

OPERATORS MANUAL
AND
INSTALLATION AND SERVICE MANUAL

8000-3488

UNIVERSAL

UNI-MATIC 325D GENERATOR

MODEL NO. 3488/3550

DEL MEDICAL IMAGING CORPORATION

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THIS DOCUMENT CONTAINS
INSTALLATION, ADJUSTMENT AND
MAINTENANCE INFORMATION

- DO NOT DISCARD -

DHHS COMPLIANCE

The 3488 Radiographic X-ray Generator and its associated accessories are certified components conforming to all applicable radiation performance standards as outlined by the Food and Drug Administration, Code of Federal Regulation, Title 21, Subchapter J, at the Time of Manufacture.

EQUIPMENT COMPATIBILITY The Generator is a certifiable, UL listed component for use in a diagnostic x-ray system. It is designed for use with a tubestand and table which is not in itself a listed component.

TUBE LISTING

Varian/EIMAC Tubes

Varian Rad 8

Varian Rad 74

Toshiba Tubes

UX51H/39 UX53H/42

UX52H/39

UX51H/42

UX52H/42

COMPATIBILITY LISTING

Tables

EV100	5480	5062 P
FTT	5472	5062
FTT / ITS	5470	6062
5482	5070	6062 P
		7062

Tubestands

3306B
3307B
3308B
3309B

Wallstands

VS-200
3546E/7E
3546/7

Manufactured by a Company which is:



MEDICAL EQUIPMENT CLASSIFIED BY UNDERWRITERS LABORATORIES INC. WITH RESPECT TO ELECTRIC SHOCK, FIRE, AND MECHANICAL HAZARDS ONLY.

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INTRODUCTION

The 3488 generator system covered in this manual will perform reliably when operated, maintained and repaired in accordance with the instructions of this manual. It should be checked periodically and repaired as necessary to insure reliable operation.

Universal Imaging cannot assume responsibility for any malfunction of this equipment resulting from improper operation, maintenance or repair, or if any of its components are damaged or modified.

Anyone using this x-ray machine must know and understand the dangers of excessive radiation exposure. This equipment is sold with the understanding that since its proper use and application is in the hands of the operator and beyond the control of the manufacturer or his agents, that Universal Imaging disclaims all responsibility for any injury resulting from improper use and application of this equipment.

We at Universal Imaging are proud of our product and know your x-ray unit will provide many years of useful and enjoyable service. Thank-you for selecting our equipment.

A. CONTROL FEATURES

DISPLAYS- Indicates selected power values and time. In the event of a system problem, the mAs window will display error codes. Refer to the "Error Codes" section of this manual for details. SEE FIGURE 1-2 (A)

MAJOR kVp SELECTOR - Adjusts kVp in approximately 10 kVp increments. Turning the selector clockwise will increase kVp. SEE FIGURE 1-2 (B)

MINOR kVp SELECTOR - Adjusts kVp in approximately 1 to 2 kVp increments. Turning the selector clockwise will increase kV. SEE FIGURE 1-2 (C)

MILLIAMPERE SELECTOR - Provides selection of the tube current (mA) and focal spot size. SEE FIGURE 1-2 (D)

RADIOGRAPHIC SECONDS TIME SELECTOR - Provides 23 step time selection from .008 to 6 seconds(60 Hertz) or .010 to 7.2 seconds(50 Hertz). Turning the knob clockwise increases the exposure time. SEE FIGURE 1-2 (E)

PREP BUTTON -initiates rotation of the anode and boosts the tube filament current from the standby level to the exposure level. SEE FIGURE 1-2 (F)

EXPOSURE SWITCH -When depressed, initiates the exposure sequence. If depressed without pressing the prep switch it will initiate the prep cycle as shown above, then, at the end of prep it will start the exposure cycle. SEE FIGURE 1-2 (G)

BUCKY SWITCH - Allows selection of either the wall bucky, table bucky, or no bucky. SEE FIGURE 1-2 (H)

kVp DISPLAY – Provides a pre-exposure reading of the actual kVp which will occur during the subsequent exposure. This reading is compensated for each mA selection. For this reason it is important to set the mA selector (D) first. SEE FIGURE 1-2 (A)

mAs DISPLAY- Provides a pre-exposure reading of the actual mAs which will occur during the subsequent exposure.

TIME DISPLAY- Provides a pre-exposure reading of the actual duration of time which will occur with the subsequent exposure.

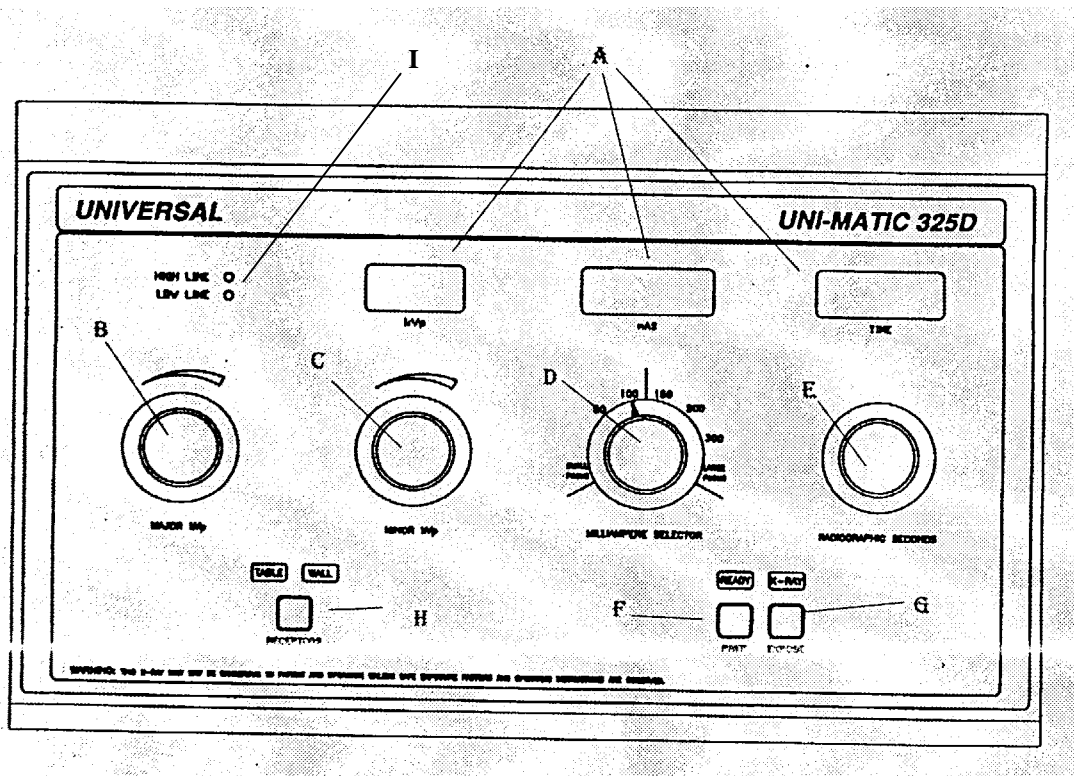
LINE VOLTAGE COMPENSATOR - provides adjustment for voltage variations in the power line. Rotate the selector until the high and low line indicators are out. SEE FIGURE 1-3 (K)

HIGH LINE AND LOW LINE- Indicates power line voltage. Either lamp illuminated will indicate the need to adjust the "Line Voltage Compensator, "K" until the effected condition is eliminated. Do not attempt to make X-ray exposures if either a "High Line" or a "Low Line" condition exists. If the line voltage compensator cannot bring the generator into the proper operating range, discontinue use of the system and notify the authorized service organization in your area.

ON/OFF CIRCUIT BREAKER - Controls power to system, and provides additional over current protection. SEE FIGURE 1-3 (L)

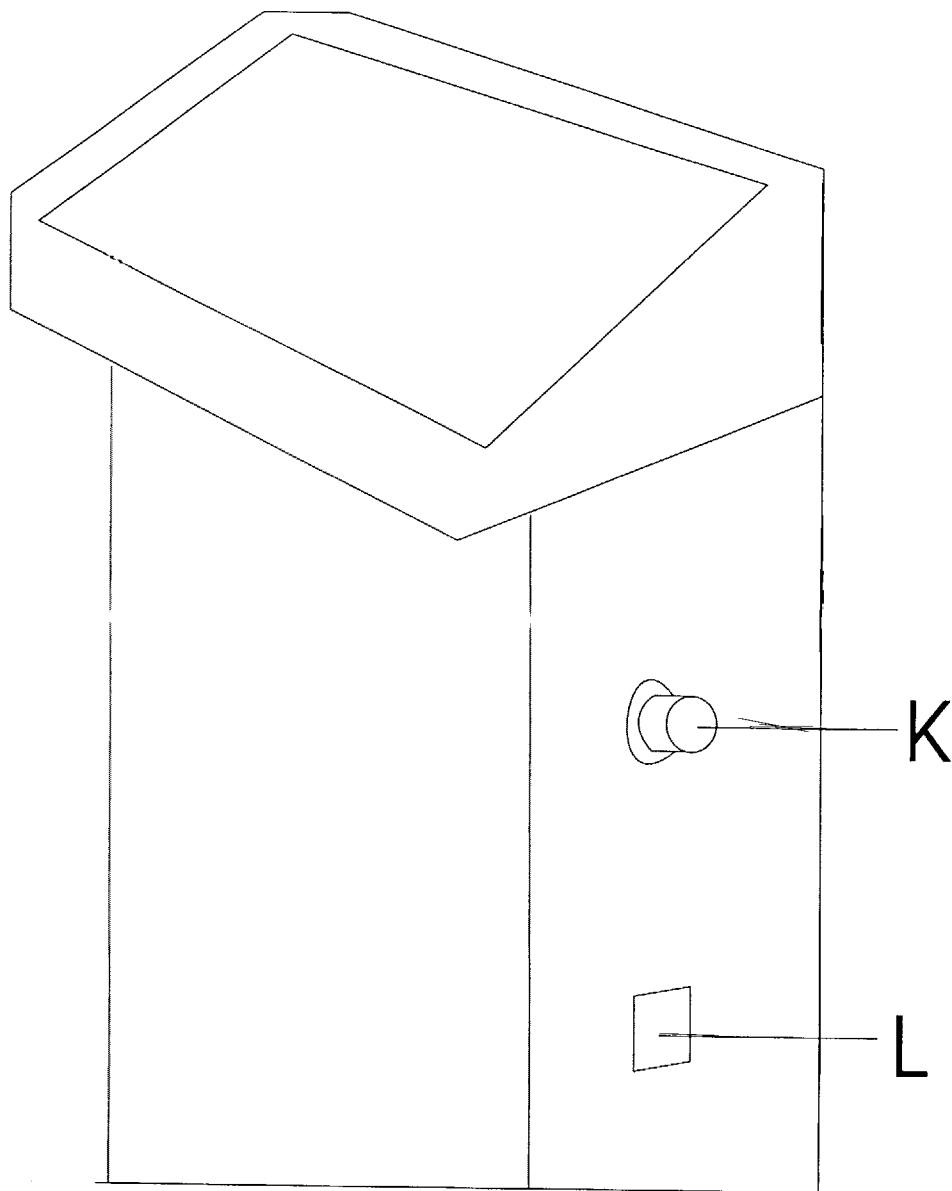


**DO NOT OPERATE ANY
SELECTOR SWITCHES DURING
EXPOSURE**



UNI-MATIC 325D CONTROL

Figure 1-2



UNI-MATIC CONTROL

Figure 1-3

B. HOW TO MAKE AN X-RAY EXPOSURE

NOTE

It is advisable to turn the system on prior to processing the patient for the x-ray examination. This will allow sufficient warm-up time to allow the circuitry to stabilize.

1. Turn the system ON and check the line voltage by looking at the two line led indicators on the front panel (I) Adjust the line voltage compensator selector (K) until both leds are out.
2. In order to prevent tube damage due to thermal shock, preheat the tube anode by perform the following procedure if the system has not been energized for eight hours or if the unit has been off for longer than two hours and the technique to be used requires high mA, high kVp and long times. Verify that the preheat technique factors are below the maximum limits of the load curve of the x-ray tube on this system.

Make first three exposures waiting approximately 30 seconds between exposures at:

75 kVp 200 mA 1 second(60 Hertz) or 0.9 seconds(50 Hertz) wait 60 seconds, then take 1 exposure at:

85 kVp 200mA 1/2 second(60 Hertz) or 0.48 seconds(50 Hertz) wait 60 seconds, then take the last exposure at:

100 kVp 200 mA 1/4 second(60 Hertz) or 0.24 seconds(50 Hertz)

3. Select the mA desired (D), which must always be selected prior to kVp.



Do not exceed the x-ray tube rating in selection of technique factors. Refer to the x-ray tube rating chart that is supplied with the tube.

4. Select the kVp desired by observing the kVp meter and adjusting the Major and Minor kVp selectors.
5. Select the exposure time desired (E)
6. Depress the prep button (F) to boost the tube filament current and initiate tube anode rotation. These actions require approximately 1 second.
7. Depress the exposure button (G) and hold. A audible alarm and X-Ray lamp indicator will signify the actual length of the exposure.

NOTE

It is permissible to depress the exposure button only, A one second time delay is built into the circuit.

C. TECHNICAL INFORMATION**Usable Range of Operation:**

mA 50S, 100S, 150L, 200L, 300L kVp 40 - 125
in two kVp steps

Maximum Unit Rating:

300 mA @ 125 kVp

Rated Line Voltage:

240 VAC 60 Hz

240 VAC 50 Hz

Maximum Line Current at Rated Line Voltage:

140 Amps(60 Hertz) or

168 Amps(50 Hertz)

Technique Factors Resulting in Maximum Line Current:

300 mA @ 125 kVp

Maximum Line Regulation:

$\frac{VN - VL}{VL} \times 100 = 5\%$

VL

(@ 300 mA and 125 kVp)

VN - "No Load" Line voltage

VL - Line Voltage under full load

Duty Cycle

100 mA @ 125 kVp 4%

200 mA @ 125 kVp 2%

300 mA @ 125 kVp 1%

MAXIMUM DEVIATION

The maximum deviation given here for individual control settings are broad and do not reflect on the ability of the x-ray unit to conform with the Reproducibility

and Linearity requirements of the Bureau of Radiological Health.

KILOVOLTS

+/- 10% of the full scale value within a range of 40-125 kVp. The basis upon which the maximum deviation of kVp as stated is a calibrated high voltage bleeder unit such as the Machlett Dynalyzer.

MILLIAMPERE

+/- 20% of selected mA within a kVp range of 50-125 kVp. +/- 20% of selected mA within a kVp range of 40-49.9 kVp. The measurement basis upon which the maximum deviations of mA are stated is a D.C. mA meter calibrated against a laboratory standard meter, in series with the x-ray tube.

TIMER

+/- 1 Pulse for time settings of 0.008 - 0.10 second range(60 Hertz) or 0.010(50 Hertz)

+/- 15% Pulse for time settings of 0.15 - 6 seconds(60 Hertz) or 0.12 - 7.2 seconds (50 Hertz)

The measurement basis upon which the maximum deviations of exposure time is stated are half cycle impulses of a 60 or 50 Hertz power line measured at the primary winding input to the high voltage transformer or in the secondary circuit by means of a high voltage bleeder unit and an oscilloscope.

mAs DISPLAY

The maximum deviation of mAs from the pre-indicated value shall not exceed +/-35%

D. PREVENTIVE MAINTENANCE

In order to assure continued safe performance of the equipment and compliance with applicable Federal and State regulations, the following Preventative Maintenance Program must be adhered to:

1. SERVICE PERSONNEL

Effective preventative maintenance requires the use of specifically trained and experienced medical x-ray apparatus service personnel. It is the user's responsibility to select personnel who are so qualified, or to consult with the factory in the event recommendations are required.

2. FREQUENCY

Inspection and required service should be performed within 30 days after installation and every 6 months thereafter.

C. REQUIRED MAINTENANCE**1. CALIBRATION**

Verify the accuracy of kVp, mA, time and calibrate as necessary according to the instructions in Section II.

2. CONTACTORS AND RELAYS

Inspect electromechanical contactors and relays for pitting, poor contact, loose or missing parts. Replace if necessary.

3. HIGH VOLTAGE TRANSFORMER

- a. Check transformer oil level. Proper oil level should be within 1/2" to 3/4" below the bottom side of the cover. To replenish transformer oil, fill with Diala-Ax oil only.
- b. Check for clean, tight connections for the primary cables. Clean and tighten as necessary.

4. HIGH VOLTAGE CABLES

Inspect high voltage cable bushings at the transformer and rotating anode tube for signs of carbonization, tracking or moisture.

5. AUDIBLE & VISUAL EXPOSURE INDICATORS

Confirm that the audible indicator which indicates of an x-ray exposure and the visual indicator which indicates the production of x-rays, are functioning correctly.

6. INSPECT AND TEST DIALS AND KNOBS

Inspect all knobs on the control to be sure that the pointer is indicating to the proper value, and is secure to the shaft.

PERIODIC MAINTENANCE RECORD**Model:** _____**Serial Number:** _____**Date of Original Installation:** _____**IMPORTANT:** This document should remain with the equipment at all times.

Record satisfactory accomplishment of required maintenance activity below. (See Maintenance Schedule for Radiation Safety of X-ray Apparatus).

Date Performed	Check if Tube Replacement Only	Qualified Organization Performing Service: Name and Address	Signature of Tester

ERROR CODES

ERROR CODE	CAUSE
E01	Tube limit
E02	kVp out of range
E03	kVp out of range
E04	mA not selected
E05	Open time cable or switch
E06	Shorted SCR

Error Code**Probable Cause****E01**

Control settings not in range for this tube.
Check settings on generator.

E02 or E03

kVp is either too low or too high for selection.
Adjust major and minor kVp switches.

E04

mA selection is an open circuit.
Control is sensing mA switch not selected.
Check mA switch.

E05

Time select open circuit. Check time switch.

E06

Sensed shorted SCR. Backup timer ended exposure.
Call service.

MODEL _____

TABLE A

With the mA selector in the 100mA position.

Switch Position	Pulses	mAs (60 Hertz)	Time (60 Hertz)	mAs (50 Hertz)	Time (50 Hertz)
1	1	.8	.008	1.0	.010
2	2	1.6	.016	2.0	.020
3	3	2.5	.025	3.0	.030
4	4	3.3	.033	4.0	.040
5	5	4.1	.041	5.0	.050
6	6	5.0	.05	6.0	.060
7	8	6.6	.066	8.0	.080
8	10	8.3	.083	10.0	.100
9	12	10	.100	12	.120
10	18	15	.150	18	.180
11	24	20	.200	24	.240
12	30	25	.250	30	.300
13	36	30	.300	36	.360
14	48	40	.400	48	.480
15	60	50	.500	60	.600
16	90	75	.750	90	.900
17	120	100	1.0	120	1.20
18	150	125	1.25	150	1.50
19	180	150	1.50	180	1.80
20	240	200	2.0	240	2.40
21	300	250	2.5	350	3.00
22	360	300	3.0	360	3.60
23	720	600	6.0	720	7.20

TABLE – B

TUBE LIMIT									
	MAXIMUM ALLOWABLE EXPOSURE TIME IN MAS								
	MA SELECTED								
KVP	25S	50S	100S	100L	150L	200S	200L	300L	500L
50	N/A	300	600	N/A	450	N/A	600	600	N/A
60		300	600		450		600	600	
70		300	600		450		600	600	
80		300	600		450		600	450	
90		300	300		450		600	25	
100		300	200		450		500	150	
110		300	200		450		300	90	
120		300	150		300		300	60	
125	N/A	300	150	N/A	300	N/A	200	45	N/A

TUBE RAD 8**FOCAL SPOT SMALL 1.0****FOCAL SPOT LARGE 2.0**

A. INSTALLATION INSTRUCTIONS

1. ELECTRICAL REQUIREMENTS

Values given in the table below are taken from NEMA Standards for Minimum Power Supply requirements for X-ray machines. These requirements are for a single x-ray machine. A dedicated line is required.

Nom. Line voltage:

240 volts 60 HZ single phase.

240volts 50 HZ single phase.

Current Rating: 140 amps(60 Hertz)

168 amps(50 Hertz)

Wire Size from Power Transformer
to Switch Box:

50 ft. #2, 100 ft. #00, 200 ft.

250 mcm

Minimum Circuit Breaker Rating:

70 amps(60 Hertz)

85 amps(50 Hertz)

Line voltage Regulation:

at maximum rated line current must not be
greater than 5%.

Percent line voltage regulation

$$= \frac{(VN-VL) \times 100}{VL}$$

VN = No load line voltage.

VL = Line voltage at maximum line current.

Alternate line voltage which will provide
normal operation are indicated on the wiring
diagram of the particular model.

2. UNPACKING

- a. Examine all cartons carefully at time of delivery. If damage is apparent, have delivering driver write a "bad order" note on all copies of the freight bill and sign it. Should you discover concealed damage, immediately notify the transportation agent and ask for an "Inspection Report of Damage". Carriers will not accept concealed damage claims if filed after 15 days from date of receipt of merchandise. Open crates and cartons carefully and do not dispose of them until you have located all parts and the machine is fully assembled.

- b. Check the oil level in the transformer to be sure that none had been spilled out through improper handling in shipping. At room temperature the oil level should be 1/2" to 3/4" below bottom side of cover.

3. GENERAL ASSEMBLY NOTES

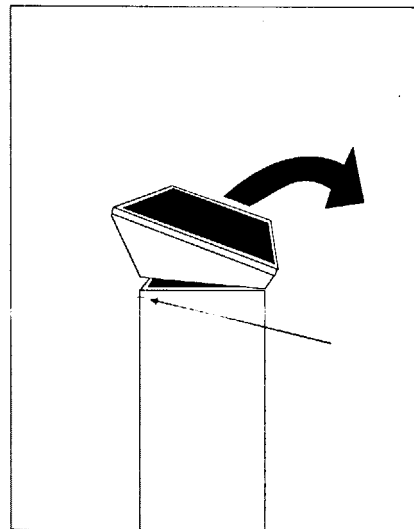
- a. The control is shipped with a 13' line cord and a 25' control-transformer cable to facilitate a wide variety of control and transformer arrangements.
- b. Electrical power must be supplied to a switch and fuse box located in a position readily accessible from a control location. (National Electrical Code requirement).
- c. Most State regulations require the operator's station at the control to be behind a protective barrier. Consult your local regulations for specific requirements.
- d. Once the transformer has been set in place, loosen the vent screw on the top of the transformer to permit expansion of oil with temperature changes. Use one of the plastic receptacle covers to cover the vent screw (oil filling) so that possible contamination of the transformer oil will be avoided.

4. OPENING CONTROL

The control features serviceability from the front of the cabinet. In very rare cases where access to the rear is required, a removable panel is supplied on the rear of the cabinet.

To Open:

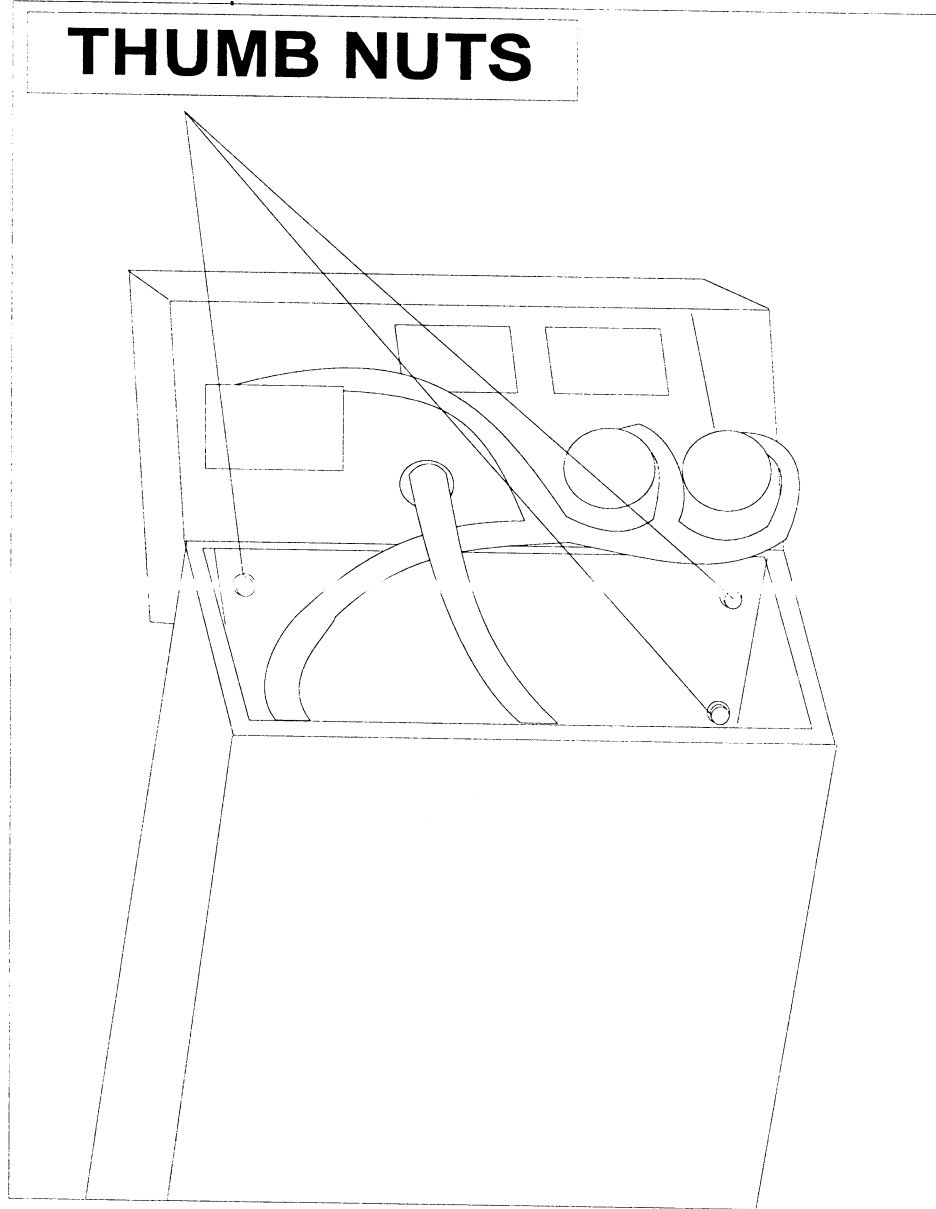
- a. Loosen the two screws, one on each side of the control.
- b. Grasp the top of the control under the rear lip, pull up and rotate forward.



c. From the inside of the control remove the two thumb nuts that hold the front panel of the control to the cabinet.

panel until the bottom portion disengages from the cabinet; then push the lower portion of the panel out and lower it to the floor. Remove front of the control and place aside.

d. Pull up on the handle in the middle on the top rear of the



5. INTERCONNECTING CABLES

a. Uncoil the control-transformer cables. Connect the loose ends to the H.V. generator, checking each wire terminal marking before connecting to terminal post with corresponding marking.

b. The control provides a 5 wire rotor cable capability. Connect leads marked 07, 08, and 09 to the terminal strip so marked in the control. If the tube has a thermal cutout switch, attach leads to terminals marked "T5" and "T6" on terminal strip in the control. If not, connect a jumper across "T5" and "T6" of terminal strip.

c. Bucky Cable Connection:
When a grid cabinet is used, no electrical connections are needed and terminals B1 and B2 are jumped (connected together).

L/F SERIES 8000 OBSOLETE MARKINGS	PROGENY TRUE SPEED or L/F SERIES 8000 CURRENT MARKINGS	GENERATOR CONNECTIONS	
		TABLE	WALL
B1	1	B1 T	B1 W
B2	2	B2 T	B2 W
B3	3	B3 T	B3 W
B4	N	F 1	F1
B8	L	B4 T	B4W

When a 14 x 36 Midwest Bucky is used a four wire connection is required as follows. Remove jumper in control between B1W and B2W.

Control Terminal	Midwest Bucky Terminal markings If Not Purchased Thru Universal		Midwest Bucky Markings If Supplied by Universal	
Connect	BIW	To	B2	or B1
Connect	B3W	To	B1	or B3
Connect	B4W	To	B4	or B4
Connect	F1	To	B3	or S1

d. Connect High Voltage Cable as Follows:

Extreme care should be used when handling the high voltage cable to avoid the possibility of damage to the plugs or the contact pins on the end of these plugs. Before inserting cable plugs into the transformer or the tube receptacle, be sure they are clean and dry. Insert the plug in its receptacle and screw on the cable nut as tightly as possible, using two hands to grip the nut. Do not use a wrench.



Be sure that anode connects to anode and cathode to cathode. The receptacles on the transformer and tube are marked "Anode" and "Cathode". The anode receptacle of the tube can be identified as being the receptacle near the end where the stator cord emerges. Both high voltage cables use Federal bushings and are identical in construction. Therefore, they can be used for either anode or cathode.

e. Electrical Lock and Collimator Power Supply

Terminals marked "C1" and "C2" in the control chassis provide 24 VAC (unfused) to supply power for collimators or accessories requiring this voltage.

This 24 VAC supply eliminates the need for a separate power supply when using the Duocon M. Collimaster M, or equivalent. Connect the black and white wires to "C1" and "C2" and the green wire to ground.

Terminal marked "DC+" and "DC-" in the control chassis provide 24V (fused) to supply power to the electrical locks.

f. Line Cable

Insure main disconnect box is OFF. Uncoil line cable and connect loose end to appropriate terminals in the switch and fuse box. Double check to be sure that the ground wire is connected to a good ground connection. **LEAVE MAIN DISCONNECT OFF.**

6. PRELIMINARY CHECKS**(PRIOR TO GENERATING X-RAYS)**

- a. **Adjust control for existing line voltage.**
Measure the line voltage at the main disconnect box and relocate the line voltage adjustment wire "12M" on the terminal strip above the auto transformer, to the terminal that corresponds closest to the line voltage. The terminals are marked 190,210, 230, 240, 250 and 270.
- b. **Disconnect the wires marked "P1" and "P2" at the high tension transformer and insulate with electrical tape.**
- c. **Select 200 mA, set the minor kVp selector fully counterclockwise and the major kVp selector to mid-range.**
- d. **Turn the main disconnect ON and then turn the generator ON. Rotate the line compensator switch until the low line led and the high line led are turned off.**
- e. **While observing the filaments through the port of the x-ray tube, select each mA station and verify that the appropriate filament, large or small, is lit and that there is only one filament lit at a time.**
- f. **Actuate the prep switch, observe the following, and then release the prep switch: The x-ray tube rotor should start running and after**

approximately 1 second a relay comes in and the prep or ready indicator is on.

- g. **While looking into the port of the x-ray tube, actuate the prep switch and verify proper "filament boost" operation and direction of anode rotation. The selected filament should glow bright, "boost", when the prep switch is activated and should become dimmer, "de-boost", when prep switch is released.**

The direction of anode rotation should be determined by viewing the anode from the cathode end and should be as follows:

**VARIAN TUBES CW
TOSHIBA TUBES CCW**

- h. **The 325D generator is designed with an adjustable "kVp" "Compensator Circuit" and should be spot checked to verify that it is operating properly.**

With power OFF, connect an AC voltmeter, capable of reading 0-300 VAC, to terminals "PF" and "PS" of x-ray generator. This will allow measurement of the unloaded H.T. primary voltage.

Turn unit on and select 50mA and adjust the major and minor kVp selectors until 198 VAC is indicated on your voltmeter. Adjust R10 on the display board for a 100Kvp reading. Select 100 mA and adjust the major and minor Kvp selectors until 213 VAC is indicated on

your volt meter. Adjust R11 on the display for 100Kvp reading. Select 150 mA and adjust the major and minor Kvp selectors until 214 VAC is indicated on your volt meter. The KV display should indicate 100 KV. Adjust R12 if Necessary.

Select 200 mA. and adjust the KV major and minor selectors until the volt meter reads 228 VAC. The KV display should read 100 KV. Adjust R13 if necessary.

Select 300 mA. and adjust the KV major and minor selectors until the volt meter reads 253 VAC. The KV display should read 100 KV. Adjust R14 if necessary.

- i. Turn the system OFF and reconnect "P1" and "P2" at the high tension transformer.**

7. CALIBRATION

The 325 generator is fully tested in factory prior to shipment. The unit is shipped set for 240 VAC operation and with the RXS and RXL filament, adjust slider bands in the maximum resistance position, and RSCC resistor bands set to "approximate" positions, probably requiring fine adjustments only.

If the unit is connected to a nominal 240 volt power line with a regulation of not more than 5%, the calibration required will normally be limited to calibrating the mA circuit and verifying the accuracy of the kVp and time. This assumes use of standard interconnecting cables, no shipping damage, and that the test equipment used is calibrated.

If the unit is connected to a power line that exceed 5% regulation and equipment is not available to measure and calibrate actual kVp, then there is no guarantee that the calibration of the unit will be acceptable and the unit should not be connected.

- a. Switch the unit "ON". Adjust the line comp switch up or down and see if both the high and low line led indicators on the front panel will light and if at some point they are both out indicating a correct line match to the auto transformer.



2. mA CALIBRATION Observe X-ray Tube Rating Charts to prevent overloading of Tube.

First select 150 mA and 80 kVp.

Adjust the 150 mA station slider band on the resistor RXL to produce approximately 155 mA. Moving the slider band to the right increases mA. Adjust resistor RXS for small focal spot stations and resistor RXL for large focal spot stations. Notice that

part of resistor RB is common to both filaments and any adjustment to the slider to the right will affect all mA settings.

If means are available, measure kVp to verify kVp meter indication. If more than 5 kVp error, refer to kVp accuracy test. If within 5 kVp, proceed to step "d".

If means are not available to measure actual kVp, limit operation to 120 kVp for this procedure. Select 50 kVp and note the mA produced. Select 125 kVp and note the mA produced.



During calibration of a new x-ray tube or one that has not been used at the higher kVp levels; increase kVp in 10 kVp increments, making several exposures at each setting to check for tube instability.

Adjust the 150 mA slider band on resistor RSCC until the mA at 50 and 125 kVp are approximately equal. If the mA at 125 kVp is higher than that at 50 kVp, move slider band on RSCC to the right; if lower, move slider to the left.

Select 80 kVp and adjust the 150 mA slider on resistor RXL for 155 mA.

Check mA tracking from 50 to 125 kVp and fine tune as required. The RSCC resistor adjustment is used to equalize mA at the 50 and 125 kVp point. The RXL resistor adjustment is used to raise or lower the mA at all kVp points. Normal tracking will result in a low point at 50 and 125 kVp, being approximately equal, and a high point at approximately 80 kVp.

Perform steps "a" through "g" for the remaining mA stations on the large focal spot and then on the small focal spot. In steps "b" and "f" use the following:

<u>mA Station</u>	<u>mA</u>
50	52
100	105
200	210
300	315

C. kVp ACCURACY TEST

Actual kVp-

Must be measured with a calibrated H.V. bleeder tank or equivalent method of checking the kVp. This should be done at all mA settings and throughout the specified KV range. The results should not exceed the published specifications.

kVp calibration-

Adjust the following resistors if necessary. Select 100KV for all mA settings. Resistors are located on the display board.

<u>mA</u>	<u>Resistor</u>
50	R10
100	R11
150	R12
200	R13
300	R14

d. CALIBRATION OF THE TUBE CURRENT SENSING RESISTOR

Inside the Control, mounted on the Main Chassis panel in the upper right corner above the RB resistor, is located the Tube Over current Protection Resistor assembly. This assembly consist of two resistors, one is a fixed 300 ohms (RF) in series with a variable 150 ohm resistor (RV). The RV resistor will allow the Installer to

control the circuit breaker trip time. The assembly has been factory tested and adjusted. However, a different time setting maybe necessary for a particular installation, dependent upon the x-ray Tube rating, the operator desired techniques and the tube rating.

e. TIMER CALIBRATION

The timer used with this Generator does not require any calibration. Just verify that all times are with in specifications.



WARNING



If adjustment is necessary, it is **ONLY** to be adjusted by "Authorized Service Personnel." This is **NOT** an operator adjustable item.

If longer exposure times are required adjust the band on the RV resistor to the left so that the total resistance of the two

resistor is less. Be sure to carefully check the tube rating chart before deciding upon a difference resistance value (trip time), to verify the tubes' maximum power-time limitations.

300 Ma x 120 kVp x See chart
below sec.

Approximate trip times at specific resistance values for both the Airpax breaker and the Heineman circuit breaker.

AIRPAX

<u>TUBE CURRENT</u>	RESISTANCE	APPROX TRIP TIME
<u>300 mA</u>	350 ohms	0.50 sec (60 Hertz) 0.48 sec (50 Hertz)
<u>300 mA</u>	325 ohms	0.75 sec (60 Hertz) 0.90 sec (50 Hertz)

HEINEMAN

<u>TUBE CURRENT</u>	RESISTANCE	APPROX TRIP TIME
<u>300 mA</u>	400 ohms	0.50 sec (60 Hertz) 0.48 sec (50 Hertz)
<u>300 mA</u>	325 ohms	1.00 sec (60 Hertz) 0.90 sec (50 Hertz)

8. FINAL COMPLIANCE TESTS

It is necessary for the assembler to perform tests on the newly-assembled x-ray system prior to release to the user. These tests must assure compliance with the applicable requirements of the FDA performance standard at the time of installation.

Perform these tests in accordance with NEMA publication #XR8-1979, Test Methods for Diagnostic X-Ray machines for Use During Initial Installation. It is necessary that the assembler document these tests to demonstrate at a later date that all tests were performed and that the x-ray system was left in full compliance with the standard. The test results obtained must verify that the following system specifications are met or the system must be removed from service until corrective action is completed.

SYSTEM SPECIFICATIONS

BEAM QUALITY

The half-value layer of the useful beam shall not be less than 2.3 mm of aluminum at 80kVP or 2.5 mm at 90 kVp.

REPRODUCIBILITY AND LINEARITY

When the x-ray unit is operated on an adequate power supply (see section II A) : (1) the estimated coefficient of variation of radiation exposure shall not be greater than .048 for any specific combination of technique factors, and (2) the average ratios of exposure to the indicated tube current exposure time product (mAs) obtained at any two consecutive tube

current settings shall not differ by more than .095 times their sum, or

$$\frac{\overline{X1} - \overline{X2}}{\overline{X1} + \overline{X2}} \leq 0.095$$

where $\overline{X1}$ and $\overline{X2}$ are the average mR/mAs value obtained at each of two consecutive tube current settings.

PEAK TUBE POTENTIAL

The maximum deviation of the peak tube potential from its pre-indicated value during an exposure, when the equipment is connected to an adequate power supply (see section II A) shall not exceed +/- 10% of full scale value within the range of 40 - 125 kVp.

TUBE CURRENT

The maximum deviation of the tube current from its pre-indicated value during an exposure, when the equipment is connected to an adequate power supply (see section II A) shall not exceed +/-20% of selected tube current within the range of 50 - 125 kVp, and +/- 20% of selected tube current within the range of 40 - 49.9 kVp.

mAs DISPLAY

The maximum deviation of mAs from its pre-indicated value shall not exceed +/-35%.

EXPOSURE TIME

The maximum deviation of the exposure time from its pre-indicated value during an exposure, when the equipment is connected to an adequate power supply (see section II A) shall not exceed +/- 1 pulses within the range of 1/120-1/10 (60 Hertz) or 1/100-1/10 (50 Hertz), +/-15% of selected time within the range of 3/20 - 6 seconds (60 Hertz) or 3/25 - 7 2/10 seconds(50 Hertz).

9. CERTIFICATION OF COMPATIBILITY

Universal Inc. certifies that its certified x-ray controls and high voltage generators are compatible with all certified Radiographic x-ray tubes concerning compliance with 21CFR, Chapter I, Subchapter J, only if the ratings of the control, generator and tube are strictly observed and the control is calibrated within the applicable published limits.

Universal Inc. certified controls and generators, when combined with other certified components, will not affect the compliance of these components when these components are installed, connected and adjusted in accordance with the applicable Universal's instructions and specifications.

**10. COMPLIANCE WITH U.L.
REQUIREMENT FOR FIRE & SAFETY**

Underwriters Laboratories, Inc. Standard for Safety of X-Ray Equipment, UL 187, Section 29, requires that this x-ray control cabinet be safely secured to the floor to prevent accidental tipping which could result in injury.

Use the two (2) slotted holes (.375 x .875 inches) provided in the base of the cabinet to safely secure the unit to the floor with appropriate type of fasteners which must be determined by the installer depending upon the type of floor encountered.

THEORY OF OPERATION

1. PREP OPERATION

The source voltage comes from a winding of the auto transformer C5 and C6 through F6 supply 8 VAC on control circuit diagram 110-5012 S to J6 1 & 2 meter display board D7835. This voltage is rectified and used as a supply voltage for this board. The + supply is sent out on J4 pin 1 to the prep and exposure switch and ready and exposure lamp indicator D7849. By activating either the prep switch or the exposure switch, the voltage is applied to J4 pin3. This is inverted through U5 on the D7835 display board and turns on K3. 120 VAC from the auto transformer, from F2, to T5 and T6 out to the thermal switch of the X-Ray tube, to J6 pin 9 of the D7835 display. When K3 closes this voltage is applied to J6 pin-7 and is used as a source for the rotor PCBD7634. This starts the prep sequence. See rotor control operation for sequence.

2. ROTOR OPERATION

120 VAC is applied to D7634 the rotor PCB 8 and 10. This applies 120 VAC to T1 transformer. The secondary of this transformer is rectified and energizes K3 it is then sent through a regulator. The regulated voltage is used on this PCB. When prep is applied K1 energizes and its contacts apply 220 VAC to the Rotor. K3 relay has two sets of contacts. Open contacts close on pins 3 and 5, and go to filament resistor R8 and boost the filament to exposure level. The open contacts on pins 9 and 6 close and go into the D7844 timer module. This takes a DC

voltage from the input to VR1 and through the contacts to energize K2 and this energizes K1. K1 contacts apply voltage through J2-2 to the back up contactor T J2-pin 2 to the back up contactor.

3. EXPOSURE OPERATION

When the exposure switch S2 is closed then the DC supply is switched to pin-4 of J1 ,to pin-4 of J4 on D7835 display board, inverted by U6, and operates K4. At the end of prep the rotor sends 120VAC through K4's contact and out through bucky selection to J1-9 of the D7844 timer board.

4. TIMER OPERATION

This 120VAC is applied to pin 9 of J1 of the timer board energizing K1 and K2. U8 pin 11 goes high and signal is inverted by U8 pin 12 going low. This makes U1 pin 1 to go low 100 milliseconds later. U9 pins 2 and 5 go high, and U10 pins 8, 9, and 10 go high turning on Q16. This applies 5VDC to resistors R12 and R13, and connector J6 pin 4 which turns on the X-Ray light bar on the Prep and X-Ray switch assembly. Zero crossing pulses are formed from the secondary of T1 and transistors Q9 and Q10. Their outputs are sent to Pins 12 and 13 of U9. This gate generates zero crossing pulses at U9 pin11. These pulses are applied to U5 J-K flip flop pins 4 and 3. The output of U5 pins 1 and 2 drives the SCR pulse transformer T2 via transistors Q1 ,Q7 and Q8. The pulses triggering the SCR's go through U9 pin 10 activating Q17 and sending pulses to U1 pin 33.

U1 pin 16 goes low and the audio alert sounds for approximately 1 second. This gives a audio signal after the exposure is done.

The backup timer is set for one pulse more than the main timer U1. The SCR drive pulses are used to clock the binary counter U11 pin 1. The backup timer receives a pulse every time the main timer receives one, through U16 pin 4,5 and 6. When the main timer completes its time delay, another pulse is clocked into U11 pin 10 through C13 and the drive to the SCR's are terminated. U16 pin 3 goes high and turns on transistors Q21 and Q22 De-energizing the backup contactor through relay K1. If the main timer fails to terminate, the backup timer will turn off the backup contactor through relay K1 on the next pulse to the SCR's. In addition (LT-1) LED will turn on (on timer board). This stays on until input power is removed then turned back on. Also the audio alarm stays on until the exposure switch is released. This tells the operator that backup timer ended the exposure.

Releasing the X-Ray switch during exposure will terminate the exposure.

5. AEC OPERATION

12VDC is supplied at D7844 J1 pin 6. A external AEC system should supply at set of N.O. contacts, that close at the termination of an AEC timed exposure. Put these contacts on J1 pin 6 and J2 pin 4 of D7844 timer board. When this 12 VDC is applied to J2 pin 6 it goes through CR36 to the base of Q21 turning off K1 and de-energizing the backup contactor. It also goes to the base of Q19 turning it on. This puts a low on U1 pin 4 terminating the drive to

the SCR's and sending an audio alert for X-Ray indication.

6. kVp SENSE AND DISPLAY

A voltage proportionate to kVp from the major and minor kVp switches is applied to D7844 timer board J1 pins 3 and 5. This is sent to the primary of transformer T3. The secondary of T3 is rectified and sent to kVp display board 7835 by J4 pin 1. It is sent to U1 pin 31 on the D7835 display board. U1 has an analog input and its output drives the kVp digital display. This voltage on the D7844 timer board is also sent to voltage divider made up of R59, R75, and Potentiometer R76. R76 is adjusted for maximum kVp setting. This voltage is sent to U1 microprocessor pin 2. This is an analog input that generates over or under kVp errors (E02 or E03) which are sent to the mAs display.

7. mA SENSE AND DISPLAY

mA select switch sends 5VDC in J7 of the D7835 meter display board. This selection goes in two directions. it is used on this board for input of the kVp sense circuit. This used for the load compensation circuit. Resistors R11, R12, R13, and R14 for the calibration of the kVp with load. The mA select is also sent out J2 pins 3,4, 7, 8, and 10 to the timer D7844 board for mA decoding. Diodes CR41, CR42, CR43, and CR44 are used for a selection of any mA. If this selection is open an error (E04) is displayed in the mAs display. The mA selected lines also goes through a diode matrix. This makes up a 4 line code, that enters the microprocessor U1. U1 decodes both the mA and the time selected and then sends out a selected mAs to the display.

8. AUTO LINE SENSE

On D7844 board T1 transformers secondary develops a voltage that is sent through CR39 and CR40 across R77 and R89. The junction of R77 and R89 is sent to a window comparator formed by U18 pins 1, 2 and 3 and U18 pins 5, 6, and 7. The reference voltage is formed by a regulated 5VDC supply across resistors R74, R87, R79, and R78. The window is adjusted by R78 and R87. When the voltage on U18 pin 6 is greater than U18 pin 5, U18 pins 7 and 1 are low, U19 pins 1 and 2 are low and the high and the low line comp LED's A8 and A9 (on D7835 display board) are off. If U18 pin three is greater than U18 pin 2, or if U18 pin6 is less than U18 pin 5, then the corresponding LED's A8 or A9 will be on. This indicates that the incoming line is out of range. If either LED is on then X-Ray exposure is locked out.

9. FREEZE MODE

When the prep or x-ray switch is depressed 12VDC is applied to connector J1 pin 7 of D7844 timer board from the rotor control board K3. This turns on Q2 and sends a low to U1 pin 16. This locks out any change in mA, kVp, time, or line comp sensing.

10. SCR SHORT SENSE

Connector J1 pins 8 and 10 are connected across the normally open contacts of the backup contactor and SCR's. When the backup contactor comes in if the SCR's are shorted, a voltage is applied to resistors R1 and R2 and rectified by CR19 to 22 through U17. U17 turns on, turning off Q20. U6 pins 12 and 13 are high, pins 8, 9, and

11 are low, U6 pin 10 is high, U1 pins 7 and 15 are high, transistor Q21 is on and relay K1 is de-energized preventing X-Ray exposure. A (E06) error code is displayed on the mAs display.

ERROR CODES

ERROR CODE	CAUSE
E01	Tube limit
E02	kVp out of range
E03	kVp out of range
E04	mA not selected
E05	Open time cable or switch
E06	Shorted SCR

Error Code**Probable Cause****E01**

Control settings not in range for this tube.
Check settings on generator.

E02 or E03

kVp is either too low or too high for selection.
Adjust major and minor kVp switches.

E04

mA selection is an open circuit.
Control is sensing mA switch not selected.
Check mA switch.

E05

Time select open circuit. Check time switch.

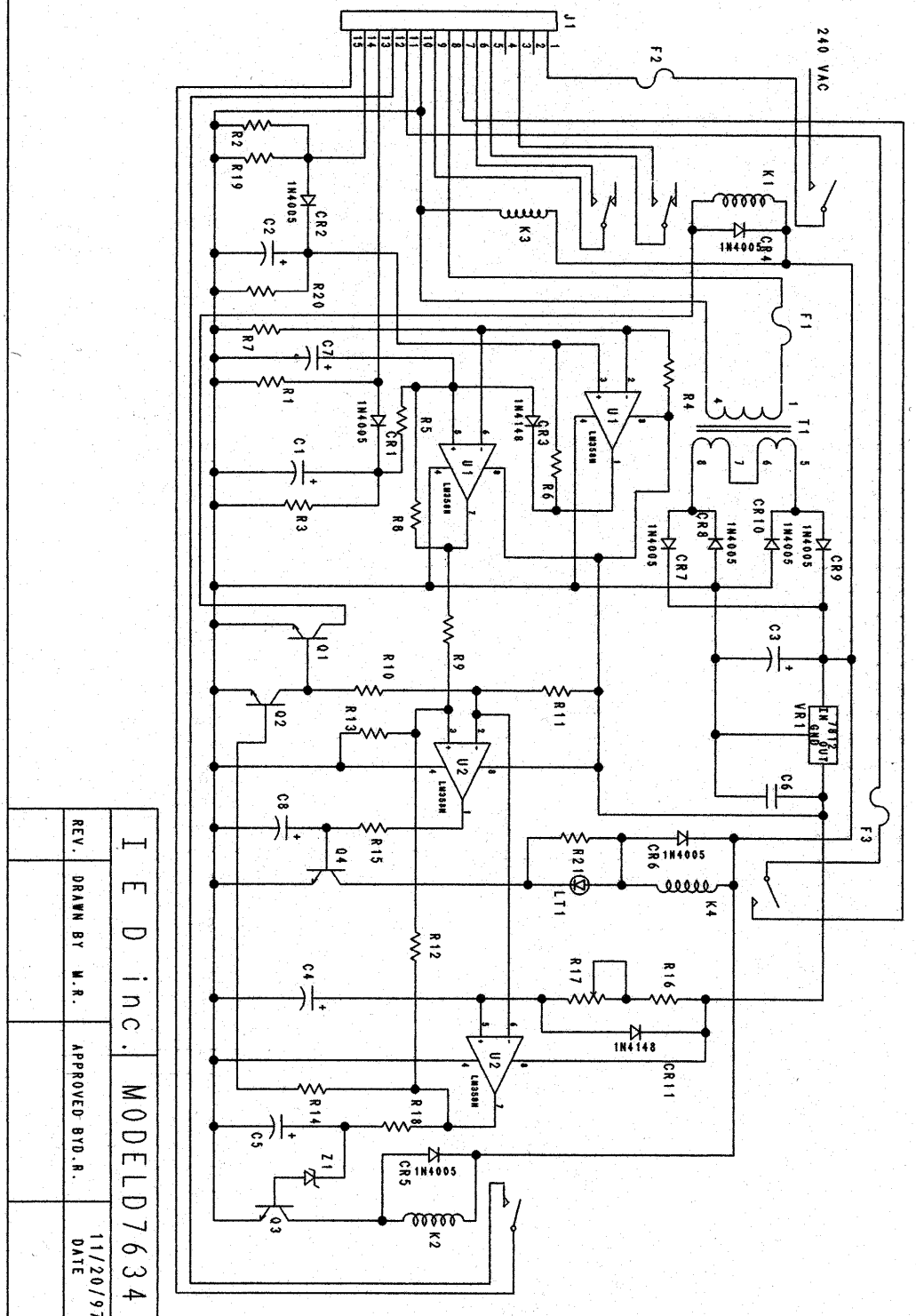
E06

Sensed shorted SCR. Back up timer ended exposure.
Call service.

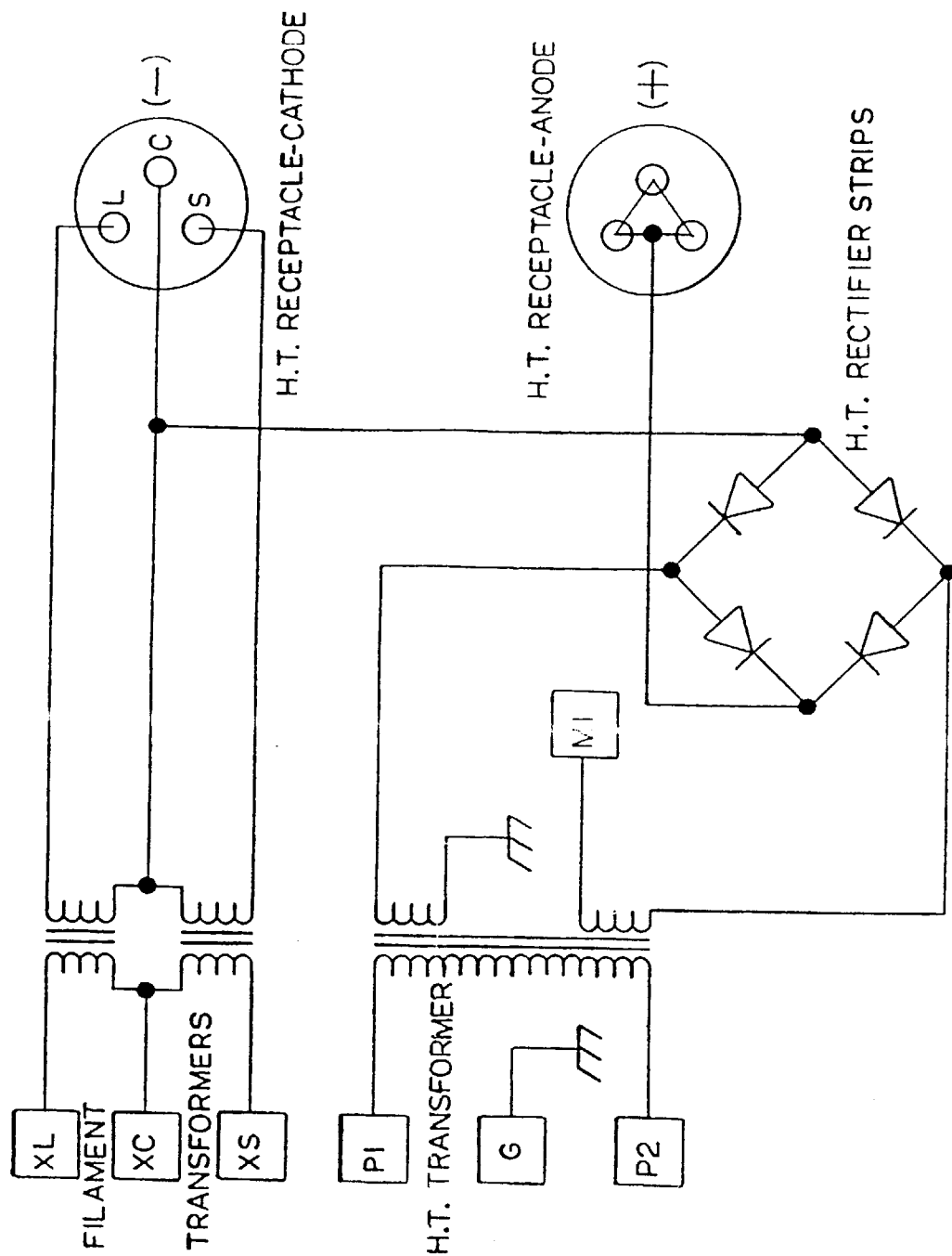
Appendix A: Schematic and Circuit Diagrams

- 1. D7634 Rotor Control Schematic**
- 2. 3550 High Tension Transformer Schematic**
- 3. Tube Rotor Circuit**
- 4. D7849 Prep & Exposure switch Schematic**
- 5. D7848 Table & Wall Bucky switch Schematic**
- 6. D7844 Control Logic Schematic**
- 7. D7835 kVp, mAs, & Time Display Schematic**
- 8. 110-5012-S60 Control Wiring Schematic**

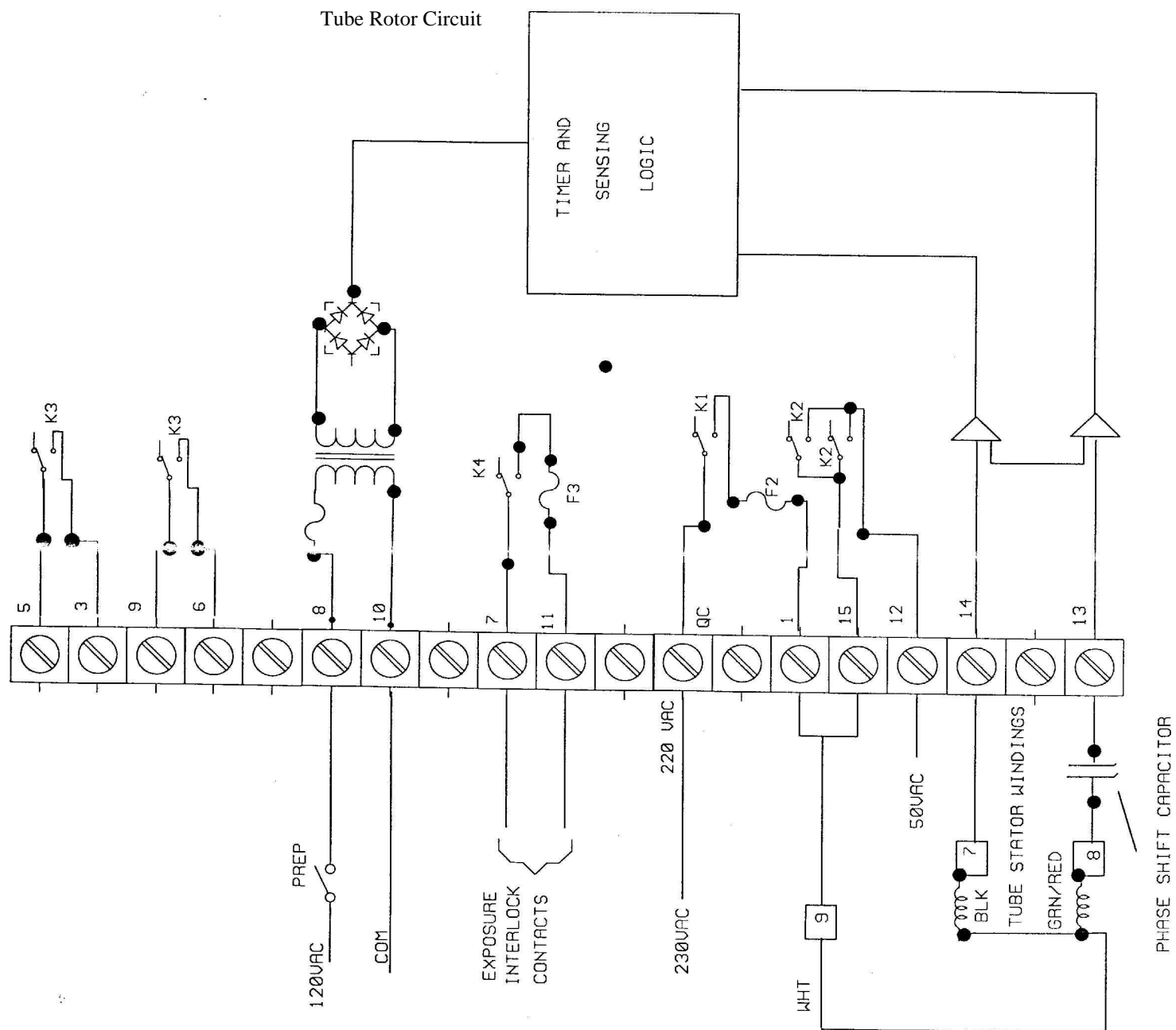
Rotor Control Board Model D7634



SCHEMATIC NO. 5500-2115



3550 H.T. TRANSFORMER



Prep and Exposure Switch Model D7849

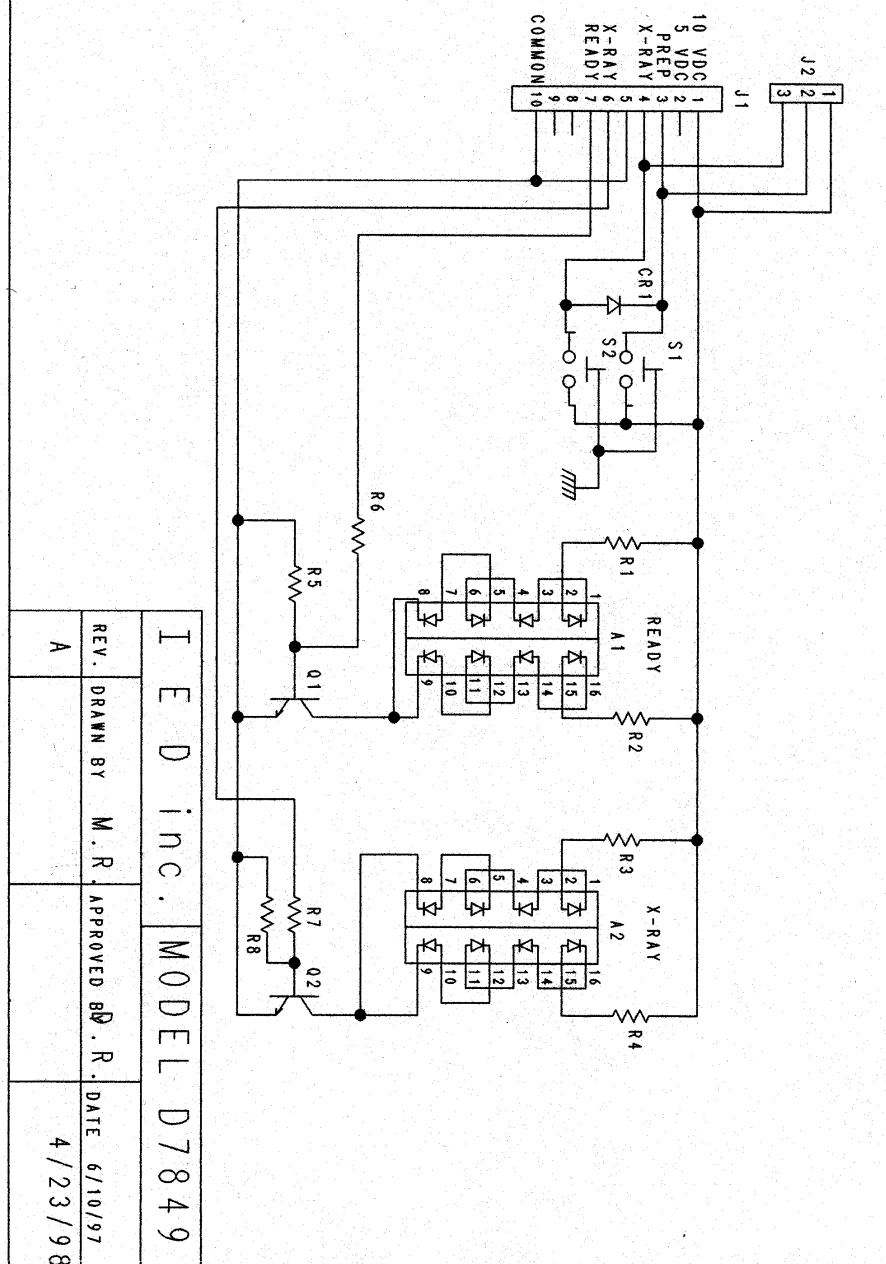


Table and Wall Bucky Switch Model 7848

