



# MatGuard Control Unit with MatGuard Pressure Sensitive Safety Mat System

Catalog Numbers 440F-C4000D, 440F-C4000P



**Allen-Bradley**

by ROCKWELL AUTOMATION

Guardmaster®

User Manual

Original Instructions

## Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.



**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

---



**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

---

---

**IMPORTANT** Identifies information that is critical for successful application and understanding of the product.

---

These labels may also be on or inside the equipment to provide specific precautions.



**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

---



**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

---



**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

---

The following icon may appear in the text of this document.



Identifies information that is useful and can help to make a process easier to do or easier to understand.

|   |   |
|---|---|
| About This Publication .....                            | 5 |
| Who Would Use This Manual .....                         | 5 |
| Safety Standards.....                                   | 5 |
| Pressure Sensitive Safety Mats.....                     | 5 |
| EMC Directives .....                                    | 5 |
| Functional Safety Data .....                            | 6 |
| Safety Certification .....                              | 6 |
| Markings.....   | 6 |
| Storage .....   | 7 |
| Handling and Transport.....                             | 7 |
| Safety Mat Environmental and Operating Conditions ..... | 7 |
| Possible Misuse.....                                    | 8 |
| Additional Resources.....                               | 9 |

## Chapter 1

### Product Overview

|  |    |
|--|----|
| Introduction.....                        | 11 |
| System Components .....                  | 11 |
| MatGuard Control Unit .....              | 12 |
| Pressure Sensitive Safety Mats.....      | 12 |
| Active Uniting Trim.....                 | 12 |
| Perimeter Trim.....                      | 12 |
| Safety Mat Functionality.....            | 13 |
| MatGuard Control Unit Functionality..... | 13 |
| MatGuard Control Unit Selection .....    | 14 |
| Approximate Dimensions.....              | 14 |

## Chapter 2

### System Design

|   |    |
|---|----|
| Nature of Hazard .....                                      | 17 |
| Nature of Safeguarding.....                                 | 17 |
| Safety Mat Positioning .....                                | 17 |
| Combined Trip and Presence Sensing Device.....              | 18 |
| Safety Distance Calculations.....                           | 19 |
| Presence Sensing System Within Perimeter Guarding Area..... | 20 |
| Fixed Guards .....  | 21 |
| Bypass Prevention .....                                     | 21 |
| Safety Mat Pattern .....                                    | 22 |
| Wear and Damage .....                                       | 23 |
| Floor requirements.....                                     | 23 |
| MatGuard Control Manager Mounting.....                      | 23 |
| Electrical Interface .....                                  | 24 |
| Select the Power Supply .....                               | 24 |
| Reset Modes .....   | 29 |
| Auxiliary Output.....                                       | 30 |
| Arc Suppression .....                                       | 30 |
| Contactor Monitoring.....                                   | 30 |
| Final Safety Mat Layout.....                                | 30 |
| Wiring.....   | 30 |

|                         |  |    |
|-------------------------|--|----|
|                         | Final Details .....                        | 31 |
| <b>Installation</b>     | <b>Chapter 3</b>                           |    |
|                         | Safety Mat Installation .....              | 33 |
|                         | Unite Trim Fixing .....                    | 34 |
|                         | Perimeter Trim Fixing .....                | 34 |
|                         | Control Unit Installation and Wiring ..... | 35 |
|                         | Installation Procedure .....               | 37 |
|                         | Check the Mechanical Installation .....    | 39 |
|                         | Check the Electrical Functions .....       | 39 |
|                         | Manual Mode Only .....                     | 39 |
|                         | Auto Reset Mode Only .....                 | 39 |
|                         | Under Fault Condition .....                | 40 |
|                         | Check Safety Functions .....               | 40 |
|                         | Single-channel Systems .....               | 40 |
|                         | Dual-channel Systems .....                 | 40 |
|                         | All System Types .....                     | 40 |
|                         | Functional Checkout .....                  | 41 |
| <b>System Operation</b> | <b>Chapter 4</b>                           |    |
|                         | Pre-operation Checks .....                 | 43 |
| <b>Maintenance</b>      | <b>Chapter 5</b>                           |    |
|                         | Safety Mat Cleaning .....                  | 45 |
|                         | Routine Inspection and Test .....          | 45 |
|                         | Thorough Examination and Test .....        | 45 |
|                         | Dismantle and Disposal .....               | 46 |
|                         | Fault Finding .....                        | 46 |
|                         | Symptom: No Start .....                    | 46 |
|                         | Symptom: No Stop .....                     | 47 |
|                         | Symptom: Unexpected Stoppage .....         | 47 |
|                         | Repair .....                               | 48 |
|                         | Replacement Parts .....                    | 48 |
|                         | Service .....                              | 50 |
| <b>Specifications</b>   | <b>Appendix A</b>                          |    |
|                         | MatGuard Control Units .....               | 51 |
|                         | Sensor Mat .....                           | 52 |
|                         | <b>Index</b> .....                         | 53 |

### About This Publication

This manual is a reference guide for the proper installation of the 440F-C4000D/P MatGuard™ Control Unit in combination with 440F-Mx MatGuard Pressure Sensitive Safety Mats.

### Who Would Use This Manual

Use this manual if you design, install, program, or troubleshoot systems that use the 440F-C4000D/P MatGuard control unit.

You must have a basic understanding of electrical circuitry and familiarity with safety-related systems. If you do not, obtain the proper training before using this product.

Qualified personnel must conduct all inspections and perform the following tasks:

- Undergo the appropriate technical training.
- Instruct personnel in the operation of the machine and the current safety guidelines.
- Read and have access to the user manual.

### Safety Standards

#### Pressure Sensitive Safety Mats

The following standards are referred to in this manual:

- ISO 12100: 2010 - Safety of machinery - General principles for design - Risk assessment and risk reduction.
- BS EN ISO 13857: 2019 - Safety of machinery - Safety distances to help prevent upper and lower limbs from reaching hazardous zones.
- ISO 14120: 2015 - Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards.
- ISO 13849-1: 2015 (EN 954-1): Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design.
- ISO 13855 - Safety of machinery - Positioning of safeguards regarding the approach speeds of parts of the human body.
- ISO 13856-1: 2013 - Safety of machinery - Pressure-sensitive protective devices - Part 1: General principles for the design and testing of pressure-sensitive safety mats and pressure-sensitive floors.
- IEC 60204-1: 2016 - Safety of machinery - Electrical equipment of machines - Part 1: General requirements.
- ANSI B11.TR3 - 2000 (2015): Risk Assessment and Risk Reduction-A guide to estimate, evaluate, and reduce risks that are associated with machine tools.
- IEC 62061:2015: Safety Of Machinery - Functional Safety Of Safety-Related Electrical, Electronic And Programmable Electronic Control Systems

### EMC Directives

The safety mat system complies with the requirements of the European EMC Directive. Normal operation under interference conditions likely in industrial environments is confirmed and has been tested and certified.



# Functional Safety Data

Compliance for the MatGuard control unit is achieved with the requirements of a category 3 per EN ISO 13856-1, PLd per ISO 13849-1, and SIL 2 per IEC 62061 regarding reliability and electrical faults and can be met for the associated part of the machine control system. Compliance with the requirements of EN ISO 13856-1 category 1 is achieved for the safety mat sensors.

# Safety Certification

The type of safeguarding system must be suitable for the application for which it is intended. A documented process of risk assessment of the machinery or process reveals the identity and nature of the hazards together with other relevant information. The machinery manufacturer must conduct a risk assessment to determine the PL or SIL requirements. The characteristics of the safeguarding system must then be compared with the results of the risk assessment to determine whether the risk can be reduced to an acceptable level. On some applications, to achieve an acceptable level of risk, it can be necessary to combine multiple types of safeguarding systems.

# Markings

Figure 1 - Control Unit Marking 440F-C4000P

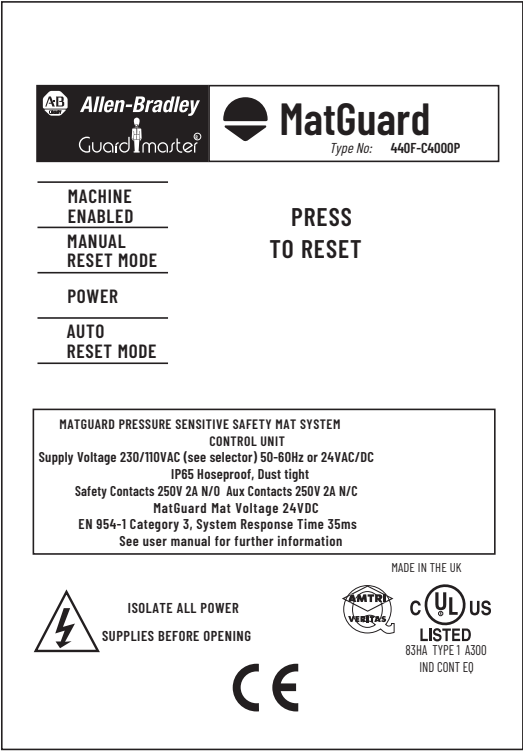


Figure 2 - Control Unit Marking 440F-C4000D

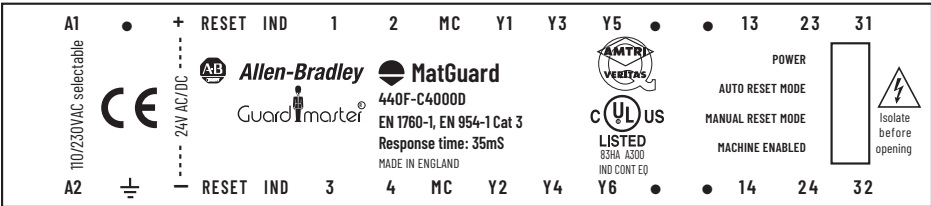


Figure 3 - Safety Mat Marking



## Storage

Store MatGuard control units and safety mats within the temperature range -40...+70 °C (-40...+158 °F). Store safety mats vertically.

## Handling and Transport

Transport MatGuard control units and safety mats at a temperature of -40...+70 °C (-40...+158 °F). To protect from damage and flex, use the original packaging or similar together with stiffeners, if necessary. Always unpack carefully and avoid damage by sharp objects.

When you move safety mats into position, never pull or lift safety mats by their connecting wires.

**IMPORTANT** Never pull or lift sensor mats by their connecting wires when moving the mats into position.  
For larger sensor mats, two people are required for safe lifting to help prevent the risk of damage to the mat sensor from excessive flexing.

## Safety Mat Environmental and Operating Conditions

In general, the covering has excellent resistance to acids, alkalis, and salt. Hot acids, alkalis, and 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. Combinations of chemicals can have unpredictable effects. We recommend tests in such cases. Small pieces of the vinyl material are available if tests are required.

**Table 1 - Chemical Resistance of Safety Mat Covering**

| <b>Substance</b>  | <b>Safety Mat Resistance</b> |
|-------------------|------------------------------|
| Water (sea)       | 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                         |
| Trichloroethylene | Fair to poor                 |
| Benzene           | Poor                         |
| Acetone           | Poor                         |
| Lubricating oil   | Fair to excellent            |
| Cutting fluids    | Fair to excellent            |
| Oil (auto)        | Fair to excellent            |
| Brake fluids      | Poor to fair                 |

## Possible Misuse

The MatGuard safety mat system is designed for the protection of personnel by sensing their presence on floor areas around machinery and other similar hazards.

Only use the MatGuard safety mat system only within the given specification limits, and install units strictly in accordance with the information that is provided in this manual.

The MatGuard safety mat system alone does not provide protection against hazards that arise from the ejection of materials, gases, and radiation. For these applications, additional protective measures, such as physical guards, are required.

The MatGuard safety mat system is not intended:

- For use as a perimeter only guard.
- For use as a machine initiation or reinitiation device.
- For use for use in explosive atmospheres.

---

**IMPORTANT** Special measures can be required in the presence of abnormally high levels of E.M.I. (electromagnetic interference), for example, near to welding or induction heating equipment, or near radio transmitters or transceivers.

---

Configure the machine control circuit so that the closing of the MatGuard safety mat system output contacts enables the starting circuit of the machine, but does not directly cause the machine to start. The start or restart of the machine must only be possible by a separate and deliberate action at the designated machine controls.



## Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

| Resource   | Description  |
|--|--|
| Hazardous Location Switch Amplifiers with Safeguarding Devices Wiring Diagram, publication <a href="#">937TH-WD001</a>   | Provides examples for how to connect safeguarding devices to isolating switch amplifiers.  |
| Safety Mat and E-stop Control Using SmartGuard 600 Packaged Safety Controller Safety Application Example, publication <a href="#">SAFETY-AT008</a>               | Provides guidance on how to wire, configure, and program a SmartGuard™ 600 safety controller for use with a dual-channel safety mat and E-stop.  |
| Safety Mat Control Using CompactBlock Guard I/O and GuardLogix Integrated Safety Controller Safety Application Example, publication <a href="#">SAFETY-AT011</a> | Provides guidance on how to wire, configure, and program a GuardLogix® integrated safety controller with a CompactBlock™ Guard I/O™ module for use with a dual-channel safety mat and E-stop.  |
| Safety Mat Stop Safety Function Application Technique, publication <a href="#">SAFETY-AT118</a>  | Explains how to wire, configure, and program a compact GuardLogix controller and POINT Guard I/O™ module to monitor a 440F safety mat.   |
| Safety Function: Safety Mat Stop Application Technique, publication <a href="#">SAFETY-AT122</a>   | Explains how to wire and configure a Guardmaster® dual-input safety relay (GSR DI) to monitor a pair of 440F safety mats and an E-stop.  |
| Safety Mat Stop via a GuardLogix Controller Safety Function Application Technique, publication <a href="#">SAFETY-AT159</a>                                      | Explains how to wire, configure, and program a compact GuardLogix controller and POINT Guard I/O module to monitor a 440F safety mat.  |
| System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a>   | Provides guidance on how to conduct security assessments, implement Rockwell Automation® products in a secure system, harden the control system, manage user access, and dispose of equipment.   |
| UL Standards Listing for Industrial Control Products, publication <a href="#">CMPNTS-SR002</a>   | Assists original equipment manufacturers (OEMs) with construction of panels to conform to the requirements of Underwriters Laboratories.   |
| American Standards, Configurations, and Ratings: Introduction to Motor Circuit Design, publication <a href="#">IC-AT001</a>                                      | Provides an overview of American motor circuit design, which is based on methods that are outlined in the NEC.   |
| Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication <a href="#">IC-TD002</a>                               | Provides a quick reference tool for Allen-Bradley® industrial automation controls and assemblies.  |
| Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication <a href="#">SGI-1.1</a>                                 | Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies that incorporate solid-state components. |
| Industrial Automation Wiring and Grounding Guidelines, publication <a href="#">1770-4.1</a>  | Provides general guidelines for installing a Rockwell Automation industrial system.  |
| Product Certifications website, <a href="http://rok.auto/certifications">rok.auto/certifications</a>   | Provides declarations of conformity, certificates, and other certification details.  |

You can view or download publications at [rok.auto/literature](http://rok.auto/literature).

**Notes:**

## Product Overview

### Introduction

When designed by professional personnel for use as a safety product in an industrial environment, the MatGuard™ safety mat system provides protection against risks that can be eliminated by the isolation of electrical power when an operator is in the vicinity of the hazard. This manual covers the installation and use of all components of the Allen-Bradley® MatGuard Mats system.

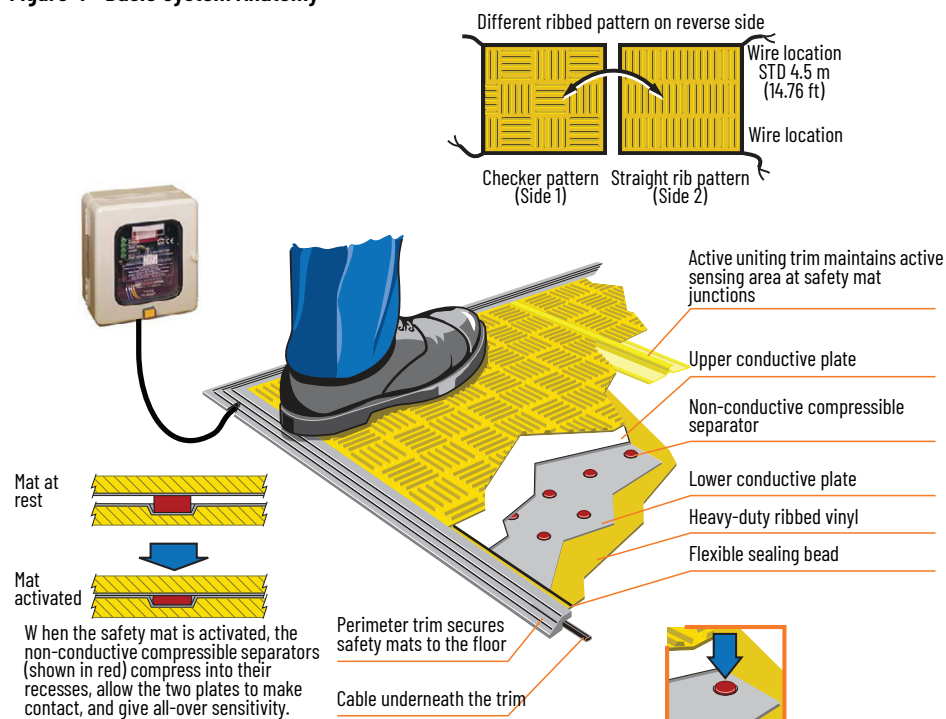
Only suitably trained and qualified personnel can conduct all installation procedures, which must be in accordance with statutory requirements for safety.

### System Components

The MatGuard safety mat system is composed of a safety mat control unit, one or more interconnected pressure sensitive safety mats, active uniting trim, and perimeter trim, as shown in [Figure 4](#).

When the system includes a suitable safety mat control unit, the control unit detects a presence on the safety mat, a short circuit, or an open circuit. Under each of these conditions, the safety control issues a stop command. Multiple safety mats can combine into one safety mat system with the use of joining trim.

**Figure 4 - Basic System Anatomy**



## MatGuard Control Unit

The MatGuard control unit that is shown in [Figure 5](#) monitors all safety mats that are connected together to form a safeguarded zone. The safeguarded zone can be up to a total of 100 m<sup>2</sup> (1076 ft<sup>2</sup>) and made from any number of safety mats.

The control unit detects a presence on the safety 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 receives a stop signal and an auxiliary output relay turns on.

**Figure 5 - MatGuard Control Units**

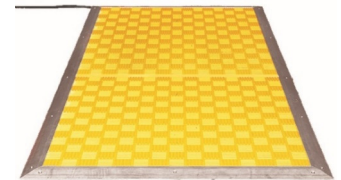
**440F-C4000P**

**440F-C4000D**



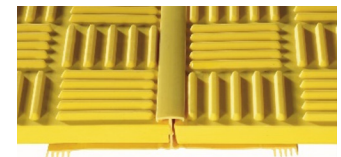
## Pressure Sensitive Safety Mats

Pressure sensitive safety mats are designed to detect persons on their surface. Individual safety mat sections are available in rectangular standard sizes and also in specially cut shapes, up to the size of the largest standard safety mat.



## Active Uniting Trim

Active uniting trim installs between adjacent safety mats to detect individuals present on the junction of the safety mats. There are no dead areas within the detection zone when safety mats are properly installed.



## Perimeter Trim

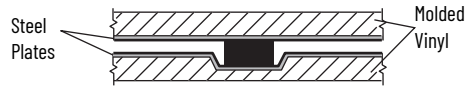
Perimeter trim is used around the edges of the safety mats to hold the safety mats in place and to help prevent trip hazards. Various lengths and corner pieces are available to fit the safety mat area.



## Safety Mat Functionality

All safety mats have the same construction and operation principle. Each safety mat has two conductive plates that are held apart by non-conductive compressible separators. The operating principle of the safety mat is shown in [Figure 6](#) and [Figure 7](#).

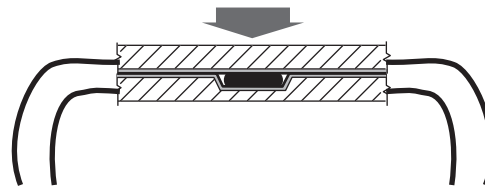
**Figure 6 - Safety Mat at Reset**



Each safety mat has four attached wires that operate at 24V DC and connect in series. Safety mats are available with Micro QD connections or flying lead cables. Your catalog selection defines the exit points on the safety mat wiring.

When the safety mat is activated, the non-conductive compressible separators (shown as black) compress into their recess, which allows the two plates to make contact.

**Figure 7 - Safety Mat Activated**



Safety mat wiring is connected directly to the mat manager, which monitors the individual safety mat connections.

You can arrange multiple safety mats around the machinery and, depending on the configuration, safety mats can be wired in series to protect a large area.

The MatGuard safety mat system is intended for the detection of adult persons with a weight of 35 kg (77.16 lb) or more and is suitable for the detection of adults with walking aids (for example, walking sticks or frames). The MatGuard safety mat system forms a floor-level sensing system for hazardous areas around machinery.

---

**IMPORTANT** The system is not suitable for the detection of children. The system must not be used with any additional covering on the safety mat.

---

## MatGuard Control Unit Functionality

The MatGuard control unit is designed to accept one series of safety mats. The MatGuard control unit monitors the 24V DC series circuit of safety mats, providing a status indication of the safety mat system.

When the protective area is clear, the MatGuard control unit provides a signal to the machine control circuit to allow the machine to start. When the protective area is not clear (personnel is present stepping on a safety mat), the conductive plates touch in the safety mat and the resistance in the circuit drops. The MatGuard control unit monitors this action and turns the output off to initiate the machine shut-down sequence. Any single electrical fault in the safety mat, wiring, or safety mat manager is detected, and the MatGuard control unit outputs goes to a safe (off) state.

## MatGuard Control Unit Selection

The mounting option, the size of the control unit, and the Manual Reset button determines the correct MatGuard control unit for your application. See [Table 2](#).

Table 2 - MatGuard Control Units

| Cat. No.    | Power Required           | Safety Mat Connector    | Safety Outputs | Auxiliary Outputs | Mounting   | Power/I/O Connector Type | Manual Reset Button |
|-------------|--------------------------|-------------------------|----------------|-------------------|--|--------------------------|---------------------|
| 440F-C4000P | 24V AC/DC<br>115/230V AC | Direct wiring (1 input) | 2 N.O.         | 1 N.C.            | Mounting holes for polycarbonate enclosure, IP65 | Direct wiring            | Yes (on enclosure)  |
| 440F-C4000D | 24V AC/DC<br>115/230V AC | Direct wiring (1 input) | 2 N.O.         | 1 N.C.            | DIN rail, IP40                                   | Direct wiring            | No                  |

## Approximate Dimensions

Figure 8 - Dimensions [mm (in.)]

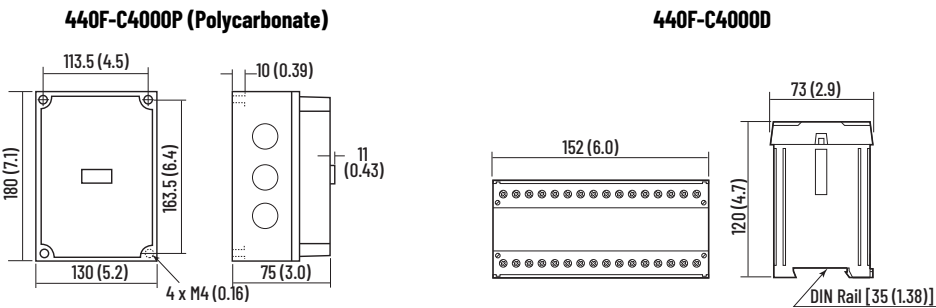




Figure 9 - Basic System and Connections 440F-C4000P (Two Contactors)

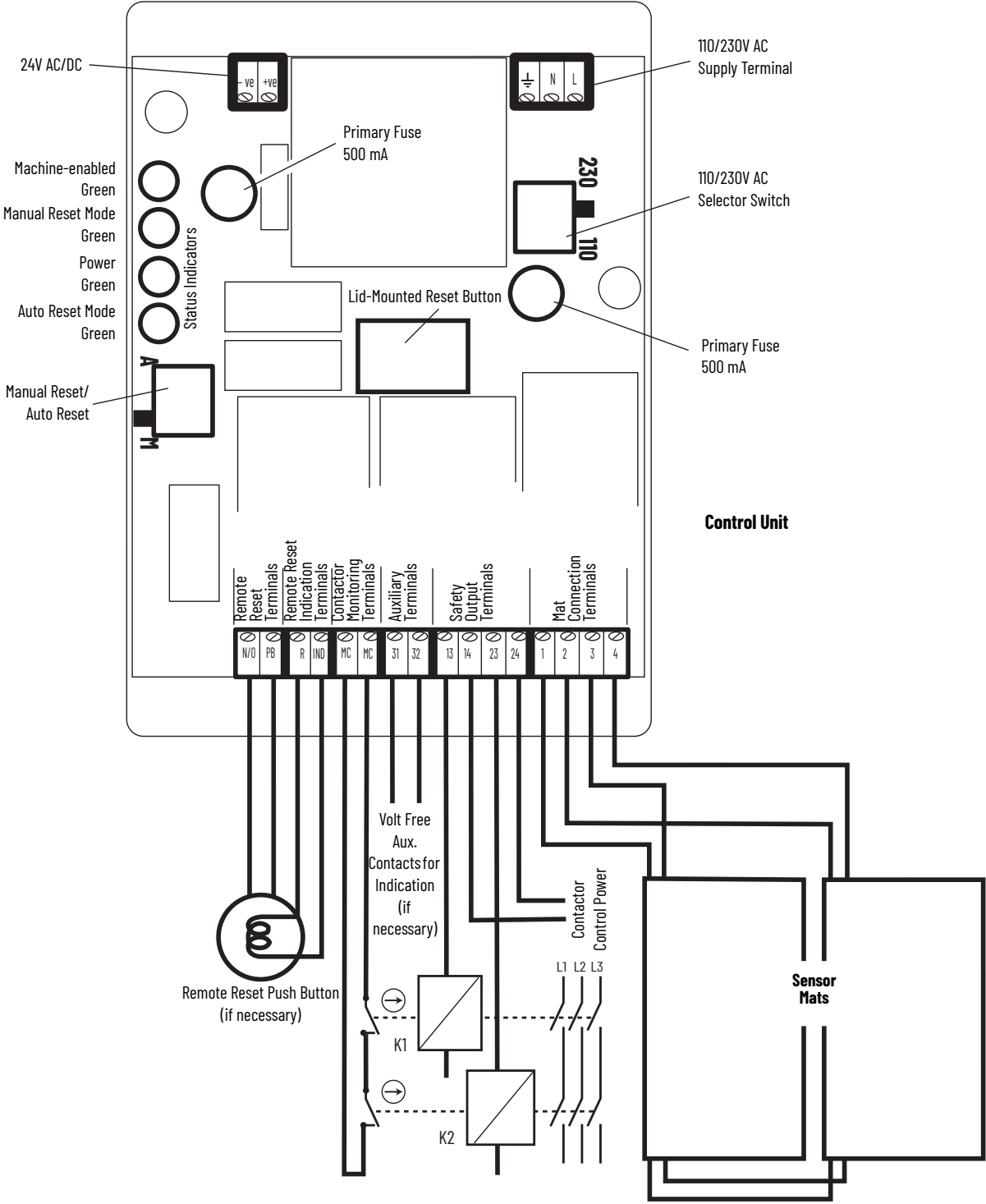
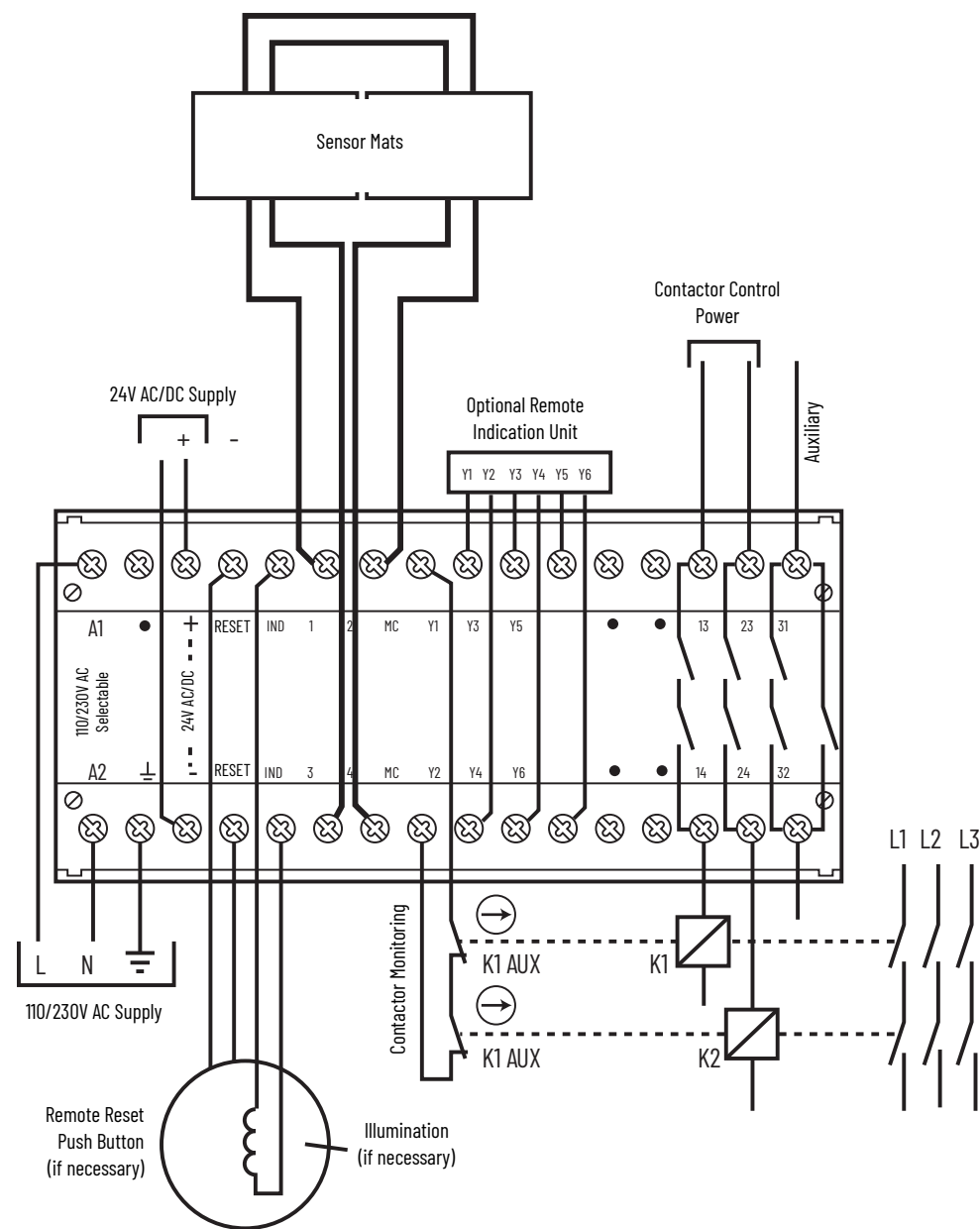


Figure 10 - Basic System and Connections 440F-C4000D (Two Contactors)



## System Design

We recommend that only persons who have experience in safety-related control system design, and are suitably competent in electrical and mechanical engineering, design the system.

### Nature of Hazard

The MatGuard™ safety mat system provides protection against such risks that can be minimized by the isolation of electrical power when an operator is near the hazard. Additional measures are required to address other hazards identified in a risk assessment (for example, part ejection and hot surfaces). These measures can include fixed guards, interlocked guards, and warning notices.

---

**IMPORTANT** A risk assessment is included and detailed in ISO 12100-2010 and detailed in ANSI B11.TR3 2000 (2015).

---

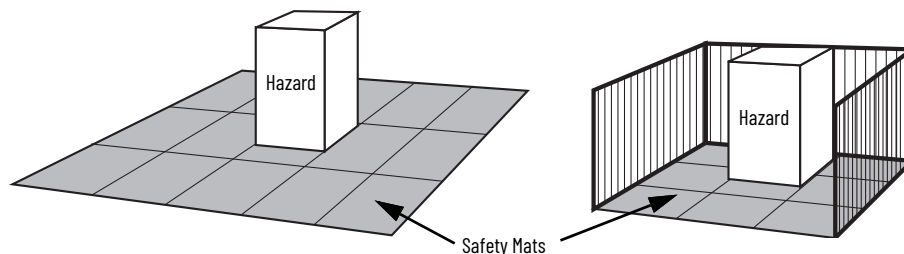
### Nature of Safeguarding

The system design must satisfy three main requirements:

- The machine must stop if a person is in a position where they are able to reach into the hazardous zone.
- The machine must come to a stop before an approaching person can be in the position where they are able to reach into the hazardous zone.
- The system must not be easily bypassed.

The recommended use of the MatGuard safety mat system is to give presence sensing over the entire area where access is possible to the hazard (see [Figure 11](#)). Other uses of the MatGuard safety mat system such as a perimeter access only guard or as a machine enabling device, are not recommended.

**Figure 11 - Layout Examples**



### Safety Mat Positioning

The position of the safety mats depends on the use case. You can use safety mats as:

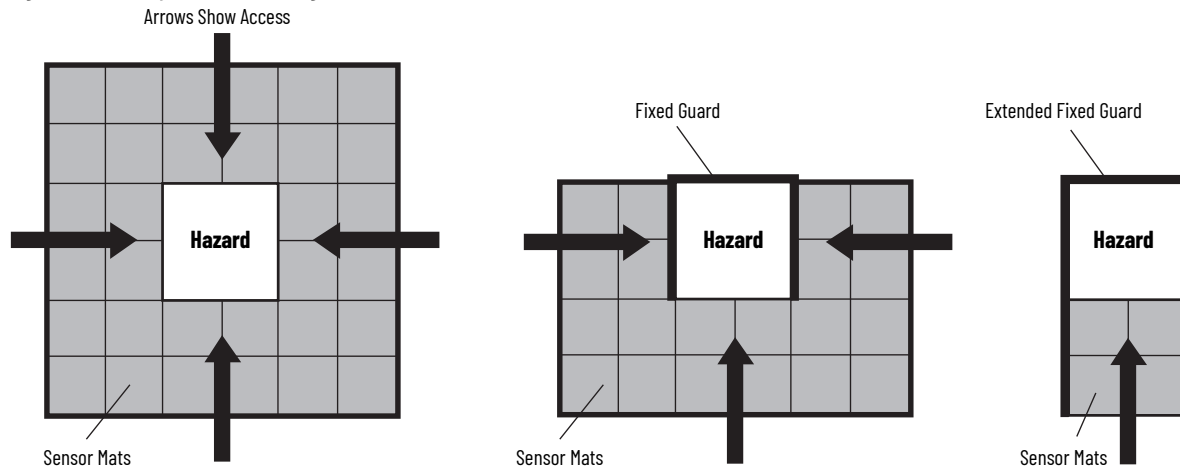
- Combined trip and presence sensing devices.
- Presence sensing systems within a perimeter guarded area.

## Combined Trip and Presence Sensing Device

The position of safety mat edges is calculated as a horizontal distance from the hazardous zone. Define the hazardous zone as a volume, account for all possible modes of the machine, and for all variations in the size of the workplace. To check the adequacy of the safeguards, record the dimensions and position of the hazardous zone and the use case assumptions.

Other safeguarding measures that are used with the MatGuard safety mat system can affect the requirements for the size and position of the safety mats, as shown in [Figure 12](#).

**Figure 12 - Safety Mat Positioning**



### Safety Mat Position Requirements

- Determine the safe distance to the hazard - There must be sufficient space to allow the minimum distance from the hazard to the accessible safety mat perimeter to be in accordance with ISO 13855 safety distance calculations. See [Figure 13 on page 19](#).
- Full coverage of safety mats around the hazard - Safety mats must cover the entire floor area between the defined perimeter and the hazard so that it is not possible to approach or stand in the vicinity of the hazard without actuating the MatGuard safety mat system.

### Determine Proper Safety Mat Position

1. Determine the routes where unobstructed access to the hazardous zone is required across the MatGuard safety mat system. Consider:
  - All routine needs for access, such as product inspection, machine inspection and adjustment, tool changes, and clearing blockages.
  - Visual observation of the process.
  - Space requirements of people and ancillary equipment close to the machine during interventions.
2. There must be sufficient space to allow the minimum distance from the hazard to the accessible safety mat perimeter, in accordance with the safety distance calculations (see [Figure 13 on page 19](#)). Applications that use the MatGuard Mats system as a combined trip and presence sensing system must be in accordance with ISO 13855.

#### IMPORTANT

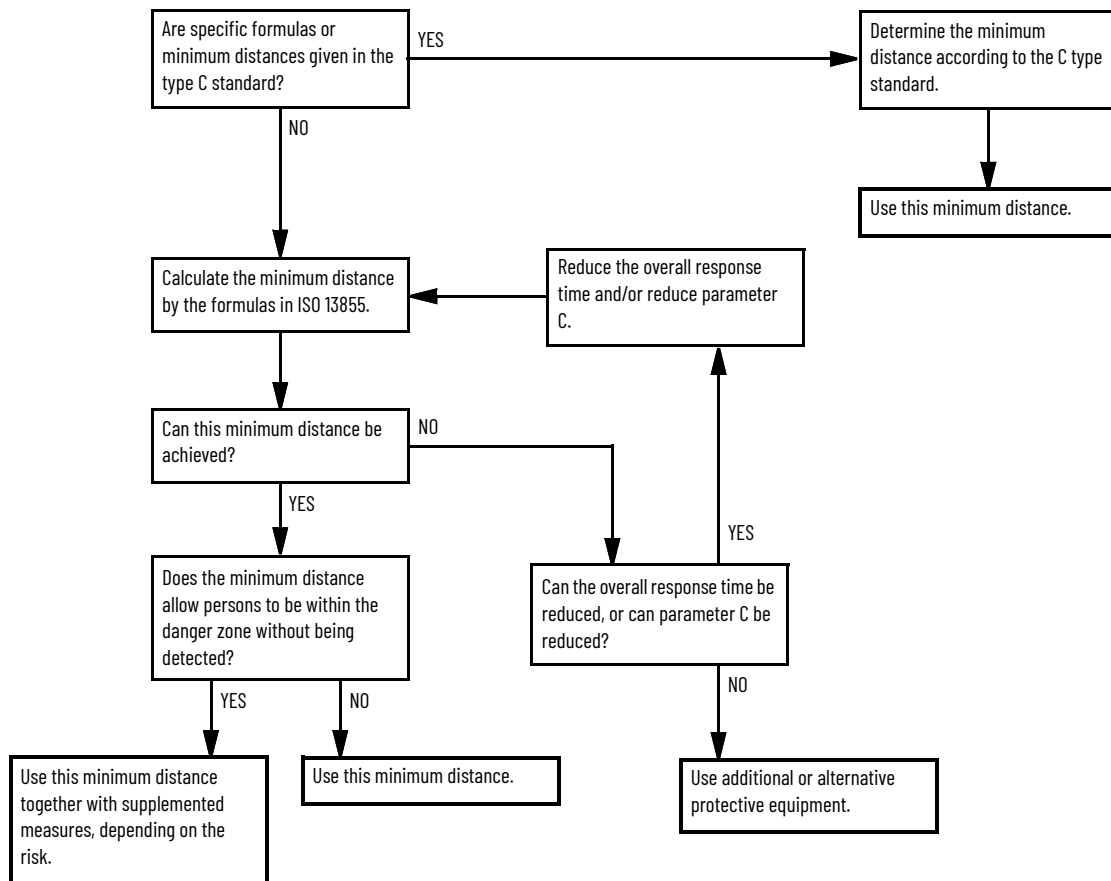
If the machine is designed in conformity with an existing harmonized European C type standard for that machine (which gives specific formulas or minimum distances), then these standards must be used in preference to the standards given in ISO 13855.

- Safety mat sensors must cover the entire floor area between the defined perimeter and the hazard so it is not possible to approach, or be in the vicinity of, the hazard without actuating the MatGuard safety mat system.

## Safety Distance Calculations

Applications that use the safety mat system as a combined trip and presence sensing system must be done in accordance with ISO 13855. See [Figure 13](#).

Figure 13 - Methodology Flowchart



The calculated minimum distance is the minimum horizontal distance from the outer edge of the MatGuard safety mat system detection zone to the nearest part of the hazard.

The ISO 13855 formula for floor-mounted safety mats is:

$$S = (1600 \times T) + 1200 \text{ mm}$$

S is the minimum safety distance in millimeters.

The factor of 1600 is based on the standard assumption of 1600 mm/s (63 in./s) as the approach speed.

T is the overall stopping time in seconds.

The added 1200 mm (47.24 in.) is parameter C given in ISO 13855 and accounts for stride length and arm reach.

The overall stopping time  $T$  is the sum of two parts:

$$T = t_1 + t_2$$

$t_1$  is the maximum time between actuation of the sensing function and the output signal switching devices being in the off state.

For the MatGuard safety mat system,  $t_1 = 35$  ms.

$t_2$  is the response time of the machine, that is, the time that is required to stop the machine or remove the risks after receiving the output from the MatGuard safety mat system.

The response time of the machine that is used in the calculation must be the worst case time. Some machines have inconsistent response times, which are dependent upon the mode of operation, the nature of the workpiece, and the point in the operating cycle at which stopping is initiated. Allow for conditions that can affect the response time, such as wear on brakes. An allowance for further delays in the machine control system can be required in some circumstances.

### Calculation Example

In the following example, the MatGuard safety mat system is used with a machine with a worst case response time measured as 0.485 seconds.

Using the formula,

$$\begin{aligned} T &= t_1 + t_2 \\ &= 35 \text{ ms} + 485 \text{ ms} \\ &= 520 \text{ ms} = 0.520 \text{ s} \end{aligned}$$

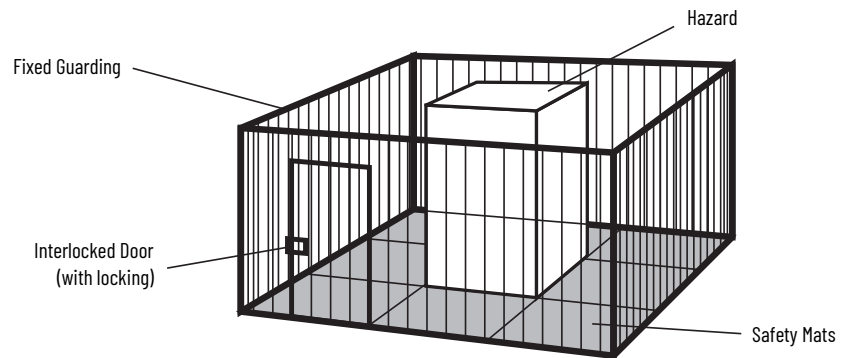
$$\begin{aligned} S &= (1600 \times 0.520) + 1200 \text{ mm} \\ &= 832 + 1200 \text{ mm} = 2032 \text{ mm} \end{aligned}$$

Safety mats are required from 2032 mm (80 in.) up to the edge of the machine baseplate.

## Presence Sensing System Within Perimeter Guarding Area

If the area around the hazard is enclosed within a guarded perimeter (see [Figure 14](#)), the requirements of ISO 13855 Safe Distance Requirements do not necessarily apply. In these applications, the MatGuard safety mat system detects the presence of an operator to help prevent reset of the perimeter-guarding system and the restart of the machine while the operator is inside the enclosure.

**Figure 14 - Guarded Perimeter**





A suitable perimeter guarding system would be a fixed guard with an access door that is fitted with an interlock switch with conditional guard unlocking (see ISO 14119). A trip device, such as a safety light curtain, can also be suitable for some applications. The position of the safety light curtain must be calculated according to ISO 13855.

When using the MatGuard safety mat in these applications, safety mats must cover the entire enclosed floor area between the enclosed perimeter and the hazard. It must not be possible for personnel to be in the enclosed area when activating the MatGuard safety mat system.

---

**IMPORTANT** When the MatGuard system is used as a secondary protective system, safety distance calculations are not acceptable.

---

#### *Safety Mat Position Requirements*

- Perimeter-guarding - The perimeter-guarding method must conform with all relevant requirements.
- Full coverage of safety mats around the hazard - Safety mats must cover the entire floor area between the defined perimeter and the hazard so that it is not possible to approach or stand in the vicinity of the hazard without actuating the MatGuard safety mat system.

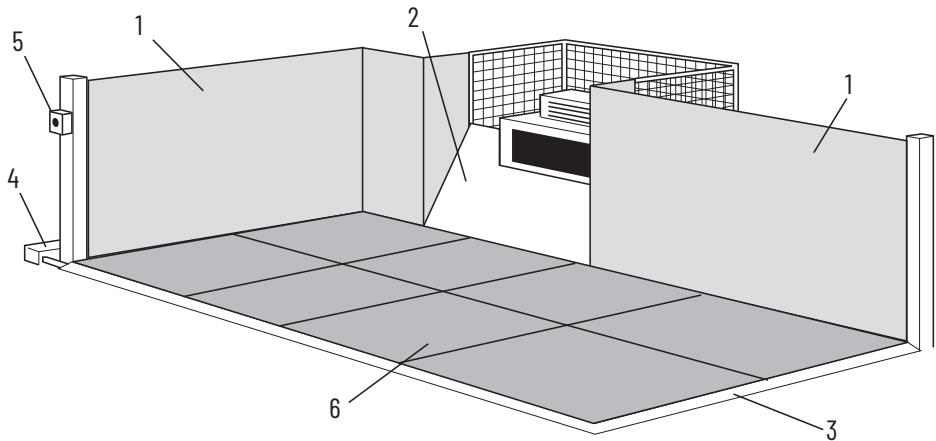
## **Fixed Guards**

The fixed guards must be designed so that access is not possible to the hazardous zone other than via the MatGuard safety mat. Guard construction and position must be in accordance with EN ISO 13857 and ISO 14120.

## **Bypass Prevention**

It must not be possible to reach the hazard without standing on the MatGuard safety mats. Prevent access to the hazardous zone from positions that do not involve standing on the MatGuard safety mats. This restricted access requires additional angle plates and the careful position of pipework and trunking. Best practice is illustrated in [Figure 15 on page 22](#).

Figure 15 - Bypass Prevention Best Practice



| Item | Description  |
|------|--|
| 1    | Fixed guards help prevent access to the hazardous zone in such a way that there is no access between the guards and sensors.   |
| 2    | A sloping cover plate helps prevent the operator from avoiding the sensing area by standing on the machine base plate.   |
| 3    | A ramp at the point of access reduces the tripping hazard at the sensor edge. The ramp can also protect connected cables. The optional perimeter trim is a ramp section. |
| 4    | Cable trunking is installed outside of the fixed guard. This configuration helps prevent against the misuse as access to the hazardous zone.                             |
| 5    | A reset button is in a well-protected location that gives full visibility of the machine.  |
| 6    | Safety mats are properly installed.  |

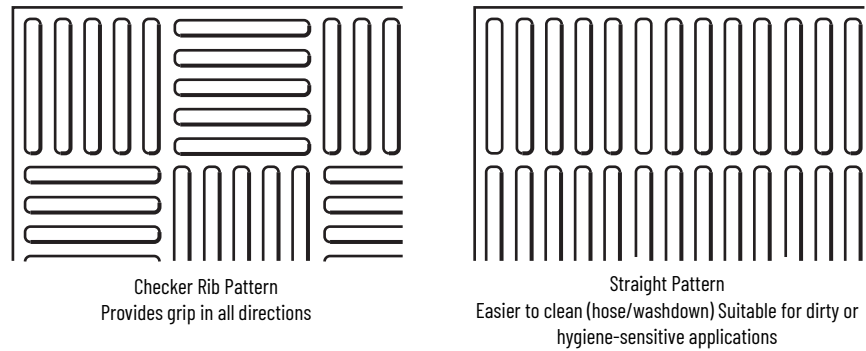
Safety Mat Pattern

The MatGuard safety mat has two different rib patterns as shown in [Figure 16 on page 23](#). Either pattern can be used as the upper surface. Identify which side of the safety mat must face upward.

Both MatGuard safety mat patterns provide a non-slip surface under most conditions, but must be kept free from large deposits of grease, soaps, or gels. If the straight rib side is uppermost, we recommend that the ribs run across the hazard to give improved grip.

The vinyl outer surface of the safety mat is sealed to resist the ingress of liquids and rated to IP67. Safety mats resist bleaches, acids, salt, and most industrial chemicals. See [Table 1 on page 8](#).

Figure 16 - Rib Pattern



## Wear and Damage

Impacts from sharp or heavy objects can damage the outer surface of the safety mat. After every such event, the safety mat must be inspected for deformation or puncture and replaced, if necessary.

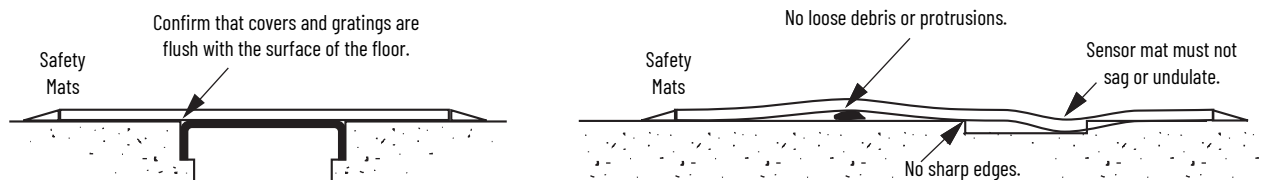
MatGuard safety mats are designed and tested to withstand one million operations in any one spot. In use, this number of operations in one location must not be exceeded. Occasional heavy loads (for example, up to three-ton trucks) are unlikely to damage the MatGuard safety mats, but the safety mats must not be used on traffic through routes.

## Floor requirements

The floor or mounting surface for the MatGuard safety mats must be flat, smooth, and rigid, as shown in [Figure 17](#). The floor or mounting surface must show no perceptible distortion under the heaviest load anticipated. Undulations, protrusions, large gaps, or other irregularities increase the sensitivity of the safety mats and can result in intermittent unintended switching off (nuisance tripping).

Small and regular protrusions, such as checker plate pattern, are acceptable. Skimmed concrete floors are ideal.

Figure 17 - Floor Conditions



## MatGuard Control Manager Mounting

**IMPORTANT** The MatGuard control unit must not be mounted within the detection zone.

If access to the MatGuard control unit is required for manual reset or routine indicator observation, it must be mounted at an accessible position outside the protection zone that provides a good view of the hazard and protection zone.

In other cases, the MatGuard control unit can be mounted anywhere convenient outside the protection zone, with consideration of access requirements for tests and maintenance.

---

**IMPORTANT** The MatGuard control unit is not suitable for direct exposure to high-pressure cleaning.

---

## Electrical Interface

The protection that is provided by the Guardmaster® system depends on the correct interfacing between the Guardmaster system and the machine.

The safety output contacts from the Guardmaster safety mat manager are arranged as independent voltage-free N.O. contact pairs. The terminal positions are given in [Control Unit Installation and Wiring on page 35](#) and ratings are given in [Specifications on page 51](#).

The MatGuard control unit conforms to category 3 according to ISO 13849-1. In common with other safety mats and floors, category 3 performance for the safety mat cannot be achieved for faults that result from severe mechanical damage or long-term degradation. The safety mats conform to category 1 according to ISO 13849-1.

The safety mat system can be used as the sole protective measure or in combination with other measures or devices (for example, a safety light curtain, system of work).

Where a harmonized European C standard is available for the machine type, it contains requirements and guidance for the safety-related control system of the machine. ISO 13849-1 also provides guidance. You must provide an adequate level of protection against foreseeable faults to the appropriate category of ISO 13849-1. For this reason, we recommend that a dual-channel configuration with duplication and monitoring of the final switching elements (contactors) be used on all higher risk applications.

### Select the Power Supply

The MatGuard control unit offer two possibilities for power supply. Check that the power supply parameters conform to the requirements of the Guardmaster system as given in the specification. Where a 24V DC supply is used, it must be isolated from the mains supply in accordance with international electrical safety practice (IEC 364-4-41). One pole must be earthed (negative to be earthed for DC supplies).

[Figure on page 25...](#)[Figure 23 on page 29](#) show examples of interconnections of the safety mat system.

Figure 18 shows a 440F-4000P control unit application with one contactor (single channel).

- Circuit status
- Supply power is on
- No presence on safety mat
- Reset button operated (if in Manual Reset mode)
- Machine start circuit enabled

**IMPORTANT** If the contactor sticks on, the motor does not stop when the safety mat is stood on.

Figure 18 - Single-channel Diagram - 440F-4000P Control Unit

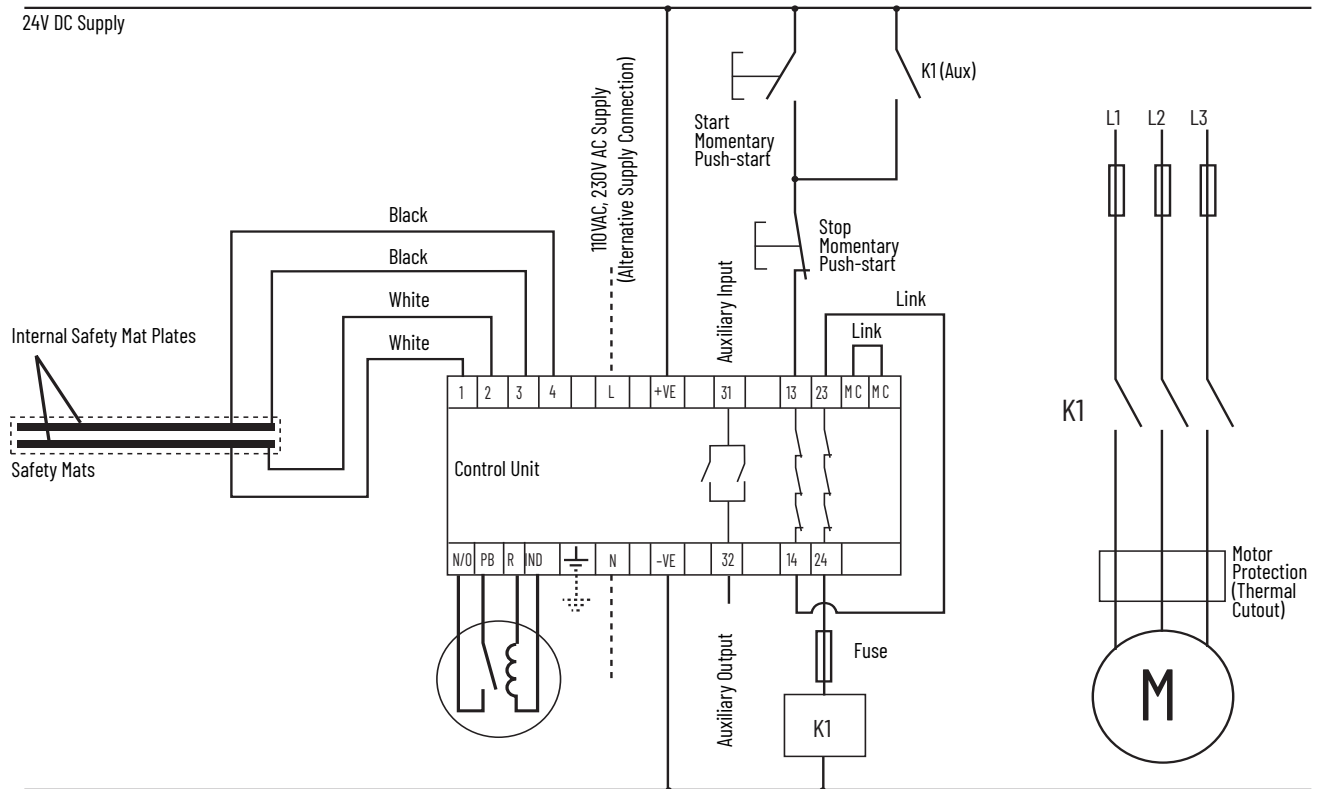


Figure 19 shows a 440F-4000P control unit application with two contactors and contactor monitoring (dual-channel).

- Circuit status
- Supply power is on
- No presence on safety mat
- Reset button operated (if in Manual Reset mode)
- Machine start circuit enabled

**IMPORTANT** If either of the contactors sticks on, the motor stops when the safety mat is stood on and the fault is detected.

Figure 19 - Dual-channel Diagram - 440F-4000P Control Unit

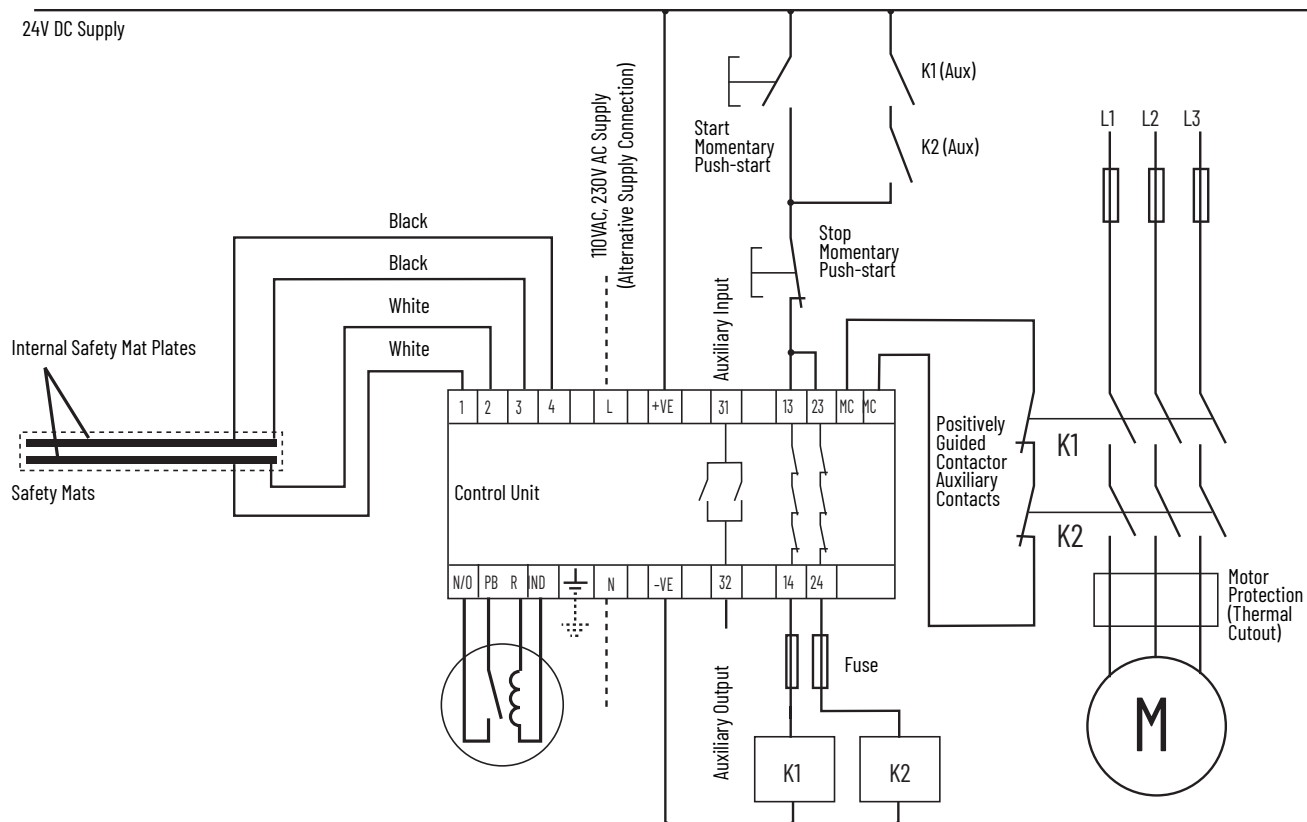




Figure 20 shows a 440F-C4000D control unit application with one contactor (single-channel).

- Circuit status
- Supply power is on
- No presence on safety mat
- Reset button operated (if in Manual Reset mode)
- Machine start circuit enabled

**IMPORTANT** If the contactor sticks on, the motor does not stop when the safety mat is stood on.

Figure 20 - Single-channel Diagram - 440F-4000D Control Unit

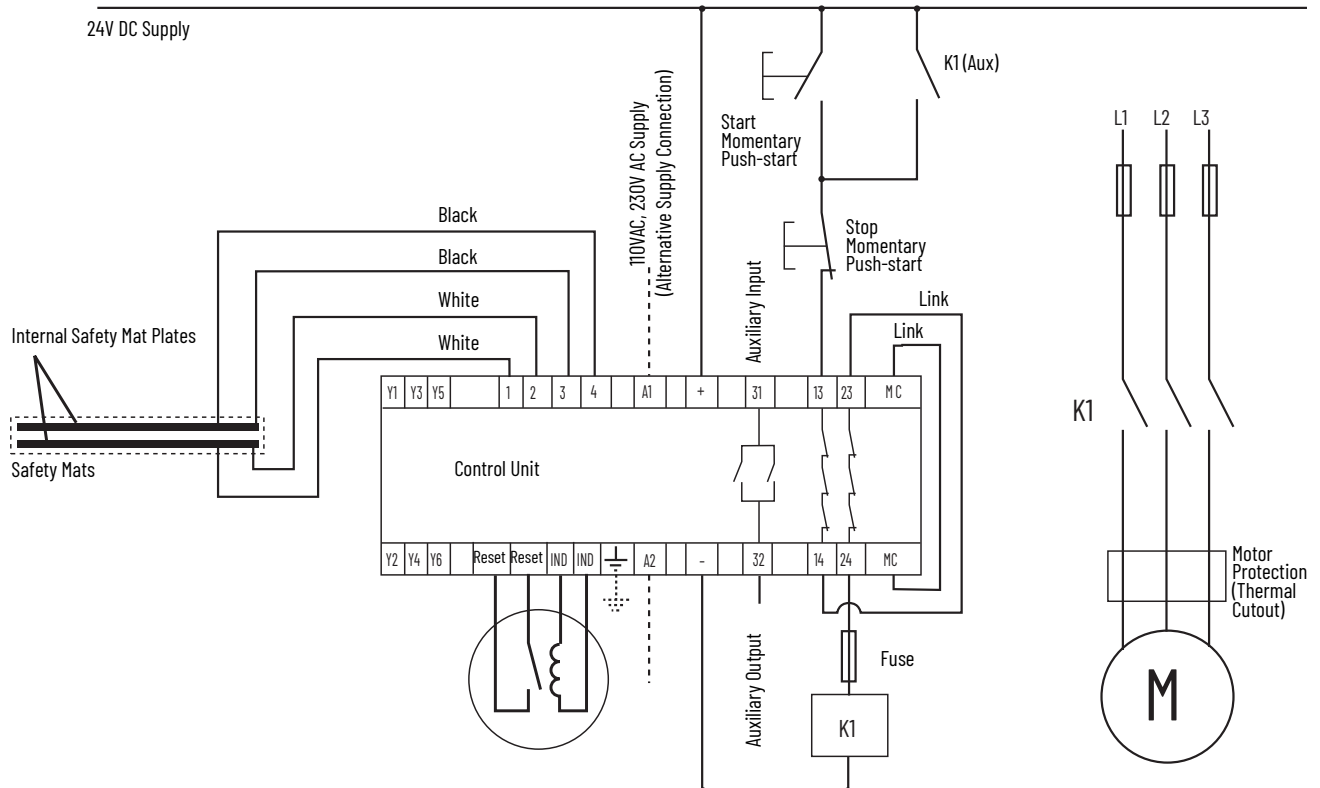
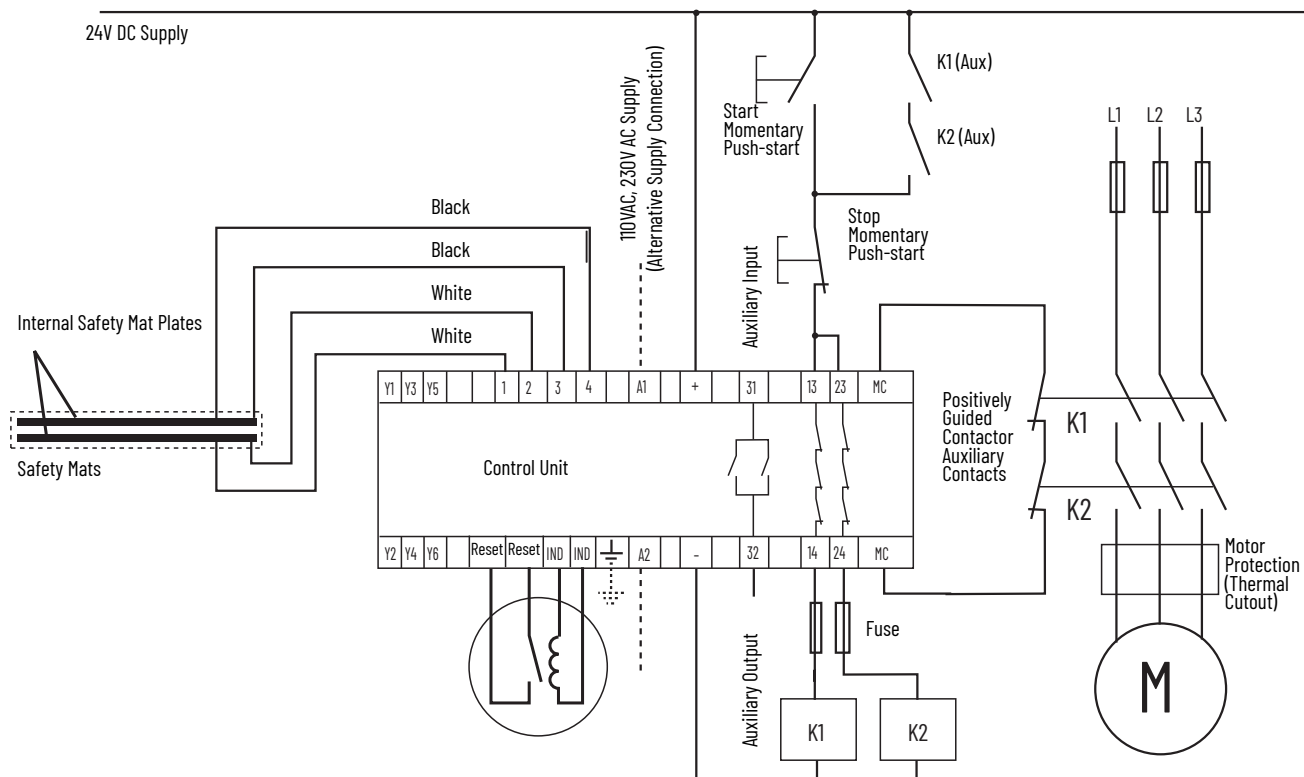


Figure 21 shows a 440F-C4000D control unit application with two contactors and contactor monitoring (dual-channel).

- Circuit status
- Supply power is on
- No presence on safety mat
- Reset button operated (if in Manual Reset mode)
- Machine start circuit enabled

**IMPORTANT** If either of the contactors sticks on, the motor stops when the safety mat is stood on and the fault is detected.

Figure 21 - Dual-channel Diagram - 440F-4000D Control Unit



After completion of the safety-related control system design, confirm that the response time assumed in [Combined Trip and Presence Sensing Device on page 18](#) remains valid. If the value changes, repeat the safety distance calculations.

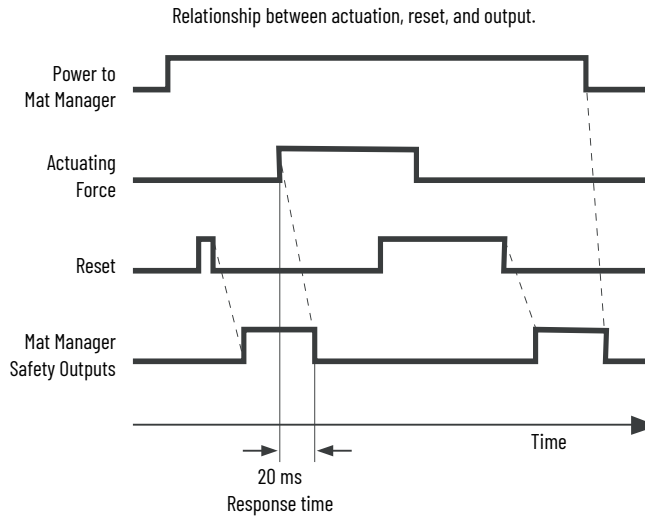
Next, consider the options for reset. Account for the consequences of the selected reset scheme for hazards such as unexpected startup, both under normal conditions and under fault conditions. [Figure 22 on page 29](#) and [Figure 23 on page 29](#) show both reset modes of the MatGuard safety mat system.

## Reset Modes

### Manual Reset Mode

In Manual Reset mode, the output (on) signal is restored after the actuating force is removed and after a reset. To initiate manual reset, push and release a remotely mounted momentary Reset button, or use voltage-free contacts within the machine safety-related control system. At power-on or following the loss and subsequent restoration of power, the outputs are off until a reset signal is received even if the safety mat is not actuated. The safety outputs of the Guardmaster safety mat manager remain off until reset after power-up and can require primary/secondary reset circuits in complex systems where other power-up interlocks (start interlocks) are present.

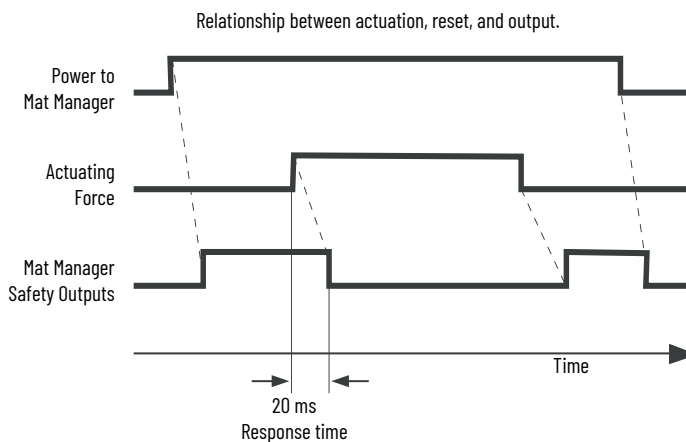
**Figure 22 - Manual Reset Mode**



### Auto Reset Mode

When used in Auto Reset mode, the control system of the machine requires a separate reset function to help prevent machine startup when stepping off the safety mat, or after a temporary power supply failure or dip.

**Figure 23 - Auto Reset Mode**



## Auxiliary Output

An auxiliary output is a non-safety, status output. Use an auxiliary output, for example, as a status import to the PLC in systems that use PLC functional machine control in combination with hard wired safety circuits. Other uses include diagnostics in protection schemes, and/or driving status lamps or alarms. The safety function must not depend on this output.

## Arc Suppression

We recommend arc suppression networks or devices for all inductive loads. For safety circuits, suppressors must fit across the load and never across the contacts. The supply and load characteristics determine the type and ratings of the suppressors. Suppressors can increase response time, particularly suppressor diodes across DC coils, and must be in place when you measure response times.

## Contactors Monitoring

Contactors monitoring is provided via the two terminals marked MC. Use contactors monitoring in all dual-channel, two contactor systems. If one of the contactors fails to isolate the power, the safety mat control unit locks out and helps prevent the re-energization of the other contactor until the fault is rectified.

## Final Safety Mat Layout

After you have considered the previous factors, check and finalize the safety mat layout. Consider whether the machine response time changed from the initial calculations.

Whenever possible, arrange safety mats with the wires at the outside edge of the detection zone. This arrangement simplifies installation and replacement, if necessary, and all wiring is protected by the perimeter trim.

## Wiring

Protect all system wiring from mechanical damage and suitably seal all wiring for the operating environment. Waterproof butt connectors are supplied for safety mat to safety mat connections and are protected by the edge trim. Where wire runs are required across the floor, the 440F-T3230 wire guide provides suitable protection. Use conduit or trunking for other wire runs. Use correctly sized and tightened conduit fittings or cable glands to IP65 to maintain the sealing integrity of the control unit.

Wiring practices must be in accordance with EN 60204-1 Clause 14.

---

|                  |  |
|------------------|--|
| <b>IMPORTANT</b> | To isolate the 110/230V supply, separately rout the input power supply to enter the control unit via separate fittings or glands than those fittings that are used for the output wiring. You can use conduit to bury wiring from the control unit to the safety mat in the floor, or pass the wiring via the edge trim. We recommend flexible conduit for this type of installation. See <a href="#">Installation on page 33</a> for further details. Determine the wiring method and determine the input and output connection points for the safety mat to control unit wiring. |
|------------------|--|

---

## Final Details

Prepare a work schedule and drawings of the system layout and the electrical circuit. We recommend that you record and retain all measurements and calculations in the technical file for the machine.

**Notes:**



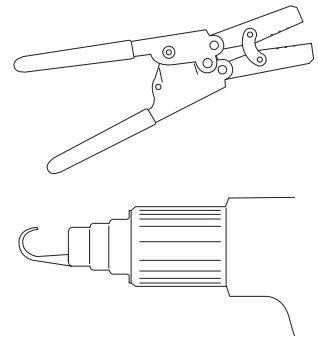
## Installation

The system designer must supervise the installation and commissioning. A mechanical technician and an electrician familiar with industrial wiring practices are required for the installation.

Only a trained electrical technician with experience in safety installations can do the commissioning.

The following special tools are required:

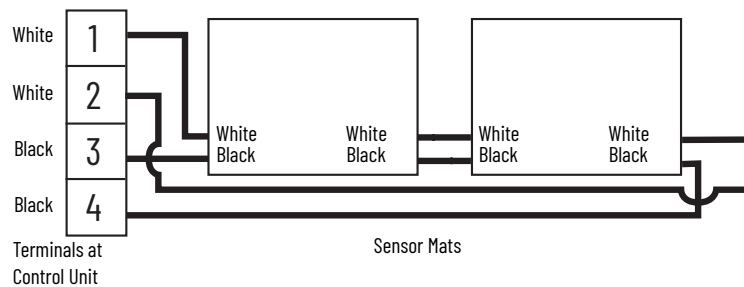
- Crimp tool for pre-insulated butt splice connectors
- Hot air gun with reflector attachment for heat shrinking



## Safety Mat Installation

Isolate and lock off the machine power supply at the source. Verify that the floor is flat, smooth, clean, free of debris, and that any buried conduit or other wiring provision is correctly in place. Unpack the safety mats; take care to keep them flat and not to pull on the wires. Place the safety mats on the floor in the planned positions with the connecting wires at the periphery of the detection zone. Connect the safety mat sections together according to [Figure 24](#).

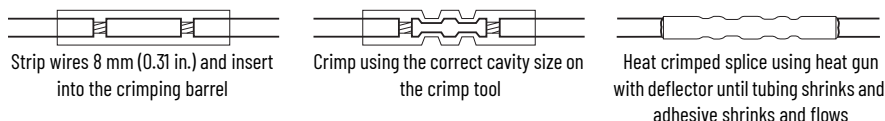
**Figure 24 - Safety Mat Connections**



The safety mat wires have a black outer covering; two have a black inner sheath and two have a white inner sheath (see [Figure 24](#) for positions).

Leave a sufficient wire tail length to enable the connection to be remade if a safety mat must be replaced, but confirm that the interconnecting wires fit easily under the edge trim without being crushed. Use the supplied butt connectors to join the wires, as shown in [Figure 25](#). Where the safety mat wires require extending (for example, front safety mat to rear safety mat connections, and control unit connections), use an extra pair of the butt connectors and a length of twin wire.

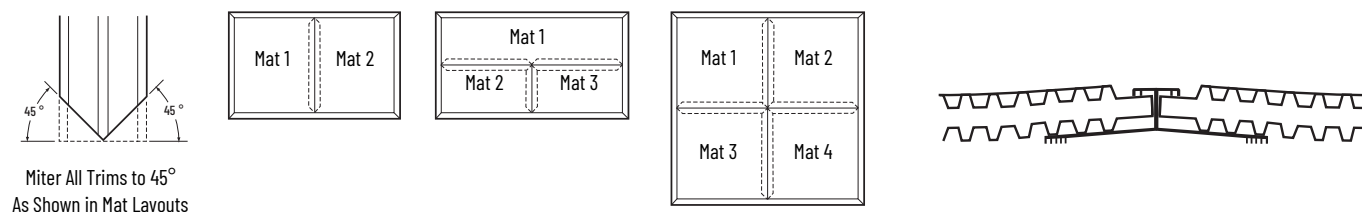
**Figure 25 - Wire Connections**



## Unite Trim Fixing

All active uniting trim sections that are used in the installation must be mitered to 45°. Mitered trim aids in installation and helps retain the overall sensitivity of the sensing area.

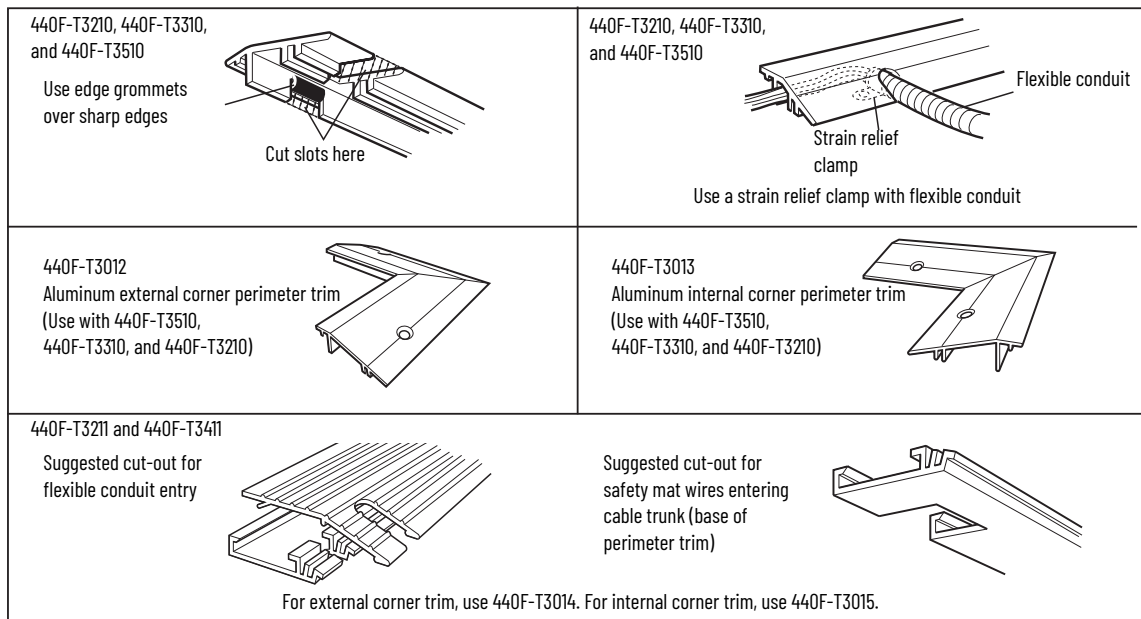
**Figure 26 - Unite Safety Mats**



## Perimeter Trim Fixing

Where the wiring to the control unit is not buried, notch the perimeter trim at the wire entry and exit positions, and cut the trim slope to suit the conduit system selected. Notch the perimeter trim completely so that any flexing of the perimeter trim does not trap the wiring. Confirm that there are no sharp edges or burrs that can damage the wires.

Figure 27 - Details of Trim Fixings



Mark out the edge trim fixing positions on the floor, allowing the trim to overlap the safety mat. Use the holes in the trim as a guide to mark out and drill the floor (fit plugs if necessary). Clean off the floor and use countersunk screws that are suited to the application to fix the safety mats and edge trim in place.

As you fit the perimeter trim, confirm that none of the wiring is trapped or crushed between the trim and the floor or the top and bottom sections (depending on trim type).

If it is possible for the wires to be caught or pulled, a strain relief clamp must be used where the wiring exits the perimeter trim. All wiring must be protected in suitable conduit. If possible, the wiring and conduit must not cross a floor area where it is a tripping hazard. If crossing the floor is unavoidable, the wiring and conduit must be enclosed within our catalog number 440F-T3230 protective wire guide.

## Control Unit Installation and Wiring

Only install the control unit as supplied. Do not modify or subject the control unit to any procedures or connections other than what is described in this manual.

Prepare the control unit by carefully knocking out (catalog number 440F-C4000P) the cable entry positions to be used. The input power supply must be separately routed and enter the control unit via a separate entry that what is used for the output wiring. Mount the control unit in the planned position. All wiring to the control unit terminals must use either the supplied wire type, or multi-strand conduit cable, switchgear cable, or equipment wire with 0.5...1.5 mm<sup>2</sup> (30...16 AWG) conductors. Use glands or adapters that provide an ingress protection rating of IP65 to achieve cable entry into the control unit (catalog number 440F-C4000P). Confirm that the glands or adapters are of a suitable size and are fully tightened.

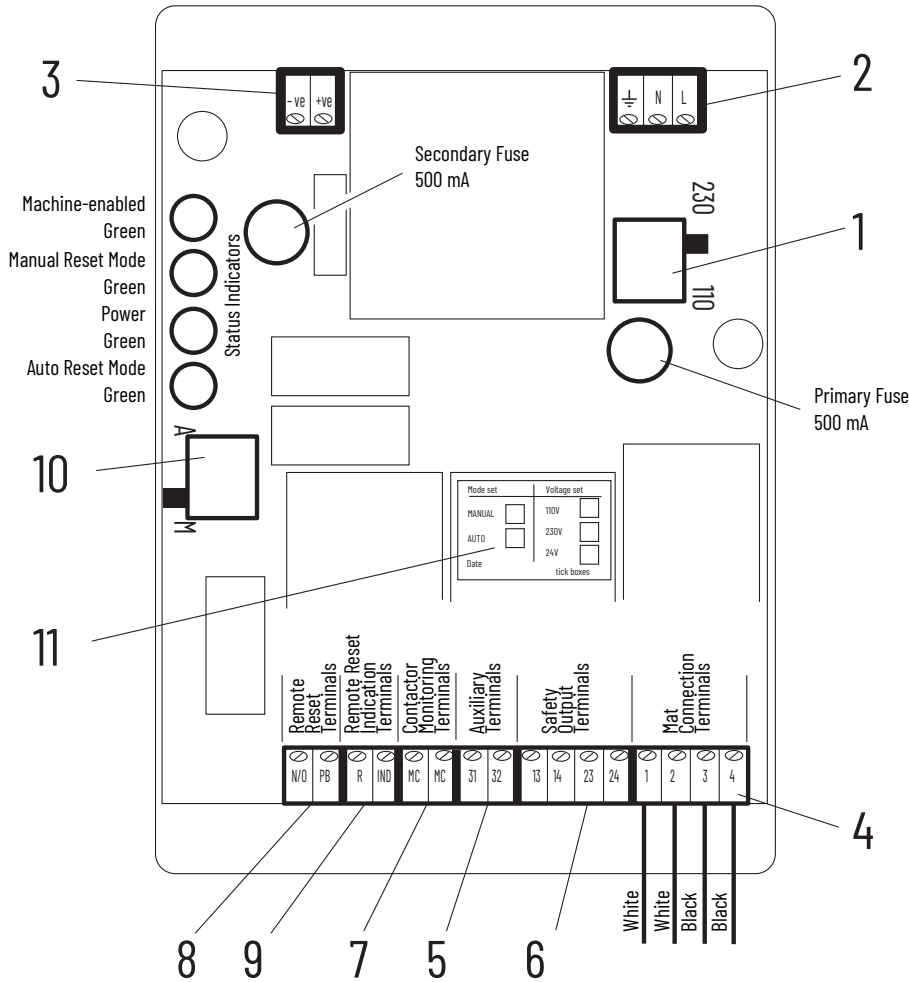
Only use the supplied insulated pin crimps. This wire and terminal combination avoids the possibility of shorts from loose strands or open circuits that overtightening or vibration can cause.

Only use a suitable ratchet type crimp tool. Crimp onto both the conductor and the insulation. Do not connect multiple wires onto one crimp.

Verify that the power supply remains isolated and locked off until [Check the Electrical Functions on page 39](#).

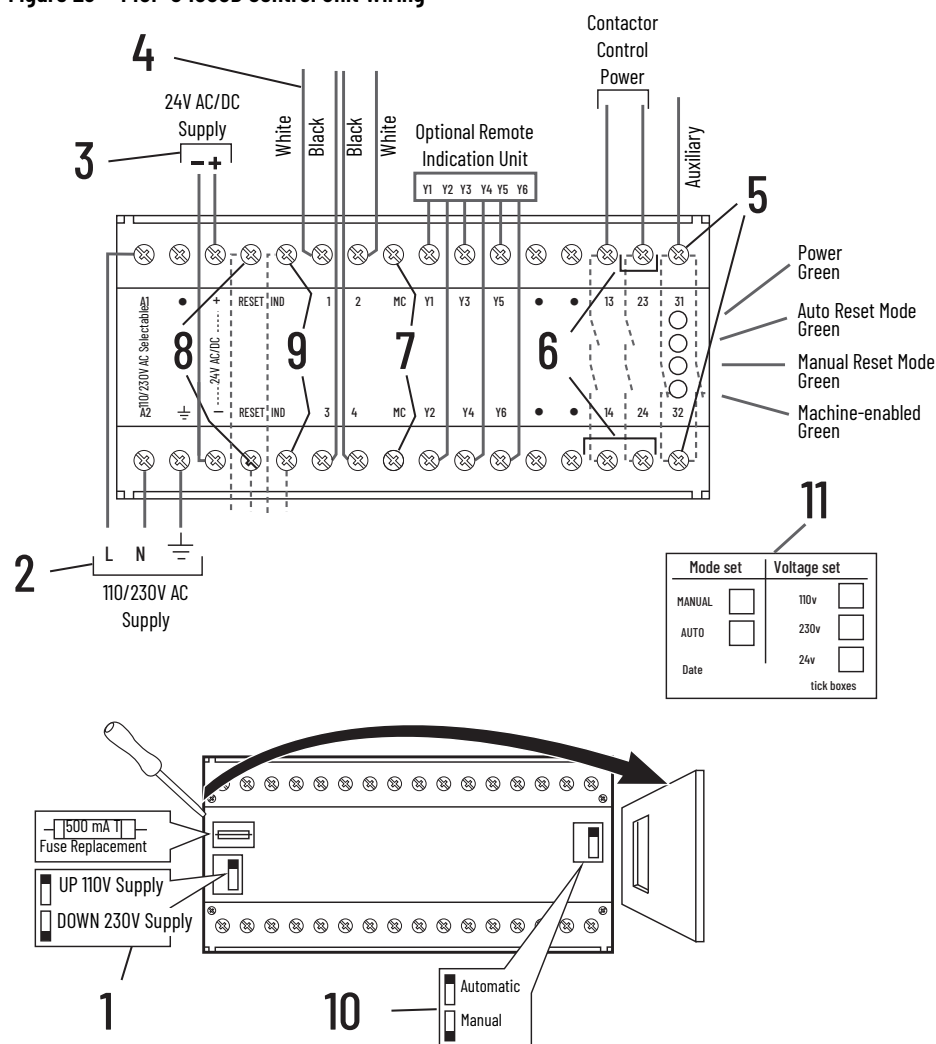
The main AC supply must be externally fused at the point of supply by a 500 mA maximum high rupture capacity (HRC) fuse. The neutral side of the supply must be fused to the same specification, unless it is referenced to earth.

Figure 28 - 440F-C4000P Control Unit Wiring



For correct installation, follow the [Installation Procedure on page 37](#).


Figure 29 - 440F-C4000D Control Unit Wiring



For correct installation, follow the [Installation Procedure](#).

## Installation Procedure

- Switch the voltage selector switch to 110V or 230V as appropriate to match the supply voltage.
 

 The system is factory set at 230V AC.
- If a 110V or 230V AC supply is used, it must be wired, including a protective earth, to the terminals shown. Check the setting on the voltage selector switch, set in [step 1](#). Do not make any connections to the terminal shown in [step 3](#). The size of the protective earth wire must be at least equal to that of the supply wire.
- If you use a 24V AC/DC supply, connect to the terminals shown to deliver the correct polarity. Do not make any connections to the terminals shown in [step 2](#). With 24V AC, the earthed pole of the power supply must be connected to the terminal (-ve).
- Safety mat connections: Connect the leads from the safety mat to the terminals shown. 1=White, 2=White, 3=Black, 4=Black.

5. The auxiliary outputs terminal provides auxiliary N.C. contacts (for example, closed when the machine-enabled light is off) suitable for indication or alarm devices. The auxiliary N.C. contacts must not be connected to the safety circuit.
6. Safety outputs are volt free terminals for connection to the machine safety circuit; they are connected in series with the machine contactor control circuit (max rating 250V, 4 A). They must be externally protected by suitably rated fuses.

For one contactor, use terminals 13 and 24 with terminals 14 and 23 linked.

For two contactors with two independent control circuits (dual-channel system), use terminals 13 and 14 for connection to one contactor control circuit and terminals 23 and 24 for connection to the other.

See [Figure 18 on page 25](#)...[Figure 21 on page 28](#) for examples of typical interfacing with the machine control circuit.

---

**IMPORTANT** The safety outputs must be connected directly via hard wiring to the machine primary control elements (contactors). They must not be connected via any elements such as ordinary relays or PLCs not suitably specified for safety-related functions.

---

7. The control unit is provided with contactor monitoring terminals linked. When the link is removed, they can be connected to positively guided N.C. auxiliary contacts on the machine contactors to provide monitoring of the contactors in dual-channel control systems. If one contactor fails to isolate the power at de-energisation of its control coil, the safety mat control unit does not allow the other contactor to energize until the fault is rectified.
8. Remote reset N.O. terminals are provided for the connection of a remote reset button.  
The reset button must be a N.O. momentary push-button device that is positioned at a location that allows a full view of the detection zone.  
Catalog number 440F-C4000P: If there is not a full view of the hazardous zone from the control unit, disconnect the wires from the reset switch on the control unit lid at the terminal block to disable the reset function at the control unit.
9. The reset indication (if used) with an illuminated push-button remote reset switch, shows when the safety mat system must be reset. Remote reset indication terminals are for connection to the bulb (28V).
10. Set the manual reset/auto reset (M/A switch) to the required setting.  
M = Manual reset mode  
A = Auto reset mode
11. Mark and sign the label according to the established voltage and mode settings.
12. Recheck the wiring connections including connections or modifications that were made to the machine control system wiring. Replace the lid. Secure the lid on relevant units.

---

**IMPORTANT** Disconnect the machine prime mover from the final contactors so that no machine movement can take place.

---

## Check the Mechanical Installation

1. Check that sensor mats, perimeter trim, and uniting trims are undamaged and correctly positioned and secured. Check that the designed safety distance is achieved.
2. Check that access to the hazardous zone is not possible other than via the safety mat and that any fixed guards are positioned according to the design and are secure.
3. Check that the presence of a person between the hazardous zone and the safety mat system is restricted.
4. Check that the environmental conditions, present or foreseeable, correspond to conditions considered during the design stage.
5. Check that the installation is free of hazards that were not foreseen at the design stage.
6. Check that any warning notices are in place.
7. Check that any other required protective measures are installed.

## Check the Electrical Functions

### Manual Mode Only

1. Confirm that the safety mat is clear of persons and equipment. Temporarily disconnect any automatic reset function provided by the machine control system. Reinstall the machine power supply but confirm that the machine prime mover is still disconnected from the machine final contactors.
2. Check the indicators on the control unit:
  - The power indicator (green) is illuminated
  - The Manual Reset indicator (green) is illuminated
  - Reset lamp in the reset button is illuminated
  - Machine-enabled indicator (green) is off
3. Press and release the reset button.
  - a. Verify that the machine-enabled indicator comes on and the reset lamp turns off.
  - b. Stand on the safety mat and check that the machine-enabled indicator turns off.
4. Step off the safety mat, check that the machine-enabled indicator remains off and the reset button illuminates.
  - a. Press and release the reset button, check that the machine-enabled indicator comes on and the reset button turns off.
5. To check the remote reset buttons and lamps (if fitted), repeat the previous tests.
6. To check the correct operation of any status monitoring that is connected to the safety mat system, repeat the previous steps.

### Auto Reset Mode Only

1. Confirm that the safety mat is clear of persons and equipment. Temporarily disconnect any automatic reset function provided by the machine control system. Reinstall the machine power supply but confirm that the machine prime mover is still disconnected from the machine final contactors.
2. Check the indicators on the control unit:
  - Power indicator (green) illuminates
  - Machine-enabled indicator (green) illuminates
3. Stand on the safety mat and check that the machine-enabled indicator goes off.

4. Step off the safety mat, check that the machine-enabled indicator goes on.
5. To check the correct operation of any status monitoring that is connected to the safety mat system, repeat the previous steps.

## Under Fault Condition

Machine-enabled indicator turns off and does not allow reset until the fault is rectified. In the fault condition, if there is a safety mat fault, one or more of the safety mat status indicators illuminate. Under an open circuit or short circuit, the indicators illuminate red. If there is a fault condition and none of the safety mat status indicators illuminate, then it is a control unit fault.

## Check Safety Functions

### Single-channel Systems

See [Figure 18 on page 25](#) and [Figure 20 on page 27](#).

Simulate normal operation. Actuate the safety mat by standing on it and check that the main contactor drops out immediately. Check that any other safety-related stop functions like the brake or clutch contactors are operating as intended.

### Dual-channel Systems

See [Figure 19 on page 26](#) and [Figure 21 on page 28](#).

1. Simulate normal operation. Actuate the safety mat by standing on it and check that both final contactors drop out immediately. Check that any other safety-related stop functions like the brake or clutch contactors are operating as intended.
2. Isolate the power source and then short circuit terminals 13 and 14 at terminal block 6 to install a temporary fault (see [Figure 28 on page 36](#) or [Figure 29 on page 37](#)).
3. Reinstall the power source and actuate the sensor mat and check that one of the final contactors drops out immediately and any other stop functions that are associated with that channel operate as intended.
4. Check that the control unit does not reset.
5. Isolate the power source and remove the temporary fault. Reinstall the power source and check that the safety mat system operates normally. Take the same electrical safety precautions and repeat the test with a temporary short circuit across terminals 23 and 24 at terminal block 6 (see [Figure 28 on page 36](#) or [Figure 29 on page 37](#)).
6. Again, check that the control unit does not reset.
7. Remove the temporary fault, check that the safety mat system operates correctly.

### All System Types

1. Conduct any other tests required to confirm that the safety-related control system meets the requirements of its category according to ISO 13849-1, and works as intended.
2. Check any other safety functions associated with the machine circuits that the installation of the safety mat system can affect. You must have an existing procedure for these tests.
3. Isolate the machine power supply at the source.



4. Reconnect any automatic reset function provided by the machine control system.
5. Reconnect the machine prime mover to the final contactors.
6. Secure all covers and doors.

## Functional Checkout

Reinstate the machine electrical supply.

Check the following:

1. Machine operation cannot commence until the safety mat control unit has been reset. Perform the walking test described in [Routine Inspection and Test on page 45](#).
2. Check that actuation of the safety mat stops hazardous movement.
3. Check that the machine does not start, but does enable restart, when you step off the safety mat.
4. Check that when approaching the machine at a walking pace, hazardous movement stops before the hazardous zone can be reached. In critical applications, stop-time tests must be conducted.
5. If any type of muting system is installed, check that the safety mat system is muted only during non-hazardous parts of the operating cycle and that any mute indicators operate correctly.
6. Test the emergency stop function of the machine.

**Notes:**

## **System Operation**

### **Pre-operation Checks**

Before you return the machine into normal service, confirm that operators and supervisors are aware of the nature and purpose of the safety mat system and that they understand the functions of the controls and indicators.

Confirm that the technical specifications, together with inspection, test, and service instructions, are available to the appropriate personnel and that a system to keep inspection records is in place.

Verify that all personnel understand that no additional coverings, boards, plates, or planks can be on the sensor mat during machine operation.

**Notes:**

## Maintenance

During maintenance operations, disconnect the prime mover of the machine before working on the safety mat system. Observe electrical safety precautions.

### Safety Mat Cleaning

The sensor mats must be regularly swept to clear them of deposits such as swarf and other materials. Use warm water and detergent to wash or hose down the sensor mats to clean or remove buildup, such as grease, if necessary. Do not use solvents.

### Routine Inspection and Test

We recommend weekly routine inspections.

1. Stop the machine. Clean the sensor mats and allow them to dry. Inspect the top surface of the safety mat for damage. Minor nicks and abrasions of the vinyl cover are acceptable, but any damage that exposes the metal plate must be dealt with immediately.
2. Check that the perimeter trim and uniting trim are not cracked, broken, or distorted and that the fixings are secure. Damaged parts must be replaced immediately.
3. Test the safety mat operation. Two persons are required, one to walk on the safety mat, the other to observe the control unit. On systems that use manual reset mode, the reset button must be continuously pressed and released.
  - a. Check that the machine-enabled indicator is on before actuation of the safety mat, and goes off as soon as the safety mat is stepped on.
  - b. Walk over each section of the safety mat and each joining section in turn. Stand with both feet on the same uniting trim between two sections. The machine-enabled indicator must remain off during the entire time.
  - c. Step off the safety mat, operate the reset button. Check that the machine-enabled indicator is illuminated.
  - d. Start the machine, step onto the safety mat and check that the machine stops immediately.
4. Check that all barriers such as fixed guards and angle plates are in place, undamaged and securely fixed. If these checks reveal any problems, do not allow the use of the machine until they are rectified. Record the inspection and test in a written log.

### Thorough Examination and Test

We recommend thorough inspections twice a year or after damage.

Contact your local Allen-Bradley distributor or Rockwell Automation sales office for information on an authorized testing service. A person who is competent in electrical and mechanical engineering must perform the tests. Two persons are required, one to walk on the safety mat, the other to observe the MatGuard™ control unit.

1. Conduct the [Routine Inspection and Test on page 45](#).
2. Isolate the power source to the machine and safety mat system. Observe electrical safety precautions.
3. Inspect the safety mat components thoroughly for mechanical damage.
4. Disconnect the wires to the safety mat at terminals 1...4 at the MatGuard control unit.
5. Connect the two white wires to one test input of an ohmmeter and connect the two black wires to the other input. Walk over each section of the safety mat and each joining section in turn. Stand with both feet on the same uniting trim between two sections until all areas of the sensor mat have been covered. The maximum resistance with presence on the safety mat must not exceed 100  $\Omega$ .

If these checks reveal any problems, do not allow the use of the machine until they are rectified.

Check that the stopping performance of the machine has not deteriorated from the stopping performance that was used in the original safety distance calculations (see [Safety Distance Calculations on page 19](#)). Record the inspection and test in a written log.

## Dismantle and Disposal

To dismantle the safety mat system, the procedure is the reverse of the installation, with no extra hazards.

Confirm that the machine and safety mat system power is isolated and locked off at the source before starting work.

If the system is to be reconfigured or relocated, observe the handling precautions that are given in [Product Overview on page 11](#). The safety mat system does not contain any hazardous materials that require special precautions for disposal.

## Fault Finding

Disconnect the prime mover before working on the safety mat control system with power applied.

Observe electrical safety precautions.

### Symptom: No Start

With no presence on the safety mat and after following the correct reset procedure, the machine does not start.

1. If the machine-enabled indicator on the safety mat control unit is on, there is a probable fault on the machine or the control system external to the safety mat system.
  - a. Check the external fuses in the control unit safety output wiring and replace if necessary. Confirm that the correct value of the fuse is used (2 A max).
  - b. Record the replacement in the inspection log. If either fuse blows immediately or requires early replacement, there is a probable fault in the machine control circuit between the safety output of the safety mat control unit and the machine's final control elements (contactors).
2. If the machine-enabled indicator on the safety mat control unit is off, take the following actions:
  - a. Check that the power indicator is illuminated. If it is not, check the power supply to the safety mat control unit.

- b. Check that the power supply is connected to the appropriate terminals.
  - c. Check the primary and secondary fuses in the control unit and replace if necessary. Confirm that the correct value of fuse is used (500 mA anti-surge) for both primary and secondary fuses.
  - d. Record the replacement in the inspection log. If either fuse blows immediately or requires early replacement, contact your local Allen-Bradley distributor or Rockwell Automation sales office.
3. If the machine-enabled indicator on the safety mat control unit is off and the power indicator is on, there is a fault in the system. On dual-channel systems with contactor monitoring, if the external safety output fuses have not blown, it is still probable that there is a fault external to the control unit. One fault in either wiring channel can cause the safety mat control unit to lock off the safety outputs until the fault is rectified and the control unit is reset.
    - a. Check that all connecting wiring in the system is configured correctly and has not been damaged and that both contactors are functioning correctly.
    - b. Rectify any faults and, if in manual reset mode, press and release the control unit reset button.
  4. If the problem is not resolved, contact your local Allen-Bradley distributor or Rockwell Automation sales office.

### Symptom: No Stop

The machine does not stop or can be started with a presence on the safety mat.

Do not allow use of the machine with presence on the safety mat.

1. Check that the machine-enabled indicator is illuminated on the safety mat control unit.
2. If the machine-enabled indicator is not illuminated, there is a probable fault on the machine or the control system external to the safety mat system. Do not allow use of the machine until the fault has been rectified and tested.
3. If the machine-enabled indicator is illuminated, do not allow use of the machine and contact your local Allen-Bradley distributor or Rockwell Automation sales office immediately.

### Symptom: Unexpected Stoppage

The machine stops unexpectedly with no presence on the sensor mat but can be restarted after stepping on and off the sensor mat (and reset when in manual reset mode).

1. Check that all indicator lights are operating correctly. If they are, it is likely that a dip in supply power of a certain value and duration is causing the problem. This dip can cause one of the internal relays in the control unit to drop out and simulate a fault condition. This occurrence is unlikely and no remedial action is required.
2. If the problem persists, take measures to achieve a smoother power supply to the safety mat system.

## Repair

Before working on the safety mat system or machine control system, isolate the power source to the machine and safety mat system. Observe electrical safety precautions.

User repairs are limited to replacement by new safety mat system parts. If problems occur, the units must be returned to your Allen-Bradley distributor.

Any repairs to the connecting wires must be made using the recommended butt splice connectors.

Tampering with components parts invalidate the warranty.

The warranty is invalid if the quality seal is broken on the DIN rail control unit.

## Replacement Parts

| Safety Mat Size |             | Safety Mat     | Standard Perimeter Trim Kit |
|-----------------|-------------|----------------|-----------------------------|
| Millimeters     | Inches      | Cat. No.       | Cat. No.                    |
| 500 x 500       | 19.7 x 19.7 | 440F-M1010BYNN | 440F-T1010                  |
| 500 x 600       | 19.7 x 23.6 | 440F-M1012BYNN | 440F-T1012                  |
| 500 x 900       | 19.7 x 35.4 | 440F-M1018BYNN | 440F-T1018                  |
| 500 x 1000      | 19.7 x 39.4 | 440F-M1020BYNN | 440F-T1020                  |
| 500 x 1200      | 19.7 x 47.2 | 440F-M1024BYNN | 440F-T1024                  |
| 500 x 1500      | 19.7 x 59.1 | 440F-M1030BYNN | 440F-T1030                  |
| 600 x 600       | 23.6 x 23.6 | 440F-M1212BYNN | 440F-T1212                  |
| 600 x 750       | 23.6 x 29.5 | 440F-M1215BYNN | 440F-T1215                  |
| 600 x 900       | 23.6 x 35.4 | 440F-M1218BYNN | 440F-T1218                  |
| 600 x 1000      | 23.6 x 39.4 | 440F-M1220BYNN | 440F-T1220                  |
| 600 x 1200      | 23.6 x 47.2 | 440F-M1224BYNN | 440F-T1224                  |
| 600 x 1500      | 23.6 x 59.1 | 440F-M1230BYNN | 440F-T1230                  |
| 750 x 500       | 29.5 x 19.7 | 440F-M1510BYNN | 440F-T1510                  |
| 750 x 750       | 29.5 x 29.5 | 440F-M1515BYNN | 440F-T1515                  |
| 750 x 1500      | 29.5 x 59.1 | 440F-M1530BYNN | 440F-T1530                  |
| 800 x 600       | 31.5 x 23.6 | 440F-M1612BYNN | 440F-T1612                  |
| 800 x 750       | 31.5 x 29.5 | 440F-M1615BYNN | 440F-T1615                  |
| 800 x 900       | 31.5 x 35.4 | 440F-M1618BYNN | 440F-T1618                  |
| 800 x 1000      | 31.5 x 39.4 | 440F-M1620BYNN | 440F-T1620                  |
| 800 x 1200      | 31.5 x 47.2 | 440F-M1624BYNN | 440F-T1624                  |
| 800 x 1500      | 31.5 x 59.1 | 440F-M1630BYNN | 440F-T1630                  |
| 900 x 900       | 35.4 x 35.4 | 440F-M1818BYNN | 440F-T1818                  |
| 900 x 1000      | 35.4 x 39.4 | 440F-M1820BYNN | 440F-T1820                  |
| 900 x 1200      | 35.4 x 47.2 | 440F-M1824BYNN | 440F-T1824                  |
| 900 x 1500      | 35.4 x 59.1 | 440F-M1830BYNN | 440F-T1830                  |
| 1000 x 750      | 39.4 x 29.5 | 440F-M2015BYNN | 440F-T2015                  |
| 1000 x 1000     | 39.4 x 39.4 | 440F-M2020BYNN | 440F-T2020                  |
| 1000 x 1200     | 39.4 x 47.2 | 440F-M2024BYNN | 440F-T2024                  |
| 1000 x 1250     | 39.4 x 49.2 | 440F-M2025BYNN | 440F-T2025                  |
| 1000 x 1500     | 39.4 x 59.1 | 440F-M2030BYNN | 440F-T2030                  |



| Item   | Cat. No.   |
|--|--|
| Standard Perimeter Trim [2 m (6.56 ft)]            | 440F-T3210   |
| Standard Perimeter Trim [3 m (9.84 ft)]            | 440F-T3310   |
| Standard Perimeter Trim [5 m (16.4 ft)]            | 440F-T3510   |
| External Corner Standard Perimeter Trim            | 440F-T3012   |
| Internal Corner Standard Perimeter Trim            | 440F-T3013   |
| Perimeter Trim with Cable Channel [2 m (6.56 ft)]  | 440F-T3211   |
| Perimeter Trim with Cable Channel [4 m (13.12 ft)] | 440F-T3411   |
| External Corner Perimeter Trim with Cable Channel  | 440F-T3014   |
| Internal Corner Perimeter Trim with Cable Channel  | 440F-T3015   |
| Active Uniting Trim                                | 440F-T3020   |
| Vinyl Wire Guide                                   | 440F-T3230   |
| Safety Mat control units                           | 440F-C4000P<br>440F-C4000S<br>440F-C4000D<br>440F-C28013 |
| Fuse [500 mA]                                      | 440R-A31562  |
| Shorting Plug                                      | 440F-A28639  |

For special sized sensor mats, refer to the model number printed on the label.

After replacing any parts, you must conduct the inspection and test that is shown in [Routine Inspection and Test on page 45](#). Pay special attention to those parts that were replaced.

---

**IMPORTANT** After maintenance or repair operations, it is important that all edging trims, fastenings, and cable protection are correctly refitted. Failure to do this step, the use of non-approved parts, or modifications can prevent the safety mat system from achieving its specified performance.

---

Record of [Routine Inspection and Test on page 45](#) (weekly)[illegible]Record of [Thorough Examination and Test on page 45](#) (every 6 months)[illegible]

## Specifications

### MatGuard Control Units

| Attribute   | 440F-C4000P  | 440F-C4000D   |
|---|--|---|
| Conformity  | EN 60204-1, ISO 13849-1, ISO 13856-1, UL 508   |   |
| Response time (mat pressed, safety contacts open) | 35 ms  |   |
| Environmental protection                          | IP65   | <ul style="list-style-type: none"> <li>Enclosure-IP40: DIN0470</li> <li>Terminals-IP20: DIN0470</li> </ul>                        |
| Impulse withstand voltage                         | 2500V  |   |
| Contamination level                               | III  |   |
| Switched current/voltage, min                     | 10 mA/10V  |   |
| Power supply (user select)                        | 110/230V AC <sup>(1)</sup> (50-60Hz) and 24V AC/DC +10% -15%   |   |
| Power consumption                                 | < 9VA 6 W  |   |
| Relay outputs                                     | 2 x independent volt free N.O. safety contacts<br>1 x volt free N.C. auxiliary contact<br>NB - Aux must not be used for safety circuit<br>Fuse externally, 5 A max (quick acting) for AC/2.5 A max (quick acting) for DC |   |
| Utilization category                              | <ul style="list-style-type: none"> <li>AC - 15; 4 A/250V AC</li> <li>DC - 13; 2 A/30V DC</li> </ul>  |   |
| Outputs: remote reset/indicator                   | 24V DC/0.24 W  |   |
| Inputs  | Remote reset switch (2 x N.O.)   |   |
| Safety inputs                                     | 4-wire mat   |   |
| Status Indicator                                  | 1 - Power (green)<br>2 - Auto reset mode (green)<br>3 - Manual reset mode (green)<br>4 - Machine-enabled (green)   |   |
| Internal controls                                 | AC Voltage selector, auto/manual reset selector  |   |
| Internal supply fuses                             | 500 mA replaceable (2 off)   | <ul style="list-style-type: none"> <li>500 mA replaceable (1 off)</li> <li>500 mA resettable (1 off)</li> </ul>                   |
| Operating temperature range                       | -10...+45 °C (14...113 °F)   |   |
| Relative humidity                                 | Up to 90% at 50 °C (122 °F)  |   |
| Vibration   | Tested in accordance with IEC 68-2-6, frequency range<br>10...55 Hz, displacement 0.15 mm (0.01 in.)<br>10 cycles per axis, sweep rate, 1 octave per minute  |   |
| MC-MC contactor monitor loop                      | Normally closed contactor loop   |   |
| Conductor size, max                               | 1 x 1.5 mm <sup>2</sup> (16 AWG) stranded with sleeves stripped 5 mm (0.2 in.), 1 x 2.5 mm <sup>2</sup> (14 AWG) solid conductor   | 2 x 1.5 mm <sup>2</sup> (16 AWG) stranded with sleeves stripped 8 mm (0.31 in.), 2 x 2.5 mm <sup>2</sup> (14 AWG) solid conductor |
| Terminals   | Minus terminal screws M2.5 that are mounted at 45° to PCB  | Plus/minus captive terminal screws M3.5 with self-lifting connection, washer terminal boards separately removable                 |
| Installation group                                | C in accordance with VDE 0110  |   |
| Material  | Polycarbonate  | Polycarbonate   |
| Mounting details                                  | 4 x M4 holes   | 35 mm (1.38 in.) DIN rail   |
| Misc.   | —  | In the manual reset mode (M), a reset button must be connected  |
| Housing   | D = 75 mm (2.95 in.)<br>H = 180 mm (7.09 in.)<br>W = 130 mm (5.12 in.)   | D = 120 mm (4.72 in.)<br>H = 73 mm (2.87 in.)<br>W = 152 mm (5.98 in.)<br>32-way DIN rail   |
| Weight  | 0.88 kg (1.94 lb)  | 0.92 kg (2.03 lb)   |

(1) 110V setting also allows use at 100V ±10%

# Sensor Mat

| Attribute                             | Value                                      |
|---------------------------------------|--|
| Sensor mat conformity                 | ISO 13849-1, ISO 13856-1, UL 508           |
| Weight of person with detection, min  | 35 kg (77 lb)                              |
| Detection zone, max                   | 100 m <sup>2</sup> (1076 ft <sup>2</sup> ) |
| Number of individual safety mats, max | No limit (up to max 100 m <sup>2</sup> )   |
| Total length of connection wires, max | 200 m (656 ft)                             |
| Mass / m <sup>2</sup> (sensor mats)   | 24 kg (53 lb)                              |
| Environmental protection mats         | IP67                                       |
| Mechanical life                       | 1 x 10 <sup>6</sup> operations             |
| Relative humidity                     | 0...100%                                   |
| Sensor mat outer cover material       | Vinyl                                      |
| Standard color                        | Yellow                                     |
| Operating temperature range           | -10...+55 °C (14...131 °F)                 |
| Storage temperature range             | -40...+70 °C (-40...+158 °F)               |



The system that is composed of interconnected sensor mats and control unit meets the requirements of ISO 13849-1.

## Numerics

**440F-C4000D** 16, 51  
**440F-C4000P** 15, 38, 51

## A

**about publication** 5  
**active uniting trim** 12  
**additional resources** 9  
**all system types** 40  
**arc suppression** 30  
**auto reset mode** 39  
**auxiliary output** 30  
**available spares** 48

## B

**bypass prevention** 21

## C

**check**  
     electrical functions 39  
     mechanical installation 39  
     pre-operation 43  
     safety functions 40  
**checkout functional** 41  
**cleaning** 45  
**combined sensing device** 18

## D

**description general** 11  
**dismantle** 46  
**disposal** 46  
**dual-channel systems** 40

## E

**electrical interface** 24  
**examination** 45

## F

**fault condition** 40  
**fault finding** 46  
**fixed guards** 21  
**functional checkout** 41

## G

**general description** 11

## H

**hazard** 17

## I

**installation design** 21  
**interface**  
     electrical 24

## L

**layout**  
     sensor mat 30

## M

**maintenance** 45  
**manual mode** 39  
**mat** 52  
     layout 30  
     positioning 17  
**mats** 12  
**mechanical installation checking** 39

## N

**nature of hazard** 17  
**nature of safeguarding** 17  
**no start** 46  
**no stop** 47

## O

**operation** 43  
**operation system** 43  
**output**  
     auxiliary 30  
**overview product** 11

## P

**perimeter guarding area** 20  
**perimeter trim** 12  
**power supply**  
     select 29  
**pre-operation checks** 43  
**presence sensing**  
     device 18  
     perimeter guarding area 20  
**product overview** 11  
**publication about** 5

## R

**repair** 48  
**reset mode**  
     auto 39  
**resources** 9  
**routine inspection** 45

## S

- safeguarding** 17
- safety distance calculations** 19
- safety functions check** 40
- safety mat**
  - cleaning 45
  - positioning 17
- select**
  - power supply 29
- sensor mat** 52
- sensor mat layout** 30
- service** 50
- single-channel systems** 40
- spares** 48
- specifications** 51
- standards** 5
- stoppage** 47
- storage handling** 7
- suppression**
  - arc 30
- symptom**
  - no start 46
  - no stop 47
  - unexpected stoppage 47
- system operation** 43
- systems** 43
  - all types 40
  - dual-channel 40
  - single-channel 40

## T

- test** 45
- thorough examination** 45
- trim**
  - perimeter 12
  - uniting 12
- trip sensing device** 18

## U

- under fault condition** 40
- unexpected stoppage** 47
- uniting trim**
  - active 12



# Rockwell Automation Support

Use these resources to access support information.

|  |  |  |
|--|--|--|
| Technical Support Center                         | Find help with how-to videos, FAQs, chat, user forums, and product notification updates.           | <a href="http://rok.auto/support">rok.auto/support</a>             |
| Knowledgebase                                    | Access Knowledgebase articles.   | <a href="http://rok.auto/knowledgebase">rok.auto/knowledgebase</a> |
| Local Technical Support Phone Numbers            | Locate the telephone number for your country.  | <a href="http://rok.auto/phonesupport">rok.auto/phonesupport</a>   |
| Literature Library                               | Find installation instructions, manuals, brochures, and technical data publications.               | <a href="http://rok.auto/literature">rok.auto/literature</a>       |
| Product Compatibility and Download Center (PCDC) | Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes. | <a href="http://rok.auto/pcdc">rok.auto/pcdc</a>                   |

## Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at [rok.auto/docfeedback](http://rok.auto/docfeedback).

## Waste Electrical and Electronic Equipment (WEEE)



At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at [rok.auto/pec](http://rok.auto/pec).

Allen-Bradley, CompactBlock, expanding human possibility, Guard I/O, GuardLogix, Guardmaster, MatGuard, POINT Guard I/O, Rockwell Automation, and SmartGuard are trademarks of Rockwell Automation, Inc.

Trademarks not belonging to Rockwell Automation are property of their respective companies.

Rockwell Otomasyon Ticaret A.Ş. Kar Plaza İş Merkezi E Blok Kat:6 34752, İçerenköy, İstanbul, Tel: +90 (216) 5698400 EEE Yönetmeliğine Uygundur

Connect with us.    

**rockwellautomation.com** — expanding **human possibility**<sup>®</sup>

AMERICAS: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000

EUROPE/MIDDLE EAST/AFRICA: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2663 0600

ASIA PACIFIC: Rockwell Automation SEA Pte Ltd, 2 Corporation Road, #04-05, Main Lobby, Corporation Place, Singapore 618494, Tel: (65) 6510 6608

UNITED KINGDOM: Rockwell Automation Ltd., Pitfield, Kiln Farm, Milton Keynes, MK11 3DR, United Kingdom, Tel: (44)(1908) 838-800

Publication 440F-UM003A-EN-P - January 2024

Copyright © 2024 Rockwell Automation, Inc. All rights reserved. Printed in the U.S.A.