TAPESWITCH
SAFETY MATS-
CKP/S1 Sensors
with PRSU/4 control units

TECHNICAL MANUAL 343181-08

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. INTRODUCTION

1.1 PRODUCT DESCRIPTION

Tapeswitch safety mat systems are pressure sensitive safety devices designed to protect operators working at or near dangerous machinery. A system consists of a pressure sensitive sensor and a control unit. When correctly installed at and interfaced to a suitable machine the system 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)**.

Pressure sensitive sensors are fixed to the floor. The area covered by the sensor depends on which of the functions (a), (b) or (c) is to be performed. When a person steps onto a sensor a signal is transmitted to the control unit which will in turn transmit a stop signal to the machine control system.

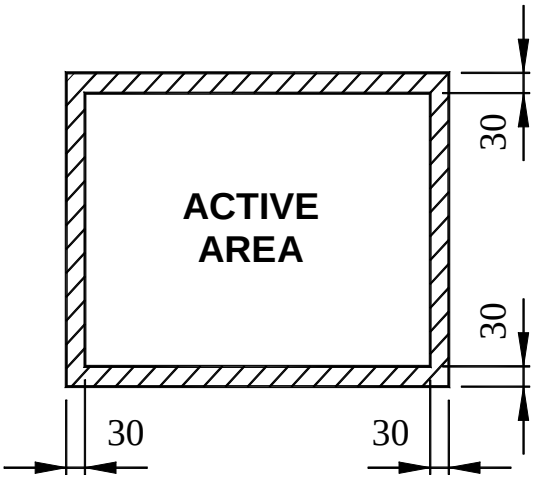


Figure 1 - Dimensions of the inactive area around outer edge of sensor

1.2 PRODUCT RANGE

1.2.1 SENSORS

1.2.1.1 SENSOR SHAPES AND SIZES

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

- all corners, internal or external, should be 90 degrees.
- the maximum possible width of a mat is 1200 millimetres.
- the maximum possible length of a mat is 2400 millimetres.
- the maximum total area is 2.88m².

Rectangular shapes are preferred although any shape which meets the restrictions outlined above is possible.

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. Further guidance is given in section 1.6.

NOTE: CKP/S1 sensors have an inactive area around the outer edges. This inactive area is 30 millimetres wide which means that the dimensions of the active area (i.e. the zone within which the application of pressure will actuate the sensor) is 60 millimetres less than the overall dimensions of the mat as shown in Figure 1. This should be borne in mind when specifying the size of mat for a particular application. See section 1.6 for further guidance on determining sensor dimensions.

1.2.1.2 SENSOR OPTIONS

CKP/S1 sensors can be supplied with two 2-core leads or a single 4-core lead. Where a single mat sensor is used a single 4-core lead is most practical. Where several mats are connected in series to form a larger sensor two 2-core leads should be specified.

1.2.2 PRSU/4 CONTROL UNIT

The PRSU/4 control unit is designed to monitor 4-wire safety sensors. The unit provides monitoring of a sensor (or a number of sensors connected in series), auto or manual reset function and 3 safety outputs.

1.2.3 ACCESSORIES

Aluminium edging is available for fixing the sensors in position. This edging consists of two interlocking aluminium extrusions, a base and a cover. The edging can accommodate the mat wiring and provides a 20 degree ramp to prevent a tripping hazard at the mat edge.

1.3 PRODUCT FEATURES

1.3.1 SENSORS

* Tapeswitch internal switching elements.
* Sealed to IP65.
* 24 volt operation.
* Low pressure actuation.
* Heavy duty, abrasion and chemical resistant materials.
* Multiple sensors can be connected to one control unit.

1.3.2 CONTROL UNIT

* Cross-monitored safety output relays with force guided contacts.
* Auto or manual reset function
* DIN rail mounting enclosure.
* Simple, reliable, proven technology.
*One control unit capable of monitoring multiple sensors.
* Built in diagnostic indication.
* 24Vdc supply.

NOTE: The external 24Vdc power supply must either be provided from a safety transformer meeting EN60742 or from a battery. Cables feeding the supply should be run separately and should be protected against damage.

1.4 PRODUCT APPLICATION

1.4.1 GENERAL

Tapeswitch safety mat systems can be used either to provide primary guarding where other types of guarding are impractical or to provide secondary guarding where the primary guarding method cannot protect all danger areas. Safety mats are particularly useful for protecting operators who may be inside large machines and for awkwardly shaped machines. Applications include:

* Robot cells
* Tube bending machines
* Carton folding/gluing machines
* Punching machines

1.4.2 FACTORS AFFECTING SUITABILITY

1.4.2.1 PERSONS TO BE PROTECTED

CKP/S1 safety mats are not suitable for use where children are to be protected.

1.4.2.2 MACHINE CONTROL FACTORS

The machine control system must satisfy the following requirements:
(a) The dangerous motion of the machine must be electrically controllable.
(b) The machine response/stopping performance must be adequate and consistent.
(c) It must be possible to stop the dangerous motion of the machine at any point in its operation.
(d) The control system as a whole must be constructed to provide the level of safety integrity determined by a risk assessment as described in section 1.4.2.2.

1.4.2.3 RISK FACTORS

Every machine has its own unique hazards. In order to determine the level of risk in a particular application a risk assessment must be performed. In many countries methods have been developed and published, usually by the organisations responsible for industrial safety, to enable a systematic risk assessment to be carried out.

The guidance available in a particular country may take the form of national, European or international standards. Persons responsible for selecting safety devices should be familiar with the guidance available in his country before specifying particular safety devices. In most current guidance the factors considered in risk assessment are:

(a) the severity of possible injury.
(b) the frequency of exposure to the hazard.
(c) the possibility of avoiding the hazard.

CKP/S1 mat sensors are suitable for use in low to medium risk applications where the following conditions apply:

EITHER

- the severity of possible injury is slight.

OR

- the severity of possible injury could be serious and
- the frequency of exposure to the hazard is low and
- the possibility of avoiding the hazard is high.

1.4.2.4 ENVIRONMENT FACTORS

The existence of the following factors may preclude the use of safety mat systems in particular applications:

(a) risk of injury from thermal or other radiation.
(b) a tendency for the machine to eject materials or components.
(c) a need for heavy vehicles to frequently enter the dangerous area.
(d) continuous or repeated immersion in water or other fluids.
(e) exposure to damage due to droppage of heavy or sharp objects.
(f) exposure to spillage of hot and/or solidifying substances.
(g) exposure to spillage of aggressive chemicals.

Consult Tapeswitch or your Tapeswitch agent if in doubt.

1.5 STANDARDS AND SAFETY

1.5.1 GENERAL

Tapeswitch CKP/S1 safety mat systems have been designed to meet the requirements of the European Standard EN1760-1 "Safety of Machinery. Presssure-sensitive protective device. General principles for the design and testing of pressure-sensitive mats and floors".

They also conform to Performance Level PLd of EN13849-1 "Safety of machinery. Safety-related parts of control systems. General principles for design" when used with a Tapeswitch PRSU/4 control unit. In this case the probability of dangerous failures per hour, PFHd , is 1.03×10^{-7}

As a component only, the B_{10d} lifespan value for the mat sensor is 4.0×10^{6} cycles.

1.6 SPECIFICATION AND ORDERING INFORMATION

1.6.1 DETERMINING SENSOR DIMENSIONS

1.6.1.1 GENERAL

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 inactive areas
- overtravel of dangerous parts after stop signal is generated

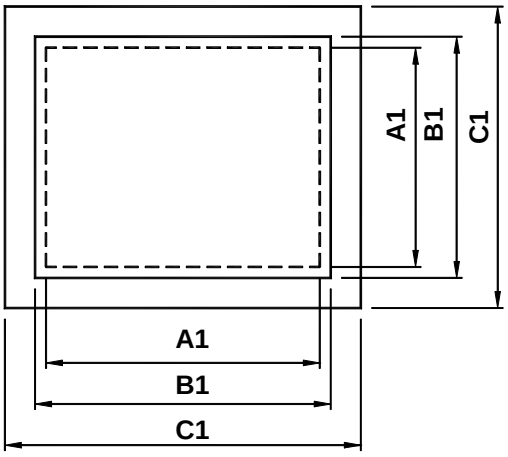
A Tapeswitch pressure sensitive safety mat system can be used as:

(a) a combined trip and presence sensing device - the device is positioned such that it will be activated when a person enters a dangerous area and remains activated whilst the person is inside the dangerous area.

(b) a presence sensing device - the sensor is positioned such that it will be actuated by a person who is inside a dangerous area.

(c) a trip device - the sensor is positioned such that it will detect a person entering a dangerous area.

NOTE: Tapeswitch CKP/S1 safety mats have an inactive area around the outer edges. This inactive area is 30 millimetres wide which means that the dimensions of the active area (i.e. the zone which must cover the dangerous area) will be 60 millimetres less than the overall dimensions of the mat, as shown in Figure 2. This should be borne in mind when specifying the size of mat for a particular application.



Active Area = A1 x A2
Overall Mat Dimensions = B1 x B2
Area Covered with Edging = C1 x C2

C1 = B1 + 126mm
C2 = B2 + 126mm
B1 = A1 + 60mm
B2 = A2 + 60mm

Figure 2 - Sensor Dimensions

Where possible, the shape and size of the dangerous area should be designed such that a single rectangular sensor, preferably of a standard size, can be used. Where this is not possible, non-standard rectangular shapes, irregular shapes and combinations of sensors will be required. The range of standard sizes and the restrictions on size and shape for individual sensors are given in section 1.2.

Where a combination of sensors is required the following considerations apply:

(a) If possible all mat sensors in a combination should be the same shape and size. This makes it possible for the user organisation to hold spare sensors and simplifies the ordering of replacements.

(b) If possible the mat sensors should be arranged in a single row with joints perpendicular to the normal direction of approach of the operator as illustrated in Figure 3.

(c) When mats must be arranged in an array, one side of the array must not exceed two mats as shown in Figure 4.

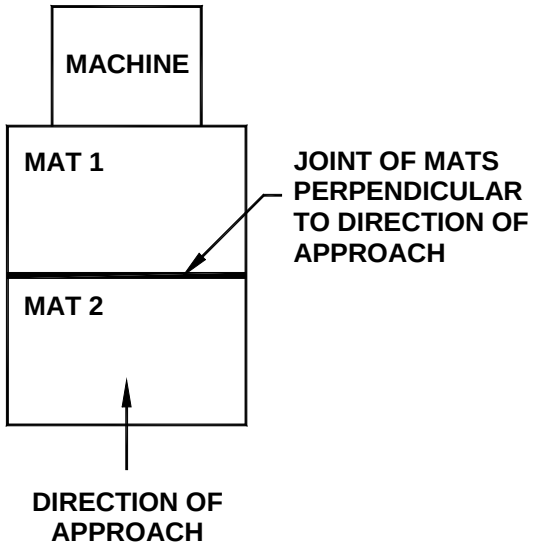


Figure 3 - Arrangement of mat joints

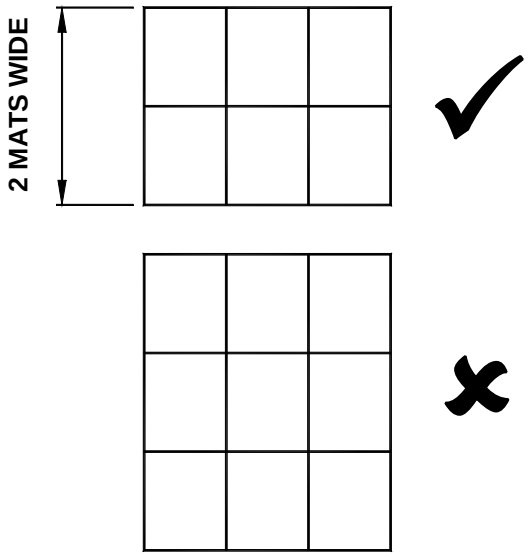


Figure 4 - Mat array requirements

1.6.1.2 USE AS A COMBINED TRIP AND PRESENCE SENSING DEVICE

When a system is used as a combined trip and presence sensing device it will normally be the sole means of guarding at that particular part of the machine. In this case it is necessary to ensure that the dimensions of the sensor(s) are such that the machine will be brought to rest before an approaching person can reach the dangerous parts and that the sensor covers all of the dangerous area. It should not be possible for a person to stand anywhere between the front edge of the active zone of the mat, and the machine without standing on the mat.

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 time to come to rest after a stop signal is generated.

From the instant that a persons foot touches the mat to the instant that 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 = 30ms

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 at 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 5 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 nearest dangerous parts must be maintained.

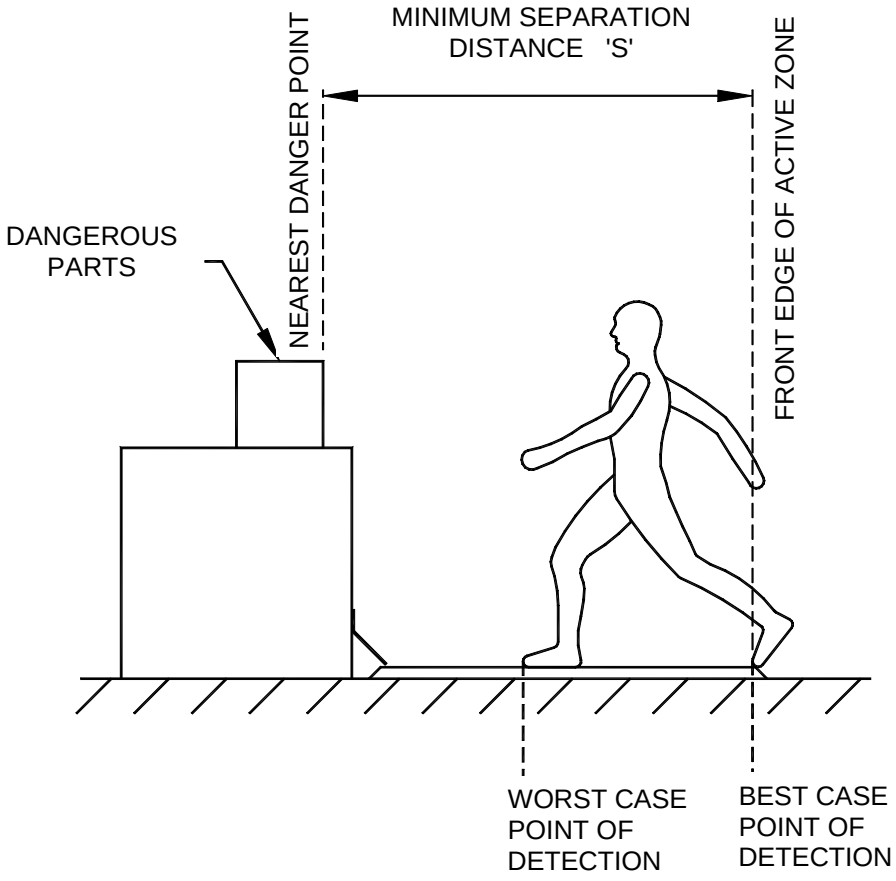


Figure 5—Minimum separation distance

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.

1.6.1.3 USE AS PRESENCE SENSING DEVICE

When the system is used solely as a presence sensing device it is normally used as a secondary guarding device in conjunction with a separate primary guarding device. The primary guarding device would normally, as a minimum, operate as a trip device. The position of the trip device should be determined according to the manufacturers instructions. The primary guarding device could be an interlocking fence, photo-electric curtain or similar device.

In this case it is necessary to ensure that the dangerous area, between the primary guarding device and the machine is completely covered by the active area of the sensor(s), such that it is impossible for a person to stand between the primary guarding device and the dangerous parts of the machine without standing on the active area of the mat(s).

1.6.1.4 USE AS A TRIP DEVICE

When the system is used solely as a trip device the minimum separation distance, i.e. the distance from the front edge of the active zone of the mat to the nearest dangerous parts should be calculated as described in section 1.6.1.2.

The minimum width of the active zone of the mat should be 750 mm (i.e 810 mm overall) to ensure that an operator cannot inadvertently step over the mat into the dangerous area without actuating the mat. See Figure 6.

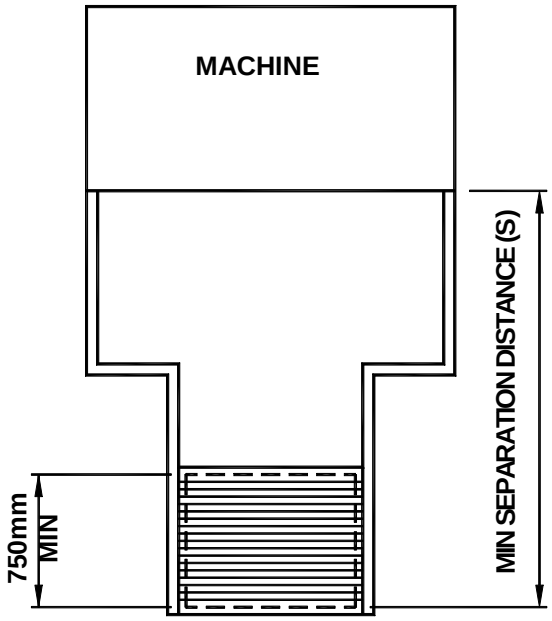


Figure 6—Mat solely used as a trip device

1.6.2 ORDERING INFORMATION

1.6.2.1 MAT SENSORS

When ordering mat sensors the following order code should be used. See Figure 7 for lead position details:

ORDER CODE: CKP/S1 / XX / XX / XXXX / XXXX / XXXX

SENSOR TYPE

EDGE PREPARATION
SE - SQUARE EDGE

CABLE POSITION
LD - LONG EDGE, TWO 2-CORE LEADS
SD - SHORT EDGE, TWO 2-CORE LEADS
LLS - LONG EDGE, LEFT SIDE, ONE 4-CORE LEAD
LRS - LONG EDGE, RIGHT SIDE, ONE 4-CORE LEAD
SLS - SHORT EDGE, LEFT SIDE, ONE 4-CORE LEAD
SRS - SHORT EDGE, RIGHT SIDE, ONE 4-CORE LEAD

LONG EDGE LENGTH mm

SHORT EDGE LENGTH mm

CABLE LENGTH mm

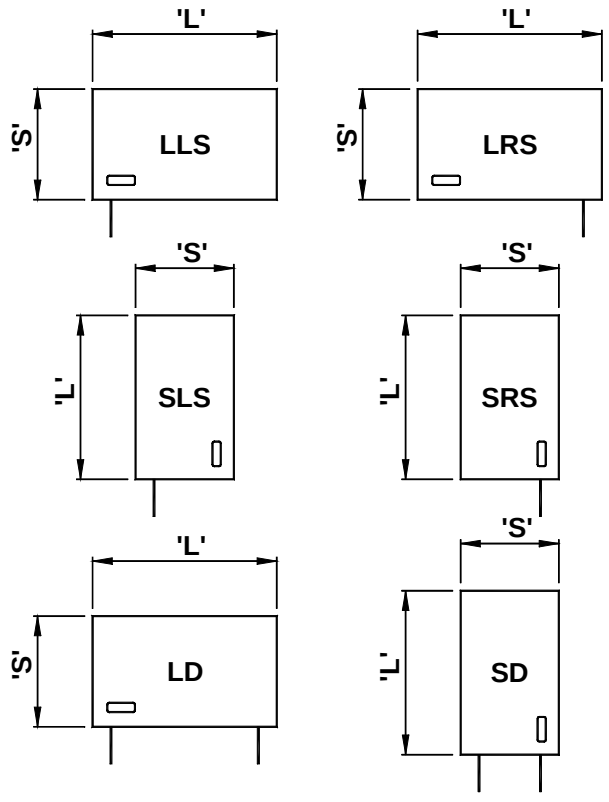


Figure 7 - Lead position options

1.6.2.2 CONTROL UNIT

When ordering control units simply use the control unit type designation i.e. PRSU/4.

1.6.2.3 AE-13 MAT EDGING

AE-13 Mat Edging is for use with the CKP/S1 Mats. The edging can be supplied in kit form already prepared, or in D-I-Y form for the edging to be prepared when the mat is being installed.

2. TECHNICAL DESCRIPTION

2.1 SYSTEM OVERVIEW

A Tapeswitch safety mat system consists of two elements: a sensor and a control unit. The sensor may consist of a single mat sensor or a combination of mat sensors. When a person stands on the sensor a stop signal is transmitted to the control unit. On receiving a stop signal from the sensor the control unit switches off its output relays causing dangerous motion to cease or be prevented.

The control unit contains the system power supply, the sensor monitoring circuit and the safety output relays. The safety output relay contacts must be connected into the machine control circuit such that when the output relays are switched off, power to the machine primary control element(s) is removed.

A machine primary control element or MPCE is defined as 'an electrically controlled element which directly controls the normal operating motion of a machine such that it is the last (in time) to operate when motion is initiated or arrested'.

NOTE: On low to medium risk machines a single MPCE is normally used. If two MPCE's are provided their function should be such that each of them is capable of stopping the machine, regardless of the state of the other.

2.2 SENSORS

2.2.1 MAT SENSORS

The construction of the CKP/S1 sensor is shown in figure 8. A network of Tapeswitch ribbon switching elements is sandwiched between two thick sheets of PVC material. The switching elements are connected in series. The switch elements are glued to the bottom layer.

The top and bottom layers are sheets 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 top sheet is 6.5 millimetres thick and the bottom sheet is 5 millimetres thick.

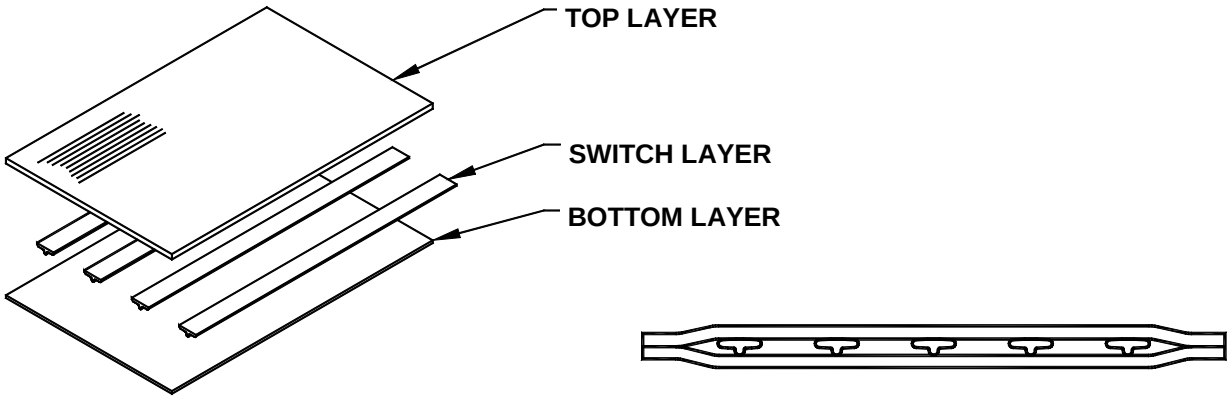


Figure 8 - Construction of CKP/S1 sensor

The construction of the Tapeswitch elements is shown in Figure 9. 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.

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 copper-plated steel 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.

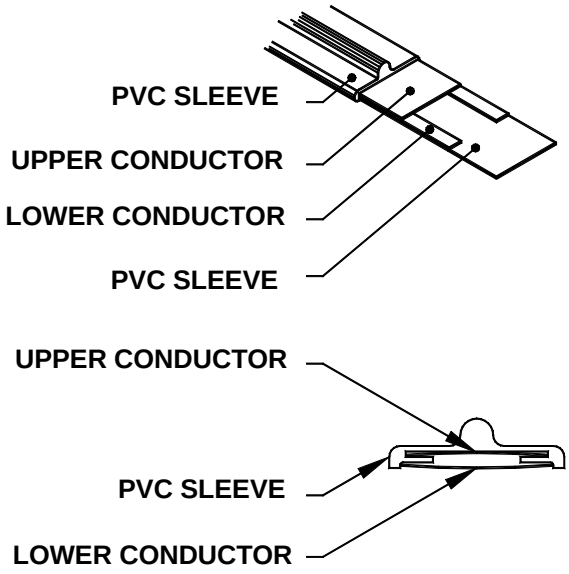


Figure 9 - Construction of Tapeswitch elements

2.2.2 COMBINATION OF SENSORS

When a number of mat sensors are used in combination, sensors with two 2-core leads should be used. The sensors should be connected in series such that the control unit 'sees' a single normally open switch. One of the 2-core cables can be considered to be the inlet cable and the other the outlet cable. When connecting a number of sensors together the outlet cable of the first sensor is connected to the inlet cable of the second sensor and so on. This leaves the inlet cable of the first sensor and the outlet cable of the last sensor to be connected to the control unit as illustrated in Figure 10.

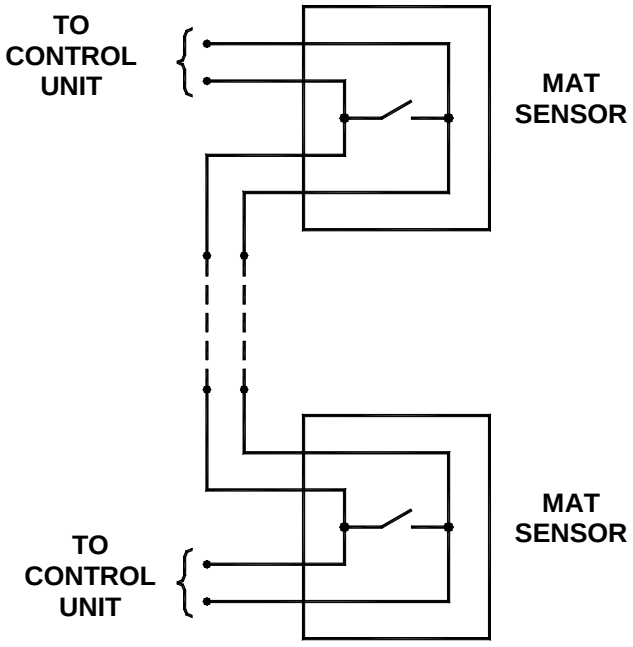


Figure 10-Construction of sensors in series

3. 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.

3.1 GENERAL

The attention of the installer is drawn to 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 11.

(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 300 millimetres. 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) No devices other than those specified in this manual should be connected to the internally generated power supply of the system.

(j) After installation the machine/mat system must be commissioned in accordance with section 4 of this manual.

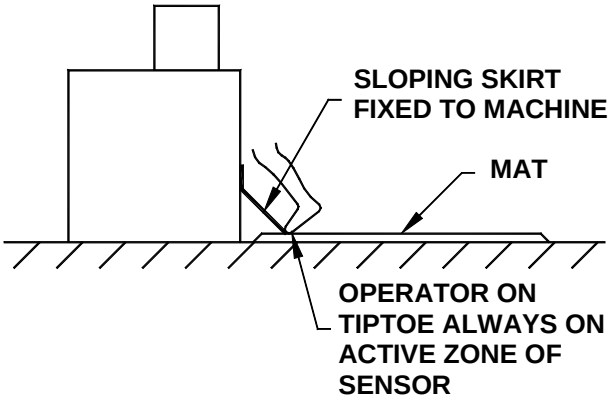


Figure 11 - Ensure operator is always standing on active area of sensor

3.2 SENSOR INSTALLATION

3.2.1 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.

3.2.2 SENSOR FIXING

The sensor(s) must be fixed permanently in position. Tapeswitch aluminium edging 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. The base can accommodate sensor wiring which protects the cables from damage and acts as a conduit to route the cables to the control unit. Type AE-13 edging is illustrated in Figure 12 and AE-C corner pieces in Figure 13. At the junction of several mats, the mats should be fixed to the floor using double sided tape.

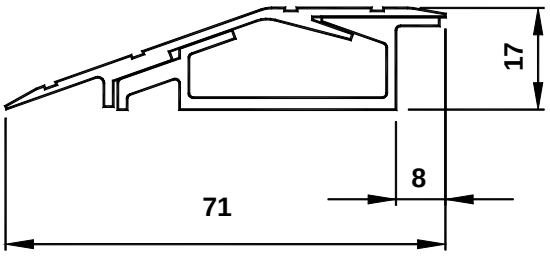


Figure 12 - AE-13 Sensor Edging

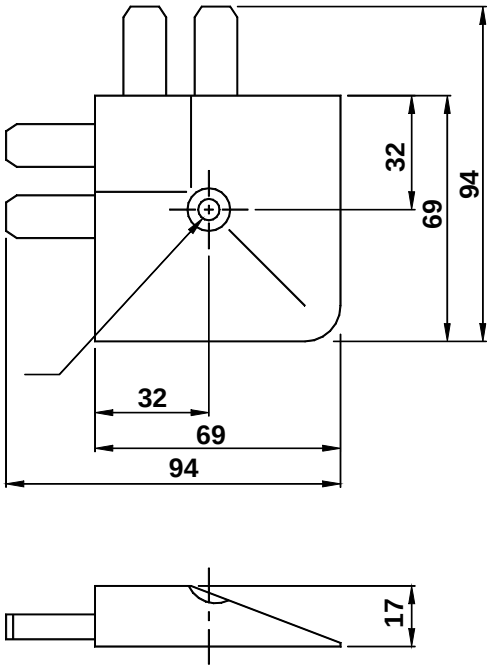


Figure 13 - AE-C Corner piece

3.2.3 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.

Step 4 - Position the base sections around the mat and fit AE-C corner pieces as shown in figure 14. 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, ensuring the cable exits neatly through the slot(s) in the base section.

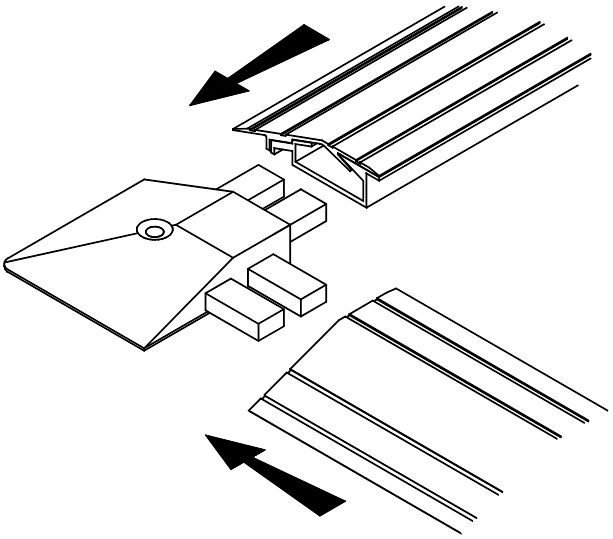


Figure 14 - AE-13 & AE-C Installation

Step 5 - In the case of a combination of sensors connect the sensors in series as shown in Figures 15 and 16. Special grease filled waterproof connectors are available from Tapeswitch Ltd. for this purpose. If necessary cut the cables to length. Always leave some slack in the cables in order that a sensor can be disconnected and reconnected at a later date. The connectors are fitted using a pair of pliers. Make sure that they are fully mated.

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

Step 6 -Route the cable(s) to the control unit. The cable(s) should exit from the edging as close to the control unit position as possible. The cables should be protected in suitable conduit between the edging and the control unit. Protect any edges over which the cables pass with grommet strip or similar.

Step 7 - Fit the cover extrusion of the edging using suitable self-tapping screws.

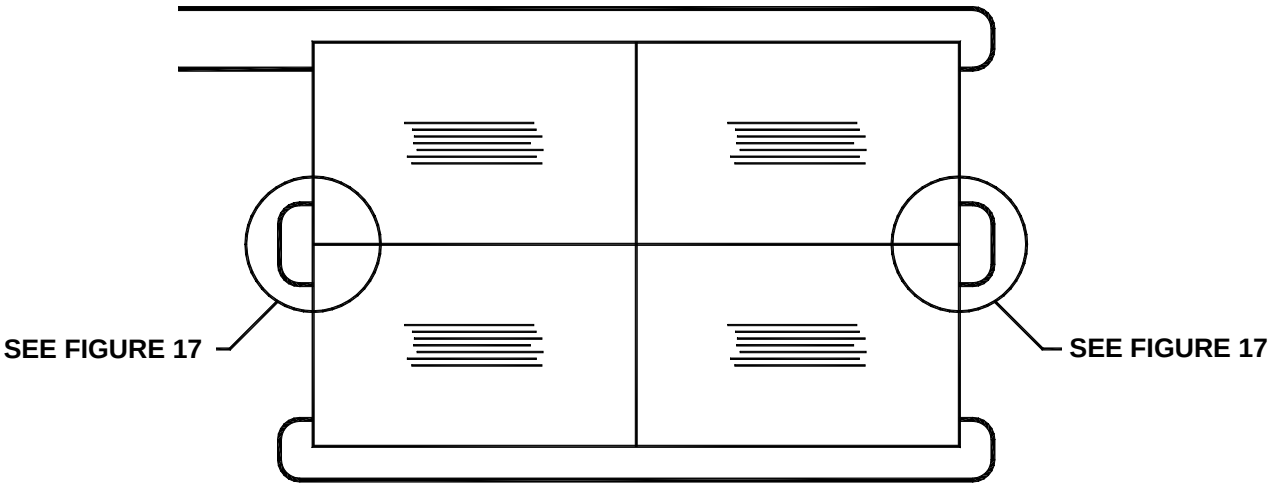


Figure 15 - Connection of sensors in series

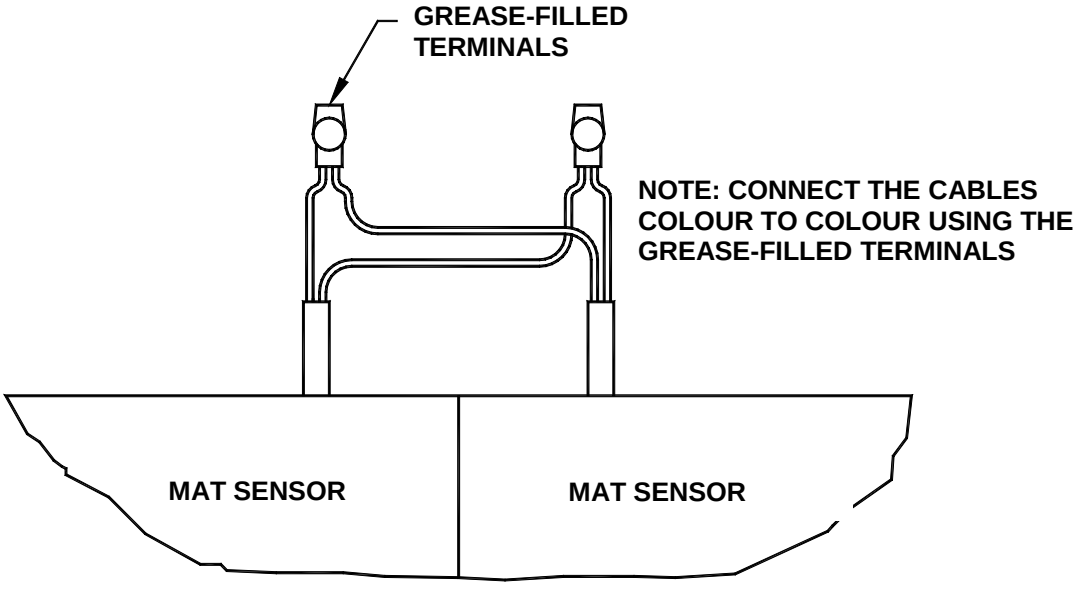


Figure 16 - Wiring of two mat sensors each with 2 x 2 core cables

3.3 CONTROL UNIT

3.3.1 GENERAL

The connections for the PRSU/4 control unit are shown in Figure 17. Crimped ferrules should be fitted on all stranded wires. It is recommended that electrical installation is performed in the order described below.

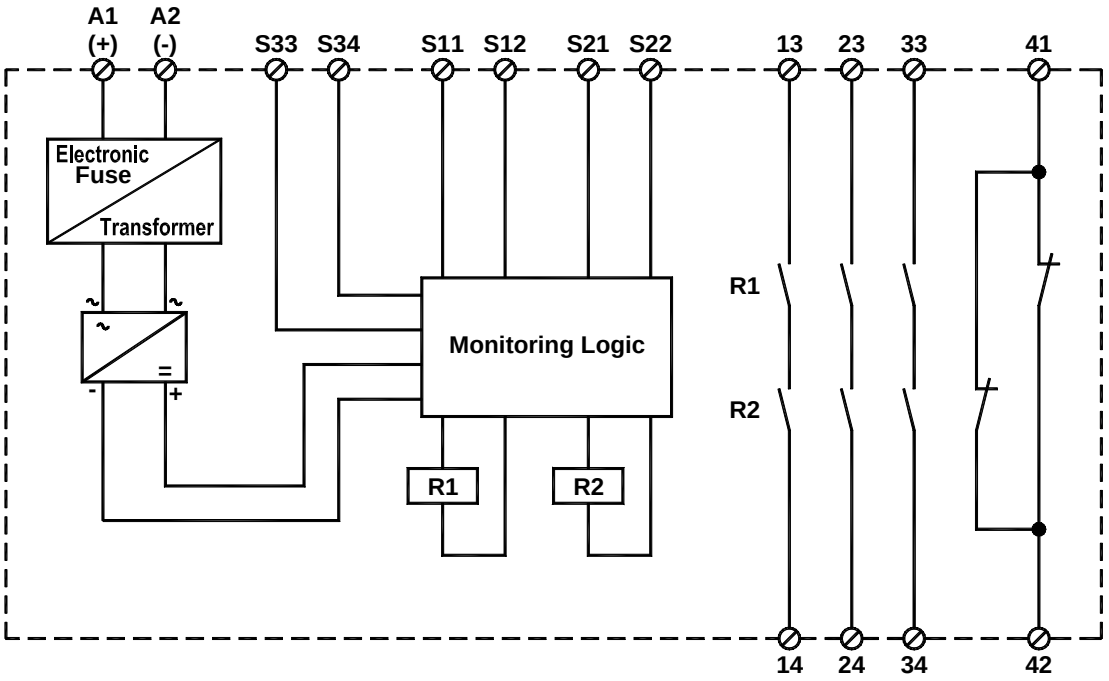


Figure 17 - Control unit connection

3.3.2 SENSOR CONNECTION

Connect the sensor cables to the control unit according to Table 1, taking particular care that there are no stray strands which could cause a short between adjacent terminals.

SENSOR TYPE	SENSOR CONNECTION			
	S11	S21	S12	S22
Single Lead 4-wire	Brown	Blue or Green	Black or Yellow	White
Dual Lead 4-wire	Brown 1	White 1	Brown 2	White 2

Table 1

3.3.3 POWER CONNECTION

Connect +24V to terminal A1 and 0V to terminal A2 as shown in Figure 17. The maximum power consumption is 5VA.

3.2.4 RESET INPUT CONNECTION

For auto reset mode connect a link across terminals S33 & S34 as shown in Figure 18. For manual reset mode connect a normally-open switch across terminals S33 & S34 as shown in Figure 19

If the machine has two MPCEs, a pair of normally-closed auxiliary contacts from each MPCE can be connected in series with the reset input as shown in Figure 20. This provides cross-monitoring of the MPCEs such that if they are in disparity due to a fault, reset will be prevented until the fault is rectified

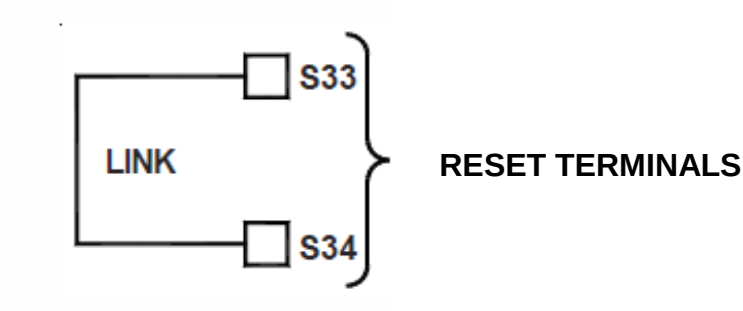


Figure 18 - Auto Reset

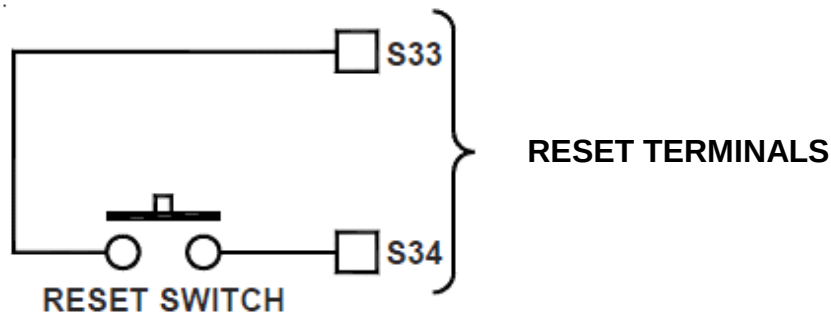


Figure 19 - Manual Reset

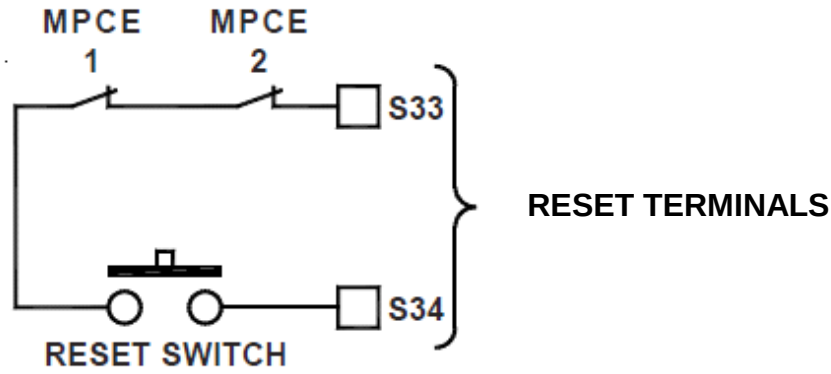


Figure 20– Cross Monitoring of MPCEs

3.2.5 SAFETY OUTPUT CONNECTION

Three normally-open safety outputs are provided. In low to medium risk applications the machine is normally provided with a single MPCE.

In such cases both safety outputs should be connected in series with the MPCE coil as shown in Figure 21. If the machine is fitted with two MPCEs, one safety output should be connected in series with each MPCE coil as shown in Figure 22.

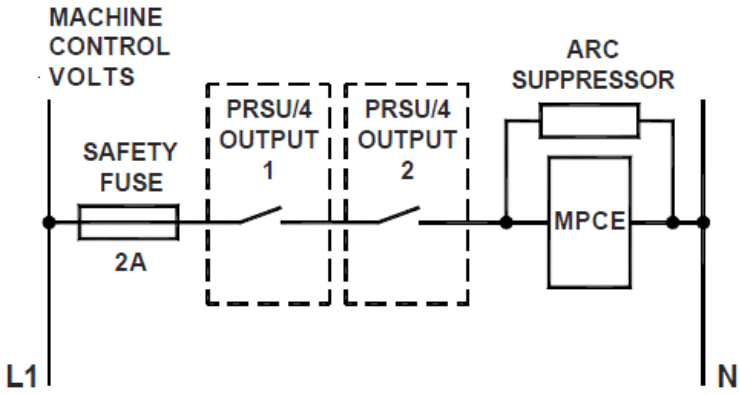


Figure 21– Safety Output Connection (single MPCE)

To protect the contacts of the safety output relays from the effects of switching inductive loads, it is recommended that arc suppressors should be fitted in parallel with the MPCE coils as shown Figures 21 and 22. Arc suppressors must not be fitted across the safety relay contacts.

To protect against the possibility of both safety outputs welding in, due to an overcurrent fault in the machine circuit, 2A fuses should be fitted in series with the MPCE coils as shown in Figure 21 and 22. This limits the current through the safety output contacts to well below that which could cause the contacts to weld.

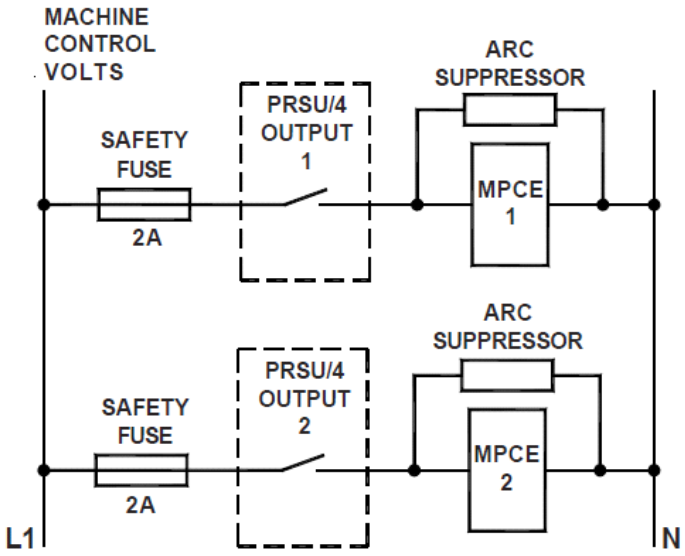


Figure 22– Safety Output Connection (Two MPCEs)

4. PERIODIC CHECKING

4.1 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.

4.2 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 Tapeswitch safety mat system is suitable for use in the application in question using the guidance provided in section 1.4 of this manual. In particular:

(i) Check that the machine control system meets the general requirements of section 1.4.2.1 of this manual.

(ii) Check that the level of safety integrity provided by the safety mat system is suitable for the level of risk presented by the machine as described in section 1.4.2.2 of this manual.

(iii) Check that the environment is suitable for the use of the device taking into account the factors described in section 1.4.2.3 of this manual.

(b) Check that the dimensions and position of the sensor(s) are correct taking into account the operating mode as described in section 1.6.2 of this manual. 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 sensor(s).

(d) Examine the machine controls and connections to the Tapeswitch safety mat system to ensure that the requirements described in this manual and in the machine manual have been met.

(e) Check that the sensor(s) are 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 sensor(s).

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

(h) Check that actuation of the sensor 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 safety mat system, it is not possible for the dangerous parts to be set in motion until the sensor 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 safety mat system 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 sensor(s) operate over the whole active area by walking, 'heel to toe', over the whole area in two directions, as shown in Figure 23. Actuation can be checked by observing the SENSOR CLEAR indicator which is lit when the sensor is clear and off when the sensor is actuated.

(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.

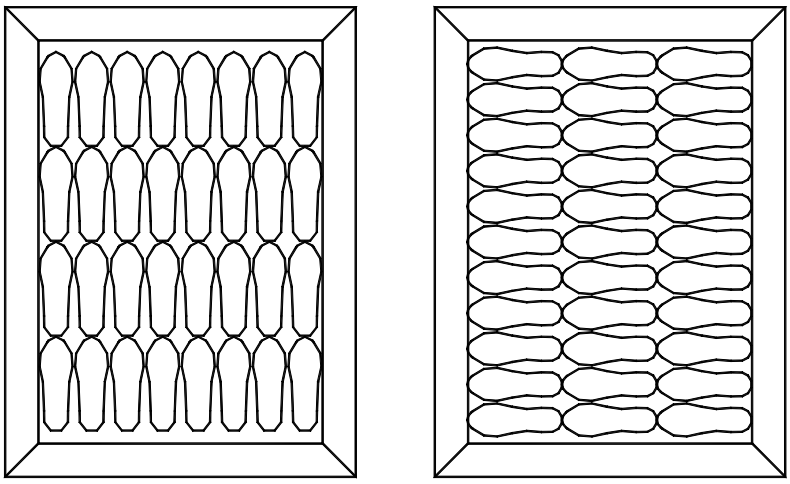


Figure 23 - Checking operation of sensor

4.3 SIX MONTHLY CHECKS

These examinations should be carried out by competent persons. The results should be recorded and a copy kept by the user.

The person should perform all the checks detailed in section 4.2. In addition the person should:

(a) Examine and test the machine primary control element(s) to ensure that they are functioning correctly and are not in need of maintenance or replacement.

(b) Inspect the machine to ensure that there are no mechanical or structural aspects which could prevent the machine from stopping or assuming an otherwise safe condition when called upon to do so.

(c) Check that no modifications have been made to the machine control system, the safety mat system or the interface between them, which could adversely affect the system and that any suitable modifications have been correctly performed and suitably recorded.

4.4 DAILY/SETTING CHECKS

The following tests should be carried out daily and after setting by a designated person appointed by the machine user. The results should be recorded and a copy should be kept on or near the machine. Specific statutory requirements may apply to certain types of machine.

The designated person should:

(a) Inspect the top surface of the mat sensor(s) for mechanical damage to ensure that the top surface has not been penetrated or chemically damaged.

(b) Check the operation of the sensor in several locations by operating the reset and stepping on the sensor. Check at different locations each day such that the entire active area of the mat is periodically checked.

(c) Check that access to the dangerous parts of the machine is not possible from any direction not covered by the sensor.

(d) Check that it is not possible for a person to stand in the dangerous area without actuating the sensor.

(e) Check that when the muting facility (if fitted) is operative the moving parts are no longer dangerous.

(f) Check that the stopping performance monitor (if fitted) is in use and is set up and functioning correctly.

(g) Check that all electrical enclosures are closed and locked and that any keys have been removed for retention by a designated person.

(h) Check for signs of damage to cables and connections.

5. OPERATION, MAINTENANCE AND SERVICING

5.1 OPERATION

5.1.1 GENERAL

Operation of the system is straightforward. The only control device associated with the system is the reset device, which must be actuated when the system is powered up and after each actuation of the mat.

5.1.2 SENSOR SURFACE LOADING

Daily work on the mat by one or several persons will not lead to any deterioration of the sensor. In addition, the sensors can withstand heavy loads from the wheels of vehicles provided that these wheels have pneumatic tyres with a diameter of 300mm or more. The maximum allowed wheel load for CKP/S1 type sensors is 1.5 tonnes although for these loads damage may occur if the floor is not flat.

NOTE: THE VEHICLE MUST NOT BE STEERED WHILST ON THE SENSOR. THE VEHICLE SHOULD BE DRIVEN STRAIGHT ON AND STRAIGHT OFF.

Heavy or heavily laden vehicles with small wheels or with wheels made of hard material must not be driven over the sensor(s). Where there is a temporary need to drive such a vehicle onto or over the mat a temporary protecting surface of wood or metal should be placed on top of the sensor.

NOTE: WHILST ANY TEMPORARY PROTECTIVE SURFACE IS PLACED ON THE SENSOR THE MACHINE MUST BE SWITCHED OFF. THE PROTECTIVE SURFACE MUST BE REMOVED BEFORE THE MACHINE IS USED.

5.2 MAINTENANCE

5.2.1 SENSORS

The sensors do not need any maintenance, however the life of the sensor will be considerably increased if a basic cleaning routine is observed.
NOTE: The requirements of this section are in addition to those required in the periodic checking regime described in section 4.

The surface of the mat should be cleaned daily. Dust and swarf should be swept off the mat.Grease and oil spillages can cause the surface to be made slippery and should be removed immediately or covered with sawdust and removed at the next daily cleaning. Mineral oils can be removed from the mat by using a cold de-greasing compound and rinsing with water. No solvents of any kind should be used as a cleaning agent.

Sharp objects such as sheet metal offcuts, should be removed from the mat immediately.

The frequency of cleaning depends on the nature of the environment. In relatively clean environments where water or other fluids rarely come into contact with the sensors monthly cleaning is sufficient. In dirtier environments weekly cleaning may be necessary.

5.2.2 CONTROL UNITS

The control units require no maintenance. Provided that the system has been installed in accordance with this manual, and is operated within the performance parameters described herein, the periodic examination in section 4 and the self-monitoring features of these devices are sufficient to ensure their safe operation.

5.3 SERVICING

WARNING

SERVICING OF SAFETY EQUIPMENT SHOULD ONLY BE CARRIED OUT BY QUALIFIED PERSONNEL. SERVICING INVOLVES THE EXPOSURE OF TERMINALS AND DEVICES CARRYING POTENTIALLY LETHAL VOLTAGES. ONLY THOSE PERSONS WITH THE APPROPRIATE TRAINING AND EXPERIENCE SHOULD UNDERTAKE THIS WORK. IF IN ANY DOUBT CALL TAPESWITCH OR YOUR TAPESWITCH DISTRIBUTOR.

IMPORTANT

AFTER ANY PART OF THE SYSTEM HAS BEEN REPLACED THE INSTALLATION SHOULD BE CONSIDERED AS NEW AND AS SUCH SHOULD BE COMMISSIONED IN ACCORDANCE WITH SECTION 4 OF THIS MANUAL.

6. TECHNICAL SPECIFICATION

6.1 SYSTEM

Safety Integrity	PLd to EN 13849-1 when used with PRSU/4
Safety Configuration	Category 3
PFHd	1.03×10^{-7}
Response Time	30ms

6.2 MAT SENSOR

Lifetime value (B10d)		4.0×10^{6} cycles
Actuating/Test Force		<300N
Temperature Range	Operating	0 to 50^{O}C
	Storage	0 to 70^{O}C
Actuating Force	11mm dia test piece	300N
	40mm dia test piece	150N
	80mm dia test piece	300N
	200mm dia test piece	600N
Protection Rating		IP65
Inactive Area		50mm wide around outer edge of single sensor or combination of sensors
Operating voltage		30Vdc maximum
Weight (approx)		$16kg/m^2$
Static Load		$75kg/cm^2$
Vehicle Traffic		See 5.1.2
Top surface material		Koroseal

6.3 MATERIAL SPECIFICATION

The material used for the outer surfaces of CKP/S1 sensors is Koroseal. Koroseal is a PVC based, heavy duty matting material which has been specially formulated for use in industrial environments. The following specifications are those of the manufacturer and have not been verified independently

6.3.1 MECHANICAL

CHARACTERISTIC	PERFORMANCE	TEST METHOD
Tensile Stregth	1200lbs/in2	ASTM-D-412
Elongation	150% minimum	ASTM-D-412
Abrasion	0.09grams lost maximum	Taber, 1kg on CS-17 wheel for 1000 revs
Flammability	Self-extinguishing—A	Motor VehicleSafety Standard #302
Aging and weathering	168 hrs, 10 x magnification. No change observed	ASTM-D-518
Hardness	88+/-5 points	ASTM-D-2240

6.3.2 CHEMICAL RESISTANCE

A = Little or no effect, **B** = Minor to moderate effect, **C** = Moderate to severe effect, **D** = Not recommended

Chemical name	**Rating**
Acetic Acid - concentrated	C
Acetic Acid - dilute	B
Acetone	C
Ammonium Hydroxide	A
Amyl Acetate	C
Benzene	B
Butyl Alcohol	B
Carbon Tetrachloride	C
Chloroform	C
Creosote	C
Cresol	C
Ethyl Acetate	C
Ethyl Alcohol	B
Ethyl Ether	B
Formaldehyde	B
Gasoline	B
Hydrochloric Acid - concentrated	B
Hydrofluoric Acid - concentrated	B
Iodine	A
Methyl Alcohol	B
Methyl Ethyl Ketone	D
Mineral Oil	B
Nitric Acid - concentrated	C
Nitric Acid - dilute	B
Phenol	B
Silver Nitrate	A
Sodium Hydroxide (up to 30%)	A
Sulphuric Acid - concentrated	B
Sulphuric Acid - dilute	A
Trichlorethylene	B
Xylene	B

6.4 CONTROL UNIT

Supply voltage	24Vdc
Power Consumption	<5VA
Max Inrush Current	1.4A
Operating Temperature	-25^{o}C to +55^{o}C
Reset Function	Manual or Auto (Link Selectable)
Safety Outputs: Device Type Contacts Contact Rating	 Safety Relay Force operated contacts 3 x Normally Open 1 x Normally Closed (monitor, non-safety) 5A@240Vac
Maximum mat sensor area	7.5m^{2}
Enclosure: Protection rating Terminal capacity Material	 IP20 2 x 1.5mm^{2} Polycarbonate

7. CONTACTS

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EC Declaration of Conformity

Tapeswitch Ltd hereby certifies that the product(s) identified below conform(s) to the essential health and safety requirements of the European Machinery Directive 2006/42/EC and that the Conformity Procedures specified in Article 12 (1) and Annex VIII of the Directive have been fully completed.

Technical File No: **TCF 0283**

Product(s):
CKP/S1safety mats (NBR, SBR Koroseal® and PVC material versions)
RKP safety mats
MDP safety mats
Armormat safety mat
DPM safety mat

Tested in accordance with:
BS EN 1760-1:1998 *Safety of machinery. Pressure sensitive protective devices. General principles for the design and testing of pressure sensitive mats and pressure sensitive floors*

BS EN ISO 13849-1:2008 *Safety of machinery. Safety-related parts of control systems. General principles for design*.
The safety mats mentioned above achieve PLd when used with Tapeswitch control units PSSU1, PSSU2, PSSU3, PSSU4, PRSU2, PRSU4 and PRSU4/R and the system has a PFH_d of 1.03×10^{-7}

As a component alone, the safety mats have a B_{10} value of 4.0×10^6 cycles.

Signed

Technical Manager, Tapeswitch Ltd.
Authorised to declare on behalf of the company and to compile the Technical File

Chorley, UK *Place*

04.01.2011 *Date*

Manufactured by:
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under the control of a Quality System certified to ISO9001:2008 by

342929-01