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This manual covers the full configuration of the HD361 Three Phase Heavy Duty Rotor Controllers. Refer to the overall wiring diagram in Section 7.0 and component location drawing in Section 3.0 for an overview.

1.0 INTRODUCTION

The Rotor-AID HD361 Heavy Duty Rotor Controller provides the necessary control signals, interlocks and power outputs to drive the anode rotors of x-ray tubes to near 3810 rpm (63.5 Hz) or 5710 rpm (95.2 Hz) or to other rotational speeds using the PROM programmed frequency memory and then to dynamically Brake them. Both Boost and Brake are achieved in the shortest possible time periods which are digitally preset for each individual tube.

These Rotor Controllers are designed to provide the maximum Boost power that almost any tube can accept for rapid acceleration. CARE MUST BE TAKEN NOT TO SELECT OPERATING FACTORS AND DUTY CYCLES THAT ARE BEYOND THE CAPACITY OF THE PARTICULAR X-RAY TUBE TO BE DRIVEN.

Three separate inverters are used to drive pre-selected high power into the three stator windings of the x-ray tube at phase angles of exactly 120 degrees; no phase shift capacitors are required. Pre-selected DC power is used to Brake rapidly.

Current sensing is provided to monitor stator currents during Boost and Run periods and to provide relay interlock contacts to prevent x-ray exposures if these currents are not within preset limits.

2.0 SPECIFICATIONS

2.1 Control Interface Input Voltages

Field selectable jumpers for each input circuit permit nominal input levels of 12VDC, 24VDC, or 120VAC for each input circuit. Loading is nominally 10mA for any input voltage selected.

2.2 Control Input Functions (60971C TB1)

All inputs must be held on for the duration of the function.

FUNCTION	60971C TB1 INPUT
ROTOR START (PREP)	PINS 1 & 2
HIGH SPEED SELECT	PINS 3 & 4
AUXILIARY INPUT (AUXIN)	PINS 5 & 6
COAST	PINS 7 & 8

2.3 Control Interface Output (61079D TB4)

(All contacts rated 120VAC, 2 Ampere resistive, except as noted)

FUNCTION	CHARACTERISTIC	CONTACTS
ROTOR INTERLOCK	SEE TIMING DIAGRAMS SECTION 5.3	2 SETS N.O. 1 SET N.C.
TUBE ACTIVE	CLOSED DURING BOOST, RUN AND BRAKE OPERATION	1 SET N.O.

2.4 Power Requirements

Line voltages:
Single phase 190VAC to 277VAC $\pm$ 10%, 50/60 Hz.

Isolation transformer, TR1, 74067.
Input voltage taps: 190, 200, 210, 220, 230, 240, 277 VAC.

Nominal 60 Ampere service required, preferably wired from the same source as the generator power rather than from the generator. Wiring should conform to local and national safety codes using #6AWG wire for runs up to 115 feet (35m) in order to minimize voltage drops during Boost.

Internal circuit breakers:
Time delay rated 60 Amperes, 240VAC.

2.5 Power Output

FUNCTION (ADJUSTMENT)	ADJUSTABLE PHASE TO PHASE VOLTAGE RANGE
HIGH SPEED BOOST (60980I R6)	<50VAC TO ABOUT 800VAC (INVERTER TAPS 4-6)
	<50VAC TO ABOUT 500VAC (INVERTER TAPS 4-5)
	<50VAC TO ABOUT 320VAC (INVERTER TAPS 5-6)
HIGH SPEED RUN (60980I R5)	SAME RANGES AS HIGH SPEED BOOST.
HIGH SPEED (DC) BRAKE (60980I R2)	<50VDC TO ABOUT 160VDC AT UP TO 10 AMPERES PER WINDING.
LOW SPEED BOOST (60980I R4)	<50VAC TO ABOUT 800VAC (INVERTER TAPS 4-6)
	<50VAC TO ABOUT 500VAC (INVERTER TAPS 4-5)
	<50VAC TO ABOUT 320VAC (INVERTER TAPS 5-6)
LOW SPEED RUN (60980I R3)	SAME RANGES AS LOW SPEED BOOST.
LOW SPEED (DC) BRAKE (60980I R1)	<50VDC TO ABOUT 130VDC AT UP TO 10 AMPERES PER WINDING.

Boost - Maximum available power output - Nominally 3.3kW per inverter (3 inverters) into most three phase stator windings rated for intermittent power levels of up to about 800VAC and up to 10 Amperes per winding.

2.6 Duty Cycle

In the High Speed (nominal 95.2 Hz) mode the following Boost/Run duty cycle can be run on a continuous basis using a tube with a three phase stator:

61 second Boost, 500VAC $\pm$ 10%

Continuous Run, 450VAC $\pm$ 10%

The maximum power output of this Rotor Controller exceeds the limits that most tubes can safely accept. Check with the tube manufacturer for the maximum power and duty cycle permitted to avoid damaging the x-ray tube.

2.7 Anode Rotation Maintained During Run

When the 61077D Interlock board W1 jumper set in the 2-3 position for the MRC200 x-ray tube:

High Speed near 5710 rpm (95.2 Hz).
Low Speed near 3810 rpm (63.5 Hz).

When the 61077D Interlock board W1 jumper set in the 1-2 position for the GS5070 x-ray tube with three-phase stator:

High Speed near 7270 rpm (121.2 Hz).
Low Speed near 3010 rpm (50.3 Hz).

When the 61077D Interlock board is custom programmed for specific drive frequencies the anode rotation speed is near the programmed drive frequencies. Boost frequencies are independent of Run frequencies.

2.8 Timer Adjustment Ranges

(Refer to Section 5.3 for timing sequences).

A 60972D timer board is provided to set Boost and Brake times; another 60972D timer board is provided to set the Off and On delay times and one additional 60972D timer board is provided to set continuance (holdover time) and to set the Rotor Interlock delay time. Time intervals are set by DIP switches on the boards as follows:

CONTROL	RANGE	RESOLUTION
BOOST	0 TO 127 SECONDS	1 SECOND
BRAKE	0 TO 15 SECONDS	1 SECOND
OFF DELAY	0 TO 21 MINUTES 10 SECONDS	10 SECONDS
ON DELAY	0 TO 21 MINUTES 10 SECONDS	10 SECONDS
CONTINUANCE	0 TO 21 MINUTES 10 SECONDS	10 SECONDS
ROTOR INTERLOCK DELAY	0 TO 21 MINUTES 10 SECONDS	10 SECONDS

2.9 Controls and Indicators

External Controls and Indicators- None

Internal Indicators - Power On Lamp, Stator Current Led (61074E LED1), Rotation Supervision LED (61074E LED2), Fault Indicator LED (61078D LED1), Tube Active LED (61079D LED1), 2 Rotor Interlock LEDs (61079D LED2 and LED3).

2.10 Three Phase Drive

Tube drive is accomplished in this unit by means of three separate inverters. The three inverters are always electrically 120 degrees out of phase with one another.

2.11 Isolation Transformer

The transformer TR1 provides seven input power taps from 190VAC to 277VAC.

A 150 degrees C thermal-overload switch is located inside the transformer to prevent damage in case of excessive temperature buildup.

2.12 Interlocks

Exposure interlocks are provided to prevent exposures under the following operating conditions:

- During Boost and Brake portions of the timing cycle. On delay and Off delay times are included in the Boost portion of the timing cycle.
- Stator winding currents less than preset amounts, to prevent exposures for defective or unconnected windings or inadequate drive from the controller.
- Before the x-ray tube has reached sufficient speed as determined by the rotation supervisory circuit.

2.13 Physical Appearance and Dimensions

Painted steel cabinet with hinged door and key lock. Air intake filter assembly in bottom and two exhaust fans in top.

Nominal Dimensions (refer to Figures 3.1 and 3.2):

inches - 40 high x 21-1/4 wide x 10-1/2 deep
mm - 1016 high x 540 wide x 265 deep

Weight - 265 pounds (120kg),
295 pounds (135kg), shipping

2.14 Environmental Characteristics

Ambient Temperature, storage: -20 to +65 degrees C

Ambient Temperature, operating: +10 to +40 degrees C

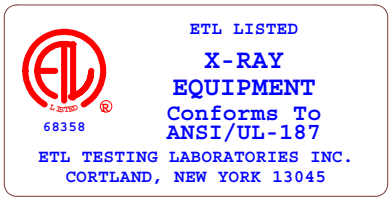
Humidity: 10% to 95%, non-condensing

2.15 Regulatory Compliance

ETL Testing Laboratories, Inc.

This product complies with the requirements of the Standard for X-ray Equipment (ANSI/UL 187, 5TH Ed.) when labeled:

ETL LISTED
X-RAY EQUIPMENT
(with the ETL monogram)



3.0 INSTALLATION AND SUPPORT REQUIREMENTS

Electrical Service - 190VAC to 277VAC, Nominal 60 Ampere service required, preferably wired from the same source as the generator power rather than from the generator. Wiring should conform to local and national safety codes using #6AWG wire for runs up to 115 feet (35m) in order to minimize voltage drops during Boost.

Mounting Access - Requires mounting access as shown in Figure 3.1. Mounting wall access is at least 23 inches wide x 38 inches deep x 52 inches high (584mm x 965mm x 1321mm). Requires wall or mounting surface rated to 300 pounds (140kg). Requires free air circulation above and below cabinet of at least 6 inches (150mm). Intake air temperature and mounting surface not to exceed 40 degrees C.

External Wiring - Control signals - #18AWG, 300VAC, 100 feet (30.5m) maximum length. If control signals are 120VAC, each line must be fused for 5 Amperes or less.

3.1 Tools and Materials Required

- Standard field service tool kit.
- A digital voltmeter AC/DC.
- Oscilloscope with 10X and 100X probes.
- Four bolts or studs suitable for hanging the cabinet on the wall.

3.2 Cabinet Installation

The complete unit weighs approximately 265 pounds (120kg). For details on wall mounting see Figure 3.1. The wall and cabinet attachment anchors must be strong enough to support the rotor controller weight.

3.3 Power Connections

Make a ground connection to the large ground stud on the cabinet, marked G1. If the cabinet is deleted, make a ground connection to the large ground stud on the base plate, marked with a ground symbol.

Connect single phase power (190VAC to 277VAC). Note that a 60 Ampere service is required by the rotor controller. Make the power connections to the terminal strip positions for the line filter. The output of the line filter must be connected to the proper input tap of the transformer.

FIGURE 3.1
CABINET INSTALLATION

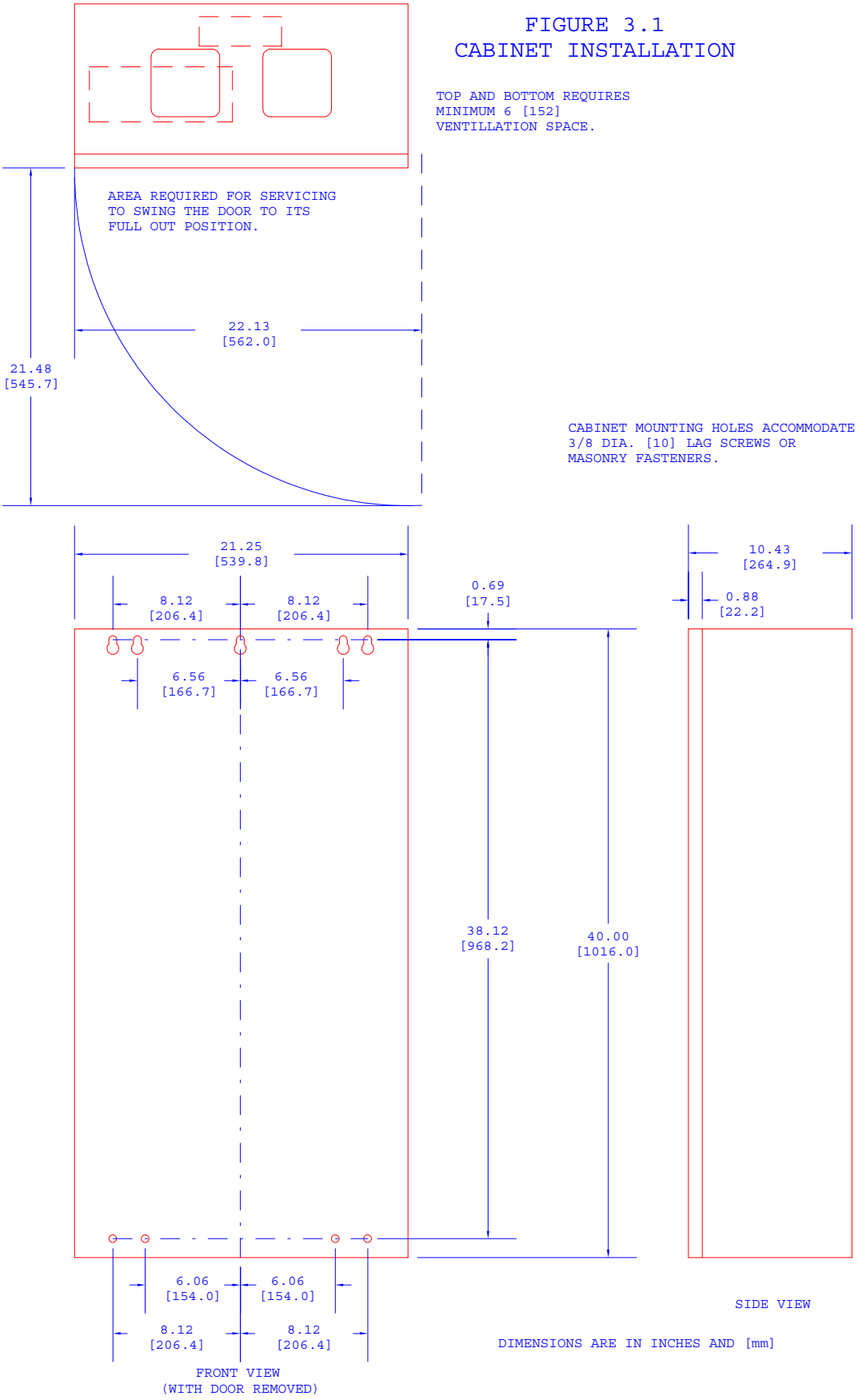
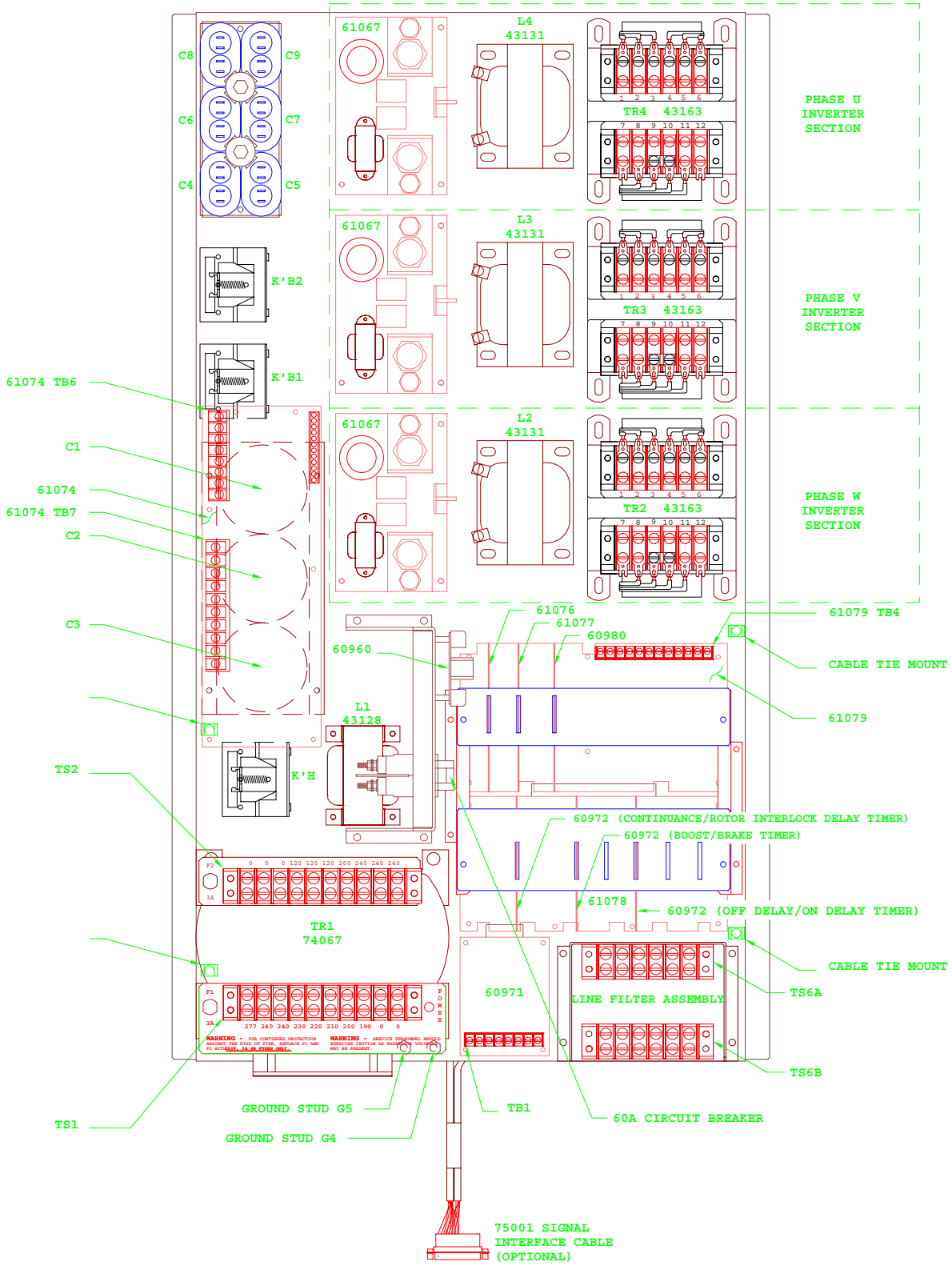


Figure 3.2

HD361 OVERALL COMPONENT LAYOUT



3.4 Interconnections to X-Ray Control

Refer to Figure 3.2 for component locations. Use the cable clamps provided to route any interface wiring inside the rotor controller.

a) Inputs to the Rotor Controller

All input signals to the rotor controller may be either 100VAC to 125VAC, 20VDC to 30VDC or 10VDC to 15VDC. Unless otherwise requested, the rotor controller is shipped configured for 100VAC to 125VAC input signals and may be field programmed for other input voltages. Loading is approximately 10mA in all cases. Refer to schematic 60971C, HD361 overall schematic and input voltage programming detail for programming information.

ROTOR START - for all radiographic work connect to TB1 pins 1 and 2. For DC input signals pin 1 is positive and pin 2 is common. This signal will cause the rotor controller to begin the sequence of Boost and Run. Removal of the Rotor Start signal will initiate Brake unless a continuance time is programmed. If a continuance time is programmed then the rotor will continue to Run for the duration of the continuance time and will initiate Brake at the end of the continuance time. Selection of a 0 second brake time will allow the tube to coast to a stop at the end of either Run or continuance.

HIGH SPEED SELECT - connect to TB1 pins 3 and 4. For DC input signals pin 3 is positive and pin 4 is common. This signal determines the speed at which the rotor will run. Absence of the high speed select signal will cause low speed operation (63.5 Hz) and the presence of it causes high speed operation (95.2 Hz).

AUXILIARY INPUT - Not normally used. TB1 pins 5 and 6.

COAST INPUT - Connect to TB1 pins 7 and 8. For DC input signals pin 7 is positive and pin 8 is common. A Coast input will cause the rotor controller to stop driving the rotor for a period of up to 15 seconds. No braking will occur. Power will be completely removed from the stator during the Coast time. During Coast, rotor interlock drops out.

b) Outputs from the Rotor Controller

BRAKE INTERLOCK - (Optional) A set of normally closed or normally open contacts can be provided at TB6 pins 3, 4 and 5 to indicate when a Brake is in progress. These contacts will open or close during braking.

ROTOR INTERLOCK - A set of normally open contacts, 61079D RY3, for rotor interlock is available at TB4 pins 3 and 4. These contacts are rated at 120VAC, 2 Amperes and are used to inhibit an exposure when open. A second set of normally open contacts, 61079D RY2, is also available for rotor interlock at TB4 pins 7 and 8 by positioning jumper 61079D W3 (2-3).

INTERLOCK CHECK - A set of normally closed contacts for rotor interlock check is available at TB4 pins 5 and 6. These contacts are rated at 120VAC, 2 Amperes and should be used to check the interlock condition prior to Rotor Start. An open condition prior to a Rotor Start indicates an interlock malfunction.

TUBE ACTIVE - A set of contacts connected to TB4 pins 9 and 10 indicate when the rotor controller is currently driving or braking an x-ray tube rotor. Jumper 61079D W1 selects either a normally closed (W1; 1-2) or normally open (W1; 2- 3) configuration for these contacts. These contacts are provided for use only in installations where the generator system provides stator switching but does not include an internal interlock to prevent stator switching while the rotor controller is driving or braking an x-ray tube. Contacts are rated 120VAC, 2 Amperes.

3.5 Tube Stator Connections

STATOR WIRE COLOR	HD361 CONNECTION	DESCRIPTION
WHITE	TS6A PIN 1	PHASE U
RED	TS6A PIN 3	PHASE V
BLACK	TS6A PIN 5	PHASE W

When connecting the HD361 Three-Phase Rotor Controller to the Philips MRC Tube it will be necessary to make the following connections at the terminal strip as shown in Figure 3.3:

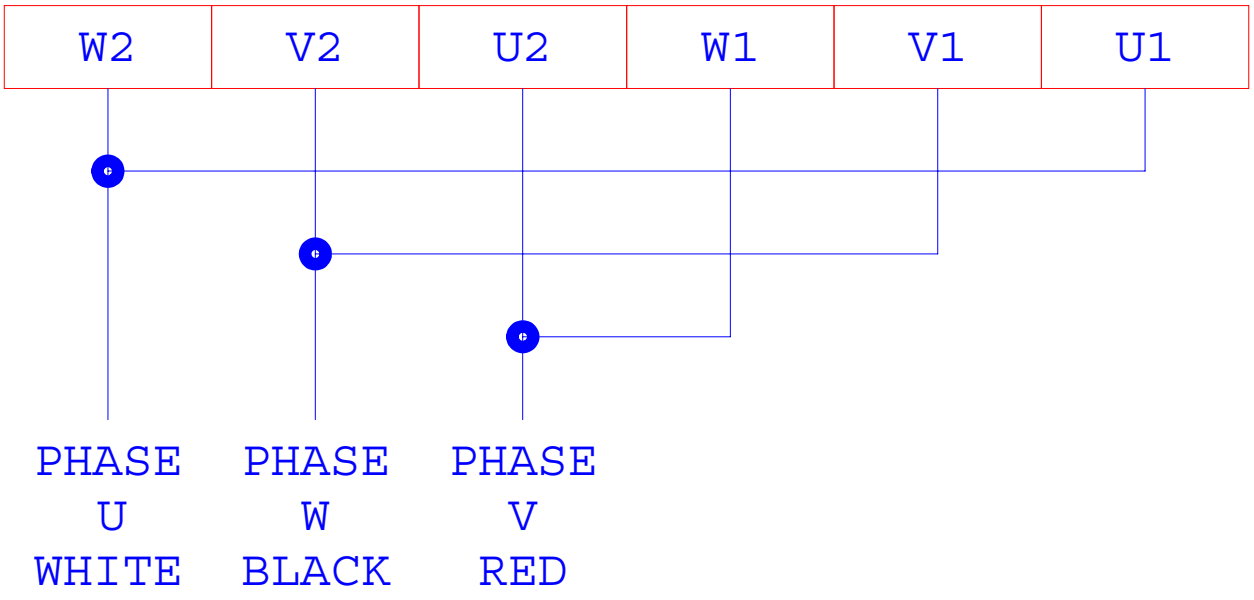
Jumper U1 to W2 and connect the white stator lead for Phase U to W2.

Jumper V1 to U2 and connect the red stator lead for Phase V to U2.

Jumper W1 to V2 and connect the black stator lead for Phase W to V2.

Figure 3.3

Philips MRC Tube



Proceed to Section 4, Tests and Adjustments.

4.0 TESTS AND ADJUSTMENTS

4.1 Adjustment Notes

Stator voltages are factory set. Different voltages may be set during installation, if desired.

If an oscilloscope is used for troubleshooting or to make adjustments, it must have a differential mode of operation or equivalent, dual trace capability with algebraic addition features, and 100X probes.

4.2 Control Signal Input Voltage Programming

Refer to 60971C schematic and component layout in Section 7.0 for control signal input voltage programming detail. The rotor controller is normally programmed for 100VAC to 125VAC input signals. If 20VDC to 30VDC or 10VDC to 15VDC signals are used, then:

1. Locate the jumper corresponding to the input command being changed.

2. Move the jumper to the set of pins corresponding to the input voltage being used for that signal. Note that the 120VAC selection is valid for voltages between 100VAC and 125VAC, the 24VDC selection is valid for voltages between 20VDC and 30VDC, and the 12VDC selection is valid for voltages between 10VDC and 15VDC.

4.3 Inverter Transformer Tap Selection

HD361 Rotor-AID rotor controllers are programmed to be used with three phase stators, which have balanced impedance stator windings. All three inverter transformers, TR2, TR3 and TR4, are connected for the highest output voltage (taps 4-6 selected on each inverter transformer output).

4.4 Functional Programming Information

Refer to the 61078D schematic and component layout for jumper selection detail.

ROTOR INTERLOCK DELAY TIMER - The Rotor Interlock delay timer is used at the end of a Boost to allow the anode to reach the desired Run speed determined by the Run frequency. This delay can be set between 0 and 21 minutes, 10 seconds in 10 second increments at 60972D SW1 on the Continuance/Rotor Interlock Delay timer board at 61078D J1.

DRIVE FREQUENCIES - The Boost and Run drive frequencies for the Rotor-AID HD361 Rotor Controller are determined by the programmed PROM used with the 61077D Rotor Interlock board.

The HD361 Rotor-AID is normally shipped with the 61077D W1 jumper in the 2-3 position and 32276 PROM, programmed for 50.3 Hz Boost (low and high speed), 63.5 Hz low speed Run and 95.2 Hz high speed Run.

Custom PROMs can be programmed for any of the following specific Boost or Run frequencies (Hz): 46.0, 46.8, 47.6, 48.5, 49.4, 50.3, 51.3, 52.3, 53.3, 54.4, 55.6, 56.7, 59.3, 60.6, 62.0, 63.5, 65.0, 66.7, 68.4, 70.2, 72.1, 74.1, 76.2, 78.4, 80.8, 83.3, 86.0, 88.9, 92.0, 95.2, 98.8, 102.6, 106.7, 111.1, 115.9, 121.2, 127.0, 133.3, 140.4, 148.1, 156.9, 166.7, 177.8, 190.5, 205.1, and 222.2.

CONTINUANCE TIMER OPERATION - In the normal mode of operation the continuance timer is used for high and low speed continuance; however, selection of 61078D W2 1-2 will select continuance on high speed only. Continuance is initiated by the Rotor Start command.

4.5 Timer Adjustments

Refer to the overall component location drawing in Section 3.0 for timer board locations.

Refer to the timer switch selection detail on the 60972D Component Location diagram in Section 7.0.

Boost Timer Adjustments:

Set the Boost time at 60972D SW2 on the Boost/Brake timer board at 61078D J3. The timer switch selections are additive. Turn on the switches that cumulatively add up to the Boost time desired.

Brake Timer Adjustments:

Boost the x-ray tube anode to high speed Run and remove the Rotor Start command. The Brake time should be long enough to bring anode speed to less than 500 rpm. Excessive Brake time should be avoided. Adjust the Brake timer switches, 60972D SW1 on the Boost/Brake timer board at 61078D J3, if necessary. The timer switch selections are additive. Turn on the switches that cumulatively add up to the high speed Brake time desired. If no Brake time is desired, then turn off all switches at 60972D SW1 on the Boost/Brake timer board.

Continuance Timer Adjustments:

Set the Continuance time at 60972D SW2 on the Continuance/Rotor Interlock Delay timer board at 61078D J1. The timer switch selections are additive. Turn on the switches that cumulatively add up to the continuance time desired.

Rotor Interlock Delay Timer Adjustments:

Set the Rotor Interlock delay time at 60972D SW1 on the Continuance/Rotor Interlock Delay timer board at 61078D J1. The timer switch selections are additive. Turn on the switches that cumulatively add up to the Rotor Interlock delay time desired (See Section 4.9).

Off Delay / On Delay Timer adjustments:

Refer to Section 5.3 for Off Delay and On Delay timer settings.

4.6 Output Voltage Adjustments

Six output voltage adjustment potentiometers are located on the 60980I board. The function of the six potentiometers and their typical factory settings are listed below. Other voltages may be factory set at the customer's request. Any of these voltages, specifically those that are not in the x-ray tube manufacturer's recommended range, may be adjusted as required.

60980I ADJUSTMENT POTENTIOMETER	FUNCTION	STATOR OUTPUT VOLTAGES (INVERTER TAPS 4-5)
R101	LOW SPEED BRAKE	BRAKE NOT USED
R102	HIGH SPEED BRAKE	BRAKE NOT USED
R103	LOW SPEED RUN	450VAC
R104	LOW SPEED BOOST	500VAC
R105	HIGH SPEED RUN	450VAC
R106	HIGH SPEED BOOST	500VAC

4.7 Rotor Interlock Adjustment

The rotor interlock is adjusted for general purpose tubes. For maximum protection these adjustments may be changed at installation for optimum performance. Make sure Boost and Run voltages have been set to their desired levels (Section 4.6) prior to making interlock adjustments.

TP1 and TP2 on the 61079D board are test points to monitor the stator winding currents.

Note: Adjustments should be made after the x-ray tube housing has been warmed up.

1. Monitor 61079D TP1 with an oscilloscope or DVM. Boost and Run the x-ray tube rotor at high speed. Adjust 61079D R3 for a minimum voltage of 2VDC at 61079D TP1 during high speed Run. Check for approximately the same voltage during low speed Run.

2. Monitor 61079D TP2 with an oscilloscope or DVM. Boost and Run the x-ray tube rotor at high speed. Adjust 61079D R4 to a minimum voltage of 2VDC at 61079D TP2 during high speed Run. Check for approximately the same voltage during low speed Run.

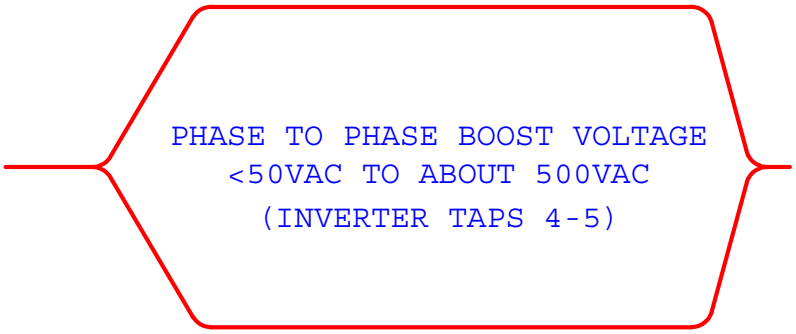
4.8 Functional Test

Oscilloscope setting:
Horizontal 0.2 seconds/cm.
Vertical 10V/cm (using 100X probe).
Monitor: Between any two stator leads.

Boost the x-ray tube anode to high speed. The envelope of the phase to phase stator voltage will appear as in Figure 4.1.

Figure 4.1

Envelope of Phase to Phase Stator Boost Voltages.



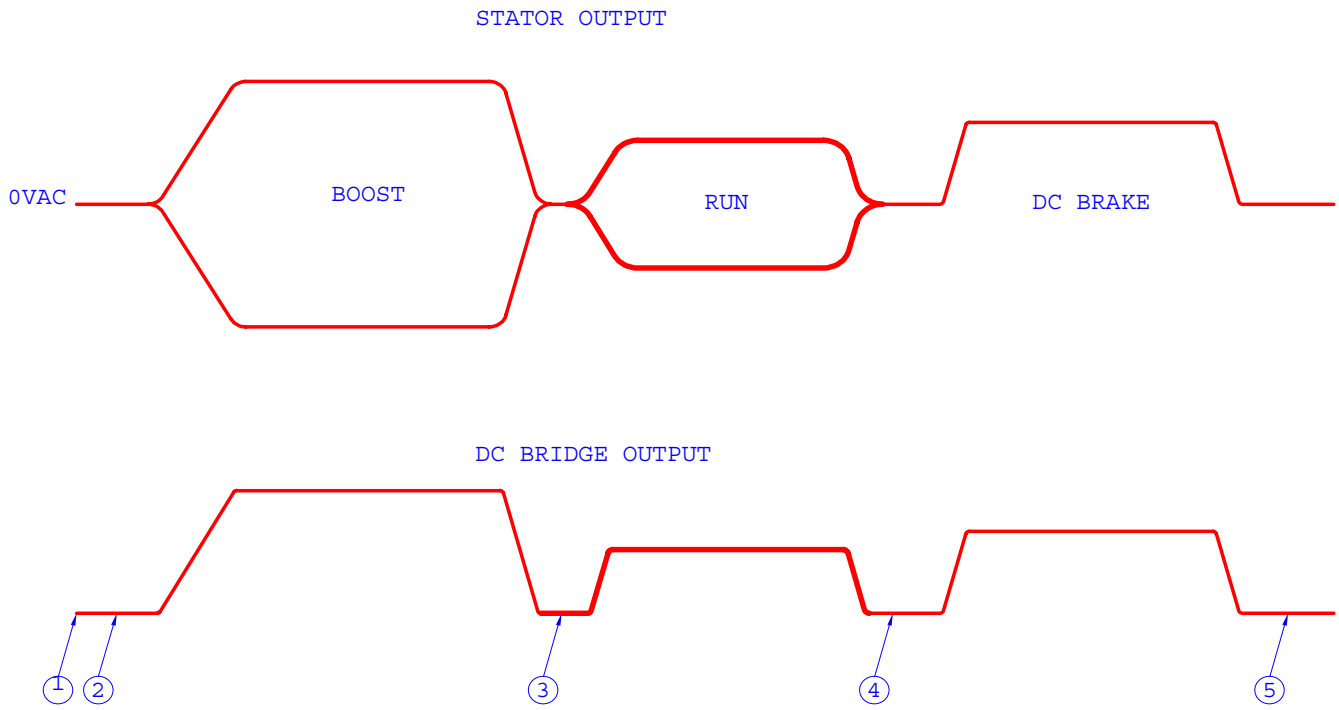
4.9 Anode Rotation Speed

The tube must reach the manufacturer's recommended speed before making exposures. Use a reed tachometer or the tube manufacturer's recommended speed measurement equipment to make sure the tube is up to speed before the Rotor Interlock allows exposures to be made.

The 32276 PROM is programmed for 50 Hz Boost. At the end of the appropriate Boost time the tube anode speed should be approximately 1000 rpm. Excessive Boost time should be avoided as it puts unnecessary heat into the x-ray tube stator and reduces the duty cycle capability of the system. The Boost time may be adjusted for any time between 0 and 127 seconds, as required, by setting dip switches on the 60972D timer board at 61078D J3. See Section 4.5 for Boost Timer Adjustments.

Adjust the Rotor Interlock delay timer, by setting dip switches on the 60972D timer board at 61078D J1 to attain the tube's recommended speed during Run before allowing exposures. See Section 4.5 for Auxiliary Timer Adjustments.

Fig. 4.2



Inhibit Timing (Numbers in parentheses refer to numbers in circles in Figure 4.2).

(1) Rotor Start signal (prep).

(2) 47ms inhibit, 61078D C28 and R30.

(3) End of Boost, 100ms, 61078D C30 and R32.

(4) End of Run or continuance, total delay time = 220ms, 61078D C22 and R24. Simultaneously, there is a 130ms delay, 61078D C27, R34 and R35.

At the end of the 130ms delay the Brake relay is pulled in by turning on 61078D Q2. After 220ms of inhibit, Brake power is applied to the stator for the time selected on the 60972D timer board at 61078D J3. See Section 4.5 for Brake timer Adjustments.

(5) 4 At the end of Brake the Brake relay is held on for an additional 330ms, 61078D C27 and R34, to discharge the power supply before switching the Brake relay.

4.10 Rotation Supervisory Circuit Adjustments

Adjustment of this circuit must be made with the rotor controller running in either high speed or low speed as determined by the x-ray system configuration.

1. Verify that the boost and run voltages are set according to the tube manufacturers specifications.

2. Measure the reference voltage between 61074E TP8 and 61074E TP0. It should be about 4.8 VDC.

3. Set boost time to 3 seconds.

4. Verify the tube is not rotating at the beginning of adjustment (wait about 10 minutes after the last run for the tube to stop).

5. Monitor the voltage between 61074E TP7 and 61074E TP0 with a DVM.

6. Boost the tube.

7. If the rotation has started properly the DVM voltage will decrease significantly (from about 10 VDC to about 4 VDC) until the tube reaches the final rotation speed.

8. After 5 minutes of operation the stator will reach its thermal balance. While the tube is running adjust 61074E R22 for 0.7 VDC less than the reference voltage measured in step 2 (about 4.1 VDC).

9. Reset the boost time according to the tube manufacturer's specification.

4.11 Programmable Jumper Selections

The following is a list of all programmable jumpers in the HD361 Rotor-AID Rotor Controller. These jumpers are set at the factory to customer specifications. Asterisks (*) are used to denote the factory settings. Under normal conditions these jumpers need not be adjusted in the field.

Jumper	Position	Function
60971C	12V*	12VDC input signals.
	24V	24VDC input signals.
	120V	120VAC input signals.
		[See Section 3.4 a) INPUTS TO THE ROTOR CONTROLLER and Section 4.2].
61074E W1	1-2	Relay 61074E RY2 driven by external power.
	2-3*	Relay 61074E RY2 driven by HD361 25VDC supply.
61074E W2	1-2	25VDC to thermal switch.
	2-3*	Ground to thermal switch.
61074E W3	1-2	Relay 61074E RY2 used as optional brake relay.
	2-3*	Thermal switch in series with 61074E RY2 relay coil.
	3-4	60960A TB8-1 receives power (+25VDC) through thermal switch.
	4-5*	60960A TB8-1 receives power (+25VDC) through 61074E RY2 N.O. contacts.
61074E W6	1-2*	Rotor Interlock relay 61074E RY1 in series with Rotation Supervisory relay 61074E RY3.
	2-3	Rotor Interlock relay 61074E RY1 in parallel with Rotation Supervisory relay 61074E RY3.
61076C W1	1-2	Start count at 0.
	2-3*	Start count at 10.
		(See Section 5.4 CONVERTER MODULE).
61076C W2	1-2	Start count at 0.
	2-3*	Start count at 20.
		(See Section 5.4 CONVERTER MODULE).

Jumper	Position	Function
61076C W3	1-2*	Low fault reference voltage.
	2-3	High fault reference voltage.
61077D W1	1-2	IC "R" = 2732 SECTION 1.
	2-3*	IC "R" = 2716 and 2732 SECTION 2.
		(See Section 4.4 DRIVE FREQUENCIES).
61078D W1	1-2	CONTINUANCE in high speed only.
	2-3*	CONTINUANCE in high and low speed.
		(See Section 4.4 CONTINUANCE TIMER OPERATION).
61078D W2	1-2*	Storage position.
	2-3	CONTINUANCE triggers high speed.
61079D W1	1-2*	N.O. contacts used for TUBE CHANGE INTERLOCK.
	2-3	N.C. contacts used for TUBE CHANGE INTERLOCK.
		[See Section 3.4 b) TUBE ACTIVE].
61079D W2	1-2	Normal or alternate frequency used for low speed boost.
	2-3*	High speed frequency used for low speed boost.
		Not used on Model HD361.
61079D W3	1-2	RY2 is used for HIGH SPEED VERIFICATION.
		Not used on Model HD361.
	2-3	RY2 is used for ROTOR INTERLOCK.
		[See Section 3.4 b) ROTOR INTERLOCK].
60980I W1	a/b	3-Tube units.
		Not used on Model HD361.
	b/c*	1-Tube units.

4.12 X-Ray Tube Conversions (Refer to Figure 3.2 for component locations).

a) Converting from Philips MRC200 stator to Varian GS5000 3-phase stator:

1. Change the EPROM, 61077D U8, to AID P/N 32276. Move jumper 61077D W1 from the 2-3 position to the 1-2 position.

2. Move the white wires on all three inverter transformers, TR2, TR3, TR4 from terminal 5 to terminal 6. Move the black/white wires from terminal 4 to terminal 5.

3. On the input transformer, TR1, move the red wire from the 120VAC secondary tap to the 200VAC secondary tap. Note: The red wire goes to K'H relay normally open contact.

4. Move jumper 61074E W6 from the 1-2 position to the 2-3 position.

5. Move jumper 61076C W3 from the 1-2 position to the 2-3 position.

6. Set the 60972D Timer Board switches as follows:

Mother bd.	60972D	Switch Settings								Timer
Plug-in Slot	SW No.	1	2	3	4	5	6	7	8	Setting
61078D J1	SW1	off	off	off	off	off	off	off	off	Rotor interlock delay = off
61078D J1	SW2	on	on	off	on	off	off	off	off	Continuance = 110 sec.
61078D J3	SW1	off	on	off	on	off	off	off	off	Brake time = 10 sec.
61078D J3	SW2	off	on	off	on	off	off	off	off	Boost time = 10 sec.
61078D J5	SW1	off	off	off	off	off	off	off	off	On delay = off
61078D J5	SW2	off	off	off	off	off	off	off	off	Off delay = off

7. On the 60980I Phase Shift I I Board, turn all potentiometers to their minimum settings (approximately 20 turns counter-clockwise). Using a true RMS digital volt meter adjust the stator voltages (measured from phase U to phase V at terminal strip TS6A) during boost, run, and brake as follows:

Adjustment	Function	Voltage Setting
60980 I R106	High Speed Boost	450 VAC
60980 I R105	High Speed Run	100 VAC
60980 I R102	High Speed Brake	100 VDC
60980 I R104	Low Speed Boost	220 VAC
60980 I R103	Low Speed Run	70 VAC
60980 I R101	Low Speed Brake	75 VDC

8. Monitor 61079D TP1 with an oscilloscope or DVM. Boost and Run the x-ray tube rotor at high speed. Adjust 61079D R3 for a minimum voltage of 2 VDC at 61079D TP1 during Run. Check for approximately the same voltage during low speed Run.

9. Monitor 61079D TP2 with an oscilloscope or DVM. Boost and Run the x-ray tube rotor at high speed. Adjust 61079D R4 for a minimum voltage of 2 VDC at 61079D TP1 during Run. Check for approximately the same voltage during low speed Run.

b) Converting from Varian GS5000 3-phase stator to Philips MRC stator:

1. Move jumper 61077D W1 from the 1-2 position to the 2-3 position.

2. Move the black/white wires on all three inverter transformers, TR2, TR3, TR4 from terminal 5 to terminal 4. Move the white wires from terminal 6 to terminal 5.

3. On the input transformer, TR1, move the red wire from the 200VAC secondary tap of the transformer to the 120VAC secondary tap. Note: The red wire goes to K'H relay normally open contact.

4. Move jumper 61074E W6 from the 2-3 position to the 1-2 position.

5. Move jumper 61076C W3 from the 2-3 position to the 1-2 position.

6. Set the 60972D Timer Board switches as follows:

Mother bd.	60972D	Switch Settings								Timer
Plug-in Slot	SW No.	1	2	3	4	5	6	7	8	Setting
61078D J1	SW1	off	on	on	on	on	off	off	off	Rotor interlock delay = 30 sec.
61078D J1	SW2	off	off	off	off	off	off	off	off	Continuance = off
61078D J3	SW1	off	off	off	off	off	off	off	off	Brake time = off
61078D J3	SW2	off	on	on	on	on	off	off	off	Boost time = 30 sec.
61078D J5	SW1	off	off	off	off	off	off	off	off	On delay = off
61078D J5	SW2	off	off	off	off	off	off	off	off	Off delay = off

7. On the 60980 I Phase Shift I I Board turn all potentiometers to their minimum settings (approximately 20 turns counter-clockwise). Using a true RMS digital volt meter adjust stator voltages (measured from phase U to phase V at terminal strip TS6A) during boost, run, and brake as follows:

Adjustment	Function	Voltage Setting
60980 I R106	High Speed Boost*	500 VAC
60980 I R105	High Speed Run*	450 VAC
60980 I R102	High Speed Brake*	0 VDC
60980 I R104	Low Speed Boost	500 VAC
60980 I R103	Low Speed Run	380 VAC
60980 I R101	Low Speed Brake	0 VDC

* High speed is not normally used with the Philips MRC 200 stator.

8. Monitor 61079D TP1 with an oscilloscope or DVM. Boost and Run the x-ray tube rotor at low speed. Adjust 61079D R3 for a minimum voltage of 2 VDC at 61079D TP1 during run. Check for approximately the same voltage during high speed run (if used).

9. Monitor 61079D TP2 with an oscilloscope or DVM. Boost and Run the x-ray tube rotor at low speed. Adjust 61079D R4 for a minimum voltage of 2 VDC at 61079D TP1 during Run. Check for approximately the same voltage during high speed run (if used).

10. Check the operation and adjustment of the rotation supervisory circuit as described in Section 4.10.

5.0 PRINCIPLES OF OPERATION

5.1 Functional Description

The Rotor-AID HD361 Heavy Duty Controllers use three high efficiency inverters to supply the necessary power to accelerate an x-ray tube's anode rotor rapidly to its operational speed.

The 61077D Interlock board with PROM programmed drive frequencies allows for alternative selections of Boost and Run frequencies (see Sections 2.7, 4.4 and 4.11). In addition, taps on the inverter output transformers are provided for stator matching.

5.2 Basic Timing/Logic Cycle:

As diagrammed in Figures 5.1, 5.2 and 5.3, an externally derived Rotor Start signal initiates a Boost time period during which maximum power is delivered to the tube stator/rotor. The setting of the Boost time period is determined by the physical characteristics of the tube as a motor. At the conclusion of the Boost time, the anode rotor continues to Run with less power applied until the external Rotor Start signal is removed. During this interim Run time, after the selected Rotor Interlock delay, exposures may be taken.

At the conclusion of Run the controller may optionally:

1. Automatically Brake for a period of time preset to bring the rotor to near zero rpm.

2. Continue to provide Run power (continuance) for a preset period of time which maintains rotation at the correct speed thus allowing exposures to be made immediately without the need for subsequent Boost periods. At the conclusion of the continuance time, the controller will automatically Brake to stop rotation as described above.

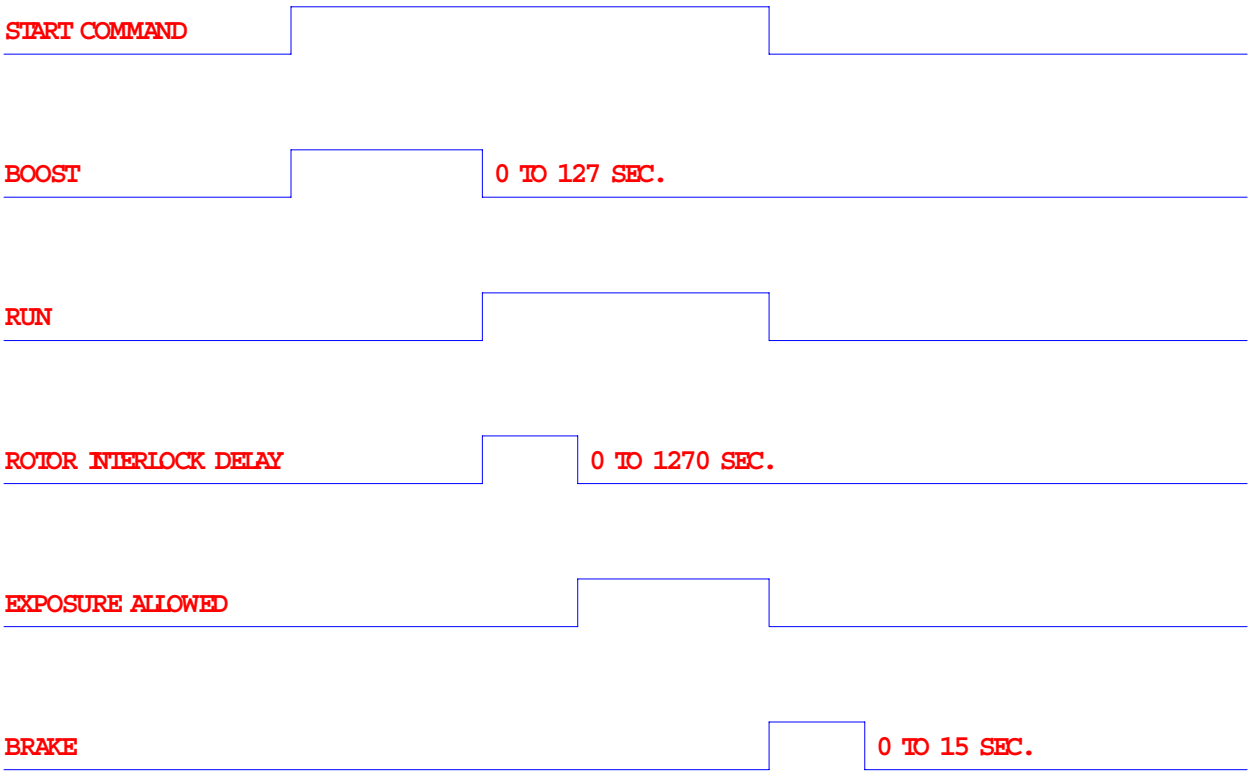
5.3 Applications

In addition to the basic timing cycle, several special application modes are provided:

RADIOGRAPHIC MODE - In the Radiographic mode, the basic Boost-Run (continuance)- Brake cycle is used with either high or low speed selected. Figures 5.1 and 5.2 illustrate the basic timing cycle without and with, respectively, the use of continuance timing. Figure 5.3 shows the effect of a coast input signal on rotor controller output.

Figure 5.1

BASIC TIMING LOGIC WITHOUT CONTINUANCE



Notes:

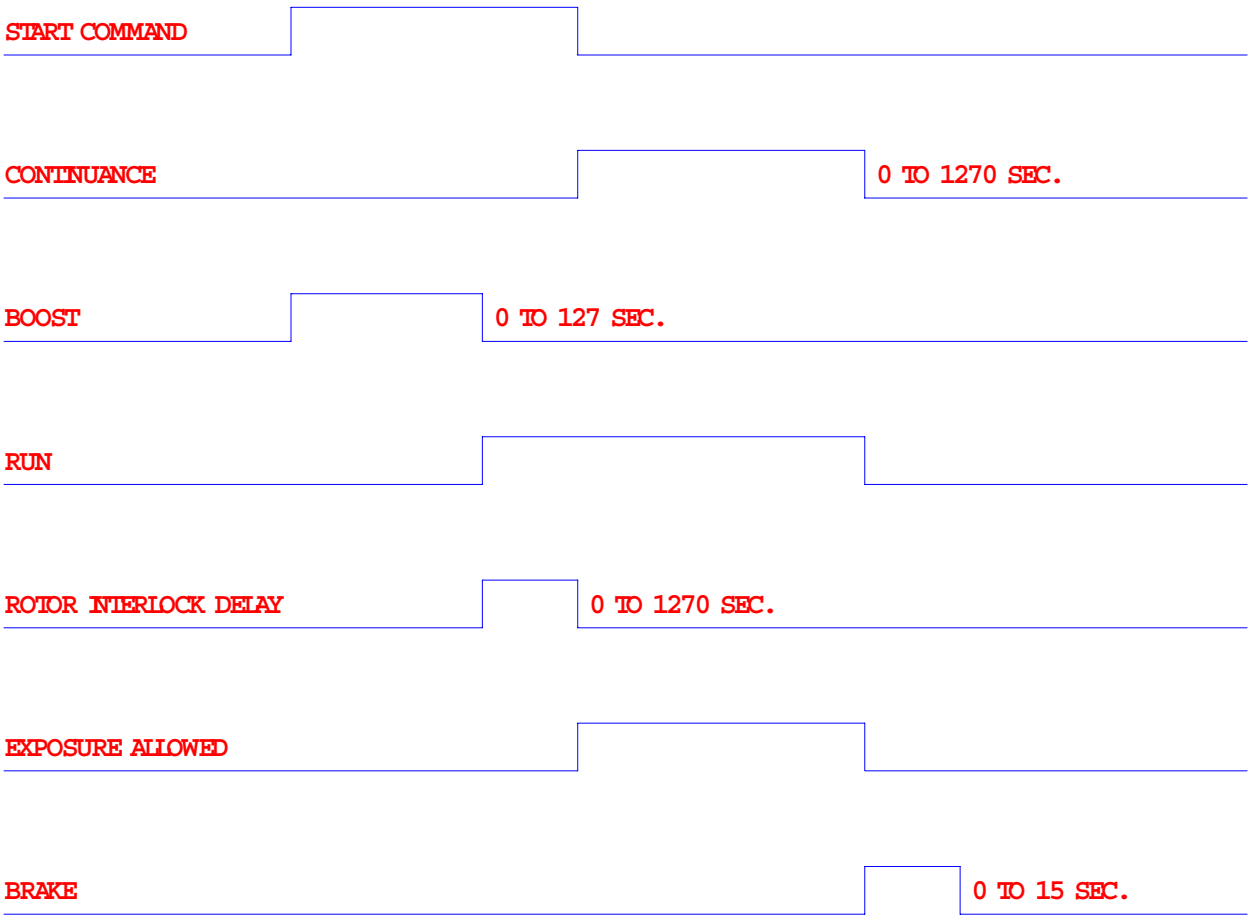
1. Above times (in seconds) indicate programming ranges accommodated by the Rotor-AID Rotor Controller. Refer to Section 4.5.

2. Start and Run times depend upon exposure duration and the operator's "rotor prep" control.

FLUOROSCOPIC MODE - In the Fluoroscopic mode, the basic timing logic cycle as described below is used except that only Low Speed is required.

Figure 5.2

BASIC TIMING LOGIC WITH CONTINUANCE



Notes:

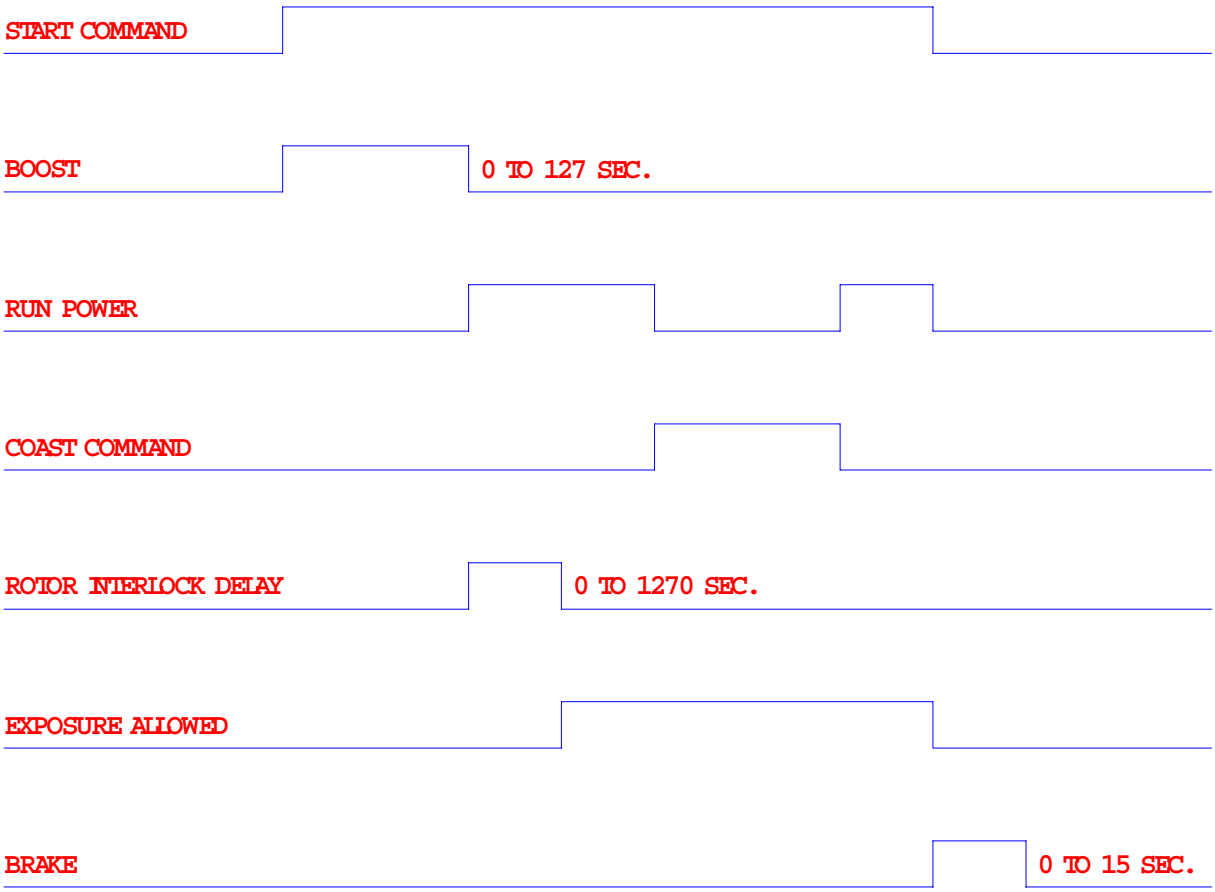
1. Above times (in seconds) indicate programming ranges accommodated by the Rotor-AID Rotor Controller. Refer to Section 4.5.

2. Start and Run times depend upon exposure duration and the operator's "rotor prep" control.

COAST MODE - To assure proper interlock operation the coast command should be applied only after Boost is completed and rotor interlock closure has occurred. Rotor interlock drops out during the coast period. If the Rotor-AID rotor interlock normally open or normally closed contacts are used by the generator to inhibit exposures, then these inhibits must be over-ridden during Coast to allow exposures. Coast time is limited internally by the rotor controller to a maximum of about 15 seconds.

Figure 5.3

BASIC TIMING LOGIC WITH COAST



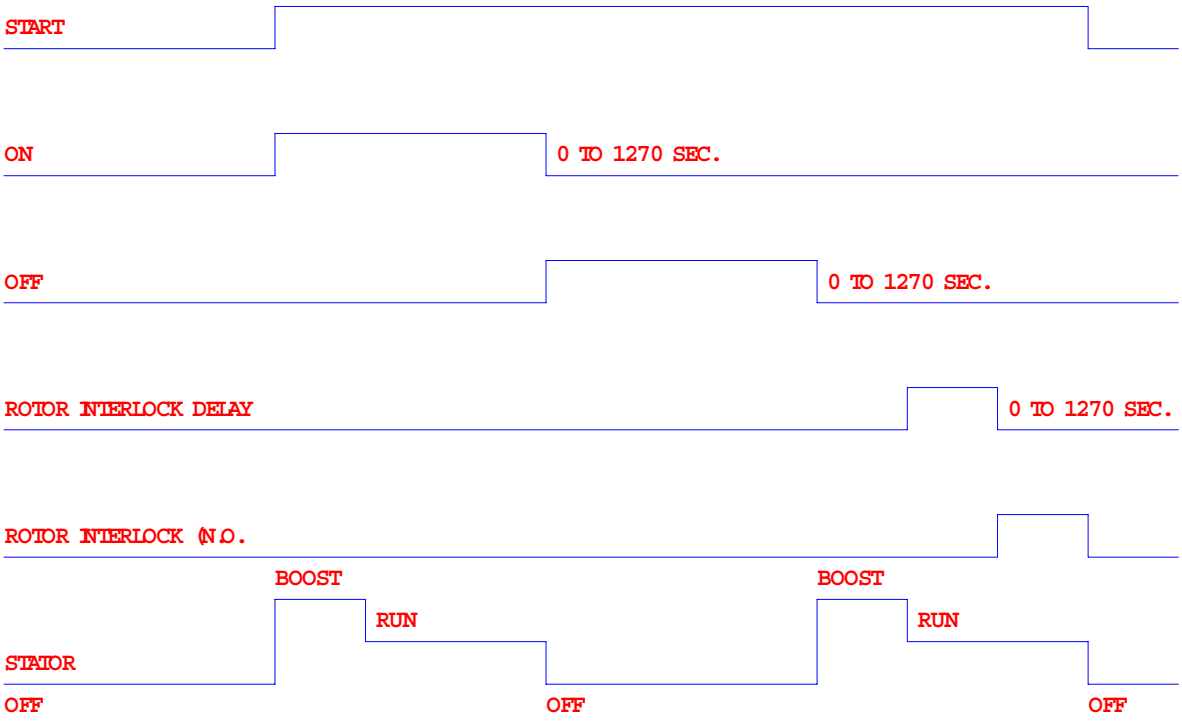
Notes:

1. Above times (in seconds) indicate programming ranges accommodated by the Rotor-AID Rotor Controller. Refer to Section 4.5.

2. Start and Run times depend upon exposure duration and the operator's "rotor prep" control.

Figure 5.4

TIMING LOGIC WITH ON DELAY/OFF DELAY TIMER



The On Delay/Off Delay timer logic uses a 60972D timer board plugged into the 61078D Mother board J5 connector. The On Delay timer is used to boost and run the x-ray tube for a short period of time. This time period is set using SW1 of the timer board. It may be set from 0 to 1270 seconds in 10 second increments. The On Delay timer is triggered by the Rotor Start Command at 60971C TB1 pins 1 and 2.

As the On Delay timer turns off, it triggers the Off Delay timer. During the Off Delay timer time period, power is removed from the stator output. This time period is set using SW2 of the timer board. It may be set from 0 to 1270 seconds in 10 second increments. When the Off Delay timer time period is finished, the rotor controller will again boost and run the x-ray tube. The rotor controller will now remain in run until the Rotor Start Command is removed.

The Rotor Interlock Delay timer is provided by the 60972D timer board plugged into the 61078D Mother board J1 connector. At the end of the second boost, the Rotor Interlock Delay timer, 60972D SW1, will be activated. This delay timer may be set from 0 to 1270 seconds in 10 second increments. At the end of this delay, the normally open Rotor Interlock contacts at TB4 pins 3 and 4 will close to allow x-ray exposures.

Other signals supplied by the 60980I board include:

- A short, active low, sync pulse that appears at 60980I TP3 for each zero crossing of input line voltage. This signal is used to reset and load the firing counters E and P on the 61076C Phase Shift and Fault Detect board once every half cycle.

- A square wave generated using a sign detector to direct which SCR is firing for a given half cycle.

- A 10kHz or 12kHz clock that is used to break up each half cycle into 100 possible firing points regardless of line frequency. This signal appears at 60980I TP1 and is 10kHz for a 50Hz line and 12kHz for a 60Hz line.

The 61076C board utilizes signals generated by the 60980I board to adjust the firing point of SCRs in the DC supply bridge. Counters N and E on the 61076C board are starting point memories which may be set to numbers from 16 to 99. Initially at the start of any Boost, Run or Brake, the counters are reset to 16. A Count of 16 is the minimum firing point and will produce an output voltage of approximately 50Vrms at taps 4 and 5 of the inverter transformers. A count of 99 produces the maximum voltage on the DC supply, approximately 200VDC (approximately 800Vrms at taps 4 and 6 of the inverter transformers). The count contained in N and E is adjusted up or down every half cycle depending upon the logic state of the error direction line.

The count contained in N and E is loaded into P and F once every half cycle near the zero crossing. P and F are then allowed to count up to 100 utilizing the 10kHz or 12kHz clock. When the counters overflow a latch consisting of 2 gates is set and one of the 2 SCRs in the DC bridge is fired. Counters P and F will overflow (reach 100) almost instantly if loaded with a count of 99. This would cause the SCR to be turned on for almost a complete half cycle assuring maximum charging of the DC supply capacitors.

SECTION 5.0 PRINCIPLES OF OPERATION

In order to have DC supply voltage the following conditions must be satisfied:

- The POR (power-on-reset) line must be high (9-12VDC).
- The fault line must be high. A low fault line would indicate a condition of excessive current draw by the inverters.
- The coast line must be low. Coast causes an interruption of DC supply voltage.
- The inhibit line must be high. Inhibit will be low prior to Boost and after Brake. It will pulse low during transitions from Boost to high speed Run (100ms), from Boost to low speed Run (100ms), and from Run to Brake (220ms).
- Counters N and E must have a decimal output significantly greater than 0. Note that counter E is the most significant digit.
- The output of counter F must be pulsing at a point other than a zero crossing of the line voltage.

Inverter Modules:

Refer to the overall HD361 Series wiring diagram and the schematics for the 61077D Interlock board and the 61067C Inverter boards in Section 7.0. The 61077D Interlock board supplies SCR gate pulses of approximately 200us via pulse transformers on the 61067C Inverter Drive boards to the three inverters at the proper frequency for the particular operation being executed.

High speed Run is always at a higher frequency and low speed Run is always a lower frequency. The outputs of the three inverters always operate at the same frequencies. They have a fixed phase relationship of 120 degrees to provide proper drive to the 3 phase induction motor in the x-ray tube (no phase shift capacitors are utilized.)

The 61077D board utilizes a pre-programmed PROM to provide the proper drive signals for the inverter SCRs.

The SCR inverters are class C inverters. One SCR is gated off by the other turning on. Should an SCR fail to commutate off for any reason the fault detector will shut off the DC supply.

Fault Detector Circuit:

Refer to 61076C, 61079D and the HD361 overall schematics. The fault detector is designed to monitor the current in the AC to DC bridge. A current transformer with a 1/2 turn primary is connected between the input transformer and the DC power bridge. The secondary of the current sense transformer is connected to a 10 ohm resistor on the 61076C board. The voltage developed across the resistor is connected through a filter to the input of voltage comparator IC-A (LM311). During normal operation the voltage generated by the current sense transformer does not exceed the reference voltage of the comparator. If a fault should occur during either Boost or Run, the voltage increases and exceeds the reference voltage and causes the fault line to go low, which gates off the SCR firing pulses. If the fault was due to a non-recurring condition the rotor controller will continue to work normally and no correction will be necessary.

Rotor Interlock Circuit:

The current to the x-ray tube stator is monitored by the rotor interlock circuits on the 61077D Interlock Board and the Stator Output board, 61074E. Before an exposure can be made, sufficient Boost and Run current must flow in the leads to the x-ray tube stator.

The Rotor Interlock circuit is factory adjusted for general purpose tubes. For maximum protection, these adjustments may be changed on location for optimum performance of the circuit. Refer to Section 4.7 for detailed adjustments to this circuit.

Rotation Supervisory Circuit:

The voltages of phases U and V and the current of phase W are monitored by the Rotation Supervisory Circuit on the 61074E Stator Output board. The Rotation Supervisory Circuit operates a set of normally open contacts, 61074E RY3, that are wired in series Rotor Interlock Circuit. Before an x- ray exposure can be made, the x-ray tube anode must be up to speed during run. Refer to Section 4.10 for Rotation Supervisory Circuit adjustments.

6.0 TROUBLE SHOOTING GUIDE

The following is a list of possible problems and their likely corrections. The list is not all-inclusive, but covers field serviceable problems. Additional questions should be referred to the factory or service center.

Refer to Section 7.0 for schematics and component location diagrams. Refer to Section 3.0 Figure 3.2 for overall component locations.

6.1 Preliminary Checks:

Check all external connections to the rotor controller for proper wiring and secure connections.

Check to see that all shunts (jumpers) are in place and programmed correctly (see Section 4.11).

Check input power voltage and make sure that the input power is wired to the correct voltage input tap.

Check to see that the Power On indicator on the input transformer, TR1, assembly is lighted. If it is not lighted, check input power lines to the rotor controller and correct any problems.

Check to see that the circuit breaker is on and that no fuses are open.

Check the Boost, Continuance and Brake time settings.

Check the voltage at the input and output of the Input Line Filter. If the proper input line voltage is being applied to the Input Line Filter, but the wrong output voltage is being observed, replace the Input Line Filter (49063).

Note: Whenever replacing parts, boards or assemblies make note of their EXACT wiring before removing them.

6.2 Trouble Shooting

SYMPTOM: NO BOOST

Check the stator leads to make sure they are not shorted and are properly connected. Correct any problems.

Check the K'H relay (41006) for good connections and proper mechanical operation. Replace if necessary.

Does 61079D LED1 light during a Rotor Start signal?

If yes, then:

- Check to see if the Circuit Breaker is on.
- See that the Boost time, 60972D SW2 at 61078D J3, is set properly.
- Replace 60972D Boost/Brake timer board.
- Replace 61076C board.
- Replace 60980I board. Check the six Boost, Run and Brake voltages and adjust the appropriate potentiometers if necessary.

If no, then:

- Check the interface wiring.
- Check for the presence of the Rotor Start signal.
- Replace 60971C board. Position program jumpers per Section 4.11.
- Check thermal switch. If switch is bad, replace input power transformer 74067.
- Check wiring to the Stator Output board. Replace board if necessary.
- Check the 61079D board for the -12VDC, +12VDC and +25VDC supply voltages.

If all voltages are missing, check the in-line 3A SB fuse, F1, at the input transformer, 74067.

If any voltage is missing, check fuses F1, F2 and F3 on the 61079D board. Replace any open fuses. If replaced fuses open when power is applied, then remove all plug- in PC boards from the 61078D and 61079D boards. Replace open fuses and reinstall the plug-in PC boards one at a time until the fuses open again. Replace any plug-in PC boards that cause the fuses to open. Note: Do not install or remove any PC boards with the power on.

If any voltage is still missing or incorrect in value, replace 61079D and then adjust 61079D R3 and R4 as described in Section 4.7.

If unit faults, see trouble shooting section on faults.

SECTION 6.0 TROUBLE SHOOTING GUIDE

SYMPTOM: NO RUN

Check for the presence of a Rotor Start command.

Check to see that the 60972D Continuance time is set correctly.

Replace the 60972D Continuance/Rotor Interlock Delay timer board.

Replace 60980I board. Check the six Boost, Run and Brake voltages and adjust the appropriate potentiometers if necessary.

Check K'H relay (41006) for good connections and proper mechanical operation. Replace K'H if necessary.

If unit faults, see trouble shooting section on faults.

SYMPTOM: NO BRAKE

Check to see that the Brake time, 60972D SW1 at 61078D J3, is set properly.

Replace the 60972D Boost/Brake timer board if necessary.

Replace 60980I board. Check the six Boost, Run and Brake voltages and adjust the appropriate potentiometers if necessary.

Replace 61078D board. Position program jumpers per Section 4.11.

Check K'B2 relay (41006) for good connections and proper mechanical operation. Replace K'B2 if necessary.

SYMPTOM: FAULT OCCURS DURING BOOST OR RUN

Check the line voltage to make sure that the proper input tap is being used.

Check the stator resistance and stator wiring. Correct any problems.

Using an oscilloscope, check all inverter gate pulses (61077D board, P10-23, P10-22, P10-21, P10-20, P10-9 and P10-17). If necessary, replace 61077D board. Position program jumpers per Section 4.11.

SYMPTOM: FAULT OCCURS DURING BOOST OR RUN (cont'd)

Check wiring to the 61067C in all three Inverter Sections. Correct any misconnections.

Disconnect the wire from TR2 terminal 2. Operate the rotor controller.

IF NO FAULT OCCURS then replace the 61067C Inverter Drive board in this Inverter Section and reconnect the wire to TR2 terminal 2.

IF A FAULT STILL OCCURS then reconnect the wire to TR2 terminal 2 and disconnect the wire from TR3 terminal 2. Operate the rotor controller. If no fault occurs then replace the 61067C Inverter Drive board in this Inverter Section. Reconnect the wire to TR3 terminal 2.

IF A FAULT STILL OCCURS then reconnect the wire to TR3 terminal 2 and disconnect the wire from TR4 terminal 2. Operate the rotor controller. If no fault occurs then replace the 61067C Inverter Drive board in this Inverter Section. Reconnect the wire to TR4 terminal 2.

Replace the 60960A board.

Check the K'H relay (41006) for good connections and proper mechanical operation. Replace if necessary.

Check the SCRs/Diode (DC bridge) for good connections and proper electrical operation. If necessary, replace blocks with part number 31081.

Check the 8MFD capacitors (24042). Replace any that are shorted or open.

Replace 61076C board.

Replace 61077D board. Position program jumpers per Section 4.11.

Replace 60980I board. Check the six Boost, Run and Brake voltages and adjust the appropriate potentiometers if necessary.

SYMPTOM: MISSING ROTOR INTERLOCK

Check the status of the Rotor Interlock indicators, 61079D LED3, 61074E LED 1 and 61074E LED 2 during rotor controller operation. If the Rotor Interlock indicators light during Run, then check the interface wiring to TB4. Correct any problems.

If the Rotor Interlock indicators fail to light during Run, then check the Rotor Interlock relays, 61079D RY3, 61074E RY1, and 61074E RY3 and correct any problems.

Check stator connections to the Stator Output board as listed in Section 3.5. Correct any problems.

Check the Rotor Interlock Delay time setting.

Replace 61077D board. Position program jumpers per Section 4.11.

Adjust 61079D R3 and R4 as described in Section 4.7.

Adjust the Rotation Supervisory Circuit as described in Section 4.10.

Replace 61079D board. Position program jumpers per Section 4.11. If necessary, adjust 61079D R3 and R4 as described in Section 4.7.

Check the Boost and Run voltages. If necessary, adjust the Boost and Run potentiometers on the 60980I board.

Replace the 61074E Stator Output board and adjust the Rotation Supervisory Circuit as described in Section 4.10.

Replace the 60972D Continuance/Rotor Interlock Delay timer board at 61078D J1.

Replace the 60972D Off Delay/On Delay timer board at 61078D J5.

SYMPTOM: BOOST AND OR RUN VOLTAGES EXCESSIVELY HIGH

Check the Boost, Run and Brake voltages and adjust the appropriate potentiometers on the 60980I.

Replace 60980I board. Check the six Boost, Run and Brake voltages and adjust the appropriate potentiometers if necessary.

Replace 61079D board and adjust 61079D R3 and R4 as described in Section 4.7.

Replace 61076C board.

Check for good connections to the DC supply at TB4 pin 11 (ground) and TB4 pin 12 (+DC supply), and at the buss bars on the three 3000MFD capacitors (C1, C2, and C3).

SYMPTOM: INCORRECT BOOST, RUN OR BRAKE VOLTAGE(S)

Adjust the appropriate potentiometer on the 60980I board.

Replace the 60980I board. Check the six Boost, Run and Brake voltages and adjust the appropriate potentiometers if necessary.

Check the K'H relay (41006) for good connections and proper mechanical operation. Replace if necessary.

SYMPTOM: BOOST TOO LOW, CANNOT ADJUST

Check K'H relay (41006) for good connections and proper mechanical operation. Replace if necessary.

Adjust the appropriate potentiometer on the 60980I board.

Replace 60980I board. Check the six Boost, Run and Brake voltages and adjust the appropriate potentiometers if necessary.

Check wiring on inverter output transformer taps 4, 5 and 6.

SECTION 6.0 TROUBLE SHOOTING GUIDE

SYMPTOM: CIRCUIT BREAKER TRIPS DURING BOOST

Check SCRs/Diode in the DC bridge for good connections and proper electrical operation. If necessary, replace.

Replace the Circuit Breaker (45072).

Replace the 60960A board.

Replace the 61067C boards, one at a time, for each of the inverter sections.

SYMPTOM: 60971C BOARD FAILS DURING AN INPUT COMMAND

This means that either the wrong input voltage was applied to the board or that the voltage selector shunts (jumpers) were in the wrong positions for the voltages being applied. Replace the 60971C board and program the voltage selector shunts (jumpers) for the input voltages that are being applied.

SYMPTOM: FAN DOES NOT WORK

Check to make sure that the fan blade turns freely. Clear any mechanical obstruction.

Check the fan fuse, F2 (3A SB), at the input transformer, TR1.

Check the connections (plug) at the non-working fan.

Check the voltage at the fan. Make sure that the proper voltage is being applied to the fan(s).

If the proper voltage is at the fan and the fan still does not work, replace the fan (49009).

7.0 DOCUMENTATION

Applicable Patents - US Patent #3,641,408.

Schematics and Component Layouts:

WHD361	HD361 Overall Schematic
S75001	Optional Signal Interface 25 Pin Sub D
60960A	Driver, SCR gate
60971C	Input board
60972D	Dual timer board (Continuance/Rotor Interlock Delay timer) (Boost/Brake timer) (Off Delay/On Delay timer)
60980I	Phase shift 2 board
61067C	Inverter drive and SCR board
61074E	Stator Output board - Three-phase
61076C	Phase shift 1 / fault detector board
61077D	Interlock board - Three-phase
61078D	Mother board - Three-phase
61079D	Power supply board - Three-phase

Assemblies

60960A	Driver, SCR gate board
60971C	Input board
60972D	Dual timer board (Continuance/Rotor Interlock Delay timer) (Boost/Brake timer) (Off Delay/On Delay timer)
60980I	Phase shift 2 board
61067C	Inverter drive and SCR board
61074E	Stator Output board - Three-phase
61076C	Phase shift 1 / fault detector board
61077D	Interlock board - Three-phase
61078D	Mother board - Three-phase
61079D	Power supply board - Three-phase

Spare parts lists:

The following spare parts list is recommended for all field service personnel. The quantities listed are suggested on- hand stock levels for each field service person.

Printed Circuit Boards

P/N	DESCRIPTION	QTY
60960A	Driver, SCR Gate	1
60971C	Input	1
60972D	Timer	1
60980I	Phase Shift 2	1
61067C	Inverter Drive and SCR	1
61074E	3-Stator Output Phase	1
61076C	Phase Shift/Fault Detect	1
61077D	Interlock	1
61078D	Mother	1
61079D	Power Supply	1
70557	Extender board kit	1 kit

Fuses

P/N	DESCRIPTION	QTY
45045	3A SB 3AG fuse	5
45073	1A SB Pico fuse	5
45075	0.125A SB 5x20 mm fuse	5
45077	0.05A SB 5x20 mm fuse	5

Miscellaneous Repair Parts

P/N	DESCRIPTION	QTY
24042	8uf 660VAC	2
31018	Diode S3280	2
31086	STD-057/08 SCR/Diode power module	1
41006	K'H, Brake (K'B1, K'B2)	2
49009	Fan	1
54392	Air filter	1

The following is a list of additional parts recommended for companies whose service people trouble-shoot down to the defective component.

Transistors

P/N	DESCRIPTION	QTY.
30004	TIP111 NPN DARLINGTON TO-220AB	2
30006	2N5308 NPN DARLINGTON TO-92	1
30007	2N4125 PNP GENERAL PURPOSE T0-92	1
30008	2N4123 NPN GENERAL PURPOSE T0-92	1
30027	2N6718 NPN MEDIUM POWER TO-237	1

IC's

32001	74C00N	1
32002	74C192N	1
32042	74C10N	2
32046	74C20N	2
32048	74C02N	1
32054	4040B	2
32060	LM340T-12 (OR 7812)	2
32065	4093B	4
32072	74C14N	4
32074	74C30N	2
32105	LM311	1
32124	LM3302N	1
32132	CD4089	1
32138	LM1458N	2
32140	CD4028A	1
32144	CD4020A	1
32161	LM320T-12 (OR 7912)	2
32193	74C914N	1

Relays

41002	Optional Functions	1
41040	Function	2
41051	Signal Input	1

Miscellaneous Repair Parts

31001	IN4004	1
31003	1N4148 diode	1
31068	SCR Inverter	1
31090	P6KE18CA	1
33013	NEON 250V	1
40022	DIP Switch 8 position	1
40029	DIP Switch 6 position	1
43083	Pulse transformer	1
45072	Circuit breaker, 60A	1
49002	MOV	1

8.0 MAINTENANCE

8.1 Air Filter Assembly

A removable air filter is located on the bottom of the rotor controller cabinet. There are four screws holding it in place. If the two screws on the front side are removed and the two screws on the back side loosened, the air filter can be removed easily.

If necessary, the air filter can be washed out in warm soapy water; otherwise shaking it out will suffice. Re-install it and tighten the screws. Depending on the environment, check the air filter at least once a year.

8.2 Fan Assemblies

The HD361 series rotor controller has three fans. Two of them are attached to the top, inside of the rotor controller cabinet and one is located on the input transformer assembly.

Look at each fan and determine if it is running properly. It might be necessary to use a flashlight to accomplish the inspection. Determine if they are all running at the same speed by comparing one to another. Dirt or worn bearings can cause them to run at less than their normal speed.

Check the fan fuse, F2 (3A SB), at the input transformer.

Proper operation of the rotor controller depends upon both fans running properly, especially for high duty cycles.
Check the fans at least once a year or at any occasion of service.

8.3 Stator Voltages

Stator voltages, Boost (AC), Run (AC), and Brake (DC), should be checked at least once a year or on any occasion of service. This can be accomplished very easily with the use of a digital voltmeter. Refer to Section 3.5 and to the 61074E Stator Output board schematic in Section 7.0 to determine where to measure these voltages. When rotor controllers are shipped, the stator voltages are set to customer specifications. If these are not logged on site, call your office for the information, or call Advanced Instrument Development, Inc.