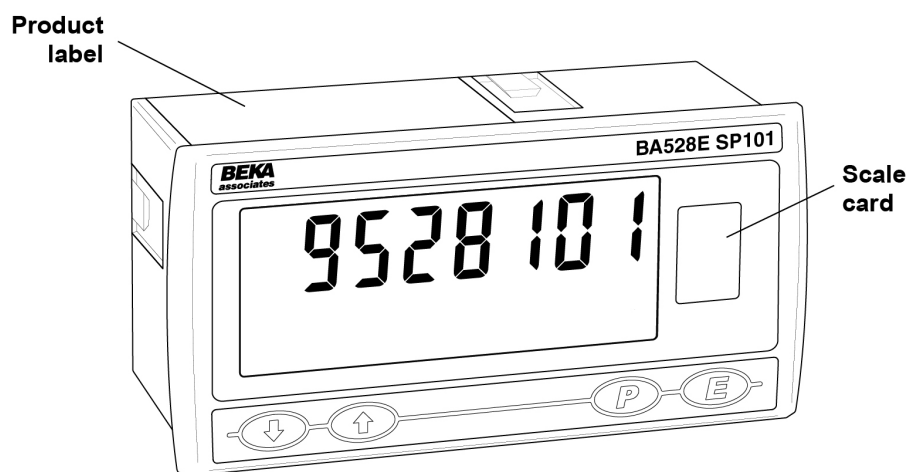


BA528E SP101
General Purpose 7 digit
loop-powered
panel mounting indicator
Issue 2



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1. DESCRIPTION

The BA528E SP101 is a general purpose, 7 digit panel mounting indicator based on the BEKA 5 digit BA528E.

The indicator is loop powered, but only introduces a 1.2V drop, allowing installation into almost any 4/20mA current loop. It is identical to the established BA528E except for, 2 additional display digits, an additional adjustable digital filter and removal of the bargraph display. No additional power supply or battery is required.

The indicator can be calibrated to display engineering units with a maximum display of 9999999.

The main application of the indicator is to display a measured variable or control signal in a process area. The zero and span of the display are independently adjustable so that the indicator can be calibrated to display any variable represented by the 4/20mA current, e.g. temperature, flow, pressure or level.

The BA528E SP101 is not certified for use in explosive atmospheres.

2. OPERATION

Fig 1 shows a simplified block diagram of the indicator. The 4/20mA input current flows through resistor R1 and forward biased diode D1. The voltage developed across D1, which is relatively constant, is multiplied by a switch mode power supply and used to power the instrument. The voltage developed across R1, which is proportional to the 4/20mA input current, provides the input signal for the analogue to digital converter.

Each time a 4/20mA current is applied to the instrument, initialisation is performed during which all segments of the display are activated, after five seconds the instrument displays the input current using the calibration information stored in the instrument memory. If the loop current is too low to power the instrument the indicator will display the error message 'LooPLo'.

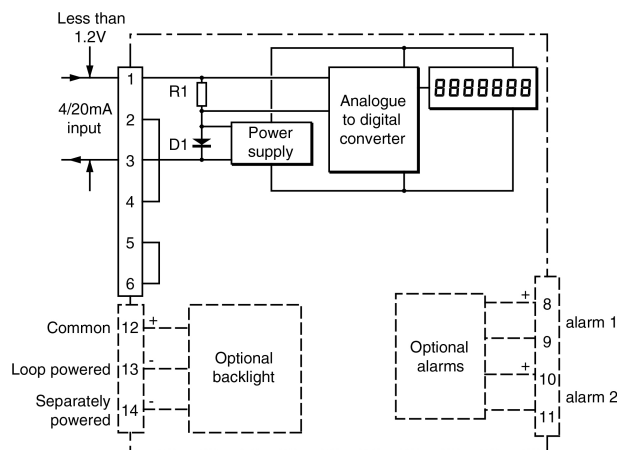


Fig 1 Indicator block diagram

2.1 Controls

The indicator is controlled and calibrated via four front panel push buttons located below the display. In the display mode i.e. when the indicator is displaying a process variable, these push buttons have the following functions:

- P** While this button is pushed the indicator will display the input current in mA, or as a percentage of the instrument span depending upon how the indicator has been conditioned. When the button is released the normal display in engineering units will return. The function of this push button is modified when optional alarms are fitted to the indicator.
- ▼** While this button is pushed the indicator will display the numerical value the indicator has been calibrated to display with a 4mA^Φ input. When released the normal display in engineering units will return.
- ▲** While this button is pushed the indicator will display the numerical value the indicator has been calibrated to display with a 20mA^Φ input. When released the normal display in engineering units will return.
- E** No function in the display mode unless the tare function is being used.
- P + ▼** Special firmware number.
- P + ▲** Direct access to the alarm setpoints when optional alarms are fitted to the indicator and the 'ACSP' access setpoints in display mode function has been enabled.
- P + E** Access to configuration menu via optional security code.

Note: ^Φ If the indicator has been calibrated using the CAL function, calibration points may not be 4 and 20mA.

3. APPLICATIONS

3.1 Transmitter loops

The BA528E SP101 may be connected in series with any 4/20mA current loop and calibrated to display the measured variable or control signal in engineering units.

Fig 2 illustrates a typical application in which an indicator is connected in series with a 2-wire transmitter.

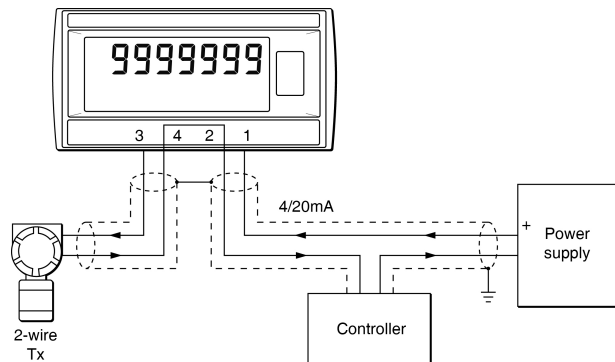


Fig 2 Indicator in a transmitter loop

Considering the example shown in Fig 2, the sum of the maximum voltage drops of all the components in the loop must be less than the minimum power supply voltage.

Minimum operating voltage of 2-wire Tx	10.0
Maximum voltage drop of controller	5.0
Maximum voltage drop of BA528E SP101	1.2
Maximum voltage caused by cables	0.4
	<hr/> 16.6V

Therefore at 20mA in this example the power supply must have a minimum output of 16.6V

3.2 Remote indication

The BA528E SP101 may be driven from a 4/20mA signal to provide a remote indication. Fig 3 shows a typical application in which the 4/20mA output from a gas analyser is connected to a BA528E SP101 loop powered indicator to provide a remote indication of the analyser's output. Again it is necessary to ensure that the voltage capability of the 4/20mA source is greater than the sum of the voltage drops introduced by the indicator and the cable resistance.

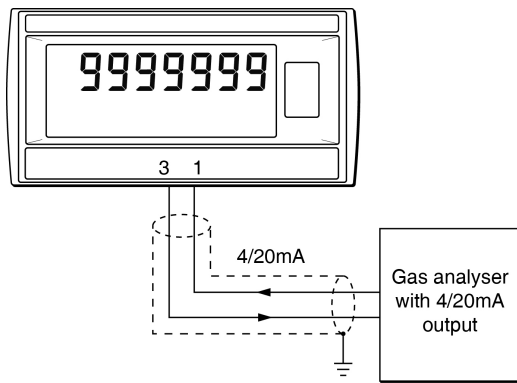


Fig 3 Indicator providing a remote display

4. INSTALLATION

4.1 Location

The BA528E SP101 has a robust glass reinforced Noryl enclosure with a toughened glass window. The front of the indicator has IP66 protection and a gasket seals the joint between the instrument enclosure and the panel. The rear of the indicator has IP20 protection.

The indicator may be installed in any panel providing that the operating temperature is between -40°C and $+70^{\circ}\text{C}$.

Fig 4 shows the overall dimensions of the indicator together with the recommended panel cut-out dimensions. To achieve an IP66 seal between the instrument enclosure and the instrument panel the smaller tolerance aperture must be used, and the indicator must be secured with four panel mounting clamps.

Although the indicator front panel provides IP66 protection it should be shielded from direct sunlight and severe weather conditions.

Cut-out dimensions

Recommended for all installations.

Mandatory to achieve an IP66 seal between the instrument and the panel
 $136 +0.5/-0.0 \times 66.2 +0.5/-0.0$

Note: Four panel mounting clamps required to achieve an IP66 seal

DIN 43 700

$138.0 +1.0/-0.0 \times 68 +0.7 -0.0$

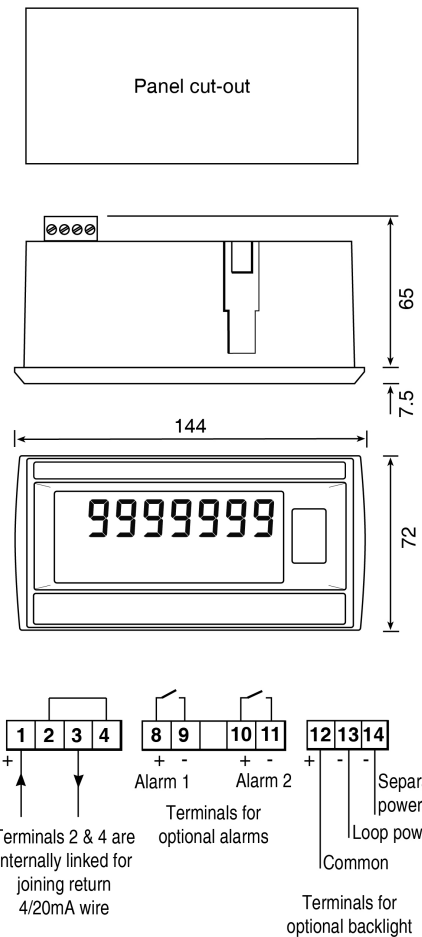


Fig 4 BA528E SP101 dimensions and terminals

4.2 Installation Procedure

- Cut the specified aperture in the panel. To achieve an IP66 seal between the instrument enclosure and the instrument panel the aperture must have the tighter tolerances specified in Fig 4.
- Slide the gasket over the body of the indicator before inserting the instrument into the panel aperture.
- Firstly ensure that all the panel mounting clamps are closed by turning the knurled screws fully anti-clockwise until the two pins in the clamp foot align with holes in the clamp body.
- Place a clamp in the recess on each side of the indicator, pulling gently to slide it onto the dovetail as shown in Fig 5. Push the knurled screw slightly forward to engage the thread and tighten by turning clockwise until it is just finger tight. When both clamps are fitted ensure that the gasket behind the front panel bezel is correctly positioned before fitting the other two clamps and fully tightening all the clamps to secure the instrument. The maximum recommended clamp tightening torque is 22cNm (1.95 lbf in) which is approximately equivalent to finger-tight plus one half turn. **Do not over tighten.**
- Four panel mounting clamps are required to achieve an IP66 seal between a BA528E SP101 indicator and the instrument panel.
- Connect the panel wiring to the rear terminal block(s) as shown in Fig 4. To simplify installation, the terminals are removable so that the panel wiring can be completed before the instrument is installed.

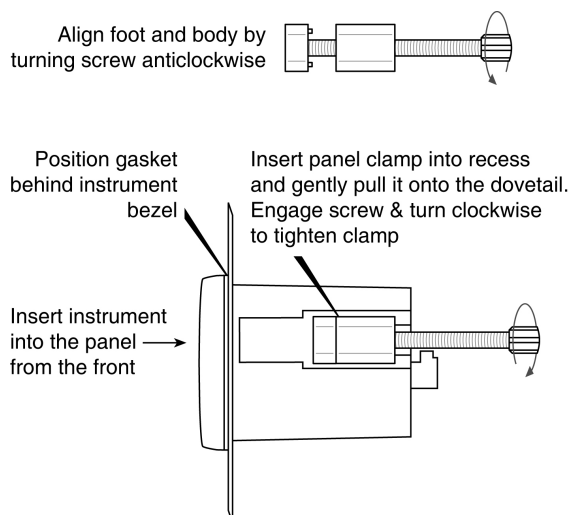


Fig 5 Fitting panel mounting clamps

4.3 Scale card

The indicator's units of measurement are shown on a printed scale card in a window at the right hand side of the display. The scale card is mounted on a flexible strip that is inserted into a slot at the rear of the instrument as shown in Fig 6. Thus the scale card can easily be changed without removing the indicator from the panel or opening the instrument enclosure.

New indicators are supplied with a printed scale card showing the requested units of measurement, if this information is not supplied when the indicator is ordered a blank card will be fitted.

A pack of self-adhesive scale cards printed with common units of measurement is available as an accessory from BEKA associates. Custom printed scale cards can also be supplied.

To change a scale card, unclip the protruding end of the flexible strip by gently pushing it upwards and pulling it out of the enclosure. Peel the existing scale card from the flexible strip and replace it with a new printed card, which should be aligned as shown below. Do not fit a new scale card on top of an existing card.

Install the new scale card by gently pushing the flexible strip into the slot at the rear of the indicator. When it reaches the internal end-stop, secure it by pushing the end of the flexible strip downwards so that the tapered section is held by the rear panel.

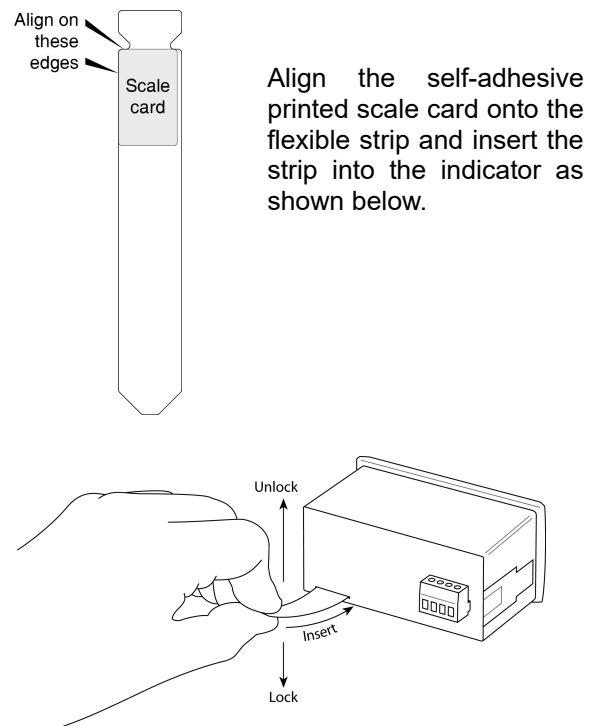


Fig 6 Inserting flexible strip carrying scale card into slot at the rear of indicator.

4.4 EMC

The BA528E SP101 indicator complies with the requirements of the European EMC Directive 2014/30/EU and UK Electromagnetic Compatibility Regulations UKSI 2016:1091 (as amended). For specified immunity all wiring should be in screened twisted pairs, with the screens earthed at one point.

5. CONFIGURATION AND CALIBRATION

The BA528E SP101 indicator is configured and calibrated via the four front panel push buttons. All the configuration functions are contained in an easy to use intuitive menu that is shown diagrammatically in Fig 7.

Each menu function is summarised in section 5.1 and includes a reference to more detailed information. When the indicator is fitted with alarms additional functions are added to the menu which are described in section 8.3

Throughout this manual front panel push buttons are shown as **P**, **E**, **▼** or **▲**, and legends displayed by the indicator are shown within inverted commas e.g. 'CAL' and 'ALr2'.

Access to the configuration menu is obtained by operating the **P** and **E** push buttons simultaneously. If the indicator security code is set to the default 0000 the first parameter 'FunC' will be displayed. If a security code other than the default code 0000 has already been entered, the indicator will display 'CodE'. Pressing the **P** button will clear this prompt allowing each digit of the code to be entered using the **▲** and **▼** push buttons and the **P** button to move control to the next digit. When the correct four digit code has been entered pressing **E** will cause the first parameter 'FunC' to be displayed. If the code is incorrect, or a button is not pressed within twenty seconds, the indicator will automatically return to the display mode.

Once within the configuration menu the required parameter can be reached by scrolling through the menu using the **▲** or **▼** push buttons as shown in Fig 7. When returning to the display mode following recalibration or a change to any function, the indicator will display 'dAtA' followed by 'SAVE' while the new information is stored in non-volatile memory.

All new indicators are supplied calibrated as requested at the time of ordering. If calibration is not requested, BA528E SP101 indicators will be configured as follows:

Access code 'CodE'	0000
Function 'FunC'	Std
Resolution 'rE5n'	1 digit
Display at 4mA 'Zero'	0.0000
Display at 20mA '5PAn'	100.0000
P button in display mode 'C—P'	%
Tare 'tArE'	Off
Filter 'FiLrE'	00

Default configuration can easily be changed on-site.

5.1 Summary of configuration functions

This section summarises each of the main configuration functions and includes a cross reference to a more detailed description. Fig 7 illustrates the location of each function within the configuration menu. The lineariser and the optional factory fitted alarms are described separately in sections 6 and 8.3 of this manual.

Display	Summary of functions
---------	----------------------

'FunC' Indicator function

Defines the relationship between the 4/20mA input current and the indicator display. May be set to:

- '5td' Standard linear relationship
- 'root' Square root extraction
- 'Lin' 16 segment adjustable lineariser – see section 6.

See section 5.2

'rE5n' Display resolution

Defines the resolution of the least significant display digits. May be set to '1', '2', '5', '10', '50', or '100' digits.

See section 5.3

'dP' Decimal point

Positions a dummy decimal point between any of the digits or turns it off.

See section 5.4

'CAL' Calibration of the digital display using an external current source.

Enables the zero and span of the indicator to be adjusted using an external current source such as a 4/20mA calibrator. When used with an accurate traceable current source or calibrator, this is the preferred method of calibration.

See section 5.5

'5Et' Calibration of display using internal references.

Enables the zero and span of the indicator to be adjusted without the need for an accurate input current or disconnection from the 4/20mA loop.

See section 5.6

'C - - P' Function of **P** push button

The indicator may be configured to display the input current in milliamps, or the input current as a percentage of the 4/20mA input, when the **P** push button is operated in the display mode.

See section 5.7

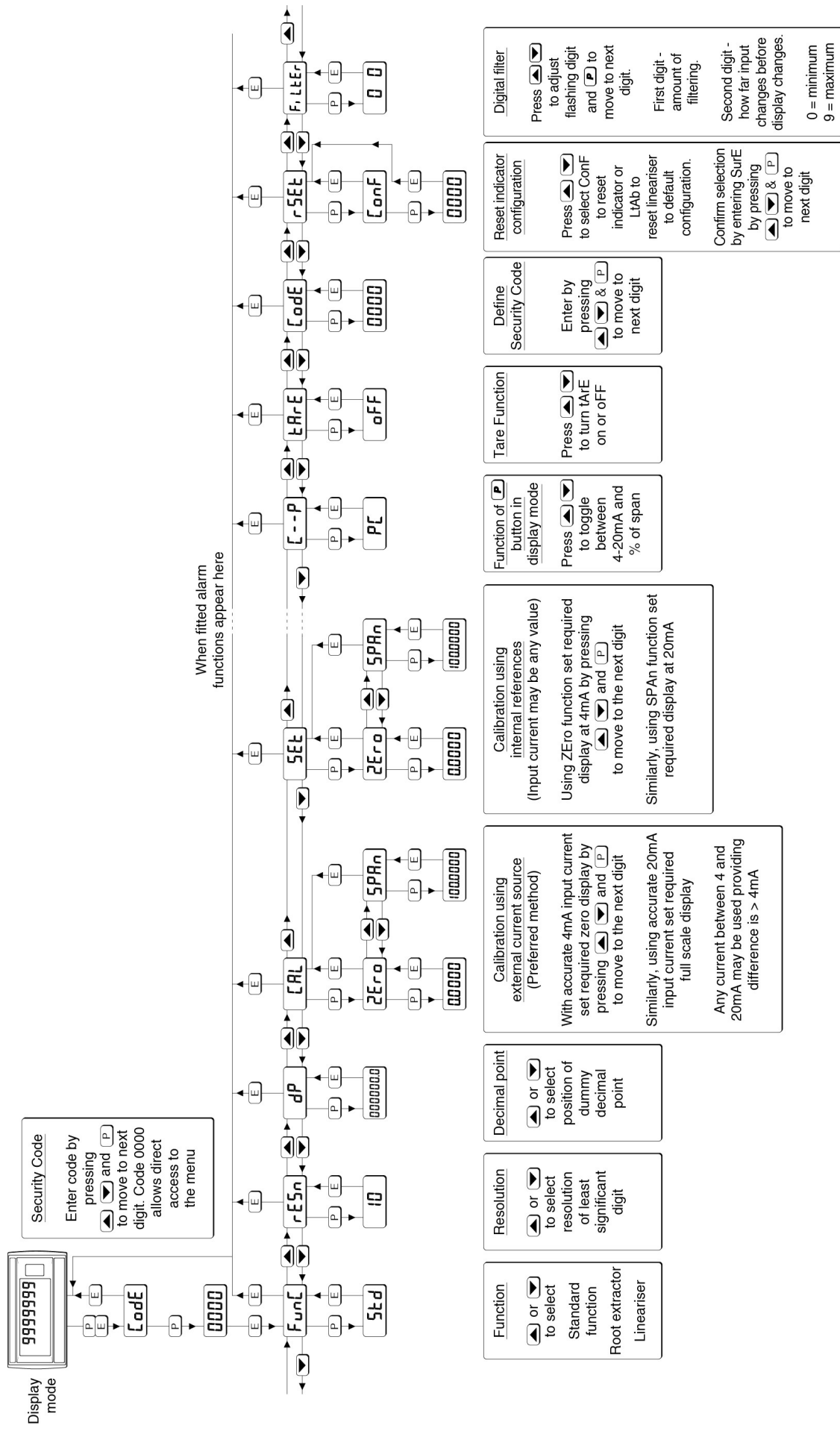


Fig 7 Configuration menu

Display	Summary of functions
---------	----------------------

'tArE' Tare function

When enabled the tare function sets the indicator display to zero, irrespective of the input current, when the **E** push button is operated in the display mode.
See section 5.8

'CodE' Security code

Defines a four digit numeric code that must be entered to gain access to the configuration menu. Default code 0000 disables this security function and allows unrestricted access to all conditioning functions.
See section 5.9

'r5Et' Reset

Contains two sub-functions, 'ConF' which returns the indicator to the default conditions, and 'LtAb' which returns the lineariser to the default conditions. To prevent accidental use both resets must be confirmed by entering '5urE' before they will be executed.
See section 5.10

'FiLtEr' Filter

An adjustable digital filter to reduce noise on the indicator display is controlled by two parameters each adjustable between 0 and 9.

The first digit defines the amount of filtering applied to the indicator display. The higher the number, the more filtering and the slower the display will reach its final value.

The second digit defines how far the input signal changes before the display deviates from existing value.
See section 5.11

5.2 Indicator function: 'FunC'

This configuration function defines the relationship between the indicator's 4/20mA input current and the indicator's display. Three alternatives are available:

'Std'	Standard linear relationship
'root'	Square root extraction
'Lin'	16 segment adjustable lineariser.

To reveal the existing indicator function select 'FunC' from the configuration menu and press **P**. If the function is set as required, press **E** to return to the menu, or press the **▲** or **▼** button to change the setting, followed by the **E** button to enter the selection and return to the configuration menu.

'5td' Linear

Provides a linear relationship between the 4/20mA indicator input current and the indicator display.

'root' Square root extraction

Primarily intended to linearise the square law 4/20mA output from differential flowmeters.

For reference, the following table shows the output current from a non-linearised differential flowmeter.

% of full flow	Current output mA
2.5	4.01
10.0	4.16
25.0	5.00
50.0	8.00
75.0	13.00
100.0	20.00

When the root function is selected the indicator will display flow in linear units.

'Lin' 16 segment adjustable lineariser

Enables non-linear variables to be displayed by the indicator in linear engineering units. Use of the lineariser is described in section 6 of this instruction manual.

5.3 Resolution: rE5n

This function defines the resolution of the least significant display digits. Decreasing the display resolution can improve the readability of a noisy signal and should be used in conjunction with the indicators digital filter 'FiLteR' which is described in section 5.11.

Select 'rE5n' from the menu and press **P** which will reveal the current display resolution. To change the resolution press the **▲** or **▼** button to select 1, 2, 5, 10, 50 or 100 digits, followed by the **E** button to enter the selection and return to the configuration menu.

Selecting 10 will provide 6 active digits with 1 dummy trailing digit, selecting 100 will provide 5 active digits with 2 dummy trailing digits.

5.4 Position of the decimal point: 'dP'

A dummy decimal point can be positioned between any of the digits or it may be absent. To position the decimal point select 'dP' from the menu and press **P**. The decimal point can be moved by pressing the **▲** or **▼** push button. If a decimal point is not required it should be positioned beyond the most or least significant digit. When positioned as required press the **E** button to enter the selection and return to the configuration menu.

5.5 Calibration using an external current source: 'CAL'

This function enables the zero and span of the indicator to be adjusted using an external calibrated current source. When used with an accurate traceable current source this is the preferred method of calibration.

Zero is the indicator display with 4mA input

Span is the indicator display with 20mA input

To calibrate the indicator select 'CAL' from the configuration menu and press **P**. The indicator will display 'ZEro' which is a request for a 4mA input current. Adjust the external current calibrator to 4.000mA and again press **P** which will reveal the current zero display. The flashing digit of the indicator display can be changed by pressing the **▲** or **▼** buttons, when set as required pressing **P** will transfer control to the next digit. When all the digits have been adjusted, press **E** to enter the new zero and return to the 'ZEro' prompt.

Pressing the **▲** button will cause the indicator to display '5PAAn' which is a request for a 20mA input current. Adjust the external current calibrator to 20.000mA and again press **P** which will reveal the existing span display. The flashing digit of the indicator display can be changed by pressing the **▲** or **▼** buttons, when set as required pressing **P** will transfer control to the next digit. When all the digits have been adjusted, press **E** to enter the new span and return to the '5PAAn' prompt. Finally press **E** again to enter the revised calibration and return to the configuration menu.

Notes:

- The resolution and accuracy of the external calibrated current source should be appropriate for the number of digits the BA528E SP101 indicator is being calibrated to display.
- The indicator input current must be adjusted to the required value before the zero and span functions are entered by pressing the **P** button.
- Indicators may be calibrated at currents other than 4 and 20mA, within the range 3.8 to 21.0mA providing the difference between the two currents is greater than 4mA. If these conditions are not complied with, the indicator displays 'Fail' and aborts the calibration.
- If the zero current is greater than the span current, the instrument will be reverse acting i.e. an increasing input current will cause the display to decrease.

5.6 Calibration using internal reference: '5Et'

Using the '5Et' function the indicator can be calibrated without the need for an accurate external current source, and without the need to disconnect the indicator from the 4/20mA measuring loop.

The indicator's internal reference is used to simulate a 4mA and 20mA input current, so the actual indicator input current does not have to be known during calibration.

Zero is the display with a simulated 4mA input

Span is the display with a simulated 20mA input

To calibrate the indicator display select '5Et' from the configuration menu and press **P**. The indicator will display 'ZEro', pressing **P** again will reveal the current display at 4mA. The flashing digit can be adjusted by pressing the **▲** or **▼** buttons, when the flashing digit is correct pressing **P** will transfer control to the next digit. When all the digits have been adjusted, press **E** to return to the 'ZEro' prompt.

To adjust the display at 20mA, press the **▲** button which will cause the indicator to display '5PAN', pressing **P** will then reveal the indicator's existing display at 20mA. The flashing digit can be adjusted by pressing the **▲** or **▼** buttons, when the flashing digit is correct pressing **P** will transfer control to the next digit. When all the digits have been adjusted, press **E** to return to the '5PAN' prompt. Finally press **E** again to enter the revised calibration and return to the configuration menu.

5.7 Function of the **P** push button: 'C - - P'

When the indicator is in the display mode, operating the **P** push button will display the input current in milliamps, or the displayed value as a percentage of the difference between the calibrated display values at 4mA and 20mA inputs.

To check or change the function of the **P** push button select 'C - -P' from the configuration menu and press **P** to reveal the current setting. Pressing the **▲** or **▼** button will toggle the setting between, '4-20' the current display in milliamps, and 'PC' the percentage display. When set as required press **E** to return to the 'C - - P' prompt in the configuration menu.

5.8 Tare function: 'tArE'

The tare function is primarily intended for use with a weighing system. When the indicator is in the display mode and the tare function is activated, pressing the **E** button for more than three seconds will zero the indicator's digital display with 'tArE' shown below. Subsequent operation of the **E** push button for less than 3 seconds, will return the indicator to the gross display and deactivate the tare annunciator.

To check or change the tare function select 'tArE' from the configuration menu and press **P** to reveal the current setting. Pressing the **▲** or **▼** button will toggle the setting between 'on' and 'oFF'. When set as required press **E** to return to the 'tArE' prompt in the configuration menu.

5.9 Security code: 'CodE'

Access to the indicator's configuration menu may be protected by a four digit security code which must be entered to gain access. New instruments are configured with the default security code 0000 which allows unrestricted access to all configuration functions.

To enter a new security code select 'CodE' from the configuration menu and press **P** which will cause the indicator to display the existing security code with one digit flashing. The flashing digit can be adjusted using the **▲** and **▼** push buttons, when set as required operating the **P** button will transfer control to the next digit. When all the digits have been adjusted press **E** to return to the 'CodE' prompt. The revised security code will be activated when the indicator is returned to the display mode. Please contact BEKA associates sales department if the security code is lost.

5.10 Reset to factory defaults: 'r5Et'

This function enables the indicator and the lineariser to be quickly returned to the factory default configurations shown in sections 5 and 6.

To reset the indicator or lineariser select 'r5Et' from the configuration menu and press **P**, the indicator will display one of the reset options 'ConF' or 'LtAb'.

'ConF' Resets the indicator to defaults

'LtAb' Resets the lineariser to defaults

Using the ▲ or ▼ push button select the required sub-function and press **P**. To prevent accidental resetting the request must be confirmed by entering '5urE'. Using the ▲ button set the first flashing digit to '5' and press **P** to transfer control to the second digit which should be set to 'u'. When '5urE' has been entered pressing the **E** button will reset the selected configuration menus and return the display to the 'r5Et' function in the configuration menu.

5.11 Filtering and stability: 'FiLtEr'

Because the BA528E SP101 can have 7 active digits to display the 4/20mA input, the least significant digit may represent an input current change of much less than 1 microamp. Such a minute current change is almost certain to be swamped by electrical noise.

The BA528E SP101 therefore contains a digital filter with two independent adjustable parameters. A weighted averaging filter with an adjustable time-constant, and a jump-out function which defines the change in input at which the filter will be overridden and the display will move rapidly to a new value.

Filtering

Amount of filtering applied (time constant). Adjustable between 0 and 9, where 0 is no filtering and 9 is maximum filtering.

Filtering first digit	Filter time constant seconds
0	0
1	1.3
2	4.3
3	6.5
4	8.7
5	11.3
6	15.7
7	20.9
8	25.2
9	31.5

Jump-out

Defines the deviation from the displayed value at which the filter will be overridden and the display will move rapidly to the new value.

Jump-out second digit	Magnitude of % step change which will produce a rapid display change
0	off
1	1
2	2
3	4
4	8
5	12
6	16
7	24
8	32
9	64

During commissioning it is recommended that initially Jump-out is set to 0 (off) and the filter is adjusted to provide acceptable display stability. Jump-out should then be increased until the selected step size is greater than the noise on the display, at which setting the display should become stable.

Together with realistic adjustment of the indicator resolution 'rE5n' as described in section 5.3, these filter and jump-out parameters should be optimum for display stability and the fastest possible response. If the display remains noisy, the indicator display resolution should be reduced, or the 4/20mA input signal noise reduced.

To check or change the filter or jump-out parameters, select 'FiLtEr' from the configuration menu and press **P** to reveal the current setting of the filter, which can be adjusted by operating the ▲ or ▼ button. Pressing **P** will toggle the display between the first digit for filter adjustment, and the second digit for jump-out adjustment. When both are set as required, press **E** to return to the 'FiLtEr' prompt in the configuration menu.

5.12 Under and over-range

If the numerical display range of the indicator is exceeded, all the decimal points will flash as shown below:

Underrange -9.9.9.9.9.9.9

Overrange 9.9.9.9.9.9.9

Although not guaranteed, most indicators will continue to function normally with an input current between 1.8mA and 4mA. At lower currents, the instrument will display 'LooPLo' before stopping.

6. LINEARISER

A sixteen segment, seventeen break-point (0 to 16) lineariser may be selected in the 'FunC' section of the configuration menu. The position of each break-point is fully adjustable so that the slope of the straight line between break-points can be set to compensate for input non-linearity, thus allowing the indicator to display a non-linear process variable in linear engineering units. Each break-point must occur at a current greater than the preceding break-point and less than the following break-point, in the range 3.8 to 21.0mA. If this requirement is not observed when configuring the lineariser the indicator will display 'Fail' and the configuration adjustment which produced the error message will be ignored. Fig 8 shows a typical linearised indicator characteristic.

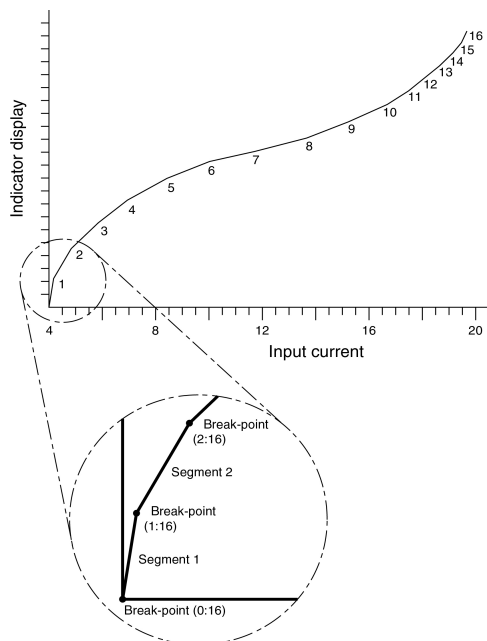


Fig 8 shows a typical linearising characteristic

Selecting 'Lin' in the 'FunC' section of the configuration menu activates the lineariser, this does not change the configuration menu shown in Fig 7, but the 'CAL' and '5Et' functions are extended as shown in Fig 9. As with a linear indicator, calibration of the lineariser may be performed with an external current source using the 'CAL' function, or with the internal reference using the '5Et' function.

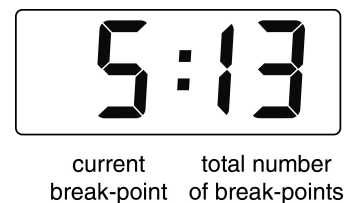
The lineariser calibration is retained irrespective of how the indicator function 'FunC' is subsequently changed. It is therefore possible to select and deselect the lineariser without having to reconfigure it each time.

The lineariser calibration may be reset to the factory default settings without changing the indicator configure using the 'LtAb' function described in section 5.10.

6.1 Lineariser calibration using an external current source.

This method allows direct calibration of the lineariser with an external current source and is the preferred method when traceability is required. If the exact system non-linearity is unknown, this method also allows direct calibration from the variable to be displayed. The output from a level sensor in an irregular tank may be displayed in linear volumetric units by filling the tank with known incremental volumes and calibrating the indicator to display the sum of the increments at each break-point.

The number of break-points required should first be entered using the 'Add' and 'dEL' functions. In both these sub-functions the indicator initially displays the current break-point and the total number of break-points being used as shown below.



Display

Summary of functions

'Add'

Add a break-point

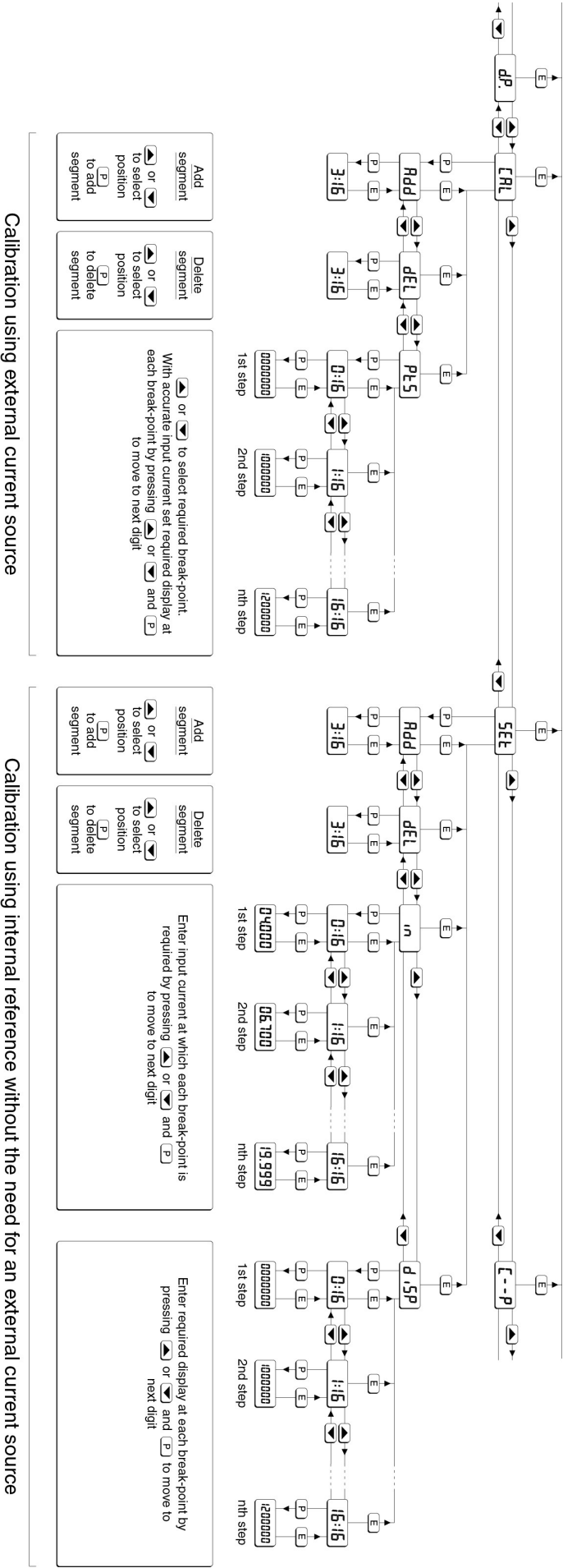
Adds a new break-point before the displayed break-point. The calibration of existing break-points is not changed, but the identification number of all subsequent break-points is increased by one.

'dEL'

Remove a break-point

Removes the displayed break-point and joins the preceding break-point to the following break-point with a straight line. The identification number of all subsequent break-points is decreased by one.

To add a break-point use the ▲ or ▼ button to select 'CAL' from the configuration menu and press **P** which will result in the 'Add' sub-function prompt being displayed. To enter the sub-function press **P** which will reveal the current break-point and the total number of break-points which have already been entered. When adding a break-point the insertion position can be selected using the ▲ and ▼ push buttons followed by **P** push button to insert the additional break-point. In previously uncalibrated linearisers each new break-point should be added in front of the highest existing break-point, if this sequence is not followed a 'Fail' message will occur in the 'Pt5' function. See example in section 6.1.1.



Each break-point must occur at an input current greater than the preceding break-point and less than the following break-point, in the range 3.8 to 21.0 mA

Fig 9 Extension of CAL and SET functions for lineariser configuration

The delete break-point sub-function 'dEL' operates in exactly the same way as the 'Add' sub-function described above. Once within the 'dEL' sub-function each time the **P** button is pressed a break-point is removed. When deleting a break-point from a calibrated indicator, the break-point to be deleted can be selected using the **▲** and **▼** push buttons. The minimum number of break-points is 2, break-points '0:1' and '1:1'.

When the required number of linearising break-points has been entered, return to the linearisation sub-menu by pressing **E**. The indicator will display the 'Add' or 'dEL' prompt depending upon the last function used. Using the 'Pt5' sub-function the input current at which each break-point occurs and the corresponding indicator display may now be defined.

Using the **▲** or **▼** button select the 'Pt5' function in the sub-menu and press **P** to enter the function which will display the first break-point '0:n', where n is the total number of linearising break-points entered – see Fig 8. The selected linearising break-point can be changed using the **▲** and **▼** buttons. When the required linearising break-point has been selected set the indicator input current to the exact value at which the break-point is required and press **P***. Using the **▲** and **▼** buttons and the **P** button to move between digits, enter the required indicator display at this break-point. When set as required, press the **E** push button to enter the required indicator display and return to the sub-menu from which the next break-point can be selected.

When all the break-points have been calibrated pressing **E** twice will return the indicator to the 'CAL' function in the configuration menu.

Note: * The indicator input current must be adjusted to the required value before the **P** button is operated to enter the required indicator display.

Error message

If during calibration the indicator displays a 'FAiL' error message the current at which the selected break-point is being set is not above the preceding break-point or is not below the following break-point.

6.1.1 Example

Adding break-points to a new indicator

When adding break-points to a new indicator, or to a lineariser following resetting to the factory defaults using the 'r5Et' function described in section 5.10, each additional break-point should be added before the highest existing break-point. The first additional break-point should be added before the default break-point '1:1' which will result

in a display of '1:2'. If more new break-points are required, using the **▲** button select the new highest break-point '2:2' and add the second additional break-point by operating the **P** push button which will result in a display of '2:3'. Repeat the sequence until the required number of break-points has been entered.

The input current and at which each break-point occurs and the corresponding indicator display may now be entered as described above.

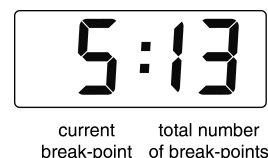
6.2 Lineariser calibration using the internal reference.

The '5Et' function enables the lineariser to be calibrated without the need for an accurate external current source. Throughout the calibration the indicator input current may be any value between 4 and 20mA.

The '5Et' functions contains four sub-functions.

Display	Description of function
'Add'	Add a break-point Adds a new break-point before the displayed break-point. The calibration of existing break-points is not changed, but the identification number of all subsequent break-points is increased by one.
'dEL'	Remove a break-point Removes the displayed break-point and joins the preceding segment to the following segment with a straight line. The identification number of all subsequent break-points is decreased by one.
'in'	Defines the current at which break-point occurs. Enables the required current at each break-point to be defined without having to input an accurate input current to the indicator.
'diSP'	Defines indicator display at break-point. Enables the indicator display at each break-point to be defined.

The number of break-points required should first be entered using the 'Add' and 'dEL' sub-functions. In both these sub-functions the indicator initially displays the current break-point and the total number of break-points being used as shown below.



To add a break-point using the ▲ or ▼ button select '5Et' from the configuration menu and press **P** which will result in the 'Add' sub-function prompt being displayed. To enter the sub-function press **P** which will reveal the current break-point and the total number of break-points which have already been entered. When adding a break-point the insertion position can be selected using the ▲ and ▼ push buttons followed by **P** push button to insert the additional break-point. In previously uncalibrated linearisers each new break-point should be added in front of the highest existing break-point, if this sequence is not followed a 'Fail' message will occur when the breakpoints are calibrated. See example in section 6.2.1.

The delete break-point, sub-function 'dEL' operates in exactly the same way as the 'Add' sub-function described above. Once within the 'dEL' function each time the **P** button is pressed a break-point is removed. When deleting a break-point from a calibrated indicator, the break-point to be deleted can be selected using the ▲ and ▼ push buttons. The minimum number of break-points is 2, break-points '0:1' and '1:1'.

When the required number of linearising break-points have been entered, return to the linearisation sub-menu by pressing **E**. The indicator will display the 'Add' or 'dEL' prompt depending upon the last sub-function used. The indicator input current and corresponding indicator display at each break-point, which is the segment finishing point as shown in Fig 8, can now be entered using the 'in' and 'di5P' sub-functions.

Using the ▲ or ▼ button select 'in' from the sub-menu and press **P** which will reveal the starting point for the first segment '0:n', where n is the total number of break-point entered. Press **P** and use the ▲ and ▼ buttons and the **P** button to move between digits, to enter the input current in milliamps, with one microamp resolution, at which the first break-point is required, usually 4.000mA. When set as required, press **E** to return to the '0:n' prompt from which the next break-point can be selected using the ▲ and ▼ buttons. When the required break-point has been selected press **P** and enter the indicator input current at which this break-point is required using the ▲ and ▼ buttons and the **P** button to move between digits. Repeat this procedure until the indicator input current at all the break-points has been defined and then return to the 'in' sub-function by pressing the **E** button.

The corresponding indicator display at each of the break-points can now be defined using the 'di5P' sub-function. Using the ▲ and ▼ buttons select the 'di5P' sub-function and press **P** which will reveal the starting point for the first break-point '0:n', where n is the total number of break-points entered. Press **P** and use the ▲ and ▼ buttons

and the **P** button to move between digits, to enter the required indicator display at the first break-point. When set as required, press **E** to return to the '0:n' prompt from which the next break-point can be selected using the ▲ or ▼ buttons. When the required break-point has been selected press **P** and set the required indicator display at this break-point.

Repeat this procedure until the indicator display at all the break-points has been defined and then return to the '5Et' function in the configuration menu by pressing the **E** button twice.

Error message

If during calibration the indicator displays a 'FAiL' error message the current at which the selected break-point is being set is not above the preceding break-point or is not below the following break-point.

6.2.1 Example

Adding break-points to a new indicator

When adding break-points to a new indicator, or to a lineariser following resetting to the factory defaults using the 'r5Et' function described in section 5.10, each additional break-point should be added before the highest existing breakpoint. The first additional break-point should be added before the default break-point '1:1' which will result in a display of '1:2'. If more new break-points are required, using the ▲ button select the new highest break-point '2:2' and add the second additional break-point by operating the **P** push button which will result in a display of '2:3'. Repeat the sequence until the required number of break-points has been entered.

6.3 Under and over-range

The lineariser does not change the under and over-range indication described in section 5.12. At input currents below that specified for the first break-point '0:n', the indicator will continue to use the specified slope of the first segment.

At input currents above that specified for the last break-point 'n:n', the indicator will continue to use the slope specified for the last lineariser segment.

6.4 Lineariser default configuration

When the lineariser is reset to the factory defaults using the 'LtAb' function described in section 5.10, the defaults conditions are:

		Indicator display
First break-point	'0:1' 4mA	0.0000
Second break-point	'1:1' 20mA	100.0000

7. MAINTENANCE

7.1 Fault finding during commissioning

If an indicator fails to function during commissioning the following procedure should be followed:

Symptom	Cause	Solution
No display	Incorrect wiring	Check wiring There should be 0.6 to 1.2V between terminals 1 & 3 with terminal 1 positive. With an optional loop powered backlight, there should be 3.4 to 5V between terminals 3 & 12 with terminal 12 positive.
No display, 0V between terminals 1 & 3.	Incorrect wiring or no power supply	Check supply voltage and voltage drop caused by all the instruments in the loop.
All decimal points flashing.	Overrange, or underrange if -ve sign displayed.	Recalibrate Zero and Span.
Unstable display	4/20mA input is noisy.	Eliminate noise on 4/20mA input. Decrease indicator resolution and / or increase display filtering. See note below.
Unable to enter configuration menu.	Incorrect security code entered.	Enter correct security code, or contact BEKA if the code has been lost.

Note:

Depending upon the indicator calibration, the least significant active digit of the display may represent a very small change in input current and be less than the 4/20mA input current electrical noise. This should be considered when deciding how many active digits to display. The following table shows examples of the input current equivalent to one digit change of the least significant active digit.

Display calibration		Input current equivalent to the least significant active digit μA	Percent of input range %
Zero	Span		
0	10000	1.6	0.01
0	99999	0.16	0.001
0	999999	0.016	0.0001
0	9999999	0.0016	0.0001

7.2 Fault finding after commissioning

ENSURE PLANT SAFETY BEFORE STARTING MAINTENANCE

If an indicator fails after it has been functioning correctly follow the procedure shown in section 7.1. If this does not reveal the cause of the fault, it is recommended that the instrument is replaced. This can be done without disconnecting power, but while the indicator is disconnected the 4/20mA loop will be open circuit.

7.3 Servicing

All BA528E SP101 loop powered indicators are interchangeable if the required optional backlight and alarms are fitted. A single spare instrument may quickly be recalibrated to replace any instrument that is damaged or fails. No attempt should be made to repair instruments at component level.

We recommend that faulty instruments are returned to BEKA associates or to your local BEKA agent for repair.

7.4 Routine maintenance

The mechanical condition of the instrument and electrical calibration should be regularly checked. The interval between inspections depends upon environmental conditions. We recommend that initially instrument calibration should be checked annually.

7.5 Guarantee

Indicators which fail within the guarantee period should be returned to BEKA associates or your local BEKA agent. It is helpful if a brief description of the fault symptoms is provided.

7.6 Customer comments

BEKA associates is always pleased to receive comments from customers about our products and services. All communications are acknowledged and whenever possible, suggestions are implemented.

8. ACCESSORIES

8.1 Scale card

All models have a window on the right hand side of the display through which to view a scale card showing the units of measurement such as °C, mBar, RPM. New indicators are fitted with a scale card showing the units of measurement specified when the indicator was ordered, if the units are not specified a blank scale card will be fitted. A pack of scale cards pre-printed with common units of measurement is available as an accessory. These can easily be fitted on-site to the indicator without opening the indicator enclosure or removing it from the panel. See section 4.3 of this instruction manual.

Custom scale cards for applications requiring less common units of measurement are also available.

8.2 Tag information

New indicators are supplied with tag or application information thermally printed onto the rear panel adjacent to the terminals, legend as specified when the indicator was ordered. This tag information is not visible from the front of the instrument after installation.

8.3 Alarms

CAUTION

These alarm outputs should not be used for critical safety applications such as an emergency shut down system.

All models can be supplied with factory fitted dual solid state, single pole alarm outputs. Each alarm output may be independently conditioned as a high or low alarm with a normally open or normally closed output in the non-alarm condition.

When the 4/20mA current powering the indicator is removed both alarm outputs will open irrespective of configuration. The open circuit condition should therefore be chosen as the alarm condition when designing an alarm system. Fig 10 illustrates the conditions available and shows which are fail safe.

When an alarm occurs an alarm annunciator on the indicator front panel is activated and if required the numerical display can alternate between the measured value and the alarm channel identification 'ALr1' or 'ALr2'.

CAUTION

The alarms are activated by the indicator's numerical display. Use of the Tare Function 'tArE' will change the numerical display, the alarms will continue to function at the original displayed value, but this will correspond to a different input current.

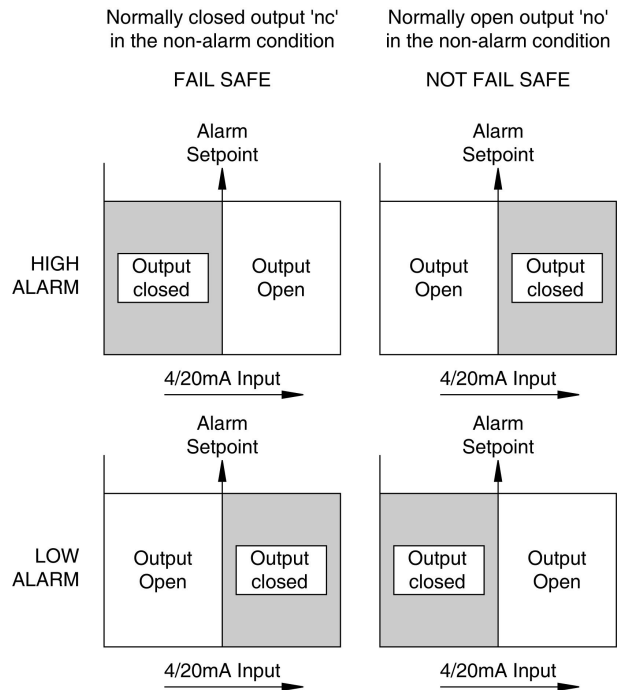


Fig 10 Alarm outputs

Configurable functions for each alarm include adjustable setpoint, hysteresis, alarm delay and alarm accept.

8.3.1 Solid state output

Each alarm has a galvanically isolated single pole solid state switch output as shown in Fig 11. The output is polarised and current will only flow in one direction.

$$\begin{aligned} R_{on} &= \text{less than } 5\Omega + 0.7V \\ R_{off} &= \text{greater than } 1M\Omega \end{aligned}$$

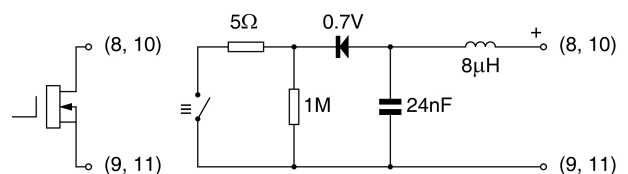


Fig 11 Equivalent circuit of each alarm output

The solid state output of each alarm may be used to switch any dc circuit with parameters equal to or less than:

$$\begin{aligned} V &= 40V \\ I &= 200mA \end{aligned}$$

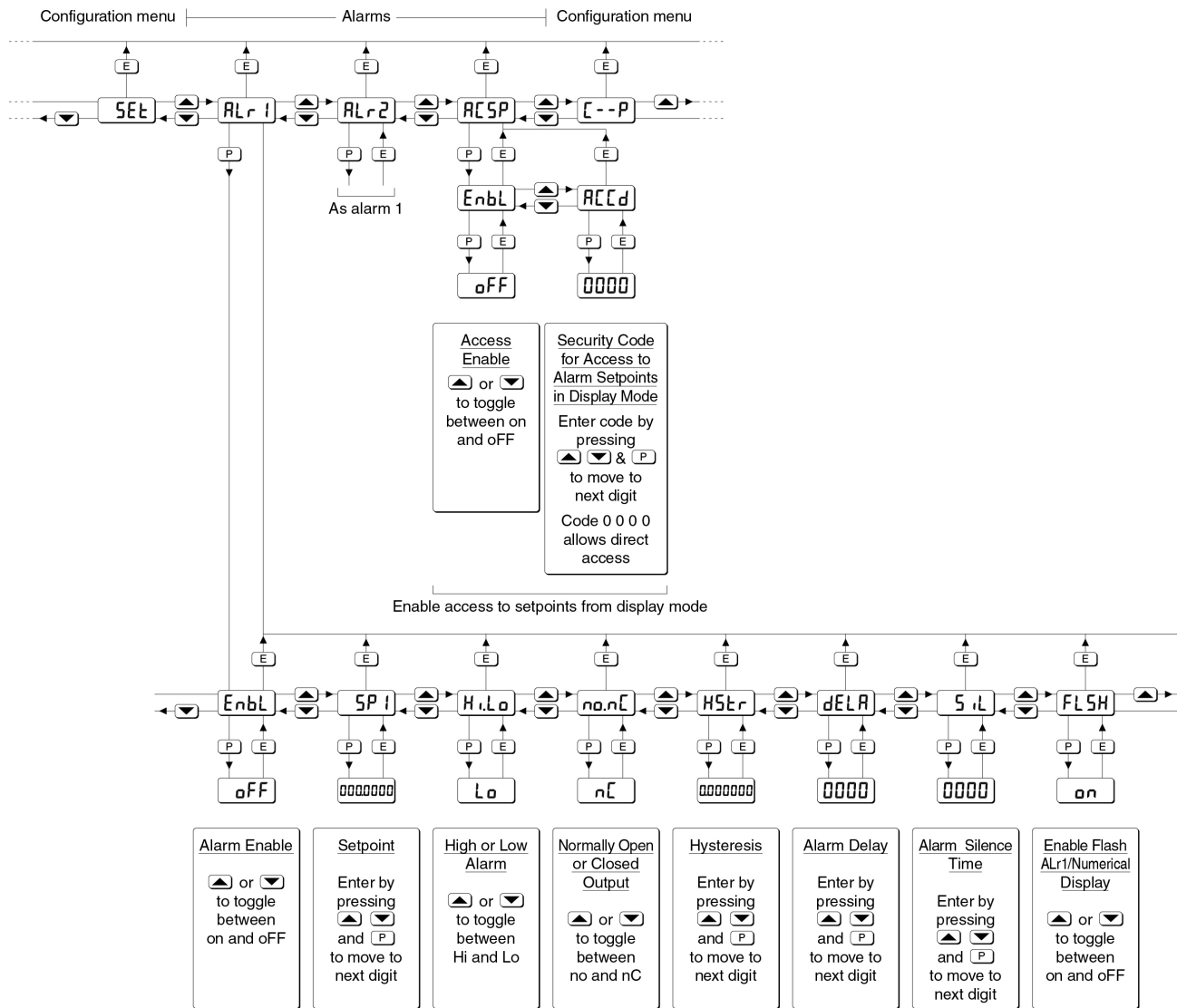


Fig 12 Alarm Configuration Functions in Configuration Menu

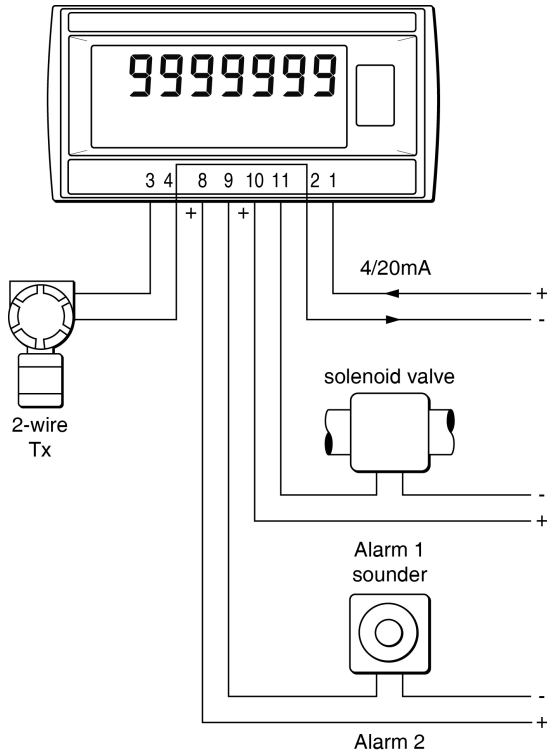


Fig 13 Typical alarm application
(Shown without recommended screened cables)

8.3.2 Configuration and adjustment

When optional alarms are fitted to a loop powered indicator the configuration menu is extended as shown in Fig 12. The additional functions appear between the '5Et' and the 'C - P' functions. For simplicity, Fig 12 only shows the additional functions for alarm 1, but alarm 2 has identical functions.

The following section summarises each of the alarm configuration functions and includes a cross reference to more detailed information. Again only the functions on alarm 1 are listed, but alarm 2 has identical facilities.

Summary of alarm configuration functions

Display	Summary of functions
'EnbL'	Alarm enable Enables or disables the alarm without changing the alarm parameters. See section 8.3.3
'5P1'	Alarm setpoint 1 Adjusts the alarm setpoint. The alarm is activated when the indicator display equals the setpoint. See section 8.3.4
'Hi.Lo'	Alarm function Defines the alarm function as High or Low. See section 8.3.5
'no.nC'	Normally open or normally closed output Sets the alarm output open or closed in the non-alarm condition. See section 8.3.6
'H5tr'	Hysteresis Adjusts the alarm hysteresis. See section 8.3.7
'dELA'	Alarm delay time Introduces adjustable delay between the display equalling the setpoint and the alarm output being activated. See section 8.3.8
'SiL'	Alarm silence time Defines the time that the alarm output remains in the non-alarm condition following acceptance of an alarm. See section 8.3.9
'FL5H'	Flash display when alarm occurs When enabled, alternates the numerical display between process value and alarm reference, 'ALr1' or 'ALr2', when an alarm output is activated. See section 8.3.10
'AC5P'	Access setpoint Sub-menu which enables direct access to the alarm setpoints from the indicator display mode, and defines a separate security code. See section 8.3.11

8.3.3 Alarm enable: 'EnbL'

This function allows each alarm to be enabled or disabled without altering any of the alarm parameters. To enable or disable the alarm select 'EnbL' from the alarm menu and press **P** which will reveal the current setting 'on' or 'oFF'. The function can be changed by pressing the **▲** or **▼** button followed by the **E** button to return to the alarm menu.

8.3.4 Setpoint adjustment: '5P1' and '5P2'

The setpoint of each alarm may be positioned anywhere in the numerical display of the indicator providing that this corresponds to an input current between 3.8 and 20.2mA. e.g. If the indicator has been calibrated to display 0 with 4mA input and 10000 with 20mA input, the two alarm setpoints may be positioned anywhere between -125 and 10125.

To adjust the setpoint select '5P1' or '5P2' from the alarm configuration menu and press **P** which will reveal the existing alarm setpoint. The flashing digit of the setpoint can be adjusted using the **▲** and **▼** push buttons, and the **P** button to move control to the next digit. When the required setpoint has been entered press **E** to return to the alarm configuration menu.

The alarm setpoints may also be adjusted when the indicator is in the display mode, see section 9.3.12.

8.3.5 Alarm function: 'Hi.Lo'

Each alarm can be independently conditioned as a high alarm or as a low alarm. To check or change the alarm function select 'Hi.Lo' from the alarm menu and press **P** to reveal the current setting. The function can be changed by pressing the **▲** or **▼** button followed by the **E** button to return to the alarm menu.

8.3.6 Alarm output status: 'no.nC'

Configures the solid state alarm output to be open 'no' or to be closed 'nC' in the non-alarm condition. When deciding which is required, care should be taken to ensure that the alarm output is fail safe as illustrated in Fig 10.

'no' Alarm output open in non-alarm condition

'nC' Alarm output closed in non-alarm condition

CAUTION

When the 4/20mA supply is removed from the loop powered indicator, both alarm outputs will open irrespective of conditioning. Therefore for fail safe operation both alarm outputs should be conditioned to be open in the alarm condition 'nC'.

To check or change the alarm output status, select 'no.nC' from the alarm configuration menu and press **P** to reveal the setting. The function may be changed by pressing the **▲** or **▼** button followed by the **E** button to return to the alarm configuration menu.

8.3.7 Hysteresis: 'H5tr'

Hysteresis is shown in the units that the indicator has been calibrated to display.

To adjust the hysteresis select 'H5tr' from the alarm menu and press **P** which will reveal the existing figure. The flashing digit can be adjusted using the **▲** and **▼** push buttons, and the **P** button will move control to the next digit. When the required hysteresis has been entered press **E** to return to the alarm configuration menu.

e.g. An indicator calibrated to display 0 to 10000, with a high alarm set at 9000 and hysteresis of 200 will perform as follows:

The high alarm will be activated when increasing indicator display equals 9000, but will not reset until the indicator display falls below 8800.

8.3.8 Alarm delay: 'dELA'

This function delays activation of the alarm output for an adjustable time following the alarm condition occurring. The delay can be set in 1 second increments between 0 and 3600 seconds. If a delay is not required zero should be entered. To adjust the delay select 'dELA' from the alarm configuration menu and press **P** which will reveal the existing delay. The flashing digit of the delay can be adjusted using the **▲** and **▼** push buttons, and the **P** button to move control to the other digits. When the required delay has been entered press **E** to return to the alarm menu.

e.g. An indicator with a high alarm set at 9000 and an alarm delay of 30 seconds will perform as follows:

The alarm annunciator will start to flash when an increasing indicator display equals 9000, but the alarm output will not be activated until the alarm condition has existed continuously for 30 seconds. When the alarm output is activated, the alarm annunciator will stop flashing and become permanently activated.

If the 'FL5H' function, which flashes the indicator display when an alarm occurs, has been enabled, it will not start to function until the alarm output is activated.

See section 8.3.10

8.3.9 Alarm silence time: 5iL

This function is primarily intended for use in small installations where the alarm output directly operates an alarm annunciator such as a sounder or beacon. When the alarm silence time, which is adjustable between 0 and 3600 seconds in 1 second increments, is set to any figure other than zero, the **P** push button becomes an alarm accept button. After an alarm has occurred, operating the **P** button will cause the alarm output to revert to the non-alarm condition for the programmed alarm silence time. If the alarm condition still exists at the end of the silence time, the alarm output will be reactivated. During the silence time the indicator alarm annunciator will flash until the silence time expires or the alarm is cleared.

If the 'FL5H' function, which flashes the indicator display when an alarm occurs, has been enabled, it will only function when the alarm output is activated, not during the silence time. See section 8.3.10.

To adjust the alarm silence time select '5iL' from the alarm configuration menu and press **P** which will reveal the existing silence time. The flashing digit of the silence time can be adjusted using the **▲** and **▼** push buttons, and the **P** button to move control to the other digits. When the required silence time has been entered press **E** to return to the alarm menu.

8.3.10 Flash display when alarm occurs 'FL5H'

In addition to the two alarm annunciators on the top left hand corner of the indicator display which show the status of both alarms, this function provides an even more conspicuous indication that an alarm condition has occurred.

When enabled, the function alternates the indicator display between the numerical value and the alarm reference, 'ALr1' or 'ALr2', when the alarm output is activated. If both alarm outputs are activated, the alarm references are displayed in sequence.

To enable or disable the function select 'FL5H' from the alarm menu and press **P** which will reveal the current setting 'on' or 'oFF'. The function can be changed by pressing the **▲** or **▼** button followed by the **E** button to return to the alarm menu.

8.3.11 Access setpoint in display mode: AC5P

This function enables a separate menu providing access to the alarm setpoints from the display mode by simultaneously operating the **P** and **▲** push buttons. An operator can therefore adjust the alarm setpoints without having access to the indicator configuration menu. Protection against accidental adjustment of the setpoints when the

indicator is in the display mode is provided by a separate security code.

This direct setpoint access menu is enabled and the separate security code entered from the 'AC5P' function in the alarm configuration menu as shown in Fig 12. To change the menu parameters select 'AC5P' from the configuration menu and press **P** which will display the enable prompt 'EnbL'. Press **P** again to reveal if the direct access menu is 'on' or 'oFF'. The **▲** or **▼** button will toggle the display between the two conditions.

If 'oFF' is selected, the operator will not have access to the setpoints from the display mode. Return to the 'AC5P' prompt in the main menu by pressing **E** twice.

If 'on' is selected, the operator will have direct access to the alarm setpoints from the display mode via a separate optional security code. To define this four digit security code press **P** to return to the 'EnbL' prompt followed by the **▲** or **▼** button to select the access code prompt 'ACCd'. Pressing **P** will reveal the current security code. Each digit of the code may be changed by operating the **▲** and **▼** push buttons, and the **P** button to move control to the next digit. When the required code has been entered, press **E** twice to return to the 'AC5P' prompt in the configuration menu.

Default code 0000 will disable the security code allowing direct access to the setpoints in the display mode by pressing the **P** and **▲** buttons simultaneously. Unless otherwise requested new instruments with alarms are supplied with this function disabled and the security code set to 0000.

8.3.12 Adjusting alarm setpoints from the display mode

Access to the alarm setpoints from the indicator display mode is obtained by operating the **P** and **▲** push buttons simultaneously as shown in Fig 14. If the setpoints are not protected by a security code the alarm setpoint prompt '5P1' will be displayed. If the setpoints are protected by a security code, 'Code' will be displayed first. Pressing **P** again will enable the alarm security code to be entered digit by digit using the **▲** and **▼** buttons to change the flashing digit, and the **P** push button to move control to the next digit. If the correct code is entered pressing **E** will cause alarm setpoint prompt '5P1' to be displayed. Pressing the **▲** or **▼** button will toggle the display between the two alarm setpoint prompts '5P1' and '5P2'.

If an incorrect security code is entered, or a button is not pressed within twenty seconds, the indicator will automatically return to the display mode.

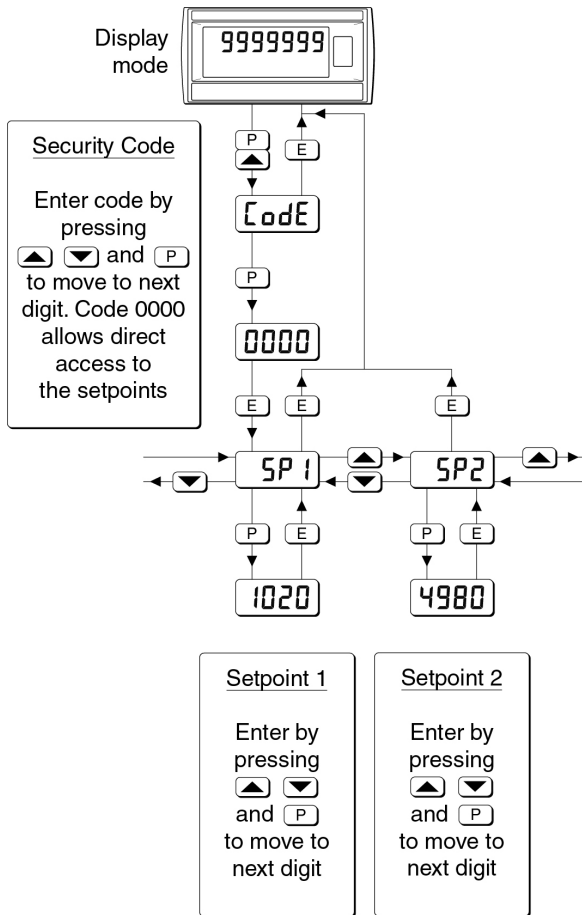


Fig 14 Setpoint adjustment from the display mode

To adjust an alarm setpoint select '5P1' or '5P2' and press **P** which will reveal the current setting. Each digit of the setpoint may be adjusted using the \blacktriangle and \blacktriangledown push buttons, and the **P** button to move control to the next digit. When the required setpoint has been entered, pressing **E** will return the display to the '5P1' or '5P2' prompt from which the other setpoint may be selected, or the indicator may be returned to the display mode by pressing **E** again.

Note: With the indicator in the display mode, direct access to the alarm setpoints is only available when the AC5P menu is enabled - see section 8.3.11

8.4 Display backlight

The BA528E SP101 loop powered indicator can be supplied with a factory fitted backlight that may be loop or separately powered.

When loop powered the backlight produces green background illumination enabling the display to be read at night or in poor lighting conditions. No additional power supply or field wiring are required, but the indicator voltage drop is increased. When separately powered the backlight is slightly brighter, but an additional power supply and field wiring are required.

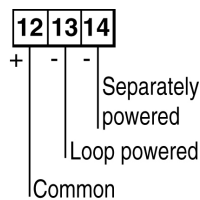


Fig 15 Terminals for optional backlight

8.4.1 Loop powering the backlight

The backlight is loop powered by connecting it in series with the indicator 4/20mA input as shown in Fig 16, which increases the maximum indicator voltage drop from 1.2 to 5V.

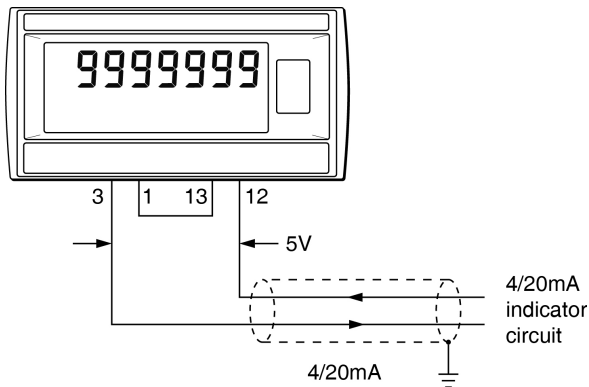


Fig 16 Loop powered backlight

8.4.2 Separately powering the backlight

The optional backlight may also be powered from a separate safe area power supply via an intrinsically safe interface as shown in Fig 17.

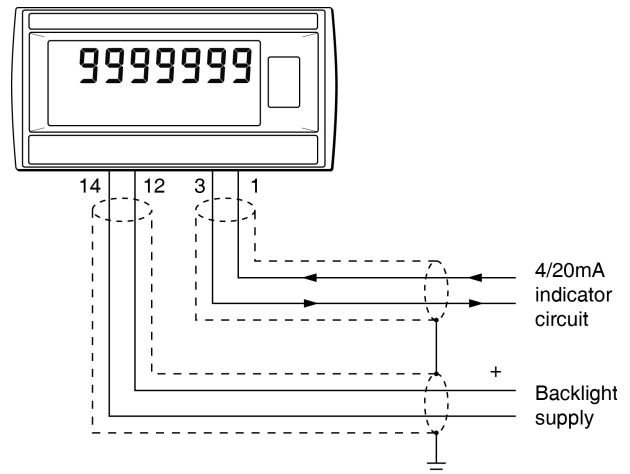


Fig 17 Separately powered backlight

When separately powered the backlight draws a constant current when supply is equal to or greater than 11V. Below this supply voltage the backlight continues to function but with reduced brilliance.