# Rotor-AID™

## RC100 Series
## Rotor controller

### Model RC103-04

### Electromed P/N 8092.04

# Owner's Manual
**(p/n 69267 Rev. D)**

# June 2008

--SERVING THE MEDICAL X-RAY FIELD SINCE 1969 –

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# 1.0 INTRODUCTION

This manual covers the 3-tube radiographic and fluoroscopic configurations of the Rotor-AID RC103-04 Rotor Controller.

## 1.1 General Information

Rotor-AID RC100 Series Rotor Controllers provide the necessary control signals, interlocks and power outputs to drive the anode rotors of x-ray tubes to near 3600 or 10,800 rpm or to other rotational speeds using selectable programmed frequencies 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.

Solid state logic and microprocessor control is provided to accommodate all common procedures such as fluoroscopic, cine and spot film as well as radiographic, CT and digital.

These rotor controllers are designed to provide the maximum boost power that almost any small to medium size 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.

IGBT inverters are used to accelerate the rotor to low or high speeds. No phase shift capacitors are required because power is supplied at precise phase angles.

Current sensing is provided to monitor main, phase and common stator currents during boost and run periods and to provide relay interlock contacts to prevent x-ray exposures if these currents are not present.

Medium size anode tubes with heat storage capacities of up to 1.5 million heat units can be rapidly accelerated to full speed.

# 2.0 SPECIFICATIONS

## 2.1 Control Interface Input Voltages

Factory/field selectable jumpers for each input circuit permit nominal input levels of 12VDC, 24VDC, or 120VAC for each input circuit (refer to Section 3.4a). Loading is nominally 10mA for any input voltage selected.

## 2.2 Control Input Functions (Refer to Figures 3.7, 3.8 and Section 7.1 Interface Schematics.)

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

| Input Command | Input Location |
|---|---|
| Rotor Start | 61096A TB2 pins 1 & 2 |
| High Speed Select | 61096A TB2 pins 3 & 4 |
| Auxiliary | 61096A TB2 pins 5 & 6 |
| Cancel Continuance | 61096A TB2 pins 7 & 8 |
| Fluoro | 61096B TB3 pins 1 & 2 |
| Spot | 61096B TB3 pins 3 & 4 |
| Cine | 61096B TB3 pins 5 & 6 |
| Tube 1 Select | 61096B TB3 pins 7 & 8 |
| Tube 2 Select | 61096B TB3 pins 9 & 10 |
| Tube 3 Select | 61096B TB3 pins 11 & 12 |

## 2.3 Control Interface Output (Refer to Figure 3.9 and Section 7.1 Interface Schematics).

| Relay Function | 61095A Output Location |
|---|---|
| Rotor Interlock | TB1, pins 1 & 2 |
| High Speed Verify | TB1, pins 3 & 4 |
| Tube Active | TB1, pins 5 & 6 |
| Auxiliary Relay | TB1, pins 7 & 8 |

All contacts are rated 5A, 24VDC/240VAC resistive.
All relays are jumper selectable for either normally open or normally closed contacts

2.4 Power Requirements

Line voltages: Single phase 200VAC to 277VAC + 10%, 50/60 Hz.

Input autotransformer input voltage taps: 200, 208, 220, 240 and 277VAC

Nominal 25 Ampere service required, preferably wired from the same source as the generator rather than from the generator. Wiring should conform to local and national safety codes using #10 AWG wire for runs up to 115 feet (35m) in order to minimize voltage drops during operation.

Internal circuit breaker:
Time delay rated 20 Amperes 277VAC

2.5 Power Output (Refer to the overall wiring diagram, WRC103, in Section 7.1.)

The output voltage is line dependent. The output to the tube stator is supplied as fixed voltages with pre-programmed duty cycles to provide proper stator currents during boost, run, and brake. The output voltage is a function of the input autotransformer tap selected. The input autotransformer may be wired to supply higher or lower output voltages. This selection is factory set at 240VAC for boost and 120VAC for run, unless otherwise requested. The voltage selection should be made in accordance with the x-ray tube manufacturer's recommendations. An optional relay may be used to select either of two voltage taps and is activated using the auxiliary relay 61095A RY1 as controlled by switches 61096B SW5-4, SW5-5 and SW5-6 (OFF = normal voltage, On = alternate voltage), see Section 4.9 Programmable Jumper Selections.

| INPUT AUTOTRANSFORMER VOLTAGE SELECTION | HIGH SPEED BOOST MAIN STATOR WINDING VOLTAGE[1] |
|---|---|
| 200VAC | 460VAC TRMS |
| 208VAC | 475VAC TRMS |
| 220VAC | 500VAC TRMS |
| 240VAC | 550VAC TRMS |

[1]Output voltages listed are approximations.

The output current will not exceed 10 Amperes per stator winding.

Output frequency is jumper selectable in 2.5 Hz increments.
High speed 100 Hz to 197.5 Hz
Low speed 50 Hz to 72.5 Hz
(see Section 4.5 Functional Programming Information -- DRIVE FREQUENCIES).

2.6 Duty Cycle (continuous)

Boost 3 seconds
Run 15 seconds
Brake 8 seconds
Idle 34 seconds

2.7 Anode Rotation Maintained During Run

When the 61097B micro-controller board is factory/field programmed for a specific drive frequency, the anode rotation speed is near the programmed drive speed. (see Section 4.5 Functional Programming Information DRIVE FREQUENCIES)

2.8 Timer Adjustment Ranges

Individual timers are provided for each x-ray tube to set boost and brake times; additional timers are available to set continuance (holdover time) and to set time for an auxiliary function such as fluoro hold. Time intervals are set by DIP switches on the 61096A and 61096B Input Boards as follows.

| Control | Usable Range | Resolution |
|---|---|---|
| Tube 1 Boost 61096A SW1 | 0.0 to 12.6 seconds | 0.2 second |
| Tube 1 Brake 61096A SW2 | 0.0 to 12.6 seconds | 0.2 second |
| Continuance 61096A SW3 | 0 to 10 minutes 30 seconds | 10 seconds |
| Auxiliary 61096A SW4 | 0 to 10 minutes 30 seconds | 10 seconds |
| Tube 2 Boost 61096B SW1 | 0.0 to 12.6 seconds | 0.2 second |
| Tube 2 Brake 61096B SW2 | 0.0 to 12.6 seconds | 0.2 second |
| Tube 3 Boost 61096B SW3 | 0.0 to 12.6 seconds | 0.2 second |
| Tube 3 Brake 61096B SW4 | 0.0 to 12.6 seconds | 0.2 second |

2.9 Controls and Indicators

External Operator Controls - None

External Operator Indicators - None

Internal Indicators - (Refer to Figures 3.1 and 3.9)

2.10 Split-Phase Drive

Tube drive is accomplished by means of an IGBT inverter output driving both windings of an x-ray tube's split stator. The phase (auxiliary) winding is always electrically 90 degrees out of phase with the main winding.

2.11 Interlocks

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

- During boost and brake portions of the timing cycles and during tube switching.
- When any of the three stator leads are not drawing sufficient current.

A high speed verify interlock is provided to indicate that a high speed select signal has been received and the rotor controller is in high speed run.

A tube active interlock is available as a means to prevent stator switching when the rotor controller is active, either driving or braking a rotor.

2.12 Physical Appearance and Dimensions

Zinc plated steel housing with yellow chromate finish.

| | Physical Dimensions Height x Width x Depth | Weight of Basic Unit | Reference |
|---|---|---|---|
| RC103 19" rack mount model | 8.75 x 19 x 11.88 inches (222 x 483 x 302 mm) | 55 pounds (25kg) | Figure 3.3 |
| 705101 wall mount cabinet | 17 x 20 x 9 inches (432 x 508 x 229 mm) | | Figure 3.6 Section 3.2 |

2.13 Environmental Characteristics

Ambient Temperature, storage: -40 to +70$^{o}$ C

Ambient Temperature, operating: +10 to +40$^{o}$ C

Humidity: 10% to 95%, non-condensing

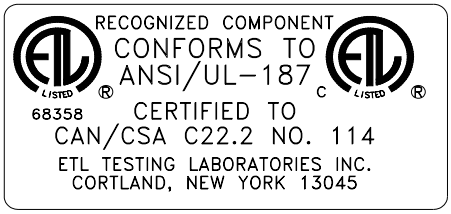
2.14 3-Tube Radiographic and Fluoroscopic Model

3-Tube switching - utilizing tube select signals from the x-ray generator, the rotor controller provides stator switching and tube changeover logic. Different boost and brake time adjustments are provided for each tube.

## 2.15 Regulatory Compliance

ETL Testing Laboratories, Inc.

This product complies with the applicable requirements of the Standard for X-ray Equipment (UL 187, 6TH Ed.) and the Standard for Diagnostic Imaging and Radiation Therapy Equipment (CAN/CSA 22.2 No. 114-M90) when labeled:




This product has been tested and found to be in compliance with the following standards:

EN 60601-1; 1989: Medical Electrical Equipment; Part 1: General Requirements for Safety.

EN 60601-1-2: Requirements for Medical Electrical Equipment, Section 1.2: Collateral Standard: Electromagnetic Compatibility - Requirements and Tests: 1993.

EN 55011, Group I, Class A: Limits and Methods of Measurement of Radio Disturbance Characteristics of Industrial, Scientific, and Medical (ISM) Radio-Frequency Equipment.

EN 50082-1: Requirements for Electromagnetic Compatibility - Generic Immunity Standard, Part 1: Residential, Commercial and Light Industry, January 1992.

# 3.0 INSTALLATION AND SUPPORT REQUIREMENTS

Electrical Service - 200VAC to 277VAC, Nominal 25 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 #10AWG wire for runs up to 115 feet (35m) in order to minimize voltage drops during boost.

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 at the source.

## 3.1 Tools and Materials Required

- Standard field service tool kit.
- A true RMS digital voltmeter AC/DC.
- Oscilloscope with 10X and 100X probes.
- Bolts or studs suitable for mounting the optional wall mount or floor mount cabinets (see Figures 3.6 and 3.9).

## 3.2 Cabinet Installation

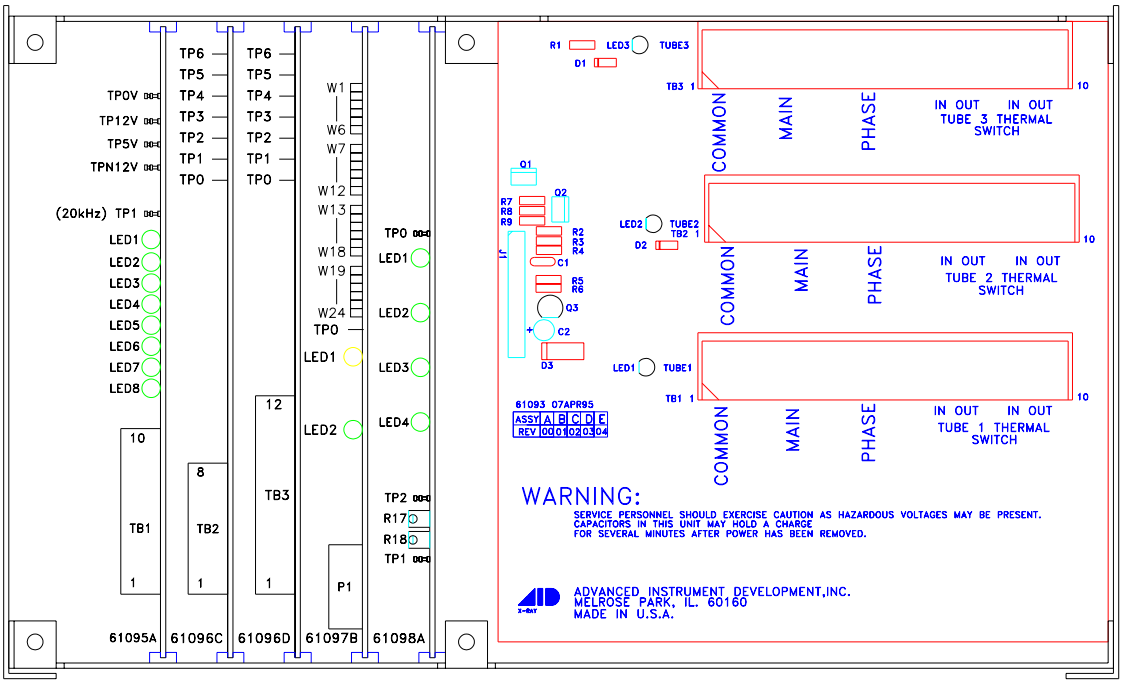
The complete unit with all options weighs approximately 75 pounds (34 kg). For details on wall mounting see Figure 3.6. For wall mount installations be sure that the wall and cabinet attachment anchors are strong enough to support the rotor controller weight. Air clearance is required above the unit for PC board removal; below unit for cable routing; on the left and right sides to secure the cover screws and in front to remove the cover. Therefore, mounting wall area should be at least 30 inches (762mm) wide x 19 inches (483mm) deep x 27 inches (686mm) high.

## 3.3 Power Connections (Refer to Figures 3.5 and 3.8)

Connect single phase power (200VAC to 277VAC) to line filter (L1 and L2). Note that a 25 Ampere service is required by the rotor controller. Make a ground connection to the 8-32 ground stud, G1, marked with a ground symbol. Position the input line voltage selector (black wire with blue fast-on) at TS3 to select the appropriate tap of the input autotransformer matching the line voltage to the input requirement of the rotor controller. This selection is factory set at 240VAC, unless otherwise requested.

Figure 3.1

RC103 ELECTRONICS CARD CAGE




| LED | Function |
|---|---|
| 61093A LED1 | TUBE 1 SELECTED |
| 61093A LED2 | TUBE 2 SELECTED |
| 61093A LED3 | TUBE 3 SELECTED |
| 61095A LED1 | POWER SURGE RELAY |
| 61095A LED2 | PHASE TRANSFORMER RELAY |
| 61095A LED3 | HIGH SPEED RELAY |
| 61095A LED4 | AUXILIARY RELAY |
| 61095A LED5 | TUBE ACTIVE RELAY |
| 61095A LED6 | HIGH SPEED VERIFY RELAY |
| 61095A LED7 | ROTOR INTERLOCK RELAY |
| 61095A LED8 | VOLTAGE SWITCHING RELAY |
| 61097B LED1 | FAULT |
| 61097B LED2 | MICRO-CONTROLLER ON OK |
| 61098A LED1 | STATOR COMMON CURRENT |
| 61098A LED2 | STATOR PHASE CURRENT |
| 61098A LED3 | STATOR MAIN CURRENT |
| 61098A LED4 | MAINS OK |

Figure 3.2

RC103 ELECTRONICS CARD CAGE

REAR VIEW

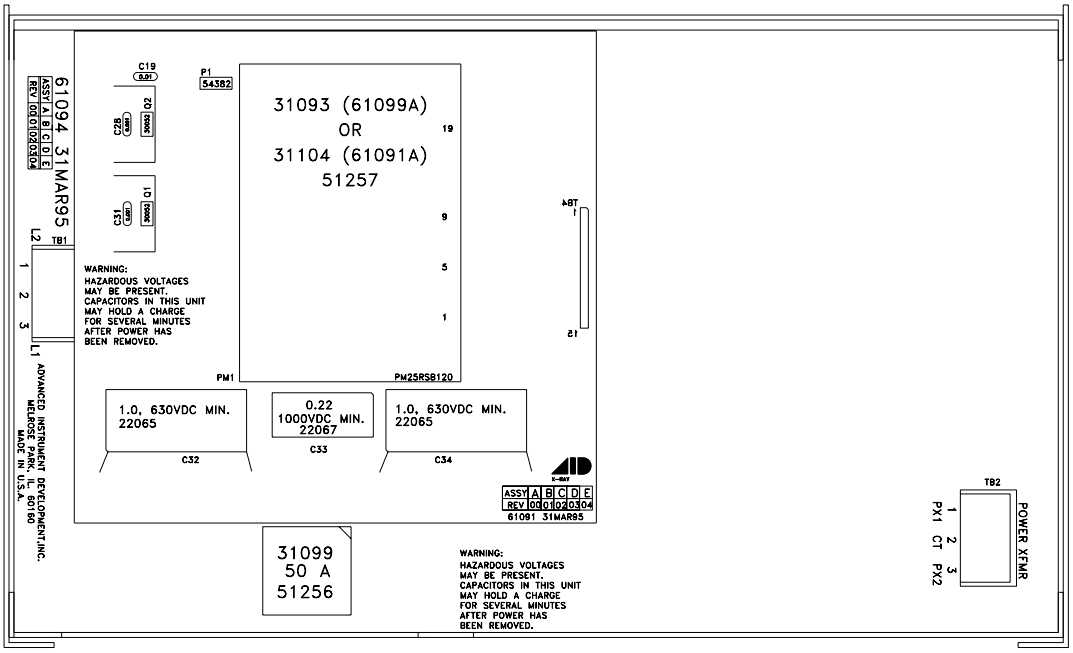
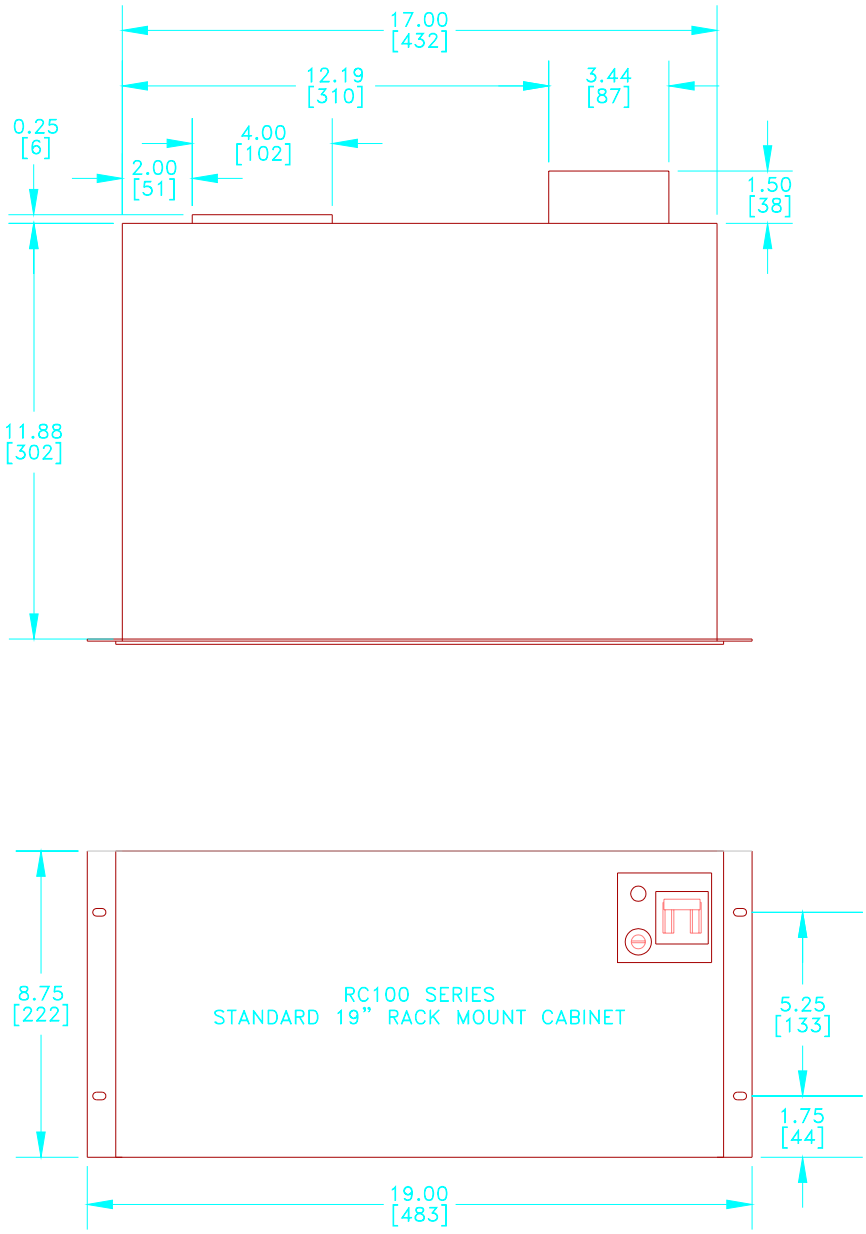


Figure 3.3
RC103
19-INCH RACK MOUNT CABINET



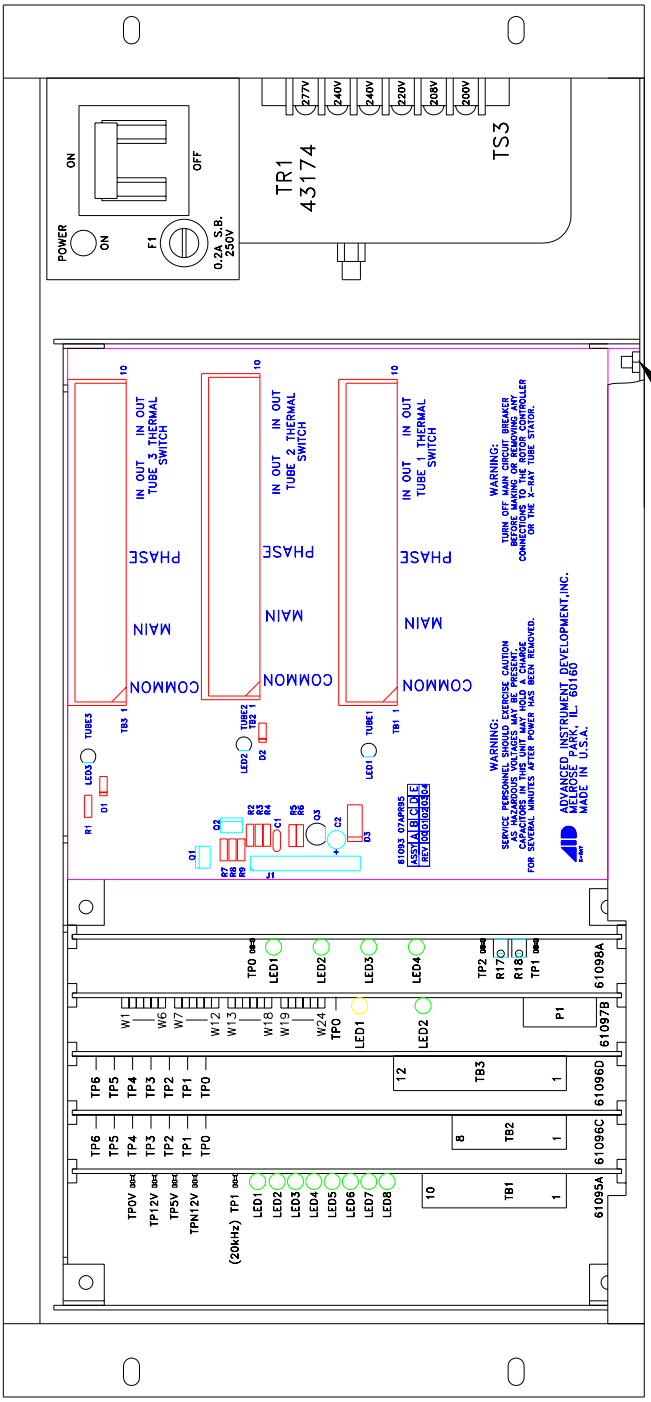



Figure 3.4
19-Inch Rack Mount
Front View

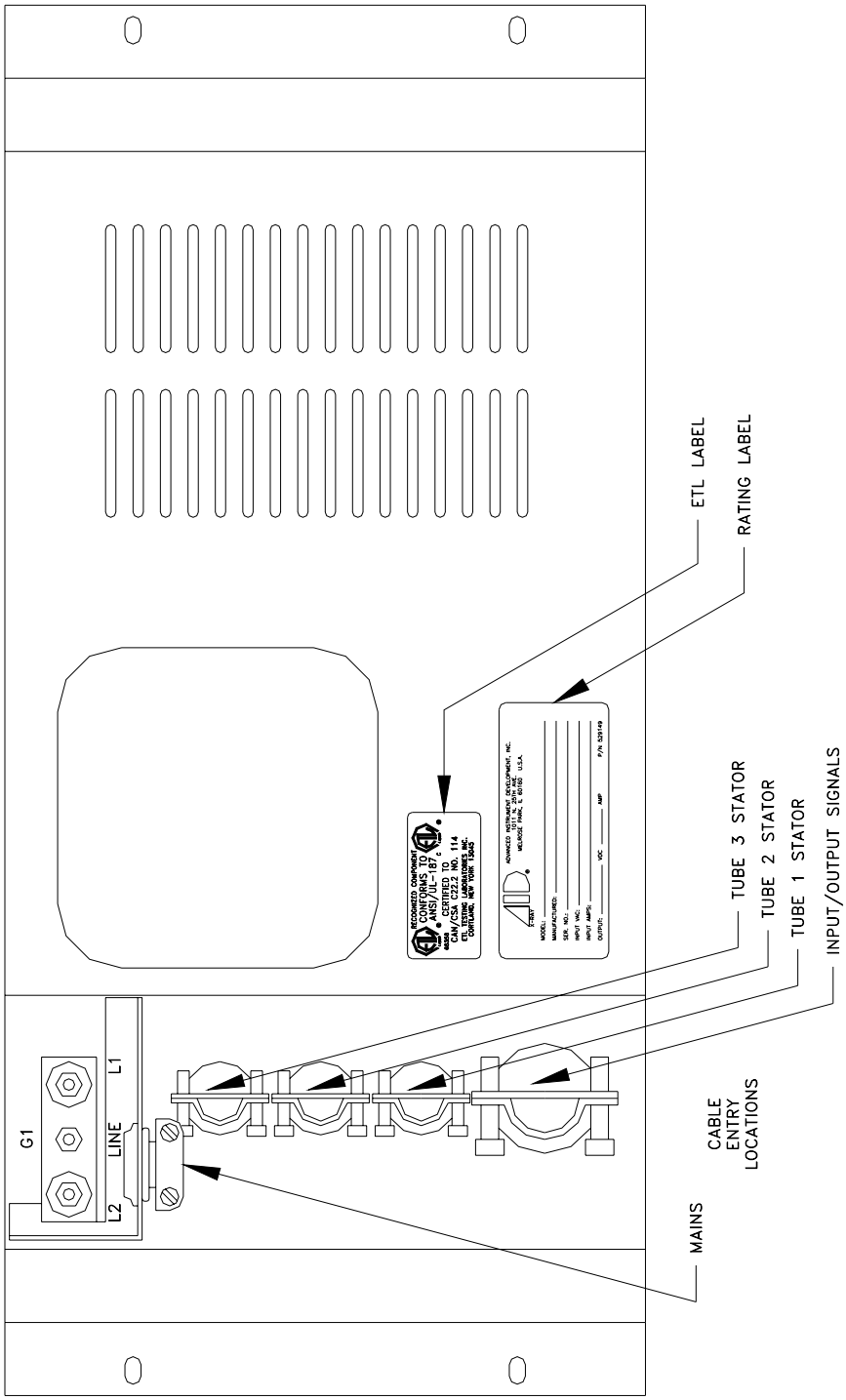



Figure 3.5
19-Inch Rack Mount
Rear View

Figure 3.6

RC103 WALL MOUNT CABINET INSTALLATION

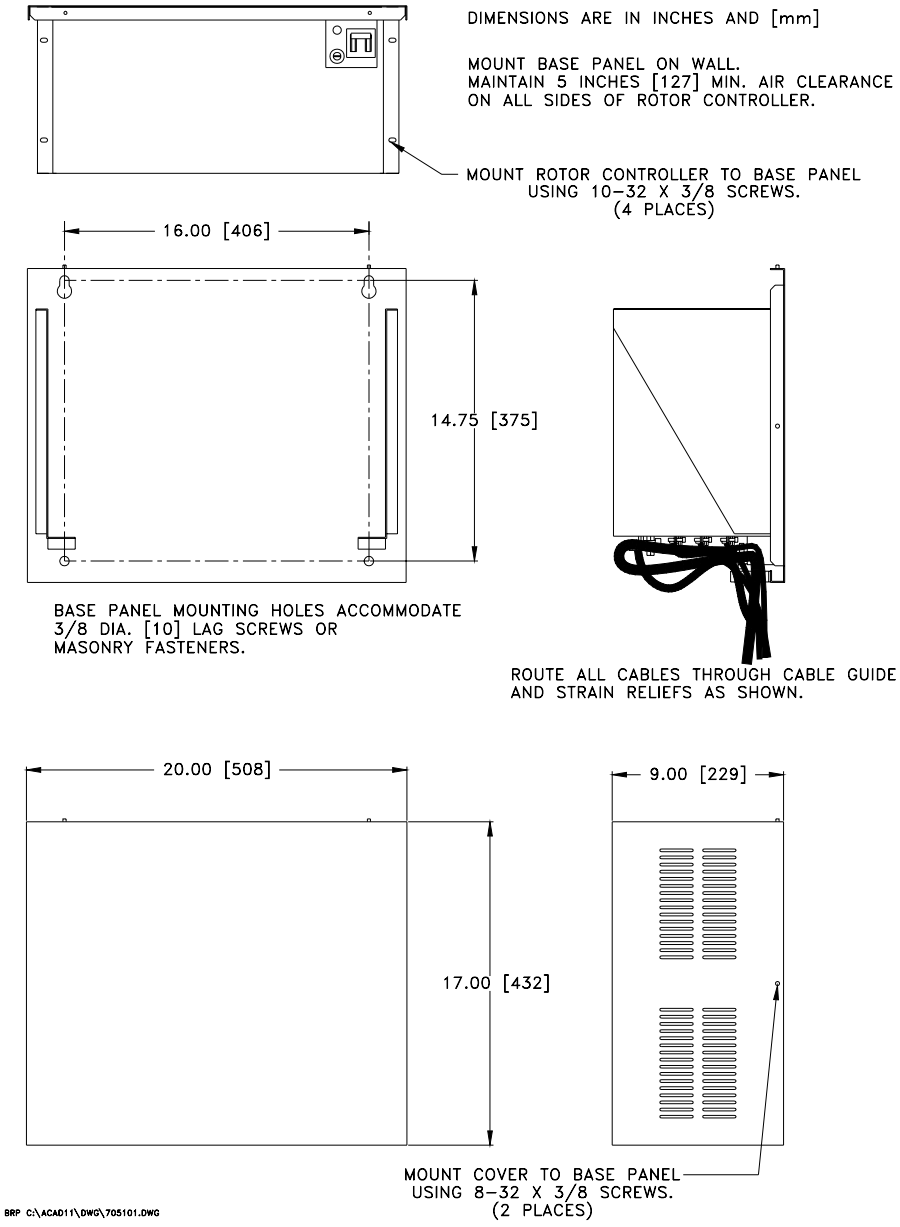
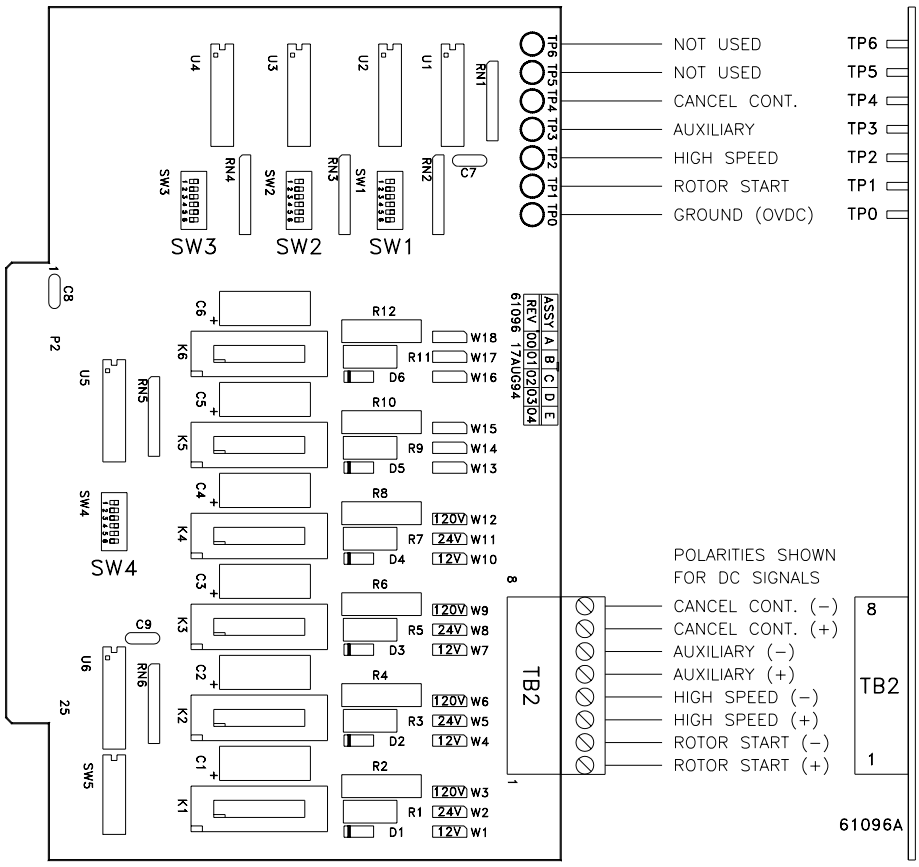
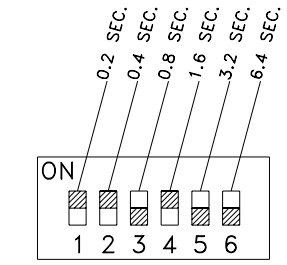


Figure 3.7

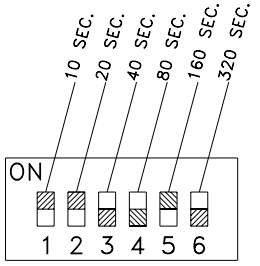
61096A INPUT BOARD DETAIL




BOOST AND BRAKE TIME SETTINGS
RANGE 0.0 TO 12.6 SECONDS
IN 0.2 SECOND INCREMENTS.
SETTINGS ARE ADDITIVE.

SW1 = TUBE 1 BOOST
SW2 = TUBE 1 BRAKE

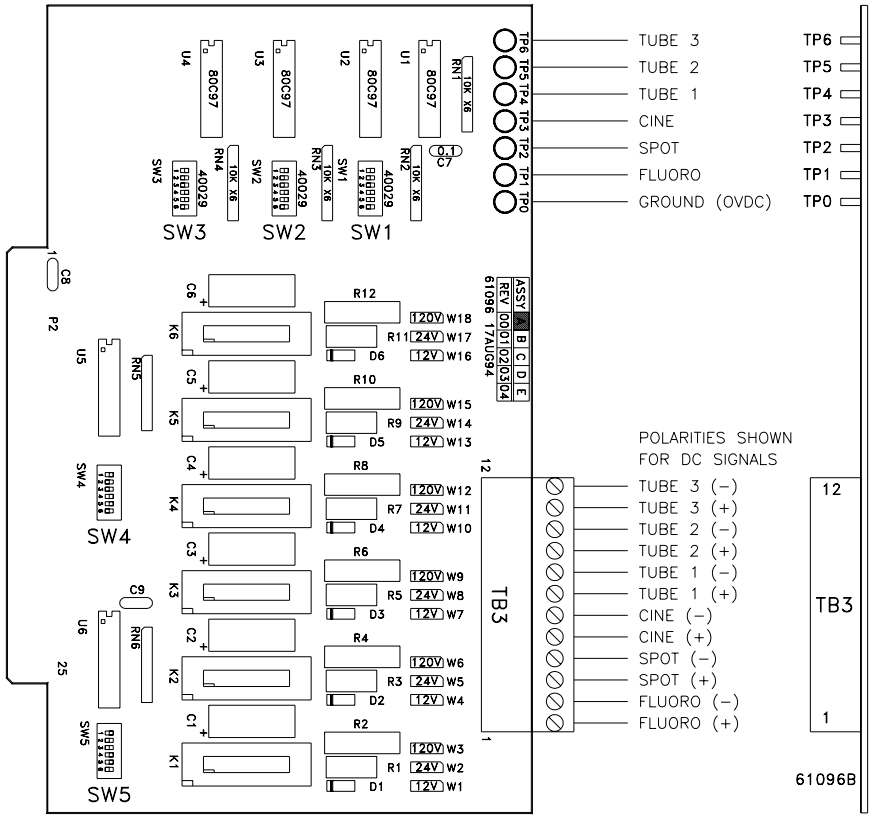


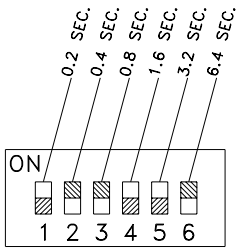

CONTINUANCE AND AUXILIARY TIME SETTINGS
RANGE 0.0 TO 10 MINUTES 30 SECONDS
IN 10 SECOND INCREMENTS.
SETTINGS ARE ADDITIVE.

SW3 = CONTINUANCE
SW4 = AUXILIARY

Figure 3.8

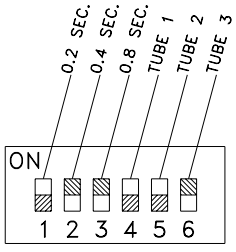
61096B 3-TUBE INPUT BOARD DETAIL




BOOST AND BRAKE TIME SETTINGS
RANGE 0.0 TO 12.6 SECONDS
IN 0.2 SECOND INCREMENTS.
SETTINGS ARE ADDITIVE.

SW1 = TUBE 2 BOOST
SW2 = TUBE 2 BRAKE
SW3 = TUBE 3 BOOST
SW4 = TUBE 3 BRAKE




SW5 1, 2 AND 3 = CASSETTE DELAY.
CASSETTE DELAY TIME SETTINGS
RANGE 0.0 TO 1.4 SECONDS
IN 0.2 SECOND INCREMENTS.
SETTINGS ARE ADDITIVE.

SW5 4, 5 AND 6 = ACTIVATE 61095A RY1 (AUX. RELAY)
WHEN CORRESPONDING TUBE IS SELECTED.

Figure 3.9

OUTPUTS AND INDICATORS

61095A POWER SUPPLY BOARD DETAIL

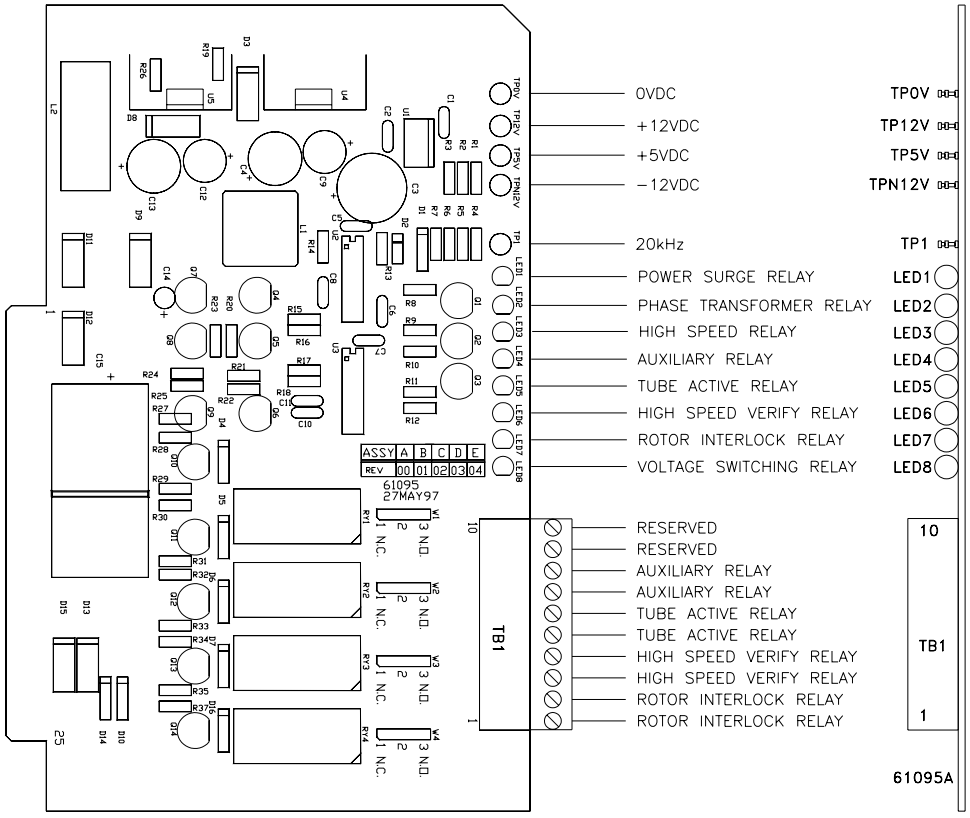
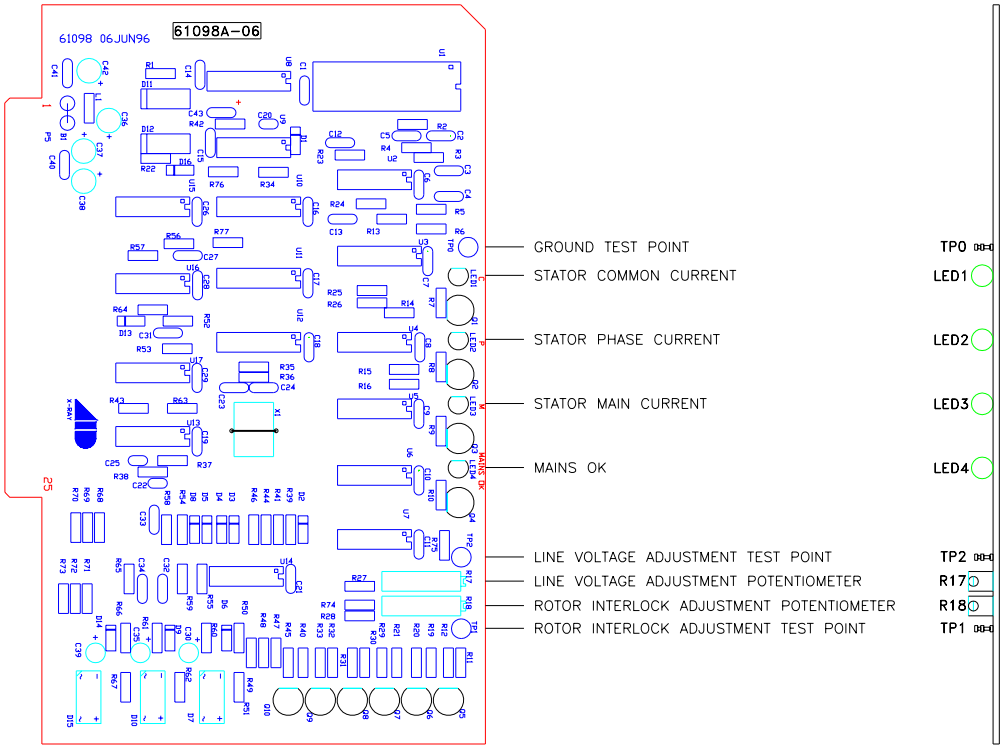


Figure 3.10

61098A CONTROL BOARD DETAIL



3.4 Interconnections to X-Ray Control (refer to Figures 3.1, 3.2, 3.4 and 3.5 for component locations and Section 4.5 for programming options).

NOTE: The circuit breaker must be turned OFF whenever making any connections to or disconnections from the rotor controller or x-ray tube.

3.4a) Inputs to the Rotor Controller (refer to Figures 3.7 and 3.8 for input signal information).

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. The other input voltages may be field programmed using selectable jumpers. Loading is approximately 10mA in all cases.

| INPUT SIGNAL VOLTAGE | AC VOLTAGE RANGE | DC VOLTAGE RANGE |
|---|---|---|
| 12V | 10VAC TO 15VAC | 10VDC TO 19VDC |
| 24V | 22VAC TO 36VAC | 19VDC TO 30VDC |
| 120V | 100VAC TO 125VAC | NOT APPLICABLE |

All input signals to the rotor controller may be simulated by jumpering the appropriate test point to ground (TP0 on any PC board). Remove any simulated signals before initiating a tube change. Refer to figures 3.7 and 3.8 and to signal descriptions below for input signal test point designations.

ROTOR START - For all radiographic work connect to 61096A TB2 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. Simulate rotor start at 61096A TP1.

HIGH SPEED SELECT - Connect to 61096A TB2 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 and the presence of it causes high speed operation. Simulate high speed select at 61096A TP2.

AUXILIARY INPUT - 61096A TB2 pins 5 and 6. The auxiliary input signal is not used on this unit. Simulate the auxiliary input at 61096A TP3.

CANCEL CONTINUANCE - Connect to 61096A TB2 pins 7 and 8. For DC input signals pin 7 is positive and pin 8 is common. A cancel continuance input will cause the rotor controller to terminate a continuance run and initiate a brake sequence. Simulate the cancel continuance command at 61096A TP4.

FLUORO INPUT - Connect to 61096B TB3 pins 1 and 2. For DC input signals pin 1 is positive and pin 2 is common. The fluoro command is used to initiate a boost-run sequence and activate a fluoro continuance timer for the duration of the timer switch settings at 61096A SW3. Fluoro work will occur at the selected speed (either low speed or high speed). Simulate the fluoro command at 61096B TP1.

SPOT INPUT - Connect to 61096B TB3 pins 3 and 4. For DC input signals pin 3 is positive and pin 4 is common. The spot command is used to supply a rotor start and high speed select signal to the rotor controller. The spot command also activates the spot continuance (auxiliary) timer for the duration of the timer switch settings at 61096A SW4. The fluoro continuance timer will be initiated at the end of spot continuance. Simulate the spot command at 61096B TP2.

CINE INPUT - Connect to 61096B TB3 pins 5 and 6. For DC input signals pin 5 is positive and pin 6 is common. The cine command may be used to supply a high speed speed rotor start signal to the rotor controller. Simulate the cine command at 61096B TP3.

TUBE SELECTS - Tube selection is accomplished by supplying a signal to 61096B TB3 pins 7 and 8 (tube 1), 61096B TB3 pins 9 and 10 (tube 2) or 61096B TB3 pins 11 and 12 (tube 3). For DC input signals pins 7, 9 and 11 are positive and pins 8, 10 and 12 are common. If a boost, run, brake sequence is in progress when a tube selection change is made, the rotor controller will switch its output to the tube selected after the boost, run, brake sequence has been completed. The tube select signal is also used to select the appropriate set of boost and brake time settings for that tube. Operation is not allowed if no tube is selected or if more than one tube is selected. Simulate tube 1, tube 2 and tube 3 selections at 61096B TP4, TP5 and TP6, respectively.

3.4b) Outputs from the Rotor Controller (refer to Figure 3.9 for output signal information).

All relay contacts for outputs from the rotor controller are rated at 5 Amperes 24VDC/240VAC resistive .

ROTOR INTERLOCK - Rotor interlock is available at 61095A TB1 pins 1 and 2. These contacts are used to allow an exposure when activated. Normally open or normally closed contacts are jumper selectable using 61095A W4.

HIGH SPEED VERIFIED - Available at 61095A TB1 pins 3 and 4 as an interlock to verify that the rotor controller is operating in the high speed mode. This set of contacts will be activated when the rotor controller has received a high speed select signal and rotor interlock has been activated. Normally open or normally closed contacts are jumper selectable using 61095A W3. This connection does not eliminate the need for the rotor interlock function. (See ROTOR INTERLOCK above).

TUBE ACTIVE - A set of contacts connected to 61095A TB1 pins 5 and 6 indicate when the rotor controller is currently driving or braking an x-ray tube rotor. 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. Normally open or normally closed contacts are jumper selectable using 61095A W2.

## 3.5 Tube Stator Connections

NOTE: The circuit breaker must be turned OFF whenever making any connections to or disconnections from the rotor controller or x-ray tube.

Make stator connections as indicated in table below:

| Stator Wire Color | Connection | Description |
|---|---|---|
| White | 61093A TB3 pin 1 | Tube 3, H9, Stator Common |
| Black | 61093A TB3 pin 3 | Tube 3, H7, Main Stator |
| Green (Red) | 61093A TB3 pin 5 | Tube 3, H8, Phase Stator |
| | 61093A TB3 pins 7 & 8 | Tube 3 thermal switch tie point |
| | 61093A TB3 pins 9 & 10 | Tube 3 thermal switch tie point |
| White | 61093A TB2 pin 1 | Tube 2, H9, Stator Common |
| Black | 61093A TB2 pin 3 | Tube 2, H7, Main Stator |
| Green (Red) | 61093A TB2 pin 5 | Tube 2, H8, Phase Stator |
| | 61093A TB2 pins 7 & 8 | Tube 2 thermal switch tie point |
| | 61093A TB2 pins 9 & 10 | Tube 2 thermal switch tie point |
| White | 61093A TB1 pin 1 | Tube 1, H9, Stator Common |
| Black | 61093A TB1 pin 3 | Tube 1, H7, Main Stator |
| Green (Red) | 61093A TB1 pin 5 | Tube 1, H8, Phase Stator |
| | 61093A TB1 pins 7 & 8 | Tube 1 thermal switch tie point |
| | 61093A TB1 pins 9 & 10 | Tube 1 thermal switch tie point |

Deleted: PIN 5

Connect all stator cable shields to the ground stud marked "G2" (refer to Figures 3.4 & 3.8).

**Special Tube Type Considerations:**

**Philips "P" stator** U = phase
V = common
W = main

Program for "E" (balanced) stator. See Figure 4.1

Move the Blue wire from TS3-240V to TS3-208V. This is the blue wire going to the voltage selection relay RY1 (see Wiring Diagram WRC103-04).

# 4.0 TESTS AND ADJUSTMENTS

Adjustment Notes:

During calibration it may be advantageous to maintain a continuous rotation of the x-ray tube anode. Excessive boosting and braking will add unnecessary heat to the x-ray tube stator. Low speed continuous rotation may be achieved by connecting a jumper from 61096A TP1, Rotor Start, to TP0, DC ground, on any PC board. High speed continuous rotation may be achieved by connecting jumpers from 61096A TP1, Rotor Start, and TP2, High Speed Select, to TP0, DC ground, on any PC board.

The stator output voltage is fixed. The boost time is set on dip-switches. Pre-programmed duty cycles of the output waveform provide the proper stator current during boost, run and brake.

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.

## 4.1 Autotransformer Tap Selections

Refer to Figures 3.4 and 3.8. An input autotransformer is provided to adjust the available line voltage to ensure that the RC100 Series Rotor Controller operates at 240VAC as intended. Move the autotransformer input lead with the fast-on connector to the appropriate pin of the TS3 terminal strip (200, 208, 220, 240 or 277VAC) to match the input line voltage. This selection is factory set at 240VAC, unless otherwise requested.

## 4.2 Line Voltage Adjustment

Refer to Figures 3.1 and 3.10. Monitor 61098A TP2 with an oscilloscope or DVM referenced to DC ground at 61098A TP0. After setting the proper input line voltage selection (see Section 4.1), adjust 61098A R17 for 6.0VDC $\pm$ 0.3VDC at 61098A TP2.

## 4.3 Control Signal Input Voltage Programming

Refer to Figures 3.7 and 3.8 and schematics for 61096A and 61096B 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.

## 4.4 Output Autotransformer Selection

Unless otherwise requested, rotor controllers are programmed to be used with "R" stators, which have unbalanced impedance stator windings. The main stator winding is normally connected for an output boost voltage of approximately 550VAC (refer to Section 2.5 Power Output). The phase stator winding is also connected to this output voltage except during high speed boost when the output autotransformer, TR2, is used to increase the output boost voltage to approximately 1100VAC.

When using balanced impedance ("E") stators, both outputs should be the same. Refer to Figure 4.1 and Section 4.9

## 4.5 Functional Programming Information

Refer to Figure 4.1 and Sections 3.4 and 4.9 for jumper selection detail.

ROTOR START OPTIONS - The presence of an input signal at 61096A TB2 pins 1 and 2 is used to initiate rotor start. The fluoro, spot and/or cine inputs may also be used to initiate a rotor start. The presence of any one of these input signals will force a rotor start. Setting 61097B W16 to the 2-3 position will force a rotor start whenever a high speed input is present at 61096A TB2 pins 3 and 4.

HIGH SPEED SELECT OPTIONS - The cine input will force the rotor controller into a high speed condition. The fluoro and spot inputs may also be used to force a high speed condition. Fluoro forces high speed when 61097B W17 is set to the 2-3 position. Spot forces high speed when 61097B W15 is set to the 1-2 position. Setting 61097B W15 to the 2-3 position allows either high speed or low speed spot operation depending upon the presence or absence of a high speed selection signal at 61096A TB2 pins 3 and 4. The auxiliary timer may be used to force a high speed condition (e.g. when used for spot continuance).

CONTINUANCE TIMER OPERATION - In the normal mode of operation the continuance timer, 61096A SW3, is used for high and low speed continuance. Continuance may be initiated by normal rotor, fluoro, spot or high speed.

SEPARATE CONTINUANCE TIMES FOR FLUORO AND SPOT - The continuance timer, 61096A SW3, is used for fluoro as described above in CONTINUANCE TIMER OPERATION. The auxiliary timer, 61096A SW4, is used for spot continuance.

FLUORO FORCES LOW SPEED - The high speed select input may be deactivated during fluoro by setting 61097B W14 to the 1-2 position (61097B W17 must be set to the 1-2 position). Setting 61097B W14 to the 2-3 position allows either high speed or low speed fluoroscopic operation depending upon the presence or absence of a high speed selection signal at 61096A TB2 pins 3 and 4.

DRIVE FREQUENCIES - The boost and run drive frequencies for the Rotor-AID RC100 Series Rotor Controller are determined by the frequency selection jumpers located on the 61097B micro-controller board. The various high speed drive frequencies and jumper selections are listed in Table 4.1. The various low speed drive frequencies and jumper selections are listed in Table 4.2.

Table 4.1
HIGH SPEED FREQUENCY SELECTION

| Micro-controller Board (61097B) | | | | | | | |
|---|---|---|---|---|---|---|---|
| W1 | W2 | W3 | W4 | W5 | W6 | Frequency (Hz) | RPM (max.) |
| 2-3 | 2-3 | 2-3 | 1-2 | 1-2 | 2-3 | 197.5 | 11,850 |
| 2-3 | 2-3 | 2-3 | 1-2 | 1-2 | 1-2 | 195.0 | 11,700 |
| 2-3 | 2-3 | 1-2 | 2-3 | 2-3 | 2-3 | 192.5 | 11,550 |
| 2-3 | 2-3 | 1-2 | 2-3 | 2-3 | 1-2 | 190.0 | 11,400 |
| 2-3 | 2-3 | 1-2 | 2-3 | 1-2 | 2-3 | 187.5 | 11,250 |
| 2-3 | 2-3 | 1-2 | 2-3 | 1-2 | 1-2 | 185.0 | 11,100 |
| 2-3 | 2-3 | 1-2 | 1-2 | 2-3 | 2-3 | 182.5 | 10,950 |
| 2-3 | 2-3 | 1-2 | 1-2 | 2-3 | 1-2 | 180.0 | 10,800 |
| 2-3 | 2-3 | 1-2 | 1-2 | 1-2 | 2-3 | 177.5 | 10,650 |
| 2-3 | 2-3 | 1-2 | 1-2 | 1-2 | 1-2 | 175.0 | 10,500 |
| 2-3 | 1-2 | 2-3 | 1-2 | 1-2 | 2-3 | 172.5 | 10,350 |
| 2-3 | 1-2 | 2-3 | 1-2 | 1-2 | 1-2 | 170.0 | 10,200 |
| 2-3 | 1-2 | 1-2 | 2-3 | 2-3 | 2-3 | 167.5 | 10,050 |
| 2-3 | 1-2 | 1-2 | 2-3 | 2-3 | 1-2 | 165.0 | 9,900 |
| 2-3 | 1-2 | 1-2 | 2-3 | 1-2 | 2-3 | 162.5 | 9,750 |
| 2-3 | 1-2 | 1-2 | 2-3 | 1-2 | 1-2 | 160.0 | 9,600 |
| 2-3 | 1-2 | 1-2 | 1-2 | 2-3 | 2-3 | 157.5 | 9,450 |
| 2-3 | 1-2 | 1-2 | 1-2 | 2-3 | 1-2 | 155.0 | 9,300 |
| 2-3 | 1-2 | 1-2 | 1-2 | 1-2 | 2-3 | 152.5 | 9,150 |
| 2-3 | 1-2 | 1-2 | 1-2 | 2-3 | 1-2 | 150.0 | 9,000 |
| 1-2 | 2-3 | 2-3 | 1-2 | 1-2 | 2-3 | 147.5 | 8,850 |
| 1-2 | 2-3 | 2-3 | 1-2 | 1-2 | 1-2 | 145.0 | 8,700 |
| 1-2 | 2-3 | 1-2 | 2-3 | 2-3 | 2-3 | 142.5 | 8,550 |
| 1-2 | 2-3 | 1-2 | 2-3 | 2-3 | 1-2 | 140.0 | 8,400 |
| 1-2 | 2-3 | 1-2 | 2-3 | 1-2 | 2-3 | 137.5 | 8,250 |
| 1-2 | 2-3 | 1-2 | 2-3 | 1-2 | 1-2 | 135.0 | 8,100 |
| 1-2 | 2-3 | 1-2 | 1-2 | 2-3 | 2-3 | 132.5 | 7,950 |
| 1-2 | 2-3 | 1-2 | 1-2 | 2-3 | 1-2 | 130.0 | 7,800 |
| 1-2 | 2-3 | 1-2 | 1-2 | 1-2 | 2-3 | 127.5 | 7,650 |
| 1-2 | 2-3 | 1-2 | 1-2 | 1-2 | 1-2 | 125.0 | 7,500 |
| 1-2 | 1-2 | 2-3 | 1-2 | 1-2 | 2-3 | 122.5 | 7,350 |
| 1-2 | 1-2 | 2-3 | 1-2 | 1-2 | 1-2 | 120.0 | 7,200 |
| 1-2 | 1-2 | 1-2 | 2-3 | 2-3 | 2-3 | 117.5 | 7,050 |
| 1-2 | 1-2 | 1-2 | 2-3 | 2-3 | 1-2 | 115.0 | 6,900 |
| 1-2 | 1-2 | 1-2 | 2-3 | 1-2 | 2-3 | 112.5 | 6,750 |
| 1-2 | 1-2 | 1-2 | 2-3 | 1-2 | 1-2 | 110.0 | 6,600 |

| Micro-controller Board (61097B) | | | | | | | |
|---|---|---|---|---|---|---|---|
| W1 | W2 | W3 | W4 | W5 | W6 | Frequency (Hz) | RPM (max.) |
| 1-2 | 1-2 | 1-2 | 1-2 | 2-3 | 2-3 | 107.5 | 6,450 |
| 1-2 | 1-2 | 1-2 | 1-2 | 2-3 | 1-2 | 105.0 | 6,300 |
| 1-2 | 1-2 | 1-2 | 1-2 | 1-2 | 2-3 | 102.5 | 6,150 |
| 1-2 | 1-2 | 1-2 | 1-2 | 1-2 | 1-2 | 100.0 | 6,000 |

Table 4.2
LOW SPEED FREQUENCY SELECTION

| Micro-controller Board (61097B) | | | | | |
|---|---|---|---|---|---|
| W9 | W10 | W11 | W12 | Frequency (Hz) | RPM (max.) |
| 2-3 | 1-2 | 1-2 | 2-3 | 72.5 | 4,350 |
| 2-3 | 1-2 | 1-2 | 1-2 | 70.0 | 4,200 |
| 1-2 | 2-3 | 2-3 | 2-3 | 67.5 | 4,050 |
| 1-2 | 2-3 | 2-3 | 1-2 | 65.0 | 3,900 |
| 1-2 | 2-3 | 1-2 | 2-3 | 62.5 | 3,750 |
| 1-2 | 2-3 | 1-2 | 1-2 | 60.0 | 3,600 |
| 1-2 | 1-2 | 2-3 | 2-3 | 57.5 | 3,450 |
| 1-2 | 1-2 | 2-3 | 1-2 | 55.0 | 3,300 |
| 1-2 | 1-2 | 1-2 | 2-3 | 52.5 | 3,150 |
| 1-2 | 1-2 | 1-2 | 1-2 | 50.0 | 3,000 |

## 4.6 Boost/Brake Timer Adjustments

Boost Time Setting:

Refer to the timer switch selection detail on the 61096A Input board in Figure 3.7. The timer switch selections are additive. To set the boost time for tube 1, locate 61096A SW1. Turn on the switches that cumulatively add up to the high speed boost time desired. If the required boost time is unknown, start at a low setting, then progressively increase the boost time until high speed is attained from a dead stop within the boost time. Typically, tubes with 4" anodes up to 1.5 million heat units require less than 3 seconds to reach 9600 rpm.

Refer to Figure 3.8 and repeat this process on 61096B for tube 2 and tube 3, if used.

Set the fluoroscopic continuance timer switch, 61096A SW3, and auxiliary (spot continuance) timer switch, 61096A SW4, switch settings, as needed, referring to Figure 3.7 for timer switch selection detail.

Brake Time Setting:

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.

The brake timer is adjusted by means of dip switches on the 61096A and 61096B timer boards. Refer to Figures 3.7 and 3.8 for 61096A and 61096B, respectively.

| TIMER SWITCHES | BOOST | BRAKE |
|---|---|---|
| TUBE 1 | 61096A SW1 | 61096A SW2 |
| TUBE 2 | 61096B SW1 | 61096B SW2 |
| TUBE 3 | 61096B SW3 | 61096B SW4 |

## 4.7 Functional Test

Use a reed tachometer or the tube manufacturer's recommended speed measurement equipment to make sure the tube is up to speed. The tube must reach the manufacturer's recommended speed before making exposures; however, 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 0.0 and 12.6 seconds, as required, by setting dip switches corresponding to the selected tube. See Section 4.6 for Boost/Brake Timer Adjustments.

Check this up-to-speed time for all tubes connected to the system.

## 4.8 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 the boost time has been set properly prior to making the rotor interlock adjustment. See Section 4.7 for a functional test of the x-ray tube's up-to-speed time.

Refer to Figure 3.1 and 3.10 for component locations.

61098A TP1 is used to monitor the x-ray tube's main winding current.

Note: The rotor interlock adjustment should be made after the x-ray tube housing has been warmed up.

Monitor 61098A TP1 with an oscilloscope or DVM referenced to DC ground at 61098A TP0. Boost and run the x-ray tube rotor at high speed. Adjust 61098A R18 for a minimum voltage of 1.7VDC at 61098A TP1 during high speed run. Check for approximately the same voltage during low speed run. If the voltage is lower than 1.7VDC during low speed run, readjust 61098A R18 to bring this voltage up to a minimum of 1.7VDC.

Check this adjustment setting for all tubes connected to the system and make certain that this voltage does not fall below 1.7VDC for any of the tubes.

## 4.9 Programmable Jumper Selections

Table 4.3 lists all programmable jumpers in the RC100 Series Rotor-AID Rotor Controllers. These jumpers are set at the factory to customer specifications. Under normal conditions these jumpers need not be adjusted in the field.

Table 4.3
PROGRAMMABLE JUMPERS AND SWITCHES

| JUMPER/SWITCH | POSITION | FUNCTION | REFERENCE |
|---|---|---|---|
| 61095A W1 | 1-2 | AUXILIARY RELAY NORMALLY CLOSED CONTACTS | FIGURE 3.9 |
| " | 2-3 | AUXILIARY RELAY NORMALLY OPEN CONTACTS | " |
| 61095A W2 | 1-2 | TUBE ACTIVE RELAY NORMALLY CLOSED CONTACTS | " |
| " | 2-3 | TUBE ACTIVE RELAY NORMALLY OPEN CONTACTS | " |
| 61095A W3 | 1-2 | HIGH SPEED VERIFY RELAY NORMALLY CLOSED CONTACTS | " |
| " | 2-3 | HIGH SPEED VERIFY RELAY NORMALLY OPEN CONTACTS | " |
| 61095A W4 | 1-2 | ROTOR INTERLOCK RELAY NORMALLY CLOSED CONTACTS | " |
| " | 2-3 | ROTOR INTERLOCK RELAY NORMALLY OPEN CONTACTS | " |
| 61096A W1 | 12VDC | ROTOR START COMMAND | FIGURE 3.7 |
| 61096A W2 | 24VDC | " | " |
| 61096A W3 | 120VAC | " | " |
| 61096A W4 | 12VDC | HIGH SPEED COMMAND | " |
| 61096A W5 | 24VDC | " | " |
| 61096A W6 | 120VAC | " | " |
| 61096A W7 | 12VDC | AUXILIARY COMMAND | " |
| 61096A W8 | 24VDC | " | " |
| 61096A W9 | 120VAC | " | " |
| 61096A W10 | 12VDC | CANCEL CONTINUANCE COMMAND | " |
| 61096A W11 | 24VDC | " | " |
| 61096A W12 | 120VAC | " | " |
| 61096A SW1 | 1-6 | TUBE 1 BOOST TIMER SWITCH RANGE: 0.0 TO 12.6 SECONDS 0.2 SECOND INCREMENTS | " |
| 61096A SW2 | 1-6 | TUBE 1 BRAKE TIMER SWITCH RANGE: 0.0 TO 12.6 SECONDS 0.2 SECOND INCREMENTS | " |
| 61096A SW3 | 1-6 | CONTINUANCE TIMER SWITCH RANGE: 0 TO 10 MINUTES 30 SECONDS 10 SECOND INCREMENTS | FIGURE 3.7 |
| 61096A SW4 | 1-6 | AUXILIARY TIMER SWITCH RANGE: 0 TO 10 MINUTES 30 SECONDS 10 SECOND INCREMENTS | " |
| 61096B W1 | 12VDC | FLUORO COMMAND | FIGURE 3.8 |

| JUMPER/SWITCH | POSITION | FUNCTION | REFERENCE |
|---|---|---|---|
| 61096B W2 | 24VDC | " | " |
| 61096B W3 | 120VAC | " | " |
| 61096B W4 | 12VDC | SPOT COMMAND | " |
| 61096B W5 | 24VDC | " | " |
| 61096B W6 | 120VAC | " | " |
| 61096B W7 | 12VDC | CINE COMMAND | " |
| 61096B W8 | 24VDC | " | " |
| 61096B W9 | 120VAC | " | " |
| 61096B W10 | 12VDC | TUBE 1 COMMAND | " |
| 61096B W11 | 24VDC | " | " |
| 61096B W12 | 120VAC | " | " |
| 61096B W13 | 12VDC | TUBE 2 COMMAND | " |
| 61096B W14 | 24VDC | " | " |
| 61096B W15 | 120VAC | " | " |
| 61096B W16 | 12VDC | TUBE 3 COMMAND | " |
| 61096B W17 | 24VDC | " | " |
| 61096B W18 | 120VAC | " | " |
| 61096B SW1 | 1-6 | TUBE 2 BOOST TIMER<br>SWITCH RANGE: 0.0 TO 12.6 SECONDS<br>0.2 SECOND INCREMENTS | " |
| 61096B SW2 | 1-6 | TUBE 2 BRAKE TIMER<br>SWITCH RANGE: 0.0 TO 12.6 SECONDS<br>0.2 SECOND INCREMENTS | " |
| 61096B SW3 | 1-6 | TUBE 3 BOOST TIMER<br>SWITCH RANGE: 0.0 TO 12.6 SECONDS<br>0.2 SECOND INCREMENTS | " |
| 61096B SW4 | 1-6 | TUBE 3 BRAKE TIMER<br>SWITCH RANGE: 0.0 TO 12.6 SECONDS<br>0.2 SECOND INCREMENTS | " |
| 61096B SW5 | 1-3 | CASSETTE DELAY<br>SWITCH RANGE: 0.0 TO 1.4 SECONDS<br>0.2 SECOND INCREMENTS | " |
| " | 4 | WHEN SW5-4 IS ON,<br>TUBE 1 SELECTION ACTIVATES<br>AUX. RELAY (61095A RY1) | " |
| " | 5 | WHEN SW5-5 IS ON,<br>TUBE 2 SELECTION ACTIVATES<br>AUX. RELAY (61095A RY1) | " |
| " | 6 | WHEN SW5-6 IS ON,<br>TUBE 3 SELECTION ACTIVATES<br>AUX. RELAY (61095A RY1) | " |
| 61097B<br>W1 TO W6 | | HIGH SPEED<br>FREQUENCY SELECTION | FIGURE 4.1<br>TABLE 4.1 |
| 61097B W7 | 1-2 | PROGRAM SELECTION FOR TUBES LESS THAN 1 MHU | FIGURE 4.1 |
| " | 2-3 | PROGRAM SELECTION FOR TUBES GREATER THAN 1 MHU | " |
| 61097B W8 | 1-2 | RESERVED | " |
| " | 2-3 | " | " |
| 61097B<br>W9 TO W12 | | LOW SPEED<br>FREQUENCY SELECTION | FIGURE 4.1<br>TABLE 4.2 |

| JUMPER/SWITCH | POSITION | FUNCTION | REFERENCE |
|---|---|---|---|
| 61097B W13 | 1-2 | RESERVED | FIGURE 4.1 |
| “ | 2-3 | 61097B W13 MUST REMAIN IN THE 2-3 POSITION | FIGURE 4.1 |
| 61097B W14 | 1-2 | FLUORO FORCES LOW SPEED | “ |
| “ | 2-3 | HIGH SPEED OR LOW SPEED FLUORO | “ |
| 61097B W15 | 1-2 | SPOT FORCES HIGH SPEED | “ |
| “ | 2-3 | HIGH SPEED OR LOW SPEED SPOT | “ |
| 61097B W16 | 1-2 | STORAGE POSITION | “ |
| “ | 2-3 | HIGH SPEED FORCES ROTOR START | “ |
| 61097B W17 | 1-2 | STORAGE POSITION | “ |
| “ | 2-3 | FLUORO FORCES HIGH SPEED | “ |
| 61097B W18 | 1-2 | RESERVED | “ |
| “ | 2-3 | RESERVED | “ |
| 61097B W19 TO W20 | | TUBE 1 STATOR TYPE SELECTION | FIGURE 4.1 TABLE 4.4 |
| 61097B W21 TO W22 | | TUBE 2 STATOR TYPE SELECTION | “ |
| 61097B W23 TO W24 | | TUBE 3 STATOR TYPE SELECTION | “ |
| 61097B W25 | IN | RESERVED JUMPER MUST BE IN PLACE | FIGURE 4.1 |
| 61097B W26 | 1-2 | INTERNAL MEMORY | “ |
| ” | 2-3 | EXTERNAL MEMORY | “ |

FIGURE 4.1

61097B MICRO-CONTROLLER BOARD DETAIL

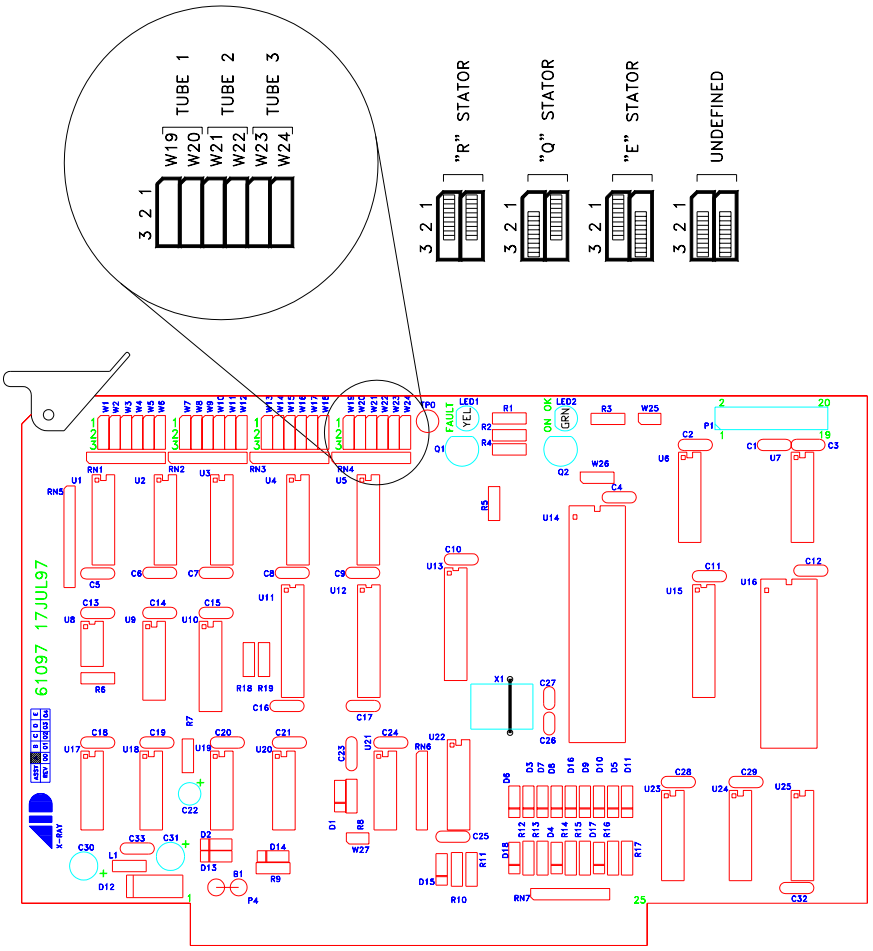



Table 4.4
Stator Option Jumper Selection

| | JUMPER | R STATOR | Q STATOR | E STATOR | UNDEFINED |
|---|---|---|---|---|---|
| TUBE 1 | 61097B W19 | 1-2 | 2-3 | 1-2 | 2-3 |
| " | 61097B W20 | 1-2 | 1-2 | 2-3 | 2-3 |
| TUBE 2 | 61097B W21 | 1-2 | 2-3 | 1-2 | 2-3 |
| " | 61097B W22 | 1-2 | 1-2 | 2-3 | 2-3 |
| TUBE 3 | 61097B W23 | 1-2 | 2-3 | 1-2 | 2-3 |
| " | 61097B W24 | 1-2 | 1-2 | 2-3 | 2-3 |

# 5.0 PRINCIPLES OF OPERATION

## 5.1 Functional Description

The Rotor-AID RC100 Series Rotor Controllers use the inverters of an intelligent power module to supply the necessary power to accelerate an x-ray tube's anode rotor rapidly to its operational speed.

High speed and low speed may be programmed for any of the frequencies listed in Tables 4.1 and 4.2 by jumper selection on the 61097B micro-controller board.

## 5.2 Basic Timing/Logic Cycle:

As shown 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 minimum power applied until the external rotor start signal is removed. During this interim run time, 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.

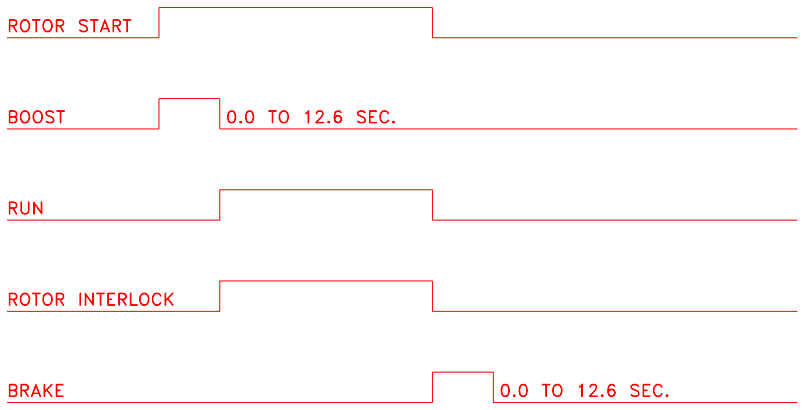
## 5.3 Applications

RADIOGRAPHIC MODE - In the radiographic mode, the basic boost-run-(continuance)- brake cycle is used with either high or low speed selected. Figure 5.1 represents the basic timing cycle. The basic timing cycle with continuance is shown in Figure 5.2. Figure 5.3 details the basic functions when switching between low speed and high speed operation.

In addition to the basic timing cycle, several special application modes are accommodated. Figures 5.4 to 5.6 illustrate a few of the many possible application variations.

Figure 5.1

BASIC TIMING LOGIC WITHOUT CONTINUANCE

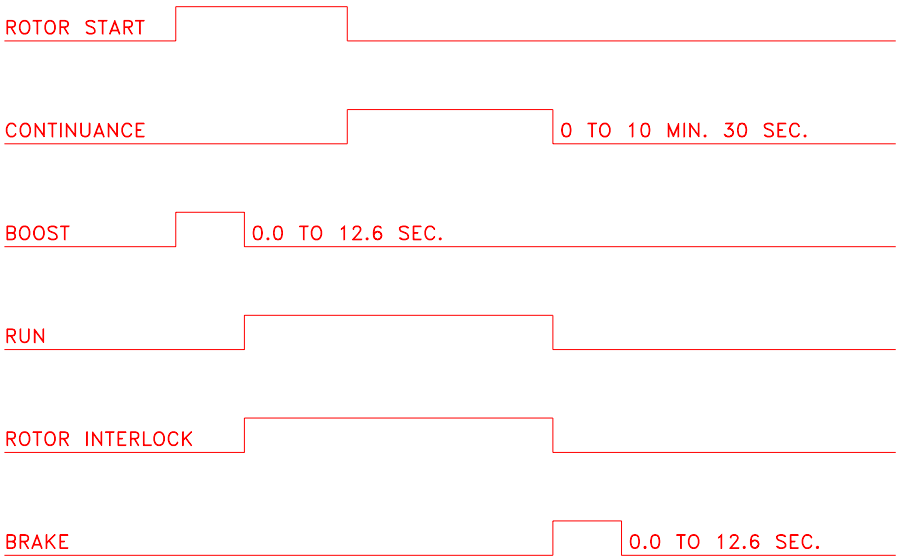



Notes:

1. Times listed indicate programming ranges accommodated by the Rotor-AID Rotor Controller.
2. Start and run times depend upon exposure duration and the operator's "rotor prep" control.

Figure 5.2

## BASIC TIMING LOGIC WITH CONTINUANCE

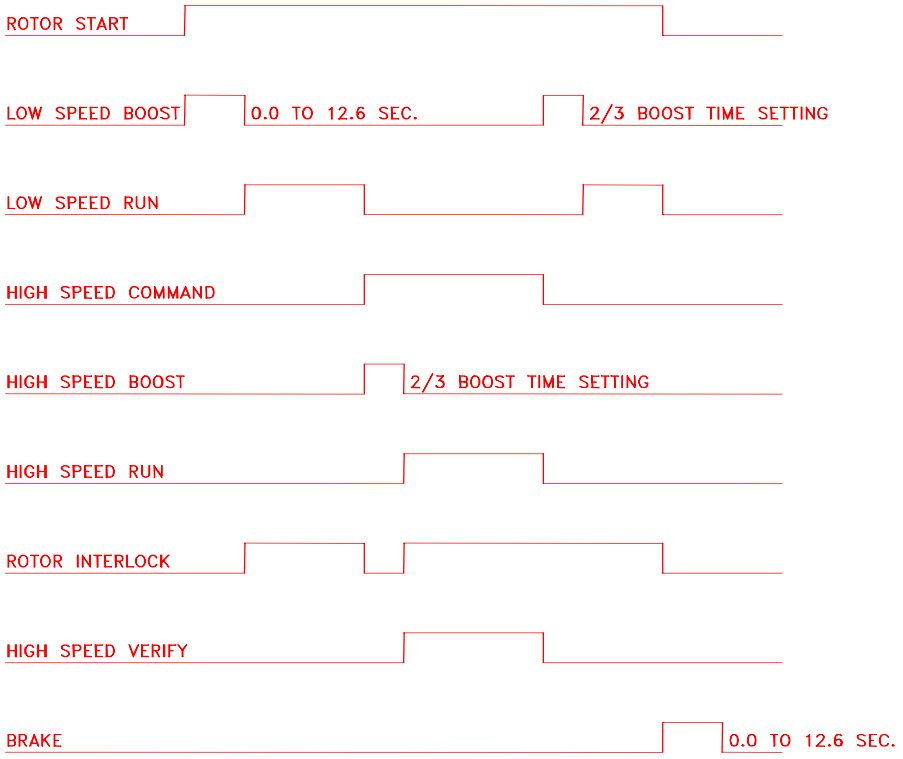



Notes:

1. Times listed indicate programming ranges accommodated by the Rotor-AID Rotor Controller.
2. Start and run times depend upon exposure duration and the operator's "rotor prep" control.
3. When a continuance time is selected, the rotor start signal may be released during boost (pulsed rotor start) and the sequence will continue through the boost-run-brake cycle. The continuance timer is triggered at the end of rotor start or boost, whichever is longer.

Figure 5.3

BASIC LOW SPEED / HIGH SPEED TIMING LOGIC



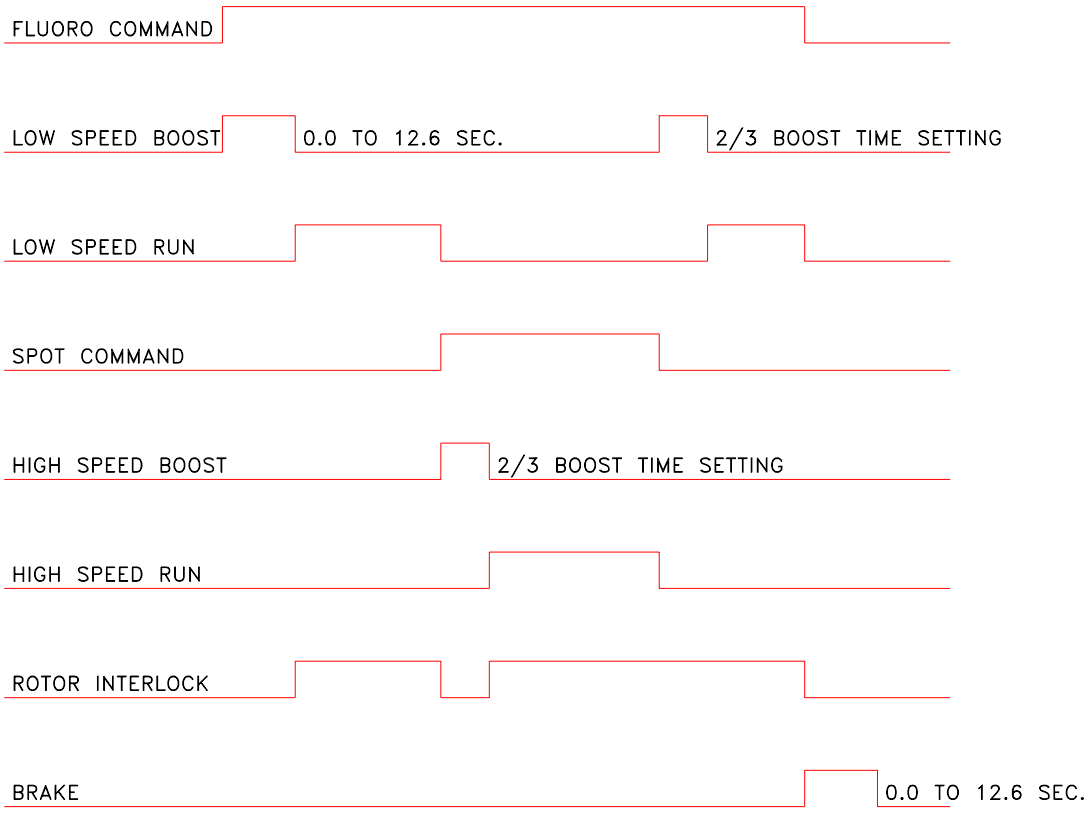

Notes:

1. Times listed indicate programming ranges accommodated by the Rotor-AID Rotor Controller.
2. Start and run times depend upon exposure duration and the operator's "rotor prep" control.
3. A low speed boost is used to decelerate the tube from high speed to low speed. The boost times from low speed to high speed and from high speed to low speed are automatically adjusted to 2/3 of the boost time setting. When jumper 61097B W7 is set in the 2-3 position (for tubes greater than 1 MHU) the boost time from high speed to low speed is automatically adjusted to 5/3 of the boost time setting.

FLUORO / SPOT FILM MODE - Radiographic and Fluoroscopic Units Only

As shown in Figure 5.4 the spot film mode is often preceded by fluoro mode operation, the anode is then taken from low speed to high speed rotation. A low speed boost is used to decelerate the anode from spot back to the fluoro mode. The boost times from low speed to high speed and from high speed to low speed are automatically adjusted to 2/3 of the boost time setting. When jumper 61097B W7 is set in the 2-3 position (for tubes greater than 1 MHU) the boost time from high speed to low speed is automatically adjusted to 5/3 of the boost time setting.

Figure 5.4



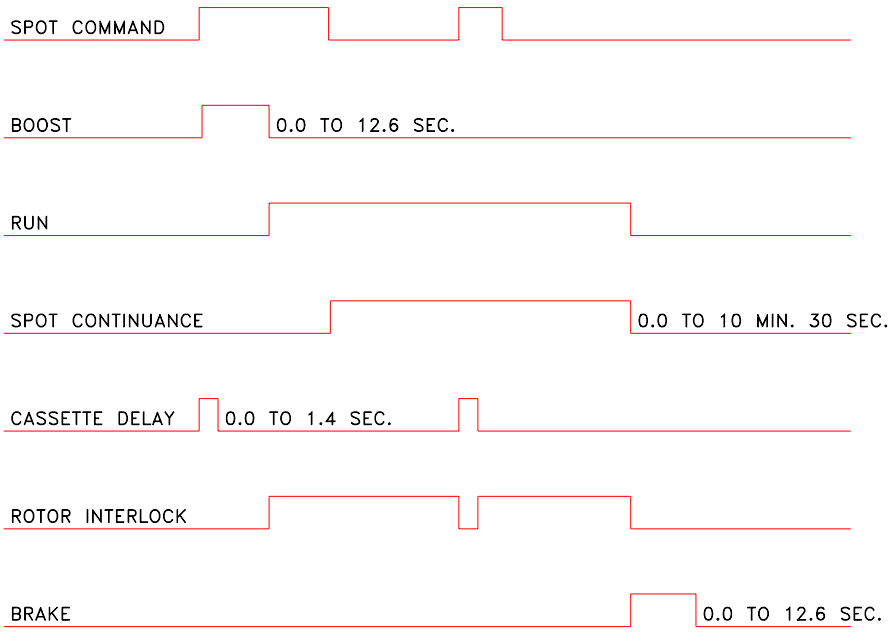

Note If the spot continuance (auxiliary) timer is set, the rotor will remain in high speed between spot film exposures avoiding the delays required to accelerate between low and high speeds. Separate continuance times may be set for fluoro, 61096A SW3, and spot, 61096A SW4. Refer to Figure 3.7, Section 4.5 and Table 4.3 for timer switch details.

SPOT FILM MODE - Radiographic and Fluoroscopic Units Only

Spot may be used to force a high speed boost directly as illustrated in Figure 5.5. The cassette delay is activated each time a spot command is given.

Figure 5.5

SPOT FILM TIMING LOGIC WITH CASSETTE DELAY




Notes:

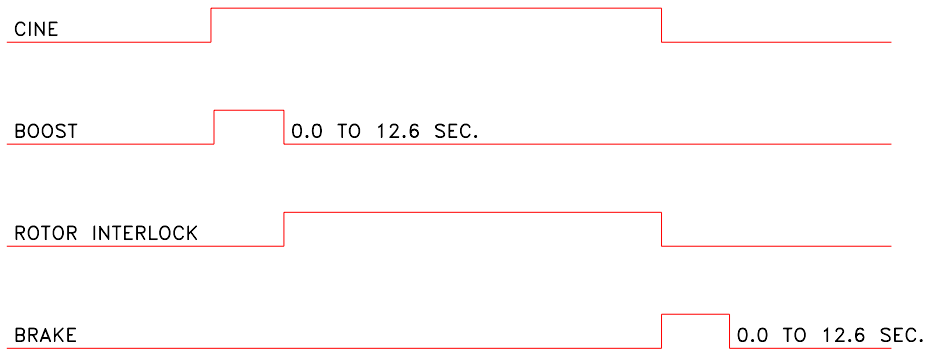
1. Times listed indicate programming ranges accommodated by the Rotor-AID Rotor Controller.
2. Start and run times depend upon exposure duration and the operator's "rotor prep" control.

CINE MODE - Radiographic and Fluoroscopic Units Only

Cine is a high speed rotor start command as illustrated in Figure 5.6. Cine may be preceded by the system being in the fluoro mode in which case the boost and brake times are automatically adjusted to 2/3 the times required from and to zero speed.

Figure 5.6

CINE TIMING LOGIC




Notes:

1. Times listed indicate programming ranges accommodated by the Rotor-AID Rotor Controller.
2. Start and run times depend upon exposure duration and the operator's "rotor prep" control.
3. When going from the spot or cine mode (high speed) back to the fluoro mode (low speed), the low speed boost is used to brake the tube to the low speed. The boost times from low speed to high speed and from high speed to low speed are automatically adjusted to 2/3 of the boost time setting. When jumper 61097B W7 is set in the 2-3 position (for tubes greater than 1 MHU) the boost time from high speed to low speed is automatically adjusted to 5/3 of the boost time setting.

# 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. Refer to the figures in Section 3.0 for component locations.

Note: The circuit breaker must be turned OFF whenever making connections to or disconnections from the rotor controller or the x-ray tube.

## 6.1 Preliminary Checks

Check all external connections to the rotor controller for proper wiring and secure connections. (See Section 3.0).

Check to see that all selectable jumpers are in place and programmed correctly (See Section 4.9).

Check to see that all plug-in PC boards are seated properly.

Check the input power voltage and make sure that the input power voltage tap of the input autotransformer is properly selected.

Check to see that the circuit breaker is switched to the ON position and that the Power On indicator on the circuit breaker 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 low voltage power supply fuse, F1, is not open.

Check the boost, continuance and brake time settings.

Note: Whenever replacing parts, boards or assemblies make note of their EXACT wiring before removing them. DO NOT install or remove PC boards when the power is on.

## 6.2 Trouble-shooting Procedures

SYMPTOM: NOTHING SEEMS TO WORK

Does the Micro-controller On OK indicator, 61097B LED2, light when power is applied to the unit?

If no then:

- Check the power supply voltages at test points 61095A TP12V (+12VDC), TP5V (+5VDC), and TPN12V (-12VDC) referenced to 61095A TP0 (0VDC).
- Replace 61097B board. Position program jumpers per Section 4.9.

Does the Power Surge Relay indicator, 61095A LED1, light shortly after power is applied to the unit?

If no then:

- Replace 61095A board. Position program jumpers per Section 4.9.

Does the Fault indicator, 61097B LED1, light?

- See trouble shooting section on faults.

SYMPTOM: NO BOOST

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

Does the Tube Active indicator, 61095A LED5, light during a rotor start signal?

If yes, then:

- Check to see that the boost time is set properly.

If no, then:

- Check to see that 61097B W13 is set in the 2-3 (3-tube) position.
- Make sure a tube is selected.
- Check the interface wiring.
- Check for the presence of the rotor start signal.
- Make sure that the 61096A shunts (jumpers) are programmed for the correct input voltages.
- Replace 61096A board. Position program jumpers per Section 4.9

If the unit faults, 61097B LED1 lights, see trouble shooting section on faults.

SYMPTOM: NO RUN

- Check to see that the continuance time is set correctly.

If the unit faults, 61097B LED1 lights, see trouble shooting section on faults.

SYMPTOM: NO BRAKE

- Check to see that the brake time is set correctly.

SYMPTOM: FAULT OCCURS DURING BOOST OR RUN

A fault condition is indicated by the Fault LED, 61097B LED1.

- Check to see that the stator or stator cord is properly connected and not shorted.
- Check to see that the proper stator type is selected 61097B W19-W24 (refer to Figure 4.1 and Table 4.4).
- The duty cycle may have been exceeded. Wait for the unit to cool.

Tube arcs may cause a fault condition. Occasional faults will automatically reset. If several faults occur within a short period of time the unit will latch-up as an indication of a persistent problem. Once the problem has been corrected, the fault condition may be manually reset by supplying a Cancel Continuance command at 61096A TB2 pins 7 & 8, by changing the tube selection or by removing power from the unit either at its source or at the unit's circuit breaker. If, after resetting the fault condition, the problem recurs:

- Replace 61091A or 61099A IPM board.
- Replace 61094A Main board.

SYMPTOM: MISSING ROTOR INTERLOCK

- Check the status of the Mains OK 61098A LED4, if it turns off during boost, the line voltage or power is inadequate.
- Check the status of the rotor interlock indicator, 61095A LED7.
- Check the rotor interlock adjustment, 61098A R18, as described in Section 4.8.
- Check the status of the stator current sense LEDs.

| LED | Function |
|---|---|
| 61098A LED1 | STATOR COMMON CURRENT |
| 61098A LED2 | STATOR PHASE CURRENT |
| 61098A LED3 | STATOR MAIN CURRENT |

- Check stator connections to the stator output board as listed in Section 3.5.

SYMPTOM: CIRCUIT BREAKER TRIPS

- Duty cycle of unit exceeded (refer to Section 2.6).
- Replace the circuit breaker (45080).
- Replace the 61094A Main Board.
- Replace the 61091A or 61099A IPM board

SYMPTOM: 61096A OR 61096B BOARD DOES NOT RESPOND TO 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. Program the voltage selector shunts (jumpers) for the input voltages that are being applied [refer to Sections 3.4a) and 4.9]. If the voltage selector shunts are set correctly and the 61096A or 61096B board still does not respond during an input command, replace the board.

# 7.0 DOCUMENTATION

## 7.1 Interface Schematics

| DRAWING | DESCRIPTION |
|---|---|
| WRC103-04 | Overall Wiring Diagram for RC103-04 |
| 61091A | 25 Amp Series 3 IPM Board |
| 61094A | Main Board |
| 61095A | Power Supply Board |
| 61096A | Input Board |
| 61096B | 3-Tube Input Board |
| 61097B | Micro Controller Board |
| 61098A | Control Board |

## 7.2 Spare Parts List

The following spare parts lists are recommended for all field service personnel.

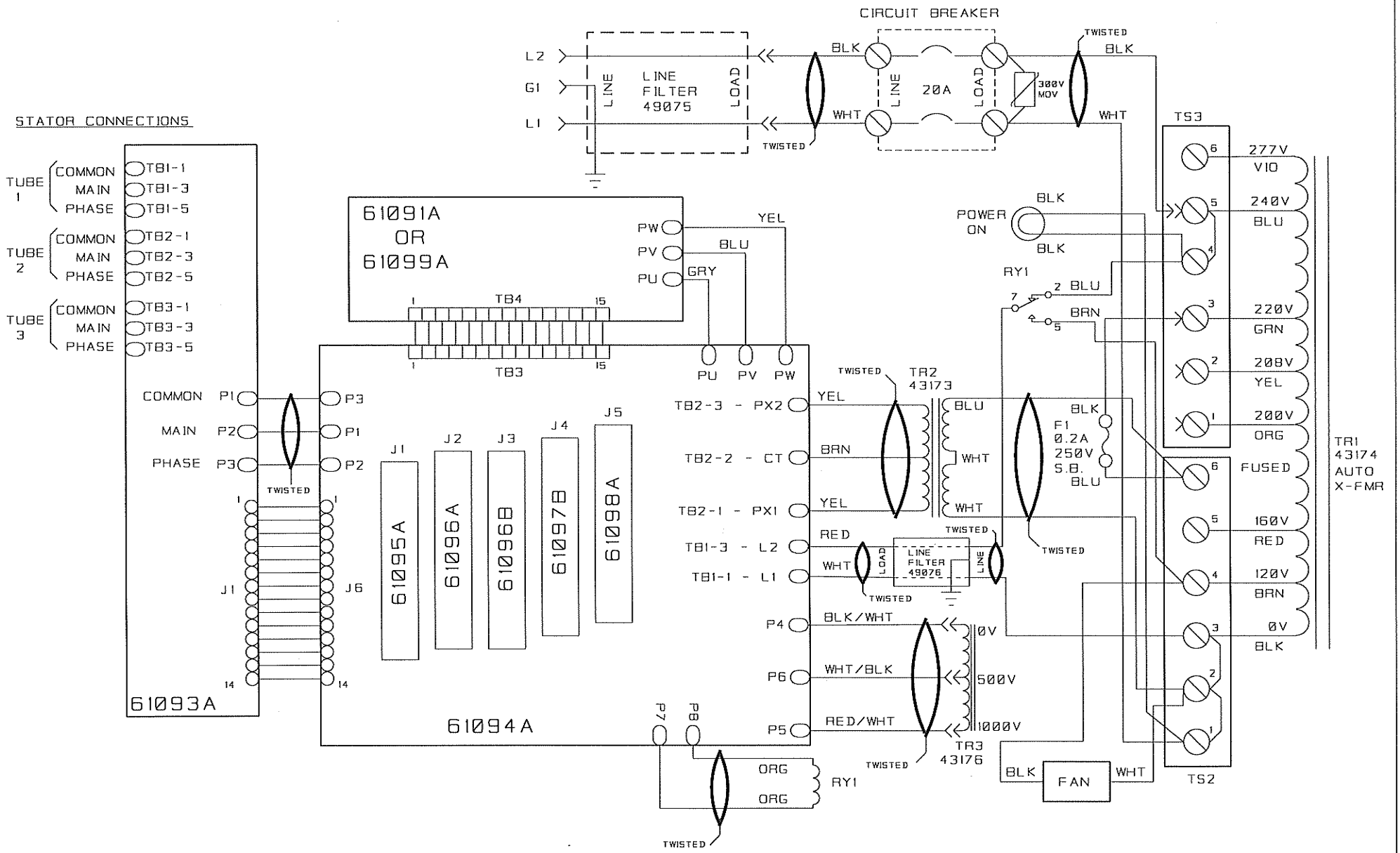
Printed Circuit Boards:

| PART NO. | DESCRIPTION |
|---|---|
| 61091A[1] | IPM Board |
| 61093A | 3-Tube Stator output board |
| 61094A | Main Board |
| 61095A | Power Supply Board |
| 61096A | Input Board |
| 61096B | 3-Tube Input Board |
| 61097B | Micro Controller Board |
| 61098A | Control Board |

Miscellaneous:

| PART NO. | DESCRIPTION |
|---|---|
| 45081 | 0.200A SB 5x20 mm fuse |
| 49009 | Fan |
| 49075 | 277V 20A line filter |
| 49076 | 240V 20A RFI filter |

[1]61099A IPM board may be substituted for 61091A.




| REV | ECN NO. | DATE | REVISIONS | BY |
|---|---|---|---|---|
| C | 1644 | 20OCT97 | FILTER 49075 WAS 49074 ADDED FILTER 49076 | JC |
| B | 1642 | 06OCT97 | PHASE SHIFT CAPACITOR REPLACED BY TR3 | JC |
| A | 1573 | 21MAY97 | VOLTAGE SWITCHING RELAY REPLACES OPTIONAL RELAY | JC |

DO NOT SCALE

UNLESS SPECIFIED OTHERWISE: DIMENSIONS ARE IN INCHES
FRACTIONS +/- 1/64 DEC. +/- 0.010 ANGLES +/- 1 DEGREE

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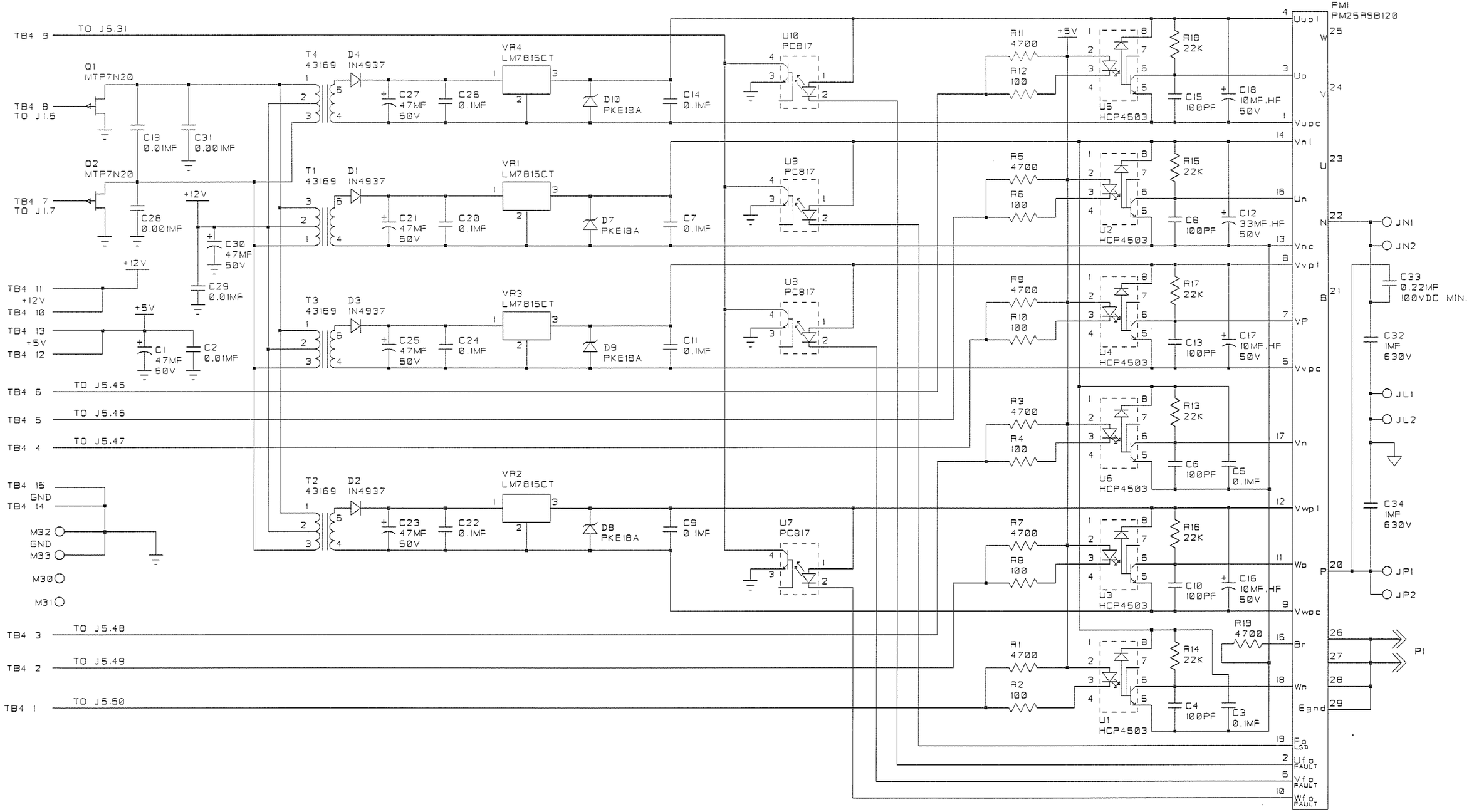
| SCALE | DRAWN BY | DATE |
|---|---|---|
| NONE | JC | 18MAR97 |
| MATERIAL | CHECKED BY | 21 oct 97 |
| FINISH | APPROVED BY | 21oct97 |

RC103-04 WIRING DIAGRAM

| USED ON | DRAWING NO. | REV |
|---|---|---|
| RC103-04 | WRC103-04 | C |




| REV | ECN NO. | DATE | REVISIONS | BY |
|---|---|---|---|---|
| 01 | 1645 | 20OCT97 | SEE COMPONENT LAYOUT | JC |

DO NOT SCALE

UNLESS SPECIFIED OTHERWISE DIMENSIONS ARE IN INCHES

FRACTIONS +/- 1/64 | DEC. +/- 0.010 | ANGLES +/- 1 DEGREE

| | | |
|---|---|---|
| SCALE NONE | DRAWN BY E.G.S. | DATE 15MAR95 |
| MATERIAL | CHECKED BY BRP | 13Nov97 |
| FINISH | APPROVED BY BRP | 13Nov97 |



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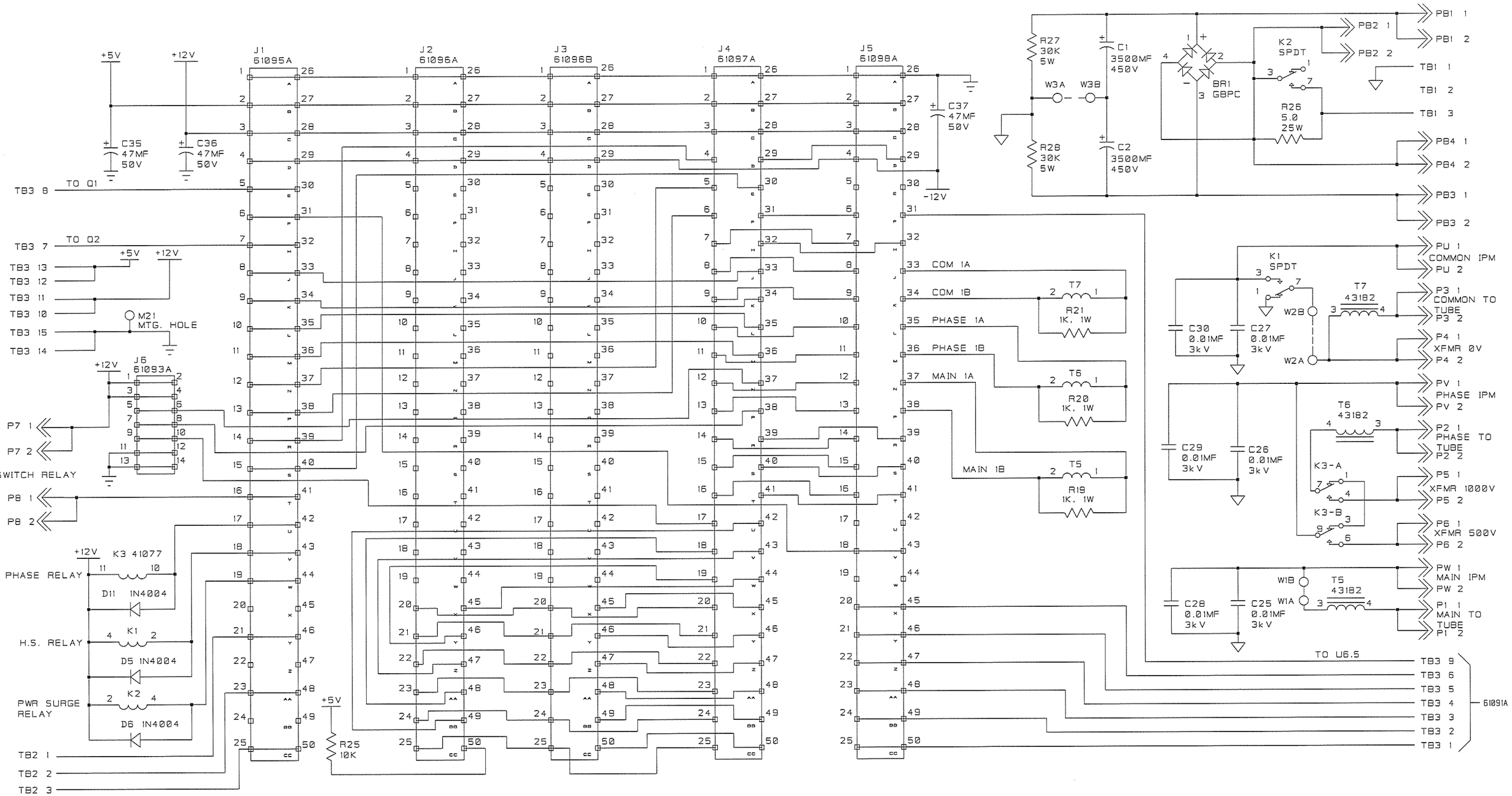
# 25 AMP SERIES 3 IPM BOARD

| USED ON | NEXT ASSY | DRAWING NO | REV |
|---|---|---|---|
| RC101/RC103 | | 61091A | 01 |




| REV | ECN NO. | DATE | REVISIONS | BY |
|---|---|---|---|---|
| 07 | 2474 | 08NOV04 | NEW BOARD ARTWORK 61094-04 CD 08NOV04<br>ADDED JUMPER W3 | CJL |
| 06 | 2221 | 26OCT04 | CORRECTED T5, T6, & T7 PINOUTS<br>ALSO SEE COMPONENT LAYOUT | SO |
| 05 | 1645 | 20OCT97 | SEE COMPONENT LAYOUT | JC |
| 04 | 1573 | 21MAY97 | 1K RESISTORS WERE 0.5W | JC |
| 03 | 1573 | 21MAY97 | ADDED P7 & P8 TO "B" SIDE | JC |
| 02 | 1578 | 23JUN97 | W1 & W2 CHANGED FROM 14 AWG 1kV WIRE TO 18 AWG WIRE WITH TEFLON TUBING. | JC |
| 01 | 1487 | 03JUN96 | C25,C27,C28,C30 WERE 0.01MF 1kV CAPS | JC |

DO NOT SCALE

UNLESS SPECIFIED OTHERWISE:
DIMENSIONS ARE IN INCHES
FRACTIONS +/- 1/64 DEC. +/- 0.010 ANGLES +/- 1 DEGREE

SCALE NONE | DRAWN BY E.G.S. | DATE 24JAN95
MATERIAL | CHECKED BY SO | 11JUL07
FINISH | APPROVED BY TMJ | 11JUL07



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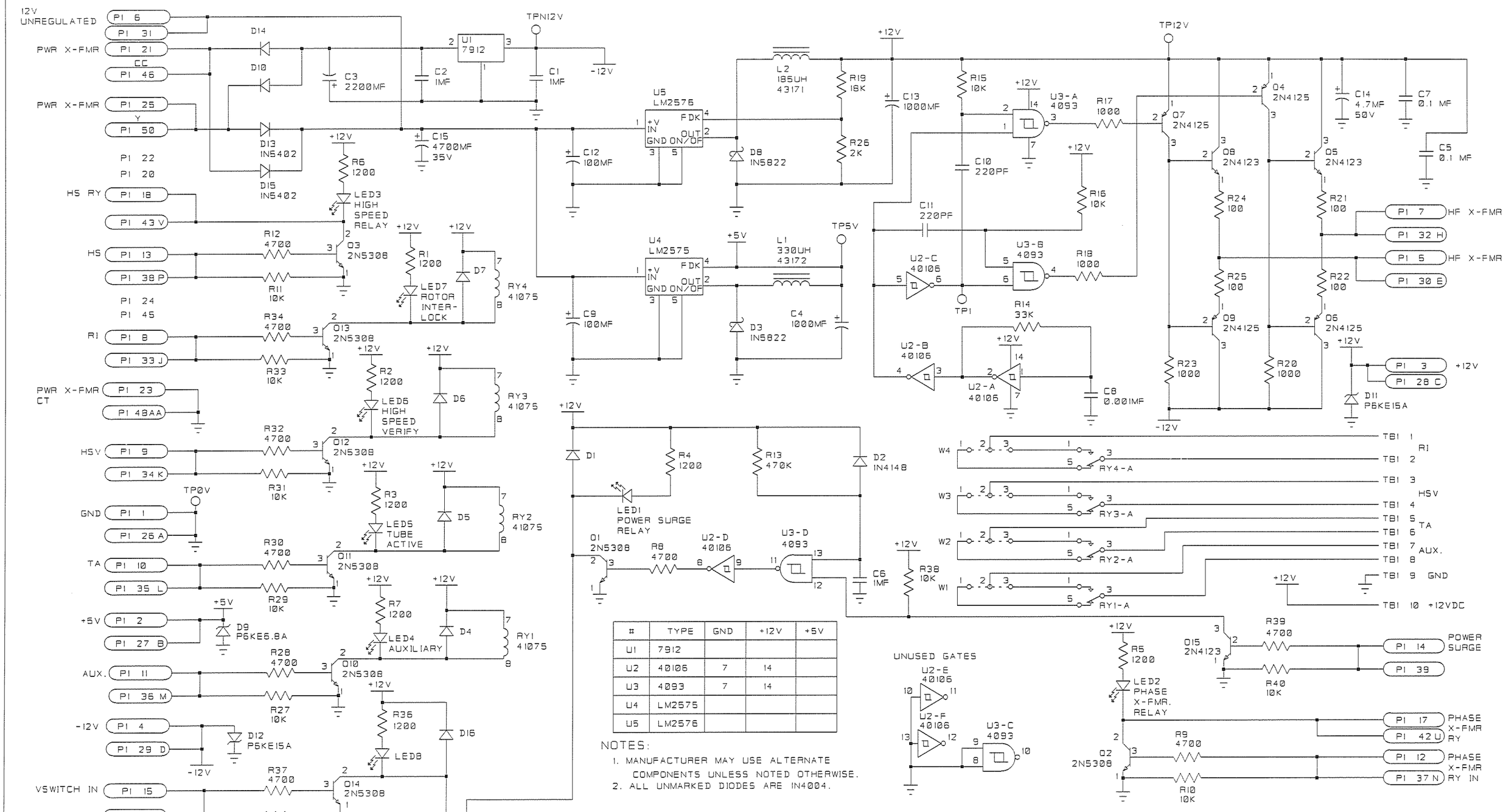
MAIN BOARD

| USED ON | NEXT ASSY. | DRAWING NO. | REV |
|---|---|---|---|
| RC101/RC103 | | 61094A | 07 |




| # | TYPE | GND | +12V | +5V |
|---|---|---|---|---|
| U1 | 7912 | | | |
| U2 | 40106 | 7 | 14 | |
| U3 | 4093 | 7 | 14 | |
| U4 | LM2575 | | | |
| U5 | LM2576 | | | |

NOTES:

1. MANUFACTURER MAY USE ALTERNATE COMPONENTS UNLESS NOTED OTHERWISE.
2. ALL UNMARKED DIODES ARE IN4004.

UNUSED GATES: U2-E 40106 (10, 11); U2-F 40106 (13, 12); U3-C 4093 (9, 8, 10)

| REV | ECN NO | DATE | REVISIONS | BY |
|---|---|---|---|---|
| 02 | 1573 | 21MAY97 | ADDITIONAL POWER DRIVER FOR VOLTAGE SWITCHING RELAY | JC |
| 01 | 1578 | 03JUN97 | U2 MUST USE P/N 32072 (4010B OR 74C(H) NSC ONLY. | JC |

DO NOT SCALE

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FRACTIONS +/- 1/64 | DEC. +/- 0.010 | ANGLES +/- 1 DEGREE

| | | |
|---|---|---|
| SCALE NONE | DRAWN BY E.G.S. | DATE 11OCT94 |
| MATERIAL | CHECKED BY BRP | 18Jul97 |
| FINISH | APPROVED BY BRP | 18Jul97 |

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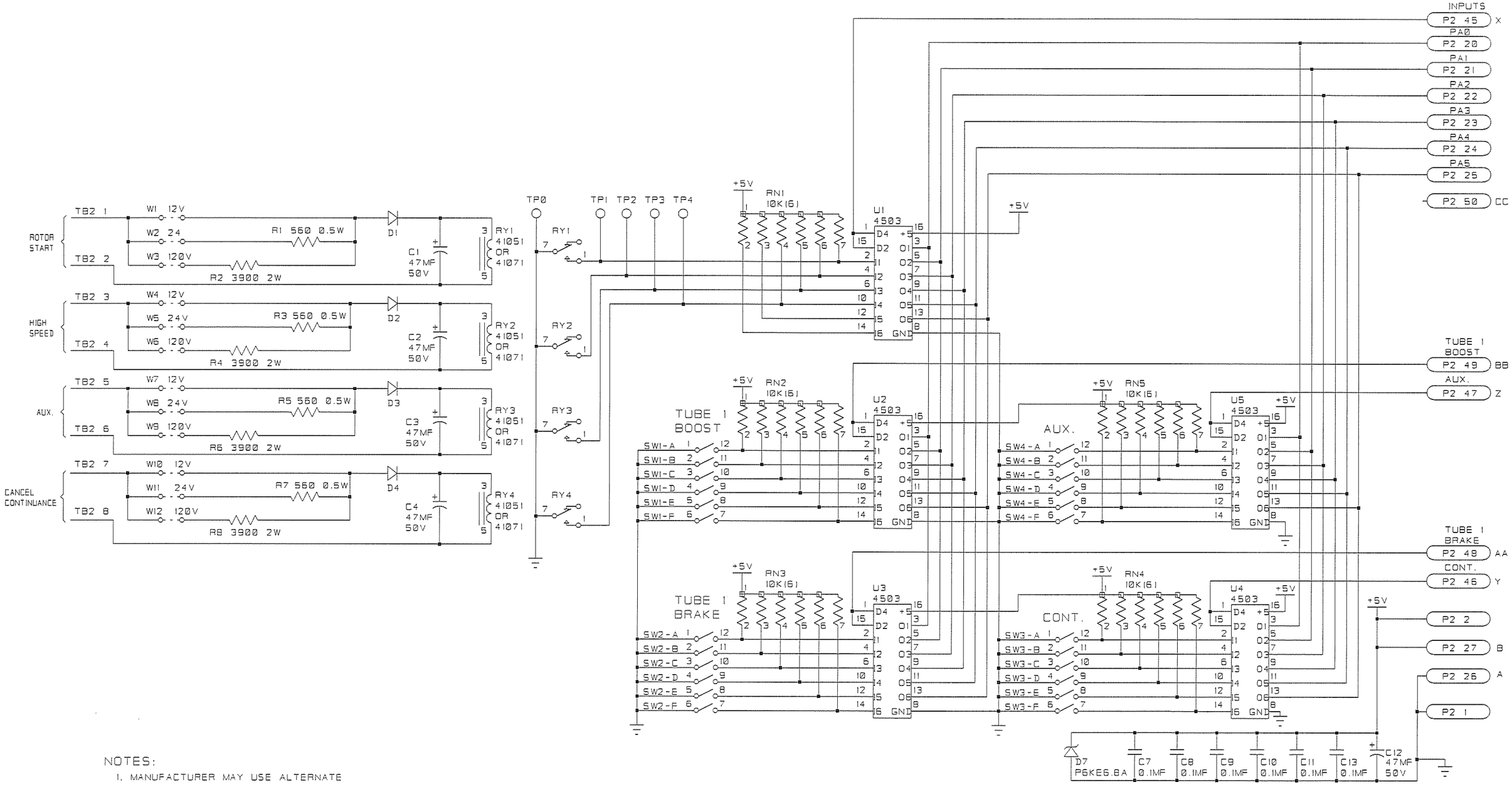
POWER SUPPLY BD

| USED ON | NEXT ASSY. | DRAWING NO. | REV |
|---|---|---|---|
| RC101/RC103 | | 61095A | 02 |




NOTES:

1. MANUFACTURER MAY USE ALTERNATE COMPONENTS UNLESS NOTED OTHERWISE.
2. ALL UNMARKED DIODES ARE IN4004

| REV | ECN NO | DATE | REVISIONS | BY |
|---|---|---|---|---|
| NOTE | 1524 | 29AUG96 | CHANGE COAST COMMAND TO CANCEL CONT. | JC |
| 01 | 1519 | 26AUG96 | R1,R3,R5,R7 WERE 1K, 1/2W, R2,R4,R6,R8 WERE 4700, 2W | JC |

DO NOT SCALE

UNLESS SPECIFIED OTHERWISE: DIMENSIONS ARE IN INCHES

FRACTIONS +/- 1/64 | DEC. +/- 0.010 | ANGLES +/- 1 DEGREE

| | | |
|---|---|---|
| SCALE NONE | DRAWN BY E.G.S. | DATE 11JUN93 |
| MATERIAL | CHECKED BY BRP | 7oct96 |
| FINISH | APPROVED BY BRP | 7oct96 |

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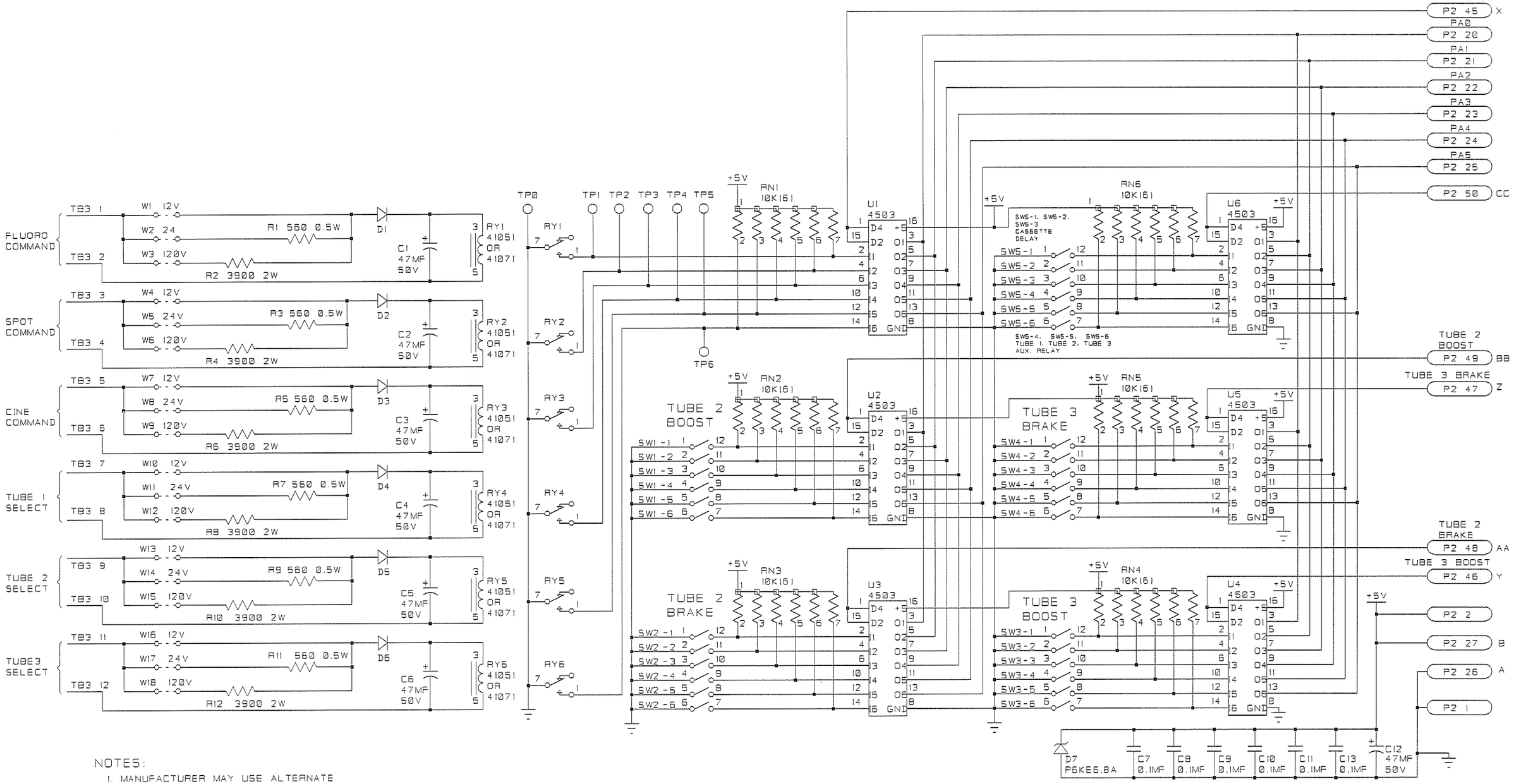
# INPUT BOARD

| USED ON | NEXT ASSY. | DRAWING NO. | REV |
|---|---|---|---|
| RC101/RC103 | | 61096A | 01 |




NOTES:

1. MANUFACTURER MAY USE ALTERNATE COMPONENTS UNLESS NOTED OTHERWISE.
2. ALL UNMARKED DIODES ARE IN4004.

| REV | ECN NO | DATE | REVISIONS | BY |
|---|---|---|---|---|
| 01 | 1519 | 26AUG96 | R1,R3,R5,R7,R9,R11 WERE 1K, 1/2W. R2,R4,R6,R8,R10,R12 WERE 4700, 2W | JC |

DO NOT SCALE

UNLESS SPECIFIED OTHERWISE: DIMENSIONS ARE IN INCHES

FRACTIONS +/- 1/64 | DEC. +/- 0.010 | ANGLES +/- 1 DEGREE

| | | |
|---|---|---|
| SCALE NONE | DRAWN BY E.G.S. | DATE 11JUN93 |
| MATERIAL | CHECKED BY | 7oct96 |
| FINISH | APPROVED BY | 7oct96 |



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# 3-TUBE INPUT BD.

| USED ON | NEXT ASSY. | DRAWING NO. | REV |
|---|---|---|---|
| RC103 | | 610968 | 01 |

NOTES:
1. * MANUFACTURER MAY USE ALTERNATE COMPONENTS UNLESS NOTED OTHERWISE.
2. ALL UNMARKED DIODES ARE 1N4148.

| # | TYPE | GND | +5 | # | TYPE | GND | +5 |
|---|---|---|---|---|---|---|---|
| 1 | 4503 | 7 | 14 | 14 | 80C51 | 20 | 40 |
| 2 | 4503 | 7 | 14 | 15 | 74HC373 | 10 | 20 |
| 3 | 4503 | 7 | 14 | 16 | 27C256 | 14 | 28 |
| 4 | 4503 | 7 | 14 | 17 | 74HC14 | 7 | 14 |
| 5 | 4503 | 7 | 14 | 18 | 4093 | 7 | 14 |
| 6 | 4503 | 7 | 14 | 19 | 4093 | 7 | 14 |
| 7 | 4503 | 7 | 14 | 20 | 74HC14 | 7 | 14 |
| 8 | DS1232 | 4 | 8 | 21 | 74HC14 | 7 | 14 |
| 9 | 74HC14 | 7 | 14 | 22 | 4503 | 7 | 14 |
| 10 | 4017 | 8 | 16 | 23 | 74HC138 | 8 | 16 |
| 11 | 74HC373 | 10 | 20 | 24 | 74HC138 | 8 | 16 |
| 12 | 74HC373 | 10 | 20 | 25 | 74HC138 | 8 | 16 |
| 13 | 74HC373 | 10 | 20 | | | | |

UNUSED GATES

DO NOT SCALE

UNLESS SPECIFIED OTHERWISE: DIMENSIONS ARE IN INCHES
FRACTIONS +/- 1/64 DEC. +/- 0.010 ANGLES +/- 1 DEGREE

| REV | ECN NO. | DATE | REVISIONS | BY |
|---|---|---|---|---|

SCALE NONE | DRAWN BY JC | DATE 17JUL97
MATERIAL | CHECKED BY BRP 18Jul97
FINISH | APPROVED BY BRP 18Jul97

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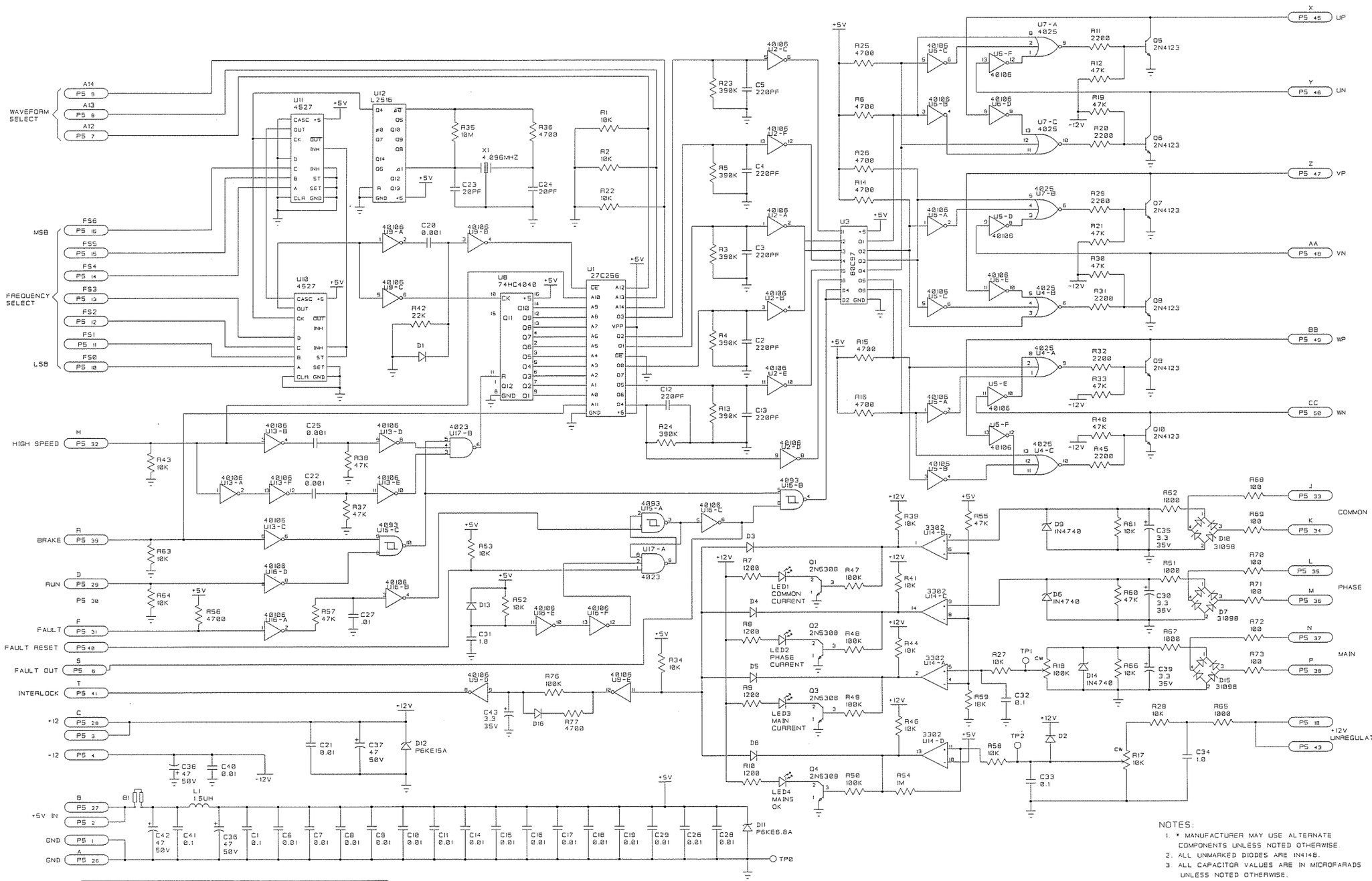
X-RAY

MICRO CONTROLLER

| USED ON | NEXT ASSY. | DRAWING NO. | REV |
|---|---|---|---|
| RC101/RC103 | | 61097B | 00 |




| # | TYPE | GND | +12 | +5 | # | TYPE | GND | +12 | +5 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 27C256 | 14 | | 28 | 10 | 4527 | 8 | | 16 |
| 2 | 40106 | 7 | | 14 | 11 | 4527 | 8 | | 16 |
| 3 | 4503 | 8 | | 16 | 12 | 74HC4060 | 8 | | 16 |
| 4 | 4025 | 7 | | 14 | 13 | 40106 | 7 | | 14 |
| 5 | 40106 | 7 | | 14 | 14 | 3302 | 12 | 3 | 10 |
| 6 | 40106 | 7 | | 14 | 15 | 4093 | 7 | | 14 |
| 7 | 4025 | 7 | | 14 | 16 | 40106 | 7 | | 14 |
| 8 | 74HC4040 | 8 | | 16 | 17 | 4023 | 7 | | 14 |
| 9 | 40106 | 7 | | 14 | | | | | |

NOTES:
1. * MANUFACTURER MAY USE ALTERNATE COMPONENTS UNLESS NOTED OTHERWISE.
2. ALL UNMARKED DIODES ARE IN4148.
3. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS NOTED OTHERWISE.

| BY | DATE | ECN NO. | REVISIONS |
|---|---|---|---|
| TRW | 11OCT00 | | U17 WAS 74C10. R74, R75 REMOVED |
| JC | 21MAY97 | | R60 WAS 220K. R66 WAS OMITTED |
| JC | 21MAY97 | | C43 WAS IMP. R68 WAS 47K. R66 WAS 10K |
| JC | 55EP96 | | ADDED D16 & R77 TO ARTWORK |
| JC | 18MAR96 | | SEE COMPONENT LAYOUT |
| JC | 05JUN96 | | C43 WAS 0.1MF. ADDED R65 & DIODE AT R70 |
| JC | 14FEB96 | | R60 WAS 10K |
| BY | DATE | ECN NO. | REVISIONS |

DO NOT SCALE

UNLESS SPECIFIED OTHERWISE: DIMENSIONS ARE IN INCHES. FRACTIONS +/- 1/64. DEC +/- 0.010. ANGLES +/- 1 DEGREE.

| | | | |
|---|---|---|---|
| SCALE | NONE | DRAWN BY | E.G.S. |
| MATERIAL | | CHECKED BY | BRP 17Feb04 |
| FINISH | | APPROVED BY | BRP 17Feb04 |

DATE 21OCT94



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CONTROL BOARD

| USED ON | NEXT ASSY. | DRAWING NO. | REV |
|---|---|---|---|
| RC100/RC103 | | 51098A | 07 |