

NEW
Switching
SD
DEVICE

Safety Mat System

**Complies with ANSI/RIA Standard
R15.06-1999, ANSI/B11.19-1990
OSHA 1910.217b, CSA and
UL 508 Requirements**

**Designed to EN1760-1, EN954-1
Category 4 Controllers &
EN60204-1 for CE certification**

**Hazardous area presence sensing
detection**

Cross monitored system

NEMA 6 (IP 67) rated mat system

High-grade vinyl plastisol sealed housing

*Customized Safety Mat
Systems Our Specialty
and are available in
Ribbed, Non-Skid and
High-Temperature Surfaces*

PINNACLE
SYSTEMS, INC.

NEW Switching Device

Revolutionary Switching Mechanism is Changing the Safety Mat Industry

Break through **NSD** technology provides digital (on/off) switching for safety mat applications. The advanced **NSD** switching mechanism provides the following:

- Open architecture digital mat (on/off) design permits interfacing with all existing types of safety mat controllers, safety PLCs, and safety relay systems for normally open SPST, 4 wire safety mats.
- The **NSD** safety mat has no rigid steel electrodes used in the switching mechanism that can rust and dent.
- The **NSD** safety mat contains no wiring solder joints within the mat assembly that could degrade or short out. Wiring solder joints can fail under loads such as fork truck or hand cart traffic.
- **NSD** flexible electrodes life cycle over 5,000,000 switch activations.
- **NSD** safety mats provide increased reliability and safety with longer product life.
- Customized wire exit positions available with no additional tooling costs.
- **NSD** flexible electrodes provide a product that is flexible and won't kink or short out like rigid steel electrodes when bent.
- The **NSD** mat electrodes are:
Non-Corrosive Flexible
Non-Magnetic Anti-Static
- **NSD** safety mats can use AC or DC input power.
- Large single mat manufacturing process helps eliminate additional interconnect pieces required by others and simplifies installation.
- Dual 20' (6.1m) lengths of two-conductor, 22 gauge multistrand 300 VAC (four conductors total), CSA & UL Listed wiring per mat eases installation time.
- Fast delivery on custom shapes and sizes with no need for special tooling costs.
- Multiple zones in one mat housing available.
- Designed specifically for the rigorous industrial environment.
- Easy system to install.
- No adjustments required.
- No vacuum seal to break which induces rust and leads to dead zones.
- Can absorb punctures.
- Dual ribbed mat housing.
- Ribbed, non-skid, or high temperature mat surfaces available.
- Hermetically sealed sensor system (NEMA 6, IP67).
- Adapts well to uneven factory floor installations.
- Custom engineered systems available.
- Large selection of sizes and capabilities.
- Maximum intermittent load on an **NSD** mat is 3000 PSI.
- Patents pending.
- Warranty - 2 years.



Questions for the Rigid “Steel Electrode” Safety Mat

1. How are rust pockets (dead zones) monitored within the mat switching electrode?
2. How much can you bend a steel mat before it kinks the steel electrode and shorts out (fails)?
3. How flexible is the system for specials, unique sizes, and wire exits?
4. What happens when a heavy load (fork truck) rides along side a raised elastomer that distorts the steel and shorts out the electrode?
5. What happens when the steel used in the electrode element isn't perfectly flat?
6. Does the steel electrode have a pocket of air (oxygen = rust) between the two steel electrodes?
7. What happens when a steel electrode mat is installed on uneven floors?
8. Does the steel electrode mat manufacturer pull a vacuum and inject an inert gas between the steel electrode switch assembly to assure that no oxygen is exposed to the steel electrode to prevent rusting? (Remember, oxygen = rust, rust = dead zones, and dead zones = loss of safety)
9. What happens when the vacuum seal is broken?
10. What happens when the elastomer's glue releases and slides out of position?
11. How many switch cycles can be made at the same point before carbon deposits are created by arcing?

Facts on the Use of “Steel Electrode” Safety Mats

Tired of rigid electrode (steel or copper) style mats? No wonder, steel electrode safety mats were designed in the mid 1950's. Some of their disadvantages include:

- Bend with subsequent short outs, especially in the corners of steel mats.
- Naturally rust which create dead zones.
- Have multiple dead zones on the mat surface where elastomers are installed.
- Cannot handle heavy loads.
- Fail at a high rate.
- Are not flexible.
- Have limited sizes available.
- Are heavy and awkward to install.
- Require multiple wiring connections buried in perimeter trim.
- Require long lead times for special sizes and shapes, if possible at all.
- Have limited wire exit positions available.
- Are extremely difficult to troubleshoot a daisy chained system.
- A punctured steel mat immediately shorts out and will fail due to the metal roll over at the point of puncture.
- Continued switching in the same area “arcing” creates carbon deposits and potentially creates a dead zone and an unsafe condition.
- Steel mats are not PSI based switches but rather “force” related switching.
- Cannot be installed on uneven floors.

NEW Switching Device

NSD Mat Layout Procedure

1. Sketch total area to be guarded.
2. Locate desired mounting position of mat controller.
3. List mat sizes and styles desired to completely guard the hazardous zone.
4. If area to guard is too complex to determine mat sizes, submit drawing to the factory.

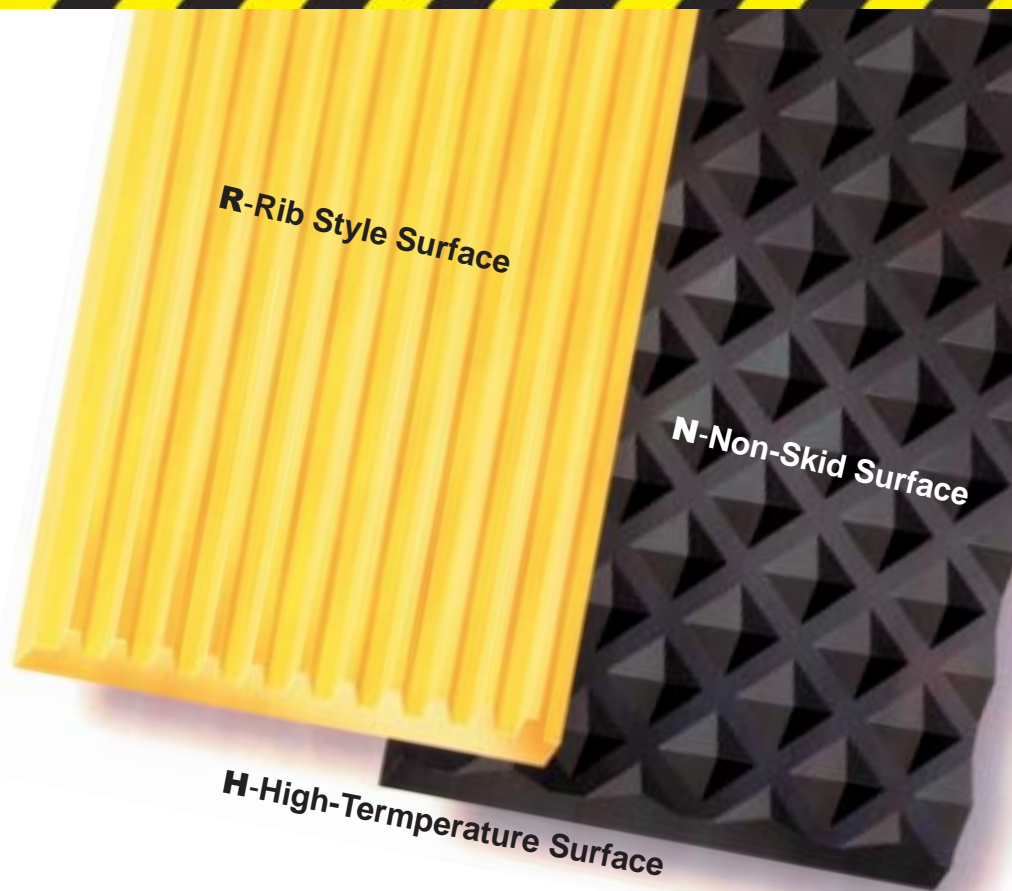
Mat Sizes - Inches/Millimeters

Standard Mat Widths (A)

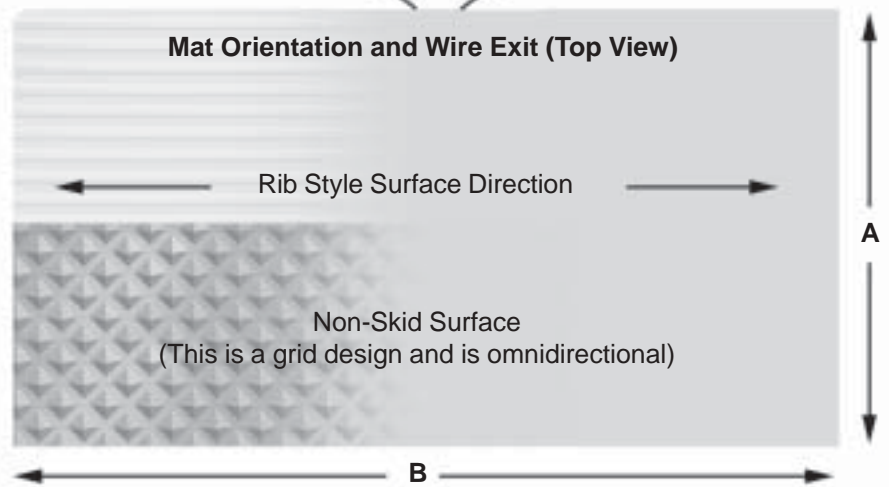
12" / 305mm	48" / 1219mm
18" / 457mm	54" / 1372mm
24" / 610mm	60" / 1524mm
30" / 762mm	66" / 1676mm
36" / 914mm	72" / 1829mm
42" / 1067mm	

Standard Mat Lengths (B)

12" / 305mm	84" / 2134mm
18" / 457mm	90" / 2286mm
24" / 610mm	96" / 2438mm
30" / 762mm	102" / 2591mm
36" / 914mm	108" / 2743mm
42" / 1067mm	114" / 2896mm
48" / 1219mm	120" / 3048mm
54" / 1372mm	126" / 3200mm
60" / 1524mm	132" / 3353mm
66" / 1676mm	138" / 3505mm
72" / 1829mm	144" / 3658mm
78" / 1981mm	



2-2 conductor 20' (6.1m) wire leads, 22 gauge, CSA & UL listed



Example Part

NSD - 36 - 96 - Y - R - X - 20 - S

(prefix)	Width	Length	Color	Mat Style	Mat Wiring	Wire Length	Options
	12, 18, 24	12, 18, 24, 30,	<u>Y</u> -Yellow	<u>R</u> -Rib Surface	See options shown right	Order in feet.	<u>S</u> -Designates a special cut, contour notch, wire exit or angle in mat (please submit drawing).
	30, 36, 42	36, 42, 48, 54,	<u>B</u> -Black	<u>N</u> -Non-Skid Surface		20' (6.1m) supplied standard. Specify longer lengths if needed, 100' (30.48m) maximum.	
	48, 54, 60	60, 66, 72, 78,		<u>H</u> -High Temperature (Excellent for weld splatter, molten plastic, die casting, and forging operations)	<u>X</u> <u>E</u> <u>W</u> <u>P</u>		
	66, 72	84, 90, 96, 102, 108, 114, 120, 126, 132, 138, 144					

SPECIALS....

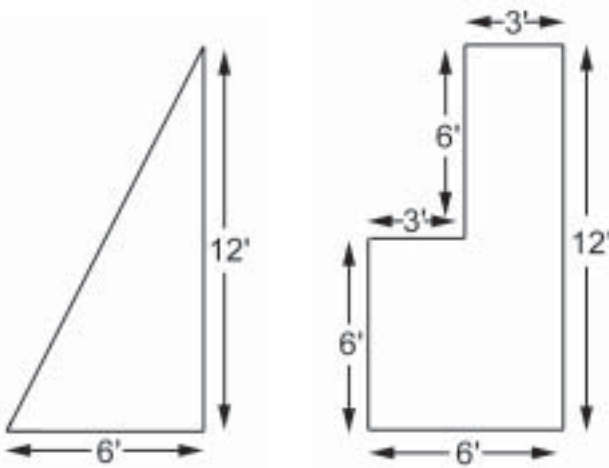
The ultimate customized mat system in the industry. This series can provide customized mats, machine inlays, wire exits, etc. Submit drawing and requirements to factory.

NSD Single Mat Capability





Save time and installation costs with single piece mat installations. Help eliminate or reduce daisy chain wiring practices required by competitive systems.

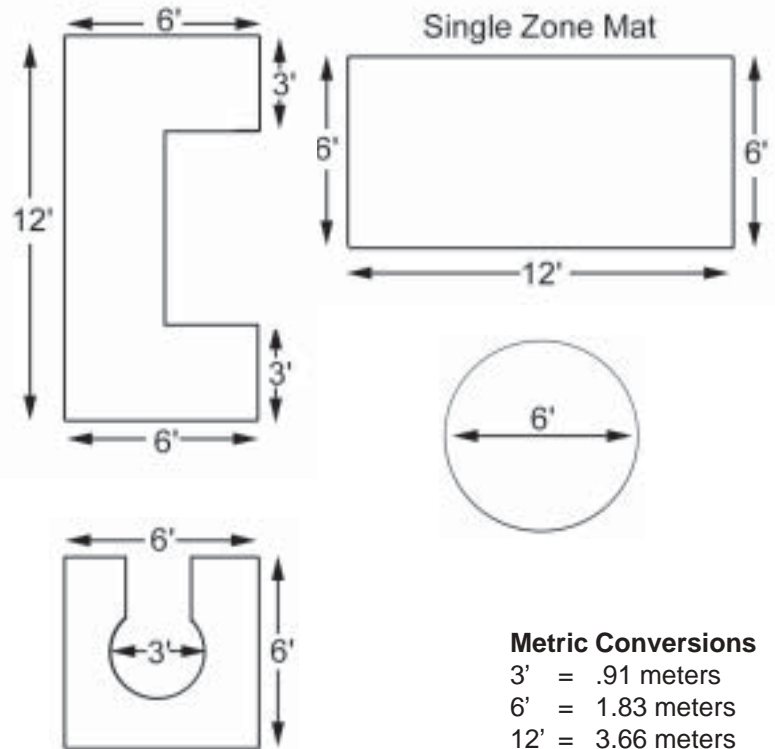
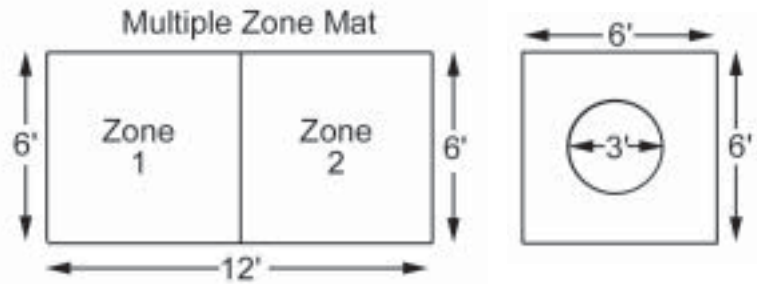
The sizes shown are typical single piece mat installations that illustrate the manufacturing versatility of the **NSD** Safety Mat System.

- The wiring exit positions can be located anywhere on the mat perimeter.
- The mat sizes shown can easily be altered to fulfill your specific project needs.
- No tooling fees for special mat designs.



NSD Mat Wiring Options

-  **X** - (standard) 2 - 2 conductor wires exiting at center of mat on B dimension.
-  **E** - 2 - 2 conductor wires exiting at opposite corners on B dimension.
-  **W** - 4 conductor cable out of the top left corner (home run wiring to mat controller).
-  **P** - 4 conductor plug out of the upper left corner; 20' (6m) plug extension supplied standard. Hardwired to mat controller.



Metric Conversions

3' = .91 meters
6' = 1.83 meters
12' = 3.66 meters

NSD Safety Mat Label

Provides immediate safety mat system information required by international guarding standards. The label is located on the mat surface. Bar coding is supplied standard to ease in receiving and inventory control. Customized labels are available.



(actual size)

Perimeter Trim for NSD Mats

Perimeter Trim (Part #M001) is used for anchoring the outside perimeter of the safety mat assembly to the floor and to run the mat wiring back to a location near the mat controller. The unique wire raceway is built into the perimeter trim and is supplied standard with all Part #M001 orders. The perimeter trim adds 2.5" (64mm) to mat dimension per edge.

Ordering Procedure: Specify linear feet or dimensions followed by one of the following:

- TK: (picture frame trim kit)
- M001: (bulk)
- M001-M: (bulk/machined)
- Custom Trim Kit: (consult factory)

Example: Part # 2442TK.

This example is a 24" x 42" mat with a 24" x 42" picture frame trim kit; total area is 29" x 47".

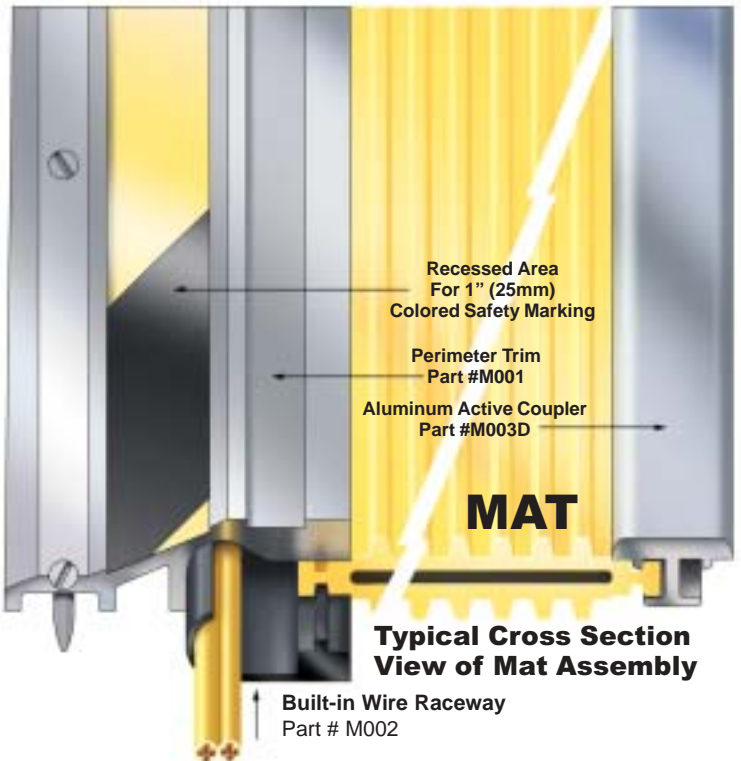


Active Coupler (Part #M003D) is used whenever the mats are placed side to side or end to side. This will activate the "Active Edging™" feature which will eliminate dead zones between mats. The active coupler adds .25" (6mm) to mat system's overall dimension.

Ordering Procedure: Specify Part Number and total length required in feet.

Built-in Wire Raceway (Part #M002)

This innovative design concept provides excellent wiring protection for your safety mat system. The design provides an elevated off the floor wire raceway to protect the wiring and connections from fluids and caustic materials on the floor. It also provides a wiring harness to protect the mat wires from being pinched by improper perimeter trim installations commonly found in the industry.



Safety mats are required by law to be "fixed" in position for machine guarding applications.

Mat Wiring: Dual 20' (6.1m) 2 conductor, 22 gauge (wiring styles X and E) and 24 gauge (wiring styles W and P), multistrand wires. CSA & UL Listed.

Mat Cable Diameter: .18" (5mm)

Mat Housing: .25" (6mm) top and bottom mat housing, cross drain built-in on mat bottom, hermetically sealed, NEMA 6 IP(67) rated. Special mat housings available, consult factory.

Perimeter Trim: Part # M001 High-grade aluminum #6063-T5

Active Coupler: Part # M003D High-grade aluminum #6063-T5

Wire Raceway: Part # M002 High-strength PVC (black)

Mat Temperature Rating: -15°C to 55°C / 4°F to 130°F

Maximum Mat Input: 24V (AC or DC) @ 75 mA

Chemical Resistance

The mat housing has excellent resistance to acids, alkalis, and salts. Hot acids and alkalis, as well as concentrated oxidizing and organic acids, have a deleterious affect over prolonged exposure.

Mat Chemical Resistance

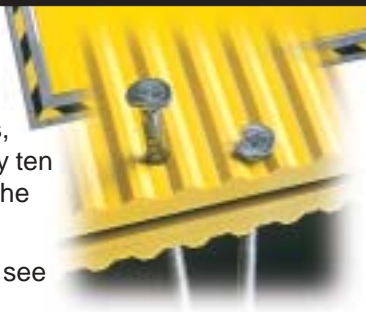
Water	E	Acetic Acid	F
Ethyl Alcohol	E	Gasoline	F
Sodium Chloride	E	ASTM 1 Oil	F
Bleach	E	Benzene	P
Hydrochloric Acid	F to E	Aceton	P
Sulfuric Acid	F to E	Trichlorethylene	P to F
Nitric Acid	F to E		

Key: E=Excellent; F=Fair; P=Poor

NSD vs. Steel Electrode Durability Test

Simple in-house tests for you to try!!!

1. Stab or puncture with nails, ice pick, etc. approximately ten times in various areas on the mat sensing surface.
2. Bend the mat corners and see what happens.
3. Place on uneven floors and compare.





Safety Mat Controllers

System Overview

The **NSD** Safety Mat System controllers contain two independent control circuits which allow for shut down due to any single failure in one of the control circuits. The N.O. output circuit is controlled by two captive contact relays in series which are both monitored. If the contact in one relay should stick closed (i.e., contact weld), the other relay will shut down and the LED will indicate the fault; if the contact on the bad relay opens back up, you must reset the power to clear the fault. This relay contact monitoring provides a high degree of user safety.

Circuit Description

A low voltage (24VAC or 24VDC) signal is sent out to the safety mat(s) through two wires. Two special optically-isolated diverse redundant circuits look at the signals coming back from the mat(s) detecting the presence of proper positive and negative voltage (AC) levels and output their signals to redundant missing pulse detectors. If the voltage coming back is too high or low, the missing pulse detectors will drop out and de-energize the relay circuit. If the voltage coming back is not AC (missing either positive or negative peaks), then the signal going to the missing pulse detector will disappear which will, in turn, drop out and de-energize the relay circuit.

Redundant relay position detectors watch for a relay contact stuck in the wrong position. The circuits will lock out the reset feature of the **NSD** control unit if a relay contact is closed when it should be open.

Each relay has its own driver circuit to complete the redundancy of the circuits.

Model NSD-TR-01 Metal Box Controller



Specifications

Enclosure:	NEMA 12, 13, IP 54
Input Power:	120VAC +/- 10% @ 3 watts 50-60 Hz fused
Category/Type:	4
Relay Style:	Monitored force-guided captive contact safety relays
Relay Configuration:	2 N.O. Safety Relays (closed when circuit activated) 1 Aux. Output N.O. or N.C
Safety Relay Rating:	4A @ 220VAC
Reset Provisions:	Manual or Automatic
Controller Response Time:	15 ms
Self-Checking Intervals:	Every 20 ms
Number of Isolated Zones:	1 to 13 (customer specified)
Maximum Number of Mats:	20 with daisy chain wiring
External Reset Provision:	Green push button
Indicators:	
<i>Internal (on board):</i>	<u>Yellow LED</u> = +5VDC power supply <u>Red LED</u> = Normally dim, brighter when mat is stepped on. Cut wire detected when not lit. <u>Green LED</u> = Relay contact detected closed when it should have been open when not lit. Must reset power to clear.
<i>External:</i>	<u>Red LED</u> = 1 or both relays are de-energized. <u>Green LED</u> = All relays are energized.
Diagnostic Message Display:	N/A
DeviceNet:	N/A
Warranty:	2 years

Model NSD-DR-01 DIN-rail Controller



NEMA 1, IP 32

24VDC +/- 20% @ 7 watts

4

Monitored force-guided captive contact safety relays

2 N.O. Safety Relays (closed when circuit activated)

1 Aux Output N.O. or N.C

4A @ 220VAC

Manual or Automatic

19 ms

Every 20 ms

1 per controller

20 with daisy chain wiring

Green push button

Green LED(s) = next to each relay (3)

Red LED = +12V

Yellow LED = +5V

Green LED = -5V

Red LED = 1 or both relays are de-energized.

Green LED = All relays are energized.

Yellow LEDs = 2 to show on/off mat.

Green LED = Relay fault if it turns off.

N/A

N/A

2 years

Model NSD-DR-04 DIN-rail Controller (with Diagnostics Message Display)



NEMA 1, IP 32

24VDC +/- 20% @ 7 watts

4

Monitored force-guided captive contact safety relays

2 N.O. Safety Relays (closed when circuit activated)

1 Aux Output N.O. or N.C.

1 Fault Relay N.O.

4A @ 220VAC

Manual or Automatic

19 ms per mat input used

Every 20 ms

1 per controller

4 with homerun wiring

20 with daisy chain wiring

Green push button

Red LED = +12VDC

Green LED = +20VDC

Yellow LED = +5VDC

Green LEDs = one for each relay (4 total)

Red LED = 1 or both relays are de-energized.

Green LED = All relays are energized.

Yellow LEDs = 1 for each mat status — (4 total)

Built-in diagnostic message display

Add suffix DN to Model #

2 years

Remote Status Display (RSD) Optional for DIN-rail Controller NSD-DR-04

The RSD (front panel shown below) may be used in conjunction with the NSD-DR-04 DIN-rail Controller. The RSD provides the machine operator and front line supervisor immediate system status and diagnostics when the DIN-rail Controller is mounted inside the machine control panel.

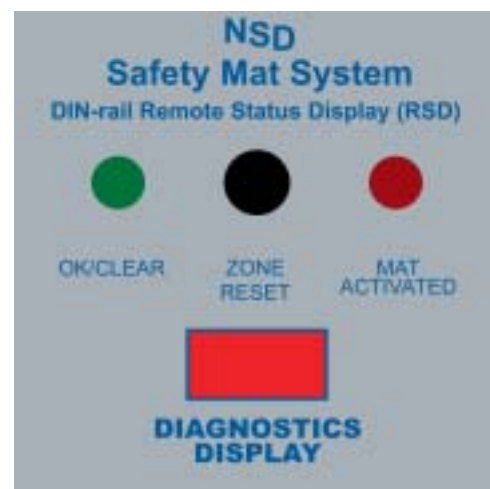
Remote Status Display components:

- Red/Green indicator lights
- Diagnostic scrolling message display with 5' (1.52m) of connector cable
- Zone reset button

The components are mounted on a steel plate and are designed to be exterior panel mounted. The RSD option enhances safety and is a time saver at machine set-up and when maintenance diagnostics are required.

Ordering Procedure: Add suffix RSD to controller part number.

Example: NSD-DR-04-RSD.



Remote Status Display Requires:

Panel Cutout:

3" (76mm) x 3" (76mm)

Mounting Hole Dimensions:

3.7" (94mm) x 3.7" (94mm)

Center to Center

Dimensions

Metal Box Controller

Board Only:

Model NSD-TR-BO

5" (127mm) x 7" (178mm) plate with 4 holes 4.25" (108mm) x 6.25" (159mm) on center

Controller:

Model NSD-TR-01 = 1 Zone

8" (203mm) x 6" (152mm) x 3.5" (89mm) with
4" (102mm) x 8.75" (222mm) holes

Model NSD-TR-02 = 2 Zones

12" (305mm) x 10" (254mm) x 5" (127mm) with
8" (203mm) x 12.75" (324mm) holes

Model NSD-TR-03 & TR-04 = 3 & 4 Zones

16" (406mm) x 14" (356mm) x 6" (152mm) with
13" (330mm) x 16.75" (425mm) holes

DIN-rail Controller — Model NSD-DR-01

5.87" (149mm) length x 4.33" (110mm) width x 2.95" (75mm) height.

DIN-rail Controller with Diagnostics — Model NSD-DR-04

5.87" (149 mm) length x 4.33" (110 mm) width x 2.95" (75mm) height.

DIN-rail enclosure mounting:

35mm DIN-rail mountable or mounting screws on corners of enclosure requiring two combo-head screws (3.5mm x 0.6mm x 14mm or #6 x .5).

Ordering Procedure

Specify controller model number and quantity desired.

Sizing Your Safety Mat System

How to Properly Size your NSD Safety Mat System

The following formula is a domestic and international guideline for the proper positioning and application of safety mats for machine guarding. This formula must be followed for all safety mat applications supplied to the European Community (CE) member nations. CEN is the European Committee for Standardization. Final draft #prEN999. The formula is also incorporated in ANSI/RIA Standard R15.06-1999.

The minimum distance from the danger zone shall be calculated by using the general formula:

$$S = (K \times T) + C$$

S is the safety mat minimum distance in inches/millimeters in a horizontal plane from the danger zone to the detecting edge of the safety mat furthest from the danger zone.

K is a parameter in inches/millimeters per second derived from data on approach speeds of the body or parts of the body. $K = 63"/\text{second}$ (1600mm/second).

T is the total system stopping time performance which includes activating the safety mat, the mat controller output signal switching device, and the time required to stop the machine and remove risk.

C is an additional distance in inches/millimeters, based on intrusion towards the danger zone prior to actuation of the protective safety mat equipment. $C = 48"$ (1219mm).

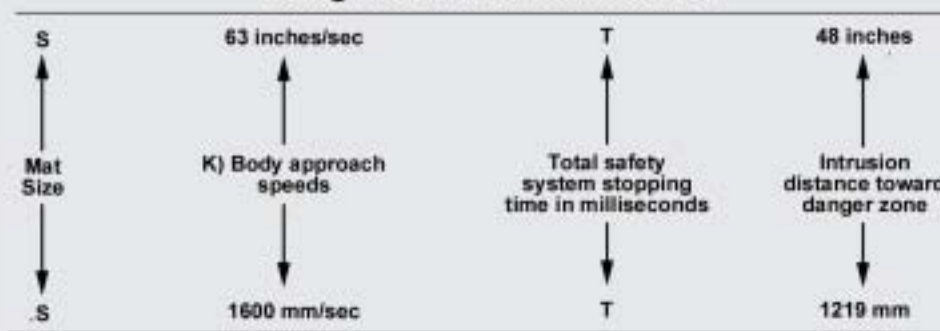
Annex B (informative)

Walking speeds and stride lengths. The positioning of equipment which is activated by a person walking into the detection zone by stepping onto a pressure sensitive mat is affected by speed of approach and stride length. The walking speed and stride length depend on the physical and anthropometric data of the population.

Speed of Approach. This standard assumes the approach of persons towards the danger zone will be at walking speed.

Stride Length. Available research data has shown the 95th percentile of two steps (i.e., starting and finishing with the same foot) measured from heel contact at walking speed is approximately 75" (1905mm). By dividing by two and subtracting the 5th percentile shoe length this gives a stride length of 28" (711mm). If it is assumed that an allowance has to be made (for example, between the detection zone and the stride length of 2"/50mm), this gives a minimum width of 30" (762mm) for the detection zone.

Examples of safety mat sizing calculations using inches and millimeters:



T-The NSD Safety Mat System activation time including controller is 35 ms. This amount is to be added to the machine stopping time in milliseconds to fulfill the T requirement of the formula.