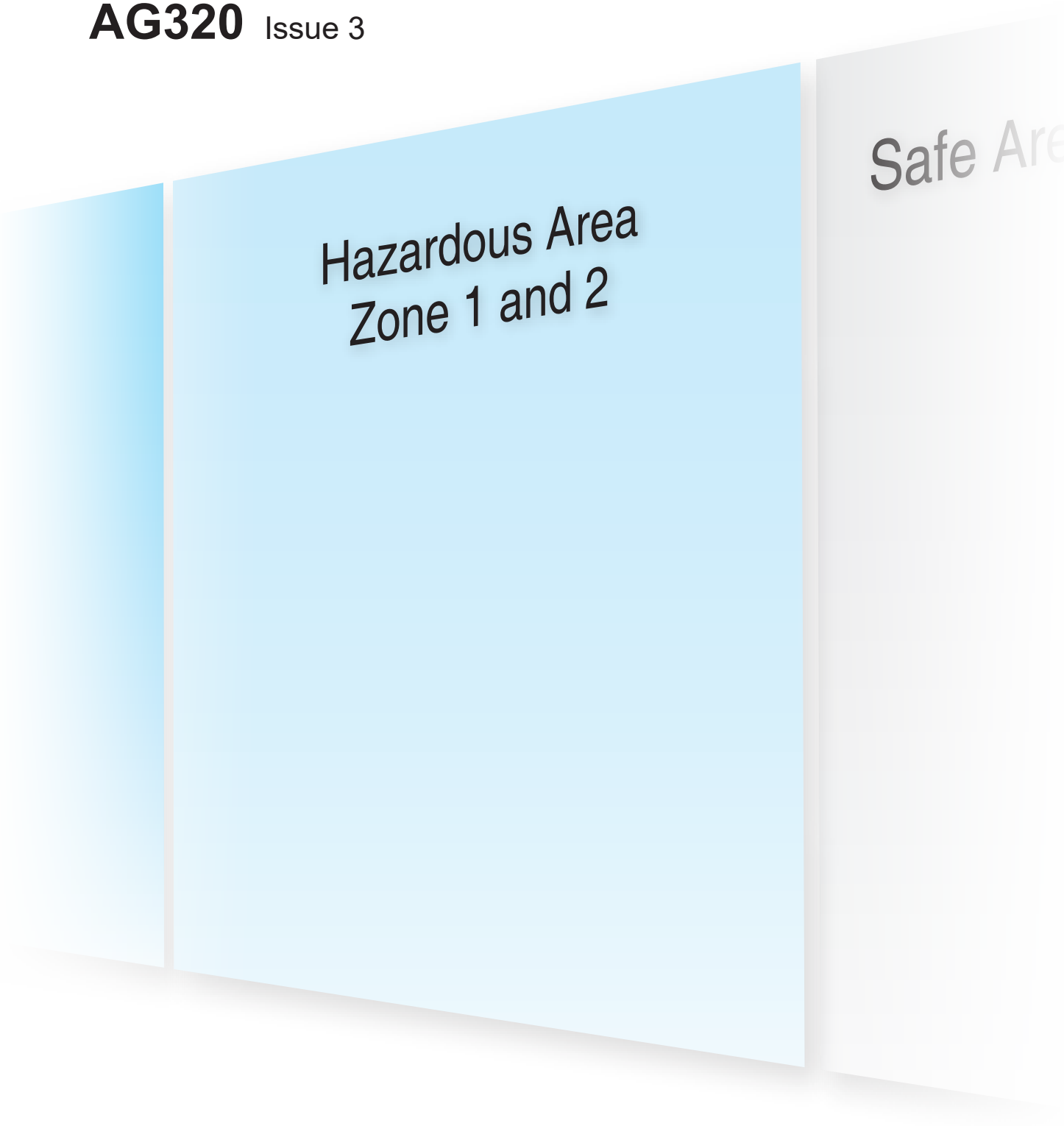
Application Guide

AG320 Issue 3



Installation of
[extra low voltage dc]
Ex eb and Ex tb instrumentation
Including BA304SG & BA324SG

BEKA associates

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1. INTRODUCTION

In 2020 BEKA introduced new Ex eb increased safety loop powered indicators which are alternatives for Ex d flameproof indicators. The BA304SG (4 digits) and the BA324SG (5 digit) are less expensive than flameproof indicators, have larger displays and feature push buttons that can be safely operated in a hazardous area. They also only require Ex e cable glands, which are less expensive and easier to install than those required for flameproof instruments.

Following semiconductor improvements, it has been possible to reduce the voltage drop that the BA304SG and BA324SG indicators introduce in a 4/20mA loop, and to include some customer requested features. All models are now available with a choice of the original GRP enclosure, or a stainless steel version, and certification has been extended to include US and Canadian approvals.

Issue 3 of this Application Guide has been update to include these additional features, and the improved performance of the BA304SG and the BA324SG loop powered indicators.

2. ALTERNATIVE ZONE 1 INSTRUMENTS

Although explosion protection techniques such as encapsulation Ex m and powder filling Ex q can be used alone for Zone 1 instruments, they are not suitable for display instrumentation.

Increased safety Ex e protection can be used in Zone 1, but until recently it has always been primarily intended to protect electrical machines and high power equipment such as motors and trace heating. The technique is frequently used to protect electrical junction boxes and field cable termination enclosures for flameproof equipment.

Both the IEC and CENELEC are in the process of replacing Zone 2 protection techniques with variations of other methods of protection. Intrinsic safety without faults Ex ic has already replaced energy limiting Ex nL and non-sparking protection Ex nA is being replaced by Ex ec. As part of this exercise the most recent edition of the IEC Ex e increased safety standard IEC 60079-7:2015 now includes two levels of a protection one of which is intended to replace Ex nA.

2.1 The increased safety Ex e standard

Increased Safety Ex e protection applies additional measures to provide increased security against the possibility of excessive temperatures and against the occurrence of arcs and sparks. The fifth edition of international standard IEC 60079-7:2015 Equipment Protection by Increased Safety ‘e’ defines two levels of protection:

Ex eb	EPL Gb	Equipment may be installed in Zones 1 or 2. *Electronic components may not be used.*
Ex ec	EPL Gc	Equipment may be installed in Zone 2. Electronic components may be used. *Intended to replace Ex nA protection.*

Instruments that satisfy level of protection Ex ec requirements can contain electronic components and may be installed in Zone 2, hence they can replace non-sparking Ex nA instruments.

Instruments that satisfy level of protection Ex eb requirements can be installed in Zones 1 and 2 but they cannot contain electronic components unless these components employ an additional method of explosion protection. This additional protection can be any type of explosion protection that may be used in Zone 1.

The BEKA alternative Zone 1 instrument design complies with Ex eb requirements allowing installation in Zone 1. To retain maximum flexibility two additional explosion protection techniques have been used to protect the electronic components.

- **Encapsulation Ex mb**
  Energy limiting components encapsulated within an assembly having an intrinsically safe output.

- **Intrinsic safety Ex ib**
  Instrument display and controls

The resulting instruments have an increased safety enclosure that provides environmental protection and houses the Ex e approved terminals for connecting field wiring to the instrument.

As unprotected electronic components are not permitted in an Ex eb enclosure located in Zone 1, energy limiting components are contained within an encapsulated Ex mb assembly producing an intrinsically safe output.

The instrument display, associated electronics and the push button switches are connected to this intrinsically safe supply, but unlike a conventional intrinsically safe instrument the resulting Ex eb instrument has no entity or cable parameters and does not need to be protected by a Zener barrier or galvanic isolator.

See BEKA video VDO 0520.

This technique is applicable to a wide range of display instrumentation allowing for installation in Zone 1 and Zone 2 without the need Zener barriers or galvanic isolators. In this guide BEKA BA304SG and BA324SG loop powered 4/20mA indicators are used to illustrate the advantages of this alternative technique which is shown in Fig 1.

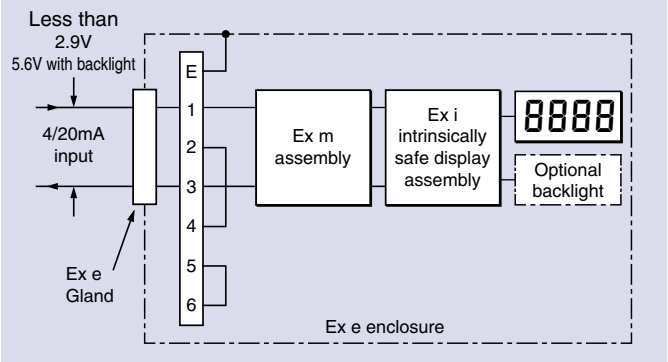

Fig 1 BA304SG and BA324SG 4/20mA indicators

2.2 Advantages of alternative technique

The BA304SG and BA324SG loop powered 4/20mA indicators have the following advantages compared to most flameproof Ex d instruments:

- Less expensive than most Exd indicators
- Larger easy to read display
- Only require low cost Ex e glands
- Tactile push buttons that can be operated in a hazardous area.
- Not so heavy as most equivalent flameproof indicators.
- Dust protection by enclosure Ex tb allows use in flammable dust atmospheres and in hybrid mixtures of gas and dust.

The BA304SG and BA324SG indicators may be used in place of flameproof Ex d indicators. The same installation rules apply and they may be safely connected in series with loops protected by any type of explosion protection except intrinsic safety Ex i and energy limiting Ex nL .

In Zone 2 the BA304SG and BA324SG may be used in place of a non sparking Ex nA instrument.

3. INCREASED SAFETY PROTECTION Ex e

Ex e increased safety protection relies heavily on the apparatus enclosure protecting the electrical equipment within the enclosure, but it does not exclude the explosive atmosphere from the enclosure. The thermal, impact and ingress protection requirements for the enclosure are defined in IEC 60079-0 and IEC 60079-7. Additional requirements for non-metallic enclosures are formidable, largely because early non-metallic enclosures were not very durable.

3.1 BEKA Ex e 'G' GRP enclosure

The BEKA 'G' GRP enclosure which houses the BA304SG and BA324SG indicators, consists of a back-box with two M20 x 2.5mm threaded cable entries and the enclosure cover as shown in Fig 2. The enclosure is surface mounted by four M6 bolts which pass through holes located outside of the silicone gasket that seals the joint between the enclosure front and the back-box.

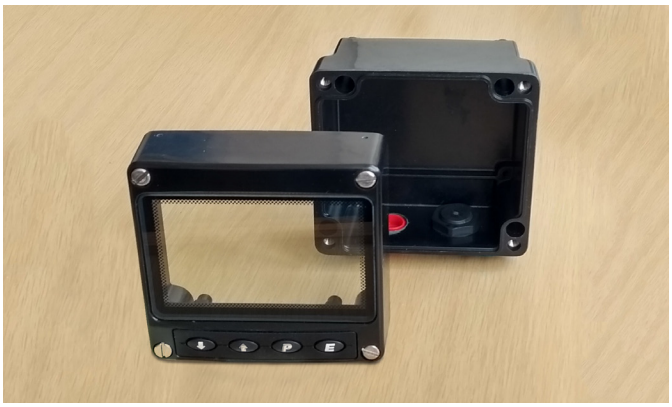

Fig 2 BEKA Ex e & Ex t certified enclosure showing large display window.

Unlike a traditional flameproof enclosure, two thirds of the 'G' enclosure front is occupied by a large rectangular toughened glass display window. This can accommodate a 34mm high 4 digit or a 29mm high five digit display plus a 31 segment bargraph. Below the window is an elastomeric keypad which activates tactile switches located within the enclosure.

The BEKA 'G' enclosure is very robust and will provide similar mechanical protection as a conventional metal flameproof enclosure. It was awarded IECEx and ATEX Ex e and Ex t component certification by Intertek after successfully completing the following IEC specified tests.

To prevent the non metallic GRP enclosure accumulating an electrostatic charge which could result in an ignition risk, the enclosure material is slightly electrically conductive. The BEKA 'G' enclosure is manufactured from compression moulded glass reinforced polyester (GRP) loaded with carbon. Intertek's report confirmed that the enclosure has a surface resistance of less than the required 10^9 ohms.

To ensure that the BEKA 'G' enclosure does not degrade in service, samples were subjected to a high temperature at high humidity for a prolonged period. This was followed by a shorter exposure to a low temperature. For the specified operating temperature of -40ºC to +60ºC, thermal endurance tests were conducted at:

+85ºC 90% RH for 28 days

-45ºC for 1 day

Following thermal endurance the sample enclosures were impact tested. A 1 kg weight with a 25mm diameter hardened steel impacting surface was dropped from 70cm in two places on the samples. This impactor has a potential energy of 7J and the ITS certifying engineer chose the point of impact which he considered to be the most destructive. The window was subjected to a lower impact by dropping the 1 kilogram weight from 40cm. The tests were performed at -45ºC and repeated at +85ºC.

Finally, after thermal endurance and impacting, the enclosure's water and dust ingress protection was measured. The IEC Ex e standard requirement is a modest minimum level of IP54. The Intertek tests found that the BEKA 'G' enclosure provided IP66 ingress protection, confirming that it is suitable for installation in most industrial environments. This has been substantiated by many thousands of successful industrial and marine installations employing this enclosure.

3.2 BEKA Ex e 'G' stainless steel enclosure

In 2025 an optional 316 stainless steel 'G' Ex e enclosure was introduced. This provides the same thermal, impact and ingress protection as the original GRP enclosure and has similar Ex e component certification. Apart from depth, all dimensions and the viewing area are the same as the GRP enclosure. Indicators with a stainless steel enclosure have an -SS suffix on their part number. e.g. BA304SG-SS.

4. PROTECTION BY ENCAPSULATION Ex m

Ex m is a method of protection in which components that are capable of igniting an explosive atmosphere by sparking or heating are enclosed within a non metallic compound. The requirements are specified in international standard IEC 60079-18.

The requirements for the encapsulating compound are stringent as it must exclude the explosive atmosphere from the electronic components under all conditions throughout the life of the product. To ensure that the encapsulated Ex mb assembly does not degrade in service, sample encapsulated assemblies were subjected to 28 days exposure to a high temperature at high humidity. This was followed by a shorter exposure to a low temperature for 1 day. Because the encapsulating material is in direct contact with the electronic components, the upper test temperature was 20ºC above the maximum component surface temperature under the worst case operating conditions with an external fault applied.

4.1 BEKA Ex mb encapsulated assembly

The encapsulated assembly is located within the 'G' Ex e enclosure back-box as shown in Fig 3. It has been tested by Intertek to confirm that it complies with the Ex mb requirements and that it has an intrinsically safe Ex i output. This energy limited output is unable to cause ignition by sparking, or to supply enough power to produce a hot surface which could cause ignition even under fault conditions.

Fig 3 Ex m encapsulated assembly

5. INTRINSIC SAFETY PROTECTION Ex i

Intrinsic safety protection Ex i is a well established technique that provides the ultimate ignition protection, as it is an energy limiting technique in which faults are considered. International standard IEC 60079-11 defines three levels of intrinsic safety protection:

Ex ia Equipment protection level EPL Ga
for installation in Zone 0, 1, 2, 20, 21 & 22.

Ex ib Equipment protection level EPL Gb
for installation in Zone 1 , 2, 21 or 22.

Ex ic Equipment protection level EPL Gc
for installation in Zone 2 or 22.

Although the Ex eb instrument can only be installed in Zone 1 and 2, for maximum safety the BEKA intrinsically safe display electronics remains safe with two countable faults applied, but to avoid confusion the instrument is coded Ex ib.

5.1 BEKA intrinsically safe 4/20mA display assembly.

Almost any intrinsically safe electronic display assembly could be safely connected to an appropriate energy limited intrinsically safe output from an Ex m assembly. For this guide, the BA304SG and BA324SG 4/20mA digital indicators are used to illustrate this alternative design.

The only source of power for the display electronics is the intrinsically safe Ex ib output from the Ex mb encapsulated assembly. By definition this can not cause spark ignition, therefore no additional protection is required for the push button switch contacts that control the display. Energy storing components within the display electronics, such as capacitors and inductors, are locally suppressed to ensure that faults can not cause an incendive discharge.

6. ADVANTAGES OF BEKA Ex eb INDICATORS

For users of flameproof protected 4/20mA indicators, the alternative instrument design described in this guide offers the following advantages:

- **Less expensive, alternative for a flameproof Ex d indicator. Complies with same installation rules.**
- **Larger easier to read display**
- **Tactile controls can be operated in hazardous area.**
- **Only requires lower cost easier to install Ex e cable glands.**
- **May be safely connected in series with any hazardous area 4/20mA loop with any tyoe of explosion protection apart from intrinsic safety.**
- **Not so heavy as most equivalent flameproof Ex d indicators.**

An Ex eb certified indicator can also be used as a replacement for an Ex nA instrument. Ex nA type of protection has been removed from the latest edition of the IEC Ex n standard.

Although not usable in Zone 0, for some simple systems Ex eb instruments may have advantages compared to intrinsically safe instruments:

- **No Zener barrier or galvanic isolator required**
- **No entity or cable parameters**

6.1 Reduced 4/20mA loop voltage drop

In 2025 improved technology enabled the voltage drop introduced by the BA304SG and BA324SG indicators to be reduced, particularly with a backlight. This issue 3 of Application Guide AG320 includes the revised figures.

7. BEKA Ex eb ALTERNATIVE DESIGN MODELS.

The BEKA Ex eb loop powered 4/20mA indicators employing this alternative design are:

BA304SG GRP enclosure	4 digits 34mm high.
BA304SG-SS Stainless steel enclosure	4 digits 34mm high.
BA324SG GRP enclosure	5 digits 29mm high and 31 segment bargraph.
BA324SG-SS Stainless steel enclosure.	5 digits 29mm high and 31 segment bargraph.

Fig 4 BA304SG & BA324SG-SS Ex eb indicators.

The IECEx and ATEX certification for these indicators confirms that they comply with Ex eb ib mb IIC T5 requirements, which allows them to be safely installed in Zones 1 or 2.

The T5 temperature classification permits use with almost all common industrial gases. The exceptions listed in IEC 60079-20-1 [The IEC standard which lists the relevant data on gases] are carbon disulphide and ethyl nitrate which have ignition temperatures of 90ºC and 95ºC respectively. There are other gases with a low ignition temperature not listed in IEC 60079-20-1 such as arsine, [which are used in the semiconductor industry] and consequently a check is always necessary.

The following documents are relevant for the safe use of a BEKA Ex eb ib mb loop powered 4/20mA indicator in a hazardous area:

a) The IECEx certificate IECEx ITS 19.0018X. This certificate has been issued by Intertek Testing and Certification Ltd, a certification body accredited by an organisation spawned by the IEC and using IEC standards as a basis of the certificate.
The certificate states, *'These instruments may be used as an alternative to a certified flameproof Ex d instrument in Zones 1 & 2, or as an alternative to a certified Ex nA instrument in Zone 2'.*

Increasingly this is the certification that is directly or indirectly acceptable in large parts of the world. A copy of this certificate can be downloaded from the BEKA website beka.co.uk/3x4sg_iecex_cert.pdf.

b) The ATEX EU-Type Examination Certificate ITS19ATEX304891X. This certificate has been issued by an EU Notified Body Intertek Testing and Certification Ltd. ATEX certificates use CENELEC standards as a basis for certification, fortunately IEC and CENELEC standards are identical in their requirements.
This certificate states, *'These instruments may be used as an alternative to a certified flameproof Ex d instrument in Zones 1 & 2, or as an alternative to a certified Ex nA instrument in Zone 2'.* A copy of this certificate can be downloaded from the BEKA website beka.co.uk/3x4sg_atex_cert.pdf.

c) The Declaration of Conformity is created by BEKA associates which confirms that the instruments satisfy the requirements of all relevant EU directives and are manufactured under a recognized quality control system. The use of the CE mark confirms this statement. A copy of this certificate can be downloaded from the BEKA website beka.co.uk/ba3x4sg_d_of_c.pdf.

7.1 BEKA Ex eb indicator certification coding

The use of multiple explosion protection results in potentially confusing certification codes, not helped by them being listed in alphanumerical order.

7.1.1 IECEx gas certification and label marking

Ex eb ib mb IIC T5 Gb
Ex ib mb tb IIIC T80ºC Db
IECEx ITS 19.0018X
-40ºC ≤ Ta ≤ +60ºC

IECEx ITS 19.0018X
Certificate number issued by ITS (Intertek Testing and Certification Ltd). 19 is the year of the first issue.

Ex eb ib mb Methods of explosion protection employed within the instrument. Listed in alphabetical order.

eb	Increased safety
ib	Intrinsic safety
mb	Encapsulation

IIC Surface industry gas group. Representative gas hydrogen.

T5 In gases that may safely be used with equipment having a temperature classification of:

T1	450ºC
T2	300ºC
T3	200ºC
T4	150ºC
T5	100ºC

Gb Equipment protection level [EPL] indicating suitability for use in a Zone 1 and Zone 2 gas hazard.

-40ºC≤ Ta≤+60ºC
Ambient temperature range, including effect of adjacent equipment.

Ex ib mb tb IIIC T80ºC Db
Relates to the instruments dust ignition protection by enclosure Ex tb. See section 9.

7.1.2 ATEX gas certification and label marking

II 2GD Ex eb ib mb IIC T5 Gb
Ex ib mb tb IIIC T80ºC Db
ITS19ATEX304891X
-40ºC ≤ Ta ≤ +60º

ITS19ATEX304891X
ATEX certification number issued by Notified Body ITS (intertek Testing and Certification Ltd).
19 refers to the year of the first issue.

This mark indicates compliance with the EU apparatus directive.

II Surface industry

2GD Category 2 for use in gas and dust hazards in Zones 1, 2, 21 and 22.

Ex eb ib mb Methods of explosion protection employed within the instrument. Listed in alphabetical order.

eb	Increased safety
ib	Intrinsic safety
mb	Encapsulation

IIC Surface industry gas group. Representative gas hydrogen.

T5 In gases that may safely be used with equipment having a temperature classification of:

T1	450ºC
T2	300ºC
T3	200ºC
T4	150ºC
T5	100ºC

Gb Equipment protection level [EPL] indicating suitability for use in a Zone 1 and Zone 2 gas hazard.

-40ºC≤ Ta≤+60ºC
Ambient temperature range, including effect of adjacent equipment.

Ex ib mb tb IIIC T80ºC Db
Relates to the instruments dust ignition protection by enclosure Ex tb.
See section 9.

8. APPLICATIONS AND INSTALLATIONS

8.1 BA304SG & BA324SG in a gas atmosphere

The BA304SG four digit and BA324SG five digit Ex eb loop powered 4/20mA indicators employ the alternative design using multiple explosion protection techniques described in this guide. Both may be used in exactly the same way as a certified flameproof indicator, except that only Ex e cable glands are required.

The indicators have a maximum input voltage U_N of 30V dc allowing them to be connected in series with any 4/20mA Zone 1 or 2 loop with a supply of 30V or less. The loop may employ any form of explosion protection except intrinsic safety. In normal operation the current flowing in the loop will be determined by another device such as a transmitter or set point station, however if an indicator is connected directly to a 30V dc supply, the indicator will limit the current to approximately 36mA and will not be damaged.

When either indicator is connected in series with a 4/20mA loop it will introduce a voltage drop of less than 2.9V at 20mA. When the indicator is fitted with a loop powered display backlight the maximum total voltage drop will be less than 5.6V at 20mA.

8.2 Loop design example

A BA304SG or BA324SG indicator may be connected in series with a 2-wire flameproof transmitter to display the current and hence the process variable in engineering units. Considering the voltage drops around the simplified loop shown in Fig 5.

2-wire transmitter	8.0V
Maximum voltage drop caused by BA304SG indicator.	2.9V
Max voltage drop caused by cables. (10Ω x 20mA)	0.2V
Safe area load	5.0V
Total voltage drop around loop	16.1V

In this example the instrument power supply must therefore have an output between 16.1V and 30V dc. If the indicator is fitted with a backlight, the indicator voltage drop increases to 5.6V and the supply must be between 18.8V and 30V dc.

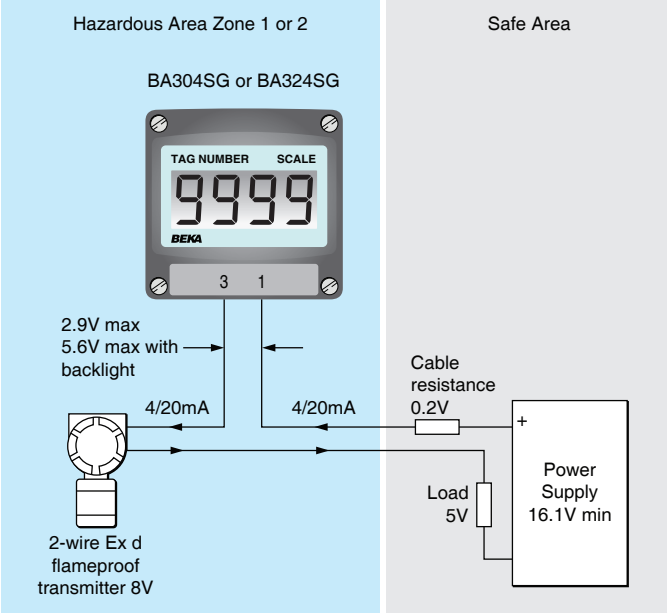

Fig 5 Voltage drops in a simplified measurement loop

8.3 Safe area power supply

The IECEx and ATEX certificates specify that the BA304SG and BA324SG indicators should be supplied from, *'a SELV or PELV supply or from adequately approved supply providing double or reinforced insulation as required in IEC 60079-14 standard'*.

A SELV supply is a 'Safety or separated extra-low voltage' floating supply which incorporates a transformer with double or reinforced insulation. A PELV supply is a *'Protected extra-low voltage'* which is exactly the same, but it may have an earthed output.

The certification requirement to use a SELV or PELV supply does not usually cause any difficulties as the instrument supply is required to be safe for personnel contact which requires the use of a transformer with double or reinforced insulation. In European terms, compliance with the Low Voltage Directive ensures that this requirement is met. The requirement to use a SELV or PELV supply applies to all types of extra low voltage explosion protected equipment including flameproof Ex d.

Figures 7 to 11 use a power supply and receiving equipment block to illustrate the equipment used in the safe area. In practice there are no significant limitations on the permissible safe area apparatus. Like most flameproof indicators

the BEKA Ex eb ib mb indicators have no maximum input current rating only a maximum input voltage U_N of 30V. The BA304SG and BA324SG indicators may be used in exactly the same way as a certified flameproof indicator, providing that the loop supply voltage is equal to, or less than 30V.

8.4 Protection of Zone 1 and Zone 2 wiring

The wiring for all types of electrical circuits in Zones 1 and 2, including Ex d and Ex e systems, but excluding intrinsically safe circuits, should comply with IEC 60079-14 *Electrical installation design, selection and installation of equipment, including initial inspection*.

Cables should have an adequate current and voltage rating, be mechanically robust with a toughened outer sheath, or they should be armoured. Cables should be suitable for the expected operating temperature and be compatible with the glands used to seal equipment enclosures.

In addition there is a requirement that hazardous area cables should be protected from accidental electrical overloads and have a clearly defined means of isolation i.e. be de-energised. When using a power supply complying with the European Low Voltage Directive, overload protection is provided by the power supply and isolation of this type of 4/20mA circuit may be achieved by switching off the power supply. The need for a specific means of isolation is not essential .since the risk is not as great as it is for higher power installations.

The application diagrams in this guide therefore do not show separate fuses and a means of individually de-energising each loop, this accords with current practice in most extra low voltage instrument systems.
If site practice requires all 4/20mA loops to be protected by individual fuses and a means of isolating each loop, this can be readily achieved by using distribution cabinet terminals which incorporate a fuse and a means of isolation as shown in Fig 6. However, this may marginally reduce the system operational reliability.

If used it is important that the fuses are clearly identified so that correct isolation is readily accomplished. A 100mA fuse which effectively limits the transferred power is considered to provide the required level of protection for a single 4/20mA loop.

This satisfies the requirements of IEC 60079-14 *Switch-off and isolation* which applies to all hazardous area loops, apart from intrinsically safety systems, including those containing flameproof Ex d and increased safety Ex e instruments. Other methods of isolation, de-energising, and current limiting such as an mcb are equally acceptable.

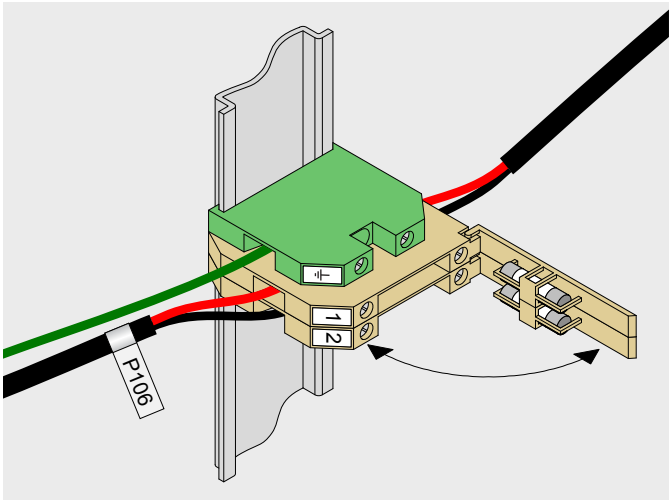

Fig 6 Typical fused and isolating terminal block

The 4/20mA circuit can be fully floating but is more usually ‘earthed’ at one point in the safe area by the common power supply and/or the receiving equipment. This earth [usually combined with the cable screen earth] and the plant reference potential should be bonded together. Earthing at more than one point should be avoided since the possible circulating currents cause both safety and operational problems. In those rare cases where multiple earths cannot be avoided the use of bonding conductors provides a possible solution.

The cable screens are all shown ‘earthed’ in the safe area and isolated elsewhere. The screen is earthed or bonded to the plant reference point which should be as electrically quiet as possible. In particular it is desirable to avoid the bond sharing any interconnections which carry the fault or leakage currents from power equipment such as motors.

This is the practice commonly used to ensure safety and to minimize interference but other techniques may be used.

Provision is made within the BA304SG and BA324SG indicators via terminals 5 and 6 to carry the screen through the indicator and maintain continuity without earthing the screen at this point.

8.5 Cable glands

All BEKA Ex eb field mounting indicators are supplied fitted with one Ex e and Ex t certified stopping plug and one temporary hole plug which prevent dust and debris entering the instrument during transportation. When installed in Zone 1 or Zone 2 indicators should be fitted with certified Ex e cable glands, conduit entries and / or stopping plugs. If two cable entries are used each with armoured cables, the armour on both cables should be earthed.

8.6 Enclosure earthing

To prevent the build up of an incendive electrostatic charge the indicator's GRP enclosure is slightly electrically conductive. If the indicator enclosure is not mounted on a metal structure that provides a discharge path, the enclosure should be earthed using the indicator's internal earth terminal.

Similarly, if an indicator in a stainless steel enclosure is not mounted on a metal structure that provides a secure earth, the enclosure should be earthed using the indicator's internal earth terminal.

8.7 Typical applications

Figures 7 to 11 illustrate applications where the field equipment is loop-powered by the 4/20mA safe area signal. These figures show how the BA304SG and BA324SG may be safely used with equipment having any type of certified explosion protection except intrinsic safety.

In figure 12 the 4/20mA signal is derived from hazardous area equipment contained within an Ex d enclosure. This is a common requirement. Fig 13 shows a similar situation but with the hazardous area equipment contained in a pressurised Ex p enclosure. If site practice requires all 4/20mA loops to be protected by individual fuses and a means of isolating each loop, fuses as shown in Fig 6 should be located within the Ex d or Ex p enclosure. The procedure for using these isolating fuses within the flameproof or pressurised enclosure needs to be carefully documented, since opening the enclosure should only be done under carefully controlled conditions.

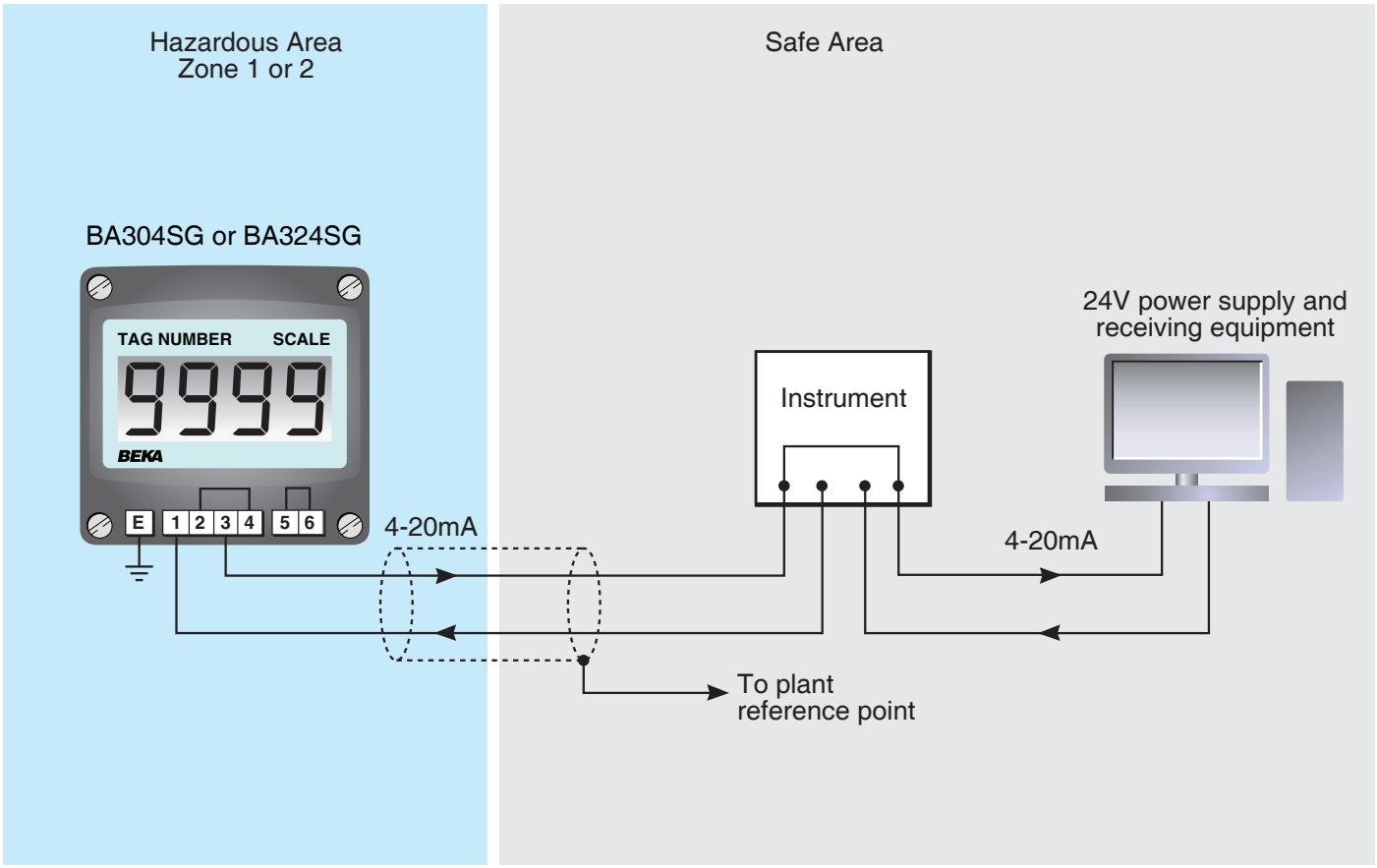

Fig 7 Ex eb indicator in Zone 1 or 2 monitoring instrument in safe area

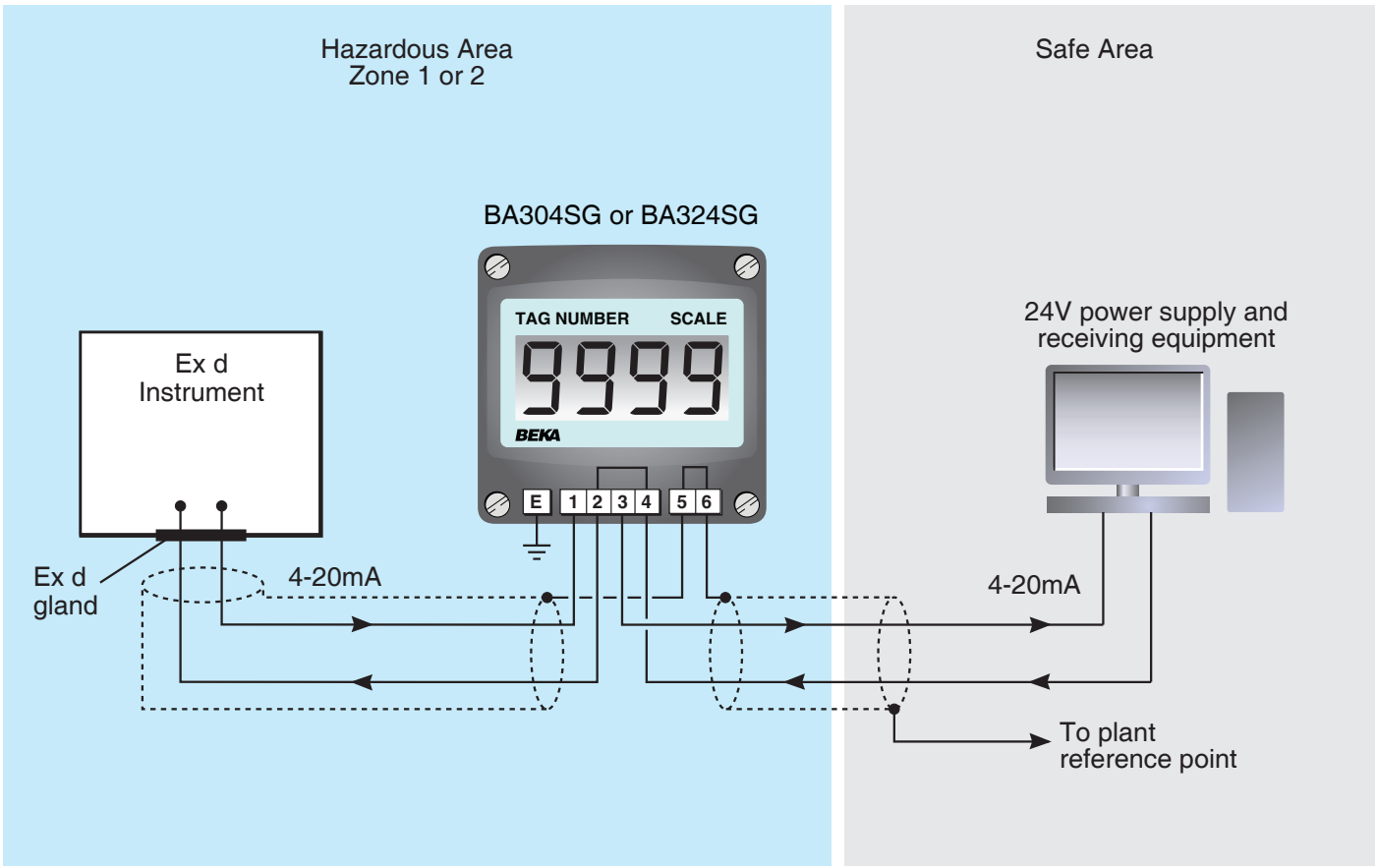

Fig 8 Ex eb indicator monitoring Ex d instrument in Zone 1 or 2

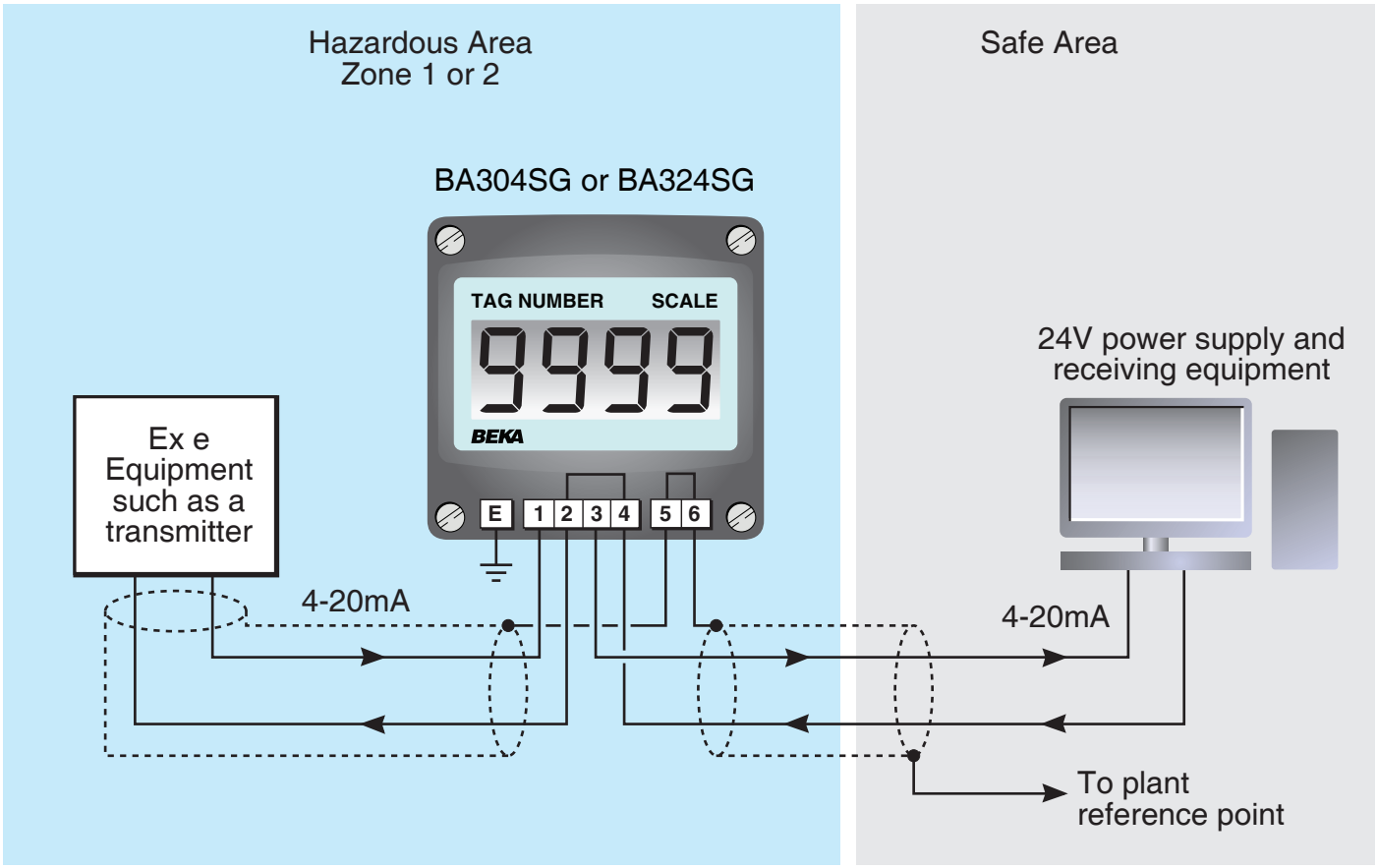

Fig 9 Ex eb indicator in Zone 1 or 2 monitoring Ex e instrument in Zone 1 or 2

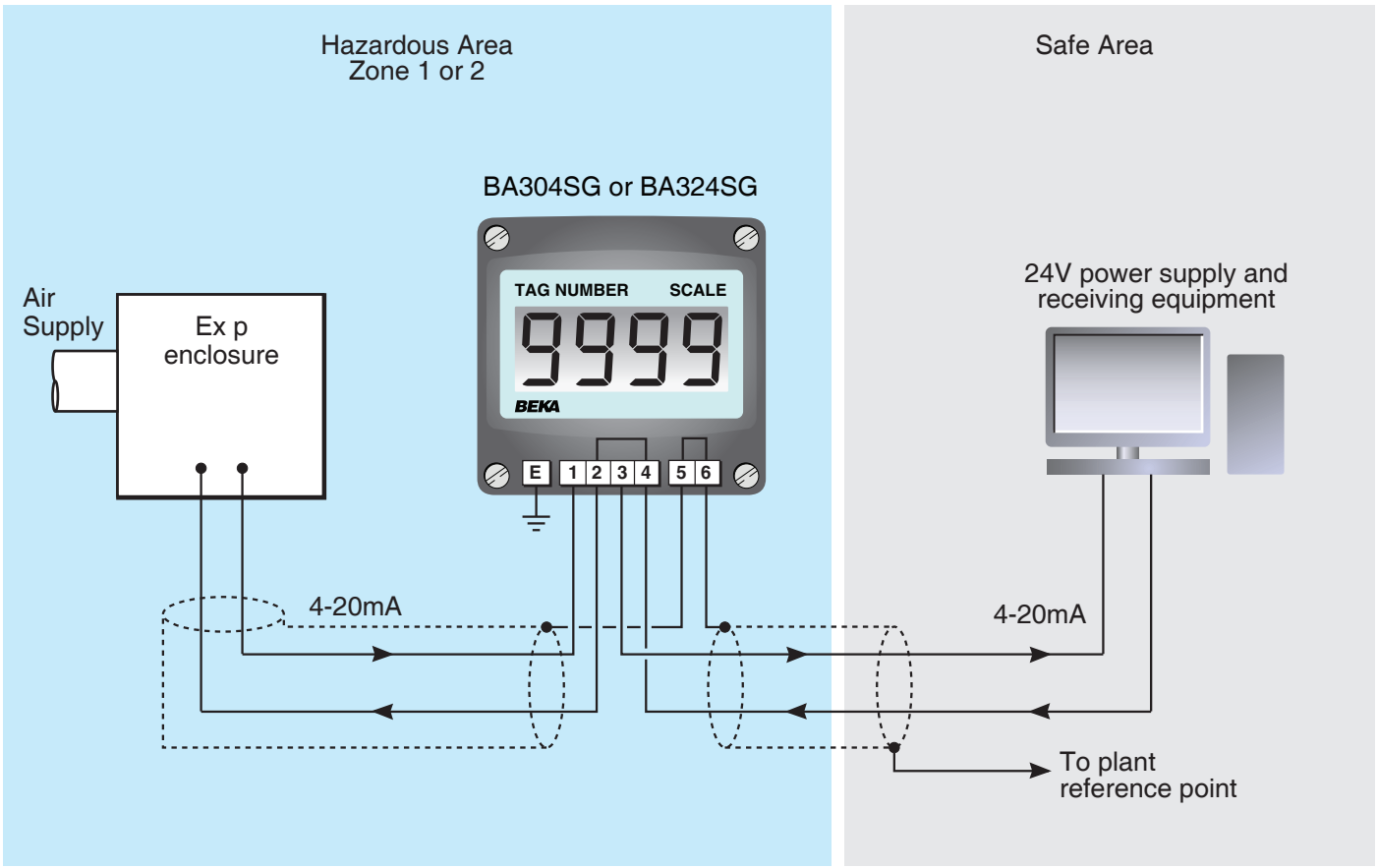

Fig 10 Ex eb indicator in Zone 1 or 2 monitoring Ex p instrument in Zone 1 or 2

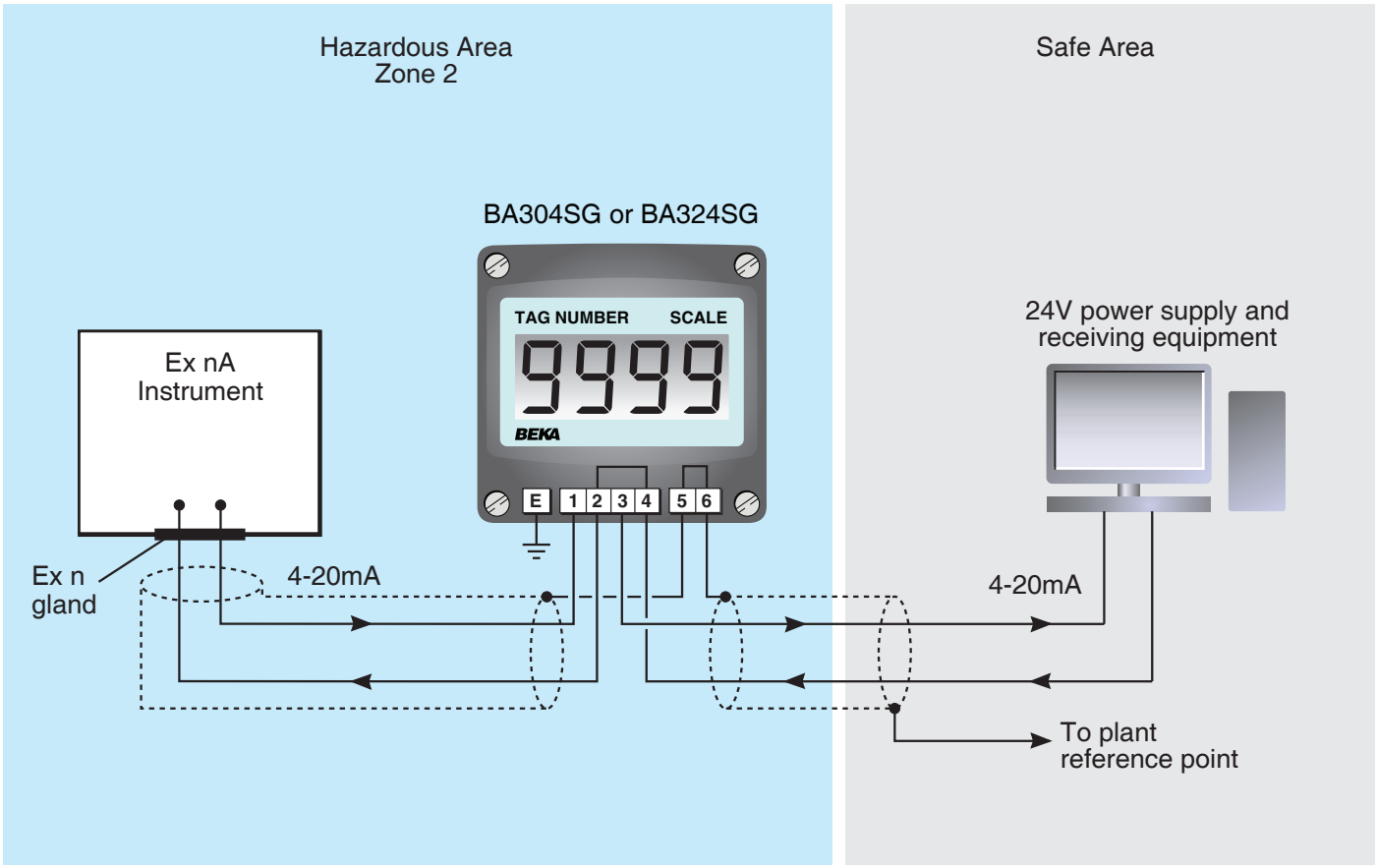

Fig 11 Ex eb indicator in Zone 2 monitoring Ex nA instrument in Zone 2

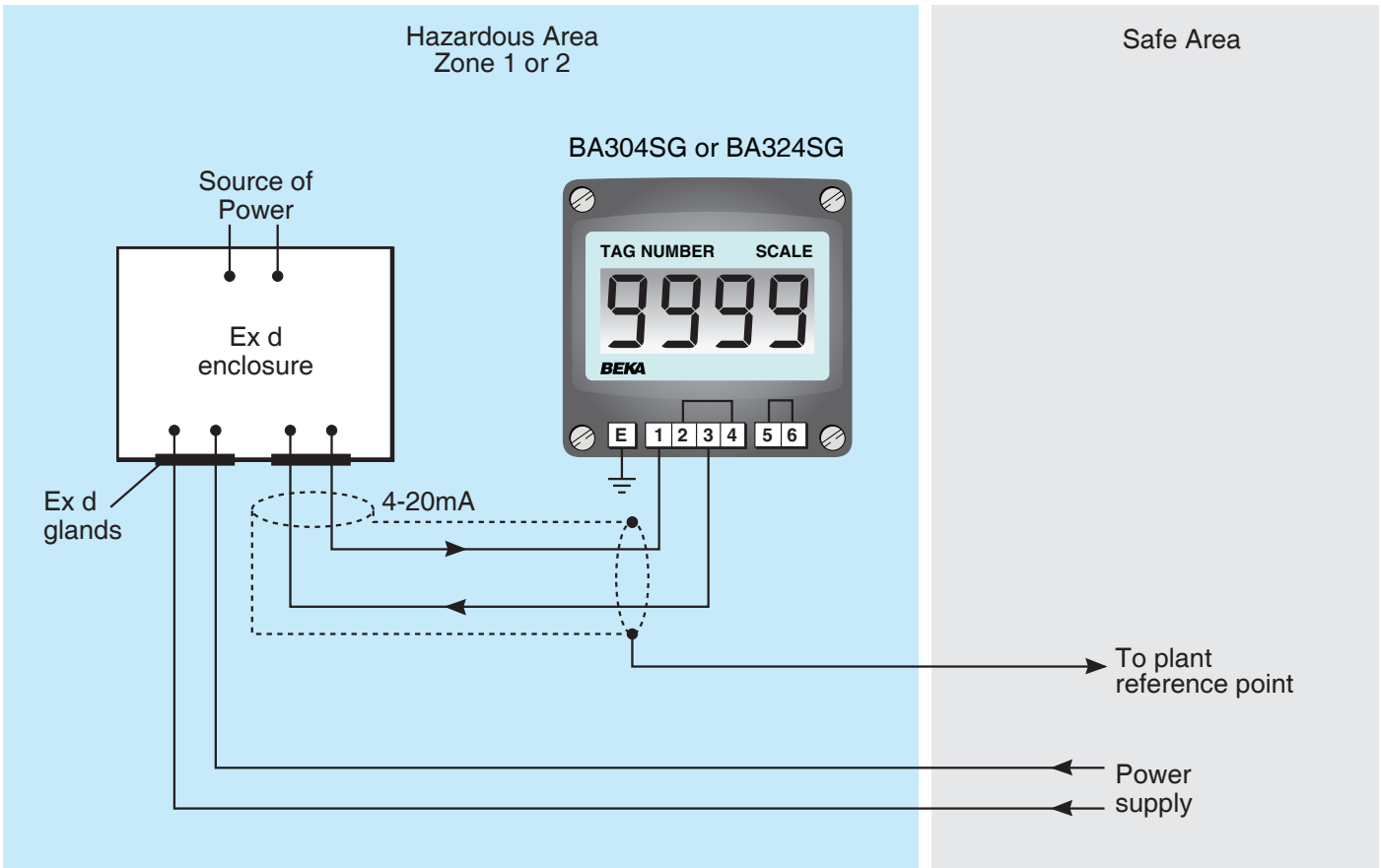

Fig 12 Ex eb indicator in Zone 1 or 2 monitoring equipment located within Ex d enclosure

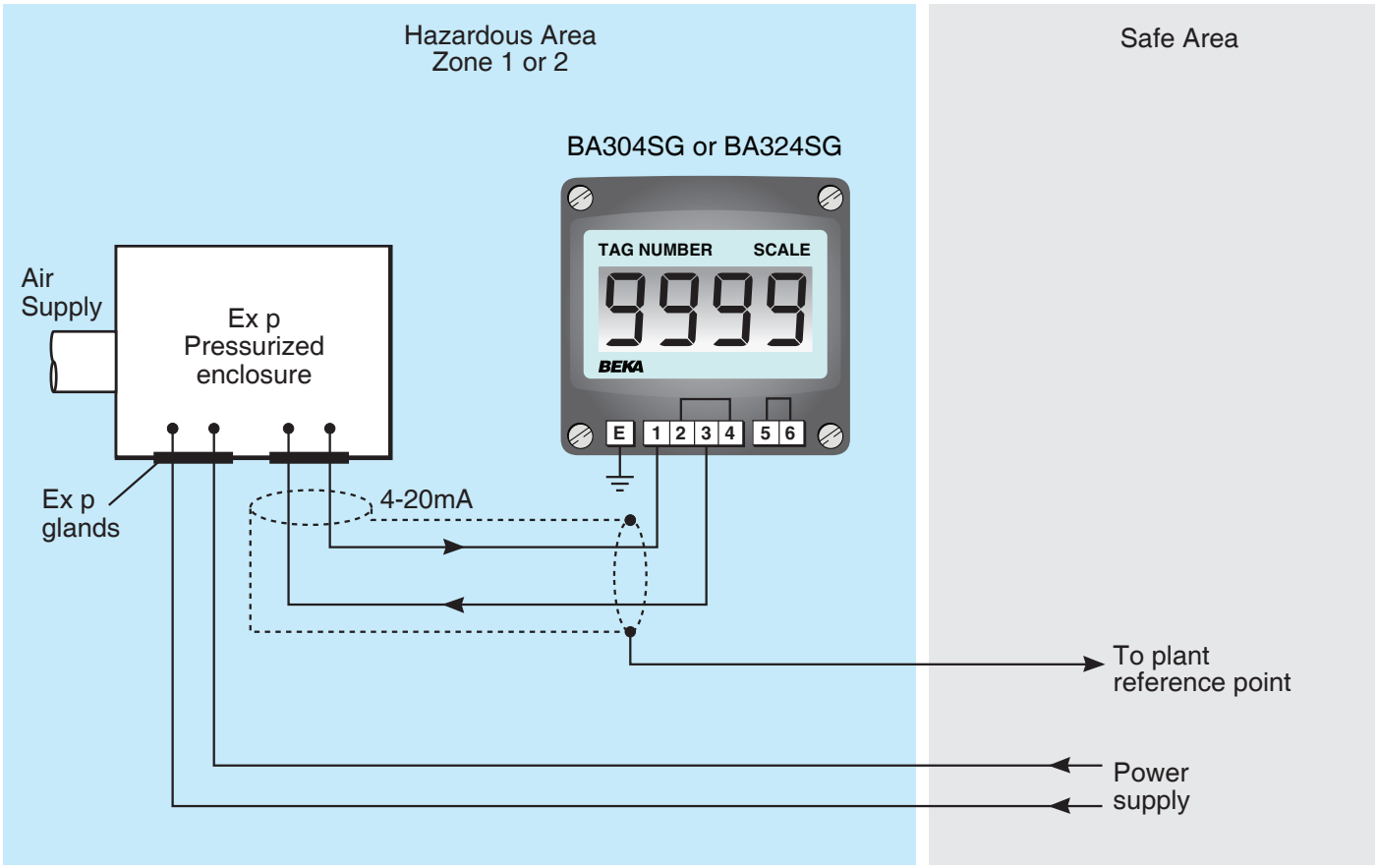

Fig 13 Ex eb indicator in Zone 1 or 2 monitoring equipment located within Ex p enclosure

9. COMBUSTIBLE DUST ATMOSPHERES

In addition to Ex e increased safety component certification, the BEKA 'G' GRP and stainless steel enclosures also have Ex tb dust ignition protection by enclosure component certification. The thermal, impact and ingress protection requirements for an Ex t enclosure are defined in IEC 60079-0 and IEC 60079-31. Basically the enclosure sealing is required to prevent a combustible dust atmosphere entering the enclosure after thermal endurance and impact testing as described in section 3.1.

In addition to a component approved enclosure, Ex t certified apparatus requires the electrical equipment within the enclosure to incorporate thermal protection such that the maximum external surface temperature of the enclosure is defined.

9.1 BEKA loop powered 4/20mA indicators

Both of the BEKA Ex eb loop powered 4/20mA indicators also have IECEx and ATEX Ex tb certification.

BA304SG GRP enclosure	4 digits 34mm high.
BA304SG-SS Stainless steel enclosure	4 digits 34mm high.
BA324SG GRP enclosure	5 digits 29mm high and 31 segment bargraph.
BA324SG-SS Stainless steel enclosure.	5 digits 29mm high and 31 segment bargraph.

Dust ingress protection is provided by the component approved Ex t enclosure. The Ex mb encapsulated assembly limits power dissipation within the enclosure and thus defines the maximum external surface temperature of the enclosure.

9.2 BEKA Ex tb indicator certification marking

The use of multiple explosion protection results in potentially confusing certification codes, not helped by them being listed in alphanumerical order.
The BA304SG and the BA324SG have the same IECEx and ATEX certification codes.

9.2.1 IECEx dust certification marking

Ex ib mb tb IIIC T80ºC Db IP66
IECEx ITS 19.0018X
-40ºC ≤ Ta ≤ +60ºC

IECEx ITS 19.0018X
Certificate number issued by ITS (Intertek Testing and Certification Ltd).
19 is the year of issue.

Ex ib mb tb Methods of explosion protection employed within the instrument. Listed in alphabetical order.

ib	Intrinsic safety
mb	Encapsulation
tb	Protection by enclosure

IIIC Surface industry dust group includes sub groups:

IIIA	combustible flyings
IIIB	non-conductive dust
IIIC	conductive dust

T80ºC Maximum exterior surface temperature of the enclosure. At 60ºC ambient, allows safe use with dusts having a minimum ignition temperature of:

120°C	Dust cloud
155°C	Dust layer on indicator up to 5mm thick.
	Dust layer on indicator over 5mm thick. See IEC 60079-14

Db Equipment protection level [EPL] indicating suitability for use in a Zone 21 and Zone 22 dust hazardous area.

-40ºC≤ Ta≤+60ºC
Ambient temperature range, including effect of adjacent equipment.

9.2.2 ATEX dust certification marking

II 2GD Ex eb ib mb IIC T5 Gb
Ex ib mb tb IIIC T80ºC Db
ITS19ATEX304891X
-40ºC ≤ Ta ≤ +60º

ITS19ATEX304891X
ATEX certification number issued by ITS (Intertek Testing and Certification Ltd).
19 refers to the year of issue.

This mark indicates compliance with the EU apparatus directive.

II Surface industry

2GD Category 2D for use in dust hazards in Zones 21 and 22.

Ex ib mb tb Methods of explosion protection employed within the instrument. Listed in alphabetical order.

ib	Intrinsic safety
mb	Encapsulation
tb	Protection by enclosure

IIIC Surface industry dust group includes sub groups:

IIIA	combustible flyings
IIIB	non-conductive dust
IIIC	conductive dust

T80ºC Maximum exterior surface temperature of the enclosure. At 60ºC ambient, allows safe use with dusts having a minimum ignition temperature of:

120°C	Dust cloud
155°C	Dust layer on indicator up to 5mm thick.
	Dust layer on indicator over 5mm thick. See IEC 60079-14

Db Equipment protection level [EPL] indicating suitability for use in a Zone 21 and Zone 22 dust hazardous area.

-40ºC≤ Ta≤+60ºC
Ambient temperature range, including effect of adjacent equipment.

9.3 BA304SG and BA324SG in dust atmosphere

The indicators have a maximum input voltage U_N of 30V allowing them to be connected in series with any 4/20mA loop with a supply of 30V or less. In normal operation the current flowing in the loop will be determined by another device such as a transmitter or set point station, however if an indicator is connected directly to a 30V dc supply, the indicator will not be damaged and the current will be limited to about 36mA.

When either indicator is connected in series with a 4/20mA loop it will introduce a voltage drop of less than 2.9V at 20mA. When the indicator is fitted with a loop powered display backlight the maximum voltage drop will be less than 5.6V at 20mA.

9.4 Loop design

Loop design for use in a hazardous dust atmosphere is identical to that described in section 8.2 for use in a hazardous gas atmosphere.

9.5 Common factors

Any of the indicator circuits shown in section 8 may be used for applications in explosive dust atmospheres, provided that the other apparatus in the hazardous area is dust certified.

The BA304SG or BA324SG indicators should be fitted with Ex t certified glands and / or stopping plug.

The BA304SG and BA324SG indicators may be used with dusts having a minimum ignition temperature of:

Dust cloud	120°C
Dust layer on indicator up to 5mm thick	155°C
Dust layer on indicator over 5mm thick.	Refer to IEC 60079-14

9.6 Hybrid mixture of gas and dust

There are some locations where there is an explosion risk due to the presence of both a flammable gas and a flammable dust. These hybrid mixtures can occur in many different circumstances such as some parts of the pharmaceutical industry and where organic products are being packed or stored. The interaction between the gas and dust can cause the combination to be slightly more incendive than that of the individual constituents. There is very little guidance in the IEC standards on this subject and it is usual to take a cautious approach when choosing equipment for use in this environment.

However, the combination of Ex eb and Ex tb protection techniques used in these indicators provides an acceptable solution to this problem except for the uncommon situation where the hybrid mixture is continuously present in Zones 0 and 20. The Ex tb enclosure excludes the dust from the interior so the internal risk is from the gas that is IIC T5 certified which as explained elsewhere covers the majority of gases. The remaining risk is temperature ignition by the external surface of the enclosure. The dust certification gives a maximum exterior surface temperature of 80ºC at an ambient of 60ºC so temperature ignition is improbable.

A reasonable conclusion is that providing the gas in the hybrid mixture is adequately covered by the IIC T5 specification and the dust has a smouldering temperature greater than 80ºC the use of these indicators in a hybrid mixture of gas and dust is acceptably safe.

10. INSPECTION

The recommended inspection procedures for installations such as BA304SG and BA324SG indicators are contained in IEC 60079-17. Three grades of inspection are proposed, ***Detailed***, ***Close*** and ***Visual***:

Detailed inspections are usually carried out if there is some reason to suspect that there is a significant problem. It would involve removing the indicator to a safe area and removing the covers, checking the gaskets, removing any pollution and looking for any damage or obvious deterioration in condition. A functional check would confirm that there was not significant electrical damage. This type of inspection should only be necessary on very rare occasions. For example, it is not necessary on initial installation since the indicator will have been subjected to a detailed final inspection by BEKA.

The initial detailed inspection should confirm that the indicator is being installed in accordance with the installation drawing or instructions. The questions of where to install it and choice of cables glands should all have been decided by the compiler of the installation drawing. The installing technician should be encouraged to question any aspect which he has cause to doubt and should have access to the safety documentation and the relevant certificates if he wishes.

Close inspections are not relevant to indicators. If the indicator is of the required type and is working then a visual inspection is all that needs to be done. Removing covers and attempting to check the status of the electronics except when absolutely necessary is to be discouraged.

Visual inspections are inspections looking for obvious faults and do not require the use of tools or the removal of covers. In the case of the indicator a check that the indicator is the intended model, is reasonably clean and undamaged and the glands and immediately adjacent cable are in good condition is all that is necessary.

11. MAINTENANCE

Any maintenance should only be attempted in accordance with the permitted work practice of the particular site, which should ensure personnel and plant safety. All maintenance work should be carried out subject to the precautions which would be applied in a safe area.

There is no requirement for routine maintenance of the indicator. If the indicated value becomes obscured cleaning the window with a damp cloth is the recommended solution.

If the indicator appears not to be functioning then this should be confirmed by measuring the current in the safe area. Live maintenance of increased safety Ex eb and dust ignition protection by enclosure Ex tb apparatus is not permitted in Zones 1 or 21. In Zones 2 and 22 live maintenance may be performed when a risk analysis demonstrates that it is acceptably safe to do so. Clause 4.8.1 of IEC 60079-17: 2007 sets out the requirements of the risk analysis in detail.

The principles to be followed are that the maintenance procedure shall not cause incendive sparks or expose or create hot surfaces. However if the indicator malfunctions the only universally acceptable recourse is to remove it for examination in the safe area and this is frequently the most practical solution. It is necessary to isolate the hazardous area circuit before disconnecting the indicator. If fitted, isolation can be achieved by opening the switches in the switch-fuse terminal blocks, and unauthorised re-energising prevented by removing and retaining the fuses.

It is always worthwhile to check that the circuit is isolated before working on it. This can be done by using an intrinsically safe multimeter such as the Fluke 87V. This is quite safe if the meter is used only on the voltage range [input impedance 10 megohms] since the current drawn is non-incendive even if the circuit is not isolated. While it is safe to make voltage measurements, an energized circuit should not be broken in the hazardous area to make current measurements since there is a slight possibility of an incendive spark being created.

It is usually possible to conveniently monitor circuit currents at the fuse–switch isolator in the safe area.

Fault finding on a live circuit in Zone 2 can be done safely using an intrinsically safe multimeter on the voltage range. The voltage measurements listed in the indicator manual can be safely used. Each circuit is slightly different but most faults can be diagnosed by measuring the voltages on the indicator terminals. It is permissible to temporarily remove the terminal cover to permit these measurements to be made and the intrinsically safe display assembly may be unplugged from the back-box.

Care must be taken to avoid contaminating the interior during the temporary relaxation of the ingress protection and the gaskets checked as the cover is replaced. It is possibly hazardous to disconnect any of the field wiring and hence the circuit should be isolated or a gas clearance certificate obtained before loosening terminals.

If it is necessary to reconfigure the indicator this can be done safely in situ using the indicator's front panel push buttons which are intrinsically safe.

Appendix 1
US and Canadian certification

BA304SG, BA304SG-SS, BA324SG and BA324SG-SS loop powered indicators have AEx eb ETL approval allowing installation in NEC505 Zones 1 and 2 in the USA. They also have Ex eb cETL approval for use in Canada.

The ETL and cETL gas parameters are the same as the IECEx parameters shown in 7.1.1, but AEx tb dust approval is **NOT** included. Installations in the USA and Canada must comply with the BEKA Control Drawing CI300-68 and with local codes of practice.

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