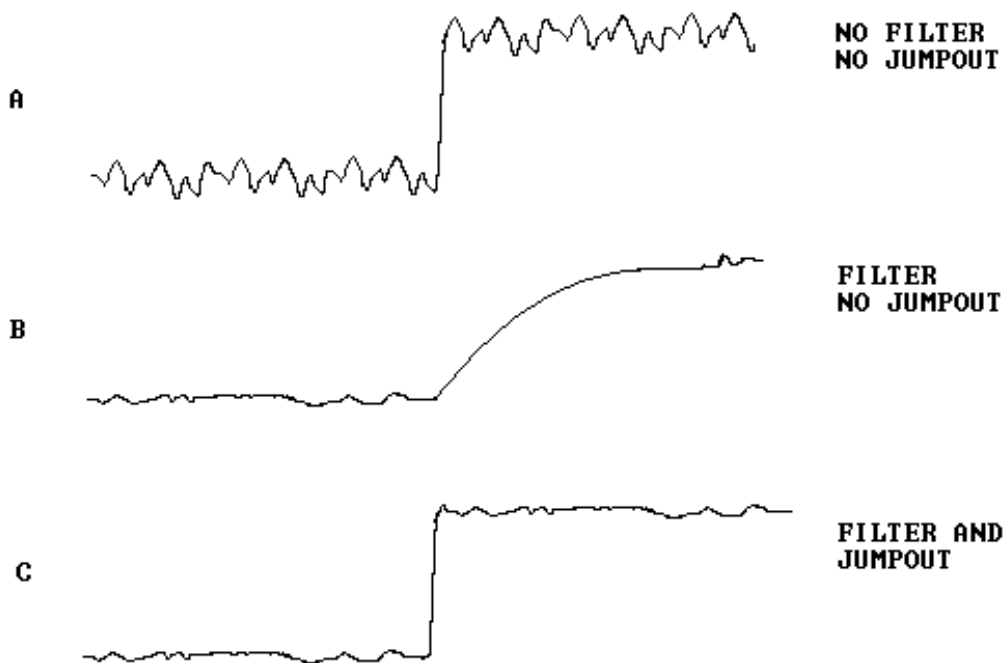
nonE	(Filtering switched off)
0.5 SEC	(Filter Factor 0.5 seconds)
1 SEC	(Filter Factor 1 second)
2 SEC	(Filter Factor 2 seconds)
4 SEC	(Filter Factor 4 seconds)
8 SEC	(Filter Factor 8 seconds)
16 SEC	(Filter Factor 16 seconds)
32 SEC	(Filter Factor 32 seconds)

default setting: **2 SEC**

Also see jump out in section 4.2.2.7

4.2.2.7 JP out (Filter jump out)

This sets the change in input value, expressed as a percentage of full scale, below which the filter operates and above which the filter is inoperable. This enables the indicator to respond quickly to large changes, whilst filtering smaller noisy signals. The diagram below shows the operation of the Jumpout on a filtered input. Each of the waveforms is based upon the same raw input 'A'. By setting the Jumpout band just greater than the noise level; the filtering is switched off for any change in actual signal. In this way, a compromise between heavy filtering and signal response can be reached.



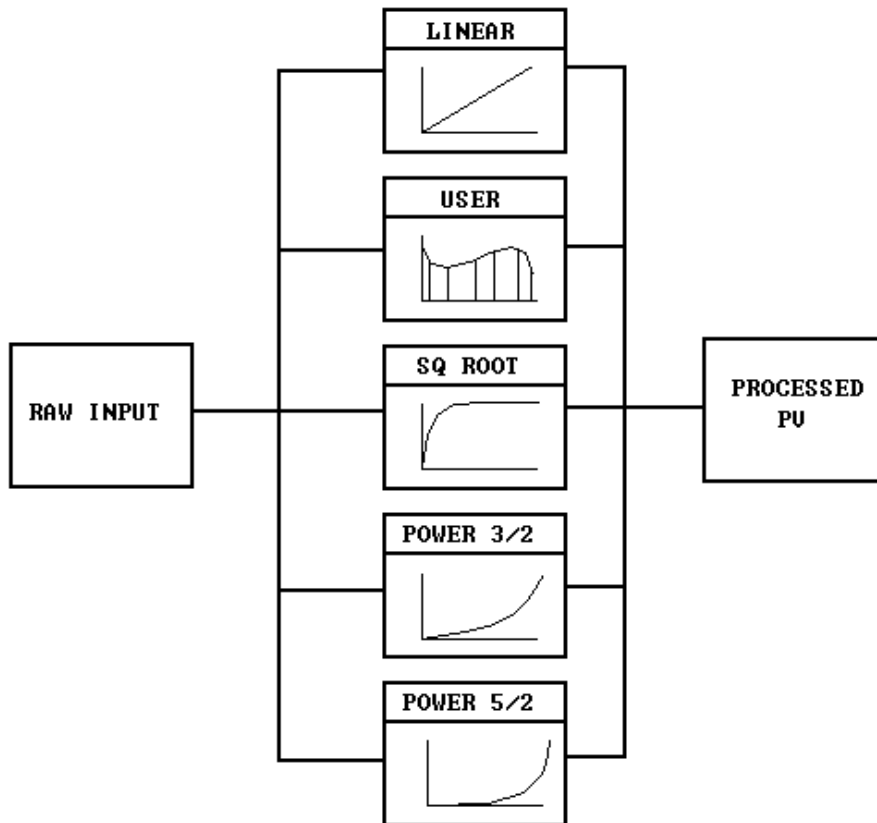
The following options are available:

- nonE** (No jump out, filter in operation all of the time)
- 1 PEr** (Jump out band, 1% of engineering range)
- 5 PEr** (Jump out band, 5% of engineering range)
- 10 PEr** (Jump out band, 10% of engineering range)

default setting: **1 PEr**

4.2.2.8 Cond (Input conditioning)

This option enables the user to specify a linear, square root, root 3/2, root 5/2 or a user defined function for the Rate input characteristic.



The five options are:

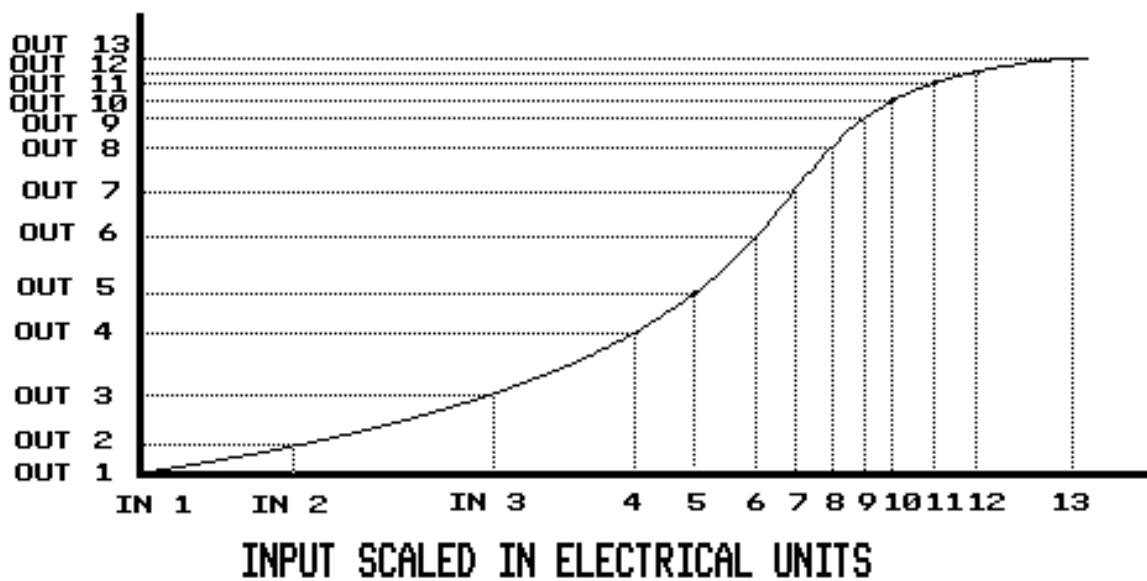
LinEAr	(Linear relationship, no conditioning)
USEr	(User defined characteristic. See 4.2.2.9)
S root	(Square root Law. See 4.2.2.10)
root32	(Power 3/2 law. See 4.2.2.11)
root52	(Power 5/2 law. See 4.2.2.11)

default setting: **LinEAr**

4.2.2.9 User linearisation

Selection of this option for **Cond** allows access to the User submenu. Within this menu, thirteen points may be programmed to relate electrical input to a user defined Rate characteristic in engineering units. These points are represented by IN and OUT entries within the menu, where IN are the electrical inputs and OUT the resultant engineering value. An example of a user linearisation utilising all thirteen points is shown below.

OUTPUT SCALED IN ENGINEERING UNITS

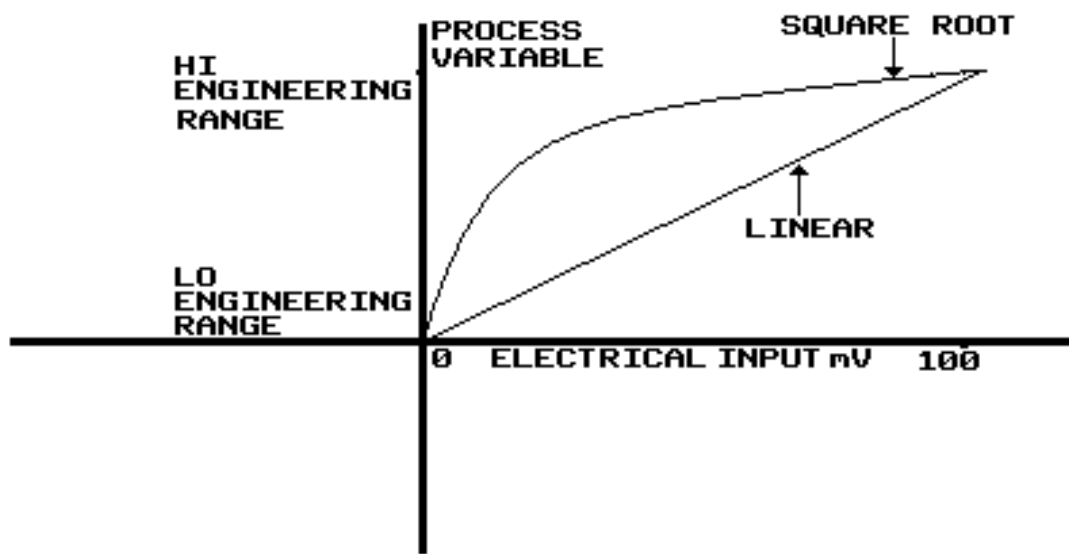


There are a few rules which should be observed when using this facility.

- The HI and LO values for engineering range should have been set before any entry of data. Any engineering values entered should lie between HI and LO.
 - The entries for the electrical inputs should progressively increase. There is no such restriction on the engineering units.
 - If not all thirteen points are used, it is necessary to reproduce the values in the last entry in entry 13.
 - Any electrical input falling outside the bounds specified by the table will be regarded as out of bounds and under-range or over-range will be indicated instead of the Process Variable. If a small amount of valid signal over/under range is required, this must be built into the linearisation table.
-

4.2.2.10 Square Root.

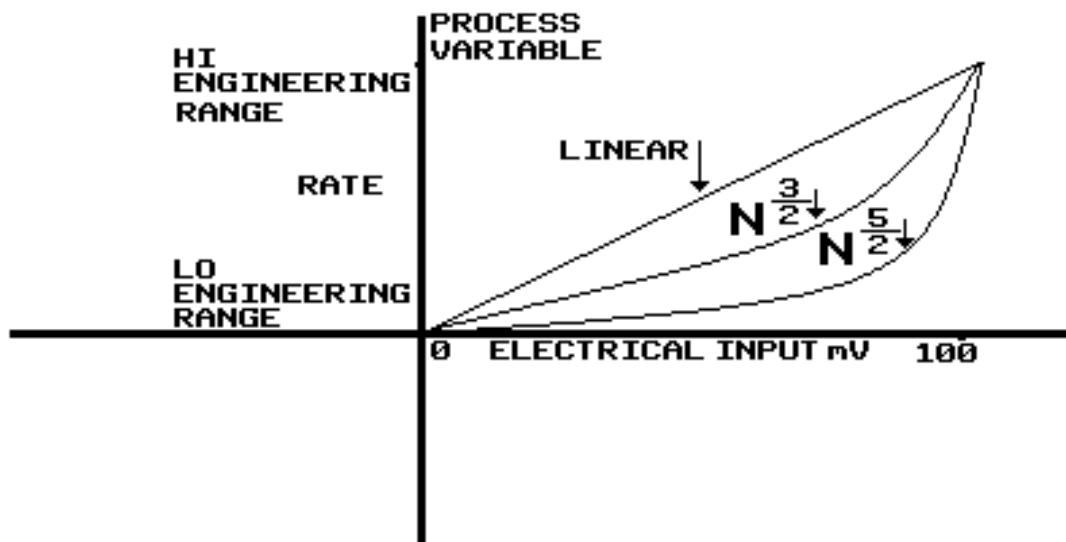
When the Square root characteristic has been selected, the engineering range will still increase from LO to HI as the electrical input is increased, but the response will be a square root rather than Linear, see diagram below.



The bottom 1% of the range is made linear to avoid the near infinite gradient at zero. The Process Variable is set to Low engineering range for all negative electrical inputs.

4.2.2.11 Root 3/2, Root 5/2 Power Law

The root 3/2 and root 5/2 characteristics are for specific applications. For example, calculation of Flow Rate from rectangular and 'V' notch weirs require these non-linear corrections. The operation of the characteristic is the same as for square root except that the bottom 1% is not made linear, the response is as follows.



4.2.2.12 diSPLY (Display parameter)

The instrument has two variables of interest: Rate and Total. Both of these are available to be shown on the display during RUN DISPLAY MODE, but obviously there can only be one shown as the primary display. The other is accessible as the secondary parameter by pressing the SHIFT key down. The display will return to the primary display a short time after releasing the SHIFT key.

This option selects the parameter, either Rate or Total which is shown on the display as the primary parameter. This option does not affect any of the output options, only what is shown on the display. If Total is chosen as the primary display, only the lower six digits are shown. The most significant six digits are available by pressing ESCAPE whatever has been selected as the primary display.

The two options are:

rAtE (Rate display shown. Total available as secondary)

tOtAL (Total display shown. Rate available as secondary)

default setting: **rAtE**

4.2.2.13 t bASE (time base for the totalise)

The time base is required for the totalise calculation and is taken as the time factor associated with the Rate input. For instance, if the engineering range for the Rate has been programmed to reflect 0 to 100 litres per hour, the time base should be programmed with hours.

There are three possible options:

SECS (Rate in units per second)

60SECS (Rate in units per minute)

hour (Rate in units per hour)

default setting: **SECS**

4.2.2.14 diviSr (Divisor applied to the Totalise)

This factor divides into the Totalise value to get a more flexibly scaled total. It adds the convenience to divide by 1000, say, to convert litres into kilolitres. The range of the divisor is 1 to 9999.

default setting: **1**

4.2.2.15 rSEt t (Reset Total from front panel)

This option allows the facility of resetting the Totalised value to zero from the front panel. If enabled, pressing CLEAR in RUN DISPLAY MODE resets all twelve digits of total.

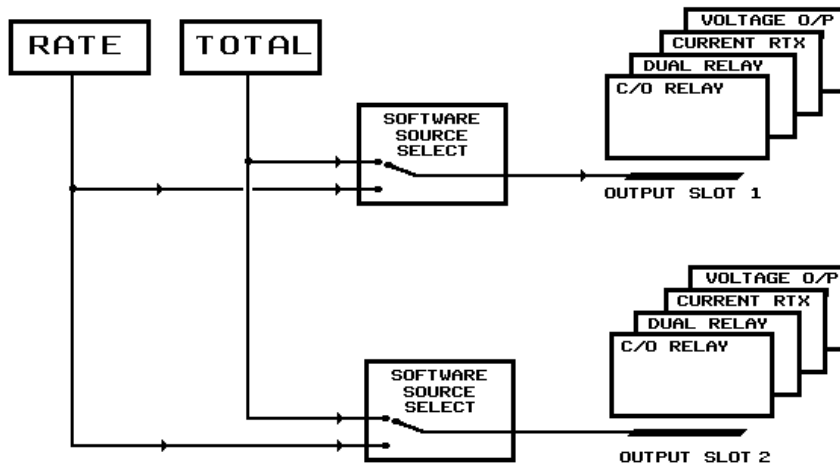
The two options are:

- | | |
|---------------|---|
| diSAbL | (Disables front panel reset facility) |
| F PANL | (Enables front panel reset facility) |

default setting: **diSABL**

4.2.3 OUTPUT SUBMENU

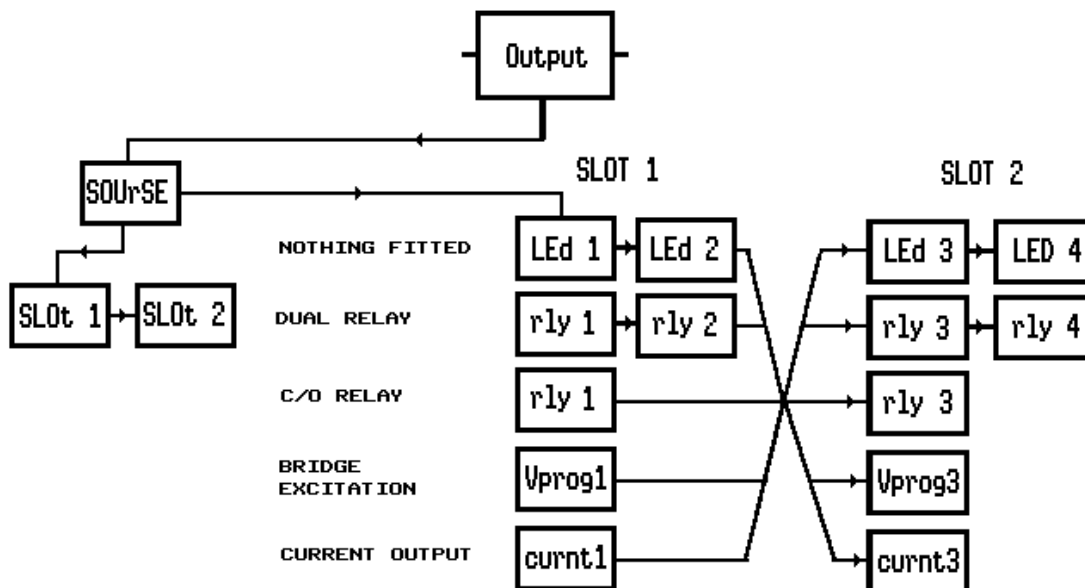
The diagram below shows a schematic of the output card arrangement.



Any of the four option output cards may be fitted in either slot 1 or slot 2. Rate or Total value may be used as the output process variable for either slot. The selection being done from the program menus.

The contents of the output menu will vary depending upon the type of card fitted in the output slot and the selected process variable.

Entry into the outputs menu presents a list of submenus relating to the output cards fitted. The conditions determining the availability of submenus is summarised below.



4.2.3.1 SourceE (Selection of Output slot PV)

This submenu contains two parameters, Slot 1 and Slot 2 which may be programmed to select the process variable to be used to drive the output option in that slot position. The options and the default value for both parameters are the same. This flexibility means that it is possible to re-transmit Rate from one output slot and Total from the other, for instance.

Note that the selection of Rate or Total will effect the contents of the menus for each of the output board types except for the Voltage output card. In each case, both menu lists will be shown.

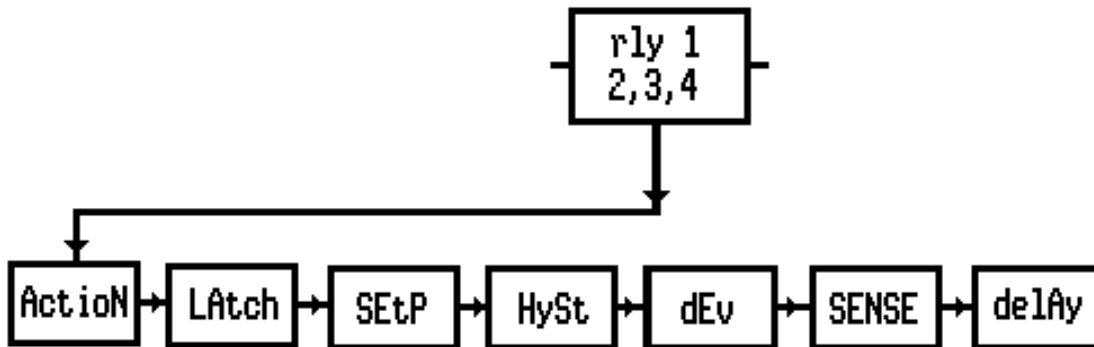
There are two options

- RAtE** (Select Rate as the slot process variable)
- TotAL** (Select Total as the slot process variable)

default setting: **Rate**

4.2.3.2 Relay and LED alarms submenus (Rate)

The submenus for the Relay and LED alarms are shown below.



Note that the only difference in content between them, is there is no SENSE option in the LED submenu. This is because the SENSE option relates to the activation of a relay and is therefore irrelevant if no relay is fitted. Both types of alarms activate an discrete LED on the front panel of the instrument if triggered, although this is all a LED alarm does, hence its name.

4.2.3.2.1 ActOn (Alarm action)

This programs how the alarm is to operate. The options are:

oFF	(Alarm inactive)
Lo	(Low alarm. Triggers when PV goes below setpoint)
Hi	(High alarm. Triggers when PV goes above setpoint)
dEv	(Deviation alarm.)

default setting: **oFF**

4.2.3.2.2 LAtch (Latch enable for an alarm)

When Latch is enabled, the alarm remains set once triggered, even when the Process Variable has returned to a non alarm condition. A non-latching alarm is self-resetting when the alarm condition is removed.

Pressing CLEAR from the RUN DISPLAY MODE, clears a latched alarm if not in an alarm state.

The options for this are:

FALSE	(Latch disabled)
trUE	(Latch enabled)

default setting: **FALSE**

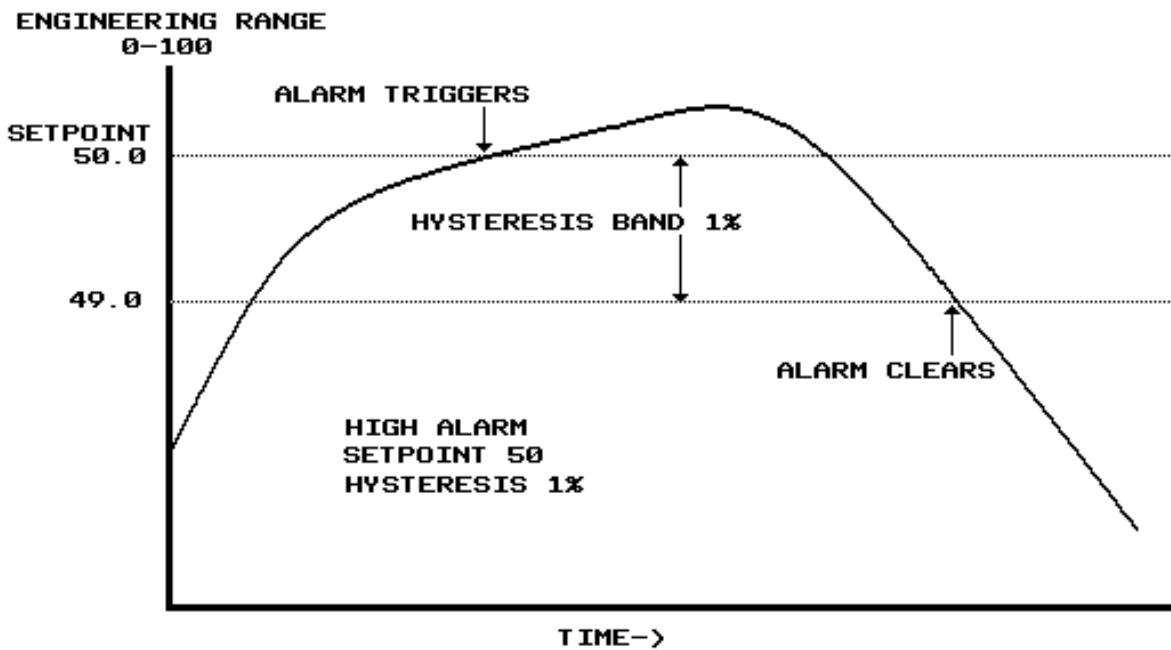
4.2.3.2.3 SEtP (Alarm Setpoint)

This entry allows the user to program the setpoint value. This is entered in engineering units. This can also be set from the SEtP menu which provides a quick means of adjusting setpoints whilst running.

default setting: **0.0**

4.2.3.2.4 HySt (Alarm hysteresis or dead band)

This enables the hysteresis or dead-band to be programmed. This is the difference between the points at which the alarm triggers and releases and is expressed as a percentage of engineering range. For high and low alarms, the alarm triggers exactly at setpoint and is removed at the hysteresis level away from the setpoint. See example based upon a high alarm below.



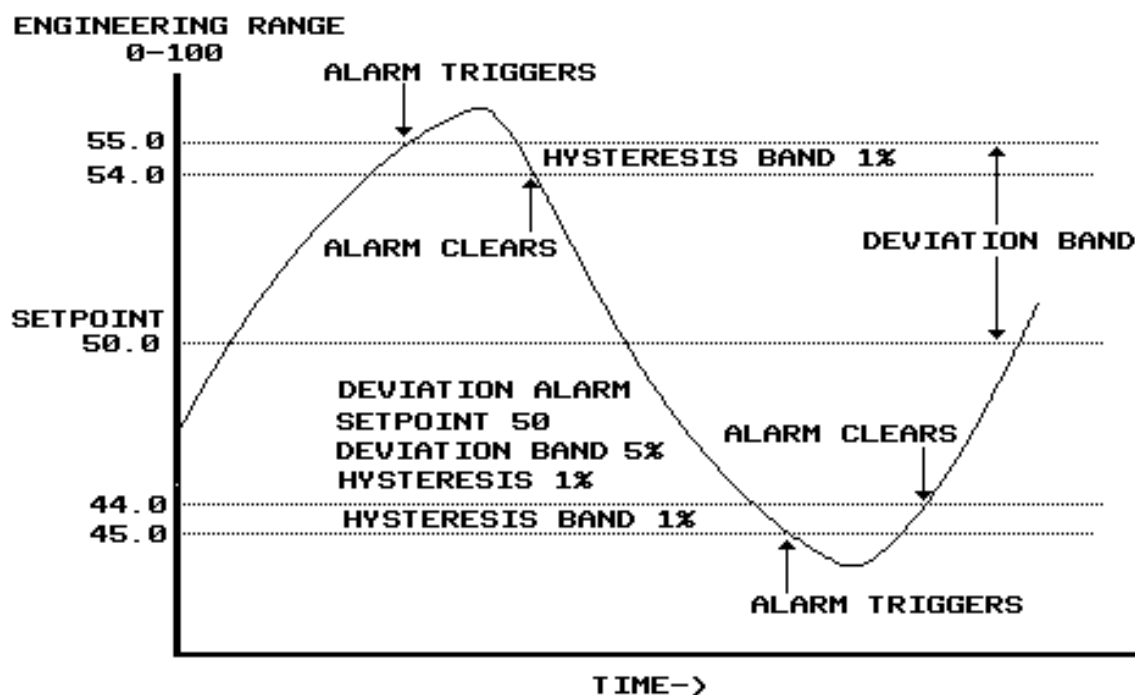
In the case of deviation alarms, the hysteresis is applied to each trigger point either side of the setpoint.

default setting: **0.00**

4.2.3.2.5 DEv (Deviation band)

This option will only appear if the alarm action is set for deviation, and it signifies the amount, as a percentage of the engineering range that the input variable may vary before the alarm condition is activated. This is illustrated in the example below.

The deviation alarm creates two alarm trigger points; one above and one below the



setpoint. The trigger points are equally distant from the setpoint. This is known as the deviation band and is a percentage engineering range.

Each of these trigger points may be regarded as an upper and lower setpoint, and as such the operation of the hysteresis is as on individual upper and lower setpoints.

default setting: **0.00**



4.2.3.2.6 SENSE (Invert activation of relay)

This option sets the sense of the relay, ie in the event of an alarm, is the relay to be energised or de-energised.

The options are:

- noninv** (energise relay on alarm, de-energise normally)
- iNv** (energise normally, de-energise relay on alarm)

This function is tied in with the fail safe requirements of the relay and its electrical configuration. The following table summarises all options.

	ALARM OPTION	POWER OFF	POWER ON	
			NO ALARM	IN ALARM
	NON INV	1:3 CLOSED 2:3 OPEN	1:3 CLOSED 2:3 OPEN	1:3 OPEN 2:3 CLOSED
	INV	1:3 CLOSED 2:3 OPEN	1:3 OPEN 2:3 CLOSED	1:3 CLOSED 2:3 OPEN
	NON INV	1:3 CLOSED 2:3 CLOSED	1:3 CLOSED 2:3 CLOSED	1:3 OPEN 2:3 OPEN
	INV	1:3 CLOSED 2:3 CLOSED	1:3 OPEN 2:3 OPEN	1:3 CLOSED 2:3 CLOSED

default setting: **noninv**

4.2.3.2.7 dElAy (Delay before alarm activation)

This option allows a delay time to be programmed (in seconds) which must elapse between an alarm being detected and then indicated (and relay state changed).

The options are:

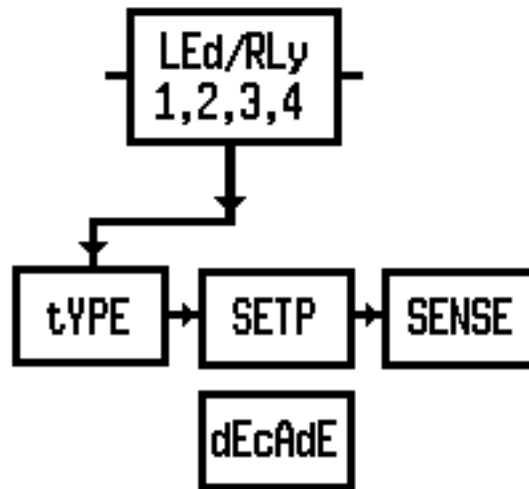
oFF	(No delay time)
1 SEC	(1 second delay)
2 SEC	(2 second delay)
5 SEC	(5 second delay)
10 SEC	(10 second delay)
15 SEC	(15 second delay)
20 SEC	(20 second delay)

If the alarm condition is removed during the delay period and then re-applied, the delay time starts again from the time the alarm condition re-occurs.

default setting: **oFF**

4.2.3.3 Relay and LED alarms submenus (Total)

The submenus for the Relay and LED alarms are shown below. Note that the menu contents will vary depending upon the setting of the **tYPE** option.



4.2.3.3.1 tYPE (Type of Relay operation)

This option selects between modes of operation of the alarm. The options are:

- triP** (Alarm operates as a Totalise trip)
- PuLSE** (Operates as a pulse output)

default setting: **triP**

4.2.3.3.2 SEtP (Trip Setpoint)

This menu entry is displayed if the typE option has been set to triP.

This sets a six digit setpoint on the least significant part of the twelve decade total. This is an integer value which relates to the scaling of the Totalised value.

default setting: **000000**

4.2.3.3.3 SEnSE (Trip Sense)

This menu entry is displayed if the typE option has been set to triP.

This option determines whether the Alarm is activated above the setpoint or below the setpoint. There are three options:

- oFF** (Trip is disabled)
- oVEr** (Trip above setpoint)
- UndEr** (Trip below setpoint)

default setting: **oFF**

4.2.3.3.4 dEcAdE (Totalise decade pulse output)

This menu entry is displayed if the typE option has been set to PULSE. The pulse output operates every time a pre-selected decade on the totalise increments. This parameter defines the decade. Everytime the decade increments, a 100ms pulse is issued to the relay. It is important that the decade selected is not able to change faster than once per second, as this is the maximum speed of the pulse output detection.

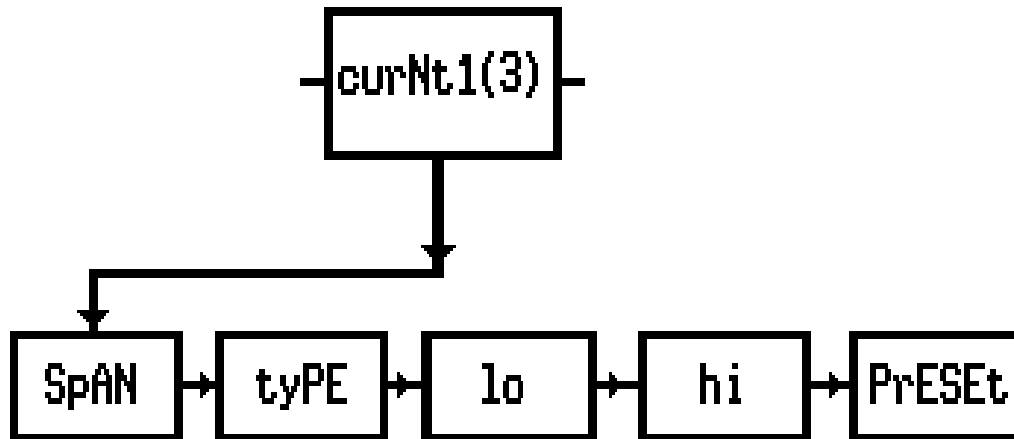
There are six options:

100000	(Pulse output every 100000 units)
010000	(Pulse output every 10000 units)
001000	(Pulse output every 1000 units)
000100	(Pulse output every 100 units)
000010	(Pulse output every 10 units)
000001	(Pulse output every unit)

default setting: **100000**

4.2.3.4 curnt1(3) CURRENT O/P (Rate)

The current re-transmission board provides a range of current output options. If fitted, and Rate chosen for the process variable, the following menu will be shown.



4.2.3.4.1 SPAN (Output current span)

Span is the current range that the output board is to operate.

The options are:

4-20mA (Output current will vary from 4 - 20mA)

0-20mA (Output current will vary from 0 - 20mA)

default setting: **4-20**

4.2.3.4.2 tyPE (Type of output operation)

This determines the type of operation. The choices are either fixed programmable output or current retransmission based upon the input signal.

The options are:

rEtrAN (Retransmission of the input)

PrESEt (Constant preset output)

default setting: **rEtrAN**

4.2.3.4.3 lo (low retransmission range)

This is the engineering value at which the current output will be at its minimum value (either 0 or 4mA), depending upon the span setting.

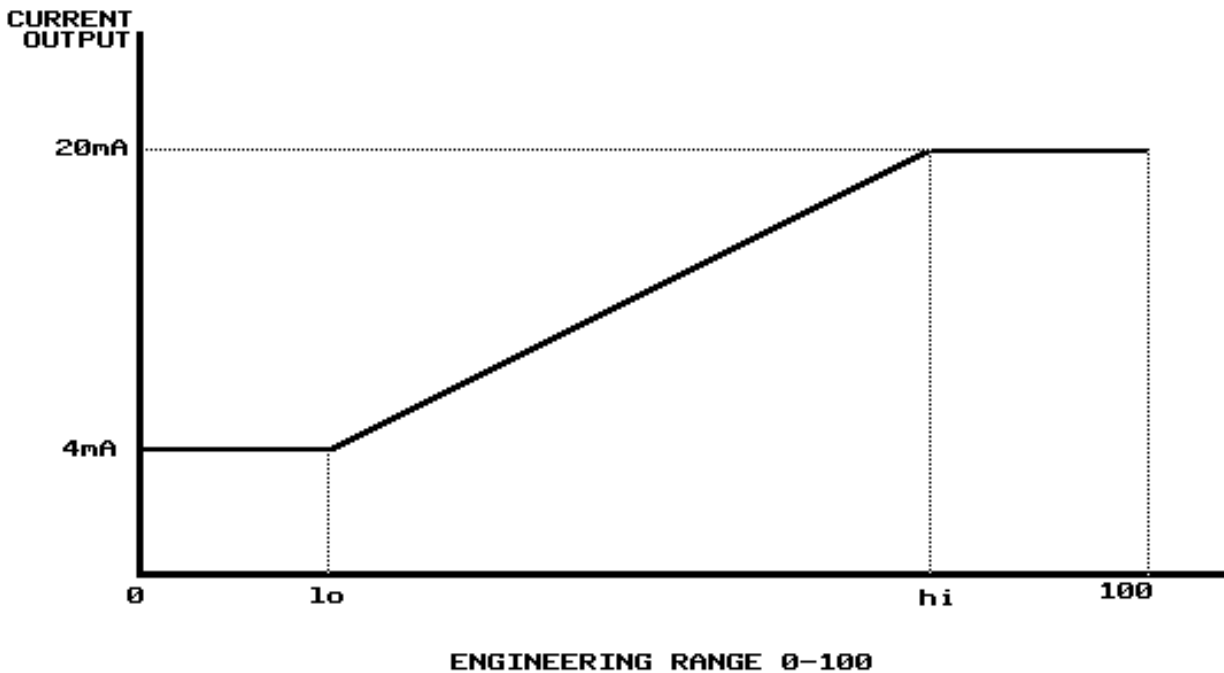
The value is entered as an engineering value.

default setting: **0.0**

4.2.3.4.4 hi (high retransmission range)

This is the engineering value at which the current output will be at its maximum value (20mA).

Note that it is acceptable for the hi range to be less than the lo; although both must be within the span of the input engineering range. See the diagram for an example of the operation of this feature.



default setting: **100.0**

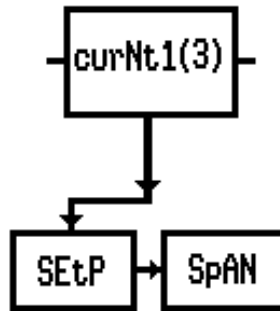
4.2.3.4.5 PrESEt (Preset output value)

This line is only available if `PrESEt` has been selected as the tyPE of operation. In this mode the current output will depend upon the value set within this programmable option. The value entered must fall within the hi and lo range and will cause 20mA to be output when set to the `hi` value and the minimum output current when set to the `lo` value.

default setting: **0.0**

4.2.3.5 curnt1(3) CURRENT O/P (Total)

If Total is selected for the Current Output the following menu will be shown.



4.2.3.5.1 SETP (20mA output level)

This six digit value determines the totalise value that will produce 20mA output. The current span will swing from minimum to maximum as the Totalise value goes from zero to SETP.

default value: **000000**

4.2.3.5.2 SPAN (Current output span)

This option the span that the current operates across.

The options are:

4-20 (Output operates 4-20mA)

0-20 (Output operates 0-20mA)

default value: **4-20**

4.2.3.6 Vprog1 (3) Bridge Excitation board

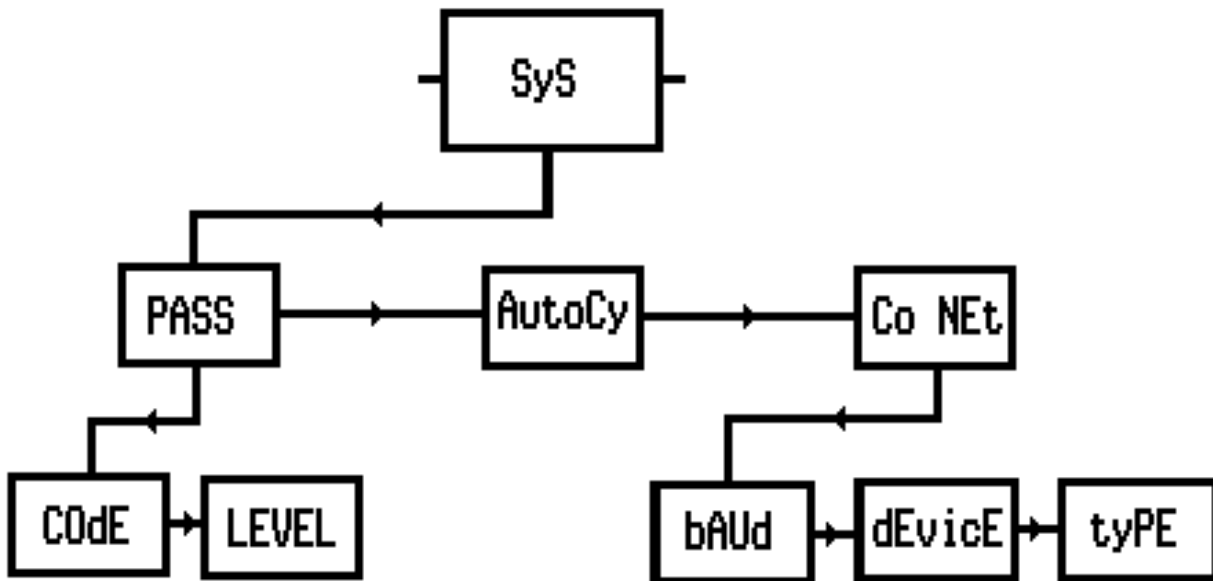
This menu entry is available when a bridge excitation board is fitted in either slot 1 or 2. This is used to program a fixed voltage output from the following range of options. The selection of the source has no effect on this option.

2	2 volts output
2.5	2.5 “
3	3 “
3.5	3.5 “
4	4 “
4.5	4.5 “
5	5 “
6	6 “
7	7 “
8	8 “
9	9 “
10	10 “
12	12 “
15	15 “
20	20 volts output

default setting: **2v**

4.2.4 SyS (System parameters submenu)

This submenu allows access to all of the system based parameters such as passwords and communications facilities. The system submenu is as follows:



4.2.4.1 PASS (Password submenu)

This provides access to the password submenu. The password facility provides protected access to the submenus within the root menu. The level of password protection works progressively down the menu.

This submenu is itself protected with a password. The message **ENtEr..PASS** will be displayed before showing the password template. This will be shown as four zeros with the leading zero flashing. This may be edited as an ordinary numeric field. The password should be entered. Pressing ENTER with the correct password takes the user into the submenu shown below. An incorrect password displays **ACCESS..dEniEd** before returning to the point of entry.

4.2.4.1.1 CodE (Password code)

This entry allows the user to modify the password code. The current password is shown as an editable numeric entry. Passwords are four digits long and can range from 0000 to 9999.

default setting: **4000**

4.2.4.1.2 LEvEL (Level at which passwords start)

The password level may be set up to start from any of the following levels.

- SEtPt** (The passwords apply to all submenus)
- INPUt** (Passwords start from in INPUT submenu)
- OUtPUt** (Passwords start from the OUTPUT submenu)
- SyS** (Passwords start from the System submenu)
- CALib** (Passwords apply to the Calibration submenu only)

default setting: **CALib**

4.2.4.2 AUtOCy (Automatic cycle)

Autocycle is a parameter which is used to control the way that the menu operation works. If Autocycle is enabled (its default state), the menu steps on to the next menu entry after each menu item action. This is convenient when programing a completely new set of parameters into the unit. After each menu item has been programmed, the next one is stepped on to. There are certain situations, however, when this is inconvenient. Switching the Autocycle feature off (Setting to FALSE) will inhibit any automatic stepping.

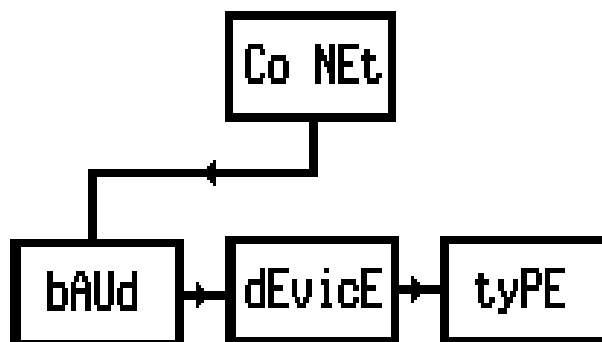
There are two possible options:

- trUE** (Autocycle enabled)
- FALSE** (Autocycle disabled)

default setting: **trUE**

4.2.4.3 Co NEt (Communications submenu)

This submenu contains the parameters required for the communications to operate on the instrument. The submenu is described as follows:



4.2.4.3.1 bAUd (Baud rate)

This allows the transmit and receive baudrate to be set. The options are:

75	(75 baud)
150	(150 baud)
300	(300 baud)
600	(600 baud)
1200	(1200 baud)
2400	(2400 baud)
4800	(4800 baud)
9600	(9600 baud)

Default setting: **9600**

4.2.4.3.2 dEviCE (Network Device number)

It is possible to multidrop up to 99 instruments on one network. The device number allocates a unique device reference for each individual unit. Note that without suitable buffering, there is a hardware limit of 32 instruments.

default setting: **1**

4.2.4.3.3 tyPE (mode of Comms operation)

It is possible to operate the instrument in one of two modes. If the instrument is to be operated within a network, or a host computer accesses selective data then Slave mode is used. The other mode, simply outputs a complete ascii status report, consisting of the process variable and the state of any alarms or output options. It is possible to dump this data to a dumb terminal or to a printer.

The options are:

SLAVE	(Slave mode)
ASC OP	(Ascii output report mode)

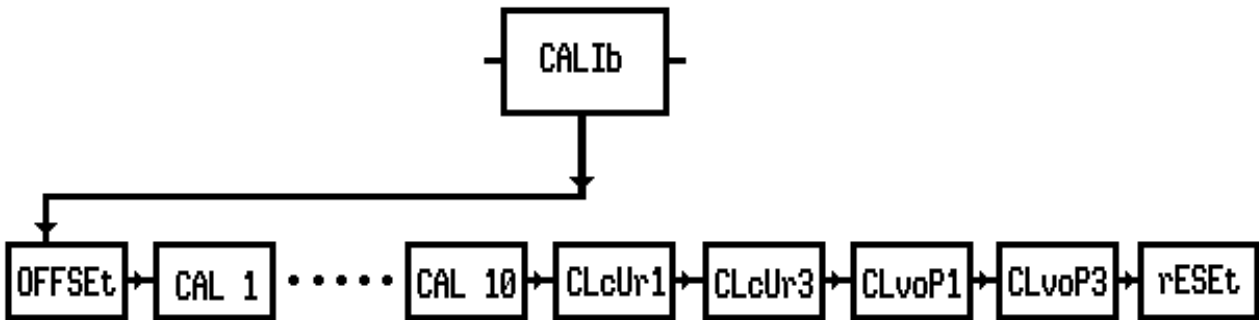
default setting: **SLAVE**

4.2.5 CALIb (Calibration submenu)

This submenu, which will always have password protection, provides access to enable the total (or partial) recalibration of the System. Casual access into this submenu is therefore discouraged.

Do not enter the CALIB submenu unless you know exactly what you are doing. If the calibration settings are disturbed, it may be necessary to return the unit to the factory.

The submenu may alter with the fitting of various output options, but is represented as follows:



4.2.5.1 OFFSEt (Input offset adjustment)

This is a numeric value in engineering units which is added to the Process Variable value in order to take out any system offset errors. This should be used with care as there is no indication in the Process Variable display mode that this offset is being applied and is thus capable of introducing an inadvertent error.

default setting: **0.0**

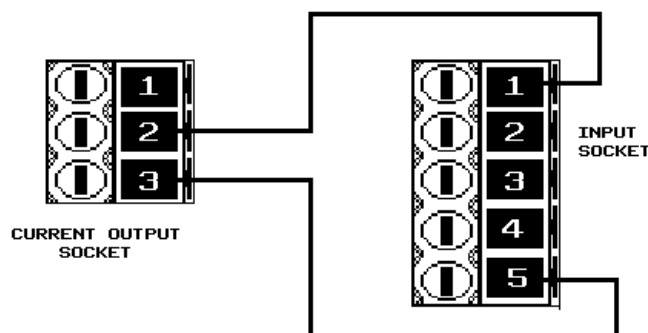
4.2.5.2 CAL 1,2,3,5,6,9 (Input Calibration points)

These are used to calibrate the input system. Not recommended for users.

4.2.5.3 CLcUr1(3) Calibrate Current (o/p) board

If the Current Output Board (Option 03) is to be fitted in the instrument by the user, it is necessary to use this entry to calibrate the option.

Connect up the Current output board to the Sensor input board as shown in below.



Press ENTER, to commence automatic calibration.



ENTER

The display will go blank for a few seconds as the instrument attempts to measure the actual performance of the output board. If the instrument returns with **Sig hi** or **Sig lo** check the wiring and retry. If this message persists, there may be a fault with the instrument and you should consult your supplier.

The instrument will display **Good** on successful calibration.

On completion ESCAPE back to the Process Variable display mode. This stores the calibration information into non-volatile memory.

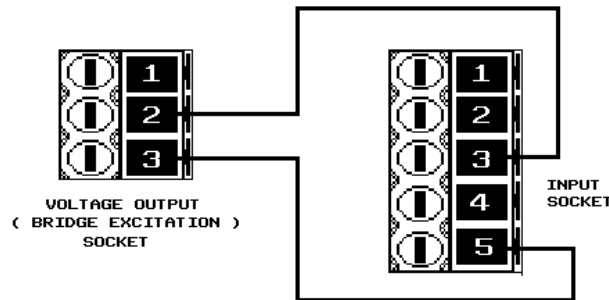


ESCAPE

4.2.5.4 CLvoP1(3) Calibrate Bridge excitation board

If the Voltage Output Board (Option 04,Bridge Excitation) is to be fitted in the instrument by the user, it is necessary to use this entry to calibrate the option.

Connect up the Voltage output board to the Sensor input board as shown in below.



Press ENTER, to commence automatic calibration.



The display will go blank for a few seconds as the instrument attempts to measure the actual performance of the output board. If the instrument returns with **Sig hi** or **Sig lo** check the wiring and retry. If this message persists, there may be a fault with the instrument and you should consult your supplier.

The instrument will display **Good** on successful calibration.

On completion ESCAPE back to the Process Variable display mode. This stores the calibration information into non-volatile memory.



4.2.5.5 rESEt (Set all parameters to default value)













Pressing ENTER on this option resets all programmable parameters to their default values.

5.0 OPERATION

Previous sections have shown how the unit may be configured for user applications. This section shows how the user may access additional information from the RUN DISPLAY MODE and an explanation of how the instrument processes input data and activates outputs.

5.1 USER OPERATION

The normal display shown in this mode is the Primary display parameter. There are other functions available which are summarised below.

KEYPRESS				ACTION
CYCLE				VIEW SETPOINTS
SHIFT				VIEW SECONDARY PARAMETER
ESCAPE				VIEW TOP SIX DIGITS OF TOTAL
CLEAR				CLEAR LATCHED ALARMS RESET TOTAL

   ENTER

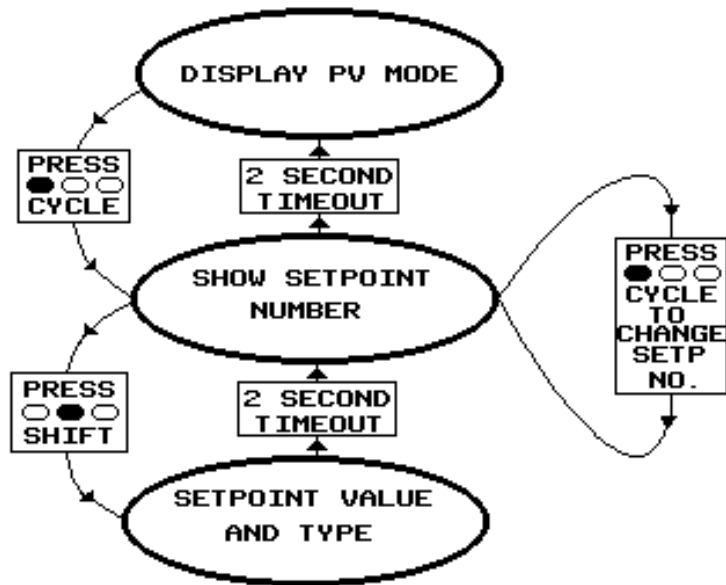
followed by

   ESCAPE

5.1.1 VIEW SETPOINTS

The function of this mode is to provide a quick read-only access to the Alarm setpoints (for either Rate or Total). This operation is easier to do than it is to describe and is therefore shown diagrammatically below.

Pressing the CYCLE key puts you into VIEW SETPOINTS MODE. The display will show the first setpoint number available to be viewed, possibly SEtP1. Successive pressings of the CYCLE key will list through the other available setpoints. If any setpoint value is required to be viewed, the SHIFT key is pressed. The actual setpoint value is now displayed.



If the setpoint relates to a Rate; the format of the display will be <alarm action><Setpoint value>

where alarm action will be one of four single characters:

o-Alarm Off, **L**-Low Alarm, **h**-High Alarm, **d**-Deviation Alarm

The Setpoint will be a five digit value scaled in the units of the Rate engineering range.

If the setpoint relates to a Total; the format will be a six digit value with the scaling of the lower six digits of the twelve digit total.

5.1.2 VIEW SECONDARY PARAMETER

There are two parameters available to be displayed; Rate or Total. One of these is chosen as the primary display from a menu selection in the Inputs menu. The remaining parameter is available for display by pressing the SHIFT key. This value will only be shown while the key is being pressed.

5.1.3 VIEW TOP SIX DIGITS OF TOTAL

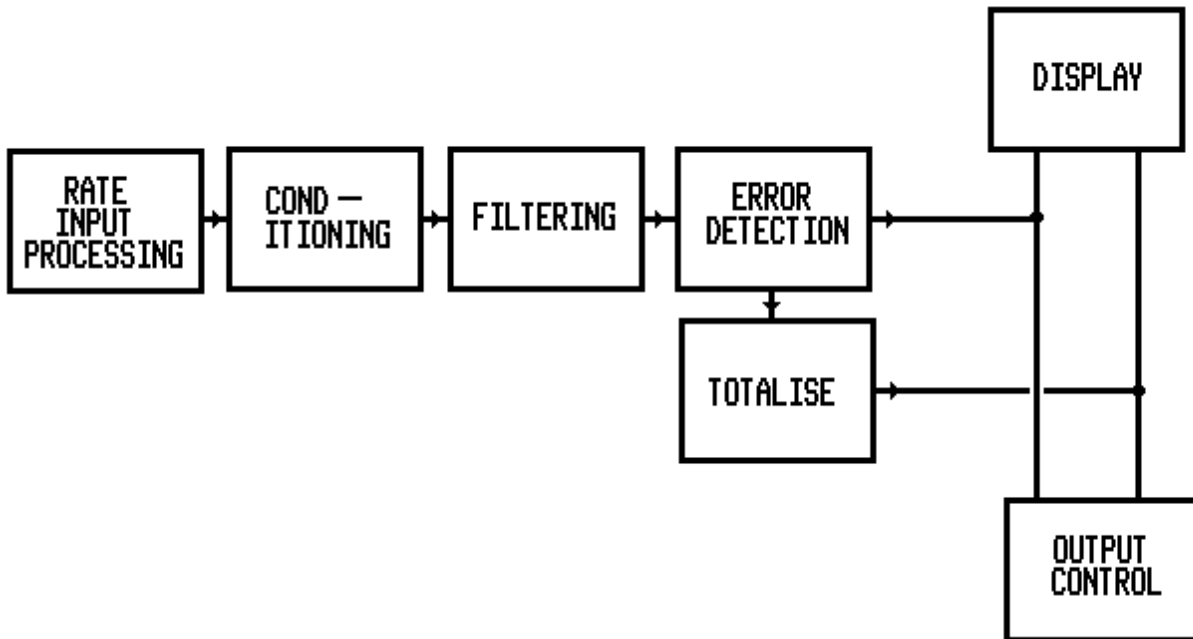
A twelve digit totalise value is continuously accumulated within the instrument whilst the Rate is valid. The lower six digits are used for Primary/Secondary display, the top six digits may be viewed by pressing the ESCAPE key.

5.1.4 CLEAR LATCHED ALARMS/RESET TOTAL

The CLEAR key has two functions. If there are any latched alarms, pressing CLEAR removes them. If the Reset Total from front panel feature has been enabled within the Inputs menu, CLEAR will also reset the twelve digit accumulator.

5.2 INSTRUMENT OPERATION

This section describes how the instrument processes input data and activates outputs. The diagram below shows the sequence of processing.



5.2.1 INPUT PROCESSING

The electrical input is read in and converted to a digital value corresponding to the Rate, and corrections are made for any drift or offset errors. Readings are made approximately 10 times a second.

5.2.2 SIGNAL CONDITIONING

This process removes any non-linearity within the raw Rate signal. The options are Linear, Square Root, Power Law or User Defined as programmed within the inputs menu.

5.2.3 FILTERING

The Programmable filter reduces noise from the conditioned input. There is an obvious trade off between speed of response and noise suppression.

5.2.4 ERROR DETECTION

The input sensor and the instrument are continuously monitored for faults. The range of checks are as follows.

5.2.4.1 UNDER RANGE/ OVER RANGE

If the input is found to be greater than 107% or less than -107% of full range it is limited to 107% and -107% of full range respectively. If this condition exists and the Rate is shown on the display, **OVER** or **UNdEr** will be shown in place of the Rate value. If the Total is shown on the Display, the current accumulated Total will be shown as normal, although it will no longer be updated by the Rate value. The value will therefore be frozen.

5.2.4.2 INSTRUMENT FAULTS

The instrument continuously checks itself. On detection of a hardware fault, one of a range of error codes will be displayed. These error codes have the following meanings.

Err 01 Non Volatile memory failure

Err 02 Ram Decode Error

Err 03 Ram Size unrecognised

Err 04 Input Card fault

Err 05 EPROM checksum error

Err 06 Ram Read/Write Fault

Err 07 Calibration Data corruption fault

Although rare, these faults are serious and normally will require return to your supplier for repair.

5.2.5 OUTPUT CONTROL

There are a range of output options which may be fitted to the instrument. Each output may be driven by either the Rate or the Total as programmed by the user. There are slight differences between how the Outputs operate if driven by Rate or by Total.

5.2.6 DISPLAY

The Display will show either the Rate or the Totalised value.

Rate Display

This will show the Rate in engineering units, filtered and conditioned. If any errors have been detected, they will be indicated on the display. The number of places of decimal are defined in the rES entry in the inputs menu, **but if there are more significant digits than can be displayed within the five digit field available, the number will be right justified.** For example 1234.567 will be displayed as 1234.57. Although the electrical input is updated ten times a second, the display is updated at the visually more practical rate of three times a second. The most significant 6 digits of Total are available on pressing the ESCAPE keys.

Total Display

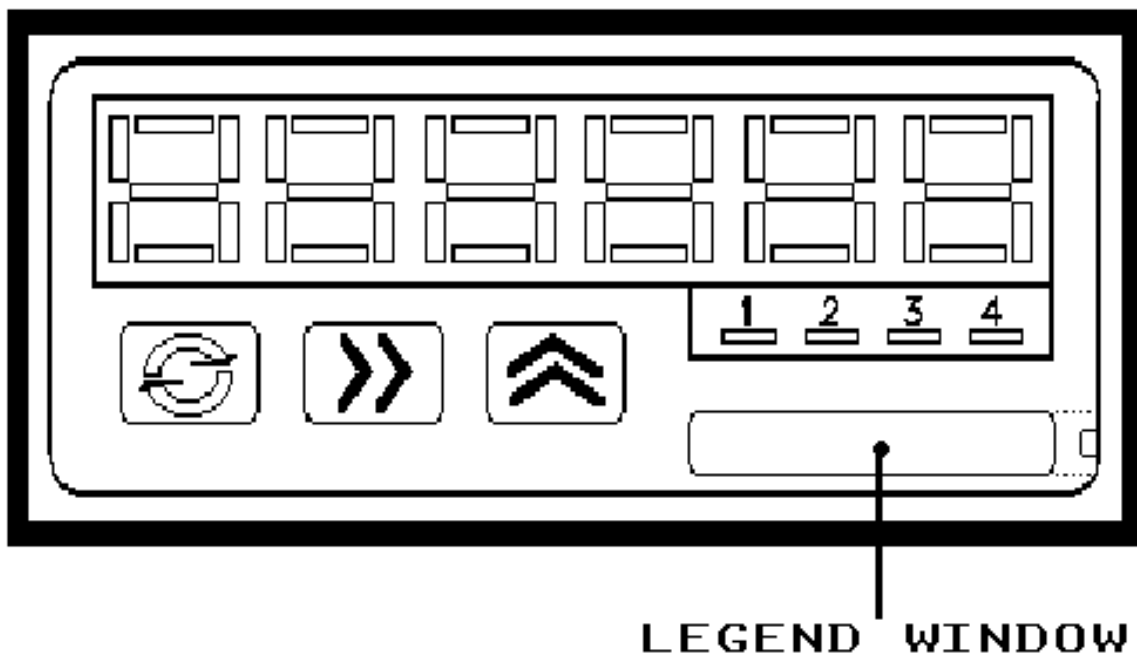
This will show the Least significant 6 digits of the Totalise. The update Rate is approximately once per second. The most significant 6 digits are available on pressing the ESCAPE keys. The Most significant and the Least significant may be considered as a 12 digit accumulator. There is an additional unseen 6 digits of underflow to accurately accumulate slowly increasing totals.

APPENDIX A

FITTING OF LEGEND/IDENTIFICATION

A standard sheet of legends is supplied which may be used for the engineering units being displayed. The selected legend should be carefully cut from the overall sheet, marked with any appropriate plant tag or identification, and pushed gently into the slot provided in the bottom right hand corner of the front panel of the instrument (see drawing below). These legends may be subsequently removed by means of a sharp pin in the notch provided.

The Legend sheet is included with the instrument.



APPENDIX B

TECHNICAL SPECIFICATION

INPUT PERFORMANCE @20°C

Type	Accuracy ⁽ⁱ⁾	Resolution ⁽ⁱⁱ⁾	Nominal range ⁽ⁱⁱⁱ⁾	
10 volts	0.02%	0.004%	-10V	to 10V
1-5 volts	0.04%	0.008%	1V	to 5V
1 volt	0.02%	0.003%	-1V	to 1V
100 mV	0.02%	0.006%	-0.1V	to 0.1V
4-20mA	0.1%	0.004%	4	to 20mA
0-20mA	0.1%	0.004%	0	to 20mA
0-10mA	0.2%	0.008%	0	to 10mA

ADDITIONAL INPUT SPECIFICATION

Input Type	Average ^(iv) Acquisition Rate	Input Impedance	Thermal drift per °C
mV	8.9Hz	1M ohm	0.004%
Volts	8.9Hz	2M ohm	0.002%, 0.011% ^(v)
Current	8.9Hz	51 ohm	0.001%

Isolation	Power Supply:	2500VAC)
	Output Option:	500VAC) See safety information
	Comms Interface:	500VAC) on page 8

OVER-RANGE PROTECTION

Input Pin	Usual Function	Absolute Maximum Rating
1	0V	NA
2	UNUSED	NA
3	Volts	200VAC ^(vi)
4	Millivolts	200VAC ^(vi)
5	Current	100mA

RELAY OUTPUT BOARD (OPTION 01 AND 02)

	A/C	D/C
Maximum Rated Load	7A @250V	7A @30V
Maximum Power	1750VA	210W
Maximum Switching Voltage	380V	125V

Electrical Life	10 ⁵ operations at rated load
Mechanical Life	50 million operations

Contact shunt capacitance 200pF
This is due to the Varistor and causes a reactance of 15Mohms at 50Hz.

Alarm detection delay 200mS

**CURRENT RETRANSMISSION BOARD (SOURCE AND SINK) OPTION 03
PERFORMANCE @20°C**

Accuracy: 20uA (0.1% of Max current)
Resolution: 2uA (0.01% of Max current)
Response: 100ms for approx 63% of step change

Minimum Current O/P: 0mA
Maximum Current O/P: 21mA(approx)
Thermal Drift: 900nA/°C (0.0045% of Max current /°C)

Maximum loop impedance: 1000 ohms (Source)
Output voltage drop @20mA: 3 Volts (Source & Sink)
Maximum external loop power supply voltage: 30VDC (Sink)
Minimum practical loop power supply voltage: (RL*21mA)+3 (Sink)
Where RL is the Loop impedance

Ripple current: approx 5uA

Isolation: Input 500VAC) See safety
Power Supply 2500VAC) information
Comms I/F 500VAC) on page 8

**VOLTAGE OUTPUT BOARD (OPTION 04)
PERFORMANCE @20°C**

Accuracy: 24mV (0.1% of Max voltage)
 Range 2-24VDC
 Maximum Current O/P: 50mA(xi)
 Thermal Drift: 1080uV/°C (0.0045% of Max voltage /°C)
 Ripple: Approx 6mV

Fixed Voltage: 24V
 Programmable Voltages: 2,2.5,3,3.5,4,4.5,5,6,7,8,9,10,12,15,20

Isolation: Input 500VAC) See safety
 Power Supply 2500VAC) information
 Comms I/F 500VAC) on page 8

RS485 COMMUNICATIONS OPTION

GENERAL

Configuration Four wire, Half Duplex
 Maximum fan-out 32 units^(vii)
 Baud Rate 9600
 Data bits 8
 Start bits 1
 Stop bits 1
 Parity none
 Maximum line length 4km
 Protocol based on ANSI X3.28

TRANSMITTER

Maximum differential output voltage 5v
 Output voltage with 50ohm load >1.5v

RECEIVER

Differential input threshold voltage +/-200mV
 Input receiver inpedence 12kohms
 Common mode range -7v to +12v

ENVIRONMENTAL

Ambient operating temperature range	0 to 50°C	
Ambient storage temperature range	-20 to 80°C	Relative
Humidity	5% to 95% non condensing	EMI
Emissions	BS EN 61326-1	EMI
Susceptibility	BS EN 61326-1	Safety
	BS EN 61010-1	Power
Supply consumption	240VAC, 120VAC, 24VAC 50/60Hz	Power
	6.5Watts max	Max
in-rush current	100mA @240VAC	
Front panel sealing(with gasket)	IP65	

PHYSICAL

Dimensions	48 x 96 x 140mm
Mounting	Panel cutout (91to92)mm x (43 to 44)mm
Terminals	All two part captive screw terminals
Weight	850g

- (i) The accuracy values represent +/- spread from nominal. '%' represents percentage of full scale value.
- (ii) '%' represents percentage of full scale value.
- (iii) Input is measured correctly within a small margin outside the nominal range. This is 7% for bipolar (+/-) electrical inputs. Current inputs that go down to zero do not under-range otherwise all other sensor inputs have a 7% over/under-range margin.
- (iv) Average taken over a 1 second time frame. Acquisition defined as complete refresh of electrical sensor value including readings to compensate for gain and offset errors.
- (v) 1V and 10V respectively.
- (vi) With respect to Pin 1 or Pin 5.
- (vii) This may be extended with suitable buffering

APPENDIX C

TROUBLESHOOTING

1) UNIT IS COMPLETELY DEAD

- 1.1) Check supply voltage is present on the rear connector
- 1.2) Check that supply voltage corresponds with voltage stated on the top of the instrument
- 1.3) Consult service manual for instructions on replacing internal fuse

2) INCORRECT READING

- 2.1) Check that the unit is set up for the correct sensor type
- 2.2) Check that the Engineering range has been set correct for voltage and current and correct units for temperature sensors.
- 2.3) Check that thermocouples have correct compensation cable and the polarity is correct.
- 2.4) Check that all three wires are connected properly for an RTD.

3) UNDER/OVER RANGE

- 3.1) Check that the sensor wiring is correct.
 - 3.2) Check that voltage/current sensor is not open circuit
 - 3.3) Check that the unit is set up for correct sensor
-

4) ERROR CODES

Several error codes may appear due to the internal self checking of the instrument. These indicate serious faults which cannot be rectified by the user. In the event of these codes being displayed, the unit should be returned to the supplier.

The Error Codes are as follows:

Err 01 Non Volatile memory failure

Err 02 Ram decode error

Err 03 Ram size unrecognised

Err 04 Input card Error

Err 05 EPROM Checksum error

Err 06 RAM fault

Err 07 Calibration data corruption fault

APPENDIX D

MAINTENANCE

The instrument is a precision piece of electronic measuring equipment, and yet, due to the nature of its design, requires very little maintenance.

1) CLEANING

The only cleaning required is to wipe the front panel with a damp cloth containing a small quantity of detergent.

DO NOT use an abrasive cleaner

DO NOT use any industrial solvents as they might affect the polyester membrane.

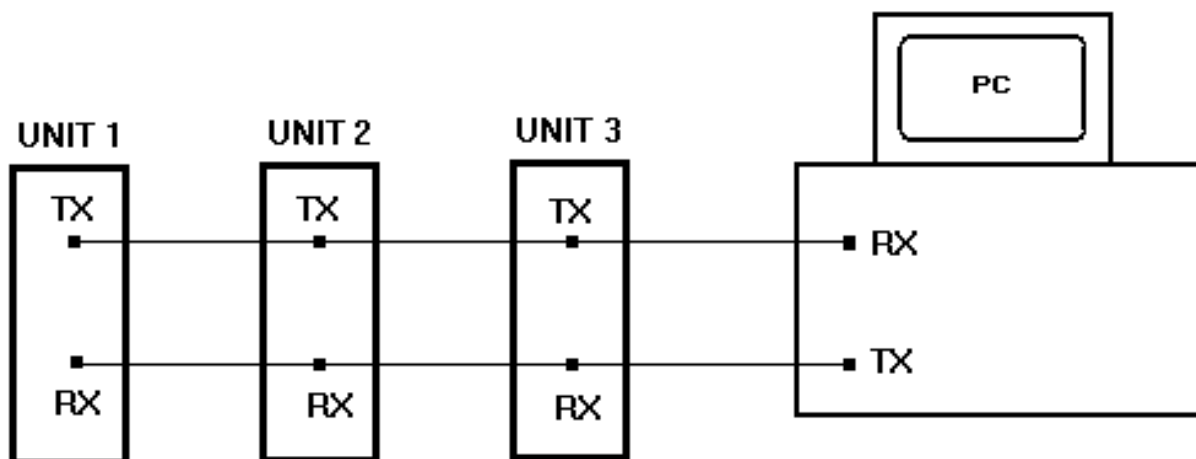
DO NOT apply water to any other part of the instrument other than the front panel. The rear of the instrument is not sealed, and water in this area could be dangerous and may lead to damage of the instrument.

APPENDIX E

USER COMMUNICATION SOFTWARE

This section aims to provide sufficient information to enable a user to write software for a Personal Computer to interface directly with instruments on a network. As all configuration and runtime data are available via the comms, there is great potential to tailor a system to a users individual requirements.

Information for electrically connecting a network of units is dealt within the wiring section of this manual. This section explains the software interface and the basic comms operation of the instrument. The schematic of a typical network showing three instruments is shown below. Note that this is not wiring detail, only a schematic of signal interconnections.



You will notice that the transmit lines from the units are connected together. This means that only one unit can transmit at a time without clashing the signal. For this reason the communication software in the instrument(s) only responds to messages issued by the PC. No messages are generated spontaneously by the units, in this way the PC maintains control over the network. Thus the PC is regarded as the MASTER and the units on the network are SLAVES.

The other problem obvious from the above schematic is that even though the MASTER transmits to all of the SLAVES simultaneously, only one may respond, otherwise signals will clash together. This is arranged by allocating each SLAVE unit a unique address. This address is called the device number and is programmed into the unit before it is connected to the network by programming the CO NET parameters menu within the SYS menu. See the programming section for details.

The comms messages issued by the host can be one of two types.

Data Request - MASTER requests data from a SLAVE.

Data Imposition - MASTER *writes* data to a SLAVE.

The most convenient way to describe these message types is to show an example for each message type. It is not important to understand the full detail of the message at this stage as this will be covered later, however the following control code definitions will probably be useful.

<SOH>	Start Of Header
<STX>	Start Of Text
<ETX>	End Of Text
<ACK>	Acknowledge
<BCC>	Block Check Character

For the purposes of this example assume that the MASTER is connected to three SLAVE units as shown in the above schematic. The Device numbers for the units are 1,2 and 3 and device number 2 has an Thermocouple input measuring 79.8 degrees C and an Alarm Output.

EXAMPLE 1 DATA REQUEST

The MASTER requests the Process Variable from SLAVE device 2. The process is initiated by the MASTER sending the following message.

02<STX>?CH000<ETX><BCC>

In order to see what actual data is sent from the host, see the table below. Note that the data is in hexadecimal.

PC MASTER TO SLAVE DEVICE(S) DATA REQUEST											
SOH	"02"		STX	"?CH000"						ETX	BCC
01	30	32	02	3F	43	48	30	30	30	03	BC

All three units receive the message, although units 1 and 3 will disregard it as the **02** carried in the initial part of the message designates the message as being for device 2 only. Device 2, on receipt of the message recognises the **02** address as its own device number and examines the main part of the message to see what action to take. The main part of the message in this case is **?CH000**. The question mark is the first character and is used to denote that the message is a data request. **CH** is a mnemonic representing CHannel value (Process Variable). A full list of mnemonics are available later on in this Appendix. The remainder of the message is called the index, and as there is only one Channel on this device it is superfluous and is set to zero. Having recognised a valid message, the instrument first acknowledges back to the host and then replies with the current Process Variable value. The format for the message is shown below, notice there is no device number embedded in the message- there is only one MASTER device.

SLAVE DEVICE TO MASTER REPLY										
ACK	SOH	STX	" 79.8"						ETX	BCC
06	01	02	20	20	37	39	2E	38	03	16

EXAMPLE 2 DATA IMPOSITION

For a second example, take the case of the MASTER issuing a message, this time to change an Alarm Setpoint value again directed at device 2.

The MASTER sends the following sequence.

PC MASTER TO SLAVE DEVICE(S) DATA IMPOSITION															
SOH	"02"		STX	!AS00180.0										ETX	BCC
01	30	32	02	21	41	53	30	30	31	38	30	2E	30	03	0C

The receipt of the message by device number 2 is exactly as in the previous example. This time, however, the ! indicates the message is a data imposition and applies to the Alarm Setpoint (AS). There are two alarms, the index 001 indicates that it applies the first Alarm (Alarm 2 would have an index of 002). Device 2 updates the Alarm setpoint with 80.0 and then responds with an acknowledgement as shown below.

There is one important point to understand here. The new Alarm Setpoint has been

SLAVE DEVICE TO MASTER REPLY					
ACK	SOH	STX	ACK	ETX	BCC
06	01	02	06	03	06

programmed into the device and will be used to control the Alarm operation. However, it has not been programmed into non-volatile memory within the instrument, so when power is removed, it will be lost and on powering the instrument again, the original setpoint value will be restored.

The next example shows how programmed data is stored to non volatile memory.

EXAMPLE 3 ACTION

Although, at the start of this section, it was stated that there are two types of message; a Data Request and a Data Imposition; there is strictly a third type. This message has the same format as a data imposition except no data is transferred and it has the effect of making the instrument do an action. In this case the action is to save all of the settings to non volatile memory.

The MASTER sends the following sequence.

PC MASTER TO SLAVE DEVICE[S] DATA STORE								
SOH	"02"		STX	"!ds"			ETX	BCC
01	30	32	02	21	41	53	03	17

Again device 2 receives the message which is initially treated as a Data imposition. The **ds** mnemonic is taken as an instruction to do a data store to non volatile memory. An index or data is superfluous and is not included. On doing a data store an acknowledge is issued as shown below.

SLAVE DEVICE TO MASTER REPLY					
ACK	SOH	STX	ACK	ETX	BCC
06	01	02	06	03	06

THE CONTROL CODES

Up to now the control codes have broadly been ignored, although the function of most of them is probably self-evident from the above examples. These will be explained in more detail here.

The control codes have two functions. First of all, they provide markers to indicate the start of the message and separate the different types of data with the message. And secondly, they provide integrity checking of the message.

The <**SOH**> Start of Header control code will always be the first character in the message. This indicates that the Header will follow and has a value of 01.

The <**STX**> Start of Text character indicates that the Header information has finished and the Text or main body of the message will follow. this has a value of 02.

The <**ETX**> End of Text character indicates the end of the end of the main part of the message and the Block check character will follow. The End of Text character has a value of 03.

The <**BCC**> has not got a fixed value like the other control codes as it is a calculated value based upon a modulo 256 sum of all non control code characters in the message. This is calculated for each message before it is transmitted and the receiver confirms that a repeat calculation of the message results in the same block check value. If there has been any corruption in any part of the message, the block check character and the recalculated value will not tie up. If an instrument receives a corrupted message, it is ignored. It is up to the writer of PC software to determine what the MASTER does in such a situation.

The Block check character is for the message in example 1 is calculated as follows:-

30
32
3F
43
48
30
30
30

Total 1BC

Modulo 256 (least significant byte) **BC**

EXAMPLE BASIC PROGRAM

The following basic program provides an example of a simple communications interface to run on a PC. The program is coded to use COM1 and communicate with device 1, but these may be modified as required.

```
10 OPEN ``COM1:9600,N,8,1" AS #1: header$="01"
20 INPUT ``Enter text string ( 0 to quit)";text$:if text$="0" goto 90
50 gosub 100: PRINT#1,TX$
70 gosub 200: if left$(text$,1) = `!" then mid$(text$,1,1)= `?":goto 50
80 print ``RECEIVED[ `';rx$;" ]": goto 20
90 end
100 REM Calculates block check character based on header and text strings
150 sum=0: lh=len(header$):lt=len(text$)
170 for i=1 to lh:sum=sum+asc(mid$(header$,i,1)):next
180 for i=1 to lt:sum=sum+asc(mid$(text$,i,1)):next:bcc=sum-(256*int(sum/256))
190tx$=chr$(1)+header$+chr$(2)+text$+chr$(3)+chr$(bcc)
195 return
200 REM Reads in received data without checking block check character
240 rx$=""
245 ch$ = input$(1,#1):if ch$ <> chr$(1) goto 245
250 ch$ = input$(1,#1):if ch$ <> chr$(2) goto 250
260 ch$ = input$(1,#1):if ch$ = chr$(3) goto 270
265 rx$=rx$+ch$:goto 260
270 return
```

The following tables list the available comms mnemonics for the instrument.

INSTRUMENT COMMS MNEMONICS

DESCRIPTION	MNEM	INDEX	DATA	FORMAT
RATE IN ENGINEERING UNITS	CH	NA	VALUE	ENGINEERING UNITS
TOTALISE VALUE	TL	0,1	VALUE	TOTALISE UNITS
DISPLAY VARIABLE	DY	NA	OPTION	RATE,TOTAL
NO OF DECIMAL PLACES FOR ENG UNITS	DP	NA	OPTION	0,1,2,3
SENSOR INPUT TYPE	IT	NA	OPTION	VOLTS, CURRENT
VOLTAGE RANGE	RV	NA	OPTION	100mV, 1V, 1-5V, 10V
CURRENT RANGE	RC	NA	OPTION	4-20, 0-20, 0-10mA
ENGINEERING UNITS HIGH RANGE	IH	NA	VALUE	REAL
ENGINEERING UNITS LOW RANGE	IL	NA	VALUE	REAL
CUT LOW INPUT LEVEL	CL	NA	VALUE	ELECTRICAL UNITS
RESET TOTAL FROM KEYPAD	RT	NA	OPTION	DISABLED, ENABLED
FILTER FACTOR TIME CONSTANT (SECONDS)	FF	NA	OPTION	OFF, 0.5,1, 2, 4, 8, 16, 32
FILTER JUMP-OUT (PERCENTAGE)	FJ	NA	OPTION	NONE, 1, 5, 10
INPUT CONDITIONING	IC	NA	OPTION	LINEAR, SQUARE-ROOT, USER-DEFINED
TIMEBASE	TB	NA	OPTION	SECONDS, MINUTES, HOURS
DIVISOR	DV	NA	VALUE	UNSIGNED INTEGER
USER LINEARISATION ELECTRICAL UNITS	IX	1-13	VALUE	ELECTRICAL UNITS
USER LINEARISATION ENGINEERING UNITS	IY	1-13	VALUE	ENGINEERING UNITS
OUTPUT SELECT	OS	1,3	OPTION	RATE TOTAL
ALARM ACTION	AA	1,2,3,4	OPTION	OFF, LOW, HIGH, DEVIATION
ALARM LATCH ENABLE	AL	1,2,3,4	OPTION	FALSE, TRUE
ALARM SETPOINT	AS	1,2,3,4	VALUE	ENGINEERING UNITS
ALARM HYSTERESIS	AH	1,2,3,4	VALUE	PERCENTAGE OF ENGINEERING RANGE
ALARM DEVIATION	AD	1,2,3,4	VALUE	PERCENTAGE OF ENGINEERING RANGE
ALARM RELAY SENSE	As	1,2,3,4	OPTION	NON-INVERTED, INVERTED
ALARM DELAY (SECONDS)	Ad	1,2,3,4	OPTION	OFF, 1, 2, 5, 10, 15, 20
ALARM CONDITION	AC	1,2,3,4	OPTION	NO-ALARM, SENSED, DETECTED, LATCHED
TRIP MODE	TM	1,2,3,4	OPTION	TRIP, PULSE
TRIP SETPOINT	TS	1,2,3,4	VALUE	ENGINEERING UNITS
TRIP SENSE	Ts	1,2,3,4	OPTION	NON-INVERTED, INVERTED
TRIP DECADE	TD	1,2,3,4	OPTION	100000,10000,1000,100,10,1
CURRENT RTX SPAN OUTPUT	SI	1,3	OPTION	4-20, 0-20mA
CURRENT RTX MODE OF OPERATION	TI	1,3	OPTION	RETRANSMISSION, PRESET
CURRENT RTX HIGH RANGE	HI	1,3	VALUE	ENGINEERING UNITS
CURRENT RTX LOW RANGE	LI	1,3	VALUE	ENGINEERING UNITS
CURRENT RTX PRESET VALUE	PI	1,3	VALUE	ENGINEERING UNITS
PROGRAMMABLE VOLTAGE OUTPUT	OV	1,3	OPTION	2, 2.5, 3, 3.5, 4, 4.5, 5, 6, 7, 8, 9, 10, 12, 15, 20
AUTOCYCLE	Ac	NA	OPTION	ENABLED, DISABLED
PASSWORD CODE	PC	NA	VALUE	UNSIGNED INTEGER
PASSWORD LEVEL	PL	NA	OPTION	SETPOINT, INPUT, OUTPUT, SYSTEM,CALIB
USER OFFSET	UO	NA	VALUE	ENGINEERING UNITS
SYSTEM CONFIGURATION REPORT	SY	NA	STRING	See notes
INSTRUMENT ID TAG	TG	NA	STRING	Up to six character ASCII
STORE DATA TO NON-VOLATILE MEMORY	ds	NA	NO DATA	

DATA FORMAT DEFINITION

NO DATA No data actually transferred.

This type of message initiates an activity within the instrument rather than accessing data. For instance, sending the Text string **!ds** will cause the unit to store its scratch parameter data area to EEPROM. This must always be done after configuration parameters have been modified via the Comms. If this is not done the changes will be lost when the instrument is switched off.

OPTION An ASCII number corresponding to the position of an item within the list of parameters denoted in the associated **FORMAT** column of the **Message table**. The numbering starts from zero. E.G An Alarm action (AA) High Alarm will have a data field corresponding to 2.

VALUE These are ASCII numeric fields which are scaled and formatted according to the entry in the **FORMAT** column of the message table.

TYPE OF DATA	LOW LIMIT	HIGH LIMIT	FIELD WIDTH	DECIMAL PLACES
ENGINEERING UNITS	<i>-ENG HI - 7%</i>	<i>+ENG HI +7%</i>	6	DP
REAL	<i>-32000</i>	<i>64000</i>	6	DP
ELECTRICAL UNITS				
10 Volt range	<i>-10</i>	<i>10</i>	6	2
1-5 Volt range	<i>0</i>	<i>5</i>	6	3
1 Volt range	<i>-1</i>	<i>+1</i>	6	3
100mV range	<i>-100mV</i>	<i>+100mV</i>	6	1
4-20mA	<i>0</i>	<i>20</i>	6	2
0-20mA	<i>0</i>	<i>20</i>	6	2
0-10mA	<i>0</i>	<i>10</i>	6	2
% of Eng range	<i>0.00</i>	<i>99.99</i>	5	2
Unsigned integer	<i>0</i>	<i>65535</i>	5	0

STRING This is an individually formatted string, usually (but not always) read-only. See below for details.

SY: System request

This reports upon the identity of the instrument. This may only be data requested the returned data format is as follows.

aabbbbb0ccde0000ff0000

- aa:** device type DM for Digital Meter
- bbbbbb:** Issue date of software
- cc:** Variant type; U=01, C=02; A=03
- d:** Contents of option slot 1;
 - Nothing fitted=0;
 - Single Relay board=2;
 - Dual Relay board=3;
 - Volt o/p=4;
 - RTX board=5
- e:** Contents of option slot 2; Format as above.
- ff:** Number of channels; 01 always