TAPESWITCH
SAFETY MATS
CKP/*Solo* Sensors

TECHNICAL MANUAL 343184-01

English

WARNING

Tapeswitch safety mat systems are intended to protect operators working at or near dangerous machinery. They can only perform this function if they are correctly fitted and interfaced to a suitable machine. It is essential that the full contents of this manual and all the authoritative documents referred to herein are fully understood before any attempt at installation is made. If in doubt contact Tapeswitch or your Tapeswitch distributor.

IMPORTANT

This manual must accompany the product throughout its working life. Those persons responsible for the use of the product must ensure that all persons involved in the installation, commissioning, operation, maintenance and servicing of the product have access to all the information supplied by the manufacturers of the machine and its safety system.

CONTENTS

1. GENERAL

The CKP/*Solo* mat is a pressure sensitive safety device designed to protect operators working at or near dangerous machinery.

The mat is designed to meet the requirements of BS EN 1760-1:1998 and contains an integral fail-safe function which monitors the switching elements to Category 3 of EN954-1 providing dual channel outputs.

When correctly installed at and interfaced to a machine via a suitable control, which monitors the dual outputs of the mat, the CKP/*Solo* mat will:

(a) detect a person present in the dangerous area and prevent dangerous motion from occurring.

(b) detect a person entering the dangerous area and cause dangerous motion to cease before the person can reach the dangerous parts.

(c) a combination of (a) and (b). The area covered by the sensor depends on which of the functions (a), (b) or (c) is to be performed.

NOTE: The CKP/*Solo* mat is not suitable for detecting children.

The CKP/*Solo* mat is ideal for use with safety bus systems. The mats can connect directly to the same kind of standard safety bus I/O connection modules that are used to connect E-Stop switches over the bus system. This is much more convient than the alternative of having an additional control unit close to the mat so that it can provide the volt-free, normally closed connections to the safety bus I/O module.

WARNING

The information contained in this manual relates to the use of a CKP/*Solo* mat, to provide a basic safety switching device.

In some applications the CKP/*Solo* mat may be used together with other equipment to provide additional functions and features i.e. for use with Safety Bus systems. Any other documentation supplied must be used in conjunction with this manual.

In some cases some installation parameters, notably the positioning of the mat in relation to the dangerous parts of the machine, can be affected and close attention must be paid to all information supplied with all equipment.

2. TECHNICAL DESCRIPTION

2.1 SYSTEM OVERVIEW

A sensor may consist of a single mat sensor or a combination of mat sensors. When a person stands on the sensor it is detected, and by means of its output switching devices, the sensor causes dangerous motion to cease or be prevented.

IMPORTANT

From the above it can be seen that the safe use of the CKP/*Solo* Mat relies not only on the safety integrity of the mat itself but also on its mechanical and electrical interfacing to the machine.

The safety integrity of the CKP/*Solo* mat itself is the responsibility of Tapeswitch.

Proper mechanical and electrical interfacing is the responsibility of the user. Comprehensive information for this purpose is provided in section 4 of this manual.

2.2 SENSORS

2.2.1 SENSOR SHAPES AND SIZES

Mat sensors can be produced in any shape and size which meets the following restrictions:

- all corners, internal or external, to be 90º.
- the maximum width of a mat is 1200 mm.
- the maximum length of a mat is 2400 mm.
- the maximum total area is 2.88m².

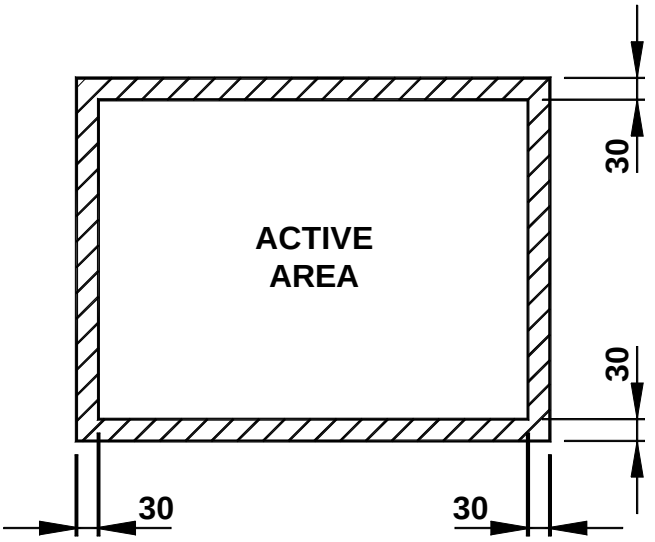


Figure 1 - Dimensions of the inactive area around outer edge of sensor

The dimensions of sensors and their layout must be such access to the machine is not possible without stepping on a sensor. It should not be possible to move the sensors or bridge them using boards, plates etc.

NOTE - CKP/*Solo* sensors have a 30mm inactive area around the outer edges, which means that the dimensions of the active area (i.e. the area within which the application of pressure will actuate the sensor) is 60mm less than the overall dimensions of the mat as shown in Figure 1. This should be kept in mind when specifying the size of mat for a particular application.

2.2.2 CKP/Solo SENSORS

The construction of the CKP/*Solo* sensor is shown in Figure 2. A network of Tapeswitch ribbon switching elements is sandwiched between two thick sheets of PVC material. The switching elements are connected in series and are connected to the integral fail-safe monitor. The switch elements are adhered to the bottom layer.

The top layer is a sheet of ribbed, heavy duty matting material. This material is of laminated construction and is PVC based with special additives and fillers to increase its abrasion and chemical resistance. This material can withstand years of pedestrian traffic and is resistant to most chemicals commonly found in an industrial environment including water, coolant, oil and hydraulic fluid.

The bottom sheet is a solid smooth rubber matting sheet.

The top sheet is 6.5mm thick and the bottom sheet is 6mm thick.

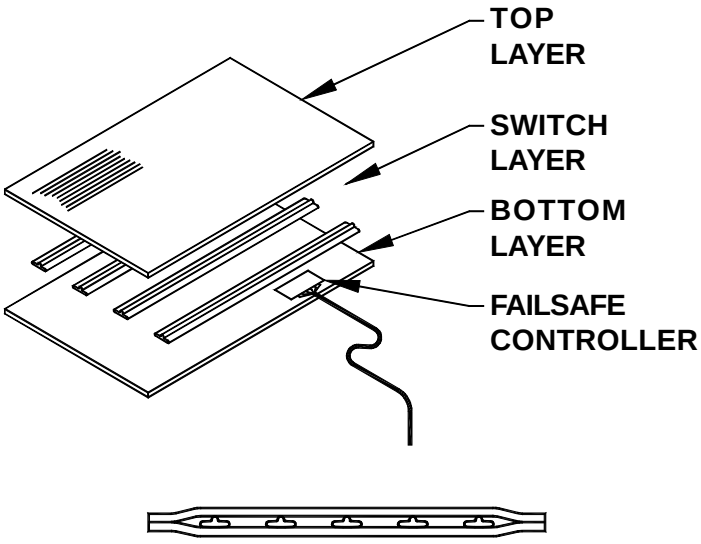


Figure 2 - Construction of CKP/S*olo* Mat Sensor

All the upper conductors of all the switch elements are connected together and all lower conductors are connected together, effectively creating a single normally open switch. Heavy gauge tin plated copper wire is used for all internal wiring and all connections to the switching elements are direct solder joints. The switches are self-bottoming and as a result they can withstand very high loads and repeated operation. Several million operations is typical.

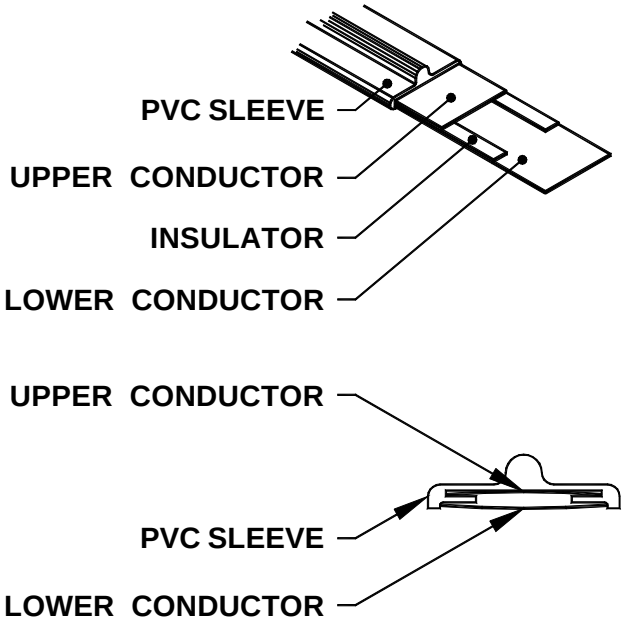


Figure 3 - Construction of Tapeswitch Switch Elements

The construction of the Tapeswitch elements is shown in Figure 3. Each switching element is a long normally open switch. The switch consists of two copper plated steel conductors held apart at the sides by an insulator. When pressure is applied to the bead, the two conductors are forced together in the centre, closing the switch.

3. DETERMINE THE DIMENSIONS OF THE SENSOR

The dimensions of the sensors and their layout must be such that, access to the machine is not possible without stepping on the sensor. The dimensions of the dangerous area depend on the particular application. The parameters to be considered include:

- Speed of walk or arm movement (typically 1.6m/s).
- Arm length (typically 0.85m).
- Length of stride (typically 0.7m).
- Response time of system.
- Position of dead zones.
- Overtravel of dangerous parts after stop signal is generated

To determine the size of sensor needed, use this simple formula below:

Active Area + 60mm = Overall Sensor length or width

i.e. For a sensor measuring 2000mm x 1000mm the size of active area = 1940mm x 940mm.

Note that if the sensor is to be supplied and fitted with AE-13 Aluminium edging then:

Total Area Covered with AE-13 Edging = Overall Sensor length or width + 126mm

i.e. For a sensor measuring 2000mm x 1000mm the total area covered = 2126mm x 1126mm.

In order to determine the position of the front edge of the active zone it is necessary to consider the stopping performance of the machine.

Any machine regardless of the efficiency of its braking system, will take a certain amount of time to come to rest after a stop signal is generated. From the instant that a persons foot touches the sensor to the instant that the dangerous motion actually ceases is called the overall system response time.

The overall system response time, T, is given by the following calculation:

$$T = t1 + t2$$

where t1 = the maximum response time of the safety device between the actuation of the sensor and the generation of the stop signal.

and t2 = the response time of the machine between receiving a stop signal from the safety device and the dangerous parts coming to rest.

The dangerous parts will obviously continue to move during this time. The sensor must therefore be dimensioned such that the nearest point at which a person could first touch the mat is a certain minimum distance from the dangerous parts, to prevent the person from reaching the dangerous parts before they have stopped.

This must take into account the worst case conditions illustrated in Figure 4 where a person could be a full stride onto the sensor before the sensor is actuated. This means that a certain distance from the front edge of the sensor and the dangerous parts must be maintained.

This distance is the minimum separation distance. All possible directions of approach must be considered. The minimum separation distance, S, can be calculated using the following formula:

$$S = (1600 \times T) + 1200$$

The overall system response time, T, should be measured several times and the highest value recorded, plus a suitable allowance for brake deterioration, should be used in the calculation of the minimum separation distance.

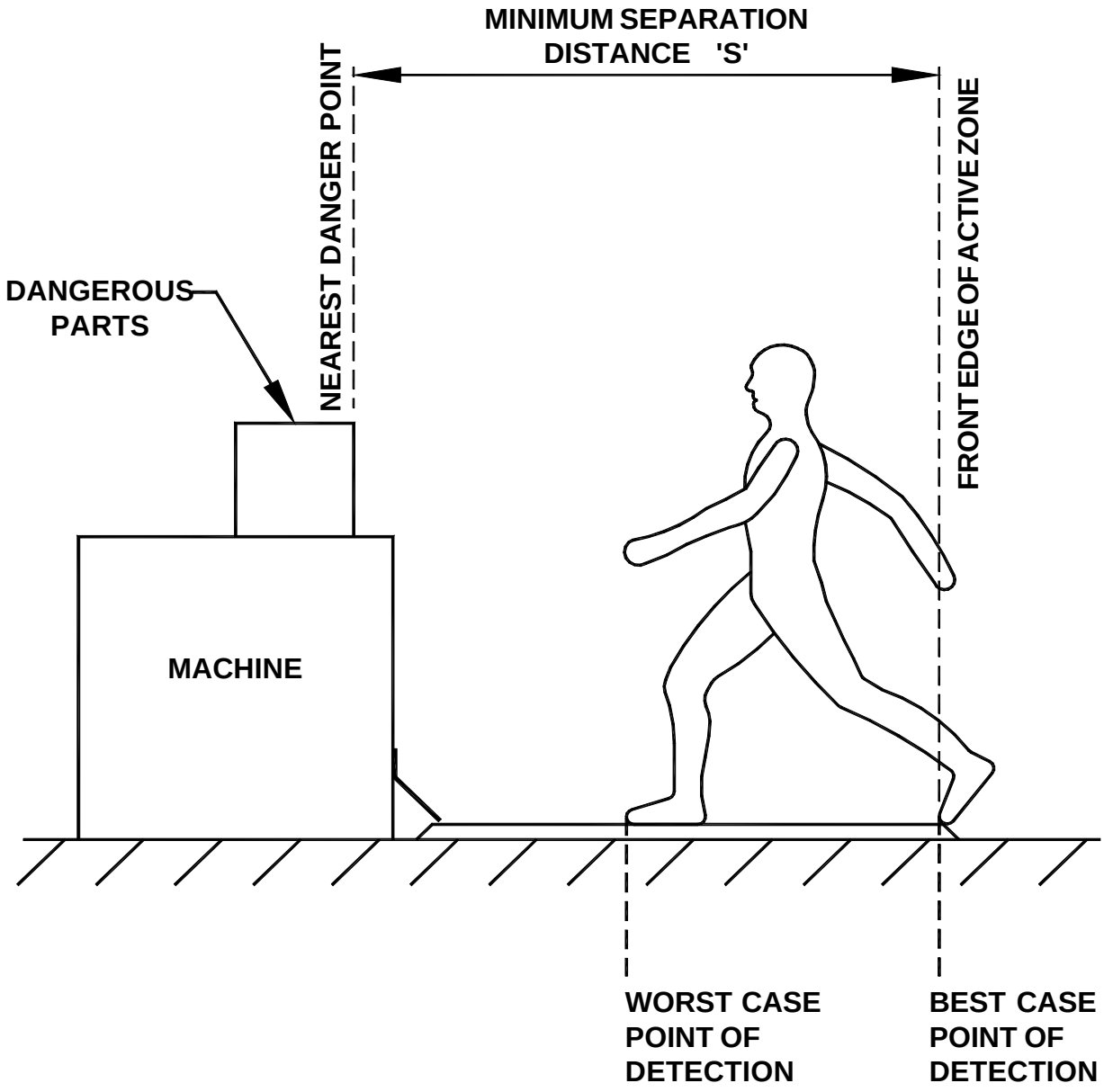


Figure 4 - Minimum Separation Distance

4. INSTALLATION

WARNING

TAPESWITCH SAFETY MAT SYSTEMS ARE DESIGNED TO PROTECT OPERATORS WORKING AT OR NEAR DANGEROUS MACHINES. THEY CAN ONLY PERFORM THAT FUNCTION IF THEY ARE CORRECTLY FITTED AND INTERFACED TO A SUITABLE MACHINE. EVERY EFFORT HAS BEEN MADE IN THE PRODUCTION OF THIS MANUAL TO PROVIDE COMPREHENSIVE AND ACCURATE INFORMATION. IT IS THE RESPONSIBILITY OF THE USER TO ENSURE THAT ALL PERSONS INVOLVED IN THE INSTALLATION OF THE PRODUCT HAVE THE KNOWLEDGE, TRAINING AND EXPERIENCE NECESSARY AND THAT THEY ARE FULLY CONVERSANT WITH ALL LAWS, RULES, REGULATIONS AND CODES OF PRACTICE PERTAINING TO THEIR TASK.

4.1 GENERAL

The attention of the installer is drawn to the following general requirements for the installation of a Tapeswitch safety mat system:

(a) The machine must be electrically controllable.

(b) It must be possible to stop the dangerous motion of the machine at any point in its operation, in any operating mode.

(c) The control system as a whole must be designed to provide the level of safety integrity determined by the risk assessment.

(d) Steps must be taken to prevent access to the dangerous parts of the machine from any direction not covered by the sensor. Such steps could include fixed or interlocking fences or screens, additional pressure sensitive mats or photo-electric devices.

(e) Steps must be taken to prevent a person standing in the dangerous area without standing on the sensor. The inner surfaces of fixed mechanical fencing should be designed such that there are no ledges or steps on which a person could stand and thereby avoid the sensor. It may be necessary to fit additional mechanical barriers, covers etc. to cover any surfaces within the dangerous area on which a person could stand, such as the feet of the machine. Particular attention should be paid to the edge of the mat nearest to the machine. Ensure that a person tip-toeing at the front of the machine will still be standing on the active area of the mat. See Figure 5.

(f) Wherever possible rectangular mats of standard sizes should be used. Where this is not possible, due to obstructions, mats with edge or corner cutouts and even with holes can be specified. This should only be done where the obstructions are permanent.

(g) Under no circumstances should a mat sensor be cut or drilled. It is not possible for the user to modify the size or shape of a mat sensor.

(h) Great care should be taken when handling mat sensors. Never pick the sensor up or drag it around using the cables. Never bend a mat at a radius less than 300mm. Keep mat sensors flat whenever possible. Always store flat. Mat sensors with one edge longer than 1 metre should be handled by two people.

(i) After installation the machine/mat system must be commissioned in accordance with section 5 of this manual.

(j) Any covers removed during installation must be replaced as soon as possible.

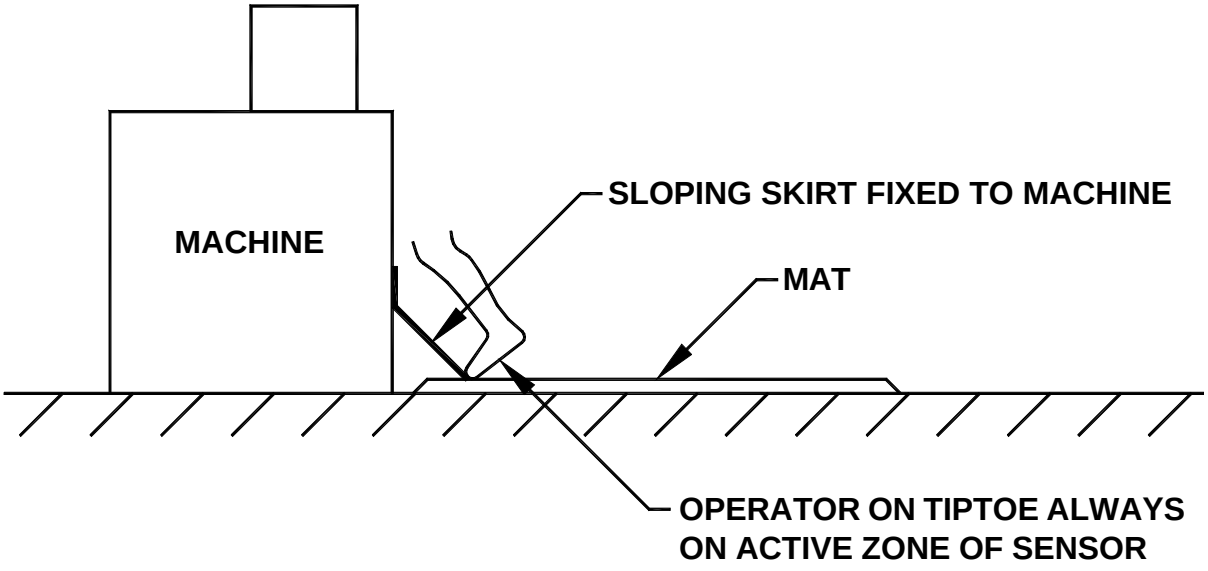


Figure 5 - Ensure operator is always standing on active area of sensor

4.2 SENSOR INSTALLATION

4.2.1 SENSOR MOUNTING SURFACE

The surface on which the sensor is mounted must be sound and reasonably flat. The sensor can tolerate minor irregularities but sharp edges or projections greater than 1mm may cause premature degradation. Where the surface is rough, cracked or breaking up, it should be treated using proprietary sealing and levelling compounds.

4.2.2 SENSOR FIXING

The sensor(s) must be fixed permanently in position. Tapeswitch aluminium edging AE-13 should be used around the outer edge of the sensor. This specially designed edging comes in two parts, a base and a cover. The cover provides a 20 degree ramp to prevent a tripping hazard at the outer sensor edges.

Type AE-13 edging is illustrated in Figure 6 and AE-C corner pieces in Figure 7. At the junction of several mats, the mats should be fixed to the floor using double sided tape.

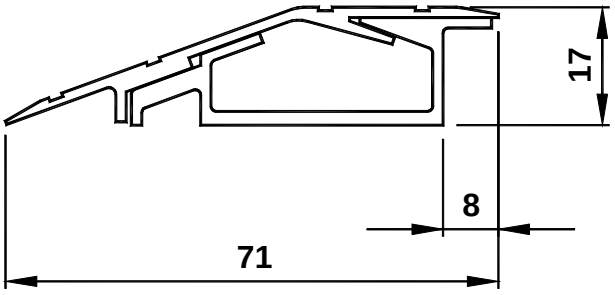


Figure 6 - AE-13 Sensor Edging

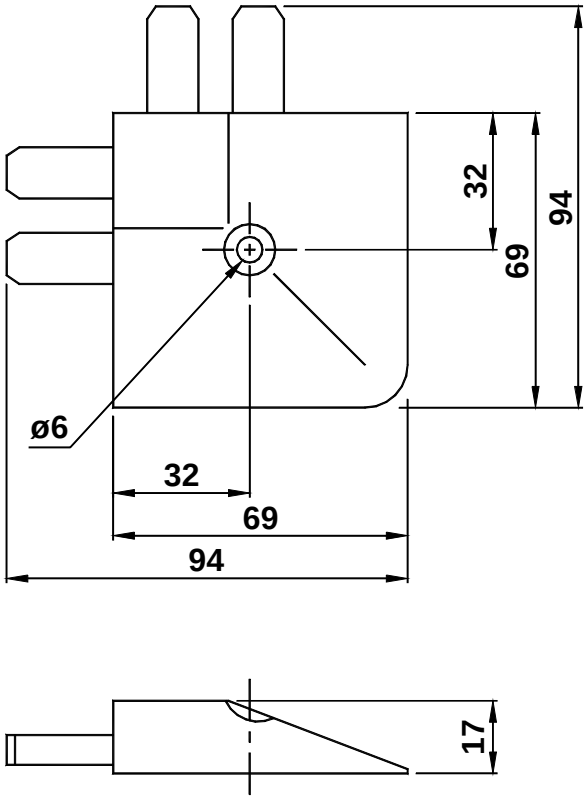


Figure 7 - AE-13 Sensor Edging

4.2.3 INSTALLATION PROCEDURE

Step 1 - Plan the layout. Mark out on the floor the position and size of each sensor. Take care to use the overall dimensions of mat sensors.

Step 2 - Cut all edging to size. Remove any burrs and sharp edges with a file.

Note: If AE-C corner pieces are used then:

the cut length = mat dimension - 12mm. of AE-13

Step 3 - Mark the positions of the sensor cables and cut slots in the inner face of the edging base extrusion to allow access for the sensor cables.

4.2.4 ELECTRICAL INSTALLATION

Step 4 - Position the base sections around the mat and fit AE-C corner pieces. Drill pilot holes through each corner piece and holes in the base sections if applicable. Remove base sections / corner pieces and drill and plug the floor. Refit base sections and corner pieces and secure in position with the screws provided, as shown in figure 8. Ensure the cable exits neatly through the slot(s) in the base section.

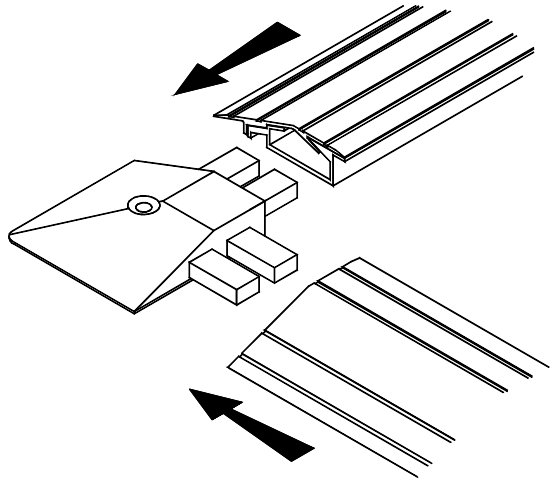


Figure 8 - AE-13 & AE-C Installation

NOTE: MAT SENSORS MUST BE FITTED WITH THE LABEL SIDE UP.

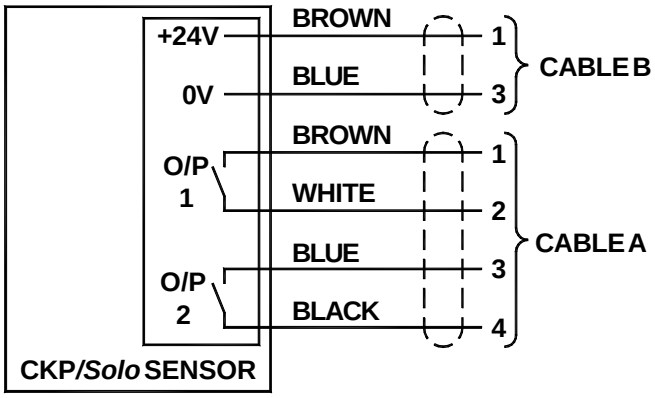
Step 5 - Route the cable(s) to the interface. The cable(s) should exit from the edging as close to the interface position as possible. The cables should be protected in suitable conduit between the edging and the interface. Protect any edges over which the cables pass with grommet strip or similar.

Step 6 - Fit the cover extrusion of the edging using suitable self-tapping screws.

The CKP/*Solo* mat is supplied with 2 x 4 core cables 0.5m long, each cable is fitted with an M12 plug. The connections to the mat sensor are shown in Figure 9.

One cable is used for the d.c. supply, and one cable is used for the Volt-Free Safety Outputs.

NOTE: In order to achieve EN954-1 Category 3 safety integrity, the outputs must be wired as two separate channels to a suitable control capable of monitoring them for equivalence.



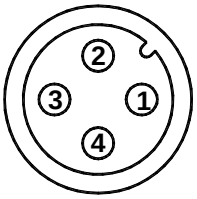


Figure 9 - CKP/*Solo* Connection Details

5. PERIODIC CHECKING

5.1 GENERAL

The following sections describe the periodic checks to be performed on a machine fitted with a Tapeswitch safety mat system. If the machine is fitted with additional safety devices the periodic checks prescribed by the manufacturer of these devices should be incorporated into the periodic checking regime described below.

If the machine fails any of the prescribed checks the machine must be isolated and must not be used until the fault has been identified and rectified.

5.2 COMMISSIONING CHECKS

The commissioning checks should be carried out by persons who are competent and who have access to all the information supplied with the machine and its safety equipment. The results of the examination should be recorded and copies of this record should be kept by the user and the employer of the person performing the examination.

The person carrying out the examination should, as a minimum, perform the following checks:

(a) Check that the CKP/*Solo* is suitable for use in the application:

(i) Check that the level of safety integrity provided by the CKP/*Solo* is suitable for the level of risk presented by the machine.

(ii) Check that the environment is suitable for the use of the CKP/*Solo*.

(b) Check that the dimensions and position of the CKP/*Solo* are correct taking into account the operating mode. For this purpose it will be necessary to check the overall system response time using a device designed for this purpose.

(c) Check that adequate measures have been taken to prevent access to the dangerous parts of the machine from any direction not covered by the CKP/*Solo*.

(d) Examine the machine controls and connections to the CKP/*Solo* to ensure that the requirements described in this manual and in the machine manual have been met.

(e) Check that the CKP/*Solo* is fixed in position and that no trip hazards are present within the dangerous area.

(f) Except where the device is used solely as a trip device, check that it is not possible for a person to stand in the dangerous area without actuating the CKP/*Solo*.

(g) Check that it is not possible for the dangerous parts of the machine to be set in motion while the CKP/*Solo* is actuated.

(h) Check that actuation of the CKP/*Solo* during a dangerous phase of operation of the machine results in the dangerous parts being arrested, or where appropriate, assuming an otherwise safe condition, before any part of a person could reach them.

(i) Check that, after the machine has been stopped by the actuation of the CKP/*Solo*, it is not possible for the dangerous parts to be set in motion until the CKP/*Solo* has been cleared, the reset button has been operated and released, and the machine start control has been re-operated.

(j) Check that the removal of power from the CKP/*Solo* prevents further operation of the machine. It should not be possible for the dangerous parts of the machine to set in motion until power has been restored, the reset button has been actuated and released, and the machine start control has been actuated.

(k) Check that the CKP/*Solo* operates over the whole active area by walking, 'heel to toe', over the whole area in two directions, as shown in Figure 10.

(l) Examine the stopping performance monitor (if fitted) to ensure that it is fitted and functioning correctly. Ensure that the means by which the stopping performance can be assessed by the operator is indicating correctly.

(m) Test the muting arrangements (if fitted). Ensure that the muting is only possible during non-dangerous operation and ensure that the safety level of the muting device is at or above that of the safety mat but never below.

(n) Examine brakes and clutches (if fitted) as recommended.

NOTE: No stopping performance monitor or muting facilities are provided with the Tapeswitch safety mat system and there is no means provided for the connection of such devices to the system. These devices may however have been provided elsewhere in the machine control system.