



GE Medical Systems

Technical Publications

2124114–100

Revision 5

TIRC-G MP TIRC-G MPG 100 V3 TIRC-G MP sm Service Manual

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ATTENTION

LES APPAREILS À RAYONS X SONT DANGEREUX À LA FOIS POUR LE PATIENT ET POUR LE MANIPULATEUR SI LES MESURES DE PROTECTION NE SONT PAS STRICTEMENT APPLIQUEES

Bien que cet appareil soit construit selon les normes de sécurité les plus sévères, la source de rayonnement X représente un danger lorsque le manipulateur est non qualifié ou non averti. Une exposition excessive au rayonnement X entraîne des dommages à l'organisme.

Par conséquent, toutes les précautions doivent être prises pour éviter que les personnes non autorisées ou non qualifiées utilisent cet appareil créant ainsi un danger pour les autres et pour elles-mêmes.

Avant chaque manipulation, les personnes qualifiées et autorisées à se servir de cet appareil doivent se renseigner sur les mesures de protection établies par la Commission Internationale de la Protection Radiologique, Annales 26 : Recommandations de la Commission Internationale sur la Protection Radiologique et les normes nationales en vigueur.

WARNING

X-RAY EQUIPMENT IS DANGEROUS TO BOTH PATIENT AND OPERATOR UNLESS MEASURES OF PROTECTION ARE STRICTLY OBSERVED

Though this equipment is built to the highest standards of electrical and mechanical safety, the useful x-ray beam becomes a source of danger in the hands of the unauthorized or unqualified operator. Excessive exposure to x-radiation causes damage to human tissue.

Therefore, adequate precautions must be taken to prevent unauthorized or unqualified persons from operating this equipment or exposing themselves or others to its radiation.

Before operation, persons qualified and authorized to operate this equipment should be familiar with the Recommendations of the International Commission on Radiological Protection, contained in Annals Number 26 of the ICRP, and with applicable national standards.

ATENCION

LOS APARATOS DE RAYOS X SON PELIGROSOS PARA EL PACIENTE Y EL MANIPULADOR CUANDO LAS NORMAS DE PROTECCION NO ESTAN OBSERVADAS

Aunque este aparato está construido según las normas de seguridad más estrictas, la radiación X constituye un peligro al ser manipulado por personas no autorizadas o incompetentes. Una exposición excesiva a la radiación X puede causar daños al organismo.

Por consiguiente, se deberán tomar todas las precauciones necesarias para evitar que las personas incompetentes o no autorizadas utilicen este aparato, lo que sería un peligro para los demás y para sí mismas.

Antes de efectuar las manipulaciones, las personas habilitadas y competentes en el uso de este aparato, deberán informarse sobre las normas de protección fijadas por la Comisión Internacional de la Protección Radiológica, Anales No 26: Recomendaciones de la Comisión Internacional sobre la Protección Radiológica y normas nacionales.

ACHTUNG

RÖNTGENAPPARATE SIND EINE GEFAHR FÜR PATIENTEN SOWIE BEDIENUNGSPERSONAL, WENN DIE GELTENDEN SICHERHEITSVORKEHRUNGEN NICHT GENAU BEACHTET WERDEN

Dieser Apparat entspricht in seiner Bauweise strengsten elektrischen und mechanischen Sicherheitsnormen, doch in den Händen unbefugter oder unqualifizierter Personen wird er zu einer Gefahrenquelle. Übermäßige Röntgenbestrahlung ist für den menschlichen Organismus schädlich.

Deswegen sind hinreichende Vorsichtsmaßnahmen erforderlich, um zu verhindern, daß unbefugte oder unqualifizierte Personen solche Geräte bedienen oder sich selbst und andere Personen deren Bestrahlung aussetzen können.

Vor Inbetriebnahme dieses Apparats sollte sich das qualifizierte und befugte Bedienungspersonal mit den geltenden Kriterien für den gefahrlosen Strahleneinsatz durch sorgfältiges Studium des Hefts Nr. 26 der Internationalen Kommission für Strahlenschutz (ICRP) vertraut machen: Empfehlungen der Internationalen Kommission für Strahlenschutz und anderer nationaler Normenbehörden.

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WARNING

- THIS SERVICE MANUAL IS AVAILABLE IN ENGLISH ONLY.
- IF A CUSTOMER'S SERVICE PROVIDER REQUIRES A LANGUAGE OTHER THAN ENGLISH, IT IS THE CUSTOMER'S RESPONSIBILITY TO PROVIDE TRANSLATION SERVICES.
- DO NOT ATTEMPT TO SERVICE THE EQUIPMENT UNLESS THIS SERVICE MANUAL HAS BEEN CONSULTED AND IS UNDERSTOOD.
- FAILURE TO HEED THIS WARNING MAY RESULT IN INJURY TO THE SERVICE PROVIDER, OPERATOR OR PATIENT FROM ELECTRIC SHOCK, MECHANICAL OR OTHER HAZARDS.

AVERTISSEMENT

- CE MANUEL DE MAINTENANCE N'EST DISPONIBLE QU'EN ANGLAIS.
- SI LE TECHNICIEN DU CLIENT A BESOIN DE CE MANUEL DANS UNE AUTRE LANGUE QUE L'ANGLAIS, C'EST AU CLIENT QU'IL INCOMBE DE LE FAIRE TRADUIRE.
- NE PAS TENTER D'INTERVENTION SUR LES ÉQUIPEMENTS TANT QUE LE MANUEL SERVICE N'A PAS ÉTÉ CONSULTÉ ET COMPRIS.
- LE NON-RESPECT DE CET AVERTISSEMENT PEUT ENTRAÎNER CHEZ LE TECHNICIEN, L'OPÉRATEUR OU LE PATIENT DES BLESSURES DUES À DES DANGERS ÉLECTRIQUES, MÉCANIQUES OU AUTRES.

WARNUNG

- DIESES KUNDENDIENST-HANDBUCH EXISTIERT NUR IN ENGLISCHER SPRACHE.
- FALLS EIN FREMDER KUNDENDIENST EINE ANDERE SPRACHE BENÖTIGT, IST ES AUFGABE DES KUNDEN FÜR EINE ENTSPRECHENDE ÜBERSETZUNG ZU SORGEN.
- VERSUCHEN SIE NICHT, DAS GERÄT ZU REPARIEREN, BEVOR DIESES KUNDENDIENST-HANDBUCH NICHT ZU RATE GEZOGEN UND VERSTANDEN WURDE.
- WIRD DIESE WARNUNG NICHT BEACHTET, SO KANN ES ZU VERLETZUNGEN DES KUNDENDIENSTTECHNIKERS, DES BEDIENERS ODER DES PATIENTEN DURCH ELEKTRISCHE SCHLÄGE, MECHANISCHE ODER SONSTIGE GEFAHREN KOMMEN.

AVISO

- ESTE MANUAL DE SERVICIO SÓLO EXISTE EN INGLÉS.
- SI ALGÚN PROVEEDOR DE SERVICIOS AJENO A GEMS SOLICITA UN IDIOMA QUE NO SEA EL INGLÉS, ES RESPONSABILIDAD DEL CLIENTE OFRECER UN SERVICIO DE TRADUCCIÓN.
- NO SE DEBERÁ DAR SERVICIO TÉCNICO AL EQUIPO, SIN HABER CONSULTADO Y COMPRENDIDO ESTE MANUAL DE SERVICIO.
- LA NO OBSERVANCIA DEL PRESENTE AVISO PUEDE DAR LUGAR A QUE EL PROVEEDOR DE SERVICIOS, EL OPERADOR O EL PACIENTE SUFRAN LESIONES PROVOCADAS POR CAUSAS ELÉCTRICAS, MECÁNICAS O DE OTRA NATURALEZA.

ATENÇÃO

- ESTE MANUAL DE ASSISTÊNCIA TÉCNICA SÓ SE ENCONTRA DISPONÍVEL EM INGLÊS.
- SE QUALQUER OUTRO SERVIÇO DE ASSISTÊNCIA TÉCNICA, QUE NÃO A GEMS, SOLICITAR ESTES MANUAIS NOUTRO IDIOMA, É DA RESPONSABILIDADE DO CLIENTE FORNECER OS SERVIÇOS DE TRADUÇÃO.
- NÃO TENTE REPARAR O EQUIPAMENTO SEM TER CONSULTADO E COMPREENDIDO ESTE MANUAL DE ASSISTÊNCIA TÉCNICA.
- O NÃO CUMPRIMENTO DESTES AVISOS PODE POR EM PERIGO A SEGURANÇA DO TÉCNICO, OPERADOR OU PACIENTE DEVIDO A CHOQUES ELÉTRICOS, MECÂNICOS OU OUTROS.

AVVERTENZA

- IL PRESENTE MANUALE DI MANUTENZIONE È DISPONIBILE SOLTANTO IN INGLESE.
- SE UN ADDETTO ALLA MANUTENZIONE ESTERNO ALLA GEMS RICHIEDE IL MANUALE IN UNA LINGUA DIVERSA, IL CLIENTE È TENUTO A PROVVEDERE DIRETTAMENTE ALLA TRADUZIONE.
- SI PROCEDA ALLA MANUTENZIONE DELL'APPARECCHIATURA SOLO DOPO AVER CONSULTATO IL PRESENTE MANUALE ED AVERNE COMPRESO IL CONTENUTO.
- NON TENERE CONTO DELLA PRESENTE AVVERTENZA POTREBBE FAR COMPIERE OPERAZIONI DA CUI DERIVINO LESIONI ALL'ADDETTO ALLA MANUTENZIONE, ALL'UTILIZZATORE ED AL PAZIENTE PER FOLGORAZIONE ELETTRICA, PER URTI MECCANICI OD ALTRI RISCHI.

警告

- ・このサービスマニュアルには英語版しかありません。
- ・GEMS以外でサービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。
- ・このサービスマニュアルを熟読し理解せずに、装置のサービスを行わないで下さい。
- ・この警告に従わない場合、サービスを担当される方、操作員あるいは患者さんが、感電や機械的又はその他の危険により負傷する可能性があります。

注意：

- 本维修手册仅存有英文本。
- 非 GEMS 公司的维修员要求非英文本的维修手册时，客户需自行负责翻译。
- 未详细阅读和完全了解本手册之前，不得进行维修。
- 忽略本注意事项会对维修员，操作员或病人造成触电，机械伤害或其他伤害。

REVISION HISTORY

REV	DATE	REASON FOR CHANGE
0	31-Mar-95	Initial version.
1	15-Mar-96	Updated for TIRC-G (63 Hz) and V3-TIRC
2	28-Oct-96	Corrections for V3 (pages 1-2, 1-3, 1-15, 5A-11, 5A-35) C189 and C209 values modified (100pF) C4 and C8 locations corrected on illustration "Capacitor module for GEMS stator 2121071"
3	02-Dec-97	Updated release
4	19-Feb-98	Part Number 2162092 added to Parts List
5	April 2002	Spare Parts updated for V2 and V3 TIRC-G MP

LIST OF EFFECTIVE PAGES

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Title page	5	46-904890	—		
Safety Instructions	5	2119123 SID	—		
		2126864 SID	—		
i thru viii	5	2128125 SID	A		
		2127732 SID	B		
1-1 thru 1-20	5	2148633 SCH 1/2	B		
		2148633 SCH 2/2	B		
2-1 thru 2-4	5	2148664 SCH	A		
3-1 thru 3-10	5				
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5-i thru 5-ii	5				
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6-1 thru 6-40	5				
2116766 SCH 1/2	—				
2116766 SCH 2/2	—				
45434920	—				
2121145 SCH 1/2	—				
2121145 SCH 2/2	—				
46-903708 SCH	—				
46-904926 SCH 1/2	—				
46-904926 SCH 2/2	—				
2118972 SCH	—				
2121071 SCH	—				
45435165	—				

NUMBER	FORMAT	REVISION
2124114-100TPH	A4	5

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CHAPTER 1 – INSTALLATION

EVERY TIRC MODULE IS ABLE TO CONTROL UP TO FOUR (4) X-RAY TUBES (ALL OF THEM WITH SAME STATOR TYPE).

TIRC-G for MP Ph.4 and V3-TIRC can control only two (2) X-Ray tubes.

SECTION 1 TOOLS AND TEST EQUIPMENT

The following list summarizes the tools and test equipment needed to install and calibrate the TIRC-MP (Ph.2, Ph.4) – MPG 65/80/100 and V3-TIRC.

In addition to the standard serviceman's tools the following items are required:

- Dual trace memory oscilloscope with 10X and current probes.
- Current amplifier for scope current probes (TM501 or similar).
- Digital multimeter.

SECTION 2 APPLICATION AND COMPATIBILITY

The Transformer Inverter Rotor Controller (TIRC) provides acceleration power for X-ray tube rotors operating at low speed (3000 rpm, 3400 rpm for GE Maxiray X-ray tubes MX 150 V3 = 6900) and high speed (9000 rpm, 10000 rpm for GE Maxiray X-ray tubes). The TIRC also provides the power required by the rotor to reduce the speed from 3400 to 0 rpm (GE Maxiray X-ray tubes) and after each exposure taken at 9000 rpm or 10000 rpm (GE Maxiray X-ray tubes) to 3000 or 3400 rpm (GE Maxiray X-ray tube) or 6900 to 0 rpm (MX 150 V3 tube).

Note: MAXIRAY 120 and MAXIRAY 150 are GE X-ray tubes.

The TIRC is compatible with the following stators manufactured by GE and CGR:

- GE 24 SLOT 23/23 Ω
- CGR 8 SLOT 50/100 Ω
- MACHLETT 23/56 Ω
- MX 150 V3 (Maxiray 150 TH.13)

ONLY TUBE 1 CAN HAVE A COOLING WATER SYSTEM CONTROLLED BY A THERMOSTAT DEVICE (TRIGGERS WHEN THE TUBE HOUSING TEMPERATURE REACHES 40°C).

Convention for some generator designation, unless specified:

- MPG 100 = MPG 65/80/100.
- MP = MPPU phase 2 or MPPU phase 4 (+ Vascular option).

Note: MPPU phase 4 + Vascular option is also called VAMP or VMP.

SECTION 3 GENERAL AND OPERATION SPECIFICATIONS

3-1 Power Requirements

Frequency	50/60 Hz $\pm$ 5%
Nominal voltage	220 V $\pm$ 10%
VA capacities	10 kVA momentary 1.5 kVA continuous

3-2 R.M.S. Current Applied to Motor (Common Wire)

SIGNALS – Hz	STATORS			
	GE	MACHLETT	CGR	MX 150 V3
ACC.60, 63 (115 MX 150 V3)	9.4 A	7 A	3.8 A	9.5 A
RUN 60, 63 (115 MX 150 V3)	2.6 A	1.9 A	1.3 A	3 A
ACC.180	11.3 A	7 A	6 A	11 A
RUN 180	3.6 A	1.8 A	1.3 A	2.9 A
BRAKE (60, 63) (115 MX 150 V3)	8.6 A	4.2 A	1 A	3.8 A

3-3 Duty Cycle

Continuous operation for a 75, 100, 120 or 150 MAXIRAY X-ray tubes at 3400 (6900 for MX 150 V3) or 10000 rpm.

Two accelerations per minute at high speed for 75 or 100 MAXIRAY X-ray tubes.

One acceleration per minute at high speed for 150 MAXIRAY X-ray tube.

No limit for acceleration at low speed for all X-ray tube types.

3-4 Specified Maximum Acceleration and Braking Times in Seconds

SPEED (rpm) X-RAY TUBE TYPE	0-3400 0-6900 MX 150 V3	0-10000	3400-10000 (6900-10000) (MX 150 V3)	10000-3400 (10000-6900) (MX 150 V3)	3400-0 6900-0 MX 150 V3
GE MAXIRAY 150 (V2)	1.50	3	2.40	2.50	2.50
GE MAXIRAY 120	1.20	1.80	1.20	1.50	1.50
GE MAXIRAY 100	0.85	1.15	0.88	1.00	1.30
GE MAXIRAY 75	0.65	0.67	0.38	0.80	1.10
MACHLETT 3" WMO	1.20	1.20	0.80	4.70	N/A
MACHLETT 4" WMO	1.50	1.50	1.00	6.00	N/A
CGR 8 SLOT 50/100 Ω 150 G	3.50	3.50	2.40	13.50	N/A
CGR 8 SLOT 50/100 Ω 120 G	2.10	2.10	1.50	8.30	N/A
CGR 8 SLOT 50/100 Ω 9 WMO	1.80	1.80	1.30	7.10	N/A
CGR 8 SLOT 50/100 Ω 90 G	1.20	1.20	0.90	4.70	N/A
GE MAXIRAY 150 V3	7	8	2	0.9	4
Note: WHEN AN MPPU OR MP GENERATOR IS USED, ACCELERATION AND BRAKE TIMES ARE CONTROLLED BY THE GENERATOR.					

3-5 Stability

Inverter frequency stability will be $\pm 1\%$ for all line and temperature conditions.

3-6 Environment Requirements

Maximum temperature 45°C

Maximum relative humidity 80 %

SECTION 4 OUTPUT SIGNALS

ROTOR ON signal is enabled whenever an acceleration signal is received by the TIRC and remains enabled as long as the rotor keeps on rotating.

EN EXP signal is enabled when the rotor is at operational speed (at the end of acceleration).

INTERDIT TIRC signal disables tube change options.

SECTION 5 MODE OF OPERATION

TIRC operation is based on a transistor power stage controlled by a microprocessor (or by the generator in the case of an MPPU generator).

Power and frequency supplied to the X-ray tube anode motor are controlled for every exposure sequence.

Power control is based on the transistor conducting time modulation which is different for every sequence. The power supplied only reaches its maximum value only when the acceleration is carried out at high speed in which case no modulation is provided.

Once the motor is accelerated to operational speed, the power supplied is decreased by modulation to such an extent that the anode keeps on rotating with no X-ray tube heating

The braking system, controlled by the microprocessor, is intended to reduce the anode rotation speed to 3000 rpm (0 rpm for GE tubes), thus protecting the rotor bearings and lengthening tube life.

SECTION 6 SYSTEM PROTECTION

The TIRC is protected against the following conditions:

- Microprocessor fault
- Low input voltage
- Open stator lead
- Short stator lead
- Incorrect input

Two warning LEDS (DS33, DS42) on the TIRC Control PWB indicate:

- DS33 (yellow): Low acceleration current
 Short circuit output
 Open circuit output
 Low running current
- DS42 (red): Timing problem (acceleration time too long, etc.)

During the checksum at power-on both LEDS light **ON** then go **OFF** at the end of checksum. After power-on both LEDS will flash intermittently if stator selection is incorrect, except in MP/MPPU Generator.

SECTION 7
BEFORE YOU BEGIN

7–1 Basic Configuration

	6 users	MX 150 V2 2115418	MX 150 V3 2148069
Basic TIRC module	2121065	2116766	2148660
Tube selection module	2121066	2116767	2116767

One of the following capacitor modules:

- GE 24 slot 23/23Ω option 2121071
- MACHLETT 23/56Ω option 2121302
- CGR 8 slot 50/100Ω option 2121135
- Mod. cond. p/stator MX 150 V3 2148664

Optional:

- 3rd/4th Tube option 2122723

7–2 Preinstallation Notes

For X–ray subsystems to be installed with MPG generators refer to the corresponding service manuals supplied with those systems.

TIRC–G MP/MPG100 installed with **MP ph. 4 generators** are factory set for one MAXIRAY 150 V2 (Tube 1) and one MAXIRAY 100 (Tube 2) X-ray tubes.

TIRC–G MP/MPG100 installed with **MPG 65/80/100 generators** are factory set for one MAXIRAY 120 (Tube 1) and one MAXIRAY 100 (Tube 2) X-ray tubes.

V3 TIRC installed with MP ph. 4 generator are factory set for one MX 150 V3 (Tube 1) and one MX 100 (Tube 2) X–ray tubes.

7–3 General Cautions



All appropriate electrical, mechanical and radiation safety precautions must be taken during all installation and maintenance procedures.

7–3–1 Operation

Prior to installing or servicing the TIRC, Service Engineers should become thoroughly familiar with the system operation by reading and reviewing this service manual.

7-3-2 Circuit Modifications

Do not make any circuit modifications unless specifically directed to do so by the appropriate service documentation.



ENSURE TO TURN POWER OFF BEFORE REMOVING CIRCUIT BOARDS OR COMPONENTS, OR REMOVING OR ADDING JUMPERS.

7-3-3 MOS Devices

MOS (Metal Oxide Semiconductor) devices are used throughout the system. These devices are extremely sensitive to static electricity.



Always use proper caution when handling circuit boards or components. Ensure to place circuit boards and components on conductive foam when removing. Use conductive packing material when storing.

SECTION 8 UNPACKING AND INSTALLATION

Inspection of all parts should be made promptly upon delivery of the equipment. Any damage should be reported at this time and replacements ordered.

Final unpacking, except that necessary to inspect for possible shipping damage, must not be done until the equipment has been moved into the X-ray room.

Unnecessary shortage claims of small parts may be avoided if packing material such as envelopes and small packages are carefully inspected. Do not discard any material until all items have been checked against the packing list.

SECTION 9 SET-UP PROCEDURE

9-1 3rd/4th Tube Option Module Installation (Optional)

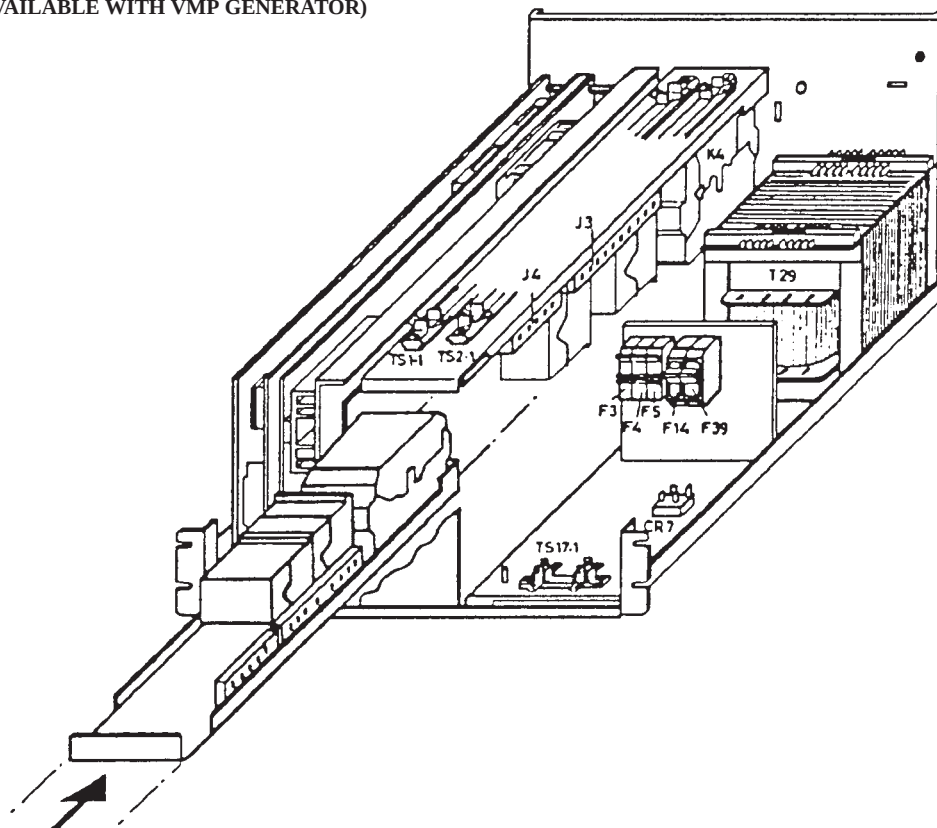
When applicable, proceed to install the 3rd/4th tube option module in the TIRC module following the procedure indicated below:

If your current TIRC system does not have this option proceed to step 3.2.

1. Install the 3rd/4th tube option module assembly in place fixing it with supplied screws and bolts (*see Illustration 1-1*).

ILLUSTRATION 1-1
3RD / 4TH TUBE OPTION MODULE INSTALLATION

(NOT AVAILABLE WITH VMP GENERATOR)



2. Connect the TS2 connector of the 3rd/4th tube option module to the TS2 connector of the basic tube selection module already installed (see Table 1-1 and interconnection schematic 2118972).

TABLE 1-1
TABLE 3RD / 4TH TUBE OPTION MODULE CONNECTION

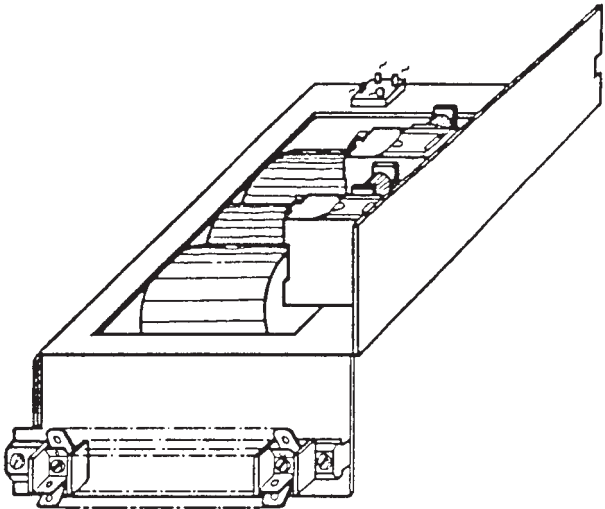
3/4 TUBE MODULE	TUBE SELECTION MODULE	TIRC INTERFACE PWB
TS2- 4	TS2- 4	
TS2- 6	TS2- 6	
TS2- 7	TS2- 7	
TS2- 8	TS2- 8	
TS2- 9	TS2- 9	
TS2-13	TS2-13	
TS2-14	TS2-14	
TS2-15		J-113. PIN 7
TS2- 16		J-113. PIN 6
TS2-17	TS2-17	
TS2-18	TS2-18	
TS2-19	TS2-19	
TS1-20	TS2-20	

9-2 Capacitor Module Installation

Make sure that the capacitor module shipped corresponds to the stator type in the current system. Only one of the four possible capacitor modules can be installed with every TIRC module.

1. Install the capacitor module (one listed below) in the basic TIRC assy. using provided nuts and bolts (see *Illustration 1-2 for location*).
 - GE 24 slot 23/23 Ω option Cat.3864 2121071
 - MACHLETT 23/56 Ω option Cat.3865 2121302
 - CGR 8 slot 50/100 Ω option Cat.3866 2121135
 - mod. cond. p/stator MX 150 V3 2148664
2. Install 34-Pin male connector J2 to the capacitor module (see *Illustration 1-2*).
3. Connect the basic TIRC harness to the capacitor module terminal strip (see *Table 1-2, schematic 2116766 and Illustration 1-2*).

ILLUSTRATION 1-2
TERMINAL STRIP CONNECTION



TS 15

TABLE 1-2
TIRC HARNESS CONNECTION

INTERCONNECTION HARNESS	CAPACITOR MODULE
CABLE 1 (1)	TS15- 1
CABLE 2 (1)	TS15- 2
CABLE 3 (1)	TS15- 3
CABLE 5 (1)	TS15- 5
CABLE 6 (1)	TS15- 6
CABLE 8 (1)	TS15- 8
CABLE 9 (1)	TS15- 9
CABLE 10 (1)	TS15-10
CABLE 11 (1)	TS15-11*

* (Only in GE Capacitor Modules and MX 150 V3)

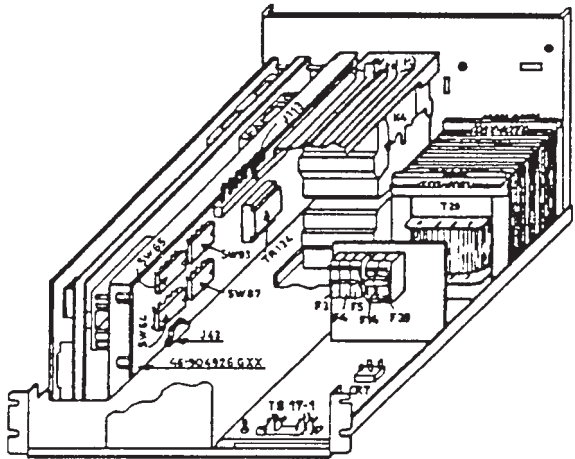
9-3 Anode Size and Stator Type Selection

9-3-1 Anode Size Selection & X-Ray Tube's Speed

Anode size and X-ray tube speed are selected with SW 93 (tube 1), SW 87 (tube 2), SW 64 (tube 3) and SW 65 (tube 4), located on the generator interface PWB, 46-904926G03.

(For switches exact location in board, see Illustration 1-3).

ILLUSTRATION 1-3
LOCATION OF SWITCHES



Codification is achieved selecting the correct switch positions. See Table 1-3.

TABLE 1-3
SWITCH CODIFICATION ACCORDING TO TUBE TYPE

MSB = SWITCH No. 1 LSB = SWITCH No. 3	NOTE: IF MP/MPPU GENERATOR IS USED PUT ALL SWITCH POSITIONS TO OFF.			0 = ON 1 = OFF
ANODE SIZE	CODE			SW 4
	SW 1	SW 2	SW 3	
MAXIRAY 75	ON	ON	ON	ON (low speed)
MAXIRAY 100	ON	ON	OFF	
MAXIRAY 120	ON	OFF	ON	
150 G	ON	OFF	OFF	
3" WMO	OFF	ON	ON	OFF (high speed)
4" WMO	OFF	ON	OFF	
120 G	OFF	OFF	ON	
90 WMO	OFF	OFF	OFF	
90 G	OFF	ON	ON	

9-3-2 Stator Type Selection

Stator types are coded with JP328 & JP329, located on the TIRC Control PWB. See Table 1-4 below.

TABLE 1-4
JUMPER POSITION ACCORDING TO STATOR TYPE

0 = POS. B 1 = POS. A	STATOR TYPE	JP328	JP329
	GE 24 SLOT 23/23 Ω	B	B
	CGR 8 SLOT 50/100 Ω	A	B
	MACHLETT24 SLOT 23/56 Ω	A	A
	MX 150 V3	B	B

9-4 Transformer Connection

To connect the power supply to the TIRC assembly, connect the capacitor module terminal TS15-8 to the lead of transformer T 29 indicated in Table 1-5 below (see *Illustration 1-2 and TIRC-BASIC schematic 2116766*).

TABLE 1-5
T 29 TRANSFORMER CONNECTION ACCORDING TO STATOR TYPE

STATOR TYPE	T29 TRANSFORMER LEAD
	220 V LINE
GE 24 SLOT 23/23 Ω	8
CGR 8 SLOT 50/100 Ω	10
MACHLETT24 SLOT 23/56 Ω	10
MX 150 V3	8

9-5 Generator Type Selection

Generator selection is made with JP353 located on the TIRC Control PWB. See Table 1-6 below for jumper set-up.

TABLE 1–6

JP 353 JUMPER POSITION ACCORDING TO GENERATOR TYPE

GENERATOR TYPE	JP353 POSITION
MPG 65/80/100, MPG 50, MVP μ , TRIPLUNIX	A
MP/MPPU ph. 2 and ph. 4	B

9–6 Cooling Mode Selection of Tube 1

Cooling mode selection is made with one jumper on the tube selection module, likewise on the 3rd/4th tube option module. See below:

MAXIRAY 150, MAXIRAY 120 X-ray tubes and water cooling tube:
remove jumper between TS2–10 and TS2–13.

MAXIRAY 100 and air cooling tubes:
connect jumper between TS2–10 and TS2–13.

9–7 Operation Mode Selection

Operation mode selection is made with JP12 located on the interface PWB. For jumper settings refer to Table 1–7 below:

TABLE 1–7

JP 12 JUMPER POSITION ACCORDING TO OPERATION MODE

OPERATION MODE	JP12 POSITION
WITH PERMANENT HOLD–TIME	A
PARKING	B
NOTE: WHEN MP/MPPU GENERATOR IS USED NO SELECTION IS NECESSARY	

9–8 TIRC–Generator and Tube Interconnection

1. Install the TIRC assembly in the generator cabinet. Use supplied nuts and bolts to secure TIRC to the generator frame.
2. Connect the 34–Pin female connector from the generator (80PL21 in Phasix, PR–401 in MPG 50, XJ–8 in MP/MPPU) to the 34–Pin male connector installed in the TIRC (J–2) capacitor module in step 2 of Section 3–2.

Note:

For MP/MPPU ph. 2 and 4 generator: connect MP/MPPU cable XJ–14 to J78 of the TIRC Control PWB.

3. Connect the power line supply (220V) to TS17–1 and TS 17–2 and the TIRC ground cable to the generator ground pole. If power line supply is 3–phase, connect 3rd phase input to TS17–3.

4. Connect the X-ray tube cables to the corresponding TIRC tube module connector (see schematic 2118972).
5. Proceed to para. 9-8-1 for GE/CGR / Machlett water cooled tubes or para. 9-8-2 for GE/CGR air cooled tubes.

Tables 1-8 and 1-9 show the two possible tube types (CGR/Machlett or GE) and their interconnection when the system is composed of 1, 2, 3 or 4 tubes.

9-8-1 CGR Water Cooled MAXIRAY 120 and 150 X-ray tubes

1. Remove the jumper between terminals TS2 – 10 and TS2 – 13 on the basic tube selection module, likewise (if applicable) on the 3rd/4th tube option module.
2. CGR X-ray tubes: on tube interface board (45434920) located below rack who support TS1 and TS2 connectors, change J13 to 220 Vac position for fans or electrovalves.
For MAXIRAY 120, 150 and 150 V3 X-ray tubes, ensure that J13 is in 115 Vac position on interface board (45434920).

Note:

If the tube 1 is convection cooled, connect the jumper between TS2-10 and TS2-13.

TABLE 1-8

CGR Water Cooling, MAXIRAY 120 X-ray tube

TUBE 1	TUBE SELECTION MODULE
STATOR COMMON	TS 1 – 1
MAIN	TS 1 – 4
AUXILIAR	TS 1 – 5
70°C	{ TS 1 – 6 ⇒ COMMON TS 1 – 7
ELECTROVALVE AND OIL PUMP	{ TS 1 – 12 TS 1 – 19 ⇒ COMMON
40°C	{ TS 1 – 13 TS 1 – 15 ⇒ COMMON
WATER SECURITY	{ TS 1 – 11 TS 1 – 14 ⇒ COMMON
SELECTION LAMP TUBE 1	{ TS 2 – 2 TS 2 – 4 ⇒ COMMON
SECURITY FILTER	{ TS 1 – 10 TS 1 – 20 ⇒ COMMON
GND	TS 2 – 5
TUBE 2	TUBE SELECTION MODULE
STATOR COMMON	TS 1 – 1
MAIN	TS 1 – 2
AUXILIAR	TS 1 – 3
70°C	{ TS 1 – 6 ⇒ COMMON TS 1 – 8
FAN	{ TS 2 – 4 ⇒ COMMON TS 2 – 2
GND	TS 2 – 5

TABLE 1-8 (CONT.)
MAXIRAY 150 X-ray tube

TUBE 1	TUBE SELECTION MODULE
STATOR COMMON	TS 1 – 1
MAIN	TS 1 – 4
AUXILIAR	TS 1 – 5
70°C	{ TS 1 – 6 ⇒ COMMON TS 1 – 7
ELECTROVALVE	{ TS 1 – 12 TS 1 – 19 ⇒ COMMON
OIL PUMP	{ TS 1 – 16 TS 1 – 19 ⇒ COMMON
40°C	{ TS 1 – 13 TS 1 – 15 ⇒ COMMON
WATER SECURITY	{ TS 1 – 11 TS 1 – 14 ⇒ COMMON
SELECTION LAMP TUBE 1	{ TS 2 – 2 TS 2 – 4 ⇒ COMMON
SECURITY FILTER	{ TS 1 – 10 TS 1 – 20 ⇒ COMMON
GND	TS 2 – 5
TUBE 2	TUBE SELECTION MODULE
STATOR COMMON	TS 1 – 1
MAIN	TS 1 – 2
AUXILIAR	TS 1 – 3
70°C	{ TS 1 – 6 ⇒ COMMON TS 1 – 8
FAN	{ TS 2 – 4 ⇒ COMMON TS 2 – 2
GND	TS 2 – 5

TABLE 1-8 (CONT.)

CGR Water Cooling, MAXIRAY 120 and 150 X-ray tubes (N.U., only 2 tubes with MPPU ph. 4 generator)

TUBE 3	3rd/4th TUBE MODULE
STATOR COMMON	TS 1 – 1
MAIN	TS 1 – 4
AUXILIAR	TS 1 – 5
70°C	{ TS 1 – 6 ⇒ COMMON TS 1 – 7
FAN	{ TS 2 – 4 TS 2 – 2 ⇒ COMMON
SECURITY FILTER	{ TS 1 – 10 TS 1 – 20 ⇒ COMMON
GND	TS 2 – 5
TUBE 4	3rd/4th TUBE MODULE
STATOR COMMON	TS 1 – 1
MAIN	TS 1 – 2
AUXILIAR	TS 1 – 3
70°C	{ TS 1 – 6 ⇒ COMMON TS 1 – 8
FAN	{ TS 2 – 4 TS 2 – 3 ⇒ COMMON
GND	TS 2 – 5

9–8–2 GE or CGR Air Cooling

- 1. Install jumpers between terminals TS2–10 and TS2–13 on the basic tube selection module, likewise (if applicable) on the 3rd/4th tube option module.
- 2. On tube interface board (45434920) ensure that J13 is in the 115 Vac position for fans. For 220 Vac fans, change J13 to 220 Vac position on interface board (45434920).

Note: If the tube 1 is convection cooled, connect the jumper between TS2–10 and TS2–13.

TABLE 1–9
GE or CGR Air Cooling

TUBE 1	TUBE SELECTION MODULE
COMMON	TS 1 – 1
MAIN	TS 1 – 4
AUXILIAR	TS 1 – 5
FAN	{ TS 2 – 4 ⇒ COMMON TS 2 – 2
PRESOSTATE	{ TS 1 – 7 TS 1 – 6 ⇒ COMMON
GND	TS 2 – 5
TUBE 2	TUBE SELECTION MODULE
COMMON	TS 1 – 1
MAIN	TS 1 – 2
AUXILIAR	TS 1 – 3
FAN	{ TS 2 – 4 ⇒ COMMON TS 2 – 3
PRESOSTATE	{ TS 1 – 8 TS 1 – 6 ⇒ COMMON
GND	TS 2 – 5

TABLE 1–9 (CONT.)
GE or CGR Air Cooling

TUBE 3	3rd/4th TUBE MODULE
COMMON	TS 1 – 1
MAIN	TS 1 – 4
AUXILIAR	TS 1 – 5
FAN	{ TS 2 – 4 ⇒ COMMON TS 2 – 2
PRESOSTATE	{ TS 1 – 7 TS 1 – 6 ⇒ COMMON
GND	TS 2 – 5
TUBE 4	3rd/4th TUBE MODULE
COMMON	TS 1 – 1
MAIN	TS 1 – 2
AUXILIAR	TS 1 – 3
FAN	{ TS 2 – 4 ⇒ COMMON TS 2 – 3
PRESOSTATE	{ TS 1 – 8 TS 1 – 6 ⇒ COMMON
GND	TS 2 – 5

9–9 Firmware Installation

Install the supplied programmable memory in the TIRC Control PWB. See Table 1–10
(See *firmware versions in Chapter 6*)

TABLE 1–10
FIRMWARE INSTALLATION

MODE SELECTION	PROGRAMMABLE MEMORY		FIRMWARE
R&F + VASCULAR 16 s	46–904895G02	45435780 (GE Tubes)	45435164
		45435781 (CGR Tubes)	45435165
		45435782 (Machlett Tubes)	45435168
VASCULAR 30 s (CGR tubes)	45435783		45435169
TRIPLUNIX	46-904897G01		46–904894P01
MP/MPPU ph. 2, ph. 4 60 Hz	46-904889G01		46–904890P01
MP/MPPU ph. 4 63 Hz	2143930		
RF CGR 60 s	2119124		2119123
RF GE Tj 60 s	2126862		2126864
RF GE MAXIRAY 120 60 s	2127731 kit		2127732
RF GE MAXIRAY 120 16 s	2128124		2128125
MAXIRAY 150 V3	2161104		

SECTION 10 ADJUSTMENTS

The cooler limit potentiometers (R100 and R101), on the TIRC Control PWB, are factory adjusted. Should readjustment be required, proceed as follows:

1. Adjust R100 and R101 fully CCW.
2. Connect the current probe to one of the inverter output cables (see Schematics 2116766).
3. Connect the scope probe at TP 85 and order start-up at 3400 rpm. Adjust R100 (first limit) to change voltage at TP 85 from 1 to 0 (5V to 0V) when the primary current is 32 A approximately. (If the second limit is actuated during this adjustment, slightly readjust R101 CW).
4. Place jumper between TP 83 and TP 84.
5. Connect the scope probe to TP 265.
6. Adjust R101 to change voltage at TP 265 from 1 to 0 (5V to 0V) when the primary current is approximately 36 A.
7. Remove jumper between TP 83 and TP 84.

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INSTALLATION

CHAPTER 2 – FUNCTIONAL CHECKS

SECTION 1 INTRODUCTION

OSCILLOSCOPES

WARNING

ALL OSCILLOSCOPES SHALL BE EQUIPPED WITH A THREE WIRE POWER CORD, THE THIRD WIRE BEING USED TO GROUND THE SCOPE. SERVICEMEN SHALL USE LINE CORD ADAPTERS WHEN USE OF AN UNGROUNDED SCOPE BECOMES NECESSARY.

WARNING

THIS CHAPTER IS INTENDED TO ALLOW THE OPERATOR TO QUICKLY CHECK THE EQUIPMENT FOR PROPER OPERATION.

WARNING

ALL CONTROL AND POWER CIRCUITS ARE FACTORY CHECKED, THUS THE OPERATOR SHOULD ONLY CHECK THE INSTALLATION CABLES FOR PROPER CONNECTION.

SECTION 2 GROUNDING

Check ground continuity by connecting an ohmmeter between the generator power cabinet and a ground outlet. Measured resistance should be lower than 0.1 Ω .

SECTION 3 SYSTEM SWITCH ON

After switching the system **ON**, the microprocessor performs a quick checking of its circuits. During this check, the red and yellow LEDS light **ON** for approximately one second and then go off if the checksum result is correct.

In case both the LEDS remain **ON**, this will indicate a failure in the microprocessor.

Once the red and yellow LEDS are turned **OFF**, the TIRC will be ready for operation.

SECTION 4 CONTROL CHECK

With an x-ray tube connected as shown in Chapter 1, proceed as follows:

1. Order acceleration to low speed.
2. Order acceleration to high speed (if applicable).
3. Order brake from high speed to low speed (if applicable).

Throughout these operations, no error should be displayed and the **ROTOR ON** signal performance should be correct.

1. Disconnect one motor cable.
2. Order acceleration to low speed.
3. After approximately 400 ms, check that the transistor bridge modulation is stopped, the **ROTOR ON** signal is transferred to Logic 1 and the yellow LED turns **ON**.
4. Connect the motor cable (disconnected during step 1).
5. Order brake.
6. Order acceleration to 3400 rpm.
7. Disconnect the motor cable after reaching the 3400 rpm.
8. Check that the transistor bridge modulation has stopped and that the **ROTOR ON** signal is transferred to Logic 1. (Red LED turns **ON**).
9. Order brake.
10. On short-circuiting two motor cables and ordering acceleration to low or high speed, an acceleration error should be displayed.

SECTION 5

SAFE USE OF OSCILLOSCOPES

5-1 Ungrounded Oscilloscopes

Oscilloscopes should be grounded. Only use ungrounded oscilloscopes when absolutely necessary.

In the case it is necessary to use an ungrounded oscilloscope, follow the set-up indicated in Section 5-3.

Service personnel should proceed to modify oscilloscopes as follows:

1. If the ground lug has been removed from the line plug, replace with a new grounding plug approved by U/L (or one U.S. equivalent).
2. Remove signal probe ground clips in such a way that they can be easily re-installed.
3. Apply warning signs to top and sides of scope. Order T8012E from NPS.

In addition, the following should be added to oscilloscope accessory kit:

1. Ground lug "cheater". (Procure locally.)
2. Two additional warning signs (included in T8012E).
3. An outlet box with 3-prong receptacles, the three wires terminating in push-on connectors. Two wires may be black, and the ground wire must be green. (Procure locally.)
4. A roll of white safety tape (twenty-five yards included in T8012E).

5–2 Using the Dual–Channel Scope Grounded

5–2–1 In Grounded Circuits

The scope probe is used normally, but the ground clip is not used, since the line cord grounds the scope.

Possible problem: Scope plug ground is different from ground of circuit being viewed.

Test for problem: 60 (or 50) Hertz signal and/or hash shows on waveform. Disconnect probe from circuit, and place it touching chassis. If power–line frequency or hash is seen on scope at some sensitivity setting, ground difference exists.

Solution: Connect accessory outlet box to 115V power for circuit being viewed (ex: A1 + A2), and connect box ground (green wire) to circuit chassis or cabinet. Plug scope into outlet box. Slight inconvenience awaiting scope warm–up when turning power on equipment is small price to pay for safety.

5–2–2 In Ungrounded Circuits, Single Place

Connect channel 2** scope probe normally, but instead of the ground clip, connect channel 1 scope probe to other point. Set scope to Algebraic Add, Channel 1 inverted**. Both channels must have the same gain setting. To invert scope image, interchange probes to interchange channels.

Possible problem: You are now observing the difference between two voltages with respect to ground. How well the subtraction occurs is called “common mode rejection” – rejection of the subtracted part of the signal. If the characteristics of both amplifiers are not identical, the rejection will be poor, and the difference waveform distorted. You can check your measurement two ways as described below:

1. If the scope can handle the “common mode” signal without overloading.
2. If the gain and frequency response of the two amplifiers are equal.

Test for problem: First, disconnect the channel 2 probe. You will now see channel 1 only (you can consider this the “common mode” signal). The signal may be so large it goes off the screen top and bottom. Note position of channel 2 attenuator, and increase the setting until the top and bottom of the waveform just come into view. The setting should not have been advanced by a factor greater than 20*. Return setting to original position.

Second, connect channel 2 probe to the same circuit point as channel 1 probe. A straight horizontal line should result. If not, try adjusting the gain of either channel slightly. If the line appears to have high–frequency components, try matching the frequency response (adjustment on the input of most scope amplifiers–see scope directions).

Solution: If both conditions above are met, return channel 2 probe to measuring point, and proceed. If not, you must resort to an ungrounded scope.

* Use 10 on Tektronix 422.

** If channel 1 is invertable. In case channel 2 is invertable instead, interchange “1” and “2”.

5-2-3 In Ungrounded Circuits, Dual Trace

First try the connections described in sections 5-2-1 and 5-2-2. You may be able to recognize the critical points you are seeking, even though the waveforms are quite different. If not, you must resort to an ungrounded scope.

5-3 Using an Ungrounded Scope

If you must use your scope ungrounded, the following set-up is mandatory:

1. Use the “cheater” – do not clip the ground lug.
2. String white tape (from the accessories kit) around the scope so that no one can touch it without having to remove the tape.
3. Hang the warning signs from the accessories kit on the white tape.
4. Proceed with connections for ungrounded scope, using probe ground clips from accessories kit.

CHAPTER 3 – THEORY OF OPERATION

SECTION 1 GENERAL

The TIRC basically consist of a transistor inverter (with its control circuit based on a micro computer), an interface (with generators and x-ray tubes), an output transformer and a phase shift capacitor module that includes a rectifier for braking on GE tubes.

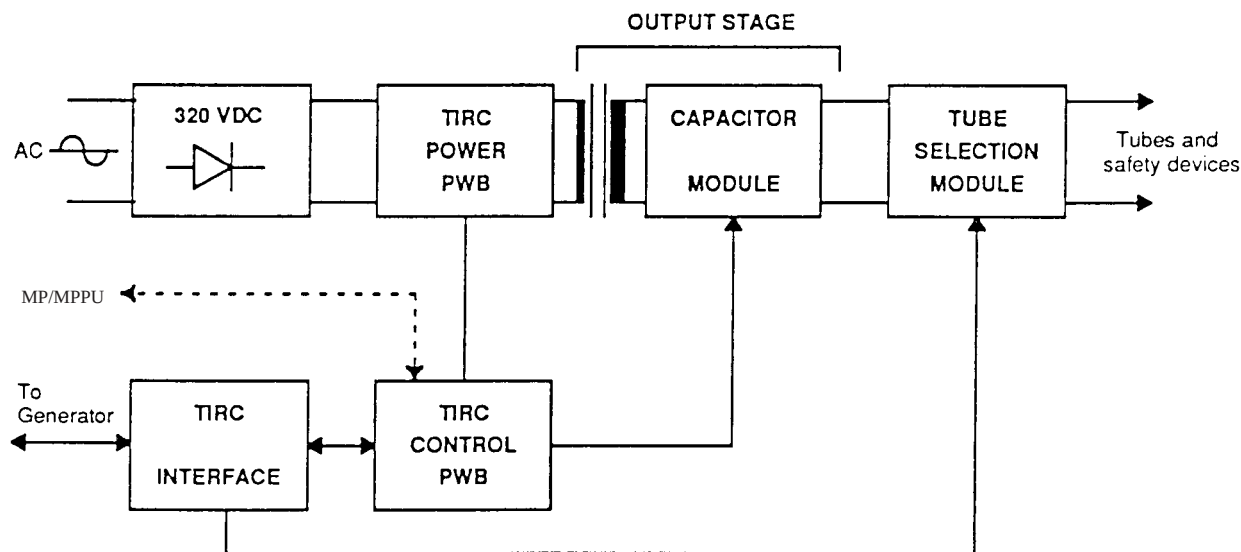


Use extreme care when taking measurements on the equipment while it is switched on. The high voltage existing at various parts of the equipment can be dangerous.



As the TIRC is not provided with an Input transformer, any contact between the d.c. supply and a.c. ground could produce catastrophic damage. To avoid risks, use only Insulated oscilloscopes.

ILLUSTRATION 3-1 TIRC-G BLOCK DIAGRAM



SECTION 2

320 VDC POWER SUPPLY

The 320 Vdc Power Supply rectifies and filters the ac input to supply the power inverter, slowly charging the filter condensers.

The main single-phase current is rectified by the single-phase bridges and filtered through electrolytic capacitors C10, C11 and C12 (see *TIRC-BASIC schematic 2116766*).

When switching the system ON, the capacitor load current is limited by R8. Once the capacitors are sufficiently loaded, resistor R8 is short circuited by relay K9.

SECTION 3 TIRC POWER PWB

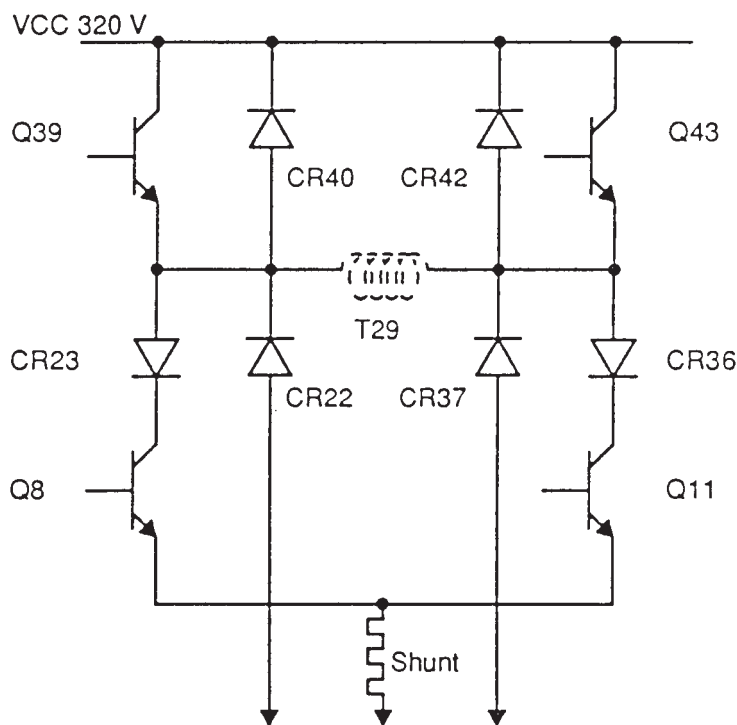
The power inverter is the essential ingredient of the power stage. It is composed of four power transistors and quick diodes intended to control the current flow (*see Illustration 3-2 below and TIRC Power schematic, 46-903708S*).

Q39 and Q43 are the upper transistors of the power inverter and Q8 and Q11 the lower transistors.

The upper transistors are the power supply for the load (the T29 transformer primary) and the lower transistors are the power drain. Q39 and Q11 are simultaneously switched on for one half-wave and switched off for the other half-wave.

The inverter operation principle is based on the control of the effective current and voltage supplied by the inverter with each half-wave modulation.

ILLUSTRATION 3-2
POWER INVERTER

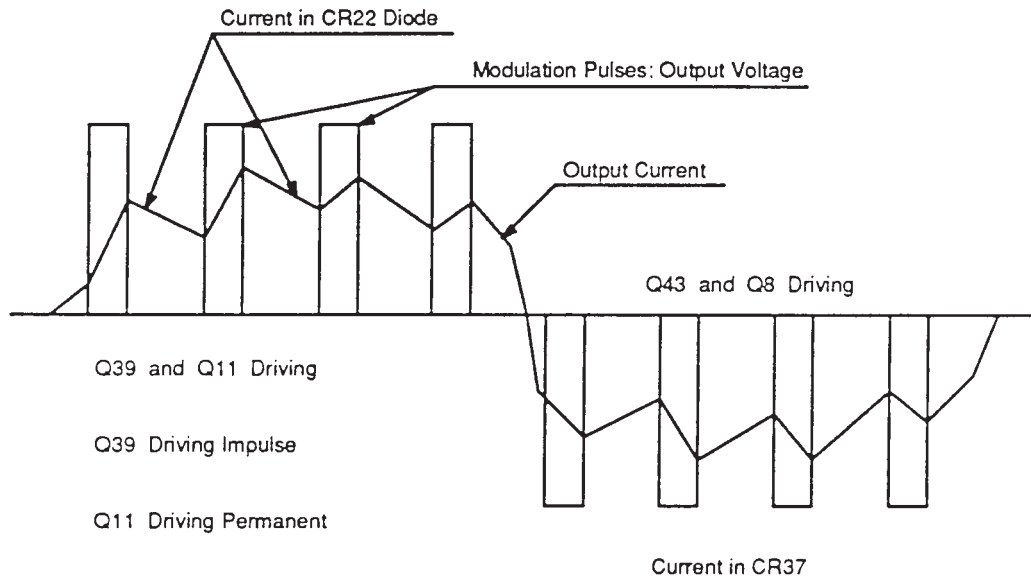


The switch-on time is clipped by the modulation pulses only in the upper transistors. During the acceleration time to reach hi-speed, no modulation is provided and the inverter supplies maximum power.

For acceleration to lo-speed and in the running and braking sequences, the switch-on time is clipped by the modulation pulses.

Illustration 3-3 gives a detailed illustration of the output of the Power Circuit.

ILLUSTRATION 3-3
DETAIL OF POWER CIRCUIT OUTPUT



Due to the complex nature of the load while Q39 and Q11 are switched-on, whenever Q39 is switched-off, the current will then flow from ground through CR22 and the Q11 transistor load, i.e. the current flows from ground to ground through the load. The same occurs through CR37 when the other phase is in operation.

The CR23 and CR36 series diodes prevent an inverse conduction across the lower transistors. Whenever the lower transistor is switched-off, the energy stored by the load is returned to the supply through the CR40 and CR42 diodes. In such case, conduction is carried out from ground to the power supply through the load and the diodes.

SECTION 4 TIRC CONTROL PWB

4-1 General

The TIRC Control PWB is based on an INTEL 8749 microprocessor, operating at 6 MHz, which controls system operation and timing.

The principle function of TIRC Control PWB is to generate frequency and modulation signals for switching on and off the power inverter transistors. Besides this, the TIRC Control PWB monitors the current on the stator cables and the power inverter transistors in order to protect the inverter and prevent an exposition from the generator when the anode has not started.

When the TIRC Control PWB receives an acceleration command (FLUORO or PREP), it activates frequency and modulation signals. If there is a current error, the signals are deactivated and the error is indicated.

The TIRC Control PWB is also equipped with +5V and +12V power supplies, necessary to supply the control and power circuits respectively.

4-2 Start Up

When switched-on, the microcomputer performs a check of the EPROM, RAM and CPU, during which time the red and yellow LED's (DS33 and DS42) are on (*see TIRC Control schematic 2121145*).

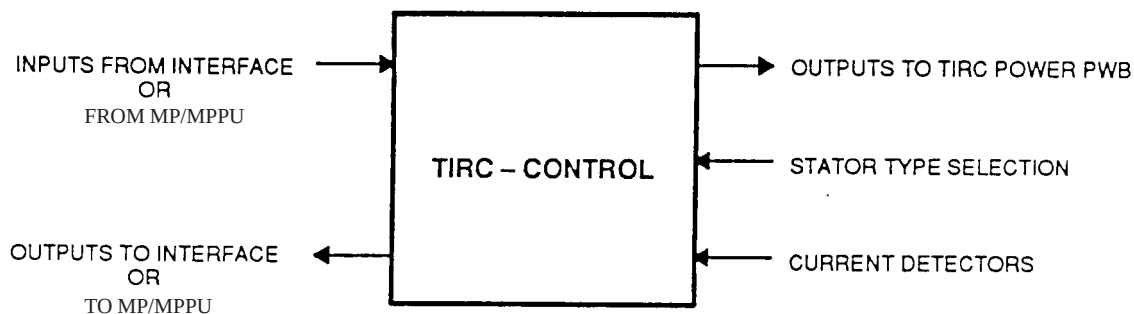
Upon completion of the check-out, the LED's will go out if there is no fault, or remain on if a fault exists. From this time and if the start-up has been correct, the microprocessor continuously scans the inputs while waiting for a command.

4-3 Microprocessor Interface Signals

Illustration 3-4 summarizes the TIRC Control PWB microprocessor interface signals (*see TIRC Control schematic 2121145*).

Note: When an MPPU generator is used the TIRC control signals bypass the TIRC Interface and go directly to the TIRC Control PWB.

ILLUSTRATION 3-4
TIRC CONTROL PWB BLOCK DIAGRAM



INPUTS FROM INTERFACE:

FLUOROSCOPY (SCOP), PREP (GR), CHANGE, CLICHE (SPOT FILM, 3000T, anode size selection (M0, M1, M2)

OUTPUTS TO INTERFACE:

EN EXP and INTERDIT TIRC

OUTPUTS TO TIRC POWER PWB:

To high-speed and brake contactors (TS264-4, 8), and power transistors (TS3, 9, 15, 28, 29 & 30).

STATOR TYPE SELECTION:

JP-328, JP-329.

CURRENT DETECTORS:

MAIN, AUXILIARY (TS264-2, 3)

*** INPUTS FROM MP/MPPU:**

LOW/HIGH SPEED ACCELERATION, LOW/HIGH SPEED PILOT, BRAKE PILOT, BRAKE POWER

(See MPPU Generator Service Manual.)

*** OUTPUTS TO MP/MPPU:**

ROTOR ON

(See MPPU Generator Service Manual.)

4-4 Non-Regulated Power Supply

The non-regulated power supply is integrated by transistors Q251, Q258 and Q267 (see TIRC Control schematic 2121145).

The +12 Vdc power supply must be turned on after the +5 Vdc is regulated and quickly turned off before the latter stops regulating. This ensures that the power bridge lower transistors will not be active when the logic loses control due to a low voltage, thus preventing short circuits.

The switch-off must be quick since the power transistors may be conducting current when the power supply is cut off.

Zener diode CR10 and transistor Q293 ensure that the power bridge upper transistors are OFF when the lower transistors are cut off due to a power failure. The equipment power-up sequence is carried out as follows:

- 5 Volts regulated.
- 12 Vdc.
- Power bridge upper transistor switch-on enable.
- For power off, the sequence is performed the other way around.

4-5 Current Limits

The current limiting circuit is essential to prevent the destruction of the power transistors in case of a short circuit in either the transformer secondary or the motor, or due to transformer saturation.

The circuit consists of two current limit comparators, outputs 1 and 13 of U141 on the TIRC Control PWB (see TIRC Control schematic 2121145) and one current detector, R24 on the TIRC Power PWB (see TIRC Power schematic 46-903708).

When the voltage drop in the shunt exceeds the threshold voltage set by R100, the output of the U141–1 comparator changes to high level, thus cutting off the power bridge upper transistors. (R124 resistor controls the comparator hysteresis.)

If current increases too rapidly, e.g. in case of a short circuit, the U141–13 comparator will be triggered and the U68 one-shot will maintain the four power bridge transistors cut off for approximately 400 msec.

Whenever one of the current limit comparators is activated, the current detected on the stator cables will not be enough and the microprocessor will stop operation, thus preventing operation in short circuit conditions.

4-6 Stator Current

The purpose of the TIRC Control current detectors is to read the current at both windings of the stator and inform the microprocessor when there is not sufficient current.

The current is measured at two stages:

1. acceleration time, which is read at the T1 input of the microprocessor, and
2. running time, which is read at the T0 input of the microprocessor. (*See TIRC Control schematic 2121145*).

SECTION 5 OUTPUT STAGE

The output stage is formed by an output transformer to adapt the inverter voltage to that required for the different types of stators, and a capacitor module for voltage phase shift between the stator windings.

There are four types of phase shift capacitor modules (GE, CGR, Machlett, MX 150 V3 tube), but only one can be installed for each TIRC, so that all of the tubes that control the same TIRC must have the same type of stator, except Capacitor Mod for MX 150 V3 tube which allows association MX 150 V3 (T1) – MX 100 (T2).

In the case of GE tubes, the capacitor module also contains a contactor and rectifier for carrying out DC braking (up to 0 rpm).

(*See Capacitor Module schematic 2121071*).

SECTION 6 TUBE SELECTION MODULE

The Tube Selection Module carries out the selection of the tube (1 or 2), besides controlling the corresponding tube's safety devices. The Tube Selection Module also supplies 220 V or 110 V to electro-valves (CGR or MAXIRAY 120 and 150 x-ray tubes) or fans (GE tubes) respectively.

A second tube selection module (3rd & 4th Tube Option Module) can be installed, thus permitting the TIRC to control up to four tubes, except with MP ph. 4 generator.

(*For detail see Tube Interface 45434920S and 3rd & 4th Tube Option Module 2118972 schematics*).

SECTION 7 TIRC INTERFACE

The purpose of the TIRC Interface board is to receive the signals from the generator and adapt them to the levels required by the TIRC Control PWB, and in turn, it adapts the TIRC Control PWB output signals to the levels required by the generator.

When the tube selection is incorrect, this board generates the INTERDIT signal, which inhibits an exposition from the generator.

Fluoroscopy Enable (ENABLE SC) and X-ray Enable (ENABLE GRAPH) are also generated from this board.

(See *TIRC–MPG/PHASIX Interface 46–904926S*).

Note: Except for tube selection, all the generator control signals bypass the TIRC Interface and go directly to the TIRC Control PWB when an MP/MPPU generator is used.

SECTION 8 OPERATING SEQUENCES

The basic operating sequences for different modes are shown in Illustrations 3–5 to 3–7.

ILLUSTRATION 3-5
OPERATING SEQUENCES FOR TIRC R&F CGR-GE

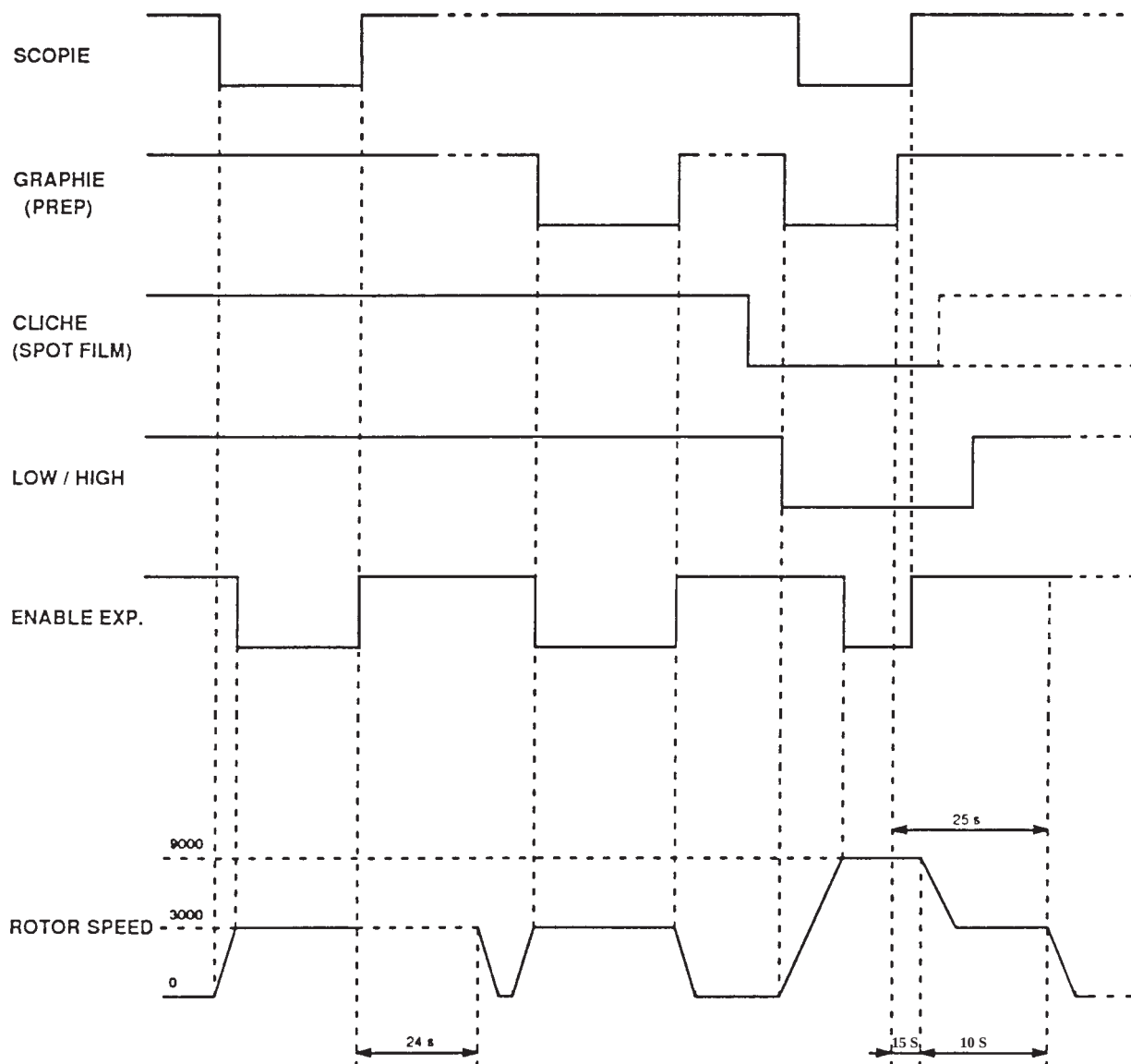
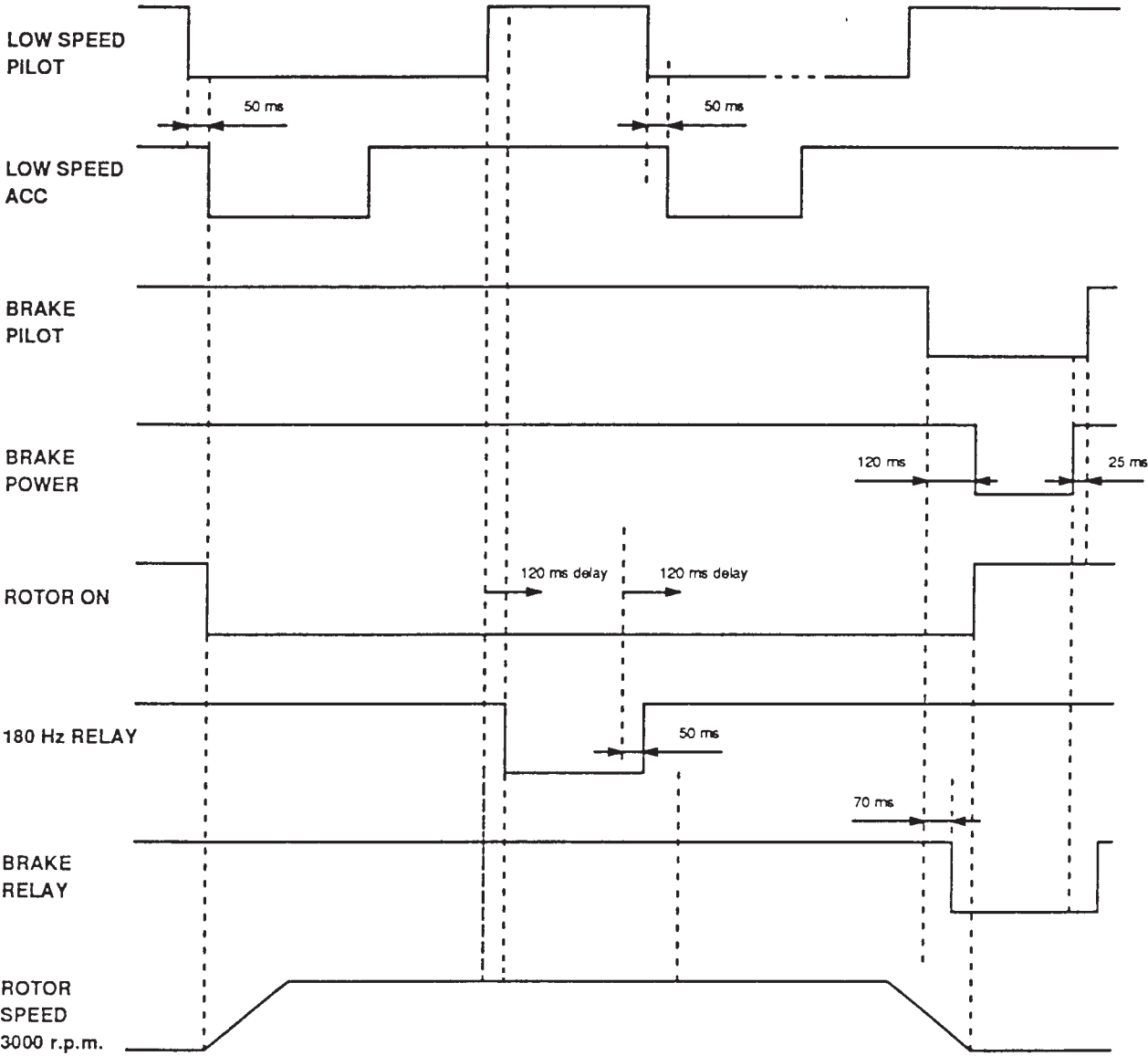
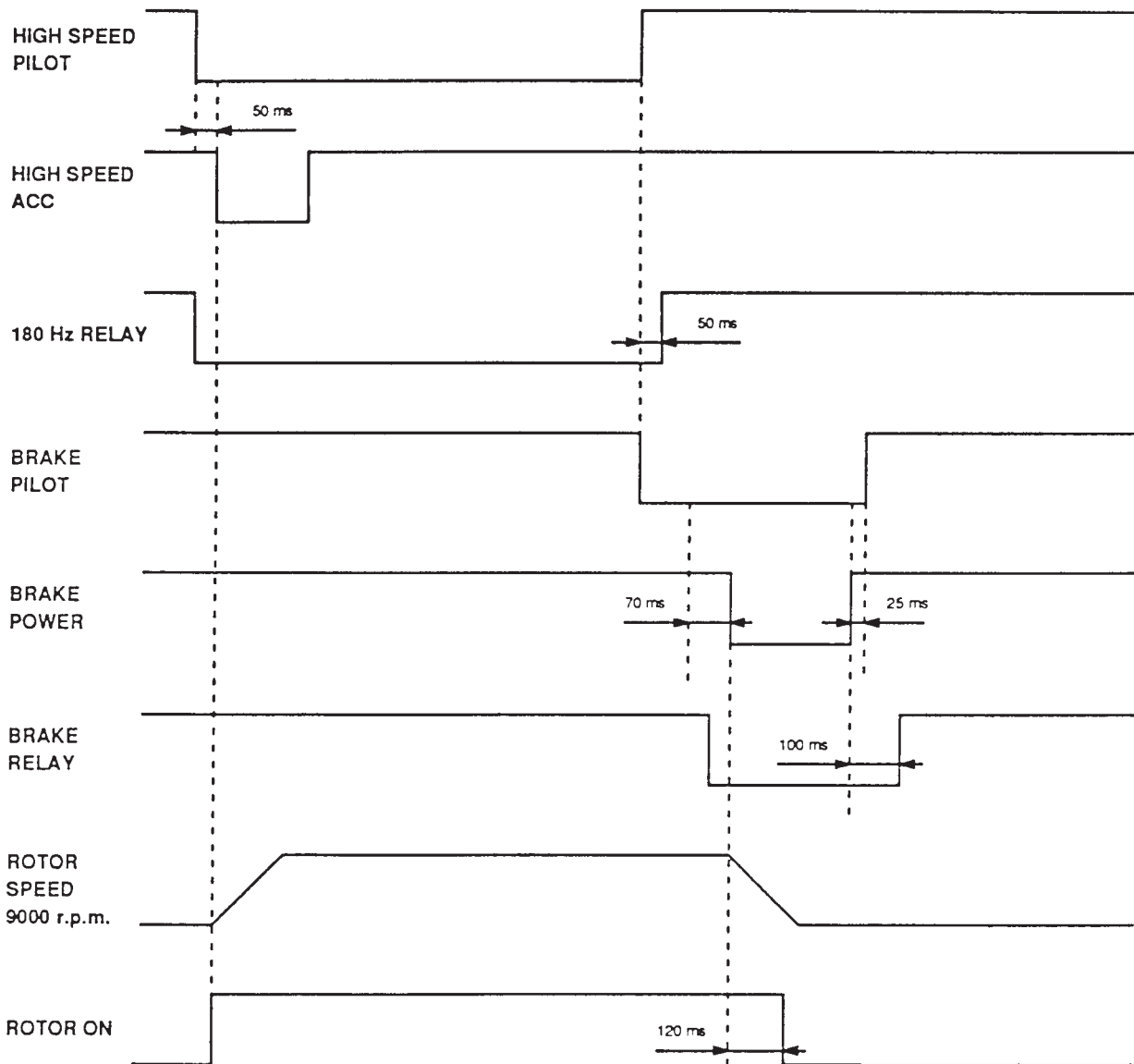


ILLUSTRATION 3-6
LOW SPEED OPERATING SEQUENCE FOR MP

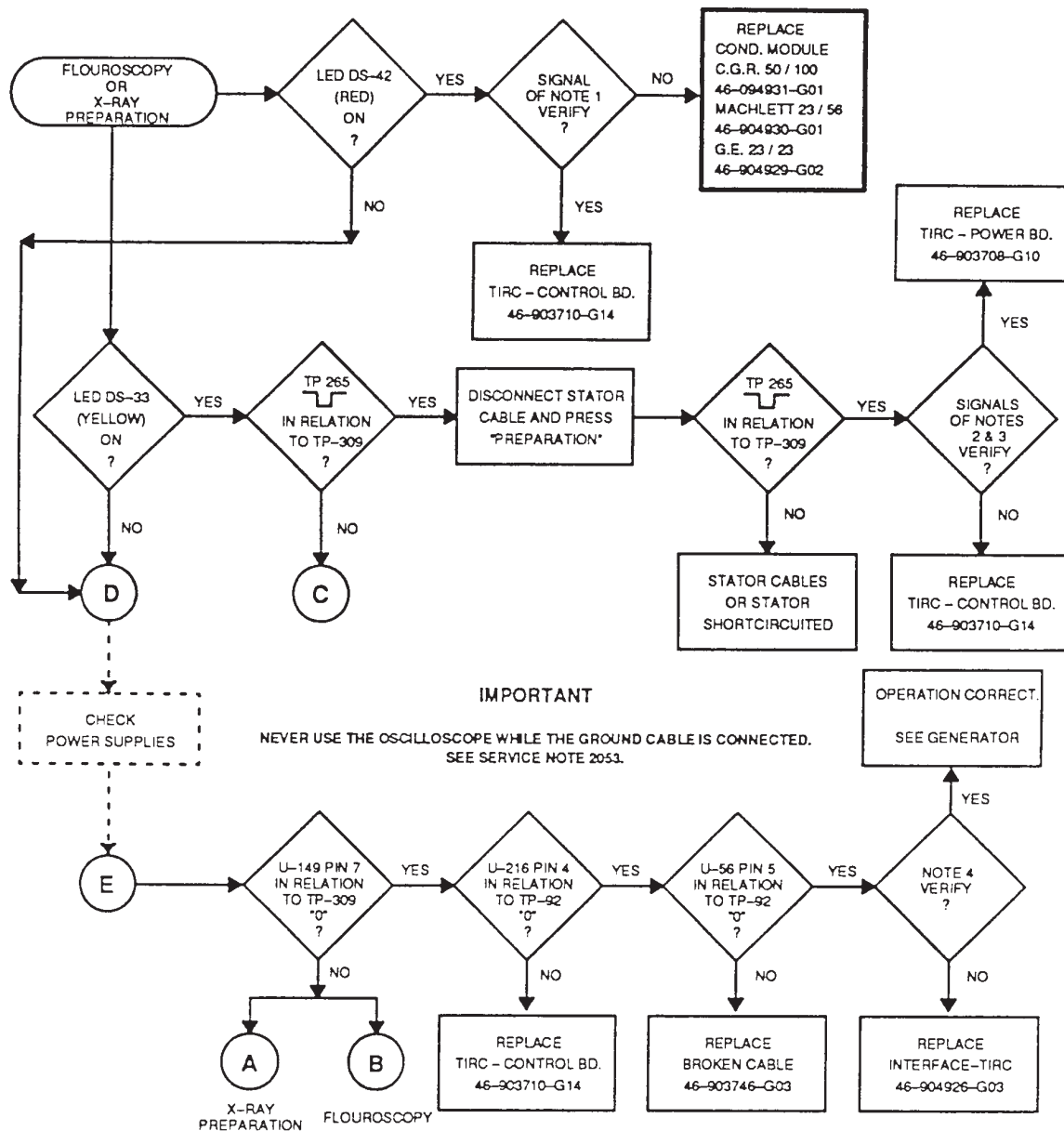


THEORY OF OPERATION

ILLUSTRATION 3-7
HIGH SPEED OPERATING SEQUENCE FOR MP



CHAPTER 4 – DIAGNOSTICS



NOTE *1.- CHECK TS264-2 AND TS264-3 IN RELATION TO TP-309. SIGNAL SHOULD APPEAR AS INDICATED. THE WAVEFORM AND THE FREQUENCY WILL DEPEND ON THE SELECTED R.P.M.

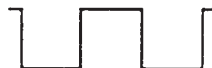


V. > 0.7 V DURING L.S. OP.
V. > 0.2 V DURING L.S. MAN.
V. > 1.0 V DURING H.S. OP.
V. > 0.2 V DURING H.S. MAN.

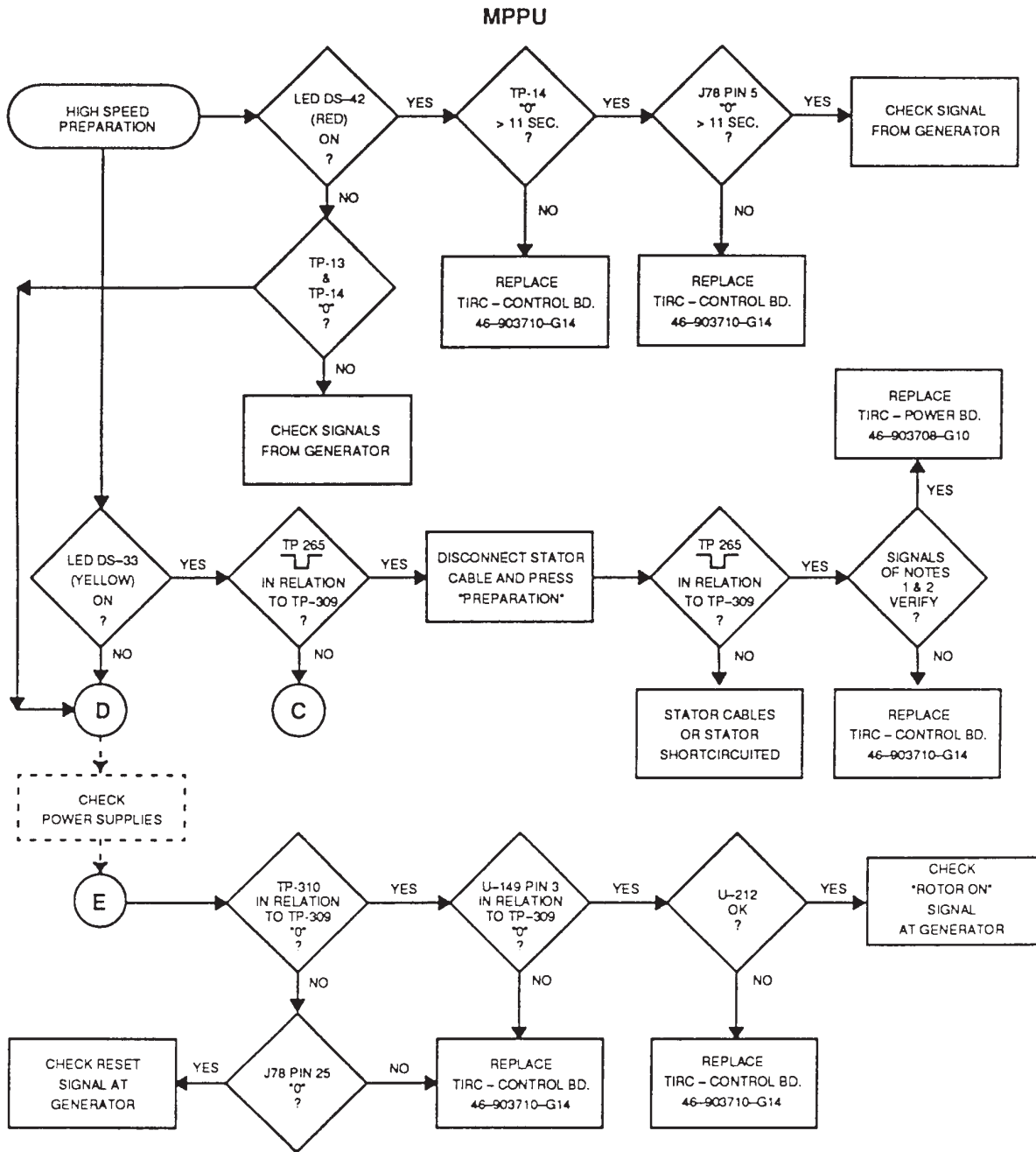
NOTE 2.- CHECK TS-191 AND TS-174 IN RELATION TO TP-309. SIGNAL SHOULD APPEAR AS INDICATED. THE NUMBER OF MODULATION PULSES AND THE FREQUENCY WILL DEPEND ON THE SELECTED TUBE (300 v.p.p.)



NOTE *3.- CHECK TS-151 AND TS-239 IN RELATION TO TP-309. SIGNAL SHOULD APPEAR AS INDICATED. THE FREQUENCY WILL DEPEND ON THE SELECTED TUBE AND THE SELECTION OF LOW OR HIGH SPEED (3 v.p.p.)



NOTE *4.- WITH JP-97 IN "A" CHECK FOR 24 V BETWEEN J43-12 AND TP-92
WITH JP-97 IN "B" CHECK FOR CONTINUITY BETWEEN J43-12 AND J43-24

**IMPORTANT**

NEVER USE THE OSCILLOSCOPE WHILE THE GROUND CABLE IS CONNECTED.
SEE SERVICE NOTE 2053.

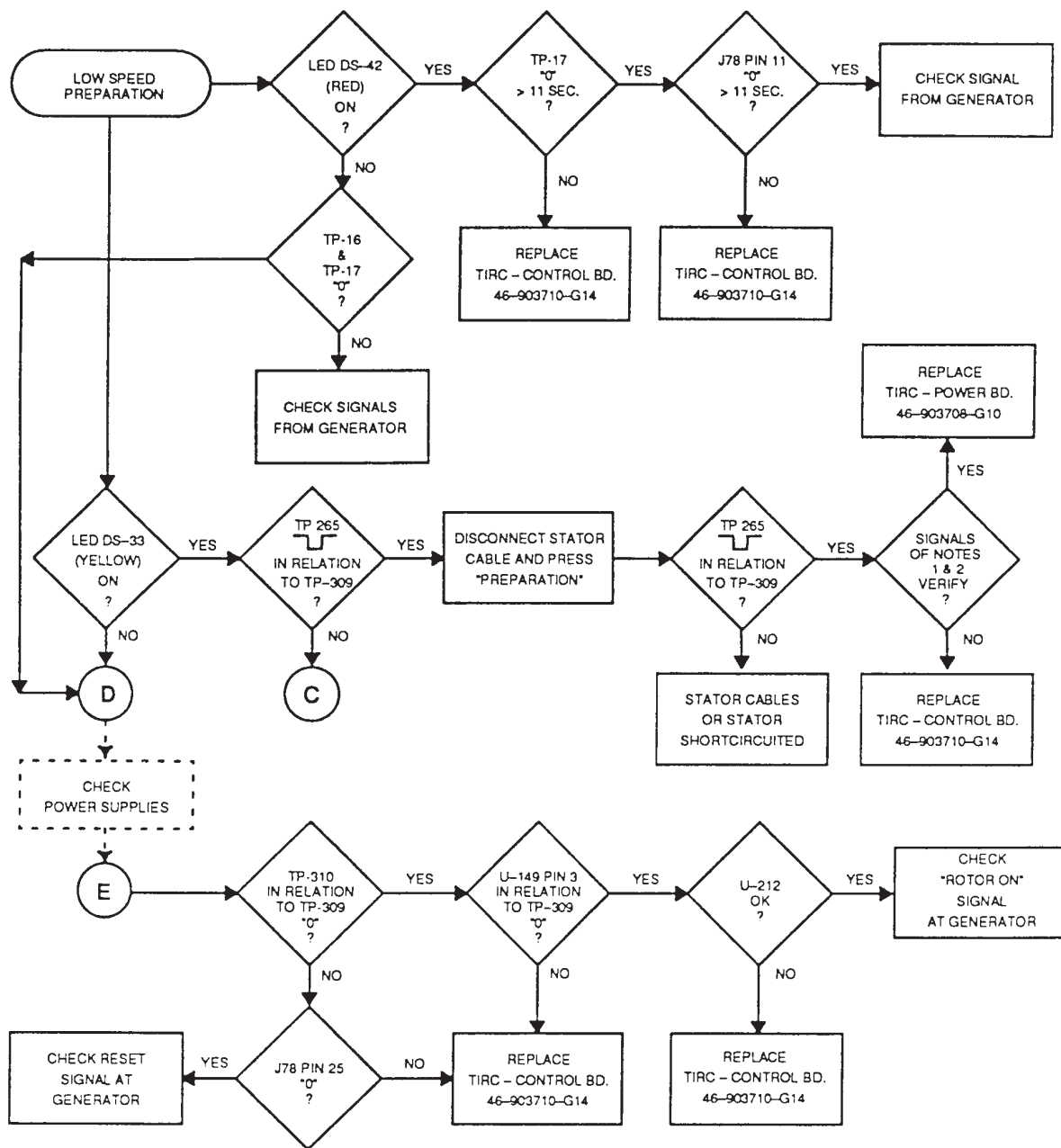
NOTE *1.- COMPARE TS-191 AND TS-174 IN RELATION TO TP-309. SIGNAL SHOULD APPEAR AS INDICATED. THE NUMBER OF MODULATION PULSES AND THE FREQUENCY WILL DEPEND ON THE SELECTED TUBE (300 v.p.p.)



NOTE *2.- COMPARE TS-151 AND TS-239 IN RELATION TO TP-309. SIGNAL SHOULD APPEAR AS INDICATED. THE FREQUENCY WILL DEPEND ON THE SELECTED TUBE AND THE SELECTION OF LOW OR HIGH SPEED (3 v.p.p.)



MPPU



IMPORTANT

NEVER USE THE OSCILLOSCOPE WHILE THE GROUND CABLE IS CONNECTED.
SEE SERVICE NOTE 2053.

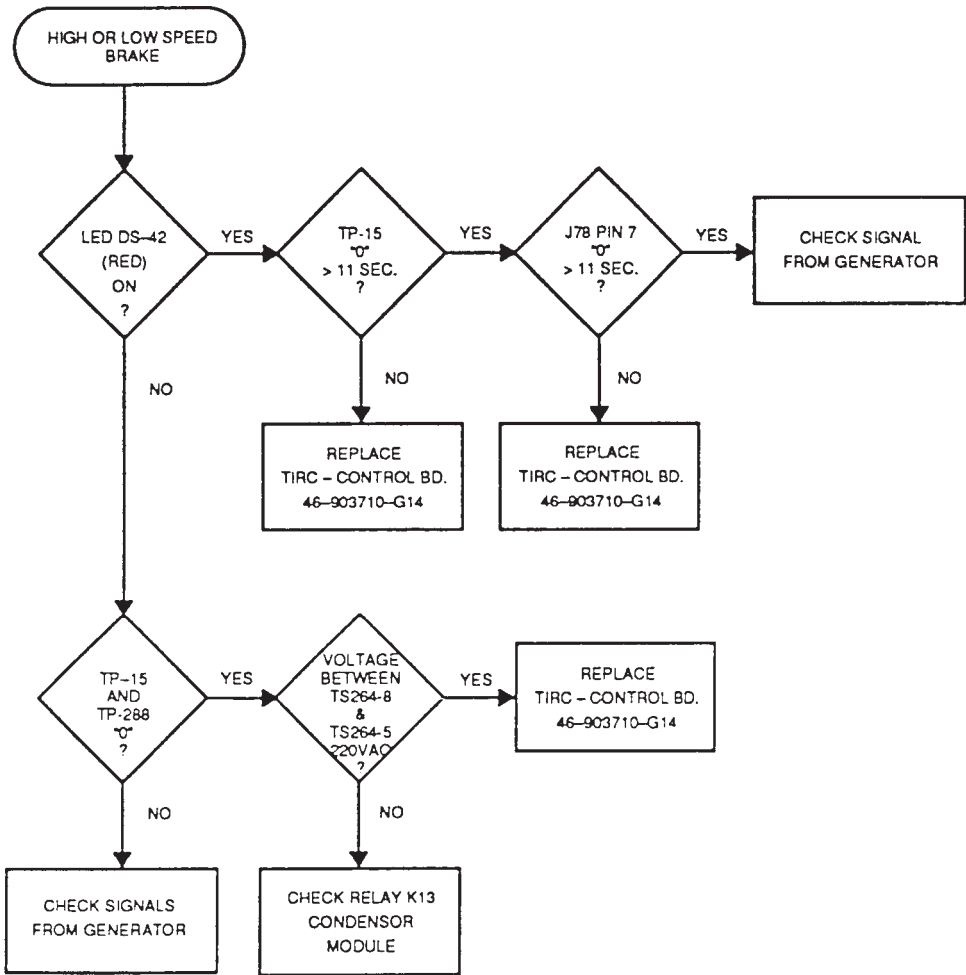
NOTE *1.- COMPARE TS-191 AND TS-174 IN RELATION TO TP-309. SIGNAL SHOULD APPEAR AS INDICATED. THE NUMBER OF MODULATION PULSES AND THE FREQUENCY WILL DEPEND ON THE SELECTED TUBE (300 v.p.p.)



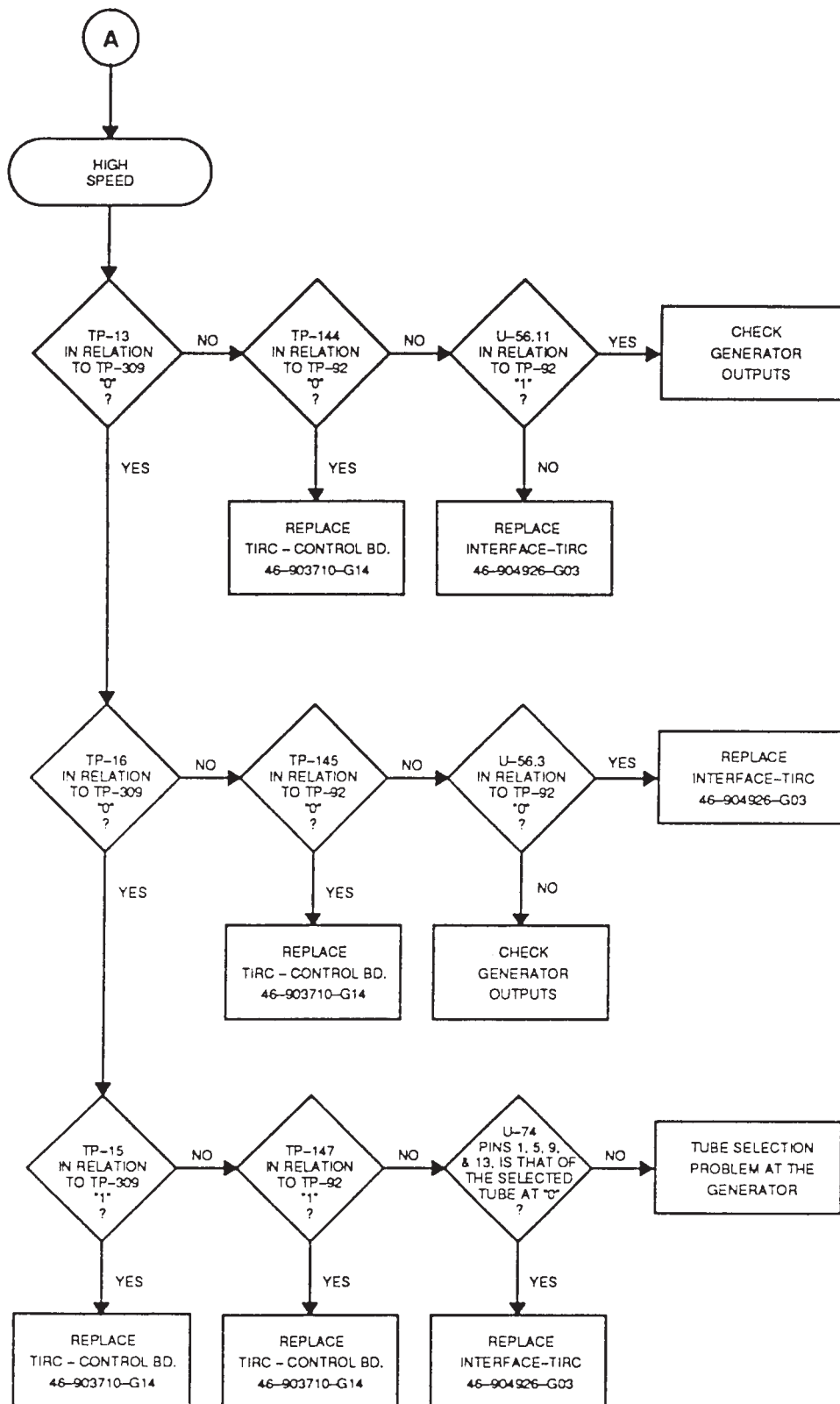
NOTE *2.- COMPARE TS-151 AND TS-239 IN RELATION TO TP-309. SIGNAL SHOULD APPEAR AS INDICATED. THE FREQUENCY WILL DEPEND ON THE SELECTED TUBE AND THE SELECTION OF LOW OR HIGH SPEED (3 v.p.p.)

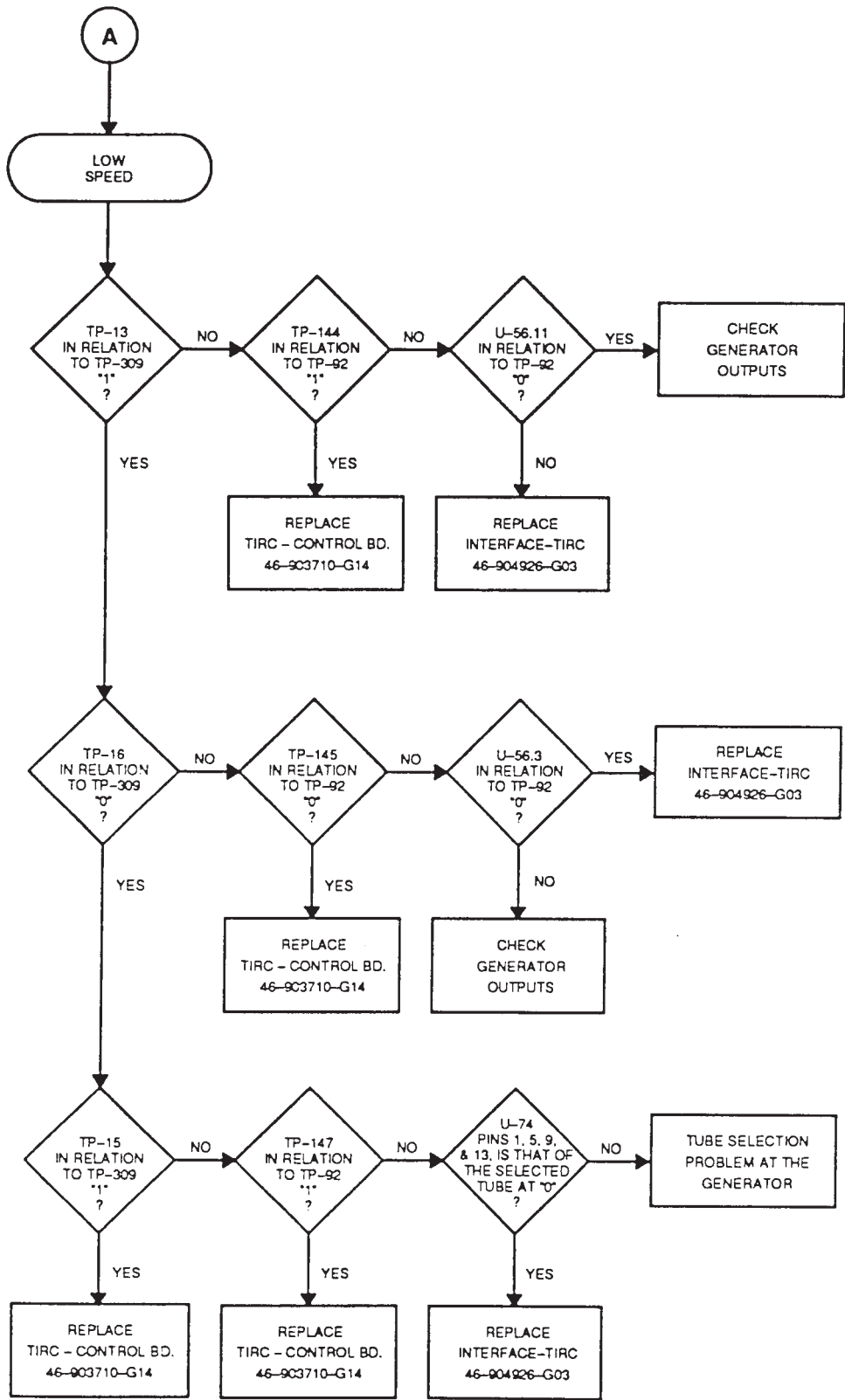


MPPU

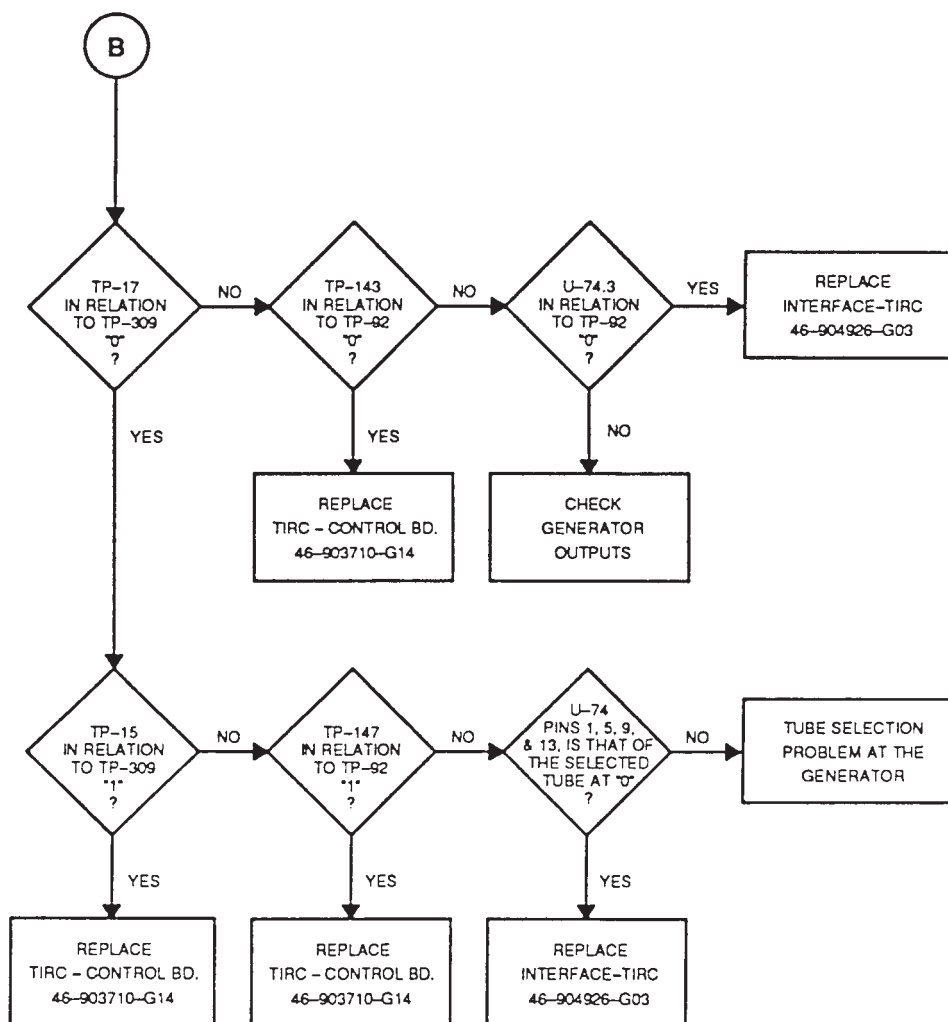


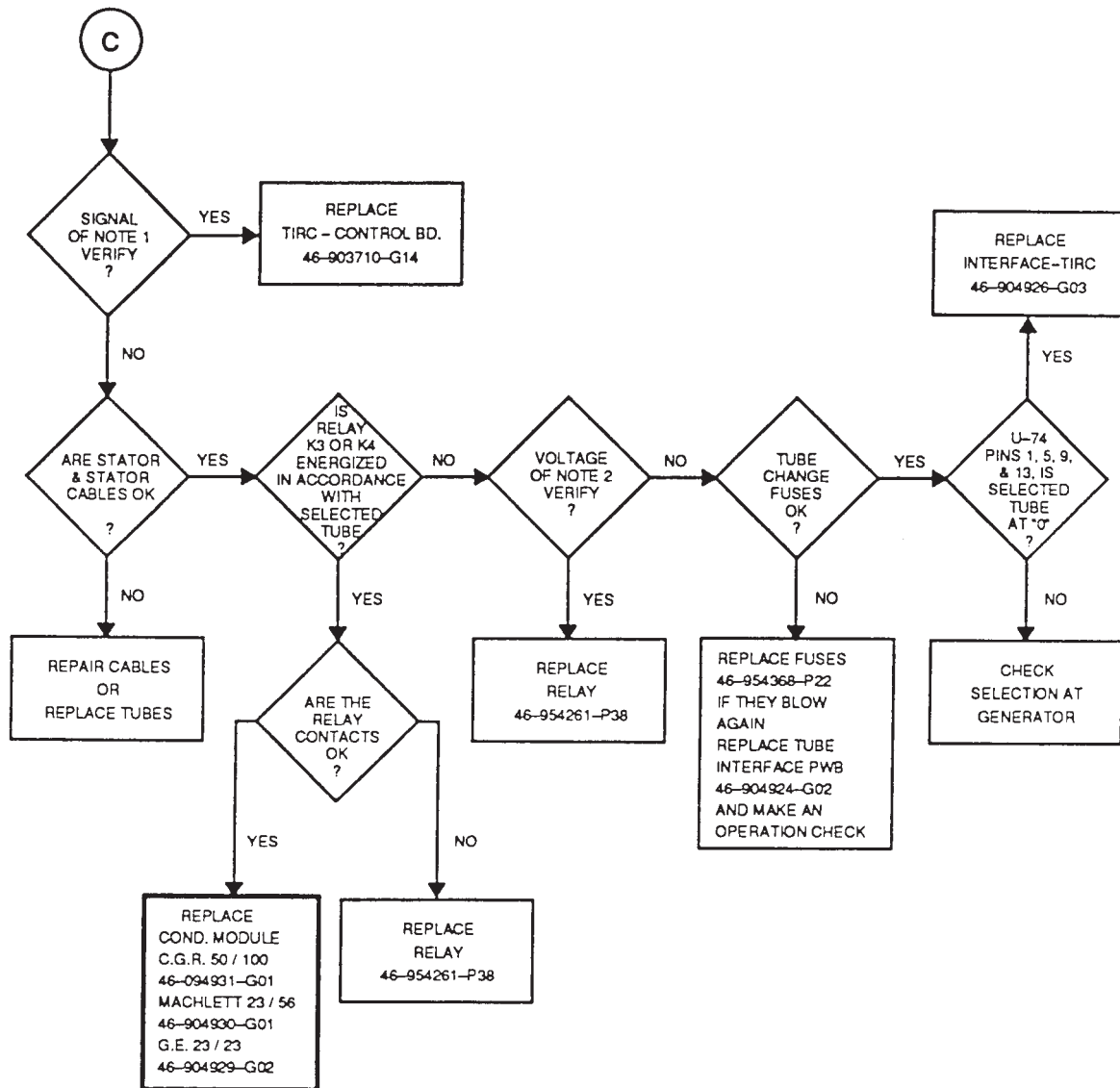
DIAGNOSTICS



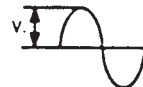


DIAGNOSTICS





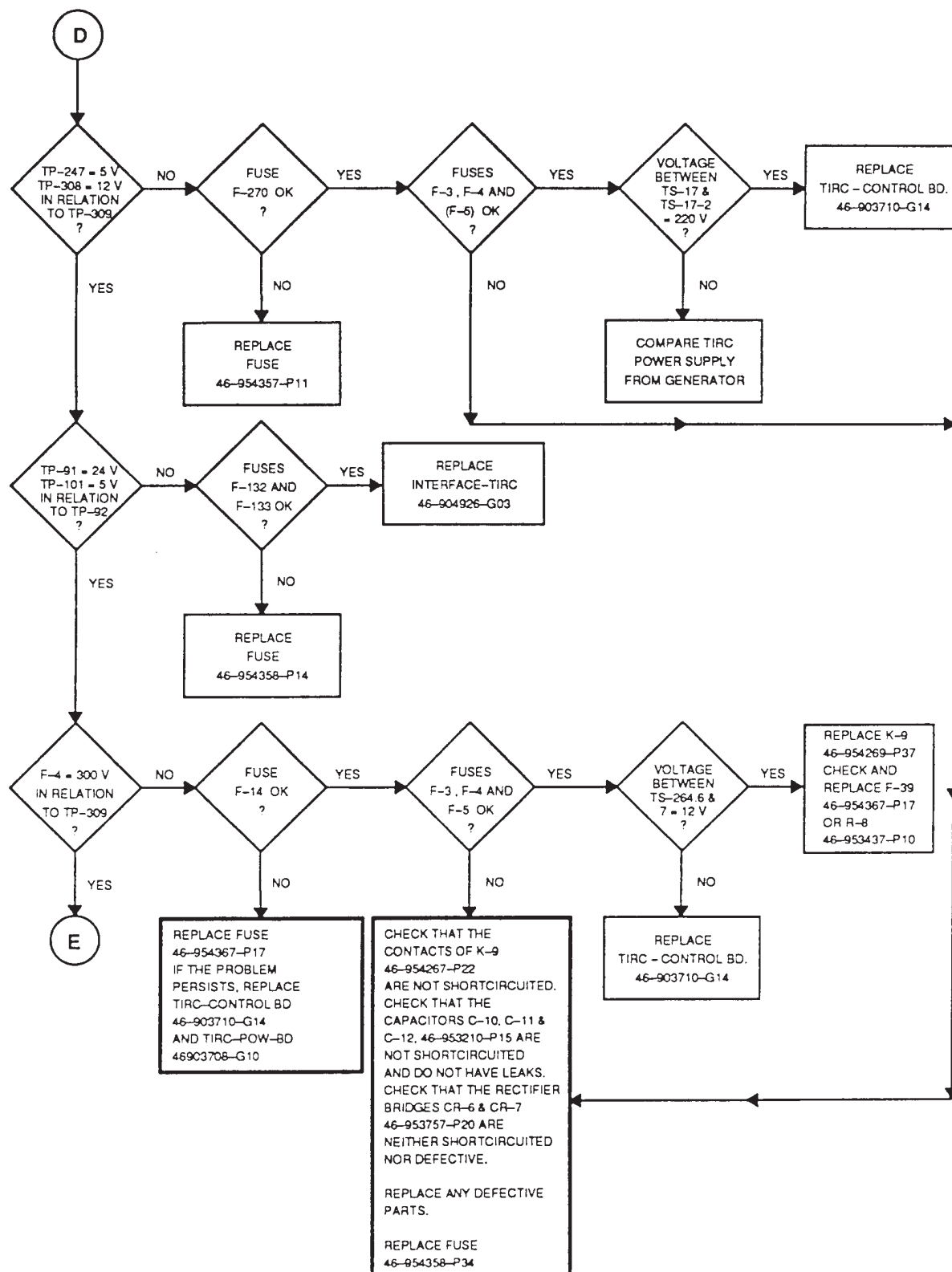
NOTE *1.- CHECK TS264-2 AND TS264-3 IN RELATION TO TP-309. SIGNAL SHOULD APPEAR AS INDICATED. THE WAVEFORM AND THE FREQUENCY WILL DEPEND ON THE SELECTED R.P.M.



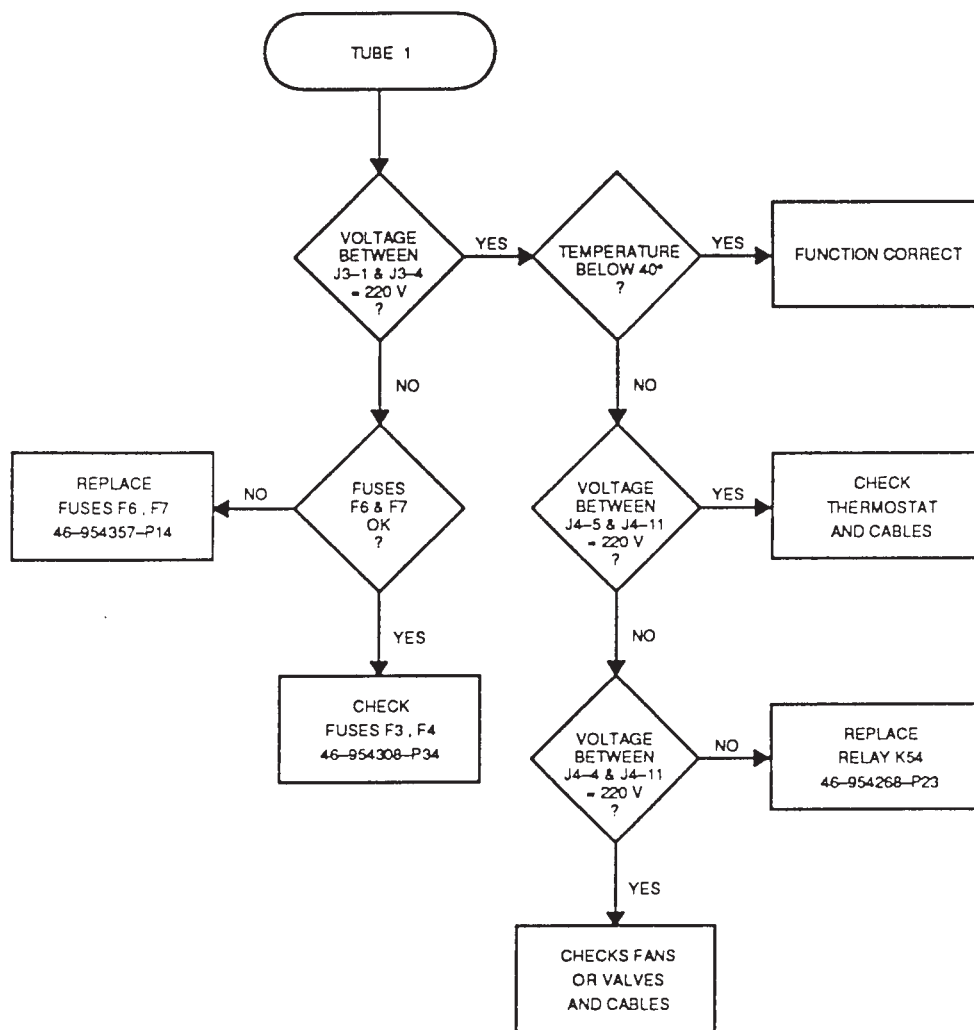
V. > 0.7 V DURING L.S. OP.
V. > 1.0 V DURING H.S. OP.

NOTE *2.- 220 V BETWEEN : TS2-14 & TS2-15 (TUBES 1 & 3)
TS2-14 & TS2-16 (TUBES 2 & 4)

CHECK POWER SUPPLIES

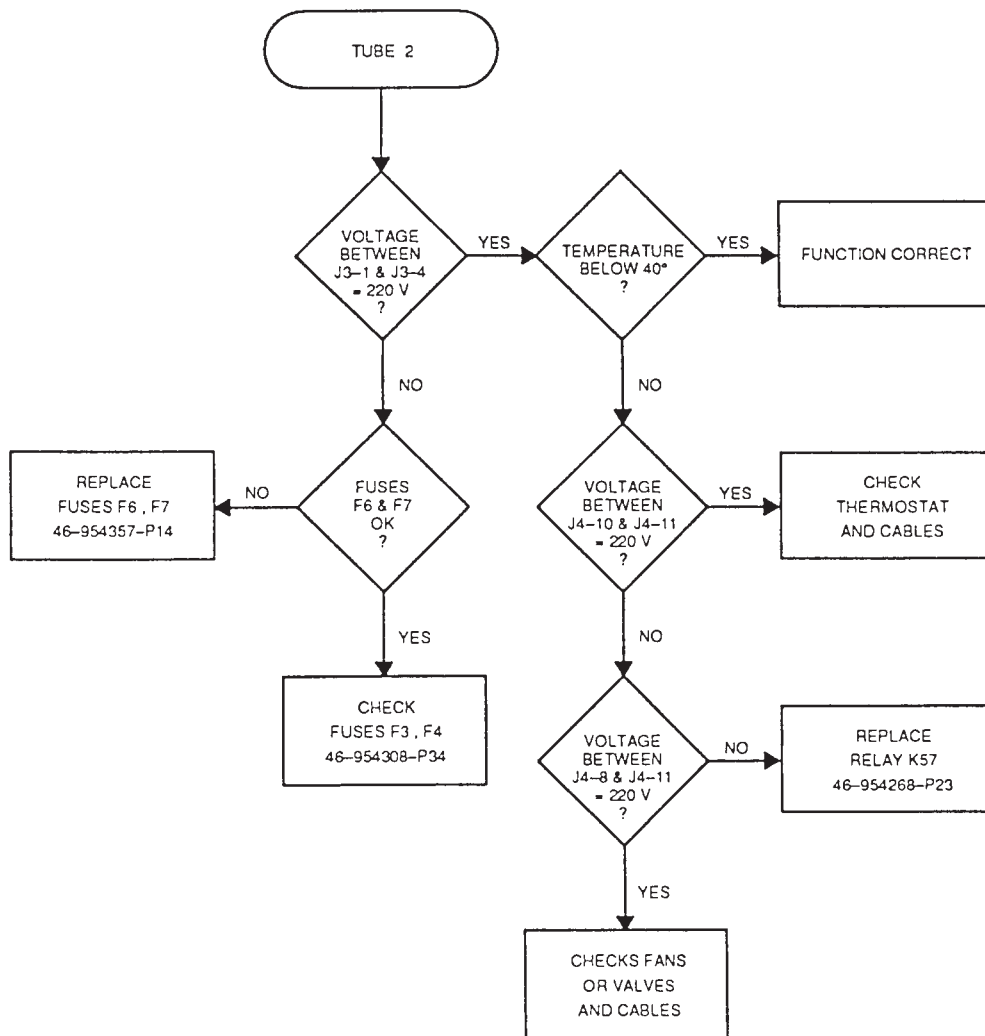


FANS AND ELECTROVALVES SUPPLIED AT 220 V



NOTE.- IF THE POWER SUPPLY FOR THE FANS AND VALVES IS 220 V A.C., JUMPER JP43 MUST BE INSTALLED AT THE TUBES INTERCONNECTION BOARD.

FANS AND ELECTROVALVES SUPPLIED AT 220 V



NOTE.- IF THE POWER SUPPLY FOR THE FANS AND VALVES IS 220 V A.C., JUMPER JP43 MUST BE INSTALLED AT THE TUBES INTERCONNECTION BOARD.

CHAPTER 5– RENEWAL PARTS

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ABBREVIATIONS

ITEM NO.
–
– 6

Not illustrated.
Item No. 6 not illustrated.

FRU
1
2
N

Field Replaceable Unit.
Critical.
Not critical.
Not available.

REP
Y

Repairable.

QTY
PL
AR

Previously listed as an assembly or subassembly.
As required.

APP

Applies to.



Viewing direction.



Renewal Parts

ILLUSTRATION 5-1

MPPU A2 V2 TIRC G/MP FOR MX 150 (X-RAY TUBE) 63 HZ 2115418

MPPU A2 V3 TIRC G/MP FOR MX 150 (X-RAY TUBE) 115 HZ 2148069

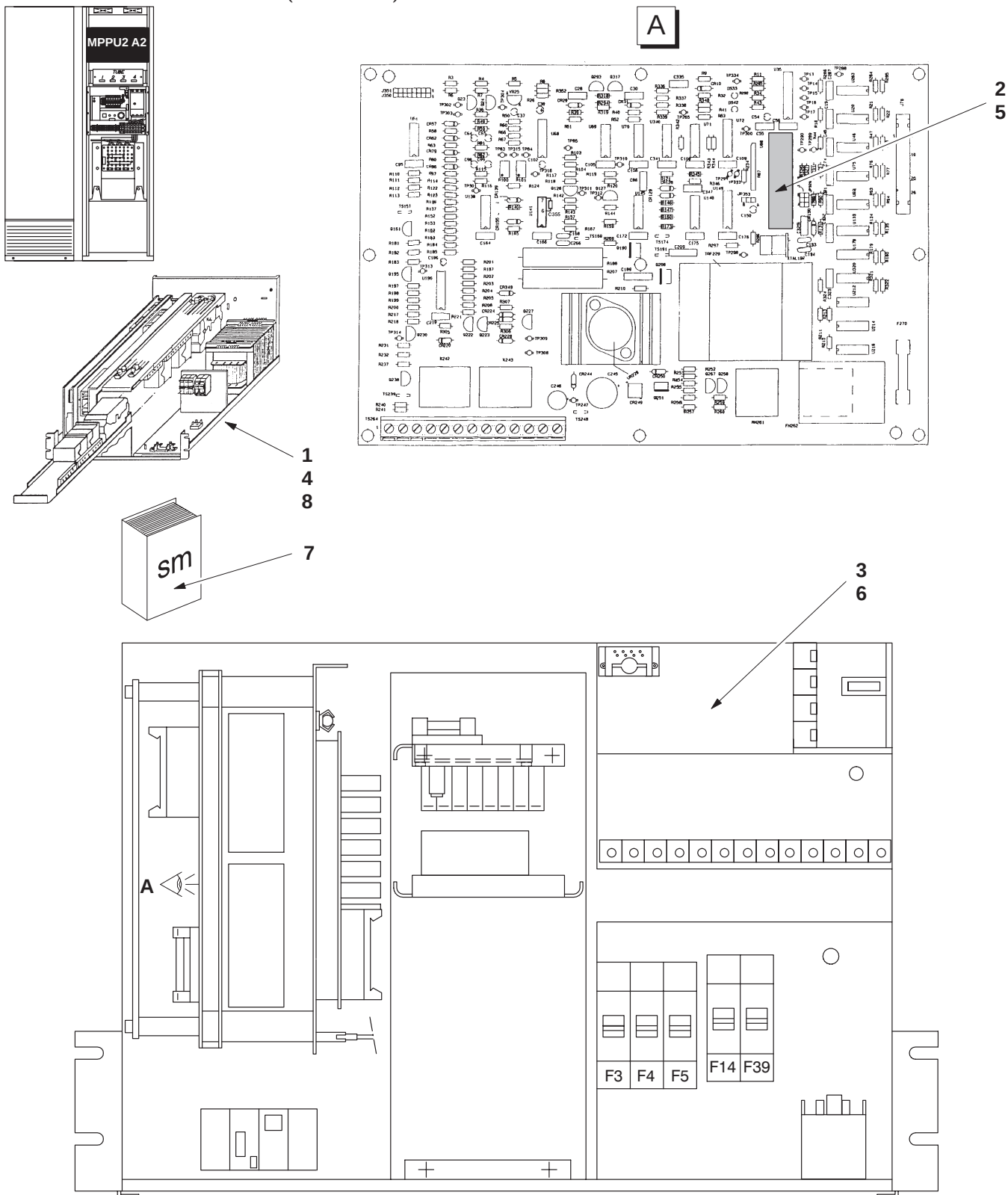


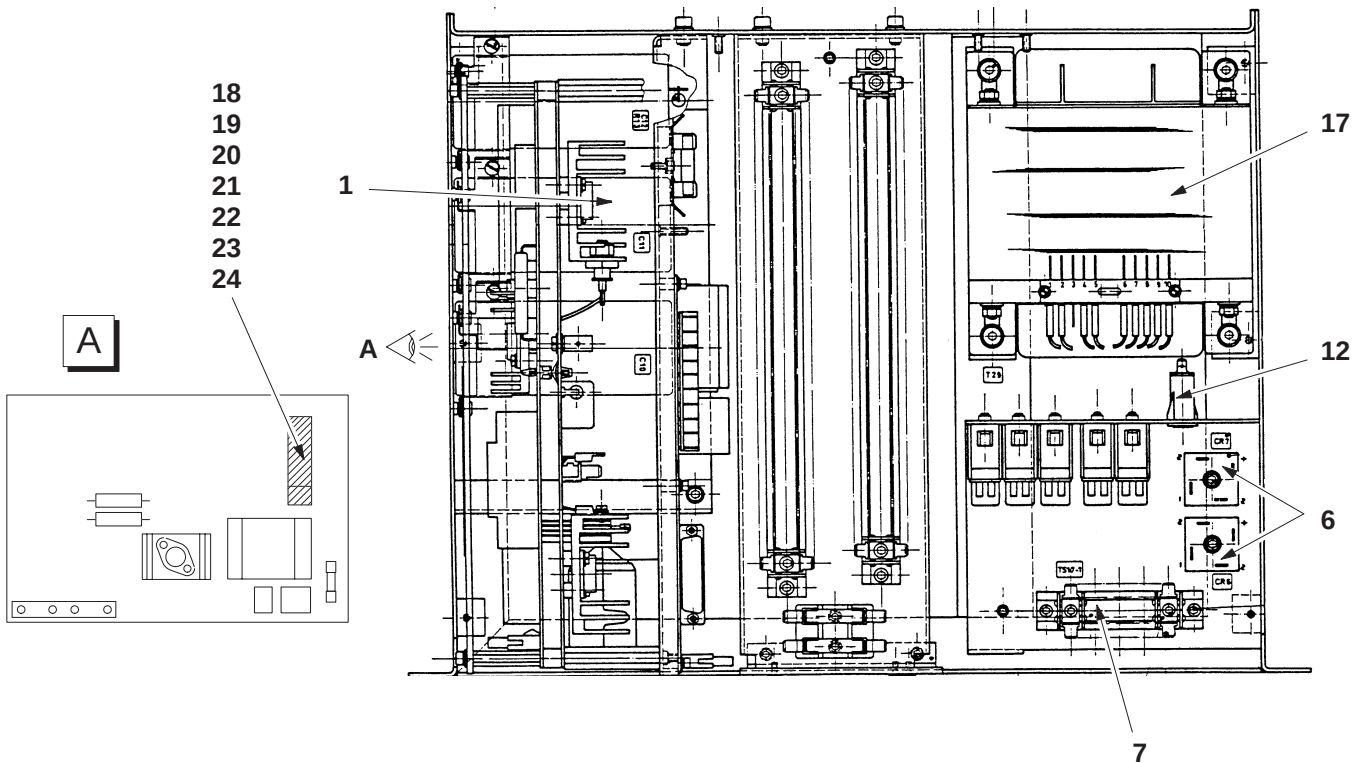
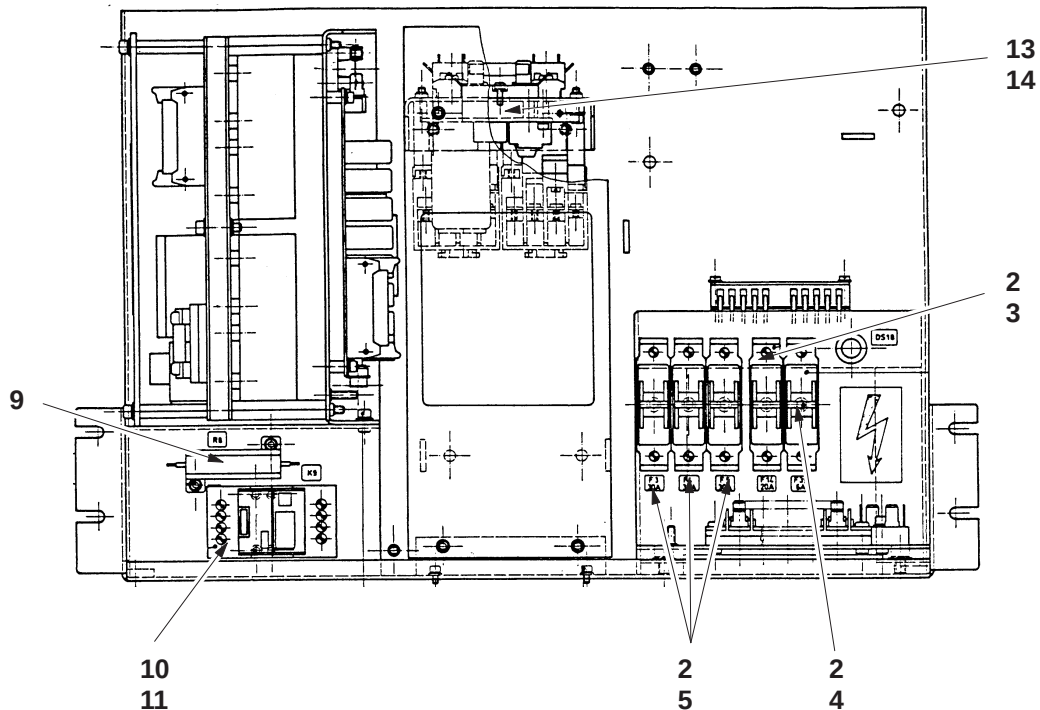
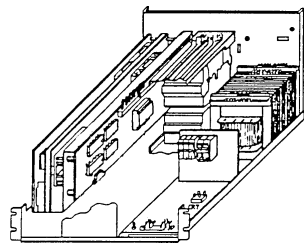
ILLUSTRATION 5-1

MPPU A2 V2 TIRC G/MP FOR MX 150 (X-RAY TUBE) 63 HZ 2115418

MPPU A2 V3 TIRC G/MP FOR MX 150 (X-RAY TUBE) 115 HZ 2148069

ITEM NO.	PART NO.	FRU	REP	DESCRIPTION	QTY	APP
—	2115418	1	Y	MPPU2 A2 V2 TIRC G/MP FOR MX 150 (X-RAY TUBE*) 63 HZ * THESE SPARE PARTS ARE THE ONLY TO BE USED IN V2 AND V3 TIRC-G MP	1	
1	2116766	1		• V2 TIRC STARTER (SEE ILL. 5-2)	1	
2	2143930	1		• PROGRAMMABLE MEMORY (63 HZ) FOR MX 150 X-RAY TUBE V2	1	
3	2121071	1		• CAPACITOR MODULE FOR MX 150 X-RAY TUBE V2	1	
—	2148069	1		MPPU2 A2 V3 TIRC G/MP FOR MX 150 (X-RAY TUBE) 115 HZ	1	
4	2148660	1	Y	• V3 TIRC STARTER (VAMP) (SEE ILL. 5-2)	1	
5	2161104	1		• PROGRAMMABLE MEMORY (115 HZ) FOR MP/MPPU MX 150 X-RAY TUBE V3	1	
6	2148664	1		• CAPACITOR MODULE FOR STATOR V3 MX 150 V3	1	
7	2124114-100	2		• TIRC MPG 100-MP, SERVICE MANUAL	1	
8		N		BASIC TIRC (SEE ILL. 5-2)	1	
—	2162092	1		SERVICE FIRST AID KIT	1	
—		N		• • FUSE 20A 600V	2	
—		N		• • FUSE 6A 600V 10X38 JX	2	
—		N		• • FUSE 30A 600V 10X38	6	
—		N		• • BRIDGE RECTIFIER 26MB60A	2	
—		N		• • BRIDGE RECTIFIER 20MBF80AS05	1	
—		N		• • RELAY C2A20.012 VCC	1	
—		N		• • FUSE 3.2A 250V 6X32	4	
—		N		• • FUSE 0.125A 250V 6X32	6	
—		N		• • TRANSZORBS ASSEMBLY	1	

ILLUSTRATION 5-2
BASIC TIRC 2116766



RENEWAL PARTS

ILLUSTRATION 5-2
BASIC TIRC 2116766

ITEM NO.	PART NO.	FRU	REP	DESCRIPTION	QTY	APP
—	2116766	N		BASIC TIRC * * SPARE PARTS ONLY FOR TIRC-G MP AND TIRC-G MPG 100	PL	
1	2193476	1		• CAPACITOR ITELCOND 400V 1000 μ F	2	
2	46-954363P02	1		• FUSE OLDER SI810 + PRE10	5	
3	46-954367P17	1		• FUSE 20A A060URB020T13	1	
4	46-954362P43	1		• FUSE 600V 6A 10X38 JX	1	
5	99175458	1		• QUICK-BREAK FUSE 10.3X38.3	3	
6	46-953757P20	1		• RECTIFIER JUMPER 26MB 60A	2	
7	46-954075P10	1		• TERMINAL STRIP ENSB HIL 5 BORN	2	
— 8	46-9549376G02	1		• GENERATOR CONNECTION CABLE (BASIC TIRC)	2	
9	46-953437P10	1		• RESISTOR ENC 10 OHM 50W 5%	2	
10	46-954269P37	1		• RELAY C2A20 012 VCC	2	
11	46-954268P86	1		• BASE S2-B C/RC	—	
12	99184033	1		• INDICATOR LAMP, RED	—	
13		N		• TUBE SELECTION (BASIC TIRC) (SEE ILL. 5-3)	1	
14		N		• TUBE SELECTION (SEE ILL. 5-3)	1	
17	46-904928P02	2		• TRANSFORMER	1	
18	45435780	1		• PROGRAMMABLE MEMORY FOR R&F + VASC 16S (GE)	1	
19	45435781	1		• PROGRAMMABLE MEMORY FOR R&F + VASC 16S (CGR)	1	
20	45435782	1		• PROGRAMMABLE MEMORY FOR R&F + VASC 16S (MACHLETT)	1	
21	45435783	1		• PROGRAMMABLE MEMORY FOR VASCULAR 30S (CGR)	1	
22	46-904897G01	1		• PROGRAMMABLE MEMORY FOR TRIPLUNIX	1	
23	46-904889G01	1		• PROGRAMMABLE MEMORY FOR MP/MPPU 60HZ	1	
24	2127731	1		• PROGRAMMABLE MEMORY MAXIRAY 120 60S (GE)	1	

ILLUSTRATION 5-3
TUBE SELECTION 2116767 OR 2121066

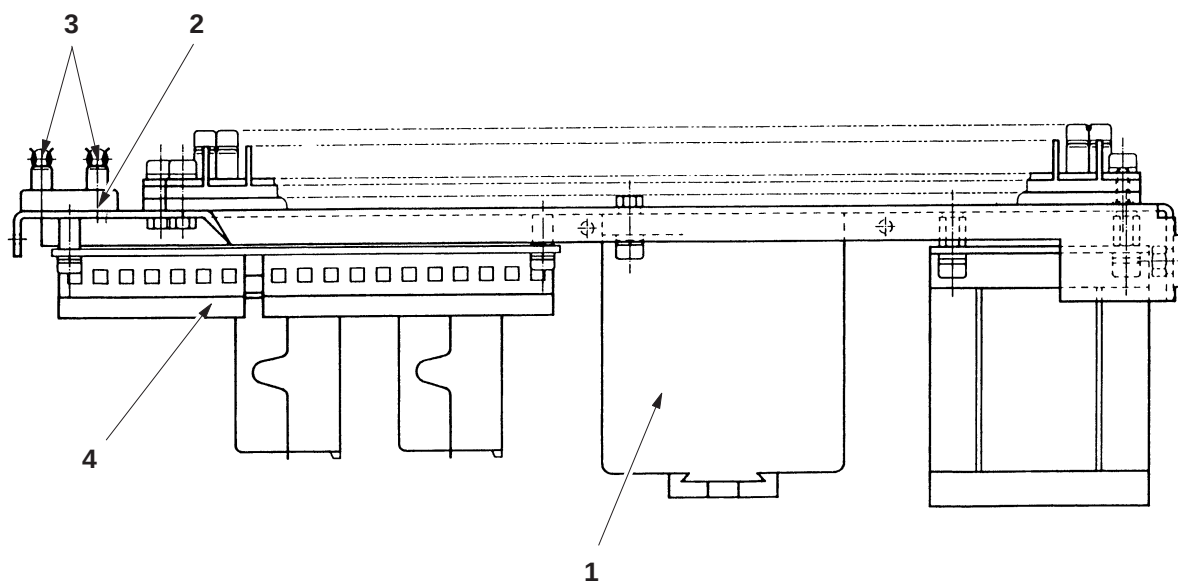
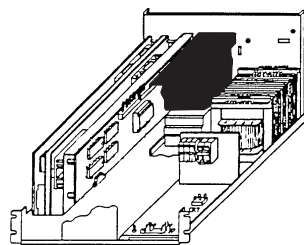
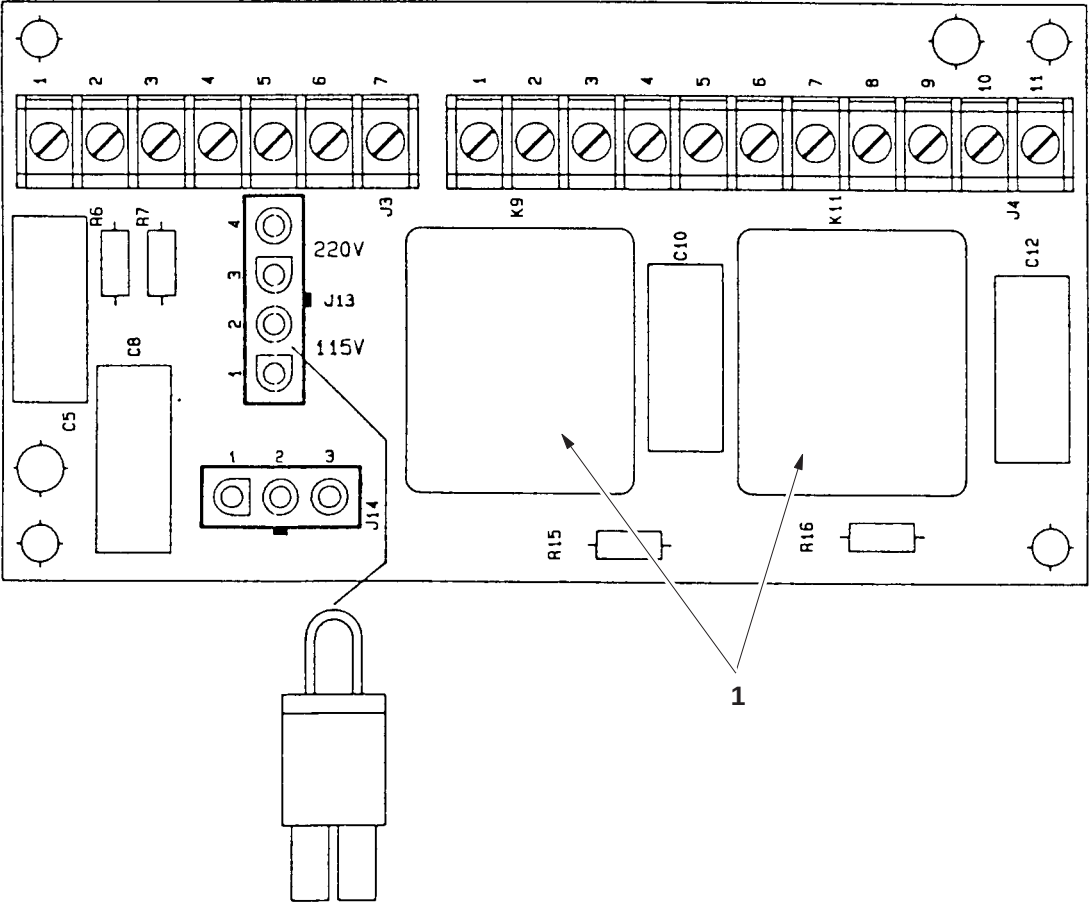
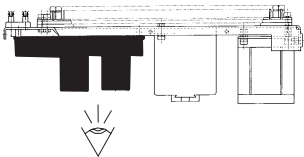


ILLUSTRATION 5-3
TUBE SELECTION 2116767 OR 2121066

ITEM NO.	PART NO.	FRU	REP	DESCRIPTION	QTY	APP
				1 2 3 4 5		
-		N		TUBE SELECTION (BASIC TIRC)	PL	
-		N		TUBE SELECTION	PL	
1	46-95261P38	1		• CONTACTOR CA2-DN140M-A65	2	
2	46-954354P15	1		• FUSE HOLDER 350330, LITTEL FU	1	
3	46-954361P31	1		• FUSE 250V 3.2A 6X32	2	
4		N		• TUBE INTERFACE PWB (SEE ILL. 5-4)	1	

RENEWAL PARTS

ILLUSTRATION 5-4
TUBE INTERFACE PWB 45434920



RENEWAL PARTS

ILLUSTRATION 5-4
TUBE INTERFACE PWB 45434920

ITEM NO.	PART NO.	FRU	REP	DESCRIPTION					QTY	A P P
				1	2	3	4	5		
—		N		TUBE INTERFACE PWB					PL	
1	46–954268P23	1		• RELAY MR–31.3 220 VCA					2	

ILLUSTRATION 5-5
TIRC ASSEMBLY 2121144

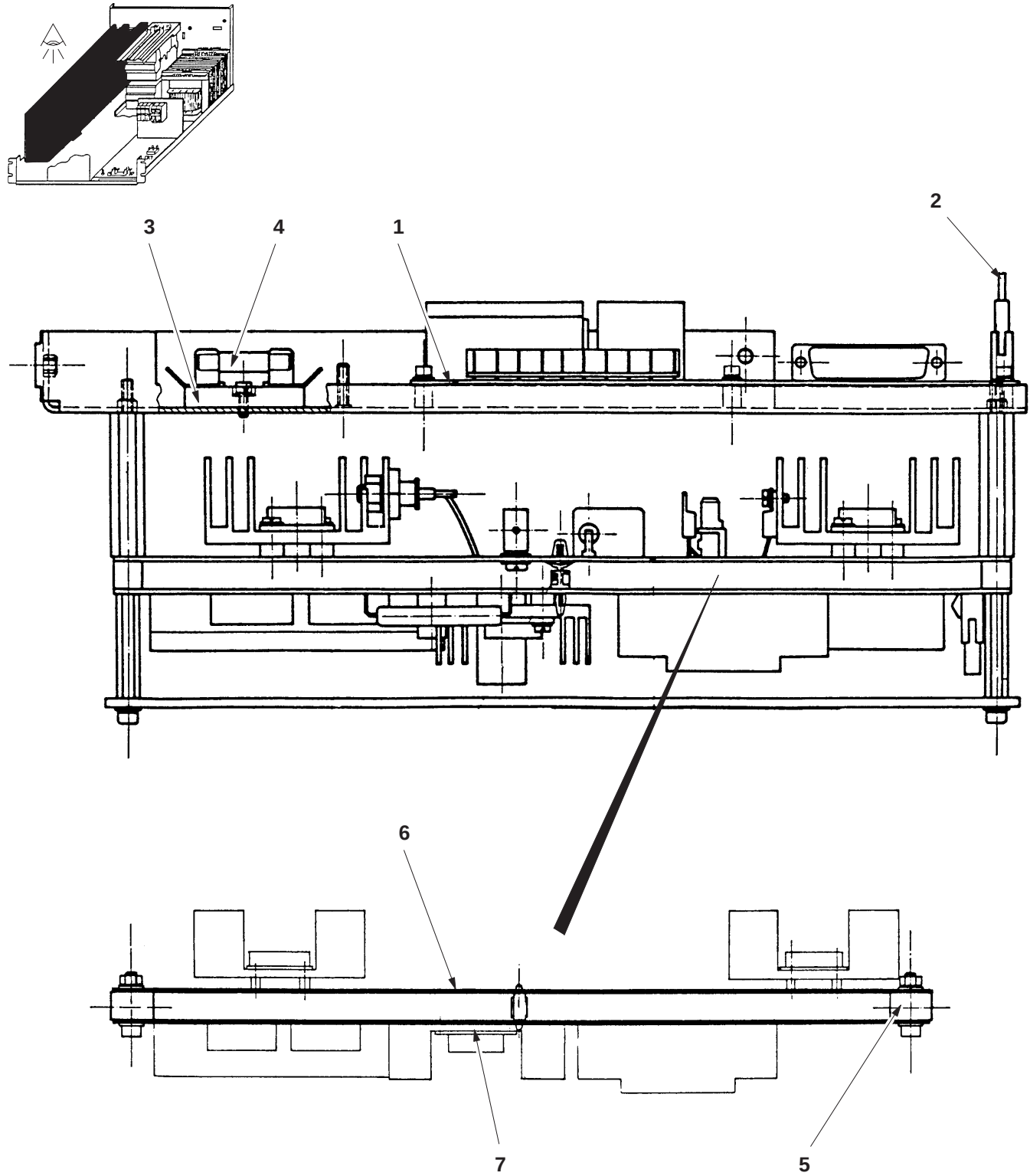


ILLUSTRATION 5-5
TIRC ASSEMBLY 2121144

ITEM NO.	PART NO.	FRU	REP	DESCRIPTION	QTY	APP
1	46-904926G03	1		• TIRC-MPG-PHASIX INTERCONNECTION PWB	1	
2	46-903746G03	1		• 26-WAY FLAT RIBBON CABLE	1	
3	46-954354P15	1		• FUSE HOLDER 350330, LITTEL FU	2	
4	46-954358P14	1		• SLOW-BLOW FUSE 0.5A 250V	2	
5	2121151	N		• PWB SUBASSEMBLY	1	
6		N		• • TIRC POWER PWB (SEE ILL. 5-6)	1	
7		N		• • TIRC CONTROL PWB (SEE ILL. 5-7)	1	

RENEWAL PARTS

ILLUSTRATION 5-6
TIRC POWER PWB 46-903708G10

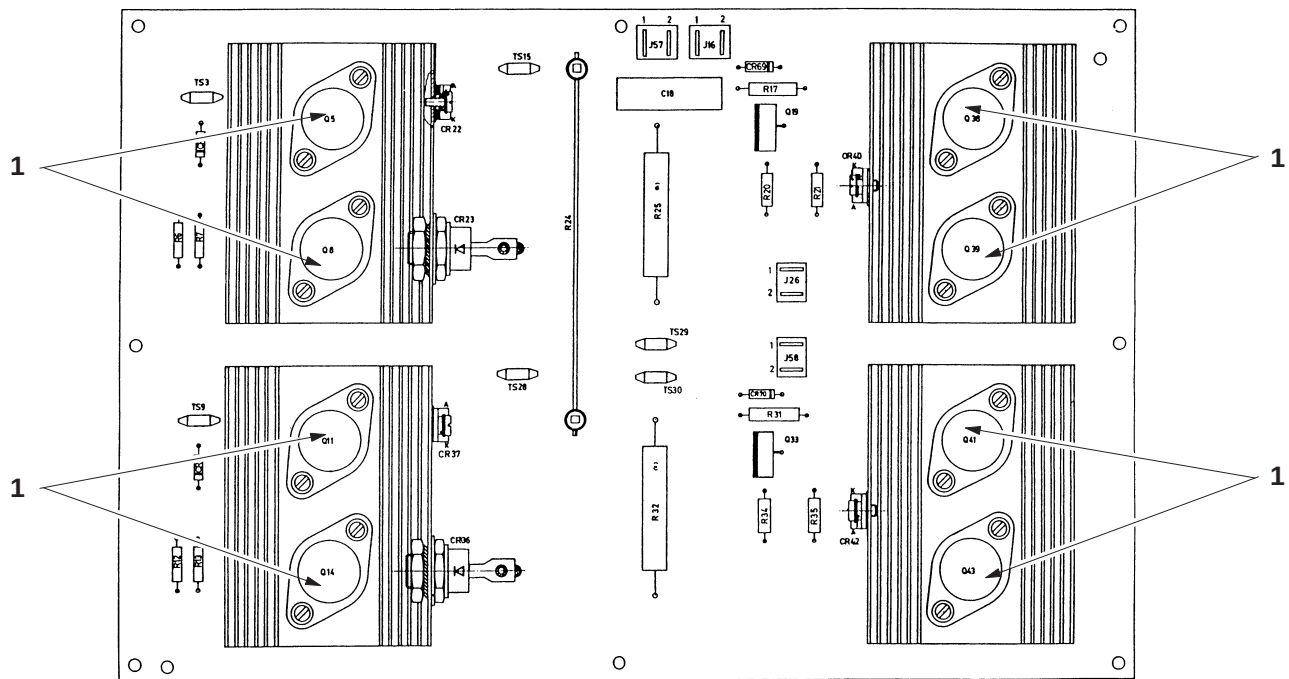
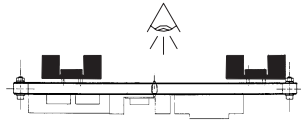
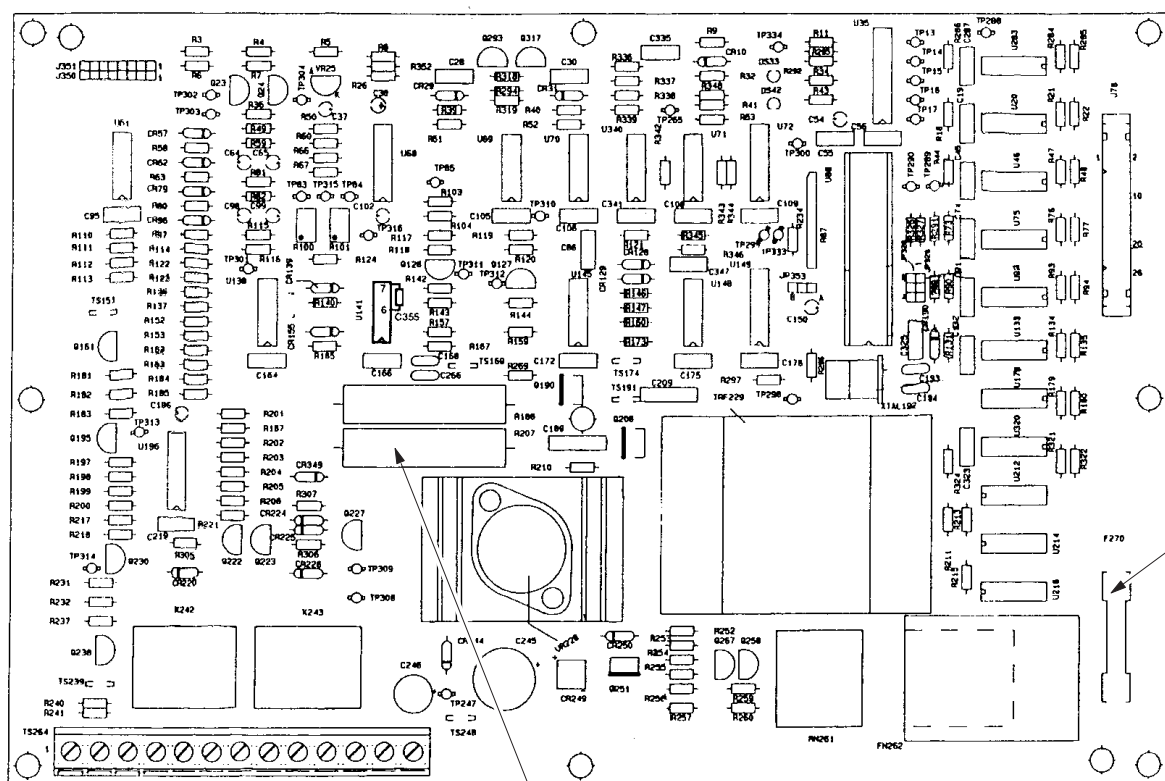


ILLUSTRATION 5-6
TIRC POWER PWB 46-903708G10

ITEM NO.	PART NO.	FRU	REP	DESCRIPTION					QTY	A P P
				1	2	3	4	5		
—	46-903708G10			TIRC POWER PWB					PL	
1	46-953693P01	1		• TRANSISTOR MJ10016					4	

ILLUSTRATION 5-7
TIRC CONTROL PWB 2121145



2

1

ILLUSTRATION 5-7

ITEM NO.	PART NO.	FRU	REP	DESCRIPTION					QTY	A P P
				1	2	3	4	5		
—		N		TIRC CONTROL PWB					PL	
1	46-953433P78	2		• RESISTOR 39K OHMS 12W 5%						
2	2119885	1		• SLOW-BLOW FUSE 0.125A 250V V100A ULL					1	

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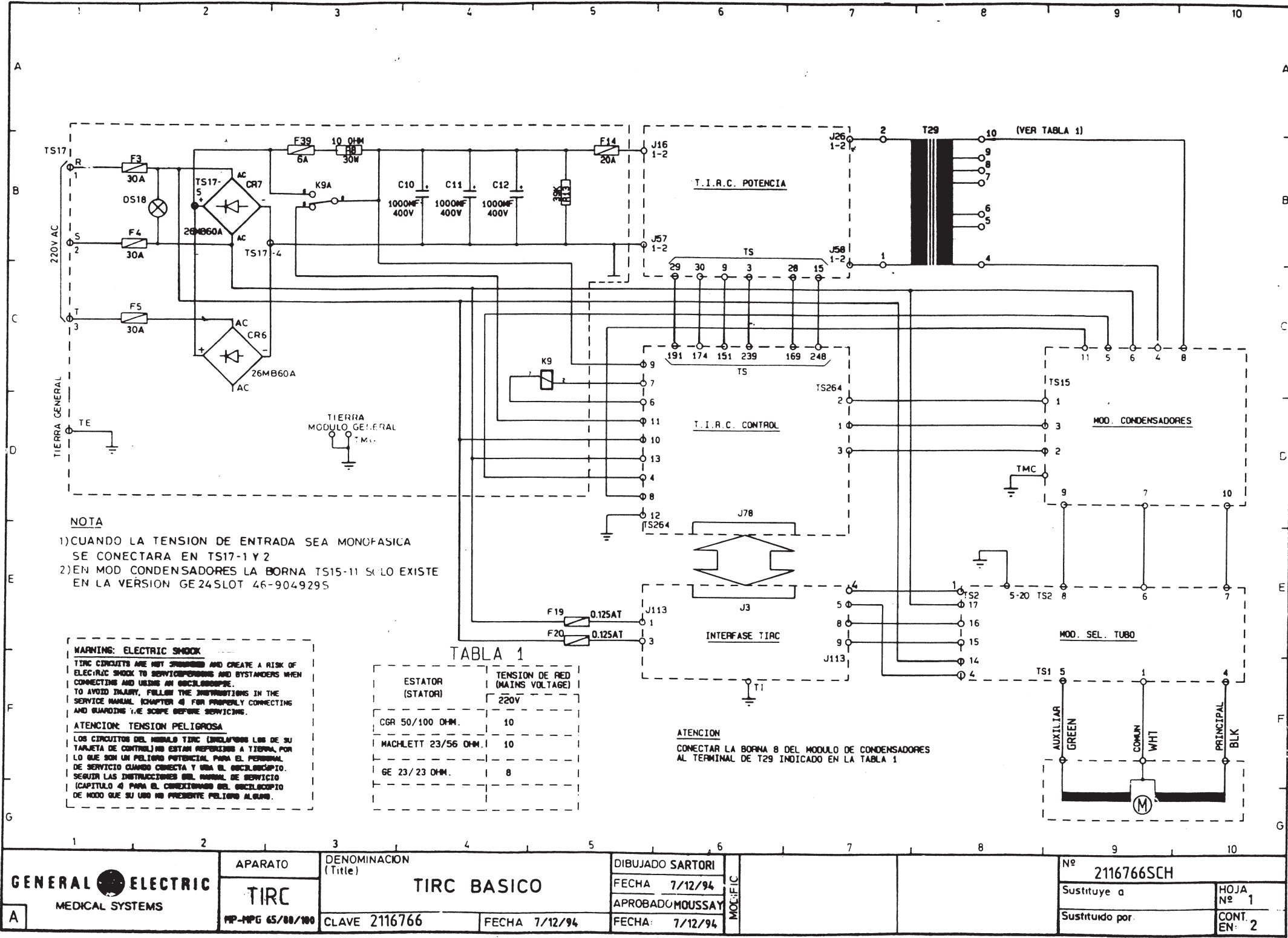
CHAPTER 6 – SCHEMATICS

TABLE OF CONTENTS

TITLE	REF.
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TIRC BASICO	2116766 SCH 2/2
TUBE INTERFACE	45434920
TIRC CONTROL (G16)	2121145 SCH 1/2
TIRC CONTROL (G16)	2121145 SCH 2/2
TIRC POWER (G10)	46–903708 SCH
TIRC–MPG/PHASIX INTERFACE	46–904926 SCH 1/2
TIRC–MPG/PHASIX INTERFACE	46–904926 SCH 2/2
3RD & 4TH TUBE OPTION MODULE	2118972 SCH
CAPACITOR MODULE (GEMS)	2121071 SCH
TIRC – R&F + VASCULAR 16 SEC. FIRMWARE (CGR TUBES)	45435165
TIRC – MPPU FIRMWARE (P01)	46–904890
PROM TIRC RF CGR	2119123 SID
PROM TIRC RF GE Tj	2126864 SID
PROM TIRC RF GE MAXIRAY 120 16 s	2128125 SID
PROM TIRC RF GE MAXIRAY 120 60 s	2127732 SID
TIRC CONTROL FOR TIRC V3 – MAXIRAY 150 V3	2148633 SCH 1/2
TIRC CONTROL FOR TIRC V3 – MAXIRAY 150 V3	2148633 SCH 2/2
CAPACITOR MODULE FOR MAXIRAY 150 V3	2148664 SCH

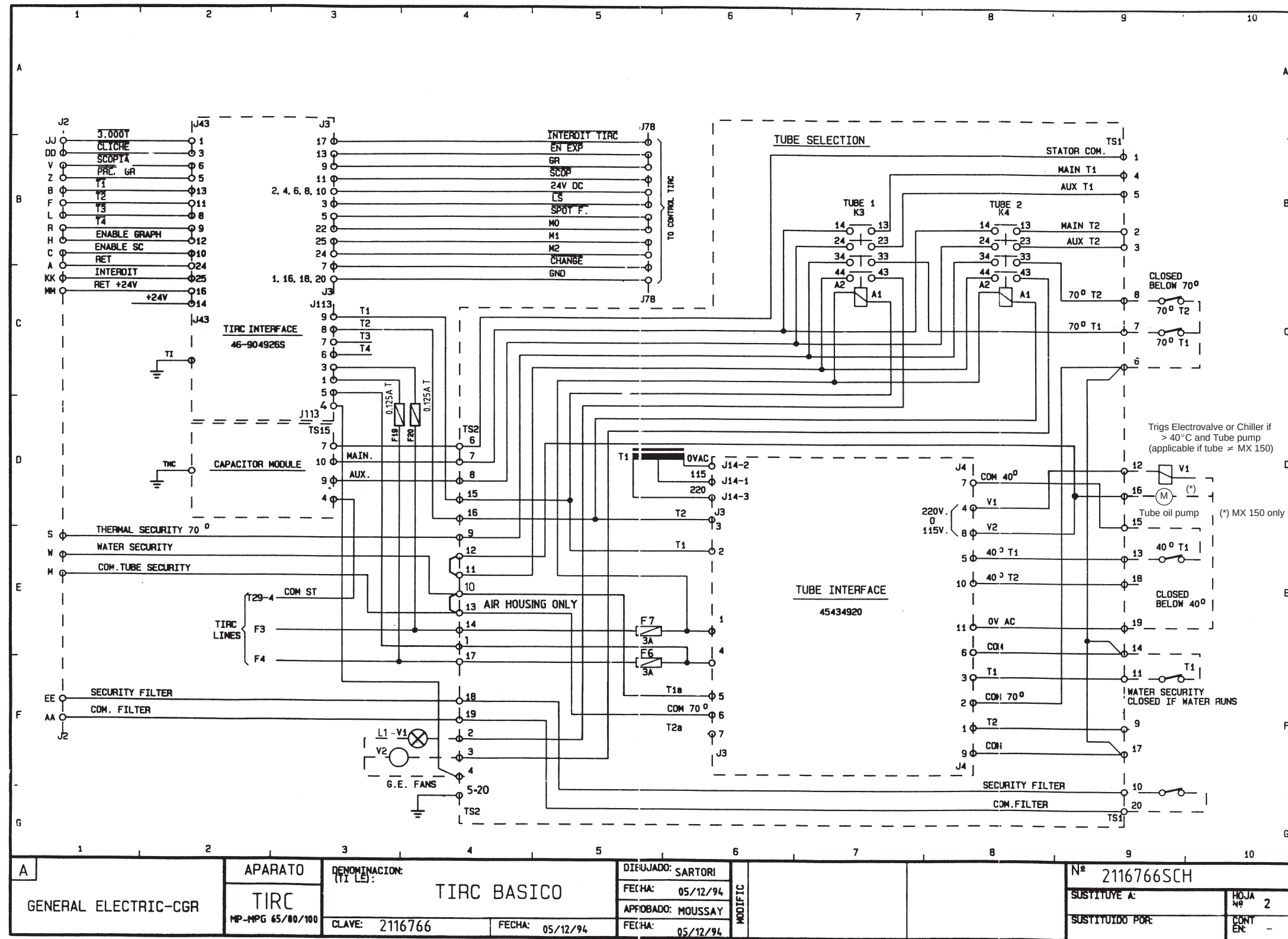
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ILLUSTRATION 4-1



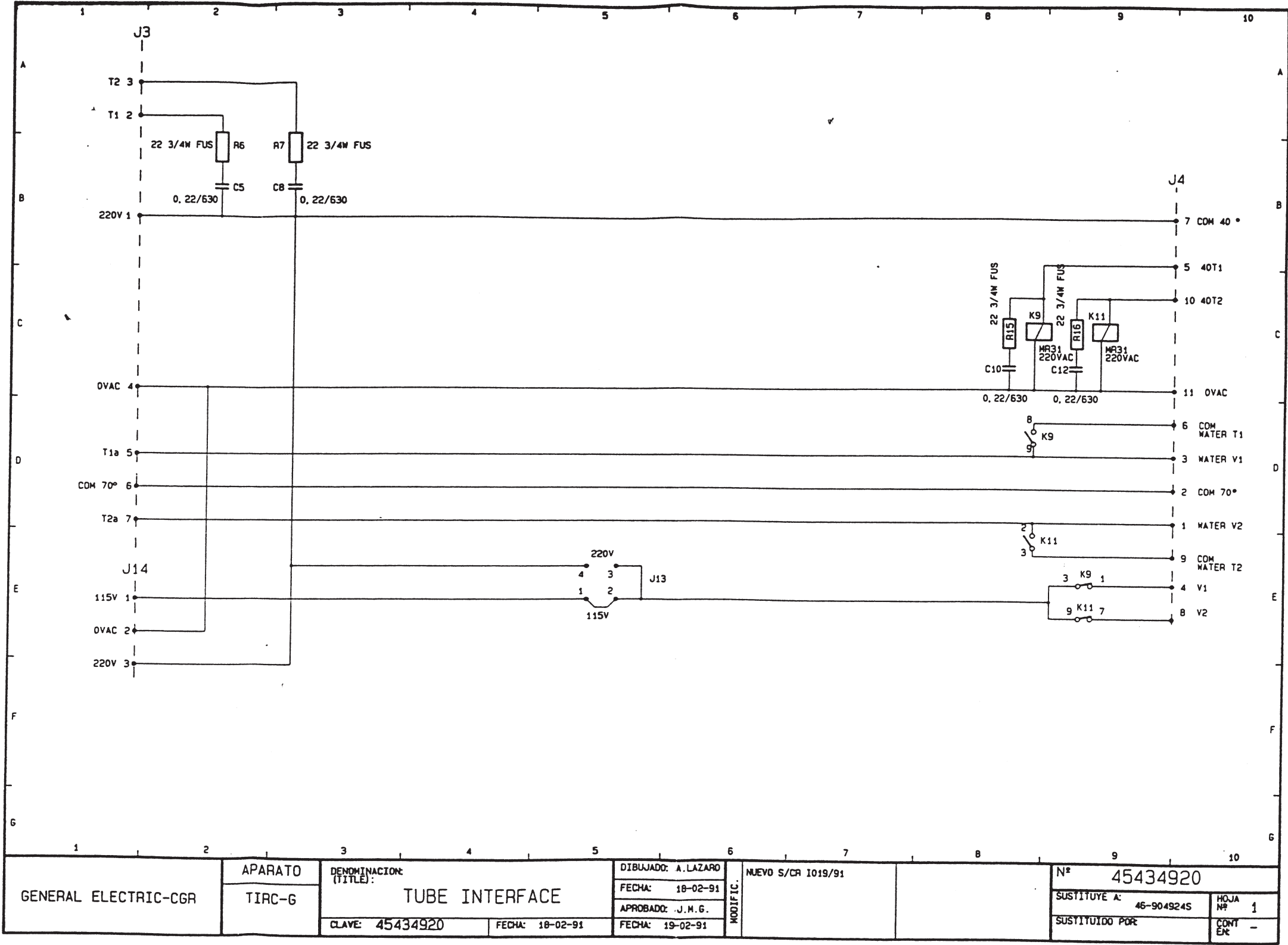
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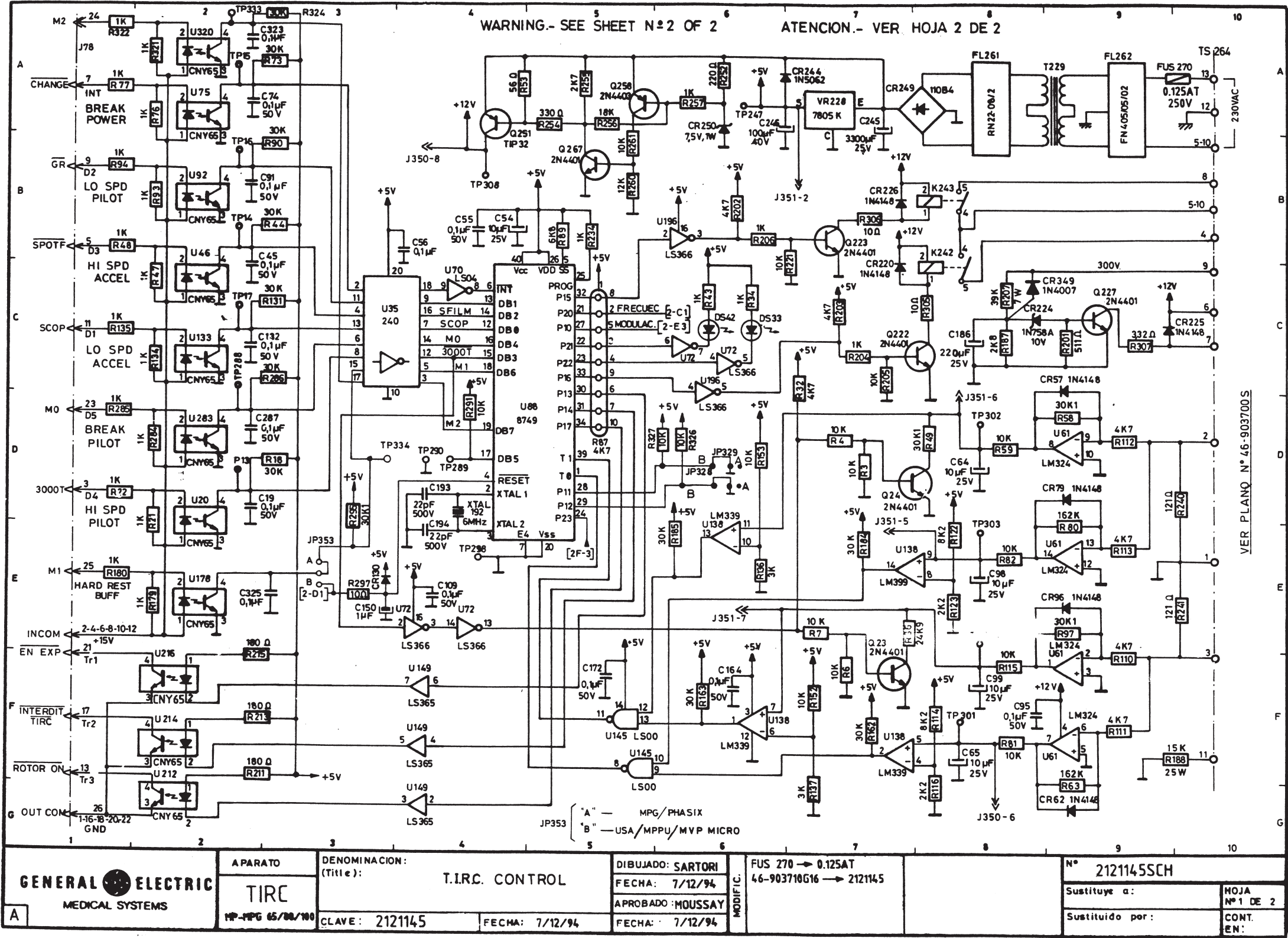
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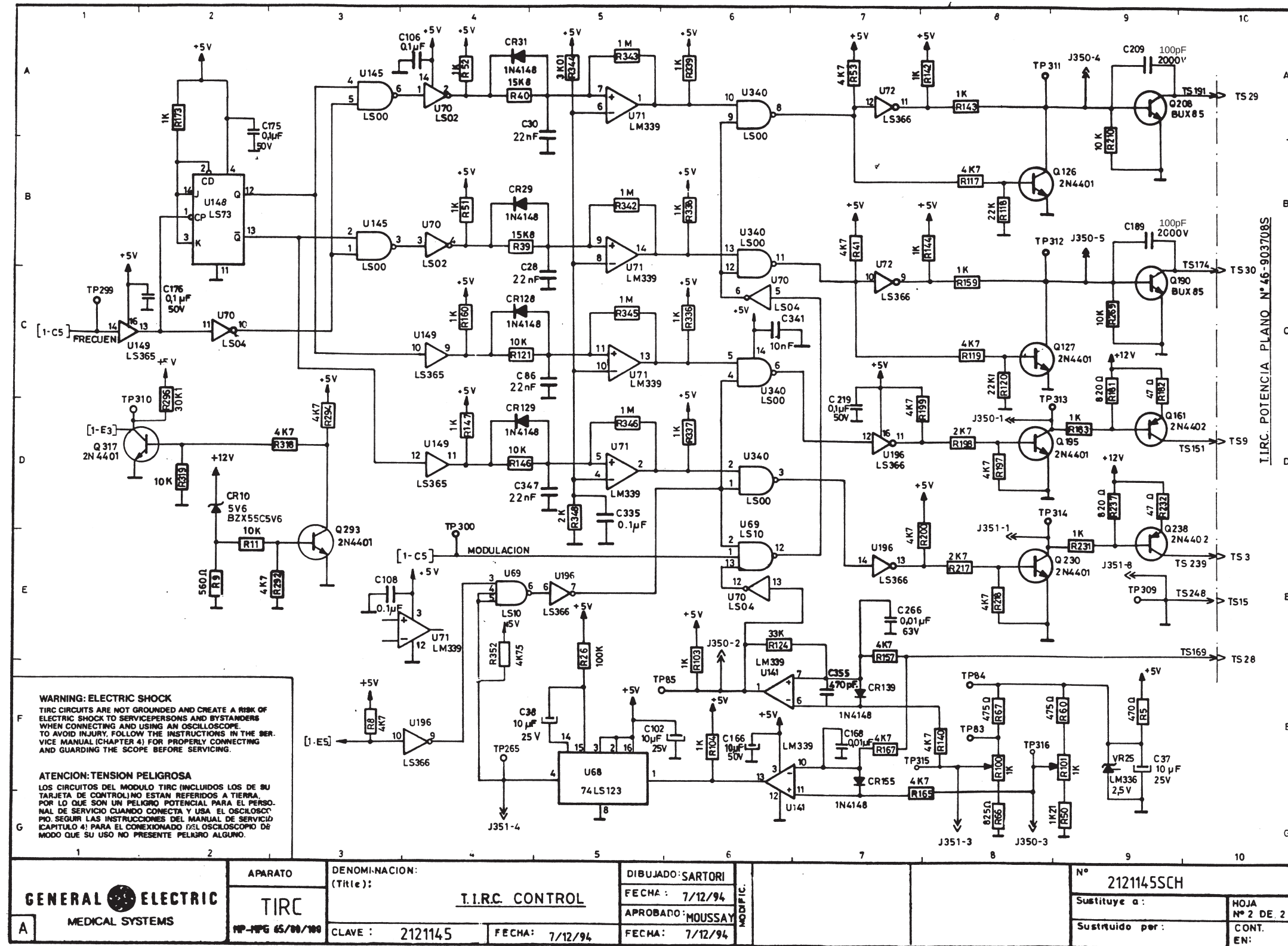
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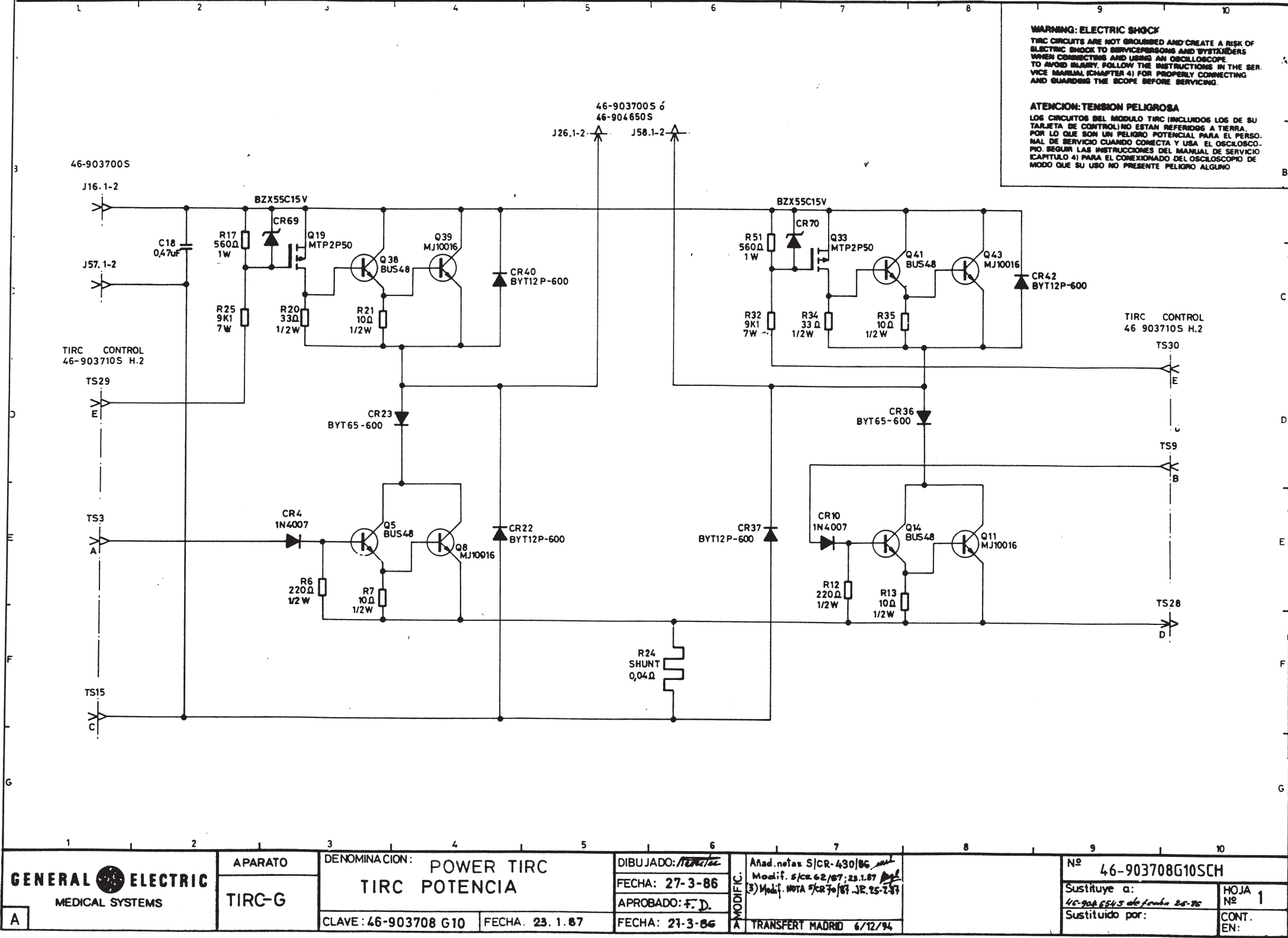
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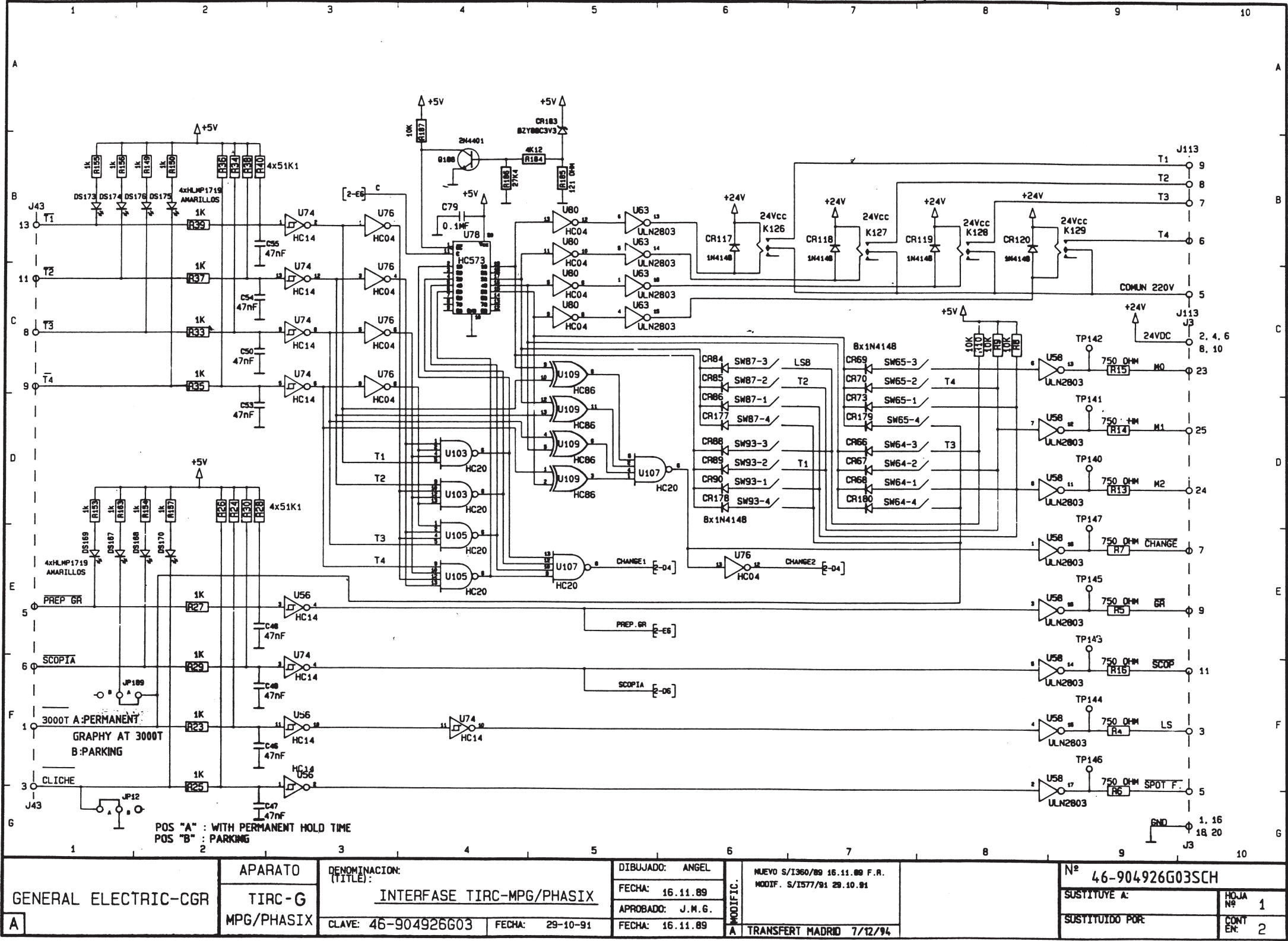
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ILLUSTRATION 4-6



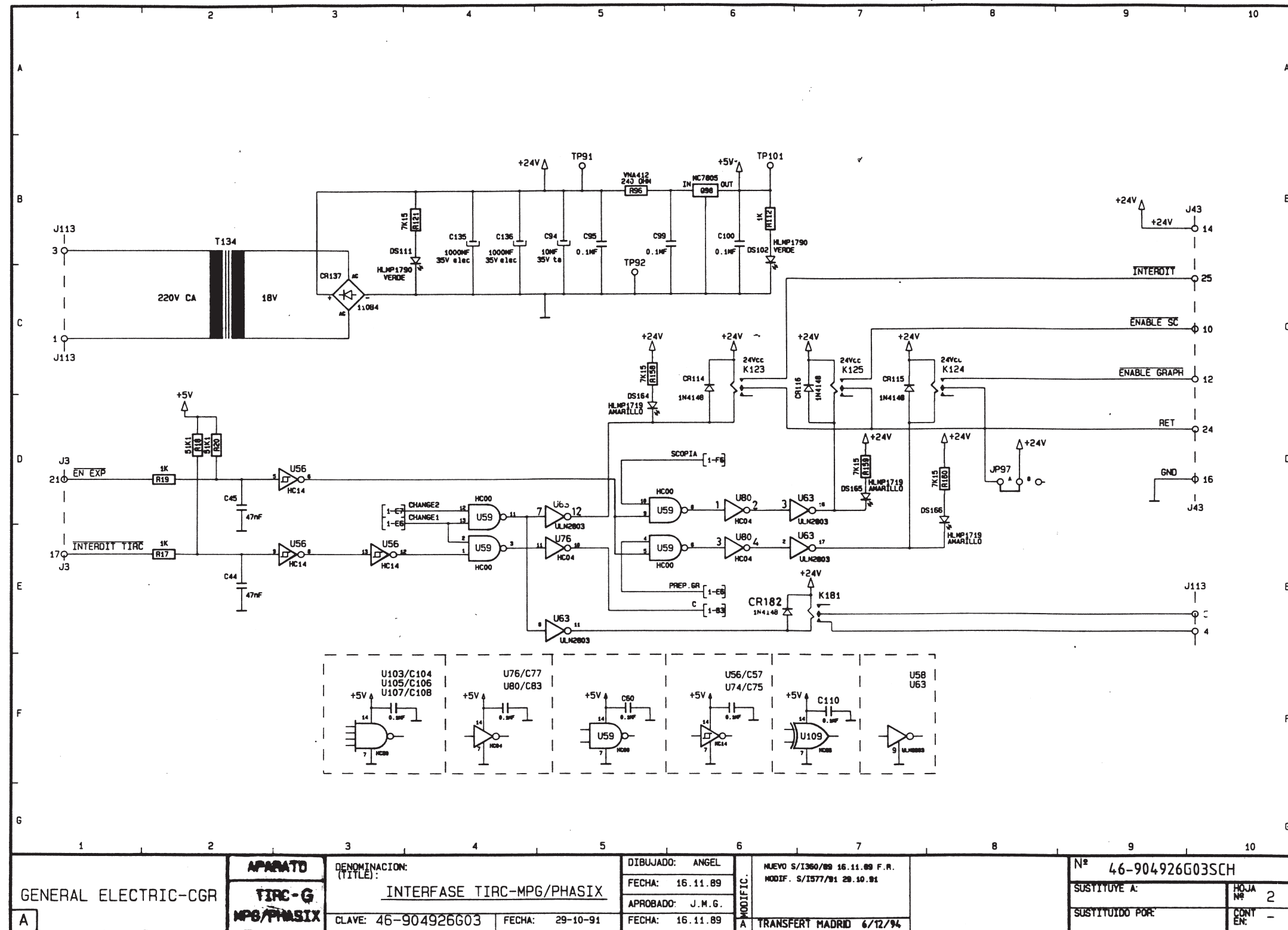
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ILLUSTRATION 4-7



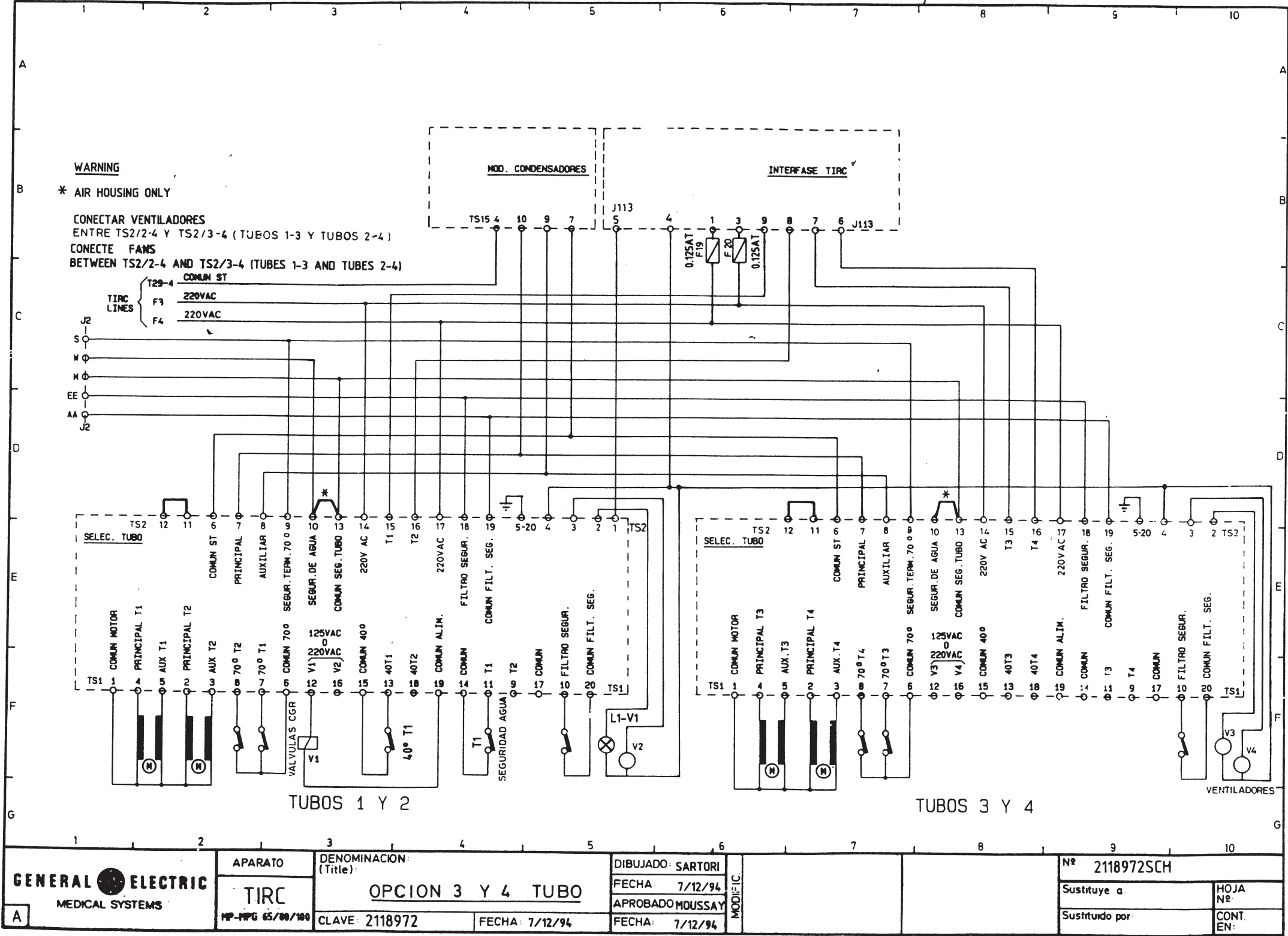
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ILLUSTRATION 4-8



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ILLUSTRATION 4-9



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SCHEMATICS



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ILLUSTRATION 4-14

DENOMINACION P.C.I.: TIRC CONTROL				46-903710GXX		
No de IDENT.	FECHA	VERSION DE SOFTWARE	Pos. en P.C.I.	OBSERVACIONES		
				OBSERVATIONS : TIRC MPG65/80/100 OU TIRC-G SEULEMENT TUBES 23/23Ω. MAINTIEN 9000 Tours 60 sec COURANTS AJUSTES SELON SPECIFICATIONS SARC TIRC RF GE TJ U88 V1.3 2126864		
NOTA: EN LAS MEMORIAS PROGRAMADAS, SE COLOCARA UNA ETIQUETA AUTOADHESIVA INDICANDO EL EQUIPO. LA P.C.I.,POSICION EN LA P.C.I.,VERSION Y CLAVE.						
DISEÑADO: SARTORI		MODIFIC.			Nº 2126864SID	
FECHA: 6/9/94					SUSTITUYE A:	HOJA Nº 1/1
APROBADO: MOUSSAY					SUSTITUIDO POR:	CONT EN:
FECHA: 6/9/94						
A			APARATO	DENOMINACION: (TITLE)		
GENERAL ELECTRIC-CGR			TIRC	TIRC RF GE TJ		
				CLAVE: 2126862	FECHA:	

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ILLUSTRATION 4-15

REV	MODIFIE PAR	VERIFIE PAR	DATE	NUMERO DE DDM	DESCRIPTION
REVISIONS					
A DENOMINATION P.C.I.: <u>TIRC CONTROL</u>					
N° DE IDENT.	FECHA	VERSION DE SOFTWARE	POS. EN P.C.I.	OBSERVACIONES	
				<u>OBSERVACIONES:</u> Tirc RF (o Tirc G) solo para tubos GE elimina permiso de exposiciones de floro a RAD. Aumenta et tiempo de 8 a 16 sgs de dropout delay en spot film. <u>OBSERVATIONS:</u> Tirc RF (ou Tirc G) seulement pour tubes GE élimine l'autorisation de pose, de fluoro à RAD. Augmente le temps de maintien de 8 à 16s en spot film. Introduit le temps d'acceleration et de freinage de la Mx120 à la place de la Mx125. TIRC RF GE Mx120 16s U88 V1.4 2128125	
NOTA: EN LAS MEMORIAS PROGRAMADAS, SE COLOCARA UNA ETIQUETA AUTOADHESIVA INDICANDO EL EQUIPO. LA P.C.I., POSICION EN LA P.C.I., VERSION Y CLAVE.					
TOLERANCES GENERALES				DISPOSITION DES VUES	
TITRE TIRC RF GE Mx120				LONGUEUR 2M : ±0,02 M/M AVEC UN MINIMUM DE ±0,01M.	
				LONGUEUR > 2M : ±0,04 M/M.	
FAIT PAR GECOM				10/03/95	
VERIFIE PAR MOUSSAY				14/03/95	
PROJET PROJET				REV A	
GE Medical Systems				2128125 SID	
BUC - FRANCE				PAGE 001/001	

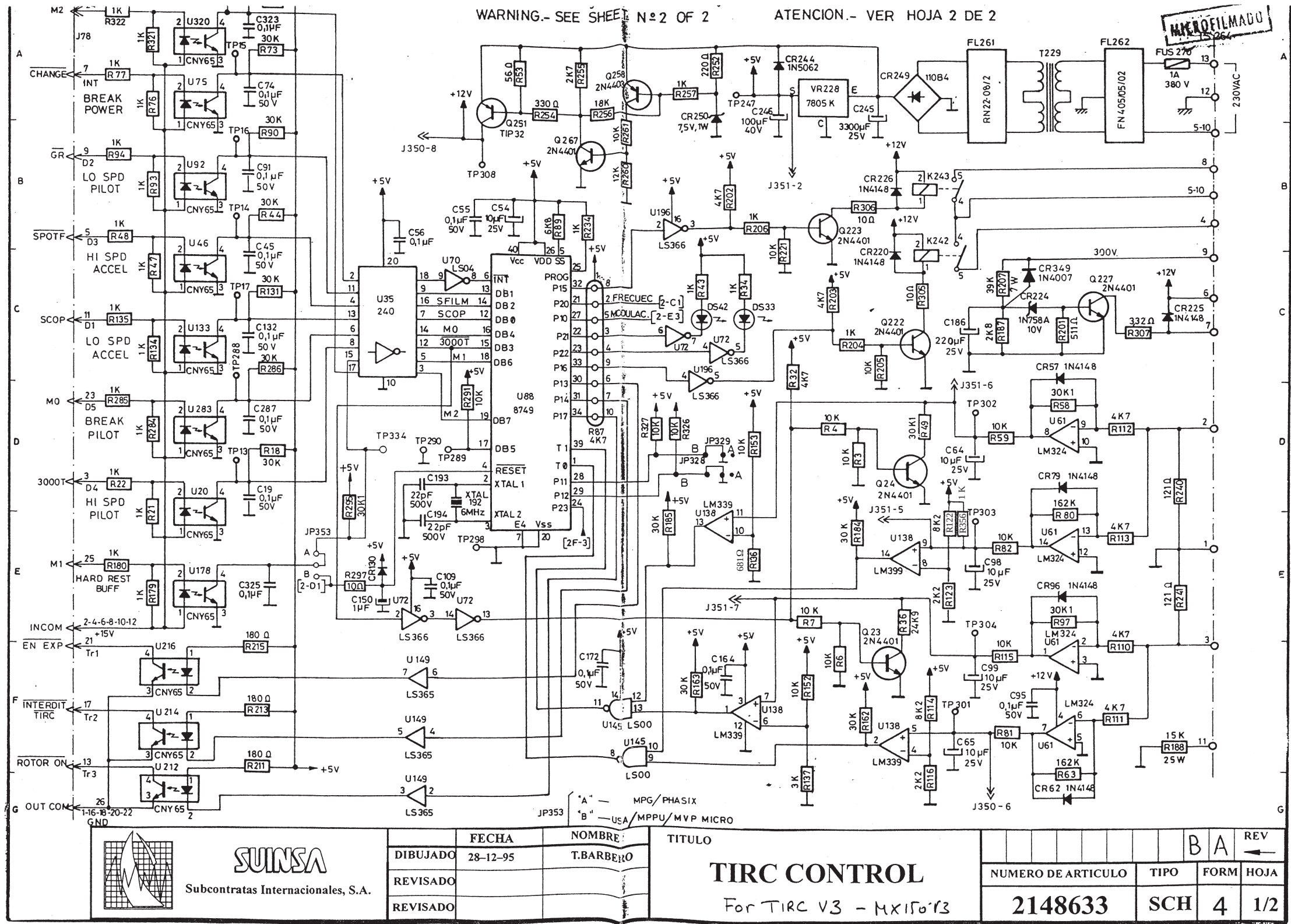
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ILLUSTRATION 4-16

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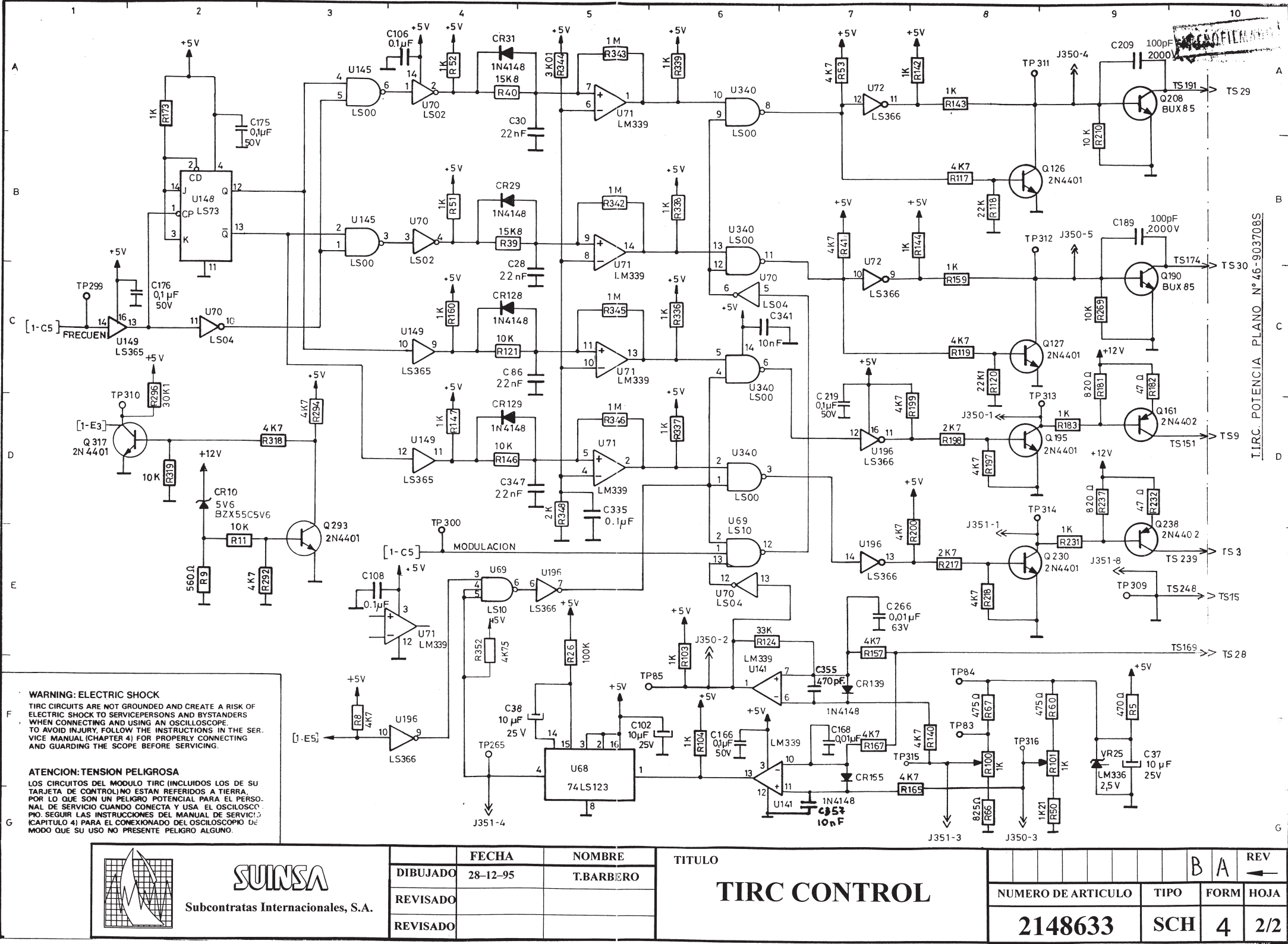
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ILLUSTRATION 4-17



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ILLUSTRATION 4-18



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ITS15

2N15KE300CP

CR12
20MBF80AS05

AC

AC

3
K13D

4
K13C

7

120F 450V
C5

43K
R6

16uF 650V
C8

43K
R7

8uF 1200V
C4

43K
R3

K2C

R4

50uF 250V
C6

K13B

R2

R1

K13A

2

1

K13F

62

61

K13E

54

53

PRIM.

PRINCIPAL

T11

1

3

2

SEC.

SEC.

T14

PRIM.

AUXILIAR

9

10

11

FRENO

ALTA VELOCIDAD

5

6

K2

A2

A1

R9
470R

C10
0.33uF
1000V

A2

K13

A1

R18
470R

C17
0.33uF
1000V

E			J		
D			I		
C			H		
B			G		
A			F		
REV	DESCRIPCION	FECHA	REV	DESCRIPCION	FECHA

MATERIAL:

PESO:

	FECHA	NOMBRE	ESCALA	TITULO
DIBUJADO	24-11-95	T.BARBERO		MODULO COND. P/ESTATOR MX150V3
REVISADO				

NUMERO DE ARTICULO	TIPO	FORM	HOJ
2148664	SCH	4	1/

SUINSA

Subcontratas Internacionales, S.A.

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