BA404B, BA405B & BA405C Intrinsically safe manual setpoint stations

BEKA associates

APPLICATION GUIDE AG404

BA404B, BA405B & BA405C

Intrinsically safe manual set point stations

1. Description

1.1 Electrical

The BA404B and BA405B manual set point stations enable the current flowing in a 4/20mA loop to be manually adjusted from the process area. The field and panel mounting models, which are electrically identical, are loop powered and require no additional power supply or batteries. Both models have been certified intrinsically safe by BASEEFA to the CENELEC standard.

The BA405C is a replacement for the BA405B which provides enhanced features and can be fitted with an optional internal digital indicator. It is anticipated that a BASEEFA certificate will be issued for the BA405C in December 1996.

The set point stations are current sinks which can be manually adjusted to pass any current between 4 and 20mA. Fig 1 shows an equivalent circuit. The output resistance of the current sink is very high, so the current is virtually unaffected by changes in the supply voltage within the operating limits of 10 and 30V (5 to 30V for BA405C). Zener diode D1 protects the manual set point station from overvoltage and damage caused by reverse connection.

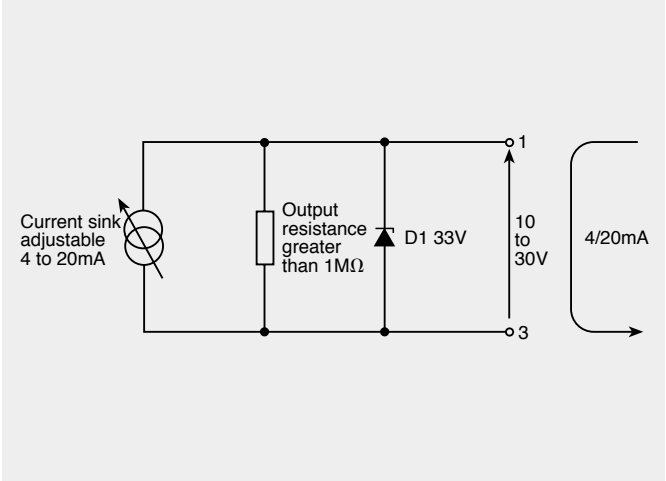

Figure 1. Equivalent circuit of manual set point station

1.2 BA404B field mounting manual set point station

The BA404B is housed in an epoxy painted cast aluminium case which is sealed with a neoprene gasket to form an IP65 enclosure. The enclosure may be surface mounted or clamped to a pipe stand using the optional pipe mounting kit. The 32mm diameter 10 turn control knob is ungraduated and fitted with a heavy duty locking mechanism and mechanical end stops. Both the control and locking knobs are deeply knurled allowing easy adjustment by an operator wearing gloves.

The BA404B enables the current flowing in a loop to be set at any value between approximately 3.5 and 21mA. If an indication of the current flowing in the loop is required, a BA304C intrinsically safe indicator may be connected in series with the manual set point station. If the indicator is calibrated in the units represented by the 4/20mA signal, e.g. temperature or pressure, the operator will have an accurate display of the manual set point station output in engineering units.

1.3 BA405B panel mounting manual set point station

The panel mounting BA405B is housed in a 96 x 48 DIN standard Noryl enclosure which flush mounts onto a control panel. The 10 turn control knob, which is not graduated, enables the current flowing in the loop to be set to any value between approximately 3.5 and 21mA. If an indication of the current is required, a BA307C or BA308C intrinsically safe panel mounting digital indicator may be connected in series with the manual set point station. If the indicator is calibrated in the units represented by the 4/20mA signal, e.g. temperature or pressure, the operator will have an accurate display of the manual set point station output in engineering units.

1.4 BA405BT panel mounting manual set point station with turns counting dial

The BA405BT is identical to the BA405B, apart from the inclusion of a 10 turn mechanical counting dial. The dial shows the 4/20mA output as a percentage of 16mA with a resolution of 0.1 per cent. The BA405BT provides a lower cost alternative to a BA405B plus an electronic digital indicator when a display in engineering units is not required.

1.5 BA405C panel mounting manual set point station

The BA405C is a new intrinsically safe manual set point station incorporating enhanced features which will supersede the BA405B. It is anticipated that a BASEEFA certificate will be issued in December 1996.

The BA405C is identical to the BA405B except that it:

- Will operate from a 5V supply
- Can be supplied with an integral $3^1/_2$ digit indicator.
- Will be certified EEx ia IIC T5
- Has an IP65 front

1.6 BA505C panel mounting manual set point station

The BA505C is a non certified version of the BA405C for use in safe areas.

2. Explanation of the BA404B and BA405B intrinsic safety certification

2.1 The CENELEC certificate

The BA404B and BA405B set point stations have been certified intrinsically safe by BASEEFA to BS5501: Part1:1977 EN50 014 and BS5501:Part7:1977 EN50 020. The set point stations bear the Community Mark and, subject to local Codes of Practice, may be installed in any of the CENELEC member countries i.e. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom. This guide describes installations which conform with the UK Code of Practice BS5345:Part 4:1977. When designing systems for installation outside the UK the local Code of Practice should always be consulted.

The BA404B and the BA405B have the same BASEEFA apparatus and system certificate numbers. The BA404B is shown on the primary certificates and the BA405B on variations of the original certificates. Copies of these certificates are available from BEKA associates.

2.2 Zones, Gas Groups & T ratings

The BA404B & BA405B have been certified EEx ia IIC T4, which means that when connected to a suitable Zener barrier or galvanic isolator they may be installed in:

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

Be used with gases or vapours in gas groups:

Group IIA	propane
Group IIB	ethylene
Group IIC	hydrogen

Having a temperature classification of:

T1	450^0C
T2	300^0C
T3	200^0C
T4	135^0C

This means that the BA404B and BA405B manual set point stations may be installed in all Zones, and be used with most common industrial gases except carbon disulphide and ethyl nitrate.

2.3 Safety description

The system certificates for the BA404B and BA405B define the safety parameters of the Zener barrier to which the manual set point stations may be connected. The certificates state:

This allows the BA404B and the BA405B to be connected to

"A shunt Zener Diode Safety Barrier or an arrangement of shunt Zener Diode Safety Barriers certified by an EEC approved body to [EEx ia] IIC with a maximum open circuit voltage (Uz or Umax:out) not exceeding 30 volts and power into an optimum load not exceeding 1W. In any safety barrier/s used the output power must be limited by a resistor/s 'R' such that:

$$\frac{(Uz \text{ or } Umax:out)^2}{4R} \text{ is not greater than 1W".}$$

single channel 28V 300Ω barriers, 28V 300Ω plus 10V 50Ω barriers, and 28V 300Ω plus diode return barriers.

The set point stations may also be connected to the galvanic isolators specified on the system certificates.

2.4 Cable parameters

The BA404B and BA405B do not contain significant inductance or capacitance. The maximum permissible capacitance, inductance and L/R ratio for the cables connecting the manual set point station to the Zener barrier or galvanic isolator are therefore those specified on the system certificate for the barrier or isolator used.

2.5 Connection to other equipment within the hazardous area

The BA404B and BA405B certificates allow an optional loop powered indicator to be connected in series with the manual set point station. The indicator must be certified EEx ia IIC T4, T5 or T6 and have Intrinsic Safety parameters not exceeding 1.2V, 100mA, 25mW or 20μJ. The BEKA BA300 series intrinsically safe digital indicators comply with these requirements and may be connected in series with either set point station without additional certification.

No other equipment should be connected in series with the set point station within the hazardous area unless a system certificate is available, or the equipment complies with the requirements for simple apparatus.

3. Electrical system design for hazardous area installations

3.1 Systems with a common power supply

The BA404B and the BA405B require a minimum operating voltage of 10V at 20mA and have a maximum permitted working voltage under all conditions of 30V. Design of a loop incorporating a manual set point station is similar to that for a 2-wire pressure or temperature transmitter.

Figure 2 shows a BA404B manual set point station controlling the current flowing through a BA304C local indicator and a 250 safe area load. The loop is powered from a common supply with the negative terminal earthed. To enable the negative side of the load to also be earthed, it is necessary to have a Zener barrier in series with both of the wires going to the hazardous area.

When designing a loop it is necessary to establish the maximum voltage drop caused by the manual set point station, both Zener barrier channels, the load, the local digital indicator and the cables, and to ensure that the sum of these voltage drops is less than the minimum power supply voltage. Considering the loop shown in Fig 2.

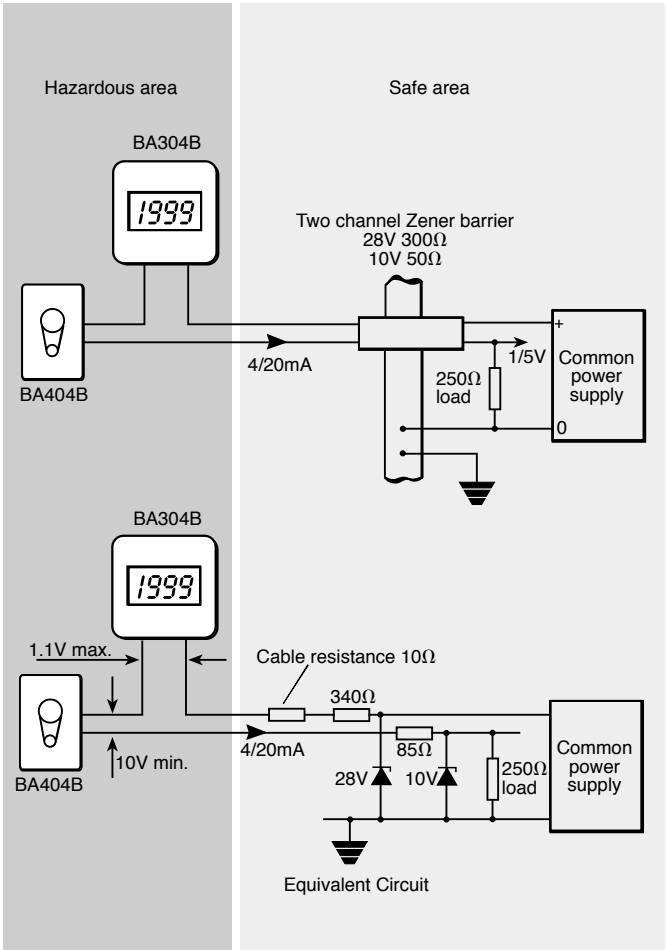

Fig 2 BA404B powered from common power supply

Total voltage drop around the loop shown in Figure 2	
Minimum operating voltage for BA404B manual set point station	10.0
Maximum voltage drop caused by BA304C digital indicator	1.1
Maximum voltage drop caused by 28V 300Ω barrier (340Ω end to end resistance x 20mA)	6.8
Maximum voltage drop caused by 10V 50Ω barrier (85Ω end to end resistance x 20mA)	1.7
Maximum voltage drop caused by 250Ω load (250Ω x 20mA)	5.0
Maximum voltage drop caused by cable resistance (10Ω x 20mA)	0.2
Total maximum voltage drop around loop	24.8V

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

3.2 Systems with a floating power supply

Fig 3 shows the set point of a safe area speed controller being adjusted by a BA404B located in a hazardous area. The set point input of the speed controller is floating, i.e. it is not connected to earth, therefore one of the wires entering the safe hazardous area may be earthed and only one Zener barrier channel is required. As in the previous example, the sum of the voltage drops around the loop must be less than the minimum supply voltage at 20mA, and the maximum supply voltage must be less than the maximum working voltage of the Zener barrier.

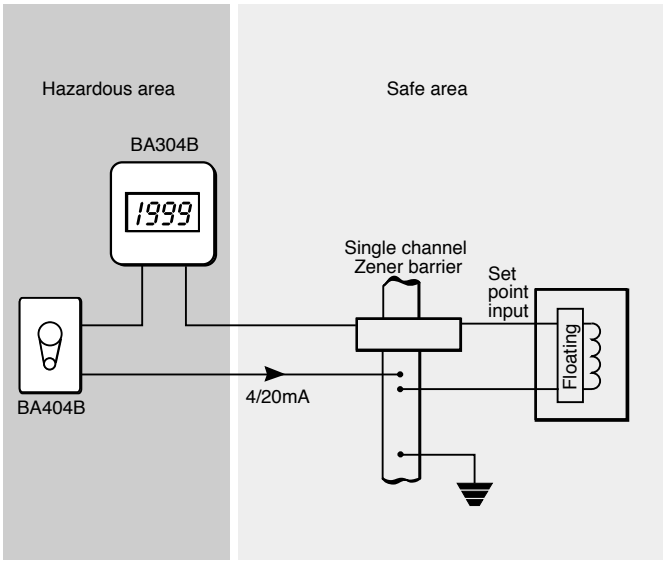

Fig 3 BA404B powered from a floating supply

3.3 Use with galvanic isolators

Galvanic isolators, although more expensive than Zener barriers, do not require a high integrity earth connection. For small systems where a high integrity earth is not already available, the use of isolators often reduces overall installation costs.

The example described in section 3.1 can be simplified by the use of an isolator as shown in Fig 4. Again, voltage drops must be considered, but the available voltage in the hazardous area is usually greater than in loops incorporating Zener barriers. In the United Kingdom only the galvanic isolators specified on the systems certificates should be used.

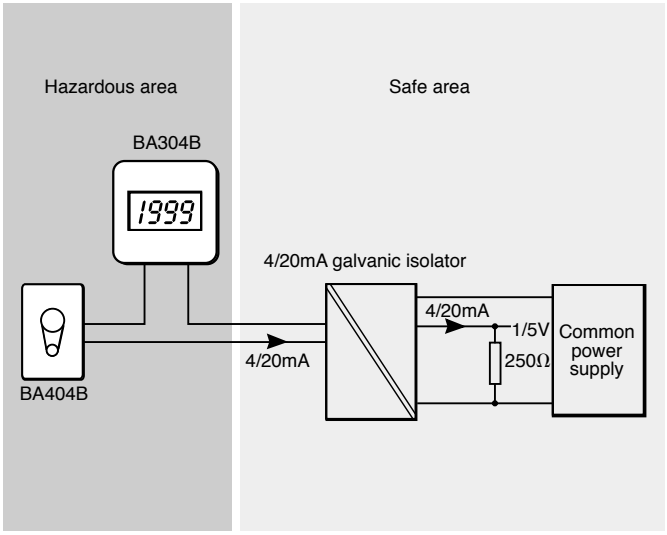

Fig 4 Use with a galvanic isolator

4. Use of a BA405C

The BA405C may be used in exactly the same way as the BA405B which it will replace. However, the minimum operating voltage is only 5V which enables lower power supply voltages or higher resistance loads to be driven. The BA405C can incorporate an optional digital indicator which will simplify loop design, and reduces panel space and costs.

5. Electromagnetic compatability

All the manual set point stations described in this Application Guide comply with the European EMC Directive 89/336/EEC and carry the CE mark. Copies of the test reports are available from BEKA associates.