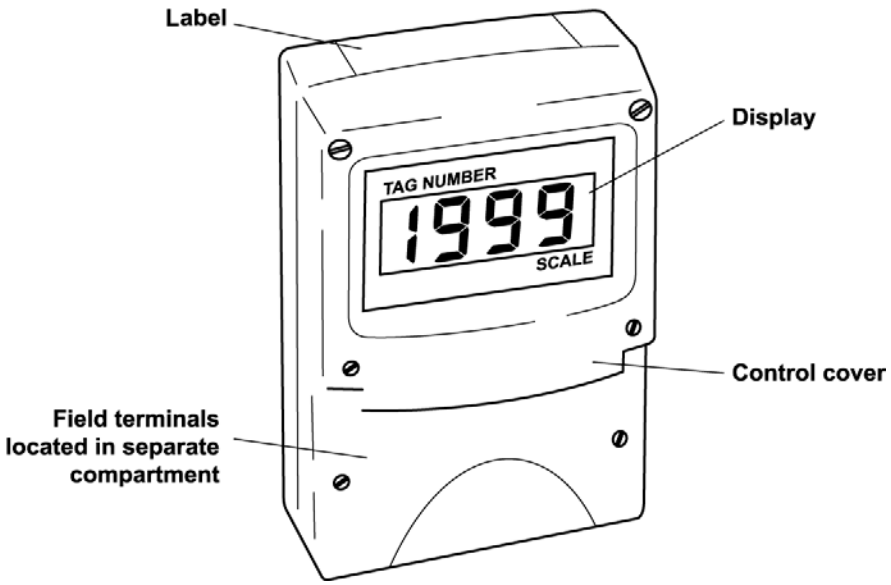
# BA304ND
# Type nL certified loop-powered 3½ digit field mounting indicator

issue: 8




**Only for replacement use after May 2013.**
**Use BA304NE for new applications**

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The BA304ND is CE marked to show compliance with the European Explosive Atmospheres Directive 94/9/EC and the European EMC Directive 2004/108/EC

## 1. DESCRIPTION

The BA304ND is an Ex nL certified loop powered digital indicator which displays the current flowing in a 4/20mA loop in engineering units. The instrument introduces less than 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. Housed in a robust IP66 glass reinforced polyester (GRP) enclosure with an armoured glass window the BA304ND is suitable for installation in most industrial environments.

The BA304ND is a third generation instrument which, although having additional features including a separate terminal compartment and ATEX certification, remains functionally compatible with the original BA304N and BA304NC.

The main application of the BA304ND is to display a measured variable or control signal in a Zone 2 hazardous area. The zero and span of the display are independently adjustable so that the indicator may be calibrated to display any variable represented by the 4/20mA current, e.g. temperature, flow, pressure or level.

The BA304ND complies with the European ATEX Directive 94/9/EC for Group II, Category 3G equipment.

## 2. OPERATION

Fig 1 shows a simplified block diagram of a BA304ND. The 4/20mA input current flows through resistor R1 and forward biased diode D1. The voltage developed across D1, which is relatively constant, is multiplied by a switch mode power supply and used to power the analogue to digital converter and liquid crystal display. The voltage developed across R1, which is proportional to the 4/20mA input current, provides the input signal for the analogue to digital converter.

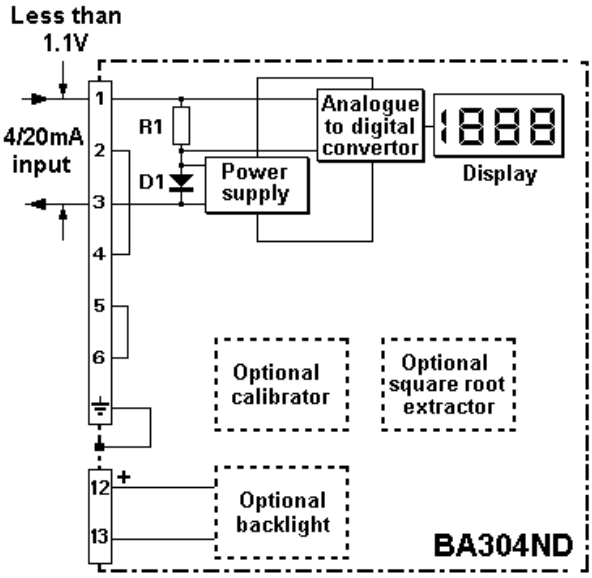


Fig 1 Simplified block diagram of BA304ND

## 3. TYPE 'nL' CERTIFICATION

### 3.1 Certificate of Conformity

ITS Testing and Certification Ltd. (formerly ERA Technology Ltd) has issued a Certificate of Conformity Ex99Y4003 confirming that the BA304ND complies with the CENELEC standard BS EN50021:1999. This European standard defines the requirements for the construction, testing and marking of Group II electrical apparatus with type of protection 'nL' intended for use in Zone 2, where an explosive atmosphere of gas is unlikely to occur, or if it does occur will be infrequent or remain for short periods only.

### 3.2 ATEX certification

The BA304ND complies with the European ATEX Directive 94/9/EC for Group II, Category 3G equipment. It has been assessed using the 'Internal Control of Production' procedure specified in Annex 8 of the Directive. A technical dossier has been prepared and an EC Declaration of Conformity BEKA00ATEX0010 has been issued.

The instrument bears the Community Mark and, subject to local codes of practice, may be installed in any of the European Economic Area (EEA) member countries. ATEX certificates are also acceptable for installations in Switzerland.

This manual describes installations which conform with BS EN60079:Part 14 Electrical Installation in Hazardous Areas. When designing systems for installation outside the UK, the local Code of Practice should be consulted.

### 3.3 4/20mA input terminals

Input terminals 1 and 3 may be safely connected in series with any 4/20mA loop providing that in normal operation the input current to the indicator (Ii) does not exceed 30mA dc.

### 3.4 Zones, gas groups and T rating

The BA304ND has been certified as Group II, Category 3G Ex nL IIC T5 apparatus with a Tamb of -20 to 60°C.

'L' indicates that the BA304ND uses an energy-limiting technique to achieve compliance as defined by EN 60079-15. This technique is based on the philosophy of intrinsic safety which limits the current and voltage applied to components which may generate a spark in normal operation. e.g. switches and potentiometers.

These approvals confirm that the BA304ND is 'safe in normal operation' and may be:

Installed in a Zone 2 hazardous area

Used at ambient temperatures between -20 and +60°C

Used with gases in groups:

| | | |
|---|---|---|
| Group | A | propane |
| Group | B | ethylene |
| Group | C | hydrogen |

Used with gases having a temperature classification of:

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

This allows the BA304ND indicator to be installed in Zone 2 low risk hazardous areas, and to be used with most common industrial gases.

### 3.5 Certification Label Information

Certification information is shown on a label fitted in a recess on the top outer surface of the enclosure. The instrument serial number and date of manufacture are shown on a separate label inside the terminal compartment.


## 4. SYSTEM DESIGN FOR ZONE 2

### 4.1 Transmitter loops

A BA304ND indicator may be connected in series with almost any 4/20mA current loop and calibrated to display the measured variable or control signal in engineering units.

Fig 2 illustrates a typical application in which a BA304ND indicator is connected in series with a 2-wire transmitter and controller.

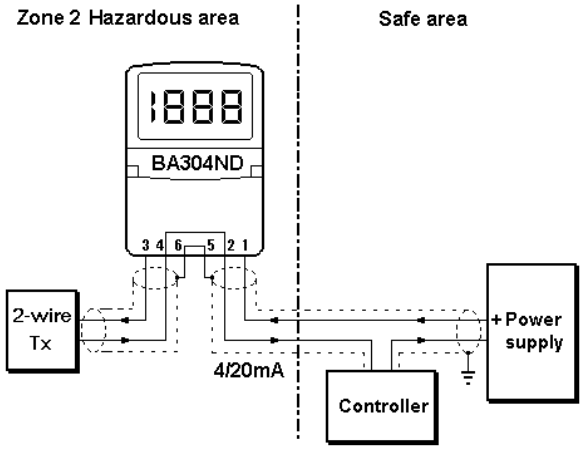


Fig 2 BA304ND in a transmitter loop

There are two basic design requirements:

1. In normal operation the voltage and current applied to terminals 1 and 3 of the BA304ND must not exceed:

   Ui = 4V dc
   Ii = 30 mA dc

   Providing the maximum input current in normal operation is less than 30mA, the maximum voltage between the indicator terminals will automatically be limited by the internal safety components.

2. The 4/20mA loop must be able to tolerate the additional 1.1V required to operate the indicator.

In practice it is only necessary to ensure that in normal operation the maximum current flowing in the loop is less than 30mA. In the example shown in Fig 2 this current is determined by the maximum current from the transmitter.

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

| | |
|---|---|
| Minimum operating voltage of 2-wire Tx | 10.0 |
| Maximum voltage drop caused by controller | 5.0 |
| Maximum voltage drop caused by BA304ND | 1.1 |
| Maximum voltage drop caused by cables | 0.4 |
| | 16.5V |

Therefore at 20mA the power supply in this example must have an output greater than 16.5V

### 4.2 Remote indication

A BA304ND indicator may be driven from any 4/20mA signal to provide remote indication. Fig 3 shows a typical application in which the output from a gas analyser drives a BA304ND. Again it is necessary to ensure that the loop complies with the two design requirements listed in section 4.1

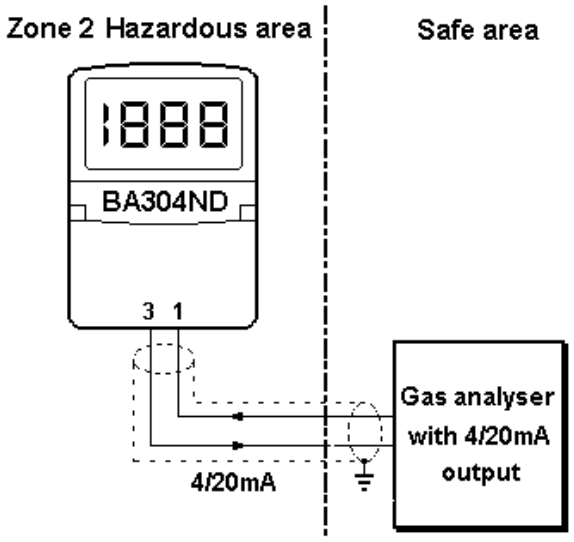


Fig 3 Remote indication

## 5. INSTALLATION

### 5.1 Location

The BA304ND indicator is housed in a robust IP66 glass reinforced polyester (GRP) enclosure incorporating an armoured glass window and stainless steel fittings. This makes it suitable for exterior mounting in most industrial applications, including off-shore and waste water treatment. Please contact BEKA associates if high vibration is anticipated.

The BA304ND is surface mounting, but may be pipe or stem mounted using the accessory kits described in sections 8.5 and 8.6 of this manual.

The field terminals and the two enclosure mounting holes are located in a separate compartment with a sealed cover allowing the instrument to be installed without exposing the display assembly or controls. Terminals 2 and 4 are internally joined and may be used for linking the return 4/20mA wire - see Fig 2. Similarly, terminals 5 and 6 are internally joined and may be used for linking the cable screens. The BA304ND earth terminal is connected to the internal EMC filters. For maximum radio frequency interference rejection this terminal should be connected to a local earth, or to an earthed cable screen. To prevent circulating currents, cable screens should only be earthed at one point in the safe area.

The BA304ND enclosure is supplied with a bonding plate to ensure electrical continuity between the three conduit / cable entries.

### 5.2 Installation Procedure

Fig 4 illustrates the instrument installation procedure.

a. Remove the instrument terminal cover by unscrewing the two captive 'A' screws.

b. Mount the instrument on a flat surface and secure with M6 screws through the two 'B' holes. Alternatively use one of the pipe or stem mounting kits described in sections 8.5 and 8.6

c. Remove the temporary hole plug and install an Ex n or Ex e cable gland or conduit entry. If more than one entry is required, replace one or both IP66 stopping plugs with an Ex n or Ex e cable gland or conduit entry.

d. Connect the field wiring to the terminals as shown in Fig 5.

f. Ensure that the instrument terminal cover sealing gasket is undamaged and free from dirt and foreign bodies. Replace the terminal cover and tighten the two 'A' screws.

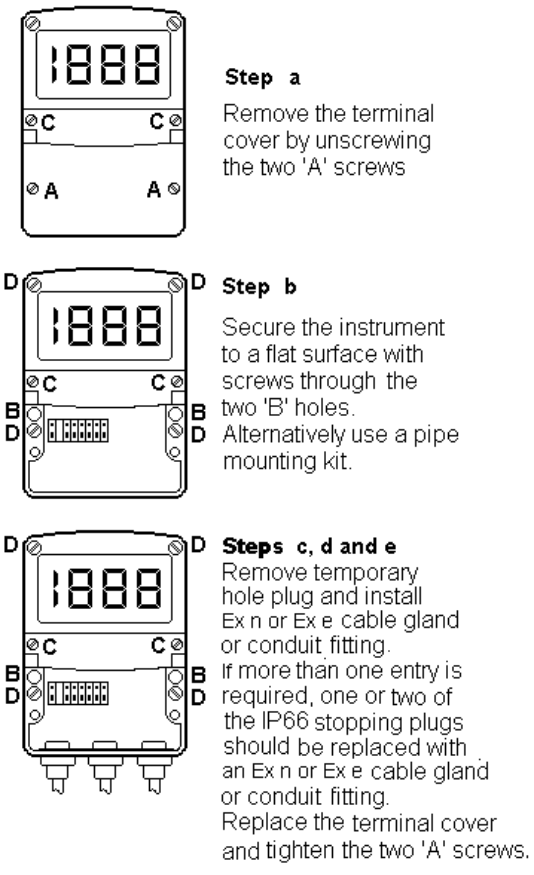


Fig 4 BA304ND installation procedure

### 5.3 EMC

The BA304ND complies with the requirements of the European EMC Directive 2004/108/EC. For specified immunity all wiring should be in screened twisted pairs.

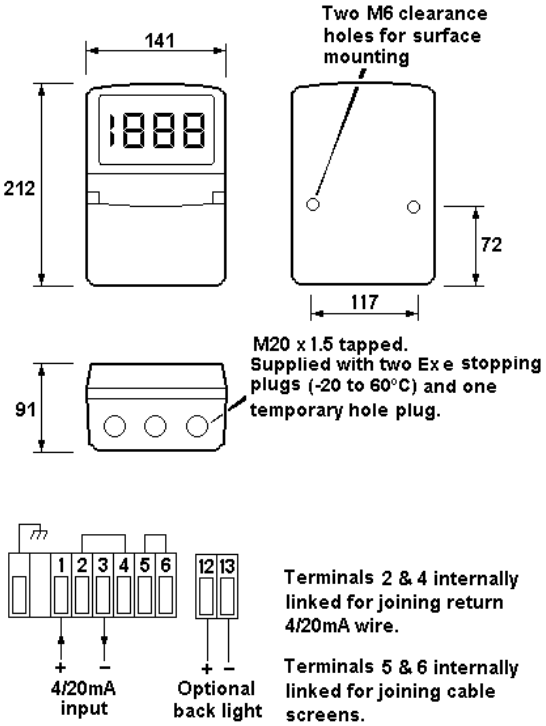


Fig 5 Dimensions and terminal connections

### 6. CALIBRATION

The BA304ND will be supplied calibrated as requested at time of ordering. If calibration is not requested, the indicator will be set to display 00.0 with 4.000mA input, and 100.0 with 20.000mA input.

The indicator is conditioned and calibrated by plug-in links and two multi-turn potentiometers located behind the control cover which is secured by two 'C' screws - see Figs 4 & 6.

**CAUTION!**

**The plug-in links and the two potentiometers are energy limited and will not cause ignition in normal operation. Ex 'n' certification requires that the instrument enclosure provides IP54 protection, the control cover may therefore only be removed for calibration when there is no possibility of dust or water ingress. Before replacing the cover ensure that the sealing gasket is undamaged and free from dirt and foreign bodies.**

For maximum accuracy, the instrument should be calibrated using an external traceable current source with a resolution of at least 4µA. However, when verification is not required, the instrument may be fitted with an optional internal calibrator which allows rapid calibration without the need for external instruments or disconnec-tion from the 4/20mA input current. See section 8.2 for details.

**6.1 Zero adjustment**

Zero is defined as the number displayed by the indicator with a 4.000mA input current, and may be adjusted between -1000 and 1000. The zero potentiometer has two ranges, 0 to 500 and 500 to 1000. Zero polarity is defined by the position of the suppression / elevation links which are shown in Fig 6.

**Suppression / elevation links**

| **Position** | **Display with 4mA input adjustable between** |
|---|---|
| Elevation | 0 and 1000 |
| Suppression | 0 and -1000 |

**Zero link**

| **Position** | **Display with 4mA input adjustable between** |
|---|---|
| 0 to 500 | 0 and 500 |
| 500 to 1000 | 500 to 1000 |

**6.2 Span adjustment**

Span is defined as the difference between the number displayed with 4.000mA input, and the number displayed with 20.000mA input. It is adjustable between 0 and 1999 in four ranges. Fig 6 shows the position of the span links and the span potentiometer.

| | **Position of of span links** | **Instrument span adjustable between** |
|---|---|---|
| | 000 to 500 | 000 and 500 |
| or | 500 to 1000 | 500 and 1000 |
| or | 1000 to 1500 | 1000 and 1500 |
| or | 1500 to 1999 | 1500 and 1999 |

**6.3 Decimal point**

A dummy decimal point may be displayed between any of the four digits. The position or absence of this decimal point is determined by the position of the decimal point plug-in link shown in Fig 6. When calculating the required span and zero settings the decimal point should be ignored.

**6.4 Reverse action**

Normally the BA304ND display increases as the input current increases, but this can be reversed. Please contact BEKA associates for details.

**6.5 Calibration example**

The BA304ND is required to display:

25.0 with 4.000mA input
115.0 with 20.000mA input

i.e. A zero of positive 250 (Ignoring decimal point)
A span of 900 (Ignoring decimal point)
A decimal point in position 00.0

The following adjustments are required:

Step 1 The BA304ND 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 in the 0 to 500 position.

Step 3 The required span is 900, therefore the span links should be placed in the 500 to 1000 position.

Step 4 The decimal point is required between the two least significant digits, therefore the decimal point link should be placed in the 00.0 position.

Step 5 With 4.000mA input adjust the zero potentiometer until the indicator displays 25.0

Step 6 With 20.000mA input adjust the span potentiometer until the indicator displays 115.0

Step 7 Repeat steps 5 and 6 until both calibration points are correct. The span and zero controls are almost independent so it should only be necessary to repeat each adjustment twice.

**6.6 Over and under-range**

If the indicator display range is exceeded, the three least significant digits will be blanked. Under-range is indicated by -1 and over-range by 1. If the display range is not exceeded, the BA304ND will produce accurate readings outside the 4/20mA current range. Although not guaranteed, most BA304ND indicators will operate between 3 and 25mA.

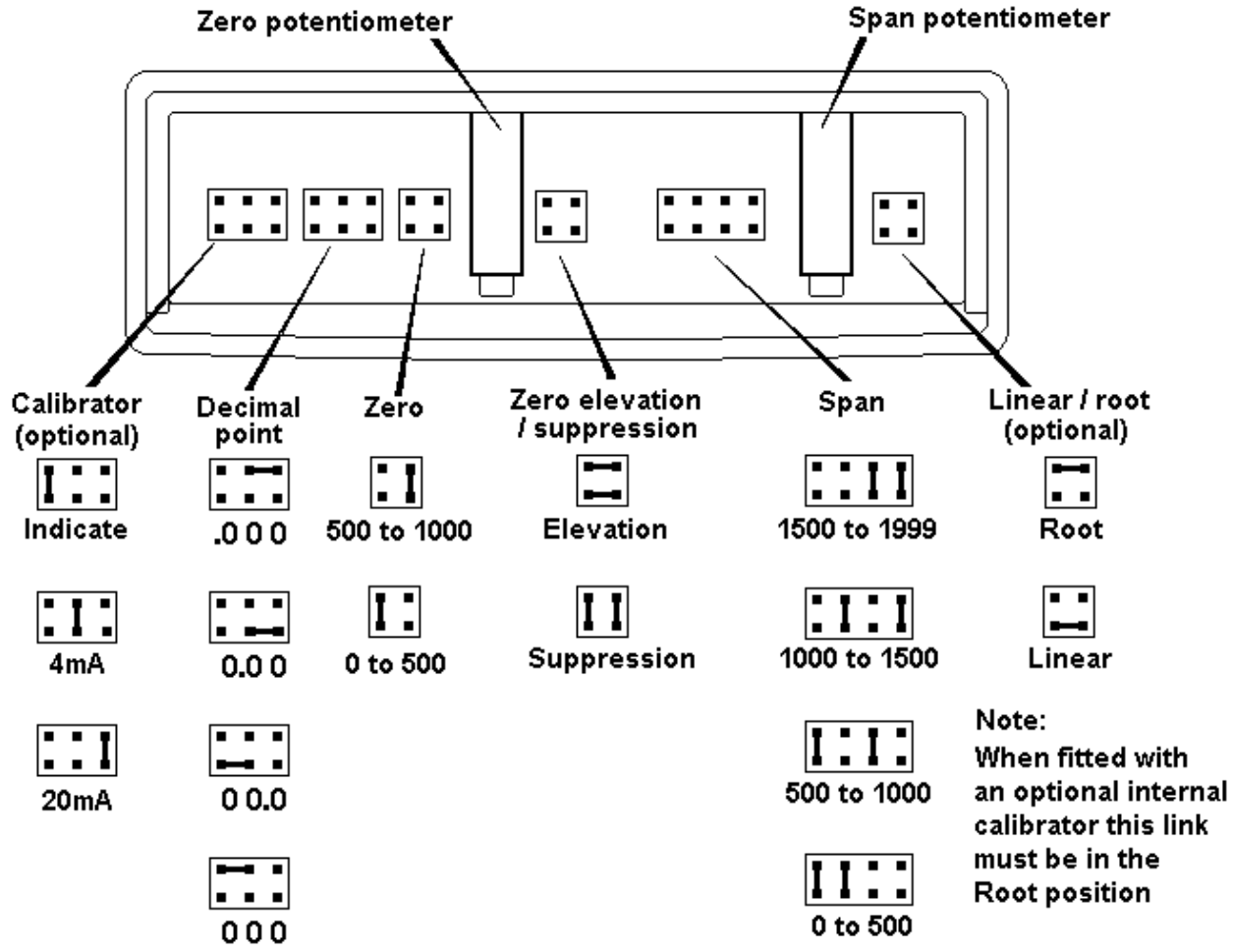


Fig 6 Position of plug-in links and potentiometers shown with control cover removed

## 7. MAINTENANCE

### 7.1 Fault finding during commissioning

If the BA304ND fails to function during commissioning the following procedure should be followed:

| Symptom | Cause | Solution |
|---|---|---|
| No display | Incorrect wiring. | There should be 1V between terminals 1 & 3 with terminal 1 positive. (5V between terminals 1 & 13 if a loop powered backlight is fitted). |
| No display and no volts between terminals 1 and 3. | Incorrect wiring or no power supply. | Check that a current is flowing in the loop. |
| | Insufficient loop voltage to operate BA304ND. | Check supply voltage and voltage drops caused by all components in the loop. |
| BA304ND displays 1 | Positive over-range. | The BA304ND has been incorrectly calibrated & is trying to display a number greater than 1999. |
| BA304ND displays -1 | Negative over-range. | The BA304ND has been incorrectly calibrated & is trying to display a number less than -1999. |
| Unstable display | 4/20mA input has a large ripple. | Check loop supply voltage. |

### 7.2 Fault finding after commissioning

**CAUTION!**
**ENSURE PLANT SAFETY BEFORE STARTING MAINTENANCE**

**Live maintenance should only be performed when there is no risk of a flammable atmosphere being present, and dust or water can not enter the enclosure. Before replacing control & terminal covers ensure that the sealing gaskets are undamaged and free from dirt and foreign bodies.**

If a BA304ND fails after it has been functioning correctly, the following table may help to identify the cause of the failure.

| Symptom | Cause | Solution |
|---|---|---|
| No display and no volts between terminals 1 and 3. | No power supply. | Check that a current is flowing in the loop. |
| Unstable display. | 4/20mA input has a large ripple. | Check loop supply voltage. |

If this procedure does not reveal the cause of the fault, it is recommended that the instrument is replaced.

### 7.3 Servicing

**CAUTION!**

**ENSURE PLANT SAFETY BEFORE STARTING MAINTENANCE**

**Live maintenance should only be performed when there is no risk of a flammable atmosphere being present, and dust or water can not enter the enclosure. Before replacing control & terminal covers ensure that the sealing gaskets are undamaged and free from dirt and foreign bodies.**

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

### 7.4 Routine maintenance

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

### 7.5 Guarantee

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

### 7.6 Customer comments

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

## 8. ACCESSORIES

### 8.1 Units of measurement and instrument identification

All BA304ND indicators are fitted with a blank escutcheon around the liquid crystal display. This escutcheon can be supplied printed with any units of measurement and tag information specified at the time of ordering. Alternatively the information may be added on-site via an embossed strip, dry transfer or a permanent marker.

**CAUTION!**

**The enclosure should only be dismantled when the instrument is de-energised, or there is no risk of a flammable atmosphere being present. Dust or water must be prevented from entering the enclo-sure. Before replacing the control & terminal covers ensure that the sealing gaskets are undamaged and free from dirt and foreign bodies.**

To gain access to the display label remove the terminal cover by unscrewing the two 'A' screws which will reveal two concealed 'D' screws. Unscrew the four 'D' screws and carefully lift off the front of the instrument enclosure - Fig 4 shows the location of these screws. Add the required legend to the display label, or replace with a new pre-printed self-adhesive label which may be obtained from BEKA associates. Before reassembling ensure that the sealing gaskets are undamaged and free from dirt and foreign bodies.

The BA304ND can also be supplied with a blank or custom engraved stainless steel plate secured to the front of the instrument by two screws.

### 8.2 Internal Calibrator

The BA304ND can be supplied with an optional internal calibrator which simulates 4 and 20mA input currents. This allows rapid calibration without the need for external instruments or disconnection from the 4/20mA input current, but it is not a substitute for calibration with a traceable external current source. Fig 6 shows the position of the calibrator link which is located behind the instrument control cover.

The plug-in root / linear link shown in Fig 6 must always be in the root position when an internal calibrator is fitted. An internal calibrator can not be fitted to an instrument with a root extractor.

When using the internal calibrator, the following procedure should be followed. The adjustments may be performed with any input current between 4 and 20mA.

Step 1 Put the suppression / elevation, zero, span and decimal point links in the required position. Put the root / linear link in the root position.

Step 2 Put the calibrator link in the 4mA position and adjust the indicator zero potentiometer to give the required display at 4mA.

Step 3 Put the calibrator link in the 20mA position and adjust the indicator span potentiometer to give the required display at 20mA.

Step 4 Repeat steps 2 and 3 until both calibration points are correct. The span and zero controls are almost independent so it should only be necessary to repeat each adjustment twice.

Step 5 Return the calibrator link to the 'indicate' position. The indicator will now respond to the 4/20mA input current with the revised calibration.

**8.3 Root extractor**

The BA304ND can be supplied with a square root extractor which enables the indicator to accurately display the output from a differential flow meter in linear engineering units between 10 and 100% of full flow (4.16 to 20mA). The lineariser continues to operate with reduced accuracy down to 2.5% of maximum flow, alternatively clip-off can be selected which will force the display to zero at flows below 5% (4.04mA). The location of the clip-off link is shown in Fig 7. Access to the link is gained by carefully removing the indicator assembly from the enclosure as follows. Remove the terminal cover by unscrewing the two ‘A’ screws which will reveal two concealed ‘D’ screws. Unscrew the four ‘D’ screws and carefully lift off the front of the instrument enclosure. Fig 4 shows the location of these screws. Finally remove screws securing the electronic assembly.

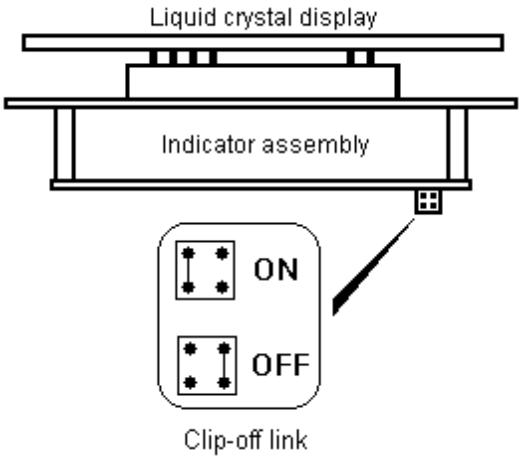


Fig 7 Location of root extractor clip-off link

When calibrating a BA304ND fitted with a root extractor the indicator zero potentiometer should be adjusted to give the required display at 10% of flow (4.16mA). The indicator zero potentiometer should not be used to set the display to zero with a 4mA input. Zero suppression or elevation may not be used, i.e. 4mA must correspond to zero flow.

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

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

A root extractor can not be fitted to an instrument with an internal calibrator.

**8.3.1 Calibration example with root extractor**

The BA304ND is required to display rate of flow in gallons per minute, with a resolution of 0.1 gallons. The differential flowmeter has an output of 20mA at a flow rate of 140.0 gallons per minute

i.e. A span of 1400 ignoring the decimal point A decimal point in position 00.0

The following adjustments are required:

Step 1 Put the suppression / elevation links in the elevation position.

Step 2 Put the zero link in the 0 to 500 position.

Step 3 The required span is 1400, therefore the span links should be placed in the 1000 to 1500 position.

Step 4 The decimal point is required between the two least significant digits, therefore the decimal point link should be placed in the 00.0 position.

Step 5 With 4.160mA input current adjust the zero potentiometer until the indicator displays 14.0 (10% of flow). If there is insufficient adjustment to achieve this, put the elevation/suppression links in the suppression position and repeat step 5.

Step 6 With 20.000mA input current adjust the span potentiometer until the indicator displays 140.0

Step 7 Repeat steps 5 and 6 until both calibration points are correct.

### 8.4 Display backlights

The BA304ND may be supplied with two different backlights. The loop powered backlight produces green background illumination enabling the display to be read at night and in poor lighting conditions. No additional power supply or field wiring are required, but the indicator voltage drop is increased. Alternatively, the separatly powered backlight has a bright orange output which enhances daylight viewing, but additional field wiring and a power supply are required.

#### 8.4.1 Separately powered backlight

The separately powered backlight is electrically segregated from the measuring circuit, and has been certified as a separate Ex nL Group II, Category 3G circuit.

The Type nL input safety parameters are:

| | | |
|---|---|---|
| Ui | = | 30V dc |
| Ii | = | 100mA dc |
| Pi | = | 1.3W |

This allows the backlight to be powered from a safe area 18 to 30V dc supply as shown in Fig 8. Providing the supply voltage is less than 30V dc, the backlight safety components will ensure that the maximum input current and power are within the safety limits.

Reducing the supply voltage below 18V, or fitting a current limiting resistor in series with the supply will reduce the display brilliance.

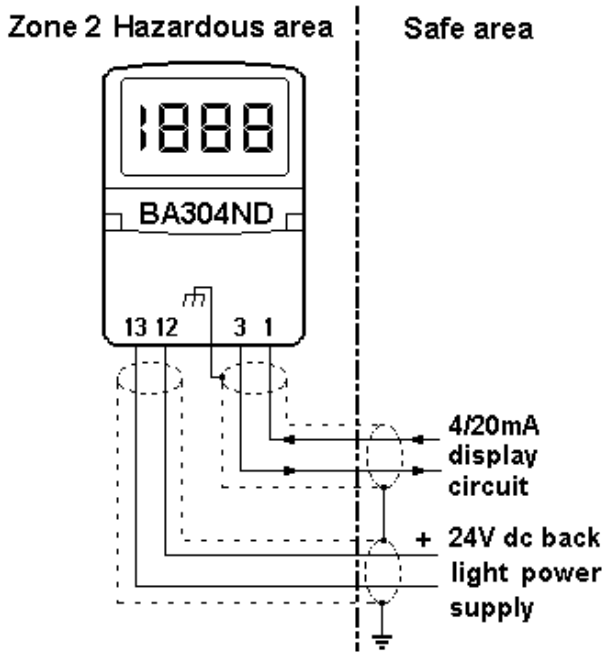


Fig 8 Separately powered backlight

#### 8.4.2 Loop powered backlight

This backlight is connected in series with the 4/20mA measuring circuit as shown in Fig 9. In normal operation the voltage and current applied to terminals 1 and 13 of the BA304ND must not exceed:

| | | |
|---|---|---|
| Ui | = | 6V dc |
| Ii | = | 30 mA dc |

Providing the maximum input current in normal operation is less than 30mA, the maximum voltage between the indicator terminals will automatically be limited by the internal safety components.

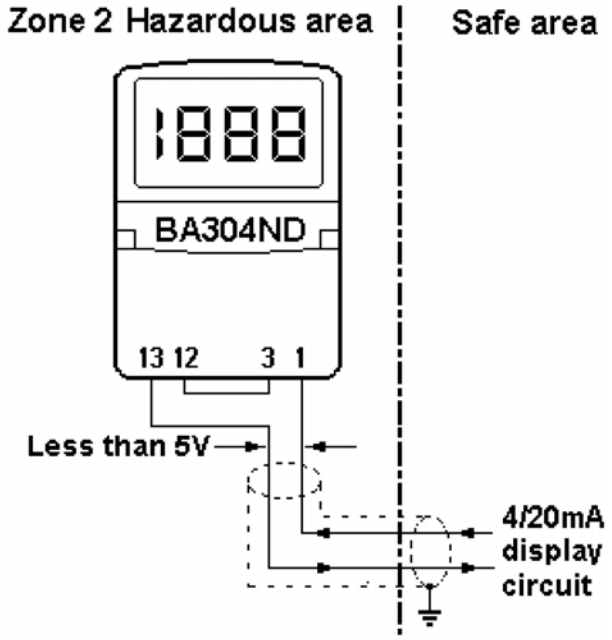


Fig 9 Loop powered backlight

**8.5 Pipe mounting kits**

Two pipe mounting kits are available for securing the BA304ND to a horizontal or vertical pipe. Detailed assembly instructions are supplied with each kit.

| | |
|---|---|
| BA392D | Stainless steel bracket secured by two worm drive hose clips. Will clamp to any pipe with an outside diameter between 60 and 80mm. |
| BA393D | Heavy duty stainless steel bracket secured by a 'V' bolt. Will clamp to any pipe with an outside diameter between 40 and 80mm. |

**8.6 Stem mounting kit**

The BA395 stem mounting kit comprises a stainless steel bracket which bolts to the rear of the indicator enclosure enabling the indicator to be mounted directly onto a flowmeter.