

BEKA associates

BA524
4/20mA 4½ digit
indicator
for use in safe areas

Instruction manual

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Appendix 1 Product specification

1 Description

The BA524 is a 2-wire field mounting 4½ digit indicator for use in safe areas. The instrument is loop-powered from the live-zero signal, but only introduces a 1.1V drop which allows it to be installed into almost any 4/20mA current loop. No additional power supply or battery is required.

The main application of the BA524 is to display a measured variable or control signal in the process area. The span and zero are independently adjustable, so that any variable represented by the 4/20mA current can be displayed in engineering units.

The indicator incorporates a square root-extractor to linearise the output of 4/20mA flow transmitters which have a square law characteristic i.e. those operating from orifice plates and venturi tubes. A flow signal can therefore be displayed in linear engineering units.

2 Operation

The BA524 incorporates a microcontroller which enables the user to calibrate and select different display modes via three push button switches located behind the enclosure front cover. To prevent accidental or unauthorised recalibration, the function of these switches can be restricted by a plug-in link. The BA524 indicator stores function and calibration information for at least five years without a 4/20mA signal connected.

A simplified diagram of the instrument is shown in Fig 1. The 4/20mA current flows through resistor R1 and forward biased diode D1. The voltage developed across D1 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 which is amplified and processed by the microcontroller.

Each time a 4/20mA current is applied to the instrument initialisation is performed. After a short delay the following display sequence occurs:

-1.8.8.8.8	Lamp test. All segments should be displayed for 0.5 seconds.
Blank display	For 0.5 seconds.
Normal display	Using calibration information stored in memory

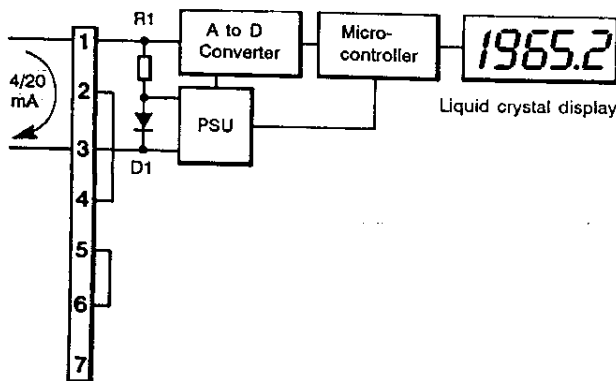


Fig 1 Block diagram of indicator

On completion of initialisation, the indicator automatically enters the display mode using the calibration information stored in the memory. After five minutes the instrument will enter an automatic self-checking routine during which a P will be displayed. This routine, which takes approximately ten seconds, is repeated automatically every thirty minutes to minimise drift caused by ambient temperature changes.

2.1 Controls

The three push button switches located behind the front cover of the BA524 indicator have two operating modes which are selected by the position of the plug-in calibration enable link. With the link in the calibration position, the switches are in the calibration mode and the zero, span and function of the indicator may be adjusted. Fitting the link in the display position puts the switches into the display mode which prevents calibration adjustments.

Except when frequent range changes are required, it is recommended that the indicator is operated in the display mode so that the calibration function of the switches is inhibited.

Calibration mode (plug-in link in calibration position)

The indicator will display the 4/20mA signal in engineering units as previously calibrated. The three switches have the following functions:

- %P Initiates calibration
- ▲ and ▼ Select display functions and adjust span and zero. See section 5 for step by step calibration procedures.

Display mode (plug-in link in the display position)

The indicator will display the 4/20mA signal in engineering units as previously calibrated. The three switches have the following functions:

- %P While this button is pushed, the indicator will display the input current as a percentage of the indicator span. When the button is released the normal display in engineering units will return.
- ▼ While this button is pushed the indicator will display the number which the indicator has been calibrated to display with a 4mA input current. When the button is released the normal display in engineering units will return.
- ▲ While this button is pushed the indicator will display the number which the indicator has been calibrated to display with a 20mA current. When the button is released the normal display in engineering units will return.

The three push buttons have additional functions which can be used in both the calibration and display modes i.e. with the calibration enable link in either the calibration or the display position.

▲ ▼ When these two buttons are pushed together the indicator performs a self check during which the display shows P. This is an automatic routine taking about ten seconds after which the indicator returns to its initial display.

%P ▲ ▼ When these three buttons are pushed together the indicator will reset and go through the initialisation sequence. NB. resetting during calibration causes any new settings to be lost.

2.2 Square root-extraction

The square root-extractor is selected by a plug-in link located behind the front cover of the indicator.

3 Application

The BA524 will operate in series with any 4/20mA current loop, providing that the loop can tolerate the additional 1.1V drop introduced by the indicator.

3.1 Electrical System Design

The indicator is connected in series with a 4/20mA current loop and introduces a voltage drop of less than 1.1V at all input currents. When designing a loop it is therefore necessary to add this voltage to the other voltage drops caused by transmitters and loads, and to ensure that the sum of all the voltage drops is less than the minimum power supply voltage. Figure 2 shows a process loop where a 2-wire transmitter is driving a controller.

Considering the total voltage drop around the loop:

Minimum operating voltage of 2-wire Tx	10.0V
Maximum voltage drop caused by controller	5.0V
Maximum voltage drop caused by indicator	1.1V
Maximum voltage drop caused by cable resistance	0.4V
	16.5V

The instrument power supply must therefore have a minimum output voltage at 20mA of greater than 16.5V.

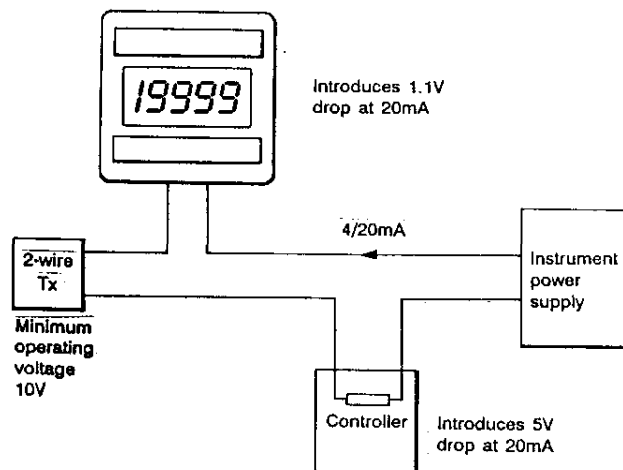


Fig 2 Indicator providing indication in a control loop

The BA524 indicator may also be driven directly from any instrument with a 4/20mA output. Figure 3 shows an indicator connected to the auxiliary 4/20mA output of a weighing system. Again, it is only necessary to ensure that the voltage capability of the auxiliary 4/20mA output is greater than the voltage drop of the indicator, plus any voltage drops caused by cable resistance.

The indicator incorporates protective components to prevent damage by non-repetitive transient currents of up to 30A for 15mS. However, when connected to long overhead or underground cables, it may be necessary to install a surge protection unit close to the indicator, if it is considered that the cable is likely to be subjected to high transient currents from lightning or electrical switch gear.

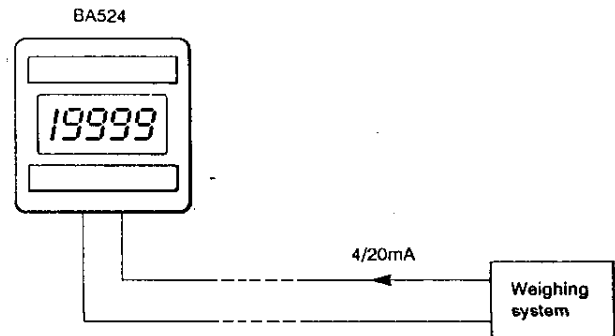


Fig 3 Indicator providing remote indication

4 Installation

4.1 Mounting

The BA524 4/20mA digital indicator is housed in either an epoxy painted die-cast aluminium enclosure, or a glass reinforced polyester (GRP) enclosure. To simplify installation, the field wiring terminals are located in the enclosure so that it can be installed and wired without the indicator in place. The enclosure also contains a 3.3V Zener diode to maintain the continuity of the 4/20mA loop when the indicator is not fitted. A simplified diagram of the indicator is shown in Figure 5.

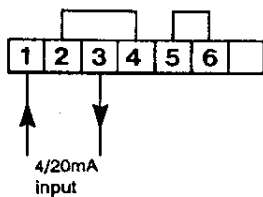
The enclosure can be directly mounted onto any flat surface using the four corner 'D' holes, or can be clamped to pipework using one of the accessory pipe mounting kits. Whichever method is used, it is important to choose a location which ensures that the indicator always remains within the environmental limits shown in the specification. If possible the display window should not be exposed to continuous direct sunlight.

When correctly installed the enclosure will provide IP66 protection.

4.2 Installation Procedure

- i Remove the enclosure cover by unscrewing the four captive 'A' screws.
- ii Remove the indicator from the enclosure by unscrewing the three captive 'B' screws and carefully lifting the assembly from the enclosure.
- iii Remove the terminals cover from the enclosure by unscrewing the two captive 'C' screws.

- iv. Mount the enclosure on a flat surface and secure with screws or bolts through the four corner 'D' holes. Alternatively, assemble a pipe or panel mounting kit as described in the instructions supplied with the kit.
- v. Fit cable glands or conduit fittings into the two M20 x 1.5 holes at the bottom of the enclosure; ensure that they provide the required environmental protection, and that the screw threads do not protrude too far into the terminals compartment.
- vi. Connect the field wiring to the terminals as shown in Figure 4. The aluminium enclosure is provided with an earth terminal which is internally connected to the enclosure die-casting. This terminal should be connected to a local earthing point to ensure personnel safety.
The glass reinforced polyester (GRP) enclosure is non conductive, but has a conductive inner coating for RFI screening. The right hand terminal in the GRP enclosure is connected to this screen, so that if necessary it can be connected to a local earthing point.
- vii. Replace terminal cover and tighten the two 'C' screws.
- viii. Replace the indicator in the enclosure and evenly tighten the three 'B' screws.
- ix. Replace the enclosure cover and evenly tighten the four 'A' screws.

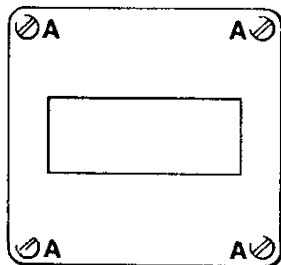


Terminals 2 & 4 are internally linked for joining return 4/20mA wire. Terminals 5 & 6 are internally linked for joining cable screens. Right hand terminal connected to enclosure in aluminium version, and to the RFI screen in the GRP version

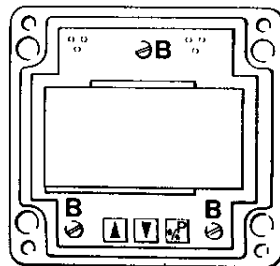
Fig 4 Terminal connections

5. Calibration

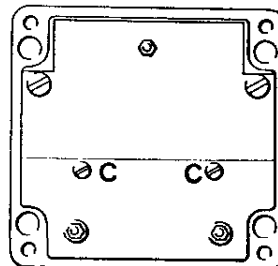
Indicators are supplied calibrated as requested. If calibration information is not supplied with the order, the BA524 will be factory set to display 0.00 at 4mA and 100.00 at 20mA with a linear input and a resolution of one digit.



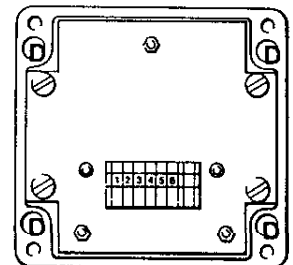
Step 1 - Remove the enclosure cover by unscrewing the four 'A' screws.



Step 2 - Remove the indicator from the enclosure by unscrewing the three captive 'B' screws.



Step 3 - Remove the terminal cover from the enclosure by unscrewing the two captive 'C' screws.



Step 4 - Mount the enclosure on a flat surface and secure with screws or bolts through the four corner 'D' holes. Alternatively, assemble the pipe mounting kit which is supplied with its own instruction sheet.

Fig 5 Disassembly sequence

5.1 Calibration controls

Linear or square law input current

A linear or square root transfer function is selected by a plug-in link. The square root-extractor provides accurate linearisation of a square law signal produced by a flow transmitter operating from an orifice plate or venturi, thus enabling the indicator to display the flow signal in linear engineering units.

Zero adjustment

Zero is defined as the figure displayed with a 4.0000mA input current. The zero may be adjusted between -19999 and 19999.

When using the square root-extractor the indicator will display zero with a 4mA input.

Span adjustment

Span is defined as the difference between the number displayed with a 4.0000mA input and the number displayed with a 20.0000mA input. The span may be adjusted to any value between 0 and ± 19999 in the linear mode, and 0 to +19999 in the square root-extracting mode.

In the linear mode the display at 20mA may be less than the display at 4mA to provide reverse acting indication ie. the indicator display decreases as the input current increases.

Note: When calibrating the indicator, the actual display at 20mA is shown, not the span.

Decimal point

A decimal point can be displayed between any of the digits, or may be omitted.

Display resolution

Resolution of the indicator can be adjusted to provide a stable display in noisy applications. One, two, five or ten digit resolution may be selected.

5.2 Calibration sequence for a linear Input

When recalibrating a BA524 indicator the complete calibration sequence must be followed even if only one parameter is to be changed. If at any point during the calibration sequence an incorrect entry is made, the indicator can be reset by pushing all three switches at the same time. This returns the indicator to the display mode, and restores the calibration which existed before recalibration was attempted.

The BA524 has a maximum span of 19999, one least significant digit is equivalent to 0.005% of span or $0.8\mu\text{A}$ change in the 4/20mA input current. To achieve maximum accuracy with large spans, appropriate calibration equipment must be used.

Before starting recalibration, remove the enclosure front cover and put the calibration enable plug-in link in the calibration position.

Position of the linear/square root extractor link

The plug-in link which selects a linear or square-root transfer function is located at the top left hand corner of the indicator. If the transfer function of the indicator needs to be changed, carefully reposition the link using a pair of long nosed pliers.

Position of the decimal point

To initiate calibration, press and hold the button marked %P until the display shows P. On completion of this self check, the indicator will display a flashing decimal point in the position previously selected. If no decimal point was selected on the previous calibration, all the decimal points will flash. To change the position, press and hold the \blacktriangle or \blacktriangledown button until the decimal point moves to the required position or is absent, if no decimal point is required.

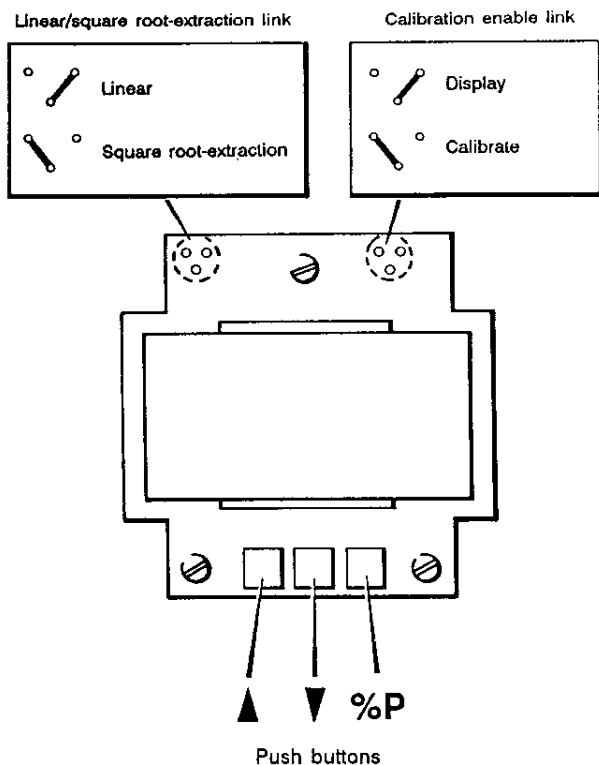


Fig 6 Location of push buttons and links

Display resolution

Press and hold the %P button until the indicator displays the number of digits resolution previously selected. To change the resolution press and hold the \blacktriangle or \blacktriangledown button to increment or decrement the resolution until the required figure is obtained. 1, 2, 5 or 10 digit resolution may be selected.

If the zero and span of the indicator are not to be changed, the new decimal point and display resolution settings may be stored in permanent memory at this point in the calibration sequence. If the span and zero of the indicator are to be changed, all information is transferred to the permanent memory at the end of the calibration sequence. Press and hold the %P button until the indicator displays 4, immediately release the button and the indicator will display an alternating E and 4. This shows that the calibration sequence may either be concluded or continued.

Exit from the calibration sequence

Press and hold the \blacktriangle or \blacktriangledown button until the display returns to the normal display mode. The new decimal point and display resolution settings will be stored in permanent memory.

OR to recalibrate the display

Span and zero adjustments are made by setting each digit of the display in turn, starting with the 1000's digit and ending with the least significant digit. To make calibration easy, the digit being adjusted will carry to the next most significant digit when it is incremented above 9 or below 0. For example, incrementing the 1000's digit above 9, causes the most significant half digit (the leading 1 of the $4\frac{1}{2}$ digit display) to be activated.

Zero adjustment (display with 4mA input)

Adjust the input current from the calibration source to exactly four milliamps, then press the %P button until the existing display at 4mA is shown. The 1000's digit will flash to show that this, and the most significant half digit, may be adjusted by pressing the \blacktriangle or \blacktriangledown button. To set the 100's digit press and hold the %P button until the 100's digit flashes. Immediately release the button and adjust the digit using either the \blacktriangle or \blacktriangledown button. Repeat for the next two digits until both are set to the required figures.

Span adjustment (display with 20mA Input)

While the least significant digit of the display is flashing following completion of the zero adjustment, press and hold the %P button until the indicator displays a flashing 20. Adjust the input current from the calibration source to exactly 20mA, and again press and hold the %P button until the existing display at 20mA is shown.

The 1000's digit will flash to show that this, and the most significant half digit, may be adjusted by pressing and holding the \blacktriangle or \blacktriangledown button. To set the 100's digit press and hold the %P button until the 100's digit flashes. Immediately release the button and adjust the digit using the \blacktriangle or \blacktriangledown button. Repeat for the next two digits until both are set to the required figures. When the least significant digit has been set, again press the %P button until the indicator displays E which shows that all the calibration information is being stored in the permanent memory. When complete the indicator will automatically return to the display mode.

Note: When calibrating the indicator, the actual display at 20mA is shown, not the span.

If no further calibration adjustments are required, return the calibration enable link in the display position to prevent unauthorised recalibration.

5.3 Calibration sequence for a square law input

When recalibrating a BA524 indicator the complete calibration sequence must be followed even if only one parameter is to be changed. If at any point during the calibration sequence an incorrect entry is made, the indicator can be reset by pushing all three switches at the same time. This returns the indicator to the display mode, and restores the calibration which existed before recalibration was attempted.

The root-extractor provides linearisation of the flow signal between 4.04 and 20mA, so the indicator will accurately display the flow in linear engineering units between 5 and 100% of full flow. Below 4.04mA the indicator will display zero.

Before starting recalibration, remove the enclosure front cover and put the calibration enable plug-in link in the calibration position.

Position of the linear/square root-extractor link

The plug-in link which selects a linear or square-root transfer function is located at the top left hand corner of the indicator. If the transfer function of the indicator needs to be changed, carefully reposition the link using a pair of long nosed pliers.

Position of the decimal point

To initiate calibration, press and hold the button marked %P until the display shows P. On completion of this self check, the indicator will display a flashing decimal point in the position previously selected. If no decimal point was selected on the previous calibration, all the decimal points will flash. To change the position, press and hold the ▲ or ▼ button until the decimal point moves to the required position, or is absent if no decimal point is required.

Display resolution

Press and hold the %P button until the indicator displays the number of digits resolution previously selected. To change the resolution press and hold the ▲ or ▼ button to increment or decrement the resolution until the required figure is obtained. 1, 2, 5 or 10 digit resolution may be selected.

If the zero and span of the indicator are not to be changed, the new decimal point and display resolution settings may be stored in permanent memory at this point in the calibration sequence. If the span and zero of the indicator are to be changed all information is transferred to the permanent memory at the end of the calibration sequence. Press and hold the %P button until the indicator displays 4, immediately release the button and the indicator will display an alternating E and 4. This shows that the calibration sequence may either be concluded or continued.

Exit from the calibration sequence

Press and hold the ▲ or ▼ button until the display returns to the normal display mode. The new decimal point and display resolution settings will be stored in permanent memory.

OR to recalibrate the display

Span and zero adjustments are made by setting each digit of the display in turn, starting with the 1000's digit and ending with the least significant digit. To make calibration easy, the digit being adjusted will carry to the next most significant digit when it is incremented above 9 or below 0. For example, incrementing the 1000's digit above 9, causes the most significant half digit (the leading 1 of the 4½ digit display) to be activated.

Zero adjustment (display with 4mA input)

When using the square root-extractor the indicator will always display zero with a 4mA input current. No zero elevation or suppression may be applied. Adjust the input current from the calibration source to exactly four milliamps, then press the %P button until the display changes to 0000 with the most significant digit flashing. Press and release the %P button three times until 0000 is displayed with the least significant digit flashing. This completes the zero adjustment.

Although the display has not been changed, this routine, which must be completed with an accurate 4mA input current, ensures that the percentage function operates correctly.

Span adjustment (display with 20mA input)

While the least significant digit of the display is flashing following completion of the zero adjustment, press and hold the %P button until the indicator displays a flashing 20. Adjust the input current from the calibration source to exactly 20mA, and again press and hold the %P button until the existing display at 20mA is shown.

The 1000's digit will flash to show that this, and the most significant half digit, may be adjusted by pressing and holding the ▲ or ▼ button. To set the 100's digit press and hold the %P button until the 100's digit flashes. Immediately release the button and adjust the digit using the ▲ or ▼ buttons. Repeat for the next two digits until both are set to the required figures. When the least significant digit has been set, again press the %P button until the indicator displays E which shows that all the calibration information is being stored in the permanent memory. When complete the indicator will automatically return to the display mode.

Note: When calibrating the indicator, the actual display at 20mA is shown, not the span.

If no further calibration adjustments are required, replace the calibration enable plug-in link in the display position to prevent unauthorised recalibration.

6 Maintenance

6.1 Fault Finding During Commissioning

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

Symptom	Cause	Solution
No display	Incorrect wiring to indicator	Correct wiring error, indicator will not be damaged by reversed connections
Indicator displays HHHH	Positive over-range	The indicator has been incorrectly calibrated & is trying to display a number greater than 19999 or input current is greater than approx 20.5mA.
Indicator displays LLLL	Negative over-range	The indicator has been incorrectly calibrated & is trying to display a number less than -19999 or input current is less than approx 3.5mA.
Unstable display. More than ± 1 digit of jitter.	4/20mA input current contains large ripple current	Reduce ripple content or reduce resolution of the indicator
	Insufficient voltage to operate indicator ie. less than 1.1V	Check supply voltage & voltage drops caused by all components within the loop
Continuous reset or no initialisation sequence	4/20mA input current too low	Check input current and ensure that it is greater than 3.5mA
Push button switches do not function correctly	Incorrect fitting of calibration enable link	Refer to section 2.1

6.2 Fault Finding After Commissioning

ENSURE PLANT SAFETY BEFORE STARTING MAINTENANCE

If an indicator fails after it has been operating correctly, the following procedure should be used:

Symptom	Cause	Solution
No display, no voltage across terminals	Short or open circuit in wiring, or fault in indicator	Check all wiring
Unstable display More than ± 1 digit of jitter	4/20mA current has developed large ripple component	Find source of ripple and if necessary reduce indicator resolution
	Insufficient voltage to operate indicator ie. less than 1.1V	Check supply voltage & voltage drops caused by all components within the loop

If the above procedure does not reveal the cause of the fault, it is recommended that the indicator is removed from the enclosure and replaced with another unit.

6.3 Servicing

The indicator has been designed so that it can easily be replaced without disturbing the field wiring. The indicators can be calibrated on site, so a single spare instrument is therefore able to replace any indicator which is damaged or fails. BEKA Associates and most distributors maintain a stock of indicators which can be used if a customer is unable to justify purchasing a spare.

BEKA Associates recommend that, except under exceptional circumstances, faulty indicators are returned to the factory or local agent for repair. However, if this is not possible BEKA Associates will provide service information for the instrument.

6.4 Warranty

Indicators which fail within the warranty period should be returned to BEKA Associates or the local distributor from whom the instrument was purchased. It is helpful if a brief description of the fault symptoms can be provided.

7 Accessories

7.1 Engraved Scale Plate

A removable blank stainless steel plate is fitted above the display on every instrument. This plate can be supplied engraved with the units of measurement eg. kg, litres/h or Tonne.

7.2 Engraved Tag Plate

A removable blank stainless steel plate is fitted below the display on every instrument. This plate can be supplied engraved with the instrument tag number or application.

7.3 Pipe mounting kits

Three kits are available for mounting the BA524 onto vertical or horizontal pipes:

BA391 Zinc plated using worm drive hose clips.

BA392 Stainless steel using worm drive hose clips.

BA393 Heavy duty stainless steel using V bolt.

7.4 Panel mounting kit

The BA394 panel mounting kit enables the BA524 indicator to be mounted into a panel aperture.

7.5 Separate terminal compartment

The BA396 is a separate GRP terminal compartment which allows access to the indicator terminals without removing the instrument front cover. It is normally factory fitted, but can be installed on site if necessary.

7.6 External percentage button

For applications where both engineering and percentage displays are required, an instrument front cover incorporating a button to operate the %P switch can be provided. The cover maintains IP66 protection, while allowing the operator to display the input signal as a percentage of span.

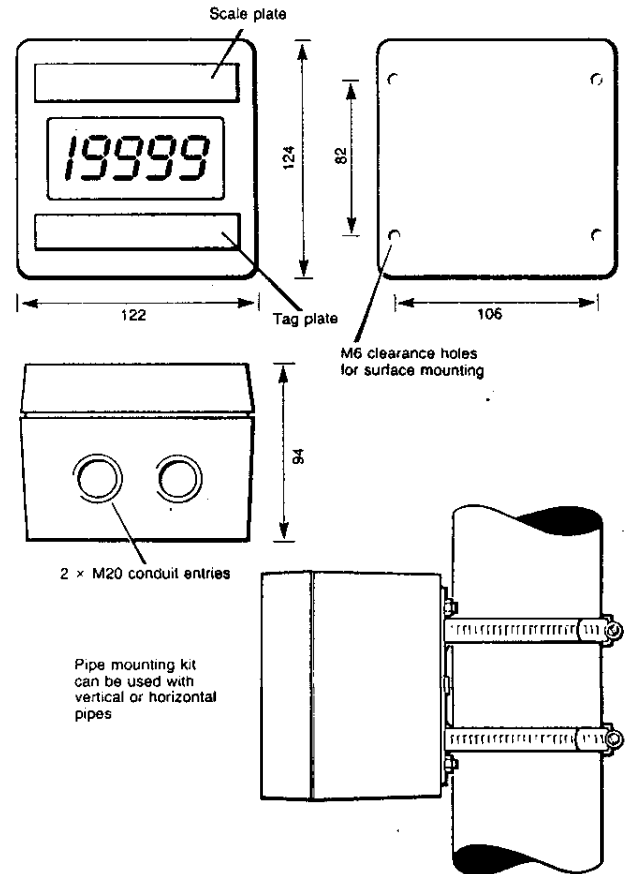
8 Customer Comments

BEKA Associates is always pleased to receive comments from customers about products and services. All communications are acknowledged and whenever possible, suggestions are acted upon.

APPENDIX 1: Product Specification

Input	
Current	4 to 20mA
Voltage drop at 4mA	Less than 0.7V at 20°C
Voltage drop at 20mA	Less than 1V at 20°C Less than 1.1V @ -20°C
Overrange	±200mA will not cause damage
Display	
Type	4½ digits (-19999 to 19999) Liquid crystal 20mm high
Span	Adjustable between: Linear input 0 and ±19999 Square law input 0 and 19999
Zero	Adjustable between: ±19999 with 4mA input linear inputs only
Polarity	Automatic minus sign
Decimal point	1 of 4 positions, or absent
Zero blanking	Only one leading zero is displayed
Reading rate	1.25 per second linear input 1 per second square law input
Overrange	Displays HHHH for readings greater than +19999 or approx 20.5mA input current.
Underrange	Displays LLLL for readings less -19999 or approx 3.5mA input current.
Calibration	
	Internal plug-in link fitted in calibration position
Internal push buttons set:	
Display calibration	Display at 4 & 20mA
Display resolution	1, 2, 5 or 10 digits
Decimal point	1 of 4 positions or absent
Internal plug-in link selects:	Linear or square law input
Calibration inhibit	
	Internal plug-in link fitted in display position
Internal push buttons select:	
	Display with 4mA input
	Display with 20mA input
	Display as a percentage of span
Accuracy	
At 20°C including non linearity & hysteresis	
Linear input	±0.02% of display ±1 digit
Square law input	±16µA at input ±1 digit for input currents between 4.04 and 20mA (5 to 100% of flow)
Temperature effect on:	
Zero	Less than 25ppm of span/°C
Span	Less than 50ppm of span/°C
Series mode rejection	Less than 0.025% of span error for 1mA pk to pk 50/60Hz signal
RF rejection	Less than 0.8% of span error for 10V/m field strength between 27 & 1000MHz

Dimensions(mm)

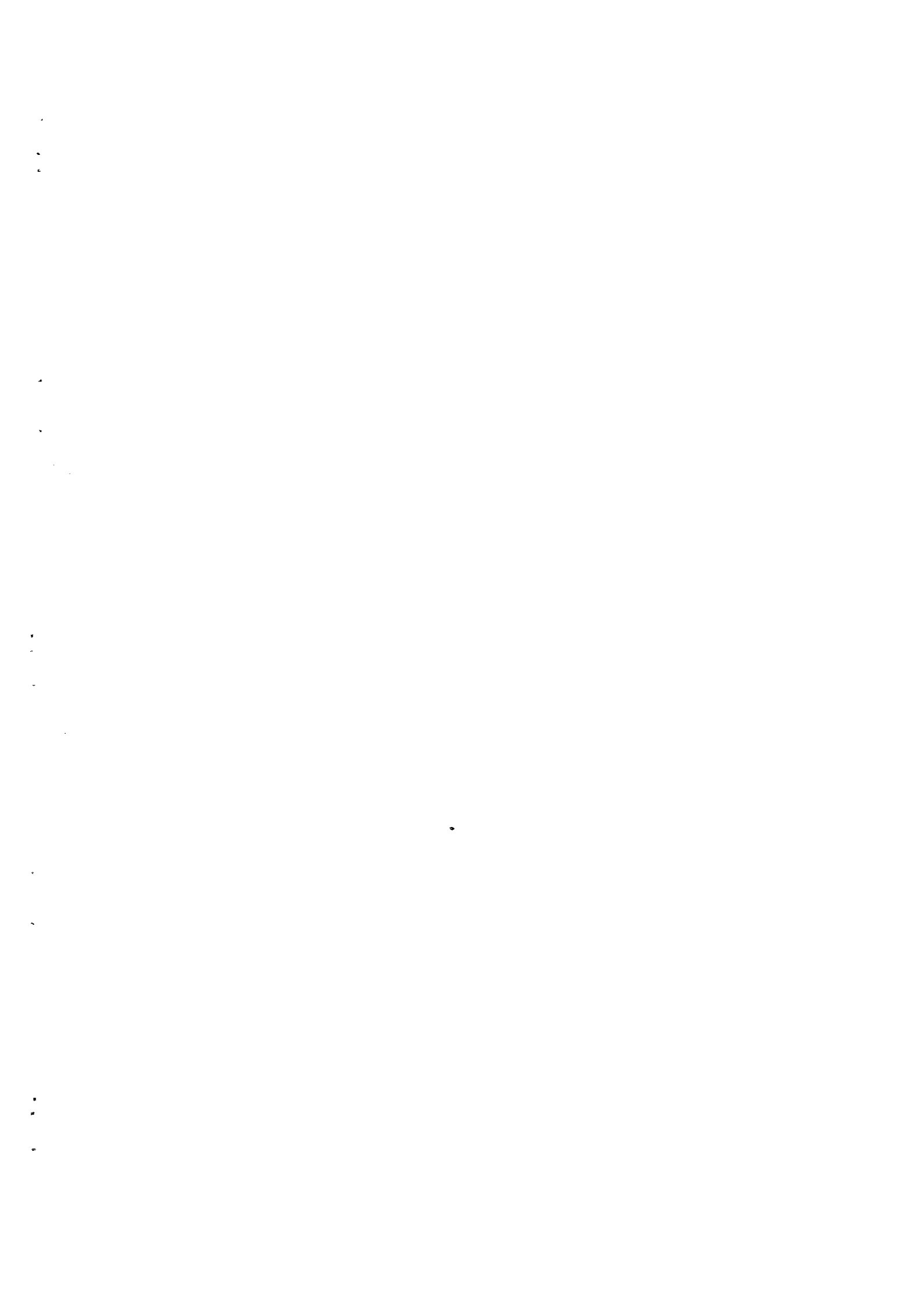


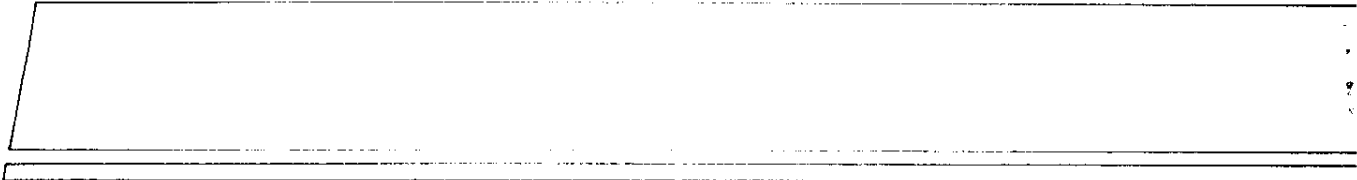
Environmental

Operating temperature	-20 to +60°C
Humidity	to 95% RH @ 40°C
Enclosure	IP66. Copy of ERA test report 5046/228 available

Mechanical

Terminals	Screw clamp for 0.5 to 2.5mm
Weight:	
Aluminium enclosure	1.4kg
GRP enclosure	1.1kg





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