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EC declaration of conformity

Torino, 1/1/2010

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dichiara che le barriere fotoelettriche **ADMIRAL** sono Dispositivi Elettrosensibili di Sicurezza (ESPE) di :

- **Tipo 4** (secondo la Norma **CEI EN 61496-1:2005; CEI EN 61496-2:2007**)
- **SIL 3** (secondo la Norma **CEI EN 61508:2002**)
- **SILCL 3** (secondo la Norma **CEI EN 62061:2005 + CEI EN 62061/EC2:2008**)
- **PL e** (secondo la Norma **UNI EN ISO 13849-1:2008**)

declares that the **ADMIRAL** photoelectric safety barriers are :

- **Type 4** (according the Standard **IEC 61496-1:2004; IEC 61496-2:2006**)
- **SIL 3** (according the Standard **IEC 61508:1998**)
- **SILCL 3** (according the Standard **IEC 62061:2005**)
- **PL e** (according the Standard **ISO 13849-1:2006**)

Electro-sensitive Protective Equipments (ESPE)

realizzati in conformità alle seguenti Direttive Europee:
complying with the following European Directives:

- **2006/42/CE** "Direttiva Macchine"
"Machine Directive"
- **2004/108/CE** "Direttiva Compatibilità Elettromagnetica"
"Electromagnetic Compatibility Directive"
- **2006/95/CE** "Direttiva Bassa Tensione"
"Low Voltage Directive"

e sono identiche all'esemplare esaminato ed approvato con esame di tipo CE da:
and are identical to the specimen examined and approved with a CE - type approval by:

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*PHOTOELECTRIC
SAFETY
BARRIER*

ADMIRAL AX BK

INSTALLATION USE AND MAINTENANCE

INDICE

INTRODUCTION	2
OPERATION.....	3
INSTALLATION	4
POSITION	5
MASTER/SLAVE POSITIONING.....	6
SAFETY DISTANCE CALCULATION.....	7
VERTICAL POSITION OF THE BARRIER	8
HORIZONTAL POSITION OF THE BARRIER	9
ELECTRICAL CONNECTIONS	10
EMITTER CONNECTIONS.....	11
RECEIVER CONNECTIONS	11
WARNINGS REGARDING THE CONNECTION CABLES.....	12
BLANKING FUNCTION	13
CONFIGURATION OF THE TYPE OF BLANKING.....	18
MULTIPLE SYSTEMS	25
USE OF DEFLECTION MIRRORS.....	26
DISTANCE BETWEEN REFLECTING SURFACES	27
MECHANICAL ASSEMBLY AND OPTICAL ALIGNMENT.....	28
OPERATION AND TECHNICAL DATA	29
SIGNALS.....	29
TEST FUNCTION	31
OUTPUT STATUS	31
TECHNICAL SPECIFICATIONS.....	32
DIMENSIONS	33
CHECKOUTS AND MAINTENANCE.....	34
TROUBLESHOOTING	36
SPARE PARTS.....	39
GUARANTEE	40



This symbol stands by a very important warning concerning the safety of persons. Its non-observance can cause a very serious risk for the exposed personnel.

INTRODUCTION

The ADMIRAL AX BK photoelectric barrier is a multi-beam optoelectronic safety system. It belongs to the family of Type 4 electrosensitive devices for the protection of personnel exposed to risks arising from the use of hazardous machinery or plant, according to standards IEC 61496-1,2 and EN 61496-1.

ADMIRAL AX BK is available in two different versions :

The ADMIRAL AX BK is a type 4 light curtain, consisting of an Emitter plus Receiver, that integrates the floating blanking function.

The ADMIRAL AX BK is also available in a Master-Slave configuration.

A diagnostic display available on Emitter and Receiver provides the necessary information for a correct use of the device and the evaluation of the possible operation defects.

ADMIRAL AX BK is ideal for the protection of :

Bending presses, presses, die cutting machines, punching machines, cutting and shearing machines, assembly lines, palletization lines, etc.



If necessary, for any safety-related problems contact the competent safety authorities or industrial associations in the country of use.



For applications in the food industry, please contact the manufacturer to ensure that the barrier contains materials that are compatible with the chemical agents utilized.

The protective function of the optoelectronic devices is not effective in the following cases:



If the machine stopping control cannot be actuated electrically and it is not possible to stop all dangerous machine movements immediately and at any time during the operating cycle.



If the machine generates dangerous situations due to material being expelled or falling from overhead.

OPERATION

If the protected area is clear, the two outputs on the Receiver are active and enable the machine to which they are connected to operate normally.

Each time that an object bigger than or equal in size to the resolution of the system intercepts the optical path of one or more beams, the Receiver deactivates the outputs.

This condition enables hazardous machine movements to be stopped (by means of an adequate machine emergency stop circuit).



The resolution is the minimum dimensions that an object must have so that, on crossing the protected area, it will certainly intercept at least one of the optical beams generated by the barrier (Figure 1).

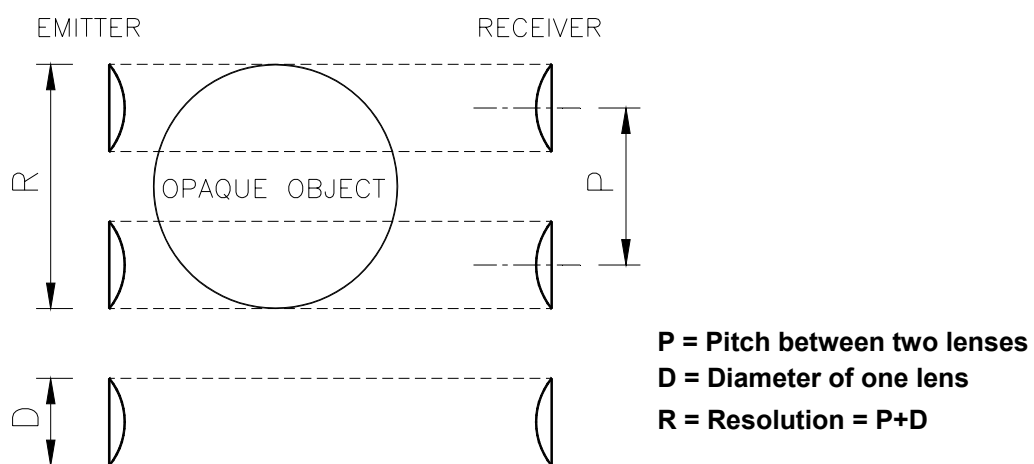


Figure 1

The resolution is constant irrespectively of work conditions, as it only depends on the geometric characteristics of the lenses and the distance between the centres of two adjacent lenses.

The **height of the protected area** is the height that is actually protected by the safety barrier. If the latter is placed horizontally, this value refers to the depth of the protected area.






The **working range** is the maximum operative distance that can exist between the Emitter and the Receiver.

ADMIRAL AX BK is available with the following resolutions:


- 14 mm, 20 mm (protected height from 150 mm to 1800 mm)
PROTECTION OF FINGERS
- 40 mm (protected height from 310 mm to 1800 mm)
PROTECTION OF HANDS
- 90 mm (protected height from 610 mm to 1800 mm)
PROTECTION OF BODY

INSTALLATION




Before installing the ADMIRAL AX BK safety system, make sure that:

-  ***The safety system is only used as a stopping device and not as a machine control device.***
-  ***The machine control can be actuated electrically.***
-  ***All dangerous machine movements can be interrupted immediately. In particular, the machine stopping times must be known and, if necessary, measured.***
-  ***The machine does not generate dangerous situations due to materials projecting or falling from overhead; if that is not the case, additional mechanical guards must be installed.***
-  ***The minimum dimensions of the object that must be intercepted are greater than or equal to the resolution of the specific model.***

Knowledge of the shape and dimensions of the dangerous area enables the width and height of the relative access area to be calculated.

-  ***Compare these dimensions with the maximum working range and the height of the protected area in relation to the specific model.***

The general instructions set out below must be taken into consideration before placing the safety device in position.

-  ***Make sure that the temperature of the environment in which the system is to be installed is compatible with the temperature parameters contained in the technical data sheet.***
-  ***Do not install the Emitter and Receiver close to bright or high-intensity flashing light sources.***
-  ***Certain environmental conditions may affect the monitoring capacity of the photoelectric devices. In order to assure correct operation of equipment in places that may be subject to fog, rain, smoke or dust, the appropriate correction factors Cf should be applied to the maximum working range values. In these cases:***

$$Pu = Pm \times Cf$$

where Pu and Pm are, respectively, the working and maximum range in meters.

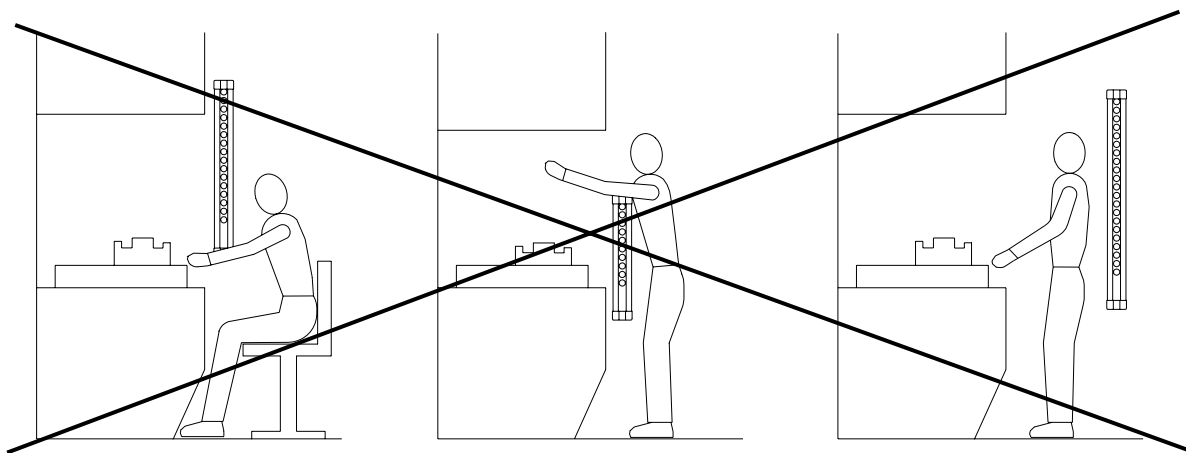
The recommended Cf factors are shown in the table below:

ENVIRONMENTAL CONDITION	CORRECTION FACTOR Cf
Fog	0.25
Steam	0.50
Dust	0.50
Dense fumes	0.25

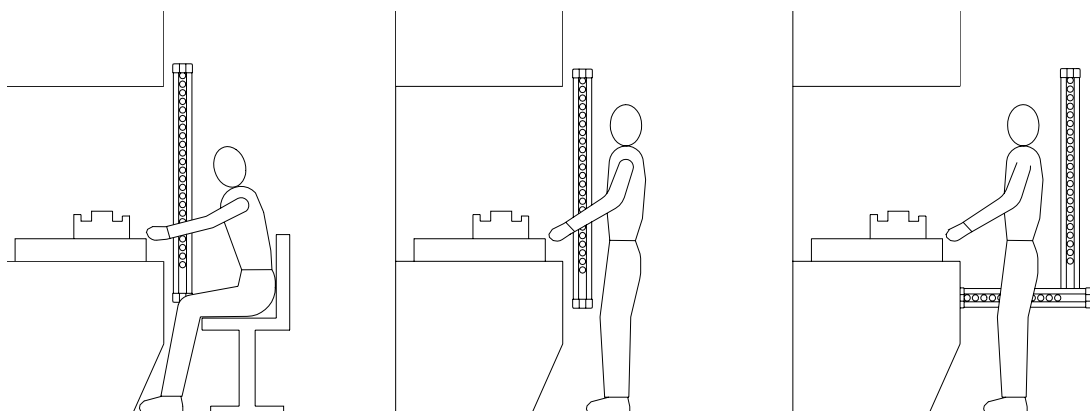
If the device is installed in places that are subject to sudden changes in temperature, the appropriate precautions must be taken in order to prevent the formation of condensation on the lenses, which could have an adverse effect on monitoring.

POSITION

The position of the *AXE BK* Emitter and the *AXR BK* Receiver must prevent access to the danger zone from above, below and from the sides, unless at least one of the optical beams has been intercepted. Some useful information regarding the correct position of the barrier is shown in the figure below.



Incorrect positioning of barrier



Correct positioning of barrier

Figure 2

MASTER/SLAVE POSITIONING

In addition to the standard ADMIRAL models, ADMIRAL AX BK is available in the MASTER/SLAVE configuration. Such configuration is made of two pairs of light curtains, where the two emitters and the two receivers are respectively connected in series.

In master/slave models the blanking function is available only on the MASTER barrier.

The most common application is shown in Figure 3: the horizontal light curtain (A) has been installed to detect the presence of a person between the vertical light curtain (B) and the dangerous machine at system power-up or restart.

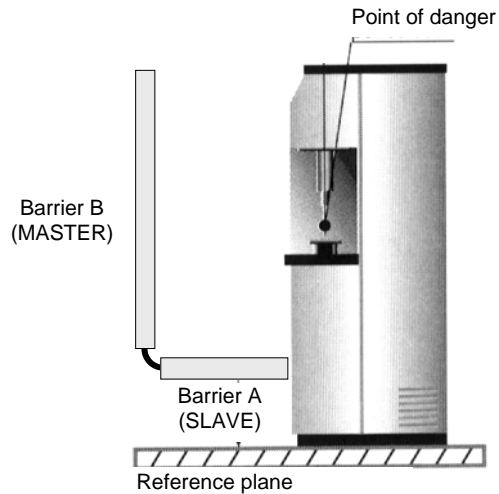


Figure 3

The length of the connection cable between the master and the slave can be up to 50 m. This makes it possible to install two light curtains - one at the front and the other at the rear of the machine – with just one connection to the power and control circuits of the machine.

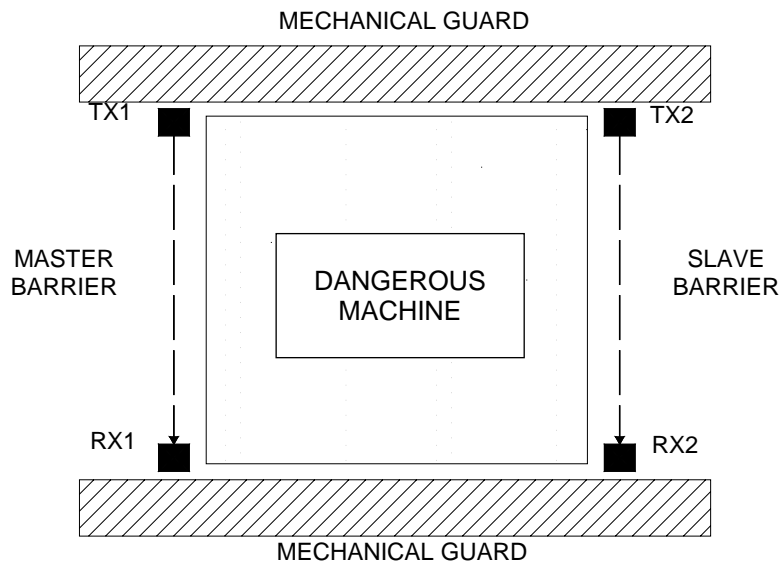


Figure 4

SAFETY DISTANCE CALCULATION

The barrier must be installed at a distance that is greater than or equal to the **minimum safety distance S**, so that a dangerous point can only be reached after all hazardous machine movements have stopped (Figure 5).

According to European standard EN999, the minimum safety distance **S** must be calculated using the following formula:

$$S = K (t_1 + t_2) + C$$

where:

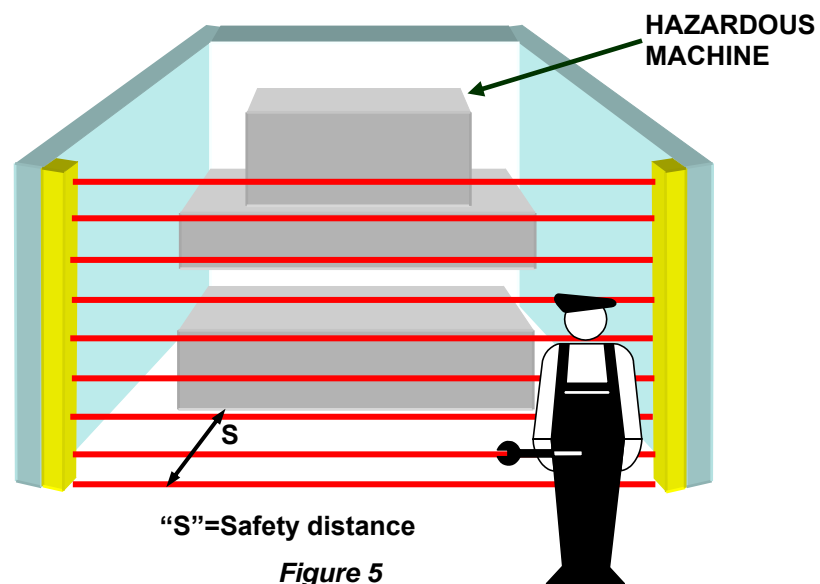
S	<i>minimum safety distance</i>	mm
K	<i>approach speed of object to the dangerous area</i>	mm/sec
t₁	<i>response time of the safety barrier in seconds</i>	sec
t₂	<i>machine response time, in seconds, meaning the time required for the machine to interrupt the dangerous movement following transmission of the stop signal</i>	sec
c	<i>additional distance</i>	mm



The non-observance of the correct safety distance reduces or cancels the protective action of the light curtain.



If the position of the barrier does not prevent the operator from having access to the dangerous area without being detected, additional mechanical guards must be installed to complete the system.



VERTICAL POSITION OF THE BARRIER

14 mm, 20 mm resolution models.



These models are suitable for the protection of fingers.

40mm resolution models.



These models are suitable for the protection of hands.

The minimum safety distance **S** is calculated according to the following formula:

$$S = 2000(t_1 + t_2) + 8(D-14)$$

(D=resolution)

This formula is valid for distances **S** between 100 and 500 mm. If this formula results in **S** being greater than 500 mm, the distance can be reduced to a minimum of 500 mm by means of the following formula:

$$S = 1600(t_1 + t_2) + 8(D-14)$$

If, due to the specific configuration of the machine, the dangerous area can be accessed from above, the highest beam of the barrier must be at a height **H** of at least 1800 mm from the base **G** of the machine.

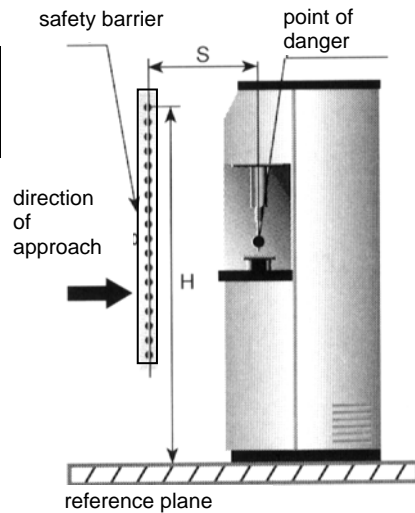


Figure 6

90 mm resolution models.



These models are suitable for the protection of arms or legs and must not be used to protect fingers or hands.

The minimum safety distance **S** is calculated according to the following formula:

$$S = 1600(t_1 + t_2) + 850$$



The height **H** of the highest beam from the base **G** must never be less than 900 mm, while the height of the lowest beam **P** must never be more than 300 mm.

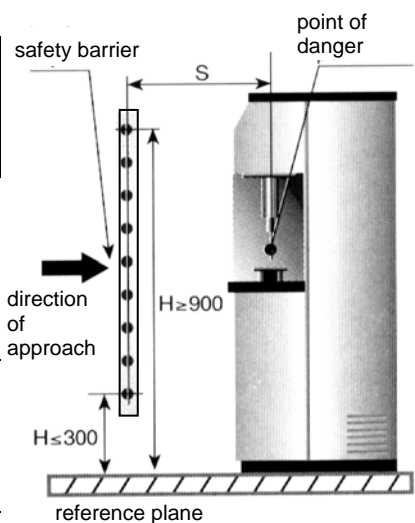


Figure 7

HORIZONTAL POSITION OF THE BARRIER

When the object's direction of approach is parallel to the floor of the protected area, the barrier must be installed so that the distance between the outer limit of the dangerous area and the most external optical beam is greater than or equal to the minimum safety distance S calculated as follows:

$$S = 1600(t_1 + t_2) + 1200 - 0.4H$$

where H is the height of the protected surface from the base of the machine;

$$H = 15(D-50)$$

(D =resolution)

In this case, H must always be less than 1 meter.

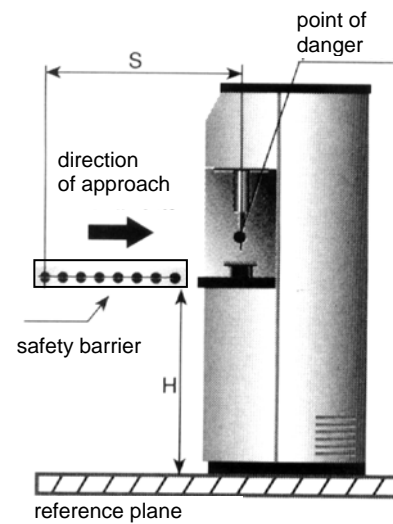


Figure 8

ELECTRICAL CONNECTIONS

WARNINGS

Before making the electrical connections, make sure that the supply voltage complies with that specified in the technical data sheet.



Emitter and Receiver units must be supplied with 24Vdc±20% power.



The external power supply must comply with the standard EN 60204-1.

The electrical connections must be made according to the diagrams in this manual. In particular, do not connect other devices to the connectors of the Emitter and Receiver.

For reliability of operation, when a diode jumper supply unit is used, its output capacity must be at least 2000µF for each absorbed A.

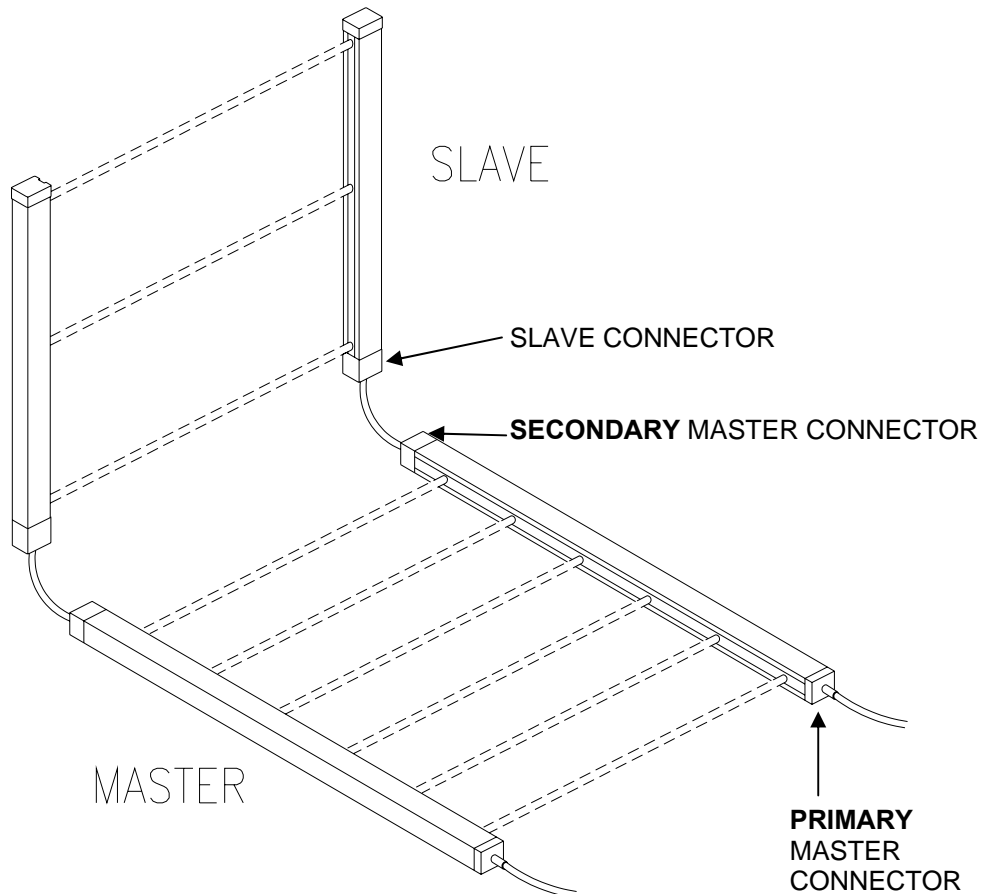
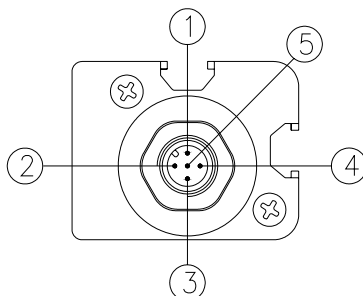
MASTER/SLAVE CONNECTORS LOCATION

Figure 9

EMITTER CONNECTIONS



MASTER MODELS (PRIMARY CONNECTOR), SLAVE and STANDARD M12, 5-pin connector.

PIN	COLOR	NAME	TYPE	DESCRIPTION	FUNCTIONING
1	Brown	24VDC	INPUT	+24 VDC power supply	-
3	Blue	0VDC		0 VDC power supply	-
5	Grey	PE		Ground connection	-
2	White	RANGE0	OUTPUT	Barrier configuration	According the standard EN61131-2 (ref. Table 3)
4	Black	RANGE1			

Table 1

MASTER MODELS (SECONDARY CONNECTOR) - M12, 5-pin connector.

PIN	COLOR	NAME	TYPE	DESCRIPTION	FUNCTIONING
1	Brown	24VDC	INPUT	+24 VDC power supply	-
3	Blue	0VDC		0 VDC power supply	-
5	Grey	PE		Ground connection	-
2	White	RANGE0	OUTPUT	Barrier configuration	According the standard EN61131-2 (ref. Table 3)
4	Black	RANGE1			

Table 2

TEST and RANGE SELECTION (MASTER ONLY)		
PIN 4	PIN 2	FUNCTIONING
24VDC	0VDC	HIGH range
0VDC	24VDC	LOW range
0VDC	0VDC	Emitter in test mode
24VDC	24VDC	Selection error

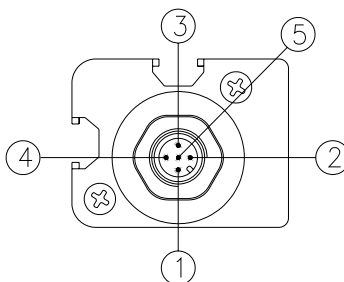
Table 3

RECEIVER CONNECTIONS

RECEIVER

SLAVE MODELS

MASTER MODELS (SECONDARY CONNECTOR)



SLAVE MODELS - M12, 5-pin connector

PIN	COLOR	NAME	TYPE	DESCRIPTION	FUNCTIONING
1	Brown	24VDC	-	+24 VDC power supply	-
3	Blue	0VDC	-	0 VDC power supply	-
5	Grey	PE	-	Ground connection	-
2	White	OSSD1	OUTPUT	Safety static outputs	PNP active high
4	Black	OSSD2	OUTPUT		

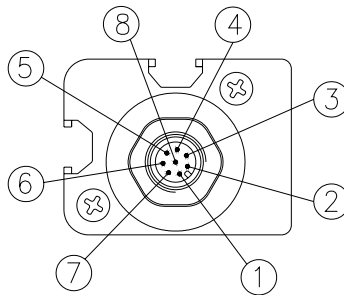
Table 4

MASTER MODELS (SECONDARY CONNECTOR) - 5 poles M12.

PIN	COLOR	NAME	TYPE	DESCRIPTION	FUNCTIONING
1	Brown	24VDC	-	+24 VDC power supply	-
3	Blue	0VDC	-	0 VDC power supply	-
5	Grey	PE	-	Ground connection	-
2	White	SLAVE1	INPUT	Slave OSSD outputs readout	According the standard EN61131-2 (PNP active high)
4	Black	SLAVE2	INPUT		

Table 5

**RECEIVER
MASTER MODELS (PRIMARY CONNECTOR) - STANDARD MODELS**



MASTER MODELS (PRIMARY CONNECTOR) - 8 poles M12.
STANDARD MODELS - 8 poles M12 connector.

PIN	COLOR	NAME	TYPE	DESCRIPTION	FUNCTIONING
2	Brown	24VDC	-	+24 VDC power supply	-
7	Blue	0VDC	-	0 VDC power supply	-
8	Red	PE	-	Ground connection	-
1	White	OSSD1	OUTPUT	Safety static outputs	PNP active high
3	Green	OSSD2	OUTPUT		
5	Grey	SEL_A	INPUT	Barrier configuration	According the standard EN61131-2 (ref. Par. "Configuration and operation modes")
6	Pink	SEL_B	INPUT		
4	Yellow	SEL_C	INPUT		

Table 6

WARNINGS REGARDING THE CONNECTION CABLES

- For connections over 50 m long, use cables with a cross-section area of 1 mm².
- The power supply to the barrier should be kept separate from that to other electric power equipment (electric motors, inverters, frequency converters) or other sources of disturbance.
- Connect the Emitter and the Receiver to the ground outlet.
- The connection cables must follow a different route to that of the other power cables.

AUTOMATIC FUNCTIONING

The ADMIRAL AX BK light curtain features only one Automatic operating mode (without re-start interlock).



The ADMIRAL AX BK light curtain is not equipped with a start/restart interlock circuit. This safety function is compulsory in most applications. The safety modules of the AD SR series permit safe implementation of this function according to IEC 61496-1. Carefully assess the related risks analysis of own application.

In this functioning mode, the OSSD1 and OSSD2 safety outputs comply with the status of the light curtain :

- with the area protected free, the outputs are active.
- with the area protected occupied, they are de-activated.

BLANKING FUNCTION

The ADMIRAL AX BK opto-electronic light curtain features a floating blanking function according to which the user can inhibit the detection function **from a minimum of 1 beam to a maximum of 3 adjacent beams** with two different types of functioning according to the selected method of configuration.

The blanking function is useful in applications in which, in specific safety conditions, opaque objects must be introduced in the area protected by the light curtain without stopping the controlled machine.

This function is particularly useful when the area protected by the light curtain may be intercepted by the material being processed or by a fixed or mobile part of the machine.



Note that this function cannot be activated on the synchronism beam (1st beam starting from the signalling label with display).

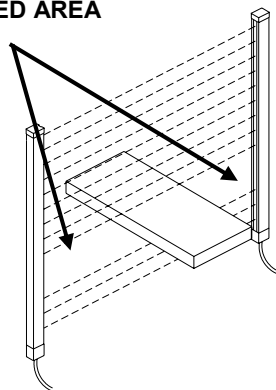


Using the blanking function, the resolution of the light curtain is modified according to Table 7 and Table 8.



When the width of the mobile object is less than that of the protected area (range), suitable mechanical guards must be provided to the sides in order to prevent accidents due to the unprotected areas. If the object is moved vertically, the safety guards must move so that they remain adjacent with this. (Figure 10)

UNPROTECTED AREA



MECHANICAL GUARDS

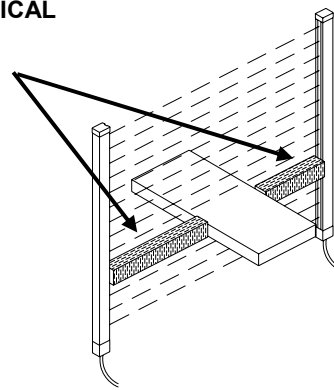


Figure 10

ADMIRAL AX BK features two different types of blanking:

- Blanking **Without Object Presence Obligation (Mode A)**
- Blanking **With Object Presence Obligation (Mode B)**

Blanking Without Object Presence Obligation (Mode A)

With this function, an object can be introduced in the dangerous area without de-activating the outputs of the light curtain. The resolution is modified for the entire height of the protected area.

When the mobile object is removed, the outputs remain active. For this type of blanking, it is possible to choose between three different methods of operation:

1. Mode A1: (Figure 11)

- With all the beams free, the protected area is free.
- With one beam occupied (except for the synchronism beam), the area is considered free.
- With two or more beams occupied, the area is considered occupied.

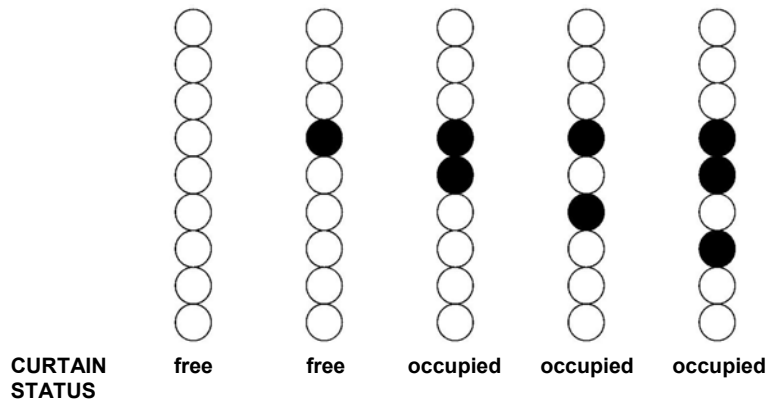


Figure 11

2. Mode A2: (Figure 12)

- With all the beams free, the protected area is free.
- With one or two **adjacent** beams occupied (except for the synchronism beam), the area is considered free.
- With two or more **non-adjacent** beams occupied, the area is considered occupied.

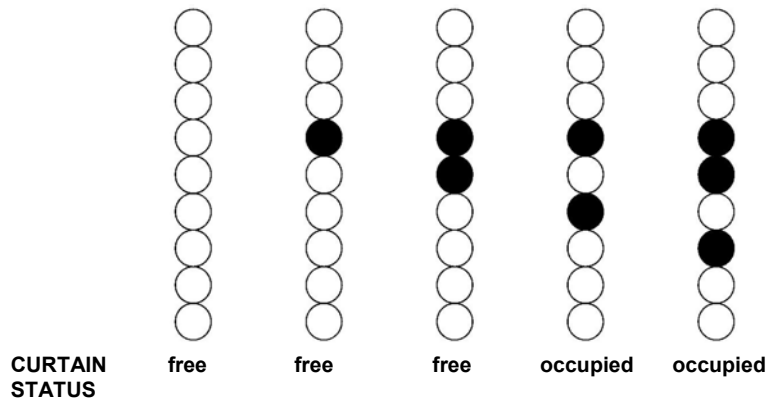


Figure 12

3. Mode A3: (Figure 13)

- With all the beams free, the protected area is free.
- With one, two or three **adjacent** beams occupied (except for the synchronism beam) the area is considered free.
- With two or more **non-adjacent** beams occupied, the area is considered occupied.

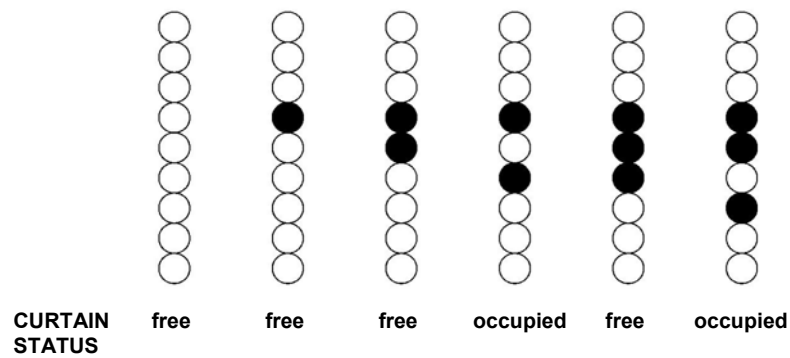


Figure 13

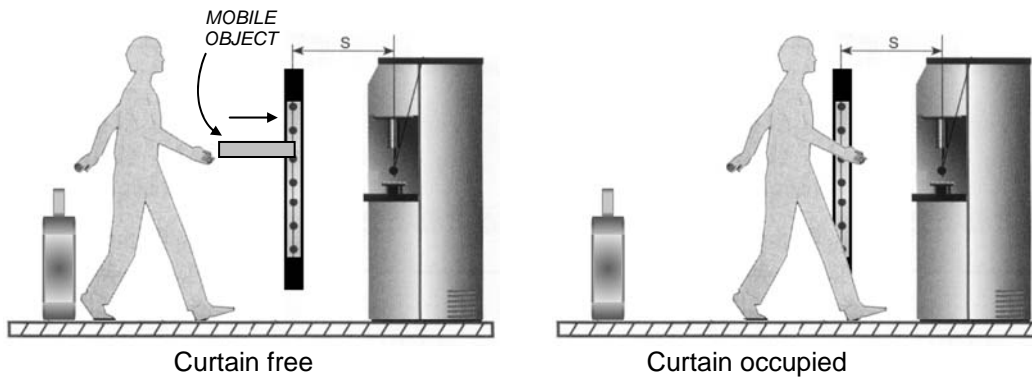
Nominal resolution	Type of Blanking	Effective resolution	Maximum size of mobile object *
14 mm	No blanking	14 mm	0
	Floating blanking A1	24 mm	8
	Floating blanking A2	34 mm	18
	Floating blanking A3	44 mm	28
20 mm	No blanking	20 mm	0
	Floating blanking A1	30 mm	10
	Floating blanking A2	40 mm	20
	Floating blanking A3	50 mm	30
40 mm	No blanking	40 mm	0
	Floating blanking A1	70 mm	30
	Floating blanking A2	100 mm	60
	Floating blanking A3	130 mm	90

Nominal resolution	Type of Blanking	Distance between beams	Maximum size of mobile object *
90 mm	No blanking	80 mm	0
	Floating blanking A1	150 mm	60
	Floating blanking A2	230 mm	140
	Floating blanking A3	300 mm	210

Table 7 - Blanking Without Object Presence Obligation

* Data obtained with optimal alignment between Emitter and Receiver

Calculate the safety distance S according to the formula provided on page 8 applying the effective value taken from Table 7 to D (resolution).



Blanking With Object Presence Obligation (Mode B)

With this function, an object (mobile or fixed) can be maintained inside the danger zone without de-activation of the light curtain outputs.

The size of the introduced object must not be less than the initial resolution of the light curtain or than the distance between the beams (in 90mm case). The object must be inside the protected area during each phase of the process in which the light curtain is active.

The width of the introduced object must be equal to that of the entire area protected by the light curtain (range); if this condition is not complied with, the effective resolution obtained from Table 8 cannot be considered valid inside and at the margins of the blanking area and a resolution corresponding to that obtained with Mode A for a corresponding number of beams must be considered (B1 is equivalent to A2 and B2 to A3).

If the object introduced has the above-mentioned characteristics, a resolution equal to the initial resolution (without blanking) can be considered for the light curtain for the entire protected area except at the margins of the blanking area where the effective resolution obtained from table 8 must be considered.

This method of blanking is available with two configurations:

1. Mode B1: (Figure 14)

- With all the beams free, the mobile object is absent, therefore the outputs are de-activated. The letter “b” is shown on the display of the receiver, indicating that the outputs are de-activated due to absence of the mobile object.
- With one beam occupied (except for the synchronism beam), the mobile object is present (blanking active and outputs ON).
- With two **adjacent** beams occupied (except for the synchronism beam), the area is considered free (tolerance of 1 beam).
- With two or more **non-adjacent** beams occupied, the area is considered occupied.

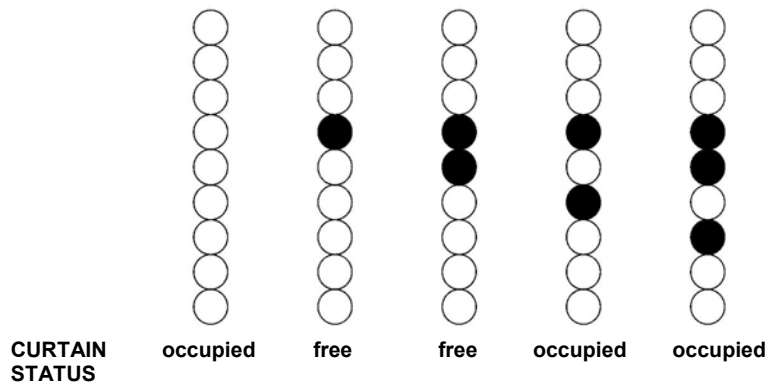


Figure 14

2. **Mode B2: (Figure 15)**

- With all the beams free, the mobile object is missing, therefore the outputs are de-activated. The letter “b” indicating that the outputs are de-activated due to the absence of the mobile object is shown on the display of the receiver.
- With one beam occupied, the mobile object is present (blanking active and outputs ON).
- With two or three **adjacent** beams occupied (except for the synchronism beam), the area is considered free (tolerance of ± 1 beam).
- With two or more **non-adjacent** beams occupied, the area is considered occupied.

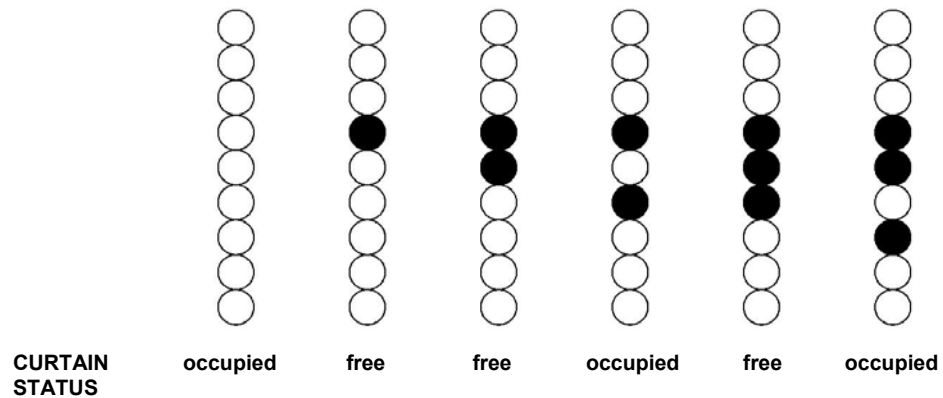


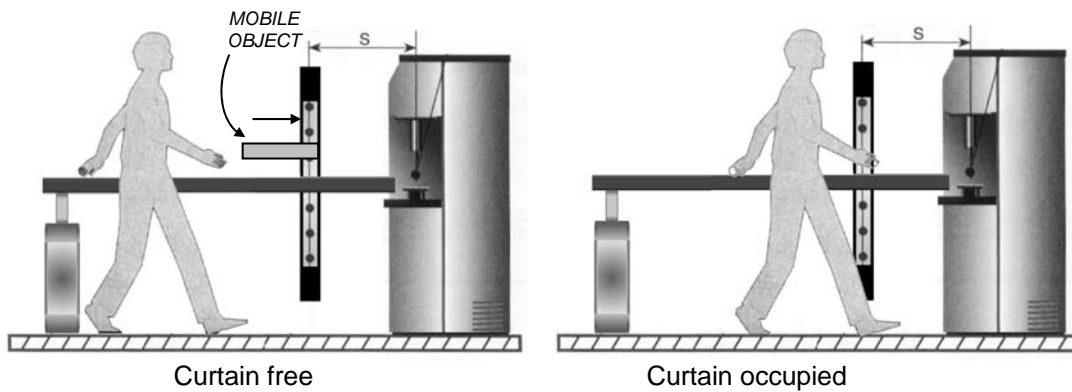
Figure 15

Nominal resolution	Type of Blanking	Effective resolution at the edges of the blanking area
14 mm	No blanking	14 mm
	Floating blanking B1	16 mm
	Floating blanking B2	26 mm
20 mm	No blanking	20 mm
	Floating blanking B1	20 mm
	Floating blanking B2	30 mm
40 mm	No blanking	40 mm
	Floating blanking B1	60 mm
	Floating blanking B2	90 mm

Nominal resolution	Type of Blanking	Minimum detectable object
90 mm	No blanking	90 mm
	Floating blanking B1	140 mm
	Floating blanking B2	210 mm

Table 8 - Blanking With Object Presence Obligation

Calculate the safety distance *S* following the formula of page 8 using the *D* value obtained from table 8.



CONFIGURATION OF THE TYPE OF BLANKING

The Type of Blanking of the ADMIRAL AX BK light curtain is set with suitable connections on the M12 8-pin connector of the Receiver (Table 9).

CONNECTIONS			FUNCTIONING MODE
SEL_A (pin 5) connected to: 0VDC	SEL_B (pin 6) connected to: 0VDC	SEL_C (pin 4) connected to: 0VDC	No blanking
SEL_A (pin 5) connected to: 0VDC	SEL_B (pin 6) connected to: 24VDC	SEL_C (pin 4) connected to: 24VDC	Blanking Without Object Presence Obligation – Mode A1
SEL_A (pin 5) connected to: 24VDC	SEL_B (pin 6) connected to: 0VDC	SEL_C (pin 4) connected to: 24VDC	Blanking Without Object Presence Obligation - Mode A2
SEL_A (pin 5) connected to: 24VDC	SEL_B (pin 6) connected to: 24VDC	SEL_C (pin 4) connected to: 0VDC	Blanking Without Object Presence Obligation - Mode A3
SEL_A (pin 5) connected to: OSSD1 (pin 1)	SEL_B (pin 6) connected to: OSSD2 (pin 3)	SEL_C (pin 4) connected to: 24VDC	Blanking With Object Presence Obligation - Mode B1
SEL_A (pin 5) connected to: OSSD2 (pin 3)	SEL_B (pin 6) connected to: OSSD1 (pin 1)	SEL_C (pin 4) connected to: 0VDC	Blanking With Object Presence Obligation - Mode B2

Table 9



It is not possible to modify the configuration of the type of Blanking with the light curtain operating. The system must first of all be switched off and then on again.

Example of MASTER-SLAVE connection in AUTOMATIC operating mode with Blanking Without Object Presence Obligation (Mode A1)

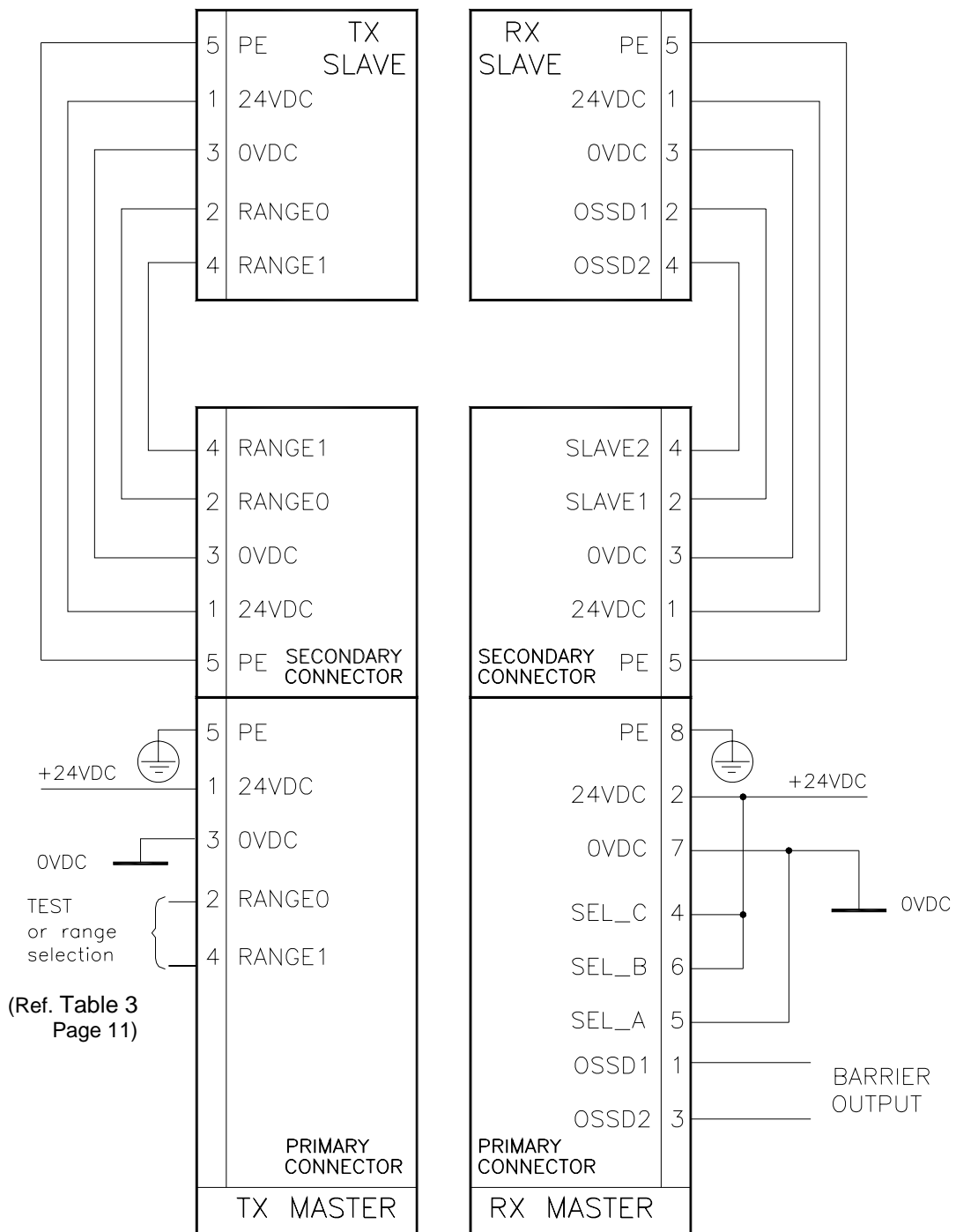


Figure 16

➔ In order to assure a correct barrier operation, it is necessary to connect the pins 2 and 4 of the Emitter according to table 3 (page 11) and to the "TEST FUNCTION" paragraph of page 31.

Example of MASTER-SLAVE connection in AUTOMATIC operating mode with Blanking Without Object Presence Obligation (Mode A2)

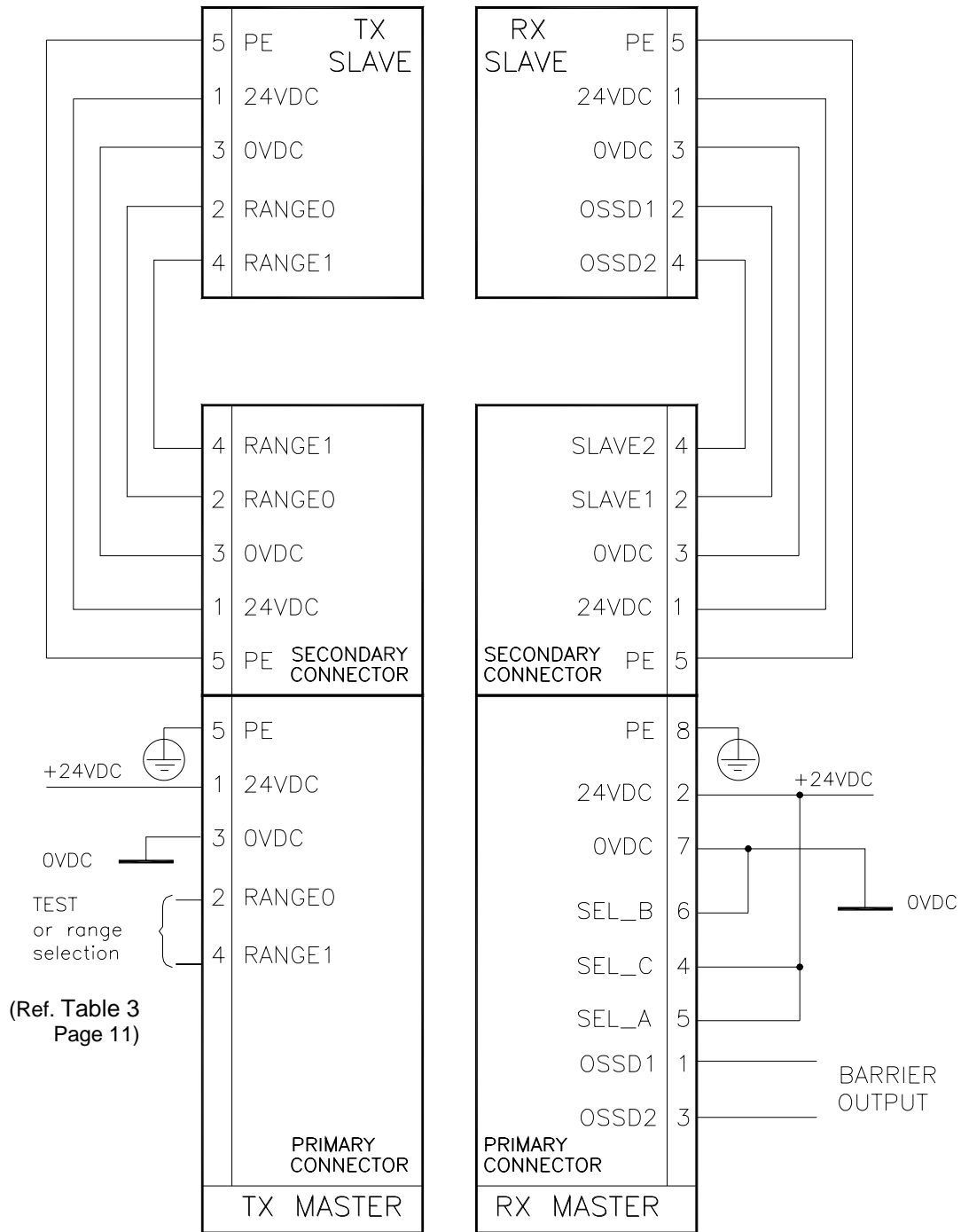


Figure 17

➔ In order to assure a correct barrier operation, it is necessary to connect the pins 2 and 4 of the Emitter according to table 3 (page 11) and to the "TEST FUNCTION" paragraph of page 31.

Example of MASTER-SLAVE connection in AUTOMATIC operating mode with Blanking Without Object Presence Obligation (Mode A3)

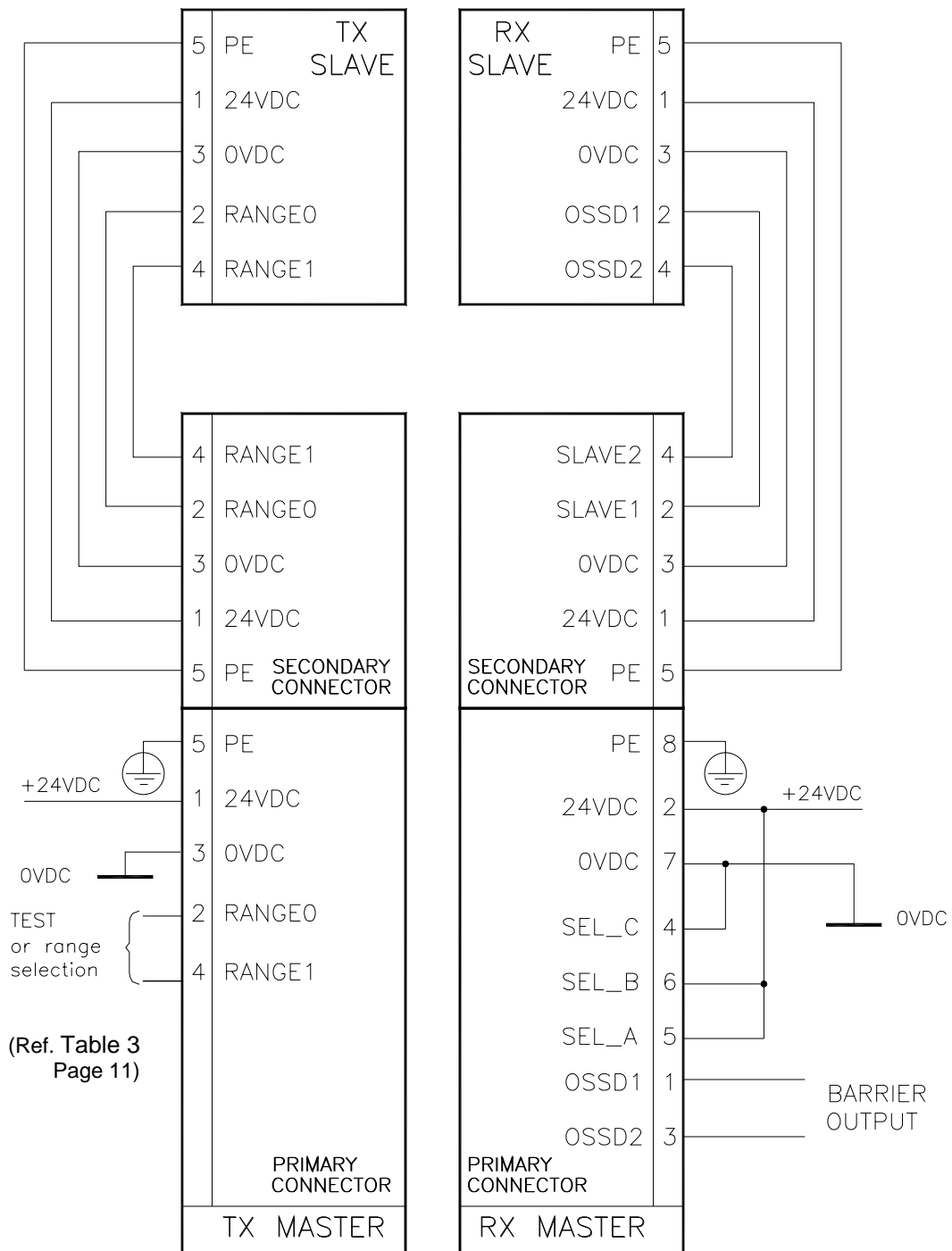


Figure 18

➔ In order to assure a correct barrier operation, it is necessary to connect the pins 2 and 4 of the Emitter according to table 3 (page 11) and to the "TEST FUNCTION" paragraph of page 31.

Example of MASTER-SLAVE connection in AUTOMATIC operating mode with Blanking With Object Presence Obligation (Mode B1)

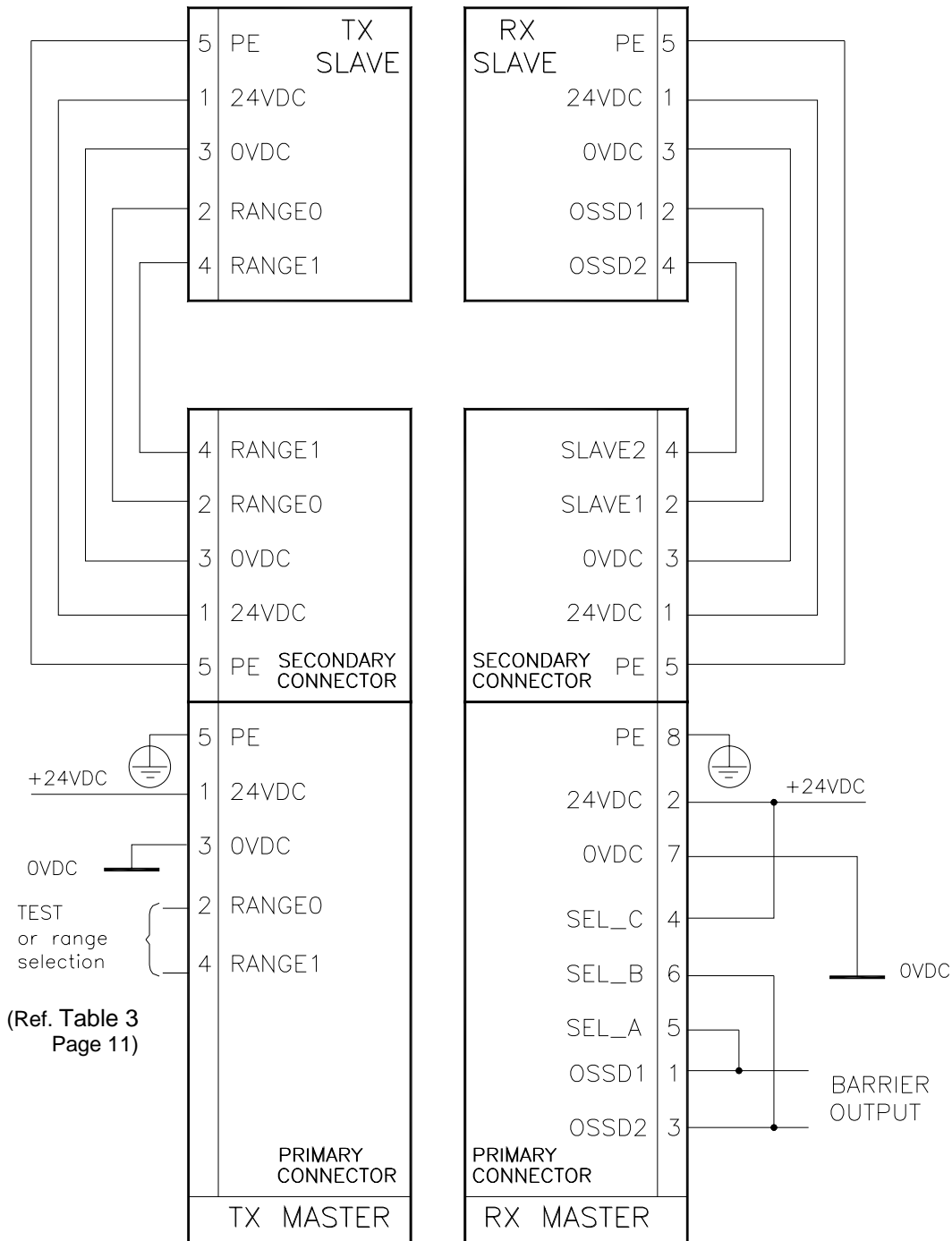


Figure 19



In order to assure a correct barrier operation, it is necessary to connect the pins 2 and 4 of the Emitter according to table 3 (page 11) and to the "TEST FUNCTION" paragraph of page 31.

Example of MASTER-SLAVE connection in AUTOMATIC operating mode with Blanking With Object Presence Obligation (Mode B2)

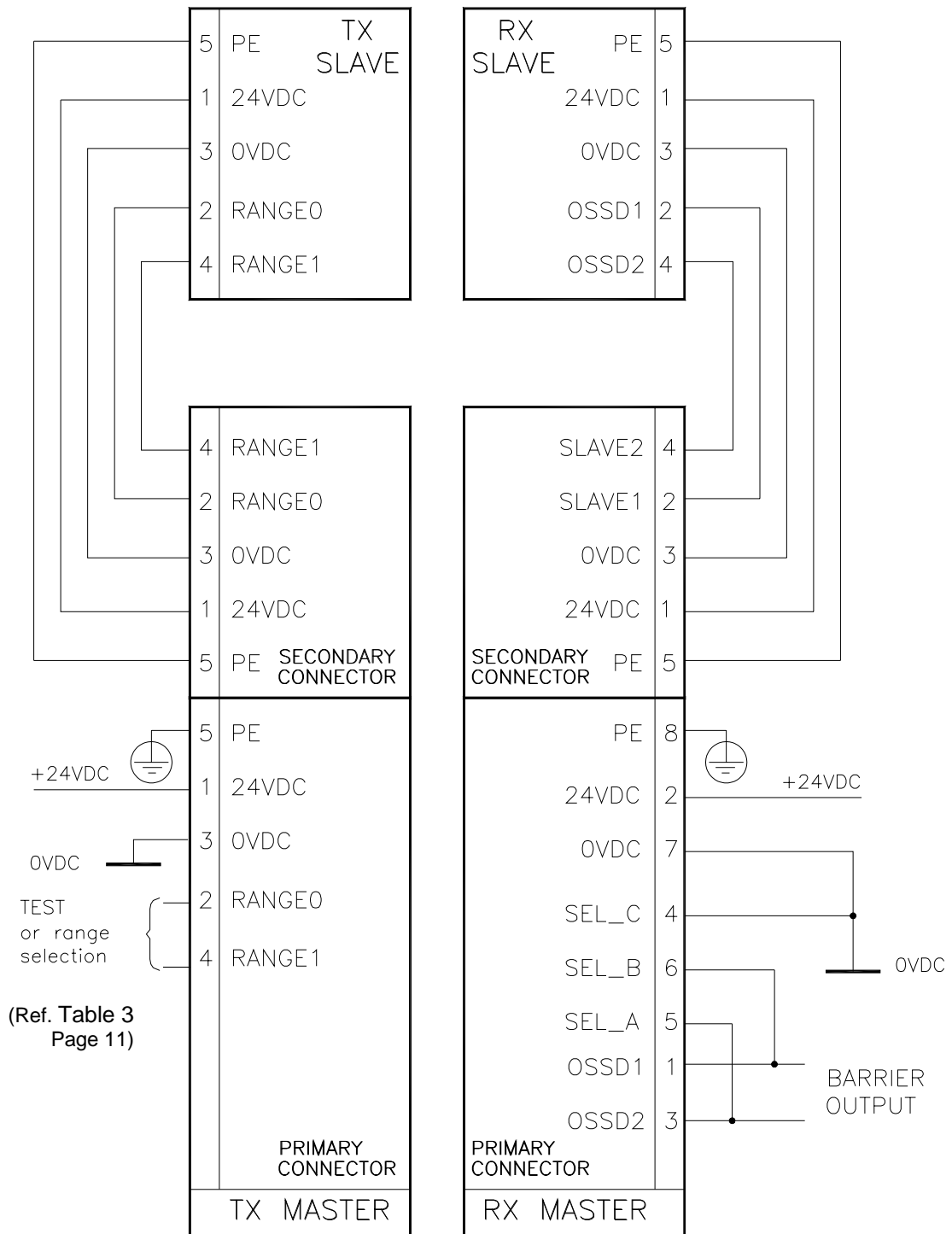


Figure 20



In order to assure a correct barrier operation, it is necessary to connect the pins 2 and 4 of the Emitter according to table 3 (page 11) and to the "TEST FUNCTION" paragraph of page 31.

**Example of connection in AUTOMATIC operating mode
with Blanking Without Object Presence Obligation (Mode A1)**

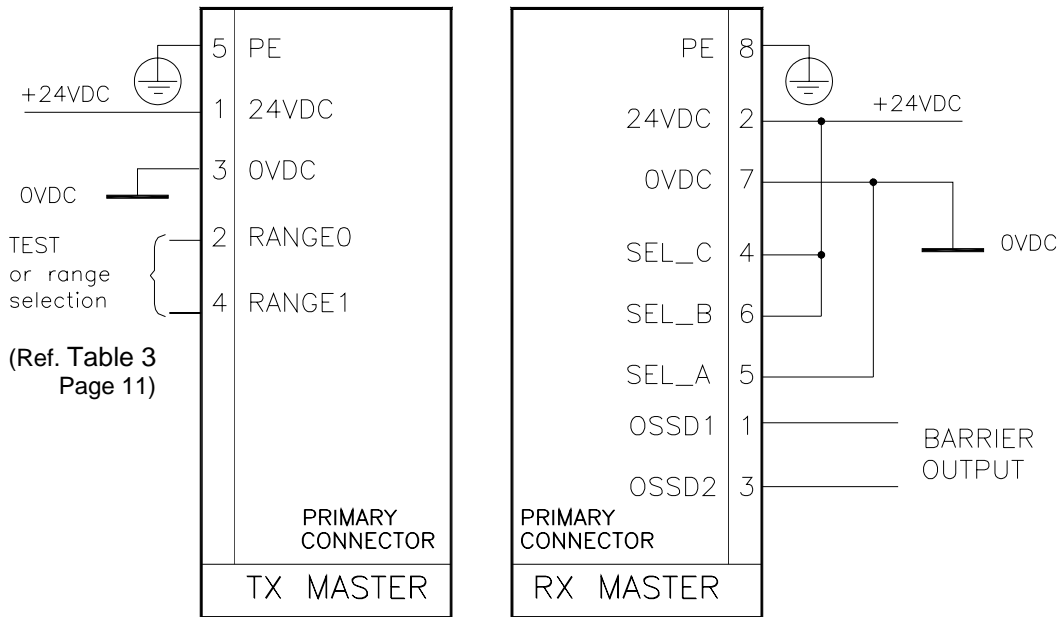


Figure 21

**Example of connection in AUTOMATIC operating mode
with Blanking With Object Presence Obligation (Mode B1)**

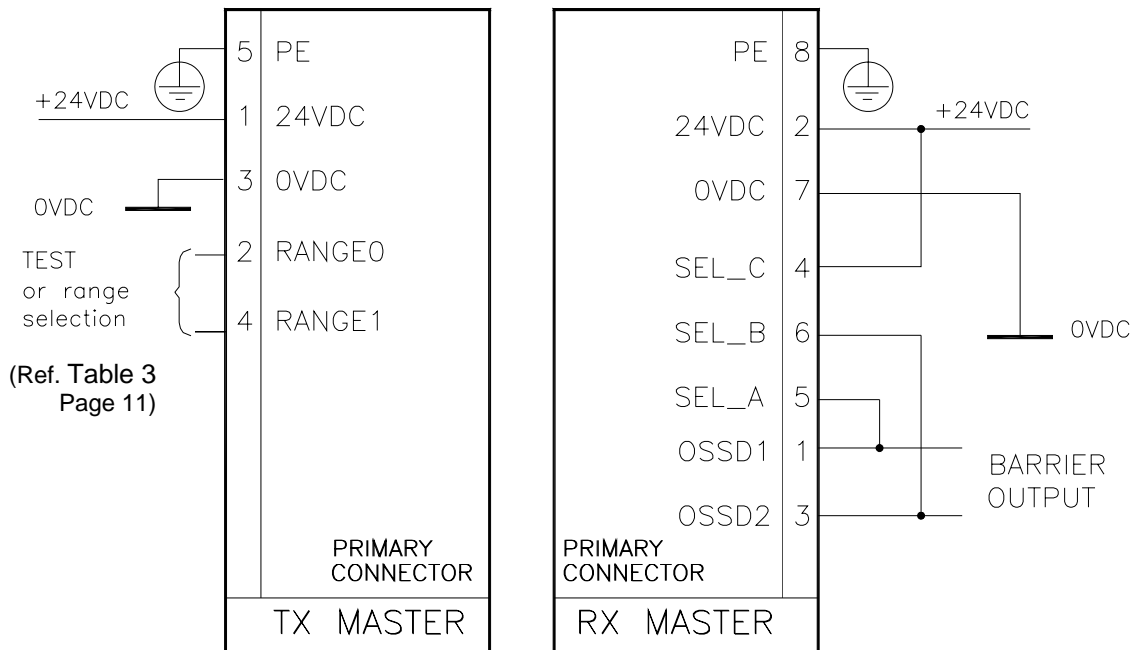


Figure 22

➔ In order to assure a correct barrier operation, it is necessary to connect the pins 2 and 4 of the Emitter according to table 3 (page 11) and to the "TEST FUNCTION" paragraph of page 31.

MULTIPLE SYSTEMS

When more than one ADMIRAL AX BK system is used, precautions must be taken to avoid optical interference between them: install the units so that the beam emitted by the Emitter of one system can only be received by the relative Receiver.

Figure 23 illustrates some examples of correct positioning when two photoelectric systems are installed. Incorrect positioning could generate interference, and may result in malfunctioning.

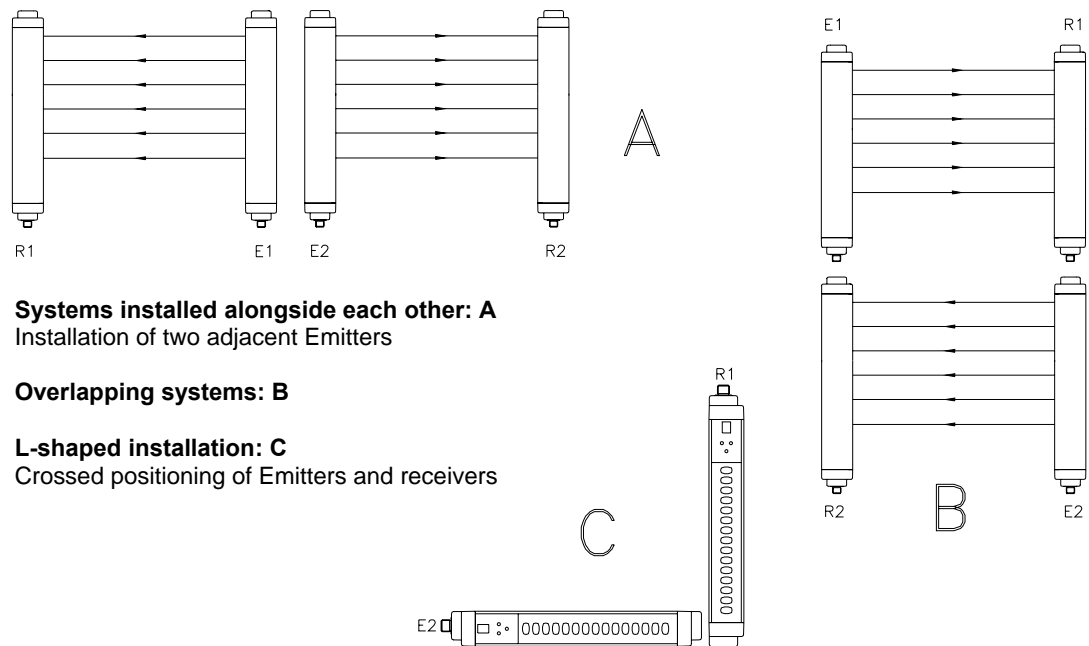


Figure 23



This operation is not necessary in case of coexistence of a MASTER and a SLAVE.

USE OF DEFLECTION MIRRORS

In order to protect or control areas that can be accessed from more than one side, in addition to the Emitter and Receiver, one or more deflection mirrors can be installed.

These mirrors enable the optical beams generated by the Emitter to be deviated on one or more sides.

If the beams emitted by the Emitter must be deviated by 90°, the perpendicular to the surface of the mirror must form an angle of 45° with the direction of the beams.

The following figure illustrates an application in which two deviation mirrors are used to provide a U-shaped protection.

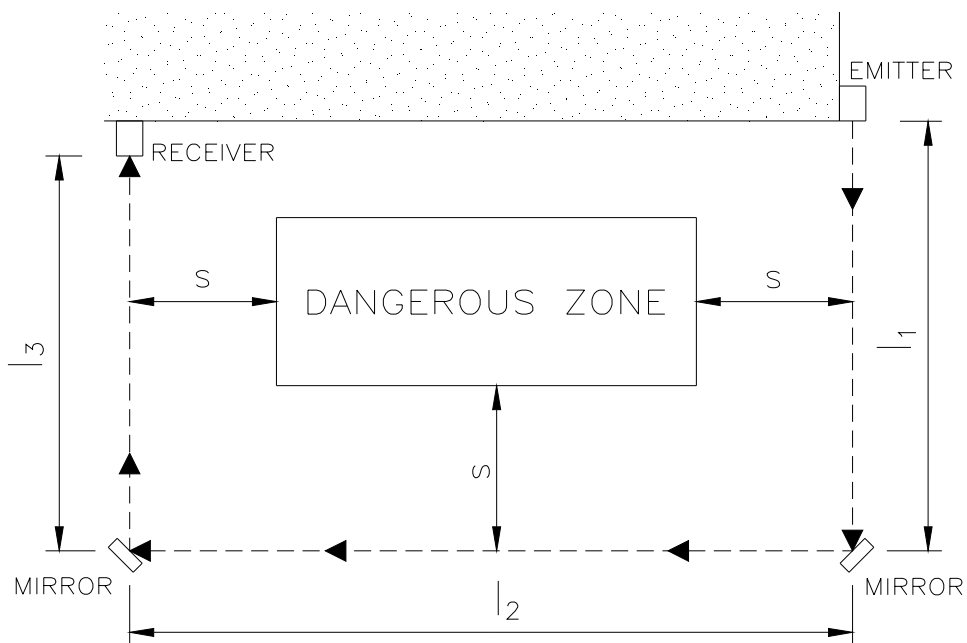


Figure 24

The following rules should be taken into consideration when using deviation mirrors:

- Place the mirrors so as to ensure compliance with the minimum safety distance **S** (Figure 24) on each side from which the danger zone can be accessed.
- The working distance (range) is given by the sum of the lengths of all the sides that give access to the protected area. (Remember that for each mirror used the maximum working range between the Emitter and the Receiver is reduced by 15%).
- During installation, take great care to avoid twisting along the longitudinal axis of the mirror.
- Make sure, by standing near to and on the axis of the Receiver, that the **entire outline** of the Emitter is visible on the first mirror.
- The use of more than three deviation mirrors is not recommended.

DISTANCE BETWEEN REFLECTING SURFACES

The presence of reflecting surfaces in proximity of the photoelectric barrier may generate spurious reflections that prevent monitoring. With reference to Figure 25, object **A** is not detected because surface **S** reflects the beam and closes the optical path between the Emitter and Receiver. A minimum distance **d** must therefore be maintained between any reflecting surfaces and the protected area. The minimum distance **d** must be calculated according to the distance **l** between the Emitter and the Receiver, considering that the angle of projection and reception is 4° .

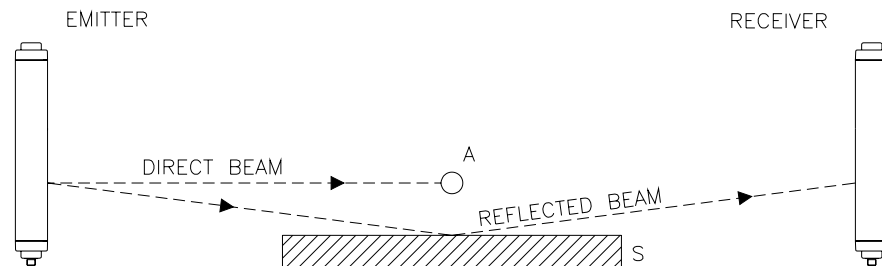


Figure 25

Figure 26 illustrates the values for the minimum distance **d** that must be maintained when the distance **l** between the Emitter and Receiver is changed.

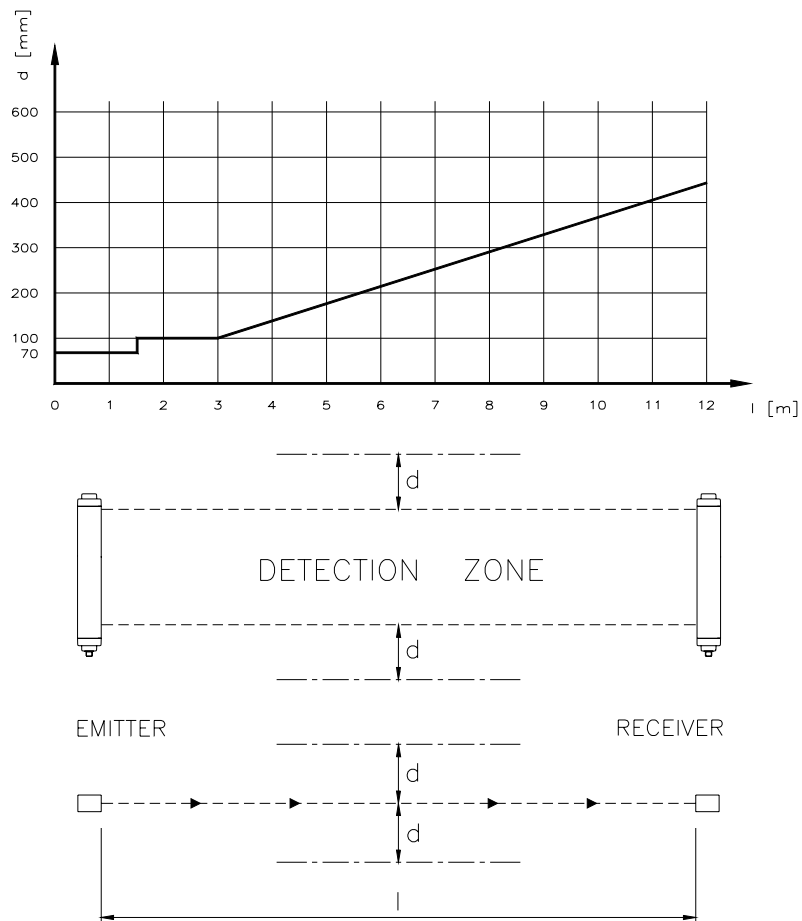


Figure 26

After installing the system, check whether any reflecting surfaces intercept the beams, first in the centre and then in the vicinity of the Emitter and Receiver. During these operations, the red LED on the Receiver should never, for any reason, switch off.

MECHANICAL ASSEMBLY AND OPTICAL ALIGNMENT

The Emitter and the Receiver must be assembled opposite each other (at a distance specified in the technical data sheet). Use the **fastening brackets and inserts** supplied with the system to place the Emitter and the Receiver so that these are aligned and parallel to each other and with the connectors facing the same way.

Depending on the dimensions and the shape of the support on which they are to be installed, the Emitter and Receiver must be assembled with the fastening inserts at the back, or else by fitting these in the side groove (Figure 27).

Perfect alignment of the Emitter and Receiver is essential in order to assure correct barrier operation. The indicator LEDs on the Emitter and Receiver facilitate this operation.



To perform an easier alignment the use of SFB circular brackets is necessary. These are available on request (ordering code 1330974).

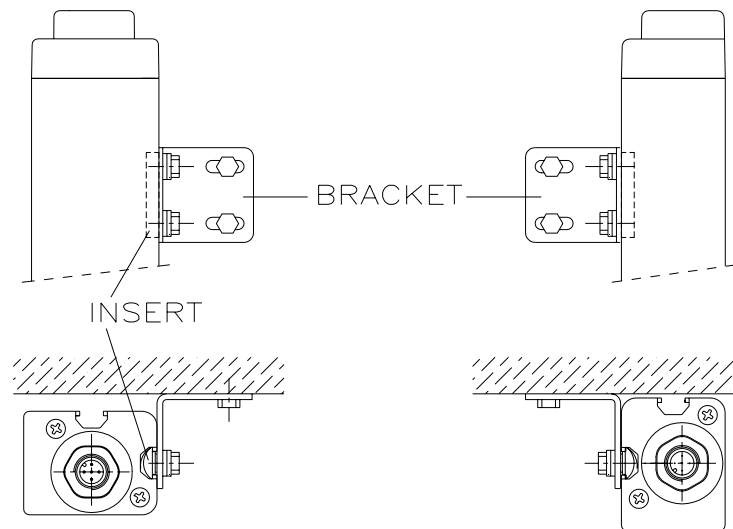


Figure 27

- Position the optical axis of the first and last beam of the Emitter on the same axis as that of the corresponding beams on the Receiver.
- Move the Emitter in order to find the area within which the green LED on the Receiver stays on, then position the first beam of the Emitter (the one close to the indicator LEDs) in the centre of this area.
- Using this beam as a pivot, effect small sideways movements of the opposite end to move to the protected area clear condition. The green LED on the Receiver will indicate this condition.
- Lock the Emitter and Receiver in place.

During these operations it may be useful to check the presence of the **yellow LED weak signal ("d" letter for the slave models) on the receiver**. Upon completion of alignment, this LED/letter must be off.



In the case of MASTER/SLAVE models, first of all align the SLAVE pair and then the MASTER pair.



If the Emitter and the Receiver are assembled in areas that are subject to strong vibrations, **the use of vibration-damping supports is necessary**, in order to prevent circuit malfunctions (code SAV-3 1200088, code SAV-4 1200089).

OPERATION AND TECHNICAL DATA

SIGNALS

The symbols showed on the 7 segments display and the leds of emitter and receiver units are visualized depending on the system operation phase. The tables below shows the different signals (ref. Figure 28).

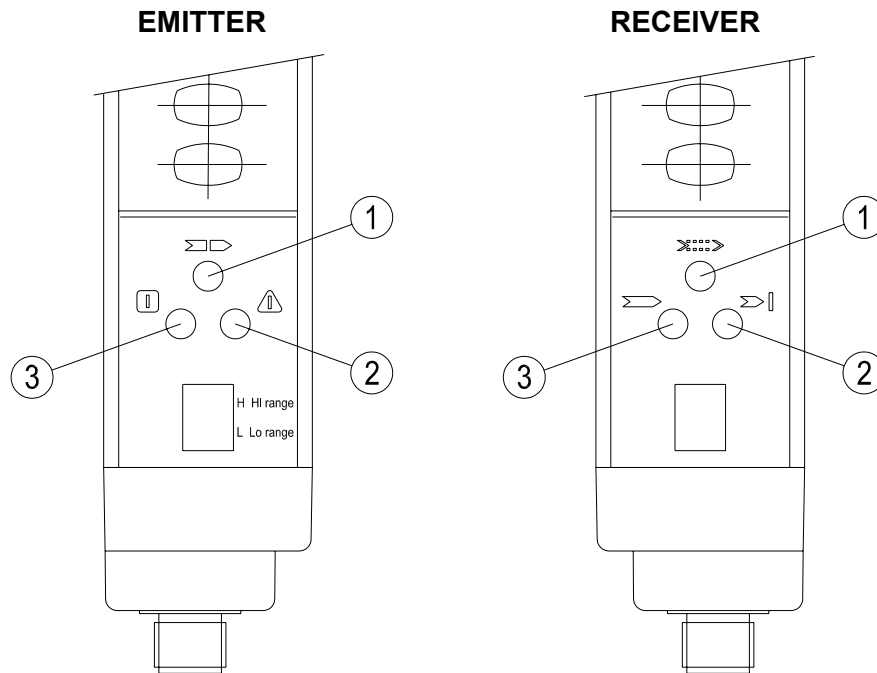


Figure 28

EMITTER SIGNALS

Normal operation (FIXED SYMBOLS)

7 SEGMENTS DISPLAY		LED		
SYMBOL	MEANING	RED (2)	GREEN (3)	YELLOW (1)
8	Power on. Initial test	ON	OFF	ON
L	Normal operation. LOW range	OFF	ON	OFF
H	Normal operation. HIGH range	OFF	ON	OFF
L	TEST	OFF	ON	ON
H		OFF	ON	ON

MASTER OF NORMAL RECEIVER MESSAGES

Normal functioning (FIXED SYMBOLS)

7-SEGMENT DISPLAY		LED		
SYMBOL	MEANING	RED (2)	GREEN (3)	YELLOW (1)
8	System power-on. Initial TEST.	ON	OFF	ON
C	ON for 10sec: Blanking S.O.P.O. (A) Mode A1	ON	OFF	OFF
C	ON for 10sec: Blanking S.O.P.O. (A) Mode A2	ON	OFF	ON
C	ON for 10sec: Blanking S.O.P.O. (A) Mode A3	ON	OFF	Flashing
C	ON for 10sec: Blanking C.O.P.O. (B) Mode B1	OFF	ON	OFF
C	ON for 10sec: Blanking C.O.P.O. (B) Mode B2	OFF	ON	ON
None	BREAK condition (C)	ON	OFF	OFF
None	BREAK condition with weak signal	ON	OFF	ON
b	BREAK condition (no mobile object) (D)	ON	OFF	OFF
b	BREAK condition with weak signal (no mobile object) (D)	ON	OFF	ON
J	Master in Clear, Slave in BREAK (E)	ON	OFF	OFF
J	Master in Clear, Slave in BREAK with weak signal (E)	ON	OFF	ON
None	GUARD condition (F) – no blanking	OFF	ON	OFF
None	GUARD condition (F), no blanking with weak signal	OFF	ON	ON
Γ	BLANKING condition active	OFF	ON	OFF
	BLANKING condition active with weak signal	OFF	ON	ON
-	Receiver initialization	ON	OFF	OFF

(A) S.O.P.O. = Without Object Presence Obligation (Mode A)

(B) C.O.P.O. = With Object Presence Obligation (Mode B)

(C) Curtain occupied - outputs de-activated

(D) Applicable only to Blanking With Object Presence Obligation

(E) Valid only in MASTER/SLAVE configuration

(F) Curtain free - outputs active

SLAVE RECEIVER SIGNALS

Normal operation (FIXED SYMBOLS)

7 SEGMENTS DISPLAY		LED		
SYMBOL	MEANING	RED (2)	GREEN (3)	YELLOW (1)
8	System power on. Initial TEST	ON	OFF	ON
Nessuno	BREAK condition	ON	OFF	OFF
Nessuno	GUARD Condition	OFF	ON	OFF
d	BREAK condition with weak signal	ON	OFF	OFF
d	GUARD condition with weak signal	OFF	ON	OFF
-	Receiver initialization	ON	OFF	OFF

N.B.: For the meaning of the number that is displayed in case of a malfunction, please refer to the “TROUBLESHOOTING” paragraph in this manual.

TEST FUNCTION

By means of the test function, which simulates occupation of the protected area, it is possible to verify the operation of the entire system by means of an external supervisor (e.g. PLC, control module, etc.).

The ADMIRAL AX BK barrier system features an automatic self-diagnosis function that enables it to detect response time malfunctions (this time is declared for each model).

This safety system is permanently active and does not require any interventions from the outside. The TEST function is available should the user wish to check equipment connected downstream of the barrier (without physically entering the protected area).

By means of this function the OSSDs can be switched from ON to OFF as long as the function remains active. Please see table 3 (page 11) for details about the use of the test function.

The minimum duration of the TEST function must be 40 msec.

OUTPUT STATUS

The ADMIRAL features two static PNP outputs on the Receiver, the status of which depends on the condition of the protected area.

The maximum load allowed is 500mA at 24VDC, which corresponds to a resistive load of 48Ω. Maxim load capacity corresponds to 2μF. The meaning of the status of outputs is defined in the table below. Any short circuit between outputs or between outputs and 24VDC or 0VDC power supplies is detected by the barrier.

NAME OF SIGNAL	CONDITION	MEANING
OSSD1	24VDC	Barrier clear condition
OSSD2		
OSSD1	0VDC	Barrier engaged condition or failure detected
OSSD2		

Table 10



In the protected area clear condition, the Receiver supplies a voltage of 24 VDC on both outputs. The required load must therefore be connected between the output terminals and the 0VDC (Figure 29).

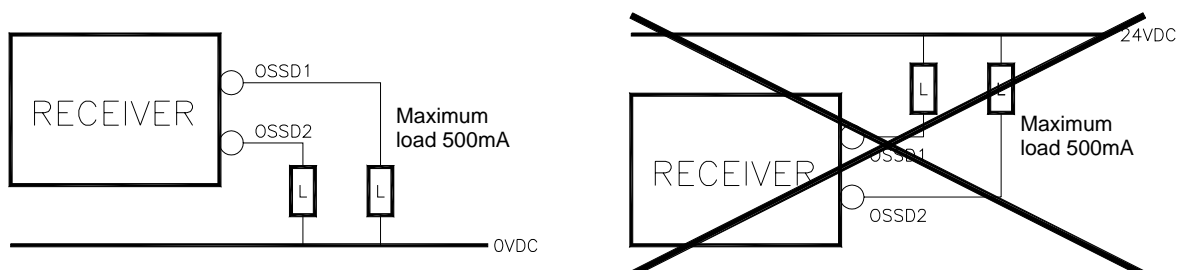


Figure 29

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS OF ADMIRAL BARRIERS AX		
Protected height	mm	160 – 1810
Resolutions	mm	14 - 20 - 40 - 90
Working range (selectable) 14mm models	m	0 ÷ 2 (low)
		0 ÷ 5 (high)
Working range (selectable) 20mm, 40mm, 90mm	m	0 ÷ 6 (low)
		3 ÷ 18 (high)
Safety outputs		2 PNP – 500mA @ 24VDC
Response time **	ms	6 ÷ 27 (see tables for specific models)
Power supply	VDC	24 ± 20%
Connections		Connectors M12 5/8-poles
Max. conn. length	m	100 (50 between Master and Slave)
Operating temperature	°C	0 ÷ 55°C
Protection rating		IP 65
Dimensions of section	mm	35 x 45
Max. consumption	W	2 (Emitter) 3 (Receiver)
Light curtain lifetime		20 years
Safety level	Type 4	IEC 61496-1:2004 IEC 61496-2:2006
	SIL 3	IEC 61508:1998
	SILCL 3	IEC 62061:2005
	PL e - Category 4	ISO 13849-1:2006

** In case of operation of ADMIRAL AX BK in Master-Slave configuration, the correct total SLAVE response time must be calculated according the following formula:

$$t_{tot_slave} = t_{slave} + t_{master} + 1,8 \text{ ms}$$

LEGENDA

Admiral (with additional functions)= AX

Admiral Master = AXM

Admiral Slave = AXS

14 mm Resolution Models	151	301	451	601	751	901	1051	1201	1351	1501	1651	1801
Number of beams	15	30	45	60	75	90	105	120	135	150	165	180
Response time (AX)	6	7,5	9,5	11,5	13,5	15,5	17	19	21	23	25	27
Response time (AXM or AXS)	-	11	13,5	16,5	19,5	22,5	25,5	28,5	-	34,5	-	-
Overall barrier ht. mm	261	411	561	711	861	1011	1161	1311	1461	1611	1761	1911
PFHd *	1,02E-8	1,17E-8	1,33E-8	1,48E-8	1,63E-8	1,79E-8	1,94E-8	2,10E-8	2,25E-8	2,40E-8	2,56E-8	2,71E-8
DCavg #	97,77%	98,07%	98,25%	98,38%	98,47%	98,53%	98,58%	98,63%	98,66%	98,69%	98,71%	98,73%
MTTFd # years	100					92,14	81,96	73,80	67,12	61,55	56,83	52,79
CCF #	80%											

20 mm Resolution Models	152	302	452	602	752	902	1052	1202	1352	1502	1652	1802
Number of beams	15	30	45	60	75	90	105	120	135	150	165	180
Response time (AX)	6	7,5	9,5	11,5	13,5	15,5	17	19	21	23	25	27
Response time (AXM or AXS)	-	11	13,5	16,5	19,5	22,5	25,5	28,5	-	34,5	-	-
Overall barrier ht. mm	261	411	561	711	861	1011	1161	1311	1461	1611	1761	1911
PFHd *	1,02E-8	1,17E-8	1,33E-8	1,48E-8	1,63E-8	1,79E-8	1,94E-8	2,10E-8	2,25E-8	2,40E-8	2,56E-8	2,71E-8
DCavg #	97,77%	98,07%	98,25%	98,38%	98,47%	98,53%	98,58%	98,63%	98,66%	98,69%	98,71%	98,73%
MTTFd # years	100					92,14	81,96	73,80	67,12	61,55	56,83	52,79
CCF #	80%											

* IEC 61508

ISO 13849-1

40 mm Resolution Models	304	454	604	754	904	1054	1204	1354	1504	1654	1804
Number of beams	10	15	20	25	30	35	40	45	50	55	60
Response time	6,5	7,5	8,5	9,5	10,5	11,5	12,5	13,5	14,5	15,5	16,5
Overall barrier ht. mm	411	561	711	861	1011	1161	1311	1461	1611	1761	1911
PFHd *	1,01E-8	1,09E-8	1,17E-8	1,24E-8	1,32E-8	1,39E-8	1,47E-8	1,54E-8	1,62E-8	1,69E-8	1,77E-8
DCavg #	97,76%	97,93%	98,06%	98,16%	98,24%	98,31%	98,37%	98,42%	98,46%	98,49%	98,52%
MTTFd # years	100										93,89
CCF #	80%										

90 mm Resolution Models	609	759	909	1059	1209	1359	1509	1659	1809
Number of beams	9	11	13	15	17	19	21	23	25
Response time	6	6	6	6	6	6	6,5	7	7
Overall barrier ht. mm	711	861	1011	1161	1311	1461	1611	1761	1911
PFHd *	1,09E-8	1,15E-8	1,21E-8	1,27E-8	1,32E-8	1,38E-8	1,44E-8	1,50E-8	1,55E-8
DCavg #	97,93%	98,04%	98,12%	98,19%	98,25%	98,30%	98,35%	98,39%	98,42%
MTTFd # years	100								
CCF #	80%								

* IEC 61508
ISO 13849-1

DIMENSIONS

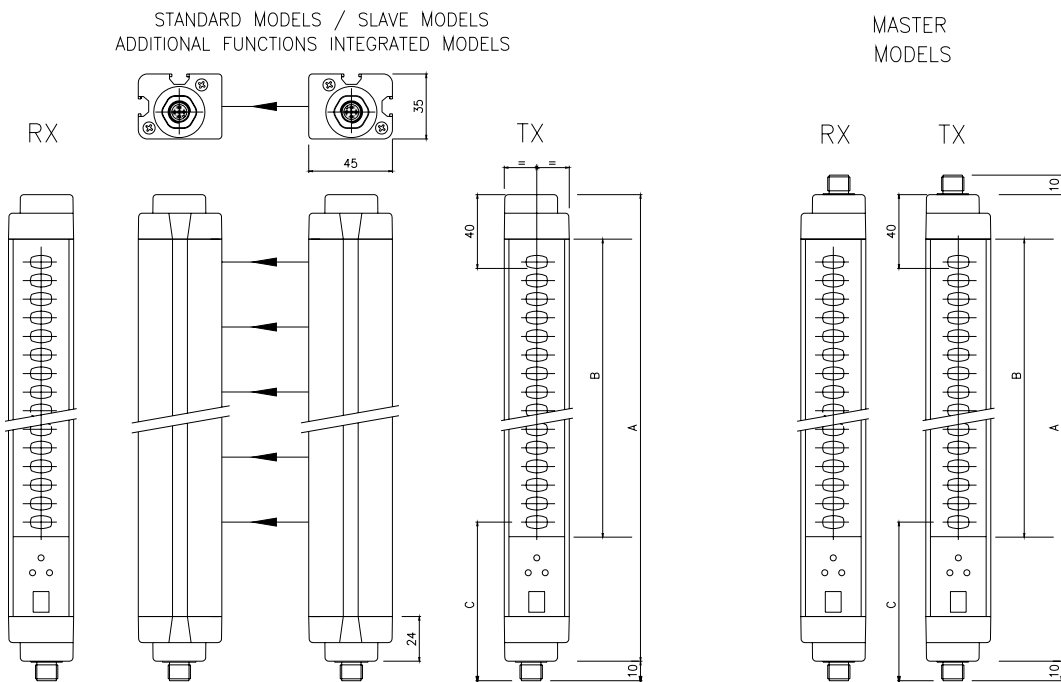


Figure 30
Emitter and Receiver

Model	150	300	450	600	750	900	1050	1200	1350	1500	1650	1800
A	251	401	551	701	851	1001	1151	1301	1451	1601	1751	1901
B (PROTECTED AREA)	160	310	460	610	760	910	1060	1210	1360	1510	1660	1810
C	85											
Mounting	2 LS Brackets with 2 mounting inserts						3 LS Brackets with 3 mounting inserts					

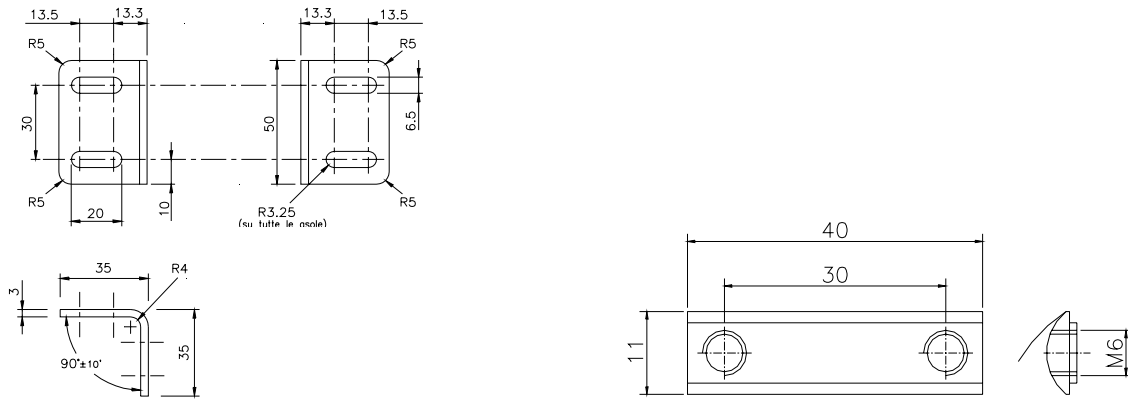


Figure 31
Fastening LS type brackets and inserts (included)

CHECKOUTS AND MAINTENANCE

Verification of barrier efficiency.



Before each work shift or before switching on, check the correct operation of the photoelectric barrier.

Proceed as follows, intercepting the beams using the appropriate test object (available free of charge on request).



The correct test object must be used for testing, depending on the barrier resolution. Please see page 38 for the correct ordering code.

Refer to Figure 32:

- Introduce the test object into the protected area and move it slowly, starting from the top and moving down (or vice versa), first in the centre and then in the vicinity of both the Emitter and the Receiver.
- **Multibeam models:**
Intercept each beam with an opaque object, first in the center of the detection zone and then close to the emitter and the receiver.
- Make sure that during each stage of the test object's movements the red LED on the Receiver is always on.

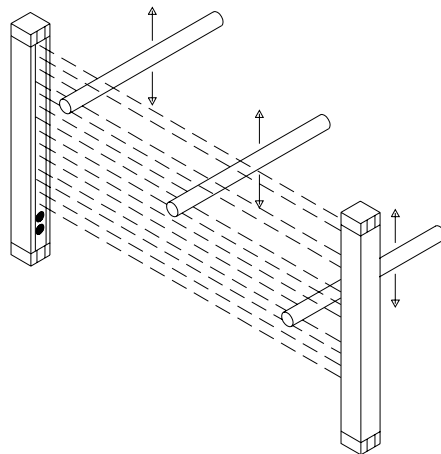


Figure 32

The ADMIRAL AX BK barrier does not require any specific maintenance operations; however, periodic cleaning of the front protective surfaces of the Emitter and Receiver optics is recommended.

Wipe using a clean, damp cloth; in particularly dusty environments, after cleaning the front surface, the use of an anti-static spray is recommended.

Never use abrasive or corrosive products, solvents or alcohol, which could damage parts. Do not use woollen cloths, that could electrify the front surface.



Grooving or fine scratching of the front plastic surfaces can increase the amplitude of the emission angle of the light curtain, jeopardising detection efficiency in the presence of lateral reflecting surfaces.



It is therefore fundamental to pay particular attention during the cleaning phases of the curtain front window, especially in environments where abrasive dusts are present. (E.g. cement factories, etc).

If the **yellow LED weak signal ("d" letter for the slave models)** on the receiver is on, check that:

- the front surfaces are clean;
- the Emitter and Receiver are aligned correctly.

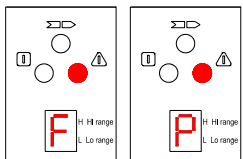
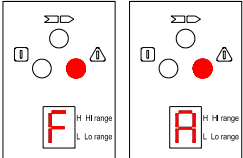
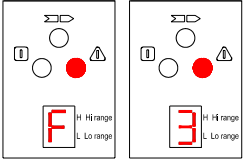
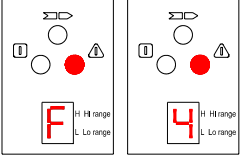
If the LED stays on, contact the REER service department.

TROUBLESHOOTING

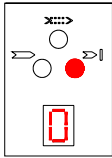
The indications provided on the displays of Emitter and Receiver make it possible to trace the cause of a system malfunction.

As indicated in the “**INDICATIONS**” chapter of this manual, in the case of a fault, the system is blocked and a “**F**” letter followed by a numeric code identifying the type of fault is shown on the display of the receiver. (See the tables below).

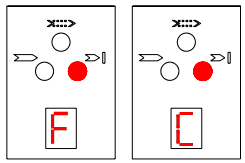
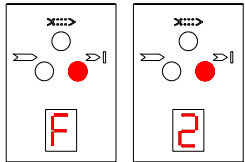
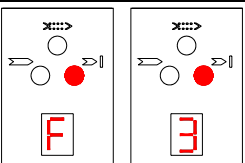
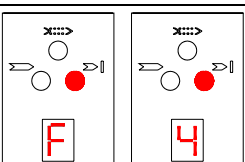
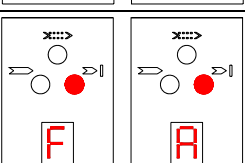
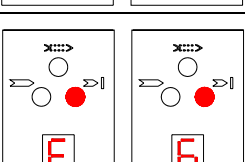
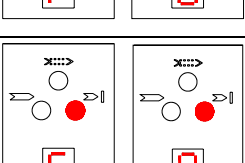
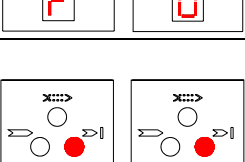
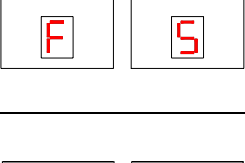
EMITTER (BLINKING SYMBOLS)

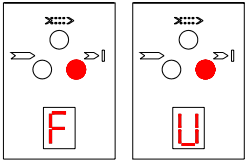
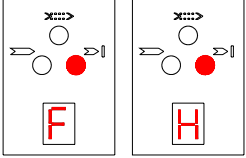
7 SEGMENTS DISPLAY		LED			REMEDY
SYMBOL	MEANING	RED	GREEN	YELLOW	
	Range selection incorrect or modified	ON	OFF	OFF	Carefully check the connection of terminals 2 and 4 (EXT_RANGE0/1) on the connector
	Internal error (add-on board)	ON	OFF	OFF	Send the equipment for repair to the REER laboratories.
	Internal error (master board)	ON	OFF	OFF	
	Internal error	ON	OFF	OFF	

RECEIVER (FIX SYMBOLS)

7 SEGMENTS DISPLAY		LED			REMEDY
SYMBOL	MEANING	RED	GREEN	YELLOW	
	Overload of the OSSD static outputs	ON	OFF	OFF	Take action in one of the following ways: <ul style="list-style-type: none"> • (STANDARD and MASTER MODELS) Carefully check the connection of terminals 1 and 3 (OSSD) on the connector. If necessary, adjust load reducing the current required to max 500 mA (2μF) • (SLAVE MODELS) Send the equipment for repair to the REER laboratories.

RECEIVER (BLINKING SYMBOLS)

7 SEGMENTS DISPLAY		LED			REMEDY
SYMBOL	MEANING	RED	GREEN	YELLOW	
	Customer configuration rejected WARNING "F" symbol remains fix on the display after the blinking	ON	OFF	OFF	Carefully check the connections
	OSSD erroneously connected o 24VDC	ON	OFF	OFF	
	Internal error	ON	OFF	OFF	Send the equipment for repair to the REER laboratories.
		ON	OFF	OFF	
		ON	OFF	OFF	
	OSSD1 - OSSD2 short-circuit	ON	OFF	OFF	Take action in one of the following ways: <ul style="list-style-type: none"> • (STANDARD and MASTER MODELS) Carefully check the connection of terminals 1 and 3 (OSSD) on the connector. • (SLAVE MODELS) Send the equipment for repair to the REER laboratories.
	(only for MASTER and STANDARD models) Overload of the OSSD static outputs	ON	OFF	OFF	Carefully check the connection of terminals 1 and 3 (OSSD) on the connector.
	OSSD static outputs error	ON	OFF	OFF	Take action in one of the following ways: <ul style="list-style-type: none"> • (STANDARD and MASTER MODELS) Carefully check the connection of terminals 1 and 3 (OSSD) on the connector. If necessary, adjust load reducing the current required to max 500 mA (2µF) • (SLAVE MODELS) Send the equipment for repair to the REER laboratories.
	Interfering dangerous Emitter detected. The receiver is able to receive simultaneously the beams from two different Emitters (30 sec)	ON	OFF	OFF	Carefully locate the interfering Emitter and take action in one of the following ways: <ul style="list-style-type: none"> • Reduce the emitter range from high to low. • Switch the position of the Emitter and Receiver. • Move the interfering Emitter to avoid this illuminating the Receiver. • Shield the beams coming from the interfering Emitter using opaque protections.

7 SEGMENTS DISPLAY		LED			REMEDY
SYMBOL	MEANING	RED	GREEN	YELLOW	
	(only for MASTER models) SLAVE connections incorrect	ON	OFF	OFF	Carefully check the MASTER-SLAVE connections
	(only for MASTER and STANDARD models) User configuration changed without system restart	ON	OFF	OFF	Operate a system restart

In any case, when faced with a system stoppage, switch the system off and then on again, to exclude any occasional electromagnetic disturbances.

Should the problem persist, contact REER's service department. In case of continued malfunctioning:

- verify the integrity of electrical connections and check that these have been made correctly;
- check that the supply voltage levels comply with those specified in the technical data sheet;
- the barrier power supply should be kept separate from that of the other electric power equipment (electric motors, inverters, frequency converters) or other sources of disturbance.
- make sure that the Emitter and the Receiver are correctly aligned and that the front surfaces are perfectly clean.



If it is not possible to clearly identify the malfunction and to remedy it, stop the machine and contact Reer's Assistance Service.

If correct system operation cannot be restored after carrying out the above procedures, send the equipment to REER's laboratories, complete with all parts, stating clearly:

- the product code number (the **P/N** field is shown on the product label)
- serial number (the **S/N** field is shown on the product label)
- date of purchase;
- period of operation;
- type of application;
- fault.

SPARE PARTS

MODEL	ARTICLE	CODE
AD SR1	ADMIRAL AD SR1 Safety Relay	1330900
AD SR0	ADMIRAL AD SR0 Safety Relay	1330902
AD SR0A	ADMIRAL AD SR0A Safety Relay	1330903
CD5	Straight 5-pin M12 female connector, 5 m cable	1330950
CD95	90° 5-pin M12 female connector, 5 m cable	1330951
CD15	Straight 5-pin M12 female connector, 15 m cable	1330952
CD915	90° 5-pin M12 female connector, 15 m cable	1330953
CDM9	Straight 5-pin M12 female connector PG9	1330954
CDM99	90° 5-pin M12 female connector PG9	1330955
C8D5	Straight 8-pin M12 female connector, 5 m cable	1330980
C8D10	Straight 8-pin M12 female connector, 10 m cable	1330981
C8D15	Straight 8-pin M12 female connector, 15 m cable	1330982
C8D95	90° 8-pin M12 female connector, 5 m cable	1330983
C8D910	90° 8-pin M12 female connector, 10 m cable	1330984
C8D915	90° 8-pin M12 female connector, 15 m cable	1330985
C8DM9	Straight 8-pin M12 female connector PG9	1330986
C8DM99	90° 8-pin M12 female connector PG9	1330987
CDS03	2 connectors female M12 5-pin straight 0,3m cable	1330990
TR14	14mm diameter test rod	1330960
TR20	20mm diameter test rod	1330961
TR30	30mm diameter test rod	1330962
TR40	40mm diameter test rod	1330963
TR50	50mm diameter test rod	1330964
FB 4	Set of 4 fastening brackets	1330970
FB 6	Set of 6 fastening brackets	1330971
LL	Set of 4 fastening brackets LL type	7200037
LH	Set of 4 fastening brackets LH type	7200081
FI 4	Set of 4 fastening inserts	1330972
FI 6	Set of 6 fastening inserts	1330973
SFB	Set of 4 swivel fastening brackets	1330974
SAV-3	Set of 2 anti-vibration supports	1200088
SAV-4	Set of 3 anti-vibration supports	1200089

GUARANTEE

All new ADMIRAL AX BK systems are guaranteed by REER for a period of 12 (twelve) months under normal working conditions, against defects due to faulty materials and workmanship. During the aforesaid period, REER promises to replace faulty parts free of charge. This guarantee covers both material and labour.

REER reserves the right to decide whether to repair equipment or replace it with equipment of the same type or having the same characteristics.

The validity of this guarantee is subject to the following conditions:

- The user must notify REER of the fault within twelve months following the date of delivery of the product.
- The equipment and all parts thereof must be in the condition in which they were supplied by REER.
- The defect or malfunction must not arise directly or indirectly from:
 - Improper use
 - Non-observance of the instructions for use;
 - Negligence, inexperience, improper maintenance;
 - Repairs, modifications and adjustments carried out by personnel not authorised by REER, tampering, etc.;
 - Accidents or collisions (also during transportation or due to acts of God);
 - Other reasons for which REER cannot be held responsible.

Repairs will be carried out at REER's laboratories, to which the material must be consigned or forwarded: transport costs and any damage or loss of material during transportation will be charged to the Customer.

All replaced products and parts are property of REER.

REER does not recognise any other form of guarantee or rights other than those expressly stated above; no requests for compensation for damages incurred for costs, suspension of activities or any other events or circumstances related in any way to malfunctioning of the product or any parts thereof will be taken into consideration.

In order to ensure the correct operation of the photoelectric barrier, careful and full compliance with all the rules, instructions and warnings stated in this manual is essential.

REER s.p.a. declines all responsibility for events arising from non-compliance with all or part of the aforesaid instructions.

Specifications subject to change without warning. • No part of this manual may be reproduced without the prior consent of REER.