Best Practices for Selecting and Installing Door Interlock Technology

Choosing the right door control system for your facility is of the utmost importance to ensure the safety and security of people, property and assets. You need to select a system that is appropriate based on the flow of people, the type of assets held within the facility, and the security threats you are most concerned about preventing today and in the future.

This whitepaper will define best practices in selecting and applying door interlock solutions, including:

- Specific Uses and Applications
- Types of Door Interlock Systems
- Choosing the Right Interlock Configuration
- Installation Guidelines
- Selecting the Proper Interlock Controller

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Introduction

People usually think of doors as a means of keeping someone out, or alternately, keeping someone in. Doors provide privacy and, when locked, a level of security that is both simple and effective. Perhaps you never thought about it at length, but there are many ways that doors can be opened and/or closed. They can be manually operated with a handle or push bar, revolve, swing or even slide into a pocket in the wall. They can be operated automatically with the push of a button, or triggered by the swipe of a card or a proximity device, or they can be programmed to lock if another door is open or unsecure.

There is more door technology on the market than ever before, including advanced programmable door interlock systems (often called mantraps), which can provide very high levels of security. By gaining a better understanding of how different door interlock systems are applied and operate, you can select the most appropriate configuration for your facility.

Specific Uses and Applications

There are numerous applications for door interlock systems that span a variety of industries. Some of the most prevalent uses include:

- **Banks and other financial institutions** where cash and valuables such as jewelry and important documents are stored for safekeeping
- **Cleanrooms where contamination** to individuals and or experiments is not acceptable
- **Casinos and gaming facilities** in areas where cash is handled
- **Armored car facilities** to control vehicle entry
- **Prisons and police stations** for transporting detainees
- **Medical facilities** for patient transport and deliveries
- **Secure government facilities** such as federal reserves and military R&D installations
- **Sensitive Compartmented Information Facilities (SCIF, pronounced "SKIFF")** where sensitive information and conversations take place
- **High risk wholesale and retail** establishments where expensive merchandise such as jewelry is exchanged
- **Check cashing facilities** to monitor individuals entering areas where cash transactions take place
- **Schools** where access to administration areas requires added security
- **Laboratory and pharmaceutical facilities** where bio labs and cleanrooms are utilized

Door interlock systems provide a unique form of protection not afforded by conventional access control systems that can more easily be compromised using lost, stolen or replicated credentials.

For instance, banks and other financial institutions require a higher level of security than most commercial sites because of the greater risk associated with the sensitive nature of their business and the value of the assets on their premises. Traditionally, these organizations rely on card access and video surveillance systems to provide a heightened level of security, but it is becoming more common for them to also incorporate multiple door interlock systems.

A good example of this is the ability to automatically lock doors in a visitor screening area if a concealed firearm is detected. In this application, an interlock door system provides unrestricted access to the interior vestibule, where customers then pass through a metal detector before entering the inner lobby through a locked door. Access to the interior is only allowed when the exterior door is closed and no metal is detected. If both conditions are met, the exterior door is locked, and the visitor is allowed to enter through the interior door. Should he or she be deemed suspicious, an alert sounds and the interior door is automatically locked, only allowing the individual exit to the street.

Door interlock systems are also commonly used in cleanrooms. Unfortunately, many cleanrooms cannot be easily expanded or reconfigured, and must still adhere to mandatory industry standards. Additionaly, many modular cleanrooms are not supplied with door interlocks and must be retrofitted in the field. As a result, cleanroom manufacturers can benefit from utilizing door interlock controllers as an option for new and existing installations to address changing needs and requirements.

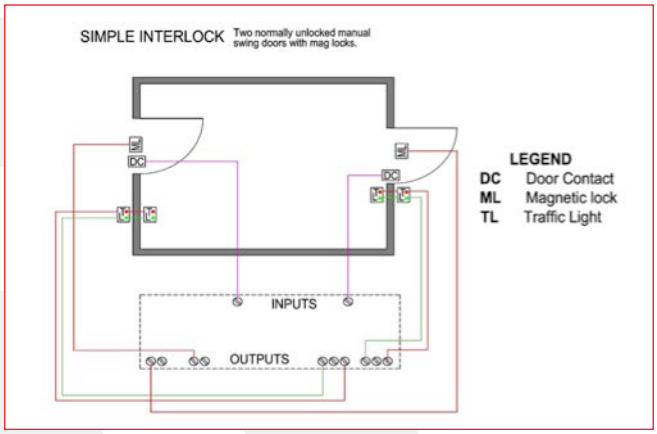
The addition of door interlocks not only assures the cleanroom meets the necessary ISO classifications by enforcing clean air control, but can also add a level of security within the controlled environment of the cleanrooms.

Types of Door Interlock Systems

Interlock systems have different names based on their functionality, and are commonly referred to as one of the following:

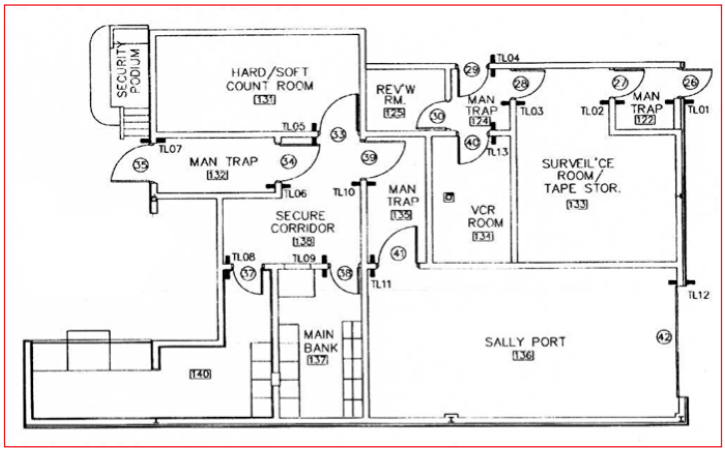
- Interlocks
- Mantraps
- Sally Ports (for vehicles)
- Secured Vestibules
- Air Locks

In its simplest form, a door **Interlock System** is composed of two doors electronically connected so one cannot open until the other has closed. A good way to visualize the technology is by picturing an entryway with a door at either end. Using some form of access control device, you are granted access through the first door to enter the hallway. Once the first door is closed, the second door can then be opened automatically or triggered by an operator to pass through the second door. These systems are often used in high end jewelry stores where an employee grants initial access to a visitor, and then visually screens them before allowing entry into the sales area. This same basic door interlocking set-up has countless applications across many different industries.



A more robust Interlock System solution would employ a *Secure Entry/Free Egress* configuration that provides a faster method of egress through a combination of locked and unlocked doors. Exterior doors are normally secured and interior doors normally unlocked. An electronic access system controls entry from the exterior and a Request-to-exit (REX) device is used on the interior of the outside door. A valid access card will unlock the exterior door only if the interior door is closed. Unlocking the exterior door will lock the interior door. Once the exterior door is re-secured, the interior door is unlocked to allow access into the facility. And opening the interior door prevents the exterior door from being unlocked. From a practical perspective, envision an entryway into an apartment building. An access card or code entered into a keypad unlocks the exterior door allowing entry into a vestibule. Once the exterior door is closed and automatically locks, the interior door can be opened using the same credentials, or by having the individual buzzed by the resident. If the interior door remains locked, the individual in the vestibule can exit the exterior door by pressing the 'request to exit' button.

The highest level of security is provided with a *Restricted Entry & Exit System*, whereby a door is unlocked by a request for access only if no other related doors are unsecured. Opening any one door keeps all other related doors locked. Restricted Entry & Exit Systems will buffer simultaneous requests for access to prevent two or more doors from being unlocked.



Example of system wide Interlock deployment in a Casino

Sally Ports are interlock systems used to control vehicle entry/egress using any combination of garage doors, gates or bollards.

Example of a Sally Port at a correctional facility

A **Sensitive Compartmented Information Facility (SCIF)**, is a term used by the U.S. Department of Defense. A SCIF can be a secure room or data center that guards against electronic surveillance and suppresses data leakage of sensitive security and military information. Mantraps are often incorporated into their design as an additional level of security.

Example of a SCIF with Integral Mantrap

Air Locks are low-security interlock systems used for environmental and air flow control, most notably for cleanroom and bio lab preassure differentials. Operation is simple: all doors are normally unlocked, and opening any door will lock the related doors so that only one door, in a designated area, can be accessed at a time. This provides easy ingress or egress to an area without destabilizing the environment of the adjoining areas, whether they be interior rooms or an exterior door. Cleanrooms and laboratories also typically include material handling pass-throughs which are yet another type of interlock system.

Cleanrooms and biological laboratories are classified by particle count in the air and/or the level of biologic containment in the work space. See tables below.

CLEANROOM CLASSIFICATIONS

Class	FED STD 209E Equivalent	Maximum concentration limits (particles/m³ of air) for particles equal to and larger than the sizes listed below					
		0.1 micron	0.2 micron	0.3 micron	0.5 micron	1 micron	5 micron
ISO 1		10	2				
ISO 2		100	24	10	4		
ISO 3	1	1,000	237	102	35	8	
ISO 4	10	10,000	2,370	1,020	352	83	
ISO 5	100	100,000	23,700	10,200	3,520	832	29
ISO 6	1,000	1,000,000	237,000	102,000	35,200	8,320	293
ISO 7	10,000				352,000	83,200	2,930
ISO 8	100,000				3,520,000	832,000	29,300
ISO 9					35,200,000	8,320,000	293,000

Biosafety Level	BSL-1	BSL-2	BSL-3	BSL-4
Description	- No Containment - Defined organisms - Unlikely to cause disease	- Containment - Moderate Risk - Disease of varying severity	- High Containment - Aerosol Transmission - Serious/Potentially lethal disease	- Max Containment - "Exotic," High-Risk Agents - Life-threatening disease
Sample Organisms	E.Coli	Influenza, HIV, Lyme Disease	Tuberculosis	Ebola Virus
Pathogen Type	Agents that present minimal potenial hazard to personnel & the environment.	Agents associated with humans disease & pose moderate hazards to personnel & the environment.	Indigenous or exotic agents, agents that present a potential for aerosol transmission, & agents causing serious or potentially lethal disease.	Dangerous & exotic agents that pose a high risk of aerosol-transmitted laboratory infections & life threatening disease.
Autoclave Requirements	None	None	Pass-thru autoclave with Bioseal required in laboratory room.	Pass-thru autoclave with Bioseal required in laboratory room.

Choosing the Right Interlock Configuration

The first best practice is to evaluate a facility's security and/or environmental control objectives to determine the level of door interlock solution required. For example, data centers typically require a higher level of security than general office buildings, as specific security restrictions such as entering a facility with portable memory devices would not pertain. Door interlock systems for cleanrooms may entail numerous sensors to monitor air pressure or temperature before granting access.

Door interlocks systems are also available with different modes of functionality. An office building that has a high amount of pedestrian traffic in the morning and late afternoon may want two doors operating during these periods with the ability to switch to a single door during midday hours.

Many door interlocking systems also include intercom communications between the person(s) inside the "mantrap" and a security guard or operator. Advanced configurations are also deployed with biometrics that read faces, eyes and/or fingerprints to provide highly accurate identity verification, adding a much higher level of sophistication and security.

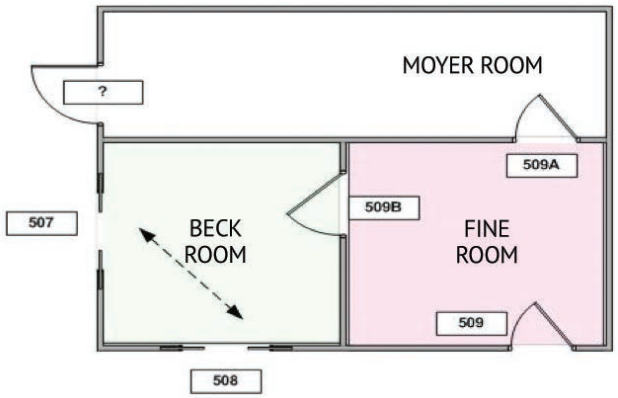
In many instances, the door interlock system must also be discreet and user friendly, or it can become a logjam for pedestrian traffic. A system should allow users to pass through with little effort and in comfort. Working with a reputable manufacturer who has in-house capabilities ensures you will get the ease of operation and specific door interlock capabilities you need, along with high-quality customer support and service.

With their high degree of programmable operations, door interlock systems are often subject to specific building code requirements, such as BOCA codes. Some municipalities may not allow any doors in a public facility to be locked at any time. While this scenario is intended to provide personnel safety, door violations can become a common occurrence and even a hazard. In some instances, this has been addressed with the use of red/green traffic lights mounted on either side of the doors to indicate when access is allowed. Adding a built-in sounder which annunciates a door violation can minimize such actions.

In an emergency, the door interlock system must also allow people to evacuate the facility. For example, if the power fails, an emergency exit device would ensure that the door can be opened manually. Moreover, life safety codes may require that the door interlock systems be integrated with the facility's fire alarm control panel to allow emergency door release. A local emergency pull station may be required to allow doors to be unlocked in non-fire alarm emergencies or to interface the system with NFPA 101 delayed egress controls.

Interlock Design Considerations

The first step in designing a door interlock system is to determine the traffic patterns and the door relationships. This plan indicates doors #507 and #508 allow entry into room BECK. Door #509B allows passage between rooms BECK and FINE. Doors #509A and #509B allow entry into room FINE from other areas. The unmarked door in MOYER is not controlled.

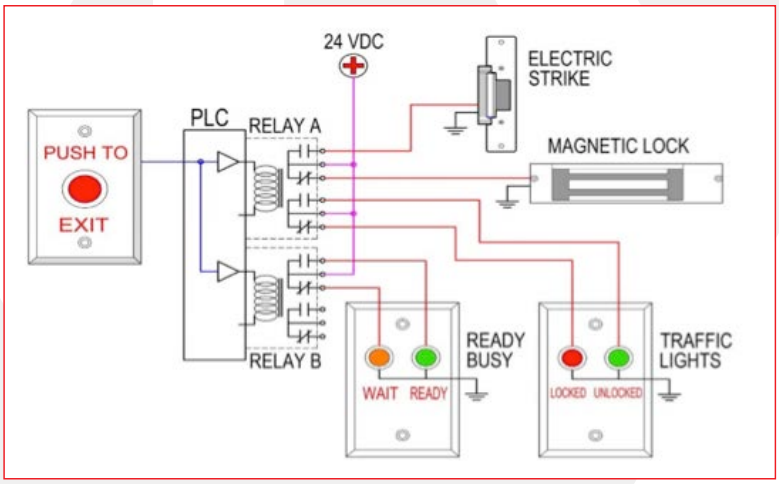


The key to specifying the interlock operation is explaining which doors will cause other doors to be locked and inhibited. From the example floor plan, we can see which doors are to be controlled and how traffic must flow through the facility. A matrix chart shows the relationships between doors and is used to designate which doors should cause other doors to be inaccessible. Swing doors are to be secured with maglocks and the automatic sliding doors are to be inhibited by disabling the "door open" push buttons.

Door #	Type	Status	Inhibits
507	Auto-Slide	Unlocked	508 & 509B
508	Auto-Slide	Unlocked	507 & 509B
509	Swing	Locked	509A & 509B
509A	Swing	Unlocked	509 & 509B
509B	Swing	Unlocked	507, 508, 509 & 509A

Open or unsecured, "shared" doors between rooms will typically cause all doors in both rooms to be inhibited. Shared doors are often normally unlocked for increased traffic flow since they are only accessible through other access controlled doors. All controlled doors in multiple rooms connected by shared doors must be controlled from the same interlock controller.

Most door interlocks will require traffic lights for user feedback as they generally cannot see the related doors to know if the door they are trying to access will be available. When card access is incorporated, it can be confusing to see a green LED on the card reader indicating a valid card read but the door will not open because a related door is unsecure.



When traffic lights are used, additional relay outputs may be required. The traffic lights for normally unlocked doors can follow lock status to indicate when the door is unlocked. Normally locked doors will need an independent relay for traffic light control to indicate when the door is available for access since the doors are always normally locked.

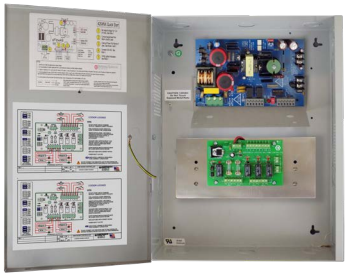
Selecting the Proper Interlock Controller

A critical consideration when choosing a door interlock system is the proper interlock controller. The number of doors, types of doors and other monitored and/or controlled devices all play into the equation when evaluating an interlock controller.

The various types of Interlock Controllers include:

Simple Relay Logic for 2-Door Systems

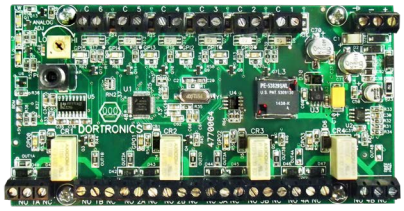
- Field assignable normally locked / unlocked
- Use with fail-safe or fail-secure locks
- Relay outputs for traffic lights
- Emergency door release inputs
- Optional 12/24 VDC power supply



Example of Simple Relay Logic with Power Supply

Factory programmed PLC Interlocks for 2 to 4 Doors

- Interface access devices through dry contact inputs (door switches & REX devices)
- Operates door locks from relay outputs



Example of PLC Controller

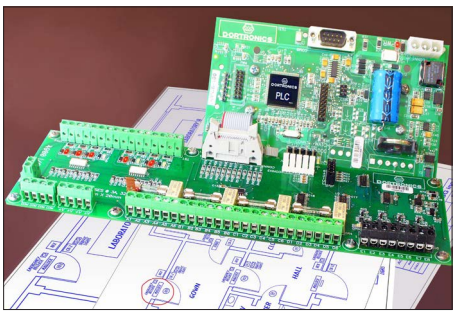
Field Configurable PLC Controllers for 2 to 5 Door Systems

- **Inputs:**
  - Five inputs for door status
  - Five request for access
  - One panic release
  - One for Interlock shunt/override
- **Outputs:**
  - Five lock relay outputs rated 2 amps @ 28 VDC
  - Five door status outputs
  - Ten LED traffic indicators (2) for each door
  - One door alarm output
  - One panic release output
- **Adjustable Timers:**
  - Door prop alarm
  - System pause (for air purge, door seals)
  - Emergency release unlock

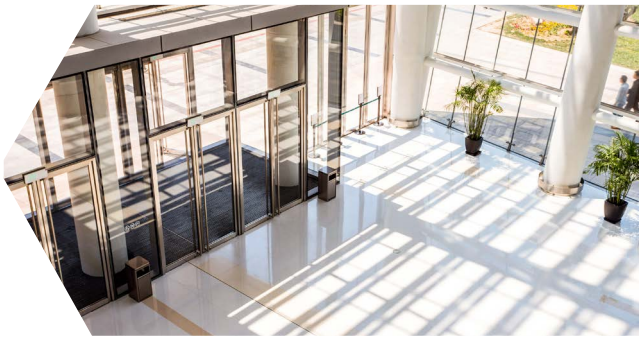
Example of Door Prop Alarm

Custom Programmed Large Multi-Door Systems

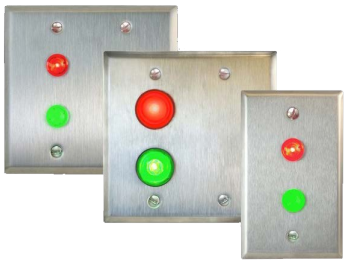
- Capable of controlling over 100 doors



Example of Large Multi-Door System



While totally independent interlocking doors can be controlled from a single PLC controller, the separation distance of the doors to be controlled can limit the number of doors per controller. This can complicate the design and deployment of a door control system. Inputs to be monitored by the controller must also be accessed. Monitored devices and operations should include door status, latch monitor, maglock bond sensor, the request-to-exit device, card access lock relay, local push button or other REX device. Normally unlocked doors require only a door position switch. Other monitored devices could be emergency override stations, tailgate detectors, and more. All inputs must be dedicated dry contacts, not shared with other systems. If required, that input devices can be mirrored with PLC relay outputs.



Outputs (relays and powered outputs) can be used to operate the electric locking devices, indicator lights, alarm sounders and to signal other systems (card access, guard station consoles, and more). At least one output relay is required for each controlled door to operate the electric lock. The lock relay contacts can also be used to signal door access status. If the doors are normally unlocked indicators should follow the lock status (example: Red = Locked / Green = Unlocked). When doors are normally locked, most systems utilize traffic lights to indicate when access may be inhibited (Red = Access not allowed / Green = Available for access) as doors may be locked awaiting authorization from the card access system or when the door is not currently available for access because another door is in use.

Summary

There are numerous commercial and industrial applications for door interlock systems having as few as two doors or over 100; including their use for highly specialized vehicular applications such as armored cars and prisoner transport vehicles. In any case, door interlock systems provide a highly efficient and effective solution for myriad security and environmental control applications.