TREX Medical Corporation
Continental Division
2000 S. 25th Avenue
Broadview, IL 60153

X-Ray Tube #1 Warm up Procedure

1. **Select the manual mode.**
2. **Select the 3-factor mode.**
3. **Select table top exposure mode.**
4. **Select the large focal spot.**
5. **Select the 200 mA station.**
6. **Select 250 ms time. (mAs should read 50)**
7. **Select 80 kVp.**
8. **Make 5 exposures, @ 30 seconds apart.**

The tube warm up procedure is complete.

X-Ray Tube #2 Warm up Procedure

1. **Set up for fluoroscopy per the exam your are going to do first.**
2. **Place a single layer of a lead apron on the tabletop under the image intensifier.**
3. **Position the table bucky under the lead apron and the image intensifier so you have something to view on the monitor.**
4. **Press on the fluoroscopic button on the handle or step on the foot pedal for 15 seconds.**
5. **Watch the fluoroscopic timer to monitor the 15 seconds of time.**
6. **Watch the monitor also to make sure you have an image and that the system is functioning properly for your first exam.**

The tube warm up procedure is complete.

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X-Ray Tube Warm up Procedure

1. **Select the manual mode.**
2. **Select the 3-factor mode.**
3. **Select table top exposure mode.**
4. **Select the large focal spot.**
5. **Select the 200 mA station.**
6. **Select 250 ms time. (mAs should read 50)**
7. **Select 80 kVp.**
8. **Make 5 exposures, @ 30 seconds apart.**

The tube warm up procedure is complete.

TREX Medical Corporation
Continental Division

MAS CONVERSION CHART

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E-mail: Trexmed.com

(MAS) MILLIAMPERE-SECONDS

TIME/SECONDS

Fraction	Decimal	Millisecond	10	15	20	25	30	50	75	100	125	150	200	300	400	500	600
	.003	3	.03	.05	.06	.08	.09	.15	.22	.30	.37	.45	.60	.90	1.2	1.5	1.8
	.006	6	.06	.09	.12	.15	.18	.30	.45	.60	.75	.90	1.2	1.8	2.4	3.0	3.6
1/120	.008	8	.08	.12	.16	.20	.24	.40	.60	.80	1.0	1.2	1.6	2.4	3.2	4.0	4.8
	.01	10	.10	.15	.20	.25	.30	.50	.75	1.0	1.2	1.5	2.0	3.0	4.0	5.0	6.0
	.013	13	.13	.20	.26	.33	.39	.65	.98	1.3	1.6	2.0	2.6	3.9	5.2	6.5	7.8
	.016	16	.16	.24	.32	.40	.48	.80	1.2	1.6	2.0	2.4	3.2	4.8	6.4	8.0	9.6
1/60	.0166		.17	.25	.33	.42	.50	.83	1.3	1.7	2.1	2.5	3.3	5.0	6.6	8.3	10.0
	.020	20	.20	.30	.40	.50	.60	1.0	1.5	2.0	2.5	3.0	4.0	6.0	8.0	10.0	12.0
1/40	.025	25	.25	.38	.50	.63	.75	1.3	1.9	2.5	3.1	3.8	5.0	7.5	10.0	12.5	15.0
	.032	32	.32	.48	.64	.80	.96	1.6	2.4	3.2	4.0	4.8	6.4	9.6	12.8	16.0	19.2
1/30	.033	33	.33	.50	.66	.83	.99	1.7	2.5	3.3	4.1	5.0	6.6	9.9	13.2	16.5	19.8
	.040	40	.40	.60	.80	1.0	1.2	2.0	3.0	4.0	5.0	6.0	8.0	12.0	16.0	20.0	24.0
1/24	.042	42	.42	.63	.84	1.1	1.3	2.1	32.0	4.2	5.2	6.3	8.4	12.6	16.8	21.0	25.2
1/20	.05	50	.50	.75	1.0	1.3	1.5	2.5	3.8	5.0	6.2	7.5	10.0	15.0	20.0	25.0	30.0
	.063	63	.63	.95	1.3	1.6	1.9	3.2	4.7	6.3	7.9	9.5	12.6	18.9	25.2	31.5	37.8
1/15	.066	66	.66	.99	1.3	1.7	2.0	3.3	5.0	6.6	8.2	9.9	13.2	19.8	26.4	33.0	39.6
3/40	.075	75	.75	1.1	1.5	1.9	2.3	3.8	5.6	7.5	9.4	11.3	15.0	22.5	30.0	37.5	45.0
	.08	80	.80	1.2	1.6	2.0	2.4	4.0	6.0	8.0	10.0	12.0	16.0	24.0	32.0	40.0	48.0
1/12	.083	83	.83	1.3	1.7	2.1	2.5	4.2	6.2	8.3	10.4	12.5	16.6	24.9	32.2	41.5	49.8
1/10	.10		1.0	1.5	2.0	2.5	3.0	5.0	7.5	10.0	12.5	15.0	20.0	30.0	40.0	50.0	60.0
5/40, 1/8	.125		1.25	1.9	2.5	3.1	3.8	6.3	9.4	12.5	15.6	19.0	25.0	37.5	50.0	62.5	75.0
2/15	.13		1.3	2.0	2.6	3.3	3.9	6.5	9.8	13.0	16.2	20.0	26.0	39.0	52.0	65.0	78.0
3/20	.15		1.5	2.3	3.0	3.8	4.5	7.5	11.3	15.0	18.7	22.5	30.0	45.0	60.0	75.0	90.0
	.16		1.6	2.4	3.2	4.0	4.8	8.0	12.0	16.0	20.0	24.0	32.0	48.0	64.0	80.0	96.0
7/40	.175		1.75	2.6	3.5	4.4	5.3	8.8	13.1	17.5	21.9	26.0	35.0	52.5	70.0	87.5	105.0
2/10, 1/5	.20		2.0	3.0	4.0	5.0	6.0	10.0	15.0	20.0	25.0	30.0	40.0	60.0	80.0	100.0	120.0
9/40	.225		2.25	3.4	4.5	5.6	6.8	11.3	16.9	22.5	28.1	33.8	45.0	67.5	90.0	112.5	135.0
MILLIAMPERE			10	15	20	25	30	50	75	100	125	150	200	300	400	500	600

TIME/SECONDS		(MAS) MILLIAMPERE-SECONDS														
Fraction	Decimal															
1/4	.25	2.5	3.8	5.0	6.3	7.5	12.5	18.8	25.0	31.2	38.0	50.0	75.0	100.0	125.0	150.0
3/10	.30	3.0	4.5	6.0	7.5	9.0	15.0	22.5	30.0	37.5	45.0	60.0	90.0	120.0	150.0	180.0
	.32	3.2	4.8	6.4	8.0	9.6	16.0	24.0	32.0	40.0	48.0	64.0	96.0	128.0	160.0	192.0
4/10, 2/5	.40	4.0	6.0	8.0	10.0	12.0	20.0	30.0	40.0	50.0	60.0	80.0	120.0	160.0	200.0	240.0
5/10, 1/2	.50	5.0	7.5	10.0	12.5	15.0	25.0	37.5	50.0	62.5	75.0	100.0	150.0	200.0	250.0	300.0
6/10, 3/5	.60	6.0	9.0	12.0	15.0	18.0	30.0	45.0	60.0	75.0	90.0	120.0	180.0	240.0	300.0	360.0
	.63	6.3	9.5	12.6	15.8	18.9	31.5	47.3	63.0	78.8	95.0	126.0	189.0	252.0	315.0	378.0
7/10	.70	7.0	10.5	14.0	17.5	21.0	35.0	52.5	70.0	87.5	105.0	140.0	210.0	280.0	350.0	420.0
3/4	.75	7.5	11.3	15.0	18.8	22.5	37.5	56.3	75.0	93.7	113.0	150.0	225.0	300.0	375.0	450.0
8/10, 4/5	.80	8.0	12.0	16.0	20.0	24.0	40.0	60.0	80.0	100.0	120.0	160.0	240.0	320.0	400.0	480.0
9/10	.90	9.0	13.5	18.0	22.5	27.0	45.0	67.5	90.0	112.5	135.0	180.0	270.0	360.0	450.0	540.0
1	1.0	10.0	15.0	20.0	25.0	30.0	50.0	75.0	100.0	125.0	150.0	200.0	300.0	400.0	500.0	600.0
1 1/4	1.25	12.5	18.8	25.0	31.3	37.5	62.5	93.8	125.0	156.3	188.0	250.0	375.0	500.0	625.0	750.0
	1.3	13.0	19.5	26.0	32.5	39.0	65.0	97.5	130.0	162.5	195.0	260.0	390.0	520.0	650.0	780.0
1 1/2	1.5	15.0	22.5	30.0	37.5	45.0	75.0	112.5	150.0	187.5	225.0	300.0	450.0	600.0	750.0	900.0
	1.6	16.0	24.0	32.0	40.0	48.0	80.0	120.0	160.0	200.0	240.0	320.0	480.0	640.0	800.0	960.0
1 3/4	1.75	17.5	26.3	35.0	43.8	52.5	87.5	131.3	175.0	218.8	263.0	350.0	525.0	700.0	875.0	1050.0
2	2.0	20.0	30.0	40.0	50.0	60.0	100.0	150.0	200.0	250.0	300.0	400.0	600.0	800.0	1000.0	1200.0
2 1/4	2.25	22.5	33.8	45.0	56.3	67.5	112.5	168.8	225.0	281.3	338.0	450.0	675.0	900.0	1125.0	1350.0
2 1/2	2.5	25.0	37.5	50.0	62.5	75.0	125.0	187.5	250.0	312.5	375.0	500.0	750.0	1000.0	1250.0	1500.0
2 3/4	2.75	27.5	41.3	55.0	68.8	82.5	137.5	206.3	275.0	343.7	413.0	550.0	825.0	1100.0	1375.0	1650.0
3	3.0	30.0	45.0	60.0	75.0	90.0	150.0	225.0	300.0	375.0	450.0	600.0	900.0	1200.0	1500.0	1800.0
	3.2	32.0	48.0	64.0	80.0	96.0	160.0	240.0	320.0	400.0	480.0	640.0	960.0	1280.0	1600.0	1920.0
3 1/4	3.25	32.5	48.8	65.0	81.3	97.5	162.5	243.8	325.0	406.3	488.0	650.0	975.0	1300.0	1625.0	1950.0
3 1/2	3.5	35.0	52.5	70.0	87.5	105.0	175.0	262.5	350.0	437.5	525.0	700.0	1050.0	1400.0	1750.0	2100.0
3 3/4	3.75	37.5	56.3	75.0	93.8	112.5	187.5	281.3	375.0	468.8	563.0	750.0	1125.0	1500.0	1875.0	2250.0
4	4.0	40.0	60.0	80.0	100.0	120.0	200.0	300.0	400.0	500.0	600.0	800.0	1200.0	1600.0	2000.0	2400.0
MILLIAMPERE		10	15	20	25	30	50	75	100	125	150	200	300	400	500	600

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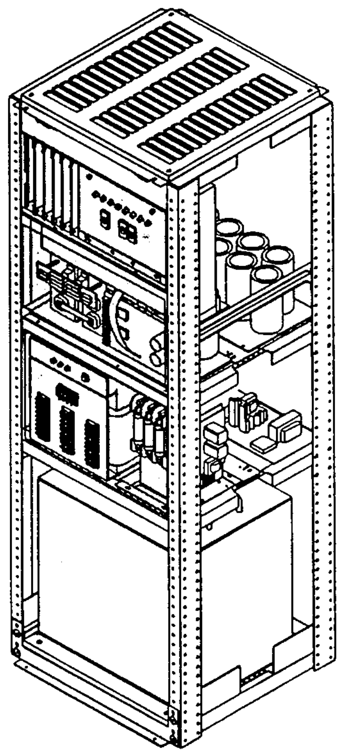
FIELD SERVICE BULLETIN
FSB 4295.262.12

TM GENERATOR
PWS MODIFICATIONS



RETROFIT BULLETIN

4295.262.12 Revision 9903

Specifications subject to change without notice.

1.0 GENERAL

This document provides the information and procedures required to modify existing 3φ 150KV Power Supply Units in TM40L, TM50, TM65 and TM80 X-ray Generators.

The program is intended to reduce catastrophic failures of components in the field and improve performance of X-ray generators.

1.1 SCOPE

This field modification consists of the following basic steps:

- removing the existing Power Supply (contactor) Panel
- installing a new Power Supply (contactor) Panel
- installing a new Main Circuit Breaker assembly behind the Auto Transformer
- moving and remounting the AUX contactor and auxiliary power strip (TB9) assembly
- removing the main line fuses, the SCR fuse and the fuse blocks
- installing new connector blocks and circuit breaker.

Note: You will need to access the front and rear of the TM RPU cabinet. Access to the right of the unit will be helpful.

Anticipated time to complete: 8 Hours.

> **Note!**
> **On some generators, the existing resistors R12, R13 and R14 are 100 watts. The new power supply/contactor panel has R12, R13 and R14 as 50 watts. This is not a concern for this modification.**

2.0 PREREQUISITES

A. HARDWARE

The following represents the Parts List (9526.206) dated 10-30-98 for this retrofit kit:

Part #	Description	Qty.
— 121.1032. 0457	10-32 x 1/4 Pan Steel Philips Screw	2 ea.
— 121.1032. 1657	10-32 x 1 Pan Steel Philips Screw	4 ea.
— 123.1310. 20	.204 ID, .438 OD, .032 T, Mach Screw Washer	4 ea.
— 123.4102. 40	#10 Medium Pattern Split Lockwasher	4 ea.
— 4295.262. 12	TM Generator PWS Modification	1 ea.
— 4260.262.03	Insulator Panel w/silk screen	1 ea.
— 5187.262. 60	Main CB 115 VAC Power Cable	1 ea.
— 5187.262. 64	Inverter Power Upgrade Cable	1 ea.
— 5187.262. 6401	TM 80 Inverter Power Upgrade Cable	1 ea.
— 5187.262. 67	J62 Adapter Cable	1 ea.
— 5285.262. 12	TM Pre-charge Circuit Breaker Assembly	1 ea.
— 5485.262. 2103	TM 150Kv Upgrade PWS Panel Assembly	1 ea.
— 5485.262. 27	TM Main Circuit Breaker Assembly	1 ea.
— 766.1054	5.5 " Cable Ties	12 ea.
— 766.1114	11.5 " Cable Ties	12 ea.
— 762.8522.1110	Terminal Lugs #10-#12 AWG 1/4" Yellow	2 ea.

B. DOCUMENTATION:

▸ 9026.253	TM Generator Maintenance Manual Addendum
▸ 5187.262.64	Drawing, cable.
▸ 5187.262.6401	Drawing, TM 80 cable.

3. TOOLS REQUIRED

Standard Tool Kit including the following :
- Phillips Screwdriver (magnetized tip preferred)
- Wire Cutter
- Adjustable wrench
- Socket head wrench (10-32)
- Crimper Tool

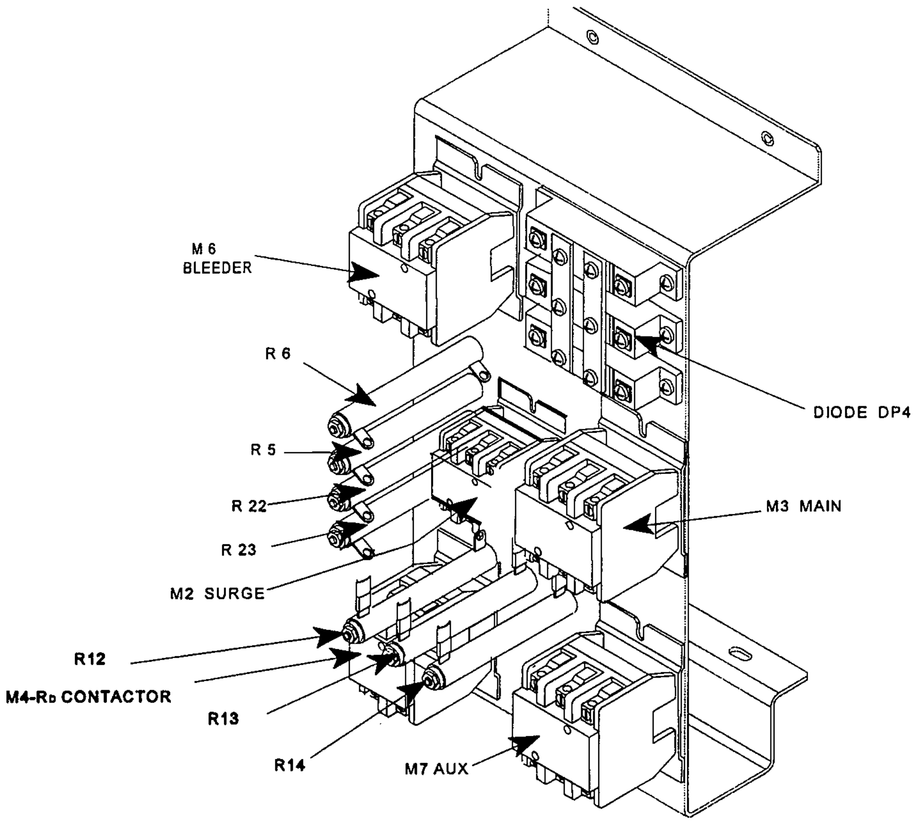


FIGURE 1 EXISTING POWER SUPPLY PANEL ASSEMBLY

4.0 RETROFIT PROCEDURE

The following sequence is recommended to allow for any problems that may be encountered during the retrofit procedure.

1. **Remove Power at the main Disconnect.** Also disconnect all auxiliary power connections and the "Room In Use" light connection.

> **WARNING!**
> **Ensure all power to the X-ray generator has been removed and that 5 MINUTES have elapsed to allow for discharge of any stored energy components, before attempting access within this area.**

4.1 Disassembly of existing Power Supply Panel Assembly (see FIGURE 1)

✓ 1. Remove the front, side, and back covers of the RPU cabinet.

✓ 2. Temporarily label and disconnect the following wires.

✓ 3. At M3 MAIN Contactor, disconnect #10 BLK wires "2-T1", "4-T2", and "6-T3".

✓ 3. At M7 AUX Contactor, disconnect ~~BRN~~ BLK wires "7-L4", "8-T4", ~~WHT~~ GREY wire "1-L1", and BLK wire "3-L2".

For R/F systems: also disconnect the BLUE wire form A1 and the WHT/BLUE wire from A2 that go to M7A, which is mounted on the Power Terminal Strip

✓ 4. At resistor R14 - disconnect #10 BLK wire "P2".

✓ 5. At M4-RD Contactor, disconnect #10 BLK wire "P1".

✓ 7. At M6 BLEEDER Contactor, disconnect ORG/WHT WIRE "A2" and ORG wire "A1".

✓ 8. At DIODE DP4, disconnect #8 BLK wires "+" and "–".

✓ 9. Locate the Power Terminal Strip (with Aux. Contactor M7A if R/F System).Disconnect and discard wires from TB9-1 (115VL) and TB9-8 (115VT)

For R/F units: disconnect and discard the wires going to the coil connections A1 and A2 of the M7A contactor)

✓ 10. Locate the two 6-pin Molex connectors (P61 and P62) which you should find at the bottom of the Power supply shelf. **Note: some older units will not have a P62 Molex.**

In units with both P61 and P62: disconnect both P61 and P62

In units without P62: ①Disconnect P61. ②Since units without this connector may have different color wire connections, it will be necessary to individually remove these wires that in newer units would connect through a "P62". These wires should now be the last remaining wires that need to be disconnected in order to remove the "old" assembly. These wires should be temporarily labeled and disconnected from:

- M3 (Main) terminal 14
- M7 -A2
- M7- A1
- M7-2T1
- M7-4T2

✓ 11. Dismount the Power Terminal Strip (with Aux. Contactor M7A if R/F System) and set it aside. There are probably some wires still connected to it but it should not be necessary to remove them. If you decide to remove them, make sure you temporarily mark them for easy re-connection later. Move the assembly aside. It will be remounted later in section 4.2 .

✓ 12. Remove existing Power Supply Panel Assembly by removing the four Phillips screws that secure it. **Note:** behind the panel, there is a spacer associated with each screw. Be careful to save this hardware because you will need it to install the new panel.

4.2 Installation of New Power Supply Panel and Main Circuit Breaker Assembly

✓ 1. Install the new Power Supply Panel Assembly 5485.262.2103.

✓ 2. Install Main Circuit Breaker Assembly 5485.262.27 (see **FIGURE 2**), using provided

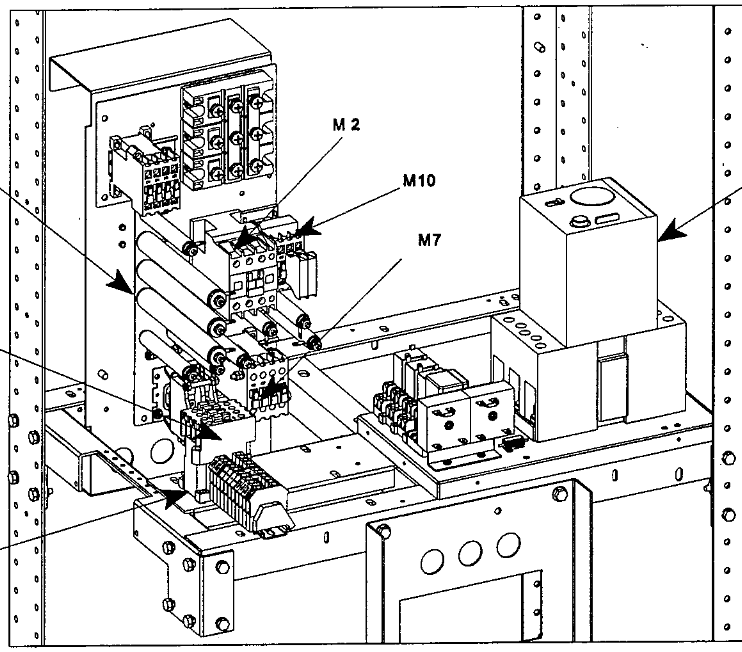


FIGURE 2 POWER SHELF (REAR VIEW)

Phillips screws and washers.

3. Connect matching connectors:

— P61 to J61,
— P63 to J63, and
— P64 to J64

✓4. **For units with P62:** connect P62 to J62

For units without P62: Use the Following table to connect the pig tails of the P62 adapter plug to the wires that were disconnected in section 4.1 step 10.

J65 JUMPER   24hr J6-3

	WIRE MARKED	CONNECT TO P62 wire color	
WHITE	M3 (Main) terminal 14 ✓	White / Black (pin 3)	
OFF WHITE	M7 -A2 ✓	Blue / White (pin 2)	→ BLUE → BLUE/WHITE
BLUE/WHITE	M7- A1 ✓	Light Blue (pin 5) NOT NEEDED DO TO JMPS	
(GREY) BRN	M7-2T1 ✓	Brown (pin 1)	
(BLACK) BLACK	M7-4T2 ✓	Black (pin 4)	

Refer to Schematic 4494.262.50 and Interconnect Diagram 4293.262.27 to ensure accurate connections of these wires.

✓5. Connect new BLACK wires (from the new Power Supply Panel assembly), 115VL to TB9-1 and 115VT to TB9-8. On R/F units, connect new Lt. BLUE wire (from the new Power Supply Panel assembly) to M7A -A1 and new BLU/WHT wire to M7A-A2.On Rad units, ensure that these two wire ends (Lt. BLUE and BLU/WHT) are insulated and tie them down.

✓6. Connect wires, ~~WHT~~ GREY wire "1-L1" and BLK wire "3-L2" , that were removed and tagged in section 4.1 step 3 to a "pig tail" emanating from the new power supply assembly. This a two conductor cable with red butt splices pre-installed to white and black wires. Match the colors black to black and white to ~~white~~ GREY and crimp the new connections with an appropriate crimping tool.

7. Connect #10 BLK wires from Circuit Breaker CB2 to DP3-AK, DP4-AK and DP5-AK.

8. Using Interconnect Drawing 4293.262.27, connect the three #10 BLK wires from Main Circuit Breaker CB-2 to Auto Transformer TB6-4, TB7-4 and TB8-4.

9. Reconnect #10 BLK wire "P2" to resistor R14.

10. Reconnect #10 BLK wire "P1" to contactor M4-RD.

11. Reconnect ORG/WHT wire "A2" and ORG wire "A1" to M6 Bleeder contactor.

12. Reconnect #8 BLK wires "+" and "–" to diode DP4. Note: **ON TM40L UNITS!** It will be necessary to replace the existing terminal lugs of these two wires with the provided yellow terminal lugs (#10-#12 AWG 1/4").

13. Reinstall Power Terminal Strip (with Aux Cont. M7A for R/F system) to its new location, as shown in **Figure 2.**

Install additional cabling into harness

1. Pull the card cage chassis out on its drawer slides and rotate the left side in and the right side out. Locate the Multi-Output Transformer TB1.

2. Disconnect the white/yellow wire from TB1-3 (third one down from the top). Cut the white/yellow wire at its terminal and strip the end back 1/4". Using the butt-splice provided with new cable 5187.262.60 , connect the stripped end of WHT/YEL wire to GRN wire going to J65-3.

3. Connect the red wire from the new cable part# 5187-262-60 to TB1-3.

4. Unplug the Molex connector going to the cooling fan in the card cage. If you have an R/F unit you may also have a fan mounted in the top panel of the RPU. In either case, install the new cable in series with either connection by plugging the male connector of the new cable into the female connector of the existing wiring harness and the female connector of the new cable into the male connector of the existing fan connection.

5. Run the cable, following the existing wiring harness to ensure that the card cage can be pulled out and rotated in the future. Connect other end of new cable part# 5187-262-60 (with connector J65) to matching connector P65 from the harness of the new Main Circuit Breaker Assembly.

4.3 Disassembly of Fuse Blocks and Installation of Pre-Charge Cct. Breaker Assy.

1 On the Power Supply Chassis Assembly (front of TM-RPU), **remove and discard** #8 BLK wire between Capacitor C15 on the Inverter Shelf and SCR fuse F9 (top terminal).

2. Remove and discard #8 BLK wire and #18 RED Teflon wire from the bottom terminal of F9 to , Anode Heat Sink of the Main Inverter (TM40, 50 and 65) or top front terminal of choke assembly (TM 80, see photo 2)and TB 5-1 of the Gate Drive PCB.

3. Remove and discard #18 WHT Teflon wire from C16 and TB 5 -2 Gate Drive PCB. C16 is located towards the front of the unit and is connected in parallel with C15. (Silk screen on the mounting board may call both of these capacitors C15.)

4. **For TM80 units:** Install new cable 5187.262.6401 where wires were removed in Steps 2 and 3 above. (See cable drawing 5187.262.6401) See Photo 2:
   - Connect the #10 wire to terminal where the wire was removed in step 2.

- Connect the white Teflon wire's spade connector to TB5-2 on the Gate Drive Board and its ring terminal to C16, where the previous white Teflon wire was connected.
- Connect the red Teflon wire's spade connector to TB5-1 on the Gate Drive Board.
- Connect the #10 and red Teflon wire's common connection to C16, opposite the terminal where the white Teflon wire is connected.

For TM40, 50 and 65 units: Install new cable 5187.262.64 (See cable drawing 5187.262.64 and Photo 1)

- Connect the #10 wire to the anode heat sink in new location to threaded hole two inches above its former connection point and attached from the rear (see Photo 1)
- Connect the white Teflon wire's spade connector to TB5-2 on the Gate Drive Board and its ring terminal to C16, where the previous white Teflon wire was connected.
- Connect the red Teflon wire's spade connector to TB5-1 on the Gate Drive Board.
- Connect the #10 and red Teflon wire's common connection to C16, opposite the terminal where the white Teflon wire is connected.

5. Disconnect three #8 BLK wires from the top terminals of line fuses F10, F11 and F12.

6. Also disconnect Power Line Cable from the bottom terminals of F10, F11 and F12.

7. Remove line fuses F10, F11 and F12 and its Fuse Block.

8. Remove SCR fuse and its fuse block.

9. Temporarily remove the neutral connector block.

10. Remove and discard the existing Insulator Panel.

11. Install new Phenolic Insulator Panel w/silk screen and secure it by re-installing the neutral connector block.

12. Using existing threaded holes on the power supply chassis, install the Pre-Charge Circuit Breaker Assembly 5285.262.12. (See **FIGURE 3**).

13. Connect Power Line Cable and #8 BLK wires from Steps 7, 6 above to Power Terminal Blocks L1, L2, L3 on Assembly 5285.262.12.

14. Refer to Interconnect Drawing 4293.262.27. Connect #10 BLK wires 2-T1, 4-T2 and 6-T3 from contactor M2 "Surge-1" on the Power Supply Panel Assembly 5485.262.2103 to 6-A circuit breaker CB1 top 3 terminals. Cables are marked 5187.262.27.

15. Connect attached #10 BLK wires from Auto Transformer TB6-4, TB7-4 and TB8-4 to CB1 bottom terminals.

16. Using Interconnect Drawing 4293.262.27, connect 2-conductor 18 AWG cable from connector J64 to Aux. normally-open contact of Circuit Breaker CB1 terminals 13 and 14. Refer to Drawing 5285.262.12 for details. When CB1 is viewed from the front, the red wire is connected to the top rear and the black wire to the bottom rear contact on part number 4181.262.2701 shown in the drawing.

17. Use the supplied cable ties to dress the wiring.

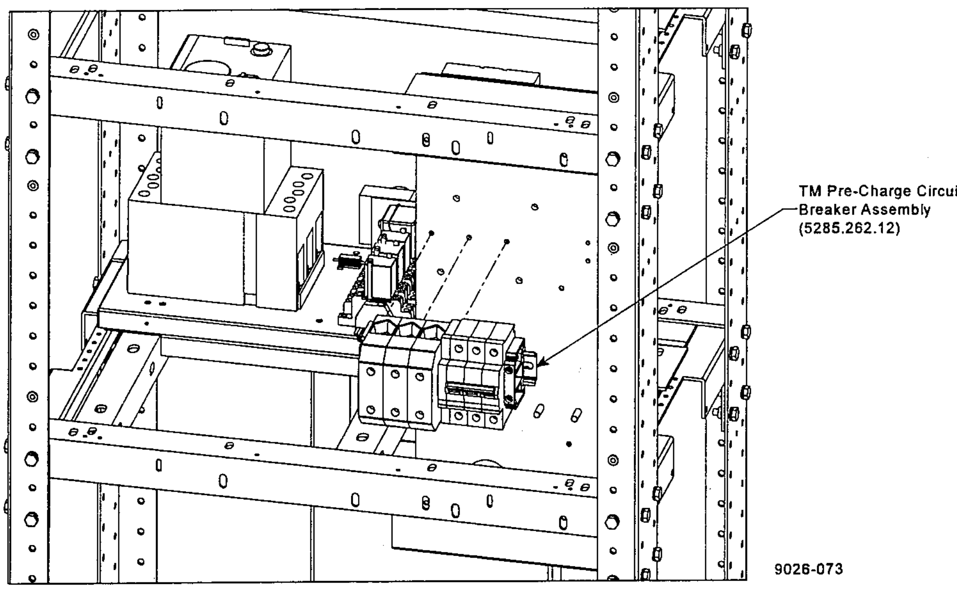


FIGURE 3 POWER SHELF (FRONT VIEW)

4.4 Testing the Upgrade Just Installed:

The unit will not need to be re-calibrated due to this change in hardware. However, the best way to test the unit is to view the kV and mA waveforms as though you were calibrating the unit. See chapter 3 of the TM manual.

1. Make exposures using the following table for techniques.

Test Techniques				
150 mA	40 KV	60 KV	125 KV	150KV
200 mA	40 KV	60 KV	125 KV	150KV
MAX mA	at	MAX	KV	possible

2. If the waveforms are correct and you do not experience any error codes, the installation of the upgrade is successful. If you do experience any error codes or incorrect waveforms; double check all your connections and try the test again.

If you have any further problems contact TREX / Continental technical support at 708-345-3070.

Please take the time to fill out the Field Upgrade Report included at the front of this bulletin. Then mail or fax the same to:
Trex Medical Corporation,
Field Service Dept.,
2000 South 25th Ave.
Broadview, IL. 60153.
Fax: (708) 345 3075.

This completes modifications to the 150Kv TM Generator Power Supply

Photo1

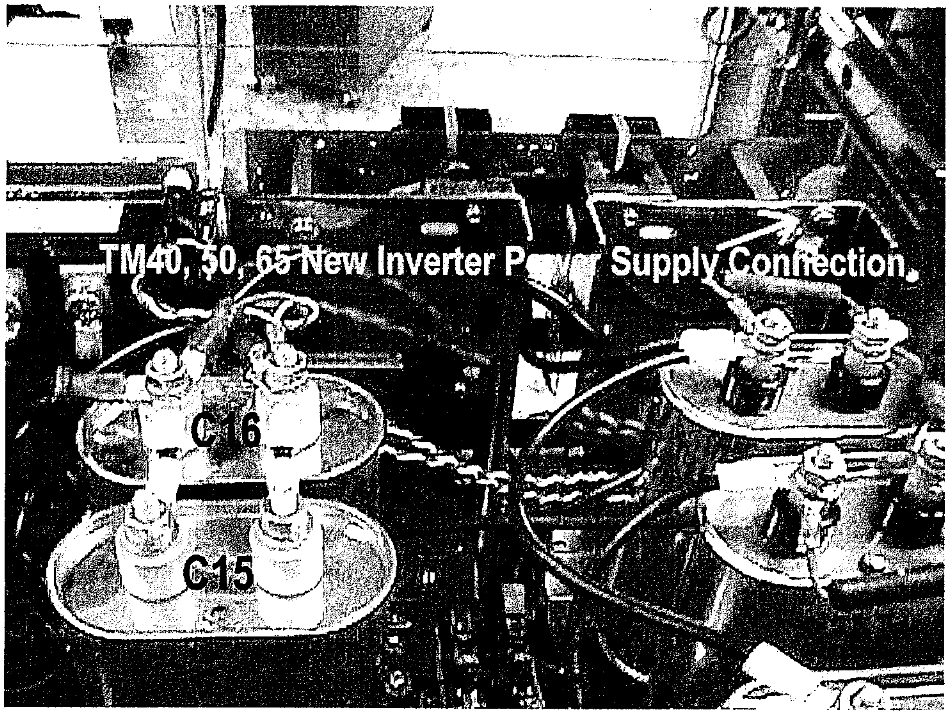
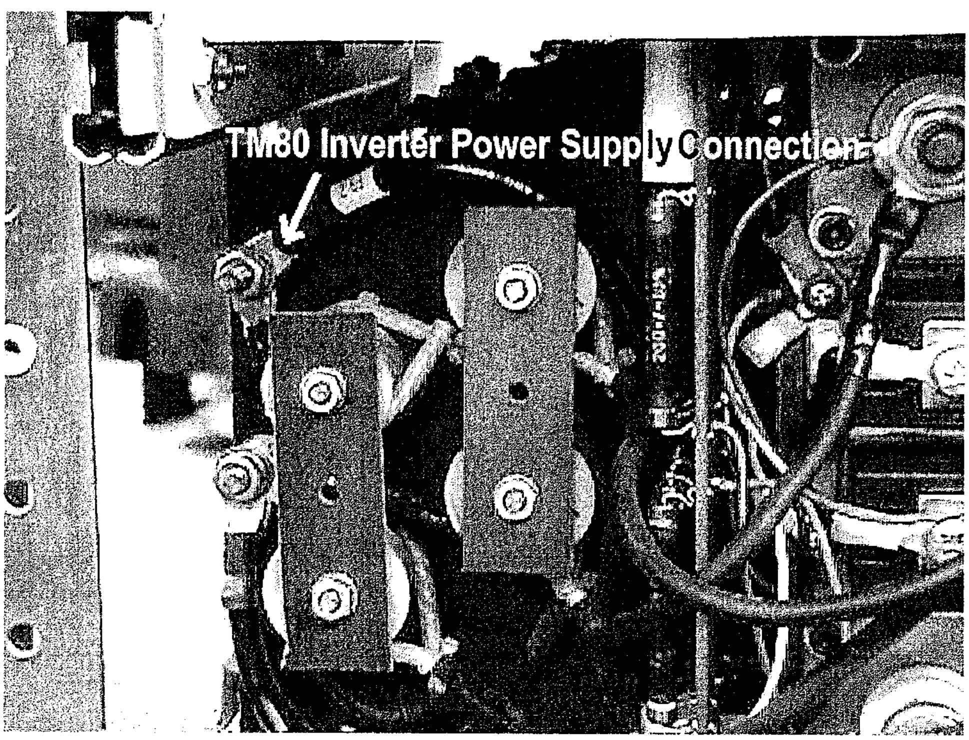
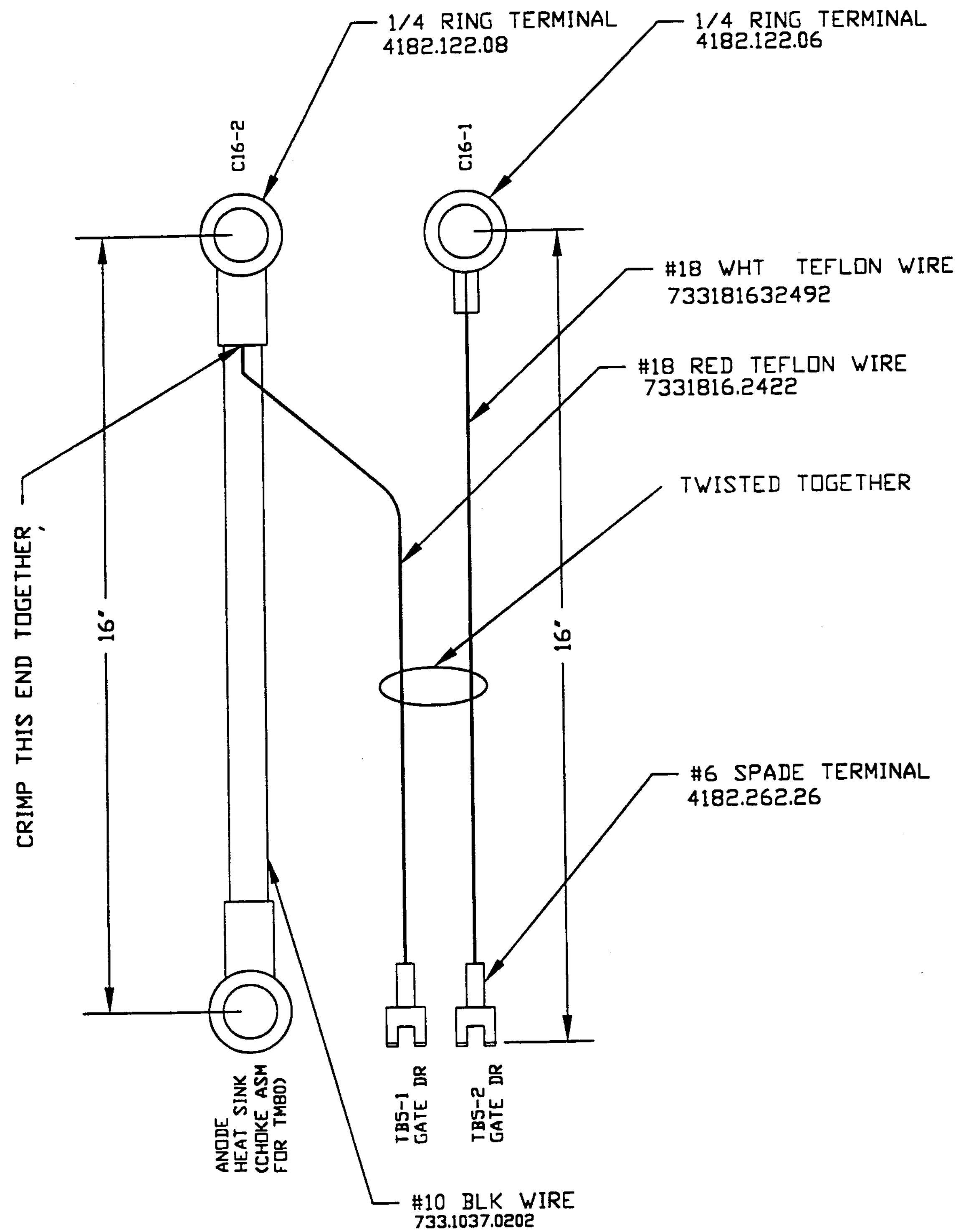


Photo 2





REV	DATE/ECN CODE	DRG.	APP.
00	9883	IN	

INVERTOR POWER UPGRADE CABLE

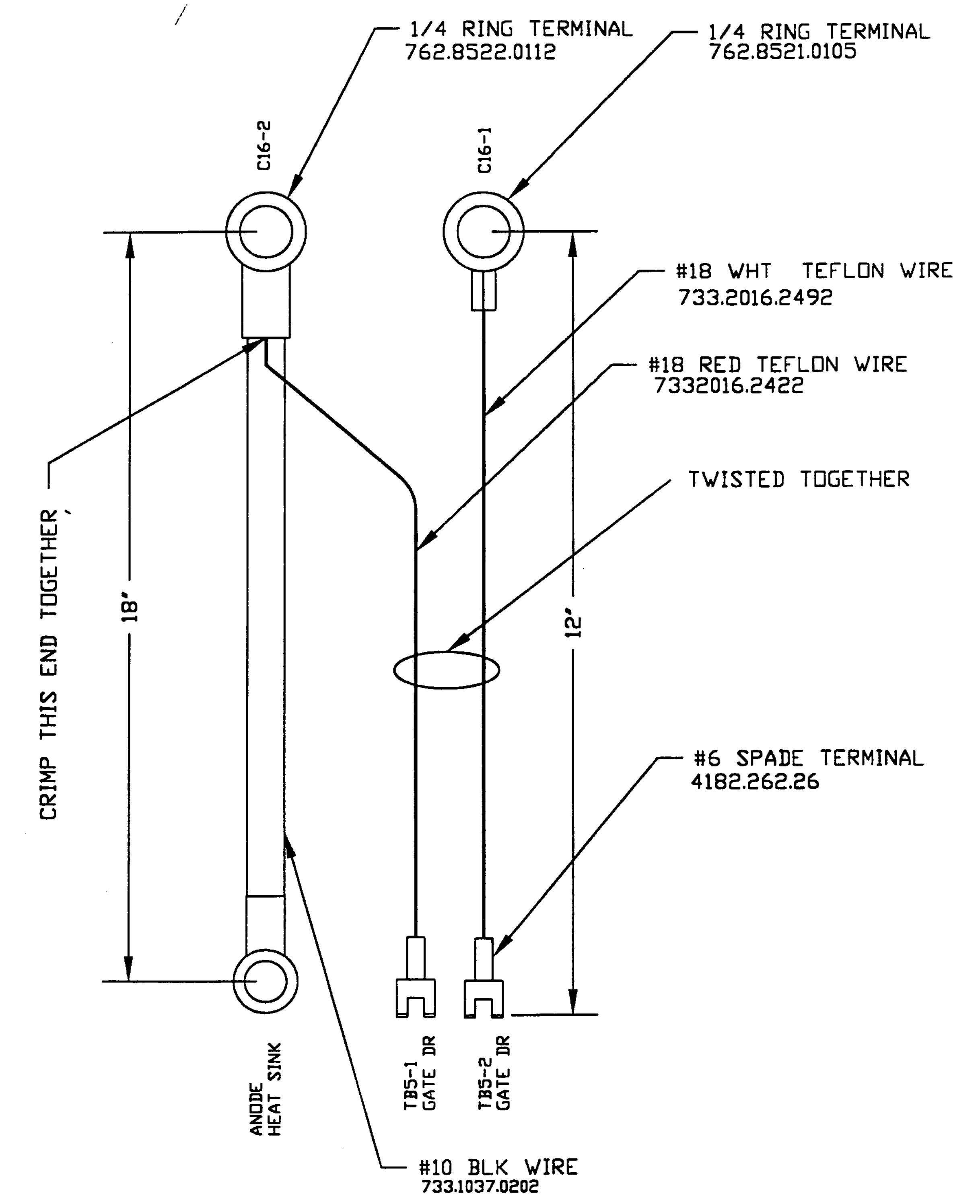
5187.262.64

MAT:

FINISH:

TREX MEDICAL
CONTINENTAL
DIVISION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE



REV.	DATE/ECN CODE	DRG.	APP.
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01	990119	IN	G.P.

TM80 INVERTOR POWER
UPGRADE CABLE

5187.262.6401

MAT:

FINISH:

TREX MEDICAL
CONTINENTAL
DIVISION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE

Important:

Before referencing any section of the manual this addendum must first be consulted if the generator incorporates the new power supply components. These new components can be recognized by the lack of main line fuses and the presence of new circuit breakers CB1 and CB2. See figures 1-1 & 1-2 in Section 1 for component locations.

The following sections of this addendum supplant specific sections of the TM manual.

Addendum Section 1: Installation - RE: Power Connection

Addendum Section 2: Calibration - RE: Line Match and Simulated Mode

Addendum Section 3: Theory of Operation - RE: Power On Sequence

Addendum Section 4: Troubleshooting - RE: Error codes that will display if the circuit breakers open or are not closed prior to turn on

Addendum Section 5: Electrical Information - RE: New Schematics

Addendum Section 6: Mechanical Information - RE: New exploded diagrams with part numbers.

SECTION 1 - INSTALLATION

1.1 POWER CONNECTION

1. Connect 3 phase line power to the connector block shown in figure 2 .Reference Schematic 4494.262.50 for input power in **SECTION 5** of this addendum.

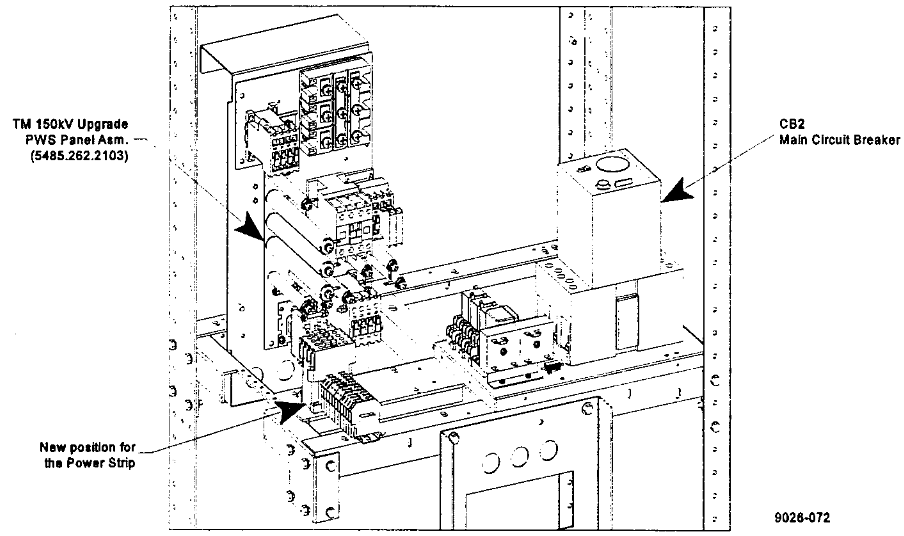


FIGURE 1-1 POWER SHELF (REAR VIEW)

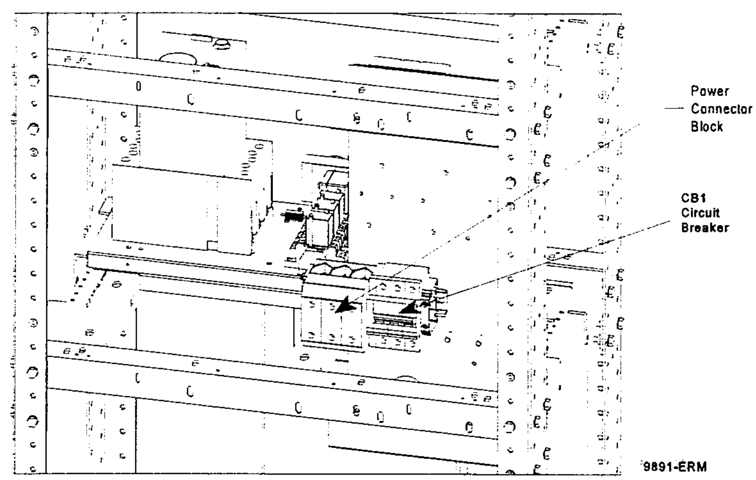


FIGURE 1-2 POWER SHELF (FRONT VIEW)

SECTION 2 - CALIBRATION

2.1 **INCOMING POWER** (replaces section 3.2.3 of the TM Maintenance Manual)
Verify that the incoming line voltage is matched to the auto-transformer. (Reference Schematic 4494.262.50 for input power in **SECTION 5** of this addendum.) Measure the line voltage at the disconnect and connect the line matching wire to the connection which corresponds to the closest match.

1. Turn OFF the inverter power supply **[SW1]**, on the fuse box (**FIGURE 2-3**, or **2-4** in the TM Maintenance Manual).
2. On the power supply shelf or turn CB1 OFF. CB1 is located next to the input power terminals (see FIGURE 1-2 of this addendum).
3. Verify all HV transformer connections are in accordance with the **RPU INTERCONNECT WIRING DIAGRAM** in **SECTION 8** of the TM Generator Manual.
4. Turn incoming power ON at the disconnect box.
5. Measure the output voltage of the autotransformer:
   TM40 3ϕ, 50/60 Hz TB6-4 to TB7-4; TB7-4 to TB8-4; TB8-4 to TB6-4 = 380 ±5%
   TM50/65 3ϕ, 50/60 Hz TB6-4 to TB7-4; TB7-4 to TB8-4; TB8-4 to TB6-4 = 351 ±5%
   TM80 3ϕ, 50/60 Hz TB6-4 to TB7-4; TB7-4 to TB8-4; TB8-4 to TB6-4 = 351 ±5%
   If not correct, find the source of the problem before continuing.
6. Turn power OFF.
7. Continue at section 3.2.4 of the TM Maintenance Manual

2.2 **SIMULATED EXPOSURE** (Replaces Section 3.4 of the TM Maintenance Manual.)

1. **On the kVp control PCB:** Remove jumpers EKV0, EKV3, and EKV9 to disable fail checks during this procedure.
2. **On the mA/mAs control PCB:** Remove the jumper EMA3, to disable filament power supply check, and install jumper EMA0, to disable Flag 21 (Filament Low Error)and Flag 7 (mA Low Error).
3. **On the I/O control PCB:** Close SW1-8.

⚠ **WARNING:**
SW1-8 WILL ALLOW X-RAYS TO BE MADE WITH THE ROTOR NOT RUNNING. THIS IS CLOSED ONLY FOR THIS PORTION OF CALIBRATION (TM MAINTENANCE MANUAL SECTIONS 3.4 THROUGH 3.7)!

⚠ **WARNING:**
ENSURE THE CB1 PRE-CHARGE CIRCUIT BREAKER IS TOGGLED OFF (AS PER STEP 2 OF SECTION 2.1 OF THIS ADDENDUM)

4. **On the card cage:** Toggle OFF CB1 (filament supply), CB2 and CB3 (rotor supply). (See figures **2-3** and **2-4** of the TM Maintenance Manual)
5. Press **[SW1]** (inverter switch) ON.

⚠ **WARNING:**
MAKE SURE THAT THE TM GENERATOR HAS BEEN OFF FOR AT LEAST 5 MINUTES!

6. Turn the TM on at the Operator's Console.
7. Measure the Charge on the Inverter Power supply. This can be done at the bottom two terminals of the Gate Drive Board TB5-1 and TB5-2. Ensure that this voltage is ZERO Volts. IF IT IS NOT, TURN POWER OFF AND WAIT UNTIL THIS VOLTAGE HAS DROPPED TO ZERO VOLTS! Then return to step 6.
8. Select: **MANUAL MODE**, **3-Factor**, **40 kVp**, **25 mA**, and **500 ms**.
9. Press both **[PREP]** and **[X-RAY]** and observe that LEDs 1, 2, 3, and 4 on the SCR Gate Drive PCB are dimly lit (gate drive signals). The LEDs must be watched very closely for they are dim, and flash very fast.

> **NOTE**:
> If you release the exposure switch prior to the end of the two second exposure, you will see a FLAG 1. If you let the exposure terminate on its own, you will see a FLAG 12. During the prep and expose, you should observe **no other error codes**.

This tests the communications of the OC to the RPU. This also tests other computer functions of the TM. The lack of other error codes appearing is a sign that the computerized section of the TM circuits are functioning correctly.

10. Turn the OC OFF.
11. **On the kVp control PCB:** Re-nstall jumpers EKV0, EKV3, and EKV9.

2.3 **NO LOAD KVP TEST** (Replaces Section 3.5 of the TM Maintenance Manual.)

The following procedure is used to make a no-load KVP test at full 150kVp level. **Safety sensing circuits will be disabled during this test**. It is therefore imperative that they be enabled after completion. This test confirms that the generator operating functions are in good order.

1. Return Surge Circuit Breaker (CB1) to the ON position.(See FIGURE 1)
2. Toggle Filament Circuit Breaker (CB1), Mains Circuit Breaker (CB2), and Rotor Circuit Breaker (CB 3) OFF.(see figures 2-5 and 2-6 of the TM Maintenance Manual)
3. **On the kVp Control PCB:** Install jumper EKV8.

> **WARNING**:
> **EKV8 IS INSTALLED ONLY FOR THIS TEST. DO NOT ATTEMPT TO MAKE AN X-RAY EXPOSURE WITH EKV8 INSTALLED.**

4. **On the I/O Control PCB:** Ensure SW1-8 is closed.
5. **On the mA/ mAs Control PCB:** Ensure EMA3 is out and EMA0 is in as per step 2 of section 2.2
6. **On the kVp Control PCB:** Connect a storage scope between TP (ground) and TP3 and set it as follows: Positive slope, 5ms/DIV, 1V/DIV
7. Place at least 2" (5.1cm) of oil in each cable receptacle.
8. Set the operator control for **40kVp, 25mA** and **.5mAs**. There will be no mA and therefore no mAs, but the above settings will normally allow for a short no-load shot for the first attempt.

> **NOTE**:
> Each time the HV inverter fires a pair of SCRs a ticking sound will be heard from the invertor shelf area of the RPU. This sound is normal, The ticking will increase in frequency each time the no- load exposure is done at a higher KVP.

9. Push the **PREP** button and when the **PREP** switch illuminates, tap the **X-RAY** button ON for the first attempt at No Load.

> **Note:**
> The exposure will terminate in approximately 250 ms, and an Error 12 flag (Exposure Time Limit Error) will appear on the console. This error is normal. Press [**RESET**] and continue. If any other error terminates the exposure, the error must be investigated and the appropriate action taken.

10. Inspect the kV Feedback ramp waveform. It should consist of 6 to 8 steps with an amplitude of about .4V and a time of about 2ms to 3ms for each step.
11. Set the scope for .2sec/DIV, select **30 mAs** and repeat **STEP 9**.
12. Press the **X-RAY** button ON and hold for about 1 second.
13. Increase the kV in 5kV steps all the way to maximum kVp, making a No-Load shot at each step. This concludes the No-Load Test. Return all jumpers and circuit breakers to there normal operating positions as per the following steps. (See also TABLE 8-8 TABLE 8-10, and TABLE 8-11 of the TM Maintenance Manual.)
14. **On the I/O Control PCB: Open switch SW1-8.** This switch MUST be open to allow the rotor to spin during an exposure.

15. **On the kVp Control PCB:** Remove jumper EKV8.
16. **On the mA/mAs Control PCB:** Remove jumper EMA0 and install it at EMA3.
17. **On the card cage:** Toggle CB1, CB2, and CB3 ON.

2.4 FILAMENT CHECK (RADIOGRAPHIC TUBE) (Replaces Section 3.6 of the TM Maintenance Manual.)

1. Coat the HV cables ends with vapor proof compound. Insert the connector into the x-ray tube. Place approximately 6cc of oil in high-voltage receptacles on transformer assembly and insert the cables into the generator.
2. If a collimator is present, open the blades fully, and move the mirror out of the way (see the collimator manufacturers manual). If the mirror cannot be moved out of the way, remove the collimator for this check.
3. Turn ON the OC.
4. Select: **MANUAL MODE, 40 kVp, 25 mA, 5 mAs, LARGE FOCUS.**
5. Press **[PREP]** only and observe via an inspection mirror, that the large filament is illuminated.

> **WARNING:**
> ⚠ **DO NOT PRESS EXPOSE! IT IS NECESSARY TO STAND ASIDE OF THE POTENTIAL X-RAY PATH AND USE AN INSPECTION MIRROR TO OBSERVE THE FILAMENT TO ENSURE THE HIGHEST LEVEL OF RADIATION SAFETY.**

6. Select: **SMALL FOCUS**, and press **[PREP]** and observe via the mirror that the small filament is illuminated.
7. Install the collimator if removal was necessary.

2.5 FILAMENT CHECK (FLUOROSCOPIC TUBE) (Replaces Section 3.7 of the TM Maintenance Manual.)

1. Remove the table top per instructions in the table Maintenance Manual.
2. Select Tube #2 and perform **SECTION 2.4** for the fluoroscopic tube.
3. Replace the top per the table Maintenance Manual.

Continue at section 3.8 of the TM Maintenance Manual.

SECTION 3 -THEORY OF OPERATION

3.1 3ϕ POWER SUPPLY

The mains input range is from 204 VAC through 480 VAC 60 Hz and 380 V~3NE through 415 V~3NE, 50 Hz. The mains must be line matched to the auto-transformer via TB6, TB7 and TB8. The auto-transformer steps the power input voltage up or down to either 351 VAC or 380 VAC.

On 150 kVp power units, the 351 VAC or 380 VAC output voltage is applied to the power rectifiers through a surge current circuit breaker (CB1), connected to the two surge contactors (M2 and M10), and then through the main circuit breaker (CB2). The purpose of the surge contactors is to limit the initial charging current to the capacitor bank of C1's and C2's. Upon power on, if the inverter power switch is on, surge contactor (M2), with its associated 10 Ohm 50 Watt current limiting resistors, activates for approximately 2 seconds. This charges the capacitors to approximately 99 % of final value. Contactor M10, with its associated 1 Ohm 100 Watt resistors, then operates, releasing M2, and completes the charge cycle. Approximately 10 seconds later, the main circuit breaker (CB2) energizes. The 351 VAC is rectified and filtered to provide approximately 490 volts DC, or if at 380 VAC to 540 volts DC for the high-voltage inverter.

There is a 24-hour Power Supply that provides power distribution to the control circuitry when the system is turned on by the ON/OFF switch on the Operator Console. There is a bleeder relay on this supply that places the bleeder resistors (R6 & R7) across the large filter capacitors whenever the unit is turned off. Additionally, there is a switch to turn off M2, M10 and CB1 to de-activate the 500 volt supply for use in troubleshooting.

SECTION 4 -TROUBLESHOOTING

4.1 EFFECTED ERROR CODES.

FLAG 21 FILAMENT LOW ERROR:

The 16 VAC power supply to the Gate Drive Board is interlocked by the Main Circuit Breaker CB1 and Main Relay K1. Therefore; if the main breaker trips or if it is in the 0 "off" position (due to the unit being powered on with CB1 tripped or in the off position) a **FLAG 21 FILAMENT LOW ERROR** will occur on PREP.

(See TM Generator Maintenance Manual Section 7 for full use of error codes).

SECTION 5 - ELECTRICAL INFORMATION

5.1 The Following Schematics are provided:

4194.262.29	**UNDER VOLTAGE RELEASE FILTER**
4293.262.27	**TM 3-PH 150 KV MAIN POWER SUPPLY INTERCONNECT**
4293.262.151	**TM 80 INVERTER T-NETWORK WIRING DIAGRAM**
4294.262.082	**TM 80 INVERTER T-NETWORK SCHEMATIC**
4294.262.083	**TM 150 KV R/F INVERTER T-NETWORK SCHEMATIC**
4494.262.50	**TM 150 KV POWER SUPPLY SCHEMATIC**

TREX Medical Corporation
Continental Division

2000 South 25th Street
Broadview, Illinois 60153

Telephone: **(708) 345-3050**
Fax: **(708) 345-3075**

MEMORANDUM

Date: **03/09/99**

To: **Field Service Organizations**

From: Customer Service

RE: New Power Supply Description

In order to enhance your understanding of the new 150kV, 3-phase power supply, attached is a chapter from our TM training manual describing its functionality. Of special value may be the chart found on the last page which details, chronologically, the specific condition of all power supply components.

We hope you find this information helpful.

Chapter 2 Power On Circuit

Circuit Description

Circuit functions:

- Provides line matching for the TM.
- Step charges the KV Inverter Power Supply Capacitors through a series of contact closures eventually providing a direct connection to the main power line via an auto transformer.
- Provides an interlock to prevent exposure in case of a tripped circuit breaker.
- Provides protection for the Inverter and it's power supply components.

Circuit Flow:

Initial Conditions: CB1 is closed, CB2 is in the "Tripped" condition and Inverter Power On/Off Switch is pushed "in" (closed).

1. Turning the power on at the wall provides 220 VAC to the 24 Hour Power Supply PCB T1 which converts 220 to 24VAC
2. Engaging the "Power on" switch at the console energizes K2 of the24 Hour Power Supply PCB which energizes K1 of the same board, the M7 and M7A AUX Contactors and the K4 (Inverter Power Relay). K1 energizes the bleeder contactor M6.
3. The AUX contactor (M7) provides 220 VAC to the Under Voltage Release of CB2. This enables CB2 to be set on or off. This 220 also powers the Multi-Output Transformer (M.O.T.) which in turn provides power to the many power supplies in the TM RPU and also the OC causing "booting" of both microprocessors.
4. The M.O.T. then provides 117 VAC to Time Delay Relay-1 through CB1 aux contact and normal closed contacts of K1 (pins 1 and 7). The time delay is set to 750 ms by R55. This relay acts as an open connection until the time delay period is over. At that time it becomes a complete connection.
5. After the 750 ms delay, K3 (SO) energizes providing:
   - 220 VAC to the motor of CB2 which drives it into the closed (out of "tripped") or "0" position. This motor current must pass through normally closed contacts of K2 (pins 1&5). When CB2 reaches the closed position, an internal limit switch terminates the current to the motor.
   - 24 VAC to the coil of M2 (Surge Relay-1) through K4 (6&4) and the normally closed contact of M10 (Surge Relay-2).
6. M2 energizing provides:
   - Main line voltage (through 10 Ohm resistors) to the KV Inverter Power Supply.

- The closing of M2's aux contact bringing power to Time Delay Relay-2 through normally closed contacts of K2 (2&6) by way of CB1 aux contact (still closed). This starts a time delay of 1.5 seconds set by R54.

7. After the 1.5 second delay, M10 (Surge Relay-2) energizes. This brings the main line power to the Inverter power supply through the 1.0 Ohm resistors R50,51 and 52. The physical nature of contacts on M10 causes time delays in the opening and closing of three aux contacts.
   - 1st contact closes and bypasses the aux of M2 (which is the "keep alive" for M10)
   - 2nd contact opens and drops out M2 (Surge Relay-1)
   - 3rd contact closes and enables Main Relay K1 (but doesn't close it)
8. Eight seconds after "booting" the RPU microprocessor, a software signal is sent via the Relay / OC Power Supply PCB (J7 pins 1&2). This signal closes K1 (Main Relay). This 24 VAC signal is present for only 1 second. This would cause K1 to drop out at the end of that time period but most likely it will remained latched through the "Trip Position" contact of CB2 (which is closed unless CB2 is tripped). This signal passes through the 3rd contact of M10 (mentioned above) to close K1.
9. K1 (Main Relay) closing causes K2 ("SC") to close and that provides 220 VAC power to CB2's motor to close the breaker to the "ON" or "1" position. This motor current must pass through K3 (1&5). K2 also drops out M10 (Surge-2) when the K2 contact at pins 2&6 opens.
10. An exposure interlock is provided by K1 pins 9&6 which passes a 16 VAC biasing power supply to the Filament Inverter. If CB2 were to trip, this would drop out K1 and remove this power from the filament inverter. This would prevent the Filament Inverter from running and would cause a Flag 21 Filament Low Error at Prep.
11. A second contact of the Inverter Power On/Off switch (SW1B) sends a signal to the RPU microprocessor via the Rad Field I/O PCB J6 pins 1 & 2. If the Switch is not "IN" (closed) a Flag 53 Surge Relay Not Energized will be displayed on the console at Prep. This signal also restarts the 8 second time delay if this switch has been activated after the TM is already on. The hardware and software actions of this switch allow the Inverter Power Supply to be turned on or off by this switch although there is no diagnostic (troubleshooting) advantage to do so.

Links

TM 150 KV Power Supply Schematic

TM Main Circuit Breaker Schematic Detail

Contactor Closure Table

Photographic Locator

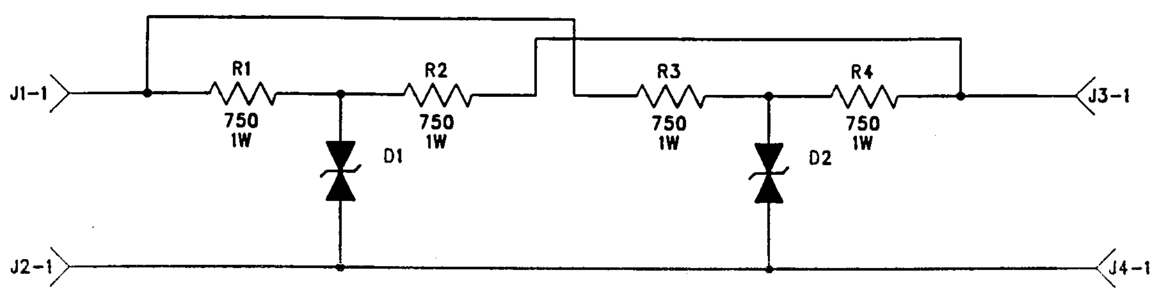
Error Codes

If this circuit fails, the most likely error codes are:

FLAG 21 FILAMENT LOW ERROR

Contactor	Pre - Power On (or Power Off)	Power On	after 750 ms	1.5 sec. Later	8 sec. after Power On	9 sec. after Power On	If CB2 TRIPS
CB1	Closed	Closed	Closed	Closed	Closed	Closed	Closed
CB2	Tripped	Tripped	Open	Relaxed	Closed	Closed	Tripped
Inverter Power Switch	IN	IN	IN	IN	IN	IN	IN
Under Voltage Release	Disable State	Enable State	Enable State	Enable State	Enable State	Enable State	Enable State
Inverter Power Relay K4	Relaxed	Energized	Energized	Energized	Energized	Energized	Energized
SC Relay K2	Relaxed	Relaxed	Relaxed	Relaxed	Energized	Energized	Relaxed
SO Relay K3	Relaxed	Relaxed	Energized	Energized	Relaxed	Relaxed	Relaxed
Main Relay K1	Relaxed	Relaxed	Relaxed	Relaxed	Energized	Energized	Relaxed
μP Main Contactor On signal	Not Present	Not Present	Not Present	Not Present	Present	Not Present	Not Present
Surge 1 Contactor M 2	Relaxed	Relaxed	Energized	Relaxed	Relaxed	Relaxed	Relaxed
Surge 2 Contactor M 10	Relaxed	Relaxed	Relaxed	Energized	Relaxed	Relaxed	Relaxed
24 hr PS K1	Relaxed	Energized	Energized	Energized	Energized	Energized	Energized
24 hr PS K2	Relaxed	Energized	Energized	Energized	Energized	Energized	Energized
Bleeder Contactor	Relaxed	Energized	Energized	Energized	Energized	Energized	Energized
AUX Contator	Relaxed	Energized	Energized	Energized	Energized	Energized	Energized
Console Power Switch	Relaxed	Energized	Energized	Energized	Energized	Energized	Energized

Yellow highlight indicates change from previous state.

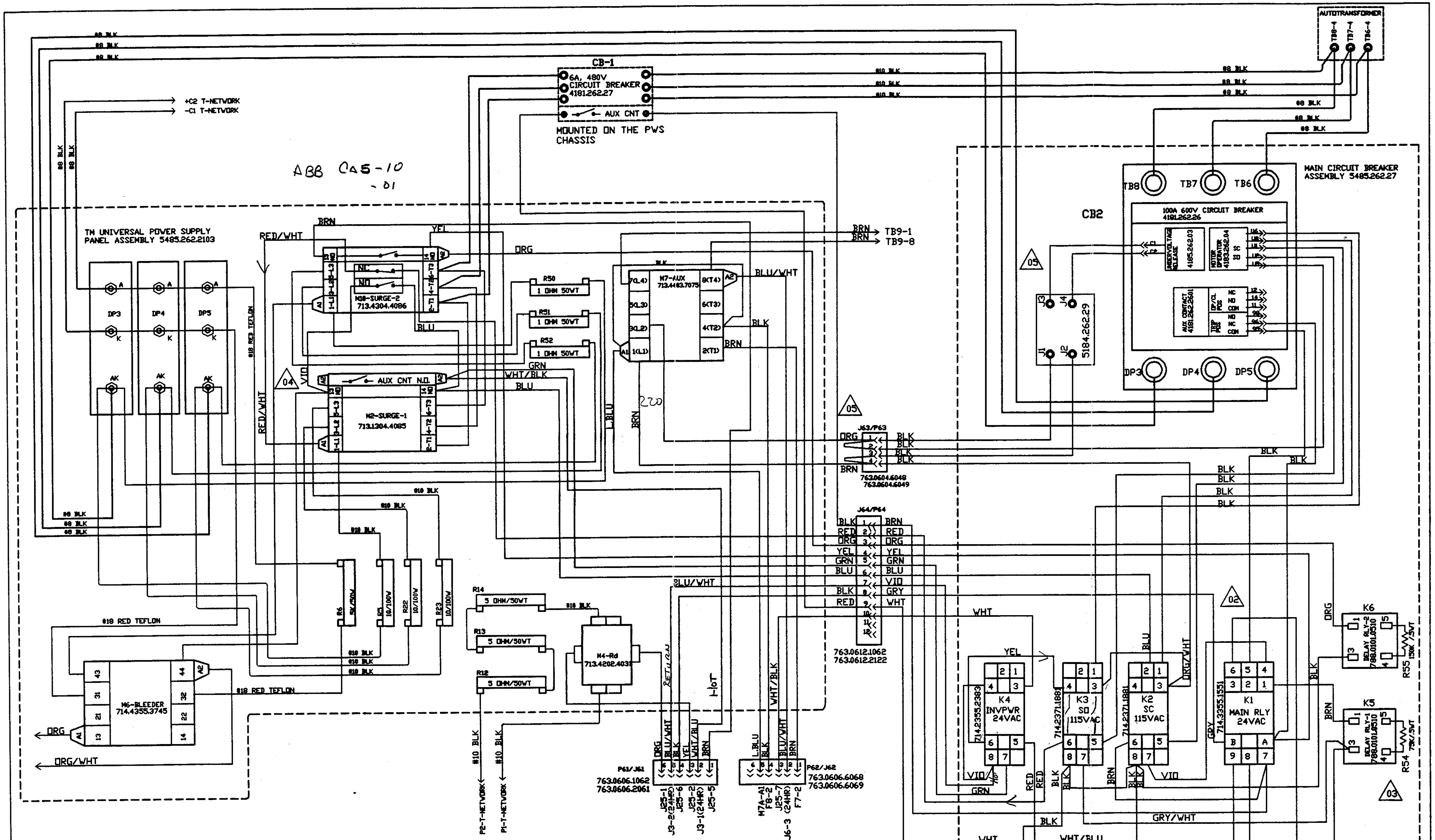


REV.	DATE CODE	ORG.	APP.
00	9892	WLW	

UNDER VOLTAGE RELEASE FILTER

4194.262.29

CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL



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02	9883	GP	
03	9885	GP	
04	981113	GP	
05	9891-02	GP	Oh

TM 3-PH 150kV MAIN POWER SUPPLY INTERCONNECT

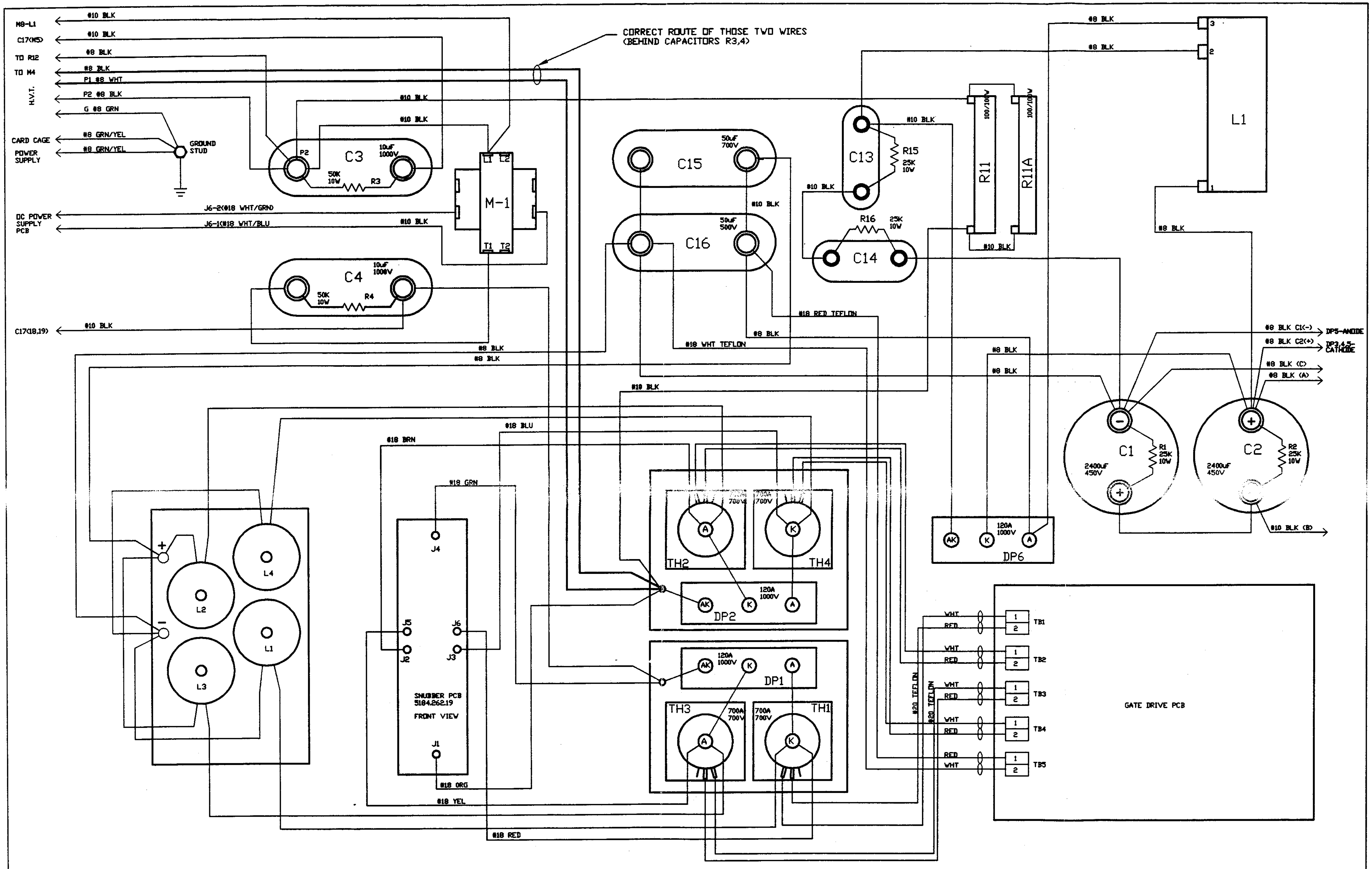
4293.262.27

MAT:

FINISH:

TREX MEDICAL
CONTINENTAL DIVISION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE



REV.	DATE/ECN CODE	DRG.	APP.
00	9873	GP	OK

TM80 INVERTOR T-NETWORK WIRING DIAGRAM

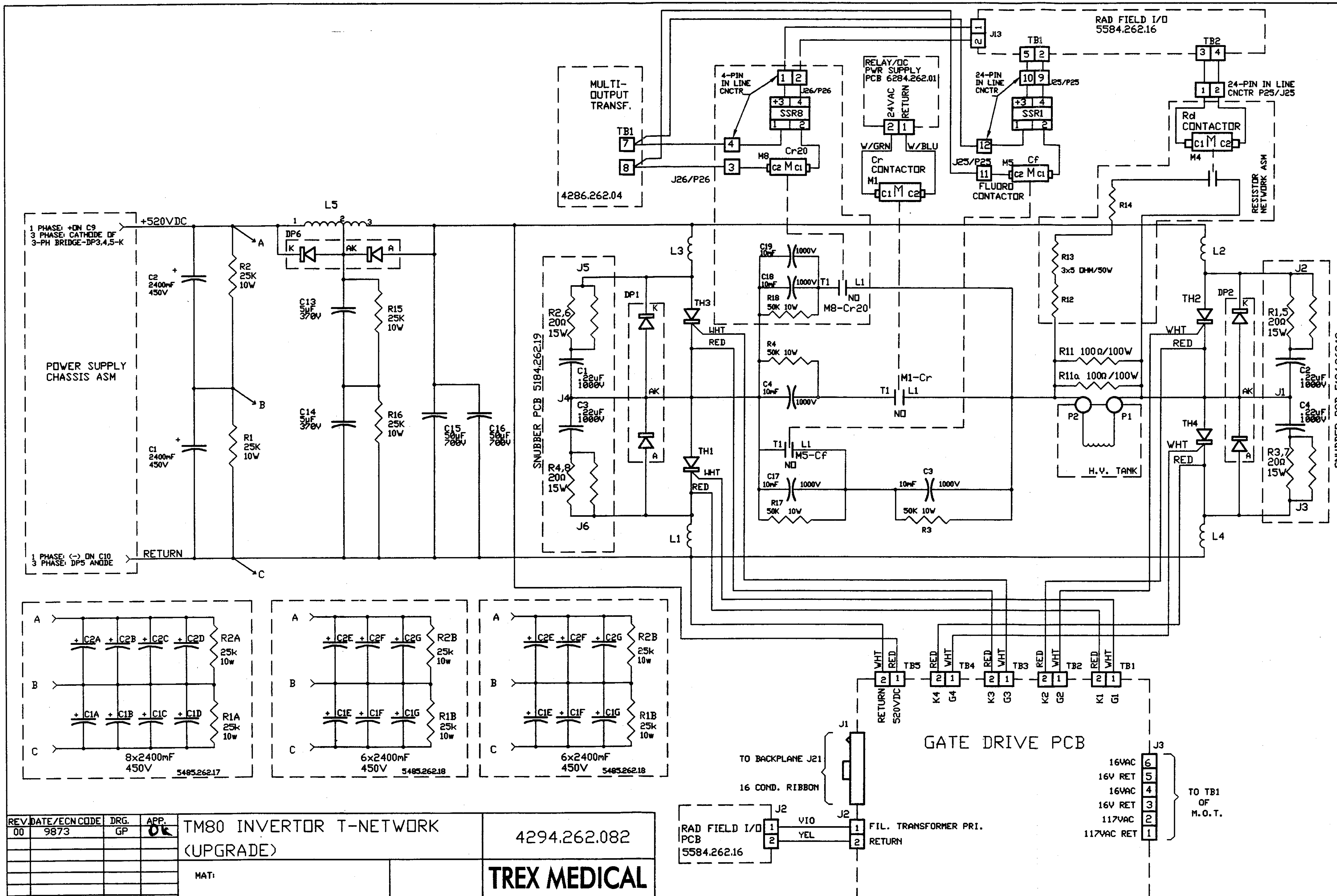
4293.262.151

MAT:

FINISH:

TREX MEDICAL
CONTINENTAL
DIVISION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE



REV.	DATE/ECN CODE	DRG.	APP.
00	9873	GP	OK

TM80 INVERTOR T-NETWORK (UPGRADE)

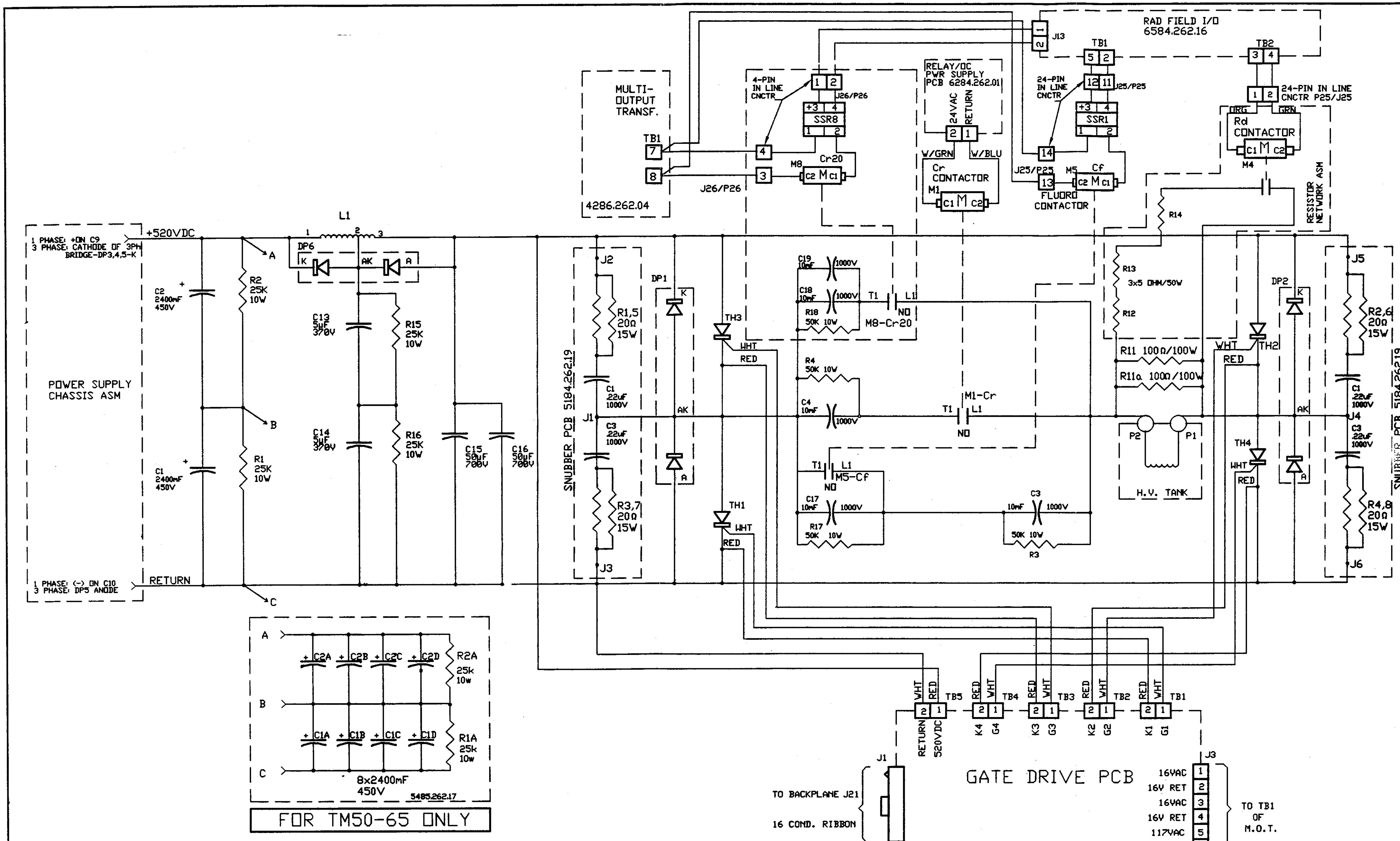
4294.262.082

MAT:

FINISH:

TREX MEDICAL
CONTINENTAL DIVISION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE



REV	DATE/ECN CODE	DRG.	APP.
00	9873	GP	

TM 150kV R/F INVERTOR
T-NETWORK SCHEMATIC

4294.262.083

MAT: –

FINISH:

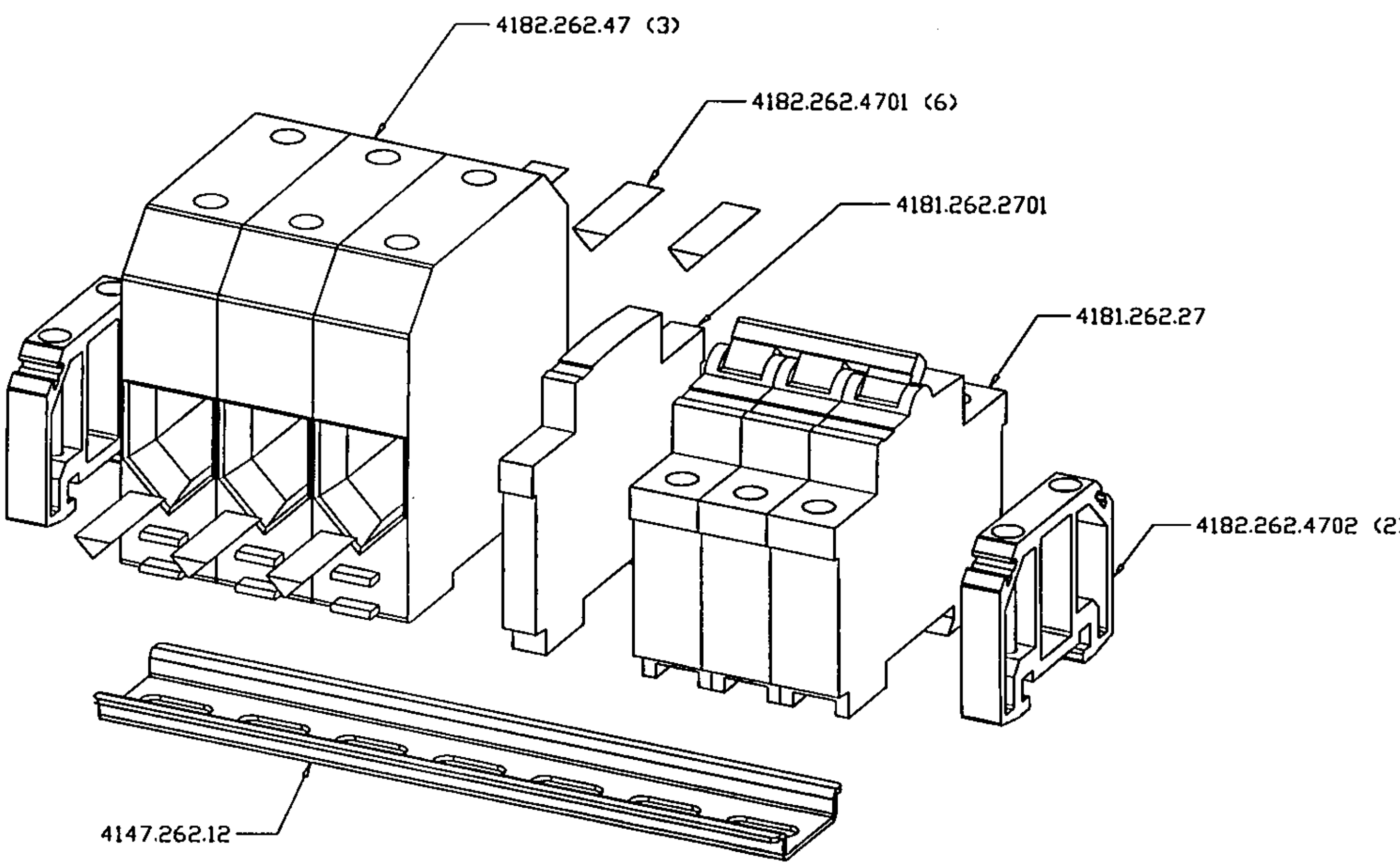
CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE

SECTION 6 - MECHANICAL INFORMATION

6.1 The Following Mechanical Diagrams are provided:

5285.262.12	TM PRE-CHARGE CIRCUIT BREAKER
5485.262.2103	TM 150 UPGRADE PWS PANEL
5485.262.27	TM MAIN CIRCUIT BREAKER



REV	DATE/ECN CODE	DRG.	APP.	
01	9879	MK	GP	TM Pre-Charge Circuit Breaker

MAT:

FINISH:

5285.262.12

TREX MEDICAL
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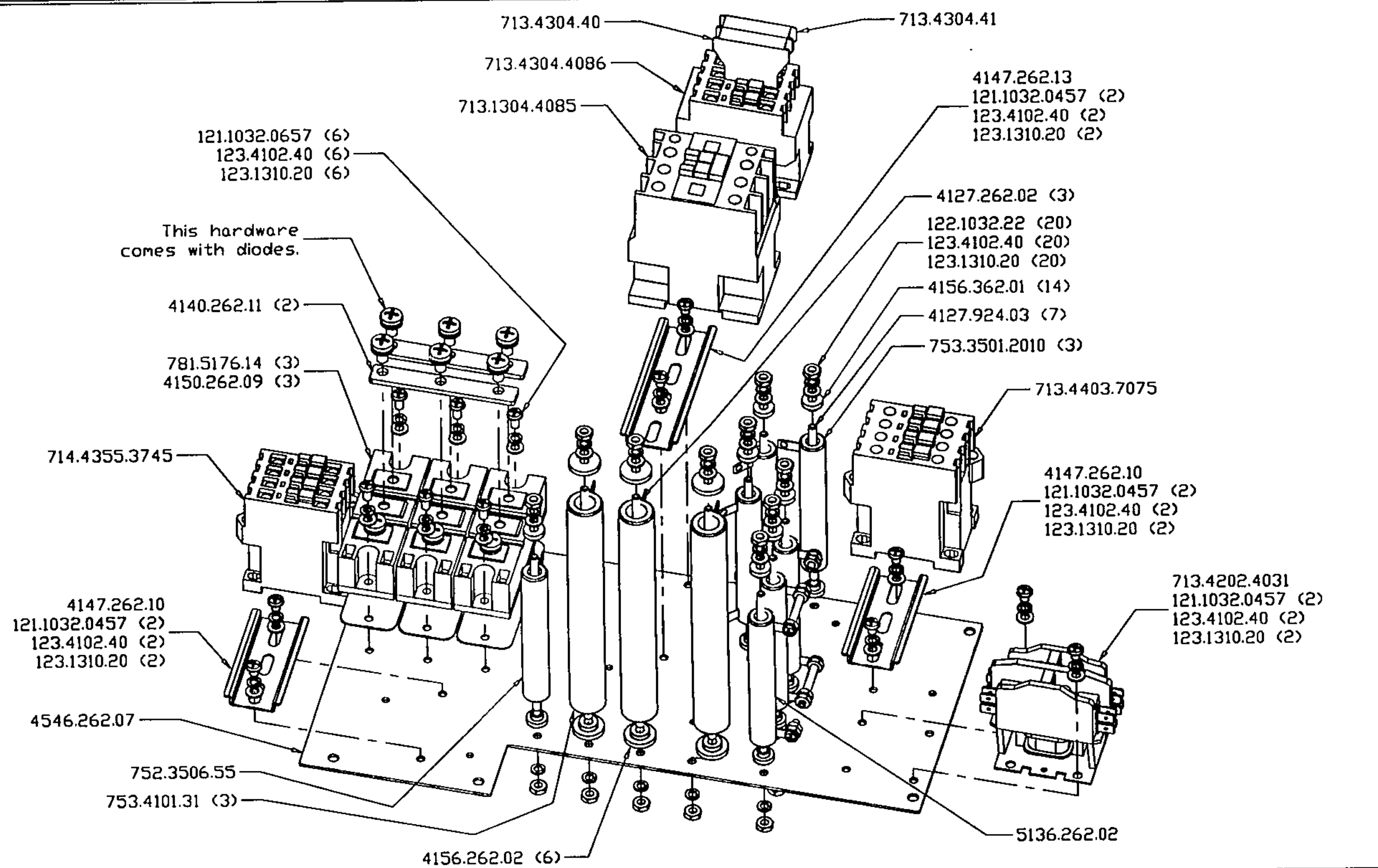
Also required:
5187.262.61 - Wiring Harness

TOLERANCES-UNLESS OTHERWISE SPECIFIED: LENGTH-DECIMALS .XXX±.005, .XX±.015-FRACTIONS ±1/32; ANGLES ± 1/2 DEGREE



REV	DATE/ECN CODE	DRG.	APP.
05	9884	MK	GP

TM 150kV Upgrade PWS Panel

5485.262.2103

MAT:

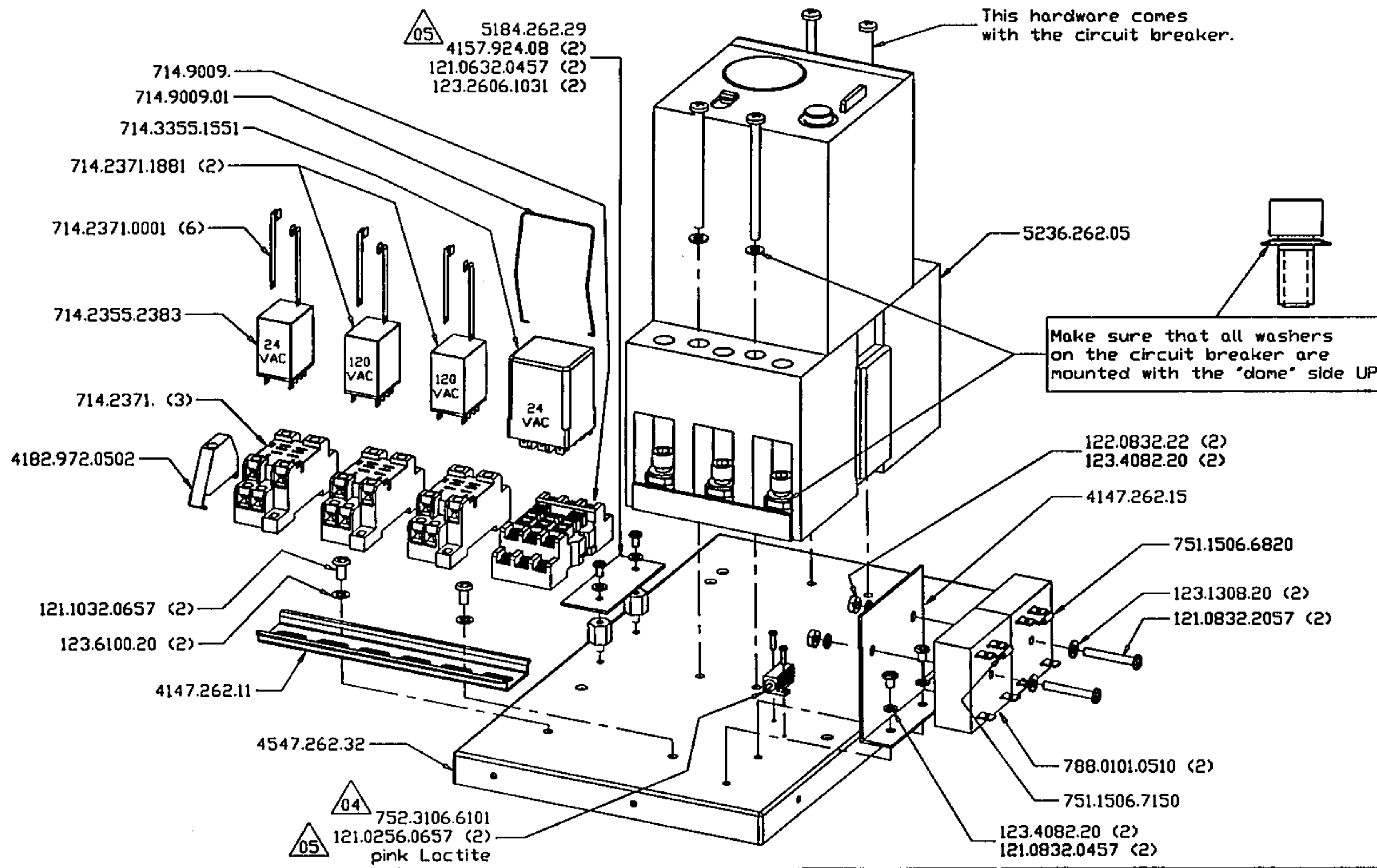
FINISH:

TREX MEDICAL
CONTINENTAL DIVISION

TOLERANCES-UNLESS OT. SPECIFIED LENGTH-DECIMALS .XXX±.005, .XX±.015-FRACTIONS ±1/32; ANGLES ± 1/2 DEGREE

Also required:
4293.262.27 - Wiring Diagram
5187.262.59 - Wiring Harness #1
5187.262.63 - Wiring Harness #2

05



REV	DATE/ECN CODE	DRG.	APP.
05	9898	MK	GP

TM Main Circuit Breaker

5485.262.27

MAT:

FINISH:

TREX MEDICAL
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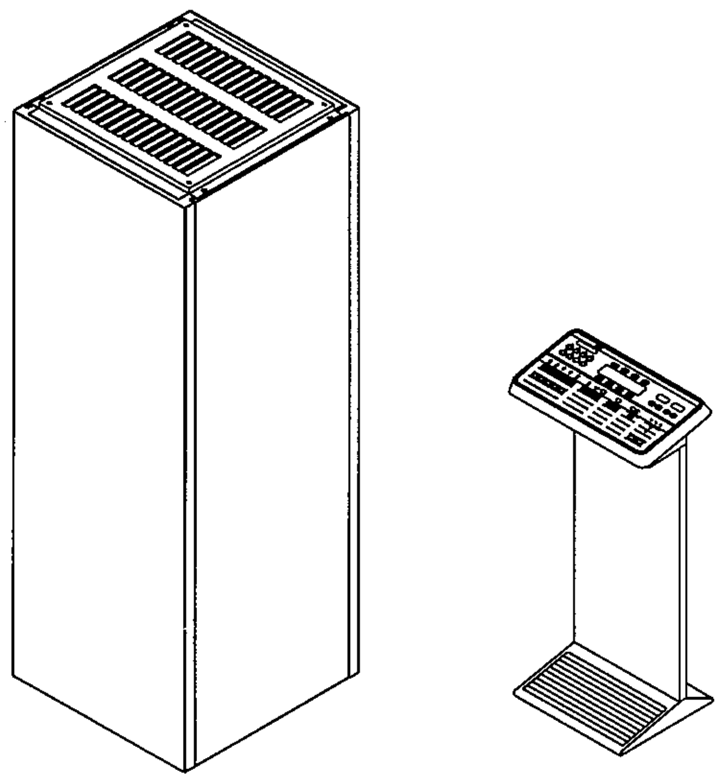
Also required:
5187.262.58 - Wiring harness.

TOLERANCES-UNLESS OTHERWISE SPECIFIED LENGTH-DECIMALS .XXX±.005, .XX±.015-FRACTIONS ±1/32; ANGLES ± 1/2 DEGREE

TREX Medical Corporation
CONTINENTAL Division

TM SERIES

X-RAY GENERATORS



MAINTENANCE MANUAL

9026.251, Revision 9890

Specifications subject to change without notice.

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9777 TUV Certification, Schematic/Diagram Organization, & Flag #11 Update/clarification
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Titlepage, TOC, Chapters 1, 2, 4, & 8.

REV REASON
9874 Revised Sectn. 4.5
PAGES
TTLpg, TOC, all in Sectn. 4, all of Sectn. 10.

REV REASON
9890 New Addendum to the manual and revisions to Chp. 8, toc.
PAGES
TTLpg, 8-11, viii

ADDENDUM 1 to TM Series Maint. Manual # 9026.251

X-Ray Tube Warm up Procedure

1. **Select the manual mode.**
2. **Select the 3-factor mode.**
3. **Select table top exposure mode.**
4. **Select the large focal spot.**
5. **Select the 200 mA station.**
6. **Select 250 ms time. (mAs should read 50)**
7. **Select 80 kVp.**
8. **Make 5 exposures, @ 30 seconds apart.**

The Tube warm up procedure is complete.

X-Ray Tube #1 Warm up Procedure

1. **Select the Manual mode.**
2. **Select the 3-factor mode.**
3. **Select the table top exposure mode.**
4. **Select the large focal spot.**
5. **Select the 200 mA station.**
6. **Select 250 ms time. (mAs should read 50)**
7. **Select 80 kVp.**
8. **Make 5 exposures, @ 30 seconds apart.**

The Tube warm up procedure is complete.

X-Ray Tube #2 Warm up Procedure

1. **Set up for fluoroscopy per the exam you are going to do first.**
2. **Place a single layer of a lead apron on the table top under the image intensifier.**
3. **Position the table bucky under the lead apron and the image intensifier so you have something to view on the monitor.**
4. **Press the fluoroscopic button on the handle or step on the foot pedal for 15 seconds.**
5. **Watch the fluoroscopic timer to monitor the 15 seconds of time.**
6. **Watch the monitor also to make sure you have an image and that the system is functioning properly for your first exam.**

The Tube warm up procedure is complete.

SECTION 1 - SPECIFICATIONS

1.1 SCOPE

This chapter provides the architect, room layout designer, and installer with the information necessary to properly plan an installation using the TM X-ray generator. This chapter can be configured two ways: it may be supplied as a separate entity, or as chapter one of the TM X-Ray Generator Maintenance Manual.

- If it is supplied as a pre-installation information package, it will be a stand-alone document containing all the information required to plan for the proper and safe installation of the generator. It will be supplied with an identifying cover sheet.
- If it is contained within the Maintenance manual, the subsequent chapters provide the information required to install, calibrate, and maintain the generator.

> **CAUTION:**
> ⚠ **Federal law restricts this device to sale by or on the order of a health care practitioner.**

1.1.1 NOTES, CAUTIONS & WARNINGS

This manual uses notes, cautions, and warnings to alert the technician and operator to important information. The definitions and presentation of notes, cautions and warnings are as follows:

> **Notes:**
> Provides information which is of special importance (i.e. hint or shortcut).

The **Note:** may be placed within a box, as above, or within the text depending on the importance of the information.

> **CAUTION:**
> ⚠ **Provides information to prevent minor injury or damage to equipment.**

> **WARNING:**
> ⚠ **PROVIDES INFORMATION TO PREVENT SERIOUS INJURY OR DEATH OR EXTENSIVE DAMAGE TO EQUIPMENT.**

1.2 DESCRIPTION

The TM x-ray generators are high frequency x-ray generators. The TM generators consist of the Operator Control (OC), Remote Power Unit (RPU) and X-Ray Generator. **TABLES 1-2** through **1-6** list the TM generator models.

TABLE 1-1 1-TUBE RAD MODELS

SYSTEM	COMPONENTS
TM30	6626.232 or 6626.232B OC and RPU 6536.206 1 tube, 125 kVp Generator
TM30L	6626.245 or 6626.245B OC & RPU 6536.205 1 tube, 150 kVp Generator
TM40	6626.233 or 6626.233B OC and RPU 6536.206 1 tube, 125 kVp Generator
TM40L	6626.246 or 6626.246B OC & RPU 6536.205 1 tube 150 kVp Generator
TM50	6626.235 or 6626.235B OC & RPU 6536.205 1 tube 150 kVp Generator
TM65	6626.234 or 6626.234B OC and RPU 6536.205 1 tube 150 kVp Generator

TABLE 1-2 2-TUBE RAD MODELS

SYSTEM	COMPONENTS
TM30-2	6626.238A or 6626.238B OC & RPU 6536.211 2 tube, HHF 150 kVp Generator
TM40-2	6626.239A or 6626.239B OC and RPU 6536.211 2 tube, HHF 150 kVp Generator
TM50-2	6626.236A or 6626.236B OC & RPU 6536.211 2 tube, HHF 150 kVp Generator
TM65-2	6626.209A or 6626.209B OC and RPU 6536.211 2 tube, HHF 150 kVp Generator
TM80-2	6626.214A or 6626.214B OC and RPU 6536.211 2 tube, HHF 150 kVp Generator

TABLE 1-3 2-TUBE R/F MODELS	
SYSTEM	**COMPONENTS**
TM30 R/F	6626.241A or 6626.241B OC & RPU 6536.211 2 tube, HHF 150 kVp Generator
TM40 R/F	6626.205A or 6626.205B OC and RPU 6536.211 2 tube, HHF 150 kVp Generator
TM50 R/F	6626.237A or 6626.237B OC & RPU 6536.211 2 tube, HHF 150 kVp Generator
TM65 R/F	6626.211A or 6626.211B OC and RPU 6536.211 2 tube, HHF 150 kVp Generator
TM80 R/F	6626.212A or 6626.212B OC and RPU 6536.211 2 tube, HHF 150 kVp Generator

TABLE 1-4 1-TUBE R/F MODELS	
SYSTEM	**COMPONENTS**
TM 1T R/F	6626.204 OC & RPU 6536.206 1 tube, 125 kVp Generator

TABLE 1-5 1-TUBE FLUORO MODELS	
SYSTEM	**COMPONENTS**
TM EP	6626.242A or 6626.242B OC and RPU 6536.213 1 tube, HHF 125 kVp Generator

1.2.1 SYSTEM ARCHITECTURE

The TM systems consist of two major assemblies the OC and RPU, and HV generator. For systems configured with the high speed starter (see **TABLE 1-11**), a second cabinet is included which houses the high speed starter. **FIGURES 1-1** through **1-3** illustrate three basic configurations of the TM models.

<u>MODELS</u>
TM30, TM40,
TM EP, TM 1T R/F

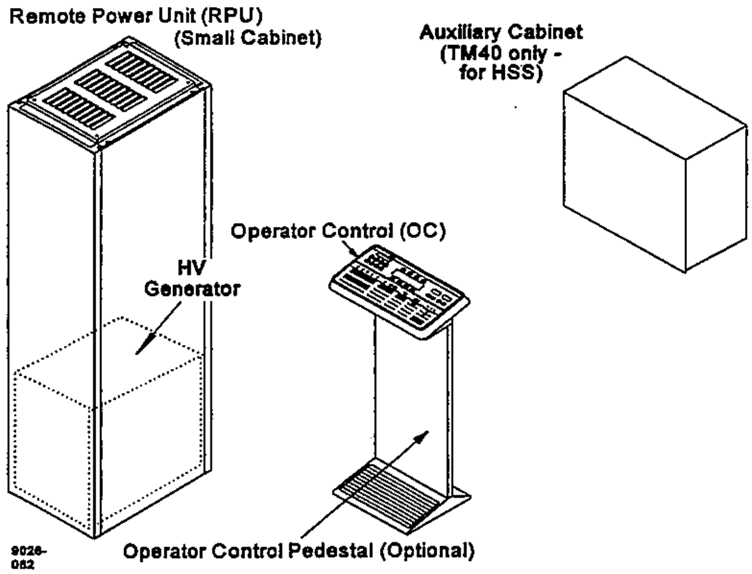


FIGURE 1-1 TM GENERATOR COMPONENTS, SMALL RPU

<u>MODELS</u>
TM30 & TM40 with PMT 6000,
TM30L, TM30-2
TM40L, TM40-2
TM50, TM50-2
TM65, TM65-2
TM80-2
TM30 R/F
TM40 R/F
TM50 R/F
TM65 R/F
TM80 R/F

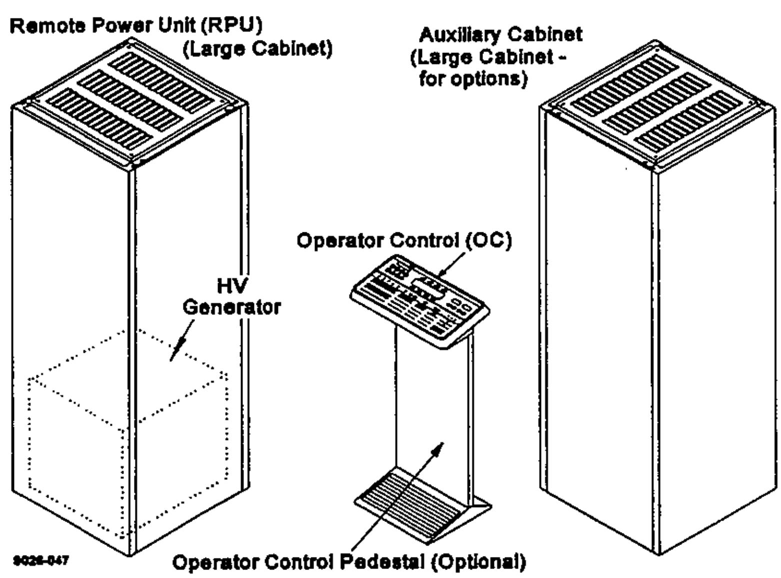


FIGURE 1-2 TM GENERATOR COMPONENTS, LARGE RPU

The RPU consists of three major subassemblies (**FIGURE 1-3**), the card cage, inverter/T-network, 1ϕ or 3ϕ power supply. The high voltage transformer is also housed within the RPU cabinet.

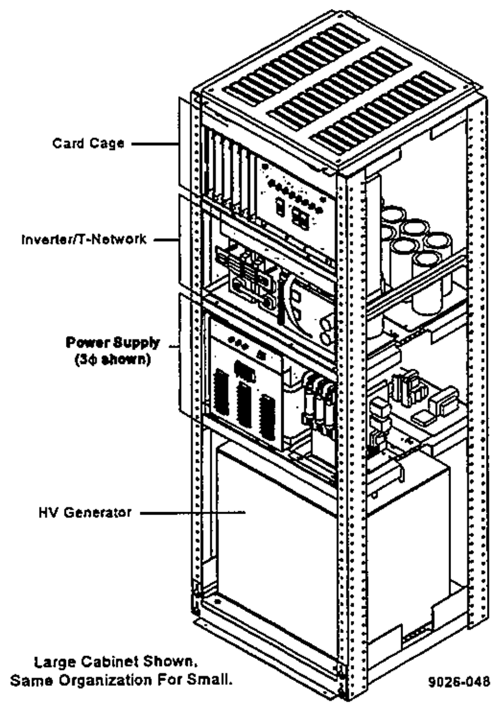


FIGURE 1-3 RPU MAJOR SUBASSEMBLIES

1.2.2 MODES OF OPERATION

The TM generators can be operated in four (five for R/F units) different modes:

1. **Three Factor:** Operator selects kVp, mA and Time.
2. **Two Factor:** Operator selects kVp and mAs. The highest mA and the shortest exposure time is utilized.
3. **Computerized Exposure Control (CEC):**
   X-ray factors are determined from a stored technique table. The operator can change the displayed body part thickness and have the techniques automatically change to compensate.
4. **Anatomically Preprogrammed Radiography (APR):** (must have AEC option)
   The operator selects body group, view section and patient size.
5. **Fluoroscopic Mode** (for R/F units only):
   3 Modes of Operation: ABS (Automatic Brightness Stabilizer) IN or OUT
   Continuous fluoroscopy
   Pulsed fluoroscopy

> **NOTE:**
> Pulsed fluoroscopy requires the use of a progressive scan TV camera system.

1.2.3 FEATURES

Radiographic and Radiographic/Fluoroscopic systems:

- Output ripple typically less than 4%.
- Built-in tube overload protection includes load and anode heat calculator.
- Last exposure recall.
- Built-in diagnostics to aid fault determination.
- "BIT" system allows quick and accurate changes in techniques for proper film density.
- Factory programmed with standard APR and CEC techniques.

- Serial PC interface to facilitate changes to the factory program for downloading APR and CEC information to the TM OC and downloading the information from the TM OC to the PC. This facilitates changes to the TM techniques as programmed at the factory.
- High speed starter (TM65, TM65-2, TM65 R/F, TM80 R/F)
- PMT 6000 servo tomo (TM30L, TM30-2, TM40L, TM40-2, TM50, TM50-2, TM65, TM65-2, TM80-2)
- Label printer.

Radiographic/Fluoroscopic Systems ONLY:
- Continuous or optional Pulsed Mode for fluoroscopy.
- 5-minute hold feature that keeps the fluoroscopy mode in a ready state for 5 minutes after release of the foot switch or a spot-film exposure. This provides an instant on image if fluoroscopy is initiated during this period. If the system is out of the 5-minute hold time, a short time is required to boost the rotor and filament of the x-ray tube before fluoroscopy is initiated.
- Display of fluoroscopic factors at both the spot-film device and the operator's console.

1.2.4 OPTIONS

- Remote exposure switch
- Printer
- OC Pedestal.
- High speed starter
- Servo tomographic system

1.3 SPECIFICATIONS

This section presents the requirements and performance characteristics of a properly installed TM generator.

1.3.1 PHYSICAL SPECIFICATIONS

Shipping Weight:			
Continental U.S. -	RPU, OC, and Generator -	1030 lbs	(470 kg)
	Covers -	200 lbs	(91 kg)
Offshore -	RPU, OC, Generator, & Covers -	1350 lbs	(615 kg)
Shipping Container Dimensions:	See Figure 1-4		
Installed Dimensions:	See Figure 1-5		
Heat Output:	1500 BTU/Hr (1.6MJ/Hr)		

TABLE 1-6 WEIGHTS

SYSTEM	GENERATOR	RPU(1)	OC(2)	AUXILIARY CABINET
TM30, TM40, TM 1T R/F, TM EP	215 lbs (98 kg)	325 lbs (148 kg)	6.5 lbs (3 kg)	N/A
TM65, TM30-2, TM30A-2, TM40-2, TM50-2, TM65-2, TM65 R/F, TM80 R/F	310 lbs (141 kg)	525 lbs (240 kg)	6.5 lbs (3 kg)	275 lbs (125 kg)
TM30L, TM30A, TM40L, TM50, TM80-2, TM30 R/F, TM30A R/F, TM40 R/F, TM50 R/F, TM65 R/F	310 lbs (141 kg)	490 lbs (223 kg)	6.5 lbs (3 kg)	275 lbs (125 kg)

(1) RPU weight does not include weight of generator. To get fully installed RPU weight, add generator weight to that of the RPU.

(2) If optional pedestal is ordered, add 45 lbs (20.5 kg) to the OC weight.

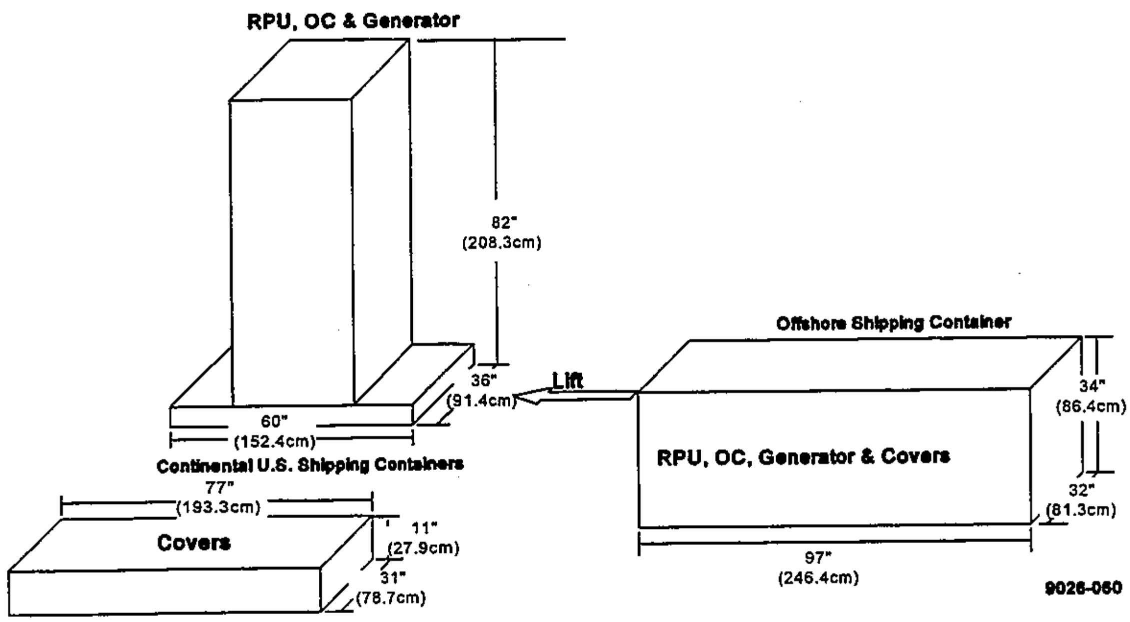


FIGURE 1-4 TM SHIPPING DIMENSIONS

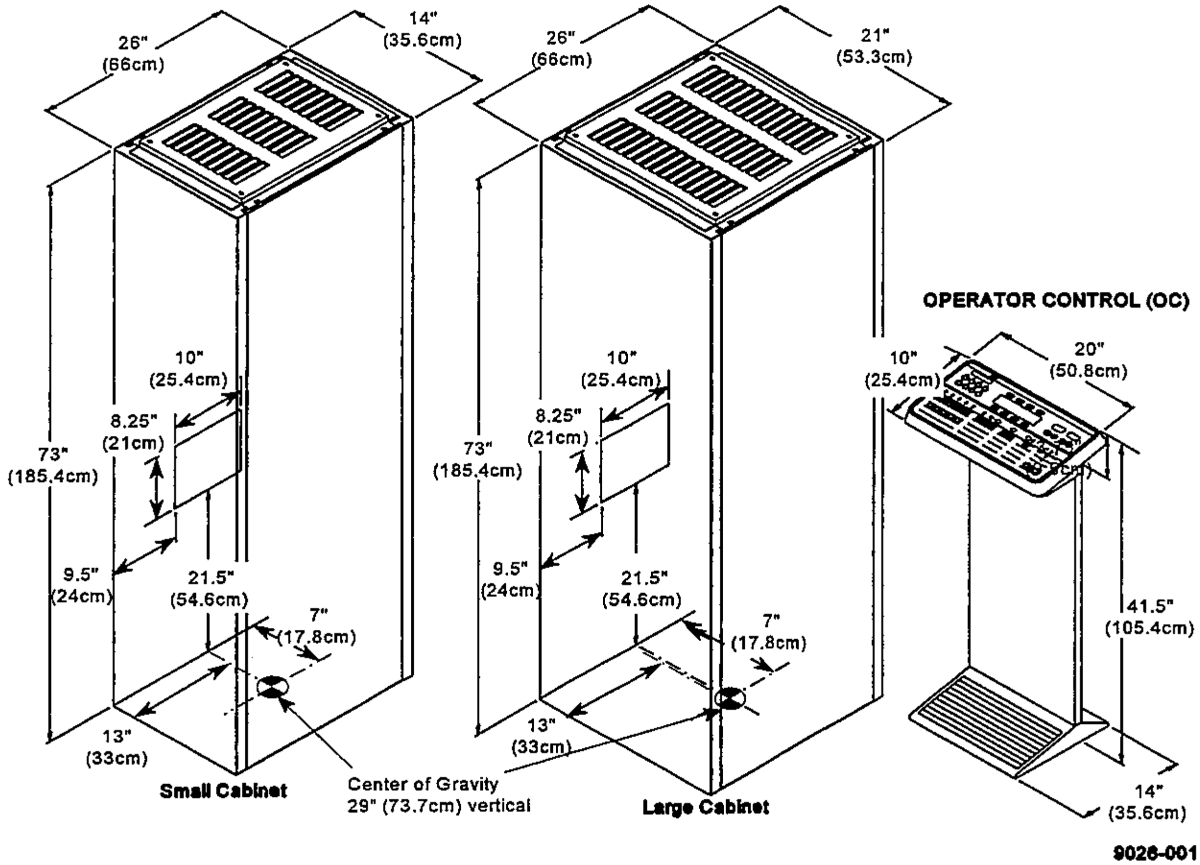


FIGURE 1-5 TM COMPONENT DIMENSIONS

1.3.2 INPUT POWER REQUIREMENTS

TABLE 1-7 TM GENERATOR INPUT POWER REQUIREMENTS

SYSTEM	Φ	INPUT LINE VOLTAGE
TM30, TM30L,TM30-2, TM30 R/F, TM 1T R/F, TM EP	1	60Hz: 208/240/277 50Hz: 220/230/240
TM40, TM40L, TM40-2, TM40 R/F	3	60Hz: 208/240/480 50Hz: 380/400/415
TM50, TM50-2, TM50 R/F	3	60Hz: 240/480 50Hz: 380/400/415
TM65, TM65-2, TM65 R/F	3	60Hz: 240/480 50Hz: 380/400/415
TM80-2, TM80 R/F	3	60Hz: 480 50Hz: 380/400/415

Note: Line regulation not greater than 8% for all systems.

TABLE 1-8 MINIMUM POWER SUPPLY REQUIREMENTS

NOMINAL LINE VOLTAGE (VAC) /Hz	RECOMMENDED DISTRIBUTION TRANSFORMER CAPACITY (kVA)	WIRE SIZE FROM DISTRIBUTION TRANSFORMER TO DISCONNECT (AWG)			X-RAY DISCONNECT MEANS (amp)			LINE IMPEDANCE Ohms	MOMENTARY LINE AMPS AT FULL LOAD (RMS amp)
					ALTERNATE #1		ALT #2		
		50 FT 15 m	100 FT 30 m	200 FT 61 m	Switch	Fuse	Circuit Breaker		
TM EP									
208/60	15	6	3	1	60	40	40	.23	72
220/50	15	10mm²	16 mm²	35 mm²	30	30**	30	.34	51
220/60	15	8	6	3	30	30	30	.34	51
240/60	15	8	6	4	30	25	25	.41	46
TM30, TM30-2, TM30 R/F, TM30L, TM 1T R/F (1ϕ)									
208/60	60	2/0	3/0	300MCM	200	160	200	.053	310
220/50	60	50mm²	95 mm²	150 mm²	200	150**	150	.075	280
240/60	60	1	2/0	250MCM	200	150	150	.075	255
277/60	60	3	1	3/0	200	100	100	.11	195
TM40, TM40L, TM40-2, TM40 R/F (3ϕ)									
208/60	75	3	0	4/0	100	100	100	.087	190
240/60	75	4	1	3/0	100	100	100	.11	165
380/50	75	16mm²	25 mm²	50 mm²	60	60	60	.25	120
480/60	75	8	6	4	60	50	60	.43	88
TM50, TM50-2, TM50 R/F (3ϕ)									
240/60	100	1	0	4/0	200	150	150	.078	245
380/50	100	25mm²	35 mm²	75 mm²	100	100	100	.17	178
480/60	100	6	4	2	100	70	70	.30	125
TM65, TM65-2, TM65 R/F (3ϕ)									
240/60	110	0	2/0	300MCM	200	150	150	.066	290
380/50	110	35mm²	50 mm²	95 mm²	100	110	110	.13	233
480/60	110	4	4	1	100	75	75	.23	165
TM80-2, TM80 R/F (3ϕ)									
380/50	150	75mm²	95 mm²	120 mm²	200	170	170	.09	325
480/60	150	1	1	0	200	125	125	.16	240

NOTES:1. All wire sizes assume copper wire.
2. Maximum line drop of 8% under full load; if in doubt, increase wire by one gauge size.
3. A three-wire feed is recommended for 1ϕ and a five-wire feed is recommended for a 3ϕ (Y) line.
4. All wiring and connections in accordance with all applicable codes.
5. Wires sizes based on NEC Table 310-16, 75°C, for copper wire @ 25°C ambient.
6. Ground in accordance with NEC **TABLE 250-94**, or local code, whichever takes precedence. Recommend that ground conductors be the same size as the power conductor.
7. **For 1ϕ power line with grounded neutral, fuse only the hot line!

* TM65 and TM80 generators use HS2-MPX R high speed starter. The installer is required to provide a separate 208 to 240 $V\sim_{AC}$, 50/60 Hz, 1ϕ power line with branch circuit protection of 20A.

1.3.3 RADIOGRAPHIC SPECIFICATIONS

TABLE 1-9 ACCURACY

TECHNIQUE	ACCURACY
kVp	±3 kVp Typical ±4 kVp maximum
mA	±3.5% Typical ±5% Maximum
mAs	±3% ±0.2 mAs Typical ±5% ±0.3 mAs Maximum
Time	±4% ±2 msec Typical ±7% ±3 msec Maximum

TABLE 1-10 RADIOGRAPHIC TECHNIQUE RANGES

TECHNIQUE	SYSTEM	VALUE
kVp Range	TM30, TM40, TM 1T R/F, TM EP	1. 2 or 3 Factor: 40 to 125 kVp, 1 kVp increments 2. BIT mode: 24 steps
	TM30L, TM30 R/F, TM50, TM30-2,TM40L, TM40-2, TM50, TM50-2, TM50 R/F TM65, TM65 R/F, TM65-2 TM80-2, TM80 R/F	1. 2 or 3 Factor: 40 to 150 kVp, 1 kVp increments 2. BIT mode: >24 steps
mA Range	TM30 (all)	25 to 500 mA (with Tomo 5 mA)
	TM40 (all)	25 to 600 mA (with Tomo 5 mA)
	TM50	25 to 800 mA (with Tomo 5 mA)
	TM65 (all)	25 to 800 mA (with Tomo 5 mA)
	TM80 (all)	25 to 1000 mA (with Tomo 5 mA)
mAs Range	All	.5 to 900 mAs
Time Range	All	5 to 6000 ms

TABLE 1-11 STATOR CONTROL

SYSTEM	STATOR CONTROL
TM30, TM30L, TM30 R/F, TM30-2, TM 1T R/F, TM EP, TM40, TM40L, TM40 R/F, TM40-2, TM50, TM50 R/F, TM50-2	Standard speed (3,000 rpm/60 Hz) (2500 rpm/50Hz) Optional high speed (see below)
TM65, TM65 R/F, TM65-2, TM80 R/F, TM80-2	High speed (9,000 rpm/60Hz) (7500rpm/50Hz)

TABLE 1-12 GENERATOR OUTPUT POWER RATING

SYSTEM	ISOWATT RATING	OUTPUT KVP/kW
TM EP	7.5 kW	See **TABLE 1-11**
TM30, TM 1T R/F	30 kW	500 mA @ 60 kVp 400 mA @ 75 kVp 300 mA @ 100 kVp 250 mA @ 120 kVp
TM30 R/F, TM30L, TM30-2	30 kW	500 mA @ 60 kVp 400 mA @ 75 kVp 300 mA @ 100 kVp 250 mA @ 120 kVp 200 mA @ 150 kVp
TM40	40 kW	600 mA @ 60 kVp 500 mA @ 80 kVp 400 mA @ 100 kVp 300 mA @ 125 kVp
TM40 R/F, TM40L, TM40-2	40 kW	600 mA @ 60 kVp 500 mA @ 80 kVp 400 mA @ 100 kVp 300 mA @ 125 kVp 250 mA @ 150 kVp
TM50, TM50-2, TM50 R/F	50 kW	800 mA @ 60 kVp 600 mA @ 80 kVp 500 mA @ 100 kVp 400 mA @ 125 kVp 300 mA @ 150 kVp
TM65, TM65 R/F, TM65-2	65 kW	800 mA @ 81 kVp 600 mA @ 108 kVp 500 mA @ 130 kVp 400 mA @ 150 kVp
TM80 R/F, TM80-2	80 kW	1000 mA @ 80 kVp 800 mA @ 100 kVp 600 mA @ 133 kVp 500 mA @ 150 kVp

1.3.4 FLUOROSCOPIC SPECIFICATIONS

TABLE 1-13 FLUOROSCOPIC TECHNIQUE RANGES

TECHNIQUE	SYSTEM	VALUE
kVp Range	All R/F TM-EP	40 to 125 kVp in 1 kVp increments
mA Range	All R/F	Continuous Mode: 4 selectable stations nominally set at .4, .8, 1.6, and 2.2 mA calibrated not to exceed 9.5 R/min entrance exposure rate.
	All R/F TM-EP	Pulsed Mode: Fixed mA calibrated not to exceed 9.5 R/min entrance exposure rate at maximum technique factors of 125 kVp and 30 PPS.
Pulse Rate	All R/F TM-EP	30, 15, 7.5, 3.8, 1.9 pps

1.3.5 TOMOGRAPHIC SPECIFICATIONS (SERVO TOMO OPTION ONLY)

TABLE 1-14 TOMO TECHNIQUE SPECIFICATIONS

kVp	SWEEP/SPEED (TIME in seconds)	mAs*
40 through 150 for all mAs stations	8°/FAST (.4)	2 - 225
	20°/FAST (.6)	3 - 350
	8°/SLOW & 30°/FAST (.8)	4 - 450
	40°/FAST (1.0)	5 - 600
	20°/SLOW (1.2)	6 - 700
	30°/SLOW (1.6)	8 - 900
	40°/SLOW (2.0)	10 - 900

* Approximately ±10% change between mAs selection steps.

1.4 COMPATIBILITY

The TM generators are compatible with the following certified components or with other certified components which meet the specifications outlined.

1.4.1 X-RAY TUBES

The TM has a tube protection circuit for the following tubes or equivalents:

Dunlee PX 1429 (0.6/1.2mm)	Toshiba E7239X (1.0/2.0mm)
Dunlee PX 1482 (0.6/1.0mm)	Toshiba E7242X (0.6/1.2mm)
Dunlee PX 1436 (0.6/1.2mm)	Toshiba E7252X (0.6/1.2mm)
Varian A192 (0.6/1.2mm) B150	Varian A256 (0.6/1.0mm) B150
Varian A292 (0.6/1.2mm) B150	Varian G292 (0.6/1.2mm) B150
Varian G1092 (0.6/1.2mm) B150	Varian A197 (0.3/0.8mm) B130
Eureka RAD- 8 (1.0/2.0mm)	Eureka RAD-74 (0.6/1.5mm)
Eureka RAD-68 (0.6/1.2mm)	Eureka RAD-13 (1.0/2.0mm)
Eureka RAD-14 (0.3/1.2mm)	Eureka RAD-14 (0.6/1.2mm)
Eureka RAD-16 (1.0/2.0mm)	Eureka RAD-21 (0.6/1.2mm)
Eureka RAD-25 (0.6/1.2mm)*	Eureka RAD-56 (0.6/1.0mm)
Eureka RAD-56 (0.6/1.2mm)	Eureka RAD-60 (0.3/1.2mm)
Eureka RAD-60 (0.6/1.2mm)	Eureka RAD-92 (0.6/1.2mm)

*125 kVp units only.

1.4.2 BEAM LIMITING DEVICES

The TM is compatible with any Automatic Collimating System that provides an isolated normally open switch which closes when the Automatic Collimating System presents an "Exposure Ready" mode to the control.

In addition, the TM is compatible with any certified beam limiting device intended for radiographic equipment.

1.4.3 X-RAY TABLES

The TM is compatible with any certified table which meets the performance standard requirements for x-ray tables in general purpose radiographic and radiographic-fluoroscopic rooms.

1.4.4 CASSETTE HOLDERS

The TM is compatible with any certified cassette holder (non-bucky) and any certified bucky cassette holder.

1.4.5 IONIZATION AUTOMATIC EXPOSURE CONTROL SYSTEMS

The TM is compatible with the folllowing ionization automatic exposure control systems equipment:

Ionization Exposure Control for up to three sensors (does not include sensor)
Ionization Exposure Control for one radiographic sensor only (needs sensor from the following list)

#153 Sensor for use in Pausch Tables
#159 Sensor for use in Liebel-Flarsheim Series 8000 entry-type buckys
#155 Sensor for use with KS-80 cassette holders
#156 Sensor for Scholz Spot-Film Device with remote pre-amplifier & 30-ft. cable
#174 Cassette-Sensor for Hydradjust-III
#158 Sensor for Continental 14" Spot-Film Device
Sensor for Eureka EXT- Spot-Film Device
#181 Sensor for 14x36 Grid Cabinet
#162 Sensor for left-hand bucky holders
#192 Sensor for right-hand bucky holders

Factory adaptation and interconnection of any AEC system to new Continental Radiographic single-phase power unit, includes kV compensation signal circuitry.

Standard 45' Interconnect Cable with above Ion Chambers
65' Ion Chamber Cable

1.4.6 HIGH SPEED ROTOR CONTROLS

The TM is compatible with the folllowing high speed rotor control equipment:

HS-2 MPX-R High Speed Rotor Control
HS-2-MPX-Q High Speed Rotor Control with "Q" Stator
Cabinet for HS-2
HS IR Radiographic 1 Tube High Speed Rotor Control.

1.4.7 CAMERA SYSTEM SELECTIONS

For software revisions 5.8.1 and above, the TM Series of X-ray generators are compatible with the following camera systems.

TABLE 1-15 AVAILABLE CAMERA SELECTIONS (RELEASE 5.8.1 AND ABOVE)

Selection	Cameras
SS-PFL	Syracuse Scientific Pulsed Fluoro: SS-750
IN-PFL	Infimed Pulsed Fluoro: FC-1500, FC-2000, QL2048.
CM2-PFL	Camtronics Pulsed Fluoro: Camtronics VP-RF with Philips XTV-11.
GLD-PFL	GoldOne Pulsed Fluoro
SS-CFL	Syracuse Scientific Continuous Fluoro: SS-750
NI-CFL	Nical Continuous Fluoro
IN-CFL	Infimed Continuous Fluoro: FC-1500; FC-2000; QL-2048
CM2-CFL	Camtronics Continuous Fluoro: Camtronics VP-RF with Philips XTV-11
GLD-CFL	GoldOne Continuous Fluoro

1.5 CDRH COMPLIANCE

All components of the x-ray system conform to the requirements of the Center for Devices and Radiological Health (CDRH), Department of Health and Human Services, 21 CFR, Chapter 1, Subchapter J, at the time of manufacture.

1.6 HAZARDOUS MATERIALS

The TM generators use Shell Diala(R) oil AX in the HV generator. This material is rated as: Acute Health - 1, Fire - 1, Reactivity - 0. Skin contact should be avoided as irritation could result. Inhalation could prove irritating to the mucous membranes and upper respiratory tract. Ingestion may result in vomiting. For full product information refer to Shell Material Safety Data Sheet 60,030-5 (contact Shell Oil Corporation).

1.7 SYMBOLS

This section presents the symbols used throughout this manual. The symbols conform to IEC 878.

Dangerous voltage. Indicates an avoidable dangerous high voltage hazard.

This symbol on the equipment means that the operating instructions should be consulted to assure safe operation.

Ground

Functional Earth (ground) Terminal. Terminal directly connected to a point of a measuring supply or control circuit or to a screening part which is intended to be earthed for functional purposes.

Protective earth (ground). Identifies any terminal which is intended for connection of an external protective conductor to protect against electrical shock in case of a fault.

Equipotentiality. Identifies terminals that bring the various parts of equipment or systems to the same potential when connected together. These terminals are not necessarily at earth (ground) potential. The value of the potential may be indicated next to the symbol.

1.8 REQUIREMENTS

The following sections provide important electrical and mechanical requirements for the proper operation of the TM x-ray generator.

1.8.1 ELECTRICAL REQUIREMENTS

1. Use a facility power source dedicated for use by the TM generator.
2. It is extremely important that a good facility ground is established. Use a dedicated wire to connect to the ground in the disconnect box and NOT the conduit. This ground must reference back to the electrical company provided ground or the ground established by the facility's cold water pipes.
3. **TABLE 1-8** lists the wire sizes required. In final testing of the generator, the assembler is required to measure the line voltage regulation under full load, since the output of this x-ray machine is dependant upon the line regulation.
4. RPU cable routing is through the back of the cabinet. **FIGURE 1-5** gives pertinent dimensional information for locating facility electrical access to the RPU. The configuration of the rear cover allows it to be readily installed/removed when necessary.
5. A six-foot cable is provided to connect the RPU power supply assembly to the disconnect box. If wiring other than the supplied cable is to be used, refer to **TABLE 1-8** for the required gauge size.
6. The RPU to OC interconnect cable is a 25-conductor shielded multi-conductor cable terminated with 25-pin D-subminiature connectors. Route the cable through a separate conduit to prevent induced noise problems.
7. Route the high voltage cables separately from the system cables.
8. Route facility input power separately from the system cables.

9. Follow all local codes for the installation of x-ray equipment. Some codes require wiring the control and high voltage generator to their respective wall junction boxes in flexible armored cable, while other codes permit the use of STO or SJTO rubber-covered interconnecting cable from these units to the wall junction boxes.
10. For TM generators which are to be used in systems with the servo tomo option, a means to route cable to the auxiliary cabinet will have to be provided. The cable access is the same as for the large cabinet. Some of the generators utilize the auxiliary cabinet regardless of the presence of the servo tomo option, and require cable routing to this cabinet also.

> ⚠ **WARNING:**
>
> **FOR PROPER OPERATION, THE TM GENERATOR REQUIRES A DEDICATED POWER LINE FREE FROM SPIKES AND GLITCHES IN ACCORDANCE WITH TABLE 1-8.**
>
> **IF A DEDICATED POWER LINE IS NOT PROVIDED, THE SYSTEM MAY MALFUNCTION OR SYSTEM DAMAGE MAY OCCUR.**

1.8.2 MECHANICAL REQUIREMENTS

1. The installer must determine the method of mounting the TM30 and TM40 series RPU base to the floor. These utilize a base with mounting brackets which can be secured to the floor with bolts fastened to lead expansion anchors. A certified engineer should be consulted to properly specify the appropriate method and hardware.
2. The small cabinets have provisions to secure the top cover to the rear wall in earthquake zones. A certified engineer must advise as to method and hardware.
3. If the TM30 or TM40 series generators are used in a PMT series servo tomo system they will use the large RPU cabinet, **NOT** the small one.
4. For all TM generators which are to be used in systems with the servo tomo option, an auxiliary cabinet is used to house the servo tomo controller PCB and the motor controllers, in addition to other system components. Some generators utilize the auxiliary cabinet regardless of the presence of the servo tomo option and therefore also require it to be taken into account during layout of the room. This cabinet is the same size as the large cabinet.
5. Access to the interior of the RPU is through the front, so space must be provided for service access of at least 2 feet. See **FIGURE 1-5** for the dimensions of the cabinets and OC.
6. Provide side access of 2 feet, if possible, as the side covers are also removable for maintenance actions.

SECTION 2 - INSTALLATION

2.1 GENERAL

This chapter provides the information required to properly and safely install the generator. It is assumed that chapter 1 has been used to plan the installation. To help ensure that the installation will proceed as smoothly as possible it is advised that the layout be verified against the room plans. The layout should be transferred to the room in pencil or chalk to aid in layout verification. Chapter 1 provides the dimensions of the cabinets and their electrical entrance positions.

The wiring of the room should also be verified against the specifications outlined in chapter 1. There are strict requirements for generator wiring which must be met if the generator is to function safely and as specified. If the wiring specifications are not met the generator may not function properly and there may be safety risks to the operator and patient, and damage to generator may result.

2.2 MATERIAL REQUIRED

- Tie wraps
- Drill and drill bits anchor installation
- Base-to-floor mounting hardware (TM 30 & TM40 only)
- Top cover to wall mounting hardware (TM30 & TM40 only)

2.3 UNPACKING

The TM R/F series generator is shipped as follows for continental U.S.:

1. RPU, generator, OC and pedestal (if ordered)
2. Covers
3. Auxiliary cabinet, for those generators which require it

For offshore shipment it is shipped in one container. Refer to Chapter 1 for the dimensions and weights of the TM generator shipping containers to determine the best route and method of moving the TM within the facility. Move the containers to a location which allows removal of the crating materials and installation of the RPU and OC.

2.4 INSTALLATION OF THE OPERATOR CONTROL

The operator control (OC) must be placed in a lead lined control booth so that the operator **CANNOT** make an exposure from the x-ray room. The operator can be prevented from operating the generator outside the control booth by allowing enough cable slack for maintenance but not enough for the operator to remove the OC from the booth.

The optional pedestal can be mounted to the floor using bolts secured into expansion anchors in the floor. There are two through holes in the pedestal base under the rubber mat.

1. Position the pedestal in its operational position and mark the locations of the holes to be drilled.
2. Move the pedestal and drill for installation of the expansion anchors.
3. Clean out the holes and install the expansion anchors.
4. Place the pedestal in operational position and secure it in place with the bolts tightened into the expansion anchors.
5. Place the OC on the pedestal top and secure with the supplied thumbscrews from below.

If the OC is to be used from a table top or a surface other than the pedestal the preferred means is to mount the OC to the surface with 6-32 screws from below.

1. Measure the center to center distance between the two threaded holes in the bottom of the OC base.
2. Using this distance mark the mounting surface for drilling.
3. Drill holes through the mounting surface for the mounting screws.
4. Place the OC on the mounting surface and install the 6-32 screws from below. If the supplied hardware is not long enough due to the surface thickness the installer should obtain two 6-32 screws of sufficient length to securely mount the OC to the mounting surface.

The installer can also affix Velcro™ to the bottom of the OC and the top of the resting surface to keep it in position during use. This allows the maintenance technician to remove the OC easily when necessary. In this case it is extremely important that the service cable length be such that the operator can operate the generator only from the x-ray booth.

2.5 INSTALLATION OF THE REMOTE POWER UNIT & AUXILIARY CABINETS

This section is to be followed for installing both the RPU cabinet and auxiliary cabinet, if used.

1. Mark the floor to show the positions of the RPU and the auxiliary cabinet (if used).
2. For continental U.S.: Remove the high voltage generator from the bottom of the RPU.
   For offshore: Remove the RPU from the shipping container and stand upright.
3. Install the cable entrance cover centrally to the rear of the RPU with two sets of provided screws, flat washers , lock washers and nuts. The mounting studs around the rectangular opening are for the two piece phenolic cable spacer and must point to the cabinet interior.
4. Install the three take-all connectors (supplied) into the three holes in the cable entry cover.
5. Route the facility power cable and the high voltage cables through the rectangular hole and the other system cables through the take-all connectors. Do not tighten the take-all clamps around the cables at this time.
6. Install the two piece phenolic cable spacers over the rectangular hole. The power cable should be run through the large hole, the high voltage cables are run through the other smaller holes. The installed cable spacer allows the cables to slide through as the RPU is positioned as necessary.
7. **For the TM30 and TM40 RPUs ONLY:**
   a. Install the base mounting brackets and their hardware (see **FIGURE 2-1**) in the RPU base.

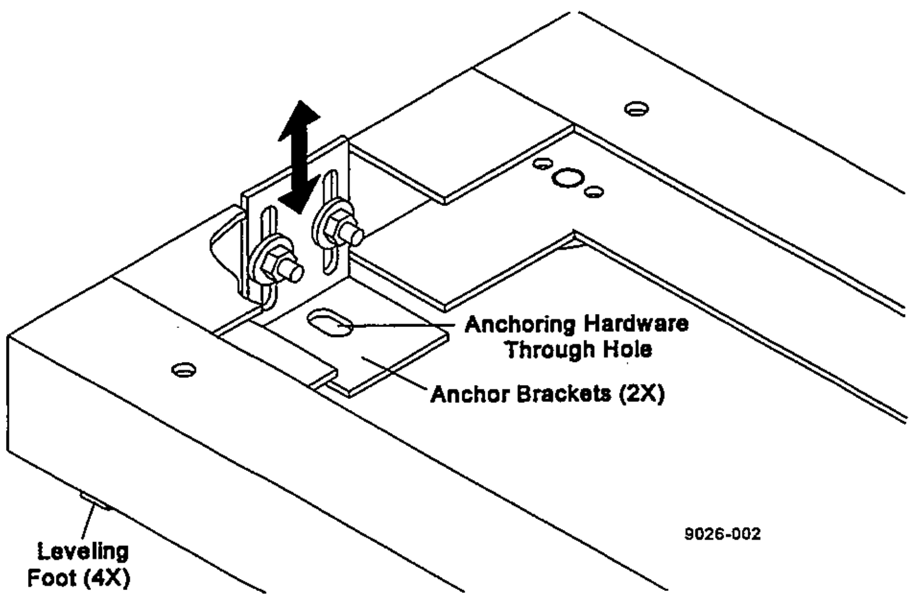


FIGURE 2-1 TM30 & TM40 RPU BASE

   b. Lower them until they touch the floor and mark for anchor installation.
   c. **If required:** place the top cover on the cabinet and mark the wall for mounting hardware.
   d. Move the RPU out of the way to drill the holes necessary for anchor installation and install the required anchors.
   e. Move the RPU into position and install the mounting hardware to secure the TM30 or TM40 RPU in position.

8. Connect power wiring to the RPU using the provided cable or hardwiring to facility wiring. Reference the appropriate power supply schematic in **SECTION 8.**
9. Position the RPU in its final installed position.
10. Level the RPU using the leveling feet attached.
11. Tighten the take-all clamps to secure the system cables in position.
12. Install the high voltage housings on the high voltage cables.
13. Place the high voltage transformer in the RPU base.

14. Verify all fuses are installed, see **FIGURE 2-2** and **FIGURE 2-3** for a 1-tube, 1ϕ and 3ϕ generators, see **FIGURE 2-4** for a 2-tube, 3ϕ generator.

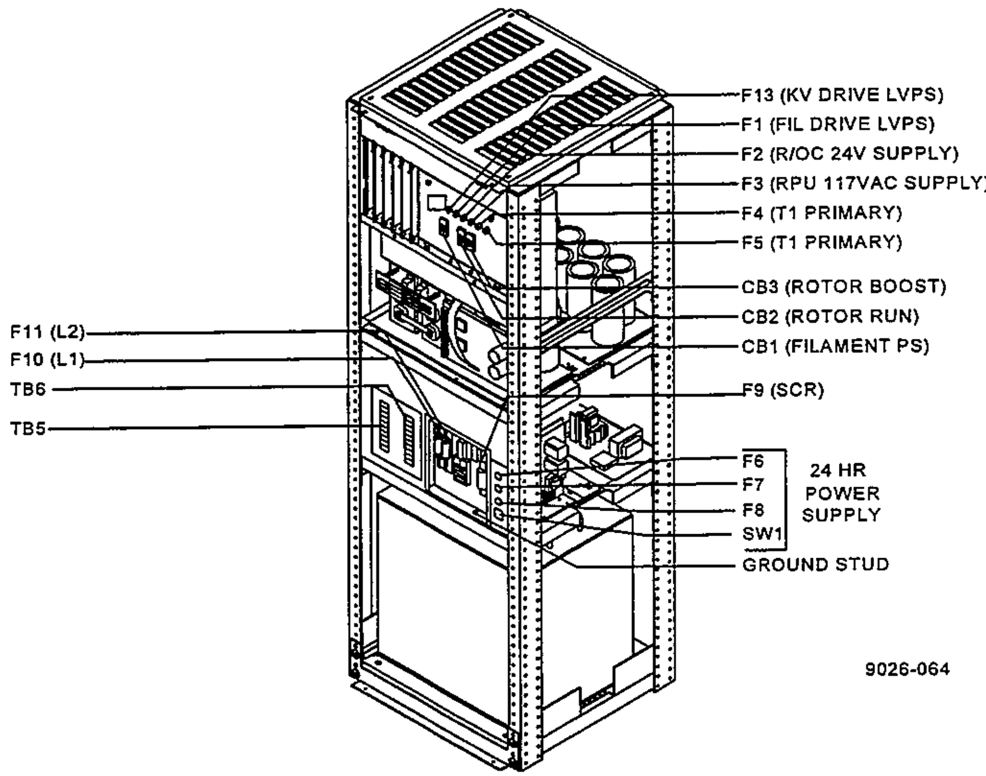


FIGURE 2-2 1-TUBE, 1ϕ RPU PROTECTION COMPONENT LOCATION

15. Verify that a good ground is established. Do **NOT** continue until a good earth ground is verified between facility ground and the RPU frame with a DVM.
16. It is important to reference the appropriate schematic in **SECTION 8-2** of **PART 2** as there are schematics for 50 and 60 Hz facility input power. Measure the line voltage at the disconnect and connect the line matching wire to the connection which corresponds to the closest match.
17. Connect the 1-tube high voltage generator as follows (**FIGURE 2-5**):
    a. Connect both of the 1 tube P1, P2, and ground leads (one each from each side of the RPU) securely to the terminals. Use two wrenches to tighten, one to hold the lower nut and the other to tighten the upper nut.
    b. Locate the two screw on connectors, the 3 pin and 6 pin. Plug them into their respective receptacles on the high voltage transformer, J1 and J2.
    c. Connect the 2-tube high voltage generator as follows: Connect P1 (3 pin connector), P2 (6 pin connector), and P3 (15 pin connector) to the HV generator.

For all 150 kVp generators:

d. Install the feedback isolation PCB on top of the high voltage generator. Place the provided spacers over the studs on top of the generator, place the PCB over the studs and secure in place with the provided hardware.

Do **NOT** connect the high voltage cables until directed to do so in **SECTION 3** during calibration.

> **Note:**
> System wiring is dependent upon system configuration and the options chosen. Refer to **SECTION 8.1** of **PART 2** for interface information. Refer to **SECTION 8.2** of **PART 2** for the wiring diagrams necessary to connect the various system components to the TM generator.

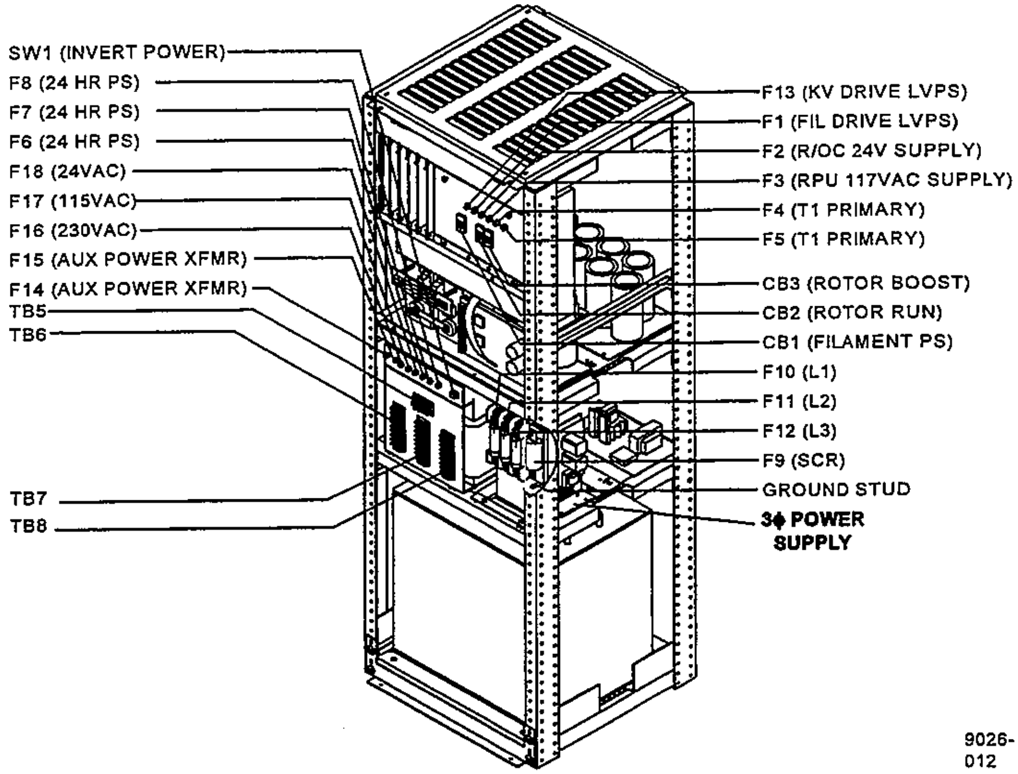


FIGURE 2-3 1-TUBE, 3φ RPU PROTECTION COMPONENT LOCATION

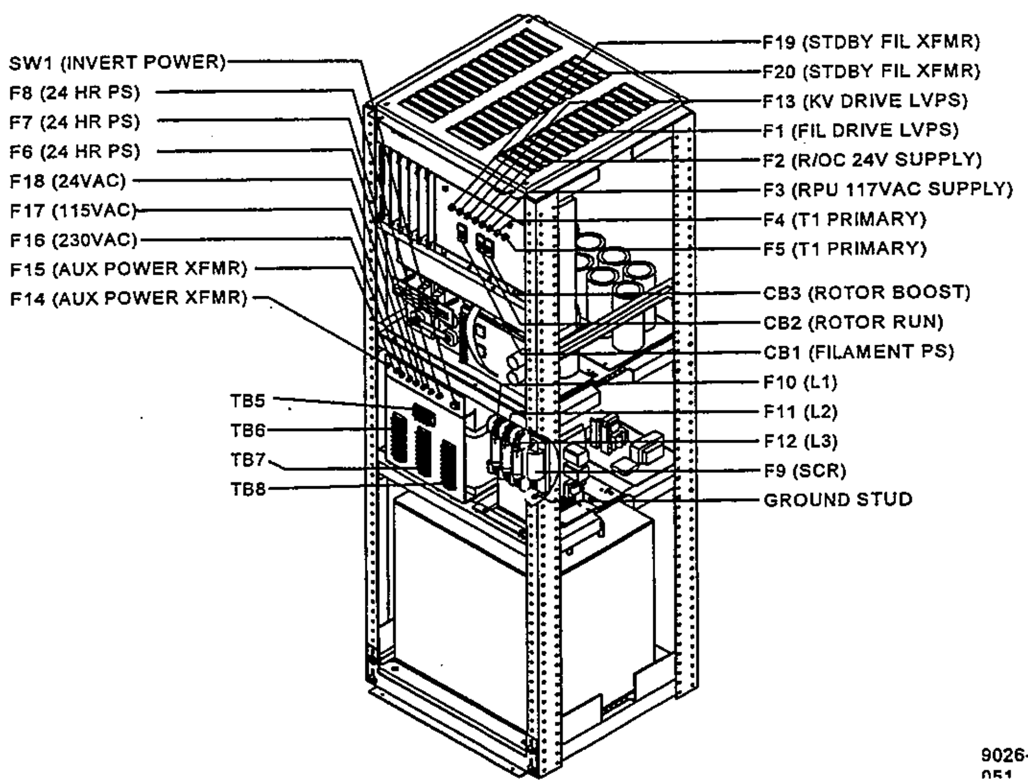


FIGURE 2-4 2-TUBE, 3φ RPU PROTECTION COMPONENT LOCATION

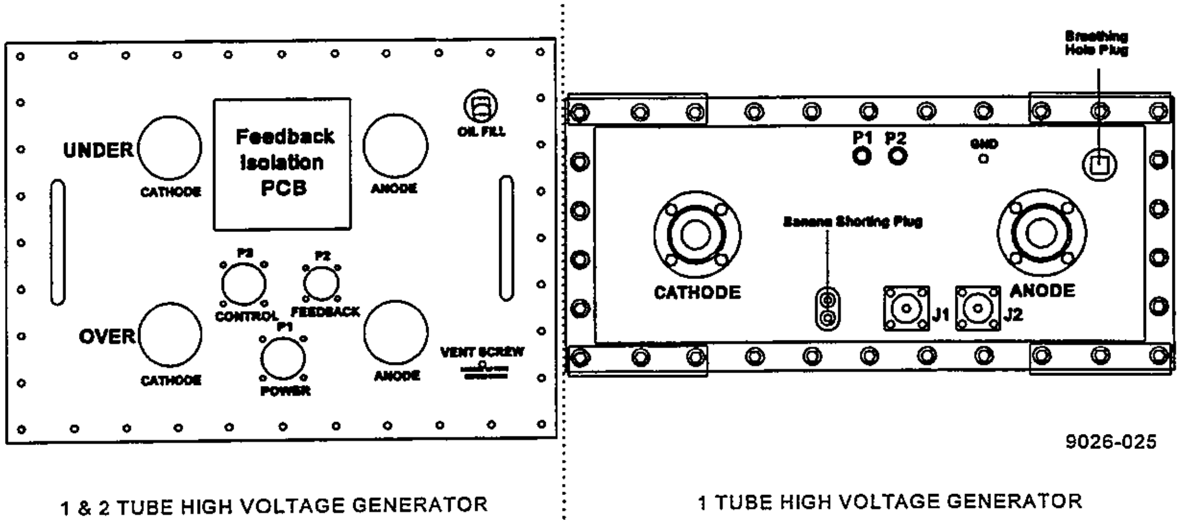


FIGURE 2-5 HIGH VOLTAGE GENERATOR CONNECTIONS

18. Remove the front cover bracket from the frame in front of the card cage. Install on the frame in front at the bottom (the same as the rear cover bracket). Some TM cabinets may have a red shipping bar installed to secure the card cage in place, if this is the case remove.
19. Release the latches holding the card cage in position and extend the card cage to make it easier to connect the system cables to their destinations in the card cage.
20. Route the system cables (See **SECTION 8** for system wiring information) to be connected to card cage PCBs up the RPU frame **(FIGURE 2-6)**. Secure the cables to the frame with tie-wraps. Assure sufficient service loops so the card cage can be extended without cable tension trying to pull it back in.

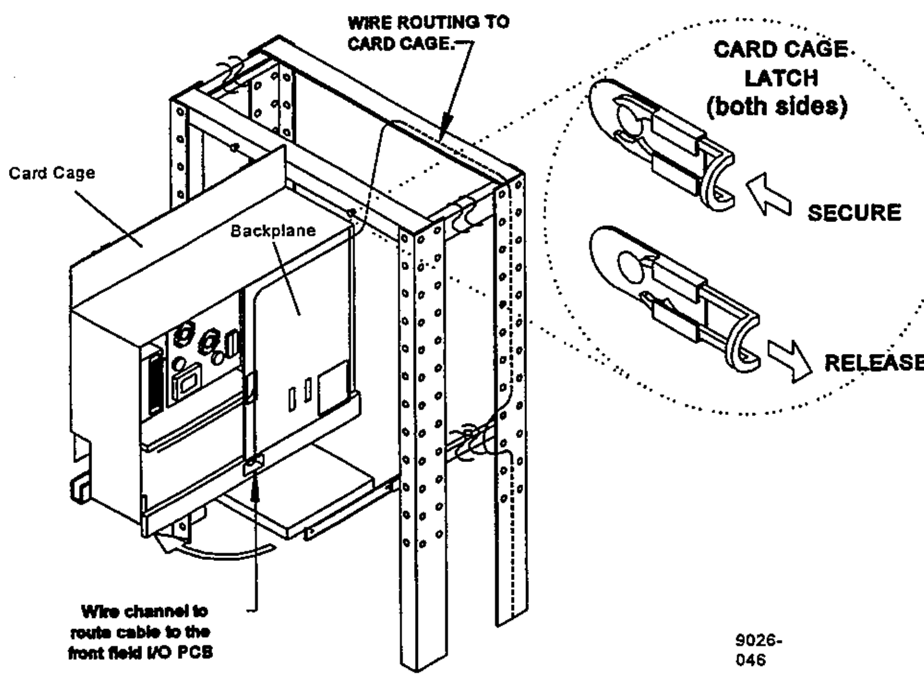


FIGURE 2-6 RPU WIRE ROUTING

21. **For 1 & 2-tube systems:** Route wires to the field I/O PCB located on the front of the card cage through the wire channel in the bottom of the card cage from the back to the front. Remove the protective panel from the front. This panel serves as the label for the terminal strip's connection functions. Use a flat-blade screwdriver with a 3/16" (0.48cm) wide blade for all connections. Strip all wires 3/8" (0.95cm) and twist the strands before securing into the terminal strip. Replace the protective cover when done.

    For 2-tube systems only: Route wires to the field I/O PCB located inside the card cage on the obverse of the fold-down panel (behind the front mounted field I/O PCB) through the rear of the card cage. Remove the protective panel to expose the field I/O's terminal strips. This panel serves as the label for the terminal strip's connection functions. Use a flat-blade screwdriver with a 3/16" (0.48cm) wide blade for all connections. Strip all wires 3/8" (0.95cm) and twist the strands before securing into the terminal strip. Replace the protective cover when done.
22. Route the cables to be connected to the RPU backplane front through the rear of the card cage. The connections to be made to the rear of the RPU backplane are not run within the card cage.
23. Connect the OC end to OC connector J2. Secure the connector with the attached hardware.
24. **IT IS EXTREMELY IMPORTANT THAT ALL ELECTRICAL CONNECTIONS BE VERIFIED AT THIS TIME.** Pull and wiggle all wires to verify that the connectors are properly seated and the mounting hardware is properly tightened.

> **CAUTION:**
> **Do not over tighten the hardware securing the wires to the capacitors as the mounting studs and receptacles are aluminum and their threads are easily damaged.**

It is important to verify all connections due to the fact that, during shipment, some may have vibrated loose. Improperly tightened and seated connections can cause the equipment to operate improperly or appear faulty.

25. Perform **SECTION 3.**
26. Perform **SECTION 10.**
27. Install the covers, see **FIGURE 2-7.**

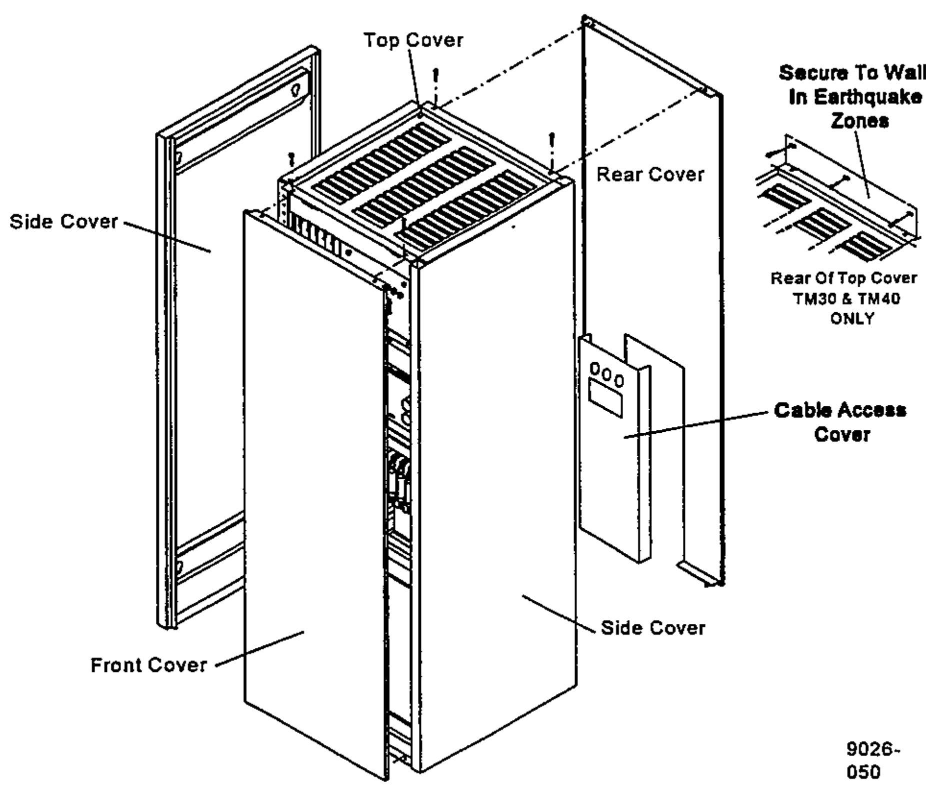


FIGURE 2-7 COVER INSTALLATION

SECTION 3 - CALIBRATION

3.0 EQUIPMENT REQUIRED

The following test equipment is required and must be properly calibrated:

- Digital multi meter - true RMS DVM with an accuracy of .5%.
- Tachometer (vibrating reed type).
- Storage oscilloscope (scope) - 2 channel, 20 MHz (min).
- Noninvasive kVp meter or invasive kVp divider (i.e. Dynalyzer)
- mAs meter
- Densitometer to measure optical density (OD) if AEC option is selected.
- Mirror
- Dark room
- X-ray film processor
- Pieces of lexan: (1) .5" (1.27cm) thick, (14) 1" (2.54cm) thick, or a plastic bucket capable of holding 15" (38.1cm) of water.
- Vapor proof compound for high voltage cables.
- Dosimeter for calibration of Entrance Exposure Rate.
- Fluoroscopic phantom (2mm of Cu) for calibrating ABS (Automatic Brightness System) function.

3.1 INTRODUCTION

The set-up and calibration of the TM generator is accomplished primarily through software control. Refer to **SECTION 8** for pertinent schematics. Refer to **FIGURE 3-1** for PCB locations and to **SECTION 9** for PCB part numbers. Read **SECTION 4** for operation instructions.

> **WARNING:**
>
> **THERE ARE FOUR FACTORY-CALIBRATED POTENTIOMETERS THAT MUST NOT BE ADJUSTED IN THE FIELD.**
>
> 1. **The master voltage-to-frequency calibration of the mAs V/F on the mA/mAs control PCB (R34). This is factory set for a frequency of exactly 60Hz/mA at TP8.**
> 2. **The maximum f_0 (operating frequency) of the inverter oscillator on the kVp control PCB (R13). It is set for a maximum frequency of exactly 12.5 kHz (11 kHz for TM65 and TM80 ONLY) at TP4.**
> 3. **The maximum f_0 (operating frequency) of the filament V/F (R10), factory set to 14.0 kHz at TP9.**
> 4. **V/F adjust for fluoro mA metering circuit. Set to 40.0 kHz at TP12.**

There are three major software routines used by the installer:

1. Test routines used to indicate the software version that is installed, and the actual heat-units in the anode and housing.
2. Set-up routines used to select the particular system configuration.
3. Calibration routines to calibrate the system. The x-ray tube filament pre-heat, mA, kVp, and mAs are all calibrated through the front panel using software control.

At this point, the entire system should be installed with all components connected, i.e., tube, collimator, Remote Power Unit (RPU), Operator Control (OC), and Remote Fluoro Control (RFC), or Digital Platform (DP) (for fluoroscopic generators).

The RPU has several switches which permit the electronics to be tested without high voltage or powering the x-ray tube filaments and rotor.

500 VDC power is supplied to the inverter via **[SW1]** located on the fuse box (**FIGURE 2-4** or **2-5**). When the 24-hour power supply is active, **[SW1]**'s indicator lamp is illuminated. LEDs L6 and L7 are located on the gate drive PCB. When L6 is ON, 500 VDC is present at the inverter. If the SCR fuse F9 opens, LED L6 will extinguish, while the **[SW1]** indicator lamp will still be ON. L7 signals failure of the 500 VDC when ON.

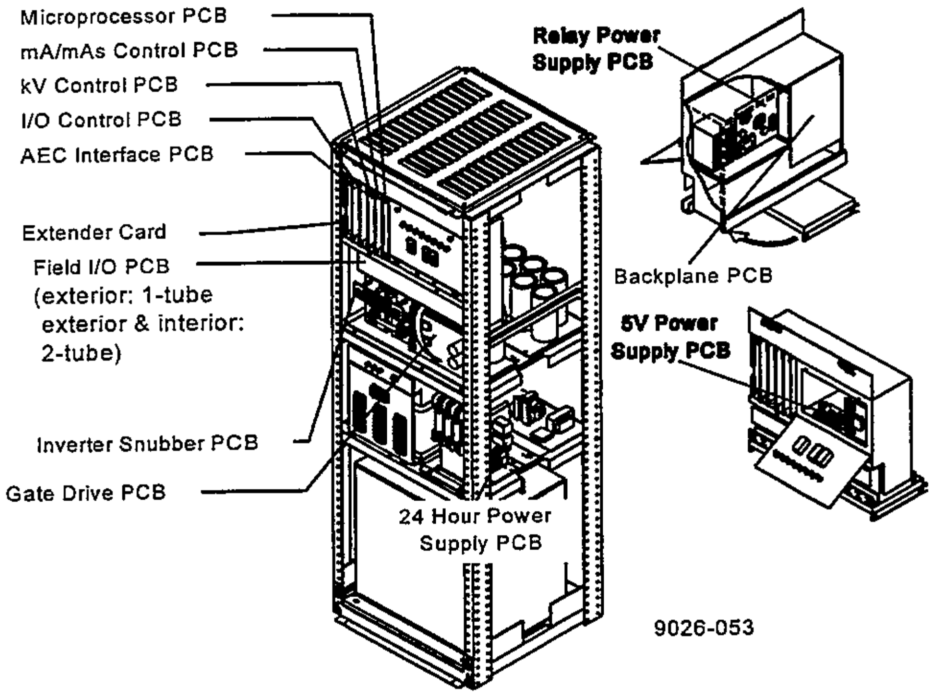


FIGURE 3-1 PCB LOCATIONS

Reference **SECTION 8** for descriptions of the PCB jumpers accessed during performance of the routines in this section. **TABLE 3-1** presents calibration sequences for the various TM generator families.

TABLE 3-1 CALIBRATION SEQUENCES FOR TM GENERATOR FAMILIES

SYSTEM	CALIBRATION SEQUENCE (section number)
1-TUBE RAD	3.3 - 3.4 - 3.5 - 3.7 - 3.8 - 3.9 - 3.10.2 thru 3.10.6 - 3.11 - 3.12 - 3.13 - 3.14 - 3.15 - 3.18
1-TUBE FLUORO	3.3.1 - 3.3.3 - 3.3.4 - 3.6 - 3.8.1 - 3.8.2 - 3.9.1 - 3.9.2 - 3.9.3 - 3.10.1 - 3.16 or 3.17
2-TUBE RAD	3.3 - 3.4 - 3.5 - 3.7 - 3.8 - 3.9 - 3.10.2 thru 3.10.6 - 3.11 - 3.12 - 3.13 - 3.14 - 3.15 - 3.18
2-TUBE R/F	3.3 - 3.4 - 3.5 - 3.6 - 3.7 - 3.8 - 3.9 - 3.10 - 3.11 - 3.12 - 3.13 - 3.14 - 3.15 - 3.16 or 3.17 - 3.18
1-TUBE R/F	3.3 - 3.4 - 3.5 - 3.6 - 3.7 - 3.8 - 3.9 - 3.10 - 3.11 - 3.12 - 3.13 - 3.14 - 3.15 - 3.16 or 3.17 - 3.18

The following presents the hierarchy of the calibration/setup routines:

OPR PROG
EXIT
TEST places the system in calibration/setup mode

1. **TEST ROUTINES**
   - **SYSTEM INFORMATION**
   - **HEAT UNITS & RTC** (Real Time Clock)
   - **AEC V/F CHECK & Cal**
   - **ION Chamber Field Drift Check**

2. **SETUP ROUTINES**
   1. **Enable PC Communications**
   2. **X-Ray Tube 1 Setup**
      - **TUBE** select installed tube
      - **%LOAD** select desired load
      - **HSS** YES/NO
      - **HS** YES/NO - displays only if HSS is YES
      - **XX-COOL** select cooling means - pressing runs through choices
      - **P/E** YES/NO
      - **STORE**
      - **EXIT Save Changes?** YES/NO
   3. **X-Ray Tube 2 Setup**
      - See above
   4. **DP & Fluoro Setup**
      - **NO FLUORO, SS PULSE, SS CONT**, or **NO CONT** fluoro choice
      - **STORE**
      - **EXIT**
   5. **PRINTER SETUP**
      - **NO PRINT/MAN PRINT/AUTO PRINT** select occurrence of printing
      - **PC PRINTER/PRINTER X** select type of printer in use
   6. **Tomo Setup**
      - **SERVO/MECH/NONE** select the type of tomo, if present
      - **TUBE ½** select the tube to be used for tomo exposure

3. **CALIBRATION ROUTINES**
   1. **MA Calibration**
      - \- decrease value a predefined amount
      - \+ increase value a predefined amount
      - **STORE**
      - **EXIT**
   2. **KV Cal**
      - see above, for 1.MA Calibration.
   - 3a. **MASTER Preheat Calibration**
      - see above, for 1.MA Calibration.
   - 3b. **POINT Preheat Calibration**
      - see above, for 1.MA Calibration.
   - 3c. Standby Preheat Adj.
      - see above, for 1.MA Calibration.
   - 3d. Preheat Boost Adj.
      - see above, for 1.MA Calibration.
   4. **MAS Calibration**
      - see above, for 1.MA Calibration.

Continuous fluoro

5a. FLUORO-1 MA Station Adj.
- \- decrease value a predefined amount
- \+ increase value a predefined amount
- **STORE** save value in memory
- **EXIT** exit routine without saving value

5b. FLUORO-2 MA Station Adj.
see above, for 5a. FLUORO -1 MA Station Adj.

5c. FLUORO-3 MA Station Adj.
see above, for 5a. FLUORO -1 MA Station Adj.

5d. FLUORO-4 MA Station Adj.
see above, for 5a. FLUORO -1 MA Station Adj.

6a. FLUORO Low KV Cal (50 KV)
see above, for 5a. FLUORO -1 MA Station Adj.

6b. FLUORO High KV Cal (120 KV)
see above, for 5a. FLUORO -1 MA Station Adj.

7a. FLUORO MA Meter, Low MA Cal
see above, for 5a. FLUORO -1 MA Station Adj.

7b. FLUORO MA Meter, High MA Cal
see above, for 5a. FLUORO -1 MA Station Adj.

8a. FLUORO KV max at -3 MA Step
see above, for 5a. FLUORO -1 MA Station Adj.

8b. FLUORO KV max at -4 MA Step
see above, for 5a. FLUORO -1 MA Station Adj.

9. FLUORO Preheat Boost Adj
see above, for 5a. FLUORO -1 MA Station Adj.

10a. FLUORO ABS Window Adj
see above, for 5a. FLUORO -1 MA Station Adj.

10b. FLUORO ABS CTR Adj.
see above, for 5a. FLUORO -1 MA Station Adj.

Pulsed fluoro

5. PULSED FLUORO MA Adj.
- \- decrease value a predefined amount
- \+ increase value a predefined amount
- **STORE** save value in memory
- **EXIT** exit routine without saving value

6a. FLUORO Low KV Calibration (50kv)
see above, for 5. PULSED FLUORO MA Adj.

6b. FLUORO High KV Calibration (120kv)
see above, for 5. PULSED FLUORO MA Adj.

7a. FLUORO MA Meter Cal. at 50 KV
see above, for 5. PULSED FLUORO MA Adj.

7b. FLUORO MA Meter Cal. at 120 KV
see above, for 5. PULSED FLUORO MA Adj.

8a. FLUORO KV max at 15 P/S
see above, for 5. PULSED FLUORO MA Adj.

8b. FLUORO KV max at 30 P/S
see above, for 5. PULSED FLUORO MA Adj.

9. FLUORO Preheat Boost Adj.
see above, for 5. PULSED FLUORO MA Adj.

10a. FLUORO ABS Window Adj.
see above, for 5. PULSED FLUORO MA Adj.

10b. FLUORO ABS CTR Adj.
see above, for 5. PULSED FLUORO MA Adj.

11. FLUORO MA Pulse Width Adj.
see above, for 5. PULSED FLUORO MA Adj.

3.2 PRELIMINARY INSPECTION

This section must be performed prior to operating the generator for the first time. It should also be performed prior to calibration, after maintenance actions to verify system wiring and safety.

WARNING:

ENSURE THAT POWER IS OFF AT THE DISCONNECT BOX BEFORE PROCEEDING. SEVERE INJURY OR DEATH CAN RESULT FROM CONTACT WITH INCOMING POWER.

3.2.1 RPU AND OC INSPECTION

1. Inspect the unit for any signs of damage.
2. Confirm that all connectors are fully seated.
3. Tighten all power connections, including line, ground, neutral, and all black #10 connections.
4. Place the system in calibration/setup mode (**SECTION 3.3**).
5. Ensure that SW4 is set for all options present in the system. See **TABLE 7-1**.

3.2.2 HIGH VOLTAGE GENERATOR CHECK

1. Remove the High Voltage generator oil fill plug and inspect oil level. It must be no greater than 3/8" (.95cm) from the bottom surface of the top panel. Replace the plug when done and loosen the vent screw.
2. Make the following checks on J2 (the 6-pin circular connector) with the DVM (See **FIGURE 3-2**):

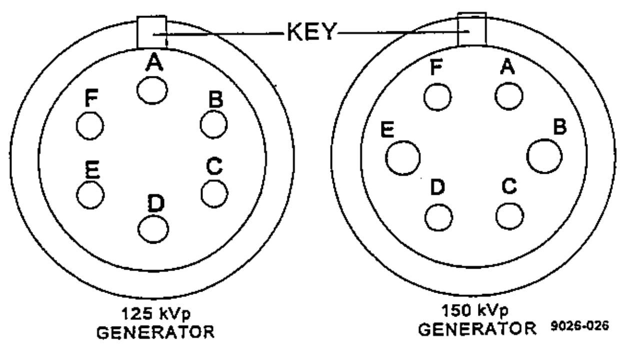


FIGURE 3-2 HV GENERATOR J2 PINOUTS

2-tube: A to GND=10kΩ
B to GND=0Ω
C to GND=Open circuit (very large resistance)
D to GND=Open circuit (very large resistance)
E to GND=0Ω
F to GND=10kΩ

1-tube: A to D=0 Ω
A to GND=0 Ω
A to B=10 kΩ ±200Ω
A to C=10 kΩ ±200Ω
A to E=10 Ω
A to F=10 Ω

3. Make the following checks on J1 (Power Plug):

150 kV units: A to GND = 0 Ω
B to GND = Open circuit (very large resistance)
C to GND = Open circuit (very large resistance)

125 kV units: P1 to GND = Open circuit (very large resistance)
P2 to GND = Open circuit (very large resistance)
P1 to P2 = 0 +1Ω

3.2.3 INCOMING POWER

Verify that the incoming line voltage is matched to the autotransformer. For detailed instructions see **SECTION 2.6, STEP 16.**

1. Turn OFF the inverter power supply **[SW1]**, on the fuse box (**FIGURE 2-4**, **2-5**, or **2-6**).
2. Remove fuse F9 (SCR fuse) in the fuse box, on the power supply shelf.
3. Verify all HV transformer connections are in accordance with the **RPU INTERCONNECT WIRING DIAGRAM** in **SECTION 8**.
4. Turn incoming power ON at the disconnect box.
5. Measure the output voltage of the autotransformer:
   1ϕ, 60 Hz TB6-1 to TB6-4 = 369 ±5%
   1ϕ, 50 Hz TB6-1 to TB6-4 = 308 ±5%
   TM40 3ϕ, 50/60 Hz TB6-4 to TB7-4; TB7-4 to TB8-4; TB8-4 to TB6-4 = 380 ±5%
   TM50/65 3ϕ, 50/60 Hz TB6-4 to TB7-4; TB7-4 to TB8-4; TB8-4 to TB6-4 = 351 ±5%
   TM80 3ϕ, 50/60 Hz TB6-4 to TB7-4; TB7-4 to TB8-4; TB8-4 to TB6-4 = 351 ±5%

   If not correct, turn power OFF and perform the procedure in **SECTION 2.6, STEP 16.**
6. Turn power OFF.

3.2.4 X-RAY TUBE AND HIGH VOLTAGE (HV) CABLE CHECK

1. Clean all HV receptacles.
2. Clean all HV cable plugs.
3. Inspect the HV cable pins and verify that they are straight, and have a gap in their ends to ensure good connections. Gap the ends very carefully **(they are very fragile)** if necessary to achieve good contact.
4. Verify that there is continuity between the connector shields through the cable shield.
5. Use vapor proofing compound on the cable ends to be inserted into the tube. Apply to the entire cable end.
6. Insert the HV cables into the tube.

> ⚠ **CAUTION:**
> **Do NOT insert the HV cables into the HV transformer at this time.**

7. Verify that there is ground continuity between the tube housing and the RPU chassis using a DVM. Grounding to the RPU is accomplished via the tube rotor cable. If there is no ground continuity, check all ground connections.

3.2.5 GATE PULSE COUNTER JUMPER CHECK

This section is for pulse fluoro generators only. On the kV control PCB, verify that jumper EKV11 (gate pulse counter) is IN for pulse fluoro systems. This will prevent flicker during fluoro exposures.

3.2.6 HMS HIGH SPEED ROTOR CB515 INTERFACE PCB DIP SW. PROGRAMMING

The **CB515 Interface PCB** is located in the Aux cabinet. Its DIP switches need to be programmed as follows:

SW1-1 set to OFF; SW1-2 set to ON; SW1-3 set to ON; SW1-4 set to OFF; SW1-5 set to ON;

SW1-6 set to ON; SW1-7 set to OFF; SW1-8 set to OFF and SW2 set to "R".

3.3 SETUP ROUTINES

This section provides for the initial setup and the verification and/or change of the existing setup for the TM generator. This must be run whenever the system configuration changes. To place the system in Calibration/Setup Mode perform the following:

1. On the rear of the OC, remove the label covering SW3 and SW4. See **FIGURE 3-3.**

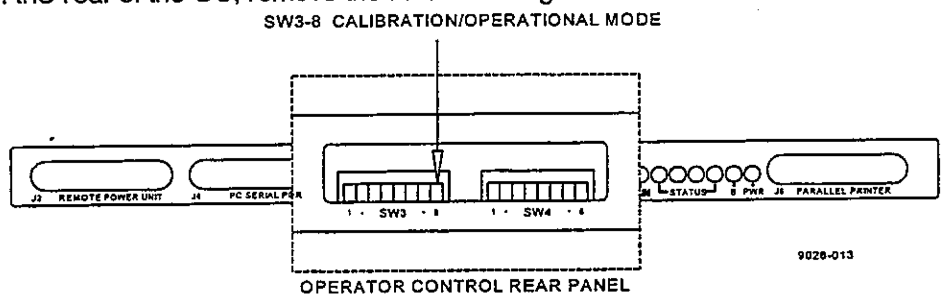


FIGURE 3-3 OPERATOR CONTROL SWITCH LOCATION

2. Ensure OC power is OFF and flip SW3-8 DOWN to allow the system to be placed in calibration/setup mode.
3. Turn the OC ON. The currently installed software versions will be displayed with the option to [**HOLD**] offered. Press [**HOLD**] and copy down the current software versions displayed. Ensure the compatibility between the OC and RPU.
4. Press [**ALT MENU**]. **OPR PROG** (**OP**erato**R PROG**ram) will be displayed allowing the system to be placed in calibration/setup mode when [**TEST**] is pressed.
5. Press [**TEST**]. The **TEST/SETUP/CALIBRATION** routine menu will be displayed.
6. Press [**2.**] to enter the **SETUP ROUTINES** program.

3.3.1 ENABLE PC COMMUNICATIONS

This routine displays the current status of PC communications, enabled or disabled. Press [**NEXT**] or [**BACK**] until **1. Enable PC Communications** is displayed and verify that communications is enabled by pressing [**EXECUTE**]. The display should show **PC Communications Enabled**. Press [**EXIT**] to return to the setup choice menu.

3.3.2 X-RAY TUBE 1 SETUP

1. Press [**NEXT**] or [**BACK**] until **2. X-Ray Tube 1 Setup** is displayed.
2. Press [**EXECUTE**].
3. Tube information will be displayed. There is a top row of keywords corresponding to the top softkeys and a bottom row of keywords corresponding to the bottom softkeys. The softkey functions are as follows:

   TUBE: Selects the tube type desired, shown in line 2. Press the key above **TUBE** to change tubes. Consult the factory if the desired tube type is not available.

   XX%: Selects the percent of maximum tube load at which exposures will be allowed. **XX% LOAD** starts at 65% (minimum) and goes to 100% (maximum) in 5% increments. If a technique is selected by the operator that exceeds this setting, the **HOLD** indicator illuminates and an exposure will not be allowed. Press the key above the maximum allowable to change displayed value.

   HSS: Selects either high speed starter controller [**YES**] (if this option is provided) or the TM's own rotor control [**NO**]. Press the key to toggle between **YES** and **NO.**

   HS: **Displayed only when HSS - YES.** Enables high speed when **HS-YES** is displayed. Press the key to toggle between **YES** and **NO.**

> **Note: HEAT UNIT ALARM**
> Whenever anode or Housing HU of selected tube exceeds 79% and HU ALARM is enabled (SW3-6 is closed), then HU display is selected, a (1.33 beeps per sec) warning beep is sounded causing HU LED to blink.

Note:
Verify that the high speed controller is properly configured, if present, in accordance with the manufacturers directions

XXX-COOL: Selects between air-cooled, fan-cooled, or oil-cooled housings.
P/E: PREP/Exposure ready may be dependant on the imaging system or receptor used, refer to the applicable imaging system or receptor manual. Toggles between **YES** (enables) and **NO** (disables).
STORE: Saves the selected setup values. Beeps twice to indicate saving in progress.
EXIT: Exits the x-ray tube setup program.

4. Select the appropriate data for tube 1. When all data is verified for tube 1 press [**STORE**]. If changes were made and [**EXIT**] is pressed **"Save Changes"** will be displayed giving the technician a last chance to save as valid data any changes made.

If this procedure was performed for a tube other than that which was initially installed at the factory, a "...not in Calibration" message will appear. Press [**RESET**] to continue with calibration.

3.3.3 X-RAY TUBE 2 SETUP

Repeat **SECTION 3.3.2** for tube 2, if present. Select **3. X-Ray Tube 2 Setup**.

3.3.4 ~~FLUORO SETUP~~

1. Press [**NEXT**] or [**BACK**] softkeys until **4. Fluoro Setup** appears on the display.
2. Press the [**EXECUTE**] softkey.
3. Fluoro mode choices will be displayed. The softkey functions are as follows:

NO FLUORO - For systems that tube 2 is operated as a radiographic tube or there is no fluoro capability.
SS-PULSE - For systems with a Syracuse Scientific progressive scan TV camera system to be used in the pulsed fluoro mode.
SS-CONT - For standard, continuous fluoro mode with conventional Syracuse Scientific TV camera.
NI-CONT - For systems with the NICAL CCD TV camera with continuous fluoroscopy. Requires the CCD TV interface PCB to integrate last image hold.
IN-PULSE - For systems with the Infimed pulse imaging system.

(Press [**SS-PULSE/SS-CONT/NI-CONT/IN-PULSE/NO FLUORO**] softkey until the correct fluoro mode for the installed hardware is displayed.)

For Digital Platform systems ONLY: The software controlling the TM used with the digital platform is a different revision (rev. 4.8.0 *series*) and presents a different display to the technician for imaging system selection. The following presents this revision:

DP=PH_SPOT This allows selection of the imaging system in use, see above choices plus the additional imaging system listed below. This should be the default selection for a generator configured with a digital platform.
IN_CONT - For systems with the Infimed continuous fluoro imaging system.

(Press [**SS-PULSE/SS-CONT/NI-CONT/IN-PULSE/IN_CONT/NO FLUORO**] softkey until the correct fluoro mode for the installed hardware is displayed.)

DP=NO This does not allow selection of any imaging system.
II=xx" This displays the currently selected aperture for the II and MAG mode in use. Press this softkey *and* the following will be *displayed*:

NORM=xx" This displays the diameter of the aperture in normal mode. Pressing this selection will highlight it allowing the displayed value to be altered. Pressing -/+ at the bottom will decrement/increment the aperture dimension.
MAG1=xx" This displays the diameter of the aperture in MAG1 mode. Pressing this selection will highlight it allowing the displayed value to be altered. Pressing -/+ at the bottom will decrement/increment the aperture dimension.

MAG2=xx"	This displays the diameter of the aperture in MAG2 mode. Pressing this selection will highlight it allowing the displayed value to be altered. Pressing -/+ at the bottom will decrement/increment the aperture dimension.
MAG3=xx"	This displays the diameter of the aperture in MAG3 mode. Pressing this selection will highlight it allowing the displayed value to be altered. Pressing -/+ at the bottom will decrement/increment the aperture dimension.
RETURN	This returns to the previous display and saves the values of the apertures of the different MAG modes.

Note:
This choice is determined by the hardware installed and is NOT a selectable option.

4. Press the **[STORE]** softkey when the desired fluoro function is displayed.
5. Press the **[EXIT]** softkey to exit the test/setup routines.

Ignore any "Fluoro Calibration Data is invalid..." message at this time. Calibration is still to be performed. Press **[RESET]** to continue.

3.3.5 PRINTER SETUP

1. Press **[NEXT]** or **[BACK]** softkeys until **5. Printer Setup** appears on the display.
2. Press the **[EXECUTE]** softkey.
3. Press **[AUTO PRINT/NO PRINT/MAN PRINT]** softkey until the desired print mode is displayed. **AUTO** prints a label automatically after each exposure, **NO** disables the print function or used when there is no printer connected to the system, and **MAN** prints a label only when the operator presses **[PRINT]** on the control panel. Press the **[STORE]** softkey when the desired printer function is displayed.
4. Press the **[EXIT]** softkey to exit the test/setup routines.

3.3.6 TOMO SETUP

1. Press **[NEXT]** or **[BACK]** softkeys until **6. Tomo Setup** appears on the display.
2. Press the **[EXECUTE]** softkey.
3. Press **[SERVO/MECH/NONE]** until the correct tomo configuration is displayed.
4. Press **[TUBE 1/TUBE 2]** softkey until the tube to be used for tomo exposures appears on the display.
5. Press the **[STORE]** softkey when the correct tomo setup is displayed.
6. Press the **[EXIT]** softkey to exit the **SETUP ROUTINES.**

3.4 SIMULATED EXPOSURE

1. **On the kVp control PCB:** Remove jumpers EKV0, EKV3, and EKV9 to disable fail checks during this procedure.
2. **On the mA/mAs control PCB:** Remove the jumper EMA3, to disable filament power supply check, and install jumper EMA0, to enable A/D sample.
3. **On the I/O control PCB:** Close SW1-8.

WARNING:
⚠ **SW1-8 WILL ALLOW X-RAY TO BE MADE WITH THE ROTOR NOT RUNNING. THIS IS CLOSED ONLY FOR THIS PORTION OF CALIBRATION (3.4 THROUGH 3.7)! ALSO, ENSURE THAT FUSE F9 HAS BEEN REMOVED (IN STEP 3.2.3).**

4. **On the card cage:** Toggle OFF CB1 (filament supply), CB2 and CB3 (rotor supply).
5. Press **[SW1]** (inverter switch) ON.
6. Turn the OC ON.
7. Select: **MANUAL MODE, 3-Factor, 40 kVp, 25 mA,** and **50 ms.**
8. Press both **[PREP]** and **[X-RAY]** and observe that LEDs 1, 2, 3, and 4 on the SCR Gate Drive PCB are dimly lit (gate drive signals), and a clicking sound is heard. The LEDs must be watched very closely for they are dim, and flash very fast. Replace the Gate Drive PCB if they are not.
9. Turn the OC OFF.
10. **On the kVp control PCB:** Install jumpers EKV0, EKV3, and EKV9.

3.5 NO LOAD kVp TEST

The following procedure enables you to make a no load kVp test at full 150kVp level. Safety sensing circuits will be disabled to perform this test, it is therefore imperative that they be enabled after completion. This test confirms that the generator operating functions are proper.

1. Reinstall F9 (SCR fuse). Use the washers provided.
2. Toggle CB1, 2, and 3 OFF.
3. **On the kVp control PCB:** Install jumper EKV8.

> **WARNING:**
> **EKV8 IS INSTALLED ONLY FOR THIS TEST. DO NOT ATTEMPT TO MAKE AN X-RAY EXPOSURE WITH EKV8 INSTALLED.**

4. **On the I/O control PCB:** Ensure SW1-8 is closed.
5. **On the kVp control PCB:** Connect a storage scope between TP (ground) and TP3 and set it as follows: Positive slope, 5ms/DIV, 1V/DIV
6. Place at least 2" (5.1cm) of oil in each cable receptacle.
7. Set the operator control for **40kVp, 25mA** and **.5mAs**. There will be no mA and therefore no mAs, but the above settings will normally allow for a short no load shot for the first attempt.

> **NOTE:**
> Each time the HV invertor fires a pair of SCRs a ticking sound will be heard from the invertor shelf area of the RPU. This sound is normal, The ticking will increase in frequency each time the no load is done at a higher kVp.

8. Push the **PREP** button and when the **PREP** switch illuminates, tap the **X-RAY** button ON for the first attempt at No Load.

> **Note:**
> The exposure will terminate in approximately 250 ms, and an Error 12 flag (Exposure Time Limit Error) will appear on the console. This error is normal. Press **[RESET]** and continue. If any other error terminates the exposure, the error must be investigated and the appropriate action taken.

9. Inspect the kV Feedback ramp. It should consist of 6 to 8 steps with an amplitude of about .4V and a time of about 2ms to 3ms for each step.
10. Set the scope for .2sec/DIV, select **30 mAs** and repeat **STEP I.**
11. Press the **X-RAY** button ON and hold for about 1 second.
12. Increase the kV in 5kV steps all the way to 150kV, making a No Load shot at each step.
13. **On the I/O control PCB:** Open SW1-8. This MUST be open to allow the rotor to spin during an exposure.
14. **On the kVp control PCB:** Remove jumper EKV8.
15. **On the mA/mAs control PCB:** Remove jumper EMA0 and install it at EMA3.
16. **On the card cage:** Toggle CB1, 2, and 3 ON.
17. Remove fuse F9.

3.6 FILAMENT CHECK (RADIOGRAPHIC TUBE)

1. Coat the HV cables ends with vapor proof compound. Insert the connector into the x-ray tube. Place approximately 6cc of oil in high-voltage receptacles on transformer assembly and insert the cables into the generator.
2. If a collimator is present, open the blades fully, and move the mirror out of the way (see the collimator manufacturers manual). If the mirror cannot be moved out of the way, remove the collimator for this check.
3. Turn ON the OC.
4. Select: **MANUAL MODE, 40 kVp, 25 mA, 5 mAs, LARGE FOCUS.**
5. Press [**PREP**] and observe via the mirror, that the large filament is illuminated.
6. Select: **SMALL FOCUS**, and press [**PREP**] and observe via the mirror that the small filament is illuminated.
7. Install the collimator if removal was necessary.

3.7 FILAMENT CHECK (FLUOROSCOPIC TUBE)

1. Remove the table top per instructions in the table Maintenance Manual.
2. Select Tube #2 and perform **SECTION 3.6** for the fluoroscopic tube.
3. Replace the top per the table Maintenance Manual.
4. Install fuse F9.

3.8 TEST ROUTINES

> **Note:**
> The following procedures may require the use of the extender card to make adjustment easier. If there is a problem with system lock-up when the extender card is used, the procedure should be performed without it. In this case the system will have to be powered down for PCB removal/insertion for component access and powered up to verify the adjustment.

The system was just used in operational mode and must be placed in **TEST/SETUP/CALIBRATION ROUTINES** mode:

1. Press [**ALT MENU**]. **OPR PROG** (**OP**erato**R** **PROG**ram) will be displayed allowing the system to be placed in calibration/setup mode when [**TEST**] is pressed.
2. Press [**TEST**]. The **TEST/SETUP/CALIBRATION** routine menu will be displayed.
3. Enter the **TEST ROUTINES** by pressing [1.] (**TEST ROUTINES**).

3.8.1 SYSTEM INFORMATION

1. Select **1. TEST ROUTINES.**
2. Press [**NEXT**] or [**BACK**] until **1. System Information** is displayed.
3. Select **EXECUTE.**
4. Verify that the **OC S/W ver** and **RPU ver** numbers are the same. This ensures compatible software versions. Verify they are recorded in **SECTION 10.8.**
5. Select [**EXIT**] to return to **1. System Information.**

3.8.2 HEAT UNITS and RTC

1. Press [**NEXT**] or [**BACK**] until **2. HEAT UNITS and RTC** (Real Time Clock) is displayed.
2. Select [**EXECUTE**]. This display shows the current **H** (housing) and **A** (anode) heat units stored in the x-ray tube units. The **RTC TOCKS** value changes once each second indicating that the real time clock is running. This clock is used in the x-ray tube cooling curve function.
3. Select [**EXIT**] to return to **2. HEAT UNITS and RTC.**

3.8.3 AEC V/F CHECK and CAL

1. Press [**NEXT**] or [**BACK**] until **3. AEC V/F CHECK and CAL** is displayed. If AEC **NOT** present, go to **SECTION 3.9.**
2. Select [**EXECUTE**]. The trip value will be shown and has been set at the factory. When first displayed, the **TRIP value** will step in value until the actual set value is reached. Record the displayed value -
   a. Turn OC power OFF.
   b. Install the AEC interface PCB (**FIGURE 3-1**) on the extender card.
   c. Turn OC power ON.
   d. Connect the DVM between TP8 (TRIP VALUE) and TP (GROUND) on the AEC interface PCB and compare the DVM reading and that shown on the OC display. EXAMPLE:TRIP VALUE 852

      TP8 = +8.52VDC

   e. The trip value must be within ±5 ±.05V. If necessary, adjust potentiometer R43 on the AEC interface PCB until the trip value matches the TP8 voltage ±5 digits. Press [**EXIT**] when complete.

3.8.4 ION CHAMBER FIELD DRIFT CHECK

There is no field service adjustment. The following procedure verifies ion chamber operation. If there is a problem with repeatability after calibration is complete first verify all connections and perform this procedure again. If the problem persists replace the ion chamber.

1. Select **[NEXT]** or [BACK] to progress to **4. ION Chamber Field Drift Check.**
2. Select **[EXECUTE]**. Verify the drift adjustments of the selected ion-chamber field. This adjustment is dependent on the system configuration, i.e. which **RECEPTORS** (ion chambers) are utilized, **[TABLE]**,**[WALL]** and/or **[AUX]**. Each chamber contains three fields which must be verified. During calibration the fields are reset every ten seconds and released. This allows for verification. **TABLE 3-2** provides the cross reference for each chamber.

CHAMBER	TEST POINT
TABLE (#1)	TP1
WALL (#2)	TP2
AUX (#3)	TP3

TABLE 3-2 CHAMBER/AEC INTERFACE PCB TEST POINTS

a. Connect the DVM across the appropriate test point per **TABLE 3-2** and TP (GROUND) on the AEC interface PCB.
b. Select the appropriate **[AEC FIELD]** on the OC.
c. Observe the DVM for a period of time to allow a few cycles. Verify that the reading remains steady. If it doesn't verify all connections.
d. Repeat **STEP 12** until all fields have been verified.
e. If additional receptors (ion chambers) are to be verified, exit calibration mode, select the appropriate receptor, and reenter calibration mode.

3.9 CALIBRATION - GENERAL

The system has been fully calibrated at the factory. The requirements of the field installer will be to match the x-ray tube characteristics with the system. This also includes compensation for different cable lengths than those used at the factory.

The prime field calibration is setting the preheat values for both large and small filaments, and calibration of mAs to match system characteristics.

Filament calibration requires calibration at the end points and at the midpoint of the available mA values. Each of the other calibration routines require calibration at the end points only, and then verification of a value between these two points. For example, mA calibration at 25mA and 300mA, then verify 150mA for the TM30 or at 25mA and 600mA, then verify at 300mA for the TM65.

1. Shut down all system power, both at the OC and the distribution box.
2. Install the noninvasive meter or kVp divider being used. Follow the manufacturers instructions for connections.
3. Remove the banana shorting plug from the Isolation P.C.B.
4. Insert the mA/mAs meter into the banana jack (red = positive).
5. Switch system power ON at the distribution box.

> ⚠ **CAUTION:**
> **This connection is in the mid-secondary of the high voltage circuit. Verify that the meter leads are installed in the current (mA) jacks of the meter. DO NOT make exposures without either the jumper plug, or the mA/mAs meter installed.**

3.9.1 CABLE LENGTH COMPENSATION

The mA regulator uses two different feedback signals to control the mA through the x-ray tube. The first is the preheat signal, and the second is the actual mA signal. The transfer time from preheat to actual mA feedback occurs when the x-ray kVp signal reaches maximum (2 to 3 ms).

The x-ray cable capacitance must be charged during this same time. As the cable lengths become longer, the charge time becomes longer, which distorts the beginning of the mA waveform. The transfer time must be delayed until the cables are fully charged. This delay is selected by jumpers on the mA/mAs PCB. Measure the cables from the HV transformer to the tube, and select the appropriate jumper combination from **TABLE 8-10.**

3.9.2 PRECALIBRATION

> ⚠ **CAUTION:**
> **It is recommended that x-rays not be produced above 90 kVp until the x-ray tube is properly conditioned.**

If a new x-ray tube is used, season it in accordance with the manufacturers instructions. It is desirable to condition a new x-ray tube at an intermediate kVp to establish a voltage gradient across the tube, and to elevate the anode temperature in order to reabsorb any gases present in the tube insert.

During this procedure, the unit will need to be precalibrated for proper preheat at 40kVp, 60kVp and 125kvp. Then the **125 kVp OFFSET** value will be entered at 150 kVp, and the preheat waveform verified at 140 kVp until the tube has been conditioned at higher kVp values.

1. Ensure power is OFF.
2. Install the high voltage cables coated with vapor proof compound in the x-ray tube. Ensure that the cable clamps are tight. Lock the set screws if present. Use approximately 6cc of oil in high-voltage transformer receptacles.

3. Set the scope as follows: Time base - 5ms/DIV
   Trigger - Ch1, positive slope
   Ch1: Vertical - 1V/DIV
   Ch2: Vertical - 0.1V/DIV
4. Place Ch1 of the scope on TP3 of the kVp control PCB, and TP (ground). This is the kVp waveform. Place Ch2 on TP2 of the mA/mAs control PCB, and TP (ground). This is the mA waveform.
5. Remove the adhesive label on the rear of the OC and flip switch SW3-8 DOWN (**FIGURE 3-3**).
6. Turn power ON and turn the OC ON.
7. Press [**ALT MENU**].
8. Press **TEST**.
9. Press [3.] CALIBRATION ROUTINES.
10. Press [**NEXT**] until **3a. MASTER Preheat Calibration** is displayed.
11. Select [**EXECUTE**].
12. Select **LARGE FOCUS, 200 mA, 40 kVp, 50 ms**. The display should show the current data for the following:

    PREHEAT — **On the mA/mAs control PCB:** The number 2971 (for example) represents the voltage at TP5 (2971 = .2971 VDC). It is one half of the preheat reference voltage at TP1 on the mA/mAs PCB. It is the value which will be modified to increase or decrease the preheat.

    [-] — Decrements the **PREHEAT Offset** number.

    [+] — Increments the **PREHEAT Offset** number.

    [STORE] — Stores the currently displayed **PREHEAT Offset** number. <u>Always [STORE] any changes.</u>

    [EXIT] Exits the **MASTER Preheat Calibration** menu.

13. Make an exposure and observe the mA waveform (**FIGURE 3-4**). Adjust the **PREHEAT** value by using the [+] and [-] keys. These will change the **PREHEAT Offset** value shown. The **PREHEAT** value will also change by the new **PREHEAT Offset** value. When the value shown is acceptable, press the **STORE** switch. Two audible beeps will be heard indicating that the value is stored. Repeat this step until the mA waveform is correct.
14. Select **60 kVp** and repeat **STEP 13.** The **PREHEAT Offset** number from this step will be used in **STEP 15.** Record **PREHEAT Offset =**
15. Select **125 kVp** and input the **PREHEAT Offset** value stored at 60 kVp, then [**STORE**]. **Do NOT make an exposure at this time.**
16. Select **80 kVp**. The display will indicate "Selected KV not in calibration range".
17. Make an exposure to verify the proper preheat waveform (**FIGURE 3-4**). If it is too high or too low, select **125 kVp** again and increase or decrease the **PREHEAT Offset** value, [**STORE**] and return to **80 kVp** for waveform verification.
18. Select **125 kVp** and repeat **STEP 13.** The **PREHEAT Offset** number from this step will be used in **STEP 17.** Record **PREHEAT Offset =**
19. Select **150 kVp** and input the **PREHEAT Offset** value stored at 125 kVp, then [**STORE**]. **Do NOT make an exposure at this time.**
20. **Wait 15 minutes before proceeding to allow the tube to cool.**

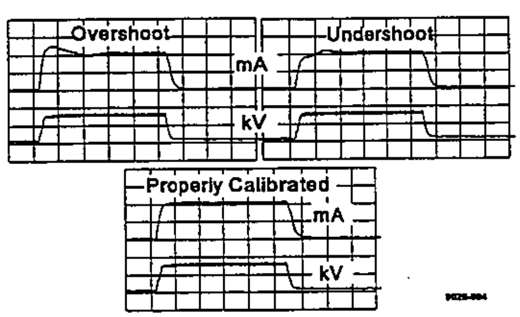


FIGURE 3-4 PREHEAT WAVEFORMS (mA)

3.9.3 X-RAY TUBE CONDITIONING PROCEDURE - EUREKA TUBES ONLY

> **Note:**
> This procedure is for Eureka tubes ONLY. For other manufacturers refer to their documentation for their recommended procedure.

A newly installed Eureka x-ray tube, especially one that will be used in a high power, high kVp, or heavy work load environment, can be seasoned to its new environment using the following procedure. The procedure consists of four parts:

1. A five to six-minute high heat input run to get the tube anode to maximum heat.
2. Followed immediately by a 10 to 12 minute period at a reduced input rate to heat soak the target.
3. A 15-minute cooling period.
4. A high voltage stability check.

Prerequisites:

1. Perform the precalibration as per **SECTION 3.9.2, STEPS 1 - 14.**
2. Proper anode rotation speed shall be verified. All test parameters are based on standard speed ratings, therefore all tests can be run either standard speed or high speed, except where high speed is specifically noted.
3. The kVp and mA waveforms shall be monitored for all exposures.
4. There must be a minimum of a 15-minute cooling period between any previous exposures and the start of this procedure.
5. If possible, keep the rotor boosted between exposures to minimize housing heat input. If possible, a fan should be used to minimize housing heat.

Procedure:

1. If not already in calibration mode, enter it at this time as outlined in **PRECALIBRATION**. Enter **3a. MASTER Preheat Calibration** to condition the tube.

> **Note:**
> **When in calibration mode only, before calibrating tube 2:**
> a. For generators with high frequency filament - disconnect the white/green wire from TB2-2 (FE) on the fluoro field I/O PCB (5584.262.20). Reinstall this wire upon completion of tube 2 calibration.
> **OR:**
> b. For R/F generators with high speed rotor control - disconnect the white/red wire from TB2-2 (FE) on the fluoro fiel I/O PCB (5584.262.20 or 6584.262.17). Reinstall this wire upon completion of tube 2 calibration.

2. ☢ High heat input. Make exposures on the large focus per **TABLE 3-3**. Continue immediately with **STEP 2.**
3. ☢ Reduced input. The same as **STEP 1**, except double the interval between exposures.

> **Note:**
> a. If this procedure is interrupted anytime during **STEP 1** or **2**, allow the tube to cool for 15 minutes minimum, before starting over.
> b. This procedure will heat up the SCR fuse (F9), and if not properly heat-sunk, i.e., proper washers installed, it may open. It is recommended to replace F9 between **STEP 1** and **2** with a cool fuse to assure operation of this procedure.
> c. If the specified **mA** and **TIME** indicated in the table cannot be obtained, use a combination of factors that will give approximately the same H.U. (kVp X mA X TIME X 1.35) per exposure. Do not exceed the single exposure ratings, refer to the proper product data sheet for a given tube type. EXAMPLE: 90kVp x 300mA x 0.7s x 1.35 = 25,500H.U./exp.
> EQUIVALENT: 90kVp x 250mA x 0.8s x 1.35 = 24,300H.U./exp. or 90kVp x 320mA x .66s x 1.35 = 25,600H.U./exp.

4. Cooling. Allow the tube to cool from 15 minutes to 1 hour.
5. High voltage test: Use Large focus, 30ms exposure time, and mA as specified in **TABLE 3-4**. Check tube stability to the maximum kVp for the tube type. Use the kVp steps per tube type as outlined in **TABLE 3-4**. Proceed as follows:
   a. ☢ Make at least four exposures at a minimum of 10 seconds apart for each kVp step per tube type. At the highest kVp step used, make at least 12 exposures.

TABLE 3-3 TUBE CONDITIONING TABLE

ANODE HEAT CAPACITY	TUBE TYPE*	LARGE FOCAL SPOT (mm^2)	TARGET ANGLE, DEGREES	CONTROL SETTINGS			HEAT UNITS PER EXPOSURE x 1000	TIME BETWEEN EXPOSURES	TOTAL EXPOSURE S
				kVp	mA	TIME			
	EMERALD								
150 KHU	RAD-8	2.0	16	80	200	1.0	21.6	30s	10
200 KHU	RAD-74	1.5	14	90	300	0.5	18.0	15s	15
300 KHU	RAD-68	2.0	14	90	300	0.7	25.5	20s	15
		1.2	14	90	300	0.25	9.1	7.5s	40
	DIAMOND								
300 KHU	RAD-13	2.0	16	90	300	0.7	25.5	20s	15
	RAD-14	1.2	12	90	300	0.5	18.0	15s	20
	SAPPHIRE								
300 KHU	RAD-25	2.0	14	90	300	0.7	25.5	20s	15
		1.2	14	90	300	0.7	25.5	20s	15
	RAD-16	2.0	16	90	300	0.7	25.5	20s	15
	RAD-21	1.2	12	90	300	0.7	25.5	20s	15
400 KHU	RAD-44	2.0	16	90	300	0.7	25.5	15s	20
	RAD-40	1.5	12	90	300	0.7	25.5	15s	20
		1.2	12	90	300	0.7	25.5	15s	20
		1.0	12	90	200	1.0	24.3	15s	20
	RAD-60	1.2	12	90	300	0.7	25.5	15s	20
	RAD-56	1.2	14	90	300	0.7	25.5	15s	20
		1.0	14	90	300	0.25	9.1	7.5s	40
	RAD-19	1.0	10	90	300	0.7	25.5	15s	20
600 KHU	RAD-52	1.2	12	90	300	0.7	25.5	12s	24
		1.0	12	90	200	1.0	24.3	12s	25
400 KHU	RAD-51	1.2	12	90	300	0.7	25.5	15s	20
		1.0	12	90	200	1.0	24.3	15s	20
325 KHU	RAD-55	1.5	12	90	300	0.7	25.5	20s	15
		1.2	12	90	300	0.7	25.5	20s	15
	RAD-77	1.0	15	90	300	0.25	9.1	7.5s	40

Please call the factory for availability.

TABLE 3-4 mA SELECTION AND kVp STEPS FOR HIGH VOLTAGE TEST

ANODE HEAT CAPACITY	TUBE TYPE	LARGE FOCAL SPOT (mm²)	TARGET ANGLE (degrees)	mA	kVp STEPS FOR HV TEST
	EMERALD				
150KHU	RAD-8	2.0	16	200	
200KHU	RAD-74	1.5	14	200	
300KHU	RAD-68	2.0	14	200	
		1.2	14	200	
	DIAMOND				
300KHU	RAD-13	2.0	16	200	
	RAD-14	1.2	12	200	
	SAPPHIRE				
300KHU	RAD-25	2.0	14	300	
		1.2	14	300	5 kVp STEPS FROM 60kVp - 125kVp
	RAD-16	2.0	16	400	
	RAD-21	1.2	12	300	
400KHU	RAD-44	2.0	16	400	
	RAD-40	1.5	12	400	
		1.2	12	300	
		1.0	12	200	
	RAD-60	1.2	12	300	
	RAD-56	1.2	14	200	
		1.0	14	200	
	RAD-19	1.0	10	200	
400KHU	RAD-51	1.2	12	300	
		1.0	12	200	
600KHU	RAD-52	1.2	12	400*	
		1.0	12	400*	
325KHU	RAD-55	1.5	12	300	
		1.2	12	300	
	RAD-77	1.0	15	200	

* HIGH SPEED RATING

i. If instability occurs at any step, reduce the kVp by 5kVp and repeat the exposures at that kVp for four clean exposures.

ii. If instability continues to occur, double check the system for possible causes such as calibration, loose connections, proper grounding, air in the housing, arcing at the cable receptacles, etc.

b. Repeat the entire procedure if necessary. If repeating the entire procedure does not insure stable operation at the kVp to be used, replace the tube.

3.10 CALIBRATION

This procedure assumes that the x-ray tube has been conditioned following the manufacturers instructions. If the previous section was not performed, do not operate the x-ray tube at a high kVp without going through an intermediate kVp level.

During preheat, calibration occurs at 40kVp, 60kVp and 125 kVp. Enter the 125 kVp offset value at 150 kVp, and return to 140kVp to verify the preheat waveform. Refer to **SECTION 3.9.2, STEPS 16** through **20**. Once this has been done, the system may be increased in 10kVp steps to 120 kVp to condition the tube and system.

3.10.1 FLUORO STANDBY FILAMENT CALIBRATION

This procedure is for adjusting the hardware (on the fluoro I/O PCB) standby filament levels for the undertable fluoro tube. The filaments are adjusted to a level just below emission.

1. Ensure that power is OFF.
2. Toggle CB1 (filament) OFF.
3. Place jumper EMA3 on EMA0 on the mA/mAs PCB.
4. Open the lower panel on the card cage to expose the fluoro field I/O PCB for adjustment.
5. Turn power ON and make a fluoro exposure @ 125 kV, -1 mA station (OR 30 pps for pulsed fluoro system).
6. **On the fluoro field I/O PCB:** Observe the fluoro monitor while adjusting R37 (large filament) **CW**. When an image appears on the monitor adjust R37 **CCW** until the image just disappears.
7. Wait for 5-minute timeout, or toggle to tube 1 then back to tube 2.
8. **On the I/O control PCB:** move SW1-7 to the ON position.
9. **On the fluoro field I/O PCB:** Observe the fluoro monitor while adjusting R38 (small filament) **CW**. When an image appears on the monitor adjust R38 **CCW** until the image just disappears.
10. Move SW1-7 to the OFF position.
11. Turn power OFF.
12. Place jumper EMA0 on EMA3 on the mA/mAs PCB.
13. Toggle CB1 (filament) ON.

3.10.2 FILAMENT PREHEAT CALIBRATION

1. Set the scope as follows: Time base - 5ms/div, Trigger - Ch1, pos. slope
   Ch1: vert. - 1V/div, TP3 (kVp Control PCB). See **TABLE 3-5**.
   Ch2: vert. - 0.1V/div, TP2 (mA/mAs Control PCB). See **TABLE 3-6**.

TABLE 3-5 kVp REFERENCES

kVp	TP3 (V_{DC})	
	150kV Units	125kV Units
40	2.40	2.90
50	3.00	3.64
60	3.58	4.36
70	4.20	5.09
80	4.80	5.82
90	5.40	6.55
100	5.99	7.27
110	6.60	8.00
120	7.20	8.73
125	7.50	9.09
150	9.00	N/A

TABLE 3-6 mA REFERENCES

mA	TP2 (V_{DC})	
	150kV Units	125 kV units
25	.19	.25
50	.38	.50
100	0.75	1.00
150	1.12	1.50
200	1.50	2.00
300	2.25	3.00
400	3.00	4.00
500	3.75	5.00
600	4.50	6.00
800	6.00	N/A
1000	7.50	N/A

2. Turn the OC OFF and flip switch SW3-8 DOWN (**FIGURE 3-3**).
3. Turn the system ON.
4. Select TUBE 2.
5. Press [**ALT MENU**].

6. Press **TEST**.
7. Press [3.] CALIBRATION ROUTINES.

FOR SW VERSION 3.8.3 & ABOVE ONLY:

8. Press [**NEXT**] until **3c. STBY_PH ADJ** is displayed. Select [**EXECUTE**].
9. Press the upper right selector switch until **STBY=OFF** is displayed. Press **EXIT** to return to the main menu.

FOR ALL SW VERSIONS:

10. Select TUBE 1.
11. Repeat **STEPS 5** to **8** for tube 1.
12. Press the upper right selector switch until **STBY=OFF** is displayed. Press **EXIT** to return to the menu screen.
13. Press [**BACK**] until **3a. MASTER Preheat Calibration** is displayed.
14. Select [**EXECUTE**].
15. Select **LARGE FOCUS, 200 mA, 40 kVp, 50 ms.**
16. Make an exposure and observe the mA waveform, (**FIGURE 3-4**) and reference **TABLE 3-6. If** the reference waveform is **not** correct, adjust the **PREHEAT** value by using the [+] and [-] keys. The **PREHEAT Offset** value shown will change. When the value shown is acceptable, press the **STORE** switch, two audible beeps will be heard indicating that the value is stored. The **PREHEAT** value will also change by the new **PREHEAT Offset** value. Repeat this step until the mA waveform is correct. Continue if the waveform is correct.
17. Select **LARGE FOCUS, 200 mA, 60 kVp, 50 ms.** Repeat the steps from **STEP 10** on until the waveform is correct.
18. Select **LARGE FOCUS, 200mA, 125 kVp, 50 ms.** Repeat the steps from **STEP 10** on until the waveform is correct.
19. Select **LARGE FOCUS, 200mA, 150 kVp, 50 ms.** Change **PREHEAT OFFSET** value and make an exposure at 140 kVp. Repeat this step until the waveform is correct.
20. Press [**EXIT**] to exit **3a. MASTER Preheat Calibration**.

3.10.3 mA CALIBRATION

Exposure timing is accomplished with the mAs timer. If mA is incorrectly calibrated, exposure times will be incorrect. The correct mAs will always be delivered regardless of the mA calibration state. Correct exposure time is the result of correct mA calibration.

1. ~~Turn~~ power OFF and install the mA/mAs control PCB on an extender card.
2. ~~Turn~~ power ON and using a DVM check for $0V_{DC}$ at TP2 on the mA/mAs control PCB. If it is not, adjust R57 until $-0.008V_{DC}$ is obtained
3. ~~Enter~~ claibration mode and press [**NEXT**] until **1. MA Calibration** is displayed.
4. Press [**EXECUTE**].
5. Select **LARGE FOCUS, 25 mA, 60 kVp, 1 s.**
6. Remove the shorting plug from the tank or the isolation feedback PCB and connect the ammeter to these points.
7. Make an exposure and note the actual mA reading. Adjust the mA value by using the [+] and [-] keys. These will change the **MA Offset** value shown. The mA value will also change by the new **MA Offset** value. When the value shown is acceptable, press the [**STORE**] switch. Two audible beeps will be heard indicating that the value is stored. Repeat this step until the mA waveform is correct. mA value = 25mA ±1mA.
8. Leaving all else the same, select the following mA setting:TM30 - **400 mA;** TM40, TM50, TM65, TM80 - **600 mA.**

NOTE:
Most digital multimeters require at least one second for a reading to stabilize. If multiple exposures are required, refer to x-ray tube rating chart, and be sure to let the target cool between exposures (up to two minutes). If the tube that is installed can not make the selected mA exposure for one second, lower the mA to perform this calibration.

9. Make an exposure and note the actual mA reading. Adjust the mA value by using the [+] and [-] keys. These will change the **MA Offset** value shown. The mA value will also change by the new **MA Offset** value. When the value shown is acceptable, press the **[STORE]** switch. Two audible beeps will be heard indicating that the value is stored. Repeat this step until the mA waveform is correct. mA value = selected mA ±3%:

TM30 - 400 mA ± 12 mA
TM40, TM50, TM65, TM80 - 600 mA ± 18 mA

10. Press **[EXIT]** to exit **1. MA Calibration.**
11. Turn power OFF and remove the mA/mAs control PCB from the extender card and install it in its slot in the card cage.
12. Disconnect the ammeter from the jumper connector and reinstall the shorting plug.
13. Turn power ON and enter calibration mode for the next section.

3.10.4 kVp CALIBRATION

This procedure ensures that the system will reliably generate the desired kVp for safe exposures. If not calibrated properly the generated kVp may not match that selected by the operator.

1. Press **[NEXT]** until **2. kV CALIBRATION** is displayed.
2. Press **[EXECUTE]**.
3. **TABLE 3-7** provides the techniques used for this calibration procedure. Perform the following for both the low and high techniques at each power level:

Make an exposure and observe the actual kVp on the noninvasive meter or the kVp divider. Adjust the kV value by using the [+] and [-] keys. These will change the **KV Offset** value displayed. The kV value will also change by the new **KV Offset** value. When the value shown is acceptable, press the **[STORE]** switch. Two audible beeps will be heard indicating that the value is stored. Repeat this step until the kV value is correct.

If further exposures are necessary for the 150kV units, select **140 kVp** and **150 kVp** and perform the calibration at these points.

TABLE 3-7 kVp CALIBRATION SELECTIONS

	RANGE	Lo			Hi		
SYSTEM	**kW**	**mA**	**kV**	**ms**	**mA**	**kV**	**ms**
125kV Units **30, 40**	<12	200	45	50	N/A	N/A	N/A
	≥12	N/A	N/A	N/A	200	125	50
150kV 30L 40L	<12	50	60	50	50	130	50
	≤30	200	60	50	200	130	50
	≤40*	400	60	50	300	130	50
150kV Units **60, 50, 80**	<12	50	60	50	50	130	50
	≤30	200	60	50	200	130	50
	≤40	400	60	50	300	130	50
	≤60	600	60	50	400	130	50
	≤80	800	65	50	500	130	50

* - 40L ONLY

3.10.5 PREHEAT POST-CALIBRATION

1. Press [NEXT] until **3a. MASTER Preheat Calibration** is displayed.
2. Press [**EXECUTE**].
3. Select **LARGE FOCUS, 200 mA, 40 kVp, 50 ms.**
4. Make an exposure and observe mA waveform (TP2 on mA/mAs Control PCB), see **FIGURE 3-5.** Adjust the **PREHEAT Offset** value by using the [+] and [-] keys. These will change the **PREHEAT Offset** value shown. The **PREHEAT** value will also change by the new **PREHEAT Offset** value. When the value shown is acceptable, press the [**STORE**] switch. Two audible beeps will be heard indicating that the value is stored. Repeat this step until the **PREHEAT** value is correct.

   If during performance of this section, the error message **"FILAMENT OVERLOAD"** is displayed, slightly increase the **PREHEAT offset** value and reshoot. If during performance of this section, the error message **"mA OVERLOAD"** is displayed, slightly decrease the **PREHEAT offset** value and reshoot.

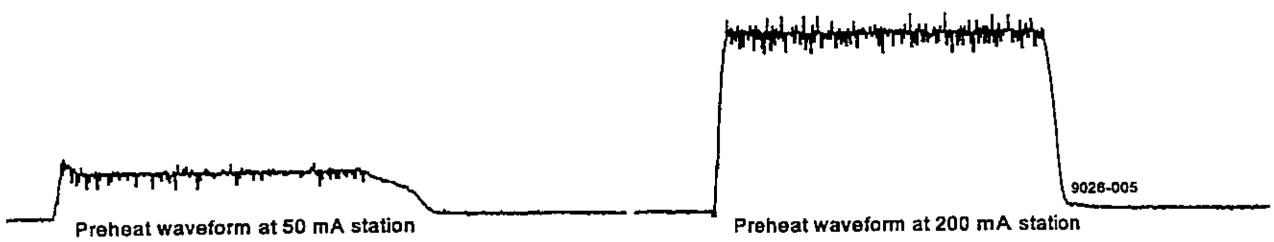


FIGURE 3-5 PREHEAT WAVEFORMS

5. Select **LARGE FOCUS, 200 mA, 60 kVp, 50 ms** and repeat **STEP 4.**
6. Select **LARGE FOCUS, 200 mA, 125 kVp, 50 ms** and repeat **STEP 4.**
7. Select **LARGE FOCUS, 200 mA, 150 kVp, 50 ms** and repeat **STEP 4.**
8. Select **SMALL FOCUS, 50 mA, 40 kVp, 50 ms** and repeat **STEP 4.**
9. Select **SMALL FOCUS, 50 mA, 60 kVp, 50 ms** and repeat **STEP 4.**
10. Select **SMALL FOCUS, 50 mA, 125 kVp, 50 ms** and repeat **STEP 4.**
11. Select **SMALL FOCUS, 50 mA, 150 kVp, 50 ms** and repeat **STEP 4.**
12. Press [**EXIT**] to exit **3a. MASTER Preheat Calibration**. The mA, kVp, and preheats are now calibrated. The **MASTER Preheat Calibration** routine was used to calibrate the 200mA curve at three kVps: 40, 60, 125 and 150. It also shifted each of the other system preheat curves at the same time, which calibrates the entire system.
13. The installer should now check each mA station at a low, middle, and high kVp (50ms exposures). The preheat should allow the mA waveform to begin at the set mA, ±5%, as measured at the end of the initial cable charge overshoot. If any preheats are found to be out of tolerance, then the **POINT PREHEAT CALIBRATION** routine in **SECTION 3.10.8** can be used to fine tune the system calibration at 40, 60, 125 and 150 kVp for any mA station needed.
14. Press [**EXIT**] until the calibration routine is exited.

3.10.6 MAS CALIBRATION

1. Press [**NEXT**] until **4. MAS Calibration** is displayed.
2. Press [**EXECUTE**].
3. Select **LARGE FOCUS, 200 mA, 80 kVp, 125 ms.**
4. Remove the banana plug shorting connector from the high voltage tank (in 125 kV units) or the isolation PCB (in 150 kV units) and connect an mAs meter in the jumper's place.
5. Make an exposure and measure the actual mAs as displayed on the mAs meter. If necessary, change the offset by pressing [+] or [-]. **STORE** and repeat the exposure until the correct value is displayed. Correct mAs value = 25 mAs ±0.95 mAs.
   Note: Adjust as accurately as possible to the actual value.
6. Select **LARGE FOCUS, 200 mA, 80 kVp, 1250 ms** and repeat **STEP 15.** Correct mAs value = 250 mAs ±7.7 mAs **Note:** Adjust as accurately as possible to the actual value.

7. Press [EXIT] until the calibration routine is exited.

3.10.7 POINT PREHEAT CALIBRATION

This procedure calibrates each mA station for 40, 60, 125 or 150 kVp. Start at the lowest mA station.

1. Press [NEXT] until **3b. POINT Preheat Calibration** is displayed.
2. Select [**EXECUTE**].
3. Select **SMALL FOCUS**, 40 kVp, 50ms.
4. Select the starting mA station.

> **Note:**
> The TM interpolates the PREHEAT number for kVps between calibration points. If a limit error occurs for a kVp cal point/mA, a lower kVp must be selected for the exposure. Any corrections required are input and stored for the actual kVp cal point and reverified at the lower kVp.

5. Perform **SECTION 3.10.5, STEP 4**.
6. Select the next mA station and repeat **STEP 5** until all mA stations have been calibrated.
7. Perform **STEPS 4** through **6** for the following kVp stations: 60, 125 or 150 (depending on the capability of the generator). When each of the kVp stations have been calibrated proceed to the next step.
8. Select **LARGE FOCUS** and perform **STEPS 4** through **7**.
9. Press [Exit] to exit **3b. POINT Preheat Calibration.**

3.10.8 RADIOGRAPHIC STANDBY FILAMENT CALIBRATION (SW Ver 3.8.3 and above)

This section is applicable only if a one-second **PREP** to **X-RAY** cycle time is required. Each focal spot of each x-ray tube is individually adjusted. The procedure adjusts the filament standby current to a level just below emission. The procedure must be repeated for each focal spot of each tube.

1. Press [NEXT] until **3c. Standby Preheat Adj** is displayed. Select [**EXECUTE**].
2. Press the upper right switch to toggle the display to **STBY=ON.**
3. Make an exposure and observe the mA waveform (TP2 on mA/mAs control PCB). The waveform should show an mA burst approximately 2 ms long and then drop to zero.
4. Adjust the **Filament Standby** value by pressing either [+] or [-]. Press [**STORE**] when the value is satisfactory.
5. Make an exposure and observe the mA waveform. Repeat **STEP 5** until the mA burst begins to lengthen. Reduce the **Filament Standby** value to a value just below this point and press [**STORE**].
6. Press [EXIT] to go back to the main menu.

3.10.9 PREHEAT BOOST ADJUST (SW Ver. 3.8.3 and above)

This procedure provides for the adjustment of the boost number to a value which will compensate for the shortened filament boost time necessary for a short Rad x-ray cycle time.

1. Press [NEXT] until **3d. Preheat Boost Adj** is displayed.
2. Select [**EXECUTE**].
3. Select **200 mA, 60 kVp,** and the desired focal spot.
4. Make an exposure and observe the mA waveform (TP2 on mA/mAs control PCB). Adjust the **BOOST Offset** value by pressing [+] or [-]. This will change the **BOOST Offset** value shown. The **PH_BOOST** value will also change by the new **BOOST Offset** value. When the value shown is acceptable, press [STORE]. Repeat this step until the ma waveform is correct. The **BOOST Offset** value will be applicable for all mA selections on the selected focal spot.
5. The large and small focal spots of each Rad x-ray tube is individually adjusted. Perform the above steps for the remaining focal spot and Rad tube.
6. Press [EXIT] to return to the main menu.

3.10.10 UNDERTABLE STANDBY FILAMENT CALIBRATION (SW Ver 3.8.5 & above)

This section and the following section are only applicable if a fast fluoro to spot cycle time is required, such as for a 105 camera or for photo spot. Each focal spot of each X-Ray tube is individually adjusted. The procedures outlined must be repeated for each focal spot. This procedure is for adjusting the filament standby current to a level just below emission.

1. Press [**NEXT**] until **3c. Standby Preheat Adj.** is displayed.
2. Select [**EXECUTE**].
3. Press the upper right switch to toggle the display to **STBY = ON**.
4. Make an exposure and observe the mA waveform.
5. The waveform should show an mA burst approximately 2-msec long and then drop to zero.
6. Adjust the **Filament Standby** value by using the [+] and [-] keys. Press **STORE**, make an exposure and observe the mA waveform.
7. Repeat **STEP 6** until the mA burst begins to lengthen. Reduce the **Filament Standby** value to a slightly lower value, make an exposure to verify and if correct, press **STORE.**
8. Press [**EXIT**] to exit **3c. Standby Preheat Adj.**

3.10.11 PREHEAT BOOST ADJUST

This procedure provides for the adjustment of the preheat boost number to a value which will compensate for the shortened filament boost time necessary for a short x-ray cycle time. This procedure is for photospot systems.

1. Press [EXIT] repeatedly to return to the Main menu. Select Tube 1 and then select Tube 2. The LCD screen should display the Fluoroscopic and Spotfilm technique factors.
2. Press [**ALT MENU**].
3. Press **TEST**.
4. Press [**3.**] **CALIBRATION ROUTINES**.
5. Press [**NEXT**] until **3d. Preheat Boost Adj** is displayed.
6. Select [**EXECUTE**].
7. Select 200 mA and 60 kVp.
8. Make a short fluoro exposure and then a photo spot exposure. Observe the mA waveform. If the waveform must be corrected, adjust the **BOOST Offset** value by using the [+] and [-] keys as required. This will change the **BOOST Offset** value shown. When the value shown is acceptable, press the **STORE** switch. The **PH_BOOST** value will now also change by the new **BOOST Offset** value. Two audible beeps will be heard indicating that the value is stored. Repeat this step until the mA waveform is correct. The **BOOST Offset** value will be applicable for all mA selections on the focal spot selected.
9. The large and small focal spots of the under-table fluoro x-ray tube are individually adjusted. Perform the above steps for the remaining focal spot.
10. Press [**EXIT**] to exit **3d. Preheat Boost Adj.**

3.11 CEC (COMPUTERIZED EXPOSURE CONTROL) DATA MODIFICATION

3.11.1 CEC RECEPTOR AND FOCUS SELECTION

This procedure is for CEC exams which are **NOT** also APR exams (if for both, **SETUP** will not appear in CEC setup). If an exam is used by both modes follow the procedure for APR setup. For CEC only exams, the selected **RECEPTOR** and **FOCUS** of the selected exam can be modified as follows (the system must be in calibration/setup mode, see **SECTION 3.3**):

1. Select **MODE CEC.**
2. Select desired exam.
3. Select the desired **RECEPTOR** and **FOCUS.**
4. Press **[SETUP]**.
5. Select **[YES]** if the OC panel LEDs display the desired **RECEPTOR** and **FOCUS.** Otherwise pressing **[NO]** will return to the **SETUP** screen.
6. Verify that the desired **RECEPTOR** and **FOCUS** are displayed by reselecting the desired exam.
7. Repeat **STEPS 1** through **6** for any other CEC exams.

3.11.2 CEC kVp AND mAs SELECTION

This procedure is for CEC exams which are **NOT** also APR exams (if for both, **SETUP** will not appear in CEC setup). If an exam is used by both modes follow the procedure for APR setup. For exams programmed for CEC only, the **KVP** and **MAS** of the selected exam can be modified as follows (the system must be in calibration/setup mode, see **SECTION 3.3**):

1. Select **MODE CEC.**
2. Select desired exam.
3. Use the **MA/CM** switches to scan through the **CM** selections and check that the **KVP** and **MAS** values at the selected **CM** value are correct. The **kVp** and **mAs** values are changed upon release of the **[MA/CM]** switch.
4. The kVp and the mAs values at the selected CM value can be modified as follows:
   a. Select the desired **KVP** and **MAS** values. The **MAS** values change in increments of 5% of the initial **MAS** value.
   b. Press **[ALT MENU]**.
   c. Press **[SAVE FP]** (front panel). The LCD will display XXcm (the current **CM** setting).
   d. To save the selected **KVP** and **MAS** at this **CM** value, press **[YES]**. To exit and retain the default **KVP** and **MAS** values, press **[NO]**.
   e. Verify the changes in **KVP** and **MAS** by selecting another **CM** then reselecting the **CM** value at with the changes were made and checking that the desired **KVP** and **MAS** values are displayed.
5. Repeat **STEPS 1** through **4** for other CEC exams.

3.12 AUTOMATIC EXPOSURE CONTROL (AEC) SYSTEM SETUP

If the system is configured with AEC, perform the following steps to input system configuration data. Reference **SECTION 4** for a discussion of the OC panel and its functions.

1. If not already done, remove the label covering SW3 and SW4, on the rear of the OC. See **FIGURE 3-3.**
2. Ensure OC power is OFF and flip SW3-8 DOWN to place the system in calibration/setup mode.
3. Turn the OC ON.
4. On the OC select **MAN MODE** (manual mode).
5. Press the **AEC FIELD** select button. The LEDs will not illuminate.
6. Select [**SETUP**].
7. The OC is now ready for input of system component definition. The display will show the current status of the following which may be changed at this time:

   Chamber: This is the current chamber designation as connected to the RPU backplane. Valid options are **1** through **6** and **none,** if no chambers are connected.

   X HAND: This designates the handedness of the current chamber being defined. This will affect the **AEC FIELD** designations. Valid options are **RIGHT** and **LEFT HAND.**

   GRID: This defines the grid option for the currently defined chamber. Valid options are **GRID IN**, **GRID OUT** and **IN & OUT**.

   FS: This defines the film/screen combination used with the currently defined chamber. Valid options are **1, 2, 3,** and **-** which designates none. These options can be input in any combination; **1,-,-** or **-,2,3** are examples of valid selections.

   Tube X: Use the **NEXT** button to select. This selects the current tube being defined for use with the currently defined chamber. Valid options are **1 & 2.**

   Receptor Setup: Use the **BACK** button to select. This defines the current receptor option for which the chamber is defined. Valid options are **TABLE, WALL,** or **AUX.**

8. When all selections are correct for the current system component and setup, press **[STORE]** to save the configuration definitions. Fill out **SECTION 10.9** when complete.
9. The TM has standard CEC and APR data installed at the factory. These preset techniques may be changed either through the OC, or by downloading data from a PC.
10. To download CEC data and APR (if AEC present) data, from the PC to the TM, see **APPENDIX A.** Replace the label over the switch access slot on the rear of the OC with a replacement label (provided). This is necessary to provide a means of detecting unauthorized tampering.

3.13 AEC CALIBRATION

The TM generator can accommodate up to six separate ion chambers, and allows for three film/screen combinations on each ion chamber.

Each of three fields on each of six (or more) ion chambers must be calibrated for each film/screen combination, up to three. **This SECTION** provides instructions to accomplish AEC calibration. If less than three film/screen combinations are used on an ion chamber, calibrate the remaining film/screen combinations to film/screen combination #1. The system does **NOT** prevent user selection of a film/screen combination that has **NOT** been calibrated.

1. Ensure the OC is OFF.
2. If jumper switch SW3-8 is not already enabled, remove the adhesive label (if present) on the rear of the OC and flip switch SW3-8 DOWN. See **FIGURE 3-3.**
3. Install grids in all buckies.
4. Install the AEC interface PCB on the extender card and attach the DVM to TP8 and TP (ground). Set the DVM on VDC mode.
5. Proceed with the following sections in sequence.

3.13.1 AEC V/F CALIBRATION

1. Turn the OC ON.
2. Press the [**ALT MENU**]
3. Press **TEST.**
4. Press [**1.**] (**TEST ROUTINES**).
5. Press either [**NEXT**] or [**BACK**] until **3. AEC V/F CHECK and CAL** is displayed.
6. Press [**EXECUTE**].
7. Adjust R30 for +8.50V at TP8 on the AEC Interface PCB.
8. Adjust R43 until the three-digit **TRIP value** in the display matches the voltage at TP8 (850 ±2).
9. Press [**EXIT**] to exit **3. AEC V/F CHECK and CAL.**
10. Press [**EXIT**] to exit **1. TEST ROUTINES.**

3.13.2 %CURVE CALIBRATION

The following procedure will calibrate AEC along a curve at three kVp values, software will calculate for other points. **Each receptor is to be calibrated for each film/screen combination used.**

1. If switch SW3-8 is not already enabled, turn OC power OFF, remove the adhesive label on the rear of the OC and flip switch SW3-8 DOWN. See **FIGURE 3-3.**
2. Turn the RPU and OC ON.
3. Select **MANUAL MODE.**
4. Press ▲ beneath **AEC FIELD**. The **MANUAL AEC - MENU** screen will come up.
5. Select [**AEC CAL**].
6. Place a phantom of 7" (17.8cm) of water or Lexan in the x-ray field.
7. Select the following: **KVP** - 90, **GRID** - IN, **AEC** - MED, **AEC FIELD** - 2 (middle chamber), **AEC DENSITY** - 0, **2F** (2 factor) - Desired backup mAs ([**MAS/TIME**] control buttons), **FOCUS** - LARGE.
8. Select the desired **RECEPTOR** (TABLE, WALL, or AUX).
9. Select **FILM/SCREEN** combination **1** for the selected receptor.
10. Make an exposure, develop the film and check the OD with a densitometer. If the OD = 1.20 ±0.05 (or desired OD) press [**EXIT**] and continue to **STEP 11**. Otherwise adjust the master gain pot R12 on the chamber pre-amp PCB in the receptor (see the manufacturers manual) and repeat this step.
11. Place a phantom of 4" (10.2cm) of water or Lexan in the x-ray field.
12. Select **KVP** - 60 and make an exposure. Develop the film and check the OD. If the OD = 1.20 ±0.05 press [**EXIT**] and continue to **STEP 13**. Otherwise, adjust the trip value by pressing [**+**] or [**-**] to change the **%CHG** value from that displayed, press [**STORE**] and repeat this step.
13. Place a phantom of 10" (25.4cm) of water or Lexan in the x-ray field.

14. Select **KVP** - 120 and make an exposure. Develop the film and check the OD. If the OD = 1.20 ±0.05 press **[EXIT]** continue to **STEP 11**. Otherwise adjust the trip value by pressing [+] or [-] to change the **%CHG** value from that displayed, press **[STORE]** and repeat this step.
15. Each receptor must be calibrated at 90 kVp in accordance with **STEPS 8** through **11** of this section, adjusting R12 in the preamp for each receptor.
16. To program the system for additional film/screen combinations: select **F/S 2** and the appropriate receptor, perform **STEPS 6** through **15**. If adjustment is necessary adjust R32 on the TM AEC interface PCB in **STEP 10** instead of R12 on the chamber preamp. For **F/S 3**, select **F/S 3** and the appropriate receptor, perform **STEPS 6** through **15**. If adjustment is necessary adjust R33 on the TM AEC PCB in **STEP 10** instead of R12 on the chamber preamp.

3.13.3 %POINT CALIBRATION

The following procedure is <u>optional</u>, to be used if it is desired to explicitly calibrate specific kVp values throughout operational range. <u>Each</u> receptor is to be calibrated for <u>each</u> film/screen combination used. **SECTION 3.13.2** must be completed before proceeding.

First, calibration will be performed using ion chamber 2 (middle chamber) at each **kVp** point listed in **TABLE 3-8**, using the specified thickness (depth) of Lexan (water) for **MEDIUM** size. Then ion chambers 1 and 3 will be calibrated at **90 kVp** for **MEDIUM** size. Finally, the remaining sizes will be calibrated using **AEC FIELD** 2 (ion chamber 2) at **90 kVp**. When changing **kVp** values the software will step through the values as listed in **TABLE 3-8**, intermediate values are not calibrated.

TABLE 3-8 FILM/SCREEN 1 BODY SIZE TABLE

kVp	INCHES OF LEXAN or WATER				
	Ped	SMALL	MEDIUM	LARGE	X-LARGE
50	1	1	3	N/A	N/A
60	1	2	4	6	N/A
70	2	3	5	7	N/A
80	3	4	6	8	10
90	4	5	7*	9	11
100	N/A	6	8	10	12
110	N/A	7	9	11	13
120	N/A	8	10	12	14
125	N/A	8.5	10.5	12.5	14.5
150	N/A	N/A	11	13	15

* = Hardware calibration point.

1. Press **[%POINT]**.
2. Select **AEC FIELD** - 2.
3. Select the desired **RECEPTOR** and **FILM/SCREEN** combination to calibrate first.
4. Select **KVP** - 50, **GRID** - IN, **AEC** - MED, **AEC DENSITY** - 0, **MAS/TIME** - Desired backup mAs (**[MAS/TIME]** control buttons).
5. Place 3" (7.6cm) of Lexan or water in the x-ray field.
6. Make an exposure and develop the film. Check the OD of the film with a densitometer. If the OD is 1.20 ±0.05 proceed to **STEP 7**. Otherwise proceed with the following steps **6a** through **6c** until the OD is 1.20 ± 0.05:

a. Use the following formula to calculate a new trip number:
New Trip # = (Desired OD/Measured OD) x Old Trip #
b. Use [+] and [-] to change the calibration trip point to the new calculated value and press **[STORE]**.
c. Repeat **STEP 6**.

7. Repeat **STEP 6** for the next **kVp** value (skipping 90 kVp), placing the necessary phantom as listed in **TABLE 3-8** in the x-ray field. If **%CURVE** was completed 120 kVp may also be skipped. If the last **kVp** station is calibrated proceed to **STEP 8**.
8. Each allowed **kVp** station has now been calibrated for **AEC FIELD** 2 select **AEC FIELD** - 1, **KVP** - 90.
9. Make an exposure and develop the film. Check the OD of the film with a densitometer. If the OD is 1.20 ±0.05 proceed to **STEP 10**. Otherwise proceed with the following steps **9a** through **9c** until the OD is 1.20 ± 0.05:

a. Use the following formula to calculate a new trip number:
New Trip # = (Desired OD/Measured OD) x Old Trip #
b. Use [+] and [-] to change the calibration trip point to the new calculated value and press **[STORE]**.
c. Repeat **STEP 9**.

10. Select **AEC FIELD** - 3.
11. Make an exposure and develop the film. Check the OD of the film with a densitometer. If the OD is 1.20 ±0.05 proceed to **STEP 12**. Otherwise proceed with the following steps **11a** through **11c** until the OD is 1.20 ± 0.05:
a. Use the following formula to calculate a new trip number:
New Trip # = (Desired OD/Measured OD) x Old Trip #
b. Use [+] and [-] to change the calibration trip point to the new calculated value and press **[STORE]**.
c. Repeat **STEP 11**.
12. Select **AEC FIELD** - 2, **KVP** - 90, **PED** (smallest size).
13. Make an exposure and develop the film. Check the OD of the film with a densitometer. If the OD is 1.20 ±0.05 proceed to **STEP 14**. Otherwise proceed with the following steps **13a** through **13c** until the OD is 1.20 ± 0.05:
a. Use the following formula to calculate a new trip number:
New Trip # = (Desired OD/Measured OD) x Old Trip #
b. Use [+] and [-] to change the calibration trip point to the new calculated value and press **[STORE]**.
c. Repeat **STEP 13**.

14. Select the next size (skipping **MEDIUM**) and proceed to **STEP 13**. If all sizes for all receptors have been calibrated, then the AEC system has been calibrated and this procedure is completed. This procedure was performed with **GRID IN;** when the system is used with **GRID OUT** the system will automatically compensate.

3.13.4 TRIP MAX VALUE ADJUSTING PROCEDURE

The TM is capable of accepting up to six ion chamber inputs. All of the chamber pre-amplifiers have gain adjustments and should be set for similar gains. The ion chamber signal is processed by the AEC interface module to accommodate three film/screen combinations, five body size density modifications, and ±50% density modification.

To assure that none of these gain modifier amplifiers saturate, causing the automatic exposure to terminate by back up time, it is required that the MAX TRIP value be determined and set after all calibration of the AEC system has been completed.

1. If switch SW3-8 is not already enabled, with power OFF, remove the adhesive label (if present) on the rear of the OC and flip switch SW3-8 DOWN. See **FIGURE 3-3**.
2. Turn the RPU and OC ON.
3. Select **MANUAL MODE**.
4. Press **AEC FIELD**.
5. Select [**AEC CAL**].
6. Select [**TRIP MAX**].
7. Press [**MAS/TIME**] on the OC front panel up or down until **BACKUP** 20.0mAs is displayed.
8. Press the [+] or [-] keys until **MAX** displays 8.0 volts.
9. Press [**STORE**]. The **TRIP** value will display 8.00volts.
10. Select [**AEC FIELD 2**], **90 kVp**, desired tube (**1** or **2**) and desired receptor (**TABLE**, **WALL**, or **AUX**).
11. ☢ With no attenuator in the field, make an exposure and note the **POST - mAs** reading. It should be under 2 mAs. If it isn't, verify all connections.
12. ☢ Increase the MAX value to 9.0 (**STEP 8**), [**STORE**], and make an exposure. Note the new value of mAs.
13. Repeat **STEPS 10** through **12** with 10.0, 11.0, and 12.0 volts, etc., noting the mAs at each step. At some value the exposure will trigger the Backup Timer and go to 20.0 mAs (BACKUP). The **MAX** value will now be decreased until taken out of the **BACKUP** range. Decrease the **MAX** value by .2V, [**STORE**] each value, then make exposures until taken out of backup timer range.
14. At this point, decrease the **MAX** value by .4V more and [**STORE**] this value.
15. Perform **STEPS 10** through **15** for all remaining tube and receptor combinations. When all have been calibrated, the **MAX TRIP VALUE** procedure is complete.

3.14 ANATOMICAL PROGRAMMED RADIOGRAPHY (APR) SETUP

Standard APR techniques are programmed in firmware and installed at the factory. These techniques can be modified through the OC or by use of the **TM GENERATOR PC INTERFACE** program as outlined in **APPENDIX A**. The AEC system must have been fully calibrated in the **MANUAL** mode. When an APR exam is selected, the **TRIP** value will be the calibrated value of the manual AEC calibration. To fine tune each APR exam, perform the following:

1. If switch SW3-8 is not already enabled, remove the adhesive label (if present) on the rear of the OC and flip switch SW3-8 DOWN. See **FIGURE 3-3.**
2. Turn the RPU and OC ON.
3. Select **APR MODE.**
4. Select the desired APR exam.
5. Check that the following items selected by the EXAM are DESIRED: **RECEPTOR, GRID, FOCUS, FILM SCREEN**, and **AEC FIELDS.**
6. If required, the items selected by the exam in **STEP 5** can be modified as follows:
   a. Use the front panel switches to select the desired setup values.
   b. Press [**SETUP**].
   c. Press [**YES**] to save the set-up values, or press [**NO**] to exit the routine without saving the values.
   d. Verify that the set-up values are correct by exiting the **EXAM** and reselecting the **EXAM.**
7. Check that the selected kVp and backup mAs are correct for each size. If desired, the selected kVp and back-up mAs for each **AEC SIZE** can be modified as follows:
   a. Use the front panel switches to select **AEC SIZE** and the appropriate **kVp** and **backup mAs** for the size.
   b. Press [**ALT MENU**].
   c. Press [**SAVE FP**].
   d. To save the selected kVp and back-up mAs, press [**YES**]. To exit this save routine without saving kVp and back-up mAs, press [**NO**].
   e. Repeat **STEPS 7a** through **7d** if changes in the kVp and mAs for other sizes are required.
   f. Verify that the kVp and mAs values selected by each size are correct by scanning through the sizes.
8. Proceed with **SECTION 3.15.2 APR %MASTER CALIBRATION.**
9. Proceed with **SECTION 3.15.3 APR %SIZE CALIBRATION.**
10. Repeat **STEPS 2** through **10** for the remaining APR exams.
11. Remove power from the OC and flip SW3-8 UP; the procedure is now complete.

3.15 ANATOMICAL PROGRAMMED RADIOGRAPHY (APR) CALIBRATION

This section provides instructions for the verification and calibration of the APR techniques. If the APR techniques are to be changed see **SECTION 3.14**. Proceed with the following sections in order.

3.15.1 APR VERIFICATION

This section will allow verification of the APR settings.

1. If switch SW3-8 is not already enabled, remove the adhesive label (if present) on the rear of the OC and flip switch SW3-8 DOWN. See **FIGURE 3-3.**
2. Turn the OC ON.
3. Select **APR MODE.**
4. Select the desired APR exam.
5. Check that the following items selected by the EXAM are DESIRED: **RECEPTOR, GRID, FOCUS, FILM SCREEN,** and **AEC FIELDS.**
6. If required, the items selected by the exam in **STEP 4** can be modified by following the instructions in **SECTION 3.14.**
7. Check that the selected kVp and backup mAs are correct for each size. If desired, the selected kVp and back-up mAs for each **AEC SIZE** can be modified by following the instructions in **SECTION 3.14.**
8. Proceed with **SECTION 3.15.2 APR %MASTER CALIBRATION.**
9. Proceed with **SECTION 3.15.3 APR %SIZE CALIBRATION.**
10. Repeat **STEPS 2** through **10** for the remaining APR exams.
11. Remove power from the OC and flip SW3-8 UP, the procedure is complete.

3.15.2 APR %MASTER CALIBRATION

%MASTER Calibration is performed at medium size and 0 density. **%MASTER Calibration** modifies all sizes by the same percent change at which medium is modified. Perform the following:

1. Select the desired APR exam.
2. Press **[%MASTER]** to enable **%MASTER** calibration mode.
3. Insert the equivalent thickness of Lexan or depth of water. See **TABLE 3-8** for "medium" of the exam selected into the x-ray field.
4. Select **AEC FIELD 2.**
5. Make an exposure and measure the OD with a densitometer.
6. Calculate: percent change = $1 - \dfrac{\textit{measured Optical Density}}{\textit{desired Optical Density}}$
7. Use [+] and [-] to add this value to the total **%CHG** displayed.
8. Press **[STORE]** to save **%CHG** and to recalculate a new **TRIP** voltage at **AEC MEDIUM** for the selected exam.
9. Repeat **STEPS 5** through **8** until the desired OD is achieved.
10. Return to **SECTION 3.15.1, STEP 9.**

3.15.3 APR %SIZE CALIBRATION

%SIZE Calibration mode allows each size to be individually modified. **%SIZE Calibration** can be used to either calibrate each size based on a desired OD for a given thickness of water or as a percent of **AEC MED** modifier.

If calibration is to be performed as a percent of **AEC MED** perform this section, then proceed to **SECTION 3.15.4** for **AEC SMALL** and **AEC LARGE.** If calibration is to be performed for all sizes, perform the following:

1. Select the desired **APR** exam.
2. Press **[%SIZE]** to enable %SIZE Calibration mode.
3. For calibration at sizes based on equivalent thicknesses of water, select the desired **AEC SIZE** to calibrate.

4. Insert the equivalent thickness of Lexan or depth of water for the size selected, (see **TABLE 3-8**), into the x-ray field.
5. Select **AEC FIELD 2.**
6. ☢ Make an exposure and measure the OD with a densitometer.
7. Calculate: percent change = $1 - \dfrac{\textit{measured Optical Density}}{\textit{desired Optical Density}}$
8. Use [**+**] and [**-**] to change the value of **%CHG** displayed.
9. Press [**STORE**] to save **%CHG** and to recalculate a new trip voltage at **AEC SIZE** for the selected exam.
10. Repeat **STEPS 5** through **9** until the desired OD is achieved.
11. If all **AEC** sizes are to be completed in this section, repeat **STEPS 3** through **10** for the remaining **AEC SIZES**; otherwise proceed to **SECTION 3.15.4** for **AEC SMALL** and **AEC LARGE.**

3.15.4 CALIBRATION OF SIZES BASED ON % CHANGE FROM MEDIUM

This calibration procedure is to be performed for **AEC SMALL** and **AEC LARGE** after **AEC MED** has been calibrated in **SECTION 3.15.3.** In this method, **AEC MED** at 90 kVp is treated as the center point for the calibration of **AEC SMALL** and **AEC LARGE. AEC SMALL** is 15% less than that of **AEC MED**, or 85% of **AEC MED. AEC LARGE** is 15% greater than that of **AEC MED**, or 115% of **AEC MED.**

The **%CHG** shown for **AEC SMALL** and **AEC LARGE** is the percent change from the nominal curve value, and does not include the **%CHG** value of **AEC MED.**

1. Select the desired **APR** exam.
2. Press [**%SIZE**] to enable %SIZE Calibration mode.
3. Select **AEC MEDIUM** and record its %CHG value:
4. Calibration of **AEC SMALL:**
   a. Select **AEC SMALL.** The first line of the LCD should read: **%SMALL CAL for "desired exam".**
   b. Calculate: **%CHG** = (**%CHG** at **AEC MEDIUM**) + (percent of **AEC MEDIUM** for **AEC SMALL** - 100%).
      Example: If **%CHG** at **AEC MEDIUM** = -1.5%, then **%CHG** = (-1.5%) + (85% - 100%) = -16.5%
   c. Use [**+**] and [**-**] to enter this value for **%CHG.**
   d. Press [**STORE**] to save the **%CHG.**

5. Calibration of **AEC LARGE:**
   a. Select **AEC LARGE.** The first line of the LCD should read: **%LARGE CAL for "desired exam".**
   b. Calculate: **%CHG** = (**%CHG** at **AEC MEDIUM**) + (percent of **AEC MEDIUM** for **AEC LARGE** - 100%).
      Example: If **%CHG** at **AEC MEDIUM** = -1.5%, then **%CHG** = (-1.5%) + (115% - 100%) = 13.5%
   c. Use [**+**] and [**-**] to enter this value for **%CHG.**
   d. Press [**STORE**] to save the **%CHG.**

6. Verify that the **%CHG** values are correct by scanning through the sizes.
7. Press [**EXIT**] to exit **%SIZE CAL MODE.**
8. Turn the OC OFF, toggle SW3-8 UP and replace the protective label.

3.16 FLUORO mA/kV CALIBRATION CONTINUOUS MODE

This section is **NOT** applicable to radiographic generators without fluoroscopic capability, and pulse fluoroscopic systems. This procedure is for tube 2 only, which is the default fluoro tube.

NOTE:

1. TP12 (mA/mAs control PCB) has been factory adjusted for 40.00 kHZ (R52).
2. If radiographic calibration procedures (procedures 1 through 4 in calibration) have just been completed: a) EXIT calibration mode, (b) select TUBE 1, (c) select TUBE 2, (d) select ALT MENU to reenter calibration mode to continue with fluoro calibration for tube 2. This is because the software defaults to purely radiographic mode when these first calibrations are performed, and fluoroscopic mode must be reentered by clearing the system through toggling between tube 1 and tube 2.

1. Place Dynalyzer in the high voltage circuit. Select "Fluoro" mA switch on divider tank.
2. Select SW3-8 on operator control rear panel to ON (DOWN).
3. On the **fluoro field I/O PCB** place a jumper on JP1-1 and JP1-2.
4. Turn power ON.
5. While in operational mode select the fluoro tube (tube 1 or 2).
6. Verify that the generator has been configured for continuous fluoro. Follow the directions found in **SECTION 3.3.4**. Correct if necessary **STORE** the changes. **EXIT** the **SETUP ROUTINES**.
7. Press [3.] (**CALIBRATION ROUTINES**).
8. Press [**NEXT**] or [**BACK**] until **5a. FLUORO -1 mA STATION ADJUST** is displayed. In all cases throughout this procedure [**NEXT**] or [**BACK**] may have to be used to select the appropriate routine.
9. Press [**EXECUTE**].
10. Press the fluoro footswitch and adjust the preheat value (using [-] or [+]) to change the -1 MA preheat value until .4 mA ± .1 actual on the Dynalyzer is achieved. Press [**STORE**] to save, then [**EXIT**].
11. Press [**EXECUTE**] for **5b. FLUORO -2 mA STATION ADJUST**.
12. Press the fluoro footswitch and adjust the preheat value (using [-] or [+]) to change the -2 MA preheat value until .8 mA ± .1 actual on the Dynalyzer is achieved. Press [**STORE**] to save, then [**EXIT**].
13. Press [**EXECUTE**] for **5c. FLUORO -3 mA STATION ADJUST**.
14. Press the fluoro footswitch and adjust the preheat value (using [-] or [+]) to change the -3 MA preheat value until 1.6 mA ± .1 actual on the Dynalyzer is achieved. Press [**STORE**] to save, then [**EXIT**].
15. Press [**EXECUTE**] for **5d. FLUORO -4 mA STATION ADJUST**.
16. Press the fluoro footswitch and adjust the preheat value (using [-] or [+]) to change the -4 MA preheat value until 2.5 mA ± .1 actual on the Dynalyzer is achieved. Press [**STORE**] to save, then [**EXIT**].

Note:
The -4 mA station will be adjusted later to limit the entrance exposure rate to 9.5 R/minute to comply with HHS regulations. This will be done after the fluoro kVp calibration procedure.

17. Press [**EXECUTE**] for **6a. FLUORO Low kV Calibration (50 kv)**.
18. The system defaults to -3 mA station and 50 kVp. Press the fluoro footswitch, and press [-] or [+] to change the 50 kV Adj. value until 50 kVp ±1 actual on the Dynalyzer is achieved. Press [**STORE**] to save, then [**EXIT**].
19. Press [**EXECUTE**] for **6b. FLUORO High kV Calibration (120 kv)**.
20. The system defaults to -3 mA station and 120 kVp. Press the fluoro footswitch, and press [-] or [+] to change the 120 kV Adj. value until 120 kVp ±1 actual on the Dynalyzer is achieved. Press [**STORE**] to save, then [**EXIT**].

Note:
If the kVp value is not 120 kVp, then return to 8a., 8b. Fluoro kV max at -3, -4 mA step, and reset the kV max value to 125 kVp.

21. Press [**EXECUTE**] for **5d. FLUORO -4 mA STATION ADJUST**.
22. Place a dosimeter probe on the table top. Collimate the field to within 1 inch all around the probe. Select 125 kVp on the fluoro control. Press the footswitch, and adjust using [-] or [+] to change the -4 MA preheat value to achieve no greater than 9.5 R/minute on the dosimeter. Press [**STORE**] to save, then [**EXIT**].

Note:
The final mA value will vary from system to system due to the x-ray tube/collimation filtration and the table top attenuation. This value is typically between 2.5 and 3.5 mA.

23. Press [**EXECUTE**] for **7a. FLUORO mA Meter, Low mA Cal.**
24. The default values are mA station -1 (.4 mA) and 80 kVp. Press the fluoro footswitch and adjust the low mA offset value using [-] or [+] to make the mA value displayed on the fluoro control to be within ± .1 mA of the actual mA displayed on the Dynalyzer. Press [**STORE**] to save, then [**EXIT**].
25. Press [**EXECUTE**] for **7b. FLUORO mA Meter, High mA Cal.**
26. The default values are mA station -4 (approximately 2.5 to 3.5 mA) and 80 kVp. Press the fluoro footswitch and adjust the low mA offset value using [-] or [+] to make the mA value displayed on the fluoro control to be within ± .1 mA of the actual mA displayed on the Dynalyzer. Press [**STORE**] to save, then [**EXIT**].
27. Press [**EXECUTE**] for **8a. FLUORO kV Max at -3 mA Step.**
28. Place the dosimeter probe on the table top. Collimate the field to within 1 inch all around the probe.
29. The rate of exposure is limited to 9.5 R/minute. Set the mA station to -3 and press the fluoro footswitch. If necessary adjust the -3 mA kVmax value using [-] or [+] so that the value displayed on the fluoro control display is the same as displayed on the dosimeter and to keep the exposure rate from exceeding 9.5 R/minute. Press [**STORE**] to save, then [**EXIT**].
30. Press [**EXECUTE**] for **8b. FLUORO kV Max at -4 mA Step.**
31. Place the dosimeter probe on the table top. Collimate the field to within 1 inch all around the probe.
32. The rate of exposure is limited to 9.5 R/minute. Set the mA station to -4 and press the fluoro footswitch. If necessary adjust the -4 mA kVmax value using [-] or [+] so that the value displayed on the fluoro control display is the same as displayed on the dosimeter and to keep the exposure rate from exceeding 9.5 R/minute. Press [**STORE**] to save, then [**EXIT**].
33. Press [**EXECUTE**] for **9. FLUORO Preheat Boost Adj.**
34. The function of this adjustment is to preheat the small filament during the rotor boost time. This brings the filament to operating temperature at initiation of actual fluoroscopy. Proper adjustment reduces the Automatic Brightness System from hunting each time fluoro is initiated outside of the 30-second hold time. This boost does not function while the system is in the 30-second hold period. The default values are -4 mA station and 80 kV.

    Place a water phantom (about 9" (22.9cm) deep) on the table, and press the fluoro footswitch. Observe the image on the CRT. If the image gradually comes on, the preheat is too low, and if the image momentary flashes too bright, the preheat value is too high. If necessary adjust the Boost preheat value using [-] or [+]. Wait for the 30-second hold to time out (the filament inverter stops running), and press the fluoro footswitch. Repeat until smooth response is achieved.

3.17 PULSED FLUORO mA CALIBRATION

This section is **NOT** applicable to radiographic generators without fluoroscopic capability, and continuous fluoroscopic systems. **This procedure is for tube 2 only,** which is the default fluoro tube. If *radiographic* calibration procedures (procedures 1 through 4 in calibration) have just been completed: a) EXIT calibration mode, (b) select TUBE 1, (c) select TUBE 2, (d) select ALT MENU to reenter calibration mode to continue with fluoro calibration for tube 2. This is due to the fact that the software defaults to purely radiographic mode when these first calibrations are performed, and fluoroscopic mode must be reentered by clearing the system through toggling between tube 1 and tube 2.

The pulsed fluoro mode provides one mA value and is not operator adjustable. This value is adjusted to provide no greater than 9.5 R/minute at maximum operating technique of 30 pulses per second at 125 kVp. If higher average mA is desired, the 30 p/s and 15 p/s stations may be limited to a kVp value that does not exceed the 9.5 R/m entrance exposure rate. This is similar to the limiting of stations -3 and -4 when in continuous mode.

1. Place the Dynalyzer in the high-voltage circuit. Select "FLUORO" mA switch on the divider tank.
2. Place the dosimeter probe on the table top. Collimate the Field within 1 inch all around the probe.
3. Select **SW 3-8** on the operator control rear panel to ON (DOWN).
4. While in operational mode select the fluoro tube (tube 2).
5. Verify that the generator has been configured for pulsed fluoro. Follow the directions found in **SECTION 3.3.4.** Correct if necessary, **STORE** the changes. **EXIT** the **SETUP ROUTINES.**
6. Press [3.] **(CALIBRATION ROUTINES).**
7. Press [**NEXT**] or [**BACK**] until **5. PULSED FLUORO mA ADJUST** is displayed. In all cases throughout this procedure [**NEXT**] or [**BACK**] may have to be used to select the appropriate routine. Default is 80 kVp and 30 p/s.
8. Press the fluoro footswitch, and adjust the mA preheat (using [-] or [+]) to achieve approximately 2.5 mA indication on the Dynalyzer readout. When this has been achieved, press [**STORE**] to store this value in memory.
9. Increase the fluoro kVp to 125 kVp on the fluoro control. Press the footswitch, and adjust the mA preheat value (using [-] or [+]) to not exceed 9.5 R/minute Entrance Exposure Rate. When this has been achieved press [**STORE**] to store this value in memory. Press [**EXIT**].
10. Press [**EXECUTE**] for **6a. FLUORO LOW kV CALIBRATION (50 kV).**
11. Press the footswitch, and adjust the 50 kV ADJ. value (using [-] or [+]) until the Dynalyzer indicates 50 kVp ± 1. When this has been achieved press [**STORE**] to store this value in memory. Press [**EXIT**].
12. Press [**EXECUTE**] for **6b. FLUORO HIGH kV CALIBRATION (120 kV).** Press the footswitch, adjust the 120 kV ADJ value (using [-] or [+]) until the Dynalyzer indicates 120 kVp ± 1. When this has been achieved press [**STORE**] to store this value in memory. Press [**EXIT**].
13. Press [**EXECUTE**] for **7a. FLUORO mA METER CAL. AT 50 kV.** Press the fluoro footswitch, adjust the 50 kV mA offset value (using [-] or [+]) so that the mA indication on the fluoro control is within ± .1 mA from the value indicated on the Dynalyzer. When this has been achieved, press [**STORE**] to store this value in memory. Press [**EXIT**].
14. Press [**EXECUTE**] for **7b. FLUORO mA METER CAL. AT 120 1 kV.** Press the footswitch, adjust the 120 kV mA OFF (SET) value (using [-] or [+]) until the mA indication on the fluoro control is within ± .1 mA from the value indicated on the Dynalyzer. When this has been achieved, press [**STORE**] to store this value in memory. Press [**EXIT**].
15. Press [**EXECUTE**] for **8a. FLUORO kV max at 15 P/S.**

> **CAUTION:**
> **If the pulsed mA is to be increased, consult the tube rating charts so that the maximum heat unit input rate of the x-ray tube is NOT exceeded.**

16. The system has the capability to limit the maximum kVp for pulse rates of 15 p/s. This permits higher pulsed mA and still not exceed the 9.5 R/minute Entrance Exposure Rate. In **STEP 8** the mA was set to 2.5. If the operator would like to increase the mA during pulsed fluoro, recalibrate for the desired mA per **STEP 8.** If the mA limit is to be left at 2.5 mA, continue without reperforming **STEP 8.**

17. Place the dosimeter probe as in **STEP 2**, adjust the fluoroscopic kVp to not exceed 9.5 R./minute. Adjust the kVp max value to indicate the same kVp value displayed on the fluoro control. When this has been achieved press **[STORE]** to store this value in memory. Press **[EXIT]**.
18. Press **[EXECUTE]** for **8b. FLUORO kV max at 30 P/S.**
19. Place the dosimeter probe as in **STEP 2**, adjust the fluoroscopic kVp to not exceed 9.5 R./minute. Adjust the kVp max value to indicate the same kVp value displayed on the fluoro control. When this has been achieved press **[STORE]** to store this value in memory. Press **[EXIT]**.
20. Press **[EXECUTE]** for **9. FLUORO Preheat Boost Adj.**.
21. The function of this adjustment is to preheat the small filament during the rotor boost time. This brings the filament to operating temperature at initiation of actual fluoroscopy. Proper adjustment reduces the Automatic Brightness System from hunting each time fluoro is initiated outside of the 30-second hold time. This boost does not function while the system is in the 30-second hold period. The default values are -4 mA station and 80 kV.
    Place a phantom on the table, and press the fluoro footswitch. Observe the image on the CRT. If the image gradually comes on, the preheat is too low, and if the image momentary flashes too bright, the preheat value is too high. If necessary adjust the Boost preheat value using [-] or [+]. Wait for the 30-second hold to time out (the filament inverter stops running), and press the fluoro footswitch. Repeat until smooth response is achieved.

3.18 CONTINUOUS FLUORO ABS CALIBRATION - INFIMED CAMERA

1. Turn ABS OFF.
2. Select a fluoro kV and mA which provides the desired image. IF CXC ABS pickup is used, adjust the pot on the pickup PCB for 4.5V at TB1-7 and TB1-8 on the fluoro field I/O PCB.
3. Turn ABS ON
4. Fluoro and adjust R4 on the fluoro field I/O PCB as required to produce an image of the same quality and at the same technique as with ABS OFF.
5. Press [**EXECUTE**] for **10a. FLUORO ABS Window adj.**
6. This procedure adjusts for a stable image on the CRT. Place a phantom on the table, and press the fluoro footswitch. Observe the CRT, if the image is not a stable brightness press [**+**] or [**-**]. Press [**STORE**] to save the altered value which produces stable brightness, then [**EXIT**].
7. Press [**EXECUTE**] for **10b.FLUORO ABS CTR Adj.**
8. Set the Fluoro ABS Center Adjustment for a value of 128.
9. Place a homogenous phantom (i.e. - 2mm copper phantom) in the field to produce the desired Image Intensifier input dose.

Note:
Factory adjustment is for 3.5 mR/min for a 12-inch image intensifier at normal magnification while in the range of 65kV to 90kV.

10. Select maximum SID, and a fluoroscopic technique.
11. Verify that the ABS input to the Fluoro Field I/O Board at TB1-7 with respect to TB1-8 is not saturated at the desired dose.

Note:
To allow for both positive and negative variation, the signal should be between 0VDC and 5VDC.

12. Adjust R89 on the Fluoro Field I/O Board for 1.25VDC at TP3 with respect to AGND at TP11 at the desired dose.
13. Verify the response of ABS, by manually raising or lowering the kV with x-ray off, and then under fluoro observe the manner in which ABS returns kV back to the desired dose level.
14. If the response of ABS is too slow (i.e., it takes longer than 2 seconds to stabilize), the gain of the ABS loop needs to be increased by turning R4 on the Fluoro Field I/O Board counterclockwise. If the ABS response caused the kV to change too quickly, the system becomes unstable, or overshoots, the gain of the ABS loop needs to be reduced by turning R4 clockwise.

Note:
After adjusting R4, it is necessary to readjust R89 for 1.25VDC at the desired dose.

15. Repeat steps 13 and 14 (response check and adjustment of R4 and R89) as necessary.

3.19 PULSED FLUORO ABS CALIBRATION - INFIMED CAMERA

1. Press [**EXECUTE**] for **10a. FLUORO ABS Window adj.**
2. This procedure adjusts for a stable image on the CRT. Place a phantom on the table, and press the fluoro footswitch. Observe the CRT, if the image is not a stable brightness press [+] or [-]. Press [**STORE**] to save the altered value which produces stable brightness, then [**EXIT**].
3. Flicker is controlled by EKV11. Reference **TABLE 8-11** for the desired position.
4. Press [**EXECUTE**] for **10b.FLUORO ABS CTR Adj.**
5. Set the Fluoro ABS Center Adjustment for a value of 128.
6. Place a homogenous phantom (i.e. - 2mm copper phantom) in the field to produce the desired Image Intensifier input dose.

Note:
Factory adjustment is for 3.5 mR/min for a 12-inch Image Intensifier at normal magnification while in the range of 65kV to 90kV.

7. Select maximum SID, and a fluoroscopic technique.
8. Verify that the ABS input to the Fluoro Field I/O Board at TB1-7 with respect to TB1-8 is not saturated at the desired dose.

Note:
To allow for both positive and negative variation, the signal should be between 0VDC and 5VDC.

9. Adjust R89 on the Fluoro Field I/O Board for 1.25VDC at TP3 with respect to AGND at TP11 at the desired dose.
10. Verify the response of ABS, by manually raising or lowering the kV with x-ray off, and then under fluoro observe the manner in which ABS returns kV back to the desired dose level.
11. If the response of ABS is too slow (i.e., it takes longer than 2 seconds to stabilize), the gain of the ABS loop needs to be increased by turning R4 on the Fluoro Field I/O Board counterclockwise. If the ABS response caused the kV to change too quickly, the system becomes unstable, or overshoots, the gain of the ABS loop needs to be reduced by turning R4 clockwise.

Note:
After adjusting R4, it is necessary to readjust R89 for 1.25VDC at the desired dose.

12. Repeat steps 10 and 11 (response check and adjustment of R4 and R89) as necessary.
13. Press [**EXECUTE**] for **11. FLUORO mA Pulse Width Adj.**
14. The pulsed fluoro pulse width has been factory adjusted to assure that the kVp rises to peak on each pulse, and provide a 1 millisecond duration at peak kVp. It should not be necessary to adjust this value in the field.

3.20 ABS CALIBRATION - NICAL CAMERA

This procedure is for use with the Nical camera ONLY. If another camera is used see the appropiate section.

1. **On the fluoro field I/O PCB:** Place JP1 to position 1-2.
2. Connect a DVM to TB1-7 (ABC IN) and TB1-8 (GND).
3. Select **50 kV, ABS OFF.**
4. With no attenuation in the beam, apply fluoro so that the ABC input is saturated. The DVM should read 12 V. If it does not, increase the kV and repeat this step until it does.
5. Connect the positive probe of the DVM to TP3.
6. Apply fluoro and adjust R4 until the DVM reads 2.5V.
7. Place a Phillips phantom (with its plates removed) on the table top in the beam.
8. Select **65 kV** and **.8 mA.**
9. Remove the top cover of the image intensifier to expose the camera.
10. Remove the camera cover. Refer to the Nical camera manual.
11. Locate the diaphragm adjustment pot, and apply fluoro while adjusting the pot to achieve a DVM reading of 1.25 ±0.1 V at TP3.
12. Turn **ABS ON.**
13. Add the two copper plates to the Phillips phantom and place phantom in the beam.
14. Apply fluoro and verify that the kV reading is at approximately 90 kV and that the image on the monitor is about the same as when the phantom did not have the plates installed. Due to the higher kV, the image may not have the same contrast. Achieve 1.25V on TP3. Slight adjustment of R4 may be necessary.

3.21 APR and CEC PROGRAMMING

The TM generators are delivered with a general radiographic technique chart installed in the program memory. The exams have been programmed for a typical 400 speed film/screen combination utilizing typically 10:1 grids.

Exams are not installed for either the upper or lower extremities for selection when in APR mode, since these views are not generally phototimed.

The kVp and mAs values may be reprogrammed via the front panel for all thicknesses when in CEC mode. kVp and back-up mAs can be reprogrammed for all APR exams.

The system is supplied with a computer disk which contains a program that allows the creation of an entirely new technique chart, or edit the existing chart in firmware. Refer to **APPENDIX A** for operating instructions for the program.

Qualified service personnel are required to place the system in **TEST/CALIBRATION/SET-UP** mode to access this program. The **RECEPTOR**, **GRID**, **FOCUS**, **FILM/SCREEN**, and **FIELD**(s) may be changed through the front panel.

3.21.1 REPROGRAMMING CEC EXAMS

The **MAS** and/or **KVP** value can be reprogrammed for each selected **CM** thickness as follows. If the **CM** range is to be extended, the PC interface program must be used. To enter the TEST and SET-UP routines, turn OFF power to the OC. Remove the label covering the switch access slot on the rear of the OC. Flip switch **SW3-8** DOWN (**FIGURE 3-3**) to put the OC in calibration/setup mode.

1. Turn OC power ON.
2. Select desired **BODY GROUP**.
3. Select desired **VIEW.**
4. Select the **CM** to modify.
5. Change **KVP** and/or **MAS** to the new desired values. Note that **ADD** and **SUB** appears next to the display.
6. When the desired values are displayed, select **ALT MENU.**
7. Select **SAVE FP.**
8. Select **YES** if the displayed technique values are to be saved in place of the current technique values. This will replace the current values with the new ones. If the old values are again desired to be the default programmed values, they will have to be programmed in accordance with these steps. Select **NO** if changes are not desired.
9. Repeat the previous steps for any other **CM** or **BODY GROUP VIEW.**
10. When alterations are complete, turn the OC OFF.
11. Toggle SW3-8 UP.

12. Replace the label which covers the switch access slot.

3.21.2 REPROGRAMMING APR EXAMS

The **KVP** and **BACK-UP MAS** values can be reprogrammed as was **KVP** and **MAS** in SECTION **3.10.4** and **3.10.6** respectively. It is desirable to have the back-up mAs as low as possible to assure that the mA will be at a high level which results in short exposure time. To enter the TEST and SET-UP routines, turn OFF power to the OC. Remove the label covering the switch access slot on the rear of the OC. Flip switch SW3-8 DOWN (**FIGURE 3-3**) to put the OC in calibration/setup mode.

1. Turn OC power ON.
2. Select desired **BODY GROUP**.
3. Select desired **VIEW**.
4. Select the desired body size (small, medium, large, ped, or x-large).
5. Change **KVP** and/or **BACK-UP MAS** to the new desired values.
6. When the desired values are displayed, select [**OP PROG**].
7. Select **SAVE FP** (save front panel).
8. Select **YES** if the displayed technique values are to be saved in place of the current technique values. This will replace the current values with the new ones. If the old values are again desired to be the default programmed values, they will have to be programmed in accordance with these steps. Select **NO** if changes are not desired.
9. Repeat the previous steps for any other body size.
10. When alterations are complete, turn the OC OFF.
11. Toggle SW3-8 UP.
12. Replace the label which covers the switch access slot.

SECTION 4 - OPERATION

This section contains information necessary to operate the TM generator.

4.1 RADIOGRAPHIC MODE - TUBE #1

This section provides information for 1 and 2-tube Rad generators. For a Rad/Fluoro generator tube #1 is Rad and #2 is fluoro.

4.1.1 MANUAL

<u>3-Factor</u> (See **TABLES 4-1** and **4-3**): kVp - 40 through 150
mA - 25 through 500 (TM30), 600 (TM40) 800 (TM50 & TM65) 1000 (TM80)
TIME - 5ms through 6000 ms (6 seconds)

<u>2-Factor</u> (See **TABLES 4-2** and **4-4**): kVp - 40 through 150
mAs - 0.5 through 900

The mA is selected as the highest value within the tube rating to assure the shortest exposure time.

<u>Manual AEC</u>

This selection requires Automatic Exposure Control (AEC) (see **Section 4.7**). The exams in this mode are selected in 2-point or 3-point modes. The exam is terminated by AEC. In 2-point mode, the unit is programmed so that the back-up mAs in each exam provides the highest mA available within the tube limits. This will assure the shortest possible exposure time. In 3-point mode, the user has the ability to select the desired mA and select back-up time.

- Film/screen combination: Up to three different film/screen combinations may be programmed. The different front panel setting (including radiographic techniques) could be programmed and saved by pressing the ALT MENU switch. For example: F/S 1= 2 factors, small focal spot, 70 kVp, small patient, left ion chamber; F/S 2 =3 factors, large focal spot, 85 kVp, large patient, central ion chamber, etc.
  Saved techniques can be recalled by selecting the appropriate Film/screen combination.
- Density selection: 11 stations with approximately 10% mAs between steps. Normal (0) and ±5 steps.
- Body size: Small, medium, and large for all exams, with the program ability to provide pediatric and/or extra large, selected by "SOFT" keys around the display window.

4.1.2 COMPUTERIZED EXPOSURE CONTROL (CEC)

This mode of operation uses an anatomical technique chart for kVp, mAs, and average body part thickness. The operator adjusts body part thickness up or down as necessary, and the technique factors are adjusted accordingly.

a. Body groups (seven):	skull, facial, chest, abdomen, spine, upper extremity, and lower extremity
b. Special group:	1-user definable for special views.
c. Programmable exams:	90 exams, typically 15 exams per body group. A maximum of 512 exams can be programmed.

4.1.3 ANATOMICALLY PROGRAMMED RADIOGRAPHY (APR)

APR requires Automatic Exposure Control (AEC). The exams in this mode are programmed in 2-point or 3-point modes. The exam is terminated by AEC. In 2-point mode, unit is programmed so the back-up mAs in each exam provides the highest mA available within the tube limits. This will assure the shortest possible exposure time. In 3-point mode user has ability to select the desirable mA and select back-up time.

1. Body groups (seven): skull, facial, chest, abdomen, spine, upper extremity, and lower extremity.
2. Special group: 1-user definable for special exams.
3. Programmable exams: 90 exams in total, typically 15 exams per body group.
4. Film/screen combination: Up to three different film/screen combinations may be programmed.
5. Density selection: 11 stations with approximately 10% mAs between steps. Normal (0) and ±5 steps.
6. Body size: Small, medium, and large for all exams, with the program ability to provide pediatric and/or extra large, selected by "SOFT" keys around the display window.

TABLE 4-1 3-FACTOR TECHNIQUES

kVp	mA	TIME		
40	25	5ms	100	1.0sec
41	50	10	125	1.25
42	100	15	150	1.50
43	150	20	200	1.75
	200	25	250	2.0
	300	30	300	2.5
	400	35	350	3.0
	500	40	400	3.5
	600#@	45	450	4.0
	800*@	50	500	4.5
150	1000*	60	600	5.0
(In 1 kVp increments)		70	700	5.5
		80	750	6.0
		90	800	

TM40/@ TM50 & TM65/* TM80

TABLE 4-2 2-FACTOR TECHNIQUES

kVp	mAs					
40	.5	5.25	18.75	48.0	137.5	360
41	.63	6.00	20.0	50.0	140	375
42	.75	6.25	21.0	52.5	150	400
43	.88	7.00	22.5	54.0	160	420
	1.00	7.50	24.0	60.0	175	450
	1.13	8.00	25.0	62.5	180	480
	1.25	8.75	27.0	67.5	187.5	500
	1.50	9.00	28.0	70.0	200	525
	1.75	10.0	30.0	75.0	210	550
	2.00	10.5	31.25	80.0	225	600
	2.25	11.25	32.0	87.5	240	625
	2.50	12.0	35.0	90.0	250	675
	3.00	12.5	36.0	100.0	270	700
150	3.13	13.5	37.5	105.0	275	750
(In 1 kVp increments)	3.50	15.0	40.0	112.5	280	800
	4.00	16.0	42.0	120	300	825
	4.50	17.5	43.75	125	320	875
	5.00	18.0	45.0	135	350	900

TABLE 4-3 BIT MODE TECHNIQUES - 3 FACTOR *					
kVp		mA		mAs	
40	73	25	500	5ms	200
41	77	32	640*@	6	250
42	81	40	800*@	8	320
44	85	50	1000*	10	400
46	90	64		12	500
48	96	80		16	640
50	102	100		20	800
52	109	125		25	1sec
55	117	160		32	1.25
57	125	200		40	1.60
60	134	250		50	2.0
63	143	320		64	2.5
66	150	400		80	3.2
70				100	4.0
				125	5.0
				160	6.4

TM40/@ TM50 & TM65/* TM80

TABLE 4-4 BIT MODE TECHNIQUES - 2 FACTOR *				
kVp		mAs		
40	73	.5	6.4	80
41	77	.64	8.0	100
42	81	.8	10.0	125
44	85	1.0	12.5	160
46	90	1.25	16	200
48	96	1.6	20	250
50	102	2.0	25	320
52	109	2.5	32	400
55	117	3.2	40	500
57	125	4.0	50	640
60	134	5.0	64	800
63	143			
66	150			
70				

* NOTE: Aggregate increases or decreases of kVp, mA, and/or TIME will result in approximately a change of ±.3 OD.

4.1.4 BIT MODE

BIT mode provides predictable exposure results with changes in technique values. In BIT mode the TM series generators are programmed to provide specific steps in kVp and mAs, for **2 FACTOR** mode, and kVp, mA, and TIME, for **3 FACTOR** mode (see **TABLES 4-3, and 4-4)**.

For every aggregate step change, the Optical Density (O.D.) changes by approximately 0.3 O.D., (+.3 O.D. for increase and -.3 O.D. for decrease).

For example increasing the kVp value by one (1) step, creates an aggregate change of +1; therefore, the optical density increases by approximately .3 O.D.. If the kVp value increases one step, and the mA value is decreased one step, the aggregate change is zero (0), and the optical density change is zero (0). If the mA value decreases by two (2) steps, and the TIME value increases by one (1) step, the aggregate change is -1, therefore the optical density changes by -.3 O.D..

BIT mode is available only in **MANUAL MODE.** When in **MANUAL MODE**, the display will show the following for **2 FACTOR:**

```
                 mAs MODE
mA   XXXma
TIME XXXms                    bit mode
                             on/off
```

When using **3 FACTOR** the top line will read **"mA/TIME MODE"**. Pressing **[bit mode on/off]** will place the OC in BIT mode. When in BIT mode **(2 FACTOR)** the LCD will display the following:

```
              mAs - BIT MODE
mA   XXXma
TIME XXXms                    bit mode
                             on/off
```

When using **3 FACTOR,** the top line will read **"mA/TIME - BIT MODE".**

4.2 FLUOROSCOPIC MODE - TUBE #2 (Not applicable to Rad generators)

For two tube Rad generators refer to **SECTION 4.1.** All numbers in parenthesis refer to reference numbers in **FIGURE 4-1.**

Selecting tube #2 will place the system into the fluoroscopic mode of operation. All spotfilm techniques are selected on the OC front panel similarly as in tube #1. The most common operation is SF-AEC which places the spotfilm operation into automatic exposure control. The operator selects the desired kVp and an appropriate **BACKUP mAs.** The spotfilm kVp appears in the kVp display (6), while the **BACKUP mAs** appears in the LCD window.

The spotfilm radiographic are taken on the large focal spot as indicated on the front panel, unless small is selected by the operator (15). Fluoroscopy is always performed using the small focal spot regardless of the front panel selection.

Spotfilming may be operated in a manual mode if desired. Selecting **2 FACT/3 FACT** mode (17) places the system in a manual selection mode. The x-ray factors are selected just as in tube #1 operation. The factors will be displayed in the LCD window. This operation permits spotfilming of subjects that the AEC cannot adequately expose the film, such as arthroscopic views. When spotfilm is in the manual mode, BIT ON/OFF selections are available.

To return to SF-AEC mode, just select an AEC field (22). When in the SF-AEC mode, the average density may be modified by either the body size select (21) and/or the density (23). There is only one sensor field size, therefore the AEC field selection is inactive for spotfilming.

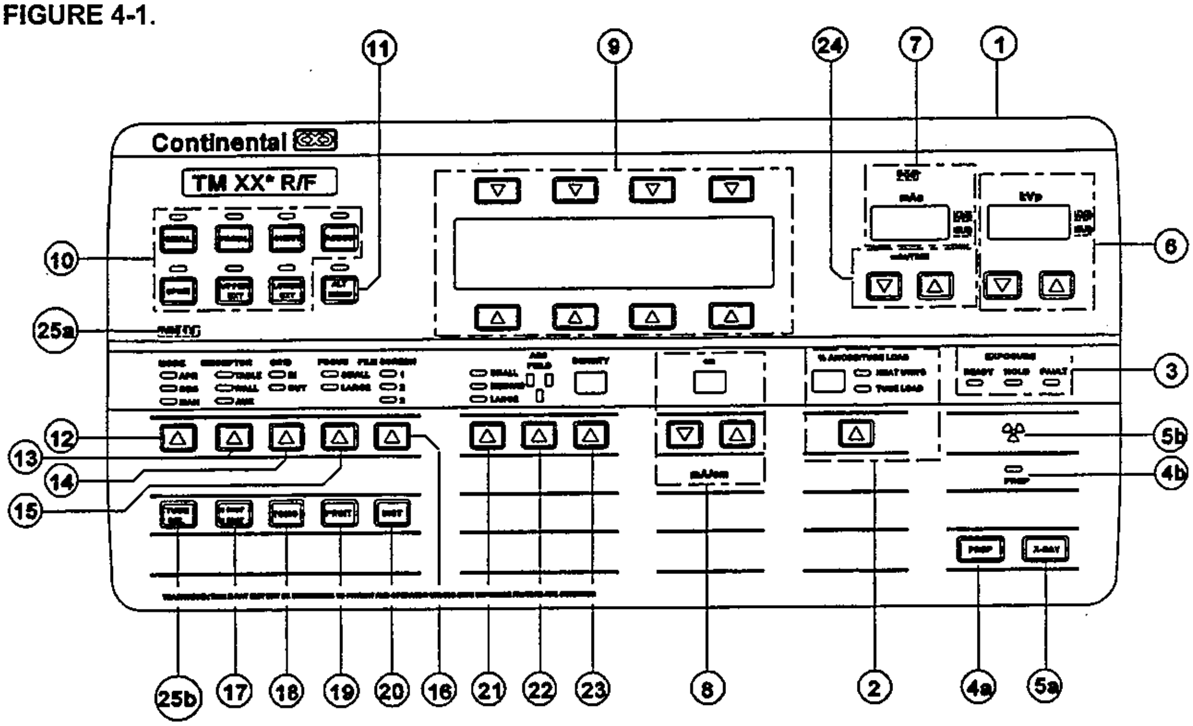
The Manual AEC selection requires Automatic Exposure Control (AEC) see **Section 4.7.** The exams in this mode are selected in 2-point or 3-point modes. The exam is terminated by AEC. In 2-point mode unit is programmed so the back-up mAs in each exam provides the highest mA available within the tube limits. This will assure the shortest possible exposure time. In 3-point mode, user has ability to select the desirable mA and select back-up time.

- Film/screen combination: Up to three different film/screen combinations may be programmed. The different front panel setting (including radiographic techniques) could be programmed and saved by pressing ALT MENU switch. For example: F/S 1= 2 factors, small focal spot, 70 kVp, small patient; F/S 2 =3 factors, large focal spot, 85 kVp, large patient, etc. Saved techniques can be recalled by selecting the appropriate Film/screen combination.
- Density selection: 11 stations with approximately 10% mAs between steps. Normal (0) and ±5 steps.
- Body size: Small, medium, and large for all exams, with the program ability to provide pediatric and/or extra large, selected by "SOFT" keys around the display window.

When switching between tubes, or turning the system OFF then ON, will return the "SETUP" to the last-used mode. This results in very little setup being required when going between radiographic to fluoroscopic operation and back.

4.3 FRONT PANEL DESCRIPTION

See **FIGURE 4-1** for the panel layout. The numbers in the text correspond to the reference numbers in **FIGURE 4-1**.



9026-054

*** - XX is the TM R/F Generator model number: 30, 40, or 60.**

FIGURE 4-1 TM GENERATORS OPERATOR CONTROL (OC) PANEL

1. **POWER ON/OFF:**
   Rocker switch located on the rear right of the OC (**FIGURE 4-9**). Turn OC power ON.

2. **%ANODE/TUBE LOAD DISPLAY AND INDICATORS:**
2-digit display (0 to 99%) of either pre-read **TUBE ANODE LOAD** (percent) for the selected technique factors, or the percent of accumulated **HEAT UNITS** stored in the tube housing. The cooling characteristics of the tube are stored in the control and will indicate tube cooling as time elapses. The push button switch located below the two indicator LEDs toggles between displaying **%HEAT UNITS** and **%TUBE LOAD. NOTE: Cooling software is active even while power to the unit is OFF.**

3. **EXPOSURE** STATUS INDICATORS:
The **READY** indicator will be lit only when a series of conditions are satisfied. If any condition is not satisfied, the **HOLD** LED will illuminate. If a generator fault occurs during the exposure (i.e. filament loses power), the **FAULT** indicator will illuminate, displaying the cause of the error in the LCD display and indicating that the control must be **RESET** (see item **9** below).

4a. **PREP** SWITCH:
Pressing **[PREP]** initiates the exposure sequence. Power is applied to the stator and filaments. After a time delay of approximately 2 seconds, the **PREP** indicator will come ON. An exposure may then be initiated by pressing **[X-RAY]**. The **[PREP]** switch must be held for the full duration of the **PREP** and **X-RAY** exposure cycles. If either switch is released during an exposure, the exposure will be immediately terminated.

4b. **PREP** INDICATOR:
The back lit indicator indicates the system is ready for an x-ray exposure.

5a. **X-RAY** SWITCH:
[X-RAY] initiates the actual x-ray exposure after the PREP sequence. Both **[PREP]** and **[X-RAY]** must remain pressed during the entire exposure. If either switch is released during an exposure, the exposure will be immediately terminated.

5b. **X-RAY** INDICATOR:
When lit, indicates that x-rays are being produced. An audible signal is also ON for the duration of x-ray production.

6. **kVp:**
Consists of **[UP]** and **[DOWN]**. By activating either the **[UP]** or **[DOWN]** switch, the kVp will be incremented in one kVp steps. Holding down either switch for more than one second will automatically increment or decrement the display at a rate of 10 per second.

The back-lit **ADD** and **SUB** indicators (to the right of **kVp**) show that the kVp has been changed when in APR or CEC mode.

> **NOTE:**
> The kVp display does not change when the mA or mAs is selected. This permits the selection of technique factors in any order without interaction between factors.

7. **mAs INDICATORS:**
3-digit display of selected mAs when in CEC or MANUAL mode or a **POST mAs** display when in APR mode. The back-lit **ADD** and **SUB** indicators show that the mAs value has been changed when in CEC mode. The back-lit **POST** indicator is ON during APR mode and indicates a post-mAs reading.

8. **mA/cm** INDICATOR and CONTROL:
The switches are used to increase or decrease the mA in 3-Factor manual mode. The actual mA is displayed on the LCD display. The 2-digit display shows the centimeter thickness of a body part in CEC mode. Upon selection of a body part, an "average" thickness is displayed for the selected technique. After measurement of the actual body part, the **CM** thickness may be increased or decreased as required.

9. **LCD DISPLAY AND SOFT-KEYS:**
The display is used for various information depending on which mode is selected. In APR and CEC, it will display the available views after a body group has been selected. Pressing the soft-key either above or below the view will select the technique values for that view. Pressing **[INST]** (INSTRUCTIONS - see #20) will display information pertaining to the selected exam.

In MANUAL mode, either 2 or 3-Factor, the mA and TIME will be displayed in this window. Whenever an error is detected in the system, an error code and/or error message will appear in this window. If a system RESET is required, such as terminating with back-up mAs during an AEC exposure, the lower right hand soft-key becomes the RESET function as indicated in the window. It is also used for system test and calibration.

10. **BODY GROUP SELECT:**
8 push-button switches for a selection of desired body group when in APR or CEC modes. Upon selection, all programmed views within that group will be displayed in the LCD window.

11. **ALT MENU:**
Pressing this switch places the control in operator program mode. It allows custom exams and special techniques to be stored. It also allows the service technician to perform test, setup, and calibration routines.

12. **MODE SELECT:**
Selects one of the three modes of operation:
a. APR
b. CEC
c. MAN (manual)

13. **RECEPTOR SELECT:**
A receptor (ion chamber), **TABLE, WALL,** or **AUX** (auxiliary) will be automatically selected in APR or CEC mode, or can be selected by the operator when in manual mode. The selected receptor is indicated by LEDs.

14. **GRID IN/OUT SELECT:**
This function is programmed in APR or CEC mode, or may be manually selected for IN or OUT as indicated.

15. **FOCUS SELECT:**
Selects the **SMALL** or **LARGE** focal spot. This is programmed by APR or CEC modes, and defaults to **LARGE** in the manual mode.

16. **FILM/SCREEN SELECT:**
Up to three different film/screen combinations may be programmed for APR or CEC operation. They will default to the programmed combination, or may be selected by the push-button.

17. **3-2 FACTOR SELECT:**
In manual mode, manual-AEC mode, and APR mode, selection of the technique is made by either the 2-Factor method (kVp and mAs), automatically selecting the highest mA available within the tube and control ratings, or the 3-Factor method (kVp, mA, and TIME) with the values indicated within the LCD display. The mode is also displayed in the LCD window.

18. **TOMO SELECT:**
When used with a tomography system (optional), this selection places the exposure under control of the tomo mechanism. **TOMO** can be selected from **MAN**ual mode only. Once in **TOMO** mode, **CEC** can be selected for preprogrammed techniques. The system defaults to **3-FACTOR** mode, **TABLE** receptor, and **LARGE** focus. Selection of the high speed starter is prevented and the actual exposure time equals the time selected on the front panel.
An x-ray exposure is performed in the same manner as when **TOMO** is not selected.

19. **PRINT:**
If an optional printer is connected to the parallel printer port, pressing **[PRINT]** will output the post-exposure data from the last six exposures.

20. **INST:**
Used in APR or CEC mode, after a body group and view have been selected. The information or instructions are programmed by the user on installation and include such information as which special cones to use, positioning information, or tube angulation.

21. **AEC-SMALL/MEDIUM/LARGE SELECT:**
When in AEC, the system defaults to medium body size technique. If a particular exam has been programmed for use with pediatrics or very large patients, the additional selections appear in the LCD window for selection with the soft-keys.

22. **AEC-FIELD SELECT:**
This permits selection of the ion chamber field or combination of fields for the particular exam. In APR mode, it will default to the programmed combination. In the manual mode, each field may be selected. Receptor must be selected **AFTER** selecting the desired field.

23. **AEC-DENSITY SELECT:**
Permits selection of PLUS or MINUS 5 steps of density modifications from nominal density. Each step will increase or decrease the mAs value in approximately 10% increments, for ±50% total allowable change.

24. **mAs/TIME SELECT:**
These dual function switches are used to increase or decrease the mAs in the 2-Factor mode, or TIME in the 3-Factor mode. Holding the switches for more than one second will increase the rate of change to 10 per second.

25a. **TUBE SELECT** INDICATOR:
The back-lit display shows which tube has been selected. **Not used in a one-tube system.**

25b. **TUBE SELECT** SWITCH:
Select Tube 1 (Radiographic) or Tube 2 (Fluoroscopic).

4.4 STEPPING OPTION SELECTION

With RPU release 5.8.1.D or higher, the maintenance technician or engineer can select Stepping or Non-stepping operation at the TM Operator Control (OC). This is done as follows:

1. Close switch SW3-8 located at the rear of the OC.
2. Power down and up to activate Service Mode.
3. Press the ALT MENU button (item 11 on page 4-7).
4. Next press the button on the lower row designated as TEST by the LCD display.
5. Press the button below the "2" to choose SETUP ROUTINES in the display.
6. Press the NEXT or BACK button until 4. DP & FLUORO SETUP is displayed and then press EXECUTE.
7. Near the lower left hand button of the LCD display, the option STEP=YES or STEP=NO will be seen.
8. Press the button to choose the desired option and press STORE.
9. Press the EXIT button three times to leave this selection mode.
10. If use of service mode is completed, return SW3-8 to the open position and turn the TM power switch off.

4.5 REMOTE FLUOROSCOPIC CONTROL PANEL (Not applicable to Rad generators)

See **FIGURE 4-2.** The Remote Fluoroscopic Control (RFC) is located at the spot-film device. The display is not illuminated when Tube 1 (RADIOGRAPHY) is selected.

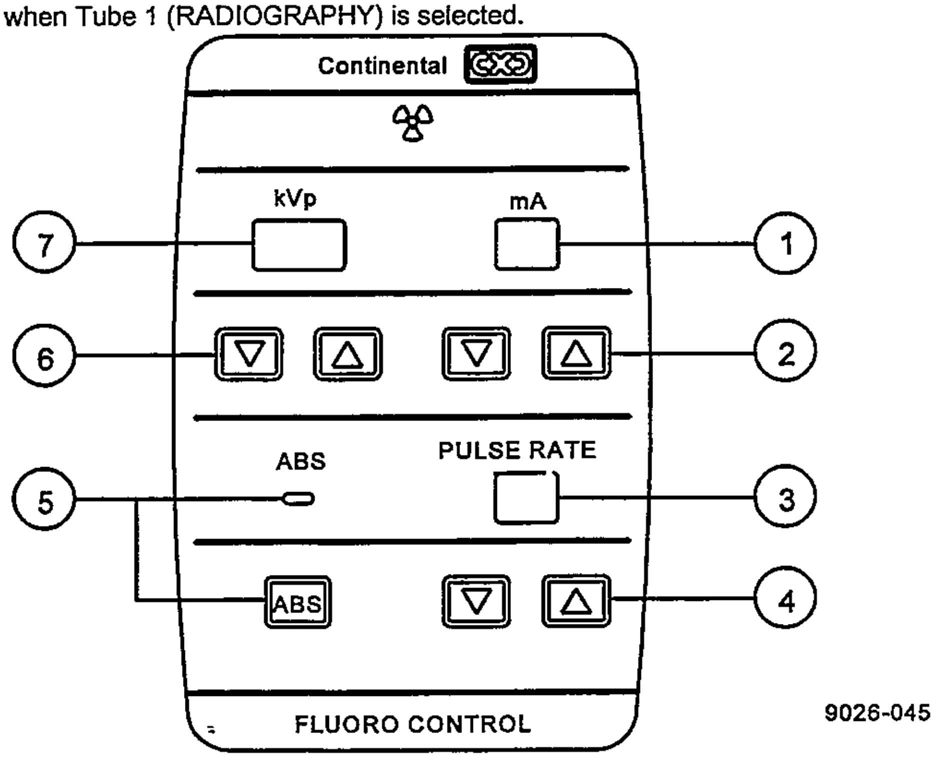


FIGURE 4-2 REMOTE FLUOROSCOPIC CONTROL

1. **mA Indication:**
Continuous fluoroscopy: during standby, the display indicates one of four mA stations that has been selected, i.e., -1, -2, -3, or -4. It then indicates average fluoroscopic mA value during fluoroscopy.

   Pulsed fluoroscopy: indicates average mA during fluoroscopy. This value is a function of actual pulsed mA and the pulses per second rate.

2. **mA Up/Down Select:**
Momentary up or down switches that change the mA station for continuous mode. Not active when in pulsed mode.

3. **Pulse Rate Indicator:**
Indicates the operating pulse rate, i.e., 30, 15, 7.5, 3.8, and 1.9 pulses per second. No indication when in continuous mode.

4. **Pulse Rate Up/Down Select:**
Momentary up or down switches that change the pulse rate when in the pulsed mode. Not active when in continuous mode.

5. **ABS Select and Indicator:**
Selects Automatic Brightness System In or Out and is indicated by L.E.D.

6. **kVp Up/Down Select:**
Momentary switches to select manual fluoroscopic kVp.

7. **kVp Indication:**
Displays fluoroscopic kVp for both manual and ABS modes.

4.6 CCD CAMERA CONTROL (Not applicable to Rad generators and DigiSpot™ systems)
See **FIGURE 2-3** below.

NOISE CONTROL:
This rotary switch allows the operator to select the number of frames to be integrated into a single image. This averages multiple images reducing the effects of noise. If motion is to be imaged this should be set to 1 or **MOTION DETECTOR** should be in the UP position.

IMAGE HOLD: (two-position switch)
UP will enable last image hold, DOWN will disable.

MOTION ENABLE: (two-position switch)
UP (enabled) will disable **NOISE CONTROL** and produce an image as though **1** was selected on **NOISE CONTROL**. DOWN (disabled) will enable **NOISE CONTROL**.

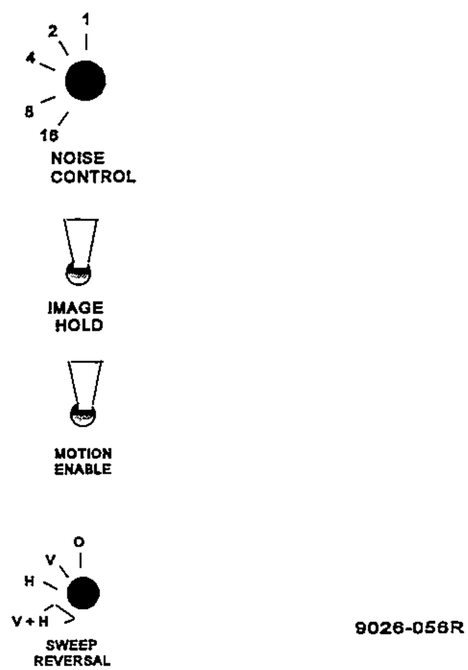


FIGURE 2-3 CCD CAMERA CONTROL

SWEEP REVERSAL:
Reverses the sweep on the monitor:

Position O: No reversal. Original orientation of image

Position V: Vertical reversal (Image flipped vertically from top to bottom)

Position H: Horizontal reversal (Image flipped from right to left horizontally from position 0)

Position V + H: Horizontal and vertical reversal of image from position O.

4.7 TOMO EXPOSURE CONTROL (OPTION)

The optional Tomo Exposure Control (TEC) allows the operator to utilize the mAs derived from an auto-timed RAD exposure made just prior to the tomo exposure. This test exposure is performed using AEC, resulting in the desired image quality. The tomographic mAs will be adjusted for the tomo sweep angle selected.

1. Exit TOMO mode.
2. Select MAN mode, tube 1, 3 FACTOR, TABLE receptor, the desired kVp, 40-inch SID and ion chamber(s).
3. Select an mA value close to the expected Tomo exposure mA.
4. Position the patient and make a radiographic exposure.
5. Develop the film and verify that the image is of the desired quality. The resultant POST mAs value will be stored in memory for use in the subsequent tomo exposure. This mAs value is termed "Scout" in the TEC screens. The value shown in the mAs display will be the value calculated by the processor which will produce the desired image quality for the sweep angle selected.

Note:
If the POST mAs value is less than 7.6 mAs, TEC will be disabled.

6. Select TOMO mode.
7. The display will request an answer to the question "Enable Tomo Exposure Control?". Select YES. If NO is selected, regular tomo techniques will be used.

Note:
If tomo mode is entered without an AEC-derived mAs scout value, the normal tomo screen will be displayed. If this is the case, to utilize the TEC, another scout exposure will be required. Select EXIT from the tomo options.

8. The screen will show **TEC Mode ** and the Scout = value signaling that the system is in TEC mode. Select the appropriate fulcrum height, sweep angle, sweep speed, and whether AUTO is OFF or ON. The mAs value displayed will change with any change of the tomo sweep.
9. Perform the tomo exposure

4.8 PRINTER

If the system has been configured with a printer, labels containing patient and exposure data can be printed and affixed to the exposure for a permanent record of pertinent data: Patient ID, mode/view, and technique data. The following presents an example of the data format (in this instance for APR mode):

```
Patient ____________________
APR - HIP A/P (2 factor)              Tube 1
TABLE, GRID IN, LFS, FS1
FIELD (2), Medium, Den +0
74kVp, 250mAs, 125post
```

The system is setup for one of three printer modes by maintenance personnel: Automatic, Manual, or No Printer. Automatic will print a label after each exposure, manual prints a label only when [**PRINT**] is pressed (see **FRONT PANEL** section above) and no printer means that labels cannot be printed.

If the system is setup for automatic printing, pressing **[PRINT]** will print a label of the last exposure, as in manual print mode.

4.9 ERROR CODES

The system has built-in diagnostics for determining system error conditions. The diagnostics are arranged into groups of common functions. If errors occur repeatedly, the service technician should be called. **SECTION 10** provides a form at the end of the **COMPLIANCE TESTING RECORD** section to log system problems, and error codes encountered to act as a history and diagnostic tool for the maintenance technician.

4.9.1 SYSTEM FLAGS - 1 THROUGH 15

These flags indicate an improperly terminated exposure, and display the information in the LCD window. The **FAULT** LED above **[PREP]**, will illuminate, and the RESET functions will appear in the lower right hand corner of the LCD window. There is a detailed description of the system flags in **SECTION 7**.

The system must be RESET before initiating another exposure.

FLAG	DESCRIPTION
#1	X-RAY SWITCH
#2	PREP SWITCH
#3	kVp COMMUTATIVE FAIL ERROR
#4	kVp HIGH ERROR
#5	kVp LOW ERROR
#6	mA OVERLOAD ERROR
#7	mA LOW ERROR
#8	FILAMENT POWER SUPPLY FAIL ERROR
#9	FILAMENT OVERLOAD ERROR
#10	BACK-UP mAs LIMIT
#11	EXPOSURE STOP ERROR
#12	EXPOSURE TIME LIMIT ERROR
#13	RPU HARDWARE FAULT
#14	kV UNBALANCED ERROR
#15	RPU FLAGS NOT RECEIVED

4.9.2 SYSTEM FLAGS - 16 THROUGH 43

These flags monitor hardware performance and will place the system into a HOLD condition. Pressing **[PREP]** will display the system flag number and a description of the HOLD condition.

Example: System Flag #28
mAs counter failed to program

The condition may clear itself. If the HOLD LED is ON, an exposure will not be permitted. Switch power OFF, then ON, to RESET the microprocessor. If the HOLD remains ON, the system requires service.

4.9.3 SYSTEM FLAGS - 48 THROUGH 50

These flags monitor communication conditions between the operator control and the RPU. A flag condition illuminates the HOLD LED and places the system on HOLD.

Service should be called immediately.

4.9.4 SYSTEM FLAGS - 51 THROUGH 63

These flags monitor external connected items to the system such as the collimator and door interlocks. A flag condition illuminates the HOLD LED and places the system on HOLD.

FLAG	DESCRIPTION	FLAG	DESCRIPTION
#51	COLLIMATOR NOT READY	#61	AUX INTERLOCK ERROR
#52	kVp FEEDBACK SIGNAL ERROR	#62	TUBE HOT
#53	SURGE RELAY NOT ENERGIZED		
#54	FILAMENT POWER SUPPLY ERROR		
#59	ROOM INTERLOCK No. 1 ERROR		
#60	ROOM INTERLOCK No. 2 ERROR		

4.9.5 SYSTEM FLAGS - 64 THROUGH 68

These flags monitor the operator control functions and will place the system on HOLD if a flag is set. If the HOLD LED is ON, an exposure will not be permitted. Switch power OFF then ON to RESET the microprocessor. If the HOLD remains ON, the system requires service.

4.9.6 SYSTEM FLAGS - 80 THROUGH 87

These flags are set when an invalid technique is selected.

Example: System Flag #82
Factors Will Exceed Max Tube Power

The system will be on HOLD until a valid technique is selected.

4.10 AUTO RAD FEATURE

This feature allows the radiographic kVp and mAs values to be automatically synchronized to those based on the immediately preceding fluoroscopic exposure parameters. The feature is particularly useful when during a fluoro exam (live video), a region of interest is identified for an immediate rad exposure (photospot), the subsequent exposure technique will be based on the immediately preceding fluoro parameters.

This feature is effective with the following **software releases**:

■ DigiSpot™ DP	1.1.3.x and higher
■ DigiSpot™ Remote	1.1.3.x " "
■ TM OC	5.9.0.x " "
■ TM RPU	5.9.0.x " "

Setup

Auto Rad can be setup from the TM OC as **default on** or **default off.**
If default on is selected, then Auto Rad mode will be automatically selected at APR or manual AEC selections, if this was the last mode used.
If default off is selected, then Auto Rad mode will be automatically deselected, and at APR or manual AEC, it needs to be activated each time from the TM, Digispot™ DP, or DigiSpot™ Remote Control.

Selection

On TM OC, select AUTO RAD = ON.
Selection at Digital Platform (DP) with Remote can be done by pressing the MODE button.
DP and Remote Control will indicate Auto Rad on by flashing the "dead-fronted" AUTO and RAD displays.

Deselection

Auto Rad mode is deselected by one of the following ways:

- on TM OC, select AutoRad=OFF
- deselect AutoRad function on the Digispot™ DP or Remote Control (Mode button)
- manually adjust Rad kVp
- exit ABS mode
- exit AEC mode.

Prerequisites

For Auto Rad feature to operate, the following conditions must be met:

(a) Automatic Exposure Control (AEC) must be ON,
(b) Automatic Brightness Stabilizer (ABS) must be ON and
(c) ABS must be stable or fluoro exposure must be ON for at least 2 seconds prior to the radiographic exposure.

AutoRad Radiographic Parameter Selection

Selection of radiographic kVp will depend on the type of exam desired (see **FIGURE 4-4**):

A. **GI applications with full barium** - relation between Fluoro and Rad kVp is linear.

B. **for swallow and air contrast barium work** - Radiographic kVp is 10% below Fluoro kVp.

C. **for myelography, ERCP and gall bladder** - relationship is linear thru 90 kVp and then changes to where 125 kVp Fluoro produces 100 kVp Rad.

D. **for angiography** - relationship is linear thru 80 kVp and then changes to where 125 kVp Fluoro produces 90 kVp Rad.

E. **for pediatrics** - radiographic kVp is 10% above Fluoro kVp at levels up to 90 kVp after which value it levels off.

- In 2-Factor mode, the mA will be the maximum available for the focal spot and kVp selected, and the preselected mAs will be a back-up mAs.
- When exposure is OFF the radiographic kVp displayed from the latest radiographic kVp system has been used.
- When fluoro exposure is ON, then after ABS is stabilized or after 2 sec of fluoro in progress, the radiographic kVp will track fluoro kVp, with the translation factors listed above.

STEPPING MODE

The AutoRad feature is operational in Manual Stepping mode. It allows a preset technique for each step, simply by following the process given below.

a. select Manual Stepping AutoRad mode
b. position system for the desired step
c. run fluoro for 2 seconds or longer, radiographic technique will be set.
d. move to the next step and repeat process described above in steps (b) and (c)
e. the radiographic techniques will be set automatically.
f. at the end of the sequence, press the SAVE button on the DP or Remote.

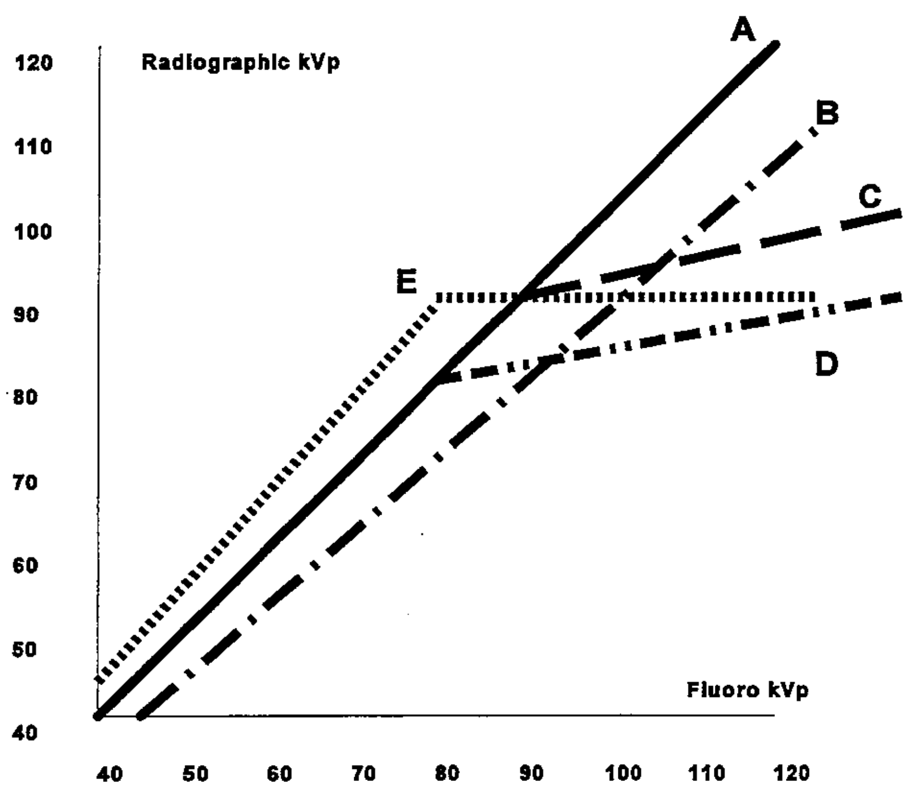


FIGURE 2-4 RADIOGRAPHIC kVp vs. FLUORO kVp

ADDENDUM TO Chapter 4 OPERATION

OF

TM X-RAY GENERATORS

MAINTENANCE MANUAL 9026.251

INSTALLATION of Remote Reversal Switch on Control Panel

Vertical and horizontal sweep reversals may be selected by using the **Remote Reversal Switch** located just behind the right side of the Control Panel on the DigiSpot.™

The camera may be operated in either the **Normal Mode, Vertical Reversal, Horizontal Reversal,** or combined **Vertical and Horizontal Reversal mode.**

See **Figure A-1** for an illustration of the Remote Reversal Switch.

This switch is for use with the **CAMTRONICS VP Sytems only.**

Sweep reversals on the INFIMED GoldOne systems are operator selectable on the system monitor.

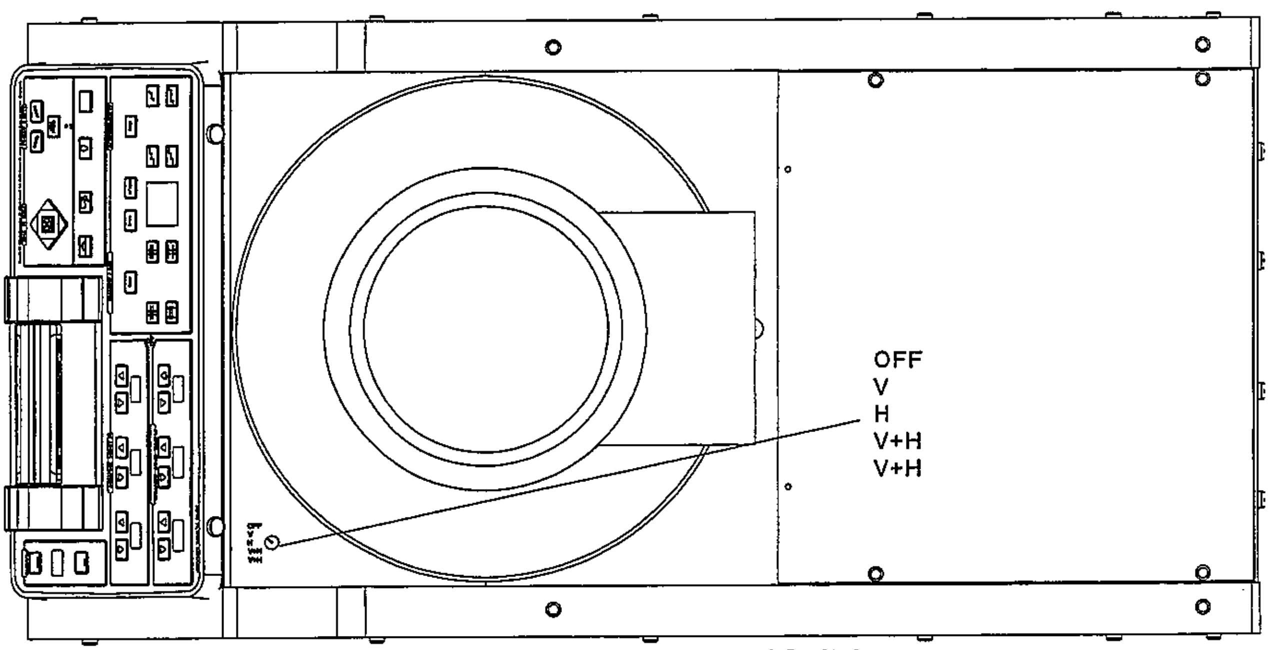


FIGURE A-1 Remote Reversal Switch

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SECTION 5 - MAINTENANCE

5.0 INTRODUCTION

Only experienced x-ray service personnel should perform maintenance on this equipment. Having consistent x-ray films does not indicate the system is performing properly. It is difficult to observe the changes or deviations in x-ray exposure on x-ray films until the deviations exceed 20% O.D.. By performing the preventive maintenance checks outlined in this section, the user can be assured that the machine is in good condition.

Prior to leaving the factory, the system was thoroughly tested and calibrated. During installation, measurements and tests verify that the machine is in good operating condition. The maintenance schedule requires the same periodic tests and calibrations as performed at initial installation. Keep a record of preventive maintenance with the equipment (in the maintenance manual) become a permanent part of the manual.

The operator should be aware of the normal operating characteristics of the machine to observe any abnormalities during operation. The operator should describe the problems encountered, and the sequence of events. This will aid the technician in maintenance actions (**SECTION 4.3**).

When performing maintenance on the TM series generators, reference **SECTIONS 8** and **9**. **SECTION 8** contains interface information, wiring diagrams, PCB configuration information, schematics, board layouts, and parts lists for the system's electronic assemblies. **SECTION 9** provides the mechanical information, assembly locations and parts lists.

> ⚠ **WARNING:**
>
> **THE TM X-RAY GENERATOR CABINETS ARE DESIGNED TO PROVIDE ADEQUATE DISSIPATION OF HEAT GENERATED BY COMPONENTS IN THE SYSTEM. UNDER NO CIRCUMSTANCE IS THE CABINET TO BE USED FOR STORAGE OF REPLACEMENT PARTS OR MATERIALS. SUCH STORAGE MAY IMPEDE HEAT DISSIPATION OF ELECTRICAL COMPONENTS CAUSING FIRE OR PREMATURE FAILURE.**

5.1 MAINTENANCE SCHEDULE

1. Perform the calibration procedure, **SECTION 3**, every 12 months to gather the data for **APPENDIX A**. Make a copy of **APPENDIX A** and record the data on the new test sheets, and place it with the TM series generator manuals.
2. Turn power OFF at the OC and the disconnect box and clean out the interior of the control of accumulated dust.
3. Periodic cleaning and recoating of the high voltage terminals should prevent high voltage breakdown at these points. Failure to follow this procedure may lead to momentary or permanent high voltage breakdown of the cable well. This can produce transients throughout the control and generator system, which damage other components of the x-ray system such as the x-ray tube, high voltage rectifiers, etc.
4. The anode of the x-ray tube and the port of the x-ray tube should be inspected for visible signs of anode etching, pitting, or cracking. The port of the tube should be inspected for deposits of tungsten. The port should not be distorted in any way.
5. The exterior surfaces of the system should be cleaned daily of dust and surface films with a mild detergent.

TABLE 5-1 MAINTENANCE SCHEDULE

FUNCTION	FREQUENCY
CALIBRATION	ANNUALLY
CABINET INTERIOR CLEANING	MONTHLY
CLEANING/RECOATING OF HIGH VOLTAGE CONTACTS/CONNECTORS	MONTHLY
TUBE INSPECTION	WEEKLY
RPU, OC AND RFC EXTERIOR CLEANING (OPERATOR)	DAILY

5.2 SPECIAL TOOLS

The following is provided with the TM R/F series generator: Precision electronic nut driver (4196.262.01) for use in removing/replacing the OC display to access the PCBs.

5.3 OPERATOR MAINTENANCE

The RPU, OC and the RFC require daily cleaning to remove surface films. In addition, the operator should record any error flags that occur during operation. The operator should report any abnormalities observed during operation. Qualified x-ray service technicians are required to perform all other maintenance.

The operator should make a copy of the **PROBLEM LOG** in the **COMPLIANCE TESTING RECORD** section of **SECTION 10** to log system problems, and error codes encountered to act as a history and diagnostic tool for the maintenance technician.

5.4 REMOVE/REPLACE OPERATIONS

5.4.1 SCR REPLACEMENT

When replacing the SCRs (see **FIGURE 5-1**):

1. The sealed evacuation tube is oriented DOWN, whether mounted on the right or left side of the cabinet. The electrodes will be UP.
2. The pin of the mounting fixture <u>**MUST**</u> engage the dimple of the SCR. The SCR has a dimple on both sides. If the pin does not engage the SCR dimple the SCR could be damaged during mounting or its operational life shortened due to poor contact with mating surfaces.
3. Proper contact force be maintained. This is assured by tightening the hardware to the point that the spring washer is fully compressed.

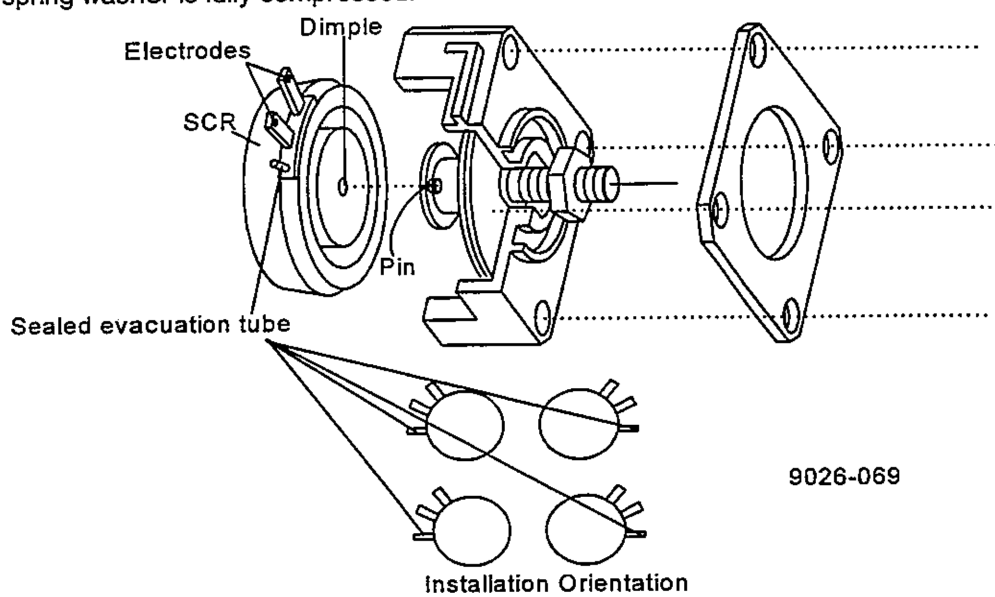

FIGURE 5-1 SCR INSTALLATION

5.4.2 HIGH VOLTAGE GENERATOR REPLACEMENT

1. Remove power from system at the facility power disconnect.
2. Remove the front panel cover from the RPU.
3. Disconnect the cables to the high voltage generator.
4. Carefully remove the generator from the RPU base.
5. **For TM50, TM65, or TM80 series generators ONLY (go to step 6 for TM30s or TM40s):** Remove the feedback isolation PCB from the old generator and install it on the replacement.
6. Install the replacement generator in the RPU base.
7. Connect the generator and the feedback isolation PCB to the wiring harness.
8. Verify connections against the wiring diagram (in Section 8) prior to providing facility power at the disconnect.
9. Provide facility power.
10. Proceed to section 5.4.2.1 and perform the procedure outlined.
11. Remove power from the system.
12. Install the front panel cover.

5.4.2.1 SELECTION OF CAPACITORS

This procedure describes a method for the optimization of the kVp rise time for the TM family of controls and is applicable during final test of the unit or when either the high voltage transformer assembly or the Feedback Isolation PCB are replaced.

The kVp rise time is a function of the relative frequency response times of the elements of the kVp sensing subsystem. The anode and cathode kVps are each sensed separately by two separate sensing networks internal to the high voltage transformer assembly. These two networks are routed to the Feedback Isolation PCB where they are connected to external capacitors C24 and C25 (see schematic 4294.262.1904). The frequency response of these sensing subsystems can be adjusted by changing the value of these external capacitors. C24 and C25 are Mylar or polypropylene, rated 250 VDC in the range of 0.047 to 0.082 uf.

Optimally, the kVp should increase, in steps, to its maximum value in 3 ms and continue at this value for the remainder of the exposure. As the value of C24 and C25 is increased, the time constant of the output is increased which reduces the settling time. If the time constant of the output is increased too much, over shoot will result. Verify performance of the system:

1. Connect a Dynalyzer in the high voltage circuit.
2. Connect the kVp output signal, from the Dynalyzer, to a storage oscilloscope.
3. Turn power ON.
4. Select 40 kVp, 25 mA and 0.5 mAs.
5. Make an exposure and examine the leading 10 milliseconds of the kV trace.
   a. If the time, to maximum kVp value, is greater than 3 milliseconds, increase the value of C24 and C25 from 0.047 to 0.082 microfarads. **Use Mylar or polypropylene capacitor types, rated 250 VDC only.**
   b. If the kVp peaks and then reduces to and remains at a lower level, decrease the value of C24 and C25.

> **WARNING:**
>
> **BE CAREFUL WHILE REPLACING CAPACITORS! IF ONE OF THE KVP FEEDBACK CAPACITORS IS SHORTED, THE RESULTANT KVP WILL BE DOUBLE THE SELECTED VALUE. VERIFY THAT CAPACITORS ARE NOT SHORTED, BEFORE INSTALLING THE BOARD!**

5.4.3 FEEDBACK ISOLATION PCB REPLACEMENT

1. Remove power from system at the facility power disconnect.
2. Remove the front panel cover from the RPU.
3. **For TM50, TM65, or TM80 series generators ONLY:**
   a. Disconnect the cable harness from the feedback isolation PCB.
   b. Remove the PCB from the high voltage generator.

c. Place the replacement PCB in its mounted position on the high voltage generator but do not secure with its mounting hardware until system performance has been verified.
d. Connect the replacement PCB to the wiring harness.

For TM 30 and TM40 series generators ONLY:

a. Remove the left (as viewed from the front) side cover from the RPU.
b. Open the lower door of the card cage to allow access to the feedback isolation PCB (PCB) mounted to the lower inside left side surface.
c. Remove the four screws securing the PCB's standoffs to the card cage.
d. Remove the PCB from the card cage.
e. Remove the four standoffs from the old PCB and install them on the new PCB.
f. Connect the new PCB to the wiring harness.
g. Install the PCB inside the card cage using only one screw. This will allow easy removal if another capacitor must replace one already mounted to the PCB.

4. Provide facility power.
5. Perform section 5.4.2.1 to verify system performance.
6. Secure the PCB in place with its mounting hardware.
7. **For TM30 and TM40 ONLY:** close and secure the lower card cage cover and replace the side cover to the RPU.
8. Install the RPU front cover.

SECTION 6 - THEORY OF OPERATION

6.1 OVERVIEW

The TM generator is a dual microprocessor-based x-ray control and generator. It has three basic modes of operation:

a. Manual - 2 Factor: incremental mode and BIT mode
3 Factor: incremental mode and BIT mode
Automatic Exposure Control (AEC)

b. Computerized Exposure Control (CEC)

c. Anatomically Programmed Radiography (APR)

The system is controlled by two microprocessors. One in the operator control (OC) controls all front panel keyboard and display functions. It handles all of the anatomical program data, and controls the anode heating and cooling calculations for tube protection. The cooling calculation is performed even when the system power is OFF. When **[PREP]** is pressed, the OC transmits the selected technique data to the Remote Power Unit (RPU).

The other microprocessor is located on the RPU microprocessor PCB. Data received from the OC is used to control the electrical settings for x-ray generation. It monitors interlocks, controls any selected options, and sends the **READY** signal to the OC. When **READY** is received by the OC, the **READY** LED illuminates on the OC and the operator may initiate an exposure.

The high voltage and x-ray tube filament controls are accomplished by high-frequency inverter technology. Both functions use feedback signals which are compared with selected value signals from the operator control. They are controlled by the closed-loop servo electronics on the mA/mAs Control PCB and the kVp Control PCB.

Exposure time in **MANUAL** operation is accomplished by the microprocessor controlled integrating timer on the mA/mAs Control PCB. When in the AEC mode, the time is derived by the digital integrating timer on the AEC Control Module.

There are several isolated power supplies, both regulated and unregulated, for supplying all power for both the OC and the RPU.

There are several interlocks available and several voltage outputs to operate indicator lamps. The system may also be interfaced with high speed starters (standard for the TM65 and TM80).

6.2 HIGH FREQUENCY INVERTER PRINCIPLES

Both the kVp and mA controls use high frequency inverter circuitry. The kVp control utilizes a full-bridge (or H-Bridge) (**FIGURE 6-2**), while the filament circuit utilizes a half-bridge inverter (**FIGURE 6-5**). In both cases, the circuit topology is that of a resonant mode inverter.

The inverter switches (SCRs) generate a square wave of voltage which is fed to the transformers through a series capacitor. The transformer equivalent input impedance is primarily inductive, and includes a reflected impedance in the form of a series resistance. Therefore the equivalent circuit is a series RCL circuit. See **FIGURE 6-1**.

When switches TH1 and TH2 are closed, the series RCL ($R_S C_S L_S$) circuit has the power supply DC voltage applied across it. At time zero (switches close) current starts to flow through the RCL circuit in a sine-wave form, at the resonant frequency (f_R) determined by the series capacitance and inductance.

$$f_{resonance} = \frac{1}{2\pi\sqrt{LC}}$$

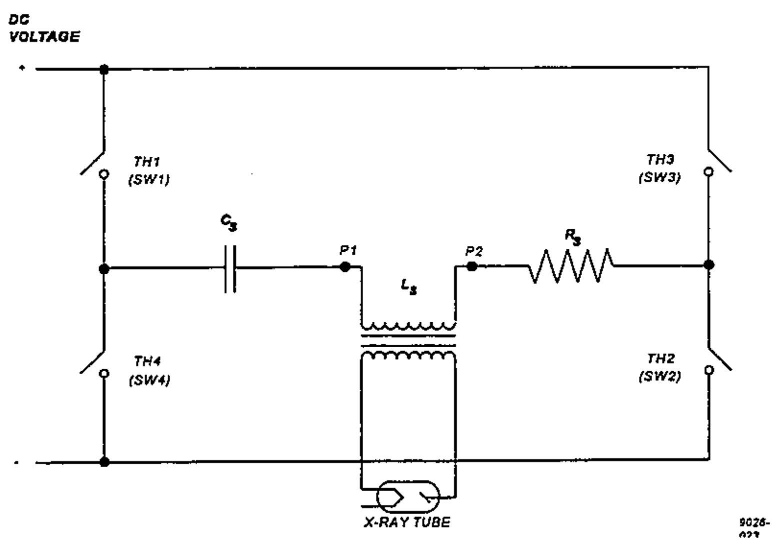

FIGURE 6-1 EQUIVALENT CIRCUIT

Semi-conductor switches (SCRs) are used, and the switches will only conduct on the positive half-cycle. There is stored energy in the negative half-cycle that has value in transferring energy. Therefore an anti-parallel, or fly-back diode is placed in reverse conducting configuration around the SCR. See **FIGURE 6-2**.

If TH1 and TH2 receive just one trigger pulse, a current waveform as shown in **FIGURE 6-3** will result. Note that the SCRs conduct for only one half cycle, they will not conduct when the current is reversed. This action is called "self-commutation".

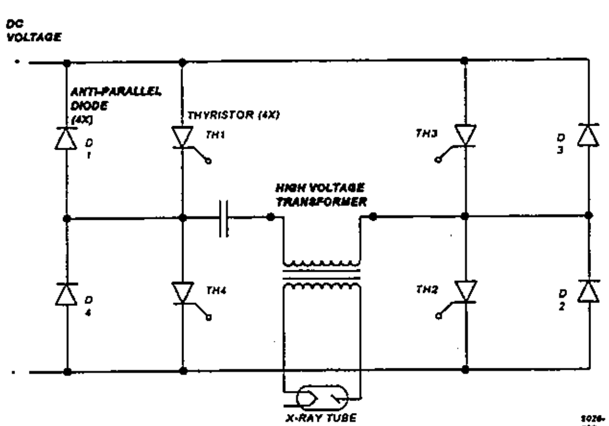

FIGURE 6-2 FULL BRIDGE INVERTER CIRCUIT

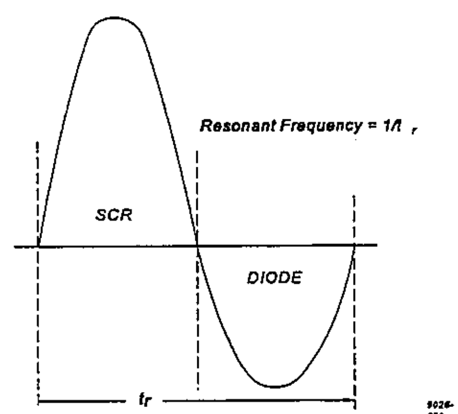

FIGURE 6-3 SINGLE PULSE SCR CONDUCTION

There is one positive pulse per trigger (**FIGURE 6-3**). If TH3 and TH4 are triggered later, the waveform, shown in **FIGURE 6-4**, will result.

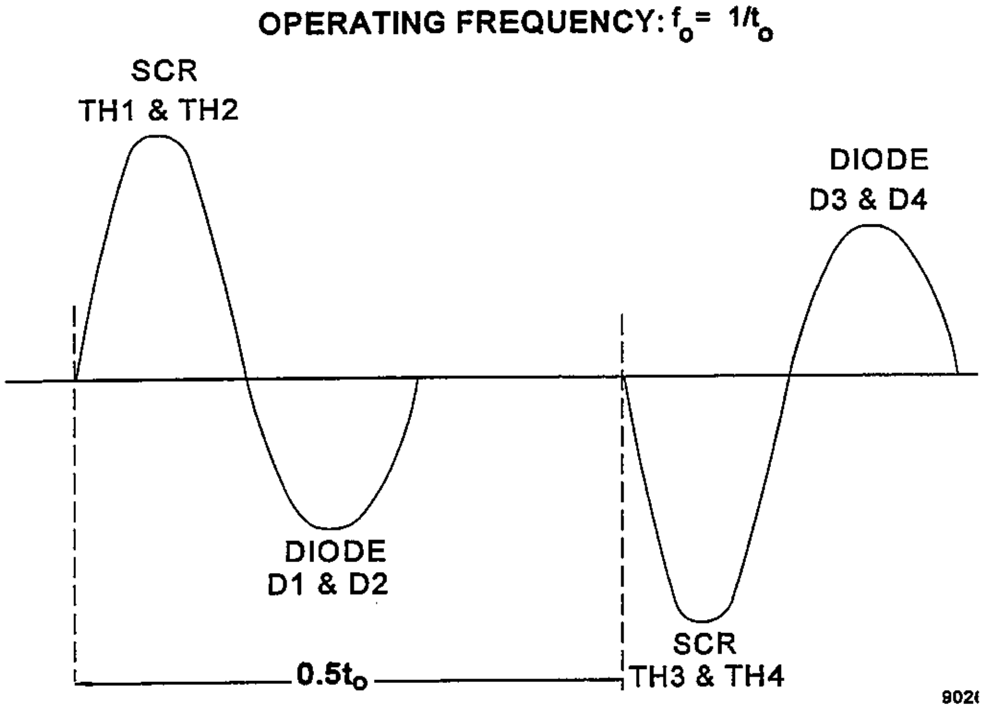

FIGURE 6-4 DOUBLE PULSE SCR CONDUCTION

Another frequency is introduced, the time between the resonant pulses. This is the operating frequency (f_o). It is this waveform of current that flows through the primary coils of the high voltage (HV) transformers. The HV generator has two transformers that derive the anode (plus) and cathode (minus) voltages with respect to ground. The output of these transformers is coupled to a voltage doubler circuit. This circuit that contains the filter capacitance to obtain a near constant potential output voltage.

To change the output kV, f_o will have to be changed. The current pulses charge the capacitors in the voltage doubler to a small percentage of voltage each time. Then the load (x-ray tube mA) will discharge the capacitors a small amount. To raise the kV across the tube, the doubler capacitors must be charged at a faster rate. Increase f_o, to increase kV, or decrease f_o to lower kV. Frequency change on the input results in amplitude change at the output.

A precision HV resistor divider is built into the HV circuit. This divider feeds back a voltage proportional to kVp (equivalent to .16V/kVp total + to -). The feedback signal is used by the kVp control circuit. Precision resistors in series with the HV circuit feed back a signal proportional to the x-ray tube current. This signal is used by the mA control circuit.

The filament inverter functions like the HV inverter. The major difference is that the filament inverter is a half-bridge circuit with IGBT transistors and two flyback diodes. Another difference is that the filament transformer is a step-down in voltage (step-up in current) and there are no rectifiers and filter capacitors in the secondary circuit. See **FIGURE 6-5**.

6.3 OPERATOR CONTROL

The input power to the microprocessor PCB is plus 24 VDC. This supplies U14 the +5 V switching regulator for the processor electronics; U28, the isolated 5 V supply for the RS 422 external communications port, and to U21 through R13 and R12 for power fail detect. R12 is factory adjusted to supply a POWER FAIL signal when a 25% drop in the nominal power mains is detected.

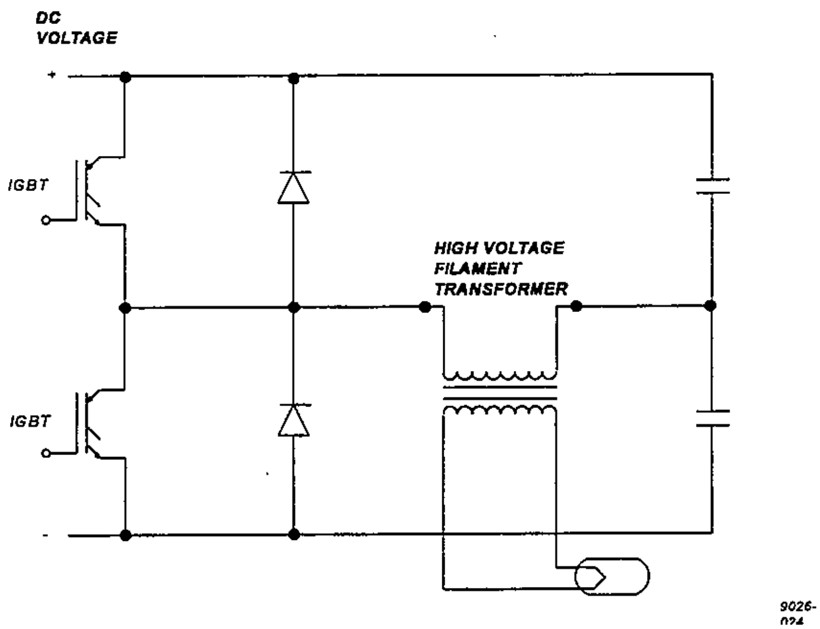

FIGURE 6-5 HALF H-BRIDGE INVERTER

The microprocessor used in this control is an 8085AH, U15. It runs on the software program in the 27C512 EPROM, U5 (program ROM). Calibration of the x-ray factors is accomplished by software control and the calibration factors are stored in the 28C256 EEPROM, U2 (CALMEM). Anatomical Program Radiography (APR) data is stored in another 28C256 EEPROM, U3, (Technique MEMory or TMEM).

The operator control has three ports to communicate with external devices.

1. J2 (OC to RPU COMMUNICATIONS):	This is the communications link between the OC and the RPU. It is an isolated RS422 serial port. Four lines are dedicated for PREP and X-Ray functions for safety purposes.
2. J4 (APR SERIAL PORT):	This is an RS232 port for interface to a PC computer. This facilitates for adding and editing APR data.
3. J8 (PARALLEL PRINTER PORT):	This is an isolated parallel printer port for outputting post exposure data to a standard PC printer.

Status LEDs are visible through the rear panel. Viewed left to right (DS1 through DS7) they are as follows:

LED#	DESCRIPTION	FUNCTION
DS1	RUN	Indicates that the μprocessor clock is RUNning. Low brightness is normal.
DS2 through DS5	Status	These indicate a binary code of the status of the microprocessor. See Status codes below.
DS6	Port B	Indicates when Port B (PC Port) is accessed.
DS7	Power	Indicates +5 volt supply is on.

TABLE 6-1 OPERATOR CONTROL INDICATORS

Status LED codes: DS5 Blinking indicates that the OC Microprocessor PCB is functioning properly, and DS2 through DS4 indicate which program routine is running. If one of the errors listed below is detected, the front panel is blanked, DS5 is turned off, and the binary error # is indicated by DS2 through DS4.

There are two push button switches, SW1 and SW2, accessible through the rear panel. SW1 is the microprocessor RESET switch that restarts the main program. By holding SW2 (TEST) and turning on the power, the unit is placed into the front panel switch TEST mode. Each front panel switch is assigned a position number which appears in the Anode/Tube Load window display as the switch is activated, i.e. kV up switch is #35 and kV down switch is #36.

Switches SW3 and SW4 are the program switches to set the microprocessor program for different functions. All switches are CLOSED or in the **down position** for FUNCTION operation. The following list outlines these switches:

SWITCH	FUNCTION	DESCRIPTION
SW3-1	SHOW FUNCTION	Permits O.C. to function without being connected to RPU (checked at Power Up).
SW3-2	NOT USED	
SW3-3	NOT USED	
SW3-4	SINGLE SOURCE	Disables exposure initiation EXPOSURE from front panel. Used with remote exposure switch.
SW3-5	TEC Enable	Tomographic Exposure Control Enable, for tomo systems only
SW3-6	NOT USED	
SW3-7	MAXIMUM KVP	Limits kVp to 125 kVp (checked at power up)
SW3-8	CALIBRATION	Places system in the calibration/test mode. (checked at Power Up)
SW4-1	NOT USED	
SW4-2	NOT USED	
SW4-3	NOT USED	
SW4-4	NOT USED	
SW4-5	NOT USED	
SW4-6	TOMO OPERATION	Enables Tomo Mode
SW4-7	NOT USED	
SW4-8	OC MSG	Enables OC "Continental..." message

TABLE 6-2 OPERATOR CONTROL SWITCHES

R24, CONTRAST, is also accessible through the rear panel. It controls the contrast of the Liquid Crystal Display (LCD) to provide proper viewing for the ambient light level in the room.

The Display PCB contains the 7-segment LED's, light bars, and the display drivers, U1, U2, and U4. U5, U6, U7 and U8 are the front panel key switch decoders. VR1 is a 12 VDC regulator supplying U3, the DC-to-AC converter that supplies 100 VAC to the Electro-Luminescence panel for the LCD backlight. This permits viewing the LCD in a darkened room.

The keyboard contains all the domed switches integrated into the panel.

6.4 RPU MICROPROCESSOR PCB

The RPU microprocessor PCB utilizes the 8085AH microprocessor, U6, and has its program residing in the 27C256 EPROM, U5. A function of this system is to communicate with the operator control. These signals enter via P10 and are interfaced to the 8085 microprocessor through U24, OC1, U19, OC2, U21A, and U22. This is an RS232 type of serial communications.

Other functions of this microprocessor are to transfer the front panel technique factors, control the exposure sequence, and monitor system functions. When errors are detected, the RPU will send the "System error Flag #" to the operator control and display the error code via LED's DS2 thru DS9 (Refer to **SECTION 7** for error codes). DS1 indicates that the RPU microprocessor is running. L1 is normally dimly lit to indicate proper operation.

There are two switches, SW1 and SW2, located on this PCB. SW1 is the microprocessor RESET switch used to RESET the program. This is used primarily for factory testing of this PCB. SW2 has no current function.

There are two switch banks SW3 and SW4. They are normally set to OFF (open) for operation. Refer to **SECTION 7, TABLE 7-2** for detailed functions.

6.5 mA/mAs CONTROL PCB

The mA/mAs PCB provides two main functions, control of the x-ray tube filament power (mA), (non-AEC) and control of the exposure time for all manual timing requirements (mAs).

Data is received from the microprocessor via the backplane bus (P7) and is interfaced with IC1-4, 7, and 10. Data representing the selected, mA value appears at the input of the digital-to-analog converter, IC14. Its output is buffered by IC17A and becomes the mA reference signal for the mA servo amplifier, IC17C. The mA is controlled before the exposure by a pre-heat value that is a function of the desired mA and kVp, for space charge compensation. During the pre-heat period, the feed-back for the

servo amplifier is derived from sensing the current in the primary of the filament transformer on the Gate Drive PCB. The signal appears on P8-1 (Fil FB). This is an AC current waveform that is converted into a DC voltage by the RMS-to-DC converter, IC5. TP5 is a voltage proportional to the current flowing in the primary of the filament transformer. This voltage is amplified by IC6D and becomes the PRE FB+ signal for comparison with the reference voltage. This signal is switched by IC15 to the actual mA feedback voltage at the moment that the kVp has reached maximum kVp.

The actual mA feedback is derived from two 10 Ω resistors in the HV transformer assembly. Plus and minus signals appear at P8-9 and P8-5 as inputs to the differential amplifier, IC6. The output of IC6 is buffered by a low-pass amplifier, IC17, and becomes the actual mA FB (+) signal. This signal is compared with the reference and applied through IC15 to the input of the servo amplifier, IC17.

Its output is then applied to the input of the voltage to frequency converter IC19. IC19 has a maximum frequency adjustment, R10 (FoMax), that limits the maximum operating frequency of the filament inverter supply. The output of IC19 is buffered by Q1 and IC8 and appears at the input of the divide-by-two flip-flop, IC16A. The Q and -Q outputs trigger the 42 microsecond one-shot mulitvibrators, IC18. These supply the Gate Drive for the filament inverter IGBT's. These signals, TP10 and TP11, exit the PCB on P8-21 and P8-23.

There are several monitored signals that will generate system flag errors if detected. These include primary filament overcurrent detect and mA overcurrent detect. These signals are applied to IC7 through jumpers EMA5 and EMA4. These jumpers are used for trouble shooting.

The other prime function on this PCB is the integrating mAs timer. All manual timing is done by the mAs timer, including the 3-factor selection of time. Since the mA is highly regulated, the time will be constant for a given mAs selection. The timer has as its input the actual mA signal (TP2) applied to the input of the voltage-to-frequency converter, IC20.

The V/F has one factory adjustment, R34 (mAs CALibrate), that sets the conversion at 60 Hz/mA. This frequency varies proportionally with mA and is applied to the input of the counter/timer, IC11.

A divide-by number representing the desired mAs (or time) is input to the counter/timer and the pulses representing actual mA are counted until they equal the preset data input at which time an exposure stop signal is generated (IC11-10). This signal is read by the microprocessor and is used to stop the exposure sequence.

6.6 kVp CONTROL

The kVp Contrl PCB contains the high voltage, or kV, control circuitry. The high-frequency inverter is controlled by a closed-loop servo system that responds to an analog reference voltage input that is proportional to the selected desired kVp.

The data from the front panel is transferred to the kVp control via the RPU microprocessor and the microprocessor bus on the backplane PCB through P5 to IC1, IC5, and IC9. These IC functions are to decode the address and interface (transfer) data both as inputs and outputs. A digital number representing the desired kVp appears at D0 thru D7 of IC2, the AD7248 digital-to-analog converter.

The output of IC2 (V out) becomes the kVp reference voltage for input to the servo amplifier. This voltage takes two paths, one thru IC6A and one thru IC6C. IC6C is an integrator function which supplies a "RAMP" to the reference voltage at the output of IC6A. This RAMP is applied at "RAMP ON" time which occurs at exposure start. The resultant wave form at TP2 contains both the ramp and reference voltage. This is a negative signal to be compared with the positive feedback signal.

The kVp feedback signal is derived from two precision voltage dividers located in the HV transformer assembly. There are both positive and negative feedback signals that are input to a differential amplifier, IC4A & B. These signals appear at TP11 (FB-) and TP12 (FB+). They are summed in IC4C and the composite signal appears at TP3 (KVFB+). It is this feedback signal that is compared with the reference signal and input to the servo amplifier, IC6D.

This servo amplifier derives a differential signal that is applied to the input of IC7, the voltage-to-frequency converter. IC7 has an output frequency proportional to the input voltage and is limited to its maximum frequency by R13 (f_o MAX). This is a factory adjustment to limit the frequency to 12.5 kHz (11 kHz for TM80 ONLY). This adjustment assures that the inverter SCR's will not operate above their safe operating frequency (T_o time). Operation above this frequency will cause SCR commutation failure resulting in a short circuit on the +500V power supply.

The output of IC7 (through Q1) and IC14B, is applied to flip-flop IC12A. IC12 divides the frequency by 2 and its outputs, Q and -Q, are used to trigger the one-shot multi-vibrators, IC13. The pulse width of these multivibrators are approximately 11 micro-seconds and appear alternately. These SCR gate drive pulses are supplied to the SCR gate drive PCB at J6-25 and J6-27.

There is circuitry to detect when the actual kVp is either 6 kVp above or below the desired kVp. IC4D and IC11C and IC11D provide this function and derive active low signals that are monitored by IC5 through jumpers JP4 and JP3. These jumpers are removed for troubleshooting purposes.

A signal from the Gate Drive PCB appears on P6-21 which indicates that SCR commutation failure has occurred. This signal sets flip-flop IC12B which then inhibits the kV gate drive. The -Q (COMM FAIL') output is sensed by IC5 thru jumper JP1.

One other signal is monitored by IC5, the interlock signal on P6-9 (125 kV) or P6-15 (150 kV) which senses the feedback cable as connected into the HV transformer assembly.

6.7 I/O CONTROL

The I/O control PCB interfaces the microprocessor bus with the FIELD I/O PCB, and to other static functions within the system.

There are 8 LED status indicators, and 8 program jumpers. Refer to **SECTION 7** for information about these indications and functions.

6.8 AEC INTERFACE

The AEC interface PCB contains the automatic exposure control circuitry to interface up to six ion-chamber inputs. These inputs all appear on P2 and are applied to the normalizing amplifiers IC15, 16, and 17. These amplifiers each have a gain adjustment that will balance each input.

These inputs are then selected by IC18 and the selected signal is input to IC19, the film/screen and density gain modifier amplifiers. This signal is then inverted and buffered by IC19D, and becomes the input to the voltage-to-frequency converter, IC22. Its conversion (V to F) is calibrated by R43 (V/F ADJUST). This adjustment is set by following the "MAX TRIP VALUE" calibration procedure found in **SECTION 3**.

The output of the V/F converter is applied through IC4 to the clock input (CLK1) of the counter/timer IC, IC9. A preset digital value, representing a threshold value determined by calibration, is applied to the D0-to-D7 input of the counter/timer. The system clock (3.012 MHZ) is applied to the other clock input (CLK0) (PIN 9) and an internal frequency is derived by this counter. These two frequencies are then compared by IC18, and when the V/F frequency equals the internal preset frequency, an AEC STOP signal is generated at IC18-9.

This signal is read by the microprocessor and the exposure sequence is terminated. Note: the V/F frequency is controlled by the integrated ramp signal from the ion-chamber pre-amplifier. Therefore this signal starts at a low frequency and increases as the ramp voltage increases. When this frequency reaches the same pre-set frequency in the counter/timer an AEC stop signal is generated. There is a memory location for each 10 kVp value that may be programmed (calibrated) for a different preset value. This becomes the kVp compensation calibration. There is also a memory location for each APR exam so each exam may be calibrated, or customized, for desired AEC film density.

The remaining circuitry on the AEC interface is used for communications to the microprocessor bus and for I/O functions such as field selection from the ion chambers.

6.9 RELAY/OC POWER SUPPLY

The Relay/OC Power Supply PCB contains the 24 VDC regulated supply to operate the Operator Control, plus a 24 VDC supply for the field I/O PCB.

There are two solid-state relays to operate the surge contactor (M2), and the contactor that switches in and out the additional series resonant capacitor (C_r) in the kVp inverter circuit.

6.10 RAD FIELD I/O

The Rad Field I/O PCB provides the interface for the generator with system components. These include the following:

TERMINAL BOARD	I/O	DESCRIPTION
TB1-1 thru TB1-9	I/O	Interface to high speed starter
TB2-1 to TB2-2	I	Tube select verify
TB2-3 to TB2-4	O	Drives the M4-RD contactor
TB2-5 to TB2-6	O	117 VAC room indicator
TB2-7 to TB2-8	I	Table interlock
TB2-9 to TB2-10	I	Tomo interlock
TB2-11 to TB2-12	I	AUX interlock
TB2-13 to TB2-14	I	Door #1 interlock
TB2-15 to TB2-16	I	Door #2 interlock
TB2-17 thru TB2-23	I/O	Collimator interface
TB3-1 thru TB3-5	I/O	AUX bucky interface
TB3-6 thru TB3-10	I/O	Wall bucky interface
TB3-11 thru TB3-15	I/O	Table bucky interface
TB4-1 thru TB4-6	I/O	X-ray tube interface

TABLE 6-3 FIELD I/O CONNECTIONS

There are two adjustments on this PCB, one for minimum stator main current detect (R57) and the other for minimum stator phase current detect (R58). These are factory adjusted for the standard speed stator.

6.11 FLUORO FIELD I/O (Not applicable to Rad generators)

This PCB provides the input/output for the generator with all ancillary items that might interface with the unit for use in fluoro mode. These include the following:

TERMINAL BOARD	I/O	DESCRIPTION
TB1-1 thru 8 & 10,12	I	Camera interface
TB2-1 thru 7	I	Spot film device
TB2-4,8	I	Auxiliary power transformer
TB3-2,3 & 7,8	I	Tube 2 stator/thermal switch
TB3-1 & 4 thru 6	I	Tube 2 stator/thermal switch
J1-1 thru 3	O	Filament drive out
J2-1 & 2	I	Filament drive in
J3-1 thru 3	O	Tube 1/2 HV switch select
J4-1 thru 3	I	Tube select verify
J7-1,2 & J10-1,2	I/O	Solid state relay SSR1
J8-1 thru 6	I	Filament standby AC supplies
J9-1 thru 6	O	Stator power supply
J11-1 thru 5	I	+5V & ±12 V_{DC} power supplies
J12-1 thru 40	I/O	System control via backplane

TABLE 6-4 FLUORO FIELD I/O CONNECTIONS

6.12 GATE DRIVE

This PCB contains the gate drive circuitry for the HV inverter and also contains the filament inverter supply.

The kV inverter drive signals come from the kVp Control PCB and are optically isolated by IC3 and IC4. They drive the HEXFETS, Q2 and Q3, that drive the SCR gate drive pulse transformers, TR1 and TR2. Q1 is a HEXFET switch that supplies the pulse transformers with supply voltage only while [**PREP**] is activated. This provides safety to prevent noise triggering the SCR's when the unit is idle.

There is a circuit that detects the presence, or absence, of the 500 volts applied to the SCR's. Should two of the SCR's on the same leg of the H-bridge conduct at the same time, a short would be applied across the 500 volt supply, and the supply voltage would decay rapidly. This circuit, IC7, detects that voltage decay and provides a logic signal to the microprocessor to terminate the exposure sequence.

Two LED's indicate status of this circuit. L6 is illuminated under normal operation, and L7 illuminates when a failure is detected.

The other function on this PCB is the filament inverter circuit. 120 VAC is rectified and filtered to supply approximately 170 volts DC to the half-bridge inverter, IGBT's Q4 and Q5. IC8 is the IGBT drive interface IC driven by the opto-isolators, IC5 and IC6. There is a current transformer in series with the output to the filament transformer's primary. This current sense supplies the signal to the mA/mAs Control PCB that is converted into the DC voltage for servo control of the filament power during pre-heat. C18, 19, 20, & 21 comprise the series resonant capacity for this inverter supply.

6.13 HIGH-FREQUENCY INVERTER

The high-frequency inverter consists of two sections. The H-bridge inverter with the four SCR's (thyristers), four anti-parallel diodes, the "snubber" networks, and the series resonant capacitors. The primary of the HV transformer is the series inductance for this inverter. The other section is known as the "T" network.

Explanation of the high-frequency inverter is found in **SECTION 6.2**. There is one unique feature of this inverter, it is the use of a second and third series resonant capacitor switched in and out by the contactors. This reduces the output ripple of the kVp waveform when the power level is reduced.

The kVp ripple is a function of the output power level. The higher the power level, the lower the ripple. Therefore, if only one series resonant capacitor was used, the ripple would vary from approximately 10% to 1% as the unit was operated between 1 kilowatt (25mA at 40 kVp) and 30 kilowatts full power. By switching the series resonant capacitor at 12.5 kilowatts, the ripple is maintained within a range of 6% to 1%, with a typical value for between 2% to 4%.

The "Snubber" networks around the SCR's are important in reducing the rate of change of voltage across the "OFF" SCR's. Without the snubbers, the "OFF" SCR's would self trigger and result in a short circuit across the power supply.

To prevent "blowing" (F9) for momentary mistriggering occurrences, there is a circuit in series with the power supply capacitors and the SCR's, the "T-network" (its elements are in a "T" configuration L1, C13, C14, R15, R16, DP6). The purpose of the T-network is to absorb the momentary short circuit current and prevent fuse (F9) from blowing. Since this network is made up of both inductance and capacitance, it will oscillate upon a short circuit resulting in a reversing of the current.

This reversing action "un-latches" the SCR's and returns the inverter to an open state. It is the short circuit that is detected by IC7 on the Gate Drive PCB that in turn inhibits additional gate pulses to occur. An error message appears in the LCD window indicating that the exposure was improperly terminated by system FLAG #3, kVp commutation fail error, and a RESET appears. The system must be reset before another exposure can be initiated.

6.14 1ϕ POWER SUPPLY

The mains input range is from 204 VAC through 276 VAC, 60 Hz. The mains must be line matched to the autotransformer via TB6. The autotransformer steps up the voltage to 369 VAC and then is applied to the rectifiers through the main line contactor (M3) and the surge contactor (M2). The purpose of the surge contactor is to limit the charging current to the capacitor bank of C5 thru C10. Upon power on, the surge contactor activates, and approximately 2 seconds later the main contactor energizes. The 369 VAC is rectified and filtered to provide approximately 500 volts DC for the high-voltage inverter.

There is 24-hour power supplied to the 24-hour Power Supply that provides power distribution to the control circuitry. There is a bleeder relay on this supply that places the bleeder resistors (R6 & 7) across the large filter capacitors whenever the unit is turned off. There is a switch to turn off M2 and M3 to de-activate the 500 volt supply for use in troubleshooting.

6.15 3ϕ POWER SUPPLY

The mains input range is from 204 VAC through 276 VAC, and 480 V_{AC} 60 Hz. The mains must be line matched to the autotransformer via TB6. The autotransformer steps up the voltage to 369 VAC and then is applied to the rectifiers through the main line contactor (M3) and the surge contactor (M2). The purpose of the surge contactor is to limit the charging current to the capacitor bank of C5 thru C10. Upon power on, the surge contactor activates, and approximately 2 seconds later the main contactor energizes. The 369 VAC is rectified and filtered to provide approximately 500 volts DC for the high-voltage inverter.

There is 24-hour power supplied to the 24-hour Power Supply that provides power distribution to the control circuitry. There is a bleeder relay on this supply that places the bleeder resistors (R6 & 7) across the large filter capacitors whenever the unit is turned off. There is a switch to turn off M2 and M3 to de-activate the 500 volt supply for use in troubleshooting.

SECTION 7 - TROUBLESHOOTING

7.1 SYSTEM FLAGS

The codes listed below are shown on the OC display window and the LEDs on the RPU microprocessor PCB (see **TABLE 8-6**).

1. Fault flags (OC FAULT INDICATOR LED ON) indicate that the exposure was improperly terminated by an error and that the improper termination of the exposure be acknowledged by pressing [**RESET**].
2. These RPU flags are cleared before the start of the prep sequence.
3. TM R/F must be turned OFF then ON to clear the flags.
4. Wire jumpers required on field I/O PCBs for multitube operation. IC10 pin 8, 11, 13, to TS1, 2, and 3.
5. These flags are set or cleared when checked.
6. On multitube units, the tube selected (1, 2, or 3) at the OC determines which field I/O PCB these flags refer to.
7. These flags are cleared at the end of the prep sequence.

OC	RPU	NOTES	LCD MESSAGE - DESCRIPTION
0	N/A	1	STACK ERROR Flag used for verification of OC software changes.
N/A	10	2	Not displayed. RPU stack error, flag used for verification of RPU software changes.
1	11	1,2	X-RAY SWITCH (RPU µP PCB, U22-32 high,$\overline{\text{X-RAY}}$). Exposure terminated by release of EXPOSURE switch.
2	12	1,2	PREP SWITCH (RPU µP PCB, U22- 33 high, $\overline{\text{ROTOR}}$). Exposure terminated by release of PREP switch.
3	13	1,2	kVp COMMUTATION FAIL ERROR (kV PCB, IC5-4 low, $\overline{\text{KVCF1}}$). Exposure terminated by collapse of the inverter power supply. Probable cause, SCR commutation fail.
4	14	1,2	kVp HIGH ERROR (kVp PCB, IC5-2 low, $\overline{\text{KVHI}}$). Exposure terminated by 3 consecutive (3ms) kV high conditions, kV actual 9kV feedback) less than kV selected 9kV reference) by 8kV or more.
5	15	1,2	kVp LOW ERROR (kVp PCB, IC5-1 low, $\overline{\text{KVLO}}$). Exposure terminated by 3 consecutive (3ms) kV low conditions, kV actual (kV feedback) less than kV selected (kV reference) by 8kV or more.
6	16	1,2	mA OVERLOAD ERROR (mA/mAs PCB, IC7 pin 19 low, -mA OVLD) Exposure terminated by 5 consecutive (5ms) mA overload conditions, mA actual (mA feedback) exceeds mA selected (mA reference) by 14.4% or more.
7	17	1,2	mA LOW ERROR (mA/mAs PCB, A/D IC10 pin 27, mA/FIL FB sample) Exposure terminated by 5 consecutive (5ms) mA low conditions.

OC	RPU	NOTES	LCD MESSAGE - DESCRIPTION
8	20	1,2	FILAMENT POWER SUPPLY FAIL ERROR (mA/mAs PCB, IC7 pin 20 low, -FIL SUP FAIL) Exposure terminated by failure of the filament power supply.
9	21	1,2	FILAMENT OVERLOAD ERROR (mA/mAs PCB, IC7 pin 18 low, -FIL OVLD) Exposure terminated by 5 consecutive (5ms) filament overload conditions, actual filament current exceeds filament max (D/A IC10 pin 2). Filament max set to 110% for filament feedback control and 120% for mA feedback control.
10	22	1,2	BACK-UP mAs LIMIT (mA/mAs PCB, IC11 Timer) AEC Exposure terminated by mAs timer.
11	23	1,2	EXPOSURE STOP ERROR (RPU µP PCB, U6-9 high, EXPSTOP) Exposure terminated by -EXPSTOP signal, but SOURCE UNKNOWN (no AEC stop, no mAs stop, no µP EXPSTOP). Probable cause, exposure watchdog time out (RPU µP PCB, U18A-4 high) or component failure.
12	24	1,2	EXPOSURE TIME LIMIT ERROR (RPU software timer) Exposure terminated by a back-up time limit based on 120% of the expected time for mAs exposure termination.
13	25	1,2	RPU HARDWARE FAULT (mA/mAs PCB 8255 IC7, kV PCB 8255 IC5) Exposure terminated by mA/mAs PCB 8255 or kV PCB 8255 becoming corrupt. Probable cause, electrical noise caused by faulty tube or loose HV cable connections.
14	26	1,2	kV UNBALANCE ERROR Exposure terminated by a kV unbalance between cathode and anode of greater than 6 kVp. Check cables and tube.
15	N/A	1	RPU FLAGS NOT RECEIVED Proper exposure not confirmed by the RPU. Probable cause, RPU shutdown during exposure.
16	30	2	X-RAY CONTROL SIGNAL ERROR (RPU µP PCB, U22-32 $\overline{\text{X-RAY}}$) -XRAY control signal failed to toggle high-low-high at the start of the prep sequence.
17	31	2	-ROTOR CONTROL SIGNAL ERROR (RPU µP PCB, U22-33 $\overline{\text{ROTOR}}$) -ROTOR control signal failed to toggle high-low-high at the start of the prep sequence.
18	32	2	FLAG NOT ASSIGNED
19	33	2	FILAMENT POWER SUPPLY FAILED (mA/mAs PCB, IC7 pin 20 low, -FIL SUP FAIL) Filament power supply failure detected during prep.

OC	RPU	NOTES	LCD MESSAGE - DESCRIPTION
20	34	2	FILAMENT OVERLOAD ERROR (mA/mAs PCB, IC7 pin 18 low, -FIL OVLD) Actual filament current exceeded filament maximum (D/A IC10 pin 2) for 5ms. Filament maximum set to 110% of the desired filament current.
21	35	2	FILAMENT LOW ERROR (mA/mAs PCB, A/D IC10 pin 27, mA/FIL FB SAMPLE) Actual filament current below filament minimum for 5ms.
22	36	2	HS ROTOR READY SIGNAL ERROR (ver 1.0.4) (Field I/O PCB, IC8 pin 15, -HS ROTOR READY) Flag set by 1 of 3 possible errors: 1. -HS ROTOR READY signal active (low) before start of PREP sequence 2. No -HS ROTOR READY signal (low) received within 7 seconds after start of PREP sequence 3. -HS ROTOR READY signal becomes inactive during PREP.
23	37	2	HS VERIFY SIGNAL ERROR (ver 1.0.4) (Field I/O PCB, IC8 pin 17, -HS VERIFY) Flag set by 1 of 2 possible errors: 1. -HS VERIFY signal active (low) before start of prep sequence. 2. HIGH speed selected but not verified (-HS VERIFY signal not active (low)). NOTE: The flag is disabled by jumper E107.
24	40	2	ROTOR BOOST ERROR (Field I/O PCB, IC10 pin 4 and 6, -STATOR MAIN CURRENT DETECT and -STATOR PHASE CURRENT DETECT) Flag set if stator main or phase current not detected during rotor boost. Flag disabled by jumper E107.
25	41	2	ROTOR RUN ERROR (Field I/O PCB, IC10 pin 4 and 6, -STATOR MAIN CURRENT DETECT and -STATOR PHASE CURRENT DETECT) Flag set if stator main of phase current not detected during rotor run mode. Flag disabled by jumper E107.
26	42	2	ROTOR ON TIME EXCEEDED (Software timer) Flag set if maximum rotor run time of 30 seconds is exceeded.
27	43	2	mAs COUNTER FAILED TO PROGRAM (mA/mAs PCB, IC11 counter/timer) Counter programmed and mode checked at power up and before the start of an exposure. Flag disabled at power up by jumper E0 on the RPU µP PCB.
28	44	2	AEC BOARD failed to program (AEC PCB, IC6 PPI) Flag set if AEC or APR mode selected and AEC PCB PPI IC failed to program at power up. Flag checked before start of prep sequence.

29	45	2	AEC COUNTER failed to program (AEC PCB, IC9 COUNTER/TIMER) Flag set if AEC or APR mode selected and AEC PCB counter modes (IC9) failed to program. Checked at power up and at start of prep sequence.
30	46	2	Selected BUCKY did not respond (Field I/O PCB, IC10 pin 2 high, -BUCKY READY) Selected bucky failed to respond (-BUCKY READY low) within 5 seconds after being selected.
31	47	2	ION CHAMBER selected is not installed (AEC PCB, IC7, CH RST 17 - 67) Selected chamber not present (CH RST x7 signal low)
32	50	2	kVp COMMUTATION FAIL HARDWARE ERROR (kV PCB, IC5 pin 4 low, -kV COMM FAIL) Unable to clear kV commutation fail latch. Checked before start of exposure sequence.
33	51	2	kVp HIGH HARDWARE ERROR (kV PCB, IC5 pin 2 low, -kV HIGH) -kV HIGH signal active (low) before start of the exposure sequence.
34	52	2	mA OVERLOAD HARDWARE ERROR (mA/mAs PCB, IC7 pin 19 low, -mA OVLD) -mA OVLD signal active (low) before the start of the prep sequence.
35	53	2	FILAMENT OVERLOAD HARDWARE ERROR (mA/mAs PCB, IC7 pin 18 low, -mAs STOP) -FIL OVLD signal active (low) before the start of the prep sequence.
36	54	2	mAs STOP HARDWARE ERROR (mA/mAs PCB, IC7 pin 18 low, -mAs STOP) -mAs STOP signal active (low) before the start of the prep sequence.
37	55	2	FLAG NOT ASSIGNED
38	56	2	FLAG NOT ASSIGNED
39	57	2	FLAG NOT ASSIGNED
40	60	3	UP BOARD 8255 failed to program (RPU UP PCB, PPI 8255) Error detected in the 8255 at power up. Error check disabled by jumpering pin 26 of IC9 (muart p25) to ground.
41	61	3	mA BOARD 8255 failed to program (mA/mAs PCB, PPI IC7) Error detected in the 8255 at power up. Error check disabled by installing jumper E0 on the RPU UP PCB.
42	62	3	kVp BOARD 8255 failed to program (kVp PCB, PPI IC5) Error detected in the 8255 at power up. Error check disabled by installing jumper E1 on the RPU UP PCB.

OC	RPU	NOTES	LCD MESSAGE - DESCRIPTION
43	63	3	RPU HARDWARE error, turn OFF to clear (mA/mAs PCB 8255 IC7, kV PCB 8255 IC5) Flag set by two possible errors: 1. mA/mAs PCB 8255 or kV PCB 8255 becomes corrupt during exposures. See system flag #13. 2. mA/mAs PCB 8255 becomes corrupt during prep sequence.
44	64	N/A	FLAG NOT ASSIGNED
45	65	4	FLAG NOT ASSIGNED
46	66	4	FLAG NOT ASSIGNED
47	67	4	FLAG NOT ASSIGNED
48	70	5	RPU RECEIVER CHECKSUM ERROR (RPU UP PCB, 8256 IC9, RS232 port) Calculated checksum of data received does not match checksum number received.
49	71	5	RPU RECEIVER DATA ERROR (RPU UP PCB, 8256 IC9, RS232 port) Framing, overflow, or parity error detected.
50	72	5	RPU - ILLEGAL ROUTINE RECEIVED (RPU UP PCB, 8256 IC9, RS232 port) Routine number received from OC does not exist in RPU software.
51	73	5,6	COLLIMATOR NOT READY (Field I/O PCB, IC8 pin 13 high, -COLL HOLD) Collimator ready signal not present (low).
52	74	N/A	kVp FEEDBACK SIGNAL ERROR (kV PCB, IC5 pin 3 high, -FB INTERLOCK) -FB INTERLOCK signal from kV feedback cable not present (low).
53	75	5,6	SURGE RELAY NOT ENERGIZED (Field I/O PCB, IC9 pin 17, -INV SUPPLY ON, IC20 pin 4, -INV SUPPLY ON) -INV SUPPLY ON signal high, therefore surge contactor de-energized, -SURGE CONTACTOR signal high. NOTE: Surge contactor energized 2.5s after the switch is turned ON.
54	76	5,6	FILAMENT POWER SUPPLY ERROR (mA/mAs PCB, IC7 pin 20 low, -FIL SUP FAIL) Filament power supply failure, -FIL SUP FAIL signal low.
55	77	N/A	FLAG NOT ASSIGNED
56	80	5,6	SELECTED TUBE NOT VERIFIED (ver 1.0.5) (Field I/O PCB, IC9 pin 2 high, -TUBE SEL VERIFY) Tube selected(IC5 pin 19 low, -TUBE SELECT) not verified by -TUBE SEL VERIFY signal.

OC	RPU	NOTES	LCD MESSAGE - DESCRIPTION
57	81	5,6	TOMO INTERLOCK HOLD (Field I/O PCB, IC9 pin 4 high, -TOMO INTERLOCK) Checked at start of prep sequence. TOMO mode selected but TOMO is not ready (-TOMO INTERLOCK signal high).
58	82	5,6	TABLE INTERLOCK HOLD (Field I/O PCB, IC9 pin 6 high, -TABLE INTERLOCK) Checked at the start of the prep sequence. Table selected but not in position (-TABLE INTERLOCK signal high)
59	83	5,6	DOOR #1 INTERLOCK HOLD (Field I/O PCB, IC9 pin 8 high, -DOOR #1 INTERLOCK) Door #1 open (-DOOR #1 INTERLOCK signal high). Interlock continuously monitored except during an exposure.
60	84	5,6	DOOR #2 INTERLOCK HOLD (Field I/O PCB, IC9 pin 11 high, -DOOR #2 INTERLOCK) Door #2 open (-DOOR #2 INTERLOCK signal high). Interlock continuously monitored except during an exposure.
61	85	5,6	AUX INTERLOCK HOLD (Field I/O PCB, IC9 pin 13 high, -AUX INTERLOCK) Similar to DOOR #1 INTERLOCK HOLD, system flag #59.
62	86	5,6	TUBE HOT (Field I/O PCB, IC9 pin 15 high, TUBE HOT) Similar to DOOR #1 INTERLOCK HOLD, system flag #59. X-ray tube has opened.
63	87	N/A	OC UP LINK NOT ESTABLISHED (RPU software flag) Flag set at power up and cleared when OC request RPU to send its software version number.
64	N/A	7	RPU RECEIVER NOT READY (OC µP PCB, IC18 pin 39 high, -CTS) RPU not ready to receive data from OC. Checked before start of prep sequence.
65	N/A	7	RPU DID NOT RESPOND (OC µP PCB, IC18 RS232) RPU did not respond that data was received from the OC via RS232 to the start of the PREP sequence.
66	N/A	7	-PREP CONTROL SIGNAL ERROR (OC µP PCB, IC18 pin 37, -PREP) -PREP control signal failed to toggle at the start of the prep sequence.
67	N/A	7	-EXPOSE CONTROL SIGNAL ERROR (OC µP PCB, IC18 pin 38, -EXP) -EXP control signal failed to toggle at the start of the prep sequence.
68	N/A	7	RPU FLAGS NOT RECEIVED (OC µP PCB, IC18 RS232) Flag set if RPU failed to send (via RS232). Flag set at the end of the prep sequence.

OC	RPU	NOTES	LCD MESSAGE - DESCRIPTION
69	N/A	7	FLAG NOT ASSIGNED
70	N/A	7	FLAG NOT ASSIGNED
71	N/A	7	FLAG NOT ASSIGNED
72	N/A	7	NO EXAM SELECTED OC in either the APR or CEC mode with no exam LCD selected. Flag cleared when exam is selected.
73	N/A	7	FLAG NOT ASSIGNED
74	N/A	7	FLAG NOT ASSIGNED
75	N/A	7	FLAG NOT ASSIGNED
76	N/A	7	FLAG NOT ASSIGNED
77	N/A	7	FLAG NOT ASSIGNED
78	N/A	7	FLAG NOT ASSIGNED
79	N/A	7	FLAG NOT ASSIGNED
80	N/A	N/A	SELECTED mAs/Time EXCEEDS mA LIMITS
81	N/A	N/A	SELECTED mA *TIME EXCEEDS mAs LIMIT Flag cleared by decreasing mA or TIME to bring mAs to 900 or less.
82	N/A	N/A	FACTORS WILL EXCEED MAX TUBE POWER Flag cleared by reducing power: kV, mAs, or mA *Time, below maximum.
83	N/A	N/A	SELECTED mA * kVp EXCEEDS GEN LIMIT Maximum kilowatt rating of TM exceeded. Flag cleared by reducing mA times kVp below maximum rating.
84	N/A	N/A	FACTORS WILL EXCEED TUBE HEAT LIMIT Flag cleared by reducing tube power or by allowing tube to cool.
85	N/A	N/A	SEL kVp & mA EXCEEDS FILAMENT LIMIT Maximum allowed filament current would be exceeded if prep sequence is allowed. Flag cleared by increasing kV or decreasing mA.
86	N/A	N/A	SELECTED FACTORS EXCEEDS AEC LIMITS The required AEC trip value exceeds the maximum. Trip value flag cleared by increasing kV or decreasing size selected.
87	N/A	N/A	FRONT PANEL EXPOSURE NOT ALLOWED (OC µP PCB, E4 installed to enable) Default flag.
88	N/A	N/A	FLAG NOT ASSIGNED
89	N/A	N/A	FLAG NOT ASSIGNED
90	N/A	N/A	AUTO STEPS WILL EXCEED FULCRUM LIMIT
91	N/A	3	X-RAY SWITCH ACTIVE AT POWER UP (OC switch PCB, IC4 pin 13 low, X-RAY SWITCH) X-ray switch checked at power up and found to be active (low).

OC	RPU	NOTES	LCD MESSAGE - DESCRIPTION
92	N/A	3	PREP SWITCH ACTIVE AT POWER UP (OC switch PCB, IC4 pin 13 low, X-RAY SWITCH) Prep switch checked at power up and found to be active (low).
93	N/A	3	REMOTE EXPOSURE SW ACTIVE AT POWER UP (OC µP PCB, IC11 pins 16 or 17, REMOTE ROTOR or X-RAY) Remote exposure switch checked at power up and found to be active.
94	N/A	5	RPU TO OC SOFTWARE VERSION MISMATCH RPU version must match OC version to assure compatibility.
95	N/A	N/A	RPU LINK UP NOT ESTABLISHED Flag set at power up and cleared when RPU sends its version number to the OC.
96	N/A	N/A	RPU HAS NOT ACKNOWLEDGED TUBE SELECTED Flag set at power up or when tube selected (TUBE switch) and cleared when RPU verifies the tube selected by the OC.
100			TOMO LINK NOT ESTABLISHED
101			TOMO AND TM S/W INCOMPATIBLE
102			TOMO DID NOT RESPOND
103			DATA MISMATCH BETWEEN TOMO AND TM
110			TOMO NOT READY

7.2 AEC TROUBLESHOOTING

The following sections will aid in the troubleshooting of problems encountered during calibration of the optional AEC capability of the TM series generators.

7.2.1 ION CHAMBER PRESET AND INSTALLATION (AID ION CHAMBER)

All information is applicable to AID Pre-Amp PCB 60917. The three ion chamber integrator amps and the ion chamber master gain amp are preset at the factory. The chamber offset potentiometers have been set at the factory and should **NOT** be adjusted. Use **TABLE 7-1** to set the chamber amplifiers to a centered starting point if problems are encountered during calibration.

a. Set each of the three field gain potentiometers for mid-range.
b. Set the master gain for mid-range.

Field 1 Gain:	R25 - set for 10KΩ
Field 2 Gain:	R15 - set for 10KΩ
Field 3 Gain:	R32 - set for 10KΩ
Master Gain:	R12 - set for 10KΩ
Field 1 Offset:	R29 - factory set
Field 2 Offset:	R20 - factory set
Field 3 Offset:	R37 - factory set

TABLE 7-1 AEC POTENTIOMETER SETTINGS

7.2.2 CHAMBER AMPLIFIERS AND FILM/SCREEN AMPLIFIER UNITY GAIN CHECK

This step is performed at the factory as part of the AEC Interface PCB test procedure and should be rechecked by the installer if calibration problems are encountered. It is only necessary to check the actual chambers and film/screens which will be used for the particular installation.

1. Ensure that the OC and RPU power is turned OFF. Place the AEC Interface PCB on the extender card.
2. Check the resistance values per **TABLES 7-2** and **7-3**.

MEASURE	ADJUST	READING	CHAMBER
TP1 to TP10	R18	20KΩ	1
TP2 to TP11	R20	20KΩ	2
TP3 to TP12	R22	20KΩ	3
TP4 to TP13	R24	20KΩ	4
TP5 to TP14	R26	20KΩ	5
TP6 to TP15	R28	20KΩ	6

TABLE 7-2 CHAMBER AMP UNITY GAIN ADJUST

MEASURE	ADJUST	READING	CHAMBER
IC19-1 to IC20-6	R31	10KΩ	1
IC19-1 to IC20-11	R32	10KΩ	2
IC19-1 to IC20-14	R33	10KΩ	3

TABLE 7-3 FILM/SCREEN UNITY GAIN ADJUST

3. Turn power OFF and replace the AEC Interface PCB.

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SECTION 8 - ELECTRICAL INFORMATION

RAD FIELD I/O (6584.262.01)

TABLE 8-1 RAD FIELD I/O PCB (6584.262.01) TERMINAL BLOCK CONNECTIONS

TB	SIGNAL	DESCRIPTION
TB1-1	**PREP READY**	Used with the Infimed fluoroscopic computer. TB1-5 provides +24VDC and is connected with TB1-1 to J9 of the Infimed/TM/CXT table interface PCB.
TB2-1 & 2	**TUBE SELECT VERIFY**	Used only with multiple tube operation. For single tube operation, there must be a jumper between TB2-1 and TB2-2.
TB2-3 & 4	**M4 COIL**	Contactor Damping Resistor: Connect TB2-3 and TB2-4 connected to the coil of the contactor located on the back of the power supply fuse panel.
TB2-5 & 6	ROOM INDICATOR	This is a 117VAC, 25W, source that is active when the control is ON. It is to be wired to a "ROOM IN USE" indicator.
TB2-7 & 8	TABLE INTERLOCK	Inhibits an exposure if an elevating table is not in its fullest UP position. **If no interlocks are used, jumpers must be in place.**
TB2-9 & 10	TOMO INTERLOCK	Inhibits an exposure if an elevating table is not in its fullest UP position. **If no interlocks are used, jumpers must be in place.**
TB2-11 & 12	AUX INTERLOCK	Inhibits an exposure if an elevating table is not in its fullest UP position. **If no interlocks are used, jumpers must be in place.**
TB2-13 & 14	DOOR #1 INTERLOCK	Access door switch activated interlock. This function will prevent an exposure start if a door is open, but will NOT stop an exposure if a door is opened during the exposure. **If the function is not used, jumpers must be in place.**
TB2-15 & 16	DOOR # 2 INTERLOCK	Access door switch activated interlock. This function will prevent an exposure start if a door is open, but will NOT stop an exposure if a door is opened during the exposure. **If the function is not used, jumpers must be in place.**
TB2-17[1]	+15V	Collimator connection - TS4-20
TB2-18	C = 0°	Collimator connection - TS3-5
TB2-19	C = +90°	Collimator connection - TS3-6
TB2-20	C = -90°	Collimator connection - TS3-7
TB2-21	SID = 40"	Collimator connection - TS4-14
TB2-22	SID = 72"	Collimator connection - TS4-9
TB2-23[1]	COLL. HOLD	Collimator connection - TS3-13
TB3-1	AUX BUCKY	Liebel/Flarsheim[2] :GND Midwest :GND
TB3-2		Liebel/Flarsheim[2] :B1 Midwest :B2

TABLE 8-1 RAD FIELD I/O PCB (6584.262.01) TERMINAL BLOCK CONNECTIONS		
TB	SIGNAL	DESCRIPTION
TB3-3	AUX BUCKY	Liebel/Flarsheim[2] :B2-3 Midwest :B1
TB3-4		Liebel/Flarsheim[2] :B4 Midwest :B4
TB3-5		Liebel/Flarsheim[2] :B8 Midwest :B3
TB3-6	Wall Bucky	Liebel/Flarsheim[2] :GND Midwest :GND
TB3-7		Liebel/Flarsheim[2] :B1 Midwest :B2
TB3-8		Liebel/Flarsheim[2] :B2-3 Midwest :B1
TB3-9		Liebel/Flarsheim[2] :B4 Midwest :B4
TB3-10		Liebel/Flarsheim[2] :B8 Midwest :B3
TB3-11	Table Bucky	Liebel/Flarsheim[2] :GND Midwest :GND
TB3-12		Liebel/Flarsheim[2] :B1 Midwest :B2
TB3-13		Liebel/Flarsheim[2] :B2-3 Midwest :B1
TB3-14		Liebel/Flarsheim[2] :B4 Midwest :B4
TB3-15		Liebel/Flarsheim[2] :B8 Midwest :B3
TB4-1	Ground	Stator (green wire)
TB4-2	Thermal Switch	Stator (brown wire)
TB4-3	Thermal Switch	Stator (blue wire)
TB4-4	Stator Common	Stator (white wire)
TB4-5	Stator Phase	Stator (red wire)
TB4-6	Stator Main	Stator (black wire)

1. When an automatic or semi-automatic collimator is used, the exposure hold function must be wired into the control, TB2-17 and TB2-23. All other connections are optional.
2. When installing a liebel/flarsheim 8000 or 9000 series bucky, make sure that a provided 6kω, 3w resistor is installed across b2 and b4. This can be added at the i/o terminal strip for the appropriate bucky.

TABLE 8-2 RAD FIELD I/O PCB (6584.262.01) JUMPER OPERATIONAL POSITIONS			
JUMPER	POSITION	FUNCTION	DESCRIPTION
TS1	IN	TUBE 1 SELECT	Install to enable field I/O PCB to function as tube 1 control and miscellaneous system I/O control.
TS2	OUT	TUBE 2 SELECT	Install to enable field I/O PCB to function as tube 2 control.
TS3	OUT	TUBE 3 SELECT	Same as TS2 but for tube 3. System flags: Field I/O PCB #1 select error (#(65), 45), Field I/O PCB #2 select error (#(66), 46), Field I/O PCB #3 select error (#(67), 47).

TABLE 8-3 RAD FIELD I/O PCB (6584.262.01) LEDs		
LED	FUNCTION	DESCRIPTION
L1	X-RAY TUBE FOCAL SPOT	ON - small focus selected, OFF large focus selected.
L2	TABLE BUCKY	ON - table bucky selected.
L3	WALL BUCKY	ON - wall bucky selected.
L4	AUX BUCKY	ON - aux bucky selected.
L5	ROOM A IND	ON - this room (1, 2, 3) is selected.
L6	RD CONTACTOR	ON - resistor-damping (RD) contactor selected
L7	TUBE SELECT	ON - this tube (1, 2, 3) is selected.
L8	ROTOR ON	ON - power applied to the tube rotor.
L9	BOOST/RUN	ON - boost voltages (220VAC), OFF - run voltage (40VAC).
L10	STATOR MAIN	ON - stator main current detected.
L11	STATOR PHASE	ON - stator phase current detected.

8.2 RPU MICROPROCESSOR PCB (6284.262.02)

TABLE 8-4 RPU MICROPROCESSOR PCB (6284.262.02) SWITCH SETTINGS			
SWITCH	POSITION	FUNCTION	DESCRIPTION
SW1	N/A	RESET	This momentary switch resets the PCB.
SW2	N/A	TEST	This momentary switch initializes the PCB self-test.
SW3-1	OPEN	mA/mAs CONTROL CHECK	Enables check of mA/mAs board 8255 (system flag (61), 41) and 8254 mAs counter (system flag (43), 27) at power ON.
SW3-2	OPEN	kV CONTROL CHECK	Enables check of kV board 8255 (system flag (62), 42) at power ON.
SW3-8	OPEN	STACK AREA	Enables check of program and data stacks (system flag (10), -) at power ON.

TABLE 8-4 RPU MICROPROCESSOR PCB (6284.262.02) SWITCH SETTINGS

SWITCH	POSITION	FUNCTION	DESCRIPTION
SW4-7 SW4-8	See Description	Selectable Spotfilm preheat boost time	1=open, 0=closed 8 7 Time 0 0 1750ms with 875ms boost 0 1 1250ms with 625ms boost 1 0 1500ms with 750ms boost 1 1 1000ms with 500ms boost

NOTE: The following switches are not used: SW3-3 thru 7 & SW4-1 thru 6.

TABLE 8-5 RPU MICROPROCESSOR PCB (6284.262.02) JUMPER SETTING

JUMPER	POSITION	FUNCTION	DESCRIPTION
PF	OUT	Power Fail	IN: Enables Power Fail check, used in factory test only. OUT: Normal operation

TABLE 8-6 RPU MICROPROCESSOR PCB (6284.262.02) LEDs

LED	FUNCTION	DESCRIPTION
L1	RUN	**DIM**: proper operation of the 1ms interrupt routine is indicated.
L2-L4	ERROR CODE, LOW BYTE	See table below.
L5	CODE IDENTIFIER	**BLINKING**:Normal operation **STEADY ON**:software fault, read L2-L4 (see **TABLE 8-6**) **OFF**:hardware fault, read L2-L4 (see **TABLE 8-6**)
L6-L9	ERROR CODE, HIGH BYTE	High byte for use in **SECTION 7.2**, with L2-L4 (see below)

ERROR #	L4	L3	L2	DESCRIPTION
0	OFF	OFF	OFF	NOT USED (invalid error #)
1*	OFF	OFF	ON	PROM checksum error (replace EPROM chip IC19).
2*	OFF	ON	OFF	RAM test error (replace RAM chip IC16).
3	OFF	ON	ON	Power fail detected (if error occurs often, contact the factory).
4	ON	OFF	OFF	Memory access error (if error occurs often, contact the factory).
5	ON	OFF	ON	Program error (if error occurs often, contact the factory).
6*	ON	ON	OFF	Muart test error (replace 8256 chip IC9).
7	ON	ON	ON	Watchdog time out (IC20 pin 4).

Example: the pattern	L9	L8	L7	L6	L5	L4	L3	L2
	ON	OFF	OFF	OFF	BLINKING	ON	OFF	OFF

yields error code 84 (binary 10000100). This can be looked up in **SECTION 7.2**.

* = only at power up

8.3 I/O CONTROL PCB (6284.262.05)

TABLE 8-7 I/O CONTROL PCB (6284.262.05)		
LED	**FUNCTION**	**DESCRIPTION**
L1	BD ON	I/O CONTROL BOARD ON
L2	TUBE 1	TUBE 1 SELECTED
L3	TUBE 2	TUBE 2 SELECTED
L4	TUBE 3	TUBE 3 SELECTED
L5	C_r SELECT	SERIES RESONANCE CAPACITOR SELECTED

NOTE: L6 and L7 currently are not used.

TABLE 8-8 I/O CONTROL PCB (6294.262.05) SWITCH OPERATIONAL POSITIONS			
SWITCH	**POSITION**	**FUNCTION**	**DESCRIPTION**
SW1-1	CLOSED	FIELD I/O CHECK	Enable check for proper switch settings on the field I/O PCB selected by the OC (ver 1.0.5): 1. Field I/O PCB #1 select error (system flag #(65), 45). 2. Field I/O PCB #2 select error (system flag #(66), 46). 3. Field I/O PCB #3 select error (system flag #(67), 47).
SW1-8	CLOSED	ROTOR CHECK	Enable the following rotor checks: 1. TM ROTOR CONTROL: a. Rotor boost error (system flag #(40), 24). b. Rotor run error (system flag #(41), 25). 2. HIGH SPEED ROTOR CONTROL: HS VERIFY signal error (system flag #(37), 23).

NOTE: The following switches are presently not used: SW1-2 thru SW1-7.

8.4 mA/mAs CONTROL PCB (6284.262.06)

TABLE 8-9 mA/mAs CONTROL PCB (6284.262.06) LEDs		
LED	**FUNCTION**	**DESCRIPTION**
L1	mA FB	mA feedback is selected if illuminated.
L2	FILAMENT ON	Filament is ON if illuminated.
L3	BOARD ON	mA/mAs PCB is powered up if illuminated.

TABLE 8-10 mA/mAs CONTROL PCB (6284.262.06) JUMPER POSITIONS

JUMPER	NORMAL	SIMULATED EXPOSURE	NO LOAD TEST	FUNCTION	DESCRIPTION
EMA0	OUT	IN	IN	A/D SAMPLE	Enables: a. mA/Fil A/D (AD 7669) sampling (upwait line). b. Check for filament low (system flag #(35, 21). c. Check for mA low (system flag #(17), 07).
EMA1,2	See description	See description	See description	mA FEEDBACK DELAY	Used to compensate for long high voltage cables. Time to mA feedback (EMA1, EMA2): EMA2 EMA1 TIME LENGTH OUT OUT 3ms Up to 35' OUT IN 5ms 35' - 45' IN OUT 7ms 45' - 55' IN IN 10ms 55' and up
EMA3	IN	OUT	OUT	FILAMENT POWER SUPPLY FAIL	Filament power supply check: 1. During an exposure (system flag #(20), 08). 2. During filament ON (system flag #(33), 19). 3. During system monitor check (system flag #(76), 54).
EMA4	IN	IN	IN	mA OVERLOAD	mA overload hardware check: 1. During an exposure (system flag #(16), 06). 2. During an hardware system check (system flag #(52), 34).
EMA5	IN	IN	IN	FILAMENT OVERLOAD	Filament overload check: 1. During an exposure (system flag #(21), 09). 2. While filament is ON (system flag #(34), 20). 3. During hardware system check (system #(53), 35).
EMA6	IN	IN	IN	HARDWARE FUNCTION	Sets up 10V FS, mA/Fil D/A reference. Standard operation.
EMA7	OUT	OUT	OUT	HARDWARE FUNCTION	Sets up 5V full scale, mA/Fil D/A reference. Installed for factory test ONLY.
ZZ1	IN	IN	IN		Analog-Digital ground

kV CONTROL PCB (6284.262.10)

TABLE 8-11 kV CONTROL PCB (6284.262.10) JUMPER OPERATIONAL POSITIONS

JUMPER	NORMAL POSITION	SIMULATED EXPOSURE	NO LOAD TEST	FUNCTION	DESCRIPTION
EKV0	IN	OUT	IN	kV COMMUTATION FAIL	kVp commutation fail hardware check: 1. During an exposure (system flag #(13), 03). 2. During hardware system check (system flag #(50), 32).
EKV1	OUT	OUT	OUT	FEEDBACK CABLE INTERLOCK	Enables kV feedback cable (system flag #(74), 52), during system monitor check.
EKV2	IN	IN	IN	kV HIGH	kVp high hardware check: 1. During an exposure (system flag #(14), 04). 2. During hardware system check (system flag #(51), 33).
EKV3	IN	OUT	IN	kV LOW	Enables kVp LOW check during an exposure (system flag #(15), 05). kVp LOW error.
EKV8	OUT	X (don't care)	IN	SLOW kVp RAMP	No load kVp test
EKV9	IN	OUT	IN	kV COMM FAIL	Special for hardware tests.
EKV10	OUT	OUT	OUT	Slow Fluoro kV Ramp-Up	TEST ONLY
EKV11	Pulse Fluoro: IN Continuous Fluoro: OUT RAD Controls: OUT	X (don't care)	X (don't care)	Gate Pulse Counter	IN: Pulse fluoro only. Enables the gate pulse counter to end each fluoro pulse to prevent flicker. OUT: Continuous fluoro. Allows the microprocessor (on RPU microprocessor PCB) to end each fluoro pulse.

NOTE: The following jumpers are presently not used: EKV4, EKV5, EKV6, EKV7.

TABLE 8-12 kV CONTROL PCB (6284.262.10) LEDs

LED	FUNCTION	DESCRIPTION
L3	BOARD ON	The kV PCB is powered up if illuminated.
L2	SURGE	The surge relay is energized if illuminated.
L1	kV ON	kV is ON (exposing) if illuminated.

8.6 AEC INTERFACE PCB (6284.262.04)

TABLE 8-13 AEC INTERFACE PCB (6284.262.04) JUMPER OPERATIONAL POSITIONS

JUMPER	POSITION	FUNCTION	DESCRIPTION
E1-0	IN	CHAMBER 1 PRESENT CHECK	Check for the presence of Chamber 1 (system flag #(47), 31).
E1-1	IN	CHAMBER 2 PRESENT CHECK	Same as E1-0 but for chamber 2.
E1-2	IN	CHAMBER 3 PRESENT CHECK	Same as E1-0 but for chamber 3.
E1-3	IN	CHAMBER 4 PRESENT CHECK	Same as E1-0 but for chamber 4.
E1-4	IN	CHAMBER 5 PRESENT CHECK	Same as E1-0 but for chamber 5.
E1-5	IN	CHAMBER 6 PRESENT CHECK	Same as E1-0 but for chamber 6.
E2 - E7	IN	CHAMBER 1 - 6	Must be installed for normal operation of the chamber. If chamber not used, remove jumper.
E8	IN	V/F GNDs	MUST BE INSTALLED

NOTE: The following jumpers are presently not used: E1-6, E1-7.

TABLE 8-14 AEC INTERFACE PCB (6284.262.04) LEDs

LED	FUNCTION	DESCRIPTION
L1 L2 L3	FIELD 1 FIELD 2 FIELD 3	ON indicates field selected, OFF state is with all fields selected, front panel fields selected at PREP, front panel LEDs match PCB LEDs when right hand chamber is selected.
L4 L5 L6	ION CHAMBER SELECT 1 ION CHAMBER SELECT 2 ION CHAMBER SELECT 3	CHAMBER SELECT CODE: <u>L6</u> <u>L5</u> <u>L4</u> <u>SELECTION</u> ON ON ON #1 ON ON OFF #2 ON OFF ON #3 ON OFF OFF #4 OFF ON ON #5 OFF ON OFF #6 OFF OFF ON V/F CAL OFF OFF OFF NONE
L7 L8 L9	FILM/SCREEN 1 FILM/SCREEN 2 FILM/SCREEN 3	Illumination indicates selected film/screen.

OC MICROPROCESSOR PCB (6484.262.03)

TABLE 8-15 OC MICROPROCESSOR PCB (6484.262.03) LED ERROR CODES

ERROR NO.	DS4	DS3	DS2	DESCRIPTION
0	OFF	OFF	OFF	NOT USED (invalid error #1)
1*	OFF	OFF	ON	Prom checksum error (replace EPROM chip U5)
2*	OFF	ON	OFF	RAM test error (replace RAM chip U4)
3	OFF	ON	ON	Power fail detected (if error occurs often, contact the factory).
4	ON	OFF	OFF	Memory access error (if error occurs often, contact the factory).
5	ON	OFF	ON	Program error (if error occurs often, contact the factory).
6*	ON	ON	OFF	Muart test error (replace 8256 chip IC18).
7	ON	ON	ON	NOT USED

* = only at power up.

DS5 flashing indicates the TM OC is functioning properly and DS2 - DS4 indicate which program routine is running. If one of the errors listed above is detected, the front panel is blanked, DS5 is turned OFF and the error # indicated by DS2 - DS4.

TABLE 8-16 OC MICROPROCESSOR PCB (6484.262.03) OPERATIONAL SWITCH SETTINGS

SWITCH	POSITION	FUNCTION	DESCRIPTION
SW3-1	DOWN	DEMONSTRATION	Permits the OC to function without being connected to the RPU. Checked at Power Up.
SW3-4	DOWN	SINGLE SOURCE	Disables exposure initiation EXPOSURE from front panel. Used with remote exposure switch.
SW3-5	N/A	TEC Enable	UP: TEC not configured in system DOWN: TEC option present
SW3-8	DOWN	CALIBRATION	Places system into the calibration/test mode. Checked at Power Up.
SW4-6	DOWN	TOMO OPERATION	Enables Tomo Mode.
SW4-7	DOWN	125 kVp LIMIT	Limits kVp to 125 kVp
SW4-8	N/A	RESERVED	Factory setup

NOTE: The following switches are presently not used: SW3-2, SW3-3, SW3-6, SW3-7, SW4-1, SW4-2, SW4-3, SW4-4, SW4-5.

8.8 POWER PROTECTION COMPONENTS

TABLE 8-17 POWER DISTRIBUTION/PROTECTION COMPONENTS

SWITCH/CB	POSITION	FUNCTION	LOCATION (FIGURE 2-5)
CB1	ON	ROTOR BOOST	CARD CAGE
CB2	ON	ROTOR RUN	CARD CAGE
CB3	ON	FILAMENT PS	CARD CAGE
SW1	IN	24 HR PWR SUPPLY	FUSE BOX, POWER SUPPLY
F1	IN	FILAMENT DRIVE LVPS	1A, 250V FUSE
F2	IN	R/OC 24V SUPPLY	3A, 250V FUSE
F3	IN	RPU 117VAC SUPPLY	3A, 250V FUSE
F4	IN	T1 PRIMARY	8A, 250V FUSE
F5	IN	T1 PRIMARY	8A, 250V FUSE
F6	IN	24 HR PS	1A, 250V FUSE
F7	IN	24 HR PS	15A, 250V FUSE
F8	IN	24 HR PS	15A, 250V FUSE
F9	IN	SEMICONDUCTOR FUSE	TM30 - 200A, 600V TM40 - 200A, 600V
F10	IN	LINE IN, FUSE	TM30 - 100A, 600V TM40 - 60A, 600V
F11	IN	LINE IN, FUSE	TM30 - 100A, 600V TM40 - 60A, 600V
F12	IN	LINE IN, FUSE	TM30 - N/A TM40 - 60A, 600V
F13	IN	KV DRIVE LVPS	.5A, 250V FUSE

8.9 SCHEMATICS/WIRING DIAGRAMS

This section provides the schematics and interconnect wiring diagrams. Table 8-18 provides a listing of the TM assembly part numbers and their associated schematic and wiring diagram part numbers for reference. The schematics and wiring diagrams are presented sequencially by page number. See Table 8-18 for the assemblies, their drawing sizes and their schematic part numbers.

TABLE 8-18 ASSEMBLY/WIRING DIAGRAM/SCHEMATIC CROSS REFERENCE

Assembly Nomenclature	Page	Size	Assembly PN	Schematic PN
BACKPLANE, RPU - 125 kV	8-15	B	5484.262.14	4494.262.14
BACKPLANE, TM RPU - 150kV	8-16	B		4494.262.1401
CONTROL PANEL, REMOTE FLUORO	8-17	A		4194.262.46
FRONT PANEL, OC	8-18	A		4194.262.45
HI SPEED ROTOR READY, TM 2-TUBE	8-20	A	5184.262.06	4194.262.06
INVERTOR/T-NETWORK, 125 kV RAD	8-21	B	5585.262.06	4294.262.01
INVERTOR/T-NETWORK, 150 kV RAD	8-22	B	5284.262.08	4294.262.08
INVERTOR/T-NETWORK, HFF R/F	8-23	B	5284.262.081	4294.262.081
INVERTOR/T-NETWORK, TM EP 125 kV	8-24	B		4294.262.38
INVERTOR/T-NETWORK, TM80	8-25	B	5585.262.21	4294.262.0801
	8-26	B		4293.262.15
PCB, 24 HOUR POWER SUPPLY	8-27	B	9284.262.22	4294.262.02
PCB, ABC ISOLATION	8-28	A	5284.262.42	4294.262.42
PCB, AEC INTERFACE	8-29	B	6284.262.04	4294.262.34
PCB, BAS-FE POWER SUPPLY	8-31	A	5184.262.18	4194.262.18
PCB, CONTROL I/O	8-32	B	6284.262.10	4494.262.15
PCB, CONTROL kV	8-33	B	4284.262.15	4494.262.10
PCB, CONTROL mA/mAs	8-34	B	6284.262.11	4594.262.11
PCB, CONTROL mA/mAs W/ HFF	8-35	B	5284.262.06	4594.262.41
PCB, FEEDBACK ISOLATION - kV/mA	8-36	B	5285.262.05	4294.262.1904
PCB, FEEDBACK ISOLATION - 150 kV/mA	8-38	B	5284.262.1901	4294.262.1906
PCB, FLUORO FIELD I/O	8-40	A	6584.262.17	4294.262.17
PCB, FLUORO FIELD I/O w/ HFF	8-46	A	5584.262.20	4294.262.44
PCB, GATE DRIVE	8-52	A	5284.262.50	4294.262.50
PCB, GATE DRIVE with HF FILAMENT	8-53	A	5284.262.51	4294.262.51
PCB, OC DISPLAY	8-55	B	5484.262.04	4494.262.04

TABLE 8-18 ASSEMBLY/WIRING DIAGRAM/SCHEMATIC CROSS REFERENCE				
Assembly Nomenclature	Page	Size	Assembly PN	Schematic PN
PCB, OC MICROPROCESSOR	8-56	B	4484.262.03	4494.262.03
PCB, POWER SUPPLY, HF FILAMENT	8-59	A	4184.262.24	4194.262.24
PCB, POWER SUPPLY, RELAY/OC	8-60	B	6284.262.01	4294.262.35
PCB, RAD FIELD I/O	8-61	A	5584.262.16	4294.262.21
PCB, REMOTE FLUORO CONTROLLER	8-69	A	6284.262.18	4294.262.18
PCB, RPU MICROPROCESSOR	8-71	B	4284.262.13	4494.262.13
PCB, SNUBBER NETWORK HV INVERTER	8-74	A	5184.262.03	4194.262.03
PCB, SNUBBER NETWORK TM80 PARALLEL	8-75	A	5184.262.19	4194.262.19
PCB, VIDEO SYNC PROCESSOR, NICAL	8-76	A	5184.262.07	4194.262.07
POWER SUPPLY, 1ϕ CONTACTOR	8-77	A		4193.262.01
POWER SUPPLY, 3ϕ CONTACTOR	8-78	B		4293.262.03
POWER SUPPLY, 3ϕ RAD - 50Hz	8-79	B		4294.262.37
POWER SUPPLY, 3ϕ RAD - 60Hz	8-80	B	5585.262.05	4294.262.32
POWER SUPPLY, IEC 1ϕ - 50Hz	8-81	B		4294.262.07
POWER SUPPLY, IEC 3ϕ RAD - 50Hz	8-82	B		4294 .262.45
POWER SUPPLY, R/F 1ϕ	8-83	B		4294.262.14
POWER SUPPLY, R/F 3ϕ	8-84	B		4294.262.06
POWER SUPPLY, TM30 1ϕ RAD - 60Hz	8-85	B		4294.262.04
POWER SUPPLY, TM80 3ϕ RAD	8-86	B		4294.262.25
POWER SUPPLY, TM80 3ϕ R/F	8-87	B		4294.262.26
RPU INTERCONNECT, 2-TUBE	8-88	B		4593.262.11
RPU INTERCONNECT, R/F	8-89	B	5585.262.08	4593.262.14
RPU INTERCONNECT, TM30/40 125 kV	8-91	B		4593.262.0201
RPU INTERCONNECT, TM40 - 80 150 kVp	8-92	B		4593.262.12
TRANSFORMER, MULTI-OUTPUT	8-93	A		4294.262.30
TRANSFORMER, MULTI-OUTPUT w/ HFF	8-94	A		4294.262.31
TRANSFORMER, 1-TUBE 50kW 150kV HF	8-95	B		4294.362.02
TRANSFORMER, 1-TUBE 125kV HF	8-96	B		4294.362.03
TRANSFORMER, 2-TUBE HF	8-97	B		4294.362.01

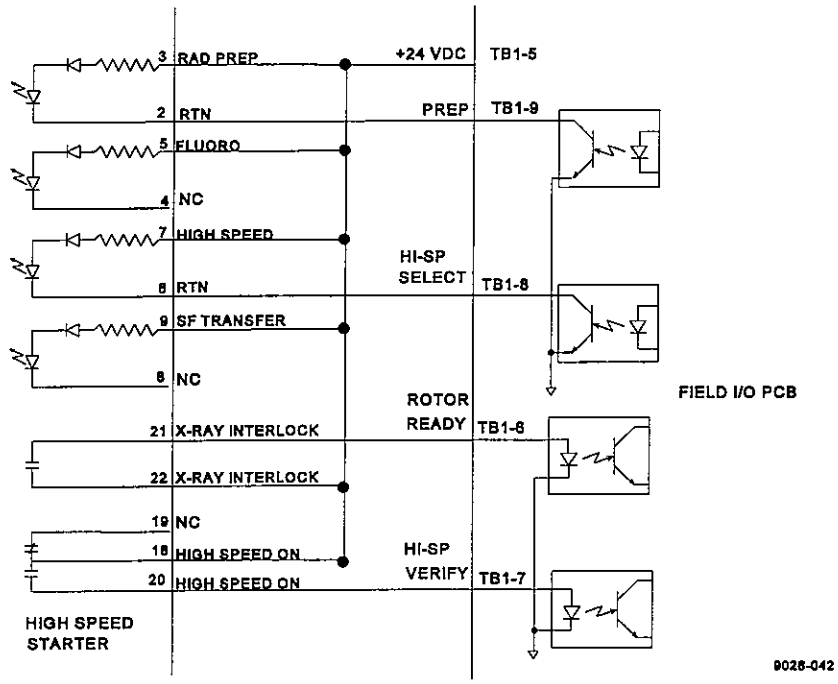


FIGURE 8-1 HIGH SPEED STARTER CONNECTIONS

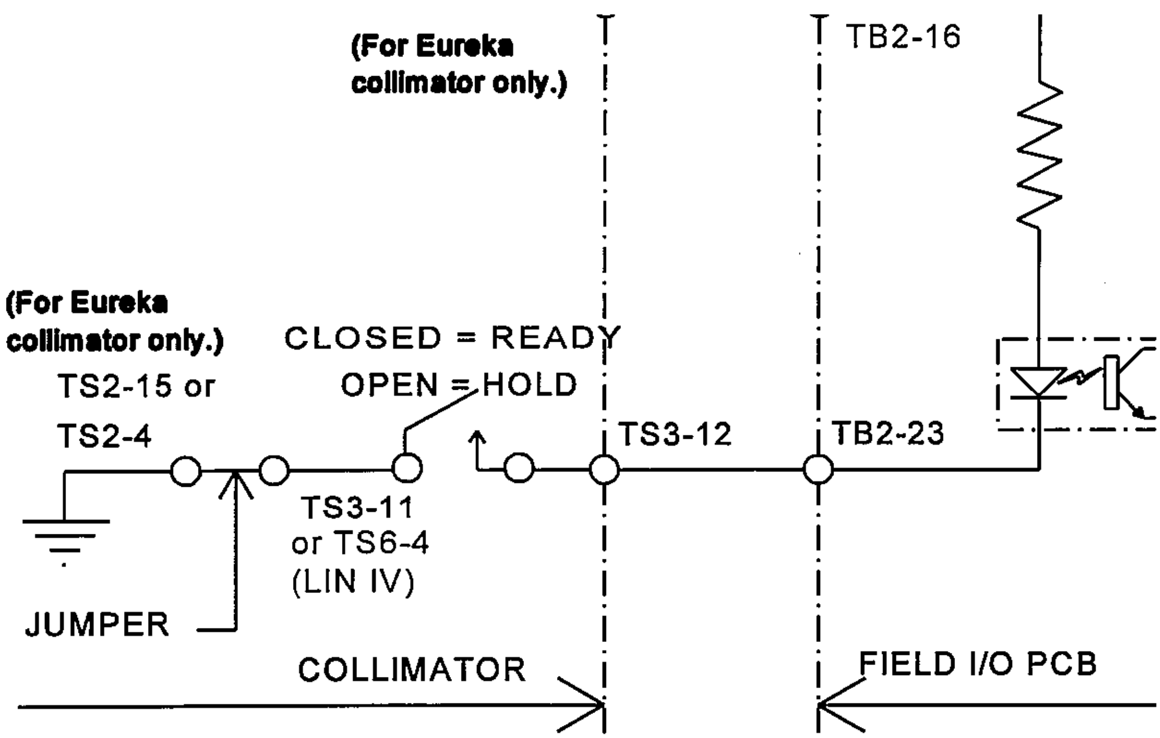
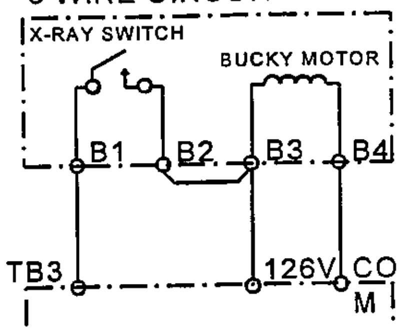


FIGURE 8-2 COLLIMATOR WIRING

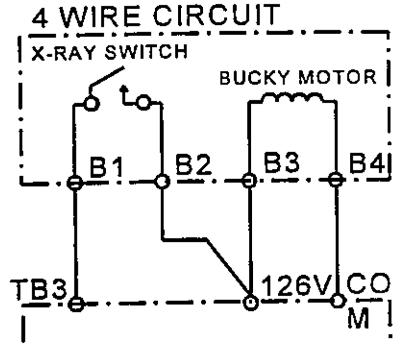
LIEBEL/FLARSHEIM PAR SPEED BUCKY

3 WIRE CIRCUIT



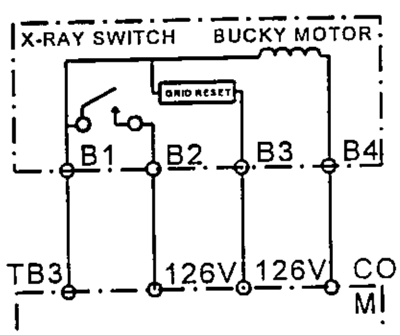
AUX	-	-	-
WALL	2	3	4
TABLE	7	8	9
	12	13	14

4 WIRE CIRCUIT



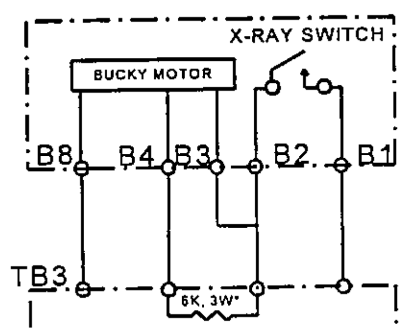
AUX	-	-	-
WALL	2	3	4
TABLE	7	8	9
	12	13	14

MIDWEST BUCKY



AUX	-	-	-	-
WALL	3	2	5	4
TABLE	8	7	10	9
	13	12	15	14

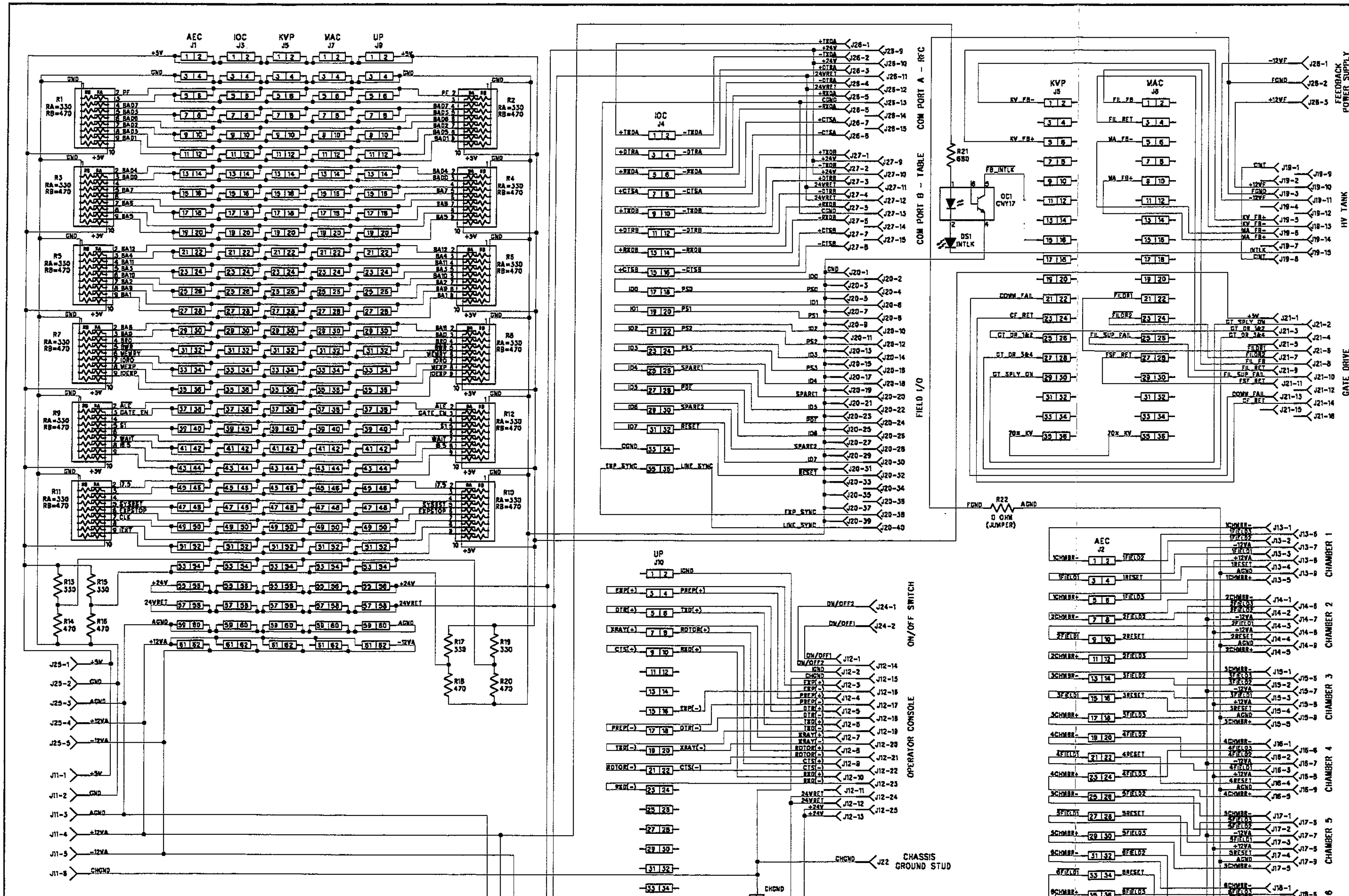
LIEBEL/FLARSHEIM SUPER SPEED BUCKY



AUX	-	-	-	-
WALL	5	4	3	2
TABLE	10	9	8	7
	15	14	13	12

*LF8000

FIGURE 8-3 BUCKY WIRING

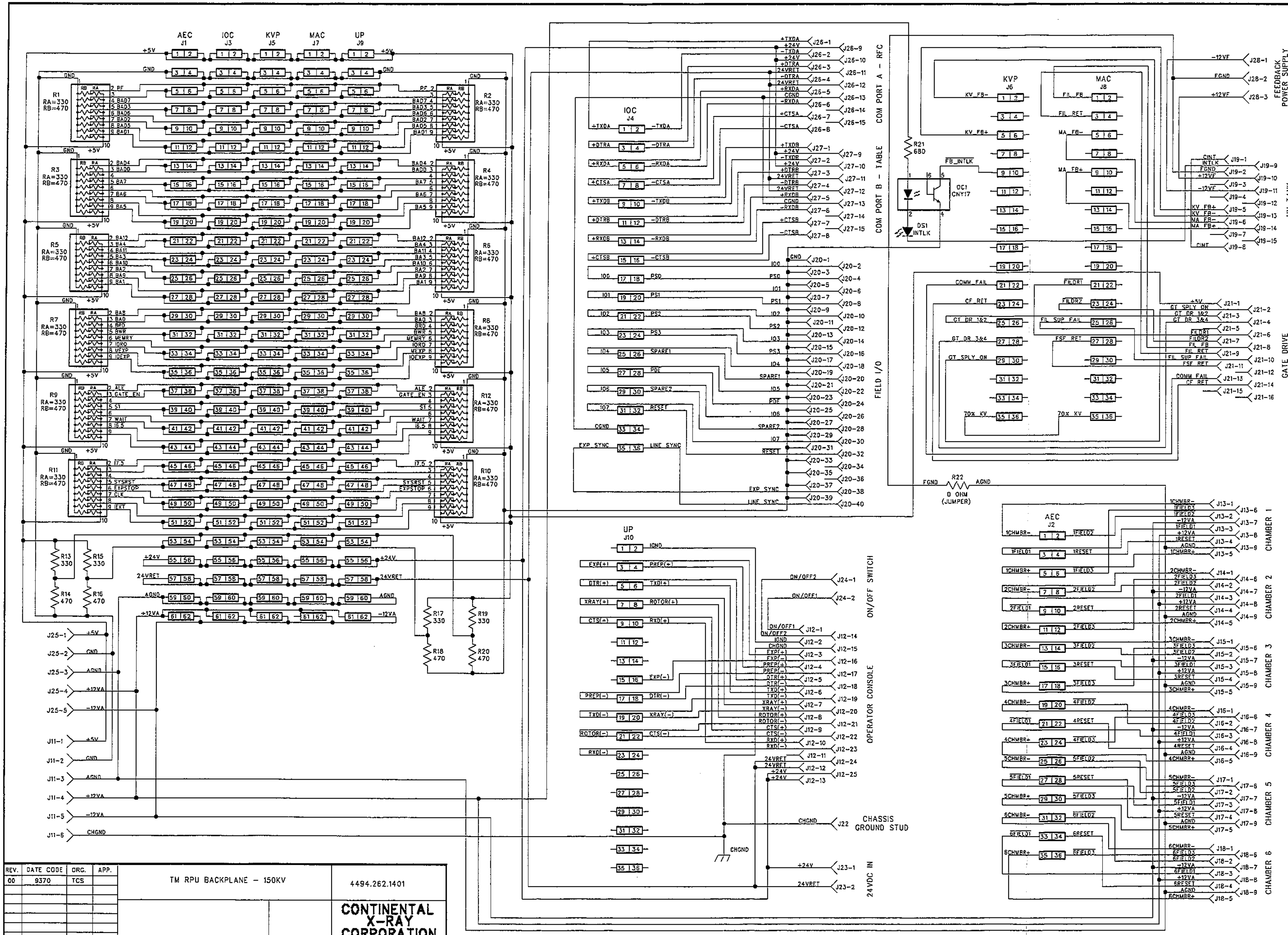


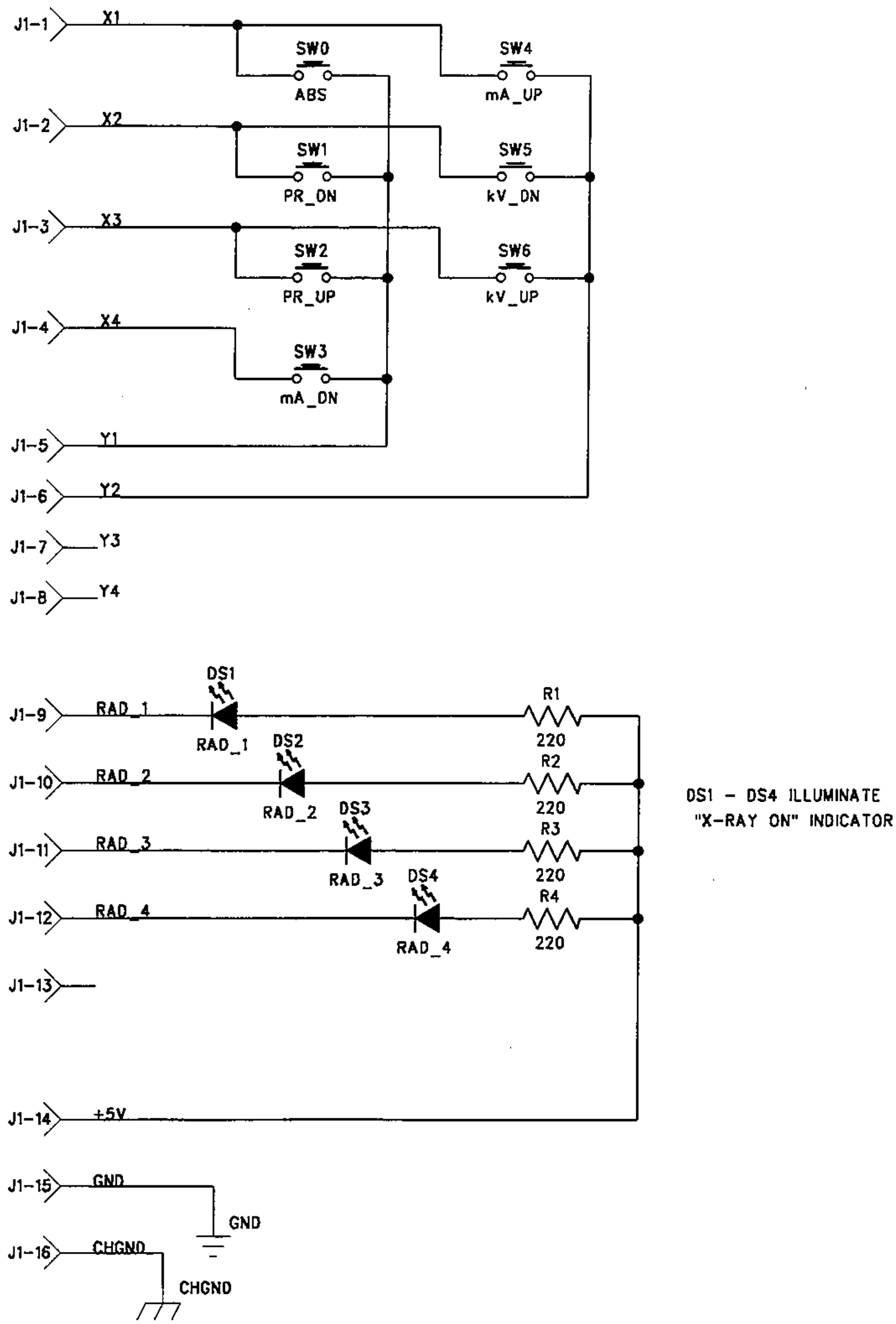
REV.	DATE CODE	ORG.	APP.
00	9268	TCS	
01	9286	TCS	
02	9348	TCS	
03	9360	CP	

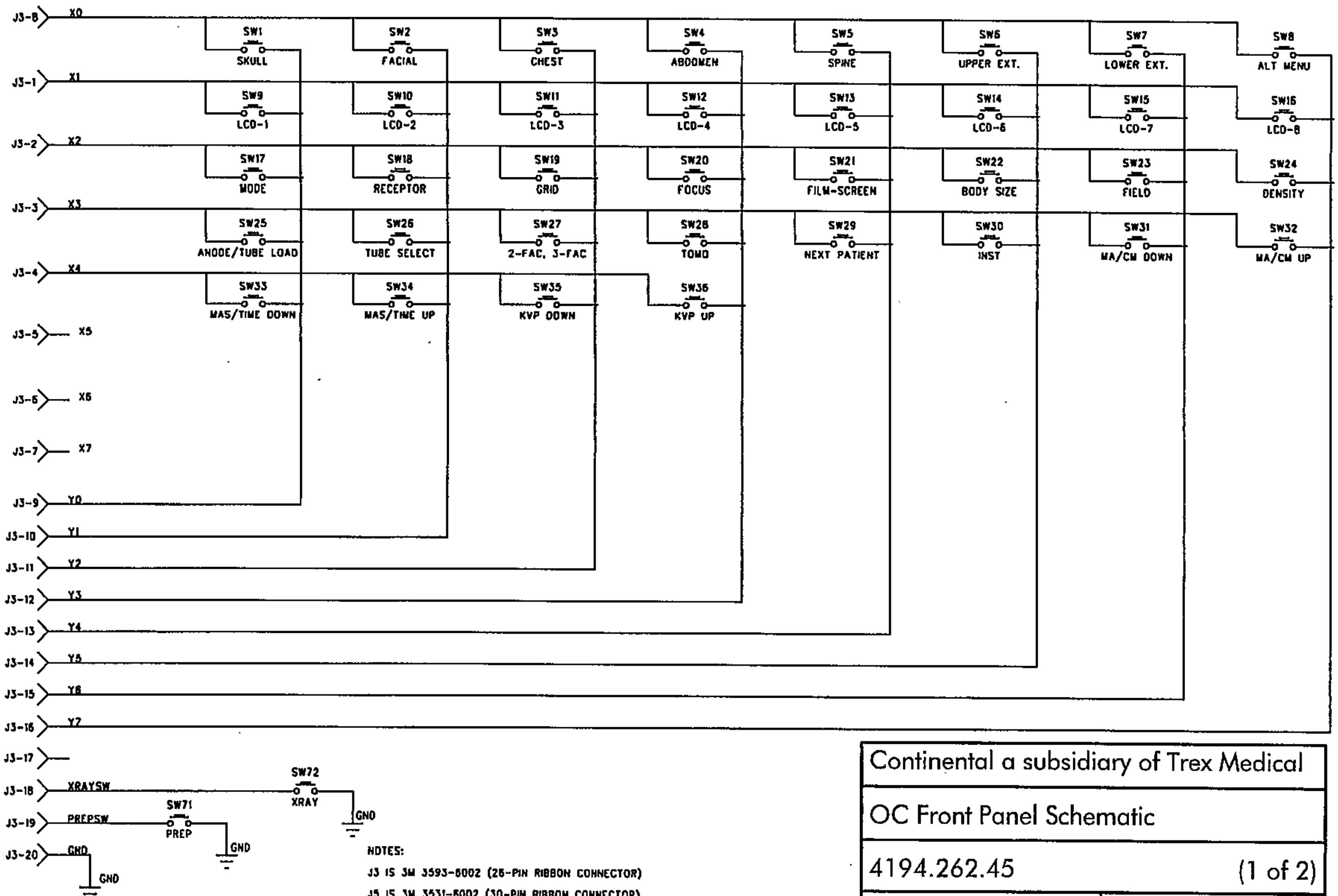
TM RPU BACKPLANE - 125KV

4494.252.14

CONTINENTAL X-RAY CORPORATION


TM RPU BACKPLANE - 150KV
4494.262.1401
CONTINENTAL X-RAY CORPORATION
REV. DATE CODE ORG. APP.
00 9370 TCS
COM PORT A - RFC
COM PORT B - TABLE
FIELD I/O
ON/OFF SWITCH
OPERATOR CONSOLE
CHASSIS GROUND STUD
24VDC IN
FEEDBACK POWER SUPPLY
HV TANK
GATE DRIVE
CHAMBER 1
CHAMBER 2
CHAMBER 3
CHAMBER 4
CHAMBER 5
CHAMBER 6


J1-1
X1
SW0
ABS
SW4
mA_UP
J1-2
X2
SW1
PR_DN
SW5
kV_DN
J1-3
X3
SW2
PR_UP
SW6
kV_UP
J1-4
X4
SW3
mA_DN
J1-5
Y1
J1-6
Y2
J1-7
Y3
J1-8
Y4
DS1
J1-9
RAD_1
RAD_1
R1
220
DS2
J1-10
RAD_2
RAD_2
R2
220
DS3
J1-11
RAD_3
RAD_3
R3
220
DS4
J1-12
RAD_4
RAD_4
R4
220
J1-13
J1-14
+5V
J1-15
GND
GND
J1-16
CHGND
CHGND
DS1 - DS4 ILLUMINATE
"X-RAY ON" INDICATOR



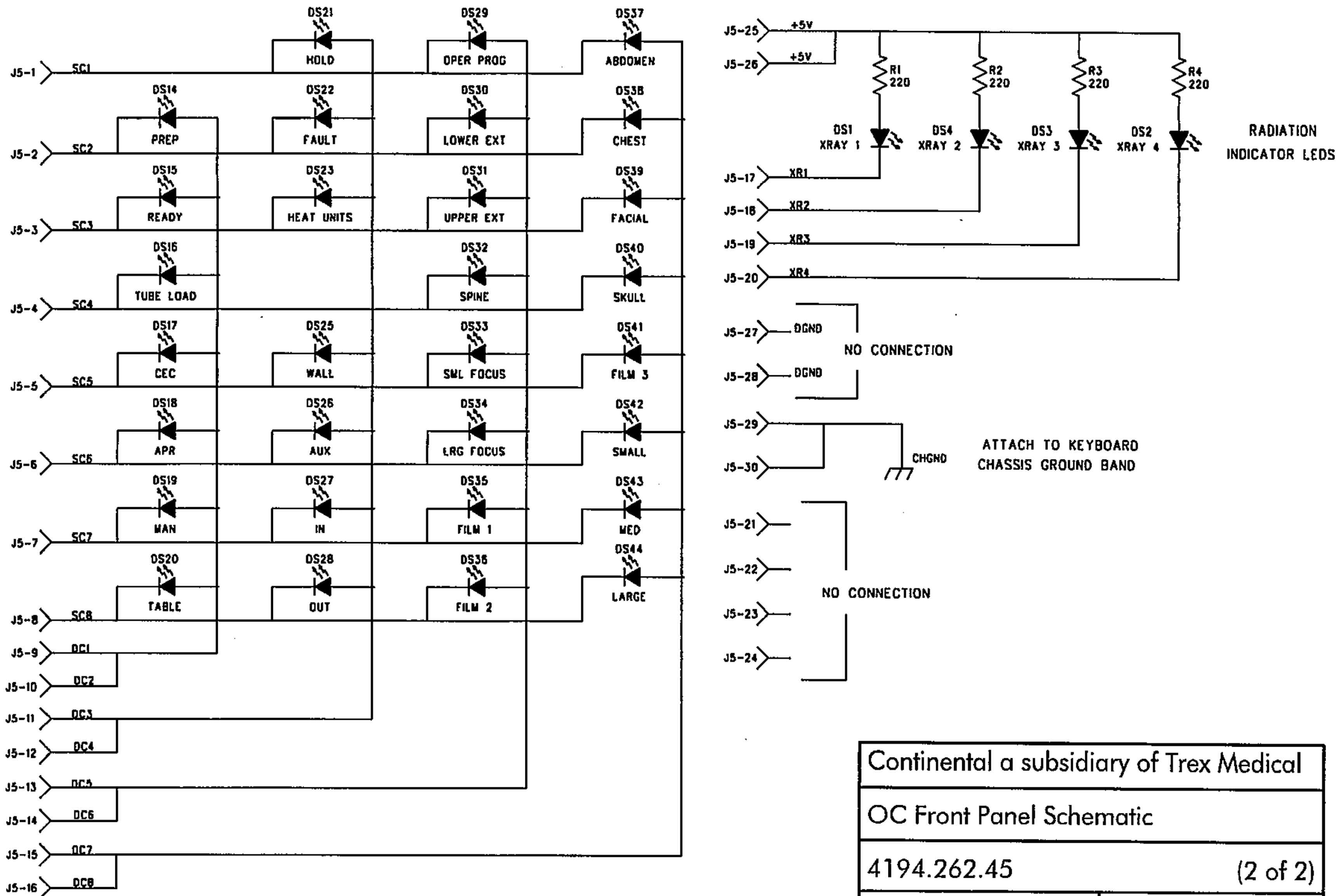
NOTES:

J3 IS 3M 3593-6002 (26-PIN RIBBON CONNECTOR)

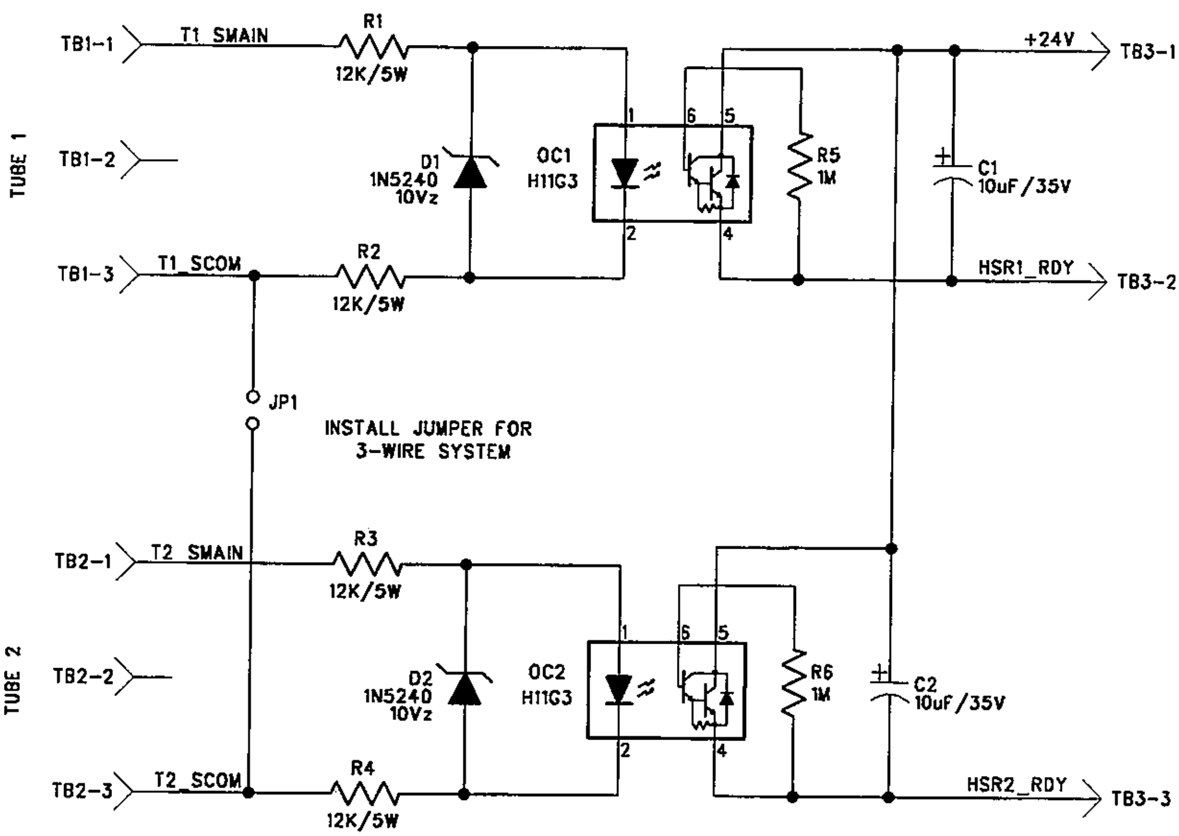
J5 IS 3M 3531-6002 (30-PIN RIBBON CONNECTOR)

9026-029

Continental a subsidiary of Trex Medical	
OC Front Panel Schematic	
4194.262.45	(1 of 2)
9715	Rev. 00



Continental a subsidiary of Trex Medical	
OC Front Panel Schematic	
4194.262.45	(2 of 2)
9715	Rev. 00 9026-030



REV.	DATE CODE	ORG.	APP.
00	9299	TCS	
00	9354	TCS	

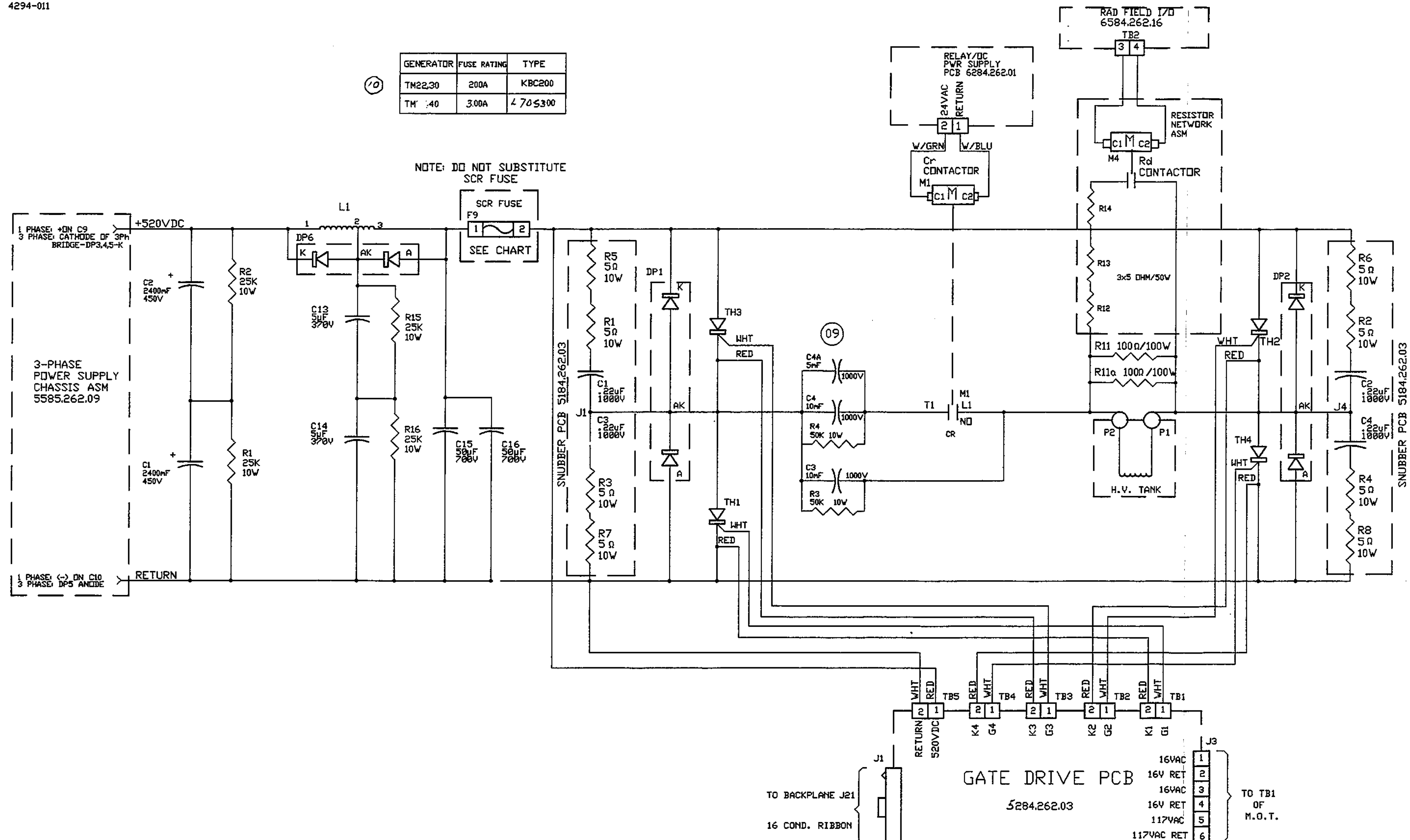
TM 2-TUBE HIGH SPEED ROTOR READY

4194.262.06

CONTINENTAL X-RAY CORPORATION

4294-011

GENERATOR	FUSE RATING	TYPE
TM22,30	200A	KBC200
TM 40	300A	L70S300



REV	DATE CODE	DRG.	APP.
07	9509	GP	
08	9543	GP	
09	9547	GP	
10	9639	G.P.	

TM 125kV RAD INVERTOR
T-NETWORK

4294.262.01

MAT:

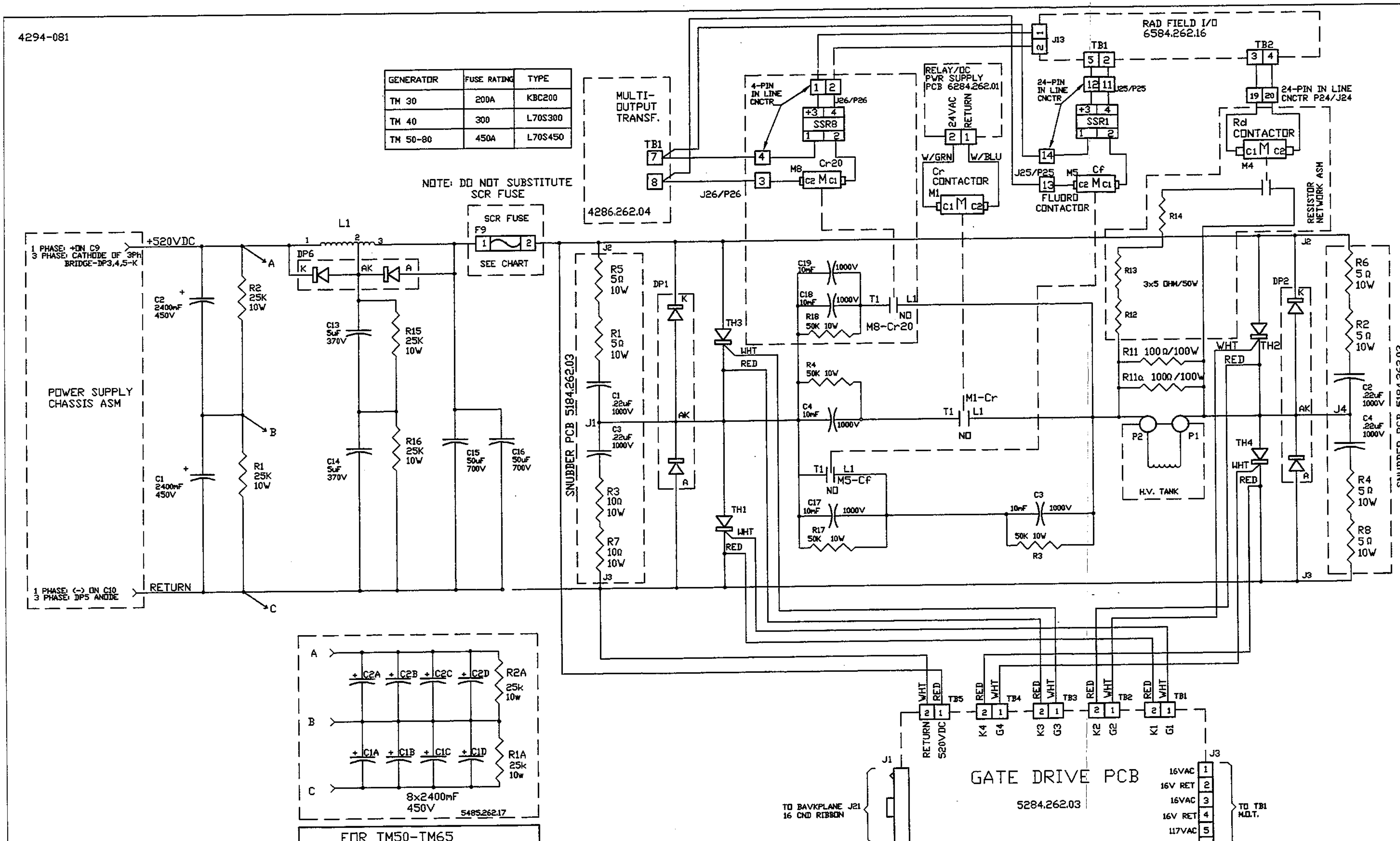
FINISH:

CONTINENTAL X-RAY CORPORATION

4294-081

GENERATOR	FUSE RATING	TYPE
TM 30	200A	KBC200
TM 40	300	L70S300
TM 50-80	450A	L70S450

NOTE: DO NOT SUBSTITUTE SCR FUSE



REV.	DATE/ECN CODE	DRG.	APP.
10	9639	GP	
11	9739	GP	

TM 150kV RAD INVERTER
T-NETWORK

4294.262.08

MAT:

FINISH:

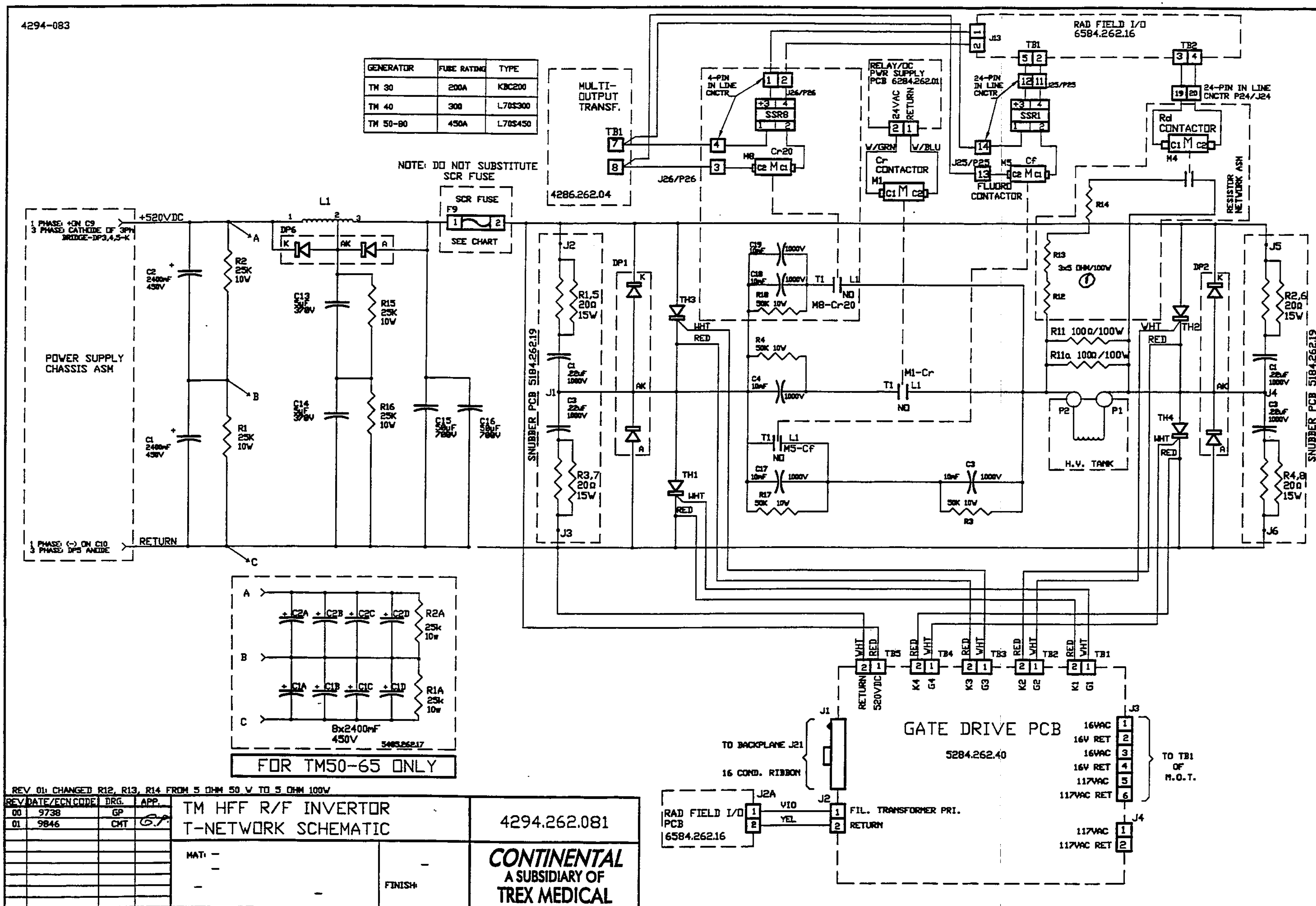
CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE

4294-083

GENERATOR	FUSE RATING	TYPE
TM 30	200A	KBC200
TM 40	300	L70S300
TM 50-80	450A	L70S450

NOTE: DO NOT SUBSTITUTE SCR FUSE



REV 01: CHANGED R12, R13, R14 FROM 5 OHM 50 W TO 5 OHM 100W

REV	DATE/ECN CODE	DRG.	APP.
00	9738	GP	
01	9846	CMT	GP

TM HFF R/F INVERTOR
T-NETWORK SCHEMATIC

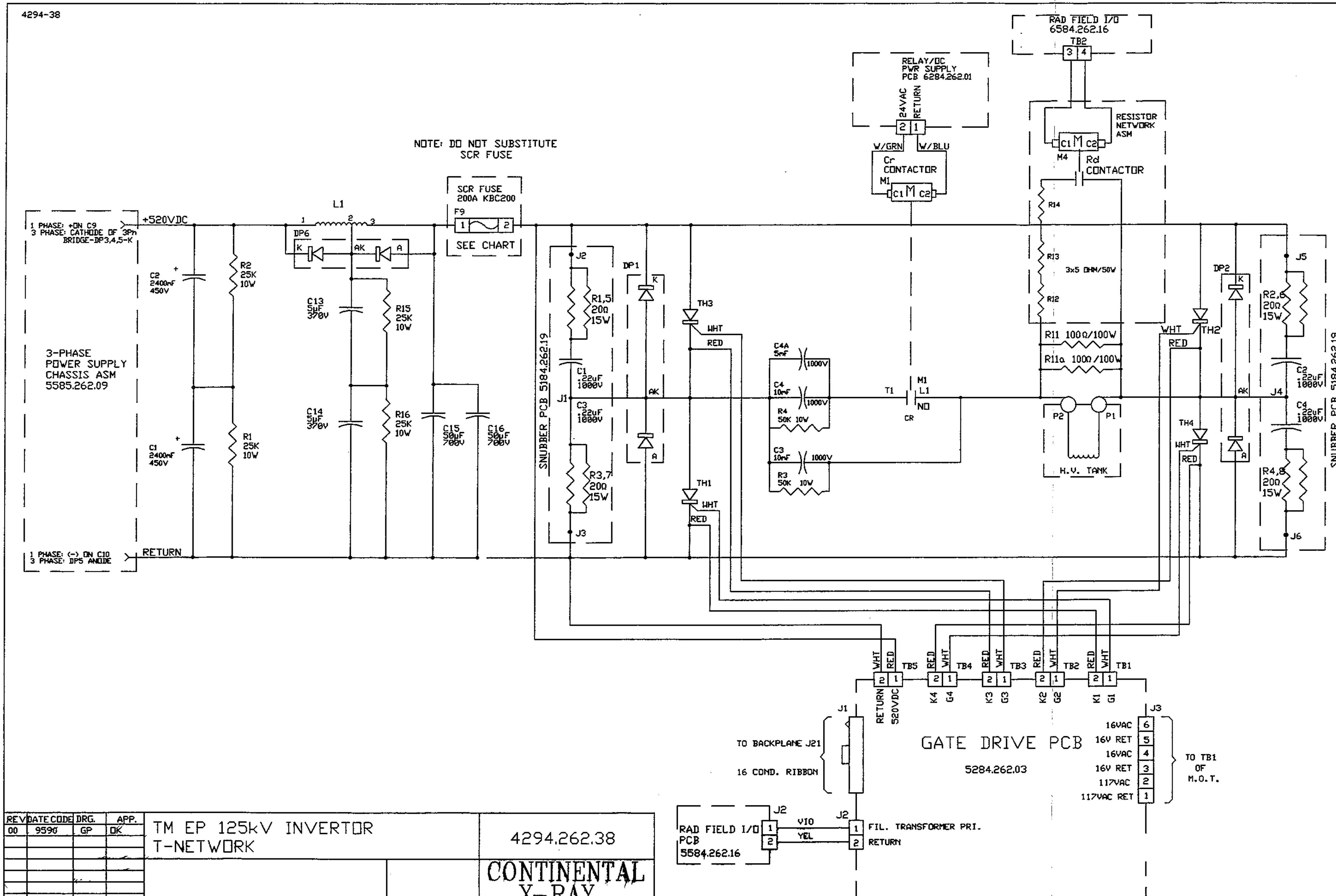
4294.262.081

MAT: –

FINISH:

CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL

TOLERANCES-UNLESS OTHERWISE SPECIFIED DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32, ANGLES ± 1/2 DEGREE



REV	DATE CODE	DRG.	APP.
00	9590	GP	OK

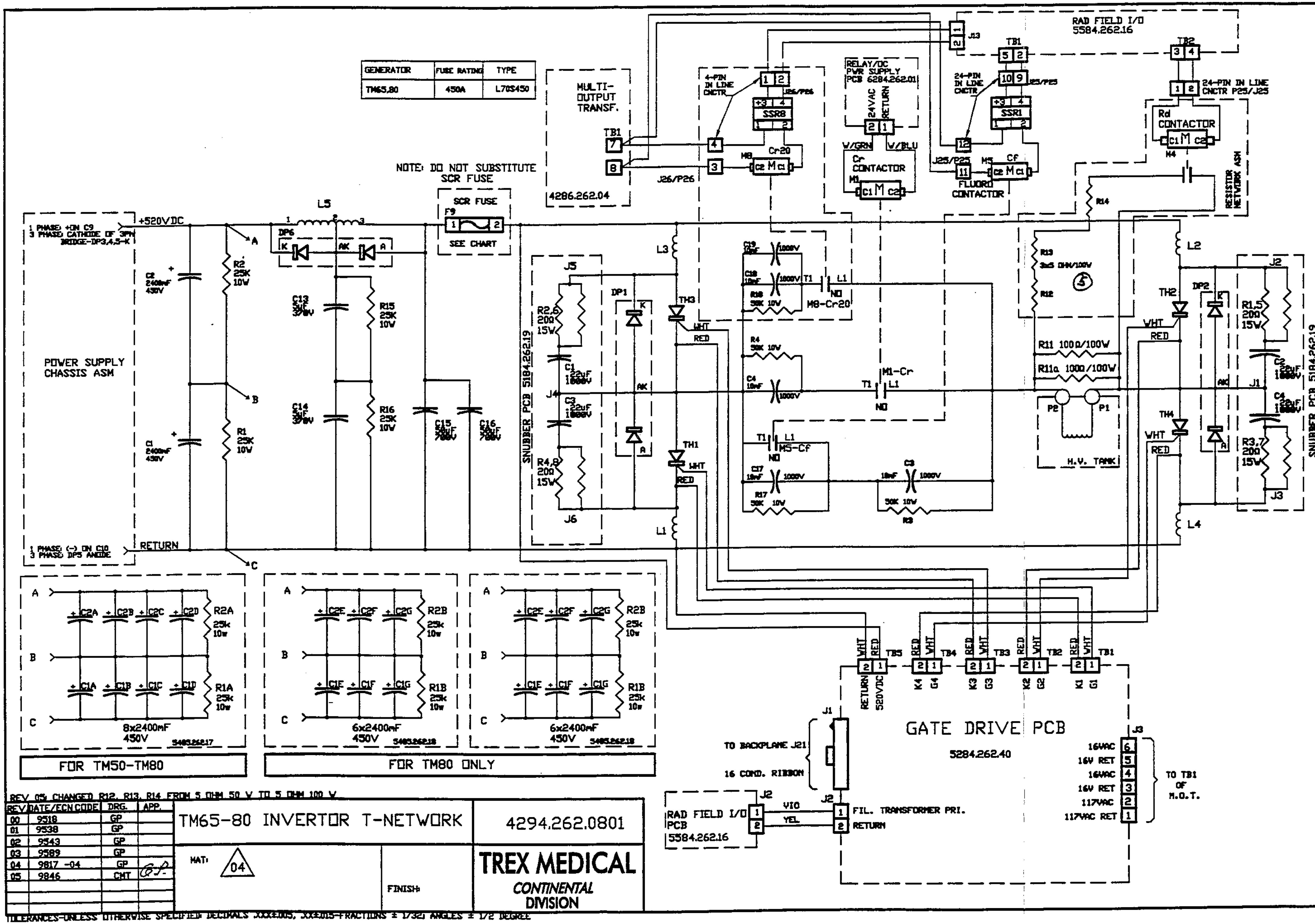
TM EP 125kV INVERTOR
T-NETWORK

4294.262.38

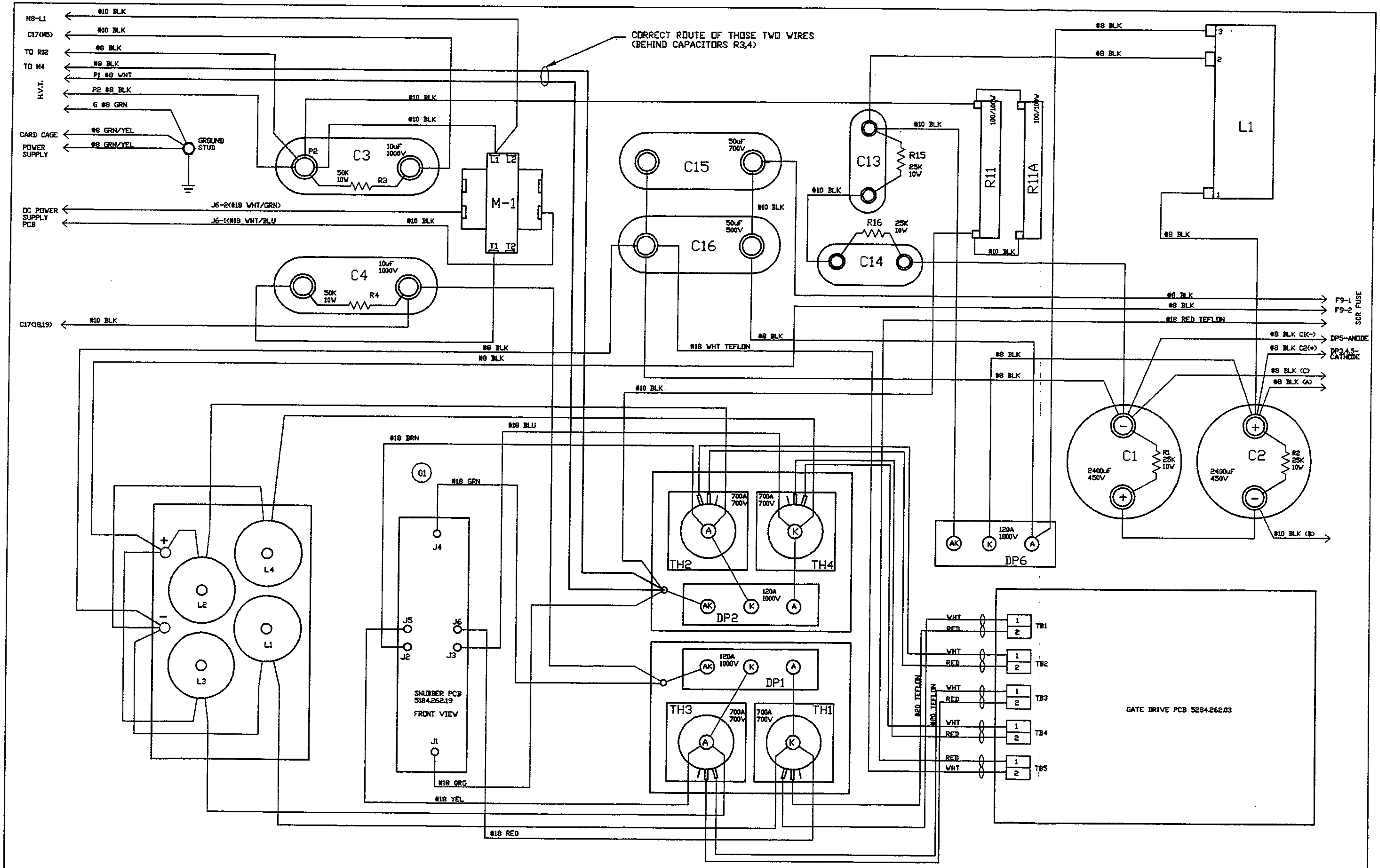
MAT:

FINISH:

CONTINENTAL X-RAY CORPORATION



TM65-80 INVERTOR T-NETWORK
4294.262.0801
TREX MEDICAL
CONTINENTAL DIVISION
REV 05: CHANGED R12, R13, R14 FROM 5 OHM 50 V TO 5 OHM 100 V
REV | DATE/ECN CODE | DRG. | APP.
00 9518 GP
01 9538 GP
02 9543 GP
03 9589 GP
04 9817 -04 GP
05 9846 CMT
MAT:
04
FINISH:
TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32, ANGLES ± 1/2 DEGREE
GENERATOR | FUSE RATING | TYPE
TM65,80 | 450A | L70S450
NOTE: DO NOT SUBSTITUTE SCR FUSE
SCR FUSE
F9
SEE CHART
MULTI-OUTPUT TRANSF.
4286.262.04
TB1
J26/P26
4-PIN IN LINE CNCTR
SSR8
Cr20
RELAY/DC PWR SUPPLY PCB 6284.262.01
24VAC
RETURN
Cr CONTACTOR
24-PIN IN LINE CNCTR
SSR1
J25/P25
FLUORO CONTACTOR
RAD FIELD I/O 5584.262.16
TB2
24-PIN IN LINE CNCTR P25/J25
Rd CONTACTOR
RESISTOR NETWORK ASM
+520VDC
RETURN
1 PHASE: +ON C9
3 PHASE: CATHODE OF 3PH BRIDGE-DP3,4,5-K
1 PHASE: (-) ON C10
3 PHASE: DP5 ANODE
POWER SUPPLY CHASSIS ASM
L5
DP6
SNUBBER PCB 5184.262.19
J5
J6
H.V. TANK
R11 100Ω/100W
R11a 100Ω/100W
8x2400mF 450V
6x2400mF 450V
6x2400mF 450V
FOR TM50-TM80
FOR TM80 ONLY
GATE DRIVE PCB
5284.262.40
TO BACKPLANE J21
16 COND. RIBBON
RAD FIELD I/O PCB 5584.262.16
FIL. TRANSFORMER PRI.
RETURN
16VAC
16V RET
16VAC
16V RET
117VAC
117VAC RET
TO TB1 OF H.O.T.



REV.	DATE/ECN CODE	DRG.	APP.
00	9519	GP	
01	9589	GP	

TM80 INVERTOR T-NETWORK WIRING DIAGRAM

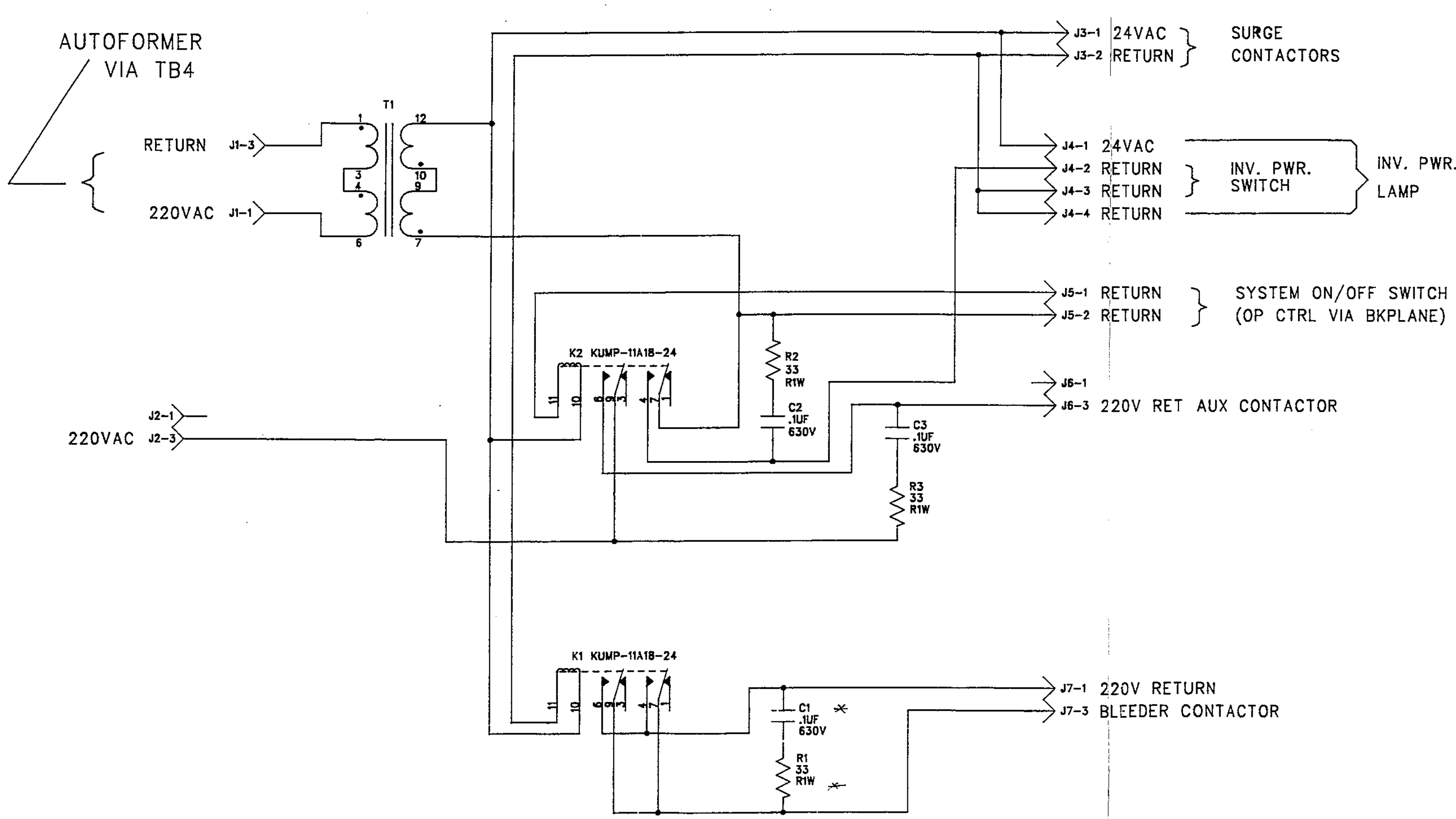
4293.262.15

MAT:

FINISH:

CONTINENTAL X-RAY CORPORATION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: LENGTH-DECIMALS .XXX±.005, .XX±.015-FRACTIONS ±1/32 ANGLES +/- 1/2 DEG.



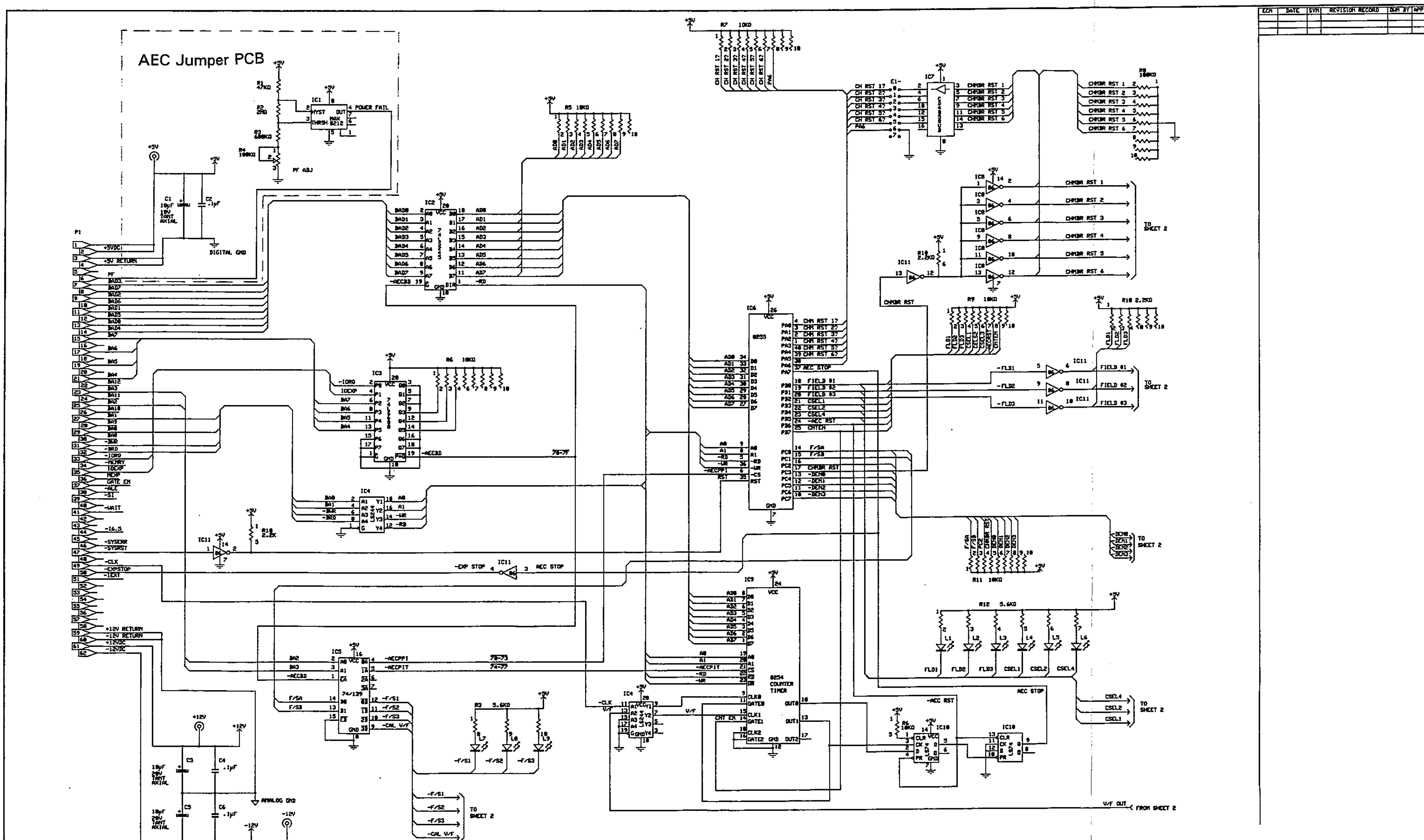
REV.	DATE CODE	ORG.	APP.
00	9299	GP	
01	9348	GP	
02	9368	GP.	
03	9452	wlw	Gp
04	9739-13	GP	[illegible]

TM R/F 24-HOUR POWER SUPPLY PCB

4294.262.02

CONTINENTAL X-RAY CORPORATION

NOTE:
* NOT INSTALLED
04

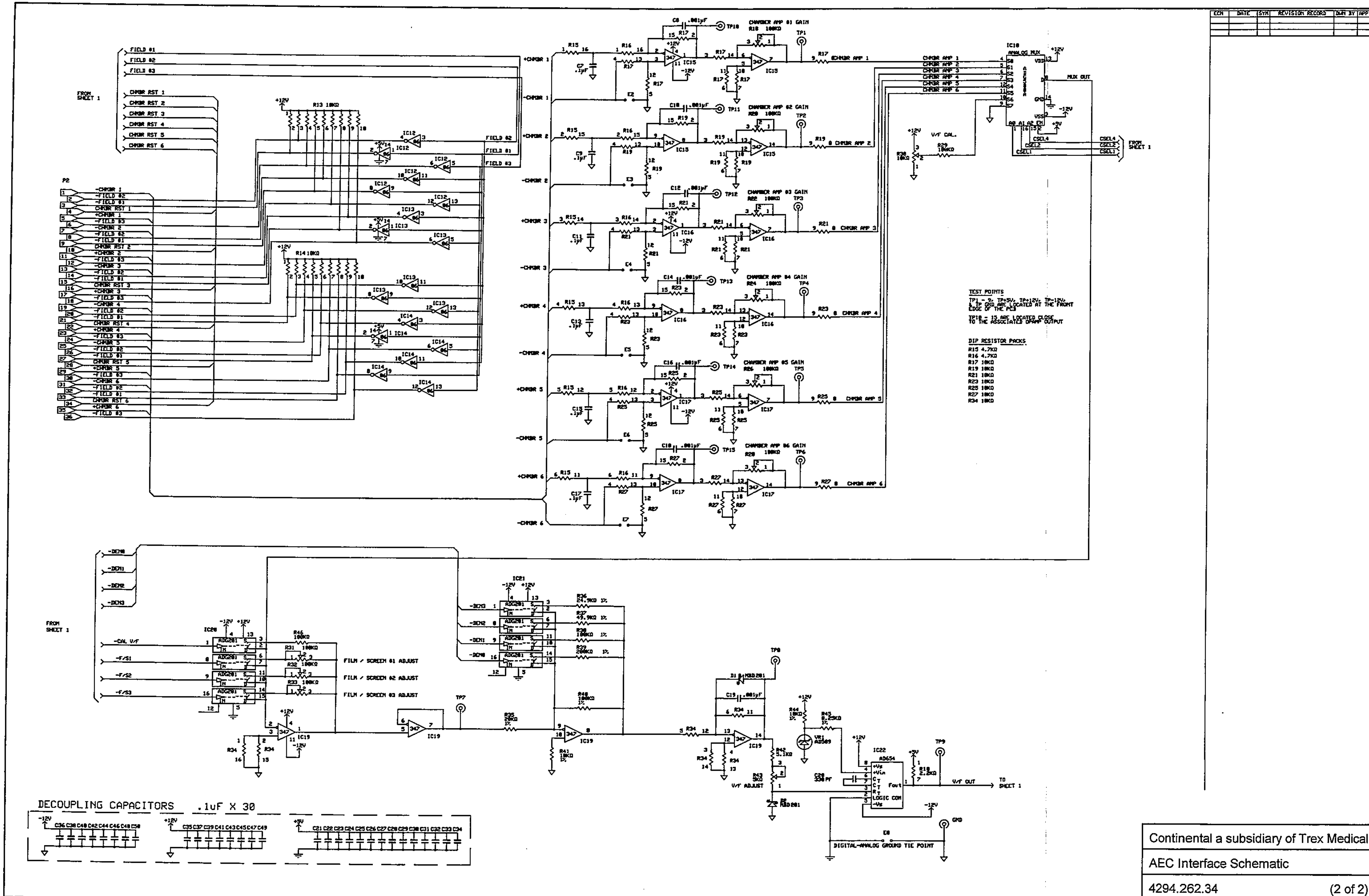


Continental a subsidiary of Trex Medical

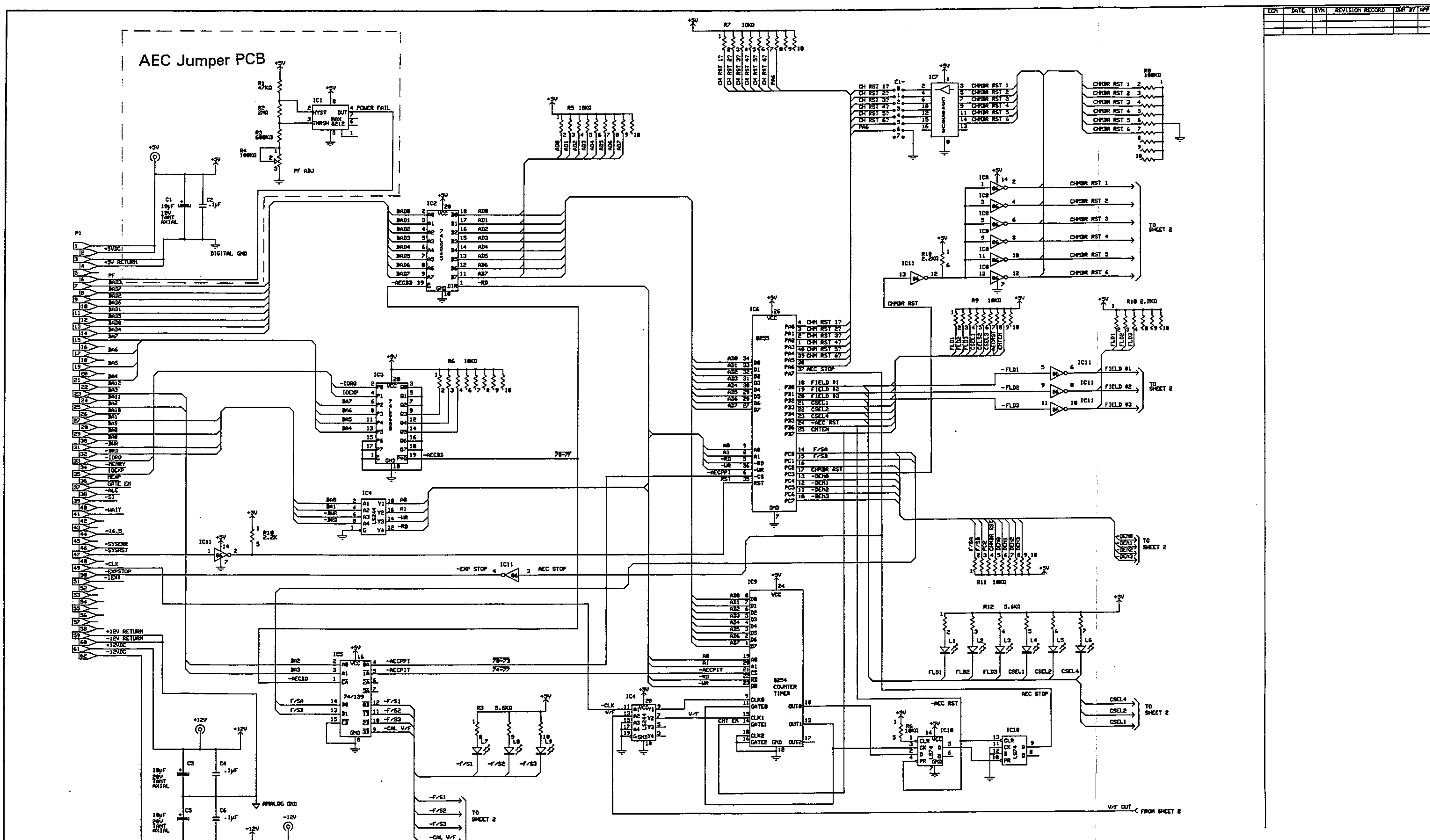
AEC Interface Schematic

4294.262.34 (1 of 2)

9487 Rev. 00



Continental a subsidiary of Trex Medical	
AEC Interface Schematic	
4294.262.34	(2 of 2)
9487	Rev. 00

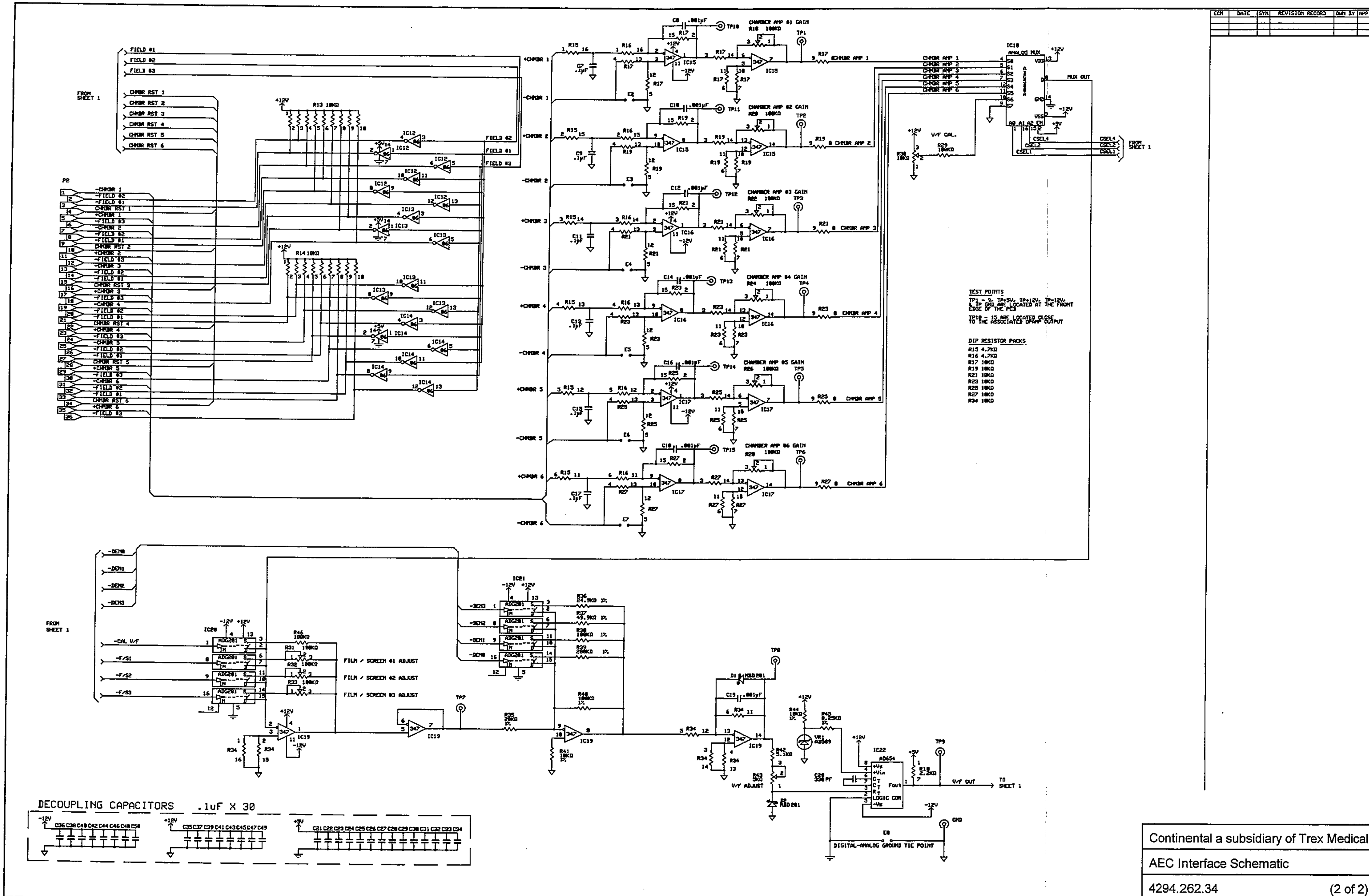


Continental a subsidiary of Trex Medical

AEC Interface Schematic

4294.262.34 (1 of 2)

9487 Rev. 00

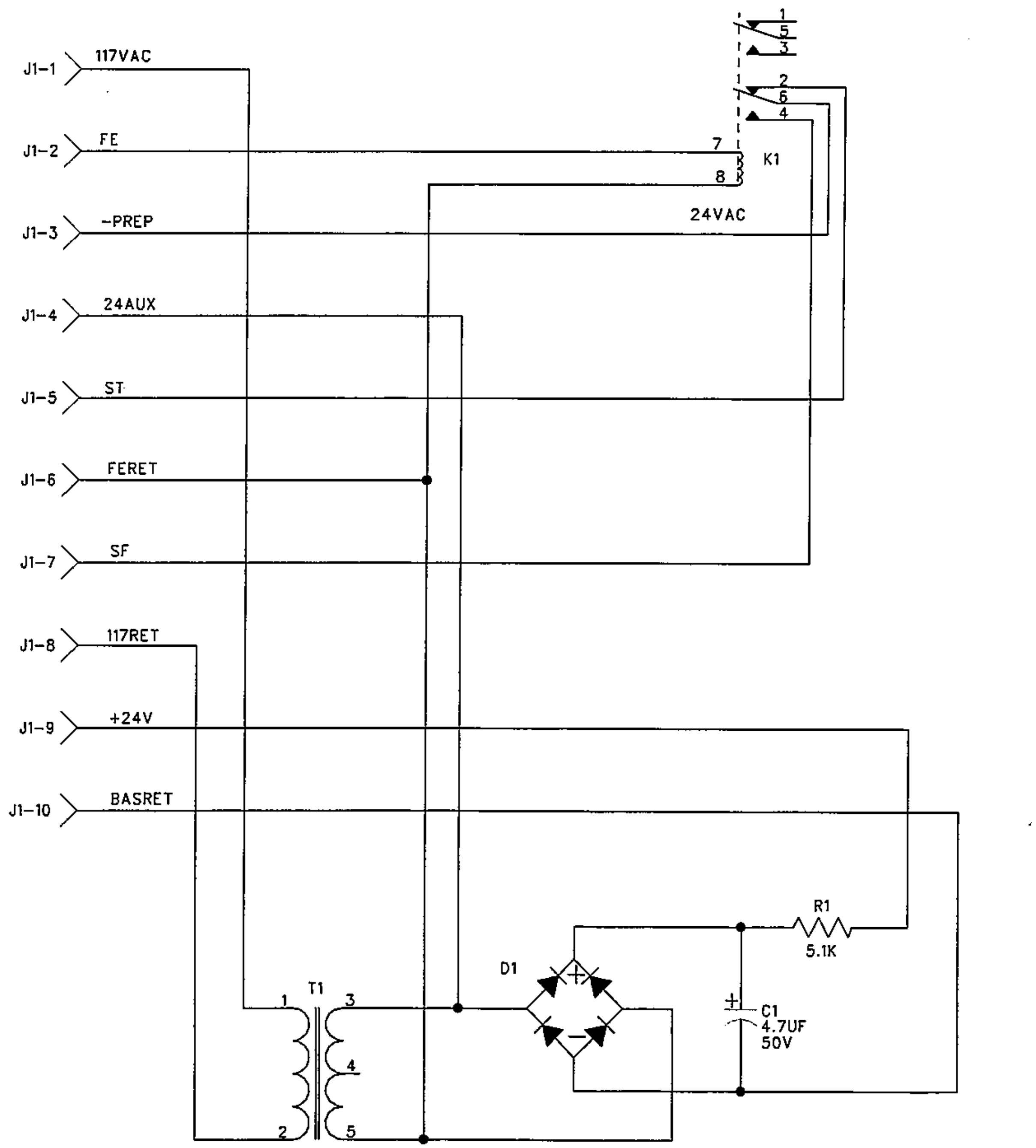


Continental a subsidiary of Trex Medical

AEC Interface Schematic

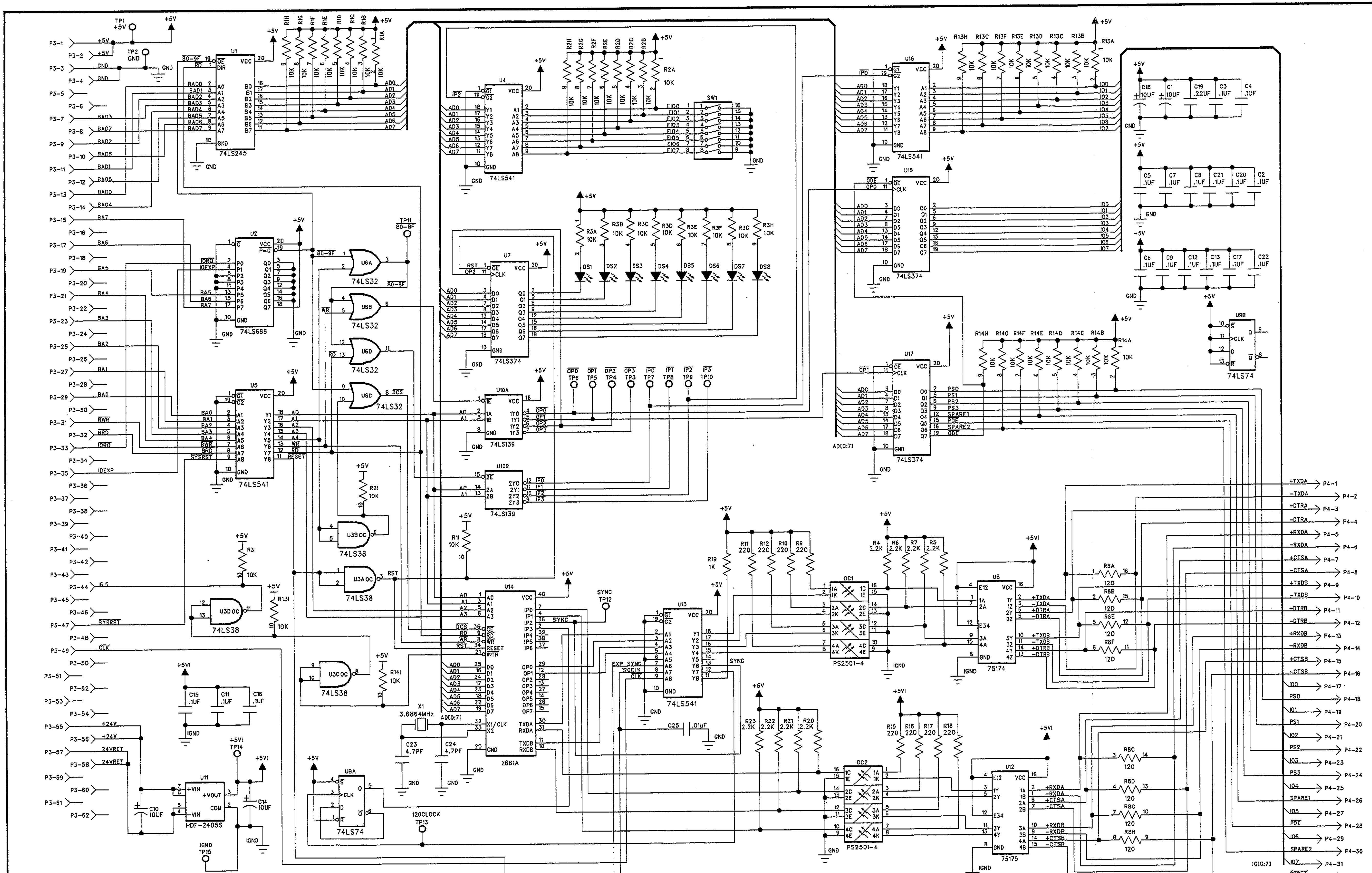
4294.262.34 (2 of 2)

9487 Rev. 00



REV.	DATE CODE	ORG.	APP.	TM R/F BAS-FE INTERFACE PCB	4194.262.18
00	9472	GP			
01	9668	GP			

CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL



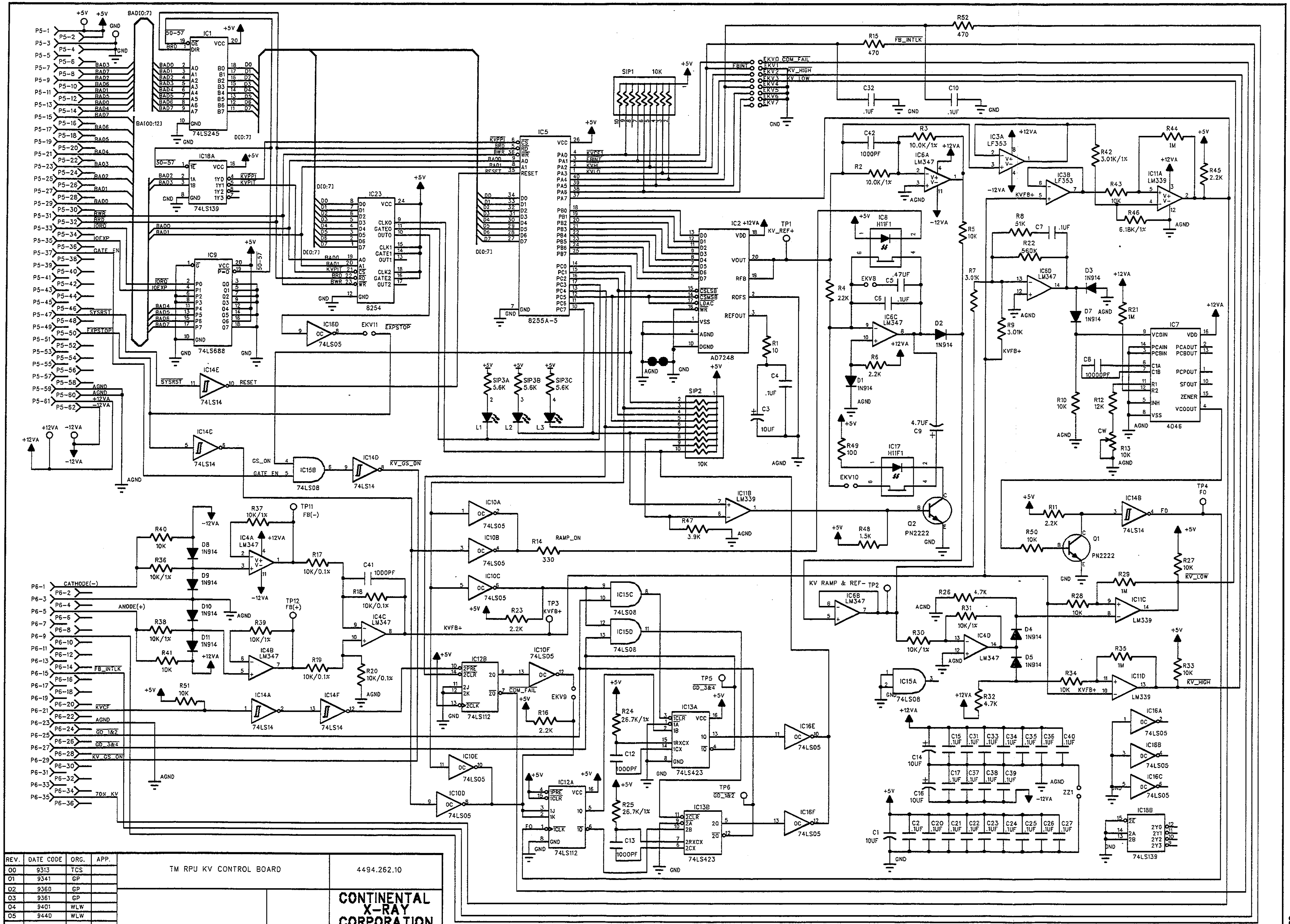
REV.	DATE CODE	ORG.	APP.
00	9262	TCS	
01	9290	TCS	
02	9347	TCS	
03	9513	WLW	

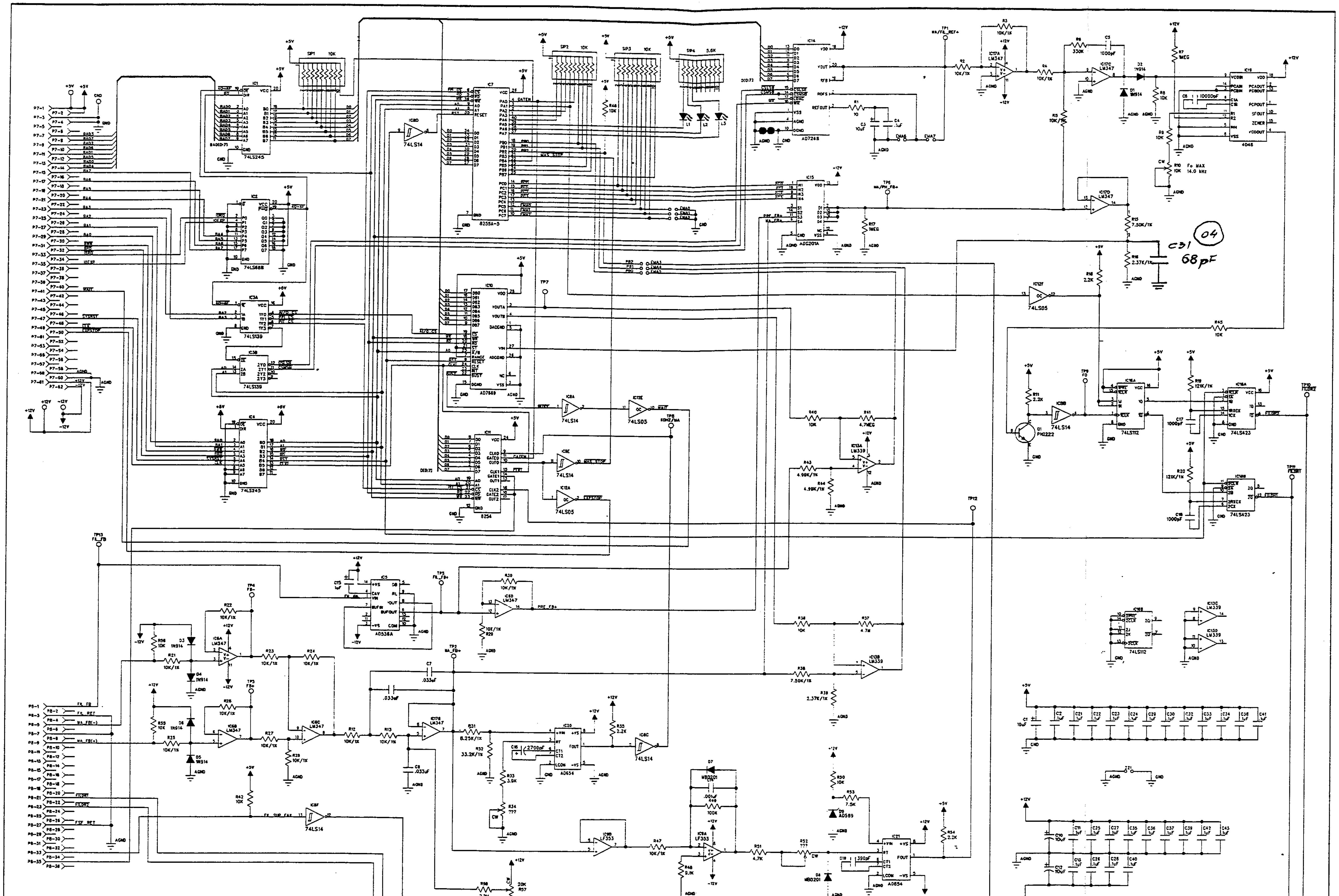
TM I/O CONTROL BOARD

4494.262.15

CONTINENTAL X-RAY CORPORATION

ASSEMBLY NUMBER 6284.262.15
BLANK PC BOARD PART NUMBER 4284.262.15


TM RPU KV CONTROL BOARD
4494.262.10
CONTINENTAL
X-RAY
CORPORATION
REV. | DATE CODE | ORG. | APP.
00 | 9313 | TCS
01 | 9341 | GP
02 | 9360 | GP
03 | 9361 | GP
04 | 9401 | WLW
05 | 9440 | WLW

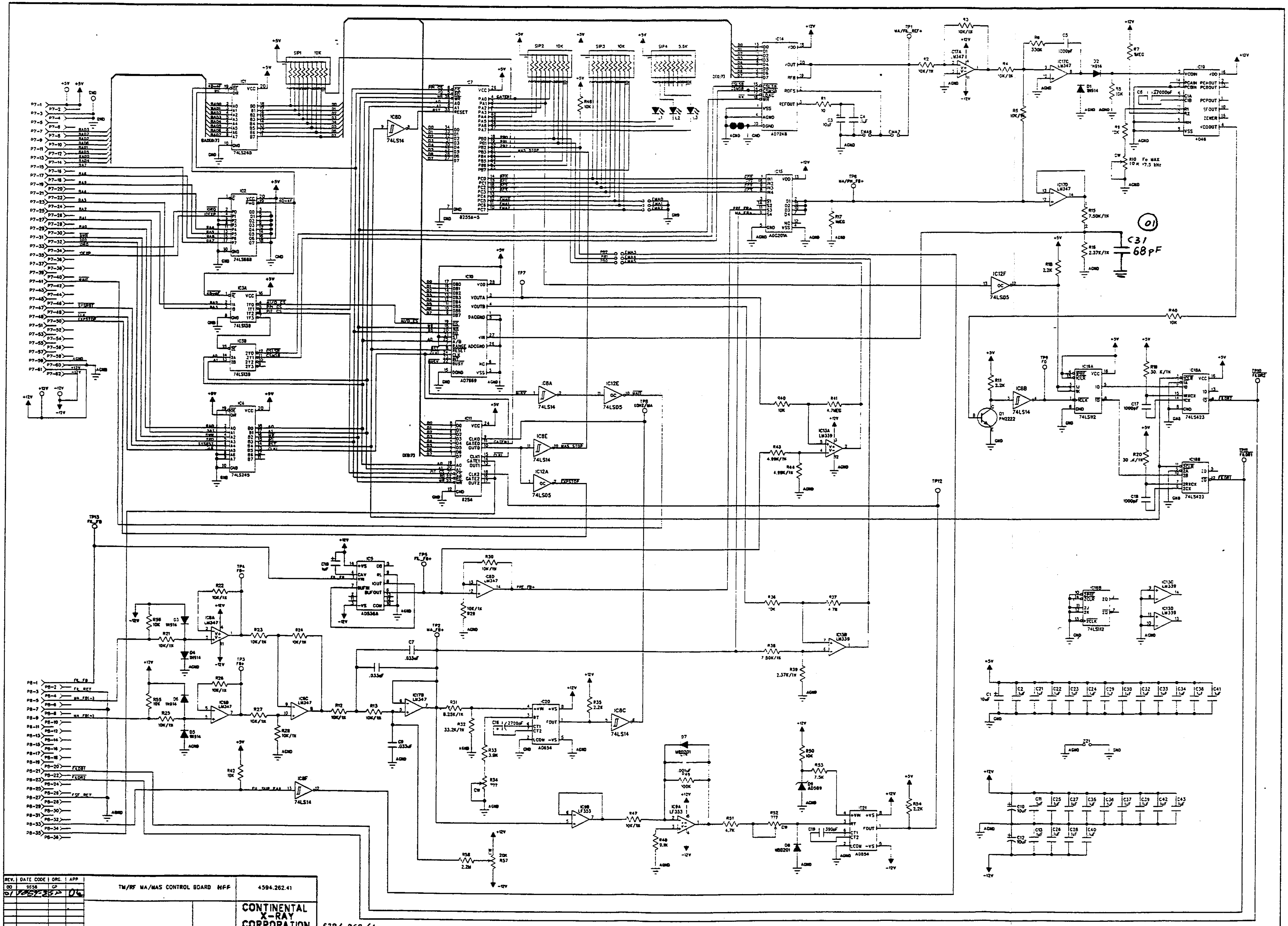


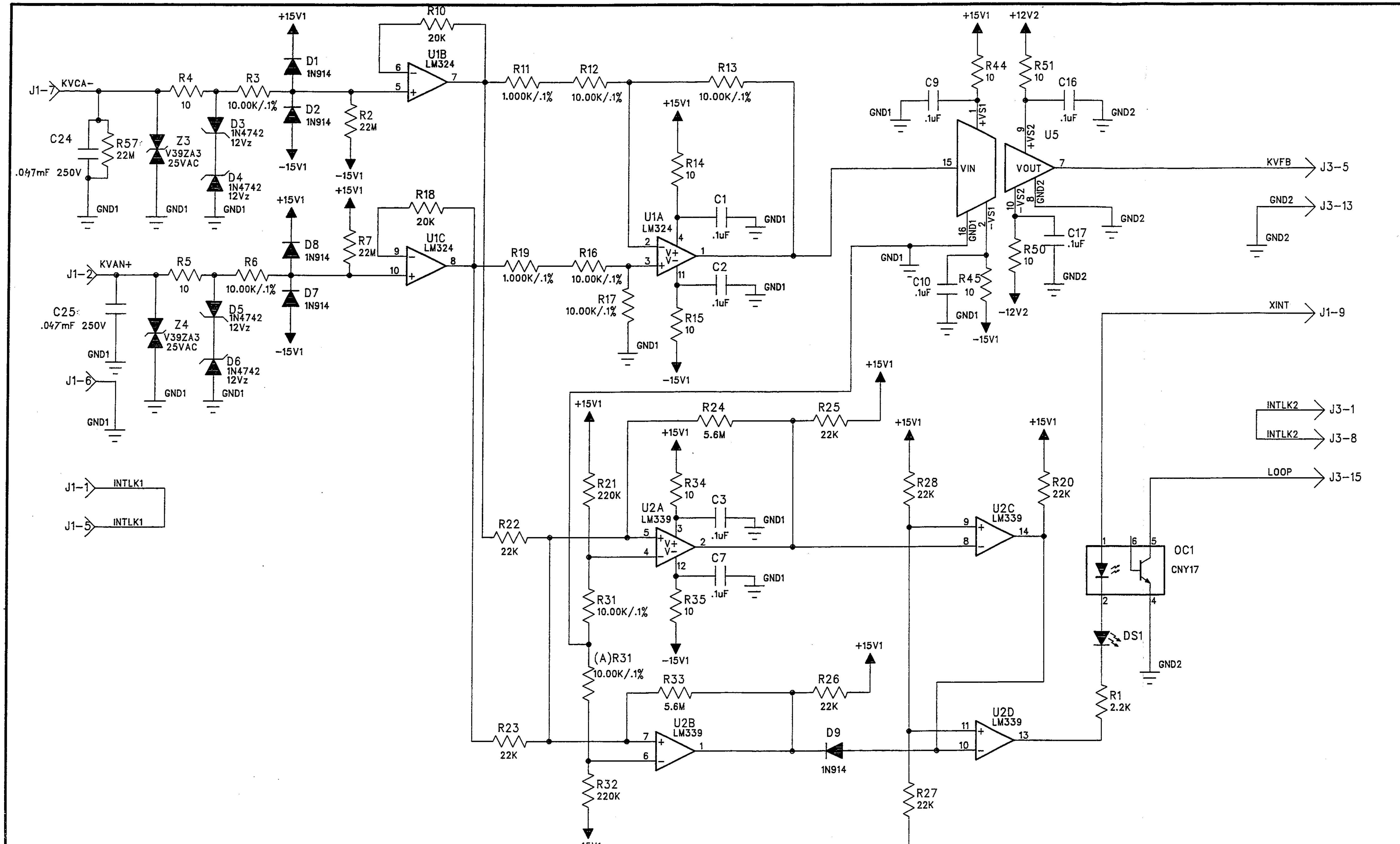
REV.	DATE CODE	ORG.	APP.
00	9354	TCS	
01	9354	C.P.	
02	9354	C.P.	
03	9373	C.P.	
04	9564-03	CP	[illegible]

TM/RF MA/MAS CONTROL BOARD

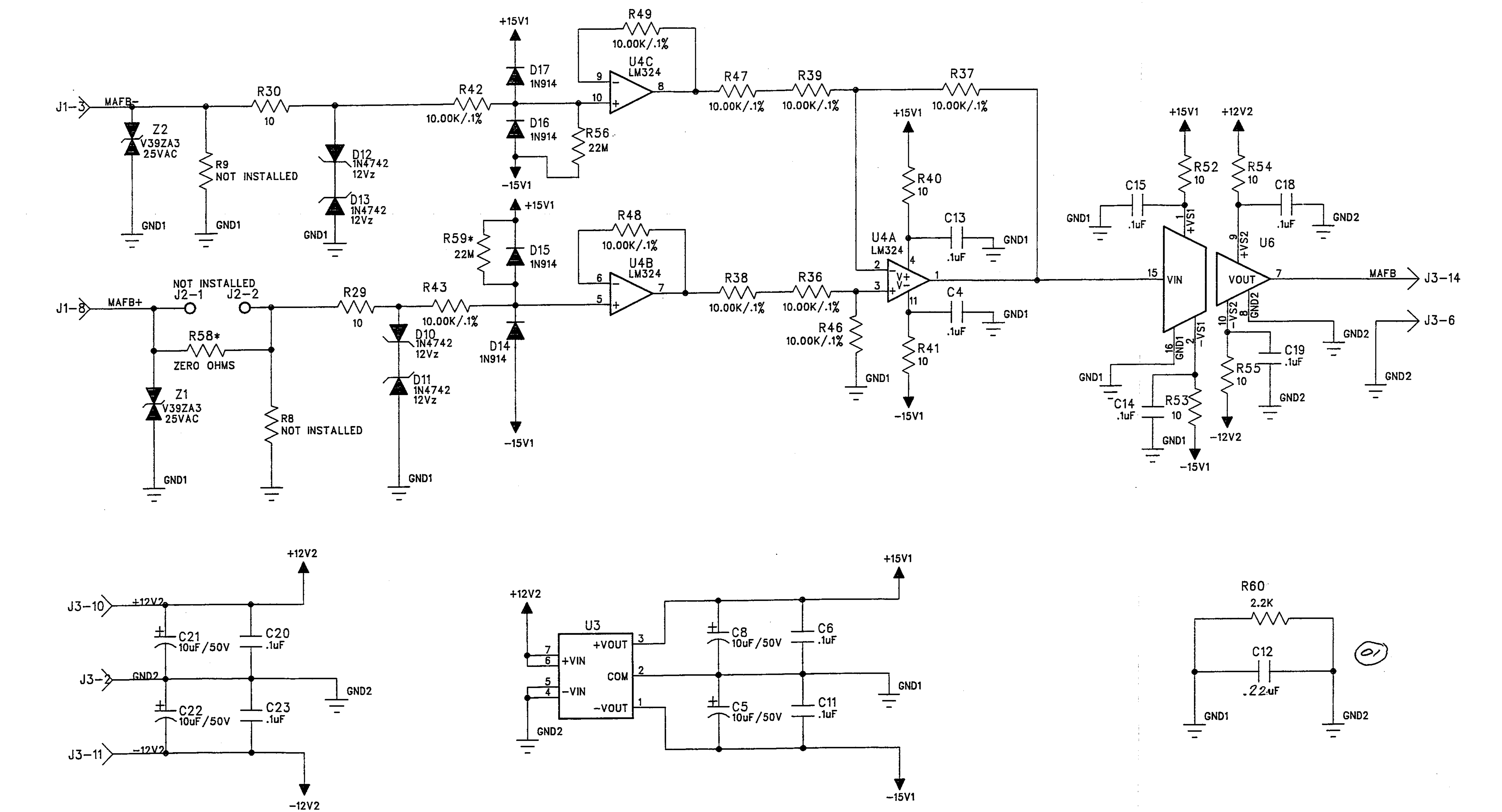
4594.262.11

CONTINENTAL X-RAY CORPORATION

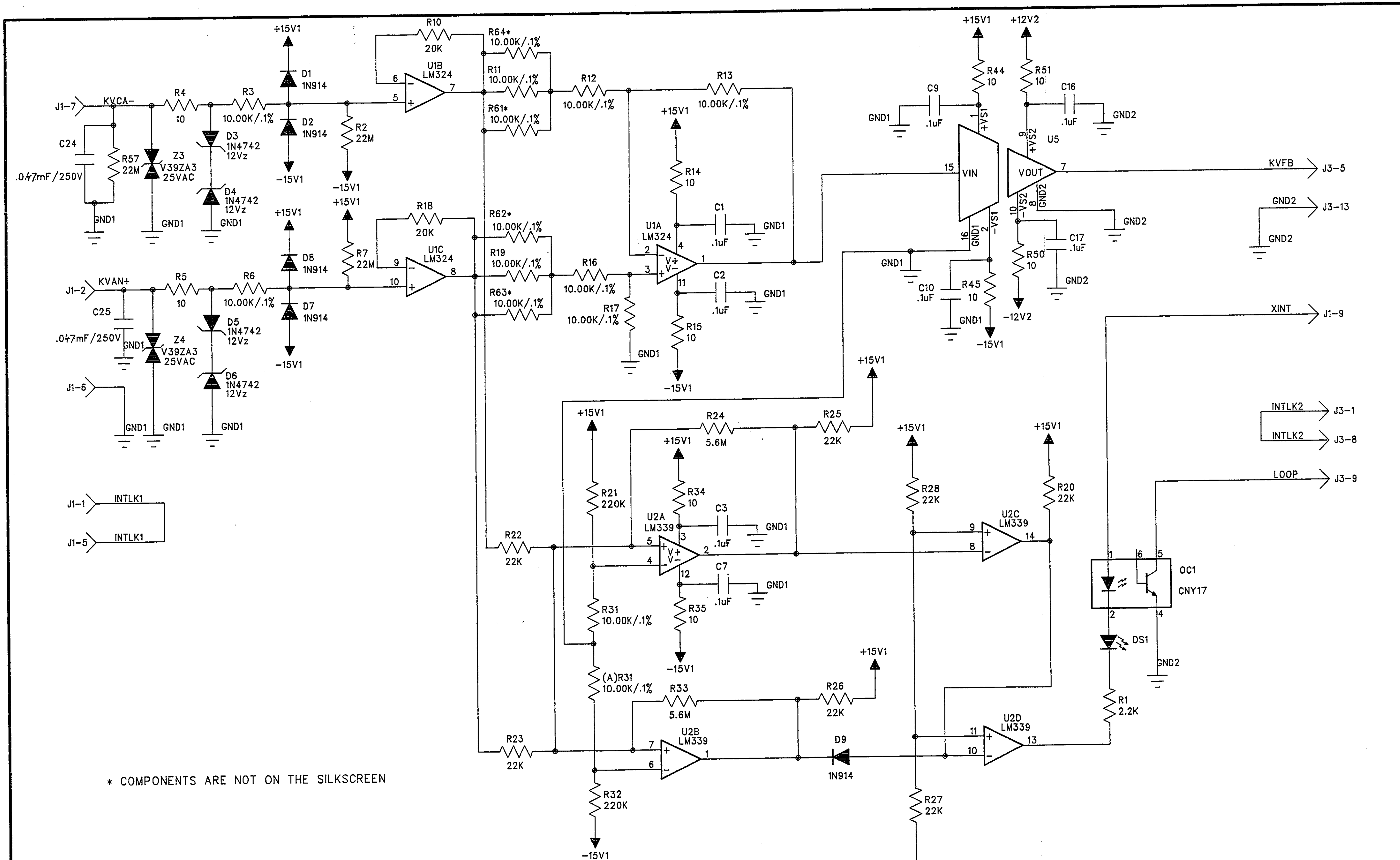

TM/RF MA/MAS CONTROL BOARD HFF
4594.262.41
CONTINENTAL X-RAY CORPORATION
5284.262.41
C31 68pF



REV.	DATE CODE	ORG.	APP.		
00	9360	GP	OK	TM SERIES kV/mA FEEDBACK ISOLATION BOARD	4294.262.1904
01	9714	GP	OK		
				SHEET 1 OF 2	CONTINENTAL X-RAY CORPORATION

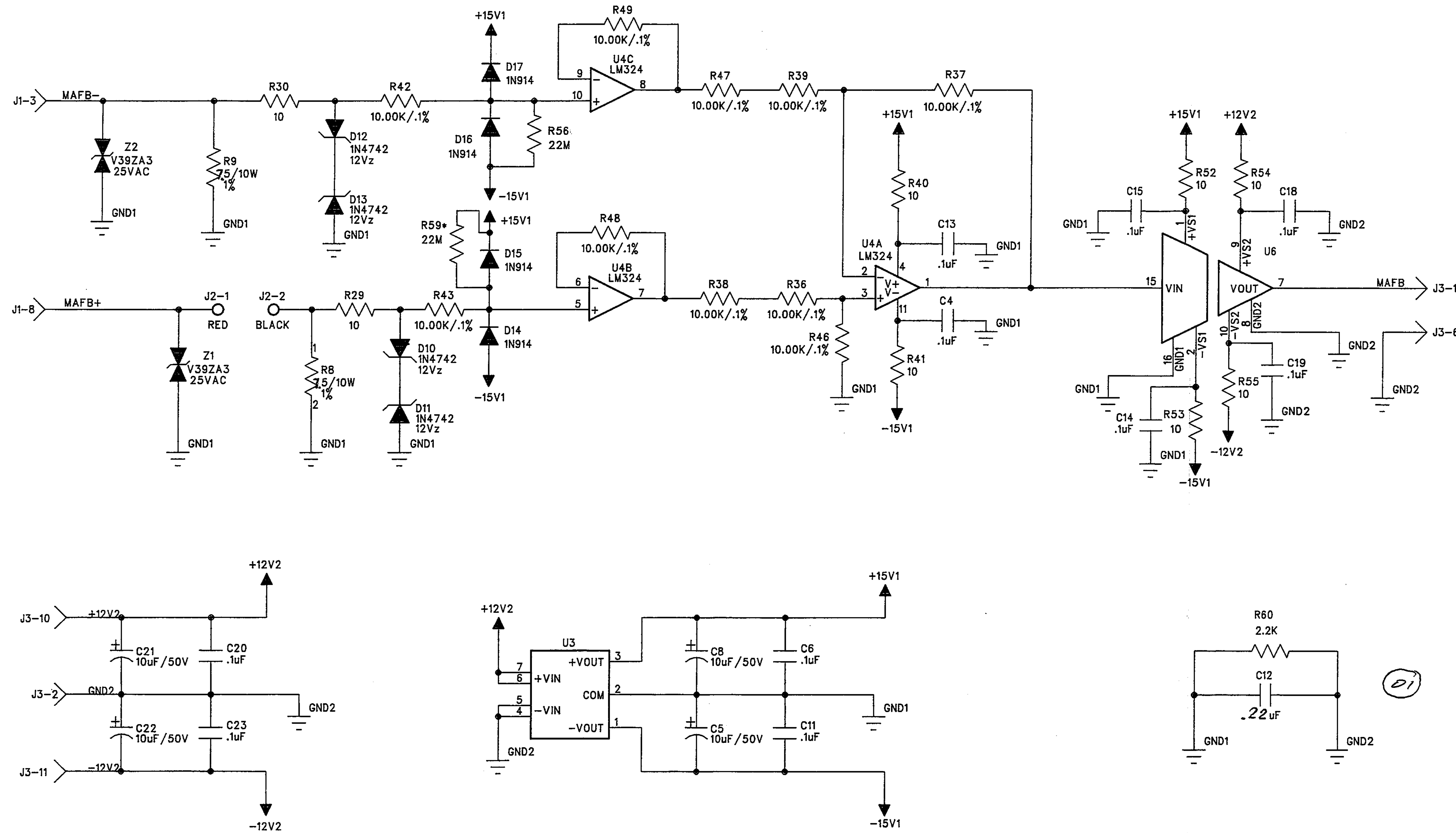


REV.	DATE CODE	ORG.	APP.	TM SERIES kV/mA FEEDBACK ISOLATION BOARD	4294.262.1904
00	9360	GP			
01	9659	G.P.	OK	SHEET 2 OF 2	CONTINENTAL X-RAY CORPORATION

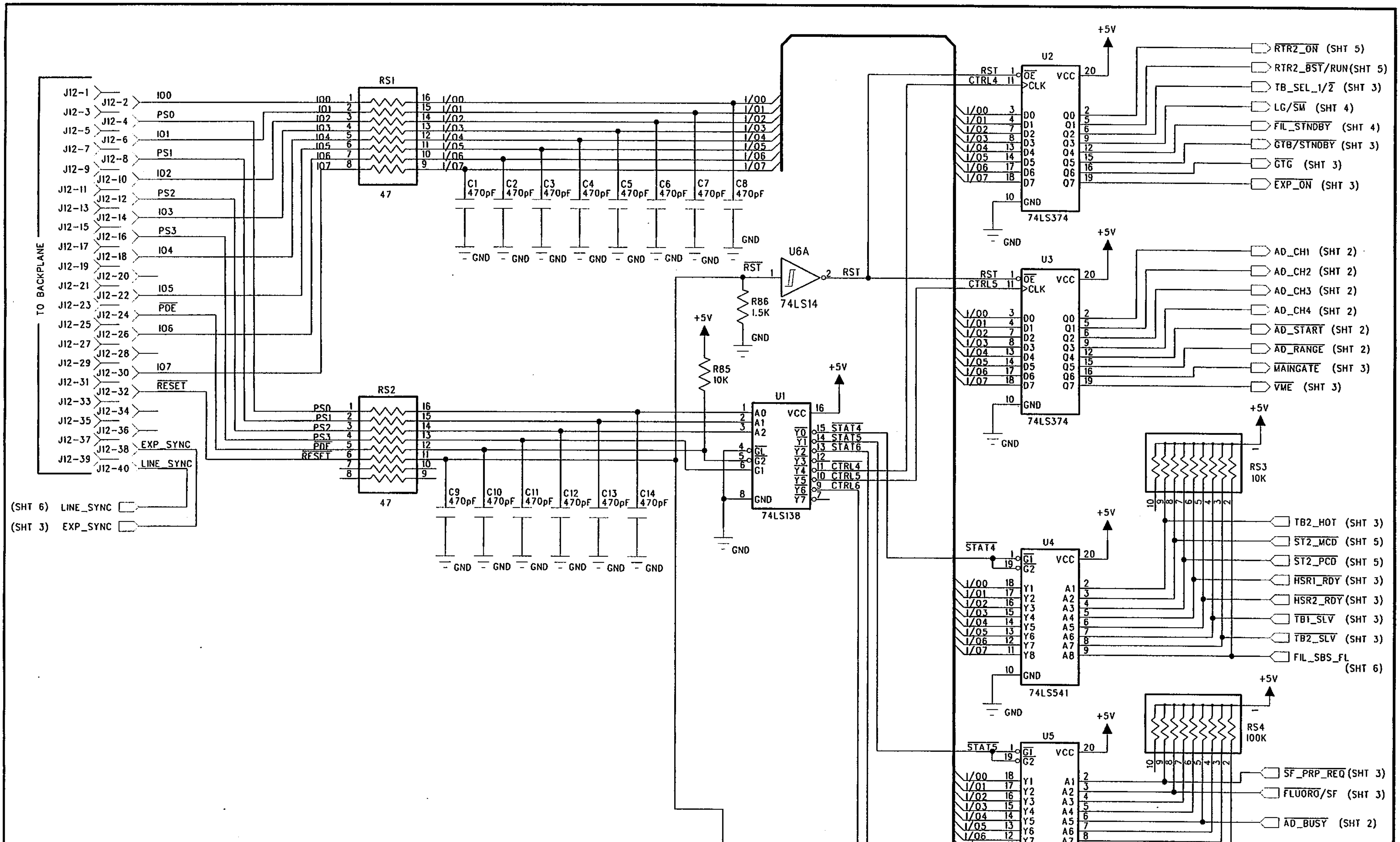


* COMPONENTS ARE NOT ON THE SILKSCREEN

REV.	DATE CODE	ORG.	APP.		
00	9360	GP	[illegible]	TM 150 kV/mA FEEDBACK ISOLATION BOARD	4294.262.1906
01	9714	GP	OC	SHEET 1 OF 2	CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.	TM 150 kV/mA FEEDBACK ISOLATION BOARD	4294.262.1906
00	9360	GP	OK		
01	2659	GP	OK		
				SHEET 2 OF 2	CONTINENTAL X-RAY CORPORATION



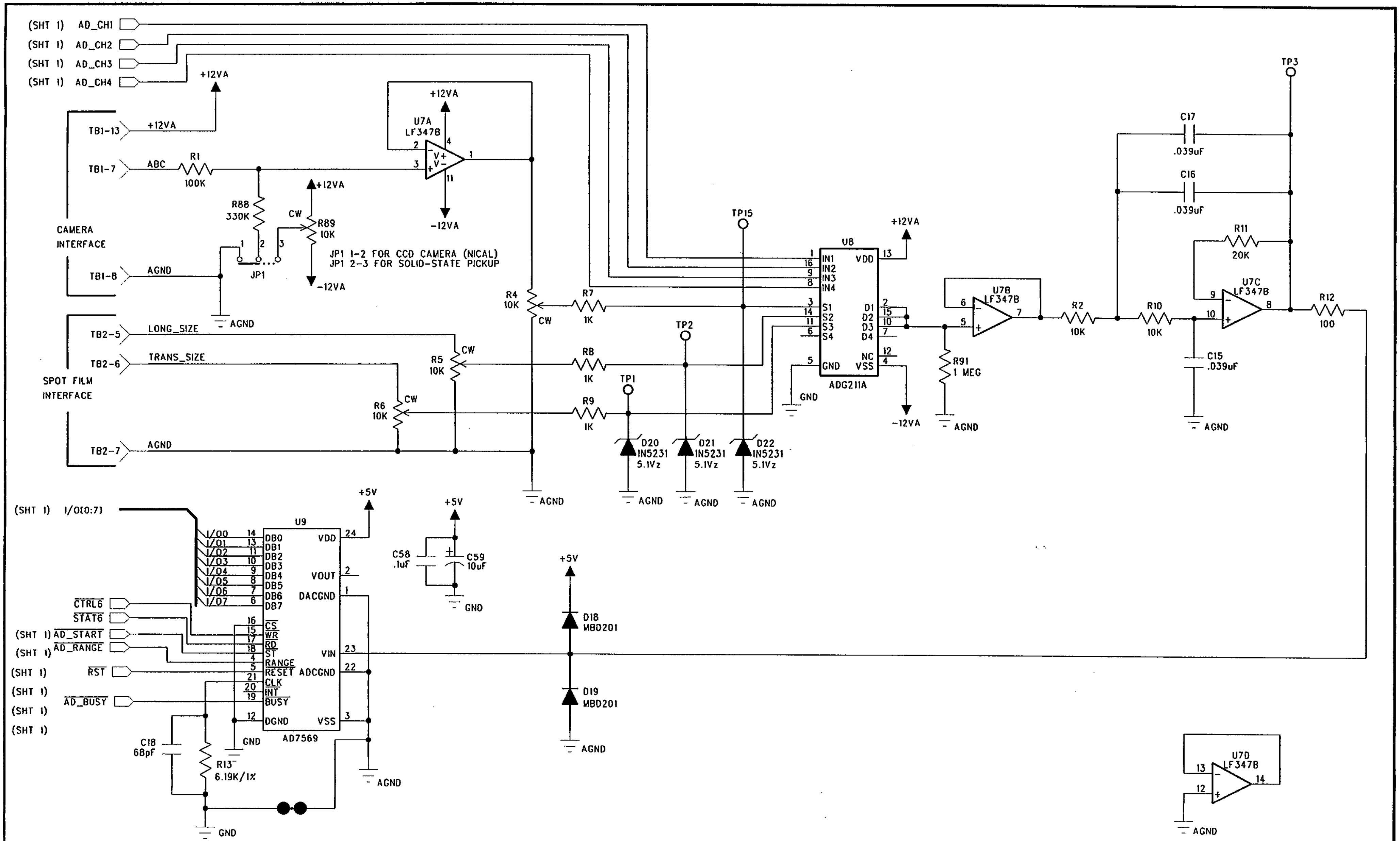
REV.	DATE CODE	ORG.	APP.
00	9271	TCS	
01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 1 OF 6

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.
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03	9352	TCS	
04	9352	GP	
05	9381	GP	
06	9533	WLW	

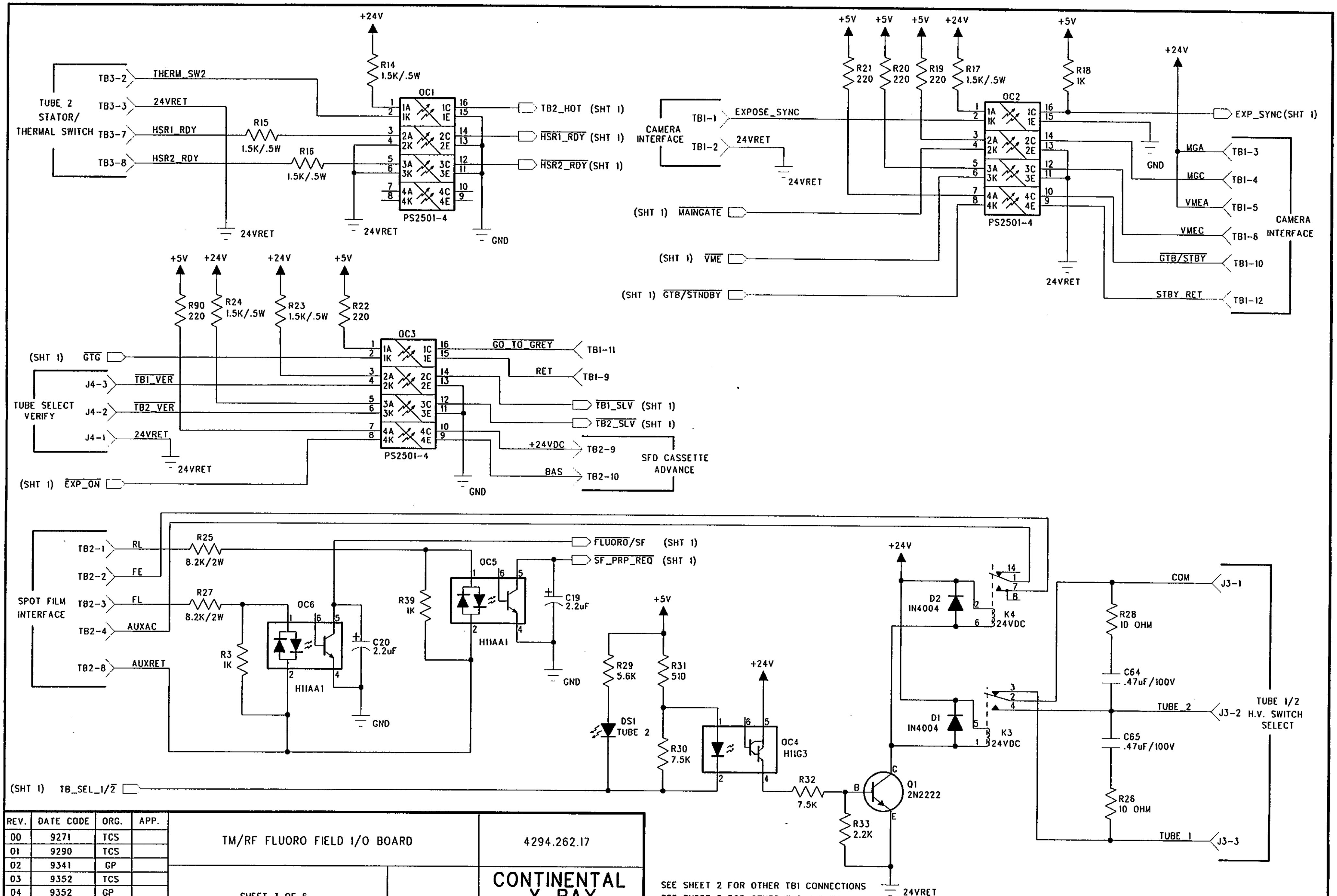
TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 2 OF 6

CONTINENTAL X-RAY CORPORATION

FOR OTHER TB1 CONNECTIONS SEE SHEET 3
FOR OTHER TB2 CONNECTIONS SEE SHEET 3



REV.	DATE CODE	ORG.	APP.
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01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

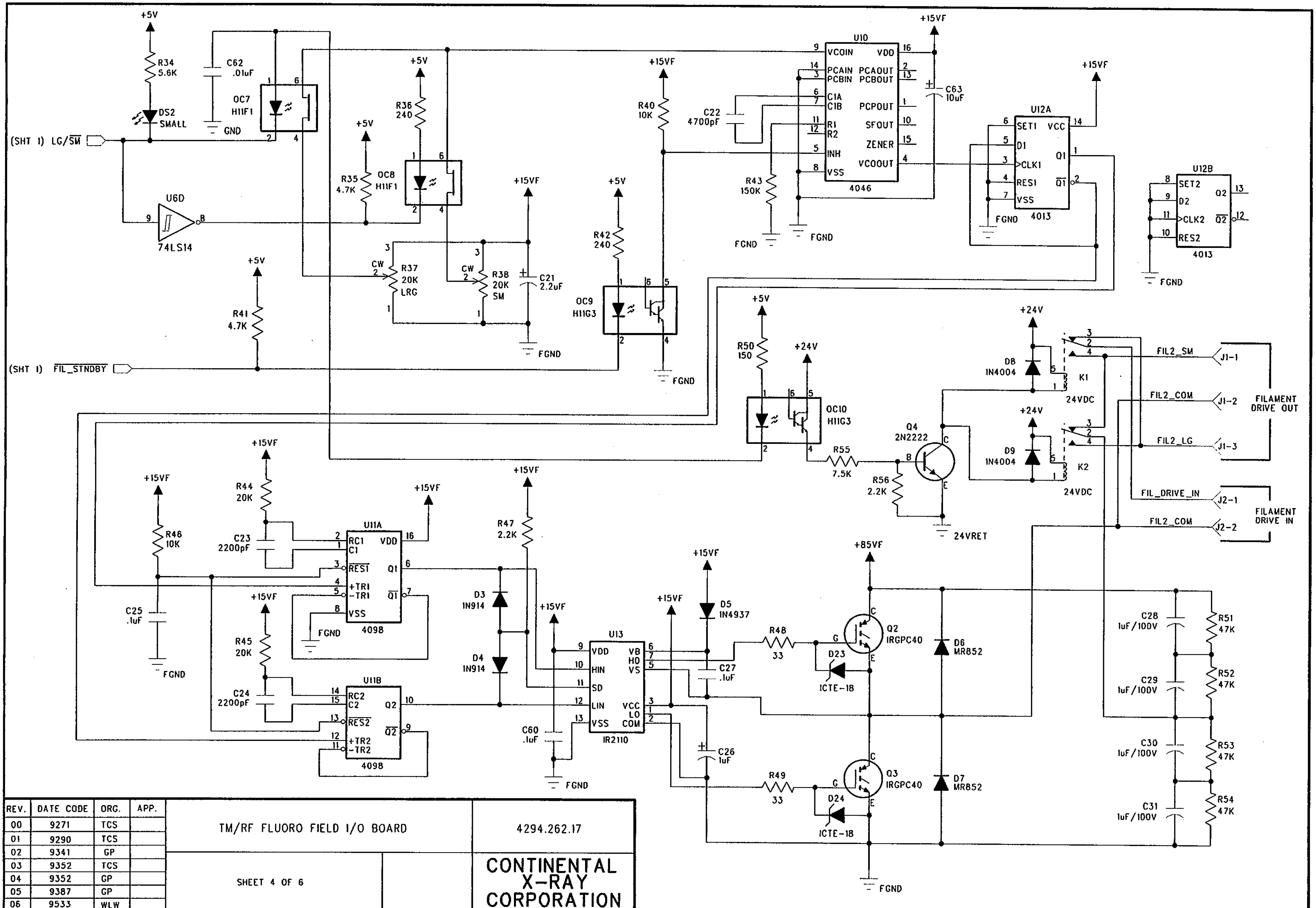
TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 3 OF 6

CONTINENTAL X-RAY CORPORATION

SEE SHEET 2 FOR OTHER TB1 CONNECTIONS
SEE SHEET 2 FOR OTHER TB2 CONNECTIONS
SEE SHEET 5 FOR OTHER TB3 CONNECTIONS



REV.	DATE CODE	ORG.	APP.
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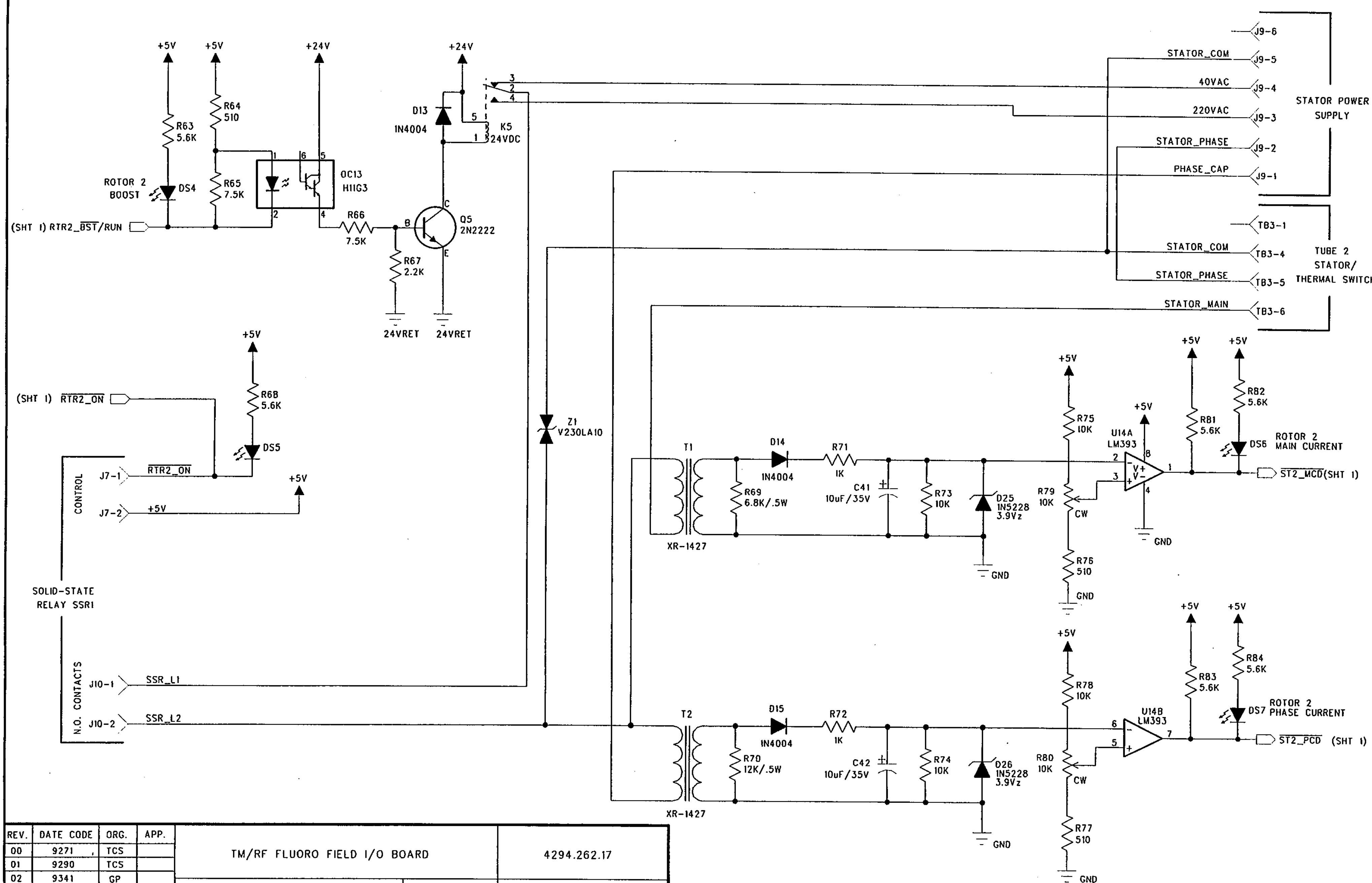
01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 4 OF 6

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.
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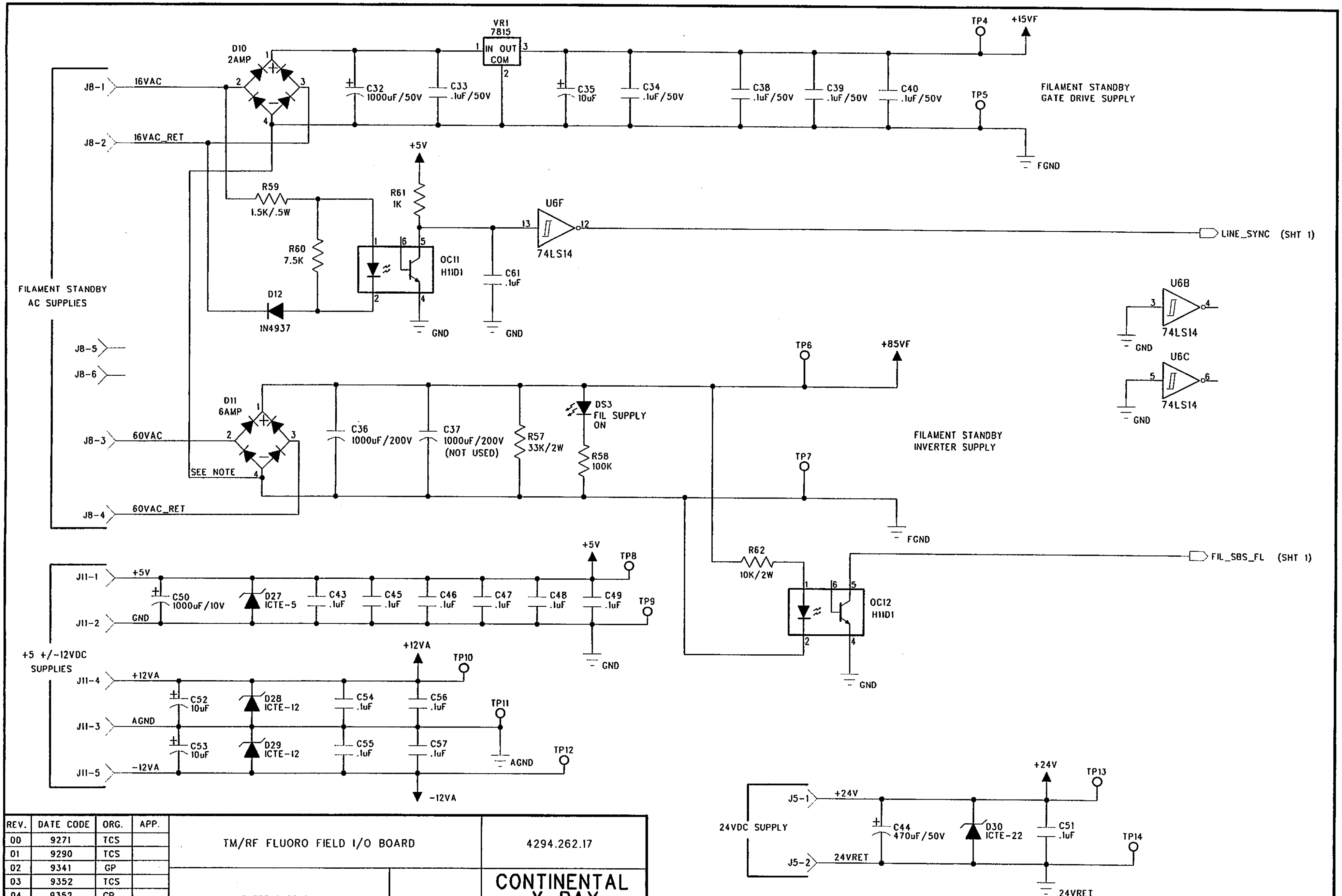
01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 5 OF 6

CONTINENTAL
X-RAY
CORPORATION



REV.	DATE CODE	ORG.	APP.
00	9271	TCS	
01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

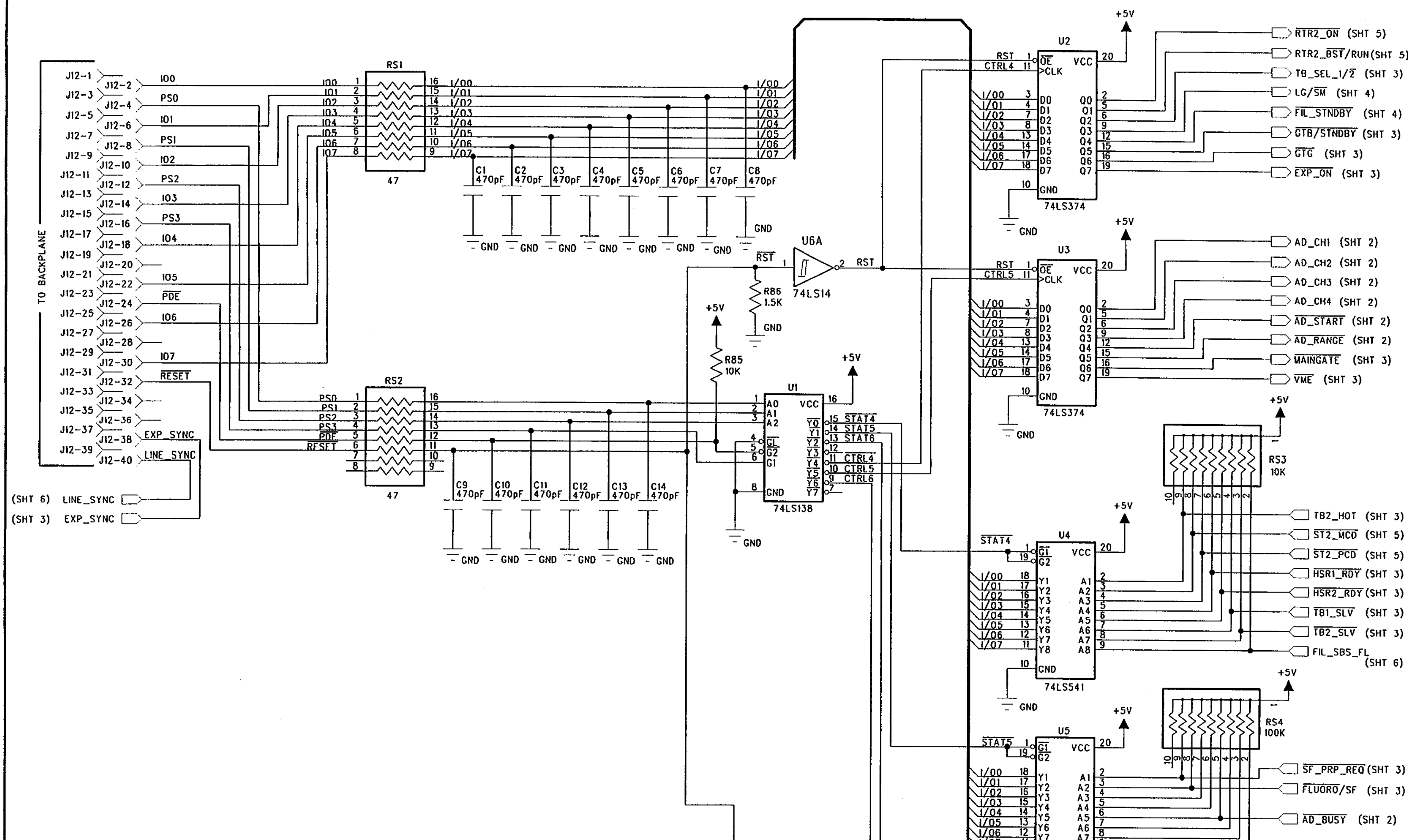
TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 6 OF 6

CONTINENTAL
X-RAY
CORPORATION

NOTE: FILAMENT DRIVE SUPPLY AND FILAMENT CONTROL SUPPLY (FGND) ARE CONNECTED AT ONLY 1 POINT -- D10 PIN 4 AND D11 PIN 4.



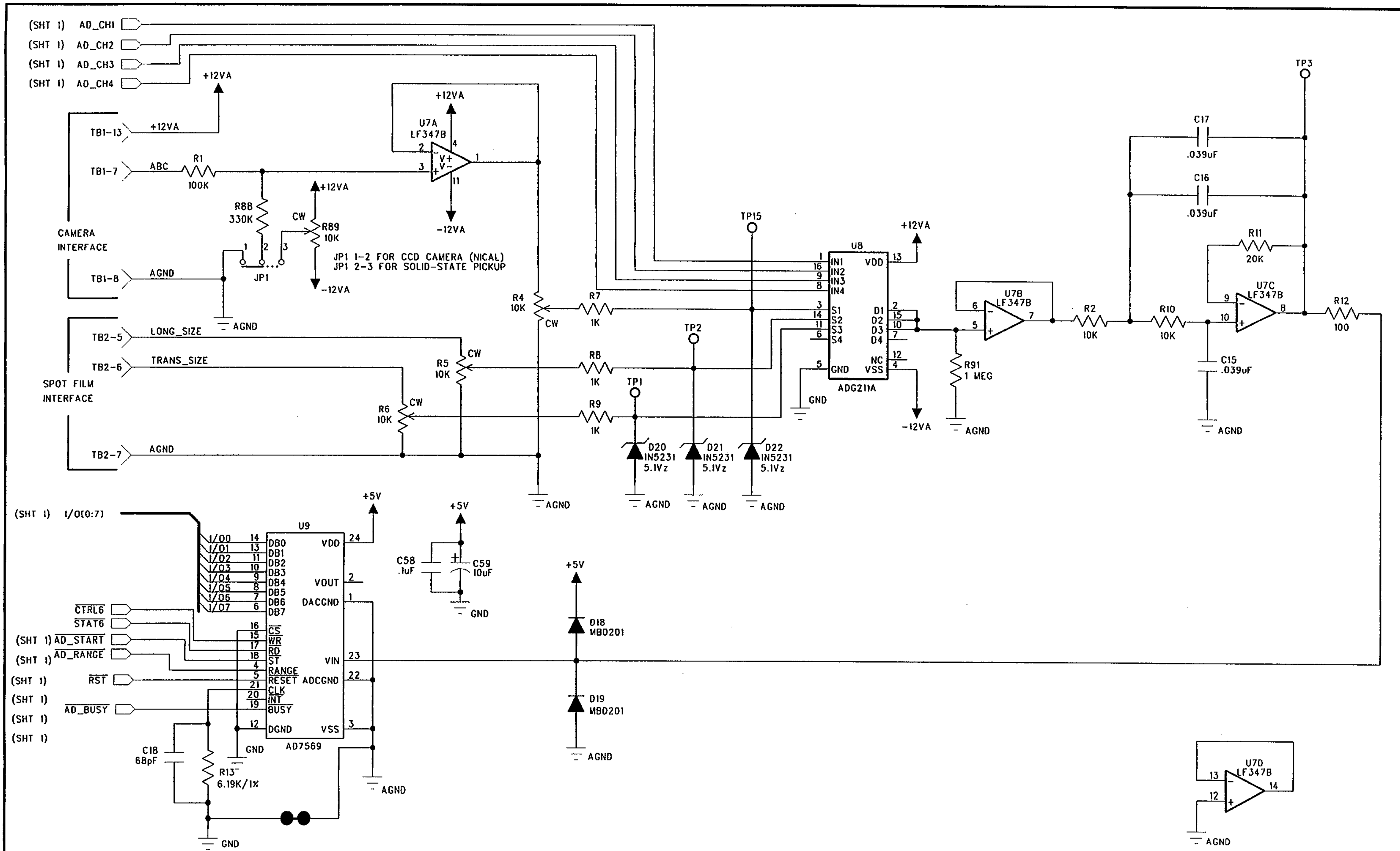
REV.	DATE CODE	ORG.	APP.
00	9271	TCS	
01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 1 OF 6

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.
00	9271	TCS	
01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9381	GP	
06	9533	WLW	

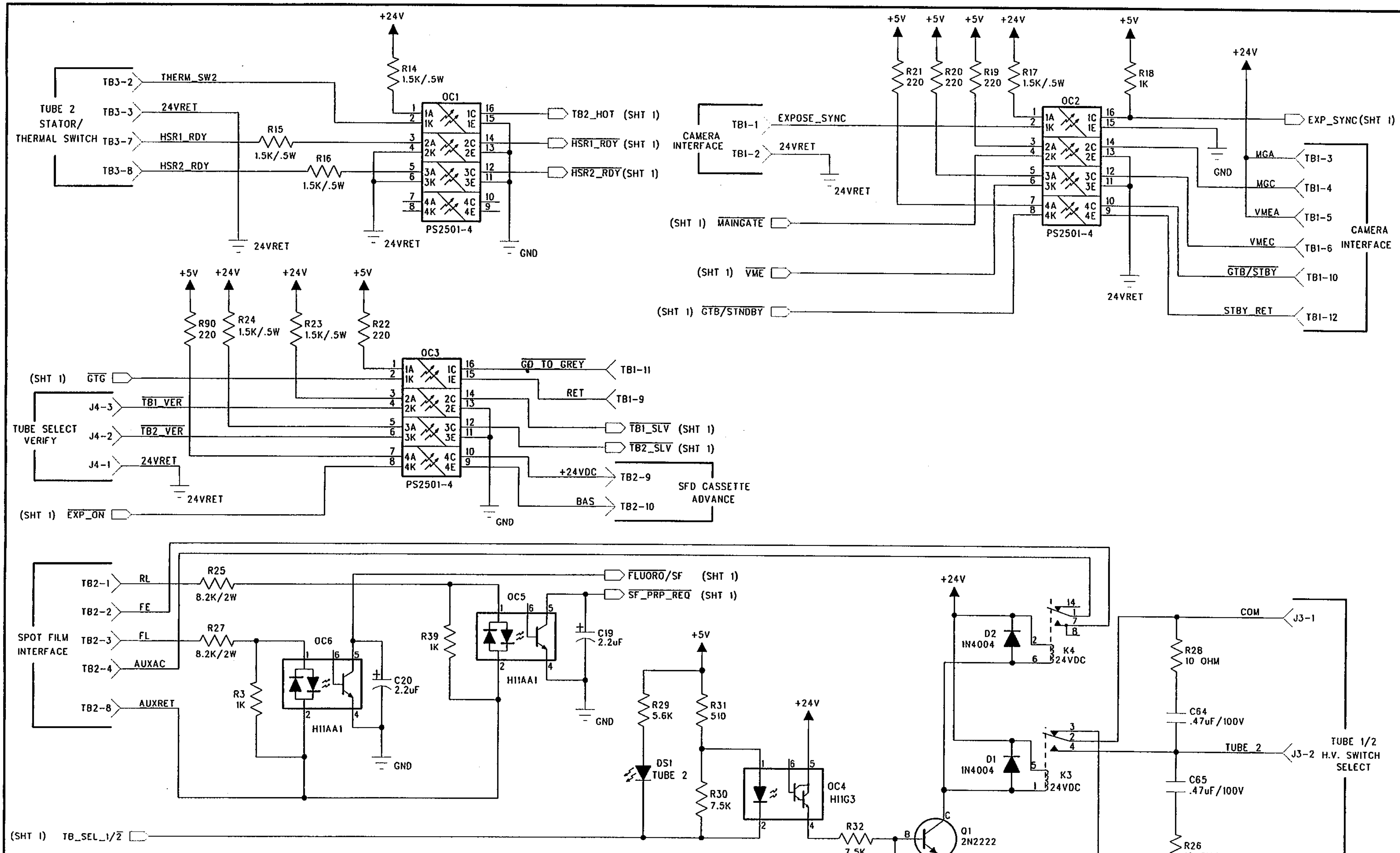
TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 2 OF 6

CONTINENTAL X-RAY CORPORATION

FOR OTHER TB1 CONNECTIONS SEE SHEET 3
FOR OTHER TB2 CONNECTIONS SEE SHEET 3



REV.	DATE CODE	ORG.	APP.
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01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

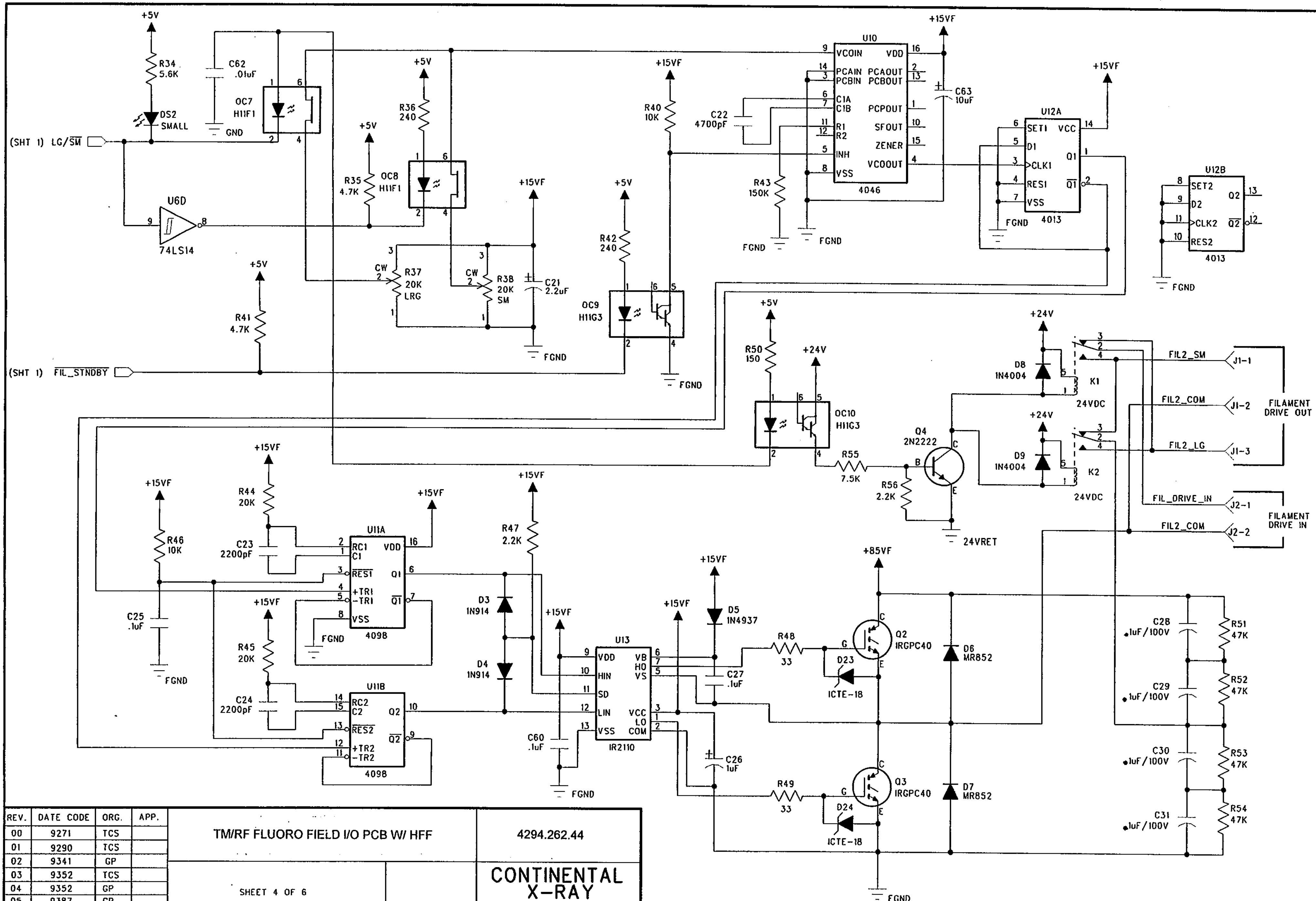
TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 3 OF 6

CONTINENTAL X-RAY CORPORATION

SEE SHEET 2 FOR OTHER TB1 CONNECTIONS
SEE SHEET 2 FOR OTHER TB2 CONNECTIONS
SEE SHEET 5 FOR OTHER TB3 CONNECTIONS



REV.	DATE CODE	ORG.	APP.
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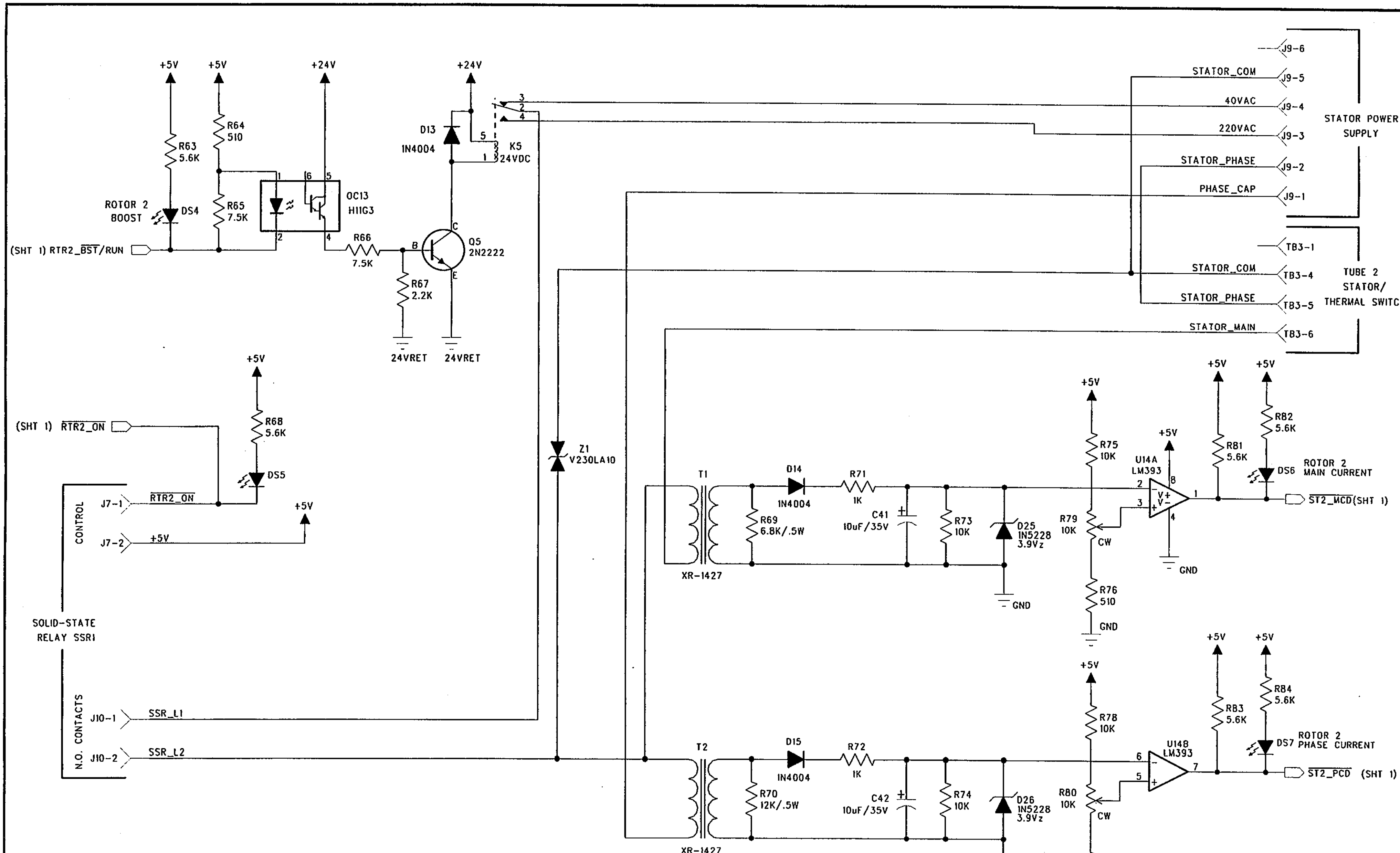
01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 4 OF 6

CONTINENTAL X-RAY CORPORATION



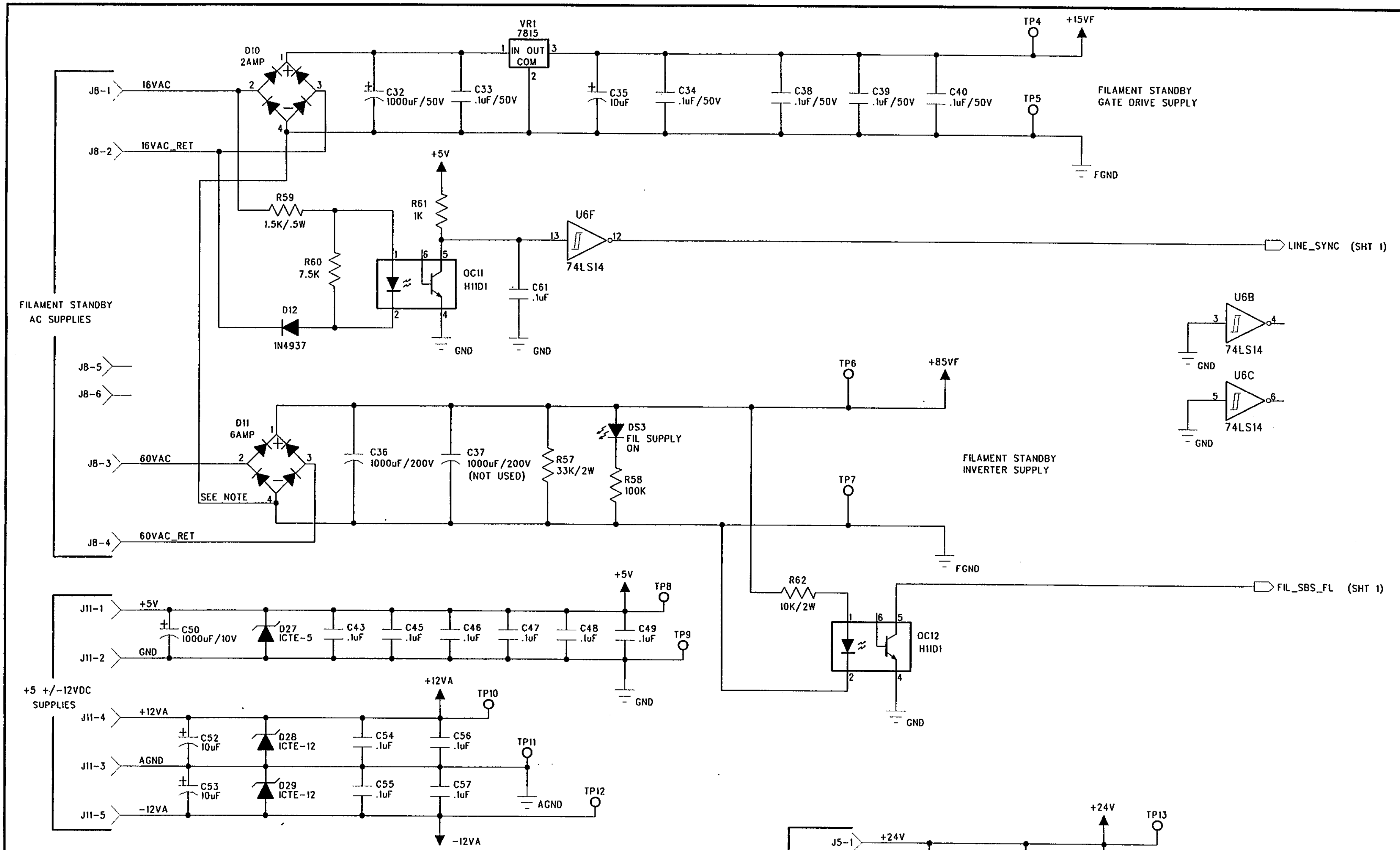
REV.	DATE CODE	ORG.	APP.
00	9271	TCS	
01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 5 OF 6

CONTINENTAL X-RAY CORPORATION



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01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

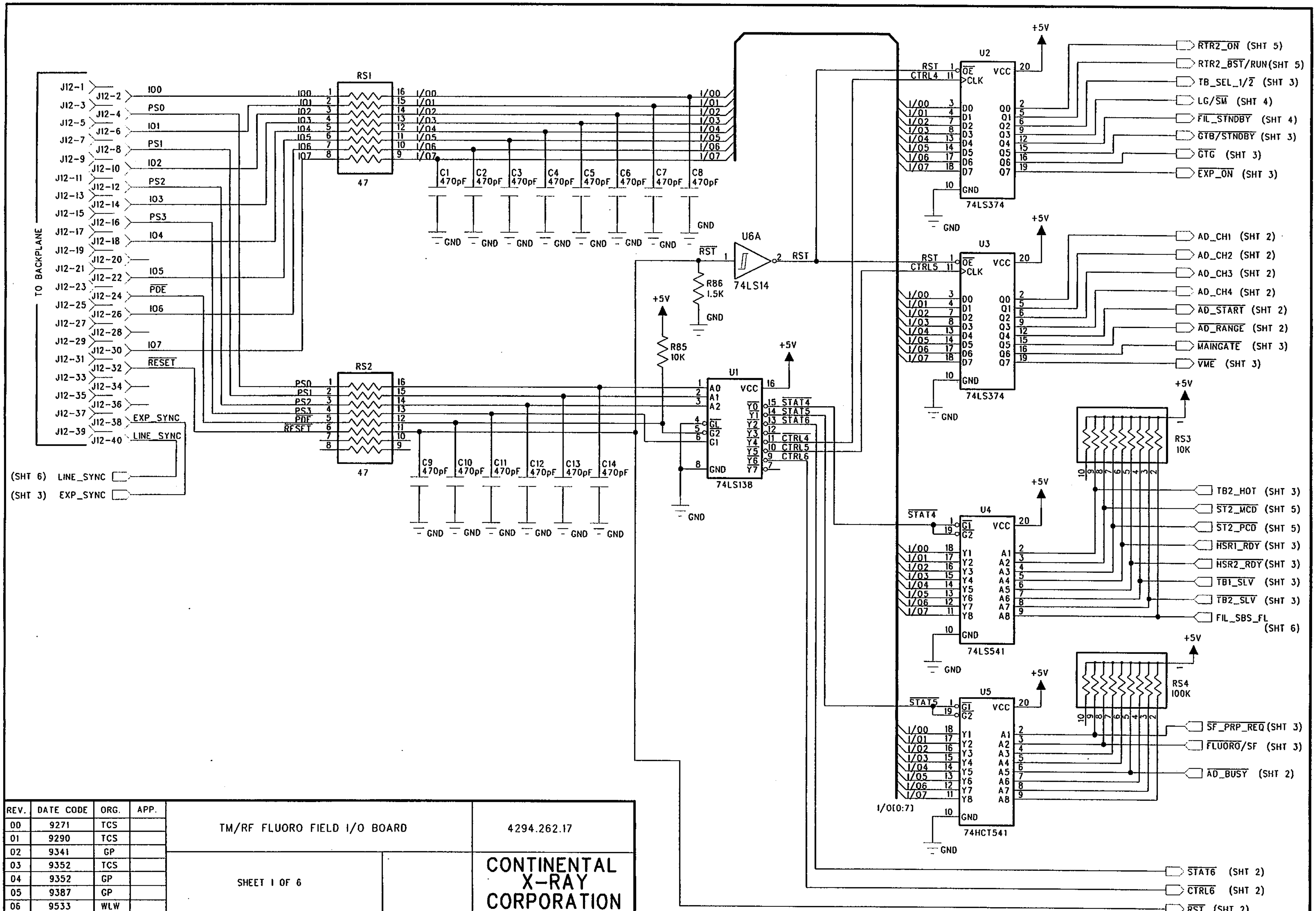
TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 6 OF 6

CONTINENTAL X-RAY CORPORATION

NOTE: FILAMENT DRIVE SUPPLY AND FILAMENT CONTROL SUPPLY (FGND) ARE CONNECTED AT ONLY 1 POINT -- D10 PIN 4 AND D11 PIN 4.



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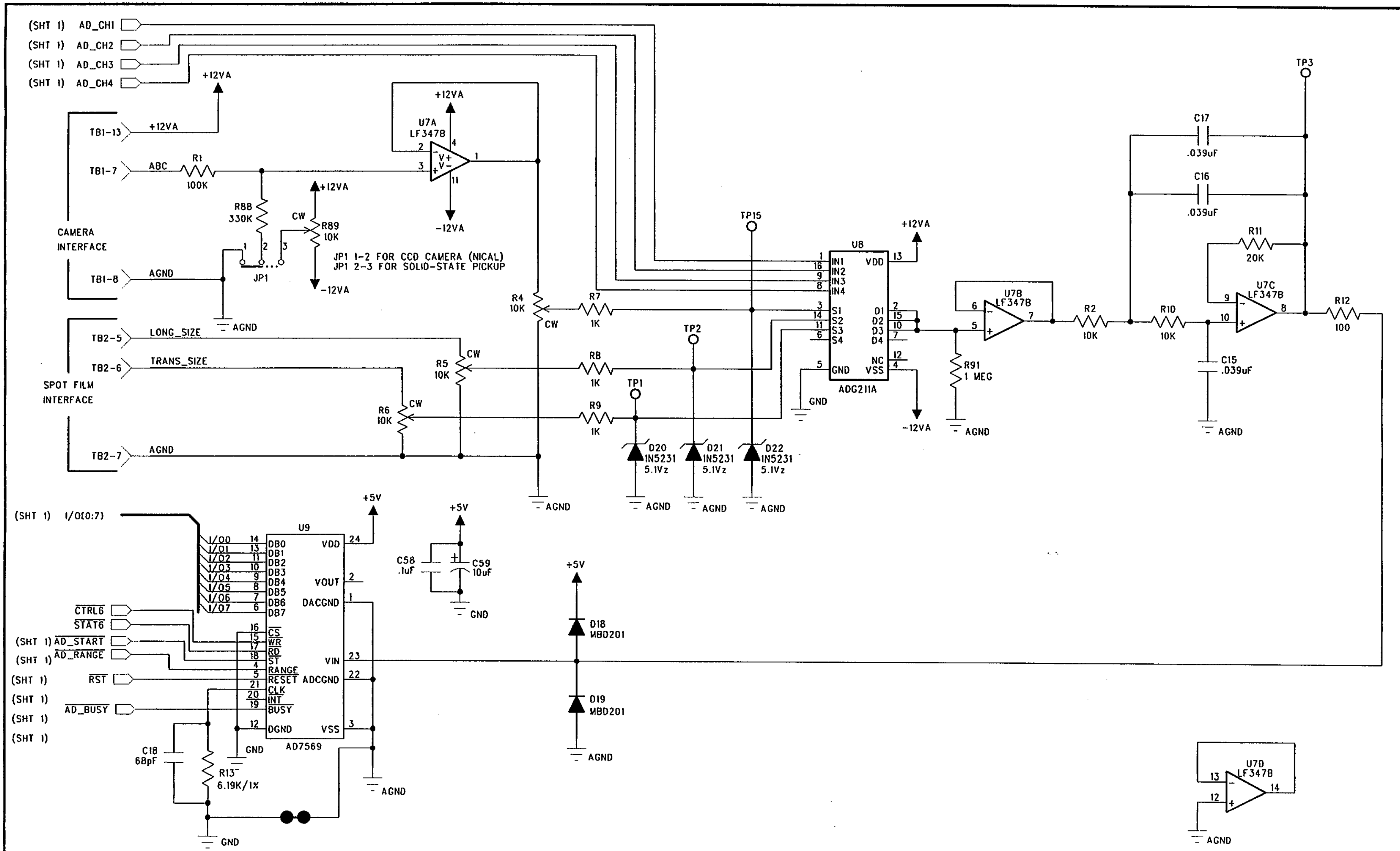
01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 1 OF 6

CONTINENTAL X-RAY CORPORATION



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01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9381	GP	
06	9533	WLW	

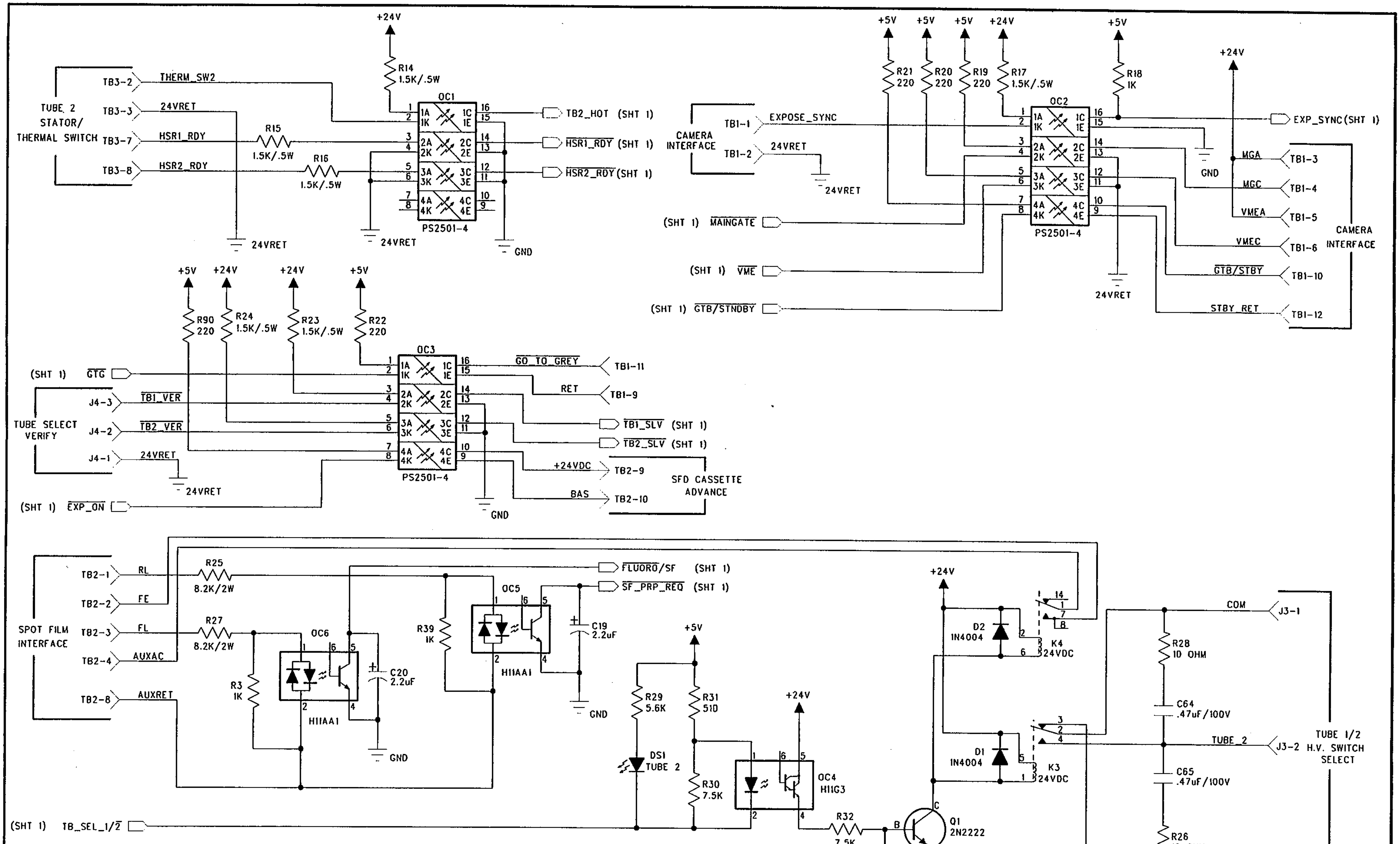
TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 2 OF 6

CONTINENTAL X-RAY CORPORATION

FOR OTHER TB1 CONNECTIONS SEE SHEET 3
FOR OTHER TB2 CONNECTIONS SEE SHEET 3



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03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

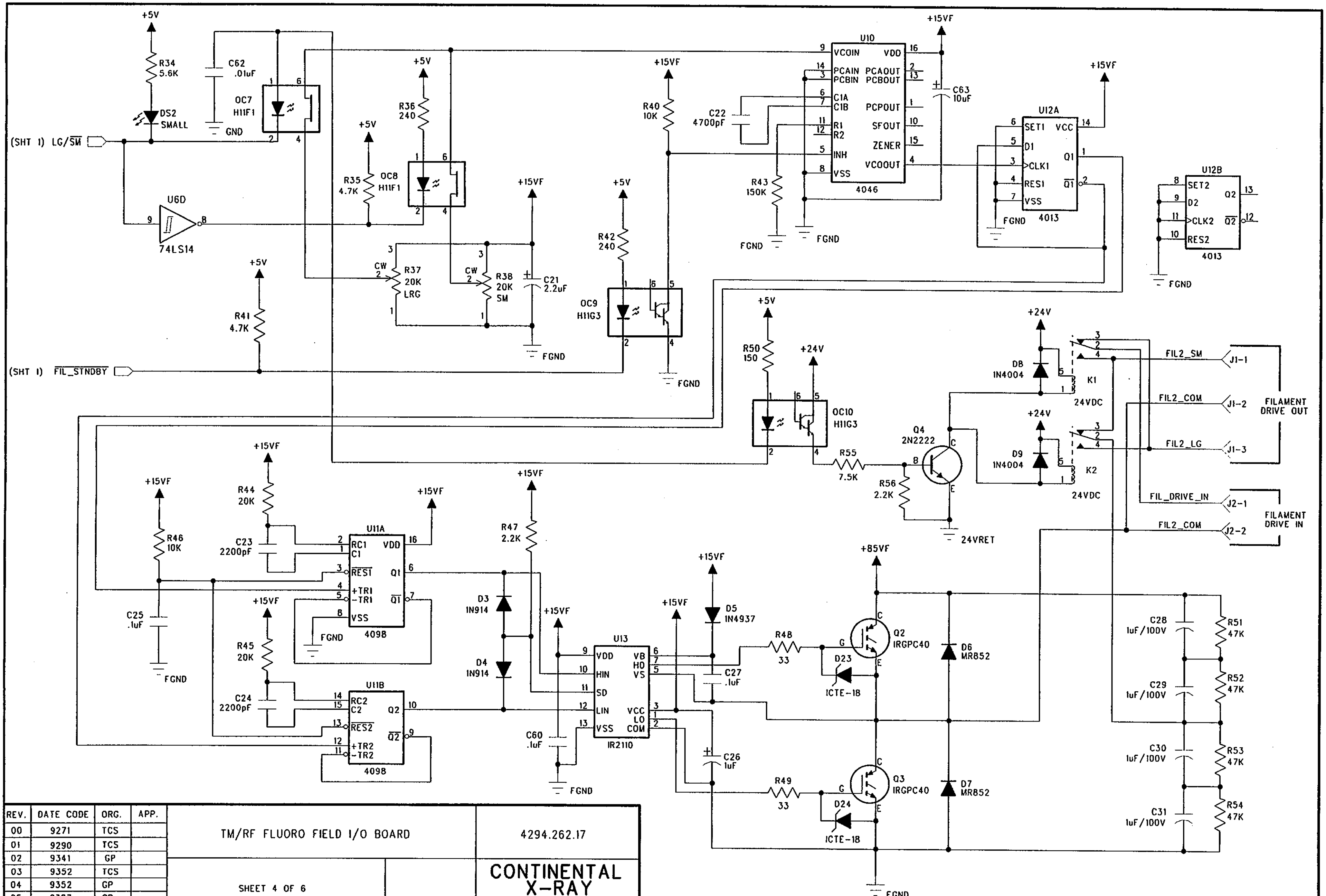
TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 3 OF 6

CONTINENTAL X-RAY CORPORATION

SEE SHEET 2 FOR OTHER TB1 CONNECTIONS
SEE SHEET 2 FOR OTHER TB2 CONNECTIONS
SEE SHEET 5 FOR OTHER TB3 CONNECTIONS



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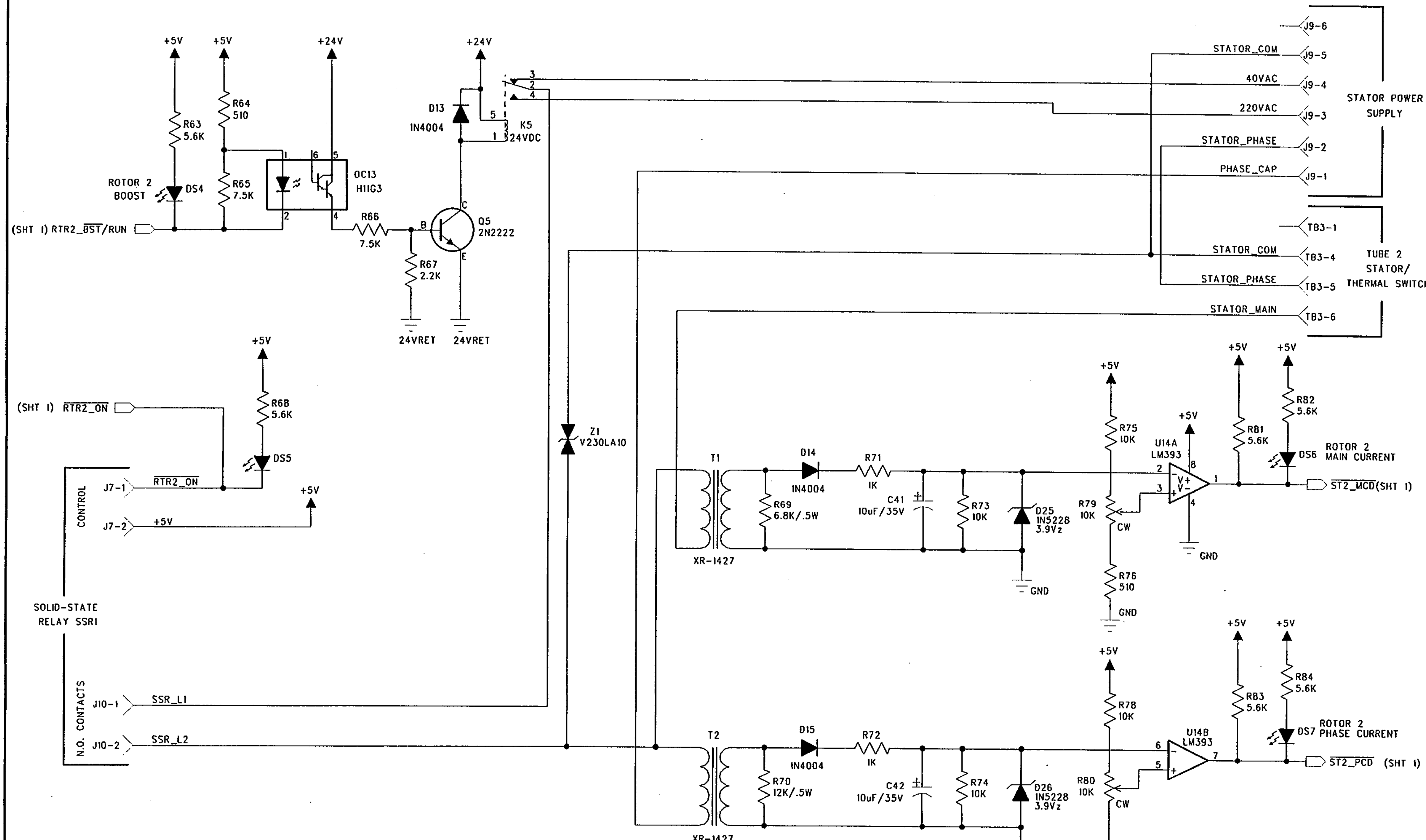
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 4 OF 6

CONTINENTAL
X-RAY
CORPORATION



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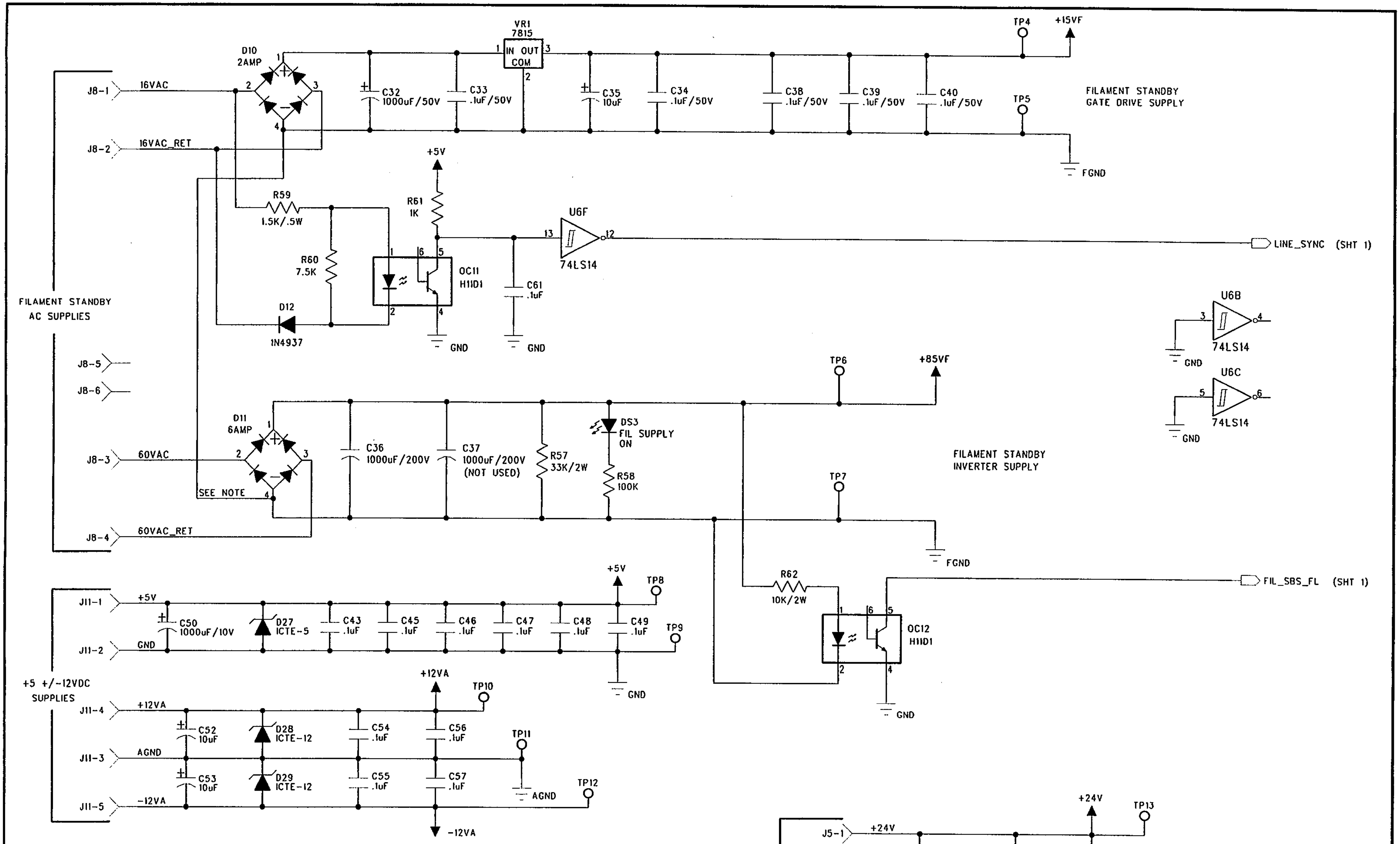
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 5 OF 6

CONTINENTAL X-RAY CORPORATION



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01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

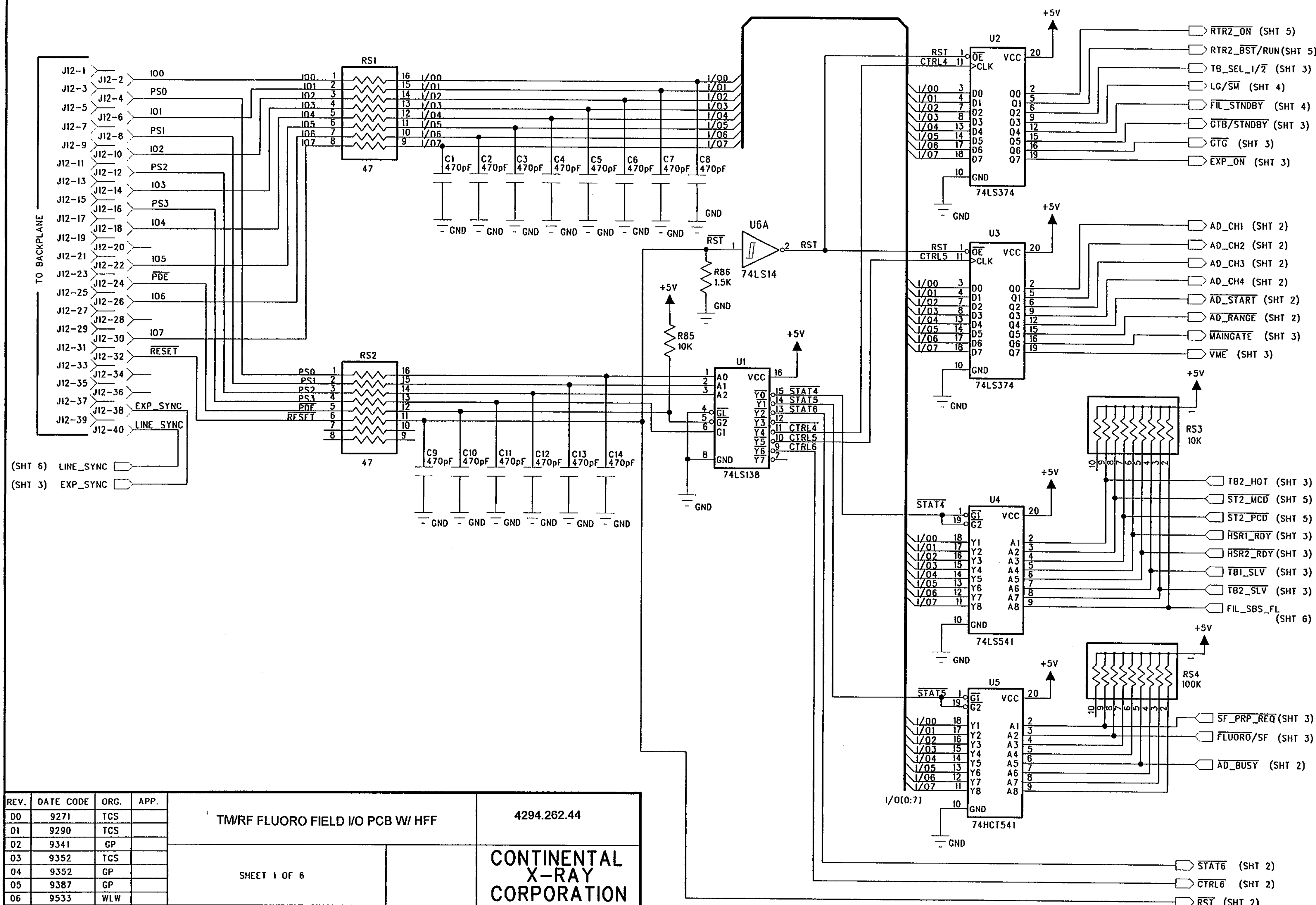
TM/RF FLUORO FIELD I/O BOARD

4294.262.17

SHEET 6 OF 6

CONTINENTAL X-RAY CORPORATION

NOTE: FILAMENT DRIVE SUPPLY AND FILAMENT CONTROL SUPPLY (FGND) ARE CONNECTED AT ONLY 1 POINT -- D10 PIN 4 AND D11 PIN 4.



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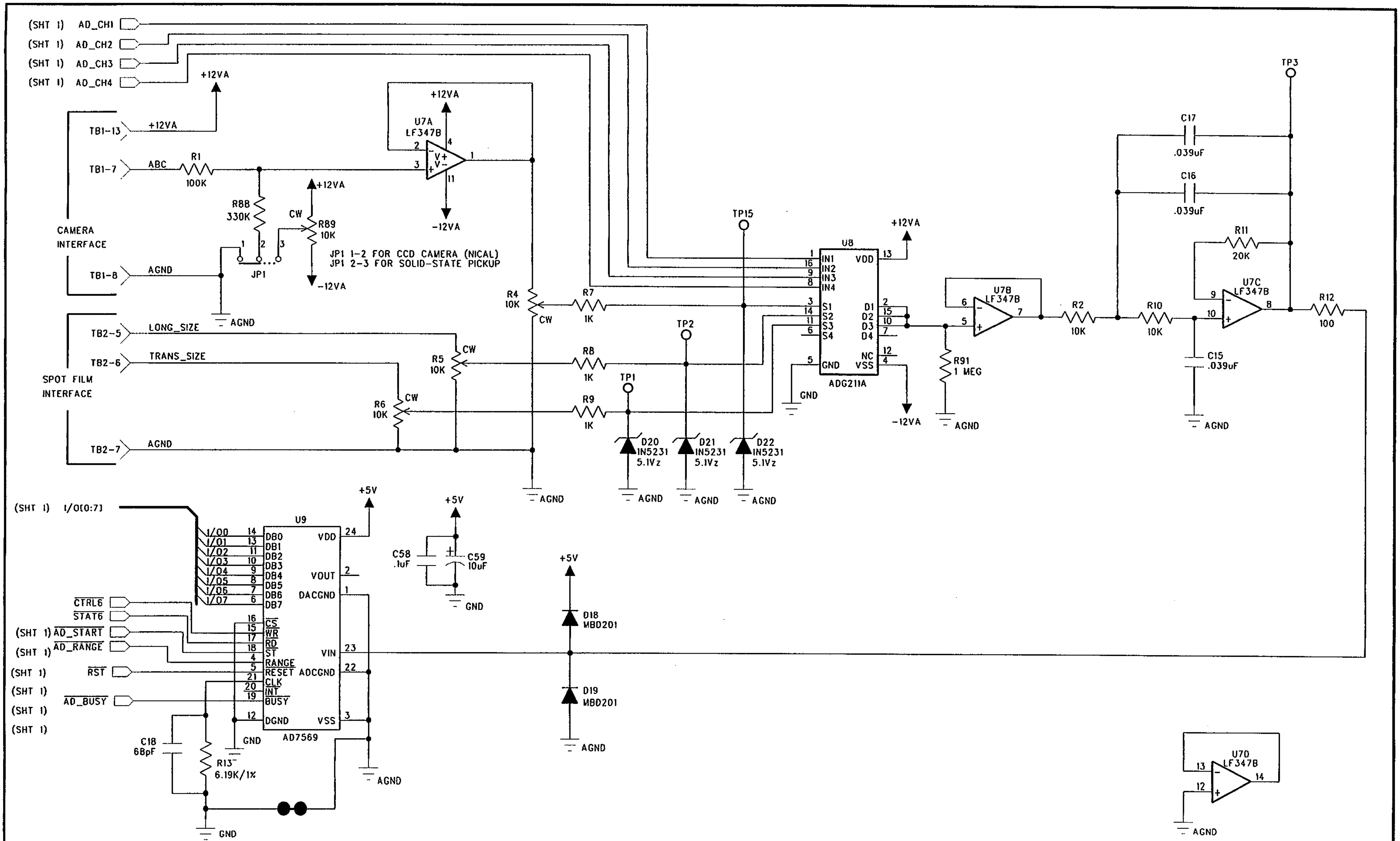
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 1 OF 6

CONTINENTAL X-RAY CORPORATION



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01	9290	TCS	
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9381	GP	
06	9533	WLW	

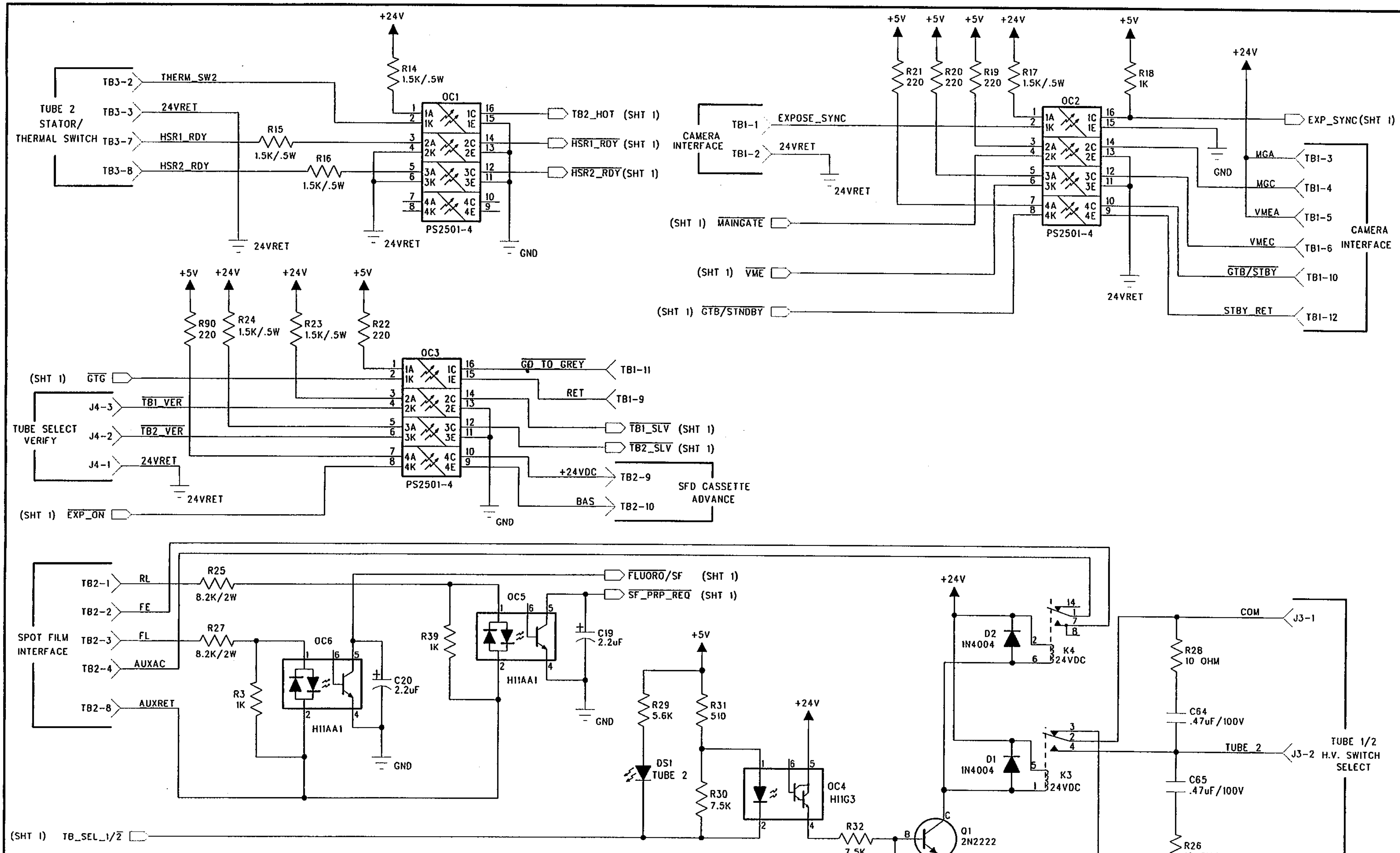
TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 2 OF 6

CONTINENTAL X-RAY CORPORATION

FOR OTHER TB1 CONNECTIONS SEE SHEET 3
FOR OTHER TB2 CONNECTIONS SEE SHEET 3



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04	9352	GP	
05	9387	GP	
06	9533	WLW	

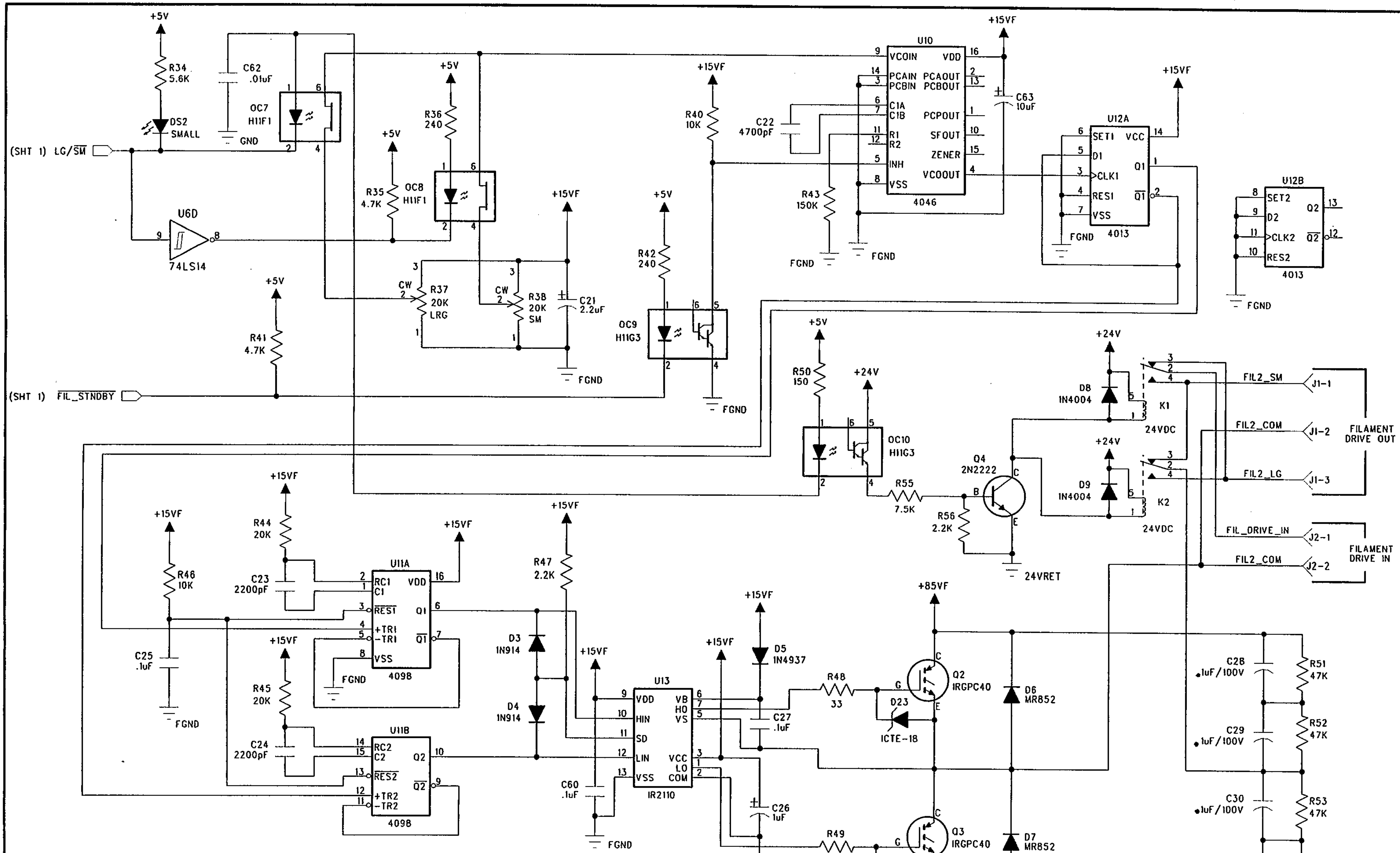
TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 3 OF 6

CONTINENTAL X-RAY CORPORATION

SEE SHEET 2 FOR OTHER TB1 CONNECTIONS
SEE SHEET 2 FOR OTHER TB2 CONNECTIONS
SEE SHEET 5 FOR OTHER TB3 CONNECTIONS



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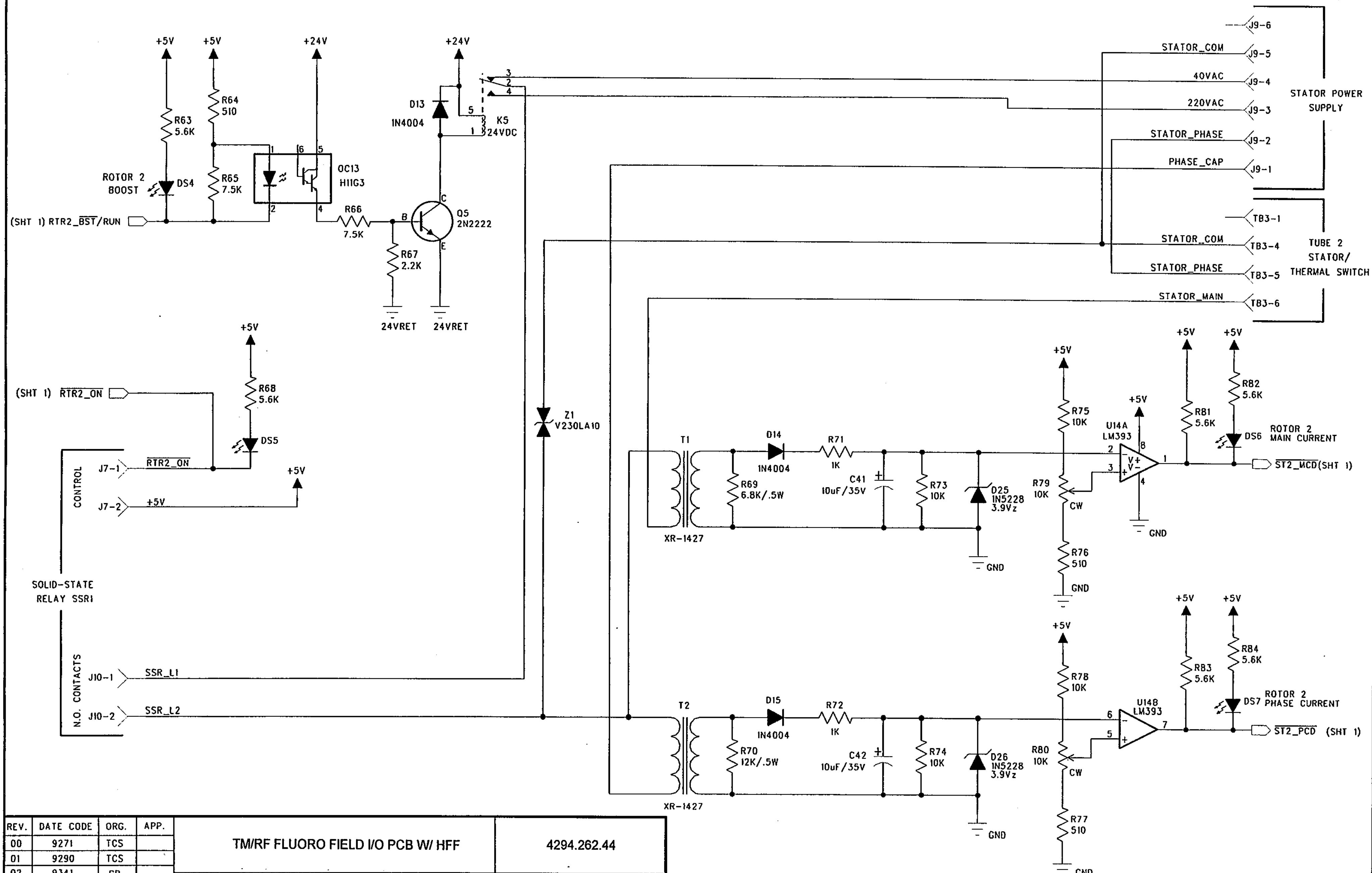
02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 4 OF 6

CONTINENTAL X-RAY CORPORATION



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02	9341	GP	
03	9352	TCS	
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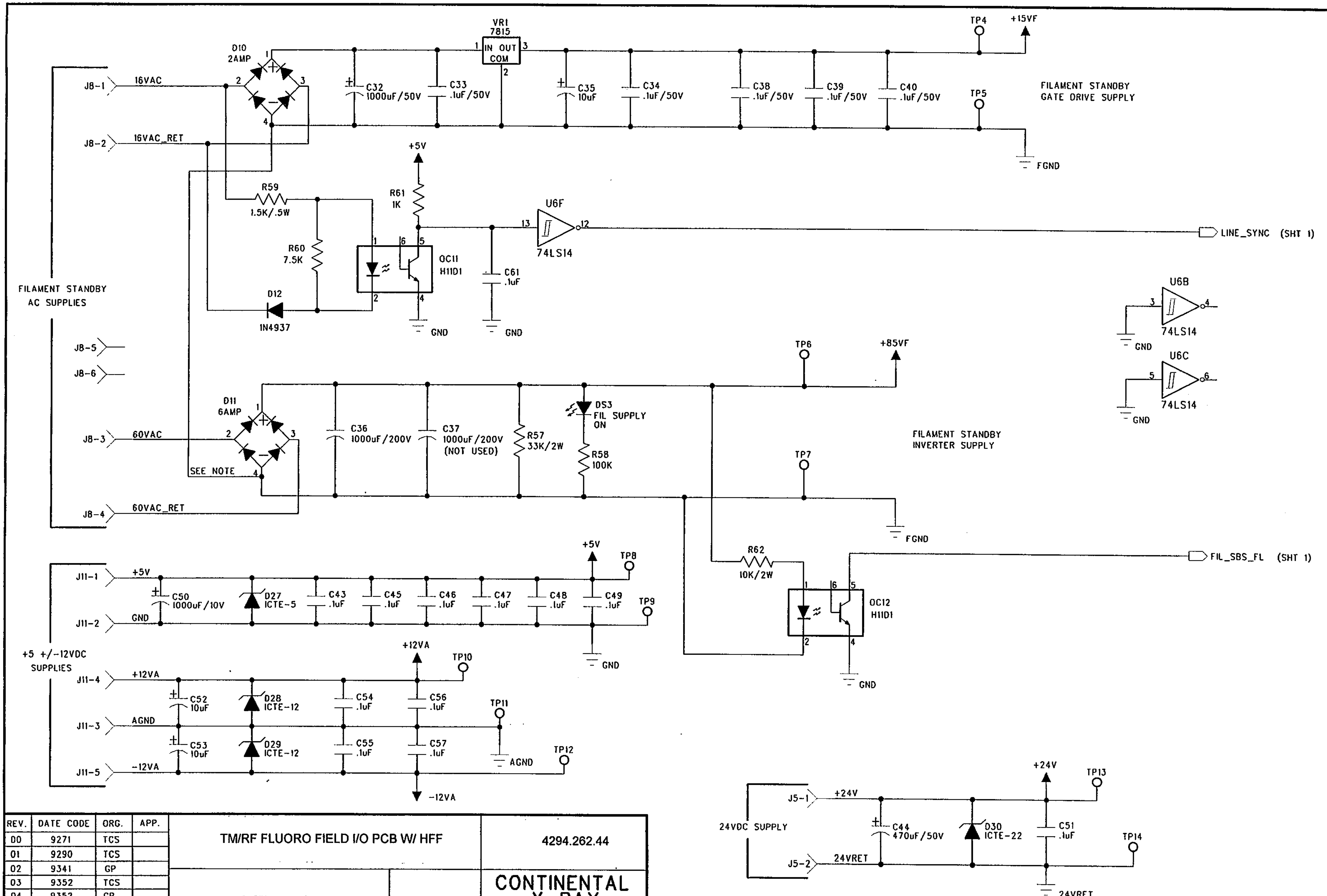
05	9387	GP	
06	9533	WLW	

TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 5 OF 6

CONTINENTAL X-RAY CORPORATION



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02	9341	GP	
03	9352	TCS	
04	9352	GP	
05	9387	GP	
06	9533	WLW	

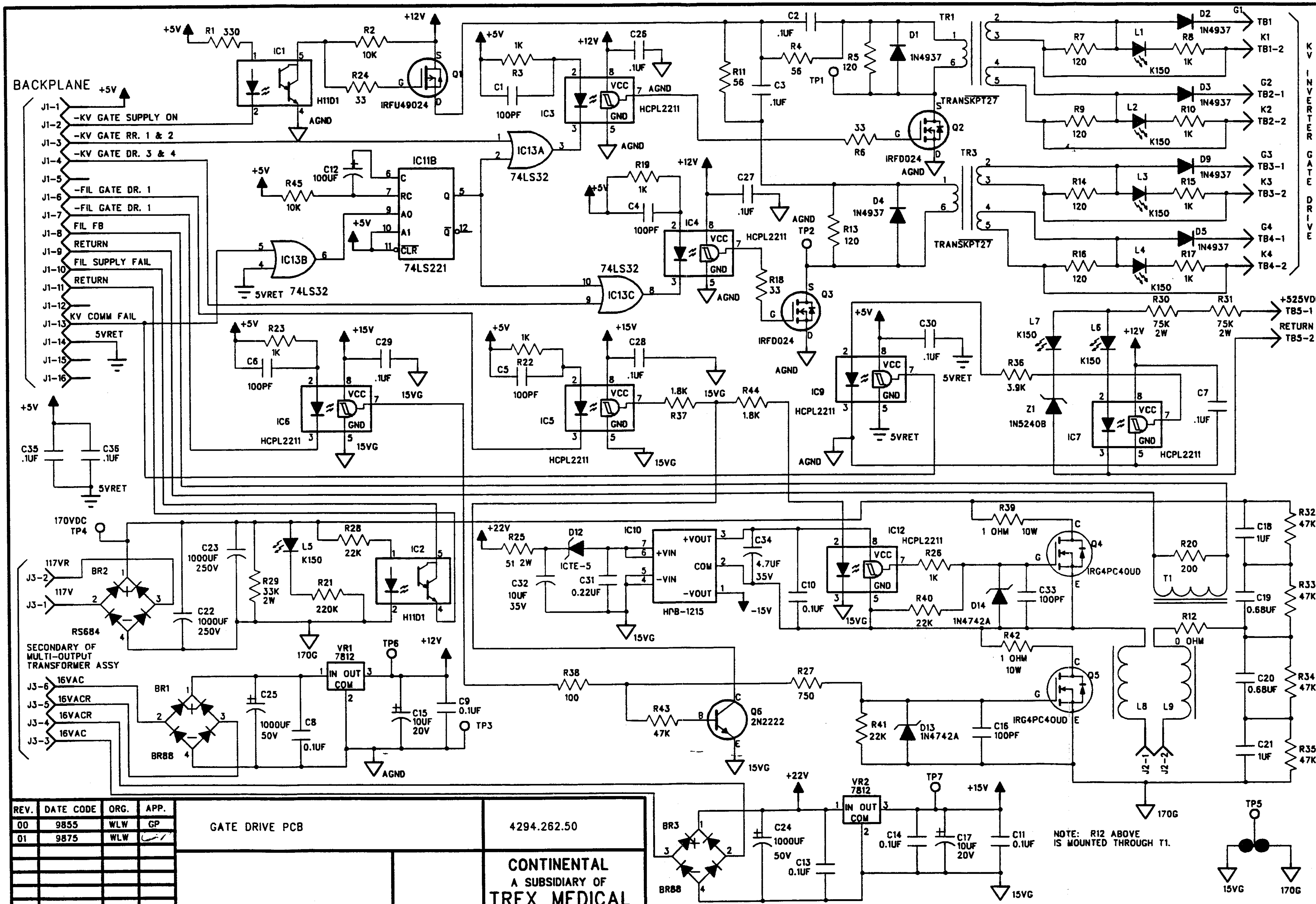
TM/RF FLUORO FIELD I/O PCB W/ HFF

4294.262.44

SHEET 6 OF 6

CONTINENTAL X-RAY CORPORATION

NOTE: FILAMENT DRIVE SUPPLY AND FILAMENT CONTROL SUPPLY (FGND) ARE CONNECTED AT ONLY 1 POINT -- D10 PIN 4 AND D11 PIN 4.

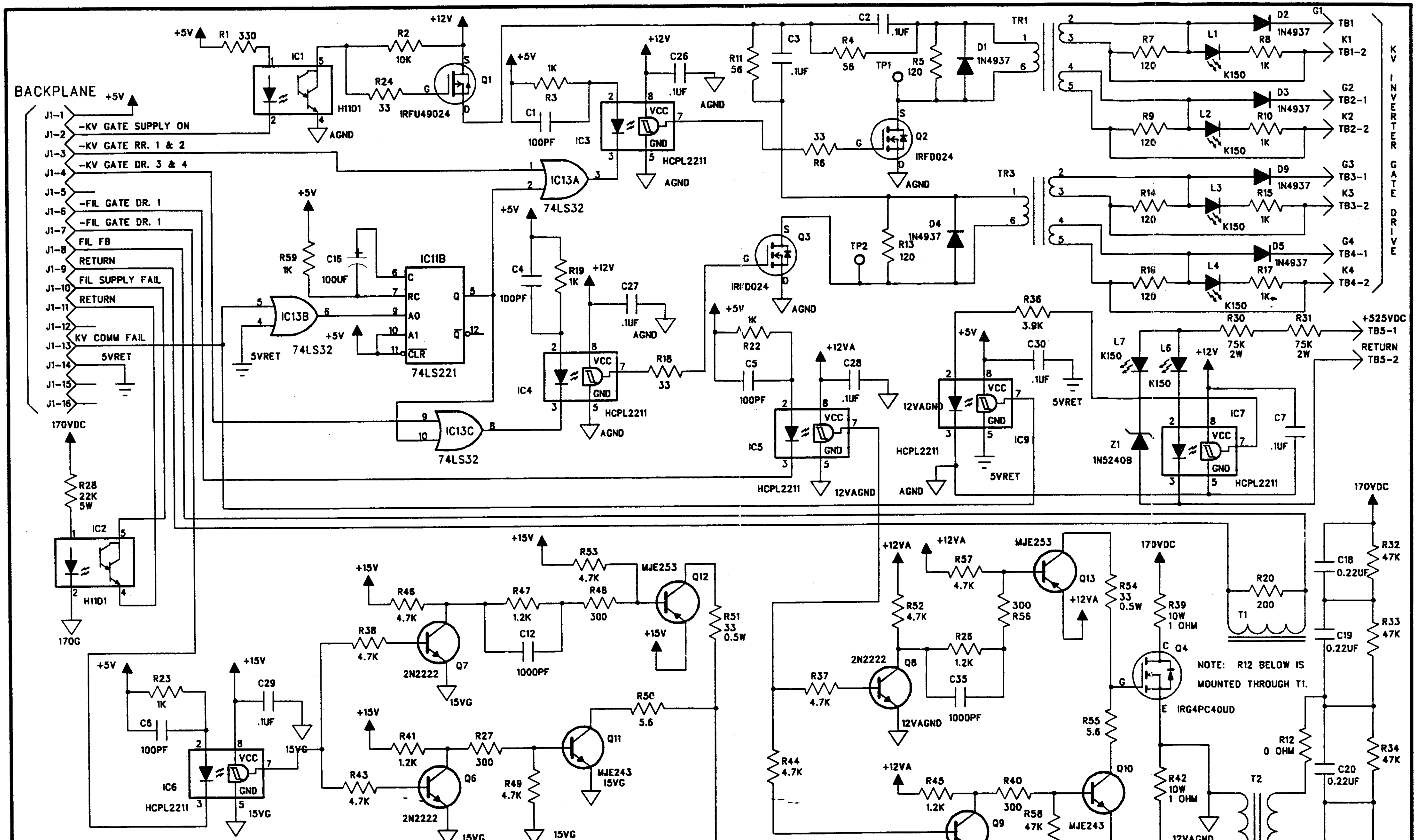


REV.	DATE CODE	ORG.	APP.
00	9855	WLW	GP
01	9875	WLW	

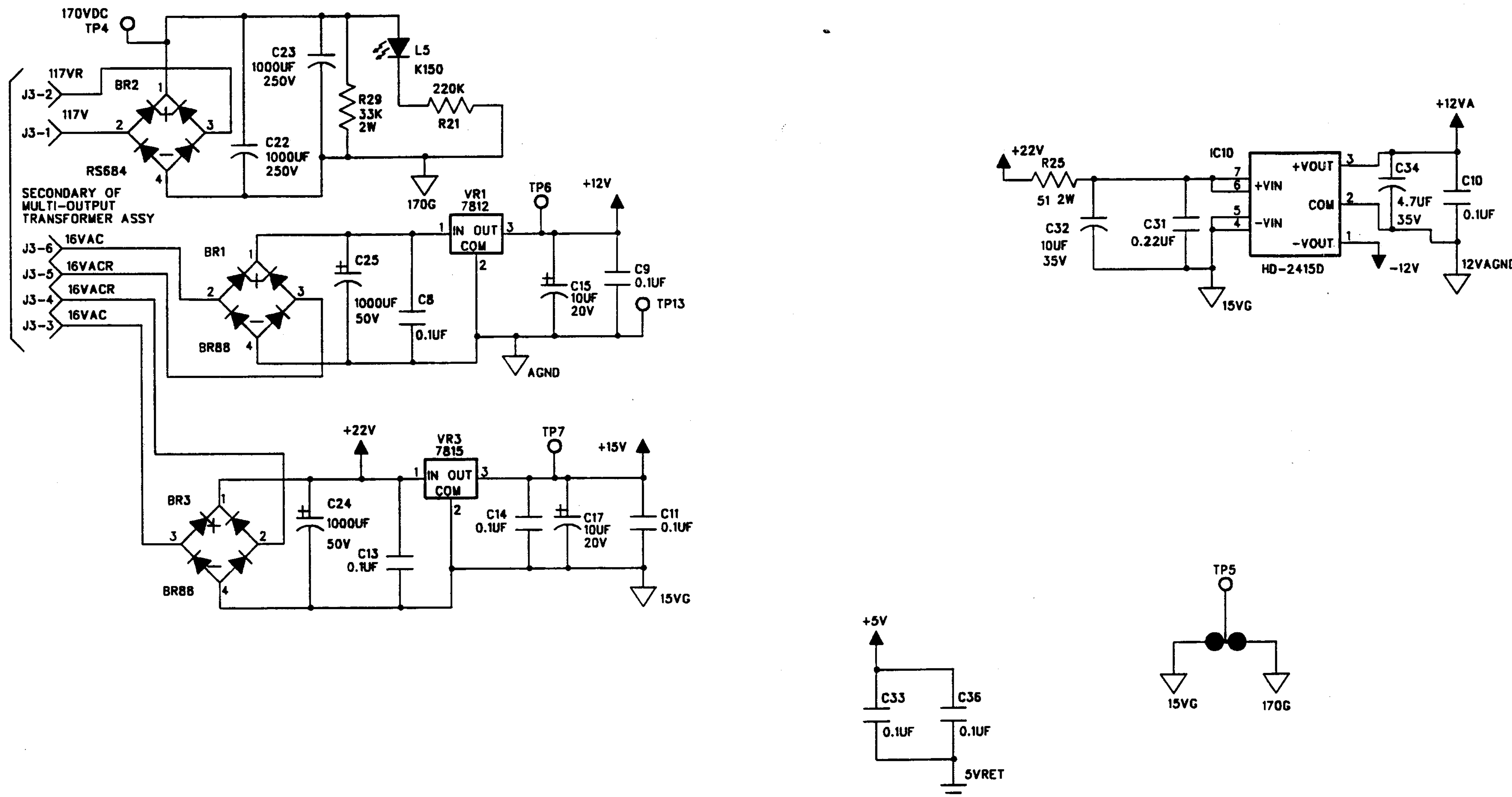
GATE DRIVE PCB

4294.262.50

CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL



REV.	DATE CODE	ORG.	APP.		
00	9853	WLW	GP	TM GATE DRIVE WITH H/F FILAMENT PCB	4294.262.51
01	9875	WLW			
				SHEET 1 OF 2	CONTINENTAL A SUBSIDIARY OF TREX MEDICAL



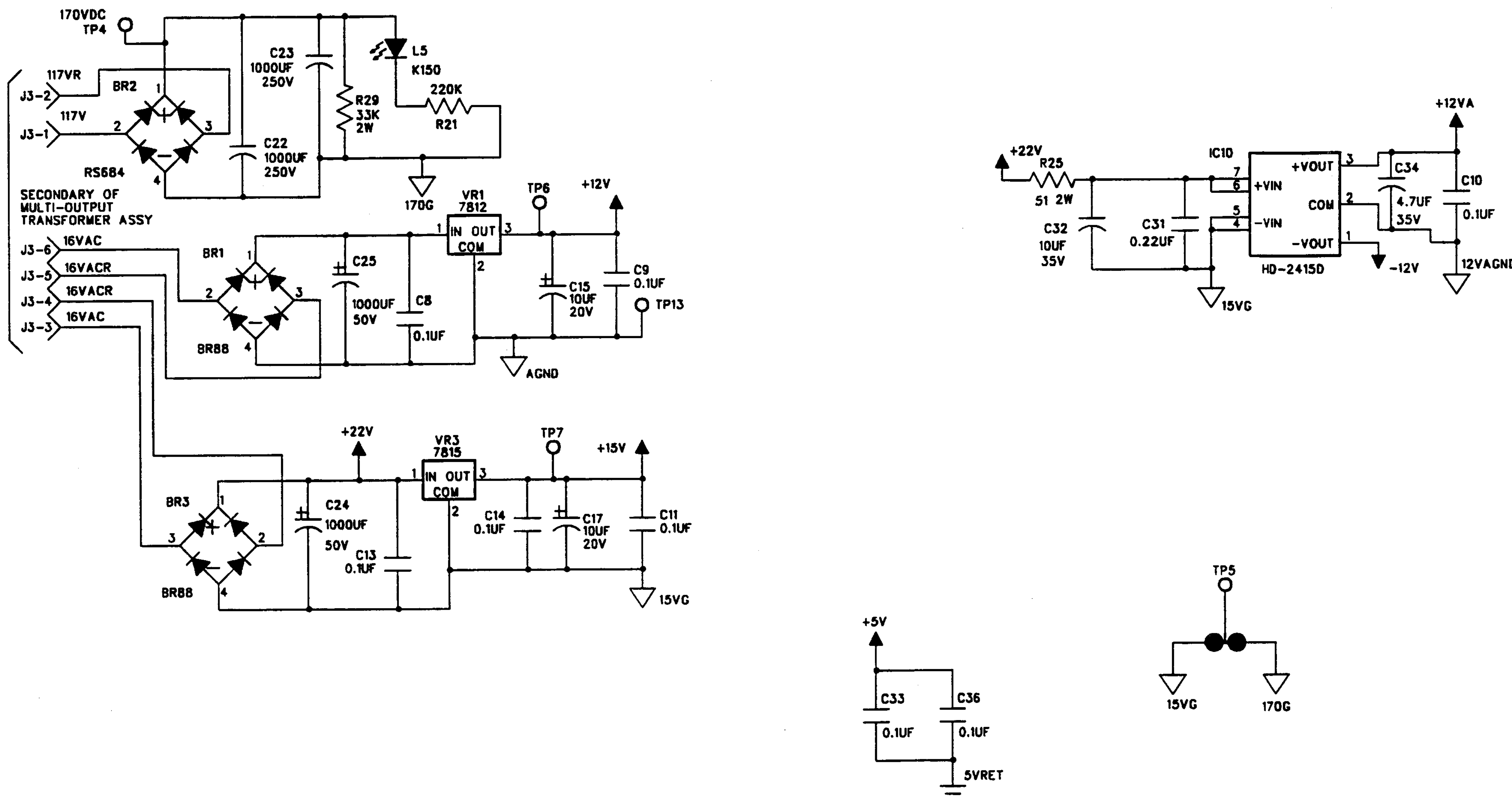
REV.	DATE CODE	ORG.	APP.
00	9853	WLW	GP
01	9875	WLW	

TM H/F GATE DRIVE WITH H/F FILAMENT PCB

4294.262.51

SHEET 2 OF 2

CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL



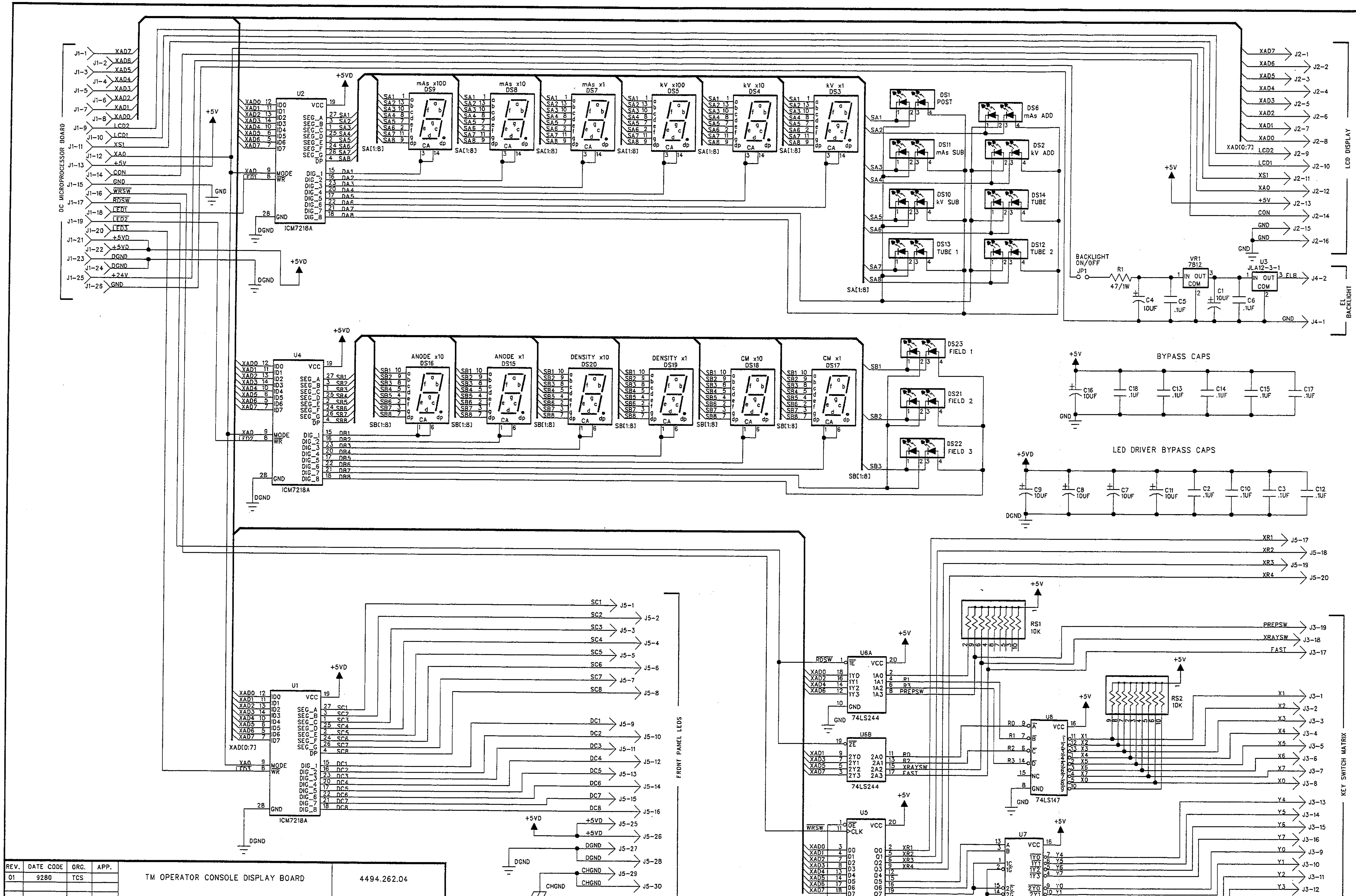
REV.	DATE CODE	ORG.	APP.
00	9853	WLW	GP
01	9875	WLW	

TM H/F GATE DRIVE WITH H/F FILAMENT PCB

4294.262.51

SHEET 2 OF 2

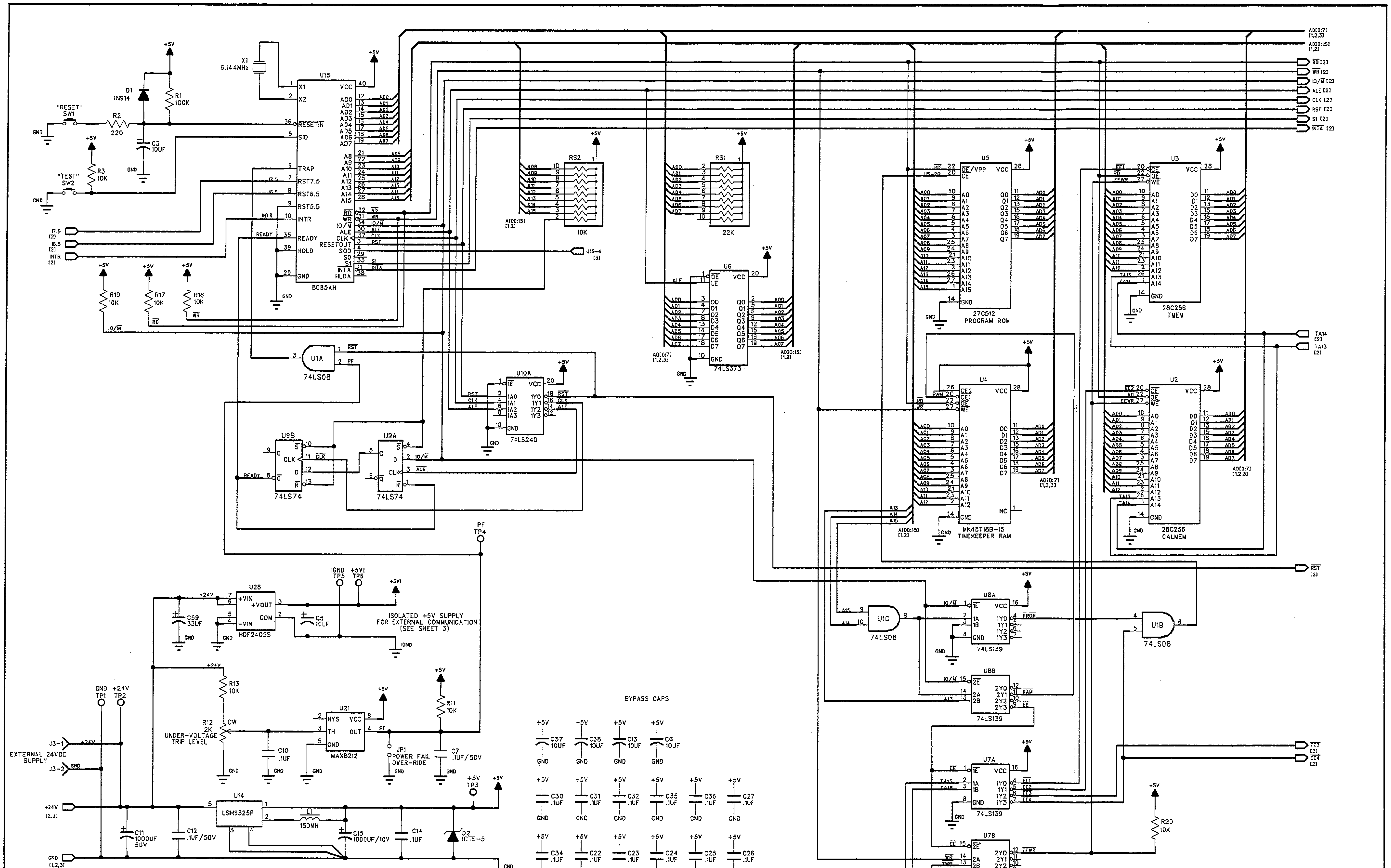
CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL



REV.	DATE CODE	ORG.	APP.		
01	9280	TCS		TM OPERATOR CONSOLE DISPLAY BOARD	4494.262.04

CONTINENTAL X-RAY CORPORATION

NOTES: +5VD AND DGND ARE POWER AND GROUND FOR LED DRIVERS ONLY.
+5V AND GND ARE CONNECTED TO +5VD AND DGND AT THE CONNECTOR ON THE OC UP BOARD.



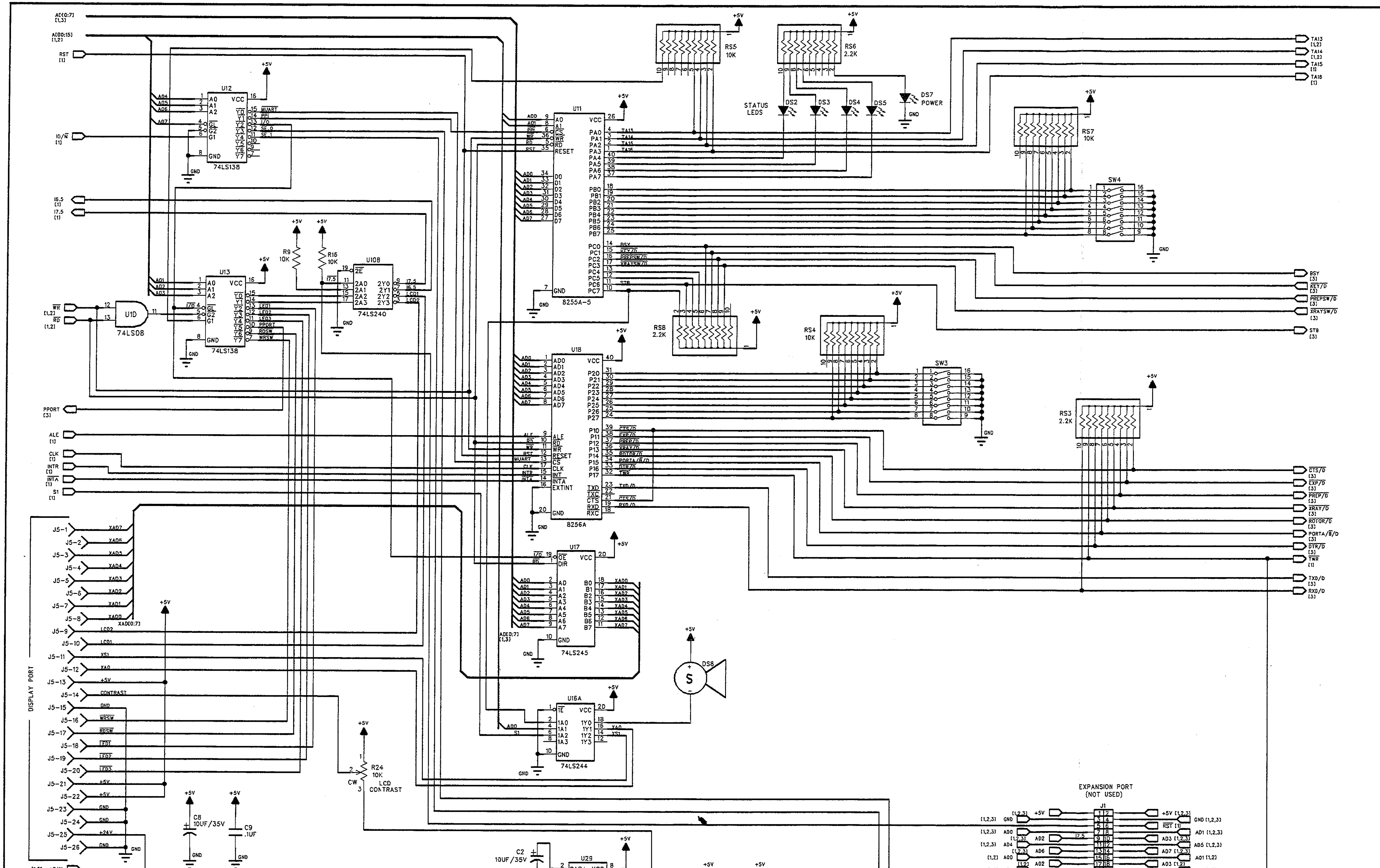
REV.	DATE CODE	ORG.	APP.
00	9255	TCS	
01	9293	TCS	
02	9376	TCS	
03	9417	WLW	
04	9635	WLW	

TM OPERATOR CONSOLE
MICROPROCESSOR BOARD

SHEET 1 OF 3

4494.262.03

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.
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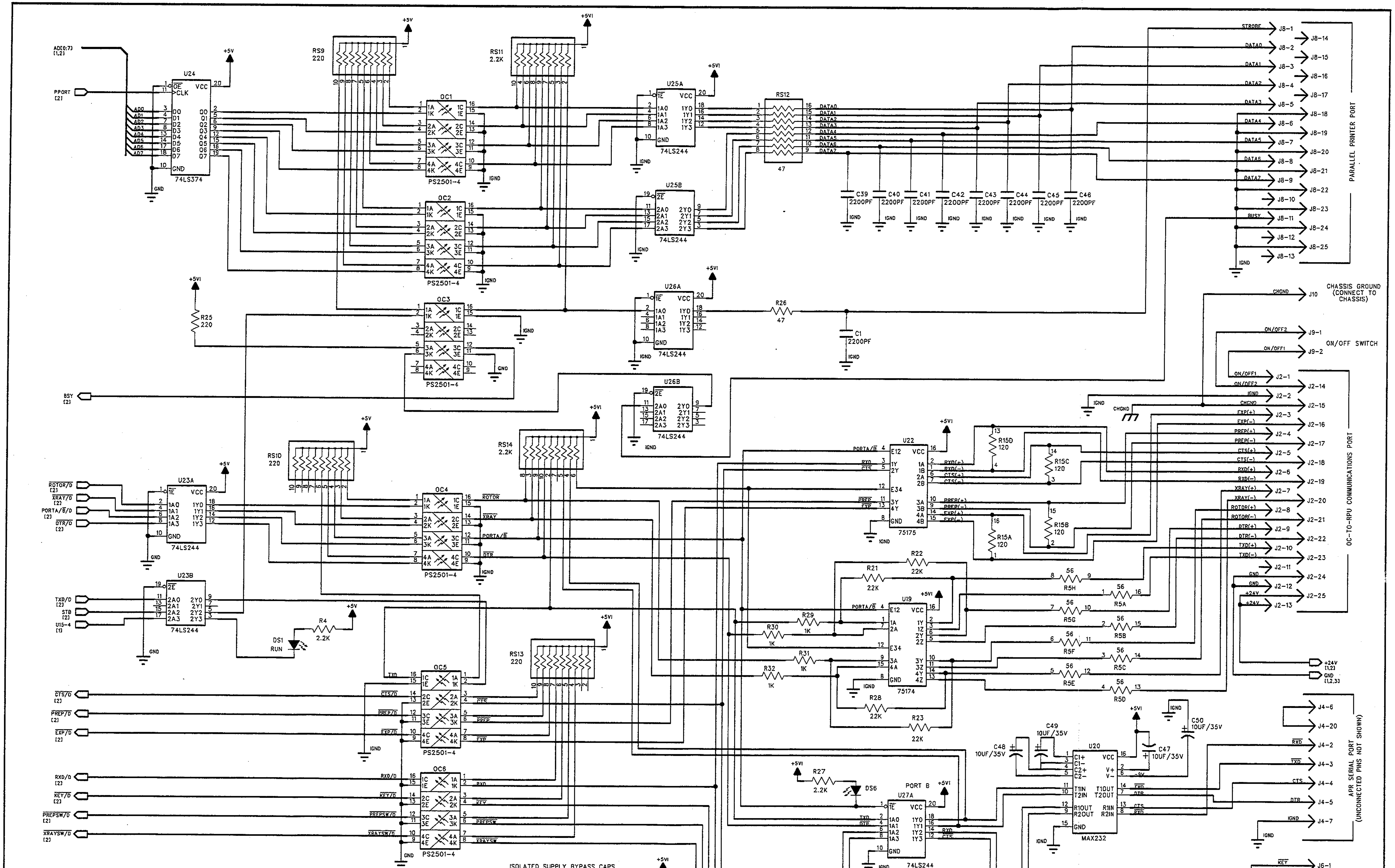
01	9293	TCS	
02	9376	TCS	
03	9417	WLW	
04	9635	WLW	

TM OPERATOR CONSOLE
MICROPROCESSOR BOARD

4494.262.03

SHEET 2 OF 3

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.
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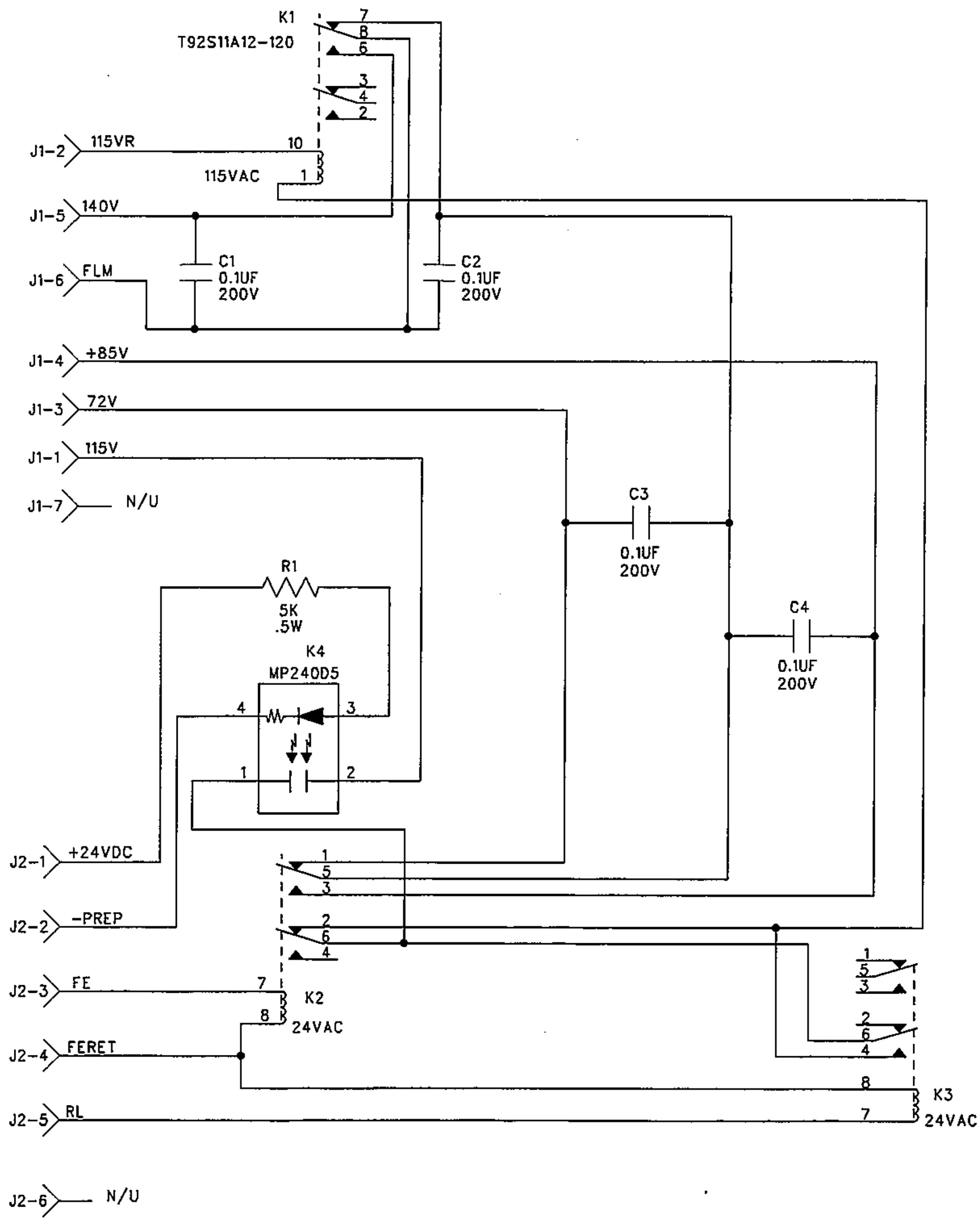
01	9293	TCS	
02	9376	TCS	
03	9417	WLW	
04	9635	WLW	

TM OPERATOR CONSOLE
MICROPROCESSOR BOARD

SHEET 3 OF 3

4494.262.03

CONTINENTAL X-RAY CORPORATION



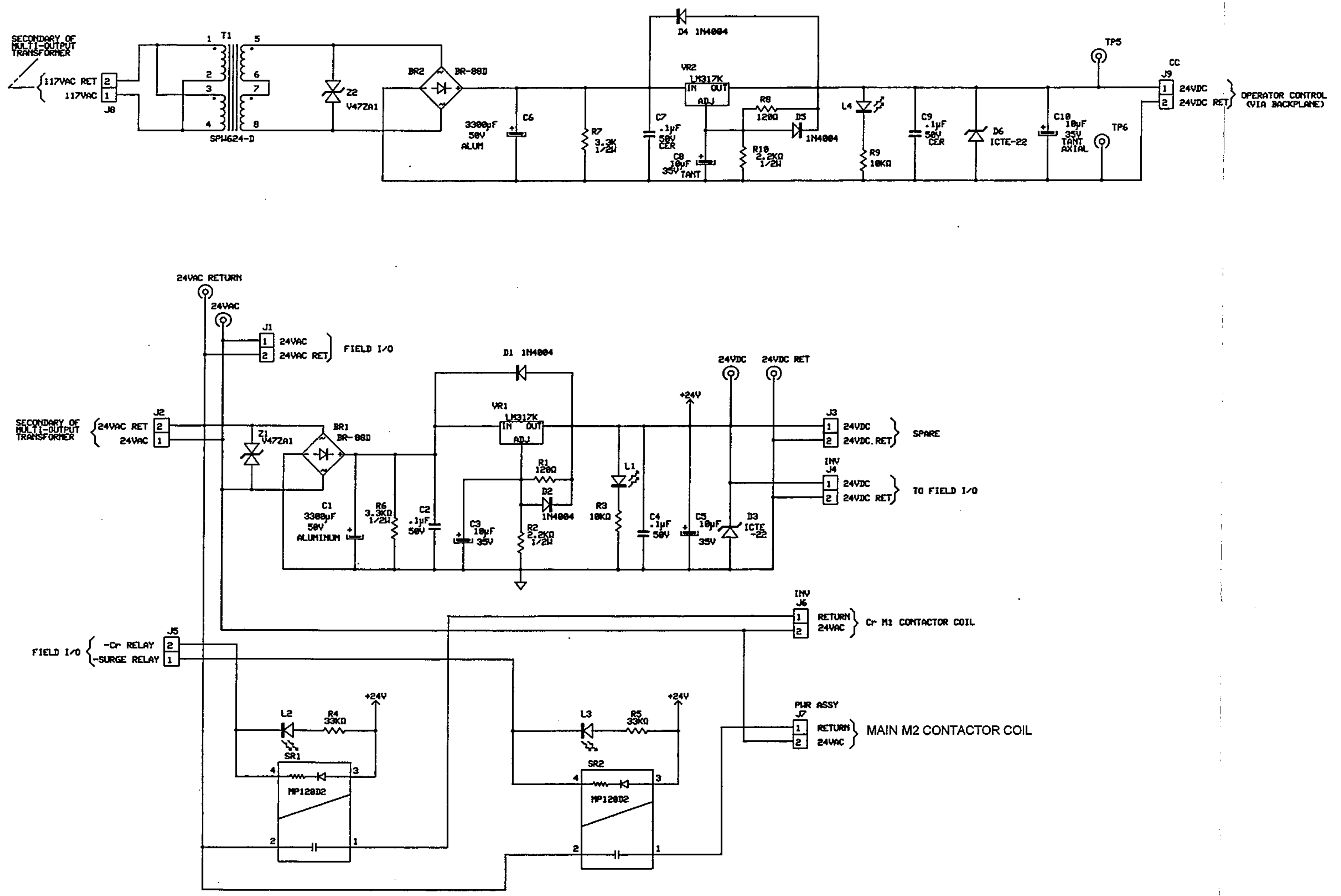
REV.	DATE CODE	ORG.	APP.
00	9639	WLW	
01	9660	WLW	

HF FILAMENT POWER SUPPLY PCB

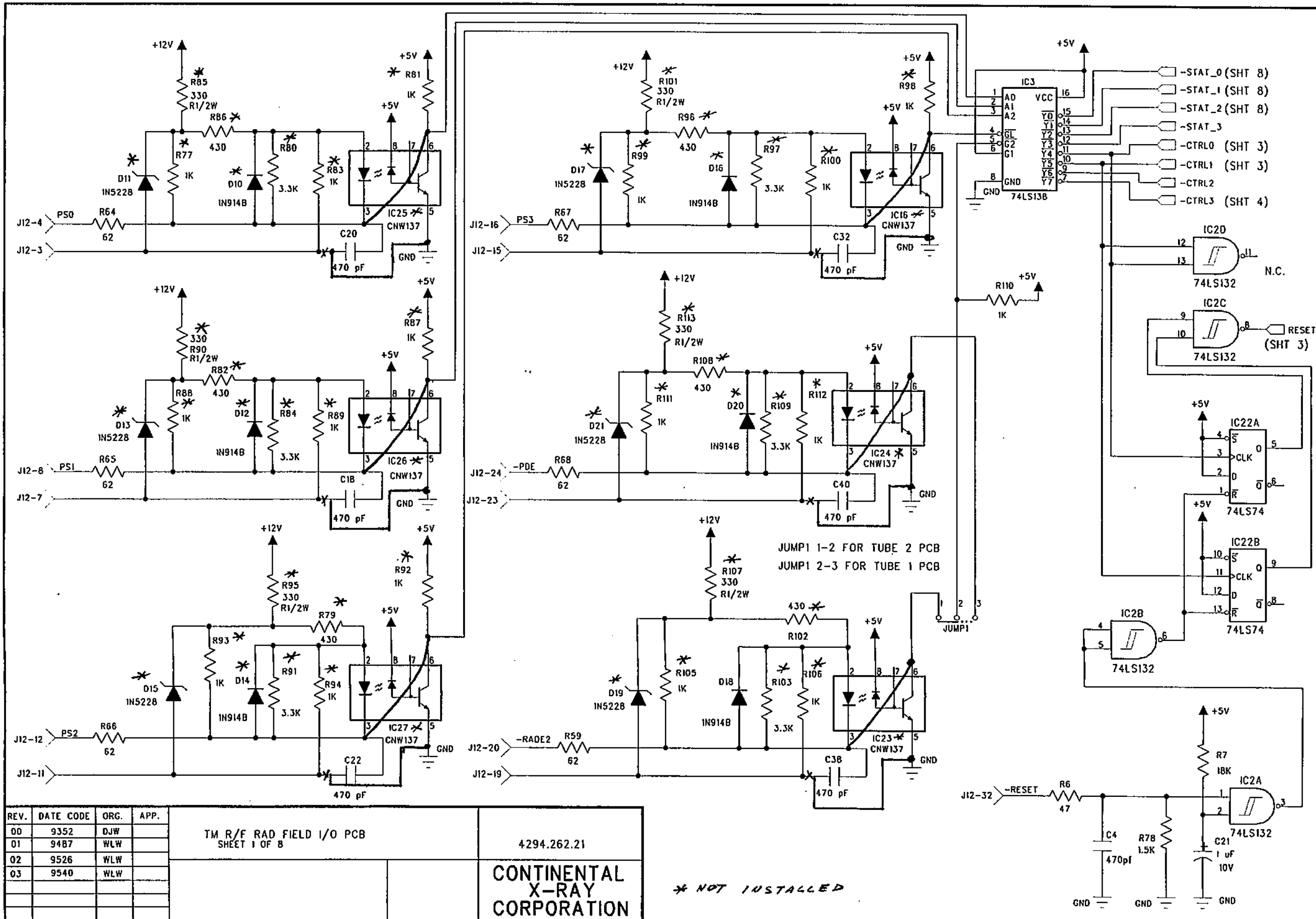
4194.262.24

CONTINENTAL X-RAY CORPORATION

ECN	DATE	SYM	REVISION RECORD	DWN BY	APP BY



Continental a subsidiary of Trex Medical	
Relay/OC Power Supply PCB	
4294.262.35	(1 of 1)
9487	Rev. 00

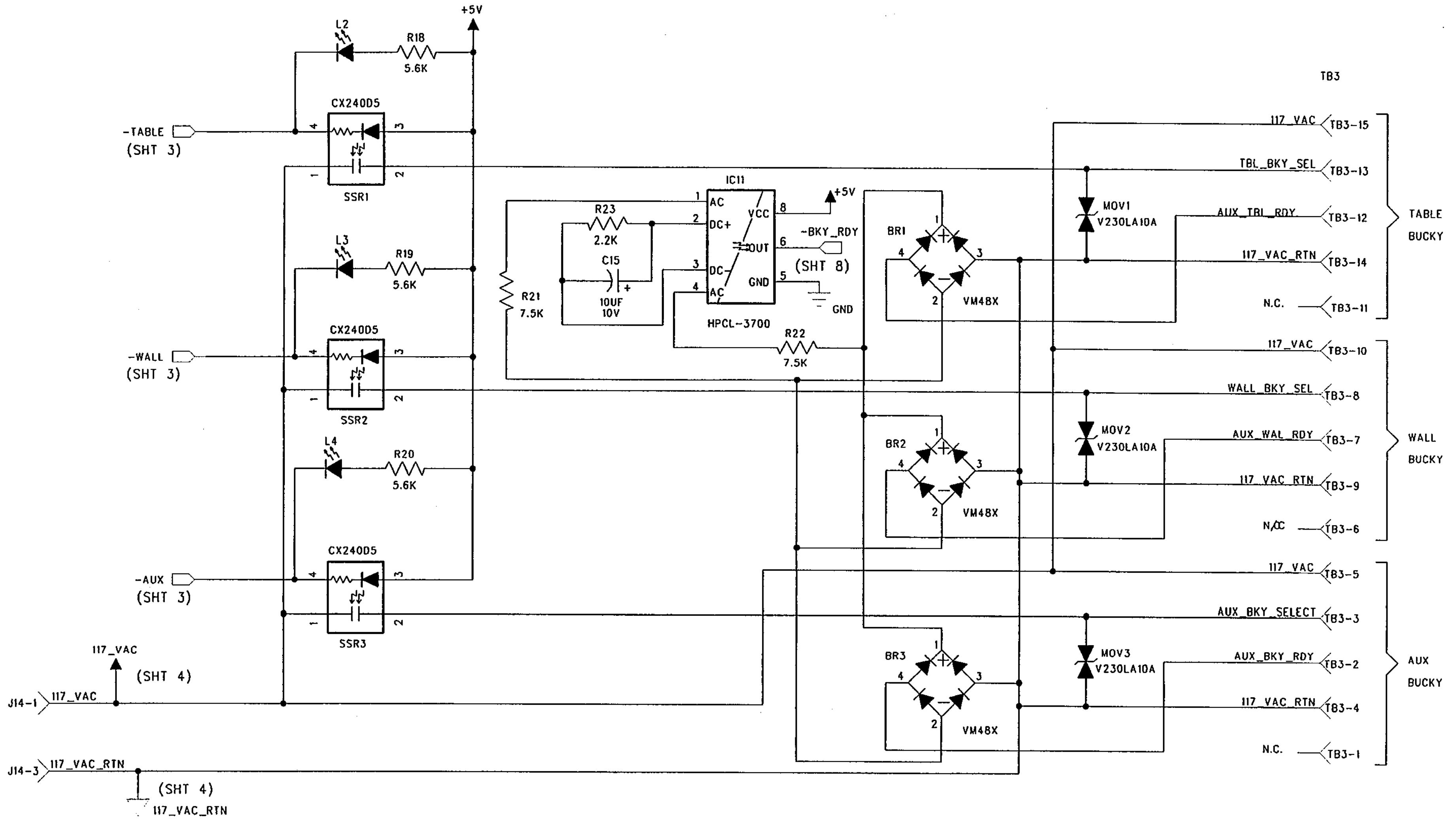


REV.	DATE CODE	ORG.	APP.
00	9352	DJW	
01	9487	WLW	
02	9526	WLW	
03	9540	WLW	

TM R/F RAD FIELD I/O PCB
SHEET 1 OF 8

4294.262.21

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.
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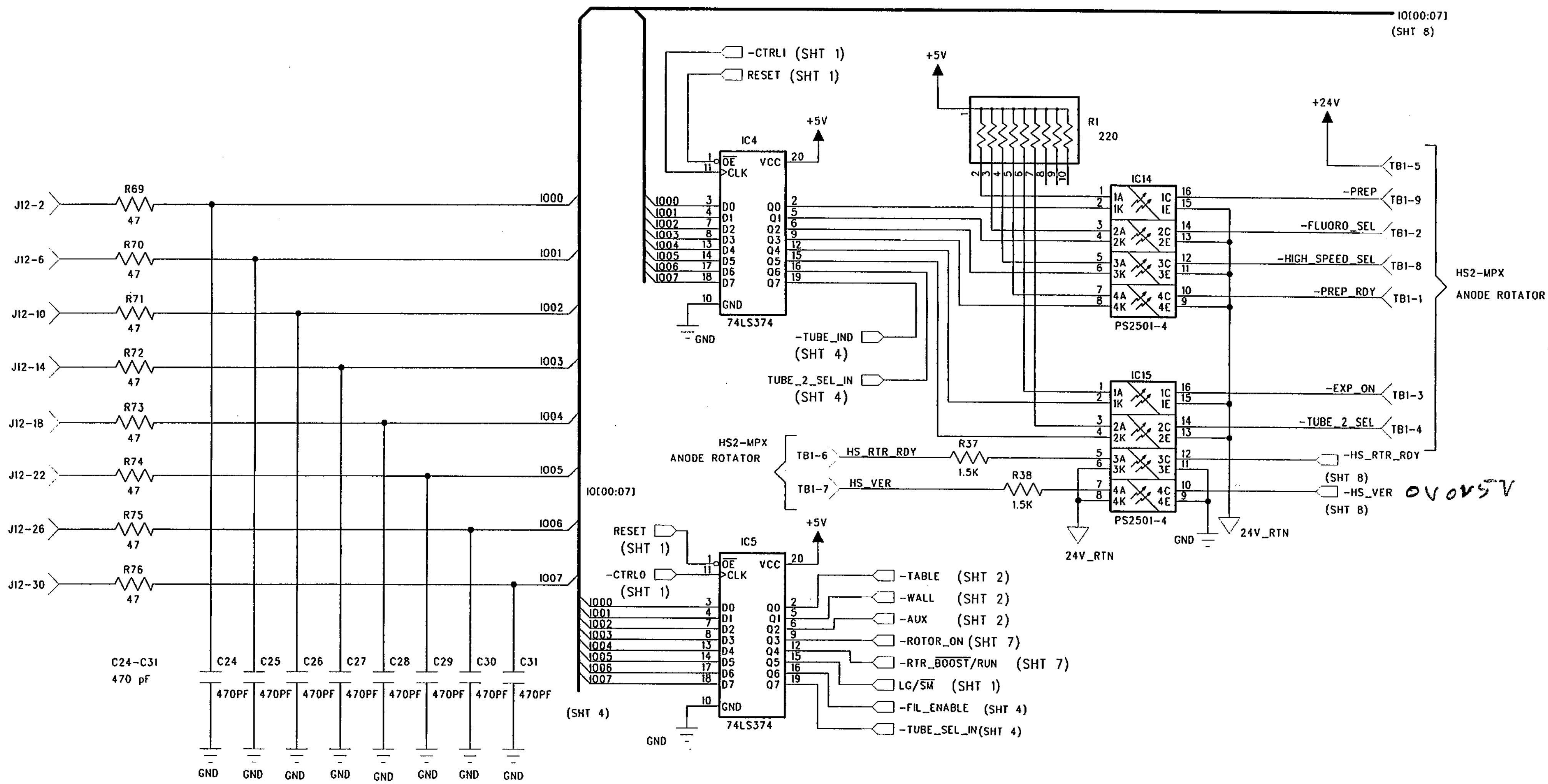
01	9487	WLW	
02	9526	WLW	
03	9540	WLW	

TM/RF RAD FIELD I/O SCHEMATIC

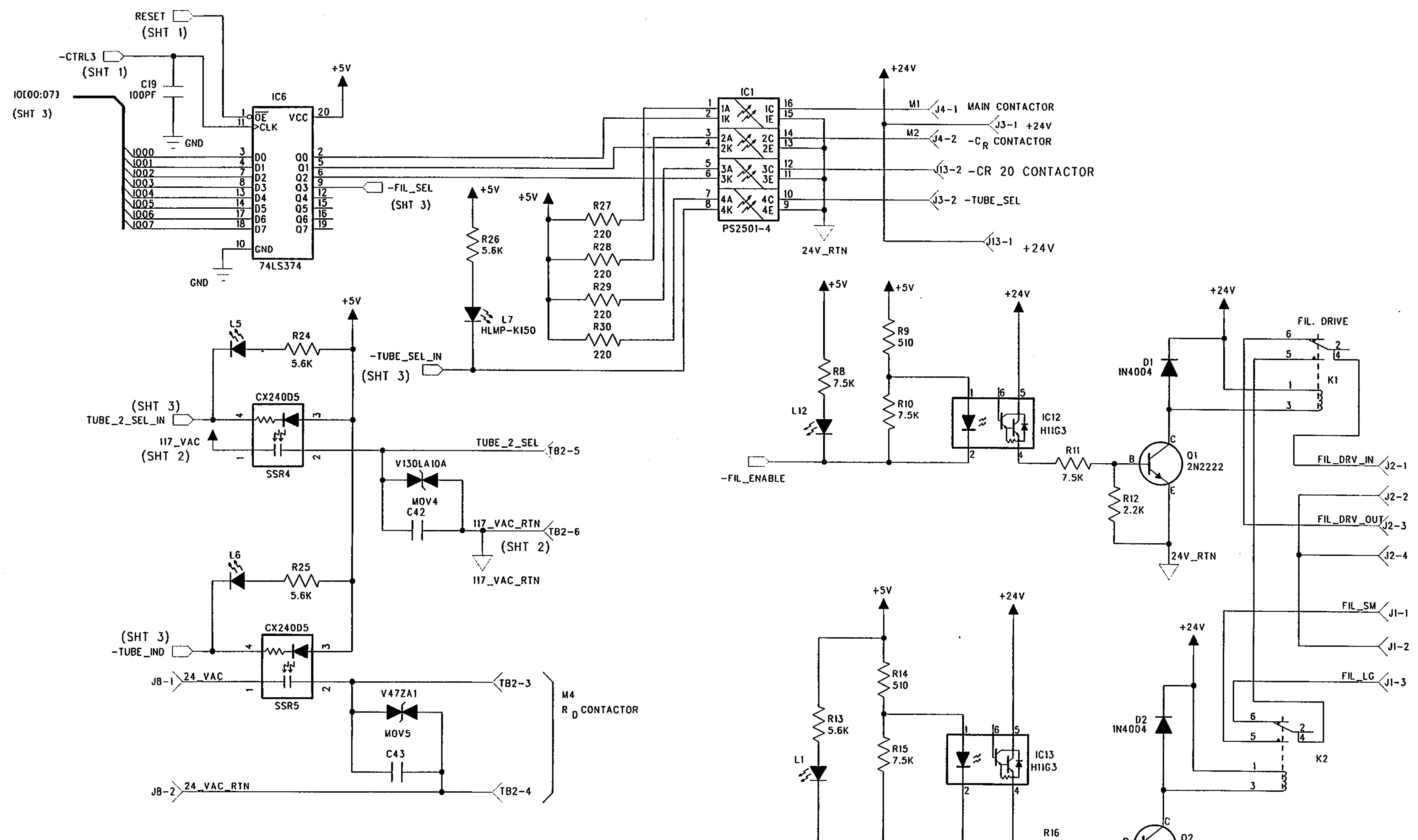
SHEET 2 OF 8

4294.262.21

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.		
00	9352	DJW		TM/RF RAD FIELD I/O SCHEMATIC	4294.262.21
01	9487	WLW		SHEET 3 OF 8	
02	9526	WLW			CONTINENTAL X-RAY CORPORATION
03	9540	WLW			



REV.	DATE CODE	ORG.	APP.
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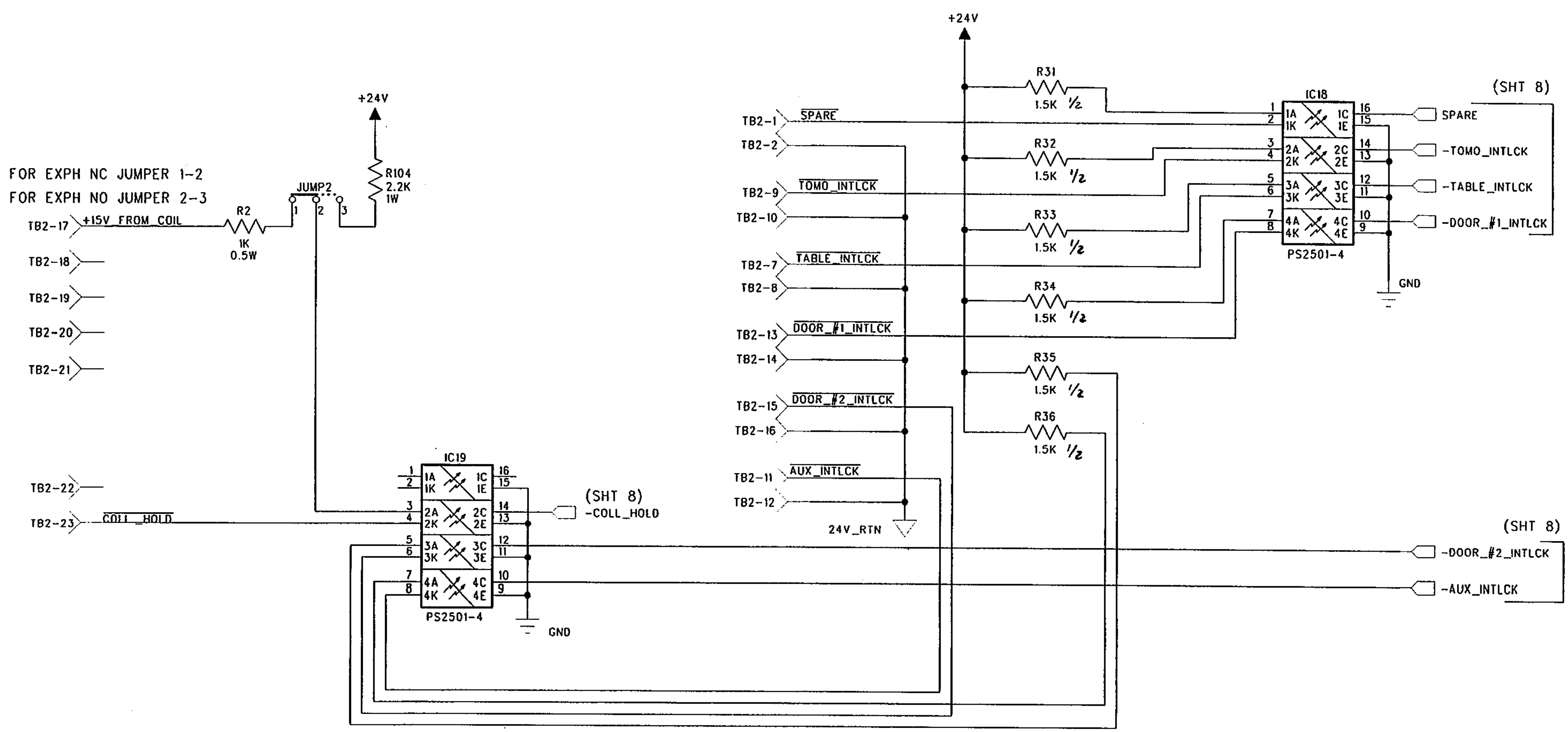
02	9526	WLW	
03	9540	WLW	

TM/RF RAD FIELD I/O SCHEMATIC

SHEET 4 OF 8

4294.262.21

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.
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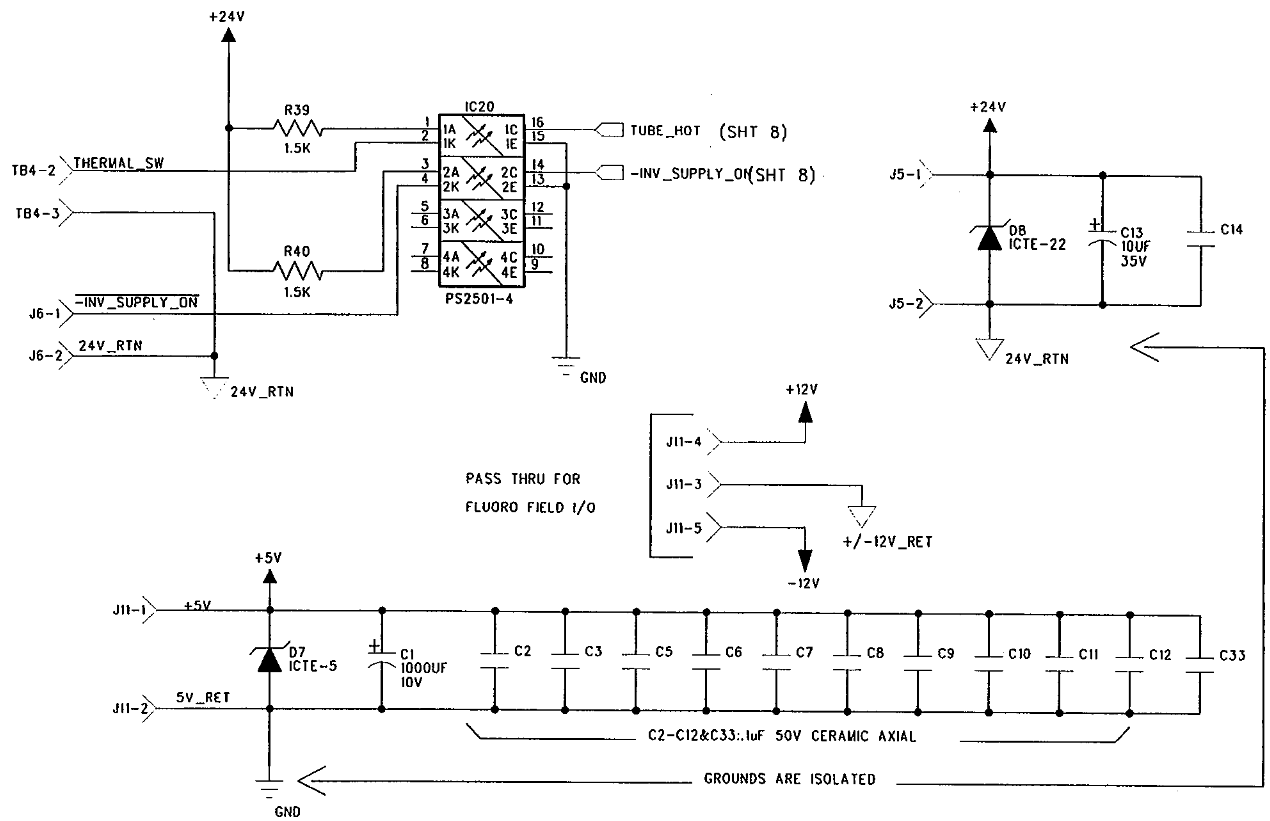
02	9526	WLW	
03	9540	WLW	

TM/RF RAD FIELD I/O SCHEMATIC

SHEET 5 OF 8

4294.262.21

CONTINENTAL X-RAY CORPORATION



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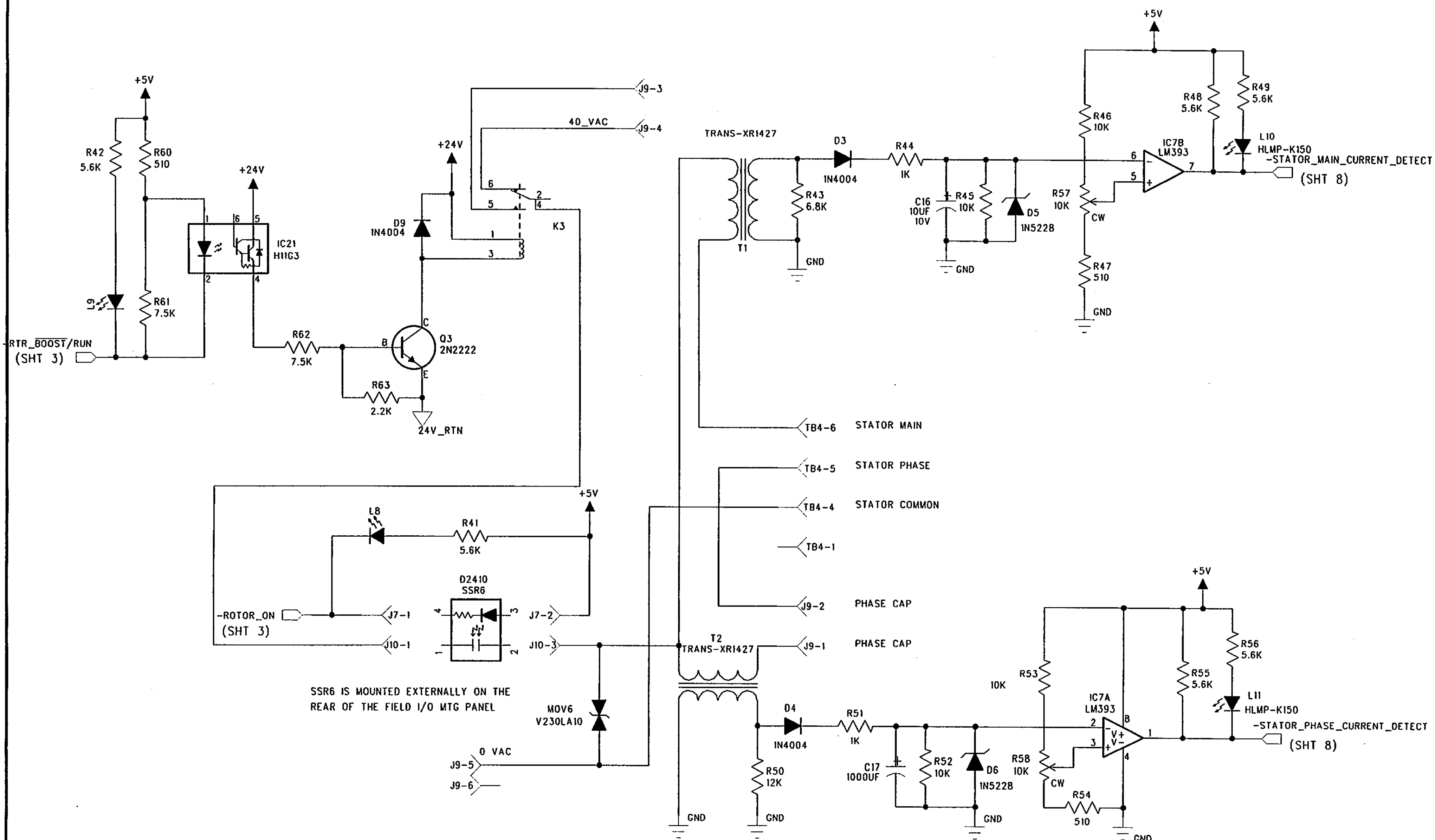
03	9540	WLW	

TM/RF RAD FIELD I/O SCHEMATIC

SHEET 6 OF 8

4294.262.21

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.
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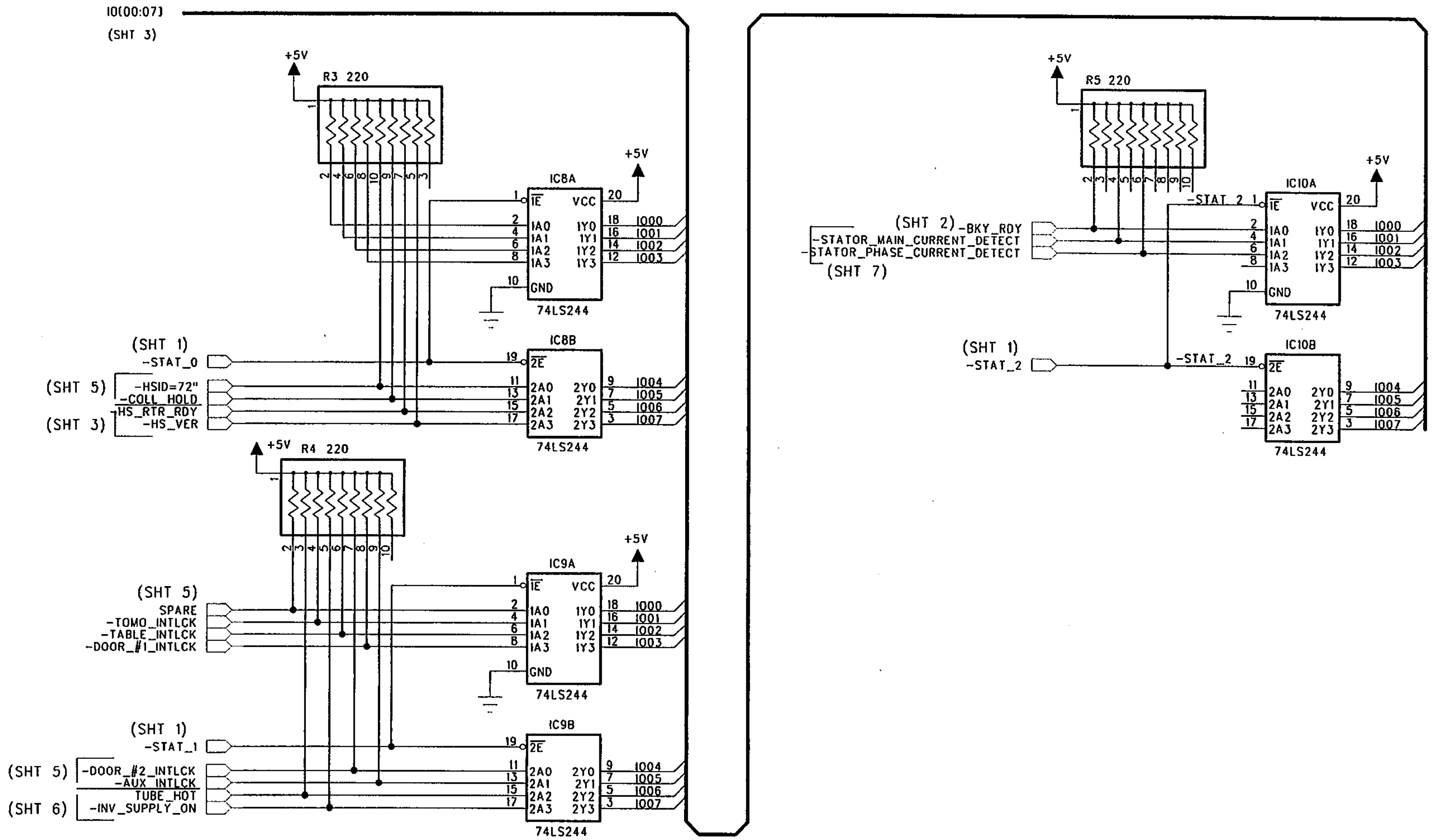
03	9540	WLW	

TM/RF RAD FIELD I/O SCHEMATIC

SHEET 7 OF 8

4294.262.21

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.
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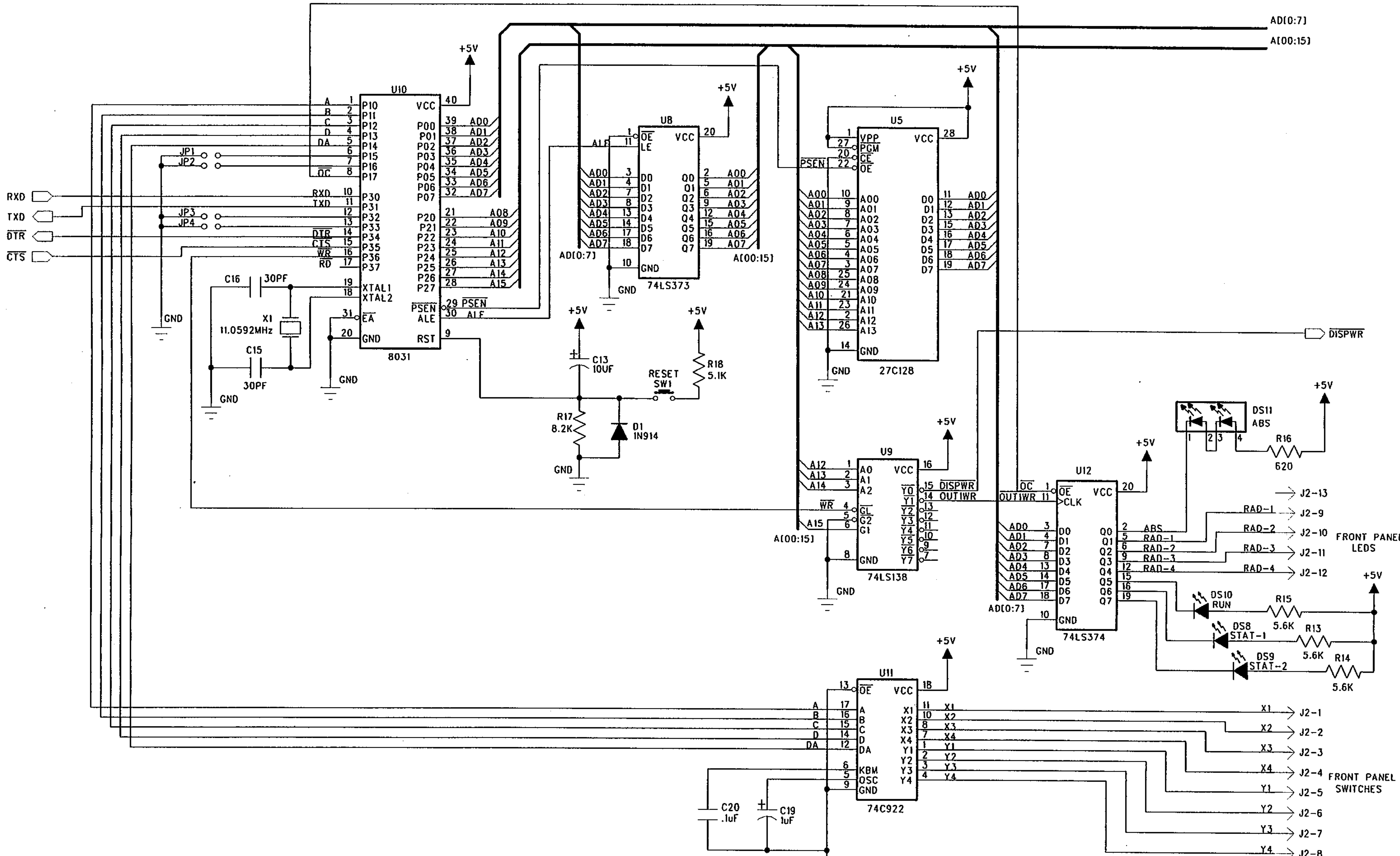
01	9487	WLW	
02	9526	WLW	
03	9540	WLW	

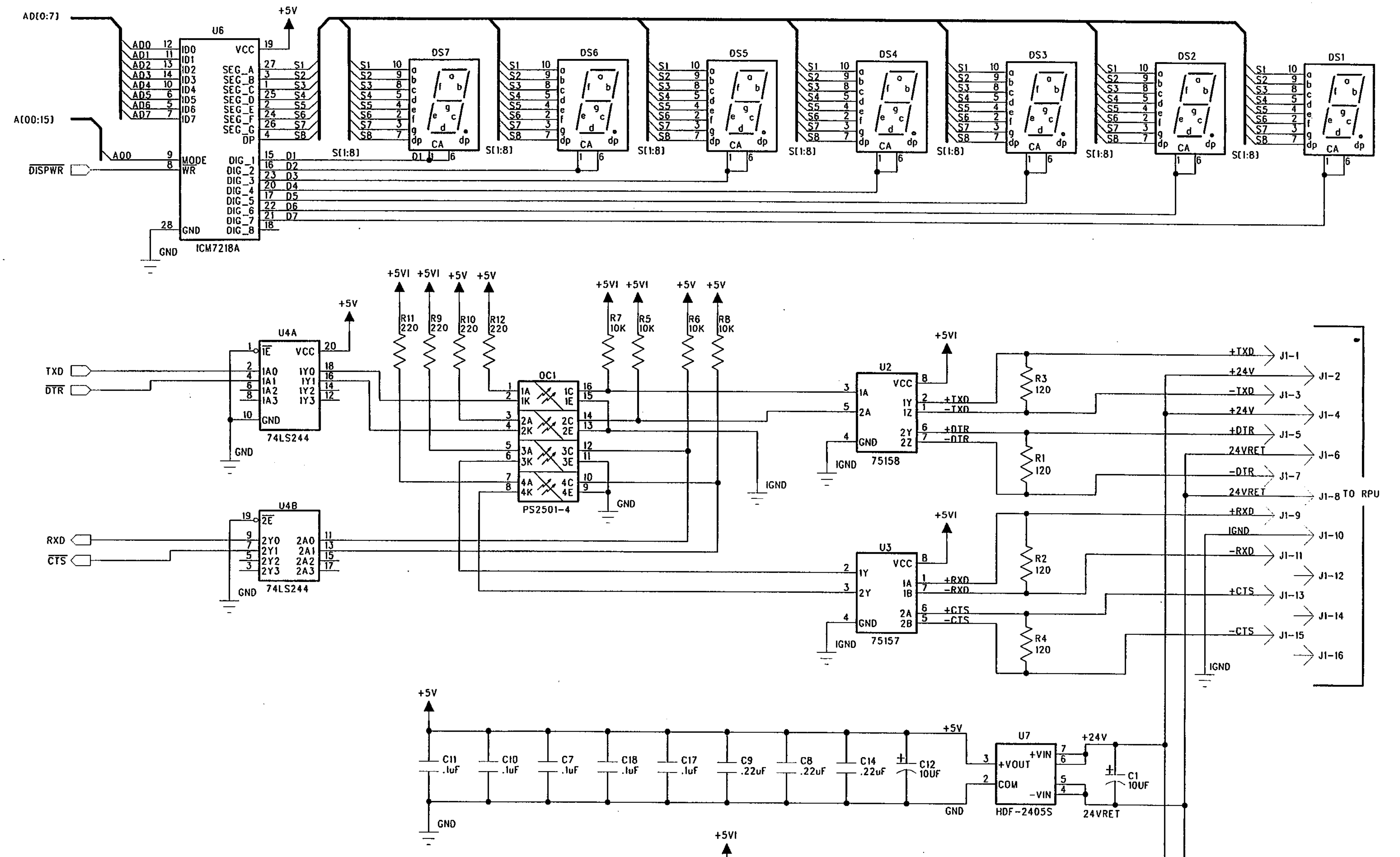
TM/RF RAD FIELD I/O SCHEMATIC
SHEET 8 OF 8

4294.262.21

CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.		
00	9272	XXX		TM REMOTE FLUORO CONTROLLER BOARD	4294.262.18
				SHEET 1 OF 2	CONTINENTAL X-RAY CORPORATION



REV.	DATE CODE	ORG.	APP.		
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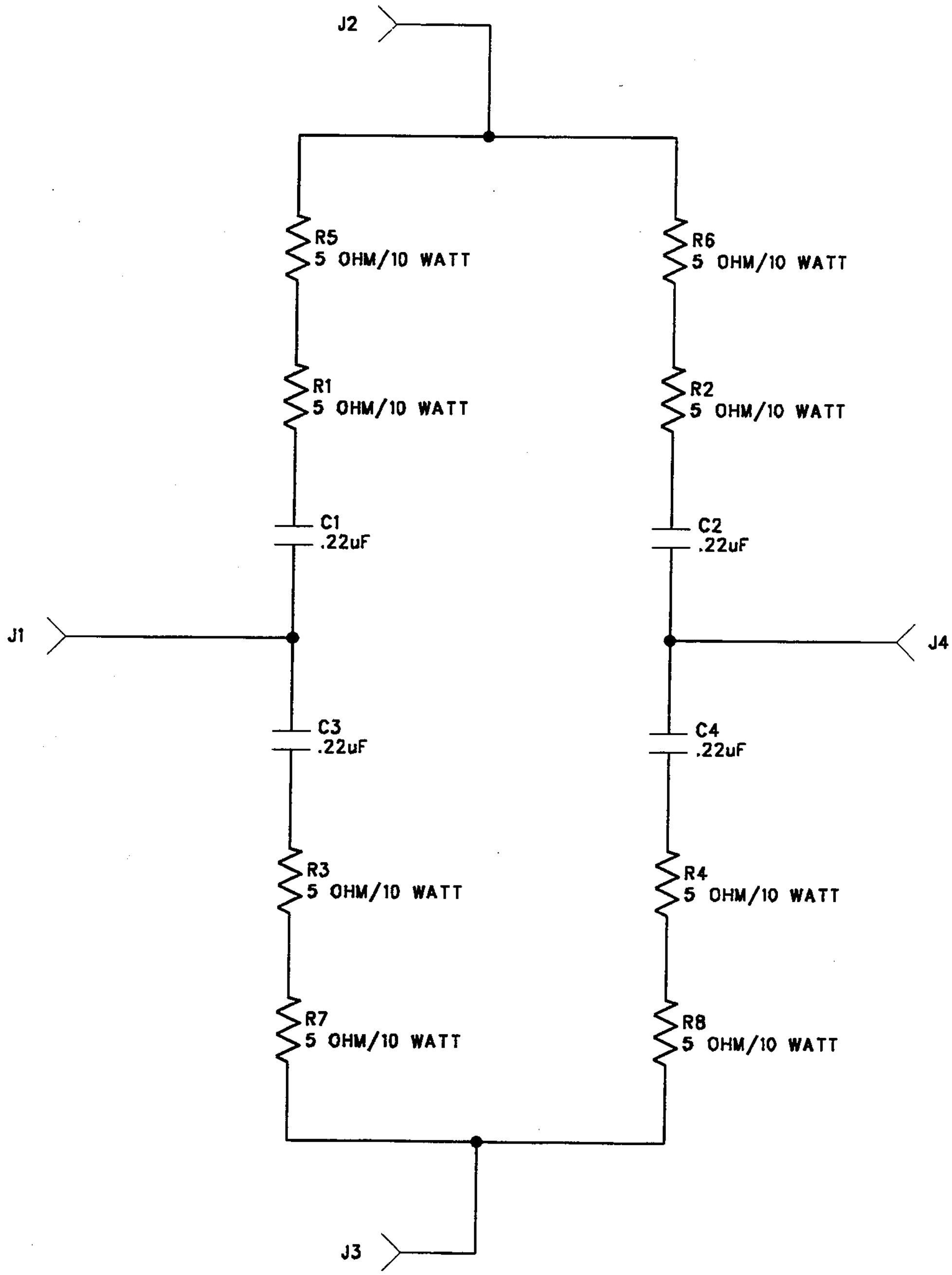
				SHEET 2 OF 2	CONTINENTAL X-RAY CORPORATION

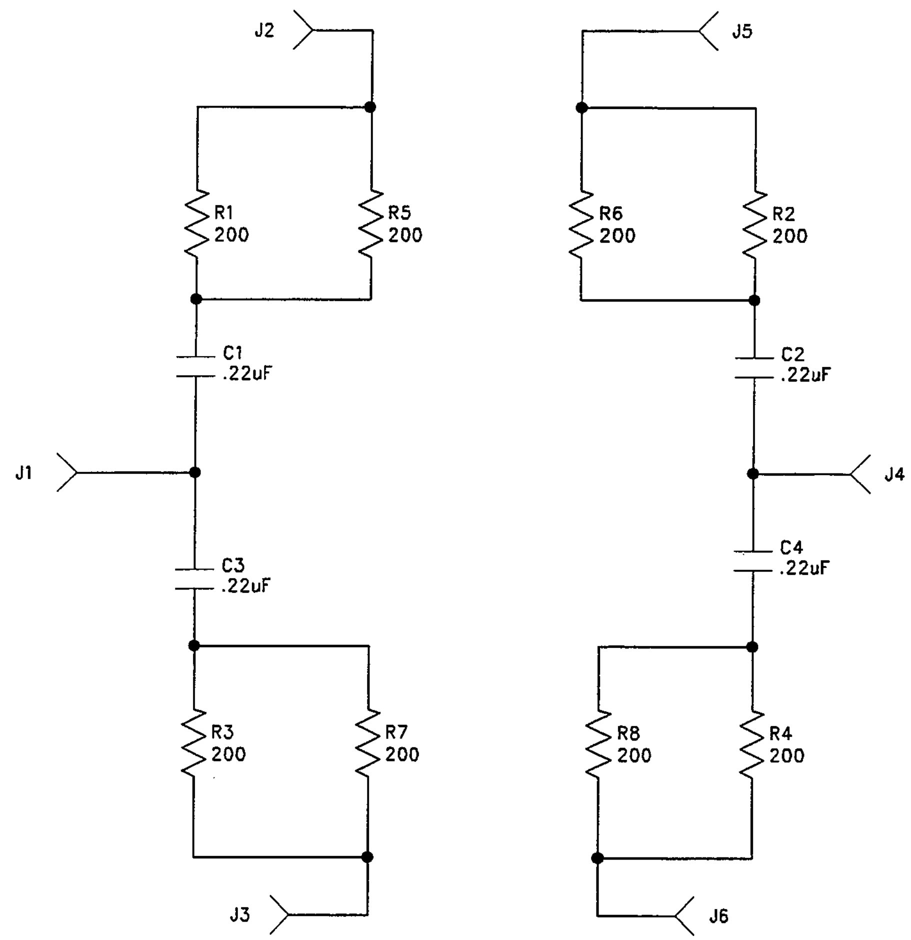


REV.	DATE CODE	ORG.	APP.
01	9017	TCS	

TM/RF HV INVERTER SNUBBER NETWORK

4194.262.03

CONTINENTAL X-RAY CORPORATION

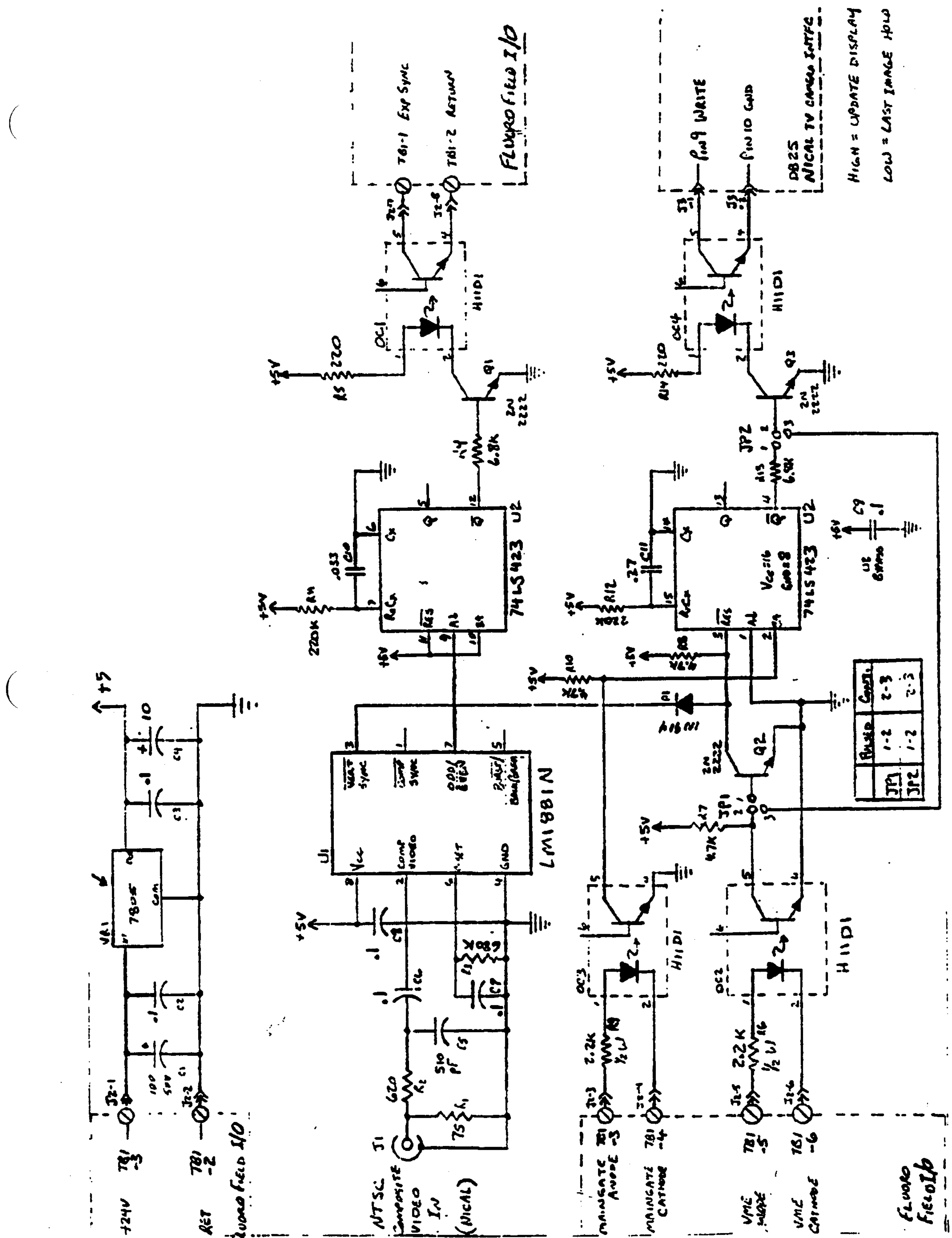


REV.	DATE CODE	ORG.	APP.
00	9534	WLW	

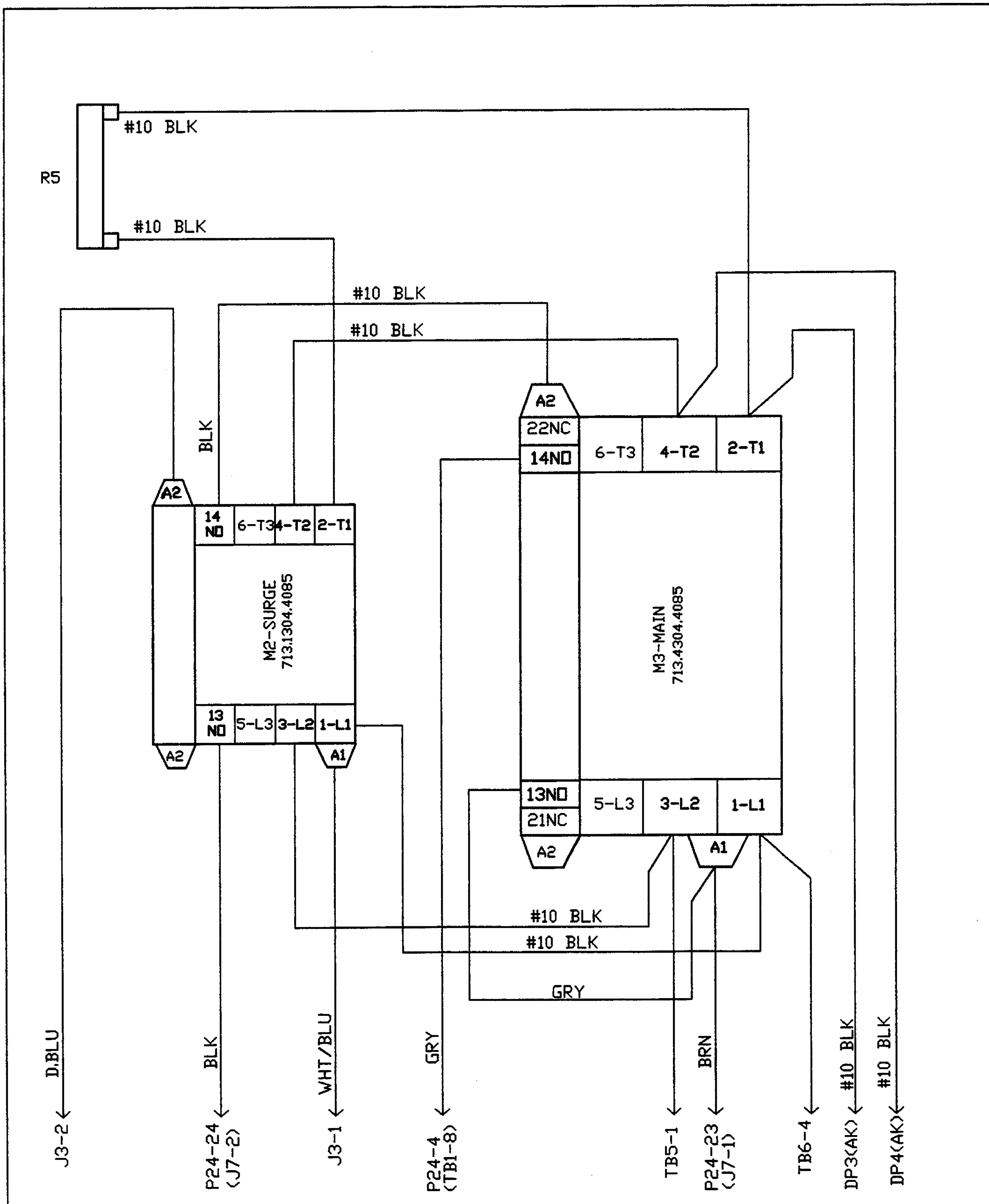
TM80 PARALLEL SNUBBER NETWORK

4194.262.19

CONTINENTAL
X-RAY
CORPORATION



Continental a subsidiary of Trex Medical	
Nical Video Sync Processor Schematic	
4194.262.07	(1 of 1)
9488	Rev. 00



REV.	DATE/ECN CODE	DRG.	APP.
00	9512	GP	
01	9570	GP	

TM 1-Ph SURGE/MAIN CONTACTORS WIRING DIAGRAM

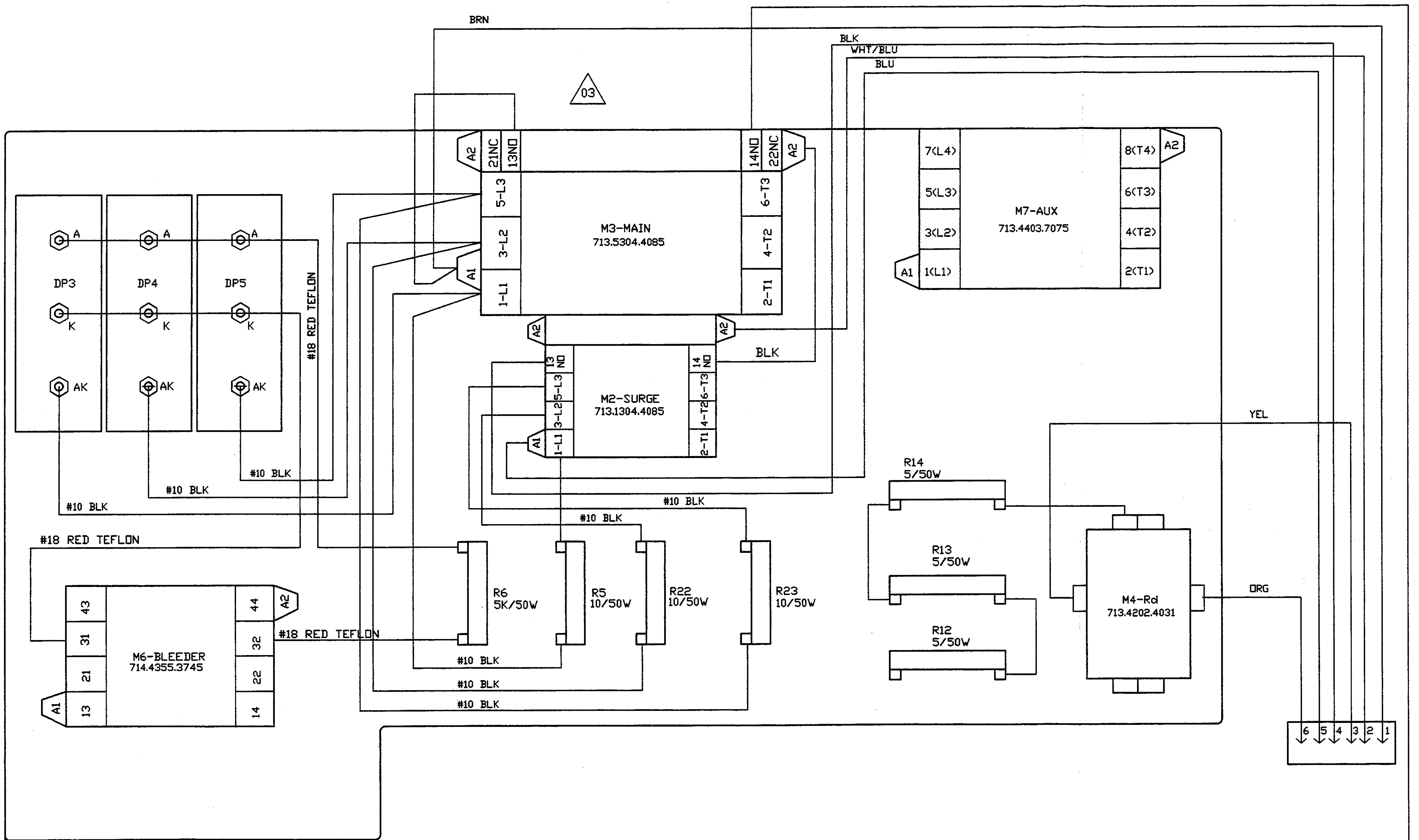
4193.262.01

CONTINENTAL X-RAY CORPORATION

MAT:

FINISH:

TOLERANCES-UNLESS OTHERWISE SPECIFIED: LENGTH-DECIMALS .XXX±.005, .XX±.015-FRACTIONS ±1/32 ANGLES +/- 1/2 DEG.



TO TB1-8 ON
MULTI-OUTPUT
TRANSFORMER

REV.	DATE/ECN CODE	DRG.	APP.
00	9463	GP	
01	9476	GP	
02	9481	GP	
03	9510	GP	

TM 3-PH PWS CONTACTOR PANEL WIRING DIAGRAM

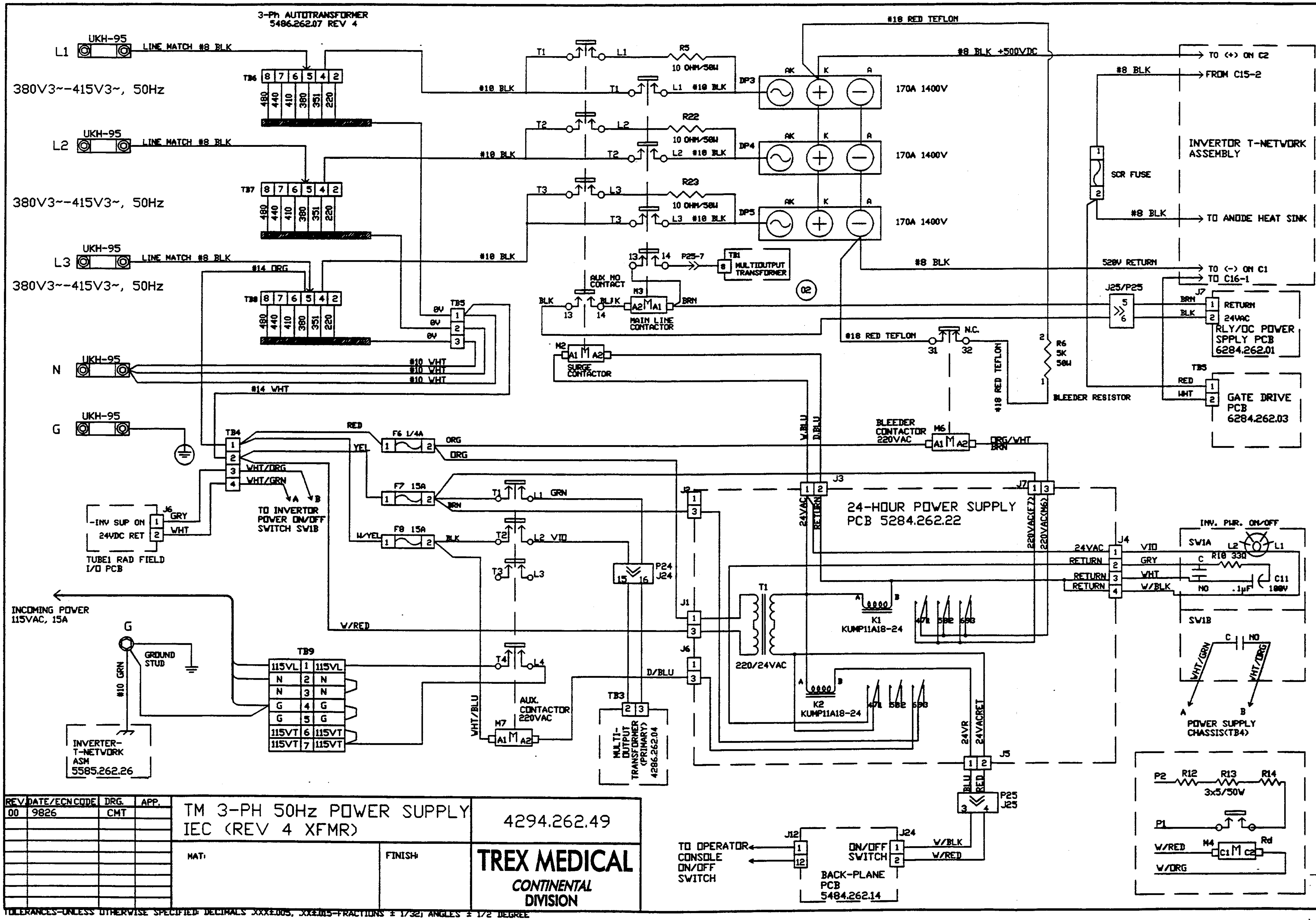
4293.262.03

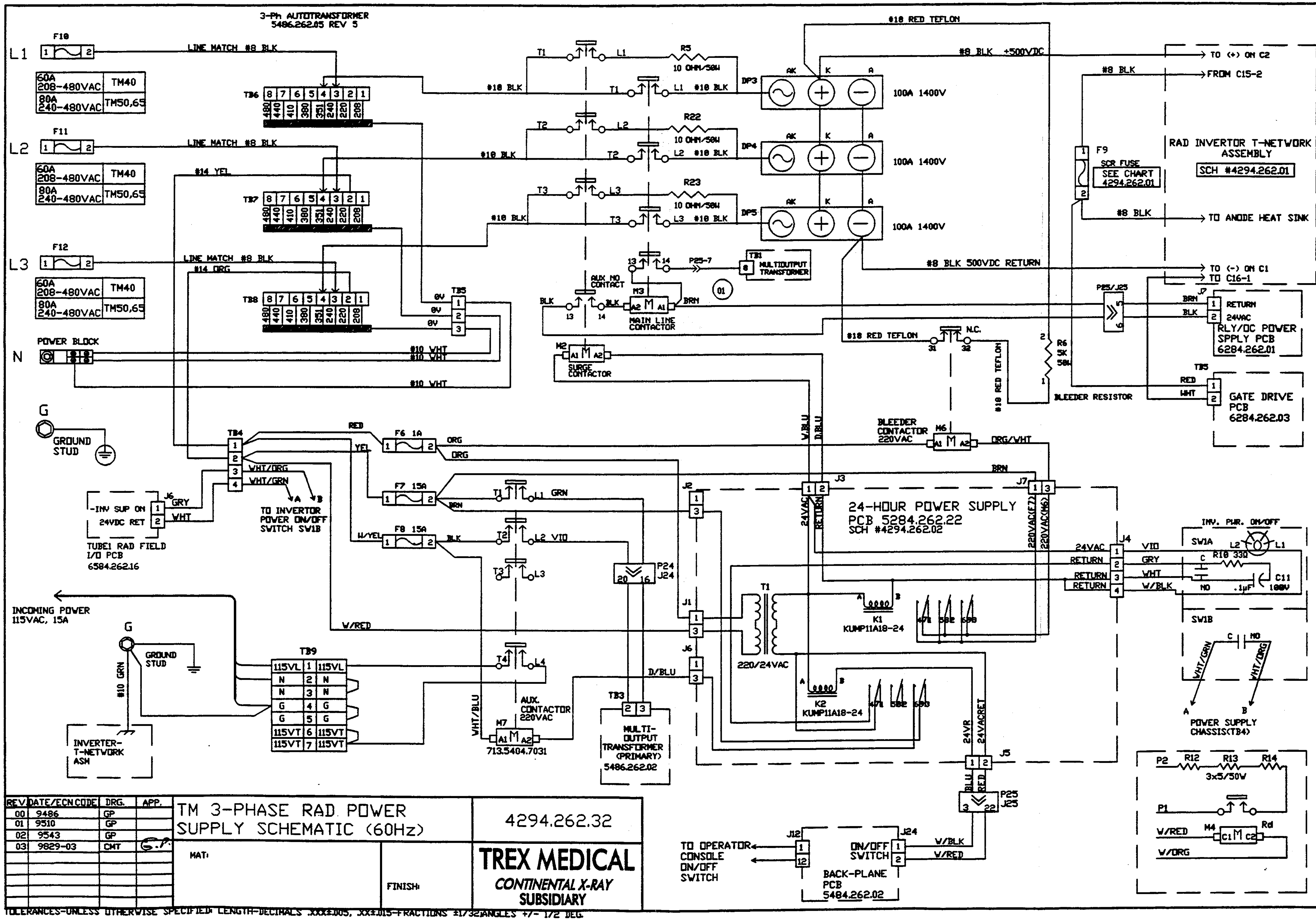
MAT:

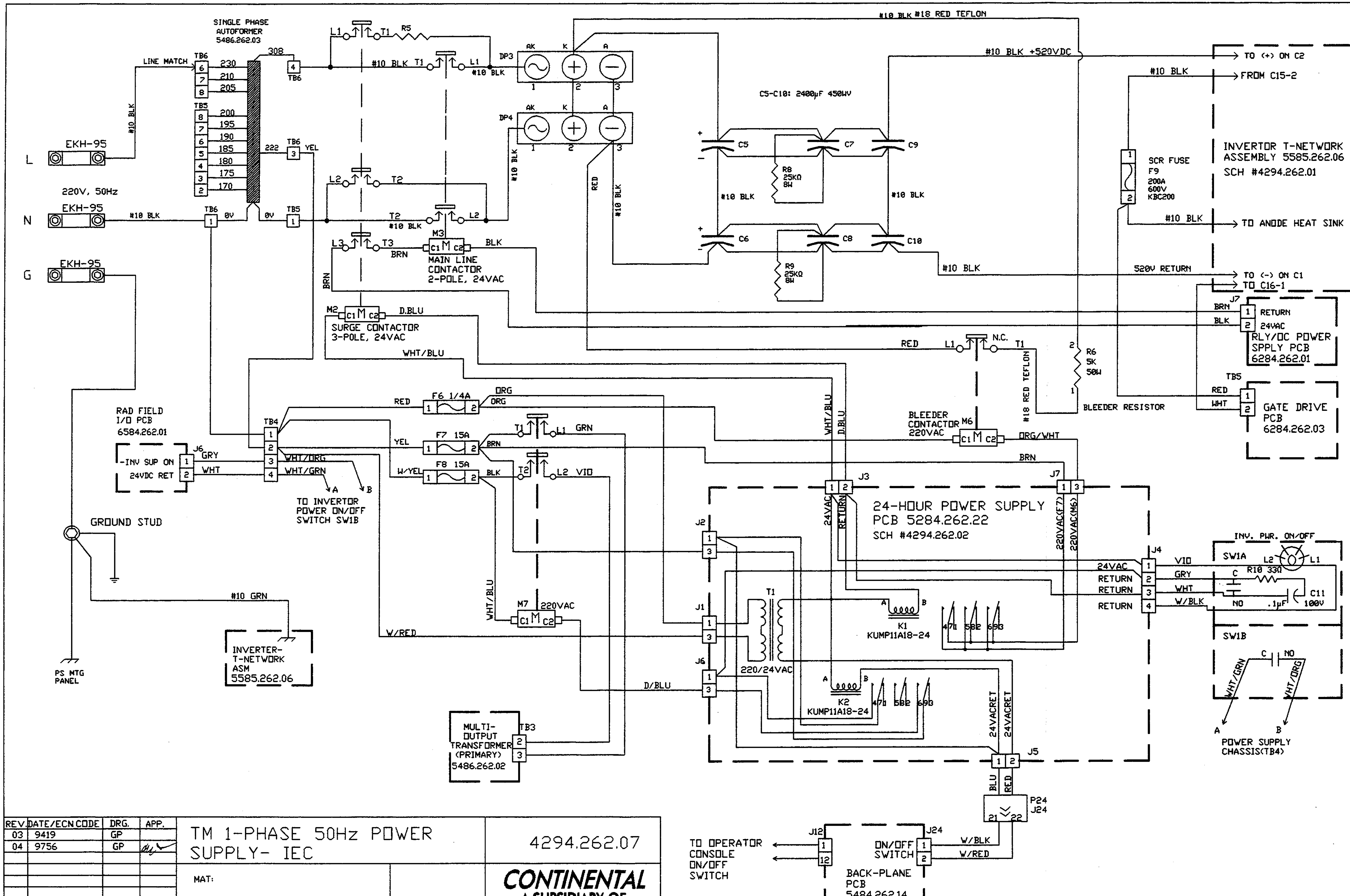
FINISH:

CONTINENTAL X-RAY CORPORATION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: LENGTH-DECIMALS .XXX±.005, .XX±.015-FRACTIONS ±1/32;ANGLES +/- 1/2 DEG.


3-Ph AUTOTRANSFORMER
5486.262.07 REV 4
L1
UKH-95
LINE MATCH #8 BLK
380V3~-415V3~, 50Hz
L2
L3
N
G
TB6
TB7
TB8
480 440 410 380 351 220
#18 RED TEFLON
#8 BLK +500VDC
TO (+) ON C2
FROM C15-2
INVERTOR T-NETWORK ASSEMBLY
SCR FUSE
TO ANODE HEAT SINK
520V RETURN
TO (-) ON C1
TO C16-1
R5 10 OHM/50W
R22 10 OHM/50W
R23 10 OHM/50W
DP3
DP4
DP5
170A 1400V
#10 BLK
#14 ORG
#10 WHT
#14 WHT
TB5
0V
AUX NO CONTACT
M3
MAIN LINE CONTACTOR
P25-7
TB1 MULTIOUTPUT TRANSFORMER
J25/P25
RETURN
24VAC
RLY/DC POWER SPPLY PCB 6284.262.01
GATE DRIVE PCB 6284.262.03
M2
SURGE CONTACTOR
R6 5K 50W
BLEEDER RESISTOR
BLEEDER CONTACTOR 220VAC
M6
TB4
F6 1/4A
F7 15A
F8 15A
TO INVERTOR POWER ON/OFF SWITCH SW1B
-INV SUP ON
24VDC RET
TUBE1 RAD FIELD I/O PCB
24-HOUR POWER SUPPLY PCB 5284.262.22
INV. PWR. ON/OFF
SW1A
R10 33Ω
C11 100V
SW1B
POWER SUPPLY CHASSIS(TB4)
INCOMING POWER 115VAC, 15A
GROUND STUD
#10 GRN
INVERTER-T-NETWORK ASM 5585.262.26
TB9
115VL
115VT
M7
AUX. CONTACTOR 220VAC
P24 J24
TB3
MULTI-OUTPUT TRANSFORMER (PRIMARY) 4286.262.04
T1
220/24VAC
K1 KUMP11A18-24
K2 KUMP11A18-24
J5
P25 J25
TO OPERATOR CONSOLE ON/OFF SWITCH
ON/OFF SWITCH
BACK-PLANE PCB 5484.262.14
P2 R12 R13 R14
3x5/50W
P1
W/RED
M4
W/ORG
REV | DATE/ECN CODE | DRG. | APP.
00 | 9826 | CMT
TM 3-PH 50Hz POWER SUPPLY IEC (REV 4 XFMR)
4294.262.49
MAT:
FINISH:
TREX MEDICAL
CONTINENTAL DIVISION
TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE


3-Ph AUTOTRANSFORMER
5486.262.05 REV 5
L1
L2
L3
N
G
F10
F11
F12
60A 208-480VAC TM40
80A 240-480VAC TM50,65
LINE MATCH #8 BLK
#14 YEL
#14 ORG
TB6
TB7
TB8
480 440 410 380 351 240 220 208
POWER BLOCK
#10 WHT
GROUND STUD
0V
TB5
T1
T2
T3
L1
L2
L3
R5
R22
R23
10 OHM/50W
#10 BLK
DP3
DP4
DP5
AK
K
A
100A 1400V
#10 RED TEFLON
#8 BLK +500VDC
#8 BLK
TO (+) ON C2
FROM C15-2
F9
SCR FUSE
SEE CHART
4294.262.01
RAD INVERTOR T-NETWORK ASSEMBLY
SCH #4294.262.01
TO ANODE HEAT SINK
#8 BLK 500VDC RETURN
TO (-) ON C1
TO C16-1
P25-7
TB1
MULTIOUTPUT TRANSFORMER
AUX NO CONTACT
M3
MAIN LINE CONTACTOR
BLK
BRN
M2
SURGE CONTACTOR
#10 RED TEFLON
N.C.
R6
5K
50W
BLEEDER RESISTOR
P25/J25
J7
RETURN
24VAC
RLY/DC POWER SPPLY PCB
6284.262.01
TB5
RED
WHT
GATE DRIVE PCB
6284.262.03
TB4
RED
YEL
WHT/ORG
WHT/GRN
F6 1A
F7 15A
F8 15A
ORG
GRN
W/YEL
BLK
VIO
TO INVERTOR POWER ON/OFF SWITCH SW1B
J6
-INV SUP ON
24VDC RET
GRY
TUBE1 RAD FIELD I/O PCB
6584.262.16
BLEEDER CONTACTOR 220VAC
M6
ORG/WHT
W/BLU
D/BLU
J2
J3
J7
24-HOUR POWER SUPPLY
PCB 5284.262.22
SCH #4294.262.02
24VAC
RETURN
220VAC(F7)
220VAC(M6)
J4
INV. PWR. ON/OFF
SW1A
R10 33Ω
C11
100V
.1µF
NO
W/BLK
P24
J24
T1
K1
KUMP11A18-24
220/24VAC
K2
KUMP11A18-24
INCOMING POWER
115VAC, 15A
#10 GRN
GROUND STUD
W/RED
TB9
115VL
115VT
VHT/BLU
AUX. CONTACTOR 220VAC
M7
713.5404.7031
TB3
MULTI-OUTPUT TRANSFORMER (PRIMARY)
5486.262.02
INVERTER-T-NETWORK ASM
J5
24VR
24VACRET
BLU
RED
P25
J25
SW1B
VHT/GRN
VHT/ORG
POWER SUPPLY CHASSIS(TB4)
P2
R12
R13
R14
3x5/50W
P1
M4
W/ORG
TO OPERATOR CONSOLE ON/OFF SWITCH
J12
ON/OFF SWITCH
W/BLK
BACK-PLANE PCB
5484.262.02
REV DATE/ECN CODE DRG. APP.
00 9486 GP
01 9510 GP
02 9543 GP
03 9829-03 CMT
TM 3-PHASE RAD POWER SUPPLY SCHEMATIC (60Hz)
4294.262.32
MAT:
FINISH:
TREX MEDICAL
CONTINENTAL X-RAY SUBSIDIARY
TOLERANCES-UNLESS OTHERWISE SPECIFIED: LENGTH-DECIMALS .XXX±.005, .XX±.015-FRACTIONS ±1/32 ANGLES +/- 1/2 DEG.



REV.	DATE/ECN CODE	DRG.	APP.
03	9419	GP	
04	9756	GP	

TM 1-PHASE 50Hz POWER SUPPLY- IEC

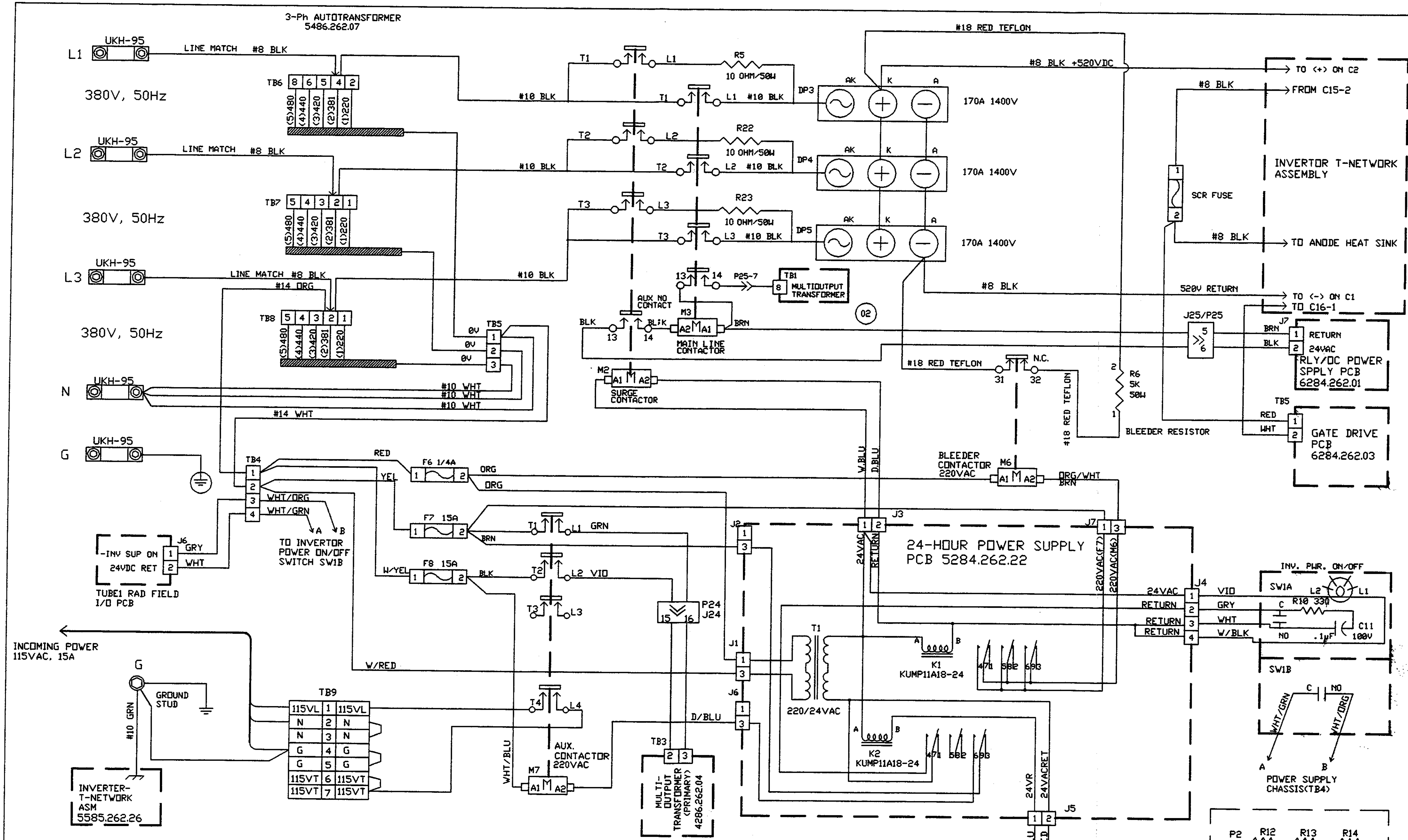
4294.262.07

MAT:

FINISH:

CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE



REV	DATE/ECN CODE	DRG.	APP.
00	9756	GP	[illegible]

TM 3-PH 50Hz RAD POWER SUPPLY - IEC

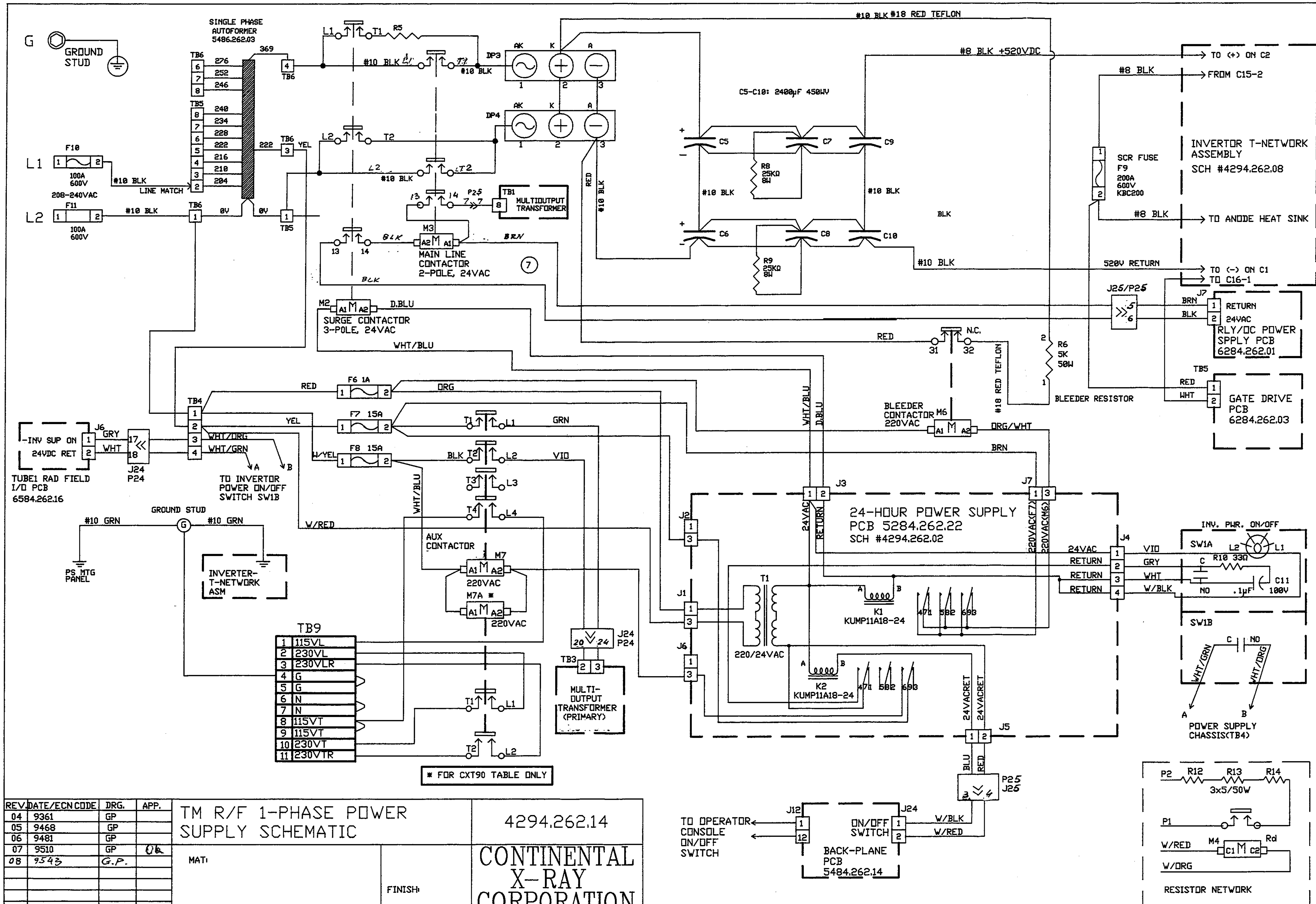
4294.262.45

MAT:

FINISH:

CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE



REV.	DATE/ECN CODE	DRG.	APP.
04	9361	GP	
05	9468	GP	
06	9481	GP	
07	9510	GP	Ob
08	9543	G.P.	

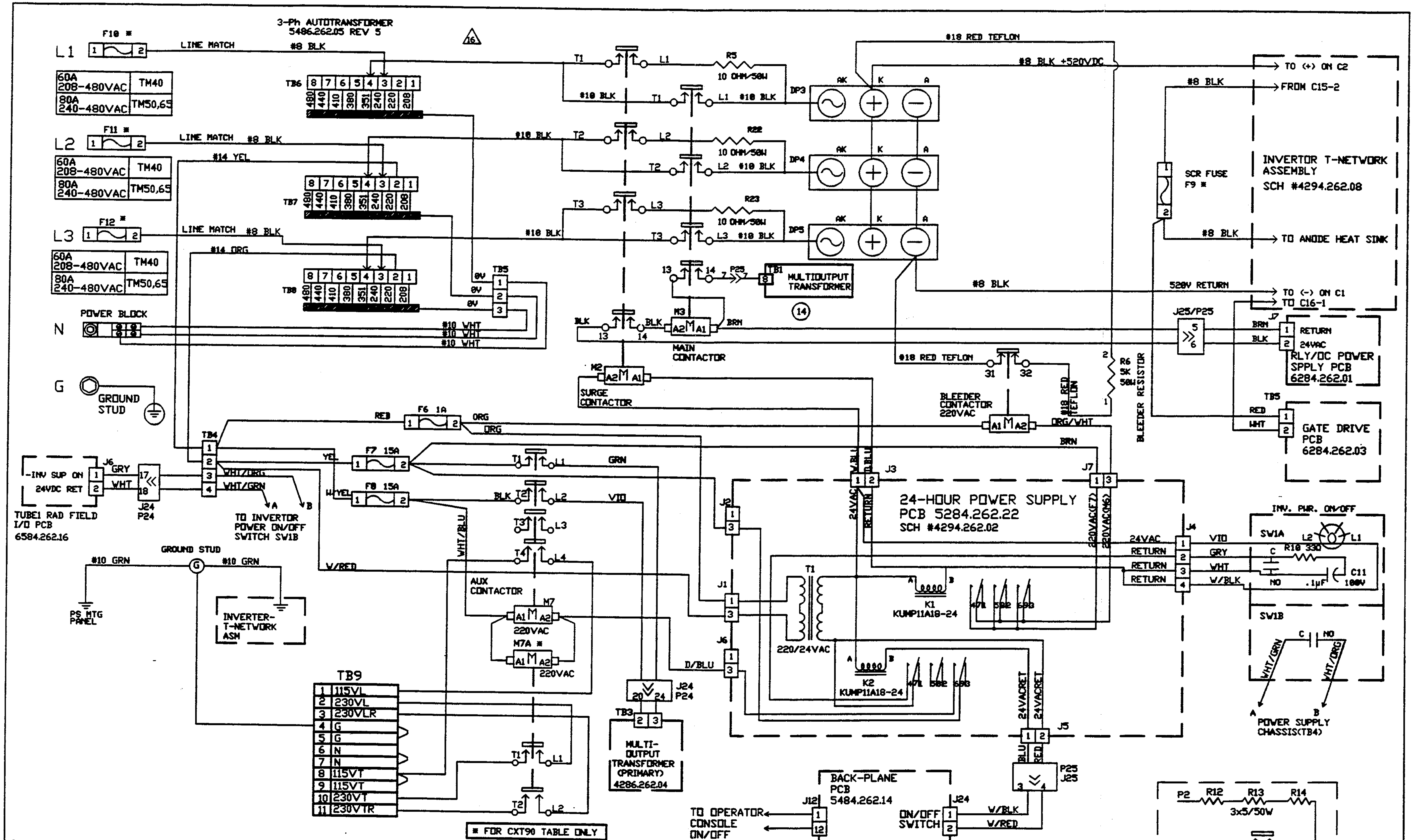
TM R/F 1-PHASE POWER SUPPLY SCHEMATIC

4294.262.14

MAT:

FINISH:

CONTINENTAL X-RAY CORPORATION



REV	DATE/ECN CODE	DRG.	APP.
11	9378	GP	
12	9468	GP	
13	9481	GP	
14	9510	GP	
15	9543	GP	
16	9836	GP	DK

TM R/F 3-PHASE POWER SUPPLY SCHEMATIC

4294.262.06

MAT:

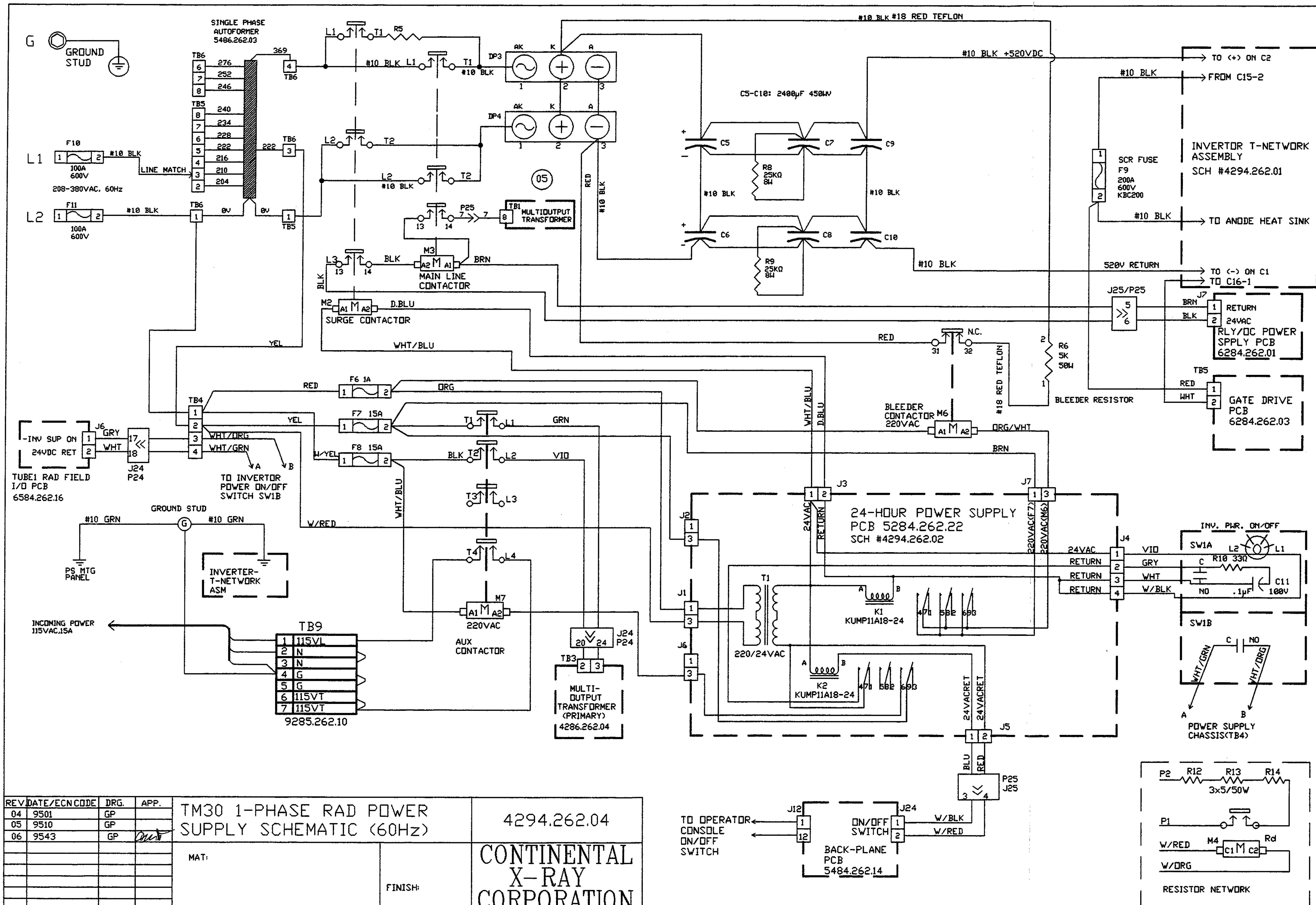
FINISH:

TREX MEDICAL
CONTINENTAL X-RAY SUBSIDIARY

FUSE CHART

GENER \ FUSE	F9	F10	F11	F12
TM40 R/F	300A	60A	60A	60A
TM65 R/F	450A	80A	80A	80A

TOLERANCES-UNLESS OTHERWISE SPECIFIED: LENGTH-DECIMALS .XXX±.005, .XX±.015-FRACTIONS ±1/32 ANGLES +/- 1/2 DEG.



REV	DATE/ECN CODE	DRG.	APP.
04	9501	GP	
05	9510	GP	
06	9543	GP	

TM30 1-PHASE RAD POWER SUPPLY SCHEMATIC (60Hz)

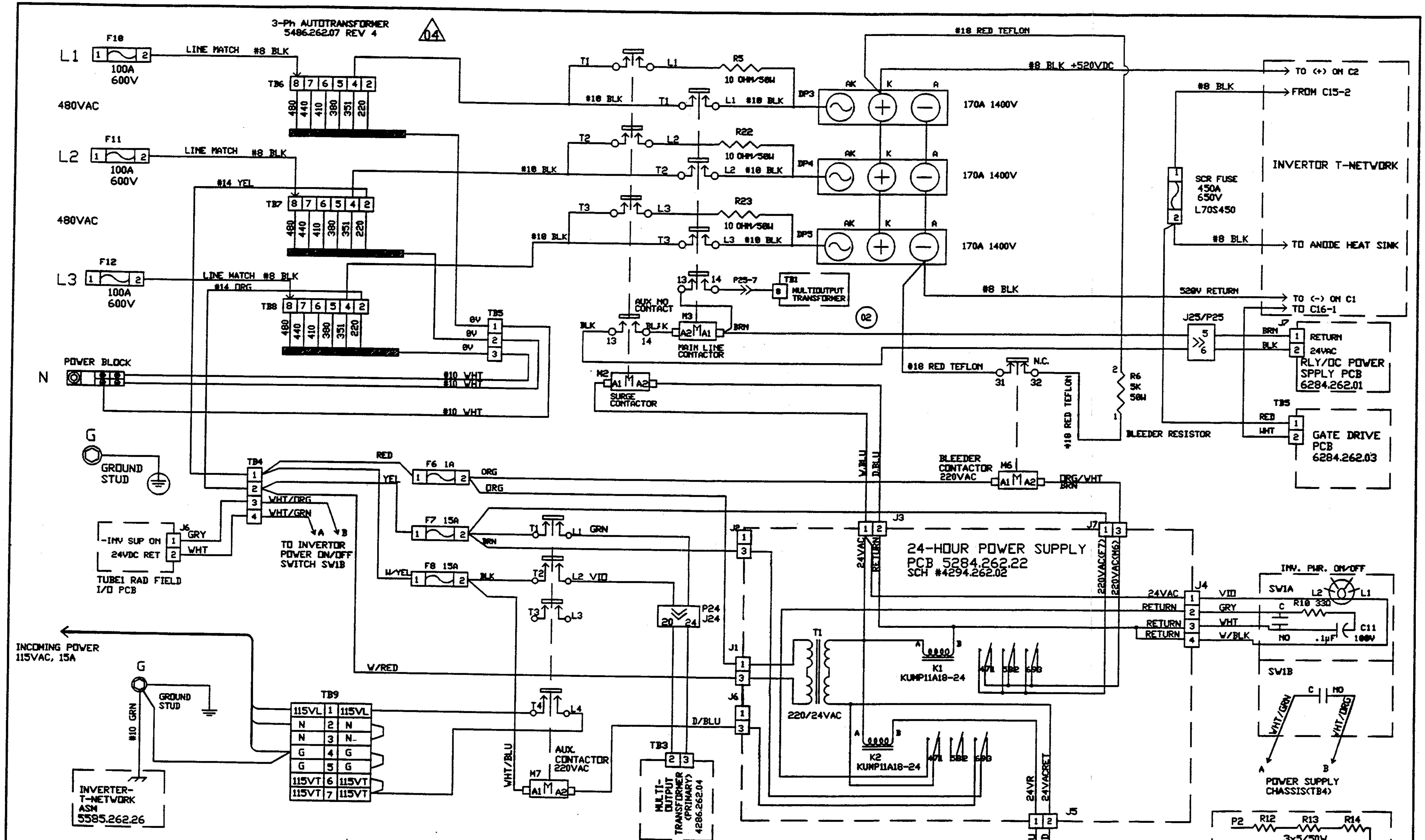
4294.262.04

MAT:

FINISH:

CONTINENTAL X-RAY CORPORATION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: LENGTH-DECIMALS .XXX±.005, .XX±.015-FRACTIONS ±1/32;ANGLES +/- 1/2 DEG.



REV	DATE/ECN CODE	DRG.	APP.
00	9411	GP	
01	9482	GP	
02	9510	GP	
03	9735	GP	
04	9836	GP	DK

TM80 3-PHASE RAD POWER SUPPLY SCHEMATIC

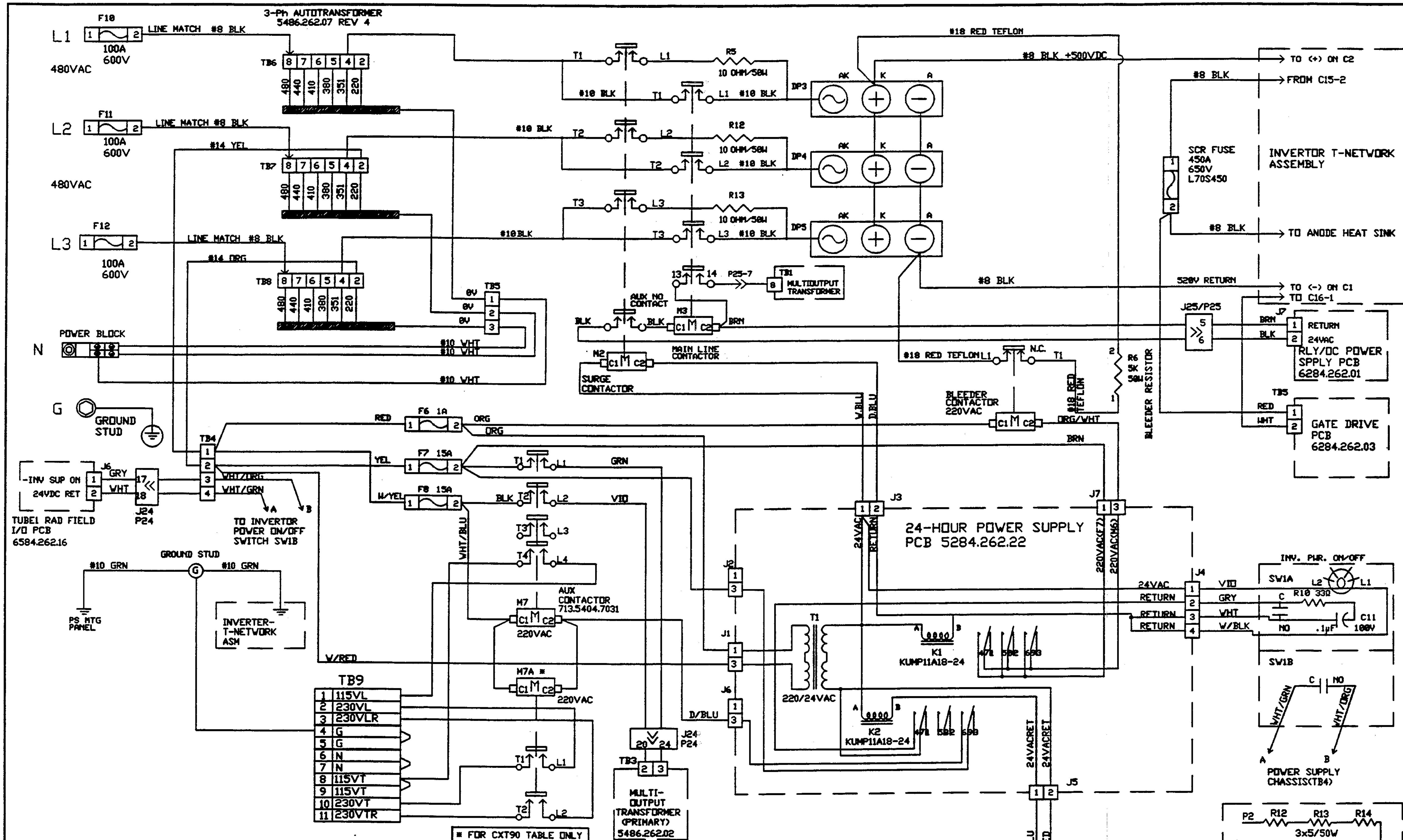
4294.262.25

MAT:

FINISH:

TREX MEDICAL
CONTINENTAL DIVISION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE



REV	DATE/ECN CODE	DRG.	APP.
00	9826	CMT	

TM80 R/F POWER SUPPLY SCHEMATIC (REV 4 XFMR)

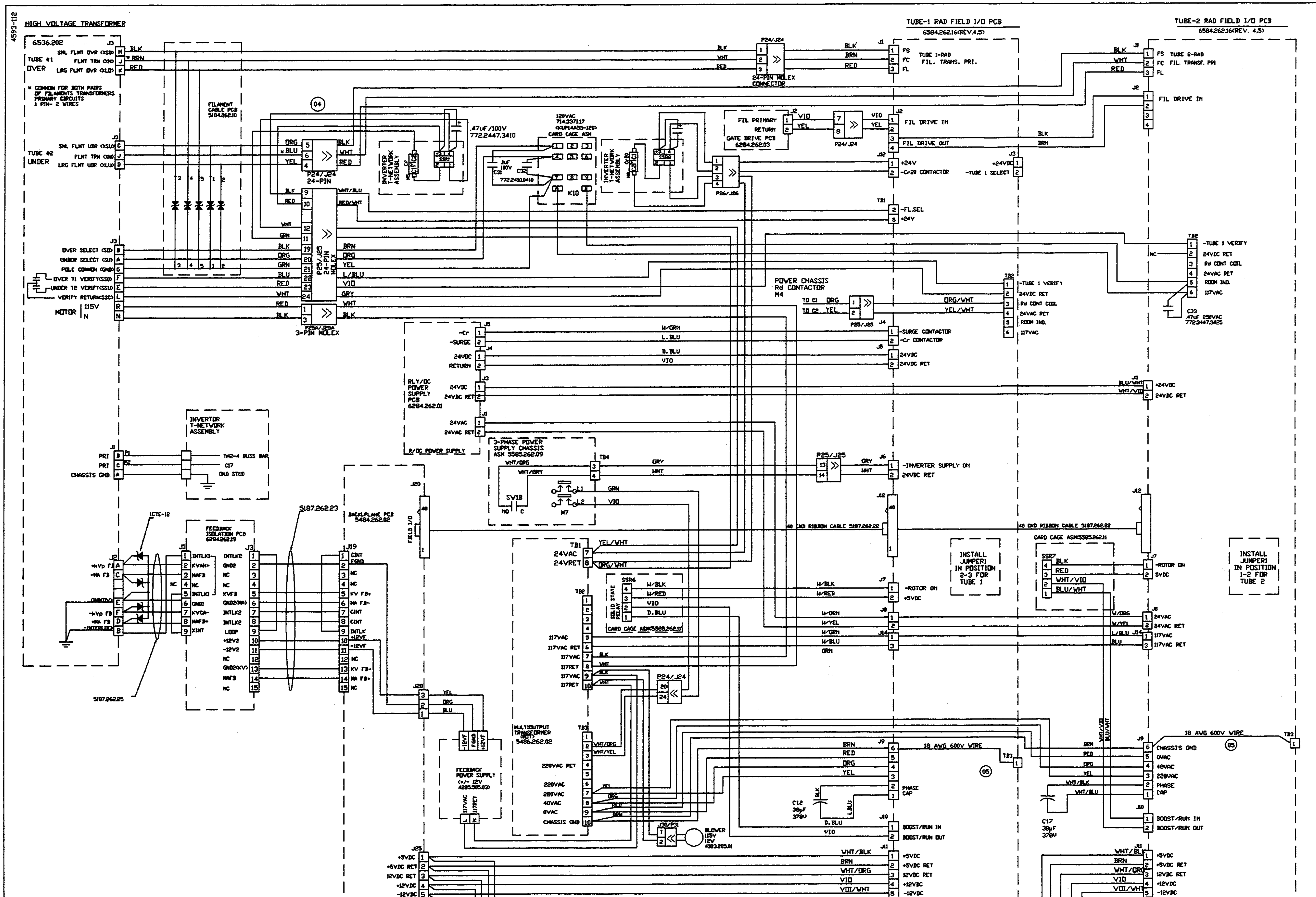
4294.262.48

MAT:

FINISH:

TREX MEDICAL
CONTINENTAL DIVISION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE



REV	DATE/ECN CODE	DRG.	APP.
01	9448		
02	9459		
03	9583		
04	9542		
05	9637		
06	9790		

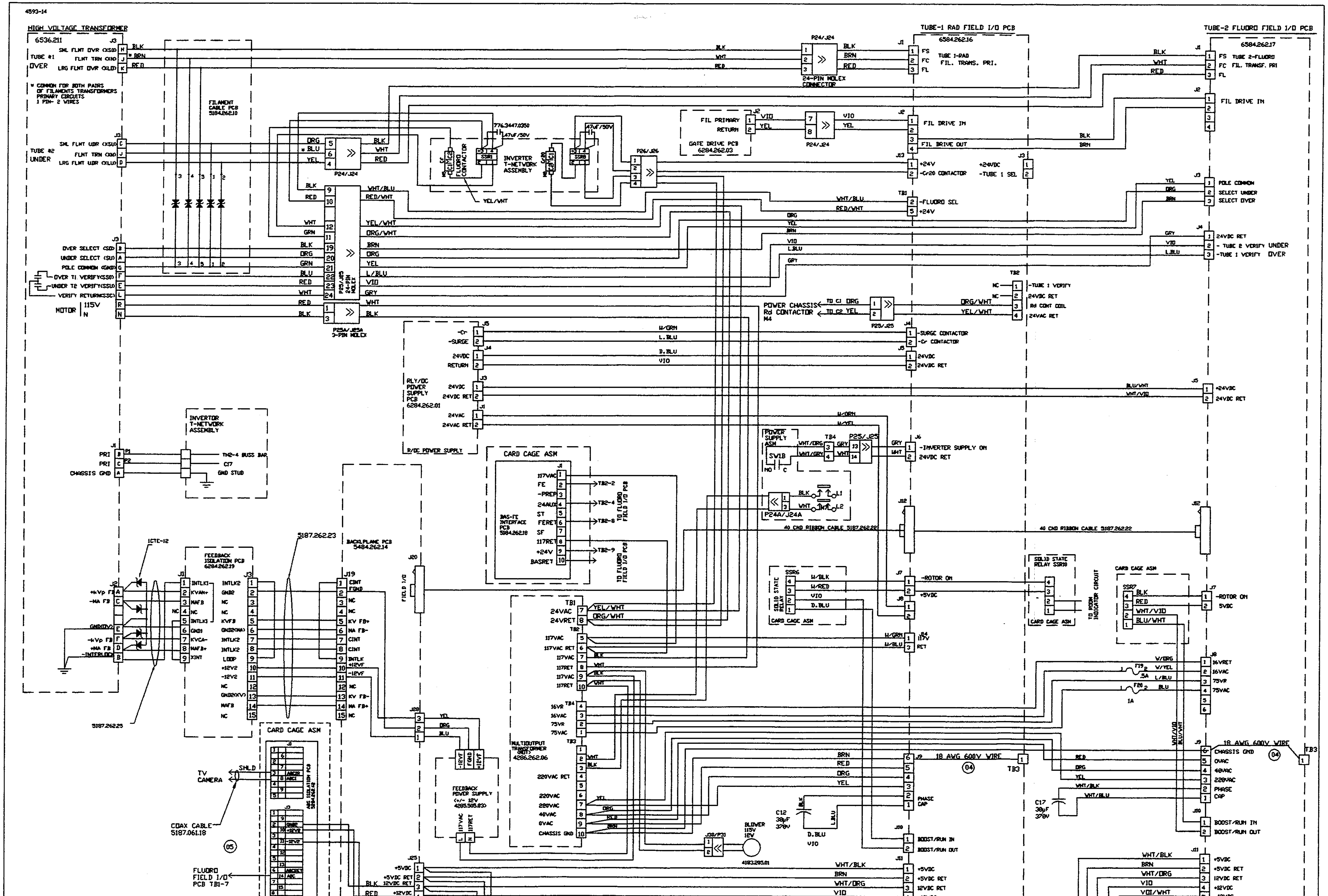
TM 2-TUBE RPU INTERCONNECT WIRING DIAGRAM

4593.262.11

MAT:

FINISH:

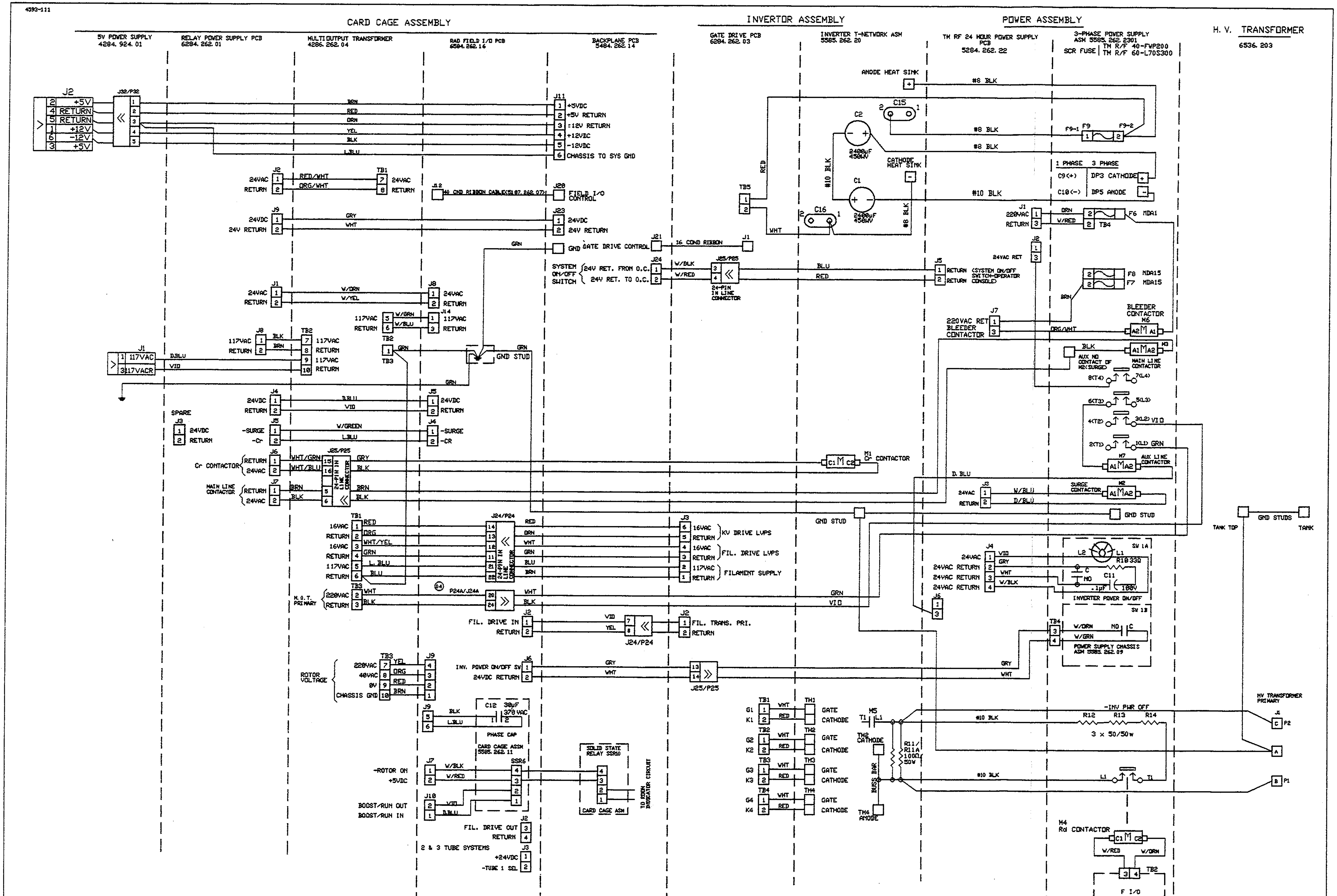
TREX MEDICAL CONTINENTAL DIVISION



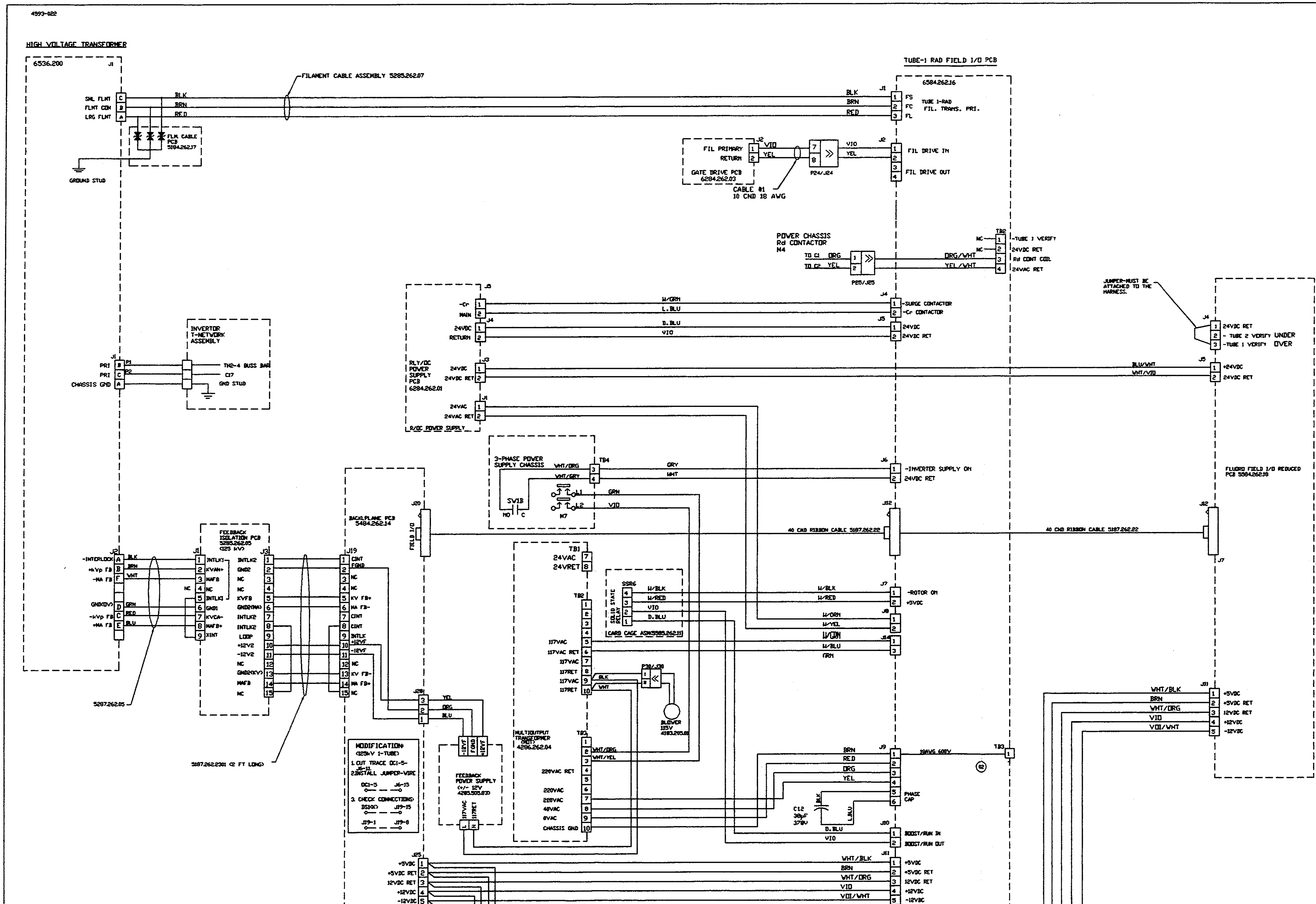
TM R/F RPU INTERCONNECT WIRING DIAGRAM

4593.262.14
PAGE 1 OF 2

CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL



TM RPU NTERCONNECT WIRING DIAGRAM	4593.262.14 PAGE 2 OF 2	CONTINENTAL X-RAY CORPORATION



TM30,40 1-TUBE RAD 125 kV RPU INTERCONNECT W.D.

4593.262.0201

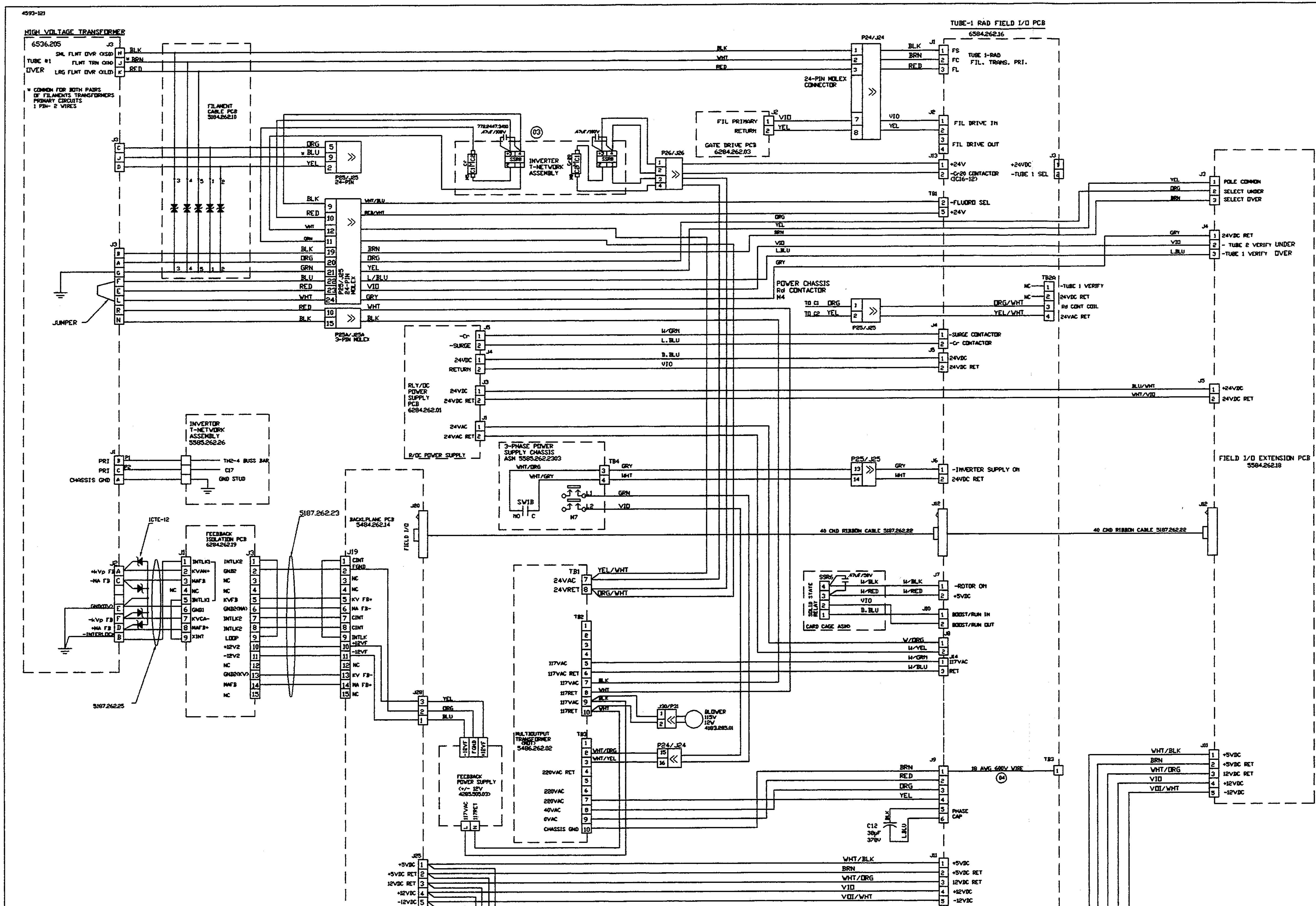
TREX MEDICAL CONTINENTAL DIVISION

REV	DATE/ECN CODE	DFG	APP
00	9587	GP	
01	9543	GP	
02	9637	GP	

MAT:

FINISH:

TOLERANCES—UNLESS OTHERWISE SPECIFIED DECIMALS .XXX±.005, .XX±.015 FRACTIONS ± 1/32 ANGLES ± 1/2 DEGREE



REV	DATE/ECN CODE	DRG.	APP.
00	9447	GP	
01	9481	GP	
02	9593	GP	
03	9643	GP	
04	9637	GP	
05	9768	GP	

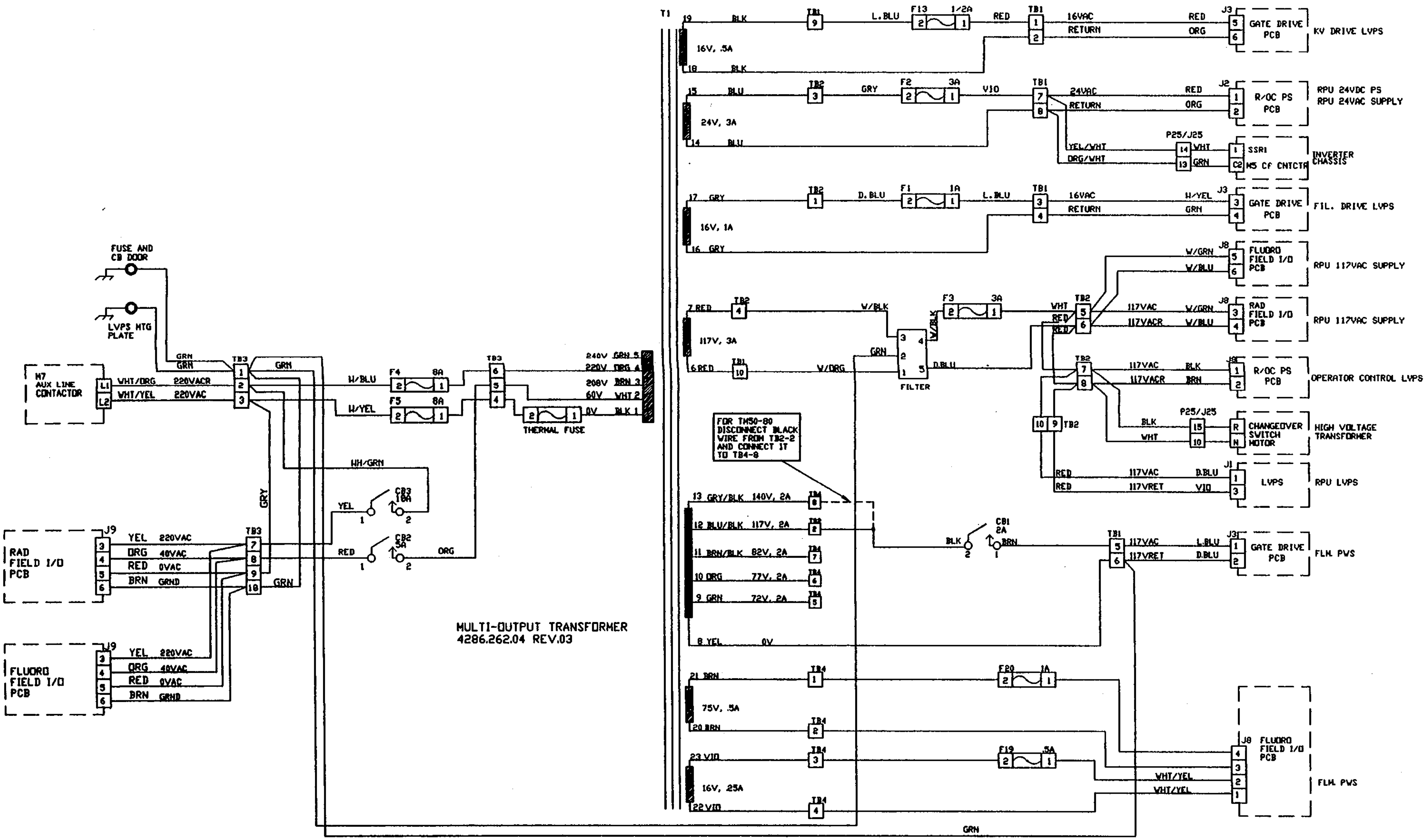
TM40-80 1-TB RAD 150kV RPU
INTERCONNECT WIRING DIAGRAM

4593.262.12

MAT:

FINISH:

TREX MEDICAL
CONTINENTAL DIVISION



REV	DATE CODE	DRG.	APP.
00	9643	GP	
01	9646	GP	OV

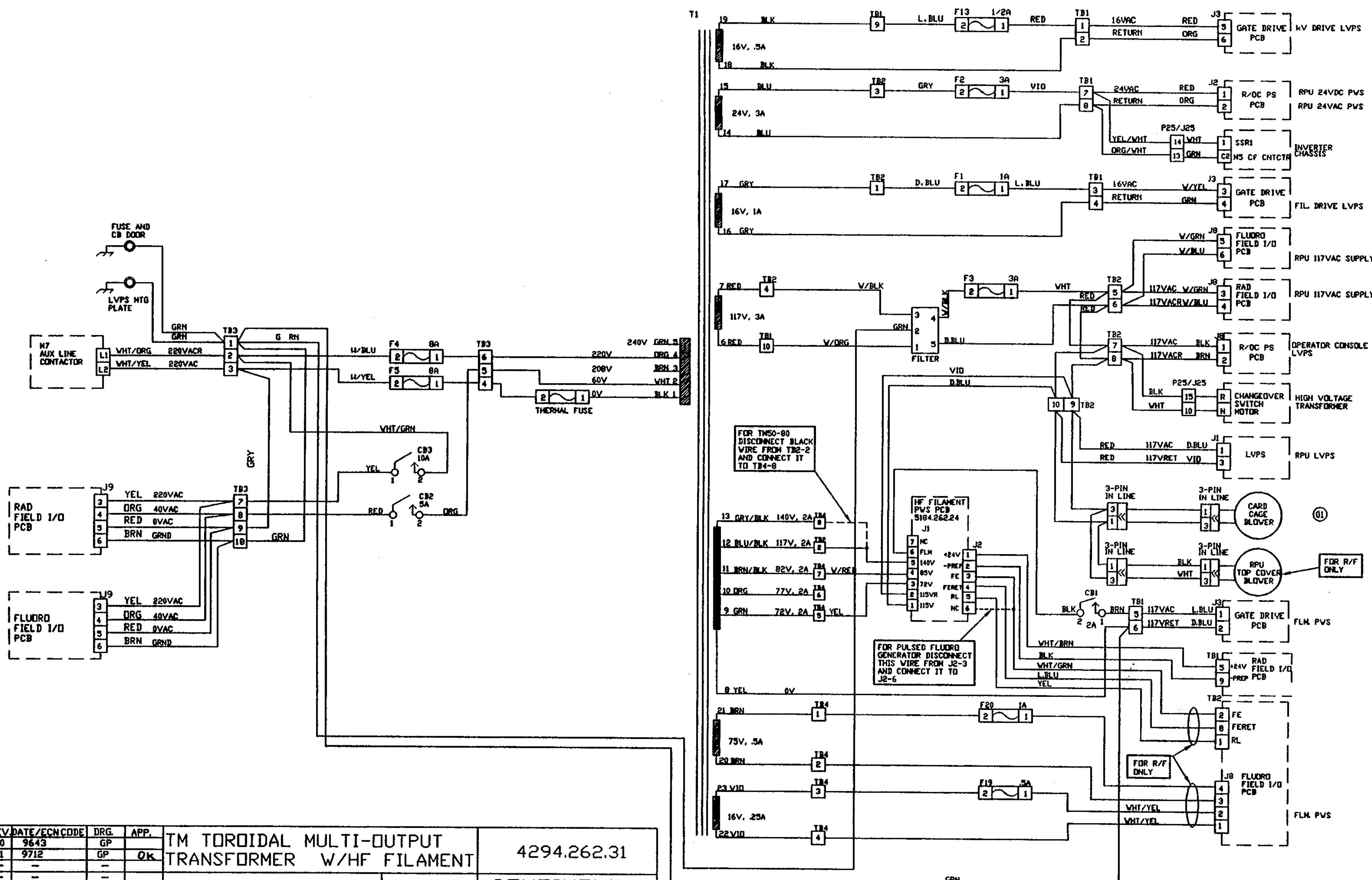
TM TOROIDAL MULTI-OUTPUT TRANSFORMER

4294.262.30

MAT:

FINISH:

CONTINENTAL X-RAY CORPORATION



REV	DATE/ECNCODE	DRG	APP.
00	9643	GP	
01	9712	GP	OK
–	–	–	
–	–	–	
–	–	–	
–	–	–	
–	–	–	
–	–	–	

TM TOROIDAL MULTI-OUTPUT TRANSFORMER W/HF FILAMENT

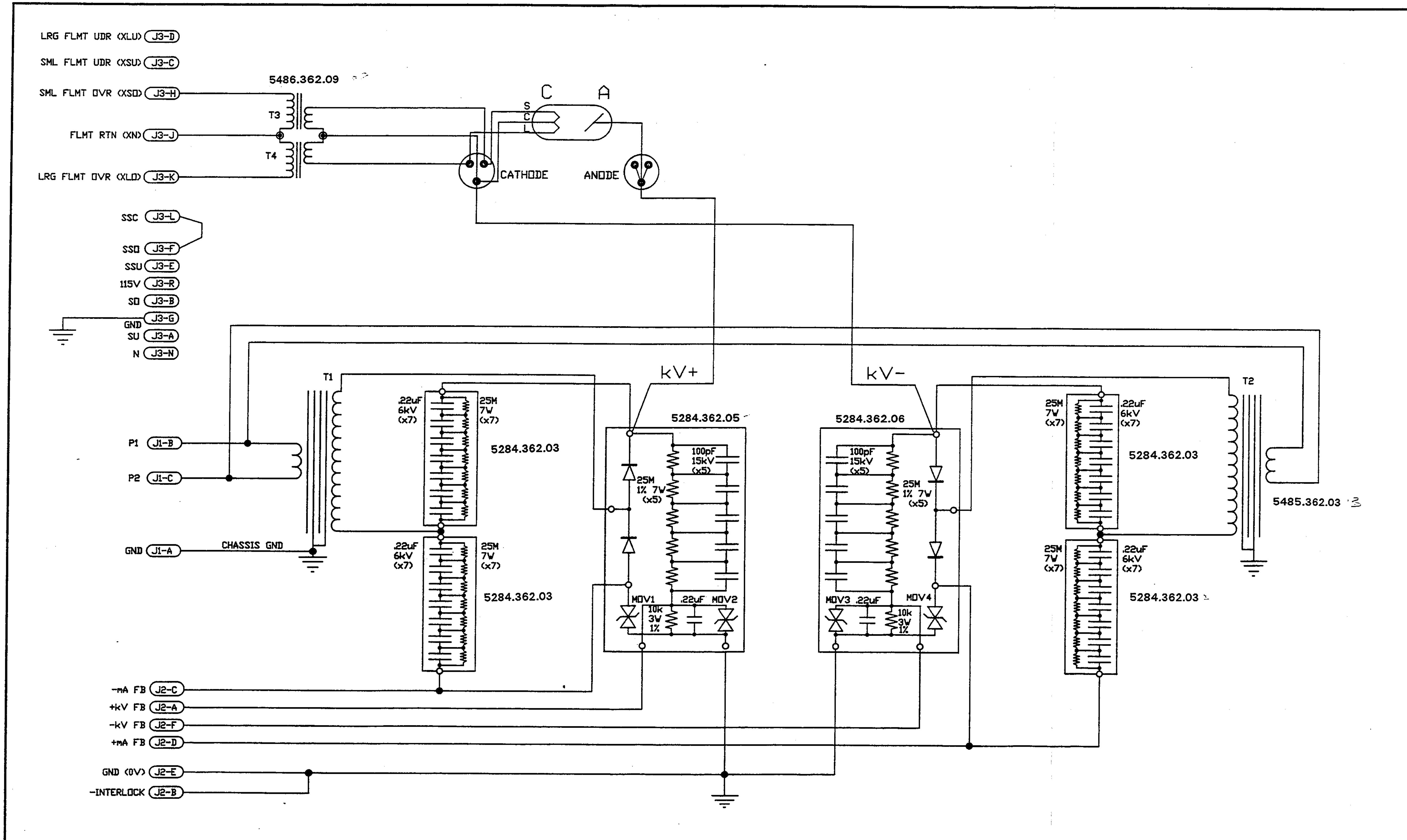
4294.262.31

MAT:

FINISH:

CONTINENTAL
A SUBSIDIARY OF
TREX MEDICAL

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE



REV	DATE CODE	DRG.	APP.
00	9447	GP	

1-TB 60kW 150kV HF TRANSFORMER SCHEMATIC

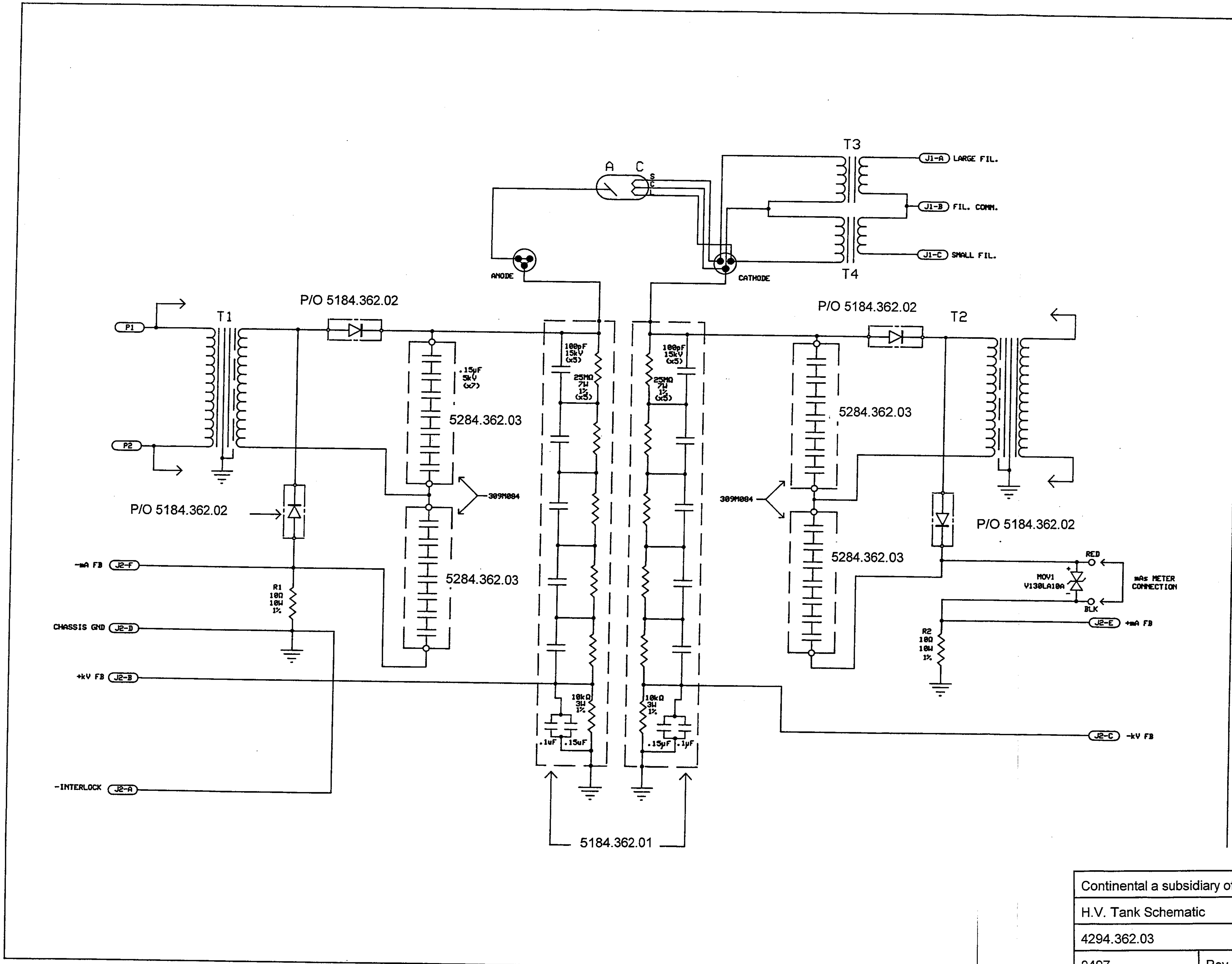
4294.362.02

MAT:

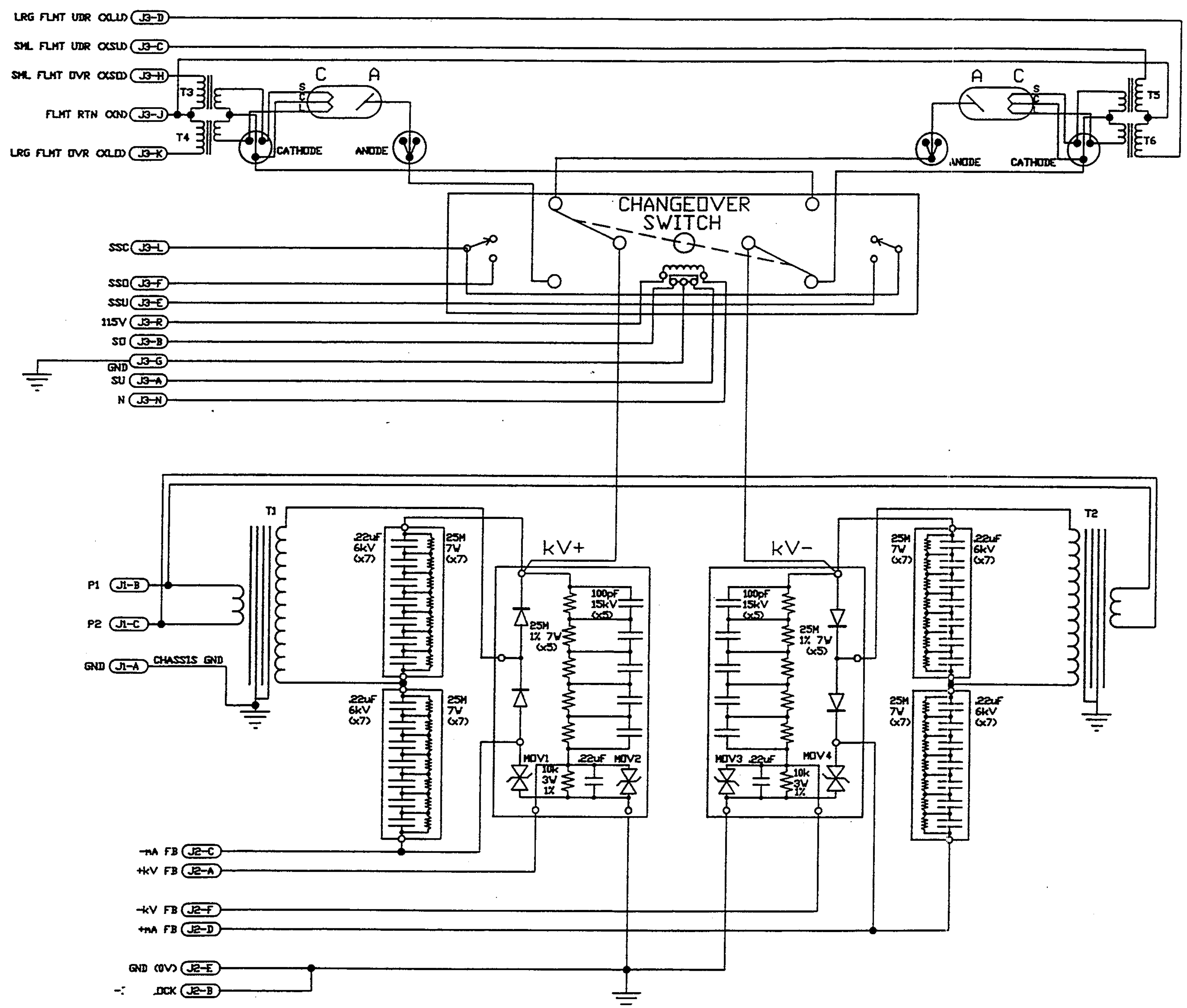
FINISH:

CONTINENTAL X-RAY CORPORATION

8-95



Continental a subsidiary of Trex Medical	
H.V. Tank Schematic	
4294.362.03	(1 of 1)
9497	Rev. 01



REV	DATE CODE	DRG.	APP.
00	9329	CMT	
01	9330	CMT	
02	9332	CMT	

2 TB HF TRANSFORMER SCHEMATIC

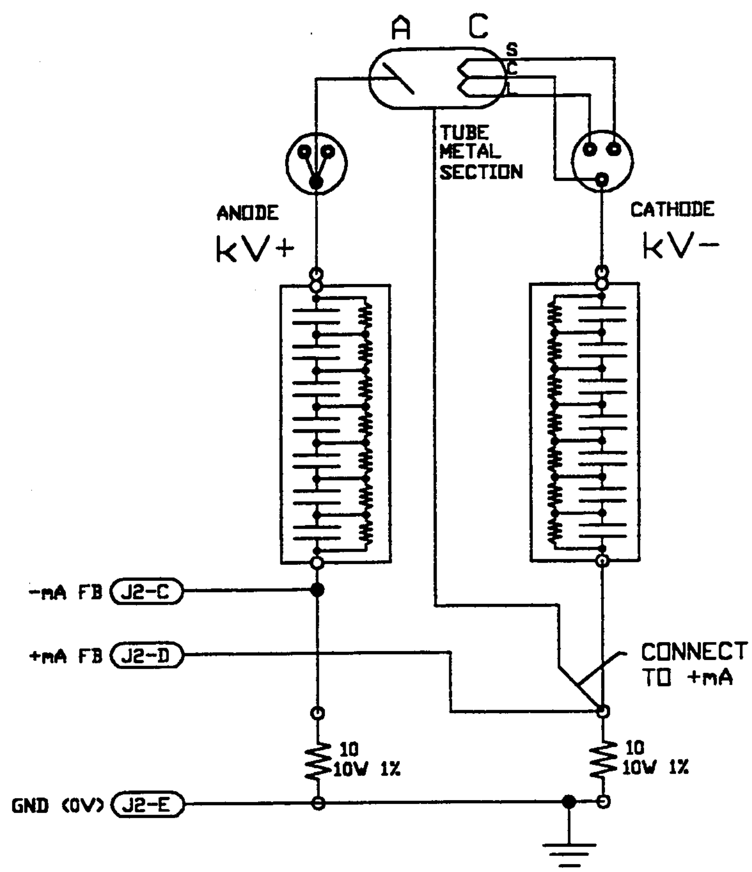
4294.362.01

MAT:

FINISH:

CONTINENTAL X-RAY CORPORATION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: LENGTH-DECIMALS .XXX±.005, .XX±.010-FRACTIONS ±1/32, DIAMETRS-DECIMALS±.002-FRACTIONS±.005



REV.	DATE/ECN CODE	DRG.	APP.
00	9845	CMT	G.P.

METAL CENTER SECTION TUBE CONNECTION SCHEMATIC

4194.362.03

MAT:

FINISH:

TREX MEDICAL
CONTINENTAL
DIVISION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE

SECTION 9 - MECHANICAL INFORMATION

This section presents parts lists and mechanical drawings on the TM series generators. **SECTION 8** contains the wiring diagrams, schematics, assembly layouts, and parts lists for all electrical assemblies.

The assemblies/parts in the **FIGURES** correlate with the listings on the associated **TABLES** with the use of locator numbers.

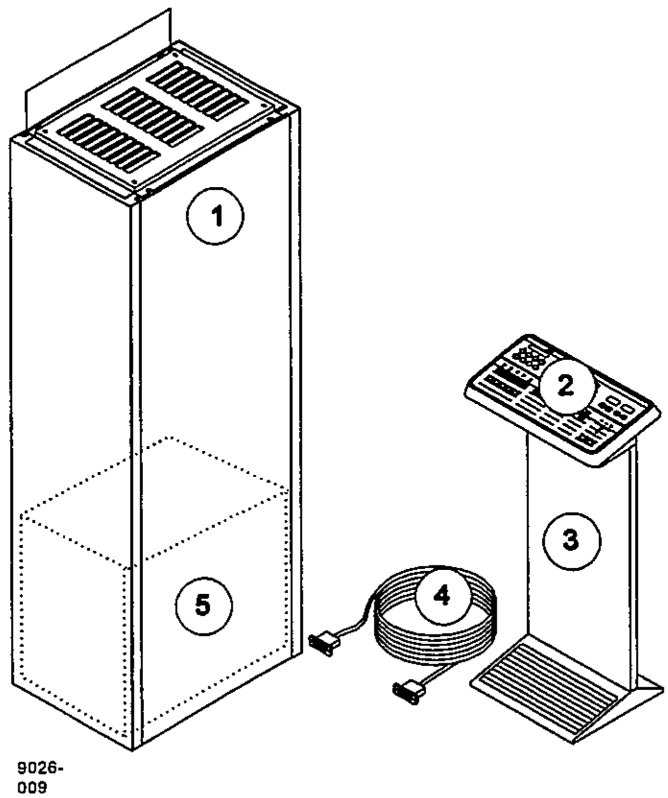


FIGURE 9-1 TM SERIES X-RAY GENERATOR
See **TABLES 9-1** & **9-2**

Locator Number	Part Number	Description	Qty
1	9726.201.01	1Ph RPU Cabinet Assy	1
2	9626.202.01	Operator Control Assy	1
3	9526.201	Pedestal (optional)	1
4	9326.200	25ft Interconnect Cable	1
5	6536.206	Generator	1

TABLE 9-1 TM30 X-RAY GENERATOR PARTS LIST

Locator Number	Part Number	Description	Qty
1	9726.233.01	3Ph RPU Cabinet Assy	1
2	9626.203.01	Operator Control Assy	1
3	9526.201	Pedestal (optional)	1
4	9326.200	25ft Interconnect Cable	1
5	6536.206	Generator	1

TABLE 9-2 TM40 X-RAY GENERATOR PARTS LIST

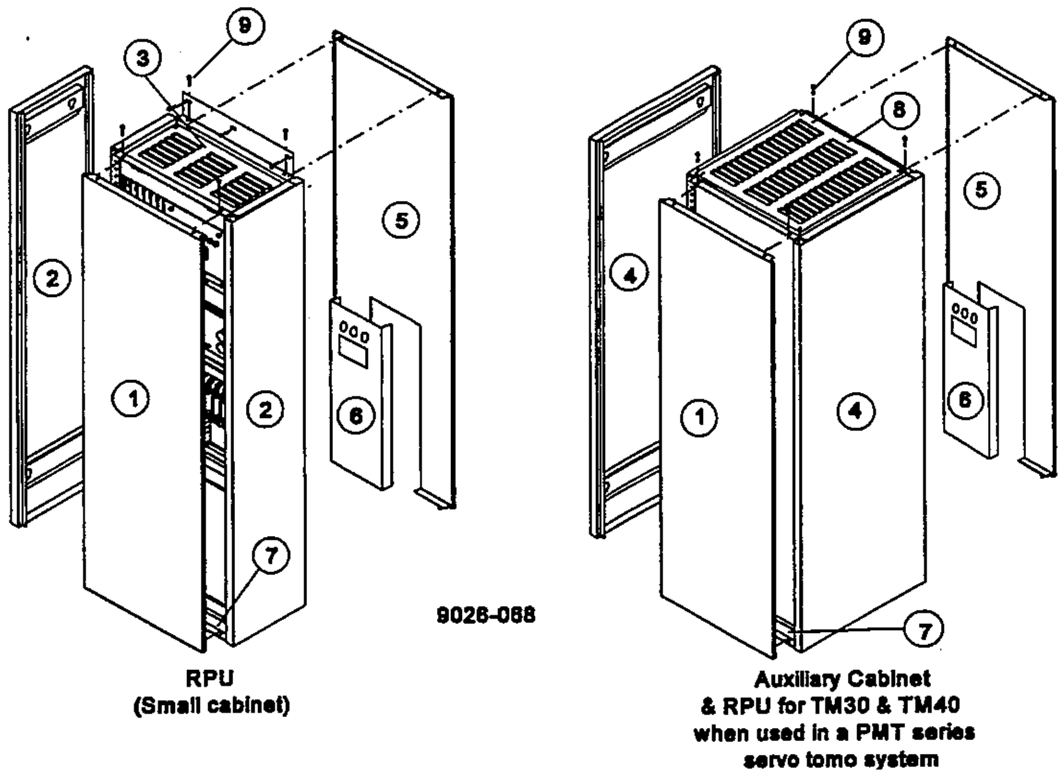


FIGURE 9-2 RPU CABINET COVERS

Locator Number	Part Number	Description	Qty
1	4547.262.15	Front Cover	1
2	4543.262.05	Side Cover Assembly	2
3	4543.262.04	Top Cover Weldment	1
4	4543.262.05	Side Cover Assembly	2
5	4542.262.14	Rear Cover Assembly	1
6	4446.262.03	Wire Entrance Plate	1
7	4541.262.27	Dual Panel Support	2
8	4543.262.04	Top Cover Weldment	1
9	5196.262.01	Cabinet Covers Hardware Kit	1

TABLE 9-3 RPU CABINET COVERS PARTS LIST

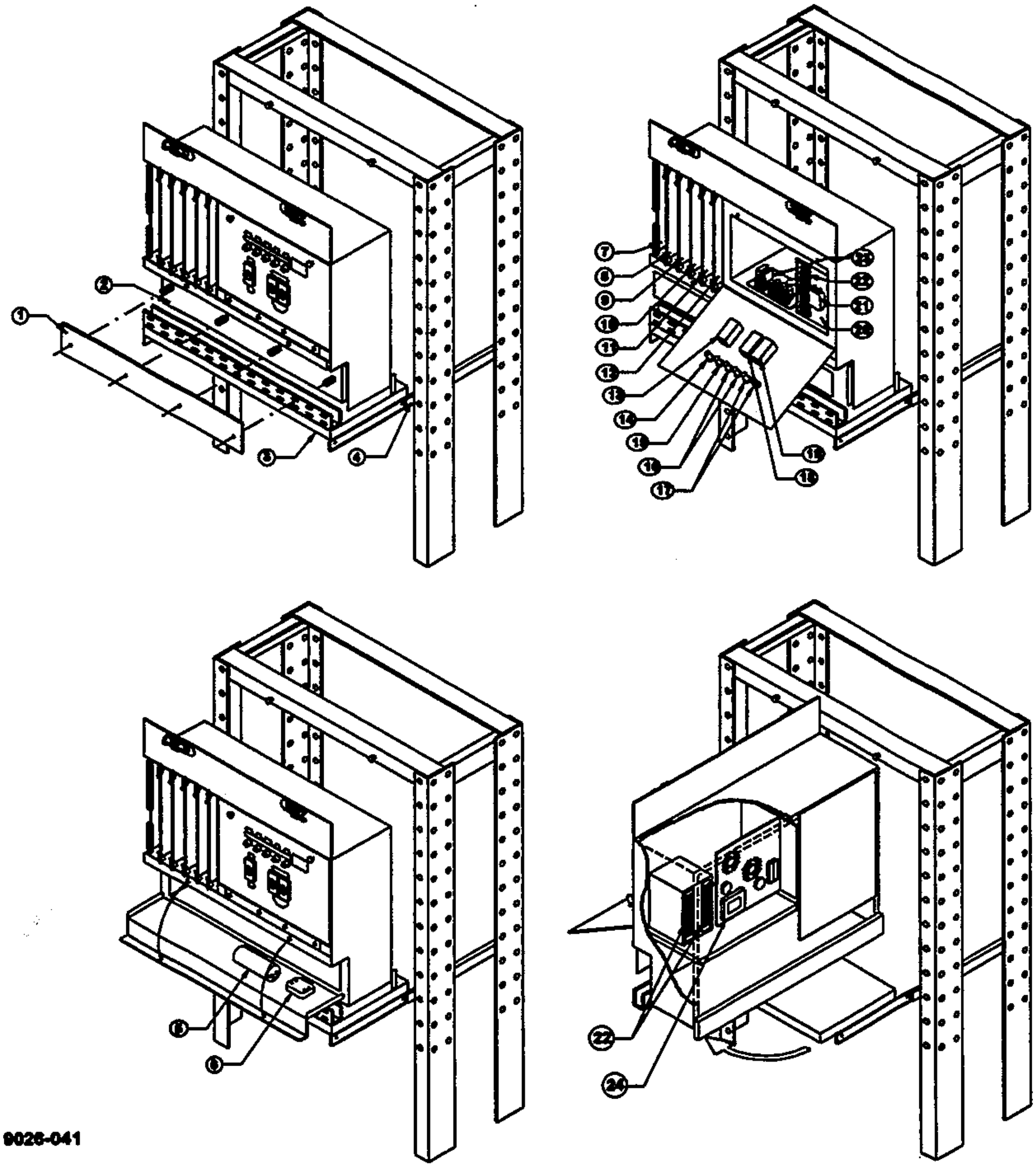


FIGURE 9-3 CARD CAGE ASSY
See **TABLE 9-4**

Find No.	Part Number	Description	Qty	Ref. Des.
1	4559.262.09	Field I/O Silkscreen Panel	1	
2	6584.262.01	Field I/O PCB	1	
3	4541.262.11	Card Cage Bottom Panel	1	
4	4234.262.01	Model-301 12" Extnsn Slide	2	
5	774.5630.3437	30μfd, 370 VAC, Capacitor	1	
6	4180.924.02	Solid state Relay	1	
7	5284.262.09	Extension Card PCB	1	
8	6284.262.04	AEC Interface PCB	1	
9	6284.262.05	RPU I/O Control PCB	1	
10	6284.262.06	mA/mAs Control PCB	1	
11	6284.262.07	kVp Control PCB	1	
12	6284.262.02	RPU Microprocessor PCB	1	
13	4181.262.08	2A, 250V, Circuit Breaker w/ Switch	1	CB1
14	243.3400.0525	.5A, 250V, Tubular Fuse	1	F13
15	243.3400.1250	1A, 250V, Tubular Fuse	1	F1
16	243.3400.3250	3A, 250V, Tubular Fuse	2	F2, F3
17	243.3400.8250	8A, 250V, Tubular Fuse	2	F4, F5
18	4181.262.10	10A, 250V, Circuit Breaker w/ Switch	1	CB2
19	4181.262.09	5A, 250V, Circuit Breaker w/ Switch	1	CB3
20	5486.262.02	Multi-Output Xfmr	1	
21	4186.262.04	5A, 250VAC, EMI Line Filter	1	
22	4182.262.15	10 Pos. Screw Type Terminal Block	3	
23	4185.924.01	3 O/P, 5V/3A, 12V/1.2A, 30W PS	1	
24	6284.262.01	Relay Power Supply PCB	1	

TABLE 9-4 CARD CAGE ASSY (5585.262.07) PARTS LIST

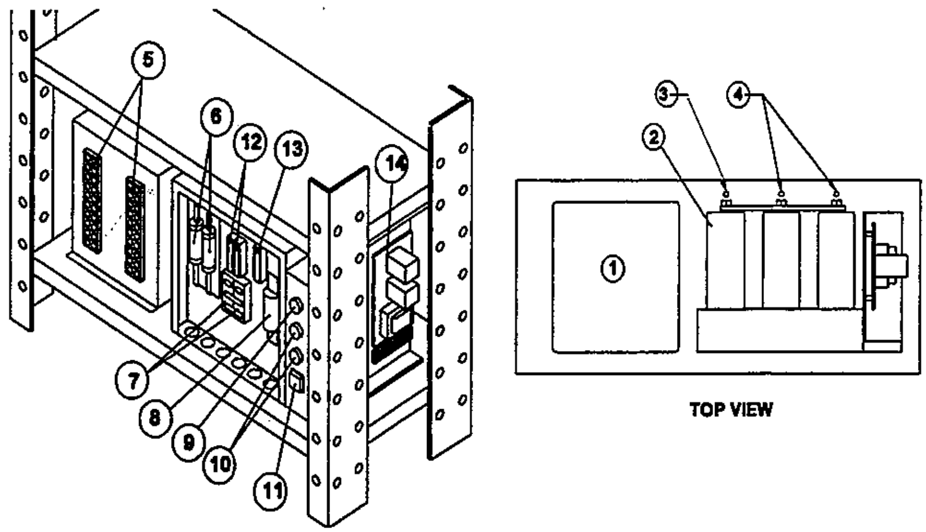


FIGURE 9-4 1ϕ POWER SUPPLY CHASSIS ASSY (5585.262.08) LAYOUT

Find No.	Part Number	Description	Qty	Ref. Des.
1	5486.262.03	TM/HFC 1 Ph Line Match Xfmr Asm	1	
2	771.5824.0445	2400 µfd, 450VDC, Electrolytic Capacitor	6	
3	753.3501.3250	25.00R, 50W, WW, Adj., Low T/C Resistor	3	
4	752.3501.52	2K, 50W, WW, Fixed Resistor	2	
5	4182.262.08	Cinch 8-150, 8 Pos Terminal Block	2	
6†	4182.262.18	FRN-100A, 2 Pole Fuse block	2	
6	243.3410.0250	Bussman Limitron, 100A Fuse	2	F10, F11
7	781.5165.8010	162A, 800V, Dual Power Diode Module	1	
8	4182.262.17	200A Fuseholder	1	
8	243.3420.0601	KBC-200, 200A, 600V, SCR Fuse	1	F9
9	4182.924.07	Panel Mnt, Blk Fuse Holder	1	
9	243.3400.1250	1A, 250V, Tubular Fuse	1	F6
10	4182.924.07	Panel Mnt, Blk Fuse Holder	2	
10	243.3401.5250	15A, 250DCV, Tubular Fuse	2	F7, F8
11	4181.262.03	AML21-Series 2 Pole Pushbutton Switch	1	SW1
11	4181.262.11	Switch Cap, Red	1	
11	4189.262.09	28V Light Bulb	1	
12	713.5404.4031	Furnas 40A, 4 PNO, 24 VAC Relay	2	
13	713.5102.4080	40A, SPST, 24 VAC, Contactor	1	
14	6184.262.04	TM/HFC 24-Hour Power Supply PCB	1	

TABLE 9-5 1ϕ POWER SUPPLY CHASSIS ASSY (5585.262.08) PARTS LIST

† For item 6, the fuses are replaced by terminal Blocks for systems shipped to Europe.

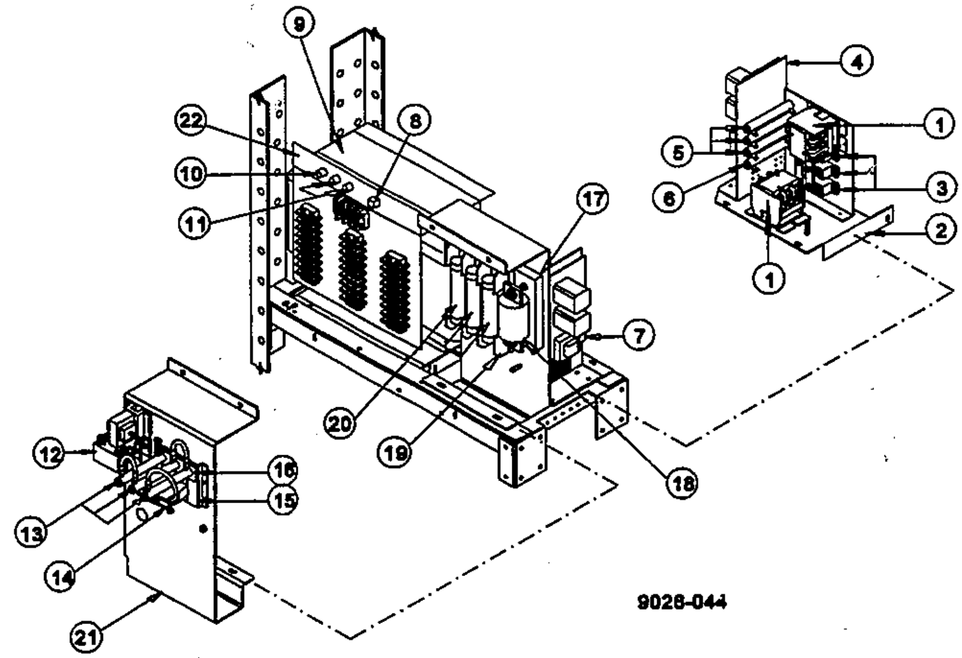


FIGURE 9-5 3ϕ POWER SUPPLY CHASSIS ASSY (5585.262.05) LAYOUT

Find No.	Part Number	Description	Qty	Ref. Des.
1	713.5302.4091	3PST 40A/240V 24V_{AC} Coil Contactor	2	
2	4447.262.05	TM/HFC PS Mtg Panel Base	1	
3	781.5106.1410	100A/1400V Std Recovery Dual Diode	3	
4	4441.262.15	TM/HFC 24 Hr Power Supply Chassis	1	
5	753.3501.31	10.00R 50W WW Adj Low T/C Resistor	3	
6	753.3501.55	5K 50W Adjustable Low T/C Resistor	1	
7	6284.262.04	TM/HFC AEC Interface PCB	1	
8	4181.262.03	TM/HFC Snap Dome SAS35C Switch	1	
9	5486.262.01	TM/HFC 3Ph Line Match Xfmr Assy	1	
10	243.3400.1250	1A 250V Tubular Fuse	1	
11	243.3401.5250	15A 250V Tubular Fuse	2	
12	713.5214.7031	Furnas 40A 201C 220V_{AC} Relay	1	
13	753.3501.2050	5.00R 50W WW Adj Low T/C Resistor	3	
14	713.5102.4080	40A SPST 24V_{AC} Contactor	1	
15	4247.362.01	TM/HFC Resistor Mntg Bracket	1	
16	4159.362.01	TM/HFC Power Resistor Insulator	1	
17	4182.262.11	200A SCR Fuse Block	1	
18	243.3420.06	200A/600V SCR Semiconductor Fuse	1	
19	4182.262.12	3 Pole Fuse Block	1	
20	243.3406.06	FRS-60 60A/600V Fuse	3	
21	4547.262.17	TM/HFC PS Fuse Mounting Bracket	1	
22	5285.262.02	TM/HFC 3Ph Pwr Supply Fuse Mnt Assy	1	

TABLE 9-6 3ϕ POWER SUPPLY CHASSIS ASSY (5585.262.05) PARTS LIST

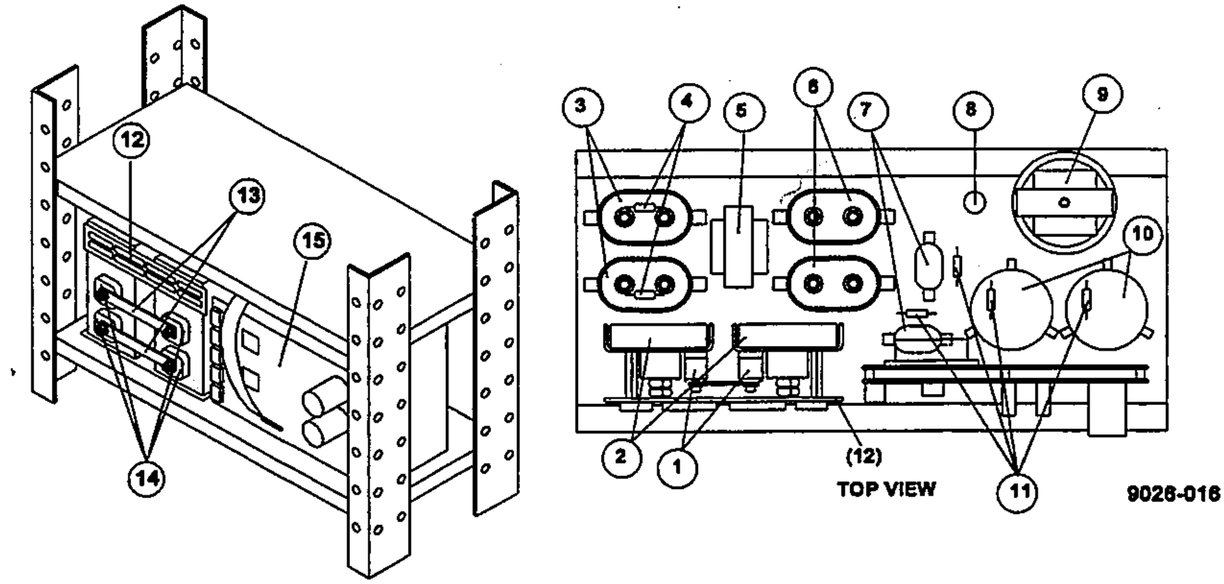


FIGURE 9-6 INVERTER/T-NETWORK ASSY (5585.262.06) LAYOUT

Find Number	Part Number	Description	Qty
1	781.4906.1010	90A, 1000V, Fast Recovery Dual Diode	3
2	4247.262.06	TM/HFC SCR Heatsink	2
3	774.2610.3510	10 µfd, 1000V, Oval Capacitor	2
4	751.2206.81	1 Meg, 2 Watt, 5%, Carbon Resistor	2
5	713.5102.4080	40A, SPST, 24VAC, Contactor	1
6	774.2650.3437	50 µfd, 700 VAC, Oil Capacitor	2
7	774.2550.3437	5 mfd, 370 VAC, Oil Capacitor	2
8	753.4101.35	50.00R, 100W, WW, Adj, Low T/C Res.	1
9	9286.262.01	TM/HFC Inverter Inductor Coil Asm	1
10	771.5824.0445	2400 µfd, 450VDC, Electrolytic Capacitor	2
11	752.3106.6250	25K, 10W, 5%, Fixed, WW, Low T/C Res.	4
12	4140.262.13	TM/HFC Inverter SCR Buss Bar	2
13	784.5435.8050	S23AF8A Inverter Type SCR	4
14	6784.262.03	TM/HFC Gate Drive PCB	1

TABLE 9-7 INVERTER/T-NETWORK ASSY (5585.262.06) PARTS LIST

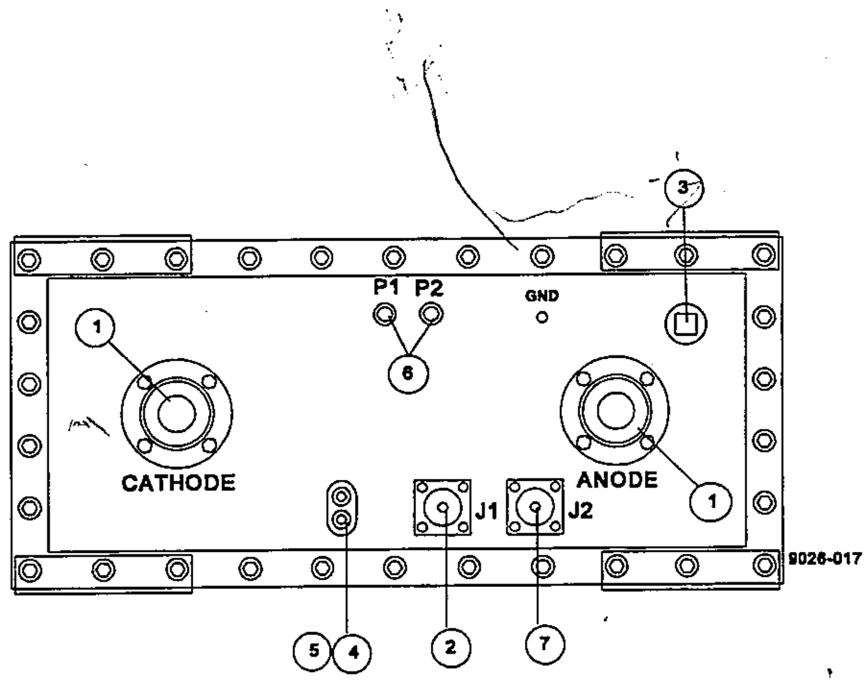


FIGURE 9-7 HIGH VOLTAGE GENERATOR LAYOUT

Find Number	Part Number	Description	Qty
1	4156.313.02	Federal std Cable Receptable	2
2	4182.362.02	3 pos Chassis Mnt Connector Male	1
3	4150.408.01	1/2" Oil Plug	1
4	4182.362.04	Double Banana Jack-Red	1
5	4182.362.05	Double Banana Plug	1
6	5136.362.01	TM/HVG H.V. xfwr Terminal Assembly	2
7	4182.362.03	6 pos Chassis Mnt Connector Male	1

TABLE 9-8 1-TUBE HIGH VOLTAGE GENERATOR (6536.200) PARTS LIST

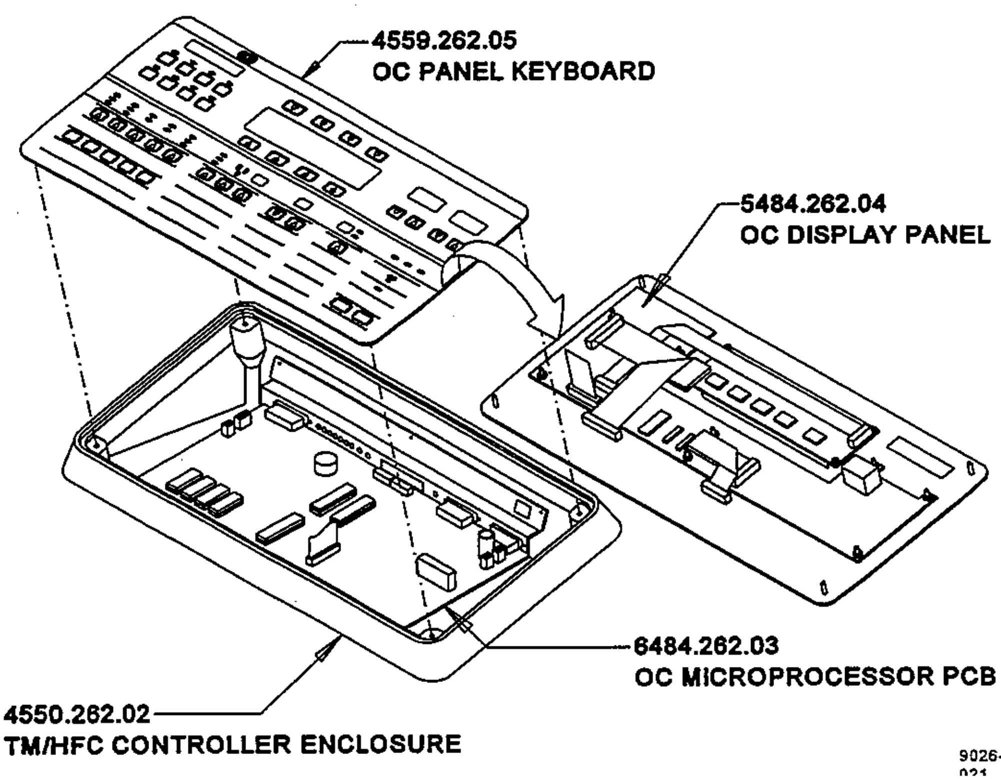


FIGURE 9-8 TM SERIES OPERATOR CONTROL (5585.262.04)

SECTION 10 - COMPLIANCE TESTING

The x-ray control must meet specific performance criteria for compliance with 21 CFR, sub-chapter J. The following tests and data collection permit verification of the system. Where directed to do so, record all required data on copies of the **COMPLIANCE TEST RECORD** sheets at the end of this section.

> **CAUTION**
> **X-ray exposures will be made during this procedure. Proper x-ray precautions must be taken at all times.**

10.1 TEST EQUIPMENT

- True RMS digital multi-meter
- Storage scope, 20MHz bandwidth, minimum of 10M sweeps/s rate
- Radiation dosimeter with ±5% accuracy in the 40 to 125kVp range
- A non-invasive kVp meter or a kVp divider (i.e. Dynalyzer)
- A calculator with statistics capability.

10.2 LINE REGULATION

All systems must be operated on incoming power lines that provide a line regulation of 8% or better. Record as directed in **SECTION 1.0** of the **COMPLIANCE TESTING RECORD.**

1. Connect the true RMS voltmeter to incoming line fuses F10 and F11 and measure and record the no-load line voltage (V_{NL}).
2. Set up the generator as directed in **SECTION 1.0** of the **COMPLIANCE TESTING RECORD.**

> **NOTE:**
> These tube factors may be near the maximum single exposure ratings. Consult the tube rating charts. If the DVM is fast acting, it may be possible to use a **TIME** setting of less than 1.5s to obtain a valid load voltage reading.

3. Make an exposure and record the loaded line voltage (V_L) reading <u>during the exposure</u>.
4. Calculate the line voltage regulation and record.

10.3 mA, mAs, TIME, and kVp ACCURACY

Configure the kVp meter or Dynalyzer into the system. Be sure the collimator is fully closed and take all radiation protection precautions. Make all exposures with at least 30 seconds between exposures. Record results as directed in **SECTION 2.0** of the **COMPLIANCE TESTING RECORD.**

Rejection limits:	mA	-	±3.5%
	mAs	-	±3%, ±0.2 mAs
	TIME	-	±4%, ±2 ms
	kVp	-	±3kVp

> **NOTE:**
> Measurements are taken at the 75% level of the kVp waveform. Set the kVp meter or Dynalyzer to trigger from kVp at 75%.

10.4 LINEARITY

Record as directed in **SECTION 3.0** of the **COMPLIANCE TESTING RECORD.**

1. Place the radiation dosimeter into the x-ray beam at a SID of 30".
2. Collimate the beam to cover just the active area of the probe. Refer to the dosimeter's operator manual.
3. Select the <u>DOSE</u> mode.
4. Make exposures at a minimum of 30-second intervals to assure proper tube cooling.
5. Make exposures with the techniques listed on the test record sheet. Record all data and calculate the <u>mR/mAs</u> and the linearity.
   X1 = mR/mAs from the first table
   X2 = mR/mAs from the next table

$$(X1 - X2)/(X1 + X2) \leq .08 \text{ rejection limit}$$

The 21 CFR Regulations state that the adjacent station linearity shall not exceed 0.1 from the above formula. The 0.08 limit above takes into account instrumentation errors to assure compliance.

10.5 REPRODUCIBILITY

Make exposures using techniques listed in the tables in **SECTION 4.0** of the **COMPLIANCE TESTING RECORD** and record the results.

The 21 CFR regulations state that the co-efficient of variation shall not exceed .05. Therefore, the above .04 limit takes into account the instrumentation errors to assure compliance.

10.6 AUTOMATIC EXPOSURE CONTROL (AEC)

If the system is installed with AEC, its functions and reproducibility must be verified. Record as directed in **SECTION 5.0** of the **COMPLIANCE TESTING RECORD.**

1. Select: **Manual - AEC** mode, Table, Grid-In, Field #2, 0 Density, Medium, Film/Screen 1, 540 mAs, 80kVp
2. Make an exposure with no absorber in the field. Confirm that the exposure time is less than 8.33ms.
3. Completely cover the ion-chamber fields with a lead blocker.
4. Select 60kVp at 541mAs.
5. Make an exposure and verify that the post-mAs is not greater than 580mAs.
6. Verify that the AEC Limit is indicated in the LCD display.
7. Verify that an exposure can NOT be initiated.
8. Press **[RESET]** (lower right hand corner of the LCD) and verify that the AEC Limit indication is removed and that an exposure can be initiated.
9. Wait 2 minutes.
10. Make another exposure, but release the exposure switch before termination by the 540mAs back-up timer. Verify **STEPS 4** and **5**.
11. Remove the lead blocker and place 3" of water or acrylic over the ion chamber input field. This should be 4" square.
12. Make an exposure and note the post-mAs.
13. Adjust kVp until the post-mAs is approximately 5mAs.
14. Place the radiation probe into the field, adjust the collimator to just include the probe, approximately 8" x 8".
15. Make 10 consecutive exposures, 1 minute apart, and record the mR for each exposure.
16. Calculate the co-efficient of variation as in **SECTION 10.5. above.** The limit is to be less than .04.

10.7 EXPOSURE FUNCTIONS

Make an exposure and observe that:

1. The x-ray LED on the operator control is ON during the exposure.
2. Select 100mAs and initiate an exposure, however, release the exposure push button before the mAs timer times out to confirm that the exposure may be terminated by the operator.
3. Record as directed in **SECTION 6.0** of the **COMPLIANCE TESTING RECORD.**

10.8 R/F EQUIPMENT

If the installation has R/F equipment, complete **SECTION 7 FLUOROSCOPIC mA and kVp ACCURACY** of the **COMPLIANCE TESTING RECORD.** Dependent on the TM Software Version in use, fill out Table A for Continuous Fluoroscopy and/or Table B for Pulsed Fluoroscopy.

10.9 LABELS

Check that all certifiable components have all of the appropriate labels attached and record as directed in **SECTION 8.0** of the **COMPLIANCE TESTING RECORD.**

10.10 SOFTWARE VERSIONS

Record, in **SECTION 9.0** of the **COMPLIANCE TESTING RECORD**, the software versions used in the system.

10.11 SYSTEM CONFIGURATION

Record, in **SECTION 10.0** of the **COMPLIANCE TESTING RECORD**, component information. This concludes the Performance Compliance Verification.

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TM SERIES GENERATOR COMPLIANCE TESTING RECORD

Photocopy these pages and use as a permanent record of the generator. Keep with the Maintenance Manual.

1.0 LINE REGULATION

1.1 Select the following factors:

Select	TM 30	TM 40	TM 50	TM 65	TM 80
mA	200	200	300	400	400
kVp	100	100	100	100	100
Time	1.5 s	1.5 s	1.5 s	1.5 s	1.5 s

1.2 Connect the true-rms voltmeter to L1 and L2 at the fuse block and measure the incoming line voltage.

Voltage at No Load = V_{NL} = _______

1.3 Make the exposure listed above and record the L1/L2 voltage reading during the exposure.

Voltage at Load = V_L = _______

1.4 Calculate the Line Voltage Regulation as follows.

TM 30
% Line Reg.=$[(V_{NL}-V_L)/V_L]$ X 100 X 1.5 = ___%

TM 40 and TM 80
% Line Reg.=$[(V_{NL}-V_L)/V_L]$ X 100 X 2.0 = ___%

TM 50
% Line Reg.=$[(V_{NL}-V_L)/V_L]$ X 100 X 1.67 = ___%

TM 65
% Line Reg.=$[(V_{NL}-V_L)/V_L]$ X 100 X 1.625 = ___%

NOTE: The Line regulation must be less than 8%.

NAME:______________________________
COMPANY:___________________________
SIGNATURE:_________________________

ACCEPT:___________
REJECT:___________
DATE:_____________

2.0 kVp, mA, TIME, mAs ACCURACY

Select the values listed in this section of the Record Sheet and record all measurements. Test Accuracy Values as follows:

kVp	± 3 kVp
mA	± 3.5%
Time	± 4% ± 2 ms
mAs	± 3% ± 0.2 mAs

NOTE: If the Technique Factors cannot be selected due to Unit power limit, kVp limit or X-ray tube limit, bypass the entry.

SELECT		ACTUAL			
	kVp	kVp	mA	ms	mAs
	40				
LARGE	60				
25mA	80				
400ms	100				
(10mAs)	120				
	130				
LIMITS		±3kVp	±.87mA	±18ms	±.5mAs

SELECT		ACTUAL			
	kVp	kVp	mA	ms	mAs
	40				
LARGE	60				
50mA	80				
200ms	100				
(10mAs)	120				
	130				
LIMITS		±3kVp	±1.75mA	±10ms	±.5mAs

NAME:______________________
COMPANY:______________________
SIGNATURE:______________________

ACCEPT:____________
REJECT:____________
DATE:____________

kVp, mA, TIME, mAs ACCURACY (contd.)

Collect data as indicated.

SELECT		ACTUAL			
	kVp	kVp	mA	ms	mAs
LARGE 100mA 100ms (10mAs)	40				
	60				
	80				
	100				
	120				
	130				
LIMITS		±3kVp	±3.5mA	±6ms	±.5mAs

SELECT		ACTUAL			
	kVp	kVp	mA	ms	mAs
LARGE 200mA 50ms (10mAs)	40				
	60				
	80				
	100				
	120				
	130				
LIMITS		±3kVp	±7mA	±4ms	±.5mAs

NAME:____________________ ACCEPT:__________
COMPANY:____________________ REJECT:__________
SIGNATURE:____________________ DATE:__________

kVp, mA, TIME, mAs ACCURACY (contd.)

Collect data as indicated.

SELECT		ACTUAL			
	kVp	kVp	mA	ms	mAs
	40				
LARGE	60				
300mA	80				
35ms	100				
(10.5mAs)	120				
	130				
LIMITS		±3kVp	±10.5mA	±3.4ms	±.52mAs

SELECT		ACTUAL			
	kVp	kVp	mA	ms	mAs
	40				
LARGE	60				
400mA	80				
25ms	100				
(10mAs)	120				
	130				
LIMITS		±3kVp	±14mA	±3ms	±.5mAs

NAME:________________________ ACCEPT:__________
COMPANY:______________________ REJECT:__________
SIGNATURE:____________________ DATE:__________

kVp, mA, TIME, mAs ACCURACY (contd.)

Collect data as indicated.

SELECT		ACTUAL			
	kVp	kVp	mA	ms	mAs
LARGE 500mA 20ms (10mAs)	40				
	60				
	80				
	100				
	120				
	130				
LIMITS		±3kVp	±17.5mA	±3.6ms	±.5mAs

SELECT		ACTUAL			
	kVp	kVp	mA	ms	mAs
LARGE 600mA 20ms (12mAs)	40				
	60				
	80				
	100				
	120				
LIMITS		±3kVp	±21mA	±2.8ms	±.56mAs

NAME:______________________________
COMPANY:__________________________
SIGNATURE:________________________

ACCEPT:____________
REJECT:____________
DATE:______________

kVp, mA, TIME, mAs ACCURACY (contd.)

Collect data as indicated.

SELECT		ACTUAL			
LARGE	kVp	kVp	mA	ms	mAs
800mA	60				
15ms	80				
(12mAs)	100				
LIMITS		±3kVp	±28mA	±2.6ms	±.56mAs

SELECT		ACTUAL			
LARGE 1000mA	kVp	kVp	mA	ms	mAs
10ms (10mAs)	80				
LIMITS		±3kVp	±35mA	±2.4ms	±.5mAs

2-Factor - mAs Check - ALL Systems

Select 60 kVp

SELECT	4.5 mAs	30 mAs	150 mAs
50 mA			
100 mA			
300 mA			
LIMITS	±.33 mAs	±1.1 mAs	±4.7 mAs

NAME:____________________________ ACCEPT:____________
COMPANY:_________________________ REJECT:____________
SIGNATURE:_______________________ DATE:______________

3.0 LINEARITY

*LIN = (X1 - X2)/(X1 + X2), (X2 - X3)/(X2 + X3), ... **Linearity must NOT exceed .08**

60kVp

SELECTED				ACTUAL mR	CALC mR/mAs	LIN CALC*
EXP	**mA**	**TIME**	**mAs**			
X1	25	400ms	10			
X2	50	200	10			
X3	100	100	10			
X4	150	70	10.5			
X5	200	50	10			
X6	300	35	10.5			
X7	400	25	10			
X8	500	20	10			
X9	600	20	12			
X10	800	15	12			

90kVp

SELECTED				ACTUAL mR	CALC mR/mAs	LIN CALC*
EXP	**mA**	**TIME**	**mAs**			
X1	25	400ms	10			
X2	50	200	10			
X3	100	100	10			
X4	150	70	10.5			
X5	200	50	10			
X6	300	35	10.5			
X7	400	25	10			
X8	500	20	10			
X9	600	20	12			
X10	800	15	12			

NAME:______________________ ACCEPT:____________
COMPANY:___________________ REJECT:____________
SIGNATURE:_________________ DATE:______________

LINEARITY (contd.)

120kVp

SELECTED				ACTUAL mR	CALC mR/mAs	LIN CALC*
EXP	mA	TIME	mAs			
X1	25	400ms	10			
X2	50	200	10			
X3	100	100	10			
X4	150	70	10.5			
X5	200	50	10			
X6	300	35	10.5			
X7	400	25	10			
X8	500	20	10			
X9	600	20	12			

NAME:____________________
COMPANY:____________________
SIGNATURE:____________________

ACCEPT:__________
REJECT:__________
DATE:__________

4.0 REPRODUCIBILITY

Coefficient of Variation = Standard Deviation/Mean = σ/X_{avg}

$$X_{avg} = (\Sigma_n X_i)/n; \qquad \sigma = [\Sigma_n(X_i - X_{avg})^2/(n-1)]^{1/2}$$

Where: X_i is the value of an entry
n is the number of entries.

MR READINGS								
SELECT	ALL SYSTEMS			TM30	TM40	TM50	TM65	TM80
kVp mA TIME	60 100 10ms	90 100 10ms	120 100 10ms	100 300 100ms	100 400 100ms	100 500 100ms	100 600 100ms	100 800 100ms
EXP. 1								
EXP. 2								
EXP. 3								
EXP. 4								
EXP. 5								
EXP. 6								
EXP. 7								
EXP. 8								
EXP. 9								
EXP. 10								
MEAN								
STD DEV								
Coeff. of VAR.								

The co-efficient of variation must not exceed 0.04

NAME:____________________ ACCEPT:__________
COMPANY:____________________ REJECT:__________
SIGNATURE:____________________ DATE:__________

5.0 Automatic Exposure Control (AEC)

1. Exposure terminates: <8.33ms or 5mAs ____________mA or ms

2. Back-up mAs: <580mAs ________________mAs

3. AEC Limit Indication: Y/ N ________
4. Exposure Inhibited: Y/ N ________
5. AEC Reset Function: Y/ N ________
6. Exposure Switch Release: Y/ N ________
7. AEC Reproducibility
   Technique: 80kVp, 540 back-up mAs, 3" of water or acrylic.
   Adjust kVp for approximately 5mAs.

EXP #	mR
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
MEAN	
STD DEV	
Coeff. of VAR*	

* Must be less than 0.04.

NAME:________________________ ACCEPT:__________
COMPANY:______________________ REJECT:__________
SIGNATURE:____________________ DATE:__________

6.0 EXPOSURE FUNCTIONS

1. X-ray LED ON ____________

2. Audible alert sound is ON ____________

3. Exposure termination ____________

7.0 FLUOROSCOPIC mA and kVp ACCURACY

(A) CONTINUOUS FLUOROSCOPY

SELECTED kVp	50	85	120
Station 1			
kVp Actual			
mA Actual			
mA Indicated			
Station 4			
kVp Actual			
mA Actual			
mA Indicated			

REJECTION LIMITS:
a) mA: Indicated mA on RFC must be within ± 25% ± .2 mA from Actual mA.
b) kVp: Actual kVp must be within ± 3 kVp from selected kVp.

NAME:____________ ACCEPT:________
COMPANY:____________ REJECT:________
SIGNATURE:____________ DATE:________

(B) PULSED FLUOROSCOPY

SELECTED kVp	60	85	120
30 PPS			
kVp Actual			
mA Actual			
mA Indicated			
1.9 PPS			
kVp Actual			
mA Actual			
mA Indicated			

REJECTION LIMITS:
a) mA: Indicated mA on RFC must be within ± 50% ± .1 mA from Actual mA
b) kVp: Actual kVp must be within ± 3 kVp from selected kVp.

8.0 LABELS

1. Operator Control
2. Remote Power Unit
3. High Voltage Generator

9.0 SOFTWARE VERSIONS

OC SOFTWARE VERSION: __________

RPU SOFTWARE VERSION: __________

NAME:__________ ACCEPT:__________
COMPANY:__________ REJECT:__________
SIGNATURE:__________ DATE:__________

10.0 SYSTEM CONFIGURATION

ITEM	MODEL (PN)	SERIAL NUMBER
High Voltage Generator:		
High Speed Starter:		
Collimator Control:		
Servo Tomographic System:		
Mechanical Tomographic System:		
Printer:		

	Chamber #	Left/Right	Grid	Film/Screen
Tube 1 Table:				
Tube 1 Wall:				
Tube 1 Aux:				

NAME:______________________________ ACCEPT:____________
COMPANY:__________________________ REJECT:____________
SIGNATURE:________________________ DATE:______________

11.0 GENERATOR PROBLEM LOG

DATE	OPERATOR	DESCRIPTION OF PROBLEM/ERROR CODE

NAME:______________________________ ACCEPT:____________
COMPANY:___________________________ REJECT:____________
SIGNATURE:_________________________ DATE:______________

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NAME:____________________
COMPANY:____________________
SIGNATURE:____________________

ACCEPT:__________
REJECT:__________
DATE:__________

APPENDIX A - TM GENERATOR PC INTERFACE PROGRAM OVERVIEW, VERSION 1.0.1

The TM generator PC interface initializes customized technique data for the APR and CEC features of the TM generator. Techniques for each exam can be determined by the user. A PC program stores this data on disk in the PC. After all data has been entered into the PC by the user, it is compiled into a form usable by the TM generator. The serial interface of the PC is used to transfer the data into the OC, where it is stored in non-volatile memory. Changes entered through the OC may also be read back out of the OC and stored on disk.

The technique data includes the exam name and description, film/screen, receptor assignment, and the actual technique to be used. Optional comments may be entered to guide the operator of the equipment. If present, these comments will appear in the LCD window of the OC after **[INST]** is pressed in APR or CEC mode.

The program will run on any IBM PC (or compatible) that uses MS-DOS version 2.1 or later. A minimum of 256KB of RAM and one serial port (RS-232) is required. A parallel interface port and printer are required if print-outs are desired.

This document assumes a basic understanding of MS-DOS computers. Any questions concerning the operation of MS-DOS should be referred to the appropriate documentation.

The program is provided on a 3.5" 1.44 MB diskette. THIS IS THE MASTER COPY. IMMEDIATELY MAKE A COPY OF IT, THEN STORE IT IN A SAFE PLACE! Do not store it near a source of magnetic fields (such as an x-ray generator) or heat.

1.0 TO START THE PROGRAM ON A FLOPPY DRIVE (NO HARD DRIVE)

1. Boot-up the computer using the DOS 3.5" floppy disk.
2. Insert the WORKING COPY of the master diskette. Make this the default drive. Use a separate diskette for each client.
3. At the DOS prompt, type "TM" and press **[ENTER]** to run the program.

2.0 TO INSTALL THE PROGRAM ON A HARD DRIVE

1. Boot-up the computer from the hard drive.
2. Insert the working copy of the diskette into drive A or B and make it the default drive by typing "A:" or "B:" and pressing **[ENTER]**.
3. At the DOS prompt, type "INSTALL" and press **[ENTER]**. Remove the diskette when the "C:\" DOS prompt returns.
4. Type "MD C:\TM\clientname" and press **[ENTER]**. "clientname" is any valid DOS directory name used to uniquely identify the client.

3.0 TO START THE PROGRAM ON A HARD DRIVE

1. Type "CD C:\TM\clientname" and press **[ENTER]**.
2. Type "\TM\TM" and press **[ENTER]** to run the program.

All files created by the program will be in the "clientname" sub-directory. Make a separate subdirectory for each client since the program itself does not allow a unique filename for the data it stores. A benefit of this technique is that each client's data is segregated into sub-directories, for a listing of subdirectories created, type "DIR C:\TM" at the DOS prompt and press **[ENTER]**.

The program is menu-driven. When a menu is displayed, an item may be selected by highlighting it with the scroll-bar and pressing the **[ENTER]** key. The scroll-bar is moved by using either the arrow keys, the **[SPACEBAR]**, the [+], or the [-] keys. The **[ESC]** key is used throughout the program to back-out of a function or menu to the previous selection. Pressing the **[ESC]** key from the main menu causes the program to terminate and returns control to DOS.

The program will load and display the configuration menu the first time the program is run. After that, the main menu will be displayed when the program is started.

4.0 MAIN MENU

1. The first selection on the main menu is Exam Menu. It brings up a menu with selections to enter, modify, delete, and print exams.
2. The next selection is Communication Menu. It is used to accomplish the communication link with the OC after all the exam data has been entered. It has selections to transfer data to or from the OC, and to indicate which serial port to use if the computer has more than one.
3. The last selection is Configuration Menu. It is used to initialize certain parameters of the technique memory that are common to all exams.

5.0 EXAM MENU

1. **Modify/Browse Exams** will review or update an exam that has been previously entered. A list is presented to select an exam to work with.
2. **Enter New Exam** will add an exam to the disk. A list is presented to allow you to select which body group to store the exam under.
3. **Delete Exam** is used to remove an exam from disk. A list is presented to allow you to select an exam. Confirmation is requested before the deletion is carried out.
4. **Print Exam Summary** will print a list of all exams currently stored on disk. Only the descriptions and information band data are printed.
5. **Print Exam** Details prints a list of all exams currently stored on disk, including all details entered for each exam.

6.0 COMMUNICATION MENU

1. **Transfer Data to TM Generator** reads the exam data stored on disk and compiles it into a format that the OC can accept. It then sends the compiled data to the serial port as a series of blocks of data until all technique memory present in the OC has been programmed.

   Once started, the process may be interrupted by pressing the **[ESC]** key. It may then be resumed or terminated when prompted. If terminated, the technique memory is left in an undefined state and will not be accessible until the transfer is rerun.

   A message will be displayed on the computer screen and on the OC LCD window when the data has been successfully transferred. A status screen is displayed and updated as the transfer is in progress. The transfer typically requires 4.5 minutes per 32KB of technique memory.
2. **Transfer Data from TM Generator** complements the previous function. It reads the data back from the OC as a series of blocks and stores it on disk. Then it decompiles the data into the original exam format so that the exams can be manipulated as if they had been entered from the keyboard. If the program detects that exam files are already present on disk (in the current sub-directory), it will rename them to prevent the incoming data from overwriting them. As above, the transfer may be interrupted by pressing [ESC].
3. **Set Communication Port** determines which serial port is connected to the TM OC. Com1 and Com2 are supported. The default is Com1. This value is stored on disk. To transfer data, see **SECTION A-10.0.**

7.0 CONFIGURATION MENU

1. The first three selections, **Receptors for tube X**, are used to enter the grid ratio information. This information is automatically displayed on the second line of the instruction screen.
2. **Film/Screen Descriptions** is used to enter the text that will be displayed for each film/screen combination used. This information is automatically displayed on the first line of the instruction window.
3. **Dealer/Client Information** is used to personalize the print-outs the program produces.
4. **Print Current Configuration** is used to produce hardcopy output with the printer connected to the PC. This print-out is useful when entering exams. The printer must be ready when this option is selected or an error will occur that causes the program to abort and return to DOS. If this happens, restart the program. No data will be lost.

8.0 ENTERING OR MODIFYING AN EXAM

On the computer, each exam has five screens associated with it. An area at the bottom of the screen contains information about some of the keys that can be used as the data is edited. These keys are not listed. The **[Page-Up]** and **[Page-Down]** keys go from screen-to-screen of each exam. Holding down the **[Ctrl]** key while pressing **[Page-Up]** or **[Page-Down]** will store the current exam to disk and present the previous or next exam sequentially. The [↑] and [↓] keys increment and decrement the numeric value of a field by one. The **[ESC]** key stores an exam to disk and returns to the previous menu.

The **Pediatric** and **X-Large** entries for APR are optional. A value of zero in either the kVp or mAs field will disable the selection.

9.0 INSTALLATION OF MEMORY CHIPS

The Technique Memory chip plugs into the socket for U3, on the microprocessor PCB in the OC. The OC software EPROM at U5 must be version 1.0.6 or higher. The Remote Power Unit (RPU) software version number must match the version number of the OC.

10.0 TRANSFERRING THE DATA

When ready to transfer the data:

1. Remove power to the OC.
2. Connect the supplied interface cable between the serial port of the PC and J5 of the OC.
3. Remove the protective label from the OC rear and flip SW3-8 DOWN in the OC.
4. Turn ON the OC and press **[ALT MENU]**.
5. Select option #2 "Setup Routines". Use the **[NEXT]** and **[BACK]** keys to select "Enable PC Communications".
6. Press **[EXECUTE]**. The LCD window will display "PC Communications Enabled".

If radiographic APR and/or CEC data from one client (source) is to be used for another (destination), copy the source client's EXAM.DAT and EXAM.IDX files to the destination client's directory.
Transferring data to TM generator:

1. On the PC, run the TM program and select "Communication Menu".
2. Select the proper communication port with the "Set Communication Port" selection.
3. Select "Transfer Data to TM Generator". A message indicating successful completion will appear on the PC display, as well as the OC LCD window, when the transfer is complete. If these messages do not appear, or other messages appear indicating that the transfer was aborted, the program must be rerun.
4. When the transfer is complete, use the **[ESC]** key to back out of the menus and return to DOS. Make a backup copy of the exam data first.
5. The PC may now be turned OFF.
6. Turn OFF the OC.
7. Disconnect the interface cable.
8. Flip SW3-8 in the OC UP and replace the supplied protective label.
9. Turn the OC ON.
10. Verify that the APR and CEC data is present.
11. The KVp and MAs values of an exam may be modified by the user. Simply select the new values, press the **[ALT MENU]** button, select **[SAVE FP]** then press the YES button in the LCD window. Two beeps will confirm that the data was stored.

Transferring data from TM generator:

When exam data is present in a subdirectory, it should be saved. Use DOS to copy the files named EXAM.DAT, EXAM.IDX, and SETUP.DAT to a floppy disk. At the beginning of the transfer, if the program detects any of the files EXAM.DAT, EXAM.IDX, or SETUP.DAT it will preserve them by renaming them to EXAM_BAK.DAT, EXAM_BAK.IDX, or SET_BAK.DAT. This is the last opportunity to save them because running the transfer a second time will overwrite these backup copies.

1. Prepare the OC as in **10.0**.
2. Run the TM program and select "Communication Menu".
3. Select the proper communication port with the "Set Communication Port" selection.

4. Select "Transfer Data from TM Generator". A message indicating successful completion will appear on the PC display as well as the OC LCD window when the transfer is complete. If these messages do not appear, or other messages appear indicating that the transfer was aborted, the program must be rerun.
5. The exam data may now be modified as desired and transferred back to the OC as detailed above.
6. When finished, turn OFF the OC, disconnect the interface cable and flip SW3-8 UP in the OC.

11.0 USING THE SUPPLIED GENERAL RADIOGRAPHY EXAMS

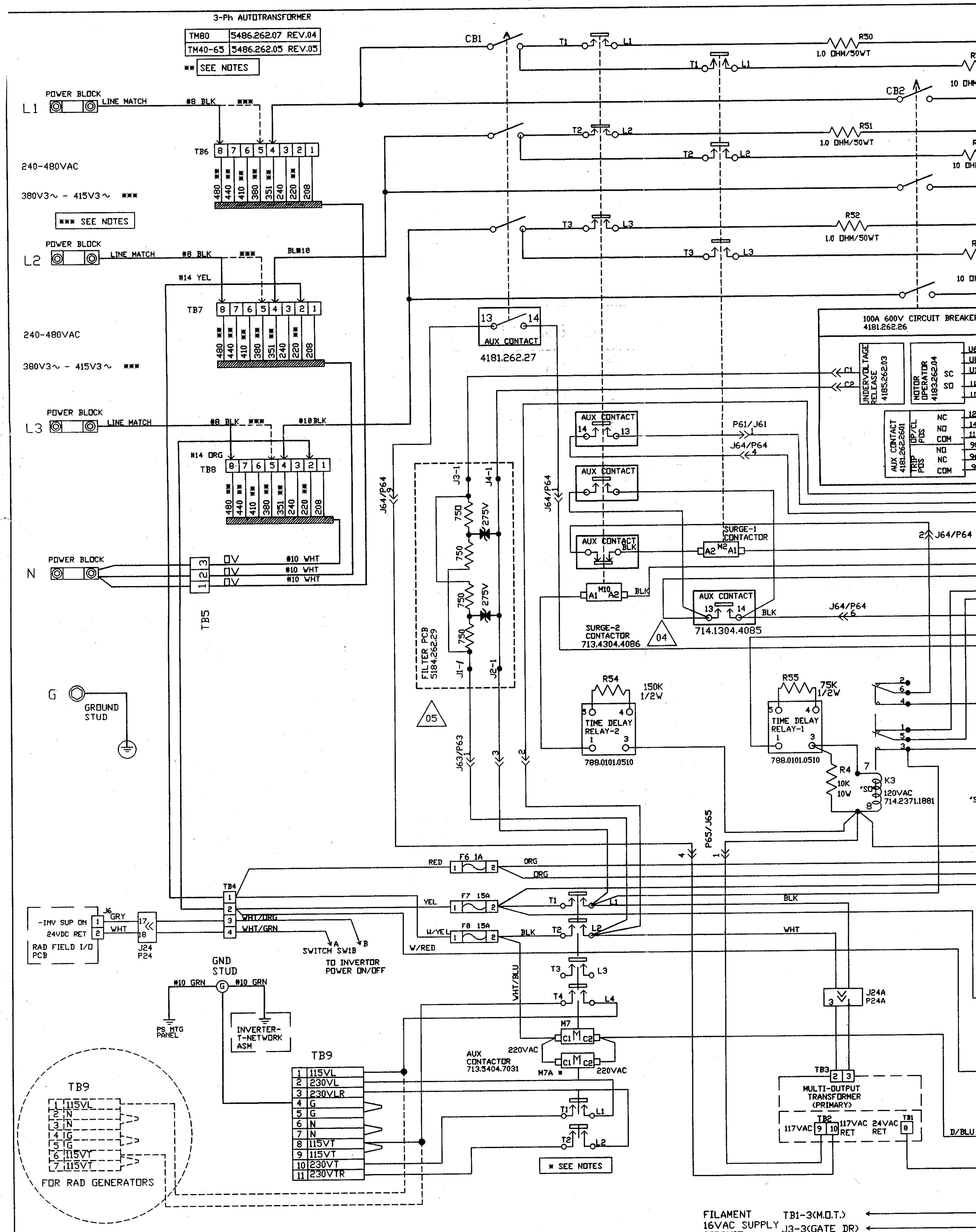
There is a collection of generic exams supplied on the diskette that may be used or modified to fit the users' needs. To access these files:

1. Boot-up the computer.
2. Follow the appropriate directions below.
   a. On a floppy based system:
      I. Insert the working copy of the diskette into drive A or B and make it the default drive by typing "A:" or "B:" and pressing **[ENTER]**.
      ii. Type "CD \GENRAD" and press **[ENTER]**.
      iii. Type "\TM" and press **[ENTER]** to run the program.

   b. On a system with a hard disk (the files are automatically copied by the INSTALL program into a separate subdirectory named GENRAD.):
      I. Type "CD \TM\GENRAD" and press **[ENTER]**.
      ii. Run the TM program as normal. (i.e. type "\TM\TM" and press **[ENTER]**)

12.0 TM MENU TREE

Main Menu	Exam Menu	Modify/Browse Exams Enter New Exam Delete Exam Print Exam Summary Print Exam Details
	Communication Menu	Transfer Data to TM generator Transfer Data from TM Generator Select Communication Port
	Configuration Menu	Receptors for Tube 1 Receptors for Tube 2 Receptors for Tube 3 Film/Screen Descriptions Dealer/Client Information Print Current Configuration



REV.	DATE/ECN CODE	DRG.	APP.
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03	9885	GP	
04	981112	GP	
05	9891-01	GP	

TM 150kV POWER SUPPLY SCHEMATIC

4494.262.50

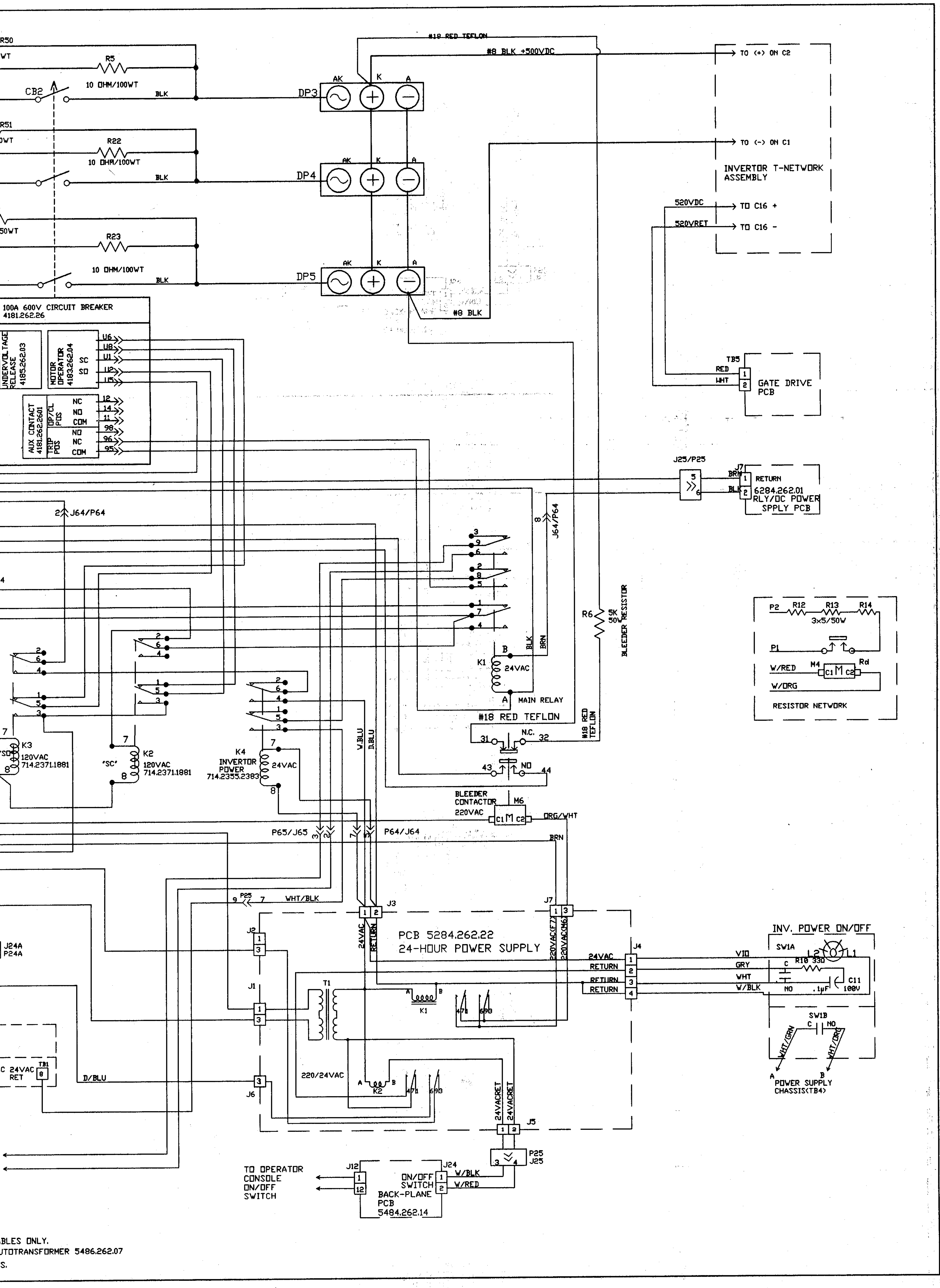
MAT:

FINISH:

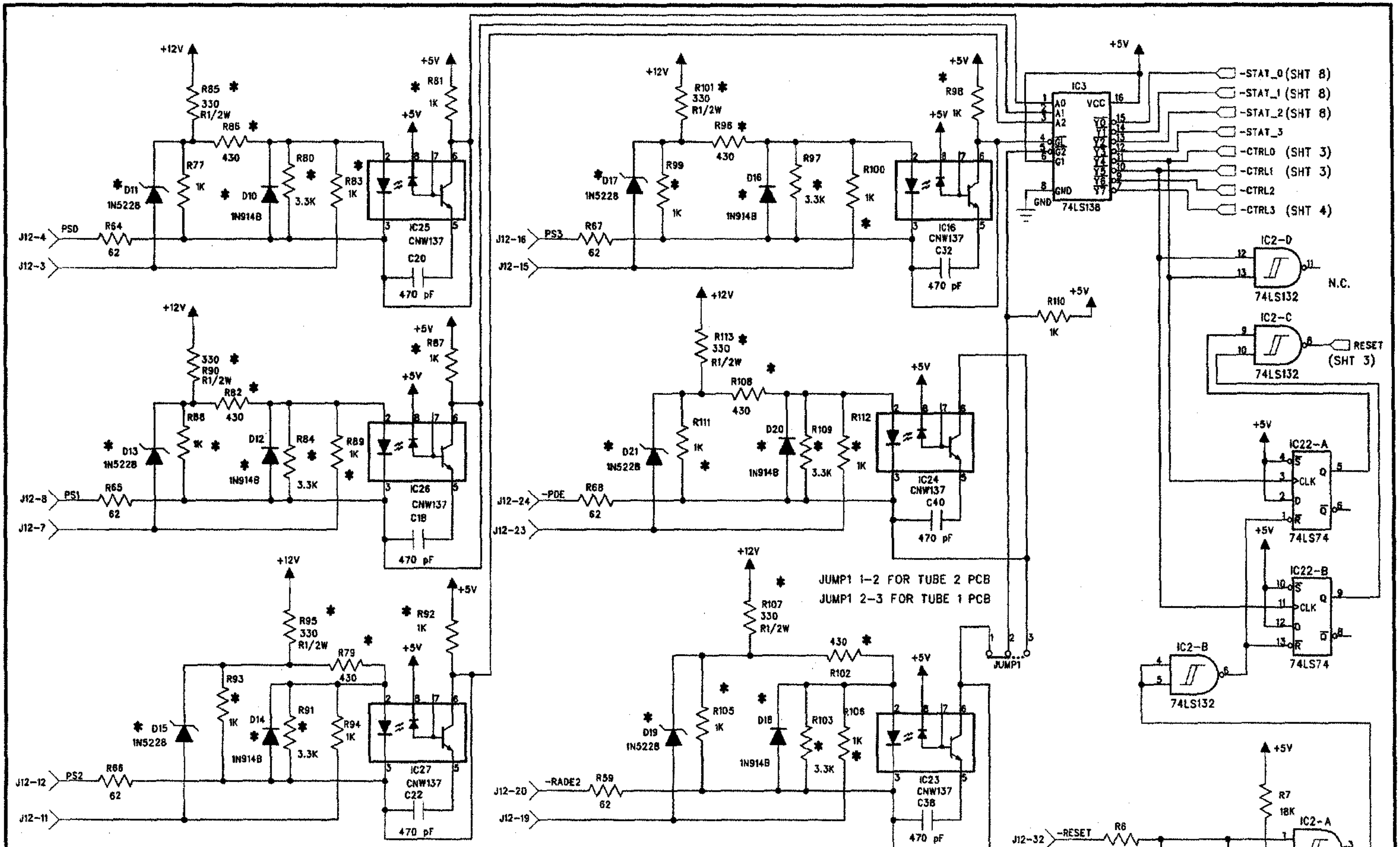
TREX MEDICAL
CONTINENTAL
DIVISION

TOLERANCES-UNLESS OTHERWISE SPECIFIED: DECIMALS .XXX±.005, .XX±.015-FRACTIONS ± 1/32; ANGLES ± 1/2 DEGREE

NOTES:
- * M7A USED FOR R/F TABLES ONLY.
- ** TAPS USED IN TM80 AUTOTRANSFORMER 5486.26
- *** FOR 50 Hz GENERATORS.



#18 RED TEFLON
#8 BLK +500VDC
TO (+) ON C2
TO (-) ON C1
INVERTOR T-NETWORK ASSEMBLY
520VDC
520VRET
TO C16 +
TO C16 -
R50
R51
R5
R22
R23
10 OHM/100WT
CB2
BLK
DP3
DP4
DP5
AK
K
A
#8 BLK
100A 600V CIRCUIT BREAKER 4181.262.26
UNDERVOLTAGE RELEASE 4185.262.03
MOTOR OPERATOR 4183.262.04
SC
SD
AUX CONTACT 4181.262.2601
OP/CL POS
TRIP POS
NC
NO
COM
TB5
RED
WHT
GATE DRIVE PCB
J25/P25
J7
BRN
BLK
RETURN
6284.262.01 RLY/DC POWER SPPLY PCB
J64/P64
R6
5K 50W
BLEEDER RESISTOR
K1
24VAC
MAIN RELAY
#18 RED TEFLON
N.C.
NO
BLEEDER CONTACTOR 220VAC
M6
ORG/WHT
K3
120VAC 714.2371.1881
K2
120VAC 714.2371.1881
K4
INVERTOR POWER 714.2355.2383
W.BLU
D.BLU
P65/J65
P64/J64
WHT/BLK
P25
J3
PCB 5284.262.22
24-HOUR POWER SUPPLY
220VAC(F7)
220VAC(M6)
J2
J1
J4
J5
J6
T1
220/24VAC
24VACRET
J24A
P24A
C 24VAC RET
TB1
D/BLU
RESISTOR NETWORK
P2
R12
R13
R14
3x5/50W
P1
W/RED
W/ORG
M4
Rd
INV. POWER ON/OFF
SW1A
SW1B
R10 330
C11 100V
.1µF
VIO
GRY
WHT
W/BLK
POWER SUPPLY CHASSIS(TB4)
WHT/GRN
WHT/ORG
TO OPERATOR CONSOLE ON/OFF SWITCH
J12
J24
ON/OFF SWITCH BACK-PLANE PCB 5484.262.14
W/BLK
W/RED
P25
J25
BLES ONLY.
UTOTRANSFORMER 5486.262.07
S.



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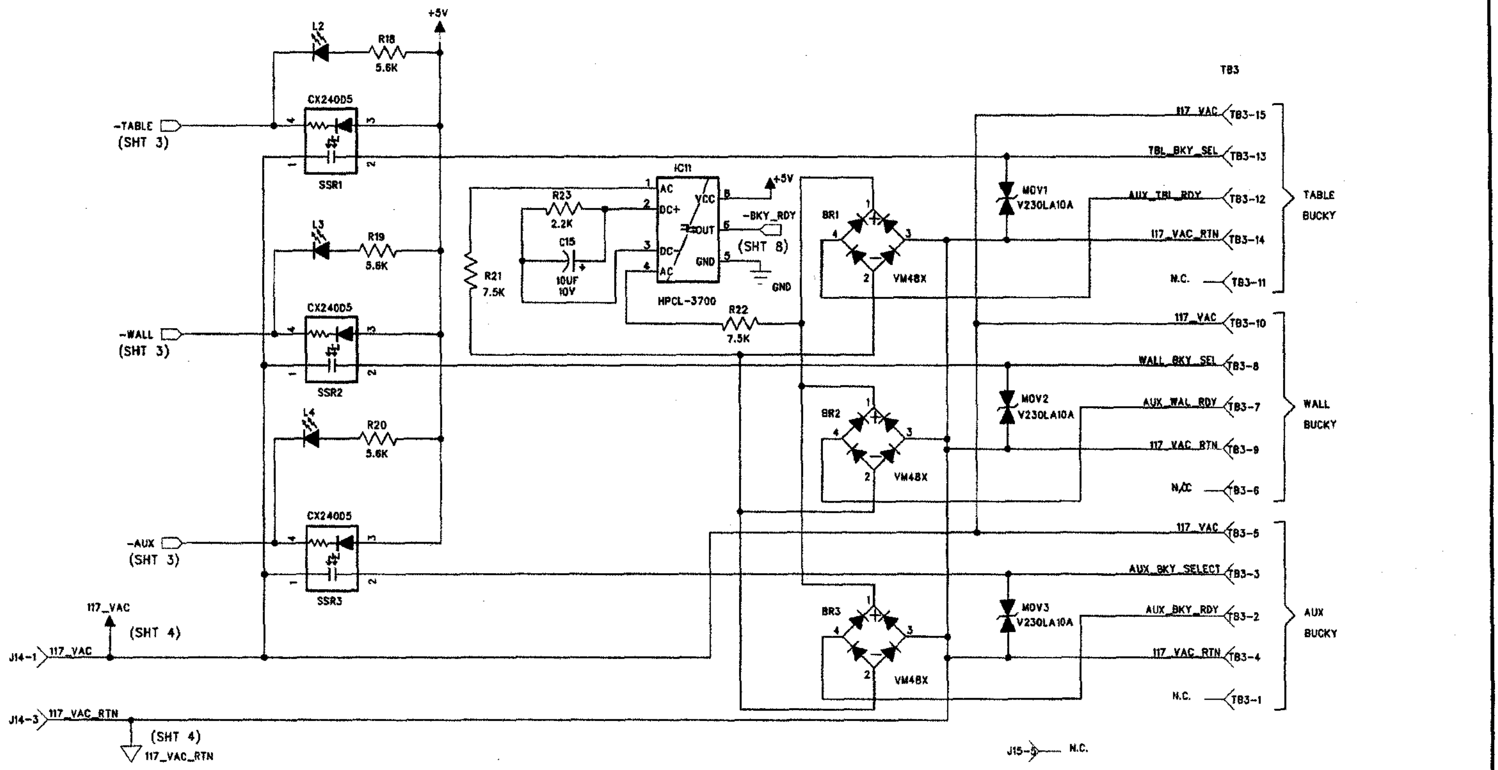
02	9526	WLW	
03	9540	WLW	
04	99021201	WLW	
10	1841	MAB	

TM R/F RAD FIELD I/O PCB
SHEET 1 OF 8

4294.262.21

* NOT INSTALLED



REV.	DATE CODE	ORG.	APP.
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02	9526	WLW	
03	9540	WLW	
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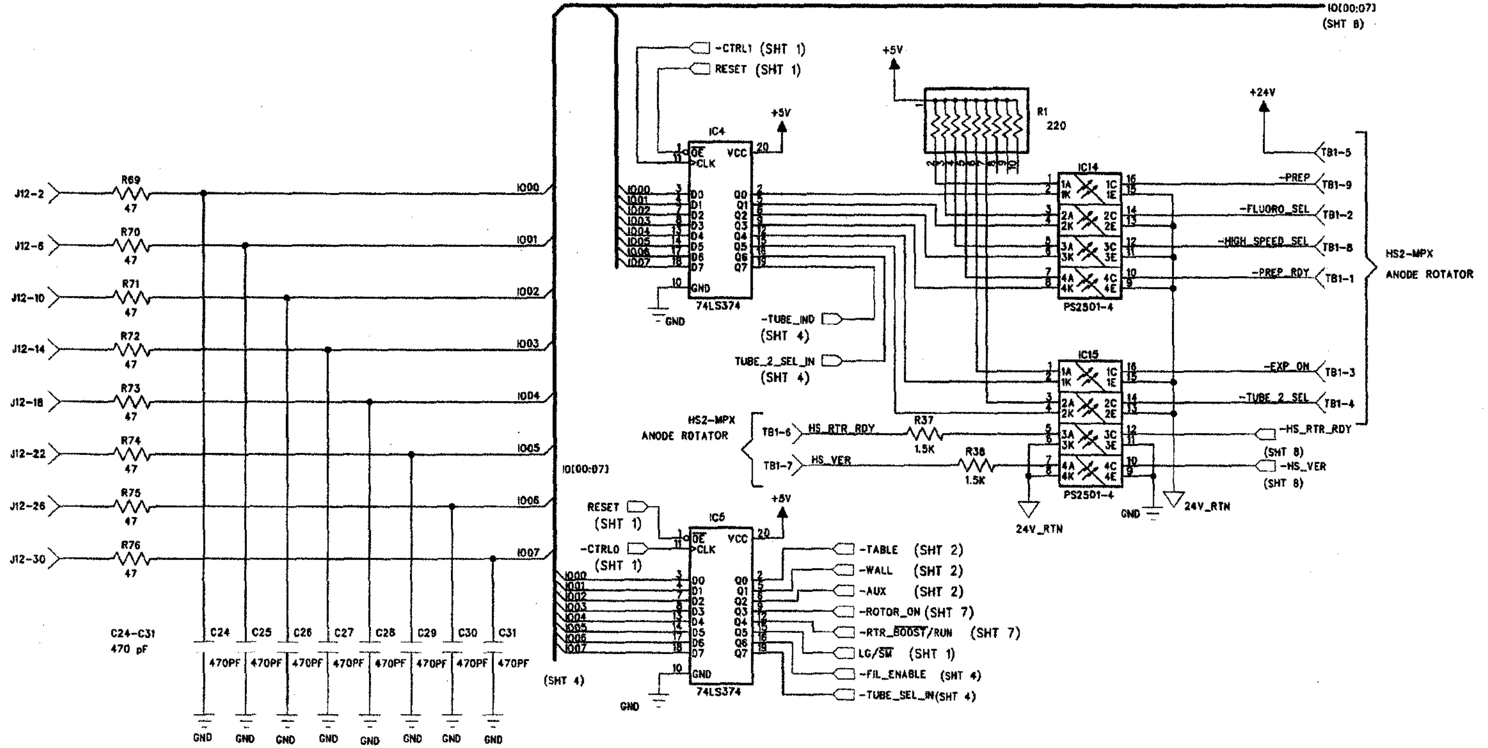
10	1841	MAB	

TM/RF RAD FIELD I/O SCHEMATIC

SHEET 2 OF 8

4294.262.21



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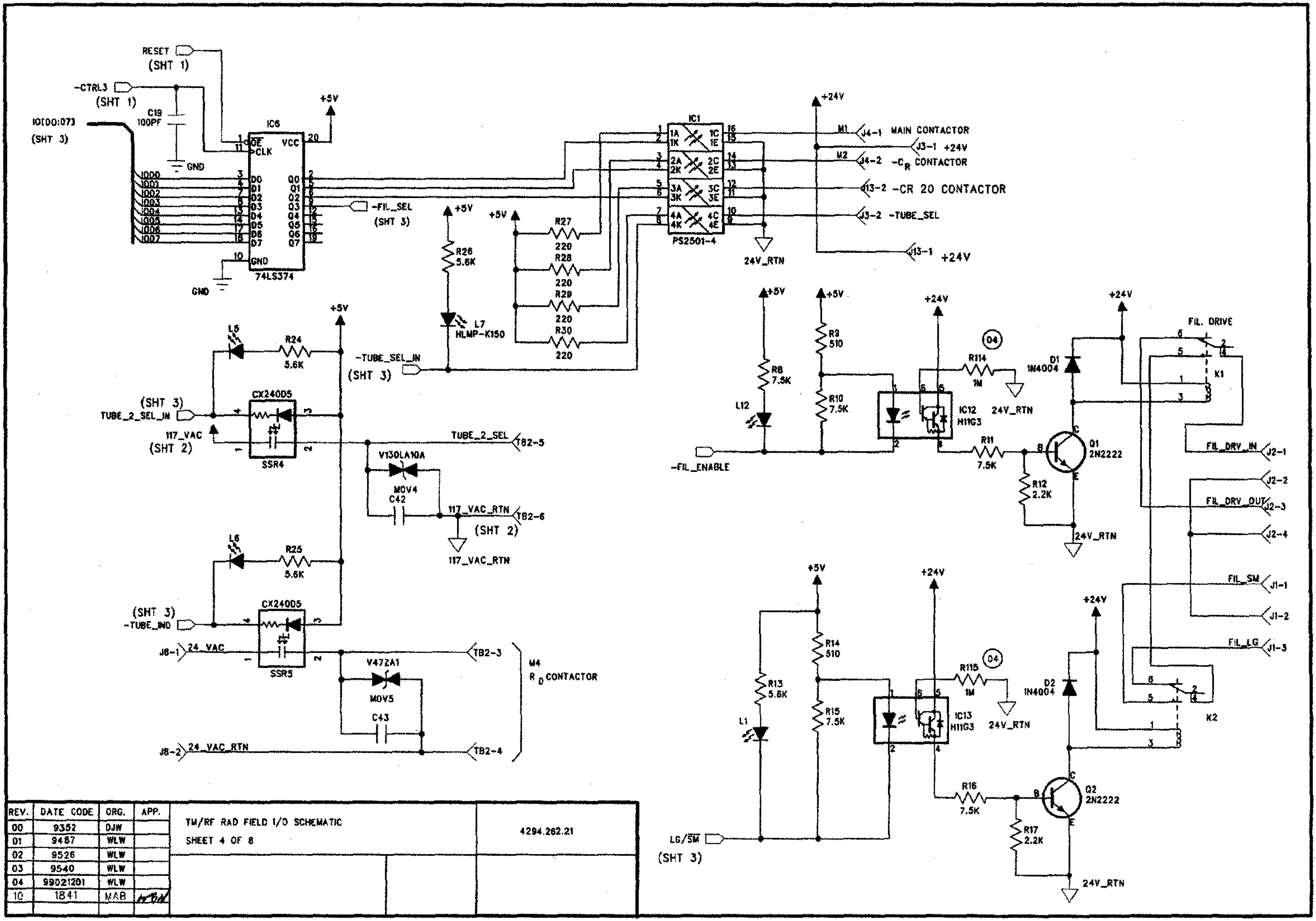
03	9540	WLW			
04	99021201	WLW			
10	1841	MAB			



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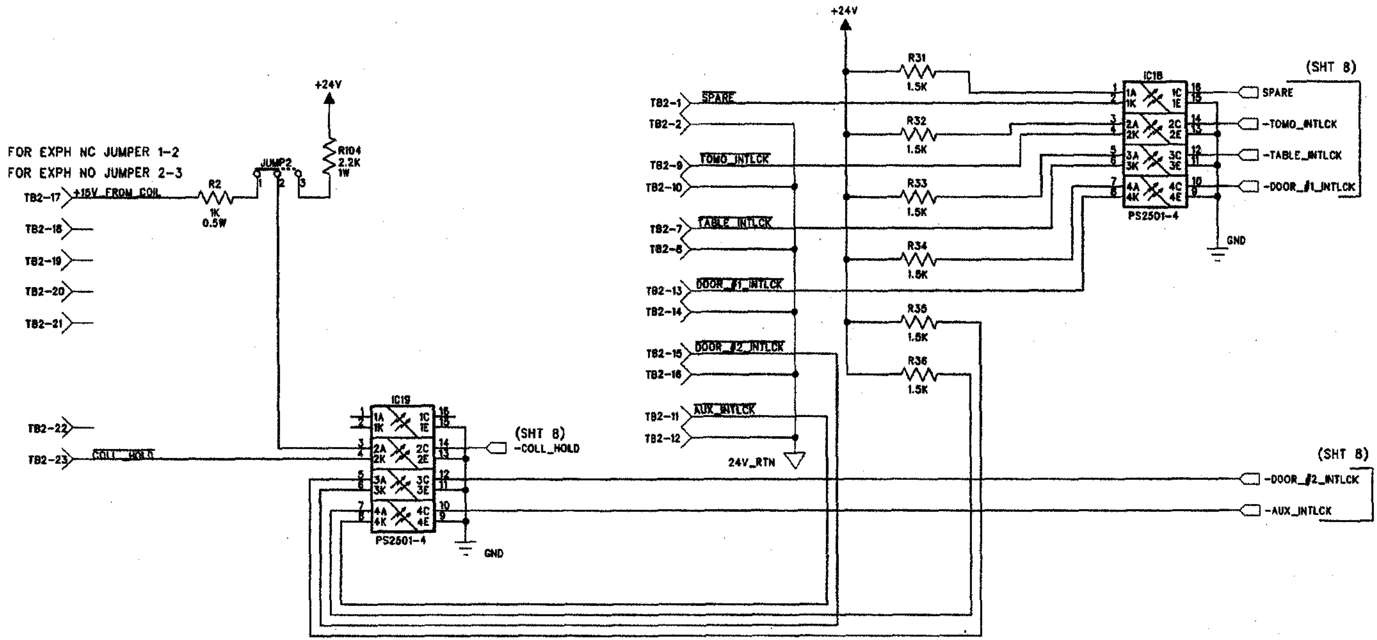
TM/RF RAD FIELD I/O SCHEMATIC

SHEET 4 OF 8

4294.262.21



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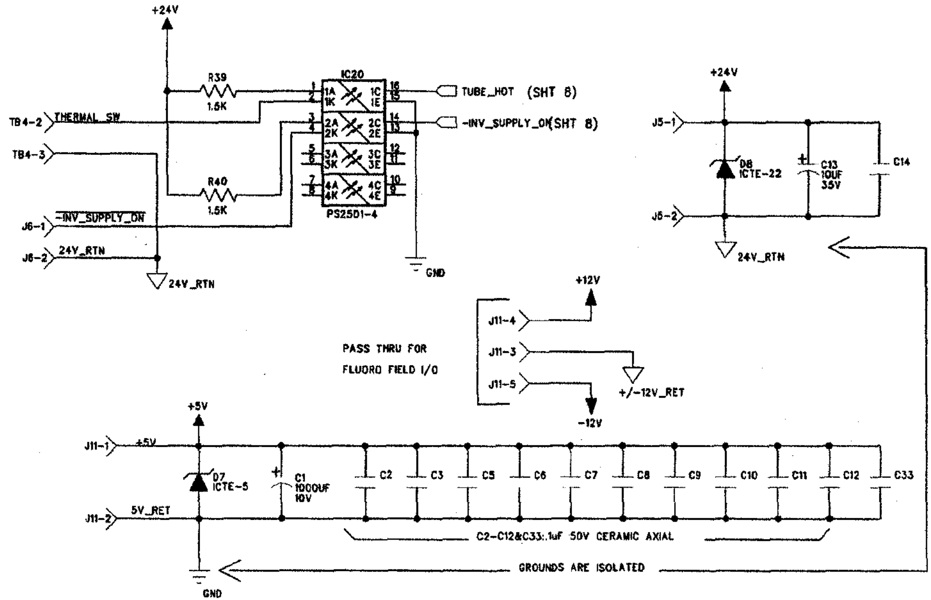
10	1841	MAB	

TM/RF RAD FIELD I/O SCHEMATIC
SHEET 5 OF 8

4294.262.21



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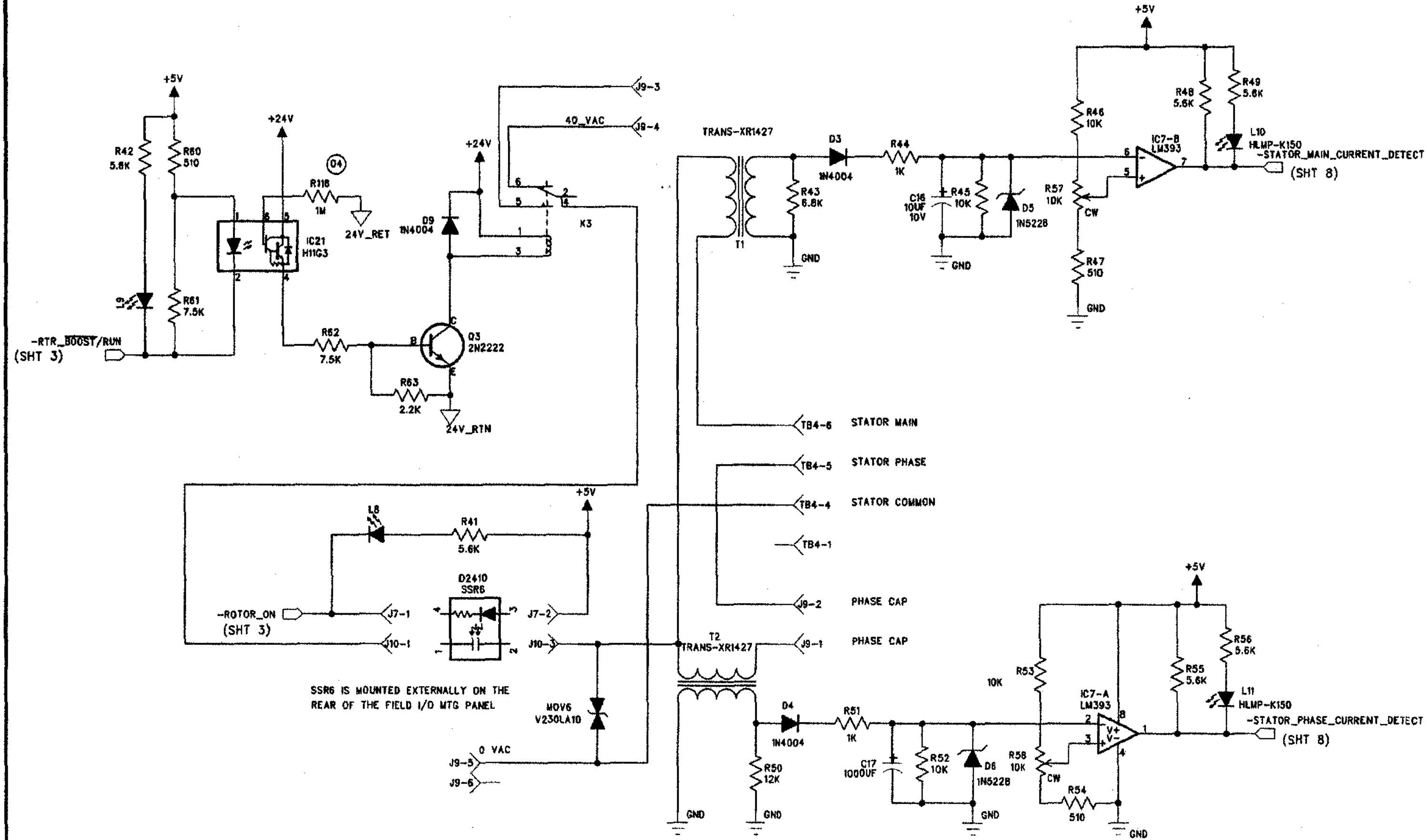
TM/RF RAD FIELD I/O SCHEMATIC

SHEET 6 OF 8

4294.282.21



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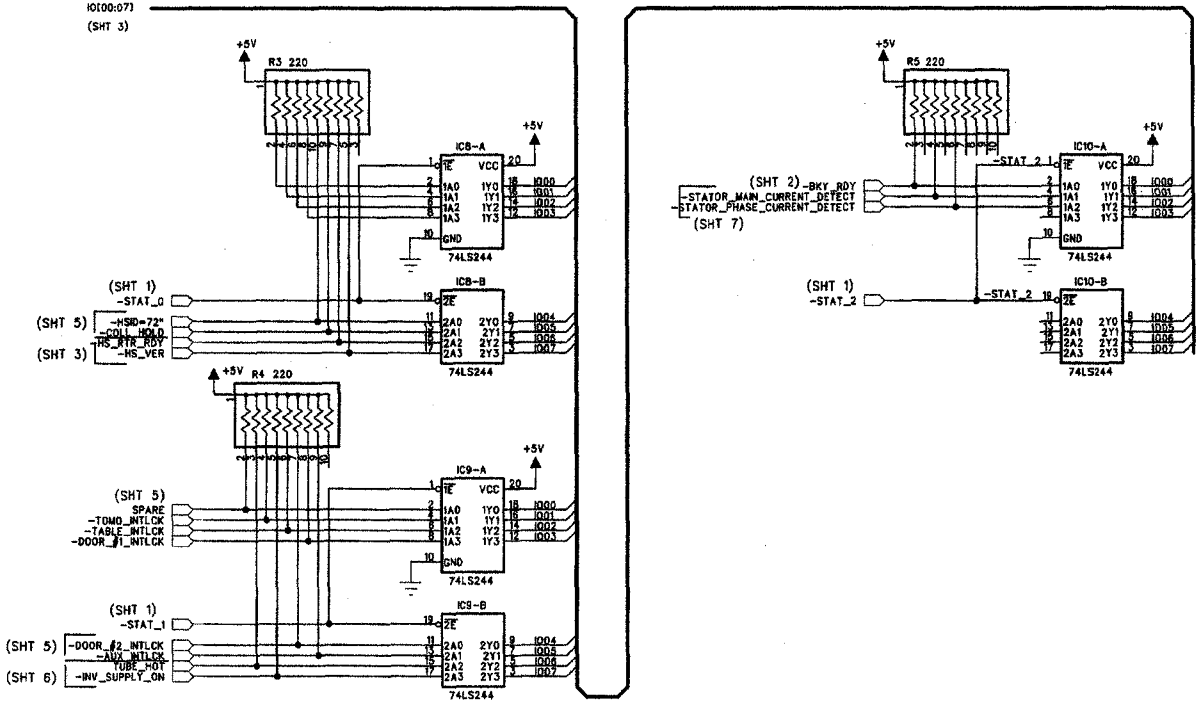
TM/RF RAD FIELD I/O SCHEMATIC

SHEET 7 OF 8

4294.262.21



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03	9540	WLW		
04	99021201	WLW		
10	1841	MAB		