

BEKA associates



BA507, BA517
BA508 and BA518
2-wire 4/20mA
digital indicators
for use in safe areas

Instruction manual

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Appendix 1 Product specification

1 Description

The BA507, BA517, BA508 and BA518 are 2-wire panel mounting digital indicators for use in safe areas. The models have different size displays, and two of them incorporate square-root extraction.

Model	Display mode	Display height	Bezel size
BA507	linear	12.7mm	48 x 96mm
BA517	root-extracting or linear	12.7mm	48 x 96mm
BA508	linear	25mm	72 x 144mm
BA518	root-extracting or linear	25mm	72 x 144mm

The indicators are loop-powered from the live-zero signal, but only introduce a 1.1V drop which allows them to be installed into almost any 4/20mA current loop. No additional power supply or battery is required.

The main application of the BA507 and BA508 is to display a linear measured variable or control signal in the process area. The span and zero of the indicators are independently adjustable so that the indicator can be calibrated to display any linear variable represented by the 4/20mA signal; for example temperature, pressure, level or actuator position.

The BA517 and the BA518 incorporate a square root-extractor to linearise the output of 4/20mA flow transmitters which have a square law characteristic e.g. those operating from orifice plates and venturi tubes. Both indicators can therefore display a flow signal in linear engineering units. The BA517 and BA518 can also display linear 4/20mA signals.

2 Operation

Apart from the display size, and the inclusion of a square root-extractor, the four models are electrically identical. The indicators are 2-wire devices which are powered by the current they are measuring, and therefore do not require an additional power supply or batteries. They may be considered, and used, in the same way as conventional moving coil analogue meters.

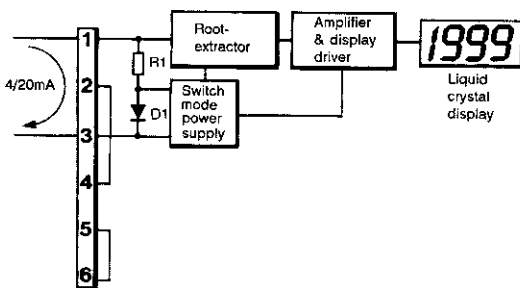


Figure 1 Simplified block diagram of BA500 series indicator

The 4/20mA current flows through resistor R1 and forward biased diode D1. The voltage developed across D1 is multiplied by the switch mode power supply and used to power the amplifier, square root-extractor when fitted, and the liquid crystal display. The voltage developed across R1, which is proportional to the 4/20mA input current, provides the input signal to the display amplifier. Low power MOS semiconductors are used throughout the indicator. The total power consumption is less than 3 milliwatts, which enables the voltage drop introduced into the 4/20mA loop to be less than 1.1V.

3 Application

The BA507, BA517, BA508 and BA518 indicators 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.

A BA507 or a BA508 should be used when the 4/20mA signal represents a linear variable, and the BA517 or BA518 with 4/20mA signals from non-linearised flow transmitters. The BA517 and BA518 can also be used with linear signals by switching off the square root-extractor.

3.1 Electrical System Design

The BA500 series indicator is connected in series with the 4/20mA current loop and introduces a voltage drop of less than 1.1V at 20mA. 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.

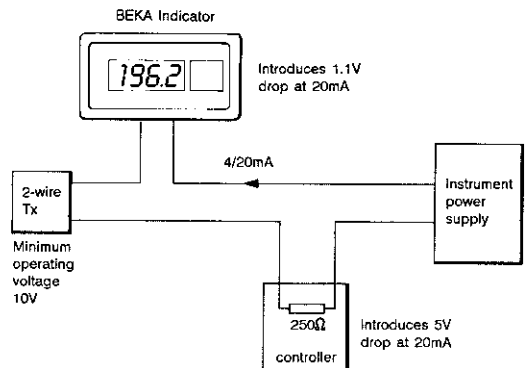


Figure 2 BA500 series indicator providing indication in a control loop

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.

The BA500 series indicators may also be driven directly from any instrument with a 4/20mA output to provide a remote indication. Figure 3 shows an indicator connected to the auxiliary 4/20mA output of a gas analyser. 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 resistances.

The BA500 series indicators incorporate 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.

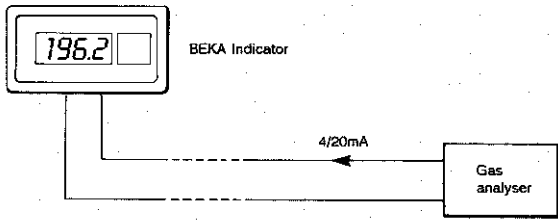


Figure 3 BA500 series indicator providing remote indication of gas analyser output

4 Installation

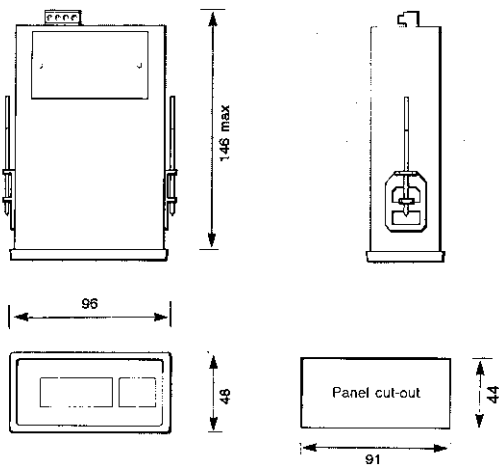
4.1 Mounting

The BA500 series panel mounting indicators are housed in standard DIN cases which may be installed into any panel, providing the environmental limits shown in the specification are not exceeded.

BA507 linear input

BA517 root-extracting or linear input

Dimensions (mm)



BA508 linear input

BA518 root-extracting or linear input

Dimensions (mm)

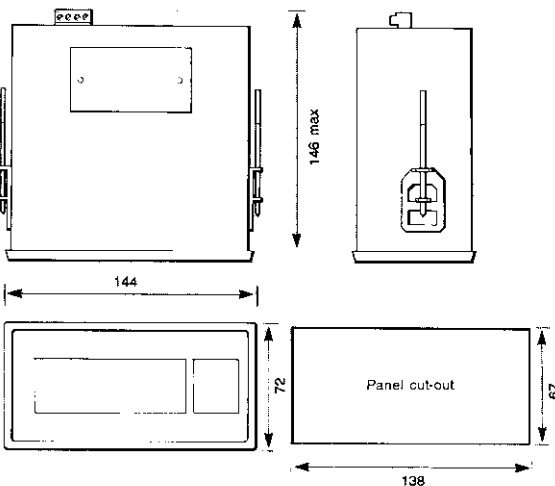


Figure 4 Case and panel cut-out dimensions

4.2 Installation Procedure

- i Insert the indicator into the panel from the front of the panel
- ii Clip a retaining bracket to each of two opposite sides of the instrument as shown in Figure 5 and tighten the two retaining bracket screws until the indicator is secure. Do not overtighten.
- iii Connect the loop wiring to the terminal block as shown in Figure 6. To ease installation the rear terminal block can be removed from the instrument by gently pulling.

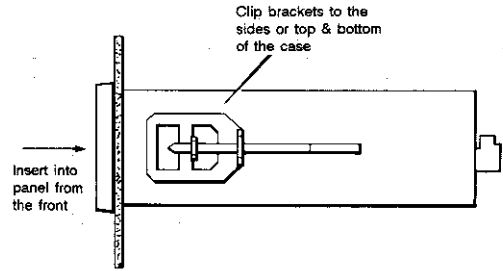
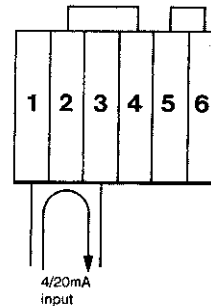


Figure 5 Mounting bracket assembly



NOTE: Terminals 2 & 4 are interlinked internally and may be used to link return 4/20mA wire. Similarly terminals 5 & 6 are internally joined and may be used to link cable screens

Figure 6 Terminal connections

5 Calibration

BA500 series panel mounting digital indicators are supplied calibrated as requested at time of ordering. If calibration is not requested, the indicator will be set to display 00.0 at 4mA and 100.0 at 20mA. BA517 and BA518 indicators, which incorporate a square root-extractor, will be set for linear operation unless otherwise specified at time of ordering.

5.1 Removal of Indicator from Case

The span and zero potentiometers are accessible through two holes in the rear panel, minor recalibration can therefore be done in situ.

To obtain access to the calibration links, the indicator must be removed from its case - see Figure 7. This can be done with or without the unit mounted in the panel as follows:

- i Unclip the front plastic bezel by gently levering with a screwdriver blade
- ii Lift out printed front panel
- iii Remove the 4 screws securing the transparent front panel
- iv Remove the rear terminal block by gently pulling.
- v Withdraw the indicator from the front of the case

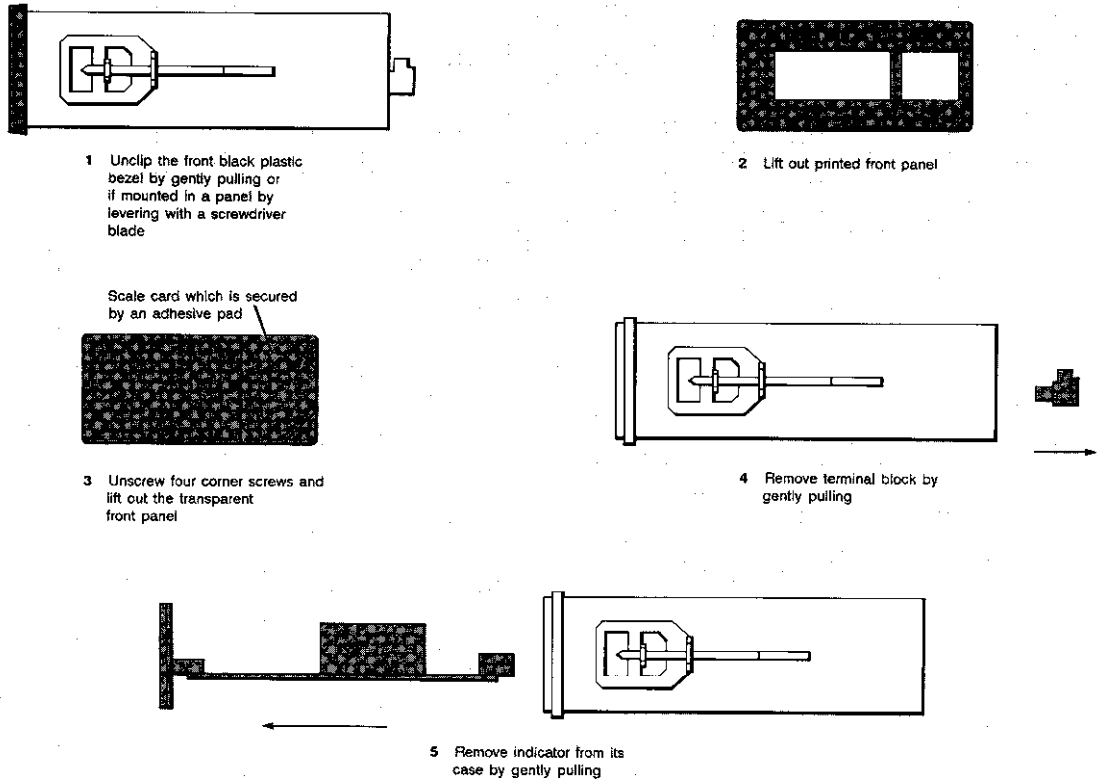


Figure 7 BA500 series panel mounting indicator disassembly sequence

5.2 Calibration Controls

The location of all calibration controls and links are shown in Figure 8. All models use the same printed circuit board. The BA517 and BA518 incorporate a square root-extractor which is located on a small sub-board which plugs into the main printed circuit board.

Zero Adjustment

Zero is defined as the figure displayed by the indicator with a 4.000mA input current. The zero may be adjusted to any figure between -1000 and 1000. The position of the suppression/elevation links determines whether a positive or negative number is displayed, and the zero potentiometer sets the exact figure displayed.

With the suppression/elevation links in the suppression position, the indicator can be adjusted to display any number between -1000 and 000 with a 4mA input. With the suppression/elevation links in the elevation position, the indicator can be adjusted to display any figure between 000 and 1000 with a 4mA input.

The zero potentiometer has two ranges. With the zero link in position 'D' the zero potentiometer will adjust the figure displayed by the indicator with a 4mA input current between 000 and 500. With the zero link in position 'C' the potentiometer will adjust the zero between 500 and 1000.

Zero suppression or elevation may not be used with the BA517 and BA518 when operating in the square root-extracting mode, see section 5.4

Span Adjustment

Span is defined as the difference between the number displayed with a 4.000mA input and the number displayed with a 20.000mA input. The span may be adjusted to any

figure between 000 and 2000.

The span potentiometer has four equal ranges which are selected by the position of links E, F, G and H - see Figure 8.

Decimal Point

The position, or absence, of the displayed decimal point is defined by the position of the decimal point selection link - see Figure 8.

Function Link

All models have a function link to select linear or square root-extracting operation. On models BA507 and BA508, which are not fitted with the root-extracting sub-board, this link should always be put in the linear position.

All the calibration links should be extracted and inserted with a pair of long nosed pliers, taking care not to damage nearby components.

5.3 Example of how to calibrate a linear indicator

This example shows how to calibrate an indicator for use with a 4/20mA signal representing a linear variable. It applies to the BA507, BA508 and to the BA517 and BA518 when set for linear operation.

The indicator is required to display:

25.0 with a 4.000mA input
and 180.0 with a 20.000 input

i.e. A zero of 250 positive } ignoring the
A span of 1550 } decimal point
A decimal point before the least significant digit

The following adjustments are required

- Step 1 The indicator is required to display a positive zero therefore the suppression/elevation links should be put in the elevation position
- Step 2 The required zero is 250, therefore the zero link should be put into the 'D' position
- Step 3 The required span is 1550, therefore the spans link should be put into the 'E' and 'F' positions
- Step 4 The decimal point is required before the least significant digit, therefore the decimal point selection link should be put in position 'L'.
- Step 5 With 4.000mA input current adjust the zero potentiometer until the indicator displays 25.0
- Step 6 With 20.000mA input current adjust the span potentiometer until the indicator displays 180.0
- Step 7 Repeat steps 5 and 6 until both calibration points are correct. The span and zero controls are almost independent, it should therefore only be necessary to repeat each adjustment two or three times.

5.4 Square root-extracting models

The BA517 and BA518 incorporate an accurate square root-extractor which enables the indicator to display a flow signal in linear engineering units. The root-extractor provides linearisation of the flow signal between 4.16mA and 20mA, so the indicator will accurately display the flow in linear units between 10 and 100% of full flow. The linearisation continues to operate with slightly reduced accuracy down

to 2.5% of maximum flow, below this level the display is clamped at zero with ± 10 digits.

Most flowmeters and the square root-extractor in the indicator, do not operate with maximum accuracy at low flows, i.e. below 10% of maximum flow (4.16mA). The indicator zero control should therefore be adjusted to give the required display at 4.16mA, which corresponds to 10% of maximum flow. The zero control must not be adjusted to give a zero display at 4mA.

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

% of full flow	Current output mA
2.5%	4.01mA
10%	4.16mA
25%	5.00mA
50%	8.00mA
75%	13.00mA
100%	20.00mA

The square root-extractor within the BA500 series indicator will only provide accurate linearisation of flow signals if 4mA corresponds to zero flow. An elevated or suppressed display zero may therefore not be used with the BA517 or BA518 when operating in the root-extracting mode.

5.5 Example of how to calibrate a square root-extracting indicator

The BA517 and BA518 indicator operating in the square root-extracting mode is to display the output from a flowmeter with a 20mA output corresponding to 140 gallons per minute.

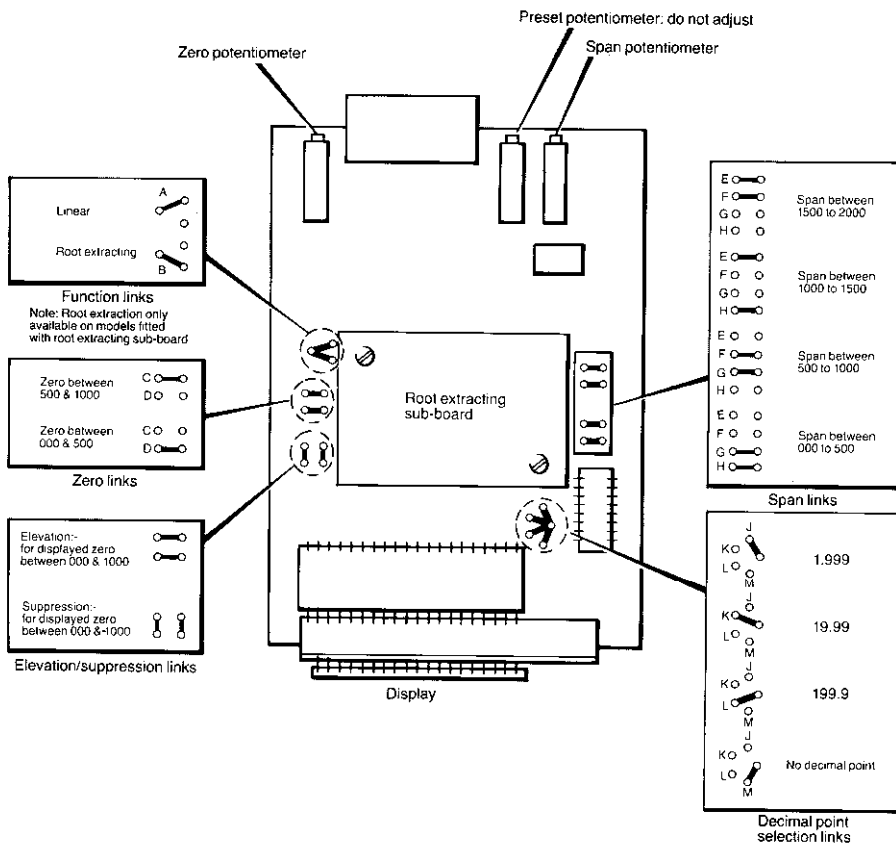


Figure 8 Location of calibration controls and links

Flow gallons/ min	% of full flow	Current mA	Indicator display
14	10%	4.160mA	14.0
35	25%	5.000mA	35.0
70	50%	8.000mA	70.0
105	75%	13.000mA	105.0
140	100%	20.000mA	140.0

The following adjustments are required:

Step 1 The BA517/BA518 may not have zero suppression or elevation when used in the square root-extracting mode. For this mode the zero suppression/elevation links should always be put in the elevation position, and the zero link in position 'D'.

Step 2 The required span is 1400, ignoring the decimal point, therefore the span links should be put into the 'E' and 'H' positions

Step 3 The decimal point is required before the least significant digit, therefore the decimal point selection link should be put into position 'L'

Step 4 With 4.160mA input adjust the zero control until the indicator displays 14.0

Step 5 With 20.000mA input adjust the span control until the indicator displays 140.0

Step 6 Repeat steps 6 & 7 until both calibration points are correct

5.6 Over and Under-range

If the display range of the BA500 series indicator is exceeded i.e. below -1999 or above 1999, the three least significant digits will automatically be blanked. Under-range is therefore indicated by a -1 display and over-range by a 1 display.

If the display range is not exceeded, the BA507, BA508 and the BA517 and BA518 indicators operating in the linear mode, will produce accurate results outside the normal 4/20mA input current range. Although not guaranteed, most BA500 series indicators will operate from 3 to 25mA in the linear mode.

6 Maintenance

6.1 Fault Finding During Commissioning

If a BA500 series 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 1	Positive over-range	The indicator has been incorrectly calibrated & is trying to display a number greater than 1999

Indicator displays -1	Negative over-range	The indicator has been incorrectly calibrated & is trying to display a number less than -1999
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Unstable display. More than ± 1 digit of jitter	4/20mA input current contains large ripple current	Reduce ripple content
	Insufficient voltage to operate indicator i.e. less than 1.1V	Check supply voltage & voltage drops caused by all components within the loop

6.2 Fault Finding After Commissioning

ENSURE PLANT SAFETY BEFORE STARTING MAINTENANCE

If a BA500 series 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
	Insufficient voltage to operate indicator i.e. 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 panel and replaced with another unit. This can be achieved quickly by unplugging the terminal block from the suspect indicator and plugging it into the replacement unit.

6.3 Servicing

BA500 series indicators have been designed so that they can easily be replaced without disturbing the field wiring. All BA500 series indicators can be calibrated on site, so a single spare instrument is therefore able to replace any indicator which 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 Scale Card

BA500 series indicators have a window on the right hand side of the liquid crystal display to hold a card showing the units of measurement e.g. °C, bar, RPM. Indicators can be supplied with scale cards printed with any units specified by the customer at the time of ordering. If a printed scale card is not requested when the indicator is ordered, a blank card will be provided.

Scale cards can easily be marked on site without removing the indicator from its panel - see Figure 7.

- i Unclip the front plastic bezel by gently levering with a screwdriver blade
- ii Lift out printed front panel
- iii Carefully remove scale card
- iv Mark legend onto scale card using a stencil or transfer
- v Replace scale card in correct position and secure with adhesive pad. Reassemble printed front panel and bezel

7.2 Tagging

BA500 series indicators can be supplied with an embossed tag plate riveted to the rear of the indicator case. This tag is not visible from the front of the instrument after installation.

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

ELECTRICAL SPECIFICATION

Common to all BA500 series indicators

Input	
current	4 to 20mA
voltage drop at 20mA	Less than 1V @ 20°C Less than 1.1V @ -20°C
overrange	±200mA will not cause damage
Display	
type	3½ digits (-1999 to 1999)
span	Adjustable between: 000 & 1999 for 4 to 20mA input
zero	Adjustable between: -1000 & 1000 with 4mA input in linear mode only
polarity	Automatic minus sign.
decimal point	1 of 3 positions, or absent, selected by internal plug-in link.
reading rate	2.5 per second.
overrange	3 least significant digits are blanked.
Operating modes	
BA504, 507 & 508	linear
BA514, 517 & 518	linear or root-extracting selected by plug-in link
Accuracy	
linear mode	±0.1% of display ± 1 digit
root-extractor mode	±16µA @ input ± 1 digit for input currents between 4.16 and 20mA (10 to 100% of flow)
Temperature effect on:	
span	typ 50ppm, max 100ppm/°C
zero	typ 0.05 digit + 100ppm/°C max 0.1 digit + 200ppm/°C
root extractor	±0.1µA/°C @ input
series mode rejection	Typ 1 digit error for 1V pk to pk 50Hz signal.
Environmental	
operating temperature	-20 to +60°C
humidity	to 95% @ 40°C

SPECIFICATION BA507 & BA517

BA507 panel mounting 12.7mm high display, linear input
BA517 panel mounting 12.7mm high display, root-extracting or linear input.

Mechanical

case	rear IP20 front IP50. See accessories for additional protection.
terminals	Screw clamp for 0.5 to 1.5mm cables. Terminal block removable.
weight	0.3kg

Accessories

typeset scale card	blank scale card fitted to each indicator, can be supplied typeset with units of measurement.
tag plate	embossed metal tag plate screwed to rear of indicator.
front covers	BA397 provides IP54 protection, BA398 provides IP65 protection. One cover protects two BA507 or BA517 indicators.

SPECIFICATION BA508 & BA518

BA508 panel mounting 25mm high display, linear input
BA518 panel mounting 25mm high display, root-extracting or linear input

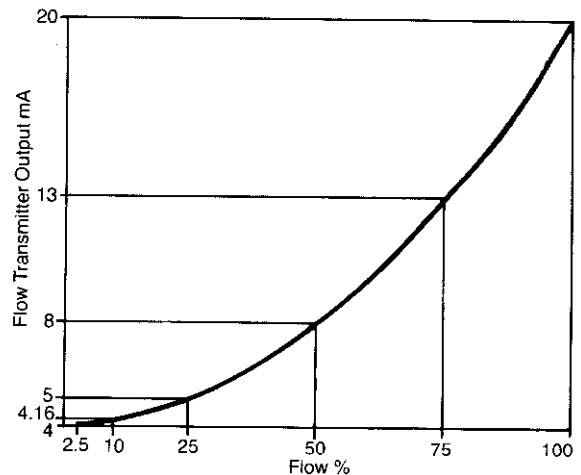
Mechanical

case	rear IP20 front IP50. See accessories for additional protection.
terminals	Screw clamp for 0.5 to 1.5mm cables. Terminal block removable.
weight	0.4kg

Accessories

typeset scale card	blank scale card fitted to each indicator, can be supplied typeset with units of measurement.
tag plate	embossed metal tag plate screwed to rear of indicator.
front cover	BA398 provides IP65 protection. Cover protects one BA508 or BA518 indicator.

SQUARE ROOT-EXTRACTOR



The BA517 and BA518 indicators incorporate an accurate square root-extractor to linearise the output of 4/20mA flow transmitters, which have a square law characteristic e.g. orifice plates and venturi tubes.

The root-extractor provides linearisation of the flow signal between 4.16 and 20mA, so that the indicator accurately displays the flow in linear units between 10 and 100% of full flow. The linearisation continues to operate with slightly reduced accuracy down to 2.5% of maximum flow, below this level the display is clamped.