

4102

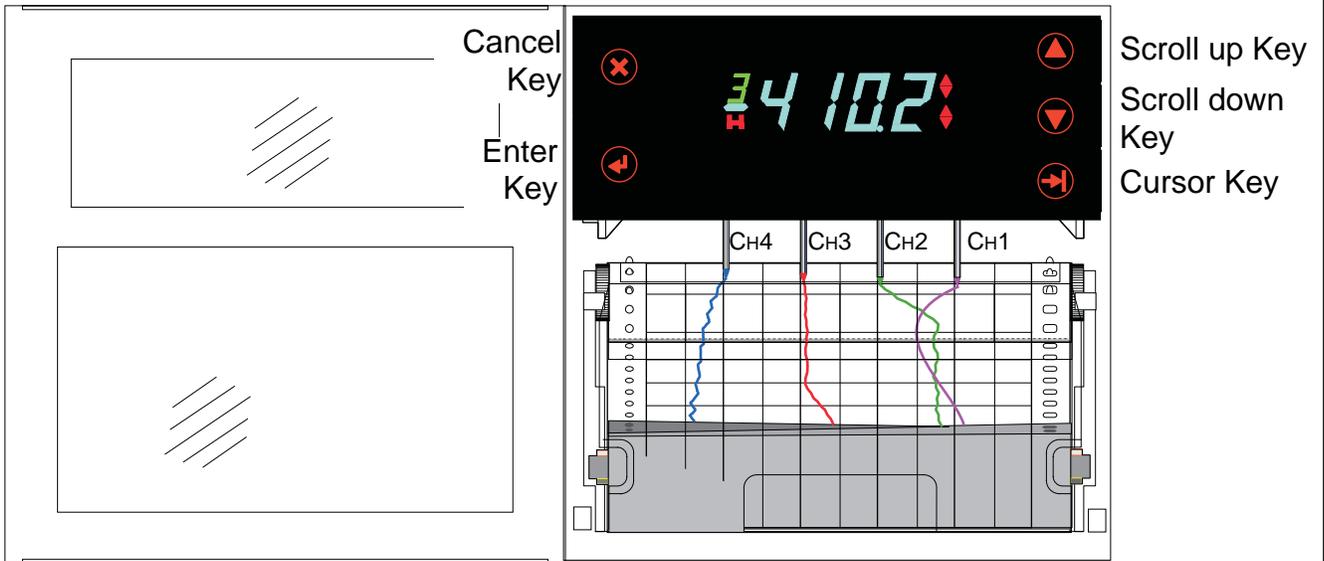
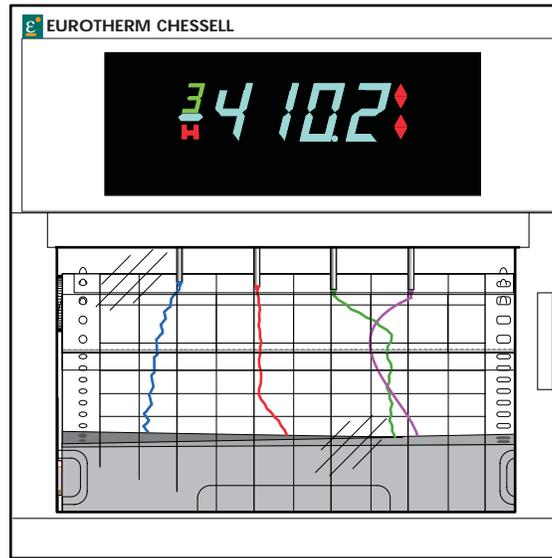


EUROTHERM
CHESSELL

Model 4102
Chart recorder

User guide

Major Functional items



PENS (Model 4102C)

Blue (channel 1).....	LA249551
Red (channel 2).....	LA249552
Green (channel 3).....	LA249553
Violet (channel 4).....	LA249554
Annotator (black).....	LA249550

Consumables

CARTRIDGE (Model 4102M)

LA249556

CHARTS

Z-fold (16 metres)....GD128970Uxxx
 Roll (32 metres).....GD128971Uxxx

Where
 xxx = 040, 045, 050, 060, 070 or 075
 = number of chart divisions

Signal conditioning components

Shunt 100LA246779UK10 Shunt 250 LA246779UK25 Attenuator..... LA244180



Declaration of Conformity

Manufacturer's name:	Eurotherm Recorders Limited
Manufacturer's address	Dominion Way, Worthing, West Sussex, BN14 8QL, United Kingdom.
Product type:	Industrial chart recorder
Models:	4102C (Status level J12 or higher) 4102M (Status level J12 or higher)
Safety specification:	EN61010-1: 1993 / A2:1995
EMC emissions specification:	EN50081-2 (Group1; Class A)
EMC immunity specification:	EN50082-2

Eurotherm Recorders Limited hereby declares that the above products conform to the safety and EMC specifications listed. Eurotherm Recorders Limited further declares that the above products comply with the EMC Directive 89 / 336 / EEC amended by 93 / 68 / EEC, and also with the Low Voltage Directive 73 / 23 / EEC

Signed: P D de la Nougerède Dated: 14 - May - 97
 Signed for and on behalf of Eurotherm Recorders Limited
 Peter De La Nougerède
 (Technical Director)



IA249986U020 Issue 3 May 97

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SAFETY NOTES

1. Before any other connection is made, the protective earth terminal  shall be connected to a protective conductor. The Mains (supply voltage) wiring must be terminated in such a way that, should it slip in the cable clamp, the Earth wire would be the last wire to become disconnected.
2. In the case of portable equipment, the protective earth terminal must remain connected (even if the recorder is isolated from the mains supply), if any of the I/O circuits are connected to hazardous voltages*.

WARNING!

Any interruption of the protective conductor inside or outside the apparatus, or disconnection of the protective earth terminal is likely to make the apparatus dangerous under some fault conditions. Intentional interruption is prohibited.

Note: In order to comply with the requirements of safety standard BS EN61010, the recorder shall have one of the following as a disconnecting device, fitted within easy reach of the operator, and labelled as the disconnecting device.

- a. A switch or circuit breaker which complies with the requirements of IEC947-1 and IEC947-3
 - b. A separable coupler which can be disconnected without the use of a tool
 - c. A separable plug, without a locking device, to mate with a socket outlet in the building
-
3. The mains supply fuse within the power supply unit is not replaceable. If it is suspected that the fuse is faulty, the manufacturer's local service centre should be contacted for advice.
 4. Batteries within recorders are not user replaceable. Contact the manufacturer's local service centre if a problem is suspected.
 5. Whenever it is likely that protection has been impaired, the unit shall be made inoperative and secured against unintended operation. The nearest manufacturer's service centre should be consulted for advice.
 6. Any adjustment, maintenance and repair of the opened apparatus under voltage, should be avoided as far as possible and, if inevitable, shall be carried out only by a skilled person who is aware of the hazard involved.
 7. Where conductive pollution (e.g. condensation, carbon dust) is likely, adequate air conditioning/filtering/sealing etc. must be installed in the recorder enclosure.
 8. Signal and supply voltage wiring should be kept separate from one another. Where this is impractical, shielded cables should be used for the signal wiring.
 9. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment might be impaired.
- * A full definition of "Hazardous" voltages appears under 'Hazardous Live' in BS EN61010. Briefly, under normal operating conditions, hazardous voltages are defined as > 30V RMS (42.2V peak) or > 60V dc.

SYMBOLS USED ON THE RECORDER LABELLING

One or more of the symbols below may appear on the recorder labelling.

	Refer to the Manual for instructions
	Protective Earth
	This recorder for ac supply only
	This recorder for dc supply only.
	This recorder for either ac or dc supply
	Risk of electric shock

USER GUIDE

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YEAR 2000 COMPLIANCE

For units with status level H8 or above, all software versions of this product comply with the requirements of the British Standards Institute document 'Disc PD2000-1. A Definition of Year 2000 Conformity Requirements', when the product is used as specified in this manual.

100 mm. RECORDER USER GUIDE

1 INTRODUCTION

The main part of this manual describes recorders fitted with membrane switches on each side of the display unit. Annex A contains information on older models, (those with status levels prior to L19 (Multi-point recorders) or L22 (Continuous-trace recorders)). The status level appears as the last two or three character section of the recorder serial number.

The recorder comes in two versions - a continuous-trace recorder with up to four pens and a multipoint recorder giving up to six traces on the chart. Chart annotation is standard with the multipoint version, but is an optional extra (specified at time of order) with the continuous trace recorder. Annotating recorders print power-on and alarm on/off messages, time and date. Scales and channel tags are also printed on the chart to simplify trace interpretation.

Designed to fit a DIN cutout (138 x 138 mm) the recorders feature an exceptionally small back of panel dimension of 220 mm. (no terminal cover) or 236 mm (with cover).

ANNOTATOR BATTERIES

When the batteries associated with the recorders are fully charged, they will maintain the real-time clock for approximately one month (depending on temperature etc.), without power applied to the recorder. The batteries are uncharged when despatched from the factory, and it takes approximately 175 hrs to charge them fully. Should power be removed from the recorder before this, the retention time will be reduced accordingly.

1.1 Unpacking the recorder

The recorder is despatched in a special pack designed to give adequate protection during transit. Should the outer box show signs of damage, it should be opened immediately and the recorder examined. If there is evidence of damage, the instrument should not be operated and the local representative contacted for instructions. After the recorder has been removed from its packing, the packing should be examined to ensure that all accessories and documentation have been removed. Once the recorder has been installed, any internal packing should be removed, and stored with the external packing, against future transport requirements.

2 INSTALLATION

2.1 MECHANICAL INSTALLATION

Figure 2.1 gives installation details.

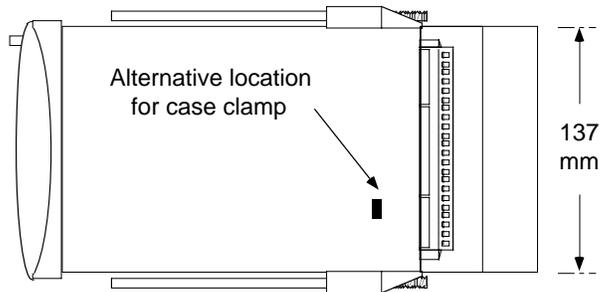
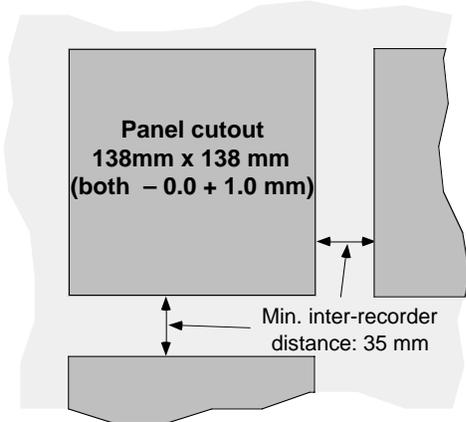
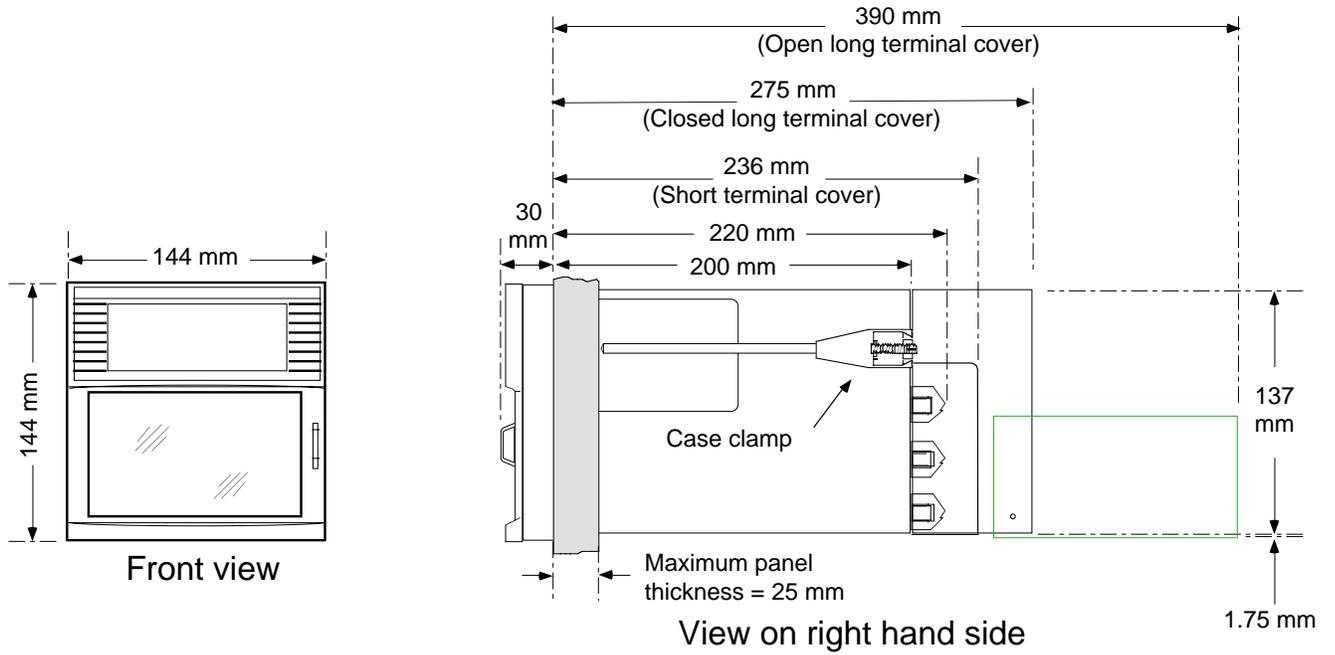
The recorder is inserted through the panel aperture from the front of the panel. With the weight of the recorder supported, the panel clamps are inserted into one pair of the rectangular apertures (either at the top and bottom or at the right and left sides) of the recorder. The jacking screws are then be tightened sufficiently to clamp the recorder into position. **EXCESS FORCE SHOULD NOT BE USED IN TIGHTENING THESE SCREWS.**

2.2 ELECTRICAL INSTALLATION

Warning!

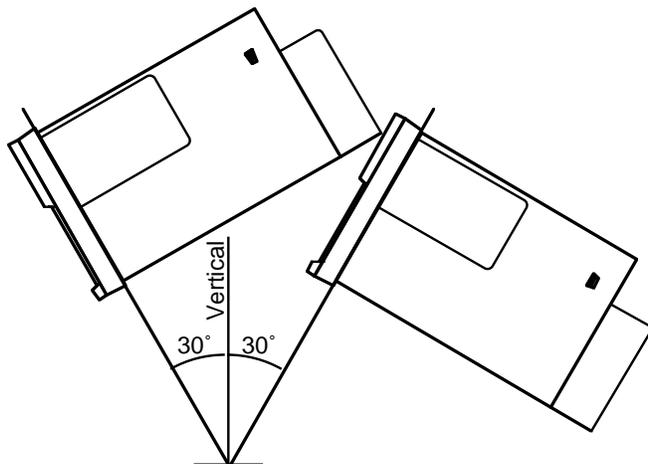
Refer to the safety notes on page 2 of this manual before proceeding.

Figure 2.2 gives mains (line) and signal wiring information.

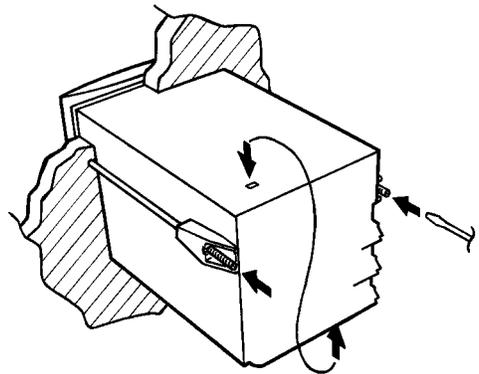


Panel cutout details

View on underside



Maximum installed angles



Case clamping

Figure 2.1 Mechanical installation

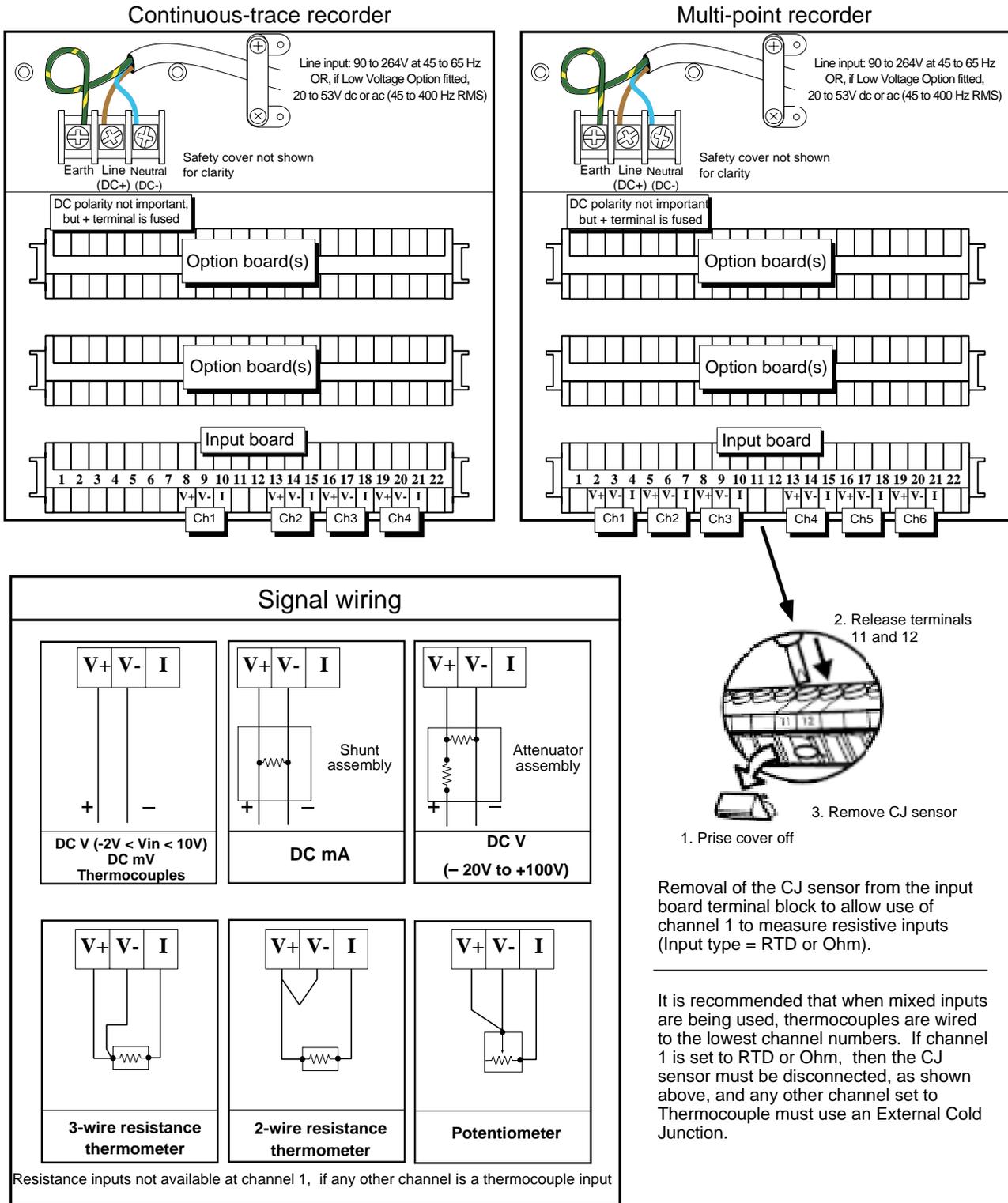


Figure 2.2 Electrical Installation

2.3 PEN/PRINT CARTRIDGE REPLACEMENT

Notes:

1. Care should be taken to avoid pen/cartridge contact with skin or clothing
2. The password is set to 010 at the factory but can be edited in Instrument Configuration.

Before changing the pens/print cartridge, the pens should be parked (fanned) as follows (ref. figure 2.3).

1. From the background display, operate the 'Enter' key.
2. Scroll-in the password, then operate 'Enter' twice.

The chart stops and the pens fan, or the printhead moves to the centre of its travel; the 'H' symbol is illuminated to indicate that the instrument is in 'chart hold' mode.

Once replacement is complete, operate the Cancel (X) key then use the 'Up arrow' key to access the zero and span setting keys. These allow the position of the new pens / printhead to be aligned with the 0% and 100% grid lines on the chart.

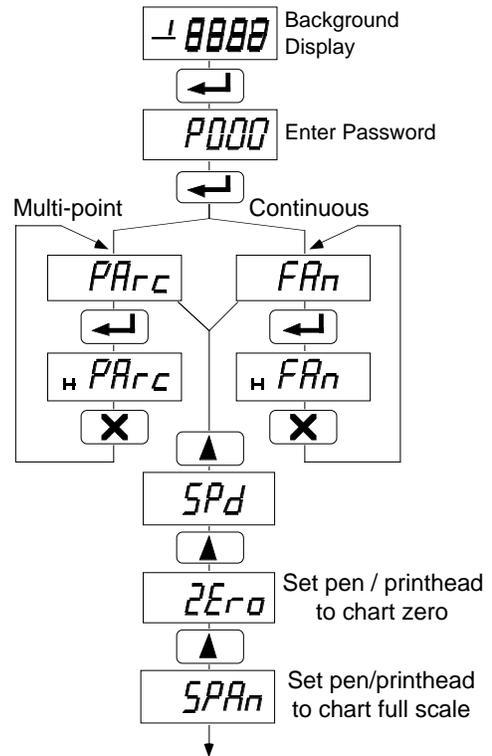


Figure 2.3 Pen park key strokes

2.3.1 Continuous-trace recorders

Once the pens have fanned, open the recorder door and the display unit (both hinged at their left edge) and pull each of the exhausted pens forwards off its guide bar.

Fit the new pens, by pushing them carefully onto the guide bar

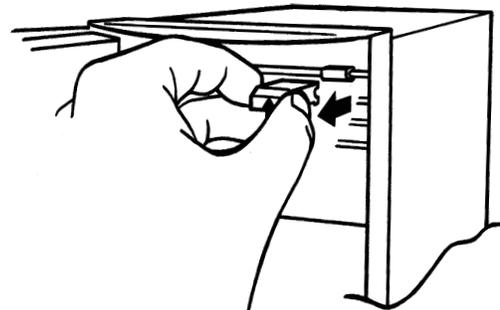


Figure 2.3.1 Pen removal

2.3.2 Multipoint recorders

Once the printhead has parked, open the recorder door and the display unit (both hinged at their left edge).

Remove the cassette (section 2.4) and pull the exhausted print cartridge vertically downwards out of its holder.

Offer up the new cartridge to the printhead, and push it upwards into place.

Return the cassette to the chassis and close the display unit and the recorder door.

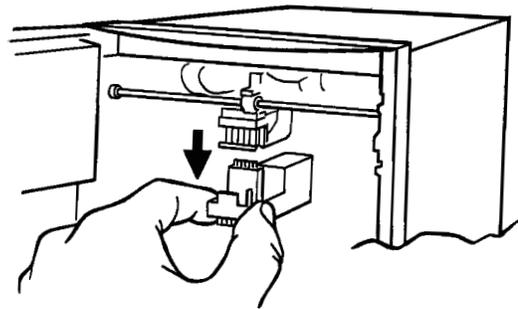


Figure 2.3.1 Cartridge removal

2.4 CHART REPLACEMENT

Note: For recorders with status levels K13 or higher, if the cassette type (i.e. roll or z-fold) is changed, or if the recorder loses its configuration, the recorder must be reconfigured for the correct cassette type (Instrument configuration) or the chart drive will not operate correctly.

Before changing the chart, carry out a pen park/fan as described in section 2.3 above. Once the chart replacement is complete, carry out an alignment procedure as described in sections 3.2.4 and 3.2.5, below.

2.4.1 Z-Fold charts

Remove the cassette, by pulling on the two latches as shown in the top figure. If a used chart is present, open the take-up retainer and remove the used chart.

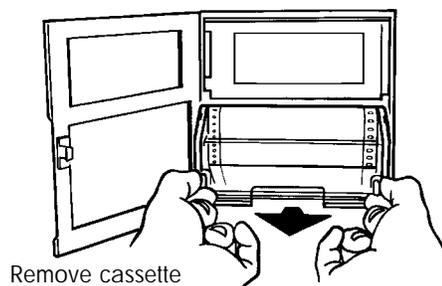
Open the top of the paper pay-out tray, and remove any residual paper dust. Open the chart guide.

Unpack the replacement chart and fan it several times to separate the leaves and to remove as much perforation dust as possible.

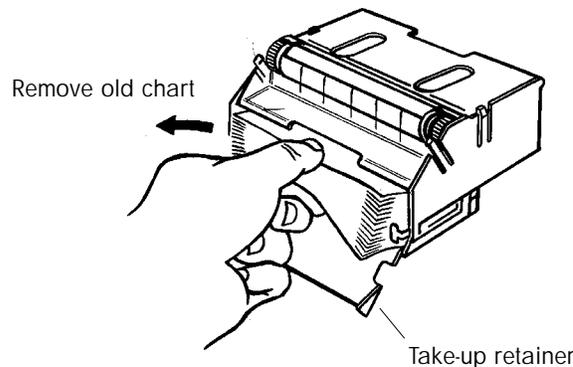
Orient the chart so that the circular holes are to the left, the slots to the right, and the red end-of-chart line to the back (all directions relative to the front of the cassette). Place the chart into the pay-out tray, unfolding three or four leaves at the same time. Pull the free end of the chart over the drive roller and down behind the chart guide and lay the free leaves in the take-up tray.

Ensure that the paper folds naturally into the tray, that the printed grid is uppermost and that the slots are at the right hand edge of the chart (i.e. the circular holes are to the left).

Close the take-up retainer and the chart guide, ensuring the paper holes/slots fit over the sprockets on the drive roller. Close the top of the paper pay-out tray, ensuring that the chart is contained behind the flanges on the top.

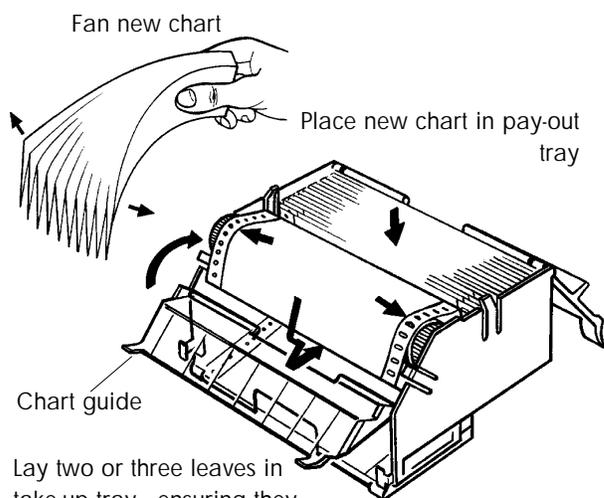


Remove cassette



Remove old chart

Take-up retainer

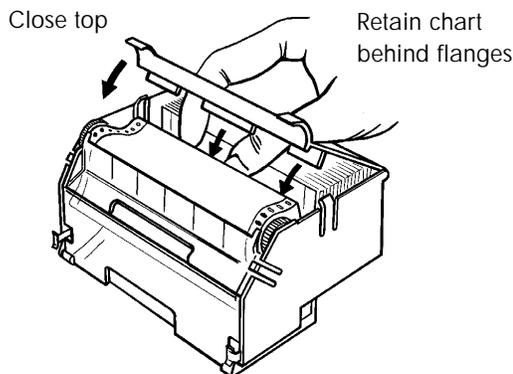


Fan new chart

Place new chart in pay-out tray

Chart guide

Lay two or three leaves in take-up tray, ensuring they fold naturally. Close take-up retainer and chart guide.

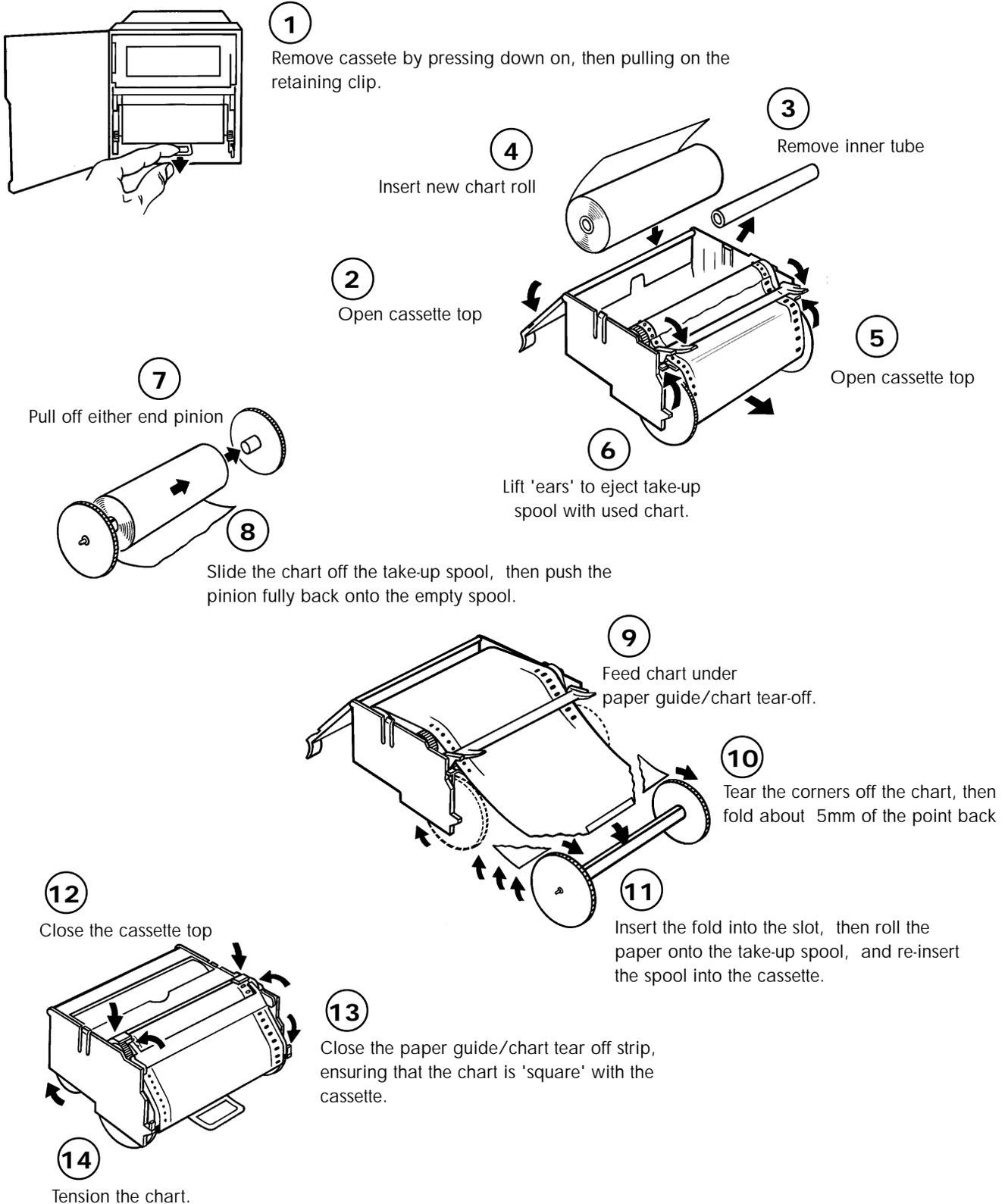


Close top

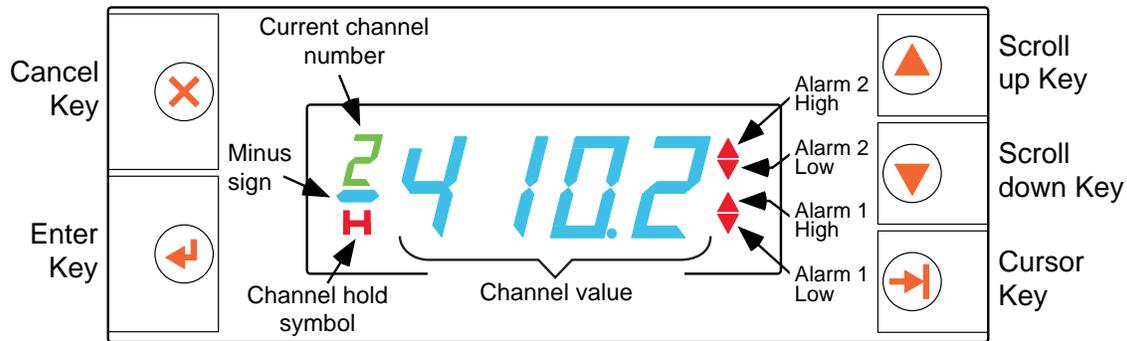
Retain chart behind flanges

2.4.2 Roll charts

Carry out the 'Park' procedure described in section 2.3 above. Once the chart has been replaced, return the cassette to the recorder and check the pens' zeros/spans against the new chart as described in sections 3.2.4 and 3.2.5.



3 OPERATION AND CONFIGURATION



3.1 OPERATION

The four-character, blue display shows the process value (PV) of each channel in turn, with each channel remaining on display for 5 seconds. If 'Units' is selected 'yes' in 'Units configuration', the channel display units alternate with the PV at the display. Current channel number is indicated by a green numeric character to the left of the PV display. Red arrow heads to the right of the PV display indicate which (if either) of the displayed channel's alarms is active, and whether the alarm is configured absolute high (up arrow) or absolute low (down arrow).

Operation of either the Enter or the Cancel key allows entry to the recorder's configuration menus, via a password. The password is set to 010 at the factory, but can be edited in 'Instrument Configuration' (section 3.2.11).

Notes:

1. Channels configured as 'Off' do not appear in the scroll sequence. If all channels are off, then channel 1 is shown 'Off' continuously.
2. When displaying unit strings, the characters k, w and x are replaced by the special symbol '5'. The letter 'm' is displayed as 'n.n'. Because this takes two character spaces, the right-most character of four-character strings is lost.
3. If the actual input value exceeds the configured range, +999.9 is displayed for over range; -999.9 for under range.

3.1.1 Channel Hold

Operation of the cursor key causes the currently displayed channel's value to remain permanently on display (Channel hold). Channel hold is indicated by a red 'H' below the channel number. (This red 'H' symbol is also used to display chart hold (pen park) mode.) To return to normal scroll mode, the cursor key is operated a second time.

3.1.2 Channel scroll (Manual)

The channels can be scrolled through in both normal and channel hold mode by operation of the scroll up/down keys. In manual scroll all fitted channels are displayed when called, even if they are configured to be 'Off'.

3.1.3 Units display

If 'Units' have been selected 'yes' in the top level configuration menu, then the PV and Units displays alternate, with the PV being displayed for three and a half seconds, then the units string for a second and a half. See note 2 above for un-displayable characters.

3.1.4 dFit display

If the recorder's configuration should be found to be corrupt at power-up, a default configuration is loaded instead and 'dFit' is displayed, as a warning to the user, until either the Cancel or Enter key is operated.

3.1.5 rEn.n display

This (remote operation) is displayed whilst configuration transfer is taking place via the configuration port

3.1.6 Annotation

Note: This applies to multi-point recorders and to those continuous-trace recorders that are fitted with the annotation option. Message colours give below apply only to multi-point recorders: for annotating continuous-trace recorders, the messages are always in black.

The following types of message can be printed on the chart:

POWER-UP MESSAGE

HH:MM:SS DD/MM/YY dddddd

This message is printed in blue at each power-up, and consists of the following elements:

- HH:MM:SS Power-on time
- DD/MM/YY Power-on date either as shown or as MM/DD/YY according to the format (fn.nt) selected in clock configuration - section 3.2.6
- ddd-ddd A 20 character descriptor editable in 'Instrument configuration'. Initially set to 'Instrument'

CYCLIC MESSAGES

Cyclic messages are printed on the chart approximately every 2 cm. on a convenient time boundary. The messages are right-justified on the chart and are printed in the following order:

Time; Date; Chart speed; Channel 1 tag, units and scale; Time; Date; Chart speed; Channel 2 tag, units and scale; ...and so on. Channel information is printed on two lines, with Channel tag and scale 'zero' value at the left of the chart and units and span value at the right of the chart, as illustrated in figure 3.1.6

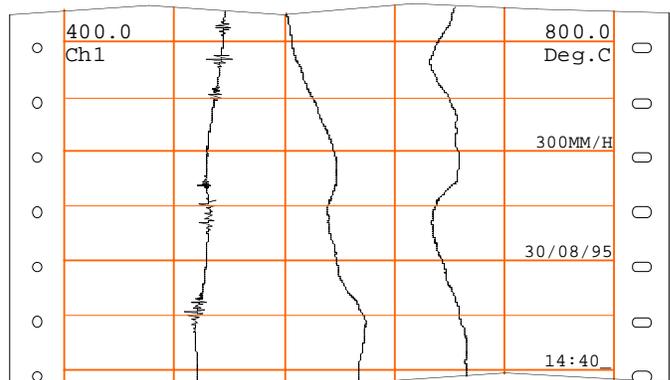


Figure 3.1.6 Cyclic message printing example

ALARM ON/OFF MESSAGES

HH:MM:SS ALARM ON(OFF) C:A

If so configured in the Instrument configuration (section 3.2.11), these messages, printed in black, appear when an alarm becomes active or ceases to be active, and consist of the following elements:

- HH:MM:SS Alarm on(off) time
- ALARM ON Specifies that the alarm became active at the above time
- ALARM OFF Specifies that the alarm ceased to be active at the above time
- C Channel number
- A Alarm number

Notes

1. Alarm messages are printed in preference to cyclic messages, should they occur simultaneously.
2. Alarm messages are inhibited when the Event Input option is fitted (section 4.3).

3.1.6 ANNOTATION (Cont.)

ON/OFFLINE MESSAGES

OFFLINE HH:MM:SS ONLINE HH:MM:SS

where HH:MM:SS are the times of occurrence, is printed in black whenever the recorder comes on-line (e.g. after the pens/printhead have been changed, or when the process value display is returned to from a configuration menu).

3.2 CONFIGURATION

Initial entry to configuration is achieved from the background display by operation of the Enter or Cancel key and then entering a password (initially 010). To enter the password 010, carry out the following procedure.

- From background display, press the Enter or Cancel key
- Display changes to 'P000' with the left-most 0 flashing
- Operate the cursor key.
- Left-most 0 stops flashing, centre 0 flashes.
- Operate Scroll Up key - centre 0 changes to 1
- Operate Enter key
- Display changes to FAn or PArC according to model

The rest of the Configuration menu (fig 3.2.1) is accessed using up/down arrow keys.

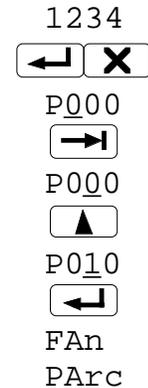


Figure 3.2a
Entry to configuration

OPERATOR ACCESS LEVEL

Initially set to '0', this 'access level' requires the user to enter a password direct from the background display as described above. Once entered, the user has full access to the recorder's configuration. See section 3.2.11 (PASS) for details of password editing.

Setting the access level to 1 or 2 (AcES - Instrument configuration - section 3.2.11) allows the operator to carry out the operations shown in table 3.2 without needing to enter the password.

Function	Minimum access level required
Pen fan/printhead park	1
Set chart speed	1
Align traces to chart zero and full scale	1
Set clock (date, time and date format)	1
Carry out input adjust	2

Table 3.2 Operator access levels

ENTER INDICATOR

Whenever a change is made to a configurable item, an E symbol appears in the channel number display. Operation of the Cancel (X) key resores the previous value and extinguishes the E. Operation of the Enter key, saves the new value to the recorder's data base, and the E symbol disappears in three stages, as depicted below whilst the save takes place.



3.2.1 Configurable items

Figure 3.2.1 shows the order in which configurable items appear in what is called 'the top level configuration menu'. The figure shows the 'up arrow' order. Use of the down arrow reverses the order. Use of the Enter key takes the user down to the next level of menu - the Cancel key takes the user back up one menu level each time it is used.

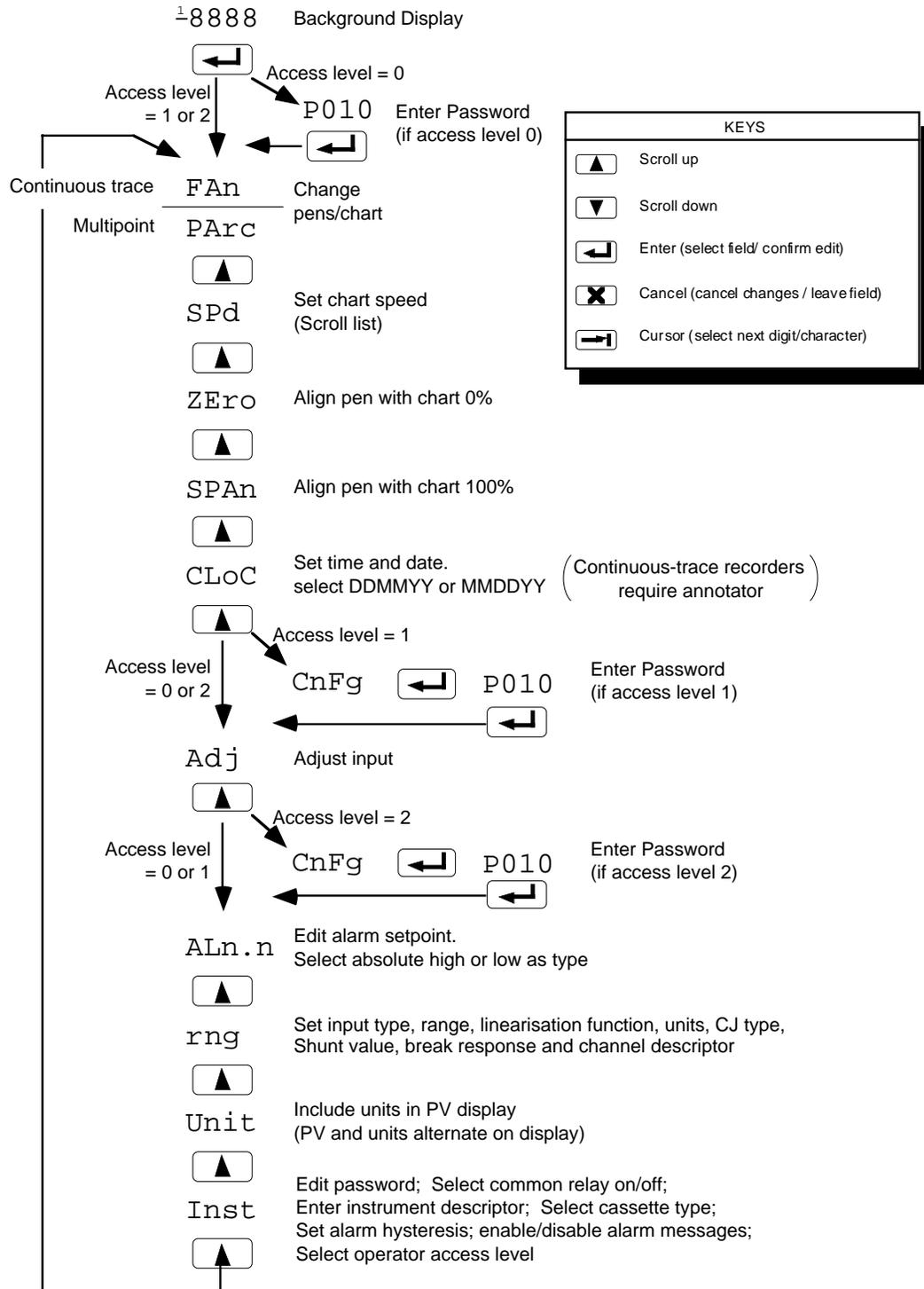


Figure 3.2.1 Configuration items

3.2.1 CONFIGURABLE ITEMS (Cont.)

CHARACTER SET

The printable character set, for use with channel and instrument descriptors, is A to Z, 0 to 9, hyphen, space, degrees, underscore. The displayable characters are limited by the nature of a seven-segment display; characters which cannot be displayed, even approximately (k, m, w, x), are replaced by the special symbol '∫'.

In scroll lists, mV for example is displayed as 'n.nU', and a type K thermocouple is displayed as 'Ca'.

3.2.2 Pen Park/Fan

As described in section 2.3, this is used to disable the chart and pen drives of the recorder so that the chart and pens or print cartridge can be changed safely. In the case of the continuous trace recorder, the pens 'fan' to allow easy access to them all.

3.2.3 Chart speed

Entry from the SPd display allows the chart speed to be chosen from a scroll list, using the scroll up and/or scroll down keys. The chart speeds available are:

MULTIPOINT RECORDERS

Off, 5 mm/hr, 10mm/hr, 20mm/hr, 30mm/hr, 60mm/hr, 120 mm/hr

CONTINUOUS-TRACE RECORDERS

Off, 5 mm/hr, 10mm/hr, 20mm/hr, 30mm/hr, 60mm/hr, 120 mm/hr, 240mm/hr, 300 mm/hr, 600mm/hr, 1200mm/hr, 3600mm/hr, 18m/hr (18n.n), 36m/hr (36n.n). If the annotator option is fitted, it will print only up to and including 300mm/hr chart speed

3.2.4 Zero

This is used to align the traces to chart zero.

MULTIPOINT RECORDERS

Upon entry, the chart advances, and a trace is placed on the chart where the recorder thinks chart zero is. The up and down arrow keys are used to adjust the position of the trace so that it is aligned with the chart zero grid line.

CONTINUOUS-TRACE RECORDERS

Upon entry, the up/down scroll keys are used to select a channel (default = channel 1). Use of the Enter key causes all pens but that associated with the selected channel to move to the centre of chart, whilst the selected pen moves to where it believes chart zero is. The up and down scroll keys are used to align this pen's trace to the chart zero grid line. Operation of the Enter key confirms the new zero position.

To align another pen, use the cancel (x) key to return to the channel select page, use the up/down scroll keys to select another channel (annotator = A), and repeat the above process. Once all the required channel pens have been zeroed, two operations of the cancel key take the user back to the main menu.

3.2.5 Span

This is used to align the traces with chart full scale, and operates in exactly the same way as described above for chart zero, except, of course, that the alignment is carried out to the 100% chart grid line, not the 0% grid line.

3.2.6 Time and date setting

Note: This section applies to continuous-trace recorders only if they are fitted with the annotation option.

Figure 3.2.6 shows the key strokes necessary to set the time and date (in this example to 10 minutes to 4 o'clock pm on the 1st May 1998), and how to set the date format to European (Eu) which is Day/Month Year, or American (USA) which is Month/Day/Year. The clock re-starts at each operation of the Enter key, although it is not printed on the chart until the recorder is returned to its 'on-line' status using the Cancel (X) key.

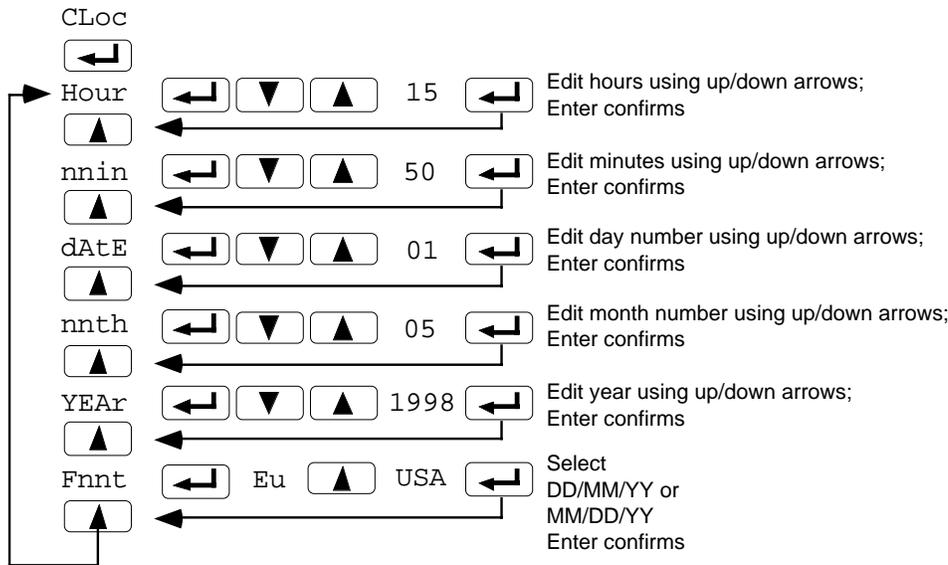


Figure 3.2.6 Time and date setting

3.2.7 ADJ

The adjust section allows the recorder's input circuits to be adjusted to make allowance for non-standard inputs. If both zero and span are adjusted, a dual point gain and offset adjustment will be applied. If only zero or only span is adjusted, then a single point offset adjustment will be carried out.

Note: If the hardware capabilities are exceeded, or if the input is in ERROR, or if the input has been configured with an invalid range, the displayed value is ---- and in such cases the adjustment is ignored.

ZErO

After selecting the required channel for adjustment, operate the Enter key whilst 'ZERO' is displayed. Apply a known input, as close to the required zero point as possible. Use the cursor and up/down arrow keys to set the displayed value to the known input value. A further operation of the Enter key confirms the change.

SPAn

This operates in the same way as described for 'ZERO' above, except the known input should be as near to the required span value as possible.

CLr

Operation of the Enter key whilst CLr is displayed calls a confirmation menu in which the up or down arrow is used to select 'yes' or 'no'. Operation of the Enter key with 'yes' selected causes any adjustments previously made to the relevant channel to be removed.

3.2.8 Alarm set up

This allows an alarm threshold to be set, and the alarm type to be defined as absolute high or absolute low. The default threshold setting is 0.000 and this can be edited using the up and down arrow keys and cursor as described in section 3.2 above.

Figure 3.2.8 shows the keystrokes necessary to set the threshold of Channel 2, alarm 1, and how to define it as absolute low.

An alarm can be disabled only by setting its threshold outside the range of the input signal.

See also CREL (section 3.2.11) for details of how to use the relay associated with channel 1 alarm 1 as a global alarm indicator and HySt (section 3.2.11) for how to set a hysteresis value for all alarms. (See glossary for a description of hysteresis.)

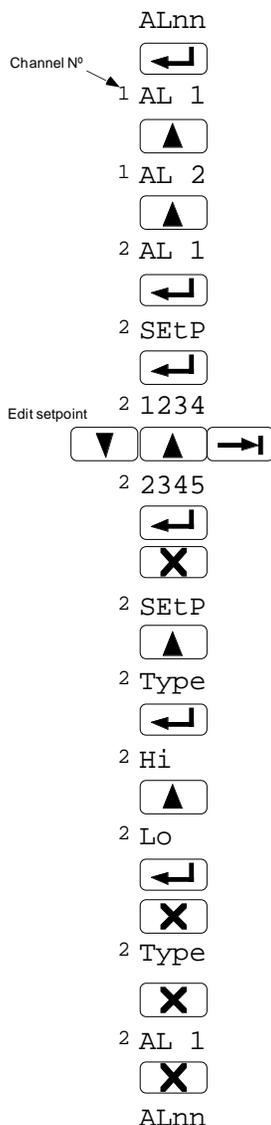


Figure 3.2.8 Alarm configuration example

3.2.9 Range

This section allows the configuration of the input channels to be entered. Figure 3.2.9 shows the top level range configuration menu for three cases:

1. Input type = thermocouple or RTD; Linearisation = TC or RTD type.
2. Input type = V, mV, mA or ohms; Linearisation type = linear or square root and
3. Input type = V, mV, mA or ohms; Linearisation function = Thermocouple or RTD type.

This last combination is used with transducer transmitters which do not incorporate their own linearisation tables.

Notes:

1. Channel one must not be used whilst configured as 'Ohm' or 'RTD' unless the CJ sensor has been disconnected (figure 2.2), or gross measurement errors will occur. When the CJ sensor disconnected, no other input channel should be configured as T/C unless it uses an external CJC.
2. The background (PV) display will show 'brng' (bad range) if any one or more of the following obtain:
 - a. Input range low \geq Input range high
 - b. Linearisation range low \geq Linearisation range high
 - c. Scale low = Scale high
 - d. Hardware capabilities are exceeded
 - e. Linearisation type is inappropriate to the rest of the configuration

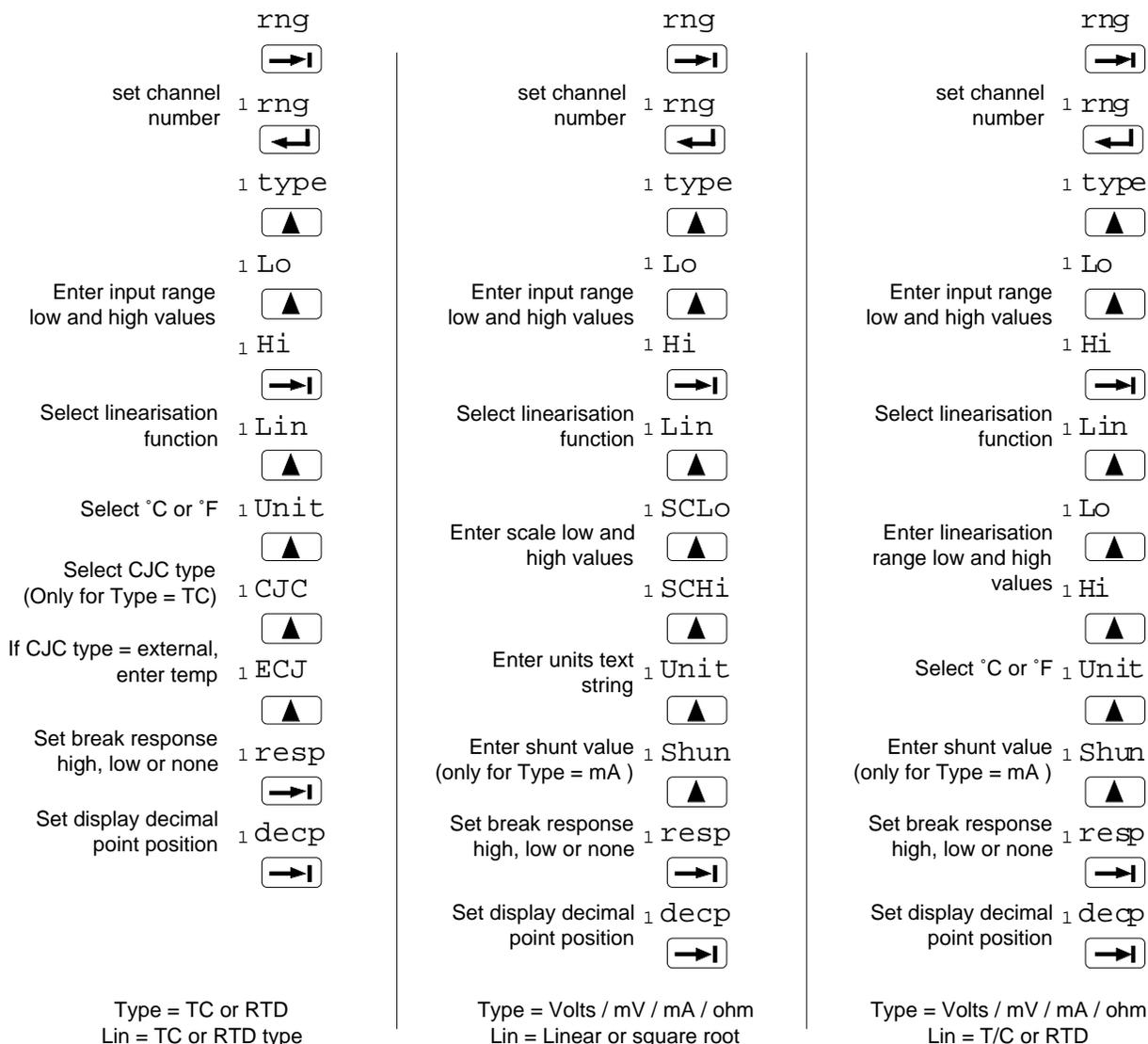


Figure 3.2.9 Channel range configuration menu

3.2.9 RANGE (Cont.)

type

Scrollable through Off, tc (thermocouple), mV, Volts, mA, RTD, Ohm. If Off, then none of the headings below appears. Where different input types are to be used, resistive inputs (RTD or potentiometer) should not be connected to channel 1. If channel 1 input must be resistive, the cold junction sensor must be disconnected as shown in figure 2.2 above, and any thermocouple inputs must then use external cold junction compensation.

Lo/Hi

These two input range entries represent the lowest and highest values the input is likely to have placed across it, in engineering units. (E.G. For a thermocouple, the input range would be in °C or °F.)

LIN

This allows a linearisation function to be chosen for the input. The scrollable list consists of the following where the actual displayed item appears in parentheses {}, if it is affected substantially by the constraints of the display:

Thermocouples type: B, C, D, E, G2 (G2), J, K (CA), L, N, R, S, T, U, NiNiMo (nini), Platinel (Plt).

Resistance thermometers type: Pt100DIN (P100), Pt100ANSII (P10A), JPt100 (JP10), Pt1000 (1000), Ni100 (N100), Ni120 (N120)

Other linearisations: Linear, Square root.

UNIT

For thermocouple or RTD types, the units string can be scrolled between °C and °F as required. For other types, a four character units string can be entered, using the text entry techniques described in section 3.2.1 (Character set).

SCLo/SCHi

For mV, mA and Volt input types only, this allows a scale low and scale high value to be entered. For example, a voltage input of 0 to 5 Volts (input range) may be required to be displayed, for example, as 0% (Scale low) to 100% (Scale high), or 1000 to 5000 RPM and so on.

Lo/Hi

Where this appears after the LIN menu item, these entries cater for the case where a remote transducer is attached to a non-linearising transmitter. In these circumstances a signal of, say, 4 to 20 mA (input range) might be equivalent to 400 to 1600 °C (linearisation range). It is this linearisation range which is entered here.

CJC

This field appears only when 'type' = tc, and 'Lin' is a thermocouple type, and allows the user to use no cold junction compensation (CJC) (none), the internal CJC supplied by the recorder (int), or an external cold junction held at a known temperature (Etn). Where external is selected, the following item is 'EJC', which allows the temperature of the external CJC to be entered.

EJC

Allows the temperature of an external cold junction to be entered. See CJC immediately above for more details. This EJC item appears only when CJC has been selected as external (Etn).

SHUN

Allows a shunt value to be entered for mA type inputs.

RESP

Allows the user to select none, Drive High (drhi) or Drive Low (Drlo) as the recorder's response to an open circuit ($R > 10M\Omega$) at its input. Where 'none' is selected, the channel drifts according to the induced voltages in the signal wiring. When selected high (low) the channel will be traced at $>100%$ ($<0%$) on the chart.

DECP

Allows the user to determine the position of the decimal point at the recorder display. The positions can be scrolled through, from 0.000 through 00.00 and 000.0 to 0000.

3.2.10 UNIT

This allows the user to choose whether or not to display the channel units or not. If 'No' is selected, the background display carries out its normal 5-second scroll through the channels as described in section 3.1 above. If 'Yes' is selected, then the normal 5-second scroll continues, but each channel's units are displayed for about a second and a half just before the next channel's PV appears. See Note 2 in Section 3.1 regarding non-displayable characters.

3.2.11 INST

This section of the configuration allows the Password to be edited, the 'Common Relay' function to be enabled/disabled, the chart cassette type to be defined (roll or z-fold (fanfold)), Alarm Hysteresis to be set, Alarm messages to be enabled or disabled, an instrument descriptor to be entered and the operator access level to be defined.

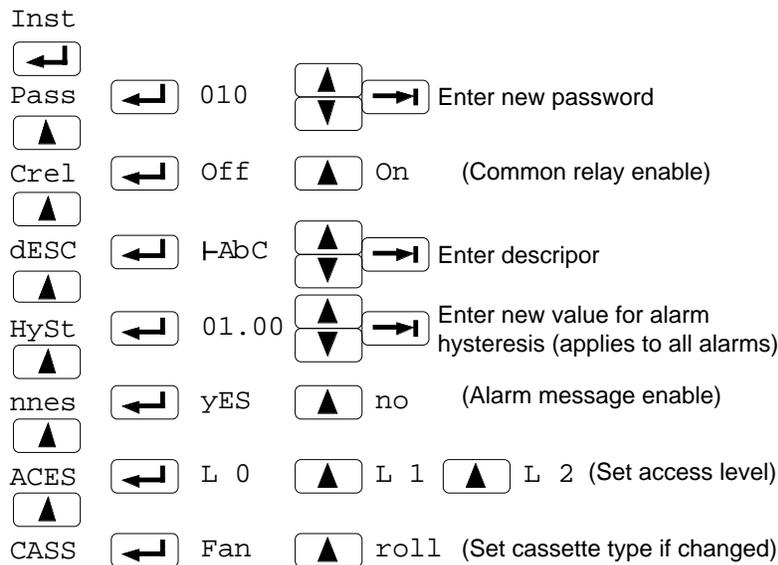


Figure 3.2.11 Instrument configuration menu.

PASS

Allows a new password to be set for entry to the configuration menus. If set to '000', no password is required for subsequent entry to configuration. See also 'Operator access' in section 3.2 above, and ACES below.

CREL

Common Relay enable. When set to 'On', Channel 1 Alarm 1 relay operates if any channel's alarm becomes active. When set to 'Off', the relay operates only when channel 1 alarm 1 becomes active.

DESC

Allows a 20-character text string (descriptor) to be entered using the cursor and up and down arrows to enter each character in turn. When the cursor is operated from the 20th character position, it returns to the 1st character position. To indicate that this has happened, character 1 of the descriptor is always preceded by a special character (†). For example, were the descriptor '† DOWNLINE TEMPERATURE' to be entered, (where the highlighted text indicates the four characters on display) and the cursor operated from the final E, the display would change to: '†DOWNLINE TEMPERATURE'.

As indicated above, characters which cannot be displayed (K, M, W, X) are represented by another special character (⌈). (These non-displayable characters do print correctly on the chart). See section 3.1 above for the full character set available.

3.2.11 INSTRUMENT CONFIGURATION (Cont.)

Hyst

Allows a hysteresis value (as a percentage of channel scale) to be entered for all the alarms' thresholds, as a percentage of Channel scale. See the Glossary of terms for a description of hysteresis.

n.nES

Allows the printing of alarm messages to be enabled/disabled. When enabled, the messages:

HH:MM:SS ALARM ON C:A, and HH:MM:SS ALARM OFF C:A

will be printed on the chart, in black, at the appropriate time.

HH:MM:SS is the time of occurrence

C is the relevant channel number

A is the relevant alarm number

Note: If the 'Event input' option is fitted, the printing of alarm messages is inhibited.

ACES

Allows operator access to be set to level 0, 1 or 2 as required. See 'Operator Access' in section 3.2 for further details.

CASS

The recorder is set up at the factory to suit the type of cassette fitted. Should the cassette type be changed (from roll to z-fold (fan fold) or *vice versa*), then this 'CASS' field needs to be accessed, and the new cassette type selected using the up/down arrow keys. If this is not done, the chart drive will become extremely noisy, or the chart time accuracy will be lost, according to type.

4 OPTIONS

Up to four 1/2-width option boards can be fitted, as specified at time of order (i.e. options are not retro-fittable).

4.1 RELAY OUTPUTS

The relay output option comes in three versions, each of which uses a 1/2 - width circuit board. The relay specification for resistive loads is as given below. With inductive loads, contact life = resistive life x reduction factor (from figure 4.1 where F1 = measured on representative samples and F2 = typical values (according to experience).

Maximum switching power	500 VA or 60 W
Maximum contact voltage	250V within the VA/Wattage ratings above
Maximum breaking current	2 A, within the VA/Wattage ratings above.
Isolation (dc to 65Hz; BS EN61010)	Installation category II; Pollution degree 2 (See section 6 for definitions)
Contact to contact:	300V RMS or dc (double insulation)
Contact to ground:	300V RMS or dc (basic insulation)
Estimated life	30,000,000 operations

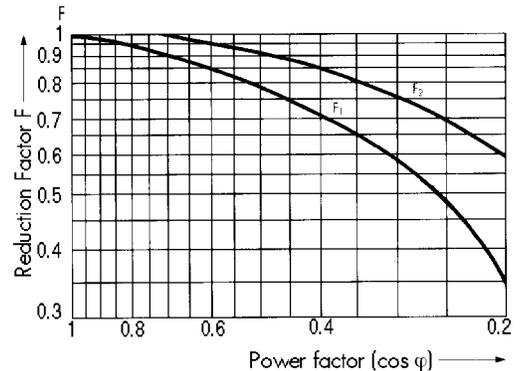


Figure 4.1 Reduction factor for inductive loads

Each recorder channel has two alarm thresholds (alarm 1 and alarm 2), which can both be either absolute high or absolute low as defined at time of order. If the channel's value lies above a high threshold, the relevant relay for that channel alarm is active. If the channel's value lies below a low threshold, the relevant relay for that channel alarm is activated.

Notes:

1. The default hysteresis value of 1% can be edited as a part of the instrument configuration (HySt). This value is a percentage of channel scale, and applies to all thresholds.
2. The relays are de-energised in alarm and power off conditions, to provide fail-safe operation.

4.1.1 Three change-over relays board

This 1/2 board provides three change-over relays (i.e. with common, normally open and normally closed contacts). In alarm, the common and normally closed contacts are closed. Wiring details for up to 12 relays is shown in figure 4.1.1.

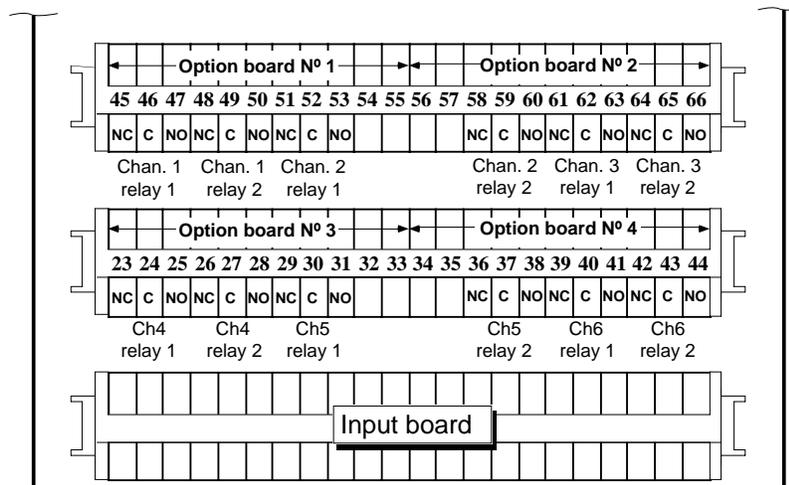


Figure 4.1.1 Change-over relay wiring (alarm / power off state)

4.1.2 Four normally-open relays board

This 1/2 board supplies four relays with common and normally open contacts. In alarm or power off conditions, the common and normally open contacts are open. Figure 4.1.2 below, shows wiring details for 12 relays located at option board positions 1, 2 and 3.

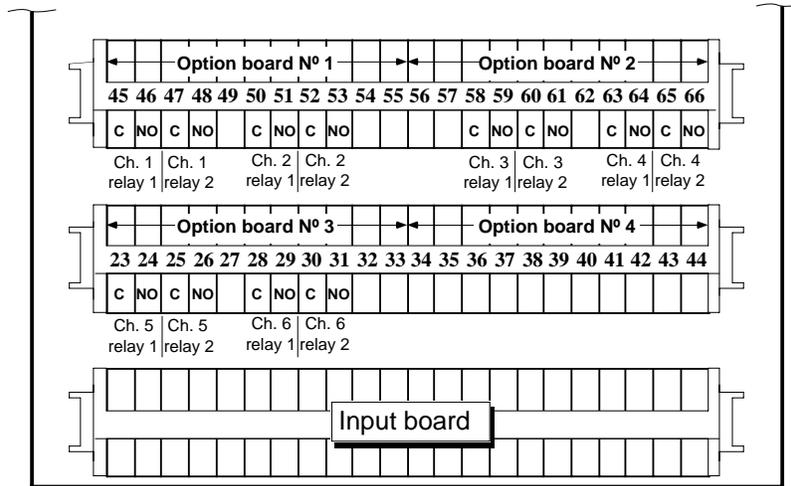


Figure 4.1.2 Normally-open relay wiring (alarm / power off state)

4.1.3 Four normally-closed relays board

This 1/2 board supplies four relays with common and normally closed contacts. In alarm or power off conditions, the common and normally closed contacts are closed. Figure 4.1.3 below, shows wiring details for 12 relays located at option board positions 1, 2 and 3.

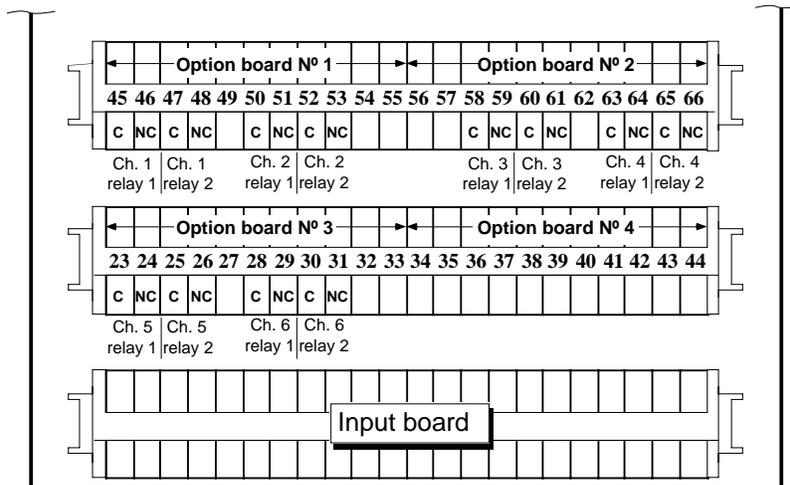


Figure 4.1.3 Normally-closed relay wiring (alarm / power off state)

4.2 TRANSMITTER POWER SUPPLY OPTION

4.2.1 Introduction

This option supplies one or two sets of three isolated 25 Volt outputs wired to terminal blocks for user connection. Each output is intended to supply power to a remote transmitter in order to run a 0 to 20 mA or a 4 to 20 mA current loop.

Figure 4.2.1 shows an overall view of a transmitter power supply option fitted in the rear terminal cover.

FUSES

The fuse is a 63mA (220/240V) or 100mA (110/120V), 20mm anti-surge type T located on the circuit board as shown in figure 4.2.1 above. Spare fuses are available from the manufacturer.

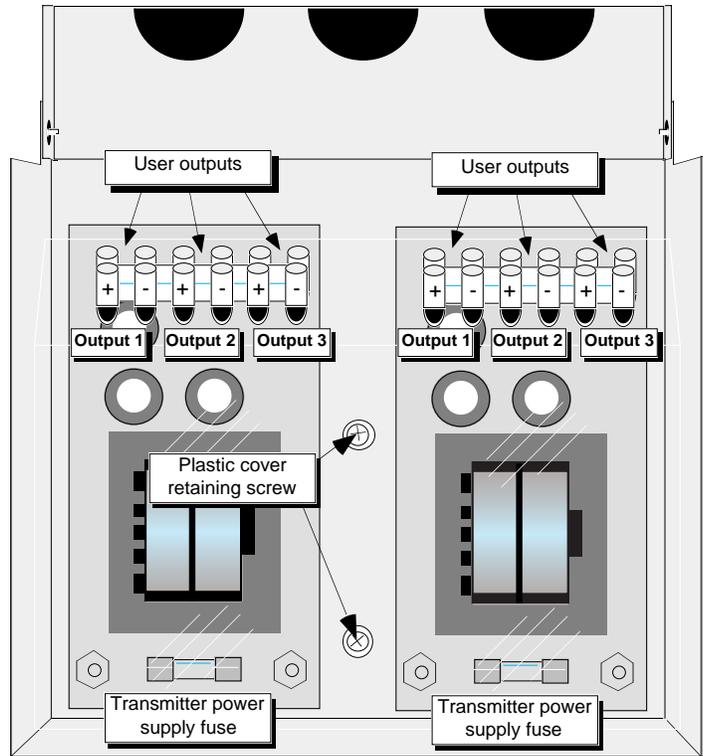


Figure 4.2.1 Transmitter power supply

SAFETY ISOLATION

Isolation (dc to 65Hz; BS EN61010)

Installation category II; Pollution degree 2 (see section 6 for definitions)

Channel to channel = 100V RMS or dc (double insulation); Channel to ground = 300V RMS or dc (basic insulation)

4.2.2 Signal wiring

Each set of outputs is terminated at a terminal block as shown in figure 4.2.2

In order to read input values successfully a resistor must be connected across V+ and V- of the input channel. This resistor should have a minimum specification of 1.4 Watt, $\pm 1\%$ and should be either 100 Ω or 250 Ω in value as required. Resistors of this kind are available from the manufacturer.

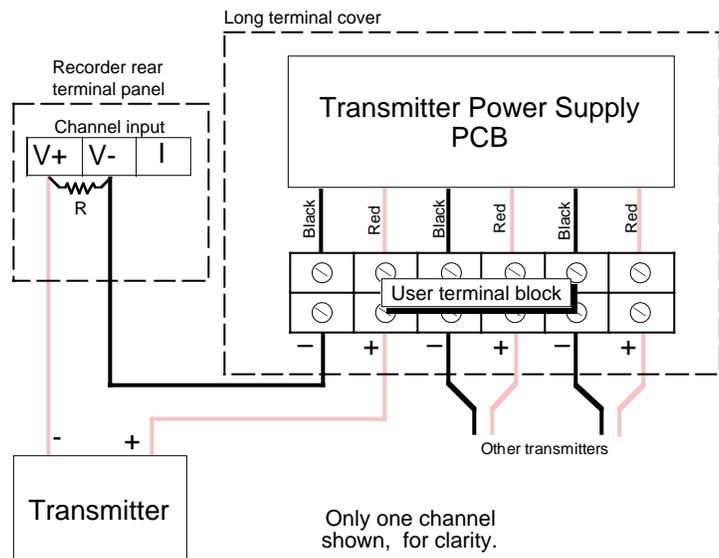


Figure 4.2.2 Transmitter power supply signal wiring

4.3 EVENT INPUT OPTION

This option offers four inputs to control chart on/off and annotation of events. Each event is initiated by a contact closure (or opening) applied between the 'C' terminal and input terminals one to four.

Note: Alarm message printing is inhibited if the Event Input Option is fitted.

4.3.1 Contact input 1

With the contact closed, the chart runs normally, at its selected chart speed.

When the contact is opened, pens are parked at zero (continuous-trace recorders) or tracing is stopped (multipoint recorders), the chart winds forward eighty mm. and stops.

Contact input 1 may not be closed if contact input 2 (below) is closed.

4.3.2 Contact input 2

This function applies only to annotating recorders.

At closure, the current time and date is printed on the chart. For as long as the contact is closed, the chart runs at its selected speed, but annotation of scales, time, date and chart speed is inhibited.

At contact opening, pens are zeroed (continuous-trace recorders) or tracing is inhibited (multipoint recorders), time, date, scales and chart speed are printed on the chart, the chart is wound forwards 80 mm. and is then stopped.

Contact input 2 may not be closed if contact input 1 is closed.

4.3.3 Contact input 3

This function applies only to annotating recorders, and is effective only if contact 1 or 2 is closed.

On closure, the message "EVENT START HH:MM:SS" is printed at the left-hand side of the chart, where HH:MM:SS shows the time of closure in hours, minutes and seconds.

On contact opening, the message "DURATION HH:MM:SS" is printed at the left edge of the chart, where HH:MM:SS shows how long the contact has been closed to the nearest second. Should the duration of closure reach 100 hours, the duration re-sets to zero.

4.3.4 Contact input 4

If contact 1 or 2 is closed, then channel four (continuous trace) or channel six (multipoint recorders) is used to show the status of contact closure 4. Whilst contact 4 is open, the trace is at 100% of chart span; whilst closed, the trace moves to 96% of span.

If neither contact 1 or 2 is closed, pen four (continuous-trace recorders) moves to chart zero or tracing by channel 6 (multi-point recorders) is stopped.

4.3.5 Event input wiring

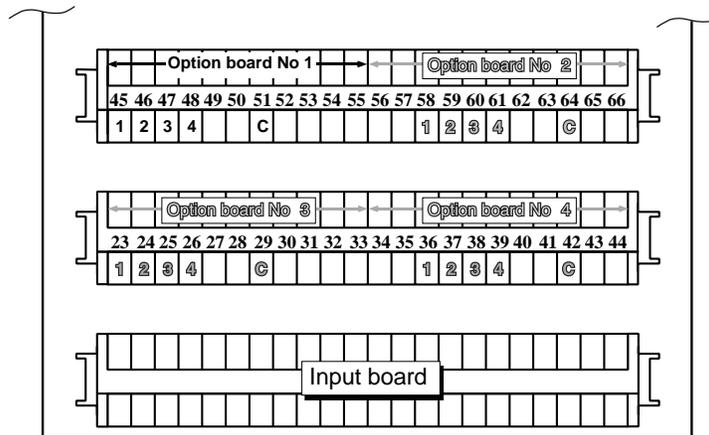


Figure 4.3.5a Event input terminations

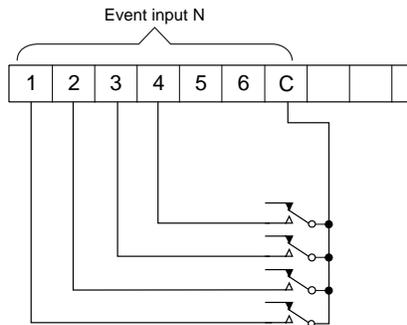


Figure 4.3.5b Event input wiring

4.3.6 Safety Isolation

Isolation (dc to 65Hz; BS EN61010)

Installation category II; Pollution degree 2 (see Specification section for definitions)

Event input to ground = 100V RMS or dc (double insulation); Event input to Event input = 0V

5 COSHH DATA

5.1 RECORDING PENS

The COSHH data presented here is derived directly from data sheets produced by the manufacturer to cover all its products. This is reflected in the fact that the list of part numbers includes more than those items relevant to this product,

Product: RECORDING PENS							
Part numbers:							
LZ127886	LA125451	LA128964	LA230393	LA234423	LA243770	LA246521	LA249550
LZ127887	LA125452	LA128965	LA233023	LA234424	LA243771	LA246522	LA249551
LZ127888	LA125453	LA128966	LA233461	LA234425	LA243772	LA246523	LA249552
LZ127889	LA128961	LA203211	LA233462	LA235347	LA243773	LA247158	LA249553
LZ127890	LA128962	LA203212	LA233701	LA235348			LA249554
	LA128963	LA203213	LA233702	LA235349			
		LA203214	LA233703	LA235350			
HAZARDOUS INGREDIENTS							
Name	% Range	TLV	Toxicological data				
Formamide	25 to 30	Not available	Not established				
Acid dyes	1.5 to 3	Not available	Not established				
PHYSICAL DATA							
Boiling point	100 ° C	Specific gravity	1.06 to 1.1				
Vapour pressure	Due to H ₂ O only. 0.62% approx	Solubility in water	Complete				
Odour	Nearly odourless	Colours	Various				
FIRE AND EXPLOSION DATA							
Flash point (deg C) (Method used)	Not flammable		FLAMMABLE LIMIT				
Extinguishing media	Use medium appropriate to primary cause of fire.		LEL	UEL			
			Not applicable	Not applicable			
Special fire-fighting procedures	None						
Unusual fire and explosion hazards	None						
HEALTH HAZARD DATA							
Threshold limit value	Not established						
LD 50 Oral	Not established	LD 50 Dermal	Not established				
Skin and eye irritation	None in normal use						
Over-exposure effects	Unknown						
Chemical nature	Solution of dyestuffs in water and organic solvents						
FIRST AID PROCEDURES							
Eyes and skin	Flush affected areas with water. If irritation develops, consult a physician						
Ingestion	If swallowed, dilute with water. Induce vomiting. Obtain immediate medical attention						
Inhalation	If inhaled, move to fresh air. If necessary, aid breathing and obtain medical attention						
REACTIVITY DATA							
STABILITY				Conditions to avoid			
Stable	Yes	Unstable	Temperatures above 70°C				
Hazardous decomposition products	None						
Hazardous polymerisation	Will not occur						
SPILL OR LEAK PROCEDURES							
Wipe up spills with towels and cloths. Remove stains with soap solution.							
Dispose of waste in accordance with local environment control regulations							
SPECIAL PROTECTION INFORMATION							
Respiratory	If vapours are generated, use organic vapour respirator						
Ventilation	Normal ventilation is adequate						
Protective clothing	Use gloves when handling pens to avoid stains on skin/clothing						
Other	All colours contain dyes which are suspected carcinogens						

5 COSHH DATA (Cont.)

5.2 PRINthead INKS

Product: WATER BASED INKS NOT CONTAINING FORMAMIDE			
Part numbers: LA248163 LA249556			
HAZARDOUS INGREDIENTS			
Name	% Range	TLV	Toxicological data
Acid dye	1 to 4	Not available	Not established
PHYSICAL DATA			
Boiling point	>212 ° C	Specific gravity	1.05 to 1.1
Vapour pressure	<20 mm Hg	Solubility in water	Complete
Odour	None	Colours	Various
FIRE AND EXPLOSION DATA			
Flash point (deg C) (Method used)	Not flammable		FLAMMABLE LIMIT
Extinguishing media	Use medium appropriate to primary cause of fire.		LEL Not available UEL Not available
Special fire-fighting procedures	None		
Unusual fire and explosion hazards	None		
HEALTH HAZARD DATA			
Threshold limit value	Not established		
LD 50 Oral	> 5g/kg	LD 50 Dermal	Not established
Skin and eye irritation	None in normal use		
Over-exposure effects	Slight irritation of mucus membrane		
FIRST AID PROCEDURES			
Eyes and skin	Flush affected areas with water. If irritation develops, consult a physician.		
Ingestion	If swallowed, dilute with water. Induce vomiting. Obtain immediate medical attention		
Inhalation	If inhaled, move to fresh air. If necessary, aid breathing and obtain medical attention		
REACTIVITY DATA			
STABILITY			Conditions to avoid Strong oxidising agents and temperatures above 90°C
Stable	Yes	Unstable	
Hazardous decomposition products	None		
Hazardous polymerisation	Will not occur		
SPILL OR LEAK PROCEDURES			
Wipe up spills with towels and cloths. Remove stains with soap solution.			
Dispose of waste in accordance with local environment control regulations			
SPECIAL PROTECTION INFORMATION			
Respiratory	If vapours are generated, use organic vapour respirator		
Ventilation	Normal ventilation is adequate		
Protective clothing	Use gloves when handling printheads to avoid stains on skin/clothing		
Other	When printheads are being used for recording purposes, there are no known deleterious effects arising from the inks or pen tips.		

5 COSHH DATA (Cont.)

5.3 NI-CAD BATTERIES

Product: BATTERY PACKS			
Part numbers: PA244816 PA250002 PA250188			
HAZARDOUS INGREDIENTS			
Name	% Range	TLV	Toxicological data
Negative electrode (cadmium metal, cadmium hydroxide, nickel sinter)	15 to 25	Not available	Highly toxic
Positive electrode (nickel hydroxide, cobalt hydroxide, nickel sinter)	5 to 15	Not available	Highly toxic if ingested
Electrolyte (potassium hydroxide)	5 to 15	Not available	Highly toxic, Highly corrosive.
PHYSICAL DATA			
Boiling point	Not applicable	Specific gravity	Not applicable
Vapour pressure	Not applicable	Solubility in water	Not applicable
Odour	Not applicable	Colours	Not applicable
FIRE AND EXPLOSION DATA			
Flash point (deg C) (Method used)	Not applicable		FLAMMABLE LIMIT
Extinguishing media	Use medium appropriate to primary cause of fire	LEL	UEL
		Not applicable	Not applicable
Special fire-fighting procedures	Not applicable		
Unusual fire and explosion hazards	Batteries might explode due to excessive pressure build-up which might not be self-venting. Toxic fumes (cyanogen) might be generated.		
HEALTH HAZARD DATA			
Threshold limit value	Not applicable		
LD 50 Oral	Not applicable	LD 50 Dermal	Not applicable
Skin and eye irritation	Should cells leak, the leak material will be a caustic solution. Avoid contact.		
Over-exposure effects	Not applicable		
Chemical nature	See above. There are no risks in normal use.		
FIRST AID PROCEDURES			
Eyes and skin	If leakage occurs, wash the affected area with plenty of water and cover with dry gauze. If eyes are affected, wash with plenty of water. Seek medical assistance.		
Ingestion	If ingestion of leak material occurs, DO NOT induce vomiting. Give plenty of milk to drink. Obtain immediate medical assistance, stating 'nickel-cadmium battery'.		
Inhalation	Not applicable		
REACTIVITY DATA			
STABILITY			Conditions to avoid
Stable	Yes	Unstable	Mechanical damage, overcharging, short circuiting terminals, storage temperatures outside the range 0 to 40° C
Hazardous decomposition products	None		
Hazardous polymerisation	Will not occur		
SPILL OR LEAK PROCEDURES			
In normal use there is no risk of leakage. If batteries are abused, this may lead to the leaking of a caustic alkaline solution which will corrode aluminium and copper. The leak material should be neutralised using a weak acidic solution such as vinegar, or washed away with copious amounts of water.			
Contact should be avoided			
DISPOSAL			
Batteries must be disposed of in accordance with current local regulations. Batteries should not be discarded with normal refuse.			
SPECIAL PROTECTION INFORMATION			
Respiratory	Not applicable		
Ventilation	Not applicable		
Protective clothing	Not applicable		
Other	In addition to the electrolyte (potassium hydroxide), nickel-cadmium batteries contain cadmium, cadmium hydroxide and nickel hydroxide, all of which are highly toxic.		

6 TECHNICAL SPECIFICATION

INSTALLATION CATEGORY AND POLLUTION DEGREE

This product has been designed to conform to BS EN61010 installation category II and pollution degree 2. These are defined as follows:

INSTALLATION CATEGORY II

The rated impulse voltage for equipment on nominal 230V ac mains is 2500V.

POLLUTION DEGREE 2

Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.

6.1 TECHNICAL SPECIFICATION (Recorder)

I/O Board types

Universal input / control board (standard)
3- Change-over relay output board, 4 Normally open relay output board, 4 Normally closed relay output board

Option boards

Transmitter power supply
Event input board
Annotator board (Continuous pen recorders only)

Environmental Performance

Temperature limits	Operation: 0 to 50°C. Storage: -20 to + 70°C
Humidity limits	Operation: 5% to 80% RH (non-condensing). Storage: 5% to 90% RH (non condensing)
Protection	Door and Bezel: IP54. Sleeve: IP20. Transmitter Power Supply option rear cover: IP10
Shock	BS EN61010
Vibration	2g peak at 10 Hz to 150Hz
Altitude (max.)	<2000 metres

Electromagnetic compatibility (EMC)

Emissions	BS EN50081-2
Immunity	BS EN50082-2

Electrical safety

BS EN61010. Installation category II; Pollution degree 2

Physical

Panel mounting	DIN43700
Bezel size	144 x 144 mm.
Panel cutout dimensions	138 x 138 (both - 0 + 1 mm)
Depth behind bezel rear face	220 mm (no terminal cover); 236 mm (standard terminal cover); 275 mm (closed long terminal cover); 390 mm (open long terminal cover)
Weight	< 3.5kg
Panel mounting angle	Vertical ± 30°

6.1 TECHNICAL SPECIFICATION (Recorder) (Cont.)

Printing system (continuous trace)

Pen type	Disposable fibre-tipped pens																
Pen resolution	0.15 mm																
Pen colours	<table border="1" style="border-collapse: collapse; text-align: center;"> <thead> <tr> <th>Channel</th> <th>Colour</th> <th>Channel</th> <th>Colour</th> </tr> </thead> <tbody> <tr> <td>1 (top)</td> <td>blue</td> <td>4 (bottom)</td> <td>violet</td> </tr> <tr> <td>2</td> <td>red</td> <td>annotator</td> <td>black</td> </tr> <tr> <td>3</td> <td>green</td> <td></td> <td></td> </tr> </tbody> </table>	Channel	Colour	Channel	Colour	1 (top)	blue	4 (bottom)	violet	2	red	annotator	black	3	green		
Channel	Colour	Channel	Colour														
1 (top)	blue	4 (bottom)	violet														
2	red	annotator	black														
3	green																
Pen life	1.2 km (channel pens); 7.5 x 10 ⁵ dots (annotator)																
Update rate	4 Hz																
Response time (10 to 90%)	2 sec max.																
Annotator characters per line	38																

Printing system (multipoint)

Pen type	Six-nib cartridge																
Print resolution	0.2 mm																
Trace colours	<table border="1" style="border-collapse: collapse; text-align: center;"> <thead> <tr> <th>Channel</th> <th>Colour</th> <th>Channel</th> <th>Colour</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>violet</td> <td>4</td> <td>green</td> </tr> <tr> <td>2</td> <td>red</td> <td>5</td> <td>blue</td> </tr> <tr> <td>3</td> <td>black</td> <td>6</td> <td>brown</td> </tr> </tbody> </table>	Channel	Colour	Channel	Colour	1	violet	4	green	2	red	5	blue	3	black	6	brown
Channel	Colour	Channel	Colour														
1	violet	4	green														
2	red	5	blue														
3	black	6	brown														
Printhead life	1.5 x 10 ⁶ dots per colour																
Update rate	2 Hz																
Print rate (maximum)	1 pass every 5 seconds																
Characters per line	42																

Paper transport

Type	Stepper motor driving sprocket tube
Chart speeds	See table below
Chart type	16-metre z-fold (standard) or 32-metre roll (option)
Transport accuracy	0.5 cm in 16 metres (0.03% approx.)

Off	5	10	20	30	60	120	Multipoint and continuous recorders Continuous only. Annotation (if fitted) inhibited above 300 mm/hr.
240	300	600	1200	3600	18000	36000	
All speeds in mm/hr							

Power requirements

Line voltage	Standard:	90 to 264V 45 to 65 Hz
	Enhanced interrupt protection:	90 to 132V 45 to 65 Hz
	Low voltage option	20 to 53V dc or ac (45 to 400Hz RMS)
Power (Max)		100VA
Fuse type		None
Interrupt protection	Standard:	40ms at 75% max. instrument load
	Enhanced:	120msec at 75% max. instrument load

6.2 TECHNICAL SPECIFICATION (Input board)

General

Termination	Edge connector / terminal block
Maximum number of inputs	Continuous trace recorder = 4. Multipoint recorder = 6.
Input ranges	- 30 to + 150 mV; - 0.2 to + 1 Volt; - 2 to + 10 Volts;
Input types	dc Volts, dc millivolts, dc milliamps (with shunt), thermocouple, 2 / 3-wire resistance temperature detector (RTD)
(Channel 1 can be RTD or Ohm only if no other channel is thermocouple - see section 3.2.9 Note 1))	
Input type mix	User configurable
Noise rejection (48 to 62 Hz)	Common mode: >140dB (channel - channel and channel - to - ground). Series mode: >60dB.
Maximum common mode voltage	250 Volts continuous
Maximum series mode voltage	180 mV at lowest range; 12 Volts peak at highest range.
Isolation (dc to 65 Hz; BS EN61010)	Installation category II; Pollution degree 2 (See section 5 above for definitions) 300V RMS or dc Channel to channel (double insulation), channel to common electronics (double insulation) and channel to ground (basic insulation)
Dielectric strength (BS EN61010)	Channel to ground =1350 Vac; Channel to channel = 2300 Vac (both 1 minute type tests)
Insulation resistance	>10MΩ at 500 V dc
Input impedance	150 mV and 1 V ranges: >10 MΩ; 10 V range: 68.8 kΩ
Over voltage protection	50 Volts peak (150V with attenuator)
Open circuit detection	± 57 nA max.
Recognition time	Continuous trace = 250 msec; Multipoint = 500 msec
Minimum break resistance	10 MΩ

DC Input ranges

Shunt/attenuator	Externally mounted resistor modules
Additional error due to shunt	0.1% of input
Additional error due to attenuator	0.2% of input
Performance	

Low Range	High Range	Resolution	Maximum error (Instrument at 20°C)	Worst case temperature performance
-30 mV	150mV	5.5μV	0.084% input + 0.053% range	80ppm of input per deg C
-0.2 Volt	1 Volt	37μV	0.084% input + 0.037% range	80ppm of input per deg C
-2 Volts	10 Volts	370μV	0.275% input + 0.040% range	272ppm of input per deg C

Thermocouple data

Temperature scale	ITS 90
Linearisation accuracy	0.05% of user entered span
Bias current	0.05 nA
Cold junction types	Off, internal, external
CJ error	1°C max; instrument at 25 °C
CJ rejection ratio	50:1 minimum
Upscale / downscale drive	High, low or none
Types and ranges	

T/C Type	Overall range (°C)	Standard	Max linearisation error
B	0 to + 1820	IEC 584.1	0 to 400°C: 1.7°C 400 to 1820°C: 0.03°C
C	0 to + 2300	Hoskins	0.12°C
D	0 to + 2495	Hoskins	0.08°C
E	- 270 to + 1000	IEC 584.1	0.03°C
G2	0 to + 2315	Hoskins	0.07°C
J	- 210 to + 1200	IEC 584.1	0.02°C
K	- 270 to + 1372	IEC 584.1	0.04°C
L	- 200 to + 900	DIN43700:1985 (To IPTS68)	0.20°C
N	- 270 to + 1300	IEC 584.1	0.04°C
R	- 50 to + 1768	IEC 584.1	0.04°C
S	- 50 to + 1768	IEC 584.1	0.04°C
T	- 270 to + 400	IEC 584.1	0.02°C
U	- 200 to + 600	DIN 43710:1985	0.08°C
Ni/NiMo	0 to + 1406	Ipsen	0.14°C
Platinel	0 to + 1370	Engelhard	0.02°C

6.1 TECHNICAL SPECIFICATION (Recorder) (Cont.)

Resistance inputs

Ranges (including lead resistance)	0 to 600 Ω , 0 to 6k Ω
Linearisation accuracy	0.05% of user entered span.
Influence of lead resistance	Error = negligible; Mismatch = 1 Ω/Ω
Temperature scale	ITS90
Ranges and temperature performance	

Low Range	High Range	Resolution	Maximum error (Instrument at 20°C)	Worst case temperature performance
0 Ω	600 Ω	22m Ω	0.045% input + 0.065% range	35ppm of input per deg C
0 Ω	6000 Ω	148m Ω	0.049% input + 0.035% range	35ppm of input per deg C

RTD ranges and standards

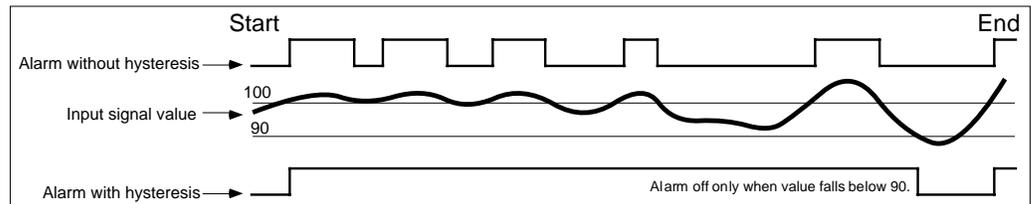
RTD Type	Overall range (°C)	Standard	Max linearisation error
JPT100	-220 to + 630	JIS C1604:1989	0.01 °C
Ni100	- 60 to + 250	DIN43760:1987	0.01 °C
Ni120	-50 to + 170	DIN43760:1987	0.01 °C
Pt100	-200 to + 850	IEC 751	0.01 °C
Pt100A	-200 to + 600	Eurotherm Recorders SA	0.09 °C
Pt1000	-200 to + 850	IEC 751	0.01 °C

7 GLOSSARY OF TERMS

Alarm	A function which is triggered when an <i>input signal</i> or a signal derived from it reaches a certain value. Once triggered, the alarm can cause a <i>relay output</i> to change state.
Analogue input	An input which changes in a smooth (non-stepped) way (e.g. thermocouples, resistance thermometers).
Attenuator	A resistive device which reduces the signal voltage by a known ratio (usually 100:1)
Break response	The recorder can detect an open circuit at its input terminals and, the instrument's response to an open circuit can be defined as 'None', 'Drive high' or 'Drive low'. If none is selected the trace is allowed to drift according to what the input wiring is picking up (acting as an aerial). Drive high (low) causes the trace to be drawn at the extreme right (left) side of the chart.
Chart cassette	A mechanical paper transport system for containing and feeding the chart past the <i>pens</i> or <i>printhead</i> at a known speed. The cassette includes reservoirs for unused (pay-out tray) and used (take-up tray) sections of chart.
Cold Junction Compensation	Also known by the abbreviation CJC. The voltage generated by a <i>thermocouple</i> (TC) junction depends on the temperature difference between the actual bonded junction (the hot junction), and the other (non-bonded) end of the conductors (the cold junction (CJ)). Thus, for any reading from a TC to be accurate, the temperature of the CJ must be taken into account. This can be done in three ways: Internal, External or Remote. <u>Internal.</u> The recorder has integral temperature detectors measuring the temperature near the terminal blocks (the cold junction for directly connected TCs). <u>External.</u> For remote TCs, the cold junction can be held at a known temperature. This temperature is entered (in degrees) as a part of the CJC configuration. <u>Remote.</u> For remote TCs, an auxiliary temperature detector can be used to measure the cold junction temperature. This detector is then connected to a separate input channel. This input channel number is entered as a part of the CJC configuration.
Configuration	This is used as a verb to mean 'the process of telling your recorder what you want it to do', and as a noun to mean 'the way in which the recorder has been set up (or configured)'.

7. GLOSSARY OF TERMS (Cont.)

Continuous trace	This is used to describe recorders which have a single <i>pen</i> associated with each <i>process variable</i> , and this pen <i>traces</i> the value continuously. See also multipoint recorder.
Digital (discrete) input	An input which has only two states (on or off). Examples are switch inputs or voltage pulse inputs.
Event input	A discrete (switch) or digital (voltage level) input.
Hysteresis	When an <i>input signal</i> is 'hovering' near a <i>setpoint</i> , then an annoying and potentially damaging series of <i>alarms</i> can be generated, instead of just one alarm the cause of which can be dealt with if necessary. To avoid this, a 'hysteresis' value of 1% span is applied, which effectively puts a dead band round the set point. For example with a span of 0 to 1000 an absolute high alarm with a set point of 100 will have a hysteresis value of 10. The alarm is triggered when the input signal value rises above 100, but will not re-trigger until after the alarm has been 'cleared' by the process value falling below 90. An attempt to depict this example is given in the figure below.



Input channel	An input circuit which accepts voltage, current or digital <i>input signals</i> from the user.
Input signal	A voltage, current or digital input applied to the recorder input circuits. See also Analogue input and Digital (discrete) input.
Linearisation table	Most <i>transducers</i> produce an output which is not directly proportional to the input. For example, the voltage output from a <i>thermocouple</i> does not vary linearly with the temperature it is exposed to. The recorder uses a 'look-up' table to find a temperature value for any mV input from a specified thermocouple type. Similar tables exist for other transducers such as <i>resistance thermometers</i> .
Measured value	An umbrella term which means: the value of an <i>input channel</i> , <i>derived channel</i> , <i>totaliser</i> , <i>counter</i> , <i>timer</i> etc. measured in mathematical units as a proportion of the <i>span</i> . See also Process variable.
Multipoint recorder	This is used to describe recorders which have multiple pen <i>printheads</i> rather than individual pens to produce the <i>trace</i> on the chart. Each trace is made up of dots, produced by the print-head as it traverses across the chart at regular intervals. Advantages are that many more traces can be laid down on the chart, the traces can be annotated for identification and messages can be printed on the chart. Disadvantages are that fast transients may be missed at low chart speeds.
Operator interface	A term used to describe the controls (e.g. pushbuttons, keypads) that are used to operate and configure the unit.
Paper transport system	This includes the <i>chart cassette</i> and the mechanical system, motors etc. needed to move the chart through the cassette. The paper transport system is often considered to be an integral part of the <i>writing system</i> .
Pen	A fibre-tipped disposable stylus with an integral ink reservoir. Used to draw (trace) the value of a single process variable on the chart in <i>continuous trace</i> recorders.
Pen tray	With modular recorder designs, each <i>pen</i> has its own mechanical system (including motor and feedback device) associated with it to drive it backwards and forwards across the chart. Pen tray is the general term for such mechanical systems. With some recorders, the pen drive electronics are integral with the pen tray.
Printhead	This is a device which, together with a disposable multi-colour cartridge, allows multi-point recorders to mark the chart.
Process variable	An umbrella term which means: the value of an <i>input channel</i> , <i>derived channel</i> , <i>totaliser</i> , <i>counter</i> , <i>timer</i> etc. measured in engineering units (e.g. Degrees Celsius). See also Measured value.

7. GLOSSARY OF TERMS (Cont.)

Relay output	A set of contacts which changes state as a result of an alarm becoming active. Relays are energised continuously except when 'in alarm', so that if power to the recorder fails they go into their 'alarm' state.
Resistance thermometer	Also known as a resistance temperature detector (RTD), a resistance thermometer is constructed of a material whose resistance varies in a known way with the temperature it is exposed to. The resistance variation is non-linear, but for any given type, this non-linearity is well known and invariable and is compensated for by <i>linearisation tables</i> in the recorder memory.
Setpoint	Also known as 'threshold', this is the point at which an <i>alarm</i> becomes active or inactive. See also <i>hysteresis</i> .
Shunt	The input circuit of each recorder channel measures voltage signals. If current signals are connected to the recorder, a low value resistor must be placed across the inputs, to convert the current signal to Volts, according to Ohms law (Volts = Amps x Ohms). Thus, a 0 to 20 mA (0.02 Amps) signal applied across a 250 Ω resistor produces a voltage range of 0 to (0.02 x 250) Volts = 5 Volts. Such resistors are called 'Shunt resistors' or 'Shunts' for short, and are usually of very close tolerance.
Span	Span has two common meanings: the right-most grid of the chart, or the value given by (maximum value - minimum value). The two meanings are identical where the minimum value is zero.
Trace	The line produced on the chart or display screen showing the value of the <i>process variable</i> being measured.
Thermocouple	A junction of two dissimilar metals which produces a small voltage, the value of which depends on the temperature of the junction. The voltage varies in a non-linear way with temperature, but for any given type, this non-linearity is well known and invariable and is compensated for by <i>linearisation tables</i> in the recorder memory.
Threshold	See setpoint.
Transducer	A device which produces an electrical output proportional to temperature, flow rate, pressure, speed, position etc. Common transducers are potentiometers, <i>thermocouples</i> , <i>resistance thermometers (RTDs)</i> and flow meters.
Transmitter	Thermocouple wire (compensation wire) is expensive, and if the thermocouple is a long way from the measuring device, it is often cheaper to instal a 'transmitter' local to the thermocouple. This device converts the mV signal from the thermocouple to a mA signal which can then be wired to the recorder using normal copper wire. Transmitters can be self powered, or they may need power generated for them. Most recorders can be fitted with Transmitter Power Supplies as an option.
Writing system	A general term used to describe the mechanical means of moving <i>pens/printheads</i> across the chart width. The term often includes the paper transport system used to drive the chart through the cassette.
Zero	Zero is generally taken to mean the value associated with the left-most grid line on the chart. Its actual value need not be zero, as long as it is less than the Span value.

Annex A: Older recorders

For recorders with status levels prior to L19 (Multipoint recorders) or L22 (Continuous-trace recorders) the following sections replace those in the body of the manual. Where information is not included in this annex, the new and old style recorders operate identically.

1 INTRODUCTION (Replaces: 1 INTRODUCTION)

The recorder comes in two versions - a continuous-trace recorder with up to four pens and a multipoint recorder giving up to six traces on the chart. Chart annotation is standard with the multipoint version, but is an optional extra (specified at time of order) with the continuous trace recorder. When fitted, this annotator option prints time, date, scales and channel tags on the chart to simplify trace interpretation.

Designed to fit a DIN cutout (138 x 138 mm) the recorders feature an exceptionally small back of panel dimension of 220 mm. (no terminal cover) or 236 mm with cover.

The recorders are factory configured to customers' requirements, but chart speed and alarm setpoints can be adjusted by the operator, as can the zero and full-scale (span) positions of the pens or printhead.

2.3 CHART REPLACEMENT (2.4 CHART REPLACEMENT)

Notes

1. If this is a multipoint recorder then for 'pens' read 'print-head'
2. For recorders with status levels K13 or higher, if the cassette type (i.e. roll or z-fold) is changed, or if the recorder loses its configuration, the recorder must be reconfigured for the correct cassette type or the chart drive will not operate correctly. The manufacturer's local service centre should be contacted for advice

Open the door of the recorder and operate the two switches (at bottom left and bottom right of the recorder) simultaneously for approximately one second, then release. (Do not expect anything to happen until you let go!)

This causes the pens to go to their park positions.

Once the chart has been replaced, return the cassette to the recorder and operate the two switches simultaneously for over four seconds (to return to normal operations) or for about one second if you wish to check the pens' zeros/spans against the new chart. See 'Setting up the recorder' below.

2.3.1 Z-Fold charts (2.4.1 Z-Fold charts)

Remove the cassette, by pulling on the two latches ('A' in the top figure). If a used chart is present, open the take-up retainer and remove the used chart.

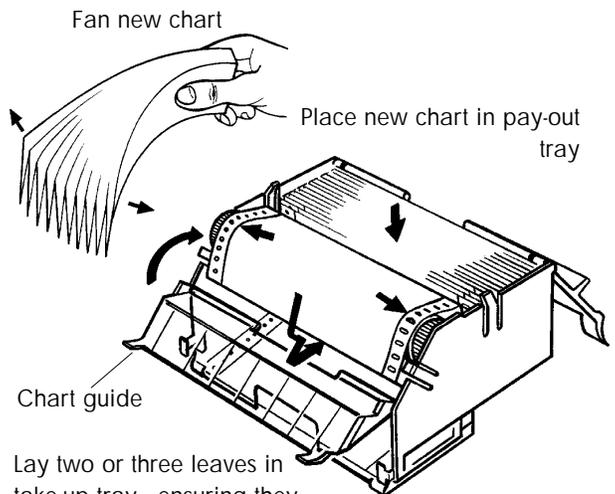
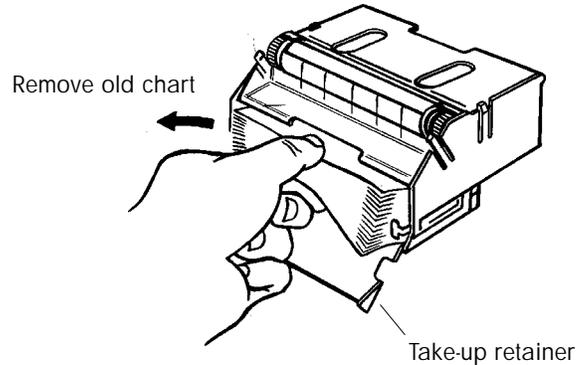
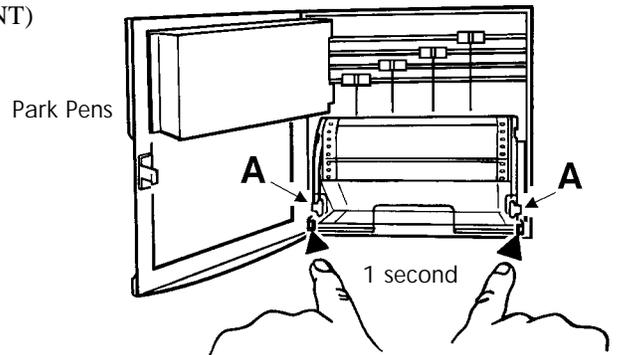
Open the top of the paper pay-out tray, and remove any residual paper dust. Open the chart guide.

Unpack the replacement chart and fan it several times to separate the leaves and to remove as much perforation dust as possible.

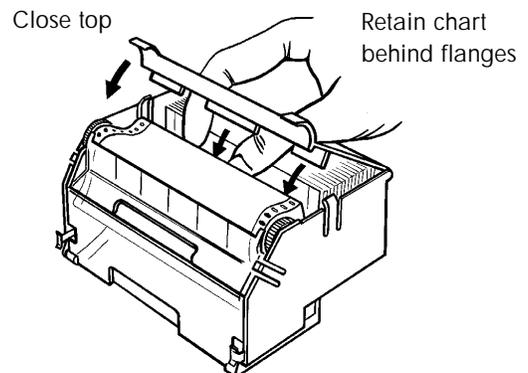
Orient the chart so that the circular holes are to the left, the slots to the right, and the red end-of-chart line to the back (all directions relative to the front of the cassette). Place the chart into the pay-out tray, unfolding three or four leaves at the same time. Pull the free end of the chart over the drive roller and down behind the chart guide and lay the free leaves in the take-up tray.

Ensure that the paper folds naturally into the tray, that the printed grid is uppermost and that the slots are at the right hand edge of the chart (i.e. the circular holes are to the left).

Close the take-up retainer and the chart guide, ensuring the paper holes/slots fit over the sprockets on the drive roller. Close the top of the paper pay-out tray, ensuring that the chart is contained behind the flanges on the top.

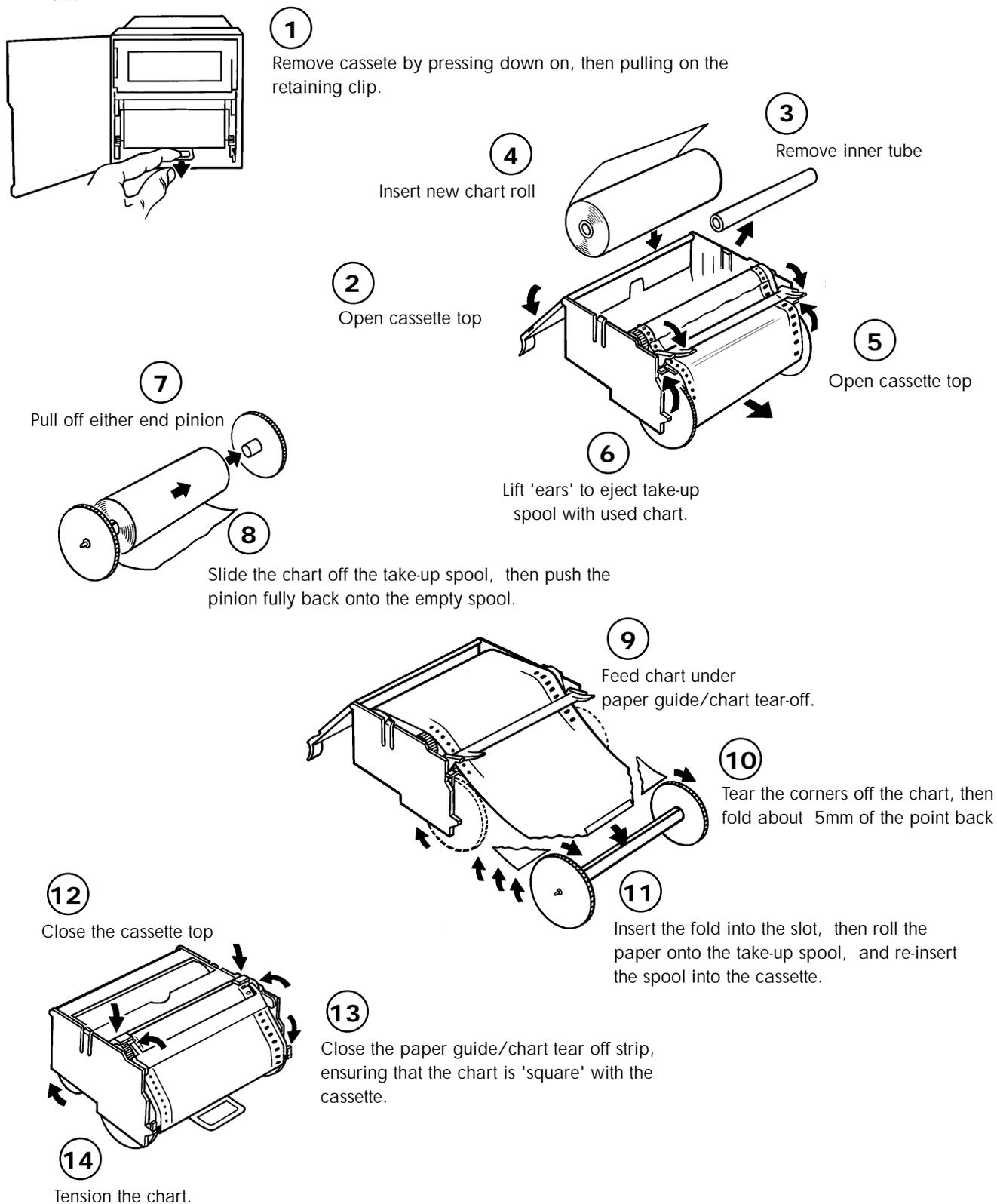


Lay two or three leaves in take-up tray, ensuring they fold naturally. Close take-up retainer and chart guide.



2.3.2 Roll charts (2.4.2 Roll charts)

Carry out the 'Park' procedure described in section 2.3 above. Once the chart has been replaced, return the cassette to the recorder and operate the two switches simultaneously for over four seconds (to return to normal operations) or for about one second if you wish to check the pens' zeros/spans against the new chart. See 'Setting up the recorder' below.



2.4 CHANGING THE PENS/CARTRIDGE (2.3 CHANGING THE PENS/CARTRIDGE)

Note: Care should be taken to avoid pen/cartridge contact with skin or clothing

2.4.1 Continuous-trace recorders

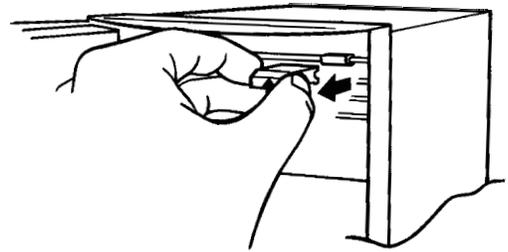
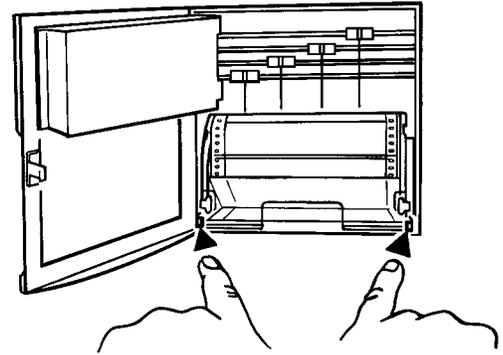
Open the recorder door, and the scale plate, both hinged at their left edge.

With power applied to the recorder, operate both push switches together, for between 1 and 2 seconds.

After the switches have been released, the pens will 'fan' to allow easy access.

Pull the pens forwards off their guide bars.

Fit the new pens and close the scale plate. Operate the switches simultaneously for over 4 seconds to return to normal recording, or for between 1 and 2 seconds to check the pen zeros and spans (section 2.5)



2.4.2 Multipoint recorders

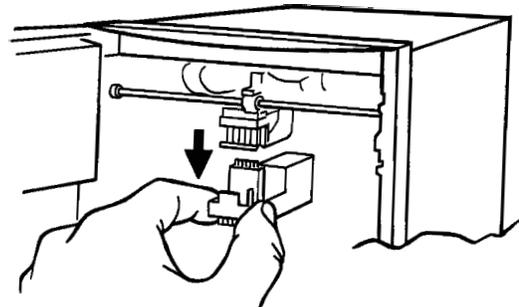
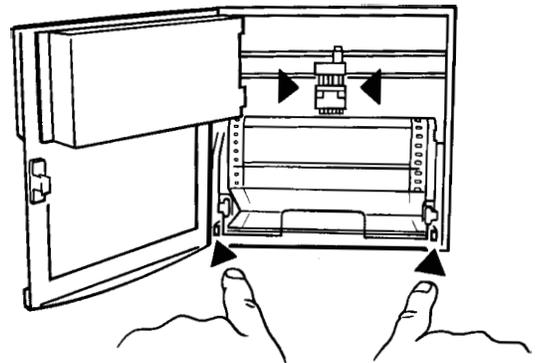
Open the door and the scale plate, both hinged at their left edge.

With power applied to the recorder, operate both push switches simultaneously for between 1 and 2 seconds. After the switches are released, the printhead travels to the centre-chart position.

Remove the chart cassette and pull the exhausted print cartridge 'vertically' downwards out of its holder.

Offer up the new cartridge to the printhead, and push it upwards into place.

Return the chart cassette to the chassis. Operate the switches simultaneously for over 4 seconds to return to normal recording, or for between 1 and 2 seconds to check the printhead zeros and spans (section 2.5).



2.5 SETTING UP THE RECORDER (Replaces: 3 CONFIGURATION)

An auto-repeat feature is included in the recorder interface, so when a key has to be operated repeatedly, the key can be held continuously actuated instead if appropriate until the required number of increments has been achieved.

2.5.1 Continuous trace recorder with no annotator

Activating the two pushbutton switches for approximately 1 second causes the chart to stop and the pens to fan ready for replacement. Repeated operations of the right hand switch scrolls through the list below. At any point, a further 1 second operation of both keys simultaneously ('Enter') allows access to the parameter for adjustment using either or both the switches.

1 Pen fan	7 Pen 3 zero	13 Channel 2 alarm 1
2 Chart speed	8 Pen 3 span	14 Channel 2 alarm 2
3 Pen 1 zero	9 Pen 4 zero	15 Channel 3 alarm 1
4 Pen 1 full scale (span)	10 Pen 4 span	16 Channel 3 alarm 2
5 Pen 2 zero	11 Channel 1 alarm 1	17 Channel 4 alarm 1
6 Pen 2 span	12 Channel 1 alarm 2	18 Channel 4 alarm 2

SETTING THE CHART SPEED

When chart speed is selected for setup, all the pens move to the centre of the chart except for pen 1 which drives to 40%, 45%, 50%, 55% or 60% of span according to the currently selected speed (40% = Chart drive off). The left and right switches can be used to move the channel 1 pen to the required chart speed position. A further simultaneous operation of the two switches causes the new chart speed to become operational.

Your recorder's chart speed range is defined at time of order. The speed range-number can be found on the configuration label on the bulkhead behind the chart cassette. Table 5.1 shows the speeds associated with that range.

SETTING THE PEN ZEROS AND SPANS

Each time a pen zero setup is selected all the pens move to 10% of chart width, except the selected pen which moves to 5%. A further enter drives this pen to where it thinks chart zero is. The left and/or right switches move the pen 0.15 mm left or right respectively each operation, allowing the pen to be aligned with the chart zero.

Similarly when a pen span is selected, all the pens move, to 90% of chart width except the selected pen which moves to 95%. After a further 'Enter', the selected pen moves to where it thinks chart span is. The left and/or right switches move the pen 0.15 mm left or right respectively each operation, allowing the pen to be aligned with the chart span.

SETTING ALARM THRESHOLDS (setpoints)

Each time an alarm 1 setup is selected all the pens move to 20% of chart width except the selected pen which moves to 15%. After a further 'Enter', the selected channel's pen will drive to its current set point. The left and/or right switches move the pen approximately 0.15 mm left or right respectively each operation, allowing the setpoint to be adjusted. A further simultaneous operation of the switches causes the new information to be saved, and alarm 2 to be moved to.

Similarly when an alarm 2 is selected for editing, all the pens move to 80% chart width except the selected pen which moves to 85%. After a further 'Enter', the selected pen moves to its current setpoint. The left and/or right switches move the pen 0.15 mm left or right respectively each operation, allowing the setpoint to be adjusted.

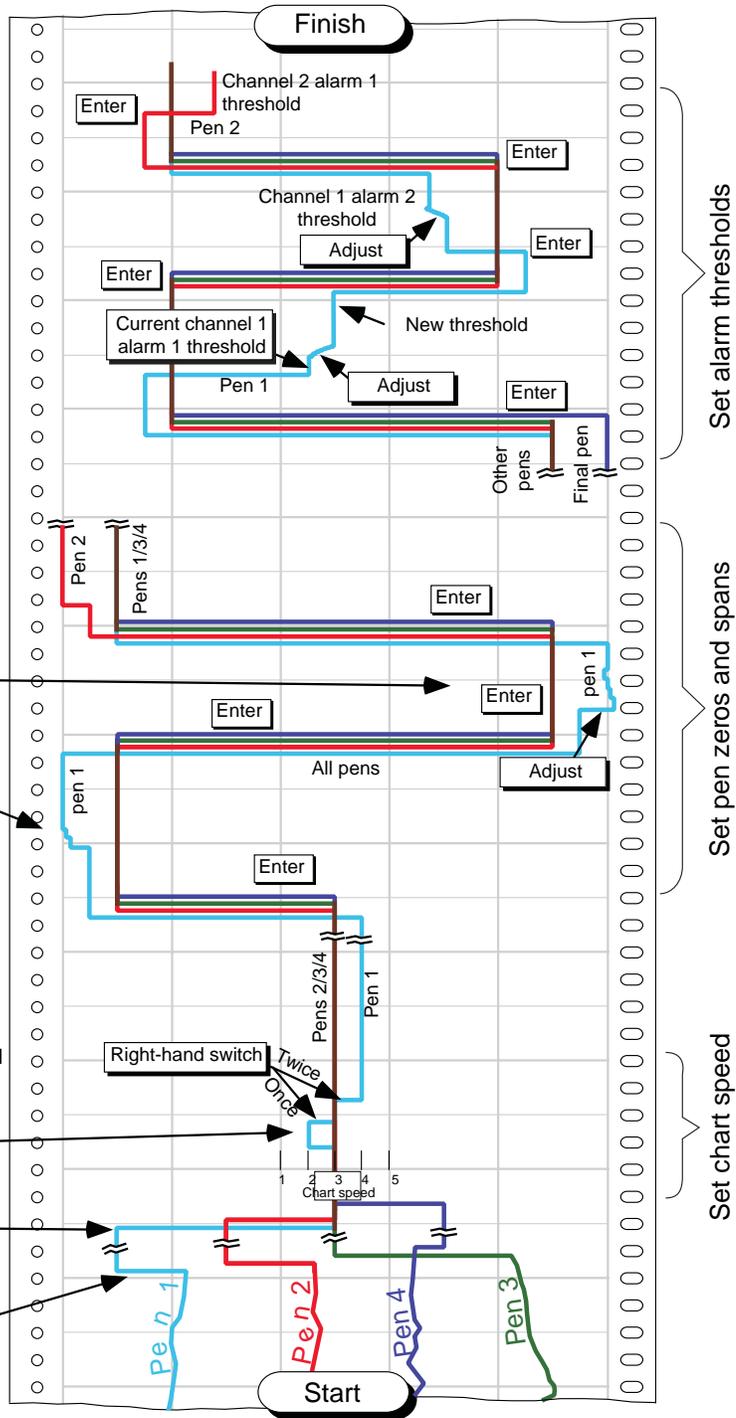
Your recorder's alarm types are defined at time of order and can be found on the label behind the cassette

RETURN TO RECORDING

At any time during setup, simultaneous operation of the two push switches for over 4 seconds returns the recorder to normal operation

2.5.1 CONTINUOUS TRACE RECORDER WITH NO ANNOTATOR (Cont.)

- 12 After 'Entering' the final channel's alarm 2 threshold, the recorder returns to normal operations
- 11 Further 'Enter' selects channel 2 alarm 1 setting, and so on.
- 10 Further 'Enter' selects channel 1 alarm 2 setting. Pens 2, 3 and 4 move to 80%; pen 1 to 85%. After further Enter, pen 1 moves to current alarm 2 threshold. Adjust using LH and RH switches, then Enter.
- 9 Pens 2, 3 and 4 move to 20%; pen 1 to 15%. After further Enter pen 1 moves to current alarm 1 threshold. Adjust using LH and RH switches, then Enter.
- 8 Further 'Enter' selects Pen 2 zero setting, and so on. When all pens' zeros and spans entered, further 'Enter' selects channel 1 alarm 1 setting
- 7 Further 'Enter' selects Pen 1 span setting. Pens 2, 3 and 4 move to 90%; pen 1 to 95%. After further Enter pen 1 moves to near 100%. Set span as for zero
- 6 Use left & right switches to adjust, then 'Enter'
- 5 Further 'Enter' selects Pen 1 zero setting. Pens 2, 3 and 4 move to 10%; pen 1 to 5%. After further Enter, pen 1 moves to near zero.
- 4 Use LH or RH switch to select new chart speed (RH twice to select speed 4 in this example)
- 3 'Enter' causes pen 1 to move to 40%, 45%, 50%, 55% or 60% according to current chart speed (2 in this example). (40% = off).
- 2 Operation of RH switch centres pens
- 1 Single 'Enter' fans pens for changing. Chart stops



Notes:

- 1 RH = Right hand; LH = Left hand
- 2 Enter = Simultaneous operation of both left and right hand switches for between 1 and 2 seconds then release. (Operation of both switches for over 4 seconds quits configuration without saving any changes made since last 'enter'.)
- 3 Chart speeds: There are five chart speeds, 1 to 5, where 1 = Off. For speed range fitted, see the label behind the cassette. Table 6.1 shows speeds per range.
- 4 Alarms (if fitted): Each alarm can be absolute high or absolute low as specified at time of order. See configuration label (behind cassette) for type fitted.

Figure 2.5.1 Simulated chart sample

2.5.2 Continuous trace recorder with annotator

Apart from the fact that the annotator prints only in black, the setting up procedure for continuous-pen recorders with annotation is the same as that given below for multi-point recorders.

2.5.3 Multipoint recorder

Operating the two switches simultaneously for between 1 and 2 seconds, causes the printhead to park at 50% chart width.

Operating the right-hand switch moves to the next parameter, or operating both switches together for about 1 second, enters the parameter's setup.

- Parameters appear in the following order:
- Chart speed,
 - Chart zero,
 - Chart span,
 - Alarm setpoints
 - Time
 - Date.

Once in setup, the right and left hand keys are used to adjust the value. Operating both keys together for 1 to 2 seconds 'enters' the new value.

Figure 2.5.3b shows the programming sequence, including changing the time from 15:12 to 16:35, and the date from 12/12/95 to 29/2/96.

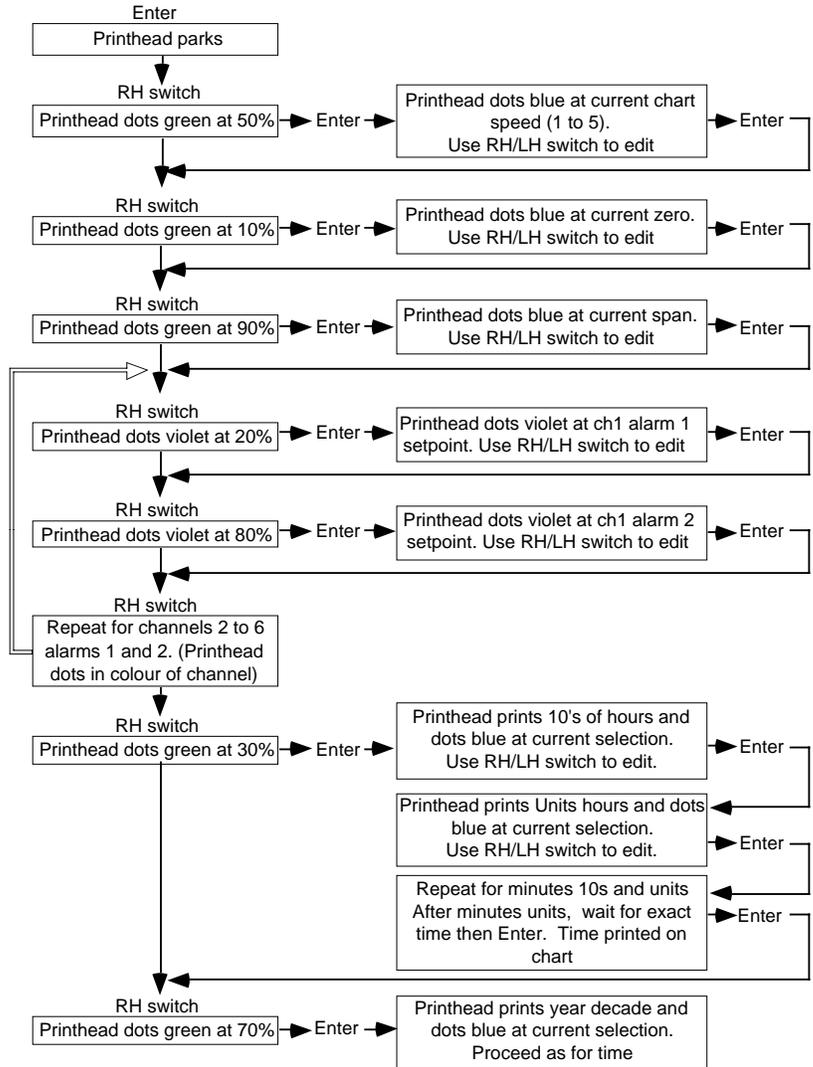


Figure 2.5.3a Set up sequence

11 Operate both keys simultaneously for more than 4 seconds to return to normal recording. End of setup indicated by black line drawn from 0 to 50%.

10 Date set up is carried out using the same method as described below for time setting. Final enter causes date to be printed.

9 After all alarms are set up, and 'entered', RH key causes 'Time' to be selected for entry. (Pen dots at 30%)

Enter causes the 10s of hours select line to be printed on the chart in green, with the current value being indicated by the blue pen. LH and/or RH keys are used to edit.

Enter followed by RH key causes next line to be printed. Hours units and Minutes 10s and units are set up in the same way.

When minutes units have been set up, wait until exact time, then Enter. Time is printed on the chart.

8 RH key causes next alarm 1 to be selected (not shown). Continue until all alarm setpoints set up, then Enter.

7 RH key causes 'Ch1 Alarm 2' set up to be selected for entry (violet pen dots at 80%). Enter causes the violet pen to indicate current setpoint. Use left/right keys to adjust, then Enter.

6 RH key causes 'Ch 1 Alarm 1' set up to be selected for entry (violet pen dots at 20%). Enter causes the violet pen to indicate current setpoint. Use left/right keys to adjust, then Enter.

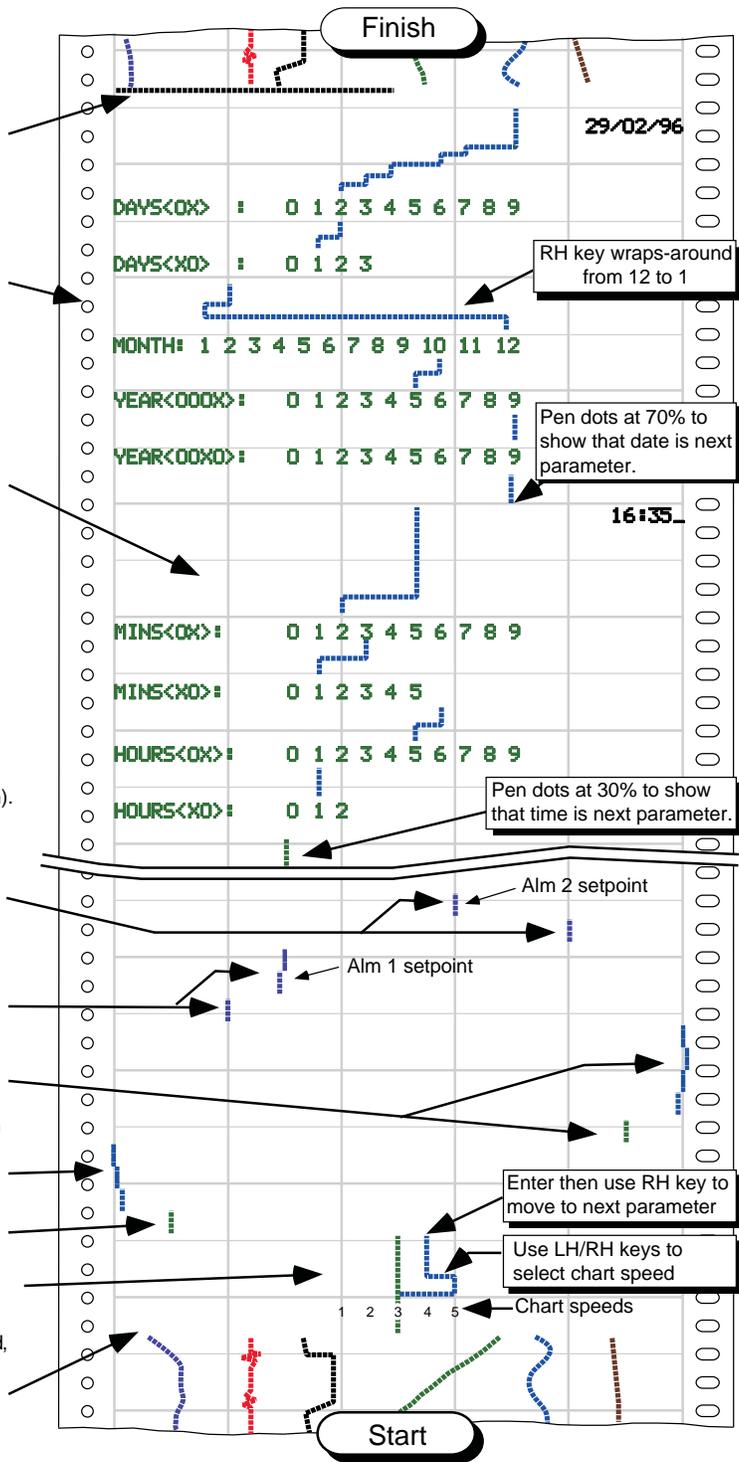
5 RH key causes 'Chart span' set up to be selected for entry (green pen dots at 90% chart width). Enter causes the blue pen to indicate current span. Use left/right keys to adjust, then Enter.

4 Enter causes blue pen to indicate current zero. Use left/right keys to adjust, then Enter.

3 RH key causes 'Chart zero' set up to be selected for entry (green pen dots at 10% chart width).

2 RH key causes 'Chart Speed' set up to be selected for entry (green pen dots at 50%). Enter key causes pen to indicate current selection. Use left/right keys to select new chart speed, then Enter.

1 Enter stops tracing and causes the print head to park at the centre of the chart (50%).



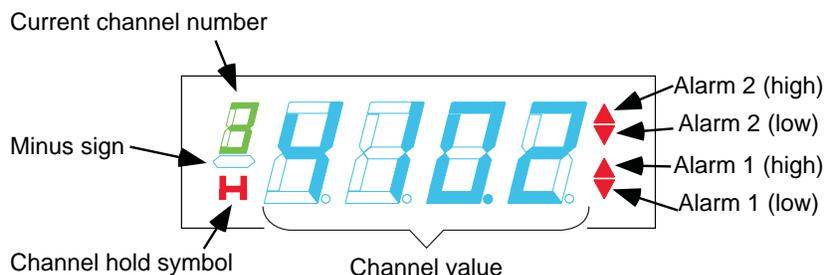
Notes:

- 1 RH = Right hand; LH = Left hand
- 2 Enter = Simultaneous operation of both left and right hand switches for between 1 and 2 seconds then release. (Operation of both switches for over 4 seconds quits configuration without saving any changes made since last 'enter'.)
- 3 Chart speeds: There are five chart speeds, 1 to 5, where 1 = Off. For speed range fitted, see the label behind the cassette. Table 6.1 shows speeds per range.
- 4 Alarms (if fitted): Each alarm can be absolute high or absolute low as specified at time of order. See configuration label (behind cassette) for type fitted.

Figure 2.5.3b Simulated chart sample

3 DISPLAY INTERPRETATION (Replaces: 3 CONFIGURATION)

The four-character, blue display shows the process value of each channel in turn, with each channel remaining on display for 5 seconds. Current channel number is indicated by a green numeric character to the left of the display unit.



Operation of the left push button switch for between 1 and 2 seconds causes the currently displayed channel's value to remain permanently on display (Channel hold). Channel hold is indicated by a red 'H' below the channel number.

The channel numbers can be scrolled through manually in both normal and channel hold mode by operation of the right-hand push switch.

The red arrow heads to the right of the display indicate which (if either) of the the displayed channel's alarms is active, and whether the alarm is absolute high or absolute low, as defined at time of order..

Range	Speed (mm/hr)					Recorder type
	1	2	3	4	5	
1	Off	5	20	60	120	Continuous and multipoint
2	Off	10	20	60	120	
3	Off	10	30	60	120	
4	Off	20	30	60	120	
5	Off	30	60	120	300	Continuous only. Annotation (if fitted) inhibited above 300 mm/hr.
6	Off	20	120	600	1200	
7	Off	20	300	1200	3600	
8	Off	20	3600	18000	36000	

Table 6.1 Chart speeds

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