BEKA associates

BA324B intrinsically safe 4/20mA 4½ digit indicator

Instruction manual

CONTENTS

1 Description

The BA324B.is an intrinsically safe 2-wire field mounting 4½ digit indicator for use in hazardous 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 BA324B 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 BA324B has been certified intrinsically safe by BASEEFA to the CENELEC standard. The indicator complies with the requirements for simple apparatus, and the certificate permits the BA324B to be connected to almost any certified intrinsically safe 4/20mA loop without the need for additional certification.

The indicator incorporates a square root-extractor which may be selected to linearise the output of a 4/20mA flow transmitter which has a square law characteristic ie. one operating with an orifice plate or venturi tube. A flow signal can therefore be displayed in linear engineering units.

2 Operation

The BA324B 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 BA324B indicator stores function and calibration information for at least five years without a 4/20mA signal connected.

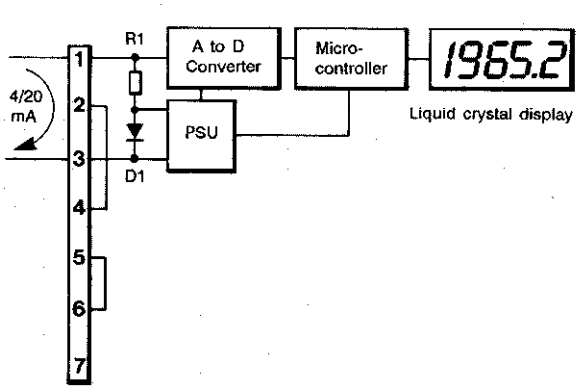


Fig 1 Simplified block diagram of indicator

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

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, which are located behind the front cover of the indicator, have two operating modes selected by a plug-in link. With the link in the display position, operating the switches causes the BA324B to display the indicator calibration, or the input current as a percentage of span.
With the link in the calibration position, the zero, span and function of the indicator may be adjusted.

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.

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.

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.

The three push buttons have additional functions which can be used in both the calibration and display modes ie. 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 Applications

The BA324B 4½ digit intrinsically safe loop powered indicator is a high performance instrument which may be connected to almost any hazardous area 4/20mA loop without additional certification. Although the BA324B may be used in safe areas, the non certified BA524 is recommended for safe area applications.

When designing a hazardous area loop incorporating a BA324B indicator, it is necessary to consider both the dc operating conditions and the intrinsic safety compatibility of all the components within the loop. Sections 3.1, 3.2 & 3.3 contain detailed descriptions of the CENELEC certification requirements, and section 3.4 describes typical applications.

3.1 CENELEC intrinsic safety certificate
The BA324B digital indicator has been certified intrinsically safe by BASEEFA to BS5501:Part 1: 1977 EN50 014 and BS5501: Part 7: 1977 EN50 020. The certificate is a variation of the certificate issued for an existing range of 3½ digit indicators.
The BA324B bears the Community Mark and, subject to local Codes of Practice, may be installed in any of the CENELEC member countries ie. Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom. This instruction manual describes installations which conform with the UK Code of Practice BS5345: Part 4: 1977. When designing systems for installation outside the UK, the local code of practice should be consulted.

A reduced copy of the BASEEFA apparatus certificate for the BA324B is included as Appendix 1 of this manual, full size copies are available from BEKA Associates and our overseas representatives.

The BA324B certificate states that:

> 'For intrinsic safety considerations the output parameters at the apparatus terminals do not exceed those specified in Clause 1.3 of BS5501: part 1 1977 EN50 014'

Clause 1.3 of BS5501: Part 1: 1977 EN50 014 says:

> 'Devices in which none of the values 1.2V, 0.1A 20μJ or 25mW are exceeded need not be certified or marked'

This type of apparatus is known as non energy-storing or simple apparatus.

The BASEEFA certificate is therefore saying that although the BA324B contains energy-storing components, it has been designed such that the energy which can be released via the two terminals is less than that specified in Clause 1.3 of EN50 014. The indicator may therefore be installed into certified intrinsically safe loops without invalidating the original certification of the loop. For this reason the BA324B only has an apparatus certificate, no system certificate has been issued or is required, because the system certificate of the loop into which the indicator is connected remains valid.

The BASEEFA apparatus certificate allows the BA324B indicator to be connected to any intrinsically safe circuit whose output parameters do not exceed the following:

$$I_{max:out} = 200mA$$
$$W_{max:out} = 0.85W$$

The circuit parameters are determined by the Zener barrier or the intrinsically safe isolator powering the loop. The certification documents and manufacturers literature for the barrier or isolator will list the output parameters, it is only necessary to check that these figures are below the maximum permitted parameters for the BA324B shown above. In practice, the indicator parameters are not restrictive, and allow connection to almost all intrinsically safe 4/20mA loops.

When two single channel Zener barriers each of the same polarity are connected to a two wire circuit, the output parameters of each channel must be below the permitted parameters specified on the BA324B certificate.

If the safety description of the barrier or intrinsically safe isolator is expressed as a voltage and resistance, eg. 28V 300Ω, $I_{max:out}$ and $W_{max:out}$ can be calculated as follows:

$I_{max:out}$ = maximum current which can flow around the loop under fault conditions.

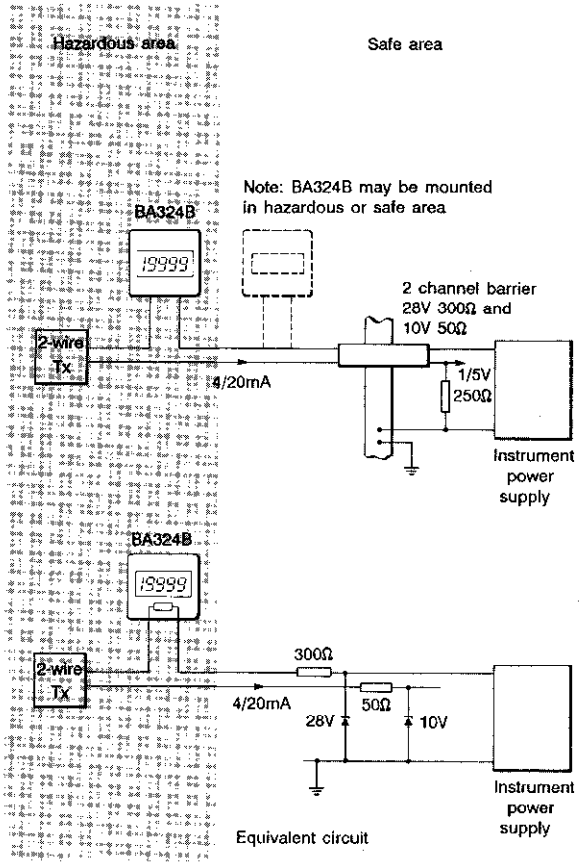
$$I_{max:out} = \frac{\text{maximum voltage of terminating Zener diode}}{\text{minimum resistance of terminating resistor} + 15.4}$$

Where 15.4Ω is the infallible resistance between the BA324B indicator terminals.

$W_{max:out}$ = maximum power which can be transferred into the hazardous area by each Zener barrier or isolator when perfectly matched.

$$W_{max:out} = \frac{\text{max voltage of terminating Zener diode} \times I_{max:out}}{4}$$

Fig 2 shows how these calculations are applied for a two channel barrier.



Barrier safety descriptions from manufacturers specification
(One 2-channel barrier or two single channel barriers)

	Max Zener voltage	Min terminating resistance
28V channel	28.0V	300.0Ω
10V channel	10.0V	50.0Ω

Considering the 28V channel:

$$I_{max:out} = \frac{28}{300.0 + 15.4} = 88.78mA$$

$$W_{max:out} = \frac{28.0 \times 88.78}{4} = 0.62W$$

Considering the 10V channel:

$$I_{max:out} = \frac{10}{50.0 + 15.4} = 152.91mA$$

$$W_{max:out} = \frac{10.0 \times 152.91}{4} = 0.38W$$

$I_{max:out}$ and $W_{max:out}$ for each channel are below 200mA and 0.85W specified on the BA324B certificate. The indicator may therefore be safely connected to the loop without the need for additional certification.

Fig 2 Example of calculations required to establish if a BA324B may be safely connected to an intrinsically safe loop.

3.2 Zones and gas groups

The BA324B has been certified EEx ia IIC T5, which means that when connected to a suitable system, it may be installed in:

Zone 0 explosive gas-air mixture continuously present
Zone 1 explosive gas-air mixture likely to occur in normal operation.
Zone 2 explosive gas-air mixture not likely to occur, and if it does will only exist for a short time.

and may be used above ground (group II) with gases or vapours in gas groups:

Group IIA propane
Group IIB ethylene
Group IIC hydrogen

having a temperature classification of:

T1 450°C
T2 300°C
T3 200°C
T4 135°C
T5 100°C

This means that the BA324B may be installed in all Zones and used with most common industrial gases.

NOTE: If the certification of the system to which the indicator is connected is more restrictive, then these restrictions also apply to the indicator eg. If the system is certified for use Zones 1 and 2, then the indicator may only be installed in these Zones.

3.3 Cable parameters

The BA324B BASEEFA certificate specifies the maximum equivalent capacitance and inductance between the two terminals of the indicator.

These are:

Ceq = 20nF
Leq = 2μH

These figures should be subtracted from the maximum cable capacitance and inductance permitted by the system certificate of the loop into which the BA324B is installed. Both reactances are small compared with permitted cable parameters for most Zener barriers and isolators. Only when 28V devices are used with IIC gases will the permitted cable capacitance, and hence the cable length, be significantly reduced.

3.4 Electrical system design

In addition to the intrinsic safety requirements described in previous sections, the electrical system design must be considered. The BA324B is connected in series with the 4/20mA current loop and introduces a voltage drop of up to 1.1V at all input currents between 4 and 20 mA. When designing a loop it is therefore necessary to add this voltage to the other voltage drops caused by Zener barriers and loads, and to ensure that the sum of these voltages is less than the minimum power supply voltage. Fig 3 shows a typical hazardous area measurement loop protected by a two channel Zener barrier. Considering the voltage drops around the loop:

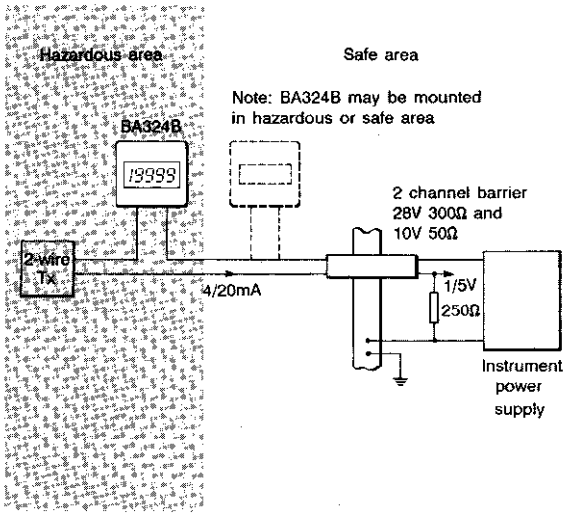


Fig 3 Hazardous area measurement loop

Minimum operating voltage of 2-wire Tx	10.0V
Maximum voltage drop caused by 250Ω load	5.0V
Maximum voltage drop caused by 28V 300Ω barrier (340Ω end to end resistance x 20mA)	6.8V
Maximum voltage drop caused by 10V 50Ω barrier (85Ω end to end resistance x 20mA)	1.7V
Maximum voltage drop caused by cable resistance (10Ω x 20mA)	0.2V
Maximum voltage drop caused by BA324B	1.1V
Total maximum voltage drop around the loop	24.8V

The instrument power supply voltage must therefore be above 24.8V but below 25.5V which is the maximum working voltage of the 28V 300Ω channel of the Zener barrier.

The Zener barrier may be replaced by a certified intrinsically safe isolator which eliminates the need for a high integrity earth connection. Again the voltage drops around the loop should be added together to ensure that there is sufficient voltage to operate the transmitter and the indicator.

The BA324B may also be driven via an intrinsically safe interface from any instrument with a 4/20mA output, to provide a remote indication in a hazardous area. The interface may be a Zener barrier or intrinsically safe isolator providing that it complies with the requirements specified in the BA324B certificate which are explained sections 3.1, 3.2 & 3.3 of this manual.

If one side of the 4/20mA signal may be earthed, a single channel Zener barrier provides the lowest cost solution. If the 4/20mA signal is not isolated, two Zener barriers or a certified isolator must be used. Again, it is necessary to ensure that the voltage capability of the 4/20mA signal is sufficient to drive the indicator, plus the voltage drops introduced by the Zener barrier(s) or isolator.

Fig 4 shows the alternative circuits which may be used.

3.5 Other certifications

In addition to CENELEC certification, the BA324B is being approved by other national authorities outside Europe. Please refer to BEKA Associates or our local representative for details.

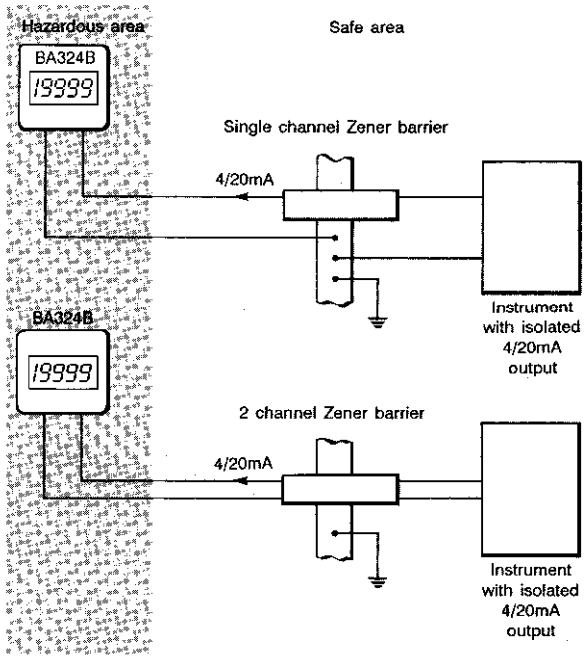


Fig 4 Alternative circuits for remote indication in a hazardous area

4 Installation

4.1 Mounting

The BA324B 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.

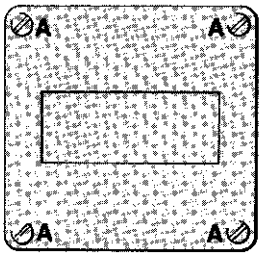
4.2 Installation Procedure

i Remove the enclosure cover by unscrewing the four captive 'A' screws.

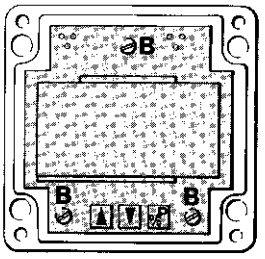
ii Remove the indicator from the enclosure by unscrewing the three captive 'B' screws and carefully lifting the assembly from the enclosure.

iii Remove the terminals cover from the enclosure by unscrewing the two captive 'C' screws.

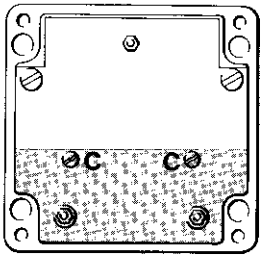
iv Mount the enclosure on a flat surface and secure with screws or bolts through the four corner 'D' holes. Alternatively, assemble a pipe or panel mounting kit as described in the instructions supplied with the kit.



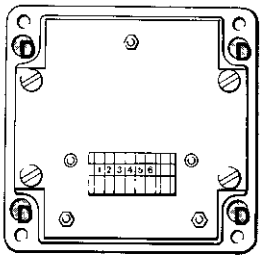
Step 1 - Remove the enclosure cover by unscrewing the four 'A' screws.



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. Alernatively, assemble the pipe mounting kit which is supplied with its own instruction sheet.

Fig 5 Simplified view of BA324B showing assembly sequence

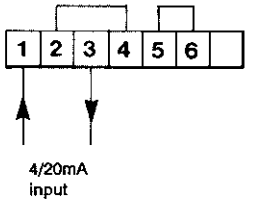
v Fit cable glands or conduit fittings into the two M20 x 1.5 holes at the bottom of the enclosure; ensure that they provide the required environmental protection, and that the screw threads do not protrude too far into the terminal compartment.

vi Connect the field wiring to the terminals as shown in Figure 6. 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 may be connected to a local earthing point.

vii Replace the terminal cover and tighten the two 'C' screws.
NOTE: When installed in a hazardous area it is mandatory that the terminal cover is fitted.

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 and 4 are internally linked and may be used to join return 4/20mA wire. Terminals 5 and 6 are internally linked and may be used to join cable screens.
Right hand terminal connected to enclosure in aluminium version, and to the RFI screen in the GRP version.

Fig 6 Terminal connections

5. Calibration

Indicators are supplied calibrated as requested. If calibration information is not supplied with the order, the BA324B 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.

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 BA324B 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 BA324B has a maximum span of 19999, one least significant digit is equivalent to 0.005% of span or 0.8μA 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 ▲ 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 increase or decrease 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.

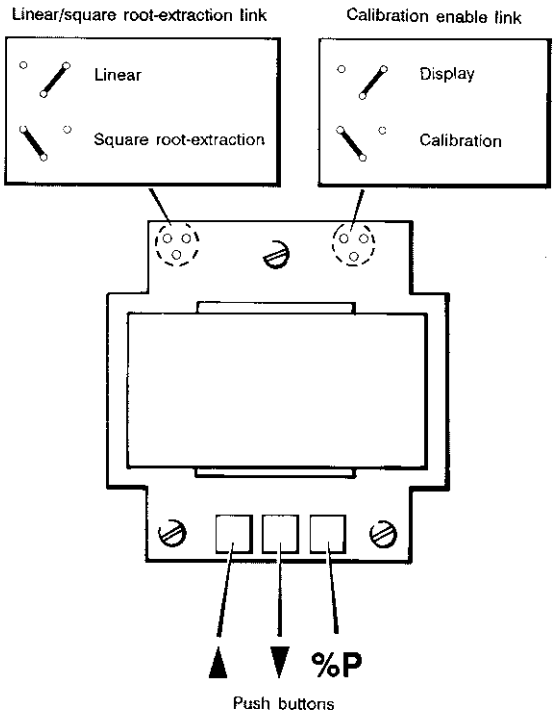


Fig 7 Location of push buttons and links

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)

Adjust the input current from the calibration source to exactly 4mA, 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 ▲ 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 either the ▲ or ▼ 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 ▲ 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 ▼ 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 BA324B 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 increase or decrease 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 4mA, 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 any 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 BA324B 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 BA324B 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 current 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

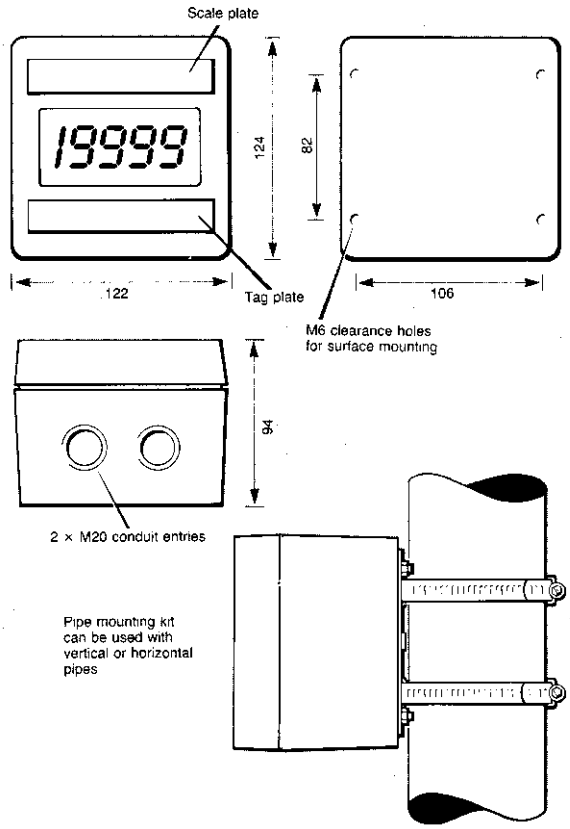
Type	4½ digits (-19999 to 19999) Liquid crystal 20mm high
Span	Adjustable between: Linear input 0 and ±19999 Square law input 0 and 19999
Zero	Adjustable between: ±19999 with 4mA input linear inputs only
Polarity	Automatic minus sign
Decimal point	1 of 4 positions, or absent
Zero blanking	Only one leading 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)



Intrinsic safety

Europe (BASEEFA)		
Standard	BS5501: Part 7: 1977 EN50 020	
Code	EEx ia IIC T5	
Certificate No.	Ex832399	
Output parameters		
Umax:out	1.12V	Complies with clause 1.3 of BS5501 Part 1: 1977: EN50 014 'Non energy-storing apparatus'
Imax:out	73mA	
Wmax:out	20mW	
Ceq	20nF	
Leq	2μH	
Location	Zone 0, 1 or 2	

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

APPENDIX 2: BASEEFA certificate

The BA324B certificate is a variation of the certificate for the BA303B 3½ digit indicator. Reduced copies of these certificates are shown in this Appendix, full size copies are available from BEKA Associates and our overseas representatives.

Health & Safety Executive

BASEEFA

British Approvals Service for Electrical Equipment in Flammable Atmospheres

1. **CERTIFICATE OF CONFORMITY**

2. BAS No Ex 852399 dated 27 January 1984

3. This certificate is issued for the electrical apparatus:

   A BA303B 4-20mA DIGITAL METER

4. manufactured and submitted for certification by:

   BEKA ASSOCIATES
   of Hitchin, Herts

5. This electrical apparatus and any acceptable variation thereto is specified in the Schedule to this Certificate and the documents therein referred to.

6. BASEEFA being an Approved Certification Body in accordance with Article 14 of the Council Directive of the European Communities of 18 December 1975 (76/117/EEC) confirms that the apparatus has been found to comply with Harmonised European Standards.

   BS 5501:Part 1:1977 EN50 014
   BS 5501:Part 7:1977 EN50 020

   and has successfully met the examination and test requirements which are recorded in confidential Test Report

   ERA Rep 362/06b, Rev 1 dated January 1984
   (Held on File No SFA 12/716/01)

7. The apparatus marking shall include the code

   EEx ia IIC T4 (T_{amb} = 60°C)

   File No. SFA 16/263/01

B HILL
DIRECTOR Sheet 1/3

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BASEEFA Harpur Hill Buxton Derbyshire SK17 9JN Tel 0298 6211 Telex 668113 RLSD G

Certificate BAS No Ex 852399 dated 27 January 1984

8. The supplier of the electrical apparatus referred to in this certificate has the responsibility to ensure that the apparatus conforms to the specification laid down in the Schedule to this certificate and has satisfied routine verifications and tests specified therein.

9. This apparatus may be marked with the Distinctive Community Mark specified in Annex II to the Council Directive of 6 February 1979 (Doc 79/196/EEC). A facsimile of this mark is printed on sheet 1 of this certificate.

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This certificate is granted subject to conditions applicable to the Approval Service, it does not necessarily indicate that the apparatus may lawfully be used in particular industries or circumstances.

CERTIFICATE OF CONFORMITY (Ex) **SCHEDULE**

NUMBER BAS Ex 852399
DATED 27 January 1984

APPARATUS

A BA303B 4/20mA DIGITAL METER is designed to display the current in a 4/20mA signal loop.

The circuit is arranged on five printed circuit boards in an aluminium alloy enclosure which provides a degree of protection of at least IP20.

Intrinsic safety is assured by limitation of capacitance, suppression of inductance by shunt components, internal voltage limitation, and limitation of input current and power.

The apparatus must be connected to an intrinsically safe circuit whose output parameters do not exceed the following :-

$I_{max:out}$ = 215mA d.c.

$W_{max:out}$ = 1.1W

The equivalent resistance of the apparatus terminals is 19.4 ohm minimum in normal operation and 24 ohm maximum under fault conditions. The internal segregation of the meter satisfies the requirements for a peak voltage of 60V.

The equivalent output parameters of the apparatus are :-

$U_{max:out}$ = 1.2V

$I_{max:out}$ = 72mA

$W_{max:out}$ = 20mW

C_{eq} = 0.015µF

L_{eq} = 2.H

For intrinsic safety considerations the output parameters at the apparatus terminals do not exceed those specified in Clause 1.3 of BS 5501 : Part 1 : 1977, EN50 014. The equivalent capacitance and inductance are the result of r.f. suppression components directly connected to the apparatus terminals.

DRAWING

Number	Issue	Date	Description
CI303-001 Sheets 1-9 & 11-16	2	Oct 1983	Certification information

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Original BA303B apparatus certificate

BA324B apparatus certificate

BASEEFA

British Approvals Service for Electrical Equipment in Flammable Atmospheres

CERTIFICATE OF CONFORMITY VARIATION

THIS IS TO CERTIFY THAT CERTIFICATE BAS No. Ex 832399

Held by BEKA ASSOCIATES LIMITED

of Hitchin, SG5 2DD

for the BA303B 4/20mA DIGITAL METER

is hereby extended to apply to apparatus designed and constructed in accordance with the specification set out in the Schedule of the said Certificate but having the variation specified in the attached Schedule.

A copy of this Supplementary Certificate shall be attached to the original certificate

Code: see schedule

File No: EECS 0121/02/003

ERA Report: 3627/578 dated June 1992

CERTIFICATE BAS No Ex 832399/6

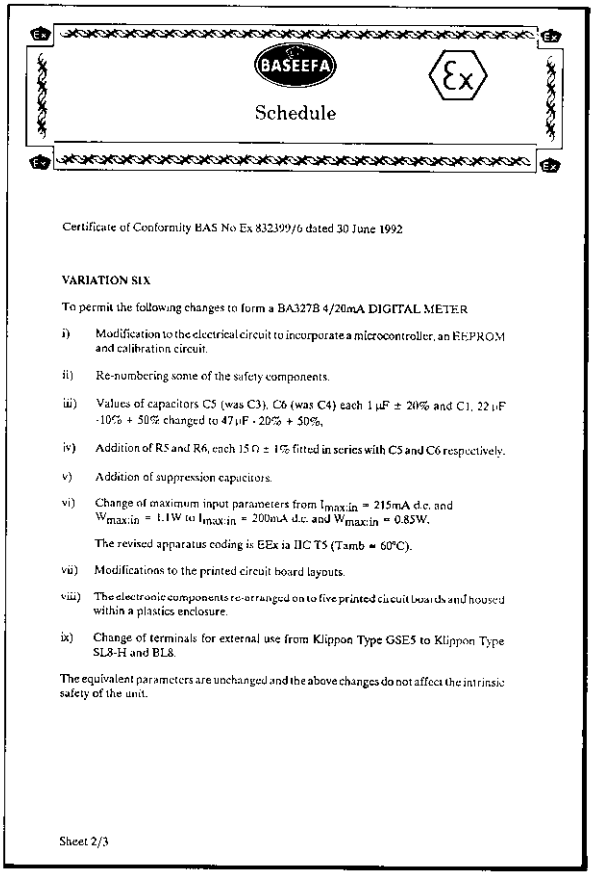
Sheet 1/3
3786/52

I M CLEARE
DIRECTOR EECS
30 June 1992

EECS

Electrical Equipment Certification Service

HSE



BASEEFA

Schedule

Certificate of Conformity BAS No Ex 832399/6 dated 30 June 1992

VARIATION SIX

To permit the following changes to form a BA327B 4/20mA DIGITAL METER

i) Modification to the electrical circuit to incorporate a microcontroller, an EEPROM and calibration circuit.

ii) Re-numbering some of the safety components.

iii) Values of capacitors C5 (was C3), C6 (was C4) each 1 µF ± 20% and C1, 22 µF -10% + 50% changed to 47 µF -20% + 50%.

iv) Addition of R5 and R6, each 15 Ω ± 1% fitted in series with C5 and C6 respectively.

v) Addition of suppression capacitors.

vi) Change of maximum input parameters from $I_{max\,in}$ = 215mA d.c. and $W_{max\,in}$ = 1.1W to $I_{max\,in}$ = 200mA d.c. and $W_{max\,in}$ = 0.85W.

The revised apparatus coding is ⟨Ex ia IIC T5 (Tamb = 60°C).

vii) Modifications to the printed circuit board layouts.

viii) The electronic components re-arranged on to five printed circuit boards and housed within a plastics enclosure.

ix) Change of terminals for external use from Klippon Type GSE5 to Klippon Type SL8-H and BL8.

The equivalent parameters are unchanged and the above changes do not affect the intrinsic safety of the unit.

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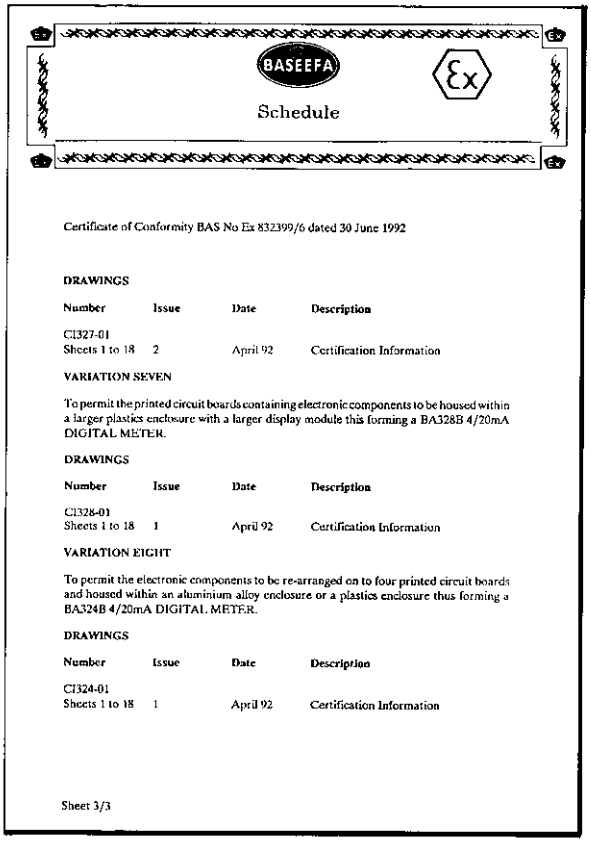

BASEEFA

Schedule

Certificate of Conformity BAS No Ex 832399/6 dated 30 June 1992

DRAWINGS

Number	Issue	Date	Description
CI327-01 Sheets 1 to 18	2	April 92	Certification Information

VARIATION SEVEN

To permit the printed circuit boards containing electronic components to be housed within a larger plastics enclosure with a larger display module this forming a BA328B 4/20mA DIGITAL METER.

DRAWINGS

Number	Issue	Date	Description
CI328-01 Sheets 1 to 18	1	April 92	Certification Information

VARIATION EIGHT

To permit the electronic components to be re-arranged on to four printed circuit boards and housed within an aluminium alloy enclosure or a plastics enclosure thus forming a BA324B 4/20mA DIGITAL METER.

DRAWINGS

Number	Issue	Date	Description
CI324-01 Sheets 1 to 18	1	April 92	Certification Information

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BEKA Associates Ltd. PO Box 39, Hitchin, Herts, SG5 2DD, UK Tel:Hitchin (0462)438301. Fax: Hitchin(0462)453971. Printed in England

Issue 1: July 92
MAN324B