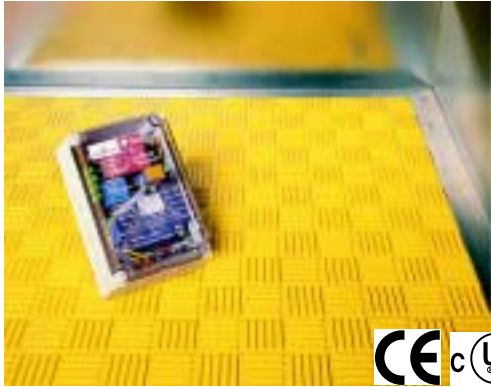


## Safety Mats

### Overview



### Description

MatGuard consists of a number of interconnecting pressure sensitive safety mats and a monitoring control unit which provide a system for area detection. The mat has been designed from the “ground up” to meet the arduous conditions found on the factory floor, and uses tried and trusted components and techniques throughout.

The mats are available in a wide range of standard sizes to meet most requirements. Special sizes and shapes can be supplied. Each mat has two conductive plates that are held apart by non conductive compressible separators. Each 4 wire mat, operating on only 24V DC is pre-wired, and connected in series with any other mats forming a complete floor level guarding system for the hazardous areas. The circuit through the mat is monitored by the MatGuard Control Unit, which, when the area is clear provides a signal to the machine control circuit.

When a mat is stepped on, the conductive plates touch and the resistance in the circuit falls to zero. This is monitored by the Control Unit, which shuts the machine down. The unique moulding process ensures the long life and reliability of the mat. Being completely sealed (IP67), water, liquids and coolants present no problem. In addition the tough vinyl will resist bleaches, acids, salts and all but the most aggressive of industrial chemicals.

A range of control units is available including the Mat Manager which monitors the status of each mat or area of mats individually. This enables quick fault detection/repair and identification of actuated area.

### Applications Types



### Features

- EC type certification
- Third party certification to EN 1760-1, EN954-1 (ISO 13849-1) category 3 and IEC/EN 60204-1, AS 4024.5, ANSI B11.19, ANSI RIA R15.06
- Overall sensitivity including uniting strip
- Control units monitor the status of each mat individually
- Completely fail-safe system with cross monitored control unit
- Rugged construction will take the pressure of 4500psi
- Vinyl construction resistant to most oils
- Sealed to IP67
- 5-year warranty on mats

### Chemical Resistance of Sensor Mat Vinyl Covering

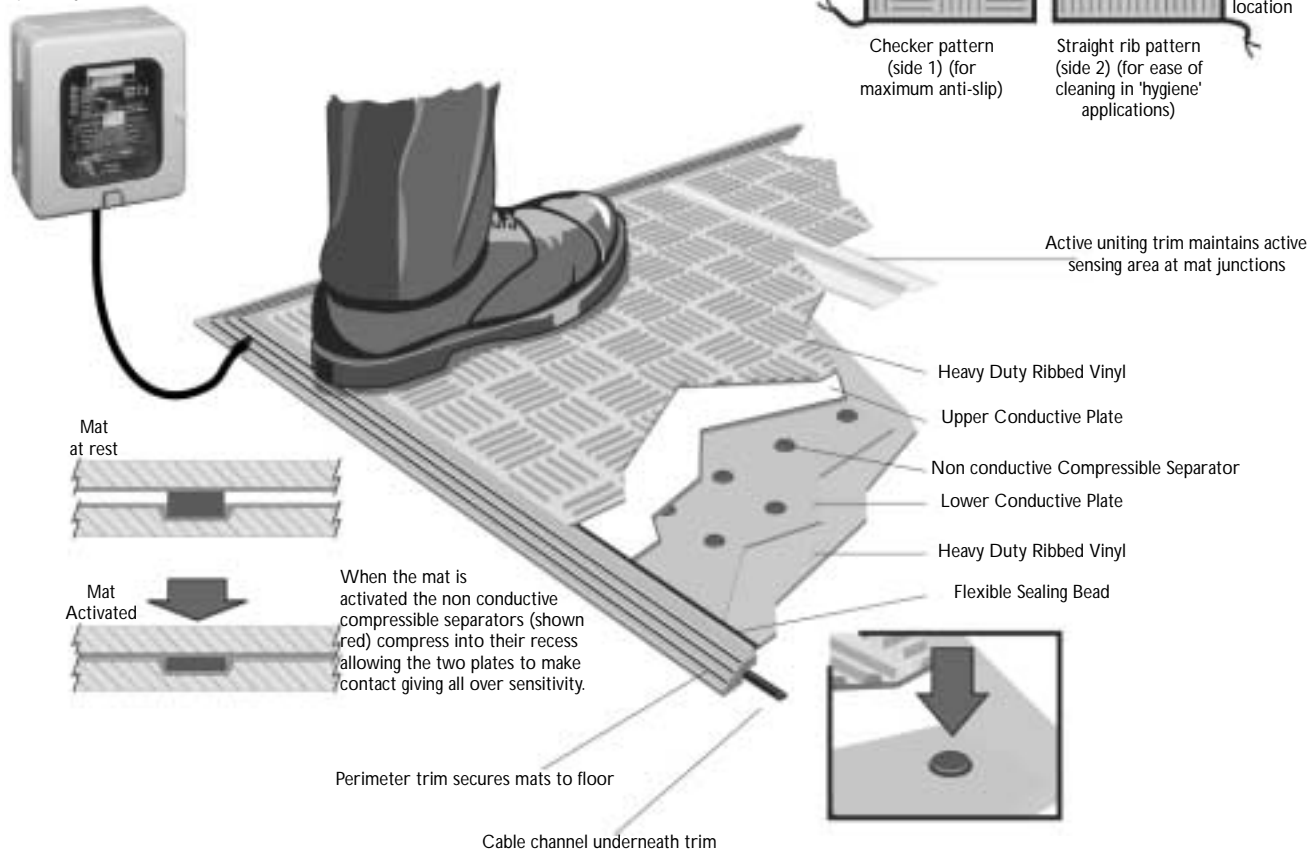
Substance	Resistance of Mat Covering
Water	Excellent
Ethyl Alcohol	Excellent
Sodium Chloride	Excellent
Bleach	Excellent
Hydrochloric Acid	Fair to Excellent
Sulphuric Acid	Fair to Excellent
Nitric Acid	Fair to Excellent
Acetic Acid	Fair
Petrol (Gasoline)	Fair
Trichlorethylene	Fair to Poor
Benzene	Poor
Acetone	Poor

In general the covering has excellent resistance to acids, alkalis and salts. Hot acids and alkalis, as well as concentrated and organic acids, have a deleterious effect on prolonged exposure. The covering has fair resistance to aliphatic solvents, fair to poor resistance to aromatic and chlorinated solvents and poor resistance to ketones and most esters.

**Note:** Combinations of chemicals can have unpredictable effects. Testing is recommended in such cases. Small pieces of the vinyl material are available if testing is required.

**Anatomy of a Mat System**

The controller detects a presence on the mat, a short circuit, or an open circuit. Under each of these conditions, the safety output relays turn off. When interfaced properly, the machine or hazardous motion will receive a stop signal, and an auxiliary output relay turns ON.



# Safety Mats

## Overview

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### Standards

The MatGuard mat system has been designed to conform with the latest European Standard EN 1760-1 "Safety of machinery—Pressure sensitive devices; mats and floors."

This standard contains requirements for all aspects of design. Some of the most important points are as follows: **(From 4.2.2)** Where an effective sensing area is built up from more than one sensor (mat) it shall have no dead zone.

The standard gives details of the size, force and positioning of test pieces for testing the mat sensitivity.

**(From 4.5.1)** A single sensor (mat) shall still perform its function after one million actuations by a mass of 75kg.

**(From 4.7)** When the actuating force is applied the output signal switching device(s) shall change from an ON state to an OFF state. It shall remain in the OFF state for at least as long as the actuating force is applied.

**(From 4.7.1)** Device with reset – b) After the actuating force has been removed, the output signal switching device(s) shall only change to the ON state after the application of a reset signal.

**(From 4.7.2)** Device without reset—For a pressure sensitive mat without reset the output signal switching device(s) shall change to an ON state at power ON and after the actuating force has been removed.

**(From 4.15)** The pressure sensitive mats shall meet the requirements of the category for which they are specified...

**Note:** The MatGuard mat system features an "active" mat and a dual channel monitoring control unit. This means that a single electrical fault in the mat, wiring or control unit will be detected and the control unit will go to a safe (OFF) condition.

(From informative annex B.1.1) The top (mat) surface should be of a material which will withstand the operating duty....The top surface should not present a risk through becoming slippery due to wear or the effects of liquids....

**(From informative annex B.1.7)** In some situations, heavy loads (such as fork lift trucks) can be applied to the sensor (mat).... If this is required the user should identify the need to the mat manufacturer.

**Note:** The standard MatGuard mat can be successfully used with fork lift trucks. The MatGuard Mat System should be installed in accordance with the requirements of EN 999, "The positioning of protective equipment in respect of approach speeds of parts of the human body."

**The MatGuard Safety Mat system is also designed to meet the U.S. standards ANSI/RIA R15.06-1999 Safety Requirements for Industrial Robots and Robot Systems and ANSI B11.19 Performance Criteria for Safeguarding.**

These two U.S. standards have many similar requirements and provide performance criteria for design, installation and use. Excerpts from these standards include:

### From RIA R15.06

**(From 11.7)** Safety mat systems shall be designed, constructed and applied such that any single component failure shall not prevent the stopping action of the robot.

**(From 5.3.4)** Safety mats shall have a minimum object sensitivity which detects 30 kg (66lb.) weight of an 80mm (3.125in) diameter circular disk anywhere on the mat sensing surface; provide a means to retain minimum object sensitivity at the area where mats joined together.

### From ANSI B11.19

**(From 11.1.1.4)** The safety mat device shall have a maximum response time that is not affected by object sensitivity adjustments or environmental changes.

**(From 11.1.1.5)** When a component, module, device or system failure occurs, the safety related function shall prevent initiation of the hazardous machine motion, initiate an immediate stop command and prevent re-initiation of the hazardous machine motion.

### From AS 4024.5

The MatGuard Safety Mat system is designed to meet the Australian Standard AS 4024.5, which has many similarities to the European Standard EN1760-1. Excerpts from this standard include:

**(From 3.2.2)** Where an effective sensing area is built up of more than one sensor, it shall have no dead zone.

**(From 3.7)** When the actuating force is applied the output signal switching device (s) shall change from an 'on' state to an 'off' state. It shall remain in the 'off' state for at least as long as the actuating force is applied.

**(From 3.8)** The sensor shall be provided with a means for fixed permanent location.

**(From 3.10)** Provisions shall be made on the top surface of the sensor to minimize slipping under the expected operating conditions.

## Application Details

### Safety Distance Calculations ANSI/RIA R15.06

The minimum distance calculated is the minimum horizontal distance from the outer edge of the MatGuard sensor mat detection zone to the nearest part of the hazard. The formula for floor mounted safety mats is:

$$D_s = [K \times (T_s + T_c + T_r)] + D_{pf}$$

- **D<sub>s</sub>** is the minimum safety distance.
- **K** is a minimum speed constant based on the movement of the hand/arm only and the body being stationary.  
 $K = 1600\text{mm/s}$  (63in/s)
- **T<sub>s</sub>** is the worst stopping time of the machine/equipment
- **T<sub>c</sub>** is the worst stopping time of the control system
- **T<sub>r</sub>** is the response time of the safeguarding device
- **D<sub>pf</sub>** is the depth penetration factor which is the maximum travel towards the hazard within the safety mat area that may occur before a stop is signalled.  
 $D_{pf} = 1200\text{mm}$  (48in)

The response time of the machine and control system used in the calculation must be the worst case. Some machines have inconsistent response times that are dependent upon mode of operation, nature of the work piece and point in the operating cycle at which stopping is initiated. An allowance should be made for wear in brakes, temperature, aging of components, etc., if this can affect the response time. An allowance for further delays in the machine control system may be required in some circumstances.

#### Calculation Example

In this example, the MatGuard system is being used with a machine and control system with a worst case response time measured at 0.485 seconds. The system is on a flat surface, it is not on a raised platform. Using the formula above,

$$T = T_s + T_c + T_r$$

$$0.035 + 0.485$$

$$0.520\text{s}$$

$$S = (63 \times 0.520) + 48$$

$$80.76\text{in}$$

Sensor mats will be required from 2032mm right up to the edge of the machine base plate.

### Safety Distance Calculations EN999

The minimum distance calculated is the minimum horizontal distance from the outer edge of the MatGuard sensor mat detection zone to the nearest part of the hazard. The formula for floor mounted safety mats is:

$$S = [1600 \times (t_1 + t_2)] + (1200 - 0.4H)$$

- **S** is the minimum safety distance in mm in a horizontal plane from the danger zone to the detecting edge of the device furthest from the danger zone.
- **1600** is a minimum speed constant based on the movement of the hand/arm only and the body being stationary.  
 $1600\text{mm/s} = 63\text{in/s}$
- **t<sub>1</sub>** is the maximum time between the actuation of the sensing function and the output signal switching devices being in the off state.
- **t<sub>2</sub>** is the maximum response time of the machine, i.e., the time required to stop the machine or remove the risks after receiving the output signal from the protective equipment.
- **1200** is the depth penetration factor which is the maximum travel towards the hazard within the safety mat area that may occur before a stop is signalled.  
 $1200\text{mm} = 48\text{in}$
- **H** is the distance above the reference plane, e.g. floor, in millimetres

The response time of the machine and control system used in the calculation must be the worst case time. Some machines have inconsistent response times which are dependent upon mode of operation, nature of the work piece and point in the operating cycle at which stopping is initiated. An allowance should be made for wear in brakes, temperature, aging of components, etc., if this can affect the response time. An allowance for further delays in the machine control system may be required in some circumstances.

#### Calculation Example

In this example, the MatGuard system is being used with a machine and control system whose worst case response time has been measured as 0.485 seconds. The system is on a flat surface, it is not on a raised platform. Using the formula above,

$$T = t_1 + t_2$$

$$0.035 + 0.485$$

$$0.520\text{s}$$

$$S = (1600 \times 0.520) + 1200$$

$$832 + 1200$$

$$2032\text{mm}$$

Sensor mats will be required from 2032mm right up to the edge of the machine base plate.