
**U100 R/D OPTION
MANUAL**

P/N: EDU133 (V1.1)



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If you should have any questions about the U100 R/D board or comments regarding the documentation, please refer to Aerotech online at:

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For your convenience, a product registration form is available at our web site.

Our web site is continually updated with new product information, free downloadable software and special pricing on selected products.

The U100 R/D board is a product of Aerotech, Inc.

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CHAPTER 1: DESCRIPTION

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1.1. Resolver-to-Digital Converter

The optional Resolver-to-Digital (R/D) converter board enables the U100/U100i to use resolver or inductosyn feedback as position and/or velocity information. It allows for high resolution positioning performance by converting analog feedback signals into 12, 14, or 16 bit digital data. Thus, one electrical cycle of a resolver or inductosyn can be interpreted as 4,096 counts (12 bit), 16,384 counts (14 Bit), or 65,536 counts (16 bit).

The controller R/D board incorporates a mode for automatic dynamic resolution switching on the fly. By switching to the 14 bit mode after exceeding a pre-determined speed, the system can maintain high speed capability. Switching back to the 16 bit mode below the speed threshold allows 16 bit positioning accuracy.

The R/D board plugs into the extension bus (P5 of the control board) and mounts to the control board. The controller provides the power for the R/D board. The interface to a resolver or Inductosyn is through a 15 pin “D” style connector (P2 on the interface card) that protrudes from one of the option ports, refer to Figure 2-2. Table 2-6 lists the pinout descriptions.

The interface is the same for the U100i using its single option port.



To use the R/D option, the controller must be configured by setting certain parameters in the controller’s battery backed memory. Table 1-1 shows the parameters and their standard settings.

Table 1-1. R/D Standard Parameter Settings

Parameter	Setting	Function
PRM:118	4	Home on zero crossing of R/D.
PRM:137	4	Enables 16/14 bit auto-select mode.
PRM:138	4	Enables velocity feedback from R/D.
PRM:139	4	Enables position feedback from R/D.
PRM:241	0	Commutation table step shift
PRM:310	4	Sets the R/D update rate at .8 ms.

The maximum R/D feedback data rate is 1,000,000 machine steps/second. If you are using a rotary resolver, this translates to 14,648 rpm in the 12 bit mode, 3,662 rpm in the 14 bit mode (or 16/14 bit mode), and 915 rpm in the 16 bit mode.

When PRM:137 is set to “4”, the controller positions in 16 bit mode. However, above a preset speed, the controller switches into 14 bit mode to allow high speed operation.

Setting parameter PRM:310 to “4” allows proper tuning and operation for most systems. This value, however, can be set from 1 to 8 depending of the construction of the system. The guideline to be observed in this setting is that the higher the inertia of the mechanical system or the lower the resolution of the feedback device (resolver or Inductosyn), the higher this value must be set. For lower inertia loads or a higher resolution feedback device, a lower value must be used.

In most cases, the R/D is the source of both position and velocity feedback for the UNIDEX 100/U100i. However, it is possible to use the R/D as only a position or velocity feedback source, while an incremental encoder is the other feedback source (position or velocity). Generally, this would only be done in a highly compliant mechanical system.

Parameters PRM:307 and PRM:308 (refer to the U100 manual for more information on these parameters) should be set to “0” if no incremental encoder is being used to supply position and/or velocity feedback to the controller.



Parameter PRM:307 applies to the primary encoder and parameter PRM:308 corresponds to the auxiliary encoder. Setting these parameters to zero provides better performance of the UNIDEX 100/U100i operating system.

1.2. Home Marker Selection

PRM: 118

This parameter selects what signal to use as the Home Marker (after finding the selected Home Limit Switch specified in PRM: 117).

This parameter should be changed to 4 when using a resolver or inductosyn.

Table 1-2. Settings for Home Marker Selection (PRM: 118)

PRM:138	Function
1	Home on Marker #1.
2	Home on Marker #2.
3	Home on the selected Limit Switch indicated by PRM: 117.
4	Home on zero crossing of R/D converter counter (applicable only with the R/D option board).

1.3. R/D Resolution Mode

PRM: 137

This parameter allows the selection of “tracking” resolution for the R/D option board as follows. The default value is (4). Table 1-3 shows the value settings for parameter “PRM:137”.

Table 1-3. Settings for R/D Resolution Mode (PRM: 137)

PRM:137	Function
1	Fixed 16 bit tracking mode (65,536 bits).
2	Fixed 14 bit tracking mode (16,384 bits).
3	Fixed 12 bit tracking mode (4096 bits).
4	16/14 bit dynamic tracking mode (65,536 bits, default setting).

The bit resolution shown above is relative to the Resolver or Inductosyn electrical cycle.

For operating mode “4”, tracking is based on 16 bit resolution starting from 0 to approximately 15 electrical cycles per second tracking rate. When this rate is exceeded, 14 bit mode is automatically entered and its result is then automatically scaled by a factor of 4 to maintain the effect of 16 bit operation. When the tracking speed falls below 13 electrical cycles per second, the 16 bit mode is, again, automatically engaged. The default value is “4”, 16/14 bit tracking mode.

If operating modes 1 through 3 are selected, the tracking loop of the converter must be altered in order for proper operation to be obtained. See Table 2-5.



1.4. Velocity Feedback Type

PRM: 138

This parameter selects what input to use as the velocity feedback for the PID Control Loop. This parameter should be changed to 4 when using a resolver or inductosyn as the velocity feedback device.

Table 1-4. Settings for Velocity Feedback Type (PRM:138)

PRM:138	Function
0	Disable.
1	Velocity feedback is Encoder 1.
2	Velocity feedback is Encoder 2.
3	Velocity feedback is ENC (optional interface).
4	Velocity feedback is R/D (optional interface).

1.5. Position Feedback Type**PRM: 139**

This parameter selects what input to use as the position feedback for the PID Control Loop. This parameter must be changed to 4 when using a resolver or inductosyn.

Table 1-5. Settings for Position Feedback Type (PRM: 139)

PRM:139	Function
0	Disable.
1	Position feedback is Encoder 1.
2	Position feedback is Encoder 2.
3	Position feedback is ENC (optional interface).
4	Position feedback is R/D (optional interface).

1.6. Brushless Commutation Table Step Shift**PRM:241**

This parameter provides a method of shifting the sine interpolation cycle, set up in PRM:240, with respect to the state transitions of the Hall effect inputs. For R/D commutation mode, this parameter is typically set to 0.

The default value for this parameter is **-42**. To change this, enter an integer from -127 to 127. The number entered through this parameter can be correlated as “degrees of shift” by using the following formula:

$$\text{DEG} = \text{PRM:241} * 1.40625$$



To activate this parameter after it has been changed, the controller must be reset. To initialize a reset, hit <CTRL>+<D>

1.7. Resolver-to-Digital Update Time **PRM:310**

This parameter selects the update rate for the R/D option. The standard setting when an R/D board is present is “4”, (.8ms).

Table 1-6. Settings for Resolver to Digital Update Time (PRM:310)

PRM:310	Function
0	Turn Off the R/D update time.
1	Set the R/D update time at 0.1 msec.
2	Set the R/D update time at 0.2 msec.
3	Set the R/D update time at 0.4 msec.
4	Set the R/D update time at 0.8 msec.
5	Set the R/D update time at 1.6 msec.
6	Set the R/D update time at 3.2 msec.
7	Set the R/D update time at 6.4 msec.
8	Set the R/D update time at 12.8 msec.

To activate this parameter after it has been changed, the controller must be reset. To initialize a reset, hit <CTRL>+<D>.



1.8. R/D Counter Register (Read Only, Integer) **REG: 038**

This register allows direct access to the R/D (Resolver to Digital) counter, when the R/D option board is installed.

The counter is aligned to the upper 24 bits of the data register. For example, if PRM: 137 is set to 4 or 1 (16 bit tracking), the valid range of this register is 000000 through ffff00. If 12 bit tracking mode is selected (e.g., PRM: 137=3), the valid range is 00000 through fff000.

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CHAPTER 2: U100 R/D SETUP

In This Section:

- R/D Board Hardware Setup..... 2-1

2.1. R/D Board Hardware Setup

The R/D board connects between the UNIDEX 100 and a feedback device, such as an inductosyn or resolver. Before the R/D board can be used, it must be configured.

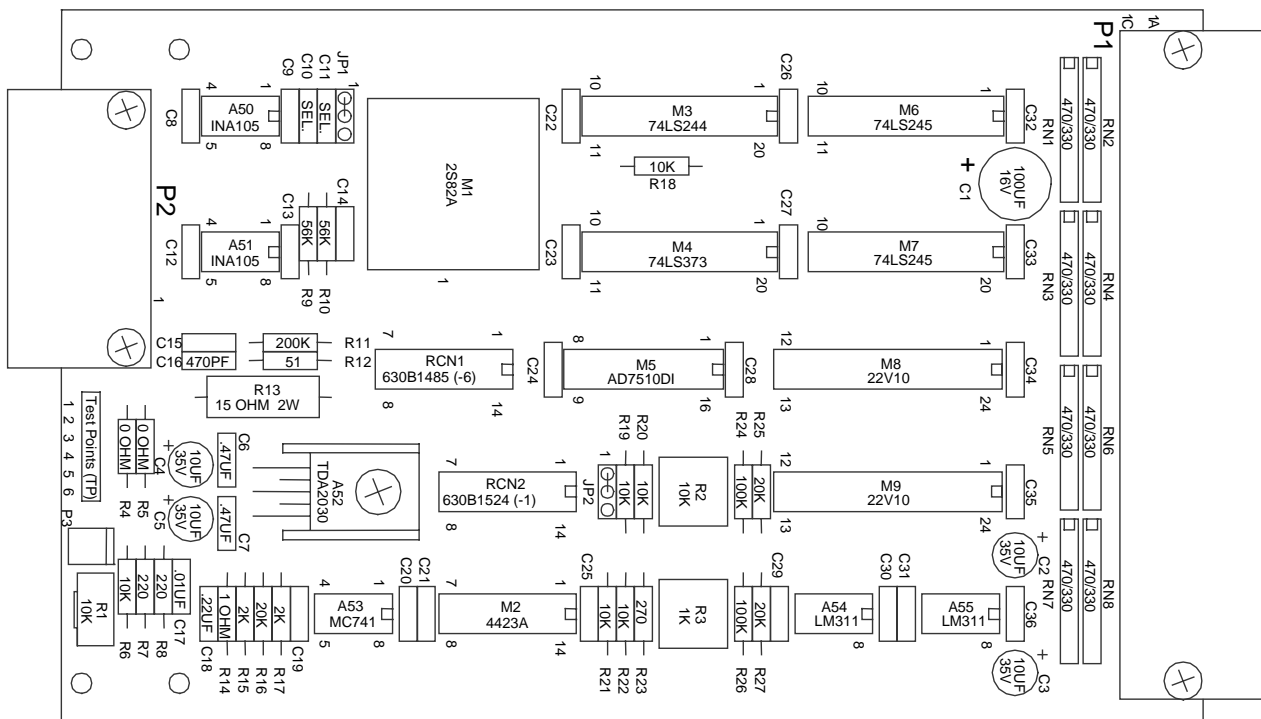


Figure 2-1. U100 RD Board

The first step is to configure the jumpers on the board. See the following tables for jumper settings and refer to Figure 2-1 for jumper locations.

Table 2-1. Jumper Settings for Converter Demodulator Adjust Mode (RD)

Axis	Enable	Disable
1	Install JP1 2-3	Install JP1 1-2 (default)



The jumper JP1 2-3 should only be enabled when adjusting the phase offset pot (R1) for rotary inductosyn.

Table 2-2. Inductosyn or Resolver Jumper Settings

Axis	Resolver	Inductosyn
#1	Set JP2 to 1-2 (default)	Set JP2 to 2-3

The next step is to configure the resistor network RCN2 (see Figure 2-1) for the oscillator frequency that will be used, refer to Table 2-3.

Table 2-3. Oscillator Frequency Configuration for RCN2

RCN2							
Description	Pins 1-14	Pins 2-13	Pins 3-12	Pins 4-11	Pins 5-10	Pins 6-9	Pins 7-8
Standard 10 kHz (default)	1.96 kΩ 1%	1.96 kΩ 1%	6.2 kΩ	3.9 kΩ	1500 pF	OPEN	OPEN
7.5 kHz	1.1 kΩ 1%	1.1 kΩ 1%	6.2 kΩ	3.9 kΩ	1500 pF	OPEN	OPEN
5 kHz	560 Ω 1%	560 Ω 1%	6.2 kΩ	3.9 kΩ	1500 pF	OPEN	OPEN

In addition, capacitors C10 and C11 must be configured for the oscillator frequency that will be used, refer to Table 2-4.

Table 2-4. Oscillator Frequency Configuration for Capacitors R/D board

Axis	10 kHz	7.5 kHz	5 kHz
C10, C11	Install a 270 pF capacitor (default)	Install a 390 pF capacitor	Install a 560 pF capacitor

The configuration of the resistor network RCN1 and the bit resolution entered in PRM: 137 determines the bit resolution used, refer to Table 2-5.

Table 2-5. Bit Resolution Configuration RCN1 on the RD Board

RCN1 Through RCN4 (where RCN1 = Axis #1)							
Description	Pins 1-14	Pins 2-13	Pins 3-12	Pins 4-11	Pins 5-10	Pins 6-9	Pins 7-8
16 Bit Resolution 1K BW	8.2 kΩ	390 pF	1800 pF	360 kΩ	62 kΩ	OPEN	OPEN
16 Bit Resolution 750 BW	8.2 kΩ	680 pF	3300 pF	270 kΩ	62 kΩ	OPEN	OPEN
14 Bit Resolution 1K BW	33 kΩ	390 pF	1800 pF	360 kΩ	62 kΩ	OPEN	OPEN
14 Bit Resolution 750 BW	33 kΩ	680 pF	3300 pF	270 kΩ	62 kΩ	OPEN	OPEN
12 Bit Resolution 1K BW	130 kΩ	390 pF	1800 pF	360 kΩ	62 kΩ	OPEN	OPEN
12 Bit Resolution 750 BW	130 kΩ	680 pF	3300 pF	270 kΩ	62 kΩ	OPEN	OPEN
16-14 Dynamic Resolution (Standard) 1K BW	8.2 kΩ	1500 pF	8200 pF	91 kΩ	64.9 kΩ 1%	21.5 kΩ 1%	OPEN

To connect the RD board to the UNIDEX 100 board, connect the 64-pin ribbon cable from P1 of the RD board to P5 of the UNIDEX 100 board.

Make sure pin #1 of the ribbon cable mates with pin #1 of the P1 and P5 connectors.



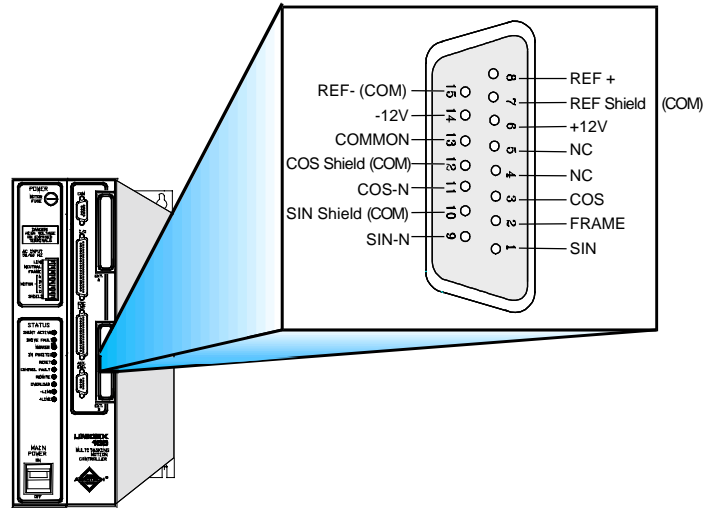


Figure 2-2. R/D Interface Board Connector Pinouts

Table 2-6. R/D Connector Pinout Descriptions

P2	Description	
Pin 1	SIN	Sine Feedback Signal
Pin 9	SIN-N	Compliment Sine Feedback Signal
Pin 2	FRAME	Earth Ground
Pin 10	SIN SHIELD (Com)	Shield Connection for SIN/SIN-N (twisted pair), connects to common
Pin 3	COS	Cosine Feedback Signal
Pin 11	COS-N	Compliment Cosine Feedback Signal
Pin 4	NC	
Pin 12	COS SHIELD (Com)	Shield Connection for COS/COS-N (twisted pair), connects to common
Pin 5	NC	
Pin 13	SIGNAL COMMON	
Pin 6	+12V P.S.	For supplying Inductosyn pre-amp board
Pin 14	-12V P.S.	For supplying Inductosyn pre-amp board
Pin 7	REF SHIELD (Com)	Shield Connection for REF/REF-N (twisted pair), connects to common
Pin 15	REF-N (Com)	Signal Common
Pin 8	REF	R/D Output Signal for Driving Resolver or Inductosyn

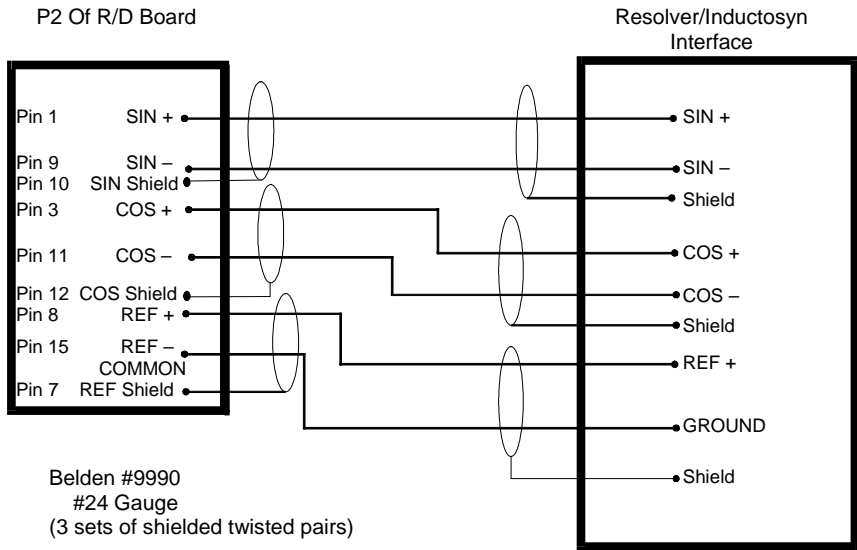


Figure 2-3. Suggested Cabling from R/D Board to Resolver/Inductosyn

Once a resolver or inductosyn is connected to the R/D board, the user must verify that a sinusoidal signal is being sent from the feedback device and adjust the amplitude, if necessary. The signals can be monitored from the test points listed in Table 2-7.

Table 2-7. R/D Board Test Points

Test Points	Axis #	Sine/Cosine Signal
TP1	1	Unmodulated Ref
TP2	1	COS
TP3	1	SIN
TP4	-	Ground (Common)
TP5	1	Inductosyn Phase Error

To verify that a sinusoid signal is being received from the axis with a resolver or inductosyn, perform the following steps.

1. Connect an oscilloscope (O-scope) to the COS signal of the axis being tested and connect the ground of the O-scope to TP4. Move the resolver or inductosyn; a COS signal (sinusoid) should be observed on the O-scope.
2. Connect the O-scope to the SIN signal of the axis being tested. Move the resolver or inductosyn again verifying that a SIN signal (sinusoid) is seen on the O-scope.
3. Verify that the amplitude of the sinusoidal signal of the axis being tested is within specification. Connect an O-scope to either the SIN or COS signal, connect the ground lead to TP4. Move the resolver or inductosyn and observe the amplitude increase and decrease.
 - Notice that when the COS signal's amplitude is at maximum, the SIN signal's amplitude is at minimum and vice-versa.
4. Stop moving the resolver or inductosyn when the amplitude of the sinusoid is at its maximum.
 - The maximum should be 2 volts RMS, which is ≈ 2.8284 volts peak or ≈ 5.6568 volts peak to peak.
5. If it is not 2 volts RMS, then adjust the R3 potentiometer until it is.

To null the phase offset, for rotary inductosyns, perform the following.

1. Disable the axis being tested.
2. Set the converter demodulator adjust mode jumper JP1 to position 2-3.
3. Connect an O-scope to TP5. Connect the ground lead to TP4.
4. Adjust the phase offset pot (R2) until the ideal rectified signal is present, refer to Figure 2-4. Get as close as possible.
 - A different capacitor may be needed for pins 5 and 10 of RCN2.
5. Return jumper JP1 to position 1-2.

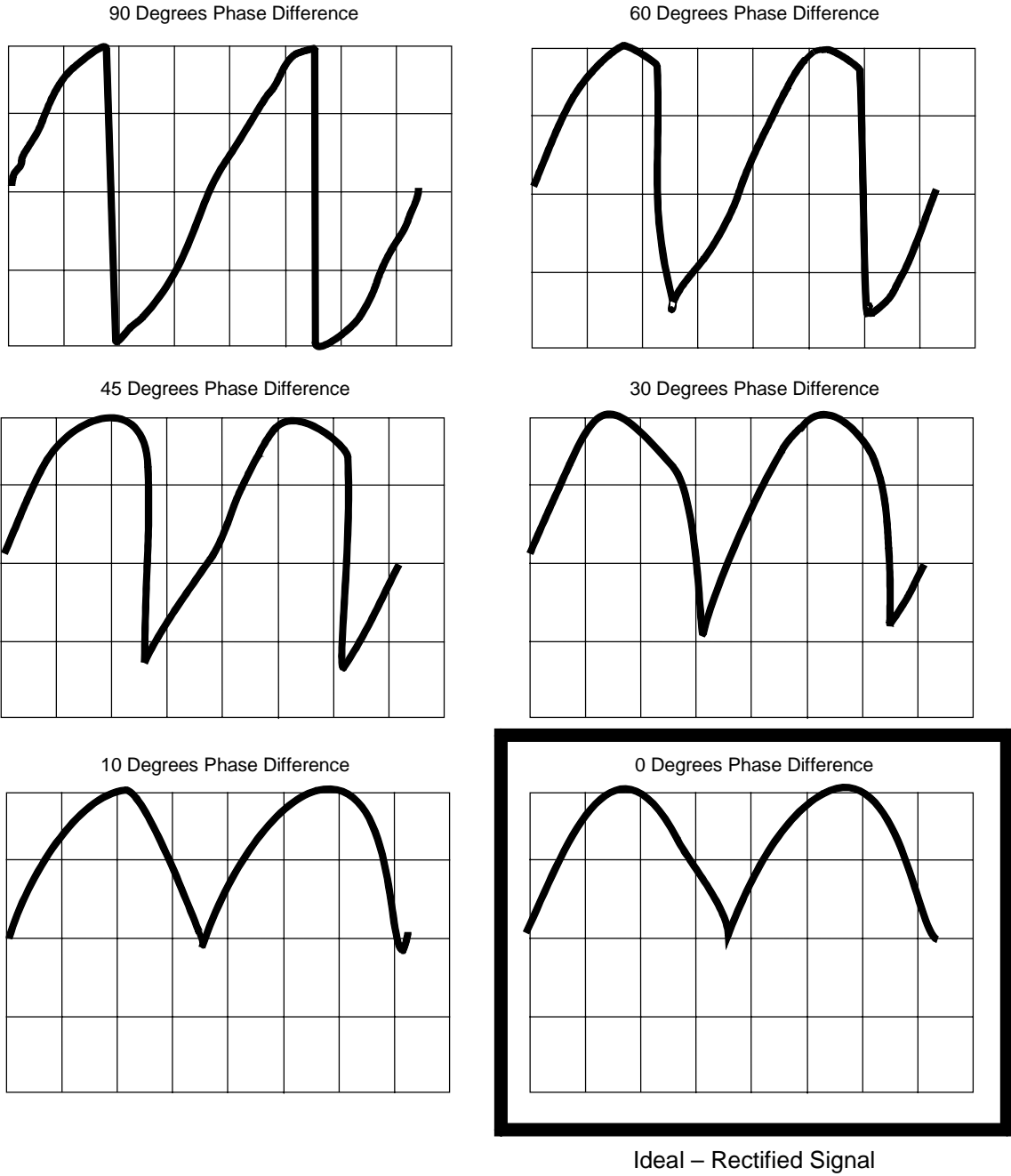


Figure 2-4. Rectified Signals with the Most Ideal Signal

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CHAPTER 3: BRUSHLESS MOTOR PHASING

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3.1. Brushless Motor Phasing

Aerotech brushless rotary motors are shipped from the factory with the correct motor phase relationship established. This is essential for proper motor commutation.

Figure 3-1 shows the proper motor phasing for both clockwise (CW) and counterclockwise (CCW) motor rotation (viewed looking into the mounting flange of the motor).

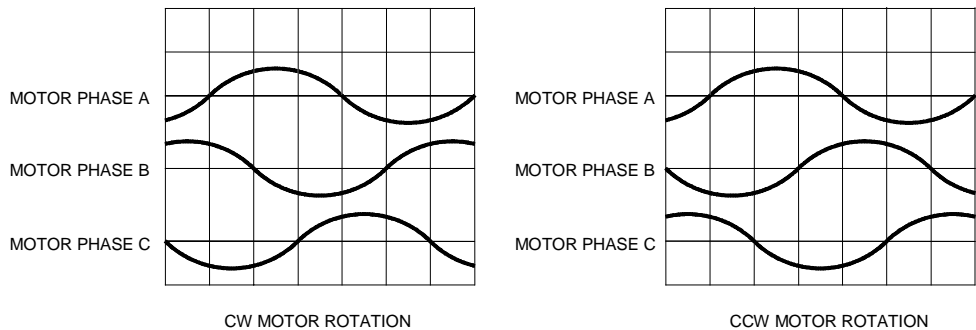
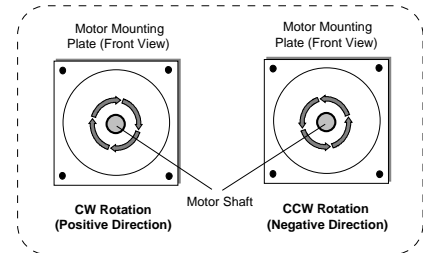
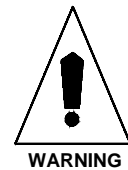


Figure 3-1. Motor Phasing



The waveforms created by the motor phasing can be observed using a wye resistor network, a dual trace oscilloscope, and by performing the following steps.

Motor voltage is monitored without power applied to the motor.
 Before performing the following steps, remove all connections to the motor except the wye resistor network. Remove all mechanical connections to the motor shaft.



1. Connect the ends of three resistors to motor terminals A, B, C. Refer to Figure 3-2.
2. Use one channel of the oscilloscope to monitor motor terminal A with respect to the “Wye” neutral (the point where all resistors are connected together), refer to Figure 3-2.
3. Connect the second channel of the oscilloscope to motor terminal B with respect to the “Wye” neutral.
4. Once the oscilloscope is connected with one probe monitoring motor phase A and the other monitoring motor phase B, rotate the motor by hand using the motor shaft. The motor will generate a voltage upon rotation.
5. Observe the phase relationship of the motor phase A to motor phase B.



It is necessary for the voltage generated by the motor phase B to be shifted 120 degrees from motor phase A, refer to Figure 3-1.

6. Move the probe on motor phase B to motor phase C, observing its phase relationship to motor phase A.



It is necessary for the voltage generated by the motor phase C to be shifted 120 degrees from motor phase A, refer to Figure 3-1.

Using this procedure, connect the appropriate motor phases as shown in Figure 3-1.

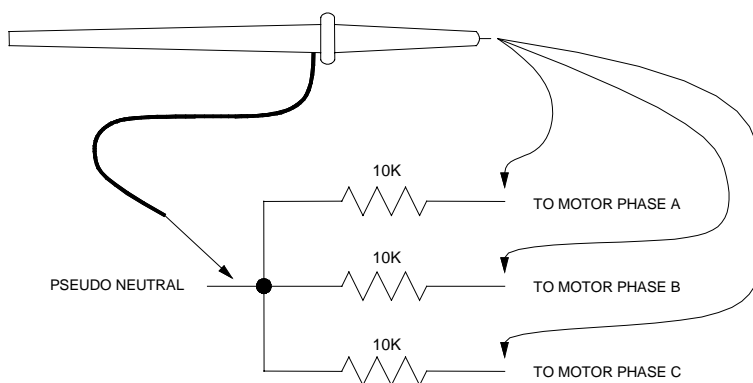


Figure 3-2. Motor Phase Voltage Observation Scheme

3.2. Brushless Motor with Resolver Commutation

An optional resolver can be used as the feedback device for a brushless rotary motor. The resolver is aligned at the factory, so that the null position of the resolver corresponds to a motor phase angle of zero degrees (refer to Figure 3-3). The null position of the resolver is considered to be the point at which the sine feedback signal is resting at a zero level and the cosine signal is resting at its positive peak.

The sine and cosine signals shown in Figure 3-3 represent demodulated waveforms. In actual operation, these signals are transmitted on a high frequency carrier (e. g., 5KHz, 10KHz).



The zero degree phase angle of the motor is defined as the position that the motor shaft will align to if phase A is energized with a positive voltage with respect to phases B and C. The 8 pole motors (4 pole pairs) have 4 zero degree points per revolution, and the 6 pole motors have 3 zero degree points per revolution.

Optionally, the absolute resolver position can be read at REG:038 and adjusted for a value of 0x000000 +/-2 degrees. (0x016C00 to 0xFE9300).

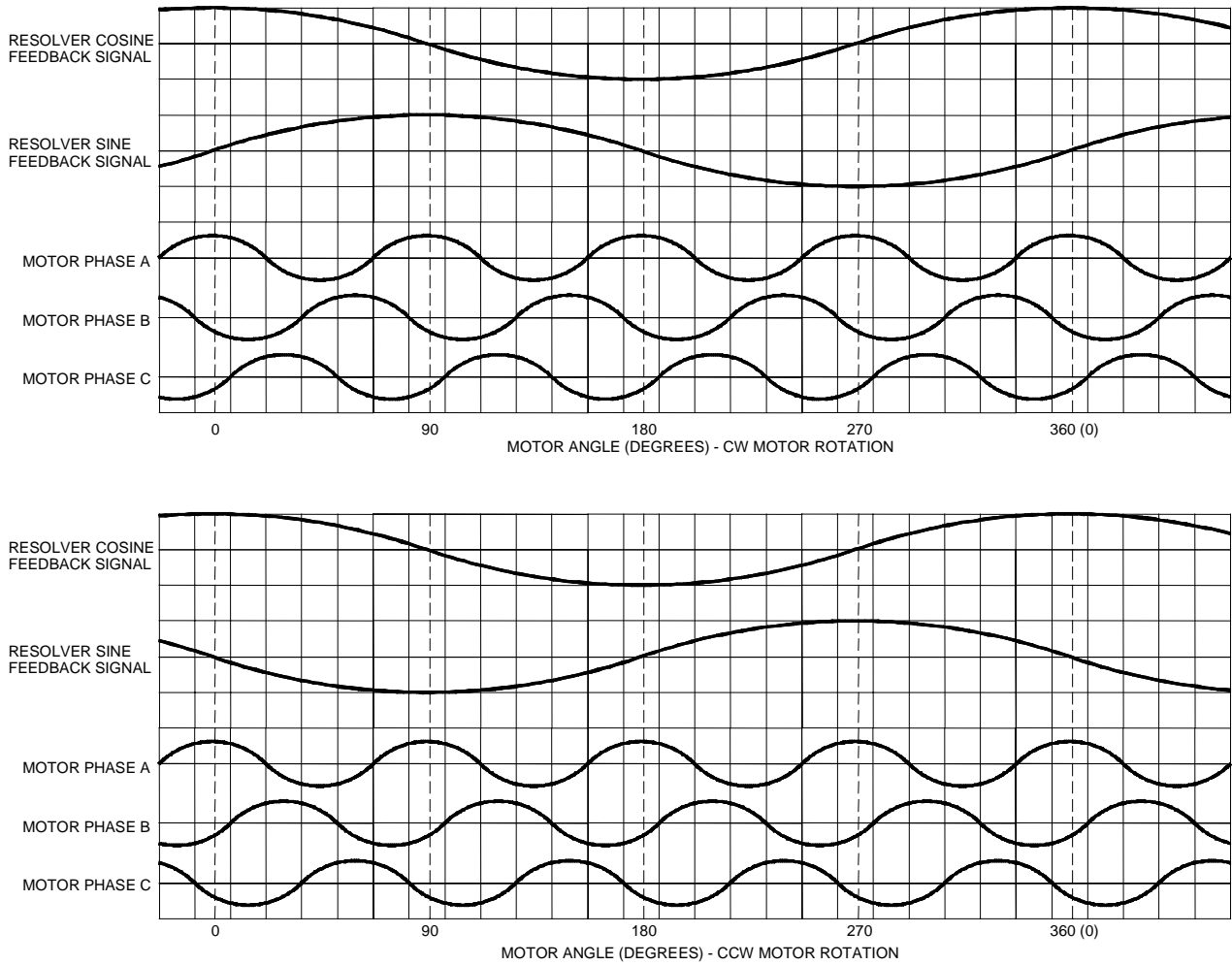


Figure 3-3. Resolver and Motor Phasing (8 pole motor shown)

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APPENDIX A: WARRANTY AND FIELD SERVICE**In This Section:**

- Laser Product Warranty
- Return Products Procedure
- Returned Product Warranty Determination
- Returned Product Non-warranty Determination
- Rush Service
- On-site Warranty Repair
- On-site Non-warranty Repair

Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products which are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, whether or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability or any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.

Aerotech, Inc. warrants its laser products to the original purchaser for a minimum period of one year from date of shipment. This warranty covers defects in workmanship and material and is voided for all laser power supplies, plasma tubes and laser systems subject to electrical or physical abuse, tampering (such as opening the housing or removal of the serial tag) or improper operation as determined by Aerotech. This warranty is also voided for failure to comply with Aerotech's return procedures.

Laser Products

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within (30) days of shipment of incorrect materials. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. Any returned product(s) must be accompanied by a return authorization number. The return authorization number may be obtained by calling an Aerotech service center. Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than (30) days after the issuance of a return authorization number will be subject to review.

Return Procedure

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warranted defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an air freight return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

***Returned Product
Warranty Determination***

Returned Product Non-warranty Determination

After Aerotech’s examination, the buyer shall be notified of the repair cost. At such time the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer’s expense. Failure to obtain a purchase order number or approval within (30) days of notification will result in the product(s) being returned as is, at the buyer’s expense. Repair work is warranted for (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech’s approval.

On-site Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special service rates apply.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

On-site Non-warranty Repair

If any Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

Company Address

Aerotech, Inc.
101 Zeta Drive
Pittsburgh, PA 15238-2897
USA

Phone: (412) 963-7470
Fax: (412) 963-7459
TWX: (710) 795-3125



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**U100 R/D Option Manual
P/N EDU 133, January 2001**

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