

### 1. Introduction

This application guide describes the use and installation of BA390 and BA390S intrinsically safe LED panel lamps. It also describes the general purpose non-certified 24V BA590 panel lamp for use in non-hazardous areas.

### 2. Description

There are three types of panel lamp in this range:

- BA390X** Certified intrinsically safe lamp that draws a constant 20mA from an intrinsically safe voltage source.
- BA390XS** Certified intrinsically safe low current lamp which requires an external current regulator.
- BA590X** General purpose panel lamp for use in non-hazardous safe areas. Draws a constant 20mA from a 14 to 30V dc supply.

Each type of panel lamp is available in five well defined colours indicated by the model number suffix.

Colour	Intrinsically safe		Safe area
	20mA lamp	Low current lamp	20mA lamp
Red	BA390R	BA390RS	BA590R
Green	BA390G	BA390GS	BA590G
Amber	BA390A	BA390AS	BA590A
Blue	BA390B	BA390BS	BA590B
White	BA390W	BA390WS	BA590W

#### 2.1 BA390X panel lamps

These panel lamps contain a 20mA constant current regulator and therefore draw a fixed current and have constant brilliance irrespective of supply voltage variations. They have IECEx and ATEX gas and dust intrinsic safety certification and FM gas intrinsic safety and nonincendive certification.



LED panel lamp

Fig 1 shows the equivalent circuit of a BA390X panel lamp. When the supply voltage to the lamp exceeds the minimum operating voltage of 14V the lamp will draw a constant current between 18 and 22mA and the lamp brilliance will be constant. Table 1 shows the typical illuminance from different colour BA390 lamps.

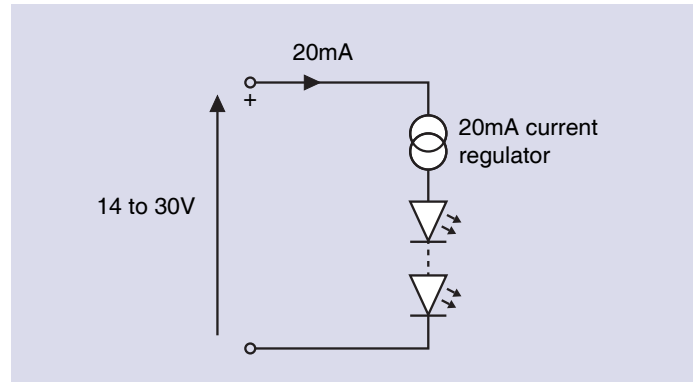


Fig 1 Equivalent circuit of BA390X

Below the minimum supply voltage the lamp will have a reduced brilliance and below a voltage which varies with the lamp's colour, it will not be illuminated.

Colour	Red	Green	Amber	Blue	White
Output lux	163	231	235	530	273

Table 1 Typical BA390X illuminance in lux 15cm from the lamp.

## 2.2 BA390XS panel lamps

This range of panel lamps are optimised for operation at low currents, if powered from a voltage source they require an external current regulator such as a series resistor or electronic current regulator. They are intended for low current applications or where it is required to vary the lamp brightness. They have IECEx and ATEX gas and dust intrinsic safety certification and FM gas intrinsic safety and nonincendive certification.

Fig 2 shows the equivalent circuit of a BA390XS panel lamp. The lamp brilliance is proportional to the input current as shown in Table 2.

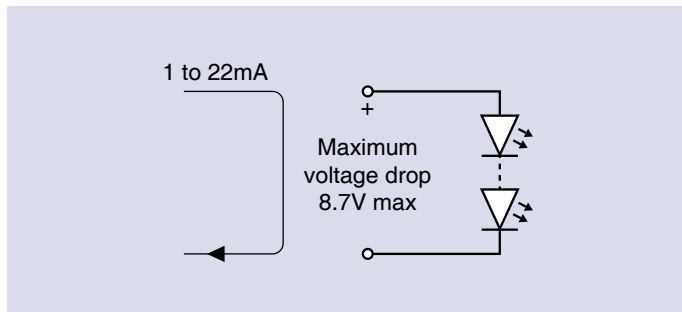


Fig 2 Equivalent circuit of BA390XS

Current mA	BA390XS colour				
	Red	Green	Amber	Blue	White
1	15	14	12	22	14
2	20	25	22	44	28
3	43	36	34	66	43
4	58	46	46	87	58
5	72	55	56	108	72
6	86	65	68	128	84
8	114	81	91	168	108
10	142	95	112	206	132
15	213	126	168	294	192

Table 2 BA390XS illuminance in lux 15cm from the lamp.

## 2.3 BA590X panel lamps

Intended for use in non hazardous areas these uncertified lamps incorporate a 20mA constant current regulator and therefore consume a fixed current and have constant brilliance irrespective of supply voltage variations. When the supply voltage to the lamp exceeds the minimum operating voltage the lamp will draw a constant current between 18 and 22mA and the lamp brilliance will be constant. Below the minimum supply voltage the lamp will have a reduced brilliance and below a voltage which varies with the lamps colour, the lamp will not be illuminated.

## 3. Intrinsic Safety Certification

The BA390X and BA390XS panel lamps have international intrinsic safety certifications allowing them to be installed in gas and dust hazardous areas worldwide. Dust certification is an option which should be specified when the lamp is ordered.

Both types of lamp have IECEx Certificates of Conformity issued by Certification Body Intertek Testing and Certification Ltd. IECEx certificates, which are based on international IEC standards, are accepted directly or indirectly in large parts of the world.

Notified Body Intertek Testing and Certification Ltd have also issued both types of panel lamp with an EU-Type Examination Certificate confirming compliance with BS EN harmonised standards which has been used to confirm compliance with the European ATEX Directive 2014/34/EU. The lamps carry 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 accepted for installations in many other countries - see Blue Book for details.

BS EN standards are identical to international IEC standards, therefore the ATEX and IECEx certificates for these panel lamps use the same terminology and have the same safety parameters.

For use in the USA both types of lamp have FM intrinsic safety and nonincendive approval for use in gas atmospheres.

### 3.1 IECEx and ATEX certification

#### 3.1.1 Gas atmospheres

The BA390X and BA390XS panel lamps have been certified:

Group II Category 1G  
Ex ia IIC T4 Ga  
 $-20^{\circ}\text{C} \leq T_a \leq 60^{\circ}\text{C}$

When connected to a suitable system the lamps 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 in groups:

Group A	propane
Group B	ethylene
Group C	hydrogen

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

T1	450°C
T2	300°C
T3	200°C
T4	135°C

In ambient temperature of between

-20°C and +60°C.

This allows both types of panel lamp to be installed in all Zones and to be used with most common industrial gases.

### 3.1.2 Dust atmospheres - option should be specified at time of ordering.

The BA390X and BA390XS panel lamps have been certified:

Group II Category 1D  
Ex ia IIIC T135°C Da  
-20°C ≤ Ta ≤ 60°C

When connected to a suitable system the lamps may be installed in:

Zone 20	explosive atmosphere in the form of a cloud of combustible dust in air is continuously present, or for long periods or frequently.
Zone 21	explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur occasionally in normal operation.
Zone 22	explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation, but if it does occur, will only persist for a short period.

Be used with dusts in subdivisions:

IIIA	combustible flyings
IIIB	non-conductive dust
IIIC	conductive dust

Having a minimum ignition temperature of:

Dust cloud	202°C
Dust layer on lamp up to 5mm thick.	210°C
Dust layer on lamp over 5mm thick.	Refer to IEC 60079-14

At an ambient temperatures between:

-20°C and +60°C.

### 3.1.3 Input safety parameters

The IECEx and ATEX input safety parameters  $U_i$  and  $I_i$  for the BA390X and BA390XS lamps are the same, but the input power  $P_i$  are different for gas and dust atmospheres.

Gas atmosphere:

$U_i$	=	30V
$I_i$	=	159mA
$P_i$	=	1.2W
$C_i$	=	0
$L_i$	=	0

Dust atmosphere:

$U_i$	=	30V
$I_i$	=	159mA
$P_i$	=	0.683W
$C_i$	=	0
$L_i$	=	0

BA390X and BA390XS panel lamps may be powered from any intrinsically safe voltage source with output parameters  $U_o$ ,  $I_o$  and  $P_o$  equal to, or less than these lamp input parameters.

## 4 System Design

### 4.1 BA390X lamps

BA390X panel lamps draw a current of between 18 and 22mA when their terminal voltage is between 14 and 30V. If the terminal voltage falls below 14V, the current consumed and the lamp brilliance are reduced.

There are three design steps:

1. Select a Zener barrier, galvanic isolator or certified voltage source with output safety parameter equal to or less than the BA390X maximum input parameters i.e.

$$\begin{aligned} U_o &= 30V \text{ dc} \\ I_o &= 159\text{mA} \\ P_o &= 1.2W \text{ for gas hazards} \\ &= 0.683W \text{ for dust hazards} \end{aligned}$$

2. Ensure that the cable capacitance and inductance are less than the maximum figures specified by the intrinsic safety certificate for the device powering the lamp(s).
3. Ensure that the voltage across the BA390X terminals is equal to or greater than 14V.

Fig 3 shows a simple application in which a single BA390X lamp is powered by a Zener barrier. The lamp may be turned on and off by switching the power supply on and off, or by a switch in series with the lamp in the safe area. The lamp may also be controlled by an IP20 protected manually operated switch in the hazardous area.

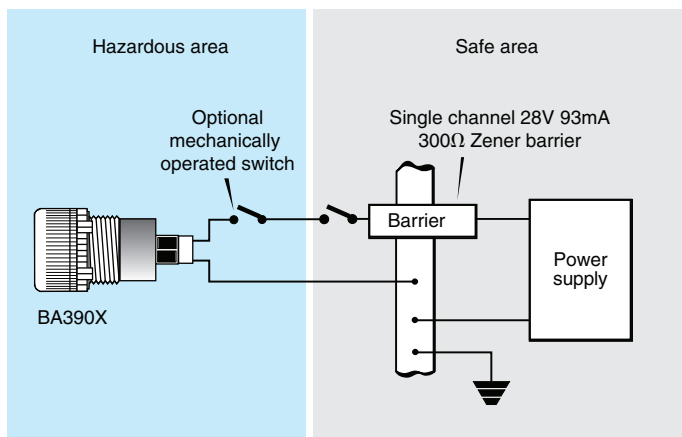


Fig 3 BA390X powered from a Zener barrier

Considering the voltage drops

Minimum operating voltage of BA390X	14.0V
Maximum voltage drop caused by barrier (22mA x 330Ω*)	7.3V
Maximum voltage drop caused by cables (22mA x 10Ω cable resistance)	0.2V
	<hr/>
	21.5V

\* maximum end-to-end resistance of barrier

The power supply must therefore have an output of greater than 21.5V but less than the maximum operating voltage of the Zener barrier, which is typically 26.5V.

Alternatively a BA390X lamp may be powered from a galvanic isolator which can power two lamps in parallel as shown in Fig 4.

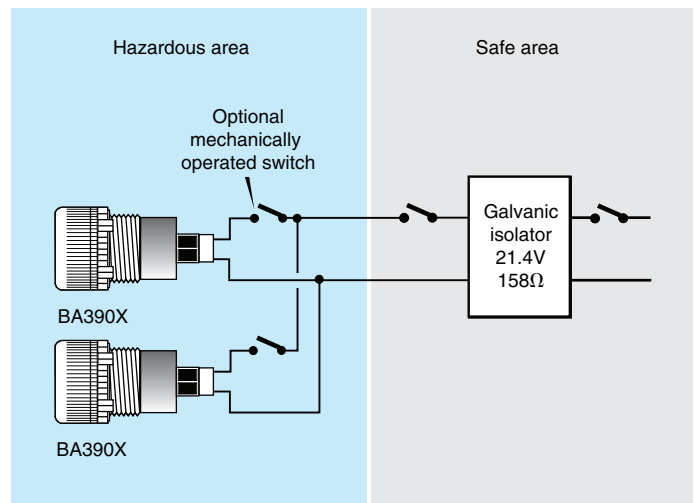


Fig 4 Two lamps powered by a IIB galvanic isolator

Considering the voltage drops when powering two BA390X lamps in parallel.

Open circuit voltage of galvanic isolator	21.4
Less maximum voltage drop caused by isolator (44mA x 158Ω*)	6.9
Less maximum voltage drop caused by cables (44mA x 10Ω)	0.4
Voltage at BA390X lamps	<hr/>
	14.1V

\* maximum output resistance of galvanic isolator

## 4.2 BA390XS

BA390XS lamps, unlike the BA390X, do not contain a current regulator. The current drawn, and hence the brightness, must be defined by an external resistor or an external current regulator.

### Caution

**Connecting a BA390XS lamp to a non current limited source may permanently damage the lamp.**

BA390XS lamps are intended for use with low current intrinsically safe logic outputs and their performance is specified at 4mA. Fig 5 shows how one multiple output bus-powered fieldbus module can control up to six BA390XS lamps.

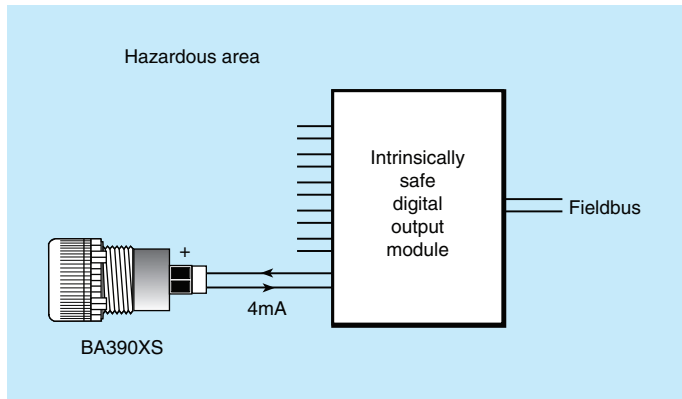


Fig 5 BA390XS lamp powered by multiple digital output fieldbus module

In this example the module has six isolated 12V outputs each current limited at 4mA, so no additional current limit is required.

When a BA390XS is powered from an intrinsically safe voltage source such as a Zener barrier or galvanic isolator, a series resistor is required to define the lamp current.

$$\text{Resistor value in k}\Omega = \frac{\text{IS supply voltage} - 8}{\text{Required lamp current in mA}}$$

This current limiting resistor may be installed in the hazardous area without additional certification using the rules for Simple Apparatus defined in section 5.7 of IEC 60079-11. The lamp current should be selected to provide the required brightness – see section 2.2 of this guide.

Fig 6 shows how four BA390XS lamps can be powered from a 24V dc supply via a single industry standard 28V 300 $\Omega$  Zener barrier or galvanic isolator. Each lamp operates at a minimum current of 5mA when all the lamps are illuminated, but the current rises and hence the lamp brightness increases when the other lamps are switched off.

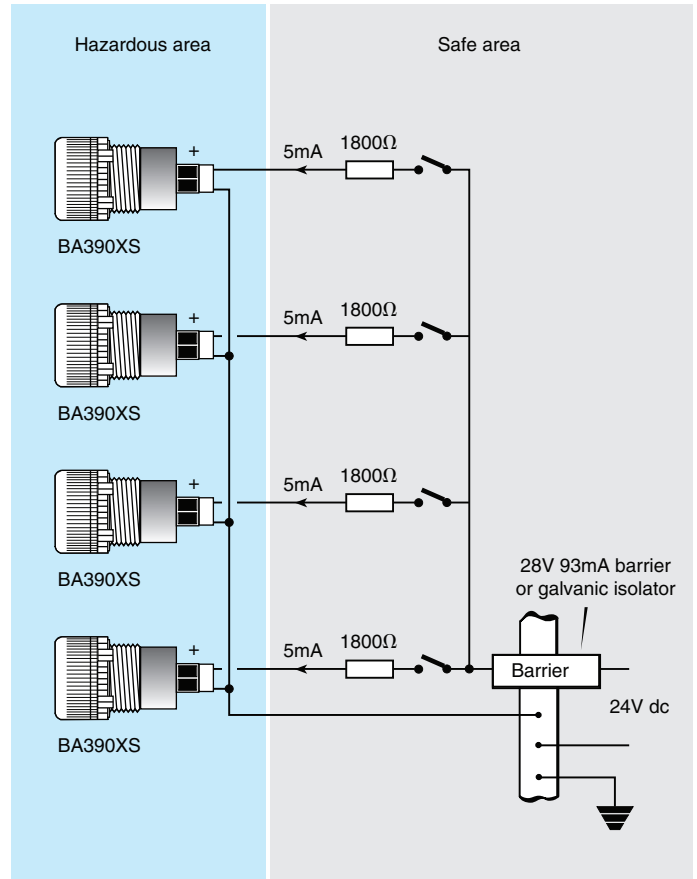


Fig 6 Four BA390XS lamps powered from a common barrier or isolator

## 5. Installation

BA390X and BA390XS lamps require a single 22.5mm diameter mounting hole and may be closely grouped as shown in Fig 7. The lamps are supplied with a gasket to seal the joint between the lamp body and the panel in which it is mounted. When correctly installed the front of the lamp provides IP66 protection and may be cleaned with a low pressure hose.

The rear of the lamp body has IP20 protection, but this can be increased to IP66 using the BA599 rear sealing kit which includes a gland to support the cable.

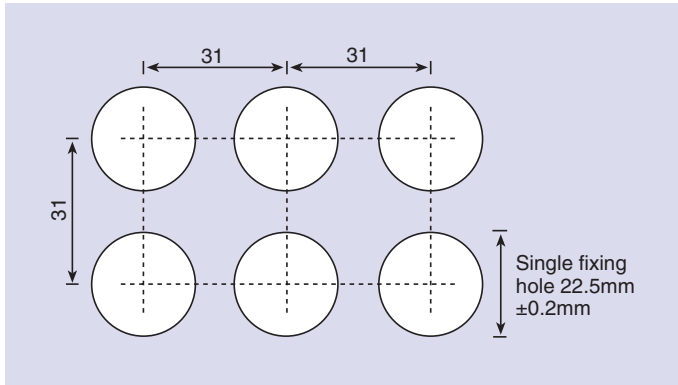


Fig 7 Fixing centres for maximum packing density

## 6. FM Approval

BA390X and BA390XS lamps have FM intrinsic safety and nonincendive approval allowing them to be installed in most gas hazardous areas in the USA. The FM and ATEX intrinsic safety parameters are identical so any of the circuits shown in this application guide may also be used for FM installations.

Detailed IS and nonincendive installation requirements are defined by FM Control Drawing CI390-12 which is appended to the FM Certificate of Compliance which may be downloaded from the BEKA website [www.beka.co.uk](http://www.beka.co.uk).

### 6.1 Intrinsic safety

FM intrinsic safety approval permits installation in:

Class I	Flammable gases, vapours or liquids
Division 1	Where ignitable concentrations of flammable gases, vapours or liquids can exist all of the time or some of the time under normal operating conditions.
Division 2	Where ignitable concentrations of flammable gases, vapours or liquids are not likely to exist under normal operating conditions.

Use with gases in groups:

Group	A	Acetylene
Group	B	Hydrogen
Group	C	Ethylene
Group	D	Propane

Having a temperature classification of:

T1	450°C
T2	300°C
T3	200°C
T4	135°C

At an ambient temperature between  $-20$  and  $+60^{\circ}\text{C}$  when powered from a barrier, isolator or voltage source with a  $U_o$  of less than 1.2W. When powered from a certified device having a  $U_o$  between 1.2 and 1.3W, the maximum permitted ambient temperature is reduced to  $+40^{\circ}\text{C}$ .

This allows BA390X and BA390XS lamps to be installed in both Divisions and to be used with most common industrial gases.

### 6.2 Nonincendive approval

FM nonincendive approval permits installation without Zener barriers or galvanic isolators in:

Class I	Flammable gases, vapours or liquids
Division 2	Where ignitable concentrations of flammable gases, vapours or liquids are not likely to exist under normal operating conditions.

Use with gases in groups:

Group	A	Acetylene
Group	B	Hydrogen
Group	C	Ethylene
Group	D	Propane

Having a temperature classification of:

T1	450°C
T2	300°C
T3	200°C
T4	135°C

At an ambient temperature between  $-20$  and  $+60^{\circ}\text{C}$

