OPERATION AND SERVICE MANUAL


# MPI–16 and MPI–16H

## Pocket Indexers

IPN 614800 Rev. B

INFICON

OPERATION AND SERVICE MANUAL

# MPI-16 and MPI-16H

## Research Quartz Crystal Microbalance

IPN 614800 Rev. B

INFICON Instruments for Intelligent Control®

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**WARNING**

**All standard safety procedures associated with the safe handling of electrical equipment must be observed. Always disconnect power when working inside the controller. Only properly trained personnel should attempt to service the instrument.**

# Warranty

INFICON warrants the product to be free of functional defects in material and workmanship and that it will perform in accordance with its published specification for a period of (twenty-four) 24 months.

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# 1 General Description

## 1.1 Purpose

The MPI-16 Pocket Indexer allows for automatic or manual control of multi-pocket beam sources that have a 4:1 gear reduction. It utilizes a stepper motor and is capable of accurately indexing a very wide assortment of crucibles. Automatic control is easily achieved by connecting the MPI-16 to a Deposition Controller, such as the INFICON MDC-360. Manual control is also made simple by connecting the MPI-16 to the optional Remote Panel. A Safety Interlock relay ensures that the e-beam supply is not active during pocket rotation.

## 1.2 Features

The MPI-16 is rich in features and was designed to be the most flexible, powerful, and intuitive crucible indexer of its kind. There are two versions of the indexers, the MPI-16 (Standard) and MPI-16H (High Torque). Except for the torque and speed, the two versions have the same functions. The following list summarizes their main characteristics.

### 1.2.1 Indexing

Both MPI-16 and MPI-16H can be configured to index up to 16 individual pockets. Specifically, it can be set for use with 4, 5, 6, 8, 10, 12 or 16 pocket positions, as well as circular (continuous trough) pockets. Up to two banana (partial trough) pockets of any length may be specified. UHV (Ultra-High Vacuum) crucibles are also supported. The MPI-16 can be set to *Fast* rotation mode, which uses a “smart” algorithm to select the shortest path to the target pocket (this setting can be overridden, however, by explicitly specifying clockwise or counter-clockwise rotation).

### 1.2.2 Speed

#### 1.2.2.1 MPI-16 Speed

While searching for a target pocket, the MPI-16 output shaft rotates at a fixed speed of 16 RPM. While on a Circular or Banana pocket, the output shaft sweeps through the specified region at a speed that is set by via the remote inputs, the remote panel or on the indexer. The speed may be set to any one of eight settings, which fall between 0.125 RPM and 16 RPM.

#### 1.2.2.2 MPI-16H Speed

Unlike the standard version, the MPI-16H output shaft rotates at the speed that is set by the remote inputs, the remote panel or on the indexer, whether it was searching for a target pocket, or sweeping on a Circular or Banana pocket. The speed may be set to any one of eight settings, which fall between 0.125 RPM and 16 RPM.

### 1.2.3 Torque

As mentioned earlier, there are two versions the indexer, the standard torque MPI-16 and the high torque MPI-16H. In both versions, the indexers normally run in Low Current mode to save power and reduce heat. They will only switch into higher torque mode, as

required, to turn the crucible. The maximum torque generated by each version is listed below.

#### 1.2.3.1 MPI-16 Standard Torque

The Standard indexer, Model MPI-16, is capable of providing up to 187 in-oz. of torque at output shaft. The output shaft size is ¼ inch in diameter.

#### 1.2.3.2 MPI-16H High Torque

The High Torque Indexer, Model MPI-16H, is capable of providing up to 310 in-oz. of torque at output shaft. The output shaft size is 5/16 inch in diameter.

### 1.2.4 Safety

An Abort/Reset button is provided to allow emergency pausing without program interruption. If this button is held for two seconds, the system resets itself. When connected to a Deposition Controller, an external Abort signal will also cause a pause in the program that can be resumed when the Abort signal is removed. The MPI-16 provides an Interlock relay that acts to ensure that the e-beam is never active during pocket rotation. The MPI-16 will halt operation if it's maximum torque is exceeded or if the motor overheats.

### 1.2.5 Deposition Controller Interface

The MPI-16 supports two modes for interfacing with an external Deposition Controller, such at the INFICON MDC-360. The simplest method is for the MPI-16 to accept BCD (Binary Coded Decimal) inputs to select the desired pocket number and provide BCD outputs to transmit the current pocket number back to the Controller. An alternate method accepts two separate inputs (Clockwise and Counter-Clockwise), which rotate the MPI-16 by one pocket in the indicated direction whenever either signal is asserted.

### 1.2.6 Remote Panel

The Remote Panel is a rack-mount control unit that provides pocket selection, speed selection, an easy-to-read LED display of the current pocket position and an Abort/Reset button. The Remote Panel is required if you do not plan to use the MPI-16 with an external controller, since it will be the only way to select pockets. Even when using external control, the Remote Panel may be useful since it allows easy manual pocket selection. For example, the remote panel allows the operator to check the material levels in the individual pockets in between deposition runs.

### 1.2.7 Error and Fault Detection

In the event of any type of error or fault, the MPI-16 makes it very clear what problem has occurred. If the unit has not been configured correctly, a blinking LED will flash a code that indicates what configuration changes need to be made. Similarly, if there is a run-time fault, a different blinking LED will flash a code that indicates what error occurred. Table 3-1 and Table 4-5 System Faults in this manual defines the meaning of the blink-codes, and a Quick Reference is provided in Appendix A.

### 1.2.8 Noise Immunity

The MPI-16 employs numerous electronics techniques (including the use of opto-isolators, switch debouncing and smoothing filters) to ensure that it operates correctly even in electrically noisy environments.

### 1.2.9 Compact Size

The MPI-16 has a very small footprint measuring only 4.0” x 4.2” so it requires minimal mounting space.

## 1.3 Specifications – MPI-16 Pocket Indexer

### 1.3.1 Indexing

| | |
|---|---|
| Number of Positions Supported | Circular, 4, 5, 6, 8, 10, 12, 16 |
| "Banana" Pockets Supported | Up to 2 |
| Rotation Modes | Fast, UHV, CW, CCW, Remote |
| Position Accuracy and Repeatability | 1° at output shaft |

### 1.3.2 Speed at Output Shaft

| | |
|---|---|
| Pocket Search Speed (MPI-16) | 16 RPM |
| Pocket Search Speed (MPI-16H) | 16, 8, 4, 2, 1, 1/2, 1/4, 1/8 RPM |
| Circular, Banana Sweep Speed | 16, 8, 4, 2, 1, 1/2, 1/4, 1/8 RPM |

### 1.3.3 Torque at Output Shaft

| | |
|---|---|
| Max. Torque (MPI-16) | 187 in-oz. |
| Max. Torque (MPI-16H) | 310 in-oz. |

### 1.3.4 Temperature Protection

| | |
|---|---|
| Auto Shut-off Temperature | 100 ± 1°C (212 ± 1.8°F) |
| Resume From Shut-off | 85 ± 6°C (185 ± 10.8°F) |

### 1.3.5 Safety Interlocks

| | |
|---|---|
| Relay output, SPST | 120 VA, 2A max. |
| Disable | Ground true.<br>4.7 K ohms pull up to 5 VDC internally. |

### 1.3.6 Inputs/Outputs Interface

| | |
|---|---|
| Inputs | Ground true.<br>4.7 k ohms pull up to 5 VDC internally. |
| Input Functions | Pocket Selection: 4-bit BCD<br>Speed Selection: 3-bit BCD<br>Clockwise rotation selection<br>Counter Clockwise rotation selection<br>Reset |
| Outputs | Optically isolated transistors. Ground true.<br>4.7 K ohms pull-up resistors. 50 mA max. |
| Output Functions | Pocket Position: 4-bit BCD<br>In Pocket Position<br>Pocket Fault |

### 1.3.7 Physical

| | |
|---|---|
| Dimensions [w] × [h] × [d] (including shaft length and protruded switches and connectors) | 4.00” × 5.29” × 4.19” (10.2 cm × 13.44 cm × 10.64 cm) |
| Weight | 4.2 lbs. (1.9 kg) |
| Power Supply | 48 VDC, 1.1 A, Desktop type |
| Input Power Requirements | 100-250 VAC, 1.5 A at 47-63 Hz. |
| Mounting Bracket (included) | Mounts to a 1” rotary motion feed through, accommodates base plate thickness of 1/2” to 1-1/8”. |
| Output Shaft Size | 1/4” diameter for the MPI-16 |
| | 5/16”diameter for the MPI-16H |

## 1.4 Specifications – Remote Panel

### 1.4.1 Displays

| | |
|---|---|
| 16 Green LEDs | Indicating current pocket position |
| Red Fault LED | Indicating a fault |
| Green In Position LED | Indicating a selected position is reached. |

### 1.4.2 Controls

| | |
|---|---|
| Auto-Manual Toggle Switch | Selecting the operating mode. |
| Pocket Select Rotary Switch | Selecting the desired pocket position (Manual Mode) |
| Speed Select Rotary Switch | Selecting the desired sweep for “banana” pocket (Manual Mode) |
| Abort/Reset Button | Use to stop the indexer operation or to reset the indexer. |

### 1.4.3 Physical

| | |
|---|---|
| Dimensions [w] × [h] × [d] (Including protruded switches and connectors) | 4.72” × 3.47” × 2.00” (11.99 cm × 8.81 cm × 5.08 cm) (Mounts in a 3.5” quarter panel) |
| Pocket Select Rotary Switch | Selecting the desired pocket position (Manual Mode) |
| Speed Select Rotary Switch | Selecting the desired sweep for “banana” pocket (Manual Mode) |
| Abort/Reset Button | Use to stop the indexer operation or to reset the indexer. |

## 1.5 Accessories

### 1.5.1 Remote Panel

The Remote Panel is a required system component if you have chosen to operate the MPI-16 without external control. The Remote Panel is a 3.5" high, quarter-size rack-mountable interface that provides a **Pocket Select** Switch, **Speed Select** Switch, and an **Abort/Reset** button. You may also toggle between Automatic and Manual operation if you are using the Remote Panel in conjunction with external control. If your Pocket Indexer kit included the Remote Panel, a 25-pin (straight-through) cable is also provided for connectivity.

### 1.5.2 External Interface Cable

A standard 25-pin cable is supplied with all MPI-16 units to allow you to interface the Pocket Indexer with any control device you wish. The most common options will be to control the MPI-16 from a Deposition Controller or from a Programmable Logic Controller (PLC) in your system. To provide maximum flexibility, the wires at the opposite end of the cable have been left unconnected (loose). Refer to Table 3-2 for the signal definitions of each pin. Since the colors of each wire may vary, a separate page will be included with your interface cable specifying the color code.

If you do not plan on using the optional Remote Panel, you may connect the External Interface Cable directly to the MPI-16. If you will be using the Remote Panel (via the provided connector), you must connect the External Interface Cable to the auxiliary connector on the Remote Panel itself. It will act the same exact way as if your control device were plugged directly into the MPI-16.

### 1.5.3 Mounting Bracket

The MPI-16 includes a mounting bracket to allow for easy installation in your system. The bracket mounts to a 1" rotary feed-through, and can accommodate a base plate thickness of 1/2" to 1-1/8". Please see Section 3.5 (Installation in Your System) for further details.

### 1.5.4 Power Supply

A 48-volt (1.1 amp) power supply is included to provide reliable power for your MPI-16. This powers the stepper motor as well as all of the low-voltage logic circuitry inside the Pocket Indexer. It is recommended that you only use the provided power supply to ensure reliability and integrity of the indexer operation.

# 2 Package Contents

Carefully inspect your MPI-16 Indexer and its shipping container for evidence of possible shipping damage or loss. If such evidence is present, a report should be filed with the carrier as soon as possible. Keep the shipping container as evidence if shipping damage is present or for possible future return of the unit. Check the material received against the packing list to be certain that all material is accounted for. The following items should have been included with your Indexer:

1 MPI-16 Pocket Indexer *and* mounting bracket
1 Operation Manual
1 Power Supply
1 Power cord
1 I/O cable (DSUB-25 Female to open-ends, 5 feet long)
1 Interlock Connector, (2-Pin terminal block)

Optionally, your package may also include the following items:

1 Remote Panel
1 DSUB-25 Female to DSUB-25 Male Cable

If you have purchased a INFICON MDC-360 Film Deposition Controller with your MPI-16 Pocket Indexer, the following cable may have also been included, as an option.

1 DSUB-25 Female to DSUB-37 Female

This cable has a set of pre-defined I/Os to ease your wiring for I/O connections between the two units. All you have to do is to configure your indexer for your crucible, and program the MDC-360 to drive the indexer. See Section 4.2.5.

## 2.1 Ordering Information

| Part Number | Description |
|---|---|
| 614800 | MPI-16 Operation Manual |
| 614410 | 1” Hole Mounting Bracket |
| 614209 | I/O Cable, DSUB-25 Female to open-ends, 5 feet long |
| 800401 | Mounting Screw, #8-32 x ¼” long |
| 803337 | Washer, Int/Ext Tooth, #8 |
| 803081 | Power Cord |
| 885077 | Interlock Connector |
| 900038 | Power Supply |
| 828011 | Cable, DSUB-25 Female to DSUB-25 Male |
| 614208 | Cable, DSUB-25 Female to DSUB-37 Female |

Refer to INFICON’s Price List for more accessories and other products.

# 3 Setup and Installation

## 3.1 Introduction

The MPI-16 Pocket Indexer is capable of working with a very large assortment of crucibles. You may interface the MPI-16 with crucibles having 4, 5, 6, 8, 10, 12, or 16 pocket positions, as well as banana (partial trough) or circular (continuous trough) crucibles. Banana length is defined as the number of pocket positions. For banana or continuous trough pockets, you may specify the speed at which the MPI-16 sweeps through the region.

You must configure the MPI-16 to meet your specific system's requirements. Configuration is achieved by setting the Configuration Switches located on the front of the MPI-16's housing. Before installing the MPI-16 into your system, you should use this guide to set the Configuration Switches and ensure that the combination that you enter does not result in a Configuration Error.

## 3.2 Setup Instructions

- Place the MPI-16 in a position that allows easy access to the Configuration Switches.
- Use the Setup Guide (Section 3.3) in this chapter to determine the correct setting for each of the Configuration Switches. Dial in the settings that match your crucible.
- Apply power to the unit, or press the **Abort/Reset** button if the power is already applied.
- If you have entered an invalid combination of switches, the **Config. Error** LED will blink. The number of times (in a row) that it blinks will help you determine the type of error you have encountered.
- Reevaluate your Configuration Switch settings, and make any alterations to the switches that you believe will solve the problem. When finished, press the **Abort/Reset** button.
- Once a valid combination of switches is entered, the MPI-16 will begin operating immediately (its first action will be to locate the first pocket).
- Keep in mind that a successful combination does not ensure that you have entered the correct settings for *your* system, but simply a combination that the MPI-16 supports. After installation, you should test the MPI-16 with your specific crucible before actually performing a real operation.

Because it can be changed during normal operation, **Speed Select** is not considered a normal Configuration Switch. Its setting has no effect on the success or failure of a Configuration Setup. Its operation is covered in Section 3.3.

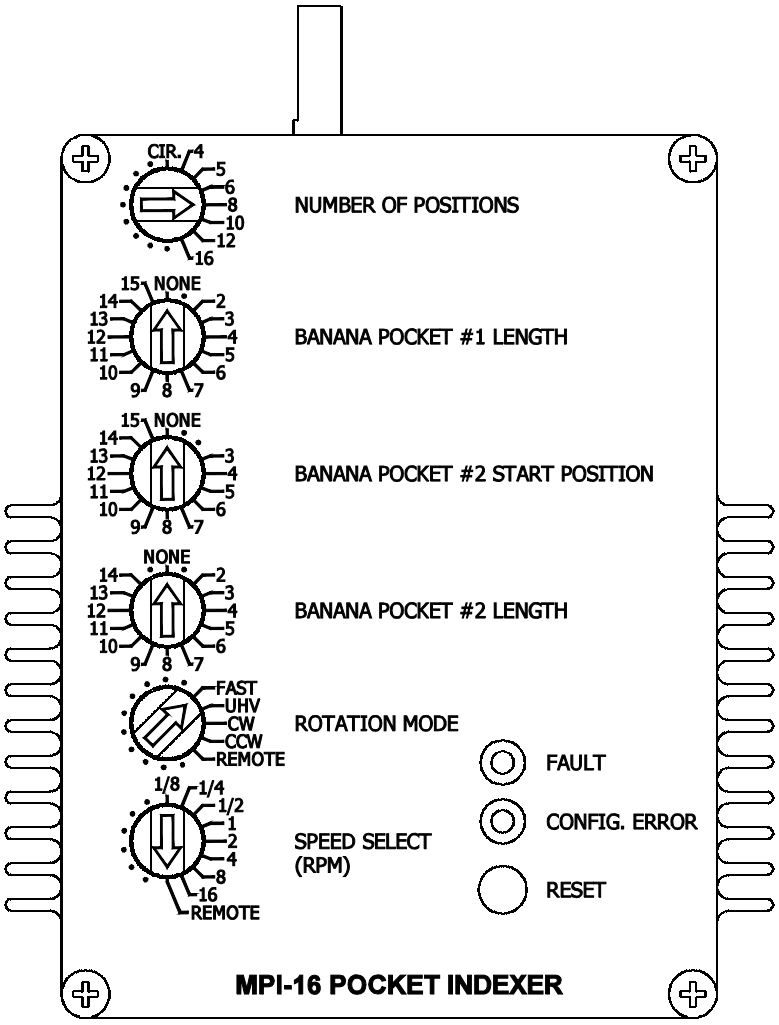



Figure 3-1 Pocket Indexer Front View

## 3.3 Configuration Switches - Setup Guide

The Configuration Switches on the MPI-16 are defined as follows –

### 3.3.1 Number of Positions

This setting indicates how many positions the MPI-16 can index. The spacing between the positions is automatically determined so that all positions are the exact distance apart from each other. If your crucible contains any Banana Pockets, you should count each position that the Banana Pockets sweep over as separate positions.

The MPI-16 is capable of indexing crucibles with 4, 5, 6, 8, 10, 12, or 16 positions. Circular (continuous trough) pockets may also be specified.

| Setting | Meaning |
|---|---|
| CIR. | **Number of Positions** = 1 (Circular) |
| 4 | **Number of Positions** = 4 |
| 5 | **Number of Positions** = 5 |
| 6 | **Number of Positions** = 6 |
| 8 | **Number of Positions** = 8 |
| 10 | **Number of Positions** = 10 |
| 12 | **Number of Positions** = 12 |
| 16 | **Number of Positions** = 16 |

### 3.3.2 Banana Pocket #1 Length

This setting indicates the length of the first Banana Pocket. The first Banana Pocket **must always** start at the first position (Home). You may choose for the first Banana Pocket to occupy any number of pocket positions, with the following restrictions:

- A Banana Pocket must occupy at least two positions, so a length of "1" is invalid.
- The length must be less than or equal to **Number of Positions**.

| Setting | Meaning |
|---|---|
| NONE | No Banana Pockets are specified |
| 1 | Not Allowed |
| n (2 - 15) | Banana Pocket #1 occupies the first 'n' pocket positions |

### 3.3.3 Banana Pocket #2 Start Position

This setting indicates the position number that the second Banana Pocket starts on. You may choose for the second Banana Pocket to start on any pocket position, with the following restrictions:

- Specifying a second Banana Pocket implies that you have already specified a first Banana Pocket (with a length of at least two positions), so the first possible position to start a second Banana Pocket is "3."
- Starting a Banana Pocket in position 16 would not accommodate the minimum size of two positions, so "16" is an invalid setting.
- The Start Position should be set so that it doesn't overlap with the length of the first Banana Pocket.

| Setting | Meaning |
|---|---|
| NONE | A Second Banana Pocket is not specified |
| 1, 2 | Not allowed |
| n (3 - 15) | Banana Pocket #2 starts at Position 'n' |

### 3.3.4 Banana Pocket #2 Length

This setting indicates the length of the second Banana Pocket. You may choose for the second Banana Pocket to occupy any number of pocket positions, with the following restrictions:

- A Banana Pocket must occupy at least two positions, so a length of "1" is invalid.
- Since a second Banana Pocket may start at a minimum position of "3," and there are a maximum of 16 positions, the length must be less than "15."

| Setting | Meaning |
|---|---|
| NONE | No Second Banana Pocket is specified |
| 1 | Not allowed |
| n (2 - 14) | Banana Pocket #2 occupies 'n' positions |
| 15 | Not allowed |

### 3.3.5 Rotation Mode

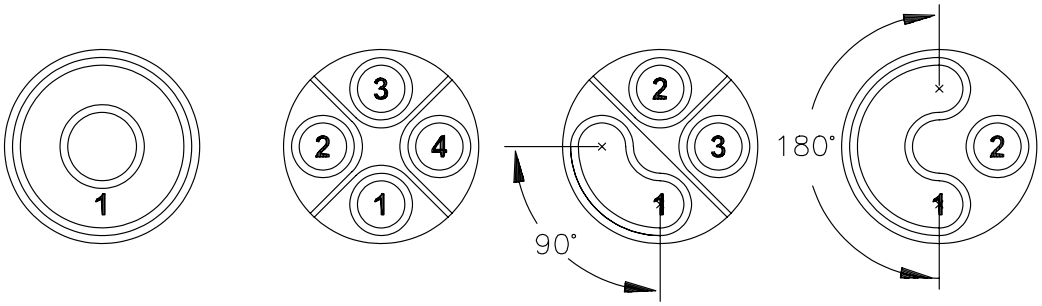
This setting indicates the mode of operation of the MPI-16. The following modes are supported:

- Fast – This mode uses a "smart" algorithm to detect the shortest path (clockwise or counter-clockwise) to the selected pocket.
- UHV (Ultra High Vacuum) – Certain crucible systems, due to obstruction, are not permitted to pass through the "Home" location. This mode finds the selected pocket using the path that is not blocked.
- CW (Clockwise) – This mode always forces clockwise operation.
- CCW (Clockwise) – This mode always forces counter-clockwise operation.
- Remote – This mode disables the manual Pocket Select feature and, instead, allows for control through an external deposition controller. It uses two input signals (CW & CCW) to determine the direction of rotation and four feedback output signals to convey the current pocket number back to the controller.

## 3.4 Configuration Examples

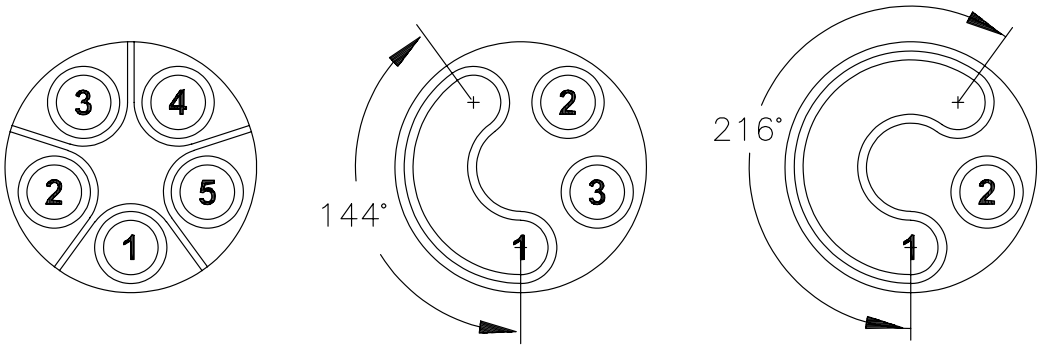
These examples illustrate a few examples of crucible setups and corresponding Configuration Switch settings. Since **Rotation Mode** does not affect the pocket positions, only the first four Configuration Switches are taken into account.

Format:
**Number of Positions,**
**Banana Pocket #1 Length,**
**Banana Pocket #2 Start Position,**
**Banana Pocket #2 Length**




**CIR, 0, 0, 0** **4, 0, 0, 0** **4, 2, 0, 0** **4, 3, 0, 0**

Figure 3-2 Configuration Example - 4-Position Crucibles




**5, 0, 0, 0** **5, 3, 0, 0** **5, 4, 0, 0**

Figure 3-3 Configuration Example - 5-Position Crucibles

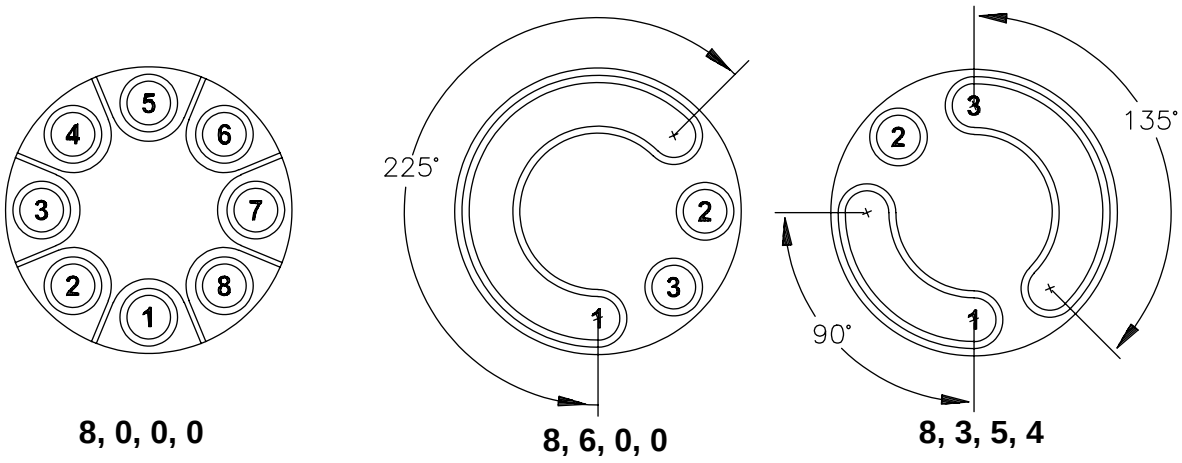



Figure 3-4 Configuration Example - 8-Position Crucibles

### 3.4.1 Configuration Error

When the MPI-16 is reset, it scans the five Configuration Switches and internally creates Pocket Position Tables for use during operation. There are a multitude of Configuration Switch settings that do not correspond with crucibles that are supported by the MPI-16, and you will receive a Configuration Error if you try to specify one of these modes. To help you determine why your switch selection is invalid, the **Config. Error** LED will blink a code telling you what type of Configuration Error occurred.

Table 3-1 describes the possible conflicts that cause the **Config. Error** LED to blink.

| 1 Blink – **Switch Out Of Range** Error ✸ |
|---|
| *Conflict:*<br>• The **Number of Positions** switch must be set on a valid, marked setting.<br>• The **Rotation Mode** switch must be set on a valid, marked setting. |
| 2 Blinks – **Circular Pocket** Error ✸✸ |
| *Condition:*<br>• Circular Mode is set (**Number of Positions** = **"Cir."**).<br>*Conflicts:*<br>• The **Rotation Mode** switch must be set to either **CW** or **CCW**.<br>• **Banana Pocket #1 Length** must be set to **0**<br>• **Banana Pocket #2 Start Position** must be set to **0**, and<br>• **Banana Pocket #2 Length** must be set to **0**.<br>*** Note:** Setting **Banana Pocket #1 Length** equal to **Number of Pockets** also specifies a Circular Pocket, but it is recommended that you use **Number of Pockets** = "**Cir."** |
| 3 Blinks – **No Banana Pockets** Error ✸✸✸ |
| *Condition:*<br>• No Banana Pockets (**Banana Pocket #1 Length** = **0**)<br>*Conflicts:*<br>• **Banana Pocket #2 Start Position** must be set to **0**, and<br>• **Banana Pocket #2 Length** must be set to **0**. |
| 4 Blinks – **One Banana Pocket** Error ✸✸✸✸ |
| *Conflicts:*<br>• **Banana Pocket #1 Length** cannot be set to **1**.<br>• **Banana Pocket #1 Length** must be less than **Number of Positions**. |
| 5 Blinks – **No Second Banana Pocket** Error ✸✸✸✸✸ |
| *Condition:*<br>• No Second Banana Pocket (**Banana Pocket #2 Start Position** = **0**)<br>*Conflict:*<br>• **Banana Pocket #2 Length** must be set to **0**. |
| 6 Blinks – **Two Banana Pockets** Error ✸✸✸✸✸✸ |
| *Condition:*<br>• **Banana Pocket #2 Start Position** > **0**<br>*Conflicts:*<br>• **Banana Pocket #2 Length** cannot be set to **0**.<br>• **Banana Pocket #2 Length** cannot be set to **1**. A pocket occupying a single position is not considered a Banana Pocket.<br>• **Banana Pocket #2 Start Position** must be greater than or equal to (**Banana Pocket #1 Length** + 1).<br>• **Banana Pocket #2 Start Position** + **Banana Pocket #2 Length** must be less than or equal to (**Number of Positions** + 1).<br>• **Banana Pocket #1 Length** + **Banana Pocket #2 Length** must be less than or equal to **Number of Positions**. |

Table 3-1 Configuration Errors

## 3.5 Installation in Your System

After successfully configuring the MPI-16, it is ready for installation on your system.

**WARNING**

**Lethal power resulting in electrical shocks may be present in your system. Make sure your system power is removed *and* discharged before installing the MPI-16.**

The MPI-16 assembly comes with a mounting bracket. This bracket mounts to a 1" rotary feed-through, and can accommodate a base plate thickness of 1/2" to 1-1/8". The only extra component needed is a coupling to join the drive shaft to the rotary feed-through. See Figure 3-6. We recommend a flexible coupling such as a HeliCal P/N HCR-075-8 to minimize torque lost in misalignment of the shafts, if any.

Refer to Figure 3-5 for the MPI-16 dimensions. Note the drive shaft offset with regard to the unit's center. Observe the location of the DB25 I/O Port connector. Allow clearance for it.

1. Manually rotate your crucible to position 1 (Home).

2. Loosen the four socket screws on each side of the bracket. You may have to remove the two lower screws completely if your base plate is less then 1" thick. **Note: Use only the screws and washers (#8-32 x 1/4" long) supplied with your MPI-16. Using screws longer than 1/4" long will damage the internal circuitry.**

3. Slide the flexible coupling over the drive shaft. Do not tighten.

4. Line up the 1" hole in the bracket with the 1" rotary feed-through. Secure the bracket to the base plate using the washer and nut supplied with your rotary feed-through.

5. Apply power to the MPI-16. It will start to rotate to find its 'home' position.

6. Once the MPI-16 has stopped at home, push the MPI-16 chassis up on the bracket so that the drive shaft and feed-through shaft almost touch. Secure the MPI-16 housing to the bracket by tightening the socket screws on each side of the bracket.

7. Slide the flexible coupling up and over both shaft. Set the coupling so that it covers an equal distance on both shafts. Make sure the crucible has not moved and tighten the coupling.

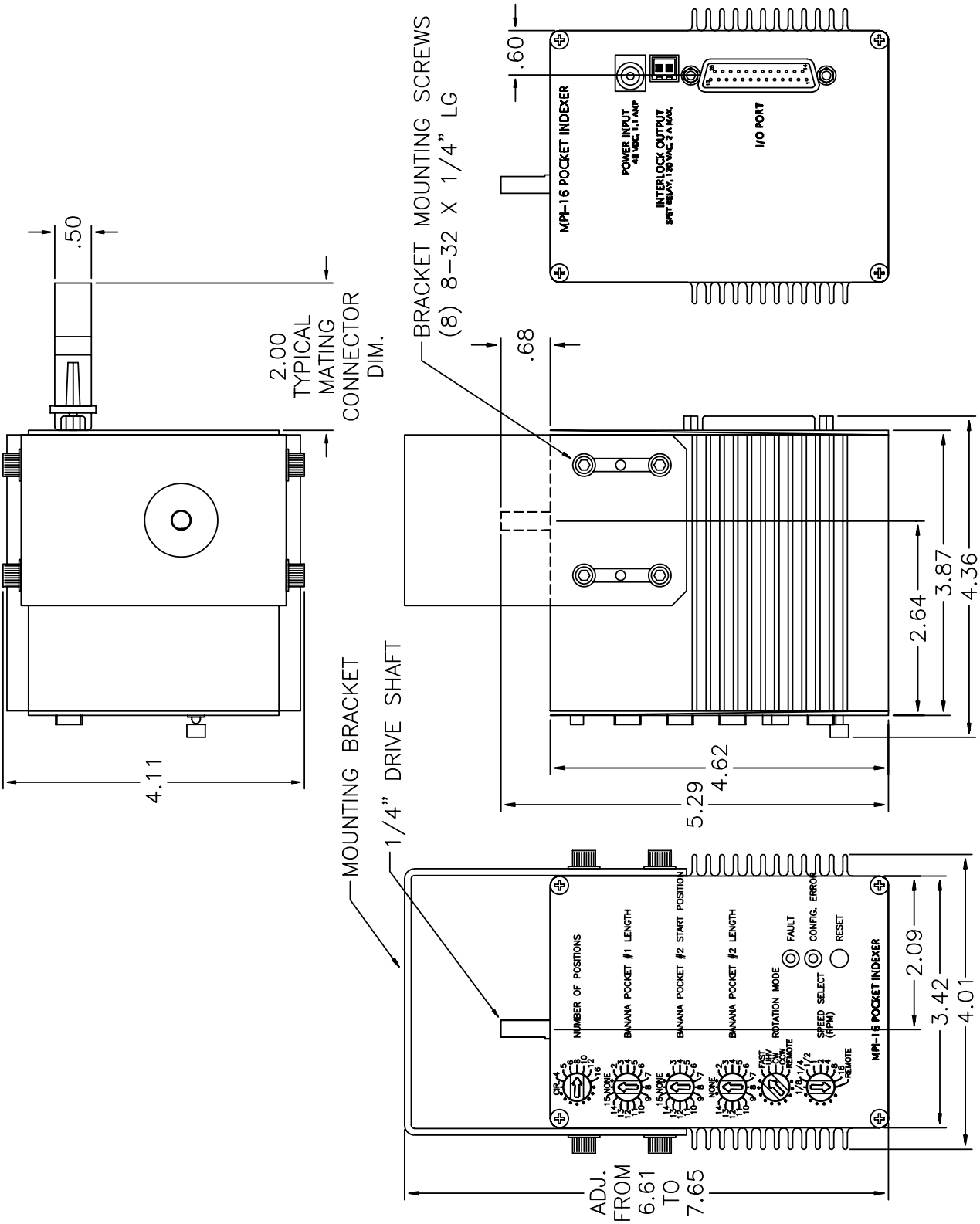



Figure 3-5 MPI-16 Outline Dimensions

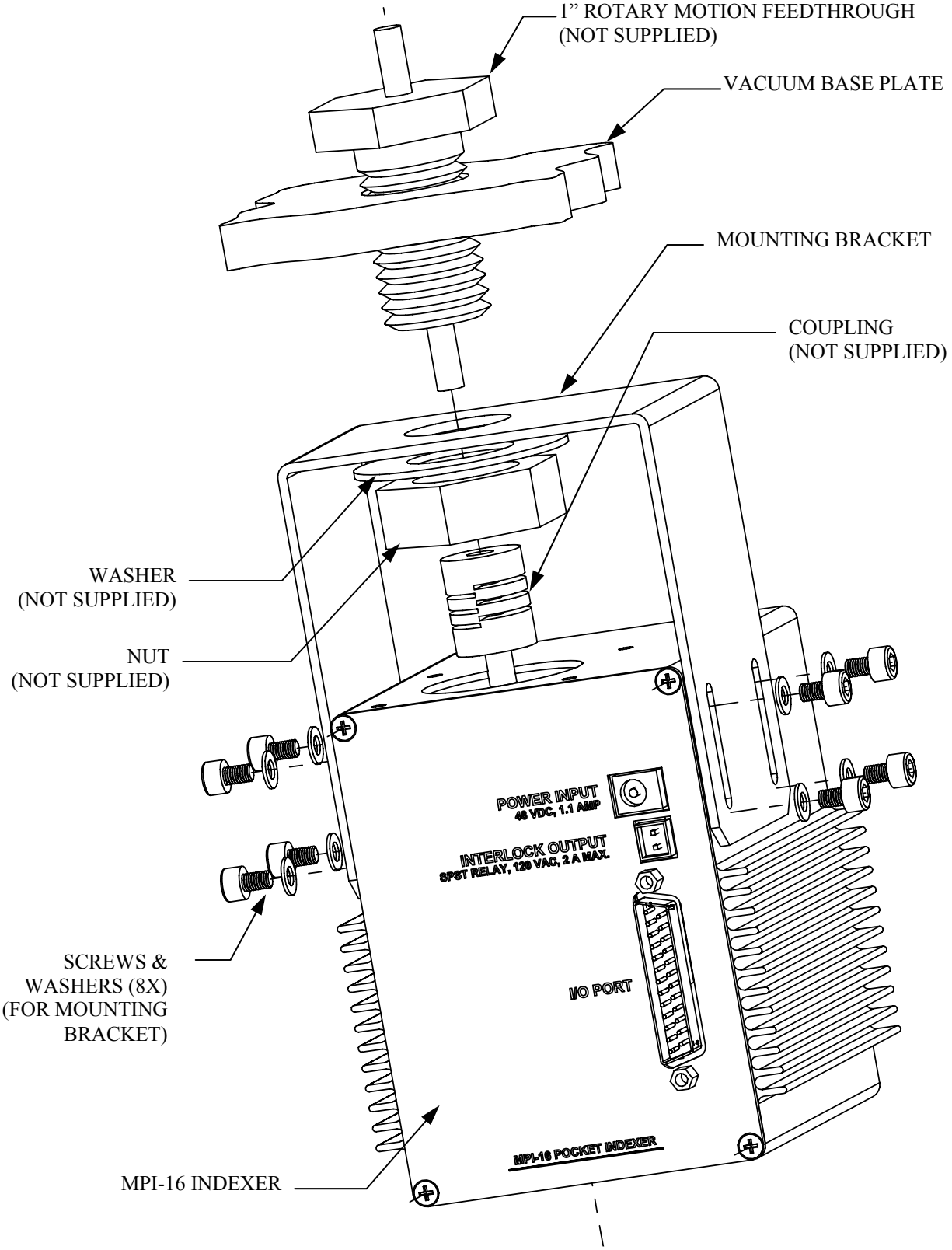



Figure 3-6 Typical Mounting

## 3.6 System Connections

On the rear side of the MPI-16, there are two connectors providing all the necessary signals to complete interfacing with other system components (see Figure 3-10). The DSUB-25 Male, I/O Port connector provides inputs and outputs, and the 2-Pin terminal block, Interlock Output connector, provides the safety interlock signal.

### 3.6.1 I/O Port Connector

Use the provided DSUB-25 Female I/O cable to connect the MPI-16 to your film deposition controller or PLC (programmable logic controller). Connect the female end of the cable to the MPI-16 I/O Port, and wire the open-end of the cable to your controller accordingly. Table 3-2 shows the signal pin assignments for the MPI-16 I/O Port connector. Refer to your controller manual for their I/Os.

| Signal Name | Signal Type | True Condition | Pin No. |
|---|---|---|---|
| Speed Select– Bit 0 | Input | Signal Ground True | 15 |
| Speed Select– Bit 1 | Input | Signal Ground True | 14 |
| Speed Select– Bit 2 | Input | Signal Ground True | 2 |
| | | | |
| Clockwise Rotation | Input | Signal Ground True | 17 |
| Counter Clockwise Rotation | Input | Signal Ground True | 5 |
| | | | |
| Pocket Select– Bit 0 | Input | Signal Ground True | 6 |
| Pocket Select– Bit 1 | Input | Signal Ground True | 7 |
| Pocket Select– Bit 2 | Input | Signal Ground True | 20 |
| Pocket Select– Bit 3 | Input | Signal Ground True | 18 |
| | | | |
| Pocket Position – Bit 0 | Output | Low true* | 22 |
| Pocket Position – Bit 1 | Output | Low true* | 9 |
| Pocket Position – Bit 2 | Output | Low true* | 21 |
| Pocket Position – Bit 3 | Output | Low true* | 8 |
| | | | |
| In Position | Output | Low true* | 11 |
| Fault | Output | Low true* | 24 |
| Disable | Input | Signal Ground True | 19 |
| Reset | Input | Signal Ground True | 12 |
| | | | |
| Inputs Return | Signal Ground | | 1, 13 |
| Outputs Return | Optocoupler | | 10 |
| | | | |
| Not Assigned | Unused | | 3, 4, 16, 23 |

Table 3-2 I/O Port Signal Assignments

* Outputs are pulled-up to 5 volts through a 4.7 K ohms resistors (50 mA max). Low true is with respect to the output return (Pin 10). All outputs are optically isolated transistors.

If you have purchased a INFICON's MDC-360 Thin Film Controller with your MPI-16 Pocket Indexer, a DSUB-25 Female to DSUB-37 Female cable may have also been included, as an option. This cable has a set of pre-defined I/Os to ease your wiring for I/O connections between the MPI-16 and the MDC-360. Connect the DSUB-25 Female end to the MPI-16 I/O connector and the DSUB-37 Female end to the MDC-360 I/O connector. All you have to do is to configure your indexer for your crucible, and program the MDC-360 to drive the indexer.

### 3.6.2 Interlock Output Connector

Use the 2-Pin terminal block connector (provided) and discrete wires (not provided) to connect the Interlock Output on the MPI-16 to your e-beam interlock input to prevent the beam from being on while the crucible is in motion. The MPI-16 Interlock Output is a relay contact. It closes when it is safe to turn on the e-beam and open up when it is NOT safe to turn on the beam. Refer to your e-beam gun manual for its safety interlock requirements.

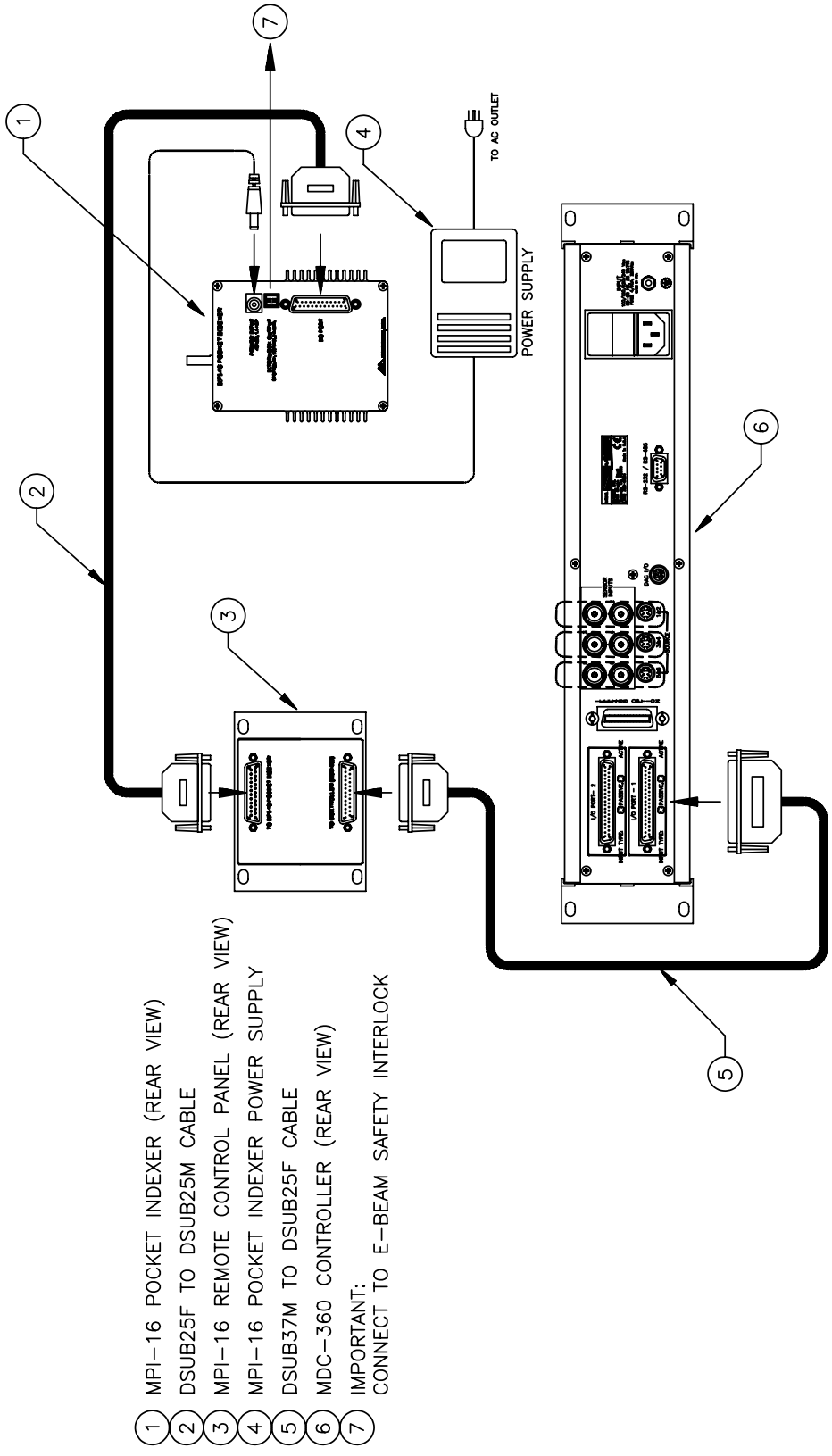



Figure 3-7 System Connections

## 3.7 Connecting to the Remote Panel

If you plan on controlling the MPI-16 manually, you must use the Remote Panel to do so.

Begin by installing the Remote Panel in your instrument rack. It can be placed side-by-side with other half-size or quarter-size rack-space equipment. Since it derives power from its connection to the Pocket Indexer, no additional power supply is required.

With the Pocket Indexer unplugged, attach the male end of the provided DB-25 cable to the MPI-16, and attach the female end of the cable to the Remote Panel.

If you are using the Remote Panel as well as a Deposition Controller, you must use the same cable as you would normally use to connect the MPI-16 to your controller. The 25-pin male jack on the Remote Panel is a pin-for-pin duplication of the I/O of the MPI-16 itself, but now runs through the Remote Panel's **Auto/Man.** switch.

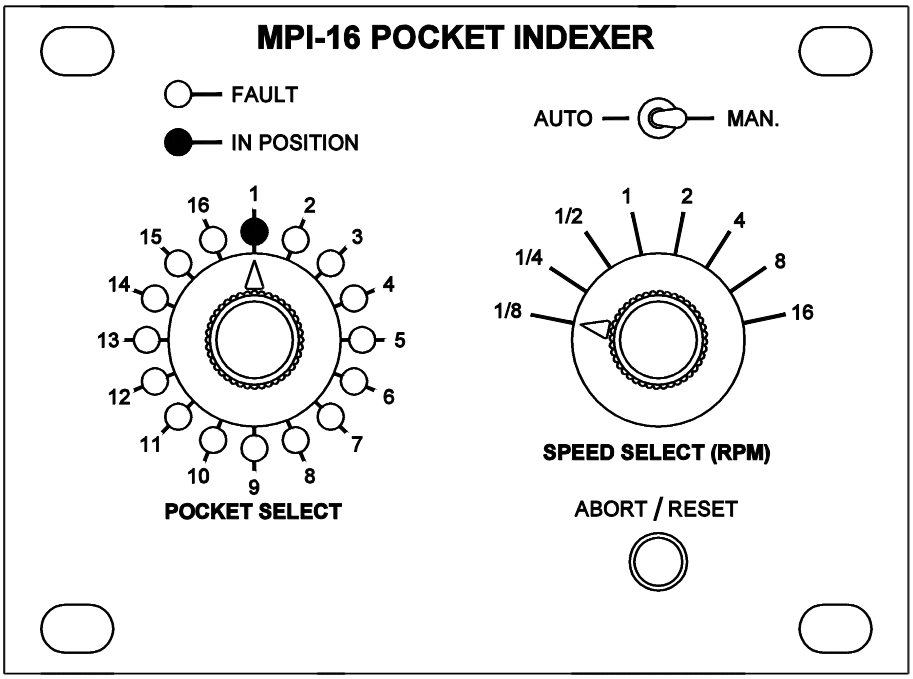



Figure 3-8 Remote Panel – Front View

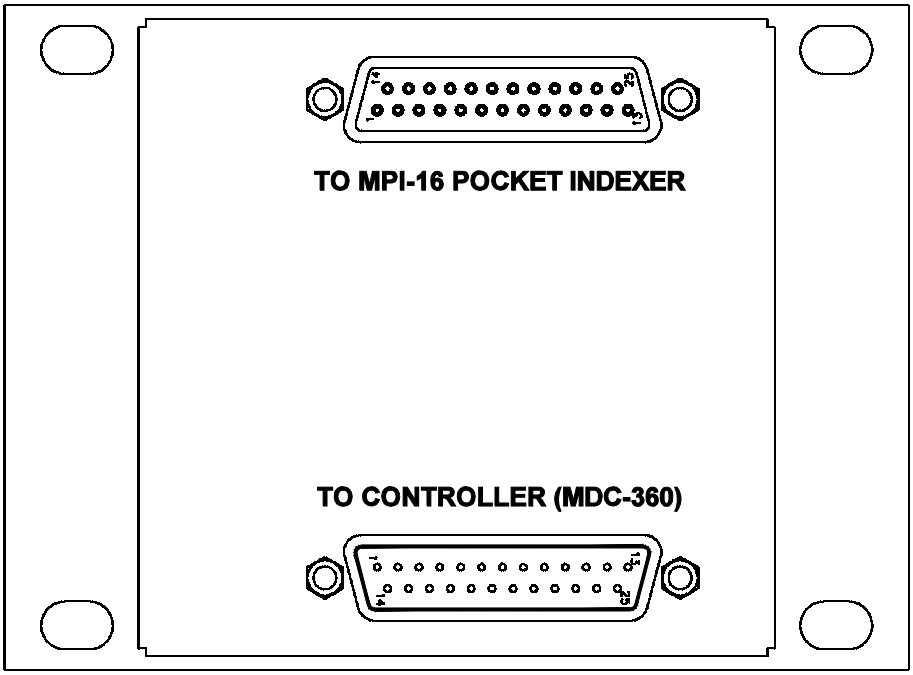



Figure 3-9 Remote Panel - Rear View

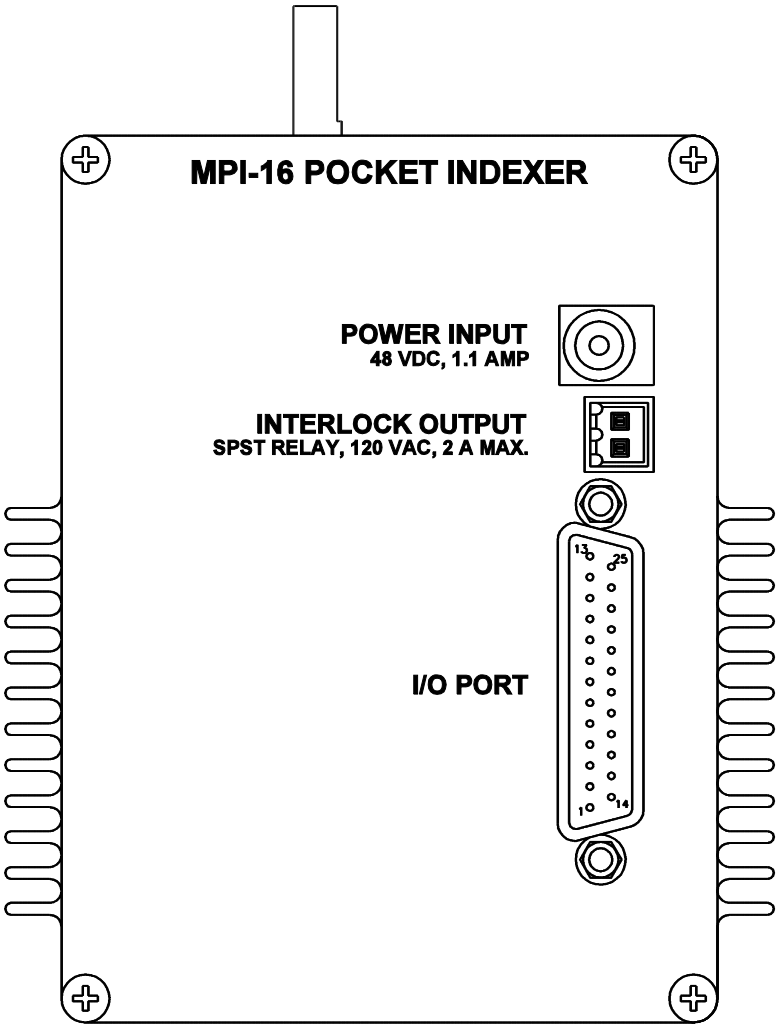



Figure 3-10 Pocket Indexer Rear View

# 4 Operation

Regardless of whether you will be running the MPI-16 in Manual or Automatic mode, be sure that you have read Section 3 and have set up your Pocket Indexer correctly. The Configuration Switch settings dictate how the MPI-16 operates.

Setting up for automatic operation is more involved than manual operation, but it can ultimately lead to greater automation and significant timesaving.

## 4.1 Controlling the MPI-16 Manually

Controlling the MPI-16 manually requires the Remote Panel. On your Remote Panel, flip the switch labeled **Auto / Man.** to the **Man.** setting. This activates the **Pocket Select** and **Speed Select** knobs on the Remote Panel instead of allowing input from an external source, such as a Deposition Controller. Also, on the MPI-16 itself, make sure that the Speed Select switch is set to **Remote**, indicating that the speed setting is to come from the Remote Panel.

Regardless of whether you will be running the MPI-16 in Manual or Automatic mode, be sure that you have read Section 3 and have set up your Pocket Indexer correctly. The Configuration Switch settings dictate how the MPI-16 operates.

Manual operation is very straightforward. Upon reset (unless Circular Mode was set), the MPI-16 finds *Home* (locates the first pocket). After *Home* is found, you are free to move the **Pocket Select** and **Speed Select** knobs to any position you desire. The **Rotation Mode** Configuration Switch determines the method that is used to get to the selected pocket (see Section 3.3).

Note that in the standard version MPI-16, the **Speed Select** setting only applies to Banana Pocket and Circular Mode, and not the seek home speed (fixed at 16 RPM). However, in the high torque version MPI-16H, the **Speed Select** setting applies to all modes: seek home, Banana Pocket and Circular Modes.

If you select a pocket out of the range set by the Number of Pocket switch, the Pocket Indexer will continue to go to the last valid pocket that it sensed, but it will not consider itself “In Position,” nor will the Interlock relay be turned on.

The **Abort/Reset** button on the Remote Panel serves two purposes. Pressing it once will cause the indexer to pause and the Interlock to turn off. Pressing it again causes the process to continue from where it left off. At any point, though, if you hold the **Abort/Reset** button for two seconds, the system will reset itself as if the power were turned on.

## 4.2 Controlling the MPI-16 Automatically

Controlling the MPI-16 automatically requires an external Deposition Controller or PLC. Combining external control with the MPI-16 Pocket Indexer provides a fully automated solution for your deposition process. Although not required when controlling the MPI-16 automatically, the Remote Panel is still a very useful add-on. Having a Remote Panel in

addition to a Deposition Controller allows the operator to run a program, pause the program, check the material level of a particular pocket using the manual Pocket Select knob on the Remote Panel, and resume the program with the Deposition Controller.

If you are using a Remote Panel in conjunction with a Deposition Controller, flip the switch labeled **Auto / Man.** to the **Auto** setting. This allows the **Pocket Select** and **Speed Select** signals from your Deposition Controller or PLC to be sent to the indexer. When you want to use the Remote Panel, simply switch the **Auto / Man.** Switch to the **Man.** setting.

Although most Deposition Controllers are capable of automatically selecting the speed as well as the pocket, it is often not necessary to have such control over the speed setting. If you know that the sweeping speed for Circular and Banana Pockets will not need to be changed, you can set the **Speed Select** switch on the indexer itself. If you want to select various speeds remotely, set the **Speed Select** switch on the MPI-16 to **Remote.** Now, the speed selection will either come from the Deposition Controller (**Auto / Man.** = **Auto**) or the Remote Panel (**Auto / Man.** = **Man.**)

### 4.2.1 Pocket Position Selection

There are two methods of controlling the pocket selection with an external controller, a 4-bit BCD (Binary Coded Decimal) signal or a directional signal. Each of these methods is described below.

#### 4.2.1.1 BCD Code Drive

This method involves setting the Pocket Select Inputs to the desired pocket as a 4-bit BCD signal. See Table 4-1 below for selection truth table. Note that, since it is BCD, if your crucible has fewer than 16 pockets, you don't have to use all four-bit inputs. For example, if you have a 4-pocket crucible, you only need to use Bit 0 and Bit 1.

In this selection mode, as soon as a new value is detected (assuming it is in range), the MPI-16 immediately begins to move to that pocket. This will be the mode of operation if the **Rotation Mode** switch is set to *Fast*, *UHV*, *CW*, or *CCW*.

| **Pocket Select Inputs** | | | | **Pocket Position** |
|---|---|---|---|---|
| **Bit 3** | **Bit 2** | **Bit 1** | **Bit 0** | |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 2 |
| 0 | 0 | 1 | 0 | 3 |
| 0 | 0 | 1 | 1 | 4 |
| 0 | 1 | 0 | 0 | 5 |
| 0 | 1 | 0 | 1 | 6 |
| 0 | 1 | 1 | 0 | 7 |
| 0 | 1 | 1 | 1 | 8 |
| 1 | 0 | 0 | 0 | 9 |
| 1 | 0 | 0 | 1 | 10 |
| 1 | 0 | 1 | 0 | 11 |

| | | | | |
|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 12 |
| 1 | 1 | 0 | 0 | 13 |
| 1 | 1 | 0 | 1 | 14 |
| 1 | 1 | 1 | 0 | 15 |
| 1 | 1 | 1 | 1 | 16 |

Table 4-1 Pocket Select Inputs Truth Table

If you select a pocket out of the range set by the Number of Pocket switch, the Pocket Indexer will continue to go to the last valid pocket that it sensed, but it will not consider itself "In Position," nor will the Interlock relay be turned on.

#### 4.2.1.2 Directional Drive

The alternate method involves sending "Directional Drive" signals from the Deposition Controller. In this mode, when "CW" input is asserted, the MPI-16 rotates clockwise exactly one pocket, and when "CCW" input is asserted, the MPI-16 rotates counter-clockwise exactly one pocket. The MPI-16 will pause briefly to allow the external controller to sense the current position before another CW or CCW signal may be accepted. This will be the mode of operation if the **Rotation Mode** switch is set to *Remote*.

### 4.2.2 Pocket Position Feedback

Typically, the Deposition Controller's program will want to know what pocket the Pocket Indexer is currently on. To facilitate this, a 4-bit "Pocket Feedback" signal is sent back to the controller. This signal is changed whenever the MPI-16 advances to a new pocket position, even if it is not necessarily the target pocket. See Table 4-2 below for position feedback truth table.

| **Pocket Position Feedback Outputs** | | | | |
|---|---|---|---|---|
| **Bit 3** | **Bit 2** | **Bit 1** | **Bit 0** | **Pocket Position** |
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 2 |
| 0 | 0 | 1 | 0 | 3 |
| 0 | 0 | 1 | 1 | 4 |
| 0 | 1 | 0 | 0 | 5 |
| 0 | 1 | 0 | 1 | 6 |
| 0 | 1 | 1 | 0 | 7 |
| 0 | 1 | 1 | 1 | 8 |
| 1 | 0 | 0 | 0 | 9 |
| 1 | 0 | 0 | 1 | 10 |
| 1 | 0 | 1 | 0 | 11 |
| 1 | 0 | 1 | 1 | 12 |
| 1 | 1 | 0 | 0 | 13 |
| 1 | 1 | 0 | 1 | 14 |
| 1 | 1 | 1 | 0 | 15 |
| 1 | 1 | 1 | 1 | 16 |

Table 4-2 Pocket Position Feedback Outputs Truth Table

### 4.2.3 Remote Selection of Rotation Modes

The **Rotation Mode** Configuration Switch determines the type of command it waits for. Upon reset (unless Circular Mode was set), the MPI-16 finds *Home* (locates the first pocket). After *Home* is found, the Pocket Indexer awaits a pocket selection command from the Deposition Controller.

As mentioned ealier, if **Rotation Mode** is set to *Fast*, *UHV*, *CW*, or *CCW*, the MPI-16 awaits a 4-bit BCD signal to select the next pocket. If **Rotation Mode** is set to Remote, the MPI-16 awaits a CW or CCW "Directional Drive" signal.

### 4.2.4 Speed Select

**NOTE:** ***MPI-16 Speed Select only controls the rotating speed in Circular and Banana Pocket Modes. MPI-16H Speed Select controls the rotating speed of all modes: Seeking home, Circular and Banana Pocket Modes.***

The available **Speed Select** settings are shown in Table 4-3 below along with input selections.

| **Speed Select Inputs** | | | **Speed at Motor Shaft (RPM)** |
|---|---|---|---|
| Bit 2 | Bit 1 | Bit 0 | |
| 1 | 1 | 1 | 16 |
| 1 | 1 | 0 | 8 |
| 1 | 0 | 1 | 4 |
| 1 | 0 | 0 | 2 |
| 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1/2 |
| 0 | 0 | 1 | 1/4 |
| 0 | 0 | 0 | 1/8 |

Table 4-3 Speed Select BCD Inputs Truth Table

You may set or control the **Speed Select** setting a number of different ways:

- If your indexer is an MPI-16 and your crucible does not contain any Circular or Banana Pockets, you don't need to worry about the setting at all. However, if it is an MPI-16H, you need to select a speed that fits for your application as this speed also dictates the home seek speed.

- If you are certain that you will not need to change the **Speed Select** setting frequently, you should set the **Speed Select** switch located on the MPI-16 itself.

- If you will need to manually change the sweeping speed frequently, you will need to connect the MPI-16 to the Remote Panel. You must first set the **Speed Select**

switch located on the MPI-16 to **Remote**, indicating you will be controlling the speed remotely. Then, as long as the **Auto/Man.** switch on the Remote Panel is set to **Man.**, you will be able to control the sweeping speed during run-time with the Remote Panel's **Speed Select** switch.

- If you need to change the **Speed Select** setting as part of your Deposition Controller's program, make sure that the correct connections have been made between your controller and the MPI-16 (see Figure 3-7). You must set the **Speed Select** switch located on the MPI-16 to **Remote**, indicating you will be controlling the speed remotely. Then, as long as the **Auto/Man.** switch on the Remote Panel is set to **Auto**, you will be able to control the sweeping speed during run-time through your Deposition Controller's I/Os. Refer to Table 4-3 for speed selection via the indexer's inputs.

#### 4.2.4.1 Drive Shaft Speed vs. Crucible Speed

The speed at the shaft is four times as fast as the speed of the crucible, since a 4:1 speed reduction gear is typically included in industry standard crucibles. Table 4-4 lists the drive shaft speed vs. the speed at the crucible.

| Speed at Motor Shaft (RPM) | Speed at Crucible (RPM) |
|---|---|
| 16 | 4 |
| 8 | 2 |
| 4 | 1 |
| 2 | 1/2 |
| 1 | 1/4 |
| 1/2 | 1/8 |
| 1/4 | 1/16 |
| 1/8 | 1/32 |

Table 4-4 Speed Settings

### 4.2.5 Example: Using the MPI Indexer with the MDC-360

This example shows how to interface the MDC-360/361/370 with the MPI-16 in BCD Control mode. Interfacing the MPI-16 to a non-INFICON controller may differ slightly depending the controller used. Consult the manual of your Deposition Controller for more information on interfacing it with the MPI-16 in either BCD Control or Direct Control mode.

1. Make sure that you have properly connected the MDC-360 as shown in Figure 3-7.
2. Begin by turning on the MDC-360 and exiting **Abort** mode.
3. Under the Main Menu, select "Edit System Setup"
4. Select "Edit Source Setup"
5. Select a Source Setup number to be associated with your specific crucible.
6. Set the number of pockets parameter to match your crucible.
7. Set the Control Parameter to BCD.

8. Set the Drive parameter to either "Up," "Down," or "Fast." (Fast mode will turn the crucible in both directions)
9. Set the Feedback Type parameter to BCD.
10. Set the Indexer Delay parameter to 30 seconds.
11. Return to the Main Menu, and select "View/Edit Material"
12. Select a material that you would like to assign to a particular Pocket Number.
13. Modify the "Pocket" setting and, if desired, any other settings particular to your material.
14. Return to the Main Menu, and select "View/Edit Process."
15. Create or copy a process to edit.
16. Edit the layers to indicate the order of the pockets you would like your program to cycle through.
17. When finished editing, press the "Start" button to select and run the program you have just created.

The MDC will have created a number of "SourceN PocketX" inputs and outputs based on the number of pockets setting, where N is the source number and X is the pocket number. The outputs must be connected to the "Pocket Select Bit X" inputs of the MPI-16. The inputs must be connected to the "Pocket Position Bit X" outputs of the MPI-16. You may also want to connect the Abort output of the MDC to the Disable input of the MPI-16 to disable rotation when the controller is aborted.

If you purchased the special cable to connect the MPI-16 to the MDC (PN#614208), then all of these connections are already made, see Figure 4-1. *Note that this cable is wired for up to 16-Pocket crucible (4 outputs and 4 inputs) AND that it utilizes the first four inputs and outputs of the MDC I/O, for selecting the pocket and position feedback. All other I/Os are not connected. See* Figure 4-1.

Simply plug the 37-pin DSUB connector into one of the MDC's passive I/O cards. Plug the other end of the cable into either the "Controller" connector on the Remote Panel or the "I/O Port" of the MPI-16.

Any problems that you encounter in this setup are most likely due to wiring problems. Return to Section 3.6 to make sure that all of the proper connections were made between your devices.

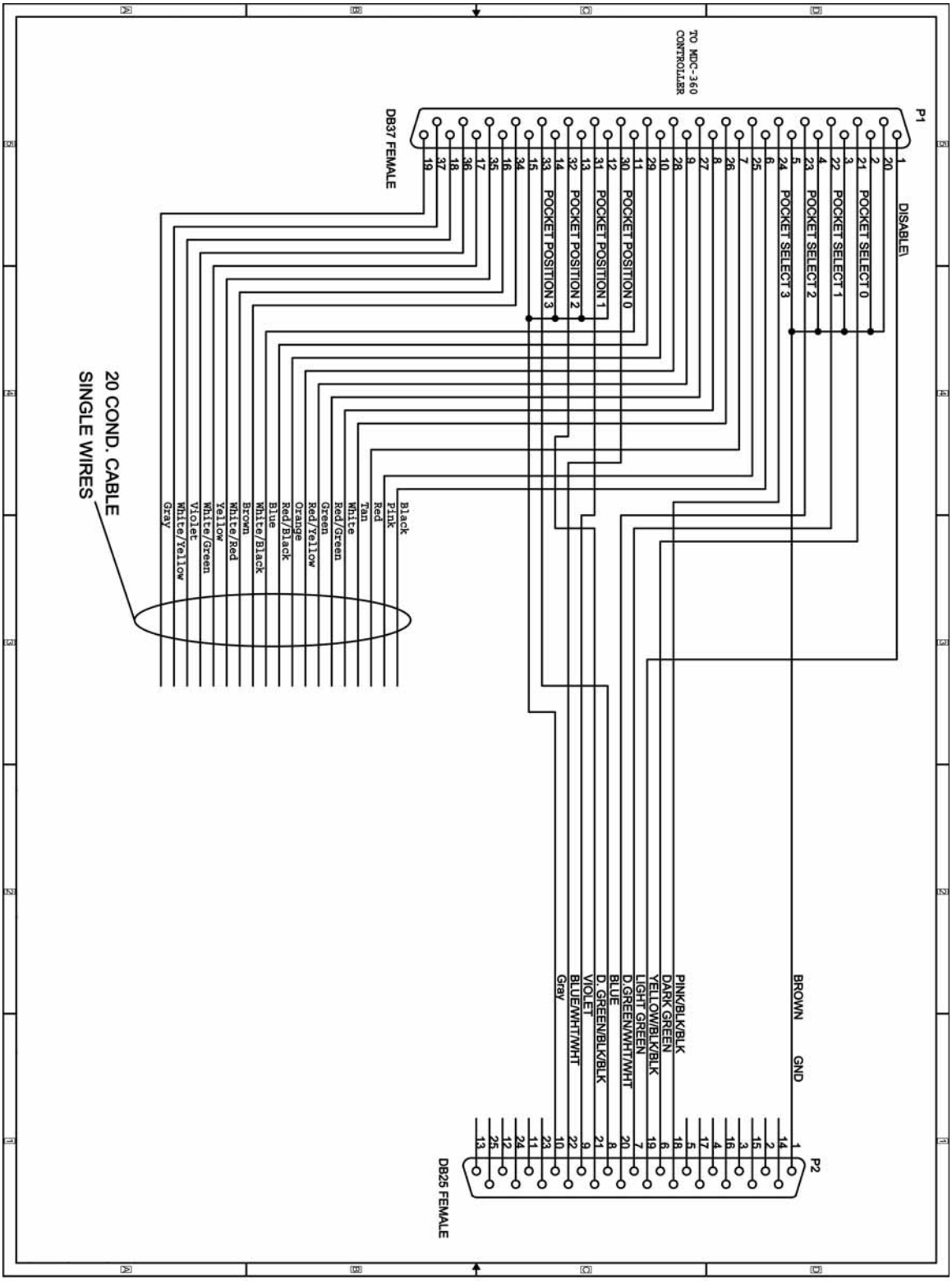



Figure 4-1 DSUB-25 Female to DSUB-37 Female Cable Diagram

## 4.3 System Faults

Several events may occur to the MPI-16 during operation that will cause a run-time fault. A blinking Fault LED will indicate exactly what error has taken place. This section describes the various error conditions and what action should be taken if one occurs.

| 1 Blink – **Abort** Fault ✸ |
|---|
| *Description:*<br>• One of the **Abort** buttons has been pressed. The MPI-16 is now paused and the Interlock has been turned off.<br>*Action:*<br>• If the **Abort** button that was pressed was the **Abort/Reset** button on the Remote Panel (or on the MPI-16 itself), press it again to resume operation.<br>• If the **Abort** button that was pressed was connected to an external controller, take whatever action is needed to remove the **Abort** signal and resume the program (on the MDC-360, this button is labeled **Reset**).<br>• If you wish to reset the MPI-16, hold the **Abort/Reset** button for two seconds. |
| 2 Blinks – **Pocket Select** Fault ✸✸ |
| *Description:*<br>• The selected pocket has exceeded the maximum pocket number that was determined by the Configuration Switch settings when the MPI-16 was last reset. The MPI-16 continues to move towards the last valid pocket number entered, and the Interlock has been turned off.<br>*Action:*<br>• Select a pocket that is within the correct range. Your program will immediately resume. If you feel that you should be able to access a pocket but are unable to, check your Configuration Switch settings. |
| 3 Blinks – **Over Temperature** Fault ✸✸✸ |
| *Description:*<br>• The temperature sensor on the MPI-16 has been activated due to excessive heat (over 100° C). The MPI-16 has stopped moving, and the Interlock has been turned off.<br>*Action:*<br>• Cool the system until it has reached 85° C. The system will automatically restart. Alternatively, you may manually reset the MPI-16, however it will still be bound by the same 100° C temperature limit. |

| 4 Blinks – **Jam** Fault ✸✸✸✸ |
|---|
| *Description:*<br>• An obstruction has caused the MPI-16 to stop rotating, or has severely hindered its ability to move. The unit has been deactivated and the Interlock has been turned off.<br>*Action:*<br>• Remove the obstruction and reset the MPI-16. There is no way to resume operation from where it was stopped. If you find that this fault is occurring without an obstruction present, the crucible is most likely too heavy for the MPI-16 to handle. |
| 5 Blinks – **Position** Fault ✸✸✸✸✸ |
| *Description:*<br>• The position of the motor, compared to the position recorded when it found "Home," has deviated by an unacceptable amount. The unit has been deactivated and the Interlock has been turned off.<br>*Action:*<br>• Reset the MPI-16. This fault is an indication of a hardware problem, and should only occur if your unit has become damaged. If the fault is persistent, contact INFICON about obtaining a replacement part. |
| 6 Blinks – **Encoder** Fault ✸✸✸✸✸✸ |
| *Description:*<br>• The feedback signal of the encoder on your MPI-16 has delivered a faulty signal. The unit has been deactivated and the Interlock has been turned off.<br>*Action:*<br>• Reset the MPI-16. This fault is an indication of a hardware problem, and should only occur if your unit has become damaged. If the fault is persistent, contact INFICON about obtaining a replacement part. |
| 7 Blinks – **No Home** Fault ✸✸✸✸✸✸✸ |
| *Description:*<br>• The MPI-16 couldn't detect the home signal.<br>*Action:*<br>• Reset the MPI-16. This fault is an indication of a magnet/sensor problem, and should only occur if your unit has become damaged. If the fault is persistent, contact INFICON about obtaining a replacement part. |

| 8 Blinks – **Firmware** Fault ✸✸✸✸✸✸✸✸ |
|---|
| *Description:*<br>• The system determined that the internal program was not executing correctly.<br>*Action:*<br>• Reset the MPI-16. This fault is an indication of a firmware problem, and should only occur if your unit has become damaged. If the fault is persistent, contact INFICON for assistance. |
| 9 Blinks – **Brown-Out** Fault ✸✸✸✸✸✸✸✸✸ |
| *Description:*<br>• The supply voltage has dropped to an unexpected level.<br>*Action:*<br>• Reset the MPI-16. Check that your power supply is operating correctly. If the fault is persistent, the problem could be due to the internal voltage regulator of the MPI-16. If you are certain that your power supply is operating correctly, contact INFICON for assistance. |

Table 4-5 System Faults

## 4.4 Abort and Reset

The MPI-16 has a multi-purpose **Abort/Reset** switch on its main panel. An additional switch providing the same functionality is located on the optional Remote Panel. This button has a long debounce time (150 ms) to ensure that noise or accidental triggering does not stop your process.

- Pressing the **Abort/Reset** button once will pause the MPI-16 and turn off the Interlock.
- Pressing the **Abort/Reset** button again will resume operation from the point it was interrupted.
- At any point, holding the button for two seconds will reset the MPI-16.

When the MPI-16 is paused with this button, the Fault LED will blink.

# 5 Troubleshooting Aids

The MPI-16 was designed around a philosophy of trouble-free and maintenance-free assembly. Field repair at the component level is not recommended and indeed can void the warranty. The following sections are intended primarily as an aid in understanding the operation of the MPI-16 and to help in identify possible problems that may occur.

| Symptom | Possible Cause | Remedy |
|---|---|---|
| MPI-16 does not find home upon power up. | No power at the wall outlet where the power cable is plugged into. | Test for correct power or try a different wall outlet. Check that the Green indicator on the portable power supply is lit. |
| | Power cable is not properly connected. | Verify that the power cable is firmly connected at both ends. Check that the Green indicator on the portable power supply is lit. |
| | The output cable from the portable supply is not properly connected to the MPI-16 input power connector. | Verify that the portable supply output cable is firmly connected to the MPI-16 input power connector. |
| MPI-16 does not response to new configuration set up. | Unit has not been reset after the configuration was changed. | Reset unit by holding the Reset button down for more than 2 seconds. |
| MPI-16 does not response or response incorrectly to a command code from the controller. | Incorrect wiring of I/O interface signals. | Verify that I/O signals driving that particular command code is wired correctly from the controller to the MPI-16 I/O port. |
| | Discontinuity or loose connection(s) in the wiring of the I/O interface signals. | |
| | The controller issues a wrong command code. | Verify the controller is indeed outputting a proper code for the desired action. |
| | The Disable input to the MPI-16 is true. | Remove or return this input to a false state. |
| | The Auto/Manual switch on the Remote Panel is set to Manual. | Set this switch to Auto. |

| | | |
|---|---|---|
| Fault LED is blinking. | Various. | Count the numbers of blinks, then refer to Table 4-5 for remedy. |
| Configuration LED is blinking. | Various. | Count the numbers of blinks, then refer to Table 3-1 for remedy. |

## 5.1 Returning The Indexer To The Factory

If there is a need to return your indexer to the factory, please call INFICON to obtain a Returned Merchandise Authorization Number (RMA#). This number is required prior to returning your indexer to the factory. You are required to show this RMA number on your shipping document. It will help us track and ensure proper actions will be made to your indexer.

# 6 Appendix A
## Quick Reference for Configuration Errors and Faults

The following guide will give you a quick idea of what problem is causing the blinking when you encounter a Configuration Error or Fault.

| Config. Error LED | | Fault LED | |
|---|---|---|---|
| **No. Of Blinks** | **Error Description** | **No. Of Blinks** | **Fault Description** |
| 1 | Switch Out of Range | 1 | Abort |
| 2 | Circular Pocket | 2 | Pocket Select |
| 3 | No Banana Pockets | 3 | Over Temperature |
| 4 | One Banana Pocket | 4 | Jam |
| 5 | No Second Banana Pocket | 5 | Position |
| 6 | Two Banana Pockets | 6 | Encoder |
| | | 7 | No Home |
| | | 8 | Firmware |
| | | 9 | Brown-Out |

Table 6-1 Quick Reference - Errors and Faults

* *Indicates a Fault that may be corrected without a system reset.*

For a complete list of Configuration Errors, see Table 3-1.

For a complete list of Faults, see Table 4-5.