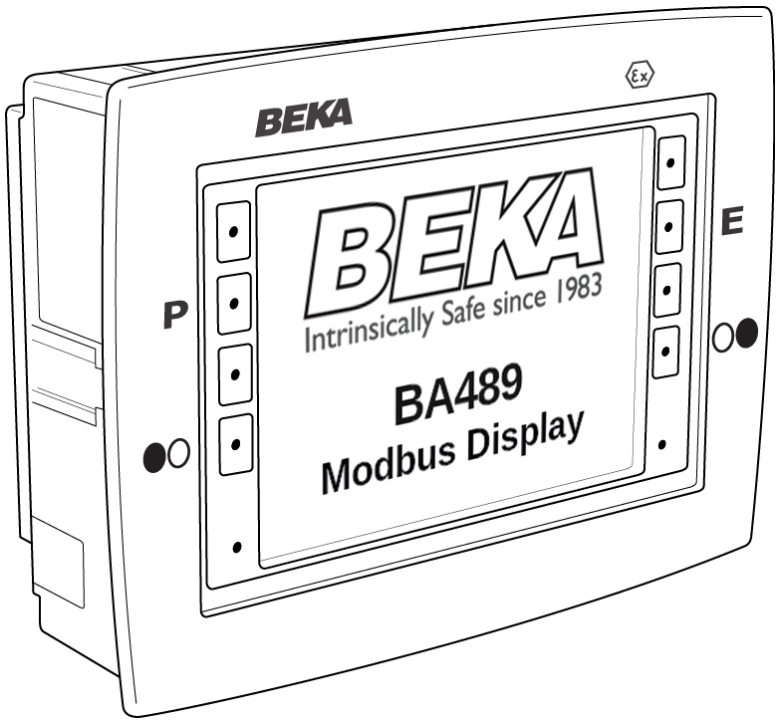
BA489-GL & BA489-PC
intrinsically safe
Modbus RTU Display

Issue 1



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The BA489 is CE marked to show compliance with the European Explosive Atmospheres Directive 2014/34/EU and the European EMC Directive 2014/30/EU.
It is also UKCA marked to show compliance with UK statutory requirements Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations UKSI 2016:1107 (as amended) and with the Electromagnetic Compatibility Regulations UKSI 2016:1091 (as amended).

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1. DESCRIPTION

The BA489 is a Modbus RTU panel mounting, intrinsically safe display. It is capable of displaying up to 8 process variables including bargraphs, units of measurements and tagging. One of nine different screens layouts can be selected to show one, two, four or eight process variables on the same screen. The BA489 is a Modbus slave only, it can not control other Modbus devices.

There are two electrically similar models:

Model	Application
BA489-GL	For intrinsic safety applications in Zones 0, 1, 2, 20, 21 and 22. Has a toughened glass display window surrounded by a stainless steel front panel. Provides IP66 front of panel protection.
BA489-PC	For intrinsic safety applications when mounted in an Ex e or Ex t enclosure. Impact resistant front ensures that enclosure apparatus certification is not invalidated. Scratch resistant polycarbonate display window surrounded by a stainless steel front panel. Provides IP66 front of panel protection.

Both models have IECEx, ATEX and UKEX Ex ia intrinsic safety certification allowing installation in Zone 0, 1, 2, 20, 21 or 22.

The Modbus RTU communication port is intrinsically safe and compliant with the Profibus RS485-IS User and Installation Guideline document. It is galvanically isolated from the power input. A RS485-IS isolator installed in the safe area or Zone 2 is also required.

The BA489 is powered by a BEKA power isolator located in a safe area, or in Zone 2 if mounted within an enclosure providing IP54 protection.
This instruction manual supplements the abbreviated instruction sheet supplied with each display.

2. CONSTRUCTION

The BA489 Modbus RTU display comprises a panel mounting BA3101 or BA3102 Operator Display containing a BA3202 CPU module. The Operator Display and each module have individual Ex ia intrinsic safety apparatus certificates allowing them to be safely interconnected in a hazardous area.

The CPU module is supplied pre-programmed. Only simple display configuration via the front panel touch buttons is required to configure the instrument.

If configuration information is supplied when the BA489 display is ordered, the display can be supplied configured, ready to install for no additional charge.

2.1 Controls

When power is applied to a BA489 display, the power indicator shown in Fig 1, which is located below the four touch buttons on the right hand side of the display will initially be red. After 100 seconds the indicator will be green and the screen will show the operating display. The start up sequence is shown in Fig 7.

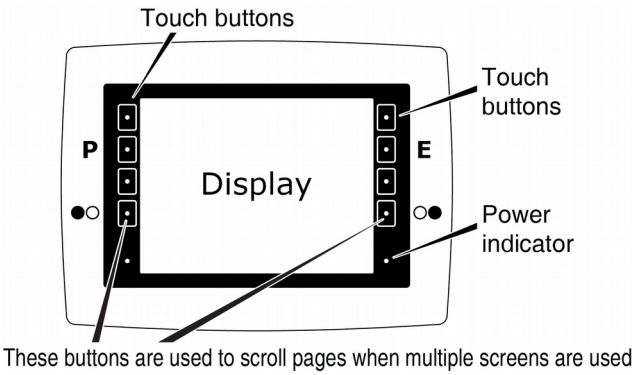


Fig 1 Controls

Access to the configuration menus is obtained by pressing the **P** and **E** touch buttons simultaneously at any time after completion of the start up sequence.

When a BA489 display is operating, the function of each touch button is under the control of the Modbus Master. The current state of the eight capacitive touch buttons is accessible via dedicated Modbus Input Status bits. Each touch button has a coloured backlight. It can be turned on or off via Modbus Holding Registers, the selectable colours are Red, Green or Amber. Note that the bottom left and right keys are used to scroll pages when less than 8 variables are shown on the screen.

The state of the display overall white backlight is also controllable by a Modbus coil which means it can be turned on or off according to current ambient light conditions.

3. INTRINSIC SAFETY CERTIFICATION

Both BA489 models have IECEx, ATEX and UKEX gas and dust certification.

3.1 Construction

The BA489-GL and the BA489-PC displays are constructed from two different modules, each with individual intrinsic safety apparatus certificates which specify that they may be safely interconnected in a hazardous area.

BA3101 or BA3102 Operator Display
IECEx CML 20.0150X
CML 20ATEX2252X
CML 21UKEX2003X

BA3202 CPU module
IECEx CML 20.0152X
CML 20ATEX2254X
CML 21UKEX2005X

The Operator Display and each module carry both the EU community CE mark and the UKCA mark. Subject to local codes of practice, BA489 displays may be installed in any of the European Economic Area (EEA) member countries and in the UK, plus areas which accept IECEx certification.

This section of the instruction manual describes IECEx, ATEX and UKEX installations conforming with EN 60079-14. When designing systems the local Code of Practice should always be consulted.

3.2 Gas Zones, groups and T rating

All the modules forming the BA489 display have been certified:

Group II Category 1G (ATEX & UKEX only)
Ex ia IIC T4 Ga
-40ºC ≤ Ta ≤ +65ºC

The BA489 display may be installed in, and connected to inputs 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

Having a temperature classification of:

T1	450ºC
T2	300ºC
T3	200ºC
T4	135ºC

At ambient temperatures between -40 and +65ºC.

Note: The operating temperature of the display is -20 to +65ºC.

This allows the BA489 to be installed in all gas Zones and to be used with most common industrial gases.

3.3 Dust Zones, groups and surface temperature

All the modules forming the BA489 display have been certified:

Group II Category 1D (ATEX & UKEX only)
Ex ia IIIC T135 Da
-40ºC ≤ Ta ≤ +65ºC

The BA489 display may be installed in, and connected to inputs in:

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

Be used with dust 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 display up to 5mm thick	210°C
Dust layer on display over 5mm thick.	Refer to EN 60079-14

At an ambient temperature between -40 and +65°C
See section 3.4 iii of these instructions.

Note: The operating temperature of the display is -20 to +65ºC.

3.4 Special conditions for safe use

All the certificate numbers for the modules comprising the BA489 have an 'X' suffix indicating that special conditions for safe use apply.

i. Under certain extreme circumstances, the non-metallic parts incorporated in the enclosure of this equipment may generate an ignition-capable level of electrostatic charge. Therefore, the equipment shall not be installed in a location where the external conditions are conducive to the build-up of electrostatic charge on such surfaces. In addition, the equipment shall only be cleaned with a damp cloth.

ii. The metal bezel of the equipment shall be connected to earth via the integral earth stud.

iii. In installations requiring EPLs Da, Db, or Dc, the surface temperature assigned to the BA3101 or BA3102 Operator Display (135ºC) shall take precedence over the surface temperature assigned to any module which may be installed within its enclosure.

iv. In installations requiring EPL Da, Db, or Dc, the equipment shall be mounted to an enclosure which provides a minimum degree of protection of IP5X and which meets the requirements of EN60079-0 Clause 8.4 (material composition requirements for metallic enclosures for Group III) and/or EN60079-0 Clause 7.4.3 (Avoidance of a build up of electrostatic charge for Group III) as appropriate. All cable entries into the equipment shall be made via cable glands which provide a minimum degree of protection of IP5X.

3.5 Power input

The BA489 display is powered via a BA212 single channel Power Isolator, or from a BA243 Power Isolator and a BA3901 Power Combiner.

CAUTION

Do not power a BA489 display from a 24V dc supply without a BA212 or BA243 Power Isolator.

The BA489 intrinsic safety input parameters for the power input terminals TB1 are:

Ui ≤ 12.4V
Ii ≤ 2.68A
Pi ≤ 5.44W
Ci = 0
Li = 0

3.6 Communication Port

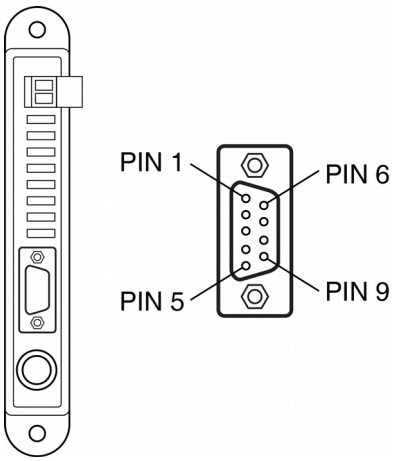
The BA489 communication port has the following input/output safety parameters:

Ui ≤ 4.2V
Uo ≤ 3.8V
Io ≤ 132mA
Po ≤ 126mW
Ci = 0
Li = 0

These parameters comply with the Profibus RS485-IS User and Installation Guideline, version 1.1 which means that RS485-IS compliant isolators can be used. BEKA can assist in selecting a suitable isolator.

Pin no.	Signal	Meaning
1	Shield	Cable screen
2	NC	
3	RxD/TxD-P	Received / transmitted data P; wire B
4	NC	
5	ISGND	Bus termination ground
6	ISP	Bus termination plus
7	NC	
8	RxD/TxD-N	Received / transmitted data N; wire A
9	NC	

Pin numbers for female 9-pole D-sub RS485-IS connector on BA489



CAUTION

When the port is fitted with a sub D9 male or BA3903 connector, the bus cable must be supported to prevent vibration damage to the connectors.

The BA3903 Sub D9 Connector and Terminator is used to connect field wiring to the BA489 communication port. It includes a switchable end of line resistor which is required for Modbus devices connected to the end of the bus.

4. SYSTEM DESIGN FOR GAS HAZARDOUS AREAS

4.1 Powering a BA489 display

CAUTION
Do not power a BA489 display from a 24V dc supply without a BA212 or BA243 Power Isolator.

For applications in gas groups IIA, IIB and in dust hazardous atmospheres, the BA489 display is powered by a BEKA BA212 Power Isolator. A BA212 Power Isolator may also be used for IIC applications when the cable length between the isolator and the display is less than a few metres long.

For most applications in a IIC gas hazardous atmosphere a BEKA BA243 Power Isolator should be used. This has four galvanically isolated intrinsically safe outputs which are remotely combined by a certified BA3901 4 way Power Combiner mounted on the BA489 display allowing longer field cables to be used.

CAUTION
Parameters for the actual cable being installed should be used when calculating the maximum safe length.

4.2 Applications in Group IIB and IIA gases

Fig 2 shows a BA212 Power Isolator powering a BA489 display. The cable between the BA212 and the BA489 should be selected to have a total inductance of less than Lo of the BA212 isolator, **or** an L/R ratio of less than Lo/Ro of the BA212 isolator as shown below.

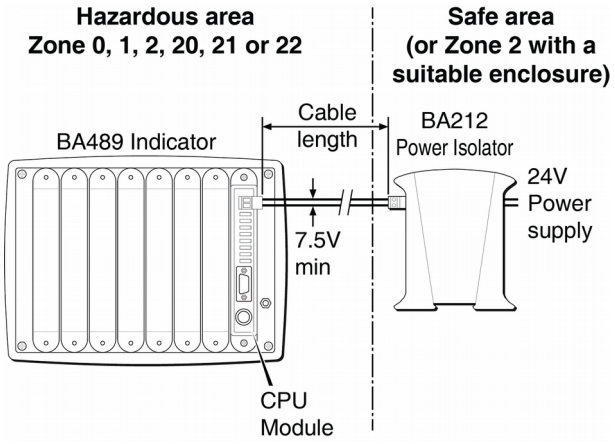


Fig 2 BA489 powered by BA212 Power Isolator

4.2.1 Maximum cable length determined by total cable inductance.

	Gas group		
	IIC	**IIB**	**IIA**
Lo of BA212 isolator	5µH	20µH	40µH

Most twisted pair instrument cables have an inductance of less than 0.8µH per metre. The addition of a screen or armour makes little difference. Twisted pairs within multicore cables also have a similar inductance. With a 0.8µH per metre cable, the maximum permissible cable length between a BA212 Power Isolator and a BA489 display is:

	Gas group		
	IIC	**IIB**	**IIA**
	6m	25m	50m

For dust applications, the IIB figures should be used.

4.2.2 Maximum cable length determined by cable L/R ratio.

Any cable with an L/R ratio equal to, or less than, the BA212 isolator's Lo/Ro ratio may be used. The practical maximum cable length depends upon the voltage drop caused by the cable, which must not reduce the voltage at the BA489 display below 7.5V.

	Gas group		
	IIC	**IIB**	**IIA**
Lo/Ro of BA212	4.3µH/Ω	17µH/Ω	34µH/Ω

Instrumentation cables with an L/R ratio equal to, or less than 4.3µH/Ω, required for IIC gas application are not generally available, but those for use in IIB and IIA gases are produced by multiple manufacturers.

Cable parameters for a typical twisted pair instrument cable (*Draka Norsk Kabe FlexFlame RFOU(i) 150/250(300)*) are shown below:

Inductance	**Resistance**	**L/R ratio**
0.67µH/m	26.3mΩ/m	12.7µH/Ω

Using this cable, the maximum cable length between the BA212 Isolator and the BA489 display will be:

	Gas group		
	IIC	**IIB**	**IIA**
Cable length	-	155m	155m

The cable length is limited by the voltage drop caused by the cable as explained in Appendix 1 of these instructions. Further information is contained in the BEKA Application Guide AG210.

4.3 Applications in Group IIC gases

For most applications in a group IIC gas, the BEKA BA243 Power Isolator should be used as shown in Fig 3. This has four galvanically isolated outputs which are remotely combined by a BA3901 Power Combiner at the BA489 display allowing a much longer cable length for applications in gas group IIC.

Each of the four cables between the BA243 Power Isolator and the BA3901 Power Combiner should be selected to have a total inductance of less than, Lo of each BA243 isolator output, **or** an L/R ratio of less than Lo/Ro of each BA243 isolator as shown below.

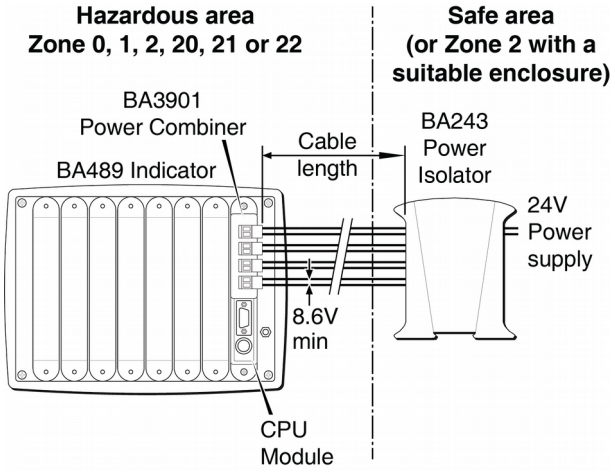


Fig 3 BA489 powered by a BA243 Power Isolator

4.3.1 Maximum cable length determined by total cable inductance.

	Gas group		
	IIC	**IIB**	**IIA**
Lo of each BA243 output	79µH	317µH	637µH

Most twisted pair instrument cables have an inductance of less than 0.8µH per metre. The addition of a screen or armour makes little difference. Twisted pairs within multicore cables also have a similar inductance. With a 0.8µH per metre cable, the maximum permissible cable length between a BA243 Power Isolator and a BA489 display is:

	Gas group		
	IIC	**IIB**	**IIA**
Maximum cable length	97m	396m	796m

However, for distance greater than approximately 300m in IIB and IIA gases the cable resistance voltage drop will become the limiting factor.

If the four isolator outputs are connected to the BA489 display via a multicore cable, the cable should be a Type A or a Type B multicore as defined in IEC 60079-14.

4.3.2 Maximum cable length determined by cable L/R ratio.

Any cable with an L/R ratio equal to, or less than, the Lo/Ro ratio of each BA243 output may be used. The practical maximum cable length depends upon the voltage drop caused by the cable, which must not reduce the voltage at the BA3901 Power Combiner mounted to the BA489 display terminals to less than 8.6V.

	Gas group		
	IIC	**IIB**	**IIA**
Lo/Ro of each BA243 output	17µH/Ω	68µH/Ω	137µH/Ω

Cable parameters for a typical twisted pair instrument cable (*Draka Norsk Kabe FlexFlame RFOU(i) 150/250(300)*) are shown below:

Inductance	**Resistance**	**L/R ratio**
0.67µH/m	26.3mΩ/m	12.7µH/Ω

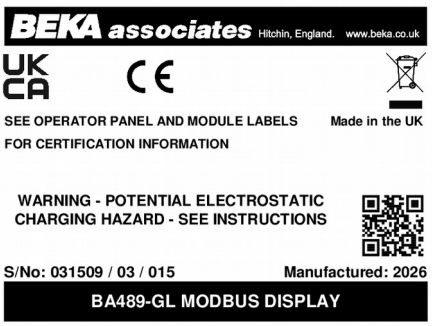
Using this cable, the maximum cable length between the BA243 isolator and the BA3901 Power Combiner at the BA489 display terminals will be:

	Gas group		
	IIC	**IIB**	**IIA**
Cable length	800m	800m	800m

Additional information about calculating maximum cable lengths is contained in Appendix 2 of these instructions, and in the BEKA Application Guide AG210.

4.4 Documentation and certification labels

Each of the apparatus certified modules forming the BA489 display has its own certification label showing certification information, the module serial number, year of manufacture plus the name and location of BEKA associates. The complete BA489 display assembly also carries a label showing the product name, serial number and BEKA associates name and location.



All intrinsically safe system installations should have a Descriptive Systems Drawing defining why the system is safe, as specified in EN 60079-25 I*ntrinsically safe electrical systems.* As the BA489 consists of a number of interconnected modules each with apparatus certification, it is an intrinsically safe system and requires a Descriptive Systems Drawing.

To assist users prepare a Descriptive Systems Drawing for their installation, Appendix 3 contains examples of Descriptive System Drawings for a BA489 display powered by a BA212 or BA243 Power Isolator and connected to an RS485-IS communication isolator.

All the intrinsic safety certificates can be downloaded from the BEKA website.

5. INSTALLATION

The BA489-GL and BA489-PC intrinsically safe panel mounting displays feature a 316 stainless steel front panel surrounding the display, with a silicone moulded gasket to seal the joint between the display and the instrument panel. The fronts of both models, including the seal between the display and the instrument panel, have third party certified IP66 protection. The rear of both models have IP20 protection.

The BA489-GL display has a toughened glass display window. It may be installed in all gas and dust hazardous environments permitted by the instruments intrinsic safety certification.

The BA489-PC display has a scratch resistant polycarbonate display window. The front of the display has been certified compliant with Ex e and Ex t impact and ingress requirements. For intrinsic safety applications, this allows the BA489-PC to be installed in an Ex e or Ex t enclosure without invalidating the certification of the enclosure.

Although the front of all BA489 displays have IP66 protection, if possible they should be shielded from continuous direct sunlight and severe weather conditions.

CAUTION

The front panel touch buttons should not be exposed to salt water.

5.1 EMC

The BA489 display complies with the requirements of the European EMC Directive and the UK EMC statutory requirements. For specified immunity all wiring should be in screened twisted pairs, with the screens earthed at one point within the safe area.

5.2 Installation Procedure

1. Cut the aperture specified in Fig 4 in the instrument panel and ensure that all edges are deburred.
2. First ensure that all eight panel mounting clamps are closed by turning the knurled screws fully anticlockwise until the two pips in the clamp foot align with holes in the clamp body as shown in Fig 5.
3. Ensure that the panel sealing gasket is correctly positioned before inserting the BA489 display into the panel aperture.
4. Place a clamp in the recess on each side of the BA489 display, pulling gently to slide it onto the dovetail as shown in Fig 5. Push the knurled screw slightly forward to engage the thread and tighten by turning clockwise until it is just finger tight. When both clamps are fitted ensure that the gasket behind the front panel bezel remains correctly positioned before fitting the remaining six panel mounting clamps. Finally, fully tighten all the panel clamps to secure the instrument. The maximum recommended clamp tightening torque is 25cNm (2.2lbf in) which is approximately equivalent to finger-tight plus one half turn. Do not over tighten.
5. Connect the power supply and RS485-IS communication cable as shown in Figs 2, 3 and 6.
6. Connect the BA489 display earth stud shown in Fig 6 to earth. If metallic, the instrument panel in which the display is mounted should also be earthed.

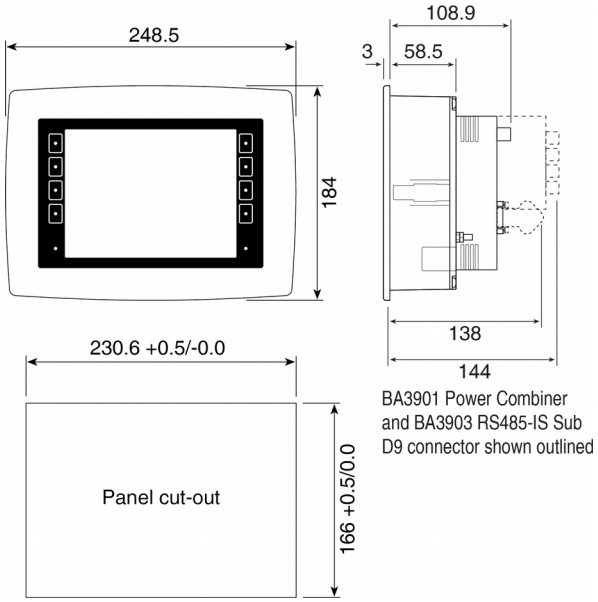


Fig 4 Dimensions including cut-out

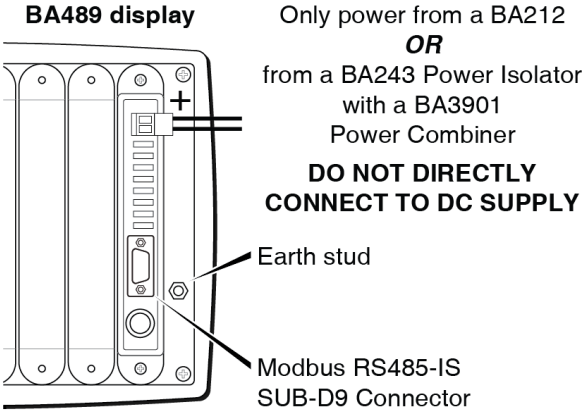
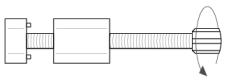


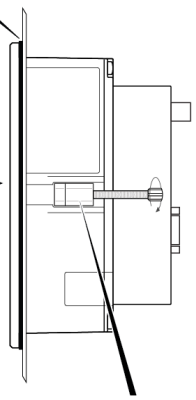
Fig 6 BA489 Power and Communication Port connections

a. Align foot and body of panel mounting clamp by turning screw anticlockwise



b. Position gasket behind instrument bezel

c. Insert BA489 display into the panel from the front



d. Place a clamp in the recess on each side of the BA489 display, pulling gently to slide them onto the dovetails. Push the knurled screws slightly forward to engage the threads and tighten by turning clockwise until both are just finger tight. When both clamps are fitted, ensure that the gasket behind the front panel bezel remains correctly positioned before fitting the remaining six panel mounting clamps. Finally, fully tighten all the panel clamps to secure the instrument. The maximum recommended clamp tightening torque is 25cNm (2.2lbf in) which is approximately equivalent to finger-tight plus one half turn.

DO NOT OVERTIGHTEN.

Fig 5 Installation of BA489 display and mounting clamps.

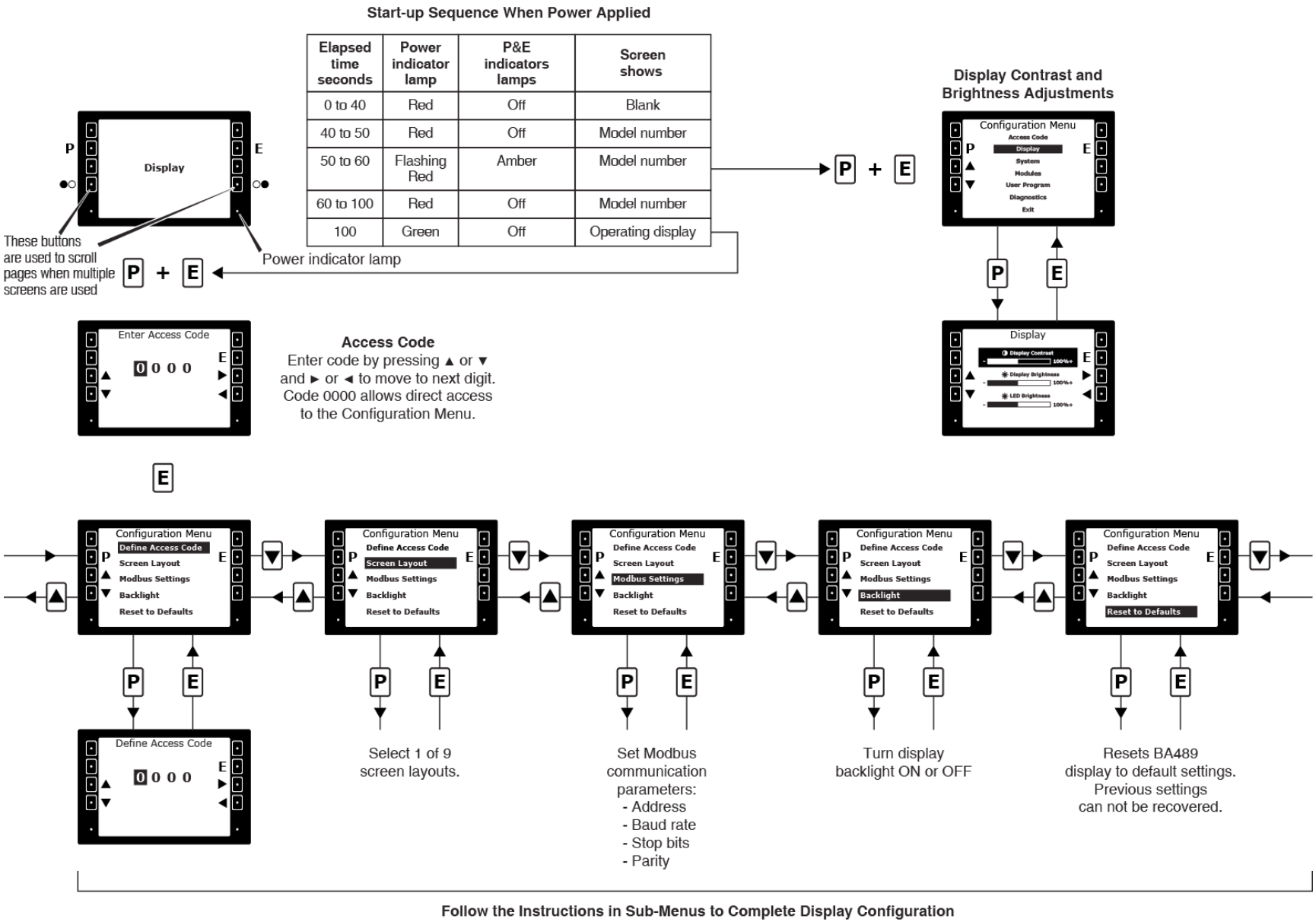


Fig 7 Configuration Menu

6. CONFIGURATION AND CALIBRATION

The BA489 display is configured via the eight front panel touch buttons using a series of intuitive sub menus accessed via the Configuration Menu.

During configuration, if a button is not touched for 1 minute, the display will time-out and return to the operating mode.

Configuration entries in sub menus are transferred to permanent memory when the **E** touch button is pressed to leave the configuration menu. If the display times-out before the **E** button is pressed, configuration information in the middle of an edit will not be saved and must be entered again.

6.1 Configuration Menu

Access to the Configuration Menu is obtained by simultaneously pressing the **P** and **E** touch buttons as shown in Fig 7. To prevent unauthorised adjustments, access may be protected by a four digit alphanumeric user definable access code. New BA489 displays are configured with default code 0000 which provides direct access to the Configuration Menu.

To gain access to the Configuration Menu of a BA489 display with an access code other than 0000, press the **P** and **E** buttons simultaneously which will cause the Enter Access Code screen to be displayed as shown in Fig 8. Enter the access code character by character, if the correct code has been entered, pressing **E** will cause the Configuration Menu to be displayed.

Please contact BEKA associates if the display's access code is lost.

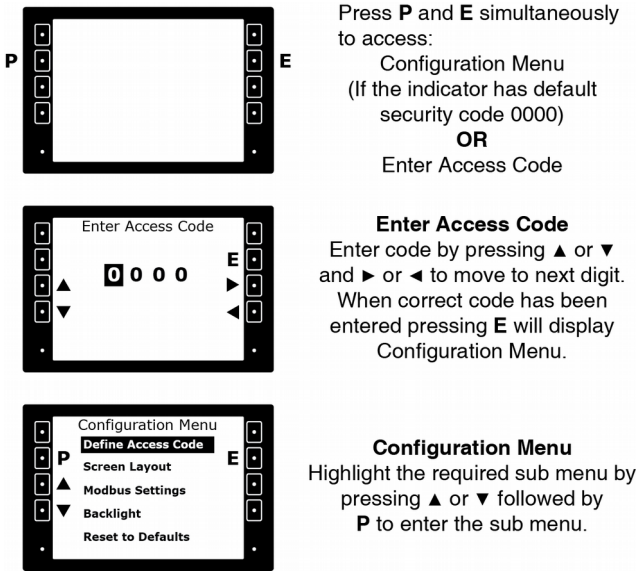


Fig 8 Access to the Configuration Menu

6.2 Define Access Code

Unless otherwise requested, new BA489 displays are supplied with the default access code 0000 which allows unrestricted access to all configuration functions.

To enter a new access code select Define Access Code from the Configuration Menu shown in Fig 7.

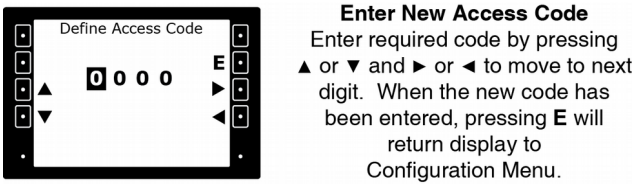
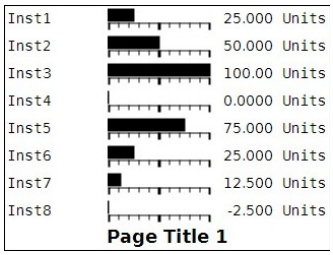


Fig 9 Entering a new Access Code

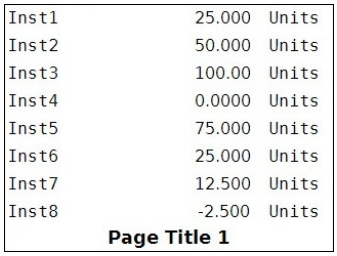
6.3 Screen layouts

This sub menu allows one of the following nine screen formats to be selected.

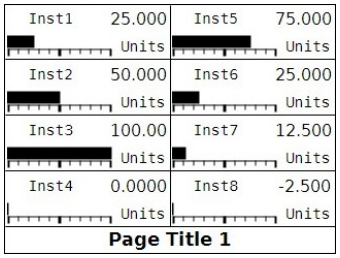
Screen Layout 1
Rows: 8 variables + bargraphs



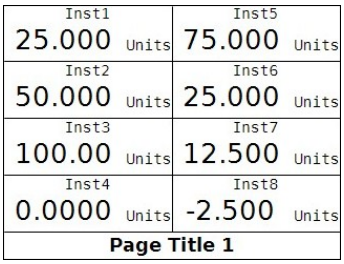
Screen Layout 2
Rows: 8 variables



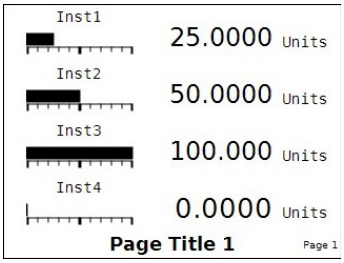
Screen Layout 3
Grid: 8 variables + bargraphs



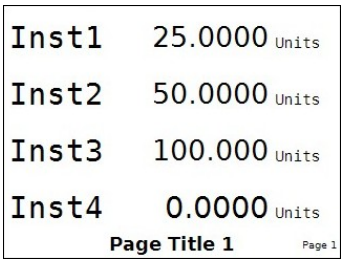
Screen Layout 4
Grid: 8 variables



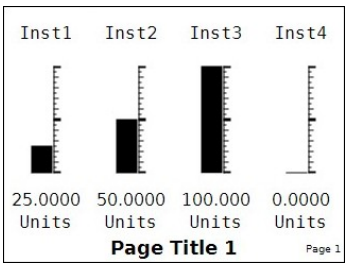
Screen Layout 5
Rows: 4 variables + bargraphs



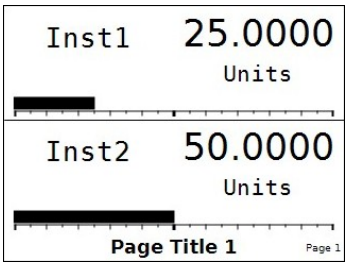
Screen Layout 6
Rows: 4 variables



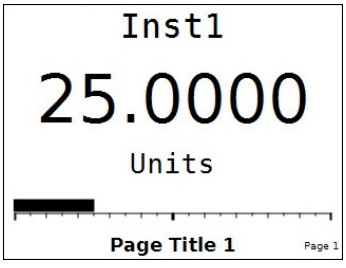
Screen Layout 7
Columns: 4 variables + bargraphs



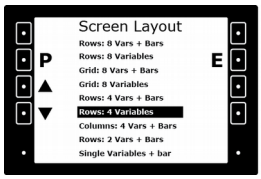
Screen Layout 8
Rows: 2 variables + bargraphs



Screen Layout 9
Single variable + bargraph



To select a screen format, first select Screen Layout from Configuration Menu shown in Fig 7 and press **P.**



Screen Layout
Highlight the required screen by pressing ▲ or ▼ followed by **E** to confirm selection and return to the configuration Menu

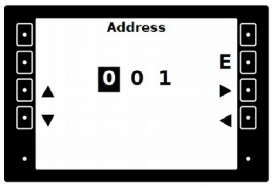
Fig 10 Selecting the required Screen Layout

6.4 Modbus Settings

This sub menu configures the communication settings on the RS485-IS line. Note that the number of data bits is fixed to 8 bits.

6.4.1 Address

The slave address of the BA489 display can be configured to any number between 1 and 247.

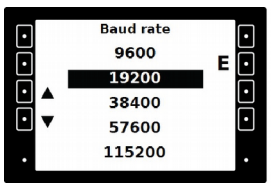


Adjust slave address
Select the address by pressing ▲ or ▼ to change a Digit value and ► or ◄ to move to the next digit. Press **E** to return to the Modbus Settings menu.

Figure 11 Selecting the slave address

6.4.2 Baud Rate

The baud rate can be selected from the following range: 9600, 19200, 38400, 57600 or 115200 bps.

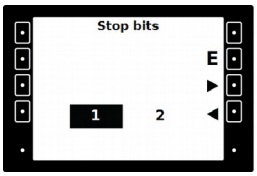


Adjust baud rate
Select the correct baud rate by pressing ▲ or ▼. Press **E** to return to the Modbus Settings menu.

Figure 12 Selecting the baud rate

6.4.3 Stop Bits

The number of stop bits can be either 1 or 2.

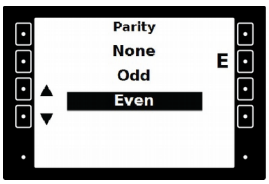


Adjust Stop bits
Select the correct number of stop bits by pressing ► or ◄. Press **E** to return to the Modbus Settings menu.

Figure 13 Selecting the number of stop bits

6.4.4 Parity

The parity can be either, None, Odd or Even.



Adjust Parity
Select the correct parity by pressing ▲ or ▼. Press **E** to return to the Modbus Settings menu.

Figure 14 Selecting the parity

6.5 Modbus RTU Protocol Implementation

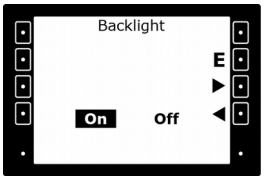
The complete table of Modbus registers is located in Appendix 5.

The following functions codes are supported:

01 – Read Coils
02 – Read Discrete Inputs
03 – Read Holding Registers
04 – Read Input Registers
05 – Write Single Coil
06 – Write Single Register
15 – Write Multiple Coils
16 – Write Multiple Registers

6.6 Backlight

From the Configuration Menu shown in Fig 7 select Backlight and press **P**.



Backlight
Press ► or ◄ to toggle backlight on and off. When set press **E** to return to the Configuration menu.

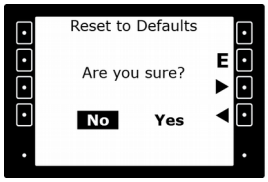
Fig 15 Backlight control

6.7 Reset to defaults

The BA489 display configuration can be reset to the following defaults using this function. After re-setting to defaults, the previous configuration can not be recovered, therefore the instruction has to be confirmed before execution.

Access code	0000
Display backlight	On
Screen layout	4 variables without bar-graph (screen layout 6)
Address	1
Baud Rate	19200
Stop Bits	1 bit
Parity	Even
Page Titles	Empty
Touch Buttons Backlight	Off
Process Variables Parameters	
Timeout	1 (10 seconds)
Value	0.0
Status	Bad
Enable	Enabled
Tag	“Inst<n>”
Unit	“Units”
Decimal Places	Variable resolution
Bargraph Low	0.0
Bargraph High	100.0
Bargraph Type	Left

From the Configuration Menu shown in Fig 7 select Reset to Defaults and press **P**.

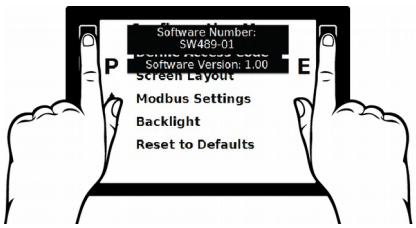


Reset to Default Confirmation
Press ► or ◄ to confirm or cancel instruction, followed by **E** to reset to defaults or return to the Configuration menu.

Fig 16 Reset to default calibration

6.8 System

The software issue number of the BA489 is displayed from the Configuration Menu as below.



System information
To view the software version number press the two upper buttons in the Configuration menu.

Fig 17 System screen

7. MAINTENANCE

7.1 Fault finding during commissioning

If a BA489 display fails to function correctly during commissioning, the following procedure should be followed:

Symptom	Cause	Solution
BA489 power indicator not illuminated.	Incorrect wiring, or no power supply.	Check wiring Using a BA212 Power Isolator there should be 7.5V min at BA489 display power supply terminals. Using a BA243 Power Isolator there should be 8,6V min between each of the four inputs of the BA3901 Power Combiner. Power Isolators should have a green LED at their input and output terminals,
	BA489 takes up to 100 seconds to start working.	Wait more than 100 seconds after applying power to the BA489.
Modbus communication not established or intermittent	Incorrect Modbus wiring.	Check RS485-IS field wiring.
	No End of Line resistors	Check that End Of Line resistors are present on the bus
	Communication isolator not configured	Check that communication settings (speed, parity, stop bits and address) are correct Check that the isolator communication settings match with the BA489
	Modbus application using wrong settings	Ensure communications settings of the Modbus application match with the BA489
	Polling period too quick	Ensure Modbus communication allows for a 150 ms timeout to get a valid response
	Modbus Register values out of range	Check that the values sent to the BA489 comply with the allowable range (see Modbus table in Appendix 5)
Error message		Contact BEKA or your local agent.

7.2 Fault finding after commissioning

ENSURE PLANT SAFETY BEFORE STARTING MAINTENANCE

Live maintenance is permitted on intrinsically safe equipment installed in a hazardous area, but only certified test equipment should be used unless a gas clearance certificate is available.

If a BA489 display fails after it has been functioning correctly, follow the procedure shown in section 7.1. If this does not reveal the cause of the fault, it is recommended that the instrument is replaced. This can be done without disconnecting power.

7.3 Servicing

No attempt should be made to repair BA489 displays at component level. We recommend that faulty instruments are returned to BEKA associates or to your local BEKA 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 inspection should be performed annually.

7.5 Guarantee

Displays which fail within the guarantee period should be returned to BEKA associates or your local agent. It is helpful if a brief description of the fault symptoms is provided in advance to sales@beka.co.uk.

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.

APPENDIX 1
Using a BA212 Power Isolator

The BA212 isolator is primarily intended to power a BA489 display in gas group IIB (ethylene) or IIA (propane). The BA212 does have IIC (hydrogen) certification, but the output inductive parameters Lo limit applications in IIC to where the BA212 isolator and the BA489 display are located close together. The maximum capacitance Co that may be be safely connected to the BA212 output is relatively large, and is unlikely to limit the cable length.

CAUTION
Parameters for the cable being installed should be used when calculating the maximum safe length.

The cable between the BA212 Power Isolator output and the BA489 diplsay should be selected to have inductance of less than Lo of the isolator, or an L/R ratio of less than Lo/Ro of the isolator.

Cable length limitation imposed by Lo or BA212:
Most twisted pair instrument cables have an inductance of less than 0.8µH per metre. The addition of a screen or armour makes little difference. Twisted pairs within multicore cables also have a similar inductance.

The equivalent inductance at the BA489 display power input terminals Li is zero. All of the allowable inductance that may be connected to the BA212 isolator output may therefore be allocated to the cable inductance.

$$\text{Max cable length} = \frac{\text{BA212 Lo for required gas group}}{\text{Cable inductance per metre}}$$

Using cable having inductance of 0.8µH per metre.

	Gas group		
	IIC	**IIB**	**IIA**
BA212 Lo µH	5	20	40
Max cable length m	6	25	50

Cable length limitation imposed by BA212 Lo/Ro:
Alternatively, any length of cable with an L/R ratio equal to, or less than, the BA212 isolators Lo/Ro may be used. The maximum length being defined by the acceptable resistive voltage drop of the cable.

	Gas group		
	IIC	**IIB**	**IIA**
BA212 Lo/Ro	4.3µH/Ω	17µH/Ω	34µH/Ω

Instrumentation cables complying with the L/R ratio required for use in IIC gases are not generally available, but those complying with requirements for use in IIB and IIA gases are common.

The maximum allowable cable length can be calculated as follows:

$$\text{Max cable length} = \left[\frac{(\text{Vo min} - \text{VL min})}{\text{IL max}} - \text{Ro max}\right]\left[\frac{1}{2 \times \text{R cab}}\right]$$

Where:

Vo min = Minimum BA212 isolator output voltage with no load which is 11.53V

VL min = Minimum operating voltage of BA489 display which is 7.5V.

IL max = Maximum current consumption of BA489 display which is 0.28A.

Ro max = Maximum BA212 isolator output resistance which is 6.22Ω

R cab = Cable conductor resistance Ω/m

Using a typical instrument cable with a resistance of 0.0263Ω per metre.

$$\text{Max cable length} = \left[\frac{(11.53 - 7.5)}{0.28} - 6.22\right]\left[\frac{1}{2 \times 0.0263}\right]$$

Max cable length = 155m

For applications in gas groups IIB and IIA the maximum permissible cable length is 155m.

This calculation should be repeated for the instrument cable being used.

APPENDIX 2
Using a BA243 Power Isolator

The BA243 Power Isolator has four galvanically isolated outputs which have been certified intrinsically safe in IIC atmospheres when remotely interconnected by a BA3901 Power Combiner. The BA3901 Power Combiner mounts onto the rear of the BA489 display and contains separate terminals for each of the four circuits. For applications in gas group IIC (hydrogen), this technique allows much longer cable lengths between the BA243 isolator and the BA489 display.

If the four isolator outputs are connected to the display via a multicore cable, the cable should be a Type A or a Type B multicore as defined in IEC 60079-14.

The maximum capacitance that may be be safely connected to each BA243 output Co, is relatively large, and is unlikely to limit the cable length.

CAUTION

Parameters for the cable being installed should be used when calculating the maximum safe length.

The cable between each BA243 Power Isolator output and the BA489 display should be selected to have inductance of less than Lo of each BA243 Power Isolator output, or an L/R ratio of less than Lo/Ro of each isolator output.

The minimum operating voltage of a BA489 display is 7.5V, and the BA3901 Power Combiner introduces an additional 1.1V voltage drop. The minimum permissible voltage at the BA3901 is therefore 8.6V. Each power input supplies 70mA which is one quarter of the BA489's maximum current consumption.

Cable length limitation imposed by BA243 Lo:

Most twisted pair instrument cables have an inductance of less than 0.8µH per metre. The addition of a screen or armour makes little difference. Twisted pairs within multicore cables also have a similar inductance.

The equivalent inductance at each of the BA3901 Power Combiner input terminals Li is zero. All of the allowable inductance that may be connected to each BA243 isolator output may therefore be allocated to the cable inductance.

$$\text{Max cable length} = \frac{\text{BA243 Lo for each output}}{\text{Cable inductance per metre}}$$

As an example, using a cable having inductance of 0.8µH per metre.

	Gas group		
	IIC	**IIB**	**IIA**
BA243 Lo µH	79	317	634
Max cable length m	98	396	792

If resistance of each cable exceeds 22Ω, the cable length will be limited by the voltage drop caused by the cable.

Cable length limitation imposed by BA243 Lo/Ro:

Alternatively, any length of cable with an L/R ratio equal to, or less than the BA243 isolators Lo/Ro ratio for each output may be used. The maximum cable length being defined by the resistive voltage drop of the cable.

	Gas group		
	IIC	**IIB**	**IIA**
BA243 Lo/Ro of each output	17µH/Ω	68µH/Ω	137µH/Ω

$$\text{Max cable length} = \left[\frac{(\text{Vo min} - \text{VL min})}{\text{IL max}} - \text{Ro max}\right]\left[\frac{1}{2 \times \text{R cab}}\right]$$

Where:

Vo min = Minimum BA243 isolator output voltage with no load which is 11.5V

VL min = Minimum operating voltage of BA489 display including BA3901 Power Combiner which is 8.6V.

IL max = One quarter of BA489 display maximum current consumption which is 0.07A.

Ro max = Maximum BA243 isolator output resistance which is 20.36Ω

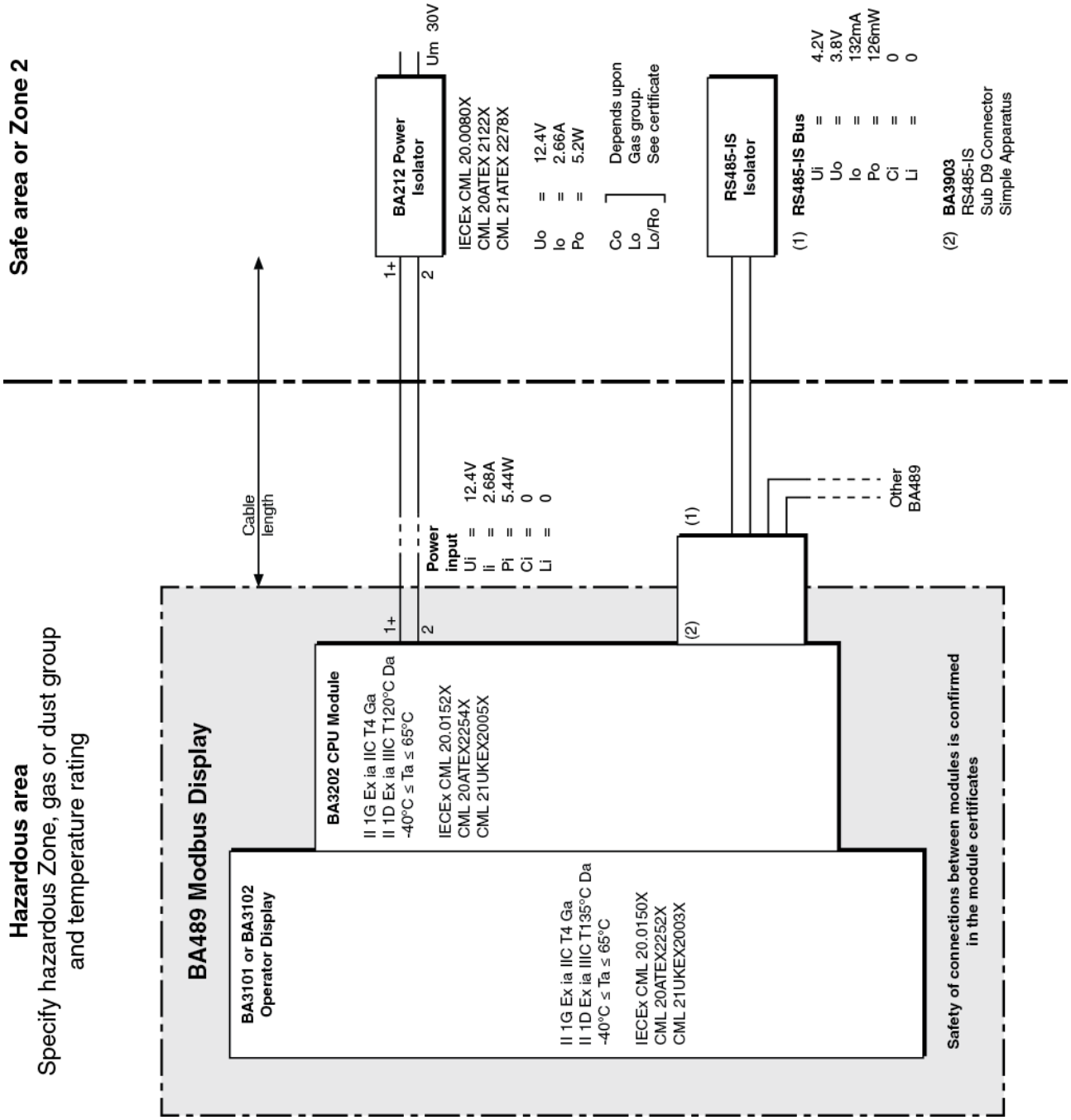
R cab = Cable conductor resistance Ω/m

For example using a typical instrument cable with a resistance of 0.0263Ω per metre.

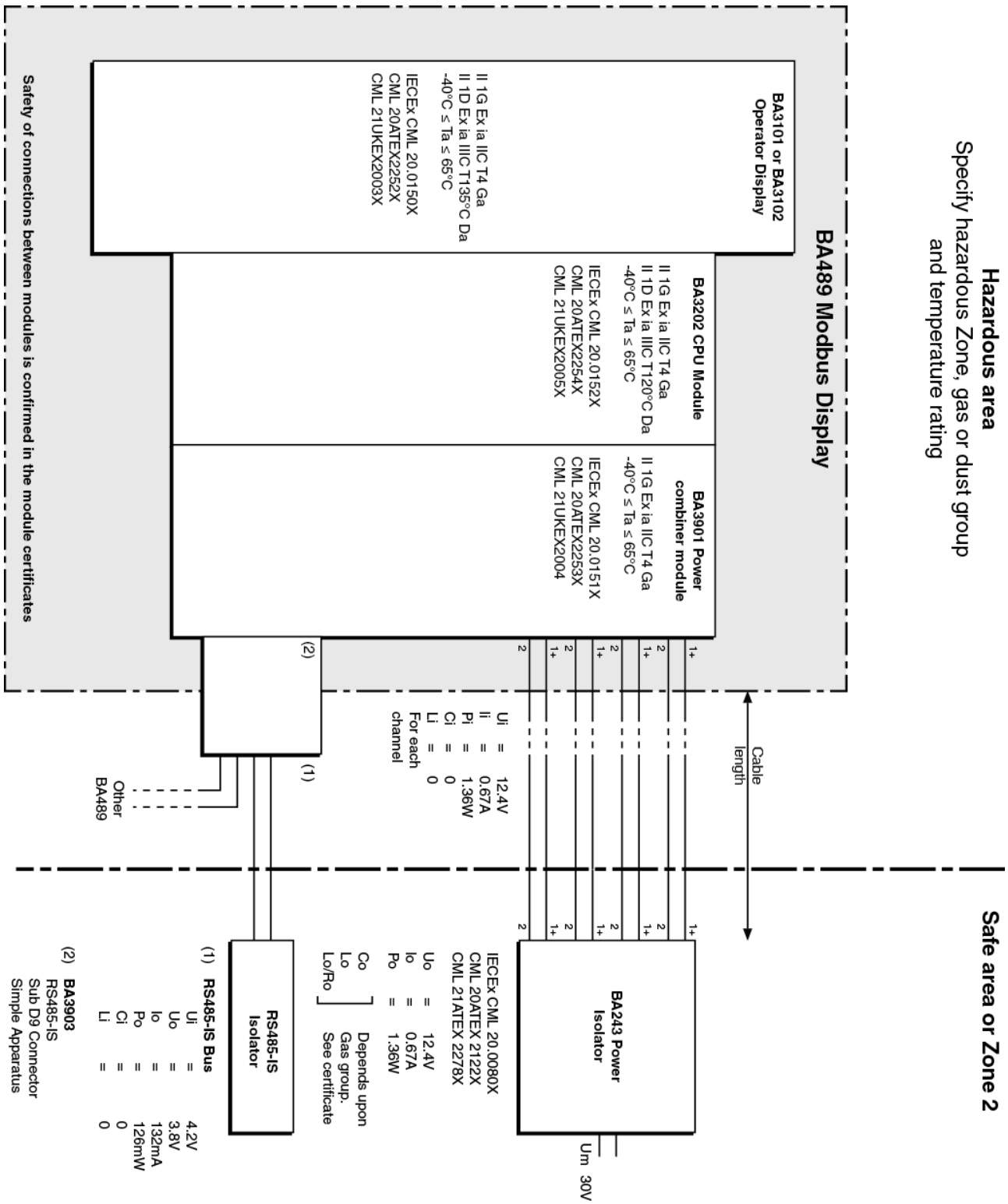
$$\text{Max cable length} = \left[\frac{(11.5 - 8.6)}{0.07} - 20.36\right]\left[\frac{1}{2 \times 0.0263}\right]$$

Max cable length = 400m

APPENDIX 3 Descriptive Systems Drawings
Using BA212 Power Isolator



APPENDIX 4 Descriptive Systems Drawings
Using BA243 Power Isolator



APPENDIX 5 MODBUS Table

Important Notes:

- Allow for at least 150 ms timeout to get a response from a Modbus command
- Do not write to non volatile registers as part of the PLC cycle as it will wear out the non volatile memory over time. These should be set as part of the initialisation routine or infrequently (for example the backlight state can be changed twice a day).
- It takes about 30 seconds for values to be saved to the non volatile memory, if the power is switched off before this happens, the saved value will be lost.

Coils	**Read / Write**					
Address	**Bits**	**Description**	**Functions Supported**	**Saved in non volatile memory**	**Default**	**Notes**
1	1	PV 1 Status	1, 5 ,15		0	0 = Bad 1 = Good If the status is set as Bad, the process variable colours will show as inverted.
2	1	PV 2 Status	1, 5 ,15		0	
3	1	PV 3 Status	1, 5 ,15		0	
4	1	PV 4 Status	1, 5 ,15		0	
5	1	PV 5 Status	1, 5 ,15		0	
6	1	PV 6 Status	1, 5 ,15		0	
7	1	PV 7 Status	1, 5 ,15		0	
8	1	PV 8 Status	1, 5 ,15		0	
9	1	PV 1 Enable	1, 5 ,15	Yes	1	0 = Disabled 1 = Enabled If a process variable is disabled, its value, unit, tag and bargraph will become invisible.
10	1	PV 2 Enable	1, 5 ,15	Yes	1	
11	1	PV 3 Enable	1, 5 ,15	Yes	1	
12	1	PV 4 Enable	1, 5 ,15	Yes	1	
13	1	PV 5 Enable	1, 5 ,15	Yes	1	
14	1	PV 6 Enable	1, 5 ,15	Yes	1	
15	1	PV 7 Enable	1, 5 ,15	Yes	1	
16	1	PV 8 Enable	1, 5 ,15	Yes	1	
17	1	Set Backlight State	1, 5 ,15	Yes	0	0 = Backlight Off 1 = Backlight On

Input Status	Read Only			
Address	**Bits**	**Description**	**Functions Supported**	**Notes**
1	1	Key 1	2	0 = Not pressed 1 = Pressed Once the key is pressed, the status bit will latch. It will clear once the value is read if the key has been released.
2	1	Key 2	2	
3	1	Key 3	2	
4	1	Key 4	2	
5	1	Key 5	2	
6	1	Key 6	2	
7	1	Key 7	2	
8	1	Key 8	2	
9	1	PV 1 Timeout	2	0 = No timeout 1 = Timeout Only effective if timeout is enabled (see Holding Register 26). If the process variable has not been refreshed within the Timeout period, the process variable colours will show as inverted.
10	1	PV 2 Timeout	2	
11	1	PV 3 Timeout	2	
12	1	PV 4 Timeout	2	
13	1	PV 5 Timeout	2	
14	1	PV 6 Timeout	2	
15	1	PV 7 Timeout	2	
16	1	PV 8 Timeout	2	
17	1	Backlight Status	2	0 = Backlight Off 1 = Backlight On
18	1	Modbus Write Error	2	0 = No Modbus write Error 1 = Modbus write Error has occurred This status bit will typically be set if an out of range value was sent to one of the holding registers. It will clear once read.
19	1	File Save Error	2	0 = No File save error 1 = File save error This status bit will be set if the configuration file has encountered an error when saving. It will clear once read.

Input Registers	Read Only			
Address	**Registers**	**Description**	**Functions Supported**	**Notes**
1	9	Unit Type – Constant String “BA489”	4	
10	9	Software Version – Constant String “SW489-01-X.XX”	4	X.XX is the current firmware version

Holding Registers	Read / Write

Address	Registers	Description	Functions Supported	Saved in non volatile memory	Default	Notes
1	2	PV 1 Value (IEEE format)	3, 16		0	
3	2	PV 2 Value (IEEE format)	3, 16		0	
5	2	PV 3 Value (IEEE format)	3, 16		0	
7	2	PV 4 Value (IEEE format)	3, 16		0	
9	2	PV 5 Value (IEEE format)	3, 16		0	
11	2	PV 6 Value (IEEE format)	3, 16		0	
13	2	PV 7 Value (IEEE format)	3, 16		0	
15	2	PV 8 Value (IEEE format)	3, 16		0	
17	8	**Reserved**				
25	1	Screen Layout (1 to 9)	3, 6, 16	Yes	6	See paragraph 6.3
26	1	Timeout Period (0 to 255)	3, 6, 16	Yes	1	Multiply this value by 10 second to define the process variable timeout value in seconds (i.e. 1 = 10s). Use 0 to disable the timeout.
27	1	Goto Variable (1 to 8)	3, 6, 16		1	For screen layouts with multiple pages, this selects the page showing the corresponding process variable.
28	6	**Reserved**				
34	8	Page 1 Title (16 Characters)	3, 6, 16	Yes	“”	
42	8	Page 2 Title (16 Characters)	3, 6, 16	Yes	“”	
50	8	Page 3 Title (16 Characters)	3, 6, 16	Yes	“”	
58	8	Page 4 Title (16 Characters)	3, 6, 16	Yes	“”	
66	8	Page 5 Title (16 Characters)	3, 6, 16	Yes	“”	
74	8	Page 6 Title (16 Characters)	3, 6, 16	Yes	“”	
82	8	Page 7 Title (16 Characters)	3, 6, 16	Yes	“”	
90	8	Page 8 Title (16 Characters)	3, 6, 16	Yes	“”	
98	2	**Reserved**				
100	8	PV 1 Tag (16 Characters)	3, 6, 16	Yes	“Inst1”	
108	8	PV 2 Tag (16 Characters)	3, 6, 16	Yes	“Inst2”	
116	8	PV 3 Tag (16 Characters)	3, 6, 16	Yes	“Inst3”	
124	8	PV 4 Tag (16 Characters)	3, 6, 16	Yes	“Inst4”	
132	8	PV 5 Tag (16 Characters)	3, 6, 16	Yes	“Inst5”	
140	8	PV 6 Tag (16 Characters)	3, 6, 16	Yes	“Inst6”	
148	8	PV 7 Tag (16 Characters)	3, 6, 16	Yes	“Inst7”	
156	8	PV 8 Tag (16 Characters)	3, 6, 16	Yes	“Inst8”	
164	4	PV 1 Units of Measurement (8 Characters)	3, 6, 16	Yes	“Units”	
168	4	PV 2 Units of Measurement (8 Characters)	3, 6, 16	Yes	“Units”	

Holding Registers	Read / Write

Address	Registers	Description	Functions Supported	Saved in non volatile memory	Default	Notes
172	4	PV 3 Units of Measurement (8 Characters)	3, 6, 16	Yes	“Units”	
176	4	PV 4 Units of Measurement (8 Characters)	3, 6, 16	Yes	“Units”	
180	4	PV 5 Units of Measurement (8 Characters)	3, 6, 16	Yes	“Units”	
184	4	PV 6 Units of Measurement (8 Characters)	3, 6, 16	Yes	“Units”	
188	4	PV 7 Units of Measurement (8 Characters)	3, 6, 16	Yes	“Units”	
192	4	PV 8 Units of Measurement (8 Characters)	3, 6, 16	Yes	“Units”	
196	1	PV 1 Decimal Places (0 to 5)	3, 6, 16	Yes	2	Sets the number of decimal places shown for the corresponding process variable: 0..4 = Fixed resolution 5 = Variable resolution dependant on the process variable value and screen layout
197	1	PV 2 Decimal Places (0 to 5)	3, 6, 16	Yes	2	
198	1	PV 3 Decimal Places (0 to 5)	3, 6, 16	Yes	2	
199	1	PV 4 Decimal Places (0 to 5)	3, 6, 16	Yes	2	
200	1	PV 5 Decimal Places (0 to 5)	3, 6, 16	Yes	2	
201	1	PV 6 Decimal Places (0 to 5)	3, 6, 16	Yes	2	
202	1	PV 7 Decimal Places (0 to 5)	3, 6, 16	Yes	2	
203	1	PV 8 Decimal Places (0 to 5)	3, 6, 16	Yes	2	
204	46	**Reserved**				
250	2	PV 1 Bargraph Low (IEEE format)	3, 16	Yes	0	
252	2	PV 1 Bargraph High (IEEE format)	3, 16	Yes	100	
254	2	PV 2 Bargraph Low (IEEE format)	3, 16	Yes	0	
256	2	PV 2 Bargraph High (IEEE format)	3, 16	Yes	100	
258	2	PV 3 Bargraph Low (IEEE format)	3, 16	Yes	0	
260	2	PV 3 Bargraph High (IEEE format)	3, 16	Yes	100	
262	2	PV 4 Bargraph Low (IEEE format)	3, 16	Yes	0	
264	2	PV 4 Bargraph High (IEEE format)	3, 16	Yes	100	
266	2	PV 5 Bargraph Low (4 bytes IEEE format)	3, 16	Yes	0	
268	2	PV 5 Bargraph High (IEEE format)	3, 16	Yes	100	
270	2	PV 6 Bargraph Low (IEEE format)	3, 16	Yes	0	
272	2	PV 6 Bargraph High (IEEE format)	3, 16	Yes	100	

Holding Registers	Read / Write

Address	Registers	Description	Functions Supported	Saved in non volatile memory	Default	Notes
274	2	PV 7 Bargraph Low (IEEE format)	3, 16	Yes	0	
276	2	PV 7 Bargraph High (IEEE format)	3, 16	Yes	100	
278	2	PV 8 Bargraph Low (IEEE format)	3, 16	Yes	0	
280	2	PV 8 Bargraph High (IEEE format)	3, 16	Yes	100	
282	1	PV 1 Bargraph Type (0 to 3)	3, 6, 16	Yes	1	0 = Off 1 = Left-aligned or Bottom-aligned for vertical layouts 2 = Centre-aligned 3 = Right-aligned or Top-aligned for horizontal layouts
283	1	PV 2 Bargraph Type (0 to 3)	3, 6, 16	Yes	1	
284	1	PV 3 Bargraph Type (0 to 3)	3, 6, 16	Yes	1	
285	1	PV 4 Bargraph Type (0 to 3)	3, 6, 16	Yes	1	
286	1	PV 5 Bargraph Type (0 to 3)	3, 6, 16	Yes	1	
287	1	PV 6 Bargraph Type (0 to 3)	3, 6, 16	Yes	1	
288	1	PV 7 Bargraph Type (0 to 3)	3, 6, 16	Yes	1	
289	1	PV 8 Bargraph Type (0 to 3)	3, 6, 16	Yes	1	
290	10	**Reserved**				
300	1	LED 1 Status (0 to 3)	3, 6, 16		0	0 = Off 1 = Green 2 = Red 3 = Amber
301	1	LED 2 Status (0 to 3)	3, 6, 16		0	
302	1	LED 3 Status (0 to 3)	3, 6, 16		0	
303	1	LED 4 Status (0 to 3)	3, 6, 16		0	
304	1	LED 5 Status (0 to 3)	3, 6, 16		0	
305	1	LED 6 Status (0 to 3)	3, 6, 16		0	
306	1	LED 7 Status (0 to 3)	3, 6, 16		0	
307	1	LED 8 Status (0 to 3)	3, 6, 16		0	

EU Declaration of Conformity

This declaration of conformity for electrical apparatus is issued under the sole responsibility of the manufacturer

Description
BA489-GL (glass window) and BA489-PC (Impact resistant window) are MODBUS RTU displays

Manufactured by
BEKA associates Ltd, Old Charlton Road, Hitchin, Herts. UK. SG5 2DA

Council Directives this equipment complies with:

2014/34/EU (ATEX Directive)

Relating to equipment and protective systems intended for use in potentially explosive atmospheres.

Provisions of the Directive fulfilled by the equipment:

Group II Category 1G Ex ia IIC T4 Ga -40°C ≤ Ta ≤ +65°C
Group II Category 1D Ex ia IIIC T135ºC Da -40°C ≤ Ta ≤ +65°C

Notified Body for EU-Type Examination
CML B.V., Chamber of Commerce No 6738671, Koopvaardijweg 32, 4906CV Oosterhout, The Netherlands, Notified Body Number 2776

Notified Body for production
INTERTEK ITALIA SPA 2575 Via Guido Miglioli, 2/A 20063 Cernusco sul Naviglio (MI) Italy.

EU-Type Examination Certificates
CML 20ATEX2252X Issue 2 14th May 2024
CML 20ATEX2254X Issue 0 25th June 2021

Standards used:
EN IEC 60079-0:2018 and EN 60079-11:2012

2014/30/EU (EMC Directive)

Standards used:
EN 61326-1:2013

2011/65/EU (RoHS Directive) relating to hazardous substances in electronic and electrical equipment.

2015/863/EU additional substances added by amending Annex II to Directive 2011/65/EU as regards the list of restricted substances.

CE **mark first affixed in 2025**

Authorised Signatory: Issue 1 6th February 2026

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