Instruction Manual 0101-8960-4
L&SP 7310

Temescal

TRC-3460
Electron Beam Source Indexer

BOC
COATING
TECHNOLOGY

Temescal
Part of BOC Coating Technology, a member of The BOC Group, Inc.
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Revision History
0101-8960

Revision	Change Description	Reason/Application	Date	Approved
-0	Initial version of manual	Preliminary dissemination of product information	7/18/94	RF
-1	Manual rewritten based on initial investigation of product	Internal review version only	6/1/95	RF
-2	Corrections to -1 version based on internal review	First formally released version of manual	6/20/95	RF
-3	Added voltage/current specs on I/Os to pp. 1-3, 2-15, and 2-16. Updated Table 2-4 on p. 2-16.	Additional I/O info. required for installations. Table 2-4 revised due to software change.	12/4/95	RF
-4	Refined instructions regarding querying the unit from a remote device via RS-232.	Per new information regarding this function	6/22/96	RF

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Fairfield, California 94533-0252

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TABLE OF CONTENTS

SUMMARY OF TERMS AND CONDITIONS OF SALE

MECHANICAL WARRANTY: For a period of twelve (12) months from the date of original shipment to Purchaser thereof, the apparatus and each part or component manufactured by Temescal, part of BOC Coating Technology, a member of The BOC Group, Inc., hereinafter known as "Seller," is warranted to be free from functional defects in materials and workmanship. The foregoing warranty is subject to the condition that the apparatus, part, or component be properly operated under conditions of normal use, and that regular periodic maintenance and service be performed, or replacements made, in accordance with instructions provided by Seller. The foregoing warranty shall not apply to any apparatus, part, or component that has been repaired other than by Seller or an authorized representative of Seller, or in accordance with written instructions provided by Seller; that has been altered by anyone other than Seller; or that has been subject to improper installation or abuse, misuse, negligence, accident, or corrosion.

Purchaser's sole and exclusive remedy under the above warranty is limited to, at Seller's option, repair or replacement of defective parts or components, or return to Purchaser of the price of the apparatus. Any such obligation on Seller's part is subject to the following requirements: (x) the defect must be promptly reported to Seller; (y) if so advised by Seller, Purchaser must return the part or component with a statement of the observed deficiency not later than seven (7) days after the expiration date of the warranty to the address designated by Seller, during normal business hours, transportation charges prepaid; and (z) upon examination by Seller, the part or component must be found not to comply with the above warranty. Return trip transportation charges for the part or component shall be paid by Purchaser. In the event that Seller elects to refund the purchase price, the apparatus shall be the property of Seller and shall be promptly shipped to Seller at Seller's expense. This mechanical warranty shall be void and the apparatus shall be deemed to be purchased AS IS in the event that the entire purchase price has not been paid within thirty (30) days of original shipment of the apparatus.

THERE ARE NO EXPRESS OR IMPLIED WARRANTIES THAT EXTEND BEYOND THE WARRANTY HEREINABOVE SET FORTH. THERE IS NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE APPARATUS OR ANY PART OR COMPONENT THEREOF, AND NO WARRANTY SHALL BE IMPLIED BY LAW.

Items not of Seller's manufacture but resold by Seller are the products of other manufacturers and their warranty, if any, shall apply. THERE ARE NO WARRANTIES OF ANY KIND ON PRODUCTS OF OTHER MANUFACTURERS RESOLD BY TEMESCAL, EXCEPT THE WARRANTY OF TITLE, AND NO WARRANTIES SHALL BE IMPLIED BY LAW. THERE IS NO EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO PRODUCTS OF OTHER MANUFACTURERS.

PERFORMANCE WARRANTY: Seller warrants that the apparatus will comply with the specifications set forth in the purchase order. All specifications are subject to the corrections and tolerances allowed by the NEC. If the purchase order expressly provides for factory testing to verify compliance with the specifications, Purchaser shall be entitled to witness the testing and the results of the testing. Upon demonstration of compliance with the specifications by factory testing, Seller's liability for failure to comply with the specifications shall terminate. In the event that the purchase order does not describe a comprehensive test program for demonstration of compliance with the specifications, Seller's test program (which may incorporate extrapolation of data or test results based upon similarity of criteria established by Seller) shall be used for such purpose.

If the purchase order does not expressly provide for factory testing, compliance with the specifications shall be demonstrated by field testing which shall be conducted by Purchaser at Purchaser's expense. Seller shall have the right to: (a) witness the field testing and to verify the results of such field testing; (b) have free access to all data compiled by Purchaser in connection with any field test; and (c) conduct its own field test at its own expense during any fourteen-day (14-day) consecutive period which may be mutually agreed upon by Seller and Purchaser; provided, however, that Seller shall have the right to field test within six (6) months of receipt from Purchaser of any notice of failure to comply with the specifications. If compliance with the specifications is to be demonstrated by field testing, Purchaser shall conduct and complete all field testing within sixty (60) days of the original shipment of the apparatus and shall promptly notify Seller of any failure to comply with the specifications. Seller shall not be liable for any failure to comply with the specifications demonstrated by field testing unless it receives notice thereof within sixty-seven (67) days of the date of original shipment of the apparatus.

In the event that factory testing or field testing does not demonstrate compliance with the specifications, Purchaser's sole and exclusive remedy under the above warranty is limited to, at Seller's option, repair or replacement of defective parts or components or return to Purchaser of the purchase price of the apparatus. In the event that Seller elects to refund the purchase price, the apparatus shall be the property of Seller.

Any obligations on Seller's part under this performance warranty are subject to the following requirements: (x) the nature of the failure of the apparatus to comply with the specifications must be promptly reported to Seller in writing; (y) if the apparatus has been delivered and field tested, Purchaser must return the apparatus or any part or component to Seller upon its request, not later than sixty-seven (67) days after initial shipment to Purchaser, to the address designated by Seller, during normal business hours, transportation charges prepaid; and (z) upon examination and testing by Seller, the apparatus must be found not to comply with the specifications. Return trip transportation charges for the apparatus or any part or component shall be paid by Purchaser. This performance warranty shall be void and the apparatus shall be deemed to be purchased AS IS in the event that the entire purchase price has not been paid within thirty (30) days of original shipment of the apparatus.

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DISCLAIMER OF LIABILITY: IN NO EVENT SHALL SELLER BE LIABLE FOR DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING FROM ANY SOURCE such as, but not limited to, the manufacture, use, delivery (including late delivery), or transportation of any apparatus, part, or component sold to Purchaser, whether such damages are caused by Seller's negligence or otherwise. Without limiting the generality of the foregoing sentence, Seller shall not be liable for: the cost of capital; the cost of substitute apparatus, services, repairs, components, or parts; loss of profit or revenue; the cost of power, whether purchased or produced by the consumer thereof; loss of use of the apparatus or any part thereof, or of any other property owned by Purchaser; claims or costs of Purchaser's customers; injury to persons, or death; or damages to any property. In the event that any limited warranty or disclaimer of liability is found to be unlawful or inapplicable, or to have failed of its essential purpose, Seller's liability shall be limited to the amount paid by Purchaser for the apparatus.

SAFETY INSTRUCTIONS FOR OPERATING AND SERVICE PERSONNEL

Operators and service personnel should always wear safety glasses. Operators shall not enter areas intended for service access only. Only experienced service personnel should enter such areas, and only after taking the preliminary precautions described in paragraphs 1 through 6 below.

DANGER

Potentially lethal voltages may exist within this unit, even with the line power switched off. Service should only be attempted by qualified personnel. Failure to observe all safety precautions may result in personal injury.

This component is designed to operate as part of a system containing high-voltage equipment. Observe the precautions described below when servicing this system, especially when servicing components where high voltages may be present.

1. Before servicing or operating this equipment, read all the component manuals supplied with the system, paying special attention to safety instructions.
2. Post HIGH VOLTAGE WARNING signs in conspicuous locations within the service area.
3. Remove rings, watches, bracelets, and any other metal jewelry before working around high voltage.
4. DO NOT WORK ALONE!
5. Be sure that all equipment is connected to a power receptacle having the correct polarity and grounding, as prescribed by the local electrical codes. Refer to the power supply portion of the documentation to determine the proper electrical ground for high-voltage components.
6. Before servicing any high-voltage component, switch off the electrical power at the component's main power switch. This switch should have a lockout feature. Lock the power off and keep the key with you while you are working on the equipment.
7. Certain electrical parts (e.g., electrolytic capacitors) hold a lethal voltage even after the power is switched off. Before entering any service area, use a grounding hook to discharge such parts. Be sure that these parts are discharged before starting any repairs.
8. DO NOT touch high-voltage leads unless power is off and a grounding hook is connected to the parts to be serviced.
9. The high-voltage components of the system should be equipped with electrical interlocks to protect personnel from injury. DO NOT ATTEMPT TO DEFEAT, OVERRIDE, OR BYPASS THESE PROTECTIVE DEVICES!
10. Never leave loose ends on high-voltage connections.
11. Observe the following warning if the system employs Radio Frequency (RF) power.

DANGER

RF radiation—even at modest power levels—can cause serious injury. If any of the RF components (e.g., the RF power supply, the RF matching network, or the RF electrodes or shielding inside the product chamber) are moved or changed in any way, the RF energy may be radiated outside the equipment. Monitor the equipment to assure that external RF radiation is below the levels prescribed by any and all applicable safety codes.

Special Amendment for United Kingdom Users

All Electrical Power Sources: Safety Precautions

This component is designed to be used in an extra-high-voltage system. Only authorized personnel should be permitted to carry out work on this system.

Prior to any servicing, grounding hooks should be used to short out all high-voltage parts and conductors in both the vacuum system and the high-voltage power supply. Screens protecting extra-high-voltage conductors should be removed only if appropriate action has been taken to ensure that extra-high-voltage conductors are dead and cannot be reenergized inadvertently.

In addition, all personnel should be aware of:

1. the Electricity (Factories Act) Special Regulations (1908 and 1944), in particular, Regulations 18(d) and 28 of the 1980 Regulations, as amended; and

2. the employer's responsibility to set up suitable systems to safeguard the health and safety of employees, according to the Health & Safety at Work etc. Act (1974).

USER RESPONSIBILITY

This equipment will perform in accordance with the instructions and information contained in the user's manual and its referenced documents when such equipment is installed, operated, and maintained in compliance with such instructions. The equipment must be checked periodically. Defective equipment shall not be used. Parts that are broken, missing, plainly worn, distorted, or contaminated, shall be replaced immediately. Should such repair or replacement become necessary, a telephone or written request for service should be made to BOC Coating Technology Fairfield.

The equipment, or any of its parts, shall not be altered without the prior written approval of BOC Coating Technology. The user and/or purchaser of this equipment shall have the sole responsibility for any malfunction which results from improper use, faulty maintenance, damage, improper repair, or alteration by any party other than BOC Coating Techology.

HEALTH HAZARD

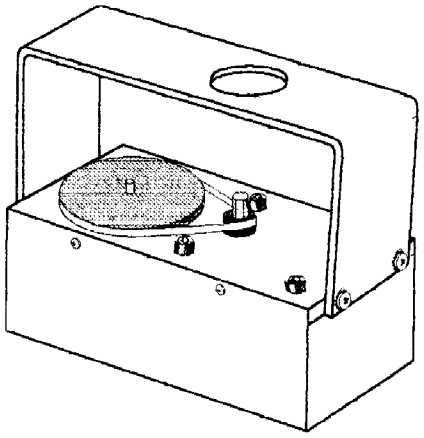
The condensates deposited on the tank walls of a vacuum system are generally in the form of extremely fine particles. The nature, as well as the form, of the materials pose the following potential health hazards:

a) Inhaling fine particles (powder) may cause damage to the lungs. To help prevent this, wear a protective respirator mask with fine filter that has been approved by the National Institute for Occupational Safety and Health (NIOSH) and the federal Mine Safety and Health Administration (MSHA).

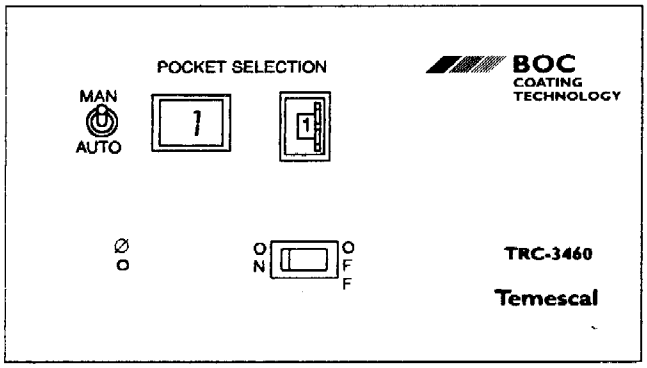
b) Some deposited condensates are toxic; inhaling them should be avoided. Take steps to ascertain whether or not the material being deposited is a known toxic substance. Refer to the Material Safety Data Sheet(s) covering the evaporant(s) in question.

c) Certain powders. (e.g. titanium) can cause flash fires when exposed to oxygen or other oxidizers. Therefore, when opening the chamber door after a deposition cycle, exercise extreme caution and allow time for the coating surface to oxidize. Breakage of some of the more reactive condensates may be hazardous, even when the above precautions are observed. In this situation, fire-protective clothing should be worn.

SECTION 1
DESCRIPTION AND SPECIFICATIONS



TRC-3460 Index Drive Unit



Front Panel of TRC-3460 Control Unit

1.1 PACKAGE CONTENTS

The shipping package for the TRC-3460 contains the following items:

- 1 Index drive unit
- 1 Control unit
- 1 Motor cable
- 1 110-volt power cable
- 1 TRC-3460 Manual

I/O cabling must be user supplied. For complete instructions on I/O wiring, see section 2.8.

1.2 PRODUCT DESCRIPTION

The Temescal model TRC-3460 source indexer operates all e-beam turret sources that feature internal 4:1 gear reduction. This versatile indexer offers manual or remote pocket selection, unidirectional or bidirectional indexing, and special control modes for UHV sources, sources with banana-shaped pockets, and sources with continuous evaporant carousels. In addition, the TRC-3460 is the only source indexer that offers front-panel electronic phase adjustment. The unit is easy to install, mounting to a standard 1-inch-diameter rotary feedthrough, and is field-retrofittable to any Temescal system.

With its standard firmware, the TRC-3460 is compatible with eight different types of sources, including standard 4-, 6-, and 8-pocket sources, 4-pocket UHV sources, standard sources with full-circle evaporant carousels, and standard sources with two circular pockets and one banana-shaped pocket. These "bananas" can be any of three different arc lengths (120°, 135°, or 145°). Custom firmware can also be developed for sources of other configurations.

For standard multipocket sources, the TRC-3460 supports both unidirectional and bidirectional indexing. In unidirectional mode, the indexer offers the choice of either clockwise or counterclockwise rotation. The bidirectional mode features "shortest path" indexing to ensure that the hearth takes the most direct path to the selected pocket.

In its special UHV mode, the indexer limits rotation to 270° clockwise from pocket 1 and prevents direct rotation between pocket 1 and the next pocket counterclockwise. Another special operating mode is provided for sources with banana-shaped pockets. In this mode, indexing occurs normally between the two standard pockets, but when the "banana" is selected, the indexer oscillates the hearth so that the beam travels from one end of the banana-shaped pocket to the other. This motion continues until another pocket is selected or until the unit is switched off.

1.3 SPECIFICATIONS

Source-control modes	Unidirectional and bidirectional indexing for standard multipocket sources Motion-limited bidirectional indexing for 4-pocket UHV sources Normal indexing plus oscillation for sources with banana-shaped pockets Continuous rotation for full-circle evaporant carousels
Source types supported	Standard 4-pocket source Standard 6-pocket source Standard 8-pocket source UHV 4-pocket source Standard source with two circular pockets and one 120° "banana" Standard source with two circular pockets and one 135° "banana" Standard source with two circular pockets and one 145° "banana" Standard source with continuous evaporant carousel
Max. rotation speed	.845 rpm
Max. output-shaft torque	120 in.-oz.
Resolution	3°
I/Os	Internally or externally supplied; outputs limited to 10 ma per output
Internally supplied	low = –9 V dc, high = +9 V dc
Externally supplied	low = 0 V dc, high = +24 V dc
Safety interlocks	
POCKET GOOD output	De-asserted when any pocket is more than 5° out of phase
System interlock input	Can be used to prevent rotation under user-defined system conditions
Utility power	
Voltage	120 or 240 V ac at 60 Hz
Maximum power	10 watts
Power cable	
120-V power	IEC type, included
240-V power	IEC type, user-supplied
Fuse required	
120-V power	1/4-A Slo-Blo, included
240-V power	1/8-A Slo-Blo, user supplied
Size	
Drive unit	2.875 in. wide x 4.875 in. high x 5.5 in. deep (74 mm x 124 mm x 140 mm)
Control unit	8.50 in. wide x 5.25 in. high x 7.00 in. deep (216 mm x 134 mm x 178 mm)
Total weight	
Drive unit	2.0 lbs.
Control unit	3.2 lbs.
Installation method	
Control unit	Mounts in standard 19-in. rack
Index drive unit	Shaft couples directly to standard 1-in.-diameter rotary feedthrough
Required Coupling	PN 9015-0121-01
Replacement drive belt	PN 9018-2030-0

SECTION 2
CONFIGURATION AND INSTALLATION

2.1 SECTION OVERVIEW

This section describes the procedures required to install the TRC-3460 in a system and to configure it for operation. These procedures include:

- Configuring the control unit for 120-V or 240-V input power (section 2.2)
- Setting the configuration DIP switches (section 2.3)
- Configuring the optoisolator PC board for 24-V dc I/Os (section 2.4)
- Bench-testing the indexer (section 2.5)
- Installation (section 2.6)
- Initial phase adjustment (section 2.7)
- Making system connections via the rear-panel I/O interface (section 2.8)
- Making system connections via the rear-panel RS-232 interface (section 2.9)

The configuration DIP switches enable you to configure the indexer to operate the specific type of source you will be using. The DIP switches also allow you to select uni- or bidirectional rotation, the rotation direction, RS-232 communications enabled/disabled, and the baud rate for RS-232 communications.

2.2 CONFIGURING THE CONTROL UNIT FOR 120-V OR 240-V INPUT POWER

The TRC-3460 is designed to operate on either 120-V or 240-V ac input power. Figure 2-1 shows the rear panel of the control unit, with the features related to input power highlighted.

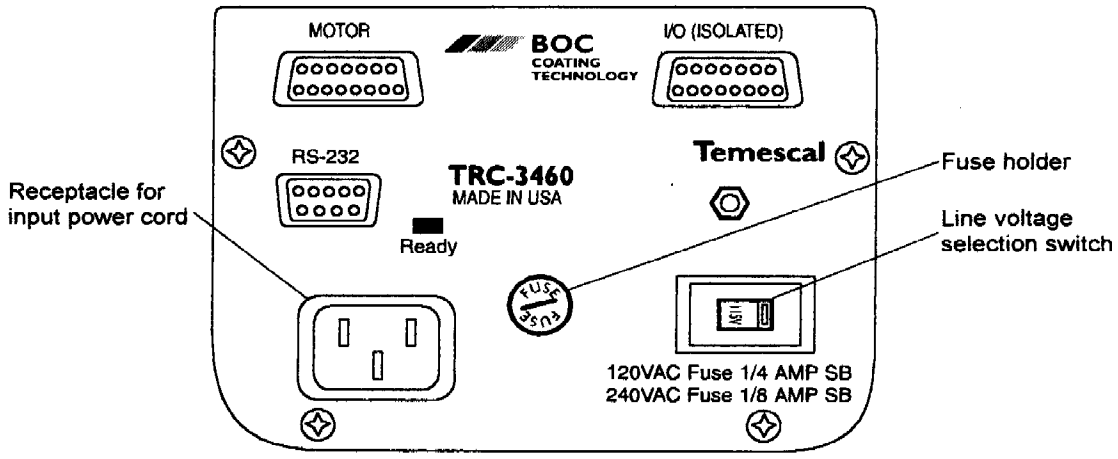


Figure 2-1. Control unit rear panel

The unit comes with an IEC-type power cord and a 1/4-A Slo-Blo fuse to support 120-V operation. If 240-V operation is required, the user must supply an IEC power cord rated for 240 volts and an 1/8-A Slo-Blo fuse. The line voltage selection switch must be set to the right for 120-V power and to the left for 240-V power. Figure 2-2 shows the switch in each of these positions.

WARNING
Operating the TRC-3460 with incorrect line voltage selected will damage the unit.

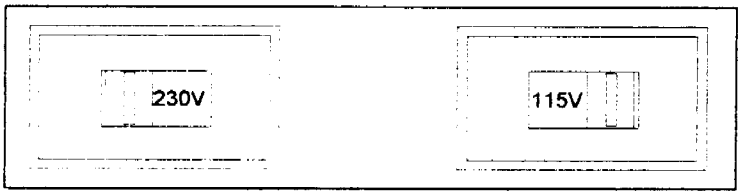


Figure 2-2. The two positions of the line voltage selection switch

2.3 SETTING THE CONFIGURATION DIP SWITCHES

The control unit contains eight internal DIP switches that enable you to configure the unit to support your application. Three of these DIP switches configure the indexer for use with a specific source type. The other switches allow you to select uni- or bidirectional motion, the rotation direction, RS-232 communications enabled/disabled, and the baud rate for RS-232 communications.

CAUTION

Internal DIP switches 1-5 MUST be set properly to configure the indexer for the type of hearth it will be controlling. Failure to set these switches correctly will lead to improper operation and may result in damage to the source.

Gaining Access to the DIP Switches

Before attempting to change any DIP switch settings, it is essential to ensure that the AC power is not connected to the controller. If the unit has been in use, first use the front-panel switch to power down the unit. Then disconnect the unit's AC power cord.

WARNING

Procedures involving the controller's internal circuitry may be hazardous if attempted with the AC power cord connected.

To gain access to the DIP switches, you must slide back the control unit's top cover. To do so, first insert a thin, flat-bladed screwdriver beneath the rear edge of the cover and pry it up enough so that the retainer dimple in its rear edge clears the top edge of the controller's rear panel. Then you can easily slide the cover back by applying thumb pressure to it and pushing rearward. When you have finished setting the DIP switches, slide the cover forward until the retainer snaps into place, firmly securing the cover.

The switch block containing the DIP switches is mounted along the front edge of the controller's main printed circuit board. If you look at the board from a position above the front panel, you will see the switch block near the right-hand edge of the board. The DIP switches are on the side of the switch block that faces the front panel. Note that they are numbered 1 through 8 from left to right, as viewed from the front end of the control unit.

Figure 2-3 illustrates the eight DIP switches from this point of view and lists the effects of their settings in tabular form. Note that these switches slide rather than rock up and down to change position and that the ON position is up. A small, fairly rigid tool with a short hook or 90° bend at one end is helpful in changing the settings of the DIP switches.

The DIP Switch Settings and Their Effects

Switches 1-3: Source Type

As Figure 2-3 shows, switches 1-3 determine source type. Further information about setting the DIP switches for specific source types is provided below.

Switch 4: Uni-/Bidirectional Rotation

Switch 4 allows you to select uni- or bidirectional rotation. If unidirectional rotation is selected (switch 4 ON), the direction of rotation is determined by the setting of switch 5. If bidirectional rotation is selected (switch 4 OFF), the indexer will employ shortest-path indexing in moving between the pockets of multipocket sources.

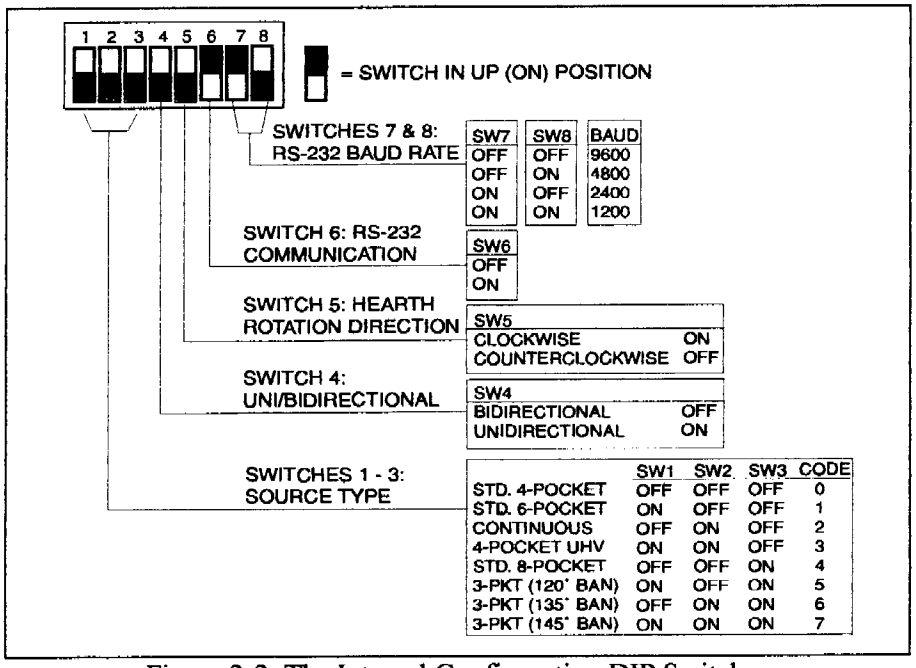


Figure 2-3. The Internal Configuration DIP Switches

Switch 5: Rotation Direction

The setting of switch 5 determines the direction of hearth rotation in unidirectional mode and the primary rotation direction in bidirectional mode. What this means, for both uni- and bidirectional operation, is that the orientation of pocket numbering (i.e., which direction is "forward," or upward through the pocket numbers) changes depending on the setting of DIP switch 5. Figure 2-4 illustrates this in the case of a 4-pocket source. When DIP switch 5 is on, the indexer will operate such a source as if its pockets were numbered 1–4 clockwise. When this switch is off, the indexer will operate the same source as if its pockets are numbered 1–4 counterclockwise. The same principle applies to all other source types.

(Note: If you observe the motion of the output shaft of the index drive unit, you will note that it rotates counterclockwise when DIP switch 5 is on and clockwise when this switch is off. Because of the effect of the internal gears in the sources supported by the TRC-3460, output shaft rotation is in the opposite direction from hearth rotation.)

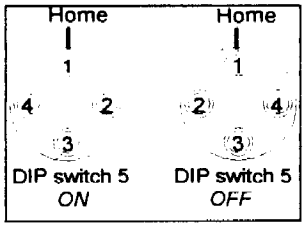


Figure 2-4. How the orientation of pocket numbering changes depending on the setting of DIP switch 5

NOTE

When planning for multipocket deposition, it is critical to bear in mind that the setting of switch 5 determines the orientation of pocket numbering. The pockets of a 4-pocket source must be thought of as being numbered 1-4 in a clockwise direction when switch 5 is on and 1-4 in a *counterclockwise* direction when switch 5 is off.

Switches 6-8: RS-232 Communications

You can disregard these switches if you are not using RS-232 communications. Note that to enable RS-232 communications, you must set switch 6 to OFF. Use switches 7 and 8 to set the baud rate.

Configuring DIP Switches 1–5 for Specific Source Types

DIP switches 1-3—and, in some cases, switches 4 and 5 as well— must be set correctly to configure the controller for the eight source types supported by the TRC-3460. These source types are illustrated in Figure 2-5.

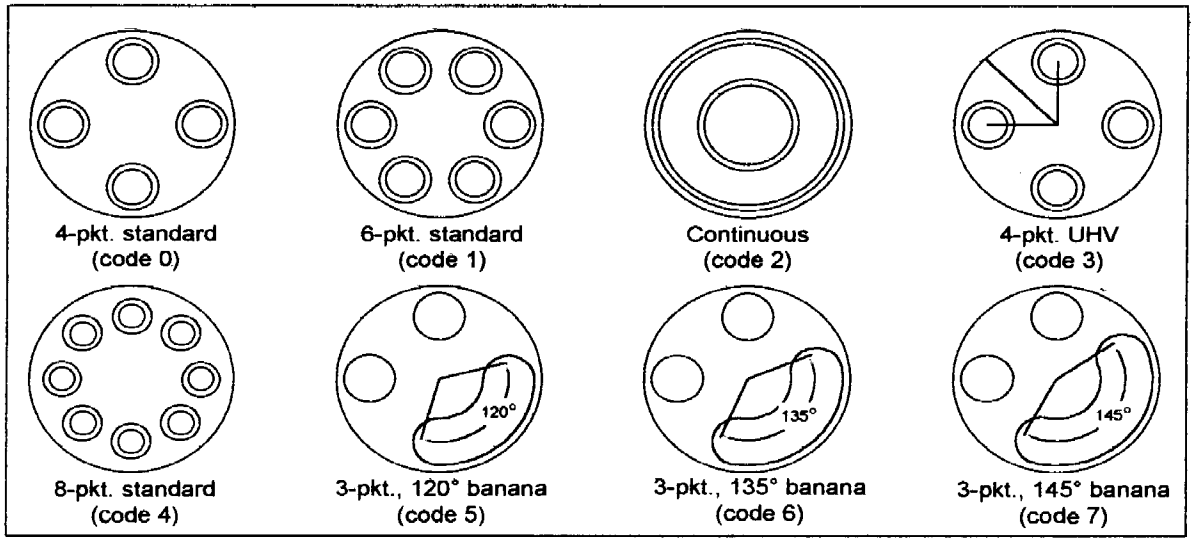


Figure 2-5. Source types supported by the TRC-3460

Standard Multipocket Sources (Codes 0, 1, and 4)

When switches 1-3 are set for code 0, the unit is configured to operate a standard 4-pocket source. When these switches are set for code 1, the unit is configured to operate a standard 6-pocket source. When these switches are set for code 4, the unit is configured to operate a standard 8-pocket source. The switch positions that select these codes are:

Code Number	DIP Switch 1	DIP Switch 2	DIP Switch 3
Code 0	OFF	OFF	OFF
Code 1	ON	OFF	OFF
Code 4	OFF	OFF	ON

UHV 4-Pocket Sources (Code 3)

If the TRC-3460 is to be used with a UHV 4-pocket source, switches 1-3 must be set for code 3. In addition, switch 4 must be set for bidirectional motion. The switch positions that select code 3 are:

Code Number	DIP Switch 1	DIP Switch 2	DIP Switch 3
Code 3	ON	ON	OFF

CAUTION

Switches 1-4 MUST be set as described above when the TRC-3460 is controlling a UHV 4-pocket source. Damage to the source and/or its bellows are likely to occur if switches 1-3 are set for a UHV source and switch 4 is set for unidirectional rotation. There are no limits programmed for unidirectional motion in UHV mode, as there are for bidirectional rotation in that mode.

This mode has a programmed "software barrier" that prevents the hearth from rotating in either direction between pocket 1 and the pocket next to it in the counterclockwise direction. This programming serves to prevent damage to the special bellows attached to the hearth in that location on UHV sources. To move the hearth between these two pockets, the indexer does not simply rotate the hearth 90° along the shortest path. Instead, the hearth is rotated 270° in the opposite direction. The indexer employs shortest-path rotation when rotating the hearth between any two other pockets.

Three-Pocket Hearths with One Banana-Shaped Pocket (Codes 5-7)

When switches 1-3 are set to codes 5, 6, and 7, the indexer is configured for hearths with two conventional pockets 90° apart and one banana-shaped pocket. These three codes configure the indexer to support "bananas" of differing arc lengths. As Figure 2-5 shows:

- Code 5 sets the indexer for a three-pocket hearth with a "banana" covering 120° of arc.
- Code 6 sets the indexer for a three-pocket hearth with a "banana" covering 135° of arc.
- Code 7 sets the indexer for a three-pocket hearth with a "banana" covering 145° of arc.

The switch positions that select these codes are:

Code Number	DIP Switch 1	DIP Switch 2	DIP Switch 3
Code 5	ON	OFF	ON
Code 6	OFF	ON	ON
Code 7	ON	ON	ON

NOTE

When switches 1-3 are set to any of these three codes, switch 4 MUST be set for bidirectional motion. If unidirectional motion is selected, the indexer will not move the "banana" correctly.

In any of these "banana" modes, the indexer moves pockets 1 and 2 to the home position when it receives the pocket-select codes for those pockets. When the indexer receives any of the pocket-select codes for pockets 3 through 7, it moves the banana-shaped pocket to the home position and then begins oscillating the hearth in such a way that the e-beam sweeps from one end of the "banana" to the other. Pocket-select codes 3-7 determine the speed of the oscillating motion, as Table 2-1 indicates. When the indexer receives the pocket-select code for pocket 8, it moves the midpoint of the "banana" to the home position and stops.

Table 2-1. How speed of oscillating hearth motion varies depending on the pocket number selected

Pocket Selected	Hearth Rotation Speed
3	. 630 RPM
4	.515 RPM
5	.405 RPM
6	.295 RPM
7	.187 RPM
8	0 RPM

Hearths with Full-Circle Evaporant Troughs (Code 2)

If switches 1-3 are set for this type of hearth (code 2), the hearth will rotate continuously in the direction set via switch 5. The setting of switch 4 has no effect on rotation in this mode.

The switch settings that select code 2 are:

Code Number	DIP Switch 1	DIP Switch 2	DIP Switch 3
Code 2	OFF	ON	OFF

In this mode, the pocket-select codes for pockets 1 through 7 determine the hearth's rotation speed, as indicated in Table 2-2. The pocket-select code for pocket 8 stops or prevents hearth rotation.

Table 2-2. How the speed of hearth rotation in continuous mode varies depending on the pocket number selected

Pocket Selected	Hearth Rotation Speed
1	.845 RPM
2	.732 RPM
3	. 630 RPM
4	.515 RPM
5	.405 RPM
6	.295 RPM
7	.187 RPM
8	0 RPM

2.4 CONFIGURING THE OPTOISOLATOR PC BOARD FOR 24-V DC I/Os

The control unit's optoisolated I/Os are factory configured to operate on 9 V dc supplied by an internal power supply. However, the control unit's optoisolator board can also be configured to operate on +24 V dc supplied by an external source. Follow the steps described below to accomplish this reconfiguration.

STEP NO.	PROCEDURE
1	Make sure the power cord is *not* connected to the control unit.
2	Remove the four screws that secure the control unit's rear panel (see Figure 2-6).

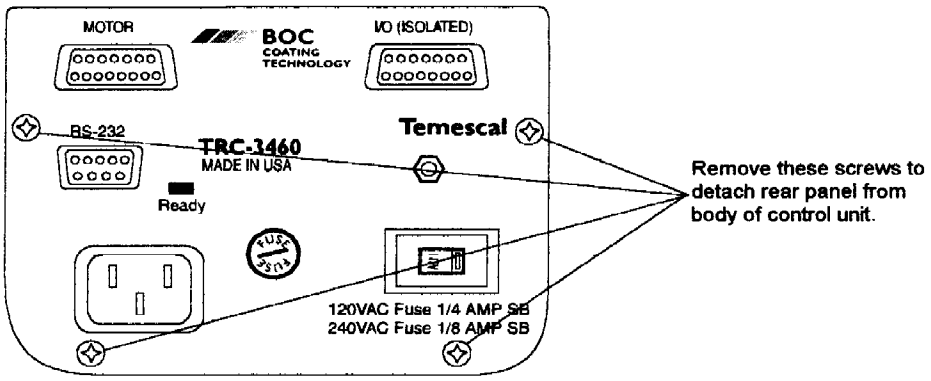


Figure 2-6. Locations of screws that secure the control unit's rear panel to its body

3	Grasp the rear panel and pull it backwards until it is approximately an inch away from the body of the controller.
4	The jumper blocks you need to reconfigure are mounted on the underside of the optoisolator PC board, which is the topmost board in the unit. Turn the control unit upside down and find the legend JP1 on the underside of this board. You will find this legend near the rear of the board and along the edge of the board that is closest to the rear-panel connector labeled I/O (ISOLATED). Jumper block JP1 is just behind the legend JP1 (or just to the right of this legend, if you are looking at it from the side of the controller).
5	The pins on jumper block JP1 are numbered from left to right as you face the side of the controller that the jumper block is on. From that point of view, pin 1 is on your left, pin 2 is in the middle, and pin 3 is on your right. The jumper across this jumper block is factory installed so that it covers pins 1 and 2, leaving pin 3 exposed. Remove the jumper and replace it so that it covers pins 2 and 3, leaving pin 1 exposed.
7	JP2 stands immediately behind and at right angles to JP1 (i.e., behind JP1 with respect to the controller's front panel). On this jumper block, pin 1 is the pin nearest the edge of the board, pin 2 is in the center, and pin 3 is nearest to the center of the board. Like JP1, this jumper block is factory configured so that the jumper covers pins 1 and 2, leaving pin 3 is exposed. Remove the jumper and replace it so that it covers pins 2 and 3, leaving pin 1 exposed.
8	Grasp the controller's rear panel and slide it forward until it is in contact with the body of the controller. As you do so, take care that the green ground wire connected to the inside of the rear panel does not get pinched between the rear panel and the controller's body.
9	Replace the four screws that secure the rear panel to the body of the controller.

2.5 BENCH-TESTING THE INDEXER

It is a good idea to bench-test the indexer after the control unit is configured for your application. Follow the steps described below in performing this test.

STEP NO.	PROCEDURE
1	Find the motor cable. This is the 25-foot cable supplied to connect the control unit to the index drive unit.
2	The motor cable has a 15-pin 'D' connector on each end. Plug the male 'D' connector on one end of the cable into the socket labeled MOTOR on the control unit's rear panel.
3	Plug the female 'D' connector on the other end of the motor cable into the 15-pin male connector on the end of the index drive unit.
4	Make sure the input power selection switch is set for the correct voltage (see Figure 2-2).
	WARNING **Operating the TRC-3460 with incorrect** **line voltage selected will damage the unit.**
5	Make sure the power switch on the control unit's front panel is OFF.
6	Plug the correct power cable for the local AC power into the three-pronged plug on the control unit's rear panel. Plug the other end of this cable into an AC power socket.
7	Make sure the MAN/AUTO toggle switch on the control unit's front panel is set to MAN. Note that this switch has a locking feature. To change its position, you must first pull the locking collar out toward you.
8	Set the front-panel thumbwheel to position 1, if it is not already at that position.
9	Using the ON/OFF switch on the control unit's front panel, switch on the indexer. If the internal DIP switches are set for a full-circle evaporant carousel, the drive unit's output shaft will begin rotating continuously at its highest speed. If the DIP switches are set for any other type of source, the indexer will stop at the factory-set home position for pocket 1 after proceeding through various rotations involved in its initialization routine.
10	Change the thumbwheel setting to select pocket 2. The indexer will rotate to the pocket-2 position after going through rotations that vary depending on the settings of DIP switches 1-5.
11	Use the thumbwheel to select other pockets and observe the rotation of the output shaft.
12	When you have completed the bench-test, switch off the control unit, disconnect the AC power cable from the rear panel, and disconnect the motor cable from both the control unit and the index drive unit.

2.6 INSTALLATION

Installing the Index-Drive Unit

Figure 2-7 shows the index-drive unit properly installed on the underside of the source tray. The drive unit is held in place by the large nut on the underside of the 1-inch-dia. rotary feedthrough.

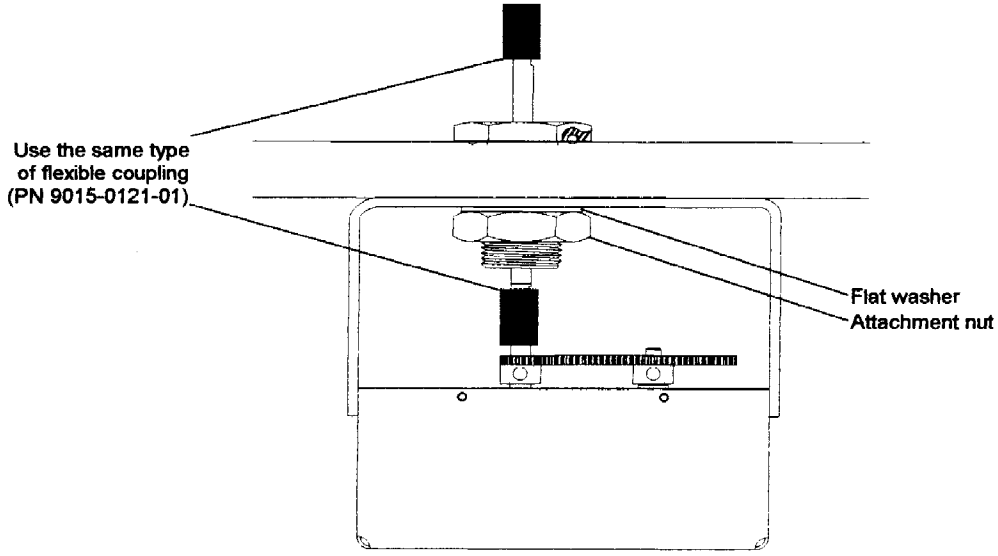


Figure 2-7. Index-drive unit mounted to 1-inch-dia. rotary feedthrough

DANGER: HIGH VOLTAGE

If a high-voltage power supply is installed in the vacuum system in which the TRC-3460 is to be installed, observe all applicable high-voltage precautions in performing the following procedure. These precautions include making sure that the high-voltage is OFF and using a properly connected grounding rod to neutralize any residual charge on the structures on and around the source tray.

Follow the procedure described below in installing the drive unit.

STEP NO.	PROCEDURE
1	Perform the following substeps only if a high-voltage power supply is connected to the vacuum system in which the TRC-3460 is being installed. Otherwise, proceed to step 2. (a) Make sure that the high-voltage power supply is switched OFF. (b) If the power supply is equipped with a keylock, remove it and keep it in your pocket while you complete this procedure.
2	Lower the source tray, open the vacuum enclosure's access doors, and swing the source tray out from the enclosure.
3	(This step may be skipped if a high-voltage power supply has *not* been connected to the vacuum system in which you are installing the TRC-3460.) Using a properly connected grounding hook, touch the source tray and the frame of the vacuum enclosure in several places to neutralize any residual high-voltage charge.

STEP NO.	PROCEDURE
4	Remove the attachment nut and flat washer (see Fig. 2-7) from the rotary feedthrough.
5	Put coupling PN 9015-0121-01 in place over the feedthrough's input shaft and secure the coupling to that shaft with the coupling's upper set screw.

WARNING

To prevent binding during source rotation and to minimize alignment problems, it is essential to use the same type of flexible coupling to connect the feedthrough's output shaft to the source's drive shaft.

6	Place the index-drive unit against the underside of the source tray so that the feedthrough's threaded shaft extends through the hole in the yoke that spans the top of the drive unit. Make sure that the drive unit's output shaft fits up into the coupling.
7	Lower the index drive unit enough to put the flat washer and attachment nut back in place around the threaded portion of the feedthrough. Then restore the drive unit to the position described in step 6.
8	Screw the attachment nut all the way on, tightening it to approximately 10 ft.-lbs.
9	Secure the coupling to the drive unit by tightening the coupling's lower set screw against the drive unit's output shaft.
10	Connect the female 'D' connector on one end of the motor cable to the 'D' connector on the index-drive unit, securing the connection with the screws on the 'D' connector.

Installing the Control Unit

Follow the procedure described below in mounting the control unit in a standard 19-inch electronics rack.

STEP NO.	PROCEDURE
1	Disconnect any cables that have been connected to the control unit's rear panel.
2	Put the half-with control unit in place a 5-1/4-in.-high space in the electronics rack.
3	Secure the front panel to the rack with the four screws and cup washers provided.
4	Connect the input power cable to the plug on the control unit's rear panel.
5	Plug the other end of the power cable into a wall socket.
6	Make sure that the line voltage selection switch is set correctly (see Fig. 2-2).

WARNING

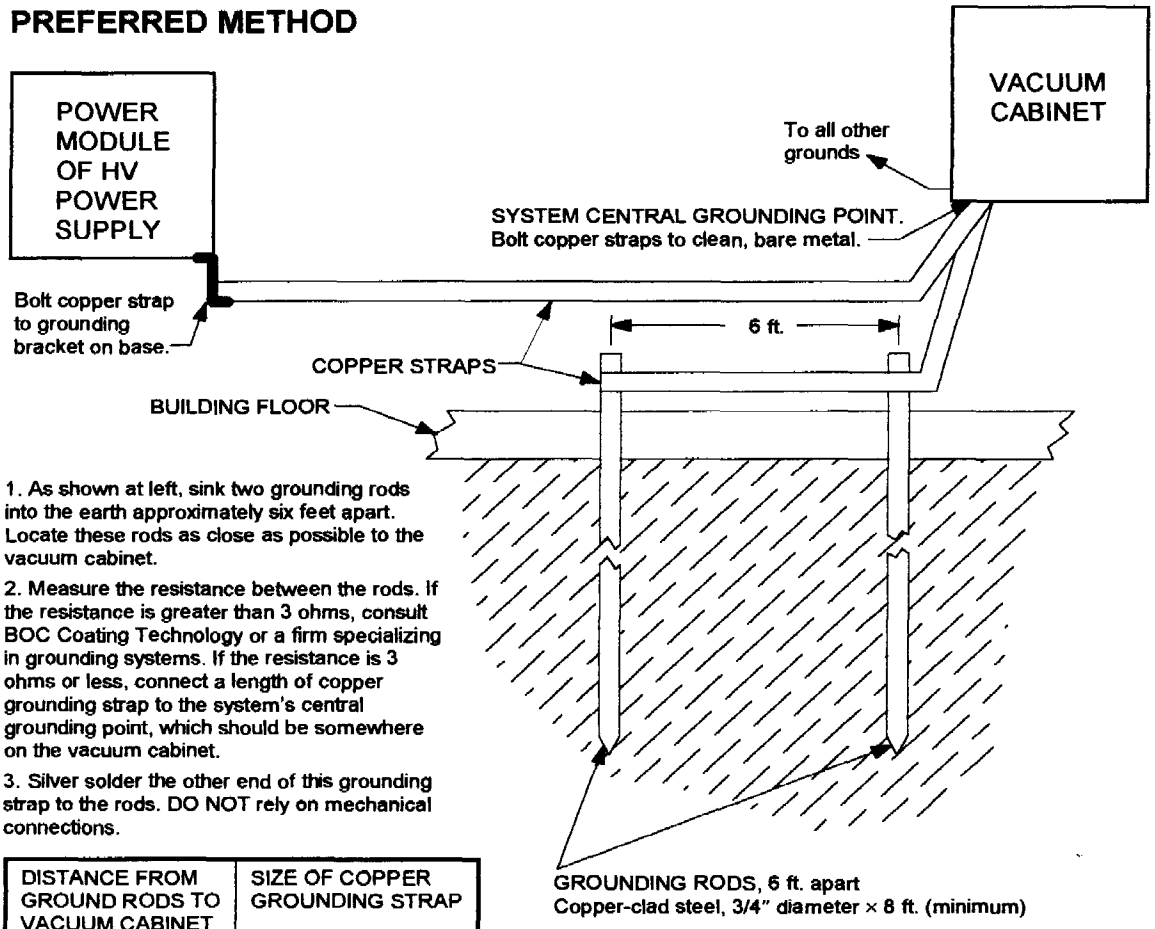
Operating the TRC-3460 with incorrect line voltage selected will damage the unit.

7	Connect the male 'D' connector on one end of the motor cable to the MOTOR connector on the control unit's rear panel. Use the screws provided on the 'D' connector to secure it to the MOTOR connector.

Indexer and System Grounding

A grounding stud is provided on the control unit's rear panel. Use a 16-gauge or larger wire to ground this stud to the electronics rack. Because the rack as a whole is likely to be subject to RF interference, it is strongly recommended that a low-impedance ground be provided for the system. Figure 2-8 shows two methods of setting up such a ground. Section 2.8 provides instructions on connecting a separate electronic ground for the I/Os.

PREFERRED METHOD



1. As shown at left, sink two grounding rods into the earth approximately six feet apart. Locate these rods as close as possible to the vacuum cabinet.
2. Measure the resistance between the rods. If the resistance is greater than 3 ohms, consult BOC Coating Technology or a firm specializing in grounding systems. If the resistance is 3 ohms or less, connect a length of copper grounding strap to the system's central grounding point, which should be somewhere on the vacuum cabinet.
3. Silver solder the other end of this grounding strap to the rods. DO NOT rely on mechanical connections.

DISTANCE FROM GROUND RODS TO VACUUM CABINET	SIZE OF COPPER GROUNDING STRAP
0–60 ft.	3" wide × .035" to .50" thick
60+ ft.	Consult BOC Coating

ALTERNATIVE METHOD

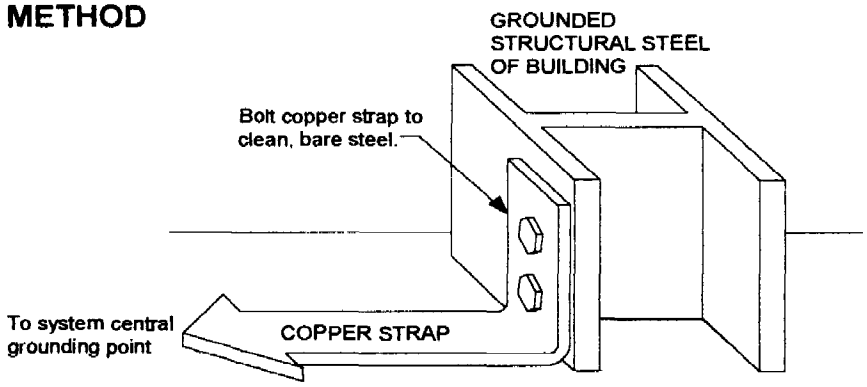


Figure 2-8. Two methods of setting up low-impedance ground required for deposition system

2.7 INITIAL PHASE ADJUSTMENT

The home position will almost certainly have to be reset after the indexer is installed. This initial phase adjustment can be accomplished in either of two ways, both described in detail below. The electromechanical method necessitates breaking vacuum and lowering and swinging out the source tray. However, this method allows extremely precise phase adjustment. The electronic method lets you reset the home position using front panel controls alone (see Figure 2-9). However, it may prove difficult to achieve the desired accuracy with this method, as it entails judging the accuracy of the phase adjustment while observing the source at an angle through a viewport.

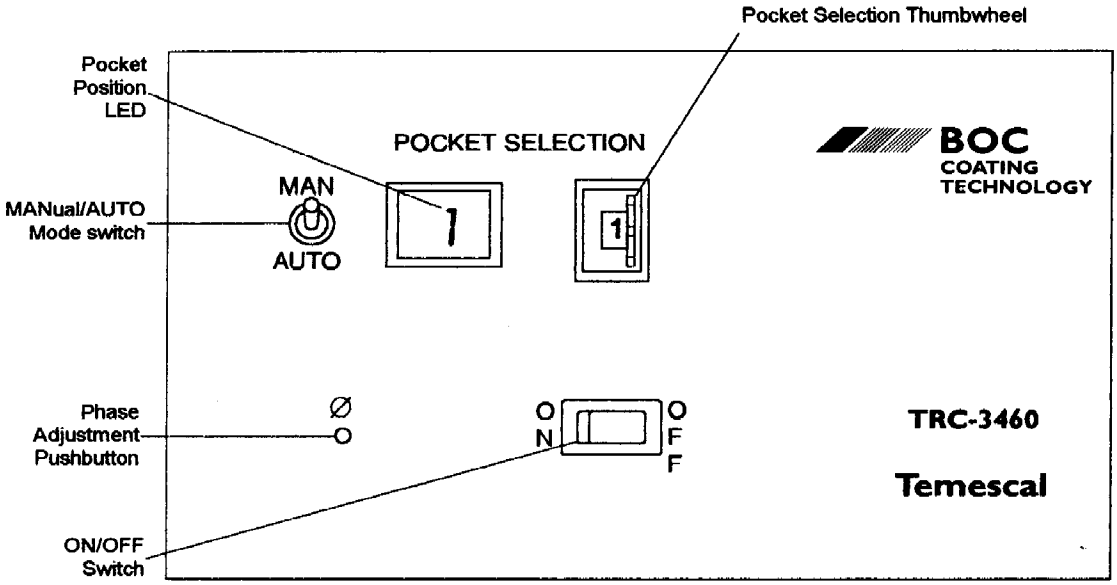


Figure 2-9. Control/display features on the control unit's front panel

Electromechanical Method

DANGER: HIGH VOLTAGE

If a high-voltage power supply is installed in the vacuum system in which the TRC-3460 has been installed, observe all applicable high-voltage precautions in performing the following procedure. These precautions include making sure that the high-voltage is OFF and using a properly connected grounding rod to neutralize any residual charge on the structures on and around the source tray.

STEP NO.	PROCEDURE
1	Perform the following substeps only if a high-voltage power supply is connected to the vacuum system in which the TRC-3460 is being installed. Otherwise, proceed to step 2.
	(a) Make sure that the high-voltage power supply is switched OFF.
	(b) If the power supply is equipped with a keylock, remove it and keep it in your pocket while you complete this procedure.

2 Lower the source tray, open the vacuum enclosure's access doors, and swing the source tray away from the enclosure.

3 (This step may be skipped if a high-voltage power supply has *not* been connected to the vacuum system in which you are installing the TRC-3460.) Using a properly connected grounding hook, touch the source tray and the frame of the vacuum enclosure in several places to neutralize any residual high-voltage charge.

4 Make sure the MAN/AUTO switch on the control unit's front panel is set to MAN.

5 Use the thumbwheel on the control unit's front panel to select pocket 1.

6 Switch on the indexer, if it is not already on. After going through some rotation involved in its initialization routine, the indexer will rotate the hearth to the factory-set home position for pocket 1.

7 If pocket 1 is not correctly centered within the cutout in the top of the source, switch off the indexer.

8 Turn the hearth by hand until pocket 1 is precisely centered within the cutout.

9 Using the end of a paper clip or some other small-diameter probe, push in the spring-loaded phase adjustment pushbutton and keep it depressed as you switch on the indexer and as the hearth goes through its initialization routine. (This routine involves what may appear to be random rotation.) Release the pushbutton only after the hearth has returned to the new home position for pocket 1 and stopped. If this is not the correct home position, switch off the indexer and repeat steps 8 and 9.

10 Use the pocket selection thumbwheel to change pockets several times, checking to see that each pocket goes to the correct home position. If the hearth does not remain properly in phase, return to pocket 1 and repeat steps 8-10.

Electronic Method

STEP NO.	PROCEDURE
1	Make sure the MAN/AUTO switch on the control unit's front panel is set to MAN.
2	Use the thumbwheel on the control unit's front panel to select pocket 1.
3	Switch on the indexer, if it is not already on. After going through some rotation involved in its initialization routine, the indexer will rotate the hearth to the factory-set home position for pocket 1.
4	If pocket 1 is not correctly centered within the cutout in the top of the source, switch off the indexer.
5	Switch the indexer on and off rapidly, watching the hearth move a small amount each time you do so. When pocket 1 is centered in the cutout, leave the indexer switched off.
6	Using the end of a paper clip or some other small-diameter probe, push in the spring-loaded phase adjustment pushbutton and keep it depressed as you switch on the indexer and as the hearth goes through its initialization routine. (This routine involves what may appear to be random rotation.) Release the pushbutton only after the hearth has returned to the new home position for pocket 1 and stopped. If this is not the correct home position, switch off the indexer and repeat steps 5 and 6.
7	Use the pocket selection thumbwheel to change pockets several times, checking to see that each pocket goes to the correct home position. If the hearth does not remain properly in phase, return to pocket 1 and repeat steps 5-7.

2.8 MAKING SYSTEM CONNECTIONS VIA THE REAR PANEL I/O INTERFACE

The I/O (ISOLATED) connector on the control unit's rear panel provides an optoisolated interface for exchanging digital signals with other system components. Cabling between this connector and external devices must be supplied by the user. Figure 2-10 identifies the signals that can be exchanged via this connector and shows the function of each pin. Power for the I/Os can be either internally or externally supplied. If internally supplied, the I/Os are –9 V dc when low and +9 V dc when high. If externally supplied, they are 0 V dc when low and +24 V dc when high. Outputs are limited by the indexer's internal circuitry to a maximum of 10 ma per output. If you use the internal +/- 9 V dc supply, connect pin 14 on the I/O connector as the ground. If an external +24 V dc is supplied, connect pin 15 as the ground.

Interlock Connections

One of two signals (either the POCKET GOOD output or the system interlock input) must be connected to provide an interlock that will prevent the e-beam from damaging portions of the hearth while it is rotating. The POCKET GOOD output is high as long as a given pocket is within 5° of the calibrated home position. To use this signal as the indexer's interlock, connect pin 5 on the I/O connector to the electron beam power supply in such a way that the power supply is switched off when POCKET GOOD goes low. If you are using a Temescal Simba 2 power supply, connect this wire to the input for the power supply's AUXiliary interlock. Refer to the Simba 2 manual for detailed instructions.

Alternatively, if a system interlock signal is input via pin 3, the signal high when as it is *not* safe for the hearth to rotate. Such an interlock would prevent hearth rotation when the e-beam is on. However, this arrangement would not protect the source from damage if the hearth should get severely out of phase.

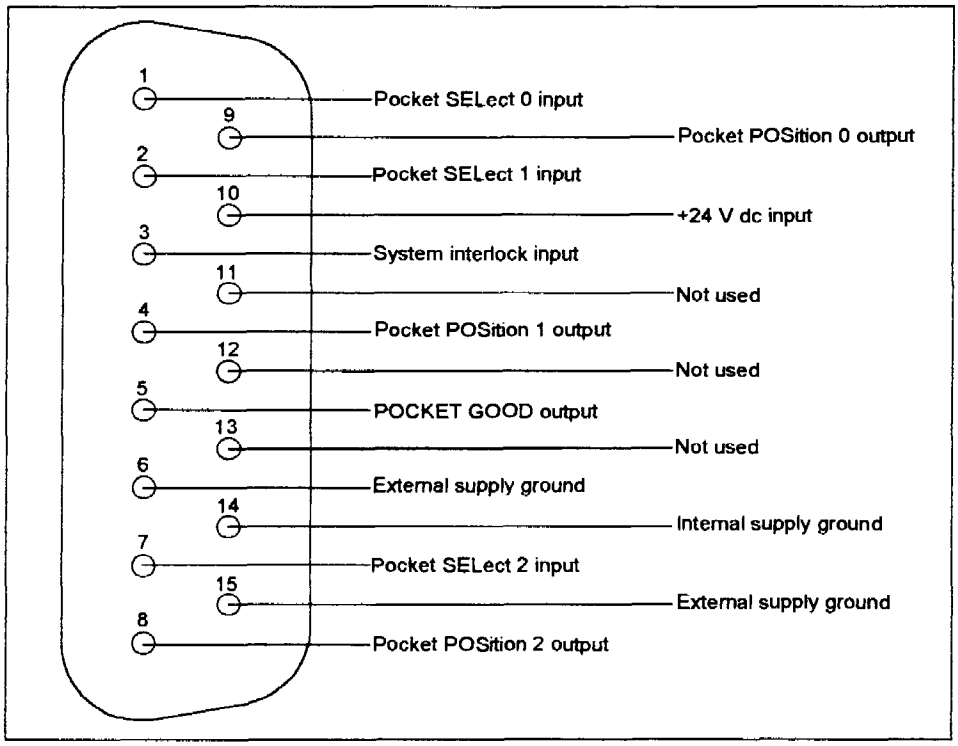


Figure 2-10. Pinout for the rear-panel I/O (ISOLATED) connector

Pin-by-Pin Functional Description of the I/O (ISOLATED) Connector

Pins 1, 2, and 7 (Pocket SELect Inputs 0,1, and 2, respectively)

When the front-panel MAN/AUTO switch is set to AUTO, these inputs control pocket selection in multipocket modes and rotation speed in banana and continuous modes. Table 2-3 shows the digital code required to select each pocket and correlates those codes to the pins 1, 2, and 7.

Table 2-3. Pocket-select codes input via pins 1, 2, and 7

Pin No. Pocket Selected	1	2	3	4	5	6	7	8
Pin 1 (SEL 0)	0	1	0	1	0	1	0	1
Pin 2 (SEL 1)	1	0	0	1	1	0	0	1
Pin 7 (SEL 2)*	1	1	1	0	0	0	0	1

*SEL 2 is not needed for 4-pocket sources.

Pin 3 (System Interlock Input)

This is a user-defined interlock input. The drive motor cannot turn when this signal is true.

Pins 4, 8, and 9 (Pocket POSition Outputs 1, 2, and 0, respectively)

These outputs indicate the current pocket location. Table 2-4 show the digital code for each pocket position and correlates those codes to pins 4, 8, and 9.

Table 2-4. Pocket-position codes output via pins 4, 8, and 9

Pin No. Pocket Selected	1	2	3	4	5	6	7	8
Pin 9 (POS 0)	0	1	0	1	0	1	0	1
Pin 4 (POS 1)	1	0	0	1	1	0	0	1
Pin 8 (POS 2)	1	1	1	0	0	0	0	1

Pin 5 (POCKET GOOD Output)

This output is high when the selected pocket is within 5° of the calibrated home position. Directions for using this signal as the indexer's interlock are provided above.

Pin 6 (External Supply Ground)

If you are providing +24 V dc from an external source to power the I/Os, either this pin or pin 15 must be connected to the ground of the external power supply.

Pin 10 (External Supply Positive Input)

Pin 10 is the input point for the externally supplied +24 V dc that can be used to power the I/Os. The control unit's optoisolator PC board must be reconfigured if you wish to use 24-V I/Os. See section 2.4 for instructions on reconfiguring this board.

Pins 11, 12, and 13

Not used.

Pin 14 (Internal Supply Ground)

If you are using the internally supplied voltage (9 V dc) to power the I/Os, a ground for this supply must be connected to pin 14. The unit is factory configured to operate with this voltage.

Pin 15 (External Supply Ground)

This pin is internally connected to pin 6. The ground for the external supply can be connected to either pin.

2.9 MAKING SYSTEM CONNECTIONS VIA THE REAR PANEL RS-232 INTERFACE

The RS-232 connector on the control unit's rear panel enables you to establish serial communications between the TRC-3460 and a host computer, a deposition controller, or another system component. This section describes the interconnection details. For further information on implementing serial communications, see Section 5.

Cabling for RS-232 communications must be supplied by the user. Figures 2-11 and 2-12 show the pin-by-pin connections required. Figure 2-11 shows how the 9-pin male connector that would plug into the indexer's RS-232 port must be wired to a 9-pin connector that would plug into the RS-232 port on an external device. Figure 2-12 shows how the 9-pin male connector that would plug into the indexer must be wired to a 25-pin connector that would plug into the external device.

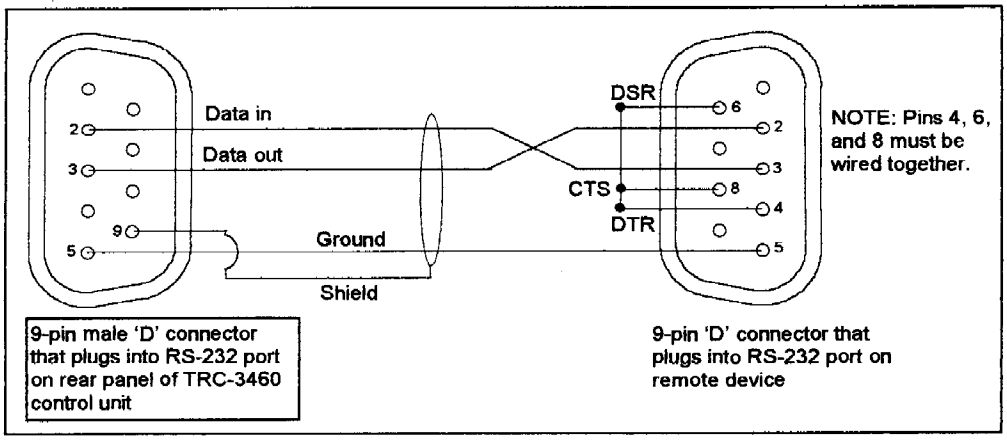


Figure 2-11. Connections required for RS-232 communications between the TRC-3460 and a remote device with a 9-pin RS-232 port

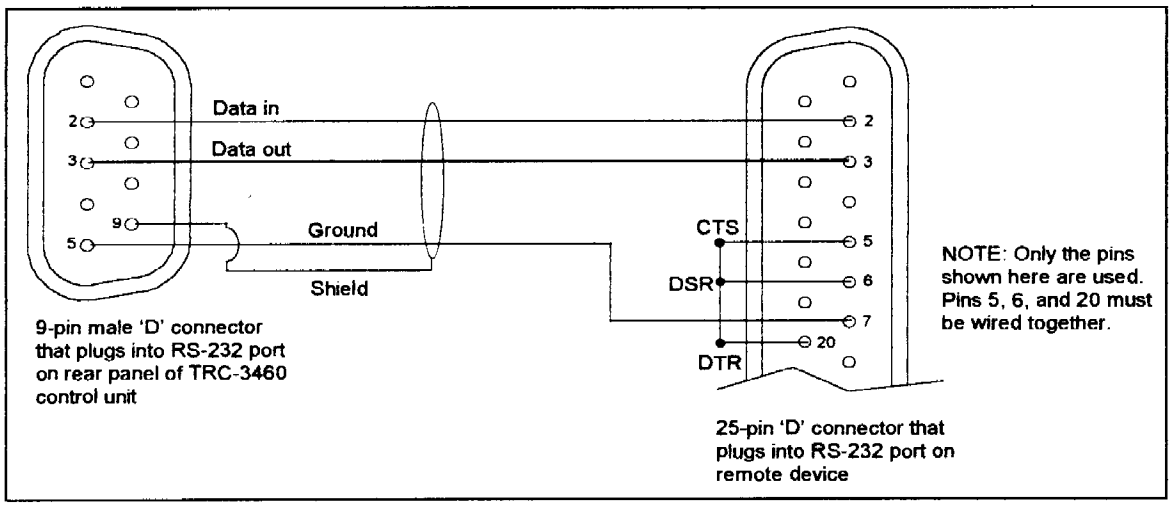


Figure 2-12. Connections required for RS-232 communications between the TRC-3460 and a remote device with a 25-pin RS-232 port

SECTION 3
INDEXER OPERATION

3.1 SECTION OVERVIEW

This section describes the operation of the TRC-3460 with a variety of source/hearth types. The specific sections are:

- Control/Display Features (section 3.2)
- Clockwise vs. Counterclockwise Pocket Numbering (section 3.3)
- Indexer Operation With Standard Multipocket Sources (section 3.4)
- Indexer Operation with 4-pocket UHV Sources (section 3.5)
- Indexer Operation With 3-pocket Sources That Have One Banana-Shaped Pocket (section 3.6)
- Indexer Operation With Continuous-Trough Hearths (section 3.7)
- Phase Adjustment (section 3.8)

3.2 CONTROL/DISPLAY FEATURES

All of the indexer's control/display features are on the control unit's front panel, which is illustrated in Figure 3-1.

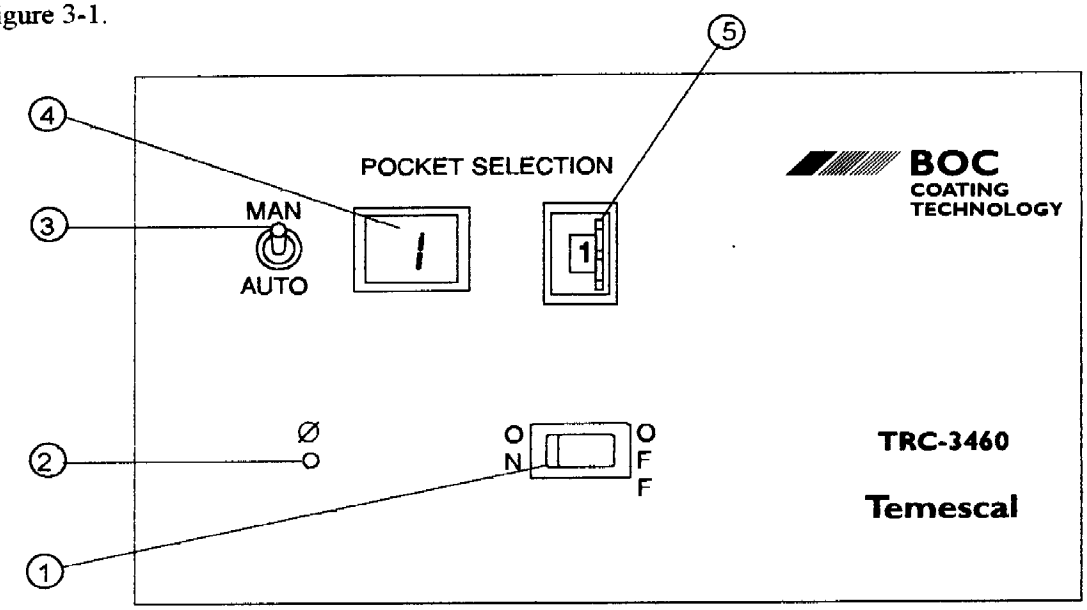


Figure 3-1. Control/display features on the control unit's front panel

1. *ON/OFF switch.* This switch controls the input power to the unit.
2. *Phase-adjustment switch.* This spring-loaded pushbutton is mounted inside a hole below the Greek letter *phi* (ϕ). See section 3.8 for instructions on using this switch to recalibrate the home position of pocket 1.
3. *MANual/AUTO mode switch.* When this switch is set toward MAN, the position of the thumbwheel (feature 5) controls the following functions:
   - pocket selection in all multipocket modes
   - rotation speed in continuous mode and oscillation speed in "banana" mode.

   When the switch is set toward AUTO, these functions are controlled by signals from a host computer, deposition controller, or other remote device. These signals are input via either the RS-232 port or the I/O (ISOLATED) connector, both of which are on the control unit's rear panel.

   Note that this switch has a spring-loaded locking feature. You must pull the switch all the way out and hold it out while changing its position.
4. *LED pocket-position indicator.* This 7-segment LED displays the numerals 0 through 7 to indicate the current pocket position. The LED also flashes between zero and the number of the current pocket position to indicate a stalled-motor condition, which usually results from the buildup of material along the edges of the cutout in the top of the source.
5. *Pocket/speed selection thumbwheel.* When the MAN/AUTO switch is set to MANual, this thumbwheel controls pocket selection and rotation/oscillation speed.

3.3 CLOCKWISE VS. COUNTERCLOCKWISE POCKET NUMBERING

When planning multipocket deposition—with the indexer in either uni- or bidirectional mode—bear in mind that the orientation of pocket numbering is determined by the setting of internal DIP switch 5. This means that the direction of "forward" rotation (i.e., rotation "upward" through the pocket numbers) depends on whether DIP 5 switch is set for clockwise or counterclockwise rotation.

Figure 3-2 shows what this means for indexer operation with a standard 4-pocket source. The pockets of such a source must be thought of as being numbered 1-4 in a clockwise direction when DIP switch 5 is on and 1-4 in a counterclockwise direction when switch 5 is off. The same principle applies to all multipocket sources.

For instructions on configuring the indexer for use with a specific source type, see section 2.3.

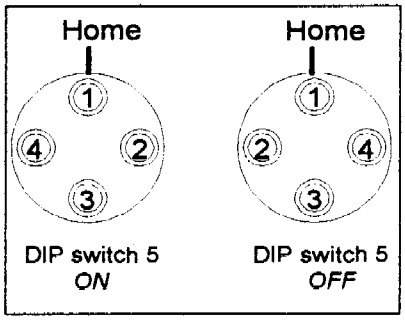


Figure 3-2. How the orientation of pocket numbering depends on the setting of DIP switch 5.

3.4 INDEXER OPERATION WITH STANDARD MULTIPOCKET SOURCES

The TRC-3460 operates any standard 4-, 6,- or 8-pocket source that has internal 4:1 gear reduction. When the internal DIP switches are configured for one of these three source types (see Figure 3.3), operation of the indexer is straightforward. After the pocket selection has been changed—either manually via the front-panel thumbwheel or automatically by a remote device—the indexer rotates the hearth to that pocket position at a constant rotational speed and then stops.

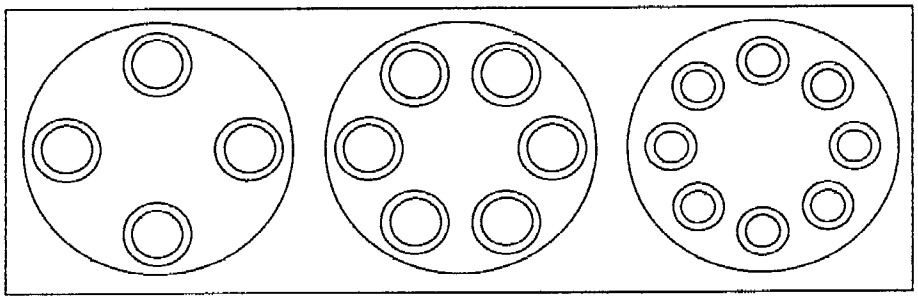


Figure 3-3. Standard 4-, 6-, and 8-pocket hearths

Source rotation can be either uni- or bidirectional. If you select unidirectional rotation, you can also select clockwise or counterclockwise rotation. If you select bidirectional rotation, the unit will index to the selected pocket by the shortest path, whether that means rotating clockwise or counterclockwise. Bear in mind that in both uni- and bidirectional modes, the orientation of pocket numbering depends on whether clockwise or counterclockwise rotation is selected (see section 3.3).

Notes on This Operating Mode

1. When the indexer is configured for a standard 4-pocket source, selecting pocket positions 1-4 moves the hearth to pockets 1-4, respectively. In addition,
   - selecting pocket 5 moves the hearth to pocket 1, as indicated by the LED
   - selecting pocket 6 moves the hearth to pocket 2, as indicated by the LED
   - selecting pocket 7 moves the hearth to pocket 3, as indicated by the LED
   - selecting pocket 8 moves the hearth to pocket 4, as indicated by the LED.
2. When the indexer is configured for a standard 6-pocket source, selecting pocket positions 1-6 moves the hearth to pockets 1-6, respectively. In addition, selecting either pocket 7 or pocket 8 moves the hearth to pocket 1, as indicated by the LED.
3. When the indexer is configured for a standard 8-pocket source, selecting pocket positions 1-8 moves the hearth to pockets 1-8, respectively. However, note that the LED displays a zero rather than an *8* when the hearth is at pocket 8.

3.5 INDEXER OPERATION WITH 4-POCKET UHV SOURCES

The distinguishing operating characteristic of the indexer in this mode is that it will not move directly in either direction between pocket 1 and the pocket 90° counterclockwise from pocket 1. (The unit's software may be thinking of the latter pocket as either pocket 2 or pocket 4, depending on the primary rotation direction. See section 3.2 for an explanation of this characteristic.) This "software barrier" (see Figure 3-4) prevents damage to the special bellows that is attached in this location to the hearth of a 4-pocket UHV source. Consequently, the indexer rotates 270° to go between these two pockets in either direction. However, because this operating mode requires the indexer to be set for bidirectional rotation, it follows the shortest path in moving between any other pair of pockets.

CAUTION

The indexer MUST be configured for bidirectional rotation when it is controlling a UHV 4-pocket source. Damage to the source and/or its bellows is likely to occur if the unit is configured for unidirectional motion. There are no limits programmed for unidirectional motion in UHV mode, as there are for bidirectional motion in UHV mode.

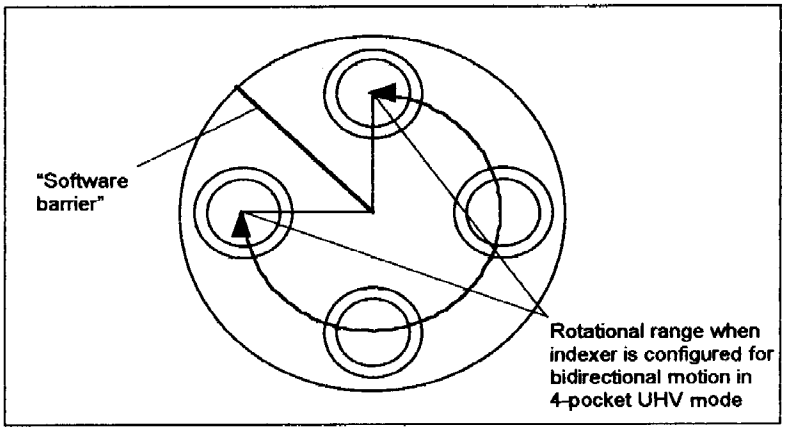


Figure 3-4. Schematic illustration of a 4-pocket UHV source, indicating the position of the "software barrier" implemented in this mode to prevent damage to the bellows attached to UHV hearths in this area

3.6 INDEXER OPERATION WITH THREE-POCKET SOURCES THAT HAVE ONE BANANA-SHAPED POCKET

The TRC-3460 can be configured to operate three-pocket sources that have two conventional circular pockets 90° apart and one banana-shaped pocket, which can be either 120°, 135°, or 145° in arc length (see Figure 3-5). Section 2.3 describes how to configure the indexer for operation with such sources.

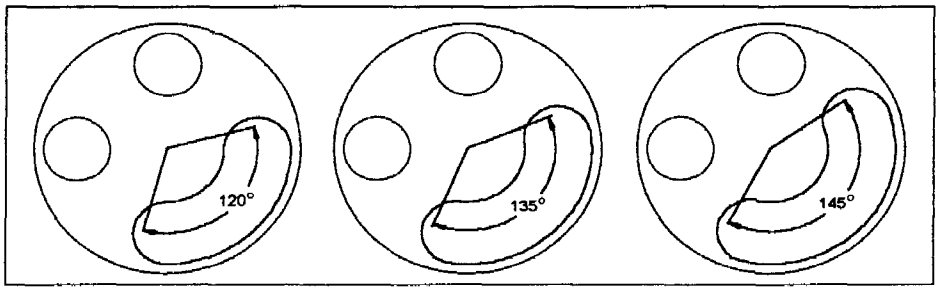


Figure 3-5. Three-pocket hearths with one banana-shaped pocket

When the indexer is properly configured to operate in this mode, selecting either pocket 1 or pocket 2 causes the indexer to rotate the hearth to one of the conventional circular pockets. However, in this mode, the pocket-select codes for pockets 3-8 all select the banana-shaped pocket. When the indexer receives any of these six pocket-select codes—either from a remote device or from the front-panel thumbwheel—it first rotates the midpoint of the "banana" to the home position. If the pocket-select code received by the indexer is one those for pockets 3 through 7, the indexer then begins to oscillate the hearth in such a way that the electron beam will sweep from one end of the "banana" to the other end. This oscillation continues until the pocket selection is changed or until indexer rotation stops, either because of interlock action or because the indexer has been switched off. As Table 3-1 shows, the speed of this oscillating motion depends on which of the pocket-select codes between 3 and 7 is received. The pocket-select code for pocket 8 causes the hearth to rotate the midpoint of the banana to the home position and then stop. Note that this means that the electron beam will be focused on the same point continuously until it is switched off or until another pocket is selected.

Table 3-1. How the speed of oscillating hearth motion in "banana" mode varies depending on the pocket number selected

Pocket Selected	Hearth Rotation Speed
3	. 630 RPM
4	.515 RPM
5	.405 RPM
6	.295 RPM
7	.187 RPM
8	0 RPM

NOTE

When the indexer is configured for "banana" mode operation, internal DIP switch 4 MUST be set for bidirectional motion. If unidirectional motion is selected, the indexer will not move the banana-shaped pocket correctly.

3.7 INDEXER OPERATION WITH CONTINUOUS-TROUGH HEARTHS

The TRC-3460 operates in a continuous-rotation mode to support the use of full-circle evaporant carousels (see Figure 3-6). When the indexer is properly configured for operation in this mode, the hearth rotates continuously at any of 7 speeds in the direction determined by internal DIP switch #5. (See section 2.3 for instructions on setting the internal DIP switches.) As the hearth rotates, the LED displays the numerals 1-4 successively and then begins again with 1. These numerals indicate motion relative to what would be the home position of pocket 1 on a 4-pocket source.

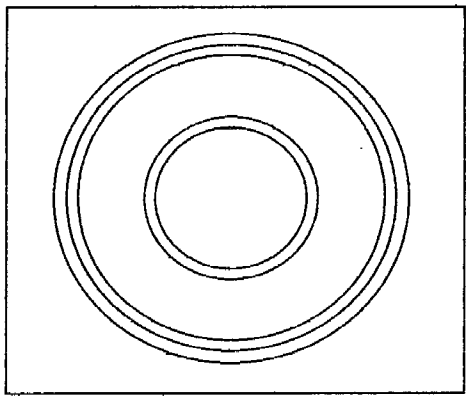


Figure 3-6. Schematic illustration of a continuous-trough hearth

In this mode, the pocket-select codes—whether issued via the front-panel thumbwheel or by a remote device—determine the hearth's rotation speed. As Table 3-2 indicates, the pocket-select codes for pockets 1 through 7 select rotation speeds ranging from .187 RPM to .845 RPM, and the pocket-select code for pocket 8 stops or prevents hearth rotation. Speed changes can be made while the hearth is rotating.

Table 3-2. How hearth rotation speed in continuous mode varies depending on the pocket number selected

Pocket Selected	Hearth Rotation Speed
1	.845 RPM
2	.732 RPM
3	.630 RPM
4	.515 RPM
5	.405 RPM
6	.295 RPM
7	.187 RPM
8	0 RPM

3.8 PHASE ADJUSTMENT

A unique front-panel feature of the TRC-3460 makes it easy to reset the home position when hearth rotation is out of phase (i.e., when the home position is no longer centered within the cutout in the top of the source). This phase adjustment can be accomplished in either of two ways, both of which are described in detail below. The electromechanical method necessitates breaking vacuum and lowering and swinging out the source tray. However, this method allows extremely precise phase adjustment. The electronic method lets you reset the home position using front panel controls alone. However, it may prove difficult to achieve the desired accuracy with this method, as it entails judging the accuracy of the phase adjustment while observing the source at an angle through a viewport.

Electromechanical Method

DANGER: HIGH VOLTAGE

Observe all applicable high-voltage precautions in performing the following procedure. These precautions include making sure that the high-voltage is OFF and using a properly connected grounding rod to neutralize any residual charge on the structures on and around the source tray.

STEP NO.	PROCEDURE
1	Make sure that the high-voltage power supply is switched OFF.
2	If the power supply is equipped with a keylock, remove it and keep it in your pocket while you complete this procedure.
3	Lower the source tray, open the vacuum enclosure's access doors, and swing the source tray away from the enclosure.
4	Using a properly connected grounding hook, touch the source tray and the frame of the vacuum enclosure in several places to neutralize any residual high-voltage charge.
5	Make sure the MAN/AUTO switch on the control unit's front panel is set to MAN.
6	Use the thumbwheel on the control unit's front panel to select pocket 1.
7	Switch on the indexer, if it is not already on. After going through some rotation involved in its initialization routine, the indexer will rotate the hearth to the factory-set home position for pocket 1.
8	If pocket 1 is not correctly centered within the cutout in the top of the source, switch off the indexer.
9	Turn the hearth by hand until pocket 1 is precisely centered within the cutout.
10	Using the end of a paper clip or some other small-diameter probe, push in the spring-loaded phase adjustment pushbutton and keep it depressed as you switch on the indexer and as the hearth goes through its initialization routine. (This routine involves what may appear to be random rotation.) Release the pushbutton only after the hearth has returned to the new home position for pocket 1 and stopped. If this is not the correct home position, switch off the indexer and repeat steps 9 and 10.
11	Use the pocket selection thumbwheel to change pockets several times, checking to see that each pocket goes to the correct home position. If the hearth does not remain properly in phase, return to pocket 1 and repeat steps 9-11.

Electronic Method

STEP NO.	PROCEDURE
1	Make sure the MAN/AUTO switch on the control unit's front panel is set to MAN.
2	Use the thumbwheel on the control unit's front panel to select pocket 1.
3	Switch on the indexer, if it is not already on. After going through some rotation involved in its initialization routine, the indexer will rotate the hearth to the factory-set home position for pocket 1.
4	If pocket 1 is not correctly centered within the cutout in the top of the source, switch off the indexer.
5	Switch the indexer on and off rapidly, watching the hearth move a small amount each time you do so. When pocket 1 is centered in the cutout, leave the indexer switched off.
6	Using the end of a paper clip or some other small-diameter probe, push in the spring-loaded phase adjustment pushbutton and keep it depressed as you switch on the indexer and as the hearth goes through its initialization routine. (This routine involves what may appear to be random rotation.) Release the pushbutton only after the hearth has returned to the new home position for pocket 1 and stopped. If this is not the correct home position, switch off the indexer and repeat steps 5 and 6.
7	Use the pocket selection thumbwheel to change pockets several times, checking to see that each pocket goes to the correct home position. If the hearth does not remain properly in phase, return to pocket 1 and repeat steps 5-7.

SECTION 4
TROUBLESHOOTING

4.1 SECTION OVERVIEW

The TRC-3460 should prove to be an extremely reliable and trouble-free unit. However, the troubleshooting checklist provided in section 4.2 will help in resolving any problems that do occur. In addition, the signal-flow diagram provided in section 4.3 will make it possible to trace signals between indexer components when problems must be tracked to their sources.

4.2 ROUTINE TROUBLESHOOTING

Symptom	Possible Cause(s)	Procedure
1. When indexer is switched on, front-panel LED on control unit does not display anything, and rear-panel READY light is not lit.	1a. Incorrect input power cable connected.	1a. Make sure that power cable is correct type for input power voltage.
	1b. Input power cable not properly connected.	1b. Check to see that power cable is securely plugged in at both ends.
	1c. No power at wall receptacle that power cable is plugged into.	1c. Plug power cable into a different receptacle of correct voltage, or test to see whether power is available at the original receptacle.
	1d. Fuse blown.	1d. Open fuseholder in rear panel of control unit, check condition of fuse. If necessary, replace with correctly rated fuse. If fuses blow repeatedly, check control unit for internal shorts in input power circuit. **DANGER** **Shocks from 120- and 240-V power can cause physical injury and even death. Perform this and all other internal checks with the input power cable disconnected.**
2. LED and READY light perform correctly, but drive motor does not turn as indexer goes through its initialization routine and as pocket selection is changed.	2a. Motor cable (which connects control unit to index drive unit) not properly connected.	2a. Check to see that connectors on both ends of motor cable are plugged in and that screws securing these connectors to the connectors on indexer components are screwed in reasonably tight.
	2b. Continuity problem in motor cable.	2b. Check continuity between pins 6 and 14 on the 'D' connectors on both ends of motor cable.
	2c. Continuity problem between motor and connector J1 on interface PC board in index drive unit.	2c. Open case of index drive unit and check continuity of wires running between motor and J1 pins 5 and 6.
3. LED on control unit front panel flashes between pocket currently selected and zero.	3. Index drive motor cannot rotate hearth because of buildup of material under edge of cutout in top of source.	3. Clean deposited material from cutout edges and from ridges in top of hearth.

4.3 SIGNAL TRACING

Figure 4-1 identifies the indexer's PC boards and other internal components, shows how they are interconnected, and gives the number of the schematic for each board. The schematics are provided in Section 6 of this manual. Together with Figure 4-1, these schematics make it possible to follow the signal flow pin-by-pin through every connector in the indexer except for:

1. The control unit's rear-panel I/O (ISOLATED) connector, which is identified on schematic 715-9532 (TRC Optoisolator Interface PC board) as connector P2. Section 2.8 provides a pin-by-pin description of the signal flow through this connector.
2. Connector J1 on the TRC Interface Board in the index drive unit (see schematic 715-9522). Pins 5 and 6 on this connector supply power to the index drive unit's stepper motor. Pins 1-4 carry the signals that control the motor's four windings, or phases. The signals that pass through pin 1 (and a red wire) control phase 1. The signals that pass through pin 2 (and a blue wire) control phase 2. The signals that pass through pin 3 (and a black wire) control phase 3. The signals that pass through pin 4 (and a white wire) control phase 4.

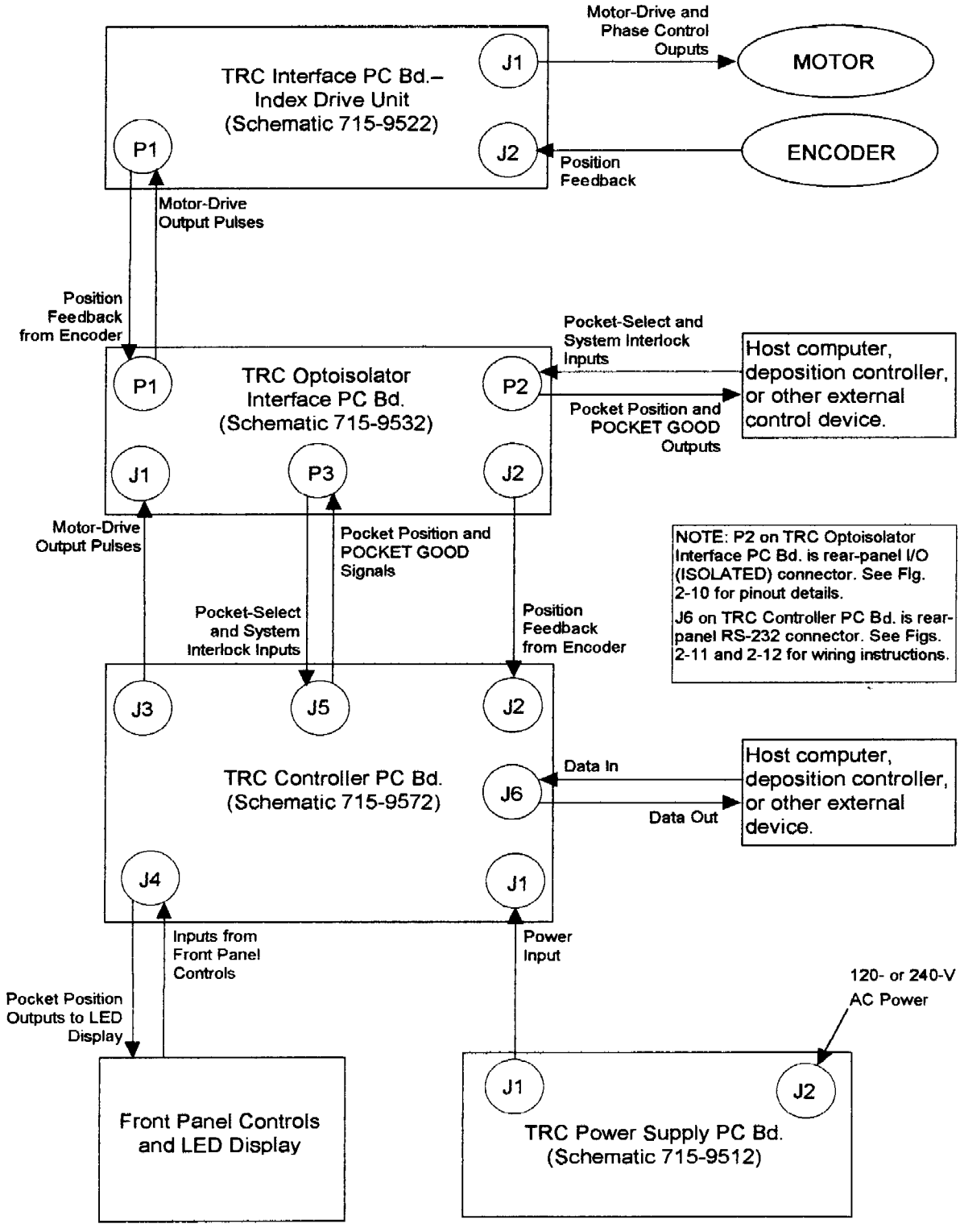


Figure 4-1. TRC-3460 Signal Flow Diagram

SECTION 5
SERIAL OMMUNICATIONS

5.1 SECTION OVERVIEW

The RS-232 interface on the control unit's rear panel allows you to establish serial communications between the TRC-3460 and a remote device, which may be a computer, a deposition controller, or another system component. In these exchanges, the indexer does not initiate any messages but simply responds to commands issued by the external device. These can be either commands for the indexer to perform various of its functions or commands for the indexer to return data to the external device.

Instructions for establishing connections between the rear-panel RS-232 interface and the external device are provided in section 2.9. Additional hardware setup details are covered in this section, but its main purpose is to describe the communications details specific to the TRC-3460. The topics covered are:

- Hardware Setup (section 5.2)
- TRC-3460 Input Command Set (section 5.3)
- The "Response Byte" in Indexer Responses (section 5.4).

5.2 HARDWARE SETUP

DIP Switch Configuration

If you wish to implement RS-232 communications, DIP switch 6 on the control unit's CPU board must be set to OFF. In addition, DIP switches 7 and 8 must be set so that the control unit's baud rate matches that of the external device. See section 2.3 for instructions on setting the DIP switches.

Setting the Baud Rate

In order for serial communications to be established, the baud rate of the indexer must match that of the external device. The control unit is factory configured for 9600 baud, but you can change this rate by resetting the control unit's internal DIP switches (see section 2.3). Alternatively, it may be simpler to set the external device for 9600 baud. To set a IBM-compatible PC for 9600 baud, enter the following DOS command:

Mode Com1:9600,8,N,1 <Enter>

This command sets the PC's COM1 port to transmit at 9600 baud using 8 data bits, no parity bit, and 1 stop bit. If you are using COM2, use the same command with **Com2** in place of **Com1.**

5.3 TRC-3460 INPUT COMMAND SET

Listed below are the specific commands to which the TRC-3460 is programmed to respond. The heading for each block of columnar information contains the name of the command followed by the basic command code in parentheses. Where applicable, variable characters that may (or must) be included in valid command strings are listed opposite "Legal parameters." The contents of a complete valid command string are provided in boldfaced text opposite "Command format." The standard messagte that the TRC-3460 would return in response to such a command appear in boldfaced text opposite "Typical response." The text opposite "Function" specifies the purpose and/or effect of the command in question. Where appropriate, additional information about a specific command and/or its response from the indexer are provided following these lines.

Version Command (@)

Command code	@ (*at* sign)
Command format	**$@?<cr>**
Function	Queries for software version loaded in indexer
Typical response	**$*TRC/1.0<cr>**

This command is useful in initial tests of the communications link and the communications software.

Lockout Command (A)

Command code	A
Legal parameters	0 or 1
Command format	**$A*N*<cr>** (where *N* is either a zero or a 1)
Function	Enables or disables the RS-232 port
Typical response	**$*<cr>**

The command *A1* enables the RS-232 port and enables control over the indexer by this port's inputs. The command *A0* disables the RS-232 port and enables control of the indexer by signals received via the rear-panel I/O (ISOLATED) connector.

Pocket Command (B)

Command code	B
Legal parameters	1, 2, 3, 4, 5, 6, 7, 8
Command format	**$B*N*<cr>** (where *N* is one of the integers 1-8)
Function	Rotates hearth to pocket position corresponding to the parameter number received
Typical response	**$*<cr>**

To query the TRC-3460 for the current pocket position, substitute a question mark for the integer represented by *N* in the command format example above. The complete query-pocket command, then, would be: **$B?<cr>**

Power-Fail Status Command

Command code	C
Command format	**$C?<cr>**
Function	Queries the unit for power-fail status.
Typical responses	**$*A<cr>** or **$*B<cr>**

The indexer returns an *A* if no power failure has occurred and a *B* if a power failure has occurred.

Moving Command (D)

Command code D
Command format **$D?<cr>**
Function Queries indexer as to whether the stepper motor is currently rotating
Typical responses **$*M<cr>** or **$*R<cr>**

The indexer returns an ***M*** if motor is rotating and an ***R*** if not.

Stall Error Command (E)

Command code E
Command format **$E?<cr>**
Function Queries indexer for a stalled motor error.
Typical responses **$*S<cr>** or **$*N<cr>**

The indexer returns an *S* if the stepper motor is stalled and an *N* if not.

Pocket-1 Offset Command (F)

Command code F
Command format **$F?<cr>**
Function Queries the indexer for the current home position of the pocket 1
Typical responses **$*0<cr>** to **$*1999<cr>**

This command enables the external device to determine which of the stepper motor's 2,000 positions is the current home position of pocket 1.

Current Location Command (G)

Command code F
Command format **$G?<cr>**
Function Queries the indexer for stepper motor position
Typical responses **$*0<cr>** to **$*1999<cr>**

This command enables the external device to determine the position of the stepper motor within its 2,000-step range.

Move-To Command (H)

Command code H
Legal parameters 0 to 1999
Command format **$H*N*<cr>** (where *N* is an integer from zero through 1999)
Function Rotates the stepper motor to the position specified by the parameter value sent
Typical response **$*<cr>**

Read Configuration Command (I)

Command code I
Command format **$I?<cr>**
Function Queries indexer for positions of internal configuration DIP switches
Typical responses **$*0<cr>** to **$*255<cr>**

This command allows the external device to read the settings of all 8 DIP switches.

Reset Command (J)

Command code J
Command format **$J<cr>**
Function Clears the reset flag (i.e., returns it to the "flag down" state)
Typical response **$*<cr>**

This command allows the controlling device to set the reset flag to the down position after the indexer has performed its initialization routine, usually following a power-up. The initialization routine sets the reset flag to the "flag up" state.

Read AUTO/MAN Switch Command (K)

Command code K
Command format **$K?<cr>**
Function Queries the indexer for the current position of the AUTO/MAN switch
Typical responses **$*A<cr>** or **$*M<cr>**

The indexer returns an *A* if the switch is in the AUTO position and an *M* if it is in the MANual position.

5.4 THE "RESPONSE BYTE" IN TRC-3460 RESPONSES

If the following two conditions are met, the TRC-3460 will respond to all commands received:

1. The baud rate of the device issuing the commands must match the baud rate for which the indexer is configured.
2. Every command must begin with the ASCII code for a dollar sign ($) and end with the code for a carriage return (<cr>).

If both of these conditions are not met, the indexer will not respond at all.

The first byte after the initial dollar-sign code in each message sent by the indexer is called the *response byte*. This byte will be the ASCII code for an asterisk (*), a pound sign (#), or one of the numbers 3 through 8 (see Table A-1). The response byte indicates to the external device whether the last command sent was valid or invalid and, if invalid, why it was invalid. The response byte also signals the status of the *reset flag*, which indicates whether the indexer has gone through its initialization routine since the previous time the reset flag was cleared.

Table A-1. Matrix of possible response bytes

Meaning of response	Response byte if reset flag is down	Response byte if reset flag is up
Command OK	*	#
Illegal Command	3	4
Illegal Data Value	5	6
Illegal Syntax	7	8

The Reset Flag

The indexer sets the reset flag to the up position when the unit is powered up. The flag remains up until it is set to the down position by a reset command (J) sent from an external device. The purpose of the reset flag is to notify a remote control device that the indexer has been switched off and back on again. This information is important to note because a power-off condition might alter a programmed process sequence. For example, the indexer would not respond to a pocket-move command issued during a power-off condition. A well designed control program would therefore begin by setting the reset flag to the down position and then check its status at each indexer response.

Responses to Valid Vs. Invalid Messages

As Table A-1 indicates, there are eight possible response bytes. If the command has the correct content and format, the indexer will return one of two response bytes:

- If the reset flag is up, indicating a power-off conditions since the previous message sent by the indexer, the response byte will be a pound sign (#).
- If the reset flag is down, the indexer will return an asterisk (*) as the response byte.

Either of these response bytes means "command OK."

If the command is incorrect in either content or format, the indexer will return a response byte that indicates the state of the reset flag and why the command is invalid. The possible responses are:

Illegal Command (ASCII codes for the numbers 3 and 4)

Both of these responses indicate that the indexer does not recognize the command code (i.e., the initial byte of the command). A response byte of *3* signals that this is the case and that the reset flag is down. A response byte of *4* signals "illegal command and reset flag is up."

Illegal Data Value (ASCII codes for the numbers 5 and 6)

Both of these codes indicate that the data value or parameter sent following the command code is either an incorrect code or outside the range of data values defined for this parameter. A *5* indicates "illegal data value and reset flag is down." A *6* indicates "illegal data value and reset flag is up."

Illegal Syntax (ASCII codes for the numbers 7 and 8)

These codes signal that the internal format of the data is incorrect. The command either contains an illegal number of data parameters or improper delimiters between data. A *7* signals "illegal syntax and reset flag is down." An *8* signals "illegal syntax and reset flag is up."